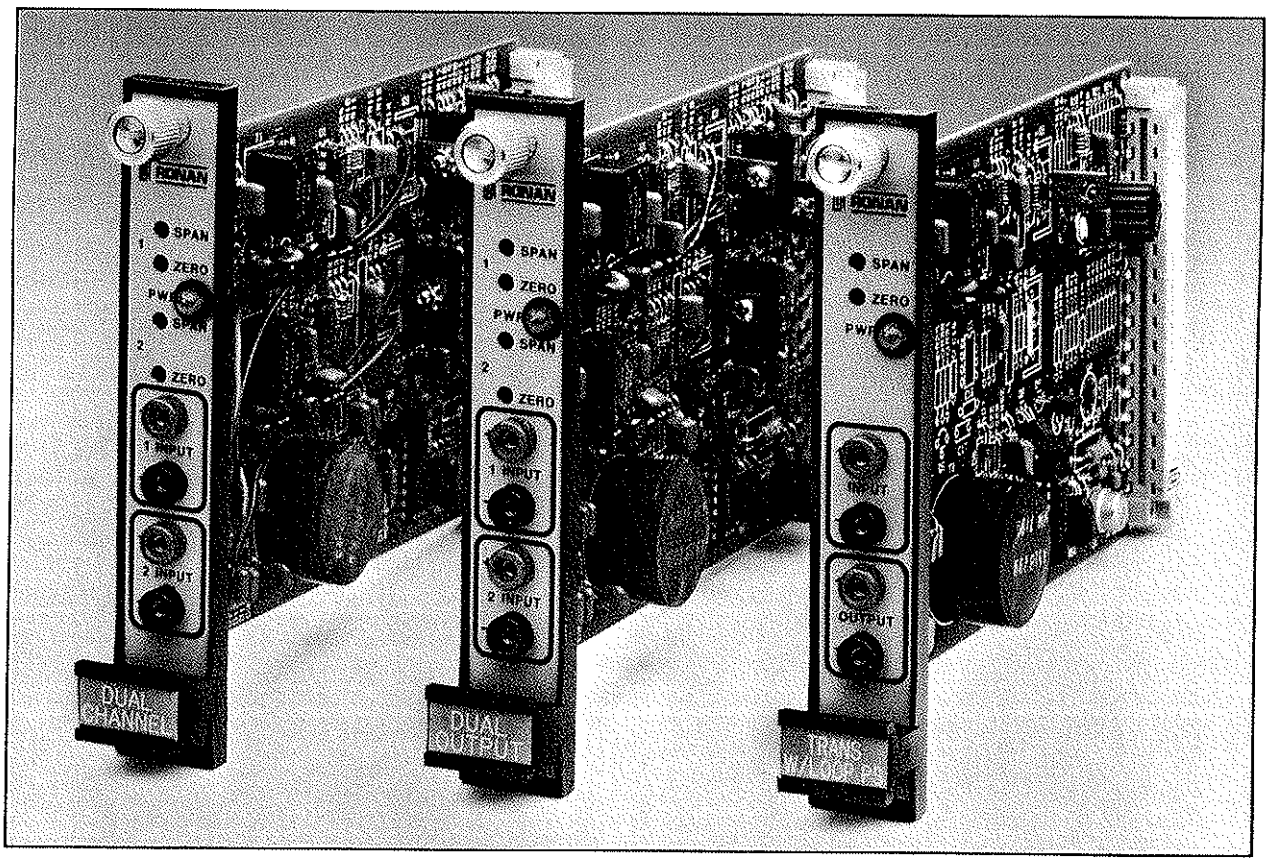
Instructions
and
Operating Manual

SERIES X51-312, -318, -322, -325, -328

DUAL CHANNEL, DUAL OUTPUT TRANSMITTERS



RONAN

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Warranty

Ronan warrants equipment of its own manufacture to be free from defects in material and workmanship under normal conditions of use and service, and will repair or replace any component found to be defective, on its return, transportation charges prepaid, within one year of its original purchase. This warranty carries no liability, either expressed or implied, beyond our obligation to replace the unit which carries the warranty.

1.0 GENERAL DESCRIPTION

The Ronan Series X51 Transmitters, Models X51-312, -318 and -322 and -328 accept inputs from thermocouple, mA, V or mV sources. Models X51-312 and -322 provide two fully isolated channels of signal processing in each module and provide either voltage or current outputs. The thermocouple input modules have 0°C reference junction circuitry on the P.C. board with the cold junction temperature sensing devices located at the terminals on the rear of the rack mount chassis. Test points are provided at the front panel for monitoring the inputs, or for injection of a calibration input without disturbing the field wiring (X51-312, -322). The test points monitor the two output signals on Models X51-318 and -328.

Model X51-325 is a single channel transmitter, using channel 1, which provides a +24 V output at terminal 11 to power a two-wire transmitter. The test points on the X51-325 monitor the input and output signals.

2.0 SPECIFICATIONS

Specifications apply at 23°C ± 2°C unless otherwise stated. Specifications subject to change without notice.

Inputs: Thermocouple, mV, V or mA.

Zero Suppression: As required for all inputs.

Input Impedance:
Thermocouple mV: 10 Mohms.
V input: 200 kohms.
mA input: 100 ohms standard.

Input Open Circuit Response: (Thermocouple or mV) Upscale standard, downscale optional.

Calibrated Accuracy: ± 0.15% of span including linearity.

Isolation: 500 Vdc.

Common Mode Rejection: 114 dB, dc to 60 Hz thermocouple input. 100 dB for mA, V inputs.

Common Mode Voltage: 500 Vrms.

Temperature Stability: ± 0.025%/°C, –5 to 60°C.

Response Time: 270 msec to within 1% of final value.

Front Panel Controls:
Span Adjust: Multi-turn potentiometer provides ± 25% adjustment range.
Zero Adjust: Multi-turn potentiometer provides ± 25% adjustment range.

Input Test Points: *X51-312, -322 and -325:* Front panel test points are provided to allow the application of a calibration input to the module without disturbing the field input wiring. Alternately, the input signal from the field can be monitored at the input test points. (See operation section for calibration information).

Output Test Points: *X51-318, -325 and -328:* Front panel test points allow monitoring of the output signal from the front panel without disturbing field wiring or output current. The mA meter used must have 10 ohms or less input resistance.

Output:
0-20, 4-20 mA into 0-1000 ohms.
0-1 Vdc; R out = 50 ohms.
0-5, 1-5 Vdc; R out = 250 ohms.
0-10, 2-10 Vdc; R out = 500 ohms.

Power Consumption: 2.5 W maximum at 20 mA output.

Power Supply: 22 to 30 Vdc. Ronan's Power Supply Model Numbers X51-115-60, -120 or -180 provides 60 W, 120 W and 180 W, respectively, of regulated power in 3.5" of vertical rack space. Power Supply Model No. X51-115-50 occupies two spaces in a standard X51 rack mount or panel mount chassis and provides 50 W of regulated power.

Power-On Indicator: Front panel LED illuminates green when module is energized.

Size: Plug-in modules are 3.94" × 6.30" (100 mm × 160 mm). Rack mount is 19" wide × 5.25" high × 7.7" deep (482.60 mm × 132.54 mm × 195.58 mm).

3.0 OPERATION

3.1 Enclosures and Power Supplies

The Series X51 modules plug into a standard 19" wide × 5.25" high × 7.7" deep (482.60 mm × 132.54 mm × 195.58 mm) rack mount. The rack mount holds up to twenty plug-in modules which may be intermixed as required. A four-position, panel-mounted chassis is also available, as are a selection of surface-mount chassis.

The enclosures require 24 Vdc ±10% for operation of the modules (22 Vdc is recommended for minimum power dissipation and heat-rise inside the chassis). Ronan's Models X51-115-60, -120 or -180 power supplies provide 22 Vdc at 60, 120 and 180 watts respectively. The 24 Vdc power is connected to the rack mount at the position 1 and 2 terminal strips, at the very bottom screw terminals, labeled "24 V+," and "24 V–." The same terminals in terminal strip positions 3 and 4 are connected in parallel to these, are

similarly labeled, and may be used to "daisy chain" the power to another chassis.

The Ronan Model X51N-115-50 is a small, regulated plug-in power supply that requires only two module positions in any of the chassis types. It is capable of powering modules with a total power requirement of 50 W or less. The output voltage of the X51N-115-50 power supply is available at the back of the chassis and can be used to power other modules as long as the total load power doesn't exceed 50 W.

3.2 Input Test Points

The input test points at the front panel of Models X51-312, -322, and -325 transmitters provide a convenient means of monitoring the field input signal, or of injecting a calibration signal without disturbing the field wiring.

(See section 3.3 for the function of the front panel test points on Models X51-318 and -328.)

3.2.1 Thermocouple, mV and Volts Inputs: Millivolt and 1-5 V inputs are applied at the input "+" and "–" test points and appear at the input amplifier, simulating an input at the field terminals. A calibrator with an output impedance of less than 1 ohm should be used to avoid calibration errors. For example, a 1 ohm output impedance of the calibrator results in an error of up to 0.05% of reading.

When measuring the field input at the front panel input test points, an accurate meter with an input impedance of 10 Mohms or more should be used. Also, the input current of the calibrator can be a source of error when measuring low-level inputs. A 10 μV measurement error occurs for each 5 nA of calibrator input current.

To calibrate a transmitter with a thermocouple input, thermocouple tables are required to obtain the correct mV input for each calibration temperature. Tables that provide data for thermocouple voltages with the reference junction at 0°C (32°F) should be used.

