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TCM-1A
THREE-CHANNEL SIGNAL CONDITIONER
INSTRUCTION MANUAL
REV. D

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1. FUNCTIONS AND CONTROLS

1.1 FRONT PANEL FUNCTIONS AND CONTROLS

- **SENSOR** receptacle accepts the cable connector from the coil and preamplifier.

- **FILTERS** switch inserts line-frequency-rejection filters in the circuit immediately following the preamplifier. A choice of 50 or 60 Hz filter sets is switch selectable (see rear panel controls). About 40 dB of rejection is provided at the power line frequency and at each of its first four harmonics (i.e., 50, 100, 150, 200, 250 Hz or 60, 120, 180, 240, 300 Hz).

- **GAIN** multiplies instrument gain in steps: x1, x3, x10, x30, x100. Instrument scale factors are multiplied by the same number.

- **LEVEL** variable attenuator allows continuous adjustment of signal gain from unity at “CAL” down to zero when the pointer is in full clockwise position. To ensure unity gain, be sure to rotate control fully counter-clockwise until it “clicks”.

- **OVERLOAD** indicator lights when the instrument output exceeds ±10 volts.

- **OUTPUT** is a BNC connector carrying an analog output signal +10 volts full scale with gain independent of signal frequency. Scale factor is 25 mV/gamma at x1 and **GAIN** at “CAL”.

- **LO BATT** indicator glows when battery needs recharging. Full charge takes about 16 hours.

- **POWER** push-on push-off switch with lampless indicator. Indicator shows Black when out (OFF) and Orange when in (ON).

1.2 REAR PANEL FUNCTIONS AND CONTROLS

- **MONITOR OUTPUT** BNC connector provides the signal conditioner output signal on the front panel.

- **CALIBRATION** is a BNC connector to a calibration winding on the sensor that produces a magnetic field with a scale factor of 20 nanotesla/volt.

- **NOTCH FILTERS** switch selects power line frequency to which line reject filters are tuned.

- **POWER SELECT** is a three position rotary switch permitting choice of power supply mode:

  1) AC — Powered by 115 VAC line.
  2) AC/CHG — Unit powered by a.c. line and batteries being charged. Associated front panel LED glows during charging.
  3) BAT — Unit powered by internal NICAD batteries.

2. INTRODUCTION

The TCM-1A is a portable, wide bandwidth, low noise three-channel signal conditioner for use with MEDA magnetometer sensors, such as the MGC-1 and MGC-1A. The unit consists of a three-channel signal conditioner unit. The sensors and signal conditioner store inside a rugged aluminum carrying case, which is suitable for typical field operating environments. The signal conditioner can be easily removed and installed in a standard NEMA rack with mounting ears provided.

The preamplifier of each sensor is connected through a 20 foot cable to the signal conditioner unit which provides power to and conditions the output from the preamplifier. The signal conditioner controls allow the operator to select five different amplification levels (x1, x3, x10, x30, x100). A separate potentiometer can be used by the operator to adjust the gain between zero and the maximum value.

The output is independent of the frequency of the measured field from 5 Hz to 10,000 Hz (3dB points). An LED indicator light which is associated with each channel indicates overloads in the output.

Calibration inputs are provided on the signal conditioner rear panel which enable a current to be passed through an independent calibration winding on each sensor.

Two sets of power line rejection filters can be switched into the circuit to overcome saturation induced by power line interference. Either 50 or 60 Hz filters can be selected. The power line frequency and each of its first four harmonics are rejected by notch filters approximately 40 dB deep.

3. DESCRIPTION

The signal conditioner package provides d.c. power to as many as three preamplifiers through 20-foot cables. The same 6 conductor shielded cables carry the preamplifier signals back to the conditioner package. See Figure 3.1.

All calibration inputs and signal outputs are brought out to BNC connectors on the rear panel.

