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BOONTON ELECTRONICS CORPORATION

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INSTRUCTION MANUAL

MODELS 42B & 42C

R.F. MICROWATTMETERS

This instruction manual applies to instruments with serial numbers 3227 and above.

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SECTION I

GENERAL INFORMATION

1-1. SAFETY NOTICE

This instrument is furnished with a three-conductor power cable and three-prong plug so that, when the plug is inserted in a properly polarized a.c. power receptacle, the instrument is grounded. The instrument depends upon such connection to ground for equipment and operator safety.

***** WARNING *****

> To avoid the possibility of electrical shock, before anything is connected to this instrument, and before you use this instrument, make certain that its power cable is plugged into a mating a.c. receptacle that has a grounded ("earthed") contact.

Never defeat the instrument's protective grounding. For example: Do not use an extension power cable if it is not equipped with a ground conductor; do not plug the instrument into an a.c. receptacle that does not provide a high-quality earth ground. If only a two-terminal a.c. power receptacle is available, use a three-prong-to-two-prong adapter and connect the ground wire of the adapter to the power-receptacle ground. Do not use such an adapter if the ground wire cannot be grounded.

1-2. DESCRIPTION

A. General. This instruction manual applies to Models 42B and 42C R.F. Microwattmeters. These instruments differ only in their power ranges (10 nW - 10 mW f.s. for the 42B, 100 nW - 100 mW f.s. for the 42C) and their power sensors (series 41-4 for the 42B, series 41-5 for the 42C). To avoid repetition, 42B is used throughout the manual; it is to be understood that the information applies as well to the 42C. In those places where data for the two differ, the first datum given applies to the 42B and the datum for the 42C follows in brackets [ ].

The 42B R.F. Microwattmeter determines r.f. power by measuring the voltage appearing across a precision noninductive resistor in the Power Sensor. The panel meter is calibrated in terms of power according to the relationship $P = E^2/R$. This detection system has important performance advantages over power meters using bolometer or thermocouple detection. The sensitivity is several orders of magnitude better; temperature stability of better than 0.01 dB/°C supports this sensitivity; and a burnout level above 300 mW [2 W] reduces the most common cause of detector failure.

This instrument is available with a number of options and Power Sensors. For all options, input-range programming can be controled by TTL logic, or transistors (or switches) to ground. It is packaged as a compact bench instrument, with a combination carrying handle and an adjustable-angle mounting foot. Should rack mounting be preferred, hardware kits to accommodate either one or two instruments are available.

B. Frequency Range. The calibrated frequency range extends from 0.2 MHz to 18 GHz, depending upon the particular sensor used. Useful response for relative measurements can be obtained from 20 kHz to approximately 20 GHz.

C. Power Range. With any of the sensors, the Model 42B will measure power from 1 nW [10 nW] up to 10 mW [100 mW]. Temporary overloads up to 300 mW [2 W] will do no permanent harm to the instrument or the sensor. When measuring the average power of pulsed signals, the accuracy is good up to 35 µW [350 µW] instantaneous peak power. The power capabilities of the 42B can be increased by the use of external attenuators.

§1-2, continued.

D. Response. At low power levels the sensor diodes operate in the square-law region; the instrument response is to the true average power of c.w., a.m., f.m., and pulsed signals. Above the transition level of approximately 20 μW [200 μW] average power, although response tends toward the peak value, the panel meter is calibrated in terms of average power; the instrument will correctly indicate the true average power of c.w. and f.m. signals.

E. Noise. The 42B has been designed and constructed to hold noise from all sources to a minimum. The Power Sensor cable is of special low-noise design; a vigorous flexing causes only momentary, minor deflection on the most sensitive range of the instrument. The Power Sensor is not sensitive to shock or vibration; even sharp tapping on its barrel causes no visible deflection on any range.

F. Zero Adjustment. Zero adjustment is normally not required on the upper ranges of the 42B. For measurement on the lower ranges, the ZERO control is adjusted on the instrument's most sensitive range before using. This control balances out small thermal voltages in the sensing elements and, once adjusted, requires only infrequent checking during the course of subsequent measurements.

G. Calibration-Factor Adjustment. A front-panel-mounted control allows the sensitivity of the 42B to be adjusted ± 1 dB to correct for the frequency response and mismatch errors of the sensor. Calibration is in the form of indicated power to incident power.

H. Analog Output. The 42B provides a d.c. output voltage proportional to the power being measured. The current capability of 1 mA in 1000 ohms is extremely stable. When used as part of an automatic test system, it is necessary to allow a settling time for the d.c. output level to reach final value after a step function in r.f. input. The settling time varies with the range and the size of the step.

1-3. ACCESSORIES FURNISHED

Model 41-2A, five-foot power-detector cable. Longer cables are available on special order.

1-4. REQUIRED ACCESSORIES

One of the following Power Sensors should be ordered with the instrument. See Specifications, §1-7, for details.

A. For Model 42B: Sensor 41-4A, 41-4B, 41-4C, or 41-4E.

B. For Model 42C: Sensor 41-5B or 41-5E.

1-5. ACCESSORIES AVAILABLE

A. Model 950030, Double Rack-Mounting Kit. Kit for mounting two 42B's side by side in a standard 19-inch rack.

B. Model 950032, Single Rack-Mounting Kit. Kit for mounting one 42B as one half of a module in a standard 19-inch rack.

C. Model 960000, Extender Card. Allows plug-in printed-circuit board to be operated in elevated position (to facilitate servicing).

1-6. OPTIONS

A. Option -08, Rear-Signal Input option. A duplicate connector for the sensor cable is provided on the rear panel of the instrument.

B. Option -11, Reversed Scales (power scale uppermost).

1-7. SPECIFICATIONS

POWER RANGE: 42B	1 nW (-60 dBm) to 10 mW (+10 dBm), 7 decades
42C	10 nW (-50 dBm) to 100 mW (+20 dBm), 7 decades
FULL-SCALE POWER RANGES:	
42B	10 nW, 100 nW, 1 µW, 10 µW, 100 µW, 1 mW, 10 mW
42C	100 nW, 1 µW, 10 µW, 100 µW, 1 mW, 10 mW, 100 mW
FREQUENCY RANGES (with indicated Power Sensor):	
42B	Model 41-4E (50 Ω): 0.2 MHz to 18.0 GHz Model 41-4B (50 Ω): 0.2 MHz to 12.4 GHz Model 41-4A (50 Ω): 0.2 MHz to 7.0 GHz Model 41-4C (75 Ω): 0.2 MHz to 1.0 GHz
42C	Model 41-5E (50 Ω): 0.2 MHz to 18.0 GHz Model 41-5B (50 Ω): 0.2 MHz to 12.4 GHz
INSTRUMENT ACCURACY:	±(0.5% f.s. + 0.15 dB) above 10 nW [100 nW] ±(1.0% f.s. + 0.15 dB) below 10 nW [100 nW]
CALIBRATION-FACTOR CONTROL:	Variable ±1 dB
METER:	4-1/2 inch taut-band, with two scales. Top scale (red), dBm: -11 to 0 dBm Bottom scale (black), power: 1 to 10
METER UNREST:	
42B (On 10 nW Range)	Above 4 nW: 1% f.s., max. 1 to 4 nW: 2% f.s., max.
42C (On 100 nW Range)	Above 40 nW: 1% f.s., max. 10 to 40 nW: 2% f.s., max.
ZERO DRIFT:	1 nW/hr [10 nW/hr] max., on 10 nW [100 nW] range
WAVEFORM RESPONSE:	
42B	1 nW to 20 µW, true average power; above 20 µW, average power of sine wave.
42C	10 nW to 200 µW , true average power; above 200 µW, average power of sine wave.
D.C. OUTPUT:	0 to 10 V on each range, proportional to input power; 9 kΩ source, 1 mA max. into 1 kΩ.
TEMPERATURE INFLUENCE:	

Temperature Range	Effect: Instrument	Effect: Sensor
21°C to 25°C	0 dB	0 dB
18°C to 30°C	0	±0.1
10°C to 40°C	±0.2	±0.2

R.F.I.:	No detectable radiated or conducted leakage from instrument or sensor.
INPUT STEP-FUNCTION RESPONSE TIME:	F.s., 10 µW to 10 mW [100 µW to 100 mW], 100 ms; f.s., 10 nW to 1 µW [100 nW to 10 µW], 1 s.
COMMANDS:	TTL-logic-level zero selects Manual Disable and Input Range.
POWER:	115 or 230 V ±10%, 50 - 400 Hz, 8 W.
DIMENSIONS:	132 mm high (without feet) × 211 wide × 305 deep (5.2 in. × 8.3 × 12).
WEIGHT: Net	3.2 kg (7.0 lb), with sensor and cable
Shipping	5.0 kg (11 lb)
POWER SENSORS:	See Table 1-1.

§1-7, continued.

Table 1-1. Power-Sensor Specifications

MODEL	41-4A	41-4B	41-4C	41-4E	41-5B	41-5E
INPUT	50 Ω	50 Ω	75 Ω	50 Ω	50 Ω	50 Ω
FREQUENCY RANGE	200 kHz-7 GHz	200 kHz-12.4 GHz	200 kHz-1 GHz	200 kHz-18 GHz	200 kHz-12.4 GHz	200 kHz-18 GHz
POWER RANGE	10 nW to 10 mW, f.s.				100 nW to 100 mW, f.s.	
SUM OF CALIBRATION-FACTOR UNCERTAINTIES	1%, 200 kHz-300 MHz 1.3%, 300 MHz-2 GHz 3.0%, 2 GHz-4 GHz 3.5%, 4 GHz-7 GHz	1%, 200 kHz-300 MHz 1.3%, 300 MHz-2 GHz 3%, 2 GHz-4 GHz 3.5%, 4 GHz-8 GHz 4.0%, 8 GHz-10 GHz 4.5%, 10 GHz-12 GHz 6.0%, 12 GHz-18 GHz				
		41-4A, -4B, -4C, -4E: Add 0.05 dB/mW above 4 GHz			41-5B, -5E: Add 0.005 dB/mW above 4 GHz	
MAXIMUM S.W.R.	1.12, 200 kHz-2 GHz 1.2, 2 GHz-4 GHz 1.4, 4 GHz-7 GHz	1.12, 200 kHz-2 GHz 1.2, 2 GHz-4 GHz 1.4, 4 GHz-11 GHz 1.6, 11 GHz-12.4 GHz	1.18, 200 kHz-1 GHz	1.3, 200 kHz-4 GHz 1.5, 4 GHz-10 GHz 1.7, 10 GHz-18 GHz	1.07, 200 kHz-1 GHz 1.10, 1 GHz-2 GHz 1.12, 2 GHz-4 GHz 1.18, 4 GHz-12.4 GHz	1.07, 200 kHz-1 GHz 1.10, 1 GHz-2 GHz 1.12, 2 GHz-4 GHz 1.18, 4 GHz-12.4 GHz 1.28, 12.4 GHz-18 GHz
MAXIMUM AVERAGE POWER	10 mW (+10 dBm)				100 mW (+20 dBm)	
OVERLOAD RATING	300 mW (+25 dBm)				2 W (+33 dBm)	
R.F. CONNECTOR	Precision Type N male					
CALIBRATION FACTOR	Individually calibrated at up to nine frequencies, depending upon sensor.					

SECTION II

INSTALLATION & OPERATION

2-1. INSTALLATION

The 42B has been inspected and tested at the Factory before packing, and it is shipped ready for operation. If there is any indication of shipping damage, immediately notify the carrier before you attempt to put the 42B into operation.

2-2. OPERATING CONTROLS AND INDICATORS

All controls, indicators and connectors used during operation of the 42B are described in Table 2-1, below.

Table 2-1. Operating Controls, Indicators, and Connectors

ITEM	FUNCTION
PWR OFF Switch	Depressing this switch turns the 42B "off".
FULL SCALE Pushbuttons	Depressing any full-scale range pushbutton will turn "on" the 42B and select the operating range
Meter	Power scale, reading 1 to 10, 1% or 2% divisions dBm scale, -10 to 0 dBm, 0.2 or 0.5 dB divisions
POWER SENSOR	The sensor cable connects to the 42B through this jack. Always check that the knurled ferrule nut of the sensor-cable connection is tightened.
ZERO Control	This control is used to zero the 42B electrically.
CAL FACTOR	Compensates for frequency effect at f > 1 GHz.
Fuse Holder (Rear Panel)	Line fuse. For 115 V, 0.10 A; for 220 V, 0.06 A; either fuse to be MDL SLO-BLO.
Slide Switch (Rear Panel)	Switch is to be set to 115 or 230 V, according to the available line voltage.
Recorder Output (Rear Panel)	A d.c. voltage proportional to the applied power level is available at these terminals.
REMOTE CONNECTIONS (Rear Panel)	The card-edge plug is intended for use with an Amphenol 225-22221-101 connector, or equivalent. See Table 2-2 for pin designations.

2-3. SAFETY REQUIREMENT SYMBOL

This safety requirement symbol (on the rear panel) has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that an instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available, and that the switch on the rear panel is set to the applicable operating voltage.

2-4. INITIAL OPERATING PROCEDURES

A. Be sure that the serial number of the sensor to be used is the same as that of the instrument. (Each 42B is calibrated for its particular sensor.) Use of a sensor other than that for which the instrument was calibrated may result in measurement errors.

B. Check the setting of the power switch on the rear panel to be sure that it is set to the proper position for the line voltage in use. See that the proper fuse for this voltage is installed in the fuseholder.

C. Connect the sensor cable to the POWER SENSOR front-panel jack; tighten the knurled clamping nut firmly. Attach the power sensor to the cable. If necessary, "zero" the meter with the zero-screw below the meter face.

D. Set the CAL FACTOR control to 0 dB.

E. Plug the instrument's power cable into a power receptacle and depress the 10 nW [100 nW] FULL SCALE pushbutton. Allow a few minutes for the 42B to warm up.

F. If the meter pointer does not remain at the red/black zero reference mark at the extreme left-hand end of the scale, use the ZERO control to adjust it. Because of the instrument's sensitivity on this range, indicator fluctuations of up to 0.5 dB can be expected. Proper zero adjustment is reached when the pointer fluctuates evenly around the zero reference mark. If the sensor is in a strong power-line or noise field, zeroing may be difficult. In this situation, refer to §2-6G for shielding instructions.

For zeroing, it is important that the sensor be in thermal equilibrium. Consequently, prolonged handling of the sensor should be avoided within a few minutes before, or during, this adjustment.

2-5. OPERATING NOTE

The power sensors are carefully insulated against external temperature variations. However, when the most sensitive ranges of the instrument are in use, it is advisable to locate the sensor away from any sources of heat. If it is monitoring the output of equipment that generates heat significantly above ambient temperature, the sensor should be allowed to reach thermal equilibrium before measurements are made.

2-6. OPERATION

A. <u>Low-Level Measurements</u>. The 42B will provide reliable, reproducible measurements of c.w., a.m., and f.m. power levels as low as 1 nW [10 nW]. It can also be used, although with slightly decreased accuracy (±1 dB), for pulse measurements. The peak power in this mode, however, should not exceed 35 μW [300 μW]. Above this level the detector enters the region where it ceases to function as a square-law detector; accuracy, except for c.w. and f.m., cannot be guaranteed under these conditions.

When using the three most sensitive ranges, the preliminary zero adjustment is required (see §2-4F).

B. High-Level Measurements. When using the higher ranges of the 42B, it is not necessary to make the zero adjustment. As noted in §2-6A, accuracy cannot be guaranteed when measuring pulse power with peaks exceeding 35 μW [300 μW]. For c.w. and f.m., power measurements within the specified accuracy will be obtained up to 10 mW [100 mW].

C. High-Frequency Measurements. To obtain the specified accuracy of the 42B at frequencies above 1 GHz, reference must be made to the correction table on the barrel of the power sensor. This table, which is individually determined for each power sensor, presents a correction factor vs frequency that must be applied to the instrument reading. While this can be done by adding algebraically the correction to the reading, use of the CAL FACTOR control automatically inserts the correction and enables the operator to read the meter directly. This control is adjusted as follows:

Read the correction to be applied at the frequency of operation from the table on the sensor's barrel. As an example, say that the correction is +0.2 dB. Set the CAL FACTOR control to +0.2 dB. All values thereafter, at that frequency, are read directly from the meter, with no further correction needed. Note that if the frequency of measurement is changed, a new CAL FACTOR setting will be required.

NOTE: The Model 41-4A, 41-4B, 41-4E, 41-5B and 41-5E sensors are calibrated for use with a 50 Ω source. Deviations from 50 Ω may give rise to errors from mismatch and increased s.w.r. This effect can be reduced by inserting a low-s.w.r. attenuator (s.w.r. $<$ 1.10) between the source and the sensor; an alternative would be the insertion of a low-loss tuner, or isolator.

