



# product modification

040-0652-03

See Below

BLANK PLUG-IN

For TEKTRONIX TM500 Series Power Modules

All Serial Numbers

Modification Kit, PN 040-0652-03, contains mechanical parts to construct a blank PLUG-IN FOR USE IN ANY TM500 Series Power Module.

This kit also contains information about the interface connections to the Power Modules.

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5-11-77

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Supersedes 1-26-77

PARTS INCLUDED IN MODIFICATION KIT:

Quantity	Part Number	Description
1 ea	105-0718-00	Release bar
1 ea	105-0719-00	Retaining Latch
1 ea	200-1273-00	Subpanel, back
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, 2-32 X .250 FH
1 ea	214-1061-00	Spring, electrical ground
1 ea	333-1483-00	Panel, front
2 ea	337-1399-00	Shield, electrical (side covers)
1 ea	366-1690-00	Knob, Latch
1 ea	386-2402-00	Subpanel, front
1 ea	388-3490-01	Circuit Board
1 ea	426-0724-00	Frame section, bottom
1 ea	426-0725-00	Frame section, top

TM500 BLANK PLUG-IN CUSTOM CIRCUITRY

Application of this blank plug in to your custom circuitry requires the design and fabrication of power supply and interface circuitry. Review of the TM 500 Series mainframe manual and TM 500 Series plug-in will give you good examples of proven circuits. If you require further information you should consult Tektronix publication A-3186 entitled "Suggested Power Supply Circuits" and the publications of the following semiconductor manufacturers.

1. Linear Integrated Circuits Data Book, Motorola Semiconductor Products, Inc.
2. The Linear Integrated Circuits Data Catalog, Fairchild Semiconductor
3. Application Note 312, Fairchild Semiconductor
4. Application Notes AN-473, AN-480, AN498, An-499, and AN-500, Motorola Semiconductor Products Inc.
5. Voltage Regulator Handbook, National Semiconductor Corp.
6. Linear Integrated Circuits (file 411) (CA 7800) RCA.
7. Linear Integrated Circuit Voltage Regulators, Texas Instrument.

Tektronix will release from time to time applications describing customer built TM 500 Series modules. For this and other technical information contact your local Tektronix Field Office.

The TM 500 Series Power Modules form 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, or TM506 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 k $\Omega$  resistor. The common should be returned to the plug-in chassis by a low resistance path.
  - 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 preferred. The common for this supply is the same as for c above.

NOTE: Each supply has a maximum current rating, and they are 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 heat-sinks are in the mainframe allowing more heat to be generated by other circuits in the plug-in.

The above power supply circuits provide a sort of "power supply kit" which can be assembled and modified within the plug-in circuits, into a variety of configuration. Regulating devices or circuits (other than series-pass) must be located in the plug-in. In some cases, alternative or supplementary pass devices may be used 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 additional 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 ambient 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 crosstalk 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 sources.

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 buss 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 TM 504 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 capacity 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.

