# Sorensen

# *PTM DUAL SERIES*

## Narrow Range
## Power Supplies

## Instruction Manual

**Includes the following PTM Models:**

| Model I | Model II | Model III |
|---|---|---|
| 12-1D | 12-1.6D | 12-3D |
| 15-.8D | 15-1.5D | 15-2.8D |



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## SORENSEN ONE–YEAR WARRANTY

Sorensen, a division of Elgar Electronics Corporation, warrants its products to be free from defects in material and workmanship. This warranty is effective for one year from the date of shipment of the product to the original purchaser. Liability of Sorensen under this warranty shall exist provided that:

- the Buyer exposes the product to normal use and service and provides normal maintenance on the product;
- Sorensen is promptly notified of defects by the Buyer and that notification occurs within the warranty period;
- the Buyer receives a Return Material Authorization (RMA) number from Sorensen's Repair Department prior to the return of the product to Sorensen for repair, phone 800-458-4258;
- the Buyer returns the defective product in the original, or equivalent, shipping container;
- if, upon examination of such product by Sorensen it is disclosed that, in fact, a defect in materials and/or workmanship does exist, that the defect in the product was not caused by improper conditions, misuse, or negligence; and,
- that Sorensen QA seal and nameplates have not been altered or removed and the equipment has not been repaired or modified by anyone other than Sorensen authorized personnel.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including, but not limited to, implied warranties of merchantability and fitness of the product to a particular purpose. Sorensen, its agents, or representatives shall in no circumstance be liable for any direct, indirect, special, penal, or consequential loss or damage of any nature resulting from the malfunction of the product. Remedies under this warranty are expressly limited to repair or replacement of the product.

## CONDITIONS OF WARRANTY

- To return a defective product, contact a Sorensen representative or the Sorensen factory for an RMA number. Unauthorized returns will not be accepted and will be returned at the shipper's expense.
- For Sorensen products found to be defective within thirty days of receipt by the original purchaser, Sorensen will absorb all ground freight charges for the repair. Products found defective within the warranty period, but beyond the initial thirty-day period, should be returned prepaid to Sorensen for repair. Sorensen will repair the unit and return it by ground freight pre-paid.
- Normal warranty service is performed at Sorensen during the weekday hours of 7:30 am to 4:30 pm Pacific time. Warranty repair work requested to be accomplished outside of normal working hours will be subject to Sorensen non-warranty service rates.
- Warranty field service is available on an emergency basis. Travel expenses (travel time, per diem expense, and related air fare) are the responsibility of the Buyer. A Buyer purchase order is required by Sorensen prior to scheduling.
- A returned product found, upon inspection by Sorensen, to be in specification is subject to an inspection fee and applicable freight charges.
- Equipment purchased in the United States carries only a United States warranty for which repair must be accomplished at the Sorensen factory.

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## SORENSEN FIVE-YEAR WARRANTY

Sorensen, a division of Elgar Electronics Corporation, warrants its products to be free from defects in material and workmanship. This warranty is effective for five years from the date of shipment of the product to the original purchaser. Liability of Sorensen under this warranty shall exist provided that:

- the Buyer exposes the product to normal use and service and provides normal maintenance on the product;
- Sorensen is promptly notified of defects by the Buyer and that notification occurs within the warranty period;
- the Buyer receives a Return Material Authorization (RMA) number from Sorensen's Repair Department prior to the return of the product to Sorensen for repair, phone 800-458-4258;
- the Buyer returns the defective product in the original, or equivalent, shipping container;
- if, upon examination of such product by Sorensen it is disclosed that, in fact, a defect in materials and/or workmanship does exist, that the defect in the product was not caused by improper conditions, misuse, or negligence; and,
- that Sorensen QA seal and nameplates have not been altered or removed and the equipment has not been repaired or modified by anyone other than Sorensen authorized personnel.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including, but not limited to, implied warranties of merchantability and fitness of the product to a particular purpose. Sorensen, its agents, or representatives shall in no circumstance be liable for any direct, indirect, special, penal, or consequential loss or damage of any nature resulting from the malfunction of the product. Remedies under this warranty are expressly limited to repair or replacement of the product.

## CONDITIONS OF WARRANTY

- To return a defective product, contact a Sorensen representative or the Sorensen factory for an RMA number. Unauthorized returns will not be accepted and will be returned at the shipper's expense.
- For Sorensen products found to be defective within thirty days of receipt by the original purchaser, Sorensen will absorb all ground freight charges for the repair. Products found defective within the warranty period, but beyond the initial thirty-day period, should be returned prepaid to Sorensen for repair. Sorensen will repair the unit and return it by ground freight pre-paid.
- Normal warranty service is performed at Sorensen during the weekday hours of 7:30 am to 4:30 pm Pacific time. Warranty repair work requested to be accomplished outside of normal working hours will be subject to Sorensen non-warranty service rates.
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# SECTION 1

# INTRODUCTION

## 1.1 PURPOSE

This manual contains operating and maintenance instructions on the dual PTM modular power supply line. The line consists of 9 models, all similar in electrical design and physical appearance. The models are grouped into 3 sizes; Modules I, II, & III, which differ in the power rating and in overall size. (See Table 1-1, General Specifications.)

## 1.2 DESCRIPTION

Designed for operation from any of three separate single-phase inputs, the units provide a variety of highly regulated dc outputs. (Refer to Table 1-1 for general specifications). They also offer extremely fast recovery times as well as characteristically low output impedances.

The supplies are designed to be mounted in any one of three positions; end, bottom or side. Four tapped mounting holes are provided on each side.

For Module II and Module III, an extruded-aluminum finned heat sink (radiator) is supplied on the rear side to eliminate the need for an external heat-dissipation device. For Module I the heat sink is mounted internally.

### 1.2.1 Functional

Operational features of the PTM series power supplies include remote sensing, remote programming, overload and short-circuit protection by current limiting (foldback), and over-voltage protection by an integral electronic crowbar circuit. (Refer to Table 1-1).

### 1.2.2 Remote Sensing

In applications where variations in the load-lead drops adversely affect load regulation, remote sensing may be used to extend the unit's regulating point from the output terminals to the load. In the PTM series, remote sensing will compensate for 250 mV of drop per load lead, maximum.

### 1.2.3 Remote Programming

With the remote-programming feature, unit output voltage may be altered from a remote location by introducing a calculated resistance into the programming network. The ohms/volt ratio is approximately 500 ± 8%.

### 1.2.4 Series Operation

The PTM dual series is not suitable for series connection. Series operation generally makes start-up difficult because of the foldback current-limiting feature.

### 1.2.5 Parallel Operation

The PTM dual series is not suitable for parallel operation.

### 1.2.6 Overcurrent Protection

In the event of an overcurrent condition, such as a short circuit, a current-foldback circuit (pre-set at the factory to 125% of rated current at 40°C), operates to reduce both the unit output voltage and current.

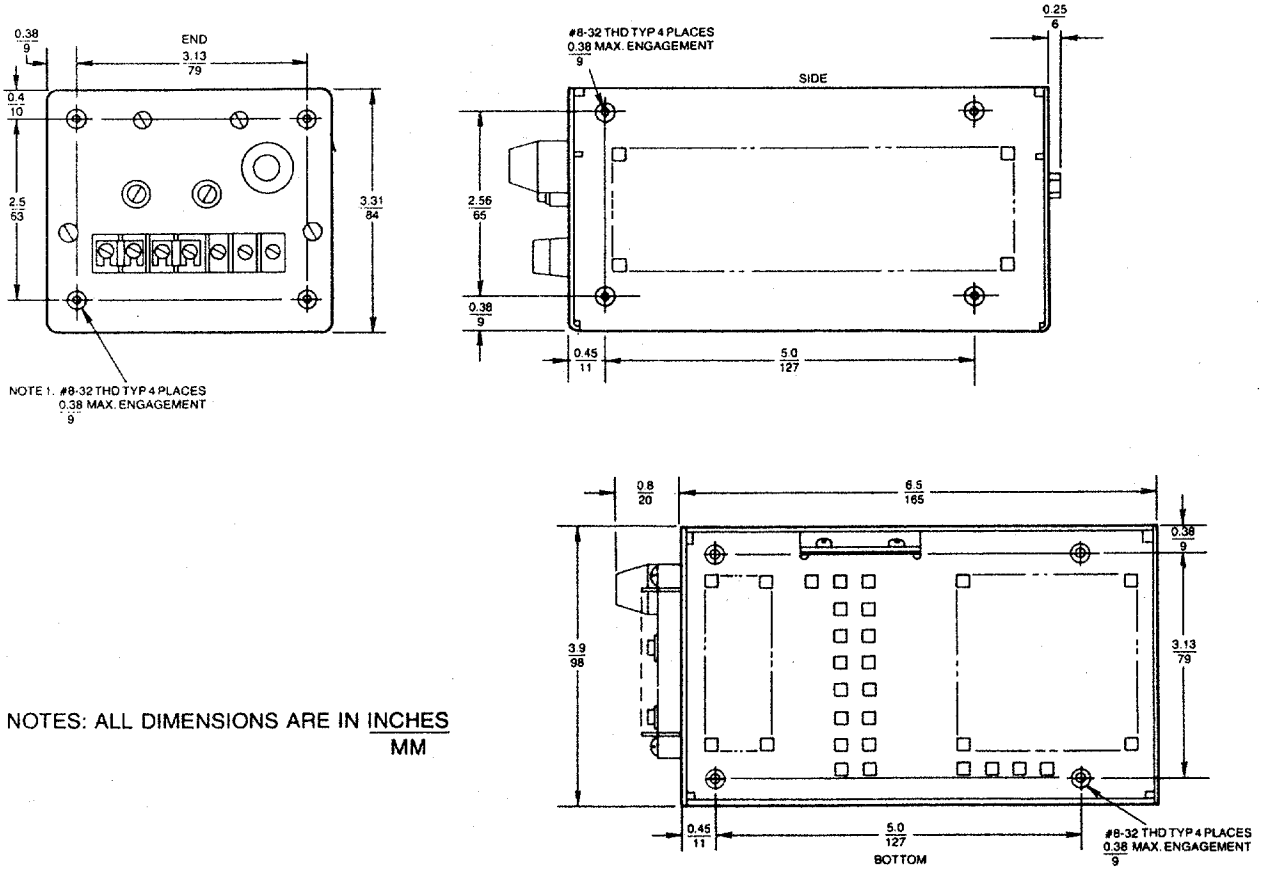
### 1.2.7 Overvoltage Protection

In the event of an overvoltage condition on the output, such as a failure in the power supply or an externally induced condition, an overvoltage electronic crowbar is actuated by an integral OVP sensing circuit. The crowbar acts quickly to reduce the output voltage to approximately zero, and then cause the power supply to go into current foldback condition.

## 1.3 INPUT OPTIONS

Standard PTM Dual models are factory wired for 115 Vac operation. Units may be field or factory modified, however, to accept inputs of 220 Vac (M1 option) or 230 Vac (M2 option). Refer to Figure 2-1 on page 2-4 for required input transformer modifications.

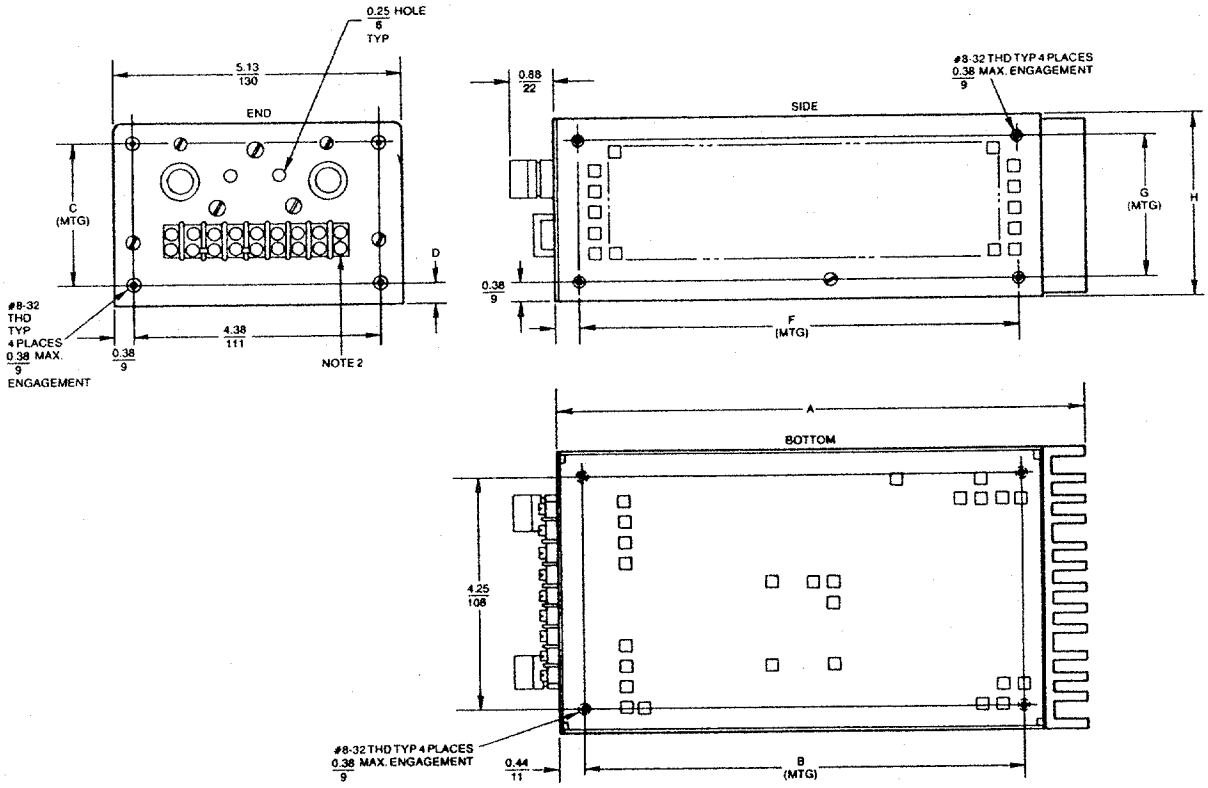
**Module I**




NOTES: ALL DIMENSIONS ARE IN INCHES
MM

Figure 1-1 PTM Outline Drawing (Module I)

## Modules II, III




| Case | Dimensions A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| II | 6.5 / 165 | 5.0 / 128 | 2.5 / 63 | 0.46 / 11 | 0.45 / 11 | 5.0 / 128 | 2.56 / 65 | 3.3 / 84 |
| III | 9.5 / 241 | 7.88 / 200 | 2.5 / 63 | 0.46 / 11 | 0.44 / 11 | 7.88 / 200 | 2.56 / 65 | 3.3 / 84 |

NOTES: ALL DIMENSIONS ARE IN INCHES / MM

NOTE 1: SCREW SIZE #6-32 (EXCEPT FOR PTM DUAL, AC INPUT #5-40).
2: CASE II & III SCREW SIZE #5-40, CASE IIIB & DUALS #6-32).

