

# INSTRUCTION MANUAL

**BK** PRECISION 520

# TRANSISTOR TESTER



**BK** PRECISION

Product of DYNASCAN CORPORATION  
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

# **INSTRUCTION MANUAL**

**for**

## **Model 520**

# **TRANSISTOR TESTER**



**DIVISION OF DYNASCAN CORPORATION**

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**Chicago, Illinois 60613**

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## INTRODUCTION

The Model 520 Transistor Tester is designed for in-circuit transistor testing, with special features for making additional tests on devices out-of-circuit.

It uses a high current, low duty-cycle pulse technique to test transistors in the presence of shunting circuitry, and a system which eliminates the need to identify the terminals of the device.

The instrument is designed for a minimum amount of control manipulation, making for rapid testing of most devices.

## SPECIAL FEATURES

1. Patented limited-energy pulse circuit permits highly successful use of in-circuit testing in the presence of low shunt impedances with complete safety for the device under test.
2. A human-engineered panel design which eliminates the need to refer to manuals – only two switches, no panel adjustments.
3. Six-position TEST switch sequentially connects the device being tested in all possible configurations making it unnecessary to know the device terminal identification. Can be left in GOOD position so that additional tests can be made without memorizing test position.
4. Base or gate lead indicated by color as test switch is operated.
5. Audible tone tells when device under test is good – no need to take eyes off circuit board while testing hard-to-get-at devices.
6. A logarithmic leakage meter which displays a wide leakage current range on a single meter scale.
7. Automatic polarity indication to identify NPN or PNP type devices.
8. Identification of SILICON and GERMANIUM device types for proper evaluation of leakage current with color-keyed LED indicators for positive test interpretation.
9. Locking test leads that make positive connections to devices in difficult locations. Frees operator's hands to make further tests.
10. Choice of test leads or front panel socket for out-of-circuit tests.

## SPECIFICATIONS

### IN-CIRCUIT:

GOOD/BAD Test for PNP, NPN transistors, FET, SCR.  
Identifies NPN or PNP transistors.  
Identifies SILICON or GERMANIUM transistors.

### OUT-OF-CIRCUIT:

GOOD/BAD Test for PNP, NPN transistors, FET, SCR.  
Identifies NPN or PNP transistors.  
Identifies SILICON or GERMANIUM transistors.  
Measures Reverse LEAKAGE from  $0.1\mu\text{A}$  to  $5\text{mA}$ .  
Measures  $I_{\text{DSS}}$  and gate leakage of FET's.

### APPLIED TEST CURRENTS:

Collector Current:  $250\text{mA}$  at 5% duty cycle.  
Base Current:  $125\text{mA}$  at 5% duty cycle.  
Test Repetition Rate: 10 per second.  
Reverse Voltage for Leakage Test:  $3.5\text{V}$ .

### LIMITING IN-CIRCUIT SHUNT

#### VALUES FOR GOOD-BAD TEST:

Resistance: Greater than 10 ohms.  
Capacitance: Up to  $5\text{mfd}$  with low beta devices, up to  $15\text{mfd}$  with higher betas.

### ACCESSORIES:

Three test leads with mini-lock clips supplied.  
FP-5 Dynaflex Probe (optional).

**SIZE:** 8" x 7" x 3½"

**WEIGHT:** 5 lbs.

## **BRIEF SUMMARY OF WHAT THE 520 WILL DO**

1. Determines good or bad transistors in or out-of-circuit.
2. Determines good or bad diodes in or out-of-circuit.
3. Identifies E-B-C leads of transistors.
4. Indicates polarity of good devices (NPN or PNP).
5. Indicates whether silicon or germanium.
6. Measures  $I_{CES}$  or  $I_{BES}$  of transistors.
7. Measures  $I_{DSS}$  of FET's.
8. Measures gate leakage of FET's.
9. Measures reverse leakage current of diodes.
10. Determines whether device is bipolar, FET, or SCR.

