HEWLETT PACKARD

APPLICATION BULLETIN 5

Current Source for Diode Testing

INTRODUCTION

A programmable current source that was designed for biasing diodes under test is easier to set to the required current than a conventional current source.

The current source, designed for testing Hewlett-Packard PIN diodes, is programmed by thumb wheel switches in 10 μA steps, from 10 μA to 700 mA with an accuracy better than $\pm$1%. Changes in current settings may be made quickly without a current monitor.

APPLICATIONS

This current source is ideal as a bias source in diode test set-ups since the current may be set accurately without any additional equipment.

It may be used either to set a particular bias current or to determine what current is required to obtain certain parameter values which vary with current.

It has been used in RF resistance test set-ups, for biasing detectors, PIN switches, and attenuators, and in various diode circuits for checking intermodulation and cross modulation distortion.

CIRCUIT DESCRIPTION

Figure 1 is a block diagram of the current source and Figures 2, 3, 4, and 5 are detailed schematics of each section.

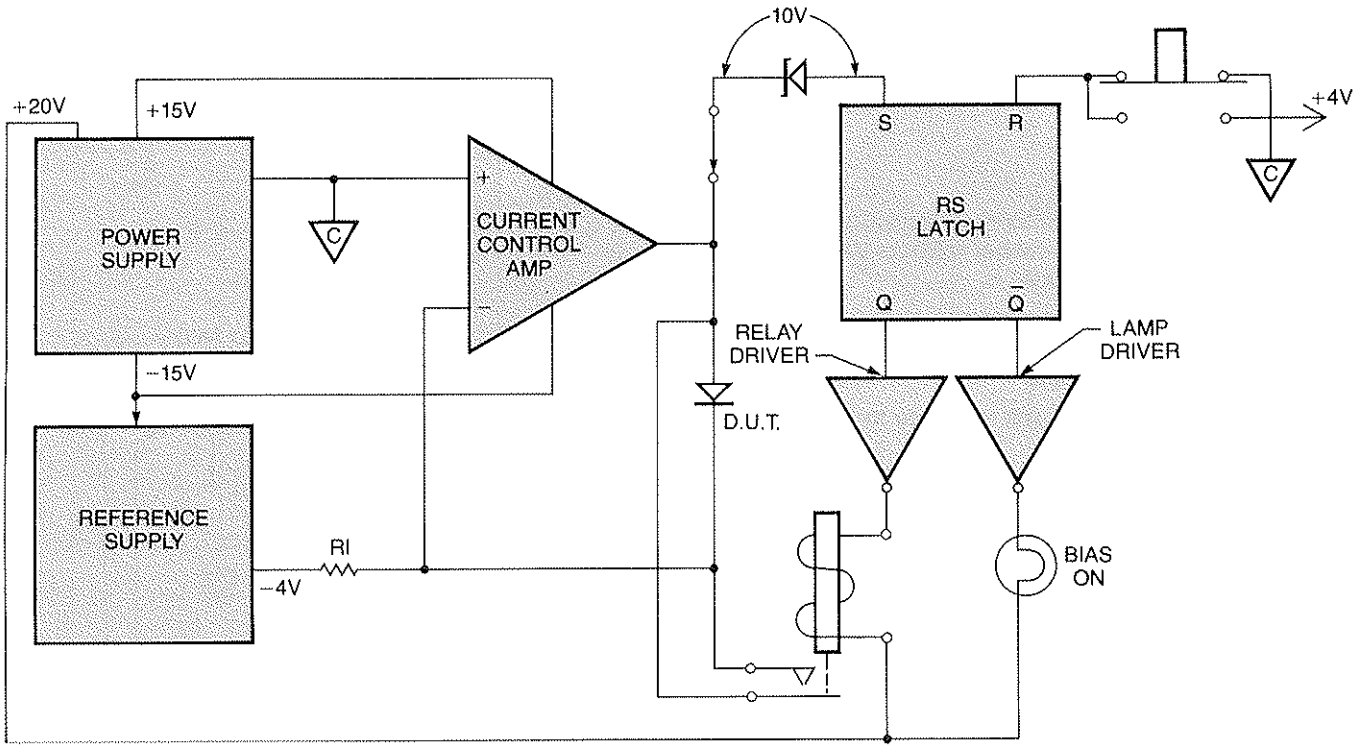

Figure 1. Current Source.

