SENCORE NEWS

FEATURING

TF166 AUTOMATIC TRANSISTOR ANALYZER

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

HOW TO WITH INSTRUMENTS THRU *PIX FACTS*

World's Largest Technical Publication—500,000 Per Month

WRITTEN BY SENCORE FIELD ENGINEERS
SEPTEMBER, 1972

NOW YOU CAN TEST OVER 20,000 TRANSISTORS & FETS!

- ✓ **Without a reference book**
- ✓ **Automatically**
- ✓ **In circuit**

WITH THE

TF166

AUTOMATIC TRANSISTOR ANALYZER

- ✓ **AUTOMATIC TEST SET-UP** – puts an end to guesswork about voltage and current levels to use.
- ✓ **FULL PUSHBUTTON OPERATION** for fast, easy transistor testing.
- ✓ **COMPLETE TESTING CAPABILITY** with both AC test for in-circuit and DC test for out of circuit – a Sencore exclusive.
- ✓ **EASY TO READ GOOD – BAD SCALE.** Ends confusion caused by complicated scales in engineering terms.
- ✓ **PATENT PENDING AUTOMATIC TEST** made with low level signals and voltages to completely protect device being tested.
- ✓ **CALIBRATED SCALES** for accurate testing of Beta, Gm, and transistor and FET leakage.

IN THIS ISSUE

- ANSWERS TO THE 20 MOST OFTEN ASKED QUESTIONS ABOUT TRANSISTORS AND TRANSISTOR TESTING.
- BOB AND NORM'S SHOP – SIMPLIFIED MODULE SERVICING WITH NEW 'MODULE MASTER'.

INTRODUCTION

Norm Pedersen

Bob Baum

This issue brings you all the good news from Bob Baum's lab, and what good news he has for you this month. Every manufacturer is nearly all solid-state in their design and the number of solid-state units requiring service is climbing every day. To help you handle the service of this transistorized equipment, Bob has designed a new type of transistor tester. And what a tester it is!

The new TF166 Automatic Transistor Analyzer is so fast, so easy and so automatic it makes any other tester old-fashioned. Transistor testing is now as simple as pushing a button and seeing the test results on the easiest-to-interpret meter ever. Why not follow along as we bring you all the information about Bob's latest engineering masterpiece?

?1 WHY BOB BAUM DESIGNED ANOTHER TRANSISTOR TESTER. ?

The first question that comes to mind when a new transistor tester is mentioned is probably "Why another transistor tester? Everybody makes transistor testers already." This is true; and the type and complexity of the transistor testers available are the main reasons for the development of the new TF166. Information gathered from our field engineering and service departments, discussions with set manufacturers, and correspondence and conversations with service technicians brought out five main points about transistors and transistor testing.

Point One. A good, reliable, in-circuit transistor analyzer is not currently available. Many of those that are on the market use complex procedures for their operation, require additional equipment, and with many you need the transistor specifications to make the test.

Point Two. Most of the testers are designed to make out of circuit tests only. This type of test is reliable, but impractical for service use. The majority of the transistors are soldered directly into the circuit boards making it necessary to unsolder them to make the test.

Point Three. Interpretation of test results is far more difficult with most testers than need be. Engineering terms are fine for engineers, but the service technician generally needs only a go-no go type of test.

Point Four. Those testers that do claim both in and out of circuit tests frequently have two different test procedures; one for in-circuit and one for out of-circuit. This can often lead to confusion about the operation of the unit.

Point Five. Advances in the design and manufacture of transistors has resulted in many new types which operate at very low bias currents, and some with built-in protection devices. These types will not test accurately on many of the current testers.

Determining the areas that are creating problems or those where a need for improvement exists is a big step in the right direction. All the various areas mentioned were covered in a product meeting and the conclusions reached in that meeting set down the criteria for the new transistor analyzer.

1. Any tester designed at this time must be fast and simple to operate. It must be able to be used efficiently by anyone wishing to check a transistor.

2. It must be able to be used without a set-up book or transistor specification sheets.

3. It must test all transistors and FET's, in circuit and out of circuit, with reliable results.

4. It must be designed so the test results are easy to interpret, preferably with a form of go-no go indication. It must also have accurate Beta and Gm scales for engineers and technicians needing this information.

5. It must use the same test procedure whether the test is being made in circuit or out of circuit.

6. It must provide some automatic means of setting the levels of current and voltage needed for test to eliminate complicated and confusing set-ups.

7. It must not damage any transistor or FET it is testing, even if the device is not connected or tested properly.

8. It must provide all the important tests needed for transistors and FET's such as Beta, mutual conductance, and various types of leakage tests.

9. It must be able to test all transistors and FET's, including the low current and protected types.

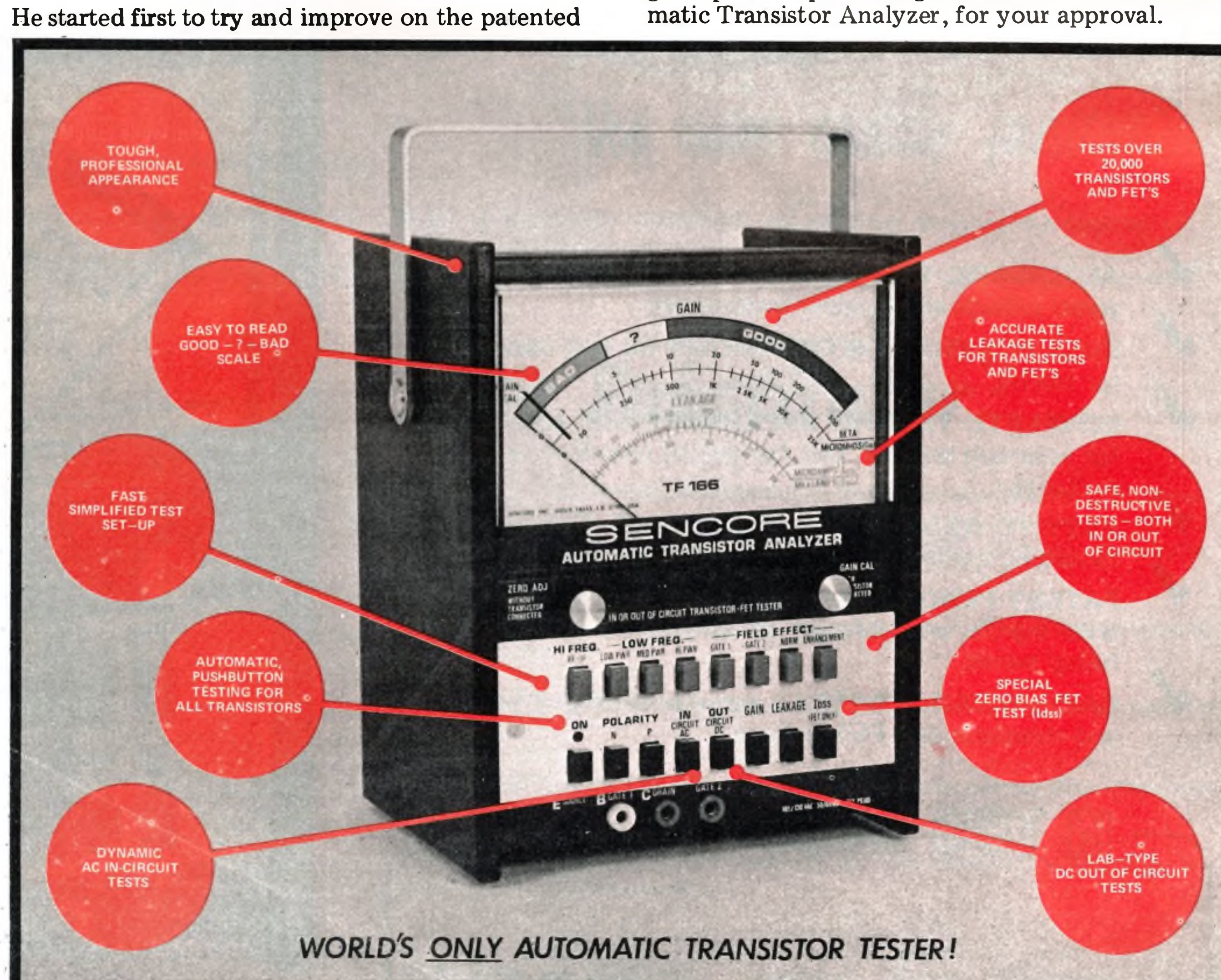
This is a pretty long list of requirements and a substantial task for any engineer. The engineering assignment was given to our Senior engineer, Bob Baum. Bob was well qualified for the task, having developed the first in-circuit transistor tester to be introduced, the Sencore TR139. Later, he designed the first in or out of circuit testers for both transistors and FET's, the TF151 and TF17. He now had to develop a unit that would do more than any of these tried and proven units, and make it even more simple to use and interpret.

He started first to try and improve on the patented system used in the TF151. He soon ran into the roadblock of the new RF type of transistors with a Faraday shield. These transistors would check bad both in and out of circuit with the AC test. He then developed an extremely accurate go-no go type of junction tester, the idea being that if the transistor junctions were good, the transistor should be good. This unit represented a curve tracer or "knee-tester" with a meter indication rather than a scope CRT. The idea went well until he came across a major stumbling block for the junction tester, the curve tracer or the knee tester. Some FET's, Insulated Gate FET (IGFET) and Metal Oxide Semiconductor FET (MOSFET), do not have the conventional channel to gate junction. These types have the gate isolated from the channel by an insulating layer. Since no junction exists, the tester would show all IGFET's and MOSFET's bad.

Bob tested hundreds of transistors during TF166 design.

This design obviously would not meet the conditions set forth originally for the Transistor Analyzer. Bob then started a totally new design, incorporating many of the good performance features of the TF151, and changed some of the basic test procedures. Next, he altered the test signals to provide six different levels for test. Finally he added a DC test to cover those transistors that cannot be tested with AC. Working carefully with signal and voltage levels, he ended up with a design that would test every transistor and every FET, accurately, and without damaging the device in any way.

He then set about the task of simplifing the test. Rotary switching was tried, but the unit became too complex for the average technician to operate with ease. He finally settled on a simple pushbutton arrangement that would take care of all test settings automatically. He was able to further simplify the new tester by making it possible to get, for the first time, a go-no go indication of transistor condition. Bob Baum and Sencore take great pride in presenting the all new TF166 Automatic Transistor Analyzer, for your approval.



The TF166 allows you to test over 20,000 transistors and FET's, in-circuit or out-of-circuit, automatically and without a reference book. All tests are made with pushbutton ease, and for the first time in transistor history, the results of tests are shown on a simple good-bad scale. An accurate Beta scale for regular transistors and Gm scale for FET's is included for those technicians, students, instructors and engineers requiring this precise information. The TF166 will test the gain of any transistor; PNP, NPN, silicon, germanium, bi-polar or FET, N or P channel, single or dual gate, normal or enhancement type, junction or insulated gate- Automatically.

Leakage tests are provided for both regular transistors and FET's, and they can be made with the push of a button. It can be used as a bench tester in the shop or lab, or used as a portable tester on the job or in the home, without the need for a data sheet, reference book or even a schematic. Important as any other feature, the TF166 will not damage any transistor in any circuit, regardless of circumstances. This is the TF166 Automatic Transistor Analyzer. To give you the complete picture, we have included a list of specifications and invite you to make comparisons with any other transistor tester, curve tracer or any other supposed transistor tester on the market. You are the jury and the case is yours.

REGULAR (BI-POLAR) TRANSISTOR TESTS

AC IN-CIRCUIT TEST:

Test method	Dynamic AC Beta
Test frequency	60 Hertz
Signal level	4 volts P-P max.
Formula used	Beta $(h_{fe}) = \frac{I_E - I_B}{I_B}$

DC OUT-OF-CIRCUIT TEST:

Test method	Static DC Beta
Test level	4 volts DC max.
Formula used	Beta $(h_{FE}) = \frac{I_E - I_B}{I_B}$

GAIN (Beta) RANGE:

Calibrated scale	0 - 500
Gain scale code	BAD = 0 - 5
	? = 5 - 10
	GOOD = 10 - 500

BASE CURRENT LEVELS (GAIN CAL level):

RF - IF	10 microamps
Low power	30 microamps
Medium power	100 microamps
High power	300 microamps

LEAKAGE TEST (I_{CBO}):

Test levels	V_{CB} @ 4 volts DC
	I_E @ 0
Leakage range	0 - 2500 microamps

FIELD EFFECT TRANSISTOR (FET) TESTS

MUTUAL CONDUCTANCE (Transconductance or G_m):

Test method	Dynamic mutual conductance
Test frequency	60 Hertz square wave
Signal level	.5 volts P-P
Voltage levels	V_{DS} @ 6.2 volts DC
	V_{GS} @ 0
Formula used	$G_m = \frac{I_d}{E_g}$

GAIN (G_m) RANGE:

Calibrated scale	0 - 25,000 micromhos
Scale code	BAD = 0 - 250 umhos
	? = 250 - 500 umhos
	GOOD = 500 - 25,000 micromhos

LEAKAGE TEST (I_{gss}):

Voltage levels	V_{GS} @ 4 volts DC
	V_{DS} @ 0
Leakage range	0 - 2500 microamps

ZERO BIAS DRAIN CURRENT TEST (I_{dss}):

Voltage levels	V_{DS} @ 6.2 volts DC
	V_{GS} @ 0
I_{dss} range	0 - 50 milliamps

GENERAL

Meter	7", 100 microamp, 2%
Power	105-130VAC, 50-60Hz 15 watts
Size	9½ X 7½ X 6
Weight	8½ lbs.
Price	$190.00

? 2 WHAT DO YOU MEAN, AUTOMATIC? ?