The Model 41-4C sensor is calibrated for use with a 75 Ω source. Similar considerations apply for deviations from 75 Ω.

D. High-Frequency Errors. Power measurements, particularly at high frequencies, are fraught with a number of uncertainties. These include such questions as: What power do we want to measure? What power is being measured? How do we convert the indicated power to the wanted power?

If all power sources and power meters had impedances that were resistive and equal to Z_O (the characteristic impedance of the measuring system), most of these problems would disappear. The incident, dissipated, and maximum available powers would all be equal, and the indicated power would differ from them only by the inefficiency of the sensor in converting all of the dissipated power to indicated power. (This inefficiency is called the effective efficiency and, for a power sensor whose input impedance is resistive and equal to Z_O, it also defines the calibration factor.)

Unfortunately, perfect impedances are seldom the case, and the source impedance of power sources can depart substantially from Z_O. The use of attenuator pads can mask this departure, as can the use of a directional coupler to level the source and reduce its reflection coefficient to a value equal to the directivity factor of the coupler. No such control over the input impedance of a power sensor is possible without the use of attenuator pads, which sacrifice sensitivity and introduce other uncertainties.

1. Mismatch Error Correction Using Complex Reflection Coefficients.

When the complex reflection coefficients of both an imperfect source and the power sensor are known, a correction factor can be calculated and applied to the measured power, P_m, to obtain the power that would be dissipated in an ideal power sensor of impedance Z_O, if it were connected to the same source. The correction factor, m, equals:

$$m = \frac{P_0}{P_m} = \frac{(1 + \rho_g \rho_\ell{}^2 - \rho_g \rho_\ell - \rho_\ell)^2}{(1 - \rho_\ell)^2} \qquad (1)$$

Where

$P_m = \frac{P}{k}$ = measured power with 42B

P_0 = measured and dissipated power in an ideal power meter (of Z_0)

P = indicated power on the 42B

k = calibration factor for the power sensor

ρ_g = complex reflection coefficient of power source

ρ_ℓ = complex reflection coefficient of power sensor

The maximum power available from this source is:

$$P_a = \frac{P_0}{1 - |\rho_g|^2} \qquad (2)$$

Assume that the complex reflection coefficients are known to be ρ_g = 0.0909 $\underline{/20°}$ and ρ_ℓ = 0.111 $\underline{/-15°}$. Assume also that the calibration factor for this power sensor at the operating frequency is -0.56 dB, or k = 1.138 (as determined from the incident power of a 50 Ω source). When the power meter and source are connected, the indicated power is 55.2 µW. Applying the calibration factor, P_m = 55.2/1.138 = 48.5 µW. The correction factor calculated from Equation (1) for the reflection coefficients given is 0.98. Thus, the power, P_0 that would be dissipated in an ideal power meter would be 0.98 × 48.5 µW, or 47.5 µW. The maximum available power from this source, from Equation (2), is:

$$47.5/(1 - |0.0909|^2) = 47.9\ \mu W.$$

Summary:

Power from an imperfect source is measured with a diode-sensor power meter. From the measurement obtained it is possible to predict the power that would have been measured with an ideal power meter.

a. Measure the power from the imperfect source with the diode-sensor power meter. Call the indicated power P.

b. Using the calibration factor, determine the measured power, P_m.

$$P_m = P/k$$

c. Knowing the complex reflection coeffiecients of the source and of the power meter, calculate m. See Equation (1).

d. Determine P_0 from: $P_0 = mP_m$.

e. The maximum available power from this source, P_a, is found with Equation (2).

2. Mismatch Uncertainties Where Only S.W.R. is Known.

When the complex reflection coefficients of both an imperfect source and the power sensor are unknown, and only the maximum or actual s.w.r. of both are known, the maximum positive and negative uncertainties of the measured power, P_m, can be determined from Figure 2-1. In the example given above, the s.w.r. of the source is known to be 1.2 and the s.w.r of the power sensor is 1.25. From Figure 2-1, the power measured by an ideal power meter connected to the same source may differ by ±2% from the power measured by the imperfect power meter--from 47.5 µW to 49.5 µW. The maximum power available from this source may be:

$$P_a = 47.5/0.99 = 48.0\ \mu W,\ \text{to}\ 49.5/0.99 = 50.0\ \mu W$$

§2-6D, continued.

3. When neither the complex reflection coefficients nor the s.w.r of both an imperfect source and the power sensor is known, the measured power cannot be defined as anything except the indicated power. If, however, the power-source impedance is Z_0, the calibration factor of the sensor can be applied to yield the incident power.

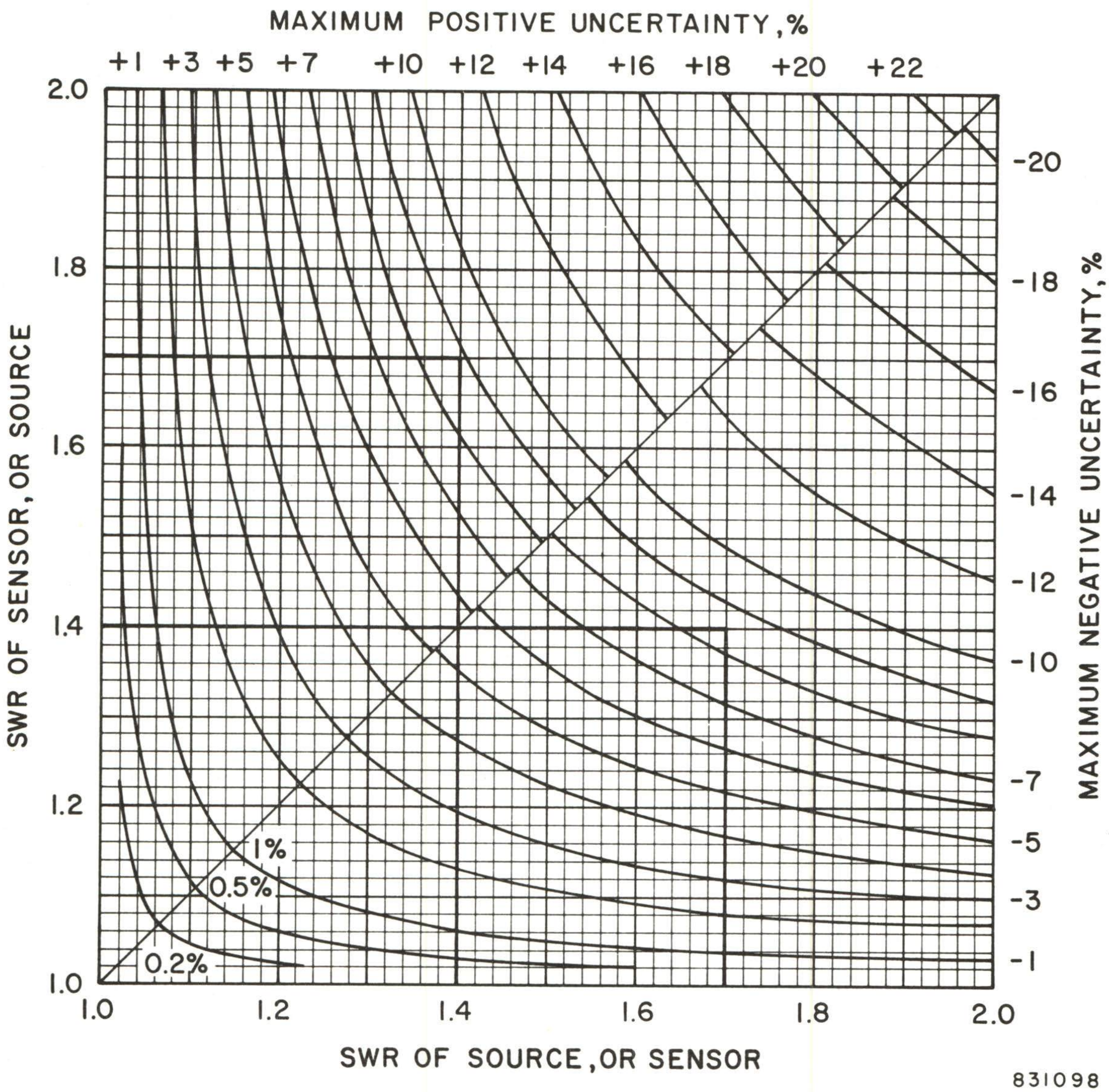


Figure 2-1. Uncertainty of Power Measurements as a Function of S.W.R.

E. Temperature Effects. The accuracy specifications for the 42B apply over an ambient-temperature range of 18°C to 30°C. Operation outside this temperature range is possible, but some inaccuracy can be expected. Figure 2-2 shows a typical temperature characteristic of a power sensor, while the typical temperature characteristic of a 42B and power sensor together is shown in Figure 2-3.

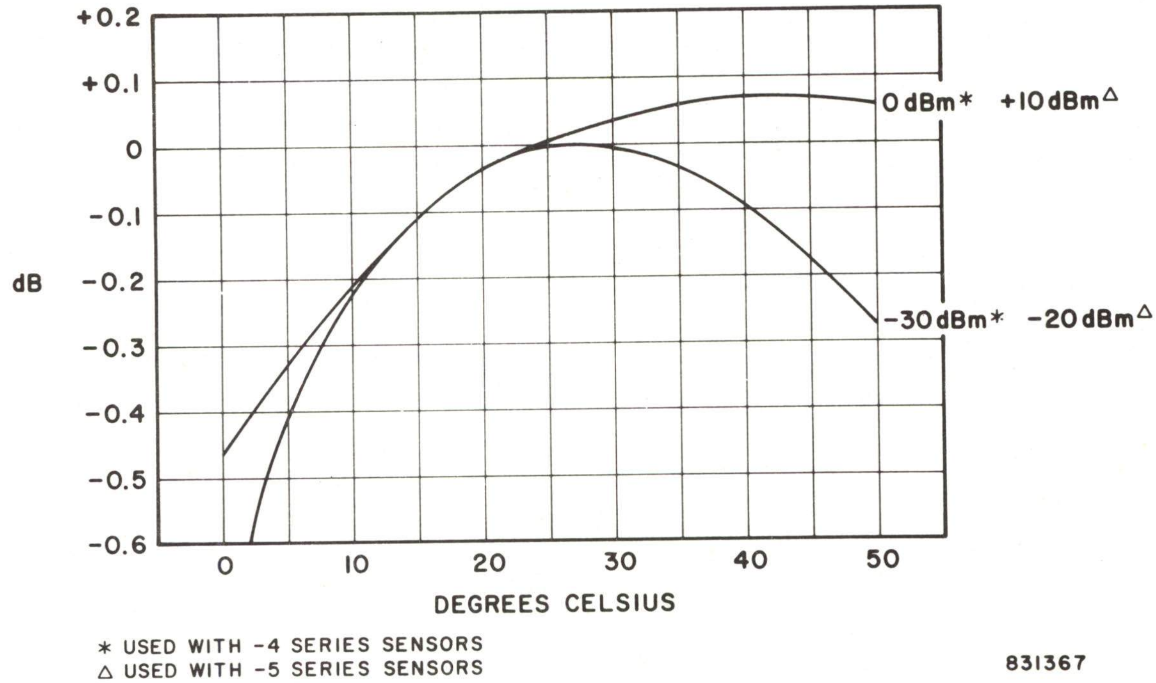


Figure 2-2. Typical Temperature Characteristic: Power Sensor Only

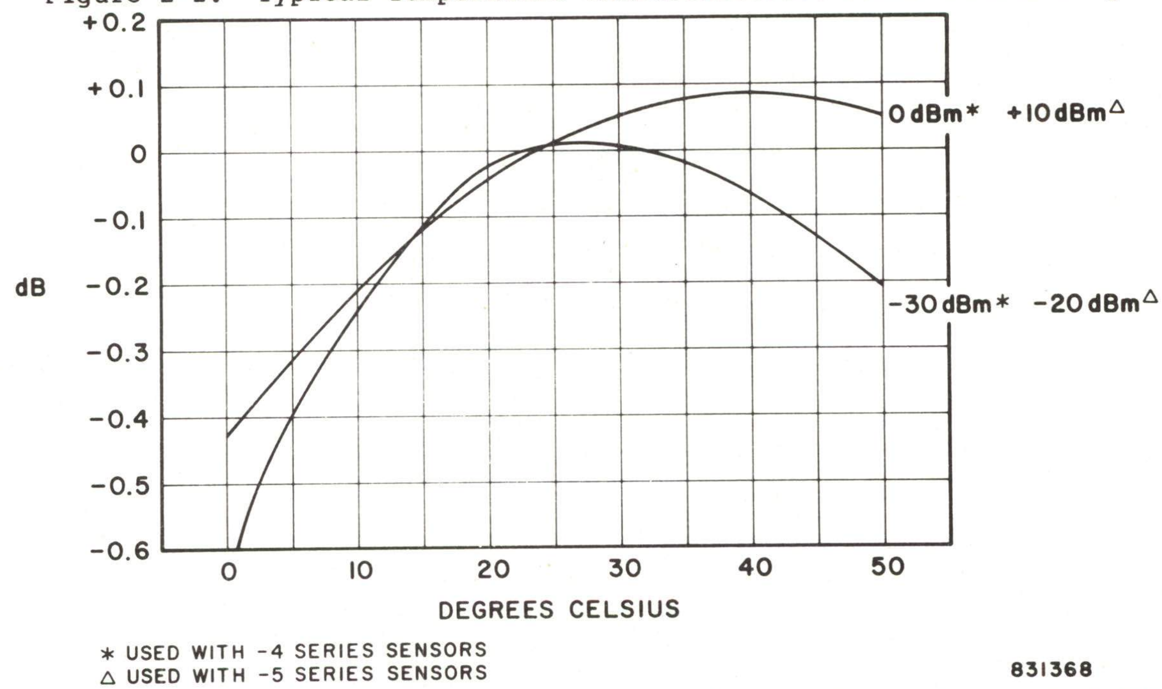


Figure 2-3. Typical Temperature Characteristics: Power Sensor and 42B

F. <u>S.W.R. Measurements</u>. The high upper-frequency limits of the 42B, and its sensitivity, make it a useful instrument for measuring s.w.r with a slotted line. As this type of measurement requires only comparative, rather than absolute values, the 41-4B [41-5B] sensor can be used up to 18 GHz and the 41-4E [41-5E] sensor can be used up to 20 GHz.

S.w.r. is determined by measuring the dB difference between a maximum and a minimum indicated power point on a slotted line, and converting the difference to s.w.r. An adapter is needed to couple the sensor to the slotted line; these are usually available from the manufacturer of the slotted line being used. Measurements are made as follows:

§2-6F, continued.

1. Connect the sensor to the slotted line's sliding carriage, using a suitable adapter.

2. With the signal source "off", zero the 42B.

3. Turn the signal source "on", and slide the carriage along the line until a point of maximum reading is located.

4. Adjust the source level and the probe positioning for the least coupling that will yield a reading of -41 dBm [-31 dBm] at the maximum point. (The incident power should be 0 dBm or greater.)

5. Slide the carriage along the line until a point of minimum reading is located. Note the meter reading (dBm) at this point, then subtract this minimum reading from the maximum reading. Convert the resultant ΔdB into s.w.r. either by use of Figure 2-4, or by computation. (The s.w.r. is the antilog, base 10, of ΔdB/20.)

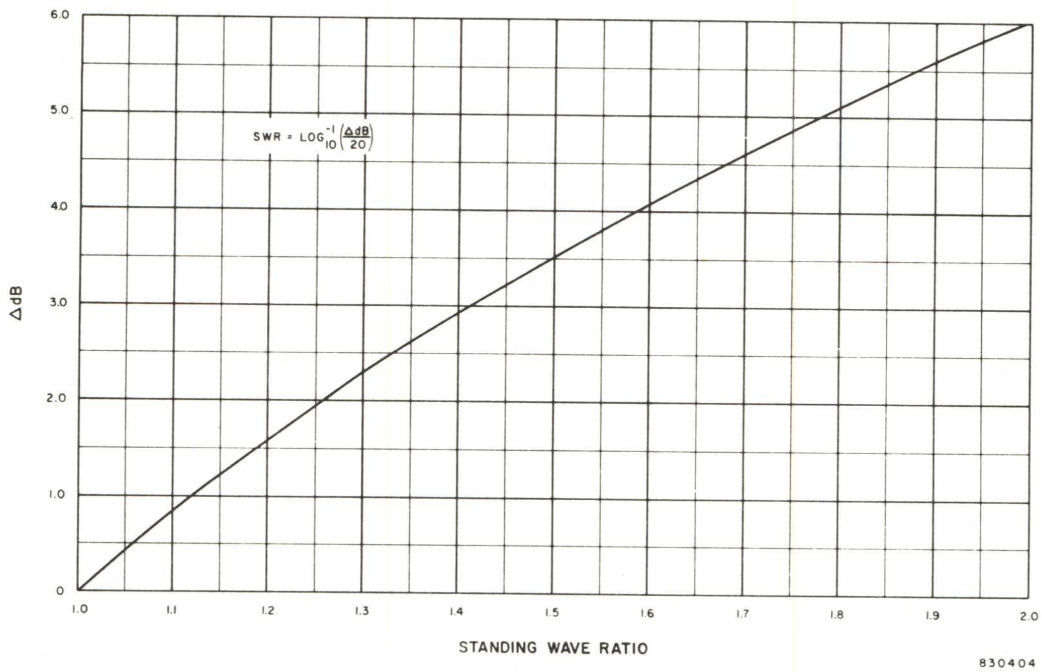


Figure 2-4. Conversion Chart: ΔdB vs S.W.R.

