# MODEL 210C SERIES

**RMS Signal Monitor**

**Operations Manual**

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE FOLLOWING SERIES OF MODEL 210/2010/2018 SIGNAL MONITORS: **210C; PCB Issue F,G**.

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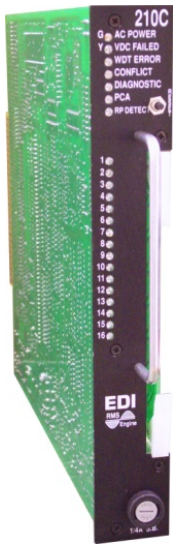


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THE 210/2010/2018 SERIES SIGNAL MONITOR UNIT IS DESIGNED AND MANUFACTURED IN THE USA BY
EBERLE DESIGN INC.
PHOENIX, ARIZONA
AN ISO 9001:2008 REGISTERED COMPANY.



## 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.**

**- 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.**

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# Section 1
# GENERAL DESCRIPTION

## 1.1 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) and *TEES 2009.*

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.

### 1.1.1 CONFLICT MONITORING

The Signal Monitor is capable of monitoring 16 channels. Each channel consists of a Green and Yellow field signal input. 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.

### 1.1.2 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 7.3.

### 1.1.3 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 7.4) 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 3.4.1) 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
# GENERAL CHARACTERISTICS

## 2.1 HARDWARE FEATURES

The 210 series Signal Monitor is a dual microprocessor based unit. 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.

A nonvolatile EEPROM device is utilized to retain fault status information 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.

## 2.2 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.

### 2.2.1 MINIMUM FLASH TIME

A Minimum Flash time option can be selected (see Section 3.4.2) 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.

## 2.3 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.

## 2.4 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.

### 2.5 INTERNAL MPU WATCHDOG

The Signal Monitor generates an internal watchdog pulse from its microprocessor. This occurs at least once per 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.

### 2.6 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.

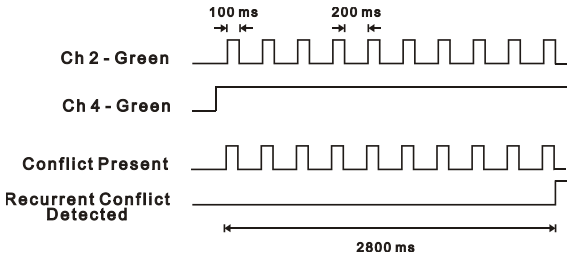
When the Configuration Change Fault select option is enabled (see Section 3.4.3), any change in the configuration parameters will cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode 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.

### 2.7 RECURRENT PULSE DETECTION

This error detection function supplements the normal Conflict 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 Aflicker@ 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 CONFLICT 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 3.3.1.

### 2.8 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 2.12).

### 2.9 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.

### 2.10 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.

### 2.11 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.

### 2.12 DIAGNOSTIC DISPLAY MODE

The Signal Monitor provides two means of displaying the individual Green and Yellow field status. The No Fault Diagnostic Display mode shows the individual colors while the monitor is not in the fault mode (intersection operating). The Fault Diagnostic Display mode shows the individual colors that were active at the time the monitor triggered to the fault mode (intersection in flash). The Fault Diagnostic Display mode also provides a review of previous fault events.

#### 2.12.1 NO-FAULT DIAGNOSTIC DISPLAY

When the Signal Monitor is not in the fault state, the unit can display the active Green and Yellow field status individually. To enter this display mode depress and hold the Reset button. Each time the Reset button is activated and held, the next set of colors will be displayed on the channel status indicators. The display will continue to show the selected color as long as the Reset button is activated. This mode only affects the monitor display and normal fault processing will continue to occur. The sequence is as follows:

| Reset | Fault Status LEDs | Channel Status LEDs |
|---|---|---|
| #1 | (G) AC POWER LED flashes | Green field status 1-16 |
| #2 | (Y) VDC FAILED LED flashes | Yellow field status 1-16 |
| ... | (repeats back to top) | |

