

MODEL 210 SERIES

RMS Signal Monitor Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE MODEL 210; PCB Issue J. INCLUDED ARE GENERAL DESCRIPTION, OPERATIONAL DESCRIPTION, INSTALLATION, AND SPECIFICATIONS.

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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.

- 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.

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Section 1
GLOSSARY

A - Ampere

°C - Celsius

Component - Any electrical or electronic device

DC - Direct Current

DIP – Dual Inline Package

Firmware - A computer program or software stored permanently in PROM

FLASH – An IC Memory with nonvolatile, electrically erasable, programmable features

Hz - Hertz

IC - Integrated Circuit

Jumper - A means of connecting/disconnecting two or more conductive by soldering/desoldering a conductive wire or by PCB post jumper

LED - Light Emitting Diode

LOGIC - Negative Logic Convention (Ground True) State

mA - milliAmpere

uH - microHenry

ms - millisecond

MCU - Micro Controller Unit

N.C. - Normally closed contact

N.O. - Normally open contact

PCB - Printed Circuit Board

RAM - Random Access Memory

RMS - Root-Mean-Square

ROM - Read Only Memory Device

s – second

Schmitt Circuit – a circuit that provides hysteresis in the threshold

SW – Switch

uF - microfarad

VAC - Voltage Alternating Current

VDC - Voltage Direct Current

VRMS - Voltage Root Mean Square

Section 2 GENERAL DESCRIPTION

2.1 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 March 12, 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.

2.1.1 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.

2.1.2 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 8.1.3.

2.1.3 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 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.

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.

Section 3

GENERAL CHARACTERISTICS

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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 3.10).

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.10.1 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:

<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
...	(repeats back to top)	

3.10.2 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:

<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	#2	Double flash	Event #2 Fault Status	Event #2 channel status
#4	#2	Double flash	(G) AC POWER LED flashes	Green field status 1-16
#5	#2	Double flash	(Y) VDC FAILED LED flashes	Yellow field status 1-16
#6	#3	Triple flash	Event #3 Fault Status (oldest)	Event #3 channel status
#7	#3	Triple flash	(G) AC POWER LED flashes	Green field status 1-16
#8	#3	Triple flash	(Y) VDC FAILED LED flashes	Yellow 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 (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 4 INSTALLATION

4.1 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.

4.2 WATCHDOG PROGRAMMING

4.2.1 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.

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.

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 3.10.

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 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 3.10.

5.1.3 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.

5.1.4 CONFLICT INDICATOR

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

5.1.5 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 3.10.

5.1.6 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.

5.1.7 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). In the event of a Conflict only the channels on which the fault occurred will be displayed.

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 3.10.

Section 6

THEORY OF OPERATION

6.1 INTRODUCTION

The Signal Monitor uses a dual microprocessor architecture consisting of an 68HC11D0 main microprocessor unit (MPU) and a PIC18F24K40T 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 68HC11D0 main microprocessor uses a high speed synchronous serial I/O system called the Serial Peripheral Interface (SPI) to exchange data with the peripheral circuit blocks. It controls all functions of the unit except for those of the RMS-Engine.

6.2 MAIN MPU LOGIC

The 68HC11D0 main microprocessor (U7) operates in the Expanded Multiplexed mode which allows for external memory devices. The program firmware is contained in the 39SF010A CMOS Flash device (U6) and program data storage is contained in the SRM2264 8Kx8 static RAM (U10). The expanded address and data buss is used to link the memory devices with the microprocessor. A 74HC137 (U8) 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 (U16), 24Vdc Logic Processor (U43), Display Multiplexer (U2), Program Card and Switch inputs (U12.11), and the RMS-Engine (U28).

Data is clocked out of the main microprocessor on the MOSI pin (U7.18) while data is clocked in on the MISO pin (U7.17). The SCLK signal (U13.20) provides the synchronous clock. A peripheral device must be selected by U12 before SPI transfers may take place.

6.4 INTERNAL MPU WATCHDOG

Circuit U3A and U3B comprise the internal MPU Watchdog circuit. If this circuit does receive an input from the main microprocessor for at least 625 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 E4 is installed this fault mode will only be reset by a complete power down cycle.

6.5 EEPROM MEMORY

The 25C640 Serial EEprom (U16) device provides 8192 bytes of nonvolatile memory. It is interfaced to the main microprocessor through the SPI port. No battery is required to maintain the data in this device.

6.6 24VDC LOGIC INPUTS

The Cabinet 24VDC input, CU Watchdog input, and External/Manual Reset inputs are processed by a PIC16F18344 microprocessor U43. Opto-couplers U33, U34, U35, and U36 provide electrical isolation between Logic Ground and Neutral.

6.7 DISPLAY

The front panel LED display is multiplexed by the row driver U2 and the column driver U1. The scan rate is approximately 60 Hz. Display data is shifted into U2 while individual columns are selected by U1 using the SPI interface.

6.8 PROGRAM CARD AND SWITCH INPUTS

The program card and configuration switch inputs are scanned through a diode matrix using row drivers U23, U24 and U25. Column drivers U26 and U27 select the column to be read. These devices transfer data to the main MPU through the SPI interface.

6.9 RMS-ENGINE

The RMS-Engine is a Microchip PIC18F24K40T (U28) 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 (U31) 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 U32 provide a buffer circuit.

6.10 POWER SUPPLY

The switching power supply is based on a MIC38C43A (U29) fixed frequency current-mode PWM controller. The AC Line is full wave rectified and charges capacitor C58 to approximately 170 Vdc. The PWM controller switches current from C58 through the transformer T1 using transistor Q1 at approximately 200 KHz. The transformer couples this energy to the T1 secondary and provides the following output voltages: VDD=+5 Vdc, VEE=-5 Vdc, and VCCL=+16 Vdc. Opto-coupler U22 provides feedback to the controller for regulation.

