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## INSTRUCTION BOOK

# Operator Manual AT-400 Antenna Tester

**BIRD<sup>®</sup>**

**Electronic Corporation  
Cleveland (Solon) Ohio USA**

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Instruction Book Part Number 920-AT400 Rev G



## **Safety Precautions**

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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 thoroughly understood and applied to all phases of operation and maintenance.

### ***Resuscitation***

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

### ***Keep Away From Live Circuits***

Operating personnel must at all times observe normal safety regulations. Do not replace components or make adjustments to the equipment with high voltage turned on. To avoid casualties, always remove power.

### ***Do Not Service Or Adjust Alone***

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

### ***Safety Earth Ground***

An uninterruptible earth safety ground must be supplied from the main power source to test instruments. 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.

### **Shock Hazard**

Do not attempt to remove the RF transmission line while RF power is present. Radiated RF power is a potential health hazard.

### **Safety Symbols**

#### **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 equipment.



The caution symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area. See page 16 and 37 for specific cautions.

 **NOTE:** Calls attention to supplemental information

## **Warning Statements**

The following equipment warnings appear in the text whenever there is a danger to people.



### **WARNING**

Live RF energy. Do not touch or ground the center conductor of a live RF connection. Failure to comply may result in equipment damage and serious burns or death to personnel.

## **Caution Statements**

The following equipment cautions appear in the text whenever the equipment is in danger of damage and are repeated here for emphasis.

### **CAUTION**

Required input is 11 to 16 VDC @ 250mA. Connector is wired outside positive, inside negative.

### **CAUTION**

#### **AVOID STATIC DISCHARGE**

Use proper Electrostatic Discharge (ESD) precautions to avoid static discharge when making connections to the test port. Equipment failure can occur if the test port is subjected to ESD.

**CAUTION**

250mW max. input

Exceeding the maximum input will cause damage to internal components. Do not connect transmitter output to the AT-400. Damage can also be caused by testing antennas near other transmitting antennas. If testing base station antennas, first measure the power at the coax end to be sure it does not exceed 250mW.

**CAUTION**

Harsh or abrasive detergents and some solvents can damage the display unit and information on labels.

**CAUTION**

Replace with only NiCad rechargeable AA batteries, IEC code KR-15/51. Nominal Voltage 1.2V; Capacity 650mAh. Do not install alkaline batteries.

**CAUTION**

Replace with only the same type and rating fuse.  
315mA 250V

**Safety Statements**



**USAGE**

ANY USE OF THIS INSTRUMENT IN A MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE INSTRUMENT'S SAFETY PROTECTION.

**USO**

EL USO DE ESTE INSTRUMENTO DE MANERA NO ESPECIFICADA POR EL FABRICANTE, PUEDE

ANULAR LA PROTECCIÓN DE SEGURIDAD DEL INSTRUMENTO.

BENUTZUNG

WIRD DAS GERÄT AUF ANDERE WEISE VERWENDET ALS VOM HERSTELLER BESCHRIEBEN, KANN DIE GERÄTESICHERHEIT BEEINTRÄCHTIGT WERDEN.

UTILISATION

TOUTE UTILISATION DE CET INSTRUMENT QUI N'EST PAS EXPLICITEMENT PRÉVUE PAR LE FABRICANT PEUT ENDOMMAGER LE DISPOSITIF DE PROTECTION DE L'INSTRUMENT.

IMPIEGO

QUALORA QUESTO STRUMENTO VENISSE UTILIZZATO IN MODO DIVERSO DA COME SPECIFICATO DAL PRODUTTORE LA PROZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.



SERVICE

SERVICING INSTRUCTIONS ARE FOR USE BY SERVICE - TRAINED PERSONNEL ONLY. TO AVOID

DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

SERVICIO

LAS INSTRUCCIONES DE SERVICIO SON PARA USO EXCLUSIVO DEL PERSONAL DE SERVICIO CAPACITADO. PARA EVITAR EL PELIGRO DE DESCARGAS ELÉCTRICAS, NO REALICE NINGÚN SERVICIO A MENOS QUE ESTÉ CAPACITADO PARA HACERLO.

**WARTUNG**

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL.

ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SIND WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

**ENTRETIEN**

L'EMPLOI DES INSTRUCTIONS D'ENTRETIEN DOIT ÊTRE RÉSERVÉ AU PERSONNEL FORMÉ AUX OPÉRATIONS D'ENTRETIEN. POUR PRÉVENIR UN CHOC ÉLECTRIQUE DANGEREUX, NE PAS EFFECTUER D'ENTRETIEN SI L'ON N'A PAS ÉTÉ QUALIFIÉ POUR CE FAIRE.

**ASSISTENZA TECNICA**

LE ISTRUZIONI RELATIVE ALL'ASSISTENZA SONO PREVISTE ESCLUSIVAMENTE PER IL PERSONALE OPPORTUNAMENTE ADDESTRATO. PER EVITARE PERICOLOSE SCOSSE ELETTRICHE NON EFFETTUARRE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.



## About This Manual

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### ***About this Manual***

Many people read the operators manual only as a last resort. If you are one of those people, you should at least read the next two pages so that you can find the information when you do need it. You will also learn where to find valuable time saving information.

### ***Changes to this Manual***

We have made every effort to ensure this manual is accurate at the time of publication. If you should discover any errors or if you have suggestions for improving this manual, please send your comments to our factory. This manual may be periodically updated, when inquiring about updates to this manual refer to the part number and revision level on the title page.

### ***Typography***

There are two types of keys on the Antenna Tester. A *Hard Key* is a key that has a particular function and it is indicated on the key. These key names are set in a bold typeface, e.g. Press the **MENU** key.

A *Menu Select Key*, (there are five under the display), will have a different label, or name, depending on the selected function. The name will be at the bottom of the display located directly above the corresponding key. These key names are set in a bold Italic typeface, e.g. Press the ***SWEPT FREQ*** key.

## **Chapter Layout**

**Introduction**—Will help you become familiar with the parts of the Antenna Tester, Features Available, and Optional Equipment.

**Basic Operation**—Everyone should read this section! This section will provide the information required to get the Antenna Tester powered up, and provides helpful information about how to operate the Antenna Tester, and some time saving hints for alternate operating methods.

**Installation**—This chapter contains the information on how to connect the AT-400 to antenna systems, and to power sources to charge and operate the unit.

**Measure Match**—Since the AT-400 Antenna Tester offers a unique method of measuring Antenna Systems we have included the section, “Understanding the Operating Modes.” Even if you already know the basics of antenna match testing you might find this section useful. The remainder of the chapter provides step by step instructions for measuring match.

**Field Strength**—Provides step by step instructions for measuring relative field strength of fixed antennas.

**Maintenance**—This chapter contains the information required to keep the AT-400 working for you. This includes battery and fuse information, troubleshooting information, parts lists, and specifications.