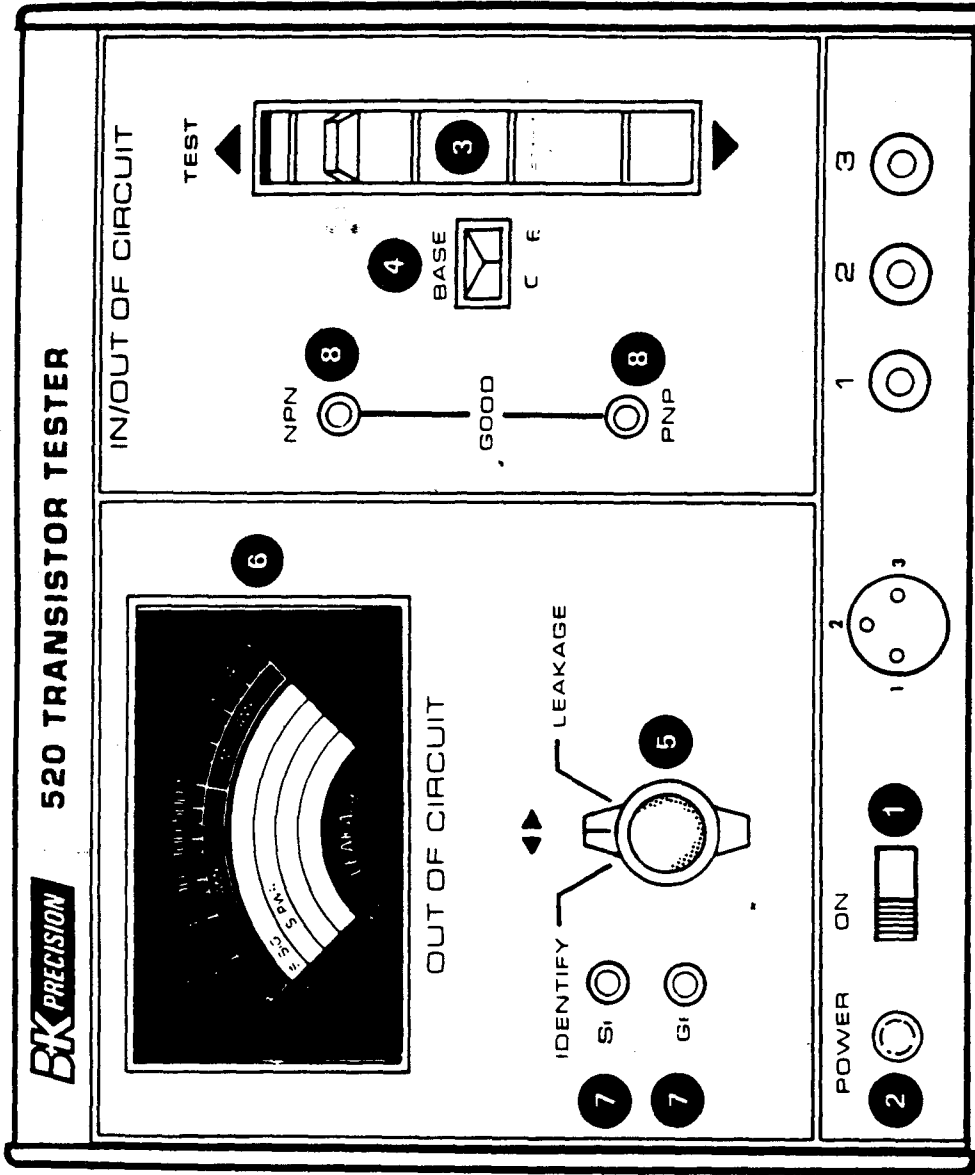


Fig. 1. Front panel showing controls and indicators.

$I_{DSS}$  - DRAIN CURRENT  
~~AT~~ AT  
Zero gate VOLTAGE

## CONTROLS AND INDICATORS

1. **POWER ON Switch:** Applies power to 520.
2. **POWER ON Lamp:** Indicates power is ON.
3. **TEST Switch:** Selects proper device terminals for testing.
4. **BASE Lead Indicator:** Identifies base lead by color.
5. **FUNCTION Switch:** Spring-return switch selects either of two additional tests:
  - a.  $I_{CES}$  or  $I_{BES}$  for transistors;  $I_{DSS}$  and gate leakage for FET's.
  - b. Identifies device material (silicon or germanium).
6. **LEAKAGE Meter:** Indicates device leakage current.
  - a. Indicates safe leakage limits for typical silicon and germanium transistors.
  - b. Indicates  $I_{DSS}$  and gate leakage for FET's.
7. **IDENTIFY Lamps:** Indicate silicon or germanium device.
8. **NPN and PNP Lamps:** Indicate polarity of good devices.
9. **AUDIBLE TONE:** Indicates good device.