Section 7 MAINTENANCE

7.1 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 C58 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 (U11) will hold the MPU in reset and the DIAGNOSTIC indicator on the front panel should illuminate. Measure the regulated voltage across capacitor C11. 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 3.8.
- 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 U3.2. If there are no

pulses, depress the front panel reset switch to re-start the MPU. If the watchdog pulses are now present on U3.2 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
Watchdog Enable	(enable)	greater than 103 \pm 2 Vrms
	(disable)	less than 98 \pm 2 Vrms
AC Line Brown-out	(drop-out)	82 \pm 2 Vrms
	(restore)	87 \pm 2 Vrms

8.1.3 DC VOLTAGE MONITORS

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

8.2 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	(no fault)	less than 1400 milliseconds
	(fault)	greater than 1600 milliseconds
	(typical)	1500 milliseconds
AC Line Brown-out	(drop-out)	80 \pm 17 milliseconds
	(restore)	80 \pm 17 milliseconds
Watchdog Disable	(disable)	80 \pm 17 milliseconds
	(enable)	80 \pm 17 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

Section 9 WIRING ASSIGNMENTS

9.1 MONITOR UNIT CONNECTOR (P6)

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.

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- 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.

9.2 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	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.

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Section 10 PARTS LIST

Bill Of Materials for 210 RMS Production Iss J Rev A (B822).sch					

Item	EDI Part Number	Qty	Description	Reference	Manufacturer

1		1	(NO COMPONENT)	P7	
2		21	(NO COMPONENT)	E1 GND GND1 TP1-13	
				TP18-20 TP30 VEE	
3		17	(NO COMPONENT)	SEL1-16 SEL18	
4		3	(NO COMPONENT)	MT1-3	
5	215-0180-S	1	RESISTOR, 1/2W, 1.8 OHMS, 5%, 2010 surface mount	R52	
6	215-3310-S	3	Resistor, 330 OHM, 1/2W, 5%, 2010 surf. mnt.	R24 R60-61	
7	215-7530-S	1	Resistor, 75K, 3/4W, 5%, 2010 surf. mnt.	R41	
8	223-3600-S	2	RESISTOR,WIREWOUND, 3W,36 Ohm,5%,7128 SMD	R65 R78	SEI SM3 36 5% R
9	237-1020-4S	1	RESISTOR, 1K, 5%, SMT603, 8 PIN 4 RES	R80	ROHM MNR14ERAPJ102
10	237-2730-8S	4	RESISTOR, 27K, 5%, SMT, 50mil, 10 PIN 8 RES	R39 R43-44 R77	ROHM (MNR35J5RJ273)
11	237-3320-8S	4	RESISTOR, 3.3K, 5%, SMT, 50mil, 10 PIN 8 RES	R70-72 R74	ROHM (MNR35J5RJ332)
12	237-4730-8S	1	RESISTOR, 47K, 5%, SMT, 50mil, 10 PIN 8 RES	R58	ROHM (MNR35J5RJ473)
13	237-5110-4S	11	RESISTOR, 510 Ohms, 5%, SMT603, 8 PIN 4 RES	R56 R86-95	ROHM MNR14ERAPJ511
14	251-1052-S	4	RESISTOR, 1/8W, 10.5K, 1%, 1206 surface mount	R62-63 R96 R171	
15	251-1211-S	4	RESISTOR, 1/8W, 1.21K, 1%, 1206 surface mount	R47 R67 R69 R79	
16	251-1692-S	1	RESISTOR, 1/8W, 16.9K, 1%, 1206 surface mount	R50	
17	251-1961-S	2	RESISTOR, 1/8W, 1.96K, 1%, 1206 surface mount	R98 R134	
18	251-3321-S	5	RESISTOR, 1/8W, 3.32K, 1%, 1206 surface mount	R35-36 R66 R68 R73	
19	255-0000-S	1	RESISTOR, 2A, 0 OHM, 1206 SMT	SEL17	
20	255-0000-S	1	RESISTOR, 2A, 0 OHM, 1206 SMT	E4	
21	255-0000-S	1	RESISTOR, 1/8W, 0 OHMS, 5%, 1206 surface mount	R28	
22	255-1020-S	6	RESISTOR, 1/8W, 1K, 5%, 1206 surface mount	R8 R26 R30 R48 R57	
				R100	
23	255-1030-S	7	RESISTOR, 1/8W, 10K, 5%, 1206 surface mount	R33 R64 R97 R99	
				R135 R169-170	
24	255-1060-S	1	RESISTOR, 1/8W, 10M, 5%, 1206 surface mount	R14	
25	255-1210-S	2	RESISTOR, 1/8W, 120, 5%, 1206 surface mount	R21 R38	
26	255-2220-S	2	RESISTOR, 1/8W, 2.2K, 5%, 1206 surface mount	R1 R16	
27	255-2240-S	1	RESISTOR, 1/8W, 220K, 5%, 1206 surface mount	R13	
28	255-2720-S	1	RESISTOR, 1/8W, 2.7K, 5%, 1206 surface mount	R46	