Figure 1-2 PTM Outline Drawing (Modules II, III)

Table 1-1 General Specifications (All Models)

| MODULE I | INPUT V | INPUT A | OUTPUT (+)V | OUTPUT A | OUTPUT (-)V | OUTPUT A | Input Fuse (A) |
|---|---|---|---|---|---|---|---|
| 12-1D | 105-125 | .6 | 11-13 | 1.0 | 11-13 | 1.0 | 1.0 |
| 15-.8D | 105-125 | .60 | 14-16 | .8 | 14-16 | .8 | 1.0 |
| 12-1DM1 | 200-240 | .35 | 11-13 | 1.0 | 11-13 | 1.0 | .5 |
| 15-.8DM1 | 200-240 | .35 | 14-16 | .8 | 14-16 | .8 | .5 |
| 12-1DM2 | 210-250 | .30 | 11-13 | 1.0 | 11-13 | 1.0 | .5 |
| 15-.8DM2 | 210-250 | .30 | 14-16 | .8 | 14-16 | .8 | .5 |
| MODULE II | | | | | | | |
| 12-1.6D | 105-125 | .90 | 11-13 | 1.6 | 11-13 | 1.6 | 1.5 |
| 15-1.5D | 105-125 | .90 | 14-16 | 1.5 | 14-16 | 1.5 | 1.5 |
| 12-1.6DM1 | 200-240 | .80 | 11-13 | 1.6 | 11-13 | 1.6 | .75 |
| 15-1.5DM1 | 200-240 | .80 | 14-16 | 1.5 | 14-16 | 1.5 | .75 |
| 12-1.6DM2 | 210-250 | .45 | 11-13 | 1.6 | 11-13 | 1.6 | .75 |
| 15-1.5DM2 | 210-250 | .45 | 14-16 | 1.5 | 14-16 | 1.5 | .75 |
| MODULE III | | | | | | | |
| 12-3D | 105-125 | 1.8 | 11-13 | 3.0 | 11-13 | 3.0 | 2.0 |
| 15-2.8D | 105-125 | 1.8 | 14-16 | 2.8 | 14-16 | 2.8 | 2.0 |
| 12-3DM1 | 200-240 | .96 | 11-13 | 3.0 | 11-13 | 3.0 | 1.0 |
| 15-2.8DM1 | 200-240 | .96 | 14-16 | 2.8 | 14-16 | 2.8 | 1.0 |
| 12-3DM2 | 210-250 | .90 | 11-13 | 3.0 | 11-13 | 3.0 | 1.0 |
| 15-2.8DM2 | 210-250 | .90 | 14-16 | 2.8 | 14-16 | 2.8 | 1.0 |

| | |
|---|---|
| Turn ON/OFF Overshoot: | 50 microseconds for load changes of 10 to 100% or 100 to 10%, based on recovery to within a ±20 mV band. |
| Remote Programming: | 500 ohms per volt (approximately). |
| Current Limit: | Automatic, adjustable, foldback type. Minimum range 50 to 130% of 40°C rated current. Factory set to approximately 125% of rated (40°C) current (see individual unit specifications. |
| Overvoltage Limit: | Automatic, adjustable (OVP) crowbar action, self contained. Factory set (see individual unit specifications for setting). Outputs are sensed separately and both outputs are shorted by an internal SCR within 50 microseconds. OVP stability is .05%/°C of voltage trip setting (typical). |

Table 1-1 General Specifications (Cont'd)

| | | | |
|---|---|---|---|
| EMI (RFI): | Requirements CE03 (conducted emissions over 20 kHz to 50 MHz) and RE02 (radiated emissions over 15 kHz to 10 GHz) of MIL-STD-461 apply. | | |
| Stability: | After one hour warm-up, 0.1% for 24 hours with all external effects held constant. | | |
| Parallel Operation: | Not recommended. | | |
| Series Operation: | Not recommended. | | |
| Remote Sensing: | 250 mV drop per leg maximum. Remote sense (+) and (-) terminals provided. | | |
| Ambient Rating: | 0 to 71°C (see current ratings in individual unit specifications. | | |
| Cooling: | Natural convection (maintain free airflow from under unit. | | |
| Dimensions - $\frac{\text{inches}}{\text{mm}}$ | Module I | Module II | Module III |
| Width: | $\frac{3\text{-}7/8}{98}$ | $\frac{5\text{-}1/8}{130}$ | $\frac{5\text{-}1/8}{130}$ |
| Height: | $\frac{3\text{-}5/16}{84}$ | $\frac{3\text{-}5/16}{84}$ | $\frac{3\text{-}5/16}{84}$ |
| Depth: | $\frac{6\text{-}1/2}{165}$ | $\frac{6\text{-}1/2}{165}$ | $\frac{9\text{-}1/2}{241}$ |
| Weight: $\frac{\text{lbs}}{\text{kg}}$ | $\frac{5.25}{2.4}$ | $\frac{7.5}{3.4}$ | $\frac{11}{5}$ |
| Input-Output Connections: | All connections on Modules II and III are made to a 10 terminal barrier strip using #5-40 screws. On Module I, all input connections are made on a 3 terminal barrier strip. A 7 terminal barrier strip is used for the output connections. | | |

Table 1-2 Unit Specifications - Module I

| Model No. | 12-1D | | 15-.8D | |
|---|---|---|---|---|
| Output Ratings | | | | |
| Nominal Voltage (Vdc) | +12 | -12 | +15 | -15 |
| Voltage Range (Vdc) | 11-12 | 11-12 | 14-16 | 14-16 |
| Regulation (mV) | 6.5 | 6.5 | 8.0 | 8.0 |
| Current (Adc)* | | | | |
| @ 40°C | 1.0 | 1.0 | .8 | .8 |
| @ 50°C | .9 | .9 | .72 | .72 |
| @ 60°C | .7 | .7 | .56 | .56 |
| @ 71°C | .4 | .4 | .32 | .32 |
| Current Limit (Adc) | | | | |
| Factory Set To: | 1.2 | 1.2 | .95 | .95 |
| Overvoltage Limit (Vdc) | | | | |
| Factory Set To: | 14.6 | 14.6 | 17.5 | 17.5 |
| Input Ratings | | | | |
| Efficiency (%) | 55 | 55 | 54 | 54 |
| Power Factor (%) | 80 | 80 | 80 | 80 |
| Output Adjust Resolution (mV) | 25 | 25 | 25 | 25 |

*NOTE

Specifications listed for balanced load conditions. If unit is to be operated with unbalanced loads, consult factory for applications assistance.

Table 1-3 Unit Specifications - Module II

| Model No. | 12-1.6D | | 15-1.5D | |
|---|---|---|---|---|
| Output Ratings | | | | |
| Nominal Voltage (Vdc) | +12 | -12 | +15 | -15 |
| Voltage Range (Vdc) | 11-13 | 11-13 | 14-16 | 14-16 |
| Regulation (mV) | 6.5 | 6.5 | 8.0 | 8.0 |
| Current (Adc)* | | | | |
| @ 40°C | 1.6 | 1.6 | 1.5 | 1.5 |
| @ 50°C | 1.4 | 1.4 | 1.35 | 1.35 |
| @ 60°C | 1.1 | 1.1 | 1.05 | 1.05 |
| @ 71°C | .65 | .65 | .6 | .6 |
| Current Limit (Adc) | | | | |
| Factory Set To: | 1.8 | 1.8 | 1.7 | 1.7 |
| Overvoltage Limit (Vdc) | | | | |
| Factory Set To: | 14.6 | 14.6 | 17.5 | 17.5 |
| Input Ratings | | | | |
| Efficiency (%) | 53 | 53 | 52 | 52 |
| Power Factor (%) | 81 | 81 | 81 | 81 |
| Output Adjust Resolution (mV) | 25 | 25 | 25 | 25 |

*NOTE

Specifications listed for balanced load conditions. If unit is to be operated with unbalanced loads, consult factory for applications assistance.

Table 1-4 Unit Specifications - Module III

| Model No. | 12-3D | | 15-2.8D | |
|---|---|---|---|---|
| Output Ratings | | | | |
| Nominal Voltage (Vdc) | +12 | -12 | +15 | -15 |
| Voltage Range (Vdc) | 11-12 | 11-12 | 14-16 | 14-16 |
| Regulation (mV) | 6.5 | 6.5 | 8.0 | 8.0 |
| Current (Adc)* | | | | |
| @ 40°C | 3.0 | 3.0 | 2.8 | 2.8 |
| @ 50°C | 2.7 | 2.7 | 2.4 | 2.4 |
| @ 60°C | 2.1 | 2.1 | 1.9 | 1.9 |
| @ 71°C | 1.2 | 1.2 | 1.1 | 1.1 |
| Current Limit (Adc) Factory Set To: | 3.4 | 3.4 | 3.2 | 3.2 |
| Overvoltage Limit (Vdc) Factory Set To: | 14.6 | 14.6 | 17.5 | 17.5 |
| Input Ratings | | | | |
| Efficiency (%) | 57 | 57 | 56 | 56 |
| Power Factor (%) | 82 | 82 | 82 | 82 |
| Output Adjust Resolution (mV) | 25 | 25 | 25 | 25 |

*NOTE

Specifications listed for balanced load conditions. If unit is to be operated with unbalanced loads, consult factory for applications assistance.

# SECTION 2

# INSTALLATION

## 2.1 GENERAL

Following unpacking, general inspection and preliminary check-out procedures should be performed to assure that the unit is in proper working order. These consists of visually inspecting for physical damage and performing a few electrical checks. If it is determined that the unit is damaged, the carrier should be notified immediately. The carrier's claim agent will prepare a report of damage. The user is required to send this report to the Service Department, Sorensen Company. Sorensen will advise the user as to what action is required to repair or replace the supply.

## 2.2 INSPECTION

Check for damage incurred during shipment as follows:

1. Inspect enclosures for dents, chips and other obvious signs of damage.
2. Check condition of external terminal board. Make certain that all terminal screws are in place and that links are fitted over the barrier strips between terminals 1 and 2, 3 and 4, and between 5, 6 and 7.
3. Inspect fuse holders for evidence of damage.
4. If internal damage is suspected;
   a. Remove the (4) flat-head screws on front panel.
   b. (Group III Only) remove the (2) flat-head screws, one on each side.
   c. Remove the (6) round-head screws on rear heat sink, top edge and end side.
   d. Loosen the (2) round-head screws on the lower edge of the heat sink.
   e. Inspect PCB, transformer, capacitor and potentiometers.
5. The PCB and potentiometer bracket assembly can be removed by removing the three round-head screws retaining the bracket to the front panel.
6. The heat-sink assembly at the rear can be removed by removing the two lower rear round-head screws. Check that the power transistors are firmly plugged into their sockets. These may be readily removed for unit servicing.

## 2.3 INPUT CONNECTIONS

If either of the two alternatives to a nominal 115-Vac input is to be used, transformer T1 primary tap wiring should be changed as indicated in Figure 2-1. The factory-wired 115-Vac configuration is included to facilitate reconversion to this input if such action becomes desirable. Remount enclosures following inspection or tap changing.

## 2.4 ELECTRICAL CHECK

To perform an initial electrical check, proceed as follows:

1. Make certain that the unit is located in an area where free passage of air is unrestricted. For Modules II & III connect input leads to terminals 9 and 10 (IN) on unit terminal board. Use terminal 8 (GND) for input system ground. For module I use 3-position terminal board. Connect input leads to terminals 1 and 2, and use terminal 3 (GND) for input system ground.

2. Connect a dc voltmeter across terminals 2 and 4, (+V) and 4 and 6 (-V). Select a voltage range compatible with rated output.

3. Apply nominal rated input power.

4. Rotate output adjust sufficiently to swing the dc voltmeter from minimum to maximum rated voltage (per Table 1-1). Do not exceed the maximum ratings.

5. Set output voltage to the unit's nominal value and remove input power.

## 2.5 MOUNTING

These units may be mounted in a variety of positions and locations, including rack mounting.

1. For cantilever - type mounting from a vertical panel or wall (where free access to vertical airflow is available):

   End Mounting - Use knockout per Figure 2-2 for Module I units, Figure 2-3 for Module II units, or Figure 2-4 for Module III units. This knockout clears the terminal block and fuses.

   Side or Bottom Mounting - No knockout is needed. Use the four mounting holes shown in Figures 2-2, 2-3 or 2-4.

2. For flat mounting from a horizontal surface (where free access to vertical airflow is not available):

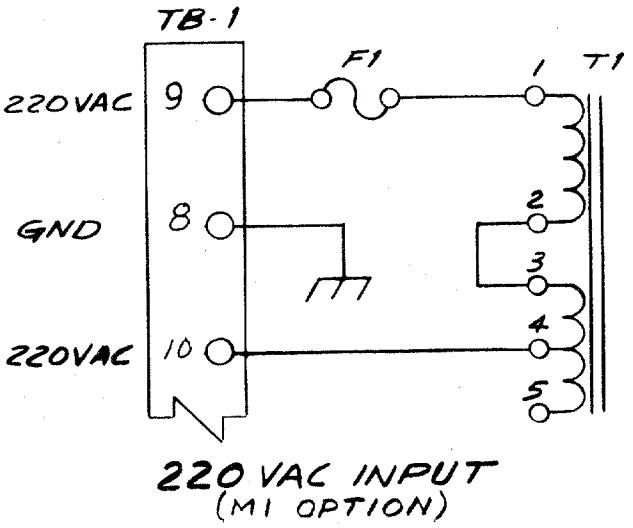
   End Mounting - Not recommended.

Side Mounting - Use knockout per Figures 2-2, 2-3 or 2-4. Note that dotted area is suggested for additional heat-sink cooling, but is optional for Modules II & III only.

Bottom Mounting - Use knockout per Figures 2-2, 2-3 or 2-4.

3. Vertical panel mounting per 1. preceding is preferred since maximum airflow is assured. Horizontal surface mounting per 2. preceding, using bottom mounting with proper knockout is the second preference.

4. Mounting screws should be No. 8-32 and just long enough to penetrate 1/4 inch into the PTM unit and through the mounting surface and lock/flat washers used.




