Errata

Title & Document Type: **1105A, 1106B and 1108A Pulse Generator Operating Note**

Manual Part Number: **5955-2714**

Revision Date: **February 1977**

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PULSE GENERATOR

Models 1105A 1106B 1108A

1105A Serials Prefixed: 726-, 1106B Serials Prefixed: 1217A, 1108A Serials Prefixed: 723- or 732-

OPERATING NOTE/FEBRUARY 1977

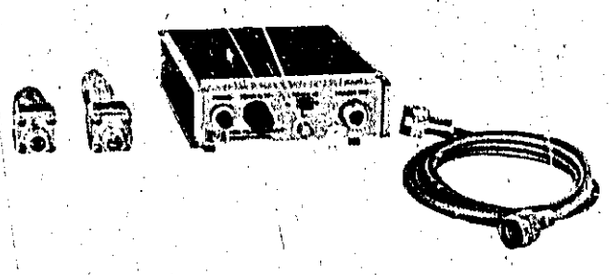

Figure 1. Model 1105A Pulse Generator and Model 1106B and 1108A Tunnel Diode Mounts

1. DESCRIPTION.

2. The Model 1105A Pulse Generator and associated Tunnel Diode Mounts (Figure 1) are combined for use in checking the dynamic response of wideband amplifiers, oscilloscopes, and transmission lines. The specifications of the Model 1105A and applicable Tunnel Diode Mount combinations are listed in Table 1.

3. This operating note applies to Model 1105A, 1106B, 1106B Opt 001, and 1108A units with serial prefixes as listed in the title block. The serial prefix is the first group of digits in the serial number. Always include the complete serial number in any correspondence with Hewlett-Packard Sales/Service Offices.

CAUTION

a. The Model 1106B and 1108A Tunnel Diode Mounts are designed to be used only with Model 1105A Pulse Generator or Model 1104A Trigger Countdown (refer to Model 1104A 1106B/1108A operating note). The female type N connector of the tunnel diode mounts should be connected only to the Model 1105A or 1104A.

b. Before connecting a Tunnel Diode Mount to a device under test, ensure that any voltage present does not exceed 1 volt across 50 ohms. Discharge any static potentials from the coaxial lines to be connected. Excessive peak current will damage the output resistor and the tunnel diode.

c. Avoid mechanical shock to the T. D. Mount. Make no attempt to open encasement. It is a delicate precision instrument.

Table 1. Specifications

OUTPUT

RISETIME: Approximately 20 ps with 1106B and 60 ps with 1108A and less than 28 ps and 66 ps respectively when observed using HP Model 1811A/1430C 20 ps Sampler and Model 909A 50-ohm termination.

OVERSHOOT: Less than ± 7 1/2% as observed using the HP Model 1811A/1430C and 909A.

DROOP: Less than 3% in first 100 ns.

WIDTH: Approximately 3 μsec.

AMPLITUDE: Greater than +200 mV into 50 ohms.

REPETITION RATE: 0 to 100 kHz depending on external trigger. Free run at 100 kHz.

OUTPUT CHARACTERISTIC: (Tunnel Diode Mounts) 50 ohms ± 2%. Less than 10% source reflection using a 40 ps TDR system. Approximately 0.1 Vdc ofiset. (A precision male type N output connector is provided on Model 1106B, AFC-7 on 1106B Opt 001, and GR-874 output connector is provided on Model 1108A).

INPUT (Trigger)

RISETIME: Less than 20 ns required. Jitter less than 15 ps when triggered by a 1 ns risetime sync pulse from HP Model 1811A Sampling Time Base and Vertical Amplifier Jitter increases with slower trigger risetimes.

WIDTH: Greater than 2 ns.

AMPLITUDE: At least ± 0.5V peak required. Maximum safe input is 10V.

INPUT IMPEDANCE: 200 ohms, ac coupled through a 20 pF capacitor.

REPETITION RATE: 0 to 100 kHz.

GENERAL

POWER: 115 or 230 vac ±10%, 50 to 1000 Hz, 1W.

WEIGHT: Model 1105A; Net, 3 lbs (1,4 kg). Shipping 8 lbs (3,6 kg). Model 1106B or 1108A; Net 1 lb (0,5 kg). Shipping 3 lbs (1,4 kg).

ACCESSORIES SUPPLIED: One 6-ft., 50-ohm cable with male type-N connectors, HP Model 10132A.

Operating Note Part No. 5955-2714
Microfiche Part No. 5955-2715

4. INITIAL INSPECTION AND CLAIMS.

5. Upon receipt of the instrument, check for physical damage. If no physical damage is evident, check the electrical performance of the instrument by accomplishing the performance check procedures given in Paragraphs 25 through 30.

6. Performance of the instrument is guaranteed by HP as stated in the specifications listed in Table 1. If the instrument is damaged or the performance does not meet the specifications listed, notify the carrier and nearest Hewlett-Packard Sales/Service Office. HP will arrange for repair or replacement of the instrument without waiting for a settlement of a claim with the carrier.

