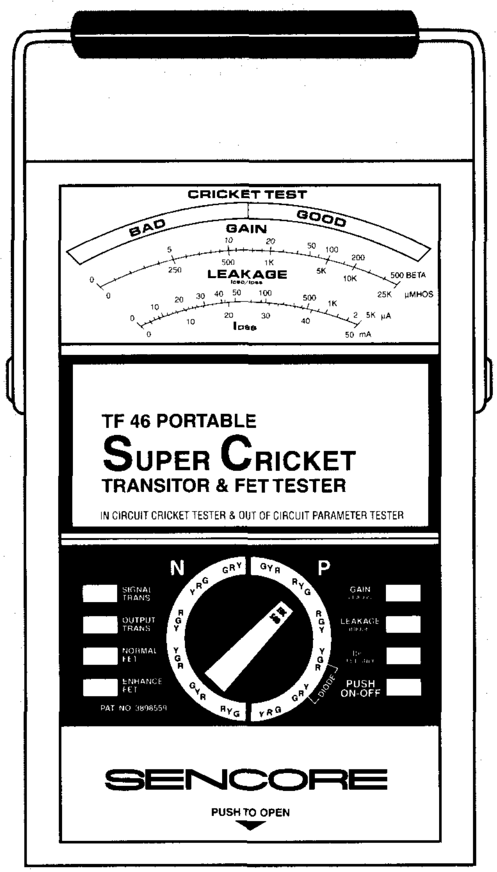
TF46

Portable
Super Cricket
Transistor/FET Tester

Operation, Application and Maintenance Manual



SENCORE

3200 Sencore Drive, Sioux Falls, SD 57107

WARNING

PLEASE OBSERVE THESE SAFETY PRECAUTIONS

There is always a danger present when testing electronic equipment. Unexpected high voltages can be present at unusual locations in defective equipment. Every precaution has been taken in the design of your instrument to insure that it is as safe as possible. However, safe operation depends on you, the operator. Become familiar with the equipment you are working with, and observe the following safety precautions:

1. Never exceed the limits of this instrument as given in the specifications section and the additional special warnings in this manual.

2. A severe shock hazard can result if the chassis of the equipment being serviced is tied to the "hot" side of the AC line. An isolation transformer should always be used with hot-chassis equipment. Also, be sure that the top of your workbench and the floor underneath it are dry and made of non-conductive materials.

3. Remove the circuit power before making connections to high voltage points. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket and stand on an insulated floor to reduce the possibility of shock.

4. Discharge filter capacitors (after removing power) before connecting to any part of the circuit requiring power to be removed.

5. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose you to dangerous voltages.

6. Remove the test lead immediately after the test has been completed to reduce the possibility of shock.

7. Do not work alone when working on hazardous circuits. Always have another person close by in case of an accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

8. Improper Fuse(s) Void Warranty. Fuses are for your protection, so always replace fuse with proper type and current rating. The proper fuse type description is marked near the fuse holder and in the manual. Always:

> **A. Be sure you are replacing the right fuse.** On units with more than one fuse, be sure you are placing the proper fuse value in the fuse holder.
>
> **B. Have the proper size replacement fuse in stock.** With each new instrument, be sure to update your fuse inventory with any special value fuses your instrument may require.

9. Explanation of symbols.

⚠ This marking indicates that the operator must refer to an explanation in the operating instructions.

⚠ A terminal at which a voltage with respect to another terminal or part exists or may be adjusted to 1,000 volts or more.

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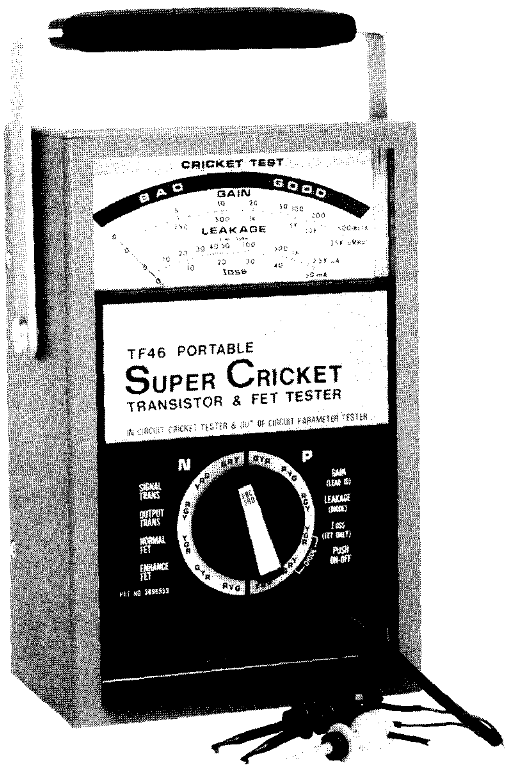

SENCORE

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TABLE OF CONTENTS

DESCRIPTION

INTRODUCTION

The transistor is one of the most common active electronic components in use today. The number of transistors used outnumbers tubes, as well as integrated circuits in most types of electronic design, including home entertainment, industrial, and maintenance equipment. A high-accuracy, easy-to-use transistor tester that allows both in- and out-of-circuit transistor testing can make any technician more efficient in troubleshooting today's solid-state circuits.

FEATURES

The TF46 Portable Super Cricket provides the Sencore patented Cricket Gain test, which allows in- or out-of-circuit Good/Bad testing of transistor gain. No basing information is required, as all possible basing combinations are tested with a rotation of the Permutator test switch. This test is backed up with the Super Cricket Parameter Test for determining the engineering parameters of transistors for matched push-pull circuits, critical gain circuits, and transistor design applications.

All six transistor leakage paths are tested for locating transistors that are just starting to go bad. A special IDSS leakage test is also available for grading FETs. In addition to these tests, the TF46 will provide complete basing information of an unknown transistor to allow a replacement transistor to be chosen when no cross-reference information is available, or to test a transistor in-circuit to be sure it is installed properly. An exclusive Auto-Off circuit saves batteries by turning the TF46 off automatically--even if the power switch is left on.

SPECIFICATIONS

Cricket Good/Bad Gain Test:

Test Method:	Detects ability of transistor to invert a square wave (Sencore patent 3,898,559)
Test Frequency:	2 kHz
Test Voltage:	V_{CE} = ±4.0 VDC V_{BE} = 7 VPP on zero reference
Test Currents:	I_C = 12 mA maximum 2-3 mA average continuous I_B = 7 mA maximum 3 mA average continuous

Bi-Polar Transistor Beta Test:

Test Method:	Dynamic Beta
Test Frequency:	2 kHz
Test Voltage:	V_{CE} = ±4.0 VDC V_{BE} = 7 VPP on zero reference
Test Currents:	I_C – (Sig Trans) 25 mA maximum I_C – (Output Trans) 150 mA maximum I_B – (Sig Trans) 50 uA maximum I_B – (Output Trans) 300 uA maximum
Beta Range:	0-500

Bi-Polar Leakage Tests:

Test Method:	Key test measures reverse collector-base leakage (ICBO). All other paths tested with rotation of permutator test switch (IEBO, IBEO, ICEO, IECO, IBCO).
Test Levels:	V_{CB} = ±3.5 VDC (emitter open)
Leakage Range:	0-2500 microamps

Field Effect Transistor Gm Test:

Test Method:	Dynamic mutual conductance
Test Frequency:	2 kHz
Test Voltage:	V_{DS} = ±4.0 VDC V_{GS} = 0 Volts
Signal Level:	.4 VPP
Gm Range:	0-25,000 micromho

FET Leakage Test (I_{GSS}):

Voltage Level:	±3.5 VDC (source open)
Leakage Range:	0-2500 microamps

Zero Bias Drain Current Test (I_{DSS}):

Voltage Level:	V_{DS}= ±4.0 VDC V_{GS} @ 0
I_{DSS} RANGE:	0-50 milliamps

General:

Test Leads:	Connected, terminated in color-coded E-Z Hook® connectors.Δ14
Batteries:	Six alkaline, carbon zinc, or rechargeable "AA"
Power Consumption:	11 mA, current at idle, 120 mA maximum.
Meter:	4½", 100 uA, 5%, mechanical shock protected.
Size:	10" x 5½" x 3½" (25.4 cm x 13.8 cm x 8.9 cm) HWD
Weight:	4½ lbs. with batteries (2.0 Kg)
Optional Accessories:	39G85 Touch-Test Probe

(Specifications subject to change without notice.)

CONTROLS

1. **Handle/Tilt Bail** with slip-proof cushion allows unit to be easily carried or used as a tilt stand on a service bench.
2. **Good/Bad** meter scale used for Cricket Gain test and battery check.
3. **Gain** meter scales give direct readout of transistor Beta or FET transconductance.
4. **Leakage** meter scales for all leakage tests, including FET I_{DSS},
5. **Polarity Indicators** for determining the polarity of an unknown transistor or FET.
6. **Color Indicators** for determining the basing of a transistor by relating the colors of the test leads to the transistor elements.
7. **Basing Indicators** provide full basing information of an unknown transistor.

