***INSTALLATION***

***OPERATION***

***MAINTENANCE***

# MELLTRONICS DRIVES

# 2300RG

## Three Phase Regenerative DC Drives
## 5 HP TO 125 HP

Melltronics Industrial, Inc.

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MATTHEWS, NC 28104-8114

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**SAFETY WARNINGS**
Improper installation or operation of this drive control may cause serious injury to personnel or equipment. Before you begin installation or operation of this equipment you should thoroughly read this instruction manual and any supplementary operating instructions provided. The drive must be installed and grounded in accordance with local and national electrical codes. To reduce potential of electric shock, disconnect all power sources before initiating any maintenance or repairs. Keep fingers and foreign objects away from ventilation and other openings. Keep air passages clear. Potentially lethal voltages exist within the control unit and connections. Use extreme caution during installation and start-up.

**BRANCH CIRCUIT PROTECTION**
Branch circuit protection is to be provided by end user.

**OVERLOAD PROTECTION**
Overload protection must be provided per national electric code article 430, Section C.

**INITIAL CHECKS**
Before installing the drive control, check the unit for physical damage sustained during shipment. Remove all shipping restraints and padding.

**INSTALLATION LOCATION OF CONTROL**
Controls are suitable for most factory areas where industrial equipment is installed. The control and operator's control station should be installed in a well-ventilated area. Locations subject to steam vapors or excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, excessive dirt, dust or lint should be avoided unless an appropriate enclosure has been supplied or a clean air supply is provided to the enclosure. The location should be dry and the ambient temperature should not exceed 104ºF. If the mounting location is subject to vibration, the enclosure should be shock-mounted.
If the enclosure has a ventilating fan, avoid, wherever possible, and environment having a high foreign-matter content otherwise the filters will have to be changed more frequently or micron-filters installed. Should a control enclosure require cleaning on the inside, a low pressure vacuum cleaner is recommended, not an air hose, because of the possible oil vapor in the compressed air and its high pressure.

## 2300RG– RECEIVING AND STORAGE INFORMATION

Please record information below before installing the unit and use these numbers when communicating with the factory.

**MODEL NAME** ______________________________

**PART NO.** ______________________________

**SERIAL NO.** ______________________________

**REVISION** ______________________________

**MODIFICATIONS** ______________________________

**ACCEPTANCE**
Carefully inspect shipment upon arrival and check items with packing list. Shortage or damage should be reported promptly to your carrier and your distributor.

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# SECTION 1
# GENERAL INFORMATION

## 1.1 INTRODUCTION

This instruction manual contains installation facts, operating instructions and troubleshooting procedures for the *MELLTRONICS 2300RG* Adjustable Speed DC Motor Control. It also includes a comprehensive description of the *MELLTRONICS 2300RG* control with detailed product specifications and a complete description of all customer selectable functions and customer installable option kits.

For most drive applications, the information in this instruction manual will describe all drive system set-up and operating procedures. It should also provide all the information required by the customer to install and maintain a *MELLTRONICS 2300RG* control. In some applications, additional drive system set-up and operating information may be required. This information will generally be supplied in the form of a system schematic and system interconnection diagrams.

## 1.2 GENERAL DESCRIPTION

The *MELLTRONICS 2300RG* is a high performance, regenerative DC motor control. Included are many standard features that are available only as options on many other three-phase regenerative drives. Terminals on the control provide accessibility to all important internal regulator points. This permits the *MELLTRONICS 2300RG* to be used in custom engineered applications, as well as in standard speed regulated applications.

The *MELLTRONICS 2300RG* controls a DC motor's speed or torque by varying the DC voltage applied to the motor's armature. Because the control is regenerative, it can provide power to the load or absorb power from the load and return that power to the AC power line. Rectilinear phase control assures stable operation at low speeds and smooth transitions between motoring and regenerative modes (zero dead band).

The *MELLTRONICS 2300RG* control converts three-phase AC input power to variable voltage DC output power. The DC output is applied directly to the DC motor armature. DC output voltage varies as a function of an input reference voltage in speed regulated applications. (Typically, this input reference voltage is provided by an operator adjustable potentiometer). Changing the speed reference (potentiometer setting) results in a motor speed change.

DC output current varies as a function of an input reference voltage in torque regulated applications. Changing the torque reference (potentiometer setting) results in a change in motor torque output.

The *MELLTRONICS 2300RG* control incorporates a fixed voltage/variable current, regulated DC source for excitation of the motor field.

The *MELLTRONICS 2300RG* is a versatile control. Simple jumpered programming allows the *MELLTRONICS 2300RG* to operate form either 240 or 480 volt AC input power at 50 or 60 Hz. Additional jumpers program the control to operate as either a speed regulator with armature voltage or DC tachometer feedback or as a torque regulator with armature current feedback. Three control models cover the entire 5 - 125 HP range of applications. (See Table 1). Drive current limit and inverse time overload protective circuits for ratings within this range are calibrated from the application by selecting and installing the proper current scaling shunt (HP) resistor.

Included in the *MELLTRONICS 2300RG* control are many built-in features not available on competitive units. Motor Field Economy and separately adjustable rates of acceleration and deceleration are included on all units. If desired, the built-in ACCEL/DECEL control ramps can be by-passed completely by a jumper change on the control. Current compounding can be added to the speed regulator by changing another jumper position. Current limit is normally set by a potentiometer located on the main printed circuit board, but if desired, it can be adjusted using a remote mounted potentiometer or a customer supplied voltage signal. Remove fault indication is possible using logic level signals available on the main PC board.

## 1.3 TYPICAL PACKAGING

AC line and DC loop fusing as well as a DC loop contactor for complete fault protection are included in the basic *MELLTRONICS 2300RG* chassis mounted control. LED indicators provide complete fault monitoring and status indication and a digital test meter with multi-position selector switch is also available as an option.

The basic *MELLTRONICS 2300RG* control is chassis mounted which makes it suitable for sub panel mounting inside a customer furnished control enclosure. (See Figure 1).

In general, *MELLTRONICS 2300RG* controls are furnished without operator's devices. Terminals are provided on the basic *MELLTRONICS 2300RG* control for connection of one or more of the following operator's devices:

Start Push-button Jog Push-button

Stop Push-button Speed Adjust Potentiometer

Remote Current Limit Potentiometer


Figure 1: Typical 2300RG Chassis Mount Control

### 1.4 EQUIPMENT IDENTIFICATION

It is important to identify your drive control completely and accurately whenever you contact Melltronics Industrial to order spare parts or request assistance in service. Every *MELLTRONICS 2300RG* includes a product nameplate located on the right side of the chassis. Record both the part number and serial number for your future reference.

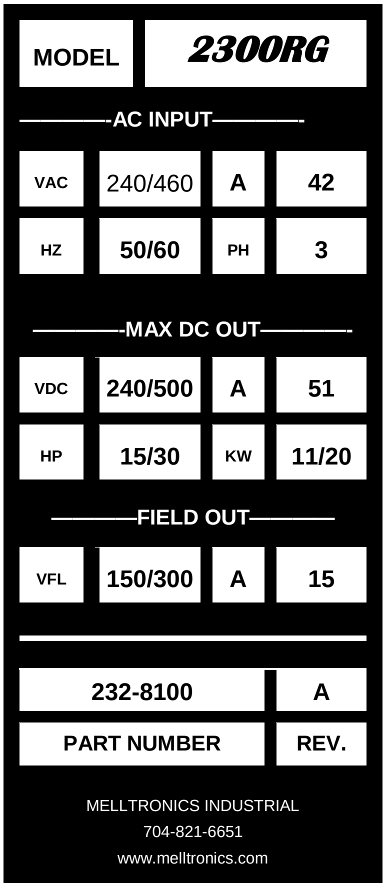



Figure 2: Typical Product Nameplate

# SECTION 2
# CONTROL SPECIFICATIONS AND FEATURES

## 2.1 EQUIPMENT RATINGS

The *MELLTRONICS 2300RG* was designed to handle most phase regenerative drive applications without the addition of external hardware and without the need for costly, time consuming engineering. Three *MELLTRONICS 2300RG* control models cover the entire 5 through 125 HP range of DC drive applications. *MELLTRONICS 2300RG* controls are reconnectable for 240 VAC or 480 VAC three-phase input power at either 50 or 60 Hz. Drive current limit and inverse time overload protective circuits are calibrated for the application by selecting and installing the proper current scaling shunt (HP) resistor.

Table 1, below, lists the AC input and DC output current ratings by control part number and motor horsepower for all possible combinations. In this table, the 240 VAC input voltage is associated with the 240 VDC armature volts and the 480 VAC input is associated with 500 VDC armature volts.

Table 1: Armature Circuit Rating Table

| Control | Horsepower | | Input Amps | DC Armature Amps @ |
|---|---|---|---|---|
| Part No. | 240 VAC | 480 VAC | @Full Load | Full Load |
| 232-8100 | — | 5 | 7.0 | 8.8 |
| | — | 7.5 | 10.6 | 13.0 |
| | 5 | 10 | 13.9 | 17.0 |
| | 7.5 | 15 | 20.7 | 25.2 |
| | 10 | 20 | 27.8 | 33.9 |
| | — | 25 | 34.9 | 42.5 |
| | 15 | 30 | 41.8 | 51.0 |
| 232-8101 | 20 | 40 | 55.7 | 67.9 |
| | 25 | 50 | 69.7 | 84.9 |
| | 30 | 60 | 83.7 | 102 |
| | 40 | — | 115 | 141 |
| | — | 75 | 104 | 126 |
| 232-8102 | 50 | 100 | 139 | 170 |
| | 60 | 125 | 174 | 212 |

A fixed voltage variable current, regulated DC motor field supply is provided on all *MELLTRONICS 2300RG* controls. The DC voltage output level is a function of the AC voltage input level. Field data for the *MELLTRONICS 2300RG* control is tabulated in Table 2.

Table 2: *MELLTRONICS 2300RG* Field Data

| | |
|---|---|
| Voltage: | 150 VDC with 240 VAC input<br>300 VDC with 480 VAC input |
| Current: | 15 amperes maximum |

## 2.2 PERFORMANCE FEATURES

**Circuit Board Indicators -** Light emitting diodes (LEDs) on the main printed circuit board indicate:

A. AC Power On
B. Anti-Plug
C. Current Limit
D. DC Overload
E. DC Power On
F. Field Loss
G. Heat Sink Over-temperature
H. Instantaneous Over-correct Trip
I. Jog Mode
J. Phase Loss
K. Anti-Plug

In addition to the indicators listed above, twelve separate LEDs indicate that each SCR is receiving gate pulses.

**Current (Torque) Regulator -** One percent accuracy armature current regulator allows the operator to control motor torque instead of speed.

**Field Current Regulator -** Built in adjustable current regulator maintains constant field flux despite changes in motor operating temperature.

**Field Economy -** Insures longer life for wound field DC motors. May be easily by-passed to meet specific application requirements.

**Full Four Quadrant Operation -** Allows operation of the drive motor in both the forward and reverse directions while producing torque in either the clockwise or counterclockwise direction.

**Inner Current Loop Regulator -** Inherent high band width capability for fast response.

**Isolated Control Circuitry -** Provides complete isolation of the control and regulator circuitry from the AC power bus for protection in the event of a ground fault. The speed potentiometer and tachometer are not at line potential. Complete system compatibilities is also possible without additional isolation accessories.

**Jog Set at Preset Speed -** Separately adjustable from zero to plus or minus 30% of base speed.

**Negative IR Compensation -** Sometimes referred to as Current Compounding, enables this drive to operate in load sharing applications. This feature becomes available by jumper connection.

**Quadrant Lockout -** May be selected by jumper programming to prevent forward nor reverse motoring in certain applications.

**Rectilinear Phase Control -** Provides significantly improved performance at low speeds and near zero load separately Adjustable Linear ACCEL/DECEL Control - Two ranges; 1.2-4 seconds and 2-30 seconds.

**Speed Regulator -** Two percent accuracy using armature voltage feedback with IR compensation or 1% accuracy with DC tachometer feedback. Regulation may be improved by selecting the proper motor mounted DC tachometer.

**Solid State Full Wave Power Bridge -** Uses generously rated power semiconductors for maximum reliability and long life. A 12 SCR back to back power bridge means better form factor, improved efficiency, better motor commutation and cooler motor operation.

**AC Line Connections -** The ***MELLTRONICS 2300RG* is** completely insensitive to AC line phase sequencing.

**Common Control Circuit Boards -** All ***MELLTRONICS 2300RG*** controls except the current feedback board utilize the same PC boards regardless of HP, voltage, frequency or control model.

**Dual Frequency Operation -** Controls may be operated from 50 or 60Hz power supplies by simple jumper change.

**Exclusive Static Adjustable Current Limit** - Allows static setting of the desired current limit value without applying DC power and without a connected output load.

**Remote Current Limit -** Available by the simple addition of a potentiometer of DC voltage input.

**Standard Adjustments -** Maximum speed, zero bias, acceleration time, deceleration time, IR compensation, current limit, jog speed, velocity stability, speed rate, and current stability.

**SCR Trigger Circuits -** Pulse transformer isolated, hard firing, high frequency "burst" type pulse train output from individually gated oscillators insures SCR conduction regardless of the effects of line notching on the incoming AC power line.

### 2.3 PROTECTIVE FEATURES

**DC Armature Loop Contactor -** Full rated and fully sequenced contactor assures positive disconnect of DC motor when the stop push-button is pushed or whenever an under-voltage condition occurs.

**DC Overload (Armature) -** Senses over-current conditions with inverse time shutdown.

**Fault Trip Circuit -** Protective circuits are designed to quickly shut the drive down whenever a drive fault condition occurs. A visual indication of the fault condition is provided and six TTL open collector logic level signals are available for remote fault indication. The fault trip circuit prevents inadvertent drive restart after a fault has occurred. It must be reset before the drive can run again.

**Field Loss Protection -** Provides protection against runaway due to loss of motor field by shutting down the drive.

**Heat Sink Thermal Switch** - Prevents long-term thermal damage to SCRs due to loss of heat sink cooling fan.

**High Speed Current Limiting SCR Semiconductor Fuses -** Provides the utmost in fuse coordination and protection of the SCRs and motor with positive circuit clearing on both AC and DC faults.

**Instantaneous Over-correct Protection -** Senses armature fault currents quickly to protect both semiconductors and motors against damaging current levels.

**Reactors, Snubber Networks -** Prevents interaction and SCR DV/DT failures, due to line spikes and transients. Provides DI/DT protection during SCR turn-on and aids in SCR turn-off during SCR commutation, thus minimizing the effects of AC power-line notching.

> NOTE: Severe system applications may require additional electrical equipment to insure proper control operation. For further information, consult the Melltronics Industrial Service Department.

**AC Line Filter and Transient Voltage Suppressor Network -** Eliminates interaction between other drives or AC equipment. (See previous "NOTE")

### 2.4 PERFORMANCE SPECIFICATIONS

Controlled Speed Range: 20:1 basic control. May be extended to 200:1 by modification

Speed Regulation:

For a 95% Load Change:

| | |
|---|---|
| Voltage Regulated: | 2-5% of maximum speed |
| Speed Regulated: | 1% of maximum speed with any DC tachometer. |

For All Other Variables:

| | |
|---|---|
| Voltage Regulated: | Changes up to 15% of top speed can result from temperature variations, voltage and frequency variations, and drift. |
| Speed Regulated: | 1% of maximum speed with any DC tachometer |

> NOTE: Speed regulation may be modified to achieve 0.1% due to a 95% load change and 0.15% due to all other variables

| | |
|---|---|
| Overload Capacity: | 150% of related current for 1 minute |
| Service Factor: | 1.0 |

### 2.5 OPERATING CONDITIONS

| | |
|---|---|
| Rated Line Voltage: | 240 or 480 Volts AC , Three-Phase |
| Line voltage Variations: | ± 10% |
| Rated Line Frequency: | 50 or 60Hz |
| Line Frequency Variations: | ± 2Hz |

### 2.6 ENVIRONMENTAL CONDITIONS

| | |
|---|---|
| Storage Temperature: | -30$^0$ C to 65$^0$ C (-20$^0$ F to 150$^0$ F) |
| Ambient Temperature (Enclosed Control): | 0$^0$ C to 40$^0$ C (32$^0$ F to 105$^0$ F)* |
| Ambient Temperature (Chassis Mount Control): | 0$^0$ C to 55$^0$ C (32$^0$ F to 131$^0$ F)* |
| Altitude: | Sea level to 3300 feet (1000 meters)* |
| Relative Humidity: | 0 to 95% |

*Operation at elevated temperature and higher altitudes requires de-rating of the control.