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## Items Supplied

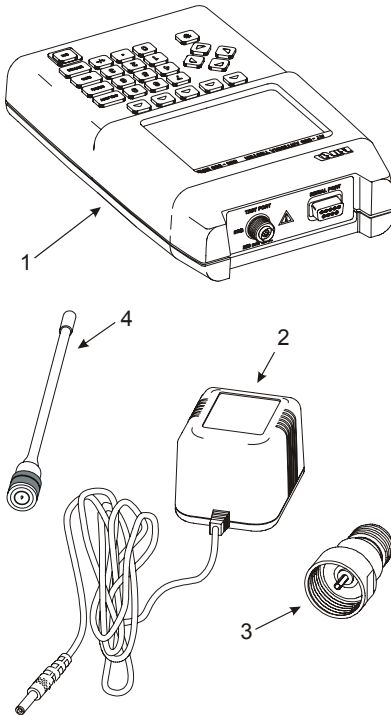


Figure 1 Supplied Items

1. Bird AT-400
2. AC Mains Adapter
3. Female TNC Connector
4. Field Strength Antenna
5. Instruction Book (Not Shown)

## Component Description



Figure 2 Component Description

- |   |   |
|---|---|
| <p><b>1. LCD Display</b></p> <p><b>2. External DC Connector</b></p> | <p>Backlit liquid crystal display.</p> <p>Connect either the ac adapter or the cigarette lighter adapter. External supplies operate the unit and charge the internal battery.</p> |
|---|---|

**3. Cursor Keys**

**Left Arrow**

Press in swept frequency mode to move the cursor to the left. Press during data entry to erase data.

**Right Arrow**

Press in swept frequency mode to move the cursor to the right.

**Up Arrow**

Moves the cursor to the maximum point on the displayed trace. Press during data entry to increase numeric data.

**Down Arrow**

Moves the cursor to the minimum point on the displayed trace. Press during data entry to decrease numeric data.

**4. Backlight Key**

Turns the backlight on or off. Backlight is on a timer to increase battery life.

**5. On Key**

Press to turn tester on, press and hold to turn tester off.

**6. +/- Key**

Toggles between positive and negative numbers.

**7. Enter Key**

Completes data entry.

**8. ESC Key**

Back up through menu structure. At the top menu level, blanks menu. Exits data entry without saving changes.

**9. Menu Key**

Displays software menu and enables menu select keys.

**10. Select Key**

Allows current parameter, indicated by flashing cursor, to be changed. Press again to enable the next parameter to be changed.

**11. Numeric Keys**

Input numeric values.

**12. Menu Select Keys**

Used to access the menu sections described directly above them. Can also be used to scroll through available settings in a particular parameter.

**13. Test Port**

Connect antenna or antenna lead.

**14. Serial Port**

Connect communication cable to allow data transfer to a PC.

## Display Description

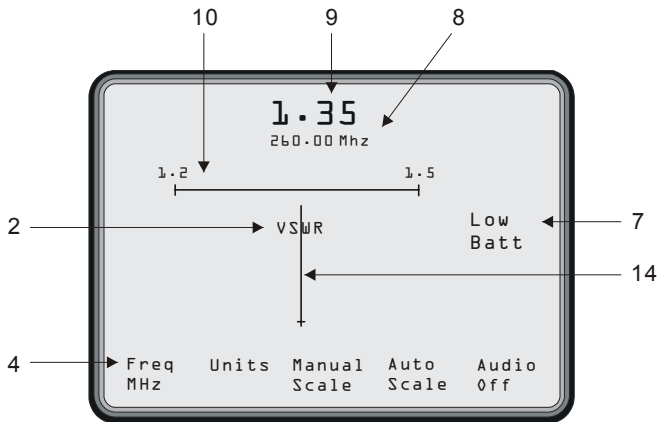
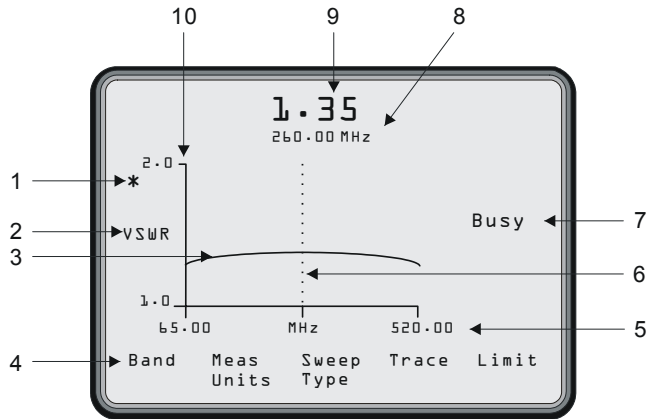


Figure 3 Display Description



1. **Sweep Rate Indicator**            Blinks when sweeping.
2. **Measurement Units**       Indicates selected measurement units.
3. **Trace**                        Graphic display of measured results across selected frequency band.
4. **Menu Select Key Labels**     Defines function of menu select keys located below the display.
5. **Frequency Band Scale**       Displays frequency band selected.
6. **Cursor**                      Used to select measurement position on the trace.
7. **Utility Label**                Area for displaying general data (Lo Batt, Busy, Hold, Noise, and test results).
8. **Frequency**                  Selected Frequency (for swept mode this is frequency at the cursor position).
9. **Measured Value**            Numeric display of measured value (for swept mode this is the value at the cursor position).
10. **Scale**                        Displays user defined measurement scale.
11. **Pointer**                     Moves across scale to show analog type indication of measured value.

## **Features**

**Swept Frequency Mode** — Fast scan shows VSWR,  $\rho$ , match efficiency or return loss across an entire band. A movable cursor can be used to pinpoint a scan frequency and the corresponding measurement value is displayed.

**Single Frequency Mode** — Provides measurement information in units of Reflection Coefficient ( $\rho$ ); Voltage Standing Wave Ratio (VSWR); % Match, or Return Loss (dB) at one frequency on a simulated meter movement. An audio generator can be enabled to produce a tone that is proportional to the match condition.

**Auto Scaling** — Used in either swept or single frequency modes, sets the Y axis for best measurement display.

**Relative Field Strength** — Provides means for optimizing the radiated signal of any transmitter within the specified frequency band.

**Limit Testing** — Quick pass-fail indication; compares measurements to user selected limits.

**Data Storage** — Saves and recalls up to 12 traces to be used to set limit or long term monitoring of antenna performance.

**Serial Communication Link** — Built in serial port and optional software uploads data to a personal computer for analysis or storage.

## **Optional Equipment**

### **Automobile Cigarette Lighter Adapter — (P/N 5A2238-1)**

Connects tester to standard 12V automotive cigarette lighter jack.

