# POWER MONITORS

## Model 460B, 480, 490, 4490 Series
## OPERATION & MAINTENANCE MANUAL

narda
microwave-east
an L3 communications company

# OPERATION AND MAINTENANCE MANUAL

Average and Peak Integrated Power Monitors

Model 460B, 480, 490, 4490 Series

U.S. Patent No. 3,668,521

THE NARDA MICROWAVE CORPORATION
HAUPPAUGE, NEW YORK 11788

# WARRANTY

The Narda Microwave Corporation warrants each product of its manufacture to be free from any defect in material and workmanship for a period of one year after delivery to, and return by, the original purchaser. All warranty returns, however, must first be authorized by a factory office representative.

The limit of liability under this warranty shall be to repair or replace any product, or part thereof, which proves to be defective after inspection by Narda. This warranty shall not apply to any Narda product that has been disassembled, modified, physically or electrically damaged or any product that has been subjected to conditions exceeding the applicable specifications or ratings.

The Narda Microwave Corporation shall not be liable for any direct or consequential injury, loss or damage incurred through the use, or the inability to use, any Narda product.

The Narda Microwave Corporation reserves the right to make design changes to any Narda product without incurring any obligation to make the same changes to previously purchased units.

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Power Monitors

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# SECTION 1

# GENERAL DESCRIPTION

## 1-1. INTRODUCTION.

1-1.1. This manual contains complete instructions for the installation and maintenance of the Model 460B, 490, and 4490 Series Average Power Monitors and Model 480 Series Peak Power Monitor (see Figure 1-1), designed by The Narda Microwave Corporation, Hauppauge, New York. This manual includes a general description of the units, purpose and use, theory of operation, maintenance procedures and replaceable parts list.

## 1-2. DESCRIPTION.

1-2.1. Narda Integrated Power Monitors are compact instruments which combine into a single package a thermocouple or diode sensing element and linear DC amplifier.

1-2.2. Slight changes in external wiring permit the monitors to perform as either a constant voltage or constant current source.

## 1-3. SPECIFICATIONS.

1-3.1. Table 1-1 lists the specifications for the Integrated Power Monitors.

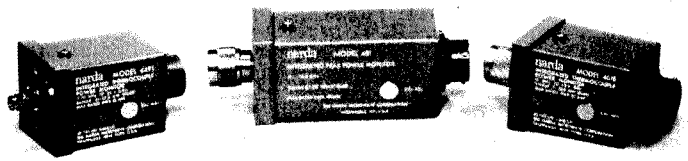


Figure 1-1. Integrated Power Monitors

# Table 1-1. Specifications

| Frequency Range (GHz) | 0.01-12.4 | | | | | | 0.1-18.6 | 0.05-18 | | 0.10-26.5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Model | 460B | 461B | 462B | 464B | 465B | 466B | 481 | 491 | 492 | 4491 |
| Dynamic Range (dB) | 30 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 0 |
| Range* | | | | | | | | | | |
| Full Scale Power Input | | | | | | | | | | |
| Lo (x.1) | 10 W | 100 W | 1.0 mW | - | - | - | 1.0 mW | 100 W | 1 mW | 100 W |
| Mid (x1) | 100 W | 1.0 mW | 10.0 mW | 100 W | 1.0 mW | 10 mW | 10.0 mW | 1.0 mW | 10 mW | 1.0 mW |
| Hi (x10) | 1.0 mW | 10.0 mW | 100.0 mW | 1.0 mW | 10.0 mW | 100.0 mW | 100.0 mW | 10.0 mW | 100.0 mW | 10.0 mW |
| Single (30 dB) | 1.0 mW | 10.0 mW | 100.0 mW | - | - | - | 100 mW | 10 mW | 100 mW | 10 mW |
| Single (20 dB) | - | - | - | 1.0 mW | 10.0 mW | 100.0 mW | - | - | - | - |
| Connector Type | N-Male | N-Male | N-Male | N-Male | N-Male | N-Male | N-Male | N-Male | N-Male | 3.5 mm |
| Input VSWR (50 ) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.3 | 1.5 | 1.5 | 2.0* |
| Peak Power Rating(Watts) | 0.1 | 3.0 | 30.0 | 0.1 | 3.0 | 30.0 | 0.2 | 5.0 | 5.0 | 5.0 |
| Constant Voltage Conn dc Linear Output fs (mV) | | | | | | | | | | |
| Lo (x.1) | 100 | 100 | 100 | - | - | - | 100 | 100 | 100 | 100 |
| Mid (x1) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Hi (x10) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Single (x.1) | 10,000 | 10,000 | 10,000 | - | - | - | 10,000 | 10,000 | 10,000 | 10,000 |
| Single (x1) | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| For Constant Voltage Min Resis Display (ohms) | | | | | | | | | | |
| Lo (x.1) | 100 | 100 | 100 | - | - | - | 100 | 100 | 100 | 100 |
| Mid (x1) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Hi (x10) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Single (x.1) | 1,000 | 1,000 | 1,000 | - | - | - | 1,000 | 1,000 | 1,000 | 10,000 |
| Single (x1) | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Constant Current Connection DC Linear Ouput fs (mA) | | | | | | | | | | |
| Lo (x.1) | 0.01 | 0.01 | - | - | -0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mid (x1) | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Hi (x10) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Single (x.1) | 0.10 | 0.10 | 0.10 | - | - | | 0.10 | 0.10 | 0.10 | 0.10 |
| Single (x1) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| For Constant Current Max Resistance including Remote Display (ohms) | | | | | | | | | | |
| Lo (x.1) | 10,000 | 10,000 | 10,000 | - | - | - | 10,000 | 10,000 | 10,000 | 10,000 |
| Lo (x1) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Hi (x10) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Single (x.1) | 1,000 | 1,000 | 1,000 | - | - | - | 1,000 | 1,000 | 1,000 | 1,000 |
| Single (x1) | 10,000 | 10,000 | 10,000 | 1,000 | 1,000 | 1,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Typ Zero Offset** (%/C) | | | | | | | | | | |
| Lo (x.1) | .500 | .500 | .500 | - | - | - | .500 | .500 | .500 | .500 |
| Lo (x1) | .050 | .050 | .050 | .050 | .050 | .050 | .050 | .050 | .050 | .050 |
| Hi (x10) | .005 | .005 | .005 | .005 | .005 | .005 | .005 | .005 | .005 | .005 |
| Output Connectors + + | 18 PIN Multi-contact Male Connector Bendix PT07A14-18P | | | | | | | | | |
| Weight | | | | | | | | | | |
| Ounces | 10 | 10 | 10 | 10 | 10 | 10 | 16 | 10 | 10 | 10 |
| Grams | 283 | 283 | 283 | 283 | 283 | 283 | 455 | 283 | 283 | 283 |

Temperature Range for Models 460B, 461B, 462B, 464B, 465B, 466B, 491, 492, and 4491: Operating -55 C to +125, Non-Operating -65 C to +150 C
Temperature Range for Model 481: Operating 0 C to +50 C Non-Operating -65 C to +125 C

* (50 MHz to 22 GHz 1.5:1) (75 MHz to 20 GHz 1.3:1)

** Zero offset can be balanced out an any temperature with zero offset control, so that no resultant error is introduced.

+ Unit may be connected for two or three selectable 10 dB ranges or for a single 20 or 30 dB range.

+ + Mating connector assembly supplied separately, Narda Part No. 30931301. Also available, is Narda Part No. 30931300, with electrically conductive rubber boot for additional EMI shielding, if required.

NOTE

The following specifictions apply to all models (except 481): Element Temperature Sensitivity (per Degree C) +/- 0.1%, Element Overload Rating 300%

# SECTION 2

# TYPICAL APPLICATIONS

## 2-1. GENERAL.

2-1.1. This section describes some of the typical applications in which the Narda Integrated Power Monitors may be used to their greatest advantage; no attempt has been made to include all possible applications.

## 2-2. REMOTE POWER MONITORING.

### 2-2.1. Constant Current Output.

2-2.1.1. Continuous RF power monitoring at the antenna with the readout instrumentation located in a console located several hundred feet away, is achieved through the use of a reflectometer coupler (see Figure 2-1) to provide a readout of the actual power transmitted from the antenna. In systems employing a rotating antenna, the monitor is attached to the

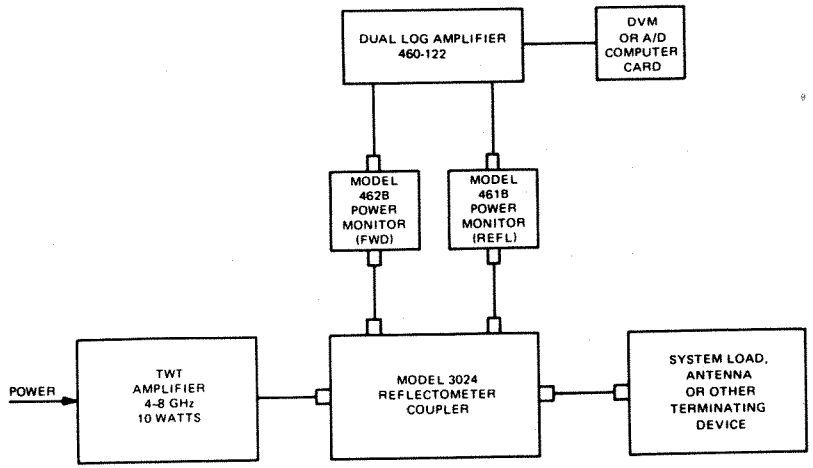



Figure 2-1. Forward and Reflected Power Measurement and Control at Remote Location

antenna, with the supply voltage and signal leads connected through the rotary joint slip rings. Due to the varying resistance of the slip ring contacts, the power monitor should be connected in the Constant Current Mode of operation. (Refer to Section 4 for appropriate external connections.)

2-2.1.2. Connection of the power monitor in the Constant Current Mode permits the maximum load resistance placed across the circuit to be dependent solely on the maximum voltage available at the constant current source, thereby, virtually eliminating measurement errors due to the varying resistance of metering circuit.

2-2.1.3. This connection is generally used to drive a low impedance readout in situations where the total path resistance in the external metering circuit may be varying.

2-2.2. Constant Voltage Outputs.