Let us consider for a moment some of the things you must go through to test a transistor with many of the testers which are currently in use. You will generally have to determine some or all of the following points before you can begin the transistor test.

1. Remove it from the circuit
2. Determine type (PNP or NPN, Silicon or Germanium)
3. Look up or guess the test voltage and test current to be used.
4. Set up as many as five different controls to establish proper test.

This type of test may be acceptable for precise testing needed in engineering labs, but is far too complex and time consuming for the busy technician in the shop or home. In addition, you must interpret the results of the test on complicated scales or readout devices to decide whether or not the transistor is good. The Automatic TF166 solves all these problems and can make your transistor testing faster and easier than ever before.

The TF166 Automatic Transistor Analyzer:

AUTOMATICALLY presets every test signal and test current needed for transistors.

AUTOMATICALLY presets proper test levels for FET's.

AUTOMATICALLY gives GOOD-BAD gain test for transistors and FET's.

AUTOMATICALLY gives accurate transistor Beta and FET mutual conductance, without interpretation or calculation.

AUTOMATICALLY tests transistor and FET leakage with the push of a button.

AUTOMATICALLY protects the transistor or FET being tested.

That is what we mean by AUTOMATIC!

Bob Baum Receives Special Recognition Award.

Bob Baum, Senior Design Engineer for Sencore, was recently honored by Mr. R. H. Bowden, Sencore President, with a special recognition award. The award commemorated the design of Bob's 100th instrument for Sencore, the all new TF166, Automatic Transistor Analyzer. The presentation was made during a national sales meeting held in Las Vegas this summer at the NEW/COM parts show. Bob Baum has been serving in

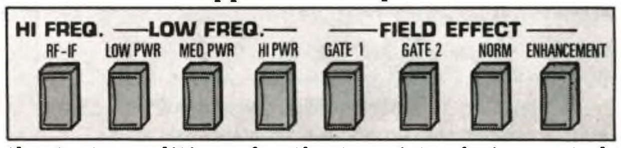
the capacity of Design Engineer with Sencore for over 17 years and holds several patents for test equipment design. The majority of the Sencore products created and produced in recent years can be attributed directly to Bob's efforts in the design lab. Congratulations, Bob, and here's to the next hundred!

? 3 IS THE TF166 SIMPLE TO OPERATE? ?

One of the upper-most questions on the mind of anyone contemplating the purchase of a new piece of equipment is; can I operate it easily and understand what I am doing? You are interested in knowing what the instrument will do, how many knobs you have to twist to get it to do what you want done, and how easy the results are to interpret.

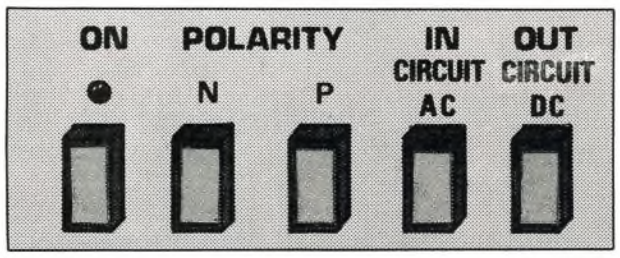
As we mentioned before, one of the primary design considerations for the TF166 was simplicity in understanding and using the instrument. Let us take a close look at the TF166 and run through its controls to show you its simple 1, 2, 3 operation.

First, you will notice that there are two rows of pushbuttons on the front panel of the TF166. These pushbuttons provide test selection and read-out. The upper row of pushbuttons select



the test conditions for the transistor being tested. All of the important test conditions are selected automatically with the push of a button. For example, the 4 pushbuttons at the left of the top row preset the proper test voltages, signals and currents for regular transistors. The 4 buttons to the right provide all the conditions needed for full testing of Field Effect Transistors. After determining the transistor type to be tested, all you have to do is push a button to automatically set up the proper test. Thats step 1!

Step 2 - Select the proper polarity for test signals to correspond to the polarity of the transistors and whether the test is being made in-circuit or out of circuit. The first portion of this step is done by depressing one of the two pushbuttons in the bottom row marked POLARITY. The N button should be depressed if you are testing an NPN transistor or an N-channel FET. The P button

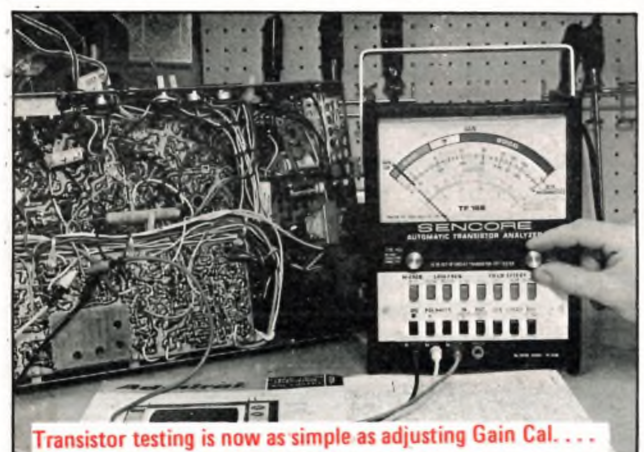


selects the correct polarity of signals for the PNP transistor and the P-channel FET. Next, select the proper test, AC or DC. Just push the AC IN CIRCUIT pushbutton if you are making the test in-circuit, or the DC OUT CIRCUIT button if the test is being made out-of-circuit. So far, so easy!

Step 3 - Connect the test leads to the transistor and adjust the GAIN CAL control at the right center of the meter. The GAIN CAL control is to be adjusted so the meter pointer is positioned over the GAIN CAL line on the meter scale. This sets the reference level for the gain test. All that remains after the Gain Cal has been set is to push the button marked GAIN. The TF166 will automatically give you the condition of the transistor on the easy-to-read GOOD-BAD scale on the top of the meter. Transistor testing done with automatic ease, simple as 1, 2, 3! To further simplify the TF166, the same identical procedure is used whether you are testing a regular transistor or a FET, and whether the test is being made in-circuit or out-of-circuit. No more confusing dials or switches to set the voltage, the current or other test conditions. You just push a button and the TF166 takes care of the rest, AUTOMATICALLY.

Now let us demonstrate the ease of testing transistors with the automatic TF166. We will test the sync separator transistor Q11 in the Admiral K-10 chassis. Since this transistor is in a signal handling circuit and not required to deliver any appreciable output power, we will check it as a Low Power type. We depress the Lo power pushbutton on the top row, and the P button on the lower row, since the schematic indicates that it is a PNP transistor.

The test is to be made in-circuit so the next step is to depress the IN Circuit AC pushbutton and then connect the leads. After connecting the leads we adjust the Gain Cal control to establish


Transistor testing is now as simple as adjusting Gain Cal. . . .

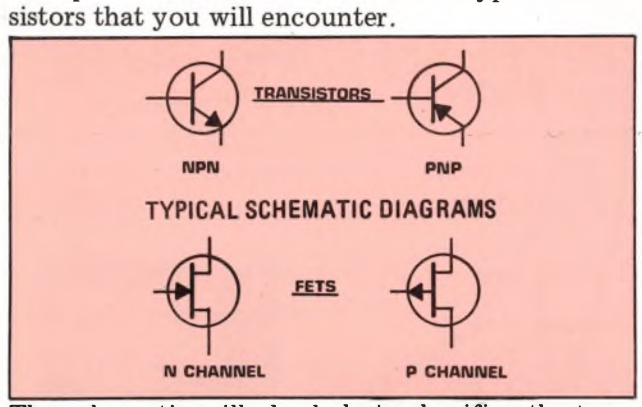
the proper test reference and push the GAIN button. That's all there is to it! We simply glance at the meter, see that the pointer is in the GOOD region and the test is complete. Simple, fast, reliable, and AUTOMATIC.


. . . and pushing the Gain Pushbutton!

? 4 HOW CAN YOU TELL THE TYPE OF TRANSISTOR?

The Automatic TF166 simplifies transistor testing to the point where very little information about the transistor is needed. The schematic diagram for the item of equipment being serviced will usually give you all the necessary information.

First, the schematic symbols for the transistors will give you the correct polarity and tell you if it is a regular transistor or an FET. The drawings shown here point out the 4 most common types of transistors that you will encounter.

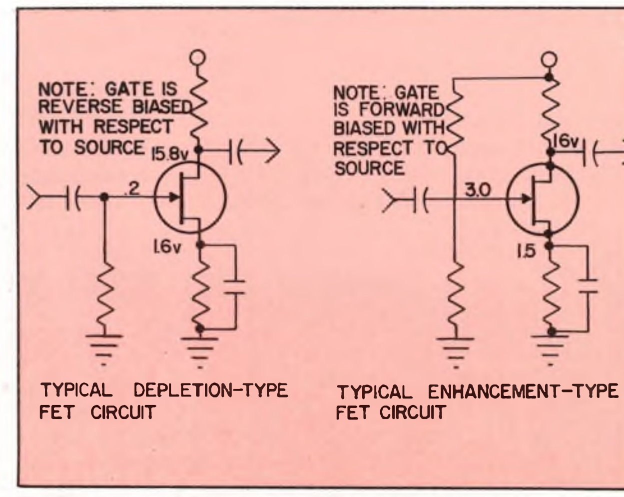


The schematic will also help in classifing the transistor into test groups by giving you the circuit location and power load of the device. Four distinct groups of regular transistors can be established for test purposes, based on power dissipation and circuit function: HI FREQ. — RF-IF, LOW FREQ. — Low Power, Medium Power, and High Power.

TRANSISTOR:	COMMON USES:
RF-IF	RF AMPS MIXERS OSCILLATORS IF AMPLIFIERS
AUDIO-LOW	PORTABLE RADIOS 1ST VIDEO AND 1ST AUDIO AMPS , SYNC SEPARATORS , SOUND IF , COLOR CIRCUITS , AUDIO IN STEREO
AUDIO-MED.	AUDIO OUTPUT DRIVER STAGES IN STEREOS, TV RECEIVERS, AUTO RADIOS, AND TAPE PLAYERS, VIDEO AND COLOR DIFFERENCE AMPS, HORIZONTAL DRIVERS, ERROR AMPS
AUDIO-HIGH	HORIZONTAL, VERTICAL, AND AUDIO OUTPUT, POWER SUPPLY REGULATORS, RIPPLE FILTERS

Transistor test groupings by function.

Field Effect Transistors can be placed in two groups, normal and enhancement types, with the normal type making up over 90% of the FET's you will encounter. The gate of the normal or depletion type FET will have a potential applied that will cause it to be reverse biased with respect to the source. A typical example of the normal type FET biasing is shown in this schematic.



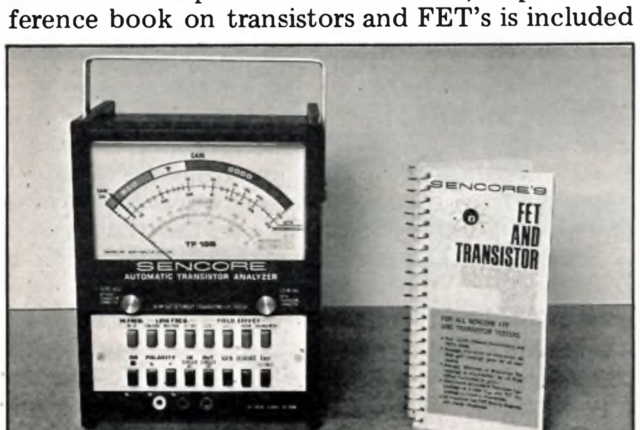
The enhancement type will seldom be encountered, but can readily be identified by the forward or zero bias potential gate to source as shown above.

4a. WHAT IF I DON'T HAVE A SCHEMATIC?

If a schematic is not available, the information as shown in the chart above regarding the transistor's location and its work load will place it in the proper test group. Other factors which will help are the size of the body of the transistor and whether or not it has a heat sink. Those transistors with heat sinks should be tested as either Medium or High power types. The large case power transistors which use a large heat sink or are thermally connected to the chassis should be checked as High power types. The smaller transistors with heat sinks will generally fall under the Medium power test. It is not necessary to know if the transistor is an NPN or PNP, silicon or germanium when you have the TF166. The circuit location, general size and shape and whether it has a heat sink or not will usually be all you need. It is then only necessary to push a button to "program" the TF166 for test. The TF166 is your mini-computer for fast, easy transistor testing.

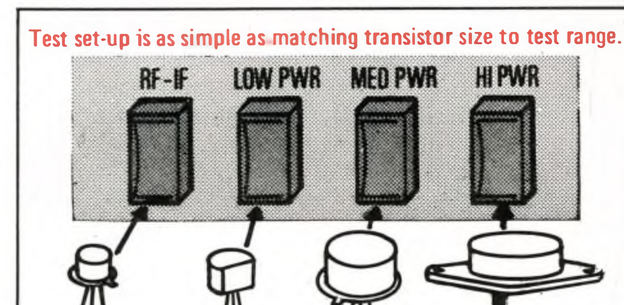
? 5 WHAT HAPPENS IF I REALLY CAN'T TELL THE TRANSISTOR TYPE? ?

