# 2010ECL(ip) - 2018ECL(ip)

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### RMS Signal Monitor

### Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE FOLLOWING SERIES
OF MODEL 210/2010/2018 SIGNAL MONITORS, PCB Issue J:
**2010ECL, 2010ECLip, 2018ECL, 2018ECLip**

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**- NOTE -**

**EDI ECCOM SOFTWARE MUST BE UPDATED TO VERSION 4.2.5 OR
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## MAINTENANCE NOTE

**EBERLE DESIGN INC. SIGNAL MONITORS HAVE BEEN CAREFULLY INSPECTED AND TESTED TO ENSURE PROPER OPERATION. IT IS RECOMMENDED THAT THE SIGNAL MONITOR BE TESTED AT LEAST ANNUALLY TO ENSURE COMPLIANCE WITH THE PROPER SPECIFICATIONS.**

## SECTION 4.1.2, SPECIAL FUNCTION INPUTS

**SPECIAL FUNCTION #2 HAS BEEN DISABLED TO PROVIDE COMPATIBILITY WITH THE MT-180 MONITOR TESTER. RESISTORS R245 AND R219 HAVE BEEN REMOVED TO DISABLE THIS CIRCUIT. IF SPECIAL FUNCTION #2 INPUT IS REQUIRED, R245 AND R219 (75K OHMS, 1/4W) SHOULD BE INSTALLED.**

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**- WARNING -**

**THE P8 RED INTERFACE CABLE SHOULD ALWAYS BE UNPLUGGED BEFORE REMOVING THE UNIT FROM THE CABINET TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK.**

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**- WARNING -**

**PIN 27 OF THE MAIN CONNECTOR PROVIDES THE CLOSED CONTACT OF THE OUTPUT RELAY WHEN THE MONITOR IS IN THE NO-FAULT STATE. WHEN THE MONITOR IS IN THE NO-FAULT STATE AND THE AUTO/FLASH SWITCH IS IN THE FLASH POSITION, AC LINE VOLTAGE MAY BE PRESENT ON PIN 27.**

**THIS PIN WAS PREVIOUSLY DEFINED AS A "NO-CONNECT' PIN IN LEGACY EQUIPMENT. TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK, BEFORE INSTALLING THIS MONITOR THE USER IS CAUTIONED TO CHECK THAT THE CABINET WIRING IS COMPATIBLE WITH THE USE OF THIS PIN AS A SOURCE OF AC LINE VOLTAGE.**

# Table of Contents

# Section 1
# BASIC FUNCTIONS

## 1.1 MODEL DESCRIPTION

The Signal Monitor series consists of three models; the 2010ECL, 2018ECL, and 2018KCL. The model 2018KCL is described in a separate manual. The model 2010ECL and 2018ECL provide an EIA-232 serial port that gives the unit the capability to communicate with a Controller Unit or PC based operational software for status and fault event data. The model 2010ECL and 2018ECL also add an enhanced event logging capability for full time stamped event reporting. The model 2010ECL and 2018ECL units are configured to be compatible with the requirements of both the 170 Controller Unit and the 2070 Advanced Traffic Controller. The model 2018ECL is equivalent to the 2010ECL but provides eighteen channels. The "ip" models replace the EIA-232 port with a 10 Mbps Ethernet port. Where not specified otherwise, the information in this manual will apply to all models.

## 1.2 BASIC FUNCTIONS

The Signal Monitor is a device used in a traffic controller assembly to monitor traffic signals at an intersection for conflicting proceed indications caused by malfunctions of the controller, load switches, field wiring and loads, or miss-wiring of the cabinet. The Signal Monitor also provides error sensing of the cabinet 24VDC supply and monitors the controller Watchdog output. The Signal Monitor is directly interchangeable with a standard model 210 Signal Monitor and complies with all specifications outlined in Chapter 4 (Model 210 Monitor Specifications) of the *Caltrans Traffic Signal Control Equipment Specifications* (January 1989).

When triggered by the detection of a fault condition which exists longer than the minimum period, the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. The cabinet assembly should be wired such that the closure of the Output relay contacts will cause an automatic switching of the field signal outputs from normal operation to flashing operation. The Signal Monitor will then display the appropriate fault indications and will remain in this fault mode until a reset command is issued. The loss of AC Line power will not reset the fault mode (except Diagnostic Fail). In the event of AC Line power loss the Signal Monitor will retain the status of all fault and channel indicators and will display the correct fault and channel status upon restoration of AC Line power.

### 1.2.1 CONFLICT MONITORING

The Signal Monitor is capable of monitoring 16 channels (2018ECL provides 18 channels). Each channel consists of a Green, Yellow, and Red field signal output. A Program Card is provided for assigning conflicting channels and inhibiting Yellow monitoring for required channels. The Signal Monitor detects the presence of conflicting Green or Yellow signals on the AC field terminations between any two or more channels assigned to conflict on the Program Card. The monitoring circuitry is capable of detecting either full wave or positive and negative half-wave field signal outputs at the specified voltage levels.

### 1.2.2 24VDC MONITORING

Sensing of the cabinet 24VDC supply is provided as specified in Section 4.2, Chapter 4 of the *Caltrans Traffic Signal Control Equipment Specifications*. When the 24VDC input falls below the specified voltage levels the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. See Section 8.1.3.

**1.2.3 CONTROLLER WATCHDOG MONITORING (WDT ERROR)**

Sensing of the controller Watchdog output is provided as specified in Section 4.3 of the *Caltrans Traffic Signal Control Equipment Specifications*. When a logic transition is not sensed for the specified period (see Section 8.2) the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller.

The WDT Latch option (see Section 4.5.1) determines whether this WDT Error fault mode is latched through an AC Line brownout or not.  If the WDT Latch option is not selected, an AC Line brownout condition will reset the WDT ERROR fault mode when the AC Line is restored. The WDT Error indicator will remain illuminated until a Reset command is issued via the front panel RESET button or External Reset input. This indicates to the technician that a WDT Error occurred but was cleared by an AC Line brownout.  If the WDT LATCH option is selected, the WDT Error fault mode is maintained until a Reset command is applied.

**Section 2
EXTENDED FEATURES**

The following extended features are provided on the Signal Monitor to provide additional fault monitoring functions, to increase the reliability of the monitor operation, and enhance the diagnostic capabilities offered to the service technician.

## 2.1 HARDWARE FEATURES

The 210/2010/2018 series Signal Monitor is a dual microprocessor based unit. All monitoring functions and features are firmware programmable that permits upgrades or modifications by simply reprogramming the Flash memory device containing the firmware with the upgraded version. Thus, most changes to the Signal Monitor specifications may be accommodated without modifying the hardware.

Since all critical timing functions are accomplished by the microprocessor, the quartz crystal based accuracy results in very precise and repeatable measurements. This accuracy is maintained on functions from timing fault conditions to implementing a unique firmware based digital sampling and filtering algorithm. This algorithm is applied to all AC field signals to help eliminate false detection in a "noisy" AC line environment.

Input voltages are measured using a true Root Mean Squared (RMS) technique. A dedicated microprocessor RMS- Engine controls the analog to digital (A/D) hardware which samples each AC input voltage 32 times per cycle. The RMS-Engine then calculates the true RMS voltage value producing accurate results which are very insensitive to changes in frequency, phase, wave shape, and distortion. Voltage references are temperature compensated for constant voltage levels within the operating temperature range.

A nonvolatile EEPROM device is utilized to retain fault status information and event logs in the event of an AC Line power interruption. The correct fault indications will be displayed upon restoration of AC Line power. This EEPROM device requires no battery back-up. The time of day in the model 2010ECL and 2018ECL model is stored in a battery-backed real time clock circuit. Should this battery fail, only current time of day and date information will be lost. No monitor configuration programming is stored under battery power.

## 2.2 RED FAILURE MONITORING

The Signal Monitor is designed to adapt Red Failure Monitoring to a conventional controller cabinet assembly. The simultaneous absence of active Green, Yellow, and Red field signal voltages on a channel places the Signal Monitor into the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. Sixteen Red signal inputs, a Red Enable input, and two Special Function preemption inputs (SF1, SF2) are connected to the monitor via a front panel connector (P8) and ribbon cable assembly. Chassis Ground may also be connected to the unit through pin P8-4. Jumper E14 must then be inserted to complete the connection.

The Red Fail fault timing value is selected by the Red Fail timing Option switch labeled RF 2010. See Section 4.4.1.

This monitoring function is enabled by applying AC+ to the Red Enable input (P8-20). Unused Red signal inputs must be tied to AC+ to prevent a Red Failure on those channels. Red Failure monitoring is disabled for all channels when the Red Enable input is not active, a Preemption input (SF1, SF2) is active, or the EE input (MC Coil) is active.

### 2.2.1 RED FAIL SSM ENABLE

The Red Fail function can also be enabled on a per channel basis using the SSM switches. If the "RF SSM" option switch is in the On position (Section 4.4.7), then each channel will be monitored for a Red Fail condition if the corresponding SSM switch is in the On position. Red

Failure monitoring is disabled for all channels when the Red Enable input is not active, a Preemption input (SF1, SF2) is active, or the EE input (MC Coil) is active.

## 2.2.2 RED INTERFACE CABLE FAULT

When inserted into the output file without the Red Interface cable assembly, the Signal Monitor will operate as a standard 210 Signal Monitor. The Red Fail, Dual Indication, and Clearance monitoring functions will be disabled. When the Red Cable Fault select option is installed (see Section 4.5.4), operating without the Red Interface cable will cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode the Red Fail indicator will be illuminated with all channel indicators Off.

The cabinet should be wired such that the Red Enable input is only interrupted by the Load Switch bus being de-energized. Red Fail preemption control to the monitor should use the Special Function inputs #1 or #2.

## 2.3 GYR-DUAL INDICATION MONITORING

This monitoring function detects simultaneous indications of active Green and Yellow, Green and Red, or Yellow and Red field signal outputs on the same channel. A GYR-Dual Indication fault places the Signal Monitor into the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. GYR-Dual Indication Monitoring is enabled concurrently with Clearance Monitoring on a per channel basis using the SSM switches (see Section 4.2) and requires the controller cabinet assembly to be adapted for Red Signal Monitoring. GYR-Dual Indication Monitoring is disabled for all channels when the Red Enable input is not active or the EE input (MC Coil) is active.

An open or no load condition (i.e., burned-out bulb) may be detected as an active signal due to load switch leakage current and may cause a Dual Indication fault. Dual Indication Monitoring may also anticipate a possible Conflict in the event that a proceed signal on a channel is constantly detected as active.

## 2.3.1 GY-DUAL INDICATION MONITORING

This monitoring function detects a simultaneous indication of active Green and Yellow field signal outputs on the same channel. A GY-Dual Indication fault places the Signal Monitor into the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. It does not require the controller cabinet assembly to be adapted for Red Signal Monitoring, and is enabled by setting option switch SW3-4 labeled GY ENABLE in the ON position (see Section 4.4.4). GY-Dual Indication Monitoring may be enabled concurrently with GYR-Dual Indication Monitoring. When GY-Dual Indication Monitoring is enabled, all channels will be individually monitored for simultaneous indications of active Green and Yellow field signal outputs. Any channels which have been selected for GYR-Dual Indication Monitoring will function as described above in Section 2.3.

This monitoring function is intended to accommodate Green and Yellow Dual Indication Monitoring on a five section PPLT signal head. It is also useful if the controller cabinet assembly is not adapted for Red Signal Monitoring as in the case of a standard 210 Signal Monitor.

## 2.4 CLEARANCE (SHORT OR ABSENT YELLOW) MONITORING

This function detects the absence of a minimum period of active Yellow field signal output during a Green to Yellow to Red sequence. Clearance (Sequence) Monitoring is enabled concurrently with GYR-Dual Indication Monitoring on a per channel basis using the SSM switches (see Section 4.2) and requires the controller cabinet assembly to be adapted for Red Signal Monitoring. Clearance Monitoring is disabled for all channels when the Red Enable input is not active or the EE input (MC Coil) is active.

A Clearance (short or absent Yellow) fault condition will place the Signal Monitor into the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. This occurs when a Red input signal to a channel is active following the termination of an active Yellow input signal which is less than the minimum duration, including zero (i.e. skipped).

## 2.5 AC LINE BROWN-OUT DETECTION

When the AC Line voltage is below the "drop-out" level the Signal Monitor will suspend all fault monitoring functions, close the Output relay contacts, and enable the Stop-Time output to the controller. The AC POWER indicator on the front panel will flash at a rate of 2Hz to indicate the brown-out status.  When the AC Line voltage returns above the "restore" level the monitor will resume normal operation and the AC POWER indicator on the front panel will remain illuminated.

The AC Brownout dropout and restore voltage levels are selected by the AC Line Brown-out Select jumper labeled SEL5. See Section 4.5.5.

AC Line Brown-out Detection is provided to prevent a dark intersection in the event a brown-out causes the cabinet controller to release control of the intersection. If this occurs and the intersection is not placed into flash, the monitor will detect a Red Failure (absence of signal) or WDT Error and will require a manual reset. **The "low AC Line Voltage" level on the Controller Unit should be set at least 5 volts below the monitor drop-out level.**

### 2.5.1 MINIMUM FLASH TIME

A Minimum Flash time option can be selected (see Section 4.5.2) which provides a flash interval of at least 6 seconds and at most 10 seconds in duration following a power-up, an AC Line interruption, or a brownout restore. During this interval the unit will suspend all fault monitoring functions and close the Output relay contacts.  The AC indicator on the front panel will flash at a rate of 4Hz.