7. OPERATION.

8. The Model 1105A is factory connected for operation from a 115 volt, 50 Hz to 1000 Hz, ac power source. To set up the instrument for 230-volt operation, remove the chassis cover plate, disconnect the jumpers joining terminals 1-2 and 3-4 on the primary of the power transformer (T1) and install a new jumper between terminals 2-3.

9. Connect the Model 1105A and applicable Tunnel Diode Mount together using the Model 10132A (6 ft) Accessory Cable. Connect the Tunnel Diode Mount output connector to the device under test.

10. For free-run operation, turn the SENSITIVITY control clockwise until a satisfactory pulse is produced. The free-run pulse rate is approximately 100 kHz.

11. For external trigger operation connect the external trigger source to the TRIGGER IN connector. Set the TRIGGER IN switch to the polarity of the trigger pulse input. Slowly adjust the SENSITIVITY control for stable triggering.

12. APPLICATION INFORMATION.

13. The Model 1105A/Tunnel Diode Mount combination is used to measure risetimes of oscilloscopes and amplifiers capable of operating up to 18 GHz.

14. A typical application involving the risetime measurement of an oscilloscope-sampler system is shown in Figure 2. The risetime of the oscilloscope-sampler system under test is determined by first measuring the observed pulse risetime on the oscilloscope. This observed risetime together with the known rise time of the Pulse Generator/Tunnel Diode Mount combination is substituted in the following equation and the equation is solved for T1.

$$T1 = \sqrt{Tm^2 - T2^2}$$

Where: T1 = Risetime of oscilloscope under test.
Tm = Risetime of the pulse observed on the oscilloscope under test.
T2 = Risetime of the applied pulse.

Example:
If: Tm = 28 ps
T2 = 20 ps (1105A/1106B combination)

Then: $T1 = \sqrt{28^2 - 20^2}$
T1 ≅ 20 ps (Risetime of oscilloscope under test.

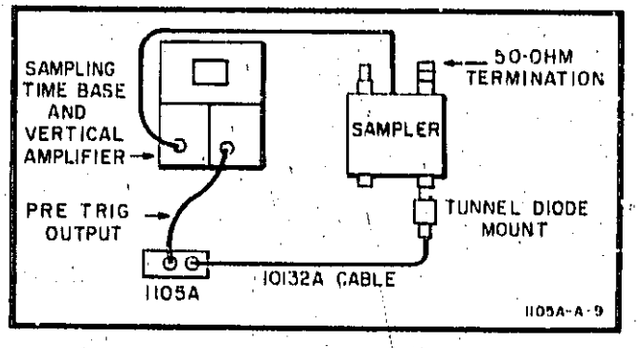

Figure 2. Typical Oscilloscope Risetime Measurement Test Setup

15. Wide-band amplifier risetime measurements are obtained in a manner similar to that used in measuring the risetime of oscilloscopes (Figure 3). However, in this application the combination of the oscilloscope and pulse generator risetime, used in the test setup, must be taken into consideration. This combination risetime can be calculated by transposing the equation of Paragraph 14 to solve for Tm.

$$Tm = \sqrt{T1^2 + T2^2}$$

Where: Tm = Risetime of test setup
T1 = Risetime of the oscilloscope
T2 = Risetime of the pulse generator

Example: T1 = 20 ps (1811A/1430C combination)
T2 = 20 ps (1105A/1106B combination)

Then: $Tm = \sqrt{20^2 + 20^2}$
Tm ≅ 28 ps (Risetime of test setup)

After determining the risetime of the test setup, the observed risetime (of the amplifier under test) is obtained by measuring the amplifier pulse output on the oscilloscope. This measured risetime together with the test setup risetime are then substituted in the previous equation and the equation is solved for T2.

$$T2 = \sqrt{Tm^2 - T1^2}$$

Where: T2 = Risetime of amplifier under test.
Tm = Measured risetime of the pulse observed on the oscilloscope.
T1 = Risetime of the test setup (oscilloscope and pulse generator).

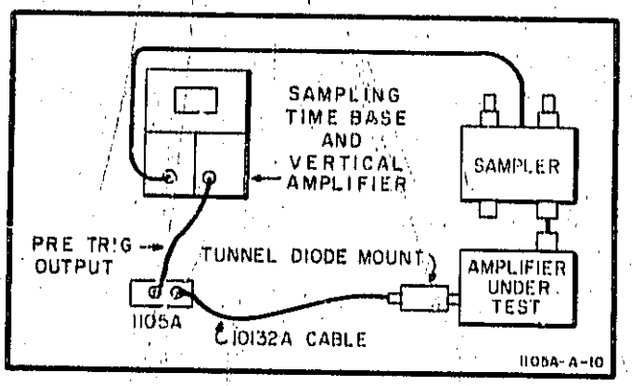

Figure 3. Typical Amplifier Risetime Measurement Test Setup

16. The Model 1105A and applicable Tunnel Diode Mount in conjunction with the HP Model 180A Oscilloscope and appropriate plug-ins can be used to make microwave transmission line measurements in 50 ohm systems. The extremely fast risetime of the pulse generator allows resolution in time-domain reflectometry down to fractions of an inch. In the free-running mode, the pulse generator may also be used to excite microwave cavities.