Occasionally you may encounter an unfamiliar piece of equipment without a schematic and you are unable to quickly determine the information you need for testing. What do you do now, just make some kind of educated guess or simply forget about testing it? Certainly not, when you have the TF166. Knowing that this situation would come up from time to time, a special reference book on transistors and FET's is included which lists over 20,000 different transistors to help you out. Simply remove the reference book from its storage compartment on the back of the TF166, obtain the number from the transistor and look up the information you need. Each transistor listing contains all the necessary information to guide you through the test. The book will also serve as a test back-up for you on those transistors that may come up with some unusual test results. Sencore is the only manufacturer of transistor testers to back up every test you make with a complete, comprehensive Transistor and FET Reference Book.



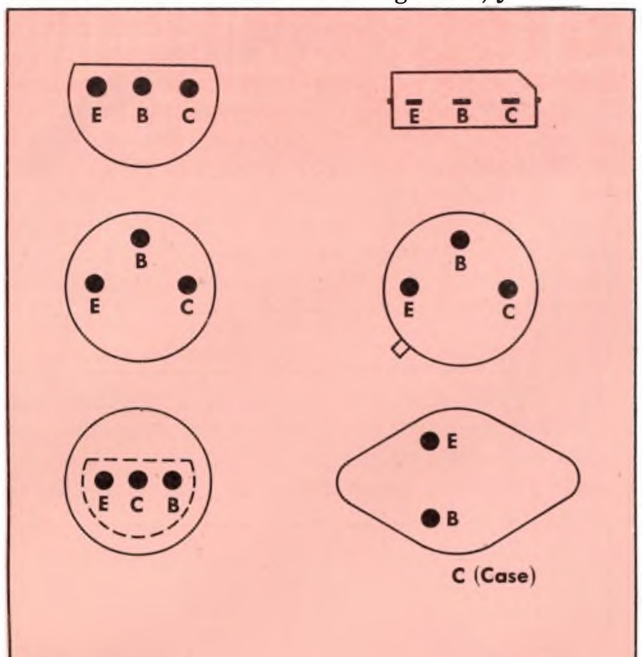
Only Sencore backs every test you make with a complete reference book.

Now, only one problem remains, and that is the transistor that has no number on it, you have no schematic and are at a loss as to how to test the little three-legged monster. Don't be discouraged. With just a little thought and the TF166 you are soon out of the woods. You need not know the polarity, or even if it is a regular or field effect transistor. The automatic circuitry of the TF166 will help you work this out and do it without any chance for damage to the transistor, the circuit its in, or the TF166. Start off by selecting the transistor type indicated by its general size. If you are uncertain, simply use the medium power test for all the smaller cased transistors. Next, with the transistor connected to the tester, depress the N or P pushbutton and see if the Gain Cal control will bring the meter to the Gain Cal line. If it does, push the Gain button for the test readout. If the Gain Cal won't adjust the needle to the Cal line, or the meter pins full left, depress the other polarity pushbutton. You should be able to get normal Cal action and Gain test. If this still doesn't get results, recheck for correct lead connections to the transistor and repeat the test. Inability to get test results at this point would indicate a defective transistor and you have found the culprit giving you the problems.

Test set-up is as simple as matching transistor size to test range.


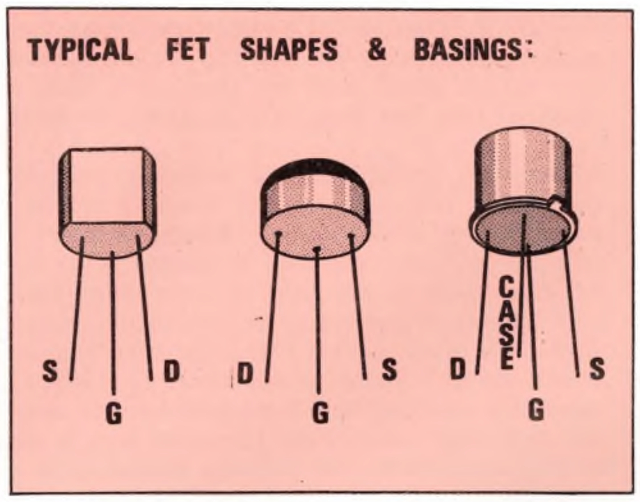
? 6 HOW ABOUT CONNECTING THE TRANSISTOR OR FET WITH SO MANY DIFFERENT BASES? ?

There are currently over 450 different basings for transistors and FET's, and more will be seen in the future. Understandably there is some concern as to how to determine the basing for a particular transistor. For all practical purposes, 6 basic transistor bases cover over 90% of all the regular bipolar transistors in use today. Being familiar with the bases shown in the following chart, you should have no difficulty in making the proper connections for the test.

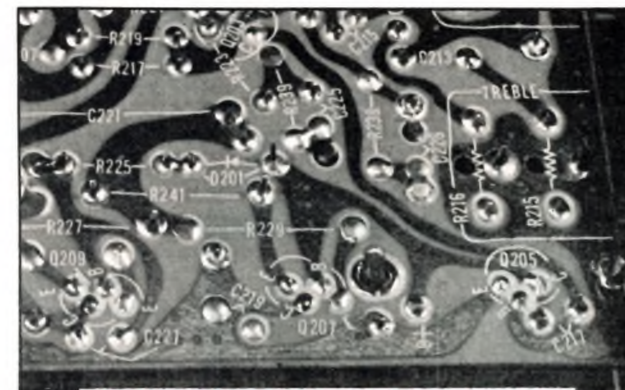


These six basing diagrams plus alternate basing with collector and base leads reversed cover over 90% of all transistors currently used.

FET's have just three shapes for the most part and they appear identical to a standard transistor. The 3 different types are shown here with the most common basings. There are, of course, deviations from these basings for FET's as there are for the standard transistors. However, with these three usual outlines and one variation for each, the gate and drain leads reversed, you should be able to make the FET tests with no problems.

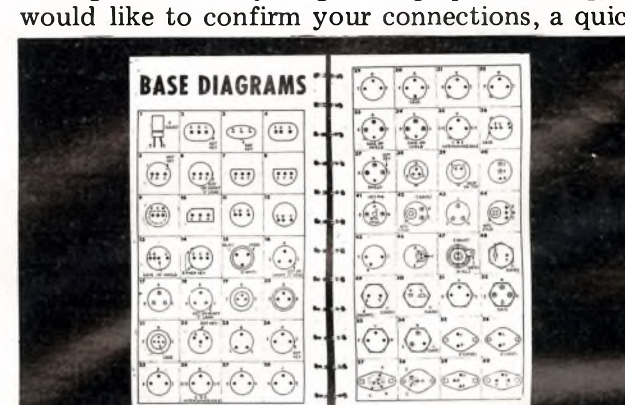


Another helpful aid to determine the basing is the "roadmap" that many manufacturers are placing on their circuit boards. It lists the E, B, C, or S, D, G, connections right on the board. This not only gives you the exact connections you need but tells you at a glance whether the device is a regular transistor or an FET.



Board legends are a big aid when testing transistors.

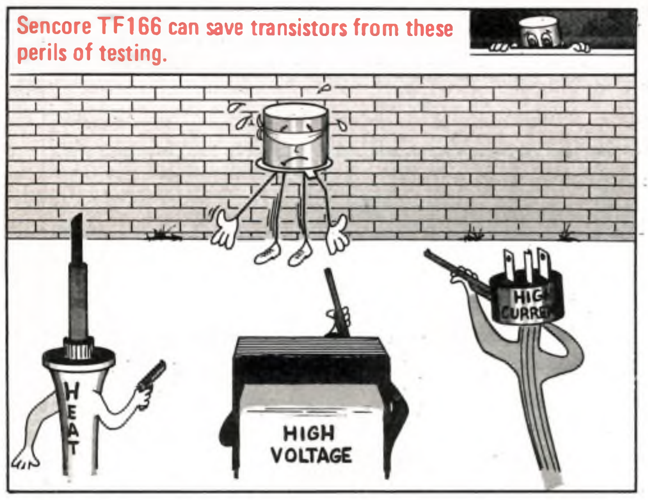
Because of the many different types of transistors and FET's in use today, and the enormous number of basings possible, the Transistor and FET Reference Book plays a big part in making your testing easier. If you get hung up on basing, or would like to confirm your connections, a quick check in the Reference Book will give you the exact basing for that transistor. The basing information alone should save you many hours of guessing and frustration, and ONLY the Sencore TF166 has it.



Sencore reference book helps you out with complete listing of all transistor basings.

? 7 CAN I BLOW THINGS UP IF I CONNECT WRONG?

One of the greatest fears of dealing with solid state equipment is that of damaging the fragile solid state devices. We have all been told over and over again that excessive heat, excessive current or improper voltage means doom for the transistor.

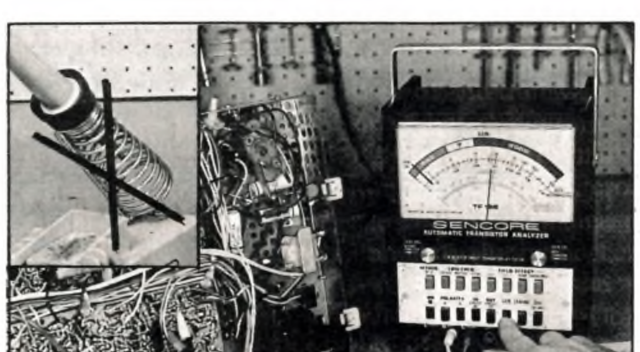


Sencore TF166 can save transistors from these perils of testing.

These cautions should be kept in mind when you are deciding on a transistor tester. Many transistor testing devices have voltage levels and output current capabilities which can send a transistor to oblivion. Some, which you may be familiar with, are passive-type, brute force test systems that drive the meter directly with the test current flowing through the transistor. This is certainly not so with the Sencore transistor testers, including the new TF166 Automatic Transistor Analyzer.

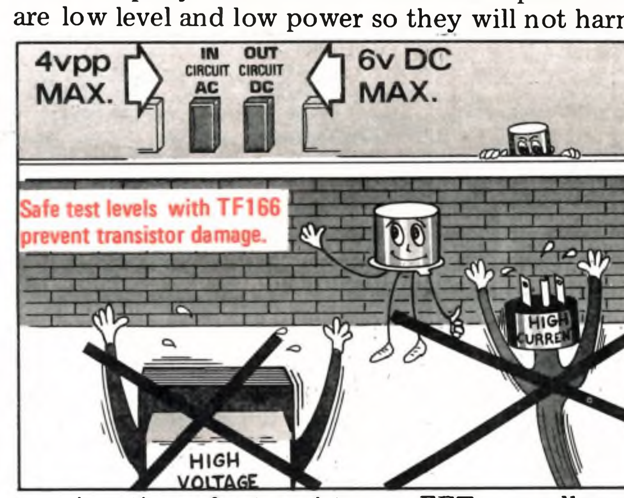
The unique design of the TF166 and the low levels used to make the tests will not harm even the most delicate transistor. You can hook-up wrong, select the wrong power type, use the wrong polarity, and even check an FET with the regular transistor tests and not damage the transistor. It has been designed to be safe and easy to use, even when you do not know the exact basing or transistor type. The TF166 is truly goof-proof!

The TF166, first of all, allows the transistor to be tested in circuit. This removes one of the three hazards for transistors - heat.



TF166 in-circuit tests prevent damage from soldering iron.

The AC-IN-CIRCUIT transistor test operates on a safe AC signal that does not exceed a maximum of 4 volts peak-to-peak. The DC OUT OF CIRCUIT transistor and FET test has a maximum of 6 volts at the output jacks of the TF166. These potentials are low level and low power so they will not harm any junction of a transistor or FET, regardless of how the test connections are made. These signal and voltage levels eliminate the hazards of both high voltage and high currents. You can be sure when you have the TF166 that you will never harm the transistor being tested. This is just another feature of the totally automatic TF166, AUTOMATIC TRANSISTOR PROTECTION.



Safe test levels with TF166 prevent transistor damage.

? 8 OK, SO I'M HOOKED UP. WHAT TEST DO I MAKE FIRST? ?

There are many different tests which can be made on transistors and FET's. Leakage tests, maximum current tests and others are a part of total testing of any transistor. These are important, in many cases, but the test which usually gives the most information about the transistor or FET is gain. Will the device amplify? Will it provide gain when a signal voltage or current is applied to its input? If it does the transistor will usually be good. The Gain test is the first test which should be made.

Transistor testing is now as simple as pushing a button.

When you push the GAIN button, you have an instant readout of the transistor condition. If the transistor shows gain, it should be ok. If the gain is low, or non-existent, either the transistor is defective or excessive leakage exists. The leakage could be in the transistor itself or in the associated circuit. At this point, the transistor should be removed and given an out-of-circuit test to confirm that it is defective before a replacement is ordered. The TF166 incorporates both the AC IN CIRCUIT test for rapid transistor isolation and testing, and a lab-type DC OUT OF CIRCUIT test. The TF166 gives you full test capabilities with the push of a button, and a simple good-bad meter scale to tell you what you need to know, quickly.