G. Shielding Recommendations. As mentioned in §2-6A, the preliminary zero adjustment is required when the instrument is to be used on the three most sensitive ranges or when first setting up. Difficulty may be experienced in zeroing if the instrument is subjected to strong noise fields (as noted in §2-4F), making it necessary to shield the input to the power sensor for this adjustment.

The simplest method of shielding the sensor (for zeroing) is to connect it to the device being used, making sure that the device is first turned off. Occasionally, however, the device itself will act as an antenna and actually introduce the noise voltage into the sensor. Should this be the case, stand the sensor vertically on a copper plate, holding it down firmly so that the rim of the connector body is in good contact with the copper at all points, then proceed with the zeroing operation. An alternative method is to wrap a piece of thin copper foil around the barrel of the sensor, and crimp or fold it around the open end of the connector. (Do not "short" the center pin, however.) If frequent zeroing in strong noise fields is necessary, construct an adapter, using a Type N connector permanently fitted with a copper-foil shield.

§2-6, continued.

H. Analog output. The d.c. output voltage at the RECORDER terminals on the 42B is proportional to input power, as shown by the straight line correction curve in Figure 2-5. The same graph shows the non-linear relationship between the RECORDER output and the dBm scale indications. NOTE: The dBm and power scales in Figure 5 bear no relationship to each other. They merely allow the drawing of two curves on the same grid.

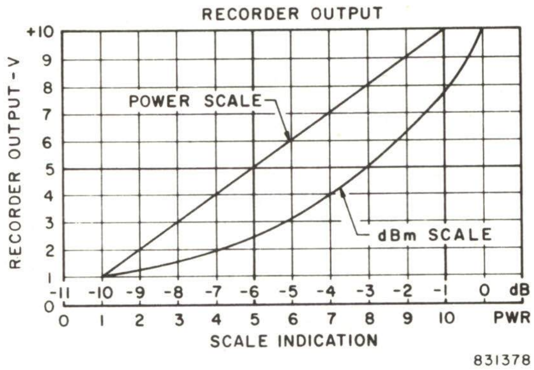


Figure 2-5. D.C. Output Correction Curves

I. Programming. External range control can be accomplished by simply grounding the appropriate pin on the edge connector (after grounding the MAN DISABLE pin). Programming can also be done with logic-level inputs to the appropriate pins on the rear card-edge connector. Logic levels are standard TTL inputs; logic 0 enables a function, while logic 1 disables it. See §2-7 for detailed information.

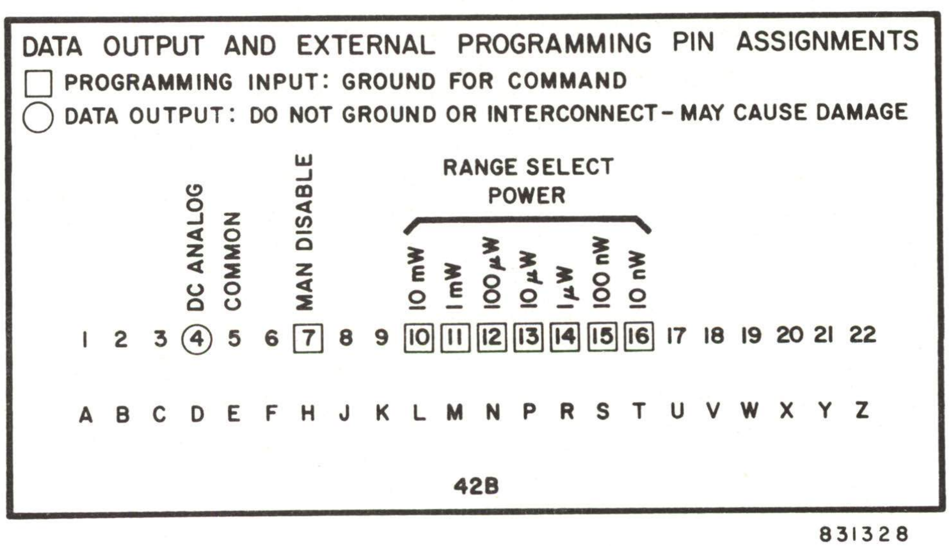


Figure 2-6. Rear-Panel Pin Assignments, 42B

NOTE: The 42C differs only in that pins 10 through 16 are for power ranges ten times higher than those shown (pin 10 = 100 mW, pin 16 = 100 nW, etc.).

2.7 REMOTE PROGRAMMING

Remote programming is accomplished by simultaneously shorting to common the Manual Disable and the appropriate range lines on the card-edge connector located at the rear of the 42B. When the Manual Disable is brought to common (i.e., pin 5), the front-panel switches in effect are disconnected. Figure 2-6 is a pictorial diagram of the rear-panel programming inputs and data output connections. Tables 2-2 and 2-3 provide additional data on these connections.

A. Programming Inputs.

Table 2-2. Rear-Panel Pins: Programming Inputs

Pin No.	Function	Comment	Command	Unit Loading
7	Man.Disable	Disables front-panel range selection	0	0.1
16	10 [100] nW	Selects range, provided that Manual	0	0.1
15	100 nW [1μW]	Disable has also been selected.	0	0.1
14	1 [10] μW	Selecting more than one range will	0	0.1
13	10 [100] μW	result in incorrect indications.	0	0.1
12	100 μW [1mW]	Range lines must be de-selected for	0	0.1
11	1 [10] mW	manual operation.	0	0.1
10	10 [100] mW		0	0.1

B. Input Characteristics. Programming input characteristics are given in Table 2-3.

Table 2-3. Programming Input Characteristics

TTL Series	Logic Level	Voltage Level	Current per Unit Load
Standard Power 54/74	0	≤ 0.7 V	-1.6 mA*
	1	2.4 to 5.25 V	40 μA

*The "-" current indicates current out of the input (the external command device must sink this current). A standard power (Series 54/74) TTL output will sink and source 10 unit loads.

C. Input Pull-Up. All input terminals have internal pull-up. The current sourced by this pull-up when the input is brought to a logic-level 0 is included in the loading shown in the "Unit Loading" column of Table 2-3.

D. D.C. Analog Output.

1. Polarity: positive with respect to instrument ground. (The negative D.C. Analog Output terminal is at ground potential.)

2. Source Resistance: 9 kΩ.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

For this discussion, refer to Figure 3-1, a block diagram of the 42B. The essential elements of the instrument are: sensor, chopper, amplifier, pulse generator, synchronous detector, shaping amplifier, power supply, meter-shaping circuits, and the meter.

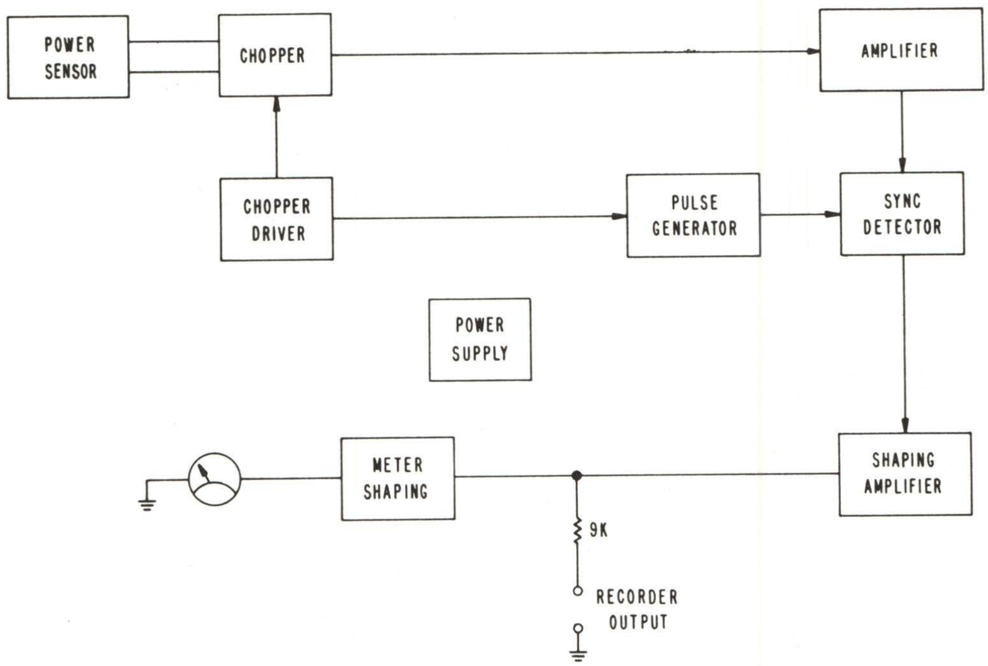


Figure 3-1. Model 42B Block Diagram

3-2. POWER SENSOR

The Power Sensor contains a non-inductive load resistor of 50 Ω (75 Ω in the 4-14C sensor), and a pair of selected diodes connected as a full-wave rectifier across the resistor. The r.f. voltage appearing across the resistor is rectified by the diodes, producing a d.c. voltage whose level is a function of the power applied. When the applied power is within the square-law region of the diodes (below 20 μW [200 μW], average power), the detector shows true r.m.s. response. Above this power level the response approaches peak-to-peak, calibrated on the indicator is terms of r.m.s. power of a sine wave--thus providing accurate power measurements for c.w. and f.m. signals up to the maximum range of the sensor.

The use of full-wave rectification in the sensor permits the measurement of highly asymmetrical waveforms without substantial error. When a voltage of asymmetrical waveform is impressed on a single-diode rectifier circuit, whether or not the portion of the waveform that "turns on" the diode is restricted to the square-law region of the diode's characteristic, the recovered d.c. voltage is dependent upon the phase of the input voltage.

Consider a positive pulse of low duty cycle applied to the anode of a diode rectifier. The rectified d.c. voltage is a function of the polarity, amplitude, and duration of the pulse. If the pulse is inverted, it drives the diode into a reversed-bias condition and the recovered d.c. is sensibly zero. A full-wave rectifier circuit, however, yields an equal amount of d.c. irrespective of the polarity of the input pulse. It is apparent that the average power in a pulse does not depend upon its phase. The response of a single diode (even when operating in its square-law region), cannot reflect that fact; a full-wave rectifier circuit does.

Special diodes are selected for use in sensors; they should not be replaced with off-the-shelf types. The considerations regarding repair of sensors are discussed in Section IV of this Instruction Manual.

3-3. CHOPPER

The chopper board contains four solid-state switches, which are used to convert input d.c. voltage to a 94 Hz square wave. The switches are controlled by 94-Hz chopper-drive signals supplied from a frequency-divider chain in the analog section. Potentiometers A4R4 and A4R5 provide means for adjusting the chopper so that it has zero output with zero input. Use of a solid-state chopper eliminates most of the undesirable characteristics of electro-mechanical choppers (for example: contact wear, bounce, and contamination). The output of the chopper is a balanced 94 Hz square wave that is directly proportional to the d.c. voltage applied from the sensor.

3-4. AMPLIFIER

The balanced 94 Hz square-wave signal from the chopper is amplified by the operational amplifiers A2U3, A2U4, A2U6 and A2U8. The gain of the op amps A2U3, A2U4 and A2U6 is controlled by adjusting feedback to the amplifier through the multiplexer A2U2 and a resistor network. The signals from the ranging section, applied through gates A2U7a and A2U7b, control the switching of input terminals D1 and D2 of multiplexer A2U2 to two of eight points in the resistance networks, thereby adjusting the feedback and the gain of the amplifier.

The 94 Hz output of op amps A2U3 and A2U4 is applied to the differential inputs of op amp A2U6, which makes the signal single-ended. This signal is amplified by op amp A2U8 and associated circuitry. Multiplexer A2U9 adjusts the gain of this op amp in eight steps, under control of signals from the ranging section, to provided decade ranging in voltage. The nominal output for a full-scale input on each range is about four volts, p-p (at TP2). Separate potentiometers are provided for full-scale calibration of the instrument on each range.

3-5. DEMODULATOR

A solid-state demodulator, comprising switches A2U11b and A2U11c, converts the amplified and scaled 94 Hz square-wave signal back to d.c. The demodulator is driven by a 94 Hz demodulator-drive signal, which is synchronized with the 94 Hz chopper-drive signal. A synchronous, sampling demodulator circuit is used, with the sample being taken at a point well removed from the chopper-switching points. The demodulator is followed by the high-input-impedance buffer A2U17 to reduce loading of the sampling capacitor, A2C10, to negligible proportions. Output d.c. is supplied to the shaping section.

3-6. SHAPING AMPLIFIER

The conversion of r.f. to d.c. in the probe is nonlinear: the response is square-law for the lower ranges, gradually becoming quasi-linear for the 10 mW [100 mW] range. The shaping amplifier converts the nonlinear output of the phase detector (§3-5) to a linear output by using a segmental approximation to the exact correction. The shaping amplifier is an operational amplifier so connected that, as the signal increases at its output, its gain is reduced by successively paralleling resistors across the feedback resistors. The number of segments required to linearize the response adequately varies from zero for the square-law range up to six for the 10 mW

§3-6, continued.

[100 mW] range. The output of the shaping amplifier at full scale is +10 volts; this voltage is applied to the panel meter and is also applied to the RECORDER terminals though a 9 kΩ resistor.

3-7. POWER SUPPLY
The power supply converts the a.c. input power to regulated +15 and -15 V outputs. Each supply is protected by current limiting against accidental short circuits. Both supplies are adjustable to 15.0 ± 0.1 V.

3-8. PROGRAMMING
The 42B is organized around a seven-line ranging system. Switching, in each functional sub-circuit, is accomplished by solid-state devices that are actuated by grounding the appropriate range line. The front-panel range switch simply connects to the seven range lines to allow range selection. The range lines are buffered by a logic-level converter. The 42B can be externally ranged by a logic "0" command on the appropriate range line and the manual-disable line.

3-9. METER SHAPING
On a linear meter, the accuracy is specified as a percentage of the full-scale indication; this means that a reading near the bottom of the scale will exhibit an appreciable absolute error. The meter-shaping dircuits act to reduce this low-end error by effectively compressing the range of the meter swing. The low end of each of the instrument's ranges is thereby set to a point appreciably above the low end of the meter scale. By this means the overall accuracy is maintained at a high level.

SECTION IV

MAINTENANCE

4-1. PERIODIC CALIBRATION

The 42B is designed to be trouble-free over extended periods of time. However, as with any precision instrument, it should have its performance checked periodically to ensure that the specified accuracy is maintained. This Section contains operation checks, procedures for calibration of the instrument, and troubleshooting. It is well to remember, when working with an instrument with the sensitivity and bandwidth of the 42B, that all precautions against stray pickup should be taken.

4-2. OPERATION CHECKS

Because of the excellent low-frequency response of the 42B, it is convenient to check the calibration by using power sources in the frequency range of 200 kHz to 1 Mhz. To make such calibration checks, The Boonton Model 25A Power Meter Calibrator is suggested. It provides a 1 MHz crystal-controlled output at the correct signal levels required to check full-scale and incremental values on all ranges of the Model 42B. If a Model 25A is not available, follow the procedure given below--using the suggested equipment or equivalents.

A. <u>All Ranges Except 10 mW [Except 10 and 100 mW]</u>.

1. Suggested Equipment (if a Model 25A is not available):

D.C. Source	H-P 6218A
A.C. Source	H-P 209A
Micropotentiometer	Ballentine Model 440 with 5 mA and 15 mA thermocouples, and radial resistors of 150 mΩ, 1.5 Ω, and 15 Ω.
D.C. Meter #1 (Digital Voltmeter)	H-P 3466A (pad for Z_{in} = 50 Ω)
D.C. Meter #2 (D.C. Null Volt-Ammeter)	H-P 419A

Refer to Figure 4-1 for the interconnection of test equipment.

2. Procedure:

Each range is checked by connecting the appropriate micropotentiometer (thermocouple and radial resistor) to the d.c. source and d.c. meter #1, then adjusting the source until d.c. meter #1 reads the voltage equivalent to full-scale power for that range. (See Table 4-1.) The reading of the d.c. meter #2 is then recorded.

