magnetic instrumentation inc.

KJS ASSOCIATES
Magnetics Engineering

INSTRUCTION MANUAL

MODEL 990 SERIES

MAGNETREATERS

(starting with S/N 36168)

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NOTICE

This manual has been compiled and checked for accuracy. The information in this manual does not constitute a warranty of performance. Magnetic Instrumentation, Inc. reserves the right to revise this manual and make changes to its contents from time to time, without notice. We assume no liability for losses incurred as a result of out-of-date or incorrect information contained in this manual.

CAUTION

FOR YOUR SAFETY

THE INSTALLATION, OPERATION AND MAINTENANCE OF THIS EQUIPMENT SHOULD BE PERFORMED BY QUALIFIED PERSONS ONLY.

WARNING:

The Equipment Herein Described Contains High Voltage.

Exercise due care during operation and servicing. Read Safety Summary that follows.

SAFETY SUMMARY

The following safety precautions must be observed at all times during operation, service and repair of this product. Failure to comply with these precautions, or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of this product. Magnetic Instrumentation, Inc. assumes no liability for failure to comply with these requirements.

GROUND THE CHASSIS

To minimize shock hazard and to allow the equipment to perform optimally, the chassis and cabinet must be connected to an electrical ground. All equipment is provided with a ground terminal on the rear, or with a three-connector AC power cable. The ground terminal must be connected to an electrical ground by suitable cabling. For its location refer to the wiring diagram for the chassis or cabinet. The power cable must be plugged into an approved three-contact electrical outlet.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the product in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

DO NOT OPERATE IN WET OR DAMP AREAS

Do not operate the product in wet or damp areas. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove covers. Replacement of components and internal adjustments must be made by qualified maintenance persons. Disconnect power cable when replacing components. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries always disconnect power and discharge circuits by grounding before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person capable of rendering first aid and resuscitation is present.

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform an unauthorized modification to the equipment. The product may be returned for service and repair to ensure that safety features are maintained.

DANGEROUS - PROCEDURE WARNINGS

Throughout this manual, warnings identify potentially dangerous procedures. Instructions contained therein must be followed.

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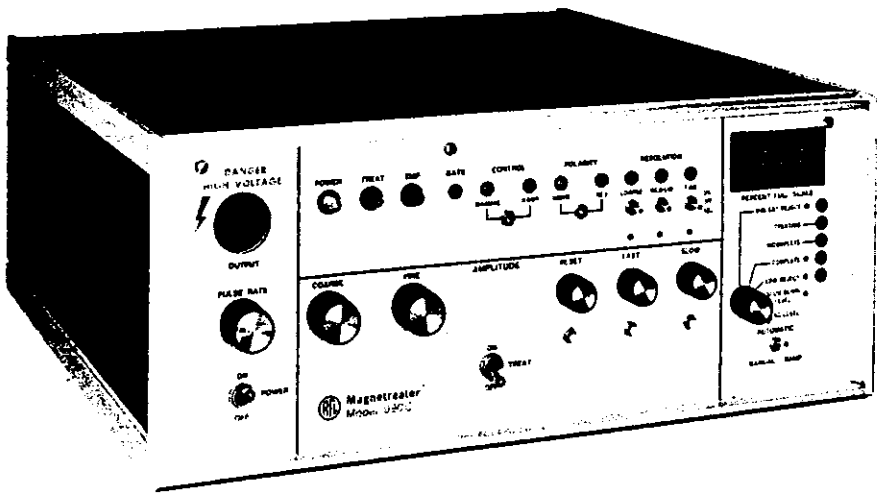


Figure 1-1. Typical 990 Series Magnetreater

A. INTRODUCTION

This manual provides information on Model 990 Series Magnetreaters (fig. 1-1). Included are a description of their purpose, a physical description, specifications, installation instructions, operating instructions, a theory of operation discussion, and information on calibration and maintenance.

B. PURPOSE OF EQUIPMENT

Model 990 Series Magnetreaters are highly accurate pulse-type ringing demagnetizers, capable of supplying precisely-controlled high-energy pulses, used for stabilizing and adjusting the flux levels of permanent magnets and magnetic assemblies. They are especially useful for stabilizing DC-indicating instruments, where the controlled flux density must be resolved to better than 0.1 percent. Model 990 Series Magnetreaters can also be used to calibrate and adjust accelerometers, DC motors with permanent-magnet fields, torque motors, traveling-wave tube magnets, and other assemblies using permanent magnets.

The treating pulses generated by the Model 990 Series Magnetreater are passed through a fixture containing the item to be treated. A gaussmeter or similar instrument is used to measure the flux density of the item after each treating pulse. As long as the flux level readings are above the desired level, demagnetizing pulses of successively-increasing amplitude are applied. When the desired level is reached, the process is terminated. The treating process can be manually controlled, automatically controlled through a local analog feedback loop, or remotely controlled by a computer using the IEEE-488 bus. Model 990 Series equipment can be used as a research tool in the laboratory, or continuously on the production line.

The amplitude of the output pulses is determined by the voltage on the energy storage capacitors inside the Model 990 Series Magnetreater when its discharge-control triac fires. During manual operation the triac firing level is set by the COARSE and FINE amplitude controls on the front panel. During dual-slope control, the firing level is set by an internally-generated reference signal. Under external computer control, the firing level may be set by either the dual-slope reference signal or by the external computer.

C. DIFFERENCES BETWEEN MODELS

The Model 990 Series contains two different models: the Model 990A and the Model 990C. The differences between the two models are discussed below; the module complements for each model are shown in Table 1-1.

Table 1-1. Model designations and module complements for various control modes

Model	Mode of Operation/ Method of Control	Comparator Module 11019103	Dual Slope Module 11007081	Automatic Control Module 11007083	IEEE-488 Interface Module 11007230	D/A Reference Generator 11006766
990A	Manual[1]/ Manual	X	...	...	...	...
990A	Automatic[2]/ Digital Bus	X	...	...	X	...
990C	Dual Slope/ Automatic	X	X	x	...	...

[1] Manual operation requires an analog feedback signal, such as the analog output of the Model 912 Gaussmeter.

[2] Automatic or digital bus operation requires a digital feedback signal, such as the parallel BCD output of the Model 912 Gausmeter.

1. **Model 990A.** The Model 990A (fig. 1-2) is designed for manual control of the treating process. An optional IEEE-488 module can be added to allow computer-controlled operation; another optional module provides a D/A reference generator, which results in greater resolution.

   To use the Model 990A manually, the operator uses the front panel COARSE and FINE controls to slowly increase the Model 990A's output amplitude until the desired flux density is obtained; this would be indicated by a gaussmeter or a similar instrument. Under remote control, a computer would monitor the flux density and adjust the output amplitude as required.

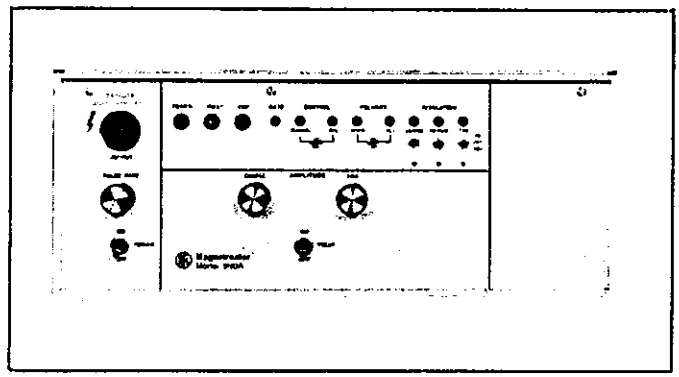


Figure 1-2. Model 990A Magnetreater

2. **Model 990C.** The Model 990C (fig. 1-1) is similar to the Model 990A, with the addition of dual-slope operation. This enables the output amplitude to increase gradually from an initial starting level at one of two different rates (FAST and SLOW). Both rates can be varied by using the front panel controls, and a reset switch will return the output to the initial starting level.

   The Model 990C can also use the analog output of a gaussmeter such as the Model 912 to control its operation; the gaussmeter and Model 990C work together as an automatic treating system.

NOTE

Throughout the rest of this manual, the term "Model 990" will be used to refer to both models in the Model 990 Series. However when information only applies to one model, the model will be specified ("Model 990A Only" or "Model 990C Only".

D. FEATURES

1. **Precise Stabilization and Demagnetization.** Model 990 Magnetreaters use continuous pulse amplitude regulation, which provides a constant output regardless of line voltage fluctuations. Average line demand is low, due to the stored energy technique used. The Model 990 can be operated from any properly-grounded 115-VAC or 230-VAC source.

2. **High Resolution (Model 990C Only):** On the Model 990C, output amplitude can be displayed on the built-in panel meter, with a resolution as great as 0.1 percent.

3. **Continuously Variable Output Power.** Output power can be varied from 20 VA to 80 kVA, and power levels equivalent to 140 kVA can be obtained in some cases. Additional energy storage is available through the use of the Model 992 Booster, which increases storage capacity from 18 watt-seconds to 36 watt-seconds. This increase adds to the developed demagnetization force and lowers the ringing frequency; this can provide greater field penetration in some applications.

4. **Optional IEEE-488 Interface (Model 990A Only).** Model 990A Magnetreaters can be controlled through the IEEE-488 bus with the addition of the Model 95680 IEEE-488 Interface, which includes a bus controller, a dual-slope latch board, and an interconnecting board. The IEEE-488 interface requires the use of a gaussmeter with a parallel BCD output (such as the Model 912), which is connected to the TALK port of the Model 990A. Output signals placed on the IEEE-488 bus conform to IEEE-488.1978 standards, and are contained in a 24-pin connector on the Model 990A rear panel.

   The IEEE-488 Interface Module comes in a standard hardware configuration that is firmware-configured by a programmable read-only memory (PROM). The firm ware defines the data polarity (positive true), status levels, and handshake line polarity. The interconnecting card includes the coupler, eight input lines for address and control, 56 parallel bi-directional I/O lines (28 used for input, and 28 for output), and 11 status and data handshake lines.

5. **Charging/Treating Capabilities.** A Model 990 Magnetreater can be interconnected with a magnet charger to allow charging and treating in a single fixture.

E. PHYSICAL DESCRIPTION

The Model 990 is contained in a single cabinet that can be used on a benchtop or mounted in a 19-inch relay rack or cabinet. Rack mounting requires the use of an optional rack-mounting kit. (See Section II. for details.) Modular construction is used throughout the Model 990; this simplifies maintenance and allows the Model 990 to be easily reconfigured for different operating and control modes.

F. TYPICAL APPLICATIONS

Model 990 Magnetreaters are suitable for many applications, including the following:

1. Laboratory testing and evaluation
2. Continuous production use
3. Magnetic stabilization of d'Arsonval meters
4. Calibration and adjustment of accelerometers, DC generators, DC motors, microwave devices (such as traveling wave tubes, isolators, and circulators), relays, speedometers, and tachometers.

The Model 990 can treat compounds containing tungsten, chromium, alnico, or lodex. It can also treat some barium-ferrite materials. In some cases, the Model 990 can be used to totally demagnetize the material.

G. SPECIFICATIONS

Energy Storage Capacity: 18 watt-seconds, expandable to 36 watt-seconds through the use of the Model 992 Booster.

Demagnetizing Power: 20 VA to 80 kVA, continuously variable.

Maximum Peak Output Current: 400 Amps.

Pulse Rate: 50 to 200 pulses per minute.

Resolution: 0.1% maximum.

Environment Requirements:
Operating:
Temperature: 0°C to +40°C (+32°F to +104°F)
Relative Humidity: 20 to 80%
Storage Temperature: -20°C to +85°C (-8°F to +185°F)

Power Requirements:
120-VAC Operation: 50/60 Hz, 3 Amps average
240-VAC Operation: 50/60 Hz, 1.5 Amps average

Dimensions:
Width: 19 inches (48.3 cm)
Height: 7 inches (17.8 cm)
Depth: 15.5 inches (39.4 cm)

Weight: 42 lbs (19 kg)

II. INSTALLATION

WARNING

HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE MODEL 990. TO PREVENT ELECTRICAL SHOCK, BE SURE TO READ AND COMPLY WITH THE HIGH VOLTAGE WARNING AND SAFETY SUMMARY INFORMATION AT THE BEGINNING OF THIS MANUAL.

THE MODEL 990 IS EQUIPPED WITH SAFETY INTERLOCKS FOR YOUR PROTECTION. NEVER ATTEMPT TO BYPASS, DISABLE, OR MODIFY THESE INTERLOCKS IN ANY WAY.

A. INTRODUCTION

This section provides information on how to install the Model 990 and prepare it for use.

B. UNPACKING

The Model 990 is packaged for shipment at the factory. Accessory items may be packed in the same carton, or they may be in a separate carton if they are large. Everything should be unpacked and inspected for damage as soon as it is delivered. To unpack the Model 990, proceed as follows:

1. Carefully open the carton containing the Model 990 to avoid scratching the cabinet.

2. Remove the packing material from the top of the carton, and lift the Model 990 out of the carton.

3. Carefully examine all packing material to make sure no items of value were overlooked.

4. Carefully open the carton(s) containing any accessory items furnished with the Model 990.

5. Remove the packing material from the top of the carton, and lift the accessory items out of the carton.

6. Carefully examine all packing material to make sure no items of value were overlooked.

If you find that your Model 990 was damaged in transit, notify the carrier who delivered it and request instructions for filing a damage claim. Be sure to save all cartons and all packing materials; these must be made available for examination by the carrier's representatives.

C. MOUNTING IN RACK OR CABINET

Model 990 Magnetreaters can be used on the bench-top, or they can be mounted in any 19-inch rack or cabinet that conforms to EIA standards. To rack-mount the Model 990, a special rack-mount kit is required (P/N 08007223). Installation instructions are included with this kit, along with all the hardware required to install it on your Model 990.

D. LINE VOLTAGE ADJUSTMENT

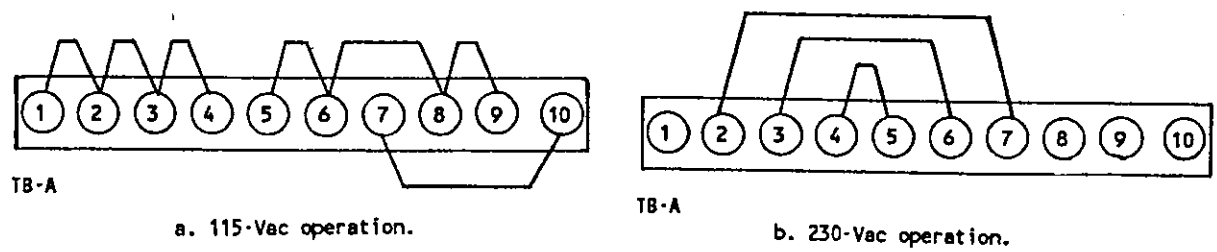
Before connecting the Model 990 to the AC line, check the line voltage adjustment markings on the rear panel. These are located directly above the mating connector for the line cord, and are marked at the factory to indicate how the unit was set. If the markings do not agree with the line voltage to be used, proceed as follows:

1. Make sure the line cord is disconnected from its mating connector.

2. Using a screwdriver, remove the screws securing the top cover to rear panel and slide the top cover back and off.

3. Using a screwdriver, remove the small safety shield toward the rear of the unit to expose terminal blocks TB-A and TB-B.

4. Refer to figure 2-1 and connect the jumpers on terminal block TB-A as required for the available supply voltage.



a. 115-Vac operation.

b. 230-Vac operation.

Figure 2-1. Connections at terminal blocks TB-A for 115-VAC and 230-VAC Operations.

5. Place the safety shield back in position. Install and tighten the screws to secure the shield in place.

6. Place the top cover back in position, making sure that the safety interlock on the inside of the cover is in place. Install and tighten the screws to secure the cover in place.

7. Re-mark the rear panel to indicate the new setting of the input voltage selector.

E. ACTIVATING THE REAR PANEL OUTPUT CONNECTOR

The OUTPUT connector on the Model 990's front panel is always active. When the Model 990 is installed in a cabinet as part of a system, it may be more desirable to use the OUTPUT connector on the rear panel. To enable this connector, proceed as follows:

1. Make sure the line cord is disconnected from its mating connector.

2. Using a screwdriver, remove the screws securing the top cover to rear panel and slide the top cover back and off.

3. Using a screwdriver, remove the small safety shield toward the rear of the unit to expose terminal blocks TB-A and TB-B.

4. Refer to figure 2-2 and connect jumpers to terminal block TB-B as shown to enable the rear-panel OUTPUT connector.

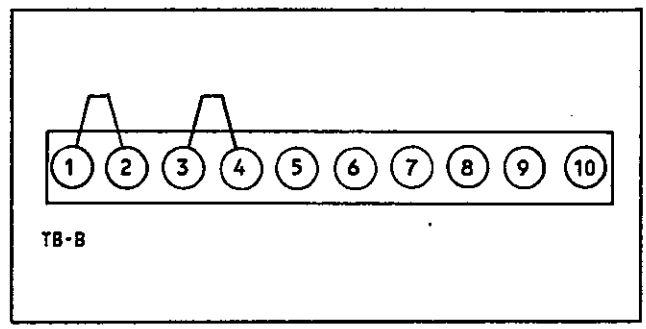


Figure 2-2. Connections at terminal block TB-B for activating the rear-panel OUTPUT connector

5. Place the safety shield in position, making sure that the safety interlock on the inside of the cover is in place. Install and tighten the screws to secure the shield in place.

6. Place the top cover back in position. Install and tighten the screws to secure the cover in place.

F. MAKING CONNECTIONS

The following section describes the connections that must be made to the Model 990 Magnetreaters. Some connectors are optional, and will not be present on all units.

1. ANALOG INPUT Connector (Model 990C Only)

The analog output of a gaussmeter such as the Model 912 is connected to the ANALOG INPUT connector on the Model 990C rear panel. This will allow the gaussmeter reading to be used to control the output of the Model 990C. Use a shielded BNC cable to make the connection.

2. PROGRAMMING Connector

The PROGRAMMING connector is only used for special applications, such as use of a Model 990 Magnetreater in a Automagnetic System. If connections have to be made to this connector they will either be made at the factory or detailed instructions will be provided with the equipment.

3. PARALLEL BCD INPUT Connector (Model 990A Only)

The PARALLEL BCD INPUT connector is used in conjunction with the Model 990A's IEEE-488 option. It accepts the BCD output of a gaussmeter such as the Model 912.

4. 488 BUSS INTERFACE Connector (Model 990A Only)

The 488 BUS INTERFACE connector complies with the requirements of IEEE-488.1978, and is used to connect the Model 990A to the IEEE-488 bus.

5. Treating Coil Connections

The treating coil to be used with the Model 990 is connected to its OUTPUT jack. The OUTPUT jack on the front panel can always be used; if the rear panel OUTPUT jack was enabled by using the procedure in Section II-E, it can be used instead of the front-panel jack.

WARNING

FOR PROTECTION AGAINST ELECTRICAL SHOCK, THE MODEL 990'S POWER CORD MUST BE CONNECTED TO A GROUNDED (3-PIN) OUTLET. NEVER CUT THE GROUNDING PIN OFF THE POWER CORD TO USE IT WITH A 2-PIN OUTLET - USE A GROUNDING ADAPTOR (COMMONLY REFERRED TO AS A "CHEATER PLUG"). IF AN EXTENSION CORD MUST BE USED TO SUPPLY POWER TO THE MODEL 990, MAKE SURE IT IS A 3-WIRE (GROUNDED) CORD; NEVER USE A 2-WIRE EXTENSION CORD.

6. Power Connections

Input power connections are made to the Model 990 through its power cord. The mating connector for the power cord on the Model 990's rear panel is a universal type that conforms with CEE standards. Power cords furnished with units sold for use in the United States and Canada are terminated with NEMA-15 plugs, which will plug into US/Canadian standard 3-pin wall sockets. When plugged in, the Model 990 is grounded through the round grounding pin. Power cords for units intended for use outside the United States and Canada are unterminated at one end; a mating connector conforming to local standards can be purchased locally, or a molded power cord can be purchased to replace the one supplied with the Model 990.

G. SWITCH SETTINGS (Model 990A Equipped with IEEE-488 Option Only)

The 488 ADDRESS switch directly above the 488 BUS INTERFACE connector sets the Model 990A to suit the requirements of the system bus controller. Figure 2-3 shows the meaning of each switch position. Refer to the IEEE-488 bus controller instruction manual to determine exactly how this switch is to be set.

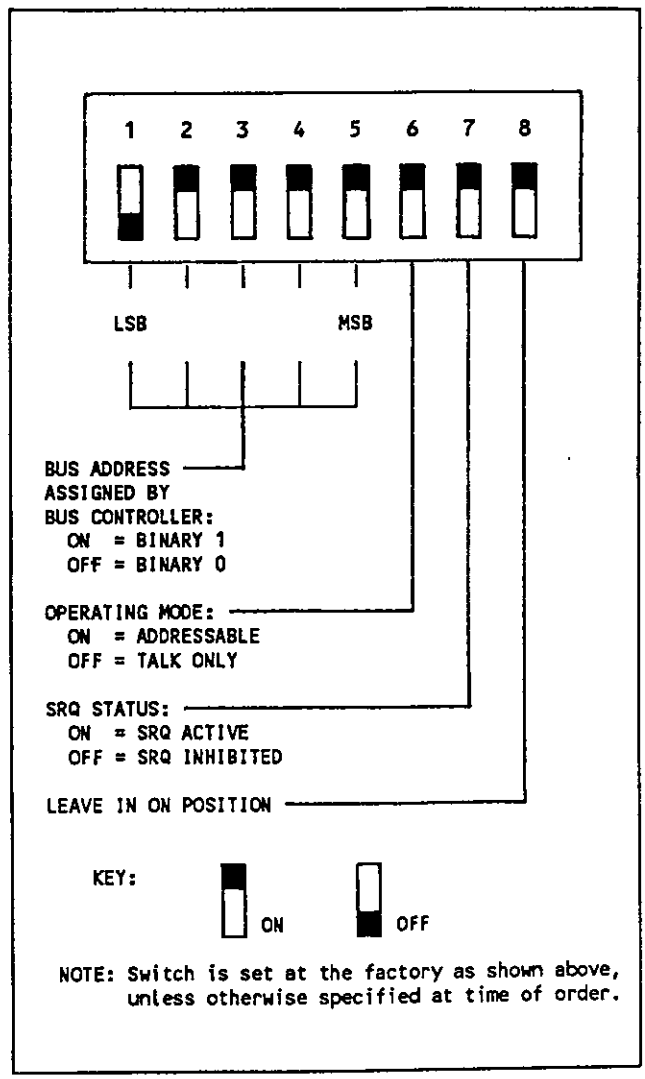


Figure 2-3. 488 INTERFACE switch settings

H. JUMPER SETTINGS

The following sections provide information on setting the jumpers inside the Model 990. Most of these jumpers are set at the factory, and will not require resetting in the field; some can be set in the field to alter the Model 990's operating characteristics.

To gain access to the jumpers inside the Model 990, proceed as follows:

1. Make sure the line cord is disconnected from its mating connector.
2. Using a screwdriver, remove the screws securing the top cover to the rear panel.
3. Slide the top cover back and off.

Once all the jumpers are properly set, close up the Model 990 by placing the top cover back in position, making sure that the safety interlock on the inside of the cover is in place. Once this is done, install and tighten the screws to secure the cover in place.

1. Motherboard

There are two turrets on the motherboard, near the mating connector for the Series 300 Automatic Module Main Board. A wire jumper must be installed between these turrets in Model 990A Magnetreaters, in order to complete the inhibit bus. There must not be a jumper between these turrets in the Model 990C Magnetreaters, because this would bypass the Series 300 board.

2. Series 100 Comparator Board

There is a single jumper on the Series 100 Comparator Board, labeled NORM and EXT SLOW. This jumper determines whether the slow mode under dual-slope operation is normal (NORM position) or slower than normal (EXT SLOW position). The EXT SLOW position will result in greater resolution of the end-point value, but will lengthen treatment time.

3. Series 300 Automatic Module Main Board

There are two jumpers on the Series 300 board, labeled REM/NORM and RESET. The REM/NORM jumper determines the source of the main reference voltage for the Series 300 board. When this jumper is placed in the REM position, the external reference voltage applied to pin 17 of rear panel connector J302 is used. The reference voltage set by REFERENCE potentiometer R318 is used when this jumper is in the NORM position.

The RESET jumper determines whether the integrator on the Series 200 board is reset at the end of each treating sequence. This is usually desirable, because this is when the part being treated is removed from the treating coil and replaced with a new part. When the RESET jumper is in the AUTO position, the integrator will be automatically reset after each treating sequence; if automatic reset is not desired, place this jumper in the NON position.

4. **Series 600 IEEE-488 Interconnecting Board (Optional - Model 990A Only)**

There is one jumper on the IEEE-488 interface option interconnecting board that must be checked after the BUS ADDRESS switch has been set. This jumper determines which DATA READY signal source is used by the IEEE-488 interface. To check this jumper, proceed as follows:

a. Locate the IEEE-488 interface boards in the card cage on the right side of the Model 990A.

The IEEE-488 interface boards are the three interconnected boards at the rear of the card cage. The Series 600 Interconnecting Board plugs into the Model 990A's motherboard; the coupler module (the board with the four LED indicators along its edge) is plugged into the component side of the Series 600 board, and a dual-slope latch card is mounted piggy-back to the solder side of the Series 600 board.

b. Disconnect the three ribbon cables from the connectors along the top edge of the Series 600 IEEE-488 Interconnecting Board.

c. Lift up on the two latches on the Series 600 board and lift all three IEEE-488 interface boards out of the card cage.

d. Note the setting of the jumper near connector P604 on the Series 600 interconnecting board.

If this jumper is in position A, the DATA READY signal for the IEEE-488 interface will be supplied by the display of the gaussmeter connected to the parallel BCD input; this avoids the occasional error that may occur if the input latches were not synchronized to the BCD output.

If this jumper is placed in position B, the DATA READY signal generated by the coupler module will be used by the coupler module.

e. Reinsert the three IEEE-488 interface boards into the card cage, and push down on both latches until the Series 600 board is fully seated in its mating connector on the 990A motherboard.

f. Reconnect the three ribbon cables to the Series 600 board as follows:

   i. Connect the ribbon cable from the PARALLEL BCD input connector on the Model 990A's rear panel to connector P603, which is along the top of the Series 600 board to the left of the coupler module.

   ii. Connect the ribbon cable from the 488 INTERFACE connector and the BUS ADDRESS switch on the Model 990A's rear panel to connector P604, which is along the top of the Series 600 board to the right of the coupler module.

   iii. Connect the ribbon cable from the Series 500 D/A Reference Generator Board to DIP socket J603, which is in the top left corner of the component side of the Series 600 board.

III. OPERATING INSTRUCTIONS

WARNING

HAZARDOUS VOLTAGES CAN BE GENERATED BY THE MODEL 990. TO PREVENT ELECTRICAL SHOCK, BE SURE TO READ AND COMPLY WITH THE HIGH VOLTAGE WARNING AND SAFETY SUMMARY INFORMATION AT THE BEGINNING OF THIS MANUAL.

NEVER USE THE MODEL 990 WITH A TREATING COIL THAT HAS NOT BEEN SPECIFICALLY DESIGNED FOR USE WITH THE MODEL 990. NEVER USE A TREATING COIL THAT IS WORN OR DAMAGED IN ANY WAY.

THE MODEL 990 IS EQUIPPED WITH SAFETY INTERLOCKS FOR YOUR PROTECTION. NEVER ATTEMPT TO BYPASS, DISABLE, OR MODIFY THESE INTERLOCKS IN ANY WAY.

A. INTRODUCTION

Instructions on how to operate the Model 990 are given in this section. All controls and indicators are shown and their functions are fully described. Basic operating procedures are also included, along with application information.

B. CONTROLS AND INDICATORS

The controls and indicators used to operate the Model 990 are shown in figure 3-1. Table 3-1 describes the function of each control and indicator.

CAUTION

Do not wear a watch while operating the Model 990. The strong magnetic field it develops may damage the timepiece.

