

OPERATIONS MANUAL

MODEL 210E SERIES RMS SIGNAL MONITOR

Addendum to 210E Signal Monitor Operations Manual, Firmware Version 16E16xx, Los Angeles County DPW.

- 1) CU Watchdog Fault
Modify Sections 1.2.3 to read:
A Watchdog fault (WDT Error) is a latching fault. The loss of AC Line will not reset a Watchdog fault.
- 2) AC Line Brownout Voltage
Modify Section 8.1.2 to read:
AC Line Brown-out (210E) (drop out) 82 $\pm$ 2 Vrms
AC Line Brown-out (210E) (restore) 87 $\pm$ 2 Vrms
- 3) Dual Indication Timing
Modify Section 8.2 to read:
Dual Indication (no fault)..... less than 700 ms
(fault)..... greater than 900 ms
(typical) 850 ms
- 4) AC POWER LED
Modify Section 2.6 and 5.1 to read:
When the AC Line voltage is below 103 $\pm$ 2 Vrms the AC POWER LED will flash at a rate of 2 Hz to indicate the brownout status. When the AC Line voltage is above 103 $\pm$ 2 Vrms the AC POWER LED will remain illuminated.
- 5) Red Failure Monitoring
Add the following sentence to Section 2.2 and Section 4.2:
The SSM Switch must be in the ENABLE position to enable Red Fail Monitoring for that channel.
- 6) Brownout / Power Fail
Modify Section 2.6 to read:
If the Red Enable input is ON, the monitor will detect a brownout condition has occurred if:
- the AC Line voltage is below 98 $\pm$ 2 Vrms, AND
- a Red Failure was detected on all channels with the SSM switch in the ENABLE position, AND
- no transition has been sensed on the Watchdog input for 200ms.
Once a brownout has been detected the monitor will override the Red Enable input to OFF and disable CU Watchdog monitoring.

Recovery from a brownout state will occur when:
- the AC Line voltage exceeds 103 $\pm$ 2 Vrms, OR
- any Green or Yellow or Red input is sensed active on a channel with the SSM switch in the ENABLE position, OR
- five transitions have been sensed on the Watchdog input.
- 7) Latent WDT Error Detection
If a WDT Error is timing when a Conflict or Red Fail fault is detected, the WDT Error will continue to time and result in a concurrent WDT Error fault indication.
- 8) RED FAIL LED and WD ERROR LED
Change "once every two seconds" TO "at a 2 Hz rate" in Section 2.16 and 2.17 and 5.1.

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210N - 210E - 210ECL - 2010ECL

RMS Signal Monitor

Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE FOLLOWING SERIES OF MODEL 210 / 2010 CONFLICT / VOLTAGE SIGNAL MONITORS: **210N, 210E, 210ECL, 2010, 2010ECL**; PCB Issue E. INCLUDED ARE GENERAL DESCRIPTION, OPERATIONAL DESCRIPTION, INSTALLATION, AND SPECIFICATIONS.

**THE 210/2010 SERIES SIGNAL MONITOR UNIT IS DESIGNED AND MANUFACTURED
IN THE USA BY EBERLE DESIGN INC., PHOENIX, ARIZONA.**

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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. RESISTOR R42 HAS BEEN REMOVED TO DISABLE THIS CIRCUIT. IF SPECIAL FUNCTION #2 INPUT IS REQUIRED, R42 (150K OHMS, 1/2W) SHOULD BE INSTALLED.

- WARNING -

THE P1 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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Section 1 BASIC FUNCTIONS

1.1 MODEL DESCRIPTION

The Signal Monitor consists of five models; the 210N, 210E, 210ECL, 2010, and 2010ECL. The model 210E is the base unit. The model 210N is equivalent to the 210E but does not include Dual Indication or Sequence monitoring. The model 210ECL adds an EIA-232 serial port that gives the unit the capability to communicate with Controller Unit or PC based operational software for status and fault event data. The model 210ECL also adds an enhanced event logging capability for full time stamped event reporting to the Controller Unit or PC based operational software. The model 2010 and 2010ECL units are specially configured versions of the 210E and 210ECL models that are compatible with the requirements of both the 170 Controller Unit and the 2070 Advanced Traffic Controller. 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. Each channel consists of a Green, Yellow, and Red field signal output at the field terminals. 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 210E/ 2010 series Signal Monitor is a dual microprocessor based unit. All monitoring functions and features are firmware programmable that permits upgrades or modifications by simply replacing the EPROM 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 210ECL unit 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 (SF1,2) are connected to the monitor via a front panel connector (P1) and ribbon cable assembly. Chassis Ground may also be connected to the unit through pin P1-4. Jumper E1 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 (P1-20). 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 (SF1,2) is active, or the EE input (MC Coil) is active.

2.2.1 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 Sequence 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 Sequence 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 useful if the controller cabinet assembly is not adapted for Red Signal Monitoring as in the case of a standard 210 Signal Monitor. This also accommodates Green and Yellow Dual Indication Monitoring on a five section signal head.

2.4 SEQUENCE (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. 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. Sequence Monitoring is disabled for all channels when the Red Enable input is not active or the EE input (MC Coil) is active.

A Sequence (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). The minimum yellow clearance interval is programmed from 2.7 seconds to 4.1 seconds using the option switch SW3-6,7,8 (see Section 4.4.6).

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

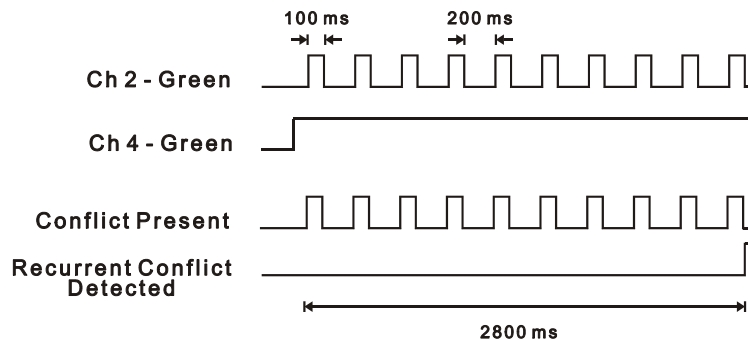
A Minimum Flash time option can be selected (see Section 4.5.2) which provides a flash interval of at least 6 seconds and at most 10 seconds in duration following a power-up, an AC Line interruption, or a brownout restore. During this interval the unit will suspend all fault monitoring functions and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

2.7 EXIT FLASH

When the 2010 / 2010ECL 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 ± 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.

2.8 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 210ECL / 2010ECL uses 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.

2.9 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.

2.10 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 SEL10 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 5 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.

2.11 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 E5 (Latching MPU Fault) may be removed.

2.12 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 2.17).

2.13 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.

2.14 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.

2.15 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.

2.16 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.

2.17 DIAGNOSTIC DISPLAY MODE (210N / 210E / 2010)

The 210N / 210E / 2010 models provides two means of displaying the individual Green, Yellow, and Red 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.

2.17.1 No Fault Diagnostic Display

When the 210N / 210E / 2010 model is not in the fault state, the unit can display the active Green, Yellow, and Red 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:

<u>Reset</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
#1	(G) AC POWER LED flashes	Green field status 1-16
#2	(Y) VDC FAILED LED flashes	Yellow field status 1-16
#3	(R) WDT ERROR LED flashes	Red field status 1-16
...	(repeats back to top)	

2.17.2 Fault Diagnostic Display

Once the 210N / 210E / 2010 model has been triggered by a fault, the Green, Yellow, and Red 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:

<u>Reset</u>	<u>Event</u>	<u>PCA LED</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
---	#1	Single flash	Current Fault Status (newest)	Current channel status
#1	#1	Single flash	(G) AC POWER LED flashes	Green field status 1-16
#2	#1	Single flash	(Y) VDC FAILED LED flashes	Yellow field status 1-16
#3	#1	Single flash	(R) WDT ERROR LED flashes	Red field status 1-16
#4	#2	Double flash	Event #2 Fault Status	Event #2 channel status
#5	#2	Double flash	(G) AC POWER LED flashes	Green field status 1-16
#6	#2	Double flash	(Y) VDC FAILED LED flashes	Yellow field status 1-16
#7	#2	Double flash	(R) WDT ERROR LED flashes	Red field status 1-16
#8	#3	Triple flash	Event #3 Fault Status (oldest)	Event #3 channel status
#9	#3	Triple flash	(G) AC POWER LED flashes	Green field status 1-16
#10	#3	Triple flash	(Y) VDC FAILED LED flashes	Yellow field status 1-16
#11	#3	Triple flash	(R) WDT ERROR LED flashes	Red field status 1-16
...			(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 to the Red field input display. The (R) WDT ERROR LED will pulse ON once per second to indicate this mode. The channel display LEDs will show the Red channels active at the time of the fault.

Depressing the Reset button again advances the display mode from the Red 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 Red 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 model 210E 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.

2.18 DIAGNOSTIC DISPLAY MODE (210ECL / 2010ECL)

The 210ECL / 2010ECL 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 210ECL / 2010ECL 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 210ECL / 2010ECL 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:

<u>Reset</u>	<u>Event</u>	<u>PCA LED</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
---	#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 model 210ECL 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.

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 2.17.

3.2 MODEL 210ECL / 2010ECL STATUS/EVENT REPORTING

The model 210ECL / 2010ECL uses the EIA-232 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 model 210ECL / 2010ECL status message format and time/date message format is compatible with BI Tran Systems Model 223 Software. On request from the operational software, the model 210ECL / 2010ECL 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 model 210ECL / 2010ECL time clock. The BI Tran Systems Model 223 Software manual should be consulted for details of operation.