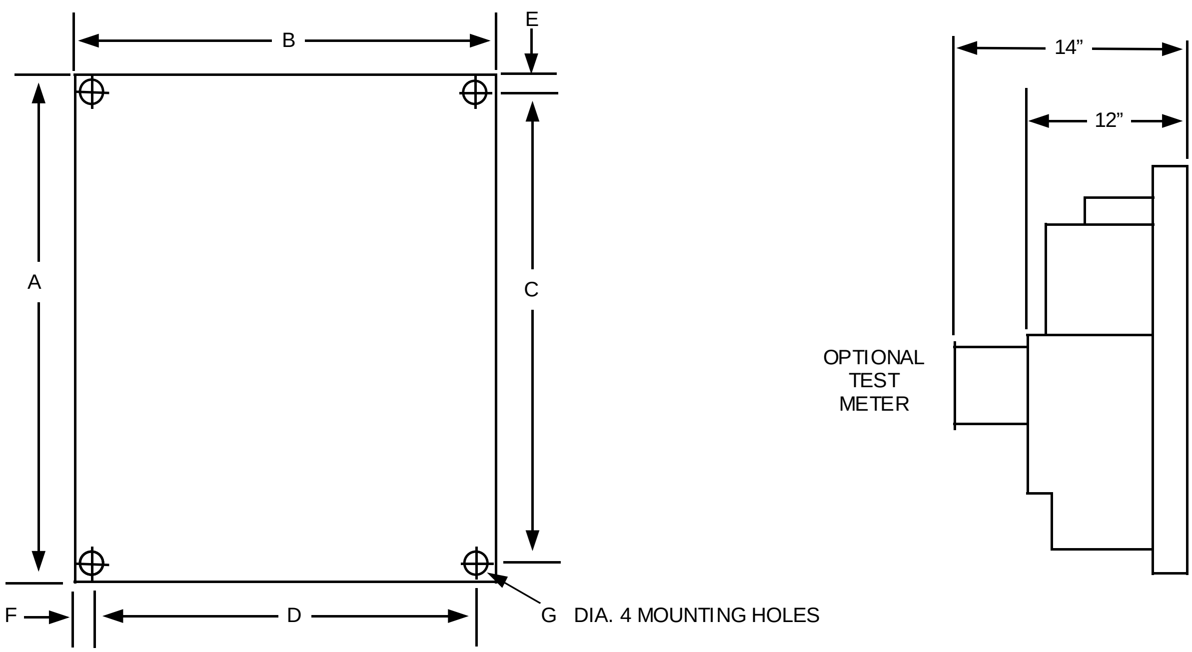
### 2.7 ADJUSTMENTS

The *MELLTRONICS 2300RG* control includes a number of potentiometers that may require adjustment during drive installation and start-up. These adjustment potentiometers are located on the main (regulator) PC board.

| | | |
|---|---|---|
| A.. | Stability | User adjusted for best results |
| B. | Deceleration Time | User adjustable from 0.2-4 sec. or 2-30 sec. (selectable) |
| C. | Acceleration Time | User adjustable from 0.2-4 sec. or 2-30 sec. (selectable) |
| D. | Maximum Speed | User adjustable from 70-130% of rated speed. |
| E. | Jog Speed | User adjustable from 0-30% of rated speed |
| F. | Current Limit | User adjustable from 0-150% of selected current range. |
| G. | Speed Rate | User adjustable for best results. |
| H. | I R Compensation | User adjustable from 0-15% of rated voltage. |

Several additional adjustment potentiometers are included on the *MELLTRONICS 2300RG*. These potentiometers are all factory set and normally do not require further adjustment.

### 2.8 CONTROL DIMENSIONS AND WEIGHTS




**DIMENSIONS IN INCHES**

| CONTROL | A | B | C | D | E | F | G | Stud | WT.-LBS. |
|---|---|---|---|---|---|---|---|---|---|
| **232-8100** | 24 | 16 | 22¾ | 15¼ | 5/8 | 5/16 | 3/8 | 1/4 | 40 |
| **232-8101** | 24 | 21 | 22¼ | 19¼ | 7/8 | 7/8 | 1/2 | 3/8 | 49 |
| **232-8102** | 24 | 21 | 25¼ | 19¼ | 7/8 | 7/8 | 1/2 | 3/8 | 58 |
| **232-8103** | 27 | 21 | 25¼ | 19¼ | 7/8 | 7/8 | 1/2 | 3/8 | 84 |

Figure 3: Outline and Mounting Dimensions for Chassis Mount Control

### 2.9 PRE-ENGINEERED MODIFICATION KITS

150VA, 115VAC CONTROL TRANSFORMER: P/N-222-9120

This option, in addition to providing 100VA at 115 VAC for customer use, also provides power for panel mounted kits requiring 115 VAC. The transformer has selectable primary windings for 240/480 VAC, 50/60Hz input jumper programmable by the customer. Both the primary and secondary windings are fused. Fuses: (2) - 1.5A/125VAC SLO-BLO.

AMMETER SHUNT P/N 232-9011

This option is used to provide a 50 millivolt isolated signal for interfacing to an external shunt rated 50mV ammeter. The ammeter shunt signal is high impedance isolated, preventing dangerous ground fault currents to the case of ammeter or wiring ground problems. The ammeter shunt is arranged to provide a 50mV signal for various current ranges on each MELLTRONICS 2300RG series control.

AMMETER: P/N SEE DRIVES CATALOG

These zero center, 50mV movement meters allow monitoring of armature current/load. The ammeter shunt is required.

DIGITAL TEST METER: P/N 232-9000

Allows instantaneous checking of :

| | |
|---|---|
| L1-L2 Line-to-Line Voltage | Field Voltage |
| L2-L3 Line-to-Line Voltage | +15 Volt Supply |
| L3-L1 Line-to-Line Voltage | -15 Volt Supply |
| 115 VAC Control Voltage | Armature Voltage |
| Percent Armature Current | Percent Current Limit |
| Phase Reference (Trigger Signal) | |

SPEED METER INTERFACE: P/N 222-9003

This board has been designed to be used with the sped meter option. Its purpose is to interface either the armature voltage or the tachometer voltage to the speed meter. When armature voltage is used as a speed sensing signal, this board provides a filtered, resistively isolated signal to the speed meter. If a tachometer is used as the speed sensing signal, this board provides a filtered, full wave rectified signal to the speed meter.

SPEED METER: P/N 222-9074

Indicates motor/line speed on a scale of 0-100%. Must be used with speed meter interface board (P/N 222-9003). The meter enclosure is included.

REVERSING: P/N 232-9005

This option provides the capability for external selection of the direction of drive rotation (forward or reverse). This option kit includes forward/reverse solid-state reference inverting circuitry which is operated using a selector switch (not provided).

DYNAMIC BRAKING RESISTOR: P/N SEE DRIVES CATALOG

These high powered resistors are designed to electrically dissipate the inertial energy of the motor for a quick stop. Kits supplied for ratings up to 60HP, 460V (30HP, 240V) are panel mountable with hock-up cable provided. Larger horsepower units are supplied with cages for outside cabinet mounting.

VOLTAGE SIGNAL ISOLATOR: P/N 222-9065

The voltage signal isolator is designed to be used in applications where the master reference transmitter or an external voltage signal is used to control the speed of the drive, and signal isolation is required.

This option provides totally isolated interface circuitry between signal and master reference options or any external voltage signals and the controller regulator circuitry.

PROCESS SIGNAL FOLLOWER: P/N 222-9064

The Process Signal Follower is designed to be used in applications where drive speed is to be controlled by process variables, such as pressure, flow, temperature, or DC tachometer generator. It provides the necessary circuitry to interface the drive with a process instrument current, voltage signal or DC tachometer voltage signal.

RAMP STOP/ZERO SPEED DETECTOR: P/N 222-9068

This option can be used with an *MELLTRONICS 2300RG* series control to provide a ramp stop function in which the control ramps down in speed at the control deceleration rate during a normal stop. When used in this manner, a separate Emergency Stop push-button is required, which defeats the normal controlled ramp stop. This option includes armature voltage and tachometer (speed) sensing circuitry which controls a relay with output contacts.

FIELD REGULATOR: P/N 232-9006

The field range regulator is designed to be used in applications where regulated field control is desired or motor field strength must be trimmed for optimum motor performance. The regulator circuitry, which is isolated from the motor field, controls a full wave, full control bridge which converts the drive input line voltage to provide either adjustable field current or adjustable field voltage to the motor.

# SECTION 3
# FUNCTIONAL DESCRIPTION

## 3.1 GENERAL DESCRIPTION

The *MELLTRONICS 2300RG is* a fully regenerative DC motor control which consists of two basic functional blocks: a power conversion assembly and a regulator assembly.

The power conversion assembly consists of twelve silicon-controlled rectifiers (SCRs) connected in a bi-directional full wave bridge configuration. This bi-directional full wave bridge can convert three phase AC power (from the AC power lines) into DC power and deliver it to the DC motor. It can also convert DC power form the DC motor when the motor is acting as a generator into AC power and return this “regenerative” power to the three-phase AC power lines.

The regulator assembly includes all of the electronic circuitry used to control (provide gating signals to) the power conversion assembly. The regulator used in the *MELLTRONICS 2300RG*, employs two control loops, and outer velocity loop and an inner current loop. There are several advantages inherent in a DC motor control that employs this dual control loop concept. First of all, the inner current loop can easily and effectively be used to limit DC motor armature current. This protects the motor, the power bridge and the fuses during abnormal (transient) loading conditions. It also helps to maintain stable drive operation under varying load conditions. Another advantage of a DC motor control that employs an inner current loop is the ease with which it can be converted from a speed regulated drive to a torque regulated drive. This provides application flexibility which would not otherwise be available.

## 3.2 BLOCK DIAGRAM DESCRIPTION

In this section, the *MELLTRONICS 2300RG* control will be analyzed and described using the functional block diagram shown in Figure 4. Incoming AC power is applied to the *MELLTRONICS 2300RG* control at terminals L1, L2 and L3. Three rectifier-type fuses (1FU, 2FU and 3FU) provide AC line short circuit protection and serve to protect the SCRs from DC fault currents. AC line power is distributed within the *MELLTRONICS 2300RG* control to three major functional blocks: the power conversion assembly, the DC motor field regulator and the control power supply.

The power conversion assembly consists of two-phase controlled, full wave rectified, SCR power conversion circuits connected in a “back to back” configuration. This power conversion assembly directly converts and AC line voltage into adjustable voltage DC power of either positive or negative polarity. The power conversion assembly can also function as a line-commutated inverter and convert DC power flowing in the motor armature circuit into a chopped AC wave-form. This allows DC power generated by an overhauling load to be returned to the AC power line (regeneration). The output of the power conversion assembly is connected to the DC motor armature through a DC loop contactor (MC). The DC loop contactor provides a positive means of disconnecting the DC motor armature from the power conversion assembly in the event of a drive fault.

The DC motor field regulator rectifies AC line voltage to produce an adjustable DC current or a fixed DC voltage which may be connected to the field windings of a constant field DC motor. A full field enable circuit “half waves” the field power supply approximately one minute after the DC loop contactor is opened. This reduces the field voltage applied to the DC motor (field economy) and helps to increase motor life in those applications where the motor field remains energized while the motor is stopped.

The control power supply assembly steps down the incoming AC line voltage, and then rectifies filters and regulates it to provide four DC power sources (±15VDC, ±24VDC) which are used internally by the *MELLTRONICS 2300RG* regulator assembly.

A ±10VDC output is also produced which may be used in conjunction with an external potentiometer to generate a drive reference signal.

The control power supply assembly includes an isolated 115 VAC power source which is used to operate the control logic relays and DC loop contactor. A fused 115VAC output is also available for customer use.

All of the remaining functional blocks shown in Figure 4 are associated with the *MELLTRONICS 2300RG* regulator assembly. An overview of the *MELLTRONICS 2300RG* regulator assembly is presented below.

The *MELLTRONICS 2300RG* control works from a zero to ±10VDC reference signal. This input reference signal can represent either a DC motor speed reference or a DC motor torque reference depending on the placement of a terminal board jumper. The input reference signal is usually introduced into the control at TB-1, Terminal #21 on the main control board.

Terminal #21 is connected to the input of the *MELLTRONICS 2300RG*’s ACCEL/DECEL circuit. This circuit controls the rate at which the drive reference can change. When a reference signal is applied to the input of the ACCEL/DECEL circuit, the output of the ACCEL/DECEL circuit changes at a linear rate with respect to time until the output of the ACCEL/DECEL circuit is equal to its input. The rate of change is adjustable and separate adjustments are provided for positive going and negative going reference changes.

The ACCEL/DECEL circuit is most commonly used in speed regulated drive applications. If the operator rapidly changes the speed reference to the drive, the ACCEL/DECEL circuit will limit the ACCELeration or DECELeration rate to a rate that will not cause machine or process problems. The ACCEL/DECEL circuit can also be used in torque regulated applications to limit the rate at which the torque reference to the drive can change.

The output of the ACCEL/DECEL circuit (Terminal #24) is usually connected to the velocity error amplifier input (Terminal #25) via a jumper connection at the customer terminal strip (TB-1). It is possible to by-pass the ACCEL/DECEL circuit completely by removing this jumper and connecting the drive input reference signal to Terminal #25 instead of Terminal #21. The ACCEL/DECEL circuit is often by-passed in custom engineered drive applications. The velocity error amplifier circuit is used in speed regulated drive applications. It compares a velocity reference signal with a velocity feedback signal to determine whether the DC motor is operating faster or slower than its commanded velocity. The output of the velocity error amplifier circuit is used as a reference signal to the *MELLTRONICS 2300RG’s* “inner current loop”. The inner current loop directly controls DC motor armature current.

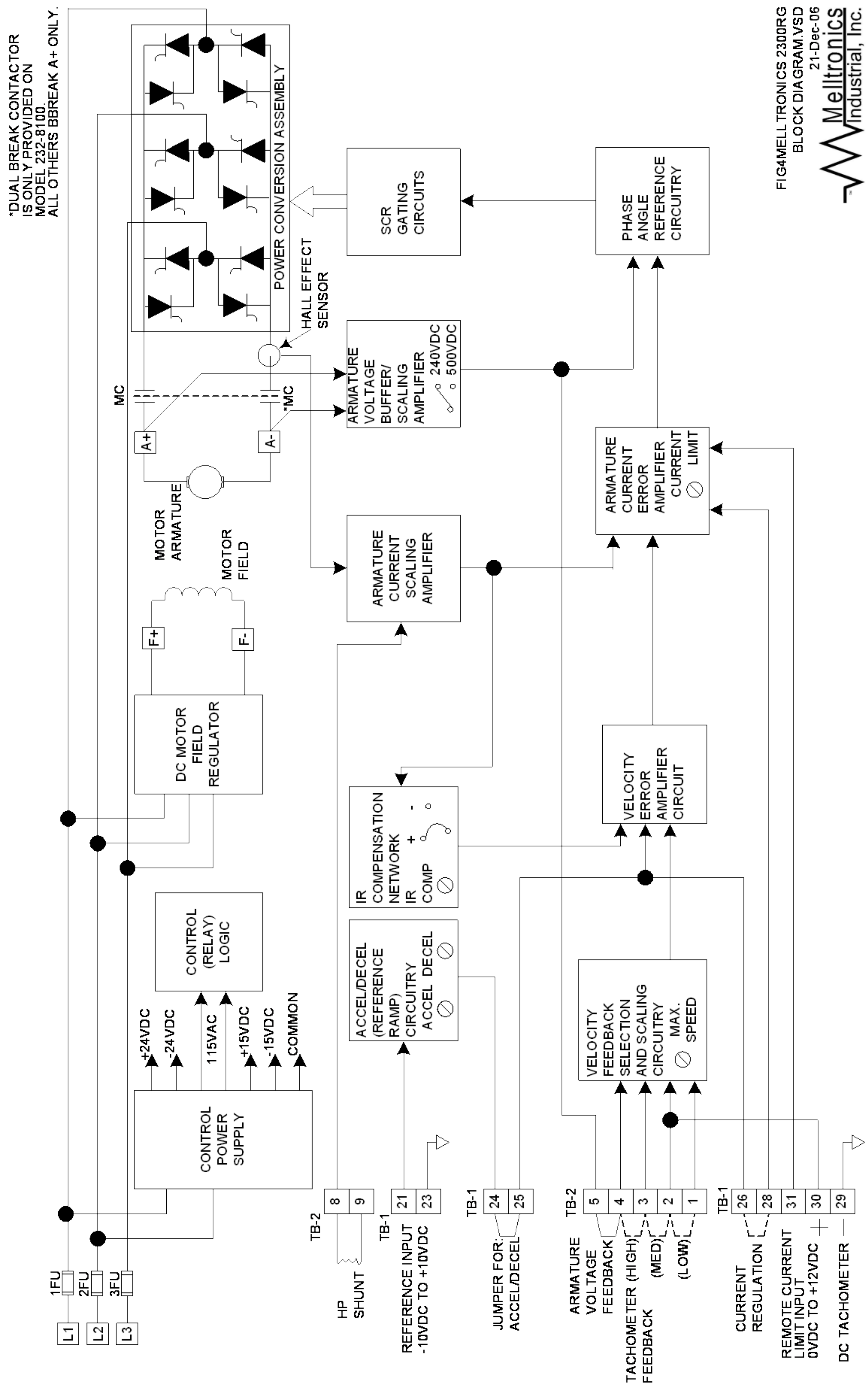



Figure 4:  *MELLTRONICS 2300RG* Block Diagram

The feedback signal to the velocity error amplifier can be a signal proportional to DC motor armature voltage or it can be a signal from a DC tachometer generator. Armature voltage feedback is used in those applications where the speed regulation and drift characteristics of the drive are not extremely critical. Tachometer feedback provides improved speed regulation and drift characteristics. The velocity feedback section and scaling circuitry allows the control to be programmed for armature voltage feedback or tachometer feedback. It allows the control to be used with 240VDC or 500VDC motors (voltage regulated applications) or with a variety of tachometer voltage output levels (speed regulated applications).

