F21 CONTROLLED T.P.M. ASSEMBLY
(30 AMP FIELD EXCITERS WITH ISOLATION)

I. INTRODUCTION

The F21 Field Exciter is a variable voltage package consisting of a single-phase, semi-converter thyristor module, a hall effect current sensor with amplifier, and an integral field current controller board. A picture of the physical assembly is shown in Figure 2. This assembly S#1775A93G0 utilizes individual thyristors and diodes on heat sinks and is rated for 280 volts dc maximum and 30 amps dc maximum. Complete isolation exists between the electronics and the power circuitry.

A front view of the controller board locating all components by schematic identification is shown on the last page of the instruction leaflet.

II. SCOPE OF APPLICATION

The F21 Field Exciter package described here constitutes a basic power converter for motor or generator field excitation systems for control of current, flux, cemf, speed or any other variable of a drive subsystem. Refer to the appropriate IL's listed at the end for a description of applicable control systems and controller kits.

III. ELECTRICAL DESCRIPTION

A simplified schematic representation of the F21 field exciter is given in Figure 3. The detail schematic for the TPM assembly is given in Figure 4. The field current controller schematic representation appears in Figures 5a, 5b and 5c.

The F21 TPM's consist of a single phase semiconverter power bridge with a free-wheeling diode, a current sensor pc board, self starting resistor (used with highly inductive loads to initiate conduction) and surge suppression networks as shown in Figure 4. The RC networks provide dv/dt protection for the thyristors. The surge suppressor protects against incoming line transients.

Since fields are usually highly inductive, continuous current flows in the DC circuit. Figure 1 shows what the voltage and current waveshapes might look like at a gating angle of α = 90 degrees. The ripple current is exaggerated to more clearly show the transition from sinusoidal current to exponentially decreasing current. This phenomenon occurs when the bus voltage (v_b) first reaches zero volts. This point marks the inception of current flow in the free-wheeling diode.

During free-wheeling periods, the current waveform becomes a decreasing exponential with a time constant equal to the time constant of the equivalent DC circuit.