4. OPERATING INSTRUCTIONS

4.1 ELECTRONIC OPERATING INSTRUCTIONS

It is of utmost importance that saturation of the sensor preamplifiers be prevented during data collection. The following procedure is recommended to avoid preamplifier overload:

1) **FILTER** switch to out.

2) **GAIN** at “x1”; attenuator at **“CAL”.**

3) Move sensor until **OVERLOAD** indicator is extinguished.

An explanation of how this procedure works is given below with reference to the Single Axis Block Diagram in Figure 4.1.

The approach to avoiding preamplifier saturation is to use the signal conditioner overload detector circuit to monitor the output voltage of the preamplifier itself. This is possible when the gain of the intervening circuits is exactly one. In order to ensure unity gain from the preamp output to the overload detector, it is necessary to place the variable attenuator at CAL and the Gain Range Switch at X1. Overload is caused by power line pickup at 60 Hz and its harmonics. For this reason, it is important that the power line rejection filters be **switched out** of the signal path when the overload detector is being used to monitor saturation of the preamplifier. Otherwise, the preamplifier output could be saturating at power line frequency or one of its harmonics, yet the rejection filters would prevent the overload indicator from revealing this condition to the operator.

When preamplifier overload is detected, there is no remedy other than relocating or reorienting the coil or coils in question. Note carefully that the line notch filters are of absolutely no avail because they are downstream of the preamplifier output where the saturation is occurring. Also, the line filters can be harmful, because they can mask the effects of preamplifier saturation if switched in, as explained above.

Given that the preamplifier is operating linearly, the gain and variable attenuator controls are set to provide a conveniently large output signal. It is here that the line notch filters have their proper use. Switching them in can eliminate an output saturation condition caused by power line pickup.

4.2 BATTERY MAINTENANCE INSTRUCTIONS

The NICAD batteries should be used until the LO-BAT indicator comes on before being recharged. They should then be recharged overnight by placing the **POWER SELECT** switch on the rear panel in the AC/CHG position and connecting the a.c. line power cord to a source of 115 VAC. A full charge takes about 16 hours and, while charging may be continued longer without immediate damage, the switch should not be left in the charge position for extended periods.

The charge indicator LED on the front panel will dim when the batteries approach full charge but will not extinguish.

<u>Note that for optimum noise performance of the signal conditioner, the a.c. line cord should be disconnected</u>. Operation on a.c. is provided only as an expedient.

4.3 BATTERY REPLACEMENT

Remove the case of the signal conditioner by first removing twelve (12) Phillips head screws and then sliding the cover to the rear. It is recommended that the Battery Fuse be removed during this operation.

Invert the signal conditioner chassis and remove two 6-32 screws securing the battery bracket.

Replace the batteries with two of the following:

Alexander H4463B, 15V, 500 mAH.

These batteries are widely used in portable communications gear and are thought to be available worldwide.

Reverse the above procedures, being sure to reinsert the battery fuse.

5. CIRCUIT DESCRIPTION

5.1 SIGNAL CONDITIONER

5.1.1 Signal Processing Amplifiers

Refer to the schematic drawing of the Signal Conditioner in Appendix A, Figure 5.1. The description below is in terms of the X channel which is shown explicitly in the diagram; it applies also to the identical y and z channels of which the component designations begin with 1 and 2, respectively.

In the signal conditioner, switch S11 places the line notch filters in or out of the signal path. C103 and R120 form a high pass filter that prevents d.c. offset voltage of the preamplifier from being amplified by U14A. Control R120 is the variable attenuator that allows continuous gain adjustment from 0 to unity. Another high pass filter is formed by C105, R136 and R137. Trimming potentiometer R136 allows calibration of the channel gain. The parallel combination of R136 and R137 forms a low pass filter with C106 that rolls the instrument gain off above 18 kHz.

Amplifier U14 is a unity gain buffer required to drive input resistor R156 without attenuation.