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29	255-2730-S	5	RESISTOR, 1/8W, 27K, 5%, 1206 surface mount	R11 R17 R27 R84-85	
30	255-3300-S	1	RESISTOR, 1/8W, 33 OHMS, 5%, 1206 surface mount	R45	
31	255-3310-S	1	RESISTOR, 1/8W, 330 ohm, 5%, 1206 surface mount	R51	
32	255-4720-S	11	RESISTOR, 1/8W, 4.7K, 5%, 1206 surface mount	R15 R19-20 R22-23	
				R25 R29 R31 R37 R42	
				R83	
33	255-4730-S	4	RESISTOR, 1/8W, 47K, 5%, 1206 surface mount	R12 R18 R34 R53	
34	255-5110-S	1	RESISTOR, 1/8W, 510 Ohm, 5%, 1206 surface mount	R59	
35	255-6800-S	8	RESISTOR, 1/8W, 68, 5%, 1206 surface mount	R2-7 R9-10	
36	261-1200-S	1	RESISTOR, PULSE RATED, 3/4W, 12 OHMS, 5%, 2010	R40	SEI
			smt		
37	261-4710-S	1	RESISTOR, PULSE RATED, 1W, 470 Ohm, 5%, 2512 SMD	R49	SEI RPC2512JT470R
38	261-7530-S	70	RESISTOR, 1/4W, 75K, 5%, 1206 smt, surge rated	R75-76 R81-82	PANASONIC
				R101-133 R136-168	ERJ-P08J753V
39	262-2002-S	2	RESISTOR, 20K OHM 1/10W .1% 0805 SMD	R54-55	PANASONIC
					ERA-6YEB203V
40	300-1080-025S	1	CAPACITOR, ELECTROLYTIC, 1000uF, 25V, LOW ESR,	C12	PANASONIC
			20%, SMT, 12.5mm D		
41	300-3370-035S	1	CAPACITOR, ELECTROLYTIC, 330uF, 35V, LOW ESR,	C15	ILLINOIS
			20%, SMT		337AXZ035MD10
42	300-3370-035S	1	CAPACITOR, ELECTROLYTIC, 330uF, 35V, LOW ESR,	C23	ILLINOIS
			20%, SMT		337AXZ035MD10
43	300-4770-251R	1	CAPACITOR, ELECT, 470uF, 250WV, 20 %, RDL,	C58	ILLINOIS CAP.
			30dx30hmm		477LBA250M2 (DG or
					DH)
44	302-1870-016S	1	CAPACITOR, POLY ALUM, 180uF, 16V, LOW ESR, 20%,	C11	Nichicon
			SMT		[RPS1C181MCN1GS]
45	310-1060-006S	1	CAPACITOR, TANTALUM, 10UF, 6.3V, 20%, 1206 CHIP	C74	PANASONIC
					ECSTOJY106R
46	310-2260-006S	1	CAPACITOR, TANTALUM, 22uF, 6.3V, 10%, 1206 CHIP	C53	
47	310-3350-016S	2	CAPACITOR, TANTALUM, 3.3UF, 16V, 20%, 1206 CHIP	C2 C20	
48	320-1010-1000S	1	CAPACITOR, CER.MULT, 100pF, 1000V, 10%, C0G, 1206	C41	AVX 1206AA101KAT1A
			CHIP		
49	320-1020-050S	2	CAPACITOR, CER.MULT, 0.001uF, 50V, 10%, 1206	C17 C38	
50	320-1030-100S	1	CAPACITOR, CER.MULT, 0.01uF, 100V, 10%, 1206 CHIP	C8	
51	320-1040-050S	52	CAPACITOR, CER.MULT, 0.1uF, 50V, 10%, 1206 CHIP	C1 C3-4 C9-10	
				C13-14 C16 C18-19	
				C21-22 C25-26	
				C29-34 C36-37	
				C44-46 C50-51	
				C54-55 C57 C59-64	
				C66 C68 C71-73	
				C75-85	

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52	320-1050-016S	1	CAPACITOR, CER.MULT, 1.0uF, 16V, 10%, 1206	C24	ECJ-3VF1C105Z	
53	320-1050-016S	2	CAPACITOR, CER.MULT, 1uF, 16V, 10%, 1206 CHIP	C56 C69		
54	320-2200-050S	4	CAPACITOR, CER.MULT, 22pF, 50V, 10%, 1206 CHIP	C5-6 C42-43		
55	320-2220-050S	1	CAPACITOR, CER.MULT, 2200pF, 50V, 10%, 1206 CHIP	C27		
56	320-2250-050S	1	CAPACITOR, CER.MULT, 2.2uF, 50V, 10%, 1206 CHIP	C35	Murata	
					GRM31CR71H225KA88L	
57	320-2260-025S	2	CAPACITOR, CER.MULT, 22uF, 25V, 10%, 1206 CHIP	C39-40	Murata	
					GRM31CR61E226KE15L	
58	320-3320-050S	1	CAPACITOR, CER.MULT, 3300pF, 50V, 10%, 1206 CHIP	C28	AVX 12065A332KAT2A	
59	320-3910-050S	5	CAPACITOR, CER.MULT, 390pF, 50V, 10%, 1206 CHIP	C7 C47-49 C52		
60	335-1040-310R	1	CAPACITOR, X2, 0.1UF, 310V, 20%, METALIZED FILM,	C70	Vishay BFC233921104	
			15mm			
61	335-2220-300R	2	CAPACITOR, Y2, 0.0022UF, 300V, 20%, METALIZED	C65 C67	Epcos	
			FILM, 10mm		B32021A3222M189	
62	405-1051-S	1	IC, SPI A/D, 10BIT, ADC101S051, SOT-23-6	U31	TI	
					ADC101S051CIMF/NOPB	
63	405-1404-S	1	IC, Oscillator Driver, TI, SN74LVC1404, SSOP8	U4	TI	
64	405-3364-S	1	IC, LM33064D-5, UNDERVOLTAGE SENSING, SO-8	U11		
65	405-6584-S	1	IC, LM6584, QUAD OP AMP, SO14	U32	NATIONAL SEMI	
					LM6584MAX/NOPB	
66	410-0006-S	1	DIODE, BRIDGE, MDB6S, 600V,1A, MICRO-DIP	CR23	FAIRCHILD MDB6S	
67	410-0016-S	13	DIODE,BAS16, TRIPLE, SMT SOT363	CR1-2 CR12-18	NXP BAS16VY	
				CR21-22 CR25 CR33		
68	410-0053-S	3	DIODE, TRANS. SUPR., SMA5.0A, 5V,SMA	CR3-4 CR6	MOTOROLA	
69	410-0160-S	1	DIODE, ULTRAFast, MURA160T3, 600V,1A, SMA	CR20	ON SEMI	
70	410-0340-S	1	DIODE, SCHOTTKY, MBRS340, 40V,3A, SMC	CR8	ON SEMI	
71	410-1200-S	2	DIODE, SCHOTTKY, SMD1200PL, 200V, 1A, SOD123	CR7 CR9	MCC SMD1200PL	
72	410-4004-S	9	TVS ARRAY, BI-DIR, TSOP-5, 4 TVS DIODES	U44-52	ON SEMI	
					NUP4004M5T1G	
73	410-4005-S	1	DIODE, S1K, 800 PIV, 1A	CR28		
74	410-4148-S	3	DIODE, 1N4148WS, SMT SOD323	CR11 CR19 CR35	DIODES INC.	
75	410-4755-S	1	DIODE, ZENER, CMZ5940B, 1.0W, 5%, 43V,SMA	CR34		
76	410-5231-S	1	DIODE, ZENER, MMBZ5231BLT1, 5.1V, 225mW,SOT-23	CR24	ON SEMI	
77	410-5231B-S	1	DIODE, ZENER, MMSZ5231B, 500mW, 5%, 5.1V,SOD-123	CR5	ON, DIODES INC.,	
					GENERAL SEMI	
78	410-5240-S	2	DIODE, ZENER, MMBZ5240BLT1, 10V, 225mW,SOT-23	CR29-30	ON SEMI	
79	410-5245-S	1	ZENER, 1N5245B,0.5W,5%,15V	CR10	ON SEMI	
80	410-5919-S	4	DIODE, TRANS. SUPR., 1SMA5919BT3G, 5.6V,SMA	CR26-27 CR31-32	ON	
81	420-2811-S	2	OPTOCOUPLER, PS2801-1, 4 PIN SOP	U22 U53	NEC PS2801-1	
82	420-6137-S	4	OPTO COUPLER, 6N137S, HIGH SPEED, SMT	U33-36		
83	425-0138-GS	1	LED, GRN, SMT,2 PIN	DS1	KINGBRIGHT	
					WP138A8QMP/ZGC	
84	425-0138-RS	22	LED, RED, SMT,2 PIN	DS2-23	KINGBRIGHT	