3.2.2 EDI *ECcom* Monitor Report

The EDI *ECcom* software package (Version 2.4 or greater is required) interfaces a Computer to the model 210ECL and 2010ECL. 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 if 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) Control Input Status: 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) Event Type: 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) AC Line Voltage: 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) Program Card Matrix: the permissive programming for each channel.
- b) Yellow Disable Jumpers: the Yellow Disable programming for each channel.
- c) SSM Switches: the SSM Switch programming for each channel.
- d) Option Switches: RF 2010, RP Disable, GY Enable, SF1 Polarity, Sequence Timing, Minimum Flash Enable, Configuration Fault Enable, Red Cable Fault enable, AC Brownout timing.
- e) Watchdog Programming: Watchdog Enable, Watchdog timing, and Watchdog Latch.
- f) Configuration Check Value: the value of the 16 bit Check Value for the reported configuration.

3.2.3 EDI ECom Monitor Event Log Examples

An example of each type of record is shown below:

1) Previous Fault (PF) Event Log

```
>> Monitor #73 Previous Fail Event Log
>> Downloaded at 2:13:12 PM Monday, June 29, 1998
>> Number of events = 1
```

```
PREVIOUS FAIL EVENT #1 at:
12:12:59 PM Monday, June 29, 1998
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) AC Line (AC) Event Log

```
>> Monitor #73 AC Line Event Log <<
>> Downloaded at 2:01:05 PM Monday, January 29, 1996 <<
```

```
AC Event #1 at:
2:41:30 PM Tuesday, January 02, 1996
Restore AC & WDT
AC Line Voltage = 119 Vac
```

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

4) Manual Reset (MR) Event Log