17. THEORY OF OPERATION.

18. The Model 1105A Pulse Generator consists of a regulated power supply, trigger input circuit and isolation and cable terminating impedance networks. It functions as the low-impedance bias source required to operate Tunnel Diode Mounts. The regulated bias output provided by the Pulse Generator minimizes jitter in the output of the Tunnel Diode Mount. See Figure 12 for the overall schematic of the Model 1105A Pulse Generator/Tunnel Diode Mount.

19. The regulated bias supply is comprised of a full wave rectifier, filter, series regulator, bias control stage, and isolation network. Transformer T1, diodes CR1 and CR2, and filter capacitor C3 provide a rectified and filtered voltage to series regulator Q1. Series regulator Q1, in conjunction with sensor Q3 and driver Q2, regulates the output voltage. Any fluctuation in output voltage is sensed by sensor Q3. Sensor Q3 in turn applies an error signal to the base of driver Q2. Driver Q2 applies a corresponding correction voltage to the base of series regulator Q1 and the current flow through Q1 is increased or decreased to compensate for the output fluctuation. The regulated output is coupled through bias control Q4 and inductor L1 to the tunnel-diode circuit. Bias control Q4 is an emitter follower and provides the low source impedance required by the tunnel diode. SENSITIVITY control potentiometer R8 determines the steady-state current conduction of bias control Q4. Bias centering adjust potentiometer R7 centers the range of the SENSITIVITY control for optimum operation of the tunnel diode.

20. External trigger input signals are routed through connector J1 and TRIGGER IN switch S2 to Balun transformer T2. Balun transformer T2 provides a positive-going trigger pulse output regardless of the polarity of the trigger pulse applied. Capacitors C8 and C9 differentiate the incoming trigger and diode CR8 and resistor R10 limit the amplitude of the trigger.

21. Resistor R11 is a 50-ohm termination load built into output connector J2. This special concentric disc resistor prevents the reflection of pulses from the Tunnel Diode Mount.

22. The Tunnel Diode Mounts consist of impedance matching and isolating components which enable optimum usage of the tunnel diode fast risetime characteristics. See Figure 4 for a typical tunnel-diode characteristic curve. A negative resistance region, in which current decreases when voltage increases, exists between points B and D on the curve. In this region, the tunnel diode characteristic curve is very unstable and rapid voltage changes occur.

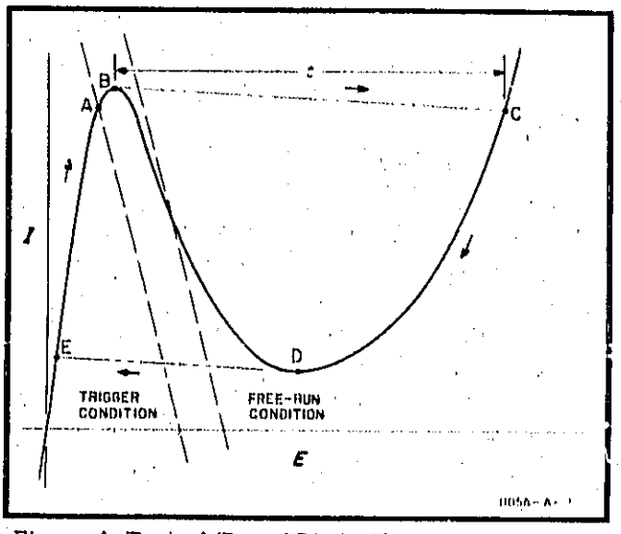

Figure 4. Typical Tunnel Diode Characteristic Curve

23. In the triggered mode of operation, the output from the Model 1105A initially biases the tunnel diode at point A (steady state condition) on the characteristic curve. When an external trigger is applied, the trigger current level causes the tunnel-diode bias level to shift to point B (negative resistance region on the characteristic curve) and the tunnel-diode operating point rapidly switches to point C. During the switch time, the current across the tunnel diode remains relatively constant, because of the action of inductor L1, while the voltage makes a rapid change across the load. This rapid voltage change produces a voltage step with a risetime of approximately 20 ps. Inductor L1 maintains a constant current through the tunnel diode for approximately 100 ns. As the current through inductor L1 decreases, the tunnel-diode operating point drops to point D on the curve (negative resistance region) and the tunnel diode rapidly switches to point E. The bias output from the Model 1105A restores the tunnel-diode operating point to point A on the curve and the tunnel diode remains in this steady state condition until again triggered. A typical output waveform is shown in Figure 5.

