Training Manual

For

NTCIP Based TS2 Controllers

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

Version 65.x – Cubic | Trafficware 2070 Controllers

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Table of Contents

1 Introduction

This manual fully describes software release version 65 (Apogee) for the Cubic | Trafficware 2070 controller which complies with the current TEES specifications required by CALTRANS for their QPL compliance. The foundation of this version is an NTCIP compliant database that is cross compatible between controller versions.

2 Getting Started

2.1 2070 Operating Modes

The 2070 controller operates in four basic cabinet configurations:

- 2070 FIO – TEES Field I/O supports C1 connectors in 170/179 cabinets
- 2070 TS2 – Software supports TS2 Type-1 in NEMA cabinet facilities using the TEES C12S connector
- 2070N – TEES specification supports TS2 Type-2 cabinet facilities (ABCD connectors)
- 2070 ATC – TEES specification that supports the ATC cabinet currently under development

"Hybrid" combinations are possible combining these modes in the same cabinet configuration. Our company takes a unique position in the 2070 controller market by supporting NEMA TS2 Type-1 devices using the TEES C12S connector. 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. Because the electrical specifications for the TEES C12S and NEMA SDLC interfaces are equivalent, the 2070 can support both NEMA and TEES cabinets as a controller software option.

2.2 Hardware I/O Differences Between NEMA TS2 and TEES 2070 Controllers

Uniformity is provided between software versions to support NTCIP for NEMA TS2 and 2070 controller specifications. To the developer, this uniformity promotes a common code base that minimizes software maintenance costs and support. To the end user, this uniformity provides a common user interface and documentation base which minimizes training and support requirements. The primary difference between software versions results from the I/O devices which are radically different in each hardware specification. Because these differences are concentrated primarily in the IO of the hardware, we have dedicated separate chapters to the Data Communications (Chapter 10), SDLC Programming (Chapter 11) and Channel and I/O Programming (Chapter 12).

2.3 Differences Between NEMA TS2 and 2070 I/O Ports

Our 2070 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, 2070 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

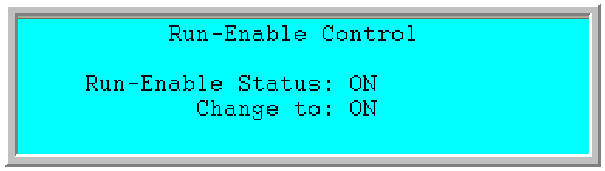
As discussed in section 2.2, the 2070 provides the flexibility of operating in any NEMA, TEES or ATC cabinet configuration using a concept called "port binding". This allows a software function (system up, system down, GPS, etc) to be assigned to a software port (such as ASYNC1 or ASYNCH2) which is in turn "bound" to a physical hardware port (such as SP1 or SP2) defined by the equipment specifications. In addition, the TEES C12S connector may be bound to different software ports (such as SYNC1 or SYNC2) that support the various SDLC protocols in NEMA and ATC cabinets.

Another concept to understand fully is the difference between "port binding" and "port mapping". ***Port Binding*** associates a controller software function with a physical hardware port defined by the TS2 or TEES standard. ***Port Mapping*** allows the individual pins of an FIO 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.

170/179 cabinets also require different *Port Maps* for the C1 connector. Allowances are made for each pin to be customized in software through the 2070 keyboard and can provide custom *Port Maps* for specific user applications.

2.4 The Run Timer (MM→1→7)

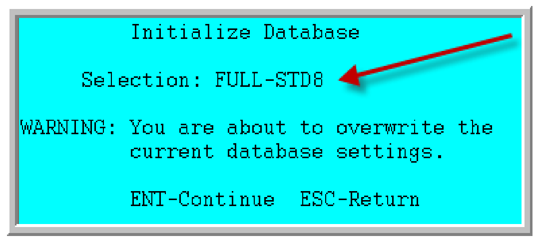


The ***Run Timer*** is turned off or on by programming it under menu **MM->1->7**. The Run Timer is normally used with the ***Clear & Init All* utility (MM->8->4->1).** This utility allows the user to initialize the controller to a default database after turning the **Run Timer to OFF (MM->1->7)**. The 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. Also note that 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.

2.5 Database Initialization and Phase Mode Selection

The 2070 or ATC database may be initialized with one of the following factory defaults*:*



- Full Clr – Initializes each value in the controller database to zero
- Full STD-8ø – Initializes the controller database to *Standard 8 Phase* operations (dual-quad operation)
- Full DIAMOND – Initializes the controller database to the *Diamond Phase Mode.*
- Specific user modes – reserved for a special application required by various agencies like NYSDOT

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)**. As explained above, 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

```
                 Main Menu
1.Controller  4.Scheduler  7.Status
2.Coordinate  5.Detectors  8.Login,Utils
3.Preempts    6.Comm
```

Keyboard sequences in this manual are referenced to the *Main Menu* using the "Main Disp" key on the TS2 and the "*" key on the 2070. 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

```
                     Phases
1.Times     4.Ring,Start,Concur  7.Times+
2.Options   5.Call,Inh,Redirect  8.Copy
3.Options+  6.Alt Progs+         9.AdvWarn
```

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 a 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. The red **ENTR** key on the TS2 and the red **ENT** key on the 2070 controller are identical.

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.

MM->1->1->1, Left Menu

MM->1->1->1, Right Menu

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

```
<Intervl P.9..10..11..12..13..14..15..16
Min Grn     0   0   0   0   0   0   0   0
Gap,Ext   0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Max 1       0   0   0   0   0   0   0   0
Max 2       0   0   0   0   0   0   0   0
Yel Clr   3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5
Red Clr   1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5
Walk      + 0   0   0   0   0   0   0   0
```

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

Our TS2 controller provides a 4-line display and the 2070 provides an 8-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 2070 uses "+" and "-" symbols. The cursor may also be moved one page at a time using the "Page Up" and "Page Down" keys on the TS2 keyboard. Page up on the 2070 keyboard is accessed from the "+" key and page down is provided from the "-" key.

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 audible tone is produced as per the 2070 specifications.

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 (ENT)

The **ENT** 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 (*)

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 (F)

The alternate function key provides access to various features such as help and the default status screen. The '**F**' 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 (TS2) or the '**F**' key (2070), then immediately presses and releases the key that corresponds to the desired function.

Help Screen ('F' 'F')

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 ('F' 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 **ENT**, they may select this alternate function and the original contents will be placed in the active field.

Key Calls Mode ('F' 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 ('F' 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
- START-UP - is displayed when the controller is timing the Startup Flash interval
- 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
- 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

```
                 Main Menu
1.Controller  4.Scheduler  7.Status
2.Coordinate  5.Detectors  8.Login,Utils
3.Preempts    6.Comm
```

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, or if *Feature Profile* is set to zero under *Unit Parameters* in the 2070.

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

```
                   Phases
1.Times     4.Ring,Start,Concur  7.Times+
2.Options   5.Call,Inh,Redirect  8.Copy
3.Options+  6.Alt Progs+         9.AdvWarn
```

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. 16 separate vehicle/pedestrian phases are provided 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

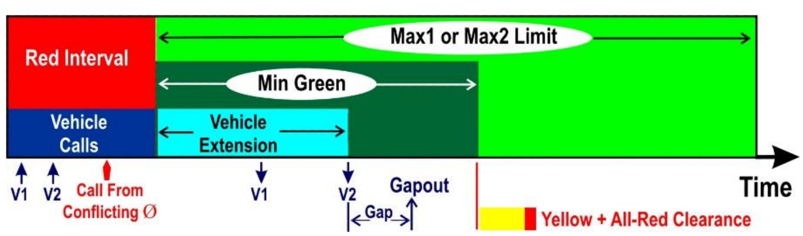
4.1.2 Vehicle Actuated Mode

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.

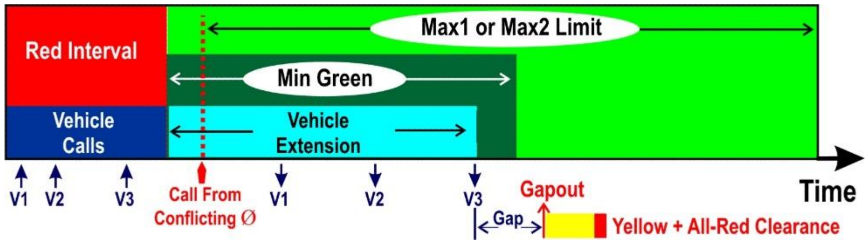
In the example below, two vehicles call the phase during the red interval from a presence detector located at the stop bar. When the phase turns green, these two vehicles leave the presence detector before the *Minimum Green* time expires and a "gap-out" occurs after the *Gap,extension* timer expires. 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

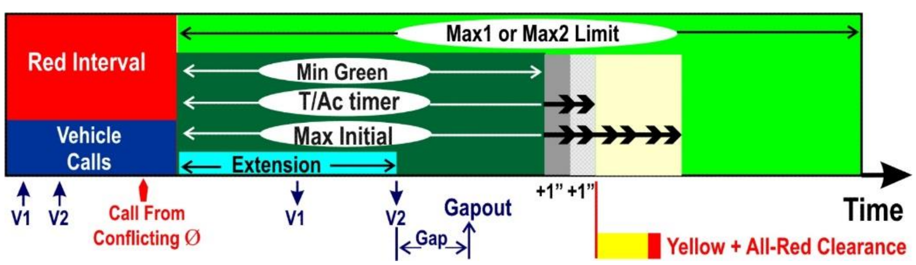
Volume Density Mode extends vehicle-actuated operation by:

- 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.

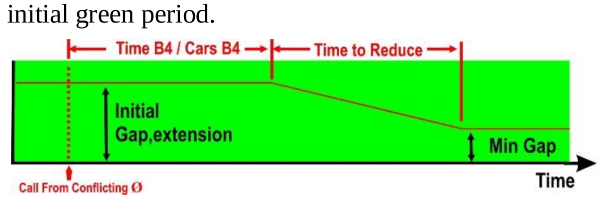
In the example below, *Added Initial* is set to 1” and “times per actuation” (*T/Ac*) is set initially to the *Minimum Green*. *T/Ac* is extended by 2 vehicle calls each adding 1” of *Added Initial* to the *T/Ac* timer. During *Min Green*, the *Gap,extension* timer “gaps-out” sending the phase to *Yellow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

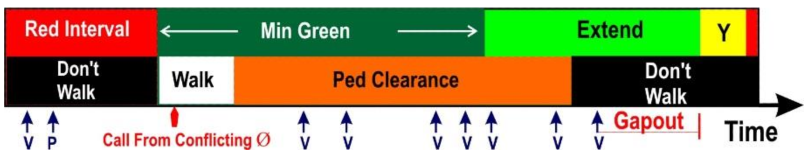
4.1.4 Pedestrian Actuated Mode

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

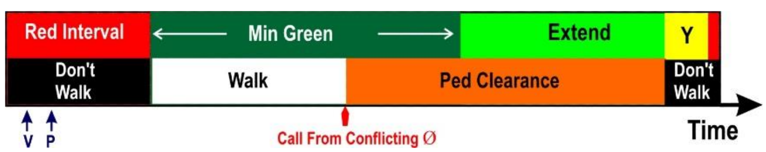
Ped Clearances Times With Vehicle Clearance if *PedClr-Thru-Yellow* is Enabled

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 extends beyond 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

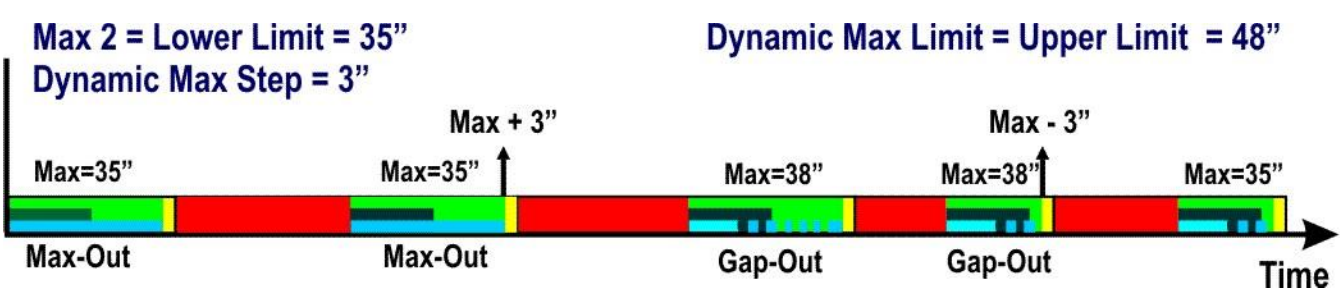
The *Minimum-Gap Time* specifies the lowest allowable time (0-25.5 sec) to which the gap time can be reduced.

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)

```
Options          P..1..2..3..4..5..6..7.8>
        Enable P  X  X  X  X  X  X  X  X
      Min Recall  .  X  .  .  .  X  .  .
      Max Recall  .  .  .  .  .  .  .  .
      Ped Recall  .  .  .  .  .  .  .  .
     Soft Recall  .  .  .  .  .  .  .  .
      Lock Calls  .  .  .  .  .  .  .  .
Auto Flash Entry+ .  .  .  X  .  .  .  X
```

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.

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.

```
Options          P..1..2..3..4..5..6..7.8>
Auto Flash Exit - .  X  .  .  .  X  .  .
      Dual Entry  .  X  .  X  .  X  .  X
Enable Simul Gap  .  X  .  X  .  X  .  X
Guarantd Passage  .  .  .  .  .  .  .  .
    Rest In Walk  .  X  .  .  .  X  .  .
Condit'l Service  .  .  .  .  .  .  .  .
  Non-Actuated 1+ .  .  .  .  .  .  .  .
```

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 section 6.7).

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' - <u>Sum</u> of the added initial from all of the detectors calling the phase during the yellow and red interval
- "L" - use the <u>Largest</u> value from the group of added initial detectors calling the phase.

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

```
Options+        P..1..2..3..4..5..6..7.8>
      Reservice   X  .  .  .  .  .  .  .
PedClr Thru Yel   .  X  .  .  .  .  .  .
 SkipRed-NoCall   .  .  X  .  .  .  .  .
       Red Rest   .  .  .  X  .  .  .  .
         Max II   .  .  .  .  X  .  .  .
    Max Inhibit   .  .  .  .  .  X  .  .
    Ped Delay +   .  .  .  .  .  .  .  X
```

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.

Red Rest on Gap

When enabled, *Red Rest on Gap* allows a phase to gap-out and remain in red-rest in the absence of calls on other concurrent phases in the same ring.

Max Inhibit

This feature allows the user to select *Max Inhibit* by phase under coordination rather than a *Coord Mode* option (MM->2->1) which applied inhibit max to all phases.

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.

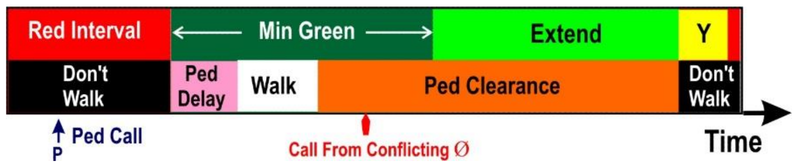
If *Ped-Delay* is disabled, the start of green is delayed by the *Grn/Ped Delay* time. This leading pedestrian interval (**LPI**) feature allows the pedestrian to enter the crosswalk while the vehicle indication is red. In the above screen, *Ped-Delay* is not enabled for phase 4 and *Grn/Ped Delay* is 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.

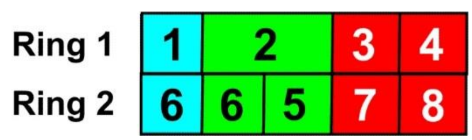


Enable *Ped Delay* to delay the Walk interval by the programmed *Grn/Ped Delay* value

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:

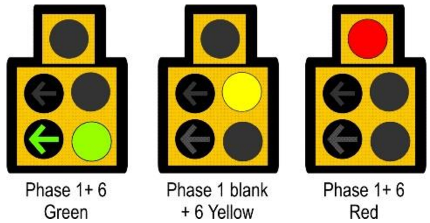


To assign conflicting phases, enter the number of the conflicting phase under the parent phase. In the menu above, “5” entered under phase 1 would prevent 1 and 5 from running together even though they are concurrent phases. It is not necessary to duplicate the entry in the column for the conflicting 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

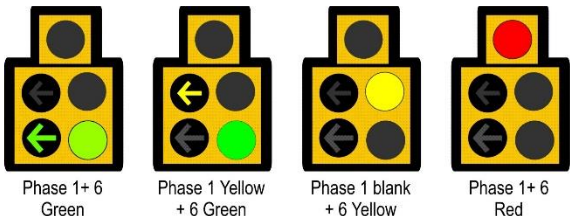
Omit Yel allows the yellow output of a phase to go dark when a specified phase is also timing yellow clearance. "*Allow Skip Yel*" must be enabled under Unit Parameters (See section 4.8) to enable this option.

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.



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



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 we added the *PED_1 Overlap* type described in section 4.4.7. 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.

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 in the controller.

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.Times                   4. 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.

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

Alternate Interval Times+ (MM->1->1->6->4)

Alternate Interval Times and *Alternate Interval Times+* may be "attached" to patterns to vary phase times by time-of-day. Up to 3 alternate sets of data for each feature may be programmed.

```
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
```

Entries in these tables are made by <u>column</u> and not by phase. For example, in the *Alternate Interval Times* menu on the right, 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.

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.

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

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.

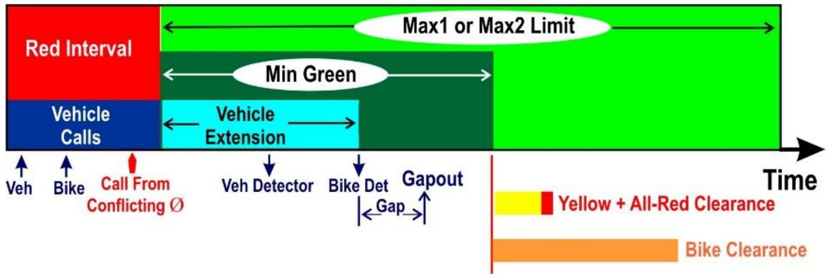
```
Times+    ..1...2...3...4...5...6...7..8>
Walk2        #   0   0   0   0   0   0   0
BikeClr    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Max1+        0   0   0   0   0   0   0   0
Max2+        0   0   0   0   0   0   0   0
DynMxLm+     0   0   0   0   0   0   0   0
```

Walk 2

The Walk2 clearance time is used in place of the Walk time if the pedestrian button is depressed longer than 2 seconds. This feature can be used to provide a "longer" clearance time to those with disabilities. However, it will be necessary to work with local grounds assisting the blind and disabled to educate those who can benefit from the longer pedestrian (clearance) times. This longer time is displayed during the walk period (i.e. longer walk time) and not during the flashing don't walk period.

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.

Max1+

The ability to allow timing to go beyond the standard 255 seconds has been added. If the user programs this timer it will be used in place of the Max 1 time programmed in MM→1→1→1. A maximum of 999 seconds can be programmed. ***Users must program Max1+ if DynMxLm+ has been programmed.***

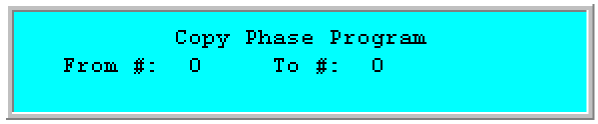
Max2+

The ability to allow timing to go beyond the standard 255 seconds has been added. If the user programs this timer it will be used in place of the Max 2 time programmed in MM→1→1→1. A maximum of 999 seconds can be programmed ***Users must program Max1+ if Max2+ has been programmed.***

DynMxLm+

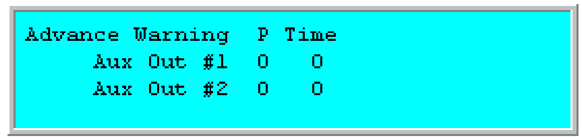
The ability to allow timing to go beyond the standard 255 seconds has been added. If the user programs this timer it will be used in place of the Dynamic Max Limit timer programmed in MM→1→1→1. A maximum of 999 seconds can be programmed. ***Users must program Max1+ and Max2+ (if Max2 was programmed) when programming this location.***

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



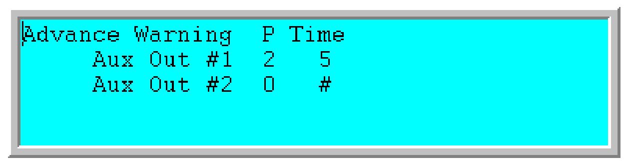
The *Copy Phase Utility* allows the user to copy phase programming from one phase to another phase. This can speed up data entry and reduce errors if complementary phases in each ring have similar programming values. This utility copies all phase times, options, and phase options+ programming from menus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

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



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.



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 activated during Free or Coordinated operation.

4.2 Rings, Sequences and Concurrency

16 phases assigned to four rings is supported. 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 in section 4.2.5.

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

16 seq # combinations are provided in the sequence table

Ring

Four rings are provided for each of the 16 sequences

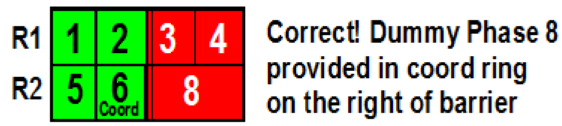
Seq#	Ring	Sequence.of.Phases							
1	1	1	2	3	4	0	0	0	0
1	2	5	6	7	8	0	0	0	0
1	3	0	0	0	0	0	0	0	0
1	4	0	0	0	0	0	0	0	0
2	1	1	2	3	4	0	0	0	0
2	2	6	5	7	8	0	0	0	0
2 +	3	0	0	0	0	0	0	0	0

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)

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

Phase ø

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

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.

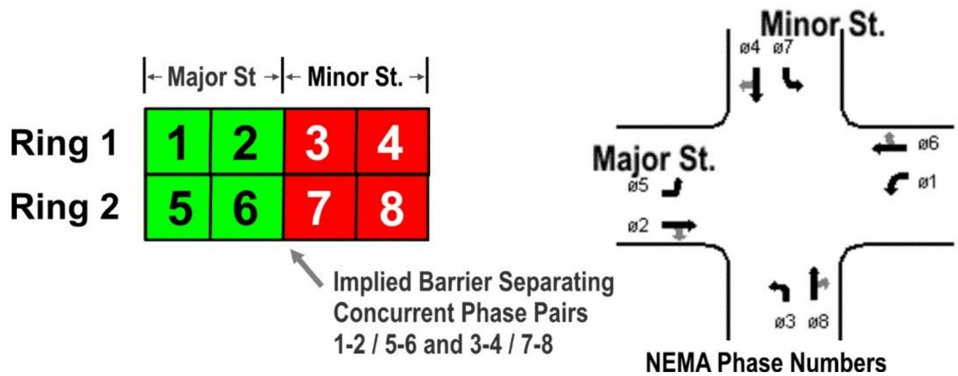
STD8 requires that:

1-2-3-4 operate in ring 1

5-6-7-8 operate in ring 2

1-2 are concurrent with 5-6

3-4 are concurrent with 7-8



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.