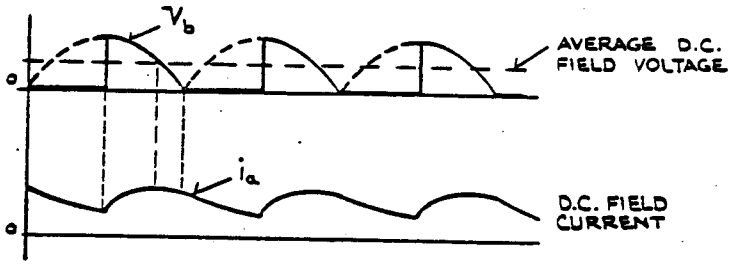


FIGURE 1

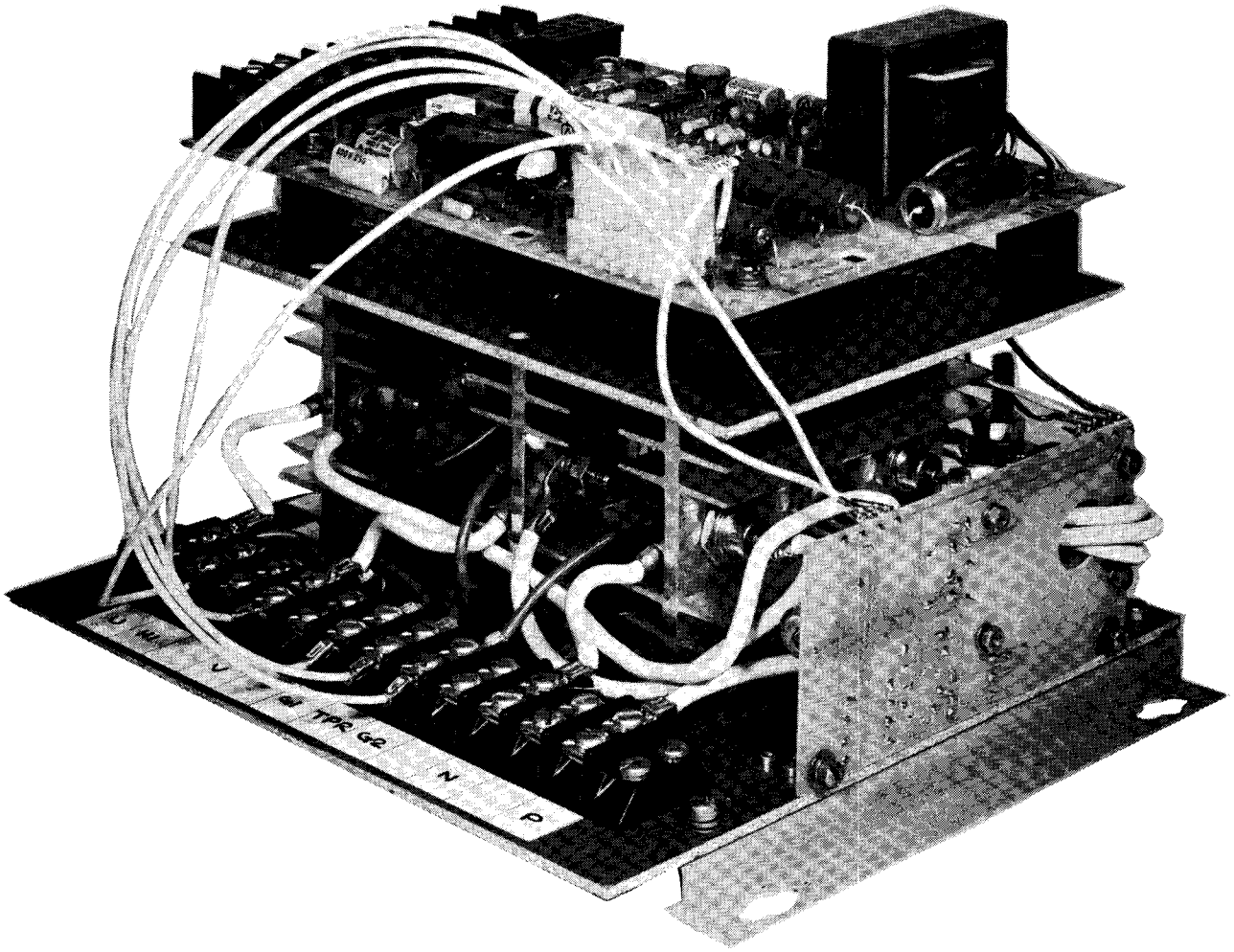
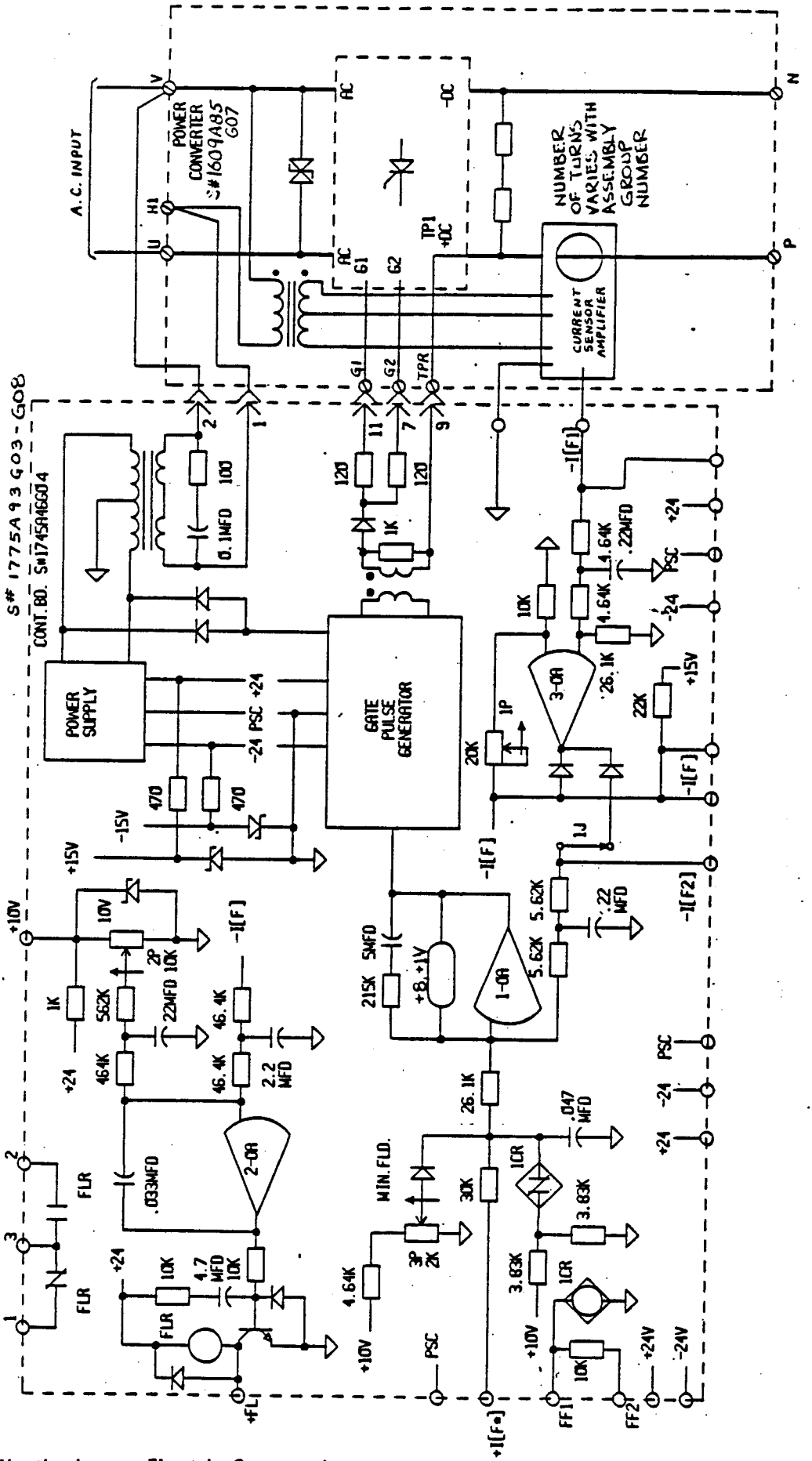