Connect the micropotentiometer to the a.c. source and to the 42B under test. Adjust the a.c. source until d.c. meter # 2 indicates the same value as that recorded above. The r.m.s. output voltage of the micropotentiometer is now equivalent to the d.c. voltage previously read on the d.c. meter #1. The 42B should now read full-scale, within the tolerances given in the Specifications.

Table 4-1. Test Levels

Model 42B F.S. Range	Model 440: Thermocouple and Resistor		Voltage to Model 42B Equivalent to D.C. Meter #1
10 nW*†	5 mA	150 mΩ	0.707 mV
100 nW†	15 mA	150 mΩ	2.236 mV
1 μW†	5 mA	1.5 Ω	7.071 mV
10 μW	15 mA	1.5 Ω	22.36 mV
100 mW	5 mA	15 Ω	70.71 mV
1 mW	15 mA	15 Ω	223.6 mV

* 42B only.
† Preliminary zero-adjustment required.

B. <u>10 mW Range</u>.

1. Suggested Equipment (if a Model 25A is not available):

D.C. Source	H-P 6218A
A.C. Source	H-P 209A
D.C. Meter #1 (Digital Voltmeter)	H-P 3466A
D.C. Meter #2 (D.C. Null Volt-Ammeter)	H-P 419A
Thermal Voltage Converter (TVC)	Ballantine 1393-1
Frequency Counter	Data Precision 585

Refer to Figure 4-2 for the interconnection of test equipment.

2. Procedure:

The 10 mW range is checked by connecting the TVC to the d.c. source. The d.c. source is adjusted until d.c. meter #1 reads 707 mV. The reading of meter #2 is now recorded.

Connect the TVC to the a.c. source tee. Adjust the a.c. source until d.c. meter #2 reads the same value as that recorded above. The r.m.s. voltage now connected to the 42B will have a value equivalent to the 707 mV reading of d.c. meter #1.

The 42B should now read full-scale, within the tolerances given in the Specifications section.

C. 100 mW Range (42C only). Suggested Equipment, interconnection, and Procedure as in (B), above, except that the 707 mV referred to twice in the Procedure should be changed to 2236 mV.

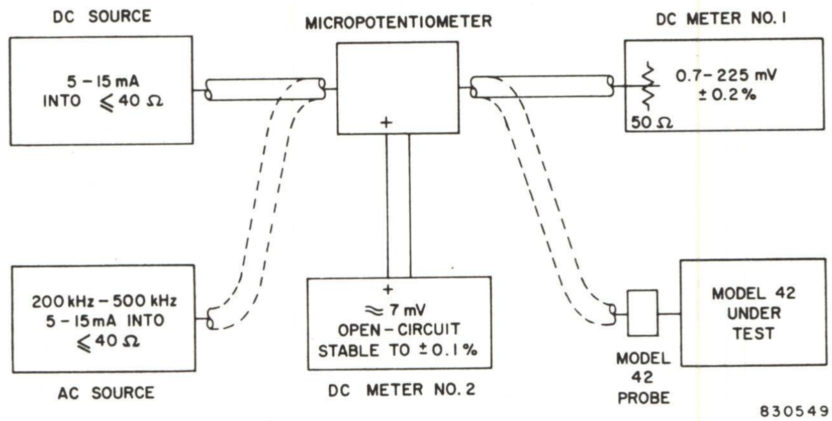


Figure 4-1. First Test Setup

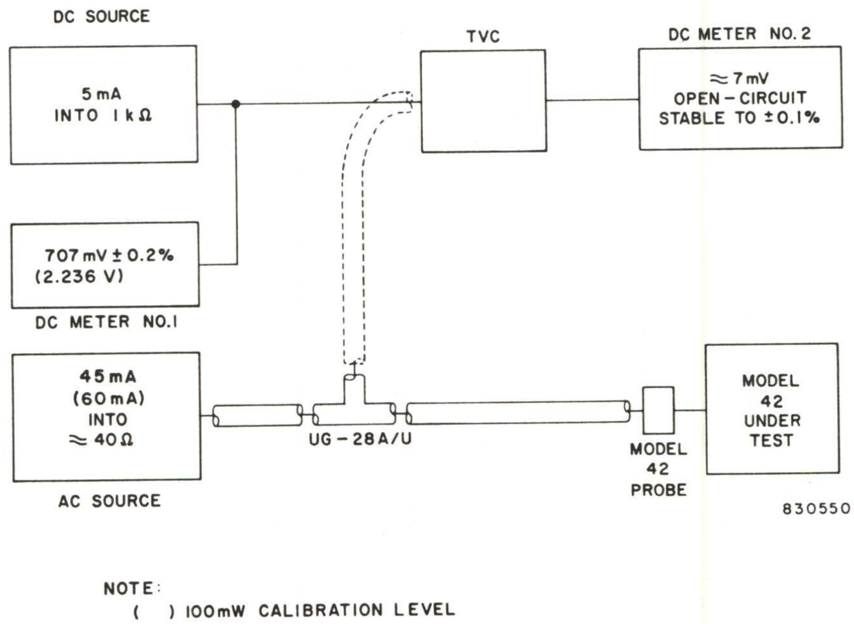


Figure 4-2. Second Test Setup

§4-2, continued.

This completes the operation checks. If any ranges are out of specified tolerance, the calibration procedures of §4-4 should be performed.

4-3. CALIBRATION REQUIREMENTS

A. General.

1. The 42B should be calibrated at an ambient temperature of 20° to 22°C (68° to 72°F) after a warm-up period of one hour.

2. Refer to Figure 4-3 for the location of PC boards and test points.

3. Be sure that the CAL FACTOR control is set at 0 (zero). If the control knob has been removed from its shaft, perform adjustment #23 first.

B. Test Instruments. A Model 25A Power Meter Calibrator is recommended as the signal source in these calibrations. Calibration adjustments that call for the application of specified input power levels then require only that the appropriate button be depressed on the 25A.

The following instruments are also needed:

1. A digital d.c. voltmeter (DVM), capable of measuring ± 15.00 V, accurate to 0.1% or better, with input impedance > 10 MΩ.

2. If a 75 Ω power sensor is being used with the 42B, a 50 Ω to 75 Ω transformer (type N connectors, 50 Ω male to 75 Ω female) will be required between the 25A and the power sensor.

As an aid in the event that a Model 25A is not available, adjustments that call for the application of specified input power levels are followed in parentheses by input voltage levels that will produce the required power across the 50 Ω sensor. Voltage levels marked with asterisks should be used for 75 Ω power sensors. The following auxiliary instruments also will be required if a Model 25A is not avaliable:

3. A reliable signal source of 200 kHz - 500 kHz with less than 1% distortion at levels up to 3 volts across 50 ohms.

4. A precision a.c.v.m. such as the Ballantine 310A or 300H, Boonton Model 93A or 93AD, the Hewlett-Packard 400D or 400H, or equivalent.

4-4. CALIBRATION PROCEDURE

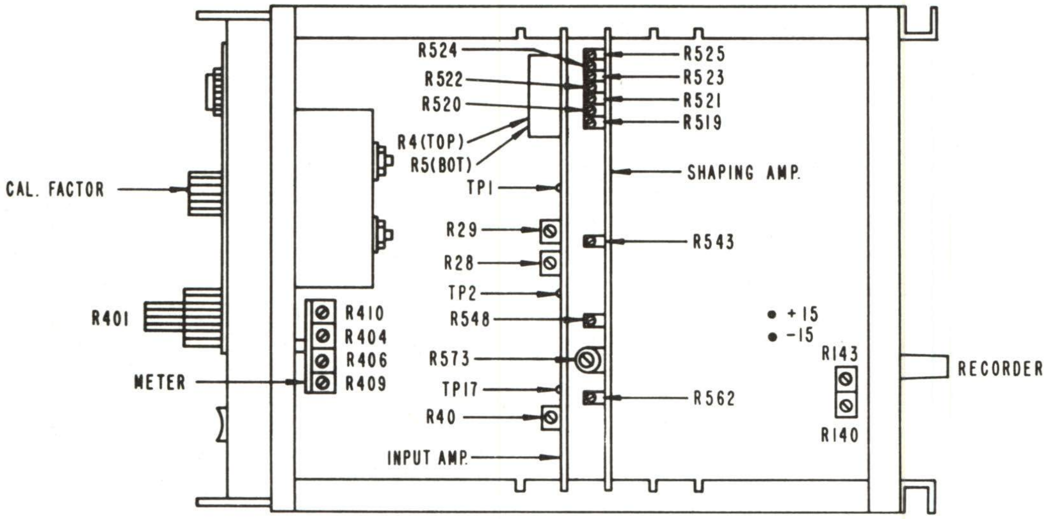
Adjustment #1. Measure the -15.0 V supply voltage at the -15 V Test Point located on the Main Amplifier Board at C119. Adjust R143 for a reading of -15.0 ± 0.1 V.

Adjustment #2. Measure the +15 V supply voltage at the +15 V Test Point located on the Main Amplifier board at C118. Adjust R140 for a reading of +15.0 ± 0.1 V.

Adjustment #3. Depress the 1 μW [10 μW] FULL SCALE range pushbutton. Connect DVM to TP2. With no input to the sensor, adjust R28 for 0.00 V d.c. on the DVM.

Adjustment #4. With zero input to sensor, connect DVM to TP17. Adjust R40 for 0.00 V d.c. on the DVM.

Adjustment #5. Depress the 10 nW [100 nW] FULL SCALE range pushbutton. Connect DVM to TP17 and note the indication (again, with zero input to the sensor). Set the two chopper adjustments, R4 and R5, to their physical midpoints. Adjust R4 to decrease the voltmeter's indication to one-half



⊛ FACTORY ADJUSTMENT: REFER TO MANUAL
• TEST POINT
† REPEAT STEP #7
( ) VOLTAGE LEVELS FOR 50 OHM SYSTEM
[ ] FOR INSTRUMENT 42C ONLY

831374

ADJ NO	CONT	FUNCTION	RANGE	INPUT PWR ±0.2% (50 OHMS)	ADJUST
1	R143	−15V ADJ	−	0	−15.0V ±0.1V AT −15V TP
2	R140	+15V ADJ	−	0	+15.0V ±0.1V AT +15V TP
3	R28	DC ZERO	1 μW [10 μW]	0	0.00V ±0.01V AT TP2
4	R40	DETECTOR ZERO	1 μW [10 μW]	0	0.00V ±0.1V AT TP17
5	R4 & R5 1/2 1/2	CHOPPER ZERO	10 nW [100 nW]	0	AVERAGE ZERO INDICATION AT TP17
6	R40	RECORDER ZERO	1 μW [10 μW]	0	0.00V ±0.01V AT RECORDER TERMINALS
7	R401	FRONT PANEL ZERO	10 nW [100 nW]	0	AVERAGE ZERO INDICATION AT RECORDER TERMINALS
8	R29	OVERALL GAIN	1 μW [10 μW]	1 μW (7.071 mV) [10 μW (22.36 mV)]	−3.00V AT TP17
9†	R523	FS RANGE ADJ	1 μW [10 μW]	1 μW (7.071 mV) [10 μW (22.36 mV)]	+10.00V AT RECORDER TERMINALS DC VOLTMETER INPUT > 10 MEGOHMS
10	R410	DS METER SHAPING	1 μW	+1.00 VDC AT TP6	−40 dBm INDICATION
11	R404	MS METER SHAPING	1 μW	+2.51 VDC AT TP6	−36 dBm INDICATION
12	R406	MS METER SHAPING	1 μW	+5.01 VDC AT TP6	−33 dBm INDICATION
13	R409	FS METER SHAPING	1 μW	+10.0 VDC AT TP6	−30 dBm INDICATION
14†	R525	FS RANGE ADJ	10 nW [100 nW]	10 nW (0.707 mV) [100 nW (2.236 mV)]	10.00 nW [100.0 nW] INDICATION
15†	R524	FS RANGE ADJ	100 nW [1 μW]	100 nW (2.236 mV) [1 μW (7.071 mV)]	100 nW [1.000 μW] INDICATION
16	R522	FS RANGE ADJ	10 μW [100 μW]	10 μW (22.36 mV) [100 μW (70.71 mV)]	10.00 μW [100.0 μW] INDICATION
17	R521	FS RANGE ADJ	100 μW [1 mW]	100 μW (70.71 mV) [1 mW (223.6 mV)]	100.0 μW [1.000 mW] INDICATION
18	R543	DS ADJ	100 μW [1 mW]	10 μW (22.36 mV) [100 μW (70.71 mV)]	10.0 μW [0.100 mW] INDICATION
19	R520	FS RANGE ADJ	1 mW [10 mW]	1 mW (223.6 mV) [10 mW (707.1 mV)]	1.000 mW [10.00 mW] INDICATION
20	R548	DS ADJ	1 mW [10 mW]	100 μW (70.71 mV) [1 mW (223.6 mV)]	0.100 mW [1.00 mW] INDICATION
21	R519	FS RANGE ADJ	10 mW [100 mW]	10 mW (707.1 mV) [100 mW (2 236 mV)]	10.00 mW [100.0 mW] INDICATION
22	R562	DS ADJ	10 mW [100 mW]	1 mW (223.6 mV) [10 mW (707.1 mV)]	1.00 mW [10.0 mW] INDICATION
23	R573	CAL. FACTOR ADJ	⊛	READJUST IF CAL. FACTOR KNOB IS REMOVED FROM SHAFT.	

Figure 4-3. Location of PC Boards and Test Points

of the value noted above. Adjust R5 to bring the indication to zero. There will be some fluctuation of the indication, and averaging will be required.

Adjustment #6. Depress the 1 μW [10 μW] FULL SCALE range pushbutton, with zero input to the sensor. Connect the DVM to the RECORDER terminals on the rear panel of the 42B. Adjust R40 for 0.00 V d.c. on the DVM.

Adjustment #7. Depress the 10 nW [100 nW] FULL SCALE range pushbutton (with zero input to the sensor), and zero the 42B as described in §2-4F.

Adjustment #8. Depress the 1 μW [10 μW] FULL SCALE range pushbutton. Connect the DVM to TP17. Apply 1 μW (7.071 mV, 8.660 mV*) [10 μW (22.36 mV)] to the sensor. Adjust R29 for a reading of -3.00 V d.c. on the DVM.

Adjustment #9. Depress the 1 μW [10 μW] FULL SCALE range pushbutton. Apply 1 μW (7.071 mV, 8.660 mV*) [10 μW (22.36 mV)] to the sensor. Measure the voltage at the RECORDER terminals on the rear panel; it should be 10.00 volts. If necessary, adjust R523 on the shaping amplifier board to obtain the required voltage.

For Adjustments 10 through 13, adjust the r.f. input in order to obtain the specified d.c. voltages at the input of the Meter PC board (TP6, white/blue wire connecting to the Amplifier PC board).

These adjustments require a continuously variable r.f. level, which can best be obtained from a signal generator or oscillator. If a 25A Power Meter Calibrator is being utilized, a low-resistance potentiometer may be connected between the 25A and the power sensor.

Adjustment #10. Depress the 1 μW [10 μW] FULL SCALE range pushbutton. Adjust the r.f. level to obtain +1.00 V, d.c., at TP6. Adjust R140 for a display indication of -40.00 dBm.

Adjustment #11. Increase the r.f. level to obtain 2.51 V, d.c., at TP6; adjust R404 for a display indication of -36.00 dBm.

Adjustment #12. Increase the r.f. level to obtain 5.01 V, d.c., at TP6; adjust R406 for a display indication of -33.00 dBm.

Adjustment #13. Increase the r.f. level to obtain 10.00 V, d.c., at TP6; adjust R409 for a display indication of -30.00 dBm.

Adjustment #14. Depress the 10 nW [100 nW] FULL SCALE range pushbutton and zero the 42B as described in §2-4F. Apply 10 nW (0.707 mV, 0.866 mV*) [100 nW (2.236 mV)] to the sensor. The display should indicate 10.00 nW [100.0 nW]. If necessary, adjust R525 on the shaping amplifier board to obtain the proper indication.

Adjustment #15. Depress the 100 nW [1 μW] FULL SCALE range pushbutton and zero the 42B as described in §2-4F. Apply 100 nW (2.236 mV, 2.738 mV*) [1 μW (7.071 mV)] to the sensor. The display should indicate 100.0 nW [1.000 μW]. If necessary, adjust R524 on the shaping amplifier board to obtain the proper indication.

Adjustment #16. Depress the 10 μW [100 μW] FULL SCALE range pushbutton and apply 10 μW (22.36 mV, 27.38 mV*) [100 μW (70.71 mV)] to the sensor. The display should indicate 10.00 μW [100.0 μW]. If necessary, adjust R522 on the shaping amplifier board to obtain the proper indication.