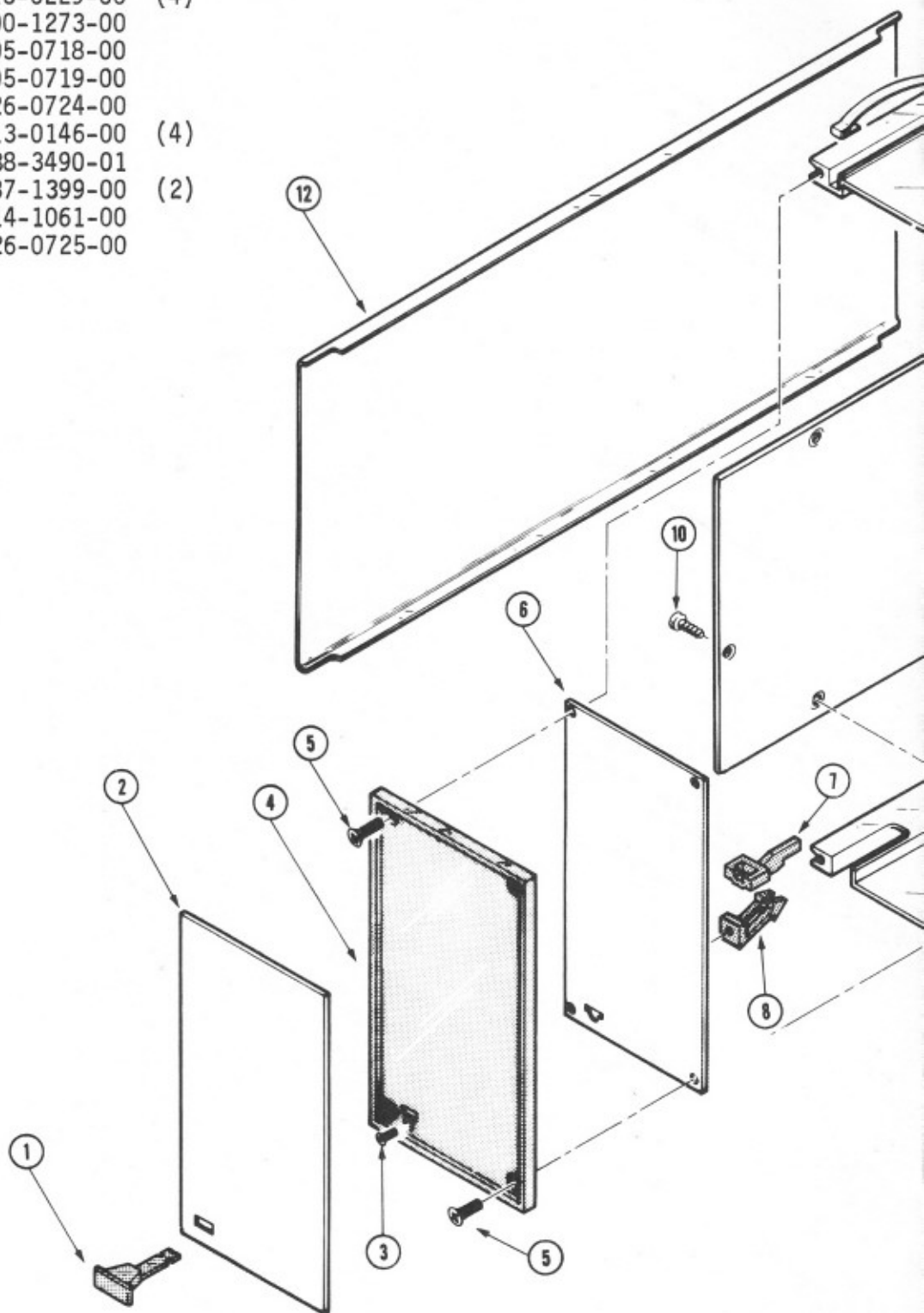
- 3) Precautions to be observed:
  - a. The +33.5 VDC supply rating and conditions are the same as for the standard compartment. The output of the 33.5 VDC supply may vary from 24 VDC with low line voltage and high current load to 38 VDC with high line voltage and low current load.
  - b. Nothing in 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.

\*2N6258 in earlier instruments.

- 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 P.N. 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.

