Training Manual

For

NTCIP Based TS2 Controllers

Based on the National Transportation Communications for ITS Protocol (NTCIP)

Ver. 61.x – Cubic | Trafficware 981 TS2 and 970 Controllers

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Table of Contents

1 Introduction

This manual fully describes software release version 61 for the Cubic | Trafficware TS2 / 970 controllers that comply with the NEMA NTCIP 1202 versions 1 and 2.   The foundation of this version is an NTCIP compliant database that is cross compatible between controller versions.

2 Getting Started

2.1 TS2 Operating Modes

The TS2 controller operates in two basic cabinet configurations:

- TS2 (Type-1) – controller I/O passed as data on a high speed SDLC interface
- TS2 (Type-2) – controller I/O supplied over the SDLC and as point-to-point cabinet wiring (like TS1)

The NEMA TS2 Type-1 specification is based on an SDLC serial data link which transmits I/O messages on a high speed data path between devices in the cabinet. NEMA TS2 Type-2 supports older NEMA TS1 cabinet facilities where all I/O to the controller is point-to-point wiring to a back-panel.

Type-2 controllers operate in either TS1 or TS2 Type-1 cabinets whereas Type-1 controllers operate only in Type-1 cabinets. The I/O in TS2 Type-2 controllers (ABCD connectors) is always active regardless of the state of any SDLC interface present. However, the TS2 Type-1 SDLC interface is only active if a NEMA *Bus Interface Unit (BIU)* is programmed as active.

"Hybrid" combinations are possible that allow a TS2 controller to operate in a TS1 cabinet with all cabinet I/O from the ABCD connectors (Type-2) and detector inputs provided from a Type-1 SDLC detector rack in the same cabinet. Another "Hybrid" approach supports TS1 conflict monitors or TS2 MMU (Malfunction Management Units) in TS1 or TS cabinets.

2.2 Differences Between NEMA TS2 and 2070 I/O Ports

TS2 controllers support an Ethernet interface that allows the user to assign one or more IP addresses to the controller. In addition to the Ethernet interface, NEMA TS2 I/O ports can be categorized as one of the following:

1) Asynchronous (ASYNC) – EIA RS-232 compliant devices that uses hardware and software handshaking protocols

2) Synchronous (SYNC) – SDLC compliant devices that use a "synchronous clock" line to strobe data between devices

3) FIO Ports – separate inputs and outputs for NEMA Type-2 or 2070N connectors (ABCD) or 170/179 C1 connectors

The NEMA platform provides a *Mode* setting for each hardware RS-232 *Com Port* that allows different software functions and protocols to be assigned to the port. For example, the *System-Up* port on a TS2 controller may be assigned a DEFAULT or NTCIP protocol to communicate with the central system. The *PC/Print* hardware port may be assigned to different software functions to communicate with a GPS, Opticom or MMU device.

Another concept to understand fully is the difference between "port binding" and "port mapping". ***Port Binding*** which is used with 2070 controllers associates a controller software function with a physical hardware port defined by the TS2 or TEES standard. ***Port Mapping*** allows the individual pins of a port to be re-mapped to conform to specific cabinet requirements required by the user.

NEMA defines different *Port Maps* for the ABC connectors which are hardware or software selectable. We also support *Port Maps* for the D connector as a controller software feature. Custom *Port Maps* may be provided to respond to user needs.

2.3 Database Initialization and Phase Mode Selection

The TS2 database may be initialized with one of the following factory defaults*:*

- NONE – Initializes each value in the controller database to zero
- STD-8ø – Initializes the controller database to *Standard 8 Phase* operations (dual-quad operation)
- DIAMOND – Initializes the controller database to the *Diamond Phase Mode*.
- USER-LOC – reserved for a special applications required by an agency

The ***Clear & Init All* utility (MM->8->4->1)** allows the user to initialize the controller to a default database after turning the **Run Timer to OFF (MM->1->7)**. The run timer disables all outputs from the controller and insures that the cabinet is in flash when the database is initialized. The user should use caution when initializing the controller database because all existing program data will be erased and overwritten. When the **MM->8->4->1** screen indicates that the initialization is complete, the user should turn the **Run Timer to ON (MM->1->7)** to finalize the initialization (i.e. finalizing phase sequence and concurrency based on phase mode programming, latching output mapping, binding communications, etc.) and activate the unit.

After the controller is initialized, the following *Phase Modes* selected under *Unit Parameters* (MM->1->2->1) determine the phase structure and barriers for the unit.

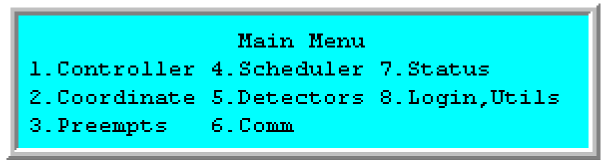
- STD8 – Standard 8 Phase
- QSeq – Quad Sequential
- 8Seq – 8 Phase Sequential
- DIAM – Diamond Phase Mode
- USER – User Programmable Mode (using 16 phases in 4 rings)

STD8 Phase Mode is the best practice for all applications unless intersection geometry and sequencing are too complex.

When considering coordination, using STD8 mode will take advantage of the most coordination diagnostic checks to catch common data entry mistakes, and if detected, times the intersection in FREE. In USER mode, most of these coordination diagnostics are removed, and the onus is on the agency verify and test the programming to ensure that coordination pattern(s) run as expected.

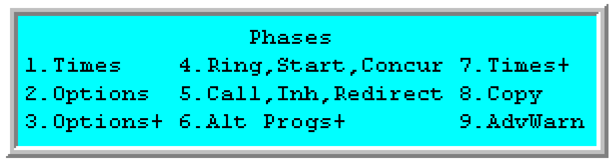
3 Interface & Navigation

3.1 Keyboard and Display



Keyboard sequences in this manual are referenced to the *Main Menu* using the "Main Disp" key on the TS2. For example, sequence MM->1->1 indicates that the "1.Controller" option is selected from the *Main Menu* shown to the right.

3.1.1 "Plus" Features



The controller database provides a one-to-one match with object definitions in the National Transportation and Communications for ITS Protocol (NTCIP) specification. NTCIP provides guidelines to extend the base NTCIP feature set using MIB extensions (Manufacturer Information Blocks). We refer to these MIB extensions as "Plus" Features which are identified on separate on menus with the "+" character. For example, the following menu groups NTCIP based phase options under menu selection 2 and "plus" phase options under menu selection 3. Menu item 6 is also an example of our MIB extensions provided as "plus" features.

3.1.2 Left and Right Menu Indicators and Cursor Movement

Four cursor keys provide navigation between user editable fields. If the user leaves a field that has been changed, then an implied **ENTR** key is issued. This feature eliminates an extra **ENTR** keystroke when a data field is changed.

Most keystroke sequences display a *Left Menu* indicated by a right arrow ("->") in the top right corner of the screen. Move the cursor beyond the left or right boundary of a *Left Menu* screen to display the *Right Menu* screen. A *Right Menu* screen will display a left arrow ("<-") in the top left corner of the screen as shown below. These menus are similar to the left and right pages of an open book. The left and right arrow keys navigate between these displays by moving the cursor past the left or right boundary of the current menu selected.

For example, the *Left Menu* used to program phases 1-8 is accessed using keyboard sequence MM->1->1->1. The *Right Menu* provides access to phases 9-16. Scroll past the left or right boundary of with the left or right arrow keys to "wrap" the cursor to the next column in the adjacent menu.

The "->" symbol indicates a "Left menu" has been selected ("<-" indicates a *Right Menu* has been selected)

The TS2 controller provides a 4-line display. Additional lines are accessed using the up and down keyboard keys to move the cursor past the top and bottom boundaries of the screen. The TS2 menu indicates that additional lines are available off screen with an arrow symbol. The cursor may also be moved one page at a time using the "Page Up" and "Page Down" keys on the TS2 keyboard.

Data that is edited is entered into the controller's RAM immediately and will be stored in the controllers EEPROM. Thus after a power down/up the edited data will saved until edited again. As an example, this includes the Run Timer (MM->1->7). If the Run Timer is in the OFF state when the controller is shut off, then the Run Timer will remain in the OFF state upon reboot until manually turned ON.

3.1.3 Audible Tones

The following three audible tones are produced to indicate the result of each keystroke. Set *Tone Disable* to ON under *Unit Parameters* (MM->1->2->1) to turn off all audible tone indications.

Key Click

If no other sounds are to be produced in response to a keystroke, the key click provides the user with audible feedback that the controller accepted the keystroke. This tone is a short clicking sound.

Acceptance Tone

Two short beeps are issued when the controller successfully executes a command. This tone is usually sounded when an entered data value has been accepted and written to EEPROM.

Error Tone

A single long tone (approximately 1/3 second) indicates that an operation is unsuccessful, when a value entered is out of range or as a warning message.

3.1.4 Entry Field Types

Toggle Fields

Toggle fields are on/off entries that are toggled with any number key on the keyboard. A toggle field is enabled (or true) if the value shown is the ‘X’ character. A toggle field is disabled (or false) if the value shown is a ‘.’ character.

Numeric Fields

Numeric data fields accept entries as whole numbers, decimal numbers, dates or time-of-day. An entry is made by pressing a numeric key corresponding to a desired digit. For multi-digit fields, the left-most or most-significant digit is entered first. As each subsequent digit is entered, the left-most digit is shifted left so that the entire number is right justified in the field. This entry/sequence is similar to the data entry used with most calculators.

Selection Fields

Selection fields are multiple choice entries toggled by any numeric keys. Examples of selection fields are day-of-week entries and flash settings.

Selection Field Groups

Selection field groups consist of two to eight fields on the same row that are updated as a group. Programming these fields can be done without moving the cursor. With the cursor on the row that you wish to edit, place it so that it rests between the first entry and the row label. Next, to cycle any entry of the group, press the numeric key that correlates with the field in the column you wish to edit.

Select/Proceed Fields

Select/proceed fields are places where the cursor stops to allow the operator to issue a command to the controller. The two main occurrences of these fields are inside menus and on warning screens. Menu screens allow the user to move the cursor to the number of the menu item, and then press **ENTR** to make the selection. The user may also press the number that correlates to the menu option of choice. Warning screens prompt the user with instructions to cancel or to proceed with the command that created the warning.

3.1.5 Function Keys

Escape Key (ESC)

The **ESC** key causes the controller to exit the active screen and display the previous screen. Each previous screen will be accessed until the main menu is reached. If **ESC** is pressed prior to saving (pressing enter) data that has been entered in an edit field, then the controller will display a warning screen allowing the user to abort the escape operation, thus giving the user an opportunity to save the data.

Enter Key (ENTR)

The **ENTR** key instructs the controller to process the current field. In the case of data entry fields, this instructs the controller to store the new value in memory. If the screen is a select field, then the controller will load the specified screen or take the desired action. In the case of proceed fields, an enter correlates to a ‘yes’.

Display Control Key (MAIN/DISP)

The display control key offers the user a quick way to move to the *Main Menu*, and turn on display backlighting. If the MAIN/DISP key is pressed in any location other than the main menu, then the controller will immediately return the user to the main menu.

Alternate Function Key (ALT FCN)

The alternate function key provides access to various features such as help and the default status screen. The **ALT FCN** key is used in combination with other keystrokes defined in the next section.

3.1.6 Alternate Functions

Alternate function key sequences require two keystrokes. The user first presses and releases the **ALT FCN** key, then immediately presses and releases the key that corresponds to the desired function.

Help Screen (ALT FCN, ALT FCN)

The help alternate function command causes the controller to load context sensitive help. When the help function is executed, the controller displays help information that corresponds to the screen or fields where the cursor is located.

Restore/Clear Field (ALT FCN, ESC)

The restore command restores the original contents of a data entry field. Once the value in a field has been changed, if the user wants to revert back to the original contents of the field prior to having pressed **ENTR**, they may select this alternate function and the original contents will be placed in the active field.

Back-Light Control (ALT FCN, MAIN/DISP)

The backlight alternate function allows the user to toggle the back lighting on/off without having to be in the main menu.

Print Active Screen (ALT FCN 0)

This alternate function will print the contents of the current screen to a serial printer. During printing, the controller keyboard is non-responsive. If you want to use the keyboard while printing is underway, you must either wait until printing is complete, or use the **ESC** key to abort printing.

Key Calls Mode (ALT FCN 1)

This mode is activated from the *Timing Status* screen (MM->7->1). Once in this mode, enter two digits for the phase number and use the Down Arrow key to apply a phase call and the Up Arrow key to remove the phase call. This mode is handy for testing purposes and any calls placed in this mode will be removed once you leave the *Phase Status* screen.

Overview Status Screen (ALT FCN 9)

```
Controller Monitor     Cabinet    System
 TIMING    | OK        | OK        | OFFLIN
 FREE      |           |           |
           |           |           |
```

The ***Controller*** section in the overview status screen reports:

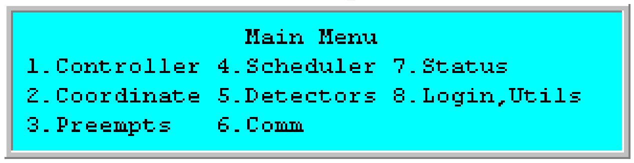
- OFF – controller *Run Timer* is OFF
- TIMING - FREE or COORD also displayed with TIMING
- FLASH-LS or FLASH-CVM - controller initiated flash through load switches (LS) or dropping CVM to the monitor The cause of flash is also displayed as STARTUP, AUTOMATIC, PREEMPT SDLC or **FAULT** If **FAULT** is displayed, the cause is also displayed as CRIT SDLC, MMU PERM or MMU FIELD
- STOP-TIME - If STOP-TIME is displayed, then INPUT or MAN-CNTRL is also displayed
- SEQ TRANS – if there is an error transitioning to a new sequence that places a phase in a different ring.
- INIT-ERR - When the controller fails to start running due to an initial ring/phase error, the following codes may be shown in the Controller column of the Overview Status Screen. These codes provide general information about the reason for the failure. Multiple, closely related types of initialization errors may share the same code.
    - INIT Err1 – Two phases in one ring are set to be active at startup
    - INIT Err2 – One phase does not have a proper initial entry
    - INIT Err3 – "Yellow Next" phase is not in ring sequence
    - INIT Err4 – Initialization phases are not compatible with "yellow next" phase
    - INIT Err5 – Compatible phases in a group do not reference each other
    - INIT Err6 – Ring sequence does not agree with ring assignment in phase programming
- PROCESSOR – is displayed if the controller has a CPU fault has multiple power failures in a 24 hour period.
- RESTART – is displayed if the controller restarts unexpectedly.
- STARTUP FLASH/ALL RED - When the controller is timing the Startup Flash an/or All-Red startup interval, the time remaining (in seconds) is displayed in the first column on the default overview status screen. This status is updated in real-time.
- T&F BIU or MMU – This is displayed for any enabled T&F BIU or MMU that does not respond upon power-up. If they do not respond, it will causes the controller to remain in flash but it does not accumulate errors on the SDLC status screen, which occurs only after a device has been successfully communicated with.
- DBASE – Occurs when the controller cannot write the Database to the hardware drive.

The ***Monitor*** status displays OK, FAULT, RESET (if monitor reset button is pressed) or NO DATA (if the controller is programmed to communicate with an MMU and the SDLC to the MMU is not active). If the *Monitor* is in a FAULT, an additional status message is displayed to show the cause of the fault (CVM/FltMon, 24V-1, CONFLICT, RED-FAIL, etc.).

The ***Cabinet*** status displays OK, FLASH or NO DATA (if the controller is programmed to communicate with a Terminal Facility BIU and the SDLC to the cabinet is not active). If the *Cabinet* is in FLASH, then the cause is also displayed as LOCAL (from a cabinet switch) or MMU.

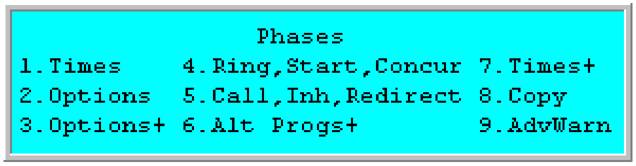
The ***System*** status displays OFFLINE if the controller is not programmed to operate in a closed-loop system. If the controller is programmed for closed-loop, the System will displays ON-LINE if the controller is communicating with a master or FALLBACK if the fallback timer has expired indicating communications is disrupted.

4 Basic Controller Operation



The *Controller Main Menu* (MM->1) accesses the basic operating features of the controller. Master programming (9.) is provided only if the TS2 version currently loaded in the controller supports it.

4.1.1 Phases Modes of Operation (MM->1->1)



A controller services competing demands for right-of-way from vehicle and pedestrian *phases*. A *phase* is composed of vehicle and pedestrian intervals assigned to each traffic movement at an intersection. We provide 16 separate vehicle/pedestrian phases that may be serviced sequentially (in a common ring) or concurrently (in separate rings). The *phase sequence* defines the order of the phases in each ring and *concurrency* defines which phases may be active in separate rings at the same time.

Vehicle detectors and pedestrian detectors (push-buttons) call phases during the red / don't walk interval to request service from the controller and *extend* the phase after a call from a competing phase is received. The controller provides a set of base phase timings (min green, walk, vehicle and pedestrian clearances) and a series of detector settings to control the extension of green when a competing call is received from another phase. The three modes of operation that extend a phase are the *Vehicle Actuated Mode, Volume Density Mode* and *Pedestrian Actuated Mode*.

Vehicle and Pedestrian Detectors Place a Service Demand on the Phase

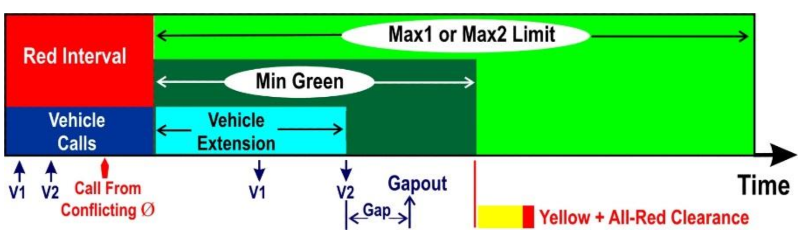
4.1.2 Vehicle Actuated Mode

The *Vehicle actuated mode* guarantees a m*inimum green* period to service vehicle calls received during the red interval. Vehicle detectors may extend the *minimum green* up to a *Max1* or *Max2* limit unless a *Gap ,extension* timer expires. Vehicle actuated mode applies a fixed *Gap, extension* timer to limit the extension of phase green.

The *Minimum Green* and *Vehicle extension* timers begin counting down at the onset of green. *Vehicle extension* allows detector actuations to extend the phase as long as the *Gap, extension* timer has not expired between actuations. The *max* timers limit vehicle extension and begin during the green interval after a conflicting vehicle or pedestrian call is received on another phase. The *max* setting (either *Max1* or *Max2)* is selectable by time-of-day.

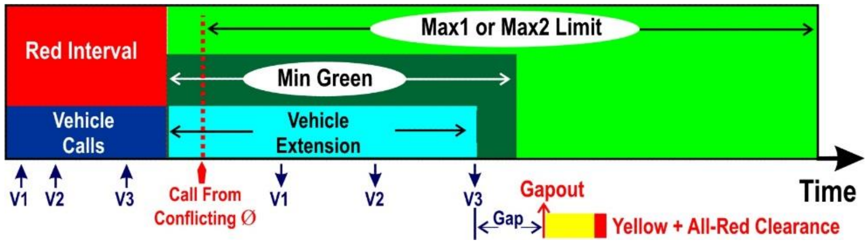
In the example below, two vehicles call the phase during the red interval from a presence detector located at the stop bar. When the phase turns green, these two vehicles leave the presence detector before the *Minimum Green* time expires and a "gap-out" occurs after the *Gap, extension* timer expires. In this case, the *minimum green* time is guaranteed even though the gap timer has expired. The phase will terminate after timing yellow and all-red clearance because a conflicting phase has requested service. During red clearance, all phases display a red indication.

A phase will dwell (or rest) in the green interval in the absence of a conflicting call unless *Red Rest* is programmed for that phase. *Red Rest* will cause the phases to remain in red until another call is received. *Red Revert* controls how quickly a phase may be reserviced once it has entered red rest and another call is received for that phase.



Minimum Green is Guaranteed When Gap-out Condition Occurs

In the example below, a third vehicle actuation extends *vehicle extension* past the end of minimum green. Vehicle detectors may continue to extend the phase green up to the *Max1* or *Max-2* limit after a conflicting phase is called. However, once a "gap-out" occurs, the phase will terminate with a yellow and all-red clearance so that a conflicting phase may be serviced during the phase red interval.



Vehicle Detectors May Extend the Green to the Max1 or Max2 limit

In summary, vehicle actuated mode arbitrates demand for service from competing phases by:

- Limiting the *minimum green* guaranteed to the phase
- Limiting the *extension of green* based on the *Gap, extension* (or gap separation) between vehicles
- Limiting the *maximum green* after a call for service is received from a competing phase

4.1.3 Volume Density Mode

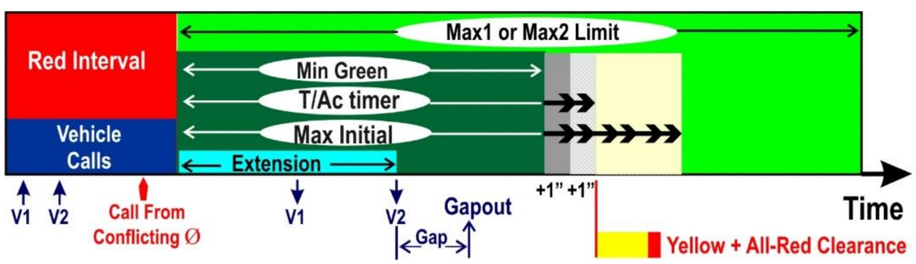
Volume Density Mode extends vehicle-actuated operation by:

- Extending *Minimum Green* based on the number of vehicle calls during the yellow and red intervals
- Reducing *Gap, extension* over a specified period to a specified minimum gap setting

The variable initial time is essentially the sum of the *Minimum Green* and the accumulated *Added Initial* time. The *Added Initial* parameter specifies the number of seconds accumulated per actuation during the yellow and red interval of the phase. Variable initial time may not be increased beyond the limits of the *Max Initial* parameter. The accumulated *Added Initial* time is reset after the phase green has been serviced. If the *Added Initial* time is calculated to be less that the Minimum green, *Minimum Green* time is guaranteed.

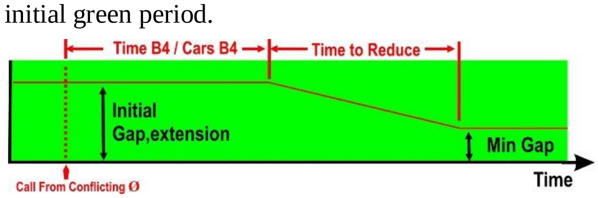
In the example below, *Added Initial* is set to 1" and "times per actuation" (*T/Ac*) is set initially to the *Minimum Green*. *T/Ac* is extended by 2 vehicle calls each adding 1" of *Added Initial* to the *T/Ac* timer. During *Min Green*, the *Gap, extension* timer "gaps-out" sending the phase to *Yellow + All-Red Clearance* after the *T/Ac* timer expires.

The *T/Ac* timer guarantees the *Min Green* plus *Added Initial* (2" in this example). Additional calls received during the *Yellow* and *Red* interval may increase the *T/Ac* timer up to the *Max Initial* setting.



Added Initial Features Provided by Volume Density Operation

Gap reduction may be delayed using *Time Before Reduction* (TBR) or *Cars Before Reduction* (CBR). TBR delay begins after the start of green when a conflicting phase is received and continues to countdown as long as there is a serviceable conflicting call. TBR is reset if the conflicting call goes away. The *Cars Before Reduction* (CBR) delay expires when the sum of the vehicles counted on the associated phase detector is greater than the CBR value specified. Both approaches delay the reduction of the gap while the initial queue dissipates during the initial green period.



After the TBR or CBR delay expires, the initial *Gap, extension* will be reduced to the *Min Gap* value over the *Time to Reduce* (TTR) period. The *Min Gap* value limits the reduction of the *Gap, extension* time as illustrated to the right. If all serviceable conflicting calls are removed, *Gap, extension* , TBR and TTR will reset and gap reduction will not take place until the next serviceable conflicting call is received. The *Min Gap* value is the limiting headway (of separation between vehicles) needed to extend the green interval to the *Max1* or *Max2* setting.

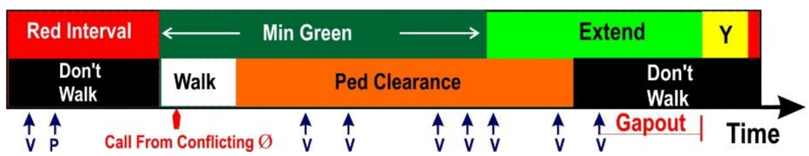
4.1.4 Pedestrian Actuated Mode

Pedestrian displays always time concurrently with the vehicle displays of a phase. During free operation, if a pedestrian call is being serviced and no vehicle calls are present to extend the phase, the pedestrian clearance interval will end at the onset of yellow as shown below. The “Don’t Walk” indication flashes during the *pedestrian clearance* interval and changes to a steady “Don’t Walk” indication at the end of *ped clearance*. If the associated phase is resting in green, a subsequent pedestrian call will reinitiate (or recycle) pedestrian sequence if there is not a call (or check) on a conflicting phase. The phase cannot enter its yellow clearance until the pedestrian clearance ceases, unless *PedClr-Through-Yellow* is enabled as a *Phase Option*. *PedClr-Through-Yellow* allows flashing “Don’t Walk” to time concurrently with yellow clearance.

Ped Clearances Ends Prior to Vehicle Clearance if *PedClr-Thru-Yellow* is Not Enabled

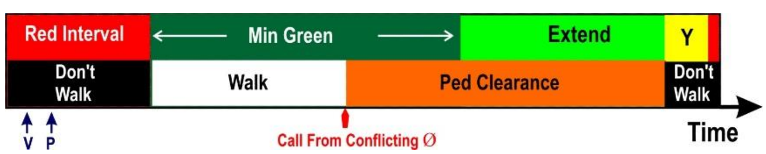
Ped Clearances Times With Vehicle Clearance if *PedClr-Thru-Yellow* is Enabled

Enabling *PedClr-Thru-Yellow* reduces the total time provided to the pedestrian by the yellow clearance time if the walk time and ped clearance time remain constant. Therefore, if *PedClr-Thru-Yellow* is enabled, do not add the yellow clearance interval to ped clearance when calculating the ped crossing time. Vehicle detection may extend the green beyond the end of the pedestrian clearance interval as shown below and is by *Max-1* or *Max-2* after a call is received from a competing phase.



In Free Operation, Vehicle Calls May Extend the Green Beyond Ped Clearance

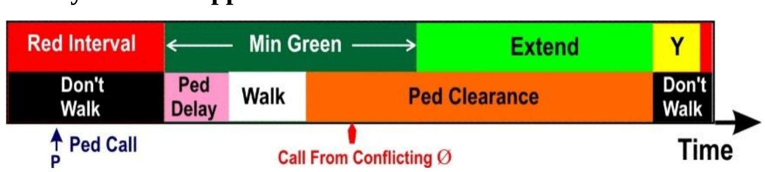
If *Rest-in-Walk* is enabled for the phase, the controller will rest in the walk interval in free operation until a conflicting call is received. During coordination, this feature insures that the end of ped clearance occurs at the force-off point of the phase.



In Free Operation, Rest-In-Walk Extends Walk Until a Conflicting Phase is Received

[*Grn/Ped Delay*]() allows the beginning of the green interval or the beginning of the walk to be delayed by a programmed amount as illustrated below: This feature is fully discussed under *Phase+ Options*.

Green Delay Used to Suppress the Start of Green When a Ped Call is Serviced



Ped Delay Used to Suppress the Start of Walk When a Ped Call is Serviced

4.1.5 Phase Times (MM->1->1->1)

```
Times    P.1...2...3...4...5...6...7..8>
Min Grn    0 255   5   5   5   5   5   5
Gap,Ext  0.025.5 1.0 1.0 1.0 1.0 1.0 1.0
Max 1      0 255  25  25  25  25  25  25
Max 2      0 255  50  50  50  50  50  50
Yel Clr  3.025.5 3.5 3.5 3.5 3.5 3.5 3.5
Red Clr  0.025.5 1.5 1.5 1.5 1.5 1.5 1.5
Walk    +  0 255   0   5   0   5   0   5
```

Minimum Green

The *Minimum Green* parameter (0-255 sec) determines the minimum duration of the green interval for each phase. When setting this time, consider the storage of vehicles between the detector and the stop-bar for the associated approach.

Gap, Extension

Gap, extension (also known as *Passage* time) determines the extensible portion of the green interval (0-25.5 sec). The phase remains in the extensible portion as long as an actuation is present and the passage timer has not expired. The timer is reset with each subsequent actuation and does not start timing again until the actuation is removed.

Max-1 Green

Max-1 (0-255 sec) limits the maximum time of the green interval after a serviceable conflicting call is received. The maximum green timer does not begin timing until a serviceable conflicting call is received. *Max-1* is set as the default max setting but may be overridden *Max-2*.

Max-2 Green

Max-2 (0-255 sec) also limits the maximum time of the green interval after receiving a serviceable conflicting call. *Max-2* may be selected by ring from an external controller input or as a pattern option. *Max-2* may also be selected by-phase under *Phase Options+* (next section). This last method allows *Max-1* to be enabled for some phases and *Max-2* for others.

Yellow Clearance

The *Yellow Clearance* parameter (0-25.5 sec) determines the yellow clearance interval of the associated phase.

Red Clearance

The *Red Clearance* parameter (0-25.5 sec) determines the all-red clearance interval of the associated phase.

Walk

The Walk time parameter provides the length of the walk indication (0-255 sec).

```
Times    P.1...2...3...4...5...6...7..8>
Ped Clr -  0 255   0  10   0  10   0  10
Red Revt 0.025.5 0.0 0.0 0.0 0.0 0.0 0.0
Add Init 0.025.5 0.0 0.0 0.0 0.0 0.0 0.0
Max Init   0 255   0   0   0   0   0   0
Gap Reduce
 Time B4   0 255   0   0   0   0   0   0
 Cars B4+  0 255   0   0   0   0   0   0
```

Pedestrian Clearance

Pedestrian Clearance (0-255 sec) is the duration of the flashing pedestrian clearance ("Don't Walk") output.

Red Revert Time

The *Red-Revert* Time parameter determines the minimum time (0-25.5 sec) that the phase must remain in red rest before it is recycled to green. The controller uses the greater of the phase *Red-Revert Time* or the *Unit Parameter, Red-Revert,* to limit how quickly each phase green is recycled.

Added Initial

Added-Initial (0-25.5 sec) is an optional volume-density feature that beyond extends the *Minimum Green* timer. *The T/Ac* (time per actuation) timer is set initially to *Min Green*. Each detector actuation during the yellow and red interval extends the *T/Ac* timer by the *Added Initial* value if the detector option *Added-Initial* is enabled. Detector actuations received during the red interval continue to extend *T/Ac* by the *Added Initial* value until the *Max Initial* limit is reached. In this way, the *T/Ac* timer behaves as a parallel timer with *Min-Green*. The greater of *Min-Green* or *T/Ac* defines the minimum green time period.

Maximum Initial

Maximum-Initial (0-255 sec) is an optional volume density feature that limits the extension of *Min Green* using *Added Initial*. The minimum or guaranteed green period cannot be greater than the *Max Initial* value specified. Note, that added-initial operation is defeated if one of the three following conditions is satisfied. If any of these conditions are true, then *Min Green* guarantees the initial green of the phase.

- *Max Initial* is equal to of less than the *Min Green* value assigned to the phase.
- The *Added Initial* value assigned to the phase is zero.
- The *Added.Initial* detector option is not enabled for the detectors calling the phase.

Time Before Reduction (Time B4)

Times	P.1	2	3	4	5	6	7	8>
Time B4-	0	255	0	0	0	0	0	0
Cars B4	0	255	0	0	0	0	0	0
Time To	0	255	0	0	0	0	0	0
ReducBy	0.0	25.5	0.0	0.0	0.0	0.0	0.0	0.0
Min Gap	0.0	25.5	0.0	0.0	0.0	0.0	0.0	0.0
DyMaxLim	0	255	0	0	0	0	0	0
Max Step	0	255	0	0	0	0	0	0

Time-Before-Reduction (0-255 sec) delays gap reduction after receiving a conflicting call. After *Time-B4* expires, the unit begins reducing *Gap, extension* over the specified *Time-to-Reduce (TTR)* period. Gap reduction is an optional volume density feature that is limited by the *Min Gap* value specified for the phase.

Cars Before Reduction (Cars B4)

Cars-Before-Reduction (0-255 vehicles) is an alternate method to delay gap reduction after a serviceable conflicting call. This feature applies the total number of detector actuations received during the yellow and all-red intervals to calculate the delay. Gap reduction begins when the total detector actuations exceeds the *Cars-B4* value or after the *Time-B4* timer expires (whichever comes first). After the *Cars-B4* or *Time-B4* delay, passage time is reduced to the *Min Gap* in a linear fashion during the *Time-to-Reduce (TTR)* period.

Cars-Before-Reduction does not replace *Time-Before-Reduction* and both are active at the same time. Therefore, set *Time-Before-Reduction* greater than *Max-1* to force the controller to use *Cars-Before-Reduction*. The detector option, *Added.Initial* must also be enabled for calling detector to enable *Cars-Before-Reduction*.

Time To Reduce (TTR)

Time-to-Reduce (0-255 sec) is an optional volume-density parameter used reduce *Gap, extension* to the *Min Gap*. The linear rate of change applied to gap reduction is the difference between *Gap, extension* and *Min Gap* divided by *TTR*. For example, assume that *Gap, extension* is initially set to 4.5 seconds, *Min Gap* is set to 3.2 seconds and *Time-to-Reduce (TTR)* is set to 40". The gap reduction rate over the TTR period is (4.5" – 3.2") / 40" or 0.033" of gap reduction per second. Therefore, the first reduced passage time is 4.5" – (4.5" * 0.03") = 4.4". The second passage time is 4.4" – (4.4" * 0.03") = 4.3". Gap reduction continues in a linear fashion over the *Time-to-Reduce* period to reduce passage to the *Min Gap.*

Reduce By

The *Reduce-By* parameter (0-25.5 sec) provides an NTCIP alternative to linear gap reduction. *Time-To-Reduce* specifies the period over which the *Gap, extension* time is reduced. However, instead of reducing *Gap, extension* in a linear fashion , the extension time is reduced by the *Reduce By* time equally over the *TTR* period.

Minimum Gap Time

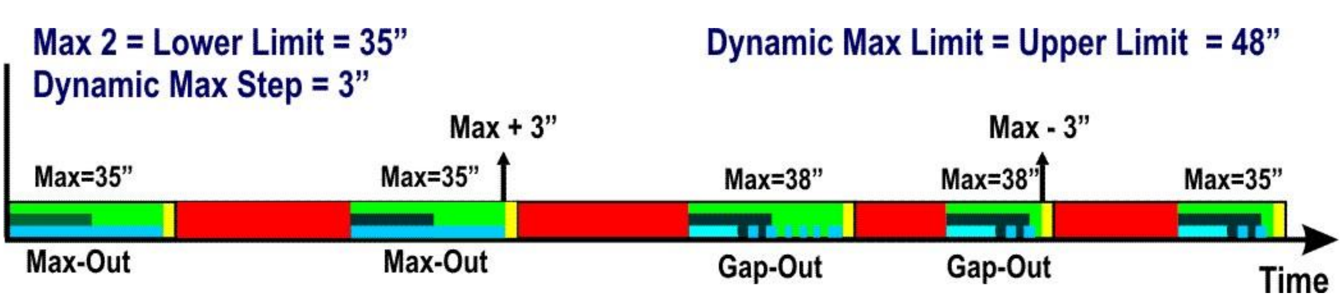
The *Minimum-Gap Time* specifies the lowest allowable time (0-25.5 sec) to which the gap time can be reduced.

Dynamic Max Limit

Dynamic-Max-Limit and active maximum (MAX1, MAX2) determine the upper and lower limit during dynamic max operation. If the *dynamic max limit* is greater than the active Max-1 or Max-2, then it becomes an upper limit. If the *dynamic max limit* is less than the active Max-1 or Max-2, then it becomes a lower limit. Maximum recall or a failed detector that is assigned to the associated phase disables dynamic max operation for the phase.

Dynamic Max Step

Dynamic-Max-Step (0-25.5 sec) determines the stepwise adjustment to the max time. When a phase maxes out twice in a row one dynamic step value is added to the running max time and to each successive max out afterwards. After two gap outs in a row, each subsequent successive gap out reduces the running max by one *dynamic step.*



4.1.6 Phase Options (MM->1->1->2)

Enable Phase

Enable is the most important phase option because unless a phase is e*nabled* it can never be serviced. When a controller is initialized, phases 1-8 are *enabled* and phases 9-16 are *not enabled* by default.

```
Options          P..1..2..3..4..5..6..7..8>
        Enable P  X  X  .  X  .  X  .  X
      Min Recall  .  X  .  .  .  X  .  .
      Max Recall  .  .  .  .  .  .  .  .
      Ped Recall  .  .  .  .  .  .  .  .
     Soft Recall  .  .  .  .  .  .  .  .
      Lock Calls  .  .  .  .  .  .  .  .
Auto Flash Entry  .  .  .  .  .  .  .  .
Auto Flash Exit   .  .  .  .  .  .  .  .
      Dual Entry  .  X  .  X  .  X  .  X
Enable Simul Gap  X  X  X  X  X  X  X  X
Guarantd Passage  .  .  .  .  .  .  .  .
     Rest In Walk .  .  .  .  .  .  .  .
```

Minimum Vehicle Recall

Minimum-Recall places a call on the associated phase when the phase is not timing the green interval. *Minimum Recall* only "calls" the phase and does not "extend" the phase during the *Minimum Green* interval. **NOTE: Programming any Coordination Split Mode (MM->2->7->1) other than NON, will override this selection.**

Maximum Vehicle Recall

Maximum-Recall places a call on the associated phase while the phase is timing the red and yellow intervals, and extends the associated phase to the *Maximum Green* time. **NOTE: Programming any Coordination Split Mode (MM->2->7->1) other than NON, will override this selection.**

Pedestrian Recall

When enabled, *Pedestrian-Recall* causes a recurring call similar to an external call. However, it will not recycle pedestrian service until a conflicting phase has been served. **NOTE: Programming any Coordination Split Mode (MM->2->7->1) other than NON, will override this selection.**

Soft Vehicle Recall

Soft-Vehicle-Recall generates a call on the associated phase when all conflicting phases are in Green Dwell or Red Dwell, and there is no serviceable conflicting call. **NOTE: Programming any Coordination Split Mode (MM->2->7->1) other than NON, will override this selection.**

Lock Calls

When *Lock-Calls* (also known as "memory on") is enabled, any call during the yellow or red interval places a constant call for service on the phase and sets the NEMA "check" output for that phase. *Lock-Calls* insures that the call remains in effect until the phase is serviced, even if the detector call is removed. If *Lock-Calls* is not enabled, the *Yellow.Lock* and *Red.Lock* detector options (MM->5->2, right menu) determine the locking options for each detector calling the phase.

Detector placement usually determines whether the phase is locked or not locked. Phases called by stop-bar detectors are typically not locked to allow permitted left-turn and right-turn-on-red movements to remove the call on the phase. Phases called by approach detectors set back more than one car length from the stop-bar are generally locked.

Automatic Flash Entry Phase

When *Automatic-Flash* is activated, the controller continues to service the phases in the current sequence. After the programmed *Automatic-Flash Entry Phases* are serviced, the controller will clear to all-red, then proceed to the programmed flashing operation until the *Automatic-Flash* input is deactivated.

Automatic Flash Exit Phase

After the *Automatic-Flash* input is deactivated, the controller will exit programmed flash and proceed to the beginning of the *Automatic-Flash Exit Phases.*

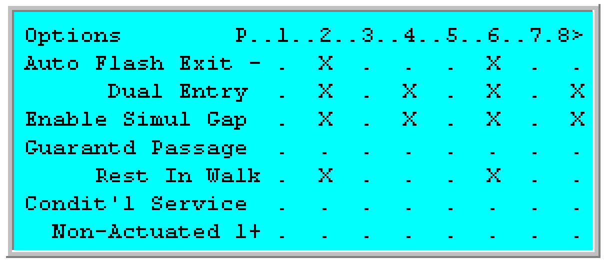
Dual Entry

Dual-Entry phases are called into service when a concurrent phase in another ring is serviced. This insures that a phase in each ring is always being serviced even when there is only a demand for service in one ring. The through phases are usually programmed for *Dual-Entry* to allow the ring without the call to rest in the through movement.

Enable Simultaneous Gap

Enable-Simultaneous-Gap allows the *Gap, extension* timer to reset if the phase(s) in the other ring(s) have not gapped out. When *Enable-Simultaneous-Gap* is not set and the phase is at a barrier, it will remain gapped out and be ready to cross the barrier when the phases in the other ring(s) gap out. *Enable-Simultaneous-Gap* is typically set for the "main street" phases to allow *Gap, extension* to reset in free operation.

Guaranteed Passage



Guaranteed-Passage-Time is an optional volume-density feature used with gap reduction. Enabling *Guaranteed- Passage-Time* insures that one full *Gap, extension* time is provided to the last vehicle after a gap-out condition. This insures that the actuated phase retains the right-of-way for a period equal to the difference between the *Gap, extension* time and the reduced gap before the green interval terminates.

Rest In Walk

In free operation, *Rest-In-Walk* causes a phase to rest in walk until there is a serviceable conflicting call. *Rest-In-Walk* may be used under coordination to time the end of ped clearance at the beginning of yellow clearance. The walk should always be recycled when using *Rest-In-Walk* in coordination (see chapter 6).

Conditional Service

Conditional Service causes a gapped/maxed phase to conditionally service a preceding actuated phase in the same ring if sufficient time remains in the phase prior to being maxed out. To set this, program the phase that gaps or maxes out, not the preceding phase. For example, phases 2 and 6 are straight through phases and phases 1and 5 are leading left turns. If you desire to serve phases 1 and 5 again, program phases 2 and 6 as conditional service phases.

Non-Actuated 1 and Non-Actuated 2

Non-Actuated 1 allows a phase to respond to external hardware input CNA1 (call to non-actuated, ring 1). *Non-Actuated 2* allows a phase to respond to external hardware input CNA1 (call to non-actuated, ring 1).

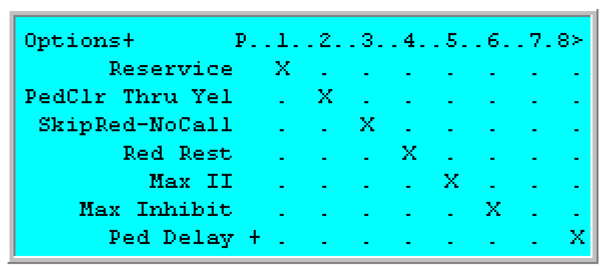
Added Initial Calculation

The *Added-Initial-Calculation* controls added initial is applied under volume-density operation and may be set to:

- 'S' - Sum of the added initial from all of the detectors calling the phase during the yellow and red interval
- "L" - use the Largest value from the group of added initial detectors calling the phase

4.1.7 Phase Options+ (MM->1->1->3)

Reservice



Reservice works in conjunction with *Conditional Service* (discussed in the last section). Once a phase leaves to conditionally service a previous phase, it cannot be serviced again until the next cycle unless *Reservice* is enabled for that phase and there is enough time left in the phase (prior to being maxed out) to service the original phase. Program the phase that was conditionally serviced to allow the original phase to be reserviced. For example, phases 2 and 6 are straight through phases and phases 1and 5 are leading left turns. If you desire to reservice phases 2 and 6 again, program phases 1 and 5 as reservice phases.

PedClr Thru Yellow

When *PedClr-Thru-Yellow* is enabled, the end of the pedestrian clearance interval times concurrently with the yellow clearance interval. When *PedClr-Thru-Yellow* is not enabled, ped clearance always ends before the yellow vehicle clearance begins.

SkipRed-NoCall

SkipRed-NoCall allows the red clearance interval to be skipped if there is not call on a terminating phase during the yellow clearance interval. *SkipRed-NoCall* is enabled on a per-phase basis

Red Rest

Red-Rest allows a phase to rest in red instead of green dwell in the absence of any calls. If *Red-Rest* is enabled and no other phases are called, the phase will terminate the green after a "gap-out" condition and move to the red rest state. The phase will remain in red rest in the absence of calls and can return to service after the *Red-Revert* timer has expired. An external *Red-Rest* inputs will override this software feature for the associated ring.

Max II

When *Max II* is enabled for a phase, *Max II* is applied with or without and external Max II controller input or pattern entry calling for *Max II*. Note that a mixture of *Max I* and *Max II* settings may be accomplished with this feature because Max II may be enabled for some phases and not others.

Ped Delay

```
Options+        P..1..2..3..4..5..6..7.8>
    Ped Delay -  .  .  .  .  .  .  .  X
Red Rest On Gap  .  .  .  X  .  .  .  X
  Conflicting P  5  0  0  0  0  0  0  0
  Grn/Ped Delay  0  0  0  7  0  0  0  4
Omit Yel, Yel P  6  0  0  0  0  0  0  0
Ped Out/Ovrlp P  2  0  0  0  0  0  0  0
StartYel,Next P  0  4  0  0  0  8  0  0
```

Ped-Delay works together with *Grn/Ped Delay* described below to either delay the start of the green or the walk interval when a pedestrian call is **first** serviced. **Note that if the phase is currently active, this feature has no effect.**

If *Ped-Delay* is enabled with an "X", the walk interval is delayed by the *Grn/Ped Delay* time. In the screen to the right, *Ped-Delay* is enabled for phase 8 and the *Grn/Ped Delay* is 4". When a pedestrian call is first serviced, the pedestrian walk period is delayed 4" after the start of green on phase 8. During this delay period, you will observe "DlyW" displayed in the status screen under MM->7->1.

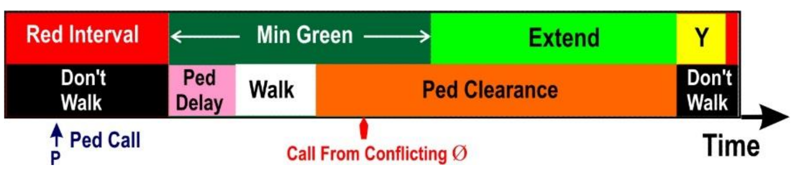
If *Ped-Delay* is disabled, the start of green is delayed by the *Grn/Ped Delay* time. This leading pedestrian interval (**LPI**) feature allows the pedestrian to enter the crosswalk while the vehicle indication is red. In the above screen, *Ped-Delay* is not enabled for phase 4 and *Grn/Ped Delay* is 7". When a ped call is serviced, the start of green is delayed 7" after Walk begins on phase 4.

Grn/Ped Delay

Grn/Ped Delay works together with *Ped/Delay* described above. This value can delay the beginning of the walk interval (*Ped Delay* enabled) or delay the beginning of green (*Ped Delay* disabled) when a pedestrian call is **first** serviced. *Grn/Ped Delay* programming is not applied when there is no pedestrian call for service. **Note that if the phase is currently active, this feature has no effect.**

Grn/Ped Delay is included in the coordination diagnostic check MM->2->8->5 to insure that the sum of *Grn/Ped Delay* + *Walk* + *Ped Clearance* + *Yellow* + *All Red* is satisfied by the split time. Ped times are checked by the coord diagnostic if STOP-IN-WALK is OFF or if STOP-IN-WALK is ON and "Rest-In-Walk" is enabled for the phase.

Grn/Ped Delay is omitted during preemption and the controller will time the appropriate walk and ped clearance times assigned to each preempt. *Grn/Ped Delay* is also omitted during manual control enable when the phase is terminated by interval advance.

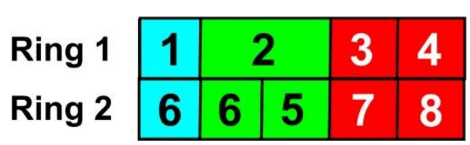


Enable *Ped Delay* to delay the Walk interval by the programmed *Grn/Ped Delay* value

Disable *Ped Delay* to delay the Green interval by the programmed *Grn/Ped Delay* value

Conflicting Ø

Conflicting Ø programming allows concurrent phases in different rings to be designated as conflicting phases. This effectively places a separate barrier between the two phases. This feature is useful when opposing left-turn movements require that each left-turn be serviced non-concurrently. In a dual-ring, quad 8-phase configuration, if phases 1 and 5 were designated as conflicting phases, the effective ring configuration would appear as follows:

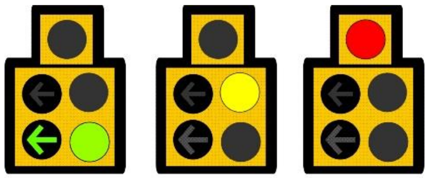


To assign conflicting phases, enter the number of the conflicting phase under the parent phase. In the menu above, "5" entered under phase 1 would prevent 1 and 5 from running together even though they are concurrent phases. It is not necessary to duplicate the entry in the column for the conflicting phase, i.e., by putting a 1 under phase 5 when there is already a 5 under phase 1. Take care not to program conflicting phases that are allowed to begin together at the barrier or the conflicting phase in ring 2 will be skipped. For example, if you never want phase 1 and 5 to run together, be sure to set the *Free Ring Seq* under *Unit Parameters* to a sequence number that leads 1 or 5 and lags the other phase.

Omit Yel, Yel Ø

Omit Yel allows the yellow output of a phase to go dark when a specified phase is also timing yellow clearance. "*Allow Skip Yel*" must be enabled under Unit Parameters to enable this option.

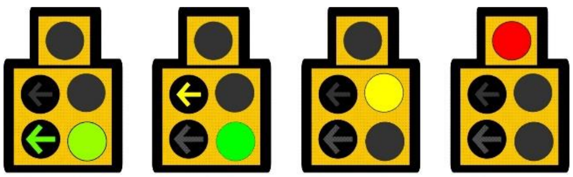
In the example below, *Omit Yel, Yel Ø* is used to prevent the left-turn yellow arrow and yellow ball from being simultaneously illuminated in a 5-section left-turn display. Whenever both phases terminate simultaneously, only the solid yellow indication is displayed during the clearance interval. In this example, phase 6 is programmed as the *Omit Yel, Yel Ø* under phase 1 in the Options+ menu below.



Phase 1+ 6 Green | Phase 1 blank + 6 Yellow | Phase 1+ 6 Red

Options+	P..1	..2	..3	..4	..5	..6	..7	.8>
Ped Delay -	.	.	.	.	.	.	.	X
Red Rest On Gap	.	.	.	X	.	.	.	X
Conflicting P	5	0	0	0	0	0	0	0
Grn/Ped Delay	0	0	0	7	0	0	0	4
Omit Yel, Yel P	6	0	0	0	0	0	0	0

MM->1->1->3: Phase Plus Options



Phase 1+ 6 Green | Phase 1 Yellow + 6 Green | Phase 1 blank + 6 Yellow | Phase 1+ 6 Red

When the yellow clearance of the phase specified in the column of the table (in this example *Ø1)* and the *Omit Yel Ø* (in this example Ø 6) are both timing, only the *Omit Yel Ø* will display an output. This insures that a single clearance indication is displayed from the *Omit Yel Ø* shown in the left figure when Ø 6 displays a solid yellow indication.

Ped Out/Ovrlap Ø (MM->1->1->3)

The *Ped Out/OverlapØ* feature allows one phase to share the pedestrian outputs of another phase within the same ring. This allows pedestrian outputs for an active phase to be redirected to the pedestrian outputs of a non-active phase. A similar operation may also be accomplished using the PED_1 overlap type to provide a separate set of outputs for pedestrian phases assigned to the overlap.

Options+	P..1	..2	..3	..4	..5	..6	..7	.8>
Ped Delay -	.	.	.	.	.	.	.	.
Red Rest On Gap	.	.	.	.	.	.	.	.
Conflicting P	0	0	0	0	0	0	0	0
Grn/Ped Delay	0	0	0	0	0	0	0	0
Omit Yel, Yel P	0	0	0	0	0	0	0	0
Ped Out/Ovrlp P	2	0	0	0	0	0	0	0

The *Ped Out/OverlapØ* feature allows the user to steer (or redirect) the pedestrian outputs of a phase to another phase. In the example menu above, the pedestrian outputs for phase 1 are directed to the pedestrian outputs of phase 2. When ped call is serviced on phase 1, the walk and ped clearance indications are driven on phase 2. In this case, a ped call serviced during phase 2 will also drive the walk and ped clearance indications assigned to phase 2.

Ped Out/OverlapØ programming may also be used to service a pedestrian movement that overlaps two sequential phases. The designated pedestrian movement must be entered under both phases as shown to the right. If phase 1 and 2 are consecutive phases in the sequence, the walk indication serviced during phase 1 will be redirected to the walk output on phase 2. This walk indication will hold until the end of the walk interval programmed for phase 2. Pedestrian clearance programmed for phase 2 will terminate the pedestrian movement which overlaps phase 1 and 2.

Options+	P..1	..2	..3	..4	..5	..6	..7	.8>
Ped Delay -	.	.	.	.	.	.	.	.
Red Rest On Gap	.	.	.	.	.	.	.	.
Conflicting P	0	0	0	0	0	0	0	0
Grn/Ped Delay	0	0	0	0	0	0	0	0
Omit Yel, Yel P	0	0	0	0	0	0	0	0
Ped Out/Ovrlp P	2	2	0	0	0	0	0	0

Operation of the pedestrian overlap is according to the following rules:

- The overlapping phases must be adjacent in the ring sequence, i.e., 1&2, 3&4, 4&1 for a STD8
- If the first sequential phase has a ped call, it will begin timing the Walk interval upon entry.
- At the end of the walk interval, if there is a ped call on the second sequential phase, the first phase will remain in walk while timing normal green and through yellow and red clearances.
- Upon entering the second sequential phase, the pedestrian timing of that phase will apply. The pedestrian movement must terminate prior to termination of the second overlap phase.

The *Ped Out/OverlapØ* feature was provided before the *PED_1 Overlap* type described later in this chapter was added. The *PED_1 Overlap* type is a more flexible method to achieve the same operation described above. The *PED_1 Overlap* type allows walk and pedestrian clearance to overlap two or more consecutive phases; however, the outputs are not confined to the walk and ped clearance outputs of the parent phase. The walk output of the *PED_1 Overlap* type is driven by the green output of the overlap and the ped clearance output is driven by the red output.

StartYel, Next Ø

When the controller is programmed to start in yellow, it will normally progress to the next sequential phase in the sequence. *StartYel, Next* Ø designates the next phase to be serviced after startup in yellow. If phase 2 is programmed with a value of 4 and the startup programming for phase 2 is yellow, then phases 4 and 8 will be serviced next instead of 3 and 7.

Safe Clr Ped Min, Safe Clr No Flash

A new feature known as the Safety Clear (Ped Extend) feature has been added. It is used to extend the pedestrian clearance interval, up to a programmed maximum by reassigning an existing Ped detector to be a Ped Extension detector. The Ped Extension detector is typically a Microwave or ultra-sonic detector that detects the presence of pedestrians in the cross-walk. It works as follows:

1. Program the existing *Pedestrian Clearance* time (MM->1->1->1) as a Maximum Ped Clearance time.
2. Program the new entry *Safe Clr Ped Min* as a Minimum Ped Clearance time.
3. Optionally program the new entry *Safe Clr No Flash* if you want the Don't Walk signal to be dark instead of flashing while the Ped clearance interval is extending.
4. A new Ped detector feature allows the ped detectors to be specified as a Pedestrian Extend input rather than a Ped Call input. A Ped detector is specified to be an extend detector by entering 17-32 for the Call phase. This number entered is the walk phase to extend, plus 16. Entries of 1-16 function as before to specify the Ped phase to call. As an example, to specify Ped detector 1 as an extend for walk phase 2, enter 18 in the Call column for Ped detector 1. If Ped detector 2 is to be the calling detector for walk phase 2, then enter 2 in the call column as you usually would.

When the Pedestrian interval times, it will time for at least the minimum time entered. It will continue while the Ped Extend detector is active or until the Maximum Ped Clearance time expires.

The Timing Status Screen (MM-7-1) shows "***Pext***" instead of "***Pclr***" while the Ped clearance is extending.

4.1.8 Call, Inhibit, Redirect (MM->1->1->5)

```
                    Inhibit Ps 1111111    >
P    ..Call.Ps..  12345678 90123456
1     6   0   0   0  ........ ........
2     0   0   0   0  X....... ........
3     0   0   0   0  ........ ........
4     0   0   0   0  ........ ........
5     0   0   0   0  ........ ........
6 +   0   0   0   0  ....X... ........
```

The *Call, Inhibit, Redirect* menu provides access to three independent features.

1) The *__Call__* feature allows a phase green to indirectly call another phase. Each controller phase can be assigned up to 4 Call Ø's. In the menu above, ø6 is a called when ø1 is green and ø1 is receiving a detector call, min or max recall.

2) The *__Inhibit Ø's__* feature places omits on inhibited phases while a phase is ON. This option can be used to prevent the controller from "backing into the previous phase" without crossing the barrier. For example, in the menu above, phase 2 inhibits phase 1 and phase 6 inhibits phase 5. This programming is useful with protected/permitted left-turn displays when you do not want to create a yellow trap condition by allowing phase 2 to "back into" phase 1 or phase 6 to "back" into phase 5 without crossing the barrier.

```
<        Redirect P Calls (from P to P)
P    From-To   From-To   From-To   From-To
1      0  0      0  0      0  0      0  0
2      0  0      0  0      0  0      0  0
3      0  0      0  0      0  0      0  0
4      3  8      0  0      0  0      0  0
5      0  0      0  0      0  0      0  0
6 +    0  0      0  0      0  0      0  0
```

3) The *__Redirect Ø Calls__* feature (MM->1->1->5, right menu) redirects a phase call from one phase to another phase. The redirected call is only issued when the programmed phase is green and the phase called is red. Please note that *__Redirect Ø Calls__* **CALLS** the redirect phase when it is red, where Detector Switching **EXTENDS** the switch phase when it is green. Therefore if you try to extend a programmed phase by redirecting another phase call to it, it will not extend the phase. Also note, do not redirect a call from the programmed phase to itself.

   For example, in the right menu, when phase 4 is green, detector calls on phase 3 are directed to phase 8. This is useful when 3+7 are leading and calls are serviced on 4+7 prior to a later call on phase 3. Redirecting calls from phase 3 to phase 8 will allow a late turn to be serviced if the left-turn display is protected/permitted.

4.1.9 Alternate Phase Programs (MM->1->1->6)

Alternate Phase Programs (or alternate *maps*) allow the phase timings, phase options and call/inhibit/redirect programming to be changed by time-of-day using timing patterns.

```
         Alternate Phase Programs
1.Interval Times
2.Options
3.Call/Inh/Redirect
```

Alternate Phase Programs may be assigned to any of the 48 patterns under Alt Tables+ (MM->2->6) as shown in the menu to the right.