The minimum flash interval will be terminated after at least 6 seconds if the Watchdog input has made 5 transitions between the True and False state and the AC Line voltage is greater than the restore level.

## 2.6 *LEDGUARD*® LED FIELD SIGNAL SENSING

The Signal Monitor can be configured to use a technique called *LEDguard*® that is designed to better monitor the characteristics of LED based signal loads (See Section 4.4.6). Each field signal input is measured and compared to both a high threshold and a low threshold value to determine On / Off status. This differs from conventional operation where the active threshold is picked according to the color of the field signal. Once the high and low On / Off thresholds (Section 8.1.2) have been determined using the input RMS voltage, the individual fault monitor functions use the appropriate threshold to determine if a fault condition exists.

| *LEDguard*® | Green/Walk | Yellow | Red/Dont Walk |
|---|---|---|---|
| Conflict | Low | Low | --- |
| Red Fail | High | High | High |
| Dual Indication | Low | Low | Low |
| Clearance | Low | Low | High |

## 2.7 RECURRENT PULSE DETECTION

This error detection function supplements the normal Conflict, Dual Indication, and Red Fail monitoring algorithms for sensing faults that are intermittent or pulsing in nature.  The RMS-Engine is designed to filter out short term transients commonly found on the electrical service and provide noise immunity against false signal detections.  The Recurrent Pulse detection

function is designed to respond to fault conditions which are intermittent in nature and do not meet the continuous timing requirements of the normal detection algorithms, yet may still produce improper signal displays.  These input conditions are differentiated by their longer time constant and fault response times.

The figure below shows a simple example of a recurrent Conflict fault. Channel 2 Green is detected active due to a malfunction of the load switch that caused the output to flicker On for 100 ms approximately every 200 ms. Since normal Conflict detection requires a continuous fault of at least 350 ms duration, this event could go undetected.  The Recurrent Pulse detection algorithm will combine these pulses into one event and trigger a Conflict fault once the longer recurrent timing threshold is exceeded.
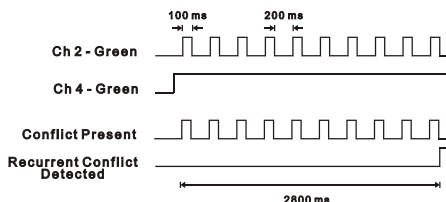


When triggered by a recurrent fault condition, the Signal Monitor will enter the fault mode, transfer the Output relay contacts to the Fault position, enable the Stop-Time output to the controller, and illuminate the appropriate CONFLICT, DUAL, or RED FAIL indicator along with the RP DETECT indicator. The unit will remain in the fault mode until reset by the Reset button or the External Reset input. Fault response times will vary depending on the pulse width and frequency of the recurrent inputs, but will range from 1000 ms minimum to 10.4 seconds maximum. Recurrent Pulse detection can be disabled with the RP DISABLE option switch (SW3-2), see Section 4.4.2.

## 2.8 EXIT FLASH

When the Signal Monitor series exits the flash state (Output relay de-energized) as a result of a Reset command or AC Line brownout restore, the Stop Time output will go to the inactive state 250 $\pm$ 50 ms before the Output relay transfers to the energized state.  This transition will provide an early indication to the 2070 Controller Unit that the cabinet will transfer from flash to signal operation.

## 2.9 NON-VOLATILE FAULT MEMORY

The Signal Monitor stores the fault and channel indicator status at the time the fault occurs into a non-volatile EEPROM device. Should an AC Line power interruption occur while the monitor is in the fault mode, then upon restoration of AC Line power, the Output relay and Stop-Time output will remain in the fault mode and the correct fault and channel indicators will be displayed.

The 2010ECL and 2018ECL models use a lifetime lithium battery to maintain the time of day clock. Should this battery fail, only current time and date functions will be lost. No monitor configuration parameters or event log data is stored under battery power.

## 2.10 PCA (PROGRAM CARD ABSENT) INDICATION

If the Program Card is absent or not seated properly in the edge connector, the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. The PCA indicator will illuminate to indicate this condition. A manual or external Reset is required after the Program Card is properly seated.

## 2.11 CONFIGURATION CHANGE MONITORING

The Signal Monitor maintains an internally calculated CRC value of the current configuration settings. These settings include the permissive diode matrix, SSM switches, Yellow Disable switches, Option switches, SEL1 through SEL16 jumpers, and the Watchdog Enable switch. On power-up, reset, and periodically during operation, the unit will compare the current configuration settings with the previously stored value. If the settings have changed, the Signal Monitor will automatically log the new setting.

When the Configuration Change Fault select option is enabled (see Section 4.5.3), any change in the configuration parameters will cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode the PCA indicator will flash at a 4 Hz rate. Depressing the Reset button for three full seconds will clear this fault and log the new configuration parameters.

If the Configuration Change Fault select jumper is not installed, the unit will not set the fault mode but will still log the configuration change.

## 2.12 INTERNAL MPU WATCHDOG

The Signal Monitor generates an internal watchdog pulse from its microprocessor. This occurs at least once per line cycle. If the internal hardware does not detect a watchdog pulse within approximately 325 milliseconds, the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. The DIAGNOSTIC indicator on the front panel will illuminate to indicate a monitor hardware and/or firmware failure.

This type of failure is configured as latching. With latching operation, only a loss of AC Line will restore operation. If the microprocessor resumes operation the unit will not return to normal operation. If non-latching operation is desired, jumper E13 (Latching MPU Fault) may be removed.

## 2.13 RESET INPUT DETECTION

A reset command from either the front panel Reset button or External Reset input will cause a one-time reset command to the monitor. If the reset command is maintained longer than 500 milliseconds, the monitor will resume monitoring functions and the Reset command will then provide input to the Diagnostic Display mode (see Section **Error! Reference source not found.**).

## 2.14 LED TEST

The monitor will illuminate all front panel indicators for 500 milliseconds when a Reset command is issued by the front panel Reset button or External Reset Input. This function provides a means to verify the operation of all front panel indicators.

## 2.15 MEMORY TEST

The Signal Monitor verifies the proper operation of the memory devices (RAM, EPROM, & EEPROM) required to operate the monitor. This test is performed when AC Line power is applied, a Reset Command is issued to the monitor, and periodically during operation. If a memory error is detected, the Signal Monitor will attempt to update the front panel display and then execute a STOP instruction. This will cause the Output relay contacts to close and enable the Stop-Time output to the controller. The DIAGNOSTIC indicator on the front panel will illuminate to indicate a monitor hardware and/or firmware failure. Due to the nature of these hardware or firmware failures, other fault indicators that may be concurrently illuminated may not be valid for trouble shooting purposes.

**2.16 WATCHDOG MONITORING DISABLED INDICATOR**

When the WDT ENABLE switch is in the OFF position to disable Watchdog Monitoring of the cabinet Controller, or the AC Line voltage is below the Watchdog disable level, the Signal Monitor will flash the WDT ERROR indicator on the front panel once every 2 seconds. This function informs the service technician that the cabinet Controller Watchdog monitoring function is disabled.

**2.17 RED FAILURE MONITOR DISABLED INDICATOR**

When the Red Fail Monitoring function is disabled because the Red Enable input is not active or the EE input (MC Coil) is active or a Special Function input is active, the Signal Monitor will flash the RED FAIL indicator on the front panel once every 2 seconds. This function informs the service technician that Red Fail Monitoring function is disabled.

**2.18 DIAGNOSTIC DISPLAY MODE (2010ECL / 2018ECL)**

The 2010ECL and 2018ECL models provide two means of displaying the individual Green, Yellow, and Red field status. The No Fault Diagnostic Display mode shows the real time individual colors while the monitor is not in the fault mode (intersection operating) using the three color LED full intersection display. The Fault Diagnostic Display mode shows the individual colors which were active at the time the monitor triggered to the fault mode (intersection in flash) as well as the channel(s) which were involved in the fault. The Fault Diagnostic Display mode also provides a review of previous fault events.

**2.18.1 NO FAULT DIAGNOSTIC DISPLAY**

When the 2010ECL and 2018ECL model is not in the fault state, the unit will continuously display the active Green, Yellow, and Red field status simultaneously on a three color LED full intersection display.

**2.18.2 FAULT DIAGNOSTIC DISPLAY**

Once the 2010ECL and 2018ECL model has been triggered by a fault the channel status display will alternate between the field signals active at the time of the fault for 6 seconds, and the channels which were involved in the fault (fault status) for 2 seconds. The channels involved in the fault will flash their respective Green, Yellow, and Red indicators simultaneously at a 4 Hz rate for the 2 second fault status interval. If the fault displayed is a Recurrent Pulse Conflict, Recurrent Pulse Dual Indication, or a Recurrent Pulse Red Fail, the RP DETECT indicator will then flash simultaneously at a 4 Hz rate with the input(s) that had Recurrent Pulse status for an additional 2 seconds following the fault channel display.

The two previous faults may be also be displayed individually. This status is not reset by an AC Line power interruption. To enter this display mode remove the Program Card. The sequence is as follows:

| Reset | Event | PCA LED | Fault Status LEDs | Channel Status LEDs |
|-------|-------|---------|-------------------|---------------------|
| --- | #1 | Single flash | Current Fault Status (newest) | Current RYG channel status |
| #1 | #2 | Double flash | Event #2 Fault Status | Event #2 RYG channel status |
| #2 | #3 | Triple flash | Event #3 Fault Status (oldest) | Event #3 RYG channel status |
| ... | | (repeats back to top) | | |

To enter this display mode remove the Program Card. The channel status display will alternate between the channels which were involved in the fault (fault status) for 2 seconds, and the field signals active at the time of the fault for 6 seconds. The channels involved in the fault will flash their Green, Yellow, and Red indicators simultaneously at a 4 Hz rate for the 2 second interval. The PCA LED will pulse once per second to indicate the current fault (#1, newest).

Depressing the Reset button advances the display mode from the current fault ( #1) to the fault display mode for fault #2. The PCA LED will pulse twice per second to indicate the previous fault (#2).

Depressing the Reset button again advances the display mode from fault  #2 to the fault display mode for fault #3. The PCA LED will pulse three times per second to indicate the previous fault (#3).

Depressing the Reset button again returns the display mode from fault  #3 to the fault display mode for fault #1.

To exit this display mode, replace the Program Card. If the Program Card is removed while the unit has **not** been triggered by a fault, the fault status display mode will show the Green, Yellow, and Red channels active when the Program Card was removed. If a PCA fault is displayed during the review, the PCA LED will not flash during the Fault Status display step to indicate the fault number.

## 2.19 FLASHING YELLOW ARROW (FYA) OVERVIEW

This unit is designed to monitor an intersection with up to four approaches using the four section FYA movement outlined by the NCHRP Research Project 3-54 and NEMA TS-2 Amendment #4-2012 on Protected/Permissive signal displays with Flashing Yellow Arrows. For monitoring purposes an FYA approach is defined as a four input "logical channel" consisting of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow (permissive), and solid Green Arrow (protected). The Signal Monitor combines two physical channels to monitor each "logical" FYA approach.

Three cabinet configurations are supported depending on the number of load switches provided and the capabilities of the Controller Unit. A Flashing Yellow Arrow approach is actually monitored using two physical channels of the Signal Monitor. In the basic FYA mode of the unit, one additional load switch is required for each FYA approach to be monitored. Thus a cabinet providing four vehicle phases, four pedestrian phases, and four FYA approaches would require sixteen load switches (Aux Assembly). See Section 0 for FYA Mode programming.

The compact FYAC mode requires the Controller Unit to remap the Yellow outputs of the pedestrian load switches to drive the protected Green Arrow signals of the FYA approaches. In this mode the cabinet can provide the four FYA approaches with the existing twelve position output assembly. See Section 4.4.8 for FYAC Mode programming.

The compact FYAC Mode-H requires the Controller Unit to remap the Yellow outputs of the pedestrian load switches to drive the permissive flashing Yellow Arrow signals of the FYA approaches. In this mode the cabinet can provide the four FYA approaches with the existing twelve position output assembly and support an Aux Assembly to provide four additional load switches for channels 9-12. See Section 2.19.3 for FYAC Mode-H programming.

### 2.19.1 FYA MODE

In the FYA mode (see Table 2-1), the cabinet must be wired such that for each FYA approach, the solid Green protected Arrow is driven by a load switch monitored on channels 1, 3, 5, and 7. The associated solid Red Arrow, solid Yellow Arrow, and flashing Yellow Arrow (Overlap phase) must be driven by a load switch monitored on channels 9, 10, 11, and 12 respectively. The Signal Monitor associates channel 1 with 9, channel 3 with 10, channel 5 with 11, and channel 7 with 12, when FYA monitoring is enabled for that respective approach. See Section 4.4.8 for FYA Mode programming.