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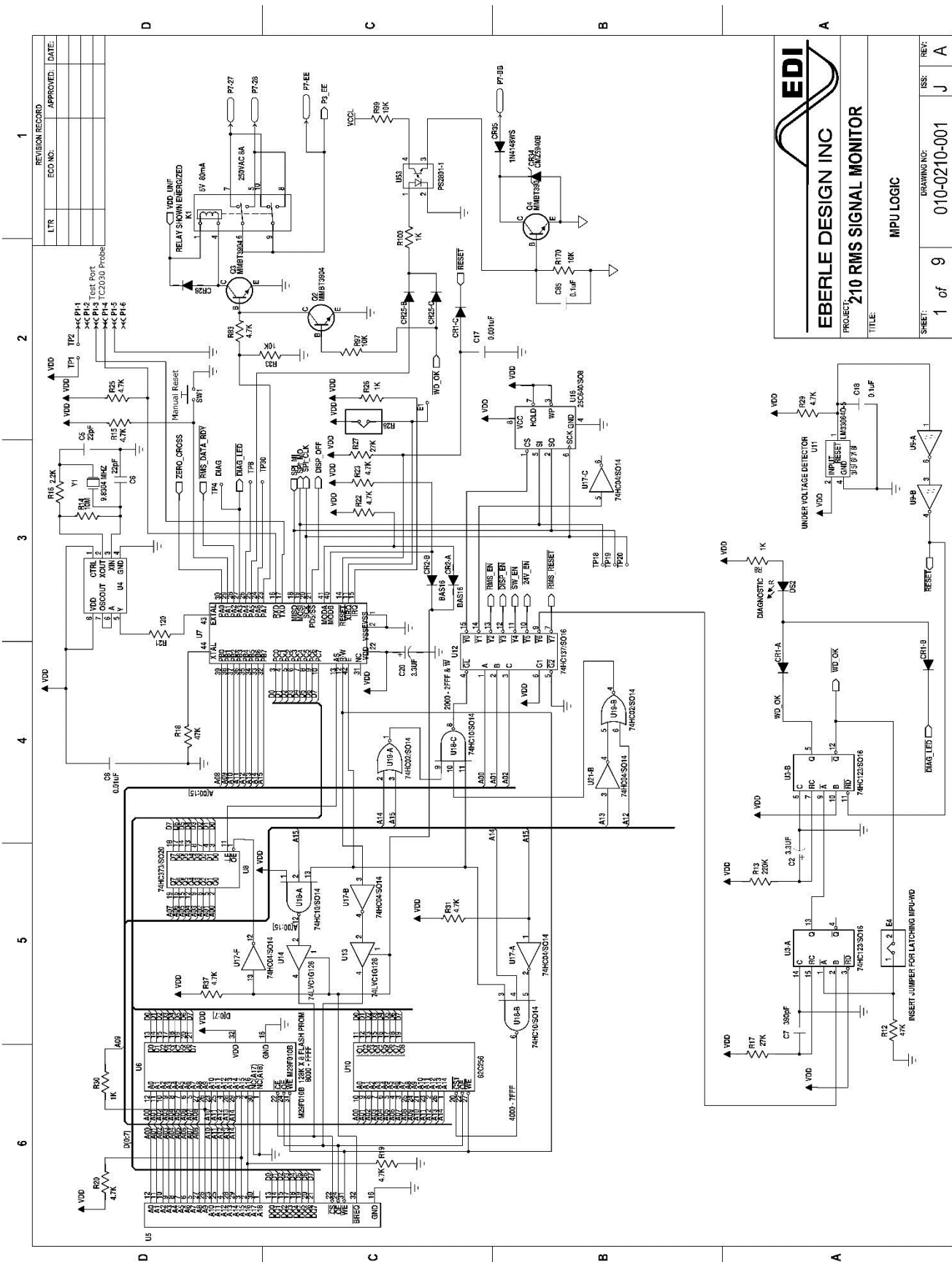
					WP138A8QMP/SRC/TG
85	430-3904-S	3	TRANSISTOR, NPN, MMBT3904LT1, SOT23	Q2-4	
86	430-8200-S	1	TRANSISTOR, IRF820S, MOSFET, 500V, 2.5A, D2PAK	Q1	IR IRF820S
87	440-0150	3	REGULATOR, METAL OXIDE VARISTOR, S14K150	RV1-3	
88	440-0431-S	1	REGULATOR, TL431AID, VOLTAGE REF., 1%, SO8	VR3	MOTOROLA
89	440-1431-S	1	REGULATOR, TL431AIDBZT, VOLTAGE REF., 1%, SOT-23	VR1	TI TL431AIDBZT
90	440-3843A-S	1	IC, MIC38C43ABM, SWITCHING PWR. SUPPLY CNTLR, SO8	U29	MICREL MIC38C43ABM
91	440-4128-S	1	PREC. VOLTAGE REF., 4.096V, 0.5%, SOT23-5	U30	NATIONAL
					LM4128CMF-4.1
92	445-7805-S	1	REGULATOR, MC78L05ABD, 100mA, 5V, SO8	VR2	MOTOROLA
93	485-2440-S	1	IC, PIC18F24K40T-I/SO, RISC MPU	U28	MICROCHIP
					PIC18F24K40T-I/SO
94	485-6911-S	1	IC, MC68HC11D0CFN2R2, 8-BIT MPU, PLCC	U7	MOTOROLA
95	485-8344-S	1	PIC16F18344T-I/SS, PROC, 20PIN SSOP	U43	MICROCHIP
					PIC16F18344T-I/SS
96	490-0002-S	1	IC, 74HC02, QUAD 2-INPUT NOR GATE, SO14	U19	
97	490-0004-S	2	IC, 74HC04, HEX INV, SO14	U17 U21	
98	490-0010-S	1	IC, 74HC10N, TRIPLE 3-INPUT NAND GATE, SO14	U18	MOTOROLA
99	490-0123-S	1	IC, SN74AHC123, DUAL ONE-SHOT, SMT SO16	U3	TI
100	490-0125-S	1	IC, 74HC125, QUAD BUS BUFFER GATE, SO14	U20	
101	490-0137-S	1	IC, 74HC137, 3:8 LINE DECODER W/ ADDR LATCH, SO16	U12	
102	490-0164-S	3	IC, 74HC164, 8-BIT PAR-OUT SHIFT REGISTER, SO14	U23-25	MOTOROLA
103	490-0165-S	3	IC, 74HC165, PARALLEL-LOAD 8-BIT SHIFT REGISTER, SOIC	U15 U26-27	
104	490-0373-S	1	IC, 74HC373, OCTAL 3-STATE D-TYPE LATCH, SO20	U8	TEXAS INSTRUMENTS
105	490-1126-S	2	IC, 74LVC1G126, TRI-STATE BUFFER, SOT353	U13-14	DIODES INC
					74LVC1G126SE-7
106	490-2014-S	1	IC, 74LVC2G14, DUAL SCHMIDT INVERTER, SOT23-6	U9	TI SN74LVC2G14DBV
107	490-4051-S	6	IC, 74HC4051N, S.P. 8-POSITION MUX/DEMUX, SO16	U37-42	
108	490-7595-S	1	IC, TPIC6C595, HI-PWR 8 BIT SHIFT REG W/ OUTPUT LATCH, SO16	U1	TI
109	491-0374-S	1	IC, 74AC374, OCTAL 3-STATE D FF, SO20	U2	FAIRCHILD
					[74AC374SC]
110	495-0101-S	1	IC, FLASH 128KX8, 70ns MAX, PLCC32	U6	
111	495-2256-S	1	IC, STATIC RAM 32KX8, 120ns MAX	U10	
112	495-2564-S	1	IC, 25C640, 8K x 8, SPI EEPROM, SO8	U16	ATMEL
					AT25640N-10SI
113	510-0028	1	CONNECTOR, 28/56 PIN EDGE CONN., RA, W/ MOLDED POLARIZE KEY	J1	SULLINS
					EBM28DSAHS-851
114	520-1032-S	1	Connector, Header, A3A-32PA-2SV(71), SMT	U5	Hirose Electric,
					A3A-32PA-2SV(71)
115	520-2030	1	CONNECTOR, Probe with latches, 6 PIN	P1	TAG-CONNECT TC2030
116	600-0060	1	SWITCH, SPST NORMALLY OPEN PUSHBUTTON, RA	SW1	PANASONIC EVQPF008K

