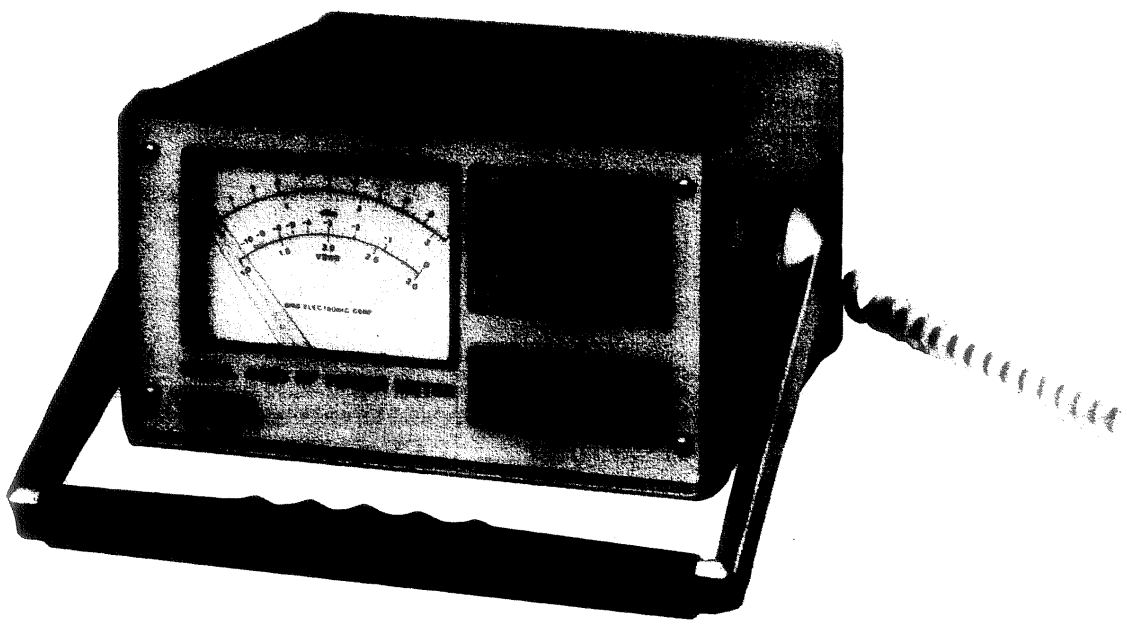
INSTRUCTION BOOK
FOR
MODEL 4420
RF POWER METER



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SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication. These precautions must be throughly understood and apply to all phases of operation and maintenance.

Operators/Technicians: Keep parts of your body away from live circuits at all times. Serious injury or death can occur if this warning is not observed.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts while power is applied. When working with high voltage, always have someone present who is capable of rendering aid, if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

Safety Earth Ground: An earth ground must be supplied from the main power source to the ac line module of the instrument. Grounding one conductor of a two conductor power cable is not sufficient protection. Serious injury or death can occur if this grounding is not properly supplied.

Warning: Warning notes call attention to a procedure, which if not correctly performed could result in personal injury.

Caution: Caution notes call attention to a procedure, which if not correctly performed could result in damage to the instrument.

The following precautions appear in the text of this publication but are shown here for emphasis.

WARNING

THE POTENTIAL OF ELECTRIC SHOCK EXISTS. ALWAYS UNPLUG THE POWER METER FROM THE AC LINE BEFORE REMOVING THE COVER.

CAUTION

BE SURE THE 115/230 VOLTAGE SELECTOR DRUM ON THE REAR PANEL IS SET TO THE PROPER LINE VOLTAGE BEFORE AC POWER IS APPLIED.

WARNING

NEVER ATTEMPT TO DISCONNECT THE EQUIPMENT FROM THE TRANSMISSION LINE WHILE RF POWER IS BEING APPLIED. LEAKING RF ENERGY IS A POTENTIAL HEALTH HAZARD.

CAUTION

DO NOT APPLY RF POWER TO DIRECTIONAL POWER SENSOR WHICH EXCEEDS 120% OF FULL SCALE OF HIGHEST RANGE.

TABLE OF CONTENTS

MODEL 4420 RF POWER METER

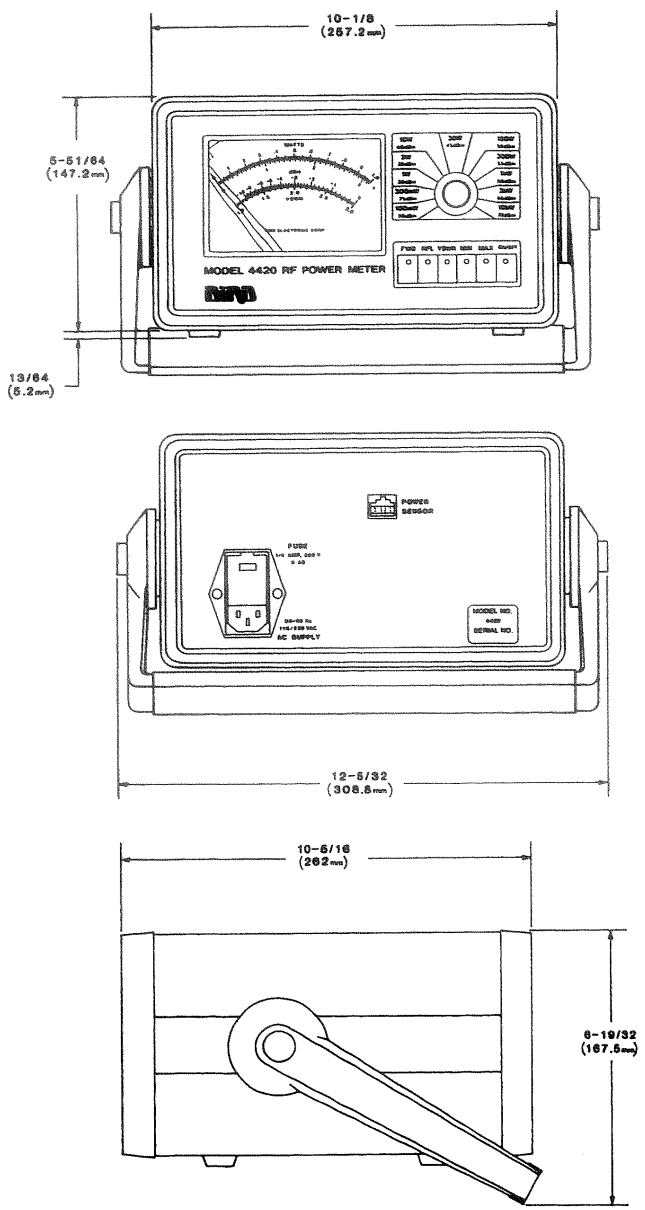
INTRODUCTION

PURPOSE AND FUNCTION

This publication refers to the Model 4420 RF Power Meter which is a member of the Bird 4420 Series of RF Power Meters. The purpose of this manual is to provide the operator with an understanding of the Model 4420 and its operation. The Bird Model 4420 RF Power Meter will generally be referred to as a power meter throughout this manual.

The Model 4420 RF Power Meter is a microprocessor-based instrument that measures forward and reflected RF power in a 50 ohm application when used in conjunction with a Model 4020 Series of RF Directional Power Sensors. This set up is designed and intended for use on CW unmodulated or FM signals only. (See Figure I-1.)

FIGURE I-1. MODEL 4420 OUTLINE DRAWING.



CAPABILITIES

When used in conjunction with a Model 4020 Series RF Directional Power Sensor the power meter will visually display an analog representation of traveling wave conditions. Three main functions, forward power measurement, reflected power measurement and VSWR measurement can be initiated through selection of front panel pushbuttons.

A rotary switch selects one of eleven overlapping ranges with .1/.3/1/3/10/30/100/300/1000/3000/10000 scaling. The total number of usable ranges is power sensor dependent.

The power meter uses a rugged meter movement based on a digitally controlled motor. The display has no overshoot and settles at any reading almost instantly. Digital control provides a linear watts scale for accurate readings and minimization of interpolation errors associate with upper end of the exponential scales. The pointer has been designed to minimize parallax.

A built-in audible alarm sounds when RF power input exceeds 120% of sensor's maximum power range.

The Model 4420 Power Meter is powered by 115/230 Vac, 50/60Hz.

TYPICAL APPLICATIONS

The Model 4420 RF Power Meter may be applied in a wide variety of applications. These include:

- In-field, operating environments
- Calibration services
- Research labs
- Quality assurance functions
- RF source engineering labs
- Manufacturing process control

SPECIFICATIONS

Overall specifications for the Model 4420 RF Power Meter are listed in Table I-1.

ADDITIONAL EQUIPMENT

SENSING DEVICES

The Model 4420 RF Power Meter is used in conjunction with Bird's 4020 Series of THRULINE® RF Directional Power Sensors. These power sensor devices are microprocessor-based, and each carries its own wideband calibration profile in a self-contained, nonvolatile memory. The sensing unit corrects readings automatically according to input frequency. Thus direct measurements at any power or frequency within the power sensor's range can be made with high accuracy without calibration curves.

Calibration data is stored in the power sensor, not the power meter. In this way any power sensor can be connected with any Model 4420 RF Power Meter.