C. OPERATING PROCEDURES

The following procedures are designed to check the operation of the Model 990 and familiarize the user with its operation. You may wish to use these procedures as the basis for developing your own operating procedures.

1. Manual Operation

Manual operation gives the operator complete control over the treating process. To operate the Model 990 manually, proceed as follows:

a. Set the front panel controls as follows

Automatic controls
(Model 990C only):
RESET control - Full CCW
FAST control - Full CCW
SLOW control - Full CCW
Mode selector - MANUAL/RAMP
Voltmeter switch - MAG LEVEL
CONTROL switch - MANUAL
POLARITY switch - NORM
RESOLUTION switches - All ON
TREAT switch - OFF
PULSE RATE control - Mid-range
COARSE level control - Mid-range
FINE level control - Mid-range

b. Connect a treating coil to the OUTPUT connector on the front panel.

The treating coil can also be connected to the OUTPUT connector on the rear panel, if this connector has been activated by the strapping of terminal block TB-B. (See Section II.)

c. Place the POWER switch in the ON position.

The red POWER indicator, the red MANUAL control indicator, and the NORM polarity indicator will light.

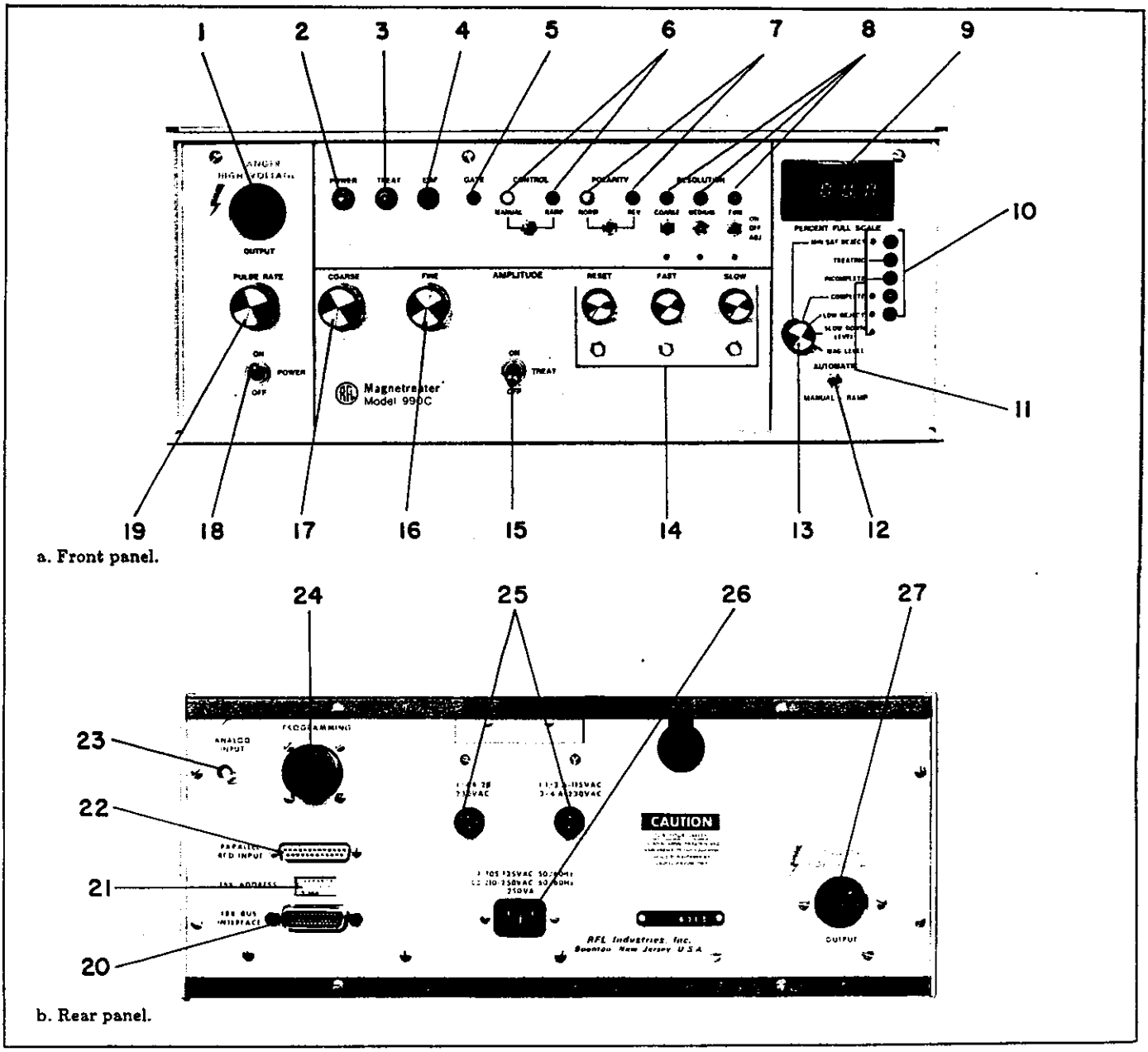


Figure 3-1. Controls and indicators, Model 990 Magnetreater

Table 3-1. Controls and indicators, Model 990 Magnetreater

Item No.	Description Marking (if any)	Functional Description
FRONT PANEL:		
1	OUTPUT connector	Connecting point for treating coil.
2	POWER indicator	Lights when input power is applied.
3	TREAT indicator	Lights when treating pulses are being generated.
4	EMF indicator	Lights when voltage is present on the capacitor bank.
5	GATE indicator	Lights at the end of each treating pulse.
6	CONTROL switch and indicators	Allows operator to choose between manual or ramp (dual slope) control of output pulse amplitude, and provides visual indication of selected control mode.
7	POLARITY switch and indicators	Allows operator to choose between normal or reversed output pulses polarity, and provides visual indication of selected polarity.
8	RESOLUTION switches, controls, and indicators	Allows operator to set the degree of resolution required for the output pulse, and provides a visual indication of the selected resolution.

NOTE

Items 9 through 14 only appear on Model 990C Magnetreaters.

9	Digital voltmeter	Displays the current value of the parameter selected by the voltmeter selector switch.
10	Status indicators	Provide visual indication of current automatic module status.
11	Level control	Sets target levels for automatic module.
12	Mode selector	Allows operator to choose automatic control of the Model 990, or manual/ramp operation.
13	Voltmeter selector switch	Determines which parameter is displayed on digital voltmeter.
14	Dual slope controls	Set shift points for dual-slope operation.

Table 3-1. Controls and indicators, Model 990 Magnetreater (con't)

Item No.	Description Marking (if any)	Functional Description
FRONT PANEL (continued):		
15	TREAT ON/OFF switch	Enables or disables output pulses.
16	FINE level control	Allows small adjustments in pulse output amplitude.
17	COARSE level control	Allows large adjustments in pulse output amplitude.
18	POWER ON/OFF switch	Applies input power to Model 990.
19	PULSE RATE control	Varies the output pulse repetition rate.
REAR PANEL:		
	NOTE	
	Items 20 through 22 only appear on Model 990A Magnetreaters equipped with the optional IEEE-488 interface.	
20	488 BUS INTERFACE connector	Allows Model 990A to be connected to IEEE-488 bus.
21	488 ADDRESS switch	Sets Model 990A for compatibility with IEEE-488 interface option.
22	PARALLEL BCD INPUT connector	Accepts BCD output from gaussmeter; used with IEEE-488 interface option.
23	ANALOG INPUT connector	Accepts analog output from a gaussmeter, which is used to control Model 990C output amplitude when operating in the AUTOMATIC mode.
24	PROGRAMMING connector	Provides electrical connection to optional programming relay (special applications only).
25	Input fuses	Input current protection for entire Model 990.
26	AC input receptacle	Mating connector for power cord set.
27	OUTPUT connector	Can be used instead of front panel OUTPUT connector.

d. Place the TREAT switch in the ON position.

One element inside the orange neon TREAT indicator will light and treat pulses will start, as indicated by a series of "thumps" coming from the treating coil. The EMF indicator will also light, and the GATE indicator will light at the end of each treating pulse.

e. Turn the COARSE level control fully counterclockwise, then fully clockwise, and then return to its mid-range position.

Thumps will get softer, then louder, and then return to their original level.

f. Turn the FINE level control fully counterclockwise, then fully clockwise, and then return to its mid-range position.

There will be a small change in the thump level.

g. Turn the PULSE RATE control fully counterclockwise, and then fully clockwise.

Thumps will get slower as the PULSE rate control is turned clockwise, and faster as the control is turned counterclockwise.

h. Return the PULSE RATE control to its fully counterclockwise position, and place the TREAT switch in the OFF position.

The thumps will stop and the TREAT indicator will go out.

i. Place the POLARITY switch in the REV position.

The NORM polarity indicator will go out and the REV polarity indicator will light. As this happens a relay inside the Model 990 will be heard operating.

j. Place the TREAT switch in the ON position.

Both elements inside neon TREAT indicator will light and treat pulses will start, as indicated by a series of "thumps" coming from the treating coil. The EMF indicator will also light, and the GATE indicator will light at the end of each treating pulse.

k. Place all three RESOLUTION switches in the OFF (center) position.

Treating pulses will either stop or occur infrequently, even though the TREAT indicator stays lit. If the pulses stop, this means that the charging current being supplied to the storage capacitors has been exceeded by the current through the bleeder resistors.

l. Place the FINE resolution switch in the ON (up) position.

Treating pulses will start again.

m. Place the MEDIUM resolution switch in the ADJ (down) position.

The MEDIUM resolution indicator will light during the early portion of each storage capacitor charge cycle. It will go out when the charge reaches the level set by the multi-turn potentiometer located below the MEDIUM resolution switch. Charging current passes through charging resistor R14 and reduces the charging time when the MEDIUM indicator is lit.

When the storage capacitors are charged at reduced level, the final charge level can be set more accurately. Because of this, the Model 990 Series Magnetreaters charge their capacitors rapidly during the early part of the cycle, at a moderate rate later in the cycle, and slowly at the end of the cycle, as the charge approached the desired value. The energy levels at which the rate changes are made are determined by the three multi-turn potentiometers directly below each resolution switch.

n. Switch the COARSE resolution switch to the ADJ (down position).

The COARSE resolution indicator will light during the early portion of each charge cycle, and go out just before the MEDIUM indicator goes out.

o. Return all three RESOLUTION switches to the ON (up) position.

Treating pulses will start again at their normal rate, as indicated by thumps coming from the treating coil.

p. Place TREAT switch in the OFF position.

TREAT indicator will go out and thumps will stop.

2. Dual-Slope Operation

In the Model 990C, a ramp generator inside the unit can be used to control treating pulse amplitude. Two ramp speeds are used (fast and slow), so this is referred to as dual-slope operation. This mode of operation is well suited for production applications, where a large number of items are to be treated at the same amplitude levels. To operate the Model 990C under dual-slope control, proceed as follows:

a. Set the front panel controls as follows:

COARSE level control - Mid-range
CONTROL switch - RAMP
FAST control - Full CW
FINE level control - Mid-range
Mode selector (Model 990C only) - MANUAL/RAMP
POLARITY switch - NORM
PULSE RATE control - Full CCW
RESET control - Full CW
RESOLUTION switches - All ON
SLOW control - Full CW
TREAT switch - OFF

b. Place the TREAT switch in the ON (up) position.

c. Press and release the RESET switch.

d. Press and hold the FAST switch.

Treating pulses will be produced. Under normal conditions, the first pulse will be nearly maximum, and after a few pulses the dual slope integrator will become saturated; when this happens, the treating pulses stop.

If your application requires the treating pulses to continue after the integrator saturates, the Series 200 Dual Slope Integrator Board will have to be re-wired. (See the schematic in Section V. of this manual.)

e. Release the FAST switch, and then press and release the RESET switch.

f. Turn the RESET control fully counterclockwise. Once the control is fully counterclockwise, release the RESET switch.

g. Press and hold the FAST switch.

Treating pulses will be produced, starting at a very low amplitude and quickly increasing until the maximum level is reached. When the maximum level is reached, the pulses will stop.

h. Release the FAST switch, and then press and release the RESET switch.

i. Press and hold the SLOW switch.

Treating pulses will be produced, starting at a very low amplitude and slowly increasing until the maximum level is reached. When the maximum level is reached, the pulses will stop.

j. Release the SLOW switch, and then press and release the RESET switch.

k. Press and hold the FAST and SLOW switches at the same time.

Treating pulses will be produced, starting at a very low amplitude and increasing at a moderate rate until the maximum level is reached. When the maximum level is reached, the pulses will stop.

l. Release the FAST and SLOW switches, and then press and release the RESET switch.

m. Turn the FAST and SLOW ramp controls fully counterclockwise.

n. Press and hold the FAST and SLOW switches at the same time.

Treating pulses will be produced, and the amplitude increase from one pulse to the next will be very small. By selecting a small amplitude and fine resolution, it is possible to terminate treating at a very precise magnetic level.

o. Release the FAST and SLOW switches, and then press and release the RESET switch.

NOTE

If the FAST or SLOW switches are released while pulses are still being generated, treating pulses will stop. When the FAST or SLOW switch is pressed again, pulses will start again at the amplittude they were being generated at when the switch was released. This feature permits the generation of a single pulse by pressing either the FAST or the SLOW switch. In some applications, this feature may be useful.

3. Automatic Operation

The Model 990C can use the analog output of a gaussmeter such as the Model 912 to enable fully automatic operation. This operating mode provides the most accurate and repeatable results. For proper operation, the gaussmeter must produce an analog output of 5 VDC for a full-scale reading; the Model 912 satisfies this requirement.

a. **Initial Setup.** The following preliminary steps must be taken to prepare the Model 990C for automatic operation:

1. Adjust the gaussmeter's range and offset controls as required to obtain a full-scale reading.

   This will result in a 5-volt signal at the rear panel ANALOG OUTPUT connector.

2. Connect the analog output of the gaussmeter to the ANALOG OUTPUT connector on the Model 990C rear panel.

3. On the Model 990C, place the AUTOMATIC-MANUAL/RAMP switch in the AUTOMATIC position.

4. Turn the rotary switch directly below the digital voltmeter on the Model 990C to the LOW REJECT position.

   The LOW REJECT indicator will light and voltmeter will display the minimum flux density level that is considered acceptable after treatment.

5. Using a small flat-blade screwdriver, adjust the potentiometer next to the LOW REJECT indicator until the voltmeter displays the desired flux density level, as a percentage of full-scale on the gaussmeter.

6. Turn the rotary switch directly below the digital voltmeter to COMPLETE position.

   The COMPLETE indicator will light and the voltmeter will display the nominal flux density level that is considered acceptable after treatment.

7. Using a small flat-blade screwdriver, adjust the potentiometer next to the COMPLETE indicator until the voltmeter displays the desired flux density level, as a percentage of full-scale on the gaussmeter.

   The COMPLETE potentiometer must be set for a higher flux density level than the LOW REJECT potentiometer was set for during step 5.

8. Turn the rotary switch directly below the digital voltmeter to the SLOW DOWN LEVEL position.

   The voltmeter will display the slow-down level, which is the point at which the incremental increases in ramp amplitude are to be decreased. This will result in higher resolution near the end-point value, and more accurate treatment.

9. Using a small flat-blade screwdriver, adjust the potentiometer next to the SLOW DOWN LEVEL indicator until the voltmeter displays the desired flux density level, as a percentage of full-scale on the gaussmeter.

   The SLOW DOWN LEVEL potentiometer must be set for a higher flux density level than the COMPLETE potentiometer was set for during step 7.

10. Turn the rotary switch directly below the digital voltmeter to the MIN SAT REJECT position.

    The MIN SAT REJECT indicator will light and the voltmeter will display the minimum flux density level that is considered acceptable before treatment.

11. Using a small flat-blade screwdriver, adjust the potentiometer next to the MIN SAT REJECT indicator until the voltmeter displays the desired flux density level, as a percentage of full-scale on the gaussmeter.

    The MIN SAT REJECT potentiometer must be set for a higher flux density level than the SLOW DOWN LEVEL potentiometer was set for during step 9. In many instances, it will be set for 100 percent of the full-scale reading; the exact setting will depend on the application.

12. Turn the rotary switch directly below the digital voltmeter to the MAG LEVEL position.

    The voltmeter reading will now match that of the gaussmeter.

The Model 990C is now set up for automatic operation. If you want to change the setting later to treat a different batch of material, repeat steps 4 through 12.

b. **Automatically Treating a Magnet.** Once the Model 990C has been set up for automatic use, saturated magnets can be treated without any further input from the operator. To treat magnets automatically, proceed as follows:

1. Make sure the AUTOMATIC-MANUAL/RAMP switch on the front of the Model 990C is in the AUTOMATIC position.

2. Place a saturated magnet in the treating coil.

   If the MIN SAT REJECT light stays lit after the magnet is placed in the treating coil, the magnet's flux density is below the established limit and treating cannot be done. Reject the magnet in the treating coil and replace it with another.

   If the magnet in the treating coil is properly saturated, the MIN SAT REJECT light will go out and treating will start.

   As the flux density of the magnet being treated decreases, the Model 990C will shift into the slowdown mode, where increases in pulse amplitude are smaller and resolution is greater. This results in more accurate treating.

3. Watch the indicator lamps on the front of the Model 990.

   The Model 990C will check the flux density of the magnet in the treating coil after each treating pulse. As long as the flux density is above the nominal value established by the COMPLETE control during initial setup, treatment will continue.

When the flux density of the magnet being treated falls to a level between the limits set by the COMPLETE and LOW REJECT controls during initial setup, the green COMPLETE indicator will light, indicating that the magnet has been successfully treated. Remove the treated magnet from the fixture, and repeat steps 2 and 3 with another saturated magnet in the treating coil.

If the flux density of the magnet being treated falls below the level set by the LOW REJECT control during initial setup, the LOW REJECT indicator will light. This indicates that one of the following events has occurred:

a. The magnet has been overtreated.
b. The LOW REJECT and COMPLETE limits may be set too low.
c. The slowdown point may be set too low.
d. The gaussmeter probe monitoring the flux density of the magnet in the treating coil may have moved from its original position.

If the dual-slope integrator in the Model 990C saturates, the INCOMPLETE indicator will light. This means that no further treating can occur unless some means is provided for increasing the density of the demagnetizing flux.

4. IEEE-488 Bus Operation (Model 990A Only)

When equipped with the optional IEEE-488 interface, the Model 990A can be connected to the IEEE-488 bus and operated in either a TALK or a LISTEN mode, under the command of the buss controller. A typical IEEE-488 system is shown in figure 3-2.

To prepare the IEEE-488 interface for use, proceed as follows:

a. Connect the BCD output of a gaussmeter (such as the Model 912) to the PARALLEL BCD INPUT connector on the rear of the Model 990A.

b. Connect the treating coil to the OUTPUT connector of the Model 990A.

c. Insert the gaussmeter probe into the treating coil in the area of interest. Secure it in place with tape.

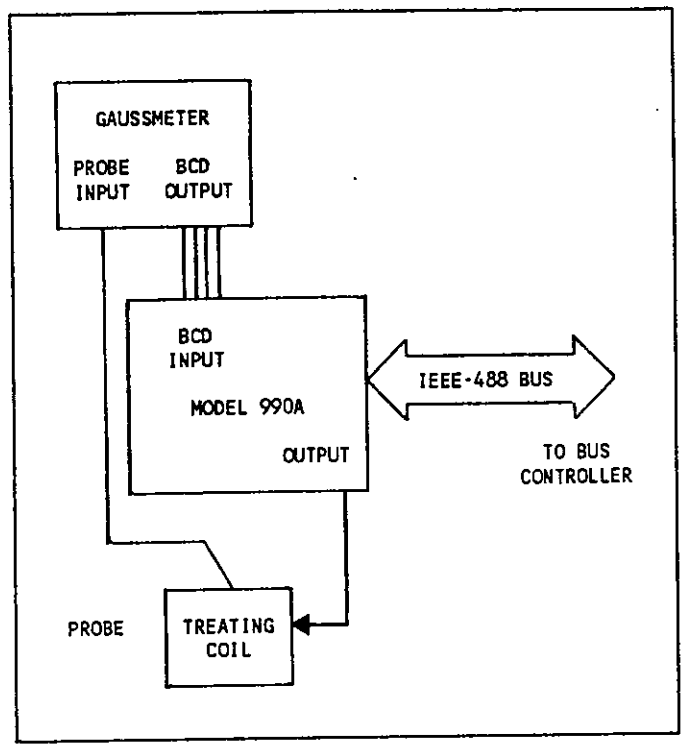


Figure 3-2. Typical system using IEEE-488 bus to control Model 990A Magnetreater

d. Set the 488 ADDRESS switches on the Model 990A rear panel as required by the bus controller. (See Section II.)

e. Connect the Model 990A to the IEEE-488 bus by inserting the IEEE-488 bus cable into the 488 INTERFACE connector on the Model 990A rear panel.

The IEEE-488 interface will now accept commands from the bus controller and use them to control the Model 990. The best way to become familiar with IEEE-488 bus operation is to refer to the bus controller instruction manual, and follow the given instructions for loading the software and running the operating program. In addition, many IEEE-488 bus controllers use software programs containing user prompts that will guide you through their operation. By following the instructions in the bus controller manual (or the prompts that appear while running the program), it should be easy to operate the system and adjust it as required to suit your needs.

Many IEEE-488 programs are written in BASIC, which is a very easy computer language to learn. With a little study and practice, you will be able to modify existing IEEE-488 programs to vary delay times, adjust acceptance limits for go/no-go testing, or other enhancements. You will also be able to write your own programs.

In order for the IEEE-488 interface to work, the Series 500 D/A Reference Generator must be installed in the second slot in the card cage behind the front panel, and a 16-conductor ribbon cable must be connected between the Series 500 board and the Series 600 interconnecting board.

To set the level of the treating pulse, numbers from +1999, decreasing through zero to -1999, are entered through the bus controller's program or manually through its keyboard. These numbers are forwarded in BCD format through the IEEE-488 cable to the D/A reference generator, where they are converted to an analog value. The more negative the analog value, the greater the treating pulse amplitude.

Some systems are set up so that the D/A reference board will produce an output of +12 volts for an input of +1999, zero volts for an input of ØØØØ, and -12 volts for an input of -1999. Another common setup incorporates a voltage offset; an entry of +1999 will produce an analog output of zero volts, ØØØØ will produce an output of -4 volts, and an input of -1999 will result in an output of -8 volts. The exact setup used will depend upon the requirements of the particular application; contact Magnetic Instrumentation, Inc. for further information. Regardless of the setup used, the analog output from the D/A reference generator should track the digital input. This can be verified by using a test program that will vary the digital input in uniform steps. The analog output should track the digital input, varying in uniform steps with no gaps or reversals.

D. APPLICATION INFORMATION

Magnetic materials are stabilized (or treated) by the Model 990 by placing the material inside a treating coil and energizing the coil with repetitive damped oscillatory pulses, which gradually increase in amplitude. The damped characteristic of the treating pulses gradually reduces the flux density of the magnet to the desired level.

Inside the magnetic material, there are magnetic domains of varying hardness. At the lowest treating levels, the weakest domains are scrambled, and the harder domains remain magnetized. As the treating pulses increase in amplitude, harder and harder domains are scrambled; the flux density will be reduced as more domains are scrambled. Each succeeding half-wave of the damped pulse train passing through the pulse coil peaks at a smaller absolute value and in the direction from the pulse preceding it.

For a given treating pulse, a number of domains are switched on by the first half-wave. But since the second half-wave is smaller and of opposite polarity, the hardest domains that were switched by the first half-wave are not switched back by the second. All the weaker domains are switched back; this process continues until all weak domains below the treating level are scrambled.

CAUTION

To prevent damage to the Model 990 or other equipment connected to it, never attempt to add capacitors to the Model 990's energy storage bank without first contacting Magnetic Instrumentation, Inc.

1. **Increasing the Capacity of the Energy Storage Bank**

   The frequency of each demagnetizing pulse is a function of the capacitance and inductance of the circuit. The energy storage capacitor bank inside the Model 990 has a capacitance of 100 uF, which results in a pulse frequency for most treating coils between 100 Hz and 200 Hz. The storage capacity of the energy storage bank can be increased by connecting a Model 992 Booster or other external capacitors to it. If you feel your application needs a larger energy storage bank, contact Magnetic Instrumentation, Inc. for information on adding external capacitors to the circuit.

WARNING

TO REDUCE THE POSSIBILITY OF ELECTRICAL SHOCK AND/OR PERSONAL INJURY, NEVER USE HOME-MADE TREATING FIXTURES WITH THE MODEL 990 MAGNETREATER. TREATING COILS MUST BE DESIGNED TO MEET THE IMPEDANCE REQUIREMENTS OF THE MODEL 990, AND TO SAFELY WITHSTAND THE HIGH VOLTAGES APPLIED TO THEM. AS AN ADDITIONAL PRECAUTION AGAINST ELECTRICAL SHOCK, REPLACE ANY TREATING COIL THAT IS WORN OR DAMAGED FROM EXTENSIVE USE.

2. Treating Coils

Table 3-2 shows the inside dimensions of several treating coils commonly used with the Model 990. Many other sizes are available; contact the factory for more information. Universal fixtures are also available for treating many types of panel meters.

Table 3-2. Standard Treating Coil Dimensions

Part Number	Inches	Centimeters
Rectangular:		
7010-1	2.2 x 4.5	5.6 x 11.4
7010-2	3 x 6	7.6 x 15.2
7010-3	4 x 8	10.2 x 20.3
Round:		
7010-16	3.5 dia.	8.9 dia.
7010-22	1.5 dia.	3.81 dia.

The volume (or dynamic level) of treating flux available in a treating coil is mainly determined by its cross-sectional area. A smaller coil will provide a higher flux density than a larger coil, when both are driven by the same amount of energy. Materials with high coercive forces (such as cobalt-platinum and barrium-ferrite) require small treating coils to provide the flux concentration necessary for treating these materials. The size and shape of the treating coil required will also depend on the size and shape of the item to be treated.

> **NOTE**
>
> The field generated in a rectangular treating coil is the least uniform, with high concentrations of flux in the corners. Circular coils are the most uniform.

The demagnetization forces developed in any treating coil will vary as the item being treating is moved with respect to the center of the coil. To reduce the effects of this natural variation, a jig should be made to hold each item in the same physical location within the treating coil when treating a large number of similar items (such as on a production line). This will ensure that each item is exposed to nearly identical demagnetization forces.

3. Design Service

Magnetic Instrumentation, Inc. provides design service geared to the requirements of each individual user. This includes the design of charging, treating, and measuring fixtures used in complete systems. Recommendations are made on the basis of economy and reliability. There is no charge for this service.

IV. THEORY OF OPERATION

A. INTRODUCTION

This section provides the theory of operation for the Model 990 Magnetreater, both on a overview and a detailed circuit level. The overview summarizes the circuit theory, and allows the reader to understand the relationships between the different sections of the Model 990. Detailed discussions describing the operation of each section are also provided.

B. OVERVIEW

Model 990 Magnetreaters use a high-voltage power supply, a bank of energy storage capacitors, connectors for a treating fixture, a triac (used for discharge control), an interlock circuit, and several control circuits. A block diagram of the Model 990 appears in figure 4-1.

1. Treating Circuits

The treating circuits generate the output signal that is delivered to the treating fixture. Input power is controlled to improve the resolution of the output signal. Output polarity can be reversed, so magnets saturated in either magnetic polarity can be treated. The energy stored in the energy storage bank is discharged into the treating fixture, where the item to be treated has been placed.

2. Level Comparator

The level comparator constantly compares the voltage level on the energy storage bank to the target level established by the COARSE and FINE level controls. When the levels match, the level comparator sends a CONTROL signal to the discharge circuit, commanding it to fire its triac, sending the contents of the energy storage bank into the treating fixture.

3. Manual Operation

The front panel controls of either Model 990 Magnetreater can be used to manually control the treating process. Switch S2 is set to the MAN position and the COARSE, FINE, and PULSE RATE controls are set as desired.

When the TREAT ON/OFF switch is placed in the ON position, treating pulses will repeat automatically. The operator then uses the COARSE and FINE controls to increase the output amplitude until the desired level has been reached; this is usually determined by placing a gaussmeter probe into the treating coil. Treating pulses will continue to be produced until the TREAT ON/OFF switch is placed in the OFF position.