2-2.2.1. The Constant Voltage Mode of operation provides a zero source impedance. Variation of load or metering resis-

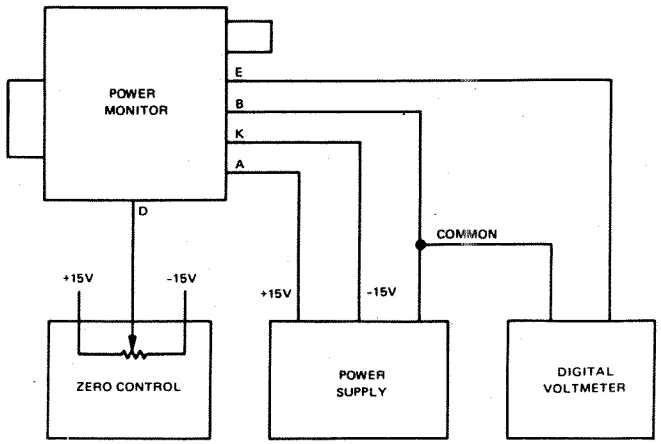



Figure 2-2. Single Range Digital Readout





tance with voltage responsive meters, will not offset the accuracy of measurement, provided that the lead resistance is negligible or accounted for. Ten dB range switching is simply accomplished by utilization of only a single pole switch (double pole switch for Model 481). Connection of the power monitor in the Constant Voltage Mode permits the monitor to be used as a single range asuring instrument with a digital readout covering the full dynamic range of the monitor. An external dc power source and a digital voltmeter are connected as shown in Figure 2-2.

## 2-3. CONTROL FUNCTIONS.

2-3.1. The Model 460B, 490 and 4490 Series Power Monitors are capable of control functions in applications where a response time of 100 milliseconds or more is acceptable. The Model 480 Series Peak Power Monitor has typical rise times of 1 microsecond in the 100 mW range, and 0.2 microseconds in the 1 mW range for applications requiring faster response to varying RF power.

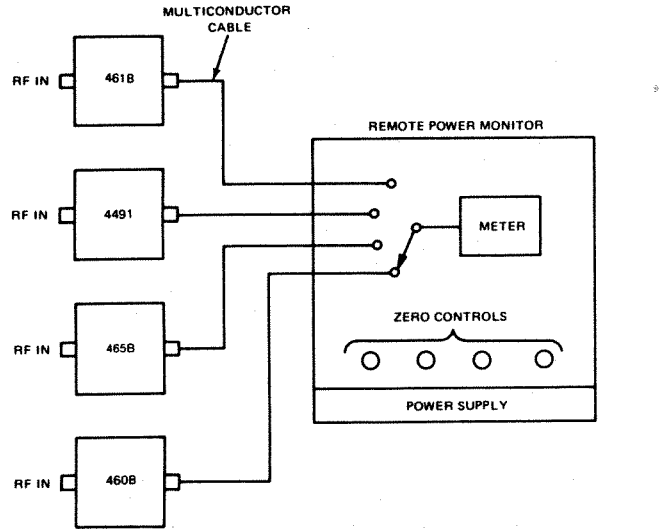



Figure 2-3. Multiple Monitoring Operation, Single Meter

2-3.2. When transmitter shutdown is required as protection for klystrons, TWTs, and magnetrons from excessive reflective power, both forward and reflected power can be measured by means of a dual directional coupler with two power monitors connected, as shown in Figure 2-1, to measure antenna return loss.

2-3.3. An installation of this type permits the transmitted power to be measured by the antenna, with the control and measuring circuits remotely located without affecting measurement accuracy.

## 2-4. MULTIPLE UNIT OPERATION.

2-4.1. Many power monitors can be operated in a system from a single power supply and meter as shown in Figure 2-3. All models can be mixed in the system with proper selection based on frequency and the levels of RF power to be measured in the system.

## 2-5. MONITORING OF SATELLITE UPLINK TRANSMITTER POWER.

2-5.1. In the case of satellite uplink station operations, it is possible to maintain a complete and accurate record of transmitted power by feeding the power monitor directly into an A/D computer card, creating a permanent record of actual transmitted power. This offers broadcasters a means of assuring complete coverage of their assigned areas under most transmission conditions and also of assuring conformity to FCC requirements. In this application, a waveguide coupler/adapter should be used to provide transition from waveguide to coaxial transmission paths. If the transmission system is coaxial, a standard Narda coaxial coupler could be used.

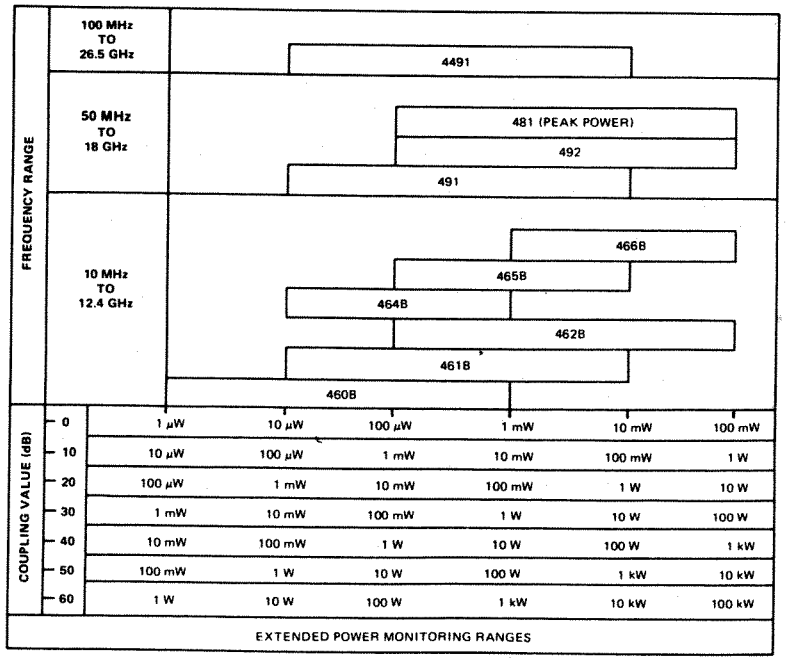




## 2-6. HIGH POWER MONITORING.

2-6.1. When higher power levels need to be monitored, using Narda high power couplers will extend the power level capability of the monitors. Table 2-1 provides a quick reference of what monitors and coupling values are needed to measure certain power levels. Contact the factory for information on high power couplers.

Table 2-1. Available Power Monitors and Measurement Ranges When Supplied with a High Power Directional Coupler



# SECTION 3

# THEORY OF OPERATION

## 3-1. GENERAL.

3-1.1. This section provides a brief description of the major circuits of the Model 460B, 490, and 4490 Series Thermocouple Power Monitors, and Model 480 Series Diode Power Monitors. The monitors consist of the RF detecting element and amplifier.

3-1.2. The thermocouple element or diode absorbs the power of the RF signal being monitored and converts it to a low level dc voltage. This voltage is fed to the controlled gain amplifier.

## 3-2. THERMOCOUPLE ELEMENT (Model 460B, 490, 4490 Series).

3-2.1. The thermocouple element terminates a 50 ohm coaxial line. The RF signal being monitored is absorbed in the element. The element provides a dc output proportional to the power dissipated within it.

3-2.2. Controlled gain amplifier, A1, and its associated circuits provide amplifiction for the low dc voltage generated in the thermocouple element. The power supply input voltages for the amplifier are applied to pins A and K. Calibration of the amplifier is achieved by the feedback network consisting of variable resistor R5 and resistors R4 and R1. Range switching is accomplished by voltage divider resistors R6, R7 and R8 on the 20 dB units and R6, R7, R8, R9, and R10 on the 30 dB units, which effectively multiply the gain of the amplifier by a factor of 10. Resistor R8 provides provides for a constant output impedance of the voltage divider. Resistors R8 and R10 provide a constant output impedance of the voltage divider.

Capacitor C10 and capacitor C5 provide frequency compensation of the amplifiers.

## 3-3. DIODE DETECTOR (480 Series).

3-3.1. The Model 481 utilizes a diode detector that terminates a 50 ohm coaxial line. The RF signal level being monitored is detected by the diode, which provides a dc voltage that is a non-linear function of the signal level.

3-3.2. The detector output is processed by a peak detecting amplifier (U1) which has a fast rise time (≈150 nsec.) and a slow fall time (Tau≈1 sec.). The output of U1 is fed to U2, which is a low drift-linear amplifier with three ranges. The signal is then routed to U3 which is a non-linear, three-range amplifier. The combined gain and slope of U2 and U3 shape the U3 output voltage so that it is linear in relation to the RF input level.

3-3.3. A voltage divider consisting of R22 and R23 allow the output of U3 to be scaled according to the output requirements. U4 is the output buffer amplifier which is externally wired to generate constant current or voltage outputs.





# SECTION 4

# INSTALLATION DRAWINGS

## 4-1. GENERAL.

4-1.1. This section contains installation drawings for the many forms of operation of Narda Integrated 20 and 30 dB Power Monitors.

## 4-2. 20 dB POWER MONITORS (Models 464B, 465B, and 466B).

4-2.1. The following figures indicate the various installation connections applicable to the 20 dB Power Monitors:

## 4-3. 30 dB POWER MONITORS (Models 460B, 461B, 481, 491, and 4491)

4-3.1. The following figures indicate the various installation connections applicable to the 30 dB monitors:



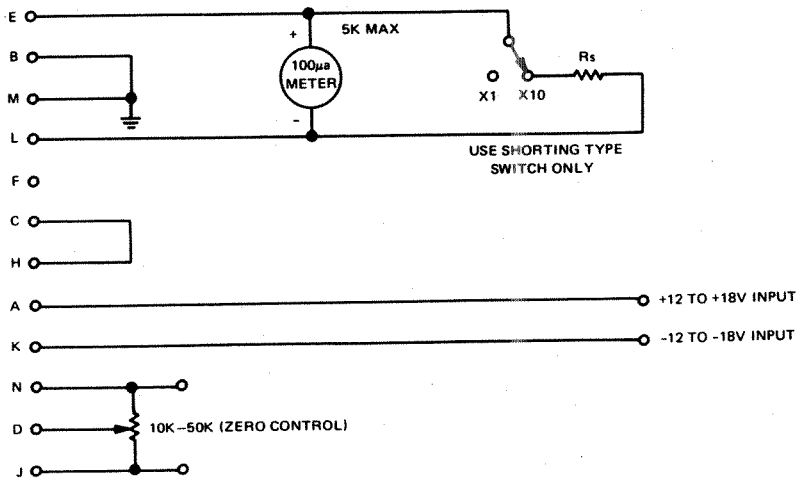



Figure 4-1. Constant Current Dual Supply Connection, Models 464B, 465B, 466B





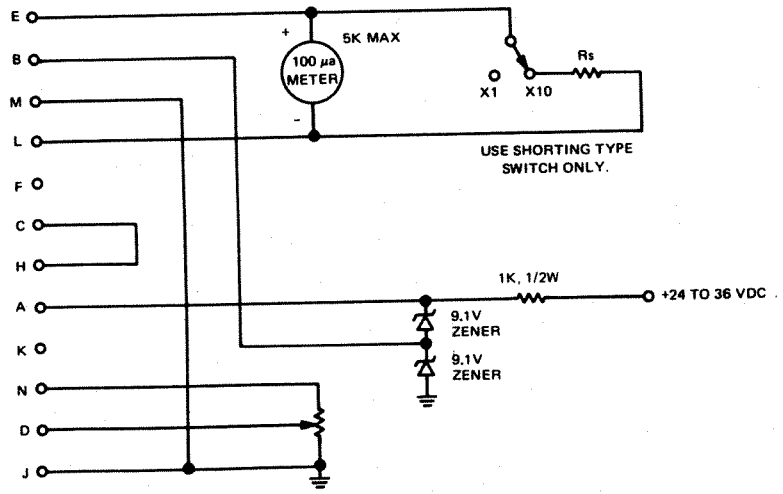



Figure 4-2. Constant Current-Single Positive Supply Connection, Models 464B, 465B, 466B