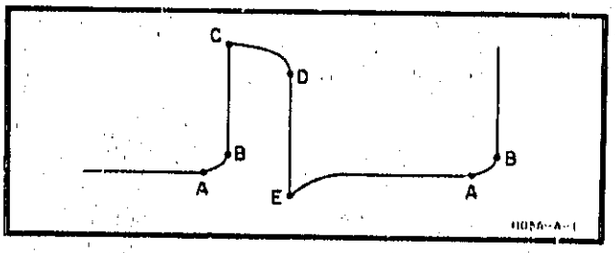

Figure 5. Typical Tunnel Diode Output Waveform

24. In the free-running mode of operation, the tunnel diode is biased at point B on the characteristic curve by turning the SENSITIVITY control on the Model 1105A clockwise. With the tunnel diode biased in this negative resistance region, the tunnel diode will switch operating states without the application of an external trigger and will continue to cycle through points B, C,

D, E of the characteristic curve at a free-running rate of approximately 100 kHz.

25. PERFORMANCE CHECKS.

26. The following performance checks verify that the Model 1105A and applicable Tunnel Diode Mount combination are operating in accordance with the specifications listed in Table 1. Recommended test equipment is listed in Table 2. Substitute test equipment must have similar characteristics. Ensure that the test equipment used is in calibration.

Table 2. Recommended Test Equipment

Type	Model	Characteristic
Sampling System	HP Models	
Sampler	1430C	20 ps risetime
Mainframe	180A	
Sampling Time Base Vert. Ampl.	1811A	10 ps/div sweep
50-ohm Termination, Precision Type N Connector	HP 909A	Non-reactive Termination
Adapter, Type N Male to BNC Female	UG-201A/U	Non-reactive Adapter
Cable, 50-ohm w/BNC Male Connectors		Non-reactive Connectors

27. OUTPUT CHECK.

28. Connect the Model 1105A and applicable Tunnel Diode Mount to the test equipment as shown in Figure 6. Then perform the following procedure.

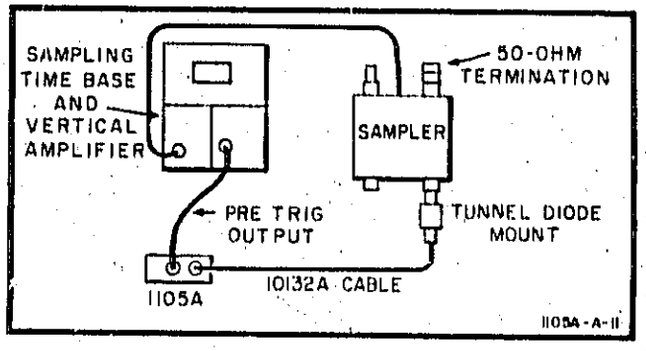

Figure 6. Output Test Setup

a. Set controls on the sampling time base and vertical amplifier as indicated:

scan . . . . . sweep
time/div . . . . . 1 ns
trigger level . . . . . center to free run
mV/div 100
normal/filtered . . . . . filtered

b. On the Model 1105A, turn the SENSITIVITY control fully counterclockwise and set the TRIGGER IN switch to positive (+). Advance the SENSITIVITY control until a stable trigger pulse is observed on the oscilloscope.

c. On sampling time base and vertical amplifier, set the expanded time/div for a sweep speed of 0.01 ns/cm and adjust the expanded position to observe the rising edge of the pulse. Readjust the Model 1105A SENSITIVITY control for best waveform and minimum jitter. See Figure 7.

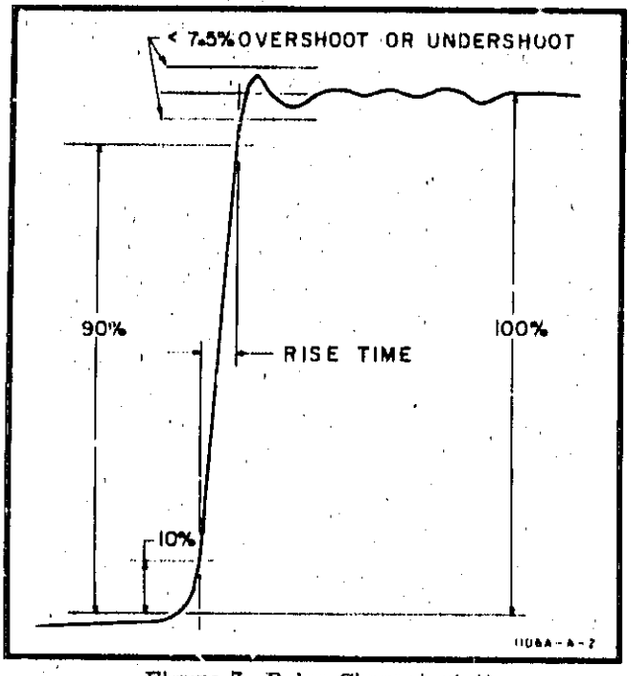

Figure 7. Pulse Characteristic

d. Pulse amplitude, as observed on the oscilloscope, should be greater than 200 mV.

e. On the sampling time base and vertical amplifier, set the mV/div switch to 50 and adjust the vernier control for an observed pulse 10 cm high. Adjust risetime for optimum display. The risetime of the observed pulse should be less than 28 ps with an over/undershoot of less than ± 7 1/2 percent (Model 1105/1106B combination). With a Model 1105A/1108A combination under test, the risetime of the observed pulse should be less than 66 ps with an over/undershoot of less than ±5 percent.

f. On the sampling time base and vertical amplifier, set sweep speed for 10 ns/div, and adjust horizontal position to place the leading edge of the pulse at the left side of the oscilloscope graticule. Pulse droop should be less than 3 percent in first 100 ns of pulse. See Figure 8.

g. On the sampling time base and vertical amplifier, set the mV/div switch to 10. Adjust expanded position and time/div controls for a sweep speed of 0.01 ns/div. Set the normal/filtered switch to normal and adjust position controls to observe the center portion of the pulse risetime. Pulse jitter should be less than 15 ps. (It may be necessary to readjust the Model 1105A SENSITIVITY control for minimum jitter.)