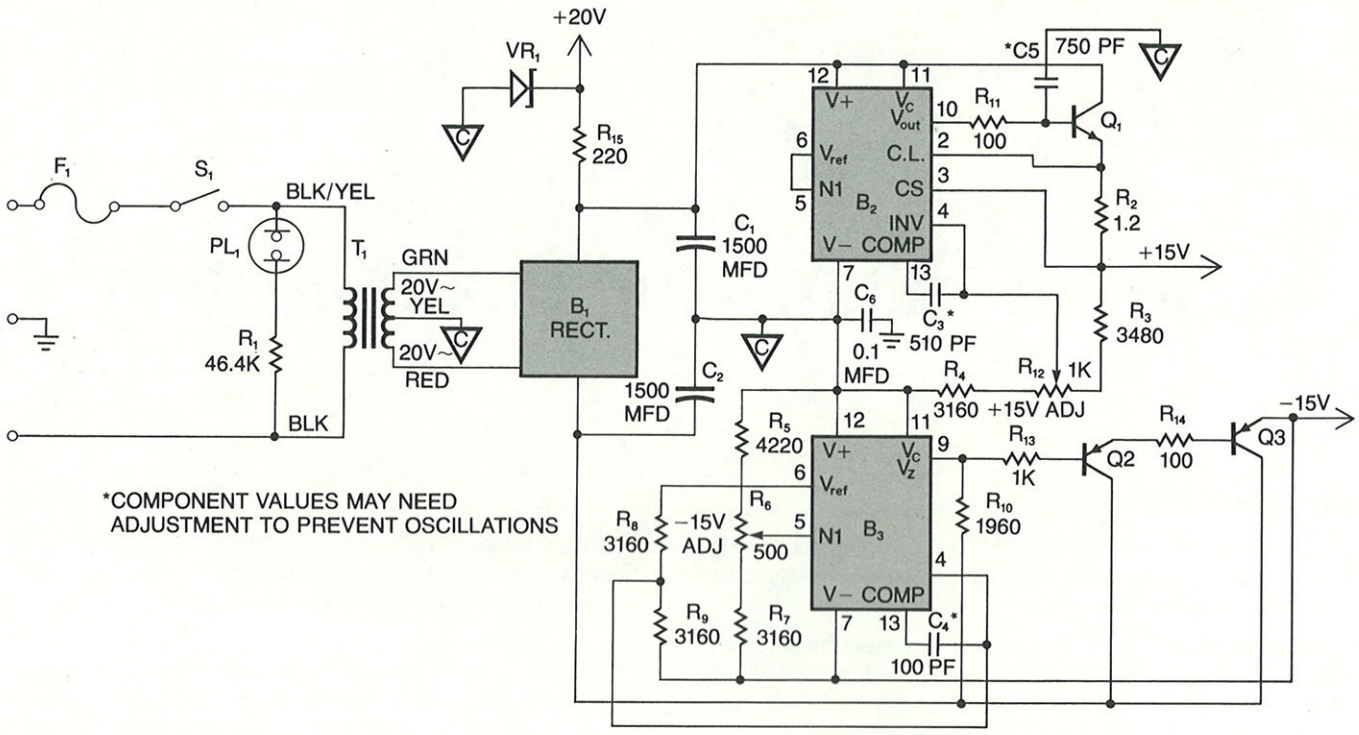

Figure 2. Power Supply.

POWER SUPPLY

The power supply (Figure 2) has a 1 amp transformer and a 1 amp bridge rectifier furnishing power to two Fairchild 723 PC voltage regulators for a regulated ±15V. A zener regulator furnishes +20V for the "current on" lamp and output shorting relay in Figure 5.

The components marked with an asterisk in Figures 2 and 3 may need to be adjusted to prevent oscillation of the voltage supplies.