## USING THE 520

### Set-Up

**CAUTION:** If testing in-circuit, make sure all power is turned off in the circuit being tested, and all capacitors are discharged.

1. Plug the Model 520 line cord into a convenient power outlet.
2. Turn on the Model 520 power switch.

### IN-CIRCUIT TESTING

#### A. Transistors/FET's

1. Connect the three test leads in any manner to the three leads of the device you wish to test.
2. Move the test switch through its six positions until the tone is heard. **WITH MOST TRANSISTORS AND FET'S THE TONE WILL BE HEARD IN TWO POSITIONS.** Transistors have some gain when the collector and emitter are interchanged, and practically all FET's are symmetrical. If the tone is heard, one of the two red indicators will light up indicating whether the device is NPN or PNP. If no tone is heard in any of the six switch positions, the device is probably defective.
3. If the device tests bad in-circuit, the test can be verified by removing the device from the circuit. Occasionally, a heavily shunted transistor will test bad (see 520 SPECIFICATIONS). Carefully unsolder at least two leads from the P.C. board and repeat the above test. (See OUT-OF-CIRCUIT TESTING.)
4. If the device tests good and does not function properly in its circuit, it should be retested out-of-circuit.

#### B. Diodes

Connect blue and yellow leads across diode. Test for LEAKAGE in uppermost and second position (GREEN BASE) of TEST SWITCH. One position will read full scale, while the other will give a low reading depending on the shunting effect of the circuitry. If both positions produce full scale readings, the diode is either shorted or heavily shunted by low resistance circuitry; for example, a transient suppressor diode across a relay or solenoid coil. In this case the diode should be disconnected and retested.

### **C. "Hands Off" Testing**

When the base lead of devices being tested can be identified, leave the test switch in the uppermost or green base position. The transistors can then be probed one by one by connecting the green lead to the base, and the blue and yellow leads to the collector and emitter respectively. The audible tone will tell you when the transistor is good. Occasionally, the collector and emitter leads may have to be interchanged to produce a tone, but this is still a valid test.

The "hands off" method is useful when it is necessary to test a number of transistors in a circuit, or when it is impossible to connect all three leads to the device being tested: if one lead can be clipped on the device, both hands are free to probe the remaining two leads. With this feature, you can also use the DYNAFLEX MODEL FP-5 PROBE (optional) to test devices from either side of the P.C. board.

### **D. Intermittent Testing**

Often the Model 520 can be used to identify intermittent transistors in a circuit. Connect the test leads to the suspected transistors and move the TEST switch until the tone is heard. Then, leaving the 520 in this position, the transistor can be subjected to various treatments such as tapping, heating or cooling. An intermittent transistor will show up as an intermittent tone.

## **OUT-OF-CIRCUIT TESTING**

### **A. Bipolar Transistors**

1. Connect the three test leads to the device or plug it into the convenient test socket on the Model 520 panel (no need to worry about basing).
2. Rotate the test switch until the 520 indicates good and produces an audible tone. Leave the test switch in this position. If the tone is heard in two positions, either position is valid for further testing.
3. Note whether the device is shown to be PNP or NPN. The BASE lead is indicated by the COLOR which appears in the uppermost area of the BASE identification window.
4. LEAKAGE TESTS. Turn the function switch to LEAKAGE and note the meter indication. Hold the function switch in LEAKAGE position and move the TEST switch to the other position which displays the same color in the BASE window. The leakage should be about equal in both TEST positions, and within the limits shown on the meter scale. In one of the positions the meter indicates ICES; in the other IEBS. To determine which measurement is being made, the collector and emitter leads must be identified. See paragraph 6 below.