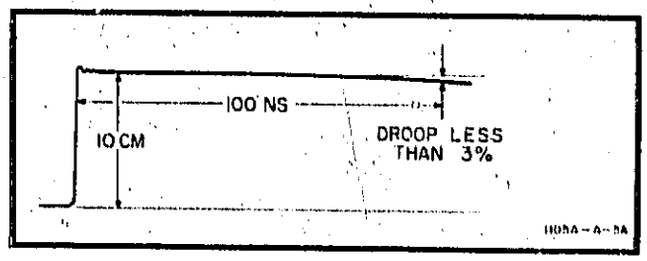

Figure 8. Pulse Droop Characteristic

29. FREE-RUN CHECK.

30. Connect the equipment as shown in Figure 9 and perform the following steps:

a. Set controls on the sampling time base and vertical amplifier as indicated:

time/div . . . . . 1 usec
mV/div 100
expanded time/div 1
norm/auto . . . . . auto

b. Adjust the SENSITIVITY control on the Model 1105A for a free-run pulse output as observed on the oscilloscope.

c. The pulse period should be approximately 10 usec and the pulse width between 2 and 4 usec.

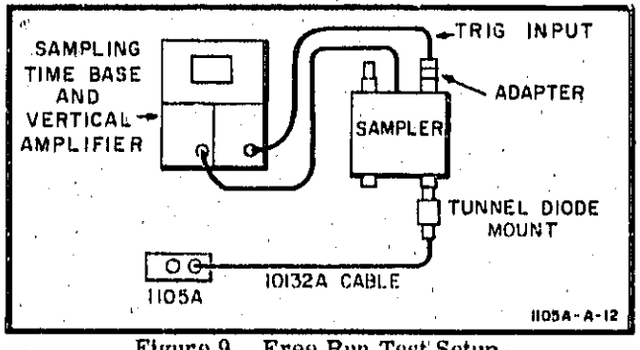

Figure 9. Free Run Test Setup

31. ADJUSTMENTS.

32. The setting of bias centering adjust potentiometer R7 is the only Model 1105A/Tunnel Diode Mount adjustment required. To make this adjustment, connect the equipment as shown in Figure 6 and perform the following procedure.

a. Set controls on the sampling time base and vertical amplifier as indicated:

scan . . . . . sweep
time/div . . . . . 1 ns
mode . . . . . free run
mV/div 100
normal/filtered . . . . . normal

b. Turn the SENSITIVITY control on the Model 1105A to a mid-range position (approximately 12 o'clock).

c. Rotate bias centering adjust potentiometer R7 fully counterclockwise; then slowly turn R7 clockwise until the pulse output observed on the oscilloscope appears delayed.

33. TROUBLESHOOTING.

34. Use the part location illustration (Figure 11) and the schematic (Figure 12) as an aid to troubleshooting the Model 1105A/Tunnel Diode Mount combination. Refer to the Theory of Operation (Para. 17) for a functional description of the circuits. Tunnel Diode Mount components are not identified since field repairs are not recommended.

35. EXCESSIVE JITTER.

36. Excessive jitter (>15 ps) may be caused by an increase in ripple in the bias output of the Model 1105A Pulse Generator, or by jitter in the external trigger source when using this mode of operation. To check the ripple in the bias output, disconnect the Tunnel Diode Mount from the Model 1105A, connect a 2.7 ohm resistor across TRIGGER OUT connector J2 and apply the bias output directly to the vertical input of a sensitive oscilloscope. No external trigger is applied to the Model 1105A during output ripple check. Typical ripple values are indicated on the schematic. If the ripple in the bias output is within tolerance, check the amount of jitter in the external trigger source being used.

37. EXCESSIVE DROOP.

38. Check inductor L1 or bias control transistor Q1 if the Model 1105A/Tunnel Diode Mount output pulse indicates excessive droop. A change in the value of disc resistor R11 may also cause excessive reflections in the output waveform. Disc resistor R11 should be 50 ohms ± 1 percent.

CAUTION

Mechanical abuse or excessive heat will damage the disc resistor. Should replacement of the disc resistor be necessary, use a low-temperature soldering iron, Indalloy No. 2 solder, and water soluable flux. Use care when soldering connections.