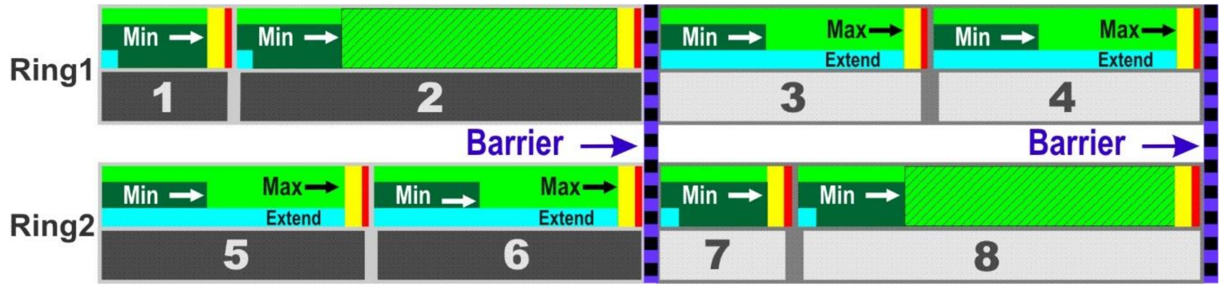
When considering coordination, using STD8 mode will take advantage of the most coordination diagnostic checks to catch common data entry mistakes, and if detected, times the intersection in FREE. In USER mode, most of these coordination diagnostics are removed, and the onus is on the agency verify and 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.

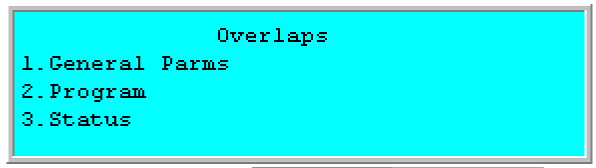
Sequential Operation may be combined with overlaps to define complex display sequences. The sequence order may be changed by defining a new phase sequence in the sequence table. However, each phase sequence in the table must contain the same number of phases and the ring assignment in the sequence table 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
```

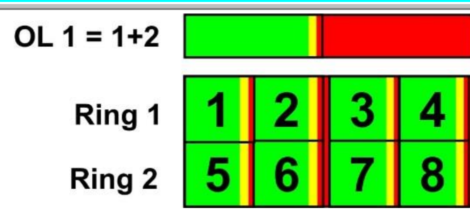
NEMA TS2 only defines ring inputs (like Stop Time 1) for rings 1 and 2. The *Ring Parameters+* screen allows the user to map the ring I/O for ring 1 and 2 to any of the 4 rings available in the controller. The default assumes that ring inputs for rings 1 and 3 and rings 2 and 4 are identical.

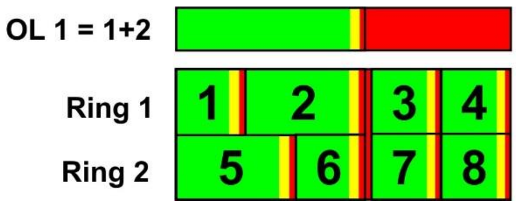
4.3 Overlaps (MM->1->5)



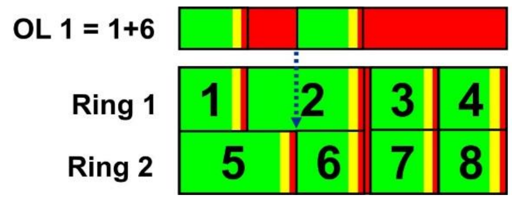
Sixteen fully programmable overlaps may be assigned to any load switch channel in the terminal facility (cabinet). Overlaps are customized channel outputs driven by one or more *included phases* that are typically consecutive phases in the ring sequence.

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.



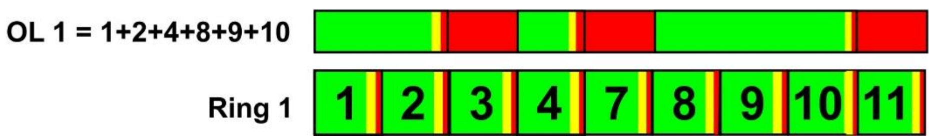


Consecutive Included Ø 1+ Ø 2 in the Same Ring



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

Note: Although Overlaps use phasing to control their outputs, they preform independently. Therefore if your agency uses specific features which may have an effect on included phases, modifier phases or various overlap types, you should thoroughly bench test the overlap to insure proper operation. For example, a feature such as the unit parameter Clearance Decide, affects phase next decision making which will have ramifications on overlap behavior.

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

```
   General Overlap Parameters
        Lock Inhibit OFF
   Confl Lock Enable OFF
     Parent P Clrncs ON
Extra Included Phases OFF
```

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

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..

Extra Included Phases

This feature is used if more than 8 parent phases are needed. When Extra Included Phases is set to "ON", any of the first four phases that are programmed under the modifier phases will also be designated as parent phases.

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

```
         Overlap A
1.Program Parms
2.Confl Prog+
3.Program Parms+
```

```
 Ovrlp A      Ps.....................
Included Ps    0  0  0  0  0  0  0  0
Modifier Ps    0  0  0  0  0  0  0  0
Type:NORMAL  Grn:  0  Yel: 3.5  Red: 1.5
```

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. When programming green extensions, the user should consider the following. In coordination, split times must accommodate green extensions for all included phases. When programming preemptions, the user should consider programming preemption phases,that are not included in the overlap, as conflicting phases under **MM->1->5->2->2**.

When running a Green Extension during an Overlap, the controller overlap software has a special case added to its termination logic as shown below. If the overlap is terminating:

AND NO green extension is programmed

AND there is a preempt in the begin phase

AND the preempt is NOT configured for All Red Before Preempt (**AllRedB4Preempt**)

then the software will provide a "dummy" 1 second green extension time.

The intention of this code is to ensure that an overlap that is currently green does not go green->red->green as it terminates the overlap to enter the preempt, but then re-enables the overlap because one of the included phases of the overlap are used by the preempt.

This code provides an extension to **ANY** overlap being terminated by a preemption that does not have a green extension configured regardless of whether or not this overlap has an included phase that is going to be serviced "next" by the preempt. This can lead to a situation where the current overlap is extending and can be in conflict with the phases becoming active as part of the preemption. To mitigate this issue, program the parameter **AllRedB4Preempt** under **MM->3->1->8**. In addition the use can consider programming the green extend inhibit parameter (**GreenExtInh**) under **MM->1->5->2->3** to not allow certain phases to extend.

Overlap “Trailing” Yellow and Red Clearance

Parent Phase Clearance (section 4.3.1) 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.

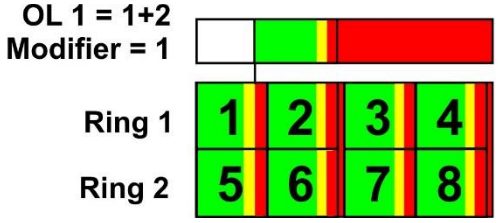
- **Normal** (NTCIP) – modifier phase causes the overlap to go dark
- **–GrnYel** (NTCIP) – modifier phase used to suppress the overlap green
- **L-Perm** – suppresses the solid green in a protected/permitted left-turn while the opposing left-turn (modifier phase) is green (this left-turn display is 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.
- **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** – 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

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 its green or yellow 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)

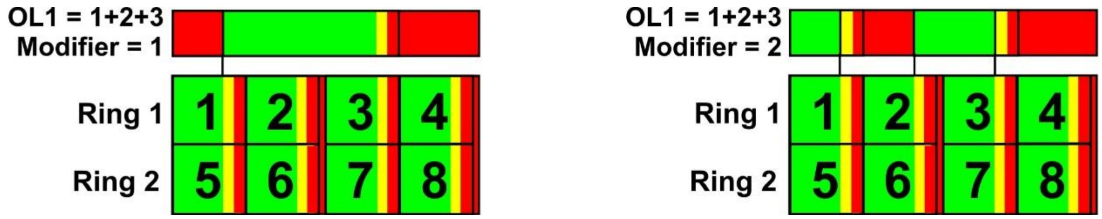
Both the *Included Phases* and the *Modifier Phases* control this overlap type as follows:

- 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).

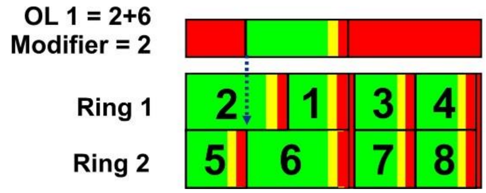


-GrnYel Type: Modifier Phases Suppresses the Overlap During When the Modifier Phase is Green

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

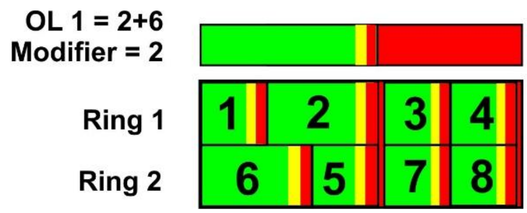
Both the Included Phases and the Modifier Phases control this overlap type as follows:

- 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)

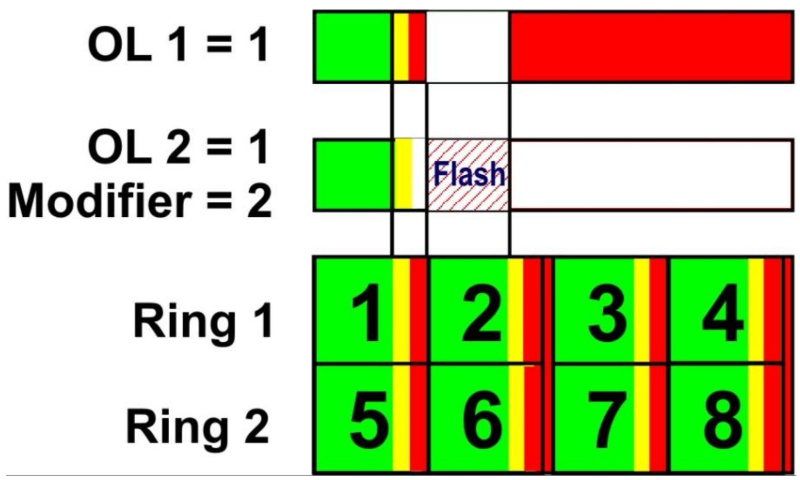
Both the Included Phases and the Modifier Phases control this overlap type as follows:

- 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: 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

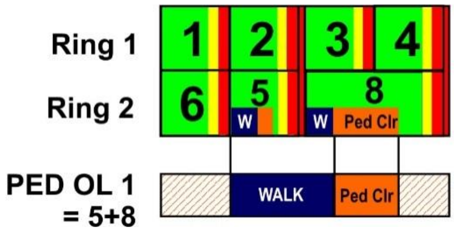
This overlap type provides a green right-turn arrow when a non-conflicting left turn is active. The overlap was designed to allow the right-turn arrow to remain illuminated through the compatible left turn clearances and move to red when the through movement becomes active.

4.4.6 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.

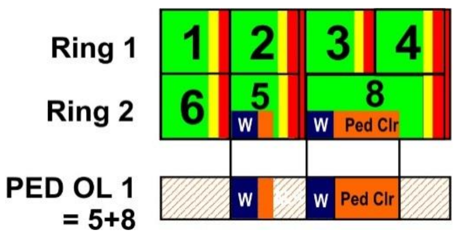
If each included phases is consecutive in the phase sequence, the ped overlap walk interval will begin timing with the first parent phase. Ped Clearance begins with the first included phase and ends with the ped clearance programmed for the last included phase assigned to the overlap.

```
 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.

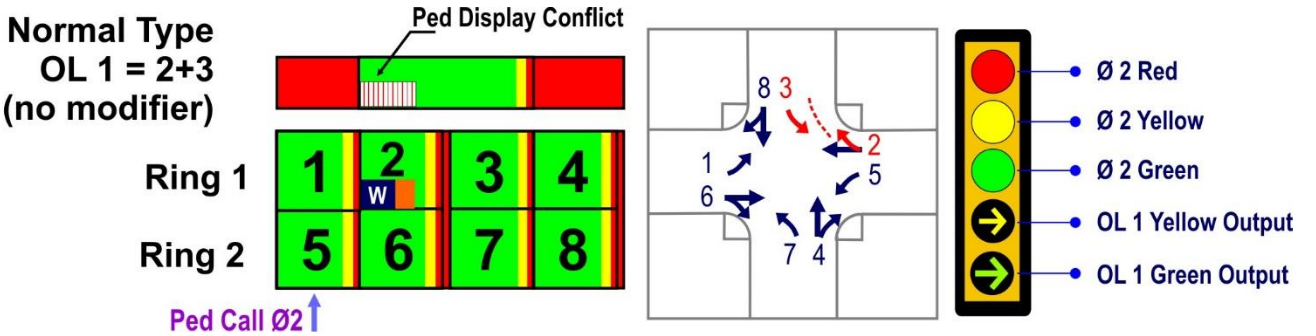
4.4.7 Overlap Type: Min Green

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.

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

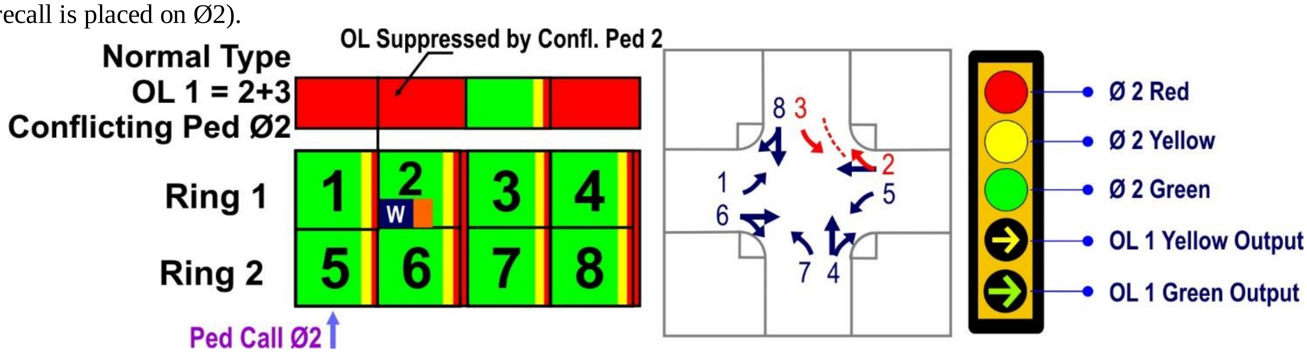
```
  Ovrlp A       Ps...................
Confl Ps         0  0  0  0  0  0  0  0
Confl Ovrlps     0  0  0  0  0  0  0  0
Confl Peds       2  0  0  0  0  0  0  0
```

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

The following screen is specific to the Model 2070 Apogee Version 65.x software and is found at MM→1→5→2→3. These additional features are explained in the section below.

```
  Ovrlp A-1
LeadGreen  OFF
GreenExtInh      0  0  0  0  0  0  0  0
```

4.6.1 Lead Green Feature

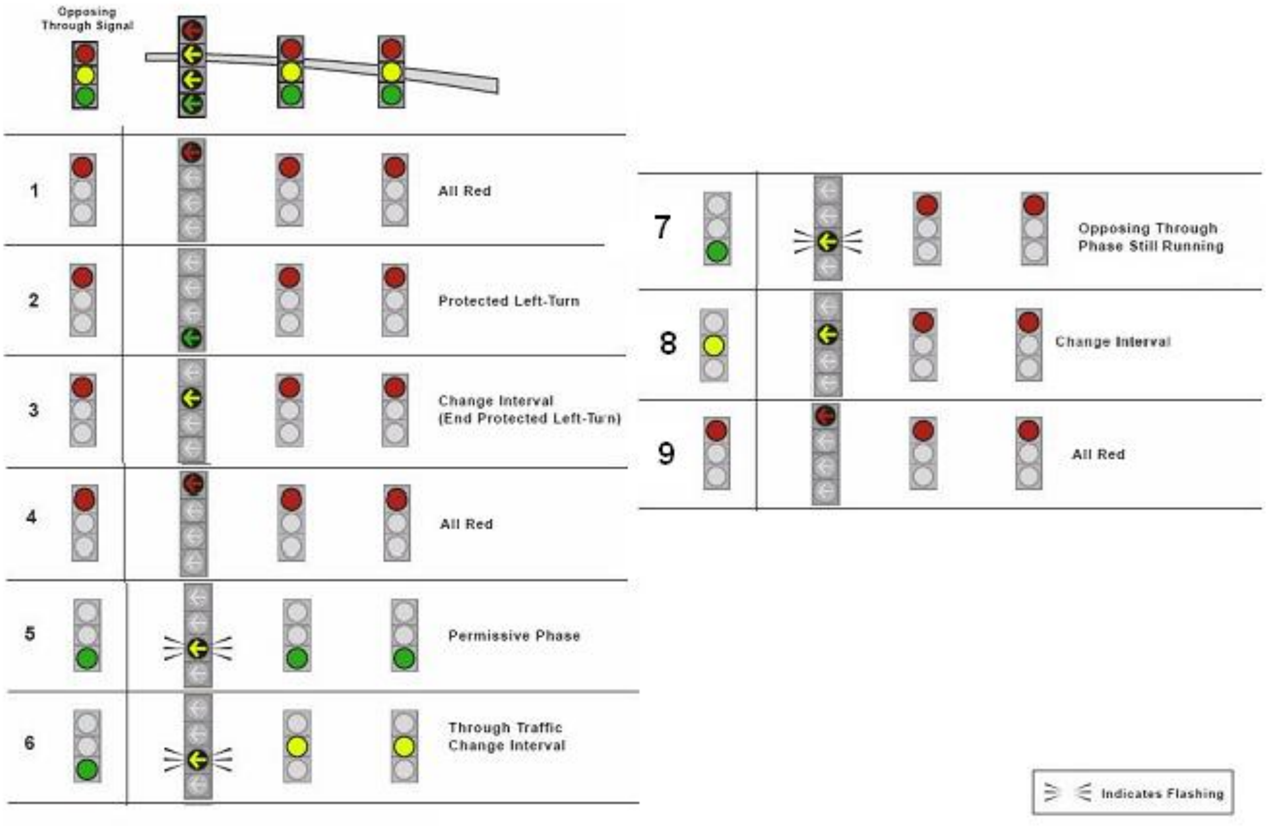
The *Lead Green* parameter (ON/OFF) delays the start of the overlap green much like *the Green/Ped Delay* which delays the start of a phase green or walk indication.

4.6.2 Green Extension Inhibit (GreenExtInh)

Green Extension Inhibit phases overrides the green extension setting in the overlap. For instance, if included phases are 1+2, and the overlap times a green extension/trailing time of 10 seconds, setting phase 1 as a GrnExtInh phase will inhibit the extension if the overlap terminates at the end of phase 1 instead of phase 2.

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 Flashing Yellow Overlap Programming

One way to accomplish a Flashing Yellow Overlap is 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. You may also accomplish a Flashing Yellow Overlap by using an existing overlap yellow or pedestrian yellows outputs. 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 A (Overlap 1) that will utilize the Yellow Flash output from Phase 2 Ped Yellow.

First set up the overlap via MM→1→5→2→(olp)1→1. Make sure you program the type as FYA-4 and set up the included phase as the protected/permitted phase and the modifier phase as the conflicting through movement.

```
  Ovrlp A-1   Ps.....................
Included Ps     1  0  0  0  0  0  0  0
Modifier Ps     2  0  0  0  0  0  0  0
Type:FYA-4   Grn:  #  Yel: 3.5  Red: 1.5
```

Use the Output Channels+ screen (MM→1→8→4) to tell channel 13 that it is having an overlap override applied, whose source is via Overlap A(Overlap 1) and that it is to flash the yellow output. Assume that Phase 2 Ped is programmed as the default Ped 2 channel, Channel 13.

```
<    Chan.9..10..11..12..13..14..15..16
Flash Red .   .   .   .   .   .   .   .
Flash Yel .   .   .   .   X   .   .   .
Flash Grn .   .   .   .   .   .   .   .
Inhibit Red Flash in
  Preempt .   .   .   .   .   .   .   .
Olap Ovrd 0   0   0   0   1   0   0   0
```

In summary, you may consider that the Flashing Yellow Arrow overlaps have 4 outputs. They have RED, YELLOW, GREEN, and AUX. In the channel+ screen, you tell which channel's yellow output is going to be overridden by the overlap AUX output. Keep in mind that you do not have to use a ped channel, but can use any channel. Therefore, you can elect to utilize a whole channel for the FYA output, or an existing pedestrian channel.

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, when programming Flashing Yellow arrow, upon controller startup (i.e. controller power up, NEMion is A Ext. Startup, startup after Flash, etc.), the FYA outputs can be programmed to be inhibited or allowed to run immediately by programming **INHFYARedS** under MM→2→1.

The unit parameter **Clearance Decide** should be set to **OFF** when programming Flashing Yellow Arrows.

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. If you program all the phases on a ring in one barrier, there is no barrier to cross into, and operation is never allowed. In this case simply set the Unit parameter Inhibit FYA Red Start to ON so the FYA will not be inhibited.

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.

```
Overlap  .A1..B2..C3..D4..E5..F6..G7.H8>
Interval --- --- --- --- --- --- --- ---
Time     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
P/Intvl   2/GRN   6/GRN   0/---   0/---
```

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)

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

```
        Auto Flash Parameters

Flash Mode            : CHANNEL
Input Source (Type 2): D-CONN
```

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* (see section 4.9.1)
- **PHS/OLAP** – Phase/overlap flash settings (discussed in the next section) are applied during *Automatic Flash*
- **CVM/WDOG** – 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.

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

```
    Phase/Overlap Automatic Flash

Yellow Clearance: 3.5
Red Clearance   : 1.5
    -----------Flash Yellow-----------
Phs:  0  0  0  0  0  0  0  0  0  0  0  0
Olp:  0  0  0  0  0  0  0  0  0  0  0  0
```

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. In addition this menu is used to program clearance times when the controller leaves automatic flash and returns to stop-and-go operation . Specifically:

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.

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

```
  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->1)

```
         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
```

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 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.

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 StreetWise system. In the example above, each event is date and time stamped with the "Stn" (controller Station ID address).

- 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).

#	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# 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 StreetWise 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 StreetWise frequently enough to avoid losing any event information stored in the controller's event buffer. StreetWise 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)

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.

#	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 *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. Also, a power down/up will clear the internal alarm buffer.

4.10.4 Clear Event and Alarm Buffers.

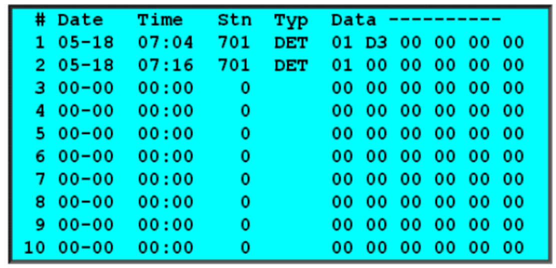
MM->1->6->3 clears the *Event Buffer* and MM->1->6->6 allows the user to manually clear the *Alarm Buffer*.

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

         press ESC to go back...
```

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

Detector Events are stored in a separate 50 record buffer and uploaded to StreetWise 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***.



```
 # 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
```

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 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.