Pat#	Alt: POpt	PTime	DetGrp	Call/Inh	>
1	0	0	0	0	
2	8	3	3	2	
3	0	0	0	0	

Alternate Interval Times (MM->1->1->6->1)

Alternate Interval Times may be "attached" to patterns to vary phase times by time-of-day. Entries in this table are made by column and not by phase. For example, in the right menu, the *Min Grn* for phase 2 may be programmed in Column 1 or Column 4 as shown. However, most users assign phases to the same column number to make the entries more readable.

Alt-3	Col.1	...2	...3	...4	...5	...6	...7	...8
Assign P	2	0	0	2	0	0	0	0
Min Grn	5	0	0	5	0	0	0	0
Gap,Ext	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0
Max 1	0	0	0	27	0	0	0	0
Max 2	0	0	0	50	0	0	0	0
Yel Clr	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Red Clr+	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0

Keep in mind, that if you wish to override only one phase time in a column, you must provide all entries for that phase or else zero values will be substituted for that phase. For example, column 1 sets *MinGrn* for Ø2 to 5". However, all entries for Ø 2 (except walk) will be set to zero values when this alternate phase timing is called. The entries shown in column 4 represent the correct way to program alternate phase times for Ø 2.

Alternate Phase Options (MM->1->1->6->2)

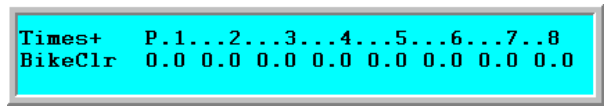
Eight separate alternate phase option tables are provided to modify the base phase options programmed under controller menu MM->1->1->2. Again, remember to program all options for the phase you assign to each column even if you only want to vary one value.

Alternate Call/Inhibit/Redirect (MM->1->1->6->3)

Two separate alternate tables are provided to modify call/inhibit/redirect features. These alternate tables may also be assigned to a coordination pattern that called by time-of-day through the TBC scheduler.

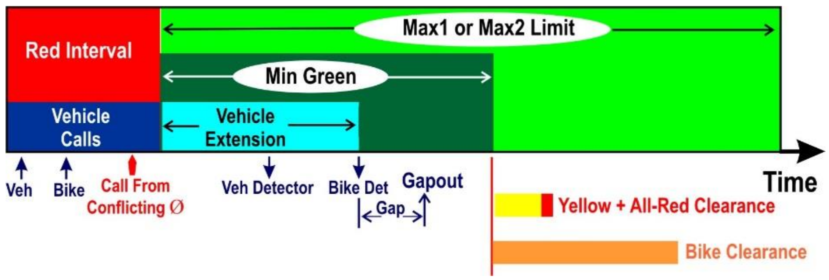
4.1.10 Times+ (MM->1->1->7)

Times+ (MM->1->1->7) provides enhanced features that extend the basic NTCIP *Times* features under MM->1->1->1.



BikeClr

A *Times+* feature called *Bike Clearance* insures that the yellow + all-red clearance terminating a phase is at least as long as the *BikeClr* value specified in the *Times+* menu if the last detection prior to gap-out is from a BIKE detector (MM->5->3). Note that *BikeClr* times concurrently with the yellow + all-red interval of the phase as shown below. If the last detection prior to gap-out is received from a BIKE detector, the controller will extend the red-clearance of the phase to insure the total bike clearance specified for the phase.



***BikeClr* Extends All-red Clearance If the Last Detection is From a BIKE Detector**

The following outlines the operation and programming of a BIKE Detector using the Bike Clearance time.

1) Program the BikeClr time as stated above. Next program the detector as TYPE= BIKE (MM->5->3) enable the detector to extend by turning on the EXTEND value under MM->5->2. Under MM->5->1, program the extension time as a 10x value. Normal NTCIP extension values are from 0.0 – 25.0 seconds. When the detector is a bicycle detector, that value is multiplied by 10, causing the extension time to be 0 – 255 seconds. The extension behavior on a bike detector is the same as extension on any detector. It will apply an extension to the green until its extension expires, or the phase maxes out.
2) Any time during green that the detector is activated, the bike clear timer is also loaded. The phase will time normally, but if the bike clear time has not counted down by the time red clearance has terminated, then the phase will hold in red until the remaining bike clearance time has expired. (This is to protect the bike due to non-typical terminations of the phase, i.e. force-offs)
3) If you have normal extension enabled, and the bike detector is extending when the phase goes to yellow, then the bike clear time will be loaded, and always time its full value. (This is to protect the bikes that were extending the phase, but could have potentially run up against the max time for the phase.) Thus, this will ensure a bike that entered intersection just prior to gap out, will clear the intersection (especially at wide intersections), before the conflicting traffic enters the intersection.

4.1.11 Copy Phase Utility (MM->1->1->8)

```
        Copy Phase Program
 From #:  0      To #:  0
```

The *Copy Phase Utility* allows the user to copy phase programming from one phase to another phase. This can speed up data entry and reduce errors if complementary phases in each ring have similar programming values. This utility copies all phase times, options, and phase options+ programming from menus MM->1->1->1, MM->1->1->2 and MM->1->1->3.

4.1.12 Advance Warning Beacon (MM->1->1->9)

```
Advance Warning  P Time
     Aux Out #1  0   0
     Aux Out #2  0   0
```

This feature is used to illuminate a warning beacon in advance of a traffic signal to alert the driver a specified number of seconds before the phase begins yellow clearance. The warning beacon is activated by an auxiliary output via a selected action that is associated with a coordination pattern. The beacon is activated for the specified number of seconds after the phase is forced off.

To activate this feature the user typically sets up a coordination pattern and associated split table. When setting up cycle lengths and split times, make sure you accommodate the length of time that the phase will remain on while the sign is illuminated for the particular split phase (normally chosen as the coord phase). The time in the cycle length needed to output the advanced warning sign and clear out the associated phase must be accommodated so that all other splits still have enough time to guarantee their minimums and clearances.

```
Advance Warning  P Time
     Aux Out #1  2   5
     Aux Out #2  0   #
```

Consider the example of outputting a five second advanced warning sign with phase 2, the coordinated phase. If using ENDGRN coordination with phase 2, the following will occur at the zero point in the cycle. Normally phases 2 and 6 run together therefore phase 6 will terminate at the zero point and phase 2 will be extended by five seconds, while the sign is being outputted. Then phase 2 will begin its clearances. Thus split 1 **must additionally accommodate** the time programmed under this menu item plus the clearance of the coord phase. If this is the case, please insure that the split time for these phases have enough time to guarantee its minimum. Early yields may be considered so that the sign is actuated prior to the zero point in the cycle. Also keep in mind that if another phase is associated with the coord phase (as phase 6 in this example), it will be terminated while the sign is being outputted.

In summary, the beacons will always be on, except during green of the phase that the sign is associated with, in which case they turn off, and will stay off until that phase terminates. When the phase terminates, it times an additional interval prior to termination, during which the beacons turn on and stay on, until the phase becomes green again. Keep in mind that this feature can be actuated during Free or Coordinated operation.

4.2 Rings, Sequences and Concurrency

Our controllers support 16 phases assigned to four rings. Phases may time concurrently with phases in other rings that are defined as concurrent phases. Any phase not defined as a concurrent phase is considered to be a conflicting phase. The controller uses ring sequence and concurrency definitions to determine the order that the phases are serviced and to insure that conflicting phases never time concurrently. Phase concurrency establishes "barriers" between non-concurrent phases.

Phase Mode defines the sequence and concurrency relationship of the phases assigned to each ring. P*hase Modes* is programmed under *Unit Parameters* and illustrated below. The most common mode, *STD8* is comprised of 8 phases operating in two rings. Phases on either side of the barrier (concurrency group) may time together in separate rings.

Eight Phase Sequential (8Seq) mode has no concurrency relationship and all phases time sequentially. *Quad Sequential (QSeq)* mode is a combination of *STD8* and *8Seq* and is typically used to provide dual ring operation for the major street and sequential (or split) phasing for the cross street.

USER phase mode applies to phase sequences that require more than 8 phases or more than two rings. *USER* mode also allows up to 16 phases to be serviced sequentially by assigning the sequences to rings 1 and 2 as discussed later in this section.

Phase Mode	Ring Sequence / Concurrency								
STD8 – Standard 8 Phase	Ring 1	1	2	3	4				
	Ring 2	5	6	7	8				
QSeq – Quad Sequential	Ring 1	1	2	3	4	7	8		
	Ring 2	5	6						
8Seq – 8 Phase Sequential		1	2	3	4	5	6	7	8
DIA – Texas Diamond	USER sequence based on the *Texas Diamond Specification*								
USER – User defined phase mode	Ring 1	1	2	3	4	5	6	7	8
	Ring 2	11	12	13	14	0	0	0	0
	Ring 3	15	0	0	0	0	0	0	0
	Ring 4	16	0	0	0	0	0	0	0

4.2.1 Ring Sequence (MM->1->2->4)

Seq#	Ring	Sequence.of.Phases							
1	1	1	2	3	4	0	0	0	0
1	2	5	6	7	8	0	0	0	0
1	3	0	0	0	0	0	0	0	0
1	4	0	0	0	0	0	0	0	0
2	1	1	2	3	4	0	0	0	0
2	2	6	5	7	8	0	0	0	0
2 +	3	0	0	0	0	0	0	0	0

Seq#

16 seq # combinations are provided in the sequence table

Ring

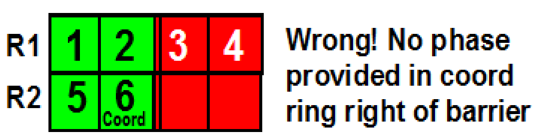
Four rings are provided for each of the 16 sequences

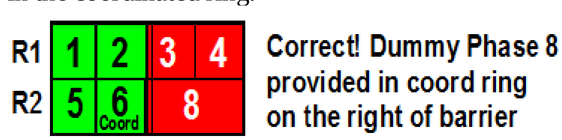
Sequence Data

A maximum of 8 consecutive phases may be programmed for each ring. STD-8ø initializes the controller with 16 default sequences that providing every lead/lag combination possible for eight-phase operation, dual ring operation.

Each sequence must contain the same phases assigned to the same ring. Do not assign a phase to different rings in different sequences or you will generate a SEQ TRANS fault under MM->7->9->5) and send the controller to flash.

In addition, a phase must be provided in the coordinated ring for each concurrency (or barrier) group. For example, consider the USER sequence below in coordination with ø 6 selected as the coord phase. A "dummy phase" must be included in ring 2 because a phase must be assigned to each side of the barrier in the coordinated ring.





4.2.2 Ring, Concurrency, Startup (MM->1->1->4)

Phase ø

Phase ø identifies the phase of the entries in the row.

P	Ring	StartUp	Concurrent Ps							
1	1	RED	5	6	0	0	0	0	0	0
2	1	RED	5	6	0	0	0	0	0	0
3	1	RED	7	8	0	0	0	0	0	0
4	1	RED	7	8	0	0	0	0	0	0
5	2	RED	1	2	0	0	0	0	0	0
6	2	RED	1	2	0	0	0	0	0	0
7 +	2	RED	3	4	0	0	0	0	0	0

Ring (Rg)

The Ring value assigns each phase to a ring.

Start Up Phases

- RED – phase startup in the red interval
- WALK **-** startup in the green and walk interval
- GREEN **-** startup in the green interval (pedestrian calls are removed for the startup phase)
- YELLOW **-** startup in the yellow interval
- RedCl **-** startup in the red interval (applies the *Start Red Time* defined under *Unit Parameters*)
- OTHER- reserved NTCIP value

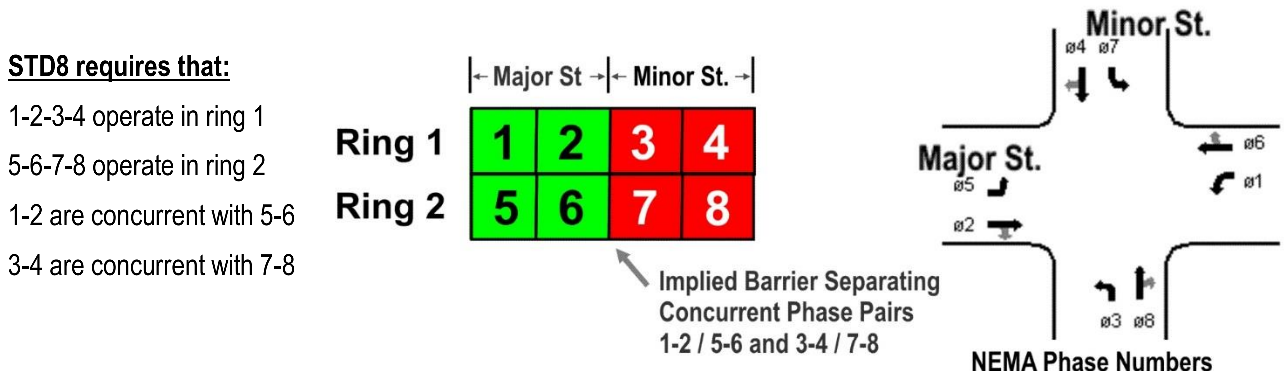
Note: You can also control which phases are serviced next using the *StartYel, Next* Ø option under MM->1->1->3.

Concurrent Phases

Concurrent Phases define which phases may time together in each ring. The *Phase ø* itself does not need to be included in the concurrency group. However, any phase that is allowed to time with the *Phase ø* in another ring must be listed as a concurrent phase. Phases that are assigned to a sequence and do not belong to a concurrency group time sequentially while are other phases in the sequence are resting in red.

4.2.3 Phase Assignments and Sequences for STD8 Operation

Most traffic signals apply STD8 operation even if all eight phases are not enabled. NEMA assigns the left-turn movements to the odd-numbered phases and the through movements to the even numbered phases. It is easy to remember this convention if you recall that the even numbered through phases are assigned in a clockwise manner (2-4-6-8) and the left-turn phases opposing each thru are numbered in pairs 1-2, 3-4, 5-6 and 7-8. Many agencies assign phase 1-2-5-6 to the major (coordinated) street and 3-4-7-8 to the cross street as shown below. Other agencies assign phases to a direction (north, south, east or west) if the non-intersecting streets in the network are parallel.



When a controller is initialized for STD8 under MM->8->4->1, the following phase sequence table is automatically programmed in the sequence table. These defaults provide all 16 combinations of leading and lagging left-turn sequences for the 8 phase, dual-ring operation illustrated above. The user may customize this table as desired under MM->1->2->4.

Seq #	Phase Seq.
1	1 2 3 4 5 6 7 8
2	1 2 3 4 6 5 7 8
3	2 1 3 4 5 6 7 8
4	2 1 3 4 6 5 7 8
5	1 2 3 4 5 6 8 7
6	1 2 3 4 6 5 8 7
7	2 1 3 4 5 6 8 7
8	2 1 3 4 6 5 8 7

Seq #	Phase Seq.
9	1 2 4 3 5 6 7 8
10	1 2 4 3 6 5 7 8
11	2 1 4 3 5 6 7 8
12	2 1 4 3 6 5 7 8
13	1 2 4 3 5 6 8 7
14	1 2 4 3 6 5 8 7
15	2 1 4 3 5 6 8 7
16	2 1 4 3 6 5 8 7

16 Default Phase Sequences for STD8 (Every Combination of Lead/Lag Left-turns)

STD8 Phase Mode is the best practice for all applications unless intersection geometry and sequencing are too complex.

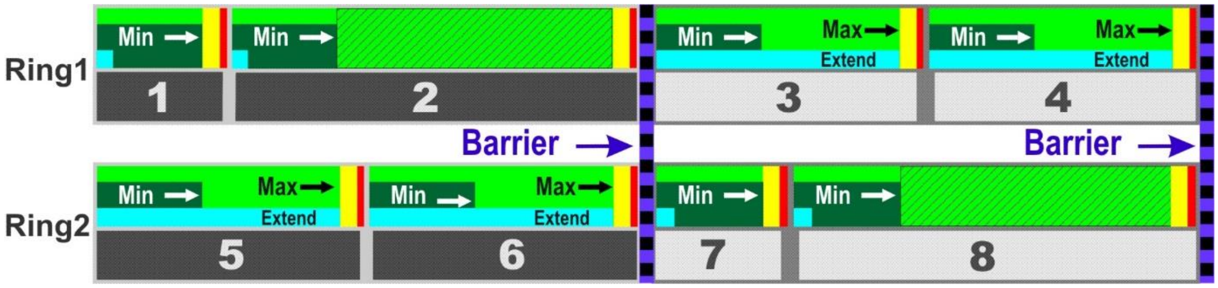
When considering coordination, using STD8 mode will take advantage of the most coordination diagnostic checks to catch common data entry mistakes, and if detected, times the intersection in FREE. In USER mode, most of these coordination diagnostics are removed, and the onus is on the agency verify and test the programming to ensure that coordination pattern(s) run as expected.

4.2.4 How Barriers Affect the Phase Timing in Each Ring Under STD8

This chapter began with a discussion of basic actuated and volume density features as related to a single phase. Individual phase timing and options determine how a phase services vehicle and pedestrian calls and transfers the right-of-way to a competing phase. Barriers also affect how phases terminate because a phase may be extended by a phase in another ring that is timing concurrently. Phases in each ring cross the barrier at the same time.

In the example below, *Min Recall* calls phases 1, 2, 7 and 8 but does not extend these phases. Without a vehicle call to extend phases 1, 2, 7 and 8, a gap-out occurs after one *Gap, extension* and the phase will terminate and move to the next phase in the sequence. In this example, phases 1, 2, 7 and 8 must dwell in green until the phases in the other ring are also ready to cross the barrier. If the phase setting, *Enable Simultaneous Gap* is not enabled on phases 1, 2, 7 and 8, their respective *Gap, extension* timers will not reset once gap-out is reached.

Max Recalls on phases 3, 4, 5 and 6 not only call these phases during their red intervals, but also extend the phases during the green interval as shown below. A *Max Recall* acts like a constant vehicle call on the phase that extends the phase to the maximum setting currently in effect (either Max-1 or Max-2). The *Gap, Extension* timer is never reset during *Max Recall*.



STD8 Operation - Min Recalls on Phases 1, 2, 7 and 8 and Max Recalls on Phases 3, 4, 5 and 6

It is important to note that a phase cannot cross a barrier until the concurrent phase in the other ring are also ready to cross the barrier. In this example, ø2 extends until ø6 has timed it's maximum because the phase concurrency for STD8 allows phase 1-2 to time concurrently with ø5-6, but never with 3-4 or 7-8. Similarly, ø 8 extends until ø 4 "maxes" out to cross the second barrier with simultaneously with ø4.

Coordinated operation is similar to the free operation example shown above except that the maximum times allocated to each phase are typically governed by *Split Times*. The same "barrier rules" rules apply during coordinated operation as during free operation and unused split time from both rings must be available before it can transfer across the barrier.

4.2.5 USER Mode - 16 Phase Sequential Operation

Seq#	Ring	Sequence.of.Phases							
1	1	7	9	15	4	2	3	12	5
1	2	1	6	11	14	0	0	0	0
1	3	0	0	0	0	0	0	0	0
1	4	0	0	0	0	0	0	0	0

The *Sequence Table* provides a maximum of 8 phases in each ring sequence. USER mode can provide a maximum of 16 sequential phases by continuing the ring sequence at the end of ring 1 in ring 2 as shown to the right. This is possible because phases are assigned to rings in the phase concurrency table. The example above illustrates 12 sequential phases assigned in the order 7-9-15-4-2-3-12-5-1-6-11-14.

When the *Concurrent Phase* programming for each sequential phase is zero, the phases in row 1 of the sequence table should be assigned to ring 1 of the *Ring/StartUp/Concurrency* table (MM->1->1->4) and the phases in ring 2 of the sequence should be assigned to ring 2. Do not move phases to a different ring when changing sequences, or else you will generate a SEQ TRANS fault under MM->7->9->5 sending the controller to flash.

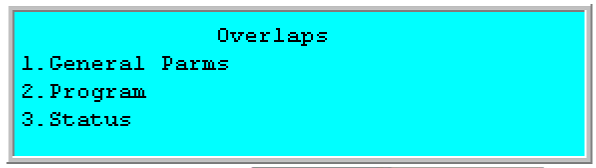
Sequential Operation may be combined with overlaps to define complex display sequences. The sequence order may be changed by defining a new phase sequence in the sequence table. However, each phase sequence in the table must contain the same number of phases and the ring assignment in the sequence table and the *Ring/StartUp/Concurrency* table must agree. You may omit (OMT) phases in the sequence through the *Mode* setting in the *Split Table*; however, you should never omit a phase in the sequence table if the phase is enabled under phase options (MM->1->1->2).

4.2.6 Ring Parameters+ (MM->1->2->5)

```
Input Map       Ring#..1..2..3..4
   Use Ring Inputs   1  2  1  2
```

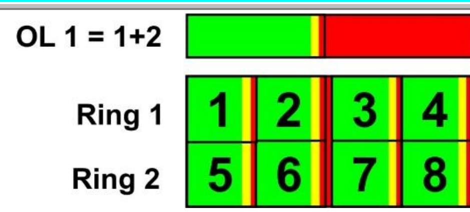
NEMA TS2 only defines ring inputs (like Stop Time 1) for rings 1 and 2. The *Ring Parameters+* screen allows the user to map the ring I/O for ring 1 and 2 to any of the 4 rings available in the controller. The default assumes that ring inputs for rings 1 and 3 and rings 2 and 4 are identical.

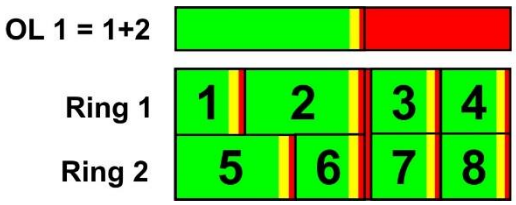
4.3 Overlaps (MM->1->5)



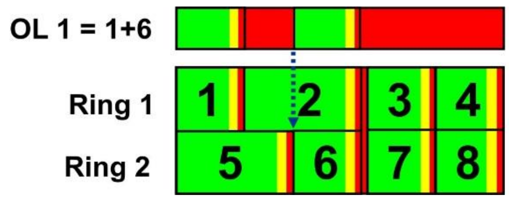
Sixteen fully programmable overlaps may be assigned to any load switch channel in the terminal facility (cabinet). Overlaps are customized channel outputs driven by one or more *included phases* that are typically consecutive phases in the ring sequence.

In the illustration to the right, OL1 is defined as an overlap of two included phases (Ø 1+ Ø 2). OL1 turns green when the first included phase turns green and clears with the last *included phase* in the sequence. Because Ø 1 and Ø 5 time together in this example, it does not matter if the *included phases* are defined as 1+2 or 1+6. The overlap extends from the beginning of Ø1 until the end of Ø2 or Ø6 green in either case. However, if Ø 5 extends past the end of Ø 1, the overlap operation varies significantly depending on whether the included phases are 1+2 or 1+6 as shown below.



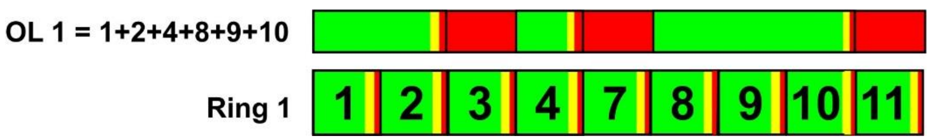


Consecutive Included Ø 1+ Ø 2 in the Same Ring



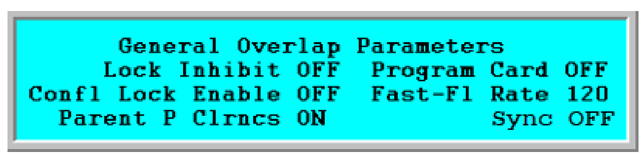
Non-consecutive Included Ø 1+6 in Separate Rings

Overlaps may be defined with any number of phases in the same ring as shown below. This feature is useful in sequential phase operation (8SEQ or USER phase mode) to create signal displays that overlap any number of phases in the sequence.



When Included Phases Are Not Consecutive, the Overlap Will Time Multiple Clearances during the Sequence

4.3.1 General Overlap Parameters (MM->1->5->1)



The following *General Overlap Parameters* apply to overlaps 1-16

Lock Inhibit

If *Lock Inhibit* is OFF, the controller will not proceed to the next phase following the last included phase until the overlap has completed timing the overlap green extension and clearance intervals. If *Lock Inhibit* is ON, the controller will time the next phase in the sequence during the overlap green extension and clearance intervals.

Conflict Lock Enable

```
      General Overlap Parameters
     Lock Inhibit OFF  Program Card OFF
Confl Lock Enable OFF  Fast-Fl Rate 120
  Parent P Clrncs ON           Sync OFF
```

Conflict Lock Enable is used together with the *Lock Inhibit* feature. If *Conflict Lock Enable* is ON, the controller suppresses all conflicting vehicle and pedestrian phases and conflicting overlaps until the end of overlap green extension, yellow and all-red clearance. If *Conflict Lock Enable* is OFF, then the conflicting vehicle and pedestrian phases and conflicting overlaps may proceed while the overlap is timing its clearances. The table below summarizes how the parameters *Lock Inhibit* and *Conflicting Lock Enable* work together to determine how the overlaps are terminated.

Lock Inhibit	***Conflicting Lock Enable***	**Effect on overlap clearance timing**
OFF	OFF	The controller will not proceed to the next phase following the last included phase until the overlap has completed timing the overlap green extension and clearance intervals
OFF	ON	Insures that the overlap green extension, yellow and all-red clearances are finished before the next phase is serviced
ON	OFF	Allows the next phase (including any conflicting phase or overlap) to begin while the overlap completes timing green extension and clearances
ON	ON	Allows the next phase to begin with the overlap green extension and clearances, but suppresses any conflicting phases or overlaps programmed for the overlap

Effect of Lock Inhibit and Conflicting Lock Enable on Overlap Termination

Parent Phase Clearance

Parent Ø Clearances determines whether the overlap times it's clearances with the included phases or uses the clearance times programmed for each individual overlap. If *Parent Ø Clearances* is ON, the clearance times of the included phase terminating the overlap are used. If *Parent Ø Clearances* is OFF, the yellow and all-red clearances as programmed in each overlap are used.

Please Note that he Yellow time that is programmed under a Flashing Yellow Arrow type overlap overrides the phase Yellow time even if *Parent Ø Clearances* is ON.

Program Card

If *Program Card* is ON, the first 8 overlaps are programmed via hardware jumpers on an external card inserted into the TS2 controller. These jumper positions assign the included phases for overlaps 1-8 overriding any overlap programming in the controller. The *Program Card* option is not a standard option for TS2 controllers.

Fast-Fl Rate

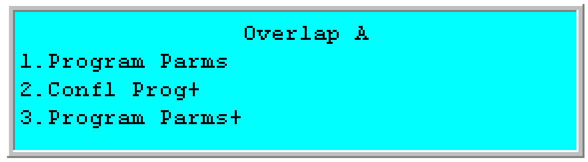
This value controls the flash rate of the *FAST-FL* overlap type. Valid selections are OFF, 60, 120, 150 and 180.

Sync

The program settings are **OFF**/**ON**. In field testing, there are some overlap types which may be displayed 0.1 seconds before the parent phase is displayed. The user can set this to **ON** to adjust (delay) the overlap from being displayed for 0.1 seconds. Thus, the overlap display will synchronize with the parent phase display. The user should only set this feature to **ON** if there is an issue after reviewing their field displays for all programmed overlaps. Setting to **OFF** will run the overlap displays normally.

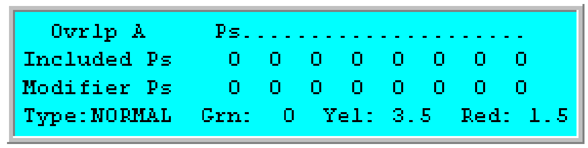
4.3.2 Overlap Program Selection and Configuration (MM->1->5->2)

Each overlap is selected separately from MM->1->5->2. TS1 convention refers to overlaps 1-4 as overlap A-D. This convention has been carried over into TS2. For example, Overlap A to the right corresponds to overlap "1" in TS2.



Included Phases

A maximum of 8 *Included Phases* (or parent phases) may be assigned to each overlap. The user should enter (program) the phases in order from the leftmost position to rightmost position.



Modifier Phases

A maximum of eight *Modifier Phases* may be assigned to the overlap to alter the operation based on the *Overlap Type*. The user should enter (program) the phases in order from the leftmost position to rightmost position.

Overlap Type

The *Overlap Type* parameter (NORMAL, -Grn/Yel or other sets the overlap operation as described in the next section

Overlap "Trailing" Green Extension

The overlap Green parameter extends the overlap green for 0-255 sec after an included phase terminates and the controller moves to the non-included phases. This overlap parameter is called "trailing green" in some controllers.

Overlap "Trailing" Yellow and Red Clearance

Parent Phase Clearance determines whether the overlap times yellow and all-red clearance with the included phases or uses the separate yellow and all-red clearances programmed in the menu above. If *Parent Ø Clearances* is OFF, the yellow and all-red clearances for each overlap are used.

Please note that these timers are always used when exiting overlaps when a pre-emption is called.

4.4 Overlap Types

The operation of each of the 16 overlaps is governed by the *Overlap Type* and the *ModifierPhase(s).* Examples are presented below to illustrate the operation available with each overlap type. We provide overlap features based on customer requirements and does not endorse any particular mode of operation provided in these examples. The user should develop applications from these features that comply with local policies and with the Manual of Traffic Control Devices.

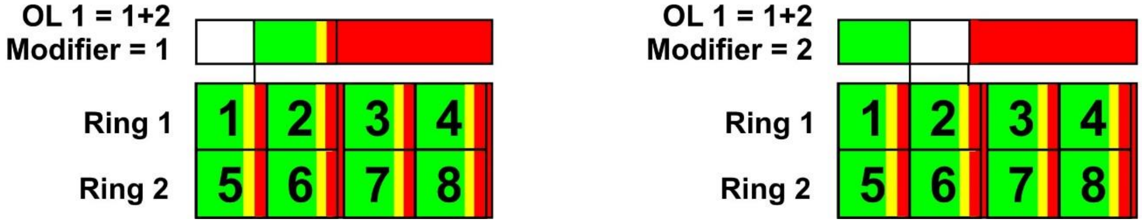
- **Normal** (NTCIP) – modifier phase causes the overlap to go dark
- **–GrnYel** (NTCIP) – modifier phase used to suppress the overlap green
- **L-Perm** – suppresses the solid green in a protected/permitted left-turn while the opposing left-turn (modifier phase) is green (this left-turn display is used by some agencies to resolve the “yellow-trap
- **Fl Red** – flashing red arrow used by some agencies for the permitted left-turn indication (another left-turn display designed to address the “yellow trap” safety issue.
- **Fast-FL** – Fast FL is used in Canada. It flashes the GREEN signal at the rate specified in the Fast-Fl Rate parameter (see MM→1→5→1). It is used for protected-permissive left turns. An overlap set to this type will flash green when the user programs both the included phase and modifier phase and that phase is active
- **Ped_1** – used to drive a walk indication timed with the first included phase and ped clearance which overlaps the following included phases defined for the overlap
- **MinGrn** – identical to the NORMAL overlap type, except that the overlap green extension is timed as a min green period when the overlap green period begins
- **RT/OTH** (Developed MIB) – selects one of the following Types+ under overlap menu selection 2, *Confl Prog+:*
  - **L-Perm** – see above description
  - **Fl Red** – see above description
  - **Fast-FL** – see above description
  - **FL GRN** – Flashing Green. This overlap type works similar to Canadian Fast Flash except that it flashes whenever the overlap is green.
  - **R-Turn** – used to drive a right-turn green arrow when a non-conflicting left-turn is being serviced and move immediately to a solid green indication of the through movement associated with the right turn
  - **Ped_1** – see above description
  - **MinGrn** – see above description
  - **FlYel-4 or FlYel-3** – this is used to Flash a yellow arrow during permissive left turns. See section 4.7 for further details.
  - **Minus Walk (-WALK) -** The **-WALK** type operation works the same as a **NORMAL** overlap except:
    - It is only when the Walk output of an inhibit phase is active that the overlap is inhibited
    - Only the Green of the overlap is darkened when inhibited by an inhibit walk.
  - **R-T,ILL -** Also known as an Illinois overlap, this overlap will output based on the following conditions:
    - If the modifier phase is green, the overlap will be red
    - If the controller is running the modifier phase, and the phase next is also a modifier phase then the overlap will remain red
    - In all other conditions, the modifier phase does not alter the overlap.
  - **RESERV1, RESERV2** – Reserved for future use.

4.4.1 NTCIP Overlap Type: Normal (NORMAL)

The Included Phases and the modifier phases control the *Normal* overlap type as follows:

- The overlap is green when an included phase is green, or an included phase is timing yellow/red clearance and an included phase is next
- The overlap is yellow when an included phase is yellow and an included phase is not next
- The overlap is red when the overlap green and yellow are not on
- The overlap is dark (all outputs off) when a modifier phase is on during it's green, yellow or all-red interval

The examples below illustrate a NORMAL overlap type with included phases Ø1 and Ø2. The Ø1 modifier blanks out the overlap outputs as long as the Ø1 outputs are green or yellow. The Ø2 modifier blanks out the overlap as long as the Ø2 outputs are green or yellow. If the modifier selected is the last included phase in the sequence (in this case Ø2), the yellow clearance will be omitted as shown.



NORMAL Type: Modifier Phases Blanks Out the Overlap When the Modifier is Green or Yellow

Note: if you specify a modifier phase for a NORMAL overlap type, be sure that your conflict monitor is programmed to allow the overlap output channel to go blank when the modifier phase is timing. It also may be necessary to adjust the monitor to accept an output sequence that omits yellow clearance such as the example above. The user is responsible to configure the phase sequence, phase concurrency and overlap programming to comply with the MUTCD.

4.4.2 NTCIP Overlap Type: Minus Green Yellow (-GrnYel)

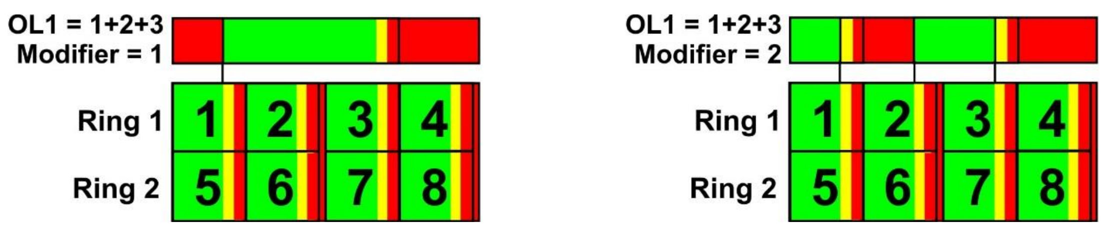
Both the *Included Phases* and the *Modifier Phases* control this overlap type as follows:

- The overlap is green when an included phase is green, or an included phase is timing yellow/red clearance and an included phase is next. In both of these cases, the modifier phase is not green.
- The overlap is yellow when an included phase is yellow, an included phase is not next, and a modifier phase is not green
- The overlap is red when the overlap green or yellow is not on

The *–GrnYel* overlap type uses the green output of the modifier phase to suppress the overlap. If the overlap is red when the modifier turns green, the overlap will be suppressed until the yellow clearance of the modifier phase (see example below with the modifier set to Ø1).

In the second example (modifier set to Ø2), the overlap will terminate at the point when the modifier phase is NEXT and remain suppressed until the end of the modifier green. This is the same configuration used in our last example for the NORMAL overlap type; however, in this case, the overlap displays a solid red indication when Ø1 is green instead of a "blank" indication used with the NORMAL type.

Please insure that all –GrnYel overlaps are included as preempt dwell overlaps in preempt Overlaps+ (MM->3->1->5).

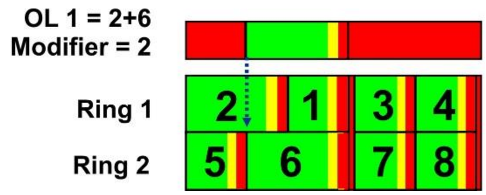


-GrnYel Type: Modifier Phases Suppresses the Overlap During When the Modifier Phase is Green

4.4.3 Overlap Type: Left Turn Permissive (L-PERM)

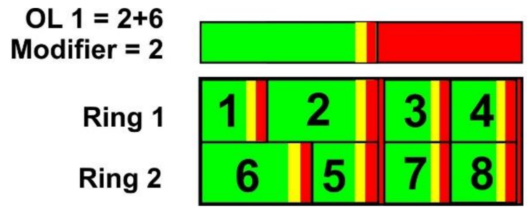
Both the Included Phases and the Modifier Phases control this overlap type as follows:

- The overlap turns green when an included phase, that is not a modifier phase, turns green (this is true even if a modifier phase is already displaying a green indication)
- The overlap remains green as long as one of the included phases remain green
- The overlap is yellow when an included phase is yellow and an included phase is not on or next
- The overlap is red when it is not green or yellow



These overlap outputs can provide the permissive green, yellow, and red indications for a 5-section left-turn display. The protected left-turn phase provides the green and yellow arrow indications. The *modifier phase* is used with the L-PERM type to suppress the overlap display when the protected movement is lagging but not leading. The *included phases* are entered as the two through movements for the barrier, and the modifier phase is entered as the conflicting through movement for the left turn. The example to the right defines an overlap used to drive the permitted indications in a left-turn display where Ø1 is the protected left-turn movement. This overlap is defined with Ø2 & Ø6 as the included phases, and Ø2 as the modifier phase.

The L-PERM overlap type suppresses the overlap green indication until the adjacent through phase turns green in the lagging left-turn display. This prevents the driver in the through direction (Ø6 in this case) from seeing a green indication in the left-turn display while the through indications are solid red. Once the adjacent through phase (in this case Ø6) turns green, the overlap remains green until the barrier is reached.



If the phase sequence is reversed (Ø1 leading instead of lagging), the overlap does not need to be suppressed, so the L-PERM overlap displays a solid green indication as shown to the right. During a dual-lead sequence (Ø1 and Ø5 leading), the overlap is suppressed with a solid read indication until the end of Ø1.

4.4.4 Overlap Type: Flashing Red (FL-RED)

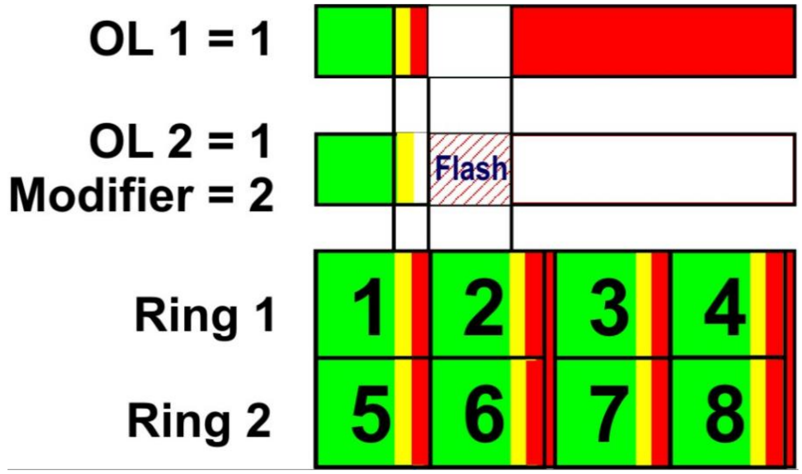
Both the Included Phases and the Modifier Phases control this overlap type as follows:

- The overlap is green when an included phase is green, or an included phase is timing yellow/red clearance and an included phase is next
- The overlap is yellow when an included phase is yellow and an included phase is not next
- The overlap is flashing red when the overlap green or yellow are not active, the modifier phase is green, and the modifier phase is not in ped clearance, or walk..
- The overlap is dark when the overlap is not green, yellow, or flashing red

This overlap type was developed to drive a flashing red indication in a 4-section left-turn signal display in place of the solid green permitted indication.

This overlap type requires two consecutive overlaps. The solid red indication in the display is driven from the first overlap and the flashing red display is driven from the second overlap red output. Never set Overlap A (1) to type FL-RED because it will be used to also clear the red of the previous overlap (i.e. overlap A (1) cannot used this feature). For example, if the protected movement (green and yellow arrow is assigned to phase 1, the solid red indication should be driven from overlap A (1) red and the flashing red indication should be driven from overlap B (2) red.

The overlaps for this configuration are shown to the right for a dual-lead sequence. Since the overlap is gated with the adjacent through movement's green, the overlap will go back to green when the adjacent turn goes to yellow, and the included left turn is next. This means that this feature should not be used if the adjacent through phase is utilizing the "walk through yellow" feature. The FL RED overlap type flashes at a rate of 60 flash cycles per minute (or once per second). This rate flashes the overlap red output at 500ms on, followed by 500ms off.



4.4.5 Overlap Type: FAST FL

The flash rate may be programmed within a range of values (OFF, 60, 120, 150 or 180 cycles per minute) from MM→1→5→1, *General Overlap Parameters.* Fast FL is used in Canada. It flashes the GREEN signal at the rate specified in the Fast-Fl Rate parameter. It is used for protected-permissive left turns. An overlap set to this type will flash green when the user programs both the included phase and modifier phase and that phase is active.

4.4.6 Overlap Type: FL GRN

FL GRN is a Flashing Green Overlap. This overlap type works similar to Canadian Fast Flash except that it flashes whenever the overlap is green.

4.4.7 Overlap Type: Right Turn (R-TURN)

The Included Phases and Modifier Phases are used to program this overlap type as follows:

- The overlap turns green when an included phase is green that is not also a modifier phase
- The overlap remains green if the next phase is also an included phase
- The overlap goes from green to red, without yellow, when the included next phase that is also a modifier phase turns green
- The overlap is yellow when an included phase is yellow, and an included phase is not next
- The overlap is red when the overlap is not green or yellow, or modifier phase is green

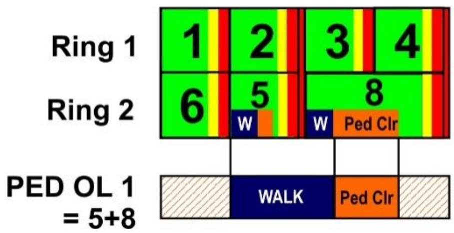
This overlap type provides a green right-turn arrow when a non-conflicting left turn is active. The overlap was designed to allow the right-turn arrow to remain illuminated through the compatible left turn clearances and move to red when the through movement becomes active.

4.4.8 Overlap Type: Ped Overlap (Ped-1)

Ped Overlaps are useful where there is a large median to store pedestrians midway in the crosswalk and the crossing can be broken into two sequential portions. The order of the included phases assigned to the overlap affects the mode of operation. This is the only overlap type where the order of the included phases is significant.

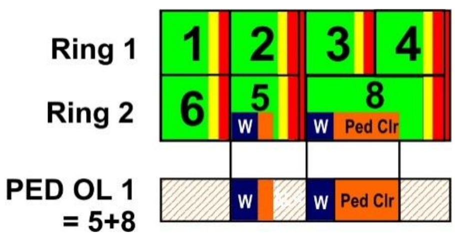
If each included phases is consecutive in the phase sequence, the ped overlap walk interval will begin timing with the first parent phase. Ped Clearance begins with the first included phase and ends with the ped clearance programmed for the last included phase assigned to the overlap.

```
  Ovrlp A     Ps.....................
Included Ps     5  8  0  0  0  0  0  0
Modifier Ps     0  0  0  0  0  0  0  0
Type:PED 1    Grn:  0  Yel: 3.5  Red: 1.5
```



Ped 1 Overlap Type With Included Phases 5 + 8 (note the order of the included phases)

Note how the operation of the PED 1 overlap changes when the order of the included phases is reversed. This operation is useful only if the pedestrian indication needs to be serviced more than once per cycle. The PED 1 overlap type will also service multiple pedestrian movements if the included phases assigned to the overlap are not consecutive.




```
  Ovrlp A     Ps.....................
Included Ps     8  5  0  0  0  0  0  0
Modifier Ps     0  0  0  0  0  0  0  0
Type:PED 1    Grn:  0  Yel: 3.5  Red: 1.5
```

The following rules must be followed to select included phases for Ped Overlaps.

- The included phases must be in the same ring
- The included phases must be sequential in the ring sequence, in order for the ped output to stay active between phase transitions. For instance, if you are overlapping 1+2 ped, then phases 1&2 must appear in order in the ring sequence. If they do not, then the ped will clear, and reactivate when the next included phase becomes active.
- For overlapping to occur, the following must happen: The walk must go active in the current included phase, and a ped call must be active in a subsequent included phase before the end of walk of the current phase.

4.4.9 Overlap Type: Min Green (Ped-1)

This overlap type is identical to the NORMAL overlap type with the exception that the overlap green extension is used to insure the minimum period that the overlap is green.

4.4.10 Overlap Type: Minus Walk (-WALK)

The **–WALK** type operation works the same as a NORMAL overlap except:

- The Overlap is inhibited only when the Walk output of an inhibit phase is active
- Only the Green of the overlap is darkened when inhibited by an inhibit walk.

To Program the **-WALK** overlap type:

- On the Overlap Program screen (MM->1→5->2->#->1) enter the included phases, and then the inhibit phases on the Modifier Phases row. Then set the Type to R-T/OTH.
- On the Overlap, Program, Confl Prog+ screen (MM->1->5->2->#->2), set the Type+ to "**-WALK**"

4.4.11 Overlap Type: R-T,ILL

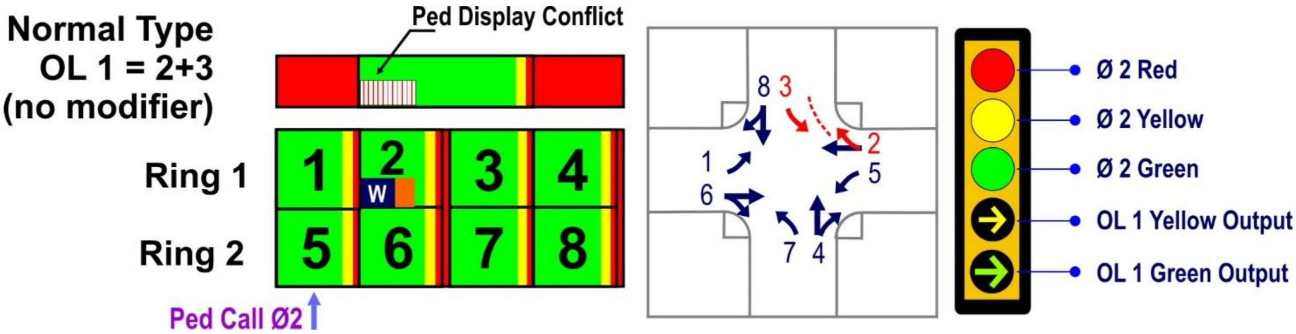
This overlap is also known as an Illinois overlap. This overlap will output based on the following conditions:

- If the modifier phase is green, the overlap will be red
- If the controller is running the modifier phase, and the phase next is also a modifier phase then the overlap will remain red
- In all other conditions, the modifier phase does not alter the overlap.

4.5 Overlap Plus Menu (MM->1->5->2->2)

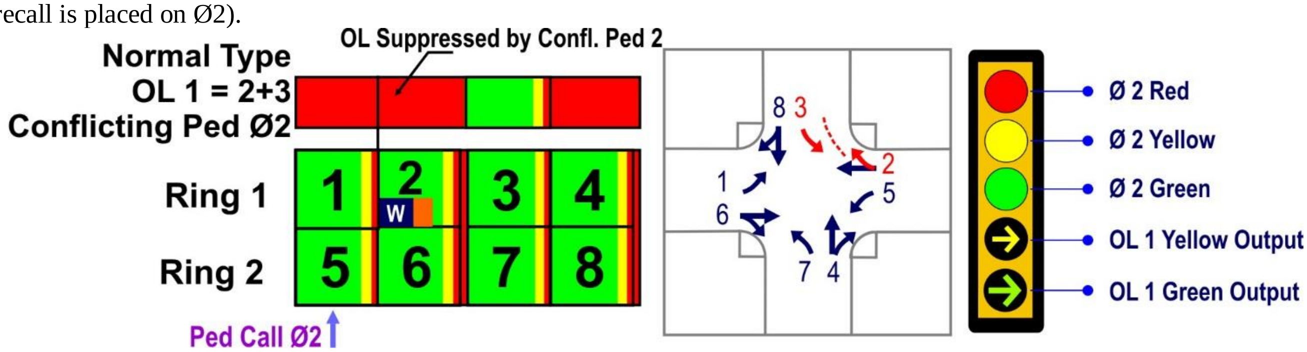
```
  Ovrlp A       Ps.....................
Confl Ps         0  0  0  0  0  0  0  0
Confl Ovrlps     0  0  0  0  0  0  0  0
Confl Peds       0  0  0  0  0  0  0  0
Lead Grn OFF    Delay   0 Type+ R-TURN
```

Conflicting phases, pedestrian and overlaps terminate an overlap when the conflicting phase, pedestrian movement or overlap is next and continue to suppress the overlap while the conflicting phase, pedestrian movement or conflicting overlap is timing green and yellow clearance. *Conflicting Peds* may be used to omit a right-turn indication when a pedestrian movement is serviced. The example below shows the right-turn arrow (overlap 1) conflicting with the ped signals during phase 2.



In this example, a right-turn indication (overlap 1 green) conflicts with the pedestrian signals during phase 2

The conflict between the right arrow and the walk indication may be avoided by programming the pedestrian phase as a *Conflicting Ped* to suppress the overlap whenever a ped call is placed on Ø2. The overlap will continue to be suppressed during Ø2 until the pedestrian call is serviced. The overlap will also be suppressed if the ped call is issued continuously (ped recall is placed on Ø2).



Here, a Conflicting Ped parameter is used to prevent the right-turn arrow conflict with the pedestrian signals

4.6 Additional Overlap Features

4.6.1 Lead Green Feature

The *Lead Green* parameter (ON/OFF) delays the start of the overlap green much like *the Green/Ped Delay* which delays the start of a phase green or walk indication.

4.6.2 Delay

The Delay parameter (0-255 seconds) is the time the overlap will remain dark, i.e. there is no red, yellow or green shown once the overlap is supposed to go green. It is used primarily in Canada.

4.6.3 FYA Delay Time

This is used in association with the flashing yellow arrow (FYA-4) overlap type. This programmable period (0-255 seconds) delays the flashing yellow arrow from immediately starting when the through phase turns green. When this timer is programmed the controller insures that the delay time that it uses is the lesser of "modifier min green - 2 seconds" or "FYA delay time".

4.6.4 FYA Skip Red

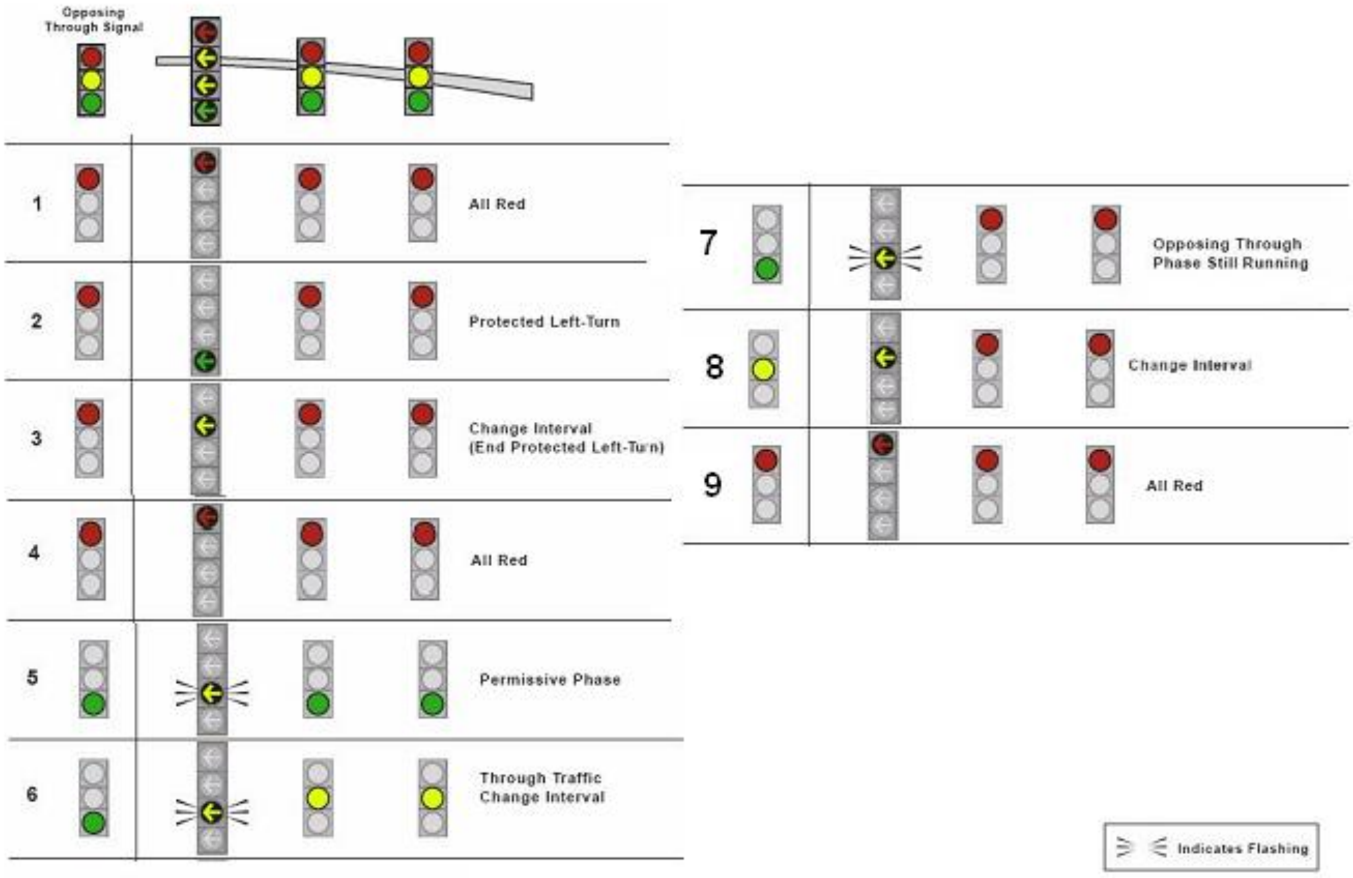
This feature is used when going from a protected movement to a permissive movement that brings up the Flashing Yellow Arrow. MUTCD allows the signal to go from steady yellow arrow of the protected movement directly to a Flashing yellow arrow on the permitted movement, without display any red on the protected movement. By setting this parameter to "**ON**", this allowed behavior will occur. Please be aware that this behavior will occur even if the protected movement has RedClr time programmed under MM→1→→1. In this case the Flashing Yellow Arrow for the permissive movement will be displayed during the Red Clearance period of the protected phase.

4.6.5 FYA AfterPreempt

Normally after any preemptions, FYA operation is suspended until the controller crosses a barrier. By setting this parameter to "**ON**", the FYA will immediately begin after the preemption is concluded, without crossing a barrier.

4.7 Flashing Yellow Arrows using Overlaps

Agencies may choose to use the flashing yellow arrow method for permissive left turns (see below). This is the implementation discussed in NCHRP Report 493. The Flashing Yellow Arrow was approved as the recommended signal indication for protected/permitted left-turn operation in the 2009 version of the MUTCD (Manual of Uniform Traffic Control Devices).



4.7.1 Version 61.x Flashing Yellow Overlap Programming

Version 61 accomplishes this by using existing pedestrian yellows outputs that are not normally used by the Walk and Don't Walk intervals. This feature allows the Flashing Yellow Arrow (FYA) output from an overlap to be mapped to the yellow output of a pedestrian channel. The yellow output is typically not used and therefore available for FYA use. In other words, the Overlap, during the modified phase period of that overlap, drives the pedestrian channel that is mapped to it, to flash the yellow arrow. This feature allows an FYA signal to be implemented without using a second full load switch position or cumbersome cabinet re-wiring. For example, we will change a protected only Phase 1 Left-turn to a Protect-Permissive using a 4-head signal with Flashing Yellow. We will program Overlap B (Overlap 2) that will utilize the Yellow Flash output from Phase 2 Ped Yellow.

Please note the user should assign only even-numbered overlaps for the Flashing Yellow Arrow(FYA). Odd-numbered overlaps that are one less than FYA must remain unassigned because the yellow is used as an alternate way to get the FYA output.

Channels are set up via MM→1→3→1. In this example we will use the default channel setup for a typical TS2 Cabinet.

Chan.	1	2	3	4	5	6	7	8
P/Olp#	1	2	3	4	5	6	7	8
Type	VEH	VEH	VEH	VEH	VEH	VEH	VEH	VEH
Flash	RED	RED	RED	RED	RED	RED	RED	RED

< Chan.	9	10	11	12	13	14	15	16
P/Olp#	1	2	3	4	2	4	6	8
Type	OLP	OLP	OLP	OLP	PED	PED	PED	PED
Flash	RED	RED	RED	RED	DRK	DRK	DRK	DRK

First set up overlap # 2 via MM→1→5→2→(olp) 2→1. Make sure you program the type as R-T/OTH and set up the included phase as the protected/permitted phase and the modifier phase as the conflicting through movement.

```
  Ovrlp B      Ps....................
Included Ps     1  0  0  0  0  0  0  0
Modifier Ps     2  0  0  0  0  0  0  0
Type:R-T/OTH Grn:  0  Yel: 3.5  Red: 1.5
```

Next go to the MM→1→5→2→(olp) 2→2 screen and make sure that you program the Type+ as FlYel-4 for a 4 section head. Note if you have a 3-section head you can program Type+ as FlYel-3.

```
  Ovrlp B        Ps.....................
Confl  Ps          0   0   0   0   0   0   0   0
Confl  Ovrlps      0   0   0   0   0   0   0   0
Confl  Peds        0   0   0   0   0   0   0   0
Lead Grn OFF     Delay   0  Type+  FlYel-4
```

Use the FYA mapping screen (MM→1→5→4) to map FYA outputs of overlaps to Pedestrian Clearance outputs of channels. Assume that Phase 2 Ped is programmed as the default Ped 2 channel, Channel 13.

```
Fl Yel Arw     # Olp Chan    # Olp Chan
               1   2   13    2   0    0
               3   0    0    4   0    0
```

The # columns show which of 4 FYA signals is being programmed. The Olp column shows the overlaps that are programmed as type FlYel-4. Up to four 4-output FYA overlaps may be mapped to Ped Clearance outputs. The first four overlaps that are programmed as type FlYel-4 will be shown in order. The user may enter the number of an output channel that is assigned as type "PED" to use its Ped clearance output. A zero entry means that no mapping takes place and the FYA output will appear as it usually does on the yellow overlap output of the overlap that is one number less than the main FYA overlap. For example, if overlap 6 is configured as type FlYel-4, its flashing yellow output will appear on the yellow output of overlap 5. If Ped Clearance mapping is setup, it will also appear on the ped clearance output of the channel programmed on this screen.

Note that if a channel assignment is made to a channel that is not assigned as Ped, the FYA mapping does not occur.

Note, too, that the overlap associated with the FYA mapping entry (#) is dependent upon whether it is first, second, etc. of the overlaps configured as FlYel-4. If overlap types are changed such that this order is changed, the Fl Yel Arrow mapping should be reviewed to ensure that the FYA outputs are mapped to the desired Ped Clearance outputs.