FIGURE 2



SIMPLIFIED SCHEMATIC

FIGURE 3

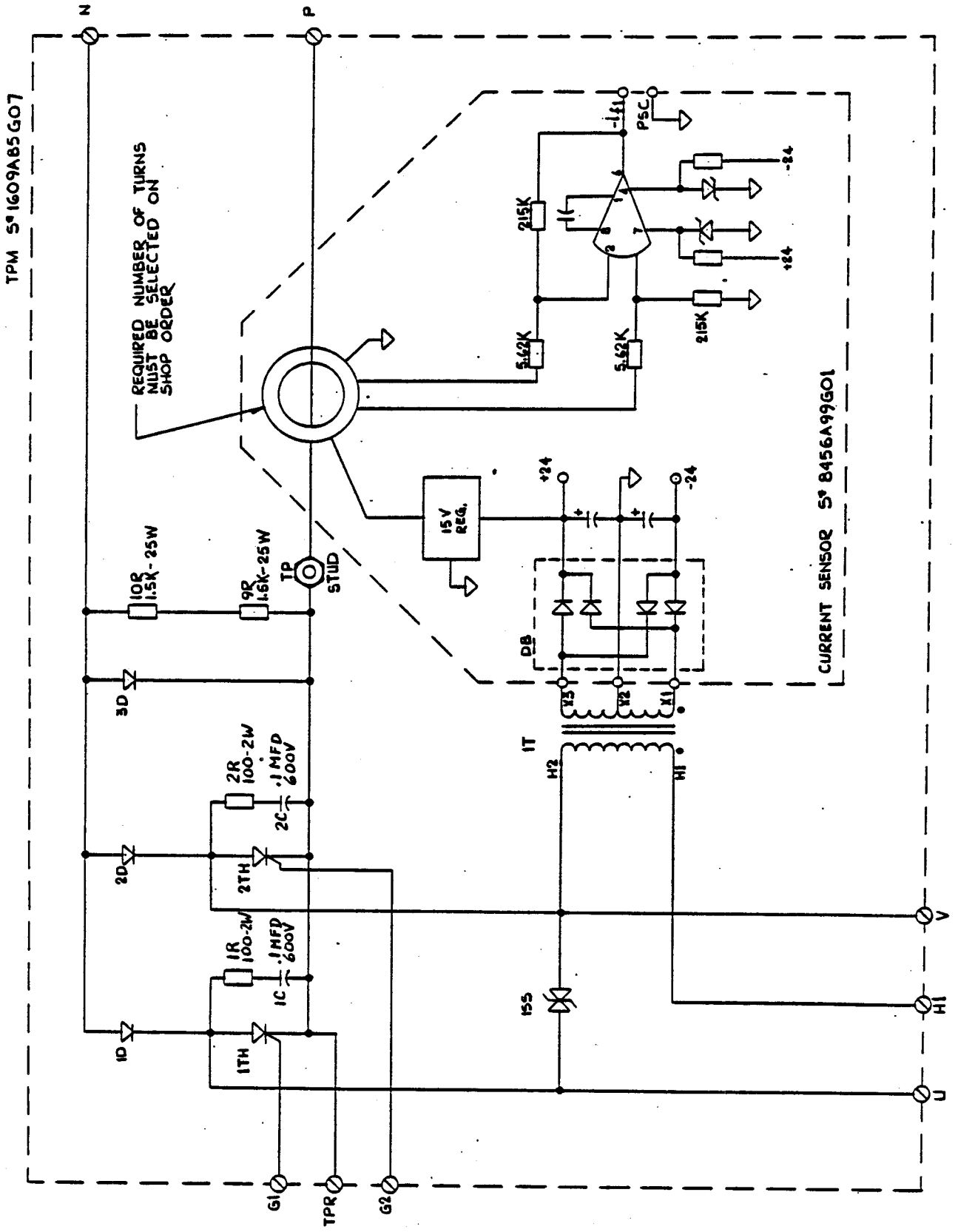
