Fermilab

SPECIFICATIONS

ES-7109 NEGATIVE HIGH VOLTAGE POWER SUPPLY FOR USE WITH MULTI-WIRE PROPORTIONAL CHAMBERS

ES-7125 POSITIVE HIGH VOLTAGE POWER SUPPLY FOR USE WITH OTHER TYPES OF DETECTORS IN THE NUCLEAR INSTRUMENTATION FIELD.

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ES-7109 NEGATIVE HIGH VOLTAGE POWER SUPPLY
ES-7125 POSITIVE HIGH VOLTAGE POWER SUPPLY

SCOPE:

A power supply for use with multi-wire proportional chambers and other application requiring high voltage at low current. Some specifications follow:

Output Voltage:	.3 to 7.5 Kilovolt
Output Current:	500 Micro Amperes
Maximum Operating Temperature:	70°C
Drift:	<.2% 25-50°C
Load Regulation:	<.2% 0-200 Micro Ampere
Rise Time:	40 Milliseconds
Lead Transient Response:	Recovers in .1% in 10 Milliseconds
Overshoot on Turn-On:	<3%
Internal Capacity:	.004 Microfarad
Output Series Resistance:	10K

DESCRIPTION:

The power supply is packaged with two complete units in a 2 wide NIM module. Front panel controls are provided to adjust the high voltage and read directly in kilovolts.

In designing this supply, particular attention has been given to reducing the stored energy. It is designed with high internal resistance to limit the energy which can be delivered to a proportional chamber under spark conditions. The supply has high internal gain and good transient response to maintain good output regulation under varying loads. The output terminal is isolated from the power supply filter capacitor by a 10K resistor to limit peak chamber current from the power supply to less than one ampere.

The combination of moderate output resistance and trip circuitry has been found to be an adequate protection scheme for operating MWPC's at high rates where it is not possible to protect chambers with large series resistors without suffering loss of gain. Tests have been made with 1/2 meter chambers using 20 micron tungsten wire and smaller chambers using 7.5 micron wire. In all cases the chambers survived thousands of sparks without wire damage using this supply.

This supply contains a number of features designed to meet the operational needs of proportional chambers.

Fast Trip: The power supply senses fast changes in output current and turns off its internal DC to DC converter. With a load short circuit or spark, the stored energy will be dissapated in a millisecond or less, most of the energy going into the internal resistance of the power supply. At higher output voltages the circuit is sensitive enough to trip out from corona without any visible sparking.

Trip Reset: The power supply by switch selection will either remain tripped, or reset automatically after a few hundred milli-seconds.

Slow Trip: The power supply will trip from slowly applied loads which exceed a current trip level which is set to 80% of the full scale meter reading.

Current Monitor: A Lemo connector is provided which monitors chamber current scaled 10V = 1 millampere. A current zero front panel trimpot and careful guarding of the output current allow measurements of chamber current to 1 nanoampere with a typical DVM.

Voltage Monitor: A Lemo connector is provided which monitors chamber voltage scaled 1V = 1 kilovolt.

Trip Monitor: The trip monitor is a TTL compatible open collector output that is grounded when either supply is tripped. A bridged Lemo connector provides the OR of the trip signal for the two supplies. This allows daisy-chaining a number of supplies to one alarm circuit.

THEORY OF OPERATION:

The MWPC power supply uses a DC to DC converter to generate up to 8 kilovolts at low current from the 24 volts available from the NIM bin power supply. A closed loop servo regulates the output voltage from an internal or external reference.

Two gates in IC-9 provide a 40 KC oscillator which is divided by 20 KC by IC-7. This assures that the transformer drive will be symmetrical. IC-8 forms a gate which allows the power drive to be turned off. TR1 and TR2 generate a square wave drive for the power transformer T2. The drive voltage to TR1 and TR2 comes from the pass transistor TR-3 which regulates the drive voltage and thus eventually the output voltage.

The transformer secondary voltage is rectified by the voltage multiplier circuit and 1/2000 is picked off by the divider R59 and R60. This voltage is buffered by the high input impedance amplifier IC-12 and compared against the command reference voltage in IC-11. IC-11 then drives the pass transistor TR-3 to close the regulation loop. IC-12 also drives IC-13 which is a gain of 2 amplifier with a resulting scale factor of +1 volt = -1 kilovolt.