39. NO OUTPUT.

40. If there is no pulse output from the Model 1105A/Tunnel Diode Mount, check circuit voltages using a VTVM. Perform the voltage checks with the Tunnel Diode Mount disconnected and a 2.7 ohm resistor connected across the Model 1105A TRIGGER OUT connector (J2). Refer to the schematic (Figure 12) for test points and typical dc voltage values. Voltages in parenthesis are with the SENSITIVITY control fully clockwise. Voltages not enclosed in parenthesis are with the SENSITIVITY control fully counterclockwise.

41. To check a Tunnel Diode Mount use a Tektronics Model 575 Transistor Curve Tracer. Set the Model 575 controls as follows: Vertical to 10mA/cm; Horizontal to 0.2 V/cm; Peak Volts Range to 0-20; Peak Volts to 0; Dissipation Limiting Resistor to zero; Polarity to positive (+). Connect lead C to center conductor to type N connector and lead E to the case of the Tunnel Diode Mount. Slowly increase Peak Volts. The characteristic curve (Figure 10) should be observed. Points on the curve should meet the following specifications:

Ip < 60 mA
Ep < 400 mA

Ip-Iv > 37 mA

Ea-Ep > 400 mV

A vertical line indicates a shorted diode.
A horizontal line indicates an open diode.

CAUTION

a. The Tunnel Diode Mount is a precision assembly with critical tolerances. Do not attempt field repairs. Return defective Tunnel Diode Mounts to the nearest HP Sales/Service Office for repairs.

b. Do not exceed an Ip of 60 mA when E ≧ Vp or an I of 25 mA when E > Vv.

42. OLDER INSTRUMENTS.

43. This operating note applies directly to the standard Models having serial prefixes as listed in the front page title block. Table 3 indicates changes required to adapt this operating note to an older instrument (lower serial prefix). Check Table 3 for the proper instrument serial prefix and make the changes indicated.

Table 3. Operating Note Changes

Serial Prefix	Make Changes
618-, 645- (1105A)	1

CHANGE 1

Page 6, Table 4,
CR8: Change to HP Part No. 1901-0115, CR: Si.

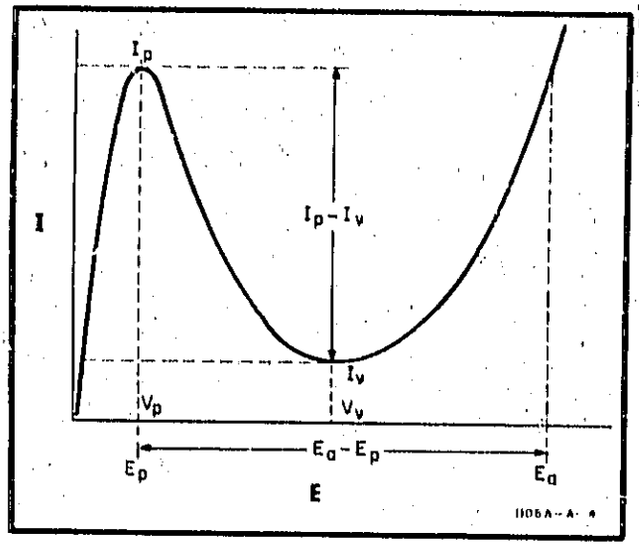

Figure 10. Tunnel Diode Curve Specifications

44. REPLACEABLE PARTS.

45. Table 4 lists Model 1105A replaceable parts in alphanumeric order by reference designation and provides data required to order replacements.

46. Order replaceable parts from the nearest HP Sales/Service Office. Include the instrument model number, complete serial number, and HP Part No. If a part number is not listed, provide a complete description including function and location.

Table 4. Replaceable Parts

Ref Desig	HP Part No.		TQ	Description		
A1	01105-66501		1	A: etched circuit with components		
C1	0150-0014		2	C: fxd cer 0.005μF 20% 500 wVdc		
C2	0150-0014			C: fxd cer 0.005μF 20% 500 wVdc		
C3	0180-0121		1	C: fxd elec 680μF 10% 10 wVdc		
C4	0150-0121		1	C: fxd cer 0.1μF 20% 50 wVdc		
C5	0180-0060		3	C: fxd elect 200μF 10% 3 wVdc		
C6	0180-0060			C: fxd elect 200μF 10% 3 wVdc		
C7	0180-0060			C: fxd elect 200μF 10% 3 wVdc		
C8	0150-0035		2	C: fxd cer 20pF 5% 300 wVdc		
C9	0150-0035			C: fxd cer 20pF 5% 300 wVdc		
CR1	1901-0025		6	CR: Si		
CR2	1901-0025			CR: Si		
CR3	1901-0025			CR: Si		
CR4	1901-0025			CR: Si		
CR5	1901-0025			CR: Si		
CR6	1901-0025			CR: Si		
CR7	1901-0033		1	CR: Si 1N485B		
CR8	1901-0050		1	CR: Si		