4. Dual-Slope Operation (Model 990C Only)

The dual-slope circuitry in the Model 990C generates a ramp-type reference voltage for the level comparator that is designed to minimize the time required for each treating cycle.

The amplitude of the first treating pulse is controlled by the setting of the RESET control. This sets the initial condition of an integrator used to develop the ramp-shaped reference signal. The level may be set high if desired, to permit a quick approach to the end-point.

Turning the FAST control clockwise will increase the slope of the reference voltage ramp. With a steeper slope, the end point is quickly reached.

Turning the SLOW control clockwise will reduce the slope of the reference voltage ramp. This will minimize the incremental increases in the reference voltage, increasing resolution.

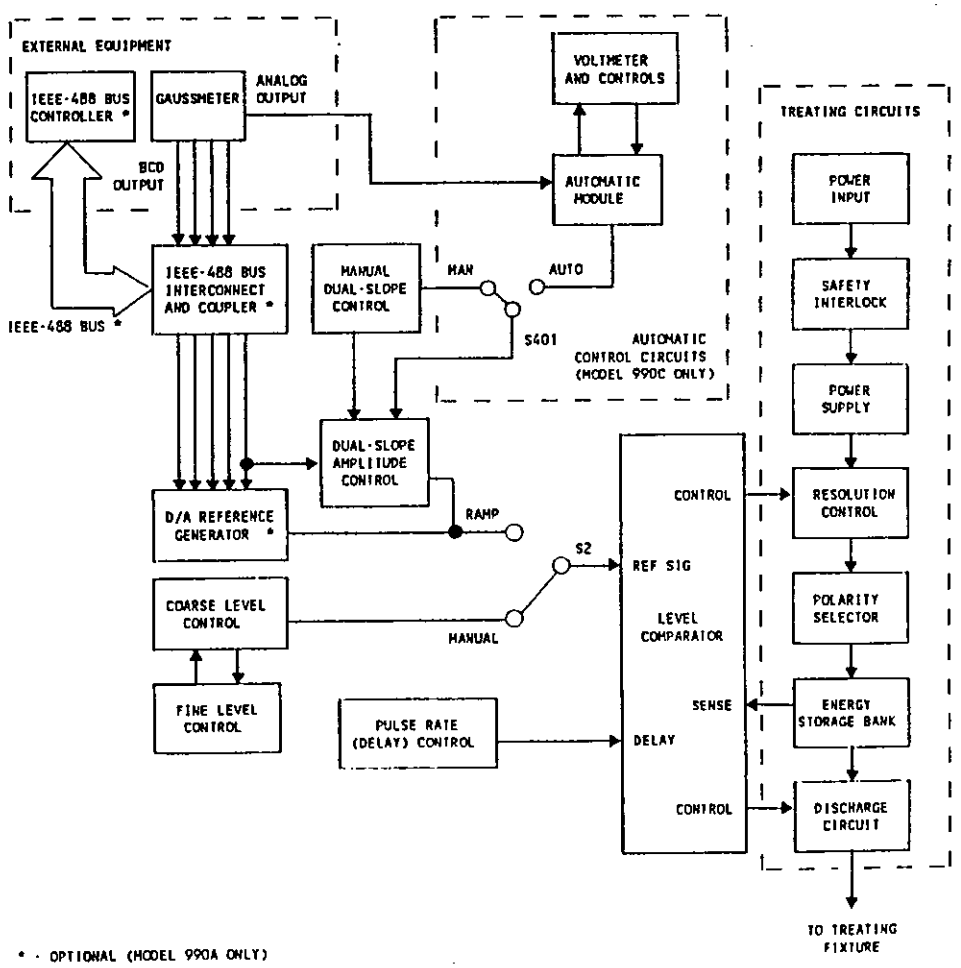


Figure 4-1. Block Diagram, Model 990 Magnetreater

5. Automatic Operation (Model 990C Only)

The Model 990C's automatic control circuits allow completely automatic closed-loop operation. Using the analog output signal from the gaussmeter monitoring the flux density of the item in the treating fixture, the automatic module checks the flux level before each treating cycle and adjusts the dual-slope module as required. When the desired end-point has been reached, the automatic module will stop the treating process. It will then check the final flux density level to determine if it is within limits.

Flux density levels at critical points in the process are set by screwdriver-adjustable potentiometers on the Model 990C front panel, using the built-in voltmeter to monitor the set levels.

6. IEEE-488 Bus Control (Optional - Model 990A Only)

Model 990A Magnetreaters can be controlled through the IEEE-488 bus with the addition of the Model 95680 IEEE-488 Interface Module, which contains a bus controller and an interconnecting board with coupler. Output signals conform to IEEE-488 standards, and are contained in a 24-pin connector on the rear panel.

The IEEE-488 Interface Module comes in a standard hardware configuration that is firmware-configured by a programmable read-only memory (PROM). The firmware defines the data polarity (positive true), status levels, and handshake line polarity.

The interconnecting card includes the coupler, eight input lines for address and control, 56 parallel bi-directional I/O lines (28 used for input, and 28 for output), and 11 status and data handshake lines.

When operating under IEEE-488 control, the level of each treating pulse must be set by the bus controller. The reference voltage required by the level comparator must be obtained from a D/A converter installed in the space vacated by the dual-slope board. The D/A reference generator accepts the target level for each pulse (received from the bus controller in digital form) and converts it to an analog signal for use by the level comparator.

C. CIRCUIT DETAILS

The following sections provide detailed theory of operating information on the various parts of the Model 990 Magnetreater. Each major subassembly is covered by a separate paragraph. Schematics for each major subassembly (and the Model 990 cabinet) can be found in Section V. Maintenance Information of this manual.

1. Main Cabinet

The main cabinet contains a card cage and motherboard for interconnecting most of the Model 990's major subassemblies. It also contains a power supply, the energy storage bank, and the triac used to discharge the energy storage bank. The controls on the cabinet's front panel are used to operate the Model 990, and the connectors on its rear panel provide connections to the AC line and other equipment.

Figure 5-10 in Section V. is the schematic of the main cabinet, which shows all interboard connections. All components that are part of the main cabinet are assigned a circuit designator between 1 and 99 (C1, C2, C3, etc).

a. **Power Circuits.** POWER switch S1 applies AC power to the Model 990 through input fuses F1 and F2. A safety interlock built into the top cover disconnects AC power if the cover is opened. Jumpers on terminal block TB-A reconfigure the Model 990 to accept the locally available line voltage (115 or 230 volts, grounded or ungrounded neutral).

   Transformer T1 steps down the incoming AC voltage and powers two regulator circuits. These circuits provide the bipolar 12-volts required by most of the Model 990's control circuits.

b. **Output Circuits.** Transformer T3 provides the high voltage required to charge capacitors C12 and C13, which form the energy storage bank. The primary of T3 is switched on and off by triac Q3. Q3 is controlled by an isolated source comprising transformer T2, driver transistor Q1, and optical isolator IC5. IC5 receives its inputs from the Series 100 Comparator Board.

Resistor R12, R14 and R16 and variable resistors. R13 and R15 form a network that controls the energy storage bank's charging rate. The network is controlled by triacs Q5 through Q7, which receive their firing voltages from the Series 100 Comparator Board. With all three triacs conducting, the charging rate is fast and the desired end point is quickly approached. As the charge on the bank nears the desired set point, Q5 and then Q6 turn off, slowing the charging rate; this allows the end point to be approached with the best possible resolution. Upon command from the Series 100 Comparator Board, triac Q8 discharges the energy storage bank into the treating coil.

c. **Bleed Control Option.** Capacitor C15 and triac Q10 are optional components that can be used to open or close the current path of optional bleeder resistor R18. When the path is open, treating levels can be more precisely controlled, because the bleeder current will override the charging current. Contact the factory for more information on this optional circuit.

2. Series 100 Comparator Board

The Series 100 Comparator Board performs all of the Model 990's basic control functions. It uses a series of comparators to compare variable voltages against established target levels. Figure 5-4 in Section V. of this manual is the schematic for the Series 100 board; all components on the Series 100 board are assigned circuit designators between 100 and 199 (C100, C101, C102, etc).

In manual operation, the COARSE and FINE controls on the front panel set the reference level for the pulse that fires triac Q8; this discharges the energy storage bank into the treating coil. The range of the COARSE and FINE controls can be set by potentiometer R153, which controls the gain of operational amplifier IC105D. The output of IC105D is fed to comparator IC103C for further processing.

Resistor R19 and R20 in the main cabinet form a voltage divider across the energy storage bank, producing a sense voltage that enters the Series 100 board at edge connector terminal 16. The sense voltage is fed to operational amplifier IC105C (connected as a voltage follower) and a precision rectifier formed from operational amplifiers IC105 and IC105A. The precision rectifier removes all ripple from the sense voltage. The output of the rectifier is compared to the output of IC105D by operational amplifier IC103C. When IC103C changes state, it triggers timer IC102, which generates a 50-ms gate pulse. This is passed through transistor Q6 and Darlington transistor Q5 to fire triac Q8 and release the treating pulse.

The 50-ms gate pulse is also passed to the INHIBIT bus and to the input of timer IC104, which places a pulse on the INHIBIT bus. This will prevent the energy storage bank's charging circuit from trying to charge it while it is discharging. The time constant of IC104 is controlled by capacitor C102, resistor R109, and PULSE RATE potentiometer R27.

The rectified sense signal is also sent to comparators IC101A, IC101B, and IC101C, where it is compared with reference levels set to determine the points at which the charging rate changes from coarse to medium, and from medium to fine. The reference levels are set by COARSE potentiometer R21, MEDIUM potentiometer R22, and FINE potentiometer R23. Darlington transistors Q102 through Q104 develop the firing voltages for Q5 through Q7, the triacs in the main chassis that control the charging rate of the energy storage bank.

COARSE switch S3, MEDIUM switch S4, and FINE switch S5 on the front panel, control the operation of triacs Q102 through Q104. When these switches are in the ON position, the triacs they control are fired; in the OFF position, the triacs are disabled. In the ADJ position, each triac will fire at the point determined by the comparator that controls it.

A logic high on the INHIBIT bus causes the output of comparator IC103A to change to a logic high. This turns off power input control triac Q3. The inhibit signal can come from the firing signal to the gate, from timer IC104, or from an external source. Q3 can also be inhibited by a logic high at edge connector terminal 5, or a logic low at edge connector terminal L.

The internal trigger signal may be blocked for applications that require synchronization of the treat pulse to an external trigger. The signal is blocked by grounding edge connector terminal 21.

3. Series 200 Dual Slope Control Board (Model 990C Only)

The Series 200 Dual Slope Control Board generates the signals required for dual-slope operation of the Model 990C. Figure 5-5 in Section V. of this manual is the schematic for the Series 200 board; all components on the Series 200 board are assigned circuit designators between 200 and 299 (C201, C202, etc).

a. **Ramp Generator.** IC205 is the active component of an integrator, that produces a negative-going ramp signal used to control the level to which the energy storage bank is charged. As the ramp voltage becomes more negative, the charging level increases and more energy is released to the treating coil when the bank is discharged.

The level of the first demagnetizing pulse is determined by the setting of START LEVEL potentiometer R34; this controls the integrator's start point. When RESET switch S3 is pressed, analog switch IC202 closes, resetting the integrator.

The voltage rise time across integrating capacitor C201 is determined by the current flowing through resistor R211. A faster rise time can be achieved by pressing FAST switch S5; this will cause analog switch IC203A to close, connecting R211 to the +12-volt supply through FAST potentiometer R32. A slower rise time is obtained when SLOW switch S4 is pressed, causing analog switch IC203B to place SLOW potentiometer R33 is series with R211; its higher resistance will result in a slower rise time. When S4 and S5 are both in the ON position, an intermediate rate is selected.

b. **Timing.** Analog switches IC203A and IC203B receive their control voltages through AND gates IC207C and IC207D. These gates are enabled by transistor Q201, which is controlled by trigger timer IC210. Trigger inputs enter the Series 200 board at edge connector terminal H. Resistor R232 and capacitor C211 control the timing of IC210, which determines the timing of each integrator charging cycle.

Integrating periods will last as long as S4 and/or S5 is pressed and the trigger timer is producing output pulses. Each integrating period will produce a larger treating pulse. Input current to the integrator will stop when S4 and S5 are no longer pressed, or when the integrator saturates.

The integrator circuit's drift is minimized so that the operator can momentarily interrupt the treating process to obtain an accurate level reading on the items being treated. When the operator restarts the process, it will begin at the same level it was at when interrupted.

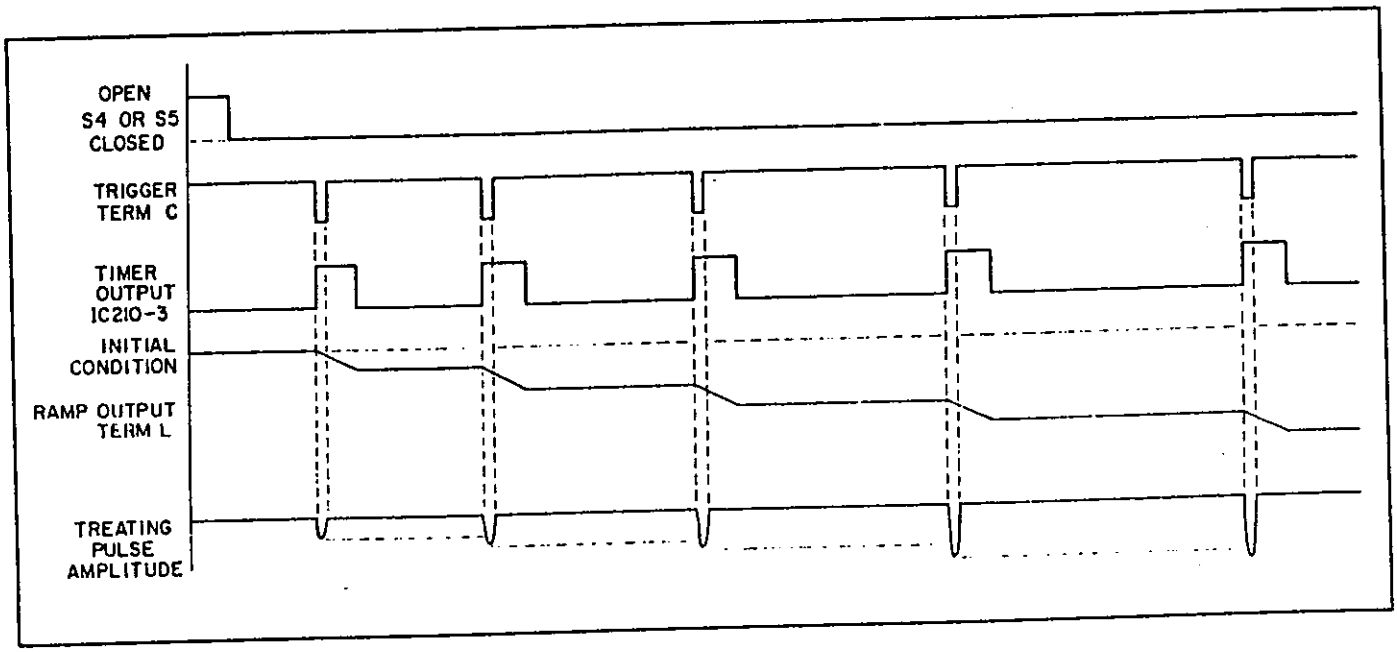


Figure 4-2. Timing Diagram, Series 200 Dual-Slope Control Board

Figure 4-2 is a timing diagram showing the development of the treating pulse under control of a negative-going RAMP OUTPUT signal at edge connector terminal L. Because each integration period is controlled by the trigger timer, each incremental increase in treating pulse amplitude is exactly the same as the preceding one, regardless of the pulse-repetition rate.

c. **Dual-Slope Inhibit Function.** If the treating operation is continued for an extended period of time, the integrator can saturate before the end point is reached. If this happens, the virtual ground between pins 2 and 3 of operational amplifier IC205 will disappear, forcing the voltage on pin 2 of operational amplifier IC206 to become more positive. IC206 is connected as a voltage comparator, with a 50-mV reference level. When the voltage at pin 2 of IC206 reaches 50 mV, pin 6 of IC206 will switch from +12 volts to -12 volts. This creates a logic low that directs NAND Schmitt trigger IC201 to send an INHIBIT pulse to edge connector terminal 20. INHIBIT indicator DS407 on the front panel will also light, telling the operator to check all control settings on the Model 990C and the gaussmeter connected to it.

4. **Series 300 Automatic Module Main Board (Model 990C Only)**

The Series 300 Automatic Module Main Board works together with the Series 400 Automatic Module Control Board to automatically control Model 990C operation. The Series 300 board contains a channel for accepting and processing the input from the external gaussmeter. It also contains five

comparator circuits which test for certain magnetic levels at different points in the treating process. Logic gates and timers are also included to implement automatic operation.

Figure 5-6 in Section V. of this manual is the schematic for the Series 300 board. All components on the Series 300 board are assigned circuit designators between 300 and 399 (C300, C301, C302, etc).

a. **Gaussmeter Channel.** The analog gaussmeter signal enters the Series 300 board at edge connector terminal Z, and is gated by analog switch IC305A. IC305A disconnects the gaussmeter signal during each treating pulse, and for a short time after each pulse. IC304, capacitor C306, resistor R328, and BLANKING potentiometer R327 form the blanking timer, which determines how long IC305A is open after a treating pulse appears at edge connector terminal H.

   The absolute value of the gaussmeter signal is generated by a full-wave precision rectifier formed from operational amplifiers IC301C and IC301B. The gain of the gaussmeter channel is controlled by GAIN potentiometer R113, which controls the gain of operational amplifier IC301A. The output of IC301A is fed to the digital voltmeter on the Series 400 board, and to the comparator circuits on the Series 300 board. Optical isolator IC303 allows external signals to be accepted and used to blank the gaussmeter.

b. **Comparator Circuits.** The Series 300 board contains five comparator circuits, which compare the measured flux density level to reference levels established by the potentiometers on the Series 400 board for different portions of the treating process. The functions of these five circuits are as follows:

   1. When the treating fixture is empty or an item is in a place that has not been magnetized, there is a logic high at pin 8 of operational amplifier IC316C. This turns off all indicators on the Series 400 board, and resets flip-flop IC309B. This condition will exist whenever the gaussmeter signal is less than 5 percent of full-scale, as set by resistors R323 and R324.

   2. When a properly saturated magnet is placed in the treating fixture, the gaussmeter signal will raise the voltage at pin 10 of operational amplifier IC317C high enough to cause it to change states. Its output (pin 8) will go high, triggering flip-flop IC309B and starting the treating process at the fast rate.

If the magnet in the fixture is not saturated to the minimum level required, the process will not start.

3. When the gaussmeter signal falls to the level set by SLOW DOWN potentiometer R441, pin 7 of operational amplifier IC317B will change from a logic low to a logic high. This triggers AND gates IC312A and IC312B, placing a logic low on edge connector terminal 18; this is a signal to the Series 200 Dual Slope Control Board to change to the slow mode.

   At the same time, a logic high appears at pin 4 of operational amplifier IC310B; this will turn on transistor Q401, creating the FAST TRIAC TURN OFF signal at edge connector terminal 15. This signal is fed to the Series 100 Comparator Board, where it is used to turn off fast triac Q5 in the main chassis. By slowing the rate at which the treating pulse amplitude is increased, the resolution is improved as the flux density level approaches the desired end point.

4. When the gaussmeter signal falls to the level set by COMPLETE potentiometer R436, pin 1 of operational amplifier IC317A will change from low to high. This will produce the COMPLETE signal at edge connector terminal Y, terminating the treating process.

   If the gaussmeter signal falls below the level set by R436, the logic high at pin 1 of IC317A will pass through NOR gates IC306B, IC306C, IC308B, and IC308D to drive the inhibit bus.

   In the event that this comparator receives a false indication (which may be caused by insufficient settling time for the reading), treating will resume if the magnetic level rebounds above the level set by R436.

5. Pin 14 of operational amplifier IC317D will change state from low to high if the measured flux density falls below the LOW REJECT limit set by potentiometer R435. This will cancel out the COMPLETE signal through operational amplifier IC301D and light LOW REJECT indicator DS409. The treating process will have already been stopped, because the magnetic level is below the level set by COMPLETE potentiometer R436.

Charging of the energy storage bank is also inhibited during the period of the treating gate and the blanking timer by NOR gates IC308A and IC308D, which control the inhibit bus.

c. **Automatic Reset.** Once the treating process is completed and flip-flop IC309B is reset, it is usually desirable to reset the dual-slope integrator, because the treating fixture is usually emptied at this time. Reset will occur if the RESET jumper is placed in the AUTO position. A reset pulse will be generated by reset timer IC307, which is started every time IC309B is reset.

Optical isolator IC302 allows external reset signals to be used to reset the integrator. These external signals will be used if the RESET jumper is placed in the NON position.

d. **Other Control Signals.** The COMPLETE signal, which appears as a logic high at pin 11 of AND gate IC312D, is carried through transistor Q302 to the Series 100 Comparator Board. On the comparator board, it is used to harmlessly discharge any remaining energy in the energy storage bank. This serves to prevent unexpected treating pulses.

A signal will enter the Series 300 board at edge connector terminal U if the integrator is saturated. This signal will be gated through to INCOMPLETE indicator DS407 on the front panel.

Operational amplifier IC310B is connected as a voltage follower. It is used as a buffer between the level-setting potentiometers and the digital voltmeter on the Series 400 board.

e. **External Reference Control.** If the REM/NORM jumper is in the REM position, external reference voltages can be applied across terminals 15, 17, and 19 of rear panel connector J302. If this jumper is in the NORM position, the reference voltage is set by REFERENCE potentiometer R318.

f. **External Blanking.** If desired, external blanking pulses can be applied across pins 12 and 14 of rear panel connector J302. These pulses will be fed to blanking timer IC304 through optical isolator IC303, NOR gate IC306A, and their associated components.

> **NOTE**
>
> **Model 990A Magnetreaters are not equipped with Series 300 boards, and a jumper must be installed on the card cage motherboard to complete the inhibit bus loop. Refer to Section II. for further information.**

5. Series 400 Automatic Module Control Board (Model 990C Only)

The Series 400 Automatic Module Control Board works together with the Series 300 Automatic Module Main Board to control automatic operation of the Model 990C. The Series 400 board is mounted immediately behind the front panel of the Model 990C. Figure 5-7 in Section V. of this manual is the schematic for the Series 400 board. All components on the Series 400 board have circuit designators between 400 and 499 (C400, C401, C402, etc).

This board contains a digital voltmeter formed from A/D converter IC401 and seven-segment displays DS401 through DS404. The voltage to be measured enters IC401 at pin 31. FULL SCALE potentiometer R402 is used to calibrate the full scale reading of the digital voltmeter.

Voltage regulator IC403 provides regulated 5-volt power for the digital voltmeter. Input power for IC403 comes from a reference diode on the Series 300 board.

Rotary switch S402 is used to control the voltmeter display; it can either display the present magnetic flux level or the flux levels set by potentiometers R435 (LOW REJ), R436 (COMPLETE), R441 (SLOW DOWN), and R442 (MIN SAT). These levels are used to control the treating process, and LED indicators DS405 through DS409 monitor the status of the process.

Toggle switch S401 is used to enable or disable the Series 300 and Series 400 boards. When S401 is in the AUTOMATIC position, the boards are enabled and the Model 990C is set for automatic operation. If S401 is in the MANUAL/RAMP position, the Model 990C can be used for regular manual or dual-slope operation.

6. Series 500 D/A Reference Generator Board (Optional - Model 990A Only)

The series 500 D/A Reference Generator is used in conjunction with the IEEE-488 interface option to convert parallel BCD inputs into analog signals that can be used by the Series 100 Comparator Board. The BCD input can range between +1999 (representing minimum treating pulse amplitude) to -1999 (maximum amplitude). From this BCD input, the Series 500 board will generate a negative-going reference signal; the more negative the reference signal, the greater the treating pulse amplitude.

The Series 500 card is installed in the space vacated by the Series 200 board when the fast and slow channels of the Model 990A are placed under IEEE-488 control. A ribbon cable is used to send parallel BCD inputs from the Series 600 IEEE-488 Interconnecting Board to the Series 500 board; all components on the Series 500 board are assigned designators between 500 and 599 (C500, C501, C502, etc).

a. **Reference Voltage Generators.** Operational amplifier IC509 generates a positive 2-volt reference, which is stabilized by diode CR511; operational amplifier IC508 generates a negative 2-volt reference. Dual analog switch IC510 selects one of these reference voltages, as determined by the $\pm$ (2000) input to the Series 500 board.

   Two inverters in hex inverter IC504 are used to process the $\pm$ (2000) signal. One inverter (pin 3 in, pin 4 out) inverts the input and applies it to pin 2 of IC510. When pin 2 goes low, the negative 2-volt reference generated by IC508 is passed on to the D/A converter. The other inverter (pin 5 in, pin 6 out) inverts the input a second time and applies it to pin 1 of IC510. When pin 1 goes low, the positive 2-volt reference is passes on to IC503; this assures that only one reference voltage at a time will be applied to IC503.

b. **D/A Converter.** IC503 is a 3 1/2-digit D/A converter, which receives its digital inputs from the Series 600 board through the interconnecting ribbon cable. The input lines are buffered by hex buffers IC501 and IC502 before being applied to IC503. The output of IC503 (pin 1) is passed on to the gain and offset circuit.

c. **Gain and Offset Circuit.** Operational amplifiers IC506 and IC507 and their associated components form the gain and offset circuit. This circuit determines the voltage range for the Series 500 board output signal (ANALOG SIGNAL OUT).

1. **+12 to -12 Volts.** When this range is selected, offset current from +2-volt reference generator IC509 is removed by omitting either R505 or R506. A 60K resistor is placed in the feedback loop of IC507 (between the turrets provides at R507); this sets the gain of IC507.

2. **Zero to -8 Volts.** For this range, R505 and R506 are in place, and a 60K resistor is used for R507.

7. **Series 600 IEEE-488 Interconnecting Board (Optional - Model 990A Only)**

The Series 600 IEEE-488 Interconnecting Board provides the mechanical and electrical interface between the Model 990A and the optional IEEE-488 coupler module. The coupler module plugs into a mating connector on one side of the Series 600 module, and a dual-slope latch board plugs into a mating connector on the other side. Figure 5-9 in Section V. of this manual is the schematic for the Series 600 Board; all components on the Series 600 board are assigned circuit designators between 600 and 699 (C600, C601, C602, etc).

a. **BCD Input Processing.** The BCD data received from the external gaussmeter is applied to the Series 600 board through connector P603. Resistor networks RZ601 and RZ602, diode networks CRZ601 and CRZ602, and capacitors C601 through C614 filter these lines and suppress any spikes that may be present. These lines are applied to the coupler module through connector J601.

Connector P601 accepts a mating connector that passes the BCD data to the Series 500 board.

b. **IEEE-488 Bus Connections.** Connector P604 accepts a mating connector that connects the Series 600 board to the IEEE-488 connector and address switch on the rear panel.

c. **Voltage Regulator.** Switching regulator IC603, transistors Q601, Q602, and Q605, and their associated components form a switching voltage regulator. It is powered from an unregulated 20-volt source and provides regulated 5-volt power for all IEEE-488 circuits. VOLTAGE ADJ potentiometer R616 is used to adjust the regulator output voltage.

d. **Level Shifters.** Quad voltage shifters IC604 through IC607 are used to convert the coupler module output signals (12 to 15 VDC) to the 5-volt level required by the Series 500 D/A Reference Generator.

e. **Relay and Device Drivers.** Transistor arrays IC601 and IC602 invert, level-shift, and sink currents for operating relays and other devices in a magnet processing system. The FAST and SLOW outputs of IC601 are fed to the piggyback dual-slope latch card through connector P602. The RESET, INHIBIT, REVERSE, SLOW DOWN, and ALARM outputs are passed through edge connector terminals W, J, X, R, and 13 to other cards inside the Model 990A.