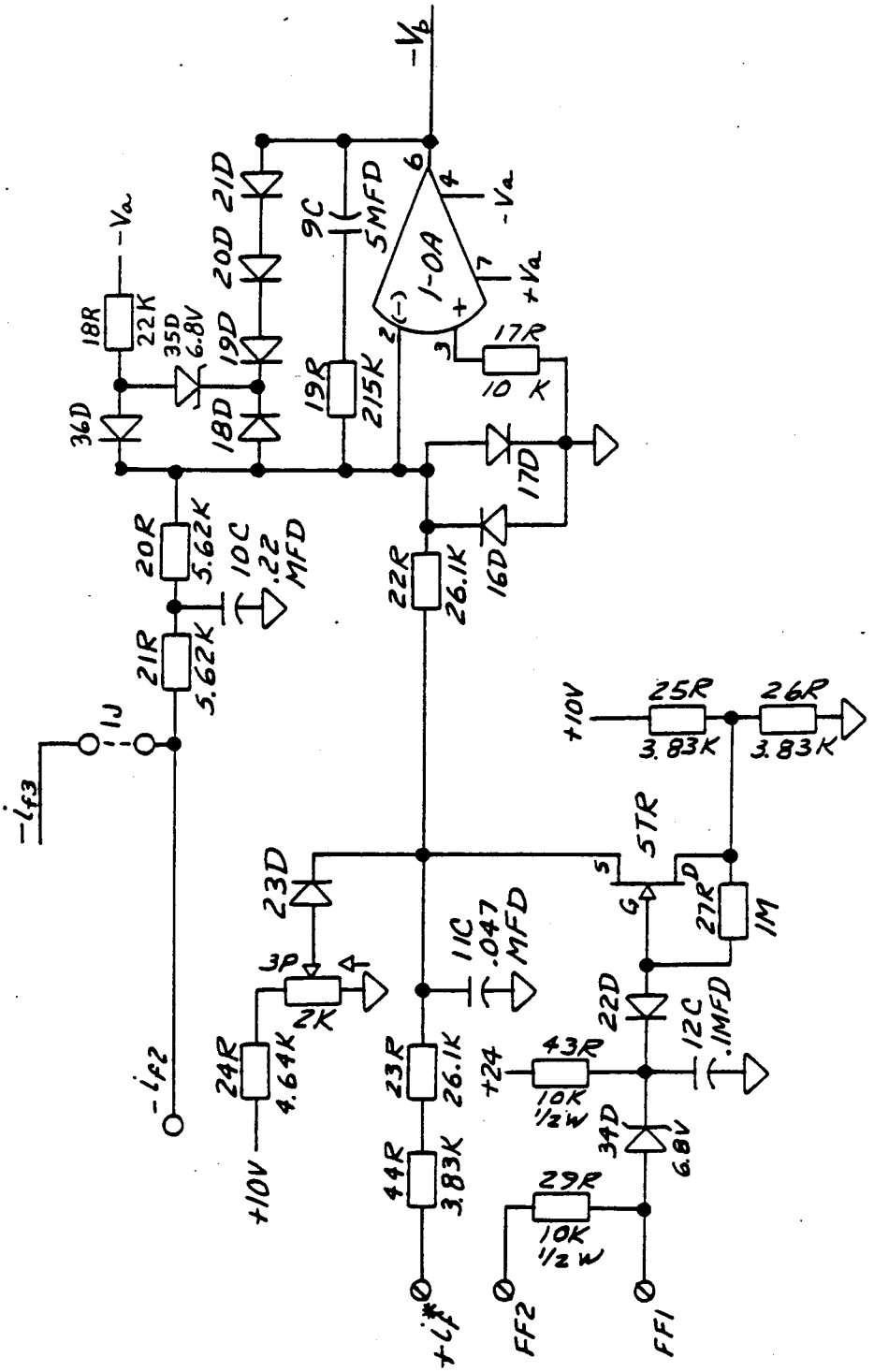
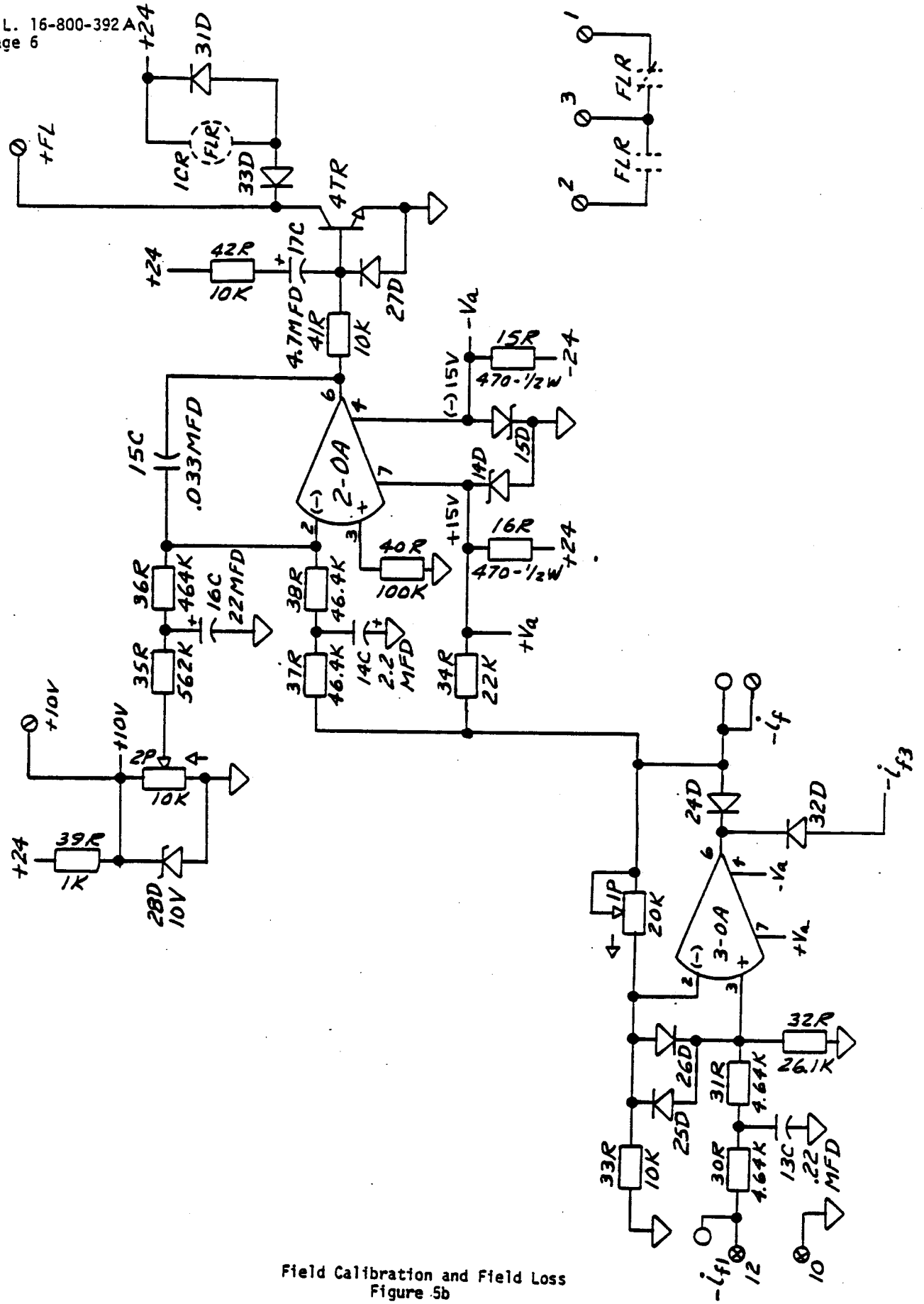