Running special operations such as preemption, may affect the output of this arrow such that you may have to "hard code" the clearance times to insure proper hardware monitoring of this channel.

Channels 13-16 Pedestrian Movements Assignment Example

The following is a reprint from the MMU manual which lays out the Ver 61 channel and left turn arrow channel assignments for a standard 16 channel TS2 controller using 4 left turn arrows.

FYA Programming 8/30/2007

4 Left Turns, Peds on 13-16

CONTROLLER

	Controller Channel Assignments															
Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Type	OLP	VEH	OLP	VEH	OLP	VEH	OLP	VEH	OLP	OLP	OLP	OLP	PED	PED	PED	PED
#	2	2	4	4	6	6	8	8	9	9	9	9	2	4	6	8

Controller FYA Overlap Setup								
Overlap		**2**		**4**		**6**		**8**
Olp Included		1		3		5		7
Olp Modifier		2		4		6		8
FYA out on Chan		13		14		15		16
OLP Type		R-T/OTH		R-T/OTH		R-T/OTH		R-T/OTH
OLP Type+		FLYel-4		FLYel-4		FLYel-4		FLYel-4

Notes

1 Assign only Even-numbered overlaps as FYA. Odd-numbered overlaps one less than FYA must remain unassigned b/c the yellow is used as an alternate way to get the FYA output.

MMU-516L

MMU FYA Setup				
FYA #	**1**	**2**	**3**	**4**
Type	FYA	FYA	FYA	FYA
FYA Channel	1	3	5	7
Yel Input Chan	13	14	15	16
Permissive 1	2	4	6	8
Permissive 2	13	14	15	16

Please note that the Channel numbers in parentheses are not programmed on the Program Card. Their FYA functionality is entered on the FYA Setup Screen as indicated above.

MMU Prog Card

Channel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1		(2)			5	6							(13)		15	
2					5	6							13		15	
3				(4)			7	8						(14)		16
4							7	8						14		16
5						(6)							13		(15)	
6													13		15	
7								(8)						14		(16)
8														14		16
9																
10																
11																
12																
13															15	
14																16
15																

FYA Inhibit and Other Considerations

The FYA will be inhibited only when the FYA overlap is not active and is not flashing yellow. This satisfies various state MUTCDs that do not allow Yellow Clearance for flashing yellow to be active while the Modifier phase (which normally conflicts with the left turn movement) is still green. The controller will begin a FYA inhibit only when the FYA overlap is Red and not flashing in two cases:

1) Inhibit by Time-of-day and
2) Inhibit due to preemption and the "**All Red B4 Prmpt**" parameter in preemption is set to ON.

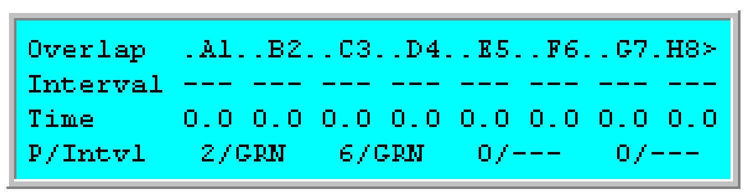
This prevents an FYA clearance from occurring asynchronously with the overlap's parent phases. If the FYA is inhibited by time-of-day, the inhibit will take affect the next time the overlap is Red. When the FYA is inhibited by preemption with "**All Red B4 Prmpt**" set, preemption will cause all rings to clear through All Red if any FYA is flashing yellow. This provides an opportunity for the FYA to clear while the conflicting thru phase (FYA modifier phase) is also timing yellow. If "**All Red B4 Prmpt**" is not set, then the FYA overlap will terminate immediately upon inhibit while the conflicting thru movement may remain green.

Note the following nuances with the FYA software. The yellow arrow will flash for a minimum of 2.0 seconds to insure proper clearances for the cabinet's conflict monitor. Also note, when the time of day pattern or preempt disables an overlap that is an FYA overlap, the software will finish out the yellow before dropping the overlap.. If FYA overlaps are inhibited during preemption, when the preemption is completed, the controller must cross the barrier before displaying the flashing yellow arrow. When time of day or preempt allows an omitted FYA overlap to be reestablished, it will not wait until the overlap is timing green or red. Finally, upon controller startup (i.e. controller power up, NEMA Ext. Startup, startup after Flash, etc. the FYA outputs will be inhibited until all phases are cycled and serviced once.

Another consideration is that FYA operation requires some synchronization before operation can begin, for safety reasons. For example, if the controller starts in the FYA modifier phases, you would then instantly startup in FYA operation – that is not always desirable. Additionally, the proper operation of FYA requires that the controller go from specific states to other specific states – you must pass through solid yellow, and for the monitor must see that yellow (or flashing yellow for a minimum time) and so forth. In order to achieve this synchronization requirement, the original implementation of FYA required that the controller cross the barrier before any FYA operation was allowed.

4.8 Overlap Status Display (MM->1->5->3)

Overlap Status is shown for each of the 16 overlaps in the controller. Intervals and timing show the individual clearance and extension timers for each overlap as shown in the figure to the right.



4.9 Automatic Flash (MM->1->4)

```
          Automatic Flash
1.Parameters
2.Phases/Overlaps
```

"Cabinet Flash" is a fallback mode of operation after an equipment failure or conflicting signal indication is detected by the MMU. During "Cabinet Flash", the transfer relays disable all channel outputs from the controller and flash the load switches though a separate flasher device.

Automatic Flash (or programmed flash) provides two alternate means of flashing the load switch channels through the controller instead of the cabinet flasher. This operation is controlled through the *Flash Mode* setting found in the *parameters* section of the *Automatic Flash* menu.

4.9.1 Flash Parameters (MM->1->4->1)

```
Auto Flash Parameters      - Clrnc Time -
  Flash Mode: CHANNEL       Yellow  3.5
 Input Src, Type 2: D-CONN    Red   1.5
 Restart upon Exit: OFF
Preempt Flash Parameters
 Pre Flash Mode: AUTO
 Pre Restart on Exit: OFF
```

The *Flash Parameters* determine the:

- *Flash Mode* used to flash the signal displays during automatic (or programmed) flash
- Source of the input triggering automatic flash
- Clearance times when the controller leaves automatic flash and returns to stop-and-go operation

Flash Mode

This entry determines the source of the flash data when the controller goes into flash. Three modes are available.

- **CHANNEL** – *Channel* settings are applied during *Automatic Flash*
- **Ø/Olap** – Phase/overlap flash settings (discussed in the next section) are applied during *Automatic Flash*
- **VOLT/MON** – the controller voltage-monitor and the fault-monitor signals are de-asserted during automatic flash causing the MMU to disengage the transfer relays and flash the cabinet through the flasher

Input Src

The *Input Source* defines the external input for *Automatic Flash*. This allows the controller to be easily adapted to TS1 cabinets without rewiring the external input. Valid values are D-CONN (D-connector input), TEST-A or TEST-B.

Yellow Clearance

If a channel is selected to flash yellow, then this parameter determines its yellow clearance time when it leaves flash.

Red Clearance

If a channel is selected to flash red, then this parameter determines its red clearance time when it leaves flash.

Restart Upon Exit

When set, this parameter causes a restart upon exit from automatic flash. It is intended to be used with Channel Flash or VOLT_MON flash modes. The variables such as all red time or startup flash will take effect is this parameter is programmed to "ON". This parameter is ignored when set to "OFF".

Pre-empt Flash Mode

This entry allows preempt flash mode to be different than automatic flash mode. Legacy operation is supported by the default mode set to "AUTO", which makes the preemption flash mode to be the same as the automatic flash mode. It determines the source of the flash data when the controller goes into Preemption Flash. Three modes are available.

- **AUTO** – Automatic Flash settings are applied as programmed on this screen
- **Ø/Olap** – Phase/overlap flash settings are applied during Preemption Flash
- **VOLT/MON** – the controller voltage-monitor and the fault-monitor signals are de-asserted during automatic flash causing the MMU to disengage the transfer relays and flash the cabinet through the flasher.

Pre Restart Upon Exit

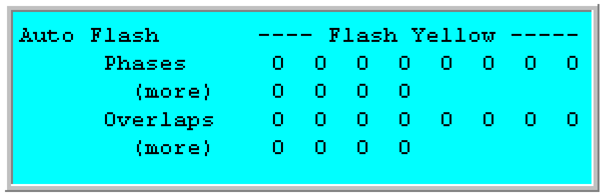
This parameter forces the controller to go through an external startup procedure when exiting the Preemption Flashing dwell period. It is intended to be used with Preempt Flash or VOLT_MON flash modes. The variables such as all red time or startup flash will take effect is this parameter is programmed to "ON". This parameter is ignored when set to "OFF".

Additional notes on the specific Flash Parameters

1) External Start with Preempt active causes startup flash until both are removed

2) Automatic flash and preempt call: When the preemption is set to NOT override automatic flash, it will cause the automatic flash to remain active until both automatic flash and preempt calls are inactive.

4.9.2 Ø / Overlap Flash Settings (MM->1->4->2)



Ø/Overlap Flash Settings provide an alternative to the CHANNEL flash settings and allow the user to specify which phases and/or overlaps flash yellow when *Automatic Flash* is activated. All undefined phases and overlaps will flash red unless programmed to flash yellow in this menu.

4.10 Events and Alarms (MM->1->6->4)

```
  Events      |    Alarms      |   Evts/Alrms
1.Enable Evts 4.Enable Alrm 7.Enables
2.Show Evts   5.Show Alarms 8.Status
3.Clear Buffr 6.Clear Buffr 9.Show Det
```

The software logs and time stamps events. Events can optionally be flagged as Alarms. Events are intended to be uploaded periodically by the central management system (perhaps only once per day) for historical purposes, whereas Alarms are typically relayed to the central management system as soon as possible

```
Event Enable     Column.1.2.3.4.5.6.7.8
    Event #s    1-8      X X X X X X X X
                 9-16     . X . . . . . .
                17-24     . . . . . . . .
                25-32     . . . . . . . .
                33-40     . . . . . . . .
                41-48     . . . . . . . .
                49-56  +  . . . . . . . .
```

There are 128 types of Events and Alarms that can be individually enabled or disabled. Events and Alarms are referenced by number; each Event number corresponds to the same Alarm number. An Alarm is enabled if and only if its corresponding Event is enabled; however, an Event does not necessarily need its corresponding Alarm to be enabled. This lets the user choose which Events should be deemed high priority and reported immediately to the central management system.

4.10.1 Pattern / Preempt Events (MM->1->6->7)

```
        Event/Alarm Parameters
Pattern Events OFF  Preempt Events OFF
Loc Txmt Alrms OFF
Re-Assign User Alarm In #1 (5):    0
Re-Assign User Alarm In #2 (6):    0
Mon/Flash Alarm Delay (31)(secs)   0
Map Ped Ins 1,3,5,7 to User Alms  OFF
```

Pattern changes and *Preempt Events* are stored in the events log and enabled separately from *Event / Alarm Parameters*.

Pattern Events

A *Pattern Event* and time-stamp is generated whenever there is a change in the active coordination pattern.

Preempt Events

A *Preempt Event* and time-stamp is generated whenever preemption begins or ends.

Local Transmit Alarms

Do not enable *Local Transmit Alarms* if the local controller is being polled by a closed loop master, ATMS.now or StreetWise. This feature should only be enabled if the local controller is programmed to forward alarms over a dialup modem.

Re-Assign User Alarm IN

These two entries allow the general-purpose NEMA Inputs, Alarm In 1 and Alarm In 2 to be mapped to the alarm # that is entered. If this entry is 0, then the Alarm inputs are mapped to their default alarm numbers that are shown in parenthesis. The alarm input flexibility that this provides allows users to mimic other manufacturers controllers when replacing them in existing non-standard NEMA cabinets.

Mon/Flash Alarm Delay (31)(secs)

Alarm # 31 is a new alarm with a built-in Delay Feature. This alarm becomes active after the user-programmed delay expires if the monitor, or a controller fault, causes the cabinet to flash. Specifically, the alarm is activated by:

1) A controller fault
2) A non-critical SDLC fault, including non-response after power-up
3) NEMA input "MMU Flash In" if the Local Flash Input is not active
4) NEMA input "Stop Time In" if the Local Flash Input is not active

This alarm will issue a pulse when three power-ups occur without sufficient time between them. The user should enter the seconds that the flash alarm may exist without setting the alarm. This allows momentary flashing due to MMU startup flash to NOT generate this alarm. If short flashes occur three times without meeting the delay, and these occur with less than 12 hours in between occurrences, then this alarm is asserted momentarily.

This alarm can be avoided for Monitor Startup Flash periods by setting a time (in seconds) in the delay parameter that is greater than the monitor's startup flash time. This alarm is not intended for use with CVM Auto-Flash Mode in the 980 as this mode of auto-flash causes the Monitor to flash the cabinet and it is indistinguishable from a monitor fault flash.

Map Ped Ins 1,3,5,7 to User Alarms

This feature will map Pedestrian inputs 1, 3, 5, & 7 to user alarms 3, 4, 5 and 6. The user enters "ON" to enable this feature and "OFF" to disable this feature. **When this feature is enabled, these inputs will not place the respective pedestrian calls.**

4.10.2 The Events Buffer (MM->1->6->2)

The *Events Buffer* stores event data so it can be uploaded to a closed loop master and/or the central system. In the example above, each event is date and time stamped with the "Stn" (controller Station ID address).

```
 # Date   Time   Stn  Typ  Data ----------
 1 05-22  11:23  701  ALM  #1   ON   00
 2 05-22  13:11  701  LPT   2   2  1   1 00 00
 3 05-22  14:47  701  PRE  #3    0     1
 3 05-22  15:27  701  PRE  #0    0     0
 5 00-00  00:00  701  LPT  54   54 8   8 00 00
 6 00-00  00:00  701  LPT  55   55 8   8 00 00
 7 00-00  00:00    0       00 00 00 00 00 00
 8 00-00  00:00    0       00 00 00 00 00 00
 9 00-00  00:00    0       00 00 00 00 00 00
10 00-00  00:00    0       00 00 00 00 00 00
```

- Event# 1 records Alarm# 1 when the controller was last powered up
- Event# 2 records a local pattern event (LPT) when pattern # 2 became active
- Event# 3 records preempt #3 activated at 14:47
- Event# 4 shows when the preempt left at 15:27
- Event# 5 records a local pattern event (LPT) running NTCIP pattern # 254 (FREE).
- Event# 6 records a local pattern event (LPT) running NTCIP pattern # 255 (FLASH)

The *Event Buffer* (internal buffer) holds 40 events and a separate *Event Display Buffer* (shown above) displays the last 10 events until the central can poll the information from the local controller. After 10 events are recorded, the most recent event will be placed in Event #1 and all events will pushed down the list to the next event # (First-in First-out stack). Therefore, *Local Events* should be polled from the central frequently enough to avoid losing any event information stored in the controller's event buffer. StreetWise and ATMS.now interprets these event codes to generate query reports at the central office, so you don't have to view them from the controller.

4.10.3 The Alarms Buffer (MM->1-6->5)

```
 # Date   Time   Stn  Typ  Data ----------
 1 05-22  21:23  701  ALM  #  1   ON   00
 2 00-00  00:00   0        00 00 00 00 00 00
 3 00-00  00:00   0        00 00 00 00 00 00
 4 00-00  00:00   0        00 00 00 00 00 00
 5 00-00  00:00   0        00 00 00 00 00 00
 6 00-00  00:00   0        00 00 00 00 00 00
 7 00-00  00:00   0        00 00 00 00 00 00
 8 00-00  00:00   0        00 00 00 00 00 00
 9 00-00  00:00   0        00 00 00 00 00 00
10 00-00  00:00   0        00 00 00 00 00 00
....
20 00-00  00:00   0        00 00 00 00 00 00
```

The internal *Alarms Buffer* and *Event Buffer* are very similar; however, only events that are enabled as alarms under menu MM->1->6->4 will be logged to the *Alarm Buffer*. Alarms enabled under menu MM->1->6->4 MUST also be enabled as events under menu MM->1->6->2 to be stored in the *Alarm Buffer*. Note that local pattern events (LPT) and preempt events (PRE) are stored in the *Event Buffer*, not in the *Alarm Buffer*. However, if preempts are required as alarms, the preempt inputs may be wired to external alarm inputs in the cabinet as shown in the table.

The *Alarm Buffer* has a capacity of 20 alarms. If the Alarm Buffer has 20 alarms, any subsequent alarms are discarded until the Alarm Buffer is manually cleared (see next section) or uploaded to the central system.

4.10.4 Clear Event and Alarm Buffers.

```
CAUTION: This function clears all Events
      press Enter to begin...

      press ESC to go back...
```

MM->1->6->3 clears the *Event Buffer* and MM->1->6->6 allows the user to manually clear the *Alarm Buffer*.

4.10.5 The Detector Events Buffer (MM->1->6->9)

#	Date	Time	Stn	Typ	Data ----------					
1	05-18	07:04	701	DET	01	D3	00	00	00	00
2	05-18	07:16	701	DET	01	00	00	00	00	00
3	00-00	00:00	0		00	00	00	00	00	00
4	00-00	00:00	0		00	00	00	00	00	00
5	00-00	00:00	0		00	00	00	00	00	00
6	00-00	00:00	0		00	00	00	00	00	00
7	00-00	00:00	0		00	00	00	00	00	00
8	00-00	00:00	0		00	00	00	00	00	00
9	00-00	00:00	0		00	00	00	00	00	00
10	00-00	00:00	0		00	00	00	00	00	00

Detector Events are stored in a separate 50 record buffer and uploaded to StreetWise or ATMS.now with the *Local Event* buffer. In the display to the right, Detector 1 at Station ID 701 failed at 07:04 with a fault code "D3" and became active again at 07:16. . ***Please Note that Detector Numbers will and error codes will be displayed in hexadecimal notation***.

NTCIP 2.3.5.4.2 OCCUPANCY DATA calls for detector faults to be stored as occupancy data using the following values. These codes are interpreted by StreetWise and ATMS.now and converted to “friendly” text messages.

The following table documents the occupancy values for each NEMA detector faults.

Fault (decimal)	Fault (Hexadecimal)	Fault (Stored as Occupancy Data)
210	D2	Max Presence Fault
211	D3	No Activity Fault
212	D4	Open Loop Fault
213	D5	Shorted Loop Fault
214	D6	Excessive Inductance Change
215	D7	Reserved
216	D8	Watchdog Fault
217	D9	Erratic Output Fault

The following table documents the occupancy values for each NEMA Pedestrian detector faults.

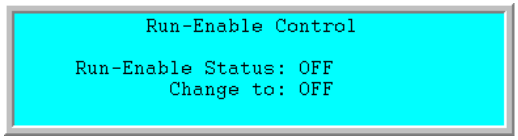
Fault (decimal)	Fault (Hexadecimal)	Fault (Stored as Occupancy Data)
1	01	No Activity Fault
2	02	Max Presence Fault
4	04	Erratic Output Fault
5	05	Erratic Output/No Activity
6	06	Erratic Output/ Max Presence

4.11 Predefined Event / Alarm Functions

See chapter 13 for a complete alarm listing with definitions for each alarm.

4.12 Enable Run Timer (MM→1→7)

Enable Run shows the current status of the ***Run Timer*** programmed under menu **MM->1->7**. As discussed in chapter 2, the Run Timer is used with the ***Clear & Init All*** **utility (MM->8->4->1).** This utility allows the user to initialize the controller to a default database after turning the **Run Timer to OFF (MM->1->7)**. The run timer disables all outputs from the controller and insures that the cabinet is in flash when the database is initialized. The user should use caution when initializing the controller database because all existing program data will be erased and overwritten. When the initialization is complete, the user should turn the **Run Timer to ON (MM->1->7)** to finalize the initialization (i.e. finalizing phase sequence and concurrency based on phase mode programming, latching output mapping, binding communications, etc.) and activate the unit. Note: when the run timer is first activated, calls are placed for all phases not omitted and for pedestrians that have walk and Ped clearance times that are programmed under MM→1→1→1. If the Run Timer is in the OFF state when the controller is shut off, then the Run Timer will remain in the OFF state upon reboot until manually turned ON.

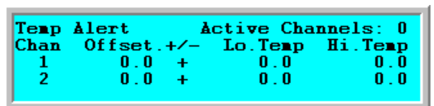


4.13 Temperature Alert (MM→1→8)

This feature is utilized with our TempAlert Road Temperature Measuring and Sensing System, which uses TempAlert probes embedded in the roadway and TempAlert rack mounted detectors that communicate to the 980 TS2 controller's PCPrint port via RS232 communications. The controller scans up to two temperature channels via a communications port and can relay this information to Streetwise ATMS. The user must set up the PC Print port to communicate with the TempAlert detector. Program the *Comm General parameters* (MM→6→1) PC/Print port's Mode to TEMP ALT and you can program other parameters such as Baud Rate *under Comm Port Parameters, P-2 PC/Print* (MM→6→2→2).

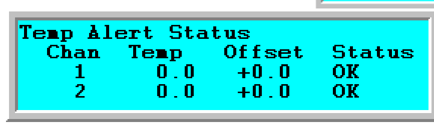
4.13.1 Temp Setup (MM→1→8→1)

This menu allows the user to set temperature thresholds for the TempAlert probes.

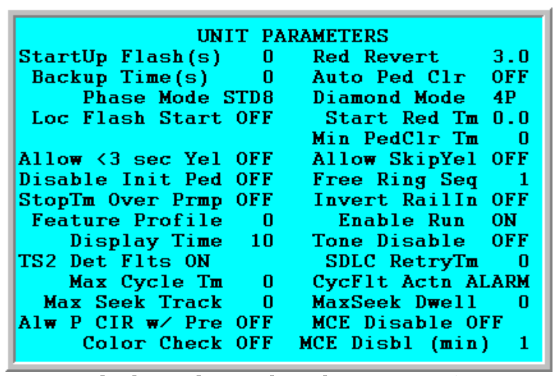


4.13.2 Temp Status (MM→1→8→2)

This menu shows the status for each probe.



4.14 Unit Parameters (MM->1->2->1)



Start Up Flash

Start-up Flash (0-255 sec) determines how long a controller will remain in flash following a power interruption. During *Start-up Flash*, the Fault Monitor and CVM (Controller Voltage Monitor) outputs are inactive. The *Start Red Time* can be used to time an all-red interval immediately after the Start-up Flash interval.

Red Revert

Red Revert (0-25.5 sec) applies to all phases that are programmed as red rest phases. This parameter insures that the phase will remain in red rest for the minimum period specified before the phase is reserviced. Each phase may override this value under *Phase Times* (MM->1->1->1).

Backup Time

Backup Time (0 – 9999 sec.) is used to test the communications between a secondary controller and a field or central master. If no communications have been received before the backup delay timer expires, the controller considers the system to be offline and reverts to its internal time based scheduler for its operating mode.

A zero *Backup Time* allows the central to override the active pattern in the controller indefinitely if the remote override time in StreetWise or ATMS.now is set to 255.

Auto Pedestrian Clear

The *Automatic Pedestrian Clear* parameter may be either enabled or disabled. This option determines the behavior of the pedestrian clearance interval for the controller when manual control is enabled. When enabled, it prevents the pedestrian clearance interval from being terminated by the Interval Advance input.

Phase Mode

```
            UNIT PARAMETERS
StartUp Flash(s)    0   Red Revert     3.0
 Backup Time(s)     0   Auto Ped Clr   OFF
     Phase Mode STD8    Diamond Mode   4P
 Loc Flash Start OFF     Start Red Tm  0.0
                        Min PedClr Tm    0
Allow <3 sec Yel OFF    Allow SkipYel  OFF
Disable Init Ped OFF    Free Ring Seq    1
StopTm Over Prmp OFF    Invert RailIn  OFF
 Feature Profile    0     Enable Run   ON
    Display Time   10   Tone Disable   OFF
TS2 Det Flts ON          SDLC RetryTm    0
    Max Cycle Tm    0   CycFlt Actn  ALARM
  Max Seek Track    0   MaxSeek Dwell    0
Alw P CIR w/ Pre OFF    MCE Disable OFF
     Color Check OFF  MCE Disbl (min)    1
```

Phase Mode sets the operating mode and automatically programs the default phase sequence and concurrencies for the specified mode. **The *Run Timer* must be turned OFF under MM->1->7 to change *Phase Mode*.** This insures that the controller outputs are off and not driving any channel outputs. The five *Phase Modes* were covered in an earlier section of this chapter.

STD8 Phase Mode is the best practice for all applications unless intersection geometry and sequencing are too complex.

NOTE: If Phase mode is reset by the user to STD8, any changes is the sequence table (MM-1-2-4) or the concurrency table (MM-1-1-4) will be overwritten by the STD8 defaults upon the Run Timer going from OFF to ON or a power cycle!

Diamond Mode

Diamond Mode only applies if the *Phase Mode* is set to DIAMOND. The three *Diamond Modes* are 4-Phase, 3-Phase, and Separate Intersection. Please refer to the *Operations Manual for Texas Diamond Controllers* for a description of the various diamond operations.

Local Flash Start

In version 61 here are 2 possible selections, ON or OFF. Set Local Flash Start to ON to force the controller to perform an "External Start" when the Local Flash input transitions from active to inactive. This feature was originally used in NEMA cabinets that were built prior to TS2-98 and that didn't have a diode/capacitor network installed in the cabinet on the EXT START input. The Local Flash Start parameter essentially replaced a diode/cap circuit with a software feature. When the feature is enabled (ON), it would issue a virtual EXT START to the controller when the Local Flash Input transitioned to the INACTIVE state (i.e. when the maintenance flash switch was turned off). This setting should typically be set to OFF for TS1 cabinets that provide hardware circuits to delay the flash transfer relays after Local Flash Input resets the controller.

Start Red Time

Start Red Time (0-25.5 seconds) is an all-red period at the end of *Startup Flash* when the controller is reset (power-up or an SDLC fault is cleared). *Startup* values (MM->1->1->4) must be set to ***RED*** or ***RED CLR*** before *Start Red Time* can be applied.

Min PedClr Tm

Minimum Pedestrian Clearance Time guarantees the specified ped clearance time (in seconds) for all active phases. This value applies to all operational modes except stop timing (police button operation). An error message is displayed from menu MM->1->1->1 if the user attempts to enter a ped clearance time less than the *Min PedClr Tim.*

Allow <3 Sec Yel

The controller enforces the minimum yellow clearance time of 3" specified in the MUTCD unless *Allow <3 Sec Yel* is ON. Turn this value ON when a yellow clearance less than 3 seconds is required on a phase (such as a clearance driving an overlap and not a vehicle display).

Allow Skip Yellow

Allow Skip Yellow must be enabled in order to use the OMIT YEL, YEL Ø discussed in the last section under options plus.

Disable Initial Ped

Disable Initial Pedestrian Movements disables pedestrian calls during the first cycle after a controller reset. This is a temporary value that is not part of the controller database and is always set to OFF after the controller powers up.

Free Ring Seq

The default phase sequence for FREE operation is Seq # 1 (dual-ring, left-turns first sequence). *Free Ring Seq* is initialized to "0" when you initialize the controller to STD8 operation that does not override the default Seq # 1. Any other value (2-16) for *Free Ring Sequence* overrides Seq# 1 as the default phase sequence for FREE operation.

Stop-Time Over Preempt (priority)

```
              UNIT PARAMETERS
StartUp Flash(s)   0   Red Revert     3.0
 Backup Time(s)    0   Auto Ped Clr   OFF
     Phase Mode STD8   Diamond Mode    4P
 Loc Flash Start OFF    Start Red Tm  0.0
                        Min PedClr Tm   0
Allow <3 sec Yel OFF   Allow SkipYel  OFF
Disable Init Ped OFF   Free Ring Seq    1
StopTm Over Prmp OFF   Invert RailIn  OFF
 Feature Profile   0     Enable Run    ON
    Display Time  10   Tone Disable   OFF
TS2 Det Flts ON         SDLC RetryTm    0
    Max Cycle Tm   0   CycFlt Actn  ALARM
  Max Seek Track   0   MaxSeek Dwell    0
Alw P CIR w/ Pre OFF   MCE Disable    OFF
     Color Check OFF  MCE Disbl (min)   1
```

Stop-Time Over Preempt causes the *Stop-Time* inputs to have priority over *Preempt* inputs. *Stop-Time* is often wired to the output of the conflict monitor unit so that in the event of a monitor fault, the controller is halted to help diagnose the fault. Since preemption has priority over stop-time, a preempt will cause the controller to begin timing again and the diagnostic information will be lost. Setting *Stop-Time Over Preempt* to ON prevents a preempt from overriding stop timing and preserves this diagnostic information. However, be aware that preempts will be ignored if the *Stop-Time* switch on the maintenance panel is activated.

Feature Profile

This parameter allows predefined selections to be removed from the menu screens. The default value, 0, allows all menu selections to be visible and accessed according to security definitions. Currently, the only other value allowed is 1 which removes selection 9 from the main menu screen on the 981 TS2 master controller.

Enable Run

Enable Run shows the current status of the ***Run Timer*** programmed under menu **MM->1->7**. As discussed in a previous section of this chapter, the Run Timer is used with the ***Clear & Init All* utility (MM->8->4->1).** This utility allows the user to initialize the controller to a default database after turning the **Run Timer to OFF (MM->1->7)**. The run timer disables all outputs from the controller and insures that the cabinet is in flash when the database is initialized. The user should use caution when initializing the controller database because all existing program data will be erased and overwritten. When the initialization is complete, the user should turn the **Run Timer to ON (MM->1->7)** to finalize the initialization (i.e. finalizing phase sequence and concurrency based on phase mode programming, latching output mapping, binding communications, etc.) and activate the unit. Note: when the run timer is first activated, calls are placed for all phases not omitted and for pedestrians that have walk and Ped clearance times that are programmed under MM→1→1→1. If the Run Timer is in the OFF state when the controller is shut off, then the Run Timer will remain in the OFF state upon reboot until manually turned ON.

Display Time

Display Time sets the timeout (0-99 minutes) that reverts the display to its default screen and logs off the user. If security is set under MM->8->2, the user must "log in" with a security access code after the *Display Time* expires. If the *Display Time* is set to zero, a value of one minute is used to insure that the screen does not timeout.

Tone Disable

Set *Tone Disable* to ON to disable audible tones for keyboard operations.

Max Cycle Tm

Maximum-Cycle-Time is a manual override value used to check that the controller is cycling properly. If no value is entered, the controller will calculate a value based on the controller phase and coordination programming. A different value is calculated for free and for coordinated operation. The user can enter a value (in seconds) to override the calculated value that the controller uses to perform this check, **for FREE operation only**. Please note that the calculated time under coordination is calculated as three times the cycle length. Under the USER phase mode, in Free operation, it is defaulted to 420 seconds. The Cycle Fault Action parameter determines the controller response to Max Cycle Time as described below.

CycFlt Actn

A *Cycle-Fault-Actn* is declared when the *Max Cycle Tm* or the preemption seek times (*Max Seek Trak Tim* or *Max Seek Dwel Tim*) are exceeded. The *Cycle Fault Action* setting determines whether the controller generates an ALARM or enters FLASH when the cycle fault occurs. A cycle fault occurs only if the controller does not service valid demand within the allotted time while it is operating in a coordinated mode. A cycle failure is declared if it is operating free.

Max Seek Trak Tim

Maximum-Seek-Track-Clearance-Time is used to check if the track phases become active as quickly as expected when a railroad preempt is received. Enter a value at least one second greater than the maximum time anticipated for the controller will take to achieve track clearance. A zero entry disables the feature.

Max Seek Dwel Tim

Maximum-Seek-Preempt-Dwell-Time is used to check if the preempt dwell phases become active within the maximum expected time following the beginning of track clearance during railroad preemption or from the beginning of an emergency preempt. Enter a value at least one second greater than the maximum time anticipated to achieve preempt dwell. A zero entry disables the feature.

Color Check

The color check feature compares the active channel color outputs to the status as reported by the MMU. It was added for versions 61.3n or above. If these disagree for 800-900 ms, then the controller declares a "color check" fault. The feature has a global enable (Color Check) on the controller parameters screen (MM->1->2->1), at the bottom. There is a screen to disable checking for individual color outputs at MM->1->3->9->3. Set this parameter to ON if you want to enable the Color Check feature.

Allow Phase CIR with Preempt

This unit parameter allows the Phase Call-Inhibit-Redirect (CIR) (MM→1→1→5) features to be active during preemption. If enabled (ON), then CIR programming remains in effect during preemption. If not enabled (OFF), then CIR programming is disabled from the beginning of preemption through the Dwell interval. It is re-enabled at the end of preempt dwell so that it will be in effect as the controller returns to normal (non-preempted) operation.

MCE Disable

Programming this unit parameter will affect the Manual Control Enable (MCE) input. This entry has three options:

OFF - The Manual Control Enable function is disabled

ON - The MCE is enabled for standard operation

TIMED - The MCE is enabled, but after being active for the time entered in MCE DISBL (min), its input is ignored until it cycles to the inactive state.

MCE Disable (min)

If the MCE Disable is set to TIMED, then this parameter determines the number of minutes that an active input will be recognized. This feature allows automatic recovery if the MCE switch is left ON inadvertently. MCE Disable is programmable from 1-24 minutes.

5 Detection

5.1 Detector Programming (MM->5)

```
              DETECTORS
1.Veh Parms    4.Ped Parms    7.Status
2.Veh Options  5.Alt Progs    8.V/O-Speed
3.Veh Parms+   6.Phas Recall  9.Copy
```

Our controllers provide all NTCIP objects related to detection with additional “plus” features to enhance functionality. NEMA TS 1 provides one detector input per phase to call and extend the phase (each phase has one source or channel of detection). TS2 cabinets provide separate detector inputs that can be individually programmed to call and/or extend any phase. Each of the 64 “logical” detectors in the controller can be visualized as an input channel assigned to a call phase. These “logical” detectors may be sourced from “physical” detectors in the detector rack or from another “logical” detector (1-64).

5.1.1 Vehicle Parameters (MM->5->1, Left Menu)

Det#		Call	Switch	Delay	Extend	Queue >
1		1	0	0.0	0.0	0
2		16	16	25.5	25.5	255
3		3	0	0.0	0.0	0
4		4	0	0.0	0.0	0
5		5	0	0.0	0.0	0
6		6	0	0.0	0.0	0
7	+	7	0	0.0	0.0	0

Detectors may be assigned to an active phase to drive the actuated features of the controller or may be used as system detectors to collect volume and occupancy or detect queue failures. The *Call* phase parameter defines an input channel for the phase that will receive the call when a detector has been actuated. The *Switch* phase allows a detector to call and extend the call phase, while also providing extends to a secondary phase.

Delay, *Extend* and *Queue* times modify the phase input. The *Delay* timer inhibits the detector input until the *Delay* timer expires. The *Extend* timer “stretches” the detector call for a user specified extend time. The *Queue* timer inhibits a detector after a delay time based on the start of the green interval.

Call Phase

The *Call Phase* receives detector actuations when the phase is red if *Call* option is enabled for the detector (MM->5->2). The *Call Phase* also receives detector actuations when the phase is green if the *Extend* or *Queue* option for the detector is enabled. If *Call Phase* is set to zero, the call and extend features of the detector are disabled, but volume and occupancy may still be sampled. Occupancy measured during the green, yellow or red interval requires a *Call Phase* other than zero.

Switch Phase

The *Switch Phase* is extended when the assigned *Call Phase* is red or yellow, and the *Switch Phase* is green. Note that the *Call Phase* is not called when the *Switch Phase* is green. This feature is typically used for protected/permitted left-turn applications to call and extend a protected left-turn phase after the cross street is serviced and extend the permitted indication by programming a *Switch Phase* corresponding with the adjacent through movement.

Delay

The *Delay* parameter is the amount of time in tenths of seconds (0-255.0 sec) that the actuation from the detector is delayed when the assigned phase is not green.

Extend

The *Extend* parameter is the amount of time in tenths of seconds (0-25.5 sec) that the actuation is extended after the point of termination, when the phase is green. *Extend* is only effective when the *Extend* option is enabled for the detector under *Vehicle Options* (MM->5->2).

Queue Limit

Queue Limit (0-255 sec) determines how long a detector actuation is active after the start of the green interval. After the timer expires, actuations from the detector are ignored. *Queue Limit* is only effective when the *Queue* option is enabled and the *Extend* option is disabled for the detector under *Vehicle Options* (MM->5->2).

5.1.2 Detector Diagnostic Vehicle Parameters (MM->5->1, Right Menu)

Vehicle Parameters include detector diagnostics programmed from the right menu of MM->5->1. The *No Activity* time insures that the detector has received a call within the specified period. The *Max Presence* time fails the detector if a constant call exceeds the specified period (both of these values are expressed in minutes). *Erratic Counts* (expressed in actuations per minute) isolates a chattering detector that is issuing false calls.

< Det#	NoAct	MaxPres	ErrCnt	FailTime
1	0	0	0	2
2	255	255	255	255
3	0	0	0	2
4	15	10	0	2
5	0	0	0	2
6	0	0	30	2
7 +	0	0	0	2

If any of these diagnostics fail, the controller will place a recall on the phase called by the detector. This recall insures the greater of *Min Green* or the *Fail Time* programmed under *Vehicle Parameters*. The recall generated is not a traditional recall but instead acts as though a continuous call is present until such time as the detector is classified as working. In addition, real-time vehicle alarm status is provided under MM->5->7->1 and MM->5->7->2.

Real-time vehicle alarm status is provided under MM->5->7->1 and MM->5->7->2.

Vehicle Detector - No Activity

No Activity (0-255 min) fails the detector if it has not issued a call within the specified period of time. The failed detector will continue to place a call on the assigned *Call Phase* and extend the *Call Phase* until the detector receives a call and resets the *No Activity* failure. The *No Activity* failure will continue to service the *Call Phase* for the greater of *Min Green* or the specified *Fail Time* for the detector. NEMA requires that *No Activity* logs a value of 211 in the current occupancy sample for the detector. A value of 0 disables this feature and a common practice is to call an alternate detector map through a pattern to disable *No Activity* diagnostics late at night when traffic volumes are light.

Vehicle Detector - Max Presence

Max Presence (0-255 min) fails the detector if it has issued a constant call after the specified period of time. The failed detector will continue to place a call on the assigned *Call Phase* and extend the *Call Phase* until the constant call on the detector is reset. The *Max Presence* failure will continue to service the *Call Phase* for the greater of *Min Green* or the specified *Fail Time* for the detector until the detector is reset. NEMA requires that *Max Presence* logs a value of 210 in the current occupancy sample for the detector. A value of 0 disables this feature; however, it is not necessary to disable *Max Presence* during light traffic conditions because a *Max Presence* failure will provide a min recall on the phase instead of driving the phase to max with a constant call.

Vehicle Detector - Erratic Counts

Erratic Counts is expressed in counts-per-minute (0-255 cpm) instead of seconds. This detector diagnostic isolates a "chattering" detector that is issuing false calls to the controller. Typical values for *Erratic Counts* range from 40-70. The *Erratic Counts* failure will continue to service the *Call Phase* for the greater of *Min Green* or the specified *Fail Time* until the number of counts per minute drops below the specified threshold. NEMA requires that *Erratic Counts* logs a value of 217 in the current occupancy sample for the detector. A value of 0 disables this feature; however, it is not necessary to disable *Erratic Counts* during light traffic conditions.

Vehicle Detector - Fail Time

When a detector diagnostic fails, a call is issued to the *Call Phase* of the failed detector and the *Call Phase* is extended by the greater of *Min Green* or the specified *Fail Time* (1-254 seconds). If the *Fail Time* exceeds the *Max Green* time for the *Call Phase*, the issued call will go to *Max Green*. Note that a 0" *Fail Time* disables this call and extend feature when a detector fails. A 0" *Fail Time* will always prevent a failed detector from placing a call, so the default Fail *Time* for STD8 is set to 2 seconds. This insures that the greater of *Fail Time* or *Min Green* is applied to recall the phase when the detector fails. A *Fail Time* equal to 255" insures that a constant call extends the phase when a detector fails.

5.1.3 Vehicle Options (MM->5->2, Left Menu)

Det#	Call	Extend	Queue	Add.Init ->	
1	X	X	.	X	Extend Selected
2	X		X	X	Queue Selected
3	X	X	X	X	Extend Selected
4	X	X	.	X	
5	X	X	.	X	
6	X	X	.	X	
7	X	X	.	X	
.....					
64	X	X	.	.	

Each of the 64 "logical" detectors may be programmed to *Call* and/or *Extend* the *Call Phase* specified under *Vehicle Parameters*. *Extend* overrides the *Queue* option as shown in the example to the right. Therefore, do not enable *Extend* if the *Queue* time under *Vehicle Parameters* (MM->5->1) is to be applied. *Extend* and *Queue* are mutually exclusive.

Vehicle Option - Call

The *Call* option enables a detector to call the *Call Phase* when the *Call Phase* is not green and any assigned *Switch* phase is also not green. If the assigned *Switch* phase is zero, then a call is issued to the *Call Phase* whenever the *Call Phase* is not green. Therefore, if a *Switch* phase is not assigned, the detector will call the *Call Phase* whenever it is in yellow or red.

Vehicle Option - Extend

The *Extend* option resets *Extension* timer of the assigned phase to extend the green interval. The *Extend* option overrides the *Queue* option as described below.

Vehicle Option - Queue

The *Queue* option allows the detector to extend the assigned phase until either a gap occurs (no actuation) or the green has been active longer than *Queue* limit specified under Vehicle Parameters (MM->5->1). This feature is useful for detectors located at or close to the stop-bar that call and extend the phase during the initial green but drop out after the queue clears to allow setback detectors to gap out the phase farther upstream. For this feature to operate, the *Extend* Vehicle Option for this detector must be disabled and the *Extend time* under Vehicle Parameters should be programmed**.**

Vehicle Option - Added Initial

This option enables the detector to accumulate vehicle volumes during the yellow and red intervals that are used with added initial calculations. *Added Initial* must be enabled for the detector before volume density parameters become effective. Providing timing for *Added Initial* and *Max Initial* under menu MM->1->1->1 does not imply that *Added Initial* will extend the *Min Green* time. You must enable *Added Initial* for the detector calling the phase before these volume density settings become effective.

< Det#	Red.Lock	Yel.Lock	Occup	Volum
1	.	.	X	X
2	.	.	X	X
3	.	.	X	X
4	.	.	X	X
5	.	.	X	X
6	.	.	X	X
7 +	.	.	X	X

5.1.4 Vehicle Options (MM->5->2, Right Menu)

The phase option, *Lock Calls* (MM->1->1->2) applies a constant call on the phase even if the call is reset before the phase is serviced. *Red Lock Calls* and *Yellow Lock Calls* are NTCIP features that apply locking to each detector rather than lock all calls to the phase. This provides individual control over each detector assigned to a *Call Phase* allowing some detectors to lock the call and others to reset the call prior to the phase being serviced.

Vehicle Option - Red Lock Calls

Red Lock Calls lock a call to the assigned phase if the actuation occurs during the red interval.

Vehicle Option - Yellow Lock Calls

Yellow Lock Calls allows the detector to lock a call to the assigned phase if the actuation occurs during the yellow interval.

Vehicle Option - Occupancy

Set *Occupancy* to log the occupancy of the detector. *Occupancy* is expressed as the ratio of the accumulated vehicle actuations during the sample period divided by the *Volume/Occupancy Period.* This ratio is expressed as a percentage in half percents over the range (0-200). The *Volume/Occupancy Period* is set in the *Report Parameters* (MM->5->8->1).

Vehicle Option - Volume

The *Volume Detector* option enables the detector to collect volume data. Volume is the accumulated number of actuations during the *Volume/Occupancy Period*. The *Volume/Occupancy Period* is set in the *Report Parameters* (MM->5->8->1).

5.1.5 Vehicle Parameters+ (MM->5->3)

Det#	Occ:	G	Y	R	Dly/	Q-Alm	Mode	Src
1		X	X	.	0	0	NORMAL	0
2		X	X	.	0	0	STOP_A	0
3		X	X	.	0	0	STOP_B	0
4		X	X	.	2	6	NRM_RR	0
5		X	X	.	0	0	BIKE	0
6		X	X	.	0	0	Q-ALRM	0
7	+	X	X	.	0	0	NORMAL	0

These plus features extend NTCIP by providing additional *Modes* of detector operation. *Delay Phases* allow the delay assigned to a detector to be inhibited only when the assigned *Delay Phase(s)* are active. Detector occupancy may be measured only during the green, yellow, and/or red intervals of the *Call Phase* assigned to the detector.

Vehicle Parms+ - Occ: G Y R

Occupancy may be measured during any combination of of the Green, Yellow and/or Red interval of the *Call Phase*. If G, Y and R are not selected, occupancy will be sampled continuously. Occupancy during G+Y can be used when detectors are located at or near the stop-bar. Be sure to select "Occ" for the detector under MM->5->2 as discussed in the last section.

Vehicle Parms+ - Dly/Q-Alm

There are two delay phases that can be programmed, under the column heading **Dly/Q-Alm**. If the *Delay Phases* are programmed to zero, the associated detector will time the delay specified for that detector under *Vehicles Parameters* (MM->5->1). If either *Delay Phase* entry is not zero, the detector delay is **<u>only</u>** timed when either programmed *Delay Phases* on this screen are being serviced. Please note that the first column can alternately be programmed as a Queue Alarm number (1-16) instead of a delay phase if the agency programs the detector mode as a Q-Alrm as described in the next section

Vehicle Parms+ - Mode

The *Mode* parameter defines the following operating modes of the detector:

- **NORMAL** – Normal operating mode is determined by the NTCIP detector options and parameters.
- **Stopbar A -** The assigned phase may be extended by the detector for the amount of time specified in the Extend parameter or until a gap occurs. Once a gap occurs, the programmed detector channel will ignore any future actuations during the green interval. Assigning the value of 0 to the Extend parameter will allow a phase to be extended until a gap occurs.
- **Stopbar B -** During the green interval, the detector will receive actuations as long as the detector has not been vacant for the specified amount of time in the Extend parameter. Once the Extend timer has expired, that detector will be disabled for the remainder of the green interval. If an actuation occurs before the Extend timer expires, the timer is reset to its programmed value. An Extend timer value of 0 will allow the detector to receive actuations only as long as there is a constant detection on that detector.
- **NRM_RR** – *Normal Red Rest* mode allows the delay assigned to a detector to force the controller to red rest instead of calling a phase. This application was developed for left-turn applications where inhibit phases prohibit a through movement from backing into a turn phase and a feature was needed to service the turn phase after moving to red rest to prevent the "yellow trap". The delay timed by the NRM_RR detector before red rest is applied is programmed in the delay setting under *Detector Parms,* MM->5->1.
- **BIKE** – When this mode is enabled, the detector will be used to generate any additional *Bike Clearance* time programmed for the phase called by the detector (MM->1->1->7). In addition, an actuation of the BIKE detector will time the Bike Extension value programmed for the detector under MM->5->1 (*Extend* parameter). **Please note that the values programmed under the Extend parameter are in one second increments not 0.1 second increments. For example programming an Extend value of 0.5 for a Bike detector will result in a 5 second extension.**
- **Q-Alrm** – A *Queue* detector generates alarm 28 when a specified QUEUE timer expires. The additional programming required for this operation is documented in the next section.
- **Adapt** – An *Adaptive* detector measures the degree-of-saturation of the phase called by the detector based on occupancy measured during green + yellow clearance.

Vehicle Parms+ - Src (Source)

Each of the 64 "logical" detectors in the controller may receive their source directly from a "physical" detector channel or indirectly from another "logical" detector using the *Source* feature. The default *Source (Src)* setting is zero that implies that the detector is sourced from a "physical" detector in the detector rack. A *Source (Src)* setting in the range of 1-64 implies that the detector is sourced indirectly from any of the 64 detectors that are currently active in the controller.

5.1.6 Queue Detector Programming

The **Q-Alrm** detector mode was defined in the last section. Keep in mind that a *Q-Alrm* detector is intended to be a system only detector to generate *Alarm # 28* and cannot be used to call a phase. Therefore, you must source a separate detector used to call a phase if you want this detector to also serve as a Queue Alarm detector (see the Src feature in the last section). However, detector diagnostics (max presence, no activity and erratic count) may be programmed for a queue detector and used to trap error conditions when they occur.

This detector feature requires that:

1) *Queue* parameter is enabled for the detector under MM->5->2 (section 5.1.5)
2) *Queue* time is programmed under MM->5->1. This is the number of minutes (0-255) used to test a constant call on the detector and generate *Alarm # 28.*
3) *Extend* time under MM->5->1 is set to the number of seconds (0-25.5) required to detect an OFF condition over the detector. This resets the *Queue* timer and *Alarm # 28.*
4) *Queue* is enabled and *Extend* is disabled for the queue detector under MM->5->2.
5) A *Queue Alarm Number* (1-16) is assigned to the first *Dly/Q-Alm Phase* under MM->5->3

A maximum of 16 queue alarms may be reported by returning a *Queue Alarm Number* (1-16) associated with each queue detector. The *Queue Alarm Number* (1-16) is assigned to the first column of ***Dly/Q-Alm*** under MM->5->3 for each detector using the **Q-Alrm** detector mode. This value is returned with Alarm #28 and allows multiple detectors to share the same *Queue Alarm Number*. The central system is capable can distinguish which queue detector(s) have activated *Alarm # 28* using the number assigned to the first column of ***Dly/Q-Alm*** associated with each detector.

5.1.7 Pedestrian Parameters (MM->5->4)

Det#	Call	NoAct	MaxPres	ErrCnt
1	14	255	255	255
2	2	0	0	0
3	0	0	0	0
4	4	0	0	0
5	0	0	0	0
6	6	0	0	0
7 +	0	0	0	0

The *Pedestrian Parameters* allow for mapping of pedestrian inputs to call the pedestrian service for a phase. Detector diagnostics are also provided to isolate pedestrian detector failures like those provided to isolate vehicle detector failures. The real-time pedestrian alarm failures are shown under *Pedestrian Detector Alarm Status* (MM->5->7->3).

Ped Parameter - Call Phase

The *Call Phase* parameter sets the phase called by the pedestrian detector. A zero value disables the pedestrian input.

Ped Parameter - No Activity

The *No Activity* parameter (0-255 min) fails the diagnostic if a pedestrian actuation is not received before the *No Activity* timer expires. A zero value disables the pedestrian input.

Ped Parameter - Maximum Presence

The *Maximum Presence* parameter (0-255 min) is a diagnostic feature. If the detector exhibits a constant actuation for the specified amount of time (0-255 min), then the detector is considered to have failed. The *Pedestrian Detector Alarm Status* (MM->5->7->3) shows the detector's failure mode. A zero value disables the pedestrian input.

Ped Parameter - Erratic Counts

The *Erratic Counts* parameter is a diagnostic feature. The detector is considered to have failed if it exhibits too many actuations per minute. The Pedestrian Detector Alarm Status shows the detector's failure mode. Enter the data as the number of counts per minute (0-255 cpm). A zero value disables the pedestrian input.

5.2 Alternate Detector Programs (MM->5->5)

Alternate Detector Programs provide a method of changing detector parameters through the pattern. This is similar to *Alternate Phase Programs* discussed in chapter 4. Three *Alternate Detector Programs* provide 16 columns used to modify a specified detector (Det#).

```
     Alternate Detector Programs
1.Veh Parms    4.Ped Parms
2.Veh Options
3.Veh Parms+                 Prog Set# 1
```

The left menu for the *Vehicle Parameters* selection is shown to the right. The other *Alternate Detector Programs* are summarized below.

Row	Det#		Call	Switch	Delay	Extend	Queu>
1	1		6	0	0.0	0.0	0
2	16		16	16	25.5	25.5	255
3	0		0	0	0.0	0.0	0
4	0		0	0	0.0	0.0	0
5	0		0	0	0.0	0.0	0
6	0		0	0	0.0	0.0	0
7	0	+	0	0	0.0	0.0	0

- Alternate Vehicle Parameters
  - Call Phase
  - Switch Phase
  - Delay
  - Extend
  - Queue Time
  - No Activity Diagnostic
  - Maximum Presence Diagnostic
  - Erratic Count Diagnostic
  - Fail Time Parameter

- Detector Options
  - Enable Call
  - Enable Extend
  - Enable Queue
  - Enable Added.Initial
  - Enable Red.Lock
  - Enable Yellow Lock
  - Enable Occupancy Sampling
  - Enable Volume Sampling

- Vehicle Parameters+
  - Occupancy on Green / Yellow / Red Interval
  - Delay Phases
  - Detector Mode

- Ped Parameters
  - Phase called by the ped detector
  - No Activity Diagnostic
  - Maximum Presence Diagnostic
  - Erratic Count Diagnostic

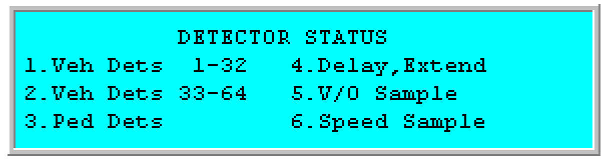
5.3 Phase Recall Menu (MM->5->6)

This menu consolidates all phase recall options on a common screen accessed under the *Detection* menu. These are the same options accessed under *Phase Options* (MM->1->1->2).

Options	P..1	..2	..3	..4	..5	..6	..7	.8>
Min Recall	.	X	.	.	.	X	.	.
Max Recall	.	.	.	.	.	.	.	.
Ped Recall	.	.	.	.	.	.	.	.
Soft Recall	.	.	.	.	.	.	.	.
Lock Calls	.	.	.	.	.	.	.	.

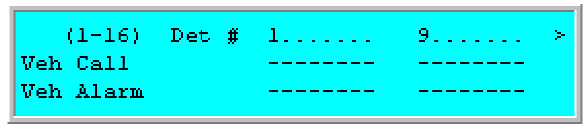
5.4 Detector Status Screens (MM->5->7)

The *Detector Status Screens* include separate real-time indication for each vehicle and pedestrian detector along with current alarm status from the detector diagnostics. Accumulated V/O (volume and occupancy) data is displayed for the current *Sample Period*. Speed trap measurements are also displayed.



5.4.1 Vehicle Detection Status (MM->5->7->1 and MM->5->7->2)

The *Vehicle Detection Status* screen displays real-time vehicle calls and alarms. This is a post-processed status, that is, calls are displayed after modification due to mapping, alarms, delays, and extends. These are the actual calls passed to the controller phase logic.



Vehicle Call

Vehicle Call status indicates the presence of a call for detector channels 1-64. The source of the channel is selected in the *Vehicle Parameters+* screen. It is important to note that the screen status displays the calls after they have been modified by extend and delay settings for the channel. A detector diagnostic alarm will place a constant call when the *Call Phase* is not green and will extend the phase in accordance with the *Fail Time* setting of the detector when the *Call Phase* is green.

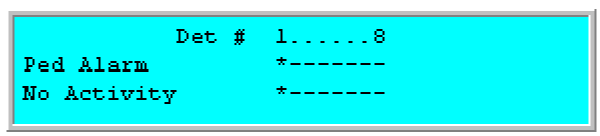
Vehicle Alarm

The *Vehicle Alarm* field shows the results of the detector diagnostics programmed under the *Vehicle Parameter* screen. When an alarm is indicated, a call will be placed on the corresponding channel's detection input.

5.4.2 Pedestrian Detection Status (MM->5->7->3)

Ped Call

Ped Call indicates the status of the pedestrian call for pedestrian channels 1-8. The active display accounts for calls generated by the pedestrian diagnostics, so keep in mind that this status screen does not show the raw inputs from the pedestrian detectors.



Ped Alarm

The *Pedestrian Alarm* indicates the real-time status of pedestrian channel alarms 1-8. When an alarm is present, a constant pedestrian call will be placed on the pedestrian *Call Phase* until the diagnostic error is corrected. The parameters for these alarms are set in the *Pedestrian Parameters* options (MM->5->4)

5.4.3 Detector Delay, Extend Status (MM->5->7->4)

This real-time status screen displays any active delay and/or extension timing for each detector. Notice that row 1 corresponds to detectors 1 – 3, row 2 to detectors 4 – 6, etc.

```
#  Del   Ext    Del   Ext    Del   Ext
1   0.0   0.0    0.0   0.0    0.0   0.0
4   0.0   0.0    0.0   0.0    0.0   0.0
7   0.0   0.0    0.0   0.0    0.0   0.0
```

5.4.4 Vol/Occ Real-Time Sample (MM->5->7->5)

The *Volume/Occupancy Real-Time Sample* status screen allows the user to view the real-time sample as volume and occupancy is being accumulated. The sample is stored and reset at the conclusion of each *Vol/Occ Period* specified in under MM->5->8->1.

```
Det Grp     1...2...3...4...5...6...7..8>
  #1-8
Vol         0   0   0   0   0   0   0   0
Occ         0   0   0   0   0   0   0   0
```

Volume

The *Volume* field shows the accumulated vehicle actuations for the channel during the current *Vol/Occ Period*. Volume is recorded as zero when a detector diagnostic failure occurs and a detector alarm is generated.

Occupancy

The *Occupancy* field indicates a measure of vehicle presence over the detector or a NEMA specified error code when the detector fails a detector diagnostic. If a detector alarm is not active, the occupancy values indicates the percentage of the *Vol/Occ Period* that a vehicle is present over the detector. This value ranges from 0-200 with each increment representing 0.5%. The total detector "on time" may be calculated by multiplying the occupancy measure by the *Vol/Occ Period* and dividing this product by 200.

When a detector alarm is active, the occupancy value represents a NEMA specified error code for the failed detector diagnostic in the range of 200 – 255 as shown below. The active alarm code may be viewed in the detector buffer found under MM->1->6->9. These codes are interpreted by StreetWise and ATMS,now and converted to "friendly" text messages in the Local Detector Event query.

Fault (decimal)	Fault (Hexadecimal)	Fault (Stored as Occupancy Data)
210	D2	Max Presence Fault
211	D3	No Activity Fault
212	D4	Open Loop Fault
213	D5	Shorted Loop Fault
214	D6	Excessive Inductance Change
215	D7	Reserved
216	D8	Watchdog Fault
217	D9	Erratic Output Fault

5.4.5 Speed Sample (MM->5->7->6)

The controller provides 16 speed traps consisting of two detectors, a specified *Zone Length* and *Car Length* (see section below). The *Real-Time Speed/Length Sample* displays the average speed for each speed trap during the active *Vol/Occ Period.* Note: Speed traps will work only with TS2 Type 1 cabinets and Detector BIU's.

5.5 Volume / Occupancy Parameters

5.5.1 Volume and Occupancy Period (MM->5->8->1)

```
Vol/Occ Period:      0   Seconds
                    15   Minutes
```

Detector volumes and/or occupancy are sampled at a rate determined by the *Volume/Occupancy Period*. Enter the *Volume/Occupancy Period* in minutes (0-99) or seconds (0-255). The actual period is the sum of the minutes and seconds, so you can enter values of seconds greater than 60, using a combination of minutes and seconds.

5.5.2 Speed Detectors (MM->5->8->2)

```
   Up Det   Dn Det   Zone Len   Car Len
 1   1        2        6.0       18.0
 2  12       14        6.0       18.0
 3   0        0        0.0        0.0
```

The *Speed Detectors* screen defines the speed trap detectors for each of the 16 speed stations. The *Up* detector number is the upstream detector which first detects the vehicle in the travel lane. The *Dn* detector number is the downstream detector that is detected next.