<u>Test Selector Switches:</u>

8. **Gain (Lead ID)** button used for parameter tests and lead ID testing.
9. **Leakage (Diode)** test button used for inter-element leakage testing and diode testing.
10. **I_{DSS}** leakage test button for industrial culling of FETs.
11. **Permutator Test Switch** tests all possible basing configurations when rotated through all positions.
12. **Power Switch** controls unit, and resets Auto-Off.
13. **Lead Storage Compartment.**

<u>Parameter Gain Test Switches:</u>

14. **Enhancement FET** selector for reading the transconductance of a positive-biased FET.
15. **Normal FET** selector button for measuring the transconductance of a normally biased FET.
16. **Output Transistor** selector button for measuring the Beta of a power transistor using the parameter gain test.
17. **Signal Transistor** selector button for measuring the Beta of a small signal or RF transistor using the parameter gain test.
18. **Sliding Meter Cover** protects meter during transportation.
19. **Battery Test Switch** (inside lead compartment) reads battery condition on Good/Bad meter scale.
20. **Speaker Switch** allows speaker to be turned off when meter only testing is desired.
21. **Battery Compartment** (rear panel) for 6 "AA" batteries for portable operation.
22. **Meter Zero** (rear panel) for setting mechanical meter zero.

<u>Optional Accessory:</u>

23. **39G85 Touch Test Probe** (optional) allows in-circuit transistor testing from foil side of printed circuit board.

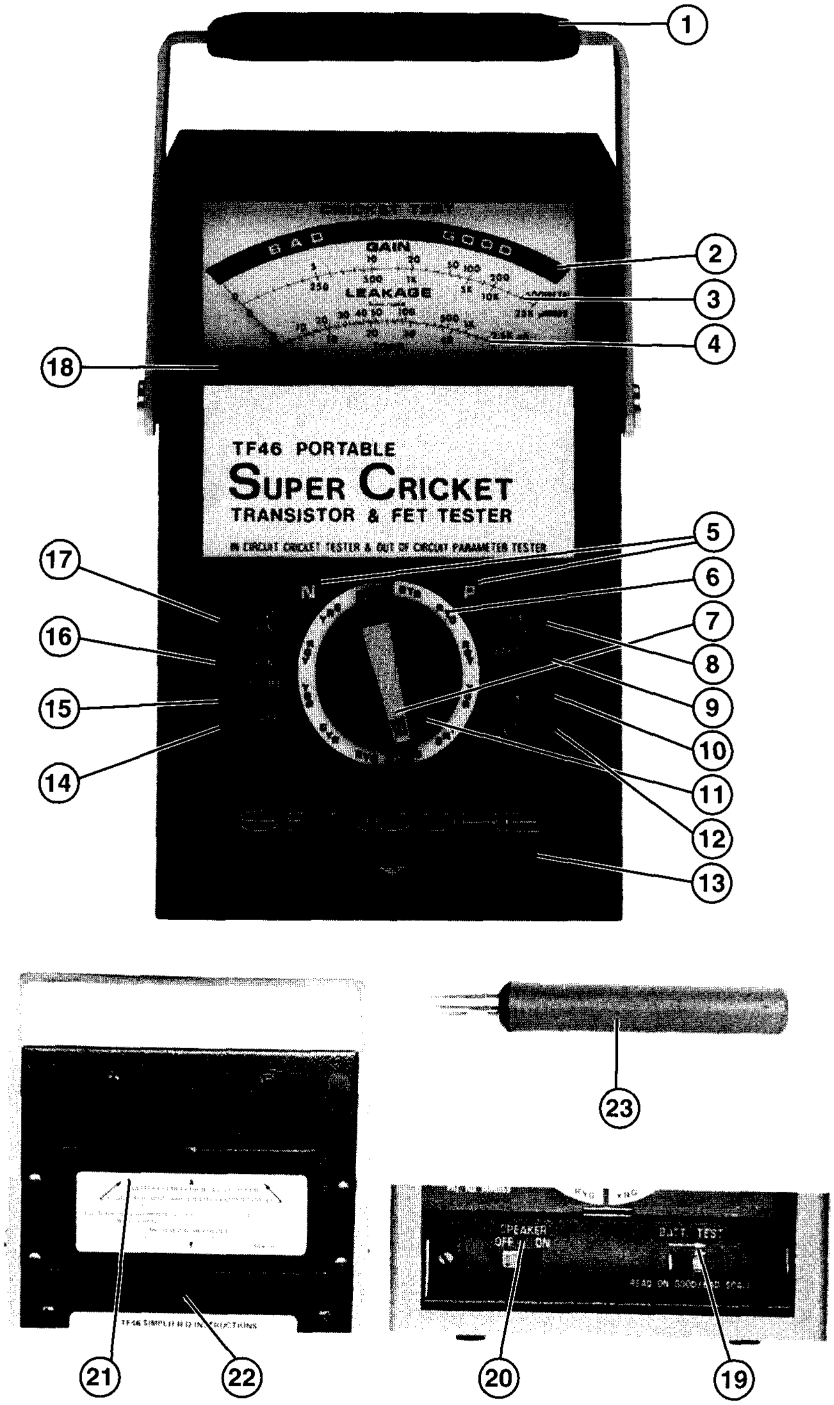


Fig. 1: Controls and Features of TF46 Portable Super Cricket.

OPERATION

INTRODUCTION

The following instructions explain the use of the TF46 in various types of applications. Each section gives details of how a test is to be performed. At the beginning of each test is a simplified front-panel drawing showing the control setup and which meter scale to read. If a control is required for the test, it is marked on the drawing. If a control is not needed, the label is not shown, and it may be left in any position without changing the test results. Several tests refer to Applications Tips. These tips are located on the last pages of the manual. These tips provide information on special testing applications that may be encountered in using the TF46. Once the operations of the TF46 are understood, the Applications Tips may be used for answering questions during routine testing.

BATTERY INSTALLATION/ REPLACEMENT

The TF46 requires 6 "AA" cells for operation. Standard alkaline, carbon-zinc, or rechargable Nickel-Cadmium cells may be used.

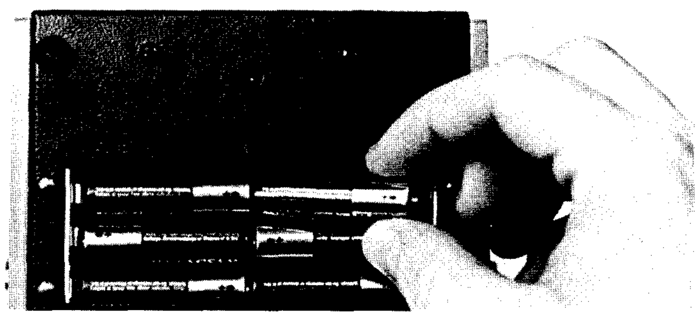


Fig. 2: Installing batteries

To install or replace batteries:
1. Remove the screw at the top of the battery compartment cover on the rear of the TF46.
2. Install 6 "AA" cells, observing proper polarity as marked in the battery compartment and as shown in Fig. 2.
3. Replace the battery compartment cover and replace the cover screw.

BATTERY TEST

The condition of the batteries may be easily tested by using the test switch in the lead storage compartment. The condition of the batteries will be read on the "Good/Bad" scale of the meter.

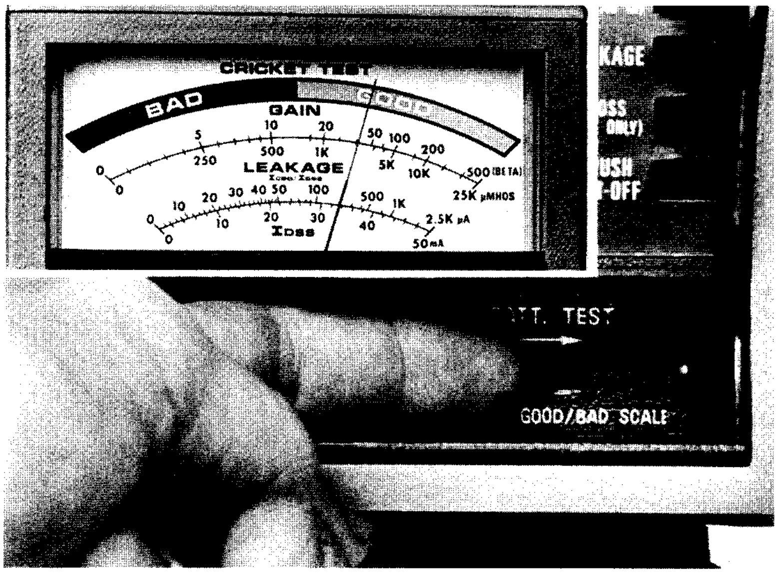


Fig. 3: Operating battery test switch.

To test battery condition:
1. Turn the TF46 on.
2. Slide the right-hand switch in the lead storage compartment to the right. (See Fig. 3.)
3. Read the condition of the batteries on the "Good/Bad" meter scale.
4. If the battery test reads in the red "bad" portion of the scale, the batteries should be replaced or recharged.

AUTO-OFF CIRCUIT

The TF46 contains a battery-saving Auto-Off circuit. This circuit will automatically turn the TF46 off after 15 minutes of operation.

To reset the Auto-Off circuit:
1. Turn the PUSH ON-OFF switch off.
2. Turn the PUSH ON-OFF switch ON again.The TF46 will now operate for an additional 15 minutes.

METER ZEROING

Proper calibration of your TF46 requires that the meter movement be properly zeroed. An adjustment screw is provided through an access hole in the rear of the unit. To adjust the mechanical meter zero:

1. Turn the TF46 off.
2. Check that the meter is reading zero.
3. If the meter is not zeroed, use a narrow blade-type screw-driver to adjust the meter zero adjustment through the hole in the rear of the case. (See Fig. 4.)