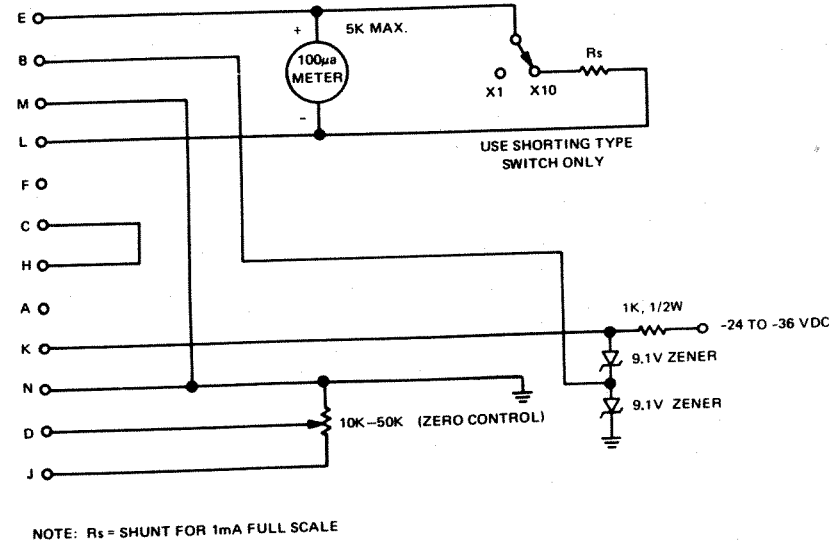
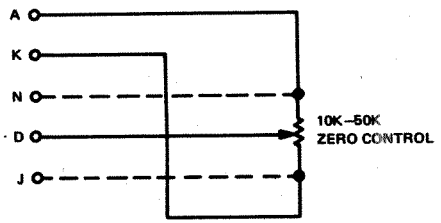



Figure 4-3. Constant Voltage-Dual Supply Connection, Models 464B, 465B, 466B




NOTE: The zero control may be connected directly across the ± power supply inputs to the power monitor, provided that this supply is well regulated. A regulation of approximately .1% is recommended.

Figure 4-8. Constant Current/Voltage Alternate Zero Connection, Models 464B, 465B, 466B

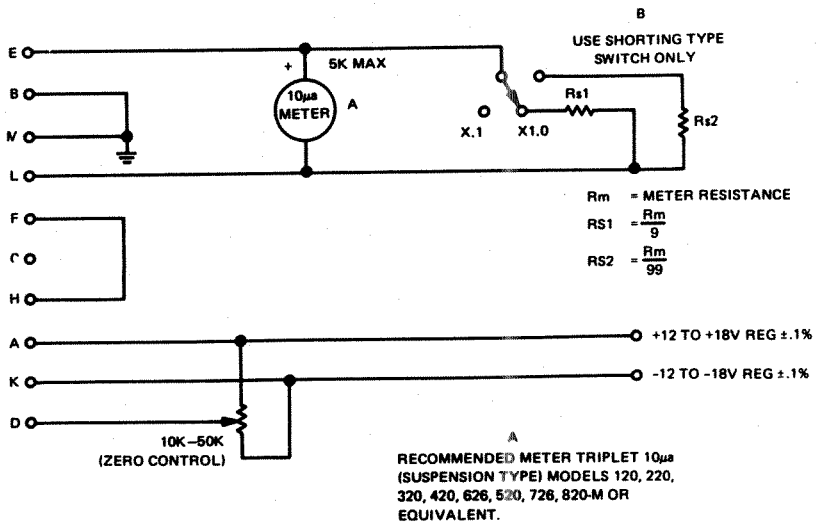



Figure 4-9. Constant Current Dual Supply Connection Models 460B, 461B, 462B, 491, 4491





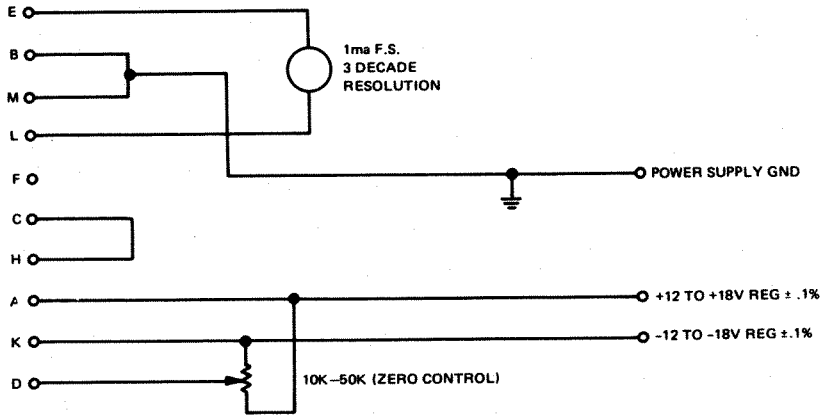



Figure 4-10. Constant Current Dual Supply Connection Single Range, Models 460B, 461B, 462B, 491, 4491

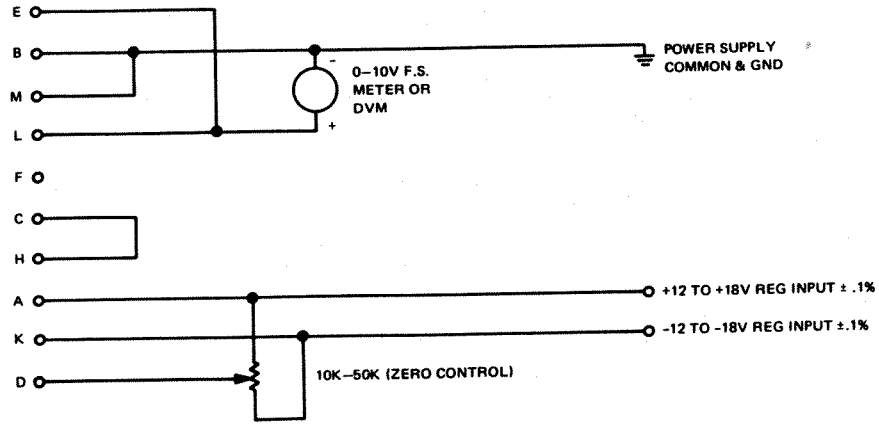



Figure 4-11. Constant Voltage Dual Supply Range Models 460B, 461B, 462B, 491, 4491

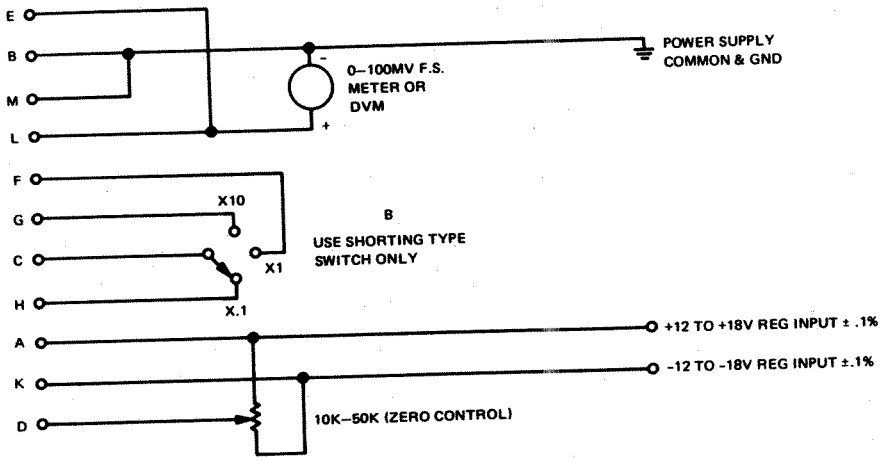



Figure 4-12. Constant Voltage Dual Supply Multiple Range Models 460B, 461B, 462B, 491, 4491