```
>> Monitor #73 Monitor Reset Event Log <<
```

**210N / 210E / 210ECL / 2010 / 2010ECL SERIES SIGNAL MONITOR
OPERATIONS MANUAL**

>> Downloaded at 1:00:20 PM Monday, January 29, 1996 <<

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

>> Monitor #73 Configuration Log
>> Downloaded at 12:04:25 PM Monday, June 29, 1998
>> Number of events = 1
>> (A '*' symbol indicates that parameter has changed)

CONFIGURATION CHANGE #1 at:
4:00:06 PM Friday, June 26, 1998

Permissive Programming:

Ch 1 with: 5 6 15
Ch 2 with: 5 6 13 15
Ch 3 with: 7 8 16
Ch 4 with: 7 8 14 16
Ch 5 with: 13
Ch 6 with: 13 15
Ch 7 with: 14
Ch 8 with: 14 16
Ch 9 with: no channels
Ch 10 with: no channels
Ch 11 with: no channels
Ch 12 with: no channels
Ch 13 with: 15
Ch 14 with: 16
Ch 15 with: no channels

Yellow Disable Jumpers (X=Disable):

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

SSM Switches (X=ON):

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

RF 2010 Switch = OFF
RP Disable Switch = OFF
GY Enable Switch = OFF
SF Polarity Switch = OFF
*> Watchdog Enable Switch = OFF
Watchdog Latch Enable = OFF
Watchdog Fault Timing = 1.0 seconds
Sequence Yellow Timing = 2.7 seconds
Minimum Flash Enable = OFF
Configuration Fault Enable = OFF
Configuration CRC = 10052

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 is 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 (P1) until the two ejector latches "snap" into place over the cable plugs.

4.1.1 Red Field Inputs

- WARNING -

THE P1 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 P1 correspond to Red channel inputs on the Signal Monitor. **All unused Red channel inputs must be terminated to AC+.** Pin #20 of P1 is the Red Enable input and must be active to enable Red Failure Monitoring, GYR-Dual Indication Monitoring, and Sequence 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 Sequence Monitoring when the intersection is in hardware flash.

4.1.2 Special Function Preempt Inputs (SF1,2)

The pins numbered 8 and 6 of Red Interface connector P1 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.

Option Switch #5 of SW3 labeled "POLARITY" may be used to change the polarity of the Special Function input #1. When the switch is in the OFF position, the Special Function input #1 will be active when AC+ is present. AC+ present on **either** input will disable Red Failure monitoring. An unused preemption input may be left OPEN (no connection) if the polarity switch is in the OFF position. When the switch is in the ON position, the Special Function input #1 will be active when AC+ is NOT present. Lack of AC+ on input #1 will disable Red Failure monitoring.

Polarity Switch	SF Input #1	SF Input #2	Red Fail Monitoring
Off	Not Active	Not Active	Enabled
Off	Not Active	Active	Disabled - Preempt
Off	Active	Not Active	Disabled - Preempt
Off	Active	Active	Disabled - Preempt
On	Not Active	Not Active	Disabled - Preempt
On	Not Active	Active	Disabled - Preempt
On	Active	Not Active	Enabled
On	Active	Active	Disabled – Preempt

4.2 SSM SWITCH PROGRAMMING

The SSM dip switches (SW4 and SW5) are located near the program card edge connector. The switch positions are labeled CH1 to CH16 on the PCB legend screen, corresponding to channels 1 through 16, respectively. To enable GYR-Dual Indication **and** Sequence 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 Sequence 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

This 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.