5. IDENTIFICATION OF TRANSISTOR TYPES. If the type of transistor is not known, turn the function switch to IDENTIFY position and the Model 520 will indicate whether the device is SILICON (yellow LED glows) or GERMANIUM (green LED glows). The leakage indicated can then be compared to the proper limits marked on the meter face. The meter leakage scales are color keyed to the LED IDENTIFY indicators.
6. IDENTIFICATION OF EMITTER AND COLLECTOR LEADS. The base lead is always identified correctly in the window by the color which appears in the upper area of the BASE IDENTIFICATION WINDOW when the tone is heard. In order to identify the collector and emitter leads, connect a  $50k\Omega$  potentiometer in series with the base lead. Increase the potentiometer resistance while switching between the two positions which produce a tone until the Model 520 responds in only one position of the test switch. In this position all three leads are properly identified by relating the colors in the window to the colors of the test leads connected to the device. Any device, such as a Darlington transistor, which responds in only one TEST position, automatically identifies its collector and emitter leads.

## B. FET'S

FET's are tested in the same manner as bipolar transistors. Move the test switch to a position which produces a good indication, then turn the function switch to LEAKAGE. The meter will read  $I_{DSS}$ .  $I_{DSS}$  of FET's can range from a few microamperes to several milliamperes, and often will read off scale on the 520.

1. FET GATE LEAKAGE. Drain-to-gate or source-to-gate leakage of either N-Channel or P-Channel FET's can be tested by treating the gate junction as a diode. First, locate the gate lead by moving the TEST switch through each of its six positions until the tone is heard. The gate lead is the color which appears in the BASE identify window. Then connect the FET gate to the blue test clip and one or both of the remaining FET leads to the yellow test clip. Move the TEST switch to the second position and check for leakage. The leakage should be zero in one of the positions if the device is a J-FET, or both positions if it is a MOS-FET.
2. N-Channel FET drain or source-to-gate leakage can be measured in another way. Leave the FET connected to the three test leads. Put the TEST switch in any position which does *not* indicate good. Then, holding the FUNCTION switch in the LEAKAGE position, move the TEST switch through all six positions and watch the meter. If the device is good, the meter will indicate zero current in two of the six positions. P-Channel FET's must be measured as diodes, as described above.

3. **DEPLETION MODE FET'S.** Drain-to-source leakage of depletion mode FET's cannot be measured reliably by the Model 520, as this requires that the gate be reverse-biased while testing. Merely disconnecting the gate lead leaves the device subject to stray pickup and/or leakage currents, and with the extremely high gate impedance there is no way of assuring that the gate will pinch off.
4. **ENHANCEMENT MODE FET'S.** Enhancement mode FET's can be tested in the same way as bipolar transistors.

### **C. Diodes**

1. Connect the blue and yellow leads to the two ends of the diode. Hold the function switch in the LEAKAGE position while moving the test switch through the two green BASE positions. If the diode is good the meter will indicate full scale in one position and in the other will indicate zero or some low value. The low reading is the LEAKAGE current of the diode.
2. The anode and cathode leads of the diode can be identified. While holding the function switch in the LEAKAGE position move the TEST switch to whichever of the two green BASE positions produces a full scale reading. The diode cathode is then connected to the blue test lead.

### **D. SCR'S**

SCR's will indicate NPN in one position of the test switch and PNP in another, UNRELATED position. Leave the test switch in the position which indicated NPN and make LEAKAGE tests as with transistors.

## HOW THE 520 WORKS

### TEST SWITCH

1. The 520 transistor tester uses a six-position lever switch located at the right side of the panel to connect the device being tested in the correct manner for testing. As this switch is moved from top to bottom, the device connected to the three test leads, or plugged into the socket, is connected in all possible configurations to the testing circuit. The uppermost position is the "normal" connection, in that the socket is connected in standard triangle configuration to the testing circuits and the blue, green, and yellow leads are connected to the collector, base and emitter circuits respectively.
2. In two of the six positions, the device is connected properly for testing. This is true since almost all bipolar transistors have gain, although usually very little, when the collector and emitter are interchanged. These two positions are always adjacent, and always display the same color in the BASE identification window, which indicates which of the three leads, or which socket pin is connected to the base or gate of the device being tested whenever the 520 is indicating a good device.