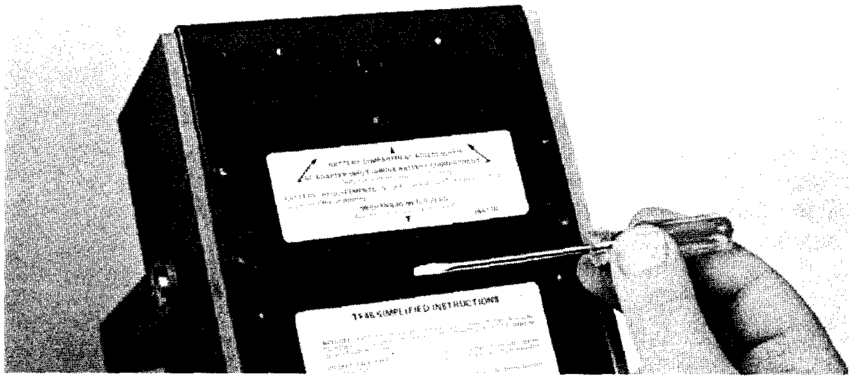


Fig. 4: Adjusting Mechanical Meter Zero.

LEAD CONNECTIONS

WARNING: Be sure power to the transistor to be tested has been removed and filter capacitors are discharged before connecting test leads.

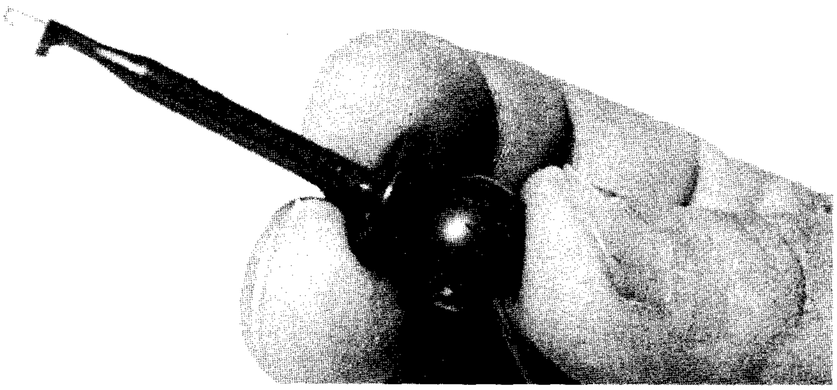


Fig. 5: Opening E-Z Hook® Connector.

The patented Cricket Gain Test used with the TF46 rotary PERMUTATOR SWITCH allows the three test leads to be connected in any order to the device to be tested. The three E-Z Hook® connectors are color-coded for lead identification testing and may be used with the optional 39G85 Touch-Test Probe for in-circuit board testing from the foil side of a printed circuit board.

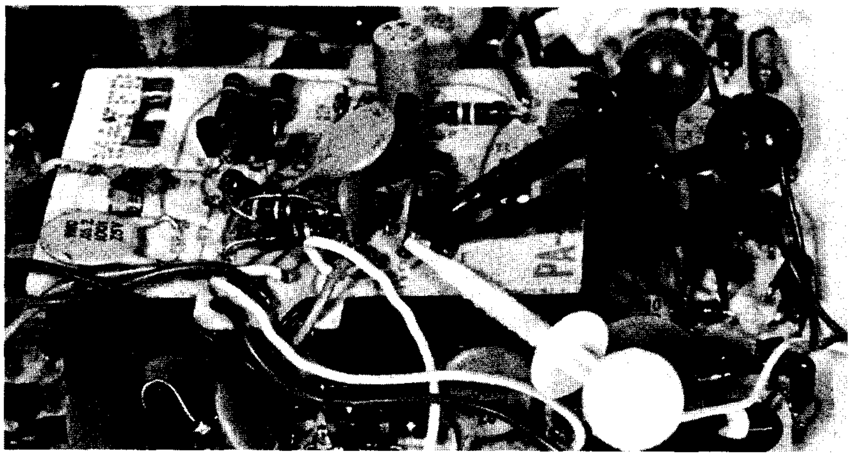


Fig. 6: Connections for Testing Transistor In-Circuit.

The small size of the E-Z Hook® connectors allows them to be connected to most transistor leads, even though only a small amount of a lead is exposed.

To connect the test leads to the transistor:

1. To open the connector:
   a. Grasp connector with the first and second fingers resting on the plastic collar. (See Fig. 5.)
   b. Place the thumb of the same hand at the rear of the ball.
   c. Pull back with the two fingers on the collar to expose the contact.
2. Connect each of the E-Z Hooks® to a lead of the transistor to be tested in- or out-of-circuit. In the case of small transistors with close leg spacing, use care to prevent shorting of the leads. (See Fig. 6.)
3. Perform the desired tests.

39G85 TOUCH TEST PROBE (Optional)

The optional Sencore 39G85 Touch Test Probe may be used with the TF46 for fast in-circuit testing from the foil side of a circuit board. At the rear of the probe are three recessed terminals which are color coded to the sleeves over the contact needles (R-Red, G-Green, Y-Yellow).

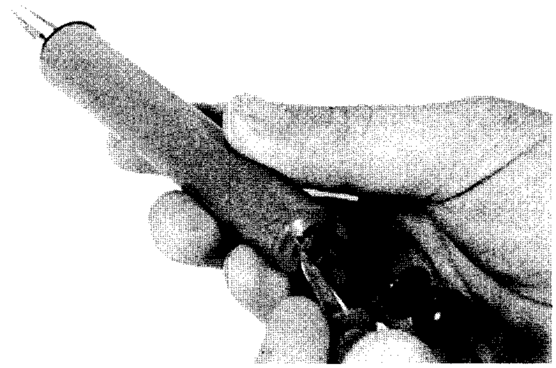


Fig. 7: Making Connections to 39G85 Touch Test Probe.

To use the 39G85:

1. Connect each E-Z Hook® test lead from the TF46 to the matched color terminal in the 39G85. (See Fig. 7.)
2. Touch each of the contact needles to the transistor terminals in any order. Be sure the sharp needle points penetrate any solder flux or coating on the board for positive electrical contact.
3. Make the in-circuit Cricket Gain test as explained under "Test Procedures."

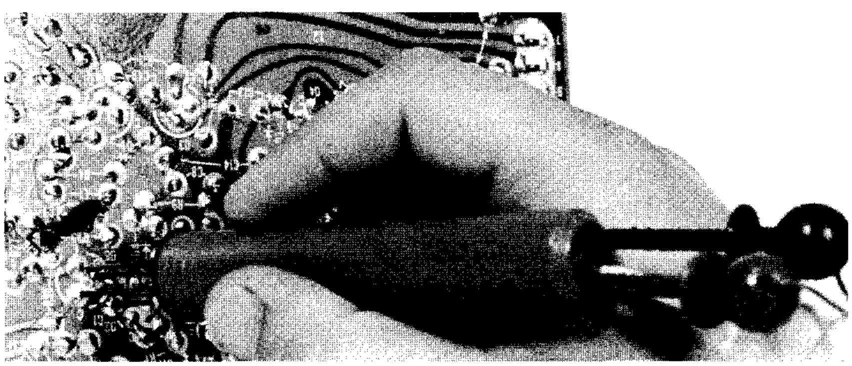


Fig. 8: Using the 39G85 Touch Test Probe.

TEST PROCEDURES

IN- OR OUT-OF-CIRCUIT CRICKET GAIN TEST

WARNING: Be sure power to the transistor has been removed and filter capacitors discharged before connecting the test leads.

The Cricket Gain test provides a safe and reliable method of determining if a transistor has gain. The Cricket Gain test is a "Go/No-Go" test providing a test tone and meter indication that indicates gain is present. No technical information is needed for testing for transistor gain. The same procedure is used for testing a transistor or FET in- or out-of-circuit.

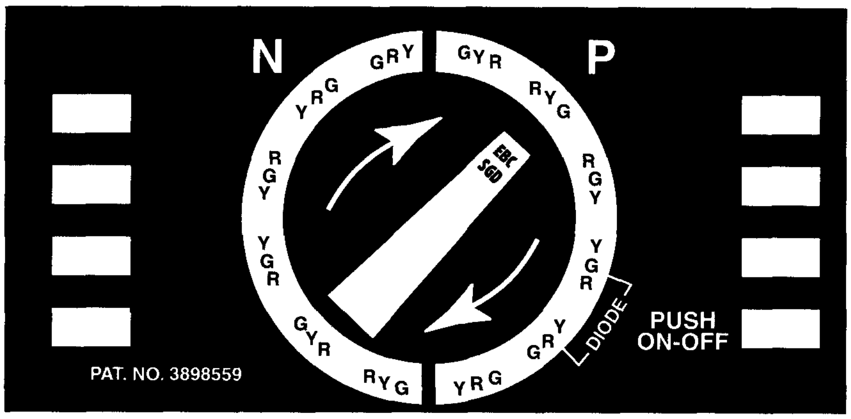


Fig. 9: Control Setup for Cricket Gain Test.

To test for transistor gain:

1. Connect the three test leads to the three leads of the transistor in any order.
2. Make sure the TF46 is turned on. Reset the Auto-Off circuit (if necessary) by pushing the PUSH ON switch off and then on if the Auto-Off circuit has cycled.
3. Any of the PARAMETER SELECTOR buttons (to the left of the

PERMUTATOR SWITCH) may be depressed, or all may be in the "out" position as they have no effect on the test.