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" (or OPT A). When this switch is in the ON position, the Red Fail fault time is set to the 2010 series value of 1350 ms. When this switch is in the OFF position, the Red Fail fault time is set to the 210E series 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" or (OPT B). 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. This function is used to provide Dual Indication monitoring for channels which have the Red input tied to AC+, such as a five section head, or cabinet assemblies which are not adapted for Red Monitoring. See Section 2.3.1.

4.4.5 Polarity Switch

Switch #5 of SW3 is labeled "POLARITY". When this switch is in the OFF position, the active state of the two Special Function inputs is when AC+ present. When this switch is in the ON position, the active state of the Special Function input #1 is when AC+ present is not present. The switch does not affect the polarity of Special Function #2. See 4.1.2 for Special Function input operation.

4.4.6 Sequence Timing Switches

Switches #6,7,8 of SW3 are labeled "YEL TIME 1", "YEL TIME 2", and "YEL TIME 3". These switches modify the minimum Yellow Clearance time used by the Sequence Monitoring function. Each binary weighted switch position adds 0.2 seconds to the minimum Yellow Clearance time.

YEL TIME 3	YEL TIME 2	YEL TIME 1	Minimum Yellow Timing
Off	Off	Off	2.7 seconds
Off	Off	On	2.9 seconds
Off	On	Off	3.1 seconds
Off	On	On	3.3 seconds
On	Off	Off	3.5 seconds
On	Off	On	3.7 seconds
On	On	Off	3.9 seconds
On	On	On	4.1 seconds

4.5 SELECT JUMPER PROGRAMMING

The Signal Monitor also provides jumper options to modify the monitor operation. The Select jumpers are labeled SEL1 through SEL10. SEL6 through SEL10 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 2.10.

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.

4.6 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 ± 2 Vac. During the minimum flash interval the indicator will flash at a rate of 4Hz. See Section 2.5.

If the 210N / 210E / 2010 model 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 2.17.

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.

If the 210N / 210E / 2010 model 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 2.17.

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.

If the 210N / 210E / 2010 model is in the Diagnostic Display mode, the (R) WDT ERROR indicator will flash ON once per second to indicate the Channel Status display is showing Red channel status. See Section 2.17.

5.1.4 CONFLICT Indicator

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

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 SEQUENCE Indicator

The SEQUENCE 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 2.17.

If the unit is in the Configuration Change Fault mode, the PCA indicator will flash at a 4 Hz rate. See Section 2.10.

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 EIA-232 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 (210N / 210E / 2010)

During normal operation the 210N / 210E / 2010 model 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). In the event of a Conflict, Red Failure, Dual Indication, or Sequence fault only the channels on which the fault occurred will be displayed.

5.1.13 CHANNEL STATUS Indicators (210ECL / 2010ECL)

During normal operation the 210ECL / 2010ECL 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 Sequence 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 2.17 and 2.18.

5.3 RED INTERFACE CONNECTOR (P1)

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 MC68HC11D0 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. 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™.

6.2 MAIN MPU LOGIC