The velocity error amplifier circuit has one additional input, IR compensation. The IR compensation network introduces an increase (or decrease) in the velocity reference proportional to motor armature current. The magnitude of the increase (or decrease) can be adjusted using the IR compensation potentiometer. On the *MELLTRONICS 2300RG*, the IR compensation signal can be either positive or negative. Positive IR compensation increases the motor velocity reference as the motor armature current increases. Positive IR compensation is used in armature voltage regulated control applications to offset the natural tendency for the speed of a motor to decrease as the load on the motor increases. Positive IR compensation is generally not used in applications which employ tachometer feedback. Negative IR compensations are just the opposite of positive IR compensation. It causes the motor velocity reference to decrease as motor armature current increases. When negative IR compensation is employed, the DC drive motor will function much like a compound wound DC motor would function in the same application. Negative IR compensation is used in “helper drive” applications where the speed of the drive must conform to the speed of the process it drives. Negative IR compensation may be used with both armature voltage and tachometer feedback regulated controls.

The armature current error amplifier compares an armature current reference signal (the output of the velocity error amplifier) with and armature current feedback signal (the output of the armature current scaling amplifier). The output of the armature current error amplifier is one of two references signals applied to the phase angel reference circuitry. The phase angle reference circuitry determines the correct SCR firing angle for the SCR power conversion assembly. Actual SCR firing is controlled by the SCR gating circuit.

A Hall Effect transducer measures the DC current flowing in the armature circuit. The transducer output wave-form is normalized by the armature current scaling amplifier to provide a bi-directional signal that is directly proportional to the current flowing in the DC motor. This signal is utilized as the feedback signal to the armature current error amplifier and it is also used as an input to the IR compensation circuit.

The armature voltage buffer/scaling amplifier is used to isolate the scale the DC motor armature voltage for use by the phase angle reference circuit. The output of the armature voltage buffer/scaling amplifier is also used as ‘velocity’ feedback in some applications.

The velocity error amplifier circuit is designed to normally function as a very high gain error amplifying circuit. It can also be configured to function as a low gain, input reference buffer amplifier. This configuration is normally used in current regulated drive applications. By jumpering terminals #26 and #28 at the user terminal block (TB-1) and eliminating both the armature voltage and tachometer feedback signals, it is possible to re-configure the *MELLTRONICS 2300RG* to function as a current (torque) regulated DC drive control. When configured in this manner, the input reference signal will control the DC motor current (torque) instead of DC motor speed.

Drive current limit is typically set using a potentiometer located on the *MELLTRONICS 2300RG* control. In many applications, it is desirable to adjust drive current limit using either a remote mounted potentiometer or a customer supplied voltage signal. A 0 to +10VDC signal applied to Terminal #31 (TB-1) adjusts drive current limit between 0 and 200% of the selected current range.

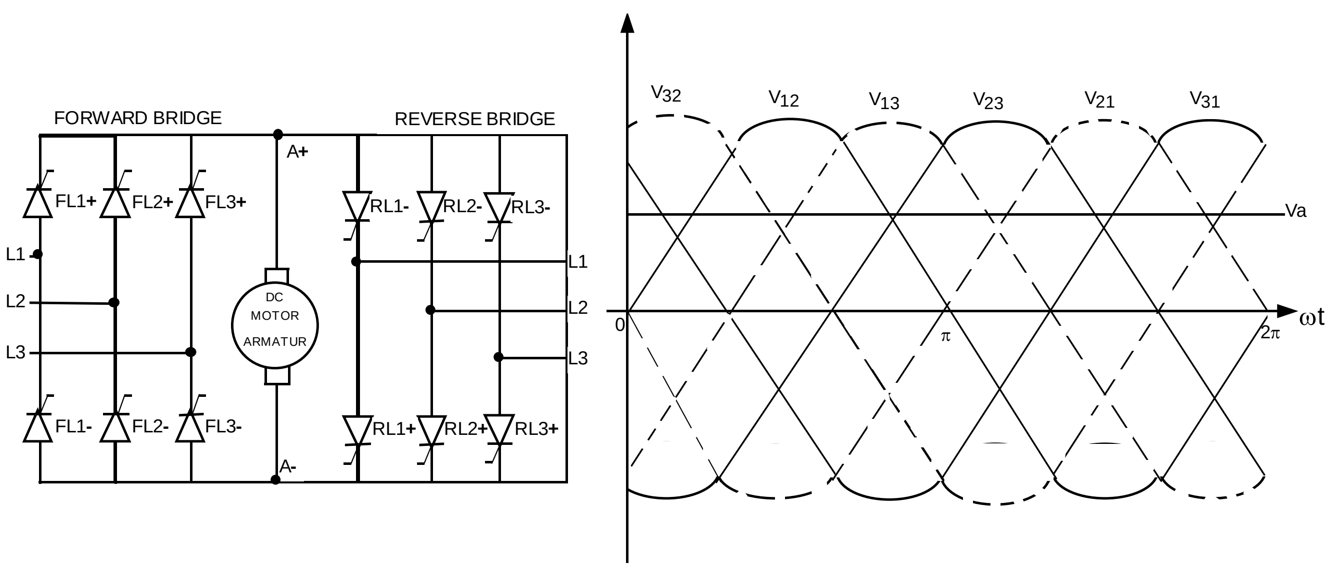



Figure 5: SCR Power Conversion Assembly and Three Phase Line-to-Line Voltage Waveform

### 3.3 DETAILED CIRCUIT DESCRIPTIONS

Functional blocks will be examined in detail.

#### 3.3.1 POWER CONVERSION ASSEMBLY

The MELLTRONICS 2300RG's power conversion assembly consists of twelve connected silicon controlled rectifiers (SCRs). These twelve SCRs form a bi-directional, full-wave power conversion bridge. The DC output voltage of a bi-directional full-wave power conversion bridge can be either positive or negative, and electrical energy can flow from the AC power lines (designated L1, L2 and L3 in Figure 5) to the DC motor (armature leads A1 and A2 in Figure 5)or power can also flow from the DC motor (now functioning as a DC generator) back into the AC power lines. The direction of power flow and the DC output polarity of the power conversion assembly are a function of the load connected to the DC motor and the phase angle reference signal applied to the SCR gating circuitry. The *MELLTRONICS 2300RG*'s SCR gating circuitry and its phase angle reference circuitry will be described in detail latter on in ths section of the Instruction Manual.

In order to understand how the *MELLTRONICS 2300RG*'s power conversion assembly works, it is first necessary to understand how an SCR works. An SCR is a three terminal semiconductor power conversion device. The three terminals are called the anode, the cathode and the gate. The schematic symbol for an SCR is shown in Figure 6 a.

The working of an SCR is best understood by first looking at how a diode works. Diodes are two terminal semiconductor power conversion devices. The two terminals are called the anode and the cathode. Whenever the voltage of a diode's anode is positive with respect to its cathode, the diode is said to be forward biased. A forward biased diode will conduct current. It looks like a short circuit (low resistance to current flow). When the voltage of a diode's cathode is positive with respect to its anode, the diode is said to be reverse biased. A reverse biased diode will block all current flow. A reverse biased diode can be thought of as an open circuit (a very high resistance to current flow).

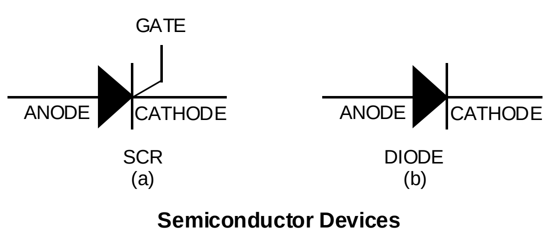



Figure 6: Semiconductor Devices

To summarize, a diode functions like a one way switch. The switch is closed whenever the anode voltage is positive with respect to the cathode, and is open whenever the cathode voltage is positive with respect to the anode voltage. Diodes are commonly used to convert fixed voltage AC power into fixed voltage DC power.

An SCR is similar to a diode. It must be forward biased (anode positive with respect to cathode) before it will conduct current. In addition to being forward biased, and SCR must also be "gated on" before it can conduct current.

SCRs are "gated on" by applying a positive voltage between the gate lead and the cathode of the SCR during a time when the SCR is forward biased. Once a SCR has been "gated on", it functions exactly like a diode would function. It conducts current (and will continue to conduct current) in the forward direction as long as it remains forward biased. Removing the gate signal from an SCR will not stop the SCR from conducting after it has been "gated on". The SCR must become reverse biased to stop the flow of current through it. After an SCR stops conducting current, it must once again be forward biased and "gated on' before it can conduct current.

The average DC output voltage of an SCR rectifying circuit can be adjusted quite easily by time delaying the application of the SCR gating signal with respect to the zero crossing of the AC power line. As the gate signal is further delayed relative to the zero crossing of the AC power line, the SCR conducts for a shorter and shorter period of time during each AC cycle. The average DC output voltage is reduced further and further as the gate signal is delayed more and more. If the gate signal is delayed a full 180 degrees, the SCR never turns on and the SCR's average output voltage is zero. SCRs are commonly used to convert fixed voltage AC power into adjustable voltage DC power.

The SCR power conversion bridge used in the *MELLTRONICS 2300RG* functions exactly as outlined above except for the fact that a DC motor is not a pure resistive load. DC motors convert electrical energy into mechanical motion. They require direct current input (current that flows in one direction) in order to make them rotate. A DC motor normally absorbs electrical energy from some type of energy source (a battery or a DC power supply) and converts that energy into mechanical energy.

Every DC motor is also capable of functioning as DC generator. When a DC motor functions as a DC generator, the motor absorbs mechanical energy from the mechanical system to which it is connected, and it converts that mechanical energy into a direct current. The electrical energy produced by a DC generator can be used to power other DC motors, or the energy can be converted to some other form.

Whenever a DC machine (motor or generator) rotates, it produces a DC voltage that is directly proportional to its rotational speed. This DC voltage is called the DC motor counter voltage or counter EMF (CEMF). It does not make any difference whether the DC machine is functioning as a DC motor or a DC generator. It still generates a voltage (CEMF) proportional to its rotational speed. The CEMF will be either positive or negative depending on the direction of machine rotation. Clockwise rotation will produce an output voltage of one polarity while counterclockwise rotation will produce an output voltage of the opposite polarity.

It is possible to control the speed of a DC motor by adjusting the magnitude of the DC voltage applied to the motor's armature. If the DC voltage source that is used to control the DC motor is a bi-directional voltage source (like the *MELLTRONICS 2300RG* ), the operating speed of the DC motor may be controlled anywhere between maximum motor speed in the forward direction and maximum motor speed in the reverse direction without the use of reversing contactors.

The direction of current flow and the polarity of the CEMF determine whether the DC machine is functioning as a DC motor (converting electrical energy into mechanical energy) or whether it is functioning as a DC generator (converting mechanical energy into electrical energy).

Figure 8 shows two DC motors. Each DC motor is connected to a fixed voltage DC power supply ( a 12VDC battery). The DC motor-(a) is operating in a motoring condition while the DC motor-(b) is operating in a regenerative condition. Each of the DC motors is represented by its equivalent circuit which consists of a voltage source (the CEMF) in series with a resistor (RA). The resistor represents the motor armature winding resistance.

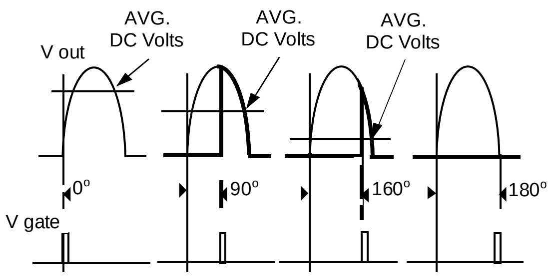



Figure 7: Typical SCR Voltage Waveforms

In Figure 7, the DC motor is rotating at a speed that produces a CEMF of 11VDC. DC current flows through the circuit in a clockwise direction because the battery voltage (12VDC) is greater than the DC Motor CEMF (11VDC). When a clockwise current flows in this circuit, electrical energy is flowing from the battery to the DC motor. The DC motor is absorbing electrical energy and converting that electrical energy into mechanical motion. This is called ‘motoring.’

The Figure 8-b the DC motor is rotating at a speed that produces a CEMF of 13VDC. DC current flows through the circuit in a counterclockwise direction because the DC motor CEMF (12VDC) is greater than the battery voltage (12VDC). When a counter clockwise current flows in the circuit, electrical energy is flowing form the DC motor to the battery. The DC motor is functioning as a generator. It absorbs mechanical energy from the mechanical system it is connected to and converts that mechanical energy into a DC current that is used to charge the battery. This is called regeneration.

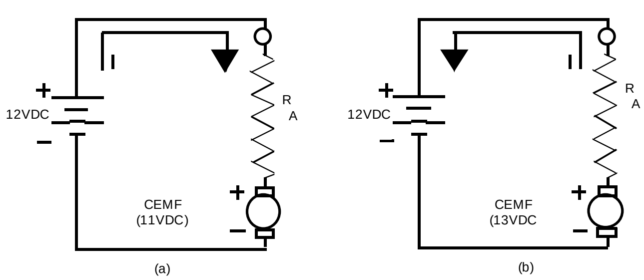



Figure 8: Motoring vs. Regenerative Operation

Even though the *MELLTRONICS 2300RG*’s output voltage is not a pure DC wave-form like the output voltage of a battery, we can still make armature current flow in either direction.

In the ‘motoring’ mode, the DC motor consumes electrical energy and converts it to mechanical motion. In the “motoring” mode, we gate the SCRs two at a time when the AC line voltage is slightly higher than the DC motor CEMF. This allows current (power) to flow from the AC line to the DC motor. (Current flows from the power source to the motor because the voltage of the power source is higher than the CEMF voltage of the motor). Current will only flow from the AC line to the DC motor for a short period of time. The flow of current ceases as soon as the AC line voltage drops below the DC motor CEMF (the SCRs become reverse biased and shut off). If we repeat the process (gate the SCRs on repeatedly at approximately the same point in the AC cycle), current will flow from the AC line to the DC motor.

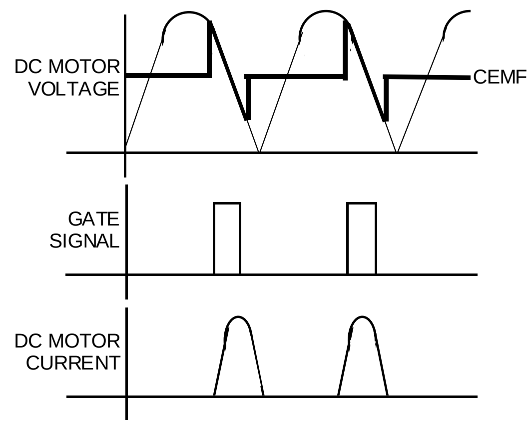



Figure 9: Voltage and Current Waveforms - Motoring Operation

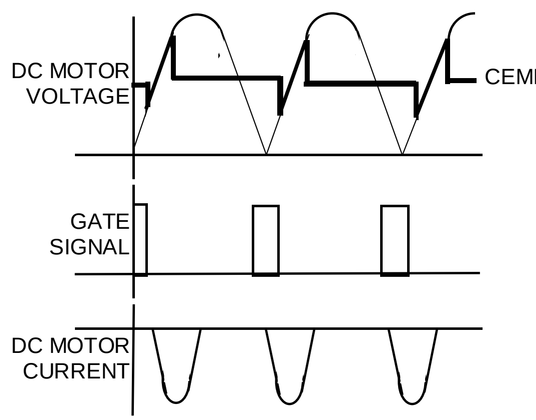



Figure 10: Voltage and Current Waveforms - Regenerative Operation

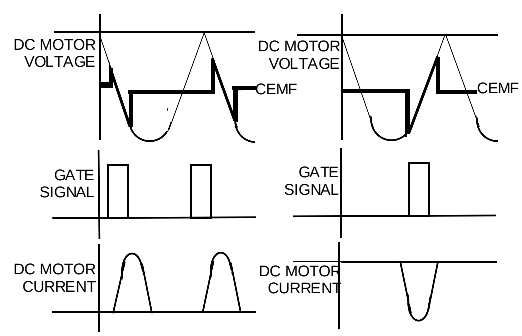



Figure 11: Voltage and Current Waveforms - Reverse Operation

In the 'regenerative' mode, the DC motor 'absorbs' mechanical energy form the machine or process it is connected to and converts that mechanical energy into electrical energy. In the 'regenerative' mode, we gate the SCRs two at a time when the DC motor CEMF is slightly higher than the AC line voltage. This allows current to flow from the DC motor to the AC line. (Current flows from the motor to the power source because the motor CEMF voltage is higher than the voltage of the source). Current will only flow from the DC motor to the AC line for a short period of time. The flow of current ceases as soon as the AC line voltage rises above the DC motor CEMF (the SCRs become back biased and shut off). If we repeat the process (gate the SCRs on repeatedly at approximately the same point in the AC cycle), current will flow from the DC motor to the AC line.

If we want 'motoring' current to flow in a motor that has a negative CEMF, we gate the SCRs on when the AC line voltage is more negative than the negative DC motor CEMF. If we want 'regenerative' current to flow in a motor that has a negative CEMF, we gate the SCRs on when the AC line voltage is less negative than the negative DC motor CEMF.