The power sensor is inserted into a 50-ohm line in order to evaluate RF equipment under actual operating conditions. It's wide dynamic range eliminates uncertainties caused by external attenuators and directional couplers.

Bird offers over 25 coaxial-type field-installable "Quick-Change" RF connectors that make the power sensors compatible with any test set-up. (Normally, Female N-type are supplied.) It must be remembered that the power rating and insertion loss may be affected if other than the "N" type connectors are used.

Currently the 4020 Series of RF Directional Power Sensors include:

- Model 4021, for 1.8MHz thru 32MHz, 300mW - 1000W
- Model 4022, for 25MHz thru 1GHz, 300mW - 1000W

TABLE I-1. SPECIFICATIONS FOR MODEL 4420 RF POWER METER

Power Range	Power Sensor dependent[1]
Scaling	.1/.3/1/3/10/30/100/300/1000/3000/10000
Display	Fast response analog movement. Motor driven pointer with near zero parallax. No overshoot or undershoot.
Display Accuracy	±0.25% of full scale
VSWR Range	1.0 — 3.0[2]
Return Loss	6-46dB[2/3]
EMI Compliance	Meets FCC Class A requirements for computing devices. (Both radiated and conducted emission.)
Temperature Range Operating	0° to 50°C (32° to 122°F)
Storage	−25° to 65°C (−13° to 149°F)
Relative Humidity	5% to 90% noncondensing
Dimensions	10 5/16"L × 12 5/32"W × 6 19/32"H (261.94 × 308.77 × 167.48)
Weight	9 lbs. (4kg)
Operating Power	115/230 Vac, ±10%, 45-66 Hz
Fuse	3 AG, 1/4 ampere, 250 volt

[1]See paragraph Sensing Devices for available power ranges.

[2]Maximum indicated VSWR reading is Power Sensor dependent.

[3]Return loss not directly displayed, but can be determined from the VSWR value.

SECTION I — DESCRIPTION

1-1. GENERAL

1-2. The purpose of this section is to familiarize the reader with the more important external and internal components of the Model 4420 RF Power Meter.

1-3. EXTERNAL COMPONENTS

a. ENCLOSURE

The Model 4420 RF Power Meter is contained within an aluminum enclosure. Its front and rear panel are recessed to avoid accidental damage to panel mounted hardware. The unit is adapted to portability and ease of operator viewing by the use of a tilt-position aluminum handle. This handle can be adjusted in 30° steps by depressing the central button at base on handle side legs (see Figure I-1.).

b. FRONT PANEL DESCRIPTION

For location of front panel features, refer to Figure 1-1.

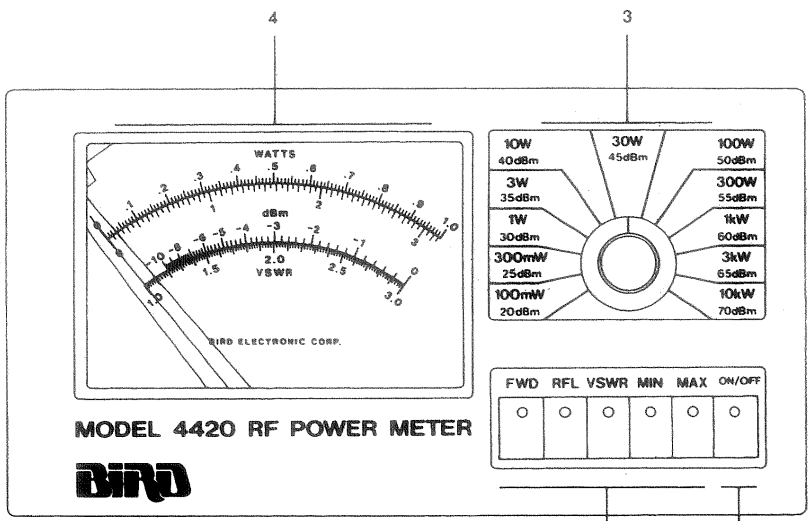
1. *FUNCTION PUSHBUTTONS*
   The five pushbuttons mounted on the front panel of the power meter select forward and reflected power, VSWR, minimum, and maximum readings. Other functions can also be initiated by pressing multiple key combinations, these are described in Section IV. Operating Procedures.

2. *ON/OFF SWITCH*
   The front panel ON/OFF pushbutton controls ac line power to the power meters circuitry.

3. *RANGE SELECTION SWITCH*
   The range selection switch provides operator selection of one of eleven overlapping ranges. Operator needs only to rotate knob so indicator line points to desired range. Each range position gives full scale power value expressed in watts or dBm.

4. *ANALOG DISPLAY*
   The analog display gives a visual indication of the present value being measured. The face of the display has four separate scales; two linear power scales (0-1.0 an 0-3), one logarithmic dBm scale (−10-0) and a linear VSWR scale (1.0-3.0). Readings are indicated by digitally controlled pointer.

FIGURE 1-1. FRONT PANEL LAYOUT.



1. Function Pushbuttons
2. On/Off Switch
3. Range Selection Switch
4. Analog Display

c. REAR PANEL DESCRIPTIONS

For location of rear panel features, refer to Figure 1-2.

1. *AC LINE MODULE*
The ac line module provides a three function capability.

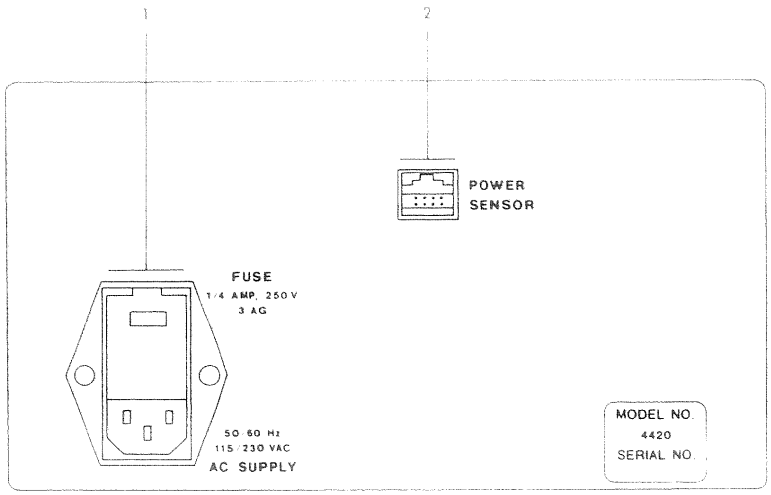
- Contains the ac line socket for input of ac power.
- Provides line voltage selection 115/230 volts.
- Contains internally, an ac line fuse.

Location of fuse and instructions on line voltage selection are detailed in Section II.

2. *POWER SENSOR CONNECTOR*

The power sensor connector provides a means of connecting the sensor cable to the internal circuitry of the power meter. It is necessary to have a power meter connected to power sensor to obtain any readings on the display.

FIGURE 1-2. REAR PANEL LAYOUT.



1. AC Line Module 2. Power Sensor Connector

1-4. INTERNAL COMPONENTS

1-5. For location of internal components, see Figure 1-3.

WARNING

THE POTENTIAL OF ELECTRIC SHOCK EXISTS. ALWAYS UNPLUG THE POWER METER FROM THE AC LINE BEFORE REMOVING THE COVER.

WARNING

THE MODEL 4420 RF POWER METER CONTINAS MOS INTEGRATED CIRCUITS WHICH MAY BE DMAGED BY STATIC ELECTRICITY. OPEN THE HOUSING ONLY WHEN SURE THAT THERE ARE NO STATIC-PRODUCING MATERIALS SUCH AS CARPETING OR STYROFOAM WHERE THE WORK IS TO BE DONE. WORK ON A CONDUCTIVE GROUNDED WORK SURFACE TOUCHING IT FREQUENTLY TO DISCHARGE STATIC FROM YOUR BODY.

1-6. In order to access these internal components, simply remove the four screws securing the top cover to the power meter. Two screws are located on either side.

1. *MAIN FRAME*

The main frame which supports the main control board is constructed of formed aluminum with an Iridite coating. This coating is intended as a corrosion preventive film for electrical and electronic applications. The main frame is attached to the power meter enclosure with selfclinching mounting studs.

2. *MAIN CONTROL BOARD*

The main control board contains the power supply circuitry and other circuitry required to control power meter activities, such as interfacing with I/O components (keyboard, meter movement, auto-zero and power sensor).