The MC68HC11D0 main microprocessor (U8) operates in the Expanded Multiplexed mode which allows for external memory devices. The program firmware is contained in the 29F010B CMOS Flash device (U12) and program data storage is contained in the SRM2264 8Kx8 static RAM (U19). The expanded address and data buss is used to link the memory devices with the microprocessor. A 74HC137 (U21) 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 (U20), Real Time Clock (U35), 24Vdc Logic Inputs (U26), Display Multiplexer (U2,3), Program Card and Switch inputs (U36,37), and the RMS-Engine™ (U40).

Data is clocked out of the main microprocessor on the MOSI pin (U8.18) while data is clocked in on the MISO pin (U8.17). The SCLK signal (U8.19) provides the synchronous clock. A peripheral device must be selected by U21 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 E5 is installed this fault mode will only be reset by a complete power down cycle.

6.5 EEPROM MEMORY

The 25C320 Serial EEprom (U20) device provides 4096 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 Reset input are thresholded by comparator U49 to determine true/false input status. Opto-couplers U44-47 provide electrical isolation between Logic Ground and Neutral. The 74HC165 (U26) shift register uses the SPI port to transfer this data to the main microprocessor.

6.7 REAL TIME CLOCK

The DS1305 Real Time Clock (U35) 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 should the AC Line voltage drop out.

6.8 DISPLAY

The front panel LED display is multiplexed by the row driver U3 and the column driver U2. The scan rate is approximately 60 Hz. Display data is shifted into U3 while individual columns are selected by U2 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 U36 and U37. Column drivers U38 and U39 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 (U65) 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 (U38) 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 U48A, U48B, and U48C perform a full wave rectification circuit.

6.11 POWER SUPPLY

The switching power supply is based on a MIC38C43 (U23) fixed frequency current-mode PWM controller. The AC Line is full wave rectified and charges capacitor C68 to approximately 170 Vdc. The PWM controller switches current from C68 through the transformer T1 using transistor Q3 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 U25 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 U31, U32, and U33. The MAX202 interface circuit U1 provides a level translation from EIA-232 voltage levels. The DTR input (J1-4) to the unit must be greater than approximately 3 Vdc for the monitor to transmit data.

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 C68 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 (U22) will hold the MPU in reset and the DIAGNOSTIC indicator on the front panel should illuminate. Measure the regulated voltage across capacitor C22. If it measures lower than 5 ± 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 2.14.
- 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 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
AC Line Brown-out (210E)	(drop-out).....	92 $\pm$ 2 Vrms
AC Line Brown-out (210E)	(restore).....	98 $\pm$ 2 Vrms
AC Line Brown-out (2010)	(drop-out).....	98 $\pm$ 2 Vrms
AC Line Brown-out (2010)	(restore).....	103 $\pm$ 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

210N / 210E / 210ECL / 2010 / 2010ECL SERIES
SIGNAL MONITOR OPERATIONS MANUAL

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
Sequence	(no fault).....	greater than 2.8 seconds
	(fault).....	less than 2.6 seconds
Brown-out (210E)	(drop-out)	80 $\pm$ 17 milliseconds
Brown-out (210E)	(restore)	80 $\pm$ 17 milliseconds
Brown-out (2010)	(drop-out)	400 $\pm$ 50 milliseconds
Brown-out (2010)	(restore)	400 $\pm$ 50 milliseconds
Minimum flash after restore		6.0 $\pm$ 0.5 seconds