**Table 2-1**

**FYA Mode Channel Configurations**



| | Protected Turn Channels (Ga) | Opposing Through Channels | Permissive Turn Channels (Ra, Ya, fYa) | Green Arrow Signal Driver Source |
|---|---|---|---|---|
| | 1 | 2 | 9 | 1 Green |
| | 3 | 4 | 10 | 3 Green |
| | 5 | 6 | 11 | 5 Green |
| | 7 | 8 | 12 | 7 Green |

### 2.19.1.1 FYA MONITORING FUNCTIONS

If a FYA channel pair is enabled for FYA operation, the Signal Monitor will monitor the FYA logical channel pair for the following fault conditions:

### 2.19.1.1.1 CONFLICT

Channel conflicts are detected based on the Permissive programming jumpers on the Program Card for each channel. This operation remains unchanged from normal operation except for the solid Yellow arrow (FYA clearance) signal.

### 2.19.1.1.1.1 PROTECTED YELLOW CHANGE INTERVAL CONFLICT

The Signal Monitor will verify during the Yellow change interval of the Protected Turn channel (Green arrow; channels 1,3,5,7) that no conflicting channels to the solid Yellow arrow channel (clearance) are active. The conflicting channels are determined by the Program Card compatibility programming of the Protected Turn channel (Green arrow; channels 1,3,5,7) of the pair.

### 2.19.1.1.1.2 PERMISSIVE YELLOW CHANGE INTERVAL CONFLICT

During all other times the Signal Monitor will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the Permissive Turn channel (flashing Yellow arrow; Channels 9, 10,11, 12).

### 2.19.1.1.2 FLASH RATE DETECTION

When the FLASHRATE FAULT option is not disabled (see Section 4.5.7), the Signal Monitor will monitor a flashing yellow arrow output for a lack of flashing operation. If any of the enabled flashing yellow arrow signals on channels 9,10,11,12 remain active for more than the FYA Flash Rate Fault time (Section 8.2), the Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display status. The Signal Monitor will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

### 2.19.1.1.3 RED FAIL

A Red Fail fault will occur if the solid Red Arrow AND solid Yellow Arrow AND flashing Yellow Arrow AND solid Green Arrow all remain inactive for the Red Fail fault response time. The fault channel status will be indicated for both channels of the pair. The Red and Yellow inputs for channels 1, 3, 5, and 7 do not affect the Red Fail condition for the FYA channels 9, 10, 11, and 12.

**2.19.1.1.4 DUAL INDICATION**

A Dual Indication fault will occur if any two or more of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow, or solid Green Arrow signal combinations are active simultaneously for the Dual Indication fault response time. The fault channel status will be indicated for the Overlap channel (9, 10, 11, 12). The fault channel status will also be indicated for the solid Green Arrow channel (1, 3, 5, 7) IF the solid Green Arrow was active.

If the SSM switch is On for the solid Green Arrow channels (1, 3, 5, 7) then a Dual Indication fault will occur if any two or more of the Red, Yellow, or solid Green Arrow inputs (1, 3, 5, 7) are active simultaneously for the Dual Indication fault response time.

**2.19.1.1.5 CLEARANCE**

A Clearance fault will be detected if the FYA channel sequences from the solid Green Arrow (1, 3, 5, 7) to the solid Red Arrow (9, 10, 11, 12) without a minimum clearance time on the solid Yellow Arrow (9, 10, 11, 12), when SSM switch 9, 10, 11, 12 is On. The fault channel status will be indicated for the Overlap channel (9, 10, 11, 12).

A Clearance fault will be detected if the FYA channel sequences from the flashing Yellow Arrow (9, 10, 11, 12) to the solid Red Arrow (9, 10, 11, 12) without a minimum clearance time on the solid Yellow Arrow (9, 10, 11, 12), when SSM switch 9, 10, 11, 12 is On. The fault channel status will be indicated for the Overlap channel (9, 10, 11, 12).

A Clearance fault will be detected if the protected channel sequences from the solid Green Arrow (1, 3, 5, 7) to the solid Red Arrow (1, 3, 5, 7) without a minimum clearance time on the solid Yellow Arrow (1, 3, 5, 7). SSM switch 1, 3, 5, 7 is On. The fault channel status will be indicated for the solid Green Arrow channel (1, 3, 5, 7).

**2.19.1.2 FYA INSTALLATION**

The cabinet must be wired such that for each FYA approach, the solid Green protected Arrow is driven by a load switch monitored on channels 1, 3, 5, and 7. The associated solid Red Arrow, solid Yellow Arrow, and flashing Yellow Arrow (Overlap phase) must be driven by a load switch monitored on channels 9, 10, 11, and 12 respectively. The Signal Monitor associates channel 1 with 9, channel 3 with 10, channel 5 with 11, and channel 7 with 12 when FYA monitoring is enabled for that respective approach.

---

**- WARNING -**

**IF THE PERMISSIVE FLASHING YELLOW ARROW AND PROTECTED GREEN ARROW CHANNEL ASSIGNMENTS ARE SWAPPED SUCH THAT THE FYA INPUT IS MONITORED ON CHANNELS 1,3,5, AND 7:**

1) The Flashrate Fault function monitors the enabled flashing Yellow Arrow input of channels 9,10,11, and 12. The Flashrate Fault function must be disabled. See Section 4.5.7.

2) Exit Flash into Start-up in all Yellow signals is not permitted.

3) Time of Day flash in all Yellow signals is not permitted.

---

To enable channel pair for FYA operation, place the Option DIP Switch labeled "FYA x-y" (where "x-y" is 1-9, 3-10, 5-11, or 7-12) in the On position. When the "FYA x-y" switch is in the Off position, both channel x and y operate in standard fashion. See Section 4.4.8.1.

This Permissive Programming (Conflict Matrix) assignment example assumes standard channel assignments for an eight phase quad intersection. The Permissive programming for channels 1, 3, 5, and 7 (solid Green Arrow) are unchanged from conventional programming for a protected left turn phase, with the addition of the jumpers for the associated FYA overlap

---

channels. The Permissive programming for overlap channels 9, 10, 11, and 12 (solid Yellow and flashing Yellow Arrow) must be set with similar programming to the associated through phase. For example:

| Primary Channel | Permissive With: |
|---|---|
| 1 | 5, 6, 11 |
| 2 | 5, 6, 9, 11 |
| 3 | 7, 8, 12 |
| 4 | 7, 8, 10, 12 |
| 5 | 9 |
| 6 | 9, 11 |
| 7 | 10 |
| 8 | 10, 12 |
| 9 | 11 |
| 10 | 12 |
| 11 | -- |
| 12 | -- |

**Note: This example is for illustrative purposes ONLY. Permissive Programming for an application depends on actual intersection geometry, cabinet wiring, and Controller programming.**

### 2.19.1.3 RIGHT TURN OVERLAPS

Because the FYA operation uses channels 9 through 12 normally assigned to overlap phases, a sixteen channel monitor does not provide enough channels for an eight phase intersection with four pedestrian channels, four right turn overlaps, and four FYA approaches. Right turn overlaps can still be implemented by driving the right turn signal heads with the corresponding protected left turn load switch. In this case, the right turn overlap will not be controlled independently. Consideration should be given for the SSM switch being On for the channel 1, 3, 5, and 7 if used in this manner.

For right turn overlaps with no Yellow Arrow, consideration should be given to driving the Green Arrow load switch input with the Phase On control.

### 2.19.2 FYAC (COMPACT) MODE

For each FYAC approach (see Table 2-2), each solid Green protected Arrow signal is monitored on channels 9, 10, 11, and 12 (Green). The associated solid Red Arrow, solid Yellow Arrow, and flashing Yellow Arrow is monitored on channels 1, 3, 5, and 7 respectively. The Signal Monitor associates channel 1 with 9, channel 3 with 10, channel 5 with 11, and channel 7 with 12, when FYAC monitoring is enabled for that respective approach. See Section 4.4.8 for FYA Mode programming.

In the FYAC mode the Signal Monitor requires that the protected Green arrow signals be driven by the unused Ped Yellow load switch outputs. This relies on a Caltrans 332 cabinet wiring requirement of connecting the Ped Yellow load switch outputs to monitor channels 9 and 10 as described in section 2.19.2.2. Using this scheme allows a standard twelve position Output File to provide the necessary signals without the addition of an Auxiliary File.

**Table 2-2**
**FYAC Channel Configurations**

| FYAC Mode | Protected Turn Channels (Ga) | Opposing Through Channels | Permissive Turn Channels (Ra, Ya, fYa) | Green Arrow Signal Driver Source |
|---|---|---|---|---|
| | 9 | 2 | 1 | 13 Yellow |
| | 10 | 4 | 3 | 14 Yellow |
| | 11 | 6 | 5 | 15 Yellow |
| | 12 | 8 | 7 | 16 Yellow |

### 2.19.2.1 FYAC MONITORING FUNCTIONS

If a FYA channel pair is enabled for FYAC operation, the Signal Monitor will monitor the FYAC logical channel pair for the following fault conditions:

#### 2.19.2.1.1 CONFLICT

Channel conflicts are detected based on the Permissive programming jumpers on the Program Card for each channel. This operation remains unchanged from normal operation except for the solid Yellow arrow (FYA clearance) signal.

#### 2.19.2.1.1.1 PROTECTED YELLOW CHANGE INTERVAL CONFLICT

The Signal Monitor will verify during the Yellow change interval of the Protected Turn channel (Green arrow; channels 9,10,11,12) that no conflicting channels to the solid Yellow arrow channel (clearance) are active. The conflicting channels are determined by the Program Card compatibility programming of the Protected Turn channel (Green arrow; channels 9,10,11,12) of the pair.

#### 2.19.2.1.1.2 PERMISSIVE YELLOW CHANGE INTERVAL CONFLICT

During all other times the Signal Monitor will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the Permissive Turn channel (flashing Yellow arrow; Channels 1,3,5,7).

#### 2.19.2.1.2 FLASH RATE DETECTION

When the FLASHRATE FAULT option is not disabled (see Section 4.5.7), the Signal Monitor will monitor a flashing yellow arrow output for a lack of flashing operation. If any of the enabled flashing yellow arrow signals on channels 1,3,5,7 remain active for more than the FYA Flash Rate Fault time (Section 8.2), the Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display status. The Signal Monitor will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

#### 2.19.2.1.3 RED FAIL

A Red Fail fault will occur if the solid Red Arrow AND solid Yellow Arrow AND flashing Yellow Arrow AND solid Green Arrow all remain inactive for the Red Fail fault response time. The fault channel status will be indicated for both channels of the pair. The Red and Yellow inputs (typically unused) for channels 9, 10, 11, and 12 do not affect the Red Fail condition for the FYA channels 1, 3, 5, and 7.

#### 2.19.2.1.4 DUAL INDICATION

A Dual Indication fault will occur if any two or more of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow, or solid Green Arrow signal combinations are active simultaneously for the Dual Indication fault response time. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7). The fault channel status will also be indicated for the solid Green Arrow channel (9, 10, 11, 12) IF the solid Green Arrow was active.

The SSM Switch for each 1,3,5,and 7 channel must be in the ON position to enable Dual Indication Monitoring for that channel pair.

#### 2.19.2.1.5 CLEARANCE

A Clearance fault will be detected if the FYAC channel sequences from the solid Green Arrow (9, 10, 11, 12) to the solid Red Arrow (1, 3, 5, 7) without a minimum clearance time on the solid Yellow Arrow (1, 3, 5, 7), when SSM switch 1, 3, 5, 7 is On. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7).

A Clearance fault will be detected if the FYAC channel sequences from the flashing Yellow Arrow (1, 3, 5, 7) to the solid Red Arrow (1, 3, 5, 7) without a minimum clearance time on the solid Yellow Arrow (1, 3, 5, 7), when SSM switch 1, 3, 5, 7 is On. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7).

#### 2.19.2.2 FYAC INSTALLATION

The cabinet must be wired such that the (unused) Ped Yellow load switch outputs are wired to the Signal Monitor inputs as follows:

| Phase | Load Switch # | Monitor Physical Input |
|---|---|---|
| Ped 2 Yellow | 3 | Ch 9 Green (pin 13) |
| Ped 4 Yellow | 6 | Ch 9 Yellow (pin 16) |
| Ped 6 Yellow | 9 | Ch 10 Green (pin R) |
| Ped 8 Yellow | 12 | Ch 10 Yellow (pin U) |

The Controller unit must be configured to drive the protected Green arrow signals from the Ped Yellow load switch outputs. If ANY channel pairs are enabled for FYAC operation, the Signal Monitor will internally remap monitor Channel 9 and 10 physical inputs such that the protected Green arrow signals will be monitored as Channels 9, 10, 11, and 12 as follows:

| Monitor Physical Input | Monitor Logical Channel | Associated FYA Channel |
|---|---|---|
| Ch 9 Green | Ch 9 Green | Ch 1 |
| Ch 9 Yellow | Ch 10 Green | Ch 3 |
| Ch 10 Green | Ch 11 Green | Ch 5 |
| Ch 10 Yellow | Ch 12 Green | Ch 7 |

The associated solid Red Arrow, solid Yellow Arrow, and flashing Yellow Arrow phases must be driven by a load switch monitored on channels 1, 3, 5, and 7 respectively. The Signal Monitor associates channel 1 with 9, channel 3 with 10, channel 5 with 11, and channel 7 with 12 when FYA monitoring is enabled for that respective approach.

> **- WARNING -**
>
> **IF THE PERMISSIVE FLASHING YELLOW ARROW AND PROTECTED GREEN ARROW CHANNEL ASSIGNMENTS ARE SWAPPED SUCH THAT THE FYA INPUT IS MONITORED ON CHANNELS 1,3,5, AND 7:**
>
> 1) The Flashrate Fault function monitors the enabled flashing Yellow Arrow input of channels 9,10,11, and 12. The Flashrate Fault function must be disabled. See Section 4.5.7.
>
> 2) Exit Flash into Start-up in all Yellow signals is not permitted.
>
> 3) Time of Day flash in all Yellow signals is not permitted.