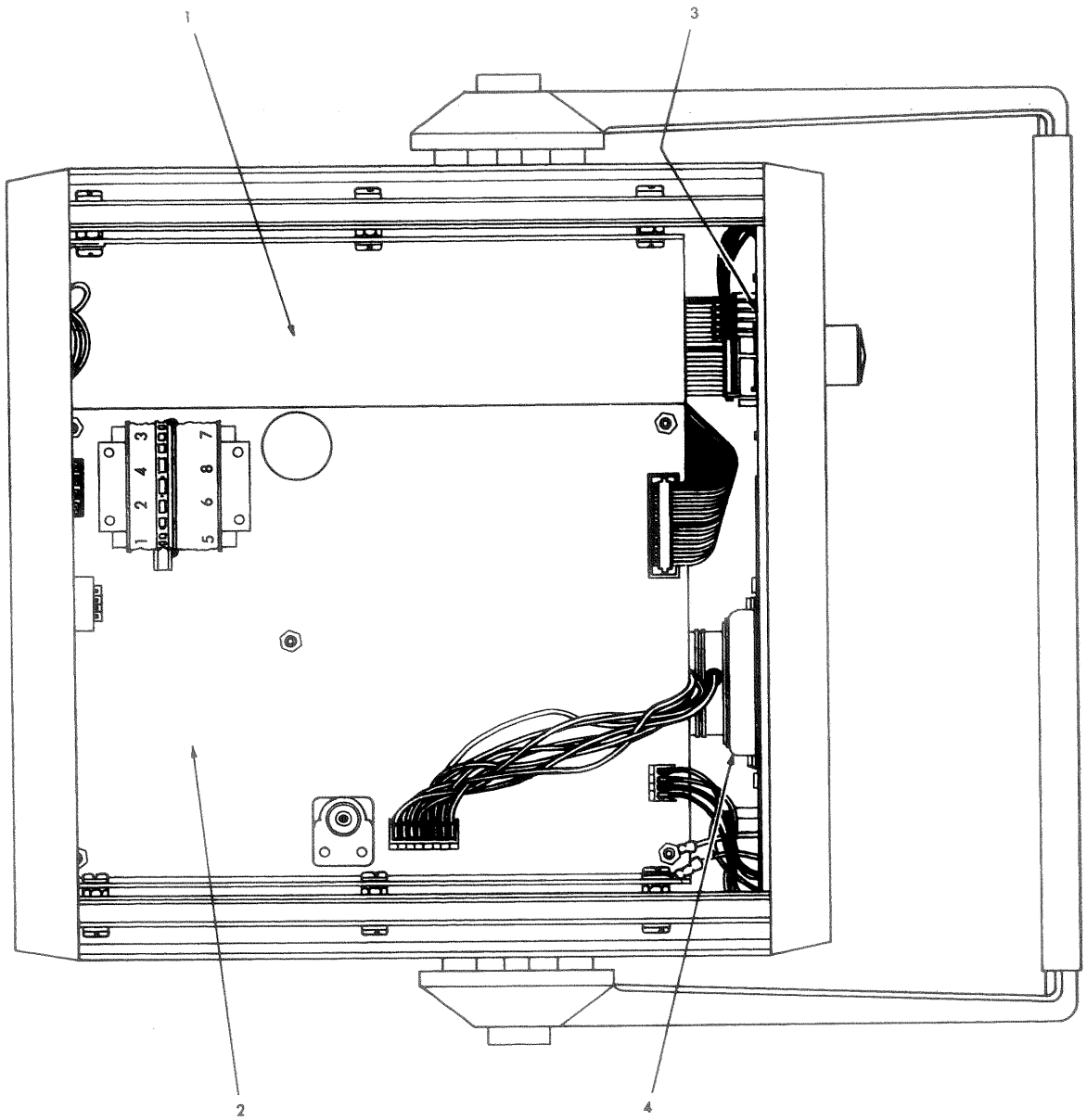
3. *KEY SWITCH BOARD*

The Key Switch Board contains function pushbuttons, their circuitry and the range selector switch circuitry. Connection to the main control board is made via a flat cable.

4. *METER ASSEMBLY*

The Meter Assembly contains digitally controlled meter, meter scale and pointer and auto-zero unit. It's connection to the main control board is made via a flat cable.

FIGURE 1-3. INTERNAL LAYOUT.



1. Main Frame
2. Main Control Board
3. Key Switch Board
4. Meter Assembly

SECTION II — INSTALLATION

2-1. GENERAL

2-2. The purpose of this section is to assist the user with the initial steps that should be performed when receiving and preparing the power meter for service.

2-3. UNPACKING

2-4. The Model 4420 RF Power Meter is shipped in a single container. Included in it are:

- 1 power meter
- Up to a maximum of two power sensor
- 1 ac power cord
- 1 sensor cable
- 1 instruction manual

2-5. The Model 4420 RF Power Meter and Model 4020 Series RF Directional Power Sensors are individually packaged in conductive bags for static protection of CMOS devices.

2-6. Unwrap the shipping containers carefully and store them in case it is necessary to return the power meter to the manufacturer.

2-7. INITIAL INSPECTION

2-8. All packages are carefully wrapped and inspected by Bird prior to shipment. If the package shows any sign of damage, open and inspect the contents. If any damage is visible, notify the carrier immediately. Retain the shipping container for inspection.

2-9. INSTALLATION

2-10. The following paragraphs describe, in step-by-step fashion, how to prepare the power meter for installation.

Step 1: After removing the power meter from its packaging, place it on a clean, flat work surface with the rear panel facing you.

Step 2: **Place the power sensor near the power meter.**

Step 3: Plug in one end of the sensor cable at the sensor. The other end of the sensor cable plugs into the power sensor connector on the rear panel of the power meter. (See the power sensor's instruction book for details.)

Step 4: Determine the voltage level of the ac line. This may be 115/230 Vac.

Step 5: Compare this voltage level with the number that appears in the ac line select window.

Step 6: The power meter is factory-shipped for 115 Vac operation. Change to 230 Vac, if necessary, by opening cover door and removing voltage selector drum. (See Figure 2-1)

Step 7: Rotate voltage selector drum to desired voltage and reinsert.

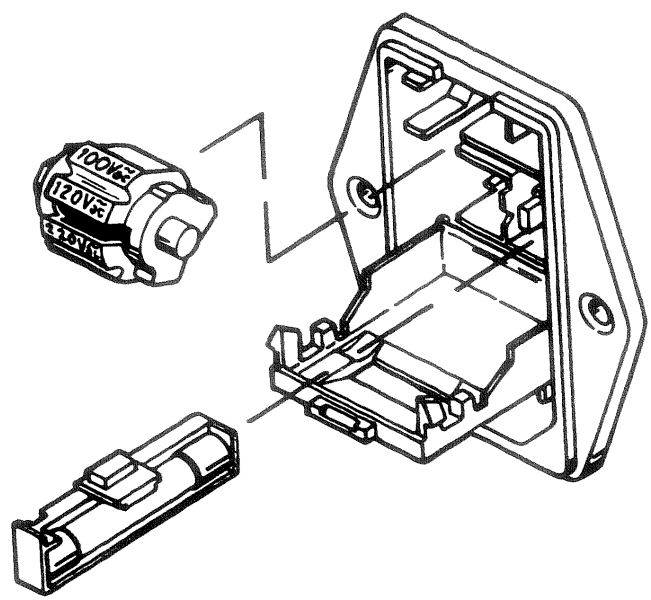
Step 8: AC line fuse is also accessible by pulling out fuse drawer.

Step 9: Close cover door.

Step 10: Locate the ac cord. Plug one end at the power meter's ac line module the other end at the line socket. (Refer to paragraph 2-12 when connecting to European style sockets).

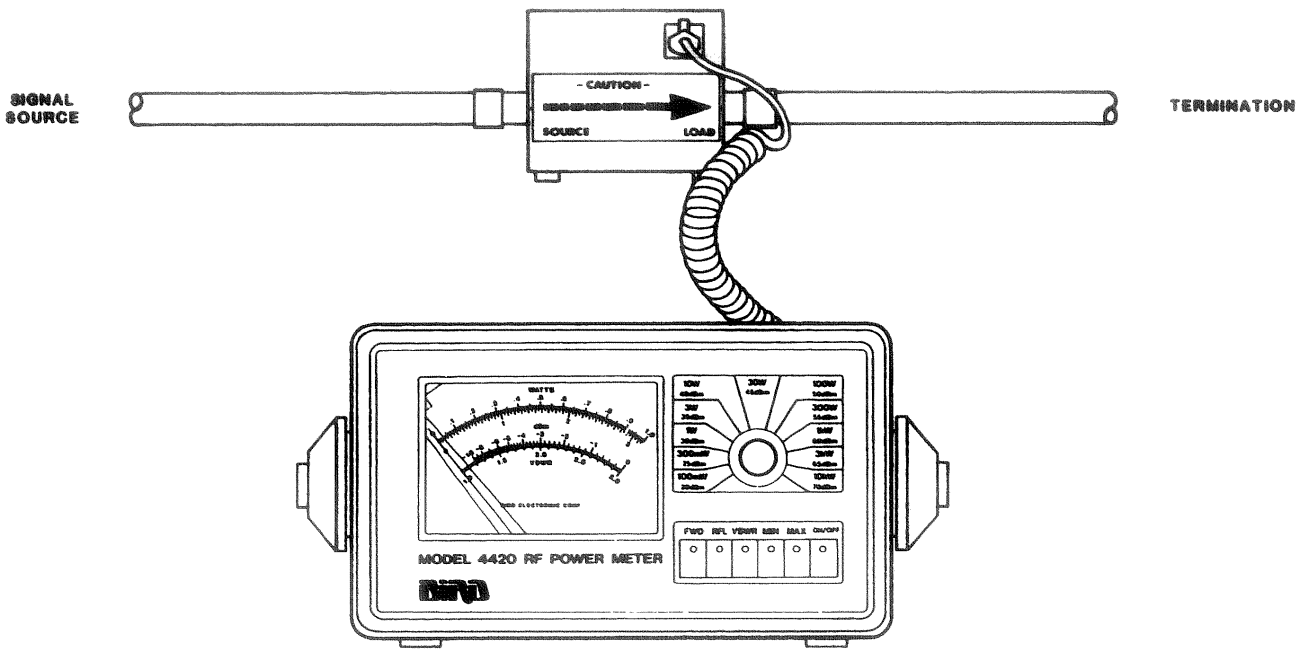
Step 11: Move power meter so front panel faces you.