Maximum flash after restore		10.0 $\pm$ 0.5 seconds
Watchdog (210E)	(disable)	80 $\pm$ 17 milliseconds
Watchdog (210E)	(enable).....	80 $\pm$ 17 milliseconds
Watchdog (2010)	(disable)	400 $\pm$ 50 milliseconds
Watchdog (2010)	(enable).....	400 $\pm$ 50 milliseconds

8.3 MECHANICAL

Height	9.3 inches
Width	1.38 inches
Depth	10.17 inches

8.4 ENVIRONMENTAL

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

210N / 210E / 210ECL / 2010 / 2010ECL SERIES
SIGNAL MONITOR OPERATIONS MANUAL

Section 9
WIRING ASSIGNMENTS

9.1 MONITOR UNIT CONNECTOR (P3)

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 ARE TIED TOGETHER]	BB	STOP TIME
25		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 (P4)

SIGNAL MONITOR OPERATIONS MANUAL

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	DC GROUND	T	CONFLICT
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	NC	CC	NC
26	NC	DD	NC
27	NC	EE	NC
28	YELLOW INHIBIT COMMON	FF	NC

=== 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 (P1)

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

SIGNAL MONITOR OPERATIONS MANUAL

Pin #	Function	Pin #	Function
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 E1. Monitor CHASSIS GROUND is also connected through the edge connector P2. 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.

- WARNING -

IF JUMPER E1 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 P1 RED INTERFACE CONNECTOR SHOULD ALWAYS BE UNPLUGGED BEFORE REMOVING THE UNIT FROM THE CABINET TO PREVENT POTENTIAL EXPOSURE TO ELECTRICAL SHOCK.

9.4 EIA-232 CONNECTOR (J1)

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

The Data Terminal Ready (DTR) input must be in the high state (>4 Vdc) for the monitor EIA-232 port (DCE device) to be active. DCD, DSR, CTS, and RTS are provided for compatibility with Data Terminal Equipment (DTE device) control signals. If required by the Data Terminal Equipment device (PC), DCD may be driven high by inserting jumper E2. If the Data Terminal Equipment device uses CTS instead of DTR to control data flow, insert jumper E3 and remove jumper E4.

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:

<u>PC DB-9</u>		<u>Monitor DB-9</u>
RX pin 2	connect to	TX pin 2
TX pin 3	connect to	RX pin 3
DTR pin 4	connect to	DTR pin 4
GND pin 5	connect to	GND pin 5

SIGNAL MONITOR OPERATIONS MANUAL

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

<u>PC DB-25</u>		<u>Monitor DB-9</u>
RX pin 3	connect to	TX pin 2
TX pin 2	connect to	RX pin 3
DTR pin 20	connect to	DTR pin 4
GND pin 7	connect to	GND pin 5

9.4.2 EIA-232 Cable to a 170 Controller Unit

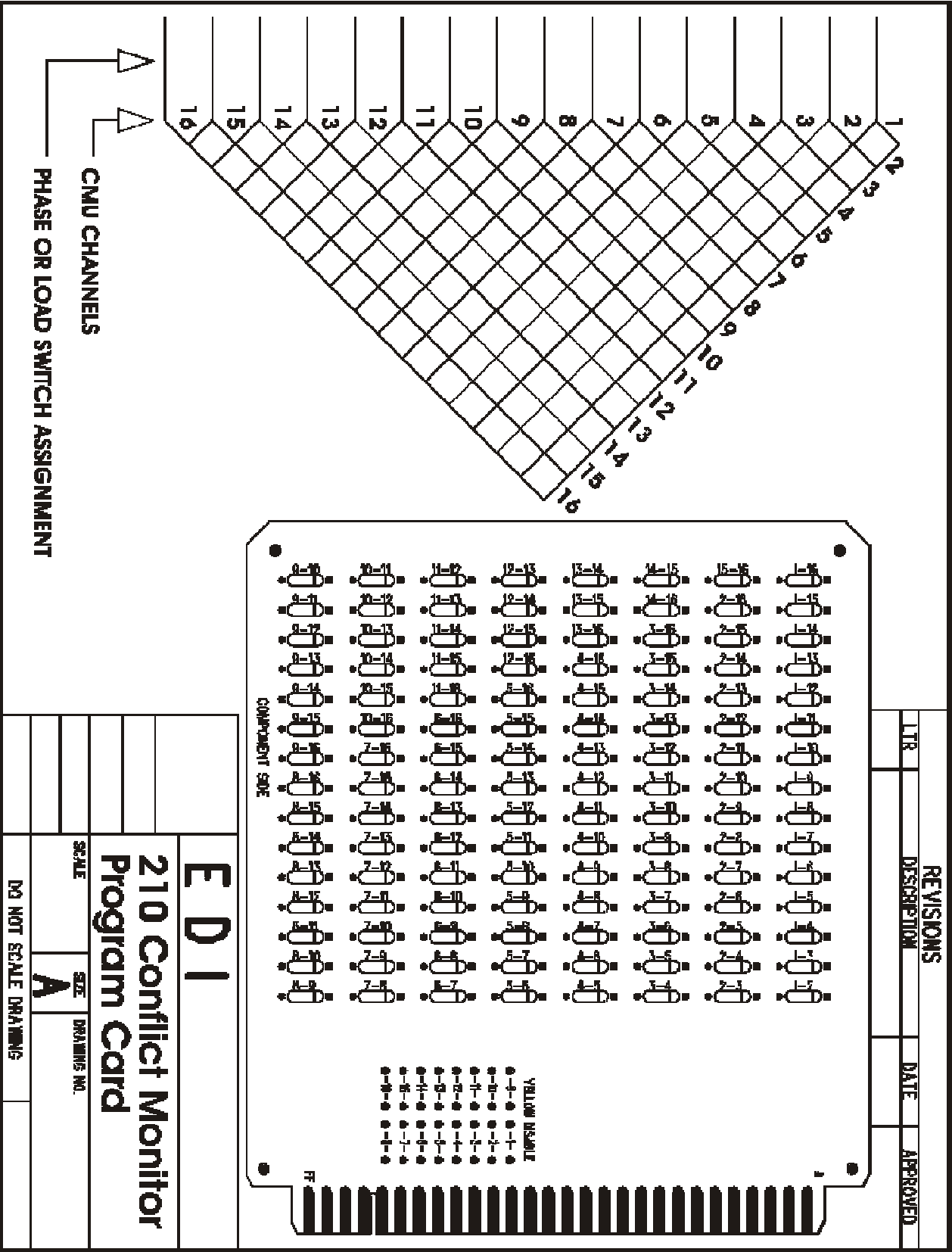
A typical cable assembly for 170 CU connector would be as follows:

<u>170</u>		<u>Monitor DB-9</u>
RX pin L	connect to	TX pin 2
TX pin K	connect to	RX pin 3
+5 pin D	connect to	DTR pin 4
GND pin N	connect to	GND pin 5

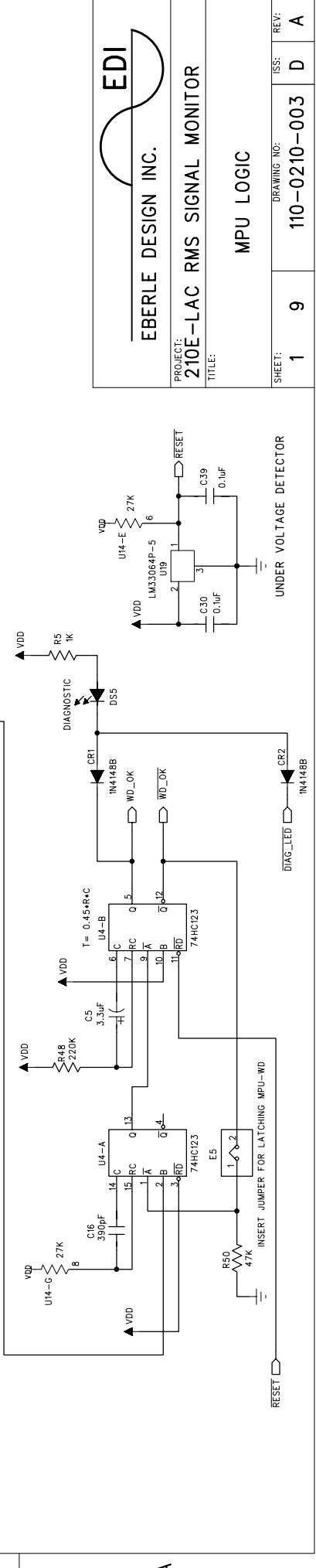
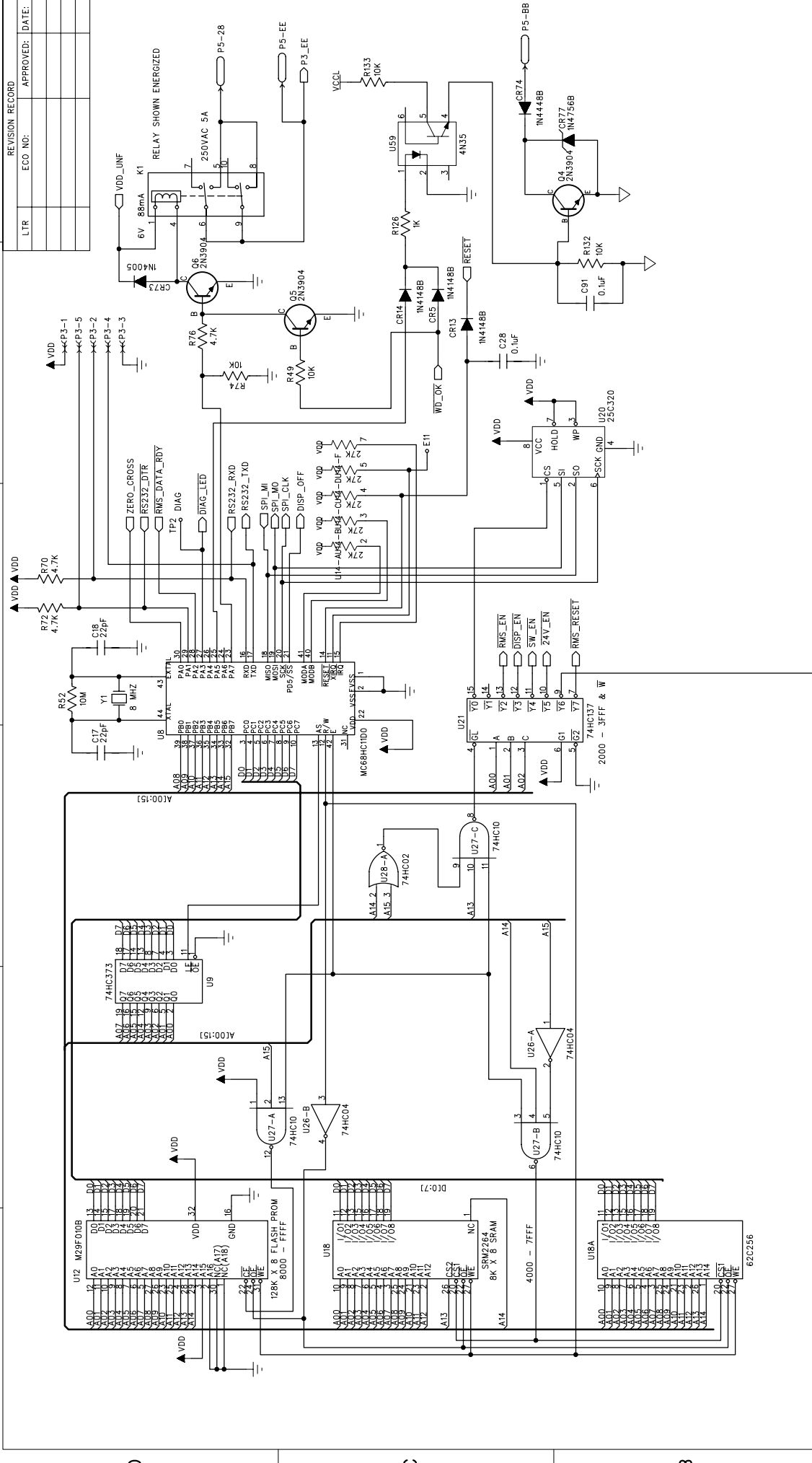
DCD pin H should be connected to +5 pin D on the Controller Unit connector.

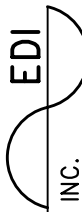
CTS pin M should be connected to RTS pin J on the Controller Unit connector.

9.5 PROGRAM CARD DIAGRAM



REVISION RECORD		
LTR	ECO NO:	APPROVED: DATE:





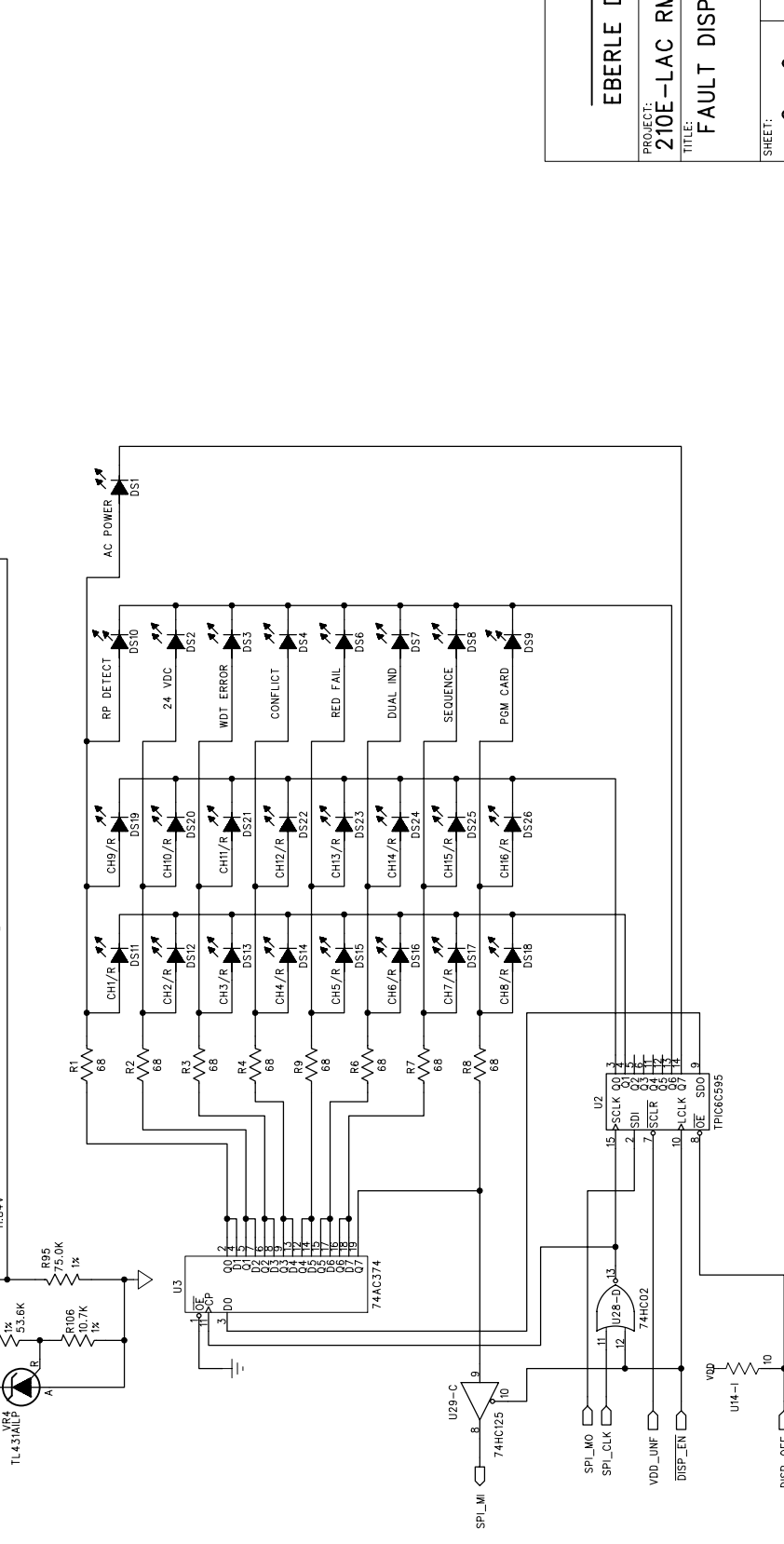
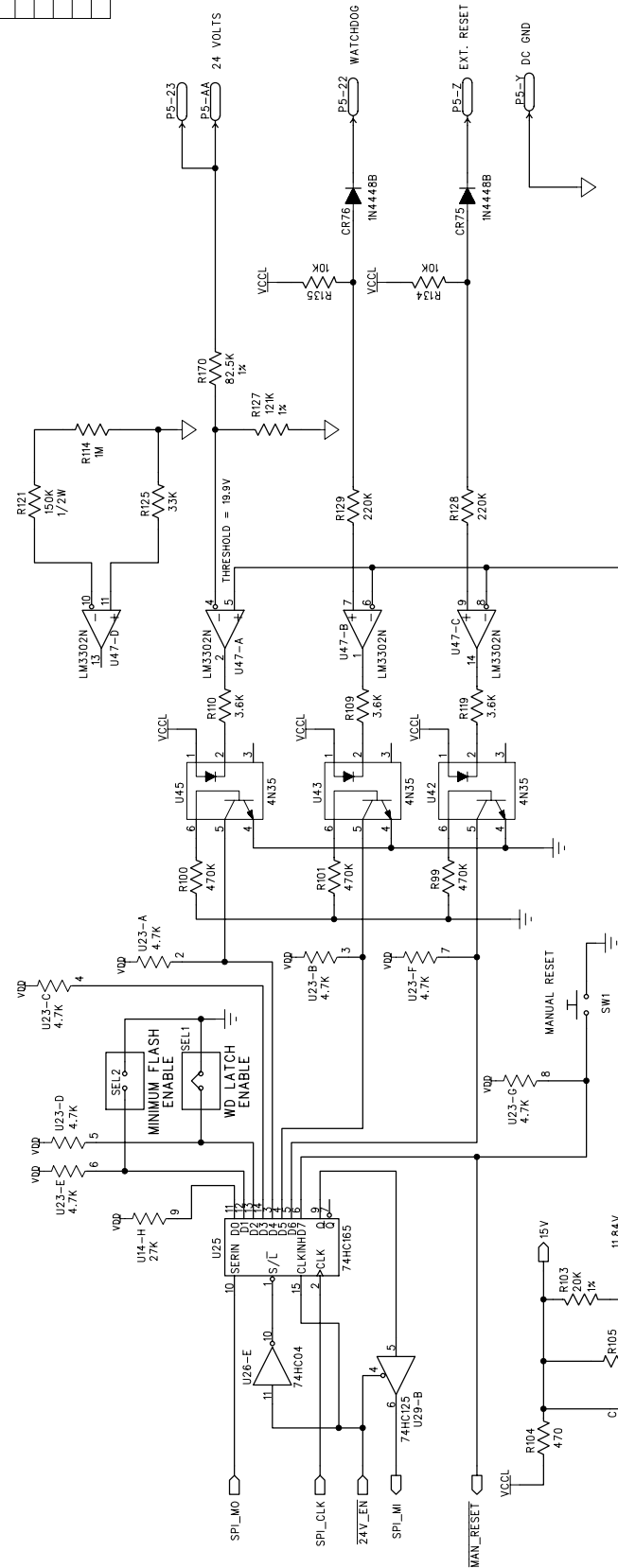
EBERLE DESIGN INC.

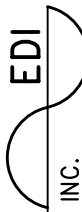
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TITLE: **MPU LOGIC**

SHEET: 1	DRAWING NO: 110-0210-003	ISS: D	REV: A
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UNDER VOLTAGE DETECTOR





EBERLE DESIGN INC.

PROJECT:
210E-LAC RMS SIGNAL MONITOR

TITLE:
FAULT DISPLAYS AND 24V INPUTS

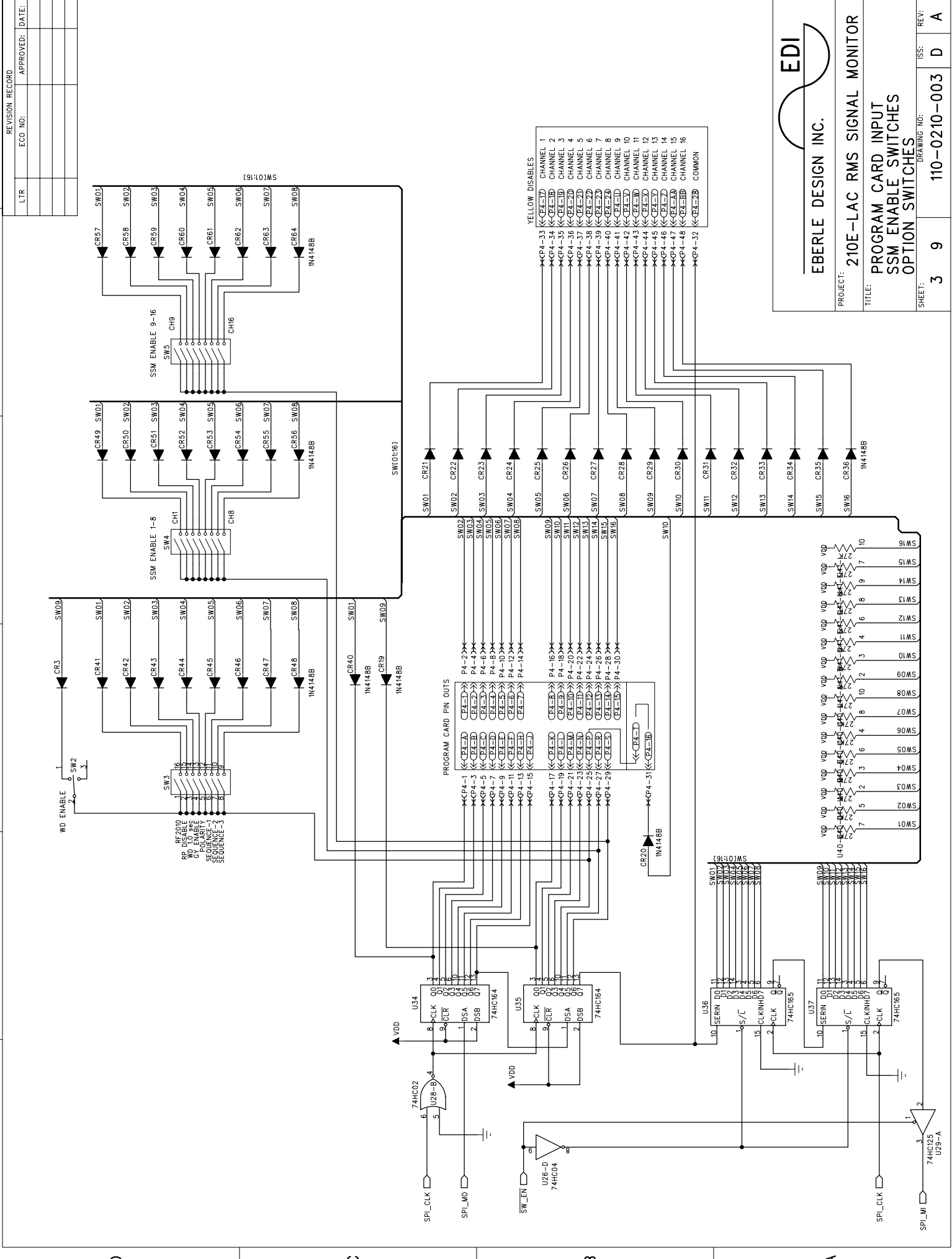