### GAIN TEST CIRCUIT

3. The 520 circuitry generates a continuous series of pulses especially designed to periodically test a transistor about ten times per second. These short, high current pulses apply a voltage pulse to the collector, first positive for testing NPN devices, followed by negative for testing PNP (see Fig. 2a). During this pulse, a shorter pulse of the same polarity is applied to the base of the device, which drives the collector voltage toward saturation.

Taking a closer look at the basic pulse circuitry, refer to Fig. 2. C1 is the period clock, which runs at approximately 10 Hz. It initiates each test period while simultaneously resetting FF1 and FF2. C2 runs at 1000 Hz and controls the pulse-forming circuits.

4. The pulse-forming circuit uses a combination of toggles and RS flip-flops to produce the proper sequence of pulses for the collector drive circuit A and the base drive circuit B. A and B are level-shifting complementary drivers which can deliver several hundred milliamperes at +5V and -5V or return to zero volts.

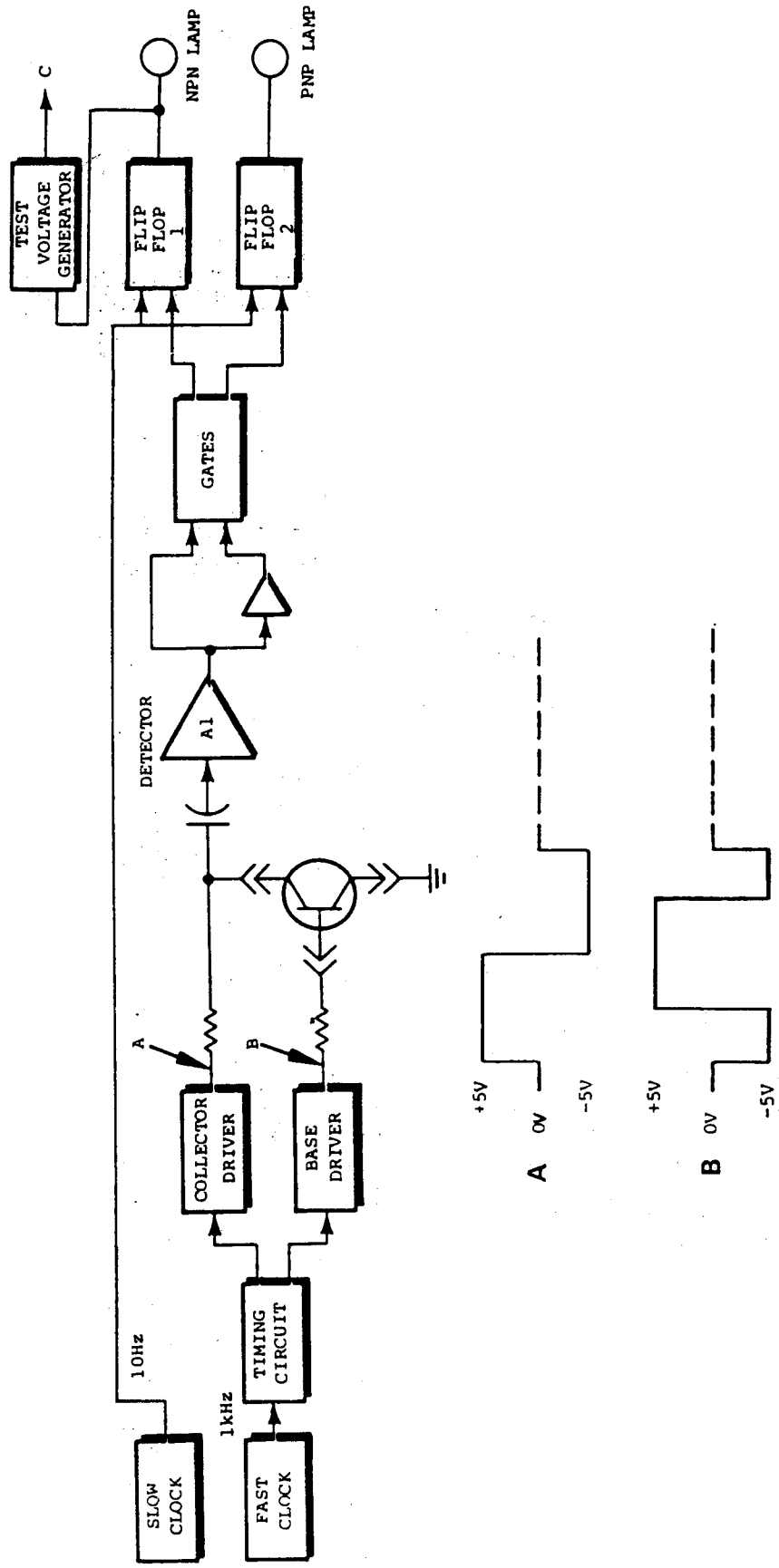


Fig. 2. Block diagram.

5. A properly connected NPN transistor, as shown above, will see the waveform at Fig. 2a, and its base will see the waveform at Fig. 2b. Note that during the positive excursion of the collector voltage, the base is driven first negative and then positive. If the transistor being tested is NPN, the collector voltage will drop abruptly when its base is driven positive. This negative-going transition, which can only occur if transistor action is present, is differentiated and the differentiated signal is used to latch flip-flop 1.

If a PNP transistor is tested, the turn-on transition occurs in the second half of waveform 2a, and in the opposite direction.

The PNP output pulse is inverted in order to have the proper polarity to operate flip-flop 2. Of course, other pulses appear at the differentiator output, since all voltage transistions are similarly differentiated, but the gating circuits prevent these from reaching the flip-flops and giving wrong indications.

The input to FF1 is only enabled during the time period in which an NPN is turned on, and that of FF2 is only enabled if a PNP is turned on. Only the flip-flop which corresponds to the type of device being tested can be latched, lighting the lamp corresponding to that device.