Thermocouple input modules have a cold junction compensation circuit with the temperature sensing element at the rear terminals. This compensation voltage, which equals the cold thermocouple junction voltage at the rear terminals, appears in series with any calibration voltage applied to the input test points. One of the calibration criterion is, therefore, to find the temperature at the rear terminals so a correction voltage can be applied to cancel the cold junction compensation voltage. (The rear terminals are quite probably at a higher temperature than the ambient air near the terminals because of the higher temperature inside the rack.) If the front panel ZERO is to be adjusted, the temperature at the rear terminals must be measured. The mV from a thermocouple table (ref. junction at °C) of the terminal temperature must be found and subtracted from the calibrator's output at the span zero value. As an example using a type K thermocouple, a rear terminal temperature of 95°F and an input span of +100°F to + 300°F: first, the mV equivalent of 95°F, type K thermocouple is found to be 1.407 mV from the tables. Then the span zero temperature of 100°F is found to be 1.520 mV from the tables. The correct value to apply at the front panel test points is 1.520 mV minus 1.407 mV which equals .113 mV for the span zero. The transmitter output should be adjusted to 4.00 mA by the front panel ZERO control (4-20 mA output range). Next, the table value for +300°F is found to be 6.092 mV. Again, subtract the reference junction voltage, 1.407 mV, for a full-scale input of 4.685 mV to be applied at the input test points. The front panel SPAN control should be adjusted, if necessary, for an output of 20.00 mA.

A gain calibration can be performed without considering the reference junction voltage by measuring a change in output current for a given change in input voltage. First, establish the correct change in output current versus a change in input voltage. Then apply an in-range mV change to the test points and measure the change in output current. The SPAN control may be adjusted for the correct output change. For the example above, the output should change 16.0 mA for an input change of 6.092 mV minus 1.520 mV equals 4.572 mV (16.0 mA ÷ 4.572 mV or 3.5 mA per mV).

When measuring a thermocouple input voltage at the input test points, the mV measured equals the thermocouple voltage minus the cold junction voltage. Therefore, the equivalent mV from the tables for the cold junction at the rear terminal ambient temperature should be added to the mV measured at the test points.

3.2.2 Milliamps Input Modules: The mA input modules convert the input current into a voltage through the use of a 100 ohms precision "loop" resistor. When measuring the input current indirectly at the front panel input test points, the voltmeter will indicate 100 mV for each 1 mA of loop current. Similarly, when inserting a calibration signal at the input test points, one would apply 100 mV for each mA of input current to be simulated. For example, to simulate a 10 mA input current, apply 1 V (10 mA × 100 ohms). When calibrating the module or measuring the input, the signal loop current is undisturbed.

3.3 Output Test Points

The output test points are available on modules X51-318, -325 and -328 only. (See section 3.2 for test point function on X51-312 and -322 models.) The output value is measured by a mA measurement device, the input resistance of which is 10 ohms or less in the current measuring mode. The mA meter is connected to the "+" and "–" output test points and indicates the output current in mA without disturbing the output current to the normal load.(If the load is disconnected, there will be no output current flowing.) If the transmitter provides a voltage output, the output value will still be indicated in mA at the test points. For this case, the output voltage can be calculated from the current readings in terms of percentages of full scale. The relationship is:

Vo=mA at test points – mA at output span zero × Vo span + output voltage span zero.

The equation reduces as follows for two common voltage outputs:

1-5 V output: Vo = mA at test points ÷ 4

0-5 V output: Vo = mA at test points × 5/16

4.0 CIRCUIT DESCRIPTION

4.1 Power Supply

The dc voltage enters the card at connector pins 15(+) and 16(–). This voltage is regulated on the card to +18 V by U6 and applied to the oscillator circuit, U5 and transformer T3. The oscillator circuit of U5 provides an approximate 80 kHz signal to the VMOS drivers Q7 and Q8 which alternately pull down windings 1 and 3 of transformer T3 to V–. The transformed voltages that power the transmitter circuits are derived from windings 10-11 and 12-13 (isolated input amplifiers) and windings 4-5-6 and 7-8-9 (output amplifiers). The voltages supplied to the output amplifier are +V3 and +V4 (+25 V), as well as –V3 and –V4 (–2.5 V). The voltages used for the input amplifiers are ± V1 and ± V2 (± 9 V) and ± VR1 and ± VR2 (± 2.5 V).

4.2 Input and Output Amplifiers

A description of the channel 1 circuits will be given, the circuits of channel 2 are identical with their own nomenclature. For the single input, dual output models (X51-318 and -328), the inputs of the B channel amplifier are jumpered to the corresponding inputs of the A channel amplifier.

The Model X51-325 uses the A channel circuits and just the output power supply from the B channel to supply a voltage at terminal 11 to power a two-wire transmitter.

The input amplifier for thermocouple, mA or voltage inputs consists of amplifier U2 and its associated components. The signal input enters the card at connector pins 1 (+) and 2 (–). Thermocouple transmitters require a cold junction compensation resistor which is mounted on the access terminal strip on the chassis rear panel. The reference junction resistor connects to the module via connector pins 3 and 4.

The input voltage is applied to the low drift operational amplifier U2, which is connected in a non-inverting gain configuration. The gain determining resistors are potentiometer R1, R17 and R18. The gain resistors are selected to provide approximately 0-1 V at the output of U2 for the standard input ranges. Potentiometer R1 is the SPAN control and is accessible at the front panel. Resistor R25 is used with thermocouple inputs in the cold junction compensation circuit. Resistors R15, R16, R23 and R27 make up the zero circuit. Refer to section 3.2 or 3.3 for operation of the test points. The output signal of U2 is applied to the transformer T1 through the modulation switch Q1.

The signal is coupled across transformer T1, demodulated and filtered by switch Q2, R8 and C4, and applied to the output amplifier, U1. Amplifier U1 controls the output current through transistor Q3. The output current path is from +V3, through Q3 and the external load, (connected between connector pins 5 and 6), and resistors R14 and R11. The output current is controlled by being forced to a value that results in a voltage at the junction of R9, R10, R11 and pin 2 of U1 that is equal to the input voltage at pin 3 of U1. Potentiometer R2 functions as the ZERO control and is accessible at the front panel. The resistance of R2 is buffered by U1-B so as not to affect the gain of the output amplifier when the setting is changed.

5.0 CALIBRATION

Calibration of the Model X51's described in this manual consists of applying a known, accurate signal to the inputs, or input test points, and adjusting the ZERO and SPAN controls for the correct output. Refer to sections 3.2 and 3.3 for calibration information when using the test points.

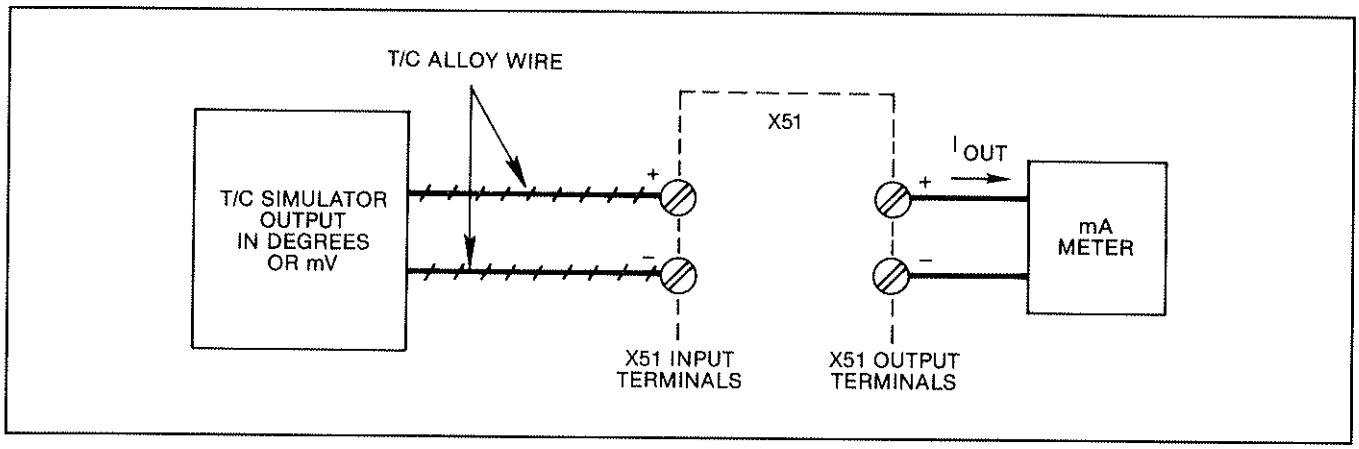


Figure 5-1: Calibration circuit using thermocouple simulator.

5.1 Thermocouple Input Models

Calibration of the thermocouple input models may be performed by using an accurate thermocouple simulator (Figure 5-1), a millivolt source and ice point reference (Figure 5-2) or a calibration method as described in sections 3.2 and 3.3.

5.2 Model X51-312, -318 Thermocouple and Model X51-322, -325 and -328 mV, V, mA Transmitter (X51-1048)

Connect a thermocouple input as in Figure 5-1 or 5-2 to the input terminals, or a mA or mV input for X51-322 and -328 models. The input test points may be used for the -312, -322 models to apply the calibration signal per section 3.2. For laboratory calibration, it is recommended that the calibration signal be applied to the input connector pins or rear terminal "+" and "–" inputs.

5.2.1 ZERO and SPAN Adjust: The calibration procedure for channel 1 will be given; channel 2, or the second output for models X51-318, -328, would be calibrated in a similar manner.

5.2.1.1: Set the module's input to its span zero value.

5.2.1.2: Monitor the voltage across C1 with a DVM and adjust R27 for 0.000 V across C1.

5.2.1.3: Remove the DVM from across C1 and monitor the output of the transmitter.

5.2.1.4: Adjust the front panel ZERO control for the span zero value at the output.

5.2.1.5: Set the input to the module to its span full scale value.

5.2.1.6: Adjust the front panel SPAN control for the span full scale value at the output.