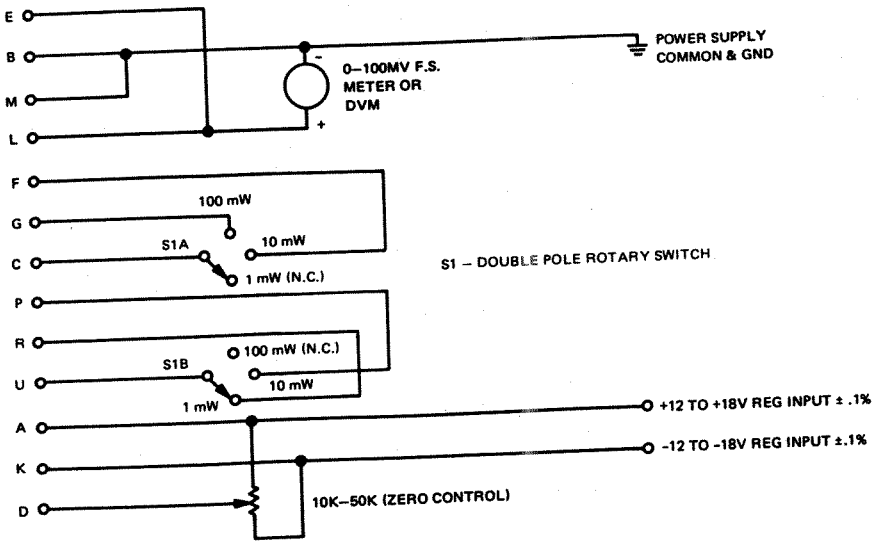



Figure 4-13. Constant Voltage Dual Supply Multiple Range Model 481





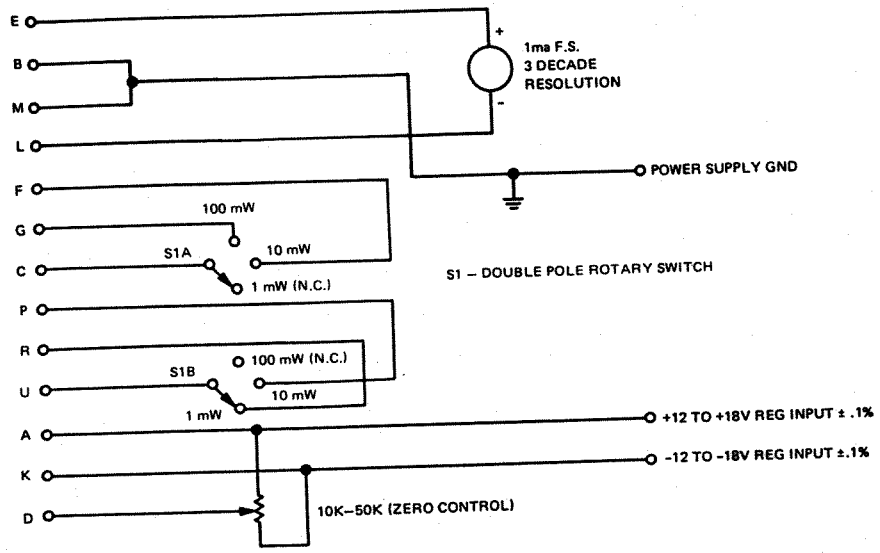



Figure 4-14. Constant Current Dual Supply Connection Multiple Range, Model 481

## 4-4. OUTPUT CONNECTOR ASSEMBLY.

4-4.1. Refer to Figure 4-15 for the proper connector assembly procedure.

## 4-5. MODEL 481 HIGH CURRENT OUTPUT.

4-5.1. The Model 481 Peak Power Monitor may be modified to provide a higher full-scale current output by following the procedures listed below:

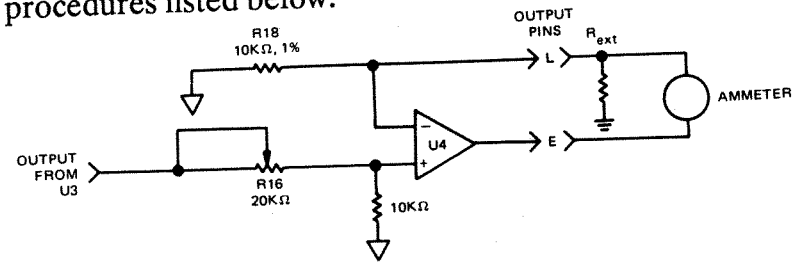



Figure 4-15. High Current Wiring for Model 481

4-5.2. The gain equation for the above circuit is:

$$\text{Iout (full scale)} = 1.0\ \text{mA} \times \frac{\text{Rext.} \,||\, 10\ \text{k}\Omega}{10\text{k}\Omega}$$

4-5.3. Figure 4-15 is capable of providing up to 5 mA (12 mA typ.) For applications requiring 10 mA full scale outputs, the following steps should be performed:

4-5.4. With Rext not connected, use R16 (Internal Gain Adjust) to lower the output current, so that Iout = 1/2 Iout (original). This adjustment lowers U4's voltage swing, allowing higher current operation. The gain equation now becomes:

$$\text{Iout (full scale)} = 0.5\ \text{mA} \times \frac{\text{Rext} \,||\, 10\ \text{k}\Omega}{10\ \text{k}\Omega}$$

Calculate Rext and add to circuit as shown in Figure 4-15.

NOTE: R16 can be used to lower gain. It is supplied from the factory at its full clockwise position (this shorts out voltage divider so that U3 and U4 outputs are equal) to give user a reference point.

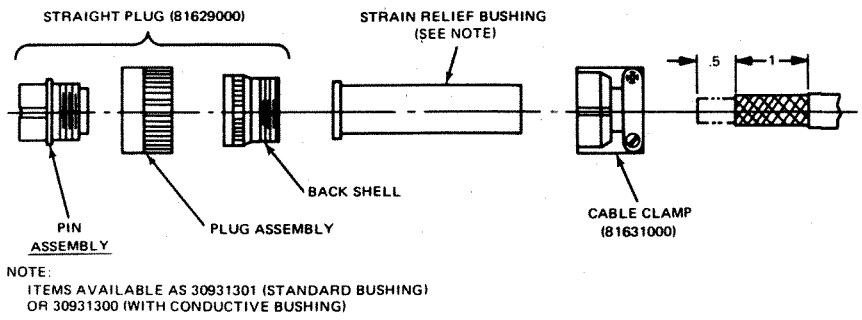



Figure 4-16. Cable Connector Assembly





4-6. CABLE INSTALLATION INSTRUCTIONS (Refer to Figure 4-16).

a. Cut cable outer jacket back 1 1/2 inches.

b. Cut shielded brading back 1/2 inch from end.

c. Strip wires 1/8 inch back on tin.

d. Loosen screws on cable clamp.

e. Insert the cable through the cable clamp (from the clamp end) and slide.

f. Insert cable through strain relief bushing and slide back.

g. Insert cable through the back shell (orient as shown).

h. Insert cable through the plug assembly (check orientation as shown).

i. Slide all components up cable.

j. Solder wires to desired pins on pin assembly (as indicated in installation connections, Figures 4-1 through 4-14).

k. Thread the back shell to the pin assembly and tighten.

l. Slide the cable clamp over the strain relief bushing thread into the back shell and tighten.

m. Tighten the cable clamp around the strain relief bushing.

## 4-7. OUTLINE DRAWINGS.

4-7.1. Figure 4-17 provides the outline drawing for the Model 460B Series and Model 491 Integrated Thermocouple Power Monitors.

4-7.2. Figure 4-18 provides the outline drawing for the Model 4491 Integrated Thermocouple Power Monitor.

4-7.3. Figure 4-19 provides the outline drawing for the Model 481 Peak Power Monitor.

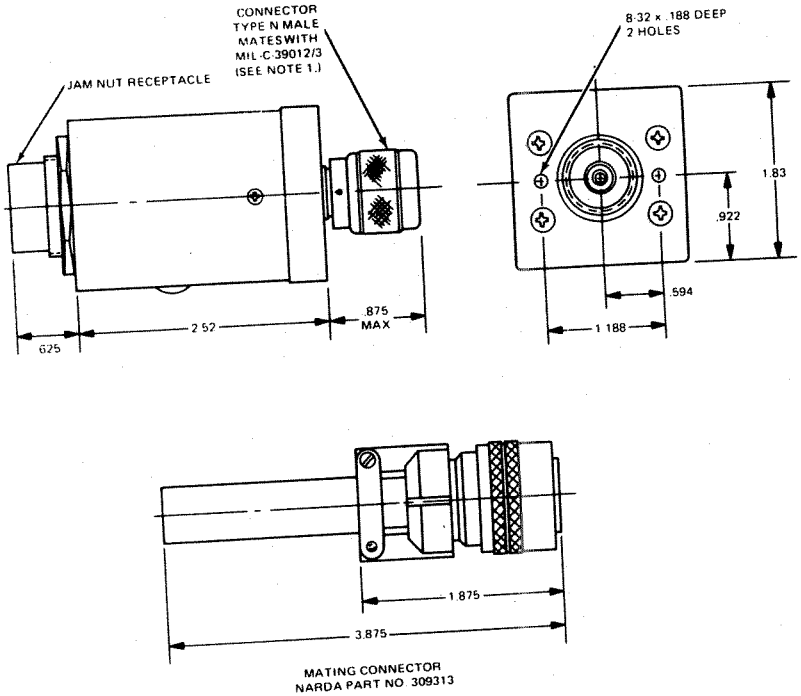



Figure 4-17. Integrated Thermocouple 20 and 30 dB Power Monitors (Models 460B through 466B & 491) Outline Drawing



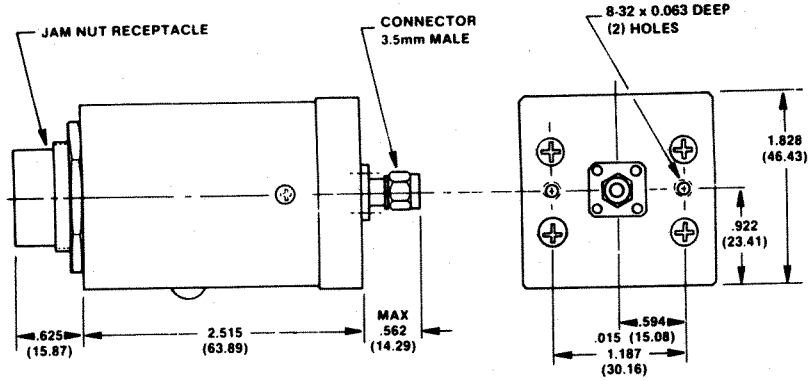



Figure 4-18. Integrated Thermocouple Power Monitor Model 4491

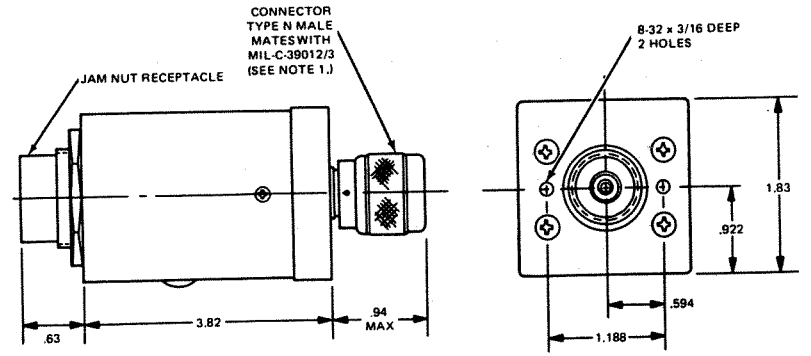



Figure 4-19. Integrated Peak Power Monitor Model 481

# SECTION 5

# MAINTENANCE

## 5-1. GENERAL.

5-1.1. This section provides information for troubleshooting and maintenance of Thermocouple and Diode Power Monitors (Refer to paragraphs 5-2 and 5-18 for Diode Power Monitoring Servicing.)