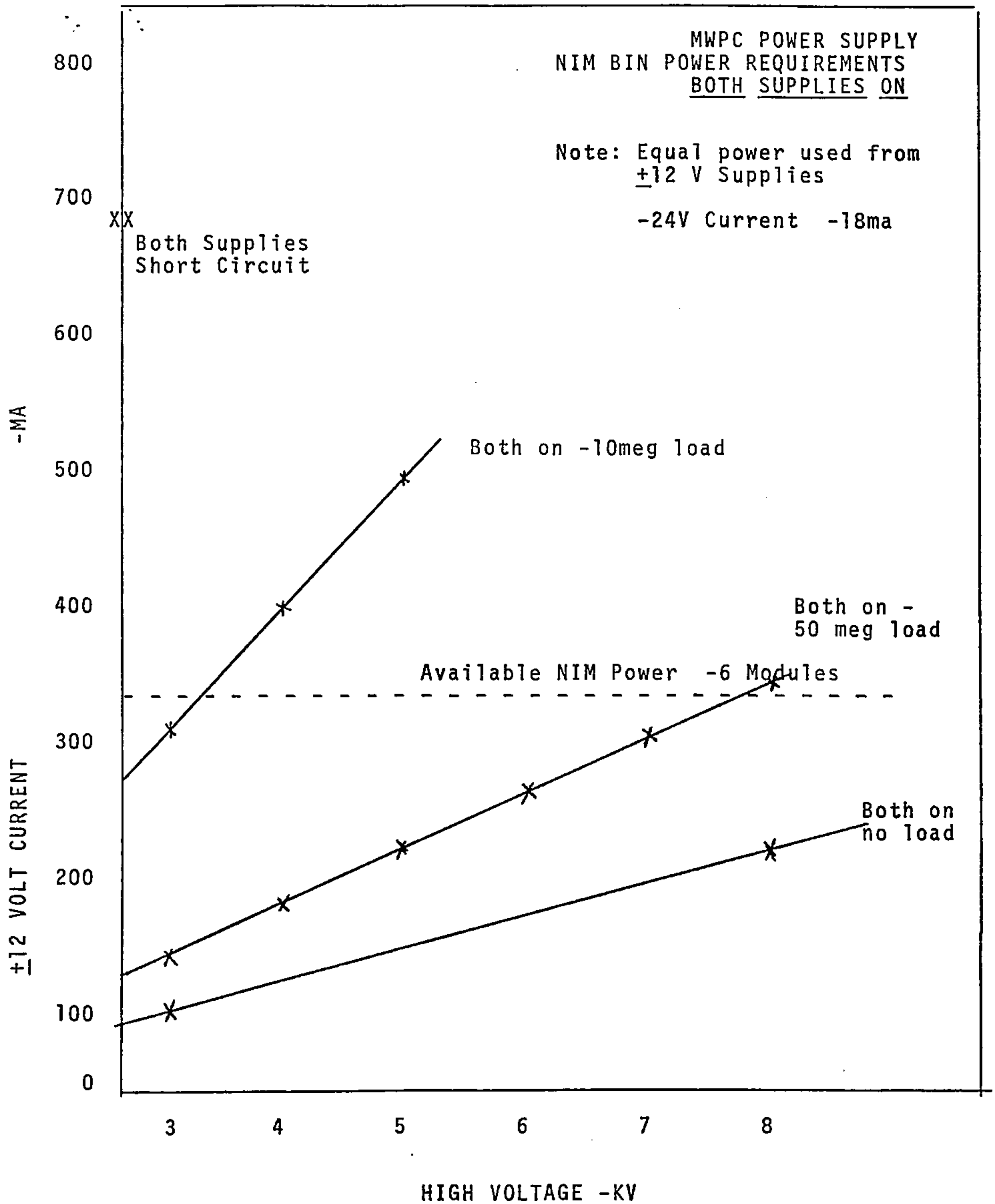
The return of the supply is not tied directly to the ground reference point (point C) but is connected through a current amplifier, IC-10. Since the power supply output current comes from the output of IC-10, the 10K feedback resistor provides a scale factor of 10 volts = 1 ma output current.