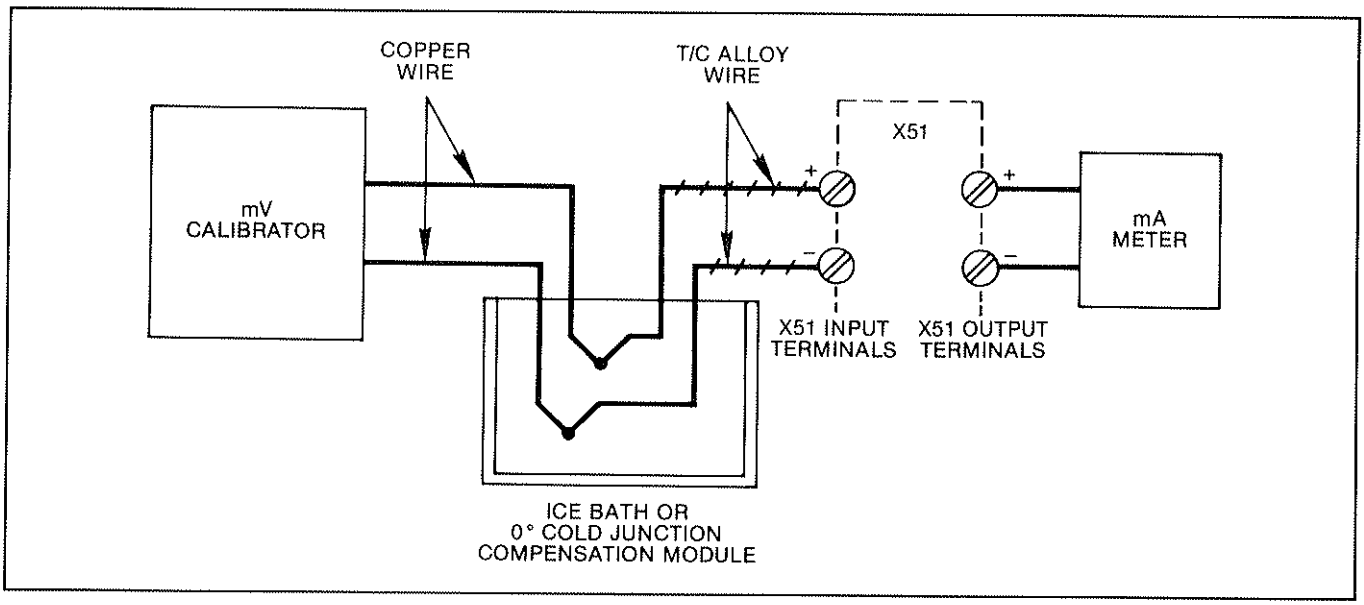


Figure 5-2: Calibration circuit using mA calibrator and cold junction compensation.

5.2.1.7: Repeat steps 5.2.1.1 and steps 5.2.1.4 through 5.2.1. until the controls no longer need adjustment.

6.0 TROUBLESHOOTING/REPAIR

The Model X51-EXT extender board is recommended as an aid to troubleshooting to allow access to the components while the module is powered up. Alternately, a bench test or calibration set-up should provide access to the components. Visually inspect the module for any obvious damage to the components or printed circuit board.

The troubleshooting procedure should start with a check of the power supplies. Refer to section 4.1 for a description of the power supply, oscillating frequencies and output voltages. The power supplies must be functioning properly before any further troubleshooting can be performed.

When troubleshooting, always apply an input signal that is within the operating range of the module under test and monitor the output(s). The input amplifier should provide an output that responds proportionally to a variation in the input signal. If the input test points are used, refer to section 3.2 and 3.3 for information concerning the use of these test points. The input amplifier provides an output that ranges from about 0 V to 1 V over the range of a standard input. The standard demodulated dc signal across C3 is over the range of about 0 to 1 Vdc, corresponding to a full scale input range.

PARTS LIST - DUAL CHANNEL

Model X51-312, -322

Item	Qty.	Ident.	Description	Part No.	Mfg.
1	1	P.C.B.	P.C. board	X51-1048	Ronan
2	1		Fastener	47-10-202-10	Southco
3	1		Handle	X51B6	Ronan
4	1		Bracket	X51B16	Ronan
5	1		Front panel	X51D210-23	Ronan
6	2		Pin jacks, red	3542-2	Pomona
7	2		Pin jacks, black Note: Wire pin jacks to TP1 and TP2 pads near front panel.	3542-0	Pomona
8	1		Connector	100-816-053	Panduit
9	1	R61	Resistor, 1/4 W, 5%, 4.7 ohms	RC07GF4R7J	AB
10	2	R19,42	Resistor, 1/4 W, 5%, 47 ohms	RC07GF470J	AB
11	4	R52,53,56,57	Resistor, 1/4 W, 5%, 1.8 k	RC07GF182J	AB
12	4	R8,12,31,36	Resistor, 1/4 W, 5%, 2.2 k	RC07GF222J	AB
13	4	R50,55,58,59	Resistor, 1/4 W, 5%, 3.3 k	RC07GF332J	AB
14	2	R6,29	Resistor, 1/4 W, 5%, 6.8 k	RC07GF682J	AB
15	4	R5,7,28,30	Resistor, 1/4 W, 5%, 470 k	RC07GF474J	AB
16	1	R62	Resistor, 1/2 W, 5%, 270 ohms	RC20GF271J	AB
17	2	R14,37	Resistor, 1/4 W, 1%, 100 ohms	RN55C1000F	Mepco
18	2	R18,41	Resistor, 1/4 W, 1%, 3.01 k	RN55C3011F	Mepco

PARTS LIST - DUAL CHANNEL (CONT.)

Model X51-312, -322

Item	Qty.	Ident.	Description	Part No.	Mfg.
19	2	R11,34	Resistor, 1/4 W, 1%, 5.23 k	RN55C5231F	Mepco
20	2	R9,32	Resistor, 1/4 W, 1%, 16.5 k	RN55C1652F	Mepco
21	2	R10,33	Resistor, 1/4 W, 1%, 18.2 k	RN55C1822F	Mepco
22	1	R60	Resistor, 1/4 W, 1%, 29.4 k	RN55C2942F	Mepco
23	2	R27,54	Potentiometer, 20 k	82PR20K	Beckman
24	2	R1,3	Potentiometer, 2 k	89PR2K	Beckman
25	2	R2,4	Potentiometer, 10 k	89PR10K	Beckman
26	2	C3,14	Capacitor, 15 pF, 5%	150R501M05	Arco
27	2	C5,17	Capacitor, 47 pF, 5%	470R501M05	Arco
28	1	C33	Capacitor, 82 pF, 5%	820R501M05	Arco
29	2	C2,30	Capacitor, .001/1 kV	102R102C20	Sprague
30	4	C10,25,34,36	Capacitor, .1/100 V	104A101C20	Sprague
31	24	C1,4,6,7,8,9,11, 12,13,15,16,18, 19,20,21,22,23, 24,26,27,28,29, 31,32	Capacitor, 1 m, F/50 V	105R500C20	Sprague
32	1	C35	Not used		
33	2	D18,19	Diode, low leakage	1N457A	Fairchild
34	10	D3,4,5,6,7, 11,12,13,16,17	Diode, signal	1N4148	Motorola
35	1	D20	Diode, rectifier	1N4005	Motorola
36	6	D2,8,9,10,14,15	Diode, zener, 2.4 V	LM336Z-2.5	National
37	1 1	D21	LED, green 1 each, ring & clip for D21	HLMP-3502 5082-4707	HP HP
38	4	Q1,2,4,5	FET, n-channel	2N4393,MPF4393	Motorola
39	2	Q3,6	Transistor, npn	MJE243	Motorola
40	2	Q7,8	FET, VMOS	VN0106N3	Supertex
41	2	U1,3	Dual op-A	LM358N	National
42	1	U5	Adjustable multivibrator	CD4047BE	RCA
43	2	U2,4	Precision op amp	NA714HC	Fairchild
44	2	U6	V. Regulator, 18 V	MC78M18CG	Fairchild
45	1	T3	Transformer, dc-dc convertor	X51B299	Merc. Mag
46	2	T1,2	Transformer, signal	PE2231X	Pulse Eng.

PARTS LIST - DUAL CHANNEL (CONT.)

Model X51-312, -322

	R26,49	R20,43
Upscale	68 M, 5%	Not used
Downscale	Not used	86 M, 5%

Table 1: Selection of resistor for up/down scale on sensor burnout.

	E	J	K	T	R	S
R25,48	165 k	196 k	249 k	249 k	1.8 M, 5%	1.5 M, 5%
R23,46	20.0	20.0	20.0	20.0	20.0	20.0
R22,45	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%
R24,47	Not used	Not used	Not used	Not used	Not used	Not used
R21,44	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%
W1,2	Not used	Not used	Not used	Not used	Not used	Not used
Ref. Junction Resistor	X80A209	X80A209	X80A209	X80A209	X80A209	X80A209

Table 2: Values determined by thermocouple input type.

	mV	1-5 V	0-10 V	4-20 mA
R25,48	Not used	Not used	Not used	Not used
R23,46	20.0	20.0	20.0	20.0
R22,45	2.2 k, 5%	200 k, .1%	200 k, .1%	200 k, .1%
R24,47	Not used	2.02 k, .1%	2.02 k, .1%	22.1 k, .1%
R21,44	4.7 k, 5%	JPR	JPR	121
Ext. Loop Resistor	Not used	Not used	Not used	100 k, .1%

Table 3: Values determined by mV, V, mA inputs.

	0-5	1-5 V	0-10 V	4-20 mA	Thermocouple
R15,38	Not used	4.99 k	Not used	1.24 k	As required
R16,39	39.2 k	49.9 k	20.0 k	12.4 k	As required
R17,40	205 ohms	162 ohms	432 ohms	750	As required

Table 4: Values for R15,38,16,39,17,40.

Formula 1: R15 when input is thermocouple
R38,15 = 50 (R25 + 923) ÷ 2307 + (V. thermocouple at span 0) (R25 + 922.7).

Formula 2: R16 (input span V is voltage across R24 when input divider is used).
R16,39 = (2.5 – .1 span) R23 ÷ .1 span.