220 VAC INPUT
(M1 OPTION)

MODULE I (SAME AS 115 Vac EXCEPT)

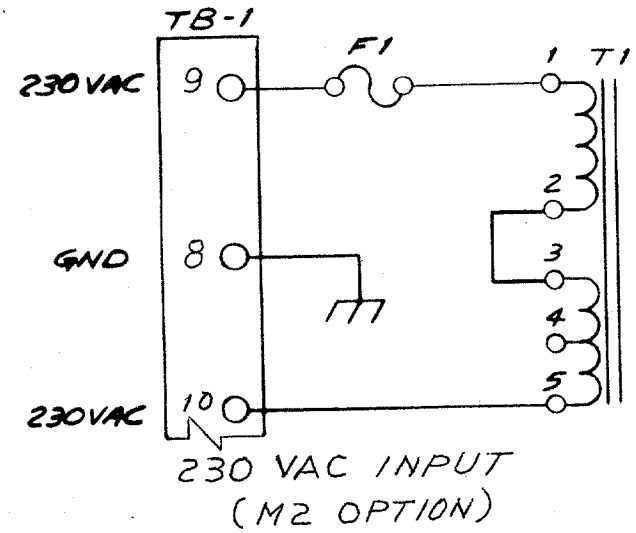
1) REMOVE JUMPER FROM T1-1 TO T1-3
2) REMOVE JUMPER FROM T1-2 to T1-5
   &LOCATE FROM T1-2 to T1-3
3) REMOVE JUMPER FROM TB1-2 to T1-5
   & LOCATE FROM TB1-2 TO T1-4
4) CHANGE FUSES:

.5 AMP. 250V to .25 AMP. 250V-PN 226-7176P32 (5/12DI)
OR
1 AMP. 250V to .5 AMP. 250V-PN 226-7176P36 (all others)

MODULES II AND III (SAME AS 115 Vac EXCEPT)

1) REMOVE JUMPER FROM T1-1 TO T1-3
2) REMOVE JUMPER FROM T1-2 TO T1-5
3) REMOVE JUMPER FROM TB1-10 TO T1-5
   & LOCATE FROM TB1-10 TO T1-4
4) CHANGE FUSES:

1.5 AMP. 250V TO .75 AMP. 250V-PN 226-7176P38 (MOD.II)
OR
2 AMP, 250V TO 1 AMP, 250V, PN 226-7176P39 ( MOD. III)




230 VAC INPUT
(M2 OPTION)

MODULE I ( SAME AS 115 Vac EXCEPT)

1) REMOVE JUMPER FROM T1-1 to T1-3
2) REMOVE JUMPER FROM T1-2 TO T1-5
   & LOCATE FROM T1-2 TO T1-3
3) CHANGE FUSES:

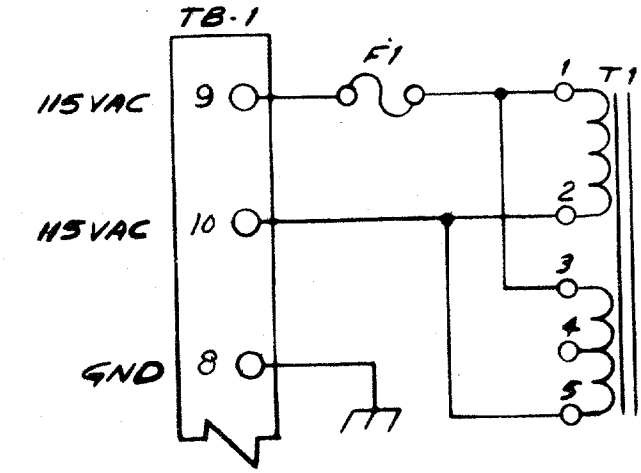
.5 AMP. 250V to .25 AMP. 250V-PN 226-7176P32 (5/12DI)
OR
1 AMP. 250V TO .5AMP. 250V-PN 226-7176P36 (all others)

MODULES II & III (SAME AS 115 Vac EXCEPT)

1) REMOVE JUMPER FROM T1-1 TO T1-3
2) REMOVE JUMPER FROM T1-2 TO T1-5
3) CHANGE FUSES:

1.5 AMP. 250V TO .75 AMP. 250V-PN 226-7176P38 (MOD. II)

2 AMP 250V TO 1 AMP. 250V-PN 226-7176P39 (MOD. III)




115 VAC INPUT

MODULE I

T1 PIN 1 TO TB-1 PIN 1
T1 PIN 2 TO TB-1 PIN 2
TB-1 PIN 3 IS GND.

MODULES II & III

T1 PIN 1 TO TB-1 PIN 9
T1 PIN 2 TO TB-1 PIN 10
TB-1 PIN 8 IS GND.

FIGURE 2-1 INPUT CONNECTIONS

Figure 2-1 Input Connections

NOTE

Vertical panel mounting per paragraph 1 preceding is preferred since maximum airflow is assured. Horizontal surface mounting, using bottom mounting with proper knockout is the second preference.

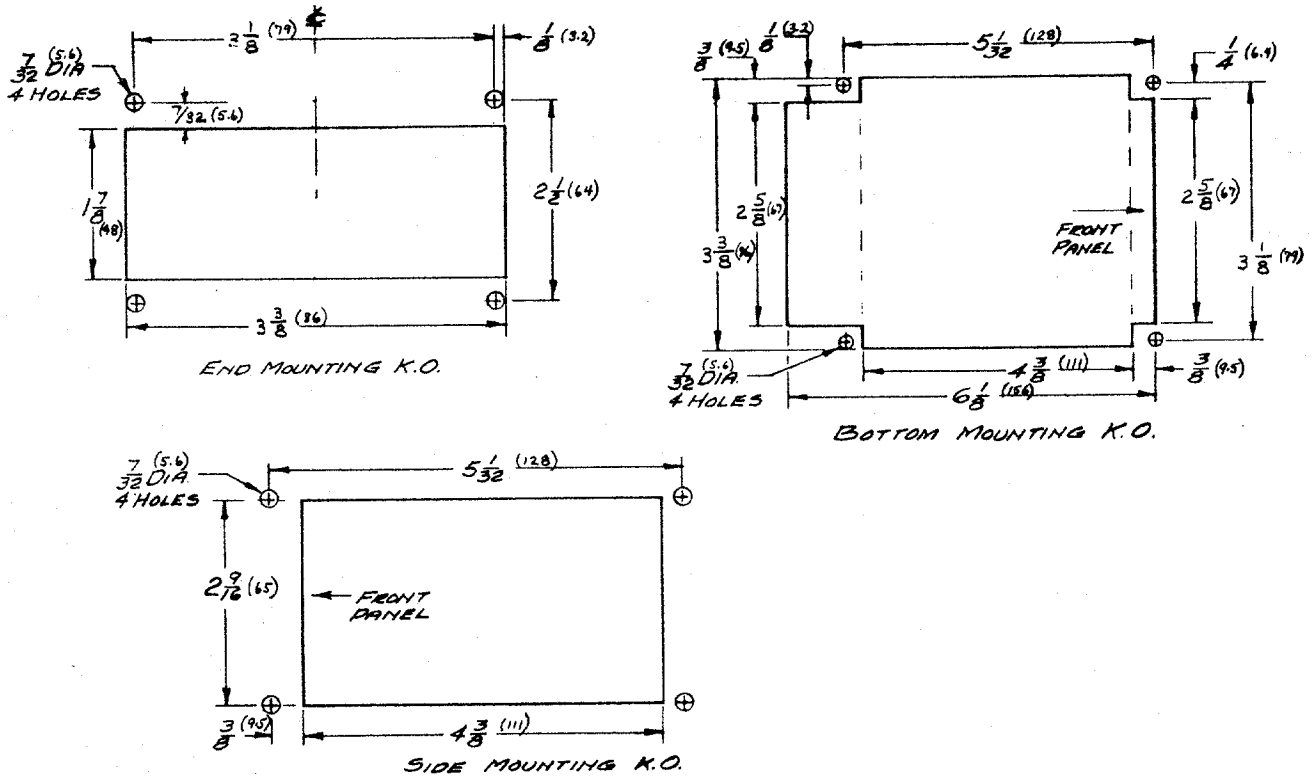



Figure 2-2 Knockout Dimensions Module I

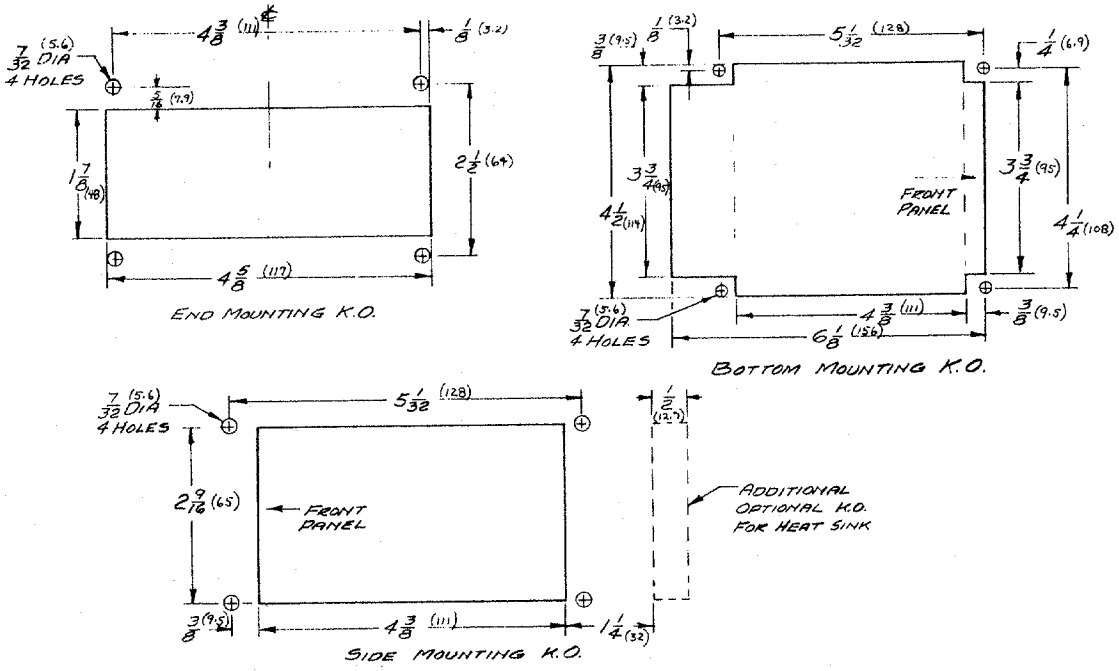



Figure 2-3 Knockout Dimensions Module II

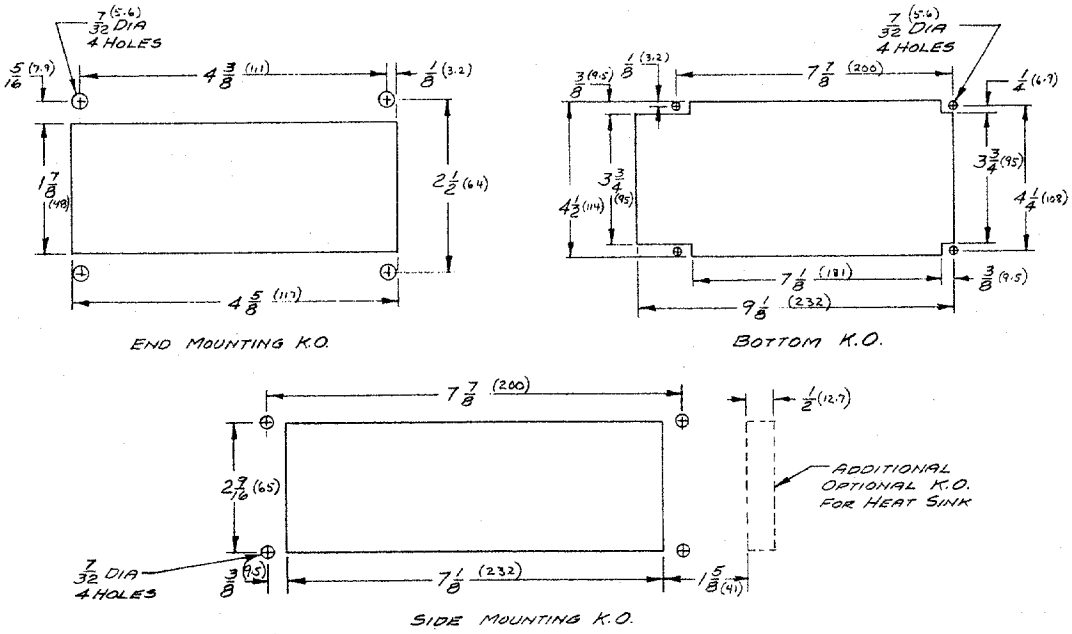



Figure 2-4 Knockout Dimensions Module III

# SECTION 3

# OPERATION

## 3.1 GENERAL

This section contains instructions on how to adapt the unit to, and operate it in, a number of varied applications. These include local sensing, remote sensing, and remote programming.

---

CAUTION

The sensing and power circuits form a closed loop. Opening this loop, either by removing a terminal board link or disconnecting a sensing or programming lead will result in a high unit output and will cause the OVP crowbar to operate, (Para. 4.3.4).

---

## 3.2 CONTROLS

PTM Dual units are equipped with two panel output controls. The output adjust controls are used to vary the output voltage. Both are factory set to nominal values (see Table 1-1).

## 3.3 PRE-OPERATION CONSIDERATIONS

### 3.3.1 Output Voltage Reset Procedure

1. There are two controls available on the front of the unit, to adjust the (+) and (-) output voltages. The (-) output pot is the master control which adjusts both outputs in a tracking mode. The (+) pot affects only the (+) output.

2. In normal applications, it is desired to have both outputs set for the same voltage (e.g., + 15.0V and - 15.0V). In these applications, use the (+) output pot only to secure an initial balance between the (+) and (-) outputs.

   Thereafter, all adjustments are made with the (-) Master control (e.g., if the - 15V is reset to - 16V, then the + 15V will also go to + 16V in a tracking mode).

3. In special applications, it may be desired to maintain a differential voltage between the (+) and (-) outputs (e.g., + 14.5V and - 15.5V, or a 1V differential). If so, preset the (+) control to obtain the desired differential (1V in our example). Thereafter, all adjustments are made with the (-) Master Control, which will maintain the differential.

### 3.3.2 Current Foldback Setting

The current foldback point is factory set to approximately 125% of rated 40°C current. If the unit is to be operated in other ambients, the rated output current is derated per Tables 1-2, 1-3, or 1-4. It is recommended for ambient temperatures above 40°C, the foldback should be reset to approximately 125% of the derated output current.

### 3.3.3 Current Foldback Reset Procedure

Two load banks are required as shown in Figure 5-4. Two ammeters and voltmeters are preferred, but one meter can be swapped, if needed, to both positions. Remove the top cover to access R4 and R18 on the PCB.

1. Preset R4 and R18 fully counterclockwise: Adjust both outputs to nominal rated volts. (V1 and V2).

2. Adjust both loads RL1 and RL2 for rated output current. (A1 and A2).

3. Short negative output (close S2) and immediately adjust R4 to reduce negative current (A2) to less than rated current.

4. Adjust R4 precisely to obtain exactly the short circuit current value (A2) per Table 4-1. Remove short (open S2).

5. Short positive output (close S1). Read short circuit current (A1). This must be at least 0.1A. Remove short circuit (open S1).