It should be noted that we gate on a different group of SCRs for motoring operation than we do for regenerative operation. The SCRs in the forward bridge are gated on to produce motoring current flow with positive CEMF. The SCRs in the reverse bridge are gated on to produce regenerative current flow with positive CEMF. If the CEMF is negative, the opposite sets of SCRs must be gated on.

### 3.3.2 SCR GATING CIRCUITRY

The output of the power conversion assembly is controlled by the *MELLTRONICS 2300RG* gate pulse circuitry controls which SCRs are gated on. The firing and interconnect printed circuit boards share this circuitry.

Six separate gating circuits are provided to control the two back to back, six element power bridges in the power conversion assembly with each gating circuit controlling a pair of SCRs. The two bridges are complementary in that for a given operating condition one bridge provides forward (motoring) action while the other allows reverse (regenerating) operation. Each gating circuit includes two pulse transformers (PT-1 through PT-12 on the interconnect board) and two driver FETs (Q-1 through Q-12 on the firing board) to create the isolated gate signals that are applied to each SCR.

The steering logic section (located on the firing circuit board) of the gate pulse circuitry senses line sync polarity, a firing pulse and a power-up lockout signal. When these three signals are high and the burst generator is enabled, a burst of SCR gating pulses is produced at the output terminals of two of the SCR gate pulse transformers. Which SCRs are gated also depends on whether the forward or reverse power bridge is enabled.

The power-up lockout circuit prevents the SCRs from being gated prematurely by any transients that may occur in the control circuitry when AC power is applied. This lockout also allows the DC power supplies time (~20msec) to reach their normal voltage levels to prevent logic errors. The three line sync circuits each provide a signal to indicate when each of the three respective line voltages cross zero. This information is used by the three timing ramp circuits to generate the SCR firing pulses.

Firing of SCRs in pairs is necessary to provide a complete path for current flow from the AC three-phase line, through the DC motor armature, and back to the AC line again.

The following is for a forward power bridge (operation of the reverse power bridge is identical, except for its opposite polarity).

An SCR conducts current only when it is forward biased and has been gated on. That is why the line sync signal is important; it tells us which SCRs are forward biased in order that we can control the firing order.

When the AC line to line voltage between L1 and L2 ($V_{12}$ on the wave-form) is positive, this indicates that the line to neutral or phase voltage on L1 is greater than the phase voltage on L2, so that current flow is positive from L1 to L2. When $V_{12}$ is more positive than the DC armature voltage at A+(Va), current may flow from L1 through the motor armature and return to line L2. To allow this current flow, SCRs FL1+ and FL2-, which are forward biased, are gated on. These SCRs will conduct until $V_{12}$ is less than Va, at which time they become reverse biased and turn off. The next voltage to rise above Va is $V_{13}$, the voltage between L1 and L3. SCRs FL1+ and FL3- are now forward biased and are gated on to conduct current from L1 through the motor and back to L3. As $V_{13}$ drops below Va, Fl1+ and FL3- turn off and $V_{23}$ rises above Va. Now Fl2+ and FL3- are forward biased and are gated on to conduct current from L2 to L3 through the motor circuit. When Fl2+ and FL3- become reverse biased, they turn off and current flow through them stops.

The level of motor armature voltage Va, is controlled by changing the moment in time when each forward biased pair of SCRs is gated on. By firing the SCRs earlier, the motor sees a longer conduction period, more line voltage is passed on to the motor, and Va rises. If the SCRs were fired later the conduction period would be shorter, the motor would see less line voltage and Va decreases. This is how the three-phase, full wave power bridge provides variable voltage DC power to the motor.

Continuing with the firing order, $V_{23}$ has dropped below Va an FL2+ and FL3- have turned off. Now the phase voltage on L2 is higher than that on L1 so that the line voltage from L2 to L1, $V_{21}$, is positive and it rises above Va. ($V_{21}$ is the opposite, or negative of $V_{12}$). SCRs FL2+ and FL1- are now forward biased and are gated on. When they become reverse biased, as $V_{21}$ falls below Va, FL2+ and FL1- turn off. The next voltage to rise above Va is $V_{31}$ and SCRs FL3+ and FL1- are fired. After they turn off the cycle is completed when $V_{32}$ rises above Va and SCRs FL3+ and FL2- are gated into conduction. When FL3+ and FL2- turn off the cycle begins again with FL1+ and FL2-.

### 3.3.3 ACCEL/DECEL (REFERENCE RAMP) CIRCUIT

When drive run is initiated, relay CRR is picked up and the input reference signal (from an operator adjusted potentiometer or master reference) is applied to the input of the ACCEL/DECEL circuit. Being a four quadrant regenerative drive control, the reference to the *MELLTRONICS 2300RG* can be either negative (forward rotation) or positive (reverse rotation).

When the reference input swings more negative (less positive), the output of the ACCEL/DECEL circuit ramps down in a linear fashion. The rate of change, or ramp time of this output is controlled by the acceleration rate adjustment (ACCEL) potentiometer. When the reference input swings more positive (less negative), the output of the ACCEL/DECEL circuit ramps linearly upward. The ramp time of this output is controlled by the deceleration rate adjustment (DECEL) potentiometer. The ACCEL/DECEL circuit provides a gradual speed change to the motor when the input reference changes rapidly, protecting the motor and driven machinery. The output of the ACCEL/DECEL circuit (TB-1, Terminal #24) is usually jumpered to the input of the velocity error amplifier (TB-1, Terminal #25). Clockwise rotation of the ACCEL and DECEL potentiometer will increase the acceleration and deceleration time. ACCEL/DECEL time is adjustable form approximately 0.2 to 4 seconds when jumpered JP-2 is in and 2 to 30 seconds when this jumper is removed. The output of the ACCEL/DECEL circuit is clamped to zero until the DC loop contactor has closed.

It should be noted that when a bi-directional speed reference signal is used, the acceleration rate potentiometer controls the acceleration rate in the forward direction but it controls the deceleration rate in the reverse direction. The deceleration rate potentiometer controls the deceleration rate in the forward direction but it controls the acceleration rate in the reverse direction. When a bi-directional speed reference signal is used, a negative signal with respect to common must be used for the forward direction and a positive signal with respect to common must be used for the reverse direction.

### 3.3.4 VELOCITY ERROR AMPLIFIER AND FEEDBACK CIRCUITRY

The velocity error amplifier is a high gain operational amplifier that algebraically sums a velocity reference signal with a velocity feedback signal and amplifies the result. The output is a velocity error signal and it becomes the reference signal for the current error amplifier. The velocity error amplifier has been scaled so that a 4VDC feedback signal exactly offsets a 10VDC input reference signal (TB-1, Terminal #21).

The velocity reference signal enters the *MELLTRONICS 2300RG* control at Terminal #21 (TB-1). In most applications, the velocity reference signal will come directly from the output of the ACCEL/DECEL (reference ramp) circuit (TB-1, Terminal #24). The ACCEL/DECEL circuit, described earlier, may be bypassed by removing the jumper normally connected between Terminals #24 and #25 (TB-1) and introducing the input reference signal

| FeedbackRange | Tachometer Voltage Output at Maximum Speed | Jumper Terminals |
|---|---|---|
| LOW | 37VDC - 130VDC | 1 TO 2 |
| MEDIUM | 55VDC - 194 VDC | 2 TO 3 |
| HIGH | 77VDC - 268VDC | 3 TO 4 |

When connected for tachometer feedback, the MAX SPEED potentiometer scales the tachometer feedback signal so that the tach feedback signal exactly offsets a 10VDC reference signal when the motor reaches the desired maximum RPM.

The velocity control loop includes two potentiometer adjustments which affect the dynamic response of the drive. These two adjustments are the velocity stability potentiometer (labeled “STAB”) and the SPEED RATE potentiometer. Together, these two potentiometers can be used to match the dynamic characteristics of the DC motor and the load it is driving.

The velocity error amplifier includes an adjustable lead circuit to compensate for the electrical and mechanical lags that exist in both the DC motor and the driven mechanical system. The STAB potentiometer adjusts the time constant of this lead circuit. Since this lead circuit is located in the drive velocity feedback network, it tends to reduce the responsiveness of the drive to step function increases in velocity by increasing the magnitude of the velocity feedback signal as a function of its rate of change. The speed rate potentiometer controls the relative magnitude of this lead component in the velocity feedback signal.

The setting of the IRA COMP potentiometer determines the magnitude of the IR compensation signal. The IR compensation signal is a signal directly proportional to DC motor armature current which is added, algebraically to the drive input reference.

The output of the velocity error amplifier is clamped to zero by a solid state switch whenever the DC loop contactor is open. This switch is controlled by a relay located on the Main Control Board. A velocity amplifier bias potentiometer is provided to zero the output of the velocity error amplifier with zero reference and zero feedback. This potentiometer is factory set and should not require adjustment.

It is desirable to control motor current, torque, rather than motor velocity in many applications. In these applications, the velocity error amplifier must be bypassed and the input reference signal must be applied directly to the current error amplifier. Terminals #26 and #28 on the TB-1 provide access to the velocity error amplifier. By jumpering these two terminals together, the gain of the velocity error amplifier is reduced to a value of one (1) and the velocity error amplifier ceases to function as an error amplifier. With a jumper between Terminals #26 and #28, the velocity reference signal can still be introduced at either Terminal #21 (TB-1) or Terminal #25 (TB-1). Any reference signal introduced at Terminal #21 will have its rate of rise or fall controlled by the reference ramp circuit described earlier.

### 3.3.5 ARMATURE CURRENT ERROR AMPLIFIER AND PHASE ANGLE REFERENCE CIRCUITRY

The armature current error amplifier is a high gain operational amplifier that algebraically sums a current reference signal with a current feedback signal and amplifies the result. The output is a current error signal and this signal is used by the rectilinearity amplifier and armature tracking amplifier to generate a phase angle reference signal for the SCR gating circuits.

The reference signal applied to the armature current error amplifier comes directly form the output of the velocity error amplifier. The feedback signal to the armature current error amplifier comes from the armature current scaling amplifier. The inputs to the armature current error amplifier have been scaled so that a 5VDC reference signal at the input will produce 100% rated armature current.

A tail-fire signal is also applied to the input of the armature current error amplifier. The tail-like input prevents the non-conducting power bridge from being gated on until the armature current has stopped flowing in the conducting power bridge.

The dynamics of most SCR drives change drastically as the average motor current increases. The rectilinearity amplifier is added to compensate for this problem and improve the dynamic performance of the drive.

The armature tracing amplifier sums the current phase reference (the output of the rectilinearity amplifier) with the armature voltage phase reference. The armature voltage phase reference causes the gating circuits to generate gate pulses at a phase angle where the armature voltage (CEMF) just crosses the AC power line. The addition of the current phase reference advances the firing (or gating) angle to provide the motor current level demanded by the current error/rectilinearity amplifier circuits. The armature voltage phase reference also phases back the reverse power bridge to the point where the gating pulses just produce zero regenerative current with a zero current reference.

The current limit in the *MELLTRONICS 2300RG* consists of a group of operational amplifiers that actively limit the maximum output of the velocity error amplifier. The current limit level is normally set by adjusting the CURRENT LIMIT potentiometer located on the upper PC board. The CURRENT LIMIT potentiometer provides an adjustment range of 0 to 150% of rated armature current (0 to 200% with the addition of jumper JP7). Current limit can also be controlled by an external voltage signal applied to Terminal #31 (TB-1). The current limit circuit is scaled such that a 0 to +10VDC external signal will limit the armature current total value between 0 and 200% of rated current (assuming the CURRENT LIMIT potentiometer is set fully counter clockwise).

In some applications, true four quadrant operation is not desirable. A circuit has been included in the *MELLTRONICS 2300RG to* prevent either forward motoring operation or reverse motoring operation in these applications. This quadrant lockout function is selectable by jumper programming. An operational amplifier monitors both the DC motor armature voltage and the output of the velocity error amplifier. If jumper JP4 is connected to the ‘C’ jumper post, the output of the operational amplifier will clamp the output of the velocity error amplifier. If jumper JP4 is connected to the ‘A’ jumper post, the output of the operational amplifier will clamp the output of the velocity error amplifier to zero whenever a reverse motoring condition is called for. If jumper JP3 is connected to the ‘D’ jumper post, the motor can rotate in the locked out direction but its speed is limited to no more than 10% of rated motor speed. Jumper JP3 must be connected to jumper post E to completely lock-out a quadrant of operation. When jumper JP4 is connected to the B jumper post, both forward and reverse motoring are enabled and jumper JP3 has no effect on operation.

The current error amplifier includes an adjustable lead circuit to compensate for the electrical and mechanical lags that exist in the DC motor and the driven mechanical system. The current loop stability potentiometer (labeled CURRENT STAB) adjusts the time constant of their lead circuit. This potentiometer is factory set and should not require adjustment. The output of the current error amplifier is clamped to zero by a solid state switch whenever the DC loop contactor is open. This switch is controlled by an auxiliary contact located on the DC loop contactor.

### 3.4 POWER COMPONENT IDENTIFICATION

All power connections are located on the mounting panel for the *MELLTRONICS 2300RG* control. All major power components are located on the extruded aluminum heat sink below the interconnect PC board on the *MELLTRONICS 2300RG* control.

### 3.5 CONTROL BOARD COMPONENT IDENTIFI-ATION

All *MELLTRONICS 2300RG* controls utilize the same four printed circuit boards. These are shown in Figure 14, Figure 15, Figure 17, and Figure 18. Figure 19 shows a *MELLTRONICS 2300RG* with the main control board swung open to sow the Firing circuit board mounted on the back. The interconnect circuit board is visible inside the chassis and the field regulator board is located on the he top, front face of the chassis. The current feedback board is mounted below and to the left of the line fuses on the mounting panel. It is mounted on edge, making it difficult to see. The power components are all mounted below the interconnect board on a fan-cooled heat sink.

The hinged main control board performs all of the regulator and logic functions. The firing circuit board generates the SCR firing pulses. The interconnect board supplies power to the other boards and routes the firing pulses from the firing circuit board to the SCRs.

Fuses 5FU, 6FU, and 7FU on the interconnect board protect the cooling fans, field regulator and control power supply which are fed by the three phase AC line. The current feedback board utilizes a Hall Effect transducer to monitor current in the A- armature lead and feed an armature current signal back to the drive regulator.

Figure 13 and Figure 23, show the locations of all important jumpers, fuses, terminal blocks, indicators, and operator adjustments.

### 3.6 DC MOTOR FIELD REGULATOR

The *MELLTRONICS 2300RG* Field Regulator provides two modes of regulation, variable current control and fixed voltage control. A two position switch on this board selects the mode of regulation.

When the switch is in the VOLT position, the board functions as a fixed voltage regulator. For a 300VDC field, jumper JP-1 should be removed and a 480VAC input supplied to the control. The field voltage is set at 150VDC when JP-1 is installed and the control is connected to a 240VAC input.

As a current regulator (switch in the CURR position), constant field flux is supplied to the motor field. This compensates for variations in temperature and operating conditions.

The field regulator board also contains field loss circuitry to shut down the *MELLTRONICS 2300RG* when the field current drops below 25% of its rated value. A field economy circuit cuts the motor field by 30%, one minute after the drive drops out of the RUN mode. This time delay allows the use of dynamic braking which requires full field strength. The field economy feature reduces motor heating when the drive is energized but not running.

### 3.7 TORQUE REGULATION THEORY

The *MELLTRONICS 2300RG* can be configured as an armature current regulator. Since motor torque is directly proportional to armature current, a DC drive set up as an armature current regulator will enable the unit to regulate torque. Torque regulators are sometimes used in helper drive situations and in various load sharing applications. To properly apply a torque regulator it is important that one understands the theory of operation and the variables that affect the control system.

The torque produced by a motor can be described as shown:

***Equation 1***

$$T = K_a \, Ø_p \, I_a \quad \textbf{Torque}$$

$K_a$ = Armature Torque Constant

$Ø_p$ = Field Excitation Flux

$I_a$ = Armature Current

It can be seen in Equation 1 that torque is based on field excitation flux and armature current. It is obvious that if the DC drive were configured to regulate armature current that torque is also regulated, assuming that the field flux is constant. Therefore, it would be best to regulate the field excitation current to maintain a constant field flux. The *MELLTRONICS 2300RG* field supply can be easily setup as a field current regulator.

The rotational speed of a DC motor can be approximated by the following equation:

***Equation 2***

$$W_m = \frac{Vt}{K_a \, Ø_p}$$

$W_m$ = Motor Speed

$K_a$ = Armature Torque Constant

$Ø_p$ = Field Flux

$V_t$ = Applied Armature Voltage

Pure current regulated drives demand that the motor shaft is loaded to some degree, at all times. Should the current set-point or reference be set to a high value and the shaft load diminish or be removed, a current regulated drive is compelled to increase voltage output to achieve the current requested. Equation 2 illustrates that if the applied voltage increases creases and the field flux remains constant, the speed is subject to increase.

The increase in speed can result in a safety concern since motor speeds can rise beyond their intended speed rating very quickly should shaft loading be suddenly removed.

Therefore, a system designer must be cognizant of the control system relationships and provide external safety mechanisms, such as an over-speed detector shutdown circuit, to prevent motor runaway conditions.