## 5-2. REQUIRED TEST EQUIPMENT.

5-2.1. The following test equipment will be required to perform maintenance on the Thermocouple or Diode Power Monitors:

5-2.2. Test Equipment Required for Thermocouple Monitors.

| Item | Description | Manufacturer | Model |
|---|---|---|---|
| 1. | Digital Voltmeter | Data Precision | 1455 |
| 2. | Attenuator, Variable | Narda | 791FM |
| 3. | Attenuator, Fixed | Narda | 768-1,-20,-30 |
| 4. | Coupler, Directional | Narda | 3002-30 |
| 5. | Differential Voltmeter | Fluke | 887AB |
| 6. | Decade Attenuator | General Radio | Type 1450 |
| 7. | Power Meter | H.P. | 438A |
| 8. | Power Meter, Head | H.P. | 8481A |
| 9. | Signal Generator | H.P. | 8350B/83592B |
| 10. | Power Supply | Lambda | LQD421 |
| 11. | Termination | Narda | 370BNM |

5-2.3. Additional Test Equipment Required for Diode Power Monitors.

| | | |
|---|---|---|
| 1. Attenuators, Fixed | Narda | 779-3,-10,-20 |
| 2. Attenuators, Step | Narda | 705B-69 |
| 3. Attenuator, Variable | Narda | 4799 |
| 4. Digital Voltmeter | Data Pecision | 1455 |
| 5. Directional Couplers | Narda | 3292-1,4203-16 |
| 6. Detector | Narda | 4507 |
| 7. Frequency Counter | E.I.P. | 548A |
| 8. Modulator | H.P. | 8403A-002 |
| 9. Network Analyzer | H.P. | |
| 10. Power Divider | Narda | 3456-2 |
| 11. Switch, Coaxial | Narda | SEM143D |
| 12. Isolators | Narda | 4914,4946, IOS-1020 |
| 13. Oscilloscope, 100 MHz | Tektronix | 2335 |

5-3. TEST CONDITIONS.

5-3.1. Test frequency shall be 8 GHz (unless otherwise noted).

5-3.2. Ambient temperature is to be $25^{\circ}$ C +/-$2^{\circ}$.

5-4. PERFORMANCE TESTS AND ADJUSTMENTS.

5-4.1. VSWR Check.

a. Connect monitor to reflectometer test setup of Figure 5-2.





b. Sweep VSWR at the test frequency: .01 to 12.4 GHz for 460B through 466B, .05 to 18 GHz for 481 and 491, and .1 to 26.5 GHz for 4491.

c. Record Maximum VSWR.

5-4.2. Preliminary Adjustments.

a. Connect dc power supply to 15.0 volts, using test fixture (see Figures 5-1 and 5-2).

b. Set range switch to X1.

c. Adjust to zero potentiometer for zero reading on meter or DVM. Large negative readings with the inability to zero would indicate an open thermocouple. If the zero drift (with respect to temperature) is excessive, the unit may require the following readjustment.

5-4.3. Ranging Check.

a. Connect test setup of Figure 5-1. Set Range switch to most sensitive power range and adjust zero control for full scale deflection. This represents 100 millivolts full scale.

b. Set Range switch up to 10 dB and note that meter now reads 10% of ull scale, or DVM reads 10% (10 mV).

c. Readjust zero for full scale (100 mV).

d. Repeat Step b.

e. Readjust zero control on most sensitive range for zero reading.

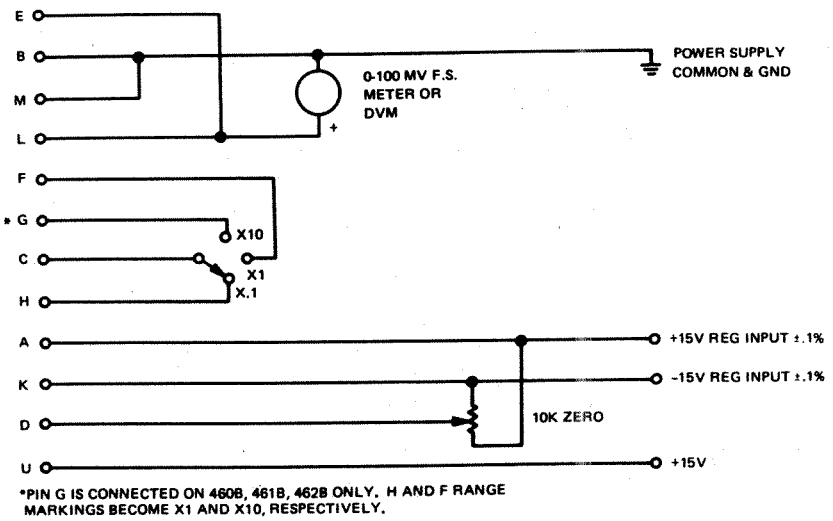



Figure 5-1. Interconnection Diagram for Thermocouple Monitors

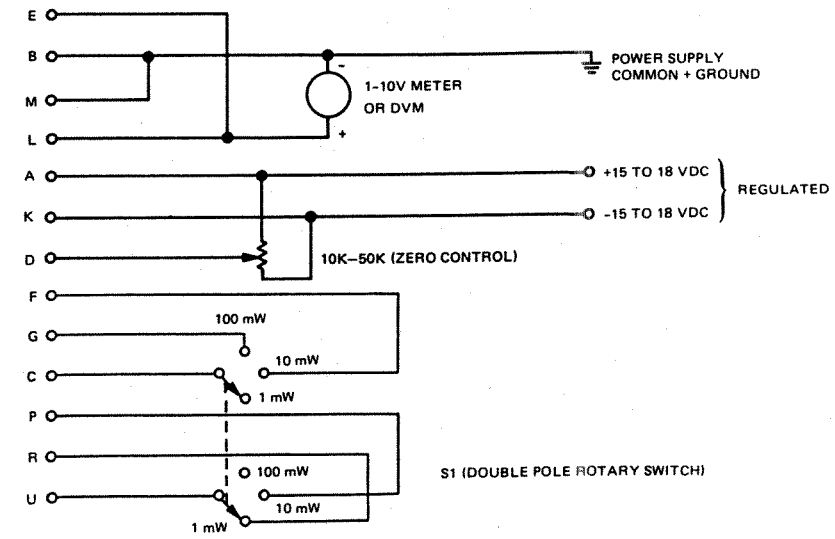



Figure 5-2. Interconnection Diagram for Diode Monitors





5-4.4. Calibration Procedure.

NOTE

The Coupler mount combination is calibrated so that the power incident upon the thermocouple mount under test can be set to an absolute power of 1 or 10 milliwatts. The calibration factor of the coupler mount combination is traceable to NIST.

a. Connect test mount to test setup of Figure 5-4. Set frequency to 7 GHz, or set to specific frequency desired.

b. Using power meter and coupler mount calibration factor, set power incident upon test mount to 1 milliwatt for Models 460B, 461B, 464B, 465B, 491, and 4491; and 10 milliwatts for Models 462B, 466B, and 492.

| Mount Under Test | Power Range | Incident Power |
|---|---|---|
| 460B, 464B | x 10 | 1 mW |
| 461B, 465B, 491, 4491 | x 1 | 1 mW |
| 462B, 466B, 492 | x 1 | 10 mW |

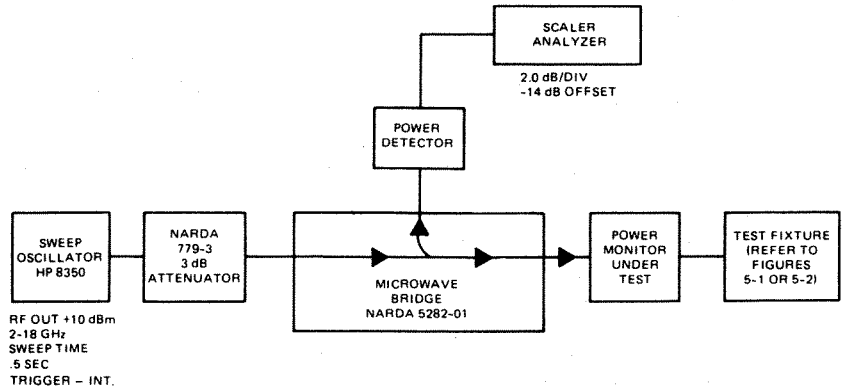



Figure 5-3. VSWR Test (2-18 GHz)

c. With standard test setup, adjust calibration potentiometer R5 (under removable cap) in test mount to indicate exactly 100 millivolts full scale on test fixture (Figure 5-1).

d. Remove RF, zero mount under test carefully.

e. Repeat Steps c and d until no further adjustments are necessary.

f. Check calibration with cover on and all screws on 460B through 466B mounts under test at 1 and 12.4 GHz. At 1 and 12.4 GHz, mount must read within 10% of absolute power.

5-4.5. Linearity Measurements (see Figure 5-4).

a. Connect 50 ohm termination to coupled port of 3292-1 and Power Meter Sensor to output of coupler.

b. Allow all test equipment to warm up to normal operational condition.

c. Set variable attenuator to minimum.

d. Adjust generator output at 7 GHz to read incident power level (5-4.4.b.) on power meter. Ensure power meter calibration factor is included.

e. Reconnect power meter to coupled port (as shown) and termination to coupler output. Note reading on power meter.

f. Increase variable attenuator setting at least 30 dB.

g. Remove 370BNM termination.

h. Zero test mount on most sensitive RF power range. Then connect as shown in Figure 5-4.





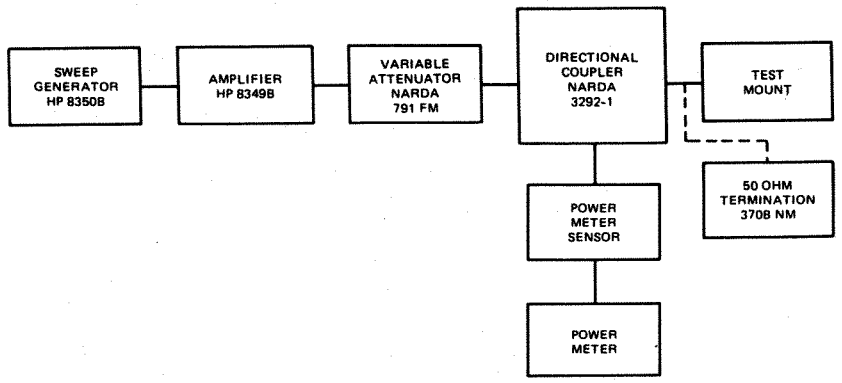



Figure 5-4. Calibration Procedure Test Setup

i. Reset variable attenuator to setting in Step c.

j. Decrease RF power using variable attenuator as read on power meter and record as follows:

| | Record Test Mount | |
|---|---|---|
| Attenuator Setting | Power Meter Reading | DC Volts Output |
| minimum | 1.00 x incident test power | 98-102 mV |
| minimum +3 dB | .50 x incident test power | 48-52 mV |
| minimum +10 dB | .10 x incident test power | 8-12 mV |

k. Linearity is to be within + 2% (full scale).

a. Test setup same as Figure 5-4 (frequency 8 GHz).

b. Set variable attenuator so that meter reads one tenth of full scale.

c. Set Range switch to most sensitive power position.

d. Set variable attenuator for exact full scale indication on meter.

e. Set Range switch up 10 dB position and record meter indication. Meter should indicate 0.1 of full scale +/- 5%. Record data.

f. Repeat Steps b through e on the next scales for 460B, 461B, 462B, 491, and 4491.