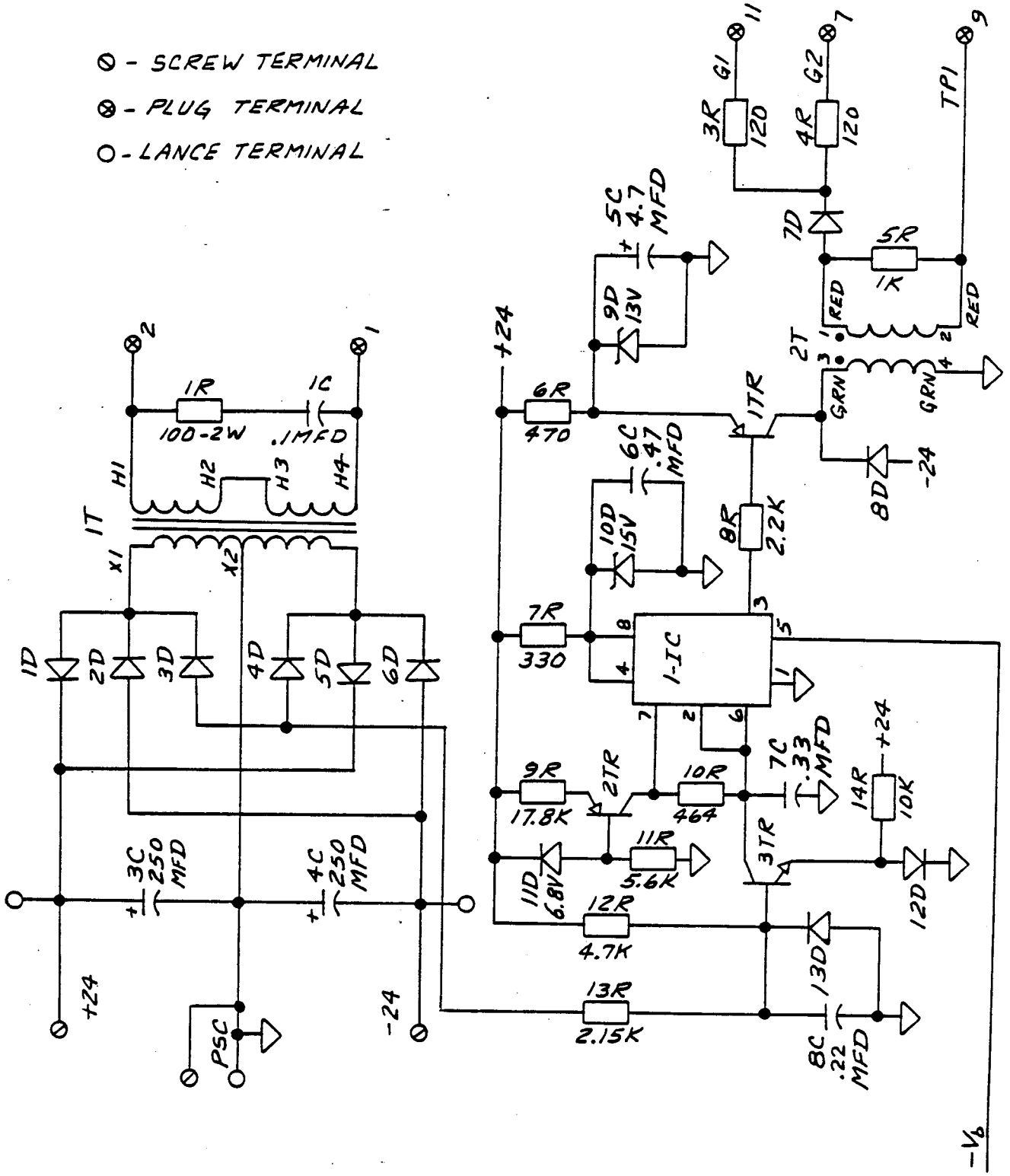
FIGURE 4
TPM SCHEMATIC



Basic Current Controller
Figure 5a



Field Calibration and Field Loss
Figure 5b



Power Supply and G.P.G.
Figure 5c

All DC current including freewheel current must pass through the current sensor. The current sensor produces 0.019 volts for each input ampere turn. For a particular amperage, the number of turns selected must produce a feedback signal between 0.8 and 2.4 volts. This signal is then calibrated to -2V on the field current controller board.