4. Rotate the PERMUTATOR SWITCH one complete turn while watching the meter and/or listening for the test tone.
5. If the transistor has gain, the meter will read in the "good" portion of the GAIN scale in either one or two PERMUTATOR SWITCH positions. At the same time, a test tone will sound from the TF46 (if the speaker switch in the lead storage compartment is in the "on" position). A transistor may test good in either one or two positions of the PERMUTATOR Switch. (See Applications Tips 11 and 12 for details.)
6. If the transistor tests "bad" in-circuit, check the schematic of the transistor being tested to see if there is a low-impedance shunt path around the transistor (between any two elements). Generally, the TF46 will be able to check in-circuit leakage paths as low as 50 ohms (or lower, depending on the transistor's gain) or capacitive leakage up to 15uF. It is recommended that transistors that check "bad" in-circuit be removed from the circuit and tested again to eliminate the possibility of external loading. If the transistor now checks "good," perform the out-of-circuit leakage check. In the case where a transistor checks "bad" in-circuit, and "good" out-of-circuit (including leakage), there is probably something wrong in the circuit. Check for:
    1. Shorted PC foils, or
    2. Shorted components in the associated circuit.

See Applications Tip 10 for additional details.

OUT-OF-CIRCUIT LEAKAGE TESTS

Leakage in a transistor or FET can shunt signals or change bias voltages and upset circuit operation even though the transistor has gain. This is true in high frequency (such as RF or IF) or direct-coupled stages. Transistor leakage should be checked whenever circuit troubleshooting indicates improper bias voltages even though the transistor has gain. There are six possible leakage paths in a transistor (see Fig. 12.) Collector/base (Icbo) and emitter/base (Iebo) leakage are the two "key leakage" paths that most often upset circuit operation. In an FET, Gate Leakage (Igss) is the "key leakage." The TF46 will read all six paths by rotating the PERMUTATOR SWITCH through all six positions indicated for the polarity of the device under test.

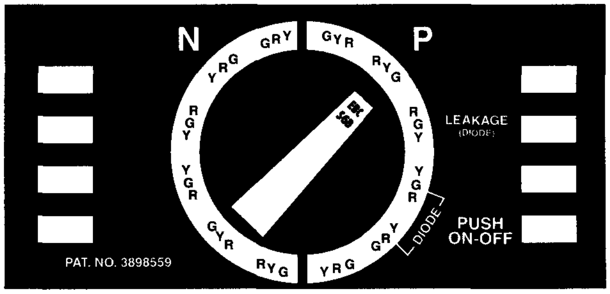


Fig. 10: Control Setup for Leakage Test.

KEY LEAKAGE TESTS

Leakage tests should be done out-of-circuit, since the associated components of the circuit may cause false leakage readings.

To test for Key Leakage:

1. Perform the Cricket Gain test as described previously. Note the two positions that indicate "good" gain on this test.

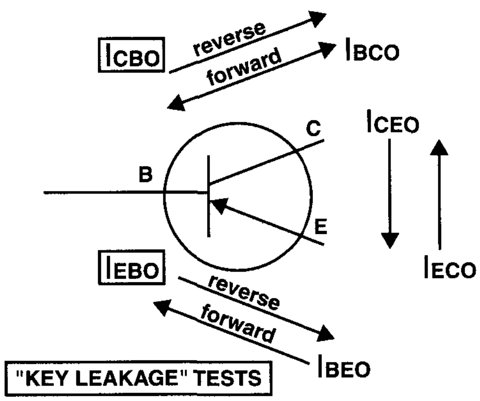


Fig. 11: Leakage Paths for a PNP Transistor.

2. Depress the LEAKAGE push button with the PERMUTATOR SWITCH in either of the Cricket Gain positions and read the leakage on the lower (Icbo/Igss) scale of the meter.
3. Switch the PERMUTATOR SWITCH to the other position that gave the Cricket Gain test. Again depress the leakage button and read the leakage on the meter. Refer to Table 1 for typical leakage limits.
4. To determine which test is for Icbo, perform the LEAD ID test. The position used for the final step of the LEAD ID test is reading Icbo,

and the other position is reading Iebo.

TABLE 1 MAXIMUM LEAKAGE FOR "GOOD" TRANSISTORS	
DEVICE	KEY LEAKAGE
Small Si. Trans.	0.1 uA
Large Si, Small Ge. Trans.	1-50 uA
Large Ge. Trans.	10-2500 uA
JFET	0 uA
MOSFET	0 uA

See Applications Tip 1 for information on when to use the Key Leakage Test.

EXTENDED LEAKAGE TESTS

Some power output transistors can develop emitter/collector leakage. The TF46 will check for this leakage with the Extended Leakage Test. The Extended Leakage Test is not required for FETs.

To perform the Extended Leakage Test:

1. Perform the KEY LEAKAGE TEST described above. You will note that there are still four untested positions on the PERMUTATOR SWITCH for the SAME POLARITY TRANSISTOR.
2. Rotate the PERMUTATOR SWITCH through these remaining four positions, and note the leakage at each position by depressing the LEAKAGE button. If you are testing a bipolar transistor, you should see two of the positions give high (usually full scale) leakage. These are the forward leakage currents, Ibco, and Ibeo. The other two positions should read lower leakage. The two leakage paths tested in these last positions are Iceo and Ieco.

A junction FET will give high leakage in all four remaining switch positions since the channel of the FET is, for all practical purposes, a low-value resistor.

See Applications Tip 2 for information on when to use the Extended Leakage Test.

LOCATING LEAKAGE

If it is desired to find out which transistor junction is showing high leakage, the following procedure may be used:

1. Locate the basing of the transistor using a reference book or by performing the “Lead ID Test."
2. Connect the test leads of the TF46 in the following order:

a. Green lead to Emitter.
b. Yellow lead to Base.
c. Red lead to Collector.

3. Repeat the Leakage Test to locate the high leakage position you wish to verify.
4. Refer to Fig. 12 to determine the leakage path read by each switch position.

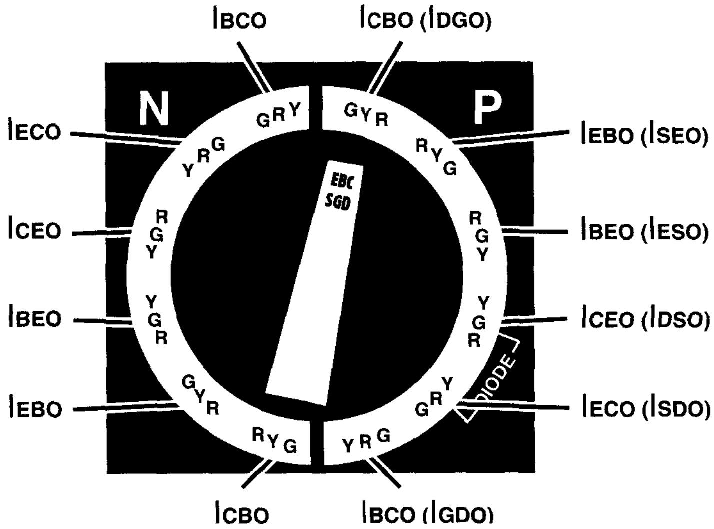


Fig. 12: Leakage path checked at each position of permutator switch when green lead is connected to emitter, yellow to base, red to collector of a PNP transistor.

OUT-OF-CIRCUIT PARAMETER TEST

The parameter test allows measurement of the actual transistor gain for matching or grading transistors and FETs. The Cricket Gain Test is used to determine if the transistor has any gain and shows which PERMUTATOR SWITCH positions provide the proper basing connections.

To measure transistor parameters:

1. Perform the Cricket Gain Test as described previously. Note the two positions that indicate "good" gain on this test.
2. Select the type of transistor under test -- signal transistor, power transistor, normal FET or enhancement FET. Generally, the correct transistor type can be selected by merely looking at the size of the device under test and checking the type of circuit in which it is used. If the type of transistor cannot be determined, refer to the

"Identifying Transistor Types" section below.

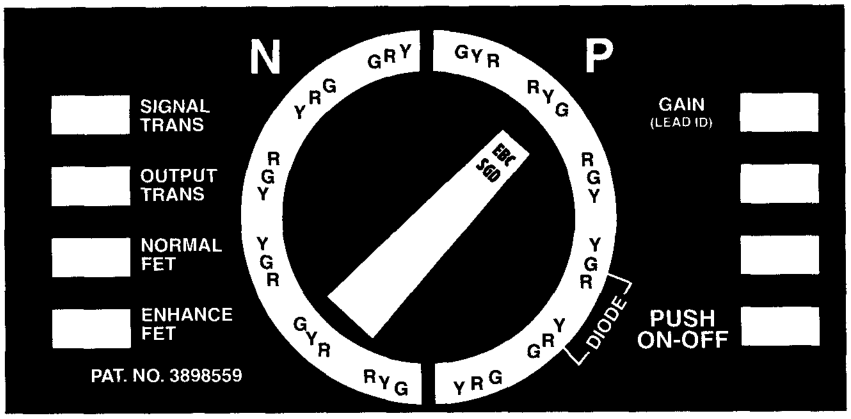


Fig. 13: Control setup for Out-of-Circuit Parameter Tests.

3. If the transistor is being tested as a normal Bipolar Junction Transistor (BJT):
   a. Depress the SIGNAL or OUTPUT TRANS button as indicated by the size of the transistor.
   b. Set the PERMUTATOR switch to one of the two positions that indicated good Cricket Gain.
   c. Depress the GAIN button and note the reading on the "Beta" Gain scale of the meter.
   d. Repeat the above test in the other position of the PERMUTATOR switch that indicated good Cricket Gain.
   e. Use the higher of the two readings as the transistor's gain.
4. If the transistor is being tested as an FET:
   a. Depress the NORMAL FET button.
   b. Set the PERMUTATOR switch to either of the two positions that indicated good Cricket Gain.
   c. Depress the GAIN button and note the amount of gain on the Gm Gain meter scale.
   d. It is not necessary to repeat the test in the second position of the PERMUTATOR switch when testing FETs.