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REV: A

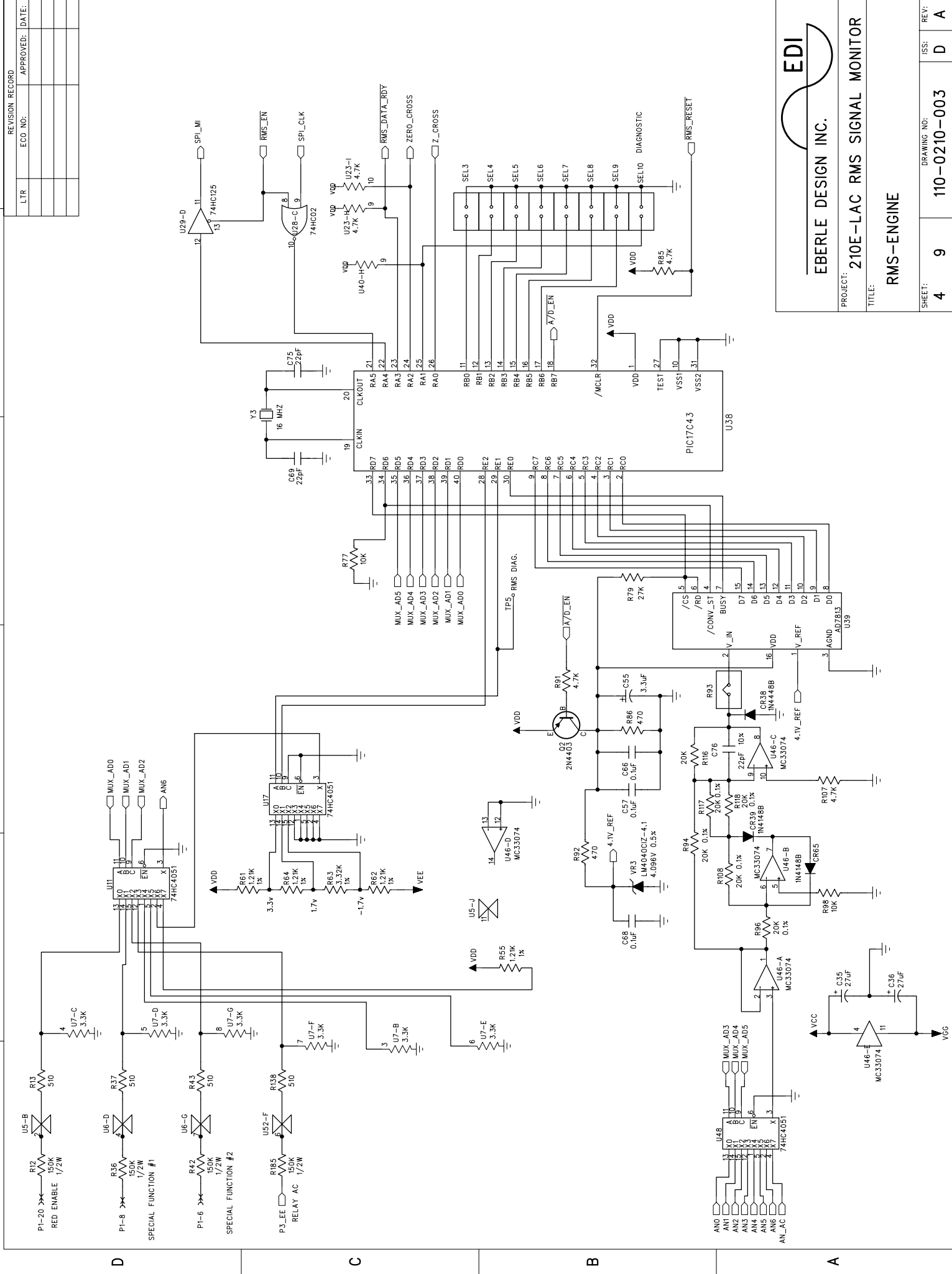
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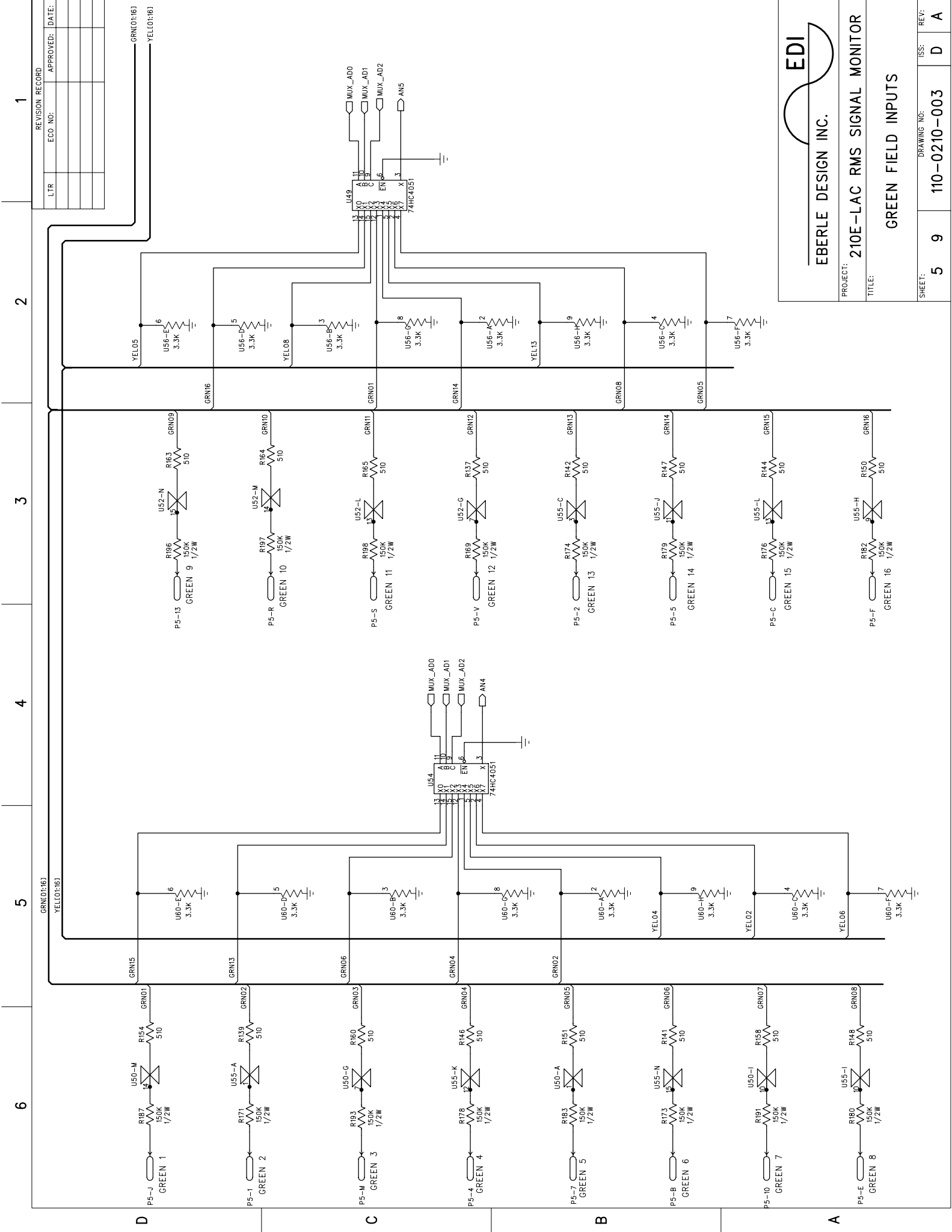


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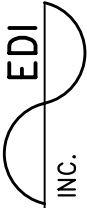
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TITLE:	PROGRAM CARD INPUT SSM ENABLE SWITCHES OPTION SWITCHES		
SHEET:	3	9	110-0210-003
ISS:	D	D	A
REV:			





REVISION RECORD			
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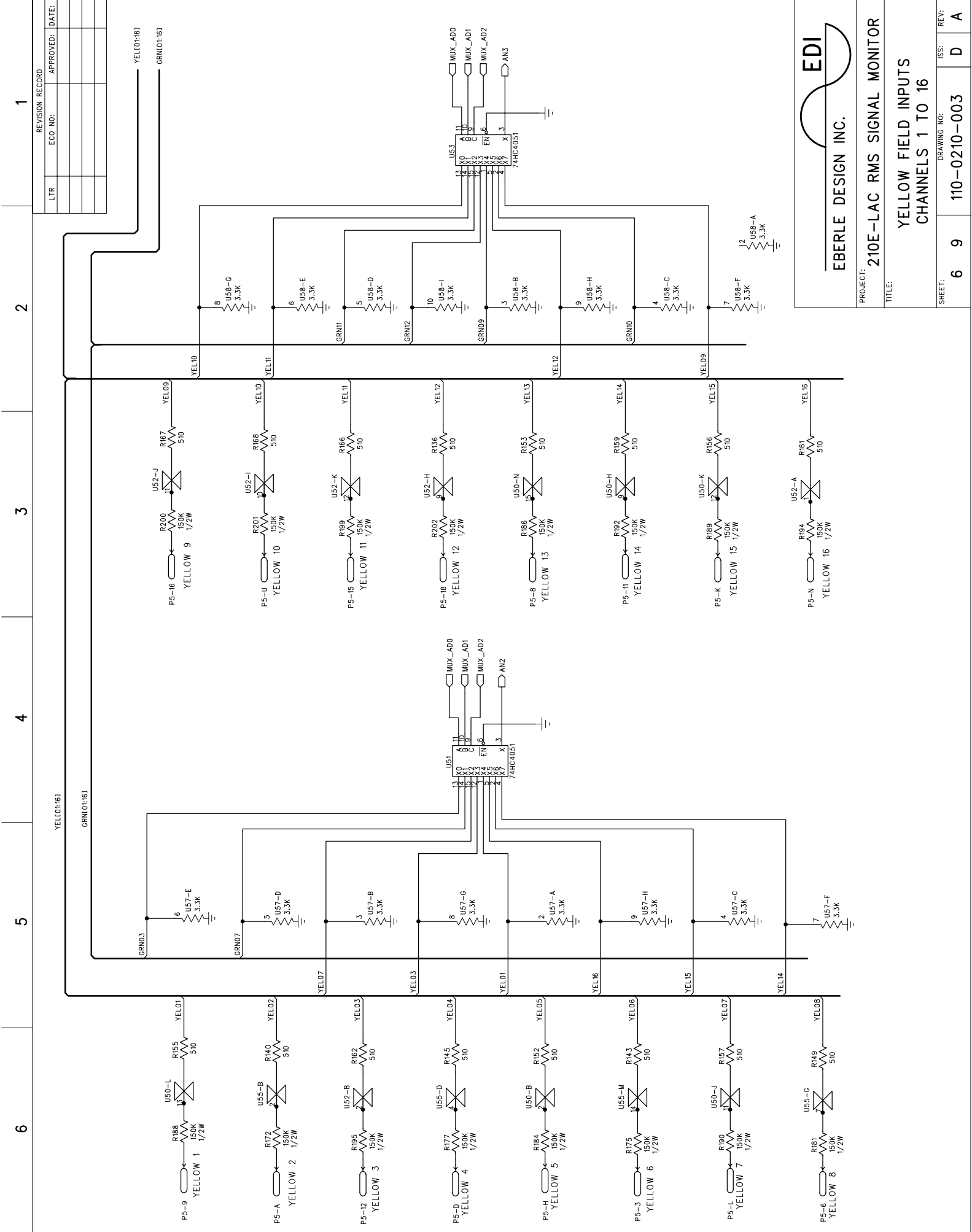


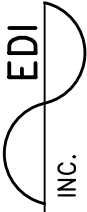
EBERLE DESIGN INC.

PROJECT: 210E-LAC RMS SIGNAL MONITOR

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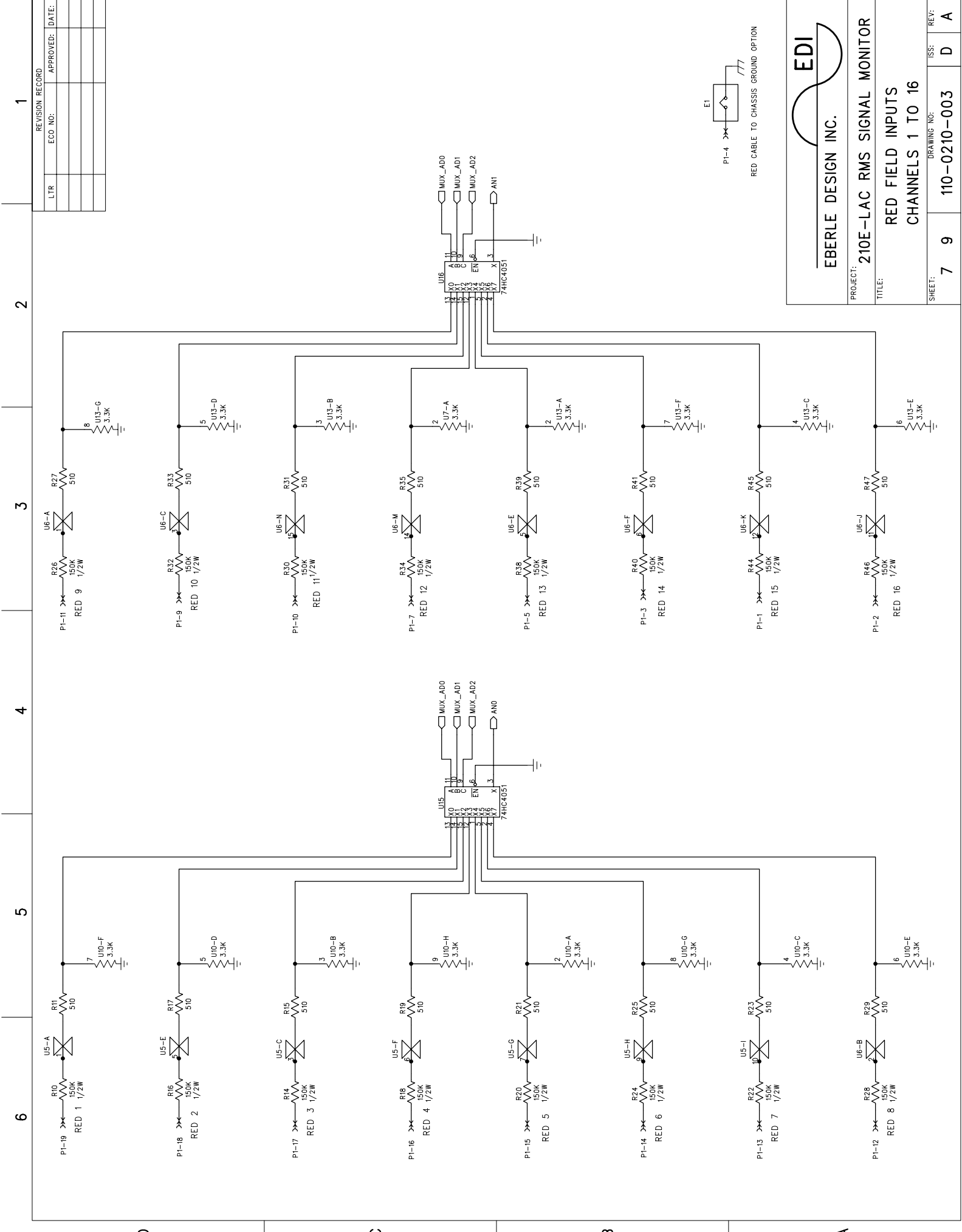


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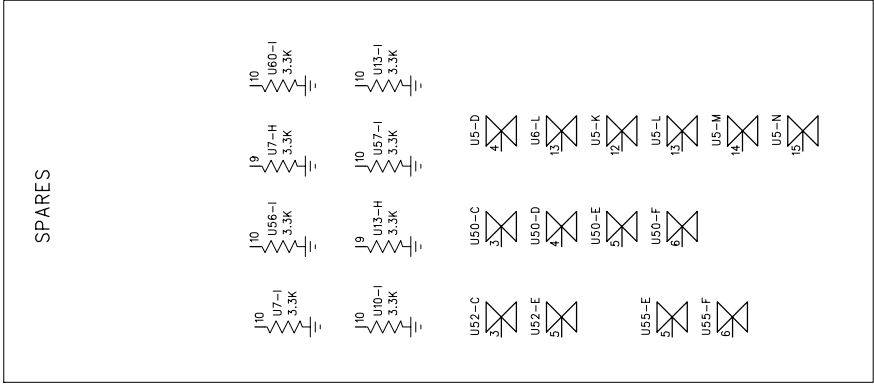
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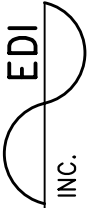
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EBERLE DESIGN INC.

PROJECT:
210E-LAC RMS SIGNAL MONITOR

TITLE:
SPARES

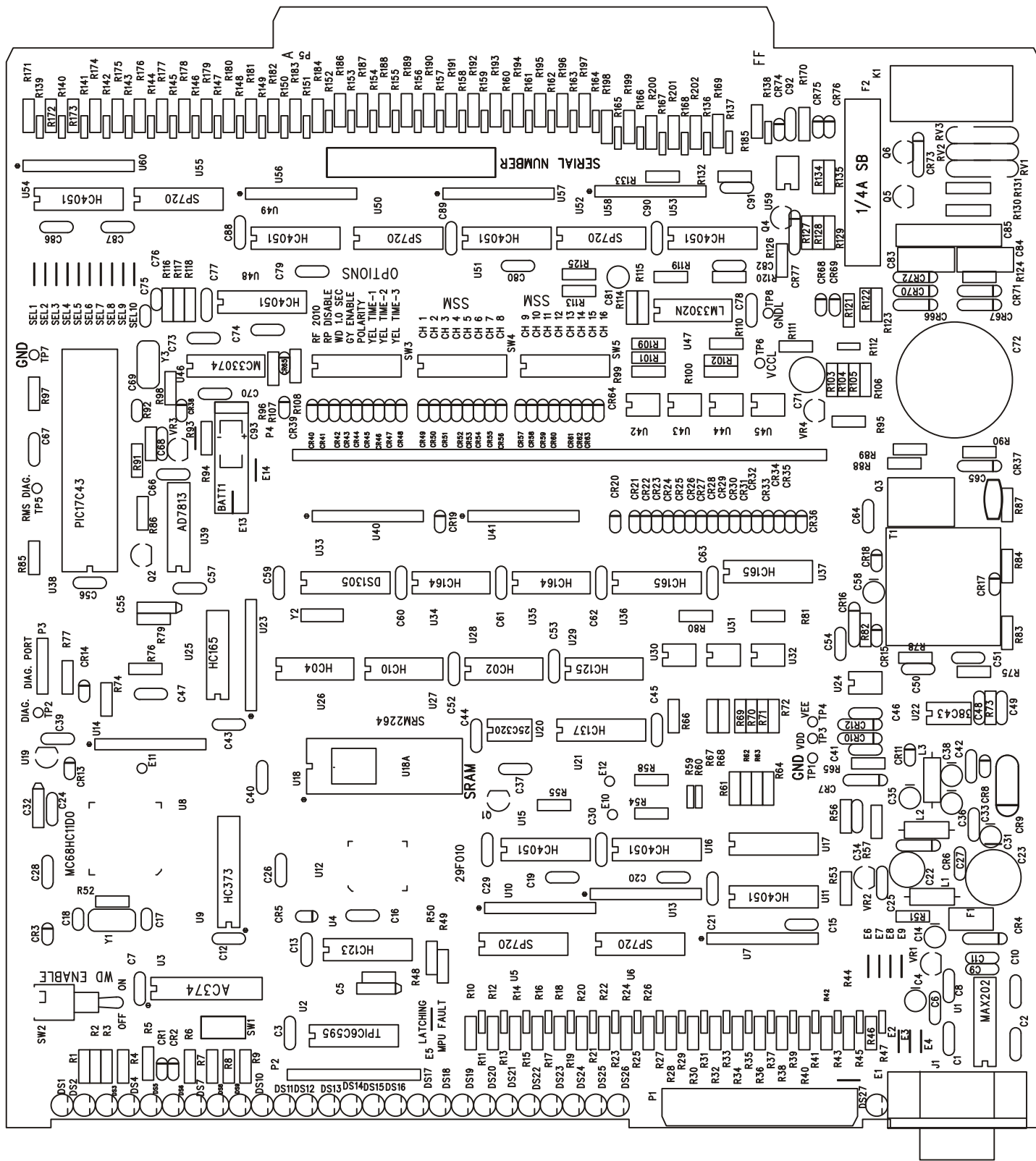
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OF: 9

DRAWING NO:
110-0210-003

ISS: D

REV: A



Item	EDI Part Number	Qty	Description	Reference
1		1	(NO COMPONENT)	P5
2		1	(NO COMPONENT)	P3
3		1	Transition Brd. to Program Card	P4
4		1	FUSE , 2 HOLE SOLDER PATTERN	F2
5		9	(NO COMPONENT)	E11 TP1-8
6		9	(NO COMPONENT)	SEL2-10
7		2	2-POSITION PCB OPTION JUMPER	E1 SEL1
8		3	(NO COMPONENT)	MT1-3
9	201-1072	1	RESISTOR, 10.7K, 1/4W, 1%	R106
10	201-1211	6	RESISTOR, 1.21K, 1/4W, 1%	R55 R61-62 R64 R75 R78
11	201-1213	1	RESISTOR, 121K, 1/4W, 1%	R127
12	201-1692	1	RESISTOR, 16.9K, 1/4W, 1%	R73
13	201-2002	1	RESISTOR, 20K, 1/4W, 1%	R103
14	201-3321	2	RESISTOR, 3.32K, 1/4W, 1%	R63 R111
15	201-5111	2	RESISTOR, 5.11K, 1/4W, 1%	R51 R53
16	201-5362	1	RESISTOR, 53.6K, 1/4W, 1%	R105
17	201-7502	3	RESISTOR, 75.0K, 1/4W, 1%	R95 R122-123
18	201-8252	1	RESISTOR, 82.5K, 1/4W, 1%	R170
19	202-2002	6	RESISTOR, 20K, 1/4W, 0.1%	R94 R96 R108 R116-118
20	205-0000	2	RESISTOR, 0 OHM, 1/4W	E5 R93
21	205-1020	3	RESISTOR, 1K, 1/4W, 5%	R5 R83 R126
22	205-1030	9	RESISTOR, 10K, 1/4W, 5%	R49 R74 R77 R97-98 R132-135
23	205-1050	1	RESISTOR, 1M, 1/4W, 5%	R114
24	205-1060	1	RESISTOR, 10M, 1/4W, 5%	R52
25	205-1210	1	RESISTOR, 120, 1/4W, 5%	R57
26	205-2240	3	RESISTOR, 220K, 1/4W, 5%	R48 R128-129
27	205-2730	1	RESISTOR, 27K, 1/4W, 5%	R79
28	205-3300	1	RESISTOR, 33, 1/4W, 5%	R82
29	205-3310	1	RESISTOR, 330, 1/4W, 5%	R84
30	205-3330	1	RESISTOR, 33K, 1/4W, 5%	R125
31	205-3620	3	RESISTOR, 3.6K, 1/4W, 5%	R109-110 R119
32	205-4710	4	RESISTOR, 470, 1/4W, 5%	R65 R86 R92 R104
33	205-4720	6	RESISTOR, 4.7K, 1/4W, 5%	R70 R72 R76 R85 R91 R107
34	205-4730	2	RESISTOR, 47K, 1/4W, 5%	R50 R56
35	205-4740	3	RESISTOR, 470K, 1/4W, 5%	R99-101
36	205-6800	8	RESISTOR, 68, 1/4W, 5%	R1-4 R6-9
37	215-0180	1	RESISTOR, 1.8, 1/2W, 5%	R87
38	215-1240	2	RESISTOR, 120K, 1/2W, 5%	R88-89
39	215-1540	54	RESISTOR, 150K, 1/2W, 5%	R10 R12 R14 R16 R18 R20 R22 R24 R26 R28 R30 R32 R34 R36 R38 R40 R42 R44 R46 R121 R124 R169 R171-202
40	215-4710	1	RESISTOR, 470, 1/2W, 5%	R90
41	223-3600	2	RESISTOR, 36, 3W, 5%	R130-131
42	230-2730-9	3	RESISTOR, SIP, 27K, 2%, 9 RESISTOR	U14 U40-41
43	230-3320-9	7	RESISTOR, SIP, 3.3K, 2%, 9 RESISTOR	U7 U10 U13 U56-58 U60
44	230-4720-9	1	RESISTOR, SIP, 4.7K, 2%, 9 RESISTOR	U23

45	255-5110	53	RESISTOR, 510 OHM, 1/8W, 5%, FRM @ 0.3"	R11 R13 R15 R17 R19 R21 R23 R25 R27 R29 R31 R33 R35 R37 R39 R41 R43 R45 R47 R112 R136-168
46	300-1860-050R	1	CAPACITOR, ELECT, 18uF, 50WV, 20 %, LOW ESR,RDL	C58
47	300-2270-035R	2	CAPACITOR, ELECT, 220uF, 35WV, 20 %, LOW ESR,RDL	C22 C71