#### 3.7.1 CONFIGURING FOR A CURRENT REGULATOR

The MELLTRONICS 2300RG can be configured as a current regulator by:

1. Removing Armature Voltage or Speed Feedback
   TB2 4-5 (Armature Voltage Feedback)
   TB1 29-30 (Speed Feedback)

**CAUTION**

**THE 2300RG IS A HIGH CURRENT AMPLIFIER WHICH REQUIRES SOME FORM OF FEEDBACK (ARMATURE VOLTAGE, ARMATURE CURRENT OR SPEED FEEDBACK) AT ALL TIMES. FAILURE TO PROVIDE PROPER FEEDBACK WILL RESULT IN EXCESSIVE AND SUDDEN ACCELERATION, HIGH VOLTAGES AND CURRENTS TO BE APPLIED TO THE MOTOR.**

2. Connecting for armature current feedback.
   Jumper TB-1 pins 26 and 28
   Remove JP1
3. The drive should also be limited to 2-quadrant operation by jumpering :
   JP4 to A to inhibit positive reference
   JP4 to B to inhibit negative reference

Application of the current reference signal to pin 21 of TB1 (common on TB1-23) will permit the ACCEL and DECEL pots to control the rate of change of current reference. It should be stressed, however, that motor acceleration and deceleration will be primarily a function of motor shaft loading and that acceleration is ultimately limited by the current limit setting and the rate of acceleration that this current level can produce.

# SECTION 4
# INSTALLATION

## 4.1 SAFETY WARNINGS

### 4.1.1 GENERAL

Improper installation or operation of this control may cause injury to personnel or equipment. Read the operating instructions. The control and its associated motors and operator control devices must be installed and grounded in accordance with all local codes and the National Electrical Code. To reduce the potential for electric shock, disconnect all power sources before initiating any maintenance or repairs. Potentially lethal voltages exist within the control unit and connections. Use extreme caution during installation and start-up.

**CAUTION**

**THE FIELD REGULATOR BOARD (232-4135) IS TIED TO THE POWER LINE AND IS THEREFORE ELECTRICALLY HOT TO THE REST OF THE CONTROL CIRCUITRY. *AT NO TIME SHOULD THE FIELD REGULATOR BOARD COMMON BE TIED TO THE CONTROL CIRCUIT COMMON ON ANY OF THE OTHER BOARDS.* THE FIELD REGULATOR BOARD IS BOTH RESISTIVELY AND OPTICALLY ISOLATED FROM THE REST OF THE CONTROL'S CIRCUITRY. *DO NOT* DEFEAT THIS ISOLATION SCHEME.**

### 4.1.2 INCOMING POWER CONSIDERATIONS

The *MELLTRONICS 2300RG* control will operate from typical AC power lines. The line should be monitored with an oscilloscope to insure that transients do not exceed limitations as listed below:

1. Repetitive line spikes of less than 10 microseconds must not exceed the following magnitude:

   240 Volt Drives .................... 400 V. Peak

   480 Volt Drives .................... 800 V. Peak

2. Non-repetitive transients must not exceed 25 watt seconds of energy. Transients of excessive magnitude or time duration can damage dv/dt networks or surge suppressors.
3. Line notches must not exceed 300 microseconds in duration.

An abnormal line condition can reflect itself as an intermittent power unit fault. High amplitude spikes or excessive notch conditions in the applied power could result in a power unit failure.

## 4.2 INITIAL CHECKS

Before installing the control, check the unit for physical damage sustained during shipment. If damaged, photograph and document damage, then file a claim with shipper and return for repair following procedures outlined on the back cover. Remove all shipping restraints and padding. Check nameplate data for conformance with the AC power source and motor.

## 4.3 CLEAN ENVIRONMENT

The *MELLTRONICS 2300RG* is suitable for most well-ventilated factory areas where industrial equipment is installed. Locations subject to steam vapors or excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, excessive dirt, dust or lint should be avoided unless an appreciate enclosure has been supplied or a clean air supply is provided to the enclosure. The location should be dry and the ambient temperature should not exceed 40ºC (104ºF). If the mounting location is subject to vibration, the unit should be shock mounted.

If the enclosure is force ventilated, avoid, wherever possible, an environment having a high foreign matter content as this requires frequent filter changes or the installation of micron-filters. Should a control enclosure require cleaning on the inside, a low pressure vacuum cleaner is recommended. Do not use an air hose because of the possibility of oil vapor in the compressed air and the high air pressure.

**CAUTION**

**IN THE INSTALLED POSITION, THE TOP, BOTTOM AND TWO SIDE SURFACES OF THE CONTROL CHASSIS MUST BE A MINIMUM OF NINE (9) INCHES FROM ANY OTHER SOLID SURFACE. FAILURE TO OBSERVE THIS PRECAUTION CAN CAUSE THE CONTROLLER TO OVERHEAT.**

## 4.4 INSTALLING CHASSIS MOUNT CONTROLS

The chassis mount *MELLTRONICS 2300RG* control is suitable for mounting in a user's enclosure where internal temperature will not exceed 55ºC (131ºF). The following procedure is recommended. Mount the control so that there is access to the front panel. See Figure 3 for dimensions. **Never operate the control on its back.**

## 4.5 INSTALLING ENCLOSED CONTROL

Enclosed *MELLTRONICS 2300RG* controls are suitable for wall mounting in an ambient atmosphere between 0ºC (32ºF) and 40ºC (104ºF). Mount the control so that there is access to the front panel. See Figure 3 for dimensions. **Never operate the control on its back.**

## 4.6 POWER WIRING

Refer to Figure 13 for power wiring connections. The *MELLTRONICS 2300RG* controller is insensitive to AC line phase sequencing. Designation of inputs L1, L2 and L3 is arbitrary.

**CAUTION**

**A SEPARATE FUSED DISCONNECT OR CIRCUIT BREAKER MUST BE INSTALLED IN THE INCOMING AC POWER LINE TO THE CONTROL, AS PER THE NATIONAL ELECTRIC CODE (NEC).**

Use the AC line current specified on the nameplate of the control being installed to size the AC input wiring.

Size the motor leads according to the motor nameplate current ratings following NEC requirements.

Connect the armature leads to the terminal lugs marked A+ and A- on contactor MC located above the upper left hand corner of the control chassis. Consult the motor connection diagram supplied with the motor for proper polarity.

Connections to the motor field should be made with due consideration to proper polarity. Consult the motor connection diagram. The MELLTRONICS 2300RG field supply provides 300VDC when the control is wired to a 480VAC line, and 150VDC when wired to a 240VAC line. The field supply provides 215VDC or 108VDC, respectively, when the field economy feature is wired in, AC power is applied to the control and the loop contactor is open.

NOTE: The *MELLTRONICS 2300RG* is shipped from the factory with the field economy feature wired for operation. It is recommended that this feature not be bypassed. It reduces the voltage to the motor field when the control is stopped but not removed from the AC input line. If the field economy feature is not desired, consult the factory as described on the inside of the back cover.

DC motors with a stabilizing series winding are normally compatible in *MELLTRONICS 2300RG* applications, including field weakening, however, if motor instability occurs, contact the field service department as described on the inside of the back cover.

Jumpers JP1, JP2 and JP3 (on the firing circuit board) are the frequency programming jumpers. Verify that the input voltage program jumpers A, B, C, D and E, the HP scaling shunt resistor value and TB-2 Terminals #1-4 are correct for your application.

The *MELLTRONICS 2300RG* control is shipped programmed for:

60Hz

480VAC

High armature voltage feedback - 500V armature

Note: A functional description of all jumpers is contained in SECTION 5 Check that all program jumpers are correct for your application.

**CAUTION**

**NO POINTS IN THE CONTROL CIRCUITRY, INCLUDING COMMON, SHOULD BE CONNECTED TO EARTH GROUND UNLESS SPECIFICALLY SHOWN ON MELLTRONICS SYSTEM DIAGRAMS.**

When ready to apply power to the MELLTRONICS 2300RG, connect the 240VAC or 480VAC supply lines to terminals L1, L2 and L3 on fuse blocks 1FU, 2FU and 3FU on the chassis assembly.

### 4.7 CONTROL LOGIC WIRING

Terminal strip TB-1 consists of one section of terminal block. Terminals #1 through #31 are located along the left edge of the main control board. Terminals #1 through #19 are used for control logic. A detailed description of control logic functions is contained in SECTION 5.

### 4.8 SIGNAL WIRING

Terminals #20 through #31 on TB-1 are used for connecting drive reference and feedback signals to the *MELLTRONICS 2300RG.*

NOTE : It is recommended that shielded wire be used for reference, tachometer, optional ammeter and other signal wire connections. Belden #83394 (2 conductor) and Belden #83395 (3 conductor) shielded wire (or equivalent) is recommended. The shields should be taped off at the remote end. At the drive control the shields should be connected to circuit common, TB-1 terminal #23. Additional consideration is recommended to route this wiring away form high current lines (I.E., AC LINE AND ARMATURE WIRING)

### 4.9 CIRCUIT BOARD INTERCONNECTIONS

Refer to Figure 14 through Figure 18 for control circuit board layouts and Figure 19 for control circuit board locations.

Most of the connections between the various circuit boards are made with wire-harness and mating connectors. The half of the mating connector attached to the end of the wire-harness is denoted as a plug (with a P) and the other half, which is board-mounted, is denoted as a jack (with a J). The other end of the wire-harness is usually soldered into the control board. This prevents the harness from being mislaid during assembly of the control.
The main control board has six interconnect jacks:

- J1 Mates with wire-harness plug P1 from the digital test meter board
- J2 Mates with wire-harness plug P2 from the field regulator board
- J3 Mates with wire-harness plug P3 from the current feedback board
- J4 Mates with board-mounted plug P4 from the fast contactor drop-out board
- J5 Mates with wire-harness plug P5 from the power supply transformer
- J6 Mates with board-mounted plug P6 form the firing circuit board

The firing circuit board has one plug and three jacks:

- P6 Mates with jack J6 on the main control board
- J7 Mates with wire-harness plug P7 from the interconnect board
- J8 Mates with wire-harness plug P8 from the interconnect board
- J9 Mates with the wire-harness plug P9 from the power supply transformer

The interconnect board has five wire-harnesses that plug into the board with ‘Fast-ons’ (spade-lug connectors). These harnesses come from the fans, the power supply transformer, the field regulator board and the power section. Two individual wires also plug in with ‘Fast-ons’ and they come from the A+ and A- connections. There are also thirteen mating connectors on the interconnect board. J10 mates with P10 from the heat-sink thermal switch with the other twelve coming from the SCR gate leads.

### 4.10 INSTALLING MODIFICATIONS

#### 4.10.1 TEST METER

There is a test meter kit available for use in starting up and troubleshooting the *MELLTRONICS 2300RG* control.

This modification consists of a digital panel meter and multi-position selector switch. It provide the capability to monitor nine critical drive parameters:

| | | | |
|---|---|---|---|
| A. | Armature Voltage | G. | Line Voltage |
| B. | Armature Current (%) | H. | Field Voltage |
| C. | Control Voltage | I. | Trigger Signal |
| D. | Current Limit (%) | | |
| E. | Positive 15VDC Reference | | |
| F. | Negative 15VDC Reference | | |

#### 4.10.2 AMMETER

The *MELLTRONICS 2300RG* has the circuitry to drive an external ammeter without addition of an armature shunt. This circuitry is located on the current feedback board. The ammeter interfaces with the current feedback board.

The ammeter is scaled by the addition of a resistor to the mating connector. The meter will indicate the load current in amps. The ammeter has a 50mV movement and can be either a zero-center or zero-left movement (available upon request). Current range for the drive control is programmed by the externally applied HP shunt resistor (at TB-2).

**WARNING**

**DO NOT USE THE OFFSET POT, ON THE CURRENT FEEDBACK SENSOR BOARD, TO ZERO AN EXTERNAL CURRENT METER MOVEMENT.**

#### 4.10.3 REMOTE CURRENT LIMIT

A potentiometer to modify the current limit setting of the MELLTRONICS 2300RG control from a remote location may be installed. The voltage signal from the wiper of the potentiometer is wired to TB-1, Terminal #31. A +7.5V signal at that terminal yields 150% current limit. The +10VDC power supply, TB-1 Terminal #22 and TB-1 Terminal #23 (common) may be used to supply voltage for the remote current limit potentiometer. The equivalent resistance of the remote current limit potentiometer, in parallel with the speed reference potentiometer, should not go below 5K ohms as this would excessively load the ±10VDC power supply.

NOTE: If remote current limit is used, turn the internal CURRENT LIMIT potentiometer fully counterclockwise, so as not to interfere with the external current limit adjustment range.

### 4.11 CONTACT SUPPRESSION

All relays or electrical solenoids with wiring in close proximity to the *MELLTRONICS 2300RG* control wiring should be properly suppressed. This reduces the possibility of electrical noise interference. Note, however, that it is generally not necessary to suppress non-inductive loads such as resistive heater elements.