To enable a channel pair for FYAC operation, place the Option DIP Switch labeled "FYA x-y" (where "x-y" is 1-9, 3-10, 5-11, or 7-12) in the On position. When the "FYA x-y" switch is in the Off position, channel x will operate in standard fashion. If all four "FYA x-y" DIP switches are in the Off position, channels 9, 10, 11, and 12 all operate in standard fashion and the remapping of Channel 9 and 10 Green and Yellow described above is not done. See Section 4.4.8.1.

Because of the remapping of the inputs to channels 9, 10, 11, and 12 Green, the functionality of the Yellow and Red inputs of channels 9, 10, 11, and 12 is not provided for when FYAC operation is enabled. The SSM switches for these four channels should be placed in the Off position.

This Permissive Programming (Conflict Matrix) assignment example assumes standard channel assignments for an eight phase quad intersection. The Permissive programming for channels 9, 10, 11, and 12 (solid Green Arrow) are unchanged from conventional programming for a protected left turn phase, with the addition of the jumpers for the associated FYAC channels. The Permissive programming for FYAC channels 1, 3, 5, and 7 (solid Yellow and flashing Yellow Arrow) must be set with similar programming to the associated through phase. For example:

| Primary Channel | Permissive With |
|:---:|:---|
| 1 | 2, 5, 6, 11 |
| 2 | 5, 6, 11 |
| 3 | 4, 7, 8, 12 |
| 4 | 7, 8, 12 |
| 5 | 6, 9 |
| 6 | 9 |
| 7 | 8, 10 |
| 8 | 10 |
| 9 | 11 |
| 10 | 12 |
| 11 | -- |
| 12 | -- |

**NOTE: This example is for illustrative purposes ONLY. Permissive Programming for an application depends on actual intersection geometry, cabinet wiring, and Controller programming.**

### 2.19.3 FYAC (COMPACT) MODE-H

For each FYAC Mode-H approach (see Table 2-3), each flashing Yellow permissive Arrow signal is monitored on channels 13, 14, 15, and 16 Yellow. The associated solid Red Arrow,

solid Yellow Arrow, and protected Green Arrow is monitored on channels 1, 3, 5, and 7 respectively. The Signal Monitor associates channel 1 with 13, channel 3 with 14, channel 5 with 15, and channel 7 with 16, when FYAC Mode-H monitoring is enabled for that respective approach. See Section 4.4.8 for FYA Mode programming.

In the FYAC Mode-H the Signal Monitor requires that the permissive flashing Yellow arrow signals be driven by the unused Ped Yellow load switch outputs. The cabinet must be wired such that the Ped Yellow load switch outputs are monitored on channel 13-16 Yellow inputs of the monitor. FYAC Mode-H is a useful mode only when an Aux Assembly is installed such that channels 9-12 can be used for other movements such as overlaps.

FYAC Mode-H has three requirements for use:

1. The permissive flashing Yellow arrow phase must have the same Conflict permissive programming as the associated pedestrian phase.
2. Exit Flash into Start-up in all Yellow signals is not permitted.
3. Time of Day flash in all Yellow signals is not permitted.

**Table 2-3**

**FYAC Mode-H Channel Configurations**



| | Ch: 1    3    5    7    9    12   13   16 | | | |
|---|---|---|---|---|
| FYAC Mode H | Protected Turn Channels (Ra, Ya, Ga) | Opposing Through Channels | Permissive Turn Channels (fYa) | Flashing Yellow Arrow Signal Driver Source |
| | 1 | 2 | 13 Yellow (Ped) | 13 Yellow (Ped) |
| | 3 | 4 | 14 Yellow (Ped) | 14 Yellow (Ped) |
| | 5 | 6 | 15 Yellow (Ped) | 15 Yellow (Ped) |
| | 7 | 8 | 16 Yellow (Ped) | 16 Yellow (Ped) |

### 2.19.3.1 FYAC MODE-H MONITORING FUNCTIONS

If a FYA channel pair is enabled for FYAC Mode-H operation, the Signal Monitor will monitor the logical channel pair for the following fault conditions:

### 2.19.3.1.1 CONFLICT

Channel conflicts are detected based on the Permissive programming of the Program Card for each channel. This operation remains unchanged from normal operation except for the solid Yellow arrow (FYA clearance) signal.

### 2.19.3.1.1.1 PERMISSIVE YELLOW CHANGE INTERVAL CONFLICT

The Signal Monitor will verify during the Yellow change interval of the Permissive Turn channel (flashing Yellow arrow; channels 13,14,15,16) that no conflicting channels to the flashing Yellow arrow channel (clearance) are active. The conflicting channels are determined by the Program Card compatibility programming of the Permissive Turn channel (flashing Yellow arrow; channels 13,14,15,16) of the pair.

### 2.19.3.1.1.2 PROTECTED YELLOW CHANGE INTERVAL CONFLICT

During all other times the Signal Monitor will verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the Program Card compatibility programming of the Protected Turn channel (Green arrow; Channels 1,3,5,7).

**2.19.3.1.2 FLASH RATE DETECTION**

When the FLASHRATE FAULT option is not disabled (see Section 4.5.7), the Signal Monitor will monitor a flashing yellow arrow output for a lack of flashing operation. If any of the enabled flashing yellow arrow signals on channels 13,14,15,16 remain active for more than the FYA Flash Rate Fault time (Section 8.2), the Signal Monitor will enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and display status. The Signal Monitor will remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

**2.19.3.1.3 RED FAIL**

A Red Fail fault will occur if the solid Red Arrow AND solid Yellow Arrow AND flashing Yellow Arrow AND solid Green Arrow all remain inactive for the Red Fail fault response time. The fault channel status will be indicated for both channels of the pair. The Red (Don't Walk) and Green (Walk) inputs for channels 13,14,15, and 16 do not affect the Red Fail condition for the FYA channels 1, 3, 5, and 7.

**2.19.3.1.4 DUAL INDICATION**

A Dual Indication fault will occur if any two or more of the solid Red Arrow, solid Yellow Arrow, flashing Yellow Arrow, or solid Green Arrow signal combinations are active simultaneously for the Dual Indication fault response time. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7). The fault channel status will also be indicated for the flashing Yellow Arrow channel (13,14,15,16) IF the solid Green Arrow was active.

**2.19.3.1.5 CLEARANCE**

A Clearance fault will be detected if the FYAC channel sequences from the solid Green Arrow (1, 3, 5, 7) to the solid Red Arrow (1, 3, 5, 7) without a minimum clearance time on the solid Yellow Arrow (1, 3, 5, 7), when SSM switch 1, 3, 5, 7 is On. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7).

A Clearance fault will be detected if the FYAC channel sequences from the flashing Yellow Arrow (13,14,15,16) to the solid Red Arrow (1, 3, 5, 7) without a minimum clearance time on the solid Yellow Arrow (1, 3, 5, 7), when SSM switch 1, 3, 5, 7 is On. The fault channel status will be indicated for the FYAC channel (1, 3, 5, 7).

**2.19.3.2 FYAC MODE-H INSTALLATION**

The cabinet must be wired such that the (unused) Ped Yellow load switch outputs are wired to the Signal Monitor inputs as follows:

| Table 2-4 Type 332 Cabinet Load Switch Map | | |
|---|---|---|
| Phase | Load Switch # | Monitor Physical Input |
| Ped 2 Yellow | 3 | Ch 13 Yellow (pin 8) |
| Ped 4 Yellow | 6 | Ch 14 Yellow (pin 11) |
| Ped 6 Yellow | 9 | Ch 15 Green (pin K) |
| Ped 8 Yellow | 12 | Ch 16 Yellow (pin N) |

| Table 2-5 Type 330 Cabinet Load Switch Map | | |
|---|---|---|
| Phase | Load Switch # | Monitor Physical Input |
| Ped 2 Yellow | 13 | Ch 13 Yellow (pin 8) |
| Ped 4 Yellow | 14 | Ch 14 Yellow (pin 11) |
| Ped 6 Yellow | 15 | Ch 15 Green (pin K) |
| Ped 8 Yellow | 16 | Ch 16 Yellow (pin N) |

The Controller unit must be configured to drive the permissive flashing Yellow arrow signals from the Ped Yellow load switch outputs. The associated solid Red Arrow, solid Yellow Arrow, and protected Green Arrow phases must be driven by a load switch monitored on channels 1, 3, 5, and 7 respectively. The Signal Monitor associates channel 1 with 13, channel 3 with 14, channel 5 with 15, and channel 7 with 16 when FYA monitoring is enabled for that respective approach.

The FYAC Mode-H is set when Option DIP Switch FYAC MODE-H (SW3 #5) and FYA COMPACT (SW3 #8) are both in the On position, see section 4.4.5 and 4.4.8.

> **Note**: On PCBs Issue H and below that have been updated with current firmware supporting the FYAC Mode-H, this Option DIP Switch #5 was labelled SF#1 POLARITY. This DIP Switch #5 has been reassigned to the Mode-H function.

To enable a channel pair for FYAC Mode-H operation, place the Option DIP Switch labeled "FYA x" (where "x" is 1, 3, 5, or 7) in the On position. When the "FYA x" switch is in the Off position, channel x will operate in standard fashion. See section 4.4.8.1.

The SSM switches for the Ped channels 13, 14, 15, and 16 only affect the Red (Don't Walk) and Green (Walk) inputs of the channel, for Dual Indication and Clearance monitoring.

This Permissive Programming (Conflict Matrix) assignment example assumes standard channel assignments for an eight phase quad intersection. The Permissive programming for channels 1, 3, 5, and 7 (solid Green Arrow) are unchanged from conventional programming for a protected left turn phase. The Permissive programming for FYAC Mode-H channels 13, 14, 15, and 16 (flashing Yellow Arrow) share the programming of the associated Ped channel. For example:

| Primary Channel | Permissive With |
|:---:|:---|
| 1 | 5, 6, 15 |
| 2 | 5, 6, 13, 15 |
| 3 | 7, 8, 16 |
| 4 | 7, 8, 14, 16 |
| 5 | 13 |
| 6 | 13, 15 |
| 7 | 14 |
| 8 | 14, 16 |
| 9 | -- |
| 10 | -- |
| 11 | -- |
| 12 | -- |
| 13 | 15 |
| 14 | 16 |
| 15 | -- |

**NOTE: This example is for illustrative purposes ONLY. Permissive Programming for an application depends on actual intersection geometry, cabinet wiring, and Controller programming.**

## Section 3
## EVENT LOGGING FEATURES

### 3.1 BASIC FRONT PANEL FAULT EVENT DISPLAY

The Signal Monitor retains three fault events in nonvolatile memory which can be reviewed via the front panel display. The contents of the log and the procedure for review is described in Section **Error! Reference source not found.** or Section 2.18.

### 3.2 MODEL 2010ECL / 2018ECL STATUS/EVENT REPORTING

The 2010ECL and 2018ECL models use the EIA-232 port to communicate status to a Controller Unit operational software and event data logs to a Personal Computer (PC). The model 2010ECLip and 2018ECLip use a 10Mbs Ethernet port to communicate status to a Controller Unit operational software and event data logs to a Personal Computer (PC).

### 3.2.1 BI TRAN SYSTEMS 233 PROGRAM MONITOR STATUS

The 2010ECL and 2018ECL model status message format and time/date message format is compatible with BI Tran Systems Model 233 Software. On request from the operational software, the 2010ECL and 2018ECL model provides the current field status if no fault has triggered the monitor. If the monitor is in the fault mode, the current fault status and field input status at the time of the fault is reported. The operational software will also periodically synchronize the 2010ECL and 2018ECL model time clock. The BI Tran Systems Model 233 Software manual should be consulted for details of operation.

### 3.2.2 EDI *ECCOM* MONITOR REPORT

The EDI *ECcom* software package (Version 4.2.5 or greater is required) interfaces a Computer to the models. The *ECcom* program will display the Status (S), Previous Fault (PF) event log, AC Line (AC) event log, Manual Reset (MR) event log, Configuration (CF) event log, and Fault Trace log. All events are time stamped with the time and date of the event. Operation of the *ECcom* software package is described in "*EDI ECcom Software Operations Manual*" and will not be covered in this manual.  The following data is available:

> General Data
> > a) Monitor ID#: a four digit (0000-9999) ID number may be assigned to the monitor.
> > b) Time and Date: each event is marked with the time and date of occurrence.
> > c) Event Number: identifies the record number in the log. Event #1 is the most recent event.
>
> Current Status (S)
> > a) Fault Type: the fault type description.
> > b) Field Status: the current or latched GYR field status and RMS voltages.
> > c) Cabinet Temperature: the current or latched temperature of the monitor.
> > d) AC Line Voltage: the current or latched AC Line voltage.
> > e) Control Input Status: the current or latched state and RMS voltages of the Red Enable input, EE input, Special Function #1 and #2 inputs, and the WDT monitor.
>
> Previous Fault (PF) Event Log (25)
> > a) Fault Type: the fault type description.
> > b) Field Status: the latched field status, RMS voltages, and fault channel status at the time of the fault.
> > c) Cabinet Temperature: the latched temperature at the time of the fault.
> > d) AC Line Voltage: the AC Line voltage at the time of the fault.

e) <u>Control Input Status</u>: the latched state and RMS voltages of the Red Enable input, EE input, Special Function #1 and #2 inputs, and the WDT monitor.

