040-0803-02

M23958, M33052

Type: See Below

BLANK PLUG-IN W/POWER SUPPLY

For TEKTRONIX® TM500 Power Modules

All Serial Numbers

This modification kit provides parts and instructions to implement the following:

1) The building of a blank PLUG-IN for use in any TM500 Series Power Module.

2) The wiring of a power supply providing three independently regulated voltages with adjustable current limits, depending on your custom circuit requirements, by selecting the value of several resistors in the power supply.

   Using the nominal value of the selectable resistors included in the kit, the voltages available are +5V, +13V to +17V adjustable, and -13V to -17V adjustable.

1-31-79
Supersedes 9-22-78

PARTS* INCLUDED IN MODIFICATION KIT

PART I Mechanical Parts

Quantity	Part Number	Description
1 ea	105-0718-01	Bar, latch release
1 ea	105-0719-00	Latch, plug-in retainer
1 ea	200-1273-02	Subpanel, back
2 ea	210-1270-00	Washer, flat 0.141 ID X 0.219 OD X 0.04
4 ea	213-0146-00	Screw, thread forming #6 X .313 PH
4 ea	213-0229-00	Screw, thread forming #6 X .375 FH
1 ea	213-0254-00	Screw, 2-56 X .250 FH
1 ea	214-1061-00	Spring, electrical ground
1 ea	333-1483-03	Panel, front
2 ea	337-1399-00	Shield, electrical (side covers)
1 ea	366-1690-01	Knob, Latch
1 ea	386-2402-05	Subpanel, front
2 ea	386-3657-01	Support, Plug-in
1 ea	426-0724-00	Frame section, bottom
1 ea	426-0725-00	Frame section, top

PART II Electrical Parts

Ckt No	Quantity	Part Number	Description
	1 ea	136-0269-02	Socket, 14 pin, low profile
	2 ea	136-0514-00	Socket, 8 pin, low profile
Q10	1 ea	151-0103-00	Transistor 2N2219A NPN TO-5
Q20	1 ea	151-0134-00	Transistor 2N2905A PNP TO-39
Q21	1 ea	151-0301-00	Transistor 2N2907A PNP TO-18
Q11	1 ea	151-0302-00	Transistor 2N2222A NPN TO-18
Q23	1 ea	151-0349-00	Transistor MJE2801 NPN TO-127
VR10 VR20	2 ea	152-0279-00	Diode, Zener; 5.1V
U10 U20	2 ea	156-0067-00	Integrated Circuit µA741 C
U30	1 ea	156-0071-00	Integrated Circuit µA723 C
C32	1 ea	283-0065-01	Capacitor, cer .001µF 100V
C16 C26	2 ea	290-0117-00	Capacitor, alum. 50µF 50V
C30	1 ea	290-0201-00	Capacitor, alum. 100µF 15V
C10 C20	2 ea	290-0512-00	Capacitor, tant. 22µF 15V

*The parts included in the kit are divided in two sections as follows:
[1]Mechanical parts required to build the Blank Plug-In and
[2]Electrical parts required to wire the Power Supply.

Ckt No	Quantity	Part Number	Description
R15 R25	2 ea	311-1560-00	Resistor, var 5K 1/2W
R36	1 ea	308-0245-00	Resistor, WW .6Ω 2W 5%
R16 R26	2 ea	308-0677-00	Resistor, WW 1.Ω 2W 5%
R11 R21 R30	3 ea	315-0152-00	Resistor, comp. 1.5K 1/4W 5%
R10 R20	2 ea	315-0223-00	Resistor, comp. 22K 1/4W 5%
R32	1 ea	321-0225-00	Resistor, prec. 2.15K 1/8W 1%
R12 R22 R31	3 ea	321-0260-00	Resistor, prec. 4.99K 1/8W 1%
R13 R23	2 ea	321-0277-00	Resisistor, prec. 7.5K 1/8W 1%
	1 ea	342-0136-00	Insulator, Transistor mounting
	1 ea	388-5299-01	Circuit Board