Three outputs of IC602 are used to drive relays K601 through K603, which can control an external magnet charger; K601 will fire the charger when the FIRE RY signal is present, K602 will use the ENERGIZE RY signal to energize the charger, and the PROGRAM RY signal will command K603 to control the charger's programming relay. The other outputs from IC602 (HALT and RETRIGGER) are passed to edge connector terminals L and N for use by other Model 990A boards.

f. **4 1/2-Digit Option.** Resistors R602 through R605 provide input protection for applications using a 3 1/2-digit BCD input. If a 4 1/2-digit BCD input is to be used, these resistors are omitted.

g. **Dual-Slope Latch Board.** The dual-slope latch board is mounted to the Series 600 board in a piggyback arrangement, through a mating connector on the solder side of the Series 600 board. Its latch circuits control the FAST and SLOW outputs from the relay and device drivers in the Series 600 board; this allows the fast and slow channels of the Model 990A to be placed under IEEE-488 control.

h. **Coupler Module.** The coupler module converts the BCD data received from the external gaussmeter into the format required by the IEEE-488 bus. This module is not manufactured by Magnetic Instrumentation, Inc., so its operation is beyond the scope of this manual. An instruction manual prepared by the module manufacturer will be furnished with every Model 990A Magnetreater equipped with the IEEE-488 option.

SECTION V. MAINTENANCE INFORMATION

WARNING

LETHAL VOLTAGES ARE STORED IN THE ENERGY STORAGE BANK. THESE VOLTAGES REMAIN IN THE STORAGE BANK EVEN AFTER THE MODEL 990 IS TURNED OFF. DO NOT ATTEMPT TO TROUBLESHOOT THE MODEL 990 UNTIL THE ENERGY STORAGE BANK IS DISCHARGED, USING THE PROCEDURE IN SECTION B. DISCHARGING THE ENERGY STORAGE BANK.

WHENEVER POSSIBLE, PERFORM MAINTENANCE ON THE MODEL 990 WITH THE POWER CORD DISCONNECTED FROM THE AC LINE. IF TROUBLE-SHOOTING IS TO BE PERFORMED WITH THE MODEL 990 TURNED ON, OBSERVE THE SAFETY PRECAUTIONS LISTED AT THE BEGINNING OF THIS MANUAL TO AVOID EXPOSURE TO HAZARDOUS VOLTAGES.

THE MODEL 990'S ENCLOSURE IS NOT CONNECTED TO ANY PART OF THE OPERATING CIRCUIT; IT IS CONNECTED TO EARTH GROUND THROUGH THE GROUND LEAD OF THE POWER CORD. A "FLOATING GROUND" CIRCUIT IS USED TO PROTECT THE OPERATOR FROM ELECTRICAL SHOCK IN THE EVENT OF A HIGH-VOLTAGE BREAKDOWN. IN ORDER FOR THE FLOATING GROUND TO WORK, THERE MUST BE CONTINUITY BETWEEN THE GROUND PIN OF THE POWER CORD AND THE MODEL 990'S ENCLOSURE; ALWAYS CHECK THIS BEFORE ATTEMPTING TO TROUBLESHOOT THE MODEL 990 WHILE IT IS TURNED ON.

A. INTRODUCTION

This section provides maintenance information for the Model 990 Magnetreater.

Under normal operating conditions, the Model 990 requires no daily maintenance. After every 1000 hours of service, all relay contacts should be checked and burnished if necessary.

B. DISCHARGING THE ENERGY STORAGE BANK

Capacitors C12 and C13 form the Model 990's energy storage bank. This bank can hold a charge even after the Model 990 is turned off, and contact with either capacitor (or any part of the Model 990's high-voltage circuits) will result in an electrical shock.

In order to safely work inside the Model 990 with the power off, the energy storage bank must be discharged. This is done by temporarily shorting the capacitor bank with a 10,000-ohm resistor, to bleed off the charge stored in the capacitors and eliminate the high-voltage hazard.

The resistor used must be rated for at least 25 watts, so it will be able to handle the peak discharge current without being damaged. Attach this resistor to an insulated handle at least 12 inches (305 mm) long; this will keep your hands far enough away from the point of discharge to prevent a shock. Solder a short piece of solid wire to each end of the resistor, and bend the wires as required until their ends are 2 inches (51 mm) apart; this is the spacing required by the terminals of C12 and C13.

To use the bleeder resistor to discharge the energy storage bank, proceed as follows:

1. Place the POWER switch on the Model 990 front panel in the OFF position.

2. Disconnect the Model 990's line cord from its mating connector on the rear panel.

3. Using a screwdriver, remove the screws securing the top cover to the rear panel and slide the top cover back and off.

4. using a screwdriver, remove the large safety shield toward the front left of the unit to expose energy storage capacitors C12 and C13.

5. Hold the bleeder resistor by the end of its handle and use it to short out either one of the capacitors; touch its leads against the terminals on the top of the capacitor, and hold it there for a few seconds.

   Being as C12 and C13 are connected in parallel, touching the bleeder resistor to one capacitor's terminals will discharge both capacitors.

6. Place the safety shield back in position. Install and tighten the screws to secure the shield in place.

7. Place the top cover back in position, making sure that the safety interlock on the inside of the cover is in place. Install and tighten the screws to secure the cover in place.

8. Reconnect the power cord to its mating connector on the rear panel.

WARNING

BE SURE YOU HAVE READ AND FULLY UNDERSTAND THE FOLLOWING PARAGRAPH AND THE SAFETY PRECAUTIONS LISTED AT THE BEGINNING OF THIS MANUAL BEFORE ATTEMPTING TO CHECK ANY OF THE MODEL 990'S HIGH-VOLTAGE CIRCUITS.

C. CHECKING HIGH-VOLTAGE CIRCUITS

When checking the Model 990's high-voltage circuits with a voltmeter, observe the following procedure to minimize the shock hazard:

1. Stand on an insulated pad.

2. Make sure the Model 990's POWER switch is in the OFF position.

3. Make connections while using only one hand. Keep the other hand in your pocket; this will avoid the possibility of accidentally touching a live circuit or ground.

4. Set the voltmeter range selector to a range that will display the anticipated voltage reading without overranging.

5. Connect the voltmeter to the circuit to be measured.

6. Place the Model 990's POWER switch in the ON position.

7. Note the voltmeter reading.

   For safety, do not touch the Model 990, the voltmeter, or the voltmeter leads.

8. Place the Model 990's POWER switch in the OFF position.

9. After waiting one full minute, discharge the energy storage bank, using the procedure given in Section B. Discharging the Energy Storage Bank.

10. Disconnect the voltmeter from the circuit.

D. TROUBLESHOOTING

If the Model 990 fails to operate, use the procedures in the following paragraphs to locate the problem.

1. Preliminary Checks

The preliminary procedure is designed to locate the source of the trouble as quickly as possible. Perform all steps in the order presented; expected results or comments appear in **boldface** type.

a. Make sure the Model 990's power cord is plugged into a live AC outlet.

If the outlet is not live, check for a blown fuse or tripped circuit breaker in the building wiring. If a switched outlet is being used, make sure the switch controlling it is turned on. If voltage still isn't present at the outlet, use another outlet.

b. Place the Model 990's POWER switch in the ON position.

The red POWER indicator on the front panel should light; if not, place the POWER switch in the OFF position, disconnect the power cord from its mating connector on the rear panel, and check both input fuses. Replace any blown fuses.

If the fuses are good, check the safety interlock on the top cover, to make sure it is properly engaged. If not, remove the top cover and put it back on, making sure the interlock is properly engaged.

If the fuses are good and the safety interlock was properly engaged, go to 2. Detailed Analysis.

c. Place the POWER switch in the ON position, and connect a known-good treating coil to the OUTPUT connector.

d. Set the Model 990's front panel controls as follows:

CONTROL switch - MANUAL
COARSE control - Mid-range
FINE control - Mid-range
PULSE RATE control - Mid-range
TREAT switch - OFF

e. Place the TREAT switch in the ON position and listen for audible thumps coming from the Model 990.

If thumps are heard, treating pulses are being passed through the treating coil.

If no thumps are heard, the fault may lie in the control circuits or the firing circuit for triac Q8. Refer to 2. Detailed Analysis to determine the exact location of the fault.

If the control and firing circuits are functioning properly, replace triac Q8; refer to Section E. Replacing the Triac for the procedure to be used.

2. Detailed Analysis

Failure of the Model 990 to perform properly can be caused not only by defective components within the Model 990 itself, but also by improper connections to the AC source, the treating coil, and other equipment being used with the Model 990. Before attempting to troubleshoot the Model 990, refer to Sections II and III of this manual and make sure all connections were properly made, and that the Model 990 was used properly.

If the problem can be traced to the Model 990 itself, the exact nature of the failure is a most valuable symptom. An understanding of how the Model 990 works, as discussed in Section IV of this manual, will help to suggest the general area where the fault is located. Be sure to check the obvious faults (such as no input power, a blown fuse, or no output from the power supply) before attempting extensive troubleshooting of the Model 990.

Circuit faults can usually be localized by taking voltage measurements with the aid of the circuit schematics in this section. Signal paths can also be traced with an oscilloscope. The oscilloscope can also be used to check the presence and frequency of all clock signals, or to trace signals in the digital sections of the Model 990.

3. Troubleshooting the IEEE-488 Interface Option (Model 990A Only)

The first step in troubleshooting the Model 990A's IEEE-488 interface option is to verify that all connections between the Model 990A, the gaussmeter providing the BCD input, and the IEEE-488 bus controller have been properly made. If the bus controller has a built-in diagnostic routine, this should be run to verify the operation of the bus controller. The gaussmeter should also be checked, to make sure that it is providing the Model 990A with a valid BCD input. If all connections were properly made and the bus controller and gaussmeter are both functioning properly, it can be assumed that the problem lies within the Model 990A.

Make sure all circuit boards are fully inserted into their mating connectors. Also check all interconnecting ribbon cables, to make sure none are damaged or disconnected.

There are four LED indicators on the edge of the IEEE-488 coupler module. These indicators are visible from the back of the Model 990A, through the space between the rear panel and the safety interlock (directly above the input fuses). The functions of the indicators are as follows:

Top Indicator - MLA (Module Listen Address); lights when the coupler module has recognized its LISTEN address, or when the coupler module has been placed in the LISTEN ONLY mode.

Second-Front-Top Indicator - MTA (Module Talk Address); lights when the coupler module has recognized its TALK address, or when the coupler module has been placed in the TALK ONLY mode.

Second-Front-Bottom Indicator - RDY (Ready); lights when the inputs on the two status lines match the user's selected logic levels.

Bottom Indicator- PWR (Power); lights when the coupler module has successfully passed its power-on-self-test.

If the PWR indicator does not come on at all, fuse F601 on the Series 600 Interconnecting Board may be blown, or the 5-volt regulator on the Series 600 card may not be functioning. If F601 is good and the 5-volt regulator is functioning properly, and the PWR indicator still doesn't light, the coupler module is defective; refer to the coupler module instruction manual for further information.

If the PWR indicator lights but none of the other indicators light, the problem may be located on the coupler module, the Series 600 Interconnecting Board, or the ribbon cables that connect to the Series 600 board.

Table 5-1 shows edge connector terminal assignments for each line into and out of the coupler module during the LISTEN mode; Table 5-2 shows these assignments during the TALK mode. Table 5-3 shows the wire assignments for the ribbon cable between connector J603 on the Series 600 Interconnecting Board and connector J501 the Series 500 D/A Reference Board. These tables may be useful when troubleshooting the IEEE-488 interface by tracing signals.

WARNING

BE SURE TO OBSERVE THE SAFETY PRECAUTIONS LISTED AT THE BEGINNING OF THIS MANUAL WHILE REPLACING THE TRIAC.

E. REPLACING THE TRIAC

The following equipment will be required if troubleshooting indicates that triac Q8 has to be replaced:

1. A replacement triac with all required hardware. (See parts list # 12007087 at the end of this manual for replacement information.)

2. A tube of heatsink compound.

3. A bleeder resistor.

4. A voltmeter or multimeter, capable of measuring up to 600 VDC without overranging.

5. Two 6-inch clip leads with alligator clips on each end.

Perform all steps in the order presented. Expected results or comments appear in **boldface** type.

1. Stand on an insulated pad.

2. Discharge the energy storage bank by using the procedure in Section V-B. Discharging the Energy Storage Bank.

3. Make sure the Model 990's POWER switch is in the OFF position.

4. Set a multimeter for voltage measurements, on its highest range.

5. Connect the multimeter across one of the capacitors in the energy storage bank.

   Make connections while using only one hand. Keep the other hand in your pocket; this will avoid the possibility of accidentally touching a live circuit or ground.

6. Note the reading on the multimeter.

   The multimeter should indicate zero volts, meaning that the energy storage bank is fully discharged. If it indicates that voltage is present, discharge the energy storage bank again by touching the bleeder resistor to the terminals of one of the capacitors. (Because the capacitors in the energy storage bank are in parallel, they will both be discharged.)

7. Connect a clip lead across the terminals of each capacitor in the energy storage bank.

8. Remove and replace the triac.

   Always use a new mica insulator when replacing the triac, and coat both sides of the insulator with enough heatsink compound to insure good heat transfer between the triac and the heatsink.

9. Remove the clip leads from across the capacitors in the energy storage bank.

10. Place the safety shield back in position. Install and tighten the screws to secure the shield in place.

11. Place the top cover back in position, making sure that the safety interlock on the inside of the cover is in place. Install and tighten the screws to secure the cover in place.

12. Test the Model 990 for proper operation by using the general troubleshooting procedure in Section D-1. Preliminary Checks.

    If the general troubleshooting procedure can be successfully completed, the Model 990 is functioning properly. If it cannot be successfully completed, refer to Section D-3. Troubleshooting the IEEE-488 Interface Option for information on isolating the cause of trouble.

F. HOW TO ARRANGE FOR SERVICING

If necessary, the Model 990 may be returned for calibration or repair. Contact Magnetic Instrumentation, Inc. for further information.

Table 5-1. IEEE-488 Interface Option Terminal Assignments During LISTEN Mode

	Digit	Edge Connector	BCD Output Connector J603	Coupler Module Mating Connector J601	Coupler Module Channel	Function of Line
MSD	1	19-20	...	A30	CH 1	Energizing Relay
	2	21-22	...	A29	CH 2	Firing Relay
	4	17-18	...	A28	CH 3	Programming Relay
	8	J	...	A27	CH 4	Treat ON/OFF
	1	U	...	A31	CH 5	Fast
	2	V	...	A26	CH 6	Slow
	4	W	...	C27	CH 7	Reset
	8	...	16	B27	CH 8	Trigger (spare)
	1	...	15	A25	CH 9	Inhibit (spare)
	2	N	...	C26	CH 10	Retrigger
	4	L	...	B26	CH 11	Halt
	8	X	...	C25	CH 12	Reverse Relay
	1	...	2	C24	CH 13	1000
	2	...	1	A23	CH 14	-2000
	4	R	...	A24	CH 15	Slowdown
	8	13	...	R25	CH 16	Alarm (spare)
	1	...	6	A19	CH 17	100 *
	2	...	5	A20	CH 18	200 *
	4	...	4	C20	CH 19	400 *
	8	...	3	B21	CH 20	800 *
	1	...	10	B20	CH 21	10 *
	2	...	9	B15	CH 22	20 *
	4	...	8	C15	CH 23	40 *
	8	...	7	B16	CH 24	80 *
LSD	1	...	14	C16	CH 25	1 *
	2	...	13	A17	CH 26	2 *
	4	...	12	C18	CH 27	4 *
	8	...	11	A18	CH 28	8 *

* - 3 1/2-digit BCD input to Series 500 D/A Reference Generator Board.

Table 5-2. IEEE-488 Interface Option Terminal Assignments During TALK Mode

	Digit	BCD Input Connector P603	Coupler Module Mating Connector J601	Coupler Module Channel	Function of Line
MSD	1	...	A16	CH 29	Treating Gate
	2	...	B17	CH 30	(1)
	4	...	C17	CH 31	(1)
	8	...	B18	CH 32	(1)
	1	18	B14	CH 33	Negative Polarity
	2	...	C14	CH 34	(1)
	4	...	A15	CH 35	(1)
	8	...	A14	CH 36	(1)
	1	7	A13	CH 37	1000(2)
	2	...	C13	CH 38	(3)
	4	...	B13	CH 39	(3)
	8	...	C12	CH 40	(3)
	1	5	B12	CH 41	100(2)
	2	16	A12	CH 42	200(2)
	4	6	C11	CH 43	400(2)
	8	17	B11	CH 44	800(2)
	1	3	A10	CH 45	10(2)
	2	14	B10	CH 46	20(2)
	4	4	C10	CH 47	40(2)
	8	15	A11	CH 48	80(2)
	1	1	B6	CH 49	1(2)
	2	12	C6	CH 50	2(2)
	4	2	B7	CH 51	4(2)
	8	13	C7	CH 52	8(2)
LSD	1	21	C5	CH 53	0.1(4)
	2	22	B5	CH 54	0.2(4)
	4	23	C4	CH 55	0.4(4)
	8	24	B4	CH 56	0.8(4)

(1) Tied to the +5-volt supply through a 2200-ohm resistor. If the two most-significant digits are not used, all eight lines are tied to the +5-volt supply through a 2200-ohm resistor. This causes the leading zeros to be suppressed.

(2) 3 1/2- or 4 1/2-digit BCD input from a gaussmeter.

(3) Tied to ground through a 2200-ohm resistor.

(4) BCD input from a gaussmeter. If these lines are not used, they must be tied to the +5-volt supply through a 2200-ohm resistor.

Table 5-3. BCD Output Cable Wire Assignments for IEEE-488 Interface Option

Pin	Signal
1	±(2000)
2	1000
3	800
4	400
5	200
6	100
7	80
8	40
9	20
10	10
11	8
12	4
13	2
14	1
15	INHIBIT *
16	Spare

* If the IEEE-488 interface is used with the Series 200 Dual Slope Control Board, INHIBIT is automatically generated by releasing the SLOW and FAST switches on the front panel.

When the Series 500 D/A Reference Board is used, the INHIBIT signal is at pin A27 of the IEEE-488 coupler module 8=RUN, 0=INHIBIT). It is connected to the normal INHIBIT on terminal 22 of connector J2 on the motherboard.

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 08005027 MODEL 990A MAGNETREATER 115V

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	12007079	990A,B,C CABINET ASSEMBLY	MII	95605 RFL
10	1.0000	18007238	TREATING COIL CABLE ASSEMBLY	MII	26101 RFL
11	1.0000	77006365	#18 AWG 3 CONDUCTOR 125 VOLT 7 AMP	AMERICAN ELC	7500-75EMF
2	1.0000	12007087	990A,B,C MAIN FRAME ASSEMBLY	MII	95640 RFL
3	1.0000	12007092	990A FRONT PANEL ASSEMBLY	MII	95660 RFL
4	1.0000	11019103	990 A/C COMPARATOR BOARD	BQ PRODUCTS	
6	1.0000	12007091	990A REAR PANEL ASSEMBLY	MII	95675 RFL
7	1.0000	18006796	990A,B,C AC HOOK-UP HARNESS	MII	96214 RFL
8	1.0000	18006817	990A,B,C MAIN HARNESS	MII	98665 RFL
9	1.0000	18006696	990A,B,C CABLE, SWITCH & INDICAT BD	MII	HB 95672 RFL

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 08005028 MODEL 990C MAGNETREATER 115V

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	12007079	990A,B,C CABINET ASSEMBLY	MII	95605 RFL
2	1.0000	12007087	990A,B,C MAIN FRAME ASSEMBLY	MII	95640 RFL
3	1.0000	12007089	990C FRONT PANEL ASSEMBLY	MII	95662 RFL
4	1.0000	12007090	990C REAR PANEL ASSEMBLY	MII	95675 1 RFL
5	1.0000	18007238	TREATING COIL CABLE ASSEMBLY	MII	26101 RFL
6	1.0000	18006765	990C AUTOMATIC MODULE CABLE	MII	B 95657 RFL
7	1.0000	18009664	912 TO 990C COAXIAL CABLE BNC/BNC	MII	
8	1.0000	77006365	#18 AWG 3 CONDUCTOR 125 VOLT 7 AMP	AMERICAN ELC	7500-75EMF
PCB2	1.0000	11007082	990C MAIN BOARD AUTO MODULE ASSY	MII	95655 RFL
PCB3	1.0000	11007083	990C CONTROL BOARD AUTO MODULE ASSY	MII	95656 RFL
PCB4	1.0000	11007081	990C DUAL SLOPE BOARD ASSEMBLY	MII	95620 RFL
PCB5	1.0000	11019103	990 A/C COMPARATOR BOARD	BQ PRODUCTS	
WH1	1.0000	18006817	990A,B,C MAIN HARNESS	MII	98665 RFL
WH2	1.0000	18006816	990A,B,C DUAL SLOPE HARNESS	MII	98664 RFL
WH3	1.0000	18006796	990A,B,C AC HOOK-UP HARNESS	MII	96214 RFL
WH4	1.0000	18006696	990A,B,C CABLE, SWITCH & INDICAT BD	MII	HB 95672 RFL

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 08007061 MODEL 990A MAGNETREATER 230V

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	12007079	990A,B,C CABINET ASSEMBLY	MII	95605 RFL
10	1.0000	18007238	TREATING COIL CABLE ASSEMBLY	MII	26101 RFL
11	1.0000	77004456	#18 AWG 3 COND. 220 VAC CORD SET	AMERICAN ELC	AEC 32
2	1.0000	12007087	990A,B,C MAIN FRAME ASSEMBLY	MII	95640 RFL
3	1.0000	12007092	990A FRONT PANEL ASSEMBLY	MII	95660 RFL
4	1.0000	11019103	990 A/C COMPARATOR BOARD	BQ PRODUCTS	
6	1.0000	12007091	990A REAR PANEL ASSEMBLY	MII	95675 RFL
7	1.0000	18006796	990A,B,C AC HOOK-UP HARNESS	MII	96214 RFL
8	1.0000	18006817	990A,B,C MAIN HARNESS	MII	98665 RFL
9	1.0000	18006696	990A,B,C CABLE, SWITCH & INDICAT BD	MII	HB 95672 RFL
F2	1.0000	57605788	.75 AMP 250V SB 3AG	LITTLEFUSE	313.750

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 08007062 MODEL 990C MAGNETREATER 230V

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	12007079	990A,B,C CABINET ASSEMBLY	MII	95605 RFL
2	1.0000	12007087	990A,B,C MAIN FRAME ASSEMBLY	MII	95640 RFL
3	1.0000	12007089	990C FRONT PANEL ASSEMBLY	MII	95662 RFL
4	1.0000	12007090	990C REAR PANEL ASSEMBLY	MII	95675 1 RFL
5	1.0000	18007238	TREATING COIL CABLE ASSEMBLY	MII	26101 RFL
6	1.0000	18006765	990C AUTOMATIC MODULE CABLE	MII	B 95657 RFL
7	1.0000	18009664	912 TO 990C COAXIAL CABLE BNC/BNC	MII	
8	1.0000	77004456	#18 AWG 3 COND. 220 VAC CORD SET	AMERICAN ELC	AEC 32
F2	1.0000	57605788	.75 AMP 250V SB 3AG	LITTLEFUSE	313.750
PCB2	1.0000	11007082	990C MAIN BOARD AUTO MODULE ASSY	MII	95655 RFL
PCB3	1.0000	11007083	990C CONTROL BOARD AUTO MODULE ASSY	MII	95656 RFL
PCB4	1.0000	11007081	990C DUAL SLOPE BOARD ASSEMBLY	MII	95620 RFL
PCB5	1.0000	11019103	990 A/C COMPARATOR BOARD	BQ PRODUCTS	
WH1	1.0000	18006817	990A,B,C MAIN HARNESS	MII	98665 RFL
WH2	1.0000	18006816	990A,B,C DUAL SLOPE HARNESS	MII	98664 RFL
WH3	1.0000	18006796	990A,B,C AC HOOK-UP HARNESS	MII	96214 RFL
WH4	1.0000	18006696	990A,B,C CABLE, SWITCH & INDICAT BD	MII	HB 95672 RFL

ASSEMBLY ID: 11019103 990 A/C COMPARATOR BOARD

ITEM	QUANTITY	MII PART	DESCRIPTION		MANUFACTURER	MANUFACTURER PART NO.
BCB	1.0000	74905046	990A COMPARATOR BD	95610	MII	D 95613 RFL
C101	1.0000	36205795	.001 uF 100V 5%		CORNELL-DUB.	CD19FD102J03
C102	1.0000	36205719	3 uF 50V 5%		WESCO	32MPC
C103	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C104	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z50105Z0 50B
C105	1.0000	36206043	471 pF 500V 2%		CORNELL-DUB.	CD19FD471G03
C106	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C107	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C108	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C109	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C110	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C111	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z50105Z0 50B
C112	1.0000	35505712	.1 uF 200V 2%		WESCO	32MM
C113	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C114	1.0000	36206043	471 pF 500V 2%		CORNELL-DUB.	CD19FD471G03
C115	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C116	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z50105Z0 50B
C117	1.0000	36206043	471 pF 500V 2%		CORNELL-DUB.	CD19FD471G03
C118	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z50105Z0 50B
C119	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C120	1.0000	35800342	.001 uF 500V 10% DISK		SPRAGUE	CE102
C122	1.0000	35800340	.1 uF 25V 20% DISK		MALLORY	LC104M
CR101	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR102	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR103	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR104	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR105	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR106	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR107	1.0000	43505687	LINEAR VOLTAGE REFERANCE 6.9V		NAT'L. SEMI.	LM329BZ
CR108	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR109	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR110	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR111	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR112	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR113	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
IC101	1.0000	43502699	COMPARATOR 4X VOLTAGER		NAT'L. SEMI.	LM339N
IC102	1.0000	43500442	TIMER 1455		MOTOROLA	MC1455P1
IC103	1.0000	43502699	COMPARATOR 4X VOLTAGER		NAT'L. SEMI.	LM339N
IC104	1.0000	43500442	TIMER 1455		MOTOROLA	MC1455P1
IC105	1.0000	44005684	LINEAR OP AMP		NAT'L. SEMI.	LM324N
ICS14	3.0000	42500424	14 PIN DIP SOCKET		AUGAT	814-AG11D-ES
ICS8	2.0000	42500419	*8 PIN DIP SOCKET		AUGAT	808-AG11D-ES
Q101	1.0000	41300410	40V 350/700mA PNP TRANSISTOR		NAT'L. SEMI.	2N2907A
Q102	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.		G.E.	TIP125
Q103	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.		G.E.	TIP125
Q104	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.		G.E.	TIP125
Q105	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.		G.E.	TIP125
Q106	1.0000	41300409	40V 400/800mA NPN TRANSISTOR		NAT'L. SEMI.	2N2222A
Q107	1.0000	41300410	40V 350/700mA PNP TRANSISTOR		NAT'L. SEMI.	2N2907A
Q108	1.0000	41300409	40V 400/800mA NPN TRANSISTOR		NAT'L. SEMI.	2N2222A
Q109	1.0000	41300409	40V 400/800mA NPN TRANSISTOR		NAT'L. SEMI.	2N2222A
Q110	1.0000	41300409	40V 400/800mA NPN TRANSISTOR		NAT'L. SEMI.	2N2222A
Q111	1.0000	41300410	40V 350/700mA PNP TRANSISTOR		NAT'L. SEMI.	2N2907A