AC Line (AC) Event Log (40)

a) <u>Event Type</u>: describes the type of AC Line event that occurred.

Power-up - - AC on, monitor performed a cold start
Brown-out - AC Line < drop-out level
Restore - AC restored from AC brown-out or AC interruption, no cold start

b) <u>AC Line Voltage</u>: the AC Line voltage at the time of the event.

Manual Reset (MR) Event Log (25)

a) The monitor was reset from a fault by the front panel Reset button or External Reset input.

Configuration (CF) Event Log (10)

a) <u>Program Card Matrix</u>: the permissive programming for each channel.
b) <u>Yellow Disable Jumpers</u>: the Yellow Disable programming for each channel.
c) <u>SSM Switches</u>: the SSM Switch programming for each channel.
d) <u>Option Switches</u>: RF 2010, RP Disable, GY Enable, SF1 Polarity, FYA, Minimum Flash Enable, Configuration Fault Enable, Red Cable Fault enable, AC Brownout timing.
e) <u>Watchdog Programming</u>: Watchdog Enable, Watchdog timing, and Watchdog Latch.
f) <u>Configuration Check Value</u>: the value of the 16 bit Check Value for the reported configuration.

## 3.2.3 EDI *ECCOM* MONITOR EVENT LOG EXAMPLES

An example of each type of record is shown below:

1) <u>Previous Fault (PF) Event Log</u>

```
>> Previous Fail Event Log
>> Monitor ID #73
>> EDI Model 2010ECL, Firmware Type 01, Firmware V5.0, Comm V3.6
>> RMS-Engine Firmware Type 01, RMS-Engine Firmware V2.3
>> ECcom Version 3.6.2
>> Downloaded at 10:23:35 AM  Friday, September 22, 2006
>> Number of events = 25

PREVIOUS FAIL EVENT #1 at:
   12:12:59 PM  Monday, October 2, 2006
   Fault = Red Fail Fault

   Channel Status:
    Ch:  1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
             *   *
         R   .   .   R   R   .   R   R   R   R   R   R   R   R   R   R
         .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
         .   .   .   .   .   G   .   .   .   .   .   .   .   .   .   .

   Channel RMS Voltages:
    R: 120   1   0 122 122   1 122 121 121 122 122 122 122 122 121 122
    Y:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    G:   0   0   0   0   0 121   0   0   0   0   0   0   0   0   0   0

                 AC Line = 122 Vrms @ 60Hz
             Temperature = 80 F
             Red Enable = Active (122 Vrms)
            MC Coil (EE) = Off    (0 Vrms)
      Special Function #1 = Off    (1 Vrms)
      Special Function #2 = Off    (0 Vrms)
             WDT Monitor = Active
```

2) <u>AC Line (AC) Event Log</u>

```
>> AC Line Event Log
>> Monitor ID #73
```

```
>> EDI Model 2010ECL, Firmware Type 01, Firmware V5.0, Comm V3.6
>> RMS-Engine Firmware Type 01, RMS-Engine Firmware V2.3
>> ECcom Version 3.6.2
>> Downloaded at 10:21:27 AM  Friday, September 22, 2006
>> Number of events = 2

AC Event #1 at:
   2:41:30 PM  Tuesday, January 02, 1996
     Restore AC & WDT
     AC Line Voltage = 119 Vrms @60 Hz

AC Event #2 at:
   2:41:25 PM  Tuesday, January 02, 1996
     Brownout AC & WDT
      AC Line Voltage = 85 Vrms @60 Hz
```

### 4) Manual Reset (MR) Event Log

```
>> Monitor Reset Event Log
>> Monitor ID #73
>> EDI Model 2010ECL, Firmware Type 01, Firmware V5.0, Comm V3.6
>> RMS-Engine Firmware Type 01, RMS-Engine Firmware V2.3
>> ECcom Version 3.6.2
>> Downloaded at 10:23:31 AM  Friday, September 22, 2006
>> Number of events = 2

Monitor Reset Event #1 at:
    9:50:08 PM  Friday, January 26, 1996

Monitor Reset Event #2 at:
    2:33:39 PM  Wednesday, January 24, 1996
```

### 5) Configuration (CF) Event Log

```
>> Configuration Log
>> Monitor ID #73
>> EDI Model 2010ECL, Firmware Type 01, Firmware V5.0, Comm V3.6
>> RMS-Engine Firmware Type 01, RMS-Engine Firmware V2.3
>> ECcom Version 3.6.2
>> Downloaded at 10:13:48 AM  Friday, September 22, 2006
>> Number of events = 10
>> (A '*>' symbol indicates that parameter has changed)

----------------------------------------------------------------------

CONFIGURATION CHANGE #1 at:
   10:13:27 AM  Friday, September 22, 2006

   Permissive Programming:
   Ch 1  with: 2  3  4  5  6  7  8  9  10 11 12 13 14 15 16
   Ch 2  with: 3  4  5  6  7  8  9  10 11 12 13 14 15 16
   Ch 3  with: 4  5  6  7  8  9  10 11 12 13 14 15 16
   Ch 4  with: 5  6  7  8  9  10 11 12 13 14 15 16
   Ch 5  with: 6  7  8  9  10 11 12 13 14 15 16
   Ch 6  with: 7  8  9  10 11 12 13 14 15 16
   Ch 7  with: 8  9  10 11 12 13 14 15 16
   Ch 8  with: 9  10 11 12 13 14 15 16
   Ch 9  with: 10 11 12 13 14 15 16
   Ch 10 with: 11 12 13 14 15 16
   Ch 11 with: 12 13 14 15 16
   Ch 12 with: 13 14 15 16
   Ch 13 with: 14 15 16
   Ch 14 with: 15 16
   Ch 15 with: 16

   Red Fail Enable (X=Enable):
       Ch: 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
           X  X  X  X  X  X  X  X  X  X  X  X  X  X  X  X

   Dual Indication Enables (X=Enable):
    Green-Yellow Dual Enable:
       Ch: 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
           .  X  .  X  X  .  X  X  .  .  .  .  .  .  .  .
    Yellow-Red Dual Enable:
       Ch: 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
           .  X  .  X  X  .  X  X  .  .  .  .  .  .  .  .
    Green-Red Dual Enable:
       Ch: 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
           .  X  .  X  X  .  X  X  .  .  .  .  .  .  .  .
```

```
Yellow Disable (X=Disable):
     Ch:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
          .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .

Unit Data:
          Red Fail Fault Timing = 1200-1500 ms
                 Recurrent Pulse = ENABLED
                 Watchdog Timing = 1.5 seconds
                       GY Enable = DISABLED
*>                   FYAC Mode-H = DISABLED
*>          LEDguard Thresholds = ENABLED
        Red Fail Enabled by SSM = DISABLED
  Dual Indication Fault Timing = 350-500 ms
          WDT Error Clear on PU = DISABLED
                   Minimum Flash = ENABLED
             Config Change Fault = ENABLED
                 Red Cable Fault = DISABLED
               AC Line Brownout = 98 +/- 2 Vrms
               Pin EE Polarity = NORMAL
         Flashing Yellow Arrows = <none>
*>    Configuration Check Value = 7633 (0x1DD1)
```

## Section 4
## INSTALLATION

The Signal Monitor is a plug-in module for the Type 170/179 output file. When inserted into the output file without the Red Interface cable assembly, it will operate as a standard 210 Signal Monitor.

### 4.1 ADAPTING RED MONITORING

A Red Interface Adapter PCB and an Interconnecting cable are used to adapt Red Signal Monitoring to the controller cabinet assembly. The interconnecting cable is terminated at each end with identically polarized 20 pin plugs. To connect the Signal Monitor with the adapter PCB, insert the Interconnecting cable plug into the Red Interface connector (P8) until the two ejector latches "snap" into place over the cable plugs.

### 4.1.1 RED FIELD INPUTS

> - WARNING -
> THE P8 RED INTERFACE CABLE SHOULD ALWAYS BE UNPLUGGED BEFORE REMOVING THE UNIT FROM THE CABINET TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK.

The pins numbered 1,2,3,5,7, and 9 through 19 of the Red Interface connector P8 correspond to Red channel inputs on the Signal Monitor. **All unused Red channel inputs must be terminated to AC+.** Pin #20 of P8 is the Red Enable input and must be active to enable Red Failure Monitoring, GYR-Dual Indication Monitoring, and Clearance Monitoring. The Red Enable input is normally connected to the load switch AC+ buss in order to disable Red Failure Monitoring, GYR-Dual Indication Monitoring, and Clearance Monitoring when the intersection is in hardware flash.

### 4.1.2 SPECIAL FUNCTION PREEMPT INPUTS (SF1, SF2)

The pins numbered 8 and 6 of Red Interface connector P8 are Special Function (SF) inputs #1 and #2 respectively. These inputs require an AC+ input to disable the Red Failure monitoring function during preemption. An active signal on **either** input will disable Red Failure monitoring. The RED FAIL indicator will then flash once every two seconds to indicate that Red Failure monitoring is disabled.

### 4.2 SSM SWITCH PROGRAMMING

The SSM dip switches (SW4, SW5) are located near the program card edge connector. The switch positions are labeled CH1 to CH16 (CH18) on the PCB legend screen, corresponding to channels 1 through 16 (18), respectively. To enable GYR-Dual Indication **and** Clearance Monitoring on a channel, place the corresponding channel dip switch to the ON position. Disabling Yellow input sensing on the program card will also disable GY-Dual Indication, YR-Dual Indication and Clearance Monitoring for that channel regardless of the dip switch position for that channel. **The corresponding channel SSM dip switch must be placed in the OFF position when an unused Red field output terminal on the adapter PCB is connected to AC+.**

### 4.3 PROGRAM CARD PROGRAMMING

The diode Program Card provides the means to assign non-conflicting channels and to disable sensing of Yellow input signals. The card is initially supplied with 120 (2018ECL has 153) diodes mounted on the card. This permits all channels to conflict with all other channels.

To program a NON-CONFLICTING (permissive) channel pair, remove the appropriate diode from the program card.

> Example: If channel 2 Green or Yellow is permissive with channel 6 Green or Yellow, remove the diode labeled "2-6".

If the Program Card is removed or not seated properly in the edge connector, the Signal Monitor will enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. The PCA indicator will illuminate to indicate this condition. A manual Reset is required after the Program Card is properly seated.

### 4.3.1 YELLOW DISABLE JUMPERS

To DISABLE sensing of a Yellow signal on a channel, solder a wire jumper between the hole pairs on the Program Card labeled for that channel. When the jumper is installed the monitor will use a value of Zero volts for the field input regardless of the actual voltage applied. When the jumper is installed Clearance monitoring (See Section 2.4) is automatically disabled for that channel.

> Example: To disable Yellow signal sensing on channel 9, a jumper wire must be soldered in between the pair of holes labeled "9" in the area designated "YELLOW DISABLE" on the program card.

### 4.4 OPTION SWITCH PROGRAMMING

The Signal Monitor provides switch options to modify the monitor operation. The Option switches are labeled OPTIONS (SW3) and are located near the program card edge connector.

### 4.4.1 RED FAIL TIMING SWITCH

Switch #1 of SW3 is labeled "RF 2010". When this switch is in the ON position, the Red Fail fault time is set to the 2010 Standard value of 1350 ms. When this switch is in the OFF position, the Red Fail fault time is set to the value of 850 ms. See Section 2.2.

### 4.4.2 RECURRENT PULSE (RP) DISABLE SWITCH (RP DISABLE)

Switch #2 of SW3 is labeled "RP DISABLE". When this switch is in the ON position, the Recurrent Pulse detection mode is disabled. See Section 2.6.

### 4.4.3 WDT TIMING SWITCH

Switch #3 of SW3 is labeled "WD 1.0 SEC". When this switch is in the ON position, the Watchdog fault time is set to $1.0 \pm 0.1$ seconds. When this switch is in the OFF position, the Watchdog fault time is set to $1.5 \pm 0.1$ seconds. See Section 1.2.3.

### 4.4.4 GY ENABLE SWITCH

Switch #4 of SW3 is labeled "GY ENABLE". When this switch is in the ON position, all channels will be monitored for a simultaneous active Green and Yellow input regardless of the Red Enable input. See Section 2.3.1.

### 4.4.5 FYAC MODE-H SWITCH

Switch #5 of SW3 is labeled "FYAC MODE-H". When this switch is in the ON position AND the switch #8 "FYA Compact" (see 4.4.8) is in the ON position, then FYAC Mode-H is enabled. See section 4.4.8.

> **Note**: On PCBs Issue H and below that have been updated with current firmware supporting the FYAC Mode-H, this Option DIP Switch #5 was labelled SF#1 POLARITY. This DIP Switch #5 has been reassigned to the Mode-H function.

### 4.4.6 LEDGUARD SWITCH

Switch #6 of SW3 is labeled "LEDguard". When this switch is in the ON position, the LEDguard® threshold mode is enabled. See Section 2.6.

### 4.4.7 RF SSM SWITCH

Switch #7 of SW3 is labeled "RF SSM". When this switch is in the ON position, then each channel will be monitored for a Red Fail condition if the corresponding SSM switch is in the On position. See Section 2.2.1.