FIGURE 2-1. AC LINE MODULE.



2-11. At this point the initial installation procedures are complete. (See Figure 2-2). Refer to the manual shipped with the power sensor for installation on how to make connection with the RF line.

FIGURE 2-2. 4420 COMPLETE INSTALLATION.



2-12. EUROPEAN STYLE CONNECTORS

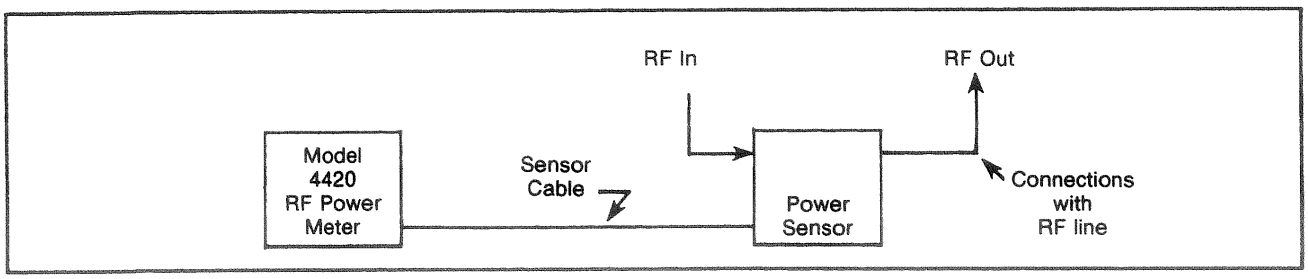
2-13. In order to make the ac line cord compatible with European style sockets, users must replace the connector at the end of the power cord. Then set the operating voltage selection drum for 230 Vac.

SECTION III — THEORY OF OPERATION

3-1. GENERAL

3-2. To understand the operation of the Model 4420 RF Power Meter, it is necessary to consider it as part of a complete RF power-measurement system. This system consists of a main display unit, (4420 RF Power Meter), a RF power sensor, (Model 4020 Series RF Directional Power Sensor) and an interconnecting communication cable. (See Figure 3-1.)

FIGURE 3-1. BASIC FUNCTIONAL BLOCK DIAGRAM.



3-3. No component within this system is a stand-alone unit; each forms a functional block of an intricate system which samples and displays the power level of traveling waves in a 50 ohm coaxial line. This system is run locally, through the use of some simple operator functions.

3-4. For a complete understanding, let's look at each functional block separately.

3-5. POWER SENSOR

3-6. Our first functional block, the power sensor, contains all the necessary circuitry to sample and accurately determine the amplitude of forward and reflected traveling waves on a 50 ohm coaxial line.

3-7. The power sensor containing a precisely machined 50 ohm line section, designed to minimize insertion loss errors, is inserted into the coaxial line. It samples different voltage levels for the determination of forward, reflected and frequency values. The forward and reflected voltage values are then corrected to minimize errors associated with frequency bandwidth and diode non-linearity. These voltage values are stored in non-volatile memory and updated at an approximate rate of two readings per second.

3-8. These readings are available to the main display unit upon request.

3-9. We have now completed our overview of the first functional block in our system. Our second block is the interconnecting cable between the power sensor and the power meter's main display unit.

3-10. SENSOR CABLE

3-11. The purpose of the interconnecting sensor cable is to supply an interface channel over which serial communication can occur between the power sensor and the power meter. The sensor cable is a coiled, eight-conductor cable with foil shield that minimizes interference. Communication over the cable is in serial format at 9600 baud. Differential signals are used between the power sensor and power meter's display unit for noise immunity.

3-12. DISPLAY UNIT

3-13. Our final block to consider is the power meter and its main display unit. It consists of a microprocessor system and multiplexer scheme for data output and entry; a ROM and RAM for program storage and use; an analog display and a keyboard for local operator-entered commands.

3-14. The power meter is responsible for all system control. It coordinates all system activities, using the microprocessor to dictate operation.

3-15. The main body of the program directs the microprocessor through a number of software routines. They allow it to perform serial communication with the power sensor so that it can send commands and accept results; strobe the keypad for depressed command key; and supply digital information for meter movement controls. They also perform calculations on resultant values so that VSWR can be determined, and power levels can be converted to logarithmic format.

3-16. The keypad is strobed by the microprocessor which looks for an indication of a depressed key. When a key has been depressed the microprocessor determines which key and issues an appropriate command. The power sensor replys by sending the proper data according to received command. The power meter's internal microprocessor receives the incoming data and performs the necessary calculation and scaling. The final value is converted to an equivalent number of steps required for the digital motor to move the pointer to the indicated value. The measured power level is then displayed for operator viewing.

3-17. **SUMMARY**

3-18. These three functional blocks form the basis of a system which is capable of highly accurate and repeatable RF power measurement.

SECTION IV — OPERATING INSTRUCTIONS

4-1. GENERAL

4-2. This section describes the operation of the Model 4420 RF Power Meter. It gives complete description of functions of pushbuttons and switches. Operator is guided through a step by step format of how to set up and take measurements.

4-3. CONTROLS

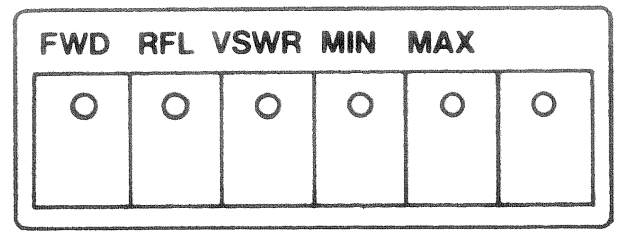
a. Pushbuttons

Power meter's pushbutton functions are described in Table 4-1. Refer to Figure 4-1 when reviewing Table.

TABLE 4-1. PUSHBUTTON FUNCTIONS

Pushbutton	Description
FWD	The forward power pushbutton, when pressed, initiates the display of the forward RF power being measured by the power sensor.
RFL	The reflected power pushbutton, when pressed, initiates the display of the reflected RF power being measured by the power sensor.
VSWR	The voltage standing wave ratio pushbutton, when pressed, initiates a calculation and display of the standing waves being measured by the power sensor. The VSWR measured will be 1.00 if the line segment is ideally matched between components. When the line is not ideally matched, a VSWR up to a maximum value of 3.0 will be displayed. VSWR will be calculated according to the following formula: $VSWR = \frac{\sqrt{FWD} + \sqrt{RFL}}{\sqrt{FWD} - \sqrt{RFL}}$ The VSWR display range is 1.0 to 3.0
MIN	The minimum pushbutton may be pressed after FWD, RFL, SWR is pressed. It initiates the display of the minimum measured value of the previously selected function currently being measured by the power sensor. In order to terminate the display of the minimum value, release the minimum pushbutton.
MAX	The maximum pushbutton may be pressed after FWD, RFL, SWR is pressed. It initiates the display of the maximum measured value of the previously selected function currently being measured by the power sensor. In order to terminate the display of the maximum value, release the maximum pushbutton.

FIGURE 4-1. PUSHBUTTONS.

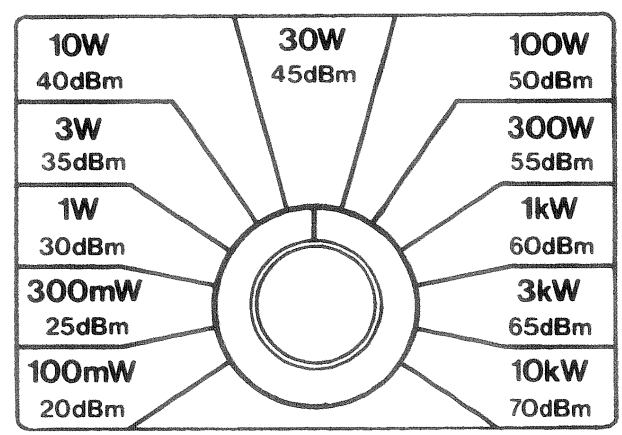


b. Rotary Switch

When set in a position; the full scale power range is selected and it's equivalent dBm value, refer to Figure 4-2. Total usable ranges is determined by power range covered by the power sensor. Any range selected that is not within power sensor range will cause a momentary sounding of the alarm and a blinking of the led corresponding to the selected function.[1] This error condition can be terminated by selecting a range within power sensor capability.

[1] In VSWR function, the alarm will sound and the led will remain on.

FIGURE 4-2. RANGE SELECTOR SWITCH.