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
R101	1.0000	31205626	3.92K 1% .25W	ANY MFG	TYPE RN 1/4
R102	1.0000	31205614	1.21K 1% .25W	ANY MFG	TYPE RN 1/4
R103	1.0000	31205638	7.5K 1% .25W	ANY MFG	TYPE RN 1/4
R104	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R105	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R106	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R107	1.0000	31205634	6.19K 1% .25W	ANY MFG	TYPE RN 1/4
R108	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R109	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R110	1.0000	31205656	33.2K 1% .25W	ANY MFG	TYPE RN 1/4
R111	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R112	1.0000	30200149	470 OHM 1/2W 5% CARBON	ANY MFG	0
R113	1.0000	30200149	470 OHM 1/2W 5% CARBON	ANY MFG	0
R114	1.0000	30200149	470 OHM 1/2W 5% CARBON	ANY MFG	0
R115	1.0000	31405976	470 OHM 2W 5%	MILLS	MRP-2
R116	1.0000	30200083	1.5 K 1/2W 5% CARBON	ANY MFG	0
R117	1.0000	30200083	1.5 K 1/2W 5% CARBON	ANY MFG	0
R118	1.0000	30200083	1.5 K 1/2W 5% CARBON	ANY MFG	0
R119	1.0000	31105820	82 OHM 6.5W 5%	CLAROSTAT	TYPE VC5E
R120	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R121	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R122	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R123	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R124	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R125	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R126	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R127	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R128	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R129	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R130	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R131	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R132	1.0000	31205614	1.21K 1% .25W	ANY MFG	TYPE RN 1/4
R133	1.0000	31205626	3.92K 1% .25W	ANY MFG	TYPE RN 1/4
R134	1.0000	31205674	332K 1% .25W	ANY MFG	TYPE RN 1/4
R135	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R136	1.0000	31205626	3.92K 1% .25W	ANY MFG	TYPE RN 1/4
R137	1.0000	31205626	3.92K 1% .25W	ANY MFG	TYPE RN 1/4
R138	1.0000	31205651	22.1K 1% .25W	ANY MFG	TYPE RN 1/4
R139	1.0000	31205614	1.21K 1% .25W	ANY MFG	TYPE RN 1/4
R140	1.0000	31205621	2.43K 1% .25W	ANY MFG	TYPE RN 1/4
R141	1.0000	31205621	2.43K 1% .25W	ANY MFG	TYPE RN 1/4
R142	1.0000	31205621	2.43K 1% .25W	ANY MFG	TYPE RN 1/4
R143	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R144	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R145	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R146	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R147	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R148	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R149	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R150	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R151	1.0000	30201441	1 M 1/4W 5% CARBON	ANY MFG	
R152	1.0000	31205660	49.9K 1% .25W	ANY MFG	TYPE RN 1/4
R153	1.0000	33006205	100 K 15 TURN 3/4W 10%	BECKMAN	HELIPOT DIV. #89WHR100K

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
R154	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R155	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R156	1.0000	31205666	90.9K 1% .25W	ANY MFG	TYPE RN 1/4
R157	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R158	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R159	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R160	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R161	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R162	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R163	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R164	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R165	1.0000	30201549	680 K 1/4W 5% CARBON	ANY MFG	0
R166	1.0000	31205656	33.2K 1% .25W	ANY MFG	TYPE RN 1/4
R167	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R168	1.0000	31205626	3.92K 1% .25W	ANY MFG	TYPE RN 1/4
R169	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R171	1.0000	30201440	100 K 1/4W 5% CARBON	ANY MFG	0
TP101	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
X	2.0000	70806328	CIRCUIT BOARD EJECTOR (BLACK)	RICHCO	CBE-11 BLACK
Y	1.0000	72506354	SHORTING BAR SINGLE	AUGAT INC	#8136-475G1
Z	3.0000	63006380	TERMINAL NON-INSULATED	ELEC. MOLD.	7618-1-268

ASSEMBLY ID: 11007081 990C DUAL SLOPE BOARD ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
BCB	1.0000	74905047	990A DUAL SLOPE CONTROL BD 95620	MII	D 95623 RFL
C201	1.0000	35505745	2.2 uF 200V 2%	WESCO	32MM
C202	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C203	1.0000	36206014	.00105 uF 500V 2%	CORNELL-DUB.	CD19FD1051G0 3
C204	1.0000	36206014	.00105 uF 500V 2%	CORNELL-DUB.	CD19FD1051G0 3
C205	1.0000	36206014	.00105 uF 500V 2%	CORNELL-DUB.	CD19FD1051G0 3
C207	1.0000	35805714	1.0 uF 50V 20%	SPRAGUE	2C37Z50105Z0 50B
C209	1.0000	35805714	1.0 uF 50V 20%	SPRAGUE	2C37Z50105Z0 50B
C211	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C212	1.0000	35800341	.01 uF 100V 20% DISK	MALLORY	GH103M
C213	1.0000	35805750	.47 uF 50V -20+80%	SPRAGUE	DR30BBN474Z
C214	1.0000	35800341	.01 uF 100V 20% DISK	MALLORY	GH103M
C215	1.0000	35805714	1.0 uF 50V 20%	SPRAGUE	2C37Z50105Z0 50B
C216	1.0000	36206043	471 pF 500V 2%	CORNELL-DUB.	CD19FD471G03
C217	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C218	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
CR201	1.0000	40400394	100V .1 AMP SIGNAL	ANY MFG	1N4148
CR211	1.0000	40400394	100V .1 AMP SIGNAL	ANY MFG	1N4148
IC1	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
IC10	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
IC201	1.0000	43500456	QUAD 2-INPUT NAND SCHMITT TRIGGER	R.C.A.	CD4093BE
IC202	1.0000	43505677	DUAL SPST ANALOG SWITCH CMOS	SILICONIX	DG200ABA
IC203	1.0000	43505677	DUAL SPST ANALOG SWITCH CMOS	SILICONIX	DG200ABA
IC204	1.0000	44000482	8 DIP OP-AMP/BUFFER	NAT'L. SEMI.	LM741CN
IC205	1.0000	44000486	JFET FAST INPUT OP-AMP	NAT'L. SEMI.	LF355N
IC206	1.0000	44000486	JFET FAST INPUT OP-AMP	NAT'L. SEMI.	LF355N
IC207	1.0000	43500454	QUAD 2-INPUT OR GATE	R.C.A.	CD4071B
IC210	1.0000	43500442	TIMER 1455	MOTOROLA	MC1455P1
IC4	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
IC5	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
IC6	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
IC7	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
Q201	1.0000	41300409	40V 400/800mA NPN TRANSISTOR	NAT'L. SEMI.	2N2222A
R201	1.0000	31205668	150K 1% .25W	ANY MFG	TYPE RN 1/4
R203	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R204	1.0000	31205670	200K 1% .25W	ANY MFG	TYPE RN 1/4
R206	1.0000	31205603	402 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R207	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R208	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R209	1.0000	31205629	4.75K 1% .25W	ANY MFG	TYPE RN 1/4
R210	1.0000	31205629	4.75K 1% .25W	ANY MFG	TYPE RN 1/4
R211	1.0000	31205666	90.9K 1% .25W	ANY MFG	TYPE RN 1/4
R212	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R213	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R215	1.0000	31205635	6.81K 1% .25W	ANY MFG	TYPE RN 1/4
R216	1.0000	31205659	47.5K 1% .25W	ANY MFG	TYPE RN 1/4
R217	1.0000	31205635	6.81K 1% .25W	ANY MFG	TYPE RN 1/4
R218	1.0000	31205659	47.5K 1% .25W	ANY MFG	TYPE RN 1/4
R219	1.0000	31205635	6.81K 1% .25W	ANY MFG	TYPE RN 1/4
R220	1.0000	31205659	47.5K 1% .25W	ANY MFG	TYPE RN 1/4
R221	1.0000	31205597	200 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R222	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R223	1.0000	31205588	49.9 OHM 1% .25W	ANY MFG	TYPE RN 1/4

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
R224	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R225	1.0000	31205643	12.1K 1% .25W	ANY MFG	TYPE RN 1/4
R226	1.0000	30205767	10 OHM 1/4W 5% CARBON	ANY MFG	
R227	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R228	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R229	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R230	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R231	1.0000	31205601	301 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R232	1.0000	31205670	200K 1% .25W	ANY MFG	TYPE RN 1/4
R235	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R236	1.0000	31205656	33.2K 1% .25W	ANY MFG	TYPE RN 1/4
R237	1.0000	31205623	3.01K 1% .25W	ANY MFG	TYPE RN 1/4
R238	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R239	1.0000	31205602	332 OHM 1% .25W	ANY MFG	TYPE RN 1/4
TP201	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
TP202	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
X	2.0000	70806328	CIRCUIT BOARD EJECTOR (BLACK)	RICHCO	CBE-11 BLACK

ASSEMBLY ID: 11007082 990C MAIN BOARD AUTO MODULE ASSY

ITEM	QUANTITY	MII PART	DESCRIPTION		MANUFACTURER	MANUFACTURER PART NO.
BCB	1.0000	74905049	990A AUTOMATIC MODULE BD	95655	MII	D 95653 RFL
C301	1.0000	35405743	4.7 uF 20V 20% TANTALUM		MALLORY	TAC475M020P0 5
C302	1.0000	35405743	4.7 uF 20V 20% TANTALUM		MALLORY	TAC475M020P0 5
C303	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z5010SZ0 50B
C304	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z5010SZ0 50B
C306	1.0000	35505711	.47 uF 200V 2%		F-DYNE	MPE11
C307	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C308	1.0000	35906474	.33 uF 100V 1%		F-DYNE	PST-11-.33-1 00-1
C309	1.0000	36205754	.47 uF 100V 2%		F-DYNE	MPC12
C310	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C311	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C312	1.0000	35800342	.001 uF 500V 10% DISK		SPRAGUE	CE102
C313	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C314	1.0000	35800341	.01 uF 100V 20% DISK		MALLORY	GH103M
C315	1.0000	35505711	.47 uF 200V 2%		F-DYNE	MPE11
CR301	1.0000	43505687	LINEAR VOLTAGE REFERANCE 6.9V		NAT'L. SEMI.	LM329BZ
CR302	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR303	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR304	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR305	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR306	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR307	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR308	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR309	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR310	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR311	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR312	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR313	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR314	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR315	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR316	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR317	1.0000	40311103	10V 1W ZENER		MOTOROLA	1N4740
CR318	1.0000	40311103	10V 1W ZENER		MOTOROLA	1N4740
CR319	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR320	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
IC301	1.0000	44005684	LINEAR OP AMP		NAT'L. SEMI.	LM324N
IC302	1.0000	43506326	OPTO-ISOLATOR PHOTO-DARLINGTON PAIR		GENERAL INST	MCA230 /OR/ MCA231
IC303	1.0000	43506326	OPTO-ISOLATOR PHOTO-DARLINGTON PAIR		GENERAL INST	MCA230 /OR/ MCA231
IC304	1.0000	43500442	TIMER 1455		MOTOROLA	MC1455P1
IC305	1.0000	43505677	DUAL SPST ANALOG SWITCH CMOS		SILICONIX	DG200ABA
IC306	1.0000	43500441	QUAD 2-INPUT NOR GATE		MOTOROLA	MC14001CL
IC307	1.0000	43500442	TIMER 1455		MOTOROLA	MC1455P1
IC308	1.0000	43500454	QUAD 2-INPUT OR GATE		R.C.A.	CD4071B
IC309	1.0000	43500453	DUAL "D" FLIP-FLOP		R.C.A.	CD4013BE
IC310	1.0000	43500463	HEX INVERTOR/BUFFER		R.C.A.	CD4049BE
IC311	1.0000	43500471	QUAD 2-INPUT NAND GATE		R.C.A.	CD4011UBE
IC312	1.0000	43500452	QUAD 2-INPUT AND GATE		R.C.A.	CD4081B
IC313	1.0000	43500452	QUAD 2-INPUT AND GATE		R.C.A.	CD4081B
IC314	1.0000	43505706	TRANSISTOR ARRAY		T.I.	ULN2004AN
IC315	1.0000	43500452	QUAD 2-INPUT AND GATE		R.C.A.	CD4081B
IC316	1.0000	44005691	LINEAR JFET OP AMP		T.I.	TL084CN
IC317	1.0000	44005691	LINEAR JFET OP AMP		T.I.	TL084CN
J301	1.0000	63206668	26 PIN MALE RIGHT ANGLE JACK		BERG ELECT.	65496-013

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
J302	1.0000	63206632	20 PIN MALE RIGHT ANGLE PLUG	BERG ELECT.	65496-007
Q301	1.0000	41300409	40V 400/800mA NPN TRANSISTOR	NAT'L. SEMI.	2N2222A
Q303	1.0000	41300409	40V 400/800mA NPN TRANSISTOR	NAT'L. SEMI.	2N2222A
R301	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R302	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R303	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R304	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R305	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R307	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R308	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R309	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R310	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R311	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R312	1.0000	31205643	12.1K 1% .25W	ANY MFG	TYPE RN 1/4
R313	1.0000	33000284	10 K 25 TURN 1/2W	BOURNS	3299X-1-103
R314	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R315	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R316	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R317	1.0000	31205614	1.21K 1% .25W	ANY MFG	TYPE RN 1/4
R318	1.0000	33000284	10 K 25 TURN 1/2W	BOURNS	3299X-1-103
R319	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R320	1.0000	31205670	200K 1% .25W	ANY MFG	TYPE RN 1/4
R321	1.0000	31205593	102 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R322	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R323	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R324	1.0000	31205605	499 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R325	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R326	1.0000	31205635	6.81K 1% .25W	ANY MFG	TYPE RN 1/4
R327	1.0000	33006282	1 M 15 TURN 3/4W 20%	BECKMAN	HELIPOT DIV. 89WHR1M
R328	1.0000	31205674	332K 1% .25W	ANY MFG	TYPE RN 1/4
R329	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R330	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R331	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R332	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R333	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R334	1.0000	30205766	2 M 1/4W 5% CARBON	ANY MFG	
R336	1.0000	31205656	33.2K 1% .25W	ANY MFG	TYPE RN 1/4
R337	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R338	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R339	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R340	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R341	1.0000	31205619	2 K 1% .25W	ANY MFG	TYPE RN 1/4
R342	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R343	1.0000	31205622	2.74K 1% .25W	ANY MFG	TYPE RN 1/4
R344	1.0000	31205667	100K 1% .25W	ANY MFG	TYPE RN 1/4
R345	1.0000	31205592	100 OHM 1% .25W	ANY MFG	TYPE RN 1/4
RZ301	1.0000	31306393	47 K x 7 RESISTOR NETWORK 1.5W 2%	PYROFILM RES	PD14M47KGA
W	1.0000	18006765	990C AUTOMATIC MODULE CABLE	MII	B 95657 RFL
X	2.0000	70806328	CIRCUIT BOARD EJECTOR (BLACK)	RICHCO	CBE-11 BLACK
XIC1	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC10	1.0000	42500426	16 PIN DIP SOCKET	AUGAT	816-AG11D-ES
XIC11	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC12	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
XIC13	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC14	1.0000	42500426	16 PIN DIP SOCKET	AUGAT	816-AG11D-ES
XIC15	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC16	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC17	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC2	1.0000	42501604	*6 PIN DIP SOCKET	T.I.	C 7206-59
XIC3	1.0000	42501604	*6 PIN DIP SOCKET	T.I.	C 7206-59
XIC4	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
XIC6	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC7	1.0000	42500419	*8 PIN DIP SOCKET	AUGAT	808-AG11D-ES
XIC8	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XIC9	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
XRZ301	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES
Y	2.0000	72506354	SHORTING BAR SINGLE	AUGAT INC	#8136-475G1
Z	6.0000	63006380	TERMINAL NON-INSULATED	ELEC. MOLD.	7618-1-268

ASSEMBLY ID: 11007083 990C CONTROL BOARD AUTO MODULE ASSY

ITEM	QUANTITY	MII PART	DESCRIPTION		MANUFACTURER	MANUFACTURER PART NO.
BCB	1.0000	74905050	990A CONTROL BD	95656	MII	C 95658 RFL
C401	1.0000	35400324	1 uF 35V TANTALUM		SPRAGUE	199D105X9035 AA1
C402	1.0000	35805721	.1 uF 50V		CENTRALAB	CY20C104P
C404	1.0000	36205792	100pF 100V 10%		CORNELL-DUB.	CD10FD101J03
C405	1.0000	36005585	.1 uF 2% 100V POLYPROP.		F-DYNE	PPA-11-.1-10 0-2
C406	1.0000	35505736	.47 uF 100V 2%		WESCO	32M
C407	1.0000	36005587	.22 uF 2% 100V POLYPROP.		F-DYNE	PPA-11-.22-1 00-2
C408	1.0000	35605733	.1 uF 600V 2%		WESCO	32M
CR401	1.0000	40300385	5.1V 5W ZENER		MOTOROLA	1N5338B
DS401	1.0000	59206672	7 SEGMENT DISPLAY (RED)		H. P.	HP5082-7736
DS402	1.0000	59206671	7 SEGMENT DISPLAY (RED)		H. P.	HP5082-7731
DS403	1.0000	59206671	7 SEGMENT DISPLAY (RED)		H. P.	HP5082-7731
DS404	1.0000	59206671	7 SEGMENT DISPLAY (RED)		H. P.	HP5082-7731
DS405	1.0000	40003015	RED LED T1&3/4 150mC/20mA		GENERAL INST	HLMP-3750
DS406	1.0000	40003015	RED LED T1&3/4 150mC/20mA		GENERAL INST	HLMP-3750
DS407	1.0000	40003015	RED LED T1&3/4 150mC/20mA		GENERAL INST	HLMP-3750
DS408	1.0000	40006677	GREEN LED		T.I.	TIL222
DS409	1.0000	40003015	RED LED T1&3/4 150mC/20mA		GENERAL INST	HLMP-3750
H5	1.0000	65006675	HEAT SINK BLACK ANODIZE TO-220		AAVID ENG.	5741B
IC401	1.0000	43505704	CONVERTER A/D 3-1/2 DIGIT		INTERSIL	ICL7107CPL
IC403	1.0000	43500445	+5V/1.5A VOLTAGE REGULATOR		NAT'L. SEMI.	LM340T-5.0
R401	1.0000	31205595	150 OHM 1% .25W		ANY MFG	TYPE RN 1/4
R402	1.0000	33006576	1 K 18 TURN 1/2W 10%		BECKMAN	HELIPOT DIV. 68XR1K
R403	1.0000	31205653	24.3K 1% .25W		ANY MFG	TYPE RN 1/4
R404	1.0000	31205659	47.5K 1% .25W		ANY MFG	TYPE RN 1/4
R406	1.0000	31205667	100K 1% .25W		ANY MFG	TYPE RN 1/4
R407	1.0000	31205617	1.62K 1% .25W		ANY MFG	TYPE RN 1/4
R435	1.0000	33006674	10 K 1W 5% PC MOUNT		BOURNS	3250W-1-103
R436	1.0000	33006674	10 K 1W 5% PC MOUNT		BOURNS	3250W-1-103
R441	1.0000	33006674	10 K 1W 5% PC MOUNT		BOURNS	3250W-1-103
R442	1.0000	33006674	10 K 1W 5% PC MOUNT		BOURNS	3250W-1-103
R445	1.0000	31205629	4.75K 1% .25W		ANY MFG	TYPE RN 1/4
R446	1.0000	30200061	100 OHM 1/2W 5% CARBON		ANY MFG	0
S1	1.0000	55206684	2PDT TOGGLE SWITCH WIRE-WRAP		C&K SWITCH	7201 SYW3DE
S2	1.0000	55406691	2-5POS 1P/D 1 DECK 36 DEG. N.SHORT.		GRAYHILL	24878-05N
W	5.0000	70106679	SPACER 1/4"OD X 5/8"LG X.140"ID NYL		PROD. COMP.	
X	4.0000	42506394	14 PIN DIP SOCKET WIRE WRAP		CIR. ASS. CO	CA-14SE-103W W
Y	1.0000	42502188	40 PIN IC SOCKET		T & B ANSLEY	240-AG39D
Z	1.0000	63206670	26 PIN MALE VERTICLE JACK		BERG ELECT.	65692-013

ASSEMBLY ID: 11006766 990A,B,C D/A REG GEN BOARD ASSY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
A	1.0000	70405514	4-40 X 1/4" X 3/32" HEX NUT SS	ANY MFG	
B	1.0000	70405522	#4 SPLIT LOCK WASHER SS	ANY MFG	
BCB	1.0000	74905054	990A,B,C D/A REFERENCE GEN. 95695	MII	D 95698 RFL
C	1.0000	70405547	4-40 X 5/16" BHMS-SS	ANY MFG	
C501	1.0000	36205794	10 pF 300V 5%	CORNELL-DUB.	CD10CD100J03
C502	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C503	1.0000	36206036	91 pF 500V 5%	CORNELL-DUB.	CD15FD910J03
C504	1.0000	36206036	91 pF 500V 5%	CORNELL-DUB.	CD15FD910J03
C505	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C506	1.0000	35500327	1 uF 100V 10%	MALLORY	PVC-11
C507	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
CR501	1.0000	40306462	SCHOTTKY DIODE	AERTECH	A2S811
D	2.0000	70806328	CIRCUIT BOARD EJECTOR (BLACK)	RICHCO	CBE-11 BLACK
H5	1.0000	65006675	HEAT SINK BLACK ANODIZE TO-220	AAVID ENG.	5741B
IC501	1.0000	43503872	HEX BUFFER NON-INVERTING	NAT'L. SEMI.	CD4050
IC502	1.0000	43503872	HEX BUFFER NON-INVERTING	NAT'L. SEMI.	CD4050
IC503	1.0000	43503919	3-1/2 DIGIT BCD MONOLITHIC	ANALOG DEVIC	AD75251N
IC504	1.0000	43500473	HEX SCHMITT TRIGGER 14 PIN	MOTOROLA	CD40106BE(MC 14584BCP,CD4
IC505	1.0000	44005688	LINEAR JFET INPUT OP AMP	NAT'L. SEMI.	LF256H
IC506	1.0000	44005688	LINEAR JFET INPUT OP AMP	NAT'L. SEMI.	LF256H
IC507	1.0000	44005688	LINEAR JFET INPUT OP AMP	NAT'L. SEMI.	LF256H
IC508	1.0000	44005689	LINEAR OP AMP	NAT'L. SEMI.	LM208H
IC509	1.0000	44005689	LINEAR OP AMP	NAT'L. SEMI.	LM208H
IC510	1.0000	43505677	DUAL SPST ANALOG SWITCH CMOS	SILICONIX	DG200ABA
IC511	1.0000	43505687	LINEAR VOLTAGE REFERANCE 6.9V	NAT'L. SEMI.	LM329BZ
IC512	1.0000	43505702	+15V LINEAR VOLTAGE REGULATOR	NAT'L. SEMI.	LM340T-15
Q501	1.0000	41300409	40V 400/800mA NPN TRANSISTOR	NAT'L. SEMI.	2N2222A
R501	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R502	1.0000	33006203	25 K 15 TURN 3/4W 10%	BECKMAN	HELIPOT DIV. #89WHR25K
R503	1.0000	33006203	25 K 15 TURN 3/4W 10%	BECKMAN	HELIPOT DIV. #89WHR25K
R504	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R505	1.0000	33006299	1 K 20 TURN 3/4W 10%	BECKMAN	89WHR1K
R506	1.0000	31205640	9.76K 1% .25W	ANY MFG	TYPE RN 1/4
R507	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R508	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R509	1.0000	33006299	1 K 20 TURN 3/4W 10%	BECKMAN	89WHR1K
R510	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R511	1.0000	31205631	5.11K 1% .25W	ANY MFG	TYPE RN 1/4
R512	1.0000	31205644	13.3K 1% .25W	ANY MFG	TYPE RN 1/4
R513	1.0000	31207240	499K 1% .25W	ANY MFG	TYPE RN 1/4
R514	1.0000	33006158	50 K 15 TURN 3/4W 10%	BECKMAN	HELIPOT DIV. 89WHR50K
R515	1.0000	31205660	49.9K 1% .25W	ANY MFG	TYPE RN 1/4
R516	1.0000	31206858	20K 1% .25W	ANY MFG	TYPE RN 1/4
R517	1.0000	31205638	7.5K 1% .25W	ANY MFG	TYPE RN 1/4
R518	1.0000	30201478	22 OHM 1/4W 5% CARBON	ANY MFG	0
RZ1	1.0000	31306407	47 K x 7 RESISTOR NETWORK	MURATA	RSH8X473G
RZ2	1.0000	31306407	47 K x 7 RESISTOR NETWORK	MURATA	RSH8X473G
RZ3	1.0000	31306192	10 K x 8 RESISTOR NETWORK	BOURNS	4116R-001- 103
RZ4	1.0000	31306192	10 K x 8 RESISTOR NETWORK	BOURNS	4116R-001- 103
TP501	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
TP502	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
TP503	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
TP504	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
XIC	1.0000	42500426	16 PIN DIP SOCKET	AUGAT	816-AG11D-ES
XIC1	1.0000	42500426	16 PIN DIP SOCKET	AUGAT	816-AG11D-ES
XIC2	1.0000	42500426	16 PIN DIP SOCKET	AUGAT	816-AG11D-ES
XIC3	1.0000	42503068	18 PIN DIP SOCKET	AUGAT INC	218-AG29D
XIC4	1.0000	42500424	14 PIN DIP SOCKET	AUGAT	814-AG11D-ES

ASSEMBLY ID: 11007230 990 INTERCONNECT BRD

ITEM	QUANTITY	MII PART	DESCRIPTION		MANUFACTURER	MANUFACTURER PART NO.
BCD	1.0000	74905052	990 INTERCONNECTING BD	95685	MII	D 95688 RFL
C601	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C602	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C603	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C604	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C605	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C606	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C607	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C608	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C609	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C610	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C611	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C612	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C613	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C614	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C615	1.0000	35105751	1000 uF 25 VDC CAPACITOR		SPRAGUE	516D108M025P R6A
C616	1.0000	35105751	1000 uF 25 VDC CAPACITOR		SPRAGUE	516D108M025P R6A
C617	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C618	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z5010SZ0 50B
C619	1.0000	35105751	1000 uF 25 VDC CAPACITOR		SPRAGUE	516D108M025P R6A
C620	1.0000	36206017	.0033 uF 500V 2%		CORNELL-DUB.	CD19FD332G03
C621	1.0000	35805746	.02 uF 25V -20+80% DISK		SPRAGUE	TGS 20-G
C622	1.0000	35805734	.1 uF 100V 20%		SPRAGUE	TG-P10 TYPE HY-K
C623	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z5010SZ0 50B
C624	1.0000	35805714	1.0 uF 50V 20%		SPRAGUE	2C37Z5010SZ0 50B
C637	1.0000	35405738	15 uF 35V 20% TANTALUM		SPRAGUE	196D156X0035 PEX
CR601	1.0000	40406405	400 VAC 2A RECTIFIER		G.E.	A114DX9
CR602	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR603	1.0000	40400394	100V .1 AMP SIGNAL		ANY MFG	1N4148
CR604	1.0000	40403375	1000V 1 AMP DIODE		ANY MFG	1N4007
CR605	1.0000	40403375	1000V 1 AMP DIODE		ANY MFG	1N4007
CR606	1.0000	40403375	1000V 1 AMP DIODE		ANY MFG	1N4007
CR620	1.0000	40306284	5.6V ZENER 5%		FAIRCHILD	1N752A DO3 5 GLASS PKG.
CRZ601	1.0000	40406458	DIODE ARRAY 16 DIODE 14 PIN		MOTOROLA	MAD1103P
CRZ602	1.0000	40406458	DIODE ARRAY 16 DIODE 14 PIN		MOTOROLA	MAD1103P
F601	1.0000	57606279	1 AMP 250V FB 3AG		LITTLEFUSE	312001
IC601	1.0000	43505707	TRANSISTOR ARRAY		SPRAGUE	ULN2013A
IC602	1.0000	43505707	TRANSISTOR ARRAY		SPRAGUE	ULN2013A
IC603	1.0000	43505696	UNIVERSAL SWITCHING REG. SUBSYSTEM		FAIRCHILD	UA78S40PC
IC604	1.0000	43505576	QUAD VOLTAGE LEVEL SHIFT		R.C.A.	CD40109BE
IC605	1.0000	43505576	QUAD VOLTAGE LEVEL SHIFT		R.C.A.	CD40109BE
IC606	1.0000	43505576	QUAD VOLTAGE LEVEL SHIFT		R.C.A.	CD40109BE
IC607	1.0000	43505576	QUAD VOLTAGE LEVEL SHIFT		R.C.A.	CD40109BE
IC608	1.0000	43505702	+15V LINEAR VOLTAGE REGULATOR		NAT'L. SEMI.	LM340T-15
J601	1.0000	63206637	96 PIN FEMALE DIN CONNECTOR		PANDUIT INC.	100-096-431
J603	9.0000	42500426	16 PIN DIP SOCKET		AUGAT	816-AG11D-ES
J604	6.0000	42500424	14 PIN DIP SOCKET		AUGAT	814-AG11D-ES
K601	1.0000	52606209	2PDT 2A		P & B	R40-E1-Y2-V3 20
K602	1.0000	52606209	2PDT 2A		P & B	R40-E1-Y2-V3 20
K603	1.0000	52606209	2PDT 2A		P & B	R40-E1-Y2-V3 20
L601	1.0000	60406324	100 uH 2A 10% FERRITE CHOKE		CADDELL-BUR.	6310-8
P602	1.0000	63106559	11 PIN WAFER ASSEMBLY		MOLEX	#A4174141-00 62
P603	1.0000	63206668	26 PIN MALE RIGHT ANGLE JACK		BERG ELECT.	65496-013