## 5-5. TROUBLESHOOTING.

5-5.1. Table 5-1 provides a troubleshooting chart for Integrated Thermocouple Power Monitors, and Table 5-2 provides a chart for the Model 481.

## 5-6. MODEL 481 ALIGNMENT AND TEST.

### 5-6.1. Test System Calibration.

5-6.1.1. Connect equipment as shown in Figures 5-2 and 5-4. Connect the reference power sensor to the test port.

### 5-6.2. Linearity Test.

a. With no RF applied to the mount, adjust R8 for 0.0 mW on Pin C, with S1 set to 1.0 mW range.



Table 5-1. Troubleshooting

| SYMPTOM | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Downscale reading on meter with inability to zero | Thermocouple element burned out | Replace element* |
| | Discontinuities in cable | Check cable |
| Large dc drifts | Defective power supply | Replace or repair defective power supply |
| | Defective Controlled Gain Amplifier | Replace defective Integrated circuit or associated components |
| Range calibration test fails | Faulty Amplifier stage | Replace defective Integrated circuit or associated component |
| | Defective feedback attenuator | Replace defective resistor |
| | Faulty External Range switch | Replace switch |
| Cannot zero power monitor | External zero potentiometer defective | Replace potentiometer |

*It is recommended that the unit be returned to the factory for thermocouple element replacement.

## Table 5-2. Troubleshooting Model 481

1. Connect 481 to test system as shown in Figure 5-4. Set frequency to 8 GHz and power level to 1.0 mW (0 dBm). Set test fixture to 1 mW (most sensitive) range. Refer to schematic in section 7.

2. Measure voltages at points listed below and compare to their nominal levels to determine defective stage.

| Measurement Point | Nominal Voltage | Voltage Measured |
|---|---|---|
| E1 (Detector Output) | -0.15V | |
| U1, Pin 7 (Peak Detector Out) | Same As E1 | |
| U2, Pin 6 (Linear Amp Out) | -7.5 V | |
| U3, Pin 4 (Non-Linear Amp Out) | +10.0 V | |
| U4, Pin 6 (Buffer Out) | Same as U3, Pin 4 (in Voltage Mode) | |

3. Use the following Table to determine the defective component if the fault is on one range only. Disconnect the 481 from the interconnect cable before measuring resistances.

| Measurement Point | Nom. Res. | Res. Meas. |
|---|---|---|
| E1 to Ground (Detector Load) | 5kΩ | |
| U2, P2 to Ground (Tin, of Linear Amp) | 2KΩ | |
| U2, P2 to Pin F (RFB, 10mW, Linear Amp) | 2.2KΩ | |
| U2, P2 to Pin G (RFB, 100mW, Linear Amp) | 3.7 KΩ | |
| U3, P3 to Pin R (RFB, 1 mW, Non-Linear Amp) | 5.5KΩ | |
| U3, P3 to Pin P (RFB, 10mW, Non-Linear Amp) | 25 KΩ | |
| U3, P3 to Pin U (RFB, 100mW, Non-linear Amp) | >100KΩ | |

4. Additional Notes

| Sympton | Probable Cause |
|---|---|
| High VSWR or Vout = 0 | Defective Detector |
| Does Not Hold Peak Value | U1, R3 or C3 Defective |
| Output Saturates Positive | Defective Interconnect Cable or Power Supply |
| Output Saturates Negative | Defective IC (See Above) or Power Supply |
| Excessive Current Draw | Defective IC or Filter CAP or Power Supply Polarity Reversed. Remove IC's from sockets to identify fault |





b. With no RF applied, adjust the external zero adjust for 0.0 mV on Pin E (Vout).

5-6.2.1. 1 mW Range.

a. Test frequency at 8 GHz.

b. Measure and record output voltages at input power levels of 0.100, 0.200, 0.500, 0.800, and 1.00 mW. All voltages must be within +/- 6% of nominal voltages (1.00V/100 micro-W). (Adjust R6 or R15 if necessary for compliance.)

NOTE

On all ranges linear gain pots (R6, R9, and R10) have most effect at high end of scales. Multiplier gain pots (R13, R14, and R15) have most effect at low end of scales. Expected errors are +/- 4% without readjustments.

5-6.2.2. 10 mW Range.

a. Set S1 to 10 mW range.

b. Measure and record output voltages at input power levels of 1.00, 2.00, 5.00, 8.00 and 10.00 mW. All voltages must be within +/- 6% of nominal voltages (1.00V 1 mW). (Adjust R9 or R14 if necessary for compliance.)

c. Adjust RF power for 20 mW and record saturated output voltage (12.2 V minimum).

5-6.2.3. 100 mW Range.

a. Set S1 to 100 mW range.

b. Measure and record output voltages at input power levels of 10.0, 20.0, 50.0, 80.0 and 100 mW. Voltages must be

within +/- 6% or nominal voltages (1.00V/10 mW). (Adjust R10 or R13 if necessary for compliance.)

NOTE

If unit passes the Linearity Test, skip paragraphs 5-6.3.1. through 5-6.3.3. Proceed to paragraph 5-6.4. If Linearity Test is not within limits, perform Alignment Procedure (5-6.3) and repeat 5-6.2.1. through 5-6.2.3.

5-6.3. PCB Alignment.

5-6.3.1. 1 mW Gain Adjustment.

a. With S1 set for 1 mW range, adjust RF power a 1.00 mW level at 8 GHz. Set R22 full CW. Adjust R6 for an output (PIN E) of 10.00V +/- 0.05V.

b. Lower power to 0.100 mW and adjust R15 for 1.000V +/- 0.01V.

c. Repeat 5-6.3.1.a. and 5-6.3.1.b. until voltage tolerances are met without readjusting either pot. This should take a maximum of 2 or 3 repetitions.

d. Set power level to 1.00 mW. Set R22 full CCW. Vout should read 3.6V to 3.1V. Reset R22 to full CW.

5-6.3.2. 10 mW Gain Adjustment.

a. Set S1 to 10 mW range and adjust RF power for 10.0 mW. Adjust R9 for an output of 10.00V +/- 0.05V.

b. Lower power to 1.00 mW and adjust R14 for an output of 1.00V +/- 0.01V.





c. Repeat 5-6.3.2.a. and 5-6.3.2.b. until voltage tolerances are met without readjusting either pot.

5-6.3.3. 100 mW Gain Adjustment.

a. Set S1 to 100 mW range and adjust RF power for 100 mW. Adjust R10 for an output of 10.00V +/- 0.50V.

b. Lower RF power to 10.0 mW and adjust R13 for an output of 1.000V +/- 0.01V.

c. Repeat 5-6.3.3.a. and 5-6.3.3.b. until voltage tolerances are met without readjusting either pot.

5-6.4. Frequency Response

a. Leave S1 set to 100 mW range.

b. Measure and record the ouput voltages for 10 mW RF power levels at 2, 4, 6, 8, 10, 12, 14, 16, and 18 GHz. Output voltages must vary less than 12% below 10 GHz and less than 17% above 10 GHz.

5-6.5. Pulse Response

a. Connect equipment as shown in Figure 5-5.

b. Set test port power level to 0.10 mW CW (EXT.AM.) with a test frequency of approximately 2 GHz.

c. Connect the power monitor to the test port and set the modulator to internal pulse. Using the oscilloscope trace set the pulse width to 2 microseconds and the PRR to 1 kHz.

d. Set S1 for the 1 mW range and note the output voltage (1V +/- 10%). Lower the PRR to 100 Hz and record the % change in the output voltage (2% spec: (1% nominal)).

e. Lower the pulse width to 0.5 microseconds and record the % change (2% spec: (1% nominal)).

NOTE

This test is performed at 1/2 microseconds PW instead of 2 microseconds to allow for degrading at low temperature.





# SECTION 6

# REPLACEABLE PARTS LIST

## 6-1. GENERAL.

6-1.1. This section provides complete listings of the replaceable parts for Model 460B, 480, 490, and 4490 Series Integrated Power Monitors. The listings contain the necessary ordering information. Parts are listed in alphanumeric order by reference designator. Complete descriptions of each component are provided in addition to the manufacturer's code and Narda part number in order to facilitate ordering of replacement parts. See Table 6-1 for Manufacturer Codes, Table 6-2 for the Thermocouple Power Monitor Parts List (Model 460B, 491 and 4491 Series), and Table 6-3 for the Diode Power Monitor Parts List (Model 480 Series).

## 6-2. ORDERING INFORMATION.

6-2.1. To order replacement parts, address the order to:

Sales Department
Narda an L-3 Communications Company
435 Moreland Road
Hauppauge, New York 11788-3994

6-2.2. When ordering a replacement part, the following information should be included:

a. Model and serial number of the instrument

b. Narda part number

c. Reference designation

d. Description

6-2.3. When ordering components or parts not listed in the Replaceable Parts List (Table 6-2 or Table 6-3), a complete description of the part, including its function and location, should be provided with the model and serial number of the instrument.

## 6-3. CUSTOMER REPAIR SERVICE.

6-3.1. Repairs or recalibration of Narda products are performed by the Customer Repair Department of the factory. However, before returning any unit, contact the Narda Microwave Corporation or the local Sales Representative in your area for shipping instructions. When requesting maintenance, complete the form provided at the rear of this manual.