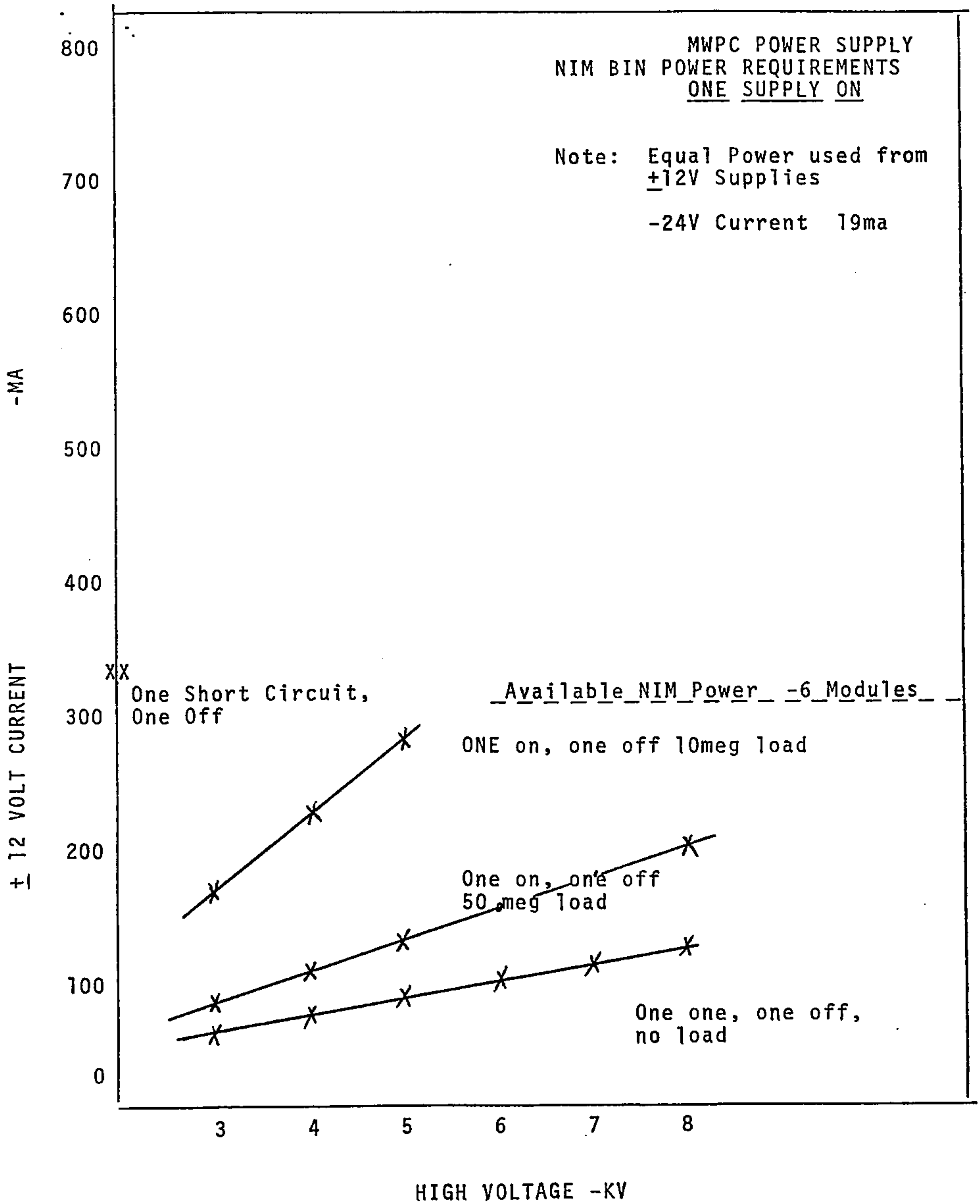
The 100 ohm resistor R64 produces a drop in feedback voltage as the load current is increased and thus an increase in output voltage as the servo works to match the reference. This increase is balanced by the drop in R56 and R57 due to the load current. The advantage of this is that R56, R57, C24 and C25 are outside the servo loop making compensation easier while still providing good regulation at DC.