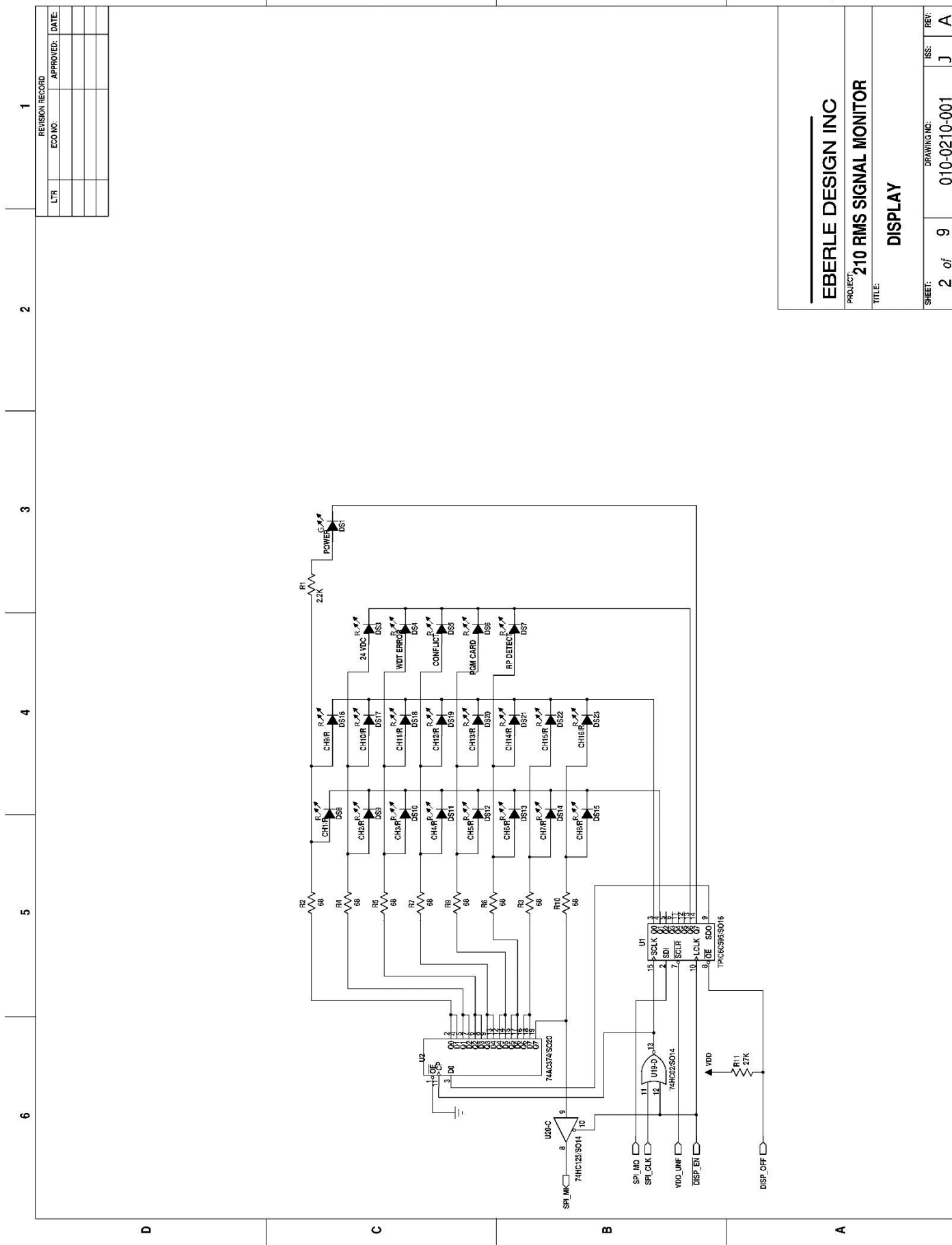
210 SERIES SIGNAL MONITOR OPERATIONS MANUAL