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
P604	1.0000	63206668	26 PIN MALE RIGHT ANGLE JACK	BERG ELECT.	65496-013
Q601	1.0000	41006310	100V 80W PNP TIP-34C	T.I.	TIP-34C
Q602	1.0000	41300410	40V 350/700mA PNP TRANSISTOR	NAT'L. SEMI.	2N2907A
Q605	1.0000	42606174	200 VAC 4 AMP SCR	G.E.	C106B1
R21	1.0000	64106551	JUMPER WIRE 0.800" X 0.250" T22	FANCORT IND.	J-0.800X0.25 0-T22
R22	1.0000	64106551	JUMPER WIRE 0.800" X 0.250" T22	FANCORT IND.	J-0.800X0.25 0-T22
R23	1.0000	64106551	JUMPER WIRE 0.800" X 0.250" T22	FANCORT IND.	J-0.800X0.25 0-T22
R601	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R602	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R603	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R604	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R605	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R606	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R608	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R609	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R610	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R611	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R612	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R613	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R614	1.0000	31205596	182 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R615	1.0000	31205606	562 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R616	1.0000	33006312	20 K 15 TURN 3/4W 10%	BECKMAN	HELIPOT DIV. 89PHR20K
R617	1.0000	31205654	30.1K 1% .25W	ANY MFG	TYPE RN 1/4
R618	1.0000	31205643	12.1K 1% .25W	ANY MFG	TYPE RN 1/4
R619	1.0000	31105812	.1 OHM 3W 5%	ANY MFG	RW69VR10
R620	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R624	1.0000	30200102	22 OHM 1/2W 5% CARBON	ANY MFG	0
R650	1.0000	30201503	33 OHM 1/4W 5% CARBON	ANY MFG	0
R651	1.0000	30201503	33 OHM 1/4W 5% CARBON	ANY MFG	0
R652	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R653	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R654	1.0000	31205614	1.21K 1% .25W	ANY MFG	TYPE RN 1/4
R655	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R656	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R657	1.0000	31205612	1 K 1% .25W	ANY MFG	TYPE RN 1/4
R658	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
R659	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
R660	1.0000	31205635	6.81K 1% .25W	ANY MFG	TYPE RN 1/4
R661	1.0000	31205620	2.21K 1% .25W	ANY MFG	TYPE RN 1/4
RZ601	1.0000	31306304	2.2 K x 7 RESISTOR NETWORK	CTS	760-3-2.2K
RZ602	1.0000	31306304	2.2 K x 7 RESISTOR NETWORK	CTS	760-3-2.2K
RZ603	1.0000	31306304	2.2 K x 7 RESISTOR NETWORK	CTS	760-3-2.2K
RZ604	1.0000	31306304	2.2 K x 7 RESISTOR NETWORK	CTS	760-3-2.2K
RZ605	1.0000	31306192	10 K x 8 RESISTOR NETWORK	BOURNS	4116R-001- 103
T	6.0000	72706402	4-40 X 1/4" CIRCUIT BOARD STANDOFF	PENN ENG.	KFSE-440-8
TP601	1.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
U	3.0000	63006380	TERMINAL NON-INSULATED	ELEC. MOLD.	7618-1-268
V	1.0000	72506354	SHORTING BAR SINGLE	AUGAT INC	#8136-475G1
W	2.0000	70806328	CIRCUIT BOARD EJECTOR (BLACK)	RICHCO	CBE-11 BLACK
X	2.0000	70405495	4-40 X 5/16" RHMS-SS	ANY MFG	
XK601	1.0000	42506322	RELAY SOCKET RIGHT ANGLE PC MOUNT	P & B	27E323 F/R40
XK602	1.0000	42506322	RELAY SOCKET RIGHT ANGLE PC MOUNT	P & B	27E323 F/R40
XK603	1.0000	42506322	RELAY SOCKET RIGHT ANGLE PC MOUNT	P & B	27E323 F/R40

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
Y	2.0000	57706248	FUSE CLIP PC MTG STD EAR 3AG	LITTLEFUSE	102.071
Z	3.0000	42506323	RELAY HOLD DOWN SPRING F/6322	P & B	20C252

ASSEMBLY ID: 11007084 990A,B,C MAIN MOTHER BOARD ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
BCB	1.0000	74905048	990A POWER SUPPLY/INTERCON. 95630	MII	D 95633
C1	1.0000	35100310	2200 uF 50 VDC CAPACITOR	NICHICON	TVX1H222MCA
C10	1.0000	35810121	1 uF 50V 10% CK06	ANY MFG	CK06BX105K
C16	1.0000	35100310	2200 uF 50 VDC CAPACITOR	NICHICON	TVX1H222MCA
C2	1.0000	35100310	2200 uF 50 VDC CAPACITOR	NICHICON	TVX1H222MCA
C3	1.0000	35105751	1000 uF 25 VDC CAPACITOR	SPRAGUE	516D108M025P R6A
C4	1.0000	35105752	470 uF 40 VDC CAPACITOR	NICHICON	TVX1H471MCA
C5	1.0000	35105751	1000 uF 25 VDC CAPACITOR	SPRAGUE	516D108M025P R6A
C6	1.0000	35800341	.01 uF 100V 20% DISK	MALLORY	GH103M
C7	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C8	1.0000	35810121	1 uF 50V 10% CK06	ANY MFG	CK06BX105K
C9	1.0000	35810121	1 uF 50V 10% CK06	ANY MFG	CK06BX105K
CN	4.0000	63206260	22 PIN 44 POSITION FEMALE EDGE CON.	TRW-CINCH	50-44H-10
CR1	1.0000	40406227	400V 3 AMP DIODE	DIODES INC.	FR305-B
CR10	1.0000	40306216	1600V 7A AVALANCHE DIODE	IXYS	DSA2-16A
CR2	1.0000	40406227	400V 3 AMP DIODE	DIODES INC.	FR305-B
CR3	1.0000	40406227	400V 3 AMP DIODE	DIODES INC.	FR305-B
CR4	1.0000	40406227	400V 3 AMP DIODE	DIODES INC.	FR305-B
CR5	1.0000	40403375	1000V 1 AMP DIODE	ANY MFG	1N4007
CR6	1.0000	40306216	1600V 7A AVALANCHE DIODE	IXYS	DSA2-16A
CR7	1.0000	40306216	1600V 7A AVALANCHE DIODE	IXYS	DSA2-16A
CR9	1.0000	40306216	1600V 7A AVALANCHE DIODE	IXYS	DSA2-16A
HS	4.0000	65006352	HEAT SINK FOR TO-220 PKG	THERMALLOY	6030B
IC1	1.0000	40206334	100 VAC 6 AMP RECTIFIER BRIDGE	GENERAL INST	GBPC601
IC2	1.0000	40206334	100 VAC 6 AMP RECTIFIER BRIDGE	GENERAL INST	GBPC601
IC3	1.0000	43505701	+12V LINEAR VOLTAGE REGULATOR	NAT'L. SEMI.	LM340T-12
IC4	1.0000	43505685	LINEAR VOLTAGE REGULATOR	MOTOROLA	MC7912CT
IC5	1.0000	43506326	OPTO-ISOLATOR PHOTO-DARLINGTON PAIR	GENERAL INST	MCA230 /OR/ MCA231
ICS	1.0000	42501604	*6 PIN DIP SOCKET	T.I.	C 7206-59
P1	1.0000	63106373	*8 PIN WAFER CONNECTOR	MOLEX	26-61-1080 ENG.#A-41761
P2	1.0000	63106373	*8 PIN WAFER CONNECTOR	MOLEX	26-61-1080 ENG.#A-41761
P3	1.0000	63106368	12 PIN WAFER CONNECTOR	MOLEX	26-61-1120
P5	1.0000	63106367	CONN WAFER ASSY 10 CKTS	MOLEX	26-61-1100
P6	1.0000	63106374	*9 PIN WAFER CONNECTOR	MOLEX	26-61-1090 ENG.#A-41761
P7	1.0000	63106367	CONN WAFER ASSY 10 CKTS	MOLEX	26-61-1100
P8	1.0000	63206669	34 PIN MALE VERTICLE JACK	BERG ELECT.	65692-013
P9	1.0000	63106369	15 PIN WAFER CONNECTOR	MOLEX	26-61-1150
Q	2.0000	70605512	6-32 X 1/4" X 3/32" HEX NUT SS	ANY MFG	
Q1	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.	G.E.	TIP125
Q2	1.0000	41303343	60V 5A PNP POWER TRANS. DARL.	G.E.	TIP125
Q3	1.0000	41006678	600V 8A TRIAC	R.C.A.	T2800M
Q4	1.0000	41300410	40V 350/700mA PNP TRANSISTOR	NAT'L. SEMI.	2N2907A
Q5	1.0000	41017429	800V 8A TRIAC	MOTOROLA	MAC 228A10
Q6	1.0000	41017429	800V 8A TRIAC	MOTOROLA	MAC 228A10
Q7	1.0000	41017429	800V 8A TRIAC	MOTOROLA	MAC 228A10
R	2.0000	70600905	#6 LOCK WASHER	ANY MFG	0
R10	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R11	1.0000	31205616	1.5K 1% .25W	ANY MFG	TYPE RN 1/4
R19	1.0000	31205647	17.4K 1% .25W	ANY MFG	TYPE RN 1/4
R20	1.0000	31405977	1.5 M 2W 1% 1000V	CADDOCK	MS220-1.5MEG
R3	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R32	1.0000	31205598	221 OHM 1% .25W	ANY MFG	TYPE RN 1/4
R4	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4

ASSEMBLY ID:

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
R5	1.0000	31405975	330 OHM 2W 5%	CORNING	FP42
R6	1.0000	31405976	470 OHM 2W 5%	MILLS	MRP-2
R7	1.0000	31205625	3.32K 1% .25W	ANY MFG	TYPE RN 1/4
R8	1.0000	31205632	5.62K 1% .25W	ANY MFG	TYPE RN 1/4
R9	1.0000	31205641	10 K 1% .25W	ANY MFG	TYPE RN 1/4
S	5.0000	70405514	4-40 X 1/4" X 3/32" HEX NUT SS	ANY MFG	
T	5.0000	70400888	#4 LOCK WASHER	ANY MFG	
T2	1.0000	60106692	115/230 VAC 4.5W 50/60 Hz PC MOUNT	LITTON IND.	TRIAD DIV. F -350XP
TNI	2.0000	63006380	TERMINAL NON-INSULATED	ELEC. MOLD.	7618-1-268
TT	4.0000	64106255	TURRET BOARD TERMINAL 1/16" THICK	CAMBRIDGE	2027-2
W	2.0000	70605538	6-32 X 1/4" BHMS SS	ANY MFG	
X	5.0000	70405547	4-40 X 5/16" BHMS-SS	ANY MFG	
Z	1.0000	72506354	SHORTING BAR SINGLE	AUGAT INC	#8136-475G1

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 12007087 990A,B,C MAIN FRAME ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	66005340	990A,B,C CAP. BANK PROTECTIVE COVER	MII	B 95678 RFL
10	1.0000	22006272	LABEL HIGH VOLTAGE 2-1/8"x 1-1/2"	YORK TAPE	36465 RFL
11	1.0000	22006268	LABEL SAFETY GLASSES SERV 3.5"x2.5"	YORK TAPE	
12	1.0000	22006267	LABEL HIGH VOLTAGE 3-1/2" X 2-1/2"	YORK TAPE	SEE DRAW. RF L #36458
13	8.0000	72706257	CARD GUIDE RACK 4"	RICHCO	#RCG-2
14	4.0000	68106128	CAPACITOR CLAMP	IND. COND.	5-1656
15	2.0000	30511249	# 9 MOUNTING BRACKET FOR 25-75 WATT	OHMITE	#9
16	2.0000	70700912	8-32 X 1/2" BHMS	ANY MFG	0
17	26.0000	70400879	4-40 X 1/4" BHMS	ANY MFG	0
18	16.0000	70600894	6-32 X 3/8" BHMS	ANY MFG	0
19	2.0000	70605532	6-32 X 5/16" BHMS SS	ANY MFG	
2	1.0000	66005339	990A,B,C TERMINAL BLOCK COVER	MII	A 95677 RFL
20	1.0000	64005891	*3 TERMINAL STRIP	NAT. TEL-TRN	#1311
21	16.0000	70605525	#6 LOCK WASHER INT.USE 0905	ANY MFG	
22	16.0000	70705523	#8 SPLIT LOCK WASHER	ANY MFG	
23	16.0000	70405522	#4 SPLIT LOCK WASHER SS	ANY MFG	
24	10.0000	70400888	#4 LOCK WASHER	ANY MFG	
25	18.0000	64106059	#16-#22 AWG #6 BOLT FKD TAPE	HOLLINGWORTH	XSF2562SX
26	8.0000	70700917	8-32 ESNA NUT	ANY MFG	0
27	4.0000	70600896	6-32 X 5/8" BHMS	ANY MFG	0
29	8.0000	70600893	6-32 X 1/4" BHMS	ANY MFG	0
3	3.0000	66006690	990A,B,C SUPPORT BAR	ANY MFG	C 95648 RFL
30	2.0000	68200873	SHOULDER WASHER	H. H. SMITH	#2664
32	1.0000	64101874	#14-#16 AWG 1/4" BOLT RING	AMP INC.	B325-14
4	1.0000	66005246	990A,B,C TERMINAL BLOCK BRACKET	MII	C 95647 RFL
5	2.0000	66006689	990A,B,C CARD GUIDE PANEL	GAMMONS	C 95646 RFL
6	1.0000	72405245	990A,B,C CHASSIS	ESTES	D 95641 RFL
7	4.0000	66006686	990A,B,C SUPPORT SPACER	MII	A 95639 RFL
8	1.0000	22006571	LABEL QUALIFIED PERSON 4.5"x2-1/8"	ANY MFG	91749 RFL
9	6.0000	60406309	FERRITE CORE BEAD	STACKPOLE	#57-1559, #57-5305
C11	1.0000	35805734	.1 uF 100V 20%	SPRAGUE	TG-P10 TYPE HY-K
C12	1.0000	36106006	50 uF 600 VDC OIL FILLED CAP.	IND. COND.	9899SAR
C13	1.0000	36106006	50 uF 600 VDC OIL FILLED CAP.	IND. COND.	9899SAR
CB1	1.0000	11007084	990A,B,C MAIN MOTHER BOARD ASSEMBLY	BQ PRODUCTS	95630 RFL
HS	1.0000	72411965	990 SERIES TRIAC HEAT SINK	GAMMONS	72411965
K1	1.0000	52606673	2PDT (12VDC)	STRUTHERS	425XBX 12VDC
Q8	1.0000	41019101	1200V 50A TRIAC	AMSC	50AC120A
R	1.0000	30205756	100 OHM 2W 5% CARBON	ANY MFG	
R1-R2	1.0000	12007086	990A,B,C RESISTOR BRACKET ASSEMBLY	MII	95676 RFL
R12	1.0000	30505810	800 OHM 50W 5%	OHMITE	L50J800
R33	1.0000	31405962	150 K 2W 5%	RCD COMPONET	FP42
T1	1.0000	12006833	990A,B,C TRANSFORMER ASSEMBLY	MII	C 95673 RFL
T3	1.0000	12006834	990 TRANSFORMER ASSEMBLY	MII	95674 RFL
TB1	1.0000	64006665	10 PIN HANDWIRED TERMINAL BLOCK	MAGNUM	#A305310-NL
TB2	1.0000	64006665	10 PIN HANDWIRED TERMINAL BLOCK	MAGNUM	#A305310-NL
WH1	1.0000	18006814	990A,B,C RELAY HARNESS K1	MII	98661 RFL
WH2	1.0000	18006815	990A,B,C POWER RESISTOR HARNESS	MII	98663 RFL

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 12007086 990A,B,C RESISTOR BRACKET ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	6.0000	30511248	# 5 MOUNTING BRACKET FOR 10/12 WATT	OHMITE	#5
2	8.0000	30511249	# 9 MOUNTING BRACKET FOR 25-75 WATT	OHMITE	#9
C14	1.0000	35605731	.3 uF 2000V 20%	F-DYNE	MPE-11H-.3-2 000-20
R1	1.0000	30405807	50 OHM 25W 5%	OHMITE	0200D W/MTG BKTS #9
R13	1.0000	30505822	2 K 25W 10% W/CENTER TAP	OHMITE	0377 TYPE 21 0-25
R14	1.0000	30505818	2 K 25W 5%	OHMITE	0207 STYLE 2 70-25
R15	1.0000	30505800	10 K 10% 12W	OHMITE	D12K10K
R16	1.0000	30505800	10 K 10% 12W	OHMITE	D12K10K
R17	1.0000	30505819	51 K 12W 5% WW	DALE	HL-12-05Z
R2	1.0000	30405807	50 OHM 25W 5%	OHMITE	0200D W/MTG BKTS #9
W	22.0000	70605875	#6 SPLIT LOCK WASHER SS	ANY MFG	
X	20.0000	70600893	6-32 X 1/4" BHMS	ANY MFG	0
Z	1.0000	66006688	990A,B,C RESISTOR MOUNTING BRACKET	MII	C 95645 RFL

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 12007089 990C FRONT PANEL ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	30205755	360 K 2W 5% CARBON	OHMITE	OH3645
10	3.0000	67006161	KNOB 15/16" DIA. BLACK W/CLEAR FACE	ROGAN	RB-67-2-M-L PLASTIC PREF
11	1.0000	62906173	250V 10A 3 WIRE CHASSIS MOUNT	HUBBELL	7487
12	3.0000	67006350	KNOB RING BASE W/INDICATING LINE	ROGAN	RB-67-1-DC-M -L
13	1.0000	67006350	KNOB RING BASE W/INDICATING LINE	ROGAN	RB-67-1-DC-M -L
14	13.0000	40006391	PANEL MOUNT BUSHING USE W/HA-38939	H. P.	#HLMP-0103
15	7.0000	70006676	#4 X 1/4" INSULATOR SCREW	PROD. COMP.	
16	1.0000	65405092	990C FRONT PANEL MARKED OVERLAY	MII	OVERLAY MII
17	1.0000	11007088	990A,B,C SWITCH & INDICATOR BD ASSY	BQ PRODUCTS	95671 RFL
18	1.0000	18006810	990C AMPLITUDE CONTROL HARNESS	MII	98657 RFL
19	1.0000	59206664	BEZEL & FILTER ASSEMBLY	RMF PRODUCTS	MODEL 140-2R
2	8.0000	70600902	6-32 ESNA NUT	ANY MFG	0
20	1.0000	72604965	990C FRONT PANEL	ESTES	95642 RFL
3	8.0000	70400888	#4 LOCK WASHER	ANY MFG	
4	7.0000	70605875	#6 SPLIT LOCK WASHER SS	ANY MFG	
5	1.0000	71805876	15/32" LOCK WASHER INT STL CP	ANY MFG	
6	3.0000	70605525	#6 LOCK WASHER INT.USE 0905	ANY MFG	
7	3.0000	70605533	6-32 X 3/8" BHMS SS	ANY MFG	
8	8.0000	70405541	4-40 X 1/4" BHMS-SS	ANY MFG	
9	1.0000	64006122	*2 TERMINAL STRIP	HH SMITH	863
DS1	1.0000	58605945	120V NEON LAMP ASSY. (RED)	DIALIGHT	249-7841-093 1-574
DS2	1.0000	58605949	LIGHT INDICATOR NEON (AMBER)	DIALIGHT	249-7841-093 3-574
DS3	1.0000	58605945	120V NEON LAMP ASSY. (RED)	DIALIGHT	249-7841-093 1-574
R24	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
R25	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
R26	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
R27	1.0000	32906150	1 M 2W 10%	CLAROSTAT	53C1 1 MEG S
R29	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
R30	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
S1	1.0000	55206489	2PDT TOGGLE 10A/250V 15A/125V	CUTLERHAMMER	7565K5
S10	1.0000	55206489	2PDT TOGGLE 10A/250V 15A/125V	CUTLERHAMMER	7565K5
S7	1.0000	55306172	SPDT PUSH BUTTON	C & K	#8121 W/WHIT E CAP #7089-
S8	1.0000	55306172	SPDT PUSH BUTTON	C & K	#8121 W/WHIT E CAP #7089-
S9	1.0000	55306172	SPDT PUSH BUTTON	C & K	#8121 W/WHIT E CAP #7089-

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 12007090 990C REAR PANEL ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	2.0000	70605498	6-32 X 1-1/2" RHMS SS	ANY MFG	
10	4.0000	70600895	6-32 X 1/2" BHMS	ANY MFG	0
11	4.0000	70605538	6-32 X 1/4" BHMS SS	ANY MFG	
14	1.0000	62906173	250V 10A 3 WIRE CHASSIS MOUNT	HUBBELL	7487
16	1.0000	62906366	250V 6A GRD/RECEP. CHASSIS MOUNT	SWITCHCRAFT	EAC-311 MALE SOCKET
17	1.0000	63006404	COAXIAL BNC BULKHEAD CONNECTOR	AMPHENOL	31-010
18	1.0000	55606480	INTERLOCK CONNECTOR SWITCH FEMALE	BRYANT	4600B
19	2.0000	70106496	SPACER 1/4"OD X 1"LG .12" TO .14"ID	H. H. SMITH	2104
2	3.0000	70605506	6-32 X 3/8" FHMS SS	ANY MFG	
20	1.0000	66005211	440/990 INTERLOCK MOUNTING PLATE	MII	A 90451 RFL
21	1.0000	72604967	990 REAR PANEL	ESTES	95643 RFL
22	1.0000	65406687	990A,B,C REAR PANEL MARKED OVERLAY	DOUGLAS CORP	65406687 MII
3	4.0000	70600902	6-32 ESNA NUT	ANY MFG	0
4	2.0000	70400881	4-40 X 1/2" BHMS	ANY MFG	
5	2.0000	70400888	#4 LOCK WASHER	ANY MFG	
6	10.0000	70605875	#6 SPLIT LOCK WASHER SS	ANY MFG	
7	2.0000	70605525	#6 LOCK WASHER INT.USE 0905	ANY MFG	
8	2.0000	70400885	4-40 ESNA NUT	ANY MFG	
9	7.0000	70600894	6-32 X 3/8" BHMS	ANY MFG	0
F1	1.0000	57605788	.75 AMP 250V SB 3AG	LITTLEFUSE	313.750
F2	1.0000	57606117	1.5 AMP 250V SB 3AG	LITTLEFUSE	31301.5
FH1	1.0000	57706535	FUSE CARRIER BODY PANEL MOUNT	SCHURTER	FEU 031.1653
FH1	1.0000	57706536	FUSE CARRIER DOMESTIC	SCHURTER	FEK 031.1666
FH2	1.0000	57706535	FUSE CARRIER BODY PANEL MOUNT	SCHURTER	FEU 031.1653
FH2	1.0000	57706536	FUSE CARRIER DOMESTIC	SCHURTER	FEK 031.1666

MAGNETIC INSTRUMENTATION, INC. 12/12/2003

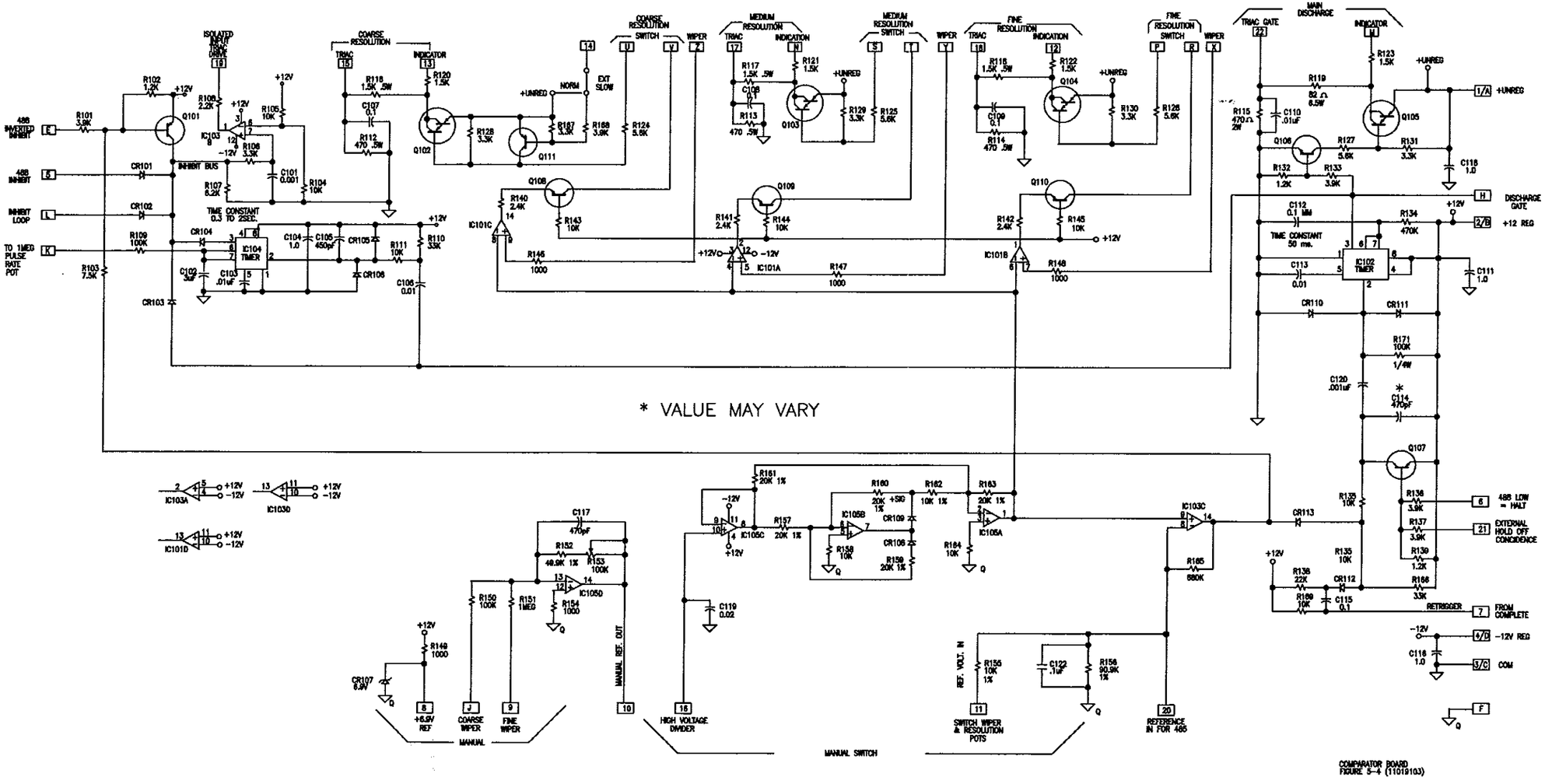
ASSEMBLY ID: 12007091 990A REAR PANEL ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	65406687	990A,B,C REAR PANEL MARKED OVERLAY	DOUGLAS CORP	65406687 MII
10	2.0000	70600895	6-32 X 1/2" BHMS	ANY MFG	0
11	4.0000	70605538	6-32 X 1/4" BHMS SS	ANY MFG	
13	1.0000	62906173	250V 10A 3 WIRE CHASSIS MOUNT	HUBBELL	7487
15	1.0000	62906366	250V 6A GRD/RECEP. CHASSIS MOUNT	SWITCHCRAFT	EAC-311 MALE SOCKET
16	1.0000	55606480	INTERLOCK CONNECTOR SWITCH FEMALE	BRYANT	4600B
17	2.0000	70106496	SPACER 1/4"OD X 1"LG .12" TO .14"ID	H. H. SMITH	2104
18	1.0000	66005211	440/990 INTERLOCK MOUNTING PLATE	MII	A 90451 RFL
2	3.0000	70600894	6-32 X 3/8" BHMS	ANY MFG	0
20	2.0000	70605498	6-32 X 1-1/2" RHMS SS	ANY MFG	
22	1.0000	72604967	990 REAR PANEL	ESTES	95643 RFL
3	5.0000	70600902	6-32 ESNA NUT	ANY MFG	0
4	2.0000	70400885	4-40 ESNA NUT	ANY MFG	
6	10.0000	70605875	#6 SPLIT LOCK WASHER SS	ANY MFG	
7	2.0000	70605525	#6 LOCK WASHER INT.USE 0905	ANY MFG	
8	2.0000	70400881	4-40 X 1/2" BHMS	ANY MFG	
9	7.0000	70605533	6-32 X 3/8" BHMS SS	ANY MFG	
F1	1.0000	57605788	.75 AMP 250V SB 3AG	LITTLEFUSE	313.750
F2	1.0000	57606117	1.5 AMP 250V SB 3AG	LITTLEFUSE	31301.5
FH1	1.0000	57706535	FUSE CARRIER BODY PANEL MOUNT	SCHURTER	FEU 031.1653
FH1	1.0000	57706536	FUSE CARRIER DOMESTIC	SCHURTER	FEK 031.1666
FH2	1.0000	57706535	FUSE CARRIER BODY PANEL MOUNT	SCHURTER	FEU 031.1653
FH2	1.0000	57706536	FUSE CARRIER DOMESTIC	SCHURTER	FEK 031.1666