See Applications Tips 14 and 15 for information on when to use the Parameter Tests.

DETERMINING TRANSISTOR TYPES

If the type of transistor under test cannot be determined using other methods, the following procedure should be used:

1. Perform the "Out of Circuit Parameter Gain" test listed above test-

ing the transistor as a Normal FET.

2. If no gain reading (or a very low gain reading) is obtained at the conclusion of the test, the transistor should be tested as a "signal" transistor.
3. If a gain reading is obtained, repeat the test in the second position of the PERMUTATOR switch that gave a good Cricket Gain reading.
   a. If the two gain readings are the same, the device is an FET.
   b. If the two gain readings are different, the device is a germanium transistor and should be re-tested as a "Signal" transistor.

DETERMINING TRANSISTOR BASING
(LEAD IDENTIFICATION)

The TF46 will completely identify the type, polarity, and basing information of a transistor.

Example: Transistor shown as a PNP with red lead connected to Emitter, yellow to Base, and green to Collector.

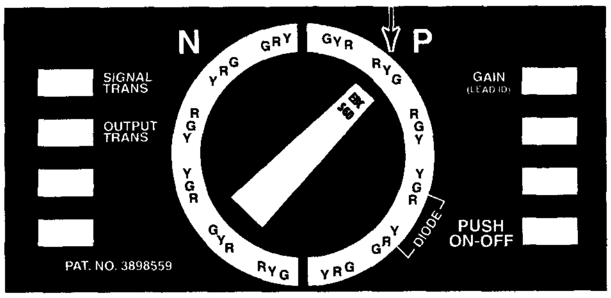


Fig. 14: Identifying Basing from Permutator Switch.

To determine transistor basing:

1. Perform the Cricket Gain test described previously. The polarity of the transistor or FET is indicated by the position of the PERMUTATOR SWITCH at the conclusion of this test. If the pointer of the switch is to the right of center, the transistor is a PNP or P-Channel FET. If the pointer is to the left of center, the transistor is an NPN or N-Channel FET.
2. Perform the Out-Of-Circuit Parameter Test. The basing of the transistor is indicated by the position of the PERMUTATOR SWITCH at the conclusion of this test.
   a. If the transistor is a Bipolar Junction Transistor (normal transistor), the three elements of the transistor are listed on the switch pointer, and the corresponding colors of the test leads are shown on the outside ring. (See Fig. 14.)
   b. If the transistor is an FET, the Gate lead is indicated by the cen-

ter color code on the outside ring. Since the Source and Drain of an FET are interchangeable in operation, the basing test will not determine these elements.

See Applications Tip 13 for information on when to use Lead ID.

DIODE TESTING

The TF46 checks the front-to-back current leakage of a diode. Since the resulting readings are given in microamps, the results may be compared to a spec sheet to determine if the diode is within specs. The test will also determine the polarity of an unknown diode. The test should be done out-of-circuit since current paths through external components in a circuit may cause false leakage readings.

To test a diode:

1. Connect the RED and GREEN test leads to the diode leads in either order.

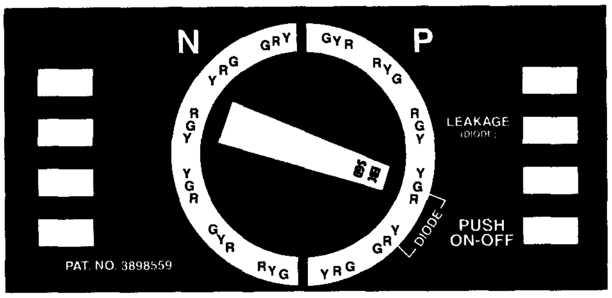
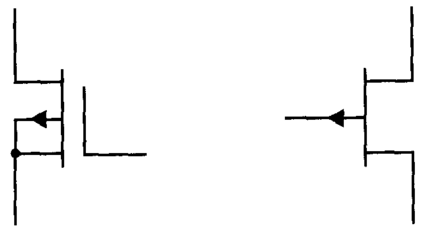


Fig. 15: Control Setup for Diode Test.

2. Move the PERMUTATOR SWITCH to either of the two positions marked "diode."
3. Press the LEAKAGE (DIODE) switch and note the amount of leakage current on the "leakage" scale of the meter.
4. Repeat Step 3 in the other position of the PERMUTATOR SWITCH marked "diode."
   a. A good diode will show one high and one low leakage reading.
   b. A shorted diode will show high leakage in both positions.
   c. An open diode will show no leakage in either position.
5. To determine the polarity of the diode under test:
   a. If the highest reading was obtained in the "YGR" position, the cathode is connected to the RED lead.
   b. If the highest reading was obtained in the "YRG" position, the cathode is connected to the GREEN lead.

SPECIAL FET TESTS

Enhancement FETs may be tested for gain using the special ENHANCEMENT FET test. These special FETs are indicated on a schematic by the following symbol:



Enhancement FET   Normal FET

Fig. 16: Schematic Symbol for Enhancement FET.

If the FET has a fourth "Substrate" lead, this lead should be connected to the Gate lead before performing the Out-of-Circuit Parameter Gain test. When testing out-of-circuit, use care in handling these insulated gate devices. See Applications Tip 7 for details on handling MOSFETs. Dual-Gate FETs may be tested by testing each gate separately. Since a dual-gate FET has four leads, it is necessary to know the basing information before hook-up. Refer to the schematic of the circuit associated with the transistor or refer to cross-reference information for basing information.

To test a dual-gate FET:

1. Connect Gate 1 to the Source lead. Connect the TF46 to the G2, D, and G1/S leads and test as a normal FET.
2. Connect Gate 2 to the Drain lead. Disconnect the previous connection to Gate 1. Connect the TF46 to the G1, S, and G2/D leads and test as a normal FET. IDSS tests are used for industrial grading or matching of FETs for critical circuits.

To check for IDSS:

1. Perform the Key Leakage test described previously.
2. Depress the IDSS button and read the leakage on the IDSS scale of the meter.

PROTECTION FOR TRANSISTORS UNDER TEST

The test currents of the TF46 tests have been chosen to provide the best balance between high testing accuracy, and protection for the device under test. The parameter tests have additional protection circuits which prevent the application of bias signals if the PERMUTA-

TOR SWITCH is not in one of the positions that produced the Cricket Gain test. This means that the TF46 is completely safe for testing any transistor or FET without the possibility of damaging the transistor under test.

TESTING SCRS

Although the TF46 is not specifically designed to test silicon controlled rectifiers (SCRs) it will test many types. The SCR specification that determines whether or not it can be tested is the gate trigger voltage or current.

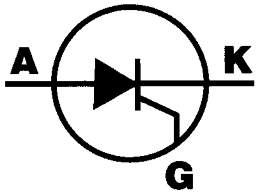


Fig. 17: Schematic symbol for an SCR.

Two tests are available for SCR testing -- "gain" (switching action) and leakage.

To test for SCR switching action:

1. Connect the three leads of the TF46 to the SCR as if it were a transistor.
2. Perform the Cricket Gain test.
3. An SCR that is being triggered by the TF46 and switching properly will show one position as a good PNP transistor, and one as a good NPN transistor.
4. If no good readings are obtained, use a comparison test by testing a replacement SCR of the same type. If the replacement SCR tests properly, use the results of Step 3 as the test results.
5. If the replacement SCR does not test, the trigger characteristics are beyond the test signal levels supplied by the TF46. Proceed with the SCR leakage test.

Testing for SCR leakage:

1. Connect the RED and GREEN leads of the TF46 to the anode and cathode leads of the SCR under test.
2. Perform the Diode Test.
3. If the SCR is shorted, both positions of the test will show high leakage.
4. If the SCR is not leaky, NEITHER position will show high leakage.
5. An open SCR will not be detected unless it is one that can be tested using the Cricket Gain test.

CIRCUIT DESCRIPTION

THEORY OF OPERATION

The reliability of the Cricket Gain test depends on two important facts about transistors:

1. Over 90% of all transistor failures result in a no-gain condition.
2. Any active gain component (including transistors) will invert a signal applied at its input. Since virtually no combination of passive components will duplicate this action, an inversion check will not give false gain indications.

BLOCK DIAGRAM AND FUNCTIONAL DESCRIPTION

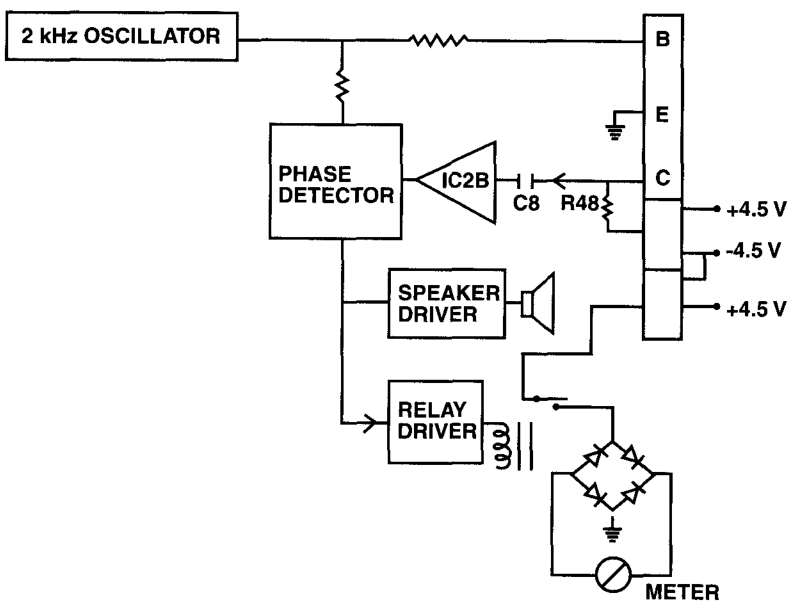


Fig. 18: Block Diagram for Cricket Gain Test.