The *Zone Len* is the separation between the detectors in feet. Use the distance between the leading edge of the upstream detector and the leading edge of the downstream detector. The *Veh Length* is the average vehicle length (in feet) specified for the calculation. Note: Speed traps will work only with TS2 Type 1 cabinets and Detector BIU's.

5.5.3 Speed Thresholds (MM->5->8->3)

```
Det Grp    1...2...3...4...5...6...7..8>
  #1-8
Vol       13   0   1  45  10   0   1  39
Occ        2   0  16  16   0   0  16  13
 #17-24
Vol        0   0   0   0   0   0   0   0
Occ        0   0   0   0   0   0   0   0
 #33-40 +
```

The *Speed Thresholds* screen allows the user to view detector volumes and occupancies based on the analysis period as programmed under MM->5->8->1.

6 Basic Coordination

6.1 Overview of the Coordination Module

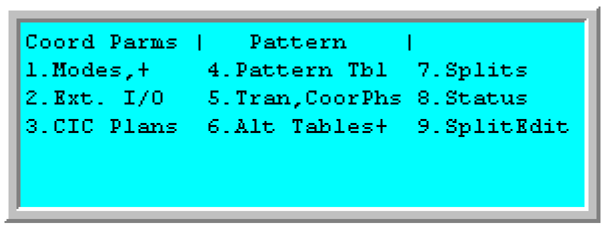
The *Coordination Module* or "Coordinator" is always active in an NTCIP based controller, even during free and flash operation. NTCIP defines the *Coord Status* and *Free Status* objects that describe the active state of the controller as show below. This status information is displayed under MM->2->8->5 in the controller.

Pattern#	Coord	FreeStat	Active State of the Coordinator
0	FREE	PATTERN	Coordinator has selected default free pattern# 0 by time-of-day
1 - 48	ACTIVE	CoorActv	Coordinator is running one of the 48 patterns under coordination
1 - 48	FREE	COMMAND	Coordinator is running one of the 48 patterns in free operation
254	FREE	COMMAND	Coordinator is running the NTCIP Free Pattern# 254
255	FREE	COMMAND	Coordinator is running the NTCIP Flash Pattern# 255

The *Free Status* also reflects other conditions such as plan, cycle, split and offset errors and external overrides such as preemption and manual control enable. However, it is important to note that patterns 1-48 can be activated as either *Coord Patterns* or *Free Patterns*. A *Free Pattern* can be created using a zero second cycle length to use any of the pattern features shown below during free operation. See section 6.13 for further information on setting up Free patterns.

Note: When considering coordination, using the STD8 phase mode will take advantage of the most coordination diagnostic checks to catch common data entry mistakes, and if detected, times the intersection in FREE. In USER mode, most of these coordination diagnostics are removed, and the onus is on the agency verify and test the programming to ensure that coordination pattern(s) run as expected.

6.2 Coordination Modes

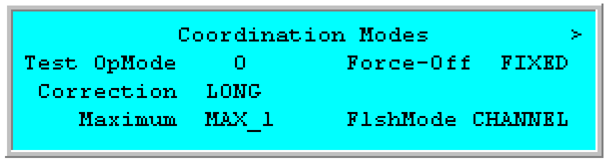


This section describes coordination parameters accessed from the Main Menu using keystroke MM->2. The first menu item provides access to *Coordination Modes* and *Coordination Modes+* menus. The *Coordination Modes* (MM->2->1, left menu) provide basic NTCIP features related to coordination. *Coordination Modes+* (MM->2->1, right menu) provides enhancements to NTCIP coordination.

Coordination Modes determine the force-off method (FIXED, FLOAT or OTHER), the offset correction method used during transition and which maximum settings are applied (or inhibited) during coordination. *Coordination Modes+* select OTHER force-off+ methods and determine if a controller is operating as a secondary in a closed loop system or using external coordination. Pedestrian features related to coordination are also modified through the *Modes+* settings.

Coordination Modes apply to all coordination patterns and may not be modified by time-of-day. The only exception is the Force-off method FIXED may be overridden by the *Flt* option. The *Flt* option is specified by pattern under Trans,CoorØ+ (MM->2->5, right menu).

6.2.1 Coordination Modes (MM->2->1, Left Menu)



Test OpMode (Operational Mode)

The *Test OpMode* parameter allows the operator to manually override the active pattern in the *Coordination Module* The "Test" mode parameter selects the active pattern (1-48) or reverts to a standby mode (Test 0). The standby mode allows the controller to receive the active pattern from another source such as a closed-loop master or the local time-of-day schedule. Be aware that *Test Mode* (1-48) overrides all other operational modes including the time base scheduler, closed loop and central control. Therefore, any pattern updates from these other operational modes will be ignored unless the *Test Mode* has been set to *Automatic (Standby)* mode (Test 0). The following are valid entries for the *Test OpMode* parameter.

0 Automatic (Standby) – TestOpMode 0, or standby mode allows the controller to receive the active pattern from the internal time base scheduler, external interconnect, a closed loop master or central control system. TestOpMode 0 is the typical default operation.

1-48 Manual Pattern Override – Test OpMode can be used to select one of the 48 patterns from the pattern table, and overrides all other pattern commands. It is common practice to force the controller to a desired pattern for testing purposes and to check coordination diagnostics as discussed later in this chapter.

254 Manual Free – selects free operation defined by NEMA as pattern 254

255 Manual Flash – selects auto flash operation defined by NEMA as pattern 255

Note: Startup-flash and conflict fault flash override the current *Test Mode* setting; however, *Test Mode* has a higher priority than any of the other operational modes and is typically only used for test applications.

Correction Mode

The *Correction Mode* parameter controls whether *Long-way* or a combination of *Short-way/Long-way* transition is used to synchronize offsets during coordination. The correction mode is also selected on a pattern by pattern basis through the short-way, long-way and dwell settings in the *Trans,CoorØ+* menu described later in this chapter. The Dwell transition method is selected under the *Trans,CoorØ+* menu when the Long% and Short% values for the pattern are coded as zero.

LONG The *Coordination Module* transitions to a new offset reference by increasing the split times by the long-way% value programmed in the *Trans,CoorØ+* menu.

SHORT/LONG The *Coordination Module* selects the quickest transition method by either lengthening split times using the long-way% value or by shortening split times using the short-way% value programmed in the *Trans,CoorØ+* menu.

Maximum Mode

The *Maximum Mode* parameter determines which maximum green time is active, or if maximum green time is inhibited during coordination. These settings do not apply to floating force-offs because FLOAT sets the max timer equal to the split time to insure that slack time developed in the non-coordinated phases is passed to the coord phase.

MAX_1 Selecting the MAX_1 mode allows *Maximum 1* phase timing to terminate a phase when FIXED or OTHER force-off methods are in effect. If MAX_1 is selected, then *Maximum 1* timing may be overridden by the *Max2* setting on a pattern by pattern basis as discussed in section 6.9, *Alt Tables+*.

MAX_2 Selecting the MAX_2 mode allows *Maximum 2* phase timing to terminate a phase when FIXED or OTHER force-off methods are in effect. This setting is equivalent to the *Max2* setting discussed in section 6.9, *Alt Tables+*.

MAX_INH Selecting MAX_INH inhibits *Maximum 1* and *Maximum 2* timing from terminating a phase when FIXED or OTHER force-off methods. When MAX_INH is in effect and a max call is placed on a phase, the max timer will decrement to zero (MM->7->1); however, the phase will not terminate under coordination until it is forced-off. The firmware now insures that MAX_INH does not inhibit the floating max timer under FLOAT, that is, the Maximum Mode setting has no effect under floating force-offs).

Flash Mode (FlshMode)

This setting is defined in chapter 4 and is duplicated on the *Coordination Modes* screen for convenience.

Force-Off Mode

Force-offs are predefined points in the signal cycle used to terminate the active phase and limit the time allocated to each active phase. NTCIP specifies FIXED and FLOAT force-off methods. A third NTCIP method, defined as OTHER, activates one of the seven additional *Force-Off+ Modes* under the *Coordination Modes+* menu. The NTCIP based *Force-Off* modes are defined as follows:

FLOAT Phases other than the coordinated phase(s) are active for their assigned split time only. This causes unused split time to revert to the coordinated phase.

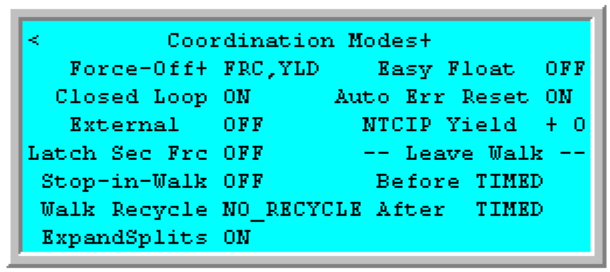
FIXED Phases are forced-off at fixed points in the cycle. This allows unused split time of a phase to revert to the phases served next in the sequence.

OTHER The coordination mode is determined by the *Force-Off+* and *Easy Float* parameters.

6.2.2 Coordination Modes+ (MM->2->1, Right Menu)

Force-Off+ Mode

Shortway+ Mode



The *Force-Off+ Mode and Shortway+* entry is only active if the *Force-Off Mode* under *Coordination Modes* is set to OTHER. This entry allows for seven additional coordination modes as described below. All OTHER modes are covered in a document on *Advanced Coordination.* NOTE: the OTHER modes are only available on TS2 controllers that contain the firmware versions listed above.

Easy Float

Easy Float only applies if OTHER is selected as the force-off mode and EASY is selected as the force-off+ mode.

OFF The maximum allocated to each phase is allowed to exceed the programmed split time (like FIXED).

ON A floating max time is used to insure that the time allocated to each phase does not exceed the programmed split This insures that all slack time from the non-coordinated phases is passed to the beginning of the coord phase.

Closed Loop

The *Closed Loop* entry enables the *System Operational Mode* and allows the coordination pattern to originate from an on-street master or from the central control system.

OFF The controller does not respond to pattern commands from an on-street master or the central system.

ON *System Operational Modes* are based on the hierarchy of control system. The central system and closed loop masters provide the highest level of control followed by the local time based scheduler in each secondary controller. The local TEST Operational Mode overrides commands from the external closed-loop system and the internal time-of-day scheduler.

Auto Error Reset

Coordination failures may occur under the coord diagnostic, if a vehicle or pedestrian call is not serviced for three cycles or if the maximum cycle counter is exceeded. A coordination failure is not reset by the next pattern change issued to the controller if *Auto Error Reset* is OFF. If *Auto Error Reset* is ON, the next system or time-of-day pattern change issued to the controller will reset the failure when the new pattern goes into effect.

External

External coordination enables the *External Operational Mode* and allows the pattern selection based on the external offset, cycle, and split inputs from the D-connector..

OFF Disables external (hardwire interconnect) coordination inputs and outputs.

ON Enables external coordination inputs and outputs

Latch Secondary Force Offs

This setting **ONLY** applies to the OTHER Force-off+ methods of coordination and insures that secondary force-offs are applied at the same point as primary force-offs.

Stop-in Walk

Stop-In-Walk is a very important feature that allows the split time of a phase less than the minimum pedestrian requirements (sum of the walk + ped clearance + yellow + all-red clearance).

Stop-In-Walk causes the local cycle counter to "stop" during coordination if a force-off is applied to the phase and it is still timing walk or pedestrian clearance. **This feature should only be used when pedestrian actuations are infrequent and split times are long enough to accommodate most of the pedestrian timing**. Stop-In-Walk is enhanced by short-way offset correction because the coordinator can usually re-synchronize the offset within one cycle when ped clearance only extends 5 – 10" beyond the force-off.

OFF *Stop-in-Walk* OFF forces the user to provide adequate split time to service the walk and ped clearance intervals assigned to the phase. The coordination diagnostic will fail the pattern if the split times do not adequately meet the pedestrian requirements.

ON *Stop-in-Walk* ON disables the coord diagnostic that insures that the split time is adequate to service the minimum pedestrian times. The local counter will "STOP" at the force-off and "suspended" until the end of ped clearance. At the end of ped clearance, the local cycle counter will begin incrementing and the coordinator will immediately begin correcting the offset using short-way transition if specified for the pattern. *Note*: *Rest-in-Walk* programmed for a coord phase defeats *Stop-in-Walk* and requires that pedestrian times be serviced within the programmed split time.

Stop-In-Walk may affect arterial phases that are push button actuated when there is no side road demand. If a late arterial Ped call comes in, the coordinator may utilize *Stop-in Walk* to finish processing the arterial Ped clearance times during the first split, thus correcting during the side road splits. If this is not desired, program the arterial phases as *Rest-in-Walk* and program the *Walk Recycle*, *Leave Walk Before* and *Leave Walk After* parameters as described below.

Walk Recycle

This parameter is used in association with arterial phases. The Options under this parameter will take effect only when *Rest-In-Walk* is set for the arterial phase(s). **If *Rest-In-Walk* is not set, this parameter is ignored.** When *Rest-In-Walk* is not set, the arterial pedestrians are subject to *PedLeav* and *Ped Yld* parameters as well as opposing phase demand.

Walk Recycle and the two *Leave Walk* settings described below, determine how walk intervals are terminated and recycled during coordination when the controller is resting in a phase and there is time available to re-service the pedestrian movement before the phase is forced off.

Walk Recycle only recycles the walk interval if a ped call has been placed on the phase or if the phase is programmed for *Rest-In-Walk*. A ped recall set through the phase options or through the *Split Table Mode* setting (PED or MxP) will not recycle the walk unless a ped detector has also called the phase or *Rest-In-Walk* is set. If you want to rest-in-walk on the arterial phases, then program *Rest-In-Walk* for those phases under menu MM->1->1->2. Below are the settings for Walk Recycle.

NO_RECYCLE After servicing walk and ped clearance, the controller will continue to rest in the coordinated phase until the next cycle (Local counter = 0) before deciding to recycle the walk. Walk Recycling is now dependent upon getting a demand from any conflicting phase ***AND*** a pedestrian actuation or recall on the rest-in-walk phase.

IMMEDIATE If *Rest-In-Walk* is set, the controller will recycle the walk immediately (without a pedestrian actuation or recall on the rest-in-walk phase) at the end of ped clearance **if a serviceable (i.e. not inhibited) conflicting call does not exist**. This setting locks out any new conflicting calls until the end of pedestrian clearance in the next cycle. Caution should be used if IMMEDIATE is programmed. One consequence of setting *Walk Recycle* to IMMEDIATE is that side road phases may not be serviced if the recycled ped finishes past the side road phase(s) apply points. There are two ways to solve the above consequence.

If IMMEDIATE recycling is desired, set the *Leave Walk After* parameter to ON DEMAND. This option ignores the PedLeave point and allows the controller to leave walk immediately when a conflicting call is received

Set the *Walk Recycle* parameter to INHIBIT_1256 or INHIBIT_3478 as discussed below.

Ø1256_INH This option is useful when the coord phase is Ø4 or Ø8. The coord phase walk is not recycled until the permissive window for the cross street (Ø1256) has had an opportunity to service conflicting pedestrian and vehicle calls.

Ø3478_INH This option is useful when the coord phase is Ø2 or Ø6. The coord phase walk is not recycled until the permissive window for the cross street (Ø3478) has had an opportunity to service conflicting pedestrian and vehicle calls.

NO_PED_INH This option allows the walk of the coord phase to recycle when the pedestrian omits are lifted on the coordinated phase (i.e. the earliest point in the cycle when the coordinator will allow a walk interval to be serviced. If a ped call is issued during or after ped clearance, the walk will be recycled immediately after the ped clearance is timed and after or at the Ped Yield point of the phase if the controller continues to rest in that phase.

NEVER This option prevents the walk from being recycled after the phase serviced by the walk has begun. A pedestrian call will not recycle the walk until the controller services a conflicting phase.

Leave Walk Before

This parameter is used in association with arterial phases. The Options under this parameter will take effect only when *Rest-In-Walk* is set for the arterial phase(s). **If *Rest-In-Walk* is not set, this parameter is ignored.** The following entries determines when a phase will leave walk if it is resting in walk but has not been recycled:

TIMED The *PedLeav* point is the latest point in the cycle that allows the controller to begin Ped clearance and have end it at the force-off of the phase. The TIMED option allows the controller to rest-in-walk until the *PedLeav* point if a conflicting call is received on another phase.

ON DEMAND This option ignores the *PedLeav* point during coordination and allows the controller to leave walk immediately when a conflicting call is received.

Leave Walk After

These entries are the same as *Leave Walk Before* except they apply to phases resting in walk after being recycled. This parameter is used in association with arterial phases. The Options under this parameter will take effect only when *Rest-In-Walk* is set for the arterial phase(s). **If *Rest-In-Walk* is not set, this parameter is ignored.**

Coord Yield

The *Coord Yield* parameter is expressed as a positive and negative number (- 15 to +15”). This parameter is used to adjust the default yield point of the coord phase under NTCIP coordination (FIXED and FLOAT modes). This adjustment is applied to only the coordinated phases, where the *Early Yield* adjustment defined in section 6.6.2 is applied to all of the non-coordinated phases.

Shortway+

When enabled, this feature allows the controller’s local cycle counter to get in step more quickly when shortway transitioning. Specifically, if the coordinator is running ‘fast or shortway’ to get in step and a phase terminates before its force-off, the cycle counter is allowed to advance to the value of the phase’s force-off. If all of that time is not required, the cycle counter is advanced to a value that allows the local coordinator to get in step. The local cycle counter will not advance more than 15 seconds using this feature.

No Added Initial

This Feature allows Added Initial Timing to be disabled whenever coordination is active (i.e. Not Free). Set this parameter to ON if you want Added Initial Timing to be disabled during coordination. Set to OFF if you want to continue to use Added Initial Timing during coordination.

6.3 Pattern Table (MM->2->4)

Coordinated *Patterns* are defined by a *Cycle* length (normally 1-255 sec.). *Free patterns* are specified in the *Pattern Table* with a zero second Cycle length. The 48 patterns in the *Pattern Table* along with Pattern# 254 (free) and Pattern# 255 (flash) provide a total of 50 patterns. Only one pattern may be active at a time.

Pat#	Cycle	Offset	Split	Seqnc
1	100	50	1	1
2	255	254	24	16
3	0	0	0	1
4	0	0	0	1

Cycle Time

Cycle Time specifies the cycle length and ranges from 0-255 seconds if *Expanded Splits* is OFF, or 0-999 if *Expanded Splits* is ON. Cycle Time is typically set to the sum of the split times in each ring during coordination. However, a *Cycle Time* of 0" implies a *free pattern* as discussed in section 6.1.2. Many features available to patterns under coordination are also available to a *free pattern* programmed with a zero second cycle length. This allows different *free patterns* to be called by time-of-day or through the system that vary the operation of the controller during free operation. Note in Version 65.x, if Expanded Splits is set to "ON cycle lengths can vary from 1-999 seconds.

Offset Time

Offset Time defines the length of time that the local counter (Loc) lags behind the system time base (TBC). Offset ranges from 0-255 seconds if *Expanded Splits* is OFF, or 0-999 if *Expanded Splits* is ON. Each controller in a coordinated system references the system time base to midnight to synchronize the offset time for each active pattern in the system. The system maintains coordination as long as each controller in the system maintains the same midnight time reference. Note that if the offset value is greater than or equal to the cycle time, then the controller is forced into free mode by the coordination diagnostic.

Split Number

Split Number is used to reference one of the 32 *Split Tables* associated with the pattern. The *Split Tables* are interpreted differently based on the force-off method. Most of these modes require split times for each phase programmed through the Split Table. However, some of the OTHER force-off methods require the setting the force-off and yield points for each phase. This chapter on, Basic Coordination, discusses the FIXED and FLOAT force-off methods that simplify coordination under NTCIP coordination. The OTHER modes are covered in a document on *Advanced Coordination*. NOTE: the OTHER modes are only available on TS2 controllers.

Sequence Number

The *Sequence Number* selects one of the 16 phase sequences to use with the pattern. Each phase sequence provides eight (8) entries per ring for each of the 4 rings. Phase sequences are fully discussed in chapter 4 of this manual. A sequence number of 0 in the database defaults to sequence number 1. Only entries between 1-16 are valid if entered through the keyboard.

6.4 Split Tables for NTCIP Modes FIXED and FLOAT (MM->2->7)

This section discusses how to program the *Split Table* when the NTCIP force-off modes (FIXED and FLOAT) are specified. The NTCIP coordination modes allow you to specify a split time in seconds to each phase and let the controller calculate all of the internal force-off and yield points for the pattern. NTCIP provides the OTHER coord mode to let the manufacturer provide additional methods of coordination. We provide seven OTHER coord modes using the *Force-off+* setting as discussed in the Advanced Coordination document.

6.4.1 Accessing the Split Tables (MM->2->7)

The *Split Table* allocates the cycle time (in seconds) to each of the 16 phases enabled in the controller. One of these phases is set as the *Coordinated Phase* to reference the *Offset* of the pattern. The recall *Mode* of each phase can also be set in the *Split Table* and overrides the recalls set in phase options when the *Split Table* is called by the active pattern. A maximum of 32 split tables may be individually assigned to any of the 48 patterns in the *Pattern Table*. Each split table (1-32) is selected individually from menu MM->2->7.

Split Menu	Coord.Modes
1.Split Table	Force FIXED
2.Plus Features	Force+ FRC,YLD

The following *Split Menu* will appears after the split number has been selected from MM->2->7. Selection 1 is used to modify the *Split Table*. Selection 2, "Plus Features" is only available with the OTHER force-off methods. *Plus Features* are not needed for FIXED and FLOAT because these modes automatically calculate the permissive period and simplify additional programming required for the OTHER non-NTCIP modes.

6.4.2 Programming Each NTCIP Split Tables for Fixed & Float

Split Time

```
Spl- 1   P..1...2...3...4...5...6...7..8>
Time       25  25  25  25  25  25  25  25
Coor-P      .   X   .   .   .   .   .   .
Mode      NON NON NON NON NON NON NON NON
```

Split Time sets the maximum time allocated to each phase during the signal cycle. *Split Time* ranges from 0-255 seconds if *Expanded Splits* is OFF, or 0-999 if *Expanded Splits* is "ON". The FIXED force-off method allows unused split time, or "slack time" to be used by the next phase in the sequence. The FLOAT method guarantees that "slack time" from the non-coordinated phases is used by the coord phase.

The controller diagnostic (discussed later in this chapter) insures that each split meets or exceeds the minimum times programmed for the phase. Each split time must be sufficient to service the minimum green, vehicle clearance and all-red clearance to prevent the min times from extending the phase past force-off point. In addition, if *Stop-In-Walk* is set to OFF, the diagnostic insures that each split is long enough to service the minimum pedestrian times (walk and ped clearance) prior to the force-off. The coordination diagnostic is always run prior to the pattern becoming active. If diagnostic errors are detected, the pattern is fails and the controller is placed into the free mode.

Coordinated Phase

The *Coordinated Phase* designates one phase in the split table as the offset reference. The offset may be referenced to the beginning or the end of the *Coordinated Phase* using the programming features from MM->2->5 (right menu).

Only one phase should be designated as the *Coordinated Phase*. If multiple coord phases are specified in different rings, the coordinator will not be able to reference the offset if the phases do not begin (or end) at the same point in the cycle. Therefore, specify one *Coordinated Phase* for the offset reference and apply a MAX mode setting (discussed in the next section) if you want to guarantee split time allocated to the coordinated movements. Consider, for example, when a lead left-turn sequence is used, and there is only one designated lead left (Phase 1) as pictured. In this case the *Coordinated Phase* should be the first "standalone" through phase (Phase 2) in the sequence after crossing the barrier. The same will apply to lag left turn sequences.

Setting *Return Hold* (MM->2->5) insures that the controller holds in the coordinated phase once it returns to the phase. Applying a MAX *Mode* setting to the coord phase in the *Split Table* also "holds" the coord phase with a max call. We recommend that you set *Return Hold* for all lead/lag left-turn sequences, because this guarantees that the *Coordinated Phase* is held to it's force-off even if the max timer expires.

It is possible to gap out of the *Coordinated Phase* if *Return Hold* and the MAX *Mode* parameters are not set. This allows the controller to leave the *Coordinated Phase* and re-service a preceding left turn phase if there is enough time in the cycle to service the phase before forcing off the coord phase and crossing the barrier. The *Early Yield* adjustment defined in Section 6.6.2 may also be used to yield to the cross street phases before the barrier to service the cross street early.

Split Table Mode Setting

The *Mode* settings ***override*** recalls programmed in *Phase Options* (MM->1->1->2) whenever the split table is active.

NON The *None* setting applies the base recall settings programmed under MM->1->1->2

MIN The *Min* setting applies a minimum recall to the phase when the split table is active

MAX The *Max* setting applies a maximum recall to the phase when the split table is active. Note that when the Force-off mode is set to **Float** mode, a *Max* setting on any non-coordinated phase will utilize the calculated Max Float time and have an opportunity to leave that phase depending on phase rotation and the calculated apply points.

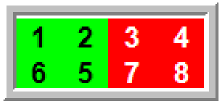
PED The *Ped* setting applies a pedestrian recall to the phase when the split table is active

MxP The *Max + Ped* setting applies maximum and pedestrian recalls to the phase when the split is active

OMT The *Omit* setting omits the phase when the split table is active

Enb The *Enable* setting enables a phase that is not enabled in the phase options (MM->1->1->2)

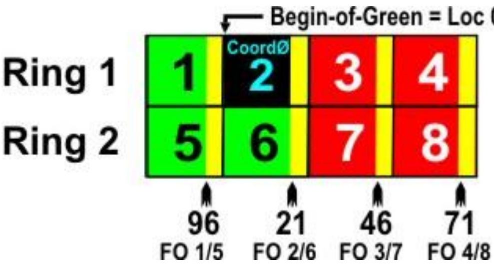
Lead/Lag Considerations with the Coordinated Phase- First coordinated Phase



Many agencies switch lead lefts to lag lefts (and vice-versa) throughout the day to meet their traffic needs by calling different Phase Sequence tables by pattern. Choosing the coordinated phase may vary based on switching the phase sequence or the offset reference point. In the example to the left Phase 1 is a lead left, phase 2 and 6 are the straight through movements and phase 5 is a lag left. NTCIP specifies that the user must choose the first through phase as the coordinated phase for ***BegGrn*** offsets.. The coordinated phase which occurs first within the concurrent group of phases containing the coordinated phase(s), when there are constant calls on all phases, is known as the **First Coordinated Phase**, in this case phase 6. In this case the user should choose Phase 6 as the Coord phase in the split table because it is the first through. If a lead/lag left-turn sequence is used and ***BegGrn*** offset reference point is used, the Coordinated Phase should be the first through phase in the sequence after crossing the barrier.

Using the ***EndGrn*** offset reference point, the user should choose Phase 2 as the Coordinated phase in the split table because it is the last through before crossing the barrier at the "0" point in the cycle.

6.5 Easy Calcs Generated For NTCIP Modes FIXED and FLOAT



Spl- 1	P..1	...2	...3	...4	...5	...6	...7	..8>
Time	25	25	25	25	25	25	25	25
Coor-P	.	X	.	.	.	.	.	.
Mode	NON	NON	NON	NON	NON	NON	NON	NON

All that is required to allocate cycle time using FIXED and FLOAT are the *Split Times* (in seconds) for each phase. The controller automatically calculates the internal force-off and yield points (called Easy Calcs) given the split times and sequence of the pattern. The OTHER coordination methods provide greater control over the yield point settings, but at the expense of additional complexity. The NTCIP yield point adjustments, *Coord Yield* (section 6.2.2) and *Early Yield* (section 6.6.2) allow the user to fine-tune the default yield points if desired (this topic is discussed in the *Advanced Coordination document*). However, for most users, the *Easy Calcs* (force-off and yield points calculated under FIXED and FLOAT) are "hidden from view" and all the user is concerned about is insuring that the split times provided pass the coord diagnostic. The *Split Table* above assigns phase 2 as the *Coordinated Phase* with 20" *Split Times* allocated to each phase.

The pattern example to the right represents a 100" cycle with the offset referenced to *Begin-of-Green* (BegGRN) coord Ø2. All splits are 25" as shown in the *Split Table#* above and the clearance times for each phase are 4". The zero point of the cycle (Loc = 0) coincides with the beginning of the coordinated phase (in this case, phase 2). The green interval for Ø2 and Ø6 is applied at Loc=21 to provide a 25" *Split Time* Each phase in the sequence is forced off 25" after the force-off for the previous phase starting at the coord phase and proceeding across the barriers.

Easy	P..1	...2	...3	...4	...5	...6	...7	..8>
PrimFrc	95	20	45	70	95	20	45	70
SecdFrc	95	20	45	70	95	20	45	70
Veh Yld	20	30	20	20	20	30	20	20
VehAply	86	11	36	61	86	11	36	61
Ped Yld	20	30	20	20	20	30	20	20
PedAply	95	11	45	61	95	11	45	61
FloatMx+	20	20	20	20	20	20	20	20

The *Easy Calcs* status screen (MM->2->8->2) displays the internal calculations for this example under FIXED or FLOAT NTCIP modes. *Secondary Force-offs* only apply to the OTHER modes, so under FIXED and FLOAT, the *Primary* and *Secondary Force-offs* are the same. The *Yield* points opens the *Permissive Periods* to service vehicle and pedestrian calls for each phase. The *Apply* points close the *Permissive Periods* as discussed in the next section. **Keep in mind that whenever the user changes any coordination parameter that the Easy Calcs may be affected.**

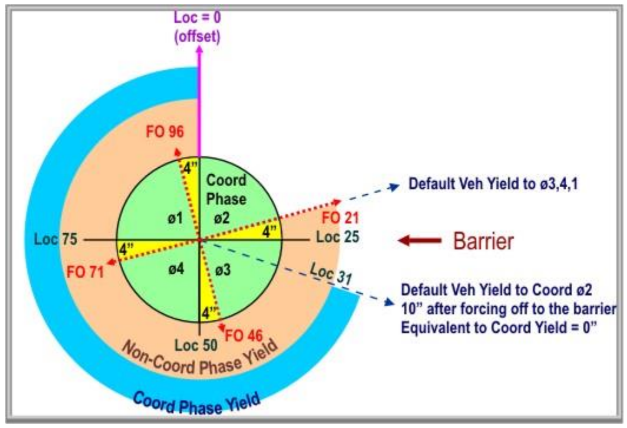
6.5.1 Permissive Periods For NTCIP FIXED and FLOAT

The vehicle permissive period is defined as the portion of the cycle during which vehicle calls can be serviced if there is a vehicle call on the phase. The permissive period begins at the *VehYield* point and ends at the *VehApply* point that inhibits vehicle calls from being serviced until the next signal cycle.

The pedestrian permissive period is defined as the portion of the cycle during which pedestrian calls can be serviced if there is a pedestrian call on the phase. The permissive period begins at the *PedYield* point and ends at the *PedApply* point that inhibits pedestrian calls from being serviced until the next signal cycle.

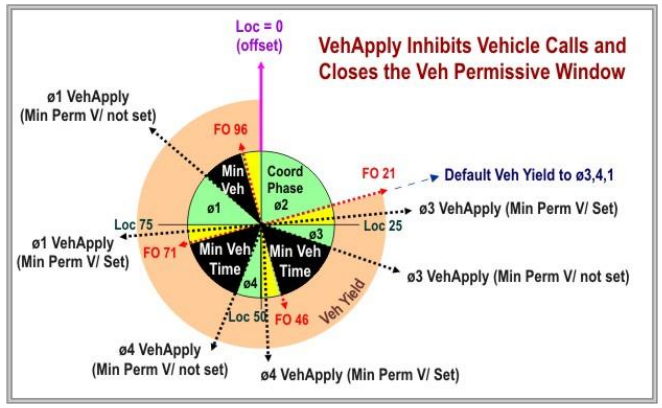
The vehicle and pedestrian *Yield* points open "windows of opportunity" to service calls for each phase. The vehicle and pedestrian *Apply* points close the permissive windows for each phase.

Default Yield Points for FIXED and FLOAT



The default *VehYield* points for the 100" cycle example are illustrated to the right. The FIXED and FLOAT coord modes set the Y*ield* points for all non-coordinated phases at the force-off of the coord phase. The default *Yield* point of the coord phase and the "pseudo" coord phase is set 10" later. This allows the controller to service the non-coordinated phases immediately at the end of the coordinated phase. However, if no calls exist on the non-coordinated phases at the barrier, the controller will dwell in the coord phase for 10" before it is reserviced. The default yield points delay the permissive period for the coord phase to allow "late" side street to be serviced after the barrier.

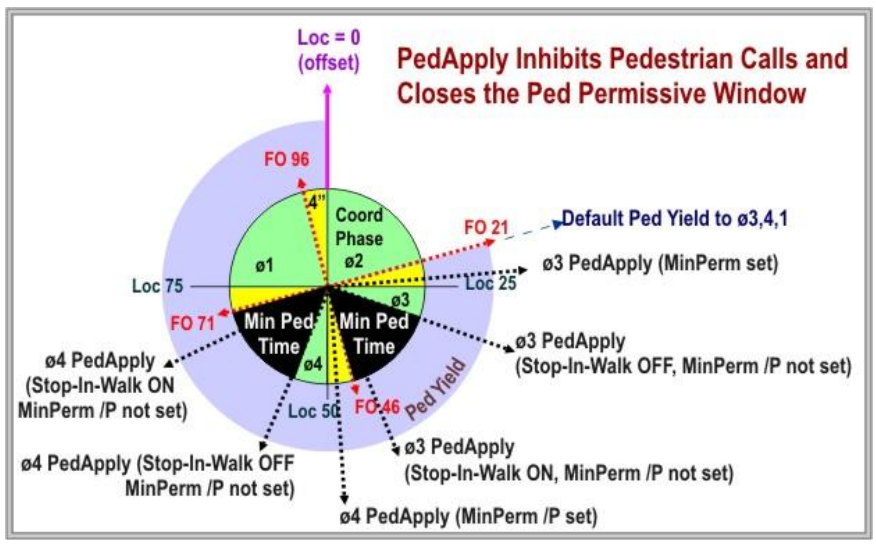
VehApply Points



The controller automatically calculates vehicle *Apply* points for FIXED and FLOAT to close the permissive period to veh calls on each phase. Each *VehApply* point is calculated by subtracting the minimum vehicle times (min green or max initial + yellow + all-red) from the force-off point of the phase. This insures that minimum veh times are serviced without overrunning the force-off. This default *VehApply* point is applied as late in the cycle as possible to maximize the permissive period for "late" vehicle calls. We provide a *Min Perm* setting for vehicle calls to minimize the veh permissive window as shown to the right.

PedApply Points

The controller automatically calculates pedestrian *Apply* points for FIXED and FLOAT to close the permissive period for ped calls on each phase. If *Stop-In-Walk* is OFF, the *PedApply* point is calculated by subtracting the minimum pedestrian times (walk + ped clearance + yellow + all-red) from the force-off point of the phase. This insures the minimum ped times are serviced without overrunning the force-off. If *Stop-In-Walk* is ON, the default *PedApply* point is applied 5" prior to the force-off to allow late ped calls to overrun the force-off. The *Min Perm /P* setting minimizes the ped permissive window as shown to the right.



6.6 Transition, Coord Ø+ (MM->2->5)

Pat#	Trans:	Short	Long	Dwell	No.Short.P>			
1		0	17	0	1	5	0	0
2		12	22	0	0	0	0	0
3		0	0	60	0	0	0	0
4		0	17	0	0	0	0	0

6.6.1 Transition Parameters (Left Menu)

Offset *Correction* may be set to LONG (long-way) or SHORT/LONG (short/long-way) under MM->2->1. *Transition,CoordØ+* specifies the amount of short, long or dwell for each pattern.

Short (Short-way Transition %)

This field sets the percent reduction applied to each split time in the *Split Table* during short-way transition. Valid values for this parameter are 0-24%. *Short-way* is disabled when the parameter is set to zero. The controller diagnostic (discussed later in this chapter) insures that minimum phase times are satisfied for each programmed split with *short-way* applied and insure that the phase minimums do not extend beyond a force-off. *Short-way* transition is very effective when used with the *Stop-In-Walk* feature discussed in the last section. It should also be noted that Rest-In-Walk does not operate for uncoordinated phases during short way transitioning. The ***No Short*** option (**MM->2->5**) can be turned on, if it desired for Rest-In-Walk to operate for a specific phase, even while in short way transition.

Long (Long-way Transition %)

This field sets the percent extension applied to each split time in the *Split Table* during *long-way* transition. Valid values for this parameter are 0-50%. *Long-way* is disabled when the parameter is set to zero. You may force the controller to use *long-way* only by coding a zero *Short* value for the pattern. Many users do this as a means to avoid the additional constraints imposed by the coord diagnostic for short-way transition. However, selecting SHORT/LONG as the *Correction* and providing short and long-way transition % values greater than zero allows the controller to select the quickest way to transition and synchronize the offset for the active pattern.

Dwell (Dwell in coord phase)

Dwell transition is enabled for a pattern if both *Short* and *Long* values are set to zero and *Dwell* is set to 1-99 seconds. The *Dwell* method corrects the offset by resting at the end of the coordinated phase until the desired offset is reached or until the *Dwell* time expires. The controller will continue to dwell in the coord phase each cycle until the desired offset is reached. Increasing the *Dwell* time reduces the number of cycles to achieve coordination, but increases delay for drivers waiting on the non-coordinated phases. *Dwell* offset correction is not as popular as the short-way/long-way method for this reason. When using *EndGrn* transitions, the controller dwells at the end of the cycle (or after the coord phase green) which could be whatever phase is running next after the coordinated phase. When using *BegGrn* transitions, the controller dwells at the beginning of the coordinated phase green.

No Short Ø's

This feature allows four phases to be excluded from short-way transition as "no short-way phases". Split times that are not long enough to service the minimum phase times with short-way applied will fail the coordination diagnostic. Occasionally, it is more convenient to exclude a phase from short-way as a "no short-way phases" than to increase the split time to pass the coord diagnostic or to reduce the short-way percent applied to all of the phases. This feature promotes the use to short-way transition to reduce the time need to get the offset in sync.

6.6.2 Yield Point Adjustments, Return Hold and Offset Reference (Right Menu)

These entries relate to the *Coord Phase* selected in the *Split Table* and referenced by each *Pattern*. The *Coord Phase* provides the "sync" point during coordination. The pattern *Offset* is referenced to either the beginning or end of the coord phase as specified by in this table. This menu provides the ability to return and hold the coord phase active until it's force-off and the also the ability to modify the yield points of the non-coordinated phases.

<-	#	ErlyYld	Offset	RetHld	Flt	MinPermV/P	
	1	0	BegGRN	X	.	.	.
	2	25	EndGRN	.	.	.	.
	3	0	BegGRN	.	.	.	.
....							
	48	0	BegGRN	.	.	.	.

Early Yield (EarlyYld)

The *Early Yield* parameter (0-25 seconds) modifies the yield calculations under NTCIP coordination (FIXED and FLOAT force-off modes). This adjustment is applied to all the non-coordinated phases, where the *Coord Yield* adjustment is applied to the coordinated phases.

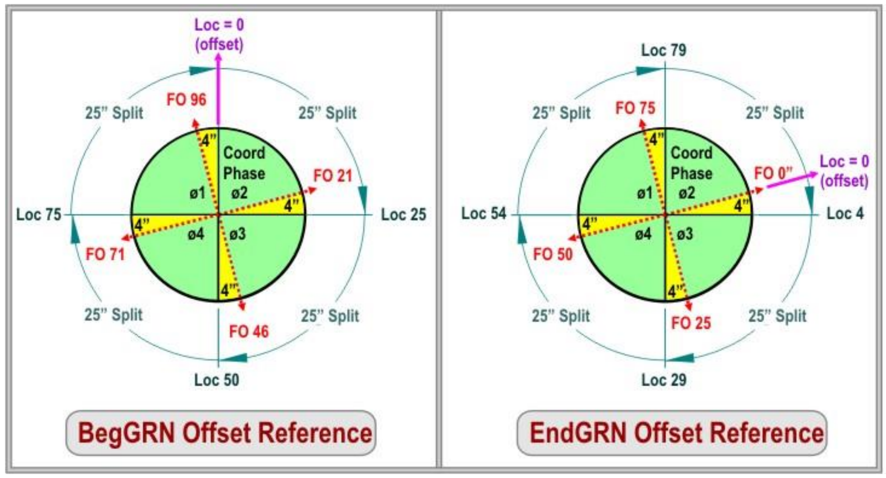
Return Hold (RetHold)

Return Hold only applies to NTCIP FIXED and FLOAT modes. Enabling *RetHold* causes a hold to be placed on the coordinated phase until it is forced-off. Disabling *RetHold* allows the controller to gap-out of the coordinated phase to service a competing vehicle or pedestrian call on another phase.

The MAX *Mode* setting in the *Split Table* can also be used to extend the coord phase. However, we recommend that unless you wish to gap out of the coord phase, that you set Return Hold as a default. This insures that if the max timer expires during a lead/lag sequence, that you will never leave the coord phase until it's force-off point. This feature is typically used in End of Green scenarios.

Offset Reference

The *Offset Reference* synchronizes the offset to either the beginning of the coord phase (BegGRN) or the end of the coord phase green (EndGRN). The 100" cycle example to the right shows how force-off points change when the *Offset Reference* is changed.



You must insure the *Offset Reference* agrees with the offset reference in the computer model used to develop the pattern. For BegGRN corresponds with the Synchro "TS2 1st Green" offset method. EndGrn corresponds with "Begin Yellow" in Synchro.

Flt

The *Flt* pattern option is provided to override the FIXED force-off method programmed under *Coord Modes* as discussed in section 6.2.1. If FIXED is selected as the default under MM->2->1, you can use this pattern option to override the force-off method as FLOAT on a pattern-by-pattern basis. This allows one pattern to guarantee slack time to either the next phase in the sequence or to the coord phase as a pattern or time-of-day feature.

MinPermV/P

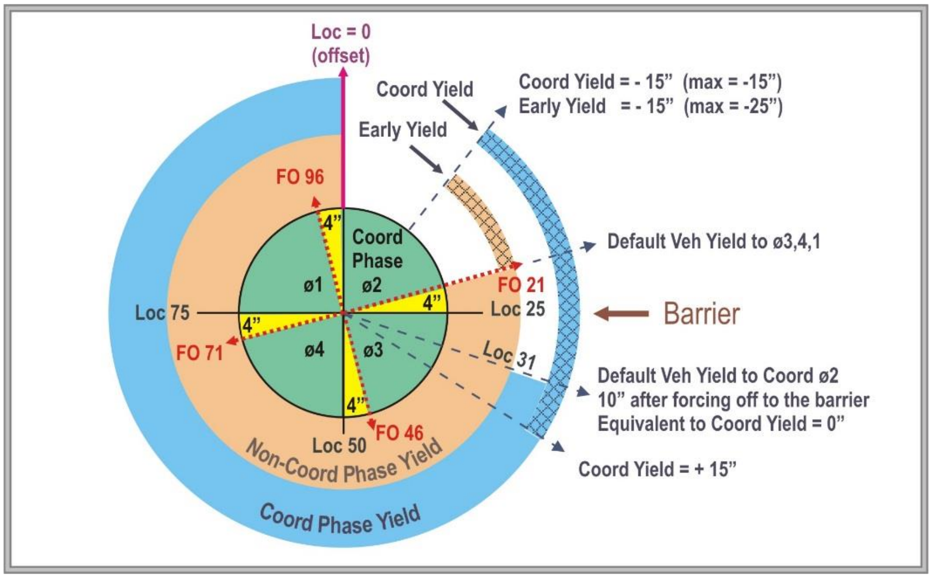
These two parameters allow the minimum permissive window for vehicles (V/) and for pedestrians (/P) to be selected on a pattern-by-pattern basis. Enabling this feature prevents a "late" vehicle and/or pedestrian call from being serviced if the call received after the force-off of the preceding phase. The *MinPermV/P* adjustments are illustrated in the next section.

6.6.3 Coord Yield and Early Yield Adjustments

The default yield points calculated by *Easy Calcs* are acceptable without modification for most applications. In fact most users continue to run coordination for years and never question the default yield point calculations. This section discusses how to adjust the default yield points calculated under FIXED and FLOAT without having to delve into the OTHER coordination modes.

The default *VehYield* points for the coord phase(s) may be adjusted using *Coord Yield*. The default *VehYield* points for the non-coordinated phases may be adjusted using *Early Yield*.

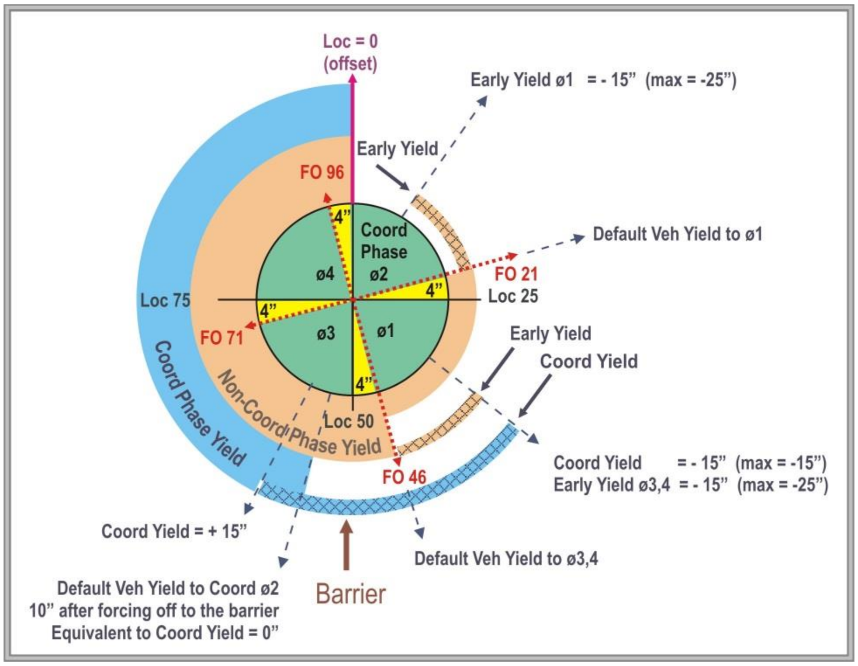
The *VehYield* point of the non-coordinated phases may be adjusted using *Early Yield* as defined in section 6.6.2 (MM->2->5). This parameter moves the *VehYield* point of the non-coordinated phases as much as 25" prior to the barrier change. Typically, this value is not changed because the user does not want to leave the coordinated phases early in a progressed signal system. However, there are unique applications when adjusting these default yield points is desirable.



The diagram to the right illustrates the *Coord Yield* and *Early Yield* adjustments when ø 1 is leading and the barrier is crossed at the end of ø2

The *VehYield* points are slightly different when the coordinated phase begins at the barrier, as in the case of a lagging left-turn sequence (see figure to the right).

The non-coordinated phases (other than the lagging turn phase) still yield at the barrier. The coord phases still yield 10" later. However, the yield point for the lagging left turn is placed at the force-off of the coord phase.



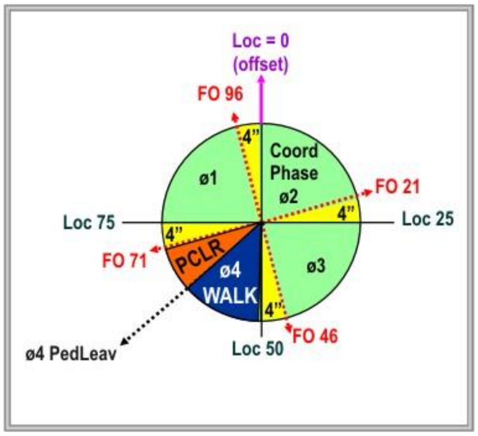
Programming Min Perm V or Min Perm P will result in the vehicle phase inhibit being set as follows:

Min Perm V: Vehicle inhibit = Force Off minus the green portion of the Split under Fixed mode.
Vehicle inhibit = Force Off (FloatMax) minus the green portion of Split under Float mode.

Min Perm P: Ped inhibit = Force Off minus the green portion of the Split plus 5 seconds under Fixed mode.
Ped inhibit = Force Off (FloatMax) minus the green portion of the Split plus 5 seconds under Float mode.

Note: If the user programs both the Min Perm V and Min Perm P, Min Perm V takes precedence.

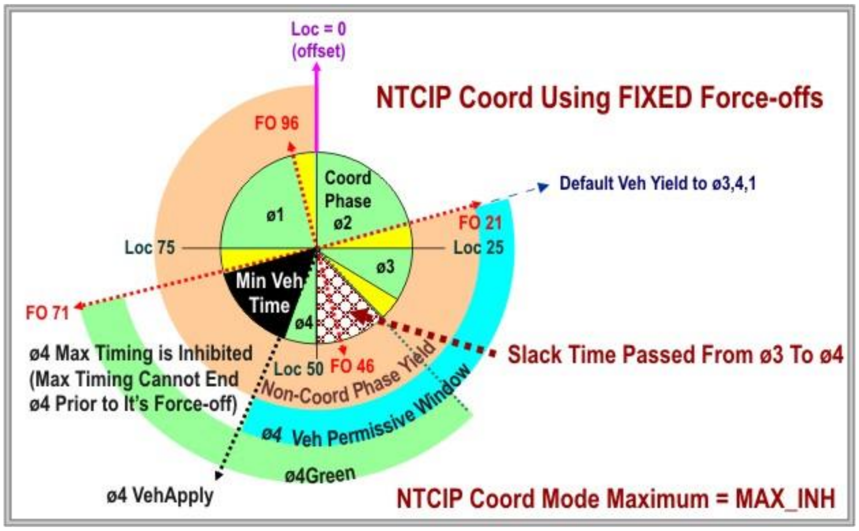
6.7 Recalling Peds With Rest-In-Walk



Pedestrian recalls may be placed on any phase during coordination through the *Mode* setting in the split table, but any setting other than NON (none) overrides the phase recall settings programmed under MM->1->1->2 or MM->5->6. Pedestrian recalls can be applied through the *Mode* setting by selecting PED to apply a ped recall MxP to place a MAX and PED recall on the phase. The PED and MxP mode settings do not recycle the walk indications if the controller is resting in the phase and the walk interval has timed out. This operation is accomplished using the walk recycle feature defined in section 6.2.2.

Agencies often want the controller to rest-in-walk in the coordinated phase to provide the maximum opportunity for pedestrians to begin crossing the street. *Rest-In-Walk* under MM->1->1->2 must be set for each phase to rest in the walk interval and time the end of ped clearance at the force-off point (beginning of yellow). The controller calculates an *Easy Calc* point, called *PedLeav* that defines the end of the end of the *Rest-In-Walk* period. This coordination feature replaces the walk-rest-modifier method used in TS1controllers to achieve rest-in-walk operation.

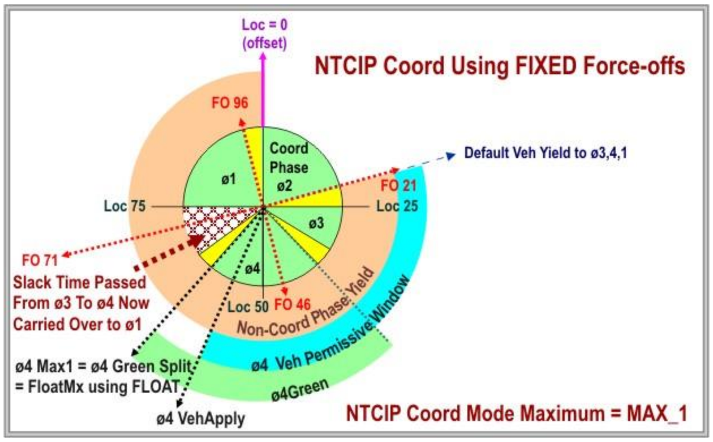
The *PedLeav* point is calculated by subtracting ped clearance time from the force-off point of the phase as shown above. If *Walk* Recycle is set to NO_RECYLE or NEVER, then *Rest-In-Walk* feature will not operate properly. Therefore, set *Walk_Recycle* under Coord Modes+ (MM->2->1, right menu) to recycle the walk indication if *Rest-In-Walk* is used.



6.8 Maximum Phase Timing Using FIXED Force-offs

Force-offs calculated for FIXED and FLOAT are fixed points in the cycle that do not change even though phases may skip, gap-out early and transfer slack time to the next phase in the sequence. FIXED force-offs allow slack time to be used by the next phase in the sequence. Max phase timing under FIXED may be inhibited (MAX_INH) or set to MAX_1 or MAX2.

FLOAT force-offs insure that all slack time is transferred from the coordinated FLOAT apples a floating max time (*FloatMx*) equal to the green portion of the split to terminate the phase prior to the force-off if the time allocated to the phase exceeds programmed split time. This insures slack time transfers to the coord phase in the sequence.



The example to the right applies FIXED force-offs with the *Maximum* mode set to MAX_INH. ø 3 gaps out early and moves to ø4 because the vehicle permissive window for ø4 is open. Because max timing is inhibited, slack time from ø3 is transferred and used by ø4 if veh calls exist extending ø 4 to the force-off for ø4.

The next example illustrates FIXED force-offs with the *Maximum* mode set to MAX_1. In this case, the active max1 phase time for ø4 is set equal to the green portion of the split assigned to ø4 which is equivalent to the *FloatMx* automatically set using FLOAT. Setting the active max1 value greater than *FloatMx* allows ø4 to use a portion of the slack time from ø3. Setting max1 to a "large" value allows the max timer to extend the phase to the force-off of ø4 and achieves the same effect as setting the *Maximum* mode to MAX_INH.

6.9 Alternate Tables+ (MM->2->6)

```
Pat#  Alt: POpt PTime DetGrp Call/Inh  >
 1          0    0      0       0
 2          8    3      3       2
 3          0    0      0       0
 4          0    0      0       0
```

```
<- Pat# Olp.Off:12345678 CIC CNA1 Max2 Dia
     1          ........  0   .    .   DFT
     2          ........  0   .    .   DFT
     3          ........  0   .    .   DFT
......
    48          ........  0   .    .   DFT
```

The *Alternate Tables+* menu attaches any of the *Alternate Phase Programs* (chapter 4) or the *Alternate Detector Programs* (chapter 5) to any of the 48 patterns. There are a total of 8 *Alternate Phase Option Programs*, 3 *Alternate Phase Time Programs*, 3 *Alternate Detector Group Programs* and 2 *Call/Inhibit Programs* assignable to each patterns in *Alternate Tables+* in the left menu of MM->2->6.

The right menu of *Alternate Tables+* allows overlaps 1-8 to be individually enabled or disabled by pattern. One application of this feature is to convert a protected/permitted left-turn signal to protected-only through a pattern that disables an overlap driving the permissive indications. *Please note overlap Types PED1 and FASTFL do not get turned off by time of day*. Note further that when an overlap is disabled by time of day, it stays disabled; the overlap won't turn on. For example, if a preemption comes up that allows the overlap to be run, the user should not expect the overlap to operate.

The *CIC* plan (1-4) for Critical Intersection Control may also be enabled or disabled for each pattern. *CIC* provides an adaptive split feature.

Enabling *CNA1* when a pattern is active applies a hold during coordination on any phases programmed for "Non-actuated 1". *CNA1* provides an external method of coordination commonly used with older UTCS type systems. However, external coordination has been replaced with internal time base methods described in this chapter.

Max2 may be selected for each pattern from Alternate Tables+ and overrides the *Maximum* setting in *Coord Modes* MM->2->1. *Max2* has no effect under coordination if the floating force-offs (FLOAT) is active (see section 6.2.1). This feature is also used to call a free pattern (0" cycle length) by time-of-day and change the current max timing in effect from Max1 to Max2.

6.10 External I/O (MM->2->2)

```
Pat# Offset Plan    Pat# Offset Plan
 1     1     1       2     1     1
 3     1     1       4     1     1
 5     1     1       6     1     1
 7     1     1       8     1     1
```

External I/O allows an external source to select the active pattern using *Offset* and *Plan* inputs provided on the D-connector. External coordination schemes date back to early TS1 days when an on-street master selected the active pattern of all secondary controllers in the system through an AC current based hardwire interconnect *External I/O* programming is provided in version 61 for backward compatibility with these older systems. The *External I/O* programming shown to the right associates the *Offset / Plan* inputs with the NTCIP pattern provided in the pattern table. Refer to the *Advanced Coordination* manual for further information.

6.11 Coordination Status Displays (MM->2->8)

```
        Coordination Status
1.Overview    4.Clear Fault
2.Easy Calcs  5.Diag Fault
3.CIC Calcs
```

The *Coordination Status Displays*:

- Show the current state of the *Coordination Module* and it's various *Operation Modes* (the active pattern and it's source along with the timers that relate to the active pattern)
- List the internal force-off and yield points driving the active pattern (Easy Calcs)
- List the optional dynamic force-of and yield points if CIC operation is in effect (CIC Calcs)
- Display phases that were skipped if the active pattern fails and allow the user to clear the fault
- Diagnose the *Next* pattern to isolate faults before they occur

6.11.1 Coordination Overview Status Screen (MM->2->8->1)

```
OpModes.Src-TEST  Cycle    Ofst  03:44:51
Sys-  0 Actv-  1  Loc- 41 Actu:  50 ACTIV
Tbc-  0 Next-  1  Tbc- 91 Err:    0
Ext-  0 Remo-  0 Prog-100 Prog:  50 SYNC
Tod-  0 Test-  1  Alt:.Opt.Time.Det.CIR
                      0    0    0    0
```

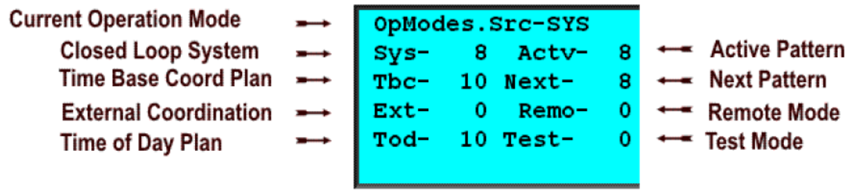
The *Coordination Overview Status Screen* is grouped into the following three distinct areas. These three areas are combined on one status display to avoid changing menus to display the current status of the coordinator:

- The current *Operation Modes* and source (*Src*) of the *Active* pattern
- The real-time status of the *Active* pattern and offset synchronization

- Alternate phase times and options, detector group and Call/Inhibit/Redirects assigned to the *Active* pattern (bottom line of the *Coordination Overview Status Screen* above)

Operational Modes and Active Pattern

The left-hand area of the *Coordination Overview Status Screen* provides the current p*attern #* generated by each of the Coordination Modes and the, *Next pattern #* and the *Active pattern #* in effect.