The Field Current Controller board (Figures 5a, 5b and 5c) is functionally divided into five circuits: Basic Current Controller (Figure 5a), Field Calibration and Field Loss (Figure 5b), Power Supply and GPG (Figure 5c).

Operational amplifier 1-OA and its associated circuitry provide the analog controller function. The approximate transfer function relating the current feedback ($-I_f$) signal and the output control voltage (v_c) can be expressed as follows:

$$v_c(s) = \frac{-18\,(1 + 1.1S)}{S} \times I_f(s)$$

Since the current feedback ($-I_f$) is calibrated for 2V at the rated field current, the reference signal required to match the feedback is given by

$$+I_f^* = -\frac{22R + 23R + 44R}{20R + 21R} \times I_f = -\frac{26.1 + 26.1 + 3.83}{5.62 + 5.62} \times (-2) = 9.97 \approx 10 \text{ volts}$$

The 5TR FET (Field Effect Transistor) Circuit along with 25R and 26R provide means for establishing full field reference irrespective of the signal level at I_f^*. The 5TR FET is controlled by a -15V or -24V potential signal at the FFI terminal. A -15V logic signal connected to FFI opens the FET circuit and, therefore, establishes either the minimum field set by 3P or that dictated by the signal at the $+I_f$ terminal whichever is higher. A zero volt logic potential or open circuit at terminal FFI establishes full field reference. The 10k resistor between terminals FF2 and FF1 is provided for loading when relay contacts are used at terminal FF1. Terminal FF2 is connected to PSP (+24V) and terminal FF1 is connected to PSN (-24V) through a low energy relay contact. Resistor 24R, potentiometer 3P and diode 3D provide means for adjusting minimum field current level.

Operational amplifier 2-OA and its associated circuitry constitute a voltage detector circuit with the 4TR transistor output circuit for field loss detection. The +FL terminal is used for static field loss. The FLR relay is a plug-in relay and is used for field loss protection where isolated contacts are required.

3-OA and associated circuitry comprise a non-inverting operational amplifier circuit with a variable gain. As described earlier, potentiometer 1P is used for calibrating the current feedback for -2V rated field current.

Transformer 1T and its associated components provide unregulated ±24V for the control circuitry.

Integrated circuit 1-1C, pulse transformer 2T and the associated components constitute the gate pulse generator producing gating pulses for each half cycle of the AC input voltage. A ramp intersect gating method is used with the control voltage output for controlling the phase shift of the gate pulse.

IV. SPECIFICATIONS AND RATINGS

A. TPM

1. Single-Phase full wave semiconverter.

2. 50/60 Hz.

   a. 230 VAC/345 VAC terminals U to V.
   b. 230 VAC only - terminals H1 to V. (H1 to V must be in phase with U to V).

3. DC Circuit

   a. 180 VDC/280 VDC terminals P to N with 230 VAC/345 VAC on terminals U to V above.
   b. Load Current - 0 to 30A DC.

4. Current sensor turn selection.

   The rating of the current sensor is 100AT. The number of turns selected should in conjunction with the maximum field current produce close to the maximum ampere turns but not exceed 100.

S#	# OF TURNS	MAX I_f
1775A93G02, G03	4	15-25A
1775A93G04	3	20-30A
1775A93G05	5	12-20A
1775A93G06	8	8-12A
1775A93G07	12	5-8A
1775A93G08	20	3-5A