Formula 3: R17,40 (input span is voltage across R24 when input divider is used)
R17,40 = 3920 (input span in V) ÷ 1 – input span in V.

Output	mA	1-5 V	2-10 V
R13,35	Not used	249 RN65C	499 RN65C

Table 5: Output table.

PARTS LIST - DUAL OUTPUT

Model X51-318, -328

Item	Qty.	Ident.	Description	Part No.	Mfg.
1	1	P.C.B.	P.C. board	X51-1048	Ronan
2	1		Fastener	47-10-202-10	Southco
3	1		Handle	X51B6	Ronan
4	1		Bracket	X51B16	Ronan
5	1		Front panel	X51D210-23	Ronan
6	2		Pin jacks, red	3542-2	Pomona
7	2		Pin jacks, black Note: Wire pin jacks to TP1 pads near Q3, and TP2 pads near Q6.	3542-0	Pomona
8	1		Connector	100-816-053	Panduit
9	1	R61	Resistor, 1/4 W, 5%, 4.7 ohms	RC07GF4R7J	AB
10	2	R19,42	Resistor, 1/4 W, 5%, 47 ohms	RC07GF470J	AB
11	4	R52,53,56,57	Resistor, 1/4 W, 5%, 1.8 k	RC07GF182J	AB
12	4	R8,12,31,36	Resistor, 1/4 W, 5%, 2.2 k	RC07GF222J	AB
13	4	R50,55,58,59	Resistor, 1/4 W, 5%, 3.3 k	RC07GF332J	AB
14	2	R6,29	Resistor, 1/4 W, 5%, 6.8 k	RC07GF682J	AB
15	4	R5,7,28,30	Resistor, 1/4 W, 5%, 470 k	RC07GF474J	AB
16	1	R62	Resistor, 1/2 W, 5%, 270 ohms	RC20GF271J	AB
17	2	R14,37	Resistor, 1/4 W, 1%, 100 ohms	RN55C1000F	Mepco
18	2	R18,41	Resistor, 1/4 W, 1%, 3.01 k	RN55C3011F	Mepco
19	2	R11,34	Resistor, 1/4 W, 1%, 5.23 k	RN55C5321F	Mepco
20	2	R9,32	Resistor, 1/4 W, 1%, 16.5 k	RN55C1652F	Mepco
21	2	R10,33	Resistor, 1/4 W, 1%, 18.2 k	RN55C1822F	Mepco
22	1	R60	Resistor, 1/4 W, 1%, 29.4 k	RN55C2942F	Mepco
23	1	R27	Potentiometer, 20 k	82PR20K	Beckman
24	2	R1,3	Potentiometer, 2 k	89PR2K	Beckman
25	2	R2,4	Potentiometer, 10 k	89PR10K	Beckman
26	2	C3,14	Capacitor, 15 pF, 5%	150R501M05	Arco
27	2	C5,17	Capacitor, 47 pF, 5%	470R501M05	Arco
28	1	C33	Capacitor, 82 pF, 5%	820R501M05	Arco
29	2	C2,30	Capacitor, .001/1 kV	102R102C20	Sprague
30	4	C10,25,34,36	Capacitor, .1/100 V	104A101C20	Sprague
31	24	C1,4,6,7,8,9,11, 12,13,15,16,18, 19,20,21,22,23, 24,26,27,28,29, 31,32	Capacitor, 1 m F/50 V	105R500C20	Sprague

PARTS LIST - DUAL OUTPUT (CONT.)

Model X51-318, -328

Item	Qty.	Ident.	Description	Part No.	Mfg.
32	1	C35	Not used		
33	2	D18,19	Diode, low leakage	1N457A	Fairchild
34	10	D3,4,5,6,7, 11,12,13,16,17	Diode, signal	1N4148	Motorola
35	1	D20	Diode, rectifier	1N4005	Motorola
36	6	D2,8,9,10,14,15	Diode, zener, 2.4 V	LM336Z-2.5	National
37	1 1	D21	LED, green 1 each, ring & clip for D21	HLMP-3502 5082-4707	HP HP
38	4	Q1,2,4,5	FET, n- channel	2N4393,MPF4393	Motorola
39	2	Q3,6	Transistor, npn	MJE243	Motorola
40	2	Q7,8	FET, VMOS	VN0106N3	Supertex
41	2	U1,3	Dual op-A	LM358N	National
42	1	U5	Adjustable multivibrator	CD4047BE	RCA
43	2	U2,4	Precision op amp	NA714HC	Fairchild
44	1	U6	V. Regulator, 18 V	MC78M18CG	Fairchild
45	1	T3	Transformer dc-dc convertor	X51B299	Merc. Mag
46	2	T1,2	Transformer, signal	PE2231X	

	R26	R20
Upscale	68 M, 5%	Not used
Downscale	Not used	68 M, 5%

Table 1: Selection of resistors for up/down scale on sensor burnout.

	E	J	K	T	R	S
R25	165 k	196 k	249 k	249 k	1.8 M, 5%	1.5 M, 5%
R23	20.0	20.0	20.0	20.0	20.0	20.0
R22	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%	2.2 k, 5%
R24	Not used	Not used	Not used	Not used	Not used	Not used
R21	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%	4.7 k, 5%
W1	Not used	Not used	Not used	Not used	Not used	Not used
Ref. Junction Resistor	X80A209	X80A209	X80A209	X80A209	X80A209	X80A209

Table 2: Values determined by thermocouple input type.

PARTS LIST - DUAL OUTPUT (CONT.)

Model X51-318, -328

	mV	1-5 V	0-10 V	4-20 mA
R25	Not used	Not used	Not used	Not used
R23	20.0	20.0	20.0	20.0
R22	2.2 k, 5%	200 k, .1%	200 k, .1%	200 k, .1%
R24	Not used	2.02 k, .1%	2.02 k, .1%	22.1 k, .1%
R21	4.7 k, 5%	JPR	JPR	121
Ext. Loop Resistor	Not used	Not used	Not used	100 k, .1%

Table 3: Values determined by mV, V, mA inputs.

	1-5 V	0-5 V	0-10 V	4-20 mA	Thermocouple
R15	4.99 k	Not used	Not used	1.24 k	As required
R16	49.9 k	39.9 k	20.0 k	12.4 k	As required
R17,40	162 ohms	162	432 ohms	750	As required

Table 4: Values for R15,16,17,40.

Output	mA	1-5 V	2-10 V
R13,35	Not used	249 RN65C	499 RN65C

Table 5: Output table.

PARTS LIST - mA TRANSMITTER

Model X51-325

Item	Qty.	Ident.	Description	Part No.	Mfg.
1	1	P.C.B.	P.C. board	X51-1048B	Ronan
2	1		Fastener	47-10-202-10	Southco
3	1		Handle	X51B6	Ronan
4	1		Bracket	X51B16	Ronan
5	1		Front panel	X51D210-5	Ronan
6	2		Pin jacks, red	3542-2	Pomona
7	2		Pin jack, black Note: Wire input test jacks to TP-1 pads near front panel; wire output test jacks to TP-1 pads near Q3.	3542-0	Pomona
8	1		Connector	100-816-053	Panduit
9	1	R16	Resistor, 1/4 W, 5%, 4.7 ohms	RC07GF4R7J	AB
10	1	R19	Resistor, 1/4 W, 5%, 47 ohms	RC07GF470J	AB
11	2	R52,53	Resistor, 1/4 W, 5%, 1.8 k	RC07GF182J	AB
12	2	R8,12	Resistor, 1/4 W, 5%, 2.2 k	RC07GF222J	AB

PARTS LIST - mA TRANSMITTER (CONT.)

Model X51-325

Item	Qty.	Ident.	Description	Part No.	Mfg
13	4	R50,55,58,59	Resistor, 1/4 W, 5%, 3.3 k	RC07GF332J	AB
14	1	R6	Resistor, 1/4 W, 5%, 6.8 k	RC07GF682J	AB
15	2	R5,7	Resistor, 1/4 W, 5%, 470 k	RC07GF474J	AB
16	1	R62	Resistor, 1/2 W, 5%, 270 ohms	RC20GF271J	AB
17	1	R14	Resistor, 1/4 W, 1%, 100 ohms	RN55C1000F	Mepco
18	1	R18	Resistor, 1/4 W, 1%, 3.01 k	RN55C3011F	Mepco
19	1	R11	Resistor, 1/4 W, 1%, 5.23 k	RN55C5231F	Mepco
20	1	R9	Resistor, 1/4 W, 1%, 16.5 k	RN55C1652F	Mepco
21	1	R10	Resistor, 1/4 W, 1%, 18.2 k	RN55C1822	Mepco
22	23	R3,4,28,30,31, 32,33,34,35, 36,37,38,39, 40,41,42,43, 44,45,46,47, 48,49	Not used		
23	1	R60	Resistor, 1/4 W, 1%, 29.4 k	RN55C2942F	Mepco
24	1	R27	Potentiometer, 20 k	82PR20K	Beckman
25	1	R1	Potentiometer, 2 k	89PR2K	Beckman
26	1	R2	Potentiometer, 10 k	89PR10K	Beckman
27	1	C3	Capacitor, 15 pF, 5%	105R501M05	Arco
28	1	C5	Capacitor, 47 pF, 5%	470R501M05	Arco
29	1	C33	Capacitor, 82 pF, 5%	820R501M05	Arco
30	1	C2	Capacitor, .001/1 kV	102R102C20	Sprague
31	4	C10,34,35,36	Capacitor, .1/100 V	104A101C20	Sprague
32	15	C1,4,6,7,8,9, 11,12,18,20, 21,22,23,28,29	Capacitor, 1 uF/50 V	105R500C20	Sprague
33	13	C13,14,15,16, 17,19,24,26,27, 31,35	Not used		
34	3	D18,19,20	Diode, low leakage	1N457A	Fairchild
35	8	D3,4,5,6,7,11, 12,13	Diode, signal	1N4148	Fairchild
36	1	D20	Diode, rectifier	N4005	Motorola
37	1	D22	Jumper 0.5	J.O.500X0.125PVC22	
38	4	D2,8,9,10	Diode, zener, 2.4 V	LM336Z-2.5	National
39	1	D21	LED, green 1 each, ring & clip for D21	HLMP-3502	HP
40	5	D14,15,16, 17,19	Not used		

PARTS LIST - mA TRANSMITTER (CONT.)