The saturation detector consists of zener diode CR15 in series with light emitting diode CR16. Diodes CR11 - CR14 form a full wave rectifier that makes the L.E.D. glow on both polarities of signal excursion. Resistor R155 controls the L.E.D. current and sets its brightness. Approximately 9 volts of amplifier output are required to cause the zener to conduct. Full brightness is achieved at 10 volts output, and output amplifier clipping occurs at about +12 volts output.

Note that the connection between power supply common and high quality ground occurs at, and only at, the positive input of the preamplifier. Thus, all voltage amplification in the signal processor is referred to the same reference point as the sensor coil, namely the positive input of the preamplifier.

In order for the signal conditioner to operate properly when being tested, this connection between HQ ground and Power ground must be made externally. That is the function served by the connection between pins B and E on the input connector shown in Figure 6.1.

5.2 NOTCH FILTERS

The top tier of circuitry on the schematic diagram is the notch filter electronics; it consists of 5 sets of cascaded circuits which are identical except for element values. The first set comprises amplifiers U11A and U11B and performs the band-reject or notch filter function for the fundamental frequency of power line interference. Amplifier U11A is a tuned amplifier which is resonant at the notch frequency; its gain is minus unity at resonance and small elsewhere as dictated by a Q of approximately 10. The inverted output of the resonator is added to the signal itself in amplifier U11B to implement the band reject function. Analog switch U16 connects resistors R102 and R103 into the circuit to raise the resonant frequency from 50 to 60 Hz.

The other sets of cascaded circuits perform analogously to provide notches at the first four harmonics of the selected power line frequency.

Switch S11 selects whether or not the filters are in the signal path. It also removes power from the integrated circuits when the filters are not in use.

Switch S2 on the rear panel selects 50 Hz or 60 Hz operation of the notch filters.

5.3 BATTERY CHARGER CIRCUIT

The three-mode circuit which provides line power and charges the NICAD batteries is shown in Figure 5.2 in Appendix A.

When rotary switch S3 is in position 1, AC, the circuit is purely a.c. powered, and the NICAD batteries are disconnected. When the switch is in position 2, AC/CHG, the unit continues to be powered by a.c., but the NICAD batteries are connected so as to charge in parallel across the 30V d.c. supply provided by power supply PS1. That is battery BAT 2 is connected in series with R13 and CR4 across the supply voltage. Resistor R13 sets the charging current at the 16-hour rate (about 36 mA). Diode CR4 prevents self discharge of the batteries in the event of a.c. interruption. Battery BAT 1, Resistor R10 and diode CR3 function in the same way.

When the rotary switch is in position 3, BAT, the batteries are connected in series to form a 30 VDC supply and power supply PS1 is open circuited.

5.4 VOLTAGE SPLITTER

In both a.c. and battery modes, a voltage splitting circuit provides a power common or ground terminal for the signal conditioner. Please refer to Figure 5.2 in Appendix A. Resistors R4 and R5 and voltage follower amplifier U2 provide a low impedance ground rail by splitting the incoming 30 volt supply.

A voltage monitor circuit is formed by resistive divider R2, R3 and integrated circuit U1. A fraction of the battery voltage is compared with an internal reference voltage. When the battery voltage falls below 24.6 volts nominal, the LO BAT LED, CR1, is illuminated.

6. SUGGESTIONS FOR ELECTRONIC CHECKOUT

6.1 SIGNAL CONDITIONER

Overall performance of the signal processor can be verified using an audio signal generator and a LEMO FGG.1B307 clad connector, as shown in Figure 6.1. Be sure to jump pin B to pin E or the circuit will not function.

The operation of the overload detector circuit can be verified by observing the output on an oscilloscope while varying the input signal amplitude.

The relative gains provided by the Gain Range Switch can also be checked using this setup.

6.2 FREQUENCY RESPONSE TEST OF COMPLETE INSTRUMENT

A check of the instrument can be performed using a coil of wire and the Hewlett-Packard 3582A Spectrum Analyzer. The general arrangement of the test is given in Figure 6.2.