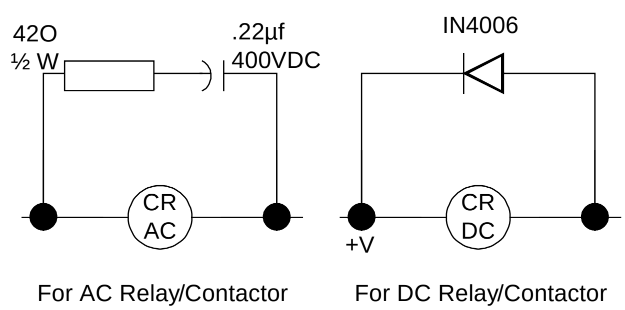



Figure 12: Suppression Techniques

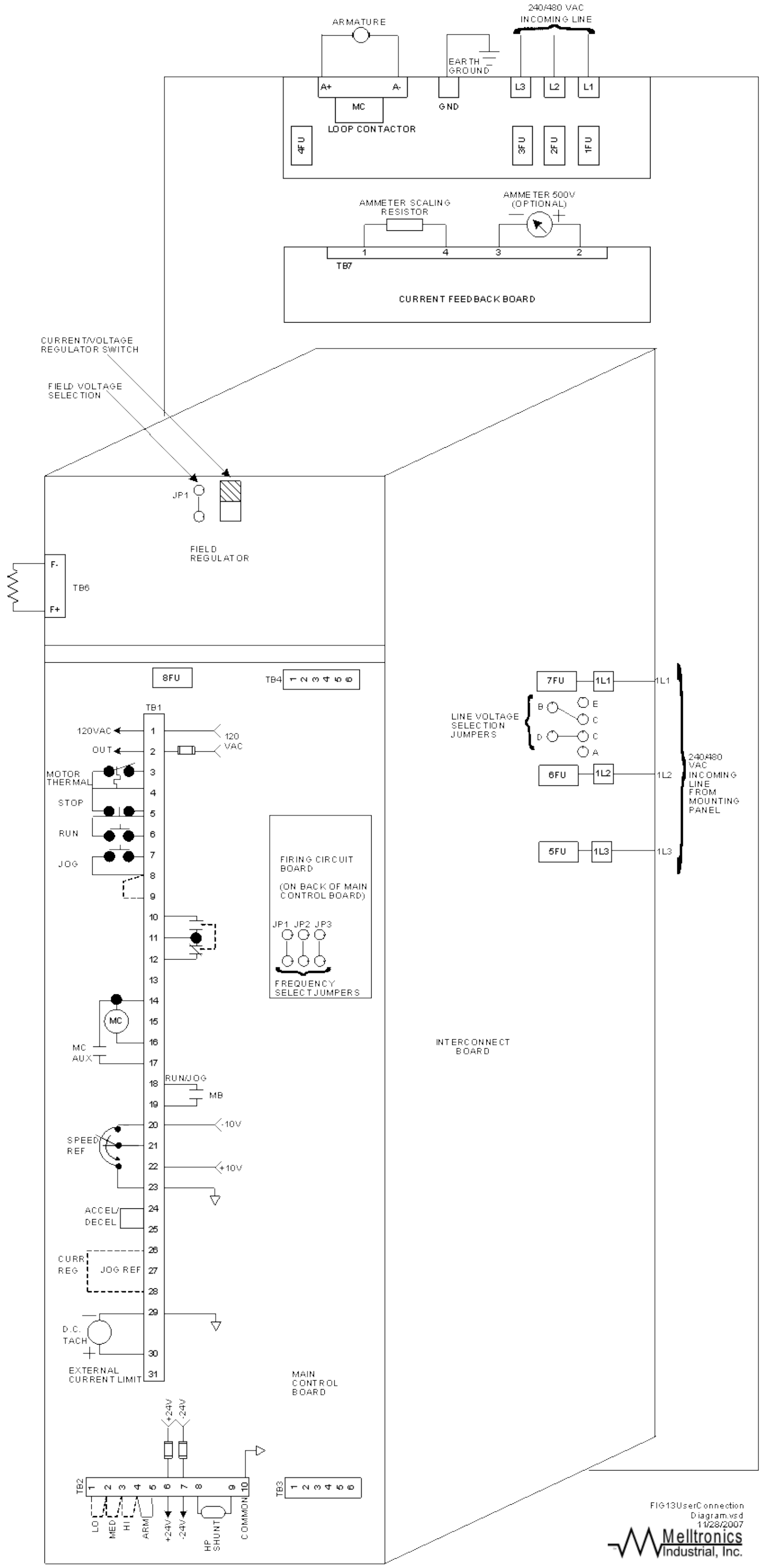



Figure 13: User Connection Diagram

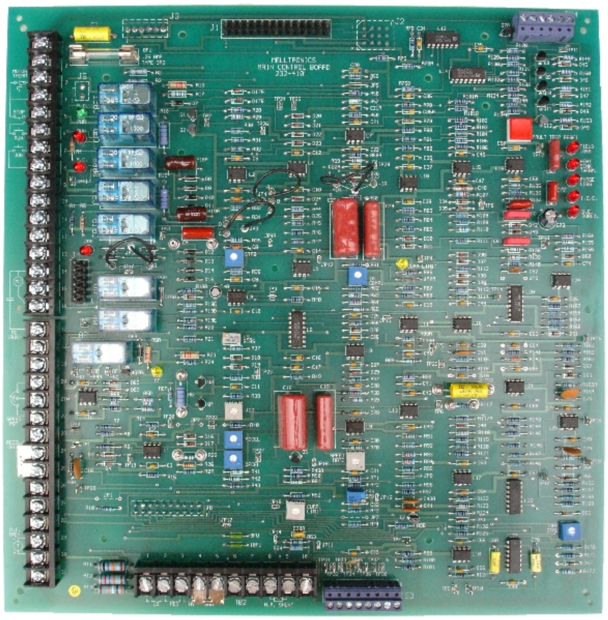


Figure 14:  Main Control Board 232-4101

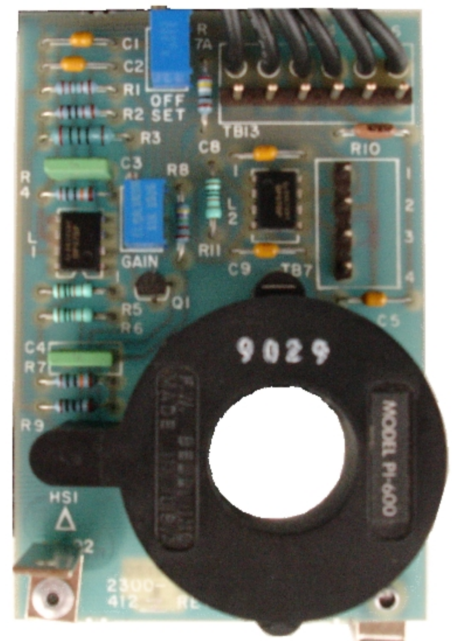



Figure 16:  Current Feedback Board  232-4121

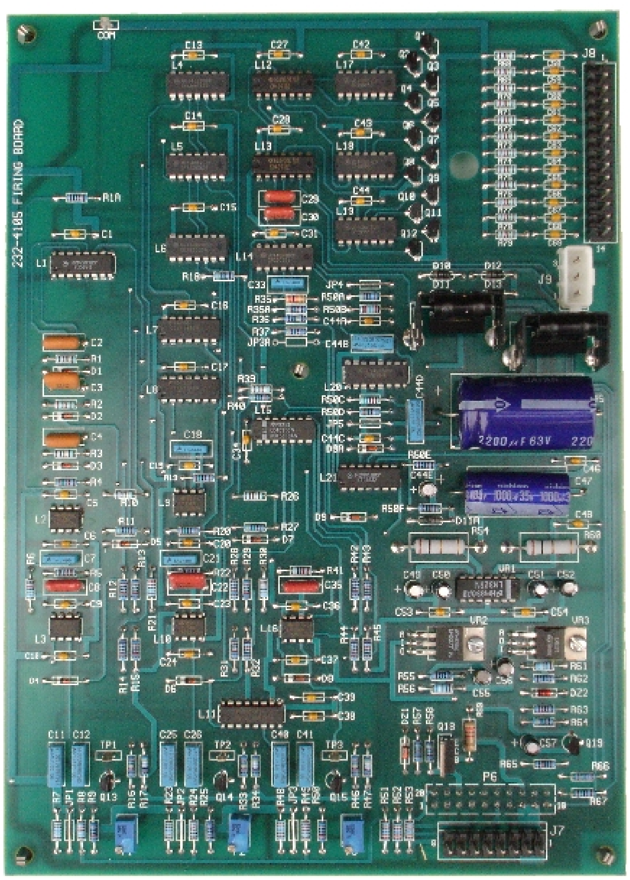



Figure 15:  Firing Circuit Board 232-4105
(On Back of Main Control Board)

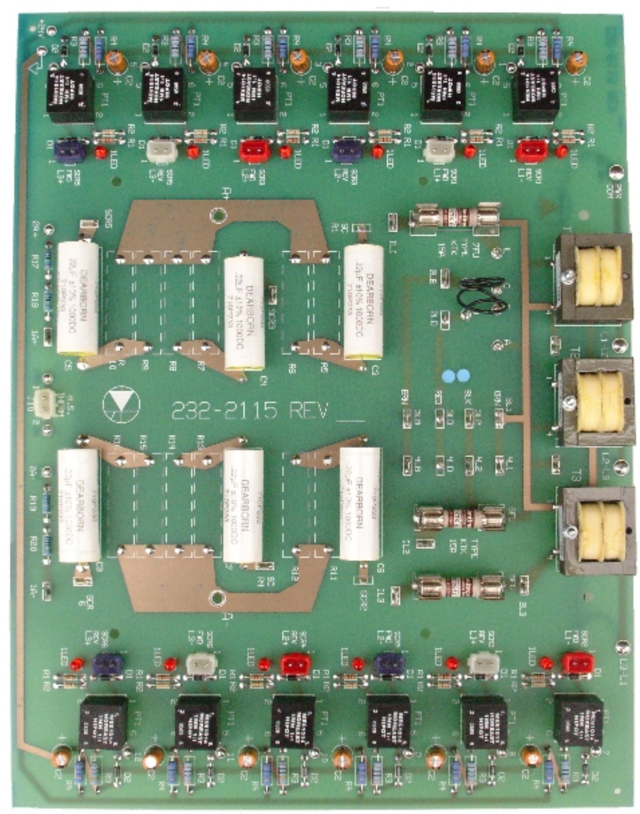



Figure 17:  Interconnect Board  232-4115

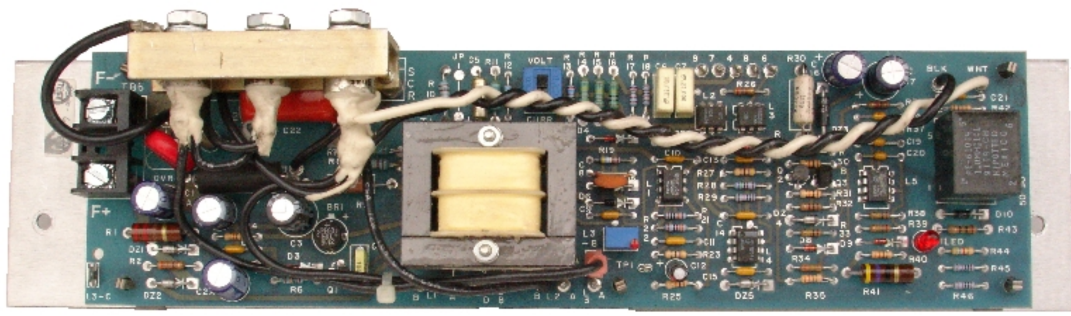


Figure 18:  Field Regulator Board  232-9135

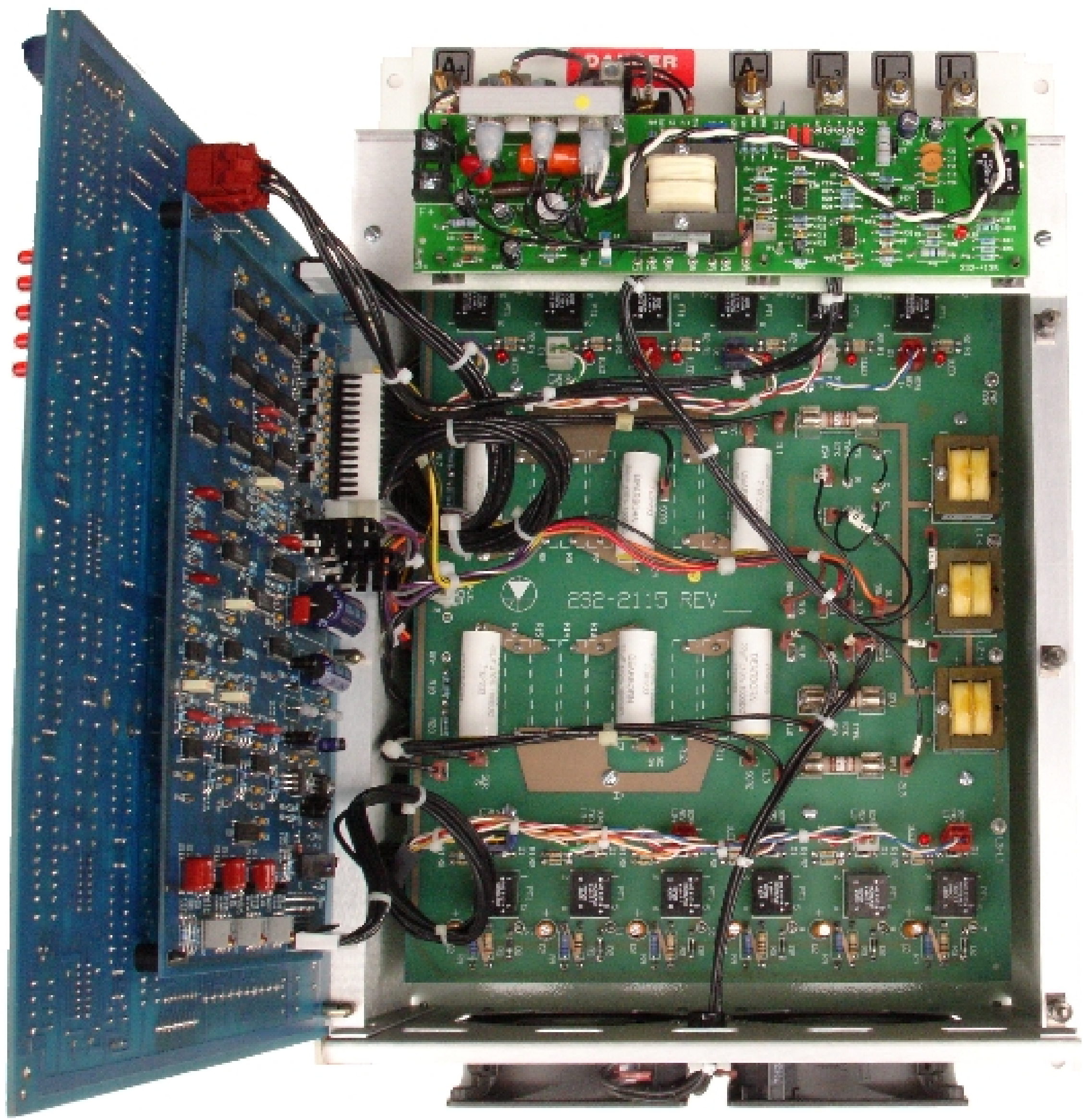



Figure 19:  Control Circuit Board Locations

# SECTION 5
# OPERATION AND START-UP PROCEDURE

## 5.1 INTRODUCTION

This section describes the operator controls and their functions, and initial start-up procedure and applications adjustments of potentiometers and jumpers for the ***MELLTRONICS 2300RG*** control.

It is recommended that you read this section thoroughly to develop and understanding of the operation and logic incorporated in the ***MELLTRONICS 2300RG*** control.

## 5.2 OPERATOR CONTROLS

Refer to Figure 23 for operator control locations.

### 5.2.1 CONTROL VOLTAGE

Terminals TB-1, #1 and #2 provide 120VAC control power for customer use. A total of 10VA of power is available for user supplied devices.

### 5.2.2 FAULT TRIP RELAY (CRFT)

Under normal conditions this relay is energized when AC power is applied to the ***MELLTRONICS 2300RG*** control. When energized, CRFT enables the operator control devices by closing the contact that provides control voltage to these devices at TB-1 terminal #3.

There are six causes for a fault trip which drops out CRFT.

#### 5.2.2.1 Field Loss (FL)

The field loss circuit monitors the presence of field current. If field current is absent after the start push-button is depressed, the FL LED lights and the CRFT drops out. The field loss LED may flash when AC power is first applied and the DC power supplies are coming up to their proper voltages. No fault trip will occur until the start push-button is depressed.

#### 5.2.2.2 Instantaneous Over-current (IOC)

A fault trip occurs dropping out CRFT and lighting the IOC LED when an armature current 300% of the rated current is detected.

#### 5.2.2.3 Phase Loss LED

The phase loss detector is located on the firing circuit board and monitors the output of the three sync circuits (also on the firing board). In the event that one of the circuits fails to produce a sync pulse, the phase loss detector turns off transistor Q7 on the main control board to activate the fault trip circuit.

High AC Line Frequency Detector In addition the high AC line frequency detector and the phase loss detector monitor the same signals. If line frequency goes too high, it also causes Q7 to activate a fault trip. Cutting JP3A will eliminate this circuit.

#### 5.2.2.4 Overheating of the Control Heat Sink

Detection of a heat sink thermal overload is performed by a temperature sensitive, normally closed switch that is mounted directly to the heat sink in the controller's power section. When the heat sink temperature rises to about 95ºC, the switch will open and activate the fault trip circuit.

#### 5.2.2.5 Prolonged Motor Current Overload

The DC overload circuit drops out CRFT and lights the DCOL LED when the drive has run at 150% current limit for approximately one minute. Less severe overloading will take longer to trip out. See the inverse time trip characteristic in Figure 20.

#### 5.2.2.6 Prolonged Motor Current Imbalance

A two-pole active filter is used to monitor the current feedback to sense a prolonged motor current imbalance. The filter is sensitive to any change in the ripple content of the feedback signal. A trip of this type will also light the DCOL LED.

When a fault trip occurs and CFRT drops out, the control voltage to the operator devices is removed and the drive sequences down the same as if the stop push-button were depressed. This sequence is given in the description of the stop circuit.

Once any fault condition has been cleared, the trip circuit must be reset by pressing the FAULT TRIP RESET button. When this is done, any previously lit LED will turn off and CRFT will re-energize. A set of form C contact off of CRFT are available to the user.

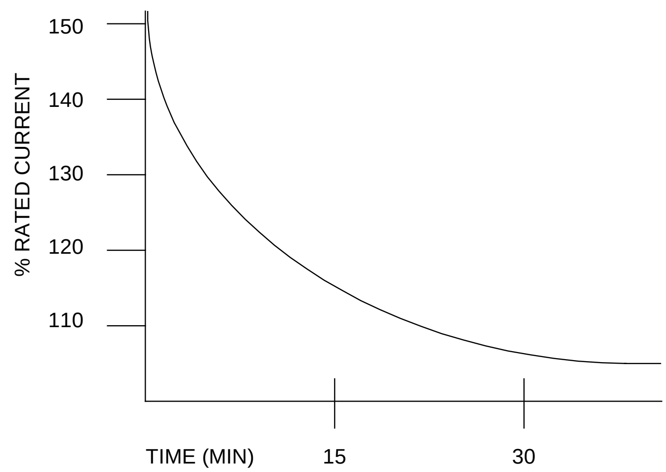



Figure 20: Inverse Time Trip Overload Characteristics

### 5.2.3 MOTOR THERMAL SWITCH/E-STOP

Motors without built-in fans may overheat when they are run for extended periods at low speed. A thermal sensing switch inside the motor will open before overheating occurs. When wired to Terminals TB-1 #3 and #4, the open switch will stop the drive control to protect the motor. A user supplied, normally closed, switch may be wired in series with the thermal switch or in place of it to provide an E-stop function. If neither the thermal switch nor the E-stop is used, TB-1 #3 and #4 must be jumpered. The shut-down sequence is the same as the stop function sequence.

### 5.2.4 STOP

When pressed, the STOP button interrupts the path that supplies the current to keep the run relay (CRR) energized. This opens the by-pass that locks in the relay (CRR), closes the contacts that permit the jog button to function, removes the supply voltage that keeps the motor contactor energized, opens the reference circuit from the speed potentiometer and clamps the ACCEL/DECEL, velocity error and current error amplifiers.

### 5.2.5 START

When CRFT is energized, the start switch momentarily closes the circuit that energizes relay CRR. CRR energization causes the following reaction:

1. A contact closes latching CRR.
2. A path is provided to energize the motor contactor.
3. Reference voltage is connected from the speed pot to the ACCEL/DECEL circuit.
4. The jog switch is disabled from energizing the jog relay (CRJ).
5. The run LED lights.

**CAUTION FIGURES FIGURE 13, FIGURE 29, FIGURE 35,THROUGH FIGURE 36 AND SECTION 8 SHOW A THREE-WIRE START/STOP CIRCUIT ON A 232-4101 MAIN PC BOARD. IF A TWO-WIRE ON/OFF CIRCUIT IS DESIRED ON THIS BOARD, IT MUST BE CONNECTED AS SHOWN IN FIGURE 21.**

### 5.2.6 JOG

When permitted by the run relay (CRR) and fault trip relay (CRFT), the jog switch completes the circuit to energize the jog relay (CRJ). The jog relay then provides a path to energize the motor contactor and connect the jog reference signal to the jog circuitry. CRJ does not lock in so that when the jog push-button is released, the motor contactor drops out and the control is in a stop condition. The jog LED lights when CRJ is energized. A latch-in jog function can be achieved by jumpering terminals #8 to #9 at TB-1.