Table 4. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.		TQ	Description
DS1	3101-0100		1	DS: ne (p/o S1 assy)
J1	1250-0118		1	J: BNC
J2	2150-0865		1	J: N-special
J3				J: nsr; p/o Tunnel Diode Mount
J4				J: nsr; p/o Tunnel Diode Mount
L1	01105-66001		1	L: 20.5 μH
Q1	1853-0071		1	Q: Si pnp 2N1132
Q2	1854-0071		2	Q: Si npn 2N3391
Q3	1854-0071			Q: Si npn 2N3391
Q4	1851-0024		1	Q: Si npn 2N388A
R1	0757-0764		1	R: fxd comp 33k ohms 10% 1/4W
R2	0757-0280		2	R: fxd metflm 1000 ohms 1% 1/8W
R3	0757-0280			R: fxd metflm 1000 ohms 1% 1/8W
R4	0684-2201		1	R: fxd comp 22 ohms 10% 1/4W
R5	0757-0416		1	R: fxd metflm 511 ohms 1% 1/8W
R6	0757-0407		1	R: fxd metflm 200 ohms 1% 1/8W
R7	2100-1770		1	R: var ww 100 ohms 1W
R8	2100-2080		1	R: var ww 50 ohms
R9	0757-0401		1	R: fxd metflm 100 ohms 1%
R10	0757-0407		1	R: fxd metflm 200 ohms 1% 1/8W
R11	0730-0161		1	R: fxd disc 50 ohms 1% 1W
S1	3101-0100		1	S: spst power (p/o DS1 assy)
S2	3101-0040		1	S: dpdt polarity
T1	9100-0145		1	T: power
T2	213A-60B		1	T: balun
W1	8120-0037		1	W: cable power
W2	Model 10132A		1	W: cable assy, 50 ohms N conn
				MISCELLANEOUS
	0370-0084		1	Knob: black 5/8" diameter
	0400-0013		1	Grommet: u/w W1
	1205-0038		1	Heat dissipator: semiconductor
	4000-0101		2	Panel: side
	5060-0072		1	Cover assy: top
	5060-0073		1	Cover assy: bottom
	5060-0213		2	Frame: casting
	5060-0727		1	Foot assy
	01105-00101		1	Deck
	01105-00201		1	Panel: front
	01105-00202		1	Panel: sub
	01105-00203		1	Panel: rear
	01105-22301		1	Holder: resistor u/w R11
	1401-0047		1	Cap: plastic, yellow
	1401-0047		1	Cap: plastic, red
	Model 1106B			Tunnel Diode Mount
	Model 1108A			Tunnel Diode Mount

Note

Do not disassemble tunnel-diode mounts.