Table 6-1. List of Manufacturers

| Manufacturer's Supply Code | Name | Address |
|---|---|---|
| 01121 | Allen Bradley | El Paso, TX |
| 12969 | Unitrode | Lexington, MA |
| 13919 | Burr-Brown Research | Tuscon, AZ |
| 15801 | Fenwal Electronics | Framingham, MA |
| 27014 | National Semiconductor | Santa Clara, CA |
| 31433 | Union Carbide | Greenville, SC |
| 50056 | Piezo Products | Metuchen, NJ |
| 56289 | Sprague | North Adams, MA |
| 59474 | Jeffers Electronics | Nogales, AZ |
| 80294 | Bourns, Inc. | Riverside, CA |
| 91637 | Dale Electronics | Norfolk, NE |





Table 6-2. Model 460B, 490, and 4490 Series Electrical Parts List

| ITEM | REF DESIG. | DESCRIPTION | MFG. CODE | MFG. PART NO. | NARDA PART NO. |
|---|---|---|---|---|---|
| 1 | R1* | Res.,Metal Film, 200Ω1/8W +/-1% | 91637 | RN55D2000F | 83049126 |
| 2 | R1 | Res.,Metal Film, 182Ω1/8W +/-1% | 91637 | RN55D1820F | 83049122 |
| 3 | R2** | Res.,Metal Film, 10Ω1/10W +/-.1% | 91637 | RN55D10R0B | 83139007 |
| 4 | R3 | Res.,Carbon, 10Ω1/4W +/-5% | 01121 | RC076F106J | 83015145 |
| 5 | R4 | Res.,Metal Film, 1kΩ1/8W +/-1% | 91637 | RN55D1001F | 83049192 |
| 6 | R5 | Res.,Variable, 10kΩ(Side Adjust) | 80294 | 3329W-1-103 | 83234125 |
| 7 | R6 | Res.,Metal Film, 900Ω 1/10W+/-.1% | 91637 | RN55E9000B | 83139006 |
| 8 | R7 | Res.,Metal Film, 90Ω1/8W +/-.1% | 91637 | RN55E90R0B | 83139005 |
| 9 | R7**** | Res.,Metal Film, 100Ω 1/10W+/-.1% | 91637 | RN55E1000B | 83139010 |
| 10 | R8 | Res.,Metal Film, 90.9Ω1/8W +/-1% | 91637 | RN55D90R9F | 83049093 |
| 11 | R9 | Res.,Metal Film, 100kΩ 1/8W +/-1% | 91637 | RN55D1003F | 83049383 |
| 12 | R10 | Res.,Metal Film, 80.6Ω1/8W +/-1% | 91637 | RN55D80R6F | 83049088 |
| 13 | R12*** | Res.,Metal Film, 68.1Ω1/8W +/-1% | 91637 | RN55D68R1F | 83049081 |
| 14 | C1 | Cap., Tantalum 4.7μF | 31433 | T-322A475K006AS | 80166000 |
| 15 | C2 | Cap., Not Replaceable | | | |
| 16 | C3 | Cap., Not Replaceable | | | |
| 17 | C4, C5 C6, C7, C10 | Cap., Ceramic .1μF, 50V | 56289 | CK5BX104M | 80187005 |
| 18 | L1, L2 | Inductor, 180μh +/-10% | 59474 | 09A181K | 87603039 |
| 19 | A1 | IC 3510 CM | 13919 | 3510CM | 86984000 |
| 20 | TH1 | Thermistor | 15801 | KD14J1 | 83254001 |

*462B, 466B Only
**460B, 461B, 462B, 491,4491 Only
***460B, 461B, 464B, 465B, 491, 4491 Only
****464B, 465B, 466B Only

## Table 6-3. Model 481 Replaceable Parts List

| ITEM | REF. DESIG. | DESCRIPTION | MFG. CODE | MFR. PART NO. | NARDA PART NO. |
|---|---|---|---|---|---|
| 1 | C1, C2 | Cap., Ceramic 0.1µf, 50V | 18796 | 8121-050-651-104M | 80214008 |
| 2 | C3 | Cap.,Ceramic 0.01µf, 50V | 56289 | CK05BX103K | 80187000 |
| 3 | C4-C7 | See C1 | | | |
| 4 | C9, C10 | Cap., Tantalum, 4.7µf, 35V | 31433 | T368B475K03AS | 80261015 |
| 5 | R1* | Res., Metal Oxide, 5.1KΩ, 5%, 1/8W | 01121 | RC06GF511T | 83164142 |
| 6 | R2 | Res., Fixed Comp., 2KΩ, 5%, 1/8W | 01121 | RC06GF202T | 83164070 |
| 7 | R3 | Res., Fixed Comp., 1MΩ, 5%, 1/8W | 01121 | RC06GF105T | 83164135 |
| 8 | R4, R5 | Res., Fixed Comp., 1KΩ, 5%, 1/8W | 01121 | RC06GF102T | 83164063 |
| 9 | R6 | Res., Variable, 2KΩ | 80294 | ET26CW202 | 83234031 |
| 10 | R7 | Res., Fixed Comp., 91KΩ, 5%, 1/8W | 01121 | RC06GF913T | 83164110 |
| 11 | R8 | Res., Variable, 20KΩ | 80294 | ET26CW203 | 83234034 |
| 12 | R9, R10 | Res., Variable, 50KΩ | 80294 | ET26CW503 | 83234036 |
| 13 | R11 | Res., Metal Oxide, 10KΩ, 1%, 1/8W | 91637 | RN55D1002F | 83049288 |
| 14 | R12 | Res., Fixed Comp., 20KΩ, 5%, 1/8W | 01121 | RC06GF202F | 83164094 |
| 15 | R13 | Res., Variable, 500KΩ | 80294 | ET26CW504 | 83234040 |
| 16 | R14 | See R9 | | | |
| 17 | R15 | Res., Variable, 10KΩ | 80294 | ET26CW103 | 83234033 |
| 18 | R16 | See R11 | | | |
| 19 | R17 | Res., Metal Oxide, 5.1KΩ, 1%, 1/8W | 91637 | RN55D111F | 83049260 |
| 20 | R18 | See R11 | | | |
| 21 | R19 | Res., Fixed Comp., 10KΩ, 5%, 1/8W | 01121 | RC06GF103T | 83164087 |
| 22 | R20 | See R2 | | | |
| 23 | R21 | See R12 | | | |
| 24 | R22 | Res., Variable, 20KΩ | 80294 | ET26CX203 | 83234057 |





## Table 6-3. Model 481 Replaceable Parts List (Cont.)

| ITEM | REF. DESIG. | DESCRIPTION | MGF. CODE | MFR. PART NO | NARDA PART NO. |
|---|---|---|---|---|---|
| 24 | R23 | See R11 | | | |
| 25 | TH1 | Thermistor, 2KΩ(23°C) | 50056 | 32TD4A | 83272006 |
| 26 | TH2,3 | Thermistor, 3.3KΩ(50°C) | 12969 | TM1/8332J | 83314007 |
| 27 | U1 | Integrated Circuit LM311H | 27014 | LM311H | 84785001 |
| 28 | U2 | Integrated Circuit LF355H | 27014 | LF355H | 84783001 |
| 29 | U3 | Integrated Circuit MPY 100 AM | 13919 | MPY 100 AM | 8495800 |
| 30 | U4 | See U2 | | | |

* R1 Optional

# SECTION 7

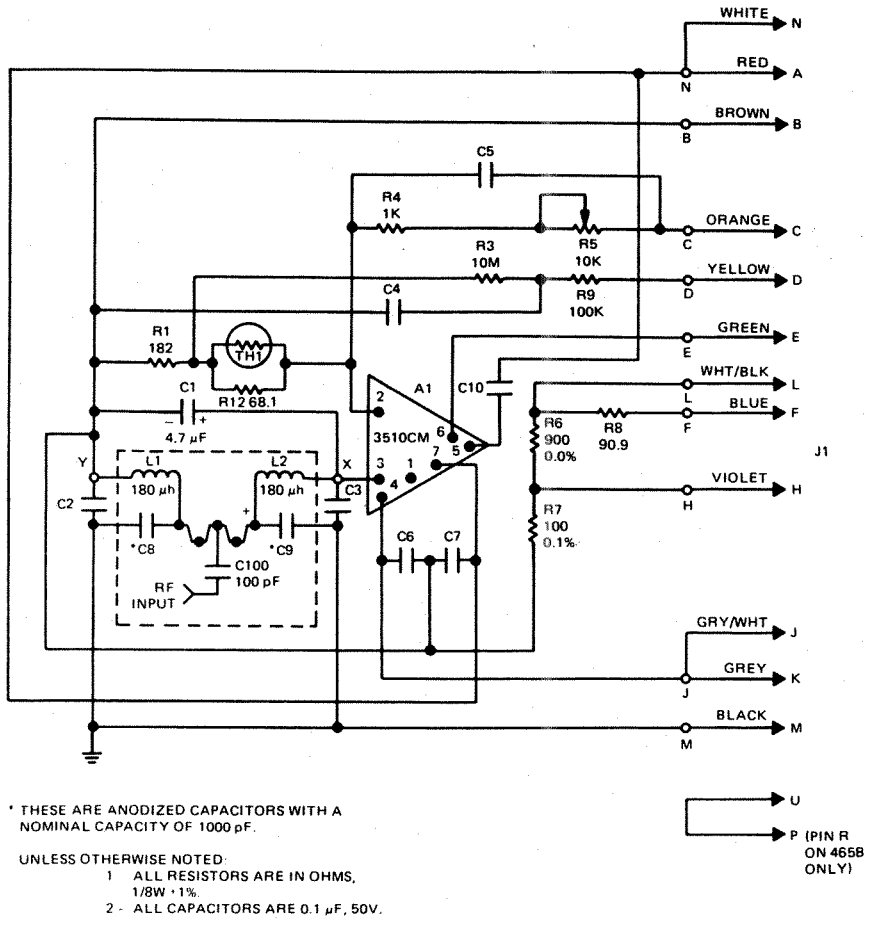
# SCHEMATIC DIAGRAMS

## 7-1. GENERAL.

7-1.1. This section contains a complete set of schematic diagrams required for maintenance of the Integrated 20 and 30 dB Power Monitors which do not otherwise appear in previous sections.

## 7-2. LIST OF DRAWINGS.

7-2.1. The following drawings are contained in this section:



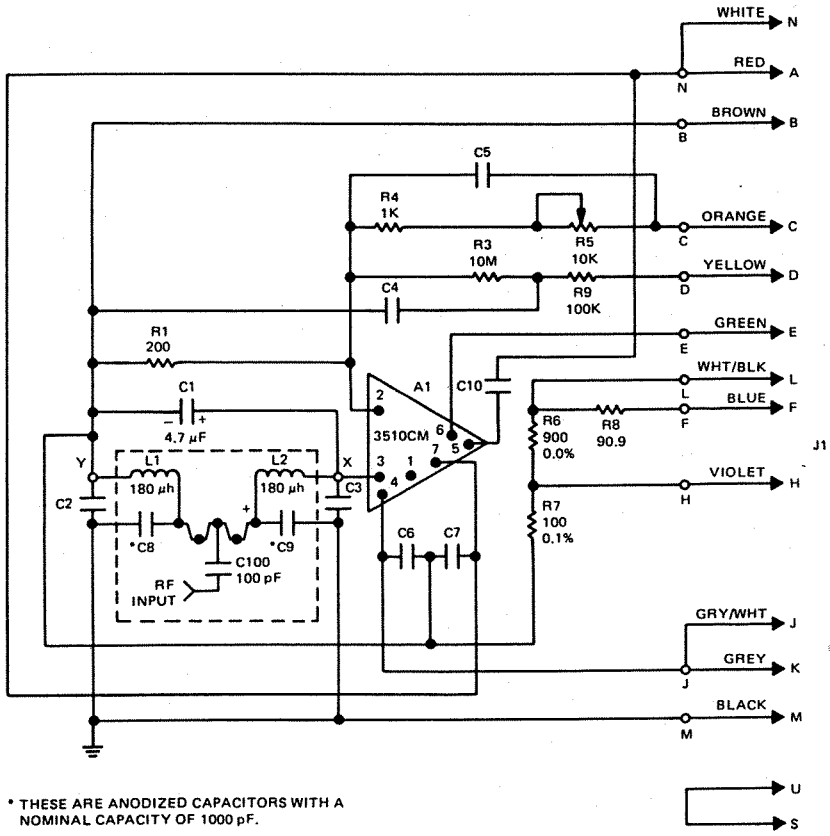

* THESE ARE ANODIZED CAPACITORS WITH A NOMINAL CAPACITY OF 1000 pF.