The performance of the notch filters can be conveniently demonstrated and measured with the setup of Figure 6.2 by running transfer functions with filters switched in.

6.3 CALIBRATION CHECK

A **CALIBRATION INPUT** BNC connector for each channel is found on the rear panel of the TCM-1A. A signal source connected to this input produces a magnetic field of 20 nanotesla/volt in any standard MEDA sensor. Because the basic scale factor of the instrument is 25 mV/nanotesla, this calibration input produces 1 volt out for two volts in.

A function check of the instrument can be made by connecting an audio signal generator to the **CAL. INPUT** and testing with an oscilloscope to verify that there is a gain of 0.5 at the **MONITOR OUTPUT** BNC on the rear panel or **OUTPUT** BNC on the front panel. Perform this check for each channel and vary the frequency over the bandwidth specified for the sensor in use.

Be sure that:

1) The variable **GAIN** control on the front panel is turned fully counterclockwise to the click position.

2) The **GAIN** switch on the front panel is set to 1. (In fact, the operation of this control can be verified during this test, because the gain of the instrument from **CAL** input to OUTPUT should be exactly the same as the setting of this **GAIN** switch.

The overall transfer function of the instrument can be measured conveniently as follows:

Connect a spectrum analyzer such as the HP 3582A to measure the transfer function between the **CAL** input and the **OUTPUT** or MONITOR OUTPUT. The effect of the notch filters will be observed in the transfer function when the **FILTERS** switch is **IN**.

7. SPECIFICATIONS

FREQUENCY RESPONSE **Flat Output:**	5 Hz to 10 kHz (3dB points)
ACCURACY @ **160 Hz:** **20 <frequency <2000 Hz:**	±1% Maximum 1dB peak-to-peak deviation
POWER LINE REJECTION FILTERS **Switch Selectable:**	40 dB notches at 50, 100, 150, 200, 250 Hz 40 dB notches at 60, 120, 180, 240, 300 Hz
A.C. POWER:	105 V to 125 V ac, 50 to 400 Hz - 7.2 WATTS
BATTERY POWER SUPPLY **Battery:** **Voltage:** **Capacity:** **Charging Time from Full Discharge:**	2 Alexander H4463B, in Series 30 V 500 mAH 16 H
CURRENT DRAIN (NOMINAL) **All Filters In:** **Filters Out:**	161 mA 122 mA

APPENDIX A

DRAWINGS

APPENDIX B

PARTS LIST

TCM-1A SIGNAL CONDITIONER ASSEMBLY

REF. DES.	PART NUMBER	DESCRIPTION	MANUFACTURER
		SCHEMATIC DIAGRAM, SIG COND	MEDA
	402197-1	MACHINING DRAWING PCB, SIG COND	MEDA
	400042-1	FRONT PANEL, SIG COND	MEDA
	401069-1	REAR PANEL, SIG COND	MEDA
	400044-1	HOUSING, SIG COND	MEDA
	200045-1	MOUNTING EAR, RACK	MEDA
	FA-201	BUTTON, LAMPLESS INDICATOR	ITT SCHADOW
	200038-1	SWITCH DETENT BRACKET	MEDA
	KPN-500B 1/8	KNOB - GAIN SELECT	ALCO
	KPN-500B ¼	KNOB - POWER SELECT	ALCO
	KLN-500B 1/8	KNOB - VARIABLE GAIN	ALCO
	MP40008-10	TILT STAND	BUCKEYE
	301064-1	BATTERY BRACKET	MEDA
B1 + B2	H4463B	NICAD BATTERY, 5V, 500 mAH	ALEXANDER
C1	199D336X9025EE2	33µF, 25V, ELECTROLYTIC	SPRAGUE
C2	199D336X9025EE2	33µF, 25V, ELECTROLYTIC	SPRAGUE
C3	199D336X9025EE2	33µF, 25V, ELECTROLYTIC	SPRAGUE
C4	CK05BX104K	.1µF, CERAMIC, 10%	AVX
*C101	PPA11.1-1-100	.1µF, 1%, POLYPROPYLENE	F-DYNE
C102	PPA11.1-1-100	.1µF, 1%, POLYPROPYLENE	F-DYNE
C103	CK06BX105K	1µF, CERAMIC	AVX
C104	CC05CG101G	100pF, 2%, NPO CERAMIC	ANY MFR.
C105	CK05BX104K	.1µF, CERAMIC	ANY MFR.
C106	CCO5CG220F	22pF, 1%, NPO CERAMIC	ANY MFR.
C111	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C112	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C113	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C114	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C115	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C116	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C117	CC05CG101G	100pF, 2%, NPO CERAMIC	ANY MFR.
C121	PPA11.1-1-100	.1µF, 1%, POLYPROPYLENE	F-DYNE
C122	PPA11.1-1-100	.1µF, 1%, POLYPROPYLENE	F-DYNE
C141	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE
C142	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE
C151	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C161	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE
C162	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE
C181	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE