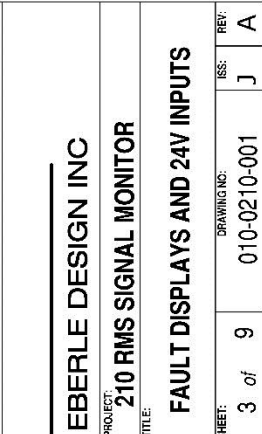
117	610-0060-S	1	SWITCH, SPDT, TOGGLE, SMT	SW2	Grayhill	
					34EWMSP12M6RT	
118	651-0983-S	2	CRYSTAL, 9.8304 MHZ, 20pF, AT CUT, HC49, SMT	Y1-2	ECS ATS-SM SERIES	
119	670-0040	1	RELAY, RTE24005F, 5V, 8A, Class F Insulation	K1		
120	740-0022	1	FUSE , HOLDER PCB HORIZONTAL MOUNT	F1	LITTELFUSE	
121	800-0240-S	1	TRANSFORMER, OFFLINE, EFD20, SMT	T1	SIGNAL TRANSFORMER	
122	850-0560-S	1	INDUCTOR, .56uH, 8.9 x 6.1 mm, 6A	L1	CENTRAL	
					TECHNOLOGIES	
					CTDO1813P-561HC	
123	NC	2	TC2050-IDC-NL (TEST PROBE)	P3 P5	TAG-CONNECT	