UNLESS OTHERWISE NOTED:
1 ALL RESISTORS ARE IN OHMS, 1/8W ±1%.
2 - ALL CAPACITORS ARE 0.1 µF, 50V.

Figure 7-1. Schematic, 20 dB Power Monitors 464B, 465B



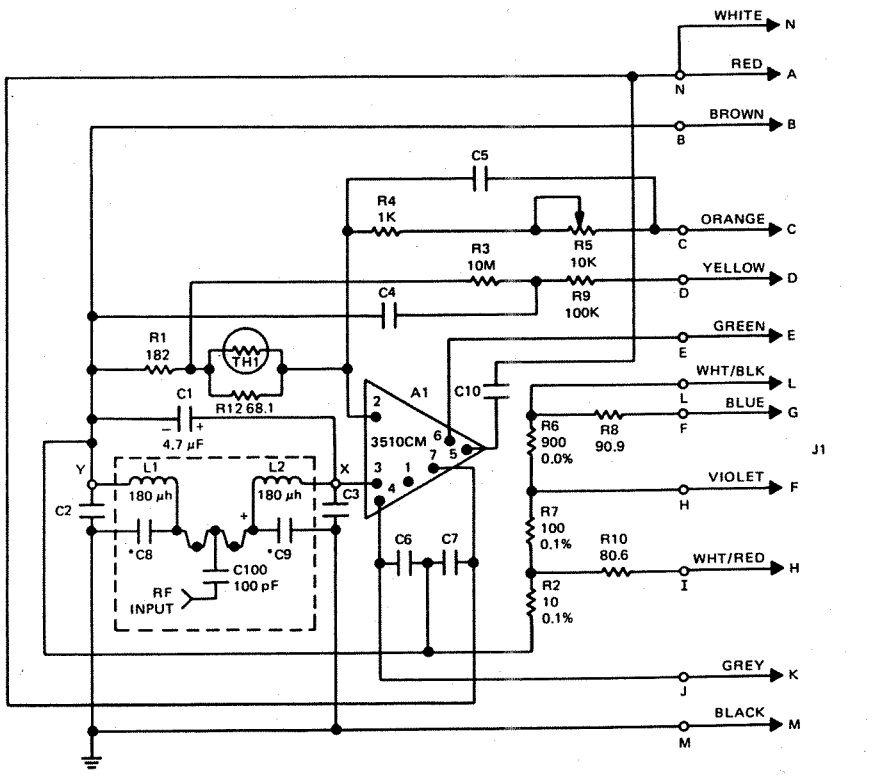





* THESE ARE ANODIZED CAPACITORS WITH A NOMINAL CAPACITY OF 1000 pF.

UNLESS OTHERWISE NOTED:
1 – ALL RESISTORS ARE IN OHMS, 1/8W ±1%.
2 – ALL CAPACITORS ARE 0.1 µF, 50V.

Figure 7-2. Schematic, 20 dB Power Monitor 466B



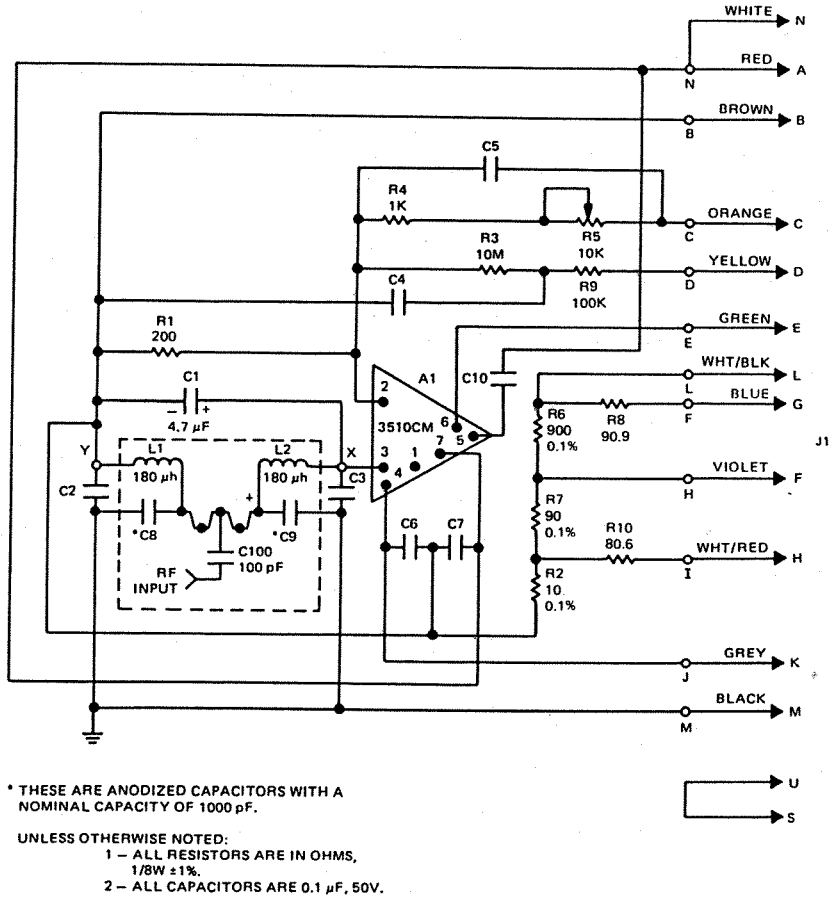

* THESE ARE ANODIZED CAPACITORS WITH A NOMINAL CAPACITY OF 1000 pF.

UNLESS OTHERWISE NOTED:
1 – ALL RESISTORS ARE IN OHMS, 1/8W ±1%.
2 – ALL CAPACITORS ARE 0.1 µF, 50V.

Figure 7-3. Schematic, 30 dB Dynamic Power Monitors 460B, 461B, 491, 4491








* THESE ARE ANODIZED CAPACITORS WITH A NOMINAL CAPACITY OF 1000 pF.

UNLESS OTHERWISE NOTED:
1 – ALL RESISTORS ARE IN OHMS, 1/8W ±1%.
2 – ALL CAPACITORS ARE 0.1 µF, 50V.

Figure 7-4. Schematic, 30 dB Dynamic Power Monitor 462. 492

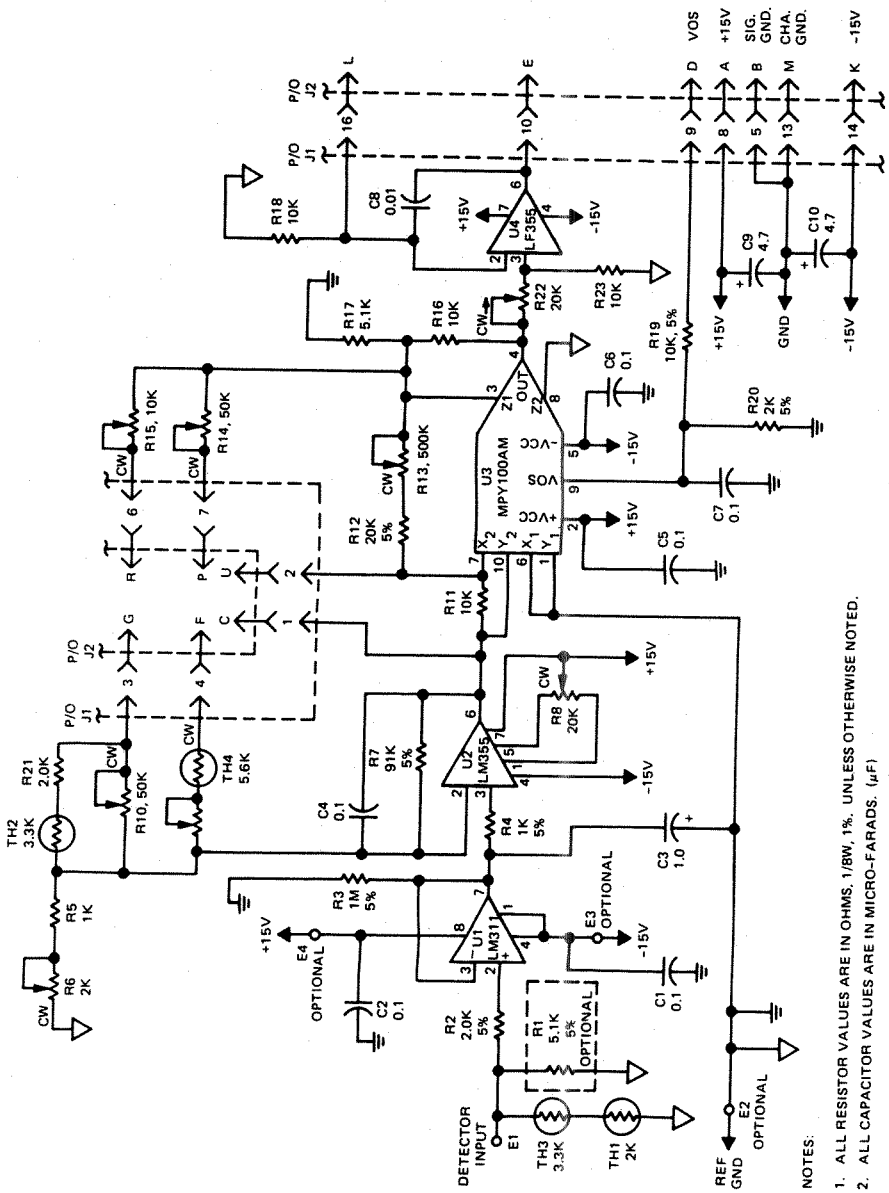



Figure 7-5. Schematic, 30 dB Diode Power Monitor 481