Warranty

SECO ELECTRONICS INC. warrants each instrument and every other piece of equipment manufactured by it to be free from defects in material and workmanship. This warranty is limited to making good at its factory any device which shall, within 90 days after date of purchase, prove to be defective.

SECO

SECO ELECTRONICS, INC.
1201 SOUTH CLOVER DRIVE
MINNEAPOLIS 20, MINNESOTA

FORM No. 5762

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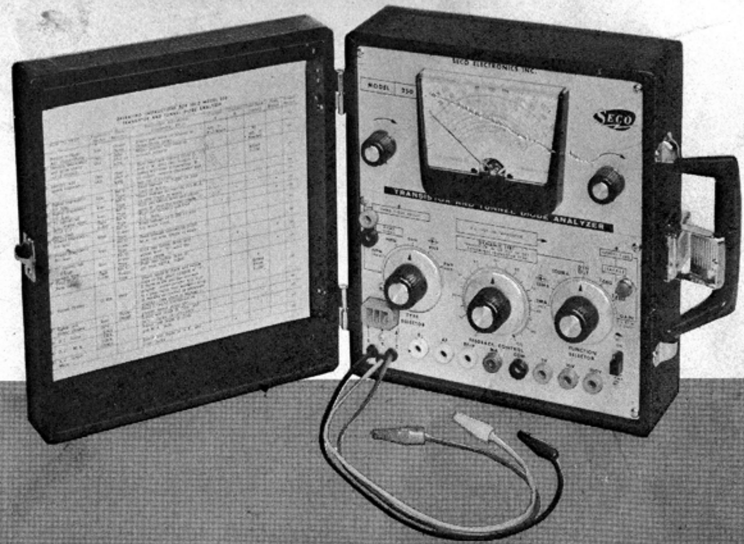
Operating Instructions



SECO

MODEL 250

TRANSISTOR & TUNNEL DIODE ANALYZER

PRICE $1.00

GENERAL DESCRIPTION

The SECO Model 250 Transistor and Tunnel Diode Analyzer is the most universal semi-conductor test set available in the medium priced field. It has been specifically designed to test the wide range of currently popular semi-conductor devices now on the market.

Simple identification of transistor polarity, a go-no-go in-circuit test and a complete analysis of important parameters at popularly used test voltages and currents can be made. The "peak" and "valley" current of signal type tunnel diodes as well as inspection for negative resistance characteristics is also possible. The 200 micro-ampere meter can be used as a reasonably sensitive voltmeter, milliammeter and ohmmeter. Utilization of the oscillator circuit components to provide a signal source, which often is desired, may be obtained by insertion of a suitable external transistor.

The following headings and specifications will explain the coverage and test methods of the Model 250 Transistor and Tunnel Diode Analyzer.

Simple and rapid identification of transistor polarity, NPN or PNP.

No set-up information is necessary.

A go-no-go in-circuit operational test as an oscillator.

Test Signal Type Transistors: Tests by the above methods can be made, as well as a complete D.C. analysis in the most important parameters.

I_{cbo} - 0-200 micro-amperes. Average (good) arc to 20 micro-amperes.

I_{ceo} - 0-1 milli-ampere. Meter arc is marked "low" (?) and "high leakage".

D.C. Beta Gain: Read directly on meter scale, 0-200. I_{ceo} cancelling is provided by a suitable reverse meter current. A real important must on signal types. This insures simple, accurate readings regardless of leakage.

No set up data is required. All of the information is obtained through operation and meter scale readings. A transistor specification chart (located in the rear of this manual) is supplied for reference as to the watts dissipation rating. This

information provides a clue to the expected leakage; the higher the wattage rating, the higher is the expected and tolerable leakage. Minimum gain value is also provided in this chart as well as polarity indication (PNP or NPN).

Tests Power Type Transistors (up to 10 watts): New 50-70 watt types which do not have leakage in excess of the full scale reading can be checked. Example: Motorla's new 3-amp power transistor series, the 2N2137-46, offers I_{cbo} (at 2-volts) of only 50 uA instead of the usual 200 uA.

Improvements in power as well as signal type transistors, from the standpoint of leakage and uniformity, influenced the use of a 0-200 micro-ampere range for the I_{cbo} test. It should be noted on the meter scale that full scale readings of 200 is acceptable. Leakage in excess of this value should be carefully considered. (I_{cbo} up to 1 milli-ampere can be measured if desired by using "C" clip on the base and setting the "function" switch at Iceo.)