Adjustment #17. Depress the 100 μW [1 mW] FULL SCALE range pushbutton and apply 100 μW (70.71 mV, 86.60 mV*) [1 mW (223.6 mV)] to the sensor. The display should indicate 100.0 μW [1.000 mW]. If necessary, adjust R521 on the shaping amplifier board to obtain the proper indication.

Adjustment #18. Depress the 100 μW [1 mW] FULL SCALE range pushbutton and apply 10 μW (22.36 mV, 27.38 mV*) [100 μW (70.71 mV)] to the sensor. The display should indicate 10 μW [100 μW]. If necessary, adjust R543 on the shaping amplifier board to obtain the proper indication. Repeat adjustments 17 and 18 as required to obtain both correct indications.

Adjustment #19. Depress the 1 mW [10 mW] FULL SCALE range pushbutton and apply 1 mW (223.6 mV, 273.8 mV*) [10 mW (707.1 mV)] to the sensor. The display should indicate 1.000 mW [10.00 mW]. If necessary, adjust R520 on the shaping amplifier board to obtain the proper indication.

Adjustment #20. Depress the 1 mW [10 mW] FULL SCALE range pushbutton and apply 100 μW (70.71 mV, 86.60 mV*) [1 mW (223.6 mV)] to the sensor. The display should indicate 0.100 mW [1.000 mW]. If necessary, adjust R548 on the shaping amplifier board to obtain the proper indication.

Adjustment #21. Depress the 10 mW [100 mW] FULL SCALE range pushbutton and apply 10 mW (707.1 mV, 866.0 mV*) [100 mW (2236 mV)] to the sensor. The display should indicate 10.00 mW [100.0 mW]. If necessary, adjust R519 on the shaping amplifier board to obtain the proper indication.

Adjustment #22. Depress the 10 mW [100 mW] FULL SCALE range pushbutton and apply 1 mW (223.6 mV, 273.8 mV*) [10 mW (707.1 mV)] to the sensor. The display should indicate 1.00 mW [10.0 mW]. If necessary, adjust R562 on the shaping amplifier board to obtain the proper indication.

Adjustment #23, Calibration-Factor Adjustment. NOTE: This adjustment will be required only if the CAL FACTOR knob has been removed from its shaft, or if slippage of the knob on the shaft is suspected.

This adjustment requires a continuously variable r.f. level, which can best be obtained from a signal generator or oscillator.

Center the CAL FACTOR knob on the shaft so that the pointer swings an equal amount past the end points on each end of the rotation. Depress the 1 μW [10 μW] FULL SCALE range pushbutton. Set the CAL FACTOR control to -1 dB. Apply an a.c. signal to the sensor and adjust its level so that a display of 0.631 μW, or -32 dBm [6.31 μW, or -22 dBm] is obtained. Rotate the CAL FACTOR control to the +1 dB position and adjust R573 on the shaping amplifier board for a display of 1.000 μW, or -30.00 dBm [10.00 μW, or -20 dBm].

4-5. TROUBLESHOOTING

If faulty operation of the 42B is evident, or if the preceding calibration procedures fail to correct an inaccurate reading, the following steps will help in isolating and correcting the fault.

A. General. Often the nature of the difficulty itself will pinpoint the location of the trouble. If not, make a visual examination of the instrument by removing the top and bottom covers and inspecting for unseated PC boards or connectors, loose components or fasteners, obviously defective components such as charred resistors, leaking capacitors, broken leads, or for foreign matter.

NOTE: Should it become necessary to remove the CAL FACTOR control knob, first turn the control fully counterclockwise and mark the position of the knob pointer by a pencil line on the front panel. When replacing the knob, first align the pointer with the scribe mark, then secure the knob in position. Check Adjustment #23 after replacing the knob.

B. Voltage and Resistance Tests. A systematic check of the a.c. and d.c. voltages, resistances, and wave forms should be made. The schematic diagrams in Section VI show the test points available, along with the voltage levels and wave forms that should be found at these points. The symptoms observed during calibration should help to narrow down the search for the faulty component or circuit.

levels and wave forms that should be found at these points. The symptoms observed during calibration should help to narrow down the search for the faulty component or circuit.

C. Power Sensor Replacement. If a second power sensor is available, it may be used for a quick check in place of the one supplied with the 42B. However, each power sensor is calibrated with the instrument with which it will be used; should a replacement sensor be necessary, the instrument must be recalibrated with the new sensor to avoid measurement errors.

4-6. POWER-SENSOR REPAIR

Repair and adjustment of a Power Sensor is a difficult operation, requiring a high degree of skill. It is strongly recommended that a defective sensor be returned to the Factory for repair.

If the user elects to make such a repair, he or she should consult with the Factory as to the recommended procedure; however, it must be understood that the repaired sensor may not meet the s.w.r. and response characteristics specified in this Manual. For best results the repaired sensor should be recalibrated by the user--a procedure requiring specialized equipment. An application note entitled Determination of Calibration Factor is available at no charge from the Factory.

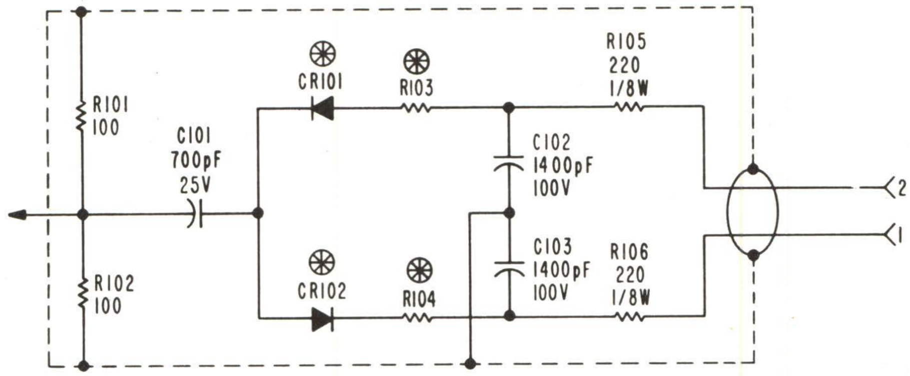
Before deciding that the sensor is defective, check all possible sources of troubles, such as the instrument itself, the sensor cable, connectors, the r.f. power source, and so forth. If the defect cannot be located, and the symptoms indicate a faulty sensor, make the external resistance measurements outlined below to localize the trouble before consulting with the Factory. (A volt-ohmeter such as the Simpson 260, or equivalent, is recommended for most of these measurements.)

A. Measure the resistance of the r.f. input connector from the center conductor to the ground shell. It should be 50 Ω, ± 1 Ω for all sensors but the 41-4C, in which case it should be 75 Ω, ± 1 Ω. (For this measurement, an instrument more accurate than the Simpson 260 should be used.)

B. Inspect the rear connector for possible damage. Measure the resistance from pins 1 and 2 to ground. They should measure > 10 MΩ.

C. With the VOM on its 10 kΩ range, measure the resistance from pin 1 (use the negative lead of the VOM) to pin 2 (positive lead of VOM). It should be 20 to 30 kΩ.

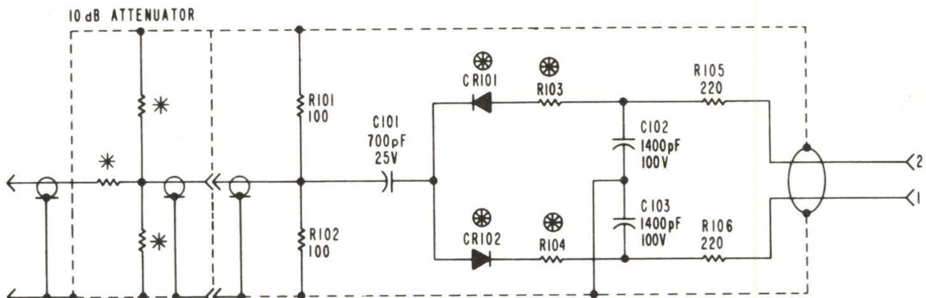
D. Reverse the connections of the VOM; it should now measure > 400 kΩ.



SCHEMATIC, POWER DETECTOR
B830657C

NOTES:
1. RESISTANCE VALUES IN OHMS.
2. ⊛ SELECTED VALUE.
3. LAST NUMBERS USED:
R106 C103

(A)



SCHEMATIC, POWER DETECTOR
C830767 C

NOTES:
1. RESISTANCE VALUES IN OHMS.
2. ⊛ FACTORY SELECTED
3. LAST NUMBERS USED:
R106 C103
4. ✳ DISTRIBUTED THIN FILM ELEMENTS.

(B)

Figure 4-4. Typical Power Sensor: (A) for 42B; (B) for 42C

SECTION V

REPLACEABLE PARTS

5-1. INTRODUCTION

Table 5-2, Replaceable Parts, identifies the manufacturers of components by five-digit groups taken from the Federal Supply Code for Manufacturers. A list of the applicable code groups and manufacturers is given in Table 5-1.

The Table of Replaceable Parts begins with major assemblies, including PC boards complete with all their parts, followed by miscellaneous parts and components not mounted on PC boards. Then all the components of the individual assemblies (including PC boards) are listed. Note the following:

A. When ordering a component or an assembly, the BEC Part Number is all that we need. However, part numbers can suffer changes during transmission and it is safer to include also a brief description. Example:
   BEC Part #200050: Mica Capacitor, 470 pF, 1%, 500V.

B. The number printed on a PC board is not an assembly number; it is the number for the bare board, alone. To order a complete assembly--the board with all its components installed--specify it by the BEC Part Number given in the Assemblies Section of this table.

C. Unless otherwise identified, the number on a schematic diagram or on a parts-location diagram is not an assembly number; it is the number for just the diagram itself.

Table 5-1. Applicable Federal Supply Code Numbers for Manufacturers

00241	Fenwal Electronics	31313	Components Corp.
01121	Allen Bradley	32293	Intersil, Inc.
01295	Texas Instruments	32575	AMP
02660	Amphenol	32897	Erie
02735	RCA Solid State Div.	32997	Bourns, Inc., Trimpot Div.
04222	AVX Ceramics Company	33883	RMC
04713	Motorola Semiconductor	34430	Monsanto
04901	Boonton Electronics	54426	Buss Fuses
06776	Robinson Nugent, Inc.	56289	Sprague Electric Company
07263	Fairchild Semiconductor	57582	Kahgan Electronics Corp.
12406	Elpac Components	71450	CTS Corp.
14655	Cornell-Dubilier	73138	Beckman Instr., Helipot Div.
16546	Centralab	82389	Switchcraft
19701	Mepco Electra	91506	Augat
20307	Arco - Micronics	91637	Dale Electronics
27014	National Semiconductor	94322	Tel Labs, Inc.
27735	F-Dyne Electronics	98291	Sealectro Corp.
		S4217	United Chemicon, Inc.

Table 5-2. Replaceable Parts

ASSEMBLIES	
Input Amplifier	Part Number 042140-01
Input Resistor Networks	Part Numbers 042141-01 & 042142-01
Master Board	Part Number 042118-01
Shaping Amplifier	Part Number 042026-01
Switch Assembly	Part Number 042123-01
Meter Assembly	Part Number 042027-01
Chopper Assembly	Part Number 042161-01
Rear-Panel Assembly	Part Number 042023-01
Sub-Panel Assembly	Part Number 042024-01
Heat-Sink Assembly	Part Number 042144-01

Table 5-2. Replaceable Parts

Item	Description	Mfr.	Mfr's Part No.	Part No.
INPUT AMPLIFIER, PART NUMBER 042140-01				
C1	Capacitor EL 100 µF 20% 25V	S4217	SM-25-VB-100-M	283334
C2	Capacitor EL 100 µF 20% 25V	S4217	SM-25-VB-100-M	283334
C3	Capacitor Mylar 0.1 µF 10% 100V (only)	19701	C280MAH/A100K (only)	234080
C4	Capacitor Mica 1500 pF 1% 500V	14655	CD19-FD152F-03	200531
C5	Capacitor Mylar 0.1 µF 10% 100V (only)	19701	C280MAH/A100K (only)	234080
C6	Capacitor PE 0.022 µF 10% 80V	56289	192P2239R8	234096
C7	Capacitor PE 0.0022 µF 10% 200V	56289	192P22292	234110
C8	Capacitor EL 100 µF 20% 25V	S4217	SM-25-VB-100-M	283334
C9	Capacitor EL 100 µF 20% 25V	S4217	SM-25-VB-100-M	283334
C10	Capacitor PP 0.1 µF 10% 100V	27735	PP11-.1-100-10	234148
C11	Capacitor PC 470 nF 10% 50V	12406	B5A474K	234128
C12	Capacitor EL 10 µF 20% 25V	S4217	SM-25-VB-10-M	283336
C13	Capacitor EL 10 µF 20% 25V	S4217	SM-25-VB-10-M	283336
J1-1	Socket Pin Spring	32575	1-332070-7	479333
J1-2	Socket Pin Spring	32575	1-332070-7	479333
J1-3	Socket Pin Spring	32575	1-332070-7	479333
J1-4	Socket Pin Spring	32575	1-332070-7	479333
J1-5	Socket Pin Spring	32575	1-332070-7	479333
J1-6	Socket Pin Spring	32575	1-332070-7	479333
J1-7	Socket Pin Spring	32575	1-332070-7	479333
Q1	IC CA3096CE Transistor Array	02735	CA3096CE	535101
Q2	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
R1	Resistor Network 10k ohm 2% SIP	71450	750-101-R10K	345038
R2	Resistor Comp 47 ohm 5%	01121	CB	343165
R3	Resistor MF 20.0k ohm 1%	19701	5043 (RN55D)	341429
R4	Resistor MF 20.0k ohm 1%	19701	5043 (RN55D)	341429
R5	Resistor MF 20.0k ohm 1%	19701	5043 (RN55D)	341429
R6	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R7	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R8	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R9	Resistor Comp 12M ohm 5%	01121	CB	343708
R10	Resistor Comp 12M ohm 5%	01121	CB	343708
R11	Resistor MF 100k ohm 1%	19701	5043 (RN55D)	341500
R12	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R13	Resistor MF 1.00k ohm 1%	19701	5043 (RN55D)	341300
R14	Resistor MF 221 ohm 1%	19701	5043 (RN55D)	341233
R15	Resistor MF 1.00k ohm 1%	19701	5043 (RN55D)	341300
R16	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R17	Resistor MF 100k ohm 1%	19701	5043 (RN55D)	341500
R18	Resistor MF 8.25k ohm 1%	19701	5043 (RN55D)	341388
R20	Resistor MF 8.25k ohm 1%	19701	5043 (RN55D)	341388
R22	Resistor MF 15.0k ohm 1%	19701	5043 (RN55D)	341417
R23	Resistor MF 1.00M ohm 1%	19701	5043 (RN55D)	341600
R24	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R25	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R26	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R27	Resistor MF 806k ohm 1%	19701	5043 (RN55D)	341587
R28	Resistor Var 10k ohm 10% 0.5W	73138	72XWR10K	311348
R29	Resistor Var 25k ohm 10% 0.5W	73138	72XWR25K	311385
R36	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R37	Resistor MF 301k ohm 1%	19701	5043 (RN55D)	341546
R38	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R39	Resistor MF 1.00k ohm 1%	19701	5043 (RN55D)	341300
R40	Resistor Var 10k ohm 10% 0.5W	73138	72XWR10K	311348
TP1	Terminal (Test Point)	31313	TP-101-10	483258
TP2	Terminal (Test Point)	31313	TP-101-10	483258
TP7	Terminal (Test Point)	31313	TP-101-10	483258
TP12	Terminal (Test Point)	31313	TP-101-10	483258
TP13	Terminal (Test Point)	31313	TP-101-10	483258
TP14	Terminal (Test Point)	31313	TP-101-10	483258
TP15	Terminal (Test Point)	31313	TP-101-10	483258
TP16	Terminal (Test Point)	31313	TP-101-10	483258
TP17	Terminal (Test Point)	31313	TP-101-10	483258
U1	IC CD4532BE	02735	CD4532BE	534340
U2	IC IH6208CPE	32293	IH6208CPE	534266
U3	IC LF356 Op Amp IT/F 535052	04901	BEC	535062
U4	IC LF356 Op Amp IT/F 535052	04901	BEC	535062
U5	IC CD4011AE	02735	CD4011AE	534022
U6	IC IT/F535052 Op Amp	04901	BEC	535079
U7	IC CD4001AE	02735	CD4001AE	534023
U8	IC CA3140AE Op Amp	02735	CA3140AE	535050
U9	IC IH6108CPE	32293	IH6108CPE	534265

Table 5-2. Replaceable Parts (Continued)