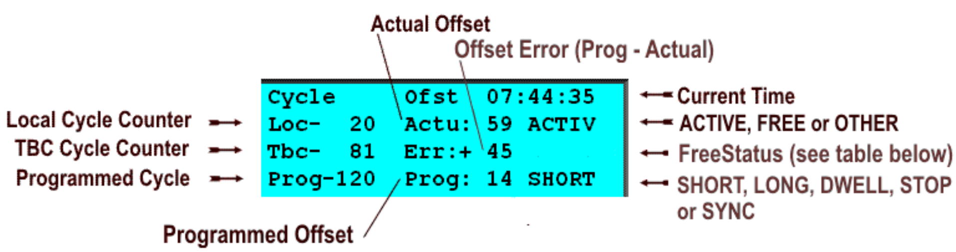
The controller may receive a pattern change from any of the *Coordination Modes* discussed in this chapter. These modes generate the *Source (Src)* of the *Active* pattern based on the following hierarchy of control:

- *Test* patterns have the highest priority and can only be overridden by modifying the *Test OpMode* value in the database (see MM->2->1)
- *Remote (Remo)* patterns downloaded from StreetWise or ATMS.now have the next highest level of priority.
- *System (Sys)* generated patterns downloaded from a closed loop master becomes active if the *Closed Loop* parameter in *Coordination Modes+* is ON (see MM->2->1).
- *External (Ext)* generated patterns are selected using D-connector plan/offset inputs rather than data communication to a central based or master based system
- *TBC* generated patterns are selected by any manual override of the Time Base Scheduler, see chapter 7. (*TBC* is usually in stand-by and therefore defaults to the current *Tod* pattern from the *Time Base Scheduler*)
- *Tod* generated patterns are selected by the *Time Base Scheduler* (see the next chapter)

During a pattern change, the *Next* pattern becomes *Active* when the *Local (Loc)* cycle counter reaches zero. This assures a smooth transition between pattern changes that may affect active cycle, splits, offsets or sequence.

Active Pattern Real-time Status

The right-hand area of the *Coordination Overview Status Screen* provides the status of the *Active* pattern and the cycle counters related to offset synchronization.



Coordination may be ACTIVE, FREE or OTHER as indicated in the right corner of this display. ACTIVE implies that coordination is active and that the *Cycle* and *Offset* values displayed and all *Easy Calcs* are in effect. FREE implies that coordination is not active and that cycle length, offset and *Easy Calcs* are ignored. OTHER is displayed when coordination is ACTIVE and a valid preempt call is received.

Synchronizing Coord patterns when using Time Based References

Synchronizing coordination on controllers that are connected to a central computer is quite easy. The user should schedule a real-Time clock download once a day so that the time based sync references are recalculated and reestablished, thus synchronizing the controllers in that system.

Now assume that two controllers are not connected to a central computer but always run a single pattern with the same coordination cycle lengths, the exact same date and time (MM->4->1) as well as the same Time based Sync Reference point (MM->4-6) programmed. The expectation is that the TBC cycle lengths with be synchronized between the controllers. This may not occur in all cases. To guarantee synchronization, the user should force a recalculation of the of the sync reference by scheduling the controller to go to a pattern of a different cycle length. Programming the last pattern to run before the Sync Reference Point to be a different cycle length than the first pattern to run after it, will guarantee that the time based sync references are recalculated and reestablished, thus synchronizing the controllers in that system.

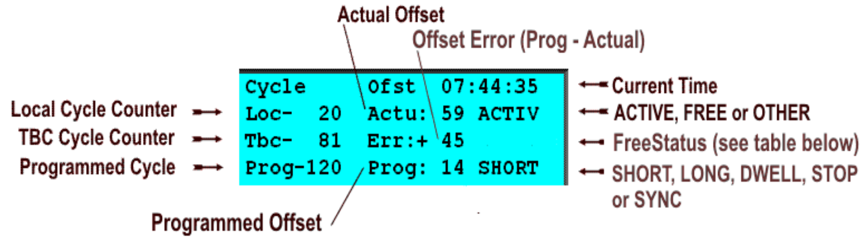
Note: Going to a FREE Pattern (NTCIP Pattern 254 or a *Free Pattern* which can be created using a zero second cycle length) will not guarantee that the time based sync references are recalculated and reestablished. Only going to a pattern of a different cycle length will do this.

FreeStatus is defined in NTCIP 1210, section 2.5.11 and is summarized in the table below:

FreeStatus Display	Definition
<blank>	Coordinator is not running free (Coordination is active)
COMND	a) The current pattern (0, 254 or 255) is calling for FREE operation b) The current pattern (1-48) is calling for FREE (Cycle = 0)
PATRN	The controller is running FREE under Pattern 0
PlnER	a) the pattern called is invalid (48 < pat# < 254 is not valid in version 61) b) the sum of the splits in a ring does not equal the cycle length c) the splits in one ring do not cross a barrier with another ring d) no coord phase or two coord phases assigned to the same ring e) coord phase are in separate rings, but are not concurrent
CycER	Cycle length is less than 30”
SplER	a) Split time is not sufficient to service minimum phase times b) Split time is zero for an enabled phase
OftER	The offset is greater than or equal to the Cycle length
FAIL	Coordination failure - a valid vehicle or ped call has not been serviced for 3 consecutive cycles
OTHER	a) A railroad or light rail preemption input has been activated b) MCE (Manual Control Enable) has been activated
INPUT	The external FREE input has been activated and the FREE pattern is Active
TRANS	Diamond operation is in transition

Tbc and Local Cycle Counters

The *Tbc* cycle counter for the *Active pattern* is a midnight time reference. Imagine that the *Tbc* counter is set to zero at midnight (00:00:00) and allowed to count up to the active *Cycle* length over and over again until the current time (now) is displayed on this screen. Every time the *Tbc* counter rolls over to zero, you have a sync point for the *Active pattern* that synchronizes the system *Time Base* at midnight.



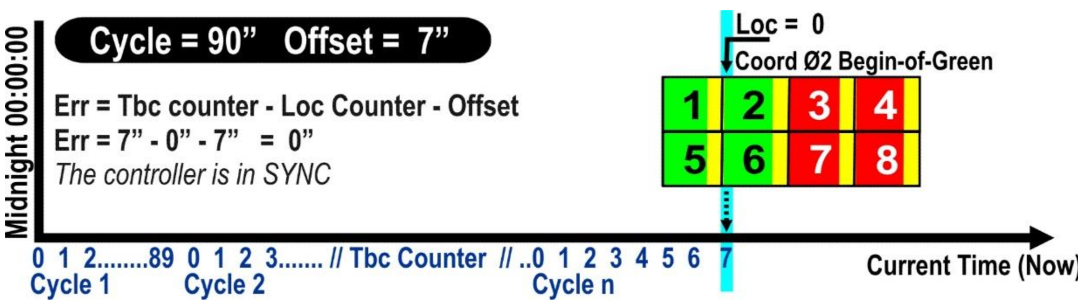
The *Programmed Offset* is added to the zero point of the Tbc counter to provide the "synch" point for the coord phase (either BegGRN or EndGRN) at Loc = 0. *Time Base Coordination* provides a way to synchronize the coord phases of all the controllers in a system running a common cycle length because the Tbc counter in each controller shares the same *Time Base* (midnight) reference. The controller is in SYNCH when the *Coord Phase* (*Loc* = 0) is lined up with *the Programmed Offset* applied to the *Tbc* counter.

Understanding Offset Errors and SHORT, LONG, SYNC and STOP

The controller is in SYNC when the *Error (Err)* display above is zero. If the controller is not in SYNC, it is in transition (SHORT, LONG or DWELL), or the Local counter is has stopped because pedestrian service has just overrun a force-off applying STOP-IN-WALK. The *Error (Err)* display shows how far the *Local* counter is "out of step" with the *Programmed Offset* and *Tbc* counter and is calculated as:

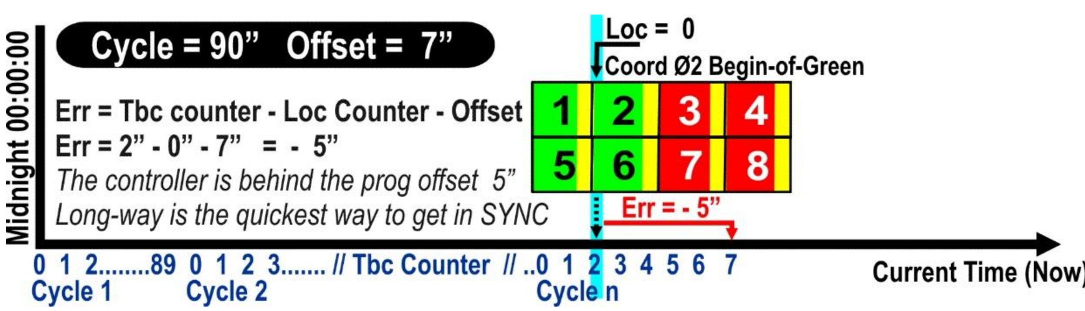
Err = Tbc counter – Loc counter - Prog Offset

The controller applies short-way, long-way or dwell transition to bring the Local counter (beginning or end of the coord phase green) into sync with the *Programmed Offset*. When the *Programmed Offset* is zero and the controller is in SYNC (Err = 0), the *Loc* counter and *Tbc* counter are equal. In summary, *Loc=0* is referenced to either the beginning or end of coord phase green (controller offset reference). This point in the cycle need to line up with the current offset relative to the system time reference (*Tbc* counter plus the *Prog* offset) to insure synchronization across the network.



The Controller is in SYNC When the Local Zero Counter (Loc = 0) is Aligned With the Programmed Offset

The above illustration shows the Tbc counter referenced to midnight for a 90" *Cycle* with a 7" *Programmed Offset*. The controller is in SYNC because *Local 0* is aligned with the *Programmed Offset* and the offset reference of coord phase 2 is begin-of-green.



LONG-way Transition Moves the Offset "Forward in Time" by <u>Increasing Split Times</u> the Long-way%

In the above case, the synch point (*Local 0*) begins 5” before the *Programmed Offset* of 7*”*. Five seconds is only 6% of the current 90” cycle, so if at least 6% *Long-way* transition is programmed (MM->2->5), the controller can easily correct *Local 0* to the current offset within one cycle. The controller accomplishes this transition by running the *Local* cycle counter “slow” by the *Long-way%* specified during the transition. This avoids recalculating the *Easy Calcs* and also insures that the programmed phase times (min greens, clearances, etc.) are all timed correctly. The user should understand that during *Long-way*, each *Split Time* is lengthened by the *Long-way%* value programmed for the pattern.

SHORT-way Transition Moves the Offset “Back in Time” by <u>Decreasing Split Times</u> the Short-way%

In the example above, the synch point (*Local 0*) is ahead of the *Programmed Offset* by 5”. If SHORT/LONG is selected under *Coord Modes* (MM->2->1) and at least 6% *Short-way* is programmed for this pattern, the controller will shorten the *Split Times* by the *Short-way%* value programmed under MM->2->5. During *Short-way* transition, the reduced *Split Times* must be adequate to service the minimum phase times or else the controller diagnostic will fail and the controller will be placed into free operation. *Short-way* is very effective with the *Stop-In-Walk* feature discussed in section 6.2.2 and allows the controller to transition quickly when an occasional pedestrian service extends a phase past it’s force-off.

6.11.2 Easy Calcs Status Screen (MM->2->8->2)

Easy	Ø..1	...2	...3	...4	...5	...6	...7	...8 ->
PrimFrc	37	7	17	27	37	7	17	27
SecdFrc	37	7	17	27	37	7	17	27
Veh Yld	7	17	7	7	7	17	7	7
VehAply	34	0	12	20	32	0	12	20
Ped Yld	7	17	7	7	7	17	7	7
PedAply	32	2	12	22	32	2	12	22
FloatMx	7	7	7	7	7	7	7	7
PedLeav	37	37	17	17	37	37	17	17

Easy Calcs show the current force-offs and yield calculations for the active pattern under FIXED, FLOAT or one of the OTHER coordination modes. *Easy Calcs* are identical for the FIXED and FLOAT modes except that “*FloatMx”* is used to limit each non-coordinated phase to it’s programmed split and move any “slack time” to the coordinated phase. Most users find these default *Easy Calc* calculations acceptable for their application and do not have to review these values with every pattern change. **Keep in mind that whenever the user changes any coordination parameter that the Easy Calcs may be affected.**

Primary Force-Off

The Primary Force-Off is the point in the local cycle that a force-off is applied to a phase causing that phase to terminate and begin timing yellow clearance. A Primary Force-off will remain applied until the phase terminates.

Secondary Force-Off

The Secondary Force-Off is a momentary force-off applied prior to the Primary Force-off. Secondary Force-offs are useful when conditionally servicing phases or when a phase is to be forced off twice per cycle. The Secondary Force-off normally default to the value of Primary Force-off. **NOTE: This feature is not used in NTCIP Coordination.**

Vehicle Yield

The Vehicle Yield is that point in the cycle that a vehicle call on a phase will be serviced, i.e. that the phase’s inhibit is removed. Note that the phase inhibit is automatically applied by the controller at a calculated time in advance of the primary force-off.

Vehicle Apply

The Vehicle Apply point defines the point in the cycle when the phase inhibit is applied. A phase may begin anytime between the Vehicle Yield point and the Vehicle Apply point.The Vehicle Apply point (VehAply) for each phase is calculated as:

Vehicle Apply Point (VehAply) = Primary Force-off – ((Max Yellow + All Red) + Minimum Green)

The yield point must be earlier than the automatic application point for the phase to be serviced. If short-cycle offset correction is enabled, the yield point must be earlier still to allow for the effective reduction in split time that occurs when the local cycle timer corrects by running fast.

Pedestrian Yield

The Pedestrian Yield is that point in the cycle that a pedestrian call on a phase will be serviced, i.e. that the phases pedestrian inhibit is removed. The phase inhibit is automatically applied by the controller at a calculated time in advance of the primary force-off.

Ped Apply

The Ped Apply point defines the point in the cycle when the pedestrian phase inhibit is applied. A pedestrian phase may begin anytime between the Ped Yield point and the Ped Apply point. The PedApply point for each pedestrian phase is calculated as:

Ped Apply Point (PedAply) = Primary Force-off – ((Max Yellow + All Red) + Pedestrian Clear)

The same considerations described above for selecting vehicle yield points apply to determining pedestrian yield points except when the STOP-IN-WALK is enabled. Refer to the explanation of Stop-In-Walk.

FloatMx

Floating max time (*FloatMx*) is equal to the green portion of the split needed to terminate the phase prior to the force-off if the time allocated to the phase exceeds programmed split time. This is used as the max green time with floating force-offs.

PedLeav

The Pedestrian Leave Point is used when Rest-In-Walk is active. This is the point in time when the Pedestrian Clearance begins after the phase has been resting in walk.

6.11.3 CIC Calcs Status Screen (MM->2->8->3)

The *CIC Calcs* provided under menu MM->2->8->3 are only applicable if *CIC (Critical Intersection Control)* is enabled for the coordination pattern. *CIC* provides a dynamic split adjustment. Phases that gap-out two cycles in a row provide "slack time" to phases that max-out during coordination. If *CIC* is enabled, the controller will make a dynamic adjustment to the primary force-off and yields shown in the *CIC Calcs* screen. *CIC* is fully discussed in the *Advanced Coordination* document.

Dyn Coor Ø	.1	...2	...3	...4	...5	...6	...7	...8
Dyn Acc	0	0	0	0	0	0	0	0
Dyn Abs	0	0	0	0	0	0	0	0
Dyn Max	0	0	0	0	0	0	0	0
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	37	7	17	27	37	7	17	27
VEH YLD	7	17	7	7	7	17	7	7

6.12 Pattern Offsets / Preempt Inhibits (MM->2->9)

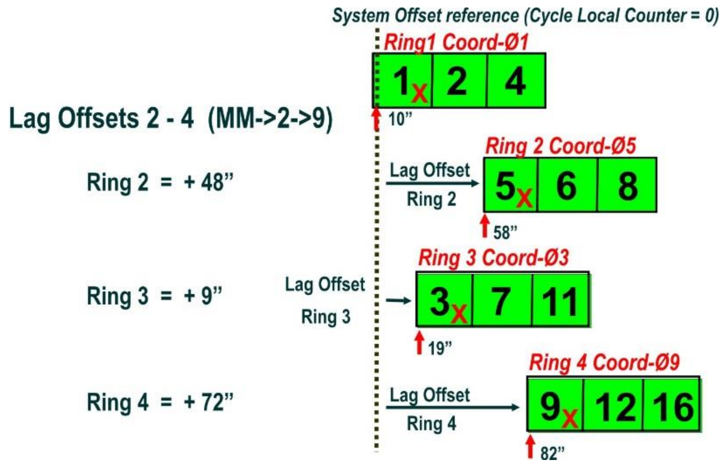
NTCIP specifies one offset per pattern referenced to either the beginning or end of the coord phase specified in the *Split Table* (MM->2->4). For example, assume that the 10” offset for Pat# 1 in the *Pattern Table* (right) is referenced to *Coord Phase* Ø2 specified in *Split Table* 1 and that the offset reference is begin-of-green (BegGRN).

Pat#	Cycle	Offset	Split	Seqnc
1	100	10	1	1
2	0	0	0	0
3	0	0	0	0

Assuming that the offset in the Pattern Table refers to the *Coord Phase* in ring 1, three additional offsets may be specified for additional coord phases in rings 2-4 under the *Pattern Offsets* menu (right). This allows up to 4 separate intersections to be controlled with a separate offset in each ring. The phases operate independently in each ring, so the phase concurrency table allow each phase to be concurrent with all phases in the other rings. In the menu example MM->2->9 (right), bus preemption is inhibited for Bus Preempt # 3 for Pat# 1 and platoon Progression 1-4 is inhibited for Pat# 2.

Pat#	Offsets 2-4			Bus,PP Inh	
1	48	9	72	..X.	....
2	0	0	0	....	XXXX
3	0	0	0	....	....
...					
48	0	0	0	....	....

Each “lag” offset (2-4) is referenced to the NTCIP offset in ring 1in the pattern table as shown in the figure to the right. If the offset in ring 1 is 10’, then the true offset for ring 2 is 10” + 48” (lag offset) or 58” as shown in the figure.



6.12.1 Pattern Offset: User mode Example

This can be helpful when simulating a Texas Diamond intersection using SEP (separate mode). As an example, the user wants to run two completely independent rings with ring 1 driving one frontage road and ring 2 driving the other.

1) First you have to set up your Phase mode as USER mode (MM-1-2-1) and modify the Sequence table (MM->1->2->4) and Concurrency table (MM->1->1->4) to match the setups below:

   Sequence:
   R1: 1- 2 -3- 4
   R2: 5- 6- 7- 8

   Concurrencies:
   Phases 1-4 concurrent with phases 5 6 7 8
   Phases 5-8 concurrent with phases 1 2 3 4

2) Next set the coord phase to any phase in ring 1. The offset in the pattern table MM->2->4 applies to that coord phase.

3) **DO NOT** set any other coord phases in the split table. The Separate Ring Offsets for rings 2-4 are set under MM->2->9. This is the offset for the first phase of the ring as shown in the figure shown above. In this figure, the coord phase in the split table could be phase 1, 2 or 4, but the lag offset in ring 2 is always from the start of the first phase in ring 1. You can select the coord phase to either 1,2,or 4. So if your diamond is running 3 phases with the arterial phases 1+5 lagging and 4+8 frontage roads it will look like this where 3 and 7 are omitted (x)

R1: 2- 1 -x -4
R2: 6 -5 -x -8

4) You could run splits without having to satisfy a barrier if you are in USER with concurrencies set as discussed above (you still have to make sure each ring adds up to the cycle). As an example for a 60 second cycle the following splits could be programmed to create a pattern offset

PHASE	1	2	3	4	5	6	7	8
SPLIT (sec)	10	20	0	30	15	30	0	15

5) Under MM->2->9, you could then apply a separate ring offset for ring 2 = 30. This would start the first phase in ring 2 (phase 6), 30" after the start of phase 2 in ring 1.

6.13 Free Patterns and Multiple Maximum Greens

Patterns 1-48 can be activated as either *Coord Patterns* or *Free Patterns*. A *Free Pattern* can be created using a zero second cycle length to use any of the coord features listed in this chapter. The most consistent way to program a Free pattern is follow the following steps.

1) Under MM->2->4 (Patterns), choose an unused pattern and program a zero second cycle length, zero second offset and an unused split table number.

2) Under MM->2->7 (Split Table), go to the unused split table that you chose under step 1, and program each phase's split time with the max green that you want to use for that phase. These green times will be used under Free operation. In this way a user can run multiple maxes.

3) **DO NOT** program a coord phase in the split table. You can optionally program the phase modes at your discretion.

6.14 Coord Diagnostics

This section documents why coord patterns fail and how to use Coord Diagnostics to isolate problems in a pattern. The *Coord Diagnostics* check patterns before they become Active to insure that phases do not skip or run past their intended force-off point under traffic conditions. Coord Diagnostics check to make sure that the sum of the splits in each ring equals the programmed cycle length and that the phases in each ring cross the barrier at the same point in the cycle. When a *Coord Diagnostic* fails, the controller provides text messages to allow you to isolate the problem with the programmed cycle, offset, split or sequence that has failed the diagnostic.

Note: When considering coordination, using the STD8 phase mode will take advantage of the most coordination diagnostic checks to catch common data entry mistakes, and if detected, times the intersection in FREE. In USER mode, most of these coordination diagnostics are removed, and the onus is on the agency verify and test the programming to ensure that coordination pattern(s) run as expected.

6.14.1 Why Coord Patterns Fail

NEMA requires that the controller monitor vehicle and pedestrian calls during coordination and detect phases that are skipped. If a vehicle or pedestrian call is not serviced for more than two consecutive cycles, the controller fails the pattern and runs FREE. NEMA also requires that split times are adequate to service the minimum phase times. When coordination fails and the controller goes to FREE, the FreeStatus display is set to one of the following values. *FreeStatus* was defined in the section on the *Coordination Status Display* (see section 6.11.1):

FreeStatus Display	Status During Coordination or During a Coord Fail
<blank>	Coordinator is not running free (Coordination is active)
PlnER	a) the pattern called is invalid (48 < pat# < 254 is not valid in version 61) b) the sum of the splits in a ring does not equal the cycle length c) the splits in one ring do not cross a barrier with another ring d) no coord phase or two coord phases assigned to the same ring e) coord phase are in separate rings, but are not concurrent
CycER	Cycle length is less than 30”
SplER	a) Split time is not sufficient to service minimum phase times b) Split time is zero for an enabled phase
OftER	The offset is greater than or equal to the Cycle length
FAIL	Coordination failure - a valid vehicle or ped call has not been serviced for 3 consecutive cycles. Coord diagnostics insure that this failure does not occur in STD8 operation with FIXED and FLOAT force-off methods. However, USER mode operation and OTHER modes of coordination do not perform the same diagnostic checks and it is quite possible to skip a phase if force-off and yield points are not specified correctly.

6.14.2 Coordination Clear Fault Status Display (MM->2->8->4)

```
Coord Fault      P 1.......   9.......  >
       Skipped Ps --------   --------
       Pattern #    0
Press ENTR to Clear Fault
```

The *Clear Fault Status Display* records any phase skipped for more than two consecutive cycles and the pattern number in effect at the time coordination failed.

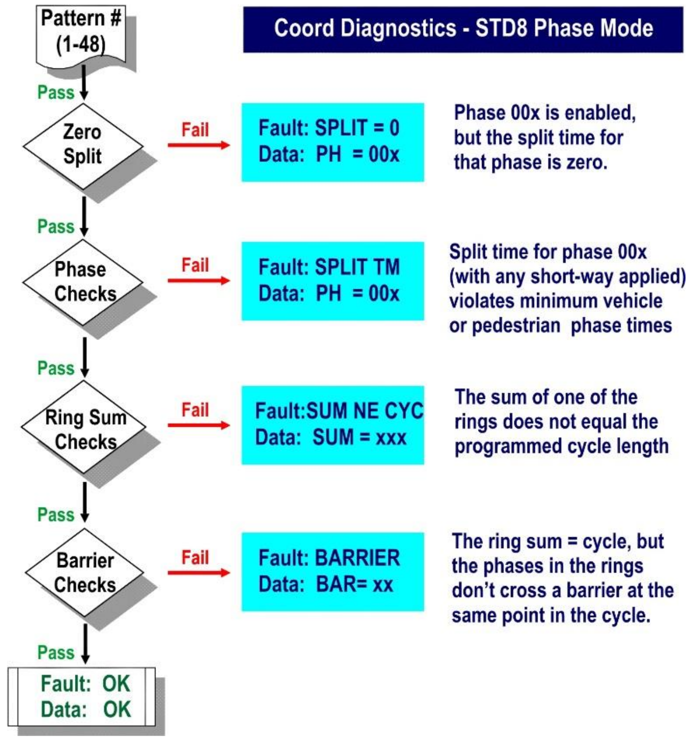
The *Coord Fault* can be cleared from this screen to reset coordination; however, the proper way to recover from coord failure is to run the *Coord Diagnostics* discussed in the next section because resetting the failure does not fix the problem. A *Coord Fault* will also be cleared when a new *Tod* pattern is called by the *Time Base Scheduler* if *Auto Err Reset* is set ON (see *Coordination Modes+*, MM->2->1, right menu).

6.14.3 Coordination Diagnostic Status Display (MM->2->8->5)

```
     Coordination Diagnostic Status
Cycle 100   Pattrn   1  Fault: OK
Offst  50   Source TEST Data :OK
Coord   1 FreeStat CoorActv
```

The *Coord Diagnostic* was designed to isolate coordination errors and identify the cause of the failure. All patterns should be checked with *diagnostic* or from central (StreetWise or ATMS.now) utilities that emulate these diagnostics. This will help you eliminate pattern errors before they are placed in operation under traffic.

The *Coord Diagnostic* displays the active *Pattern #* and the *Cycle* length and *Offset* programmed in the *Pattern Table* (MM->2->4). The *Coord* status my be FREE (0), ACTIV (1) or OTHER (2) and corresponds with the coord status described in the Coordination Status Display section above.



The *Coord Diagnostic* is typically used in conjunction with the *Test* mode to test coord patterns before placing them in service. The controller must be manually forced into each pattern under TEST (MM->2->1) and then checked with MM->2->8->5 to insure that the Fault: and Data: fields in the above menu display OK.

StreetWise and ATMS.now provides coord diagnostics that emulate the coord diagnostics in the controller and allows you to test patterns without downloading the database to the controller. The same rules used in the controller are applied in central diagnostics because the controller's diagnostics are the final checks on the pattern and determine if the coord plan passes (CoordActv) or fails (Failed).

During a pattern change, the new pattern # becomes the *Next* pattern in menu MM->7->2 and does not become the *Active* pattern until the *Local* counter of the current *Active* pattern reaches zero. The *Coordination Diagnostics* status display above shows the current *Active* pattern and a full cycle may elapse before a TEST pattern becomes Active. However, the *Coord Diagnostics* are run immediately on the *Next* pattern entered under MM->2->1, so it is not necessary to wait until the TEST pattern becomes *Active* in this display to check the Fault: and Data: fields for errors.

The *Coord Diagnostic* will stop on the first error encountered with the TEST pattern. Therefore, if a problem is isolated and corrected, the *Coord Diagnostics* must be checked again for additional errors. When the Fault: and Data: fields each display OK, the pattern has been fully tested and can be placed into service.

Diagnostic Check	STD8	QSeq	8Seq	USER	DIAMOND
Zero Split Check	■	■	■	■	■
Phase Checks	■	■	■	■	■
Ring Sum Checks	■	■	■		
Barrier Checks	■	■	N/A		

Coord Diagnostic - Phase Time Checks

The *Coord Diagnostics* perform extensive checks to insure that each *Split Time* is long enough to service the minimum phase times of each phase. This insures that a force-off is not issued to a phase while it is servicing a minimum phase time. The diagnostics take into account the following to insure minimum phase times are guaranteed for each split.

1) **Short-way Offset Correction**
   The programmed split time for each phase is reduced by the amount of short-way programmed for the pattern under MM->2->5. This insures that the minimum phase times are satisfied during short-way transition when the split times are reduced to align the coord phase with the programmed offset. You can easily calculate the split adjustment performed by the *Coord Diagnostic* as follows:

   Short-way Split = Split * (100 – Short-way%) / 100

   This adjustment is not made if the phase is assigned as a *No Short Phase* under MM->2->5. Split times for "*No Short Phases*" are not reduced by short-way transition.

2) **Minimum Phase Times**
   There are actually two minimum phase times checked by the Coord Diagnostic. Note that these minimums times are checked using the current phase times and options associated with the coord pattern. If any alternate phase times or phase options are associated with the pattern, the alternate values will be used to perform these checks.

   a) Vehicle Min Phase Time - This minimum is calculated by taking the greater of the "Min Green" or "Max Initial" and adding the "Yellow Clearance" and "All-Red" time of each phase.

   Veh Min = Min Green + Yellow + All-Red

   or if volume density is used,

   Veh Min = Max Initial + Yellow + All-Red

   b) Pedestrian Min Phase Time - If STOP-IN-WALK is OFF (MM->2->1), then the coord diagnostic will also insure the split times are long enough to service all pedestrian times. Setting STOP-IN-WALK to ON allows an occasional pedestrian call to violate the programmed split. The pedestrian times will always be guaranteed if "Rest-in-Walk" is enabled, even if the STOP-IN-WALK parameter is ON.

   If *PedClr-Thru-Yellow* is not enabled for the phase, the pedestrian min phase time is:

   Ped Min = Walk + Ped Clearance + Yellow + All-Red

   If *PedClr Thru Yellow* is enabled, the pedestrian and vehicle clearances time together and the ped min is:

   Ped Min = Walk + Ped Clearance + All-Red

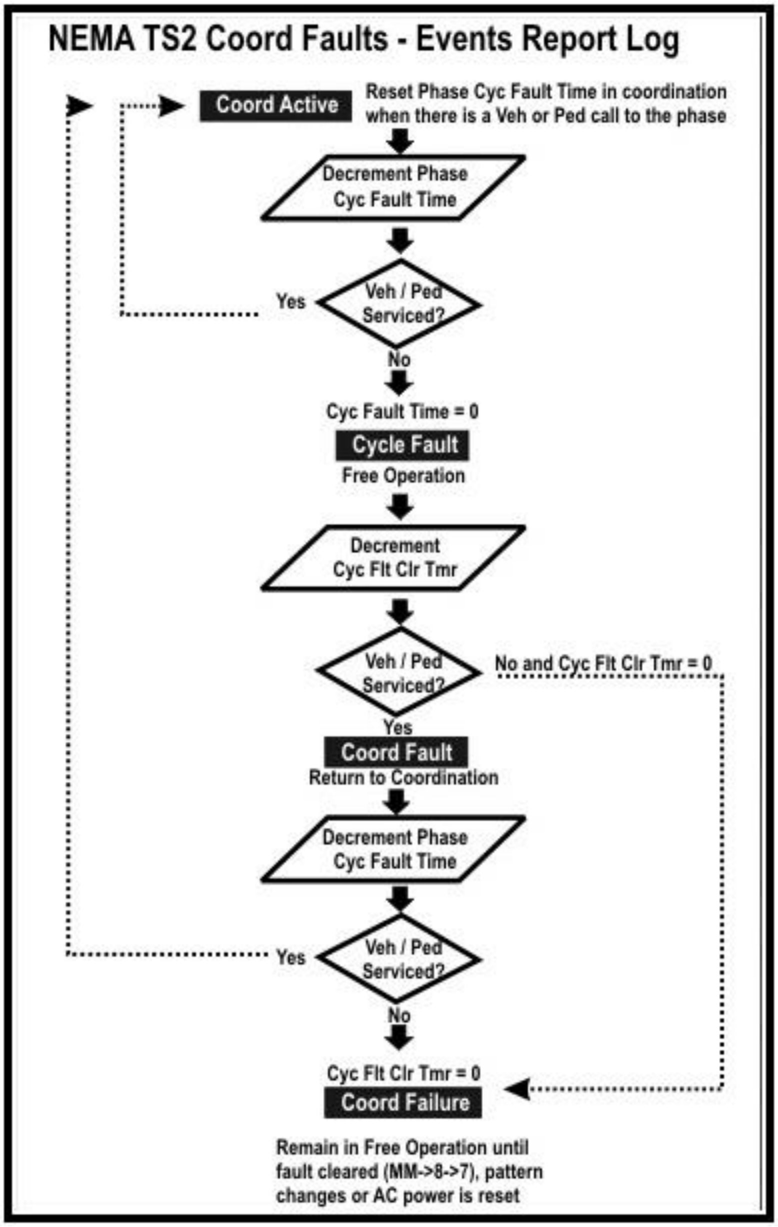
6.15 Coordination Alarm Considerations

There are specific alarms that assist the user when programming coordination. They are listed below.

Alarm #	Alarm Name	Description
4	Coordination Failure	This alarm indicates that coordination is failed. There are two ways in which coordination may fail: 1) The TS2 method in which two cycle faults have occurred during coordination, but not when coordination is inactive. 2) A serviceable call has not be serviced in 3 cycles. This is the traditional method, which predates the NEMA TS2 method.
9	Closed Loop Disabled	This alarm, when active, indicates that the Closed-loop Enable parameter is set to OFF.
13	Coordination Free Switch Input	Alarm active when System/Free Switch is FREE
17	Cycle Fault	TS2 Alarm. It indicates that a serviceable call has not been serviced in approximately two cycle times and coordination was active at the time.
18	Cycle Failure	TS2 Alarm. It indicates that a serviceable call has not been serviced in approximately two cycle times and that coordination was not active at the time.
19	Coordination Fault	Indicates that a cycle fault occurred during coordination.
30	Pattern Error / Coord Diagnostic Fault	Active when coord diagnostic has failed.
38	Pattern Change	Coordination Pattern changes are logged to the event and alarm buffers using this alarm number. The data byte stores the new pattern number.
47	Coord Active	Set when coordination is active (not free)
60	Coordination Failure	Alarm is ON when Coordination has failed (V76.x and V80.x only)
61	Coordination in (Sync) Transition	(V76.x and V80.x only) Alarm is ON when coord is active and in transition for times over 3 seconds. Alarm is OFF when coord is active and in SYNC.

6.15.1 Algorithmic details of various coordination alarms

In particular, Cycle Fault (Alarm #16) and Cycle Failure (Alarm # 17) alarms may occur if the user does not program the coordination parameters correctly. Prior to declaring a specific coordination alarm, the controller software will run as per the following flowchart.



1) The controller software will first establish the amount of time that must expire without a phase being serviced in order to declare a fault ("cycle fault time"). That amount of time is dependent upon a few settings – the phase mode (STD8, USER, etc), whether the controller is in free or coord, and whether or not the user entered a max cycle time in the unit parameters.

Phase Mode	Coord State	Max Cycle Time	Cycle Fault Time
STD8/QSEQ/DIA	Free	0	calculated from maxes
STD8/QSEQ/DIA	Free	>30	user settable time (MM-1-2-1)
STD8/QSEQ/DIA	Coord	n/a	3 x pattern cycle
USER	Free	0	420"
USER	Free	>60	user settable time (MM-1-2-1)
USER	Coord	n/a	3 x pattern cycle

2) Secondly, the controller monitors the phases to see if any phase, that had demand, was not serviced for the cycle fault time. If a fault occurs, the action is based upon user settings as follows:

a) In all cases a "***cycle fault***" is declared.

b) If the controller is running free then a "***cycle failure***" occurs

c) If the controller is running coordination then a "***coord cycle fault***" will occurs on the first occurrence of a cycle fault.

d) Once a fault occurs while running coordination, if the fault clears but occurs again before 4x the cycle fault time, then a "***coord cycle fail***" will occur, and the controller will latch in a free state.

e) Once a fault occurs for any reason or any amount of times, a timer is set to the cycle fault time. If the timer expires before the fault is cleared, then a "***cycle failure***" will occur. (The user can cause the controller to go to flash in this case). Although the algorithm is programmed for this event, **THIS SHOULD NEVER HAPPEN.**

In particular, below are further details on how the software relates to the coordination alarms.

Alarm #17 Cycle Fault

Any time a cycle fault occurs (a phase is not service for the fault timer amount of time) for any reason, the Cycle Fault is alarm is set. If it occurs during coordination or preemption the data element of the event will tell you if it was caused during coordination or preempt. If it was during preemption, the data will also tell you which preemption interval. A cycle fault is like a "first time forgiven" skipped phase.

Alarm #18 Cycle Failure

Any time a cycle fault occurs during free operation, a Cycle Failure alarm occurs. Anytime during coordination that a cycle fault occurred and did not clear for the "***cycle fault clear time***", a Cycle Failure occurs. Another way to view the Cycle Failure alarm is a way for the software to indicate an issue with the cycle. This failure occurred because it happened during free and/or the coord/preempt fault did not clear itself when the controller went free. A Cycle Failure is a critical coordination alarm that should normally not occur.

Alarm #19 Coord Cycle Fault

Any time a cycle fault occurs during coordination, the Coord Cycle Fault alarm is set.

Alarm #4 Coord Cycle Failure

Any time a cycle fault occurs a second time **BEFORE** the "***cycle fault clear time***" expires after the prior cycle fault, a Coord Cycle Failure alarm is set. If you enable this alarm, then the failure is latched, and the controller will stay free until the fault is cleared. If you do not enable this alarm, then the failure is not latched, and the controller will run coordination once the fault is cleared.

The following programming parameters should be considered:

Auto Err Reset (MM->2->1)

If the auto error reset feature is enabled in the coordination Mode parameters, then this will allow a new pattern to clear a cycle fault that was latched.

Max Cycle Tm (MM-1-2-1)
Maximum-Cycle-Time is a manual override value used to check that the controller is cycling properly. If no value is entered, the controller will calculate a value based on the controller phase and coordination programming as shown in the section above.

Cycle Fail Action (MM-1-2-1)

As explained above, a cycle failure is considered a critical problem, because it means that a phase was skipped in free or that once coordination went free, the phase that was skipped never ran. The controller gives you the option to report it as an alarm, and keep running – or, send the cabinet into flash.

For emphasis, this should simply never happen. The controller software is **NOT DESIGNED TO SKIP PHASES.** For this reason, the user can send the controller to flash when this does occur.

6.15.2 Alarm 30 Pattern Error Faults

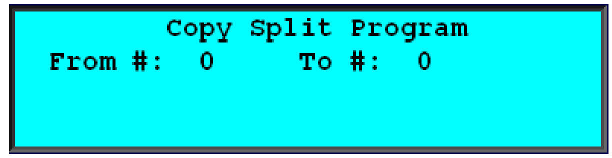
Fault #	Fault Description
1	In diamond mode, sum of major phases (splits) adds to zero
2	In diamond mode, sum of splits did not equal cycle length
3	Sum of splits exceeded max cycle length (max length currently 999 in ATC/2070, 255 in 980/v65 or older)
4	Invalid split number called out in pattern
5	Ring 1 / 2 sum of splits not equal (when applicable)
6	Split time is shorter than sum of min time for a phase
7	Coordinated phases are not compatible
8	No coordinated phase assigned
9	More than one coord phase was designated for a single ring
10	Undefined
11	Fastway/Shortway transition time greater than 25% (out of range)
12	Undefined
13	Stop-time active
14	Manual-control active
15	Error in cycle length when calculating reference point (Cycle time is greater than calculated coord max cycle length)
16	In diamond mode, error in phase split value (typically phase 12)
17	Active split had a zero split value programmed

6.16 Copy Programs

6.16.1 Copy Pattern Program (MM->2->8->7)

The Copy Pattern Program copies the pattern table (cycle, offset, split# and sequence#) from one pattern to another pattern. If you wish to modify the split table of the new pattern, then copy the existing split table # to a new split table # using the Copy Split program and edit the Split# in the new pattern under menu MM->2->4.

6.16.2 Copy Split Program (MM->2->8->8)



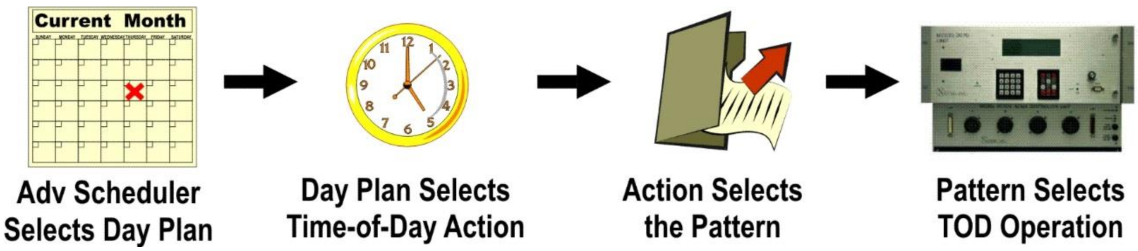
The *Copy Split Program* copies the split table data (split time, coord phase and mode setting) from one split table to another split table.

7 Time Base Scheduler

7.1 Theory of Operation

The *Advanced Schedule* is a fully compliant NTCIP based time-of-day schedule. NTCIP defines an annual schedule in terms of day-of-week, month and day-of-month. This implies that the schedule applies to the current year. We provide an *Easy Schedule* to facilitate programming the NTCIP *Advanced Schedule*; however, there is only one schedule in the controller database because *Easy Schedule* is provided as an alternative method of programming the *Advanced Schedule*.

The *Advanced Schedule* selects the *Day Plan* for the current day. The *Day Plan* contains the time-of-day events for the current day used to select actions from the *Action Table*. The controller updates the current TBC pattern once per minute based on the scheduled events from the *Action Table*.



Each day the controller checks the *Scheduler* to determine the most applicable *Day Plan*. If the current day is not specified in the *Advanced Schedule*, the controller will run "free" in Pattern# 0. The controller checks the current *Day Plan* once per minute to retrieve the current time-of-day action. The controller then performs a lookup in the *Action Table* to determine the active *TBC Pattern*. The *TBC Pattern* determines the current time-of-day operation of the controller.

All programming related to the Scheduler is accessed from MM->4 shown to the right.

```
        Time Based Scheduler
1.Set Date/Time 4.Day Plan     7.Status
2.Easy Schedule 5.Action Table 8.Resrvd
3.Adv Schedule  6.Parameters   9.More
```

7.2 Controller Time Base (MM->4->1)

The *Set Date/Time* entry screen allows the user to set the current time and date also referred to as the controller's time base.

```
Set Date & Time
            Date     Day   Time   Secs
 Current  08-29-04   SUN  03:54    9
  Set To  00-00-00        00:00   00
```

Date

The *Date* parameter is entered in MM-DD-YY format. All six numeric digits must be entered, including leading zeroes. Setting the date automatically updates the *Day* field.

Day

The *Day* parameter specifies the day of week (SUN-SAT). Setting the date automatically updates the *Day* field. Therefore, it is not necessary to update this field after the date has been set.

Time

The *Time* parameter is entered as HH:MM in 24-hour military format. All four numeric digits must be entered including any leading zeros. Pressing the Enter key after entering the 4 time digits will automatically zero out the *Seconds* field

Secs

The *Seconds* parameter will update the seconds portion of the real time clock seconds. The second entry is provided separately from the hour and minute fields to facilitate setting the time base to a known reference.

NOTE: Whenever making time changes to the clock using the Front Panel keyboard you must always reprogram seconds and that the reprogramming of seconds should be the last thing that is done.

7.3 Advanced Schedule (MM->4->3)

```
        Day        Month          more~
 #   SMTWTFS   JFMAMJJASOND
 1   .XXXXX.   XXXXXXXXXXXX
 2   .......   ............
 3   .......   ............
 4   .......   ............
```

The NTCIP based *Advanced Schedule* is an annual calendar for the current year used to select the *Day Plan* for the current day. Each entry of the scheduler specifies a day-of-week, month, day-of-month, and the *Day Plan* assigned to the entry. Each entry identifies the day or range of days during which the *Day Plan* is in effect.

It is possible for two or more schedule entries to specify the same day of the year. In this situation, the scheduler will always select the most specific entry. An entry is defined as more specific if the range of days defined by that entry is narrower in scope than another entry. For example, the user may assign *Day Plan* 1 for the entire month of March in one entry and *Day Plan* 2 for March 7 in a separate entry. This would appear to be a duplicate entry because two different day plans are programmed for March 7. However, in this situation, the *Advanced Schedule* would select *Day Plan* 2, because it more specific to the current day. The priority order of day plan selection is based upon month, day-of-week, then day of month. If no *Day Plan* is assigned to the current date (based on the time base of the unit), the controller will run free in *Pattern # 0*.

```
□     Date    1         2         3  Day
 #  1234567890123456789012345678901 Plan
 1  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX   1
 2  ...............................   1
 3  ...............................   1
 4  ...............................   1
```

The user may select multiple entries for *Day*, *Month*, and *Date*. For example, selecting all fields under *Day* implies that this entry applies to every day of the week. If a *Day* field is not selected, then the schedule is not considered valid for that particular day. Therefore, when entering a schedule event for a specific date, such as March 7, it is good practice to make that event applicable to every day of the week. This will prevent the user from having to change the day-of-week for the entry when the calendar year changes.

Day

The *Day* parameter defines the day-of-week or multiple days for the entry.

Month

The *Month* parameter defines the month or range of months for the entry based on *Begin Month–End Month*.

Date

The *Date* parameter indicates which days of the month that the entry will be allowed. More than one day of month may be selected.

Day Plan

The *Day Plan* number selects the Day Plan (1-32) placed in effect when the scheduled entry becomes active.

7.4 Easy Schedule (MM->4->2)

```
 # Day  Mo:From-Thru DOM:From-Thru Plan
 1 M-F     01-12         01-31      1
 2 OFF     00-00         00-00      1
 3 OFF     00-00         00-00      1
 4 OFF     00-00         00-00      1
```

Easy Schedule is an alternative method of coding the NTCIP based *Advanced Schedule*. The *Day* entry provides a separate entry for each day-of-week or range of days (M-F or ALL). Setting the *Day* selection to OFF disables the event #.

The *Month* and *DOM* (Day-Of-Month) entries specify begin and end values for each range. Four digits must be provided for each entry (including zero place holders). The range specified will automatically be transferred to the *Advanced Schedule* as a range of "X" values for the individual month and day entries. This "easy" method allows each entry to be specified as a range instead of having to code each individual "X" field in the *Advanced Schedule*.

Note that each entry provided in *Easy Schedule* applies to a consecutive range of days, months or days of month. It is possible to specify a non-consecutive range in the *Advanced Schedule* (such as a DOM entry including 1-4, 7, 20-25, 30 in the same event#). This complex *DOM* entry will display in *Easy Schedule* as "**-**" because it is not defined as a consecutive series of days. Complex events are programmed in the *Advanced Schedule* and less complex entries are programmed in *Easy Schedule* as a shortcut method.

7.5 Day Plan Table (MM->4->4)

The *Scheduler* reads the active *Day Plan* for the current date once per minute to update the current *Action*. The *Action* drives the active *Pattern* and controls the state of the special function outputs from the *Action Table*.

	Evt	Time	Actn	Evt	Time	Actn
Plan- 1	1	00:00	1	2	06:00	2
Link: 0	3	09:00	3	4	16:00	4
	5	19:00	5	6	00:00	0
	7	00:00	0	8	00:00	0

Time

The *Time* parameter in 24-hour military format (HH:MM) defines the time-of-day that the associated *Action* will become active. All four numeric digits must be entered, including any leading zeroes.

Action

The *Action* parameter (1-100) is associated with the *Action* in the *Action Table*. **NTCIP defines <u>Action 0</u> as the "do-nothing" action.** Therefore, do not be misled into thinking that <u>Action 0</u> places the intersection into free operation. It is good practice to assign an event and *Action* at 00:00 for every *Day Plan* called by the *Advanced Schedule*. This insures that even if the controller date is changed and a new *Day Plan* is referenced that at least the first *Action* at specified for 00:00 will be selected.

Link

The Link parameter joins (or links) two or more *Day Plans* to increase the number event entries from 16 to 32. The link parameter contains the *Day Plan* number the *Day Plan* is linked to. Multiple *Day Plans* may link to the same *Day Plan* by specifying the same *Link* entry in each plan; however, linking more than two *Day Plans* in a chain is not supported.

7.6 Action Table (MM->4->5)

The *Action* selected by the current *Day Plan* controls the state of *Auxiliary* and *Special Function* hardware outputs. In addition, the source of the source of preempt 1 and 2 may be selected by the current *Action* table. The time-of-day *Scheduler* allows the Day Plan to call different *Actions* to turn outputs ON and OFF and share the same pattern between actions. This scheme minimizes the number of patterns required to cycle outputs ON and OFF.

Actn	Patrn	Aux-12345678	Spec-12345678
1	1	....	....
2	2	....	....
3	3	....	....
4	4	....	....
5	5	....	....
6	0	....	....
7	0	....	....

Actn	Spec9-24	90123456	78901234
1		....	....
2		....	....
3		....	....
4		....	....
5		....	....
6		....	....
7		....	....

Pattern

The *Pattern* parameter (1-48) defines the *TBC Pattern* selected by the current *Action*. A value of zero or 254 will cause the controller to run free. It is very easy to confuse Action 0 and Pattern 0. Just remember that <u>a zero Action is no action</u> and <u>Pattern 0 always runs free.</u> However, keep in mind that to insure free operation in an NTCIP controller, one should program Pattern 254 instead of Pattern 0.

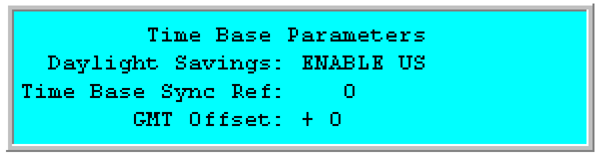
Aux Outputs

The *Auxiliary* settings define the state of each auxiliary output when the associated action is active. These outputs are activated by *Day Plan Actions* or are manually controlled from the central system. The TS2 controller firmware provides 8 *Aux* outputs per action.

Special Function Outputs

The *Special-Function* settings defines the state of each special function output when the associated action is active. These outputs are activated by *Day Plan Actions* or manually controlled from the central system. The firmware provides 24 *Special Function* outputs per action.

7.7 Time Base Parameters (MM->4->6)



Time Base Parameters provide additional NTCIP features to modify the behavior of the controller's Time Base.

Daylight Savings

The *Daylight Savings* parameter determines specifies if daylight savings is active, and which method is be used. The ENABLE US mode references daylight savings for the United States..

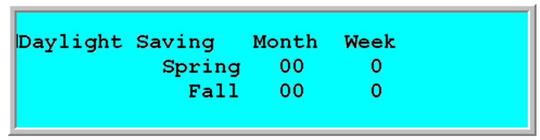
Time Base Sync Ref

The *Time Base Synchronization Reference* defines the number of **minutes** after midnight to synchronize the time base. This reference provides the zero point for the TBC counter uses to synchronize the offset called in the pattern.

GMT Offset

The *GMT (Greenwich Mean Time) Offset* adjusts the system time base for Universal Standard Time (see chapter 10).

Daylight Saving Time Override

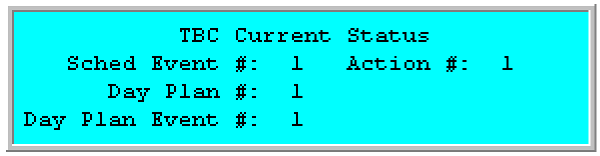


There is an additional screen on the right side, which allows the user to override the default Daylight Saving time schedule with parameters that they can program. As of 2007, you will not have to program the default values of Daylight Savings time, which are currently set to begin the second Sunday in March and end on the first Sunday in November. If Congress mandates another change don't forget to enter the leading '0' for the Month, if necessary. If the last Sunday of the month is designated (week 4 or 5) please program a 5 under the Week parameter.

R-T Clock Sync Time

This parameter is used with an external clock source to set the time once a day. If the user programmed **R-T Clock Sync Time** is non-zero, it uses a pulse on the D-connector's System input to load the Time of Day with the Sync Time setting programmed via this parameter.

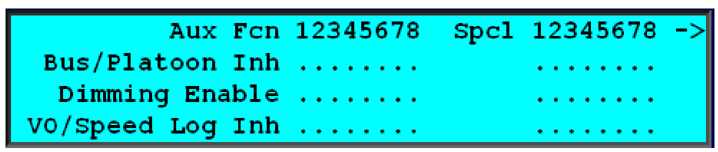
7.8 Time Base Status (MM->4->7)



Interpreting *Time Base Status* requires a thorough understanding of the relationship between the *Advanced Schedule*, day plans and actions. Compare these four status fields with the graphic provided in section 7.1. If you visualize these status fields as four steps used to select the current TBC pattern based on the current date and time, then you will understand the NTCIP time-of-day scheduler.

1. The *Schedule Event #* is the active event selected by the scheduler based on the current day-of-week, month and day-of-month. This event # is useful to determine which event is more specific if more than one entry in the scheduler references the current day.
2. The *Day Plan #* is the active day plan specified by the scheduler for the current Schedule Event #. The *Day Plan #* is programmed for each event in the *Advanced Schedule* and *Easy Schedule*.
3. The *Day Plan Event #* is the active day plan entry selected by the scheduler for the current time-of-day. The *Day Plan* Event # references the event selected in the active Day Plan #.
4. The *Action #* is the active action selected by the scheduler for the current *Day Plan*. The controller reads the current Day Plan entries once every minute to update the current *Action#*. This value is used to reference the *Pattern #* and the special function output status specified in the *Action Table*.

7.9 Special Features (MM->4->8)



The *Special Features* table allows the 8 *Auxiliary* and 24 *Special Function* bits to be mapped to different features.

Under the current software version:

- Special function bits 17 – 20 are reserved for Bus Preemption Inhibit
- Special function bits 21 – 24 are reserved for Platoon Progression Inhibit
- Any of the special function bits (1 – 24) may be mapped to Dimming Enable
- Aux function 1 and Special function bits 1, 9 and 17 are reserved for VO Logging Inhibit
- Aux function 2 and Special function bits 2, 10 and 18 are reserved for Speed Logging Inhibit

7.10 Time Base Scheduler – More Features (MM->4->9)

```
     Time Based Scheduler - more
1.Copy DayPlan    4.Specl Funct: Non-TOD
2.Control
3.GPS Status
```

7.10.1 Copy Day Plan Utility (MM->4->9->1)

```
          Copy DayPlan Progam
  From #:  0       To #:  0
```

The Copy Day Plan Utility copies the 16 Event # entries from one Day Plan # to another Day Plan #. The Link field specified in the From #: Day Plan is not copied.

7.10.2 TBC Manual Control Screen (MM->4->9->2)

```
TBC Control                  Spec.Fcn
                 Pattern     1.3.5.7.
 Current TOD       255       ........
      Set To        0        ........
```

The TBC Manual Control Screen allows the user to manually select the active Pattern and special function outputs as a keyboard entry. These selections override the Pattern and special function outputs specified for the current Action called from the Time Base Scheduler. Therefore, this screen provides the ability to override the actions of the scheduler.

The controller also allows the active Pattern to be manually controlled from the Test Mode under MM->2->1. However, patterns selected from the Test Mode cannot be overridden by future events in the scheduler, whereas patterns entered from the TBC Manual Control Screen are replaced by the next scheduled event.

7.10.3 GPS/WWW Status (MM->4->9->3)

See chapter 10 for further details.

7.10.4 Special Function Modes (MM->4->9->4)

```
Spec'l Function    Mode              Value
       1           OFF                 0
       2           NRT:RR PRE          0
       3           NRT:WLK/PCLR        2
       4           RESET PULSE         2
```

There are two non-time-of-day controlled Special Function Modes that the user can program. They are; No Right Turn sign control during Walk & Ped Clear, No Right Turn sign control during rail preempt, or a Reset pulse output after delay to reset cabinet equipment or relay logic.

To program the above features, go to MM->4->9->4. For each Special Function Output 1-4, select the mode and add a value if appropriate. The modes are:

OFF	
NRT:WLK/PCLR	No Right Turn: during Walk and Ped-Clear intervals
NRT:RR PRE	No Right Turn: during railroad preemption
NRT:WLK+RRPre	No Right Turn: during Walk & Ped Clr and during rail preempt
RESET PULSE	As the name implies

For the Walk/Ped-clear NRT sign control, the user must enter the phase of the Walk/PedClr that is to control the sign.

For the NRT:RR PRE mode, the Prmpt/ExtCoor Out (Channel & I/O Parameters screen) must be set to 820A. Therefore, for the NRT:RR PRE, there is no entry to make. It should turn on the special function output when a railroad preemption becomes active.

For the WLK+RRPre mode, this is the WLK/PCLR mode and the RR PRE modes combined. Therefore, the value is the phase # of the Walk/PedClr that is to control the sign.

For the Reset Pulse input, the user must enter the time, in seconds, to delay the 1second pulse from the de-assertion of one of the alarm inputs or from power-up. User input alarms 3 & 4 (Alarm #s 7 & 8) are used for this feature. The delayed pulse on the special function output is generated when either of the alarms is de-asserted after both have been active (ground-true).

8 Preemption

8.1 Preempt Selection (MM->3)

```
Enter Preempt #

    then press ENTER
```

Preempts 1-10 are selected using item 3 from the Main Menu. This will display the following input screen allowing you to enter a value from 1 to 10. Upon pressing the ENTR key, a submenu will be displayed for the preemption that you selected.

8.2 High Priority Preempts 1 – 6

```
# 1     High-Priority Preemption
1.Times         4.Times+       7.Inh Control
2.Phases        5.Overlaps+
3.Options       6.Options+
```

High priority preempts 1 through 6 may be programmed as RAIL or EMERG (emergency) high priority preempts. Each input is activated by a separate ground true input provided from the terminal facility. TS2 maps each input to a terminal facility BIU (type 1 cabinet). In addition, TS2 (type 2) allows preempts to be mapped to D-connector inputs as specified by the end user. Programming for low priority preempts 7-10 is provided in the next section.

Note: High Priority Preemptions will run "FREE" as long as the physical input remains "ON" or until the input terminates and the associated programmed timers expire. At that point, the preemption will go back to normal operations. Further note that normally omitted phases can be run during a High Priority Preemption. Finally note that phases which run during preemption are subject to vehicle calls (or recalls) being present.

8.2.1 Preempt Times (MM->3->1)

```
# 1  Times   |     Begin     |      Other
  Delay     0   MinGrn     0  Track Grn    0
MinDura     0   MinWlk     0  Min Dwell    0
MaxPres     0   PedClr     0
```

This screen provides entries for various time parameters defined in NTCIP. The entries in the first column relate to the preempt input or call. The second column groups the minimum times provided to the phase in service when the preempt call is received. The third column lists the track and dwell intervals. Each of these parameters is described below.

Delay

The preempt *Delay* parameter (0-600 sec) is timed prior to the track clearance interval and dwell intervals. If the *Lock Input* associated with the preempt input is enabled (set to ON), the *Minimum Duration* and *Minimum Dwell* periods are guaranteed even if the preempt call is removed. However, if the *Lock Input* is not enabled (set to OFF), and the preempt call is removed during the preempt *Delay* period, the request for service is dropped and the preempt sequence is not activated.

Minimum Duration (MinDura)

The *Minimum Duration* parameter (0-9999 sec) determines the shortest period that a preempt call is active. The *Minimum Duration* time begins at the end of the preempt *Delay* period, and prevents an exit from the dwell state until the set amount of time has elapsed.

Maximum Presence (MaxPres)

Maximum Presence (0-9999 sec) limits the period of time a preempt input is considered valid. When a preempt call exceeds this limit, the controller stops recognizing the call and returns to normal operation. Once a call becomes invalid, it will remain invalid until the input resets and becomes inactive. This feature is useful to limit the call from an emergency vehicle that has stopped upstream of the detector with the emitter locked on. A setting of 0 disables this feature.

Minimum Green (MinGrn)

The preempt *Minimum Green* parameter (0-255 sec) insures that a preempt call will not terminate an active phase green indication before the lesser of the *preempt Minimum Green* or the active *phase Minimum Gre*en.