*NOTE: X CHANNEL PARTS: TENS & ONE HUNDRED SERIES (LISTED)
Y CHANNEL PARTS: TWENTY & TWO HUNDRED SERIES (NOT LISTED)
Z CHANNEL PARTS: THIRTY & THREE HUNDRED SERIES (NOT LISTED)

TCM-1A SIGNAL CONDITIONER ASSEMBLY

REF. DES.	PART NUMBER	DESCRIPTION	MANUFACTURER
C182	PPA11.025-1-100	.025µF, 1%, POLYCARBONATE	F-DYNE
C191	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
C192	CK05BX104K	.1µF, 10%, CERAMIC	ANY MFR.
CR1	SLD821-2	L.E.D., RED	ALCO
CR2	SLD821-2	L.E.D., RED	ALCO
CR3	1N4001	DIODE	ANY MFR.
CR4	1N4001	DIODE	ANY MFR.
CR11	1N914	DIODE, SILICON	MOTOROLA
CR12	1N914	DIODE, SILICON	MOTOROLA
CR13	1N914	DIODE, SILICON	MOTOROLA
CR14	1N914	DIODE, SILICON	MOTOROLA
CR15	1N753A	DIODE, ZENER, 6.2V	MOTOROLA
CR16	SLD821-2	L.E.D., RED	ALCO
F1	270-1171	FUSE, 1 AMP SLOW-BLOW, 5X20 mm	RADIO SHACK
F2	270-1169	FUSE, ½ AMP SLOW-BLOW, 5X20 mm	RADIO SHACK
FH1	270-362	FUSE HOLDER	RADIO SHACK
FH2	270-362	FUSE HOLDER	RADIO SHACK
J1	17252	RECEPTACLE, AC	BELDEN
	17758	POWER CORD SET	BELDEN
	211	BATTERY CONTACT	KEYSTONE
	3384	RIVET, SEMI-TUBULAR	KEYSTONE
J11	EGG1B 307 CLL	CONNECTOR, SENSOR INPUT	LEMO
J13	800-2540-03-25	CONNECTOR, BNC ISOLATED	CONCORD
J14	800-2540-03-25	CONNECTOR, BNC ISOLATED	CONCORD
J15	800-2540-03-25	CONNECTOR, BNC ISOLATED	CONCORD
L11	56-590 65/4A6	INDUCTOR, FERRITE BEAD	FERROX-CUBE/ PHILLIPS
L12	56-590 65/4A6	INDUCTOR, FERRITE BEAD	FERROX-CUBE/ PHILLIPS
PS1	2.15.200	POWER SUPPLY	CALEX
R1	RC07C1242J	2.4K, 1/8W, 5% CC	ANY MFR.
R2	RN55D5623F	562K, 1/8W, 1%	ANY MFR.
R3	RN55D3921F	3.92K, 1/8W, 1%	ANY MFR.
R4	RN55D3921F	3.92K, 1/8W, 1%	ANY MFR.
R5	RN55D3921F	3.92K, 1/8W, 1%	ANY MFR.
R6	RN55D1004F	RESISTOR, 1M, 1/8W, 1%	ANY MFR.
R7	RN55D4993F	RESISTOR, 499K, 1/8W, 1%	ANY MFR.
R9	RC07GF395J	RESISTOR, 3.9M, 1/4W, 5% CC	ANY MFR.