REFERENCE SUPPLY

The accuracy of the reference supply (Figure 3) combined with the accuracy of the current control resistors determines the accuracy of the current source.

The reference supply is controlled by a Motorola MC 1439G operational amplifier and with an input from −15 volt supply provides a regulated −4 volts.

Zener VR2 furnishes a +10 volt reference for the regulator.

CURRENT CONTROL AMPLIFIER

The current control amplifier (Figure 4) also uses a Motorola MC 1439G with FET's at the inputs to keep leakage current to less than 1 nA.

The MC 1439G controls a current driver consisting of two cascaded emitter followers.

The entire circuit is an operational amplifier with R_I (input resistance) being the selected combination of 0.1% resistors R23 through R41 and R_F (feedback resistance) being the load on the output. The input current is determined by $R_I/4$ volts and since leakage of the FET is negligible the input current is also the output current to the load.

Q6 and Q7 should be selected for a voltage match of 100 mV or better with 20K resistors on the source, gates at 0 volts and V_{DD} = +15V, V_{SS} = −15V.

Both sides of the output float and either polarity may be grounded in use.

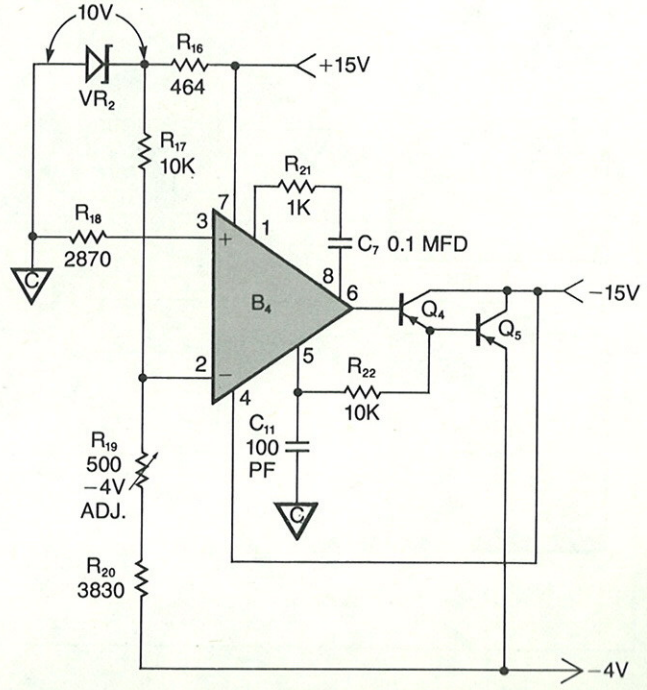

Figure 3. Reference Supply.