8a. WHERE CAN I FIND THE EXPECTED BETA READING IF I REALLY NEED TO KNOW?

Most of the time when you are testing a transistor, you want to know simply whether it is good or bad. This you can determine very quickly with the TF166. If you are trying to match certain transistors, or wish to make a replacement and don't know the Beta range of the original, the Transistor and FET reference book will have the answer for you. The minimum expected Beta for the transistor is listed, to make it easy for you to determine whether the transistor being tested has sufficient gain. The Reference Book will also help clear up any doubts you may have on those few transistors which fall into the low Beta range between 5 and 10. The minimum Beta listing in the Reference Book will tell you quickly what the low limit should be on the transistor gain. With this information, you can readily determine if the transistor is acceptable or if it should be replaced. Remember, only the Sencore TF166 backs up every test with a complete reference book!

Sencore Reference book gives minimum gain for all transistors for fast decision-making.

TRANS	BASE	POWER	POL	GAIN min.	LEAK Icbo
2N617	32	Lo	P	9*	6
2N618	56	Hi	P	60	300
2N619	500	Lo	N	8*	.1
2N620	500	Lo	N	15*	.1
2N621	500	Lo	N	30*	.1
2N622	32	Lo	N	15*	.1
2N627	56	Hi	P	10	5mA
2N628	56	Hi	P	10	2mA
2N629	56	Hi	P	10	1mA
2N630	56	Hi	P	10	700
2N631	32	Lo	P	120*	25

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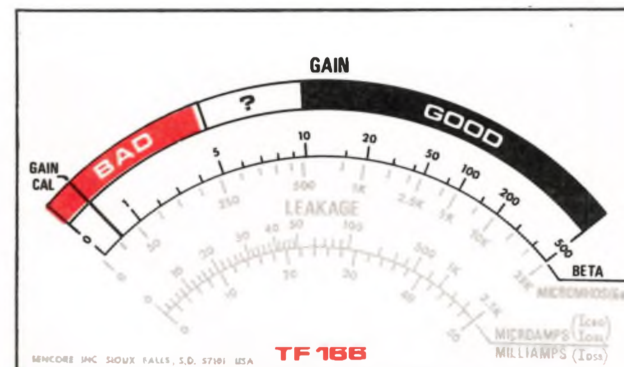
?9 IS BETA REALLY CRITICAL? ?

The regular transistor is a current controlled, current amplifying device. The term for expressing its gain is Beta. The Beta figure represents the change in collector current caused by a base current change. Since the base is the controlling element, any change occurring in its input should be amplified and appear as a larger change in the collector circuit. Whether the transistor is used as an amplifier stage, clipping stage, control stage or an oscillator, it must have some degree of gain to perform its task properly.

Beta is important to the engineer who is designing the circuit, because all circuit component values must be chosen to provide the proper operation and output levels from the transistor. Here it is essential that the Beta of a transistor be known.

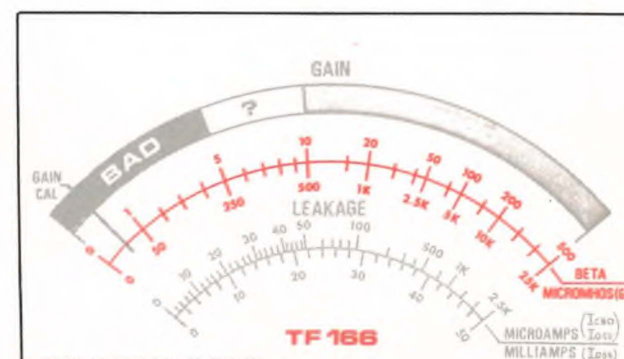
Those who are engaged in servicing electronics equipment normally do not need to know the exact Beta of a transistor to determine whether it is good or bad. All that is needed is to know whether there is any gain or not. When dealing with tube-type electronics you must be concerned with how much gain a particular tube has, since it will age and change as it is used. This is not the case with a transistor. The transistor you test today will most likely have the same gain as when it was installed at the factory, unless some catastrophic failure has occured. This fact makes it possible to reduce the complexity of Beta ranges, Beta multipliers and other confusing engineering terms to a simple GOOD-BAD scale. After all, that is what you really want to know, is it good or bad.

The values chosen to represent the areas of good, questionable, and bad for the meter scales were carefully selected. The selection of these values involved testing many hundreds of different transistor types, gathering data from manufacturers specification sheets and conversations with engineers who design the transistors. It was unanimously agreed that any transistor testing with a Beta of 10 or more should be able to perform the task for which it was placed in the circuit. If the Beta was in the range of 5 to 10, the performance of the transistor should be questioned. Below a Beta of 5, the transistor could be considered bad. This, then, became the range of the good, questionable, and bad sections of the meter scale.



Easy to interpret GOOD-?-BAD scale makes transistor servicing faster than ever before.

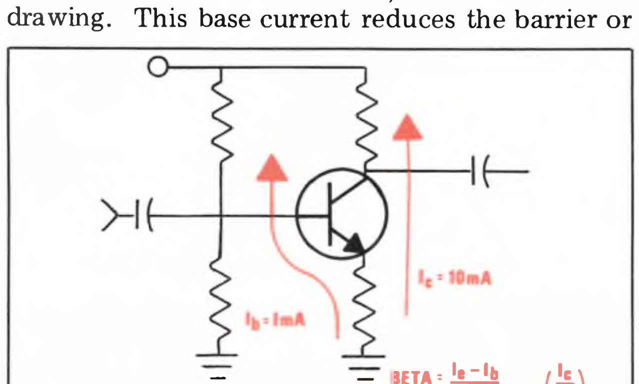
The TF166 also has accurately calibrated scales for Beta and Gm for those technicians and engineers who require precise information. The Beta scale covers a range from 0 - 500 and the Gm scale extends from 0 - 25,000 micromhos. Whether you are after a quick go-no go test or looking for the precise value of gain, the TF166 will do the job with just a push of a button.



Calibrated Beta and Gm scales provide exacting transistor and FET measurements.

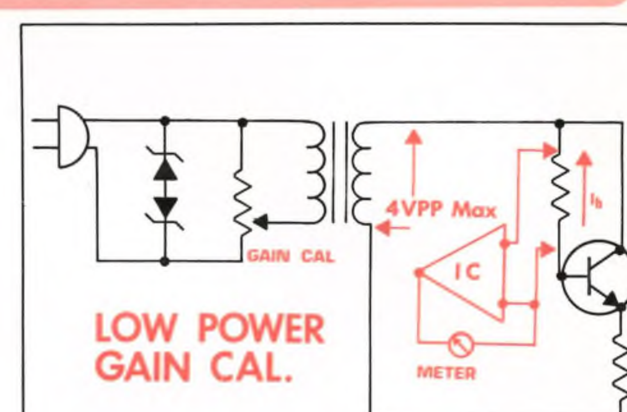
? 10 HOW DOES THE TF166 CHECK GAIN? ?

Before we get into the actual circuitry and the method by which the TF166 measures the gain of a transistor, let us review again the engineering formula for determining transistor gain or Beta. The formula is stated $B = \frac{Ic}{Ib}$. The formula can be simplified by following this illustration. In order to have a regular transistor operate, it must be forced into conduction. This is done by creating a current from emitter to base, or Ib shown in the drawing. This base current reduces the barrier or



ENGINEERING FORMULA FOR BETA

region of resistance between the emitter and the collector. With the proper voltage applied to the collector, current will flow between the emitter and collector. The Beta formula states that the level of gain or Beta of the transistor is determined by how well the base current can control the collector current. A 1 milliamp base current, as shown, creating a collector current of 10 milliamps gives the transistor a Beta or gain of 10. If the same 1 milliamp of base current creates a collector current of 20 milliamps in a different transistor, that transistor would have a Beta or gain of 20.



Gain Cal control adjusts base current (Ib) for precise value for test.

This simplified drawing shows a low power transistor connected to the TF166 set for the low power range. At this point in the test procedure, the test connections are providing potentials to both the base and collector, in the correct polarity to create a current flow through the transistor. The base current is flowing through the 8 ohm resistor in series with the transistor base lead and develops a voltage drop across it. This voltage is applied across the inputs of a sensitive operational amplifier. The meter is connected across the operational amplifier, allowing the base current to be monitored. The Gain Cal control adjusts the level of AC signal applied to the transistor, and thus the base current. Adjusting the meter pointer to the Gain Cal line with the Gain Cal control presets a precise level of base current for test. The base current levels selected for test are as follows: RF-IF 10 microamps, LO POWER 30 microamps, MEDIUM POWER 100 microamps, and 300 microamps for HIGH POWER tests. The next step in the

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CHOOSE FROM SENCORE'S 21 MOST POPULAR INSTRUMENTS

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- **DC OUT OF CIRCUIT TEST** for 100% testing capability. Only the Sencore TF166 gives you both AC and DC tests for fast problem solving.
- **LEAKAGE TESTS** for transistors (Icbo) and FET's (Igss) with direct read-out in microamps of leakage current.
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- **LEAD STORAGE COMPARTMENT** to prevent lost or tangled leads.

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FE23 *Little Henry*

FIELD EFFECT MULTIMETER

$85.00

THE TOUGHEST LITTLE METER IN THE WHOLE WIDE WORLD . . . WITH 1.5% FET ACCURACY AND PUSHBUTTON EASE OF OPERATION.

FULLY PROTECTED to 500 times overload

MINIMUM CIRCUIT LOADING with 15 megohm DC input impedance

AUTOMATIC SHUTOFF to prevent battery rundown

COMPARTMENT FOR STORING LEADS has snap action cover to prevent loss of leads

ILLUMINATED meter is fully protected with exclusive sliding cover

SIMPLE PUSHBUTTON OPERATION

1.5% DC ACCURACY - 3% AC

FE16

$90.00

Lab Accuracy
1.5% DC
3% AC

ACCURATE
RUGGED

LESS CIRCUIT LOADING THAN VTVM. 15 megohms on DC, 10 megohms on AC.
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FULL METER PROTECTION to 100 times AC overload. No more damaged meters.
SPECIAL SHIELDED INPUT LEADS prevent stray pick-up and erroneous readings.

SPECIFICATIONS

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CHECKS MORE TUBES THAN EVER BEFORE. Pin elimination allows tubes to be tested which could not be checked before.

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PATENTED PUSHBUTTON AUTOMATIC TRACKING TEST. Simply push a button to make the previously complicated tracking test.

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4½ INCH METER

LAB OR BENCH

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with 30KV hi voltage probe

A SERVICEMAN'S DREAM

PUSHBUTTON OPERATION with 7 inch meter

112 RANGES AT YOUR FINGERTIPS

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- **LOW POWER OHMS** using .08 volts to make in-circuit resistance measurements accurately. Allows you to use latest Howard Sams service information. Sams specifies it, only Sencore has it.

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- **ONE-TENTH VOLT FULL SCALE** sensitivity on both AC and DC voltage. A must when servicing in solid state circuit with critical low voltage biases.

- **PROTECTED TO 1000 TIMES OVERLOAD.** A truly burnout proof multimeter. Tested in production with 1,000 volts on .1 volt range. Multimeter resistors protected by .6 amp fuse to save these valuable and expensive components. No more trips to factory when you accidentally measure volts on ohms range.

SPECIFICATIONS FE20 and FE21

9 DC Voltage ranges from .1 to 1000 volts full scale
3 High Voltage ranges of 3, 10 and 30KV
9 DC Zero Center ranges from .05 to 500 volts
9 AC Voltage ranges from .1 to 1000 volts full scale
9 AC Peak-to-Peak ranges from .28 to 2800 volts
9 DC Current ranges from 100 microamps to 1 amp full scale
7 Hi Power ohms ranges from 1000 ohms to 1000 megohms
6 Lo Power ohms ranges from 1000 ohms to 100 megohms

SPECIFICATIONS for FE160

10 DC Voltage ranges from .1 to 3000 volts full scale
10 DC Zero Center ranges from .05 to 1500 volts
9 AC Voltage ranges from .1 to 1000 volts
9 AC Peak-Peak ranges from .28 to 2800 volts
10 DC current ranges from 30 microamps to 30 amps full scale
10 DC current ranges from 30 microamps to 3 amps full scale
8 Hi Power ohms ranges from 600 ohms to 6000 megohms
7 Lo Power ohms ranges from 600 ohms to 600 megohms

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All New Dual-Trace Triggered or Free Running Oscilloscope

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Speed Aligner SM158 $275.00

Deluxe Generator SM152

Sencore all solid-state sweep marker generators are constructed to provide the necessary signals for sweep alignment and troubleshooting. The SM158 and SM152 have these common specifications:

- **CRYSTAL CONTROLLED MARKERS** for alignment accuracy.
- **15 MEGAHERTZ SWEEP WIDTH** to cover the entire IF band.
- **SIMPLE HOOKUP** with just four cables, 2 to TV, 2 to scope.
- **ZERO BASE LINE** for reference when adjusting traps and positioning carrier markers.
- **POST INJECTION MARKERS** for distortion free response curves.

$450.00

If it is speed and simplicity that you want, the all crystal controlled SM158 is your answer and at $120.00 savings over competition.

- **PUSHBUTTON MARKERS** for the eight most often used IF frequencies: 39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, and 47.25. Trap and carrier markers listed right on front panel for fast identification.
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- **HORIZONTAL MARKERS** available at the flip of a switch.