The Iceo leakage cancelling circuit is also employed on power type transistors to assure accurate gain readings. The Iceo full scale current is 100 milli-amperes which is also the full scale current on the gain test.

Tests Tunnel Diodes: For full scale, the meter range is 10 milli-amperes. The test supply voltage is variable with the "feedback" control so that the applied 55-65 M.V. can be had for types from 1 milli-ampere to 10 milli-amperes. A negative resistance effect is noted by the sharp drop in current after the peak current value has been reached. The peak current value of a 1 M.A. tunnel diode is 1 M.A. at approximately 55 M.V. for the germanium type diode. See Fig. 2.

Applying additional supply voltage will cause a sudden drop in current as noted by the characteristic curve mentioned in the preceding paragraph. It should be noted that the forward current of 1 M.A. does not occur again until the supply voltage again reaches 550 M.V.

Tests Signal and Power Diodes: These diodes are checked at three volts and at full scale meter current of 20 M.A. The meter scale is properly scaled for each type for a good forward characteristic. Reverse current tests are made with reversed polarity and at full scale meter sensitivity of 200 micro-amperes. The function switch is set at I_{cbo} position.

CIRCUIT ANALYZER FEATURES: SCALES AND RANGES

Three D.C. voltage ranges are supplied: 0-1 V, 0-10 V and 0-100 V. Sensitivity is 5000 ohms per volt. This sensitivity is suitable for the majority of low impedance, semi-conductor circuit testing applications.

Three D.C. current ranges are supplied: 0-.2 M.A., 0-10 M.A. and 0-100 M.A. As in all other ranges, the meter movement is protected with a properly designed diode limiting circuit.

One ohms range is supplied (reading 150 ohms at center scale).

The meter, with its rectifier, may be used as an A.C. output meter.

SIGNAL SOURCE: Insert a small signal type transistor into the socket or attach it to the test leads and adjust the "feedback" control.

NOTE

Operating instructions are supplied in outline form and fastened to the inside of the instrument cover for a ready reference. Battery requirements (for the battery model) are stock number "C" cells which will provide many hours of service.

WHEN THE TESTER IS NOT IN USE, MAKE SURE THAT THE POWER SWITCH IS IN "OFF" POSITION.

HOW TO OPERATE THE MODEL 250 TRANSISTOR AND TUNNEL DIODE ANALYZER

Prior to testing any semi-conductor, a simple check should be made on the power supply. This is much like checking for the proper line voltage on a tube tester.

A. Connect the black and red test leads together. These are the emitter and collector leads.
B. Set the "type selector" control to the "ohms-diode" position.
C. Set the "functional selector" control at "I_{ceo}".
D. Push the "power" switch to "on" position.
E. Turn knob "A" clockwise so that the meter will read full scale. This also adjusts the supply for the proper ohms operation.

NOTE: Batteries (on the battery model) should be replaced when full scale readings cannot be obtained.