CRICKET GAIN TEST

There are three main sections to the Cricket Gain test. These sections are: 1) the test oscillator, 2) the permutator test switch, and 3) the logic phase detector. The PERMUTATOR TEST SWITCH applies both input signal and transistor bias to the transistor under test in all possible combinations of lead connections and polarities. The transistor polarity test is provided by reversing the bias. The PERMUTATOR TEST SWITCH also feeds the output of the transistor to the phase detector. If the phase of the returning signal is 180° from that of the test oscillator, the phase detector feeds a signal to the speaker and relay drivers.

Details of the phase detector are shown in Fig. 19. The signal from the test oscillator is fed to the base of the TR9. The second transistor, TR8, however, is normally biased on by the negative voltage at its base, shorting the output of TR9. An in-phase signal (coming from a shorted transistor) will cause the bias to increase, which causes TR8 to remain on. If the signal at the base of the TR8 is out-of-phase, however, TR8 will turn off during the positive portion of the returning signal, allowing the signal at the output of TR9 to pass to the speaker driver and the relay driver.

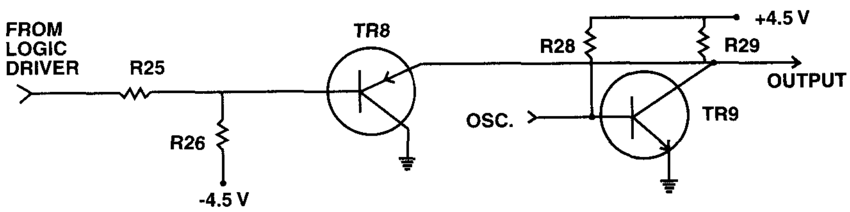


Fig. 19: Details of Phase Detector Circuit.

The relay is used to prevent bias voltages from being applied to the transistor during a parameter test if the PERMUTATOR SWITCH is not in a correct test position. The output of the relay also feeds the meter during the Cricket Gain test to provide a visual indication of a good transistor.

If the GAIN switch is pressed with either the SIGNAL or OUTPUT TRANSISTOR TYPE buttons selected, bias is applied to the emitter through the relay contacts. A signal is applied to the transistor base through one of the two precision resistors, R43 or R44. The output signal is fed through one of the collector load resistors, R45 or R46. The voltage across the selected collector load resistor is measured with the meter circuit made of IC2C and IC2D and fed through the meter bridge to the meter, which is calibrated to read the gain as Beta.

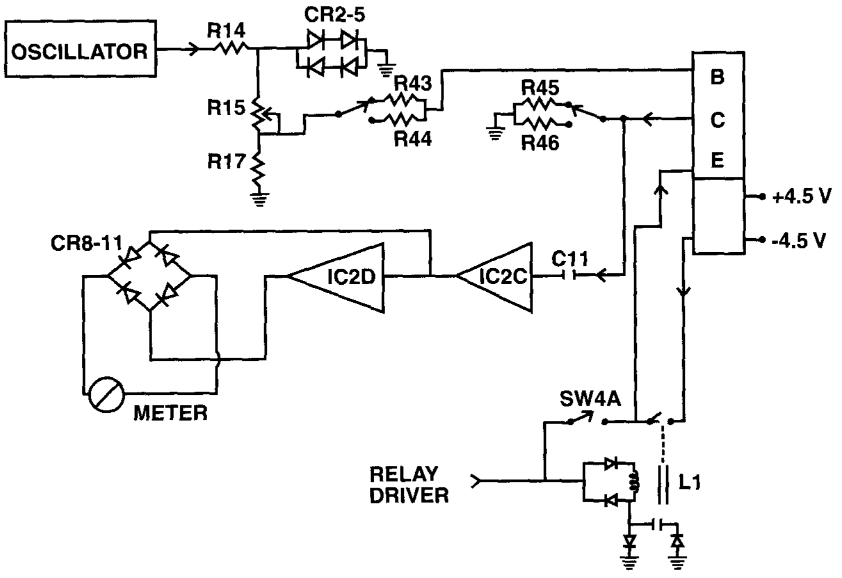


Fig. 20: Beta Test Circuit.

FET Gm Test

FET gain is determined by feeding the test signal through the voltage divider made up of R15 and R18. The signal is fed through C6 and R19 to limit the current to prevent possible gate damage. The output is fed across R45, the source load resistor. The voltage across this resistor is then measured by the meter driver circuit. The meter is calibrated to read the micromhos of gain represented by the current passing through the load resistor.

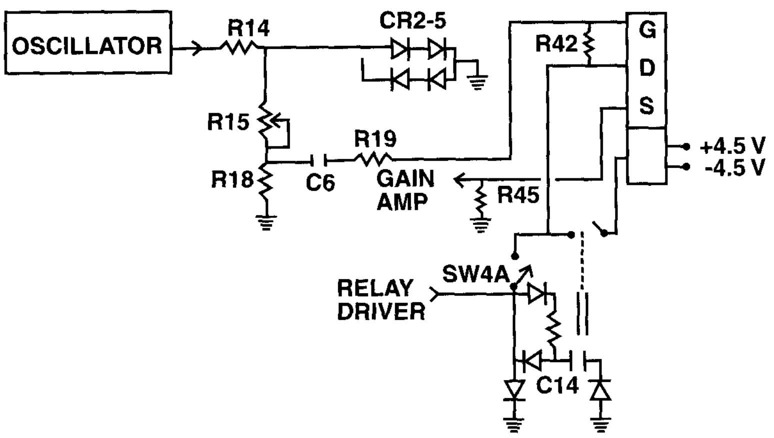


Fig. 21: FET Gm Gain Test.

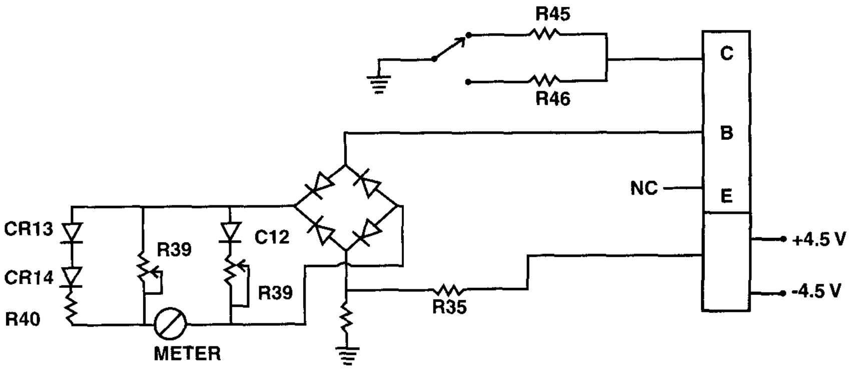


Fig. 22: Leakage Test Circuit.

The PERMUTATOR SWITCH applies + or - 4.5 VDC through the meter bridge. The current scale of the meter is compressed by diodes CR13-15. The current is then fed to the base lead of the transistor under test. After passing through the transistor, the current passes through one of the collector load resistors to ground. The meter is calibrated to read the current passing through this junction.

IDSS LEAKAGE

The test voltages are fed through the relay contacts to prevent possible damage if the PERMUTATOR SWITCH is not in the proper position. The IDSS meter bridge measures the amount of current passing through R49.

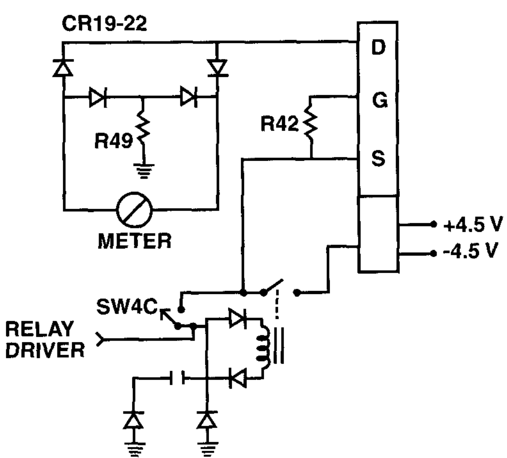


Fig. 23: IDSS Leakage Test Circuit.

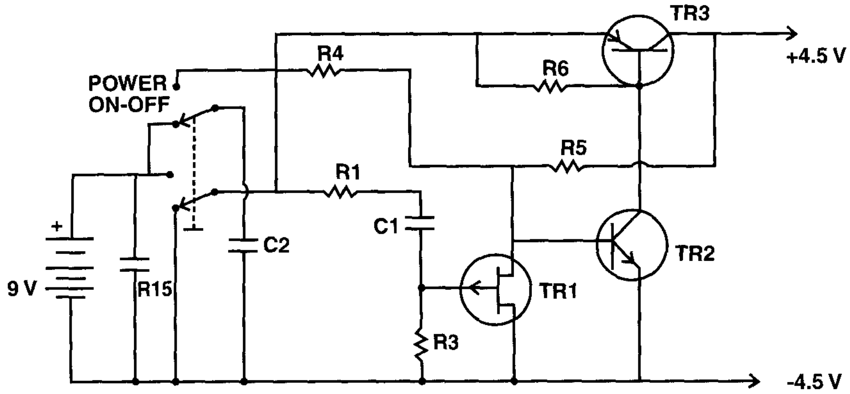


Fig. 24: Auto-Off Circuit

The power is controlled by TR1, 2, and 3. When the PUSH ON-OFF switch is "off", C2 is charged to battery potential, and C1 is discharged through R2. When the switch is turned on, power is applied to the emitter of TR3. TR3 will not conduct, however, unless TR2 is conducting. The charge stored in C2 is applied to the base of TR2, which momentarily turns it on, which in turn causes TR3 to conduct. Voltage from the output of TR3 is now fed through R5, causing TR2 to remain on. At the same time, C2 begins to charge through the 22 Meg resistor. When C2 is fully charged, TR1 conducts, shorting the base signal of TR2, causing it to turn off. This removes the base current path for TR3, which causes it to turn off, which removes power to the TF46.