**Carrying Case — (P/N 5000-030)** Convenient and protective, large enough to carry the tester, AC adapter, connectors, field strength antenna and instruction book.

**Verification Kit — (P/N 7000A445)** Used to verify tester performance. Includes standard mismatch and connector adapter.


**Interface Software — (P/N 7000A840)** PC software used to upload trace data for analysis, printing or storage.

System requirements: IBM PC or equivalent; Windows 95 or later, 4 MB free hard disk space; VGA monitor, open com port. Includes interface cable.



### Getting Started

This section describes initial quick steps to get started. For detailed information regarding connecting the Antenna Tester refer to that section at the end of this chapter.

 Note: This unit is shipped with the batteries *not charged*. Charge batteries overnight or for at least 8 hours before use.



#### Power On/Off

- To turn the Antenna Tester on, momentarily press the **ON** key. The results of a self test will be displayed if a failure is present. For more information about the self test or a failure, refer to the maintenance section.
- To turn the Antenna Tester off, press and hold the **ON** key for 1 second.



#### Backlight

- To turn the backlight on, press the **BACKLIGHT** key.
- To increase or decrease display contrast, press and hold the **BACKLIGHT** key while pressing either the **UP** or **DOWN** arrow key.
- To turn the backlight off, press the **BACKLIGHT** key.



#### Software Menu

- Press the **MENU** key to display the software menu.

### **Blinking Cursor (black square)**

The cursor will be blinking in the selected area, indicating that the parameter for that area can be changed.

#### **Enter Key**

All data entry, and mode changes accessed using select key, require the enter key to be pressed before they are initiated.

#### **Up/Down Arrow Keys**

When a function is enabled for change, the **UP** or **DOWN** arrow keys can be used to either scroll through your choices or increase/decrease the numerical value. The actual increments depend on the function.

#### **Left Arrow Key**

The **LEFT** arrow key can be used to backspace erasing one character at a time during data entry.

#### **Escape (ESC)**

Returns to previous menu without initiating a change.

#### **Select Key**

The operator instructions written for this manual were based on stepping through the software menu using the keys below the display. Once you are comfortable operating the AT-400, you might find it faster to use the **SELECT** key to access some functions. These include: Units, Scale, Start and Stop Frequencies in swept frequency mode and Units, Scale and Frequency in single frequency mode.

Press the **SELECT** key until the cursor is blinking at the desired function. The first function enabled depends on the last function selected through the menu.

## Messages

There are five utility messages that can be displayed to inform you of equipment, or procedural, conditions.

“Lo Batt” is displayed when battery voltage is less than 6.6V, refer to maintenance section for charging batteries.

“Busy” is displayed during mode changes indicating the measurement information is being updated.

“Hold” is displayed when in the Swept Frequency mode, and Single Hold is the selected sweep type.

“Pass” or “Fail” will be displayed indicating the appropriate results of a limit test.

“Noise” will be displayed if there is excessive background noise measured. The measurement may not be accurate. See troubleshooting if this condition is persistent.

## Out of Range Values

When entering numeric data, it is possible to enter a value out of range. Depending on the function, the Antenna Tester will either enter the minimum or maximum value, or the cursor will continue to blink on the function out of range waiting for the correct entry.

## Setting the Auto Shut-Off Timer

In order to preserve battery life, the Antenna Tester will automatically shut off after 5,15,30 or 60 minutes without any keystrokes.

Follow the steps below to select the length of time, before auto shut-off occurs.

- Press the **MENU** key.
- Press the **UTIL** key.
- Press the **TIMER** key until the desired interval is displayed.

## **Return to Factory Presets**

When the Antenna Tester is turned on, the various software parameters will be set to the condition they were at when the tester was turned off.

To return the parameters to the factory setting follow the steps below.

- The parameters will be set to the conditions listed below.

<b>Software Parameter</b>	<b>Factory Setting</b>
Mode	Swept Frequency
Start	65MHz
Stop	520MHz
Measurement Units	VSWR
Scale	min. 1.0; max. 5.0
Sweep Type	Continuous
Limit Value	1.5
Limit Audio	ON
Baud Rate	9600
Auto Shut-off Timer	5
Audio	ON
Cursor	300MHz

- Press the **MENU** key.
- Press the **UTIL** key.
- Press the **PRESET** key.



## **Set Serial Baud Rate**

Measurement data can be transferred between the AT-400 and a personal computer using the serial port and optional interface software. The data can then be used for analysis, printed, or stored.

The data transfer rate (baud rate) between the Antenna Tester and computer must be identical and set to 9600. To change the baud rate for the serial port on the Antenna Tester, follow the steps below.

Complete interface software instructions are included with the software.


- Press the **MENU** key.
- Press the **UTIL** key.
- Press the **SERIAL** key.
- Repeatedly press the **SERIAL** key until the 9600 is displayed.




The following paragraphs will explain how to connect the Bird Antenna Tester for various operations. Refer to the component description diagram on page 2 if needed.

### **Power Supply**

The AT-400 can use an external power source. Using the ac adapter or the 12V cigarette lighter adapter will also charge the battery. Using the ac adapter, charge time is about 8 hours. Using the cigarette lighter adapter, charge time will depend on the car battery charge. Battery life is 2 hours continuous operation, minimum, with the backlight on. “Lo Batt” is displayed when the batteries require charging.

 NOTE: This unit is shipped with the batteries not charged. Charge batteries for at least 8 hours before use.

 NOTE: For optimum battery life, only charge the batteries after the low battery indicator is displayed.

#### CAUTION

Only use the ac adapter provided with the AT.  
Do not use the adapter with the batteries removed.

- AC Mains Adapter — To use the ac adapter, insert the adapter’s barrel connector into the Antenna Tester’s dc jack. Insert the adapter plug into a wall receptacle.

#### CAUTION

Required input is 11 to 16 VDC @ 250mA. Connector is wired outside positive, inside negative.

- Automobile Cigarette Lighter Adapter — Insert the adapter’s barrel connector into the Antenna Tester’s dc jack. The negative (–) symbol must be adjacent to the word TIP as the center is negative and the outside is positive. Insert the adapter plug into a cigarette lighter.

## Connecting the Antenna



### WARNING

Live RF energy. Do not touch or ground the center conductor of a live RF connection. Failure to comply may result in equipment damage and serious burns or death to personnel.



### CAUTION

#### AVOID STATIC DISCHARGE

Use proper Electrostatic Discharge (ESD) precautions to avoid static discharge when making connections to the test port. Equipment failure can occur if the test port is subjected to ESD.



### CAUTION

#### 250mW max. input

Exceeding the maximum input will damage the unit. Do not connect transmitter output to the AT-400. Damage can also be caused by testing antennas near other transmitting antennas. If testing base station antennas, first measure the power at the coax end to be sure it does not exceed 250mW.