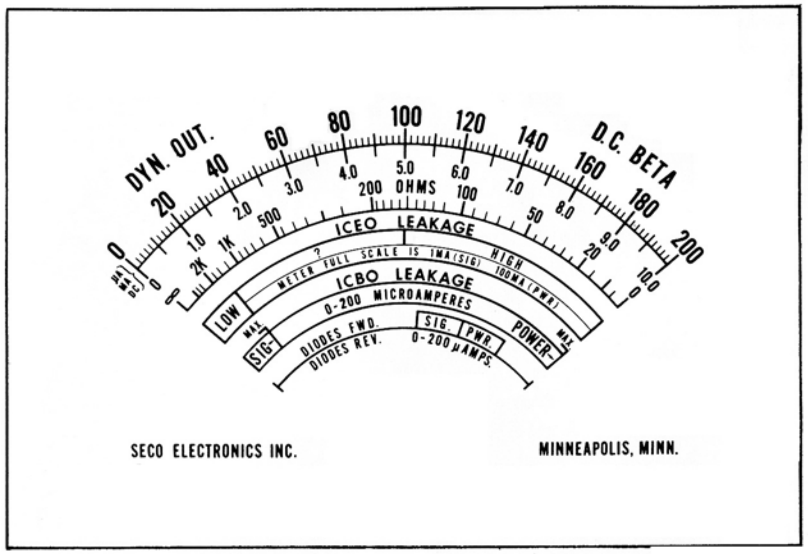


FIGURE 1A: METER SCALE

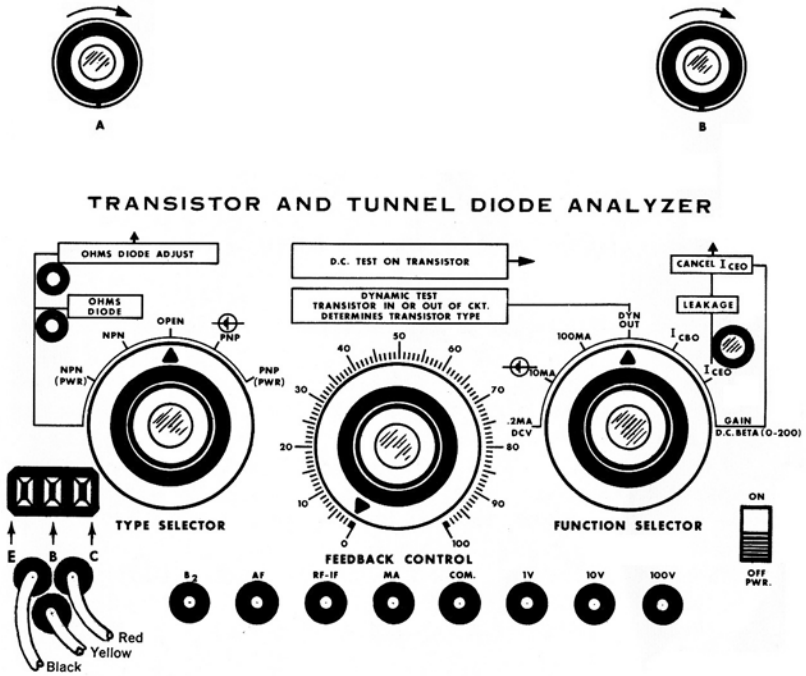


FIGURE 1B: CONTROL PANEL

TESTING SIGNAL TYPE TRANSISTORS OUT OF CIRCUIT

A. Connect the test leads properly to the transistor or insert the transistor into the socket provided on the control panel. Refer to the base diagram if necessary.

B. Set the "function" switch at "DYN. OUT".

C. Set the "feedback" control at approximately "50"

D. Set the "type selector" control at "open" position.

E. Push the "Power" switch to "on" position.

F. Turn the "type selector" control first to "PNP" (most transistors are of the PNP type).

G. If the meter does not show any output reading, turn the "feedback" control throughout its range to see if any "output" can be obtained.

H. Try the "NPN" position if no output was obtained.

I. The transistor will oscillate only if the polarity is correct. Many transistors will amplify as well as oscillate if the emitter and collector are reversed. However, the polarity must be correct in any case.

J. Next (if output was obtained in the above step) turn the "function selector: to I_{cbo} and note any deflection. Small meter deflection indicates a minimum of leakage which is of course, desirable. If the reading is above the "SIG-MAX", the transistor should be replaced unless it is in a non-critical circuit.

K. Turn the "functional selector" to the I_{ceo} position.

L. Transistors are not generally acceptable if the meter reading is more than half scale. See notes above transistor chart.

M. If the leakage is more than several divisions, push the red button down, while adjusting control knob "B", until the leakage reading is balanced out and the meter reads "0".

N. Turn the "functional selector" to "D.C. Beta Gain (0-200)".

O. Hold the red button down and read the gain figure directly on the meter.

P. Reject the transistor if the leakage or gain drifts.

ALWAYS TURN THE POWER SWITCH TO "OFF" POSITION WHEVEVER THE TESTER IS NOT IN USE.

TESTING POWER TYPE TRANSISTORS OUT OF CIRCUIT

The same procedure is used as for testing signal type transistors except that the "type selector" control is set at the power position.

I_{cbo} tests are also conducted in the same manner as for signal type transistors except that full scale leakage is tolerable in most cases (0 to 200 micro-amps.).

The Iceo test is made at a maximum of 100 M.A. at full scale. A transistor is not considered acceptable in most applications if the meter reading is over half scale (50 milli-amperes). The I_{ceo} cancelling circuit will balance out at a little over half scale deflection.

To obtain true D.C. Beta reading, set the "function selector" control at "D.C. Beta Gain (0-200)". Press the red button down while making a reading, after you have properly balanced out the leakage as stated in the previous step.

To match transistors of similar types, it is suggested that the leakage and D.C. Beta Gain data be noted first and the "DYN. OUT." check last.

IN CIRCUIT TESTING

Make the in-circuit check by using the transistor in the circuit as part of an oscillator circuit. Note if the transistor will oscillate. If oscillation occurs, the rectified output will show on the meter.