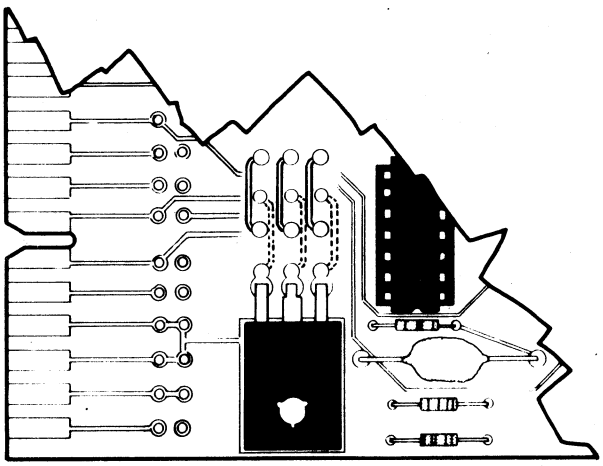


FIG. 1A

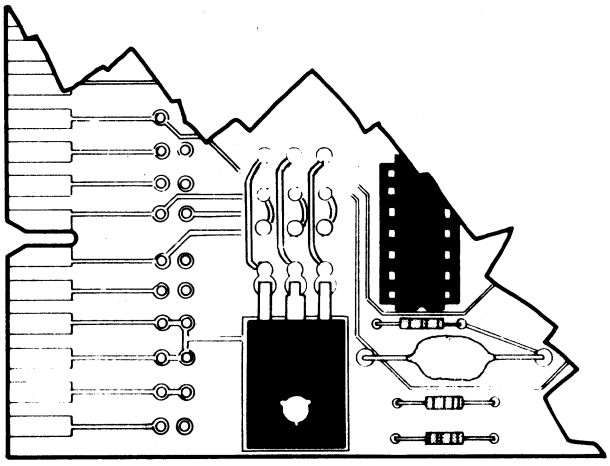
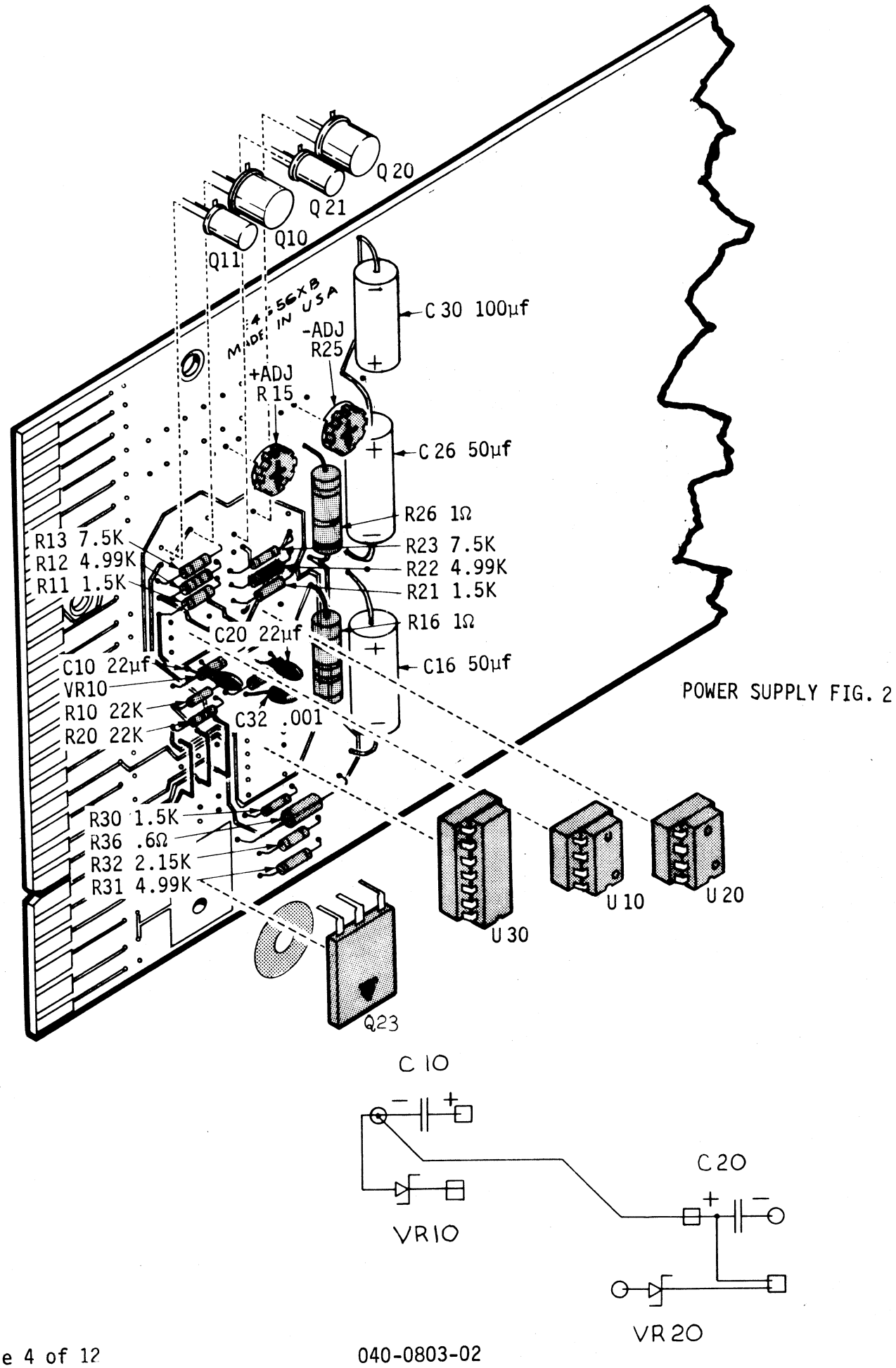