Model X51-325

Item	Qty.	Ident.	Description	Part No.	Mfg.
41	2	Q1,2	FET, n-channel	2N4393	Motorola
42	1	Q3	Transistor, npn	MJE243	Motorola
43	2	Q7,8	FET, VMOS	VN0106N3	Supertex
44	3	Q4,5,6	Not used		
45	1	U1	Dual op amp	LM358N	National
46	1	U5	Adjustable multivibrator	CD4047BE	RCA
47	1	U2	Precision op amp	NA714HC	Fairchild
48	1		Heat sink (on U6)	2260	Thermalloy
49	1	U6	V. regulator, 18 V	MC78M18CG	Fairchild
50	2	U3,4	Not used		
51	1	T3	Transformer, dc-dc convertor	X51B299	Merc. Mag.
52	1	T2	Transformer, signal	PE2231X	Pulse Eng.

	R26	R20
Upscale	68 M, 5%	Not used
Downscale	Not used	68 M, 55

Table 1: Selection of resistors for up/down scale on sensor burnout.

	mV	1-5 V	0-10 V	4-20 mA
R25	Not used	Not used	Not used	Not used
R23	20.0	20.0	20.0	20.0
R22	2.2 k, 5%	200 k, .1%	200 k, .1%	200 k, .1%
R24	Not used	2.02 k, .1%	2.02 k, .1%	22.1 k, .1%
R21	4.7 k, 5%	Jumper 5"	Jumper 5"	121
Ext. Loop Resistor	Not used	Not used	Not used	100 k, .1%

Table 2: Values determined by mV, V, mA inputs.

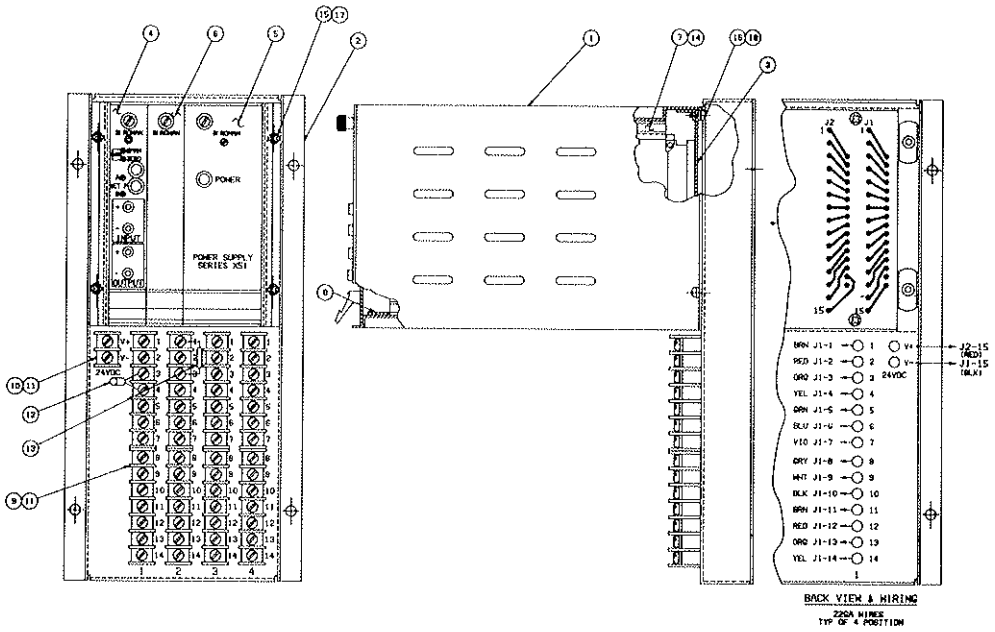
	0-5	1-5 V	0-10 V	4-20 mA
R15	Not used	4.99 k	Not used	1.24 k
R16	39.2 k	49.9 k	20.0 k	12.4 k
R17	205 ohms	162 ohms	432 ohms	750

Table 3: Values for R15,16,17,40.

Output	mA	1-5 V	2-10 V
R13,35	Not used	249 RN65C	499 RN65C

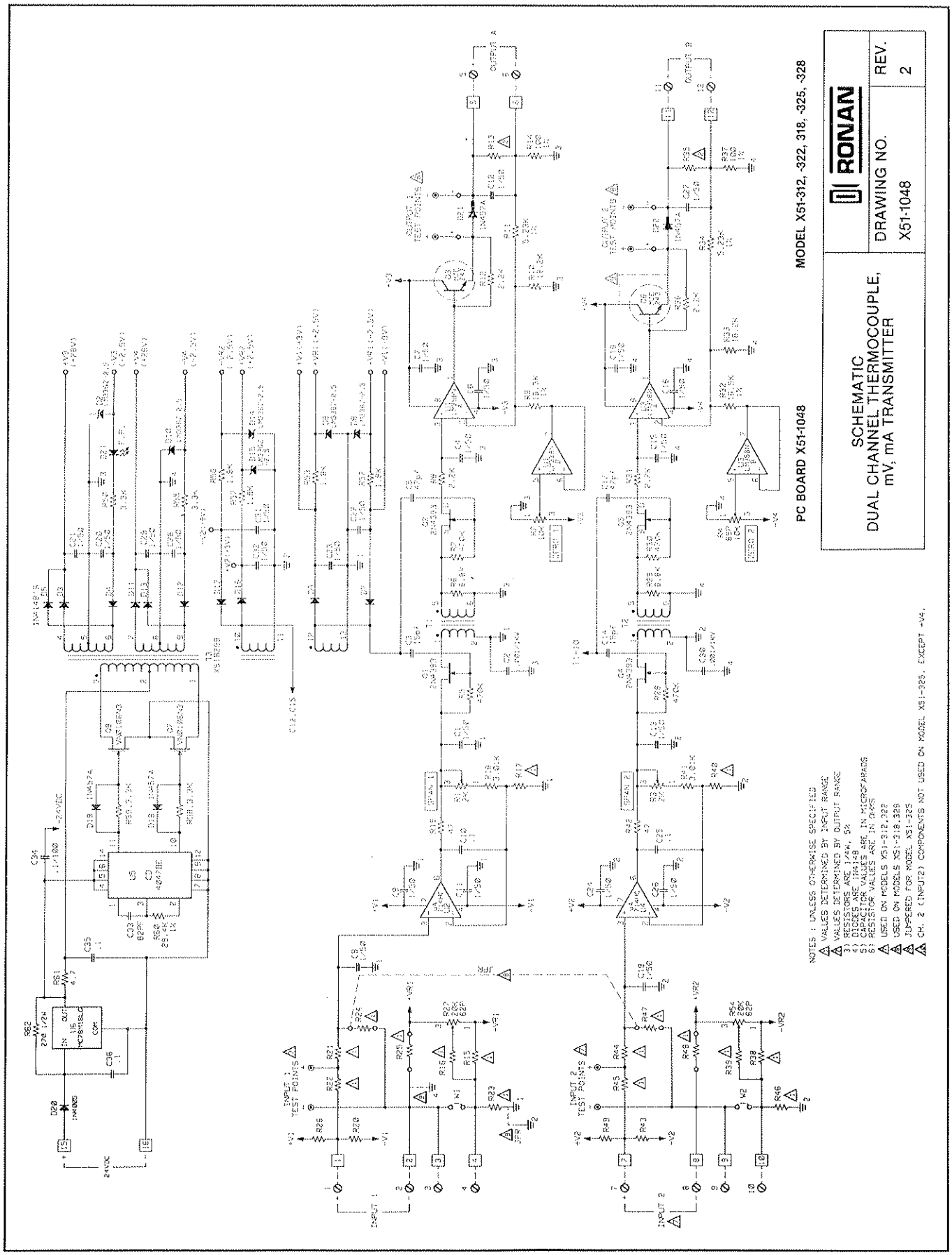
Table 4: Output table.