In addition to being connected to the LED's on the panel, both outputs are connected through an OR gate to activate the audible tone if either of the latches operate. Thus if the basing and polarity of a device is unknown, the TEST switch can be moved from position to position until the tone is heard. It is then left in that position and the polarity of the device is indicated by one of the PNP-NPN lamps on the 520 panel. If the switch is left in this position, the circuitry is then set up to make several additional out-of-circuit tests on the transistor.

The output of FF1 is either +5V or 0, depending on whether the device tested was PNP or NPN. This output in turn drives another level-shifting complementary circuit which produces either +5v or -5V, but always at the correct polarity to further test the same device. When not testing, this voltage is always left at -5V, to be available for diode testing.

## CURRENT METER

6. The 520 is equipped with a special non-linear meter circuit to measure  $I_{CES}$  and  $I_{BES}$ . When the FUNCTION switch is turned to LEAKAGE, two things happen. First, the reset pulse is inhibited from FF1 and FF2. This leaves FF1 in the state in which it was while "Gain Testing" the transistor. FF1 in turn, through the test generator, produces the correct output voltage for testing at point (C), + for NPN or - for PNP.

Second, the switch connects the collector to this supply, and the base and emitter to the current meter circuit. The meter circuit is designed for essentially zero voltage drop at its terminals so that the device is always tested at the proper voltage, and is made non-linear to measure a very wide range of currents on a single scale.

## IDENTIFICATION CIRCUIT

7. When switching to IDENTIFY, the flip-flop reset circuit is inhibited as before to lock the test voltage in the proper polarity. The base-emitter junction is then current-fed, and connected to a special voltage comparator which produces a +5V output for a Base to Emitter voltage above approximately  $\pm.5V$ , or zero output for B-E voltage less than  $\pm.5V$ . The output drives one of two LED's, depending on its state, indicating either silicon, which always produces more than .5V drop, or germanium, which seldom produces more than .4V drop. The LED's are enabled only when a good test is performed, and only when the switch is in the IDENTIFY position.