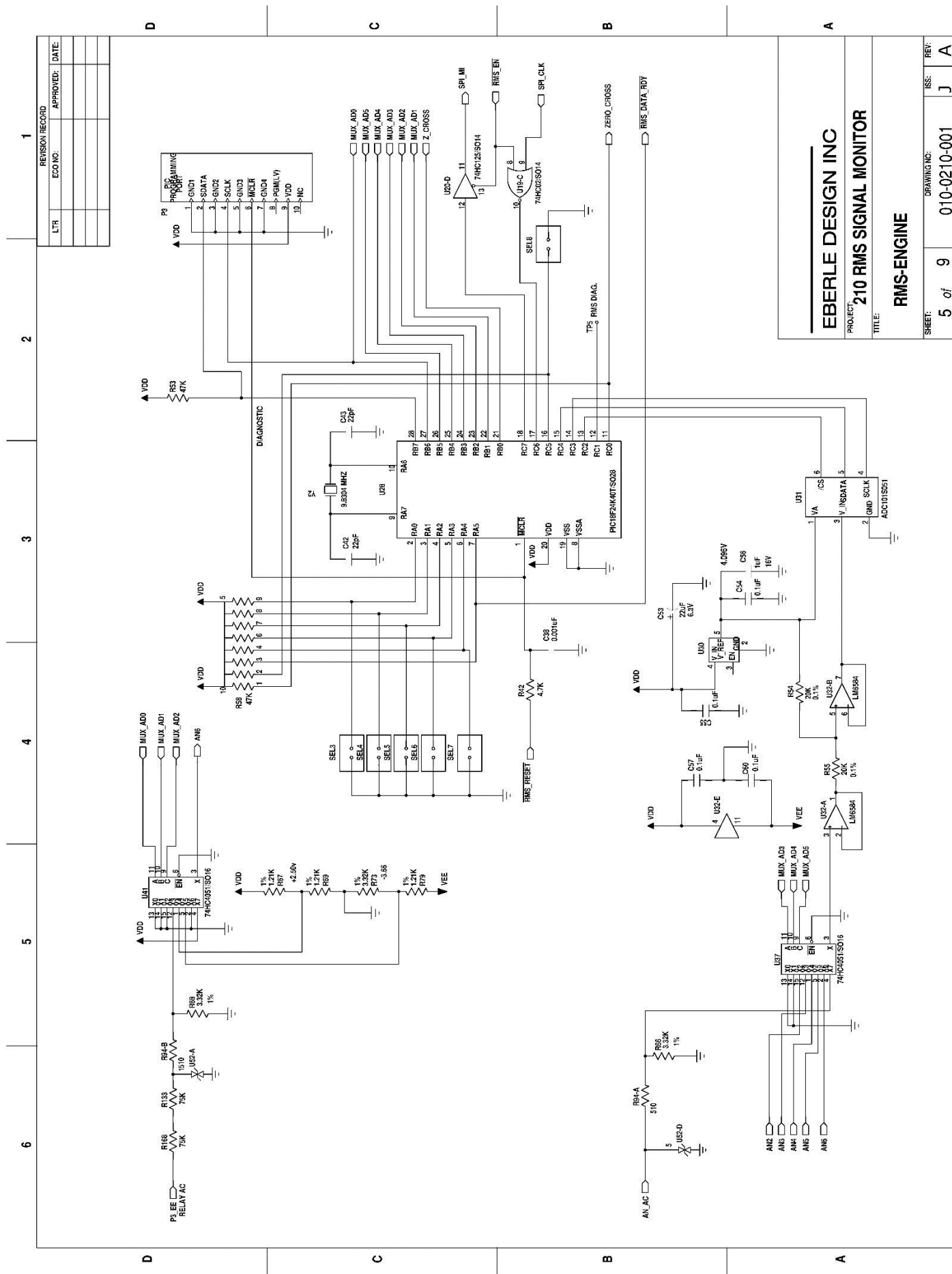
Section 11

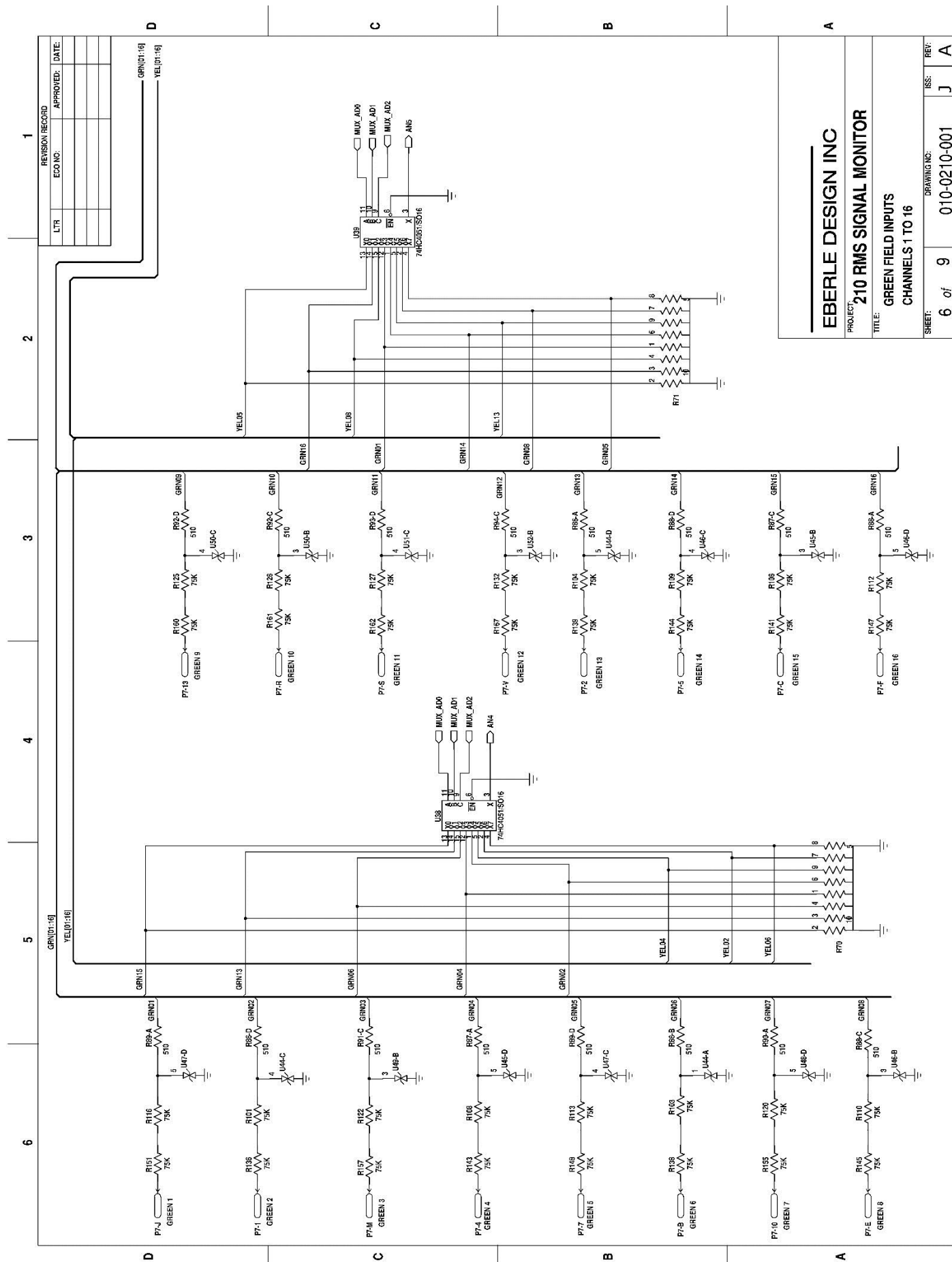
SCHEMATICS