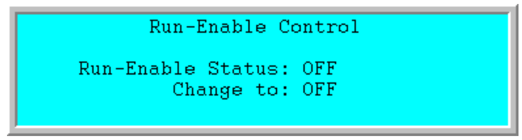
Fault (decimal)	Fault (Hexadecimal)	Fault (Stored as Occupancy Data)
1	01	No Activity Fault
2	02	Max Presence Fault
4	04	Erratic Output Fault
5	05	Erratic Output/No Activity
6	06	Erratic Output/ Max Presence

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 Channel, I/O (MM→1→8)

See chapter 12 for setting up IO in the 2070 controller

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

```
              Unit Parameters
 StartUp Flash(s)    0  Red Revert     3.0
  MCE Timeout        1  Auto Ped Clr   OFF
Local Flash Start OFF  Display Time   255
 Allow <3 sec Yel OFF  Tone Disable   OFF
   Allow Skip Yel OFF  AudioPedTime     0
   Start Red Time 0.0    Phase Mode  STD8
 Disable Init Ped OFF +CNA FreeTime     0
```

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 StreetWise to override the active pattern in the controller indefinitely if the remote override time in StreetWise 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

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 section 4.2.

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 76 there are 4 possible selections, ***ON, OFF, DRK*** and ***RED.***

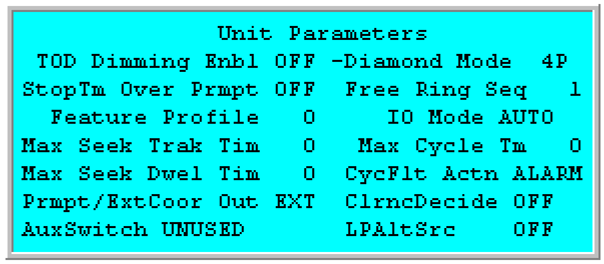
Set *Local Flash Start* to ***ON*** to force the controller to perform an "External Start" when the *Local Flash* input transitions from active to inactive. This feature was originally used in NEMA cabinets that were built prior to TS2-98 and that didn't have a diode/capacitor network installed in the 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.

Local Flash Start should only be used in 170 type cabinets when the *Local Flash Input* is used to energize the flash-transfer relays and restart the controller simultaneously. Set *Local Flash Start* to ***DRK*** in a 170-type cabinet that requires the controller indications to initialize in the DARK state when the controller resets and the flash transfer relays are energized. Set *Local Flash Start* to ***RED*** if you program the *Start Red Time* parameter as described below.. 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.

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)

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 2070 controllers with Apogee.

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. This selectiom is ignored by the 2070 hardware.

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

```
               Unit Parameters
 TOD Dimming Enbl OFF -Diamond Mode   4P
StopTm Over Prmpt OFF  Free Ring Seq   1
  Feature Profile   0      IO Mode AUTO
Max Seek Trak Tim   0    Max Cycle Tm  0
Max Seek Dwel Tim   0  CycFlt Actn ALARM
Prmpt/ExtCoor Out EXT  ClrncDecide OFF
AuxSwitch UNUSED       LPAltSrc     OFF
```

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.

MCE (Manual Control Enable) Timeout (0-255 minutes)

If MCE is applied and no interval advance is issued for this amount of time (in minutes), then MCE is disabled. To re-enable MCE, the MCE input must be cycled OFF and then back ON.

Audio Ped Time (0-255 seconds)

Pedestrian phases 2, 4, 6, and 8 have a dedicated output function (pin) called the "Audible Ped Output". If the amount of Walk time left in the associated Ped is greater than the time specified by this parameter, then the output is asserted.

CNA (Call to Non-Actuated) Free Time (0-254 seconds, 255 disables CNA)

CNA Free Time is the amount of time that CNA can be applied before it is automatically disabled. CNA must be de-asserted, then re-asserted for CNA to be active. If the value is 0, then CNA does not time out. If the value is 255, CNA is ignored.

Clearance Decide

The default phase next decision is made at the beginning of yellow clearance when a phase terminates.

> **ON** forces the controller to re-evaluate phase next at the end of all-red clearance. When the controller finishes its red clear, it looks at the all phase next selections and verifies if phases still have calls **(if any calls have been dropped)**. If they don't, then it makes the phase next decision again. In other words, it only makes a phase next decision if the original decision does not warrant service, NOT if there was a different decision to be made. This prevents the phase from moving to another phase if the call is lost during the clearance intervals.
>
> **OFF** uses the default phase next decision making

Note: Clearance Decide was developed for specific user applications, and not advised for general use. Use of this feature will have various ramifications on overlap functionality – specifically overlaps with multiple included or modifier phases, as the "next" decision affects their operation. If this feature is used, then the user must take care to carefully bench test the application to ensure that the overlaps will operate as expected. This note specifically applies to flashing yellow arrow (FYA) operation, which is implemented via special overlap functionality.

LPAltSrc

Setting this parameter allows low-priority preempts 7-10 to be assigned to oscillating inputs on preempts 1-4 instead of 3-6.

AuxSwitch

Setting this parameter to "**STOPTIME**" allows the user to toggle the 2070 Front Panel Auxiliary Switch to the "ON" position and stop the Apogee software from advancing any Phase timer. Toggling the switch to the "OFF" position will continue controller's phase timing from the point it was halted. Setting this Parameter to "**UNUSED**" will ignore the toggling of the 2070 Front Panel Auxiliary Switch.

INHFYARedS

When programming Flashing Yellow arrow, 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 when this parameter is programmed to ***OFF***. By programming this parameter to ***ON*** the FYA outputs will not be inhibited.

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). The 2070 mimics these features.

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)

<	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

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.

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.

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

< 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

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.

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 **only** 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 (5.1.6).

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 *Dl/-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 section 4.1.9. Three *Alternate Detector Programs (MAPS)* 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.

```
          DETECTOR STATUS
1.Veh Dets  1-32    4.Delay,Extend
2.Veh Dets 33-64    5.V/O Sample
3.Ped Dets          6.Speed Sample
```

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.

```
   (1-16)  Det #  1.......  9.......  >
Veh Call          --------  --------
Veh Alarm         --------  --------
```

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.

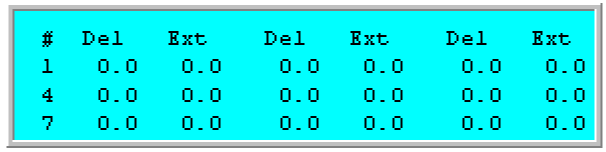
```
          Det #  1......8
Ped Alarm        *-------
No Activity      *-------
```

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)

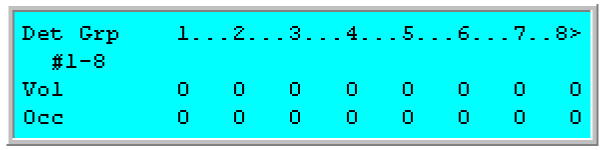
5.4.3 Detector Delay, Extend Status (MM->5->7->4)

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.



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.



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 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)

16 speed traps are provided. They consist of two detectorswhere the user specifies a *Zone Length* and a *Car Length* (see section 5.5.2 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)

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.

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

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

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.

```
   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 *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)

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.

```
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 +
```

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 (see table in section 6.11.1) 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.

```
Coord Parms |    Pattern     |
1.Modes,+      4.Pattern Tbl   7.Splits
2.Ext. I/O     5.Tran,CoorPhs  8.Status
3.Reserved     6.Alt Tables+   9.More
```

Coordination Modes determine the force-off method (FIXED or, FLOAT), the offset correction method used during transition and which maximum settings are applied (or inhibited) during coordination. *Coordination Modes+* select additional features used in coordination. For example, 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)