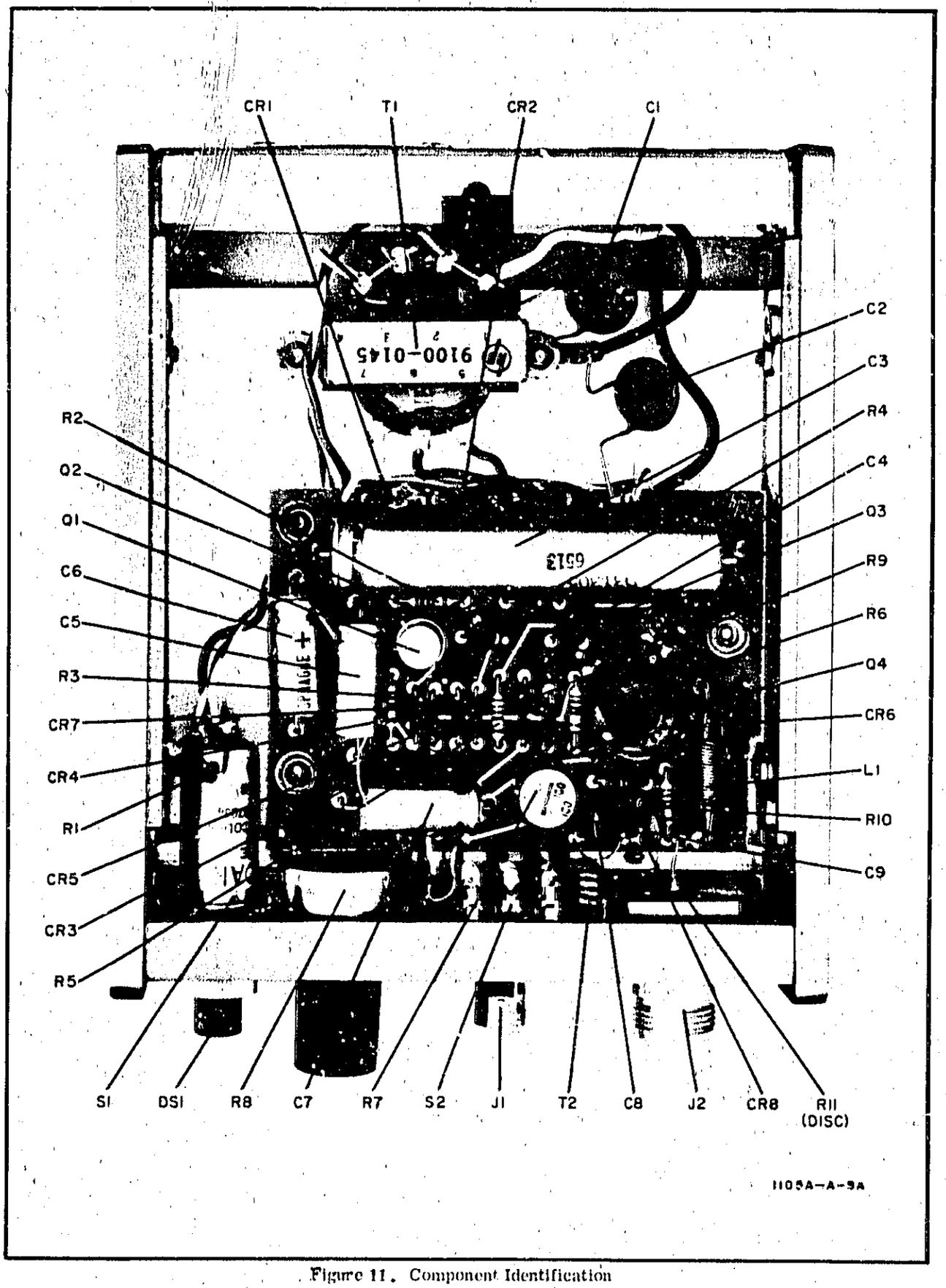

Figure 11. Component Identification

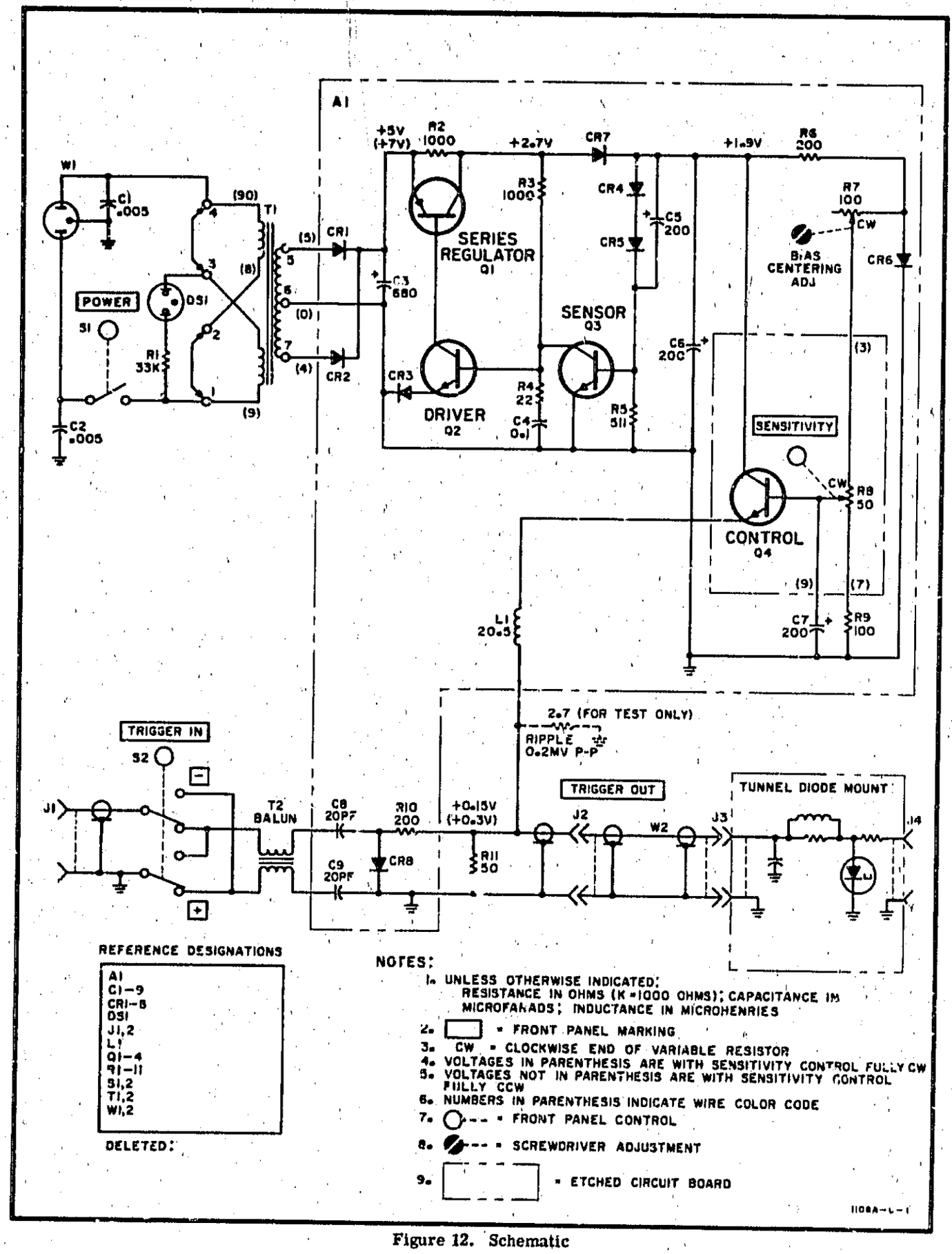

Figure 12. Schematic