   If too low, reset R4 to obtain the 0.1A. Recheck step 3 and 4 (negative output shorted) but allow 25% higher short circuit current limit than Table 4-1.

6. Adjust both loads RL1 and RL2 to obtain the specified foldback current of Table 4-1.

7. Adjust R18 until (+) output (V1) drops approximately 0.15 volts.

8. Reset both loads for rated current (both outputs A1 and A2 at rated current). Short (+) output (close S1). Remove short and verify both output voltbages recover to normal level.

### 3.3.4 Overvoltage Reset Procedure

See Figure 5-4 set-up. Neither load bank nor ammeters are required, however. Remove the top cover to access R25 on the PCB.

1. Preset OVP adjust pot (R25) on the PCB fully counterclockwise. Adjust both outputs to minimum voltage (fully counterclockwise) on V1 and V2.

2. Using the (+) output pot, increase the (+) output (V1) to desired OVP trip voltage. The factory set trip is 13.5 Vdc for 12V models and 16.5 Vdc for 15V models. (Use a setting 10% above the desired operating voltage).

3. Slowly adjust OVP pot R25 until both outputs V1 and V2 suddenly drop to zero (OVP trip). Interrupt ac power for five seconds to reset OVP.

4. Set (-) output to nominal rated voltage (V1). Adjust (+) output to equal (-) output (V2=V1).

5. Increase (-) output slowly (V2) until OVP trips. Trip-out should occur at the same voltage set in step 2.

## 3.4 LOCAL SENSING

The unit is shipped ready for use in the local sensing mode. In this mode, regulation is at the output terminals, not at the load. If variations in load-line voltage drops are expected to be prohibitive, refer to para. 3.5, remote sensing.

To operate the unit, proceed as follows:

1. Connect a voltmeter across terminals 2 and 4 (+V) or 4 and 6 (-V).

2. Attach the input leads on Modules II or III to terminals 9 and 10. Use trminal 8 (GRD) to ground input system. On Module I, use terminals 1 and 2 on 3-position board. Use terminal 3 to ground input system.

3. Apply nominal input power.

4. Rotate output adjust until desired output voltage is indicated on the voltmeter.

5. Remove input power, disconnect voltmeter and connect load leads to terminals 2 and 4 or 4 and 6. Do not remove or loosen any of the interconnecting links. Apply nominal input. Unit supplies highly regulated power to load.

---

CAUTION

Do not touch enclosure while unit is operating under load. Surface temperature is comparatively high. If unit must be handled immediately after operation, wear heat resistant gloves.

---

## 3.5 REMOTE SENSING

If it is desireable to sense (regulate) unit output at the load rather than at the output terminals, remove the links between terminals 1 and 2, 3 and 4, and 5 and 6. Run sense leads from terminals 2, 4, and 6 as shown in Figure 3-1. Sensing leads should be fabricated using a shielded, twisted, pair of wires. Put the unit into operation per para. 3.4. With remote sensing, unit transient response degenerates slightly. The load carrying leads at terminals 1, 3, and 5 should be selected to limit the voltage drop to 250 mV or less per lead.

## 3.6 REMOTE PROGRAMMING

The unit may be programmed to supply pre-determined output voltages by inserting a calculated resistance into the voltage sensing circuit. Programming sensitivity is approximately 500 ohms per volt; that is, 500 ohms are required for each volt difference between the desired output and the minimum value of the units specified range. The program resistor should be a 1/8 watt (or larger) precision film resistor with a 25 PPM/°C coefficient (equal to MIL style RN55E). The programming current is approximately 2 mA.

To adapt the unit for remote programming, proceed as follows:

1. With normal local sensing (see para. 3.4), apply power and set output control for specified rated minimum output voltage (see Tables 1-2, 1-3 or 1-4 for specific model). For example, for a 12 volt module, set the output to 11.0 volts.

2. At this point, any value within rated output range can be obtained by inserting 500 ohms per volt difference between the desired voltage and the minimum voltage. For example, to obtain 12.0 volt output in the above example, the difference is 12.0 (-) 11.0 or 1.0 volt. The programming resistor should be 1.0 X 500 or 500 ohms.

3. Remove input power. Connect programming resistor (Rp) per figure 3-2. Note that either local or remote sense can be used.

4. Apply input power and verify load voltage across terminals 2 and 4, 4 and 6, as the desired value (using local sense).

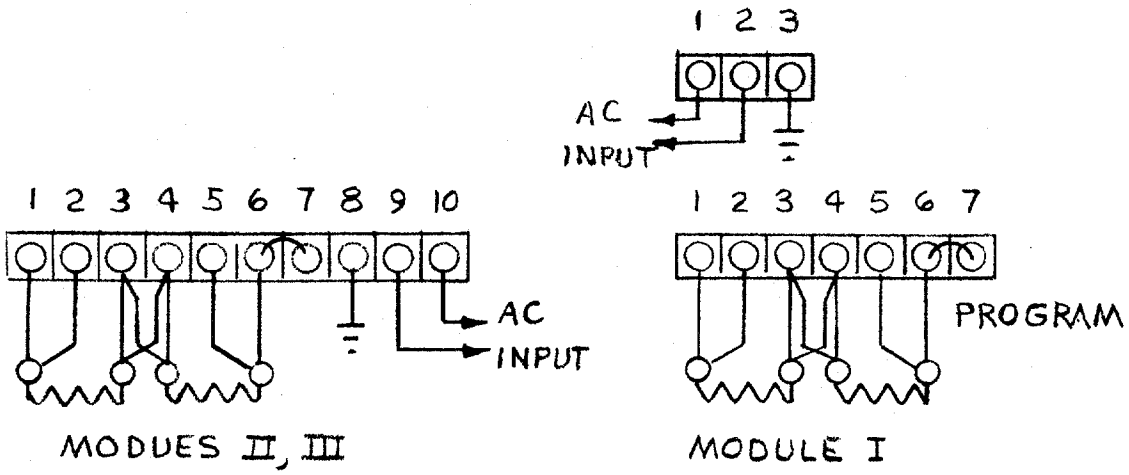



Figure 3-1 Remote Sensing Configuration

### 3.6.1 Fixed Output Voltage Setting

For the optimum long term stability of the output voltage, the remote program feature can be used to reduce the long term drift of the output by disabling the output control. Proceed as follows:

1. Remove the top cover per para. 2.2.4. Remove three screws holding the PCB to the front panel per para. 2.2.5.

2. Short out the potentiometer (R35 or R34) by soldering a wire between the two end pins of the potentiometer.

3. Reassemble the PCB and cover.

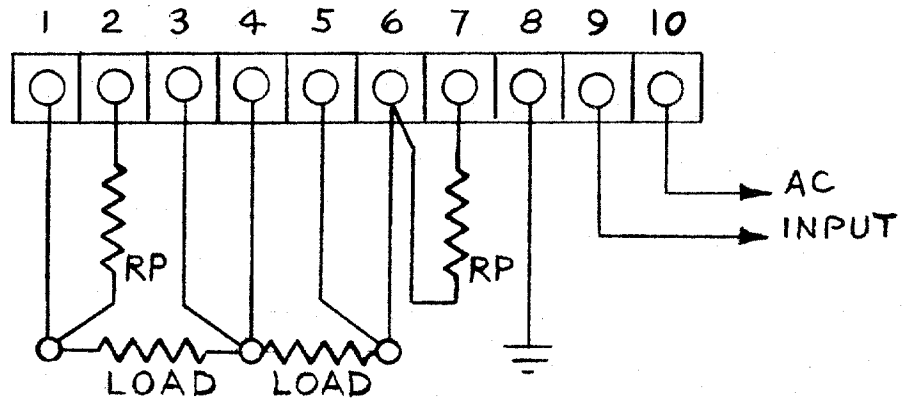
4. Connect a precision variable potentiometer or decade box for the programming resistor per Figure 3-2.

5. Set variable resistor to zero and apply input power.

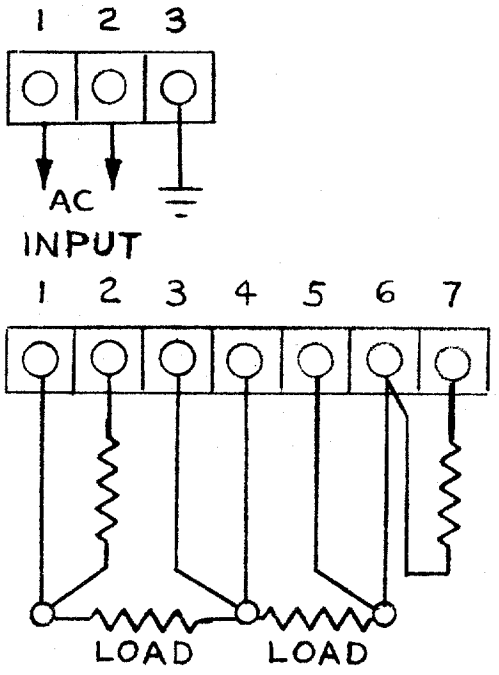
6. Vary resistor value until desired output voltage is obtained.

7. Remove power, measure variable resistor, and replace it with a fixed precision resistor (see 3.6 preceeding for type).

8. Set power to ON and verify that the output voltage is the proper value.




MODULES II, III




MODULE I

Figure 3-2 Resistance Programming Setup

# SECTION 4

# THEORY OF OPERATION

## 4.1 GENERAL

This section provides basic PTM unit operating principles, which, when used with the troubleshooting data in section 5, should contribute to the rapid isolation of unit faults. Where differences in circuitry among units are significant, separate discussions are provided.

## 4.2 PASSING-STAGE PRINCIPLE

The PTM modules utilize the series passing-stage principle in regulating unit output. With this approach, a variable impedance absorbs the difference between the desired regulated output and the filtered "brute-force" dc. The variable impedance is provided by a transistor stage which is fed by an output-related control signal.

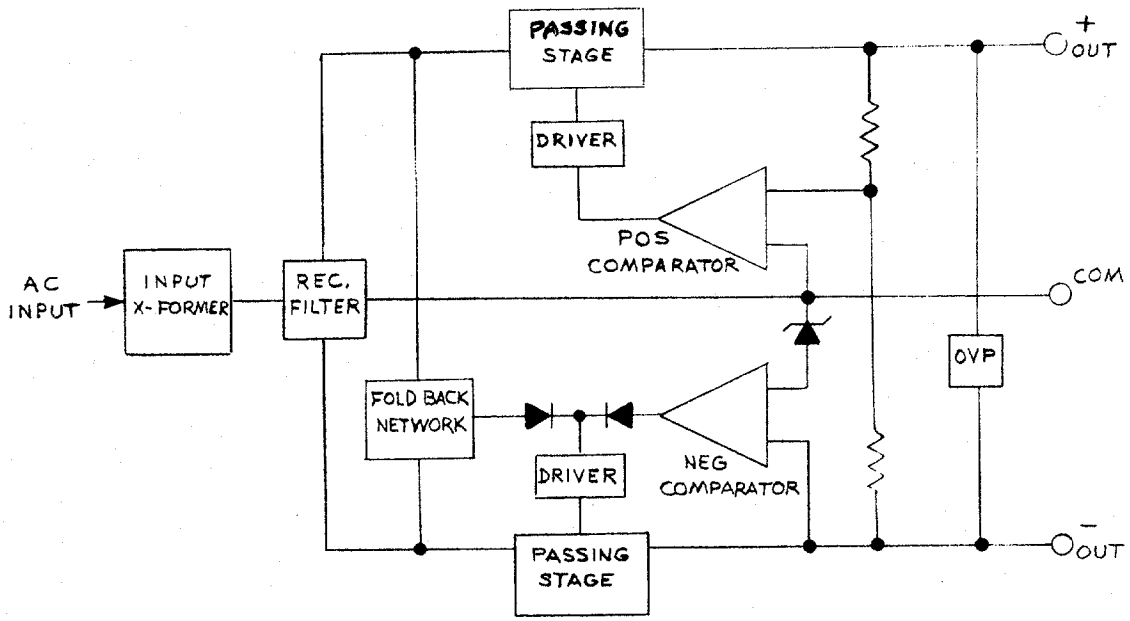



Figure 4-1 PTM Dual Simplified Diagram

## 4.3 FUNCTIONAL THEORY

Referring to Figure 4-1: The transformer center tap steps down the ac input and applies it to a rectifier circuit and filter. The dc output is fed through a passing stage to the load. The passing stage absorbs the difference between the rectifier output and the desired output voltage. The feedback loop to the passing stage includes an output voltage sensing network and a reference voltage. These two signals are compared in a differential amplifier. The amplified error signal is used to vary the drive current to the pass stage. This discussion applies to both positive and negative outputs.

Overcurrent protection is provided by the foldback section. In the event of a short circuit or overload, this circuit reduces the drive on the pass stage. Overvoltage protection is provided by a sensing network which triggers on electronic crowbar circuit in the event of excessive output voltage. (Refer to Figure 5-2.)

### 4.3.1 Sensing and Error Amplification

The positive and negative integrated circuits, U2 and U3 act to maintain a zero error signal across the IC input terminals. The amplified error signal is used to drive the passing stages; via comparators and drivers. The IC output is phased such that an increase in output voltage acts to decrease the drive. This action restores the output voltage to its regulated value (as set by the reference voltage and sense resistors).

### 4.3.2 Drivers and Passing Stage

Q1 and Q2 serve as drivers for the positive and negative output pass stages respectively. Resistors R37, R38, R40 and R41 in Module III units insure equal current sharing by all transistors.

### 4.3.3 Current-Foldback Section

Signals from two current monitoring resistors are fed to operational amplifier (U1) input through dividers R1 through R5. These two current signals are added by the divider resistors. The U1 input voltage is then proportional to the sum of the two current-monitoring resistor voltage drops. The output of the current limit operational amplifier is connected to an OR gate consisting of CR1, CR3 and R14. Once the current limit is exceeded, U1 takes control of Q2 thus taking control of the negative supply. The positive supply is slaved to the negative half and is controlled indirectly by U1.

### 4.3.4 Overvoltage Protection

The dc outputs are protected from an overvoltage condition by an internally adjustable protection circuit. The outputs are sensed separately, and in the event of an overvoltage condition in either output, an internal SCR shorts the positive output to the negative output within 50 microseconds. This feature together with built-in reverse-polarity diodes on each output effectively keeps the outputs

within 2.5 volts of the common after an OVP trip. The circuit is designed to tolerate the OVP tripped condition indefinitely. Table 4-1 represents the span of possible trip voltages for all units.

### 4.3.5 Loop Stability

Inherent in any high-gain feedback amplifier is the tendency for the loop to become unstable under certain operating conditions. To preclude this in the PTM amplifier loop, RC networks consisting of C2, C3, C1, R10, R13, C4, C5 and R20 have been incorporated.