Antenna leads and the Field Strength Antenna are connected to the test port. A known good RF cable can be used to connect the antenna tester directly to a coupler box, bypassing the antenna system lead. A female TNC connector is provided. Other connectors are available, see Parts List in the maintenance section for more information.

Special consideration must be given to the RF energy present at the feed line of site antennas. At active sites, RF energy from transmitters can be coupled to the antenna under test. If large enough, these signals will cause inaccurate measurements. For best results, the AT-400 should be used with all transmit antennas powered down.

### ***Understanding the Operating Modes***

The Antenna Tester is connected and the operating frequency band is selected (see basic operation). User selections are customized, the power is on, and the top level menu is displayed (also in basic operation). Now what?

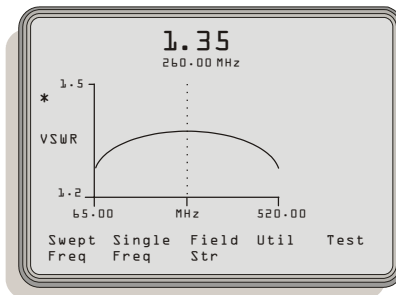
Before we explain how to measure the antenna match, a brief discussion of your options is in order.

Since the AT-400 will change the way you test antennas, we suggest taking some time to explore the different operating modes and find what is best for your application.

### **Swept Frequency vs. Single Frequency**

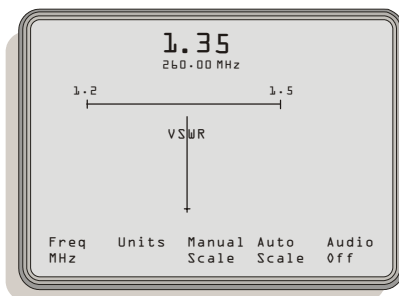
Swept frequency graphically displays the unit of measure over a band of frequencies. The cursor, a vertical dotted line, can be moved with the arrow keys to pinpoint a particular frequency. The measured match value and the frequency at the cursor position are shown at the top of the display.

*Figure 4*  
*Swept*  
*Frequency*



Single Frequency mode displays the unit of measure in a simulated analog meter graphic. This mode, particularly when audio is on, is useful when tuning an antenna.

Figure 5  
Single  
Frequency



## Measurement Units

Rho (Reflection Coefficient), VSWR (Voltage Standing Wave Ratio), Match Efficiency (%), and Return Loss (dB), are different units of measurement that can be used to present the same information. (Similarly, Celsius and Fahrenheit are different units of measurement used to express the same temperature). These units can be used to express the degree of match between an antenna system and a transceiver.

**Rho** is the ratio of reflected wave voltage to forward wave voltage. A perfect antenna would not have any reflected waves, hence would have a 0.00 reflection coefficient.

**VSWR** refers to the ratio of maximum and minimum voltages that are set up on a transmission line resulting from the combination of a forward wave and reflected wave. If the antenna system is perfectly matched, the VSWR would be 1:1 and shown as 1.00.

**Match Efficiency (%)** indicates how much of the transmitted power is being used and how much is wasted. If the antenna system is perfectly matched, the Match Efficiency would be 100%.

**Return Loss (dB)** is a comparison of the reflected signal to the forward signal in decibels. If the antenna system is perfectly matched, the Return Loss would be negative infinity dB.

Antenna manufacturers often use VSWR for specifications. Match Efficiency is popular for testing because it is easy to determine a good match versus a bad match. For example a system with a VSWR of 1.50 would show -13.98 dB Return Loss and 96% Match Efficiency.

### Auto Scale vs. Manual Scale

In swept mode Auto Scaling sets the measurement unit scale to make the trace easier to read. However, if you plan to look at the size or shape of traces for quick comparisons, it might be more meaningful to set a standard scale. Remember that it is possible to set the scale manually so the information is not on the display at all.

Figure 6  
Auto Scaling  
Swept  
Frequency  
Mode

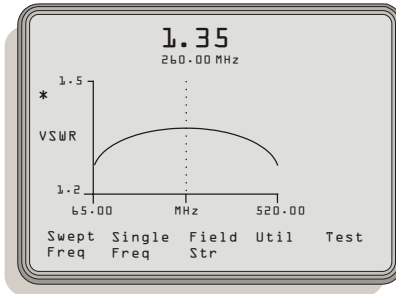
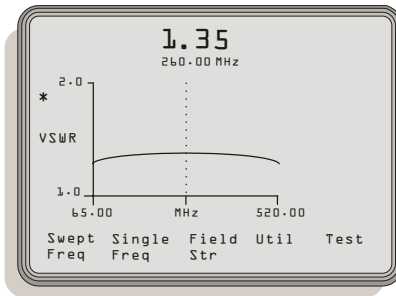
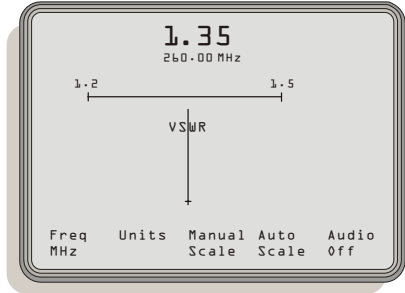


Figure 7  
Manual  
Scaling Swept  
Frequency  
Mode



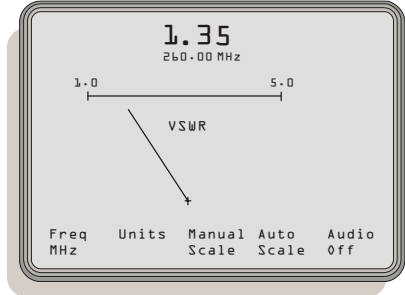
In the single frequency mode Auto Scaling sets the measurement unit scale so the pointer is mid range of the previous reading. The maximum and minimum scale values are approximately 10% higher or lower than the measured value.

*Figure 8  
Auto Scaling  
Single  
Frequency  
Mode*



This setting is an operator preference based on the mode that best presents the desired information.

*Figure 9  
Manual  
Scaling Single  
Frequency  
Mode*



## **Sweep Type-Single Hold vs. Continuous**

Continuous sweep continually sweeps the selected frequency band updating the measured value with each sweep. An asterisk (\*) is blinking on the left side of the display to indicate sweep rate. The single hold mode will freeze a trace on the display and hold is displayed on the right. Holding a trace is also helpful before saving the trace, (more about saving traces under that heading later in this section).