This procedure was introduced, as a FIRST by SECO, to the electronics industry in 1959. The transistor is substituted in a low impedance, low frequency oscillator circuit and in this way is checked for presence of gain. The transistor obviously must have some gain to oscillate. The point on the "feedback" control at which oscillation starts, as well as the amount of output, has no particular significance in this test. Circuit loading as low as 50 ohms in the output circuit, of the common emitter circuit type, will still permit oscillation to occur on most signal type transistors.

On power transistor circuits, oscillation can generally be obtained with a loading as low as 10 ohms. If oscillation cannot be obtained, with the result that no meter reading is noted, then the transistor should be removed from the circuit. The trouble can then be traced to either a faulty transistor or a faulty circuit component.

OUT OF CIRCUIT DYNAMIC TEST

When you want to identify the type of transistor (PnP or NpN), the out-of-circuit test is a very convenient preliminary check, as well as an operating check before trying the D.C. analysis. It can also be used for matching similar types of transistors.

However, it may be a good idea to test the transistors for similarity by the D.C. method as well.

TRANSISTOR INFORMATION

Transistor identification charts, located in the rear of this manual, show many of the currently popular transistors. A hyphen following the type number indicates that it is of the NPN type. The watts column will indicate either a signal or power type. What to expect in the way of leakage, on a comparison basis, is indicated in the power (watts) column. The larger the wattage rating, the greater is the leakage on similar material types. Silicons will have less leakage than similar germanium types.

The power (watts) column shows signal types in decimal parts of a watt. There is no clean break showing the distinction between the power type and the signal type. However, a rule that may be followed to distinguish where a signal type leaves off is the use of the power test position (on the Model 250) for types having ratings of above one watt. A power transistor is tested at a maximum power input of 3 tenths of a watt when the gain, of the transistor, is 200 on the SECO Analyzer.

Indicated in the "gain" column is the minimum gain value for either types. The maximum values on many types may be as high as three or four times the figure shown.

Signal types are tested with an applied base current, during the gain test, of five micro-amperes. If the collector current is full scale (1 M.A.) the gain is read on the meter scale as 200. For power types, a base current of 50 micro-amperes is applied. If the collector current is full scale (100 M.A.) the gain is indicated as 200 on the meter scale.

SUBSTITUTION HINTS

High frequency transistors may be used for low frequency application. Acceptable substitutes can be made by choosing types that have similar watts dissipation ratings and nearly the same gain values. Safe operating voltage should also be considered. The alpha frequency cut-off characteristic must be taken into account in all except non-critical, low frequency applications.

TESTING SIGNAL DIODES

A. Set the "function selector" control at the I_{ceo} position.
B. Set the "type selector" control at the diode-ohms" position.
C. Push the "power" switch to "on" position.
D. Attach the diode to the red and black test jacks or leads. A good diode should produce a meter reading into the "signal" diode arc.
E. Turn the "type selector" to PNP and read the reverse current leakage on the 0-200 micro-ampere scale.

TESTING POWER DIODES

Use the same procedure as outlined for signal diodes. The difference will be noted by a higher meter reading (labelled "PWR") on the meter arc.

OPERATION AND TEST OF TUNNEL DIODES

The tunnel diode is a revolutionary new semi-conductor device which performs many of the functions of conventional devices. However, the principles of operation are entirely different from those of other semi-conductor devices and vacuum tubes.

Because of its unique characteristics, the tunnel diode can be operated as an amplifier or as an oscillator and has promise of becoming a very important device in the role of amplifier and oscillator, especially in the micro-wave region. There are also many applications for the tunnel diode in the low frequency field.

Inasmuch as it is a diode, we would expect as usual that it must operate at low voltage drop. The several types now on the market operate at less than one volt. Typical peak currents are obtained at 55-65 millivolts.

Figure 2 illustrates the behavior of current as a function of applied voltage through a tunnel diode. As the applied voltage is increased, the current through it increases proportionately. However, the tunnel diode behaves in a peculiar fashion. You will note that as the supply voltage is increased beyond 55 millivolts, the current drops. This apparent reversal of OHMS LAW is referred to as a "negative resistance" characteristic. Finally as the current is reduced to a minimum, known as the "valley current", the tunnel diode again starts behaving the same as a normal conducting device.