If it is completeness that you want, the SM152 is the most complete on the market.

- **RF SWEEP FOR ALL BANDS,** VHF, UHF, FM, IF, and Chroma.
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Sencore Color Generators offer these all new outstanding features:

- **SMALLER LINES AND DOTS** for the most precise convergence ever.
- **PERMA-LOCK CIRCUITS** which match or out-perform the digitals.
- **"PAINTED PATTERNS"** so rock solid you'll think they are painted on the screen.
- **STANDARD PATTERNS** including RCA licensed color bars for every convergence need.

Caddy Bar Jr.

- **"POCKET SIZED"** measuring a mere 2 x 4 x 6. (Size of two 5U4's)
- **PUSHBUTTON OPERATION** for ease of operation.
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LOWEST PRICED FIELD STRENGTH METER ON THE MARKET TODAY.

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- **COMPLETE COVERAGE** of all VHF, UHF, and FM bands.
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- **COMPLETELY PORTABLE** to go where you need it without extension cords.
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Power Monitor

THE MOST PRACTICAL SERVICE TOOL EVER DEVISED.

- **AC VOLTMETER** from 65 to 135 volts. Calibrated at 115 volts for more accuracy than VOM.
- **AC AMMETER** up to 10 Amps. Check fuse and circuit breaker currents in a flash.
- **AC WATTMETER** up to 1150 watts. A real trouble shooter.
- **DC AMMETER** up to 10 Amps.
- **FUSE RESISTOR CHECKER** with special scales for each resistor.
- **MAKE ALL TESTS** with interrupted line cord or test leads.
- **FULLY PROTECTED** against shock hazard to appliance, instrument and operator.

PM157 $69.50

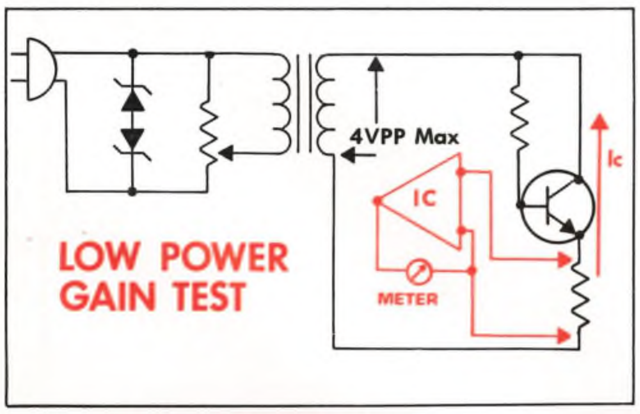
Prices shown in effect at time of printing. Prices and specifications subject to change without notice.

Printed in U.S.A.

TF166 BASE CURRENT LEVELS

RF-IF	LO	MED	HI
10uA	30uA	100uA	300uA

test procedure is to depress the Gain pushbutton and observe the reading on the meter. Depressing the GAIN button removes the meter and op amp from the base circuit and connects it across the 8 ohm emitter resistor. We can now monitor the total current flowing through the transistor. The increase in current flow in the emitter circuit, compared to the base circuit, appears on the meter as an upscale indication. The degree of upscale

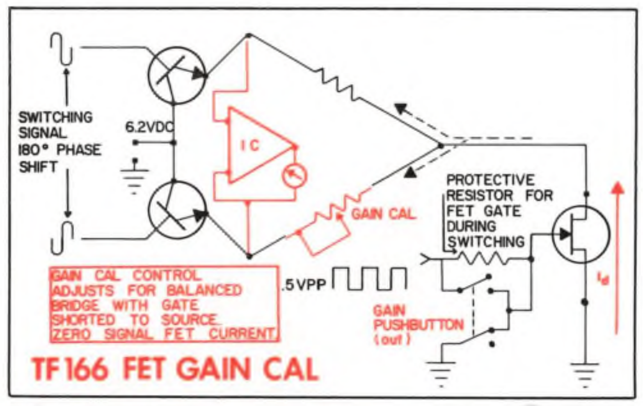


reading corresponds to the amount of emitter/collector current caused by the preset level of base current. If we look back for a moment to the formula for Beta, you can see that the TF166 follows exactly the textbook formula for Beta.

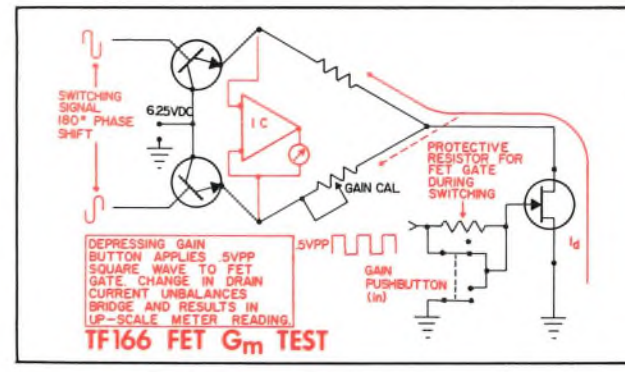
The FET is checked differently than the transistor. The FET is a voltage amplifing device, similar to the vacuum tube. The gain factor for an FET is mutual conductance or Gm, the same as for the tube. The formula for Gm for a tube or an FET is stated:

$$Gm = \frac{\triangle Ip}{\triangle Eg} \text{ (tube)} \quad \& \quad Gm = \frac{\triangle Idrain}{\triangle Egate} \text{ (FET)}$$

Therefore, to obtain an accurate measure of the performance of an FET, the tester must be able to measure the change in drain current, compared to the gate voltage change which caused it. Here again, the TF166 has been designed to allow you to measure gain as prescribed by the math formula.



The meter and sensitive op amp of the TF166 are connected across a resistive bridge for the Gm test. The Gain Cal is adjusted first to provide equal currents through each side of the bridge with the FET gate shorted to the source (no sig). When the Gain button is depressed, a low level, (0.5 VP-P) square wave is applied to the gate. The



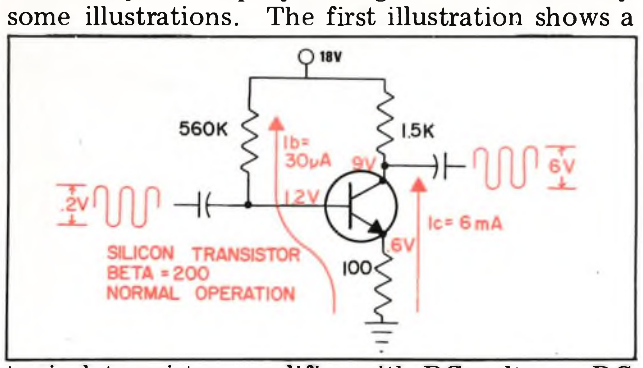
corresponding change in drain current causes an unbalance in the bridge circuit. This unbalance is amplified by the op amp and applied to the meter. The meter scale is calibrated so any upscale movement shows Gm.

As you can readily see, the voltages and currents used to provide the test information for both transistor and FET's are very low, with the high gain operational amplifier to drive the meter. Using these low potentials provides the protection necessary for the device being tested. Even if the test leads are incorrectly connected, or the FET is checked as a regular transistor, no damage will occur. Other types of testers, usually lower priced because they do not contain amplifiers, use voltages up to 200 volts and have current capabilities of up to 1 amp. These levels are sufficient to destroy a transistor if the connections are incorrectly made or the device is tested wrong. The TF166 uses state of the art integrated circuitry to allow safe and accurate testing of all transistors and FET's, by the book, and AUTOMATICALLY.

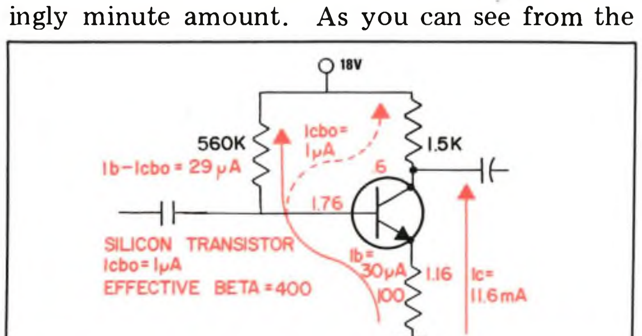
? 11 HOW IMPORTANT ARE LEAKAGE TESTS? ?

Before we jump right into making a leakage test, we should be aware of what leakage really is. The most common and most critical leakage is Icbo, reverse current through the base/collector junction.

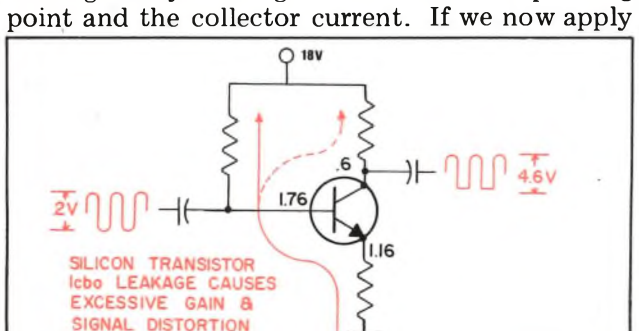
Let us try to simplify leakage and its effects by some illustrations. The first illustration shows a



typical transistor amplifier with DC voltages, DC currents and signal voltages present. This is a normally operating circuit without leakage between base and collector. Now let us look at the same circuit with Icbo of 1 microamp, a seemingly minute amount. As you can see from the

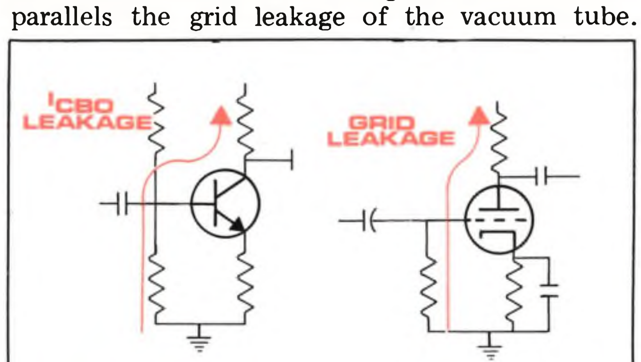


drawing, the DC biases are altered considerably, causing a major change in the transistor operating point and the collector current. If we now apply



the same signal as shown in the first drawing, we can dramatically illustrate the effects of leakage on the performance of the circuit.

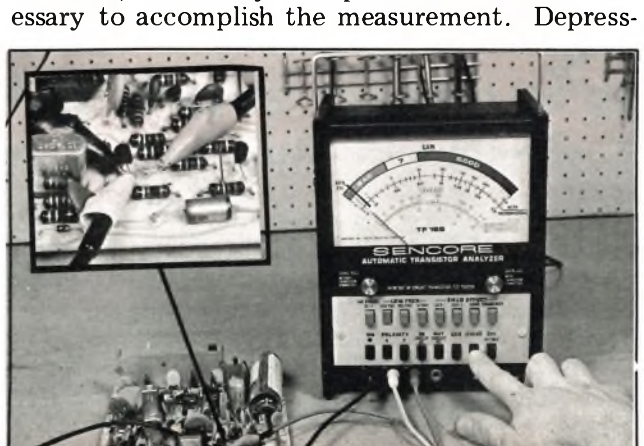
The comparison drawings below point out that the effect of the Icbo leakage of the transistor parallels the grid leakage of the vacuum tube.



Transistor Icbo and tube grid leakage are essentially the same.

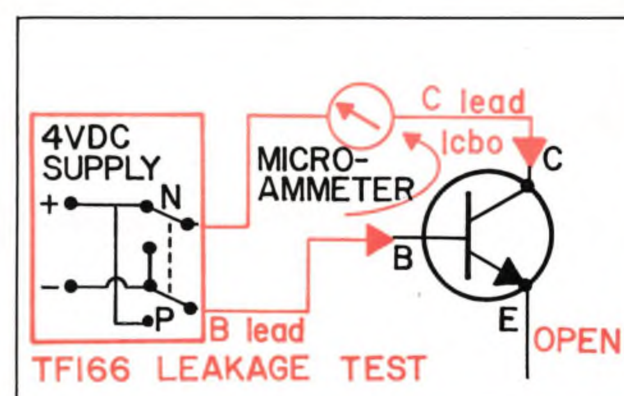
Now that a basic understanding of Icbo leakage has been accomplished, you will probably want to make this your second most important test.

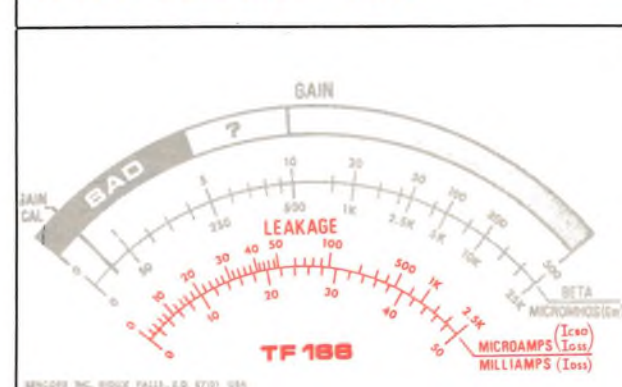
Since there are many different leakage or shunt paths present about the transistor when it is in circuit, it is virtually impossible to obtain any meaningful in-circuit test. Lifting the collector lead, or removing the transistor from the circuit, eliminates all the shunt paths and makes an accurate leakage test possible. The TF166 incorporates the Icbo leakage test as an integral part of the unit, with only the push of a button necessary to accomplish the measurement. Depress-



Pushbutton leakage test checks questionable transistors fast.

ing the LEAKAGE pushbutton disconnects the emitter lead and applies a 4 volt DC potential across the base/collector junction in a reverse bias direction. Again, the voltage applied for the test has been kept low to avoid any possible damage to the transistor. The reading obtained on the meter is directly in microamps of leakage current. The leakage test is ultra-sensitive, allowing accurate measurements of leakage currents as low as 5 microamps.