### 4.4.8 FYA MODE SWITCH

Switch #8 of SW3 is labeled "FYA Compact". When this switch is in the ON position, then the Flashing Yellow Arrow monitoring mode is selected as FYAC Mode as described in Section 2.19.2 or 2.19.3. When this switch is in the OFF position, then the Flashing Yellow Arrow monitoring mode is selected as FYA Mode as described in Section 0.

| FYAC Compact (#8) | FYA Mode-H (#5) | Mode |
|---|---|---|
| OFF | OFF | FYA |
| OFF | ON | FYA |
| ON | OFF | FYAC |
| ON | ON | FYAC Mode-H |

The FYA or FYAC monitoring mode is only active if one or more FYA channel pairs are enabled with Option switches #8, 9, 10, or 11 described in Section 4.4.8.1.

### 4.4.8.1 FYA CHANNEL PAIR ENABLE SWITCHES

To enable a channel pair for FYA operation, place the Option DIP Switch labeled "FYA x" (where "x" is 1, 3, 5, 7) in the On position. See Sections 2.19.1.2 and 2.19.2.2 and 2.19.3.

### 4.5 SELECT JUMPER PROGRAMMING

The Signal Monitor also provides jumper options to modify the monitor operation. The Select jumpers are labeled SEL1 through SEL16. SEL6 through SEL16 are reserved for EDI configuration programming and should not be modified except by the factory.

### 4.5.1 WATCHDOG LATCH SELECT (SEL1)

The WDT Latch select determines whether the WDT Error fault mode is latched through an AC Line brownout or not. If the WDT Latch select is not jumpered, an AC Line brownout condition will reset the WDT ERROR fault mode when the AC Line is restored. The WDT Error indicator will remain illuminated until a Reset command is issued via the front panel RESET button or External Reset input. See Section 1.2.3.

If the WDT LATCH select is jumpered, the WDT Error fault mode is maintained until a Reset command is applied.

### 4.5.2 MINIMUM FLASH ENABLE SELECT (SEL2)

When jumpered, the Minimum Flash function provides a flash interval of at least 6 seconds and at most 10 seconds in duration following a power-up, an AC Line interruption, or a brownout restore. See Section 2.5.1.

### 4.5.3 CONFIGURATION CHANGE FAULT SELECT (SEL3)

When jumpered, the Configuration Change Fault function will be enabled causing the Signal Monitor to enter the fault mode if any configuration parameter is changed. If the Configuration Change Fault Select jumper is not installed, the unit will not set the fault mode but will log the change event. See Section 2.11.

### 4.5.4 RED INTERFACE CABLE FAULT SELECT (SEL4)

When jumpered, the Red Cable Fault function will be enabled causing the Signal Monitor to enter the fault mode if the Red Interface cable is not connected. If the Red Cable Fault Select jumper is not installed, the unit will operate as a standard 210 monitor when the Red Interface cable is removed. See Section 4.1.

### 4.5.5 AC LINE BROWN-OUT SELECT (SEL5)

When jumpered, the AC Line Brown-out levels will be set for the 2010 series with Dropout at 98 $\pm$2 Vrms and Restore at 103 $\pm$2 Vrms with timing at 400 $\pm$50 ms. When not jumpered, the AC Line Brown-out levels will be set for the 210E series with Dropout at 92 $\pm$2 Vrms and Restore at 98 $\pm$2 Vrms with timing at 80 $\pm$17 ms. See Section 2.5.

### 4.5.6 EE INPUT POLARITY SELECT (SEL9)

The EE input is used by the monitor to sense the flash mode of the cabinet. The SEL9 jumper should be installed when the cabinet is wired to energize the MC coil and Flash Transfer Relay coils for GYR signal operation. The Active state of the EE input thus indicates normal GYR tri-color (non-flash) operation. The non-active state indicates flash operation.

The jumper should NOT be installed for a cabinet wired to energize the MC coil and Flash Transfer Relay coils for flashing operation (standard Caltrans operation). The Active state of the EE input thus indicates fault or flash mode operation.

### 4.5.7 FYA FLASHRATE MONITOR DISABLE (SEL15)

The Signal Monitor will respond to an enabled flashing Yellow Arrow signal that is not flashing at a minimum rate (see Section 2.19.1.1.2, 2.19.2.1.2, and 2.19.3.1.2). To DISABLE this monitoring function install a jumper into the SEL15 position.

## 4.6 WATCHDOG PROGRAMMING

### 4.6.1 WATCHDOG ENABLE SWITCH

The toggle switch SW2 labeled "WD ENABLE" provides control for the Watchdog Monitoring function. When the switch is in the ON position, the Watchdog Monitoring function is enabled. When the switch is in the OFF position, the Watchdog Monitoring function is disabled. The WDT ERROR LED will flash once every two seconds to indicate that Watchdog Monitoring is disabled.

### 4.6.2 WATCHDOG TIMING OPTION

Switch #3 of the OPTIONS switch (SW3) is labeled "WD 1.0 SEC". When this switch is in the ON position, the Watchdog fault time is set to 1.0 $\pm$0.1 seconds. When this switch is in the OFF position, the Watchdog fault time is set to 1.5 $\pm$0.1 seconds.

## Section 5
## FRONT PANEL DESCRIPTION

### 5.1 INDICATORS

### 5.1.1 (G) AC POWER INDICATOR

The AC POWER indicator will illuminate when the AC Line voltage level is above the brown-out "restore" level. The indicator will flash at a rate of 2Hz when the AC Line voltage is below the "drop-out" level. The indicator will extinguish when the AC Line voltage is less than 75 $\pm$ 2 Vac. During the minimum flash interval the indicator will flash at a rate of 4Hz. See Section 2.5.

### 5.1.2 (Y) VDC FAILED INDICATOR

The VDC FAILED indicator will illuminate when a 24VDC fault condition is detected. This indicator remains extinguished if the monitor has not been triggered by a 24VDC fault.

### 5.1.3 (R) WDT ERROR INDICATOR

The WDT ERROR indicator will illuminate when a controller Watchdog fault is detected. If the WD ENABLE switch is placed in the OFF position to disable Watchdog monitoring, or the AC Line voltage is below the Watchdog disable level, the WDT ERROR indicator will flash ON once every 2 seconds.

### 5.1.4 CONFLICT INDICATOR

The CONFLICT indicator will illuminate when a conflicting proceed signal fault is detected.

The CONFLICT indicator will illuminate when a FYA Flashrate Fault (see Section 2.19.1.1.2, 2.19.2.1.2) has been detected. In this fault mode the channel status indicator will flash to indicate the affected channel(s).

### 5.1.5 RED FAIL INDICATOR

The RED FAIL indicator will illuminate when an absence of signal is detected on a channel(s). If the Red Enable input is not active, or a Special Function input is active, or the EE input (MC Coil) is active the RED FAIL indicator will flash once every two seconds to indicate that Red Fail Monitoring functions are disabled.

### 5.1.6 DUAL IND INDICATOR

The DUAL IND indicator will illuminate when a GY-Dual or GYR-Dual Indication fault is detected on a channel(s).

### 5.1.7 CLEARANCE INDICATOR

The CLEARANCE indicator will illuminate when the minimum Yellow Clearance time has not been met on a channel(s).

### 5.1.8 PCA INDICATOR

The PCA indicator will illuminate if the Program Card is absent or not properly seated. A manual Reset is required after the program card is properly seated. If the unit is in the Diagnostic Display mode, the PCA indicator will flash ON (once, twice, or three times) to indicate the fault event number being displayed. See Section **Error! Reference source not found.**.

If the unit is in the Configuration Change Fault mode, the PCA indicator will flash at a 4 Hz rate. See Section 2.11.

### 5.1.9 DIAGNOSTIC INDICATOR

The DIAGNOSTIC indicator will illuminate when an internal hardware or firmware test function has failed. This indicator is intended to inform the service technician of a monitor hardware or firmware failure. Due to the nature of these hardware or firmware failures, other fault indicators that may be concurrently illuminated may not be valid for trouble shooting purposes.

### 5.1.10 RP DETECT INDICATOR

The RP DETECT indicator will illuminate when the Recurrent Pulse detection function has triggered a Conflict, Dual Indication, or Red Fail fault. See Section 2.6.

### 5.1.11 COMM INDICATOR

The COMM indicator will illuminate for a period of 50 ms when a valid frame is received on the communication port. The COMM indicator will flash at a 4 Hz rate if the port is disabled due to the DTR signal in the false state while a frame is in the transmit queue.

### 5.1.12 CHANNEL STATUS INDICATORS

During normal operation the 2010ECL and 2018ECL model Channel Status indicators will display all active signals (Green, Yellow, and Red).

In the fault mode the Channel Status indicators will display all signals active at the time of a fault. In the event of a Conflict, Red Failure, Dual Indication, or Clearance fault the channels on which the fault occurred will be displayed alternately (see Section 2.18) with the field status.

### 5.2 FRONT PANEL CONTROLS

### 5.2.1 RESET BUTTON

Depressing the Reset button resets the Signal Monitor after it has been triggered by a fault. The monitor will remain in the reset mode only if the fault condition has been restored to normal. In the event of a monitor hardware or firmware fault (DIAGNOSTIC) the Reset button may not reset the monitor. A power-up restart may be required.

The Reset button also provides control of the Diagnostic Display mode. For a complete description of Diagnostic Display operation see Sections **Error! Reference source not found.** and 2.18.

### 5.3 RED INTERFACE CONNECTOR (P8)

This connector provides the required inputs for the Signal Monitor to monitor the Red Field Signal outputs. It is polarized to insure proper mating with the adapter cable. Ejector latches are included to facilitate removal and prevents the cable from inadvertently disconnecting. **The Signal Monitor will function as a standard 210 Signal Monitor when the cable is disconnected.**

## Section 6
## CIRCUIT OPERATION

### 6.1 INTRODUCTION

The Signal Monitor uses a dual microprocessor architecture consisting of an 68HC11D0 main microprocessor unit (MPU) and a Microchip PIC17F242 based RMS-Engine. The RMS-Engine is a dedicated single-chip high speed microcontroller used to sample the AC field inputs and calculate the true Root Mean Squared (RMS) voltage. The 68HC11D0 main microprocessor uses a high speed synchronous serial I/O system called the Serial Peripheral Interface (SPI) to exchange data with the peripheral circuit blocks. It controls all functions of the unit except for those of the RMS-Engine.

### 6.2 MAIN MPU LOGIC

The 68HC11D0 main microprocessor (U13) operates in the Expanded Multiplexed mode which allows for external memory devices. The program firmware is contained in the 29F010B CMOS Flash device (U11) and program data storage is contained in the SRM2264 8Kx8 static RAM (U16). The expanded address and data buss is used to link the memory devices with the microprocessor. A 74HC137 (U14) selector also resides on the buss to generate chip select signals for the SPI devices.

### 6.3 SERIAL PERIPHERAL INTERFACE (SPI)

The Serial Peripheral Interface (SPI) is a high speed synchronous serial I/O system used to interconnect the main microprocessor to the following circuit blocks: EEprom (U21), Real Time Clock (U29), 24Vdc Logic Processor (U41), Display Multiplexer (U1), Program Card and Switch inputs (U25.4), and the RMS-Engine (U37).

Data is clocked out of the main microprocessor on the MOSI pin (U13.18) while data is clocked in on the MISO pin (U13.17). The SCLK signal (U13.20) provides the synchronous clock. A peripheral device must be selected by U14 before SPI transfers may take place.

### 6.4 INTERNAL MPU WATCHDOG

Circuit U4A and U4B comprise the internal MPU Watchdog circuit. If this circuit does receive an input from the main microprocessor for at least 325 ms, the circuit will trigger and force the Output relay to the fault mode, enable the Stop-Time output, and illuminate the DIAGNOSTIC indicator. This indicates that the microprocessor has failed to operate its program loop. Under normal conditions the microprocessor will clock this circuit every 20 ms. If jumper E13 is installed this fault mode will only be reset by a power down cycle.

### 6.5 EEPROM MEMORY

The 25C640 Serial EEprom (U21) device provides 8192 bytes of nonvolatile memory. It is interfaced to the main microprocessor through the SPI port. No battery is required to maintain the data in this device.

### 6.6 24VDC LOGIC INPUTS

The Cabinet 24VDC input, CU Watchdog input, and External/Manual Reset inputs are processed by a PIC16F687 microprocessor U41. Opto-couplers U28, U31, U36, and U38 provide electrical isolation between Logic Ground and Neutral.

## 6.7 REAL TIME CLOCK

The DS1305 Real Time Clock (U29) provides the timekeeping function. It transfers data to the main MPU using the serial SPI interface. During normal operation the RTC is synchronized to the 60 Hz AC Line for long term accuracy. The lifetime lithium battery (BATT1) provides power to the RTC when AC Line voltage is not present. Should the battery fail, no data will be lost other than the time and date.

## 6.8 DISPLAY

The front panel LED display is multiplexed by the row driver U3 and the column driver U1. The scan rate is approximately 60 Hz. Display data is shifted into U3 while individual columns are selected by U1 using the SPI interface.

## 6.9 PROGRAM CARD AND SWITCH INPUTS

The program card and configuration switch inputs are scanned through a diode matrix using row drivers U32 and U33. Column drivers U34 and U35 select the column to be read. These devices transfer data to the main MPU through the SPI interface.