4-4. START UP/SELF TEST

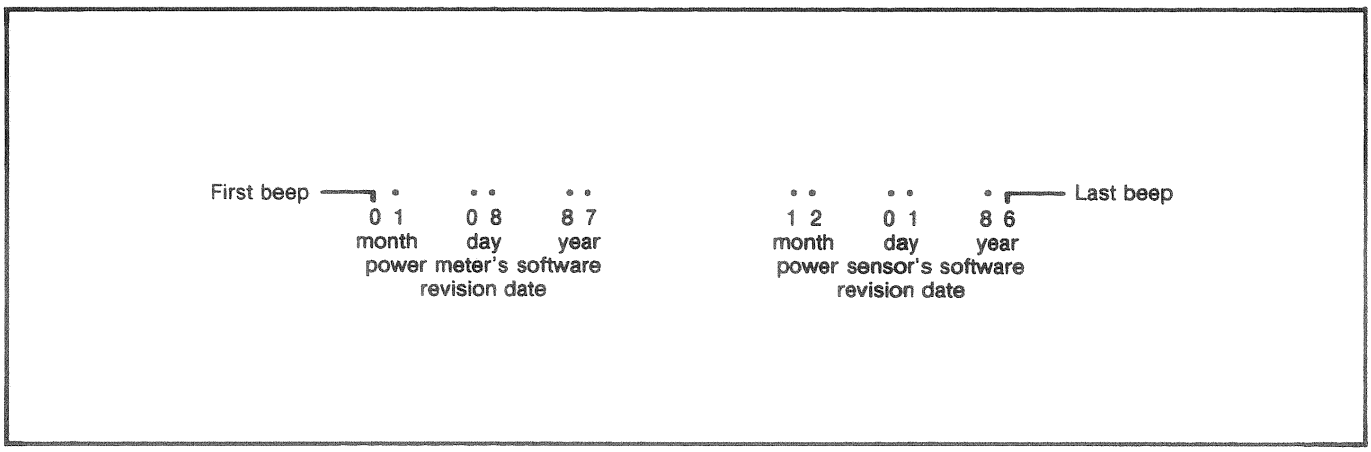
4-5. Before switching on this instrument ensure that the ac line module is matched to the available line voltage and all safety precautions are taken. See Safety Precautions, Page ii.

4-6. The self test function verifies that the Model 4420 circuitry and power supply are working properly. Always run the self test function before performing any measurement or test functions with the Model 4420.

4-7. To initiate self test, hold FWD and VSWR pushbuttons down then press the ON/OFF switch simultaneously. The power meter indicator then steps thru every .05 point on the 1.0 scale. After the full scale point has been displayed, the indicator returns to 0. The self test routine continues by displaying the software revision dates of both the power meter and connected power sensor. This is accomplished by sounding an audible beep at indicated numbers on the top scale. The first number being month, next the day then the year. Software revision date of the sensor will appear next. Also reading first month, the day, then the year, see Figure 4-3 Example of Self Test.

Self test routine has been completed indicating functional power meter and power sensor, but will continue to run starting with initial scale check. To abort the self test routine, depress the ON/OFF pushbutton.

FIGURE 4-3. EXAMPLE OF SELF TEST.



If a no-go situation should occur during any phase of the self test, refer to Section V, Maintenance to locate the source of the malfunction. After repair is made, perform the Self Test again to assure proper operation.

4-8. NORMAL OPERATION

4-9 Before performing any measurements follow these basic steps and refer to the two conditions described in Table 4-2.

a. Set Up — refer to installation procedures in Paragraph 2-9.

b. Range Selection — select a power range covered by the power sensor. Select a power range which gives the best sensitivity for the power being measured without going over scale. The occurence of an overscale condition will not damage the analog meter.

c. Power Up — turn power meter on by depressing the ON/OFF pushbutton. The red lamp associated with the ON/OFF pushbutton will light.

TABLE 4-2. POWER UP CONDITIONS

CONDITIONS	DISPLAY	MODE	MIN	MAX
1. Power up condition with no power applied to power sensor.	Slight fluctuation of indicator about zero mark.[1]	Unit goes into forward measurement mode.[2] Forward led lights.	MIN led flashes indicating min. value reset.	No Respond
2. Power up condition with power applied to power sensor.	Slight fluctuation of indicator about zero mark then indicator moves to measured power level.[1]	Unit goes into forward measurement mode.[2] Forward led lights.	MIN led flashes indicating min. value reset.	MAX led flashes indicating max value reset.

[1]Fluctuation of indicator is result of power meter performing auto-zero function.
[2]Forward power mode is power up default condition for power meter.

4-10. MEASUREMENT PROCEDURES

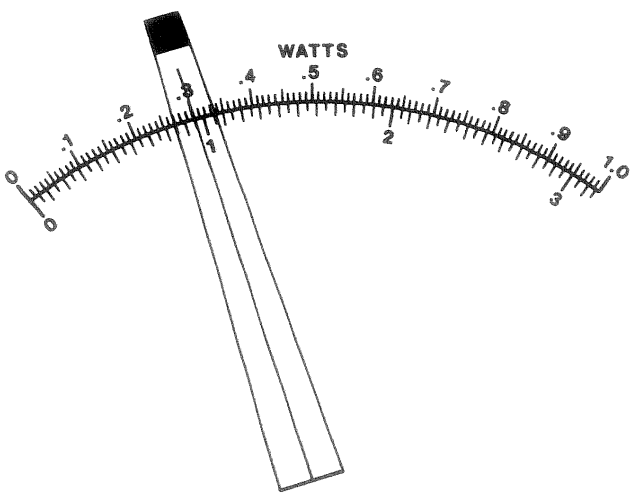
CAUTION

DO NOT APPLY RF POWER TO POWER SENSOR WHICH EXCEEDS 120% OF FULL SCALE OF HIGHEST RANGE.

4-11. FORWARD POWER MEASUREMENT

4-12. If not already in default mode from power up, then depress FWD push button to initiate a forward power measurement (FWD lamp will light). Read top two scales for measured value in watts (See Figure 4-4). The 0 to 1 scale is read when full scale ranges of 100mW, 1W, 10W, 100W, 1kW or 10kW are selected. The 0 to 3 scale is read when full scale ranges of 300mW, 3W, 30W, 300W or 3kW are selected.

FIGURE 4-4. WATTS SCALE.



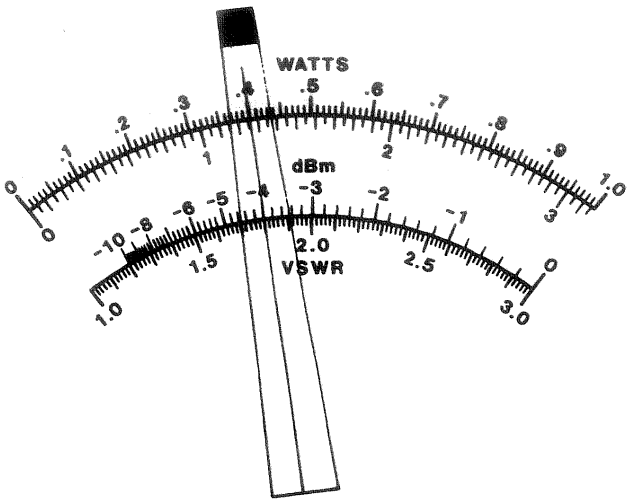
Example: Range selected 100W, 50dBm
Power indicate 30W

See Paragraph 4-25 for error conditions during operation.

4-13. FORWARD dBm MEASUREMENT

4-14. Select forward power function by depressing FWD pushbutton (FWD lamp will light). Value is read on −10 to 0 scale (dBm scale). The dBm value is obtained by adding the displayed value to the full scale dBm value selected (see Figure 4-5).

FIGURE 4-5. dBm SCALE.



Example: Range selected 40dBm
Indicated dBm reading −4dBm
Actual dBm value 40+(−4)=36dBm

See Paragraph 4-25 for error conditions during operation.

4-15. REFLECTED POWER MEASUREMENT

4-16. Press RFL pushbutton to initiate a reflected power measurement (RFL lamp will light). Use the two top scales as described in paragraph 4-11. Select the range that provides the best sensitivity without going over scale.

See Paragraph 4-25 for error conditions during operation.

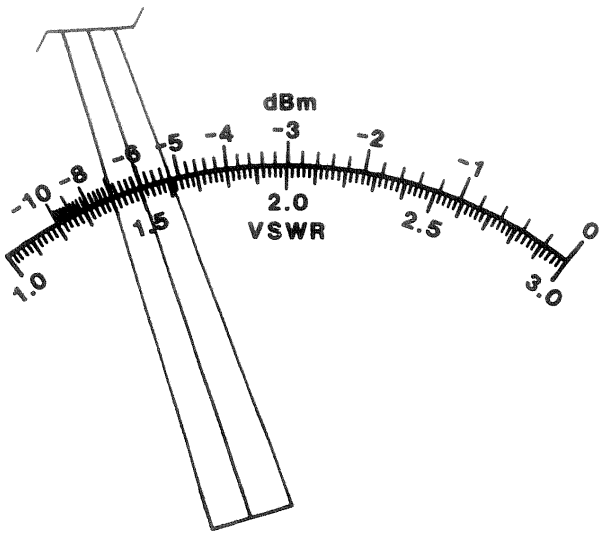
4-17. REFLECTED dBm MEASUREMENT

4-18. Select reflected power function by depressing RFL pushbutton (RFL lamp will light). Value is read on the −10 to 0 scale (dBm scale). The dBM value is obtained by adding the displayed value to the full scale dBm value selected (for example see Figure 4-5).