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REF. DES.	PART NUMBER	DESCRIPTION	MANUFACTURER
R10	RNC65J9530FS	953 OHMS, 5%, 1/2W	ANY MFR.
R11	RN55D5621F	5.62K OHMS, 1%	ANY MFR.
R12	RN55D5621F	5.62K OHMS, 1%	ANY MFR.
R13	RNC65J9530FS	953 OHMS, 5%, 1/2W	ANY MFR.
R101	RNC55H2673B	RESISTOR, 267K, 1/8W, .1%, 50 ppm	ANY MFR.
R102	RN55D4121F	RESISTOR, 4.12K, 1/8W, 1%	ANY MFR.
R103	3292W-1-501	POT, 20T, 500 OHMS, CERMET	ANY MFR.
R104	RN55D1821F	RESISTOR, 1.82K, 1/8W, 1%	ANY MFR.
R105	3292W-1-201	POT, 20T, 200 OHMS, CERMET	BOURNS
R108	RN55D5363F	RESISTOR, 536K, 1/8W, 1%	ANY MFR.
R109	RC07GF395J	RESISTOR, 3.9M, 1/4W, 5%	ANY MFR.
R110	RN55D2002F	RESISTOR, 20K, 1/8W, 1%	ANY MFR.
R111	RN55D2002F	RESISTOR, 20K, 1/8W, 1%	ANY MFR.
R112	RN55D2002F	RESISTOR, 20K, 1/8W, 1%	ANY MFR.
R113	RC07GF305J	RESISTOR, 3M, 1/4W, 5%, CC	ANY MFR.
R115	RC07GF126J	RESISTOR, 12M, 1/4W, 5%, CC	ANY MFR.
R116	RNC55H1302BS	RESISTOR, 13K, 1/8W, 0.1%	ANY MFR.
R117	RN55C2941B	RESISTOR, 2.94K, 1/8W, 0.1%	ANY MFR.
R118	RN55C9090B	RESISTOR, 909 OHMS, 1/8w, 0.1%	ANY MFR.
R119	RNC55H2670B	RESISTOR, 267 OHMS, 1/8W, 0.1%	ANY MFR.
R120	70L4G032R104W	POT, SINGLE TURN, 100K, CERMET	CLAROSTAT
R121	RN55D1333F	RESISTOR, 133K, 1/8W, 1%	ANY MFR.
R122	RN55D1821F	RESISTOR, 1.82K, 1/8W, 1%	ANY MFR.
R123	3292W-1-501	POT, 20T, 500 OHMS, CERMET	BOURNS
R124	RN55D9090F	RESISTOR, 909 OHMS, 1/8W, 1%	ANY MFR.
R125	3292W-1-201	POT, 20T, 200 OHMS, CERMET	ANY MFR.
R128	RNC55H2673B	RESISTOR, 267K, 1/8W, 0.1%, 50 ppm	ANY MFR.
R130	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R131	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R132	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R135	RN55C2612B	RESISTOR, 26.1K, 1/8W, 0.1%	ANY MFR.
R136	3292W-1-503	POT, 20T, 50K, CERMET	BOURNS
R137	RN55D8253F	RESISTOR, 825K, 1/8W, 1%	ANY MFR.
R141	RN55D3573F	RESISTOR, 357K, 1/8W, 1%	ANY MFR.
R142	RN55D5621F	RESISTOR, 5.62K, 1/8W, 1%	ANY MFR.
R143	3292W-1-501	POT, 20T, 500 OHMS, CERMET	BOURNS
R144	RN55D2491F	RESISTOR, 2.49K, 1/8W, 1%	ANY MFR.
R145	3292W-1-201	POT, 20T, 200 OHMS, CERMET	BOURNS
R148	RN55D7153F	RESISTOR, 715K, 1/8W, 1%	ANY MFR.
R150	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R151	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R152	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R153	RC07GF305J	RESISTOR, 3M, 1/4W, 5%	ANY MFR.
R155	RC07GF301J	RESISTOR, 300 OHMS, 1/4w, 5%	ANY MFR.
R156	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.