```
          Coordination Modes            >
Test OpMode     0        Force-Off  FIXED
 Correction  LONG
    Maximum  MAX_1       FlshMode CHANNEL
```

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 and NTCIP as pattern 254

255 Manual Flash – selects auto flash operation defined by NEMA and NTCIP 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 a FIXED force-off method is 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 a FIXED force-off method is 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 using the FIXED force-off method. 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.

Flash Mode (FlshMode)

This setting is defined in section 4.9.1 and is duplicated on the *Coordination Modes* screen for convenience.

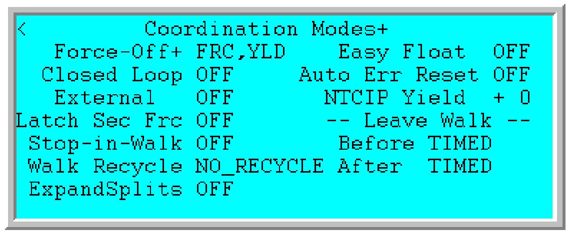
Force-Off Mode

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. 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.

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



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.

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 the split accommodates most of the pedestrian time**. 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.

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 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.

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

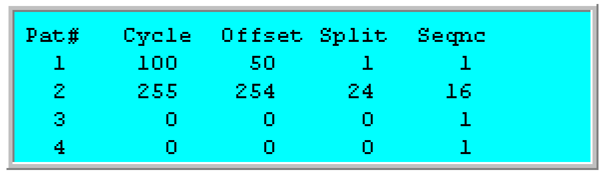
The *Coord Yield* parameter is expressed as a positive and negative number (- 15 to +15”). This parameter is used to adjust the default yield point of the coord phase under NTCIP coordination (FIXED and FLOAT modes). This adjustment is applied to only the coordinated phases, where the *Early Yield* adjustment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

Expanded Splits

Version 65.x for the 2070 controller provides the ability to extend cyles, offsets and split times beyond 255 seconds. Turn *Expanded Splits* **ON** to extend coordination times to 999 seconds. A separate pattern table and split table is provided for maintaining these extended values. All other coordination programming is unchanged when *Expanded Splits* is enabled.

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.

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 Section 4.2.1 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.

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.

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* are not needed for FIXED and FLOAT.

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

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.

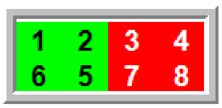
PED The *Ped* setting applies a pedestrian recall to the phase when the split table is active

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)

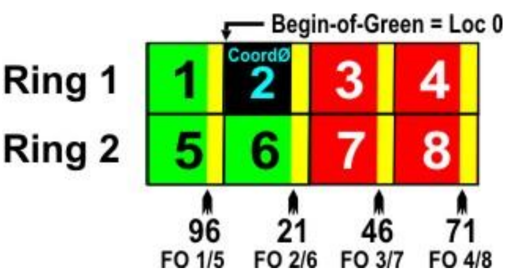
Lead/Lag Considerations with the Coordinated Phase- First coordinated Phase



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 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* are provided for additional information. The user will observe that 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

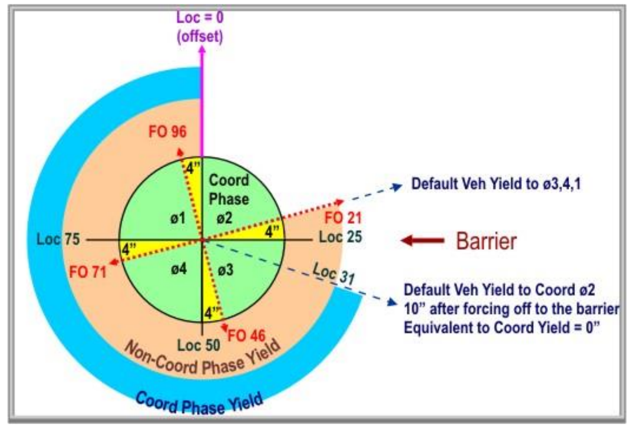
The vehicle permissive period is defined as the portion of the cycle during which vehicle calls can be serviced if there is a vehicle call on the phase. The permissive period begins at the *VehYield* point and ends at the *VehApply* point that inhibits vehicle calls from being serviced until the next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

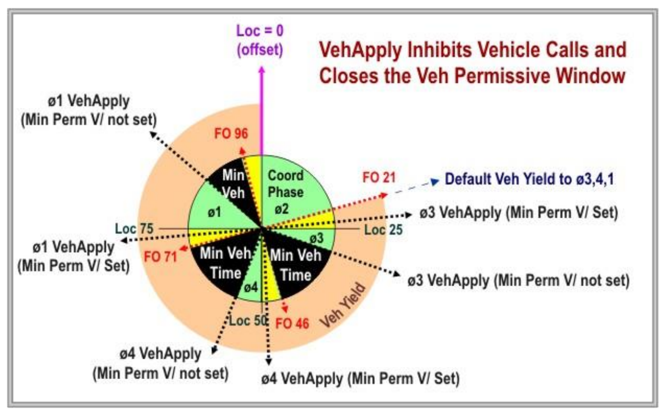
Default Yield Points for FIXED and FLOAT

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.



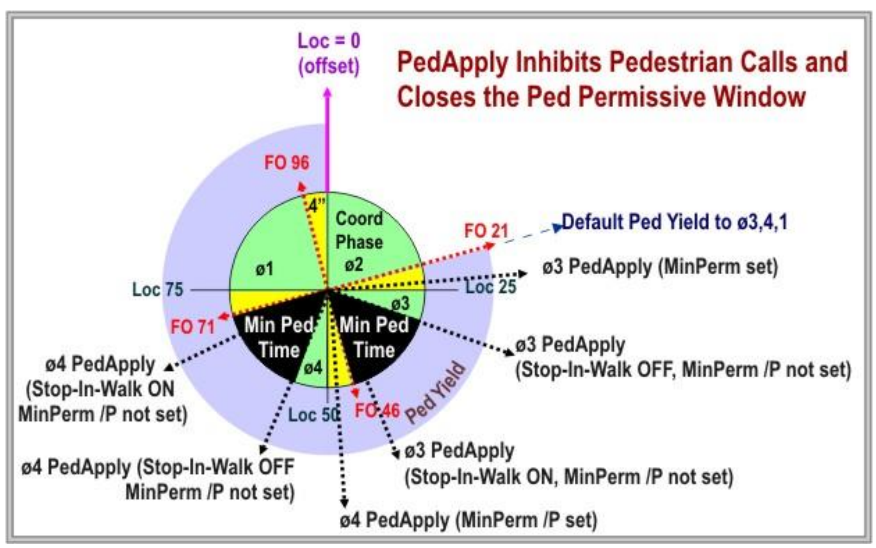
VehApply Points

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. A *Min Perm* setting is provided 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 coordinated 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 coordinated 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.

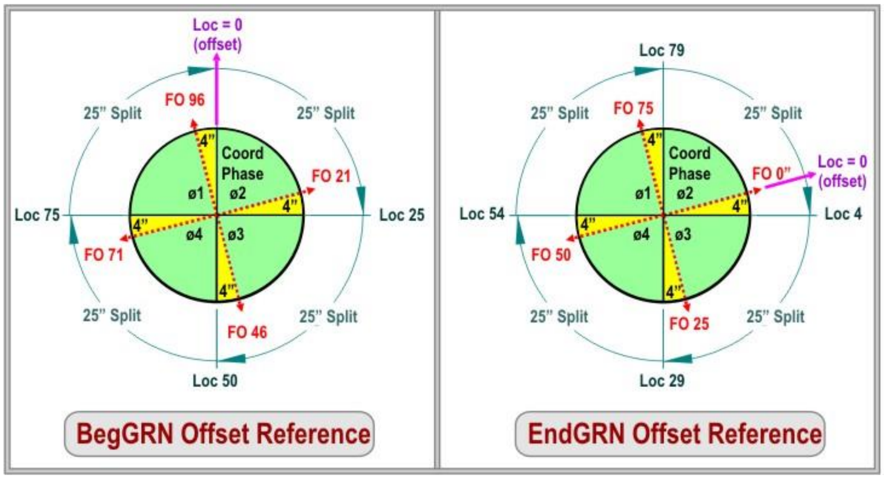
Return Hold (RetHold)

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, it is recommended 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

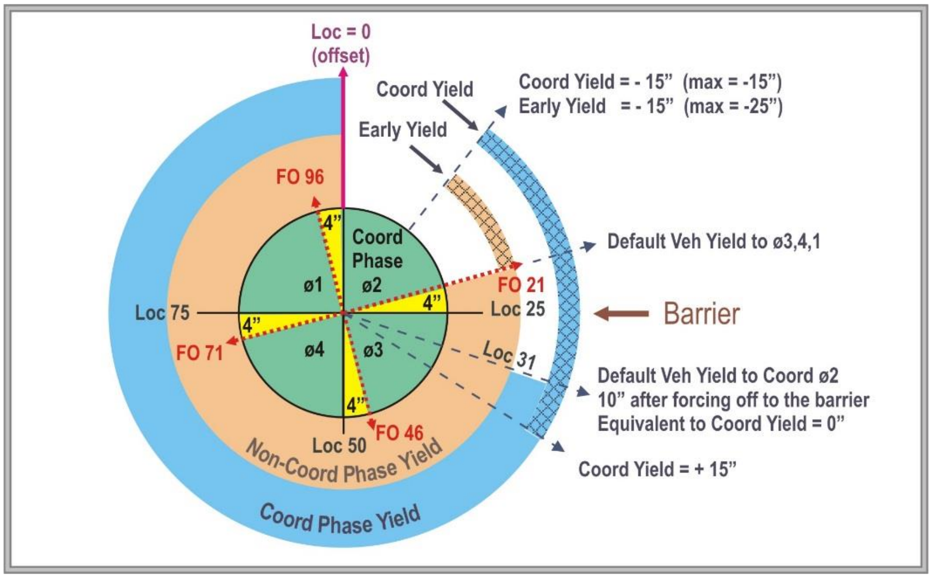
The *Flt* pattern option is provided to override the FIXED force-off method programmed under *Coord Modes* as discussed in section 6.2.1. If FIXED is selected as the default under MM->2->1, you can use this pattern option to override the force-off method as FLOAT on a pattern-by-pattern basis. This allows 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.



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

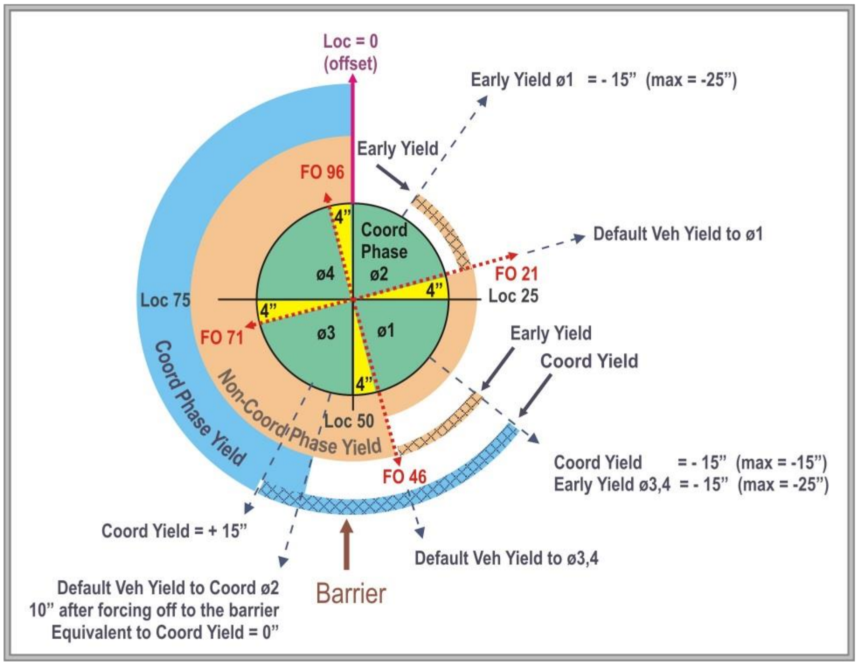
The *VehYield* point of the non-coordinated phases may be adjusted using *Early Yield* as defined in section

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:

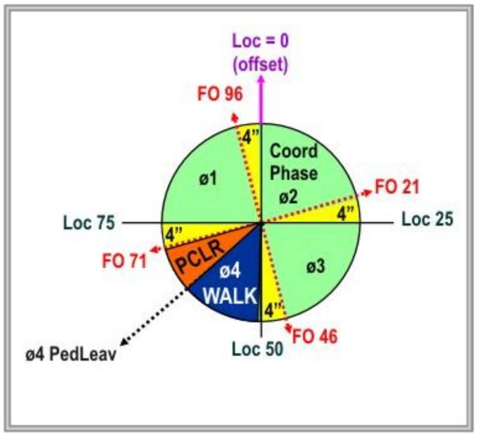
Min Perm V: Vehicle inhibit = Force Off minus the green portion of the Split under Fixed mode.
Vehicle inhibit = Force Off (FloatMax) minus the green portion of Split under Float mode.

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.

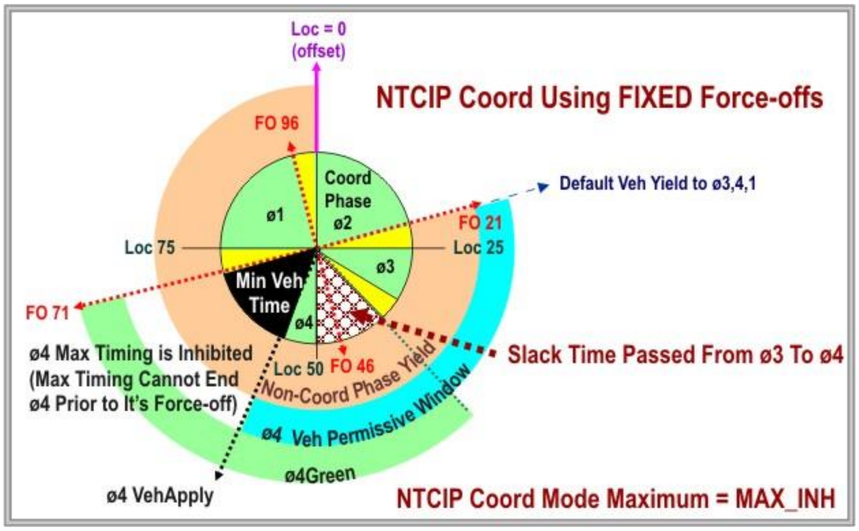
The *PedLeav* point is calculated by subtracting ped clearance time from the force-off point of the phase as shown above. If *Walk* Recycle is set to NO_RECYLE or NEVER, then *Rest-In-Walk* feature will not operate properly. Therefore, set *Walk_Recycle* under Coord Modes+ (MM->2->1, right menu) to recycle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

6.8 Maximum Phase Timing Using FIXED Force-offs

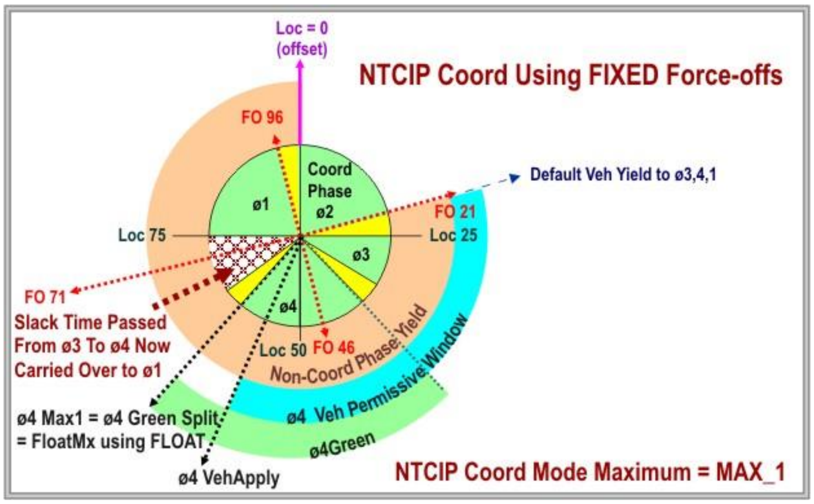
Force-offs calculated for FIXED and FLOAT are fixed points in the cycle that do not change even though phases may skip, gap-out early and transfer slack time to the next phase in the sequence. FIXED force-offs allow slack time to be used by the next phase in the sequence. Max phase timing under FIXED 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* (section 4.1.9) or the *Alternate Detector Programs* (section 5.2) 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 and is not available on the 2070.

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

The *Coordination Status Displays*:

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

- 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)
- 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

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

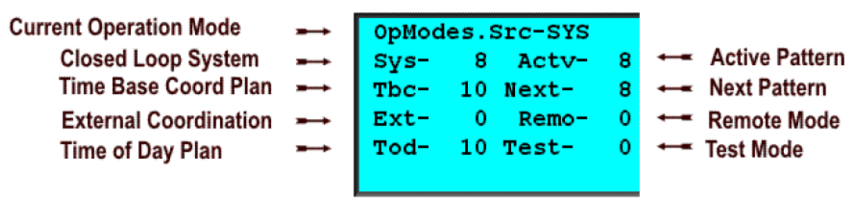
```
OpModes.Src-TEST  Cycle   Ofst  03:44:51
Sys-  0 Actv-  1  Loc- 41 Actu: 50 ACTIV
Tbc-  0 Next-  1  Tbc- 91 Err:   0
Ext-  0 Remo-  0 Prog-100 Prog: 50 SYNC
Tod-  0 Test-  1  Alt:.Opt.Time.Det.CIR
                       0    0    0    0
```

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.



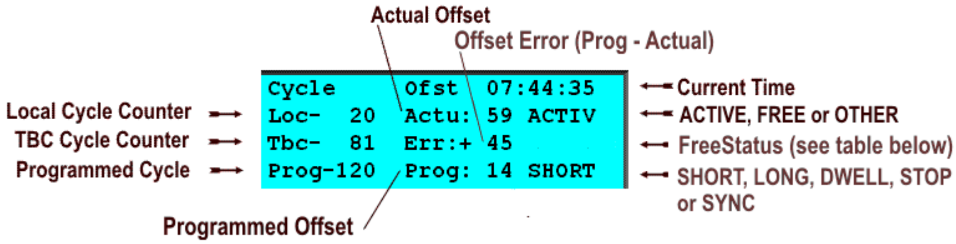
The controller may receive a pattern change from any of the *Coordination Modes* discussed in this chapter. These modes generate the *Source (Src)* of the *Active* pattern based on the following hierarchy of control:

- *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 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 section 7.10.2. (*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 section 7.1 in 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.

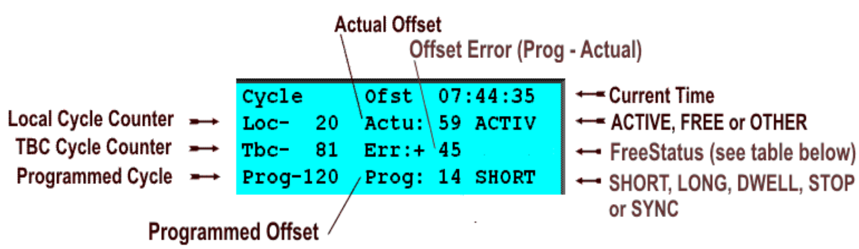
Note: Going to a FREE Pattern (NTCIP Pattern 254 or a *Free Pattern* which can be created using a zero second cycle length) will not guarantee that the time based sync references are recalculated and reestablished. Only going to a pattern of a different cycle length will do this.

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) 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.



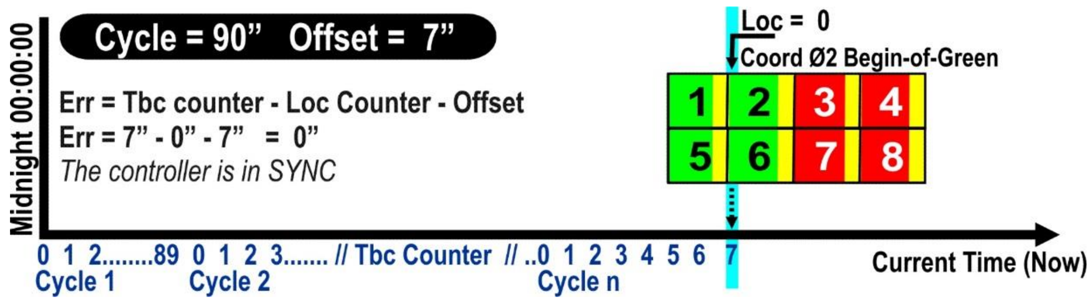
The *Programmed Offset* is added to the zero point of the Tbc counter to provide the "synch" point for the coord phase (either BegGRN or EndGRN) at Loc = 0. *Time Base Coordination* provides a way to synchronize the coord phases of all the controllers in a system running a common cycle length because 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:

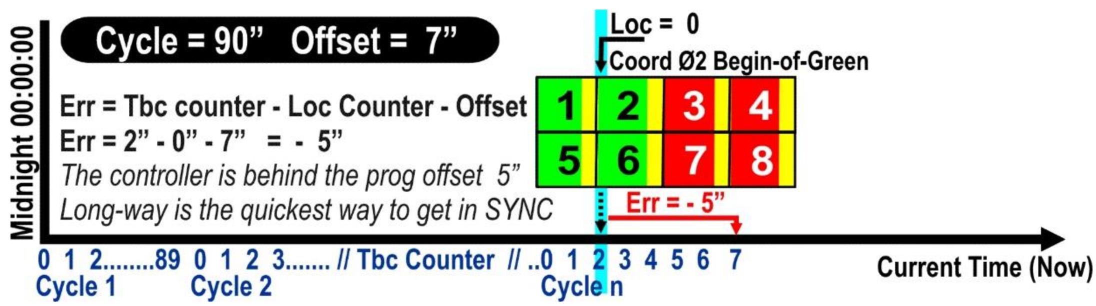
Err = Tbc counter – Loc counter - Prog Offset

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 Increasing Split Times 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 gre ens, 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 Decreasing Split Times 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.

6.10.2 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. *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 defaults to the value of Primary Force-off. **NOTE: This feature is not used in NTCIP Coordination which is the V65.x default.**

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) is calculated as:

Vehicle Apply Point (VehAply) = Primary Force-off – ((Max Yellow+Red of all Phases) + 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 is calculated as:

Ped Apply Point (PedAply) = Primary Force-off – ((Max Yellow + Red of all phases) + 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.

SplitRem

This is the remaining time in the split before the next cycle begins.

6.11 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.

6.12 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.

6.12.1 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) 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.

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

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.

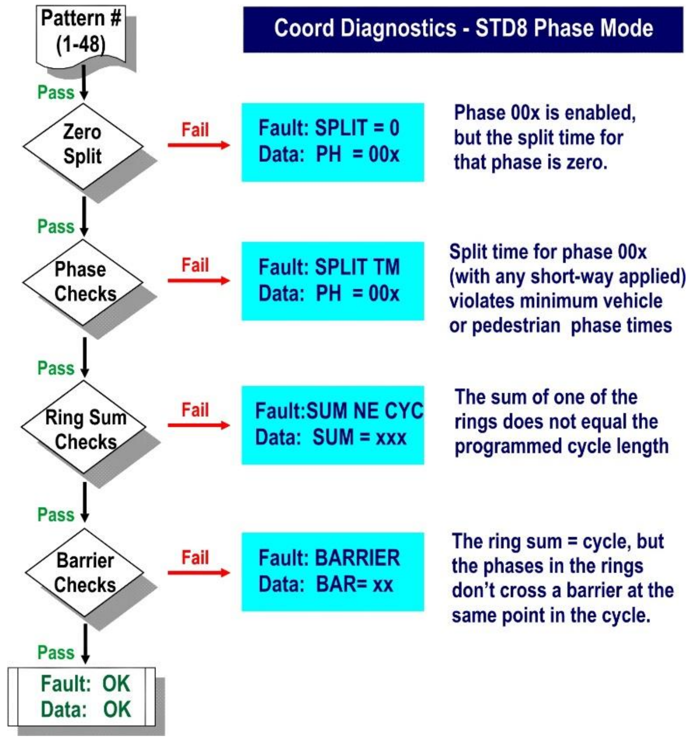
```
Coord Fault     P 1.......   9.......  >
       Skipped Ps --------   --------
       Pattern #    0
Press ENTR to Clear Fault
```

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).

6.12.3 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 StreetWise 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 may be FREE (0), ACTIV (1) or OTHER (2) and corresponds with the Coordination Status screen described 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 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 the StreetWise 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

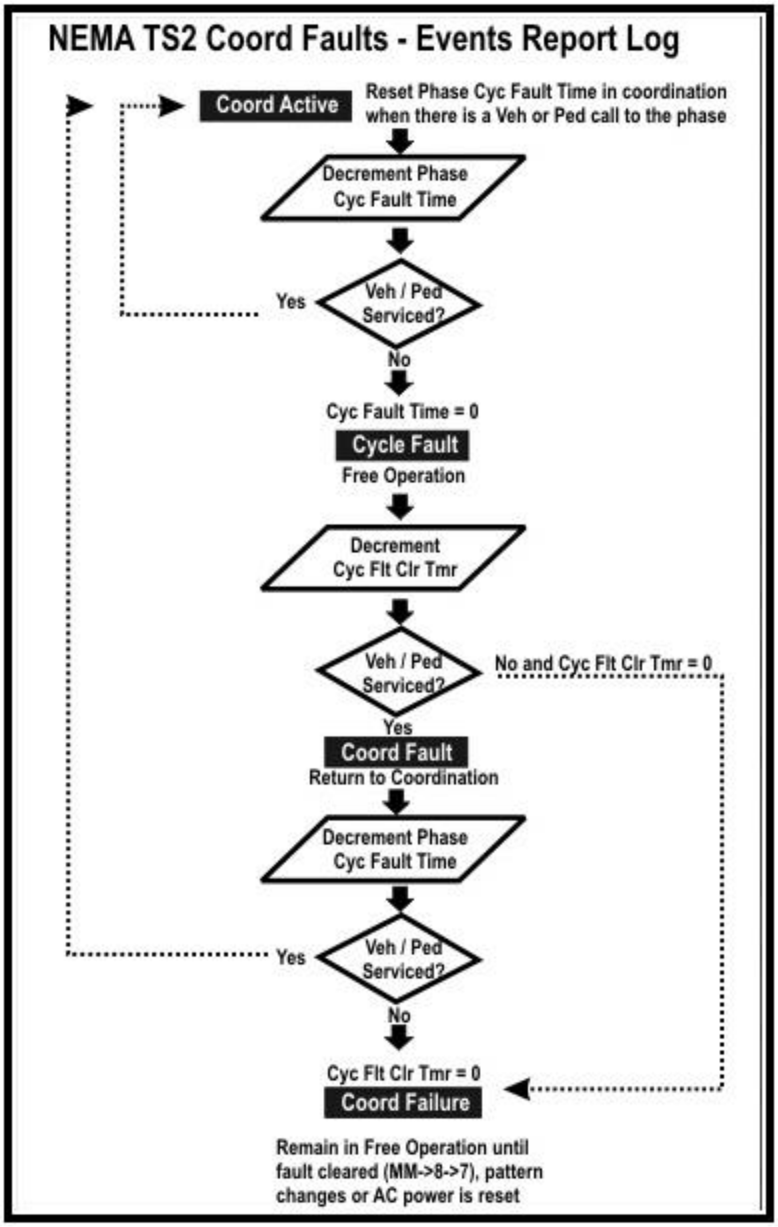
6.13 Coordination Alarm Considerations

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.

6.13.1 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)

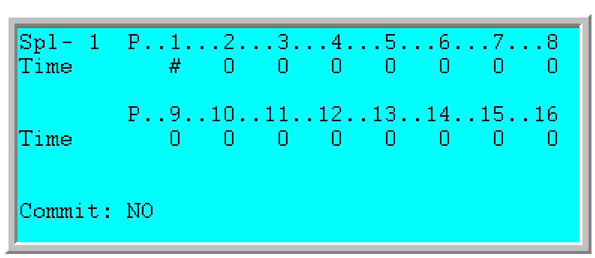
As explained above, a cycle failure is considered a critical problem, because it means that a phase was skipped in free or that once coordination went free, the phase that was skipped never ran. The controller gives you the option to report it as an alarm, and keep running – or, send the cabinet into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

6.13.2 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

6.14 Split Edit (MM->2->9->1)



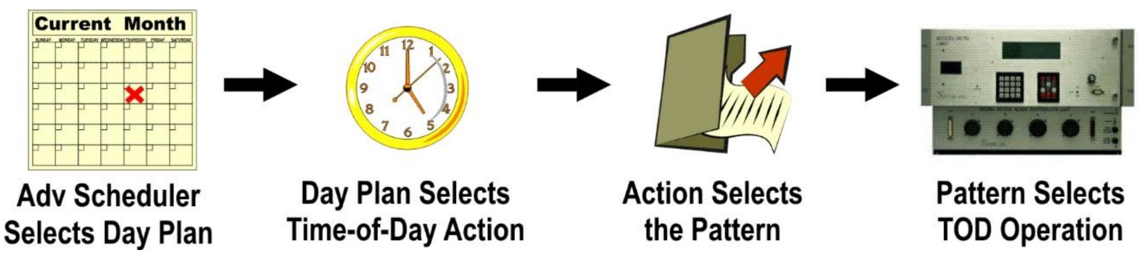
The Split Edit screen allows the user to specifically edit split times for splits 1-24. Uses can use this screen to modify the splits of the phases while the controller is currently running a coordination pattern. It is helpful when users take too long in modifying (editing) the split, and the controller begins to make the editing changes to the database, thus generating a coordination failure. Programming this screen allows all changes to be made without modifying the current running pattern until the users commit to it.

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. An *Easy Schedule* is provided 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 in ver. 60 & 61.

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.

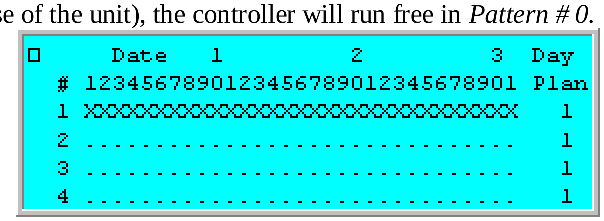
NOTE: Whenever making time changes to the clock using the Front Panel keyboard you must always reprogram seconds and that the reprogramming of seconds should be the last thing that is done.

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*.

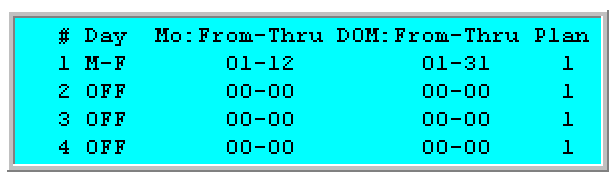
Date

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)

	Evt	Time	Actn	Evt	Time	Actn
Plan- 1	Evt	Time	Actn	Evt	Time	Actn
Link: 0	1	00:00	1	2	06:00	2
	3	09:00	3	4	16:00	4
	5	19:00	5	6	00:00	0
	7	00:00	0	8	00:00	0

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*.

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 Action 0 as the "do-nothing" action.** Therefore, do not be misled into thinking that Action 0 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)

Actn	Patrn	Aux-123	Spec-12345678	Pre.1.2
1	255	...	....	0 0
2	0	...	....	0 0
3	0	...	....	0 0
4	0	...	....	0 0
5	254	...	....	0 0

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.

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 a zero Action is no action and Pattern 0 always runs free. 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 2070 and TS2 Ver 50 controllers provide 3 *Aux* outputs and TS2 Ver 61 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 2070 and TS2 Ver 50 controllers provide 8 *Special Function* outputs and TS2 Ver 61 provides 24 *Special Function* outputs per action.

Preempt Outputs

The 2070 software allows the source of the inputs for preempt 1 and 2 to be programmed through the *Action Table*. The source for Pre.1 and Pre.2 may be set to a value between 0 and 4. Zero calls for the default input for each preempt. Setting Pre.1 to 3 would source preempt 1 with the input from Preempt 3 when the action is active.

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

```
        Time Base Parameters
Daylight Savings   : ENABLE US
Time Base Sync Ref:    0
GMT Offset         : +  0
Daylight Saving   Month   Week
           Spring    0      1
             Fall    0      1
```

The *Daylight Savings* parameter determines specifies if daylight savings is active, and which method is be used. Currently, 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 section 10.13).

Daylight Savings Time

The user is allowed 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.

7.8 Time Base Status (MM->4->7)

```
          TBC Current Status
   Sched Event #:  1   Action #:  1
      Day Plan #:  1
Day Plan Event #:  1
```

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 Time Base Scheduler – More Features (MM->4->9)

```
     Time Based Scheduler - more
1.Copy DayPlan
2.Control
3.GPS/WWV Status
```

7.9.1 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.

7.9.2 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.

7.9.3 GPS/WWW Status (MM->4->9->3)

See chapter 10 for further details.

8 Preemption

8.1 Preempt Selection (MM->3)

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.

```
Enter Preempt #

    then press ENTER
```

8.2 High Priority Preempts 1 – 6

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, 8.4.

```
# 1        Preemption
1.Times      4.Times+
2.Phases     5.Overlaps+  8.AdvTimes
3.Options    6.Options+   9.Init'lDwell
```

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)

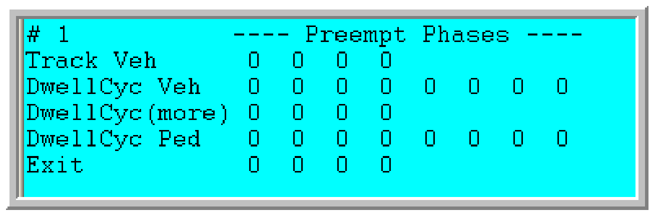
The *Track Green* parameter (0-255 sec) determines the green interval of the *Track Vehicle Phases* serviced during the track clearance movement. The track clearance movement is typically used only rail type preempts rather than high-priority or low-priority emergency vehicle preempts.

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)

Track Vehicle Phases (Track Veh)



```
# 1          ---- Preempt Phases ----
Track Veh      0  0  0  0
DwellCyc Veh   0  0  0  0  0  0  0  0
DwellCyc(more) 0  0  0  0
DwellCyc Ped   0  0  0  0  0  0  0  0
Exit           0  0  0  0
```

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. The user may specify track phases that are only enabled during preemption (phases that are normally omitted can be enabled during this period).

Dwell Vehicle (Dwell Cyc Veh) Phases

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. This version allows you to specify dwell phases that are enabled only during preemption (phases that are normally omitted can be enabled during this period).

Dwell Pedestrian (Dwell CycPed) Movements

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 preempt dwell interval unless the preempt *Stop-in-Walk* 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. For 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.*

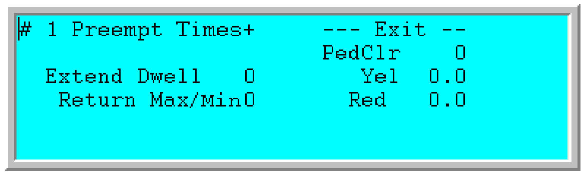
Flash in Dwell

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.

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.

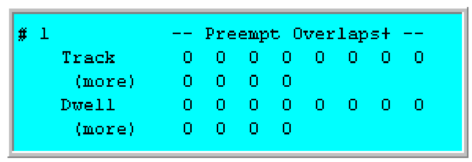
Return Max/Min

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.

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).

This version allows you 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.

When an overlap is timing a green extension and it is not programmed on this screen and the preempt is called, the overlap will begin to terminate and time the green extension immediately. If it is desired that this overlap acts normally (i.e. time the green extension when the included phase terminates) the user must program the overlap+ entry to allow the overlap to continue to be displayed while the preemption times.

8.2.6 Preempt Options+ (MM->3->6)

```
# 1      Preempt Options +
Enable OFF                   Pattern   0
  Type EMERG   Skip Track if Overide OFF
Output TS-2            Coord+Preempt  OFF
                      Volt Mon Flash  OFF
                      Return Max/Min  MAX
```

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 discussed in this chapter. 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.

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.

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.

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 [v65] Advanced Preemption timers (MM->3->8)

These times are used by the phases that are currently running prior to starting the preemption dwell interval and are used to **shorten** clearance times from their default programming. They are defined as follows:

```
# 1 AdvTimes
enterYellowChange25.5
enterRedClear    25.5
trackYellowChange25.5
trackRedClear    25.5
All Red B4 Dwell  OFF
```

EnterYellowChange (0-25.5 sec)

This parameter controls the yellow change timing for a normal Yellow Change signal terminated by a preemption initiated transition. A preemption initiated transition shall not cause the termination of a Yellow Change prior to its display for the **lesser** of the phase's Yellow Change time or this period.

CAUTION -- if this value is zero, the current phase Yellow Change is terminated immediately. If less than 3 seconds of Yellow time is needed for a phase, the user must allow the programming of this by turning **Allow <3 Sec Yel** parameter under the Unit parameters menu at MM→1→2→1 to “ON”. If not, the yellow time programmed for the phase in MM→1→1→1 will be used.

EnterRedClear (0-25.5 sec)

This parameter controls the red clearance timing for a normal Red Clear signal terminated by a preemption initiated transition. A preemption initiated transition shall not cause the termination of a Red Clear prior to its display for the **lesser** of the phase's Red Clear time or this period**.**

CAUTION -- if this value is zero, the current phase Red Clear is terminated immediately.

TrackYellowChange (0-25.5 sec)

The **lesser** of the phase's Yellow Change time or this parameter controls the yellow timing for the track clearance movement. Track clear phase(s) are enabled at MM→3→2.

CAUTION -- if this value is zero, the current phase Yellow Change is terminated immediately. If less than 3 seconds of Yellow time is needed for a phase, the user must allow the programming of this by turning **Allow <3 Sec Yel** parameter under the Unit parameters menu at MM→1→2→1 to “ON”. If not, the yellow time programmed for the phase in MM→1→1→1 will be used.

TrackRedClear (0-25.5 sec)

The **lesser** of the phase's Red Clear time or this parameter controls the Red Clear timing for the track clearance movement. Track clear phase(s) are enabled at MM→3→2.

CAUTION -- if this value is zero, the current phase Red Clear is terminated immediately.

NOTE: The default programming of 25.5 seconds for these timers will insure that Yellow Clearance and Red Clearance timers programmed under MM->1->1-> 1 are adhered to during preemption.

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.

8.2.8 Init' Dwell (MM->3->9)

Consider the programming of these parameters as entry phases prior to running the limited service preemption phases. The user can program any combination of phases, pedestrians or Overlaps to be run one time prior to running the Dwell phases as programmed at MM→3→2. The amount of time that these phases will run is based on the timing programmed under MM→1→1→1.