Item	Description	Mfr.	Mfr's Part No.	Part No.
INPUT AMPLIFIER, PART NUMBER 042140-01				
U10	IC CD4047AE (RCA only)	02735	CD4047AE	534229
U11	IC CD4016BE	02735	RCA only	534218
U12	IC CD4030AE	02735	CD4030AE	534087
U13	IC CD4013BE (only)	02735	CD4013BE	534205
U14	IC 78L05AWC Regulator	07263	78L05AWC	535044
U15	IC 79L05ACP Regulator	04713	MC79L05ACP	535090
U16	IC CD4081BE	02735	CD4081BE	534142
U17	IC CA3140AE Op Amp	02735	CA3140AE	535050
XQ1	Socket IC 16 Pin	06776	ICN-163-S3-G	473042
XU1	Socket IC 16 Pin	06776	ICN-163-S3-G	473042
XU2	Socket IC 16 Pin	06776	ICN-163-S3-G	473042
XU3	Socket IC 8 Pin	06776	ICN-083-S3-G	473041
XU4	Socket IC 8 Pin	06776	ICN-083-S3-G	473041
XU5	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU6	Socket IC 8 Pin	06776	ICN-083-S3-G	473041
XU7	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU8	Socket IC 8 Pin	06776	ICN-083-S3-G	473041
XU9	Socket IC 16 Pin	06776	ICN-163-S3-G	473042
XU10	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU11	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU12	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU13	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU16	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XU17	Socket IC 8 Pin	06776	ICN-083-S3-G	473041
INPUT RESISTOR NETWORK, PART NUMBER 042141-01				
R19	Resistor MF 1.65k ohm 1%	19701	5063J	338321
R21	Resistor MF 1.65k ohm 1%	19701	5063J	338321
R30	Resistor MF 73.2k ohm 1%	19701	5063J	338483
R32	Resistor MF 19.1k ohm 1%	19701	5063J	338427
R33	Resistor MF 5.62k ohm 1%	19701	5063J	338372
R34	Resistor MF 1.33k ohm 1%	19701	5063J	338312
R35	Resistor MF 232 ohm 1%	19701	5063J	338235
MASTER BOARD, PART NUMBER 042129-01				
C112	Capacitor EL 1000 µF -10/+50% 35V	57582	KSMM-1000-35	283350
C113	Capacitor EL 1000 µF -10/+50% 35V	57582	KSMM-1000-35	283350
C115	Capacitor Cer 0.001 µF 500V	33883	Z5U B-GP Short Dip	224114
C116	Capacitor Cer 0.001 µF 500V	33883	Z5U B-GP Short Dip	224114
C118	Capacitor EL 100 µF 25V	56289	TE-1211 (30D107G025DD2)	283105
C119	Capacitor EL 100 µF 25V	56289	TE-1211 (30D107G025DD2)	283105
C120	Capacitor Cer 1.0 µF 20% 50V	04222	SR305E105MAA	224264
C121	Capacitor Cer 1.0 µF 20% 50V	04222	SR305E105MAA	224264
CR107	Diode 1N914	01295	1N914	530058
CR108	Diode 1N914	01295	1N914	530058
CR109	Diode 1N914	01295	1N914	530058
CR110	Diode 1N914	01295	1N914	530058
CR111	Diode Bridge KBP-02	20307	KBP-02	532013
CR112	Diode Bridge KBP-02	20307	KBP-02	532013
CR115	Diode 1N914	01295	1N914	530058
CR118	Diode 1N914	01295	1N914	530058
CR119	Diode 1N914	01295	1N914	530058
CR120	Diode 1N914	01295	1N914	530058
CR121	Diode 1N914	01295	1N914	530058
CR122	Diode 1N914	01295	1N914	530058
CR123	Diode 1N914	01295	1N914	530058
CR124	Diode 1N914	01295	1N914	530058
IC104	IC LM723CN Regulator	27014	LM723CN	535037
IC105	IC LM723CN Regulator	27014	LM723CN	535037
J101	Connector 22 Pin	02660	143-022-07	479231
J102	Connector 22 Pin	02660	143-022-07	479231
Q106	Transistor PNP 2N5087	04713	2N5087	528042
Q122	Transistor MPS 6516	04713	MPS6516	528037
Q125	Transistor MPS 6516	04713	MPS6516	528037
Q126	Transistor MPS 6516	04713	MPS6516	528037
Q127	Transistor MPS 6516	04713	MPS6516	528037
Q128	Transistor MPS 6516	04713	MPS6516	528037
Q129	Transistor MPS 6516	04713	MPS6516	528037

Table 5-2. Replaceable Parts (Continued)

Item	Description	Mfr.	Mfr's Part No.	Part No.
MASTER BOARD, PART NUMBER 042129-01				
Q130	Transistor MPS 6516	04713	MPS6516	528037
Q131	Transistor MPS 6516	04713	MPS6516	528037
R102	Resistor Comp 3.9k ohm 5%	01121	CB	343357
R103	Resistor Comp 3.9k ohm 5%	01121	CB	343357
R136	Resistor Comp 1.0k ohm 5%	01121	CB	343300
R137	Resistor Comp 1.0k ohm 5%	01121	CB	343300
R138	Resistor Comp 5.1k ohm 5%	01121	EB	344368
R139	Resistor MF 3.32k ohm 1%	19701	5043 (RN55D)	341350
R140	Resistor Var 1k ohm ±10% 0.5W	73138	72PR1K	311316
R141	Resistor MF 3.01k ohm 1%	19701	5043 (RN55D)	341346
R142	Resistor MF 3.32k ohm 1%	19701	5043 (RN55D)	341350
R143	Resistor Var 1k ohm ±10% 0.5W	73138	72PR1K	311316
R144	Resistor MF 3.01k ohm 1%	19701	5043 (RN55D)	341346
R145	Resistor MF 9.09k ohm 1%	19701	5043 (RN55D)	341392
R149	Resistor Comp 160k ohm 5%	01121	CB	343520
R150	Resistor Comp 39k ohm 5%	01121	CB	343457
R151	Resistor Comp 100k ohm 5%	01121	CB	343500
R158	Resistor Comp 160k ohm 5%	01121	CB	343520
R159	Resistor Comp 39k ohm 5%	01121	CB	343457
R160	Resistor Comp 100k ohm 5%	01121	CB	343500
R161	Resistor Comp 160k ohm 5%	01121	CB	343520
R162	Resistor Comp 39k ohm 5%	01121	CB	343457
R163	Resistor Comp 100k ohm 5%	01121	CB	343500
R164	Resistor Comp 160k ohm 5%	01121	CB	343520
R165	Resistor Comp 39k ohm 5%	01121	CB	343457
R166	Resistor Comp 100k ohm 5%	01121	CB	343500
R167	Resistor Comp 160k ohm 5%	01121	CB	343520
R168	Resistor Comp 39k ohm 5%	01121	CB	343457
R169	Resistor Comp 100k ohm 5%	01121	CB	343500
R170	Resistor Comp 160k ohm 5%	01121	CB	343520
R171	Resistor Comp 39k ohm 5%	01121	CB	343457
R172	Resistor Comp 100k ohm 5%	01121	CB	343500
R173	Resistor Comp 160k ohm 5%	01121	CB	343520
R174	Resistor Comp 39k ohm 5%	01121	CB	343457
R175	Resistor Comp 100k ohm 5%	01121	CB	343500
R176	Resistor Comp 160k ohm 5%	01121	CB	343520
R177	Resistor Comp 39k ohm 5%	01121	CB	343457
R178	Resistor Comp 100k ohm 5%	01121	CB	343500
R181	Resistor Comp 1.8k ohm 5%	01121	CB	343325
R182	Resistor Comp 1.8k ohm 5%	01121	CB	343325
R183	Resistor Comp 10k ohm 5%	01121	CB	343400
R184	Resistor Comp 10k ohm 5%	01121	CB	343400
R187	Resistor Comp 750 ohm 5%	01121	EB	344284
XIC101	Socket M/F (1/2) 473048	04901	BEC	473049
XIC102	Socket M/F (1/2) 473048	04901	BEC	473049
XIC104	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
XIC105	Socket IC 14 Pin	06776	ICN-143-S3-G	473019
SHAPING AMPLIFIER, PART NUMBER 042026-01				
A501	IC LM301AN Op Amp	27014	LM301AN	535012
A502	IC LM301AN Op Amp	27014	LM301AN	535012
A503	IC LM310H Op Amp (only)	27014	LM310H	535005
C501	Capacitor Cer 0.01 µF 100V	32897	805-000X5V0103Z	224119
C502	Capacitor Cer 33 pF 5% 1 kV	56289	C030B102G330J (10TCC-Q33)	224139
C503	Capacitor Cer 0.01 µF 100V	32897	805-000X5V0103Z	224119
C504	Capacitor Cer 0.01 µF 100V	32897	805-000X5V0103Z	224119
C505	Capacitor Cer 33 pF 5% 1 kV	56289	C030B102G330J (10TCC-Q33)	224139
C506	Capacitor Cer 0.01 µF 100V	32897	805-000X5V0103Z	224119
CR501	Diode 1N914	01295	1N914	530058
CR502	Diode 1N914	01295	1N914	530058
CR503	Diode 1N914	01295	1N914	530058
CR504	Diode 1N914	01295	1N914	530058
CR505	Diode 1N914	01295	1N914	530058
CR506	Diode 1N914	01295	1N914	530058
CR507	Diode 1N914	01295	1N914	530058
CR508	Diode 1N914	01295	1N914	530058
CR509	Diode 1N914	01295	1N914	530058
CR510	Diode 1N914	01295	1N914	530058
Q501	Transistor NPN 2N5088	04713	2N5088	528047
Q502	Transistor NPN 2N5088	04713	2N5088	528047

Table 5-2. **Replaceable Parts (Continued)**

Item	Description	Mfr.	Mfr's Part No.	Part No.
SHAPING AMPLIFIER, PART NUMBER 042026-01				
Q503	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q504	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q505	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q506	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q507	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q508	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q509	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q510	Transistor NPN 2N5088	04713	2N5088	528047
Q511	Transistor NPN 2N5088	04713	2N5088	528047
Q512	Transistor NPN 2N5088	04713	2N5088	528047
Q513	Transistor NPN 2N5088	04713	2N5088	528047
Q514	Transistor JFET 2N5953	04901	BEC	528145
Q515	Transistor NPN 2N5088	04713	2N5088	528047
Q516	Transistor JFET 2N5953	04901	BEC	528145
Q517	Transistor NPN 2N5088	04713	2N5088	528047
Q518	Transistor JFET 2N5953	04901	BEC	528145
Q519	Transistor NPN 2N5088	04713	2N5088	528047
Q520	Transistor JFET 2N5953	04901	BEC	528145
Q521	Transistor NPN 2N5088	04713	2N5088	528047
Q522	Transistor NPN 2N5088	04713	2N5088	528047
Q523	Transistor NPN 2N5088	04713	2N5088	528047
Q524	Transistor NPN 2N5088	04713	2N5088	528047
Q525	Transistor NPN 2N5088	04713	2N5088	528047
Q526	Transistor JFET 2N5953	04901	BEC	528145
Q527	Transistor NPN 2N5088	04713	2N5088	528047
Q528	Transistor NPN 2N5088	04713	2N5088	528047
Q529	Transistor NPN 2N5088	04713	2N5088	528047
Q530	Transistor NPN 2N5088	04713	2N5088	528047
Q531	Transistor NPN 2N5088	04713	2N5088	528047
Q532	Transistor NPN 2N5088	04713	2N5088	528047
Q533	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
Q534	Transistor FET 2N5949 N-Channel	04713	2N5949	528019
R501	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R502	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R503	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R504	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R505	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R506	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R507	Resistor Comp 4.7M ohm 5%	01121	EB	344665
R508	Resistor MF 8.66k ohm 1%	19701	5043 (RN55D)	341390
R509	Resistor MF 8.66k ohm 1%	19701	5043 (RN55D)	341390
R510	Resistor MF 9.53k ohm 1%	19701	5043 (RN55D)	341394
R511	Resistor MF 165k ohm 1%	19701	5043 (RN55D)	341521
R512	Resistor MF 866k ohm 1%	19701	5043 (RN60D)	342590
R513	Resistor MF 499k ohm 1%	19701	5043 (RN55D)	341567
R514	Resistor MF 49.9k ohm 1%	19701	5043 (RN55D)	341467
R515	Resistor MF 4.99k ohm 1%	19701	5043 (RN55D)	341367
R516	Resistor MF 210k ohm 1%	19701	5043 (RN55D)	341531
R517	Resistor MF 536k ohm 1%	19701	5043 (RN60D)	342570
R518	Resistor MF 13.0k ohm 1%	19701	5043 (RN55D)	341411
R519	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R520	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R521	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R522	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R523	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R524	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R525	Resistor Var 2k ohm ±10% 1W	91637	784	311264
R526	Resistor MF 3.01k ohm 1%	19701	5043 (RN55D)	341346
R527	Resistor MF 3.57k ohm 1%	19701	5043 (RN55D)	341353
R528	Resistor MF 3.92k ohm 1%	19701	5043 (RN55D)	341357
R529	Resistor MF 6.04k ohm 1%	19701	5043 (RN55D)	341375
R530	Resistor Comp 180 ohm 5%	01121	EB	344225
R531	Resistor MF 84.5k ohm 1%	19701	5043 (RN55D)	341489
R532	Resistor MF 787k ohm 1%	19701	5043 (RN60D)	342586
R533	Resistor MF 78.7k ohm 1%	19701	5043 (RN55D)	341486
R534	Resistor MF 392k ohm 1%	19701	5043 (RN55D)	341557
R535	Resistor Comp 1.0M ohm 5%	01121	EB	344600
R536	Resistor MF 143k ohm 1%	19701	5043 (RN55D)	341515
R537	Resistor MF 536k ohm 1%	19701	5043 (RN60D)	342570
R538	Resistor MF 54.9k ohm 1%	19701	5043 (RN55D)	341471
R539	Resistor MF 154k ohm 1%	19701	5043 (RN55D)	341518
R540	Resistor Comp 1.0M ohm 5%	01121	EB	344600

Table 5-2. Replaceable Parts (Continued)

Item	Description	Mfr.	Mfr's Part No.	Part No.
SHAPING AMPLIFIER, PART NUMBER 042026-01				
R541	Resistor MF 90.9k ohm 1%	19701	5043 (RN55D)	341492
R542	Resistor MF 210k ohm 1%	19701	5043 (RN55D)	341531
R543	Resistor Var 20k ohm ±10% 1W	91637	Model 784	311266
R544	Resistor MF 21.0k ohm 1%	19701	5043 (RN55D)	341431
R545	Resistor Comp 1.0M ohm 5%	01121	EB	344600
R546	Resistor MF 38.3k ohm 1%	19701	5043 (RN55D)	341456
R547	Resistor MF 274k ohm 1%	19701	5043 (RN55D)	341542
R548	Resistor Var 20k ohm ±10% 1W	91637	Model 784	311266
R549	Resistor MF 48.7k ohm 1%	19701	5043 (RN55D)	341466
R550	Resistor MF 226k ohm 1%	19701	5043 (RN55D)	341534
R551	Resistor MF 35.7k ohm 1%	19701	5043 (RN55D)	341453
R552	Resistor MF 118k ohm 1%	19701	5043 (RN55D)	341507
R553	Resistor MF 45.3k ohm 1%	19701	5043 (RN55D)	341463
R554	Resistor MF 110k ohm 1%	19701	5043 (RN55D)	341504
R555	Resistor MF 36.5k ohm 1%	19701	5043 (RN55D)	341454
R556	Resistor MF 73.2k ohm 1%	19701	5043 (RN55D)	341483
R557	Resistor MF 25.5k ohm 1%	19701	5043 (RN55D)	341439
R558	Resistor Comp 1.0M ohm 5%	01121	EB	344600
R559	Resistor Comp 10k ohm 5%	01121	EB	344400
R560	Resistor MF 26.7k ohm 1%	19701	5043 (RN55D)	341441
R561	Resistor MF 158k ohm 1%	19701	5043 (RN55D)	341519
R562	Resistor Var 20k ohm ±10% 1W	91637	Model 784	311266
R563	Resistor Comp 5.1k ohm 5%	01121	EB	344368
R564	Resistor Comp 5.1k ohm 5%	01121	EB	344368
R565	Resistor MF 39.2k ohm 1%	19701	5043 (RN55D)	341457
R566	Resistor MF 169k ohm 1%	19701	5043 (RN55D)	341522
R567	Resistor MF 7.87k ohm 1%	19701	5043 (RN55D)	341386
R568	Resistor MF 32.4k ohm 1%	19701	5043 (RN55D)	341449
R569	Resistor MF 97.6k ohm 1%	19701	5043 (RN55D)	341495
R570	Resistor MF 40.2k ohm 1%	19701	5043 (RN55D)	341458
R571	Resistor MF 100k ohm 1%	19701	5043 (RN55D)	341500
R572	Resistor Comp 4.7k ohm 5%	01121	EB	344365
R573	Resistor Var 5k ohm ±20% 0.5W	32997	3359W-1-502	311293
R574	Resistor MF 27.4k ohm 1%	19701	5043 (RN55D)	341442
R575	Resistor MF 56.2k ohm 1%	19701	5043 (RN55D)	341472
R576	Resistor Comp 5.1k ohm 5%	01121	CB	343368
R577	Resistor Comp 5.1k ohm 5%	01121	CB	343368
R578	Resistor MF 3.01k ohm 1%	19701	5043 (RN55D)	341346
RT501	Thermistor 100 ohm ±10%	00241	CB21J1	325005
SWITCH ASSEMBLY, PART NUMBER 042123-02				
S401	Switch Modified M/F 465153	04901	PB-10 (Centralab Modified)	465154
METER ASSEMBLY, PART NUMBER 042125-01				
CR401	Diode S/F 530058	04901	BEC	530154
CR402	Diode S/F 530058	04901	BEC	530154
CR403	Diode S/F 530058	04901	BEC	530154
R403	Resistor MF 10.0k ohm 1%	19701	5043 (RN55D)	341400
R404	Resistor Var 2K ohm 10% 0.5W	73138	72XWR2K	311347
R405	Resistor MF 4.53k ohm 1%	19701	5043 (RN55D)	341363
R406	Resistor Var 2K ohm 10% 0.5W	73138	72XWR2K	311347
R407	Resistor MF 2.05k ohm 1%	19701	5043 (RN55D)	341330
R408	Resistor MF 7.87k ohm 1%	19701	5043 (RN55D)	341386
R409	Resistor Var 100 ohm 10% 0.5W	73138	72XWR100K	311377
R410	Resistor Var 5k ohm ±10% 0.5W	73138	72XWR5K	311307
RT401	Thermistor 400 ohm 10%	00241	KB24J1	325010
RT402	Thermistor 300 ohm 10%	00241	KB23J1	325009
RT403	Thermistor 1k ohm 1%	84322	Q81	325006
CHOPPER ASSEMBLY, PART NUMBER 042161-01				
C1	Capacitor PP 0.1 µF 10% 100V	27735	PP11-.1-100-10	234148
C2	Capacitor PP 0.1 µF 10% 100V	27735	PP11-.1-100-10	234148
IC1	IC CD4016BE (only) IT/F 534354 PED4200-3	04901	BEC	534223
P1	Terminal	98291	229-1071-23	510038
R3	Resistor MF 51.1k ohm 1%	19701	5043 (RN55D)	341468
R4	Resistor Var 20k ohm 10% 0.5W	73138	72PR20K	311354
R5	Resistor Var 20k ohm 10% 0.5W	73138	72PR20K	311354