48	300-2270-250R	1	CAPACITOR, ELECT, 220uF, 250WV, 20 %, RDL	C72
49	300-2760-035R	4	CAPACITOR, ELECT, 27uF, 35WV, 20 %, LOW ESR,RDL	C31 C35-36 C38
50	300-8270-025R	1	CAPACITOR, ELECT, 820uF, 25WV, 20 %, LOW ESR,RDL	C23
51	310-3350-015A	3	CAPACITOR, TANT, 3.3uF, 15V, 10%, AXL	C5 C32 C55
52	320-1020-050A	2	CAPACITOR, CER.MULT, 0.001uF, 50V, 10%, AXL	C25 C34
53	320-1040-050A	53	CAPACITOR, CER.MULT, 0.1uF, 50V, 10%, AXL	C3 C7 C12-13 C15 C19-21 C24 C26-30 C33 C37 C39-47 C51-54 C56-57 C59-64 C66 C68 C70 C73-74 C77-80 C82 C86-91 C17-18 C69 C75-76
54	320-2200-200A	5	CAPACITOR, CER.MONO, 22pF, 50-200V, 5%, AXL	C16 C48-50 C67
55	320-3910-050A	5	CAPACITOR, CER.MULT, 390pF, 50V, 10%, AXL	C65
56	325-1010-500R	1	CAPACITOR, CER.DISC, 100pF, 500V, 10%, RDL	C83-84
57	325-2220-400R	2	CAPACITOR, MET. FILM, 2200pF, 400V, 10%, RDL	C85
58	335-1040-630R	1	CAPACITOR, MET.FILM, 0.1uF, 630V, 10%, RDL	U5-6 U50 U52 U55
59	405-0720	5	IC, SP720, TRANSIENT PROTECTION ARRAY	U47
60	405-3302	1	IC, LM3302N, QUAD COMPARATOR	U19
61	405-3364	1	IC, LM33064P-5, UNDERVOLTAGE SENSING	U46
62	405-3374	1	IC, MC33074, QUAD OP AMP	U39
63	405-7813	1	IC, AD7813YN, 10 BIT A/D CONV.	CR6-7 CR12
64	410-0050	3	DIODE, TRANS. SUPR., SA5.0A, 5V	CR9
65	410-0340	1	DIODE, SCHOTTKY, MBR340, 40V, 3A	CR37 CR66-67 CR70-71 CR73
66	410-4005	6	DIODE, 1N4005, 600 PIV	CR1-3 CR5 CR13-14 CR19-36 CR39-65
67	410-4148	51	DIODE, LOGIC SIGNAL, 1N4148B	CR8 CR11 CR15 CR17-18 CR38 CR74-76
68	410-4448	9	DIODE, HI SPD SWITCHING, 1N4448	CR77
69	410-4756-5	1	DIODE, ZENER, 1N4756B, 47V	CR10 CR72
70	410-5231	2	DIODE, ZENER, 1N5231B, 5.1V	CR16
71	410-5245-5	1	DIODE, ZENER, 1N5245B, 15V	U24 U42-43 U45 U59
72	420-4035	5	OPTO COUPLER, TRANSISTOR OUTPUT, 4N35	DS1
73	425-3901-G	1	LED, GREEN, WC LENS, T1, HIGH INTENSITY	DS2-26
74	425-3901-R	25	LED, RED, WC LENS, T1, HIGH INTENSITY	Q4-6
75	430-3904	3	TRANSISTOR, 2N3904, NPN, TO-92	Q2
76	430-4403	1	TRANSISTOR, 2N4403, PNP, TO-92	Q3
77	430-8200	1	TRANSISTOR, IRF820, MOSFET, 500V, 2.5A, TO220	RV1-3
78	440-0150	3	REGULATOR, METAL OXIDE VARISTOR, S14K150	VR2 VR4
79	440-0431	2	REGULATOR, TL431AILP, VOLTAGE REF., 1%, TO-92	U22
80	440-3843	1	IC, MIC38C43BN, SWITCHING PWR. SUPPLY CNTLR	VR3
81	440-4040	1	IC, LM4040CIZ-4.1, PREC. VOLT. REF., 4.096V, 0.5%	U38
82	485-1743	1	IC, PIC17C43-16I/P, RISC MPU	U8
83	485-6911-S	1	IC, MC68HC11D0CFN2R2, 8-BIT MPU, PLCC	U28
84	490-0002	1	IC, 74HC02, QUAD 2-INPUT NOR GATE	U26
85	490-0004	1	IC, 74HC04, HEX INV	U27
86	490-0010	1	IC, 74HC10N, TRIPLE 3-INPUT NAND GATE	U4
87	490-0123	1	IC, 74HC123, DUAL ONE-SHOT (not 74HC123A)	U29
88	490-0125	1	IC, 74HC125, QUAD BUS BUFFER GATE	U21
89	490-0137	1	IC, 74HC137, 3:8 LINE DECODER W/ ADDR LATCH	

90	490-0164	2	IC, 74HC164N, 8-BIT PAR-OUT SHIFT REGISTER	U34-35
91	490-0165	3	IC, 74HC165, PARALLEL-LOAD 8-BIT SHIFT REGISTER	U25 U36-37
92	490-0373	1	IC, 74HC373, OCTAL 3-STATE D-TYPE LATCH	U9
93	490-4051	9	IC, 74HC4051N, S.P. 8-POSITION MUX/DEMUX	U11 U15-17 U48-49 U51 U53-54
94	491-0374	1	IC, 74AC374 OCTAL 3-STATE D FF	U3
95	495-0101-S	1	IC, FLASH 128KX8, 70ns MAX, PLCC32	U12
96	495-2256-S	1	IC, STATIC RAM 32KX8, 120ns MAX	U18A
97	495-2264	1	IC, STATIC RAM 8KX8, 120ns MAX	U18
98	495-2532	1	IC, 25C320, 4K x 8, SPI EEPROM	U20
99	495-6595	1	IC, TPIC6C595, HI-PWR 8 BIT SHIFT REG W/ OUTPUT LATCH	U2
100	560-0030	1	CONNECTOR, RIBBON, 3428-5302	P1
101	600-0020	1	SWITCH , C & K, SPST N.O. PUSHBUTTON TP11SHZQE	SW1
102	610-0060	1	SWITCH, SPDT	SW2
103	630-0080	3	SWITCH, DIP-SWITCH, 8 POS	SW3-5
104	650-0010	1	CRYSTAL, 16 MHZ, HC49U	Y3
105	650-0070	1	CRYSTAL, 8 MHZ, HC49U	Y1
106	670-0070	1	RELAY, JW2SN-B-DC6V, 6V, 5A	K1
107	800-0090	1	TRANSFORMER, OFFLINE	T1
108	850-0005	2	INDUCTOR, 5uH, MOLDED	L2-3
109	850-0560	1	INDUCTOR, 0.56uH, MOLDED	L1