## Swept Frequency

### Select Frequency Band

There are two options for selecting the frequency band. The first is simply to enter the start and stop frequencies. The second is to enter a span frequency, which is the desired width of the band, and a center frequency, that will be used as the center of the band.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **BAND** key.
- Depending on desired method press either **Start Stop MHz** or **Center MHz**:

**START STOP MHZ** - The cursor will blink on the start frequency and Start Stop MHz will be highlighted.

1. Enter the frequency using the numeric keypad or change the frequency using the **UP/DOWN** arrow keys.
2. Press the **ENTER** key. The cursor will blink on the stop frequency.
3. Enter the frequency using the numeric keypad or change the frequency using the **UP/DOWN** arrow keys.
4. Press the **ENTER** key. The tester will begin sweeping.

**CENTER MHZ** - The cursor will blink on the Center frequency and Center MHz will be highlighted.

1. Enter the frequency using the numeric keypad or change the frequency using the **UP/DOWN** arrow keys.
2. Press the **ENTER** key. The tester will begin sweeping.
3. Press the **SPAN** key. Enter the frequency using the numeric keypad or change the frequency using the **UP/DOWN** arrow keys.
4. Press the **ENTER** key. The tester will begin sweeping.

## **Select Measurement Units**

Antenna match information can be presented using four different measurement units. Depending on your application, follow the steps below to select Rho, VSWR, %Match or Return Loss.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **MEAS UNITS** key.
- Press the **UNITS** key.
- Press either the **RHO**, **VSWR**, **%MATCH** or **RETURN LOSS** key. The selected unit will be shown on the left side of the display.
- Press **RETURN** to go back one menu level or **MENU** to return to the top menu level.

## **Select Auto or Manual Scale**


Selecting the scale simply sets up how the information will look on the display.


- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **MEAS UNITS** key.
- Depending on desired mode press either **AUTO** or **MANUAL SCALE**:

**AUTO SCALE** - the units scale changes and the Antenna Tester begins sweeping.

**MANUAL SCALE** - the cursor will blink on the minimum scale value and Manual Scale will be highlighted.

1. Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
2. Press the **ENTER** key. The cursor will blink on the maximum scale value.
3. Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
4. Press the **ENTER** key. The tester will begin sweeping.

 NOTE: If an out of range value is entered, the minimum (if under-range) or maximum (if over-range) value will be substituted. If a maximum value that is lower than the minimum value is entered, the cursor will blink again on the minimum value waiting for a correct entry. The actual range depends on the units selected.

 NOTE: Using the arrow keys will keep you in the acceptable range. If you are not sure if the larger value should be at the top or bottom of the scale, press the auto scale key to see where the software puts it.

### Selecting the Sweep Type

Sweep types are continuous or single hold. Continuous will sweep and update the trace automatically. Single hold will sweep once and the trace will remain in the display. Each time single hold is pressed, the trace is updated.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **SWEEP TYPE** key.
- Depending on desired mode press either **SINGLE HOLD** or **CONT** key. HOLD will be displayed if single hold is selected. The tester begins sweeping if continuous is selected.

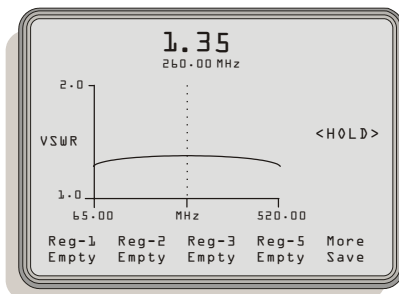
### Saving a Trace

The AT-400 can store up to 12 traces. A saved trace can be used to evaluate long term antenna performance, compare performance under different conditions or for comparison to another antenna. A saved trace is also a powerful tool in limit testing (more about limit testing later in this section). The information can later be uploaded to a PC using optional interface software and the serial port. Traces are stored in nonvolatile memory so they are not lost when the Antenna Tester is turned off.

Since the reflection coefficient is the information actually saved when saving a trace, and everything else is calculated from that, you have some flexibility when using the trace for


comparison. For example, if you save a trace displayed in VSWR, you can compare it to a trace displayed in %Match. You can also change the frequency band of the new trace to effectively zoom in on a particular section of the saved trace. This may be helpful in pinpointing a problem area in a failed limit test.

Figure 10  
Save a Trace



The desired units, band, and scale should be selected. You should be in the single hold mode and the trace you want stored should be displayed. If continuous sweep type is selected, the trace displayed when you save will be stored.


- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **TRACE** key.
- Press the **SAVE TRACE** key.
- Press a **REG-n** key that has empty displayed. If you select a full register the new trace will overwrite the old trace. If registers 1-4 are full press the **MORE SAVE** key to access 5-8 and again to access 9-12. If needed, use the **ESC** key to back up.

 NOTE: It is a good idea to keep a record of which traces are in which register as they are identified by register number only.

### Recalling a Trace

Follow the steps below to recall a saved trace.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **TRACE** key.
- Press the **RECALL TRACE** key.
- Press the **REG-n** key for the desired trace, press the **MORE RECALL** key to access 5-8 and again to access 9-12. If needed, use the **ESC** key to back up. The saved trace will be displayed and the corresponding register number will be shown at the bottom of the display.

 NOTE: The arrow keys can be used to move the cursor, and the corresponding measurement and frequency at the cursor will be displayed. Remember the up arrow key will move the cursor to the highest value on the trace and the down arrow key will move it to the lowest.

- Press the **RETURN** key to return to register selection.
- Press the **ESC** key to return to trace menu.

### Clearing a Trace

When a trace is no longer needed or you need to clear registers for space, follow the steps below.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **TRACE** key.
- Press the **CLEAR TRACE** key.
- Press the **REG-n** key for the desired trace, press the **MORE CLEAR** key to access 5-8 and again to access 9-12. If needed, use the **ESC** key to back up. The word full will be replaced by empty at the selected register.
- Press the **ESC** key to return to the trace menu.

### Limit Testing

Limit testing is a quick pass-fail test using operator defined limits or a stored trace as a minimum for acceptability. Pass

or fail will be displayed at the top of the display and an audible tone can be enabled to indicate a fail situation.

Limit testing is probably the most labor-efficient mode for operating the AT-400. Since all the software settings are retained when the tester is turned off, once the limit test is set up its simply a matter of connecting the next antenna system, turning on the power and reading pass or fail.

### **Turn Audio On/Off**

Audio tone for fail indication.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **LIMIT** key.
- Pressing the **AUDIO** key will toggle between on and off.

### **Selecting Limit Values**

Valid limit values depend on measurement units selected.  
Valid entries are:

VSWR- between 1.0 and 100.0

%Match- between 0 and 100%

Return Loss- between -32 and 0 dB

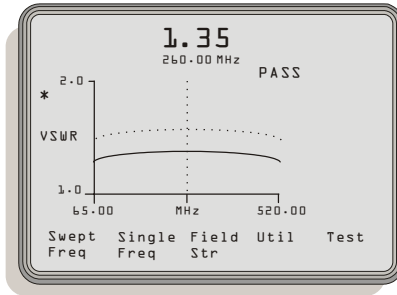
RHO- between 0.000 and 1.000

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **LIMIT** key.
- Press the **VALUE** key. The cursor will blink next to off.
- Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
- Press the **ENTER** key. Pass or Fail will be displayed, a tone will be heard for fail if audio is enabled.