A normally open (NO) contact, MB, is available to the user at Terminals TB-1 #18 and #19. This contact closes when either CRR or CRJ is energized.

### 5.2.7 MOTOR CONTACTOR

The motor contactor is factory wired to terminals TB-1 #14 and #16. When energized, the contactor closes the DC loop that supplies the motor armature, and N.O. auxiliary contact, MA, closes to enable the control circuitry to begin speed and/or current regulation.

### 5.2.8 SPEED REFERENCE POTENTIOMETER

The MELLTRONICS 2300RG can use either a 1-turn or 10-turn speed potentiometer. The 1-turn pot is used for applications requiring a zero center speed potentiometer, unidirectional applications or applications including reversing by selector switch. The 10-turn pot is used for unidirectional applications or applications including reversing by selector switch.

These potentiometers are connected to the TB-1 terminals as follows:

| Use | Bi-Directional Application (Zero Speed with wiper centered) | Unidirectional Application* |
|---|---|---|
| Reference supply | TB1-20 | TB1-20(-10V) or TB1-22 (+10V), depending on motor rotational direction |
| Control Common | — | TB1-23 |
| Inverted Reference Voltage | TB1-22 | — |
| Reference In | TB1-21 | TB1-21 |

*Direction may also be selected using JP-4 as discussed in Paragraph 5.4.3.1.

| For the 10-turn potentiometer: Use | Drive Control Terminal Number |
|---|---|
| Positive Reference Supply or Negative Reference Supply | TB1-22 or TB1-20 |
| Reference In (to ACCEL/DECEL circuit) | TB1-21 |
| Reference in (velocity error amplifiers) | TB1-25 |
| Control Common | TB1-23 |

(If the motor is turning in the wrong direction, reverse the TB1-20 and TB1-22 connections).

The negative voltage reference signal (-10VDC) at TB1-20 corresponds to positive armature voltage. The positive voltage reference signal (+10VDC) at TB1-22 corresponds to negative armature voltage to provide a reverse speed reference. Terminal TB1-23 is control common. The signal from the wiper is wired to terminal TB1-21.

Shielded wire is recommended when installing these potentiometers.

### 5.2.9 MISCELLANEOUS USER CONNECTIONS

Terminal TB-1 #23 is control common.

Terminal TB-1 #31 is the connection for the remote current limit signal covered in Paragraph 4.10.3

Field loss detection is disabled by inserting jumper JP9 on the main control board. This is generally *not recommended* as **severe motor and machine damage may result** if over-speed occurs due to field loss.

TB-2 allows the user to scale the control for the horsepower level required using a shunt resistor. The user can also select either tachometer or armature feedback by the proper placement of a jumper at TB-2. Refer to Paragraph 3.3.4, for feedback selection instructions.

## 5.3 ADJUSTMENTS

There are ten (10) adjustment potentiometers located on the main control board (P/N 232-4101). Refer to **Error! Reference source not found.**.

Exercise caution when making adjustments. With the control driving a motor, do not exceed ten (10) degrees of pot rotation per second.

### 5.3.1 DECEL TIME

The DECEL time potentiometer adjusts the amount of time the drive takes to DECELerate. This rate of change of speed (ramp) is linear (constant) throughout the speed range but may be limited by the current limit setting. Set to mid-position by the factory, clockwise adjustment of this potentiometer causes the drive to ramp down in speed more slowly.

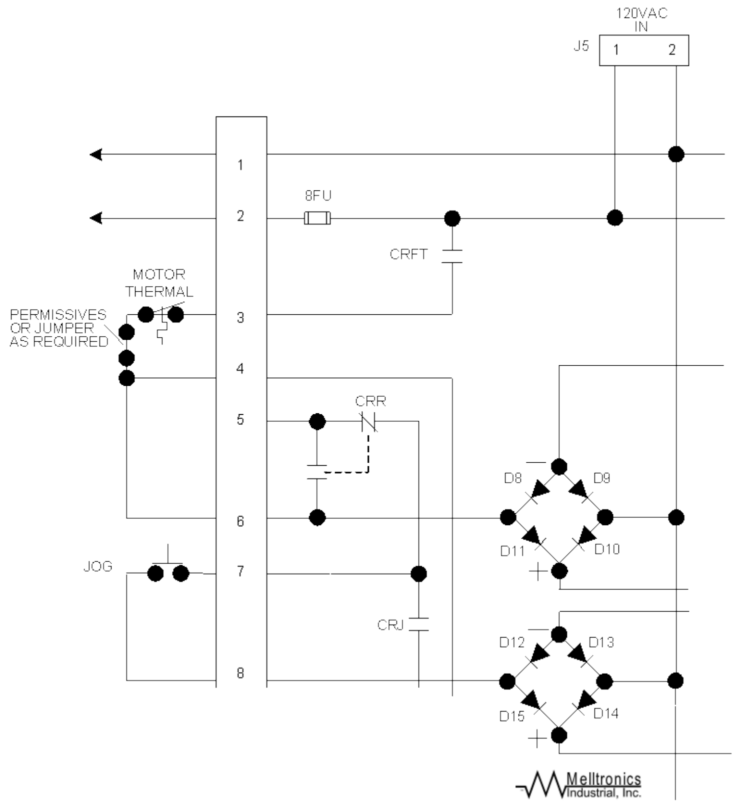



Figure 21: Two-Wire On/Off Circuit on Main PC Board P/N 232-4101

### 5.3.2 ACCEL TIME

The ACCEL time potentiometer adjusts the amount of time the drive takes to accelerate to the speed set by the speed reference potentiometer. This rate of change of speed (ramp) is linear (constant) throughout the speed range but may be limited by the current limit setting. Set to the mid-position by the factory, clockwise rotation of the ACCEL time potentiometer increases the time required to accelerate to set speed.

NOTE: The rates of the ACCEL and DECEL potentiometers are reversed when reverse rotation (positive speed reference) is applied to the motor.

### 5.3.3 JOG

If a jog push-button is wired in, the jog potentiometer will adjust the speed at which the motor will run when in jog. Jog speed may be set from 0 to 30% of maximum speed. Set fully counterclockwise by the factory, clockwise rotation of the jog potentiometer increases the jog speed. The jog reference must be externally wired at TB-1, terminal #27; jog forward can be obtained by jumpering terminals #27 to #20 (-10VDC) at TB-1; jog reverse can be obtained by jumpering terminals #27 to #22 (+10VDC) at TB-1.

### 5.3.4 CURRENT LIMIT (ARMATURE CURRENT LIMIT)

The current limit potentiometer adjusts the maximum armature current that the control will supply to the motor. The range of adjustment is 0 to 150% of the rated current. Factory setting is 2/3 clockwise (100% current for chosen horsepower level). Clockwise rotation of this potentiometer increases the allowed armature current. Refer to Table 4. Current limit may be adjusted to 200% by adding jumper JP7 to the main control board.

### 5.3.5 SPEED RATE

When the drive experiences a step change in velocity, the velocity feedback signal lags behind this change. A lead compensation network is used to supply some additional feedback to compensate for the lag and reduce the rate of change in drive velocity. This also reduces the overshot in the speed response of the drive. The amount of feedback compensating is proportional to the rate of change of feedback signal and is adjusted using the speed rate potentiometer. Clockwise rotation of this potentiometer causes a greater reduction in the rate of change of drive velocity and less overshot. Normally used in tachometer feedback applications, the speed rate potentiometer is factory adjusted to its counterclockwise position.

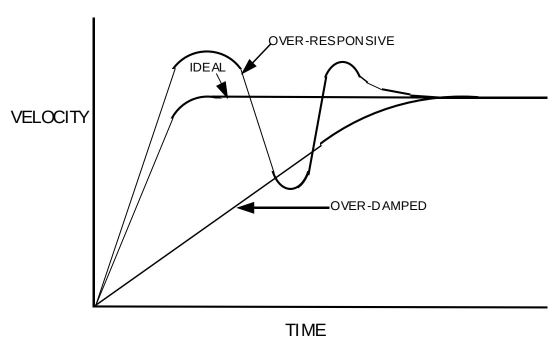



Figure 22: Stability Effects on the Velocity Profile

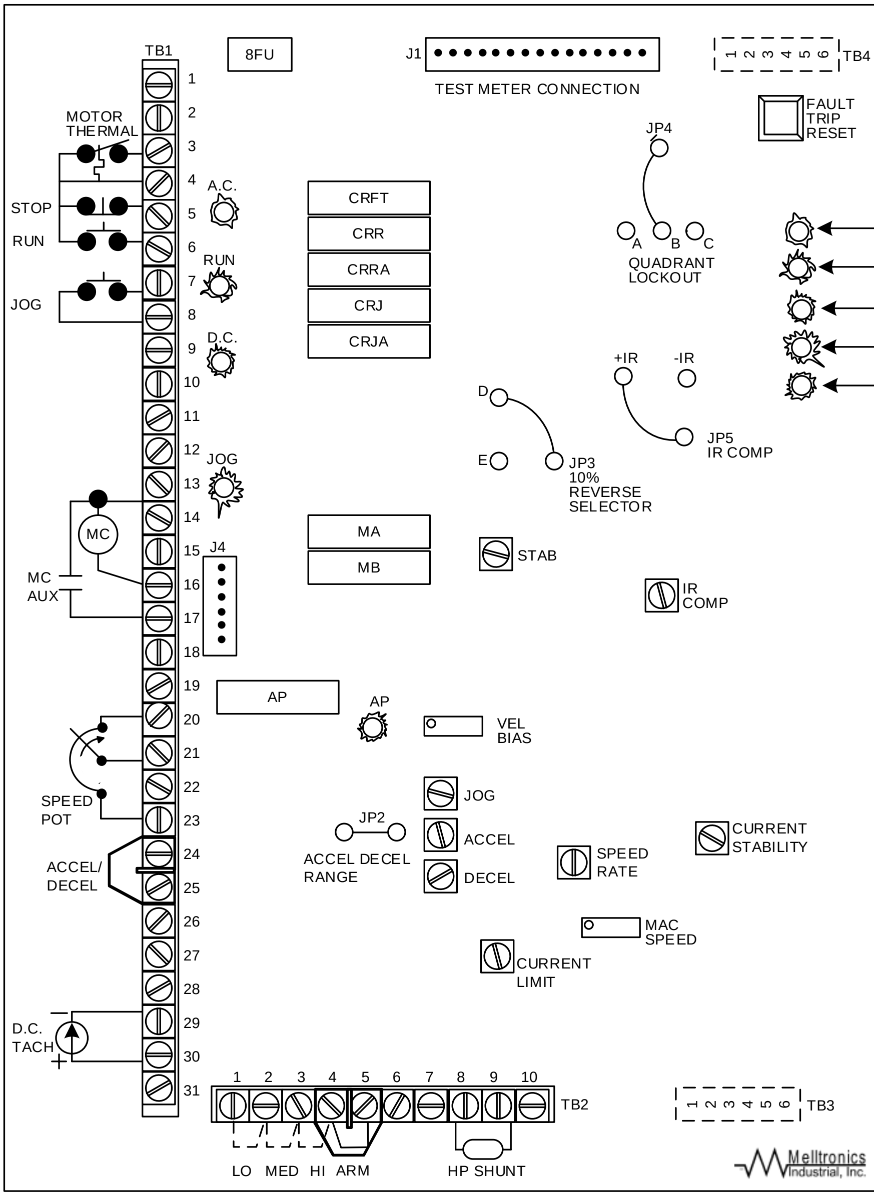



Figure 23:  Main Control Board Operator Features

### 5.3.6 IR COMP (IR COMPENSATION)

The IR compensation circuit increases the drive speed reference signal as armature current increases.  The effect of the increase in current is an increased voltage drop due to the internal resistance of the motor.  The result is a reduction in counter EMF produced by the motor and a reduction in speed, commonly called droop.  The factory setting is fully counterclockwise.  Clockwise rotation of the IR Comp potentiometer increases the amount of droop correction added to the speed reference signal.

Positive IR Comp should never be used with speed (AC or DC tach) feedback.  If speed feedback is used, turn the IR Comp pot fully counterclockwise (CCW).

### 5.3.7 MAX SPEED

When using armature voltage feedback, the max speed potentiometer scales the armature voltage feedback signal so that it exactly offsets a 10VDC reference signal when the motor reaches the desired maximum RPM.  The speed reference potentiometer must be set for maximum (10VDC) reference voltage and the motor must be running at constant speed before adjusting the max speed potentiometer.

Determine the maximum motor speed required for your machine or process; do not exceed the rated speed of the motor.  Using a tachometer or strobe light to measure the motor or machine speed, adjust the max speed potentiometer until the desired maximum speed is obtained.  Clockwise rotation of this potentiometer increases the armature voltage and motor speed.

The range of adjustment is 80 to 120% of rated armature voltage.

For applications using tachometer feedback, the max speed potentiometer scales the tachometer feedback, signal to offset the 10VDC reference signal at the chosen maximum motor speed.  Calculate the tachometer output voltage corresponding to the desired maximum motor speed, and adjust the max speed potentiometer until this voltage is read at the output of the tachometer.

### 5.3.8 CURR STAB (CURRENT STABILITY)

This potentiometer performs the same function in the current error circuit as the VEL STAB potentiometer performs in the velocity error circuit, however, since the current loop responds to current changes much faster than the velocity loop does to speed changes, the CURR STAB adjustment is much more sensitive and harder to adjust properly. Clockwise rotation increases response but the factory shipped setting of ¼ turn from full counterclockwise is adequate for most applications.

### 5.3.9 VELOCITY BIAS

The velocity bias adjustment is used to null any voltage offset in the velocity error amplifier’s output when there is a zero-speed reference applied. This improves the speed ‘match’ of the motor in both directions; that is, speed references of equal magnitudes and opposite polarities produce the same motor speed in opposite directions.

## 5.4 JUMPER PROGRAMMING

In addition to the potentiometers, the MELLTRONICS 2300RG can be programmed for specific applications. The functions of the jumpers and their positioning to achieve these functions follows. Jumpers are listed according to the board on which they are located.

### 5.4.1 INTERCONNECT BOARD

Jumpers B and D, line voltage selectors, are located on the interconnect board and are used to program the input line voltage on the control chassis. This pair of jumpers connects the incoming AC line to the control transformer and must be set to match the user supplied AC voltage.

| | |
|---|---|
| For 240VAC Input | B to E |
| | D to A |
| For 480VAC Input | B to C, Factory Setting |
| | D to C, Factory Setting |

### 5.4.2 FIRING CIRCUIT BOARD

Jumpers JP1, JP2, JP3, JP4 and JP5 frequency selectors are located on the firing circuit board. The ***MELLTRONICS 2300RG*** will operate on either 50Hz or 60Hz AC power.

JP1, JP2, JP3, JP4, and JP5 **In** = 60Hz AC power supply.

JP1, JP2, JP3, JP4, and JP5 **Removed** = 50Hz AC power supply.

Cutting JP3A disables the high AC line frequency detector.

**CAUTION**

**IF THE FIELD REGULATOR OPTION KIT (P/N 232-9006) IS BEING USED, INSURE THAT JUMPER JP101 ON THE TOP PC BOARD ON THIS KIT IS PROGRAMMED FOR THE SAME FREQUENCY AS JUMPERS JP1, JP2 AND JP3 ON THE FIRING CIRCUIT BOARD. FAILURE TO DO THIS CAN RESULT IN EQUIPMENT DAMAGE OR FAILURE. REFER TO THE INSTRUCTION SHEET SUPPLIED WITH THIS KIT FOR COMPLETE INSTALLATION AND START-UP INFORMATION.**

### 5.4.3 MAIN CONTROL BOARD

5.4.3.1 JP4 Two Quadrant Operation

The *MELLTRONICS 2300RG* is four-quadrant control, meaning that it can control the drive in either the forward or reverse direction as either a motor or a generator. The polarity of the armature voltage coincides with the direction of the drive rotation. Positive armature voltage is forward rotation and negative armature voltage is reverse rotation. Whether the drive is acting as a motor or a generator is determined by comparing the polarity of the armature voltage with the armature current polarity. The polarity of the armature current coincides with the direction of torque production. Positive armature current is forward to torque produced by the drive while negative armature current is reverse torque produced by the drive.

When the armature voltage polarity (direction of rotation) is the same as the armature current polarity (direction of torque produced), the drive is motoring. When the armature voltage polarity is the opposite of the armature current polarity, the drive is regenerating. See Figure 24 for a graphic representation.

In some applications, it is desirable to keep the machine or process from operating in a given direction while still maintaining regenerative braking capabilities in the desired direction. This is called two quadrant operation.

The function of JP4 is to select which quadrants the motor will be allowed to operate in.

JP4 to A: The reverse rotation quadrants II and III are locked out. Operation is in quadrants I and IV.

JP4 to B: Four quadrant operation.

JP4 to C: The forward rotation quadrants I and IV are locked out. Operation is in quadrants II and III.

| | $+I_A$ FORWARD TORQUE | | |
|---|---|---|---|
| $-V_A$, | QUADRANT II<br>REVERSE<br>GENERATING | QUADRANT 1<br>FORWARD<br>MOTORING | $+V_A$, |
| REVERSE ROTATION | QUADRANT III<br>REFERSE<br>MOTORING | QUADRANT IV<br>FORWARD<br>GENERATING | REVERSE ROTATION |
| | $-I_A$ FORWARD TORQUE | | |

Figure 24: Four Quadrants of Operation

When JP4 is connected to the ‘A’ post, reverse rotation is locked out as the circuitry blocks a positive reference voltage. Connecting JP4 to the ‘C’ post locks out forward rotation by blocking a negative reference voltage. This must be considered when choosing the polarity of the reference voltage.