#### 2.12.2 FAULT DIAGNOSTIC DISPLAY

Once the Signal Monitor has been triggered by a fault, the Green and Yellow field input status active at the time of the current fault and the two previous faults may 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 |
|---|---|---|---|
| --- | #1 | Single flash | Current Fault Status (newest) |
| #1 | #1 | Single flash | (G) AC POWER LED flashes |
| #2 | #1 | Single flash | (Y) VDC FAILED LED flashes |
| #3 | #2 | Double flash | Event #2 Fault Status |
| #4 | #2 | Double flash | (G) AC POWER LED flashes |
| #5 | #2 | Double flash | (Y) VDC FAILED LED flashes |
| #6 | #3 | Triple flash | Event #3 Fault Status (oldest) |
| #7 | #3 | Triple flash | (G) AC POWER LED flashes |
| #8 | #3 | Triple flash | (Y) VDC FAILED LED flashes |
| ... | | | (repeats back to top) |

To enter this display mode remove the Program Card. Depressing the Reset button advances the display mode from the normal mode to the Green field input display. The (G) AC POWER LED will pulse ON once per second to indicate this mode. The channel display LEDs will show the Green channels active at the time of the fault. The PCA LED will pulse once per second to indicate the current fault (#1, newest).

Depressing the Reset button again advances the display mode from the Green display mode to the Yellow field input display. The (Y) VDC FAIL LED will pulse ON once per second to indicate this mode. The channel display LEDs will show the Yellow channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Yellow display mode (of fault #1) to the fault display mode for fault #2. The PCA LED will pulse twice per

second to indicate the previous fault (#2). Additional button closures will cycle through the colors for fault #2 and fault #3 (oldest). After the Yellow display for fault #3, the display will return to fault #1.

To exit this display mode, replace the Program Card. If the Program Card is removed while the Signal Monitor has **not** been triggered by a fault, the fault status display mode will show the Green and Yellow 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.

# Section 3
# INSTALLATION

## 3.1 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 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. To DISABLE sensing of a Yellow signal on a channel, solder a wire jumper between the hole pairs labeled for that channel.

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

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.

## 3.2 WATCHDOG PROGRAMMING

### 3.2.1 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.

## 3.3 OPTION SWITCH PROGRAMMING

The 210C Signal Monitor provides two switch options to modify the monitor operation. The Option switches are labeled OPTIONS (SW3) and are located near the program card edge connector.

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

Switch #2 of SW3 is labeled "RP DISABLE". When a wire jumper is soldered in this position, the Recurrent Pulse detection mode is disabled. See Section 2.7.

### 3.3.2 WDT TIMING SWITCH

Switch #3 of SW3 is labeled "WD 1.0 SEC". When a wire jumper is soldered in this position, the Watchdog fault time is set to 1.0 $\pm$0.1 seconds. When this switch is in the Open state, the Watchdog fault time is set to 1.5 $\pm$0.1 seconds. See Section 1.1.3.

## 3.4 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.

### 3.4.1 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 1.1.3.

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

### 3.4.2 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 2.2.1.

### 3.4.3 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 2.6.

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

When jumpered, the AC Line Brown-out levels will be set for the 2010 series with Adropout@ at 98 ±2 Vrms and Arestore@ at 103 ±2 Vrms with timing at 400 ±50 ms. When not jumpered, the AC Line Brown-out levels will be set for the 210C series with Adropout@ at 82 ±2 Vrms and Arestore@ at 87 ±2 Vrms with timing at 80 ±17 ms. See Section 2.2.

# Section 4
# FRONT PANEL DESCRIPTION

## 4.1 INDICATORS

### 4.1.1 (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.

If the Signal Monitor is in the Diagnostic Display mode, the (G) AC POWER indicator will flash ON once per second to indicate the Channel Status display is showing Green channel status. See Section 2.12.

### 4.1.2 (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.

If the Signal Monitor is in the Diagnostic Display mode, the (Y) VDC FAILED indicator will flash ON once per second to indicate the Channel Status display is showing Yellow channel status. See Section 2.12.