FIG. 1B



POWER SUPPLY FIG. 2

Blank Plug-In For TM500

One-Wide W/Power Supply

General

This kit includes a circuit board which is divided into two major areas. One area is a matrix of pads for your custom circuitry. The other area was designed for a regulated power supply. All the parts necessary to assemble the power supply are included in the kit.

Note: A few resistors may have to be changed to meet the exact needs of your application. This is explained in the assembly instructions.

Assembly Instructions for Power Supply

The power supply should be assembled by use of the Power Supply schematic and pictorial drawing.

The following precautions must be adhered to to avoid damage to the board or parts:

a) To prevent short circuits, leave about 1/4" of clearance between transistor cases and the surface of the circuit board. This applies to Q10, Q11, Q20, and Q21. See special instructions for Q23. No sockets are provided for the transistors.

b) Install sockets for the three IC's before installing circuits components. Observe proper orientation of sockets as shown in the pictorial.

c) Use care in mounting the flat plastic power transistor (p/n 151-0349-00). This transistor (Q23) is supplied with a mica washer which must be used to insulate it electrically from the heat-sink area on the circuit board. (Use of silicone grease is helpful but is not required; none is supplied with the kit).

The transistor mounts with its metal surface towards the large metalized area of the board. This area surrounds the lower, rear mounting-screw hole. The mounting screw should be tightened to provide snug contact between the transistor, mica insulator, and the circuit board.

CAUTION: Over-tightening could crack the transistor. Do not solder the leads until alignment and mounting have proven satisfactory.

d) The two voltage adjusting potentiometers (R15 + adj and R25 - adj) mount flush to the board and should be installed with their bodies toward the top of the board.

e) The remaining diodes, resistors and capacitors may be installed by inserting their leads into the appropriate pads. For axial lead devices, bend the leads at right angles to the body, using care to avoid cracking or other damage. Observe polarity of diodes and capacitors.

To complete the circuits, some connections must be made with bare wire or hookup wire. Refer to Fig. 2. Use connection set "A" if your circuitry is powered primarily by the +5 V supply. Use connection set "B" if your circuitry draws heavily from the Vcc supply. If neither supply is used to its limit, use connection "B". See Figures 1A and 1B on page 3.

Checkout Procedure

CAUTION: Check your work visually for errors, solder bridges, etc. before applying power. Do not substitute any parts until the circuit has been found to work correctly with the parts supplied.

If a variable output transformer is available, use it to gradually raise the primary voltage applied to the power module. If no apparent overheating or damage occurs, proceed with checkout at nominal line voltage.

a) Connect a voltmeter between the Vcc pad and the GND pad. Adjust R15, "+ADJ" potentiometers for +15V DC. If the supply will not adjust to this value, troubleshoot the supply.

b) Connect a voltmeter between the VEE pad and the GND pad. Adjust R25, "-ADJ" potentiometers for -15V DC. If the supply will not adjust to this value, troubleshoot the supply.

c) Connect a voltmeter between the +5V pad and the GND pad. The voltage should be not less than 4.8V and not more than 5.2V. If the voltage is not in that range, troubleshoot the supply.

d) Using an oscilloscope, check all supplies for ripple and noise less than 5 mV peak to peak.

e) Check short circuit current-limiting of all supplies. Use a DC ammeter with at least 2A capability and with overload protection. If possible, use a series resistor which will limit current to less than 2A, in case the current-limit circuitry is not operating properly.

One at a time, connect each supply to ground via the current meter

(and series resistor, if one is used). The Vcc and Vee supplies should limit to between 500 mA and 750 mA. The 5 V supply should limit to between 1A and 1.5A. If such limiting does not occur, immediately disconnect meter and troubleshoot supply.

(4) For Operation of Vcc or Vee Supply Below 13 V or Above 17 V

The Vcc and Vee supplies are designed to operate primarily in the ±15 V range. The kit provides for an adjustment range of about 13 V to 17 V. However, operation is feasible over a total range of 8 V to 20 V. To raise the voltage, increase R13, + supply, or R23, - supply 7.5K resistor in the feedback loop (connects to pin 2 of op amp) by about 1kΩ/Volt. Also increase or decrease R11, + supply or R21, - supply, the resistor that provides current from the regulated supply to the reference zener; the resistor supplied is 1.5 kΩ. Increase or decrease this resistor by about 150Ω/Volt.