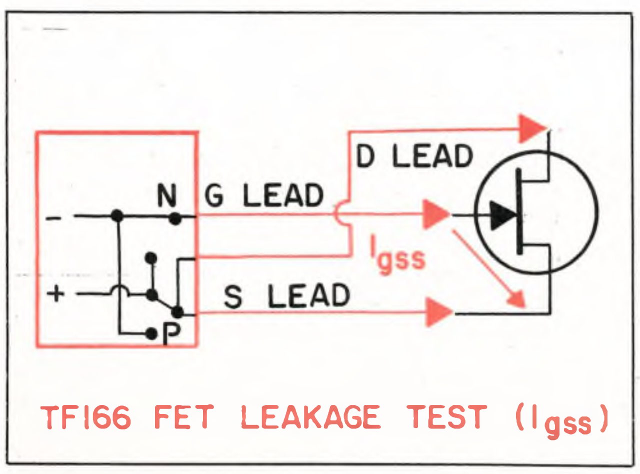




Clearly marked scales give direct leakage readout in microamps.

Leakage can also exist in junction FET's and cause problems in circuit performance. The leakage most common to FET's is termed Igss, or, stated more simply, leakage between the gate and source. This technical terminology can be somewhat misleading since the leakage indicated by the term Igss is actually between the gate and channel. Unlike the dual junction construction of a regular transistor, the FET has only a single junction. That junction is between the gate and channel. Since the source lead is on one end of the channel and the drain lead on the other end, Igss could as well be stated as Igds, or leakage between the gate and drain. Now it may be more readily apparent that this leakage is also the equivalent to grid leakage in a vacuum tube. The same problems created

by grid leakage in tube circuits can be caused by excessive Igss in FET's. Now how about testing for Igss? The TF166 uses the same basic test for Igss on FET's as is used to check leakage on regular transistors. The only major difference between the regular and FET leakage tests is that the source and drain leads are shorted together for the



FET leakage measurement. The same, single pushbutton test is used -- just push the LEAKAGE pushbutton.

? 12 WHAT CAUSES LEAKAGE? DOES IT AFFECT GAIN?

Silicon and germanium are both resistive materials and because they are resistive, some natural leakage will exist in every junction. The chart shown here indicates the normal leakage to expect from

TYPICAL TRANSISTOR LEAKAGE CHARACTERISTICS

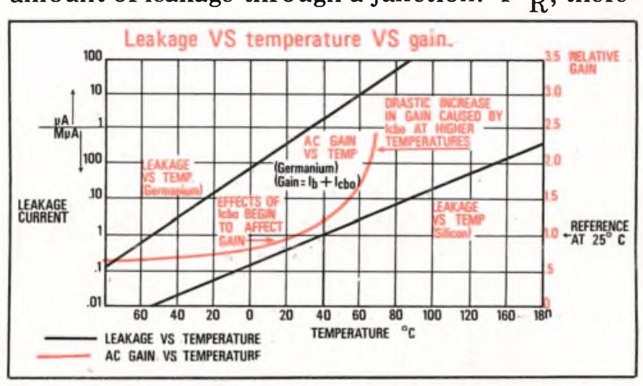
GERMANIUM		SILICON	
RF-IF	0–5 µA	RF-IF	0–.5 µA
LOW PWR.	5–50 µA	LOW PWR.	0–.1 µA
MED. PWR.	50–500 µA	MED. PWR.	.1–300 µA
HIGH PWR.	500–5000 µA	HIGH PWR.	UP TO 500 µA

different transistors. The question now is, what causes leakage to be higher than normal?

When the junction was originally formed, a barrier region was created. Application of excessive voltage or high temperatures can cause the barrier region to change or break down partially. This reduces the reverse resistance across the junction and increases leakage. If the barrier breakdown is complete. the result is a shorted transistor.

12a. WILL LEAKAGE EVER VARY ON A GOOD TRANSISTOR?

A very large but definite resistance is present across every junction. Since resistance is present, Ohms Law comes into play in regard to the amount of leakage through a junction. $I=\frac{E}{R}$, therefore the junction leakage will be directly proportional to the voltage across the junction. The higher the voltage, the higher the leakage will be.



Leakage will also vary widely with temperature variations. If you wish to prove this for yourself, simply set up the leakage test and observe the level of leakage present at room temperature. Then raise the temperature of the transistor by holding it close to a soldering iron or small flame. You should note a drastic rise in leakage as the transistor temperature increases. Mathmatically, the leakage will double for each 6° C temperature increase for silicon, and for each 10° C rise in germanium. Although this may at first sound like mumbo-jumbo, it is important to keep in mind when testing transistors. For example, you have just taken a transistor out of the circuit and the leakage tests higher than it should. Could it be that the transistor is still hot from the soldering iron, making the leakage higher than normal?

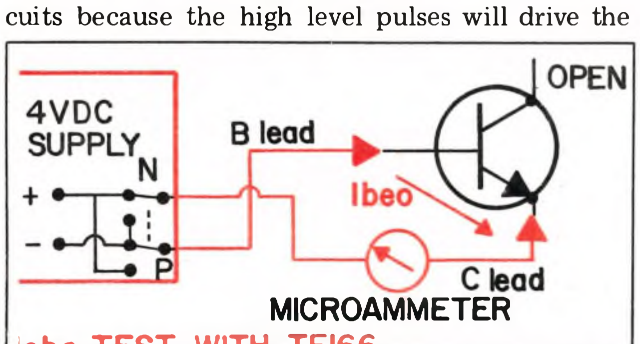
Another point that may also be of some help; if you suspect the transistor of being leaky because of its circuit performance, hold it between your fingers for a couple of moments while checking leakage to see if it rises. If the leakage increases substantially or exceeds the maximum level with just an increase to body temperature, it will exhibit a much higher leakage when operated in circuit. The results of this test would be sufficient reason to discard the transistor as defective.

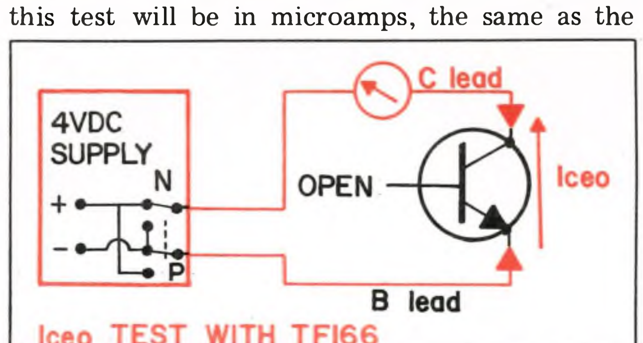
12b. WHERE DO I FIND LEAKAGE INFORMATION IF I'M LOST?

The chart shown above will provide the general leakage information that you will most often need. Should precise leakage values be needed, the Transistor and FET Reference Book contains this information. The leakage figure given is the maximum leakage a transistor should have at the 4 volt test potential used in the TF166. The pushbutton automatic TF166 makes transistor testing easier than ever before and the complete "fact" book gives you complete back-up information for every test you make.

? 13 ARE THERE OTHER KINDS OF LEAKAGE? IF SO, WHAT AND HOW DO YOU MEASURE? ?

Icbo for the regular transistor and Igss for the FET are the most important leakages to the technician dealing with consumer electronics. Those dealing with pulse circuitry have another leakage to consider and that is Iebo. This is leakage present across the emitter/base junction in a reverse bias direction. This leakage is important for pulse circuits because the high level pulses will drive the emitter base junction deep into reverse bias. Leakage across this junction could affect the shape, amplitude and timing of these circuits. Iebo can be easily checked with the TF166 by connecting the base lead normally, connecting the collector test lead to the emitter, and depressing the LEAKAGE pushbutton. The reading obtained for this test will be in microamps, the same as the test for Icbo. The value of Iebo should be very low in a good transistor, equivalent to the value expected for Icbo.

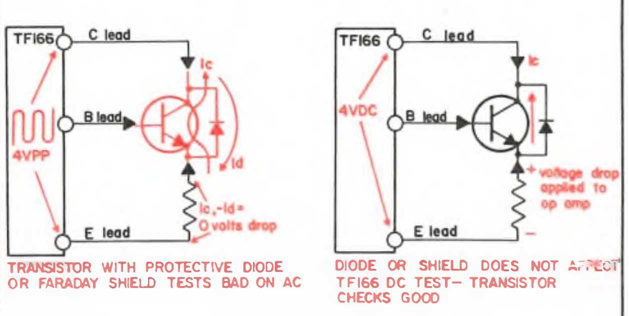




Another leakage test which is used in some special applications is Iceo, or leakage current between the collector and emitter with the base lead open. The voltage applied for this test is of the same polarity as that of normal operating potentials. This leakage will be somewhat higher than the others mentioned, usually equal to Icbo times the Beta of the transistor. In other words, if the transistor has a maximum Icbo of 2 microamps and a Beta of 200, the maximum value of Iceo should not exceed 400 microamps. Here again the leakage can be easily measured on the TF166. Simply connect the collector lead normally, the base lead to emitter, and push the LEAKAGE pushbutton. The level of Iceo leakage can be read directly on the meter in microamps. Whatever type of leakage is important to you and your application, the TF166 Automatic Transistor Analyzer will give you the information you need at the push of a button.

? 14 DOES THE TF166 WORK IN-CIRCUIT EVERY TIME? SHOW ME WHY, THEN I'LL BUY. ?

The only way to find out whether the TF166 is reliable for in-circuit testing is to use it in circuit, and this is exactly what we have done. Hundreds of different transistors in different types of circuits found in every conceivable electronic device have been tested. The results of this testing prove the TF166 in-circuit reliability, about 97% on the AC test to be exact. It will test virtually every transistor in every circuit that you will encounter. It would be foolish for us to say that the TF166 will test every transistor in-circuit every time, since unusual circuits or problems may crop up from time to time that would affect test results. There are even a couple of cases that we know where the TF166 AC test doesn't work. One is the new type of transistor for RF applications that has the internal Faraday shield to reduce the inter element capacity of the transistor. The Faraday shield is effectively an additional junction between the collector and emitter. The AC test signal will flow through the normal emitter/collector path on one half cycle and will flow through the shield on the alternate half cycle. The TF166 sees this as a shorted transistor and does not register gain. The other case is much the same, and that is the circuit that has a very low impedance or a protective diode connected between the emitter and collector. Here is where a tester with both the AC and DC transistor tests stands out alone. The DC test will check the transistors in both of these cases, in-circuit and accurately! You always have back-up for the AC IN CIRCUIT test with the TF166. If the transistor tests bad with the AC test, take an extra few seconds to repeat the test using DC.



AC test, with back-up DC test used in-circuit, provides virtually 100% in-circuit test reliability.

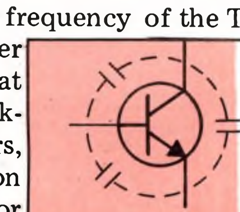
If both tests show the transistor bad, you can rest assured that it is bad. In-circuit test reliability of virtually 100% with a sensitive, low impedance AC test and a back-up DC test to catch them all. The TF166 has this kind of reliability designed in, to give you the complete testing capability you need, in circuit or out.

16 WHAT ABOUT FREQUENCY? ISN'T IT IMPORTANT?

The maximum frequency at which a transistor will operate is very important to the design engineer working on high frequency circuits. The Alpha cutoff, or high frequency limit on a transistor must be sufficiently above the maximum frequency at which the transistor will be operating. The engineer obtains this information from the manufacturers specifications or other literature and chooses the transistor he feels best suited for the job. A tester that will check the frequency cutoff of a transistor, or even make a Beta test at a variety of different frequencies is not readily available for two main reasons. One, it is quite difficult to develop a means of producing a test frequency from DC to several gigahertz. Second, the cost of such a unit would make the tester practical only to those who manufacture the transistors and must make these tests. Since there is really no practical means available to test the transistor for frequency cutoff, the engineer usually makes his tests by an in-circuit trial and error method.

When checking transistors to locate a defective device or to select a good replacement, the test frequency is relatively unimportant. The Beta of the transistor will not change because of frequency.

The high frequency cutoff is caused by the inter-element capacity of the transistor. If a transistor checks bad at the 60Hz test frequency of the TF 166, it will be bad whatever frequency it is to operate at in the circuit. As far as checking the replacement transistors, we must make the assumption that the transistor chosen for replacement is the exact replacement for the original, or one of the universal types specified to cover the frequency range required for the circuit. If it tests good with either the DC or AC tests of the TF166, it would perform as intended in the circuit.



Internal capacity = poor frequency response

? 15 WHY NOT CHECK EVERYTHING IN CIRCUIT? WHY DC OUT OF CIRCUIT? ?