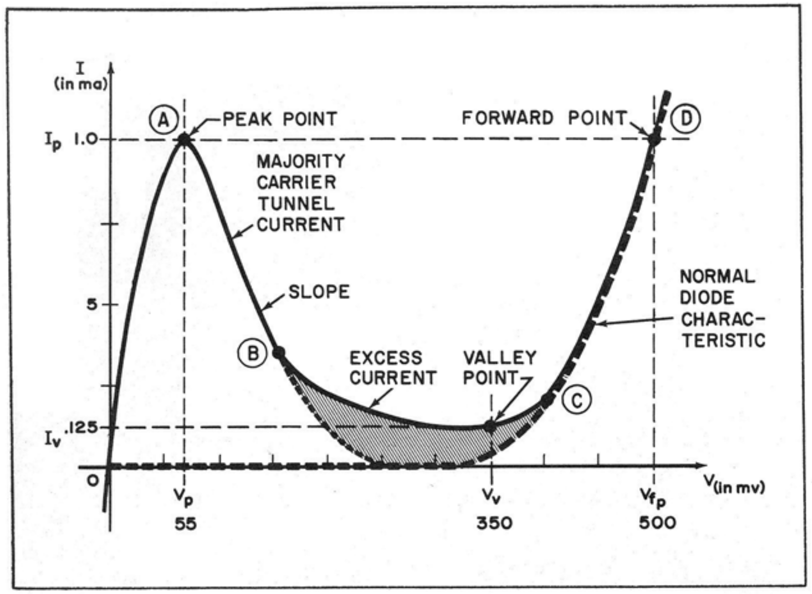


FIGURE 2

ELECTRICAL RATINGS AND CHARACTERISTICS

A negative conductance region exists between points "A" and "B". The dotted line represents a normal diode characteristic which is the result of minor carrier current. The tunnel diode follows this characteristic beyond point "C".

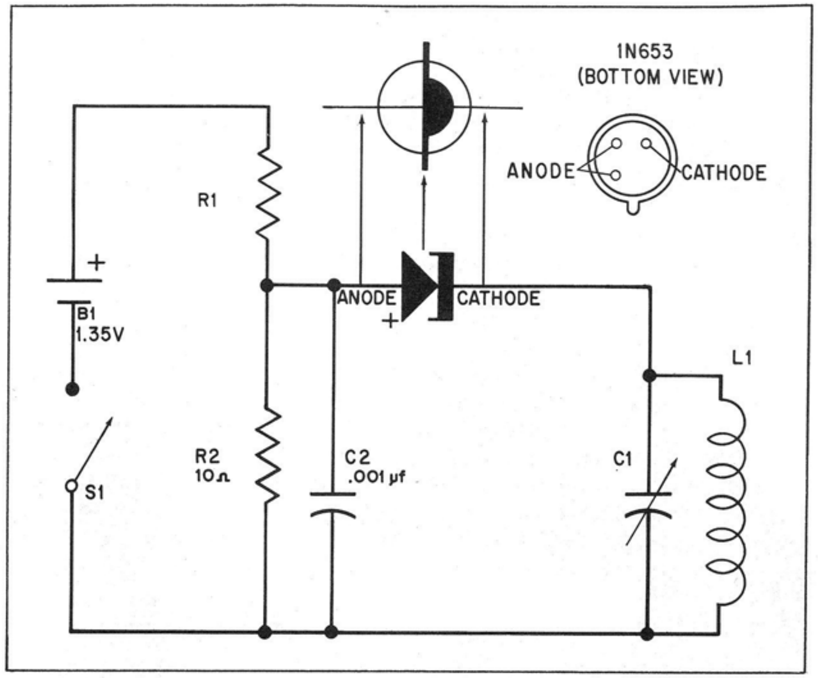


FIGURE 3

Figure 3 shows a tunnel diode in a simple oscillator circuit. The battery polarity, diode diagram and base diagram of the tunnel diode are illustrated to acquaint you with this information.

Supply voltage in the SECO Model 250 Analyzer is three volts. The feedback control pot is wired so that the supply starts at zero. As the feedback control is advanced clockwise, the current should gradually rise to its peak current value and then the current will suddenly drop. Advance the control slowly and watch carefully for the maximum dip in current. Because the circuit is designed to test the 1 M.A. up to 10 M.A. types with one divider and scale, you may note (on some types) a "hump" in the current as it decreases to minimum. This is perfectly normal and is a function of the limited current regulation within the tester itself.

ZENER DIODES

Set the switches and controls in the same manner as for tunnel diodes except, note the meter reading at which the diode starts to conduct. The current will merely continue to increase as the "feedback" control is advanced beyond the cut-in point.

CHECKING TETRODES

DO NOT confuse a transistor having a shield lead with a tetrode. You will note that if the fourth lead is a shield, no meter reading change will occur when the lead from the B2 jack is connected to the fourth lead.