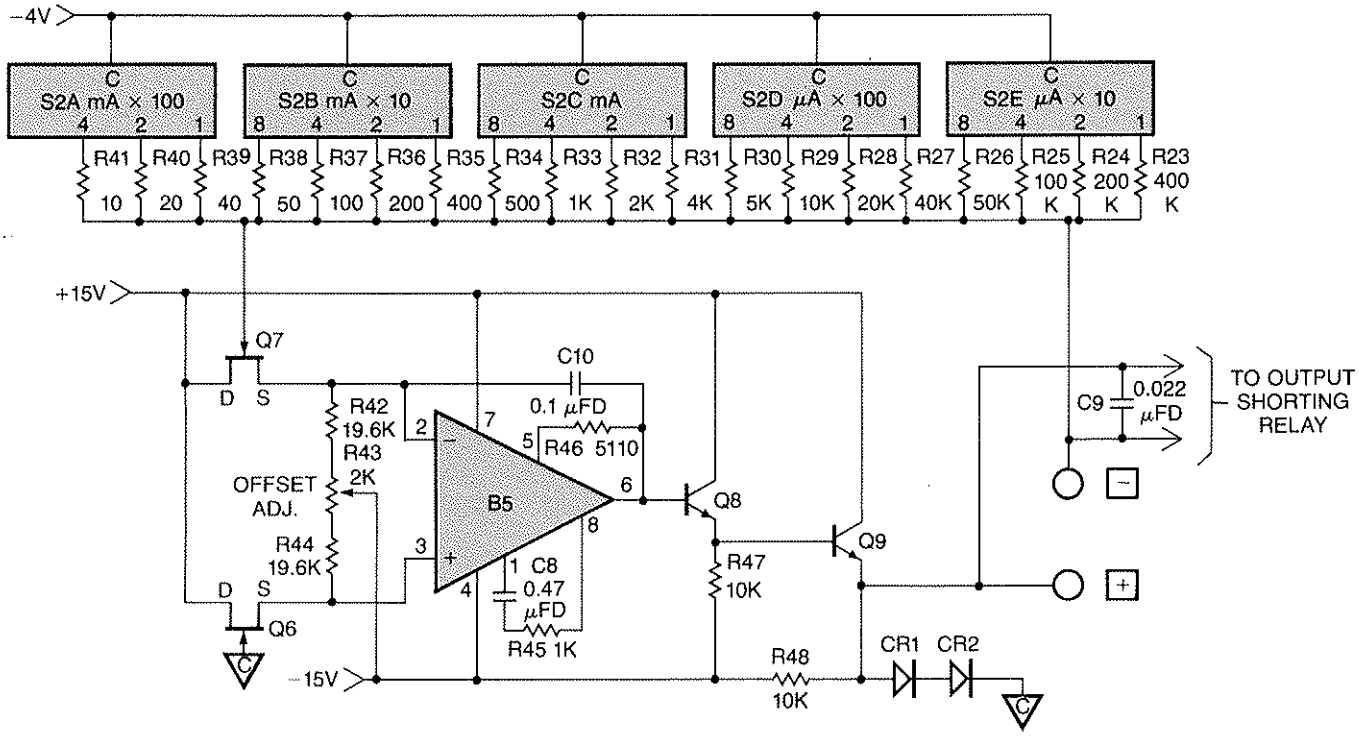

Figure 4. Current Control Amplifier.