```
# 1         --    Initial Dwell    --
Phases      0   0   0   0
Peds        0   0   0   0
Overlaps    0   0   0   0   0   0   0   0
  (more)    0   0   0   0   0   0   0   0
```

8.3 Low-Priority Preempts 7 – 10

Low-priority preempts are dedicated to preempt # 7 – 10 and can be used for bus and EMERG (emergency vehicle) preemption. Preempts 7 – 10 may be enabled as bus preempts by setting the *Bus Prmp* parameter to ON in menu MM->3->7 (below). Preempts 7 – 10 may also be enabled as low-priority emergency vehicle preempts by setting the *Bus Prmp* 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 bus 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)	BUS or EMERG – L Prior	7 EMERG shares programming with preempt 3
8	4 (oscillating)	BUS or EMERG – L Prior	8 EMERG shares programming with preempt 4
9	5 (oscillating)	BUS or EMERG – L Prior	9 EMERG shares programming with preempt 5
10	6 (oscillating)	BUS or EMERG – L Prior	10 EMERG shares programming with preempt 6

A bus 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 programming associated with the high-priority preempt to transfer control to the high-priority dwell phase. When a low-priority bus 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 bus preempt will then move immediately to the bus phase specified in the menu above.

8.3.1 Low Priority Specific Screens

The following screen is used for low priority preemption programming:

```
# 7 Bus Preempt    Times     Prior.Phases
   Enable OFF    Min    0      0  0  0  0
 Coor+Pre OFF    Max    0
 LockMode MAX    Lockout    0
 NoSkip   ON
```

Enable

The *Enable* parameter must be set to ON to enable bus preemption or OFF to disable the preempt. The parameter may also be set to EMERG to enable a low-priority emergency vehicle preemption or TRANS for a Transit preemption variable.

The primary difference between the ON (bus preempt) option and the EMERG (low-priority emergency vehicle) or TRANS options lies in the preempt response during coordination. A preempt 7 bus preempt will be recognized as the low-priority preempt which shares a preempt input with *Preempt #3*.

Please ensure if **Enable** is set to ON, EMERG or TRANS that at least one non-zero priority phase is programmed.

Prior Phases

Whenever a 6.25 Hz oscillating signal is applied to this input, the controller will either dwell in the Prior *Phases* specified if these phases are active, or move immediately to the *Prior Phases* without violating the min times and pedestrian times of the phases currently being serviced.

Please ensure if **Enable** is set to ON, EMERG or TRANS 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 in the high priority preemption section. 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 preemption 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).

LockMode and Lockout Time

The *LockMode* (*Max_Lockout)* parameter inhibits the preempt input for the specified *Lockout* value (0-255 seconds) after the preempt *Max* Time is exceeded.

NoSkip

Setting **NoSkip** to **ON** services only the minimum times for all phases with calls prior to serving the transit phase(s). Think of it as “a poor man’s transit” because in effect, it reduces each phase to the phase minimum prior to serving the transit phase(s). 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). Setting **NoSkip** to **OFF** will time out (gap out, max out or force off) the phase it is currently in and immediately move to the LP preemption phase(s).

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.

```
                 Status Displays
1.Timing        4.Reserved          7.Rpts/Buffs
2.Coord         5.Alarms            8.Reserved
3.Reserved      6.Comm Ports        9.More
```

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.

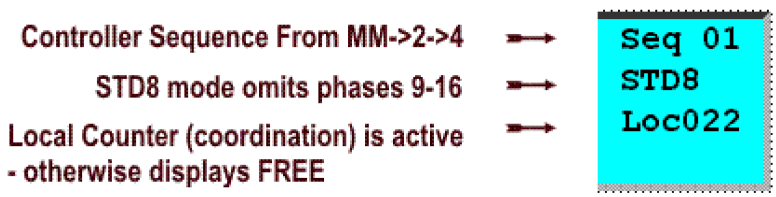
```
R1 Max1  25   P.12345678 90123456 seq 01
P2 Rest 0.0 A/N .A...A.. ........ STD8
R2 Max1  25 Veh ........ 00000000 Loc098
P6 Rest 0.0 Ped ........ ........ CoorAc
```

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.

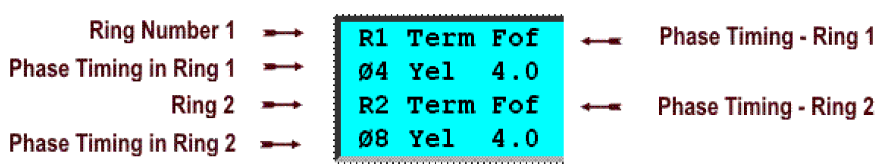


Ring Status and Phase Timing

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 section 6.8).



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

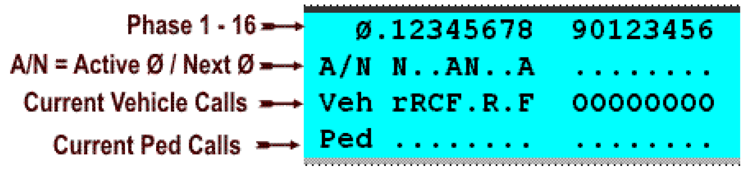
"AdIn", "MxIn" or "T/Act" ring statuses will be displayed as appropriate after minimum green has expired and while added initial or max initial are timing.

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.
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 section 6.11 for a discussion of the *Coord Status Display*.

9.1.3 Alarm Status Display (MM->7->5)

Events and *Alarms* are discussed in section 4.7. 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 section 10.13.

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 section 5.4.

9.1.6 Overlaps Status Displays (MM->7->9->1)

The *Overlap Status* screen is equivalent to MM->5->8 and is documented in section 4.6.

9.1.7 Easy Calcs (MM->7>9->2)

The *Easy Calcs* are documented in section Chapter 6. This menu is equivalent to menu MM->2->8->2.

9.1.8 Overview Status Screen (MM->7>9->5)

The *Overview Status Screen* is documented at the end of Chapter 3.

9.1.9 Phase Input / Inhibits (MM->7>9->6)

```
Input/Inh Status      P1......8  9......6
    Coord Inhibit      --**--**  ********
  Preempt Inhibit      --------  --------
       Hold Input      --------
 Phase Omit Input      --------
   Ped Omit Input      --------
```

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.

The NTCIP Ped Omits are applied remotely via an NTCIP communications object.

9.1.10 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.

9.1.11 Screen Calls (MM->7>9->9)

```
 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            ......
```

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.

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.

```
         Login and Utilities
1.Login     4.Init DBase 7.Clear Fault
2.SetAccess
3.Reserved  6.Diag Log   9.Remove Apogee
```

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.

```
Access    .#..Code..Level
Codes      1     0  NONE
           2     0  NONE
           3     0  NONE
           4     0  NONE
```

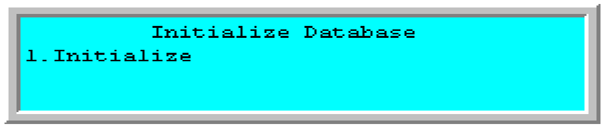
A maximum of 64 individual users and 4-digit access codes may be programmed by a SECUR user. Therefore, if access security is used, at least one access # should have *SECUR Level* access.

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 Initialize Controller Database (MM->8->4)

2070 Initialization screens



The screens for the 2070 are simpler but as powerful as the TS2 screens.

Initialize 2070 Database (MM→8→4→1)

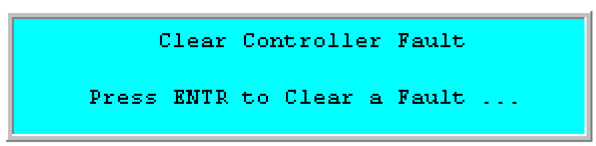
Initialize Database should be executed whenever new controller software is loaded in the 2070 controller (discussed in the next section). The controller may be initialized to one of the following default databases:

- **NO ACTION**: this default will ignore initialization
- **FULL-CLEAR**: this 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.
- **FULL-STD8**: this is the most appropriate default database and initializes the controller to 8 phase dual ring operation, often called quad-left operation
- **FULL-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.

Normally the user will choose Full-STD8 to initialize the controller and do all the I/O mapping the traditional way as outlined in Chapter 12. For those agencies that would like to utilize simple input mapping an extra step after initialization will have to be done. It is accessed through this menu and is described below.

- **FULL NYSDOT-0 and NYSDOT-8** These are custom modes defined by the State of New York. NYSDOT-8 is intended for testing purposes and NYSDOT-0 is intended as a template for creating new controller databases. Phase timing and channel outputs are not defined in NYSDOT-0 and all phases are disabled. The phase mode in NYSDOT-0 is STD8 and the IO Mode for the C1 connector is USER. The intent of these defaults is to require the user to program the inputs to the C1 connector from the 33.x INPUT FILE.
- **FULL MODE 7** This custom mode is used by Broward County for their customized cabinets.
- **FULL CALTRANS** This custom mode is used by agencies that utilize CALTRANS 332 and 336 cabinets.

9.2.3 Clear Controller Fault (MM->8->7)



"Critical SDLC Faults" isolate errors defined by the NEMA TS2 SDLC 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.

9.2.4 Remove Apogee (MM->8->9)

This screen will remove the Apogee software from the 2070. The user is cautioned not to select this feature until contacting your company representative for detailed information.

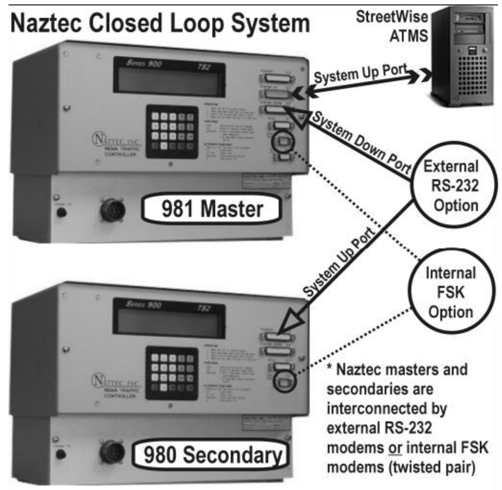
10 Data Communications

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 provided with the 2070.

10.2 ATMS/StreetWise Communications



StreetWise 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 or 2070 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 Parms          SysUp Modem Parms
StationID   :     0    EnableMdm :OFF
GroupID     :     0    IdleTime  :  0
MasterID    :     0    DialTime  :  0
BackupTime  :     0    Tel:0,0-000-000-0000
                       Alt:0,0-000-000-0000
```

MM->6->1

StationID (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 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.

MasterID (Range 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.

Backup Time (TS2 NTCIP and 2070 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 <u>any</u> valid poll received from a closed loop master or from the central office (StreetWise). 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 *Backup Time* of 900 seconds (equivalent to 15 minutes) is typically used for secondary controllers operating in a closed loop system. The user must program a backup time is using serial communications in a Closed loop system. This timer ranges from 0-9999 seconds.

A separate MIB called *Fallback Time* in the TS2 controller is provided to insure that the secondary receives the Sys generated pattern from the closed loop master before the Fallback Time expires.. The 2070 controller uses the NTCIP *Backup Time* to test the communications, so any poll received by the secondary resets the *Backup Time*.

EnableMdm

The enable field is used to turn the Modem port on or off. In the off position, the port is not available for dial-up communications.

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.

IdleTime

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.

Tel

This is the primary telephone number the controller uses to establish communications.

Alt

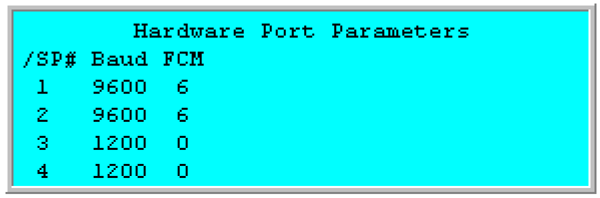
This is the secondary telephone number the controller uses to establish communications. This number will be used if the dial time expires without a connection when attempting to connect using Tel. If the controller is unable to connect using Alt, it will try again using Tel.

10.4 2070 Communications Port Parameters (MM->6->2)

After a system reset (SYSRESET), the 2070 serial ports are initialized as follows. The board label and slot position of each SP port are also provided as a reference. Note that the port must be assigned to the correct slot position in the 2070. Slot positions are read left to right with A1 at the far left when viewed from the back of the controller.

Serial Port	Board	Slot	Connector	Default Settings When the 2070 is Reset
SP1	2070-7A	A2	C21S	1.2 Kbps, 8-bit, 1 stop, no parity, no pause, no echo
SP1S	2070-7B	A2	TBD	1.2 Kbps, 8-bit, 1 stop, no parity, no pause, no echo
SP2	2070-7A	A2	C22S	
SP2S	2070-7B	A2	TBD	
SP3	2070-7A	A1	C21S	
SP3S	2070-2A/2B	A3	C12S	614.4 Kbps
SP4	FPA		C50S	9.6 Kbps, 8-bit, 1 stop, no parity, no pause, XDR off, xoff
SP5S	2070-2A/2B	A3	C12S	614.4 Kbps
SP8	2070-1B	A5	C13S	
SP8S	2070-1B	A5	C13S	

The *Communications Port Parameters* under menu MM->6->2 (menu to the right) allow you to change the default baud rate settings and the FCM (Flow Control Mode) of the eight 2070 serial ports. This programming overrides the default baud rate settings shown to the right when the 2070 is reset.



FCM	Description of FCM (Flow Control Mode)
0	**No Flow Control Mode:** The CTS and CD signals are set asserted internally, so the serial device driver can receive data at all times. Upon a write command, the serial device driver asserts RTS to start data transmission, and de-asserts RTS when data transmission is completed. When user programs issue the first RTS related command, the driver switches to Manual Flow Control Mode.
1	**Manual Flow Control Mode:** The serial device driver transmits and receives data regardless of the RTS, CTS, and CD states. The user program has absolute control of the RTS state and can inquire of the states of CTS and CD. The states of CTS and CD are set externally by a DCE. The device driver doesn't assert or de-assert the RTS.
2	**Auto-CTS Flow Control Mode:** The serial device driver transmits data when CTS is asserted. The CTS state is controlled externally by a DCE. The user program has absolute control of the RTS state. The CD is set asserted internally. The device driver doesn't assert or de-assert the RTS.
3	**Auto-RTS Flow Control Mode:** The CTS and CD are set asserted internally. The serial device driver receives and transmits data at all times. Upon a write command, the serial device driver asserts RTS to start data transmission, and de-asserts RTS when data transmission is completed. If the user program asserts the RTS, the RTS remains to be on until user program de-asserts RTS. If user program de-asserts RTS before the transmitting buffer is empty, the driver holds RTS on until the transmitting buffer is empty. Parameters related to delays of the RTS turn-off after last character are user configurable.
4	**Fully Automatic Flow Control Mode:** The serial device driver receives data when CD is asserted. Upon a write command, the serial device driver asserts RTS and wait for CTS, starts data transmission when CTS is asserted, and de-asserts RTS when data transmission is completed. Parameters related to delays of RTS turn-off after last character are user configurable. If user program asserts the RTS, RTS remains to be on until user program de-asserts RTS. If user program de-asserts RTS before the transmitting buffer is empty, the driver holds RTS on until the transmitting buffer is empty.
5	**Dynamic Flow Control Mode:** The Serial device driver maintains a transmit buffer and a receive buffer with fixed sizes, controls the state of RTS and monitors the state of CTS. The transmission and reception of data are managed automatically by the serial device driver. The serial device driver transmits data when CTS is asserted. The serial device driver asserts RTS when its receiving buffer is filled below certain level (low watermark), and de-asserts RTS when its receiving buffer is filled above certain level (high watermark).
6	**Cubic | Trafficware Enhanced Flow Control Mode**: This is the recommended flow control mode for all RS-232 applications using the 2070. This mode combines the features of modes 0 and 2 and provides a hardware RTS/CTS handshake with any device connected to the serial port. However, request-to-send and clear-to-send are controlled directly from the control program rather than through the OS-9 operating system. This method allows the control program to communicate with some devices that cannot be interfaced through OS-9.

FCM definitions above were taken from Section 9.2.7.2.5, CALTRANS TEES Specification dated November 19, 1999

10.5 Request Download (MM->6->4)

The *Request Download* screen allows an operator in the field to request a download of the local's permanent file in the Central database by selecting **LOCAL** from the menu shown in the menu to the right. In addition if the controller has master software on it, **MASTER** will request a download of the master's permanent file in the Central database.

10.6 General IP Setup (MM->6->5)

The IP Setup menu configures the IP (Internet Protocol) ports. To enable Ethernet support, you must 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.

10.6.1 Specific 2070 IP Setup

```
               IP Setup
     IP 1               Hosts
     ---------------    ---------------
Addr 192.168.104.108 1)  0.   0.   0.   0
Mask 255.255.255.255 2)  0.   0.   0.   0
Bcst    0.   0.   0.   0
Gate 192.168.104.254
Port   5010
```

The *IP Setup* menu configures the IP (Internet Protocol) ports implemented through the controller's Ethernet interface (2070-1B CPU Module). The IP settings are used to identify a 2070 residing on a TCP/IP network like the Station ID is used to identify a controller residing on a serial data link.

You must 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. The Bcast (Broadcast) address and GtWay (Gateway) address settings are optional, but may be required for your network configuration. You must also provide an IP *Port* number which will match the port number in the particular Drop that you are communicating with as specified in StreetWise or ATMS. Ask your network administrator or the one who configured your network to explain how these additional settings are used if you need additional information.

The *IP Address* and *Mask* must be configured correctly for the local network. IP 1 is assigned to the local controller. The *Broadcast* and Gateway addresses are allowed to be set to 0.0.0.0 when subnet addressing or routing is not called for. Changes to *IP Setup* should take effect when the user leaves menu MM->6->5. As noted above, depending on the controller hardware platform, any time that you change the IP settings from menu MM->6->5, you may have to toggle controller power to cause changes in the IP settings to take effect.

10.7 2070 Binding (MM->6->6)

```
                Port Binding
Async   Hdwr                   Sync    Hdwr
Chan    Port   Echo/Mode       Chan    Port
Async1: SP1    NONE    0       Sync1:  SP5S
Async2: SP2    NONE    0       Sync2:  SP3S
Async3: SP8    NONE    0
Async4: OFF    NONE    0
                                          +
```

```
                Port Binding
Func      Chan                            -
TS2 CVM:  ASYNC3
CMU/MMU:  NONE
Opticom:  NONE
LoopDet:  NONE
GPS     : NONE
SysUp   : NONE                            +
```

The *Binding* menu associates the physical hardware ports of the 2070 controller with the logical ports assigned through software. Please refer to section 14.4 if you are not familiar with the 2070 I/O modules.

For most applications, "Software Ports" SP1 and SP2 correspond with the 9-pin serial connectors, C21S and C22S on the 2070-7A card. Recall from the table in section 9.5 that the 2070-7A card must reside in slot A2 to support these two ports.

The FIO 20 interface supports the ATC cabinet and the 2070N expansion chassis. This interface requires that "Software Port" SP5 correspond with the FIO 20 interface. The hardware connector for FIO 20 is identified as the C12S connector on the 2070-2A and 2070-2B Field I/O Modules. These parameters are set by hardware and cannot be changed from their defaults: FIO20 = SYNC1 and TS2IO = SYNC2.

The FIO 20 interface must also be assigned to SP5 to interface the Cubic | Trafficware Test Box with the C12S connector. The Cubic | Trafficware Test Box essentially emulates the operation of the 2070N expansion chassis.

The user should power cycle the controller to insure that the port changes have been bound.

10.8 Basic IP Interface Connectivity Test

The following guidelines should be used to test basic connectivity between a 2070 controller and a laptop computer. The test has been created using typical agencies IP addressing setups. The communication protocol for the 2070 is NTCIP by default.

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 (typically the IP 1 address for the 2070).

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 StreetWise communication server, but you cannot communicate with the same controller in StreetWise, then you have an error in your com server software configuration.

10.9 2070 Com Status

The TS2 *Communication Status Screen* monitors the activity of each communication port and shows transmitting (TX) or receiving (Rx) bytes as well as an indication of communications activity.

	Rx....................				Tx.........	
Chan	Bytes	Count	Error	CRCEr	Bytes	Count
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
Enet	0	0	0	0	0	0
C-Clear Counters						

10.10 GPS Interface

Our controllers can be used to update the time sync from a Garmin GPS receiver such as the Garmin GPS 16x (shown to the right). 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 ATMS system.

see: https://buy.garmin.com/en-US/US/p/13194/pn/010-00258-63#

The following steps are required to setup the GPS interface.

1) The 2070 provides 4 hardware serial ports (SP1, SP2, SP3 and SP8) which may be assigned to the 4 logical ports (ASYNC 1-4) under the port binding menu. The default programming assumes that SP1 and SP2 located on the 2070-7A card are assigned to ASYNC1 and ASYNCH2 respectively. SP8 is typically assigned to ASYNC3 and dedicated for the internal hardware of the controller.

   In the example to the right, SP1 on a 2070-7A card is assigned to the system and SP2 is assigned to the GPS unit. The baud rate of SP2 must be set to 4800 under MM->6->2 as shown below.

```
                     Port Binding
Async   Hdwr                           Sync   Hdwr
Chan    Port    Echo/Mode              Chan   Port
Async1: SP1     NONE    0              Sync1: SP5S
Async2: SP2     NONE    0              Sync2: SP3S
Async3: SP8     NONE    0
Async4: OFF     NONE    0
                                                  +
```

```
                     Port Binding
Func       Chan                                   -
TS2 CVM:   NONE
CMU/MMU:   NONE
Opticom:   NONE
LoopDet:   NONE
GPS     :  ASYNC2
SysUp   :  ASYNC1                                 +
```

```
        Hardware Port Parameters
/SP# Baud FCM
 1    9600  6
 2    4800  6
 3    1200  0
 4    1200  0
 5    1200  0
 6    1200  0          +
```

2) Set the baud rate of GPS com port to "4800" under MM->6->2.

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.

```
         Time Base Parameters
  Daylight Savings: ENABLE US
Time Base Sync Ref:     0
        GMT Offset: + 0
```

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.

```
GPS/WWV Status
  Atmpt 00-00-00 00:00   Resync: NO
  Sync  00-00-00 00:00
```

   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

NOTE: If a function port is not assigned, then the GPS status screen at MM->4->9->3 displays "NO PORT" at all times.

11 SDLC Programming

```
            TS2 & FIO SDLC
1.TS2 Devices 4.MMU Permissives 7.Status
2.Parms       5.MMU Map
```

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 and is 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->1)

```
SDLC Device: Term/Fac  Detector MMU Diag
     BIU #:  12345678  12345678
Dev. Present XX......  X.......  X   .
Peer-to-Peer ........  ........  .   .
```

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.