## Using a Trace as the Limit

The trace you want to use for the limit must be saved. You can have the current antenna test running or start it after you set up the limit test.

Figure 11  
Dotted Outline  
of Limit Trace



- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **LIMIT** key.
- Press the **TRACE - > LIMIT** key.
- Press the **REG-n** key where the trace is stored. A dotted outline of the limit trace will be displayed with the new trace displayed over it. Pass or Fail will be displayed.

 **NOTE:** You can still move the cursor, change measurement units, frequency band and scale. The dotted outline of the limit trace will be automatically adjusted to provide a direct comparison with the antenna system under test.

### **Clearing a Limit**

Follow the steps below to clear either an operator defined limit value or a trace limit. The trace will still be stored in memory, the limit value will be erased.

- Press the **MENU** key.
- Press the **SWEPT FREQ** key.
- Press the **LIMIT** key.
- Press the **CLEAR LIMIT** key.

The value field will change to off if an operator value was being used, the dotted outline of the limit trace will be removed if a trace was being used.

### **Single Frequency**

This mode is useful for tuning antennas, particularly with the audio on. The frequency can be selected following the instructions below.

#### **Selecting the Frequency**

- Press the **MENU** key.
- Press the **SINGLE FREQ** key.
- Press the **FREQ MHZ** key. The cursor will be blinking at the frequency and Freq MHz will be highlighted.
- Enter the desired frequency using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
- Press the **ENTER** key. The measured value and the frequency will be shown at the top of the display.



## Select Measurement Units

Antenna match information can be presented using three different measurement units. Depending on your application, follow the steps below to select Rho, VSWR, %Match or Return Loss.

- Press the **MENU** key.
- Press the **SINGLE FREQ** key.
- Press the **UNITS** key.
- Press either the **RHO**, **VSWR**, **%MATCH** or **RETURN LOSS** key. The selected unit will be shown in the center of the display.
- Press the **RETURN** key to go back one menu level.

## Select Auto or Manual Scale

Selecting the scale simply sets up how the information will look on the display.

- Press the **MENU** key.
- Press the **SINGLE FREQ** key.
- Depending on desired method press either **AUTO** or **MANUAL SCALE**:

**AUTO SCALE** - the units scale changes.

**MANUAL SCALE** - the cursor will blink on the maximum scale value and Manual Scale will be highlighted.

1. Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
2. Press the **ENTER** key. The cursor will blink on the minimum scale value.
3. Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys.
4. Press the **ENTER** key.

☞ NOTE: If an out of range value is entered, the minimum (if under-range) or maximum (if over-range) value will be substituted. If a maximum value that is lower than the minimum value is entered the cursor will blink again on the minimum value, waiting for a correct entry. The actual range depends on the units selected.

☞ NOTE: Using the arrow keys will keep you in the acceptable range. If you are not sure if the larger value should be at the right or left side of the scale, press the auto scale key to see where the software puts it.

### **Turn Audio On/Off**

The pitch varies with the match condition allowing you to tune an antenna without having to look at the display.

- Press the **MENU** key.
- Press the **SINGLE FREQ** key.
- Pressing the **AUDIO** key toggles between on and off.

### Field Strength Measurement

With the field strength antenna installed, the Antenna Tester can be used to optimize the radiated signal of any transmitter from 65 to 520MHz. This is a relative measurement. The measurement sensitivity is such that a full scale deflection will occur for a field of 0.22 Volts/Meter at 400 MHz. The gain factor can be adjusted to increase the measurement sensitivity to 0.02 Volts/Meter. Sensitivity at other frequencies can be estimated by observing the return loss display with the field strength antenna installed.

### Turn Audio On/Off

The pitch varies with the field strength.

- Press the **MENU** key.
- Press the **FIELD STR** key.
- Pressing the **AUDIO** key toggles between on and off.

### Enter Gain Factor / Select Auto Gain

Increasing the gain factor increases the measurement sensitivity. Setting the gain to auto will set a gain factor so that the pointer is in the middle of the scale.

- Press the **MENU** key.
- Press the **FIELD STR** key.
- Press either:

**AUTO GAIN**- the pointer moves to the approximate middle of the scale.

**GAIN**- The cursor will blink on the gain value. Enter the desired value using the **numeric keypad** or change the value using the **UP/DOWN** arrow keys. Press the **ENTER** key.



### **Cleaning**

**CAUTION**

Harsh or abrasive detergents and some solvents can damage the display unit and information on labels.


Clean the antenna tester and the display with a soft cloth dampened with mild detergent and water only.

### **Calibration**

For best performance and accuracy, the Antenna Tester should be calibrated once every 12 months. Return the unit to an authorized Bird Service Center.

### **Charging Batteries**

Fully charged batteries will provide a minimum of 2 hours continuous operation with the backlight on. Charging time is typically 8 hours. The batteries are being charged when the Antenna Tester is connected to AC, with the AC mains adapter, or DC, with the automobile cigarette lighter adapter. The unit does not have to be on to charge the batteries.

 **NOTE:** For optimum battery life, charge the batteries only after the low battery indication is displayed.

## Operational Tests

### Power-up

There are several operational tests run at power up. The test is displayed only if any of the tests fail. The results are displayed to the right of the test as shown in Figure 12. If you would like the test screen displayed regardless of results, press any key while pressing the ON key at initial power up. If any test fails, check the troubleshooting section for possible correction. When displaying the tests as described above, a stuck key will be indicated.

Figure 12  
Power-up Self  
Test



Firmware Rev—Revision date for the firmware installed.

NVRam—		Checks for valid contents
Rom—		
EProm—		
Ram—		

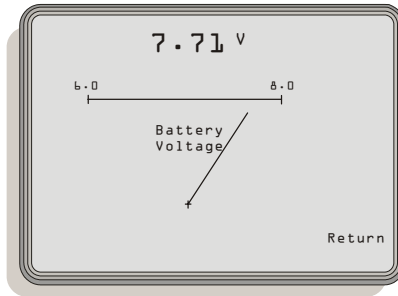
A/D—		Checks for proper circuit operation
Tempr—		
PLL—		


Stuck\_Keys—Checks if keys are depressed at power up.

## Battery Test

The battery test checks the output voltage of the batteries. The result is displayed in a simulated analog meter type graphic with the value shown at the top of the display. The scale is set from 6-8V. If the voltage measured is less than 7V you should charge the batteries.