4-19. VSWR MEASUREMENT

4-20. Select VSWR function by depressing VSWR pushbutton (VSWR lamp will light). VSWR will be calculated and displayed on bottom (VSWR) scale. Since VSWR is calculated from a ratio of two power levels (forward and reflected), a change in incident power under the same transmission line conditions will not result in a change in the VSWR reading.

FIGURE 4-6. VSWR SCALE.



Example: VSWR indicated 1.5

See Paragraph 4-25 for error conditions during operation.

4-21. RETURN LOSS MEASUREMENT

4-22. Model 4420 RF Power Meter does not display a direct reading of return loss, but can be determined by a conversion of VSWR value.

Select VSWR function by depressing VSWR pushbutton. Record VSWR value then refer to Table 4-3 for corresponding return loss.

Return loss values can be calculated according to the following formula:

$$20 \log_{10} \frac{(1 + \text{VSWR})}{(1 - \text{VSWR})}$$

4-23. MINIMUM AND MAXIMUM MEASUREMENTS

4-24. Minimum and maximum pushbuttons have similar functions but result in opposite values. They are described here together because of their similarity from an operator's standpoint.

After a main function has been chosen (forward, reflected or VSWR) the minimum and maximum internal registers are reset. A new minimum and maximum value is stored for the current function being measured. An increase of the reading will cause a new value to be stored in the maximum register, while a decrease of the reading will cause a new value to be stored in the minimum register. The LED associated with either minimum or maximum push buttons will momentarily light to indicate new value has been stored. If a value is increasing or decreasing but not greater or less than previously stored values then values remain.

The minimum and maximum functions are helpful aids when optimizing system parameters such as determining peak power level or lowest VSWR.

TABLE 4-3.
VSWR TO RETURN LOSS CONVERSION

VSWR	Return Loss, dB	VSWR	Return Loss, dB	VSWR	Return Loss, dB	VSWR	Return Loss, dB
1.01	46.06	1.51	13.84	2.01	9.49	2.51	7.33
1.02	40.09	1.52	13.71	2.02	9.43	2.52	7.29
1.03	36.66	1.53	13.58	2.03	9.37	2.52	7.26
1.04	34.15	1.54	13.45	2.04	9.32	2.54	7.23
1.05	32.26	1.55	13.32	2.05	9.26	2.55	7.20
1.06	30.17	1.56	13.20	2.06	9.21	2.56	7.17
1.07	29.42	1.57	13.08	2.07	9.16	2.57	7.14
1.08	29.30	1.58	12.96	2.08	9.10	2.58	7.11
1.09	27.32	1.59	12.85	2.09	9.05	2.59	7.07
1.10	26.44	1.60	12.74	2.10	8.10	2.60	7.04
1.11	25.66	1.61	13.84	2.11	8.95	2.61	7.01
1.12	29.94	1.62	13.84	2.12	8.90	2.62	6.98
1.13	24.29	1.63	13.84	2.13	8.85	2.63	6.95
1.14	23.69	1.64	13.84	2.14	8.80	2.64	6.93
1.15	23.13	1.65	13.84	2.15	8.75	2.65	6.90
1.16	22.61	1.66	13.84	2.16	8.71	2.66	6.84
1.17	22.12	1.67	13.84	2.17	8.66	2.67	6.87
1.18	21.66	1.68	13.84	2.18	8.61	2.68	6.81
1.19	21.23	1.69	13.84	2.19	8.57	2.69	6.78
1.20	20.83	1.70	11.73	2.20	8.52	2.70	6.76
1.21	20.43	1.71	11.63	2.21	8.47	2.71	6.73
1.22	20.08	1.72	11.55	2.22	8.43	2.72	6.70
1.23	19.73	1.73	11.46	2.23	8.39	2.73	6.67
1.24	19.40	1.74	11.37	2.24	8.34	2.74	6.65
1.25	19.09	1.75	11.29	2.25	8.30	2.75	6.62
1.26	18.78	1.76	11.20	2.26	8.26	2.76	6.59
1.27	18.49	1.77	11.12	2.27	8.22	2.77	6.57
1.28	18.22	1.78	11.04	2.28	8.71	2.78	6.54
1.29	17.95	1.79	10.96	2.29	8.13	2.79	6.52
1.30	17.69	1.80	10.88	2.30	8.09	2.80	6.49
1.31	17.45	1.81	10.80	2.31	8.05	2.81	6.47
1.32	17.21	1.82	10.73	2.32	8.01	2.82	6.44
1.33	16.98	1.83	10.65	2.33	7.97	2.83	6.42
1.34	16.76	1.84	10.58	2.34	7.93	2.84	6.39
1.35	16.54	1.85	10.51	2.35	7.89	2.85	6.37
1.36	16.33	1.86	10.44	2.36	7.86	2.86	6.34
1.37	16.13	1.87	10.37	2.37	7.82	2.87	6.32
1.38	15.94	1.88	10.30	2.38	7.78	2.88	6.29
1.39	15.75	1.89	10.23	2.39	7.74	2.89	6.27
1.40	15.56	1.90	10.16	2.40	7.71	2.90	6.25
1.41	15.39	1.91	10.10	2.41	7.67	2.91	6.22
1.42	15.21	1.92	10.03	2.42	7.64	2.92	6.20
1.43	15.04	1.93	9.97	2.43	7.60	2.93	6.18
1.44	14.88	1.94	9.90	2.44	7.56	2.94	6.15
1.45	14.72	1.95	9.84	2.45	7.53	2.95	6.13
1.46	14.56	1.96	9.78	2.46	7.49	2.96	6.11
1.47	14.41	1.97	9.72	2.47	7.46	2.97	6.09
1.48	14.25	1.98	9.66	2.48	7.43	2.98	6.06
1.49	14.12	1.99	9.60	2.49	7.39	2.99	6.04
1.50	13.98	2.00	9.54	2.50	7.36	3.00	6.02

TABLE 4-4. ERROR CONDITIONS

ERROR CONDITIONS	INDICATIONS	REMEDY
Forward and Reflected power exceeds selected range	Indicator is positioned at far right side of display	Select next highest range if covered by power senor. Decrease input power. If high power is in reflected mode check VSWR.
Forward or reflected power range chosen which is not covered by power sensor.	Alarm will momentarily sound and function led will blink.	Select range covered by power senor
No Forward power indicated	Indicator remains at zero	No power applied to sensor. Apply power. Applied power below low power level of power sensor. Increase power.
No reflected power indicated	Indicator remains at zero	No reflected power. Check VSWR, if 1.0 then normal condition. Reflected power below low power level of power sensor. Normal condition.
Forward power present but no VSWR indication	VSWR indicated is 1.0.	Check reflected power. No reflected power present. Good impedance match no correction necessary.
Forward power present but no VSWR indication (continued)	VSWR indicated is 1.0. (continued)	Check reflected power. Power present but below low power level of power sensor. VSWR can't be calculated. No correction necessary.
	VSWR lamp blinks	Check forward power. Power present but below low power level of power sensor. VSWR can't be calculated. Increase applied power.[1]
VSWR reading unstable.	Indicator fluctuates at low end of VSWR scale.	Check reflected power. Power present and changing but below low power level of power sensor. Good impedance match no correction necessary.
High reflected power or reflected power equals forward power.	Indicator is positioned at far right side of display.	Actual VSWR is greater than 3.0. Shutdown transmitter. Correct high reflected source.[2]

[1]Take caution to monitor VSWR condition when increasing applied power.
[2]Error cause could be result of load mismatch or power sensor in backwards.

As an example, an operator may want to adjust his transmitter output for peak power. He would first perform transmitter adjustments to obtain maximum power at the desired frequency. Then he would depress the maximum pushbutton. If the values agree, the maximum power output is being transmitted. If the values didn't agree then he should note the maximum value, release the maximum pushbutton and adjust the transmitter output for that maximum value.

The minimum pushbuttom can be used in a similar manner when optimizing minimum parameters. This could be used to obtain the lowest possible VSWR.

To reset minimum and maximum values it is only necessary to press another pushbutton function (FWD, RFL or VSWR) or press current function pushbutton.

4-25. ERROR CONDITIONS

4-26. An error condition occurrence does not always indicate equipment failure. Corrective action should be taken to remedy the problem. Refer to Table 4-4 for a list of error conditions and their remedy.

The power meter contains an audible alarm which is activated when RF power input exceeds 120% of the power sensor's maximum power range. Upon sounding of this alarm operator should immediately lower the input power to the power sensor to a safe level. Failure to do so could result in destruction of the power sensor.

4-27. SHUTDOWN

4-28. Shutdown conditions are initiated by depressing the ON/OFF pushbutton. This will turn power meter off in all functions.

SECTION V — MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

5-2. The power meter requires only normal and routine maintenance. Keep power meter covered and store in a clean environment when not in use. Refer to specification for storage temperature requirements.

a. HANDLING

Use reasonable care in handling. Do not drop or subject power meter to hard blows as accuracy may be impaired or other damage could result.

b. CLEANING

The operating panel and housing can be wiped with a clean soft cloth. Wipe the meter face only when necessary and use a lint-free static-treated cloth. Do not use abrasive cleaners that may scratch the meter face. Liquid cleaners should be avoided since they may enter the circuitry and cause damage.