### 4.1.3 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.

### 4.1.4 CONFLICT INDICATOR

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

### 4.1.5 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 2.12.

### 4.1.6 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.

### 4.1.7 RP DETECT INDICATOR

The RP DETECT indicator will illuminate when the Recurrent Pulse detection function has triggered a Conflict fault. See Section 2.7.

### 4.1.8 CHANNEL STATUS INDICATORS

During normal operation the Signal Monitor Channel Status indicators will display all active proceed signals (Green or Yellow). In the fault mode the Channel Status indicators will display all proceed signals active at the time of a 24VDC fault (VDC FAILED) or Watchdog

fault (WDT ERROR). For a Conflict fault only the channels on which the fault occurred will be displayed.

### 4.2 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 2.12.

# Section 5
# THEORY OF OPERATION

## 5.1 INTRODUCTION

The Signal Monitor uses a dual microprocessor architecture consisting of an MC68HC11D0 main microprocessor unit (MPU) and a 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. This true RMS voltage information is then transmitted to the main microprocessor for fault processing.

The MC68HC11D0 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™.

## 5.2 MAIN MPU LOGIC

The MC68HC11D0 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.

## 5.3 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), 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.

## 5.4 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 E5 is installed this fault mode will only be reset by a complete power down cycle.

## 5.5 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.

## 5.6 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.

### 5.7 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.

### 5.8 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.

### 5.9 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.

### 5.10 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.

# Section 6
# MAINTENANCE

## 6.1 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 2.10.
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

CAUSES:

Diode on the Program Card is open or absent

SOLUTIONS:

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 7
# SPECIFICATIONS

## 7.1 POWER REQUIREMENTS

| | |
|---|---|
| Operating Line Voltage | 75 to 135 Vrms |
| Operating Line Frequency | 60 ±3Hz |
| Power Consumption | 5W (nominal) |

## 7.2 AC VOLTAGE MONITORS

| | | |
|---|---|---|
| Green, Yellow Signal Inputs | (no detect) | less than 15 Vrms |
| | (detect) | greater than 25 Vrms |
| Watchdog Enable | (enable) | greater than 103 ±2 Vrms |
| | (disable) | less than 98 ±2 Vrms |
| AC Line Brown-out | (drop-out) | 82 ±2 Vrms |
| | (restore) | 87 ±2 Vrms |
| AC Line Brown-out (SEL5) | (drop-out) | 98 ±2 Vrms |
| | (restore) | 103 ±2 Vrms |

## 7.3 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 |

## 7.4 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 | (no fault) | less than 1400 milliseconds |
| | (fault) | greater than 1600 milliseconds |
| | (typical) | 1500 milliseconds |
| AC Line Brown-out | (drop-out) | 80 ±17 milliseconds |
| | (restore) | 80 ±17 milliseconds |
| AC Line Brown-out (SEL5) | (drop-out) | 400 ±17 milliseconds |
| | (restore) | 400 ±17 milliseconds |
| Watchdog Disable | (disable) | 80 ±17 milliseconds |
| | (enable) | 80 ±17 milliseconds |
| Watchdog Disable (SEL5) | (drop-out) | 400 ±17 milliseconds |
| | (restore) | 400 ±17 milliseconds |

## 7.5 MECHANICAL

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

## 7.6 ENVIRONMENTAL

| | |
|---|---|
| Storage Temperature Range | -55 to +90 $^{o}$C |
| Operating Temperature Range | -37 to +74 $^{o}$C |
| Humidity Range | 0 to 95% Relative |

## Section 8
## WIRING ASSIGNMENTS

### 8.1 MONITOR UNIT CONNECTOR (P6)

- WARNING -

PIN 27 OF THE MAIN CONNECTOR (P6) 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.

| 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 .156 " centers.

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

**8.2 PROGRAM CARD CONNECTOR (P4)**

| 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 | 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.

**8.3 PROGRAM CARD DIAGRAM**