Table 4-1 Possible Trip Voltages

| MODEL | | LIMITS (A) | CURRENT LIMITS (A) |
|---|---|---|---|
| MOD I | 12-1D | 0.4 | 1.25 |
| | 15.8D | 0.4 | 1.0 |
| MOD II | 12-1.6D | 0.5 | 2.0 |
| | 15-1.5D | 0.5 | 1.9 |
| MOD III | 12-3D | 1.0 | 3.75 |
| | 15-2.8D | 1.0 | 3.5 |

# SECTION 5

# MAINTENANCE

## 5.1 GENERAL

This section provides troubleshooting data, periodic servicing, and calibration and performance-testing procedures. The troubleshooting data should be used in conjunction with both the schematic diagrams, (Figures 6-1 through 6-6) and section 4, which outlines the principles of operation. Also, Figures 6-7 and 6-8 physically locate the parts contained in a typical supply. Any questions pertaining to repair should be directed to the nearest Sorensen Service Representative or to the Service Dept., Sorensen Company. Should it be necessary to return a unit to the factory for repair, authorization from the Sorensen Service Dept. must first be obtained.

## 5.2 PERIODIC SERVICING

PTM Dual models should periodically be removed from service and cleaned of any accumulations of dust or other debris which could impede natural airflow through the unit.

## 5.3 CALIBRATION

Calibration entails the checking and, if necessary, the adjustment of the foldback and OVP circuits. For foldback adjustments, use the procedure described in section 3, paragraph 3.3.2. The overvoltage set adjustment procedure is outlined in section 3, paragraph 3.3.3. The factory-set limits for these adjustments are listed in Table 1-1.

## 5.4 TROUBLESHOOTING

Table 5-1 lists a number of malfunction symptoms and probable causes. The table covers symptoms which are attributable to a single component failure only. This should not be interpreted to mean that there could not be other causes for the tabulated symptoms. Footnotes in the table indicate which components may be damaged due to a "chain-reaction" effect. If any amplifier components are replaced, unit may require recalibration. (Refer to paragraph 5.3.)

Table 5-1 Troubleshooting Data

| SYMPTOM | PROBABLE CAUSE |
|---|---|
| No Output (Positive Side): | a. Fuse F1 open.<br>b. Transistor Q1, Q2, Q6, Q7, Q8* or Q9* open.<br>c. U3, U2, or U1 defective. |
| No Output (Negative Side): | a. Fuse F1 open.<br>b. Transistor Q2, Q6, or Q9* open.<br>c. U3 or U1 defective. |
| High Output (Positive Side): | a. Transistors Q1, Q7, Q8*, or Q9* shorted.<br>b. U2 defective.<br>c. Potentiometer R35 defective.<br>d. Sense links (1-2 or 3-4) open. |
| High Output (Negative Side): | a. Transistors Q2, Q6, or Q9* shorted.<br>b. U3 defective.<br>c. Potentiometer R34 open.<br>d. Sense links (3-4 or 5-6-7) open. |
| Low Output (Positive Side): | a. Overload (external) causing foldback limiting.<br>b. OVP tripped.<br>c. Defective U1, U2, or U3.<br>d. Potentiometers R4 or R18 need to be readjusted. |
| Foldback Circuit Inoperative: | a. CR1 open.<br>b. Defective U1.<br>c. Q1, Q2, Q6, Q7, Q8*, or Q9* shorted. |

* Q8/Q9 used only in Module III.

Table 5-1 TROUBLESHOOTING DATA (Cont'd)

| SYMPTOM | PROBABLE CAUSE |
|---|---|
| Overvoltage Circuit Inoperative: | a. Q3, Q4, or Q5 shorted.<br>b. VR4 shorted. |
| F1 (ac) Fuse Blows: | a. Foldback inoperative.<br>b. Diode(s) shorted**.<br>c. C13 or C14 shorted. |
| Ripple Specifications Degenerate Positive or Negative: | a. Open diode(s)**.<br>b. IC regulator U2 or U3 defective.<br>c. Foldback set too low. |
| Regulation Specifications Degenerate: | a. IC regulator U2 or U3 defective.<br>b. Foldback set too low. |

*Q8/Q9 used only in Module III

| **Diode | Used on Modules |
|---|---|
| CR8 | II, III |
| CR9 | I |
| CR10 | I |
| CR11 | I |
| CR12 | I |

## 5.5 PERFORMANCE TESTING

### 5.5.1 Output Ripple

To measure output ripple, proceed as follows:

1. Connect a test set-up per Figure 5-4. Set oscilloscope for 1 mV/cm vertical sensitivity and 10ms/cm horizontal. The oscilloscope should have at least a 10 MHz bandwidth. Select a 0-150 Vac meter. Choose a 1 mV range for the rms voltmeter. Select a range for the dc ammeter compatible with the unit output rated current. Use a resistive load capable of fully loading the unit to rated maximum current.

2. At no load, apply an input of 115 Vac, @ 60 Hz. Adjust for nominal voltage (per Table 1-1).

3. Apply load and observe oscilloscope and rms meter. Voltmeter should not exceed 1 mV and oscilloscope display should not exceed 5 mV peak-to-peak.

### 5.5.2 Regulation

To measure the output voltage dc regulation, proceed as follows:

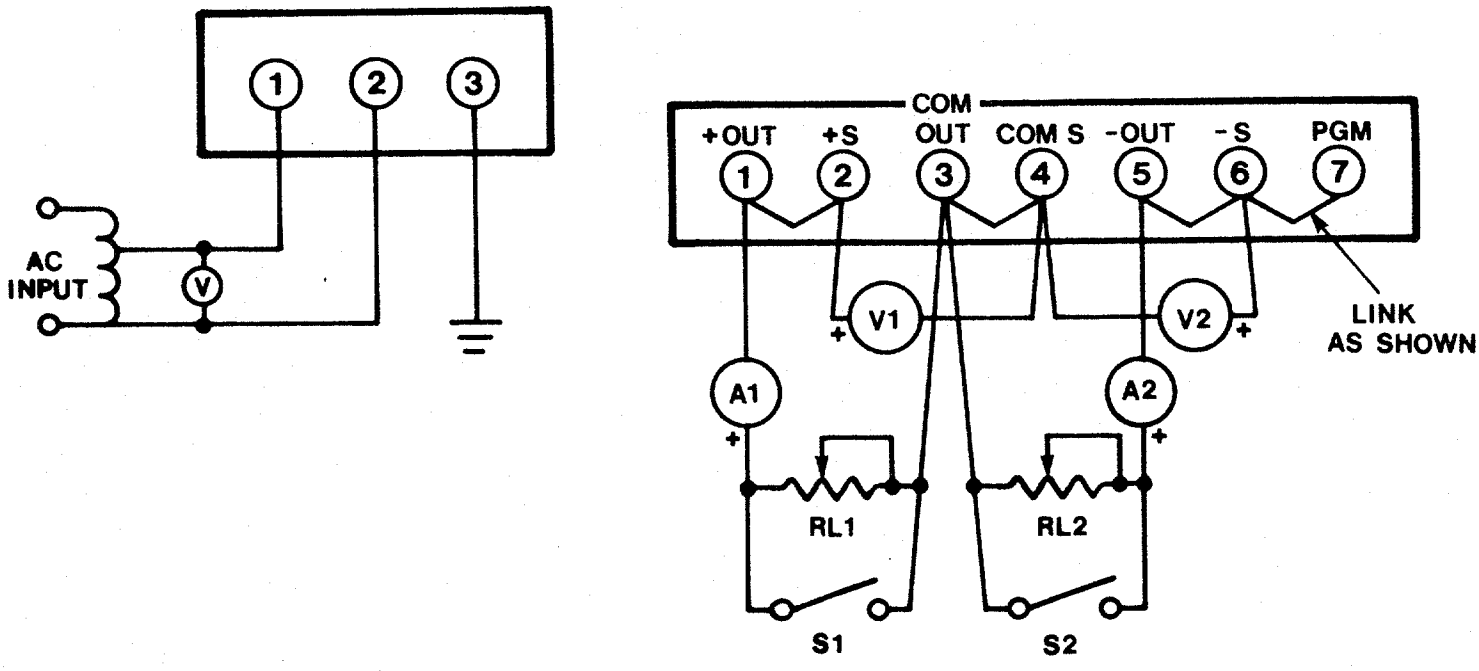
1. Connect unit to test set-up per Figure 5-1.

2. Check the ripple per preceding paragraph 5.5.1.

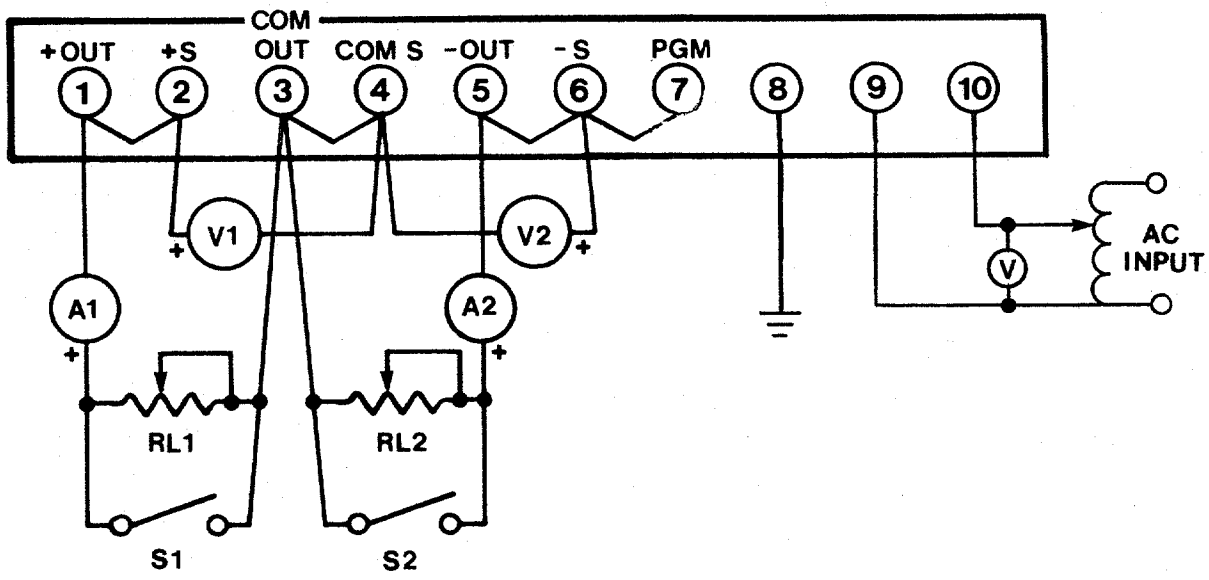
3. Use a sensitive differential dc voltmeter or dvm capable of indicating the output voltage to within 1 mV. (For example, read 12.004 volts on a 12 V unit.)

4. Apply 125 Vac, 60-Hz input at no load. Observe dc-voltmeter indication.

5. Increase load to full rated load with 105 Vac input. The dc-voltmeter indication should not change more than the value listed in Table 1-1 under "Unit Specifications".




**MODULE I**




**MODULES II AND III**

Figure 5-1 Test Equipment Setup

# SECTION 6

# DRAWINGS AND PARTS LISTS

## 6.1 INTRODUCTION

This section provides parts lists, schematic diagrams, a typical component layout for the control PCB, and a typical component layout for the complete power supply.

## 6.2 APPLICATION

The parts lists include the replaceable parts for the following models:

| Model | Final Assemblies |
|---|---|
| MODULE I | |
| 12-1D | 587596-1 |
| 15-.8D | 587596-2 |
| MODULE II | |
| 12-1.6D | 586874-1 |
| 15-1.5D | 586874-2 |
| MODULE III | |
| 12-3D | 586991-1 |
| 15-2.8D | 586991-2 |

## 6.3 TABLE HEADINGS DEFINED

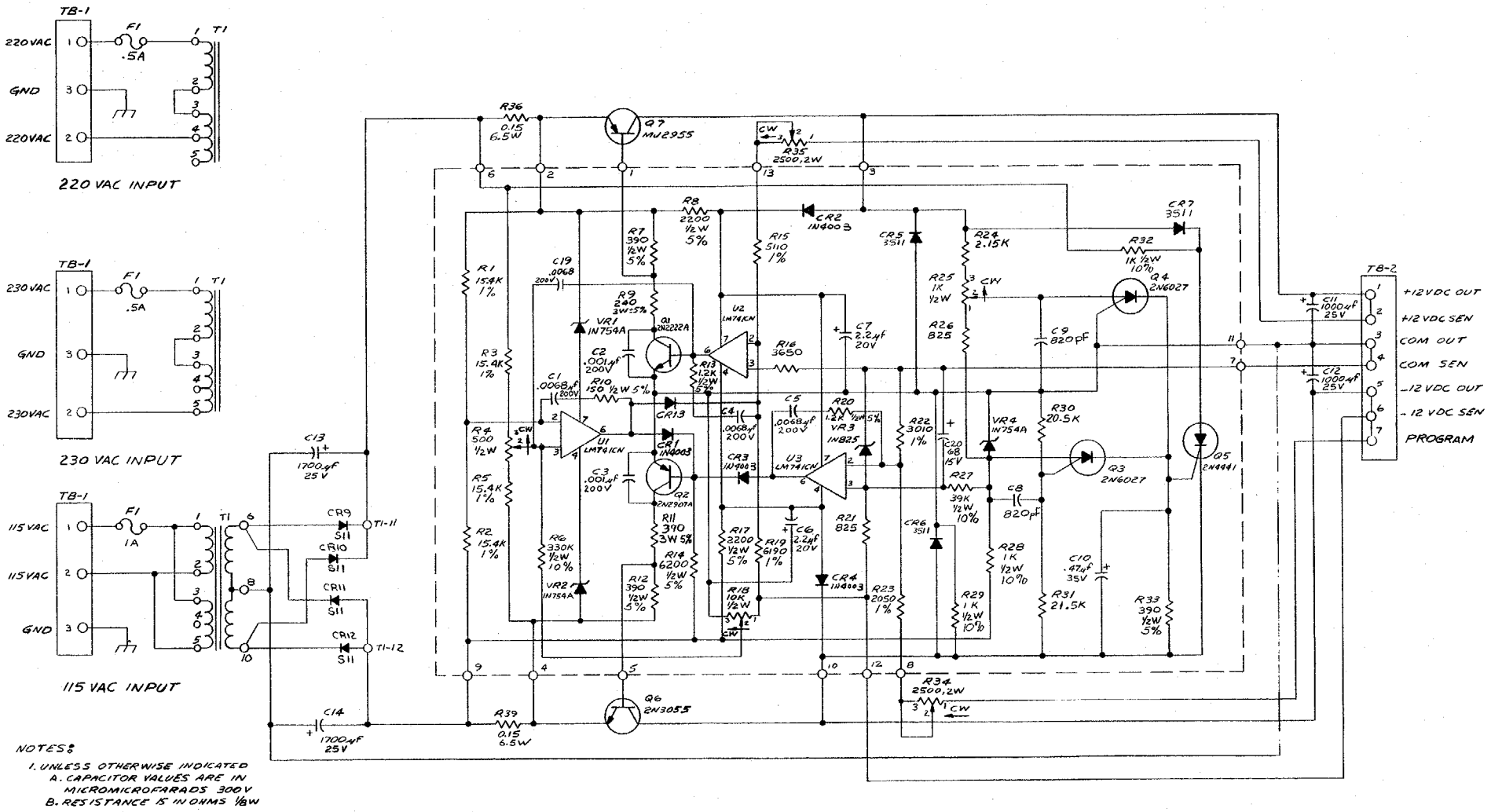
### 6.3.1 Circuit Symbol

This number will identify the part as called out on the schematic diagram.