Minimum Walk (MinWlk)

The preempt *Minimum Walk* parameter (0-255 sec) insures that a preempt call will not terminate an active phase walk interval before the lesser of the preempt *Minimum Walk* time or the active phase *Walk* time. When an active walk indication is driven by a phase output, the walk will continue to be illuminated while the walk interval times on the active phase. However, if the active walk indication is driven by a Ped_1 overlap, the walk display will terminate immediately and move to pedestrian clearance when preempted even though walk continues to time on the included phase defining the overlap.

Enter Pedestrian Clear (PedClr)

The preempt *Pedestrian Clear* time (0-255 sec) insures that a preempt call will not terminate an active phase pedestrian clearance before the lesser of the preempt *Pedestrian Clear* time or the active phase *Pedestrian Clearance* time.

Track Green (Track Grn)

The *Track Green* parameter (0-255 sec) determines the green interval of the *Track Vehicle Phases* serviced during the track clearance movement. The track clearance movement is typically used only rail type preempts rather than high-priority or low-priority emergency vehicle preempts.

Minimum Dwell (Min Dwell)

The *Minimum Dwell* parameter (1-255 sec) determines the minimum time guaranteed to the dwell phases listed under the *Dwell Phase* parameters. The dwell state will not terminate prior to the expiration of the *Minimum Dwell* time and the *Minimum Duration* time, nor will it terminate if the preempt call is still present. **Note: If the preemption has exit phases programmed, the minimum dwell time should be programmed to be at least as large as the minimum green time of the preempt dwell phases to ensure the exit phases are always selected upon exiting the preempt.**

8.2.2 Preempt Phases (MM->3->2)

```
# 1          ---- Preempt Phases ----
Track Veh     0  0  0  0
Dwell Veh     0  0  0  0  0  0  0  0
Dwell(more)   0  0  0  0
Dwell Ped     0  0  0  0  0  0  0  0
Exit          0  0  0  0
```

Track Vehicle Phases (Track Veh)

The *Track Phase* parameters allow a maximum of 8 track clearance phases to be serviced during the track green interval of the preemption sequence. Only one phase per ring should be entered for the track interval. All track phases selected must be concurrent and serviced simultaneously to insure adequate track clearance before the train arrives. You are allowed to specify track phases that are only enabled during preemption (phases that are normally omitted can be enabled during this period).

Dwell Vehicle Phases (Dwell Veh)

The *Dwell Phase* parameters allow a maximum of 12 dwell phases to be serviced during the dwell interval of the preemption sequence. Eight dwell phases may be entered on the first row and four additional dwell phases on the second row in this menu. It is not required that the dwell phases be concurrent. If more than one dwell phase is specified per ring, the controller will service the dwell phases based on the current phase sequence or the optional preempt *Pattern* selected. Care must be exercised to insure that no dwell phase conflicts with the priority vehicle that issues the preemption. Note that you are allowed to specify dwell phases that are enabled only during preemption (phases that are normally omitted can be enabled during this period).

Dwell Pedestrian Movements (Dwell Ped)

The *Dwell Ped* parameters allow a maximum of 8 pedestrian movements to be serviced during the dwell interval of the preemption sequence. *Dwell Ped Movements* must always be defined as *Dwell Vehicle Phases*.

Exit Phases (Exit)

Exit Phases (also called *Return* phases) determine how the controller leaves preemption and returns to normal stop-and-go operation. The controller returns to the *Exit Phases* at the end of the preemption dwell interval unless the coordination *Coor+Preempt* is enabled as explained below. Only one *Exit Phase* is allowed in each active ring and all *Exit Phases* must be concurrent.

The user should avoid programming any *Exit* phases when *Coord+Preempt* is turned ON. When running coordination with *Coord+Preempt* = OFF and no exit phases programmed, there is no certainty on where the Exit Phases will go nor where in the coordinator you will be. Therefore please program exit phases or *Coord+Preempt* to properly exit coordination.

Certain considerations should be taken when programming Exit phases. For example, the user should **NOT** return to exit phases that have a potential to inhibit each other. Another consideration, as stated in the section above, is when the exit phases are programmed In this case, the minimum dwell time (**MM->3->1**) should be programmed to be at least as large as the minimum green time of the preempt dwell phases to ensure the exit phases are always selected upon exiting the preempt.

8.2.3 Preempt Options (MM->3->3)

Lock Input

Enabling the *Lock Input* parameter (to ON), locks the preempt call and guarantees that the preempt *Delay*, *Minimum Dwell* and *Minimum Duration* are serviced even if the preempt call is removed. A "locked" preempt, holds a constant call on the preempt input during the *Minimum Dwell* and *Minimum Duration* periods. Once these minimum times have been met, the preempt call reflects the actual state of the preempt input

```
# 1        Preempt Options
                 Lock input ON
           Override Auto Flash ON
     Override higher # preempt ON
                Flash in dwell OFF
             Link to preempt # 0
```

If the *Lock Input* is disabled (set to OFF) the preempt call reflects the state of the actual input. Therefore, if the preempt call drops before the preempt *Delay* time has elapsed, the preempt sequence does not occur. However, once the preemption begins timing *Minimum Dwell* and *Minimum Duration*, these minimum times will be guaranteed.

Override Auto Flash

Enabling the *Override Auto Flash* parameter (to ON) allows preempt calls to have priority over automatic flash. Stated another way, if automatic flash is active when a preempt call is recognized, auto flash is terminated, including appropriate clearances, and the preempt sequence is executed. After the preemption is finished, the controller returns to automatic flash. If *Override Auto Flash* is set to OFF, the preemption does not override automatic flash. If auto flash is active when a preempt call is received, the call is ignored as long as auto flash is active.

Override higher # preempt

Preempts possess an implied priority order with the lowest numbered Preempt (#1) having the highest priority and the highest numbered Preempt (#10) having the lowest priority. *Override higher # preempt* is used to override this priority order based on the preempt number.

If *Override higher # preempt* is set to ON, then the specified preempt has priority over higher numbered ones and allows the preemption to interrupt any higher numbered preempts that are active. If this parameter is set to OFF, then this preempt cannot interrupt higher numbered preempts. Note that higher numbered preempts cannot interrupt lower numbered ones regardless of the settings of their respective *Override higher # preempt parameters*.

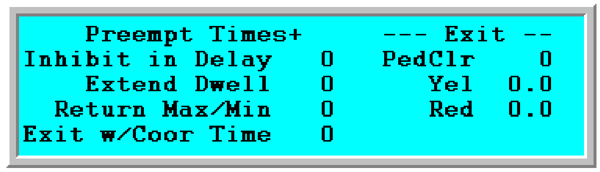
Flash in Dwell

Flash in Dwell allows the controller flash during preempt dwell instead of displaying phases or running a limited sequence of phases. If set to ON, phases in the Dwell Vehicle Phase list flash yellow during the preempt dwell. All other phases flash red.

Link to preempt

The *Link to preempt #* parameter allows the specified preempt to initiate a higher priority preempt. At the termination of the dwell time, the linked preempt automatically receives a call, which is maintained as long as the demand for this, the original, preempt are active. Linking provides a method of implementing dual track clearance intervals and other complex preemption sequences.

8.2.4 Preempt Times+ (MM->3->4)



The *Preempt Times+* screen includes fields for interval and call times that are not defined in the NTCIP standards.

Inhibit in Delay

The Inhibit in Delay parameter (0-255 seconds) allows you to specify a delay to override the time-of-day inhibits for special function bits 17-24. Bus preempts and platoon progression inhibits associated with special function bits 17 – 24 are enabled for each pattern under menu MM->2->9.

Extend Dwell

The *Extend Dwell* parameter (0-255 seconds) extends the preempt call much like the vehicle detector extension parameter extends a vehicle call. This feature is useful, to extend a preempt call in an optical preemption system when an optical sensor is installed at the leading edge of a large intersection. In this situation, the sensor stops receiving the signal from the emergency vehicle before it clears the intersection and *Extend Dwell* can be used to stretch the preempt call input to allow the emergency vehicles to clear the intersection.

Return Max/Min

The *Return Max* parameter (0-255 seconds) insures that the *Exit* phases service the current maximum (Max-1 or Max-2) or minimum programmed for the phase based on the selection chosen under MM→3→6.

Exit (Return) Clearances

The *Exit (Return) Clearances* are pedestrian clearance (PedClr, 0-255 seconds) and yellow/all-red vehicle clearance (0-25.5 seconds). These exit clearances are timed for the *Vehicle Dwell Phases* as the controller exits the preempt dwell state. The three clearance times provided are Pedestrian Clearance, Yellow Clearance, and Red Clearance.

Exit w/Coor Time

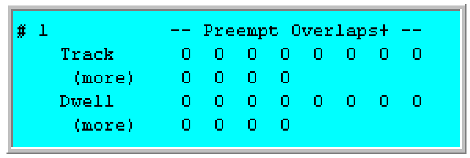
The *Exit w/Coor Time* parameter (0-255 seconds) will only be implemented when Coord+ Preempt option found under MM→3→6 is set to **On**. This feature will work differently if Track clearance phases are programmed. For the purposes of explaining this feature, returning from preemption with coordination, an emergency preempt is one that does not have track clearance phases programmed. A rail preempt is one that does have track clearance phases programmed. Keep in mind that this feature does not rely on the Emerg/Rail parameter (Options+) which is informational only and used on some logs.

When the *Exit w/Coor Time* feature is disabled (0 entry), a rail preempt <u>will use the Exit phases</u> (MM→3→2) if they are programmed, then check for coordination being active if Coor+Preempt is enabled. An emergency preempt will do the opposite, it will check to see if coordination is active before using return phases, if programmed.

When the *Exit w/Coor Time* feature is enabled, normal operation is modified as follows:

1. If the *Exit w/Coor Time* has not expired, a rail preempt will check if coordination is active before using the Exit phases (MM→3→2) .
2. If the *Exit w/Coor Time* has expired, an emergency preempt will check for Exit phases (MM→3→2) before exiting with coordination, if coordination is active.
3. Stated another way, with the *Exit w/Coor Time* feature enabled, then railroad preempts and emergency preempts exit in the same way:
    a) if the *Exit w/Coor Time* is not expired and coordination is active, it will exit with coordination
    b) if the *Exit w/Coor Time* has expired, it will exit using Exit phases (MM→3→2) if they are programmed.

8.2.5 Preempt Overlaps+ (MM->3->5)



Users have the choice to allow overlap indications to be displayed or not displayed during preemption track clearance and dwell intervals.

By default, all overlaps are disabled (i.e. displayed as all red indications) during preemption. Therefore, during the track clearance interval and the dwell interval, all overlaps are turned off (i.e. displayed as all red indications) even if the included phases defining these overlaps are assigned as track clearance and dwell phases.

The *Preempt Overlaps+* screen allows up to 12 overlaps to be programmed (i.e. turned on and allowed to display green and yellow indications) with the track clearance phases and / or the vehicle dwell phases. For each group, eight overlap entries are provided on the first row, and four additional overlaps are provided on the following row.

If any –GrnYel overlaps are programmed and used as dwell phases, the user should also include (program) them in preempt Overlaps+ (MM->3->1->5).

You are allowed to specify track and dwell phases that are enabled only during preemption. These phases can be used to drive an overlap assigned as a track clear or dwell indication only during preemption.

8.2.6 Preempt Options+ (MM->3->6)

Preempt Enable

Preempt Enable must be set to ON to enable the preempt input and allow the preempt to take place.

Type

The preempt *Type* may be identified as a railroad (RAIL) or an emergency vehicle (EMERG) preempt. This setting is only used to identify the preempt and is included on preempt event log entries.

Output

Each preempt has an *Output* signal that represents the preempt active status. The setting determines when the output becomes active during the preempt cycle as follows:

- **TS2 -** The output is active from the time the preempt is recognized until it is complete. The output is not active while the call delay period is timing.
- **DELAY -** The output becomes active when the call is received and includes the call delay period. The output remains active while the preempt is active.
- **DWELL -** The output becomes active when the preempt dwell state is reached. It is not active during the call delay period, begin clearances, or track interval.

Pattern

The *Pattern* parameter (0-24) associates any programming assigned to a pattern with a preempt. If *Coord+Preempt* (described below) is enabled, the *Pattern* parameter is disabled, preventing a preempt from changing a coordination pattern in effect when the preempt call is received. If *Coord+Preempt* is not enabled, the specified *Pattern* (1-24) will be invoked after the preempt *Delay* expires and the preempt becomes active.

When a Pattern is implemented during preemption, coordination is not active (because *Coord+Preempt* is OFF), but any other features attached to the pattern will be in effect. These features include phase recall mode assigned to the active split table, and alternate phase and detector programming attached to the pattern.

Skip Track if Override

This ON/OFF toggle field allows the track clearance interval to be skipped if the current preempt is overriding a lower priority preempt. Set this entry to ON to cause the track interval not to be serviced.

CAUTION: Use this feature carefully, it is only appropriate for complex, multi-track clearance situations. Inappropriate use can cause the track clearance interval to be skipped when it should not be.

The Exit Phases parameter is a list of up to 8 phases that are active following the termination of a preemption sequence.

Coord+Preempt

The *Coord+Preempt* parameter allows coordination to proceed in the background during the preempt sequences. This allows the controller to return to the phase(s) currently active in the background cycle rather than specific *Exit* phases. This option allows the controller to return from preemption to coordination in SYNC without going through a transition period to correct the offset. Many agencies utilize the *Coor+Preempt* option when coordination is interrupted frequently by preemption. The user should avoid programming any *Exit* phases when *Coord+Preempt* is turned ON unless *Exit w/Coor Time* is programmed.

Please note that because preemption is an emergency operation, there are times that the coordinator must go FREE to insure the safety of the motoring public. One example is during railroad preemption track clearance phase timing. If Track Clearance phases and timing are programmed, the coordinator will go free to insure that the vehicles will move off the track. Once the dwell phases begin timing, the coordinator will begin to transition back to being in SYNC.

Lnk Aft Dwell

This parameter is used with the ***Link to preempt #*** parameter found under the Peemption Options+ menu (**MM→3→3**). When this parameter is set to ***OFF***, the preemption that is programmed under MM→3→3 will be run after the current preemption is completed. If this parameter is set to ***ON,*** the preemption will not link to the other preemption programmed under MM→3→3.

Return Min/Max

This parameter is used with the ***Return Max*** parameter found under the Peemption Times+ menu (**MM→3→4**). If this parameter is set to ***MAX***, the time programmed under MM→3→4 will be used as the Maximum Green timer for the Exit Phases. If this parameter is set to ***MIN***, the time programmed under MM→3→4 will be used as the Minimum Green timer for the Exit Phases.

Max_2

Turn the Max_2 setting ON to enable Max 2 phase timing when the controller exits preemption. This feature can be used to provide additional time to the return phase in free operation.

All Red B4 Prmpt

This feature prevents the controller going directly into the preemption begin interval (dwell interval or track clearance interval) if the preempt happens to begin when the preemption begin interval phases are active. If the user needs to time an all red interval prior to serving the preemption phases, this parameter should be programmed to "**ON**". If set to "**ON**", the feature requires that the controller clear to all red before entering the dwell interval. Therefore, the phase red clear time for the terminating phase(s) or red-revert times would apply.

All Red Before Prmpt is also used in protected/permissive left turns to avoid the "yellow trap" situation. It does so by causing a conflicting through movement to terminate so that a permissive left turn interval can time yellow clearance simultaneously with the conflicting through movement.

For the description below please note that "target phases" are the phases that are programmed for the interval that follows the preemption begin phases. They are track clearance phases if defined, otherwise they are dwell phases.

1. **All Red B4 Prmpt** applies to both emergency preemptions without track clearance and to rail preempts. In both cases, the all-red interval occurs at the end of the preempt Begin interval.

2. The all-red clearance occurs if:

   a. Some, but not all, rings are in their target phases

   b. Any Flashing Yellow Overlap is flashing yellow

   c. No target phases are defined (i.e. a programming or setup error)

In summary, this feature is used by some agencies to prevent yellow trap situations. By clearing to all red, all phases must terminate together. These agencies use this feature in association with 4 channel preemptions and protected/permissive turning situations. The agencies want the intersection to clear to red, then go back to the dwell phases (or simply go all red before the dwell phases), so the on-coming emergency vehicle will know that the conflicting permissive movement is green and that they are truly in a preemption situation. This option will use the Red Revert time, if appropriate, as the time to remain all red.

Volt Mon Flash

Setting this parameter to "ON" will force to unit to use the cabinet hardware to flash during the dwell period if Flash in dwell is enabled.

8.2.7 Preempt Inhibit Control (MM->3->7)

```
Prmpt Inh Control    Bus      Platoon
                   1 2 3 4   1 2 3 4
          Current  . . . .   . . . .
           Set To  . . . .   . . . .
```

This menu provides a manual override of the 8 bus preempt and platoon progression inhibits. Bus preempts 1 – 1 correspond with Preempts # 7 – 10 and special function outputs 17 – 20. Special function outputs 21 – 24 correspond with platoon progression 1 – 4. This menu provides a way to override the time-of-day inhibits for buss preemption and platoon progression generated from the schedule for the current pattern (see MM->4->8).

8.3 Low-Priority Preempts 7 – 10

Low-priority preempts are dedicated to preempt # 7 – 10 and can be used for low priority preemption phases and EMERG (emergency vehicle) preemption. Preempts 7 – 10 may be enabled as a low priority preempts by setting the *Enable* parameter to T_PRMT in menu MM->3->7 (below). Preempts 7 – 10 may also be enabled as a high priority emergency vehicle preempts by setting the *Enable* parameter to EMERG.

The same physical inputs are shared for high-priority preempts 3 – 6 and low-priority inputs 7 – 10. The controller distinguishes between a high-priority and low priority input by recognizing a steady ground-true input as high-priority and a 6.25Hz oscillating signal as a low-priority input. The oscillating input is also recognized in a Type-1 cabinet facility when interfaced to a BIU through the SDLC port.

All programming required for low priority preemption is provided from menu MM->3->7 for preempts 7 – 10. However, low-priority EMERG preempts share programming with high-priority preempts as shown in the table below.

Preempt #	Preempt Input	Type (typical)	Programming Shared With Other Preempt
1	1	RAIL	No
2	2	RAIL	No
3	3	RAIL or EMERG – H Prior	No
4	4	RAIL or EMERG – H Prior	No
5	5	RAIL or EMERG – H Prior	No
6	6	RAIL or EMERG – H Prior	No
7	3 (oscillating)	T_PRMT or EMERG – L Prior	7 (EMERG shares programming with preempt 3)
8	4 (oscillating)	T_PRMT or EMERG – L Prior	8 (EMERG shares programming with preempt 4)
9	5 (oscillating)	T_PRMT or EMERG – L Prior	9 (EMERG shares programming with preempt 5)
10	6 (oscillating)	T_PRMT or EMERG – L Prior	10 (EMERG shares programming with preempt 6)

A T_PRMT vehicle preempt responds differently from a low-priority EMERG vehicle preempt when activated. When a low-priority EMERG vehicle preempts is activated, the controller will apply **the programming associated with the corresponding high-priority preempt** to transfer control to the high-priority dwell phase. When a low-priority T_PRMT preempt is activated, the controller will continue to service the current phase until it gaps out or maxes out (free operation) or is forced off (under coordination). The T_PRMT preempt will then move immediately to the low priority preempt phase specified in the menu above.

8.3.1 TS2 Controller screens

Low priority Preemption sub menu screen, MM→3→(low priority preemption number 7, 8, 9 or 10)

```
# 1      Low-priority / Platoon
1.Low-Priority
2.Platoon Progres'n
```

Low Priority Screen, MM→3→(low priority preemption number 7, 8, 9 or 10)→1

```
# 7  Low-Priority Times      Phases
 LP_Type T_PRMT Min    0 Dwel  0  0  0  0
Coor+Pre OFF    Max    0
    Lock ON  MaxL/O  100
Cond L/O OFF AltTbl    0
Begin Mode SKIP
F/O BeginP OFF
Hold Dwell OFF
```

Platoon Progression screen, MM→3→(low priority preemption number 7, 8, 9 or 10)→2

```
# 1  Platoon       Times       Phases
 Plat.Rx OFF  RxDel    0
               Hold    0
 Plat Tx OFF  TxDel    0    Tx  0  0  0  0
```

8.3.2 Low Priority Features

LP_Type

The LP_Type parameter must be set to T_PRMT to enable a low priority preemption or OFF to disable the preempt. There are two other selections that are available , EMERG and T_PRIOR (if the agency ha purchased the Transit Priority Module.)

The primary difference between the T_PRMT option and the EMERG (low-priority emergency vehicle) option lies in the preempt response during coordination. A preempt 7 EMERG selection will be seen as the low-priority preempt which shares a preempt input with Preempt #3. The controller will apply **the programming associated with Preempt #3** to transfer control to Preempt #3 dwell phase(s).

Priority Phases

Whenever a 6.25 Hz oscillating signal is applied to this input, the controller will either dwell in the low priority phases specified if these phases are active, or move to the Priorty Phases in an expedited manner based upon other settings described below. Please ensure if **LP_Type** is set to T_PRMT, EMERG or T_PRIOR that at least one non-zero priority phase is programmed.

Coor+Preempt

The *Coor+Preempt* feature for low-priority preemption is the same as the feature discussed earlier for high priority preemption. Many agencies utilize the *Coor+Preempt* option when coordination is interrupted frequently by preemption to minimize the transition time returning to coordination.

Min / Max Times

Min time guarantees a minimum service for the preempt if the priority phases are active when the preempt input is applied. The *Max* time is used to terminate the bus phases after the specified max time. Both values are in seconds (0 – 255).

Lock

The Lock entry is set to ON to "lock" or remember the preempt call. A Locked call is released when the dwell interval is reached.

Lockout (General)

Low priority preempt lockout is a feature that inhibits the input of a low-priority preempt for one cycle after that preempt has been serviced. This feature prevents transit vehicles from "monopolizing" service on the main lanes. Two entries (below) modify the behavior of this feature.

Max L/O

The *Max Lockout* parameter sets the maximum time that the low-priority preempt input will be locked-out after it is serviced. A value of 0-255 seconds may be entered.

Conditional L/O

Conditional Lockout releases lockout when all the phases that had demand when the preemption completed have been serviced.

Begin Mode

The Begin Mode has two options.

> **SKIP**: Upon receiving a Low-Priority preempt, the controller will service the begin phases normally and then move directly to the Priority phases, skipping any other phases in sequence that may have calls.
>
> **MIN**: Prior to entering the service (Prior) phases, this mode causes the controller to service other phases with demand but only time their minimum times. Based on when the call occurs, as well as the sequence and concurrency that is currently running, the algorithm will move to the LP phases as soon as it can. This setting does not guarantee that all phases run prior to rotating to the LP preemption phase(s) but allows other phases to run prior to serving LP phases.

F/O Begin

When the Begin Mode is set to SKIP, this feature is used to cause the Begin phases to end immediately after the minimum and pedestrian intervals are complete.

Hold Dwell

When set to ON, Hold Dwell causes the controller to maintain the dwell interval while the preempt call is active. This feature may be used to cause a low-priority preempt to operate similar to an emergency vehicle (high-priority) preempt.

8.3.3 Platoon Progression Features

Platoon Progression: The following low-priority preemption features were developed for a specific county in California. The county is using PLC devices (programmable logic controllers) at each intersection to transmit platoon progression between signals in a peer-to-peer network. A Tx-Phase (or transmit phase) is assigned to the low-priority preempt to trigger a message relayed to the downstream signal. The received message is downstream activates a low-priority preempt using the timing parameters defined below.

The four platoon progression preempts defined in this system may be inhibited by time-of-day. Each PP preempt may be assigned to a special function bits within the range of 17 – 24 (see MM->4->8 and MM->2->9). Each PP preempt can be enabled or disabled by pattern within the action table.

Plat. Rx

The *Rx Phase* (or receiver phase) is the progression phase at the downstream signal held as a low-preemption dwell phase after a D connector input is triggered and the programmed Rx Delay period expires.

Rx Delay

The *Rx Delay* (or receiver delay) is used to delay the low-priority preempt at the downstream signal after the request is received as a D-connector input.

Cond L/O

Reserved

Hold

The *Hold* parameter (0-100 seconds) acts like a max timeout once the receiver phase has entered the hold state.

Plat Tx

The *Tx Phase* (or transmit phase) at the upstream signal triggers the response message sent downstream. The transmit outputs for the four priority preempts are associated with Ped Clearance outputs 1, 3, 5 and 7. An external PLC controller is used to transmit the state of these outputs to a separate PLC located at each downstream intersection in the network.

TxDel

The *TxDel* (transmit delay) parameter (0-255 sec.) is used to delays the PP sync pulse (Ped Clearance outputs 1, 3, 5 and 7) after the Tx (transmit) phase turns green.

Tx.

A maximum of four *Tx* (transmit) phases may be specified for each low-priority preempt at the upstream signal. The TxDel (transmit delay) interval begins whenever any programmed *Tx* phase turns green. At the end of the TxDel period, a sync pulse is generated through the Ped Clearance outputs interpreted by the PLC device.

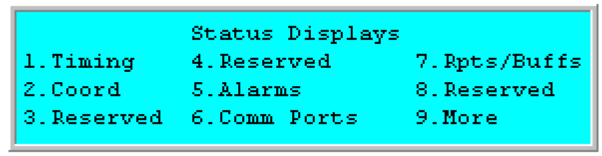
Begin

This mode will direct the Low priority preemption how to move to the dwell phases. If the user selects ***MIN*** then the preemption will time any intervening phases with demand for the Minimum Green time. If the user selects ***SKIP*** then the preemption will skip directly to the dwell phases after it completes the current phase(s) timing.

```
# 1  Platoon       Times      Phases
 Plat.Rx OFF  RxDel   0
               Hold   0
 Plat Tx OFF  TxDel   0   Tx  0  0  0  0
```

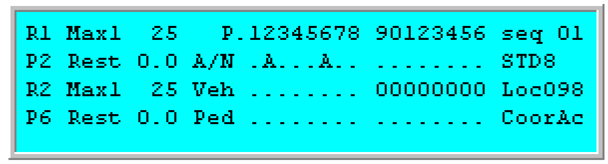
9 Status Displays, Login & Utilities

9.1 Status Displays (MM->7)



This chapter documents the *Status Displays* found under MM->7. Several of these displays were discussed in other sections of this manual where appropriate. For example, the *Coord Status Display* was discussed in depth in Chapter 6 – Coordination. Cross-references to previous sections in this manual are provided in this chapter to insure that every status display is thoroughly documented.

9.1.1 Phase Timing Status Display (MM->7->1)



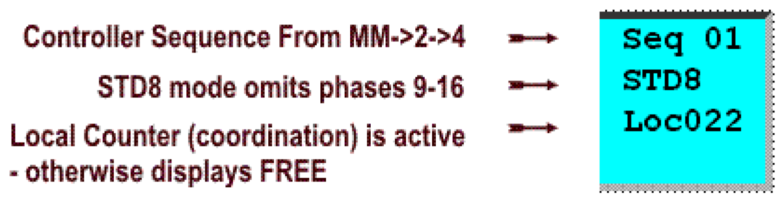
The *Phase Timing* status display indicates whether the controller is running coordination, FREE or is in flash. This status display also shows which of the 16 phases are active, calls on each phase and the phase timing in each ring.

The *Phase Timing* status screen is divided into 3 separate areas to display:

- The current operation and sequence
- Ring status and phase timing
- Active phases and *Veh* / *Ped* calls and *Veh* extension for each phase

Current Sequence and Operation

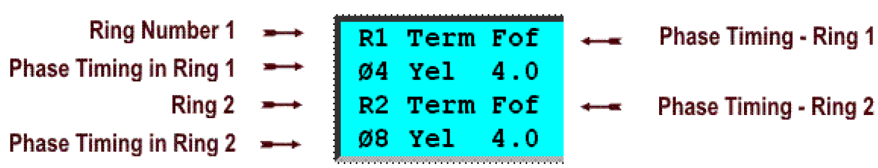
The current sequence and phase mode is displayed in the top right corner (the default is Seq 01, STD8 dual-ring). The second line will display FREE or the active Local timer if coordination is active.



Ring Status and Phase Timing

The left area of this status screen shows the active phase timing in each ring. The *Min* green, *Added Initial, Max* green, *Gap, extension*, *Yel* and *Red* intervals of the active phases are shown in each ring. The pedestrian intervals *Walk* and *Pclr* are displayed concurrently with the vehicle phase timing for each ring.

During FREE operation, *Term Gap* is displayed whenever the *Gap/extension* timer expires and the phase gaps-out. Otherwise, the *Gap, extension* timer will continue to reset and until the *Max1* or *Max2* timer expires and the *Term Max* message is displayed.

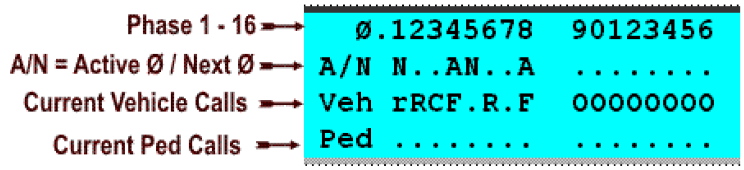


During coordination, *Term Fof* is displayed whenever a phase terminates due to a force-off. The example menu to the right is a "snapshot" taken of a controller during coordination with active phases 4 and 8 forced-off. The effect of max timing can also be observed from this display during coordination. If FLOATing force-offs are in effect, you will see a FloatMx time down in the ring as each phase is serviced. If FIXED force-offs are in effect, you will see Max1 or Max2 timing corresponding with the *Maximum* setting in *Coord Modes* (MM->2->1). If FIXED is in effect and the *Maximum* setting is MAX_INH, you will not see the max timer count down because the max timer is inhibited and cannot terminate the phase prior to it's force-off (see chapter 6).

If *Guaranteed Passage Time* is enabled for the phase, the message LCAR is displayed while the phase times the difference between initial *Gap, extension* and the final extension at the time of gap-out.

“AdIn”, “MxIn” or “T/Act” ring statuses will be displayed as appropriate after minimum green has expired and while added initial or max initial are timing.

Active / Next Phases and Veh / Calls on Each Phase



In the screen to the right, phase 4 and 8 are *Active* (**A**) and are being forced-off to phase 1 and 5 that are *Next* (**N**).

This is a STD8 controller (dual-ring 8-phase), so phases 9 - 16 are Omitted as shown with the "**O**" symbol.

Veh and *Ped* calls and *Veh* extension for all 16 phases are shown using the following symbols:

.	The phase is enabled, but there is no call on this phase
R or **r**	Max “**R**”ecall or min "**r**"ecall has been programmed for the non-active phase
C	A vehicle “**C**”all has been placed on a non-active phase
S	A vehicle call has been placed on an active phase via detector “**S**”witching
K	A “K”eyboard call has been placed on a non-active phase. Also displayed if you make a call using the Screen Calls via MM->7->9->9.
c	Indicates that there is a vehicle call placed on a non-active phase by the central system
E	A vehicle is “**E**”xtending an active phase
P or **p**	A “**P”**edestrian push-button call or a "**p**"ed recall has been placed on a non-active phase
F	A “**F**”orce-off has been issued to terminate an active phase (under coordination)

9.1.2 Coord Status Display (MM->7->2)

Please refer to chapter 6 for a discussion of the *Coord Status Display*.

9.1.3 Alarm Status Display (MM->7->5)

Events and *Alarms* are discussed in chapter 4. The *Alarm Status* for alarms 1-128 are provided in this status display. Note that alarms 129-255 are reserved for the closed loop master and are documented in the *Closed Loop Master Manual*.

9.1.4 TS2 Comm Port Status (MM->7->6)

The TS2 *Comm Port Status Display* under MM->7->6 is equivalent to MM->6->7 and is documented in chapter 10.

9.1.5 Reports and Buffers (MM->7->7)

The Volume and Occupancy Reports and Buffers menu is equivalent to MM->5->8 and is documented in chapter 5.

9.1.6 MMU Status (MM->7->8)

We provide a status buffer to retrieve the status reports from a conflict monitor or MMU supporting our enhanced Cubic | Trafficware monitor log function. The errors are logged in and displayed to the user in one of 3 ways. MM->7->8->1 displays the Fault Log, MM->7->8->2 displays a Trace Log and MM->7->8->1 displays the Current Status. The abbreviated headings for these screens are explained below.

```
1  Current   Cnf Red:F/En Clr Port1 CVM
1  NO FAULT   .       . .   .    .    .
1  00/00/00 Diag 24V:1/2/Inh Fls:Loc/SU
1  00:00:00   .       . . .        .   .
```

Conf	Conflict
Red: F/En	shows the status of the Red Enable input and indicates whether channel monitoring, other than basic Conflict monitoring, is enabled (i.e.YEL clearance, Y+R clearance, dual-indication, and field check).
CLR	Min Y+R Clearance Fault
PORT1	Comm Port 1 failure
CVM	Controller Voltage Monitor
Flt:Rel/Im	MMU relay fault status, specifically with the IN/OUT transfer. Im is the immediate response to a fault.
Diag	Diagnostic
24 V/1/2	24 volt 1 and 24 volt 2
Inh	Inhibit
FLS	Flash
Loc	Local
SU	Start Up

9.1.7 Overlaps Status Displays (MM->7->9->1)

The *Overlap Status* screen is equivalent to MM->5->8 and is documented in chapter 4.

9.1.8 Easy Calcs (MM->7>9->2)

The *Easy Calcs* are documented in chapter 6. This menu is equivalent to menu MM->2->8->2.

9.1.9 Overview Status Screen (MM->7>9->5)

The *Overview Status Screen* is documented at the end of chapter 3.

9.1.10 Phase Input / Inhibits (MM->7>9->6)

The *Phase Input / Inhibit Status Screen* is useful to study the effect of Phase holds, omits and inhibits applied during coordination. These inhibits become active at the *Veh Apply* points and *Ped Apply* points discussed in chapter 6.

```
Input/Inh Status      P1......8  9......6
    Coord Inhibit       --------  --------
  Preempt Inhibit       --------  --------
  Ped Inh(0 time)         - - - -
   NTCIP Ped Omit       --------  --------
       Hold Input       --------
 Phase Omit Input       --------
   Ped Omit Input       --------
```

Particular to this screen, the Ped Inh (0 Time) are calculated inhibits that are applied if the Ped Walk and Ped Clear times are programmed to 0.

The NTCIP Ped Omits are applied remotely via an NTCIP communications object

9.1.11 Fault Timers (MM->7>9->7)

```
Faults  P..1...2...3...4...5...6...7...8
P 1-8     299 299 299 299 299 299 299 299
P 9-16    299 299 299 299 299 299 299 299
Preempt Flt Tmr    0    Cyc Fault Time 300
Pre Seek Tk Clr    0    Pre Seek Dwell   0
Pre Seek Return    0            Fault Fail
                        Cycle       0    0
Cyc Flt Clr Tmr    0    Pre Cyc     0
```

The *Fault Timer Status* provides status displays to the errors and detector faults specified by NEMA. A brief explanation of this screen is given below.

Cycle Faults and Cycle failures occur when phases with demand are not serviced within an appropriate time. A cycle fault occurs when a phase is not serviced and coordination is active. A cycle failure occurs when a phase is not serviced during FREE operation. If a controller experiences a cycle fault (coordination active) it will kick the timer free. If the phase still isn't serviced, then a cycle failure is declared. Note that these TS2 features became defined long after Cubic | Trafficware had its own three-strike coordination failure feature. In order to continue to provide what our customers were already used to, we support both of these features simultaneously.

To accomplish the TS2 cycle fault/failure logic, a number of "cycle fault" timers are implemented. These down-timers are loaded when a phase is serviced with a value that is either entered by the user or calculated by the controller. If the controller calculates it, it provides liberal margin so that false alarms are not generated. The calculation is based upon either the cycle time or else accumulated individual phase times when operating free. If you observe the counters on the top two rows (phases 1-8 and 9-16), you will see them being pre-loaded as the phases are serviced and then count down as other phases are serviced. If they time to zero before being reloaded (i.e. serviced), then a fault or failure occurs.

The preemption timers are an enhancement. The timers work similarly to the phase timers except that they represent the times expected to achieve interval states during preemption. The "seek" timers are loaded when the controller has begun moving to the appropriate interval (track clear, dwell, and return phases). Maximum seek times may be entered by the user on the Controller Parameters screen. When programming these, it is important to include any possible clearance times and then add a little margin. For times such as "seek track clear", the margin programmed in is generally pretty small, so it is important that the user or engineer knows what the times are supposed to be. Of course, this is true of track clearance times and in general, it is important to get right. This feature is a way to double-check that the controller is clearing the track in the expected amount of time. Using the alarm feature, the customer can get notified of a problem before taking the added step of causing the controller to go to flash during preemption.

Action to be taken upon cycle fault/failure is programmed by the "Cycl Flt Actn" parameter on the Controller Parameters screen. It can set an Alarm or else cause a controller fault and Flash the controller.

9.1.12 Other Inputs (MM->7>9->8)

TS2 versions provide an additional status display of NEMA I/O functions

```
   Ring   1 2             1 2          1 2
StopTime - -     Inh Max - -   RedRest - -
Omit Red - -     Frc Off - -
Ped Recy - -       Max 2 - -   Non-Act - -
  Unit Inputs
Min Recll -      ExtStart -        MCE -
Intvl Adv -         Lamps -        WRM -
Auto Flsh -      MMU Flsh -    LocFlsh -
TBC Enbl  -      Dim Enbl -   Test A-C ---
    Flash -          Free -     System -
Offst 1-4 ----    Cyc 2/3 -/-   Pre1-3 ---
 Plan A-D ----    Spl 2/3 -/-   Pre4-6 ---
```

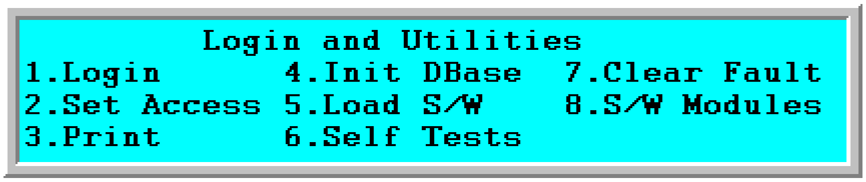
9.1.13 Screen Calls (MM->7>9->9)

This screen provides the user a method to places temporary Phase calls, Pedestrian Calls and Preemption calls for each phase using the controller's keyboard. Simply toggle the phase that you want called to the on state ("X") and the call will be placed in the controller until you toggle the phase entry to the off state ("."). Any calls that are toggled on will remain in the controller until your session is logged off. The real-time call status is also displayed on this screen. The timing status screen (MM→7→1) will display a "K" whenever these keyboard calls are made.

```
  Screen Calls       1.......  9.......
Phase Call Status    .X.....X  ........
Ped Call Status      .X.....X  ........
Prmpt Call Status    ......
Phase Call           .X.....X  ........
Ped Call             .X.....X  ........
Prmpt Call           ......
```

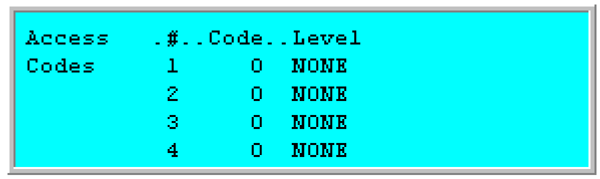
9.2 Login and Utilities

Up to 64 separate password logins are provided to control keyboard access to the controller database. The level of security can also be assigned to each user to control the ability to edit the database, load software and assign passwords. Various utilities are also provided from this menu to load the controller software (flash the EEPROMS), initialize the controller's database, print the database and perform diagnostic tests that interrogate the memory, ports and hardware associated with the controller.



9.2.1 Login Utilities (MM->8->1 & MM->8->2)

If any *Access Codes* are programmed under MM->8->2, the user will be required to provide a valid user number and access code to enable editing via the keyboard. Programming all access codes under MM->8->2 to zero and setting the Level to NONE, disables all login procedures in the controller.



A maximum of 64 individual users and 4-digit access codes may be programmed by a SECUR user. Therefore, if access security is used, at least one access # should have *SECUR Level* access.

The security Level (from highest to lowest) is assigned as follows:

- **SECURE** User has full access to the database including the ability to assign passwords
- **SW LD** User has full access to the database and the ability to run diagnostics and load the controller software. The user may not assign passwords.
- **DIAG** User has edit access to the database plus the ability to run diagnostic utilities. The user cannot load controller software (reflash the controller) or assign security passwords
- **ENTRY** User has edit access to the database but cannot run diagnostics, load software or assign passwords
- **NONE** View only access to the database

9.2.2 Controller Print Utility (MM->8->3)

This TS2 utility allows the sections of the controller database to be printed through the PC/Print RS-232 port. The port settings for the printer port must agree with the settings expected by the printer and appropriate cabling provided to use this feature. The following sections of the controller database may be selected prior to printing **– NONE, ALL, CONTROLLER, COORDINATION, PREEMPTS, TB COORD, DETECTORS, COMMS and VOL/OCC.**

9.2.3 Initialize Controller Database (MM->8->4)

TS2 Initialization screens

Initializing the controller database with Clear & Init All provides the default database and operation of the controller. The last two initialize options are primarily used for testing the integrity of the hardware.

Clear & Init All (MM->8->4->1)

```
    Initialize DataBase
1.Clear & Init All
2.Clear EEPROM
3.Initial Part
```

Clear & Init All should be executed whenever new controller software is loaded under MM->8->5 (discussed in the next section). The controller may be initialized to one of the following default databases:

- **NONE** – this default database has little practical value for the end user because this option writes zero values into every field in the controller database.
- **DIAMOND** – this default should only be used to initialize the controller to the operation defined in the *Operations Manual for Texas Diamond Controllers* that conforms with the TxDOT Diamond Controller Specification.
- **STD-8**P – this is the most appropriate default database and initializes the controller to 8 phase dual ring operation, often called quad-left operation.

You must turn off the *Run Timer* under MM->7->1 before you execute *Clear & Init All* or an error message will be displayed telling you to turn the *Run Timer* OFF. Pressing the ENTR key executes the initialization.

Clear EEPROM (MM->8->4->2)

```
CAUTION: This function erases ALL
  operator programmable settings --
       press ENTR to continue,
       press ESC to go back...
```

The Clear EEPROM utility erases the EEPROM completely. A separate command is provided to erase only the initial part of EEPROM. These utilities are primarily used for hardware testing.

Initial Part (MM->8->4->3)

This allows the user to initialize part of the **EEPROM** and leave the rest alone. Selections include **NONE, PHASE, CONTROLR, DETECTOR, COORD, SCHEDULE, PREEMPTN,** and **NTCP COM**. Initialization occurs by selecting the ***MODE. MODES*** include **NONE, STD8P** and **DIAMOND** which are detailed in the above section.

9.2.4 Load Software Utility (MM->8->5)

This utility allows the user to "flash" a controller with a new software version. We are constantly improving and adding new software features that may be easily downloaded to the controller using a palm pilot or laptop device. All programming is provided through the external serial connection and does not require the case to be opened or "chips" to be pulled and reprogrammed using a prom burner. Flash proms, or EEPROMS (Electrically Erasable Programmable Read-only Memory) are used to make updating the controller software as easy as downloading the database to the controller.

The utility waits for 3 minutes for the download device to initialize the download. During the download, the external device is in full control of the process and on completion will perform checksums on the program to insure that it was installed correctly.

```
This function waits 3 minutes for
   a software download to begin
       press ENTR to continue,
       press ESC to go back....
```

Follow the instructions on the screen until the message "Waiting for ROM download due to keyboard command…" Then, initiate the download on the Palm Pilot or via laptop software. When the download is complete, be sure to perform the following steps:

1. Verify that the checksum (actually, a CRC) of the loaded software matches that of the specific version.

   This can be found by examining the software .hdr file with notepad. The checksum is the fifth item, a four digit hexadecimal number, that follows the description of the equipment the software is for. The checksum is displayed for a period of several minutes after the loading process completes. However, it can be recalculated and displayed anytime the controller is not running by accessing the ROM diagnostic (MM->8->6->2).

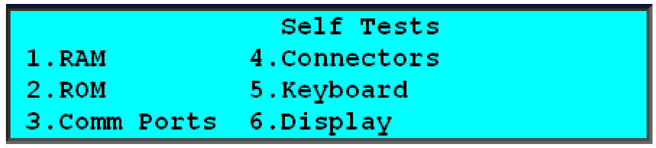
2. Cycle power to the controller/MMU.

   Once the software is re-loaded, cycle power to the controller to ensure that all of RAM memory is re-initialized for the new version. This is particularly important when the software is loaded on-site at the intersection and the controller is not being swapped or removed to accomplish the update.

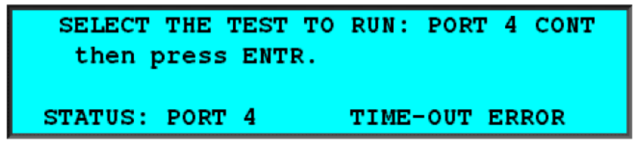
3. Be sure to clear the Event buffer and the Alarm buffer after cycling power (step 2 above). On the 980, the Event buffer is found at MM-1-6-3 and the Alarm buffer at MM-1-6-6.

4. If there are new user-programmable features in the updated software, upload the device's database and verify that the new feature's parameters are set to initial values. Initial values for new features normally disable the feature. Alternatively, set any new parameters to a desired value.

9.2.5 Self Tests (MM->8->6)

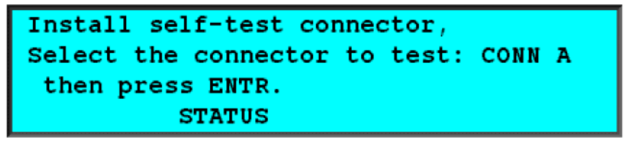


These hardware tests are specific to the NEMA TS2 controllers.

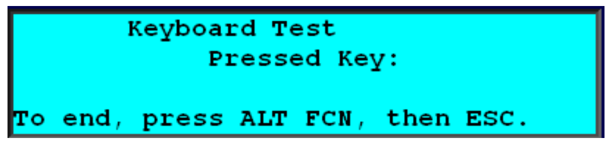


Several hardware tests are provided to insure the integrity of the RAM and ROM memory in the controller. All of these self-tests require that the *Run Timer* be turned off which insures that the controller is not currently controlling an intersection.

RAM and ROM tests perform a checksum of the controller's memory. Com port tests may be performed on any of the RS-232 ports available with the controller.

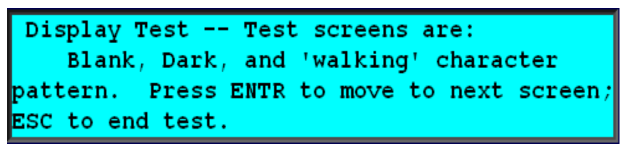


A set of test connectors can be used to connect the outputs of the Type-2 A-B-C connectors to the inputs of the connectors. This utility activates an internal program that incrementally tests each input and output to isolate I/O chip failures in a TS2 type controller.

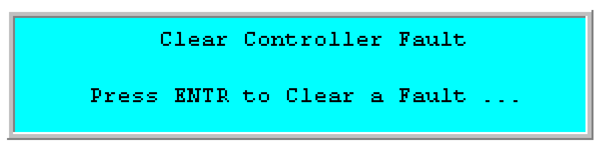


This version provides a keyboard test that echoes a character for each keystroke pressed. This test is primarily used in reliability testing of the hardware.

This version provides a display test to exercise the LCD screen and test each pixel. This test may be used to insure that no area of the display has failed.



9.2.6 Clearing Controller Faults (MM->8->7)



"Critical SDLC Faults" isolate errors defined by the NEMA TS2 specification. A controller fault is generated when communication is lost to an SDLC device (BIU) defined in MM->1->3->7. "Critical SDLC Faults" are cleared from menu MM->8->7 by pressing the **ENTR** key. This entry will also clear any Cycle Faults or Cycle failures that may occur. Cycle Faults and Cycle failures are displayed via the Fault Timer screen at MM->7->9->7.

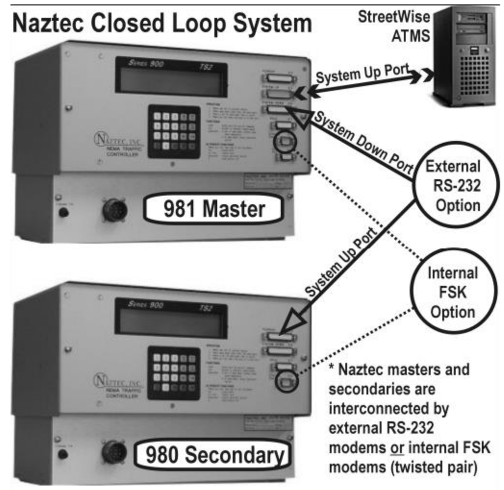
10 Data Communications

10.1 Communication Menu (MM->6)

Communication Menu		
1.General Parms	4.Req Downld	7.Status
2.Port Parms	5.IP Setup	
3.Reserved	6.Binding	

MM->6 configures the controller communications ports. The following sections describe the proper setup, observation, and use of the RS-232 communication ports and the Ethernet port.

10.2 Central Communications



StreetWise or ATMS.now central software provides either direct communication to each controller in the system (master-less), or communicates with closed loop masters that serve as communication buffers for the secondary controllers in the system.

A 981 master controller interconnects up to 32 secondary controllers using RS-232 modems communicating at 600 - 57.6 Kbaud. Internal FSK modems can also be used to provide data communication rates up to 9600 baud over twisted pair. Full and half-duplex asynchronous communication is fully supported.

10.3 General Communication Parameters (MM->6->1)

General Comm Parms		Port	Mode
Station ID	701	System	DEFAULT
Master StatID	700	PC/Print	GPS
Fallback Time(s)	0		
Dyn Obj Persist	22124		

MM->6->1: 980 TS2 Controller

General Comm Parms		Port	Mode
Station ID	701	System-Up	DEFAULT
Master StatID	700	Sys-Down	DEFAULT
Fallback Time(s)	0	PC/Print	DEFAULT
Dyn Obj Persist	22124	Aux 232	DEFAULT

MM->6->1: 981 Master Controllers

Station ID (Range 1 - 9,999 – see Note below)

The Station ID is a unique identification number (or address) assigned to every master and secondary controller in the system. When StreetWise or ATMS.now initiates a communication poll to a *Station ID*, all controllers on the same communication path (including the controllers in the master's subsystem) receive the same poll request. However, the only controller responding to this request is the *Station ID* matching the ID contained in the poll request. This unique controller addressing provides the poll/response system typically found in point-to-point traffic control systems.

Note: The Cubic | Trafficware DEFAULT protocol supports controller addresses in the range of 1-9,999; however, the valid range under the NTCIP protocol is 1-8192.

Master Station ID (1 - 9,999)

The Master Station ID is the ID of the master controller when the secondary is operating in a system under a master. Valid Master IDs are in the range of 1-9,999 under the Cubic | Trafficware DEFAULT protocol and 1-8192 under NTCIP.

Group ID

The Group ID is reserved for future under NTCIP using a broadcast message to all secondary controllers programmed with the same group address. Currently, the secondary controllers a response message is received by the central or master when a secondary controller is polled within a system. A group broadcast does not expect a reply message and provides no status indicating that the message was actually received.

Fallback Time (TS2 981 DEFAULT Protocol Only)

Fallback Time is *defined in the Cubic | Trafficware Protocol as* the time (in seconds) that a secondary local controller waits to receive a closed loop or pattern from the master before reverting to time-of-day operation. A *Fallback Time* of 900 seconds (equivalent to 15 minutes) is typically used for secondary controllers operating in a closed loop system. If the secondary "Closed Loop" parameter is set ON (under menu MM->2->1), the secondary must receive a closed loop pattern from the TS2 981 master within the *Fallback Time* to remain under closed loop control. Otherwise, if the *Fallback Time* expires, the secondary will revert back to the local time-of-day schedule (B-TBC). This timer ranges from 0-9999 seconds.

A continuous StreetWise or ATMS.now scan (such as the "General Information" scan screen) will tend to lock out all polling from the master. However, the master software can interrupt a continuous scan from the central software to pass the closed loop pattern to the secondary controllers to prevent their *Fallback Times* from reverting the secondary controllers to time-of-day operation.

Backup Time (TS2 NTCIP Protocols)

Backup Time is an NTCIP object used to revert a secondary controller to local time base control if system communication is lost. The *Backup Time* (specified in seconds) is a countdown timer that is reset by any valid poll received from a closed loop master or from the central office. Therefore, it is possible for a secondary operating under closed loop to receive polls that set the clock or gather status or detector information without receiving an updated Sys pattern.

A separate MIB called *Fallback Time* is provided in the TS2 controller to insure that the secondary receives the Sys generated pattern from the closed loop master before the Fallback Time expires.

Port Mode (TS2 Only)

The *Port Mode* setting only applies to TS2 controllers which still support the DEFAULT protocol Cubic | Trafficware developed before the NTCIP protocol was developed. When using NTCIP, the *Port Mode* is not needed to set the protocol for the communication port.

The 980 TS2 secondary controller provides a **System** and **PC/Print** port. The various modes for each port are described below:

System

The system port is used for communications with a master or central computer. The DEFAULT and SYS-UP settings are identical. In addition, the NTCIP mode implements the NTCIP protocol for the secondary controller. NTCIP Standard 1210 ("NTCIP Objects for Signal System Masters") is currently in working draft form and will be incorporated when the specification is finally adopted.

PC/Print Port Mode Configuration

The following modes are available for the PC/Print Port:

- DEFAULT - The default mode is the PC/PRINT mode
- SYS-DOWN - This mode causes the port to operate as a repeater. All messages received by the System port will be re-transmitted from this port.
- PC/PRINT - This mode is used for communications with a laptop PC or a printer
- CMU - This mode is used for communications with a Cubic | Trafficware, Inc. Conflict Monitor Unit
- 3418-TOD
- GPS – Garmin GPS/WWV Interface

Dynamic Object Persistence

Dynamic Object Persistence to maintain compliance with national NTCIP standards. *The maximum power outage time in minutes that may occur before all STMP dynamic object definitions in a device shall be invalidated. If this object is set to zero then existing dynamic object definitions shall be invalidated on device power up.* If this object is set to its maximum value (65535) the existing dynamic object definitions shall not be invalidated due to power outages of any duration.

10.4 TS2 Communications Port Parameters

The TS2 Communication Port Parameters are used to integrate the EIA RS-232 serial ports with external serial devices such as laptop computers, palm pilots and various types of modems used for systems communications through the SYSTEM-UP port. In addition, the TS2 981 Master provides a SYSTEM-DOWN port to establish communications with the SYSTEM-UP port of secondary controllers assigned to the master's sub-system.

An internal FSK modem (4800-9600 Kbaud) can be provided and can be programmed as the SYSTEM-UP port in the TS2 980 Secondary controller and as the SYSTEM-DOWN port in the TS2 981 Master controller. The 25-pin SYSTEM-UP port and the 9-pin FSK port on the 980 Secondary controller can be considered as the same physical port. The 25-pin SYSTEM-DOWN port and the 9-pin FSK port on the 981 Master controller can be considered as the same physical port.

10.4.1 Selecting the Port (MM->6->2)

```
          Port Parameters Menu
1. P-A, System-Up
2. P-2, PC/Print
```

The following menu selected from MM->6->2 allows the desired com port to be selected.

10.4.2 Setting the Parameters (MM->6->2->1)

```
Port- SYS-UP   ------- AutoDial --------
Mode  DEFAULT  Enable OFF    Modem BAS-24
Baud     9600  DialTime 0    ModmTime   5
MsgTime   2.4  Tel #1   0000 000 0000
 Duplex FULL   Tel #2   0000 000 0000
```

Once the port selection is made, press ENTER. The following screen will appear:

The message after the word **Port** will be either **–SYS–** (for SYSTEM), or **–PC/P (**for PC/PRINT**).**

The MODE field is status only, and reflects the mode configuration programmed in the General Comm. Parameters Menu for the selected port.

Enable

The enable field is used to turn the port on or off. In the off position, the port is not available for dial-up communications.

Modem

Use this field to select the modem being used with the port. The following selections are available:

- **BAS-24 -** Use this setting for a basic 2400 baud modem, including the Boca modem 2400.
- **HA-24, HA-96, HA-192, HA-288 -** These selections refer to Hayes Modems. Use the selection that describes the baud rate that the modem will be operating at: 2400, 9600, 19.2k, or 28.8K baud, respectively.
- **USRS24, USRS96 -** These selections refer to the U.S. Robotics Sportster Modems. Use USRS24 for 2400 baud operations, and USRS96 for 9600 baud.
- **USRC24, USRC96 -** These selections refer to the U.S. Robotics Courier Modems. Use the USRC24 for 2400 baud and the USRC96 for 9600 baud operations.
- **PROFIL -** Use this selection to enable the controller to load the setup string stored in the modem. Where modems have multiple setup strings, the first string will be loaded.

Baud

Use this field to select the communications data rate (baud rate). The choices are 600, 1200, 2400, 4800, 9600, 14.4K, 19.2K, 28.8K, 33.6K, 38.4K, 57.6K

DialTime

The dial time parameter tells the controller how long to wait after dialing a phone line for a connection to be made. A value of 0 to 255 seconds may be entered. If a connection is not made within the programmed dial time, the controller will attempt the call again using the alternate telephone number.

ModmTime

This parameter tells the controller how often to query the modem to verify that it is still communicating. A value of 0 to 255 minutes may be entered.

MsgTime

This parameter tells the controller how long to wait for a response to a transmitted message. A value of 0 to 9.9 seconds may be entered. If a response is not received within the programmed time, the controller will re-send the message. After three unsuccessful tries, the controller will report a message failure.

Duplex

The difference between FULL and HALF duplex is best explained by analogy comparing telephone communication (FULL duplex) with two-way radio communication (HALF duplex). The sender and receiver can both "talk" at the same time over telephone whereas only one party can be transmitting by radio while the other party "listens".

In a similar way, communication between a master and secondary controller is FULL duplex if both master and secondary are allowed to transmit data while the other device is also transmitting data. HALF duplex communication requires that the secondary wait until the master has finished transmitting data before sending data back to the master.

FULL duplex communication over twisted pair interconnect requires one pair for transmit/receive between the master and secondary and a separate pair for transmit/receive between the secondary and the master controller.

HALF duplex communication allows a single communication pair to share transmit and receive messages between the master and secondary controllers.

Tel#1

This is the primary telephone number the controller uses to establish communications.

Tel#2

This is the secondary telephone number the controller uses to establish communications. This number will be used if the dial time expires without a connection when attempting to connect using Tel#1. If the controller is unable to connect using Tel#2, it will try again using Tel#1.

10.4.3 Example Com Parameter Settings For a 981 Master Sub-System

In this example, the *"System-Up"* port on a 981 master is connected to the central at 33.6 K baud (full duplex) and the *"System-Down"* port is connected to a series of secondary controllers over twisted pair using the internal FSK modem at 9600 baud (full duplex). Note in this example that the communication link from the master to central can operate at a different baud rate as the communication link from the master to the secondary controllers.