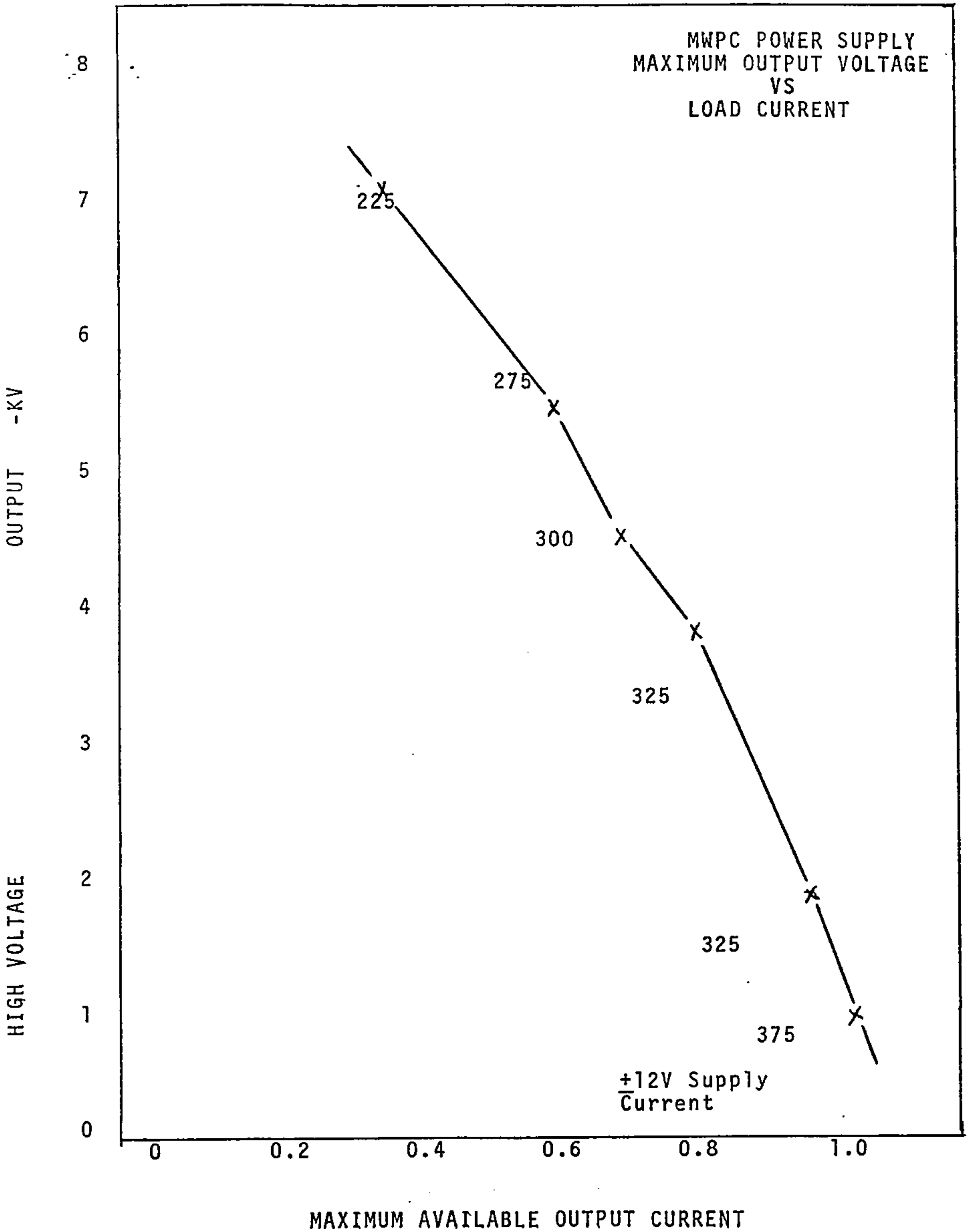
Any sudden change in load current as might be caused by a spark will couple through R58 and C25 to T1. This fires the one-shot IC-5 and removes the drive voltage. If the HOLD position is selected the drive remains off until S1 is returned to the AUTO RESET position. TR-5 drives a LED to indicate when high voltage drive is present. In the AUTO RESET position the drive remains off for the duration of the one-shot cycle.

If the load current exceeds 80% of the full scale meter setting, the comparator at IC-1 will trip IC-5 as above. This will trip out the supply for slow overloads. If either supply trips, TR-6 or TR-7 will ground the trip monitor connectors K1 and K2. These open collector transistors allow daisy chaining many power supply modules to a common trip alarm module.