## CALIBRATION AND SERVICE

1. **Meter Calibration.** The only part of the 520 which may require calibration is the leakage current meter. The following procedure should be followed:
  - a. Turn off the 520. If the meter does not indicate zero, insert a screwdriver in the hole on the front panel just below the meter and adjust it to indicate zero.
  - b. Remove the back of the instrument by removing the five screws at the bottom and rear of the case. Locate TP1 near the top center of the P.C. board. Connect TP1 to the metal chassis with a jumper. Turn on the 520. If the meter is not indicating zero, adjust the ZERO control with a screwdriver through the left side hole in the top of the chassis until the meter balances. The zero control is identified on the P.C. board just below the adjustment hole. Remove the jumper.
  - c. To calibrate the meter, put the TEST switch in the uppermost (green) position. Connect a  $2000\Omega$  potentiometer and a 0-5mA meter in series from the yellow jack to the blue jack as in Fig. 3. Then, while holding the FUNCTION switch in the LEAKAGE position, adjust the potentiometer for 5 milliamperes in the external meter. If the meter on the 520 panel does not read full scale, adjust the "CAL" control through the right side hole in the top of the chassis. The CAL pot is identified on the P.C. board just below the adjustment hole. See Fig. 3.
2. **520 Power Supply Voltages.** Can be measured at the points marked +5 and -5 and GND on the lower right hand corner of the P.C. board. They must be between 4.7 and 5.3V for proper operation.
3. **Observation of Waveforms.** The waveforms applied to the collector and base of the device under test can be observed with an oscilloscope connected to the jacks on the 520 panel. Leave the TEST switch in the uppermost position, as above, and place a  $1k\Omega$  to  $10k\Omega$  resistor between the yellow jack and the green jack. Connect the scope ground to the yellow jack (emitter) and the vertical input to the green jack (base). The base waveform should be as shown in Fig. 2a. Connect the resistor between yellow and blue jacks. Connecting the vertical input to the collector jack (blue) should produce the waveform shown in Fig. 2b. A dual trace oscilloscope is especially convenient for observing both waveforms simultaneously.

If the line fuse blows, it must be replaced with a 1/16A, 3AG Slow-Blow fuse. Remove the back cover, as in "CALIBRATION". Remove the right end panel of the case (the side nearest the "TEST" switch). The fuse is found on the P.C. board near the power transformer. It is unlikely that the fuse will blow without some accompanying circuit failure. Look for shorted rectifier diodes (D1-D4) or input filter capacitors (C1 and C2).