SUPPLY SPLITTER

The TF46 requires a positive and negative 4.5 volts from the 9 volt supply. IC2A, TR5 and TR6 form a supply splitter, which produces a reference ground point, which is always half the battery voltage.

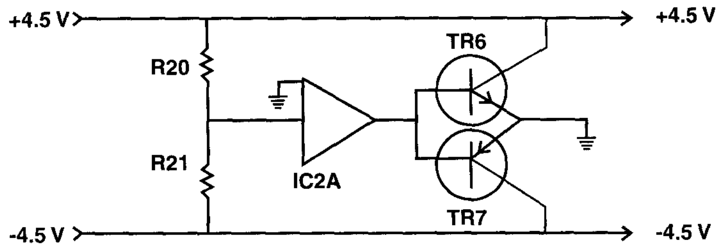


Fig. 25: Supply Splitter Circuit

MAINTENANCE AND SERVICE

INTRODUCTION

This Maintenance and Service section will help you maintain the TF46 within published specifications and assure years of useful application. The schematic, parts list, and PC board layouts are included on a separate sheet. Sencore's "Circuit Trace" schematic has the key signal paths marked for fast identification and tracing of power supply voltages, function paths, and signal paths as the various signals pass through the circuit and from board-to-board. Warranty information is printed on the back of the Quality Assurance tag attached to the instrument. Factory Service information is located inside the back cover of this manual.

CHECKING FOR BROKEN TEST LEADS

If the TF46 should fail to operate properly, check for a broken test lead. To locate a broken test lead:

1. Connect all three test leads together.
2. Depress the LEAKAGE button and switch the PERMUTATOR SWITCH through all six positions of either polarity. All six positions should read full-scale leakage.

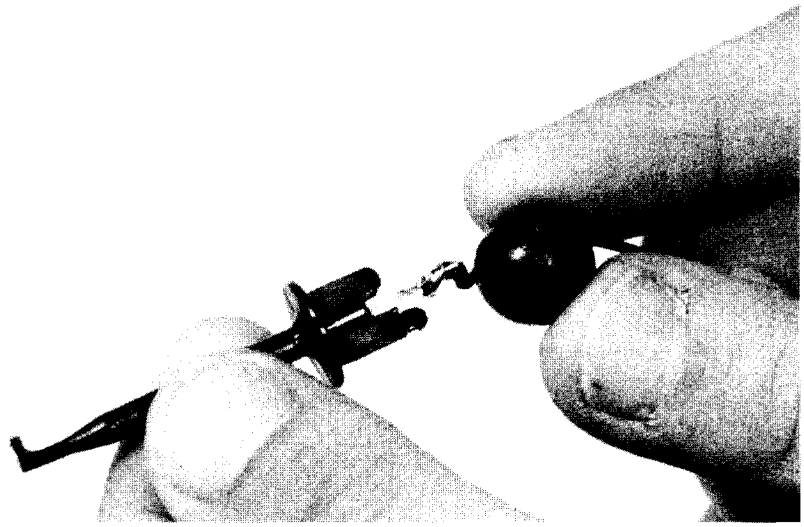


Fig. 26: Disassembly of E-Z Hook® for service.

3. If only two positions show full-scale leakage, one lead is open. To determine the open lead:
   a. Set the PERMUTATOR SWITCH to either position reading full-scale leakage.
   b. The open lead is indicated as the EMITTER lead on the color indicators around the PERMUTATOR SWITCH.

If a lead should break, the break usually occurs within ½" of the E-Z Hook® connector. To repair a broken lead:

1. Give a sharp tug to the connector of the lead that has been determined to be open. If the break is near the connector, the wire will slide out of the insulation.
2. Re-strip the wire leaving about 1/2" of exposed conductor.
3. Open the E-Z Hook® by pulling the ball straight off the back of the connector. (See Fig.26.)
4. Resolder the test lead onto the hook, and slide the ball back into place.
5. Re-test the lead to make sure the problem has been corrected.

DISASSEMBLY

To obtain access to the inside of the TF46 for service or calibration:

1. Remove the 4 screws on the sides of the plastic case. Lift the plastic case away from the rest of the unit. At this point, all calibration controls may be reached.
2. Remove the 6 screws on the back of the TF46. The inside assembly may now be pulled out of the metal portion of the case.
3. Remove the plastic strain relief holding the test leads.
4. Remove the 2 screws located in the lead storage compartment.
5. Disconnect the connector plug at the top of the board.
6. The PC assembly may now be pulled away from the front panel.
7. The connector plug may be reconnected to allow testing with all circuits connected.

To reassemble the TF46, reverse the above procedure.

CALIBRATION INSTRUCTIONS

NOTE: If calibration should be necessary, adjust the leakage calibrations before the gain calibrations. In order to assure accurate calibration, the metal meter cover door must be in its normal "open "position in front of the meter movement. The door may be removed from its track and placed in its normal "open" position without the case to allow access to the calibration controls.

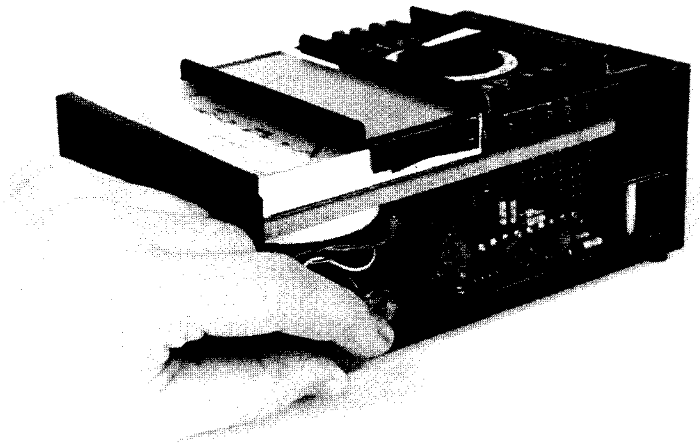


Fig. 27: Access to calibration. Note that the sliding meter cover has been placed on the meter to maintain accurate calibration.

Leakage

1. Connect a meter capable of measuring 3 mA in series with a 30 Kohm pot. Connect the Red and Yellow test leads to this series combination.
2. Set the PERMUTATOR SWITCH to the first position on the "N" side (RYG).
3. Push the LEAKAGE function button and set the pot for a reading of 2.5 mA on the external meter.
4. Adjust the Full Scale calibration control (R38) for a full scale reading on the TF46 meter.
5. Reset the external pot for a reading of .25 mA on the external meter.
6. Adjust the .25 mA calibration control (R39) for a reading of 250 uA.
7. Repeat steps 3-6 until both calibration points read correctly.

Beta Cal

An approximate calibration may be obtained using the following procedure:

1. Connect an oscilloscope between the Red and Yellow test leads.
2. Set the PERMUTATOR SWITCH to the first position on the "N" side (RYG).
3. Select the SIGNAL TRANSISTOR transistor type button.
4. Depress the GAIN button.
5. Adjust the Beta Cal control (Rl5) for an output signal of 1 VPP.

A more exact calibration may be obtained using the following procedure:

1. Connect a transistor with a known Beta to the three leads of the TF46.
2. Perform the Out-Of-Circuit Parameter Gain test.
3. Adjust the Beta Cal control (Rl5) for the proper gain reading for the transistor being tested.

FET Gm Cal

An approximate calibration may be obtained using the following procedure:

1. Connect an oscilloscope between the Red and Yellow test leads.
2. Set the PERMUTATOR SWITCH to the first position on the "N" side (RYG).
3. Select the NORMAL FET transistor type button.
4. Depress the Gain button.
5. Adjust the Gm Cal control (Rl6) for a .4 VPP signal.

A more exact calibration may be obtained using the following procedure:

1. Connect an FET with a known Gm to the three leads of the TF46.
2. Perform the Out-Of-Circuit Parameter Gain test.
3. Adjust the Gm Cal control (Rl6) for the proper gain reading for the FET being tested.

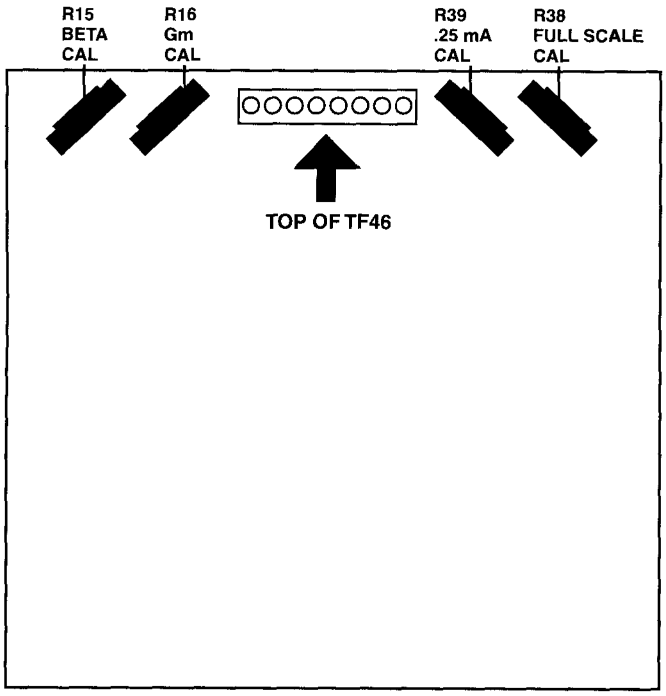


Fig. 28: Location of Calibration Controls on P.C. Board.