ASSEMBLY DRAWING X51SM-4	RONAN	
	DRAWING NO. X51D67	REV. 1

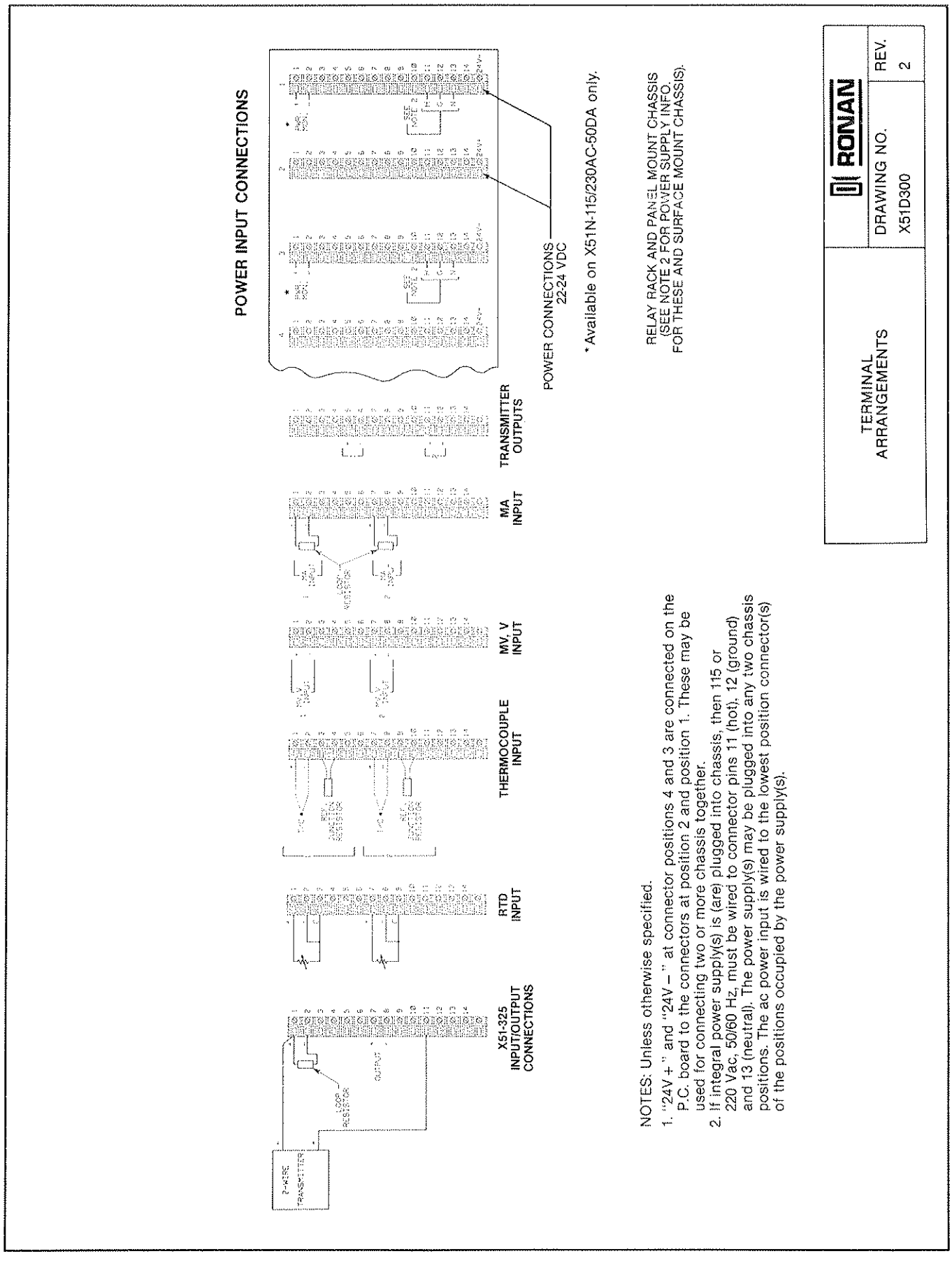


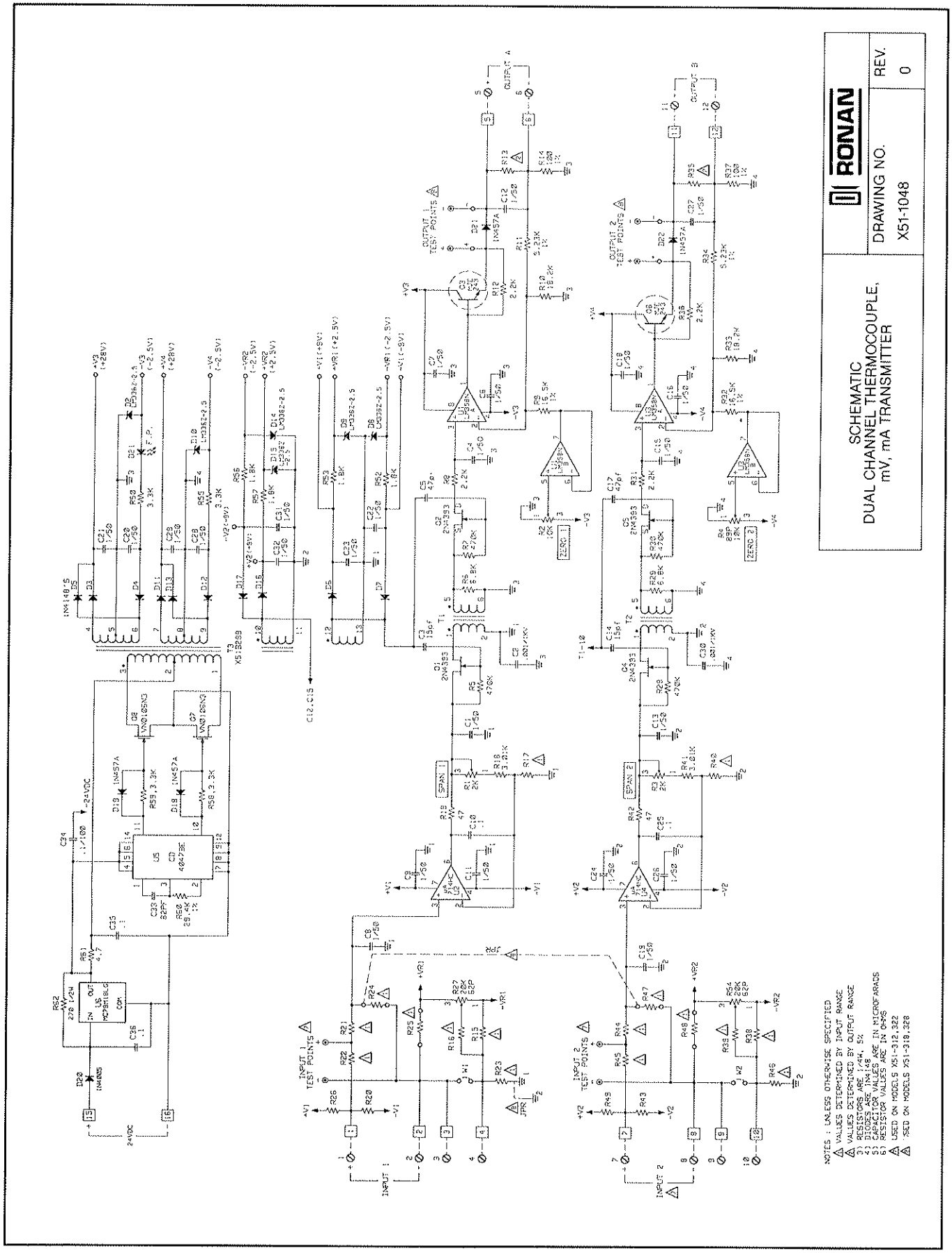
Item	Qty.	Ident.	Description	Part No.	Mfg.
1	1		Card rack	X51D68	Ronan
2	1		Chassis	X51D69-1	Ronan
3	1		Mother PCB assembly	X51C71	Ronan
4	As required		Module	As required	Ronan
5	As required		Power supply assembly	X51C44	Ronan
6	As required		Front panel, blank assembly	X51B50	Ronan
7	8		Card guide	X51C79	Ronan
8	1		I.D. strip	X51C72-3	Ronan
9	8		Terminal block	3597A-7	Kulka
10	1		Terminal block	3597A-2	Kulka
11	10		Speed nut	1599SN	Kulka
12	As required		Ref. junction resistor	X80A209	Elliot Ind.
13	As required		Resistor, 0.01%, M.Film	RN65C2500B	Dale
14	16		Rivets	AD42BS	
15	4		6-32 x 1/4" PH, RD, HD, MS		
16	4		4-40 x 1/4" PH, RD, HD, MS		
17	4		#6 Inter tooth lockwasher		
18	4		#4 Inter tooth lockwasher		

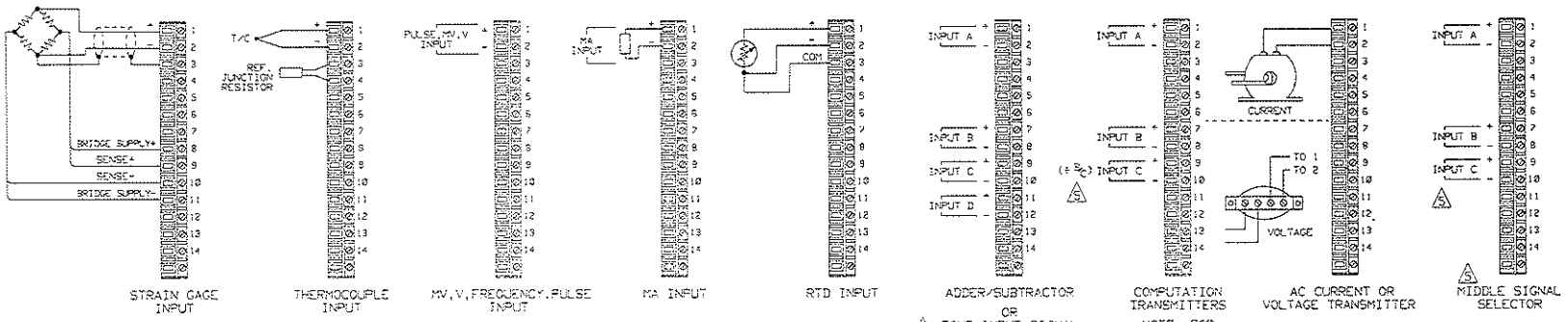
This Addendum replaces drawing X51-1048, Rev. 0, page 15 of the Series X51-312,-318, -322, -325, -328 Instructions and Operating Manual dated September, 1989.



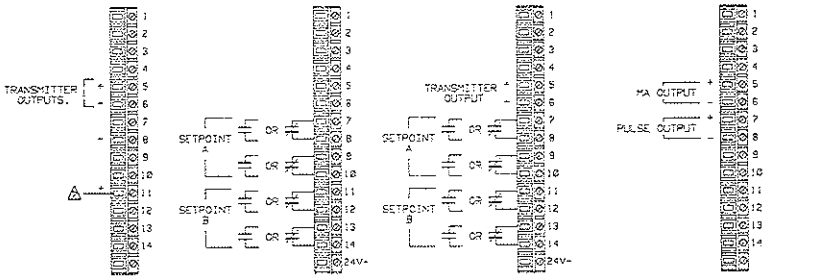
This Addendum replaces drawing X51D52, Rev. 7, page 16 of the Series X51-312, -318, -322, -325, -328 Instructions and Operating Manual dated September, 1989.