WARNING

PROVIDE ADEQUATE VENTILATION AND OBSERVE NORMAL PRECAUTIONS WHEN USING DRY CLEANING SOLVENTS. MANY DRY CLEANING AGENTS EMIT TOXIC FUMES THAT MAY BE HARMFUL TO YOUR HEALTH IF INHALED.

Clean contacts with a cotton swab stick dampened with alcohol, freon or any acceptable dry cleaning solvent.

Sensor cable connector should be cleaned frequently with alcohol.

c. INSPECTION

Periodic inspection should be performed at six month intervals.

1. Inspect power cable for damage to connector pins.
2. Inspect sensor cable for damage.

5-3. TROUBLESHOOTING

5-4. Due to its electronic complexity, repair of the Model 4420 RF Power Meter is recommended only for certain malfunctions. Table 5-1 contains a troubleshooting procedure to identify and effect such repairs.

WARNING

THE POTENTIAL OF ELECTRIC SHOCK EXISTS. ALWAYS UNPLUG THE POWER METER FROM THE AC LINE BEFORE REMOVING THE COVER.

WARNING

NEVER ATTEMPT TO DISCONNECT THE EQUIPMENT FROM THE TRANSMISSION LINE WHILE RF POWER IS BEING APPLIED. LEAKING RF ENERGY IS A POTENTIAL HEALTH HAZARD.

TABLE 5-1. TROUBLESHOOTING PROCEDURE

PROBLEM	POSSIBLE CAUSE	REMEDY
Power meter does not run from ac line power.	• Blown fuse in ac line module • Malfunctioning ac line cord • 115/230 Vac selector drum improperly set	• Replace fuse • Replace cord • Check voltage selection
Self test failure. No response from meter.	• Power meter internal circuitry malfunction	• Return for repairs
Self test failure. Power meter checks scale accuracy and displays software rev. date for power meter but then hangs up.	• No serial communication over sensor cable	• Clean and check for damaged power sensor cable connectors and power sensor connectors. • Replace cable • Return power sensor for repairs.

5-5. CALIBRATION

5-6. The Model 4420 RF Power Meter has no calibration adjustments. (Any required calibration is performed as a factory adjustment on the power sensor.)

5-7. CUSTOMER SERVICE

5-8. Bird Electronic Corporation maintains a complete repair and calibration department at our corporate headquarters. This department is set up to provide the best possible service of Bird equipment.

5-9. All instruments returned for service must be shipped prepaid and to the attention of the Customer Service Group.

Bird Electronic Corporation
30303 Aurora Road
Cleveland (Solon), OH 44139
Phone: 216-248-1200
Cable: BIRDELEC
Telex: 706898 Bird Elec UD

5-10. REPACKAGING

5-11. Should you need to return the power meter, use the original shipping package if possible. If the original package is not available, use a heavy duty corrugated box with shock-absorbing material around all sides of the unit to provide firm cushion and to prevent movement in container. Container should be properly sealed.

SECTION VI — REPLACEMENT PARTS

6-1. GENERAL

6-2. The purpose of this section is to provide the user with a consumables type spare parts listing. Quantities used within the power meter are indicated. However, it may be a good idea to stock a small quantity if local ordering is a potential problem.

6-3. A more detailed listing of all components of the power meter is contained in Appendix A.

TABLE 6-1. MODEL 4420 RF POWER METER SPARE PARTS LIST

QTY.	DESCRIPTION	PART NO.
1	Fuse, 1/4 ampere	5-721-14
1	Cord, Power 115V/230V	4421-055
1	Cable, Sensor (Cable, Interface, Latch-N-Lok)	4421-038

APPENDIX A — PARTS LIST (MODEL 4420)

A-1. GENERAL

A-2. This section lists, describes, and illustrates the component parts or assemblies of the Model 4420 RF Power Meter. The parts listed comprise a general parts list and not a list of field-replaceable parts. Refer to Table 6-1 for recommended field-replaceable parts.

A-3. ILLUSTRATIONS

A-4. Illustrations are provided of PC board assemblies for ease of component location.

A-5. EXPLANATIONS OF COLUMNS

A-6. The following paragraphs explain the information contained in the parts list.

a. The Figure and Item No. column lists the figure number of the illustration on which the part is located. It also gives the item number assigned to that part. If ref. is listed in column assigned to a part number, then this part number is for reference only with no associated illustration.

b. The Quantity column contains the quantity of that part used per that assembly.

c. The Bird Part No. column contains Bird Electronic Corporation part numbers.

d. The Description column gives the name of the part or assembly, indented by columns to indicate relationship to the next higher assembly.

TABLE A-1. FINAL ASSEMBLY 4420 PARTS LIST

FIG. & ITEM NO.	QTY.	BIRD PART NO.	DESCRIPTION
A-1	1	4420-001	. Final Assembly, Model 4420
1	1	4420-008	. . PC Board, Main Control Assembly (See Table A-3)
2	1	4420-017	. . Frame, Main Assembly
3	1	5-1774	. . Knob
4	1	4420-022	. . Nameplate, Lexan, RF Power Meter
5	1	4420-021	. . Panel, Window
6	1	4420-002	. . Panel, Front, Assembly (See Table A-2)
7	1	4420-028	. . Case
8	1	4420-003	. . Panel, Rear, Assembly
9	1	4420-054	. . Nameplate
10	1	4420-038	. . Cable, Sensor (Cable, Interface, Latch-N-Lok)
11	1	4420-055	. . Cord, Power 115V/230V/Assembly
12	1	4420-029	. . Handle, Assembly

FIGURE A-1. 4420-001. FINAL ASSEMBLY, MODEL 4420.

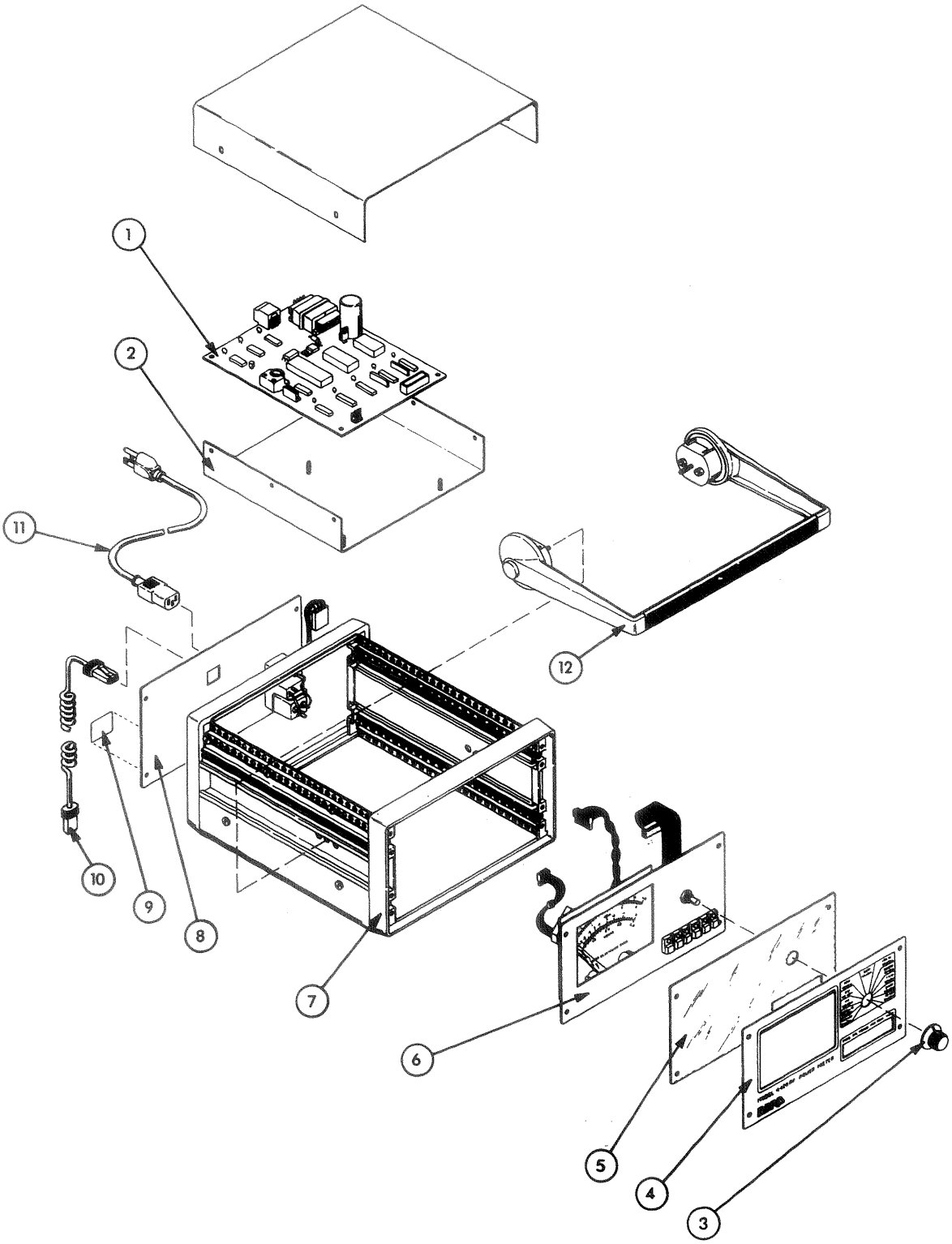


TABLE A-2. PANEL, FRONT, ASSEMBLY, 4420-002 PARTS LIST

FIG. & ITEM NO.	QTY.	BIRD PART NO.	DESCRIPTION
ref	1	4420-002	. . Panel, Front, Assembly
ref	1	4420-018	. . . . Panel, Front
ref	1	4420-004	. . . . Meter, Analog, Assembly
ref	1	4420-012	. . . . Switch, Range, Assembly
ref	1	4421-010	. . . . Cable, Ribbon, I/O — Main Control Assembly
A-2	1	4420-005	. . . . P.C. Board, Keyswitch Assembly
1	1	4420-006	. . . . P.C. Board, Keyboard
P6	1	5-1723	. . . . Header, 20 pin
P7	1	5-1712-5	. . . . Header, 5 pin
RN3	1	5-1771-1	. . . . Resistor, Network, 390 ohm, 2%
SWI-SW6	6	5-1782	. . . . Switch, key

FIGURE A-2. 4420-005 P.C. BOARD, KEYSWITCH, ASSEMBLY.