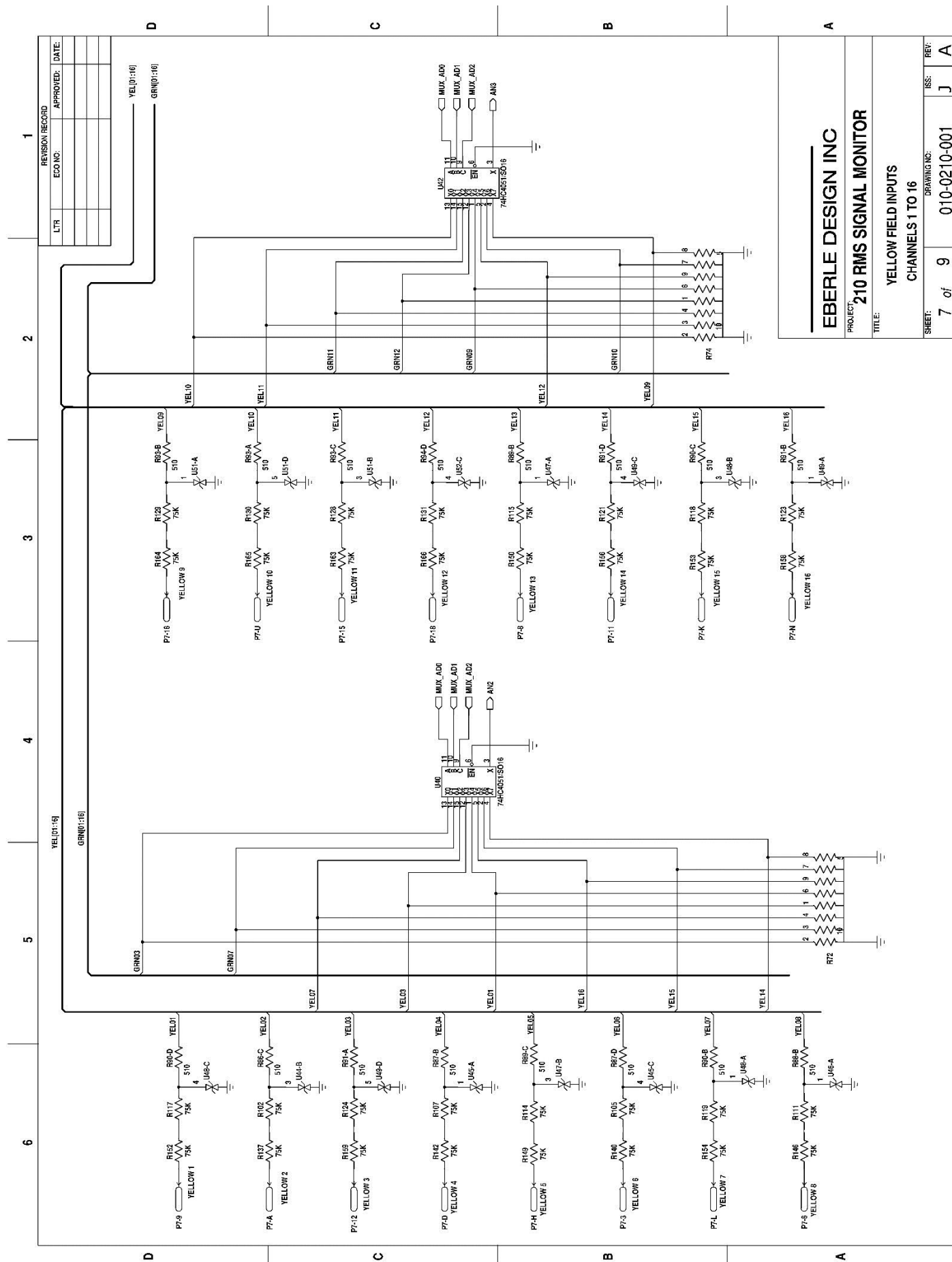


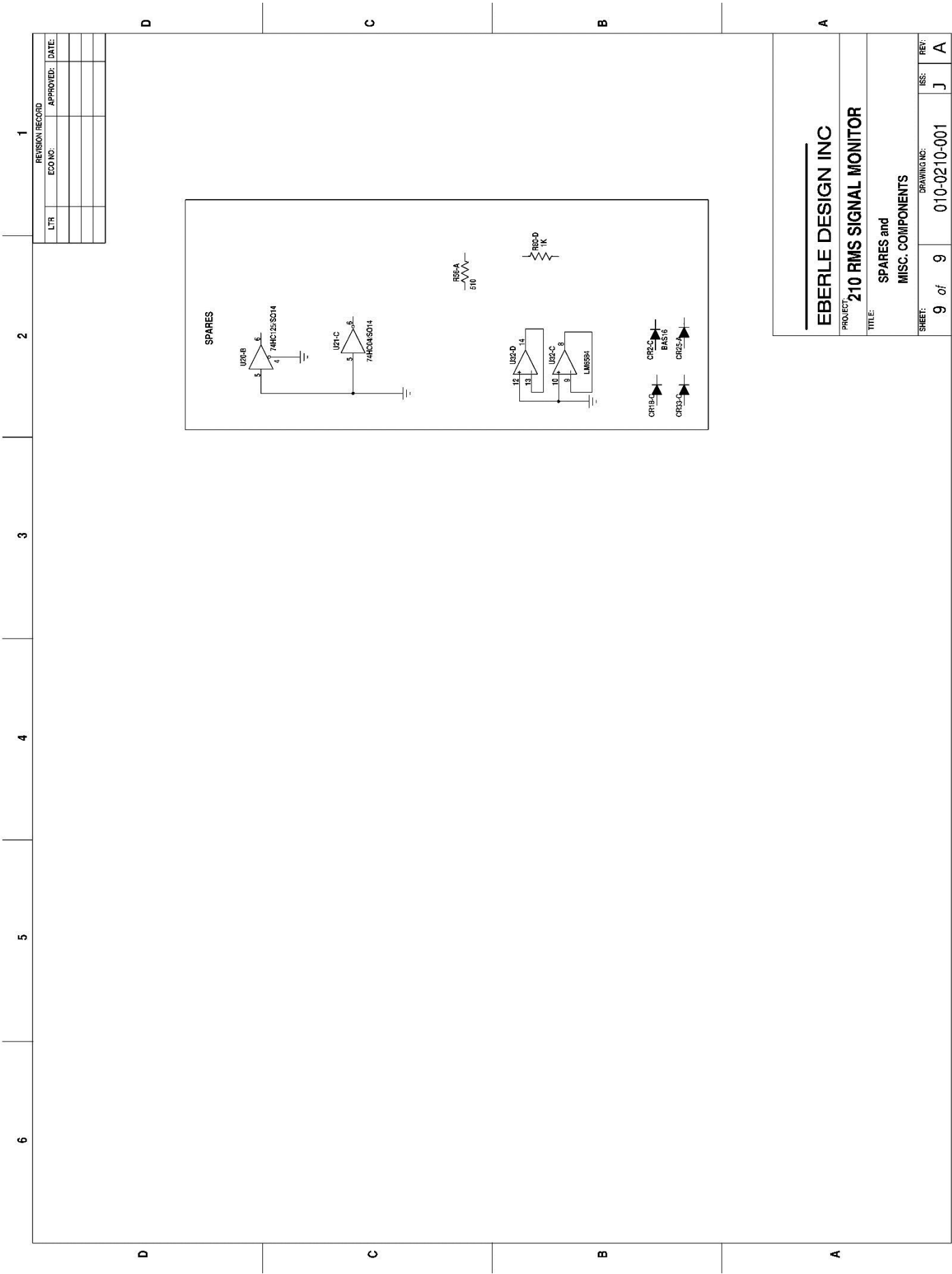












Section 12 ASSEMBLY DRAWING