APPLICATION TIPS

Due to the wide variety of transistor types and circuits, there are a few transistors you may have questions about testing. Listed below are most of these special cases.

1. Circuits Requiring "Key Leakage" Tests
Most transistors that fail, do so completely. These transistors will all be found by using the Cricket Gain test. Two exceptions are transistors that are just starting to go bad, and those in "critical-bias" circuits.

Critical-bias circuits fall into two main categories: 1) High frequency circuits, and 2) Direct-coupled circuits. In either type of circuit, any amount of transistor leakage can change the bias of the transistor enough to disrupt circuit operation. These transistors should be tested in-circuit using the Gain test. The circuit should then be tested for proper biases at the transistor leads as indicated in the schematic for the unit on which you are working. If these voltages are not as specified, the possibility of leakage is very high. If your troubleshooting points to the transistor - even though it has gain - it should be checked for leakage as explained in the Operation section. (SEE ALSO: Applications Tip No. 2).

2. Circuits Requiring "Extended Leakage" Tests
Emitter/collector leakage can cause improper circuit operation. While this type of leakage is rarely found in small signal transistors, it may appear in audio power output transistors, RF transmitter output transistors, and hi-current voltage regulator transistors. In these circuits, the voltages should be checked after the in-circuit gain test is performed. If the bias voltages are not correct, both the KEY and EXTENDED LEAKAGE TESTS should be performed. (SEE ALSO: Applications Tip No. 1).

3. Testing High Frequency Transistors
See Applications Tip No. 1.

4. Testing Direct-Coupled Transistors
See Applications Tip No. 1.

5. Testing Internally Protected Transistors
See Applications Tip No. 12.

6. Testing Dual-Gate FETs

Since a dual-gate FET has four test leads, it is necessary to know basing information to hook up the test leads for the test. The two gates of the FET are tested independently. In the case of a dual-gate MOSFET, it is also necessary to connect the untested gate lead to either the source or drain lead before the gain test is performed. This is because the second gate, if left open, will cause the FET to read "BAD". Gate one should be connected to the source while testing gate 2, and gate 2 connected to the drain while testing gate one.

7. Testing MOSFETs (IG - FETs)
When testing a metal-oxide device in circuit, no special precautions are necessary. If you test the device out-of-circuit, however, be sure to prevent possible damage to the gate due to static electricity. Keep all leads of the device shorted together by twisting them or connecting a jumper between them before removing the MOSFET from the circuit. Connect the test leads and remove the short, and test the transistor. Then, reshort the leads again before removing the test leads.

8. Testing "Noisy" Transistors
At times, an audio transistor may check "GOOD" but cause distortion to the signal being amplified. The TF46 will help locate most of these transistors. The "Noise" may be caused by an intermittent junction (see Applications Tip No. 9). At other times, high leakage is the cause. If the circuit parameters (voltage and signal) indicate the distortion is being caused in a particular transistor, it should be tested for leakage (see Applications Tips No. 1 and 2).

9. Intermittent Transistors
The combined gain and leakage test results in a 99.9% accuracy for all transistors tested. Many of the remaining .1% (1 in 1000) transistors are intermittent. The intermittent may be thermal (unit operates for a short time then cuts out) or mechanical (unit fails when bumped). Many of these intermittents may be found by taking advantage of the test tone. Perform the GAIN test, and leave the TF46 in one of the test positions that reads "GOOD". Now the transistor may be heated, cooled with freeze spray, or tapped. If there is any change in the tone, the transistor is intermittent and probably the cause of the circuit malfunction.

10. Testing Low Impedance Circuits
The few transistors that have very low-value AC shunt paths (fewer than 1 out of every 100 transistors) will not test in-circuit. In many of these circuits, it is easy to disconnect the shunting path. In the case of a direct-coupled audio-output transistor, the speaker is the load. By disconnecting the speaker, the transistor may be tested in-circuit. In

the case of an RF transmitter output, a low-resistance RF coil is usually the loading component and can be isolated from the transistor. Or, in the case of a high-power voltage regulator, the power supply filters are usually the cause of the loading, and can be eliminated by disconnecting one of the leads going to the capacitor.

11. One Position Tests (In-Circuit)

Since most transistors give a "GOOD" indication on two permutator switch positions, many technicians assume all good transistors do. This is not the case, however. If the transistor being tested has a diode connected between two elements, or is direct-coupled to another transistor or I.C., it may only check in one position. The reason is that the diode action of the second solid-state device may "short" out one of the two transistor outputs.

When you encounter a one-position in-circuit test, refer to the schematic to see if the transistor under test is direct-coupled to any other solid-state device. If so, the one position test indicates that the transistor has gain. If there is any doubt, check the bias voltages. A final confirmation may be made out-of-circuit. (SEE ALSO: Application Tips No. 1 and 12).

12. One Position Tests (Out-Of-Circuit)

Since most transistors give a "GOOD" indication on two permutator switch positions, many technicians assume all good transistors do. This is not the case, however. Some transistors have an extra diode junction built in for protection (as in a horizontal output transistor of a TV set) or to change its input characteristics (as in some IF transistors). This may cause only one switch position to give a "GOOD" test. If you have any doubt as to whether a transistor should read in one position or two, simply check a replacement transistor. If it reads on two positions and the suspected transistor on one, reject the transistor. The EXTENDED LEAKAGE test will also show an extra leakage path. Again if there is any question, compare the readings on a replacement transistor.

13. When To Use "Lead ID"

Most technicians find times when they would like to know the basing diagram of a transistor, but reference material is not readily available. The most common times are: 1) A transistor has been replaced, and there is a possibility that it was not installed property, 2) A cross-reference transistor is available, but the basing diagram is different from the original transistor, 3) An imported unit has transistors that are not shown in any cross-reference material. If any of these conditions arise, refer to the LEAD IDENTIFICATION section of the manual to determine transistor basing. If a cross-reference transistor is needed, the basing information plus the signal level and power supply ratings will usually give sufficient information to determine a cross-reference from the specifications included in most cross-reference books.

14. When To Use Parameter Tests

The actual gain of a transistor rarely changes unless the gain drops to zero. The Cricket Test will locate most bad transistors with the go/no-go test. The Parameter Test can be used, however, for testing transistors in critical gain circuits. The most common use of the Parameter Test is for matching transistors (such as for audio outputs or balanced bridge circuits) or for grading transistors for use in critical circuits such as DC control circuits or IF stages.

15. In-Circuit Parameter Tests

The Parameter Tests may be performed in-circuit, but their results will be questionable in most cases. The parallel paths formed by the circuits external to the transistor may cause the gain characteristics of the transistor to differ from an out-of-circuit test. The in-circuit Parameter Test can, however, be used for in-circuit basing tests in many circuits.

WARRANTY

Your Sencore instrument has been built to the highest quality standards in the industry. Each unit has been tested, aged under power for at least 24 hours, then, every function and range was retested to insure it met all published specifications after aging. Your instrument is fully protected with a one year warranty (or three year warranty on hand-held signal level meters) and Sencore's exclusive 100% Made Right Lifetime Guarantee in the unlikely event a defect was missed. Details are covered in a separate document included with your instrument.

SERVICE

The Sencore Service Department provides all in and out-of-warranty service and complete recalibration services for Sencore instruments. No local service centers are authorized to repair Sencore Instruments. Factory service assures you of the highest quality work, the latest circuit improvements, and the fastest turnaround time possible. Most service repairs are completed within 72 hours of receipt.

Repacking For Shipment

1. Use a corrugated cardboard shipping container that has a test strength of 100 lbs.
2. Call **1-800-SENCORE** and ask for a return unit authorization (RUA) number. Enclose the following information: Owners address, billing information, purchase order (if applicable), name and phone number of contact person, description of problem, and reason for return.
3. Enclose the unit inside a plastic bag to protect its finish and prevent foreign material from getting inside.
4. Cushion the unit equally on all sides with a minimum of 3 inches of padding material. Pack the padding tightly enough to prevent the unit from shifting during shipment.
5. Seal all seams on the container with strapping tape.
6. Send the packed unit to address listed below (we recommend shipping via United Parcel Service).

Save the original shipping carton and packing material for reuse should you ever need to ship your unit, or return it to the Sencore factory for repair. If the original materials are unavailable or unfit for reuse, repack the unit according to the following directions.

NOTE: Should you want to repair your own instrument, parts may be ordered directly from the Service Department. Any parts not shown in the parts list may be ordered by description.

We reserve the right to examine defective components before an in-warranty replacement is issued.

SENCORE SERVICE DEPARTMENT
3200 Sencore Drive
Sioux Falls, SD 57107
Toll Free: 1-800-SENCORE
FAX (605) 339-7032

Fill in for your records:

Purchase Date: ____________________ Serial Number: ________________________
Run Number:__________

***Note**: Please refer to the run number if it is necessary to call the Sencore Factory Service Department. The run number may be updated when the unit is serviced.*

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