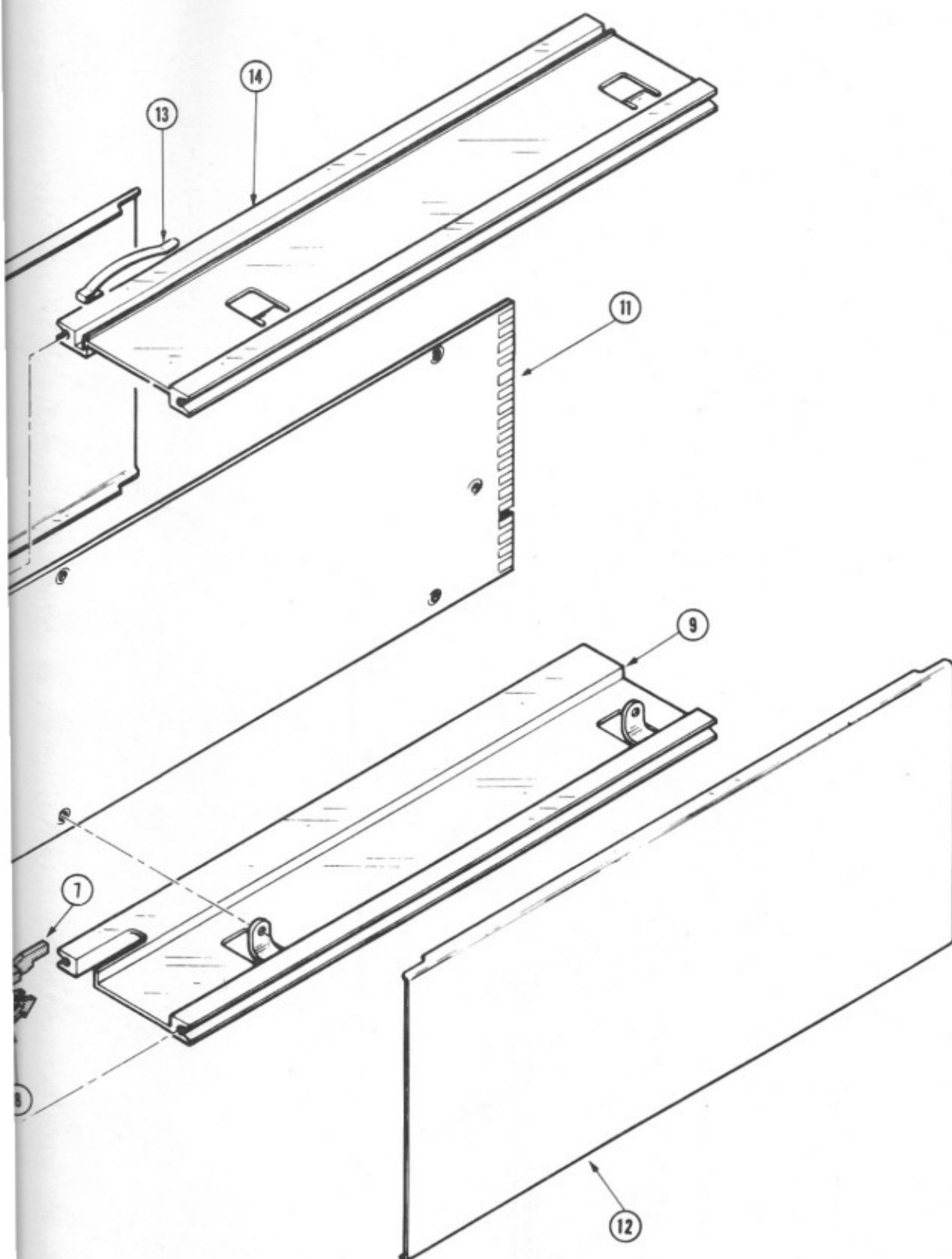
Mount the switch so that the tip of the plastic actuator is even with the end of the circuit board in its normal (extended) position. The plastic actuator should be next to contact 24A on the circuit board. Spacing from the surface of the board should be such that the opening in the mainframe shield (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.

1. 366-1690-00
2. 333-1483-00
3. 213-0254-00
4. 386-2402-00
5. 213-0229-00 (4)
6. 200-1273-00
7. 105-0718-00
8. 105-0719-00
9. 426-0724-00
10. 213-0146-00 (4)
11. 388-3490-01
12. 337-1399-00 (2)
13. 214-1061-00
14. 426-0725-00



For TB

040-065



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