Use the "IN-CIRCUIT" test position first when testing tetrodes. Connect the yellow base lead to one base of the transistor and connect the other base to the B2 jack. Note the output on the meter. Disconnect first one lead and then the other. You should get a reading in both instances providing both bases are operating. Now make the "leakage" test using first one base and then the other in the same manner as for testing a tetrode transistor.

OPERATION AND USE OF THE MODEL 250 ANALYZER AS A SIGNAL SOURCE

A. Insert a transistor that you know to be good into the test jack.

B. Set the controls (as previously explained on page 7) for the "DYN. OUTPUT" test.

C. As the "feedback" control is advanced away from zero and oscillation is noted by an indication on the meter, you will find that a sine wave signal is generated first; sa the control is advanced farther, the oscillator will operate as a blocking oscillator which is very rich in harmonics. The low frequency source can be used for an audio-frequency signal injection or testing. The RF-IF is obtained merely by inserting a series capacitor with the signal source which attenuates the low frequency output. The "feedback" control should be well over to the right for strong harmonic generation.

SERVICE NOTES

Design of the SECO Model 250 Analyzer permits continuous hard use. With reasonable care the only service requirement will be the occasional replacement of batteries (on the battery model). Most of the components, if replacement should ever become necessary, are items that are available from your electronic parts distributor. If we can be of any help in maintaining your instrument, please feel free to write to our service department.

Service Department
SECO ELECTRONICS, INC.
1201 South Clover Drive
Minneapolis 20, Minnesota