SCHEMATIC
DUAL CHANNEL THERMOCOUPLE,
mV, mA TRANSMITTER
RONAN
DRAWING NO.
X51-1048
REV.
0
NOTES : UNLESS OTHERWISE SPECIFIED
1) VALUES DETERMINED BY INPUT RANGE
2) VALUES DETERMINED BY OUTPUT RANGE
3) RESISTORS ARE 1/4W, 5%
4) DIODES ARE 1N4148
5) CAPACITOR VALUES ARE IN MICROFARADS
6) RESISTOR VALUES ARE IN OHMS
A USED ON MODELS X51-312,322
A USED ON MODELS X51-318,328

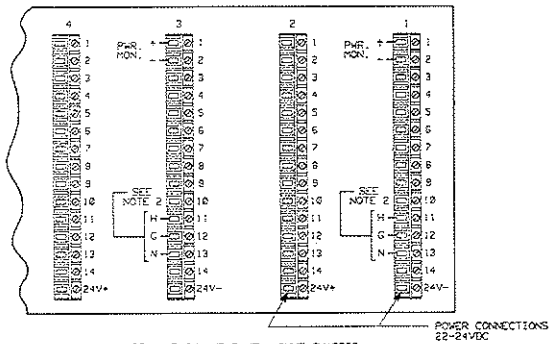


MODEL X51 SERIES OUTPUT CONNECTIONS



⚠ TERMINAL 11 USED ON MODEL X51-325 FOR 2-WIRE TRANSMITTER POWER SUPPLY +. (RETURN IS TO TERMINAL 1 WITH LOOP RESISTOR PER mA INPUTS.)

POWER INPUT CONNECTIONS

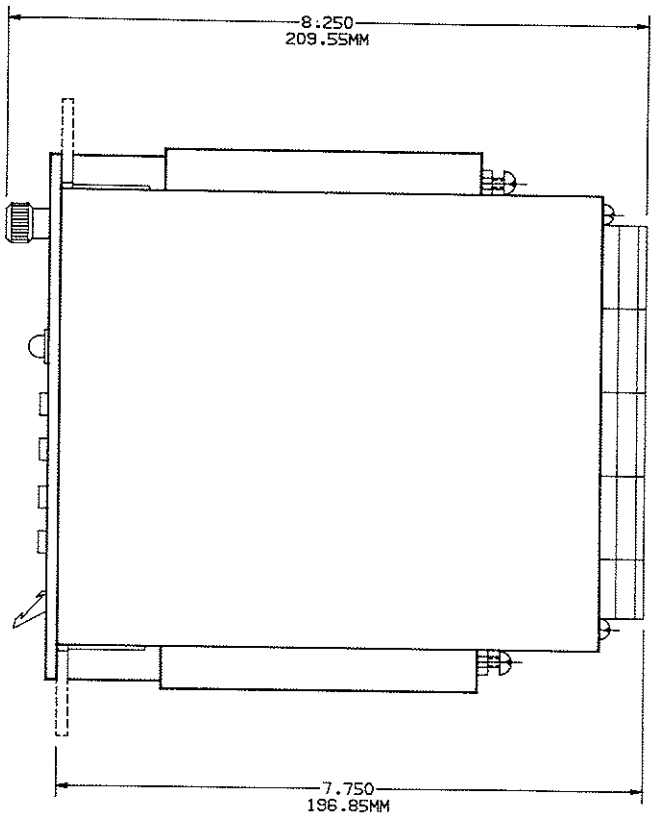


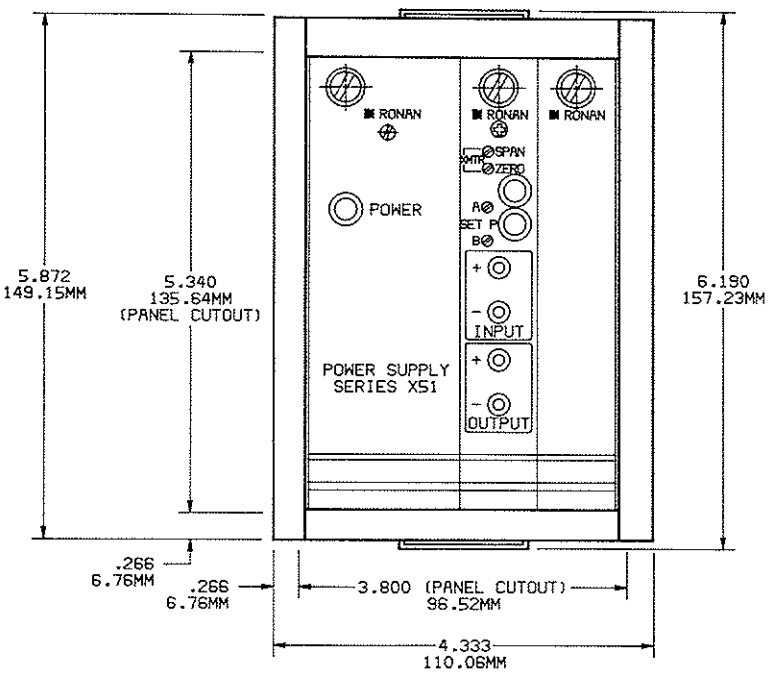
RELAY RACK AND PANEL MOUNT CHASSIS
(SEE NOTE 2 FOR POWER SUPPLY INFO FOR THESE AND SURFACE MOUNT CHASSIS)

NOTES: UNLESS OTHERWISE SPECIFIED

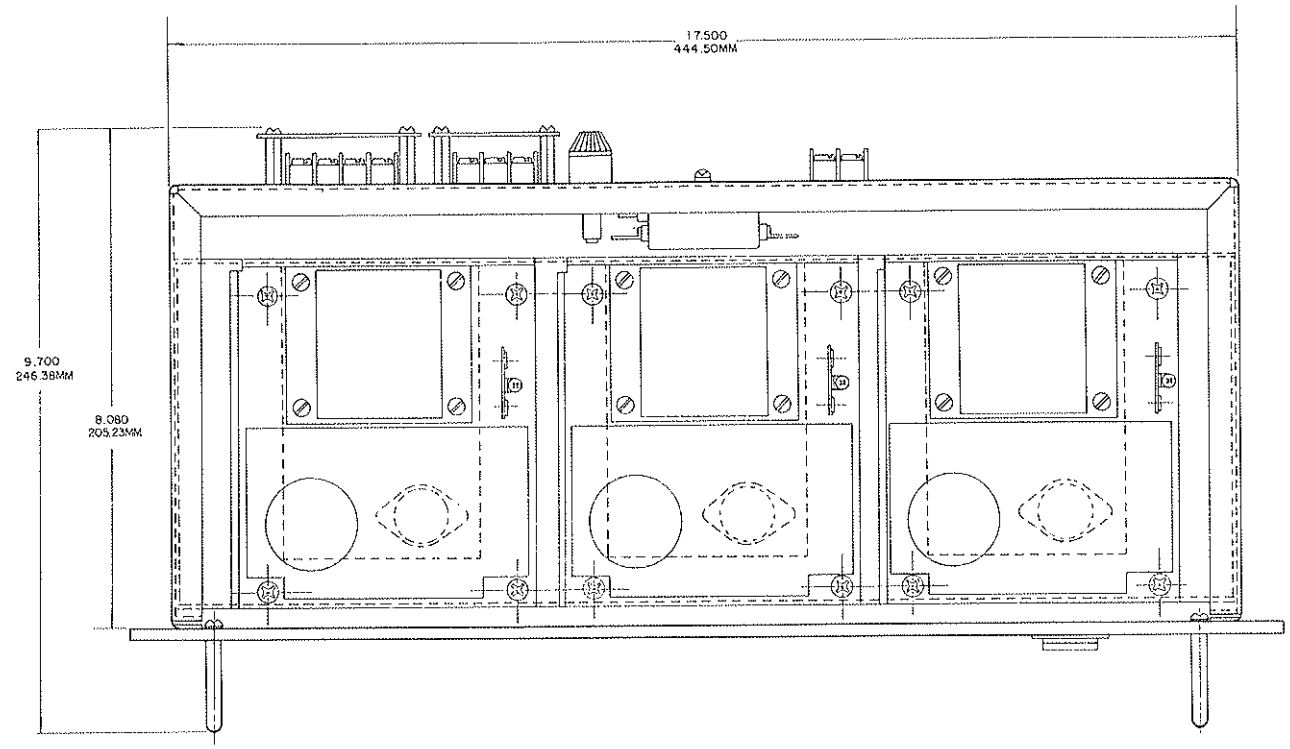
1. "24V+" AND "24V-" AT CONNECTOR POSITIONS 4 AND 3 ARE CONNECTED ON THE P.C. BOARD TO THE CONNECTORS AT POSITION 2 AND POSITION 1. THESE MAY BE USED FOR CONNECTING TWO OR MORE CHASSIS TOGETHER
2. IF INTEGRAL POWER SUPPLY (S) IS (ARE) PLUGGED INTO CHASSIS, THEN 115 OR 220VAC, 50/60HZ, MUST BE WIRED TO CONNECTOR PINS 11 (HOT), 12 (GND) AND 13 (NEUTRAL). THE POWER SUPPLY (S) MAY BE PLUGGED INTO ANY TWO CHASSIS POSITIONS. THE AC POWER INPUT IS WIRED TO THE LOWEST POSITION CONNECTOR (S) OF THE POSITIONS OCCUPIED BY THE POWER SUPPLY (S).