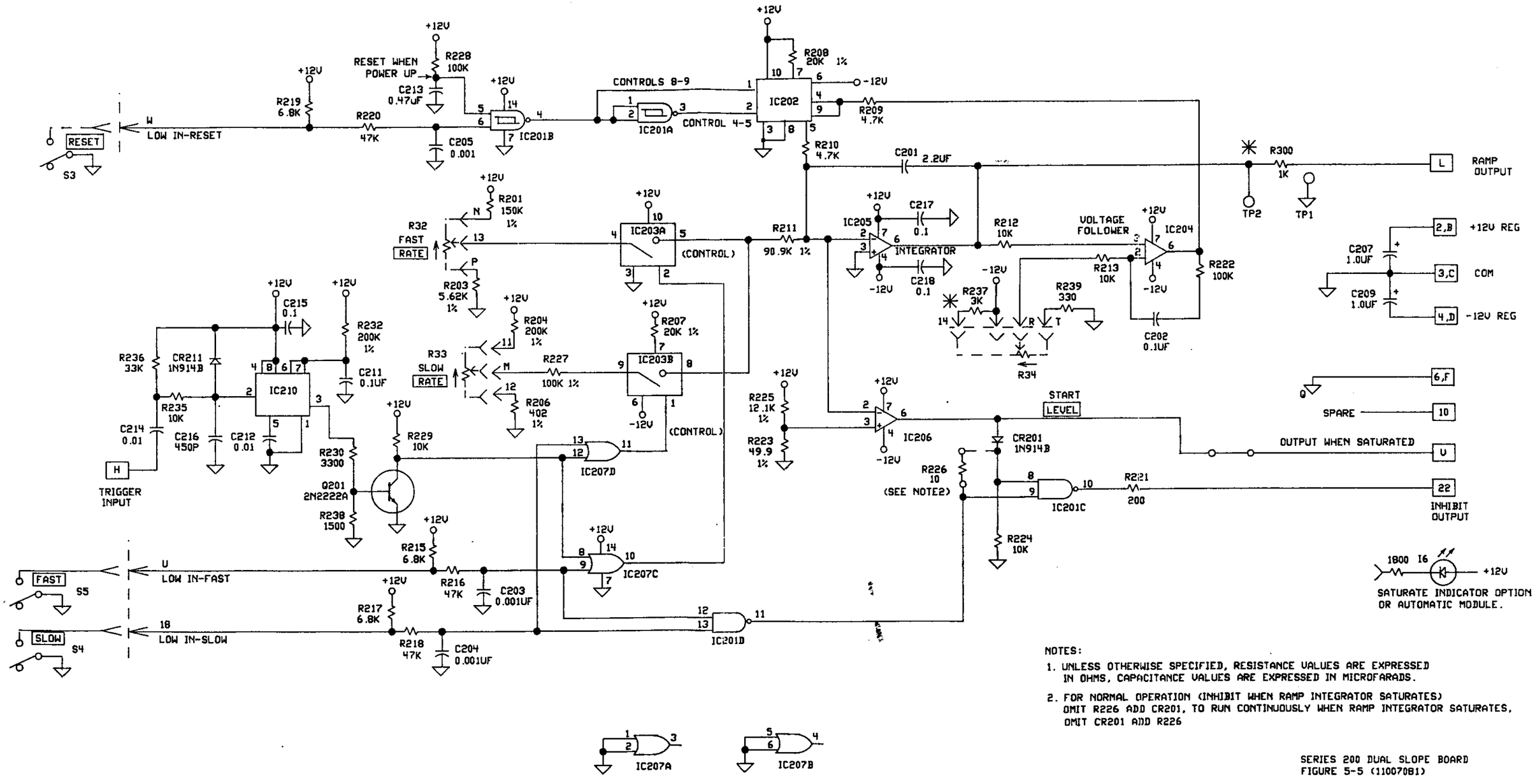
MAGNETIC INSTRUMENTATION, INC. 12/12/2003

ASSEMBLY ID: 12007092 990A FRONT PANEL ASSEMBLY

ITEM	QUANTITY	MII PART	DESCRIPTION	MANUFACTURER	MANUFACTURER PART NO.
1	1.0000	30205755	360 K 2W 5% CARBON	OHMITE	OH3645
10	3.0000	67006161	KNOB 15/16" DIA. BLACK W/CLEAR FACE	ROGAN	RB-67-2-M-L PLASTIC PREF
11	1.0000	62906173	250V 10A 3 WIRE CHASSIS MOUNT	HUBBELL	7487
12	8.0000	40006391	PANEL MOUNT BUSHING USE W/HA-38939	H. P.	#HLMP-0103
13	3.0000	70006676	#4 X 1/4" INSULATOR SCREW	PROD. COMP.	
14	1.0000	65406693	990A FRONT PANEL MARKED OVERLAY	MII	OVERLAY MII
15	1.0000	11007088	990A,B,C SWITCH & INDICATOR BD ASSY	BQ PRODUCTS	95671 RFL
16	1.0000	18006811	990A AMPLITUDE CONTROL HARNESS	MII	98658 RFL
17	1.0000	72604966	990A FRONT PANEL	ESTES	95665 RFL
2	7.0000	70600902	6-32 ESNA NUT	ANY MFG	0
3	4.0000	70400887	#4 FLATWASHER	ANY MFG	0
4	7.0000	70605875	#6 SPLIT LOCK WASHER SS	ANY MFG	
6	3.0000	70605525	#6 LOCK WASHER INT.USE 0905	ANY MFG	
7	3.0000	70600894	6-32 X 3/8" BHMS	ANY MFG	0
8	4.0000	70400879	4-40 X 1/4" BHMS	ANY MFG	0
9	1.0000	64006122	*2 TERMINAL STRIP	HH SMITH	863
DS1	1.0000	58605945	120V NEON LAMP ASSY. (RED)	DIALIGHT	249-7841-093 1-574
DS2	1.0000	58605949	LIGHT INDICATOR NEON (AMBER)	DIALIGHT	249-7841-093 3-574
DS3	1.0000	58605945	120V NEON LAMP ASSY. (RED)	DIALIGHT	249-7841-093 1-574
R27	1.0000	32906150	1 M 2W 10%	CLAROSTAT	53C1 1 MEG S
R29	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
R30	1.0000	32903868	10 K LINEAR POT 2W	CLAROSTAT	# 53C310K
S1	1.0000	55206489	2PDT TOGGLE 10A/250V 15A/125V	CUTLERHAMMER	7565K5
S10	1.0000	55206489	2PDT TOGGLE 10A/250V 15A/125V	CUTLERHAMMER	7565K5



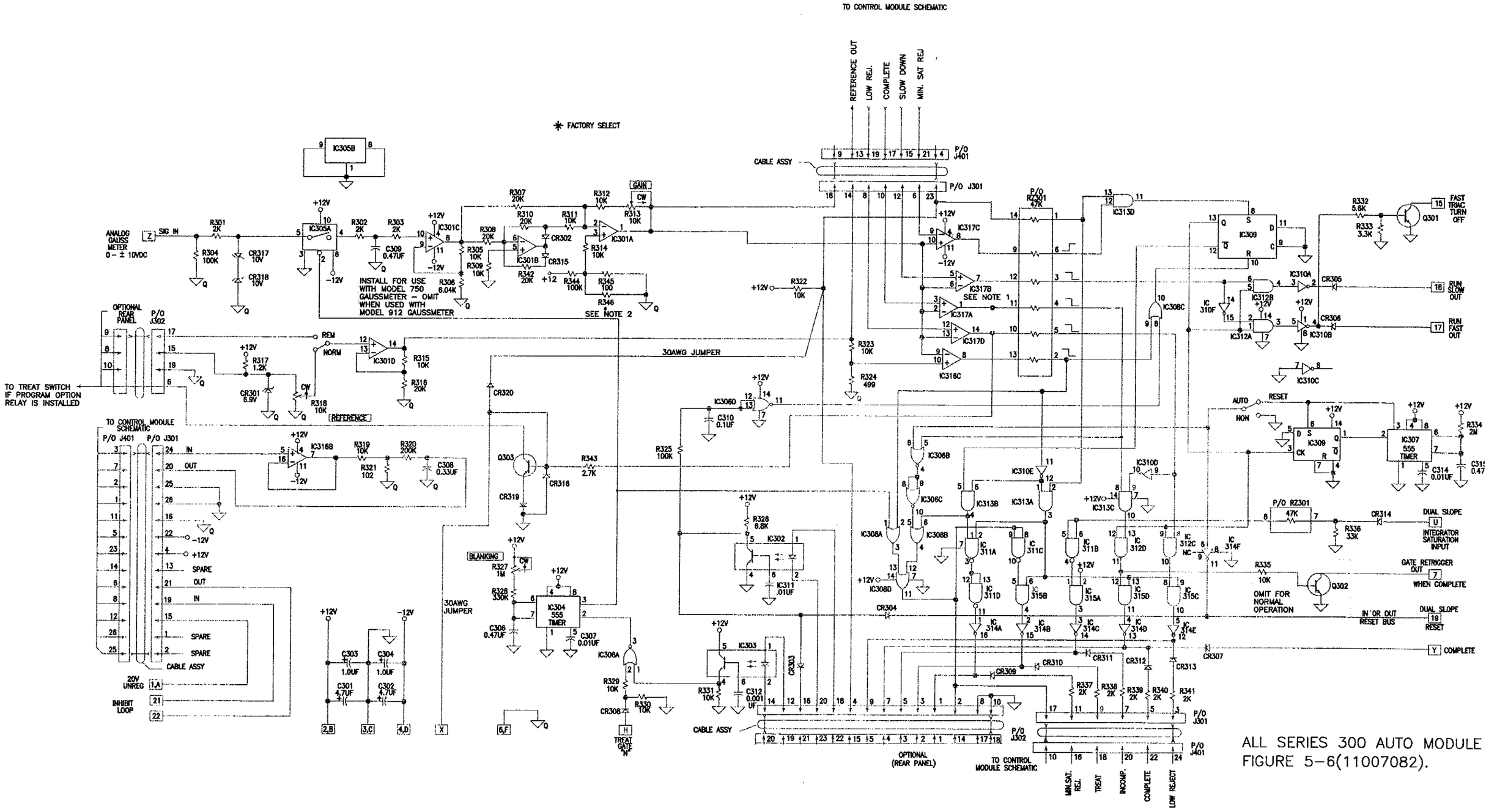
BEGINNING WITH S/N 36168



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE EXPRESSED IN OHMS, CAPACITANCE VALUES ARE EXPRESSED IN MICROFARADS.
2. FOR NORMAL OPERATION (INHIBIT WHEN RAMP INTEGRATOR SATURATES) OMIT R226 ADD CR201, TO RUN CONTINUOUSLY WHEN RAMP INTEGRATOR SATURATES, OMIT CR201 ADD R226

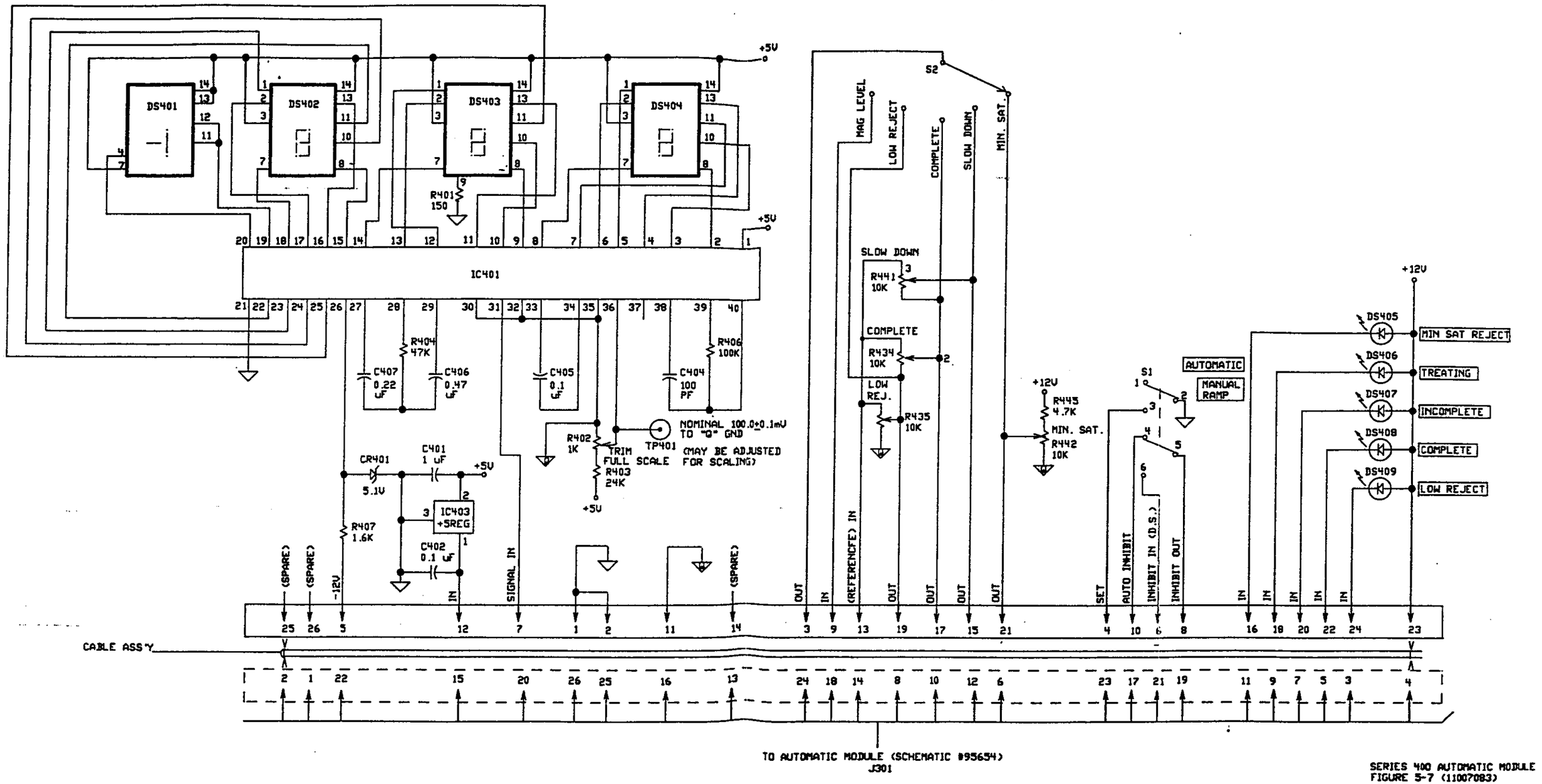
SERIES 200 DUAL SLOPE BOARD
FIGURE 5-5 (110070B1)



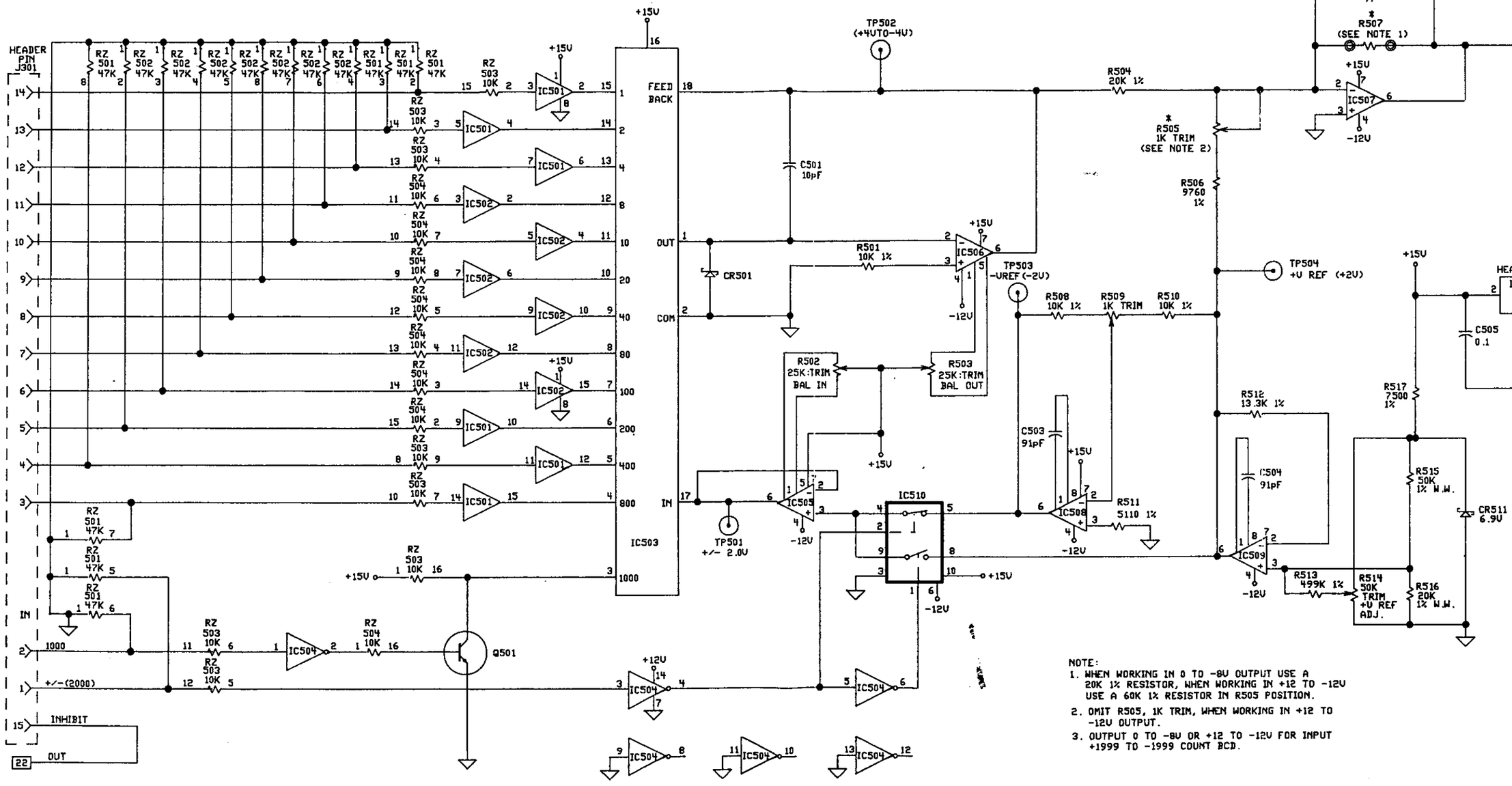
ALL SERIES 300 AUTO MODULE
FIGURE 5–6(11007082).

NOTE 1: CUT TRACE FROM R343 TO PIN 11 OF RZ301
AND TIE TRACE FROM R343 TO PIN 10 OF RZ301.

NOTE: 2 R346 IS FACTORY ADJUSTED FOR ZEROING
OF DIGITAL DISPLAY ON AUTO MODULE DISPLAY BOARD (11007083).



SERIES 400 AUTOMATIC MODULE
FIGURE 5-7 (11007083)



SERIES 500 D/A REFERENCE GENERATOR BOARD
FIGURE 5-8 (11006766)

** NOT CONNECTED TO RZ603,PIN 6 WHEN DRIVING REVERSE RELAY

* NORMALLY OMIT R607

BCD TO DIGITAL TO ANALOG REFERENCE GENERATOR

OUTPUTS
FAST
SLOW
RESET
INHIBIT
REVERSE
SLOW DOWN
ALARM

INPUTS

PROGRAM RY
ENERGIZE RY
FIRE RY
HALT
RETRIGGER
OUT/4000
SPARE
OUT/8000

TREAT GATE IN OPTION

WIRED ZERO SUPPRESS OPTION

EXIT DATA READY

POWER UP RESET

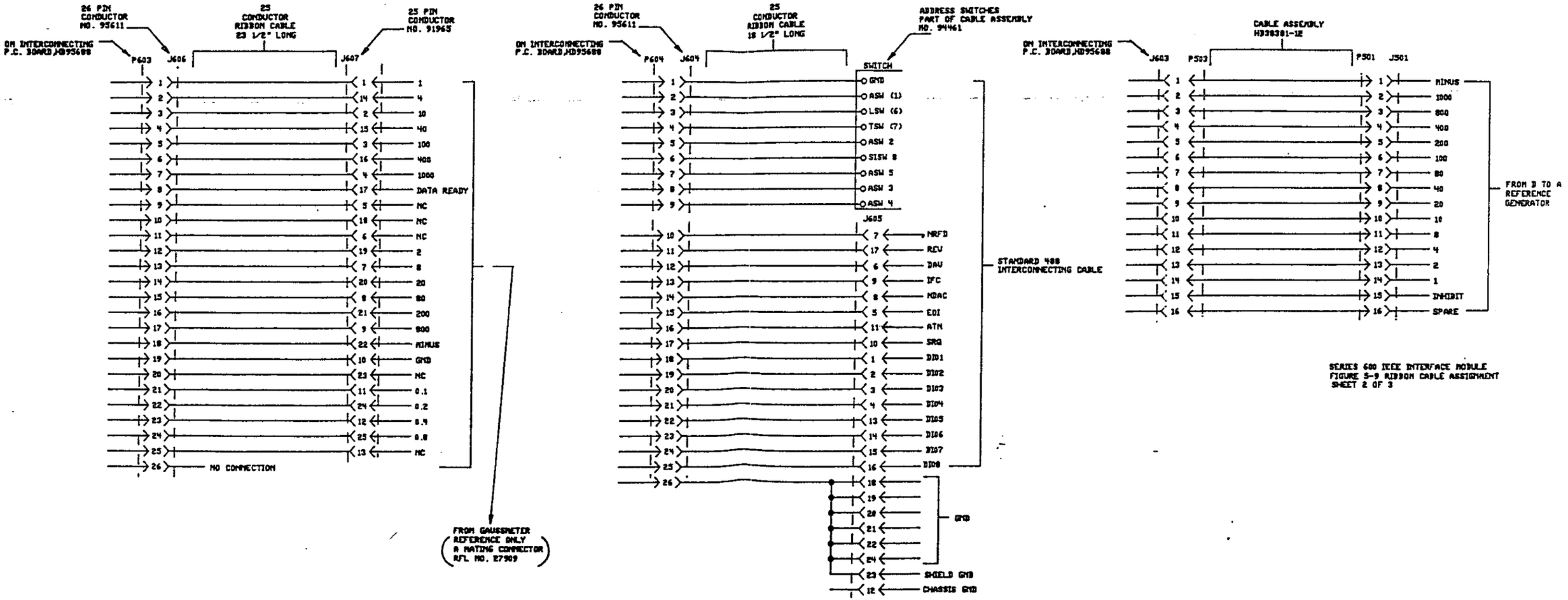
COM

SPARE

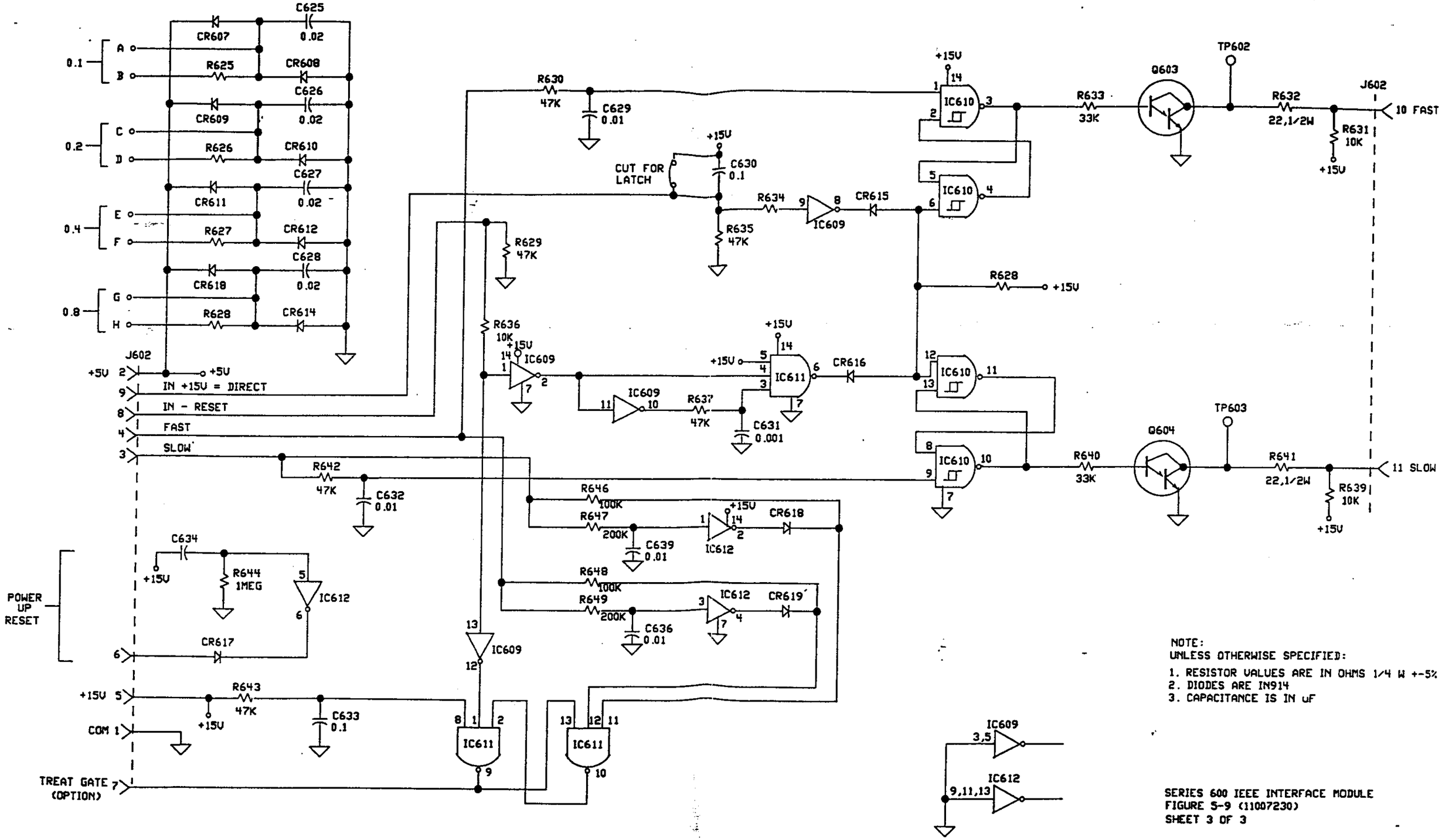
3 1/2 DIGIT OPTION SHOWN
JUMPERS TO DUAL SLOPE LATCH BOARD FOR 4 1/2 DIGIT OPTION OMIT RESISTORS 602,603,604 & 605