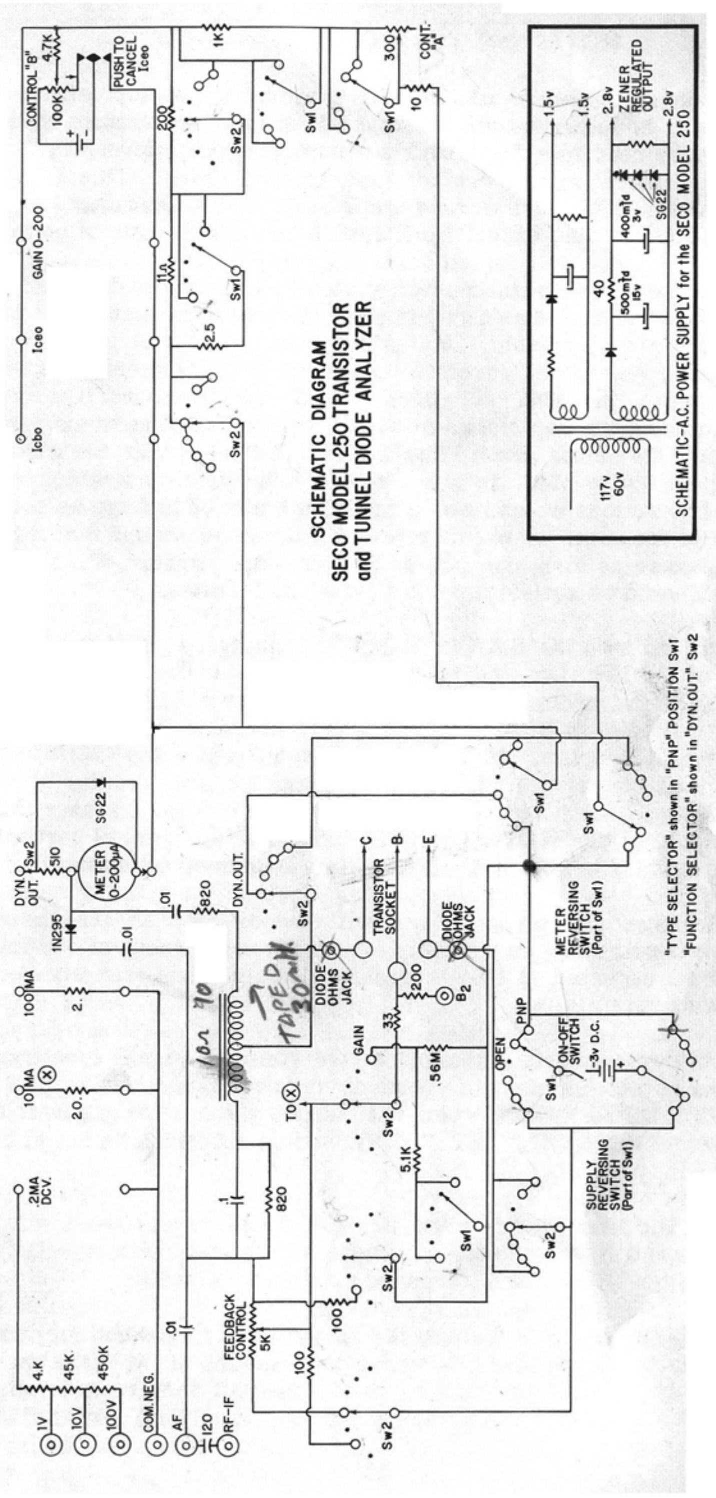


FIGURE 4: SCHEMATIC DIAGRAM

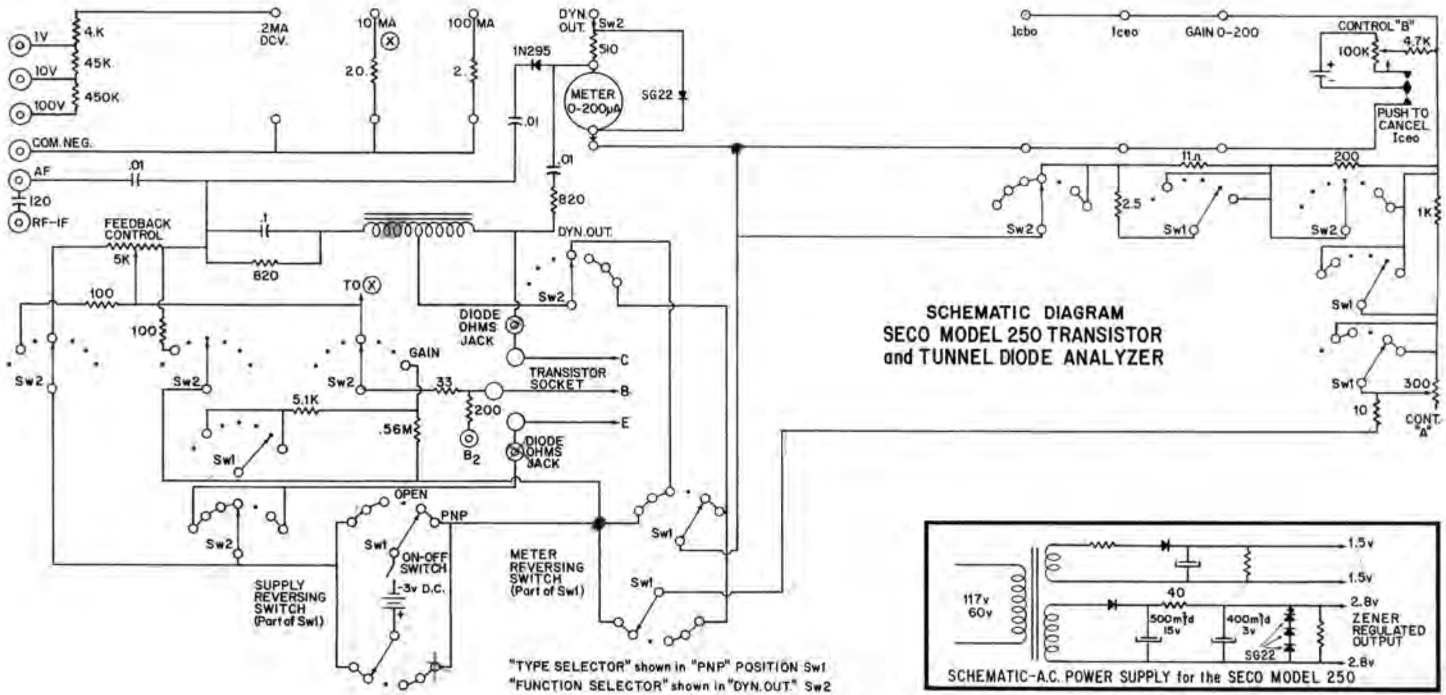


FIGURE 4: SCHEMATIC DIAGRAM

NOTES ON TRANSISTOR LEAKAGE

I_{cbo} leakage current values are published by transistor manufacturers. It is noted that silicon type transistors have a lower leakage current than do similar germanium types. However, I_{ceo} leakage current values are not generally published. This shunting resistance appears across the E and C. This leakage current contributes nothing except increased heating and waste of power.

If a transistor is operating at a collector current of 50 M.A. of which 10 M.A. is leakage current, it is evident that 20% of the input power is wasted. In testing transistors, the question of acceptable leakage is based on the percent of the gain current being used in the test. Actually, to make the decision, one must keep in mind the resistance or impedance that the transistor must work into its actual circuit application. If the circuit resistance or impedance is high, then one should be critical and select only those transistors which have a very minimum of leakage as compared to the gain. In broader terms, it can be stated that if the I_{ceo} leakage is less than 10% of the test gain current, the transistor should be satisfactory for most applications.