## 6.10 RMS-ENGINE

The RMS-Engine is a Microchip PIC18F242 (U37) single-chip high performance RISC microcomputer executing proprietary firmware that calculates true RMS voltages for each input channel. The resulting data is transferred to the main MPU via the SPI interface. The analog to digital converter (U39) provides the voltage measurement data for the RMS-Engine approximately every 6 microseconds. Analog multiplexers (74HC4051N) select the appropriate channel for sampling. Op amp circuits U40 provide a buffer circuit.

## 6.11 POWER SUPPLY

The switching power supply is based on a MIC38C43 (U20) fixed frequency current-mode PWM controller. The AC Line is full wave rectified and charges capacitor C78 to approximately 170 Vdc. The PWM controller switches current from C78 through the transformer T1 using transistor Q4 at approximately 200 KHz. The transformer couples this energy to the secondaries and provides the following output voltages: VDD=+5 Vdc, VCC=+8 Vdc, VGG=-8 Vdc, VEE=-5 Vdc, VCCL=+16 Vdc, and VDDS=+5 Vdc. Opto-coupler U26 provides feedback to the controller for regulation.

## 6.12 EIA-232 COMMUNICATIONS PORT

The EIA-232 communications port is isolated from the main circuitry of the monitor through opto-couplers U7, U12, and U15. The MAX202 interface circuit U2 provides a level translation from EIA-232 voltage levels. If enabled, the DTR input (J5-4) to the unit must be greater than approximately 3 Vdc for the monitor to transmit data.

## 6.13 ETHERNET COMMUNICATIONS PORT

The Ethernet communications port (J2) is isolated from the main circuitry of the monitor through opto-couplers U7, U12, and U15.

## Section 7
## TROUBLE SHOOTING

SYMPTOMS:
> Will not power on

CAUSES:
- A)   Blown fuse
- B)   Internal power supply is low
- C)   No AC input to the monitor

SOLUTIONS:
- A)   Remove the fuse and verify with an Ohm meter. Replace if necessary with a fuse with the same current rating.
- B)   Check the unregulated voltage across filter capacitor C78 with an oscilloscope or volt meter. It should read approximately 170 Vdc when the AC Line is equal to or greater than 110 Vrms. If the regulated supply (VDD) is less than 4.5 Vdc the internal power supply monitoring circuit (U17) will hold the MPU in reset and the DIAGNOSTIC indicator on the front panel should illuminate. Measure the regulated voltage across capacitor C28. If it measures lower than 5 $\pm$0.5 Vdc the regulated supply may be overloaded or shorted to ground.
- C)   If the fuse is not blown then the monitor may not be getting AC Line or Neutral to the edge connector of the monitor.

SYMPTOMS:
> Faults when AC power is applied

CAUSES:
- A)   Program card is absent or not seated properly
- B)   AC Line level is low
- C)   Memory device fault
- D)   No internal watchdog pulses

SOLUTIONS:
- A)   The PCA indicator on the front panel will illuminate. Re-insert the program card with the diode side of the card facing the front panel slot and depress the RESET switch. The rear edge of the program card should be flush with the front panel.
- B)   Measure the AC Line voltage level with a volt meter. If it is below the required "drop-out" level, the monitor will transfer the Output relay contacts and enable the STOP TIME output to the controller. The AC POWER indicator on the front panel will flash at a rate of 2 Hz to indicate the "brown-out" condition.
- C)   The memory devices are verified when AC Line power is applied or a Reset command is issued. If a memory fault is detected the MPU executes a STOP instruction. This causes all MPU activity to cease. Refer to Section 2.15.
- D)   Absence of internal watchdog pulses may be due to the following conditions: the MPU is not executing or completing the program loop or the hardware to detect the internal watchdog pulses is not functioning. Place an oscilloscope probe on U4.2. If there are no pulses, depress the front panel reset switch to re-start the MPU. If the watchdog pulses are now present on U4.2 then trace the remaining pulse detection hardware for the required waveforms.

SYMPTOMS:
> Required channels will not conflict

<u>CAUSES:</u>
Diode on the Program Card is open or absent

<u>SOLUTIONS:</u>
Check the program card to verify that the required diode is in place. If the diode is present then verify all connections are good and the diode is working correctly.

## Section 8
## SPECIFICATIONS

### 8.1 ELECTRICAL

### 8.1.1 POWER REQUIREMENTS
Operating Line Voltage................................................................................. 75 to 135 Vrms
Operating Line Frequency ...................................................................................... 60 $\pm$3Hz
Power Consumption ......................................................................................... 5W (nominal)

### 8.1.2 AC VOLTAGE MONITORS

| | | |
|---|---|---|
| Green Signal Inputs | (no detect)................................ | less than 15 Vrms |
| | (detect)................................. | greater than 25 Vrms |
| Yellow signal Inputs | (no detect)................................ | less than 15 Vrms |
| | (detect)................................. | greater than 25 Vrms |
| Red Signal Inputs | (no detect)................................ | less than 50 Vrms |
| | (detect)................................. | greater than 70 Vrms |
| Red Enable Input | (no detect)................................. | less than 50 Vrms |
| | (detect)................................. | greater than 70 Vrms |
| Special Function Inputs | (no detect)................................. | less than 50 Vrms |
| | (detect)............................. | greater than 70 Vrms |
| Watchdog Enable (AC level) | (enable)......................... greater than 103 $\pm$2 Vrms |
| | (disable) ............................ less than 98 $\pm$2 Vrms |

*LEDguard*® Low Threshold Signal Inputs

No Detect ................................. less than 15 Vrms
Detect ................................. greater than 25 Vrms

*LEDguard*® High Threshold Signal Inputs

No Detect ................................. less than 50 Vrms
Detect ................................. greater than 70 Vrms

AC Line 2010 Brown-out (SEL5)     (drop-out) .......................................... 98 $\pm$2 Vrms
                                                   (restore) .......................................... 103 $\pm$2 Vrms

AC Line 210E Brown-out               (drop-out) .......................................... 92 $\pm$2 Vrms
                                                   (restore) ........................................... 98 $\pm$2 Vrms

### 8.1.3 DC VOLTAGE MONITORS

| | | |
|---|---|---|
| +24VDC Input | (fault)....................................... | less than +18 Vdc |
| | (no fault).............................. | greater than +22 Vdc |
| External Reset Input | (true) ....................................... | less than 3.5 Vdc |
| | (False)................................... | greater than 8.5 Vdc |
| Watchdog Input | (true) ....................................... | less than 3.5 Vdc |
| | (false)................................... | greater than 8.5 Vdc |

### 8.1.4 OUTPUTS
Relay Output
     AC Contact Rating................................................................................3A @ 120 Vac
     DC Contact Rating.................................................................................3A @ 30 Vdc
Stop Time Output .................................................................................. 50 mA @ 30 Vdc

## 8.2 TIMING FUNCTIONS

| | | |
|---|---|---|
| Conflict | (no fault) | less than 200 milliseconds |
| | (fault) | greater than 500 milliseconds |
| | (typical) | 350 milliseconds |
| VDC Failed | (no fault) | less than 200 milliseconds |
| | (fault) | greater than 500 milliseconds |
| | (typical) | 400 milliseconds |
| Watchdog 1.0 second | (no fault) | less than 900 milliseconds |
| | (fault) | greater than 1100 milliseconds |
| | (typical) | 1000 milliseconds |
| Watchdog 1.5 second | (no fault) | less than 1400 milliseconds |
| | (fault) | greater than 1600 milliseconds |
| | (typical) | 1500 milliseconds |
| Red Fail | (no fault) | less than 700 milliseconds |
| | (fault) | greater than 1000 milliseconds |
| | (typical) | 850 milliseconds |
| Red Fail (2010) | (no fault) | less than 1200 milliseconds |
| | (fault) | greater than 1500 milliseconds |
| | (typical) | 1350 milliseconds |
| Dual Indication | (no fault) | less than 200 milliseconds |
| | (fault) | greater than 500 milliseconds |
| | (typical) | 400 milliseconds |
| Dual Indication Long | (no fault) | less than 700 milliseconds |
| | (fault) | greater than 1000 milliseconds |
| | (typical) | 850 milliseconds |
| Clearance | (no fault) | greater than 2.8 seconds |
| | (fault) | less than 2.6 seconds |
| AC Line 2010 Brown-out | (drop-out) | 400 $\pm$50 milliseconds |
| | (restore) | 400 $\pm$50 milliseconds |
| AC Line 210E Brown-out (drop-out) | | 80 $\pm$17 milliseconds |
| | (restore) | 80 $\pm$17 milliseconds |

| | |
|---|---|
| Minimum flash after restore | 6.0 $\pm$0.5 seconds |
| Maximum flash after restore | 10.0 $\pm$0.5 seconds |

| | | |
|---|---|---|
| Watchdog (2010) | (disable) | 400 $\pm$50 milliseconds |
| | (enable) | 400 $\pm$50 milliseconds |
| Watchdog (210E) | (disable) | 80 $\pm$17 milliseconds |
| | (enable) | 80 $\pm$17 milliseconds |

| | | |
|---|---|---|
| FYA Flash Rate | no fault | less than 1400 msec |
| | fault | greater than 1600 msec |

## 8.3 MECHANICAL

| | |
|---|---|
| Height | 9.3 inches |
| Width | 1.38 inches |
| Depth | 10.17 inches |

## 8.4 ENVIRONMENTAL

| | |
|---|---|
| Storage Temperature Range | -55 to +90 ºC |
| Operating Temperature Range | -37 to +74 ºC |
| Humidity Range | 0 to 95% Relative |

## Section 9
## WIRING ASSIGNMENTS

### 9.1 MONITOR UNIT CONNECTOR (P1)

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- WARNING -

PIN 27 OF THE MAIN CONNECTOR (P1) PROVIDES THE CLOSED CONTACT OF
THE OUTPUT RELAY WHEN THE MONITOR IS IN THE NO-FAULT STATE. WHEN
THE MONITOR IS IN THE NO-FAULT STATE AND THE AUTO/FLASH SWITCH IS
IN THE FLASH POSITION, AC LINE VOLTAGE MAY BE PRESENT ON PIN 27.