A TM500 Series Power Module forms the exterior package for a variety of instruments built in a standard plug-in format. In addition to basic elements, the mainframe allows custom interconnection between modules in a Type TM503, TM504, TM506, or TM515 Power Module, or to external devices in all TM500 Series Option 2 Power Modules via rear panel connectors.

Several major power supply components are located in the mainframe:

1) Primary power circuits: line cord; power switch; line fuse; line voltage selector; power transformer with option for domestic or export primaries.*

2) Secondary power circuits:

   a) Two independent, floating secondary windings for each plug-in, with a voltage suitable for providing regulated DC up to 20 volts.

   b) Raw DC (rectified and filtered only) suitable for regulation to plus and minus 20 volts (or less). The common for these supplies is tied to chassis ground in the mainframe.

   c) Raw DC (rectified and filtered only) suitable for regulation to +5V. The common of this supply is referenced to chassis ground in the mainframe via a 1.0 kΩ resistor. The common should be returned to the plug-in chassis ground through a low resistance path.

*TM501's below SN B072668 and TM503's below SN B031680 had a domestic 60Hz 115VAC power transformer. Parts Replacement kits 050-0643-02 and 050-0644-02 are available to replace the single standard domestic transformers with the dual standard transformers in the early TM501 and TM503 respectively.

d) 17.5 VAC derived from the same windings used for c above. This AC voltage is supplied for the purpose of generating -5V in the plug-in if a negative supply is prefered. The common for this supply is the same as for c above.

NOTE: Each supply has a maximum current rating, and they are somewhat interdependent. For details refer to "supply rating summary" on pages 5 and 6.

3) Series-pass transistors--Two devices for each plug-in, accessible via the interface connector. Devices are one each Motorola MJE 2801 NPN and one each Motorola MJE 2901 PNP. These devices, and their heatsinks are in the mainframe allowing more heat to be generated by other circuits in the plug-in.

It should be noted that there are "penalties" associated with the use of any of the AC sources. These are the additonal cost, weight and space requirements of rectifiers and filters in the plug-in. The advantages are the ability to float, stack, double, or further transform, etc.

NOTE: IT IS IMPORTANT TO KNOW THAT NOT ALL POWER SOURCES MAY BE USED TO THEIR FULL CAPACITY SIMULTANEOUSLY. REFER TO THE "SUPPLY RATING SUMMARY" FOR DETAILS.

THERMAL MANAGEMENT

Besides the current ratings of the various supplies, there are other considerations in determining whether or not all the resulting power may be safely used. Hot spots, general distribution of heat, and component temperature ratings all must be taken into account.

The three major areas of concern are:

1) Series-pass in mainframe.
2) Plug-in modules.
3) External loads.

External loads are obviously the easiest to handle, since the heat generated is external to the mainframe or the plug-in. It should be remembered that conventional series-pass regulator circuits shift power from the load to the pass device when the output voltage is reduced. This occurs whether the voltage to the load is reduced by means of the output voltage control, or when current-limiting occurs. Foldback current limiting reduces pass dissipation by virtue of switching to a lower current level during limit conditions, but this approach may involve latch conditions when the load returns to normal; also, it prohibits use of the supply as a current source.

Under most operating conditions, the mainframe series-pass dissipation should be held to 7.5 watts. This value may be exceeded temporarily. It may also be exceeded if the instrument is cooled with forced air or is not used in an abient above 25 deg C. It is also feasible to exceed this value for one transistor if the other two on the common sink (in the TM503) have proportionally less dissipation. The TM503 heat sinks have thermal cutouts which will protect the pass devices if a long-term thermal overload should occur. The sinking in the TM501 is adequate under all normal conditions of use and no thermal cutout is installed.

The interior temperature of a plug-in will rise about 3 deg C/Watt at an input power of 6 watts, evenly distributed. At the 12 watt level, the rise is about 2.5 deg C/W. The actual temperature, of course, depends on the temperature of the air surrounding the mainframe, its circulation and the amount of heat being dissipated in other parts of the system.

For most circuits, a plug-in's internal dissipation should be held to 10-12 watts. Temperature rise can be reduced considerably by ventilating the plug-in rails. (Introducing holes or cutouts in the rails). A decision to use ventilated rails should take into account cost, strength, and EMI or cross-talk considerations.

POWER SUPPLY RATING SUMMARY

NOTE: These unregulated supply voltages will vary in direct proportion to line voltage. Each supply voltage will also decrease appreciably as it is loaded to full current capacity. Each supply voltage will vary slightly as other supplies experience an increase or decrease in load current.