Figure 13  
Battery Test



 NOTE: The AT-400 will shut off if the battery is too low however, full accuracy is maintained at any battery voltage.

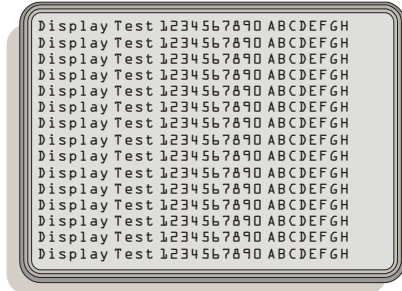
Be sure the AC mains adapter is not connected.

- Press the **MENU** key.
- Press the **TEST** key.
- Press the **BATT TEST** key.
- Press the **RETURN** key to end the test.

## Display Test

The display test is used to be sure that each area of the display is functional. When the test is started the display is filled with various characters. Each pixel then changes state, either from black to white or white to black. If there is any area that is not functional return the tester to Bird Electronic for repair.

Figure 14  
Display Test

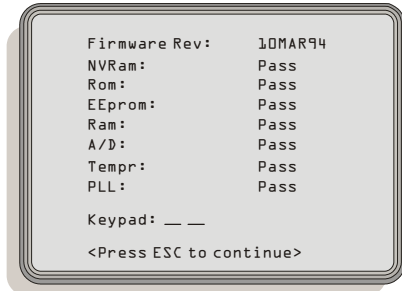


- Press the **MENU** key.
- Press the **TEST** key.
- Press the **DISP TEST** key.
- The test is started.
- Press the **ESC** key to end the test.

### Self Test

The self test is similar to the operational tests run at power up described on page 34, except for the keypad test.

Figure 15  
Self Test



- Press the **MENU** key.
- Press the **TEST** key.
- Press the **SELF TEST** key.



- To test the keypad, Press each key (except ESC and ON). The value next to Keypad is hexadecimal and corresponds to the key pressed. If the value does not change for each key, refer to Troubleshooting in this section.
- Press the **ESC** key to stop the test.


## **Battery Replacement**

The NiCad batteries need to be replaced when fully charged batteries provide less than 2 hours operation. Carefully follow the instructions below to replace the batteries.



### **CAUTION**

Replace with only NiCad rechargeable AA batteries, IEC code KR-15/51. Nominal Voltage 1.2V; Capacity 650mAh. Do not install alkaline batteries.

 **NOTE:** To retain trace data stored in nonvolatile RAM, leave the AC mains adapter connected during battery replacement.

1. Lay the Antenna Tester, display side down, on a clean surface.
2. Using a small standard screwdriver, remove six screws from the back cover.
3. Lift the back cover approximately two inches above the front cover.
4. Flip the back cover in the direction of the arrow shown below. To avoid disconnecting P2, (battery connector), lay the back cover next to the front.
5. Remove the old batteries.
6. Install the new batteries checking the orientation of the positive and negative terminals. Polarity is indicated on the case, and in Figure 16.
7. Be sure P2 is connected and the shock strips are still in place.
8. Place the back cover over the front cover making sure it is properly seated.

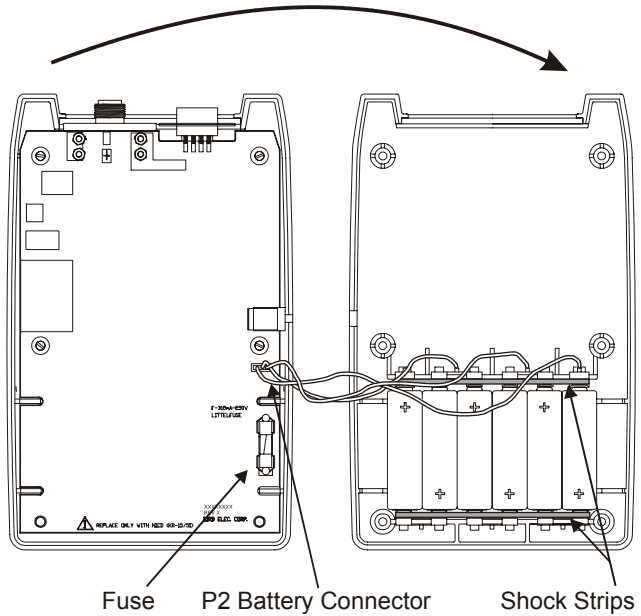
9. Replace the six screws.
10. Run the battery test on page 35 of this section.

## **Fuse Replacement**

**CAUTION**  
Replace with only the same type and rating fuse. 315mA  
250V

- Follow the steps outlined in Battery Replacement replacing the fuse where replacing the batteries is indicated.

*Figure 16 Battery / Fuse Replacement*



## **Troubleshooting**

Operator maintenance or service is limited to battery and fuse replacement. Any other required service must be performed at an authorized Bird Service Center.

Refer to the following paragraphs for help in isolating error conditions.

### **The Antenna Tester will not power up.**

Power for the Antenna Tester can be provided in three ways—the internal batteries, an AC mains adapter or an optional automobile cigarette lighter adapter. Try to power the tester using each available means. The internal batteries may need charged, or if recently replaced, are installed incorrectly. The AC mains adapter may not be securely connected, may be damaged, or there is no power supplied at the wall receptacle. The internal fuse may have opened and requires replacement.

If the unit was recently opened, recheck P2, the battery connector, be sure it is securely connected. Follow the instructions for battery and fuse replacement when opening the unit.

### **NVRAM Test Fails**

An NVRAM error indicates the information in nonvolatile RAM, a type of memory, is not valid. The probable cause is power was lost. When the unit is off, the batteries, if charged and present, or power from the AC mains adapter, if connected, supply power to retain stored trace data and software settings. This information is lost if all power is removed. Clear the error by pressing the ESC key. Be sure to read battery charging and replacement sections if the problem persists.

## **ROM, EEPROM, RAM, A/D, TEMPR, PLL Test Fails**

Ensure the results are valid by repeating the self test or turning the unit off then back on. If the problem persists return the unit for service.

## **Stuck Keys Test Fails**

If any characters other than 0 are displayed next to stuck keys during power up test, perform the keypad test on page 36 of this section. Remember, if a key is depressed during power up to display the power up test results it is normal for other characters to be displayed. If the key remains stuck return the unit for service.

## **“Noise” is Displayed During Testing**

The Antenna Tester measures background noise to determine if nearby signals could cause an erroneous match measurement. Power down all nearby transmitting antennas. All interfering signals must be removed before resuming measurement.