The **SYSTEM UP** settings for the primary master are shown to the right. The recommended *Msgtime* for the master SYSTEM UP port is 3.0 seconds. If the central does not respond within 3.0 seconds after the master initiates a message, the master will assume that the central did not hear the message and will re-transmit.

```
Port-SYS-UP   ------- AutoDial ----------
Mode DEFAULT  Enable  OFF  Modem  BAS-24
Baud    33.6  DialTime  0  ModmTime    5
MsgTime 3.0   Tel #1  0000 000 0000
Duplex  FULL  Tel #2  0000 000 0000
```

Enable AutoDial should be set to OFF for all port settings for closed loop operation. The *AutoDial* features only apply to an isolated secondary programmed to dial-up StreetWise or ATMS.now to report alarms. In addition, "Loc Txmt Alrms" must be programmed ON in MM->1->6->7 for controller to initiate communications with a central system. If the central initiates the poll to the master and secondary controllers, "Loc Txmt Alrms" under M->1->6->7 must be programmed OFF.

The **SYSTEM DOWN** settings for the primary master are shown to the right. *Msgtime* for the master SYSTEM DOWN port is 1.5 seconds. If the secondary controller has not responded in 1.5 seconds after the master initiates the message, the master will assume the secondary is not responding and will re-transmit.

```
Port-SYS-DOWN ------- AutoDial ----------
Mode DEFAULT  Enable  OFF  Modem  BAS-24
Baud    9600  DialTime  0  ModmTime    5
MsgTime 1.5   Tel #1  0000 000 0000
Duplex  FULL  Tel #2  0000 000 0000
```

The **SYSTEM UP** settings for the secondary controllers are shown to the right. The recommended *Msgtime* for the secondary SYSTEM UP port is 1.0 seconds. If the master has not responded in 1.0 seconds after the secondary initiates a message, the secondary will assume that the master did not hear the message and will re-transmit.

```
Port-SYS-UP   ------- AutoDial ----------
Mode DEFAULT  Enable  OFF  Modem  BAS-24
Baud     33.6 DialTime  0  ModmTime    5
MsgTime 1.0   Tel #1  0000 000 0000
Duplex  FULL  Tel #2  0000 000 0000
```

Recommended *Msgtime* are listed in the table to the right for different controller types.

Controller Type	Communication Port	Recommended MsgTime (sec.)
TS2/2070 Master	SYSTEM UP	3.0
TS2/2070 Master	SYSTEM DOWN	1.5
TS2/2070 Secondary	SYSTEM UP	1.0

10.5 Transfer Data Utility (MM->6->3)

Menu item MM->6->3 is labeled *Txfer Data* (Transfer Data) in the TS2. Neither menu item is implemented, but both are reserved for a utility that was provided under TS1 to allow data to be copied between controllers through their serial ports. Portable computers and palm pilots have made this TS1 feature obsolete.

10.6 Request Download (MM->6->4)

The *Request Download* screen allows an operator in the field to request a download of the permanent file in the StreetWise or ATMS.now database by selecting **LOCAL** from the menu shown in the menu to the right. You can also select **TIME** to get the time and date downloaded from the central.

10.7 IP Setup (TS2 Ethernet Port Option) (MM->6->5)

```
IP            Device              Host
 Addr  192.168.100.149 1-192.168.100.248
 Mask  255.255.255.  0 2-  0.  0.  0.  0
                             Port #: 5003
GtWay    0.  0.  0.  0       IP Enable: ON
Reset Time:    5             Status: OK
```

The IP Setup menu configures the IP (Internet Protocol) port for the controller. The IP interface PC board must be installed properly with the switch on this board set to the ON position. This enables the external RJ45 connector on the front of the controller unit (this is the connector labeled "E NET"). In addition, there must **not** be an upload-download cable installed in the *System-Up* port because jumper pins 24 and 25 on this cable disable the TS2 Ethernet interface. Whenever the Ethernet interface is enabled, the *System Up* port is disabled. Whenever the *System Up* port is enabled, the Ethernet interface is disabled.

To enable Ethernet support, you <u>must</u> program the communication *General Parameters* under menu MM->6->1. The controller *Station ID* must be set to the controller address and the *System* port must be set to NTCIP to enable the Ethernet interface. Then, set the *IP Enable* option to ON under menu MM->6->5 (shown above). You must also provide separate IP address (*Addr*) and *Mask* settings for the *Device* (local controller) and *Host* (central system). Please note that a second host computer can also be addressed via this screen. You must also provide an IP *Port* number which will match the port number for the particular Drop that you are communicating with as specified in StreetWise or ATMS.now. The *GtWay* (Gateway) address setting is optional, but may be required for your network configuration. Ask your network administrator or the one who configured your network to explain how this additional setting is used if you need additional information.

Anytime you change the IP settings from menu MM->6->5, you should toggle IP Enable OFF then ON to cause changes in the IP settings to take effect.

IP parameters are transferred from the entry screen to the IP interface upon power-up and whenever the IP Interface changes from being disabled to being enabled. The IP interface is enabled only when <u>all</u> of the following are true:

- The IP interface printed circuit board is installed in the unit
- The *System* port under MM->6->1 is set to NTCIP mode
- There is no connection to the *System-Up* serial port on the unit
- The *IP Enable* parameter is set to ON.

There is also a parameter called *Reset Time*. This parameter can be set from 0-255 minutes with a default setting of 5 minutes. This parameter is useful if the Ethernet port "locks up". The port will be reset if the controller drops central communications in the time-frame that the user programs

10.8 Basic IP Interface Connectivity Test

The following guidelines are used to test basic connectivity between a TS2 or 2070 controller and a laptop computer. This test is based on typical agencies setups. Be sure to set the TS2 communications protocol under *General Parameters* (MM->6->1) to NTCIP.

The network should be properly configured by your network administrator. As a minimum, the controller settings under MM->6->5 must provide the local IP address and mask settings for the network. These settings are discussed in chapter 9 for the TS2 Ethernet option.

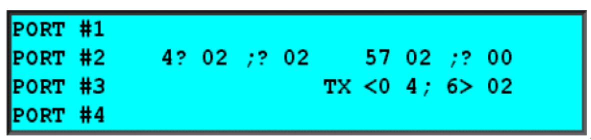
The first three octets of the IP address are typically shared by all devices on the network (including the central computer). The last 3-digit octet must be unique for all devices on the network (similar to the unique *Station ID* used with serial communications). For example, the central computer might be assigned an IP address xxx.yyy.zzz.001 and the local controller xxx.yyy.zzz.002. Every device on this network would share the same "network" address xxx.yyy.zzz. However, each device, including the central computer (.001) would be required to have a unique address on the network.

You can test connectivity using a "cross-over" Ethernet cable to interface the controller directly with the Ethernet port of your computer. A "cross-over" cable is similar to a null-modem cable that switches transmit and receive pairs between two RS-232 devices. You cannot directly connect the controller to a computer using the same RJ45 Ethernet cable that you use to connect to your local computer network. Your computer must also be configured with a "static" IP address instead of the "dynamic" address typically used with LAN and dial-up Internet connections. Changing your network settings is not advised unless you know what you are doing because this will disrupt your LAN and Internet connection.

For this test, assume that the computer is configured with "fixed" IP address 192.168.001 and the controller is configured with 192.168.100.002 under MM->6->5. The network interface of the computer and local controller share the same *Mask* address 255.255.255.0. Basic connectivity of the Ethernet circuit may be confirmed by running a command line program, called *Ping* from Windows. Select *Run* from the *Start Menu*, enter "command" and press OK. This launches a command window where you can execute the ping command. Enter the command "ping 192.168.100.002" and press return. If the Ethernet circuit is functional, you should see a several replies from the controller each time the computer "pings" it's local IP address. If the controller does not respond, you will see a timeout message indicating that the Ethernet interface is not connected. If this basic "ping test" passes from the communication server, but you cannot communicate with the same controller in StreetWise or ATMS.now, then you have an error in your com server software configuration.

10.9 TS2 Com Status

The TS2 *Communication Status Screen* monitors the activity of each communication port and shows transmitting (TX) or receiving (Rx) bytes.



10.10 TS2 GPS Interface

TS2 controllers can be used to update the time sync from a Garmin GPS receiver such as the Garmin GPS 16 (shown below). The controller date is not automatically updated, just the time sync. Therefore, you must manually adjust the current date from the MM->4->1 screen or through the central system.

see: http://www.garmin.com/products/gps16/

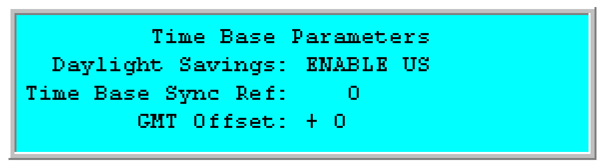
The following steps are required to setup the GPS interface.

1) Set the com port mode (MM->6->1) to "GPS" for the com port interfaced to the GPS. Typically, you will interface the GPS with the **PC/Print** port and dedicate the **System-Up** port for system access using the DEFAULT setting. In addition, a 981 Master controller has an additional port (Aux 232) that can be used to interface the GPS

For Baltimore TS2 version, the 'PC/Print' port mode should be set to "GPS".

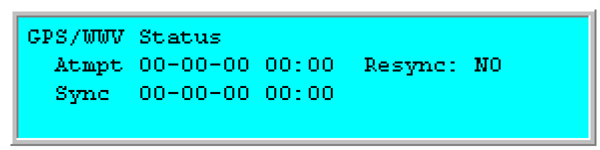
2) Set the baud rate of GPS com port to "4800" under MM->6->2.

For the Baltimore TS2 version, the key sequence would be MM-6-2-2 to select the port parameters for the 'PC/Print Port". On this screen the baud rate may be toggled to select "4800".



3) Select the GMT offset (MM-4-6) for you location based upon your time zone (EST = -5, CST = -6, PST = -8). Be sure to select the proper +/- sign.

For Baltimore, the 'GMT Offset should be set to "-5"



4) Resync the GPS

The controller will automatically resync the time from the GPS twice per hour at approximately 13 and 43 minutes past the hour, every hour. The MM->4->9->3 screen provides the last date/time stamp when the controller attempted to communicate with the GPS device. The status also shows the time returned by the GPS and a text message indicating if the attempt was successful. The menu also allows the used to manually force the controller to resync the GPS. Toggle the *Resync* setting to "YES" and press <ENTR> under MM->4->9->3.

The following status messages are displayed after the controller attempts to communicate with the GPS.

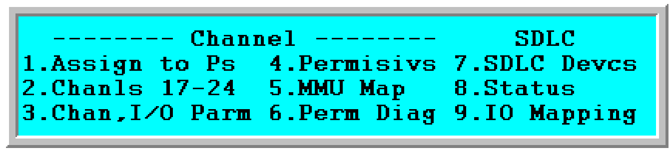
"OK Reply" **-** the received message was correct and implemented

"No Reply" **-** the controller did not receive a reply from the GPS module

"No Signal" **-** the GPS module has not acquired a signal from the satellite

"Bad Reply" **-** the receive message had a data error

11 SDLC Programming

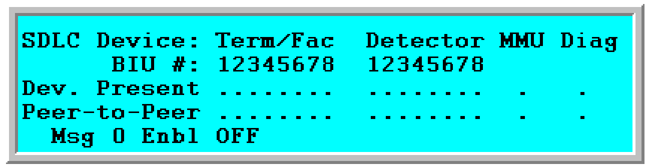


Channel and *SDLC* features are programmed from MM->1->3. Refer to Chapter 2 of this manual for an overview of the differences between TS2 and 2070 SDLC programming.

The SDLC interface is a high-speed (153.6 Kbps) serial data bus that transmits Type-1 messages between the SDLC devices between the controller, terminal facility (or back-panel), detector rack and MMU. The BIU (Bus Interface Unit) is the primary SDLC device responsible for transmitting and receiving standard messages defined in the NEMA TS2 specification. Any BIU enabled in the controller will immediately begin communicating through the SDLC interface as long as the *Run-Timer* is ON.

11.1.1 Activating TS2 Devices (MM->1->3->7)

Individual BIU devices are enabled by selecting an “X” under the device on this screen. The first eight BIUs support the terminal facility (cabinet) followed by eight BIUs for detection and one BIU for the MMU. NEMA only defines the first four terminal facility BIUs (5-8 are reserved for future expansion). Peer-to-peer BIU functions are also reserved for future implementation. The Diag selection is reserved for manufacturer’s testing purposes.



The *Msg 0 Enable* parameter was added to provide compatibility with Autoscope vehicle detection. Turn this parameter ON if Autoscope is used in a terminal facility without a SDLC interface. This causes the controller to generate Msg 0 frames required by Autoscope if an MMU is not present in the cabinet.

NOTE: In later versions of v61, SDLC Msg 0 will include any remapped MMU-to-Controller channels. This allows signal output channels in the cabinet to be wired differently for the controller and the MMU, and for the field check feature to still be used.

11.1.2 SDLC Parameters

The following SDLC parameters modify the default operation of the SDLC interface for the TS2 controller.

Alt T&F Biu Map (MM->1->3->3)

The default terminal facility map provides 16 channel outputs. The *Alt T&F Biu Map* parameter may be set to <u>24 OUT CHAN</u> to support a custom cabinet with up to 24 output channels. Setting this parameter to <u>Single TF BIU</u> provides 8 output channels with a reduced cabinet footprint. <u>IOMAP BIU 1&2</u> will allow the user to reconfigure the BIU’s. See chapter 12 for further details.

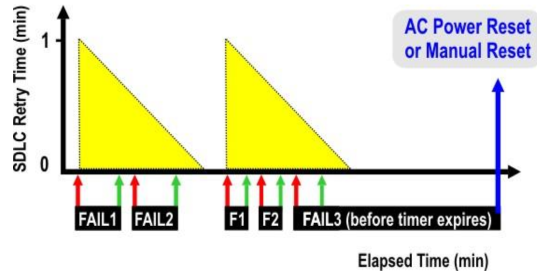
SDLC Retry Time (MM->1->2->1)

SDLC Retry Time (0- 255 minutes) is a countdown timer initiated by a critical SDLC fault that determines how the controller recovers from SDLC communication errors.

1) If the *SDLC Retry Time* is zero, a critical SDLC fault is latched by the controller until AC power is cycled or the fault is cleared manually by an operator using keystrokes MM->8->7.

2) If the *SDLC Retry Time* is not zero, a critical SDLC fault holds the controller in the fault mode until proper SDLC communication is restored. Once SDLC communication is restored, the SDLC Retry Time continues to count down and test successive faults as shown below. The first two SDLC communication faults allow the controller to recover once the communications is restored. However, if a third fault occurs before the *SDLC Retry Time* expires, a critical SDLC fault is latched by the controller until AC power is cycled or the fault is cleared manually by an operator using keystrokes MM->8->7.

You can test this feature by connecting a TS2 Test Box to the unitSet the *SDLC Retry Time* to 1 minute (MM->1->2->1). Now, manually disconnect the SDLC interface cable on the front of the unit and note that the controller registers a critical SDLC fault. If you re-insert the SDLC cable before the *SDLC Retry Time* expires, the SDLC communication will be restored. However, if you wait longer than the *SDLC Retry Time* or create more than two faults before the timer has expired, the controller will not recover and you will need to reset AC power or manually clear the fault from MM->8->7.



Changing the *SDLC Retry Time* to 1 minute helps troubleshoot intermittent SDLC problems to verify a marginal BIU in the system. We have seen cases where a BIU from a different manufacturer creates random SDLC errors that the controller traps properly as required by NEMA. This problem can sometimes be corrected by setting *SDLC Retry Time* to 1; however, it is recommended that *SDLC Retry Time* should be set to zero as a default to trap all SDLC errors at the first failure.

TS2 Detector Faults (MM->1->2->1)

Set *TS2 Detector Faults* to ON to allow faults reported by detector BIUs to generate detector events. Set this entry to OFF to prevent BIU generated detector faults from recording events. This parameter is useful in cases where a TS2 detector rack is not fully populated with loop detectors. In such cases, this parameter may be set to OFF, thereby preventing numerous unwanted detector events from being reported upon power-up. If TS2 Detector Fault is set to ON-RESET, when the controller receives a watchdog fault from the detector BIU, it will automatically issue a detector reset to try to clear the fault. Please note that a reset pulse won't be issued more than once every 20 seconds while the watchdog fault is being reported.

11.1.3 MMU Permissives (MM->1->3->4)

```
Channel.16..14..12..10.9.8.7.6.5.4.3.2
    1    . X . . . . . . . . X X . . .
    2    . X . X . . . . . . X X . .
    3    X . . . . . . . X X . . .
    4    X . X . . . . . X X . .
    5    . . . X . . . . . . .
    6    . X . X . . . . . .
    7  + . . X . . . . . .
```

MMU Permissives are only required in a TS2 type-1 configuration. When an MMU (Malfunction Management Unit) is present, the values programmed in this table must reflect the jumper settings on the MMU programming card or the controller will declare an MMU Permissive fault and go to flash.

The screen is laid out to form a diagonal matrix with channels 1-16 assigned to the rows and columns as shown to the right. This configuration is very similar to the layout of the jumper settings of MMU programming card. Compatible (or permissive) channels are indicated by a 'X' at the intersection of each channel number within the matrix. Compatible channels may display simultaneous green, yellow and/or walk indications without generating an MMU conflict fault.

11.1.4 Channel MMU Map (MM->1->3->5)

```
   MMU-to-Controller Channel Map
MMU Chan   Col.1..2..3..4..5..6..7..8
    1-8        1  2  3  4  5  6  7  8
    9-16       9 10 11 12 13 14 15 16
```

The *MMU Map* entries are used to map each of the 16 MMU channels to the 24 output channels provided in the TS2 terminal facility (cabinet). The first row correlates to MMU channels 1-8, and the second row correlates to MMU channels 9-16. A '0' entry defaults to the standard one to one mapping.

Note: Certain detector devices (like GRIDSMART video detection) that use SDLC require channel telemetry messages from output channels. MM->1->3->5 must **not** have "0" entries when this occurs but instead should be mapped. Typically, the default mapping shown above should be used.

11.1.5 Perm Diag (MM->1->3->6)

```
Channel.16..14..12..10.9.8.7.6.5.4.3.2
    1    . X . . . . . . . . X X . . .
    2    . X . X . . . . . . X X . .
    3    X . . . . . . . X X . . .
    4    X . X . . . . . X X . .
    5    . . . X . . . . . . .
    6    . X . X . . . . . .
    7  + . . X . . . . . .
```

If the controller gets a MMU permissive fault as displayed on the controller overview screen, it indicates that the programmed permissives in the controller do not match the actual permissives that are in the MMU. This screen will indicate which channels do not match. In addition, some users use this screen to automatically program the permissives under MM->1->3->4 by going to the bottom of this screen and entering ***YES*** under the selection that asks ***Fix Permissives***.

11.1.6 SDLC Status Display (MM->1->3->8)

The *SDLC Status Display* summarizes random frame errors for each BIU enabled under MM->1->3 and reports the status of each device. This display is useful to isolate a BIU failure in a TS2 or 2070 type-1 cabinet facility after checking the *Overview Status Screen* discussed in Chapter 3.

Device	Addr	Tx	Rx	Errors	Status
MMU	16	0	128	0	OK
MMU	16	1	129	0	OK
MMU	16	3	131	0	OK
Date/Time	255	9	---	0	OK
TF BIU 1	0	10	138	0	OK
TF BIU 2	1	11	139	0	OK
TF BIU 3	2	12	140	0	OK
TF BIU 4	3	13	141	0	OK
TF Txfer	255	18	---	0	OK
DET BIU 1	8	20	148	0	OK
DET BIU 2	9	21	149	0	OK
DET BIU 3	10	22	150	0	OK
DET BIU 4	11	23	151	0	OK
DET BIU 1	8	24	152	0	OK
DET BIU 2	9	25	153	0	OK
DET BIU 3	10	26	154	0	OK
DET BIU 4	11	27	155	0	OK

11.1.7 Clearing Critical SDLC Faults (MM->8->7)

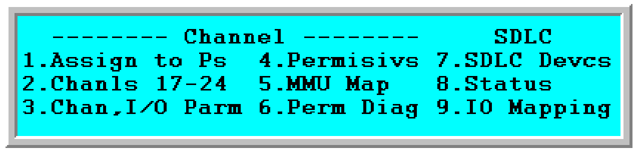
"Critical SDLC Faults" isolate errors defined by the NEMA TS2 specification. A controller fault is generated when communication is lost to an SDLC device (BIU) defined in MM->1->3->7. "Critical SDLC Faults" are cleared from menu MM->8->7 by pressing the **ENTR** key.

```
Clear Controller Fault

Press ENTR to Clear a Fault ...
```

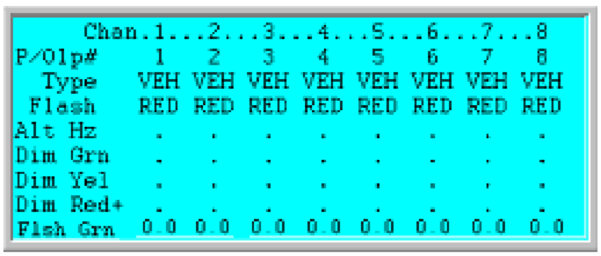
12 Channel and I/O Programming

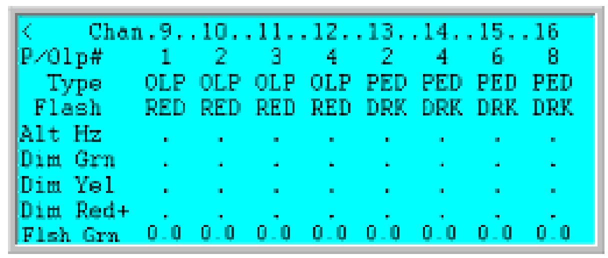
12.1 Channel Assignments (MM->1->3->1)



A *Channel* is an output driver (or load switch) used to switch AC power to a signal display. A channel is simply an output path composed of three signals - red, yellow, and green. All of the controller's main outputs (vehicle phases, overlaps, pedestrian outputs) consist of these three signals. Channel assignment allows these outputs to be applied to any of the available load switch channels. Therefore, a particular phase output or overlap output is not dedicated to a fixed channel as in the TS1 specification. This provides more flexibility to the assignment of hardware outputs.

Output mapping is accomplished by selecting a source number (1-16 for phase or overlap 1-16) followed by the source type (OLP, VEH, PED). The associated output channel will then display indications based upon the state of the assigned source. The default channel assignments shown below are defaults programmed for STD8 operation for a 16 channel cabinet





MM->1->8->1: Channel Assignments for Channels 1-8 (left menu) and Channels 9-16 (right menu)

12.1.1 Ø/Olp# and Type

The channel source (*Ø/Olp#)* directs one of the 16 phase or overlap outputs to each load switch channel. The *Channel Type* (VEH, PED or OLP) programs the channel as either a vehicle, pedestrian or overlap output. A channel may be programmed as inactive (dark) by entering a zero value for the channel source *(Ø/Olp#).*

Map Aux Outputs to Channel Outputs

In version 61.3n or later, an enhanced feature known as IO Mapping has been added. It allows the user to map Auxiliary Outputs to Channel Outputs. It is enabled by selecting a "OTHER" on the *Channel Type* parameter. The Phase/Overlap # on the channel assignment screen selects the group of auxiliary outputs are mapped to the RED/YELLOW/GREEN of that channel. The mapping procedure is shown below:

a) Set Channel Type to "**OTH**" (Other).

b) Set the Phs/Olap # to 1, 2 or 3 to map aux outputs as follows:

Phs/Olap#	Maps Aux Outs to:
1	Aux Outputs 1,2,3 to GRN, YEL, RED of the channel
2	Aux Outputs 4,5,6 to GRN, YEL, RED of the channel
3	Aux Outputs 7,8,9 to GRN, YEL, RED of the channel

Any other value of the Phs/Olap# is equivalent to a zero entry and turns all three outputs of the channel off.

12.1.2 Flash

Automatic-Flash may be programmed from the channel settings shown in the menus above or the *Phase/Overlap* flash settings under MM->1->4->2. The channel *Flash* settings above only apply if the *Flash Mode* is set to CHAN. The channel *Flash* settings may be set to RED or YEL to control the flashing displays when the *Flash Mode* is set to CHAN and *Automatic Flash* is driven by the channel settings.

12.1.3 Alt Hz

The *Alternate Hertz* entries assign the channel flash outputs to either the first half or second half of the one second flash duty-cycle. If *Alternate Hertz* is not enabled, the flash indication will be illuminated during the first half second of the flash cycle. If *Alternate Hertz* *is enabled*, the flash indication will be displayed during the second half of the one second flash duty cycle. If *Alternate Hertz* is enabled for the yellow flash channels and disabled for the red flash channels, this programming will create a "bobbing" effect that alternates between flashing yellow and flashing red every half second.

12.1.4 Dim Parameters

Dimming reduces power consumption of incandescent signal displays by trimming the AC current wave. *Dimming* should not be used with LED indications because cycling the LED on an off greatly reduces the life of the LED indication. Replacing incandescent lamps with LED's is a more effective method of reducing power consumption.

Dimming is activated by an external input typically grounded by a photocell device or a special function output. The menu to the right allows each phase to be dimmed independently and controls which half of the AC wave dimming is applied. Dimming should be assigned to concurrent phases in each ring to equalize the loading of the AC source and balance both halves of the AC cycle. This is typically accomplished by assigning the phases in one ring to the "+" side and the phases in the other ring to the "**-**" side of the AC cycle.

12.1.5 Flashing Green Clearance

In some countries, like Mexico, their phase sequence is GREEN, FLASHING GREEN, YELLOW, RED. The pedestrian sequence in these countries is WALK, FLASHING WALK, DON'T WALK. Due to this, they have an extra clearance interval in the phase, and they flash the "walk" instead of the "don't walk" for the pedestrian. NEMA controller users must program each "FlshGrn" time on the channel mapping screen **(MM->1->3->1)** under the particular channel that you want this time applied to. Apogee Users will program the GrnFlash parameter under the Times+ screen at **MM->1->1->7**.

The following describes the operation of the "Flash Green" parameter as it applies to each channel type.

Phase Operation and Programming

The 'yellow clearance' time must include time for both the 'yellow' and the 'flashing green' interval. If you want 10 seconds of 'flashing green' and 5 seconds of 'yellow', then you must enter 15.0 seconds for the 'yellow clearance' in the phase times (MM→1→1→1), and then enter the 10.0 seconds that you want the channel it to flash on the channel mapping screen under 'FlshGrn'.

In other words, the formula that determines the yellow clearance time is:

"yel clr" = yellow interval time + green flash interval time

which means…

yellow interval time = yellow clearance time – green flash time

As you can see, it is possible to enter a 'green flash time' that would reduce the 'yellow interval time' down to zero, or even negative. If the '3 second yellow disable' is not active, then the 'green flash time' will be limited such that it can not reduce the 'yellow interval' to less than three seconds.

If the 'disable 3 second yellow' is active, then the yellow interval may be reduced to zero.

In no case will entering a green flash time larger than the yellow clearance time allow the green flashing interval to exceed the yellow clearance time.

In summary, the 'yellow clearance' entered in the phase times is the clearance interval regardless of other values. The 'green flash time' simply designates what portion of the clearance time will be used to flash green.

Overlap Operation and Programming

To use Green Flash with overlaps, set the Parent Phs Clrncs parameter on the General Overlap Parameters screen to OFF. This will cause the controller will use the yellow clearance time programmed for the overlap Additionally, the overlap must have a yellow time entered in the overlap parameters that will be used as the clearance interval in the same manner the yellow clearance time is used with the phases. All of the same rules apply to the yellow clearance interval of an overlap as a phase in regards to '3 second yellow disable'.

Pedestrian Operation:

The green flash time acts as a flag. If there is a green flash time entered for a channel that is providing a PED output, then that output will flash walk, as opposed to flashing don't walk during the pedestrian clearance. The amount of time has no effect on flashing walk operation. Any amount of time will cause this operation.

12.2 Channel Parameters (MM->1->3->3)

The *Channel I/O Parameters* allow the user to customize I/O assignments for TS2, 2070 and 2070N controllers.

```
       Channel & I/O Parameters
Chan 17-24 Mapping: DEFAULT
    D Conn Mapping: TX2-V14
   Alt T&F Biu Map: NONE
            IO Mode AUTO
   TOD Dimming Enbl OFF
  Prmpt/ExtCoor Out EXT
Prmpt In,Map HP->LP OFF
    EVP Ped Confirm OFF
```

Channel 17-24 Mapping

NEMA does not define more than 16 output channels, so the DEFAULT setting defines channels 17-24. These additional outputs are provided in a Type-1 terminal facility using additional BIU devices to extend the channel outputs.

D-connector Mapping

D-connector Mapping defines the inputs and outputs of the D-connector for one of the following cabinet configurations. Chapter 14 lists the pin-out assignments for the D-connector for each of these settings.

NONE	No D-connector inputs or outputs (required for TS2 Type-2 I/O Modes 0, 1, 2 or 6) -if TS2 I/O Mode is not Mode 0, the *D-connector Mapping* MUST be set to NONE.
TX2-V14	Pin assignment compatible with Cubic | Trafficware Model 900-TX2CL, version 14
DIAMOND	Pin assignment compatible with Cubic | Trafficware Model 900-DIA6CL, version 6
LIGHT RAIL	Pin assignment compatible with the light-rail definitions defined in Chapter 12
40-DETECT	40 Detector Mapping
SCC	Special Santa Clara County Mapping

TS2 IO Mode

The TS2 IO Modes are defined by NEMA as follows:

- AUTO uses the NEMA IO Mode selected by the NEMA IO Mode inputs A, B, and C on connector A to select the appropriate TS2 IO mapping on NEMA controller and 2070 controller with NEMA interface
- Mode 0 - Mode 2 correspond with the TS2 IO Modes defined in TS2-1992
- Modes 3-5 are reserved by NEMA for future use
- Modes 6-8 are reserved for the manufacturer's use
- USER mode is required to redefine the IO pins in the 2070 and 2070N version 50 software
- NONE - this is a 2070 specific mode that disable the IO mapping (Note that these I/O Modes for the 2070 are programmed under MM->1->3->6->3

  Note: When the TS2 IO Mode is not Mode 0, the D-connector mapping MUST be set to NONE.

ALT T&F BIU Map

Version 61.3n and later has modified the above Mapping to accommodate fully mappable I/O for BIU's 1 and 2. The mapping selections include:

NONE, SINGLE TF BIU, 24 OUT CHAN, IOMAP BIU 1&2

Please refer to Chapter 14 to see the various BIU mapping. If the user wants to modify this mapping, please program these changes at MM->1->3->9->2 for BIU's 1 and 2.

TOD Dimming Enbl

Set this to "ON" to enable TOD dimming or "OFF" to disable TOD dimming. It enables dimming on outputs. This must be active with the dimming input for dimming to be active.

Invert Rail Inputs

A preemption input normally is open and when a contact closure is made, that input is recognized by the controller. Some railroads use a normally closed input and when it is open, that indicates that a railroad is preempting the controller. Agencies in the past had to create electrical relays to accommodate these rail preemption inputs. Setting this parameter to "ON" will eliminate the need for that additional cabinet relay wiring.

Prmpt/Ext Coor Out

This mode creates 7 new preempt status outputs. These outputs provide detailed status of the preempt interval and phase clearance statuses for phases moving to the next interval. In particular:

1) The outputs are multiplexed onto TS2 D connector output pins
2) The selection 820A was added to the Ext/Preempt output paramter on the Channel Parameters screen. When selected, the Preempt Interval status is output on pins normally assigned to Special Function Outputs 5-8, two offset lines and an unassigned output.
3) UCF Flash status is NOT ACTIVE when automatic flash, preempt flash, or startup flash is active.

NOTE: *When preempts are linked, the status operates as though it were two preempts that are linked, not as one preempt with multiple track clearance intervals.*

Please Refer to the 820-980 D-conn table for the assignment of these status outputs

Prmpt In, Map HP->LP

The valid selections are "ON" or "OFF". When set to ON, this parameter activates Low-Priority preemptions (7-10) when the high priority inputs (3-6) are active with a continuous low input. This is used to test low priority preemption operation without the need for a pulsed input on the Preempt 3-6 input lines.

EVP Ped Confirm

This parameter is used for preemption confirmation lights. The selections are as follows:

OFF – No preemption confirmation lights are needed

ON FLASH - The pedestrian clearances outputs (Yellows) are used for Preemption confirmations in the following manner:

a. If the preemption is a rail, then all the ped clear outputs (yellows) flash

b. If the preemption is low priority, then all the ped clear outputs flash

c. If the preemption is high priority, then all the dwell phases and the initial dwell phases for the given preempt will be solid yellow to act as confirmations, while all other ped clear outputs will flash yellow.

ON DARK – This parameter works the same as ON FLASH except that the outputs are dark when they should be flashing.

a. If the preemption is a rail, then all the ped clear outputs (yellows) are dark

b. If the preemption is low priority, then all the ped clear outputs are dark

c. If the preemption is high priority, then all the dwell phases and the initial dwell phases for the given preempt will be solid yellow to act as confirmations, while all other ped clear outputs will be dark

NOTE: *The EVP Ped Confirm outputs may be affected if you set a Ped output to control a Flashing Yellow Arrow overlap as discussed in the overlap section of Chapter 4.*

12.3 TS2 I/O Mapping, Logic and Color Check (MM->1->3->9)

Version 61.3n and later has added this menu to allow the user to customize I/O for BIU's 1 and 2, do simple I/O logic as well as comparing the active channel color outputs to the status as reported by the MMU.

```
     I/O Mapping, Logic & Check
1.IO Logic     4.Color Chk Status
2.IO Map
3.Color Check
```

12.3.1 TS2 Fully Mappable I/O for BIU 1 and BIU 2 (MM->1->3->9->2)

The I/O Mapping screen is found by accessing MM->1->3->9->2. It has an input and output column for each BIU (BIU 1 and BIU 2). The layout on the screen of the BIU Input, Output and I/O signals is as follows:

Screen Row	**Input Group**	**Output Group**
1-8	Inputs 1-8	Outputs 1-8
9-12	Opto-inputs 1-4	Outputs 9-12
13-15	Not used	Outputs 13-15
16-39	I/O 1-24	I/O 1-24

Note that individual I/O lines are assigned as either an input or output, but usually not both at the same time. Therefore, for rows 16-39, there will be an entry in either the input column or output column, but not both.

The sections below provides the dictionary of function codes and the programming for default TS2 I/O assignments.

To Enable the mappable I/O feature, go to the Chan, I/O Parameters screen (MM->1->3->3) and set the Alt T&F BIU Map to "IOMAP BIU 1 & 2".

BIU 1 #	In	Out	BIU 2 #	In	Out
1	0	0	1	0	0
2	0	0	2	0	0
3	0	0	3	0	0
4	0	0	4	0	0
5	0	0	5	0	0
6	0	0	6	0	0
7	0	0	7	0	0
8	0	0	8	0	0
9	0	0	9	0	0
10	0	0	10	0	0
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	0
16	0	0	16	0	0
17	0	0	17	0	0
18	0	0	18	0	0
19	0	0	19	0	0
20	0	0	20	0	0

21	0	0	21	0	0
22	0	0	22	0	0
23	0	0	23	0	0
24	0	0	24	0	0
25	0	0	25	0	0
26	0	0	26	0	0
27	0	0	27	0	0
28	0	0	28	0	0
29	0	0	29	0	0
30	0	0	30	0	0
31	0	0	31	0	0
32	0	0	32	0	0
33	0	0	33	0	0
34	0	0	34	0	0
35	0	0	35	0	0
36	0	0	36	0	0
37	0	0	37	0	0
38	0	0	38	0	0
39	0	0	39	0	0

TS2 IO Map – Input Function Table

Func	Input	Func	Input	Func	Input	Func	Input	Func	Input
0	Unused	50	Veh Call 50	100	Veh Chng 36	150	Ped Omit 6	200	Pre 3 In
1	Veh Call 1	51	Veh Call 51	101	Veh Chng 37	151	Ped Omit 7	201	Pre 4 In
2	Veh Call 2	52	Veh Call 52	102	Veh Chng 38	152	Ped Omit 8	202	Pre 5 In
3	Veh Call 3	53	Veh Call 53	103	Veh Chng 39	153	Ph Omit 1	203	Pre 6 In
4	Veh Call 4	54	Veh Call 54	104	Veh Chng 40	154	Ph Omit 2	204	Pre 7 In (Steady Stated Low Priority Preempt Input 1)
5	Veh Call 5	55	Veh Call 55	105	Veh Chng 41	155	Ph Omit 3	205	Pre 8 In Steady Stated Low Priority Preempt Input 2)
6	Veh Call 6	56	Veh Call 56	106	Veh Chng 42	156	Ph Omit 4	206	CMU/MMU Flash In
7	Veh Call 7	57	Veh Call 57	107	Veh Chng 43	157	Ph Omit 5	207	Reserved:33x Composite Stop Time
8	Veh Call 8	58	Veh Call 58	108	Veh Chng 44	158	Ph Omit 6	208	Local Flash In
9	Veh Call 9	59	Veh Call 59	109	Veh Chng 45	159	Ph Omit 7	209	TBC Online (Input)
10	Veh Call 10	60	Veh Call 60	110	Veh Chng 46	160	Ph Omit 8	210	Dim Enable
11	Veh Call 11	61	Veh Call 61	111	Veh Chng 47	161	R1 Frc Off	211	Auto Flash In
12	Veh Call 12	62	Veh Call 62	112	Veh Chng 48	162	R1 Stop Tim	212	Alt Seq A
13	Veh Call 13	63	Veh Call 63	113	Veh Chng 49	163	R1 Inh Max	213	Alt Seq B
14	Veh Call 14	64	Veh Call 64	114	Veh Chng 50	164	R1 Red Rest	214	Alt Seq C
15	Veh Call 15	65	Veh Chng 1	115	Veh Chng 51	165	R1 PedRecyc	215	Alt Seq D
16	Veh Call 16	66	Veh Chng 2	116	Veh Chng 52	166	R1 Max II	216	Timing Plan A
17	Veh Call 17	67	Veh Chng 3	117	Veh Chng 53	167	R1 OmtRdClr	217	Timing Plan B
18	Veh Call 18	68	Veh Chng 4	118	Veh Chng 54	168	Non-Act I	218	Timing Plan C
19	Veh Call 19	69	Veh Chng 5	119	Veh Chng 55	169	R2 Frc Off	219	Timing Plan D
20	Veh Call 20	70	Veh Chng 6	120	Veh Chng 56	170	R2 Stop Tim	220	Addr Bit 0
21	Veh Call 21	71	Veh Chng 7	121	Veh Chng 57	171	R2 Inh Max	221	Addr Bit 1
22	Veh Call 22	72	Veh Chng 8	122	Veh Chng 58	172	R2 Red Rest	222	Addr Bit 2
23	Veh Call 23	73	Veh Chng 9	123	Veh Chng 59	173	R2 PedRecyc	223	Addr Bit 3
24	Veh Call 24	74	Veh Chng 10	124	Veh Chng 60	174	R2 Max II	224	Addr Bit 4
25	Veh Call 25	75	Veh Chng 11	125	Veh Chng 61	175	R2 OmtRdClr	225	Offset 1
26	Veh Call 26	76	Veh Chng 12	126	Veh Chng 62	176	Non-Act II	226	Offset 2
27	Veh Call 27	77	Veh Chng 13	127	Veh Chng 63	177	Ext Start	227	Offset 3
28	Veh Call 28	78	Veh Chng 14	128	Veh Chng 64	178	Int Advance	228	Pre 9 In (Steady Stated Low Priority Preempt Input 3)
29	Veh Call 29	79	Veh Chng 15	129	Ped Call 1	179	Door Open	229	Pre 10 In (Steady Stated Low Priority Preempt Input 4)
30	Veh Call 30	80	Veh Chng 16	130	Ped Call 2	180	Min Recall	230	Logic1
31	Veh Call 31	81	Veh Chng 17	131	Ped Call 3	181	ManCtrlEnbl	231	Logic2
32	Veh Call 32	82	Veh Chng 18	132	Ped Call 4	182	I/O Mode Bit A	232	Logic3
33	Veh Call 33	83	Veh Chng 19	133	Ped Call 5	183	I/O Mode Bit B	233	Logic4
34	Veh Call 34	84	Veh Chng 20	134	Ped Call 6	184	I/O Mode Bit C	234	Logic5
35	Veh Call 35	85	Veh Chng 21	135	Ped Call 7	185	Test A	235	Logic6
36	Veh Call 36	86	Veh Chng 22	136	Ped Call 8	186	Test B	236	Logic7
37	Veh Call 37	87	Veh Chng 23	137	Hold 1	187	Test C	237	Logic8
38	Veh Call 38	88	Veh Chng 24	138	Hold 2	188	WalkRestMod	238	Logic9
39	Veh Call 39	89	Veh Chng 25	139	Hold 3	189	Unused	239	Logic10
40	Veh Call 40	90	Veh Chng 26	140	Hold 4	190	Free In	240	Logic11
41	Veh Call 41	91	Veh Chng 27	141	Hold 5	191	Flash In	241	Logic12
42	Veh Call 42	92	Veh Chng 28	142	Hold 6	192	Alarm 1	242	Logic13
43	Veh Call 43	93	Veh Chng 29	143	Hold 7	193	Alarm 2	243	Logic14
44	Veh Call 44	94	Veh Chng 30	144	Hold 8	194	Alarm 3	244	Logic15
45	Veh Call 45	95	Veh Chng 31	145	Ped Omit 1	195	Alarm 4	245	Logic16
46	Veh Call 46	96	Veh Chng 32	146	Ped Omit 2	196	Alarm 5	246	Logic17
47	Veh Call 47	97	Veh Chng 33	147	Ped Omit 3	197	Alarm 6	247	Logic18
48	Veh Call 48	98	Veh Chng 34	148	Ped Omit 4	198	Pre 1 In	248	Logic19
49	Veh Call 49	99	Veh Chng 35	149	Ped Omit 5	199	Pre 2 In	249	Logic20

Func	Input
250	Reserved
251	Reserved
252	Reserved
253	Reserved
254	Constant False
255	Constant True

TS2 IO Map – Output Function Table

Func	Output	Func	Output	Func	Output	Func	Output	Func	Output
0	Unused	50	Ch2 Green	100	R2 Status A	150	Reserved	200	IO UCF Flash
1	Ch1 Red	51	Ch3 Green	101	R2 Status B	151	Reserved	201	Preempt Int Stat Out 1
2	Ch2 Red	52	Ch4 Green	102	R2 Status C	152	Reserved	202	Preempt Int Stat Out 2
3	Ch3 Red	53	Ch5 Green	103	Special 1	153	Reserved	203	Preempt Int Stat Out 3
4	Ch4 Red	54	Ch6 Green	104	Special 2	154	Reserved	204	Preempt Int Stat Out 4
5	Ch5 Red	55	Ch7 Green	105	Special 3	155	Reserved	205	Preempt Int Stat Out 5
6	Ch6 Red	56	Ch8 Green	106	Special 4	156	Reserved	206	Preempt Int Stat Out 6
7	Ch7 Red	57	Ch9 Green	107	Special 5	157	Reserved	207	Preempt Int Stat Out 7
8	Ch8 Red	58	Ch10 Green	108	Special 6	158	Reserved	208	Reserved
9	Ch9 Red	59	Ch11 Green	109	Special 7	159	Reserved	209	Reserved
10	Ch10 Red	60	Ch12 Green	110	Special 8	160	Reserved	210	Reserved
11	Ch11 Red	61	Ch13 Green	111	Fault Mon	161	Reserved	211	Reserved
12	Ch12 Red	62	Ch14 Green	112	Voltage Mon	162	Reserved	212	Reserved
13	Ch13 Red	63	Ch15 Green	113	Flash Logic	163	Reserved	213	Reserved
14	Ch14 Red	64	Ch16 Green	114	170 Watchdog	164	Reserved	214	Reserved
15	Ch15 Red	65	Ch17 Green	115	Constant Zero	165	Reserved	215	Reserved
16	Ch16 Red	66	Ch18 Green	116	Pre Stat 1	166	Reserved	216	Reserved
17	Ch17 Red	67	Ch19 Green	117	Pre Stat 2	167	Reserved	217	Reserved
18	Ch18 Red	68	Ch20 Green	118	Pre Stat 3	168	Reserved	218	Reserved
19	Ch19 Red	69	Ch21 Green	119	Pre Stat 4	169	Reserved	219	Reserved
20	Ch20 Red	70	Ch22 Green	120	Pre Stat 5	170	Reserved	220	Reserved
21	Ch21 Red	71	Ch23 Green	121	Pre Stat 6	171	Reserved	221	Reserved
22	Ch22 Red	72	Ch24 Green	122	TBCAux/Pre1	172	Reserved	222	Reserved
23	Ch23 Red	73	Ph 1 Check	123	TBCAux/Pre2	173	Reserved	223	Reserved
24	Ch24 Red	74	Ph 2 Check	124	LdSwtchFlsh	174	Reserved	224	Reserved
25	Ch1 Yellow	75	Ph 3 Check	125	TBC Aux 1	175	Reserved	225	Reserved
26	Ch2 Yellow	76	Ph 4 Check	126	TBC Aux 2	176	Reserved	226	Reserved
27	Ch3 Yellow	77	Ph 5 Check	127	TBC Aux 3	177	Reserved	227	Reserved
28	Ch4 Yellow	78	Ph 6 Check	128	Coord Active	178	Reserved	228	Reserved
29	Ch5 Yellow	79	Ph 7 Check	129	Time plan A	179	Reserved	229	Reserved
30	Ch6 Yellow	80	Ph 8 Check	130	Time plan B	180	Reserved	230	Logic1
31	Ch7 Yellow	81	Ph 1 Next	131	Time plan C	181	Reserved	231	Logic2
32	Ch8 Yellow	82	Ph 2 Next	132	Time plan D	182	Reserved	232	Logic3
33	Ch9 Yellow	83	Ph 3 Next	133	Offset Out1	183	Reserved	233	Logic4
34	Ch10 Yellow	84	Ph 4 Next	134	Offset Out2	184	Reserved	234	Logic5
35	Ch11 Yellow	85	Ph 5 Next	135	Offset Out3	185	Reserved	235	Logic6
36	Ch12 Yellow	86	Ph 6 Next	136	Auto Flash	186	Reserved	236	Logic7
37	Ch13 Yellow	87	Ph 7 Next	137	Preempt Actv (Composite)	187	Reserved	237	Logic8
38	Ch14 Yellow	88	Ph 8 Next	138	Reserved: LiteRailVeh Warning	188	Reserved	238	Logic9
39	Ch15 Yellow	89	Phase 1 On	139	Reserved	189	Reserved	239	Logic10
40	Ch16 Yellow	90	Phase 2 On	140	Audible Ped 2	190	Reserved	240	Logic11
41	Ch17 Yellow	91	Phase 3 On	141	Audible Ped 4	191	Reserved	241	Logic12
42	Ch18 Yellow	92	Phase 4 On	142	Audible Ped 6	192	Reserved	242	Logic13
43	Ch19 Yellow	93	Phase 5 On	143	Audible Ped 8	193	Reserved	243	Logic14
44	Ch20 Yellow	94	Phase 6 On	144	Reserved	194	Reserved	244	Logic15
45	Ch21 Yellow	95	Phase 7 On	145	Reserved	195	Reserved	245	Logic16
46	Ch22 Yellow	96	Phase 8 On	146	Reserved	196	Reserved	246	Logic17
47	Ch23 Yellow	97	R1 Status A	147	Reserved	197	Reserved	247	Logic18
48	Ch24 Yellow	98	R1 Status B	148	Reserved	198	Reserved	248	Logic19
49	Ch1 Green	99	R1 Status C	149	Reserved	199	Reserved	249	Logic20

Func	Output
250	Reserved
251	Reserved
252	Reserved
253	Reserved
254	Constant False
255	Constant True

TS2 Default programming BIU 1

	BIU #1				BIU #1			
	Input		Assignment		Output		Assignment	
Scrn Row	**Group**	**#**	**Code**	**Description**	**Group**	**#**	**Code**	**Description**
1	**In**	1	162	Stop Timing (Ring 1)	**Out**	1	1	Red Out 1
2		2	170	Stop Timing (Ring 2)		2	25	Yel Out 1
3		3	166	Max II Selection (Ring 1)		3	49	Grn Out 1
4		4	174	Max II Selection (Ring 2)		4	2	Red Out 2
5		5	161	Force Off (Ring 1)		5	26	Yel Out 2
6		6	169	Force Off (Ring 2)		6	50	Grn Out 2
7		7	168	Call to Non-Actuated I		7	3	Red Out 3
8		8	188	Walk Rest Modifier		8	27	Yel Out 3
9	**Opto-In**	1	129	Ped Call 1		9	51	Grn Out 3
10		2	130	Ped Call 2		10	4	Red Out 4
11		3	131	Ped Call 3		11	28	Yel Out 4
12		4	132	Ped Call 4		12	52	Grn Out 4
13	**Not Used**	1	0			13	5	Red Out 5
14		2	0			14	29	Yel Out 5
15		3	0			15	53	Grn Out 5
16	**In/Out**	1	0	Assigned as Output	**In/Out**	1	6	Red Out 6
17		2	0	Assigned as Output		2	30	Yel Out 6
18		3	0	Assigned as Output		3	54	Grn Out 6
19		4	0	Assigned as Output		4	7	Red Out 7
20		5	0	Assigned as Output		5	31	Yel Out 7
21		6	0	Assigned as Output		6	55	Grn Out 7
22		7	0	Assigned as Output		7	8	Red Out 8
23		8	0	Assigned as Output		8	32	Yel Out 8
24		9	0	Assigned as Output		9	56	Grn Out 8
25		10	0	Assigned as Output		10	125	TBC Aux Out 1
26		11	0	Assigned as Output		11	126	TBC Aux Out 2
27		12	0	Assigned as Output		12	116	Preempt 1 Status
28		13	0	Assigned as Output		13	117	Preempt 2 Status
29		14	198	Preempt In 1		14	0	Assigned as Input
30		15	199	Preempt In 2		15	0	Assigned as Input
31		16	185	Test Input A		16	0	Assigned as Input
32		17	186	Test Input B		17	0	Assigned as Input
33		18	211	Auto Flash In		18	0	Assigned as Input
34		19	210	Dimming Enable		19	0	Assigned as Input
35		20	181	Manual Control Enable		20	0	Assigned as Input
36		21	178	Internal Advance		21	0	Assigned as Input
37		22	180	Min Recall All Phases		22	0	Assigned as Input
38		23	177	External Start		23	0	Assigned as Input
39		24	209	TBC On-Line (In)		24	0	Assigned as Input

TS2 Default programming BIU 2

	BIU #2				BIU #2			
	Input		Assignment		Output		Assignment	
Scrn Row	**Group**	**#**	**Code**	**Description**	**Group**	**#**	**Code**	**Description**
1	**In**	1	163	Inhibit Max Term (Ring 1)	**Out**	1	9	Red Out 9
2		2	171	Inhibit Max Term (Ring 2)		2	33	Yel Out 9
3		3	208	Local Flash In		3	57	Grn Out 9
4		4	206	Chan/MMU Flash In		4	10	Red Out 10
5		5	192	Alarm 1 In (User alarm)		5	34	Yel Out 10
6		6	193	Alarm 2 In (User alarm)		6	58	Grn Out 10
7		7	190	Free		7	11	Red Out 11
8		8	187	Test Input C		8	35	Yel Out 11
9	**Opto-In**	1	133	Ped Call 5		9	59	Grn Out 11
10		2	134	Ped Call 6		10	12	Red Out 12
11		3	135	Ped Call 7		11	36	Yel Out 12
12		4	136	Ped Call 8		12	60	Grn Out 12
13	**Not Used**	1				13	13	Red Out 13
14		2				14	37	Yel Out 13
15		3				15	61	Grn Out 13
16	**In/Out**	1	0	Assigned as Output	**In/Out**	1	14	Red Out 14
17		2	0	Assigned as Output		2	38	Yel Out 14
18		3	0	Assigned as Output		3	62	Grn Out 14
19		4	0	Assigned as Output		4	15	Red Out 15
20		5	0	Assigned as Output		5	39	Yel Out 15
21		6	0	Assigned as Output		6	63	Grn Out 15
22		7	0	Assigned as Output		7	16	Red Out 16
23		8	0	Assigned as Output		8	40	Yel Out 16
24		9	0	Assigned as Output		9	64	Grn Out 16
25		10	0	Assigned as Output		10	127	TBC Aux Out 3
26		11	0	Assigned as Output		11	128	Coord Active
27		12	0	Assigned as Output		12	118	Preempt Status 3
28		13	0	Assigned as Output		13	119	Preempt Status 4
29		14	0	Assigned as Output		14	120	Preempt Status 5
30		15	0	Assigned as Output		15	121	Preempt Status 6
31		16	200	Preempt In 3		16	0	Assigned as Input
32		17	201	Preempt In 4		17	0	Assigned as Input
33		18	202	Preempt In 5		18	0	Assigned as Input
34		19	203	Preempt In 6		19	0	Assigned as Input
35		20	176	Call to Non-Actuated II		20	0	Assigned as Input
36		21	0	Spare		21	0	Assigned as Input
37		22	0	Spare		22	0	Assigned as Input
38		23	0	Spare		23	0	Assigned as Input
39		24	0	Spare		24	0	Assigned as Input

12.3.2 Color Check Disable (MM->1->3->9->3), Color Check Status (MM->1->3->9->4)

The color check feature compares the active channel color outputs to the status as reported by the MMU. If these disagree for 800-900 ms, then the controller declares a “color check” fault. The feature has a global enable (Color Check) on the controller parameters screen (MM->1->2->1), at the bottom. There is a screen to disable checking for individual color outputs at MM->1->3->9->3.

```
Color Check Disble   12345678 90123456
             Green   ........ ........
             Yellow  ........ ........
             Red     ........ ........
```

At MM->1->3->9->4, a status screen shows in real-time for each output the number of tenths of a second that the output disagrees with what the MMU reports. Usually, these numbers are 0. During color transitions, they can be seen to count to 1 or 2. The color check timers are paused whenever the MMU is in fault, the Local Flash or MMU Flash inputs are active, or stop-time inputs are applied. This prevents the color check fault from falsely tripping during various flashing modes (start-up, fault, or tech switch).

```
   Chan.1 2 3 4 5 6 7 8  .10 .12 .14 .16
Green    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Yellow   0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Red      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

12.3.3 Programmable IO Logic (MM->1->3->9->1)

The *IO Logic* feature allows the user to “logically” combine IO to create new inputs and outputs that extend the functionality of the controller. The following are descriptions of each field