NOTE:
UNLESS OTHERWISE SPECIFIED:
1. RESISTOR VALUES ARE IN OHMS 1/4 W +-5%
2. R660 & R661 MAY BE OMITTED FOR EXTERNAL "DATA READ" SIGNAL.
3. CAPACITANCE IS IN uF

SERIES 600 IEEE-488 INTERFACE MODULE
FIGURE 5-9 (MAIN BOARD)
SHEET 1 OF 3



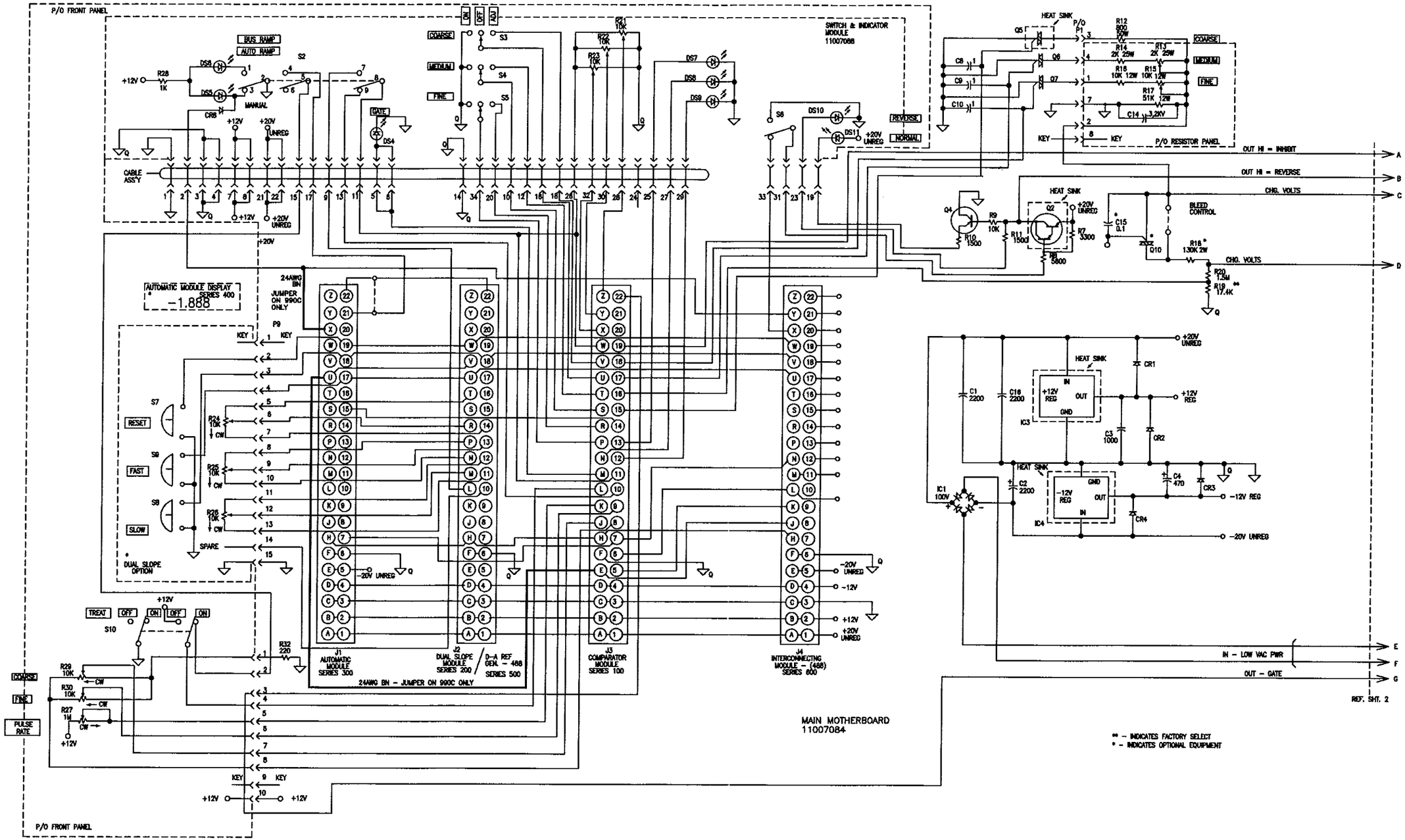
SERIES 600 IEEE INTERFACE MODULE
FIGURE 5-9 RIBBON CABLE ASSIGNMENT
SHEET 2 OF 3

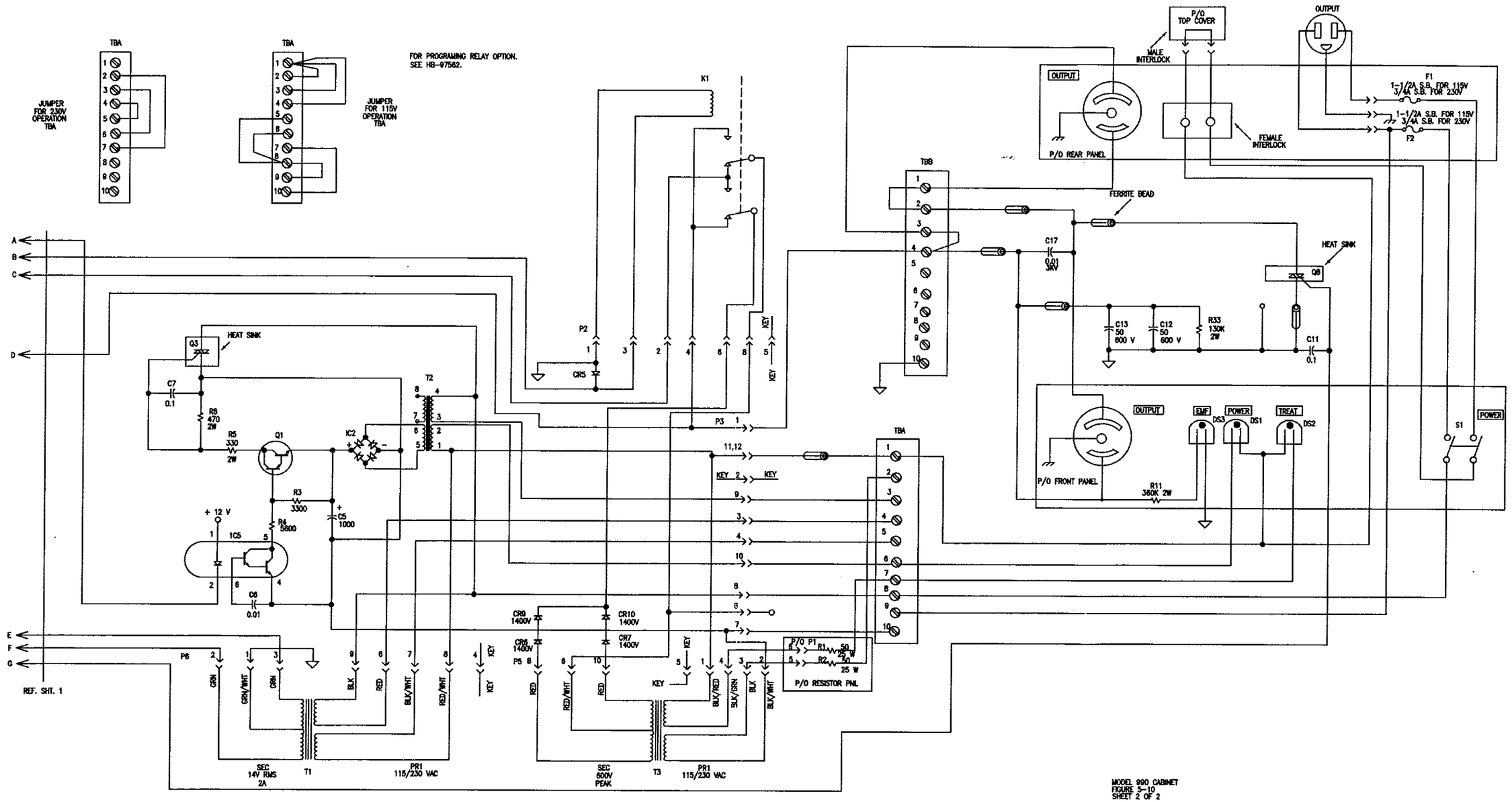


NOTE:
UNLESS OTHERWISE SPECIFIED:

1. RESISTOR VALUES ARE IN OHMS 1/4 W +-5%
2. DIODES ARE IN914
3. CAPACITANCE IS IN uF

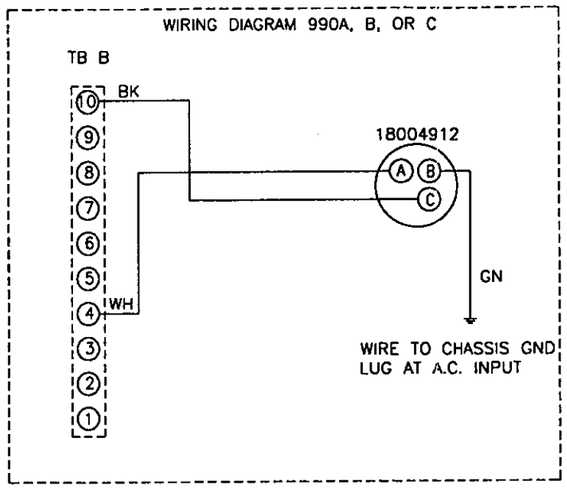
SERIES 600 IEEE INTERFACE MODULE
FIGURE 5-9 (11007230)
SHEET 3 OF 3

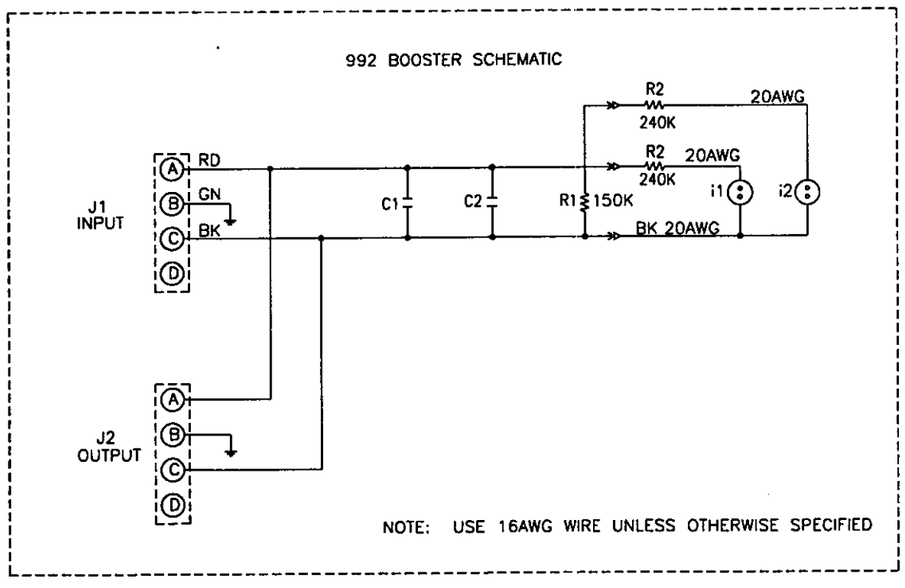

P/O FRONT PANEL
SWITCH & INDICATOR MODULE 11007088
BUS RAMP
AUTO RAMP
MANUAL
DATE
COARSE
MEDIUM
FINE
ON
OFF
ADJ
REVERSE
NORMAL
HEAT SINK
P/O RESISTOR PANEL
KEY
OUT HI = INHIBIT
OUT HI = REVERSE
CHG. VOLTS
BLEED CONTROL
AUTOMATIC MODULE DISPLAY SERIES 400
-1.888
24AWG BN JUMPER ON 990C ONLY
RESET
FAST
SLOW
SPARE
DUAL SLOPE OPTION
TREAT
PULSE RATE
J1 AUTOMATIC MODULE SERIES 300
J2 DUAL SLOPE MODULE SERIES 200 / D-A REF GEN. - 488 SERIES 500
J3 COMPARATOR MODULE SERIES 100
J4 INTERCONNECTING MODULE - (488) SERIES 600
24AWG BN - JUMPER ON 990C ONLY
MAIN MOTHERBOARD 11007084
IN - LOW VAC PWR
OUT - GATE
REF. SHT. 2
** - INDICATES FACTORY SELECT
* - INDICATES OPTIONAL EQUIPMENT



MODEL 990 CABINET
FIGURE 5-10
SHEET 2 OF 2

REVISIONS				
LET. OR E.C.N. #	LOC.	DESCRIPTION	INITIAL	DATE





AFTER S/N 25600

DATABASE FILENAME: M992MAN.DWG

WARNING:
NO MANUAL DRAWING ALLOWED ON COMPUTER GENERATED DOCUMENTS

3rd ANGLE PROJECTION WHERE APPLICABLE

DO NOT SCALE PRINT

AUTOCAD LT

REMOVE ALL SHARP EDGES & BURRS

magnetic instrumentation inc.

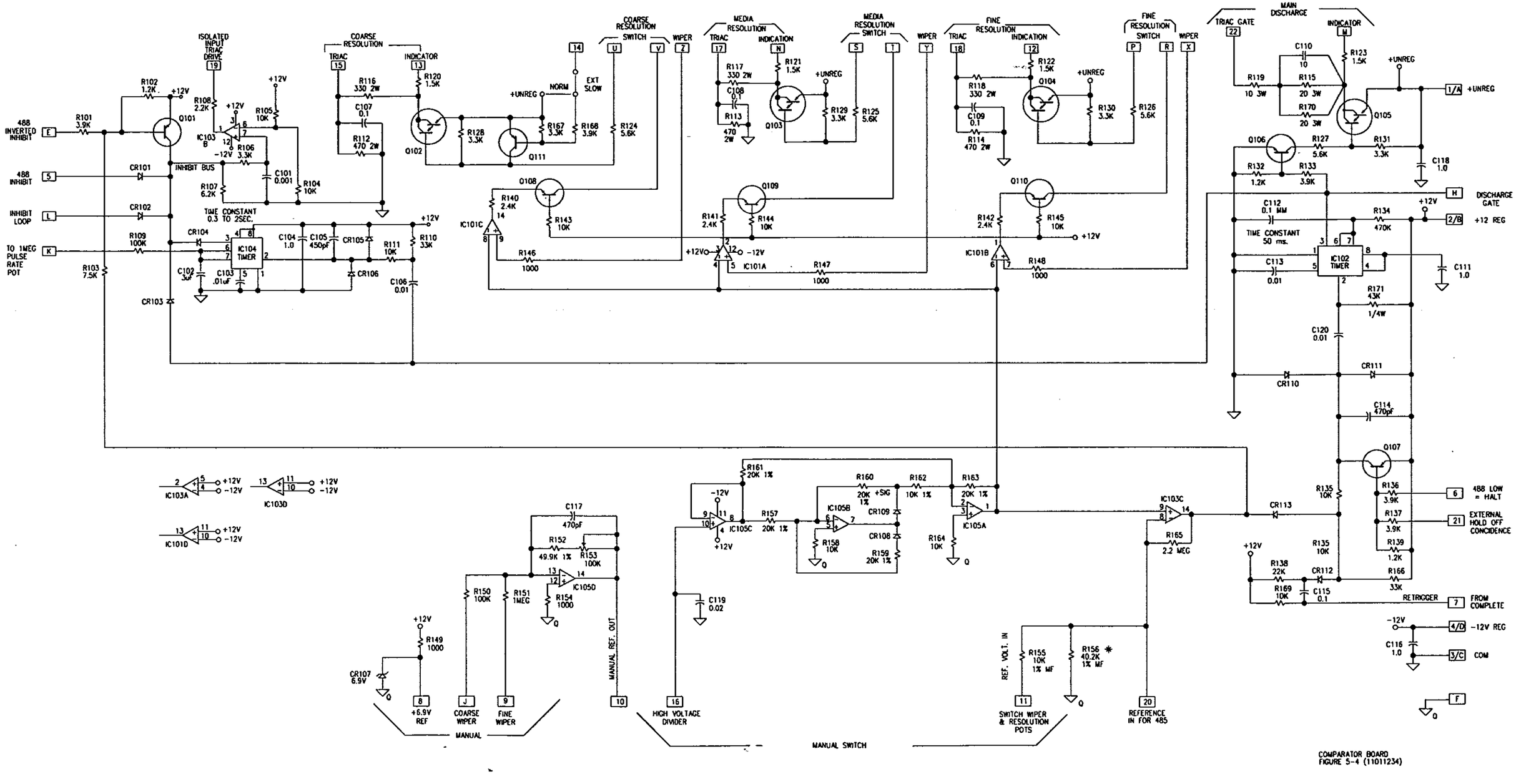
TITLE: M992 BOOSTER MANUAL DRAWING

PART NUMBER: 08005036

DESIGNED BY: MI	DATE: 09/12/96
DETAILED BY: C. POWELL	DATE: 09/12/96
CH. BY:	CUSTOMER :
J.O. NO.:	
SCALE: NONE	SHEET 1 OF 1

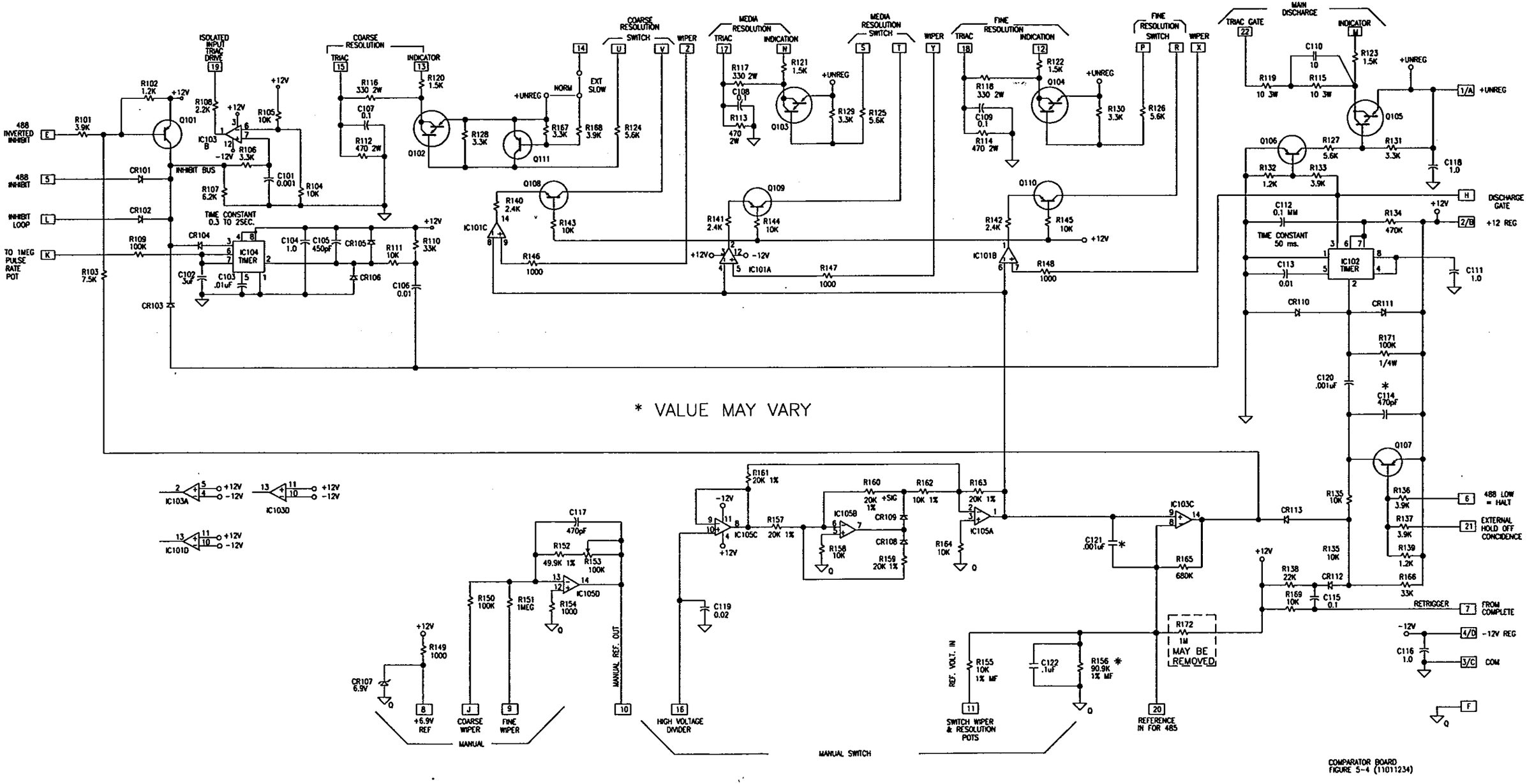
REV. MARCH 3, 1998

OBSOLETE



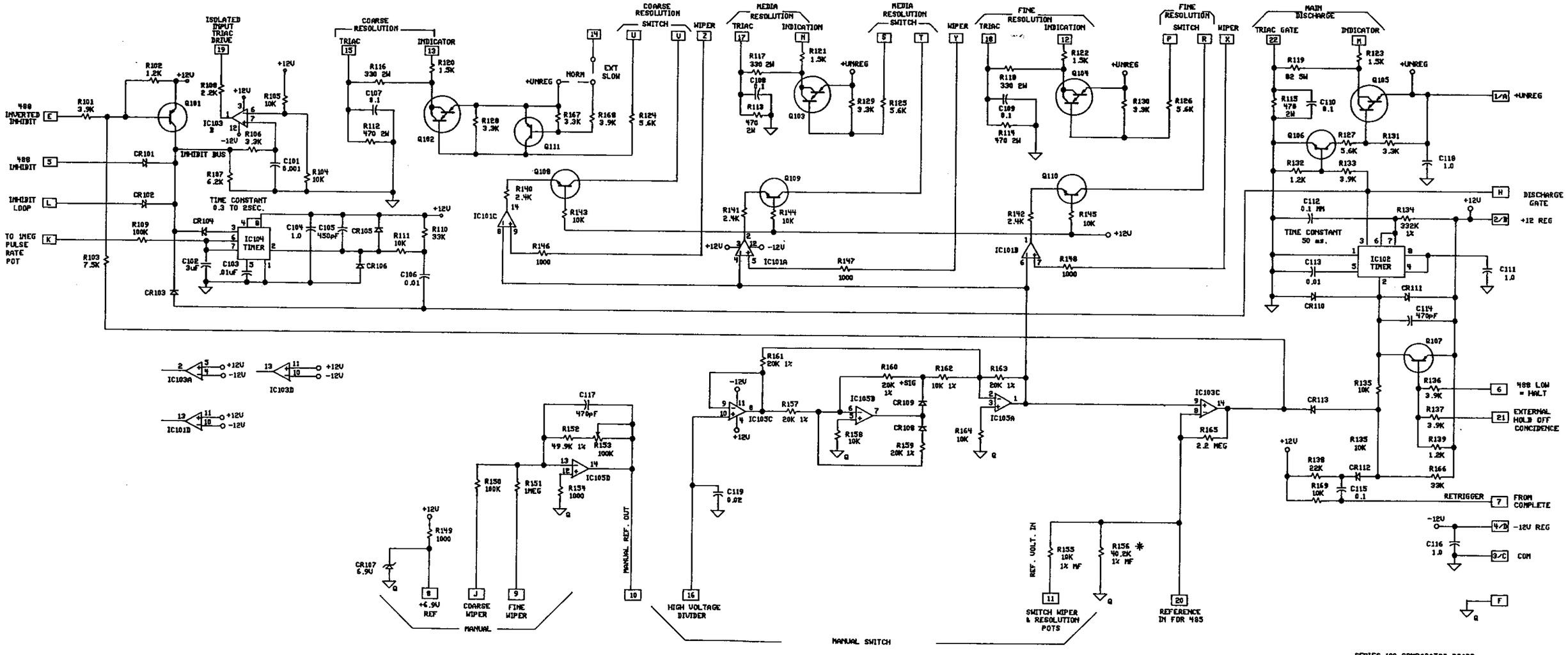
COMPARATOR BOARD
FIGURE 5-4 (11011234)

OBSOLETE



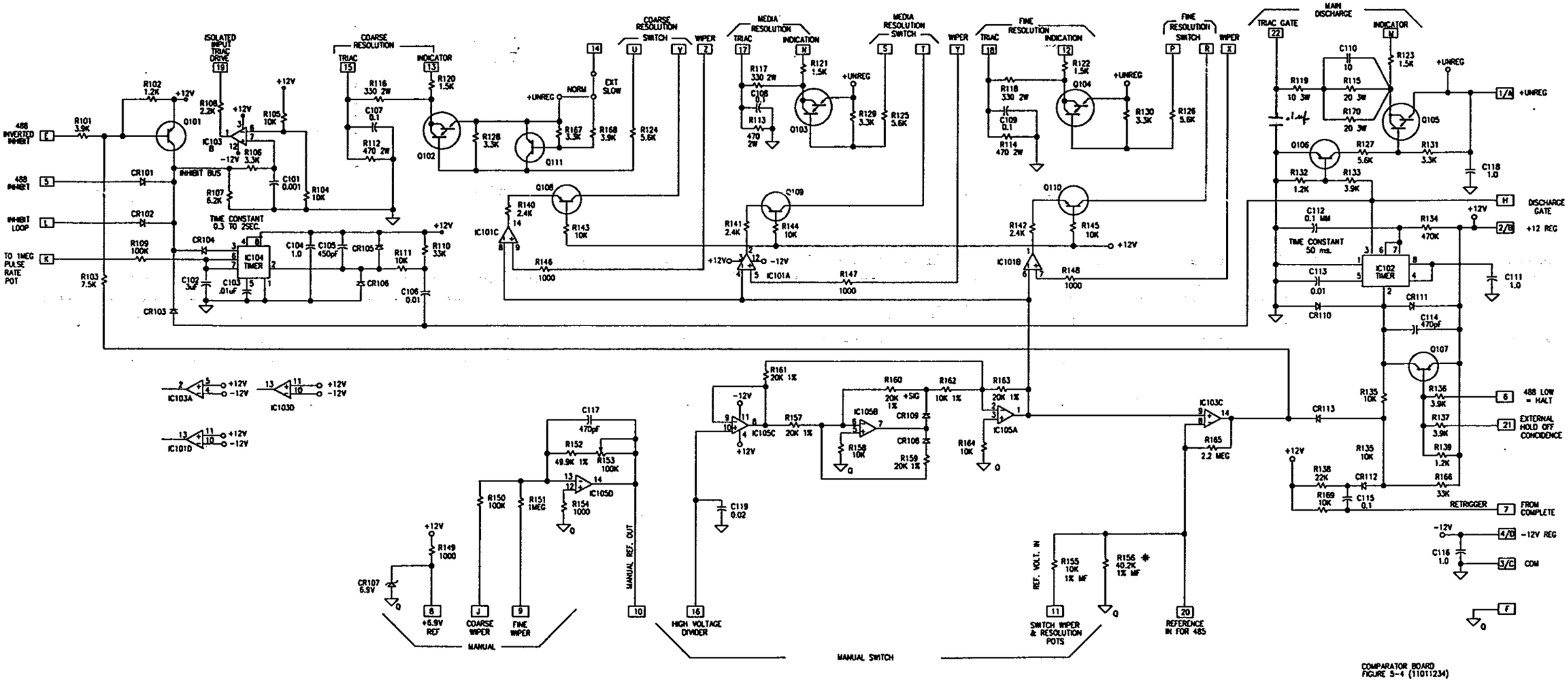
COMPARATOR BOARD
FIGURE 5-4 (11011234)

OBSOLETE



SERIES 100 COMPARATOR BOARD
FIGURE 5-4 (11007080)

OBSOLETE



COMPARATOR BOARD
FIGURE 5-4 (11011234)