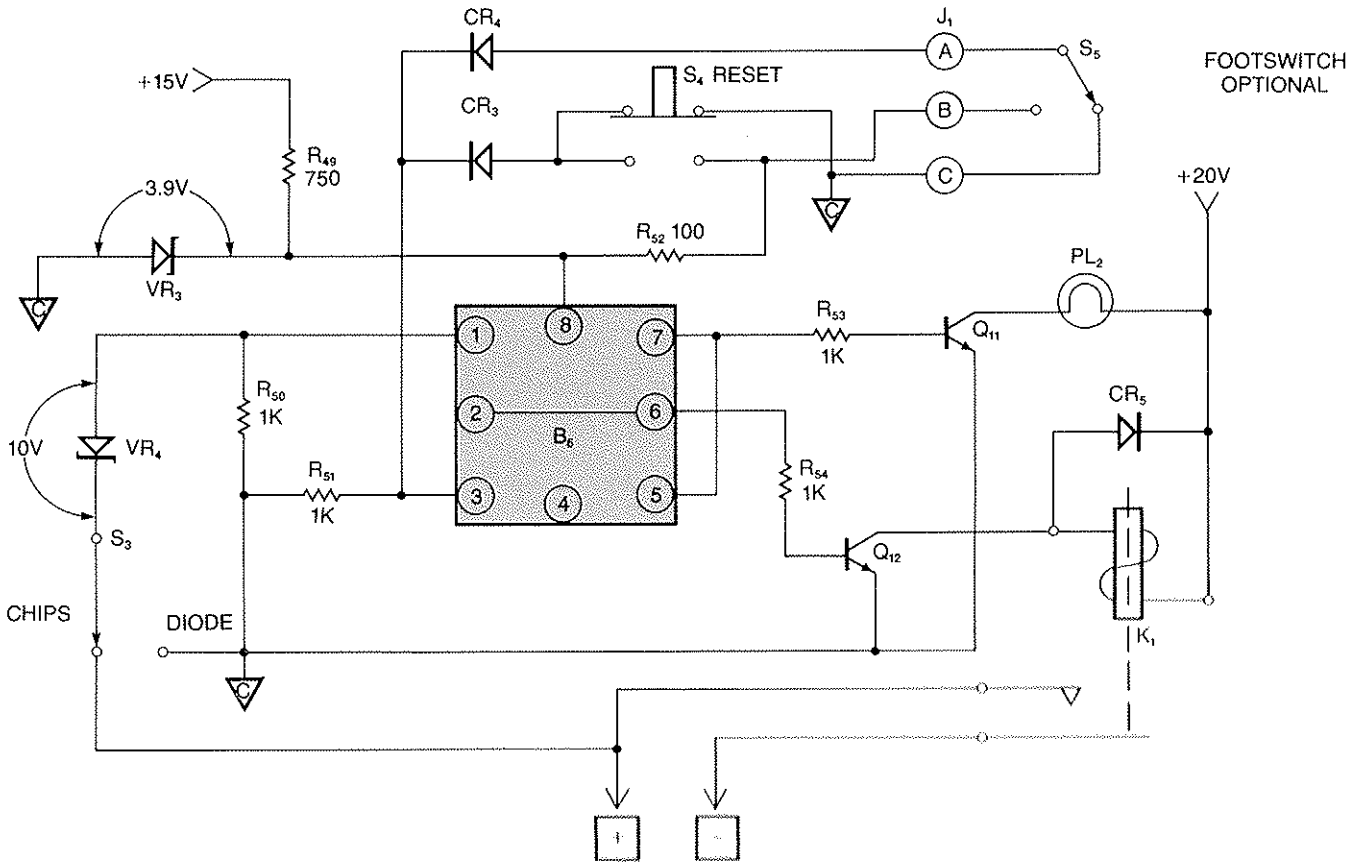

Figure 5. Output Shorting Circuit.

OUTPUT SHORTING CIRCUIT

The output shorting circuit is a safety feature which prevents the probe from welding to the chip when testing diode chips. It is also useful for testing diodes which may be burned out by the application of the current source open circuit voltage — approximately 14 volts.

When switch S3 is in the "CHIPS" position an open circuit is sensed through zener VR4 which sets RF (Set-Reset) latch B6 closing relay K1 and turning off the current on light PL-2. After a diode is placed across the output the latch is reset by momentary push button switch S4 or an optional foot switch.

ASSEMBLY

The only precautions necessary in assembly are the AC wiring should be separated from the other wiring and the chassis must be well grounded with a 3-conductor power cord.

CALIBRATION

With output terminals shorted and current set to 20 mA, adjust ±15 volt supplies to 15 volt ±1% and −4 volts supply to 4 volts ±0.1%.

Set current to 10 μA leaving output shorted. Then adjust offset balance for a reading of 0.0 ± 10 mV between current terminals and power supply common.

The current at each setting of the current switches should now be within 1% of setting. If not, replace or pad the appropriate resistor to correct it.