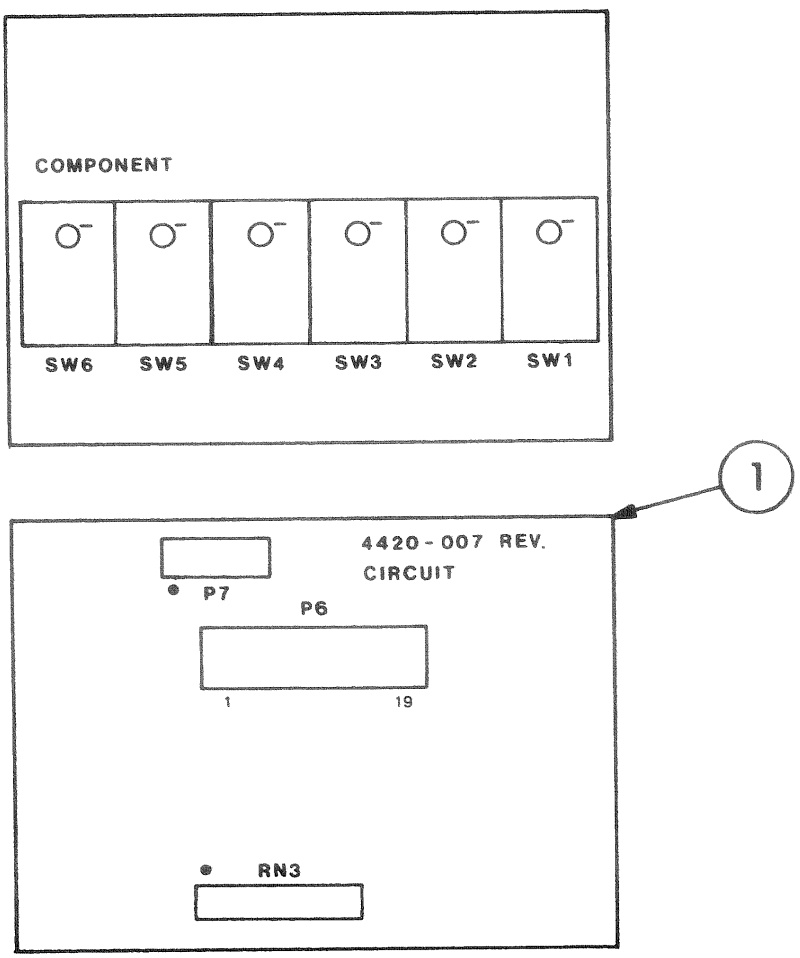
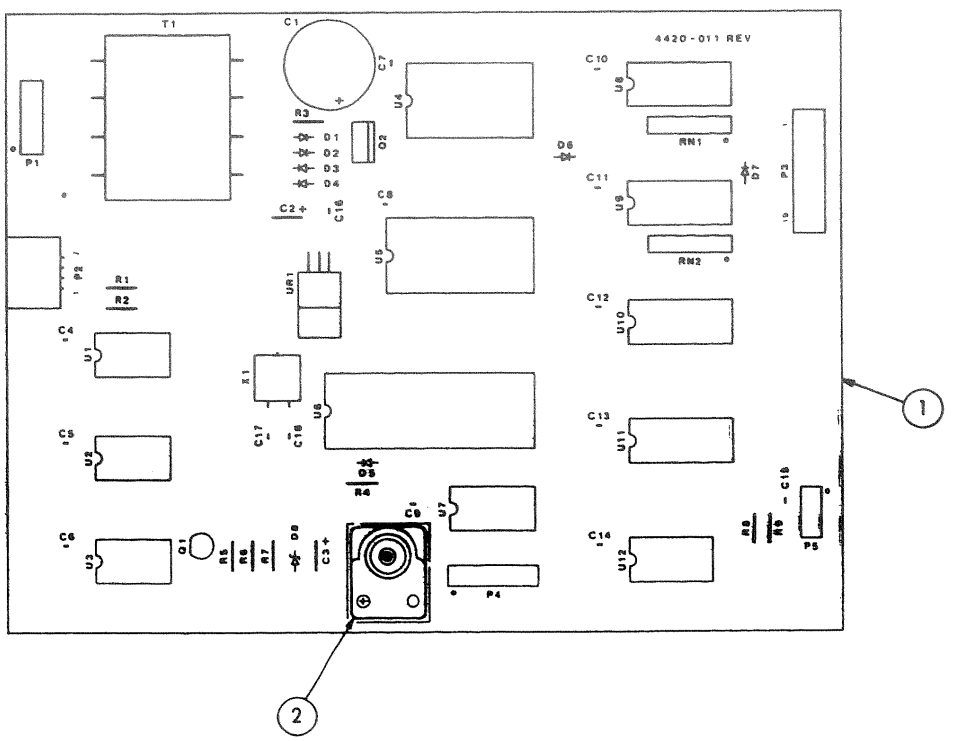


TABLE A-3. P.C. BOARD, MAIN CONTROL ASSEMBLY 4420-008 PARTS LIST

FIG. & ITEM NO.	QTY.	BIRD PART NO.	DESCRIPTION
A-3	1	4420-008	. . PC Board, Main Control Assembly
U6	1	5-1704	. . . I.C., CMOS, MCU, #63A03
U5	1	4420-031	. . . I.C., Memory, Programmed/Assembly
U4	1	5-1705	. . . I.C., LSI, 2K X 8 CMOS, Static RAM #6616
P2	1	5-1703	. . . Connector
2	1	5-1714	. . . Buzzer
1	1	4420-009	. . . P.C. Board, Main Control, Subassembly
C1	1	5-1623	. . . . Capacitor, 6800 uf
C2, C3	2	5-1239	. . . . Capacitor, 10 uf
C4-C14 & C16	12	5-688-8	. . . . Capacitor, 0.1 uf
C15	1	5-688-2	. . . . Capacitor, 1000 pf
C17, C18	2	5-1233-3	. . . . Capacitor, 18 pf
D1-D4	4	5-553	. . . . Diode, #1N4002
D5-D7	3	5-1225	. . . . Diode, #1N4148
D8	1	5-1783-20	. . . . Diode, Zener
Q1	1	5-1784	. . . . Transistor, #2N4403
Q2	1	5-1700	. . . . Transistor, Mosfet #RFP6P08
R1, R2	2	5-1520-103	. . . . Resistor, 10K, 5%
R3	1	5-1520-153	. . . . Resistor, 15K, 5%
R4	1	5-1520-105	. . . . Resistor, 1 Meg., 5%
R5, R8	2	5-1520-181	. . . . Resistor, 180 ohm, 5%
R6, R7	2	5-1520-222	. . . . Resistor, 2.2K, 5%
R9	1	5-1520-104	. . . . Resistor, 100K, 5%
RN1, RN2	2	5-1771-2	. . . . Resistor, Network, 10K, 2%
T1	1	5-1772	. . . . Transformer
U1	1	5-1708	. . . . I.C., Logic, Two input NAND Schmitt Trigger, #74HC132
U2	1	5-1768	. . . . I.C., Logic, Inverter Hex, #74HC04
U3	1	5-1709	. . . . I.C., Logic, NAND, #74HC00
U7	1	5-1770	. . . . I.C., Darlington Array, ULN-2003A
U8-U11	4	5-1706	. . . . I.C., Logic, Tri-state Latch #74HC573
U12	1	5-1769	. . . . I.C., Logic, 1 of 8 Decoder, #74HC138
UR1	1	5-1100-1	. . . . Regulator, Voltage #340T5
X1	1	5-1702	. . . . Crystal, 4.9152MHz
P1	1	5-1273-1	. . . . Header, 4 Pin
P3	1	5-1723-1	. . . . Header, 20 Pin
P4	1	5-1712-8	. . . . Header, 8 Pin
P5	1	5-1712-4	. . . . Header, 4 pin

FIGURE A-3. 4420-008 P.C. BOARD, MAIN CONTROL, ASSEMBLY.



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