TCM-1A SIGNAL CONDITIONER ASSEMBLY

REF. DES.	PART NUMBER	DESCRIPTION	MANUFACTURER
R157	RN55D9092F	RESISTOR, 90.9K, 1/8W, 1%	ANY MFR.
R158	RN55D2612F	RESISTOR, 26.1K, 1/8W, 1%	ANY MFR.
R161	RNC55H2673B	RESISTOR, 267K, 1/8W, 0.1%, 50 ppm	ANY MFR.
R162	RN55D4121F	RESISTOR, 4.12K, 1/8W, 1%	ANY MFR.
R163	3292W-1-501	POT, 20T, 500 OHMS, CERMET	BOURNS
R164	RN55D1821F	RESISTOR, 1.82K, 1/8W, 1%	ANY MFR.
R165	3292W-1-201	POT, 20T, 200 OHMS, CERMET	BOURNS
R168	RN55D5363F	RESISTOR, 536K, 1/8W, 1%	ANY MFR.
R170	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R171	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R172	RN55C2002B	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R173	RN55D49R9F	RESISTOR, 49.9 OHMS, 1/8W, 1%	ANY MFR.
R174	RN55D49R9F	RESISTOR, 49.9 OHMS, 1/8W, 1%	ANY MFR.
R175	RN55D49R9F	RESISTOR, 49.9 OHMS, 1/8W, 1%	ANY MFR.
R181	RN55D2103F	RESISTOR, 210K, 1/8W, 1%	ANY MFR.
R182	RN55D3321F	RESISTOR, 3.32K, 1/8W, 1%	ANY MFR.
R183	3292W-1-501	POT, 20T, 500 OHMS, CERMET	ANY MFR.
R184	RN55D1431F	RESISTOR, 1.43K, 1/8W, 1%	ANY MFR.
R185	3292W-1-201	POT, 20T, 200 OHMS, CERMET	BOURNS
R188	RN55D4223F	RESISTOR, 422K, 1/8W, 1%	ANY MFR.
R190	RN55C2002F	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R191	RN55C2002F	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R192	RN55C2002F	RESISTOR, 20K, 1/8W, 0.1%	ANY MFR.
R193	RC07GF395J	RESISTOR, 3.9M, 1/4W, 5%, CC	ANY MFR.
S1	NE1800EEF08010 1124201NN	SWITCH, POWER	ITT SCHADOW
S2	A123S1YZQ	SWITCH, SPDT	ALCO
S3	71BDF36-03-2-AJN	SWITCH, POWER SELECT	GRAYHILL
S11	A323S1YZQ	SWITCH, 3PDT TOGGLE	ALCO
S13	50CD36-01-1-AJN	SWITCH, 36 DEG. ROTARY	GRAYHILL
U1	LM10CN	OP AMP	NSC
U2	LM346N	OP AMP	NSC
U11	LM346N	OP AMP	NSC
U12	LM346N	OP AMP	NSC
U13	LM346N	OP AMP	NSC
U14	AD712AH	OP AMP DUAL BI-FET	ANALOG DEVICES
U15	AD712AH	OP AMP DUAL BI-FET	ANALOG DEVICES
U16	CD4066BE	ANALOG SWITCH	RCA
U17	CD4066BE	ANALOG SWITCH	RCA