11.1.2 SDLC Parameters (MM->1->3->2)

```
          SDLC Parameters
Alt T&F Biu Map: Single TF BIU
SDLC Retry Time:   0
TS2 Det Faults : ON
```

The following SDLC parameters modify the default operation of the SDLC interface for the TS2 and 2070 controller versions.

Alt T&F Biu Map

The default terminal facility map provides 16 channel outputs. The *Alt T&F Biu Map* parameter may be set to 24 OUT CHAN to support a custom cabinet with up to 24 output channels. Setting this parameter to Single TF BIU provides 8 output channels with a reduced cabinet footprint.

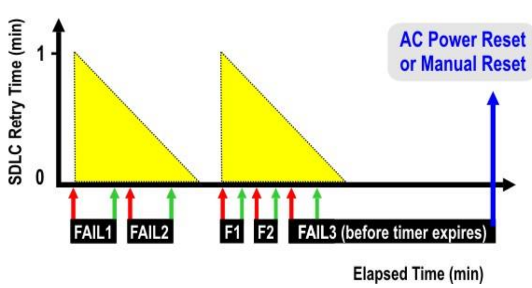
SDLC Retry Time

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 unit. Set 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, we recommend that *SDLC Retry Time* should be set to zero as a default to trap all SDLC errors at the first failure.

TS2 Detector Faults

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 should be set to OFF, thereby preventing numerous unwanted detector events from being reported upon power-up.** If TS2 Detector Fault is set to ON-RST, 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)

MMU Permissives are only required in TS2 type-1 cabinet configurations using a MMU. 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.

```
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 . . . . . .
```

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)

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.

```
   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
```

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 SDLC Status Display (MM->1->3->7)

```
 I/O Device Message Status ('C'-Clears)
Device     Addr  Tx  Rx    Errors  Status
FIO         20                  0  OK
MMU         16    0 128         0  OK
MMU         16    1 129         0  OK
MMU         16    3 131         0  OK
TF BIU1      0   10 138         0  OK
TF BIU2      1   11 139         0  OK
```

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.

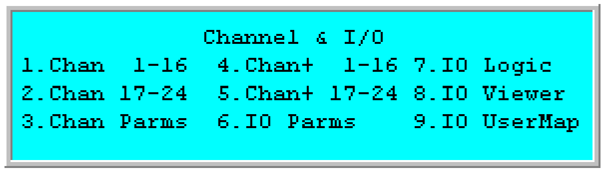
11.1.6 Clearing Critical SDLC Faults (MM->8->7)

"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 ...
```

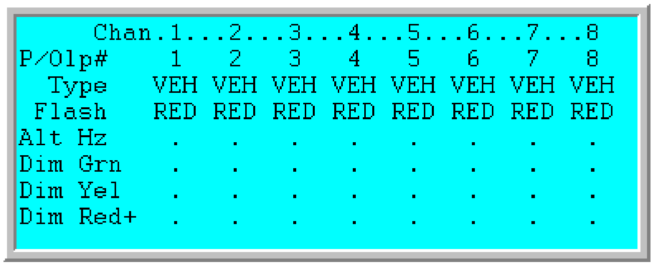
12 Channel and I/O Programming

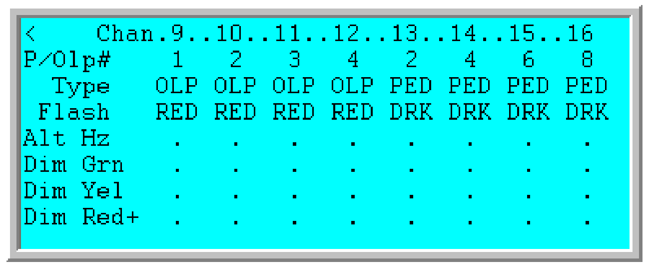


12.1 Channel Assignments (MM->1->8->1)

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





M->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#).*

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* (section 4.9.1) 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.

12.2 Chan+ Flash Settings (MM->1->8->4)

The Chan+ settings allow the user to flash any combination of outputs for channels 1-24. In addition, the user can turn off flashing red outputs for a particular phase during all preemptions.

```
     Chan.1...2...3...4...5...6...7...8
Flash Red .   .   .   .   .   .   .   .
Flash Yel .   .   .   .   .   .   .   .
Flash Grn .   .   .   .   .   .   .   .
Inhibit Red Flash in
  Preempt .   .   .   .   .   .   .   .
```

12.3 Channel Parameters (MM->1->8->3)

```
          Channel Parameters
Chan 17-24 Mapping: DEFAULT
    D Conn Mapping: NONE
Invert Rail Inputs: OFF
C1-C11-ABC IO Mode: AUTO
```

The *Channel I/O Parameters* allow the user to customize I/O assignments for 2070 and 2070N controllers.

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

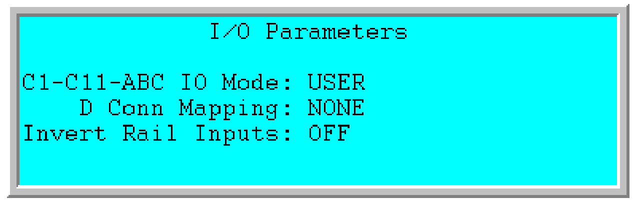
D-connector Mapping defines the inputs and outputs of the D-connector for one of the following cabinet configurations. Chapter 14 lists the pin-out assignments for the D-connector for each of these settings.

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.
TEES	Caltrans TEES pinouts
USER	User defined and mapped setup
820-VMS	820 VMS Mapping
40-DETECT	40 Detector mapping
MODE 7]	Mode 7 Mapping

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.

12.4 IO Parameters



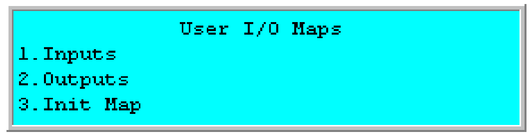
The 2070 *IO Parameters* are found at **MM->1->8->6.** The 2070 *IO Parameter* supports custom modes for the C1 connector. In addition, the 2070 provide a USER mode that allows the user to redefine any input or output provided on the C1 connector.

C1-C11-ABC IO Mode (2070 Only)

This setting remaps the C1-C11 connector of the 2070 controller and the A-B-C connectors of the 2070N controller.

NONE	Disables the I/O for the 2070 and 2070N controllers
AUTO	Applies the I/O standard published in the CALTRANS TEES Specification
Mode 0	Reserved
Mode 1	Applies the New York DOT I/O mode settings
Mode 2	Applies the Dade County, Florida I/O mode settings
Mode 3-7	Reserved
USER	Applies USER I/O mapping programmed through MM->1->3->6 discussed in the next section.

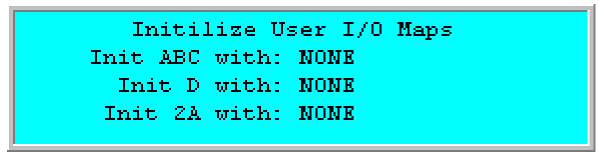
12.5 2070 IO User Map (MM->1->8->9)



MM->1->8->9 is used to customize the I/O pin assignments for the 2070 C1-C11 connector and the A-B-C connectors (2070N version).

Customizing the I/O maps for the 2070 involves three steps:

- Step 1 – Set *C1-C11-ABC IO Mode to* **USER** under menu MM->1->8->6
- Step 2 **-** Initialize the User I/O Maps from MM->1->8->9->3 (menu shown to the right)
- Step 3 – Customize the I/O Maps under MM->1->2 with selection *1.Inputs* and *2.Outputs*



Selecting *3.Init Map*, from the menu above allows NEMA A-B-C, D-connector and 2A (C1) connector to be initialized with several factory default settings as shown below

Initializing the 2070 ABC, D and 2A Connectors (MM->1->8->9->3)

The **ABC connector configurations** for the 2070N are:

- **NONE** – A-B-C inputs and outputs deactivated
- **AUTO** – default NEMA TS1 A-B-C I/O (Mode 0)
- **Mode 0–7** – Modes 0-5 (defined by NEMA) and Modes 6 and 7 (defined by the manufacturer) are listed in Chapter 14. The 2070 I/O mode is selected by initializing ABC from the above menu. The TS2 I/O modes are specified as a *Unit Parameter* (see section 4.11). These modes only applies to the TS2 and not to the 2070.
- **USER** – allows the user to configure each pin of the A-B-C connectors for the 2070N from menu MM->1->8->9

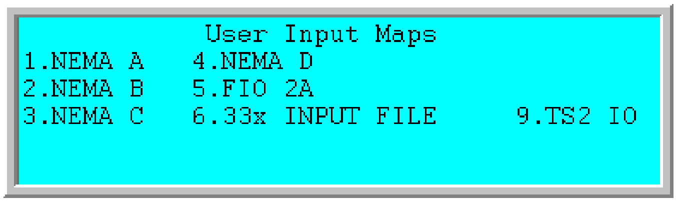
The **D connector configurations** for the 2070N controller are:

- **NONE** – All D-connector inputs and outputs are deactivated.
- **TEES** – The D-connector conforms to the TEES configuration defined in Chapter 14.
- **820A-VMS** – The D-connector conforms to I/O map of the 820A controller.

The **2A (C1) connector configurations** are:

- **NONE** – All C1-connector inputs and outputs are deactivated.
- **Mode 0** – C1 inputs and outputs conform to the latest Caltrans / SCDOT 2070 TEES specification. This will be used with Model 332/336 cabinets.
- **Mode 1**– C1 inputs and outputs conform to 179 controller defaults defined by the New York DOT. This will be used with Model 330 cabinets.
- **Mode 2-** Reserved
- **Mode 3-** Reserved

12.6 Customizing 2070 Inputs (MM->1->8->9->1)



After initializing the default I/O, you may customize the input maps selecting *1.Inputs* from MM->1->8->9->1. Each input pin on the A-B-C connector, D-connector and 2A (C1) connector may be redefined using the function numbers provided in the chart below.

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
5	Veh Call 5	55	Veh Call 55	105	Veh Chng 41	155	Ph Omit 3	205	Pre 8 In
6	Veh Call 6	56	Veh Call 56	106	Veh Chng 42	156	Ph Omit 4	206	Cab Flash
7	Veh Call 7	57	Veh Call 57	107	Veh Chng 43	157	Ph Omit 5	207	Comp StopTm
8	Veh Call 8	58	Veh Call 58	108	Veh Chng 44	158	Ph Omit 6	208	Local Flash
9	Veh Call 9	59	Veh Call 59	109	Veh Chng 45	159	Ph Omit 7	209	TBC 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
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	Plan A
17	Veh Call 17	67	Veh Chng 3	117	Veh Chng 53	167	R1 OmtRdClr	217	Plan B
18	Veh Call 18	68	Veh Chng 4	118	Veh Chng 54	168	Non-Act I	218	Plan C
19	Veh Call 19	69	Veh Chng 5	119	Veh Chng 55	169	R2 Frc Off	219	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	33x Flash Sense
29	Veh Call 29	79	Veh Chng 15	129	Ped Call 1	179	IndLampCtrl	229	33x CMU Stop
30	Veh Call 30	80	Veh Chng 16	130	Ped Call 2	180	Min Recall	230	GateMode0
31	Veh Call 31	81	Veh Chng 17	131	Ped Call 3	181	ManCtrlEnbl	231	GateMode1
32	Veh Call 32	82	Veh Chng 18	132	Ped Call 4	182	Mode Bit A	232	GateMode2
33	Veh Call 33	83	Veh Chng 19	133	Ped Call 5	183	Mode Bit B	233	GateMode3
34	Veh Call 34	84	Veh Chng 20	134	Ped Call 6	184	Mode Bit C	234	GateOpen1
35	Veh Call 35	85	Veh Chng 21	135	Ped Call 7	185	Test A	235	GateClose1
36	Veh Call 36	86	Veh Chng 22	136	Ped Call 8	186	Test B	236	GateOpen2
37	Veh Call 37	87	Veh Chng 23	137	Hold 1	187	Test C	237	GateClose2
38	Veh Call 38	88	Veh Chng 24	138	Hold 2	188	WalkRestMod	238	Reserved
39	Veh Call 39	89	Veh Chng 25	139	Hold 3	189	Unused	239	Reserved
40	Veh Call 40	90	Veh Chng 26	140	Hold 4	190	Free	240	Logic1
41	Veh Call 41	91	Veh Chng 27	141	Hold 5	191	Flash In	241	Logic2
42	Veh Call 42	92	Veh Chng 28	142	Hold 6	192	Alarm 1	242	Logic3
43	Veh Call 43	93	Veh Chng 29	143	Hold 7	193	Alarm 2	243	Logic4
44	Veh Call 44	94	Veh Chng 30	144	Hold 8	194	Alarm 3	244	Logic5
45	Veh Call 45	95	Veh Chng 31	145	Ped Omit 1	195	Alarm 4	245	Logic6
46	Veh Call 46	96	Veh Chng 32	146	Ped Omit 2	196	Alarm 5	246	Logic7
47	Veh Call 47	97	Veh Chng 33	147	Ped Omit 3	197	Alarm 6	247	Logic8
48	Veh Call 48	98	Veh Chng 34	148	Ped Omit 4	198	Pre 1 In	248	Logic9
49	Veh Call 49	99	Veh Chng 35	149	Ped Omit 5	199	Pre 2 In	249	Logic10

12.6.1 33x Input File (MM->1->8->9->1->6)

The 33.X INPUT FILE is used in conjunction with USER IO Mode to allow the user to customize the input pins of the C1.

Inputs 1-64 on this menu correspond with I1-1 through I8-8

Input	Category	Idx	Description
1	DETECTOR	2	Detector 2
2	PEDCALL	2	P 2 PedCall
3	HOLD	2	Ph2 Hold
4	OMIT	2	Ph 2 Omit
5	PEDOMIT	2	Ped 2 Omit
6	RING	2	R1 StopTime
7	CABINET	2	CNA 1
8	PREEMPT	2	Preempt 2
9	UNUSED	1	Unused

DETECTOR: Indexes 1-64 assign any vehicle detector to any input pin
PEDCALL: Index 1-8 assigns the input to one of the 8 *Ped Detectors* programmed under MM->5->4
HOLD: Indexes 1-16 apply a hold on phases 1-16 if CNA operation is in effect
OMIT: Indexes 1-16 apply an omit on phases 1-16
PEDOMIT: Indexes 1-16 apply a ped omit on phases 1-16
RING: The indexes below apply the following ring features

Index	Description	Index	Description
1	R1 Frc Off	8	R1 Frc Off
2	R1 Stop Time	9	R1 Stop Time
3	R1 Inh Max	10	R1 Inh Max
4	R1 Red Rest	11	R1 Red Rest
5	R1 Ped Recycle	12	R1 Ped Recycle
6	R1 Max II	13	R1 Max II
7	R1 Omit Red Clearance	14	R1 Omit Red Clearance

CABINET: The indexes below apply the following cabinet features

Index	Description	Index	Description
1	CNA2	11	Cab Flash
2	CNA1	12	33x Stop Time
3	External Start	13	Local Flash
4	Interval Advance	14	TBC Input
5	Door Open	15	Dim Enable
6	Min Recall	16	Auto Flash
07	Manual Control Enable	17	33xFlash Sense
8	Walk Rest Modifier	18	33xCMUStop
9	Free Command	19	Unused
10	Flash Input	20	Unused

PREEMPT: Indexes 1-10 apply a call to preempts 1-10
UNUSED: The input pin is unused

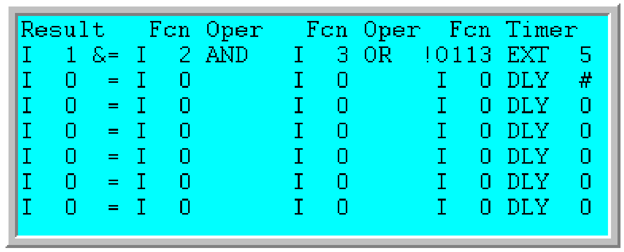
12.7 Customizing 2070 Outputs (MM->1->8->9->2)

After initializing the default I/O, you may customize the output maps selecting *2.Outputs* from MM->1->8->9->2. Each output pin on the A-B-C connector, D-connector and 2A (C1) connector may be redefined using the function numbers provided in the chart below.

```
            User Output Maps
1.NEMA A    4.NEMA D
2.NEMA B    5.FIO 2A
3.NEMA C                        9.TS2 IO
```

Func	Output	Func	Output	Func	Output	Func	Output	Func	Output
0	Unused	50	Ch2 Green	100	R2 Status A	150	Ph 9 Check	200	Reserved
1	Ch1 Red	51	Ch3 Green	101	R2 Status B	151	Ph 10 Check	201	Reserved
2	Ch2 Red	52	Ch4 Green	102	R2 Status C	152	Ph 11 Check	202	Reserved
3	Ch3 Red	53	Ch5 Green	103	Special 1	153	Ph 12 Check	203	Reserved
4	Ch4 Red	54	Ch6 Green	104	Special 2	154	Ph 13 Check	204	Reserved
5	Ch5 Red	55	Ch7 Green	105	Special 3	155	Ph 14 Check	205	Reserved
6	Ch6 Red	56	Ch8 Green	106	Special 4	156	Ph 15 Check	206	Reserved
7	Ch7 Red	57	Ch9 Green	107	Special 5	157	Ph 16 Check	207	Reserved
8	Ch8 Red	58	Ch10 Green	108	Special 6	158	Ph 9 Next	208	Reserved
9	Ch9 Red	59	Ch11 Green	109	Special 7	159	Ph 10 Next	209	Reserved
10	Ch10 Red	60	Ch12 Green	110	Special 8	160	Ph 11 Next	210	Reserved
11	Ch11 Red	61	Ch13 Green	111	Fault Mon	161	Ph 12 Next	211	Reserved
12	Ch12 Red	62	Ch14 Green	112	Voltage Mon	162	Ph 13 Next	212	Reserved
13	Ch13 Red	63	Ch15 Green	113	Flash Logic	163	Ph 6 Next	213	Reserved
14	Ch14 Red	64	Ch16 Green	114	Watchdog	164	Ph 14 Next	214	Reserved
15	Ch15 Red	65	Ch17 Green	115	Not Used	165	Ph 15 Next	215	Reserved
16	Ch16 Red	66	Ch18 Green	116	Pre Stat 1	166	Phase 9 On	216	Reserved
17	Ch17 Red	67	Ch19 Green	117	Pre Stat 2	167	Phase 10 On	217	Reserved
18	Ch18 Red	68	Ch20 Green	118	Pre Stat 3	168	Phase 11 On	218	Reserved
19	Ch19 Red	69	Ch21 Green	119	Pre Stat 4	169	Phase 12 On	219	Reserved
20	Ch20 Red	70	Ch22 Green	120	Pre Stat 5	170	Phase 13 On	220	Reserved
21	Ch21 Red	71	Ch23 Green	121	Pre Stat 6	171	Phase 14 On	221	Reserved
22	Ch22 Red	72	Ch24 Green	122	TBCAux/Pre1	172	Phase 15 On	222	Reserved
23	Ch23 Red	73	Ph 1 Check	123	TBCAux/Pre2	173	Phase 16 On	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	Free/Coord	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	GateOpen1
31	Ch7 Yellow	81	Ph 1 Next	131	Time plan C	181	Reserved	231	GateClose1
32	Ch8 Yellow	82	Ph 2 Next	132	Time plan D	182	Reserved	232	GateOpen2
33	Ch9 Yellow	83	Ph 3 Next	133	Offset Out1	183	Reserved	233	GateClose2
34	Ch10 Yellow	84	Ph 4 Next	134	Offset Out2	184	Reserved	234	Reserved
35	Ch11 Yellow	85	Ph 5 Next	135	Offset Out3	185	Reserved	235	Reserved
36	Ch12 Yellow	86	Ph 6 Next	136	Auto Flash	186	Reserved	236	Reserved
37	Ch13 Yellow	87	Ph 7 Next	137	PreemptActv	187	Reserved	237	Reserved
38	Ch14 Yellow	88	Ph 8 Next	138	Reserved	188	Reserved	238	Reserved
39	Ch15 Yellow	89	Phase 1 On	139	Reserved	189	Reserved	239	Reserved
40	Ch16 Yellow	90	Phase 2 On	140	Audible Ped 2	190	Reserved	240	Logic1
41	Ch17 Yellow	91	Phase 3 On	141	Audible Ped 4	191	Reserved	241	Logic2
42	Ch18 Yellow	92	Phase 4 On	142	Audible Ped 6	192	Reserved	242	Logic3
43	Ch19 Yellow	93	Phase 5 On	143	Audible Ped 8	193	Reserved	243	Logic4
44	Ch20 Yellow	94	Phase 6 On	144	Reserved	194	Reserved	244	Logic5
45	Ch21 Yellow	95	Phase 7 On	145	Reserved	195	Reserved	245	Logic6
46	Ch22 Yellow	96	Phase 8 On	146	Reserved	196	Reserved	246	Reserved
47	Ch23 Yellow	97	R1 Status A	147	Reserved	197	Reserved	247	Reserved
48	Ch24 Yellow	98	R1 Status B	148	Reserved	198	Reserved	248	Reserved
49	Ch1 Green	99	R1 Status C	149	Reserved	199	Reserved	249	Reserved

12.8 2070 Programmable IO Logic (MM->1->8->7)



The 2070 *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
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.

=
With V65 version 65.3x and greater, the ability to logically AND, OR, XOR, NAND, NOR XNOR the operand as part of the logic statement has been added. Vaild entries are

=	Don't use the operand as part of the logic statement
&=	AND the result operand to the logic statement and apply to the result
+=	OR the result operand to the logic statement and apply to the result
x=	XOR the result operand to the logic statement and apply to the result
!&=	NAND the result operand to the logic statement and apply to the result
!+=	NOR the result operand to the logic statement and apply to the result
!x=	XNOR the result operand to the logic statement and apply to the result

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.

To illustrate the timers, program the logic such that a physical call on detector 1 will also call detector #2 as shown below.

Result	Fcn	Oper	Fcn	Oper	Fcn	Timer
I 2=	I	1	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

Program the timer with a DLY 5

Result	Fcn	Oper	Fcn	Oper	Fcn	Timer
I 2=	I	1	I	0	I 0	DLY 5
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

Veh Call #2 will come on 5 seconds after Veh Call 1 is active, as long as Call #1 is still on (active). Now program the timer with a EXT 5

Result	Fcn	Oper	Fcn	Oper	Fcn	Timer
I 2=	I	1	I	0	I 0	EXT 5
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

Veh Call #2 will come on as soon as Veh Call 1 is activated. When Veh Call 1 is deactivated, Veh Call # 2 will remain on for an additional 5 seconds. Now program the timer with a SHF 5

Result	Fcn	Oper	Fcn	Oper	Fcn	Timer
I 2=	I	1	I	0	I 0	SHF 5
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

Veh Call #2 will come on 5 seconds after Veh Call 1 is activated, even if Veh Call 1 is then deactivated during the interim time. Veh Call # 2 will remain on for as long as Veh Call 1 was active.

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".

12.8.1 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:

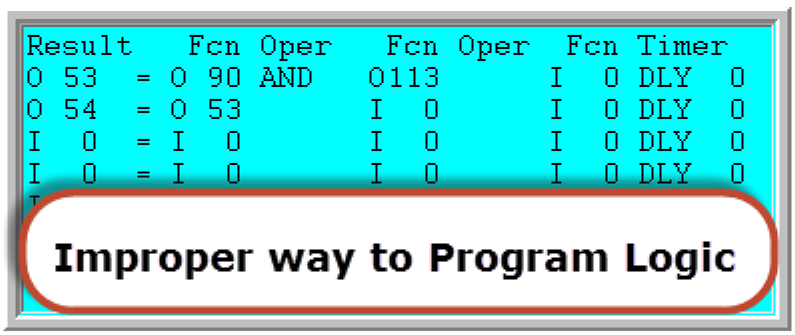
1. The controller polls all of the inputs from the I/O hardware.
2. The I/O logic executes each programmed line left to right and executes the top row to the bottom row.
3. The controller performs normal operation
4. The I/O logic stores the logic result overridden OUTPUTS for hardware processing.
5. 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.**

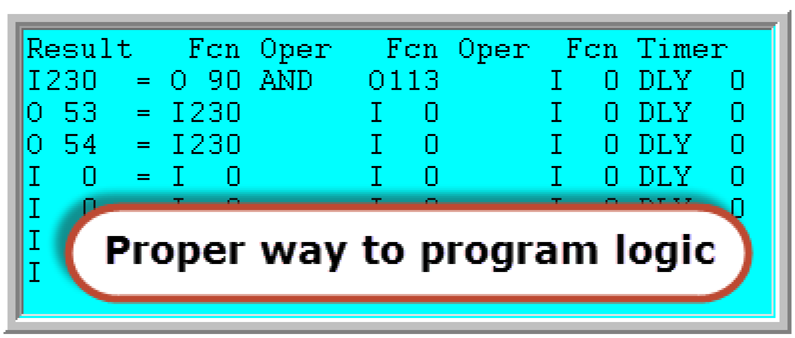
This nuance impacts the way to write a logic statement.   If you are feeding forward a result, and that result is stored in an output, then it **WILL NOT WORK**.

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:

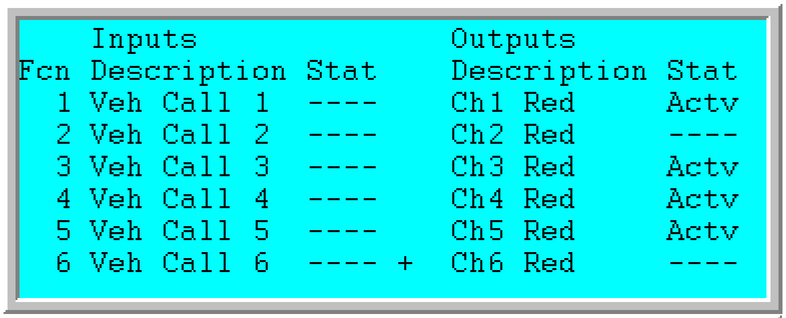


This works because you can feed forward results assigned to INPUTS, but not the results assigned to OUTPUTS

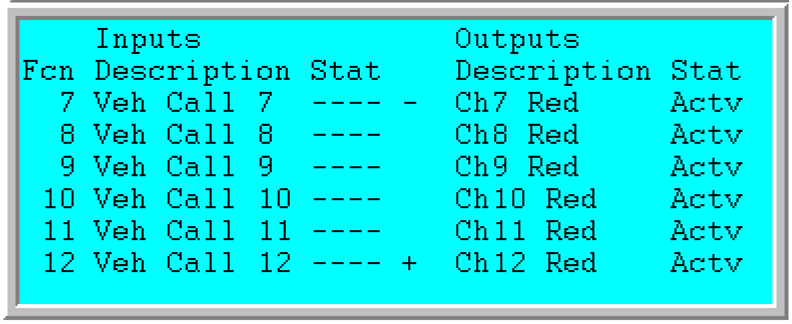
As a general rule, you should only designate the place holder I/O locations as INPUTS. So, if you are storing something in LOGIC1 it should be "I 230", and not "O 230".

12.9 2070 IO Viewer (MM->1->8->8)

An *IO Viewer* provides a real-time status monitor of all available inputs and outputs to the controller.