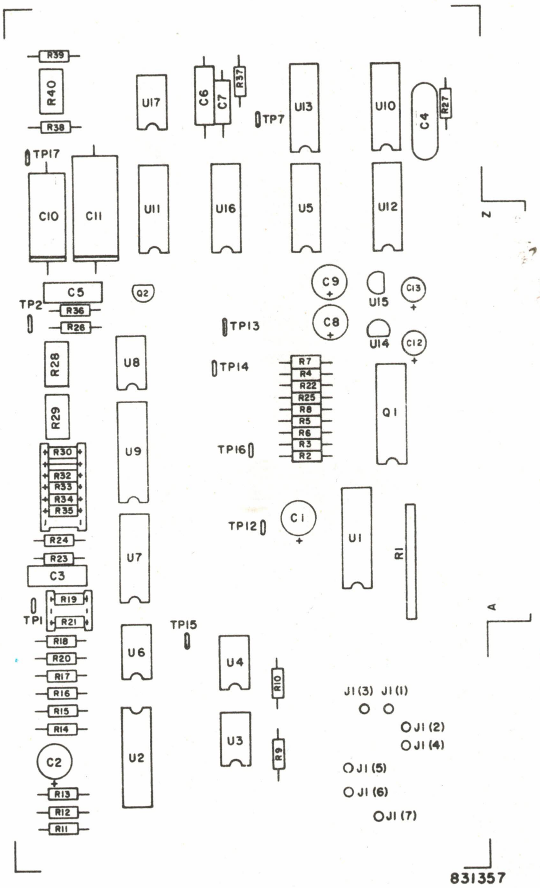
Table 5-2. Replaceable Parts (Continued)

Item	Description	Mfr.	Mfr's Part No.	Part No.
CHOPPER ASSEMBLY, PART NUMBER 042161-01				
R6	Resistor MF 51.1k ohm 1%	19701	5043 (RN55D)	341468
XIC1	Socket IC 14 Pin	91506	508-AG7D	473056
REAR-PANEL ASSEMBLY, PART NUMBER 042023-02				
F401	Fuse 0.1 A Slo-Blo	54426	MDL	545519
F401	Fuse 1/16 A Slo-Blo	54426	MDL	545518
S402	Switch Slide	82389	46202LR	465134
SUB-PANEL ASSEMBLY, PART NUMBER 042024-05				
CR125	Diode LED Red Diffused	34430	MV5025	536000
J401	Connector Assembly (female)	04901	BEC	092141
M401	Meter & Scale M/F 554215, 554285	04901	BEC	554286
R401	Resistor Var 5k ohm ±10% M/F 311413	04901	BEC	311255
R402	Resistor Var 5k ohm 10% 1W	16546	BA-0251-0001	311407
HEAT-SINK ASSEMBLY, PART NUMBER 042144-01				
IC101	IC 7805UC Regulator	07263	μA7805UC	535011
IC102	IC 7805UC Regulator	07263	μA7805UC	535011

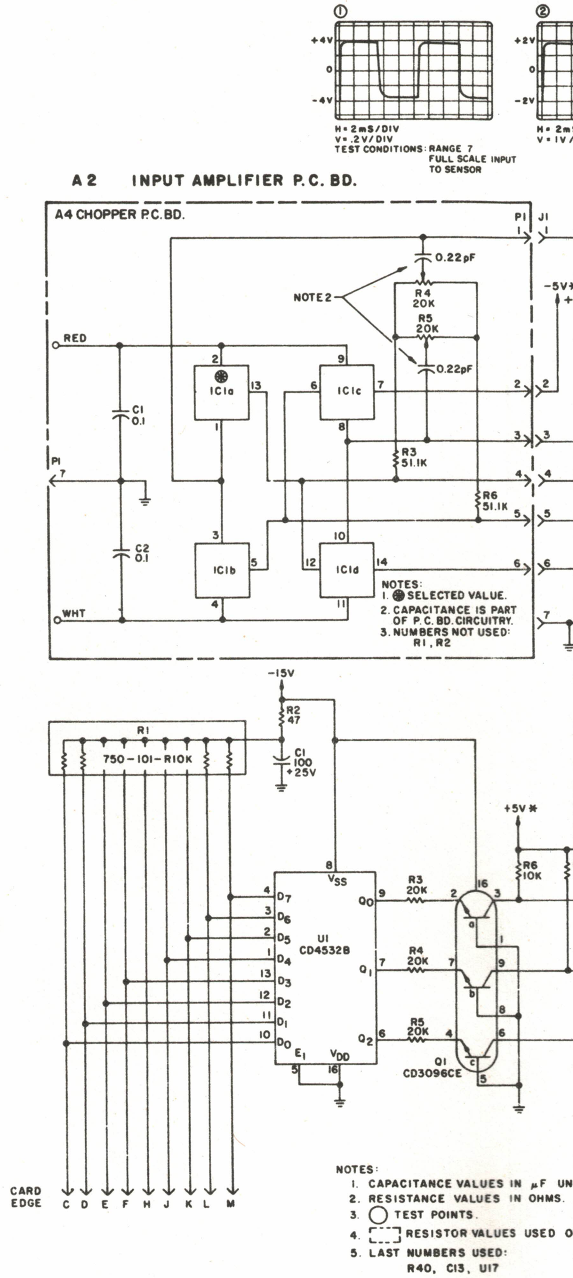
SECTION VI
SCHEMATIC DIAGRAMS

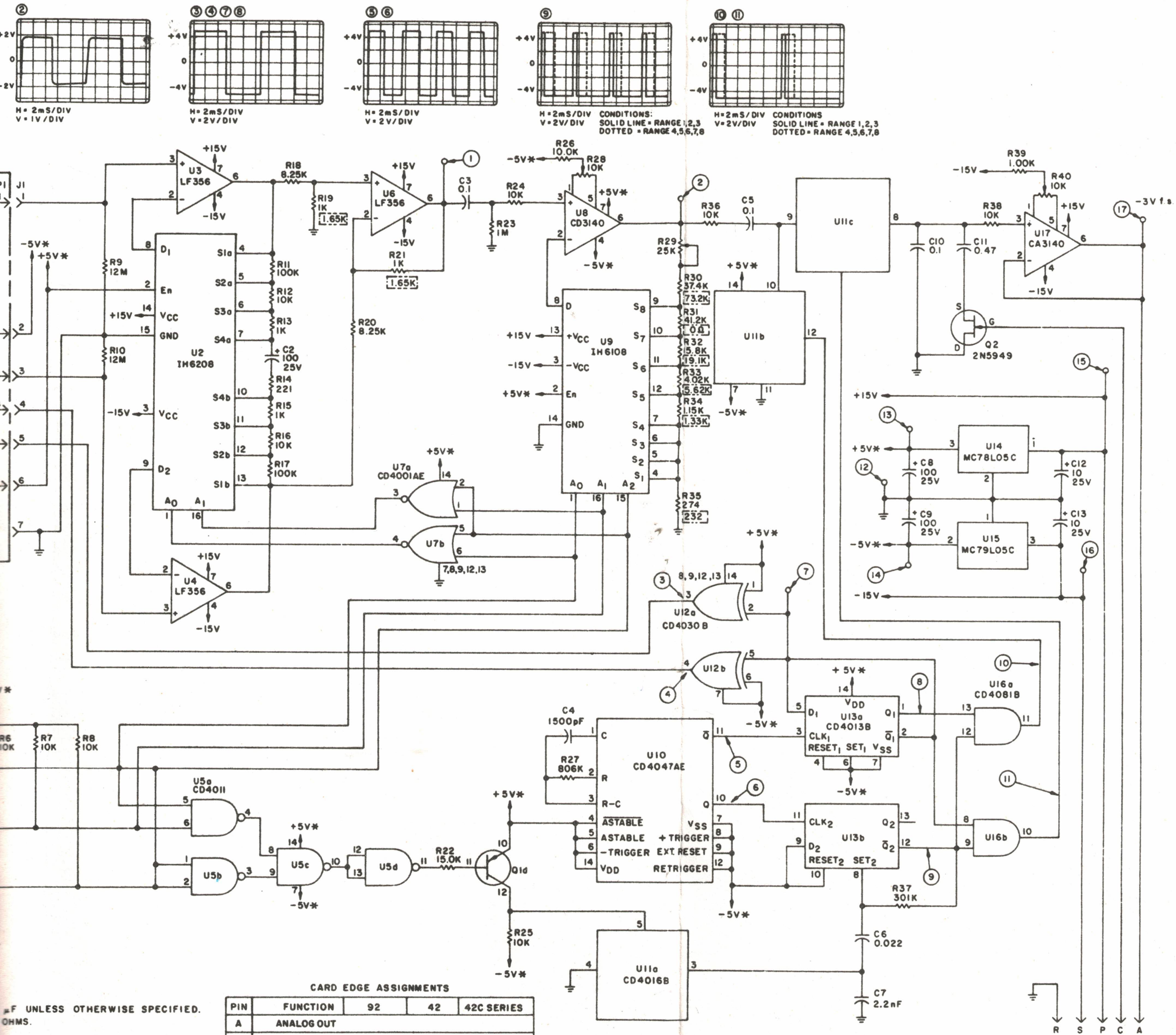
6-1. TABLE OF CONTENTS

NOTES



Input Amplifier Parts-Location Diagram (C831357B)





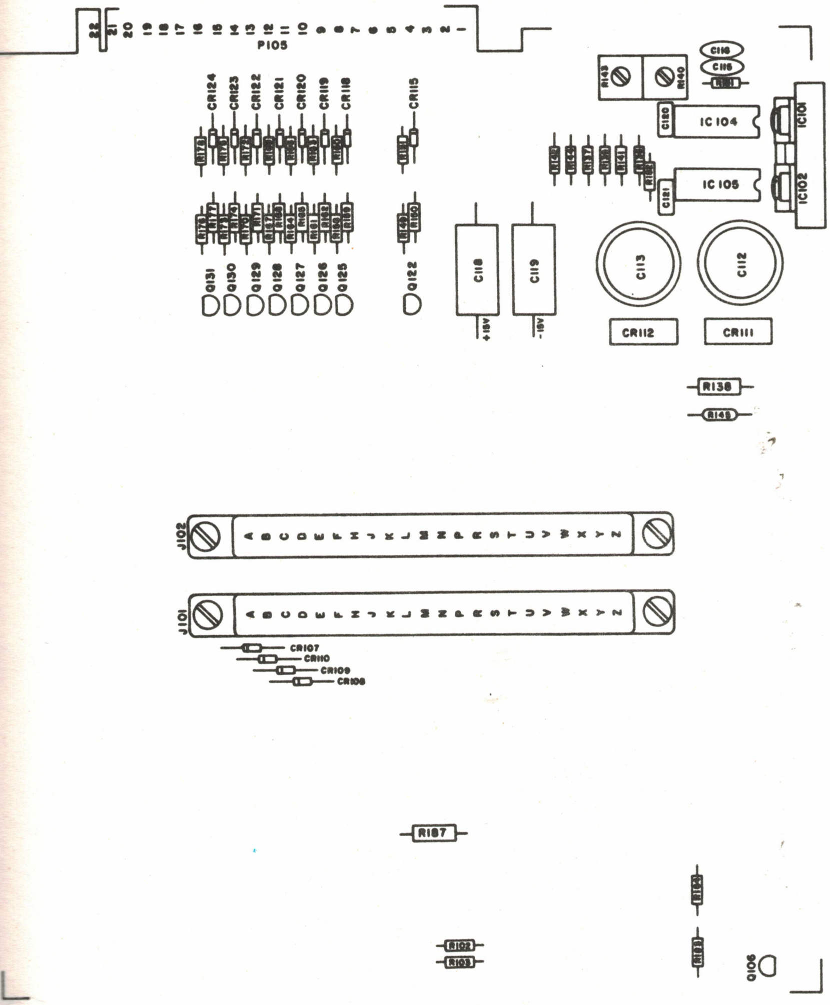
μF UNLESS OTHERWISE SPECIFIED.
OHMS.

USED ON 42B, 42BD.