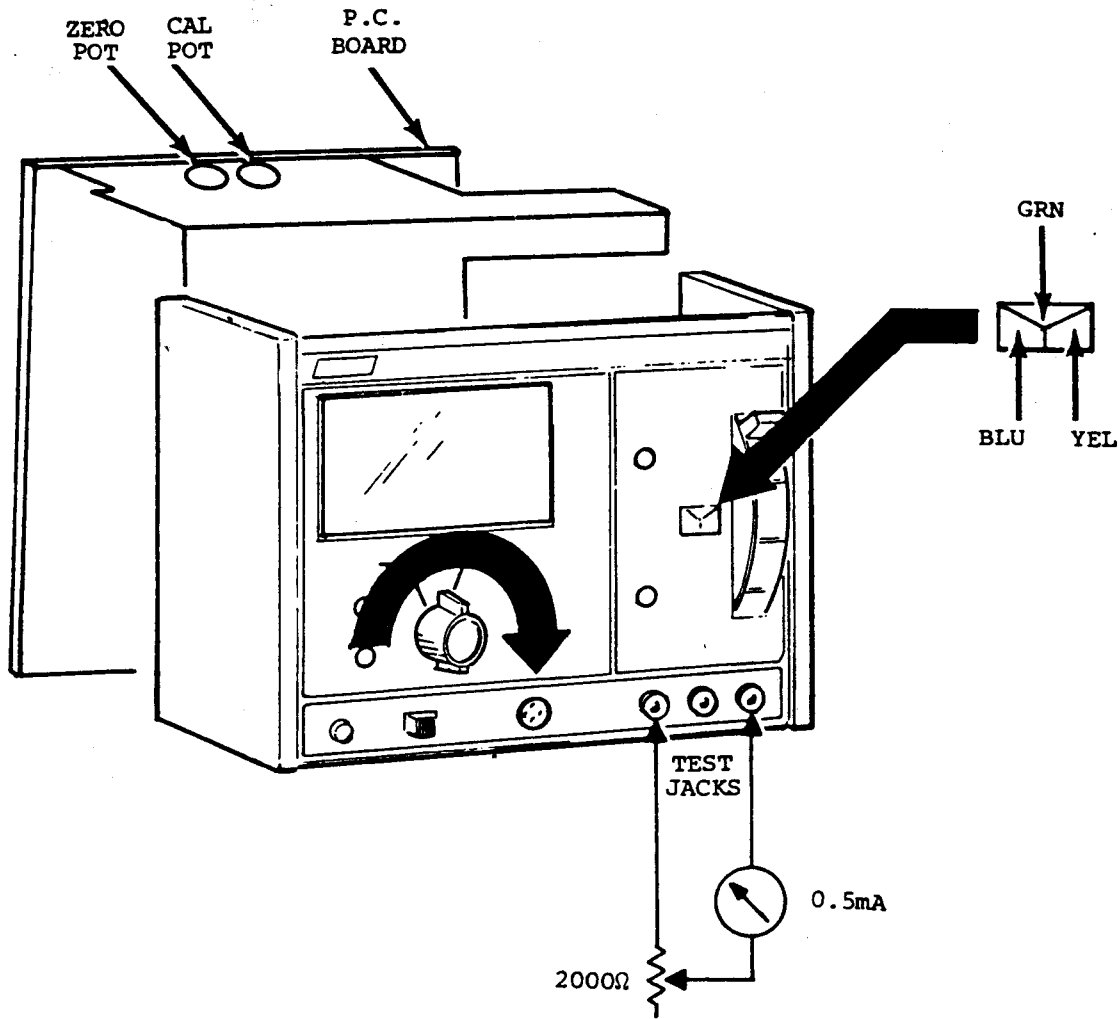


Fig. 3. Location of calibrating controls.

## HINTS AND KINKS

### IDENTIFYING TRANSISTORS AND DIODES

1. Nearly all germanium transistors come in metal cases, either the tubular type with flexible leads, or in the standard TO-5 package.
2. Power-transistors in stud packages or in the TO-5 or TO-3 can be either germanium or silicon, depending on age. Two and three digit 2N- numbers are mostly germanium.
3. The TO-66 power transistors, and the plastic power tab packages are nearly always silicon. The collector is usually, but not always, connected to the mounting tab and the center lead.
4. The base lead of most all modern plastic signal level transistors is either the center lead, or the right hand lead facing the flat side. In the latter case the collector lead is in the middle.
5. Most plastic FET's have the gate lead on the right side, with the source in the middle, but there are exceptions. With nearly all late model FET's, the source and drain can be interchanged with no adverse effects.
6. All transistors will have some gain with the collector and emitter leads interchanged, with the exception of Darlington's.
7. Germanium signal diodes can usually be recognized by their transparent hollow glass cases with either three or four color bands, or type numbers printed on them. Silicon diodes are usually painted because silicon is light-sensitive and must be protected from ambient light. The "moose" types, such as the stud package, can be either germanium or silicon.

## **WARRANTY SERVICE INSTRUCTIONS**

1. Refer to the maintenance section of the instruction manual for adjustments that may be applicable.
2. Check common electronic parts such as tubes, transistors and batteries. Always check instruction manual for applicable adjustments after such replacement.
3. Defective parts removed from units which are within the warranty period should be sent to the factory prepaid with model and serial number of product from which removed and date of product purchase. These parts will be exchanged at no charge.
4. If the above-mentioned procedures do not correct the difficulty, pack the product securely (preferably in original carton or double-packed). A detailed list of troubles encountered must be enclosed as well as your name and address. Forward prepaid (express preferred) to the nearest B & K-Precision authorized service agency.

Contact your local B & K-Precision Distributor for the name and location of your nearest service agency, or write to

*Service Department*

**B & K-PRECISION DIVISION OF DYNASCAN CORP.**

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