THIS PIN WAS PREVIOUSLY DEFINED AS A "NO-CONNECT" PIN IN LEGACY
EQUIPMENT. TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK,
BEFORE INSTALLING THIS MONITOR THE USER IS CAUTIONED TO CHECK
THAT THE CABINET WIRING IS COMPATIBLE WITH THE USE OF THIS PIN AS A
SOURCE OF AC LINE VOLTAGE.
```

### 9.1.1 SIXTEEN CHANNEL

| Pin # | Function | Pin # | Function |
|-------|----------|-------|----------|
| 1 | CHANNEL 2 GREEN | A | CHANNEL 2 YELLOW |
| 2 | CHANNEL 13 GREEN | B | CHANNEL 6 GREEN |
| 3 | CHANNEL 6 YELLOW | C | CHANNEL 15 GREEN |
| 4 | CHANNEL 4 GREEN | D | CHANNEL 4 YELLOW |
| 5 | CHANNEL 14 GREEN | E | CHANNEL 8 GREEN |
| 6 | CHANNEL 8 YELLOW | F | CHANNEL 16 GREEN |
| 7 | CHANNEL 5 GREEN | H | CHANNEL 5 YELLOW |
| 8 | CHANNEL 13 YELLOW | J | CHANNEL 1 GREEN |
| 9 | CHANNEL 1 YELLOW | K | CHANNEL 15 YELLOW |
| 10 | CHANNEL 7 GREEN | L | CHANNEL 7 YELLOW |
| 11 | CHANNEL 14 YELLOW | M | CHANNEL 3 GREEN |
| 12 | CHANNEL 3 YELLOW | N | CHANNEL 16 YELLOW |
| 13 | CHANNEL 9 GREEN | P | UNASSIGNED |
| 14 | UNASSIGNED | R | CHANNEL 10 GREEN |
| 15 | CHANNEL 11 YELLOW | S | CHANNEL 11 GREEN |
| 16 | CHANNEL 9 YELLOW | T | UNASSIGNED |
| 17 | UNASSIGNED | U | CHANNEL 10 YELLOW |
| 18 | CHANNEL 12 YELLOW | V | CHANNEL 12 GREEN |
| 19 | UNASSIGNED | W | UNASSIGNED |
| 20 | CHASSIS GROUND | X | UNASSIGNED |
| 21 | AC- | Y | DC GROUND |
| 22 | WATCHDOG TIMER | Z | EXTERNAL RESET |
| 23 | +24VDC | AA | +24VDC |
| 24 | [PINS 24 & 25 | BB | STOP TIME |
| 25 | ARE TIED TOGETHER] | CC | UNASSIGNED |
| 26 | UNASSIGNED | DD | UNASSIGNED |
| 27 | OUTPUT SW, SIDE #3 | EE | OUTPUT SW, SIDE #2 (MC Coil) |
| 28 | OUTPUT SW, SIDE #1 | FF | AC+ LINE |

NOTE: Pins 23 and AA are shorted together. Maximum current rating is 500 milliamps. Pins 24 and 25 are shorted together. The Monitor circuit and the Program Card mate with a 28/56 pin double sided edge-card connector having 0.156" centers.

OUTPUT SW, SIDE #1 closes in the fault mode. OUTPUT SW, SIDE #3 opens in the fault mode.

### 9.1.2 EIGHTEEN CHANNEL

| Pin # | Function | Pin # | Function |
|-------|----------|-------|----------|
| 1 | CHANNEL 2 GREEN | A | CHANNEL 2 YELLOW |
| 2 | CHANNEL 13 GREEN | B | CHANNEL 6 GREEN |
| 3 | CHANNEL 6 YELLOW | C | CHANNEL 15 GREEN |
| 4 | CHANNEL 4 GREEN | D | CHANNEL 4 YELLOW |
| 5 | CHANNEL 14 GREEN | E | CHANNEL 8 GREEN |
| 6 | CHANNEL 8 YELLOW | F | CHANNEL 16 GREEN |
| 7 | CHANNEL 5 GREEN | H | CHANNEL 5 YELLOW |
| 8 | CHANNEL 13 YELLOW | J | CHANNEL 1 GREEN |
| 9 | CHANNEL 1 YELLOW | K | CHANNEL 15 YELLOW |
| 10 | CHANNEL 7 GREEN | L | CHANNEL 7 YELLOW |
| 11 | CHANNEL 14 YELLOW | M | CHANNEL 3 GREEN |
| 12 | CHANNEL 3 YELLOW | N | CHANNEL 16 YELLOW |
| 13 | CHANNEL 9 GREEN | P | CHANNEL 17 YELLOW |
| 14 | CHANNEL 17 GREEN | R | CHANNEL 10 GREEN |
| 15 | CHANNEL 11 YELLOW | S | CHANNEL 11 GREEN |
| 16 | CHANNEL 9 YELLOW | T | CHANNEL 18 YELLOW |
| 17 | CHANNEL 18 GREEN | U | CHANNEL 10 YELLOW |
| 18 | CHANNEL 12 YELLOW | V | CHANNEL 12 GREEN |
| 19 | CHANNEL 17 RED | W | CHANNEL 18 RED |
| 20 | CHASSIS GROUND | X | UNASSIGNED |
| 21 | AC- | Y | DC GROUND |
| 22 | WATCHDOG TIMER | Z | EXTERNAL RESET |
| 23 | +24VDC | AA | +24VDC |
| 24 | [PINS 24 & 25 | BB | STOP TIME |
| 25 | ARE TIED TOGETHER] | CC | UNASSIGNED |
| 26 | UNASSIGNED | DD | UNASSIGNED |
| 27 | OUTPUT SW, SIDE #3 | EE | OUTPUT SW, SIDE #2 (MC Coil) |
| 28 | OUTPUT SW, SIDE #1 | FF | AC+ LINE |

NOTE: Pins 23 and AA are shorted together. Maximum current rating is 500 milliamps. Pins 24 and 25 are shorted together. The Monitor circuit and the Program Card mate with a 28/56 pin double sided edge-card connector having .156" centers.

OUTPUT SW, SIDE #1 closes in the fault mode. OUTPUT SW, SIDE #3 opens in the fault mode.

### 9.2 PROGRAM CARD CONNECTOR

### 9.2.1 SIXTEEN CHANNEL

| Pin # | Function | Pin # | Function |
|-------|----------|-------|----------|
| 1 | CHANNEL 2 GREEN | A | CHANNEL 1 GREEN |
| 2 | CHANNEL 3 GREEN | B | CHANNEL 2 GREEN |
| 3 | CHANNEL 4 GREEN | C | CHANNEL 3 GREEN |
| 4 | CHANNEL 5 GREEN | D | CHANNEL 4 GREEN |
| 5 | CHANNEL 6 GREEN | E | CHANNEL 5 GREEN |
| 6 | CHANNEL 7 GREEN | F | CHANNEL 6 GREEN |
| 7 | CHANNEL 8 GREEN | H | CHANNEL 7 GREEN |

| Pin # | Function | Pin # | Function |
|---|---|---|---|
| 8 | CHANNEL 9 GREEN | J | CHANNEL 8 GREEN |
| 9 | CHANNEL 10 GREEN | K | CHANNEL 9 GREEN |
| 10 | CHANNEL 11 GREEN | L | CHANNEL 10 GREEN |
| 11 | CHANNEL 12 GREEN | M | CHANNEL 11 GREEN |
| 12 | CHANNEL 13 GREEN | N | CHANNEL 12 GREEN |
| 13 | CHANNEL 14 GREEN | P | CHANNEL 13 GREEN |
| 14 | CHANNEL 15 GREEN | R | CHANNEL 14 GREEN |
| 15 | CHANNEL 16 GREEN | S | CHANNEL 15 GREEN |
| 16 | PROGRAM CARD | T | DC GROUND |
| 17 | CHANNEL 1 YELLOW | U | CHANNEL 9 YELLOW |
| 18 | CHANNEL 2 YELLOW | V | CHANNEL 10 YELLOW |
| 19 | CHANNEL 3 YELLOW | W | CHANNEL 11 YELLOW |
| 20 | CHANNEL 4 YELLOW | X | CHANNEL 12 YELLOW |
| 21 | CHANNEL 5 YELLOW | Y | CHANNEL 13 YELLOW |
| 22 | CHANNEL 6 YELLOW | Z | CHANNEL 14 YELLOW |
| 23 | CHANNEL 7 YELLOW | AA | CHANNEL 15 YELLOW |
| 24 | CHANNEL 8 YELLOW | BB | CHANNEL 16 YELLOW |
| 25 | NO CONNECT | CC | NO CONNECT |
| 26 | NO CONNECT | DD | NO CONNECT |
| 27 | NO CONNECT | EE | RESERVED |
| 28 | YELLOW INHIBIT COMMON | FF | NO CONNECT |

=== Mating connector shall be keyed between pins 24 and 25 and also BB and CC. The Monitor circuit and the Program Card mate with a 28/56 pin double sided edge-card connector having 0.156" centers.

**9.2.2 EIGHTEEN CHANNEL**

| Pin # | Function | Pin # | Function |
|---|---|---|---|
| 1 | CHANNEL 2 GREEN | A | CHANNEL 1 GREEN |
| 2 | CHANNEL 3 GREEN | B | CHANNEL 2 GREEN |
| 3 | CHANNEL 4 GREEN | C | CHANNEL 3 GREEN |
| 4 | CHANNEL 5 GREEN | D | CHANNEL 4 GREEN |
| 5 | CHANNEL 6 GREEN | E | CHANNEL 5 GREEN |
| 6 | CHANNEL 7 GREEN | F | CHANNEL 6 GREEN |
| 7 | CHANNEL 8 GREEN | H | CHANNEL 7 GREEN |
| 8 | CHANNEL 9 GREEN | J | CHANNEL 8 GREEN |
| 9 | CHANNEL 10 GREEN | K | CHANNEL 9 GREEN |
| 10 | CHANNEL 11 GREEN | L | CHANNEL 10 GREEN |
| 11 | CHANNEL 12 GREEN | M | CHANNEL 11 GREEN |
| 12 | CHANNEL 13 GREEN | N | CHANNEL 12 GREEN |
| 13 | CHANNEL 14 GREEN | P | CHANNEL 13 GREEN |
| 14 | CHANNEL 15 GREEN | R | CHANNEL 14 GREEN |
| 15 | CHANNEL 16 GREEN | S | CHANNEL 15 GREEN |
| 16 | RESERVED | T | DC GROUND |
| 17 | CHANNEL 1 YELLOW | U | CHANNEL 9 YELLOW |
| 18 | CHANNEL 2 YELLOW | V | CHANNEL 10 YELLOW |
| 19 | CHANNEL 3 YELLOW | W | CHANNEL 11 YELLOW |
| 20 | CHANNEL 4 YELLOW | X | CHANNEL 12 YELLOW |
| 21 | CHANNEL 5 YELLOW | Y | CHANNEL 13 YELLOW |
| 22 | CHANNEL 6 YELLOW | Z | CHANNEL 14 YELLOW |
| 23 | CHANNEL 7 YELLOW | AA | CHANNEL 15 YELLOW |
| 24 | CHANNEL 8 YELLOW | BB | CHANNEL 16 YELLOW |
| 25 | CHANNEL 17 GREEN | CC | CHANNEL 17 YELLOW |

| Pin # | Function | Pin # | Function |
|-------|----------|-------|----------|
| 26 | CHANNEL 18 GREEN | DD | CHANNEL 18 YELLOW |
| 27 | CHANNEL 16 GREEN | EE | PROGRAM CARD |
| 28 | YELLOW INHIBIT COMMON | FF | CHANNEL 17 GREEN |

=== Mating connector shall be keyed between pins 24 and 25 and also BB and CC. The Monitor circuit and the Program Card mate with a 28/56 pin double sided edge-card connector having 0.156" centers.

## 9.3 RED INTERFACE CONNECTOR (P8)

| Pin # | Function | Pin # | Function |
|-------|----------|-------|----------|
| 1 | CHANNEL 15 RED | 11 | CHANNEL 9 RED |
| 2 | CHANNEL 16 RED | 12 | CHANNEL 8 RED |
| 3 | CHANNEL 14 RED | 13 | CHANNEL 7 RED |
| 4 | CHASSIS GROUND** | 14 | CHANNEL 6 RED |
| 5 | CHANNEL 13 RED | 15 | CHANNEL 5 RED |
| 6 | SPECIAL FUNCTION #2 | 16 | CHANNEL 4 RED |
| 7 | CHANNEL 12 RED | 17 | CHANNEL 3 RED |
| 8 | SPECIAL FUNCTION #1 | 18 | CHANNEL 2 RED |
| 9 | CHANNEL 10 RED | 19 | CHANNEL 1 RED |
| 10 | CHANNEL 11 RED | 20 | RED ENABLE |

**Note:  Pin #4 may be used to connect the monitor chassis to the cabinet CHASSIS GROUND. To complete this connection, a soldered wire jumper must be placed in location E14. Monitor CHASSIS GROUND is also connected through the edge connector P1. The additional connection through the Red Interface cable can provide the CHASSIS GROUND connection to the monitor if the unit is removed from the cabinet with the Red Interface cable attached. The cabinet assembly must also be wired to connect the other end of the Red Interface cable to CHASSIS GROUND.

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**- WARNING -**

IF JUMPER E14 IS USED BE SURE THAT ANY CABINET WIRING OR MONITOR TEST EQUIPMENT DOES NOT DRIVE PIN #4 WITH AN ACTIVE SIGNAL. USE OF THIS CHASSIS GROUND CONNECTION MAY MAKE THE UNIT INCOMPATIBLE WITH SOME SIGNAL MONITOR TESTERS.

THE P8 RED INTERFACE CONNECTOR SHOULD ALWAYS BE UNPLUGGED BEFORE REMOVING THE UNIT FROM THE CABINET TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK.

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## 9.4 EIA-232 CONNECTOR (J5)

| Pin # | Function | I/O |
|-------|----------|-----|
| 1 | DCD | - |
| 2 | Tx DATA | O |
| 3 | Rx DATA | I |
| 4 | DTR | - |
| 5 | GROUND | - |
| 6 | DSR | - |
| 7 | CTS | - |
| 8 | RTS | O |

| Pin # | Function | I/O |
|-------|----------|-----|
| 9 | NC | - |

RTS is provided for compatibility with Data Terminal Equipment (DTE device) control signals.

### 9.4.1 EIA-232 CABLE TO A PC

A typical cable assembly for a DB-9 connector on the PC would be a straight through connection as follows:

| PC DB-9 | | Monitor DB-9 |
|---------|------------|--------------|
| RX pin 2 | connect to | TX pin 2 |
| TX pin 3 | connect to | RX pin 3 |
| GND pin 5 | connect to | GND pin 5 |

A typical cable assembly for a DB-25 connector on the PC would be as follows:

| PC DB-25 | | Monitor DB-9 |
|----------|------------|--------------|
| RX pin 3 | connect to | TX pin 2 |
| TX pin 2 | connect to | RX pin 3 |
| GND pin 7 | connect to | GND pin 5 |

### 9.4.2 EIA-232 CABLE TO A 170 CONTROLLER UNIT

A typical cable assembly for 170 CU connector would be as follows:

| 170 | | Monitor DB-9 |
|---------|------------|--------------|
| RX pin L | connect to | TX pin 2 |
| TX pin K | connect to | RX pin 3 |
| GND pin N | connect to | GND pin 5 |

DCD pin H should be connected to +5 pin D on the Controller Unit connector.

CTS pin M should be connected to RTS pin J on the Controller Unit connector.

### 9.5 ETHERNET LAN PORT

The Ethernet port must be configured with specific network parameters such as an IP address. The network port parameters are set or changed using the EDI *ECcom* Signal Monitor Communications software. See the "***EDI ECcom Software Operations Manual***" for details on the SETUP / COMM PORT / SETTINGS / **Search** function. Additional information on the Ethernet port capabilities can be found in the "***Ethernet Quick Start Operation Manual***", pn888-1000-101.

The factory default network settings are: IP Address = 192.168.1.100 and Subnet Mask = 255.255.255.0

### 9.5.1 ETHERNET LAN CABLE

The LAN cable required is a typical Cat-5 network cable using the 8 pin RJ-45 connector. If the connection is from the monitor to a switch or hub, a standard LAN cable is needed. If the connection is from the monitor directly to a network adaptor (PC), a cross-over or patch cable is needed.

### 9.6 16-CHANNEL PROGRAM CARD DIAGRAM