```
    Inputs                  Outputs
Fcn Description Stat      Description Stat
  1 Veh Call 1  ----      Ch1 Red     Actv
  2 Veh Call 2  ----      Ch2 Red     ----
  3 Veh Call 3  ----      Ch3 Red     Actv
  4 Veh Call 4  ----      Ch4 Red     Actv
  5 Veh Call 5  ----      Ch5 Red     Actv
  6 Veh Call 6  ---- +    Ch6 Red     ----
```



```
    Inputs                  Outputs
Fcn Description Stat      Description Stat
  7 Veh Call 7  ---- -    Ch7 Red     Actv
  8 Veh Call 8  ----      Ch8 Red     Actv
  9 Veh Call 9  ----      Ch9 Red     Actv
 10 Veh Call 10 ----      Ch10 Red    Actv
 11 Veh Call 11 ----      Ch11 Red    Actv
 12 Veh Call 12 ---- +    Ch12 Red    Actv
```

The screens will display Input functions an output functions by function number as described in section 12.5 above.

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". Typically this input is 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 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 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 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	Reserved		
33	Street Lamp Failure	Street Lamp Failure (Channel A)	
34	Street Lamp Failure	Street Lamp Failure (Channel B)	
35-36	Reserved		
37	Download Request	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	Set when any preempt is active	
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
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

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

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		

14.2 2070 Specific I/O Maps

The following maps are based on the 2070 hardware mapping as specified 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			

The following are commonly used modes standardized by a specific agency and used by multiple agencies:

MODE 0: **CALTRANS TEES Standard**
MODE 1: **NY DOT Standard**
MODE 2: **DADE County**
MODE 3: **Plano Texas**
MODE 6: **HOV Gate**
MODE 7: **Broward County**

14.2.1 2070 2A (C1 Connector) Mapping – Caltrans TEES Option (Mode 0)

*** Next to the Pin Number indicates the Pin is on the C11S rather than the C1**

C1/C11S* Pin	Source	Func	Output Description		C1/C11S* 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	1O1-8	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	Unused
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		10*	I4-1	189	Unused
28	O4-2	63	Ch15 Green		11*	I4-2	189	Unused
29	O4-3	6	Ch6 Red		12*	I4-3	189	Unused
30	O4-4	30	Ch6 Yellow		13*	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/C11S* Pin	Source	Func	Output Description		C1/C11S* 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	132	Ped Call 6
37	O5-3	38	Ch14 Yellow		69	I5-3	134	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	41	Ch17 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	18	Ch18 Red		75	I6-1	189	Unused
84	O6-2	66	Ch18 Green		76	I6-2	5	Veh Call 5
85	O6-3	12	Ch12 Red		77	I6-3	19	Veh Call 19
86	O6-4	36	Ch12 Yellow		78	I6-4	11	Veh Call 11
87	O6-5	60	Ch12 Green		79	I6-5	25	Veh Call 25
88	O6-6	11	Ch11 Red		80	I6-6	178	Int Advance
89	O6-7	35	Ch11 Yellow		81	I6-7	208	Local Flash
90	O6-8	59	Ch11 Green		82	I6-8	207	Comp StopTm
91	O7-1	17	Ch17 Red		15*	I7-1	189	Unused
93	O7-2	65	Ch17 Green		16*	I7-2	189	Unused
94	O7-3	10	Ch10 Red		17*	I7-3	189	Unused
95	O7-4	34	Ch10 Yellow		18*	I7-4	189	Unused
96	O7-5	58	Ch10 Green		19*	I7-5	189	Unused
97	O7-6	9	Ch9 Red		20*	I7-6	189	Unused
98	O7-7	33	Ch9 Yellow		21*	I7-7	189	Unused
99	O7-8	57	Ch9 Green		22*	I7-8	189	Unused
1*	O8-1	115	Not Used		23*	I8-1	189	Unused
2*	O8-2	115	Not Used		24*	I8-2	189	Unused
3*	O8-3	115	Not Used		25*	I8-3	189	Unused
4*	O8-4	115	Not Used		26*	I8-4	189	Unused
5*	O8-5	115	Not Used		27*	I8-5	189	Unused
6*	O8-6	115	Not Used		28*	I8-6	189	Unused
7*	O8-7	115	Not Used		29*	I8-7	189	Unused
8*	O8-8	115	Not Used		30*	I8-8	189	Unused

2070 2A Mapping - Caltrans TEES Option
*** Next to the Pin Number indicates the Pin is on the C11S rather than the C1**

14.2.2 2070 2A (C1 Connector) Mapping – NY DOT Mode 1

C1 Pin	Source	Func	Output Description	C1 Pin	Source	Func	Input Description
2	O1-1	1	Ch1 Red	39	I1-1	1	Veh Call 1
3	O1-2	49	Ch1 Green	40	I1-2	2	Veh Call 2
4	O1-3	2	Ch2 Red	41	I1-3	3	Veh Call 3
5	O1-4	26	Ch2 Yellow	42	I1-4	4	Veh Call 4
6	O1-5	50	Ch2 Green	43	I1-5	5	Veh Call 5
7	O1-6	3	Ch3 Red	44	I1-6	6	Veh Call 6
8	O1-7	27	Ch3 Yellow	45	I1-7	7	Veh Call 7
9	O1-8	51	Ch3 Green	46	I1-8	8	Veh Call 8
10	O2-1	4	Ch4 Red	47	I2-1	130	Ped Call 2
11	O2-2	52	Ch4 Green	48	I2-2	132	Ped Call 4
12	O2-3	5	Ch5 Red	49	I2-3	134	Ped Call 6
13	O2-4	29	Ch5 Yellow	50	I2-4	136	Ped Call 8
15	O2-5	53	Ch5 Green	51	I2-5	189	Unused
16	O2-6	6	Ch6 Red	52	I2-6	189	Unused
17	O2-7	30	Ch6 Yellow	53	I2-7	189	Unused
18	O2-8	54	Ch6 Green	54	I2-8	189	Unused
19	O3-1	7	Ch7 Red	55	I3-1	189	Unused
20	O3-2	55	Ch7 Green	56	I3-2	189	Unused
21	O3-3	8	Ch8 Red	57	I3-3	189	Unused
22	O3-4	32	Ch8 Yellow	58	I3-4	189	Unused
23	O3-5	56	Ch8 Green	59	I3-5	189	Unused
24	O3-6	9	Ch9 Red	60	I3-6	189	Unused
25	O3-7	33	Ch9 Yellow	61	I3-7	189	Unused
26	O3-8	57	Ch9 Green	62	I3-8	189	Unused
27	O4-1	10	Ch10 Red		I4-1	189	Unused
28	O4-2	58	Ch10 Green		I4-2	189	Unused
29	O4-3	11	Ch11 Red		I4-3	189	Unused
30	O4-4	35	Ch11 Yellow		I4-4	189	Unused
31	O4-5	59	Ch11 Green	63	I4-5	189	Unused
32	O4-6	12	Ch12 Red	64	I4-6	189	Unused
33	O4-7	36	Ch12 Yellow	65	I4-7	229	33xCMUStop
34	O4-8	60	Ch12 Green	66	I4-8	228	33xFlashSns

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	28	Ch4 Yellow		67	I5-1	189	Unused
36	O5-2	34	Ch10 Yellow		68	I5-2	189	Unused
37	O5-3	25	Ch1 Yellow		69	I5-3	189	Unused
38	O5-4	31	Ch7 Yellow		70	I5-4	189	Unused
100	O5-5	115	Not Used		71	I5-5	189	Unused
101	O5-6	115	Not Used		72	I5-6	189	Unused
102	O5-7	115	Not Used		73	I5-7	207	Comp StopTm
103	O5-8	114	Watchdog		74	I5-8	208	Local Flash
83	O6-1	115	Not Used		75	I6-1	130	Ped Call 2
84	O6-2	115	Not Used		76	I6-2	132	Ped Call 4
85	O6-3	13	Ch13 Red		77	I6-3	134	Ped Call 6
86	O6-4	37	Ch13 Yellow		78	I6-4	136	Ped Call 8
87	O6-5	61	Ch13 Green		79	I6-5	189	Unused
88	O6-6	14	Ch14 Red		80	I6-6	189	Unused
89	O6-7	38	Ch14 Yellow		81	I6-7	189	Unused
90	O6-8	62	Ch14 Green		82	I6-8	189	Unused
91	O7-1	115	Not Used			I7-1	189	Unused
93	O7-2	115	Not Used			I7-2	189	Unused
94	O7-3	115	Not Used			I7-3	189	Unused
95	O7-4	115	Not Used			I7-4	189	Unused
96	O7-5	115	Not Used			I7-5	189	Unused
97	O7-6	115	Not Used			I7-6	189	Unused
98	O7-7	115	Not Used			I7-7	189	Unused
99	O7-8	115	Not Used			I7-8	189	Unused
	O8-1	115	Not Used			I8-1	189	Unused
	O8-2	115	Not Used			I8-2	189	Unused
	O8-3	115	Not Used			I8-3	189	Unused
	O8-4	115	Not Used			I8-4	189	Unused
	O8-5	115	Not Used			I8-5	189	Unused
	O8-6	115	Not Used			I8-6	189	Unused
	O8-7	115	Not Used			I8-7	189	Unused
	O8-8	115	Not Used			I8-8	189	Unused

2070 2A (C1 Connector) Mapping – NY DOT Mode 1 Option

14.2.3 2070 2A (C1 Connector) Mapping – Mode 2

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
2	O1-1	14	Ch14 Red		39	I1-1	1	Veh Call 1
3	O1-2	62	Ch14 Green		40	I1-2	2	Veh Call 2
4	O1-3	4	Ch4 Red		41	I1-3	3	Veh Call 3
5	O1-4	28	Ch4 Yellow		42	I1-4	4	Veh Call 4
6	O1-5	52	Ch4 Green		43	I1-5	5	Veh Call 5
7	O1-6	3	Ch3 Red		44	I1-6	6	Veh Call 6
8	O1-7	27	Ch3 Yellow		45	I1-7	7	Veh Call 7
9	O1-8	51	Ch3 Green		46	I1-8	8	Veh Call 8
10	O2-1	13	Ch13 Red		47	I2-1	9	Veh Call 9
11	O2-2	61	Ch13 Green		48	I2-2	10	Veh Call 10
12	O2-3	2	Ch2 Red		49	I2-3	189	Unused
13	O2-4	26	Ch2 Yellow		50	I2-4	169	R2 Frc Off
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	227	Offset 3
18	O2-8	49	Ch1 Green		54	I2-8	226	Offset 2
19	O3-1	16	Ch16 Red		55	I3-1	189	Unused
20	O3-2	64	Ch16 Green		56	I3-2	11	Veh Call 11
21	O3-3	8	Ch8 Red		57	I3-3	12	Veh Call 12
22	O3-4	32	Ch8 Yellow		58	I3-4	13	Veh Call 13
23	O3-5	56	Ch8 Green		59	I3-5	14	Veh Call 14
24	O3-6	7	Ch7 Red		60	I3-6	15	Veh Call 15
25	O3-7	31	Ch7 Yellow		61	I3-7	16	Veh Call 16
26	O3-8	55	Ch7 Green		62	I3-8	17	Veh Call 17
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	18	Veh Call 18
32	O4-6	5	Ch5 Red		64	I4-6	189	Unused
33	O4-7	29	Ch5 Yellow		65	I4-7	179	Door Open
34	O4-8	53	Ch5 Green		66	I4-8	189	Unused

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	115	Not Used		67	I5-1	181	Man Ctrl Enbl
36	O5-2	115	Not Used		68	I5-2	189	Unused
37	O5-3	115	Not Used		69	I5-3	178	Int Advance
38	O5-4	103	Special 1		70	I5-4	191	Flash In
100	O5-5	115	Not Used		71	I5-5	200	Pre 3 In
101	O5-6	115	Not Used		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	115	Not Used		75	I6-1	130	Ped Call 2
84	O6-2	115	Not Used		76	I6-2	134	Ped Call 6
85	O6-3	12	Ch12 Red		77	I6-3	132	Ped Call 4
86	O6-4	36	Ch12 Yellow		78	I6-4	136	Ped Call 8
87	O6-5	60	Ch12 Green		79	I6-5	189	Unused
88	O6-6	11	Ch11 Red		80	I6-6	189	Unused
89	O6-7	35	Ch11 Yellow		81	I6-7	208	Local Flash
90	O6-8	59	Ch11 Green		82	I6-8	207	Comp Stop Tm
91	O7-1	115	Not Used			I7-1	189	Unused
93	O7-2	115	Not Used			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	Not Used			I8-1	189	Unused
	O8-2	115	Not Used			I8-2	189	Unused
	O8-3	115	Not Used			I8-3	189	Unused
	O8-4	115	Not Used			I8-4	189	Unused
	O8-5	115	Not Used			I8-5	189	Unused
	O8-6	115	Not Used			I8-6	189	Unused
	O8-7	115	Not Used			I8-7	189	Unused
	O8-8	115	Not Used			I8-8	189	Unused

2070 2A (C1 Connector) Mapping – Mode 2 Option

14.2.4 2070 2A (C1 Connector) Mapping – Mode 3

C1 Pin	Source	Func	Output Description	C1 Pin	Source	Func	Input Description
2	O1-1	1	Ch1 Red	39	I1-1	1	Veh Call 1
3	O1-2	49	Ch1 Green	40	I1-2	2	Veh Call 2
4	O1-3	2	Ch2 Red	41	I1-3	3	Veh Call 3
5	O1-4	26	Ch2 Yellow	42	I1-4	4	Veh Call 4
6	O1-5	50	Ch2 Green	43	I1-5	5	Veh Call 5
7	O1-6	3	Ch3 Red	44	I1-6	6	Veh Call 6
8	O1-7	27	Ch3 Yellow	45	I1-7	7	Veh Call 7
9	O1-8	51	Ch3 Green	46	I1-8	8	Veh Call 8
10	O2-1	4	Ch4 Red	47	I2-1	9	Veh Call 9
11	O2-2	52	Ch4 Green	48	I2-2	10	Veh Call 10
12	O2-3	5	Ch5 Red	49	I2-3	11	Veh Call 11
13	O2-4	29	Ch5 Yellow	50	I2-4	12	Veh Call 12
15	O2-5	53	Ch5 Green	51	I2-5	13	Veh Call 13
16	O2-6	6	Ch6 Red	52	I2-6	14	Veh Call 14
17	O2-7	30	Ch6 Yellow	53	I2-7	15	Veh Call 15
18	O2-8	54	Ch6 Green	54	I2-8	16	Veh Call 16
19	O3-1	7	Ch7 Red	55	I3-1	130	Ped Call 2
20	O3-2	55	Ch7 Green	56	I3-2	132	Ped Call 4
21	O3-3	8	Ch8 Red	57	I3-3	134	Ped Call 6
22	O3-4	32	Ch8 Yellow	58	I3-4	136	Ped Call 8
23	O3-5	56	Ch8 Green	59	I3-5	17	Veh Call 17
24	O3-6	9	Ch9 Red	60	I3-6	18	Veh Call 18
25	O3-7	33	Ch9 Yellow	61	I3-7	19	Veh Call 19
26	O3-8	57	Ch9 Green	62	I3-8	20	Veh Call 20
27	O4-1	10	Ch10 Red		I4-1	189	Unused
28	O4-2	58	Ch10 Green		I4-2	189	Unused
29	O4-3	11	Ch11 Red		I4-3	189	Unused
30	O4-4	35	Ch11 Yellow		I4-4	189	Unused
31	O4-5	59	Ch11 Green	63	I4-5	189	Unused
32	O4-6	12	Ch12 Red	64	I4-6	208	Local Flash
33	O4-7	38	Ch14 Yellow	65	I4-7	229	Comp Stop Time
34	O4-8	60	Ch12 Green	66	I4-8	189	Unused

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	28	Ch4 Yellow		67	I5-1	200	Pre 3 input
36	O5-2	34	Ch10 Yellow		68	I5-2	201	Pre 4 input
37	O5-3	25	Ch1 Yellow		69	I5-3	202	Pre 5 input
38	O5-4	31	Ch7 Yellow		70	I5-4	203	Pre 6 input
100	O5-5	40	Ch16 Yellow		71	I5-5	189	Unused
101	O5-6	39	Ch15 Yellow		72	I5-6	189	Unused
102	O5-7	115	Not Used		73	I5-7	189	Unused
103	O5-8	114	Watchdog		74	I5-8	189	Unused
83	O6-1	15	Ch15 Red		75	I6-1	189	Unused
84	O6-2	63	Ch15 Green		76	I6-2	189	Unused
85	O6-3	13	Ch13 Red		77	I6-3	189	Unused
86	O6-4	37	Ch13 Yellow		78	I6-4	189	Unused
87	O6-5	61	Ch13 Green		79	I6-5	189	Unused
88	O6-6	14	Ch14 Red		80	I6-6	189	Unused
89	O6-7	38	Ch14 Yellow		81	I6-7	189	Unused
90	O6-8	62	Ch14 Green		82	I6-8	189	Unused
91	O7-1	16	Ch16 Red			I7-1	189	Unused
93	O7-2	64	Ch16 Green			I7-2	189	Unused
94	O7-3	115	Not Used			I7-3	189	Unused
95	O7-4	115	Not Used			I7-4	189	Unused
96	O7-5	115	Not Used			I7-5	189	Unused
97	O7-6	115	Not Used			I7-6	189	Unused
98	O7-7	115	Not Used			I7-7	189	Unused
99	O7-8	115	Not Used			I7-8	189	Unused
	O8-1	115	Not Used			I8-1	189	Unused
	O8-2	115	Not Used			I8-2	189	Unused
	O8-3	115	Not Used			I8-3	189	Unused
	O8-4	115	Not Used			I8-4	189	Unused
	O8-5	115	Not Used			I8-5	189	Unused
	O8-6	115	Not Used			I8-6	189	Unused
	O8-7	115	Not Used			I8-7	189	Unused
	O8-8	115	Not Used			I8-8	189	Unused

2070 2A (C1 Connector) Mapping – Mode 3 Option

14.2.5 2070 2A (C1 Connector) Mapping – Mode 5

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	181	ManCtrlEnbl
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	199	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	115	Not Used	71	I5-5	200	Pre 3 In
101	O5-6	124	LdSwtchFlsh	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	115	Not Used	75	I6-1	179	Door Open
84	O6-2	115	Not Used	76	I6-2	5	Veh Call 5
85	O6-3	12	Ch12 Red	77	I6-3	19	Veh Call 19
86	O6-4	36	Ch12 Yellow	78	I6-4	11	Veh Call 11
87	O6-5	60	Ch12 Green	79	I6-5	25	Veh Call 25
88	O6-6	11	Ch11 Red	80	I6-6	178	Int Advance
89	O6-7	35	Ch11 Yellow	81	I6-7	208	Local Flash
90	O6-8	59	Ch11 Green	82	I6-8	207	Comp StopTm
91	O7-1	115	Not Used		I7-1	192	Alarm 1
93	O7-2	115	Not Used		I7-2	193	Alarm 2
94	O7-3	10	Ch10 Red		I7-3	194	Alarm 3
95	O7-4	34	Ch10 Yellow		I7-4	195	Alarm 4
96	O7-5	58	Ch10 Green		I7-5	196	Alarm 5
97	O7-6	9	Ch9 Red		I7-6	197	Alarm 6
98	O7-7	33	Ch9 Yellow		I7-7	189	Unused
99	O7-8	57	Ch9 Green		I7-8	189	Unused
	O8-1	115	Not Used		I8-1	189	Unused
	O8-2	115	Not Used		I8-2	189	Unused
	O8-3	115	Not Used		I8-3	189	Unused
	O8-4	115	Not Used		I8-4	189	Unused
	O8-5	115	Not Used		I8-5	189	Unused
	O8-6	115	Not Used		I8-6	189	Unused
	O8-7	115	Not Used		I8-7	189	Unused
	O8-8	115	Not Used		I8-8	189	Unused

2070 2A (C1 Connector) Mapping – North Carolina Mode 5 Option