There are several reasons for having both an AC and DC test for transistors. Let us list some of them.

1. The AC IN—CIRCUIT test is highly reliable, but it is possible that some circuit configuration will not permit accurate in-circuit testing.

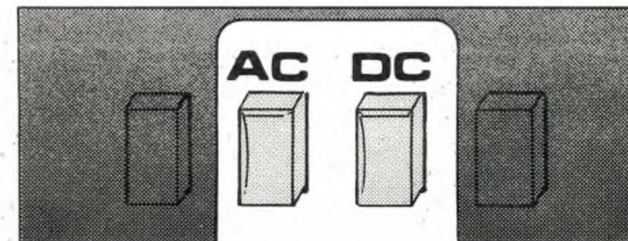
2. Many applications call for an accurate DC Beta which may differ somewhat from the AC Beta.

3. Leakage tests are to be made with DC voltage source and, because of circuit shunts, cannot be made in-circuit.

4. Some newer types of transistors are being manufactured with internal protective diodes and shields which will not test accurately with AC, either in circuit or out.

The TF166 has an AC test for in-circuit testing to speed and simplify transistor troubleshooting. The DC out of circuit test is an integral part of transistor testing and no tester would be complete without it. The DC test is a fast, 1, 2, 3 test making it easy to make a final out-of-circuit check of a transistor, before ordering or installing a replacement. The DC test allows each replacement transistor to be checked before it is installed, often saving several minutes of extra work. The DC test also serves as a secondary in-circuit test to help pinpoint the defective transistor in those few cases when the AC test cannot be made accurately.

The DC test is invaluable in those engineering applications when it is necessary to know the DC Beta value. Leakage tests are very important for many applications, and these tests can be made out of circuit only. The leakage tests are far more accurate and meaningful when they are made using DC potentials. It may come to mind that it would be simpler to just use DC for all tests, rather than have both AC and DC. The problem that arises



Only the Sencore TF166 gives you both AC and DC tests!

with this theory is that the DC in circuit test can be lead astray much more easily than an AC test. There are many DC shunt paths in transistorized equipment, and these shunt paths will create many, many situations where an in-circuit test is not possible. To be really complete, and do the job of a Transistor Analyzer, a unit must have both AC and DC tests. The TF166 is a complete Transistor Analyzer.

? 17 WHY DOESN'T SENCORE MAKE A CURVE TRACER INSTEAD? ?

Sencore has looked into the possibility of designing and manufacturing a curve tracer. The curve tracer is, and has been since its origin, an engineering tool. It has the capabilities of providing the engineer with much information regarding the transistor's parameters. However, we have not been convinced of the curve tracers merit in the service industry as a means of making servicing faster and easier.

First, an oscilloscope is required for interpretation of the test results. This prevents the tracer from being a portable service tool which can be used easily in the home or away from the shop or lab.

Second, the tracer requires interpretation of a family of curves to arrive at any meaningful conclusions for the test. This interpretation is usually centered around engineering parameters and mathematical calculations which would involve too much time for the busy technician.

Third, the tracer is an out of circuit tester, meaning the transistor must be removed before any test can be made. This exposes the transistor to possible destruction from heat.

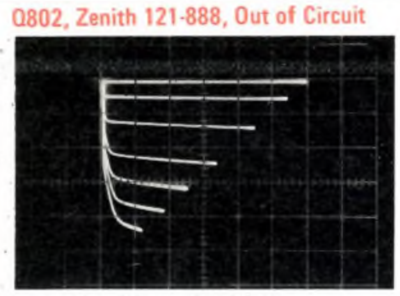
Fourth, the curve tracer provides outputs which can cause destruction of the transistor. Collector sweep voltages of up to 200 volts and current capabilities of up to 1 amp or more can be very destructive.

Fifth, even though curve tracers are advertised as in-circuit testers, the results obtained with in-circuit tests can be most confusing and often misleading.

Here is an out of circuit family of curves for a 121-888 Zenith transistor. These are meaningful curves and much information can be obtained from proper interpretation. The three curves shown below are all taken in-circuit, in different circuits of the Zenith 25D56 chassis, using the same 121-888 transistors. Can you tell whether or not the transistor is good or what the Beta might be? The first two curves are of good transistors, and the third curve was taken when the emitter lead happened to slip off the transistor.

Can you honestly trust the results of this type of tester? We do not feel that we can and have devoted our efforts to providing a simple-to-use, self-contained transistor analyzer that works in or out of circuit reliably, without any possibility of damaging the transistor or the circuit. The result of this effort is the TF166 Automatic Transistor Analyzer. No interpretation problems, additional equipment or need for reference information, and no chance for transistor damage. Consider these points carefully before you buy.

Q802, Zenith 121-888, Out of Circuit



V_{ce}=30, I_b=10uA/step

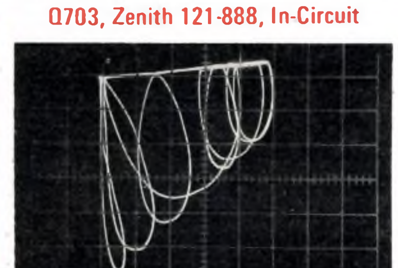
TF166 TEST
DC Out Circuit, Low Power, Beta = 90

Q802, Zenith 121-888, In-Circuit

V_{ce}=10V, I_b=20uA/step

TF166 TEST
AC In-Circuit, Low Power, Beta=90

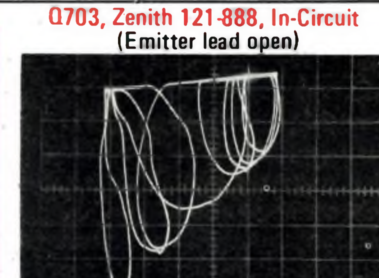
Q703, Zenith 121-888, In-Circuit



V_{ce}=10V, I_b=10uA/step

TF166 TEST
AC In-Circuit, Low Power, Beta=85

Q703, Zenith 121-888, In-Circuit (Emitter lead open)



V_{ce}=10V, I_b=10uA/step

TF166 TEST (Emitter lead open)
AC In-Circuit, Low Power, Beta=0

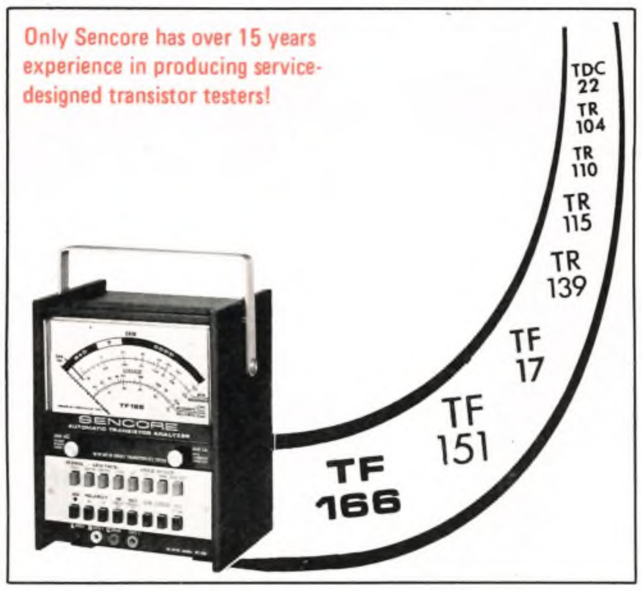
Comparison of test results with TF166 and curve tracer. Which gives you the best servicing information?

? 18 CAN THE TF166 BECOME OBSOLETE?

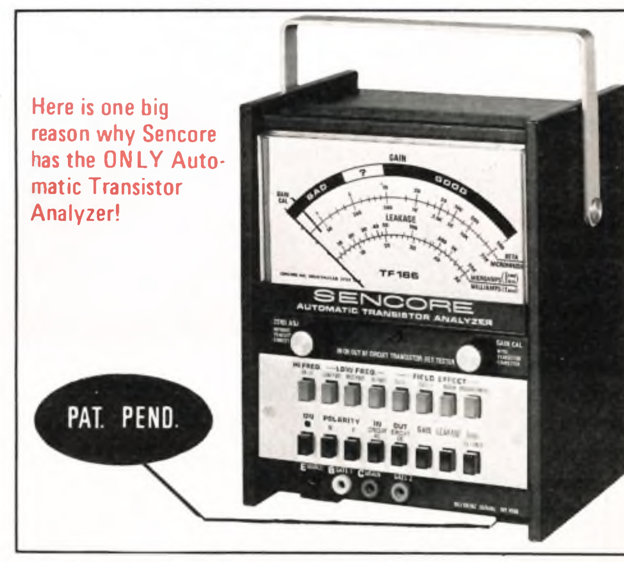
A liberal definition of obsolete would be something that would no longer adequately perform the function for which it was designed. The TF 166 has been designed to enable the user to test transistors and FET's, in-circuit or out-of-circuit with reliable results. This function the TF166 can perform, unless the transistor totally disappears from use. The TF166 has a major advantage over other transistor testers from the standpoint of obsolescence. The TF166 is the only tester or analyzer available that provides both AC and DC tests for transistors. This design permits testing of any new transistors that may be introduced. The total testing capability and automatic operation of the TF166 will make it a very useful and valuable tool for many years to come.

19 HOW COME NO ONE ELSE BUILDS AN AUTOMATIC TRANSISTOR AND FET TESTER IF THEY ARE SO GOOD?

Sencore has endeavored, through the years, to provide reliable, practical service and troubleshooting instruments. We have built several different types of transistor testers, each new unit carrying improvements and new ideas over the previous model. This has been necessary to keep pace with the rapid changes in the field of semi-conductors. The first unit announced, some 15 years ago, was



the TDC22. This was a DC tester to be used out of circuit with a set-up book. Very few transistors were in use at that time and the TDC22 could very adequately make the necessary tests. Next, came the TRC4, a tester that did not require a set-up book. An improved model, the TR115, was the next advance in solid state testing. In 1960, Sencore produced its first in-circuit transistor tester, the TR110. This was the first tester to provide testing without removing the transistor from the circuit. By 1965, it was apparent that transistorized television receivers were here to stay. A new concept of in-circuit transistor testing was introduced in the form of the TR139. The TR 139 gave technicians for the first time an in-circuit tester that would provide an accurate AC Beta reading. Shortly after its announcement, several other testers quite similar began to appear on the market. Then, the FET came along, and Sencore again provided leadership in developing testers. The patented TR151 and TF17 were the first in-or-out of circuit transistor and FET testers designed for the servicing industry. With transistors commonplace in every type of electronics equipment, many technicians have recently demanded a faster, easier means of testing the transistors and FET's. Many other companies have placed their emphasis on the current fad, curve tracers, rather than develop simpler and easier means of testing transistors. The needs of the service technician, and others looking to us for this type of equipment, inspired Sencore to develop the first Automatic Transistor Analyzer. This simplified approach to the problem of testing transistors and FET's has many new testing ideas



incorporated and is patent pending at this time. Sencore has again kept pace with the changes occuring in electronics, to try and better serve the technician.

? 20 WHY SHOULD I INCLUDE THE TF166 ON THIS YEAR'S TEST EQUIPMENT BUDGET? ?

The investment in additional equipment in any business should be based on the return which the instrument will provide or the way in which it will simplify an otherwise time-consuming or difficult task. Many items are a must for those working in electronics. The voltmeter and the oscilloscope fall into this category. The servicing of tube-type equipment would be extremely difficult were it not for the tube tester helping you locate the problems. With the tube replaced by the transistor in nearly every application, it would seem that a transistor tester is as important and necessary as the tube tester - that is, if you are to service solid state equipment quickly and profitably.

A pilot is no better than the plane he flies, and the technician is no better than the problem-solvers he uses in his work. The TF166 is a real problem-solver, when you are working on those solid-state circuits.

For example, remember how you used to cringe every time you opened up the back of the set and saw a bunch of those little creatures looking back at you? You need fear transistors no more for the TF166 will test them all, over 20,000 in fact, to get the problem solved fast.

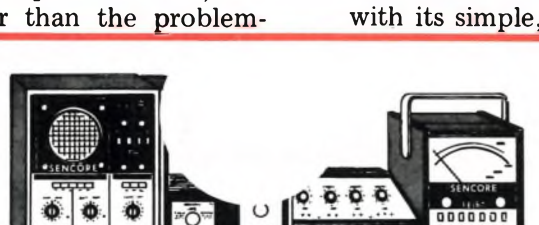
Then there are the transistor testers that you have needed the manual or a reference book to follow to make the test, and possible some pretty complicated operations which take your valuable time.

The TF166 eliminates all these headaches too, with its simple, automatic, pushbutton operation and no need for a reference book or other technical data to make the test.

There is also the matter of trying to figure out what the transistor tester is telling you after you have made the test. This couldn't be easier than the simple GOOD-BAD scale of the TF166, telling you at a glance exactly what you need to know. You and your customer will both appreciate the time-saving in-circuit test. You will get the job done faster and your customer will have the set back sooner.

The TF166 is a truly professional instrument to make sure your customer and servicing friends see you as the transistor expert you are. You can walk out those nasty transistor problems in minutes rather than hours, and the time will certainly show in the till. The little woman may even welcome the TF166, helping you get home for dinner on time, with a better disposition. The TF166 AUTOMATIC TRANSISTOR ANALYZER is YOUR problem-solver.