The reference voltage for the supply is either the internal zener reference diode D17 or an external source. An external source can be selected by a rear panel switch S5, S6, in which case an external voltage scaled 1 VOLT = 2KV determines the output voltage. Grounding the bin gate (K3) connector will cause transistors R8 and TR-9 to reduce the H. V. output by approximately 10%.


MWPC POWER SUPPLY
NIM BIN POWER REQUIREMENTS
BOTH SUPPLIES ON
Note: Equal power used from ±12 V Supplies
-24V Current -18ma
XX Both Supplies Short Circuit
Both on -10meg load
Both on - 50 meg load
Available NIM Power -6 Modules
Both on no load
±12 VOLT CURRENT -MA
800
700
600
500
400
300
200
100
0
3
4
5
6
7
8
HIGH VOLTAGE -KV


MWPC POWER SUPPLY
NIM BIN POWER REQUIREMENTS
ONE SUPPLY ON
Note: Equal Power used from ±12V Supplies
-24V Current 19ma
800
700
600
500
400
300
200
100
0
± 12 VOLT CURRENT -MA
XX One Short Circuit, One Off
Available NIM Power -6 Modules
ONE on, one off 10meg load
One on, one off 50 meg load
One one, one off, no load
3
4
5
6
7
8
HIGH VOLTAGE -KV


MWPC POWER SUPPLY
MAXIMUM OUTPUT VOLTAGE
VS
LOAD CURRENT
HIGH VOLTAGE OUTPUT -KV
0
1
2
3
4
5
6
7
8
225
275
300
325
325
375
+12V Supply
Current
0
0.2
0.4
0.6
0.8
1.0
MAXIMUM AVAILABLE OUTPUT CURRENT

CALIBRATION PROCEDURE:

Calibration can be made easier by mounting the bottom of the H.V. Board to the top three standoffs. CAUTION: The copper ground on the HV board must be grounded to the main unit at all times.

1) With power applied to the rear connector and the ON/OFF switches turned to OFF, a typical current should be drawn from the power supplies:

+12V	25ma
=12V	25ma
+24V	20ma

2) Check that IC9, Pin 4 is oscillating at 40 KHz ±20% and IC-7, Pin 2 is one-half of that frequency.

3) Adjust potentiometers R23 and R25 so that approximately 5 volts is across R24 and R26 respectively. R23 and R25 will eventually calibrate the HV output.

4) Set the voltage controls to 1.00. Looking at points K and L with a DVM, a voltage of .50 volts should be seen. Change the remote switches to remote. With 1.00 volt applied, the remote input connector a voltage of 1.00 volts should be seen at points k and L.

5) Using the front panel zeropots (R66A and B) adjust the current monitor and the meter (range switch = .1μa) for zero. Note: The current monitor may have a different zero setting than the meter.

6) Set S1 and S4 to the auto reset position. Caution: High Voltage may be present at this stage of testing.

a) Turn S2 and S3 on, noting that D15 and D14 light.

b) Set the voltage control to a setting of 4.00 (KV).

c) Adjust R71 until the voltage at Pin 3 of IC-11 equals the voltage at Point "K".

d) Adjust R68 until the voltage at Pin 3 of IC-12 equals the voltage at Point "K".

e) Repeat the above steps for side B interchanging Point "L" with Point "K".

7) Using a high voltage probe (1000 mΩ), adjust R23 and R25 until the output reads 4.00KV.

8) The current monitors (when zeroed-no load) should read 40ma, $\pm$1% and the meter should read 4μa $\pm$5%, when the HV probe (or a 1000Ω load) is attached to the output.

9) The voltage monitor should read 4.00V (1V=1KV), $\pm$5%.

10) The output voltage should track the voltage control knob ($\pm$1%) from a range of 7KV to 1KV.

(Note: The slope of this control can be adjusted slightly by changing the settings of R72, R68, and recalibrating the output voltage (R23 and R25).

11) <u>Testing the Fast Trip Feature:</u>

a) Set S8 to the 1 ma position

b) Set the voltage control to 3 KV or higher

c) Momentarily touch the HV probe to the output.

d) The output should go to zero volts and the light should blink off until the trip curcuit "times out" and the supply turns back on. When S1 and S4 are in the "hold"