MAIN SUPPLIES

Floating Windings

25 VAC nominal at nominal line voltage, unloaded. Two per plug-in. 500mA max each winding. Caution--see "combined load factor" below.

+33.5 VDC

+33.5 VDC nominal at nominal line voltage, unloaded. The output of the 33.5 VDC supply may vary from 24VDC with low line voltage and high current load to 38VDC with high line voltage and low current load. Supplied by common buss to all plug-ins.

350mA max per plug-in. Caution--see "Combined Load Factor" below.

Combined Load Factor

The floating windings and the raw DC supplies basically are alternative ways of obtaining power (other than 5 VDC logic). Although both sources may be used, they should not be used to full rating simultaneously. The pair of floating windings may be used to full capacity, or the DC supplies may be used to full capacity. Whatever percent capacity is unused in one source may be applied to the other source.

Calculate per cent current capacity used by the floating windings (100% if both are supplying 500mA). Calculate per cent current capacity used by the ±DC supplies. (100% if both are supplying 350mA to the plug-in).

Add the two percentages; total should not exceed 100%. The combined percentage is referred to as the "combined load factor".

LOGIC SUPPLIES

+ 11.5 VDC

+11.5 VDC nominal at nominal line voltage, unloaded. The output of the 11.5 VDC supply may vary from 8 VDC with low line voltage and high current load to 15 VDC with high line voltage and low current load. Supplied by common bus to all plug-ins.

1.0 A max per plug-in if the combined load factor for the main supplied is 100%. May be increased linearly to 1.3 A as the main supply combined load factor decreases to 20%.

17.5 VAC

17.5 VAC nominal at nominal line voltage, with no load on this or 11.5 VDC supply. The output of the 17.5 VAC supply may vary from 16 VAC with low line voltage and high current load to 23 VAC with high line voltage and low current load. (Voltage is measured between pins 5A and 5B). May be converted to negative DC by a pair of diodes with their cathodes connected to 5A and 5B; anodes connect to load, and load returns to supply common (3A, 4A, 3B, or 4B) and to plug-in chassis).

This supply has the same current rating as the +11.5 VDC. However, any current used by this supply must be deducted from the DC supply.

The TM504 and TM506 Power Modules have one compartment (on the extreme right, which has extra power capability. The following capabilities and limitations must be taken into account when using the high-power compartment:

1) There is nothing in the compartment which forces high power; all units designed for operation in standard compartments will operate normally in the high power compartment.

2) The extra power capability is limited to the following:

a. Mainframe series-pass power transistors. Metal case power transistors with greater heat sink capacity. Combined power dissipation for the pair 50 watts; each individual transistor up to 30 watts; NPN similar to 2N3055*, PNP similar to Motorola MJ2955.

b. Extra current capacity in the two floating ac windings (25 V rms nominal). These windings are rated at 1 A maximum (compared to 500 mA in the standard compartments).

c. Extra current capacity in the +11.5 VDC and 17.5 VAC logic supplies. These supplies are rated at 4 A (compared to 1 A in the standard compartment).

In addition, these supplies are floating. (They may operate floating, or with either the plus or the minus terminal grounded).

Note: The 4A rating is the total current capacity of both supplies; it may be shared in any desired ratio.

3) Precautions to be observed:

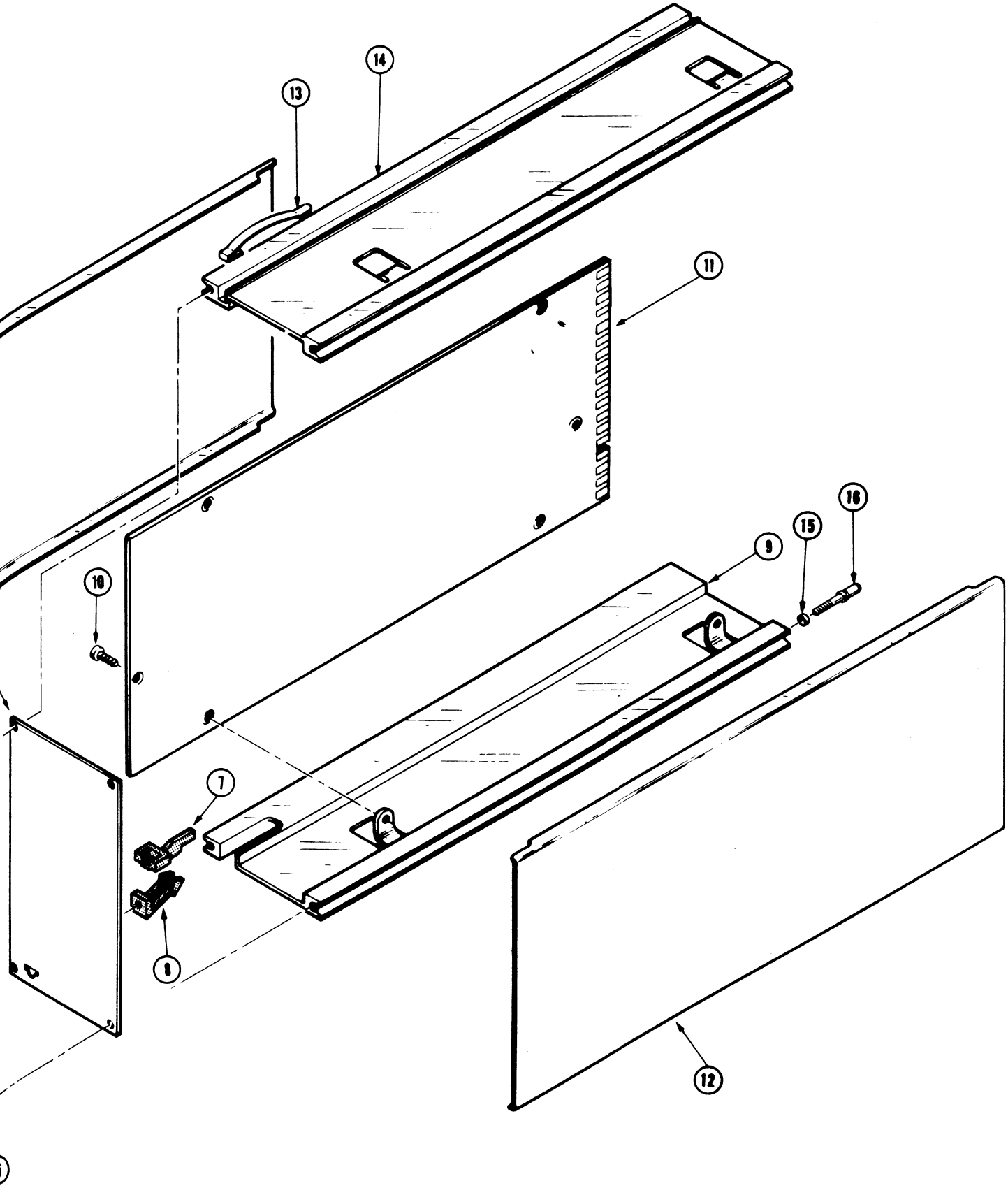
a. The +33.5 VDC supply rating and conditions are the same as for the standard compartment. The output of the 33.5 VDC supply may vary from 24 VDC with low line voltage and high current load to 38 VDC with high line voltage and low current load.

b. Nothing in the supply capability affects the ability of the plug-in module to dissipate heat; temperature rating of the plug-in and general rules for thermal management still apply.

c. Any unit designed to take advantage of the extra current available in the high power compartment may cause damage when plugged into a standard compartment. The best protection scheme is to mount a switch on the plug-in circuit board, which will be actuated by the mainframe. A suitable switch is TEK PN 260-1310-01; however, the current rating of the switch is such that it is best to use it in a low-current controlling circuit, rather than using it directly in the high-current path.

Mount the switch so that the tip of the plastic actuator is even with the end of the circuit board in its normal (extended) position. The plastic actuator should be next to contact 24A on the circuit board. Spacing from the surface of the board should be such that the opening in the mainframe shield (at the low-power compartments) leaves the switch in the extended position. Inserting the plug-in in the high-power compartment should actuate the switch.