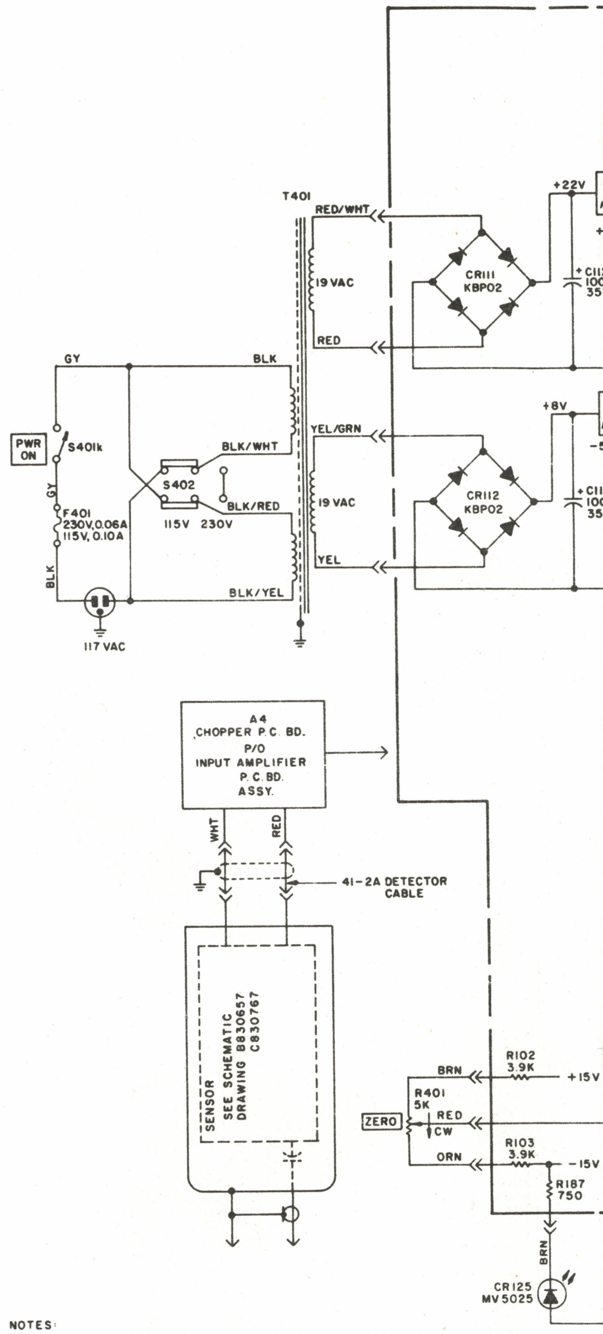
CARD EDGE ASSIGNMENTS

PIN	FUNCTION	92	42	42C SERIES
A	ANALOG OUT			
B				
C	RANGE 1	1 mV	10 nW	100 nW
D	" 2	3 mV	100 nW	1 μW
E	" 3	10 mV	1 μW	10 μW
F	" 4	30 mV	10 μW	100 μW
H	LOW 4			
J	RANGE 5	100 mV	100 μW	1 mW
K	" 6	300 mV	1 mW	10 mW
L	" 7	1000 mV	10 mW	100 mW
M	" 8	3000 mV		
N				
P	+15V			
R	COM			
S	−15V			

Figure 6-1. Input Amplifier Board Schematic Diagram (E831308B)



Parts-Location Diagram (D831349A)



NOTES:

1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. ▭ EXTERNAL MARKINGS.
4. TEST CONDITIONS:
   RANGE: 1µW } 428 SIGNAL: 1µW } ONLY — RANGE: 10µW } 42C SIGNAL: 10µW } ONLY

   ALL VOLTAGE READINGS IN VOLTS, UNLESS OTHERWISE SPECIFIED. ALL READINGS NOMINAL.
5. LAST NUMBERS
   R187 C121 CR125 Q131 IC105
   R410 CR403 RT403 M401
6. NUMBERS NOT USED:
   R101, 104 THRU R135, 146, 147, 148, R152 THRU 157, R179, 185, 186
   C101 THRU C111
   CR101 THRU 106, CR113, 114, 116, 117
   Q101 THRU 105, Q107 THRU 120, 121, 123, 124.
   IC103

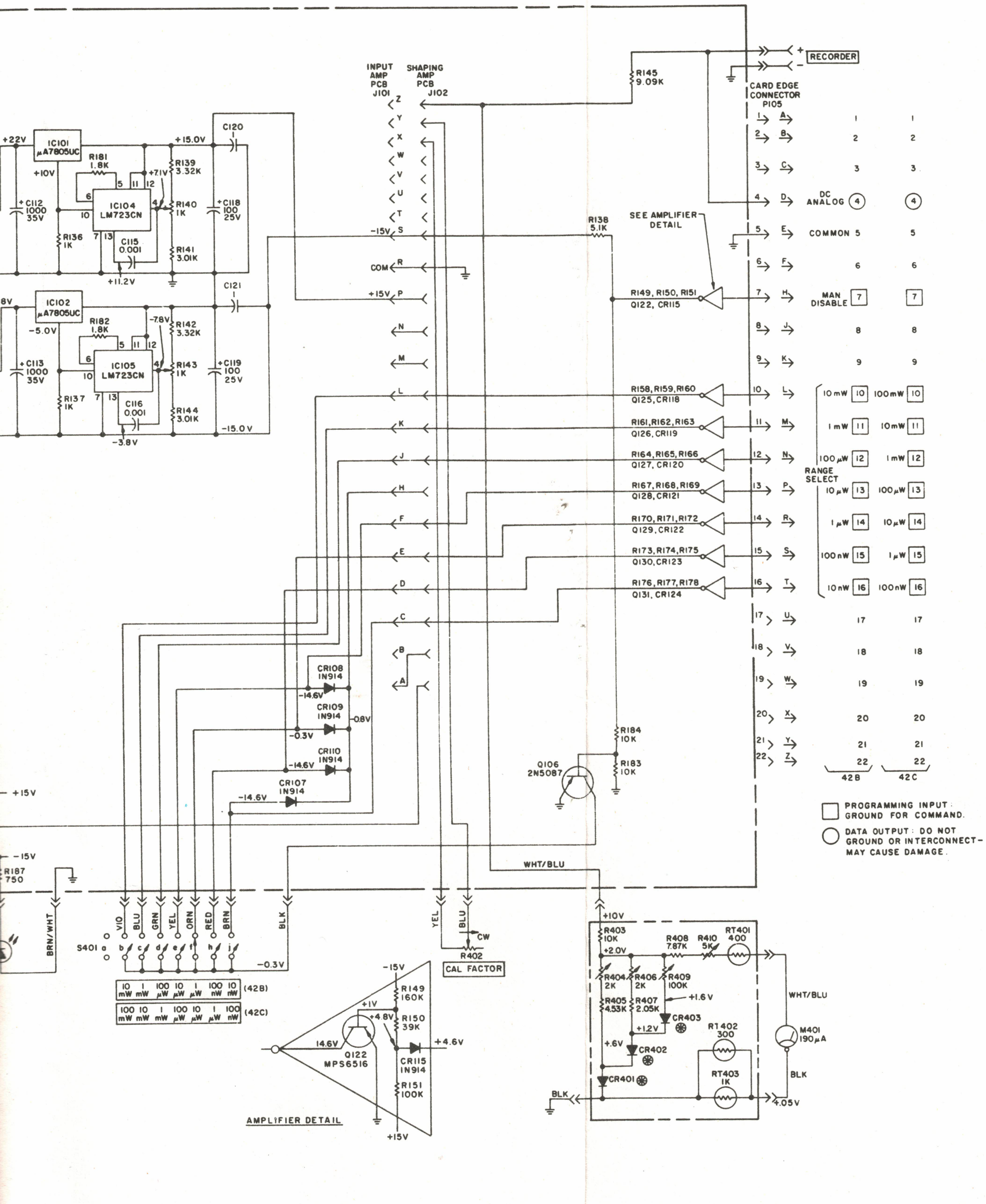
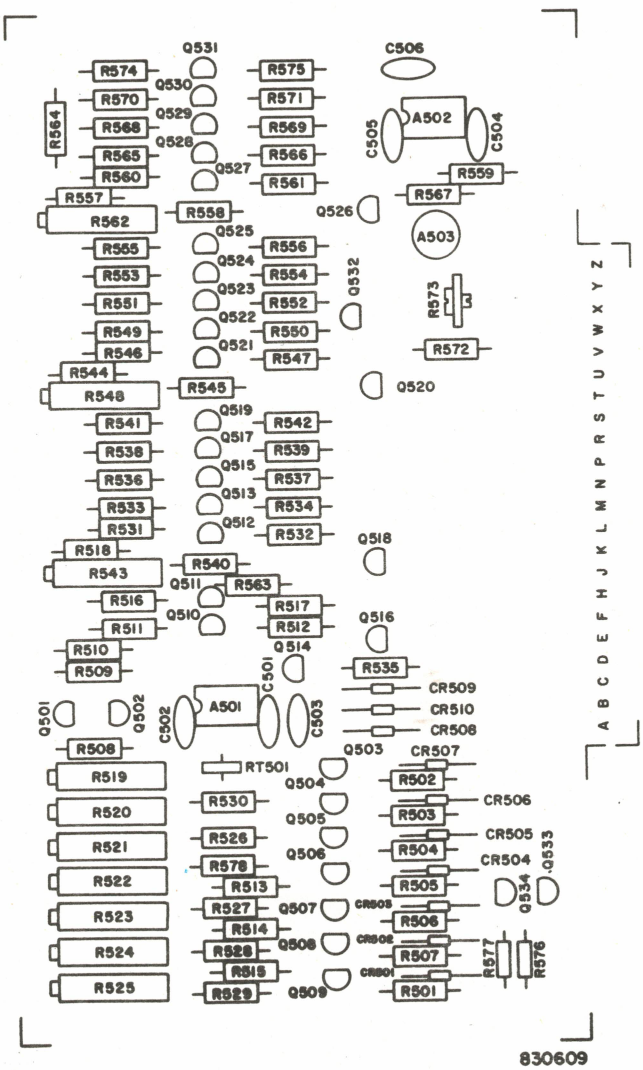
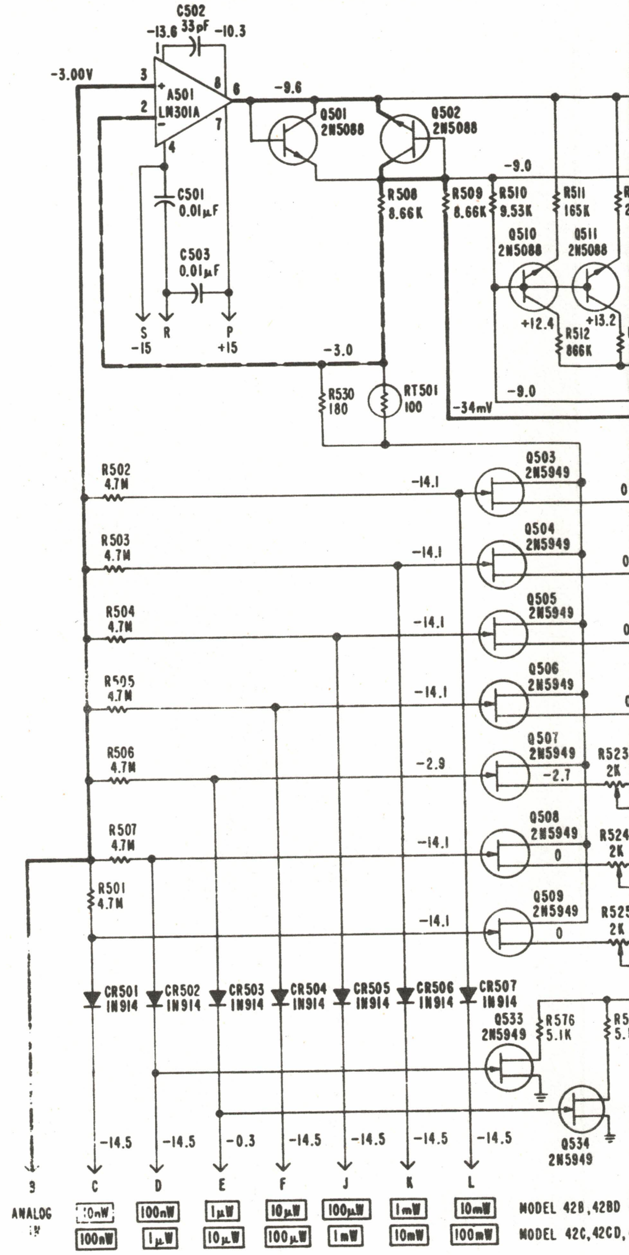
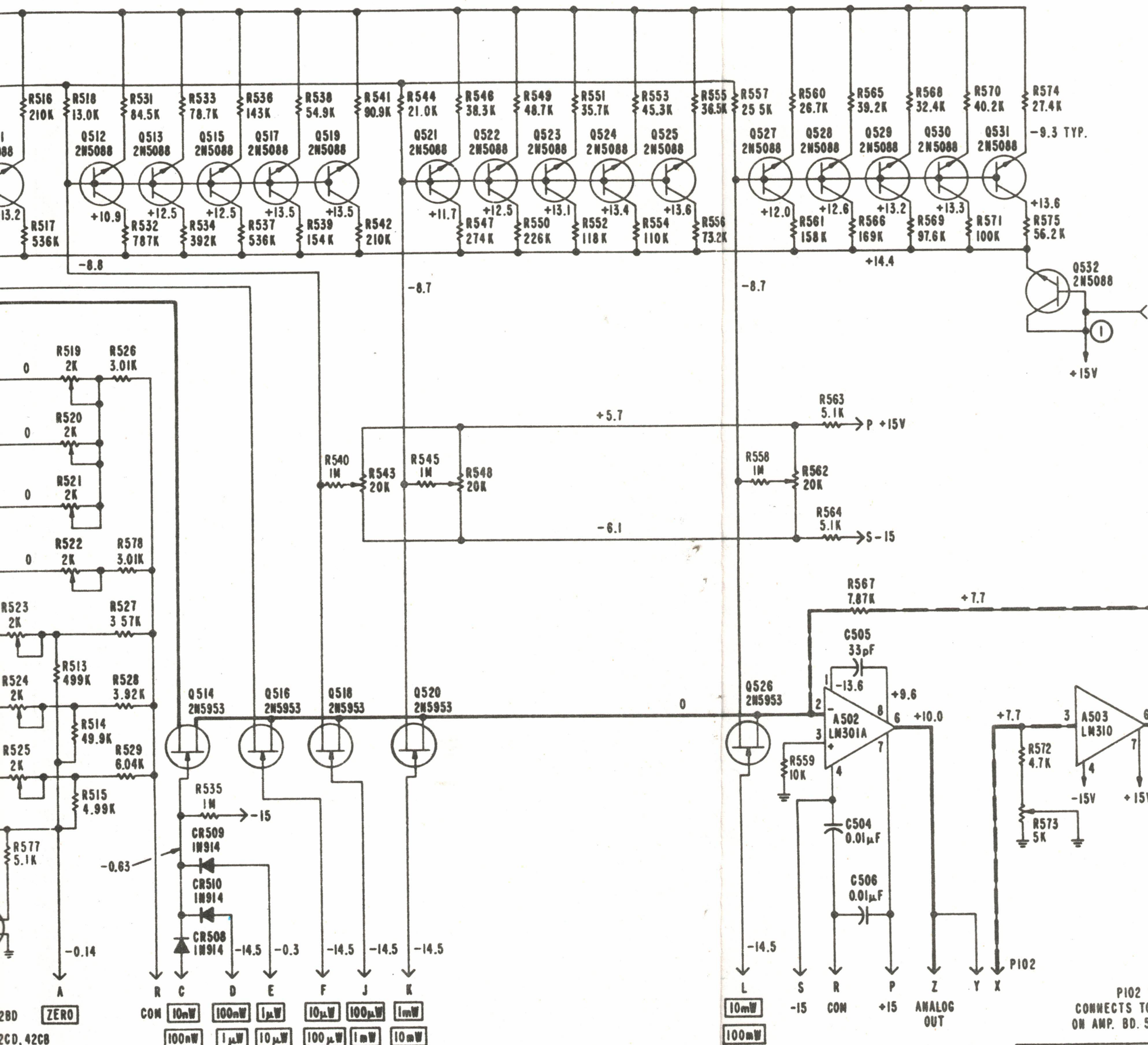


Figure 6-2. Master Board Schematic Diagram (E831313A)



Parts-Location Diagram (C830609C)





INSTRUMENT	SCHEMATIC
42B	830636
42BD	830592 SHT. I
42B-18	830640
42B-19	830641
42BB, 42CB	830658 SHT. I
42C	830636
42CD	830592 SHT. I

NOTES:
1. RESISTANCE VALUES IN OHMS.
2. ——— SIGNAL PATH.
3. — — — FEEDBACK PATH.
4. ▭ EXTERNAL MARKINGS
5. ◯ TEST POINT.
6. LAST NUMBER USED:
R578 C506 Q534 CR510 A503
7. TEST CONDITIONS:
RANGE: 1 µW, SIGNAL: 1 µW } 42B, 42BD; RANGE: 10 µW, SIGNAL: 10 µW } 42C, 42CD
ALL READINGS IN VOLTS, UNLESS OTHERWISE SPECIFIED. ALL READINGS NOMINAL.

Figure 6-3. Shaping Amplifier Schematic Diagram (E830592M, Sheet 2 of 3)

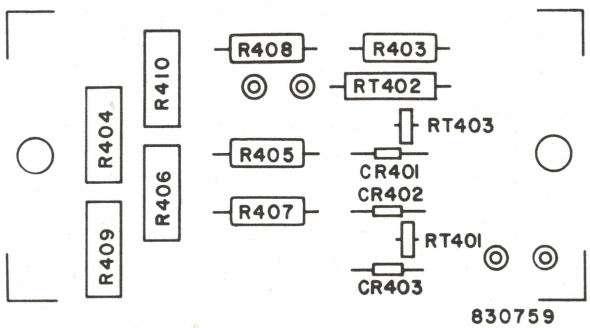


Figure 6-4. Meter Assembly, Parts-Location Diagram (B830759B)

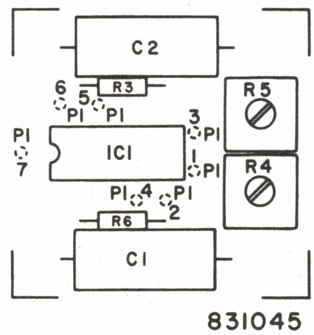


Figure 6-5. Chopper Board, Parts-Location Diagram (B831045D)

WARRANTY

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

We will repair, or at our option, replace any of our products which are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return normal ground transportation during the first three months of this warranty.*

There will be no charge for parts, labor, or return normal ground transportation during the fourth through twelfth month of this warranty.*

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

*For *overseas shipments*, there will be no charge for Air Freight during these specified time periods.

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