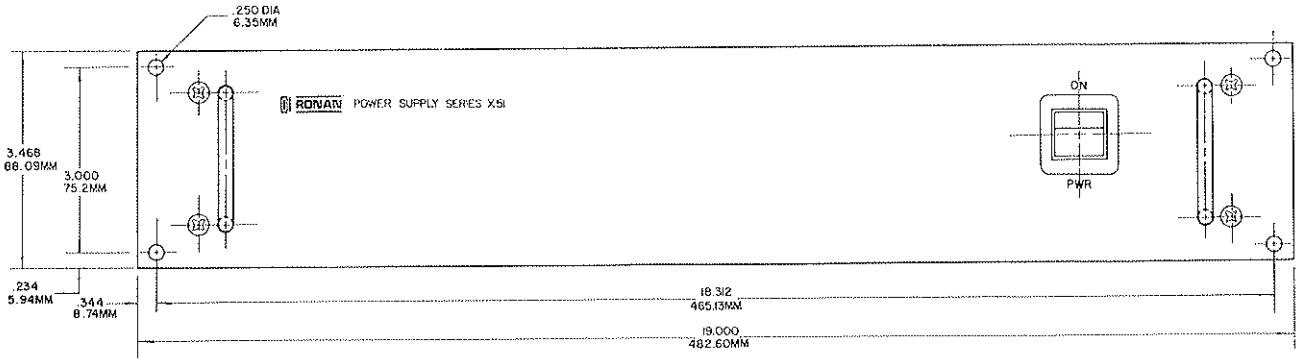
TERMINAL ARRANGEMENTS	RONAN	
	DRAWING NO. X51D52	REV. 7

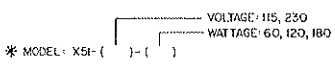




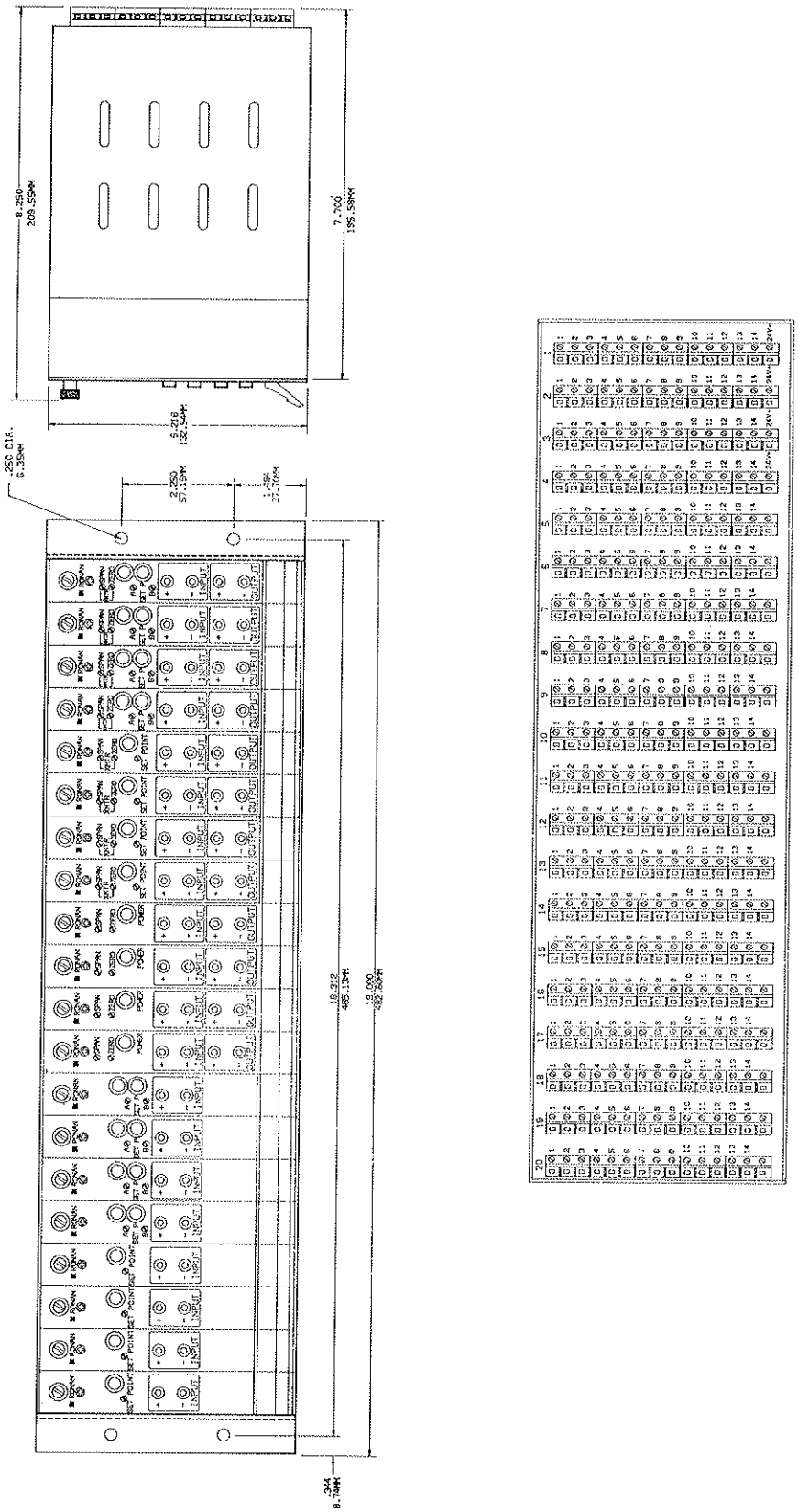
OUTLINE DRAWING CHASSIS PANEL MOUNT	RONAN	
	DRAWING NO. X51C47	REV. 0





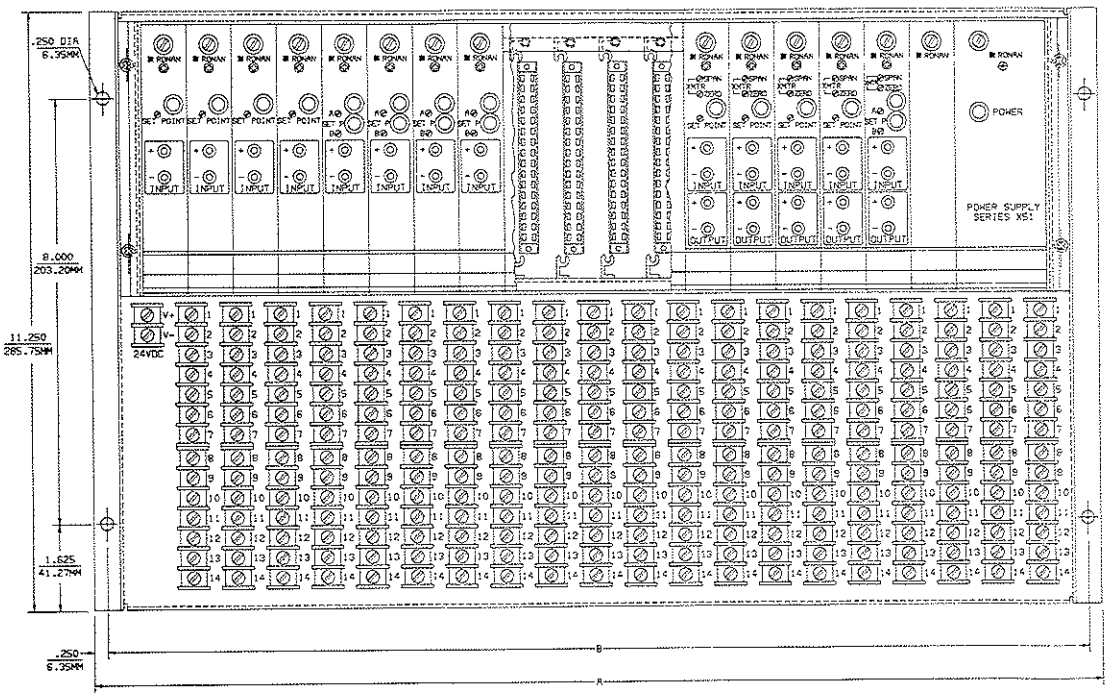


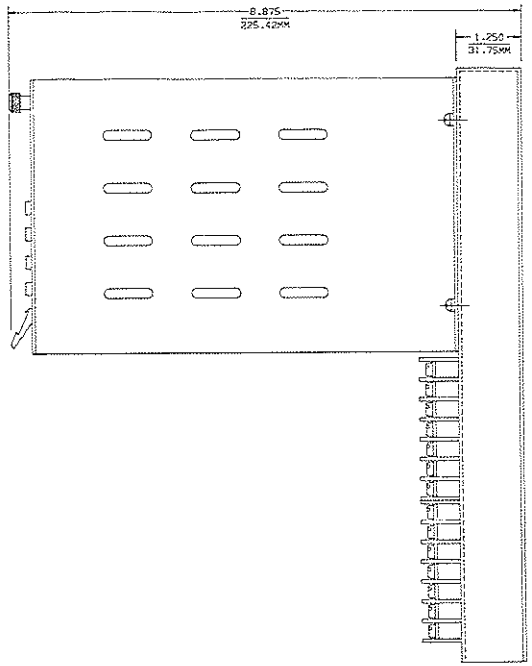
OUTLINE DRAWING X51 POWER SUPPLY	DRAWING NO. X51D38	REV. 0



RONAN

	DRAWING NO.	REV.
OUTLINE DRAWING X51RR-20 CHASSIS RACK MOUNT	X51D39	2





NOTES
1. PLUG-IN MODULES SHOWN AS AN EXAMPLE OF TYPICAL SYSTEM ONLY. ANY MODULE TYPE CAN BE PLACED INTO ANY CHASSIS POSITION

MODEL	ASSY. DWG.#	A		B	
		INCH	MM	INCH	MM
X51SM-20	X51D59	18.500	485.30	19.000	482.60
X51SM-10	X51D63	10.875	276.22	10.375	263.52
X51SM-4	X51D67	5.750	146.05	5.250	133.35

OUTLINE DRAWING
X51SM CHASSIS
SURFACE MOUNT

RONAN

DRAWING NO. X51D58

REV. 1

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