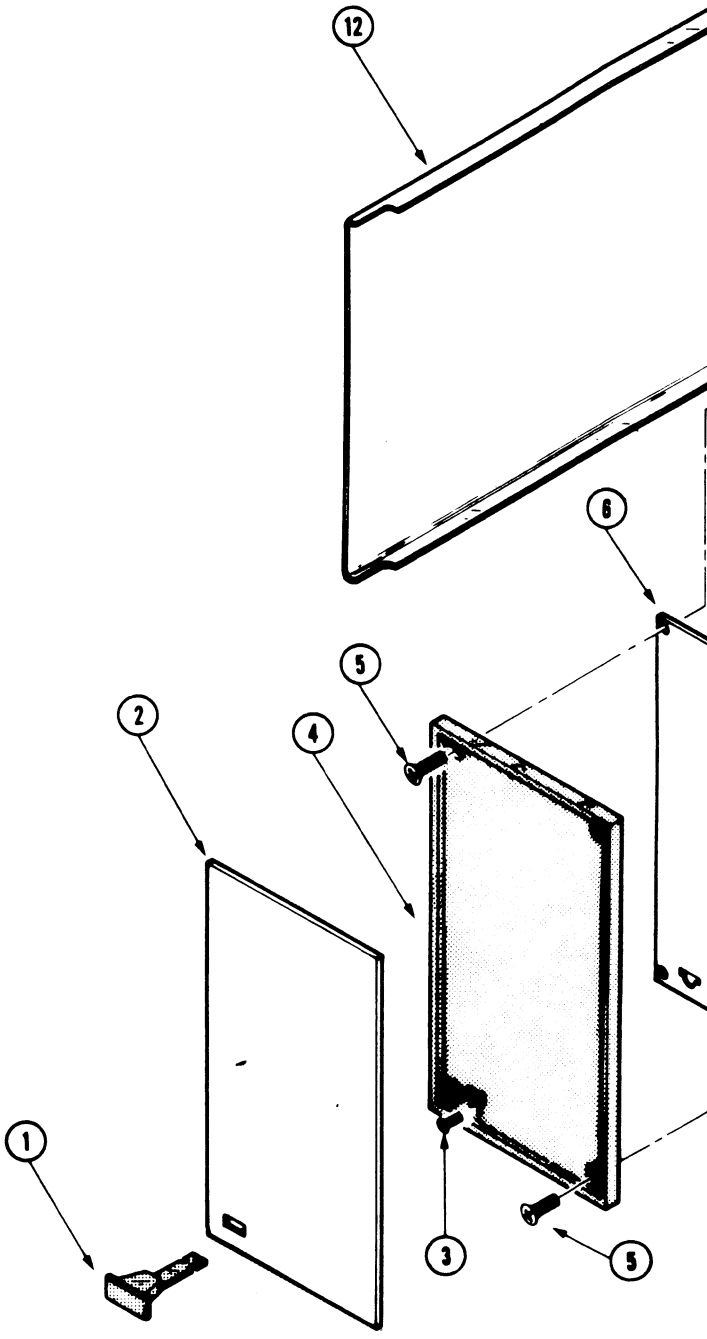
*2N6258 in earlier instruments.



BLANK PLUG-IN FIG. 3

040-0803-02

Index No.	Part Number
1.	366-1690-01
2.	333-1483-03
3.	213-0254-00
4.	386-2402-05
5.	213-0229-00 (4)
6.	200-1273-02
7.	105-0718-00
8.	105-0719-00
9.	426-0724-00
10.	213-0146-00 (4)
11.	388-5299-01
12.	337-1399-00 (2)
13.	214-1061-00
14.	426-0725-00
15.	210-1270-00 (2)
16.	386-3657-00 (2)



INSTRUCTION MANUAL

MODIFICATION INSERT

BLANK PLUG-IN W/POWER SUPPLY

This modification insert is provided to supplement the Instruction Manual for the above listed products. The information given in this insert supersedes that given in the Manual.