### 6.3.2 Sorensen Part No.

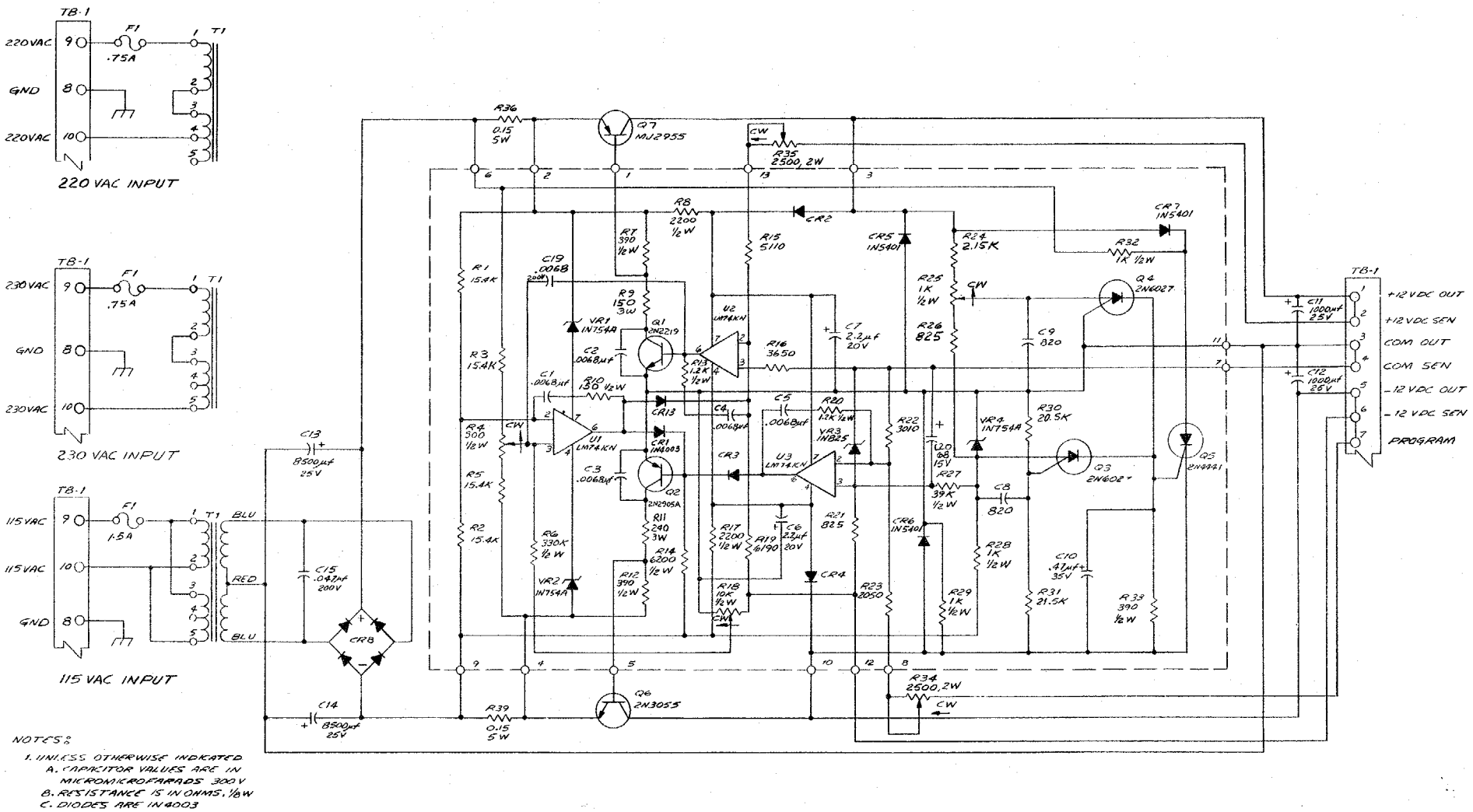
This number should be used when ordering parts directly from:

SORENSEN
9250 Brown Deer Road
San Diego, CA 92121-2294
1-800-525-2024
Tel: (858) 450-0085
Fax: (858) 458-0267
Email: sales@sorensen.com
www.sorensen.com




D587593 Rev L

**Figure 6-1 Schematic Diagram PTM 12-1D**

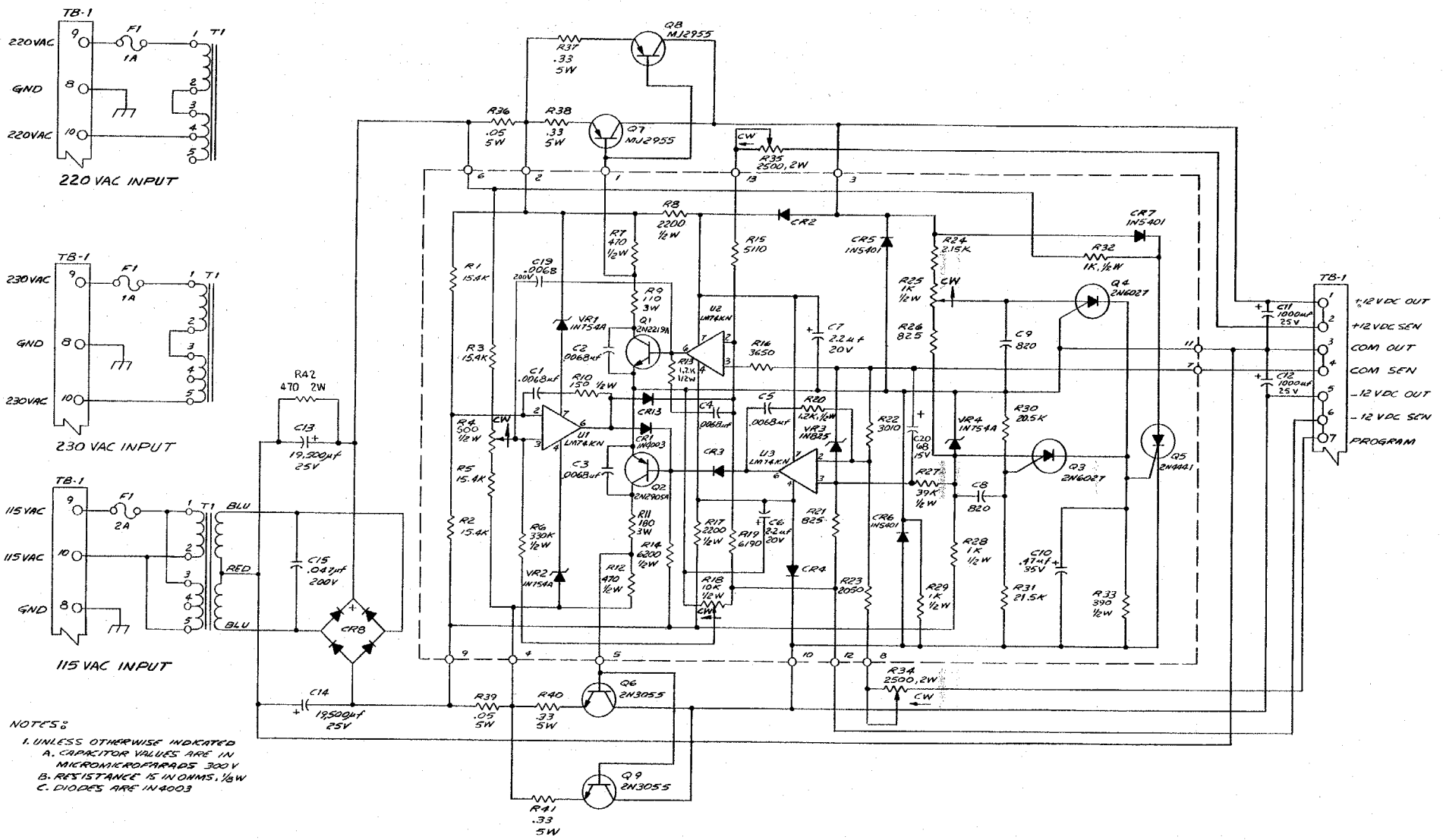



NOTES:

1. UNLESS OTHERWISE INDICATED
   A. CAPACITOR VALUES ARE IN MICROMICROFARADS 300V
   B. RESISTANCE IS IN OHMS, ½W
   C. DIODES ARE IN4003

D586823 Rev N

**Figure 6-2 Schematic Diagram PTM 12-1.6D**

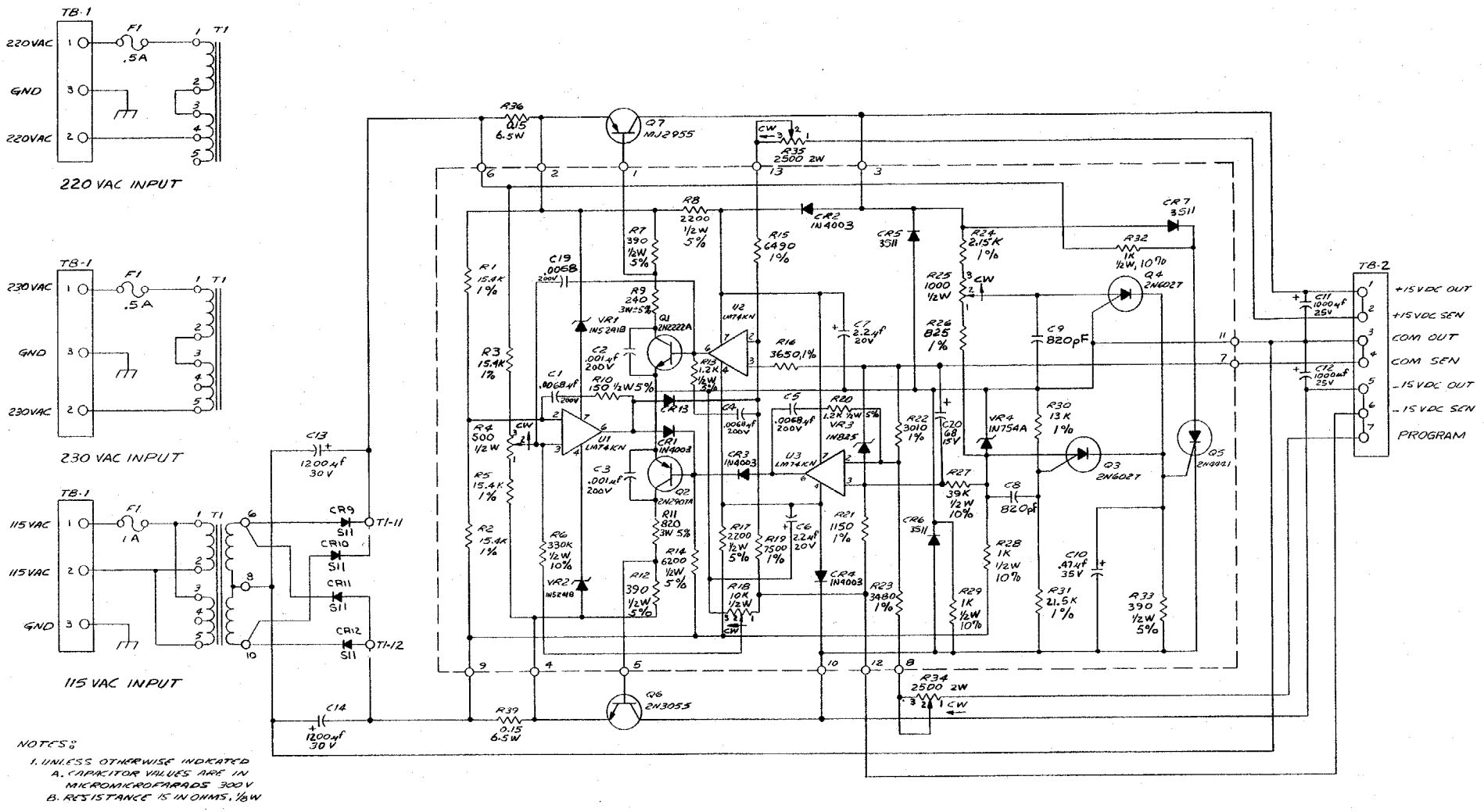


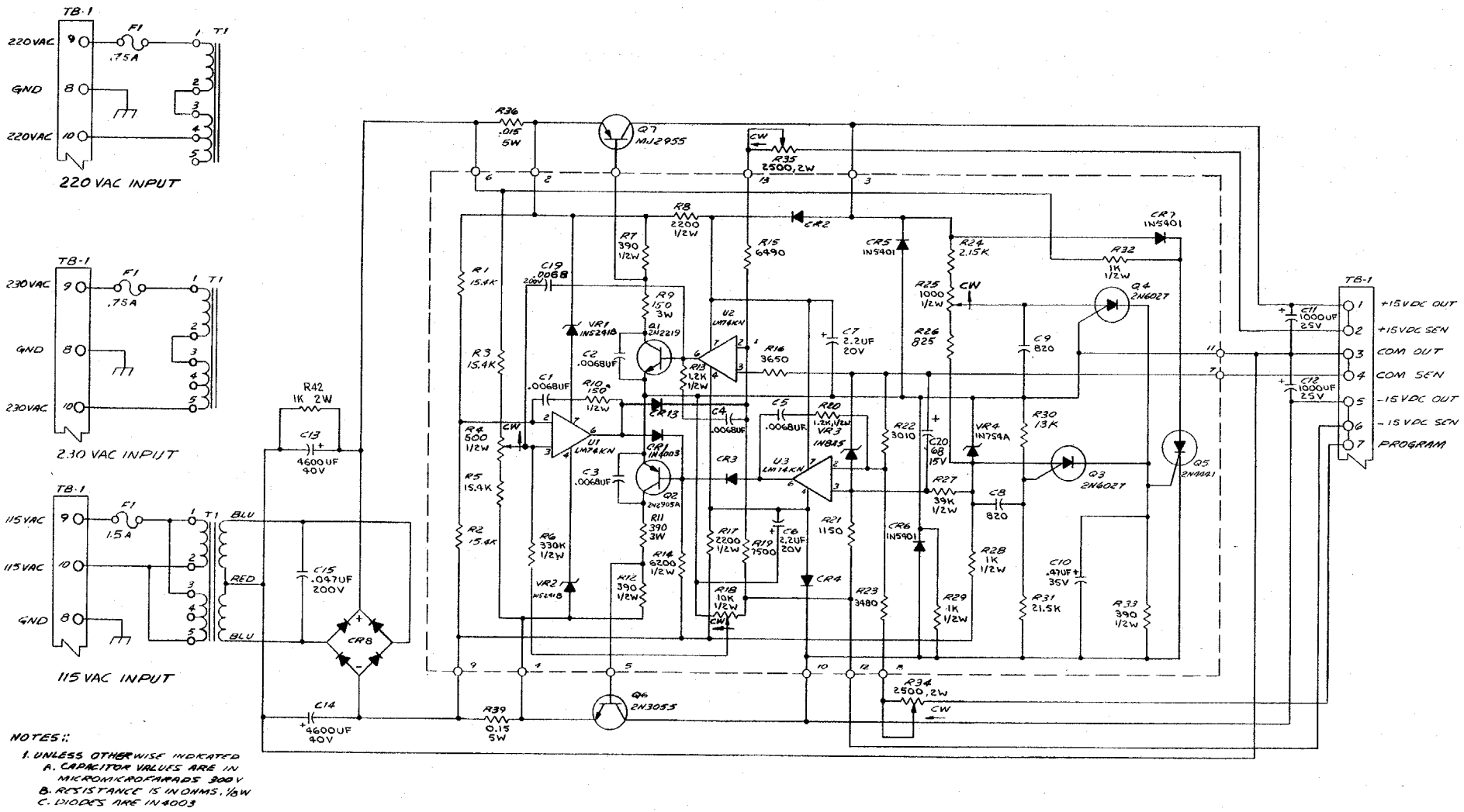

NOTES:

1. UNLESS OTHERWISE INDICATED
   A. CAPACITOR VALUES ARE IN MICROMICROFARADS 300V
   B. RESISTANCE IS IN OHMS, ⅛W
   C. DIODES ARE IN4003

D587000 Rev P

**Figure 6-3 Schematic Diagram PTM 12-3D**


TB-1
220VAC
GND
220VAC
F1
.5A
T1
220 VAC INPUT
230VAC
230 VAC INPUT
115VAC
115VAC
GND
1A
115 VAC INPUT
NOTES:
1. UNLESS OTHERWISE INDICATED
A. CAPACITOR VALUES ARE IN MICROMICROFARADS 300V
B. RESISTANCE IS IN OHMS, 1/8W
Q7 MJ2955
Q6 2N3055
Q1 2N2222A
Q2 2N2907A
Q4 2N6027
Q3 2N6027
Q5 2N4921
U1 LM746KN
U2 LM746KN
U3 LM746KN
VR1 IN5241B
VR2 IN5241B
VR3 IN825
VR4 IN754A
CR1 IN4003
CR2 IN4003
CR3 IN4003
CR4 IN4003
CR5 3S11
CR6 3S11
CR7 3S11
CR9 3S11
CR10 3S11
CR11 3S11
CR12 3S11
CR13
R1 15.4K 1%
R2 15.4K 1%
R3 15.4K 1%
R4 500 1/2W
R5 15.4K 1%
R6 330K 1/2W 10%
R7 390 1/2W 5%
R8 2200 1/2W 5%
R9 240 3W 5%
R10 150 1/2W 5%
R11 820 3W 5%
R12 390 1/2W 5%
R13 1.2K 1/2W 5%
R14 6200 1/2W 5%
R15 6490 1%
R16 3650 1%
R17 2200 1/2W 5%
R18 10K 1/2W
R19 7500 1%
R20 1.2K 1/2W 5%
R21 1150 1%
R22 3010 1%
R23 3480 1%
R24 2.15K 1%
R25 1000 1/2W
R26 825 1%
R27 39K 1/2W 10%
R28 1K 1/2W 10%
R29 1K 1/2W 10%
R30 13K 1%
R31 21.5K 1%
R32 1K 1/2W, 10%
R33 390 1/2W 5%
R34 2500 2W
R35 2500 2W
R36 0.15 6.5W
R39 0.15 6.5W
C1 .0068µf 200V
C2 .001µf 200V
C3 .001µf 200V
C4 .0068µf 200V
C5 .0068µf 200V
C6 2.2µf 20V
C7 2.2µf 20V
C8 820pF
C9 820pF
C10 .47µf 35V
C11 1000µf 25V
C12 1000µf 35V
C13 1200µf 30V
C14 1200µf 30V
C19 .0068 200V
TB-2
+15VDC OUT
+15VDC SEN
COM OUT
COM SEN
-15VDC OUT
-15VDC SEN
PROGRAM
T1-11
T1-12

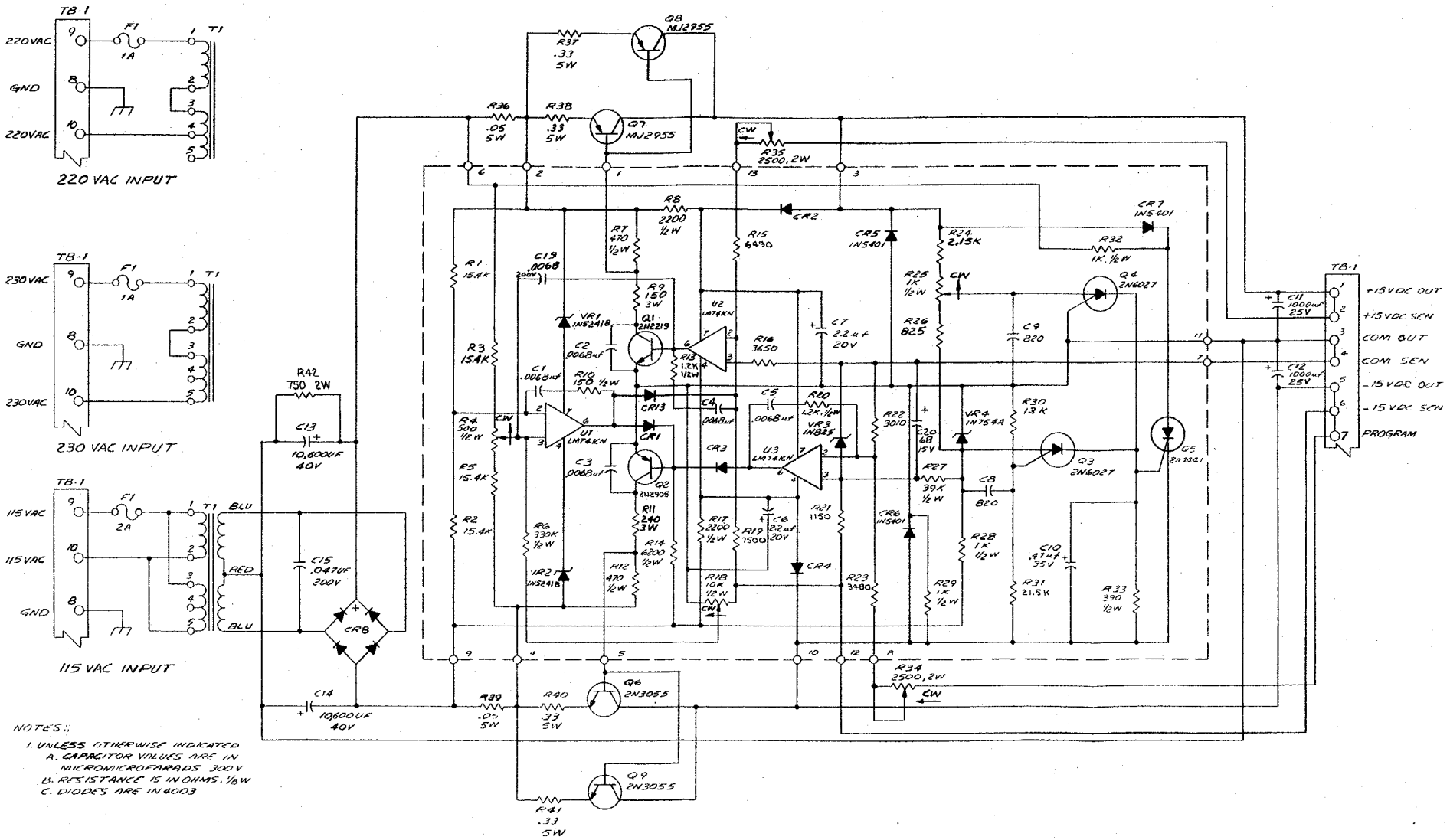



NOTES:

1. UNLESS OTHERWISE INDICATED
   A. CAPACITOR VALUES ARE IN MICROMICROFARADS 300V
   B. RESISTANCE IS IN OHMS, 1/8W
   C. DIODES ARE IN4003

D586824 Rev N

Figure 6-5 Schematic Diagram
PTM 15-1.5D




NOTES:

1. UNLESS OTHERWISE INDICATED
   A. CAPACITOR VALUES ARE IN MICROMICROFARADS 300V
   B. RESISTANCE IS IN OHMS, ⅛W
   C. DIODES ARE IN4003

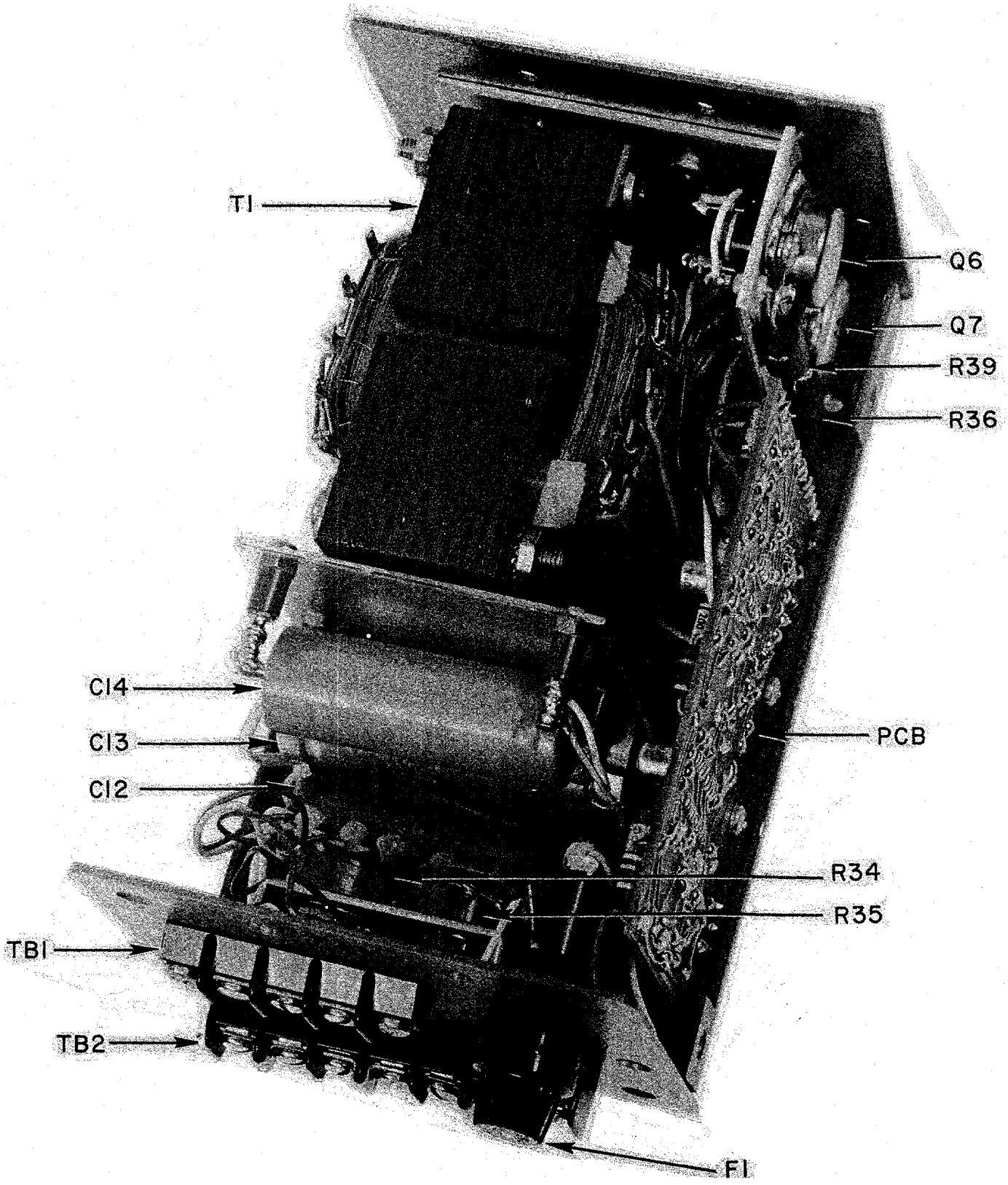
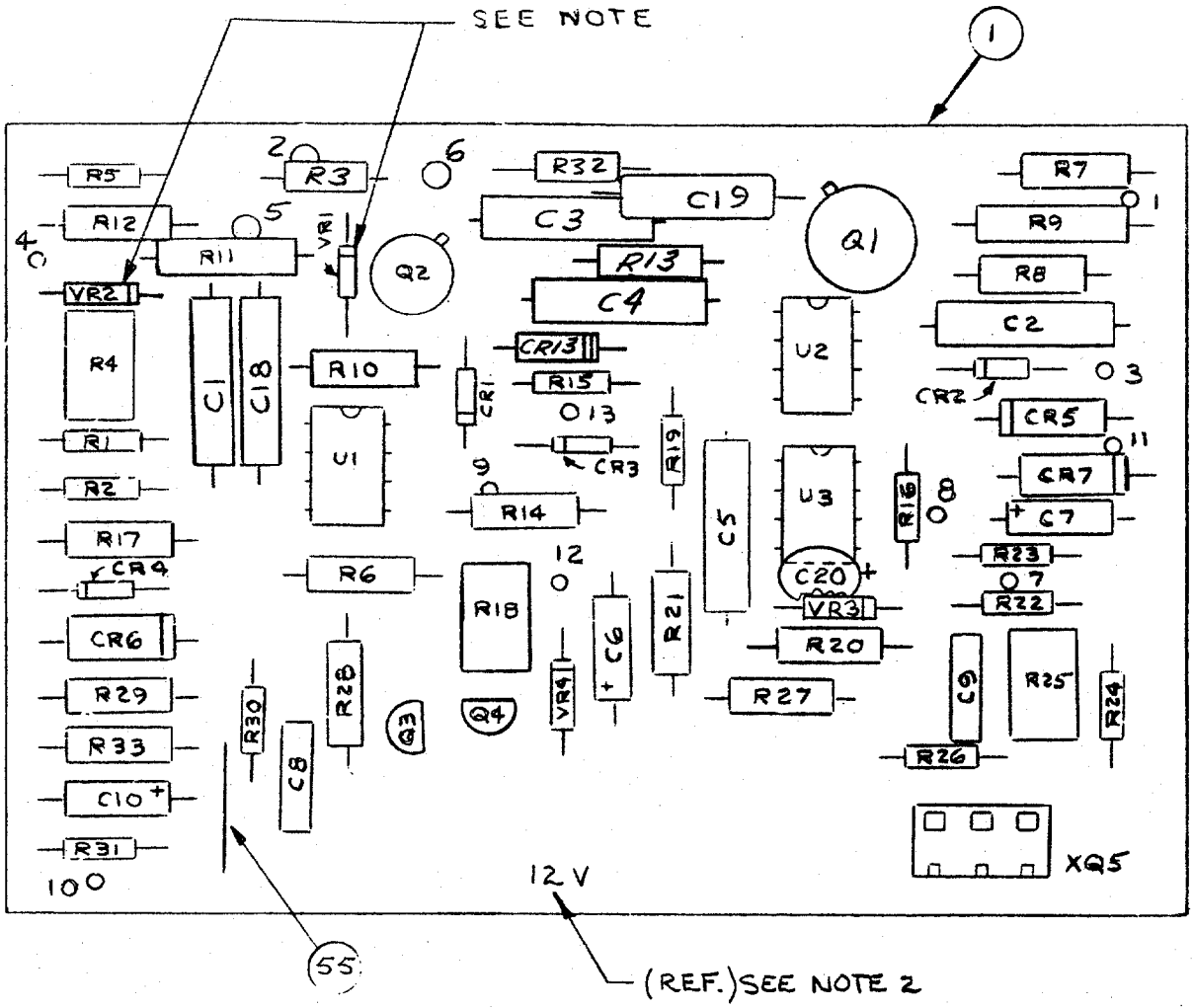



Figure 6-7 Typical Chassis Component Layout




Note: VR1 and VR2 not used on -3 only.
Install Find No. 55 in their place.