14.2.6 2070 2A (C1 Connector) Mapping – Mode 6

C1 Pin	Source	Func	Output Description	C1 Pin	Source	Func	Input Description
2	O1-1	115	Not Used	39	I1-1	1	Veh Call 1
3	O1-2	115	Not Used	40	I1-2	3	Veh Call 3
4	O1-3	115	Not Used	41	I1-3	5	Veh Call 5
5	O1-4	115	Not Used	42	I1-4	6	Veh Call 6
6	O1-5	115	Not Used	43	I1-5	2	Veh Call 2
7	O1-6	115	Not Used	44	I1-6	4	Veh Call 4
8	O1-7	115	Not Used	45	I1-7	7	Veh Call 7
9	O1-8	115	Not Used	46	I1-8	8	Veh Call 8
10	O2-1	115	Not Used	47	I2-1	189	Unused
11	O2-2	115	Not Used	48	I2-2	189	Unused
12	O2-3	232	Logic 3	49	I2-3	189	Unused
13	O2-4	233	Logic 4	50	I2-4	189	Unused
15	O2-5	115	Not Used	51	I2-5	189	Unused
16	O2-6	230	Logic 1	52	I2-6	189	Unused
17	O2-7	231	Logic 2	53	I2-7	189	Unused
18	O2-8	115	Not Used	54	I2-8	189	Unused
19	O3-1	115	Not Used	55	I3-1	189	Unused
20	O3-2	115	Not Used	56	I3-2	189	Unused
21	O3-3	115	Not Used	57	I3-3	189	Unused
22	O3-4	115	Not Used	58	I3-4	189	Unused
23	O3-5	115	Not Used	59	I3-5	189	Unused
24	O3-6	115	Not Used	60	I3-6	189	Unused
25	O3-7	115	Not Used	61	I3-7	189	Unused
26	O3-8	115	Not Used	62	I3-8	189	Unused
27	O4-1	115	Not Used		I4-1	189	Unused
28	O4-2	115	Not Used		I4-2	189	Unused
29	O4-3	115	Not Used		I4-3	189	Unused
30	O4-4	115	Not Used		I4-4	189	Unused
31	O4-5	115	Not Used	63	I4-5	1	Veh Call 1
32	O4-6	115	Not Used	64	I4-6	3	Veh Call 3
33	O4-7	115	Not Used	65	I4-7	5	Veh Call 5
34	O4-8	115	Not Used	66	I4-8	6	Veh Call 6

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	115	Not Used		67	I5-1	234	Logic 5
36	O5-2	115	Not Used		68	I5-2	230	Logic 1
37	O5-3	115	Not Used		69	I5-3	235	Logic 6
38	O5-4	115	Not Used		70	I5-4	231	Logic 2
100	O5-5	115	Not Used		71	I5-5	236	Logic 7
101	O5-6	115	Not Used		72	I5-6	232	Logic 3
102	O5-7	115	Not Used		73	I5-7	237	Logic 8
103	O5-8	114	Watchdog		74	I5-8	233	Logic 4
83	O6-1	115	Not Used		75	I6-1	179	Door Open
84	O6-2	115	Not Used		76	I6-2	2	Veh Call 2
85	O6-3	115	Not Used		77	I6-3	4	Veh Call 4
86	O6-4	115	Not Used		78	I6-4	7	Veh Call 7
87	O6-5	115	Not Used		79	I6-5	8	Veh Call 8
88	O6-6	115	Not Used		80	I6-6	189	Unused
89	O6-7	115	Not Used		81	I6-7	208	Local Flash
90	O6-8	115	Not Used		82	I6-8	207	Comp Stop Time
91	O7-1	115	Not Used			I7-1	189	Unused
93	O7-2	115	Not Used			I7-2	189	Unused
94	O7-3	115	Not Used			I7-3	189	Unused
95	O7-4	115	Not Used			I7-4	189	Unused
96	O7-5	115	Not Used			I7-5	189	Unused
97	O7-6	115	Not Used			I7-6	189	Unused
98	O7-7	115	Not Used			I7-7	189	Unused
99	O7-8	115	Not Used			I7-8	189	Unused
	O8-1	115	Not Used			I8-1	189	Unused
	O8-2	115	Not Used			I8-2	189	Unused
	O8-3	115	Not Used			I8-3	189	Unused
	O8-4	115	Not Used			I8-4	189	Unused
	O8-5	115	Not Used			I8-5	189	Unused
	O8-6	115	Not Used			I8-6	189	Unused
	O8-7	115	Not Used			I8-7	189	Unused
	O8-8	115	Not Used			I8-8	189	Unused

2070 2A (C1 Connector) Mapping – HOV Gate Mode 6 Option

14.2.7 2070 2A (C1 Connector) Mapping – Mode 7

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	6	Veh Call 6
4	O1-3	4	Ch4 Red		41	I1-3	4	Veh Call 4
5	O1-4	28	Ch4 Yellow		42	I1-4	8	Veh Call 8
6	O1-5	52	Ch4 Green		43	I1-5	10	Veh Call 10
7	O1-6	3	Ch3 Red		44	I1-6	12	Veh Call 12
8	O1-7	27	Ch3 Yellow		45	I1-7	14	Veh Call 14
9	O1-8	51	Ch3 Green		46	I1-8	16	Veh Call 16
10	O2-1	13	Ch13 Red		47	I2-1	18	Veh Call 18
11	O2-2	61	Ch13 Green		48	I2-2	22	Veh Call 22
12	O2-3	2	Ch2 Red		49	I2-3	20	Veh Call 20
13	O2-4	26	Ch2 Yellow		50	I2-4	24	Veh Call 24
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	181	Man Ctrl Enbl
18	O2-8	49	Ch1 Green		54	I2-8	205	Pre 8 In
19	O3-1	16	Ch16 Red		55	I3-1	5	Veh Call 5
20	O3-2	64	Ch16 Green		56	I3-2	1	Veh Call 1
21	O3-3	8	Ch8 Red		57	I3-3	7	Veh Call 7
22	O3-4	32	Ch8 Yellow		58	I3-4	3	Veh Call 3
23	O3-5	56	Ch8 Green		59	I3-5	133	Ped Call 5
24	O3-6	7	Ch7 Red		60	I3-6	129	Ped Call 1
25	O3-7	31	Ch7 Yellow		61	I3-7	135	Ped Call 7
26	O3-8	55	Ch7 Green		62	I3-8	131	Ped Call 3
27	O4-1	15	Ch15 Red			I4-1	188	Walk Rest Mod
28	O4-2	63	Ch15 Green			I4-2	191	Flash In
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	26	Veh Call 26
32	O4-6	5	Ch5 Red		64	I4-6	30	Veh Call 30
33	O4-7	29	Ch5 Yellow		65	I4-7	28	Veh Call 28
34	O4-8	53	Ch5 Green		66	I4-8	32	Veh Call 32

C1 Pin	Source	Func	Output Description		C1 Pin	Source	Func	Input Description
35	O5-1	140	AudiblePed2		67	I5-1	130	Ped Call 2
36	O5-2	141	AudiblePed4		68	I5-2	134	Ped Call 6
37	O5-3	142	AudiblePed6		69	I5-3	132	Ped Call 4
38	O5-4	143	AudiblePed8		70	I5-4	136	Ped Call 8
100	O5-5	115	Not Used		71	I5-5	200	Pre 3 In
101	O5-6	101	R2 Status B		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	115	Not Used		75	I6-1	189	Unused
84	O6-2	115	Not Used		76	I6-2	34	Veh Call 34
85	O6-3	12	Ch12 Red		77	I6-3	38	Veh Call 38
86	O6-4	36	Ch12 Yellow		78	I6-4	36	Veh Call 36
87	O6-5	60	Ch12 Green		79	I6-5	40	Veh Call 40
88	O6-6	11	Ch11 Red		80	I6-6	178	Int Advance
89	O6-7	35	Ch11 Yellow		81	I6-7	208	Local Flash
90	O6-8	59	Ch11 Green		82	I6-8	207	Comp Stop Tm
91	O7-1	115	Not Used			I7-1	138	Hold 2
93	O7-2	115	Not Used			I7-2	140	Hold 4
94	O7-3	10	Ch10 Red			I7-3	142	Hold 6
95	O7-4	34	Ch10 Yellow			I7-4	144	Hold 8
96	O7-5	58	Ch10 Green			I7-5	161	R1 Frc Off
97	O7-6	9	Ch9 Red			I7-6	163	R1 Inh Max
98	O7-7	33	Ch9 Yellow			I7-7	166	R1 Max II
99	O7-8	57	Ch9 Green			I7-8	168	Non-Act I
	O8-1	103	Special 1			I8-1	169	R2 Frc Off
	O8-2	115	Not Used			I8-2	171	R2 Inh Max
	O8-3	115	Not Used			I8-3	174	R2 Max II
	O8-4	128	Free/Coord			I8-4	176	Non-Act II
	O8-5	115	Not Used			I8-5	137	Hold 1
	O8-6	137	PreemptActv			I8-6	139	Hold 3
	O8-7	115	Not Used			I8-7	141	Hold 5
	O8-8	115	Not Used			I8-8	143	Hold 7

2070 2A (C1 Connector) Mapping – Mode 7 Option

14.2.8 2070(N) D-Connector – TEES Mapping

Pin	Function	I/O		Pin	Function	I/O
A	Detector 9	I		i	Door Ajar	I
B	Detector 10	I		j	Special Function 1	I
C	Detector 11	I		k	Special Function 2	I
D	Detector 12	I		m	Special Function 3	I
E	Detector 13	I		n	Special Function 4	I
F	Detector 14	I		p	Special Function 5	I
G	Detector 15	I		q	Special Function 6	I
H	Detector 16	I		r	Special Function 7	I
J	Detector 17	I		s	Special Function 8	I
K	Detector 18	I		t	Preempt 1 In	I
L	Detector 19	I		u	Preempt 2 In	I
M	Detector 20	I		v	Preempt 3 In	I
N	Detector 21	I		w	Preempt 4 In	I
P	Detector 22	I		x	Preempt 5 In	I
R	Detector 23	I		y	Preempt 6 In	I
S	Detector 24	I		z	Alarm 1 Out	O
*****T	*****Clock Update	I		AA	Alarm 2 Out	O
U	Hardware Control	I		BB	Special Function 1 Out	O
V	Cycle Advance	I		CC	Special Function 2	O
W	Max 3 Selection	I		DD	Special Function 3	O
X	Max 4 Selection	I		EE	Special Function 4	O
Y	Free	I		FF	Special Function 5	O
Z	Not assigned	-		GG	Special Function 6	O
a	Not assigned	-		HH	Special Function 7	O
b	Alarm 1	I		JJ	Special Function 8	O
c	Alarm 2	I		KK	Not assigned	-
d	Alarm 3	I		LL	Detector Reset	O
e	Alarm 4	I		MM	Not assigned	-
f	Alarm 5	I		NN	+24VDC	-
g	Flash In	I		PP	2070N DC Gnd	-
h	Conflict Monitor Status	I				

2070(N) D-Connector – TEES Mapping

*** Not Implemented**

14.2.9 2070(N) D-Connector – 820A-VMS Mapping

Warning: Identify pin M (Local Flash input), and install a 120 VAC relay to isolate the high voltage cabinet flash status signal used for the 820A flash input. Verify this AC input is not present on pin M before connecting the D harness to prevent damage to the 2070. Failure to deactivate the 120 V flash input on pin M will void the warranty of the 2070(N) expansion chassis.

Pin	Function	I/O	Pin	Function	I/O
A	N/A	I	i	Detector 16	I
B	Detector 15	I	j	N/A	-
C	Detector 17	I	k	N/A	-
D	Detector 18	I	m	N/A	-
E	Detector 19	I	n	N/A	-
F	Detector 20	I	p	Alarm 3	I
G	Detector 21	I	q	N/A	-
H	Detector 22	I	r	N/A	-
J	Detector 23	I	s	N/A	-
K	Detector 24	I	t	N/A	-
L	N/A	-	u	N/A	-
M!!!	**Local Flash In (See warning)**	I	v	N/A	-
N	Alarm 4	I	w	Alarm 1	I
P	N/A	-	x	N/A	-
R	N/A	-	y	Alarm 5	I
S	Detector 9	I	z	N/A	O
T	Detector 10	I	AA	Special Function 1 Out	O
U	Detector 11	I	BB	Special Function 2 Out	O
V	Detector 12	I	CC	Special Function 3 Out	O
W	Detector 13	I	DD	Special Function 4 Out	O
X	Detector 14	I	EE	Special Function 5 Out	O
Y	Alarm 2	I	FF	Special Function 6 Out	O
Z	N/A	-	GG	Special Function 7 Out	O
a	Preempt 1	I	HH	Special Function 8 Out	O
b	Preempt 2	I	JJ	N/A	O
c	Preempt 3	I	KK	External 24 VDC	-
d	Preempt 4	I	LL	N/A	O
e	N/A	-	MM	N/A	-
f	N/A	-	NN	N/A	-
g	N/A	-	PP	N/A	-
h	N/A	-			

2070(N) D-Connector – 820A-VMS Mapping

14.2.10 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)

14.3 TS2 and 2070 Communications Ports

14.3.1 TS2 Communication 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

14.3.2 2070 Communication Ports

2070-7A (DB-9S) Async Serial Com Module

C21 & C22 Connector Pinouts (DB-9S)			
Pin	Function	Pin	Function
1	DCD	6	N/A
2	RXD	7	RTS
3	TXD	8	CTS
4	N/A	9	N/A
5	ISO DC GND		

2070-7B (DB-15S) High Speed Serial Com Module

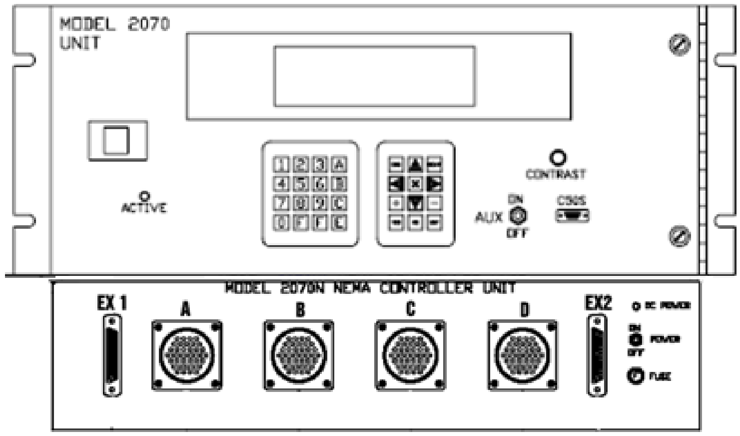
C21 & C22 Connector Pinouts (DB-15S)			
Pin	Function	Pin	Function
1	TX DATA +	9	TX DATA -
2	ISO DC GND	10	ISO DC GND
3	TX CLOCK +	11	TX CLOCK -
4	ISO DC GND	12	ISO DC GND
5	RX DATA +	13	RX DATA -
6	ISO DC GND	14	ISO DC GND
7	RX CLOCK +	15	RX CLOCK -
8	N/A		

2070-6A and 6B Async/Modem Serial Com Module

C2 & C20 Connector Pin-outs			
Pin	Function	Pin	Function
A	Audio In	J	RTS
B	Audio In	K	Data In
C	Audio Out	L	Data Out
D	ISO +5 VDC	M	CTS
E	Audio Out	N	ISO DC Ground
F	N/A	P	N/A
H	CD	R	N/A

14.3.3 External Communication Ports Provided on the 2070N Expansion Chassis

The EX1 and EX2 communication ports reside on the front of the 2070N expansion chassis as shown in the figure to the right.



The EX1 port provides an EIA RS-232 serial port. The baud rate of the EX1 port is selected by hardware jumpers to provide 300, 1200, 2400, 4800, 9600, 19,200 and 38,400 baud operation.

The EX2 port is connected to a Model 2070-6 Serial Comm Module in the 2070 unit using a 22 line HAR 2 harness. This connector provides two modems or RS-232 connections from the 2070-6 Serial Comm Module.

The pinouts for the EX1 and EX2 ports below comply with the Caltrans TEES specification.

2070N EX1 Com Port

Pin	Function	Pin	Function
1	EQ Gnd	14	2070-8 DC GND
2	TxD FCU	15	485 RX Data +
3	RXD FCU	16	485 RX Data -
4	RTS FCU	17	2070-8 DC GND
5	CTS FCU	18	485 RC Clock +
6	N/A	19	485 RC Clock -
7	2070-8 DC GND	20	
8	DCD FCU	21	
9	2070-8 DC GND	22	
10	485 TX Data +	23	
11	485 TX Data -	24	
12	485 TX Clock +	25	
13	485 TX Clock -		

2070N EX2 Com Port

Pin	Function	Pin	Function
1	EQ Gnd	14	EQ Gnd
2	TxD 1	15	TxD 2
3	RxD 1	16	RxD 2
4	RTS 1	17	RTS 2
5	CTS 1	18	CTS 2
6	N/A	19	N/A
7	DC GND #1	20	DC GND #1
8	DCD 1	21	DCD 2
9	Audio In 1	22	Audio In 2
10	Audio In 1	23	Audio In 2
11	Audio Out 1	24	Audio Out 2
12	Audio Out 1	25	Audio Out 2
13	N/A		

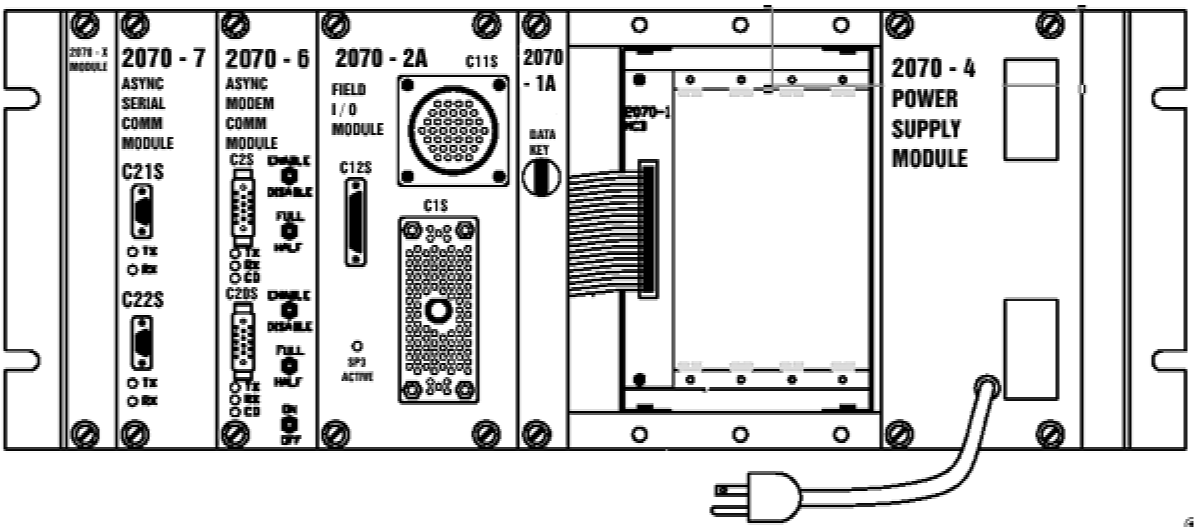
14.4 2070 / 2070N Modules

The 2070 is supplied with either full VME support or as a VME “light” configuration. The full VME version provides dual-processor support and VME expansion while the “light” version supports a single processor to reduce unit costs. The full VME version is supplied with a 2070-1A module as shown in the figure below. The VME “light” version is supplied with the 2070-1B module which also provides an Ethernet port (C14S) and an additional serial port (C13S).

Two field I/O modules are supported with either the full VME or VME “light” version. Both modules provide a C12S connector designed to interface the ATC cabinet. In addition to the C12S connector, the 2070-2A module provides a C1S and C11s connector to interface existing 170 and 179 cabinets. The 2070-2B module only provides the C12S connector to interface a 2070N expansion chassis and provide NEMA I/O support.

The LCD (Liquid Crystal Display) comes in 2 versions (a 4 line x 40 character display with ½” characters or an 8 line x40 character display with ¼” characters). The 2070 may also be supplied without the LCD and keyboard to reduce costs; however, a laptop or palm pilot must be supplied for the user interface using the C60P connector.

The 2070 modules used with these various configurations are listed below.



Rear View of 2070 Controller – VME Version, 170 Compatible I/O, 2 Async Serial Ports and 2 Modem Ports

Module #	Module Description
2070 – 1A	Full VME CPU – dual board module with VME master and slave capability
2070 – 1B	VME “Light” CPU – single board module with Ethernet and serial port 8 support
2070 – 1C	Future API support – processor and operating system independent
2070 – 2A	170/179 Compatible Field I/O Module with ATC support (C12S connector)
2070 – 2B	ATC Compatible Field I/O Module (used to interface the 2070N expansion chassis)
2070 – 3A	Front Panel with 4 line x 40 character LCD (1/2 inch letter height) – full VME only
2070 – 3B	Front Panel with 8 line x 40 character LCD (1/4 inch letter height)
2070 – 3C	Front panel without LCD or keyboard
2070 – 4A	10 amp, +5VDC Power Supply (used with the full VME version)
2070 – 4B	3.5 amp, +5VDC Power Supply (used with the VME “light” version)
2070 – 5	VME Assembly
2070 – 6A	Two modems and/or 1200 baud RS-232 serial ports – interfaces with either voice grade telephone or direct connection
2070 – 6B	Two modems and/or 9600 baud RS-232 serial ports – interfaces with either voice grade telephone or direct connection
2070 – 6C	1 channel auto-dial and 1 channel 400 modem
2070 – 6D	2 channel – fiber communication
2070 – 7A	2 Asynch Serial RS-232 Comm Channels
2070 – 7B	2 Asynch Serial RS-485 Comm Channels
2070 – 8	NEMA expansion module used with the 2070-2B module

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