GENERAL INFORMATION

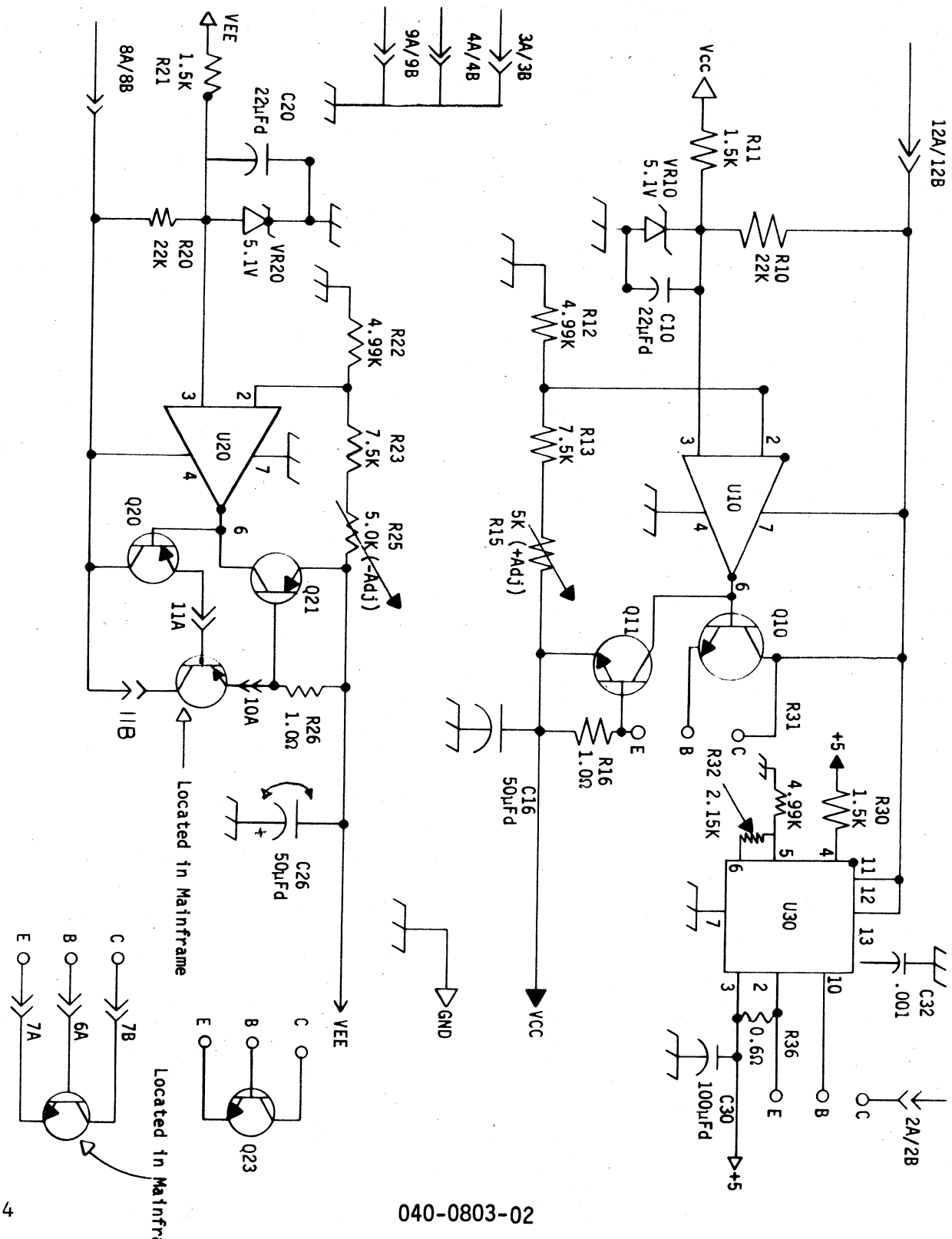
This Modification Kit includes parts and instructions to build a Blank Plug-In with a regulated power supply providing +5V, a positive supply adjustable from approximately +13 to +17V and a negative supply adjustable from approximately -13V to -17V.

ELECTRICAL PARTS LIST

Ckt No	Part Number	Description
		CAPACITORS
C10	290-0512-00	22µF 15V
C16	290-0117-00	50µF 50V
C20	290-0512-00	22µF 15V
C26	290-0117-00	50µF 50V
C30	290-0201-00	100µF 15V
C32	283-0065-01	.001µF 100V
		DIODES
VR10	152-0279-00	Zener 5.1V
VR20	152-0279-00	Zener 5.1V
		TRANSISTORS
Q10	151-0103-00	NPN 2N2219A
Q11	151-0302-00	NPN 2N2222A
Q20	151-0134-00	PNP 2N2905A
Q21	151-0301-00	PNP 2N2907A
Q23	151-0349-00	NPN MJE2801
		RESISTORS
R10	315-0223-00	22K 1/4W 5%
R11	315-0152-00	1.5K 1/4W 5%
R12	321-0260-00	4.99K 1/8W 1%
R13	321-0277-00	7.5K 1/8W 1%
R15	311-1560-00	5K 1/2W Var.
R16	308-0677-00	1.0Ω 2W 5%
R20	315-0223-00	22K 1/4W 5%
R21	315-0152-00	1.5K 1/4W 5%
R22	321-0260-00	4.99K 1/8W 1%
R23	321-0277-00	7.5K 1/8W 1%
R25	311-1560-00	5K 1/2W Var.
R26	308-0677-00	1.0Ω 2W 5%
R30	315-0152-00	1.5K 1/4W 5%
R31	321-0260-00	4.99K 1/8W 1%
R32	321-0225-00	2.15K 1/8W 1%
R36	308-0245-00	.6Ω 2W 5%

INTEGRATED CIRCUITS

U10	156-0067-00	µA741c
U20	156-0067-00	µA741c
U30	156-0071-00	µA723c


12A/12B
Vcc
R11
1.5K
VR10
5.1V
R10
22K
C10
22µFd
R12
4.99K
R13
7.5K
5K (+Adj)
R15
U10
Q10
Q11
R31
R16
1.0Ω
C16
50µFd
VCC
+5
R30
1.5K
R32 2.15K
4.99K
U30
C32
.001
R36
0.6Ω
C30
100µFd
+5
2A/2B
B
C
E
3A/3B
4A/4B
9A/9B
8A/8B
VEE
1.5K
R21
C20
22µFd
R20
22K
VR20
5.1V
R22
4.99K
R23
7.5K
R25
5.0K (-Adj)
U20
Q20
Q21
11A
11B
10A
R26
1.0Ω
C26
50µFd
VEE
GND
Located in Mainframe
Q23
7A
6A
7B
Located in Mainframe

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