B587373 Rev N

Figure 6-8 Typical PCB Assembly (Module II Shown)

# Table 6-1
# Replaceable Parts List

| CIRCUIT SYMBOL | PTM DUAL MODEL | | | | | | | DESCRIPTION | SORENSEN PART NUMBER |
|---|---|---|---|---|---|---|---|---|---|
| | 12-1D | 15-.8D | 12-1.6D | 15-1.5D | 12-3D | 15-2.8D | | | |
| C1 | X | X | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C2 | X | X | | | | | | Cap, .001 uF, 200V | 24-2409-1 |
| | | | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C3 | X | X | | | | | | Cap, .001 uF, 200V | 24-2409-1 |
| | | | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C4 | X | X | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C5 | X | X | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C6 | X | X | X | X | X | X | | Cap, 2.2 uF, 20V | 586385-2 |
| C7 | X | X | X | X | X | X | | Cap, 2.2 uF, 20V | 586385-2 |
| C8 | X | X | X | X | X | X | | Cap, 820 pF, 300V | 235-7053P334 |
| C9 | X | X | X | X | X | X | | Cap, 820 pF, 300V | 235-7053P334 |
| C10 | X | X | X | X | X | X | | Cap, .47 uF, 35V | 586058-3 |
| C11 | X | X | X | X | X | X | | Cap, 1000 uF, 25V | 235-7353P84 |
| C12 | X | X | X | X | X | X | | Cap, 1000 uF, 25V | 235-7353P84 |
| C13 | X | | | | | | | Cap, 1700 uF, 25V | 235-7353P88 |
| | | X | | | | | | Cap, 1200 uF, 30V | 24-2449-2 |
| | | | X | | | | | Cap, 8500 uF, 25V | 586043-1 |
| | | | | X | | | | Cap, 4600 uF, 40V | 586044-1 |
| | | | | | X | | | Cap, 19,500 uF, 25V | 586043-2 |
| | | | | | | X | | Cap, 10,600 uF, 40V | 586044-2 |
| C14 | X | | | | | | | Cap, 1700 uF, 25V | 235-7353P88 |
| | | X | | | | | | Cap, 1200 uF, 30V | 24-2449-2 |
| | | | X | | | | | Cap, 8500 uF, 25V | 586043-1 |
| | | | | X | | | | Cap, 4600 uF, 40V | 586044-1 |
| | | | | | X | | | Cap, 19,500 uF, 25V | 586043-2 |
| | | | | | | X | | Cap, 10,600 uF, 40V | 586044-2 |
| C19 | X | X | X | X | X | X | | Cap, .0068 uF, 200V | 24-2409-6 |
| C20 | X | X | X | X | X | X | | Cap, 68 uF, 15V | 235-7395P43 |
| CR1 | X | X | X | X | X | X | | Diode, 1N5614 | 587565-2 |
| CR2 | X | X | X | X | X | X | | Diode, 1N5614 | 587565-2 |
| CR3 | X | X | X | X | X | X | | Diode, 1N5614 | 587565-2 |
| CR4 | X | X | X | X | X | X | | Diode, 1N5614 | 587565-2 |
| CR5 | X | X | X | X | X | X | | Diode, 1N5401 | 587566-1 |
| CR6 | X | X | X | X | X | X | | Diode, 1N5401 | 587566-1 |
| CR7 | X | X | X | X | X | X | | Diode, 1N5401 | 587566-1 |
| CR8 | | | X | X | X | X | | 200V, 30A Bridge | 847-990-3X |
| CR9 | X | X | | | | | | Diode, 1N5614 | 587565-1 |
| CR10 | X | X | | | | | | Diode, 1N5614 | 587565-1 |
| CR11 | X | X | | | | | | Diode, 1N5614 | 587565-1 |
| CR12 | X | X | | | | | | Diode, 1N5614 | 587565-1 |
| CR13 | X | X | X | X | X | X | | Diode, 1N5614 | 587565-2 |
| F1 | X | X | | | | | | Fuse, 1A, 250V | 226-7176P39 |
| | | | X | X | | | | Fuse, 1.5A, 250V | 226-7176P41 |
| | | | | | X | X | | Fuse, 2A, 250V | 226-7176P43 |
| XF1 | X | X | X | X | X | X | | Fuseholder | 42-459 |
| Q1 | X | X | | | | | | Xstr, 2N2222A | 386-7249P57 |

Table 6-1 (Cont'd)
Replaceable Parts List

| CIRCUIT SYMBOL | PTM DUAL MODEL 12-1D | 15-.8D | 12-1.6D | 15-1.5D | 12-3D | 15-2.8D | DESCRIPTION | SORENSEN PART NO. |
|---|---|---|---|---|---|---|---|---|
| Q1 | | X | X | X | X | | Xstr, 2N2219A | 386-7249P32 |
| Q2 | X | X | | | | | Xstr, 2N2907A | 386-7249P58 |
| | | X | X | X | X | | Xstr, 2N2905 | 386-7249P28 |
| Q3 | X | X | X | X | X | X | Xstr, 2N6027 | 386-7304P1 |
| Q4 | X | X | X | X | X | X | Xstr, 2N6027 | 386-7304P1 |
| Q5 | X | X | | | | | Xstr, 2N4441, Mod | 587760-1 |
| | | X | X | X | X | | Xstr, 2N4441 | 586820-1 |
| Q6 | X | X | X | X | X | X | Xstr, 2N3055 | 18-151 |
| Q7 | X | X | X | X | X | X | Xstr, 2N6246 | 586862-3 |
| Q8 | | | | X | X | | Xstr, 2N6246 | 586862-3 |
| Q9 | | | | X | X | | Xstr, 2N3055 | 18-151 |
| XQ6 | X | X | X | X | X | X | Socket, Xstr. | 586065-1 |
| XQ7 | X | X | X | X | X | X | Socket, Xstr. | 586065-1 |
| R1 | X | X | X | X | X | X | Res, 15.4K, 1/8W, 1% | 586250-131 |
| R2 | X | X | X | X | X | X | Res, 15.4K, 1/8W, 1% | 586250-131 |
| R3 | X | X | X | X | X | X | Res, 15.4K, 1/8W, 1% | 586250-131 |
| R4 | X | X | X | X | X | X | Res, 500, 1/2W, Variable | 167877-3 |
| R5 | X | X | X | X | X | X | Res, 15.4K, 1/8W, 1% | 586250-131 |
| R6 | X | X | X | X | X | X | Res, 330K, 1/2W | 280-1145P164 |
| R7 | X | X | X | X | | | Res, 390, 1/2W, 5% | 280-1145P58 |
| | | | | | X | X | Res, 470, 1/2W, 5% | 280-1145P61 |
| R8 | X | X | X | X | X | X | Res, 2.2K, 1/2W | 280-1145P86 |
| R9 | X | X | | | | | Res, 240, 3W, 5% | 27-397-82 |
| | | | X | X | | X | Res, 150, 3W, 5% | 27-397-77 |
| | | | | | X | | Res, 110, 3W, 5% | 27-397-74 |
| R10 | X | X | X | X | X | X | Res, 150, 1/2W | 280-1145P44 |
| R11 | | X | | | | | Res, 820, 3W, 5% | 27-397-95 |
| | | | X | | | X | Res, 240, 3W, 5% | 27-397-82 |
| | X | | | X | | | Res, 390, 3W, 5% | 27-397-87 |
| | | | | | X | | Res, 180, 3W, 5% | 27-397-79 |
| R12 | X | X | X | X | | | Res, 390, 1/2W, 5% | 280-1145P58 |
| | | | | | X | X | Res, 470, 1/2W, 5% | 280-1145P61 |
| R13 | X | X | X | X | X | X | Res, 1.2K, 1/2W, 5% | 280-1145P76 |
| R14 | X | X | X | X | X | X | Res, 6.2K, 1/2W, 5% | 280-1145P102 |
| R15 | X | | X | | X | | Res, 5.11K, 1/8W, 1% | 586055-108 |
| | | X | | X | | X | Res, 6.49K, 1/8W, 1% | 586055-113 |
| R16 | X | X | X | X | X | X | Res, 3.65K, 1/8W, 1% | 586055-101 |
| R17 | X | X | X | X | X | X | Res, 2.2K, 1/2W | 280-1145P86 |
| R18 | X | X | X | X | X | X | Res, 10K, 1/2W, Variable | 586370-7 |
| R19 | X | | X | | X | | Res, 6.19K, 1/8W, 1% | 586055-112 |
| | | X | | X | | X | Res, 7.5K, 1/8W, 1% | 586055-116 |
| R20 | X | X | X | X | X | X | Res, 1.2K, 1/2W, 5% | 280-1145P76 |
| R21 | X | | X | | X | | Res, 825, 1/8W, 1% | 586250-70 |
| | | X | | X | | X | Res, 1.15K, 1/8W, 1% | 586250-77 |
| R22 | X | X | X | X | X | X | Res, 3.01K, 1/8W, 1% | 586055-97 |

Table 6-1 (Cont'd)
Replaceable Parts List

| CIRCUIT SYMBOL | PTM DUAL MODEL 12-1D | 15-.8D | 12-1.6D | 15-1.5D | 12-3D | 15-2.8D | DESCRIPTION | SORENSEN PART NO. |
|---|---|---|---|---|---|---|---|---|
| R23 | X | | X | | X | | Res, 2.05K, 1/8W, 1% | 586055-89 |
| | | X | | X | | X | Res, 3.48K, 1/8W, 1% | 586250-100 |
| R24 | X | X | X | X | X | X | Res, 2.15K, 1/8W, 1% | 586250-90 |
| R25 | X | X | X | X | X | X | Res, 1K, 1/2W, Variable | 586370-4 |
| R26 | X | X | X | X | X | X | Res, 825, 1/8W, 1% | 586250-70 |
| R27 | X | X | X | X | X | X | Res, 39K, 1/2W | 280-1145P131 |
| R28 | X | X | X | X | X | X | Res, 1K, 1/2W | 280-1145P74 |
| R29 | X | X | X | X | X | X | Res, 1K, 1/2W | 280-1145P74 |
| R30 | X | | X | | X | | Res, 20.5K, 1/8W, 1% | 586250-137 |
| | | X | | X | | X | Res, 13K, 1/8W, 1% | 586055-189 |
| R31 | X | X | X | X | X | X | Res, 21.5K, 1/8W, 1% | 586250-138 |
| R32 | X | X | X | X | X | X | Res, 1K, 1/2W | 280-1145P74 |
| R33 | X | X | X | X | X | X | Res, 390, 1/2W, 5% | 280-1145P65 |
| R34 | X | X | X | X | X | X | Res, 2.5K, 2W, Variable | 585348-12 |
| R35 | X | X | X | X | X | X | Res, 2.5K, 2W, Variable | 585348-12 |
| R36 | X | X | X | X | | | Res, .15, 5W | 586054-3 |
| | | | | | X | X | Res, .05, 5W | 586054-68 |
| R37 | | | | | X | X | Res, .33, 5W | 586054-7 |
| R38 | | | | | X | X | Res, .33, 5W | 586054-7 |
| R39 | X | X | X | X | | | Res, .15, 5W | 586054-3 |
| | | | | | X | X | Res, .05, 5W | 586054-68 |
| R40 | | | | | X | X | Res, .33, 5W | 586054-7 |
| R41 | | | | | X | X | Res, .33, 5W | 586054-7 |
| R42 | X | X | X | | | | Not Used | |
| | | | | X | | | 1K, 2W | 280-1147P73 |
| | | | | | X | | 470, 2W | 280-1147P61 |
| | | | | | | X | 750, 2W | 280-1147P69 |
| T1 | X | | | | | | Transformer, Power | 587585-1 |
| | | X | | | | | | 587585-2 |
| | | | X | | | | | 586808-1 |
| | | | | X | | | | 586808-2 |
| | | | | | X | | | 586999-1 |
| | | | | | | X | | 586999-2 |
| TB1 | X | X | | | | | 3-Terminal Board | 247-7201P3 |
| | | | X | X | X | X | 10-Terminal Board | 1058662-10 |
| TB2 | X | X | | | | | 7-Terminal Board | 1058662-7 |
| U1 | X | X | X | X | X | X | IC, 741CN | 586372-3 |
| U2 | X | X | X | X | X | X | IC, 741CN | 586372-3 |
| U3 | X | X | X | X | X | X | IC, 741CN | 586372-3 |
| VR1 | X | | X | | X | | 1N5235B | 588101-10 |
| | | X | | X | | X | 1N5242B | 588101-15 |
| VR2 | X | | X | | X | | 1N5235B | 588101-10 |
| | | X | | X | | X | 1N5242B | 588101-15 |
| VR3 | X | X | X | X | X | X | 1N825 | 588105-3 |
| VR4 | X | X | X | X | X | X | 1N5235B | 588101-10 |