B. Field Controller

1. Normal Forcing Factor: 1.5 for 180 VDC unit with 120V fields
   1.5 and 280 VDC unit with 180V fields

2. Maximum Field Current: Adjust (1P) for -2V feedback at rated field current (I_f).

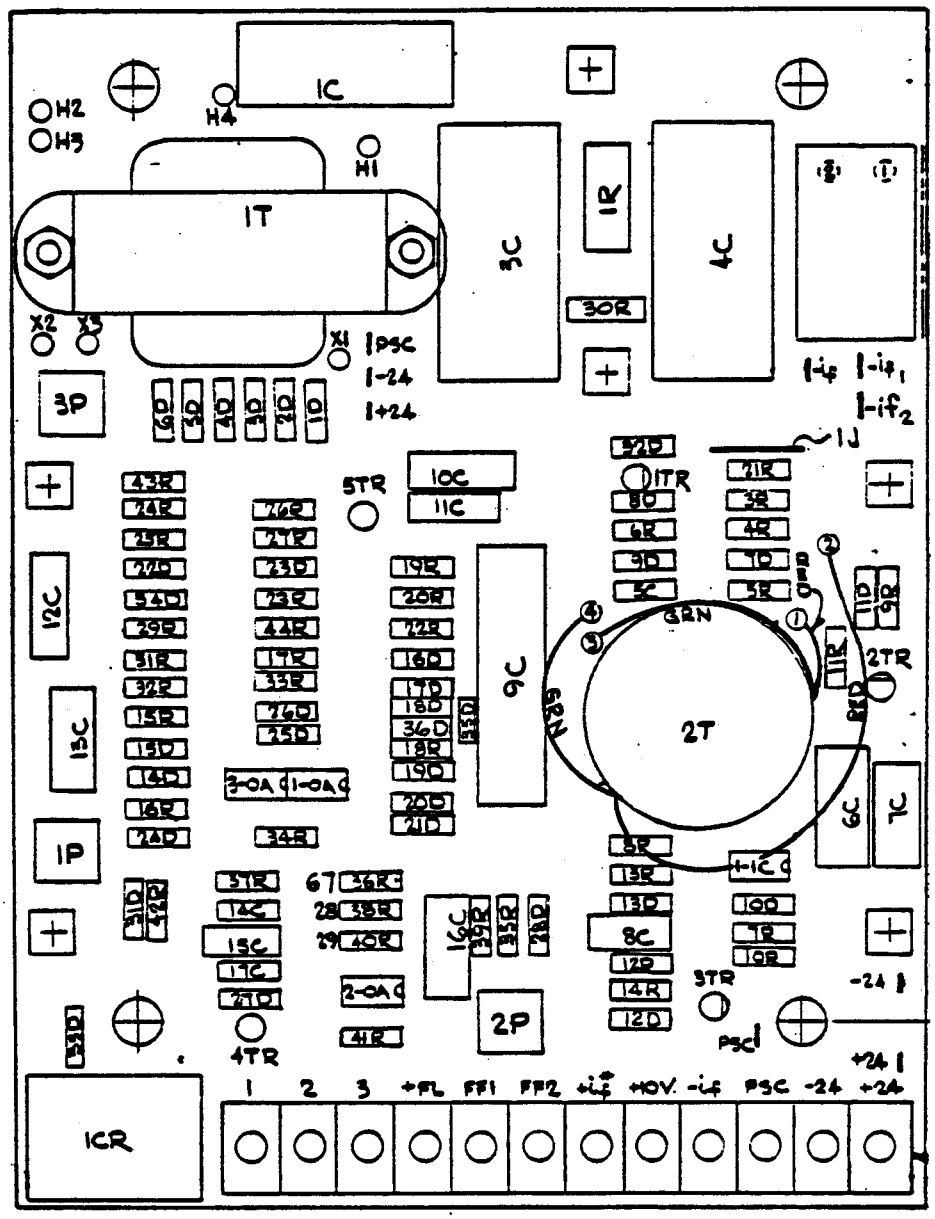
3. Minimum Field Current: Adjust (3P) Range 0 to 60% rated I_f.

4. Field Loss: Adjust (2P) Range full field to zero.

5. Inputs: (Ref. to PSC)
   $+I_f$* = 10V for rated field amps.
   FF1 = -15V logic signal for field control from $+I_f$* terminal.
   = -24V FET drive signal for field control from $+I_f$* terminal.
   = -24V through relay contact with FF2 at +24V for field control from $+I_f$* terminal.
   FF1 = open circuit or zero to +15V for full field.

V. REFERENCE MATERIAL

Optional Controllers	B/M Dwg.	I.L.
CEMF Sensor	1745A48	16-800-306
Flux Function Gen.	1745A47	16-800-306
Field Crossover	1781A89	16-800-306
Differential Isolator	1745A48	16-800-306



F21 CONTROLLER BOARD ASSEMBLY

FIGURE 6