## **Antenna Tester indicates a Perfect Match**

When measuring the match of an antenna in a high RF environment, the Antenna Tester indicates a perfect match (i.e. VSWR = 1.00, Return Loss = -32 dB, or Match Efficiency = 100%). This is caused by the coupling of interfering signals into the Antenna-Under-Test. If sufficiently strong, the interfering signals can over-power the measurement signal inside the Antenna Tester. Normally, this results in degraded measurement accuracy. Bird Antenna Testers minimize this effect by measuring the interfering signal during the time between match measurements. The interferer magnitude is subtracted from the magnitude of the measurement signal. For relatively small interferers (i.e. interfering signal smaller than the measurement signal), this technique yields approximately 10 dB better rejection. If the interfering signal becomes larger than the measurement signal, the correction output approaches zero, corresponding

to a perfect match. Measurement results are not accurate under these circumstances. The remedy is to disable the interfering source, if possible, or postpone the measurement to a time when the interfering source is not operating.

## **Customer Service**

Any maintenance or service procedure beyond the scope of those in this chapter should be referred to a qualified service center.

If you need to return the unit for any reason, contact the Bird Service Center for a return authorization. All instruments returned must be shipped prepaid and to the attention of Bird Service Center.

### **Bird Service Center**

30303 Aurora Road  
Cleveland (Solon), Ohio 44139-2794  
Phone: (440) 519-2298  
Fax: (440) 519-2326  
E-mail: [bsc@bird-technologies.com](mailto:bsc@bird-technologies.com)

For the location of the Sales Office nearest you, give us a call or visit our Web site at:

*<http://www.bird-electronic.com>*

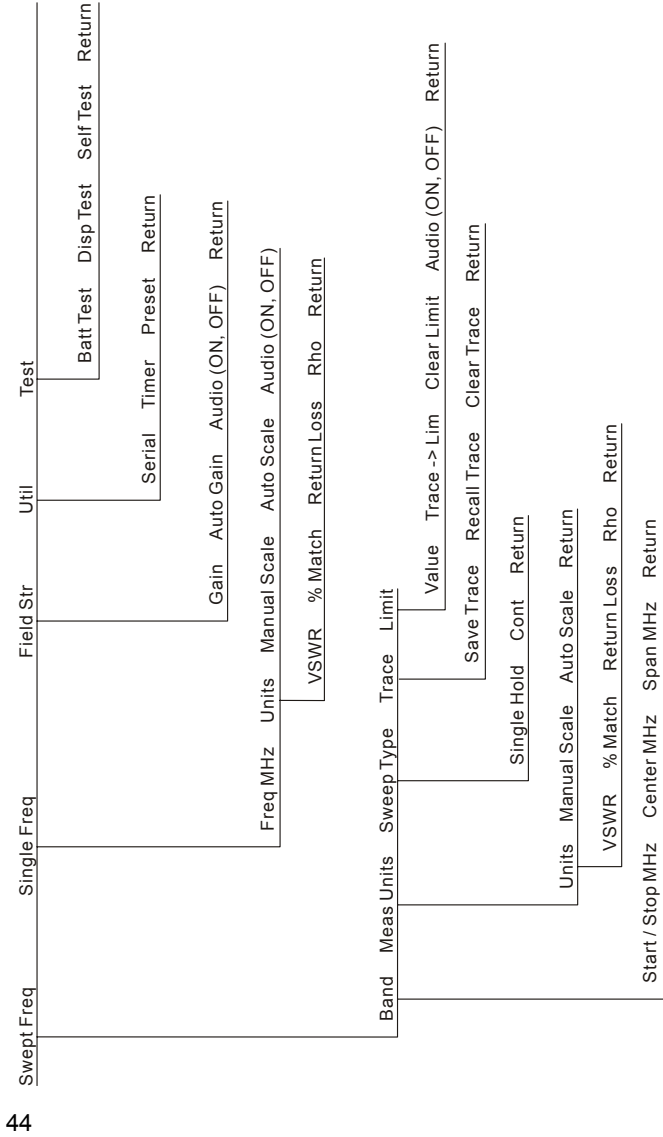
## **Parts List**

Part Name	Part Number
AT-400 Complete	7000A401
Parts Supplied with AT-400 Complete, or installed when shipped.	
Battery (6 required)	5A2230
Fuse	5-1976-11
AC Mains Adapter, 115v	5A2229
or	
AC Mains Adapter, 230v	5A2226
Female N Connector	4240-403
Field Strength Antenna	5A2228-3
Instruction Book	920-AT400
Foam Shock Strips (2)	5A2243
Optional Adapters:	
N/m	4240-402
BNC/m	4240-404
BNC/f	4240-405
TNC/m	4240-406
TNC/f	4240-407
UHF/m	4240-408
UHF/f	4240-409
SMA/m	4240-410
SMA/f	4240-411
Optional Parts or Accessories:	
Automobile Cigarette Lighter Adapter	5A2238-1
Interface Software	7000A840
Includes Cable	5A2264-9MF-10
Verification Kit	7000A445
Carrying Case	5000-030

**Specifications**

Frequency Range	65 to 520 MHz
Frequency Resolution	20 kHz
Measurement Range	
VSWR	1.00 to 100.00
Match Efficiency	0 to 100%
Return Loss	-32 to 0 dB
Rho	0.000 to 1.000
Measurement Speed	(Typical)
Single Frequency	5 Readings/second
Swept Frequency	1 Sweep/second
Test Port	
Impedance	50 $\Omega$ nominal
Connector	(Field Interchangeable) Female N
Field Strength	
Range	0 to 100% Relative
Sensitivity	Full scale deflection at 0.22 Volts/Meter at 400 MHz, depending on gain setting.
Power Requirements	
Batteries	Six Rechargeable AA (KR-15/ 51)
External DC	11 to 16 VDC 250mA
External AC Adapter	108 to 132, or 207 to 253 VAC @ 48 to 63 Hz
Interface	Serial (female DB-9 connector)
Operating Temperature	0° to 50°C (32° to 122°F)
Storage Temperature	-40° to 71°C (-40° to 160°F)
Size (including connector)	8" x 4-5/8" x 1-3/4" (204mm x 118mm x 42mm)
Weight	1-3/4 lb (0.8 kg)

## Menu Structure





## Limited Warranty

All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

If Seller's products are claimed to be defective in material or workmanship or not to conform to specifications, drawings, blueprints and/or samples, Seller shall, upon prompt notice thereof, either examine the products where they are located or issue shipping instructions for return to Seller (transportation charges prepaid by Buyer). In the event any of our products are proved to be other than as warranted, transportation costs (cheapest way) to and from Seller's plant, will be borne by Seller and reimbursement or credit will be made for amounts so expended by Buyer. Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing within ten (10) days from the date of discovery of the defect.

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. Routine (regularly required) calibration is not covered under this limited warranty. In addition, Seller's warranties do not extend to the failure of tubes, transistors, fuses and batteries, or to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to Seller.

The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu of all other remedies including claims for special or consequential damages. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR SELLER ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.