MATERIAL LIST FOR CURRENT SOURCE

B1	RECTIFIER BRIDGE MOTOROLA MDA-920
B2,3	VOLTAGE REGULATOR FAIRCHILD 723 PC
B4,5	OPERATIONAL AMPLIFIER MOTOROLA MC 1439G
B6	DUAL 2 INPUT NOR GATE FAIRCHILD 9914
C1,2	CAPACITOR, 1500 MFD, 50V
C3	CAPACITOR, 510 PFD
C4	CAPACITOR, 100 PFD
C5	CAPACITOR, 750 PFD
C6,7	CAPACITOR, 0.1 MFD
C8	CAPACITOR, 0.47 MFD
C9	CAPACITOR, 1 MFD, 25V CERAMIC
C10	CAPACITOR, 0.1 MFD
C11	CAPACITOR, 100 PFD
CR1-5	DIODE-SWITCHING FAIRCHILD FD2225
F1	FUSE, 1A, 250V
J1	CONNECTOR, 3 PIN AMPHENOL, MS3102A-10SL-3P (OPTIONAL)
J2	BINDING POSTS H.H. SMITH 1814 RB
K1	RELAY, SPST MAGNECRAFT W102MPCX-8
P1	PLUG, 3 PIN AMPHENOL MS3106A-10SL-3S (OPTIONAL)
PL1	PILOT LIGHT, PART OF S1
PL2	LAMP, 18V DRAKE 10-607
Q1,9	TRANSISTOR, 2N3054
Q2,4	TRANSISTOR, 2N1132
Q3,5	TRANSISTOR, FET, 2N4856
Q8	TRANSISTOR, 2N4239
Q10,11	TRANSISTOR, 2N3417
R1	RESISTOR, 46.4K, ¼W
R2	RESISTOR, 1.2Ω, 1W
R3	RESISTOR, 3.48K, ¼W
R4,8,9	RESISTOR, 3.16K, ¼W
R5	RESISTOR, 422K, ¼W
R6,19	RESISTOR, VAR, 500Ω
R7	RESISTOR, 1.21K, ¼W
R10	RESISTOR, 1.96K, ¼W
R11,14,52	RESISTOR, 100Ω, ¼W
R12	RESISTOR, VAR, 1K
R13,21,45, 50,51,53,54	RESISTOR, 1K, ¼W
R15	RESISTOR, 220Ω
R16	RESISTOR, 464Ω
R17,22,48	RESISTOR, 10K, ¼W
R18	RESISTOR, 2887K, ¼W
R20	RESISTOR, 3.83K, ¼W
R23	RESISTOR, 400K, ⅛W, 0.1%
R24	RESISTOR, 200K, ⅛W, 0.1%
R25	RESISTOR, 100K, ⅛W, 0.1%
R26	RESISTOR, 50K, ⅛W, 0.1%
R27	RESISTOR, 40K, ⅛W, 0.1%
R28	RESISTOR, 20K, ⅛W, 0.1%
R29	RESISTOR, 10K, ⅛W, 0.1%
R30	RESISTOR, 5K, ⅛W, 0.1%
R31	RESISTOR, 4K, ⅛W, 0.1%
R32	RESISTOR, 2K, ⅛W, 0.1%
R33	RESISTOR, 1K, ⅛W, 0.1%
R34	RESISTOR, 500, ⅛W, 0.1%
R35	RESISTOR, 400, ⅛W, 0.1%
R36	RESISTOR, 200, ¼W, 0.1%
R37	RESISTOR, 100, ¼W, 0.1%
R38	RESISTOR, 50, ½W, 0.1%
R39	RESISTOR, 40, ½W, 0.1%
R40	RESISTOR, 20, 1W, 0.1%
R41	RESISTOR, 10, 2W, 0.1%
R42,44	RESISTOR, 19.6K, ¼W
R43	RESISTOR, 2K
R46	RESISTOR, 5.11K, ¼W
R49	RESISTOR, 750, ¼W
S1	SWITCH, LIGHTED, P.B. OAK 53-67280-121-A1H
S2	THUMBWHEEL SWITCH, 5 POLE, 1-2-4-8 BCD DIGITRAN 378-5
S3	SWITCH, TOGGLE, SPDT ALCO MST-205N
S4	SWITCH, SPDT, PUSHBUTTON, MOMENTARY C&K 8121
S5	FOOTSWITCH, SPDT (OPTIONAL)
T1	TRANSFORMER TRIAD F-92A
VR1	DIODE, ZENER, 20V, 1W, 1N4747
VR2,4	DIODE, ZENER, 10V, 0.4W, 1N758A
VR3	DIODE, ZENER, 3.9V, 0.4W, 1N748A
XB2,3	SOCKET DIP, 14 PIN
XB4,5,6	SOCKET, 8 PIN, IC, ROUND
XF1	FUSEHOLDER - PANEL MOUNT
XP2	HOUSING - INDICATOR LAMP SYLVANIA SM-1
POWER CORD 3 CONDUCTOR	

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Printed in U.S.A. Data Subject to Change 5952-9854(08/80)