```
Result Fcn Oper   Fcn Oper   Fcn   Timer
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
I   0= I  0       I  0       I  0 DLY   0
```

Result
The user sets this field to either an **I** (for Input) or **O** (for Output). This selection determines if you are assigning the result of the statement to an input or an output.

The user can optionally set a **!** prior to the **I** or **O** result. The exclamation point indicates that the term is inverted during evaluation of the statement.

Note: Once the user programs Logic lines, the resultant (*Result)* input or output **will** replace the original physical input or output.

Fcn
This is the IO Function Number as described in Chapter 14 of the NTCIP Controller Training Manual

The version 65 software utilizes 10 Logic Functions variable numbered 240-249, where Functions 240-249 are functions "Logic 1" **-** "Logic 10". Whether they are denoted as input or output, they point to the same location. Think of these functions as temporary storage locations. If you want to feed the output of one statement into the next, you can make an assignment of the first statement to one of these logic variables, and they use it as a term in the next statement.

Operator
This is the Logical Operation (Boolean Logic). Among the choices are: AND, NAND, OR, NOR, XOR, XNOR
The logic will follow the following truth tables-- Where ‘0’ represents OFF or False and “1” represents ON or True

AND NAND

0	0	0		0	0	1
0	1	0		0	1	1
1	0	0		1	0	1
1	1	1		1	1	0

OR NOR

0	0	0		0	0	1
0	1	1		0	1	0
1	0	1		1	0	0
1	1	1		1	1	0

XOR				XNOR		
0	0	0		0	0	1
0	1	1		0	1	0
1	0	1		1	0	0
1	1	0		1	1	1

Timer

The timer can optionally be specified to SHIFT, DELAY, or EXTEND the result of the logic statement for the number of seconds specified by the user.

SHF- Shift logic

DLY- Delay logic by ### **-** the number of seconds to SHF/DLY/EXT

EXT – Extend logic

This timer operates similar to detection delay and extend.

In summary, the logic statement is performed from left to right. The result of each statement is accumulated. For example, "1 AND 2 AND 3" is processed as follows " (RESULT OF 1 AND 2) AND 3".

12.3.4 I/O Logic Considerations and Best Practices

The controller I/O logic has the ability to store temporary states in a place holder I/O locations (variable) regardless if it is an input or output function, i.e. Function 230 (Logic 1), Function 231 (Logic2)…..Function 249 (logic 20). Controller I/O logic can also override inputs and outputs.

The algorithmic process for I/O logic follows the following steps:

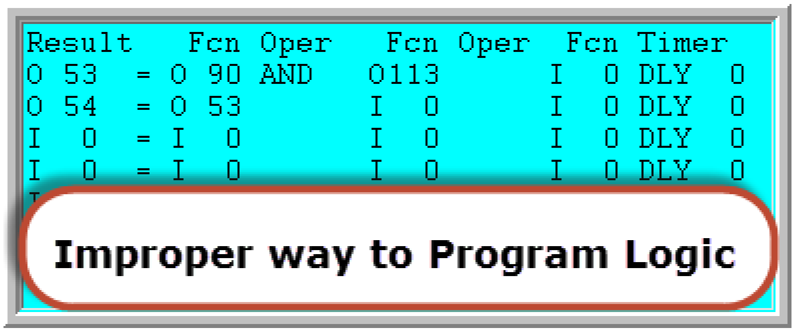
1. The controller polls all of the inputs from the I/O hardware.
2. The I/O logic executes each programmed line left to right and executes the top row to the bottom row.
3. The controller performs normal operation
4. The I/O logic stores the logic result overridden OUTPUTS for hardware processing.
5. The controller then pushes the outputs to the physical I/O hardware.

There is a much nuanced detail that must be noted based on the above algorithm: **Any logic statement that stores its results to an output, then the logic is evaluated after the inputs are polled, but the assignment of the result of the output bit does not happen until right before the controller pushes the output to the hardware.**

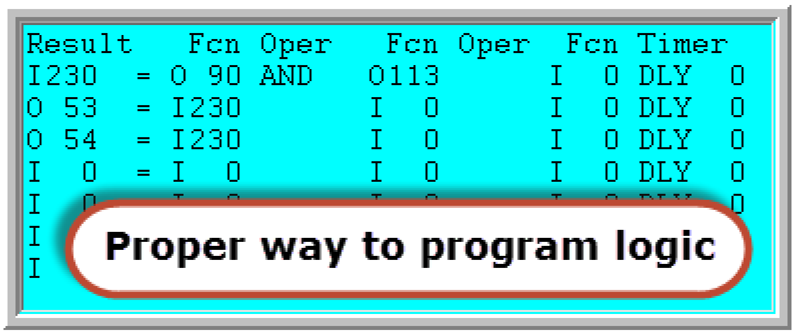
This nuance impacts the way to write a logic statement. If you are feeding forward a result, and that result is stored in an output, then it **WILL NOT WORK**.

Consider the example below. When phase 2 is ON, the user wants to turn on and flash the Channel 5 Green output. The user also wants to flash the Channel 6 Green output whenever Phase 2 is ON. The functions to do this are O53 (Channel 5 Green), O54 (Channel 6 Green), O90 (Phase 2 ON) and O113 (Flashing logic).

Logic programming on the screen below will FAIL based on the above algorithmic process. The second statement would fail because Channel 5 will not receive its value after the first statement is executed.



The way to work around this is to assign the result of the first statement to one of the LOGIC variables as a place-holder, and use the LOGIC variable to feed the state forward to other statements. We will use I230 (Logic1) to be this placeholder variable. **Remember to store and this variable as an INPUT**. The proper way to program the desired result is below:



This works because you can feed forward results assigned to INPUTS, but not the results assigned to OUTPUTS

As a general rule, you should only designate the place holder I/O locations as INPUTS. So, if you are storing something in LOGIC1 it should be "I 230", and not "O 230".

13 Controller Event/Alarm Descriptions

Event / Alarm #	Alarm Name	Comments	Hardware Specific
1	Power Up Alarm.	Is active when power is applied to the controller. Transitions upon power-up and power-down may be logged.	
2	Stop Timing	Indicates that one of the stop time inputs is active.	
3	Cabinet Door Activation	This is brought into the NEMA input called "lamps" or "indicator". This input is typically used for the cabinet door switch in TS1 cabinets.	
4	Coordination Failure	This alarm indicates that coordination is failed. There are two ways in which coordination may fail: 1) The TS2 method in which two cycle faults have occured during coordination, but not when coordination is inactive. 2) A servicable call has not be serviced in 3 cycles. This is the traditional method, which predates the NEMA TS2 method.	
5	External Alarm # 1		
6	External Alarm # 2		
7	External Alarm # 3		
8	External Alarm # 4		
9	Closed Loop Disabled	This alarm, when active, indicates that the Closed-loop Enable parameter is set to OFF.	
10	External Alarm # 5		
11	External Alarm # 6		
12	Manual Control Enable	Alarm active when *Police Push Button* is ON	
13	Coordination Free Switch Input	Alarm active when System/Free Switch is FREE	
14	Local Flash Input	Asserted by monitor or cabinet switch when in flash	SDLC or I/O Mode
15	CMU or MMU Flash Input	Alarm is active when the controller receives an SDLC message from the MMU that it is in flash	SDLC or I/O Mode
16	MMU Fault	Indicates a Conflict Monitor Hardware Fault has occurred when CVM is NOT asserted by the controller and Stop-Time is applied.	
17	Cycle Fault	TS2 Alarm. It indicates that a serviceable call has not been serviced in approximately two cycle times and coordination was active at the time.	

18	Cycle Failure	TS2 Alarm. It indicates that a serviceable call has not been serviced in approximately two cycle times and that coordination was not active at the time.	
19	Coordination Fault	Indicates that a cycle fault occurred during coordination.	
20	Controller Fault	Intersection is in Flash due to a critical controller fault. This fault includes Field Check, Response Frames, Proc Diagnostics.	
21	Detector SDLC Fault	Indicates SDLC communication with at least one of the Detector BIUs is faulted. This is a non-critical fault and will not cause the intersection to flash.	SDLC
22	MMU SDLC Fault	SDLC communication with the MMU has experienced a Response Frame Fault. This is a critical fault and will cause the controller to flash.	SDLC
23	Terminal Facility (cabinet) SDLC Fault	SDLC communication with one or more of the Terminal and Facilities BIUs is faulted. This is a critical fault and will cause the controller to Flash.	SDLC
24	SDLC Response Frame Fault	Report from SDLC interface	TS2 SDLC
25	EEPROM CRC Fault	The background EEPROM diagnostic has detected an unexplained change in the CRC of the user-programmed database.	
26	Detector Diagnostic Fault	One of the controller detector diagnostics (No Activity, Max Presence or Erratic Count) has failed. See section 13.1 for further details.	
27	Detector Fault From SDLC	One or more local detectors have been reported to be faulted by the Loop Amplifer and BIU. These faults include open loop, shorted loop, excessive inductance change, and watch-dog time-out.	SDLC
28	Queue Detector alarm	Associated with the queue detector feature. Data indicates which queue detector is generating the alarm.	
29	Ped Detector Fault	A ped detector is faulted due to user program limits being exceeded. These include *No Activity*, *Max Presence* and *Erratic Count* on screen MM->5->4.	
30	Pattern Error / Coord Diagnostic Fault	Active when coord diagnostic has failed. See section 13.1 for further details.	
31	Cabinet Flash Alarm	Active after a delay timer expires (see MM->1->6->7) if the monitor, or a controller fault, causes the cabinet to flash.	TS2 - Ver 61
32	Download Request Time Clock	Requests Time clock Download from central system (see MM->6->4)	
33	Street Lamp Failure	Street Lamp Failure (Channel A)	
34	Street Lamp Failure	Street Lamp Failure (Channel B)	
35-36	Reserved		
37	Download Request Database	Requests Download from central system (see MM->6->4	

38	Pattern Change	Coordination Pattern changes are logged to the event and alarm buffers using this alarm number. The data byte stores the new pattern number.	
39	Reserved Apogee	Reserved	2070
40	Reserved Apogee	Reserved	2070
41	Temperature Alert #1	Temp Alert 1 – High Temp	Temp Alert
42	Temperature Alert #1	Temp Alert 1 – Low Temp	Temp Alert
43	Temperature Alert #1	Temp Alert 1 – Status Alarm	Temp Alert
44	Temperature Alert #2	Temp Alert 2 – High Temp	Temp Alert
45	Temperature Alert #2	Temp Alert 2 – Low Temp	Temp Alert
46	Temperature Alert #2	Temp Alert 2 – Status Alarm	Temp Alert
47	Coord Active	Set when coordination is active (not free)	
48	Preempt Active TSP Active Trigger	Set when any preempt is active Used with ATMS to initiate download of TSP Data	
49	Preempt 1	Rail Preempt 1	
50	Preempt 2	Rail Preempt 2	
51	Preempt 3	High-Priority Preempt 3	
52	Preempt 4	High-Priority Preempt 4	
53	Preempt 5	High-Priority Preempt 5	
54	Preempt 6	High-Priority Preempt 6	
55	Preempt 7	Low-Priority or Transit Priority Preempt 7	
56	Preempt 8	Low-Priority or Transit Priority Preempt 8	
57	Preempt 9	Low-Priority or Transit Priority Preempt 9	
58	Preempt 10	Low-Priority or Transit Priority Preempt 10	

59	EEPROM Compare Fault	Checksum of firmware memory has changed	
60	Coordination Failure	Alarm is ON when Coordination has failed	2070
61	Sync Transition	Alarm is ON when coord is active and in transition for times over 3 seconds. Alarm is OFF when coord is active and in SYNC.	
62-64	Reserved		
65-68	Reserved for Light Rail		
69-72	Reserved		
73	Controller Access	Active when a key is pressed until the *Display Time* expires (see Unit Paramters, MM->1->2->1)	
74	User Key Login	Active when user enters security key – records the User # in the data byte	
75-80	Reserved		
81	FIO Changed Status	FIO Status has changed	2070
82-86	Reserved		
87	External Alarm # 7		2070
88	External Alarm # 8		2070
89	External Alarm # 9		2070
90	External Alarm # 10		2070
91	External Alarm # 11		2070
92	External Alarm # 12		2070
93	External Alarm # 13		2070
94	External Alarm # 14		2070
95	External Alarm # 15		2070
96	External Alarm # 16		2070
97-128	Reserved		

13.1 Error Data

13.1.1 Alarm 21 Detector SDLC Diagnostic Fault Data

Fault Description	Det BIU Out Fault Data	Det BIU In Fault Data
Detector BIU # 1	148	152
Detector BIU # 2	149	153
Detector BIU # 3	150	154
Detector BIU # 4	151	155

13.1.2 Alarm 22 MMU SDLC Diagnostic Fault Data

Fault #	Fault Description
129	MMU SDLC fault

13.1.3 Alarm 23 Terminal Facilities SDLC Diagnostic Fault Data

Fault Description	Det BIU Out Fault Data
Terminal Facilities BIU # 1	138
Terminal Facilities BIU # 2	139
Terminal Facilities BIU # 3	140
Terminal Facilities BIU # 4	141

13.1.4 Alarm 26 Detector Diagnostic Fault

Fault (decimal)	Fault (Hexadecimal)	Fault (Stored as Occupancy Data)
210	D2	Max Presence Fault
211	D3	No Activity Fault
212	D4	Open Loop Fault
213	D5	Shorted Loop Fault
214	D6	Excessive Inductance Change
215	D7	Reserved
216	D8	Watchdog Fault
217	D9	Erratic Output Fault

13.1.5 Alarm 30 Pattern Error

Fault #	Fault Description
0	No Error
1	In diamond mode, sum of major phases (splits) adds to zero
2	In diamond mode, sum of splits did not equal cycle length
3	Sum of splits exceeded max cycle length (max length currently 999 in ATC/2070, 255 in 980/v65 or older)
4	Invalid split number called out in pattern
5	Ring 1 / 2 sum of splits not equal (when applicable)
6	Split time is shorter than sum of min time for a phase
7	Coordinated phases are not compatible
8	No coordinated phase assigned
9	More than one coord phase was designated for a single ring
10	Undefined
11	Fastway/Shortway transition time greater than 25% (out of range)
12	Undefined
13	Stop-time active
14	Manual-control active
15	Error in cycle length when calculating reference point (Cycle time is greater than calculated coord max cycle length)
16	In diamond mode, error in phase split value (typically phase 12)

14 Hardware I/O and Interfaces

14.1 TS2 and 2070(N) I/O Maps

14.1.1 A-Connector - TS2 (type-2) and 2070N

Note: Refer to the TS2 I/O Mode chart (section 14.1.4) to reference Inputs 1-24 and Outputs 1-24. These inputs and outputs may be reassigned using the *I/O Mode* setting under Unit Parameters (MM->1->2->1). Mode 0 is the default mode.

Pin	Function	I/O	Pin	Function	I/O
A	Fault Monitor	O	f	Det Ch 1	I
B	+24 VDC	O	g	Ped Det 1	I
C	Voltage Monitor	O	h	Input 1	I
D	Ch 1 Red	O	I	Force Off (1)	I
E	Ch 17 Red	O	J	External Recall (min)	I
F	Ch 2 Red	O	k	Man Control Enable	I
G	Ch 13 Red (ø 2 Don't Walk)	O	m	Call to Non-Actuated I	I
H	Ch 13 Yel (ø 2 Ped Clear)	O	n	Test A	I
J	Ch 13 Grn (ø 2 Walk)	O	p	AC Line	I
K	Det Ch 2	I	q	I/O Mode Bit A	I
L	Ped Det Ch 2	I	r	Status Bit B (1)	O
M	Input 2	I	s	Ch 1 Grn	O
N	Stop Time (1)	I	t	Ch 17 Grn (ø 1 Walk)	O
P	Inh Max (1)	I	u	Output 17	O
R	External Start	I	v	Input 18	I
S	Internal Advance	I	w	Omit Red Clr (1)	I
T	Ind. Lamp Control	I	x	Red Rest (1)	I
U	AC Neutral	I	y	I/O Mode Bit B	I
V	Earth Ground	I	z	Call to Non-Actuated II	I
W	Logic Ground	O	AA	Test B	I
X	Flashing Logic	O	BB	Walk Rest Modifier	I
Y	Status Bit C (1)	O	CC	Status Bit A	O
Z	Ch 1 Yel	O	DD	Output 1	O
a	Ch 17 Yel (ø 1 Ped Clear)	O	EE	Input 9	I
b	Ch 2 Yel	O	FF	Ped Recycle (1)	I
c	Ch 2 Grn	O	GG	Max II (1)	I
d	Output 18	O	HH	I/O Mode bit C	I
e	Output 2	O			

TS2 (type-2) and 2070N: A-Connector

14.1.2 B-Connector - TS2 (type-2) and 2070N

Note: Refer to the TS2 I/O Mode chart (section 14.1.4) to reference Inputs 1-24 and Outputs 1-24. These inputs and outputs may be reassigned using the *I/O Mode* setting under Unit Parameters (MM->1->2->1). Mode 0 is the default mode.

Pin	Function	I/O	Pin	Function	I/O
A	Output 9	O	f	Output 12	O
B	Preempt 2	I	g	Input 12	I
C	Output 10	O	h	Input 4	I
D	Ch 3 Grn	O	i	Input 3	I
E	Ch 3 Yel	O	j	Input 19	I
F	Ch 3 Red	O	k	Input 22	I
G	Ch 4 Red	O	m	Input 23	I
H	Ch 14 Yel (ø 4 Ped Clear)	O	n	Input 24	I
J	Ch 14 Red (ø 4 Don't Walk)	O	p	Ch 9 Yel (OL A)	O
K	Output 20	O	q	Ch 9 Red (OL A)	O
L	Det Ch 4	I	r	Output 19	O
M	Ped Det Ch 4	I	s	Output 3	O
N	Det Ch 3	I	t	Output 11	O
P	Ped Det Ch 3	I	u	Ch 12 Red (OL D)	O
R	Input 11	I	v	Preempt 6	I
S	Input 10	I	w	Ch 12 Grn (OL D)	O
T	Input 21	I	x	Input 20	I
U	Input 9	I	y	Free	I
V	Ped Recycle (Ring 2)	I	z	Max II select (Ring 2)	I
W	Preempt 4	I	AA	CH 9 Grn (OL A)	O
X	Preempt 5	I	BB	Ch 10 Yel (OL B)	O
Y	Ch 18 Grn (ø 3 Walk)	O	CC	Ch 10 Red (OL B)	O
Z	Ch 18 Yel (ø 3 Ped Clear)	O	DD	Ch 11 Red (OL C)	O
a	Ch 18 Red (ø 3 Don't Walk)	O	EE	Ch 12 Yel (OL D)	O
b	Ch 4 Grn	O	FF	Ch 11 Grn (OL C)	O
c	Ch 4 Yel	O	GG	Ch 10 Grn (OL B)	O
d	Ch 14 Grn (ø 4 Walk)	O	HH	Ch 11 Yel (OL C)	O
e	Output 4	O			

TS2 (type-2) and 2070N: B-Connector

14.1.3 C-Connector - TS2 (type-2) and 2070N

Note: Refer to the TS2 I/O Mode chart (section 14.1.4) to reference Inputs 1-24 and Outputs 1-24. These inputs and outputs may be reassigned using the *I/O Mode* setting under Unit Parameters (MM->1->2->1). Mode 0 is the default mode.

Pin	Function	I/O	Pin	Function	I/O
A	Status A Bit (2)	O	i	Ch 5 Grn	O
B	Status B Bit (2)	O	j	Ch 18 Grn (ø 5 Walk)	O
C	Ch 16 Red (ø8 Don't Walk)	O	k	Output 21	O
D	Ch 8 Red	O	m	Input 5	I
E	Ch 7 Yel	O	n	Input 13	I
F	Ch 7 Red	O	p	Input 6	I
G	Ch 6 Red	O	q	Input 14	I
H	Ch 5 Red	O	r	Input 15	I
J	Ch 5 Yel	O	s	Input 16	I
K	Ch 19 Yel (ø 5 Ped Clear)	O	t	Det Ch 8	I
L	Ch 19 Red (ø 5 Don't Walk)	O	u	Red Rest (2)	I
M	Output 13	O	v	Omit Red (2)	I
N	Output 5	O	w	Ch 16 Yel (ø 8 Ped Clear)	O
P	Det Ch 5	I	x	Ch 8 Grn	O
R	Ped Det Ch 5	I	y	Ch 20 Red (ø 7 Don't Walk)	O
S	Det Ch 6	I	z	Ch 15 Red (ø 6 Don't Walk)	O
T	Ped Det Ch 6	I	AA	Ch 15 Yel (ø 6 Ped Clear)	O
U	Ped Det Ch 7	I	BB	Output 22	O
V	Det Ch 7	I	CC	Output 6	O
W	Ped Det Ch 8	I	DD	Output 14	O
X	Input 8	I	EE	Input 7	I
Y	Force Off (2)	I	FF	Output 24	O
Z	Stop Time (2)	I	GG	Output 8	O
a	Inh Max (2)	I	HH	Output 16	O
b	Test C	I	JJ	Ch 20 Grn (ø 7 Walk)	O
c	Status C Bit (2)	O	KK	Ch 20 Yel (ø 7 Ped Clear)	O
d	Ch 16 Grn (ø 8 Walk)	O	LL	Ch 15 Grn (ø 6 Walk)	O
e	Ch 8 Yel	O	MM	Output 23	O
f	Ch 7 Grn	O	NN	Output 7	O
g	Ch 6 Grn	O	PP	Output 15	O
h	Ch 6 Yel	O			

TS2 (type-2) and 2070N: C-Connector

14.1.4 TS2 and 2070(N) - I/O Modes 0 – 3

Input	Mode 0	Mode 1	Mode 2	Mode 3
1	Ph1 Hold	Prmpt 1	Prmpt 1	Prmpt 1
2	Ph2 Hold	Prmpt 3	Prmpt 3	Prmpt 3
3	Ph3 Hold	Det Ch 9	Det Ch 9	
4	Ph4 Hold	Det Ch 10	Det Ch 10	
5	Ph5 Hold	Det Ch 13	Det Ch 13	
6	Ph6 Hold	Det Ch 14	Det Ch 14	
7	Ph7 Hold	Det Ch 15	Det Ch 15	
8	Ph8 Hold	Det Ch 16	Det Ch 16	
9	Ph1 Phase Omit	Det Ch 11	Det Ch 11	
10	Ph2 Phase Omit	Det Ch 12	Det Ch 12	
11	Ph3 Phase Omit	Timing Plan C	Det Ch 17	Timing Plan C
12	Ph4 Phase Omit	Timing Plan D	Det Ch 18	Timing Plan D
13	Ph5 Phase Omit	Alt Seq A	Det Ch 19	Alt Seq A
14	Ph6 Phase Omit	Alt Seq B	Det Ch 20	Alt Seq B
15	Ph7 Phase Omit	Alt Seq C	Alarm 1	Alt Seq C
16	Ph8 Phase Omit	Alt Seq D	Alarm 2	Alt Seq D
17	Ph1 Ped Omit	Dimming Enabled	Dimming Enabled	Dimming Enabled
18	Ph2 Ped Omit	Auto Flash	Local Flash Status	Auto Flash
19	Ph3 Ped Omit	Timing Plan A	Addr Bit 0	Timing Plan A
20	Ph4 Ped Omit	Timing Plan B	Addr Bit 1	Timing Plan B
21	Ph5 Ped Omit	Offset 1	Addr Bit 2	Offset 1
22	Ph6 Ped Omit	Offset 2	Addr Bit 3	Offset 2
23	Ph7 Ped Omit	Offset 3	Addr Bit 4	Offset 3
24	Ph8 Ped Omit	TBC On Line	MMU Flash Status	TBC On Line
Output	**Mode 0**	**Mode 1**	**Mode 2**	**Mode 3**
1	Ph1 On	Prmpt Stat 1	Prmpt Stat 1	
2	Ph2 On	Prmpt Stat 3	Prmpt Stat 3	
3	Ph3 On	TBC Aux 1	TBC Aux 1	TBC Aux 1
4	Ph4 On	TBC Aux 2	TBC Aux 2	TBC Aux 2
5	Ph5 On	Timing Plan A	Timing Plan A	Timing Plan A
6	Ph6 On	Timing Plan B	Timing Plan B	Timing Plan B
7	Ph7 On	Offset 1	Offset 1	Offset 1
8	Ph8 On	Offset 2	Offset 2	Offset 2
9	Ph1 Next	Prmpt Stat 2	Prmpt Stat 2	
10	Ph2 Next	Prmpt Stat 4	Prmpt Stat 4	
11	Ph3 Next	Prmpt Stat 5	Prmpt Stat 5	
12	Ph4 Next	Prmpt Stat 6	Prmpt Stat 6	
13	Ph5 Next	Offset 3	Offset 3	Offset 3
14	Ph6 Next	Timing Plan C	Timing Plan C	Timing Plan C
15	Ph7 Next	Timing Plan D	Timing Plan D	Timing Plan D
16	Ph8 Next	Reserved	Reserved	
17	Ph1 Check	Free/Coord	Free/Coord	
18	Ph2 Check	Auto Flash	Auto Flash	Auto Flash
19	Ph3 Check	TBC Aux 3	TBC Aux 3	
20	Ph4 Check	Reserved	Reserved	
21	Ph5 Check	Reserved	Spec Func 1	
22	Ph6 Check	Reserved	Spec Func 2	
23	Ph7 Check	Reserved	Spec Func 3	
24	Ph8 Check	Reserved	Spec Func 4	

TS2 and 2070(N) I/O Modes 0 – 3: Selected under Channel/IO Parameters (MM->1->3->3)

14.1.5 TS2 and 2070(N) - I/O Modes 4 – 7

Input	Mode 4	Mode 5	Mode 6	Mode 7
1	Reserved by NEMA	Reserved by NEMA		
2	Reserved by NEMA	Reserved by NEMA		
3	Reserved by NEMA	Reserved by NEMA		
4	Reserved by NEMA	Reserved by NEMA		
5	Reserved by NEMA	Reserved by NEMA		
6	Reserved by NEMA	Reserved by NEMA		
7	Reserved by NEMA	Reserved by NEMA		
8	Reserved by NEMA	Reserved by NEMA		
9	Reserved by NEMA	Reserved by NEMA		
10	Reserved by NEMA	Reserved by NEMA		
11	Reserved by NEMA	Reserved by NEMA		
12	Reserved by NEMA	Reserved by NEMA		
13	Reserved by NEMA	Reserved by NEMA		
14	Reserved by NEMA	Reserved by NEMA		
15	Reserved by NEMA	Reserved by NEMA		
16	Reserved by NEMA	Reserved by NEMA		
17	Reserved by NEMA	Reserved by NEMA		
18	Reserved by NEMA	Reserved by NEMA		
19	Reserved by NEMA	Reserved by NEMA		
20	Reserved by NEMA	Reserved by NEMA		
21	Reserved by NEMA	Reserved by NEMA		
22	Reserved by NEMA	Reserved by NEMA		
23	Reserved by NEMA	Reserved by NEMA		
24	Reserved by NEMA	Reserved by NEMA		
Output	**Mode 4**	**Mode 5**	**Mode 6**	**Mode 7**
1	Reserved by NEMA	Reserved by NEMA		
2	Reserved by NEMA	Reserved by NEMA		
3	Reserved by NEMA	Reserved by NEMA		
4	Reserved by NEMA	Reserved by NEMA		
5	Reserved by NEMA	Reserved by NEMA		
6	Reserved by NEMA	Reserved by NEMA		
7	Reserved by NEMA	Reserved by NEMA		
8	Reserved by NEMA	Reserved by NEMA		
9	Reserved by NEMA	Reserved by NEMA		
10	Reserved by NEMA	Reserved by NEMA		
11	Reserved by NEMA	Reserved by NEMA		
12	Reserved by NEMA	Reserved by NEMA		
13	Reserved by NEMA	Reserved by NEMA		
14	Reserved by NEMA	Reserved by NEMA		
15	Reserved by NEMA	Reserved by NEMA		
16	Reserved by NEMA	Reserved by NEMA		
17	Reserved by NEMA	Reserved by NEMA		
18	Reserved by NEMA	Reserved by NEMA		
19	Reserved by NEMA	Reserved by NEMA		
20	Reserved by NEMA	Reserved by NEMA		
21	Reserved by NEMA	Reserved by NEMA		
22	Reserved by NEMA	Reserved by NEMA		
23	Reserved by NEMA	Reserved by NEMA		
24	Reserved by NEMA	Reserved by NEMA		

14.1.6 TS2 D-Connector - DIAMOND Mapping

Pin	Function	I/O		Pin	Function	I/O
10	Special Function 2	O		9	System Detector 6	I
14	Special Function 6	O		11	Free	I
22	Special Function 5	O		12	Not Assigned	I
23	Ext. Coord Active	O		13	Not Assigned	I
24	Flash Active	O		14	Not Assigned	I
35	Offset 1	O		15	Reserved	I
39*	I/O Spare	O		16	Reserved	I
42	Not Assigned	O		17	N/A	I
43	Special Function 1	O		18	Reserved	I
44	Split 3, Preempt 2	O		19	Preempt 1	I
45	Split 2, Preempt 1	O		20	Preempt 2	I
46	Offset 4, Preempt 5	O		21	Preempt 3	I
47	Offset 3, Preempt 6	O		22	Preempt 4	I
48	Offset 2	O		23	Preempt 5	I
49	Flash	O		24	Preempt 6	I
50	Cycle 3, Preempt 4	O		25	Detector 45P	I
51	Cycle 2, Preempt 3	O		26	Detector 25S	I
52	Offset 1	O		27	Detector 18P	I
53	+24 VDC	O		28	Detector 16S	I
54	Logic Ground	O		29	Det. Cir. 2b/1P	I
55	Chassis Ground	O		30	Det. Cir. 2a	I
56	Not Assigned	O		31	Det. Cir. 1b/5P	I
57	Not Assigned	O		32	Det. Cir. 1a	I
				33	External Alarm 1	I
1	System Detector 2	I		34	External Alarm 2	I
2	System Detector 7	I		35	Not Assigned	I
3	System Detector 8	I		36	Not Assigned	I
4	Flash	I		37	Not Assigned	I
5	System Detector 3	I		38	Not Assigned	I
6	System Detector 4	I		39	External Alarm 3	I
7	System Detector 1	I		40	External Alarm 4	I

TS2 D-Connector DIAMOND Mapping (provided under MM->1->3->3)

14.1.7 TS2 D-Connector - Texas 2, V14 (TX2-V14) Standard Mapping

Pin	Function	I/O		Pin	Function	I/O
10	Prmpt Active	O		6	Offset 3	I
14	Special Function 6	O		7	Flash In	I
22	Special Function 5	O		8	Prmpt 5	I
23	Ext. Coord Active	O		9	Prmpt 3	I
24	Flash Active	O		11	Split 2	I
35	Offset 1	O		12	Cycle 3	I
39*	I/O Spare	O		13	Offset 1	I
40	Special Function 8	O		15	Prmpt 2	I
41	Special Function 7	O		16	Prmpt 1	I
42	Offset 2	O		17	Veh16	I
43	Offset 3 / Preempt 6	O		18	Alarm1	I
44	Split 3 / Preempt 2	O		19	Split 3	I
45	Special Function 1	O		20	Offset 4	I
46	Special Function 3	O		21	Veh15	I
47	Special Function 4/Pulse	O		25	Veh14	I
48	Spare			26	Alarm 3	I
49	Offset 4 / Preempt 5	O		27	Alarm 4	I
50	Split 2 / Preempt 1	O		28	Dimming/Alarm 5	I
51	Cycle 3 / Preempt 4	O		29	Alarm 2	I
52	Special Function 2	O		30	Veh13	I
53	+24 VDC	O		31	Veh10	I
54	Logic Ground	O		32	Veh11	I
55	Chassis Ground	O		33	Veh12	I
56	Cycle 2 / Preempt 3	O		34	Prmpt 6	I
1	Offset 2	I		36	Alarm 6	I
2	Free	I		37	Enable Prmpt	I
3	System/TOD Resync	I		38*	Spare	I
4	Prmpt 4	I		39*	Spare	I
5	Cycle 2	I		57	Veh9	I

TS2 D-Connector TX-2 V14 Mapping (provided under MM->1->3->3)

14.1.8 TS2 D-Connector - Texas 2, V14 (TX2-V14) Alternate 820A Mapping

The 820A function is enabled by a new selection ("820A") of the Prmpt/ExtCoor Output parameter, which is on the Channel and I/0 Parameters entry screen. When 820A is selected, the new Preempt interval status for intervals 1-7 is output on pins 14, 22, 35, 39-42, and 48. Also, the standard Preempt Status for Preempts 1-6 is output on pins 43, 44, 49-51, and 56 is output.

Pin	Function	I/O		Pin	Function	I/O
10	Prmpt Active	O		6	Offset 3	I
14	Spec Func 6 / Prmpt Interval 1	O		7	Flash In	I
22	Spec Func 5 / Prmpt Interval 2	O		8	Prmpt 5	I
23	Ext. Coord Active	O		9	Prmpt 3	I
24	Flash Active	O		11	Split 2	I
35	Offset 1 / Prmpt Interval 3	O		12	Cycle 3	I
39*	I/O Spare / Prmpt Interval 4	O		13	Offset 1	I
40	Spec Func 8 / Prmpt Interval 5	O		15	Prmpt 2	I
41	Spec Func 7 / Prmpt Interval 6	O		16	Prmpt 1	I
42	Offset 2 / Prmpt Interval 7	O		17	Veh16	I
43	Offset 3 / Preempt Status 6	O		18	Alarm1	I
44	Split 3 / Preempt Status 2	O		19	Split 3	I
45	Special Function 1	O		20	Offset 4	I
46	Special Function 3	O		21	Veh15	I
47	Special Function 4/Pulse	O		25	Veh14	I
48	UCF Soft Flash			26	Alarm 3	I
49	Offset 4 / Preempt Status 5	O		27	Alarm 4	I
50	Split 2 / Preempt Status 1	O		28	Dimming/Alarm 5	I
51	Cycle 3 / Preempt Status 4	O		29	Alarm 2	I
52	Special Function 2	O		30	Veh13	I
53	+24 VDC	O		31	Veh10	I
54	Logic Ground	O		32	Veh11	I
55	Chassis Ground	O		33	Veh12	I
56	Cycle 2 / Preempt Status 3	O		34	Prmpt 6	I
1	Offset 2	I		36	Alarm 6	I
2	Free	I		37	Enable Prmpt	I
3	System/TOD Resync	I		38*	Spare	I
4	Prmpt 4	I		39*	Spare	I
5	Cycle 2	I		57	Veh9	I

TS2 D-Connector TX-2 V14 Alternate 820A Mapping (provided under MM->1->3->3)

14.1.9 TS2 D-Connector – 40 Detector Mapping

10	Special Function 5	O	Pin	Function	I/O
10	Special Function 5	O	6	Veh Det 19	I
14	Veh Det 39	I	7	Veh Det 32	I
22	Veh Det 40	I	8	Preempt In 5	I
23	Veh Det 29	I	9	Preempt In 3	I
24	Veh Det 28	I	11	Veh Det 23	I
35	Special Function 6	O	12	Veh Det 22	I
39	Spare	O	13	Veh Det 17	I
40	Veh Det 37	I	15	Veh Det 30	I
41	Veh Det 38	I	16	Preempt In 1	I
42	Special Function 7	O	17	Veh Det 16	I
43	Preempt 6 Out	O	18	alarm 1	I
44	Special Function 8	O	19	Veh Det 24	I
45	Spec Func 1	O	20	Veh Det 20	I
46	Special Function 3	O	21	Veh Det 15	I
47	Special Function 4	O	25	Veh Det 14	I
48	Aux Out 1	O	26	Veh Det 25	I
49	Preempt 5 Out	O	27	Veh Det 26	I
50	Preempt 1 Out	O	28	Veh Det 27	I
51	Preempt 4 Out	O	29	Alarm 2	I
52	Special Function 2	O	30	Veh Det 13	I
53	+24 VDC	O	31	Veh Det 10	I
54	Logic Ground	O	32	Veh Det 11	I
55	Chassis Ground	O	33	Veh Det 12	I
56	Preempt 3 Out	O	34	Preempt In 6	I
1	Veh Det 18	I	36	Veh Det 33	I
2	Free Input	I	37	Veh Det 34	I
3	Veh Det 31	I	38	Veh Det 35	I
4	Preempt In 4	I	39	Veh Det 36	I
5	Veh Det 21	I	57	Veh Det 9	I

TS2 D-Connector 40 Detector Mapping (provided under MM->1->3->3)

14.1.10 TS2 D-Connector – Santa Clara County (SCC) Mapping

Pin	Function	I/O		Pin	Function	I/O
10	Special Function 7	O		6	Platoon Rx 3	I
14	Special Function 2	O		7	Spare 1	I
22	Special Function 1	O		8	Preempt 6 In	I
23	Veh Det 24/ Bike 8	I		9	Preempt 4 In	I
24	Veh Det 23 / Bike 7/ Alarm 8 (User Alarm 4)	I		11	Low Priority Preempt Inhibit 3	I
35	Offset 4 Out / Preempt 5 Out	O		12	Low Priority Preempt Inhibit 2	I
39	Spare	O		13	Platoon Rx 1	I
40	Special Function 4	O		15	Preempt 3 In	I
41	Special Function 3	O		16	Preempt 1 In	I
42	Offset 3 Out / Preempt 6 Out	O		17	Veh Det 16	I
43	Offset 2 Out	O		18	Veh Det 17 / Bike 1 / Alarm 5 (User Alarm 1)	I
44	Split 2 Out / Preempt 1 Out	O		19	Low Priority Preempt Inhibit 4	I
45	Spare 2	O		20	Platoon Rx 4	I
46	Spare 4	O		21	Veh Det 15	I
47	Spare 5	O		25	Veh Det 14	I
48	Special Function 8	O		26	Veh Det 19 / Bike 3 / Alarm 6 (User Alarm 2)	I
49	Offset 1 Out	O		27	Veh Det 20 / Bike 4	I
50	Split 3 Out / Preempt 2 Out	O		28	Veh Det 22 / Bike 6	I
51	Cycle 2 Out / Preempt 3 Out	O		29	Veh Det 18 / Bike 2	I
52	Spare 3	O		30	Veh Det 13	I
53	+24 VDC	O		31	Veh Det 10	I
54	Logic Ground	O		32	Veh Det 11	I
55	Chassis Ground	O		33	Veh Det 12	I
56	Cycle 3 Out / Preempt 4 Out	O		34	Veh Det 21 / Bike 5 / Alarm 7 (User Alarm 3)	I
1	Platoon Rx 2	I		36	Special Function 5	O
2	Local Flash In	I		37	Special Function 6	O
3	Free Input	I		38	Det Fail / Alarm 10 (User Alarm 5)	I
4	Preempt 5 In	I		39	Alarm 11 (User Alarm 6)	I
5	Low Priority Preempt Inhibit 1	I		57	Veh Det 9	I

TS2 D-Connector SCC Mapping (provided under MM->1->3->3)

14.2 970 C1 Hardware

The 970 controller hardware is based on the Model 170 hardware. As such it uses a C1 type connector to interface with field inputs and outputs. Please refer to the wiring assignment from the Caltrans Specification as shown in the tables below:

C1S PIN ASSIGNMENT

PIN	FUNCTION		PIN	FUNCTION		PIN	FUNCTION		PIN	FUNCTION	
	NAME	PORT		NAME	PORT		NAME	PORT		NAME	PORT
1	DC GROUND		27	O24	O4-1	53	I14	I2-7	79	I44	I6-5
2	O0	O1-1	28	O25	O4-2	54	I15	I2-8	80	I45	I6-6
3	O1	O1-2	29	O26	O4-3	55	I16	I3-1	81	I46	I6-7
4	O2	O1-3	30	O27	O4-4	56	I17	I3-2	82	I47	I6-8
5	O3	O1-4	31	O28	O4-5	57	I18	I3-3	83	O40	O6-1
6	O4	O1-5	32	O29	O4-6	58	I19	I3-4	84	O41	O6-2
7	O5	O1-6	33	O30	O4-7	59	I20	I3-5	85	O42	O6-3
8	O6	O1-7	34	O31	O4-8	60	I21	I3-6	86	O43	O6-4
9	O7	O1-8	35	O32	O5-1	61	I22	I3-7	87	O44	O6-5
10	O8	O2-1	36	O33	O5-2	62	I23	I3-8	88	O45	O6-6
11	O9	O2-2	37	O34	O5-3	63	I28	I4-5	89	O46	O6-7
12	O10	O2-3	38	O35	O5-4	64	I29	I4-6	90	O47	O6-8
13	O11	O2-4	39	I0	I1-1	65	I30	I4-7	91	O48	O7-1
14	DC GROUND		40	I1	I1-2	66	I31	I4-8	92	DC GROUND	
15	O12	O2-5	41	I2	I1-3	67	I32	I5-1	93	O49	O7-2
16	O13	O2-6	42	I3	I1-4	68	I33	I5-2	94	O50	O7-3
17	O14	O2-7	43	I4	I1-5	69	I34	I5-3	95	O51	O7-4
18	O15	O2-8	44	I5	I1-6	70	I35	I5-4	96	O52	O7-5
19	O16	O3-1	45	I6	I1-7	71	I36	I5-5	97	O53	O7-6
20	O17	O3-2	46	I7	I1-8	72	I37	I5-6	98	O54	O7-7
21	O18	O3-3	47	I8	I2-1	73	I38	I5-7	99	O55	O7-8
22	O19	O3-4	48	I9	I2-2	74	I39	I5-8	100	O36	O5-5
23	O20	O3-5	49	I10	I2-3	75	I40	I6-1	101	O37	O5-6
24	O21	O3-6	50	I11	I2-4	76	I41	I6-2	102	O38 DET RES	O5-7
25	O22	O3-7	51	I12	I2-5	77	I42	I6-3	103	O39 WDT	O5-8
26	O23	O3-8	52	I13	I2-6	78	I43	I6-4	104	DC GROUND	

C11S PIN ASSIGNMENT

PIN	FUNCTION		PIN	FUNCTION		PIN	FUNCTION		PIN	FUNCTION	
	NAME	PORT		NAME	PORT		NAME	PORT		NAME	PORT
1	O56	O8-1	11	I25	I4-2	21	I54	I7-7	31	DC GROUND	
2	O57	O8-2	12	I26	I4-3	22	I55	I7-8	32	NA	- - -
3	O58	O8-3	13	I27	I4-4	23	I56	I8-1	33	NA	- - -
4	O59	O8-4	14	DC GROUND		24	I57	I8-2	34	NA	- - -
5	O60	O8-5	15	I48	I7-1	25	I58	I8-3	35	NA	- - -
6	O61	O8-6	16	I49	I7-2	26	I59	I8-4	36	NA	- - -
7	O62	O8-7	17	I50	I7-3	27	I60	I8-5	37	DC GROUND	
8	O63	O8-8	18	I51	I7-4	28	I61	I8-6			
9	DC GROUND		19	I52	I7-5	29	I62	I8-7			
10	I24	I4-1	20	I53	I7-6	30	I63	I8-8			

14.3 Model 970 (C1 Connector) Mapping

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
2	O1-1	14	Ch14 Red		39	I1-1	2	Veh Call 2
3	O1-2	62	Ch14 Green		40	I1-2	16	Veh Call 16
4	O1-3	4	Ch4 Red		41	I1-3	8	Veh Call 8
5	O1-4	28	Ch4 Yellow		42	I1-4	22	Veh Call 22
6	O1-5	52	Ch4 Green		43	I1-5	3	Veh Call 3
7	O1-6	3	Ch3 Red		44	I1-6	17	Veh Call 17
8	O1-7	27	Ch3 Yellow		45	I1-7	9	Veh Call 9
9	O1-8	51	Ch3 Green		46	I1-8	23	Veh Call 23
10	O2-1	13	Ch13 Red		47	I2-1	6	Veh Call 6
11	O2-2	61	Ch13 Green		48	I2-2	20	Veh Call 20
12	O2-3	2	Ch2 Red		49	I2-3	12	Veh Call 12
13	O2-4	26	Ch2 Yellow		50	I2-4	26	Veh Call 26
15	O2-5	50	Ch2 Green		51	I2-5	198	Pre 1 In
16	O2-6	1	Ch1 Red		52	I2-6	199	Pre 2 In
17	O2-7	25	Ch1 Yellow		53	I2-7	189	Manual Ctrl Enable
18	O2-8	49	Ch1 Green		54	I2-8	189	Unused
19	O3-1	16	Ch16 Red		55	I3-1	15	Veh Call 15
20	O3-2	64	Ch16 Green		56	I3-2	1	Veh Call 1
21	O3-3	8	Ch8 Red		57	I3-3	21	Veh Call 21
22	O3-4	32	Ch8 Yellow		58	I3-4	7	Veh Call 7
23	O3-5	56	Ch8 Green		59	I3-5	27	Veh Call 27
24	O3-6	7	Ch7 Red		60	I3-6	13	Veh Call 13
25	O3-7	31	Ch7 Yellow		61	I3-7	28	Veh Call 28
26	O3-8	55	Ch7 Green		62	I3-8	14	Veh Call 14
27	O4-1	15	Ch15 Red			I4-1	189	Unused
28	O4-2	63	Ch15 Green			I4-2	189	Unused
29	O4-3	6	Ch6 Red			I4-3	189	Unused
30	O4-4	30	Ch6 Yellow			I4-4	189	Unused
31	O4-5	54	Ch6 Green		63	I4-5	4	Veh Call 4
32	O4-6	5	Ch5 Red		64	I4-6	18	Veh Call 18
33	O4-7	29	Ch5 Yellow		65	I4-7	10	Veh Call 10
34	O4-8	53	Ch5 Green		66	I4-8	24	Veh Call 24

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	37	Ch13 Yellow		67	I5-1	130	Ped Call 2
36	O5-2	39	Ch15 Yellow		68	I5-2	134	Ped Call 6
37	O5-3	38	Ch14 Yellow		69	I5-3	132	Ped Call 4
38	O5-4	40	Ch16 Yellow		70	I5-4	136	Ped Call 8
100	O5-5	42	Ch18 Yellow		71	I5-5	200	Pre 3 In
101	O5-6	35	Ch11 Yellow		72	I5-6	201	Pre 4 In
102	O5-7	115	Not Used		73	I5-7	202	Pre 5 In
103	O5-8	114	Watchdog		74	I5-8	203	Pre 6 In
83	O6-1	14	Ch18 Red		75	I6-1	189	Unused
84	O6-2	62	Ch18 Green		76	I6-2	5	Veh Call 5
85	O6-3	17	Ch17 Red		77	I6-3	19	Veh Call 19
86	O6-4	41	Ch17 Yellow		78	I6-4	11	Veh Call 11
87	O6-5	65	Ch17 Green		79	I6-5	25	Veh Call 25
88	O6-6	12	Ch12 Red		80	I6-6	178	Int Advance
89	O6-7	36	Ch12 Yellow		81	I6-7	208	Local Flash
90	O6-8	60	Ch12 Green		82	I6-8	207	Comp StopTm
91	O7-1	11	Ch11 Red			I7-1	189	Unused
93	O7-2	59	Ch11 Green			I7-2	189	Unused
94	O7-3	10	Ch10 Red			I7-3	189	Unused
95	O7-4	34	Ch10 Yellow			I7-4	189	Unused
96	O7-5	58	Ch10 Green			I7-5	189	Unused
97	O7-6	9	Ch9 Red			I7-6	189	Unused
98	O7-7	33	Ch9 Yellow			I7-7	189	Unused
99	O7-8	57	Ch9 Green			I7-8	189	Unused
	O8-1	115	Unused			I8-1	189	Unused
	O8-2	115	Unused			I8-2	189	Unused
	O8-3	115	Unused			I8-3	189	Unused
	O8-4	115	Unused			I8-4	189	Unused
	O8-5	115	Unused			I8-5	189	Unused
	O8-6	115	Unused			I8-6	189	Unused
	O8-7	115	Unused			I8-7	189	Unused
	O8-8	115	Unused			I8-8	189	Unused

970 C1 Connector Mapping

14.4 Terminal & Facilities BIU Mapping

14.4.1 Default BIU Input Map (MM->1->3->3)

BIU #1

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	189	Unused
B11	189	Unused	B12	189	Unused
B13	189	Unused	B14	198	Pre1In
B15	199	Pre 2 In	B16	185	Test A
B17	186	Test B	B18	211	Auto Flash
B19	210	Dim Enable	B20	181	Man Ctrl Enbl
B21	178	Int Advance	B22	180	Min Recall
B23	177	Ext Start	B24	209	TBC Input
I01	162	R1 Stop Tim	I02	170	R2 Stop Tim
I03	166	R1 Max II	I04	174	R2 Max II
I05	161	R1 Frc Off	I06	169	R2 Frc Off
I07	168	Non-Act	I	I08	188
Op1	129	Ped Call 1	Op2	130	Ped Call 2
Op3	131	Ped Call 3	Op4	132	Ped Call 4
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #2

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	189	Unused
B11	189	Unused	B12	189	Unused
B13	189	Unused	B14	189	Unused
B15	189	Unused	B16	200	Pre3 In
B17	201	Pre 4 In	B18	202	Pre5 In
B19	203	Pre 6 In	B20	176	Non-Act II
B21	189	Unused	B22	189	Unused
B23	189	Unused	B24	189	Unused
I01	163	R1 Inh Max	I02	171	R2 Inh Max
I03	208	Local Flash	I04	206	Cab Flash
I05	192	Alarm 1	I06	193	Alarm 2
I07	190	Free	I08	187	Test C
Op1	133	Ped Call 5	Op2	134	Ped Call 6
Op3	135	Ped Call 7	Op4	136	Ped Call 8
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #3

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	164	R1RedRest	B08	172	R2RedRest
B09	167	R1OmtRdClr	B10	175	R2OmtRdClr
B11	165	R1PedRecyc	B12	173	R2PedRecyc
B13	212	AltSeqA	B14	213	AltSeqB
B15	214	AltSeqC	B16	215	AltSeqD
B17	153	PhOmit1	B18	154	PhOmit2
B19	155	PhOmit3	B20	156	PhOmit4
B21	157	PhOmit5	B22	158	PhOmit6
B23	159	PhOmit7	B24	160	PhOmit8
I01	137	Hold1	I02	138	Hold2
I03	139	Hold3	I04	140	Hold4
I05	141	Hold5	I06	142	Hold6
I07	143	Hold7	I08	144	Hold8
Op1	216	PlanA	Op2	217	PlanB
Op3	218	PlanC	Op4	219	PlanD
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #4

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	220	Addr Bit 0
B11	221	Addr Bit 1	B12	222	Addr Bit 2
B13	223	Addr Bit 3	B14	224	Addr Bit 4
B15	189	Unused	B16	189	Unused
B17	189	Unused	B18	189	Unused
B19	189	Unused	B20	189	Unused
B21	189	Unused	B22	189	Unused
B23	189	Unused	B24	189	Unused
I01	145	Ped Omit 1	I02	146	Ped Omit 2
I03	147	Ped Omit 3	I04	148	Ped Omit 4
I05	149	Ped Omit 5	I06	150	Ped Omit 6
I07	151	Ped Omit 7	I08	152	Ped Omit 8
Op1	225	Offset 1	Op2	226	Offset 2
Op3	227	Offset 3	Op4	189	Unused
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

14.4.2 Default BIU Output Map (MM->1->3->3)

BIU #1

Pin	Fcn	Description	Pin	Fcn	Description
O01	1	Ch1 Red	O02	25	Ch1 Yellow
O03	49	Ch1 Green	O04	2	Ch2 Red
O05	26	Ch2 Yellow	O06	50	Ch2 Green
O07	3	Ch3 Red	O08	27	Ch3 Yellow
O09	51	Ch3 Green	O10	4	Ch4 Red
O11	28	Ch4 Yellow	O12	52	Ch4 Green
O13	5	Ch5 Red	O14	29	Ch5 Yellow
O15	53	Ch5 Green	B01	6	Ch6 Red
B02	30	Ch6 Yellow	B03	54	Ch6 Green
B04	7	Ch7 Red	B05	31	Ch7 Yellow
B06	55	Ch7 Green	B07	8	Ch8 Red
B08	32	Ch8 Yellow	B09	56	Ch8 Green
B10	122	TB CAux/Pre1	B11	123	TBC Aux/Pre2
B12	116	Pre Stat 1	B13	117	Pre Stat 2
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #2

Pin	Fcn	Description	Pin	Fcn	Description
O01	9	Ch9 Red	O02	33	Ch9 Yellow
O03	57	Ch9 Green	O04	10	Ch10 Red
O05	34	Ch10 Yellow	O06	58	Ch10 Green
O07	11	Ch11 Red	O08	35	Ch11 Yellow
O09	59	Ch11 Green	O10	12	Ch12 Red
O11	36	Ch12 Yellow	O12	60	Ch12 Green
O13	13	Ch13 Red	O14	37	Ch13 Yellow
O15	61	Ch13 Green	B01	14	Ch14 Red
B02	38	Ch14 Yellow	B03	62	Ch14 Green
B04	15	Ch15 Red	B05	39	Ch15 Yellow
B06	63	Ch15 Green	B07	16	Ch16 Red
B08	40	Ch16 Yellow	B09	64	Ch16 Green
B10	127	TBC Aux 3	B11	128	Free/Coord
B12	118	Pre Stat 3	B13	119	Pre Stat 4
B14	120	Pre Stat 5	B15	121	Pre Stat 6
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #3

Pin	Fcn	Description	Pin	Fcn	Description
O01	129	Time plan A	O02	130	Time plan B
O03	131	Time plan C	O04	132	Time plan D
O05	133	Offset Out 1	O06	134	Offset Out 2
O07	135	Offset Out 3	O08	136	Auto Flash
O09	103	Special 1	O10	104	Special 2
O11	105	Special 3	O12	106	Special 4
O13	115	Not Used	O14	115	Not Used
O15	115	Not Used	B01	115	Not Used
B02	97	R1 Status A	B03	98	R1 Status B
B04	99	R1 Status C	B05	100	R2 Status A
B06	101	R2 Status B	B07	102	R2 Status C
B08	115	Not Used	B09	115	Not Used
B10	115	Not Used	B11	115	Not Used
B12	115	Not Used	B13	115	Not Used
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #4

Pin	Fcn	Description	Pin	Fcn	Description
O01	89	Phase 1 On	O02	90	Phase 2 On
O03	91	Phase 3 On	O04	92	Phase 4 On
O05	93	Phase 5 On	O06	94	Phase 6 On
O07	95	Phase 7 On	O08	96	Phase 8 On
O09	81	Ph1 Next	O10	82	Ph2 Next
O11	83	Ph3 Next	O12	84	Ph4 Next
O13	85	Ph5 Next	O14	86	Ph6 Next
O15	87	Ph7 Next	B01	115	Not Used
B02	88	Ph8 Next	B03	73	Ph1 Check
B04	74	Ph2 Check	B05	75	Ph3 Check
B06	76	Ph4 Check	B07	77	Ph5 Check
B08	78	Ph6 Check	B09	79	Ph7 Check
B10	80	Ph8 Check	B11	115	Not Used
B12	115	Not Used	B13	115	Not Used
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

14.4.3 Solo TF BIU1 Input Map

BIU #1

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	189	Unused
B11	189	Unused	B12	189	Unused
B13	189	Unused	B14	198	Pre 1 In
B15	199	Pre2 In	B16	206	Cab Flash
B17	191	Flash In	B18	211	Auto Flash
B19	210	Dim Enable	B20	181	Man Ctrl Enbl
B21	178	Int Advance	B22	190	Free
B23	177	Ext Start	B24	209	TBC Input
I01	162	R1 Stop Tim	I02	170	R2 Stop Tim
I03	192	Alarm1	I04	193	Alarm 2
I05	194	Alarm3	I06	195	Alarm 4
I07	168	Non Act 1	I08	188	Wlk Rst Mod
Op1	129	Ped Call 1	Op2	130	Ped Call 2
Op3	131	Ped Call 3	Op4	132	Ped Call 4
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #2

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	189	Unused
B11	189	Unused	B12	189	Unused
B13	189	Unused	B14	189	Unused
B15	189	Unused	B16	200	Pre 3 In
B17	201	Pre 4 In	B18	202	Pre 5 In
B19	203	Pre 6 In	B20	176	Non-Act II
B21	189	Unused	B22	189	Unused
B23	189	Unused	B24	189	Unused
I01	163	R1 Inh Max	I02	171	R2 Inh Max
I03	208	Local Flash	I04	206	Cab Flash
I05	192	Alarm 1	I06	193	Alarm 2
I07	190	Free	I08	187	Test C
Op1	133	Ped Call 5	Op2	134	Ped Call 6
Op3	135	Ped Call 7	Op4	136	Ped Call 8
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #3

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	164	R1 Red Rest	B08	172	R2 Red Rest
B09	167	R1 Omt Rd Clr	B10	175	R2 Omt Rd Clr
B11	165	R1 Ped Recyc	B12	173	R2 Ped Recyc
B13	212	Alt Seq A	B14	213	Alt Seq B
B15	214	Alt Seq C	B16	215	Alt Seq D
B17	153	Ph Omit 1	B18	154	Ph Omit 2
B19	155	Ph Omit 3	B20	156	Ph Omit 4
B21	157	Ph Omit 5	B22	158	Ph Omit 6
B23	159	Ph Omit 7	B24	160	Ph Omit 8
I01	137	Hold 1	I02	138	Hold 2
I03	139	Hold 3	I04	140	Hold 4
I05	141	Hold 5	I06	142	Hold 6
I07	143	Hold 7	I08	144	Hold 8
Op1	216	Plan A	Op2	217	PlanB
Op3	218	Plan C	Op4	219	PlanD
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

BIU #4

Pin	Fcn	Description	Pin	Fcn	Description
B01	189	Unused	B02	189	Unused
B03	189	Unused	B04	189	Unused
B05	189	Unused	B06	189	Unused
B07	189	Unused	B08	189	Unused
B09	189	Unused	B10	220	Addr Bit 0
B11	221	Addr Bit 1	B12	222	Addr Bit 2
B13	223	Addr Bit 3	B14	224	Addr Bit 4
B15	189	Unused	B16	189	Unused
B17	189	Unused	B18	189	Unused
B19	189	Unused	B20	189	Unused
B21	189	Unused	B22	189	Unused
B23	189	Unused	B24	189	Unused
I01	145	Ped Omit 1	I02	146	Ped Omit 2
I03	147	Ped Omit 3	I04	148	Ped Omit 4
I05	149	Ped Omit 5	I06	150	Ped Omit 6
I07	151	Ped Omit 7	I08	152	Ped Omit 8
Op1	225	Offset 1	Op2	226	Offset 2
Op3	227	Offset 3	Op4	189	Unused
***	189	Unused	***	189	Unused
***	189	Unused	***	189	Unused

14.4.4 24 Out Chan Output Map (output map same as Default output map)

BIU #1

Pin	Fcn	Description	Pin	Fcn	Description
O01	1	Ch1 Red	O02	25	Ch1 Yellow
O03	49	Ch1 Green	O04	2	Ch2 Red
O05	26	Ch2 Yellow	O06	50	Ch2 Green
O07	3	Ch3 Red	O08	27	Ch3 Yellow
O09	51	Ch3 Green	O10	4	Ch4 Red
O11	28	Ch4 Yellow	O12	52	Ch4 Green
O13	5	Ch5 Red	O14	29	Ch5 Yellow
O15	53	Ch5 Green	B01	6	Ch6 Red
B02	30	Ch6 Yellow	B03	54	Ch6 Green
B04	7	Ch7 Red	B05	31	Ch7 Yellow
B06	55	Ch7 Green	B07	8	Ch8 Red
B08	32	Ch8 Yellow	B09	56	Ch8 Green
B10	122	TBC Aux/Pre1	B11	123	TBC Aux/Pre2
B12	116	Pre Stat 1	B13	117	Pre Stat 2
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #2

Pin	Fcn	Description	Pin	Fcn	Description
O01	9	Ch9 Red	O02	33	Ch9 Yellow
O03	57	Ch9 Green	O04	10	Ch10 Red
O05	34	Ch10 Yellow	O06	58	Ch10 Green
O07	11	Ch11 Red	O08	35	Ch11 Yellow
O09	59	Ch11 Green	O10	12	Ch12 Red
O11	36	Ch12 Yellow	O12	60	Ch12 Green
O13	13	Ch13 Red	O14	37	Ch13 Yellow
O15	61	Ch13 Green	B01	14	Ch14 Red
B02	38	Ch14 Yellow	B03	62	Ch14 Green
B04	15	Ch15 Red	B05	39	Ch15 Yellow
B06	63	Ch15 Green	B07	16	Ch16 Red
B08	40	Ch16 Yellow	B09	64	Ch16 Green
B10	127	TBC Aux 3	B11	128	Free/Coord
B12	118	Pre Stat 3	B13	119	Pre Stat 4
B14	120	Pre Stat 5	B15	121	Pre Stat 6
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #3

Pin	Fcn	Description	Pin	Fcn	Description
O01	129	Time plan A	O02	130	Time plan B
O03	131	Time plan C	O04	132	Time plan D
O05	133	Offset Out 1	O06	134	Offset Out 2
O07	135	Offset Out 3	O08	136	Auto Flash
O09	103	Special 1	O10	104	Special 2
O11	105	Special 3	O12	106	Special 4
O13	115	Not Used	O14	115	Not Used
O15	115	Not Used	B01	115	Not Used
B02	97	R1 Status A	B03	98	R1 Status B
B04	99	R1 Status C	B05	100	R2 Status A
B06	101	R2 Status B	B07	102	R2 Status C
B08	115	Not Used	B09	115	Not Used
B10	115	Not Used	B11	115	Not Used
B12	115	Not Used	B13	115	Not Used
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

BIU #4

Pin	Fcn	Description	Pin	Fcn	Description
O01	17	Ch17 Red	O02	41	Ch17 Yellow
O03	65	Ch17 Green	O04	18	Ch18 Red
O05	42	Ch18 Yellow	O06	66	Ch18 Green
O07	19	Ch19 Red	O08	43	Ch19 Yellow
O09	67	Ch19 Green	O10	20	Ch20 Red
O11	44	Ch20 Yellow	O12	68	Ch20 Green
O13	21	Ch21 Red	O14	45	Ch21 Yellow
O15	69	Ch21 Green	B01	115	Not Used
B02	22	Ch22 Red	B03	46	Ch22 Yellow
B04	70	Ch22 Green	B05	23	Ch23 Red
B06	47	Ch23 Yellow	B07	71	Ch23 Green
B08	24	Ch24 Red	B09	48	Ch24 Yellow
B10	72	Ch24 Green	B11	115	Not Used
B12	115	Not Used	B13	115	Not Used
B14	115	Not Used	B15	115	Not Used
B16	115	Not Used	B17	115	Not Used
B18	115	Not Used	B19	115	Not Used
B20	115	Not Used	B21	115	Not Used
B22	115	Not Used	B23	115	Not Used
B24	115	Not Used	***	115	Not Used

14.5 TS2 Communications Ports

System (P-A)

Pin	Function	Pin	Function
1	Earth Ground	7	Signal Ground
2	TX	8	DCD
3	RX	20	DTR
4	RTS	24	Enable
5	CTS	25	Logic Ground

System Up (P-A)

Pin	Function	Pin	Function
1	Earth Ground	7	Signal Ground
2	TX	8	DCD
3	RX	20	DTR
4	RTS	24	Enable
5	CTS	25	Logic Ground

System Down (P-B)

Pin	Function	Pin	Function
1	Earth Ground	5	CTS
2	TX	7	Signal Ground
3	RX	8	DCD
4	RTS	20	DTR

15 Release Notes

Listed below are the general release notes for V61.x that was updated since V61.4q was released.

V61.4r

- Changes to Emergency.now module:
  - Added alarm when active
  - Added status output signal that is asserted when Emergency.now is active.

V61.4t

- Canadian Fast Green Flash – improve efficiency of transition to preemption sequence

V61.4u

- Expanded Station ID in 980 Secondary to 5 digits from 4 digits.

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