You will note on the SECO Model 250 Analyzer, that the upper limit of the arc (Labeled "LOW" on the Iceo leakage scale) is at 10% of the full scale. Consider a transistor having a DC beta gain reading of 200 (full scale). Its maximum leakage rating, using the 10% figure, would be at the upper limit of the "LOW" arc. Likewise, consider a transistor having a gain reading of 100 (half scale). It should not indicate an Iceo leakage greater than the middle of the "LOW" arc. This analysis of observed percentage is made possible by our design of the choice test currents.

Iceo leakage current increases with the size of the transistor. A transistor having a collector dissipation rating of one watt would be expected to have a greater leakage than one with a 50 milliwatt rating.

The following charts list most of the common signal type transistors as well as many of the medium power types. If the power "WATTS DISSIPATION" column indicates a rating of one watt or higher, the "TYPE SELECTOR" switch should be set at the "POWER" position.

NOTE: The transistors listed are all "PNP" except those which are followed by a hyphen (-). These are of the "NPN" type. The "gain values" listed are published minimum values.

Although the Model 250 Analyzer is primarily intended for testing signal type and lower power type transistors, it will also be extremely useful for testing a great number of higher power units in which the leakage and gain values are within the limits of the design.

TRANSISTORS

(A hyphen (-) following the "type" number indicates it is of the NPN type)

TYPE	MAX. COLL. DISSIPATION WATTS	GAIN	TYPE	MAX. COLL. DISSIPATION WATTS	GAIN
2N27-	.05	100	2N118-	.15	.95
2N28-	.05	100	2N118A-	.15	.95
2N29-	.05	100	2N119-	.15	.97
2N34	.05	25	2N120-	.15	.99
2N35-	.15	25	2N122-	8.75	3+
2N36	.05	45	2N123	.15	30
2N37	.05	30	2N124-	.05	24
2N38	.05	15	2N125-	.05	48
2N39	.03	40	2N126-	.05	100
2N40	.03	30	2N127-	.05	200
2N41	.05	40	2N128	.025	19
2N42	.05	15	2N129	.03	.95
2N43	.24	34	2N130	.05	22
2N43A	.24	34	2N131	.05	45
2N44	.24	18	2N132	.05	90
2N44A	.24	18	2N133	.05	25
2N45	.15	9	2N135	.10	20
2N46	.05	40	2N136	.10	40
2N47	.05	38	2N137	.10	60
2N48	.05	32	2N138	.05	140
2N49	.05	-	2N139	.035	48
2N52	.12	-	2N140	.08	75
2N54	.20	32	2N141	1.5	40
2N55	.20	20	2N142-	1.5	40
2N56	.20	12	2N143/13	4.	10+
2N57 thru 2N60	.18	100	2N144/13-	4.	10+
2N61	.18	45	2N160A-	.15	9
2N62	.05	40	2N161A-	.15	19
2N63	.10	22	2N162-	.15	19
2N64	.10	.45	2N163A-	.15	39+
2N65	.10	90	2N164-	.06	40
2N68	2.	40	2N165-	.06	72
2N71	1.	50	2N166-	.03	32
2N72	.05	-	2N167-	.075	17
2N76	.05	20	2N167A-	.075	17
2N77	.03	55	2N168-	.065	23
2N78-	.065	45	2N169-	.065	34
2N78A-	.065	45	2N169A-	.065	34
2N79	.03	46	2N170-	.03	32
2N80	.05	80	2N172-	.06	-
2N81	.05	20	2N175	.02	65
2N82	.03	20	2N176	65.	25
2N94-	.05	30	2N178	10.	30
2N94A-	.05	40	2N180	.15	60
2N95	2.5	40	2N181	.25	60
2N96	.05	35	2N182-	.10	20
2N101/13	4.	10	2N183-	.10	35
2N102/13-	4.	10	2N184-	.10	60
2N104	.15	44	2N185	.15	60
2N105	.035	55	2N186	.10	24
2N106	.10	25	2N186A	.20	24
2N107	.05	-	2N187	.10	36
2N108	.05	-	2N187A	.20	36
2N109	.15	75	2N188	.10	54
2N111	.15	25	2N188A	.20	54
2N112	.15	30	2N189	.07	24
2N113	.10	45	2N192	.07	75
2N114	.10	65	2N193-	.05	4
2N115	-	40	2N206	.07	47
2N117-	.15	.9	2N207	.05	100