Bob Baum



Norm Pedersen

BOB AND NORM'S SHOP

• SERVICE TIPS
• SHORT CUTS

"Say Bob, we've got a bit of a problem over here. Maybe you can help us out."

"Sure, what is it?"

"We have this Motorola Quasar I color set with a bad IF panel. We don't have a replacement panel and the customer is anxious to get the set back for the weekend. Any suggestions on what we can do to get it going for them?"

"Well, let's think for a moment. What would you do if the problem was in a regular solid-state set?"

"I'd troubleshoot the set and find the problem, then fix it!"

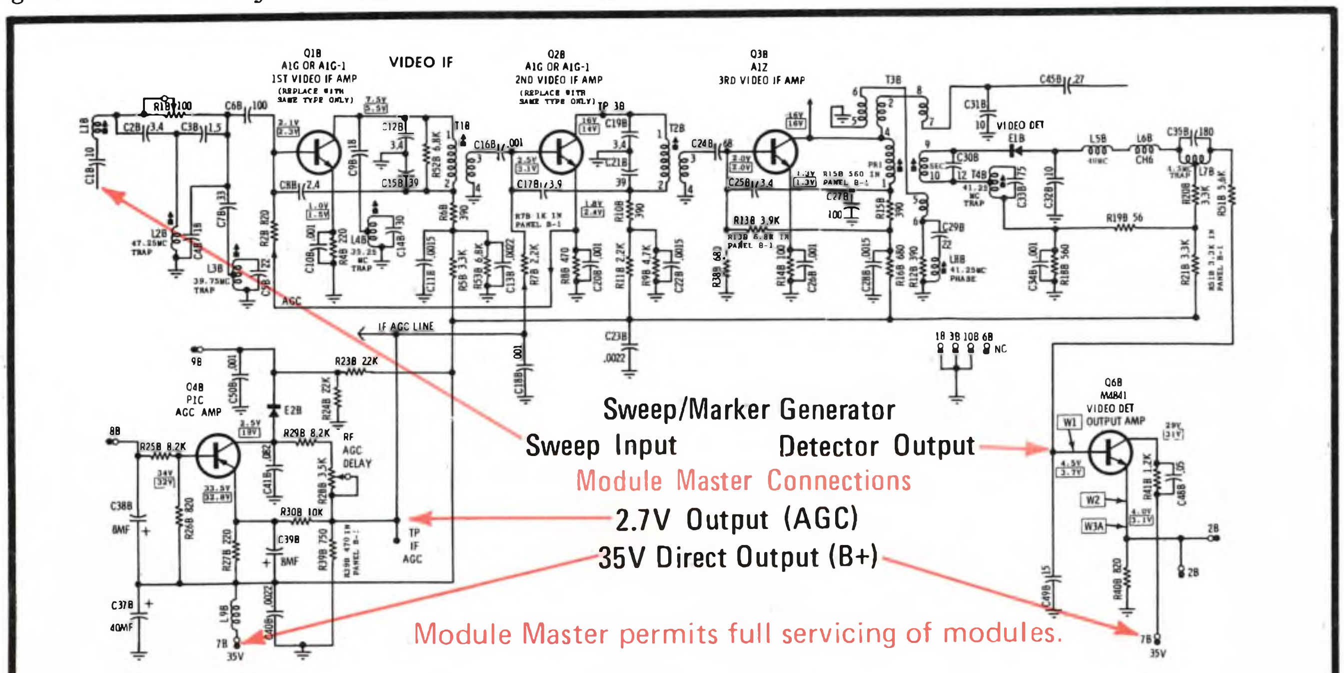
"Why don't you do that with the set you now have?"

"How can I? With the panel mounted in the set, I can't get at the board to do any troubleshooting."

"Well, take the board out and work on it on the bench where you can get at it."

"Hold it a minute - how am I supposed to get the thing to operate on the bench without the rest of the set?"

"Okay, Norm, let me show you. We have just worked out the circuitry for the 'Module Master' accessory for the UPS164 Universal Power Supply. The idea behind the Module Master is to be able to provide all the different regulated voltages you need to work on the boards. This set will give us a good chance to try it out and see how well it works. Get the board over here and we'll give it a try. Just look at the schematic and determine those points that require operating or bias voltages and then set the Module Master to give them to you. Your Motorola board requires 35 volts for the main power supply, and about 2.7 volts for AGC bias.



Quasar I "B" panel courtesy of Motorola, Inc.

Now, if we connect the Module Master and adjust to get these voltages, we will have the board operating on the bench exactly the same as if it were still in the set."

Regulated, variable outputs of the Module Master allow precise voltage adjustments for module servicing.

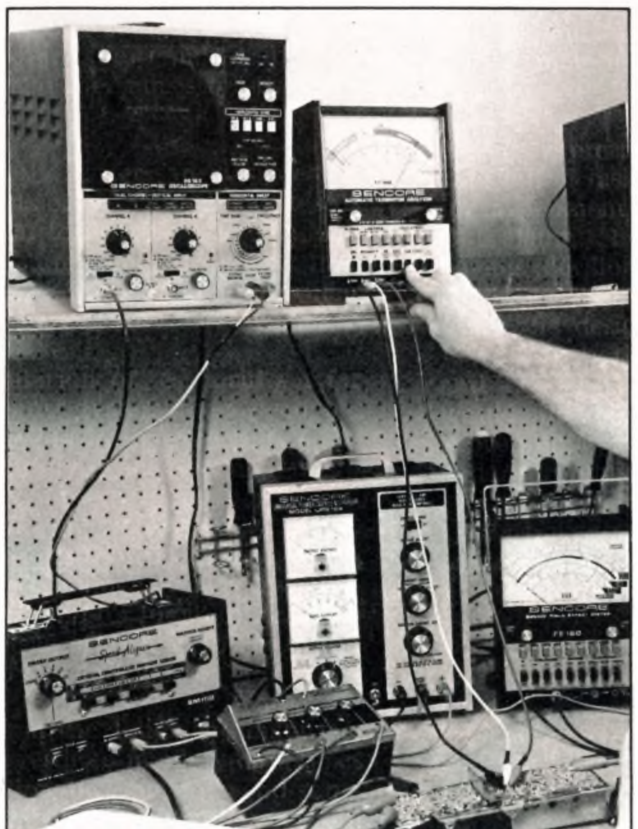
"I agree that you have the DC voltages that you need but what are we going to do about a signal for troubleshooting?"

"Good question. If you were working on a regular set, you would probably use the sweep generator as a signal source for IF troubleshooting, so why don't we use that here. Just because we are working on a plug-in section of the receiver does not mean that we have to alter our normal troubleshooting methods. Hook up the sweep generator to the IF input jack and connect the detector cable to the video output point on the board. You should be able to walk through the panel just as if it were part of a conventional set."

"Good point, Bob - let me have a few minutes to see what I can come up with."

The scope gave no indication of a response curve at the video detector output amplifier on the board, so the detector cable was moved to the 3rd IF output. Still nothing. Moving to the 2nd IF output gave a reasonable indication of the response curve so the trouble should be somewhere in the 3rd IF.

The 3rd IF transistor was checked with the new TF166 Automatic Transistor Analyzer and gave a good indication. Power up again and check the DC voltages. Ah-ha, here it is. The voltage on both the base and emitter of the 3rd IF transistor are zero, meaning the transistor is cut off. Now what can be causing that?



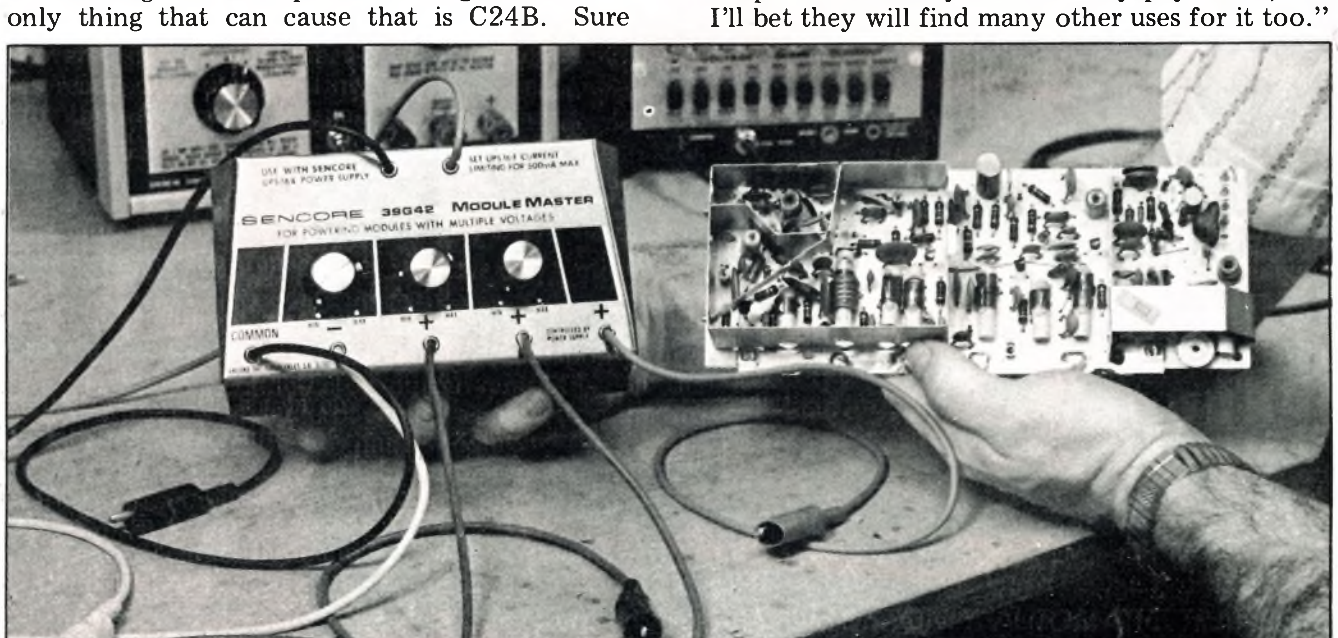
New TF166 helps Module Master pinpoint problems for you.

Since the base drives the transistor on, we must be shorting the base potential to ground. The only thing that can cause that is C24B. Sure enough, it checked dead shorted with the ohmmeter. Replacing the capacitor gave us a response curve at the video detector output amplifier. We plugged the panel back in the set and it worked as good as new.

SM158 Sweep/Marker generator and PS163 Triggered scope team up with Module Master for final board checkout.

"Bob, that Module Master is a real help when you are working on modular sets. I'm glad we have it, its going to save us a lot of time plus inventory stocking panels. How do other service technicians get one for their UPS164 Universal Power Supply?"

"Norm, all they have to do is send their order to Sencore Service Department, 3200 Sencore Drive, Sioux Falls, So. Dak., 57107. The order number is 39G42 and the price is only $35.00. Just a couple of module jobs will easily pay for it, and I'll bet they will find many other uses for it too."



UPS164 Module Master accessory and removable modules go hand in hand for faster service.

TIME-SAVING TIPS
FROM OUR READERS.

"A man is only as good as his tools — and the tools are only as good as the man."

Press time and the mail box is still empty! Guess we'll just have to try again, so here we go.

We know you have many Time-Saving shortcuts using your Sencore equipment because many of you have mentioned them to us at meetings and conferences. We know you like to exchange suggestions and ideas with your fellow technicians so everyone has a chance to make the job of servicing a little faster and easier.

Send us your Time-Saving Tip using Sencore equipment and we'll pass it on to our half million readers. Not only that but we will pay you for your time and trouble for sending it in to us. Yes, we will do our part to make your time profitable by sending you $5.00 for each Time-Saving Tip printed in the Sencore News.

Let's hear from you this month (We'll even put your name in print!).

FEATURED last month

FE23
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and it has 1.5 % FET accuracy!

- FULLY PROTECTED OUTSIDE. Tough, molded PVC Acrylic case with exclusive sliding meter cover means full protection, no matter how rugged the use.
- FULLY PROTECTED INSIDE with protected meter movement, fuse protection, and input protection to 500 times overload. It's burnout proof.
- LESS CIRCUIT LOADING THAN VOM OR VTVM with 15 megohm DC input impedance. Reliable results on every test!
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- ILLUMINATED METER SCALE for those darkened areas you often must work in. Just flip a switch whenever the light is needed.
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- AUTOMATIC SHUTOFF when lead compartment cover is closed. Prevents run-down batteries should you forget to shut it off after the job.
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- ATTRACTIVE UNBREAKABLE PVC ACRYLIC CASE - for long life and good looks.

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- **EXCLUSIVE OVERLOAD INDICATOR** for low voltage electrolytics - helps eliminate accidental overloads.
- **NEW! HIGH VALUE—LOW VOLTAGE ELECTROLYTICS** for solid state troubleshooting.

- **24 - ½ and 1 WATT RESISTOR VALUES** from 10 ohms to 5.6 megohms to make sure you have the one you need!
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RC167

"The Substitutor"

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- SILICON AND SELENIUM RECTIFIER SUBSTITUTES - help whip those power supply failures.
- HIGH POWER 20 WATT RESISTORS - from 2.5 ohms to 150k promptly pinpoint power problems.
- HIGH STYLED CASE of vinyl-clad steel and brushed aluminum for professional appearance.
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RC167 *your leg saver*