If the load causes the drive to back up or creep forward slightly at zero speed, the drive will compensate in either direction to maintain zero speed. See the description of jumper JP#3 below as this jumper affects two quadrant operation.

PARAMETERS SUMMARIZATION

| | FORWARD | | REVERSE | |
|---|---|---|---|---|
| | Motoring<br>I | Regene-rating<br>IV | Motoring<br>III | Regene-rating<br>II |
| ForwardTorque | X | | | X |
| ReverseTorque | | X | X | |
| Pos. Armature Volts | X | X | | |
| Neg. Armature Volts | | | X | X |
| Pos. Armature Curr. | X | | | X |
| Neg. Armature Curr. | | X | X | |

Table 3: Four Quadrants of Operation

Table 4: Armature Current Overload Scaling

| CONTROL | HORSEPOWER 240VAC | HORSEPOWER 480VAC | HP SHUNT RESISTOR VALUE | INPUT AMPS AT FULL LOAD | DC ARMATURE AMPS AT FULL LOAD | OPTIONAL 50MV.AMM.(AMPS FS) | AMMETER SCALING RESISTOR VALUE |
|---|---|---|---|---|---|---|---|
| 232-8100 | —— | 5 | ① * | 7.354 | 9 | 10 | 2.49K |
| | —— | 7.5 | 121.0K | 10.6 | 13 | 15 | 1.65K |
| | 5 | 10 | 61.9K | 13.9 | 17 | 20 | 1.24K |
| | 7.5 | 15 | 30.9K | 20.4 | 25 | 25 | 1.00K |
| | 10 | 20 | 20.0K | 27.8 | 34 | 30 | 825Ω |
| | — | 25 | 15.0K | 34.3 | 42 | 40 | 619Ω |
| | 15 | 30 | 11.8K | 41.6 | 51 | 50 | 499Ω |
| | | | | | | 60 | 421Ω |
| | | | | | | 75 | 332Ω |
| 232-8101 | 20 | 40 | ② 61.9K | 55.5 | 68 | 75 | 1.33K |
| | 25 | 50 | 40.2K | 69.4 | 85 | 100 | 1.00K |
| | 30 | 60 | 30.1K | 83.3 | 102 | 120 | 825Ω |
| | 40 | — | 19.1K | 115 | 141 | 150 | 665Ω |
| | — | 75 | 22.1K | 104 | 127 | 180 | 549Ω |
| | | | | | | 200 | 499Ω |
| 232-8102 | 50 | 100 | ③ 41.2K | 138 | 169 | 180 | 1.10K |
| | 60 | 125 | 28.7K | 173 | 212 | 200 | 1.00K |
| | | | | | | 250 | 806Ω |
| | | | | | | 300 | 665Ω |

*NOT REQUIRED    ALL SHUNT RESISTORS ARE AVAILABLE IN KIT FORM    LEGEND: ①232-6116 ②232-6118 ③ 232-6117 ④232-6119

5.4.3.2 JP3 10% Reverse Selector

If JP4 has been set for two quadrant operation, the drive will operate in only one direction. In some applications where two quadrant operation is required, it may also be desirable to allow the drive to back up slowly for threading or loading operations or to supply additional holding torque at zero speed. The 10% REVERSE feature allows the drive to operate up to 10% of maximum speed in the locked out direction.

JP3 to E: Drive will not operate in locked out direction

JP3 to D: Drive will operate up to 10% of max speed in locked out direction.

Jumper JP3 has no effect on the drive if JP4 is set for four quadrant operation.

5.4.3.3 JP6 IR Compensation Selector

Jumper JP6 selects either positive or negative IR compensation to be adjusted by the IR Comp potentiometer. Positive IR compensation was explained in Paragraph 5.3.6, as an increase in the speed reference when increasing armature current and speed droop occur. Negative IR compensation is a subtraction from the speed reference signal when armature current increases. This causes a greater droop in speed to occur. Negative IR compensation is useful when the *MELLTRONICS 2300RG* control is used in a follower or helper type application to keep the follower drive from taking too much load on itself or overrunning the lead drive. The IR Comp potentiometer increases the amount of droop in speed when it is turned clockwise and JP6 is set for negative IR compensation.

JP6 to IR: Positive IR Compensation

JP6 to -IR: Negative IR Compensation

5.4.3.4 Fixed Jumpers Programming

Two fixed jumpers are on the Main PC board.

1. Jumper JP8 scales the motor armature voltage feedback

    Remove JP8 for 230VAC line operation

    Install JP8 for 460 VAC line operation

The input line voltage is programmed as described in Paragraph 5.4.1.

2. Jumper JP2 selects the range of adjustment for the ACCEL and DECEL potentiometers. Jumper JP2 removed selects the 2-30 second range. This is the factory supplied setting. Jumper JP2 must be added to select the 0.2-4 second range. Jumper JP5 must be left in. It is for factory use in custom system applications.

5.4.3.5 HP Scaling

The horsepower scaling shunt resistor is connected to TB-2 Terminals #8 and #9. Appropriate HP shunt resistor values are listed in Table 4.

5.4.3.6 JP1A Contactor Coil Voltage Selector

The Model 232-8102, 125HP drive control uses a contactor with a different coil voltage than the other MELLTRONICS 2300RG models. The Model 232-8102 is shipped with a diode in series with the normally closed auxiliary contact from the contactor wired between terminals 14 and 15 on TB-1. Jumper JP1A is connected to the ‘B; post on the 232-8102 drive control. All other models have JP1A connected to the ‘A’ post. Jumper JP1A is found on main control boards.

5.4.3.7 JP1C Anti Plug-Circuit

Jumper JP1C controls the use of the anti-plug circuit. When it is removed, a drive restart is not permitted until armature voltage (motor speed) has dropped to a safe level. This feature is intended primarily for dynamic braking applications. Installing JP1C defeats this circuit.

### 5.5 FIELD REGULATOR BOARD SET-UP PROCEEDURE

#### A. VOLTAGE REGULATION

Move the slide switch to the 'VOLT' position. With a small alligator clip, jumper out resistor R31. Jumper JP1 should be removed for 300 volt fields ( and 480VAC input), or installed for 150 volt fields (and 240VAC input). With the motor field connected, apply AC power to the control. The field voltage should measure to be within a few percent of rated voltage. While monitoring the voltage at the bottom of resistor R13, adjust P1 until the voltage is -0.2 volts. Turn off the AC power and remove the jumper from resistor R31.

#### B. CURRENT REGULATION

Move the slide switch to the ''CURR' position. With a small alligator clip, jumper out resistor R31. With the motor field connected, apply AC power to the drive. While monitoring the voltage at TP1 with respect to F+, adjust P1 until the number of volts is equal to one half (½) the number of name-plate rated amps (-3 volts for a field rated at 6 amps). If the field current is properly adjusted, then the voltage at the bottom of resistor R13 (with respect to F+) should be -0.2 volts. If not, then readjust P1 until the voltage reaches this level. Turn off the AC power and remove the jumper from resistor R31. It should be noted that the field voltage may be somewhat less than the rated value at rated current when the field is cold.

#### C. VOLTAGE RANGE PROGRAMMING

A pre-installed jumper wire and fast-on contacts L3-B and L3-C are also located on this board to program the desired field voltage range. Contact L3-B is located in the center of the bottom edge of the board and contact L3-C is located in the lower left corner of the board. Program this jumper as follows:

For a line voltage of 480VAC

| JUMPER | RANGE |
|---|---|
| Jumper to L3-C | 0-220VDC range |
| Jumper to L3-B | 220-310VDC range |

For a line voltage of 240VAC

| JUMPER | RANGE |
|---|---|
| Jumper to L3-C | 0-110VDC range |
| Jumper to L3-B | 110-155VDC range |

JP1 is used to set the voltage feedback for fixed voltage field.

JP1 Installed = 150V JP1

Removed = 300V (with 480VAC in)

The input line voltage is programmed as described in Paragraph 5.4.1.

### 5.6 START-UP PROCEDURE

To insure maximum efficiency with a minimum amount of delay in production, factory start-up assistance by a factory engineer is available. Contact your sales representative at least two weeks prior to the required date.

**CAUTION**

**THE FOLLOWING START-UP INSTRUCTIONS ARE INTENDED ONLY AS A GUIDE AND SHOULD BE CLEARLY UNDERSTOOD BY THE RESPONSIBLE INSTALLATION PERSONNEL BEFORE PROCEEDING.**

#### 5.6.1 POWER OFF CHECKS

Check that the motor armature, motor field, AC input power and operator devices are connected in accordance with these instructions an existing system diagrams.

On the main PC board, make the following jumper connections (Jumpers were explained earlier in this section):

JP6 to +IR

JP3 to E

JP4 to B

Remove JP8 for 230VAC line operation

Install JP8 for 460VAC line operation

On the interconnect PC board, set the jumpers as follows:

For 240VAC operation: JB to E and JD to A

For 480 VAC operation: JB to C and JD to C

Set the potentiometers on the main control board as follows:

Velocity stability - 25% clockwise

ACCEL/DECEL - fully counterclockwise

Maximum speed - fully counterclockwise

Jog speed - fully counterclockwise

Current Limit- 25% counterclockwise

Speed rate - fully counterclockwise

IR Comp- fully counterclockwise

Current stability - 1/4 turn from full counterclockwise position

Vel bias - factory set

Make a detailed visual inspection of the system, checking for:

Loose electrical connections

Pinched wires at the control, motor or operator's station

Loose mechanical connections, especially the tachometer coupling

Mechanical binding

Incorrect power transformer connections

Metallic chips within the drive caused by drilling into the enclosure

Incorrect jumper programming

Using a Simpson 260 or equivalent, measure the resistance between the following points. Disconnect test meter plug P1 from connector J1.

| TEST LEAD POINTS | METER READING | TEST LEAD POINTS | METER READING |
|---|---|---|---|
| L1 to L2 | At least 100 ohms | A+ to chassis | Infinite |
| L1 to L3 | At least 1K ohms | A- to chassis | Infinite |
| L2 to L3 | At least 1K ohms | F+ to chassis | Infinite |
| A+ to L1 | At least 1 Meg | F- to chassis | Infinite |
| A+ to L2 | At least 1 Meg | TP1 to chassis | Infinite |
| A+ to L3 | At least 1 Meg | L1 to TP1 | At least 500K |
| A- to L1 | At least 1 Meg | L2 to TP1 | At least 500K |
| A- to L2 | At least 1 Meg | L3 to TP1 | At least 500K |
| A- to L3 | At least 1 Meg | A+ to TP1 | At least 500K |
| A+ to A- | Infinite | A- to TP1 | At least 500K |
| L1 to chassis | Infinite | F+ to TP1 | At least 500K |
| L2 to chassis | Infinite | F- to TP1 | At least 500K |
| L3 to chassis | Infinite | Across Contactor | Infinite |

All the resistance checks involving A+ or A- should be performed on the drive control side of the contactor.

### 5.6.2 POWER ON CHECKS

A. Remove the six (6) color-coded 2 pin AMP connectors from the top edge of the interconnect PC board. Also remove the six (6) two-pin AMP connectors from the bottom edge of the same board. These are the gate lead connections to the SCR's.

B. Apply AC power.

C. With a volt-meter, check the power supply voltages using the following table:

| (+) Lead | (-) Lead | Reading |
|---|---|---|
| TB-1, #1 | TB-1, #2 | 120VAC |
| TB-1, #22 | TB-1, #23 | +10VDC |
| TB-1, #20 | TB-1, #23 | -10VDC |
| TP16 | TB-1, #23 | +15VDC |
| TP18 | TB-1, #23 | -15VDC |
| TB-2, #6 | TB-1, #23 | +24VDC |
| TB-2, #7 | TB-1, #23 | -24VDC |

D. If the optional test meter was reconnected after the power off checks, remove AC power and disconnect P1. Apply AC power and check the following voltages on J1.

| (+) Lead | (-) Lead | Reading | Parameter |
|---|---|---|---|
| Pin 12 | Pin 9 | 0 VDC | Armature volts |
| Pin 13 | Pin 9 | 0 VDC | Armature amps |
| Pin 15 | Pin 9 | ±0.1 VDC | Trigger signal |

E. Check the field voltage at terminals F+ and F-. With the field economy feature operational, you should read (after one minute):

Approximately 215VDC for a 480VAC input

Approximately 108VDC for a 240VAC input

The field should be reduced by approximately 30%.

F. Set the speed reference potentiometer to +10VDC and depress the start push-button. **Note that the reverse gate firing indicators will illuminate when pins 1 and 2 of each of the reverse gate lead connectors are jumpered together, one pair at a time.**

G. Set the speed reference potentiometer to -10VDC. **Note that the forward gate firing indicators will not light when pins 1 and 2 of each of the forward gate lead connectors are jumpered.**

H. Depress the stop push-button. One set of LEDs (forward or reverse) will remain on, depending on amplifier offsets.

### 5.6.3 DYNAMIC CHECKS

A. Remove AC power. Connect the twelve (12) SCR gate lead connectors to the interconnect board according to their color coding. Apply AC power.

B. Set the current limit potentiometer to approximately 10% current (9 o'clock position).

C. Set the speed reference potentiometer to -10VDC.

D. Start the drive and slowly adjust the current limit potentiometer to the mid-position. When the motor no longer ACCELerates, adjust the maximum speed pot so that the voltage at the armature terminals is 500VDC for a 480 VAC input or 240VDC for a 240VAC input. See Paragraph 5.3.7, for adjusting max speed to suit your application.

E. Adjust the velocity stability (STAB) and speed rate potentiometers to achieve the desired motor response to speed changes. These adjustments were discussed previously in this section.

**CAUTION**

**THESE STABILITY ADJUSTMENTS MUST BE PERFORMED WITH CARE. MOTOR INSTABILITY WILL RESULT IF THSE POTENTIOMETERS ARE ADJUSTED TOO QUICKLY OR SET TOO HIGH. THESE POTENTIOMETERS SHOULD BE TURNED CLOCKWISE JUST ENOUGH TO PREVENT VELOCITY OVERSHOOT.**

F. Adjust the current limit potentiometer for 100% current by turning it clockwise until +5VDC is measured at TB-1, terminal #31 on the main control board.

G. Check the ACCEL/DECEL circuit for the 0.2-4 second range.
1. Stop the drive and remove AC power.
2. Jumper JP2 on the upper board.
3. Set the ACCEL and DECEL potentiometers fully clockwise.
4. Apply AC power and start the drive. Note that the motor ramps to full speed in about 4 seconds.
5. Reduce the speed reference to zero. Note that the motor ramps to zero speed in about 4 seconds.
6. Set each of the ACCEL and DECEL potentiometers for the requiring ramping rate in the desired time range using the above procedure. Clockwise rotation of these potentiometers increases the ramp time.

H, If required, check the drive for two quadrant operation. Always stop the drive and remove AC power before changing a jumper setting.
1. Set JP4 to the C position. Note that only positive armature Voltage is attainable when adjusting the speed reverence.
2. Set JP4 to the A position and tone that only negative armature voltage is attainable.
3. Set JP3 to the D position and note that only negative and a small (10%) positive armature voltage is attainable.
4. Stop the drive and remove AC power. Set JP4 and JP3 to their desired positions.

I. Check the jog Circuit.
1. Set the jog potentiometer fully clockwise.
2. Supply voltage to the jog reference by placing a jumper between TB-1 #20 (-10 VDC) and TB-1 #27 (jog reference).
3. While depressing the jog push-button, the armature voltage should read approximately 150 VDC for a 500 VDC armature. (75 VDC for a 240 VDC armature).
4. Set the jog potentiometer for the desired jog speed.

J. Set the IR compensation.
1. Run the motor at maximum speed with no load.
2. Record the motor RPM (hand tachometer required).
3. Load the motor.
4. Again measure the motor RPM. Match this loaded speed to the unloaded speed of Step 1 using the IR Comp potentiometer.
5. Repeat Steps 1 through 4.

NOTE: Excessive IR compensation can cause the drive control to become unstable.

# SECTION 6
# MAINTENANCE AND TROUBLESHOOTING

## 6.1 IMPORTANT SAFEGUARDS

All work on the drive should be performed by personnel familiar with it and its application. Before performing any maintenance or troubleshooting, read the instructions and consult the system designs

**WARNING**

**MAKE SURE THAT ALL POWER SOURCES HAVE BEEN DISCONNECTED BEFORE MAKING CONNECTIONS OR TOUCHING INTERNAL PARTS. LETHAL VOLTAGES EXIST INSIDE THE CONTROL ANYTIME INPUT POWER IS APPLIED, EVEN IF THE DRIVE IS IN A STOP MODE. EXERCISE CAUTION WHEN MAKING ADJUSTMENTS. WITH THE CONTROL DRIVING A MOTOR, DO NOT EXCEED TEN (10) DEGREES OF POT ROTATION PER SECOND. NEVER INSTALL OR REMOVE THE CONTROL BOARD WITH POWER APPLIED TO THE CONTROLLER.**

## 6.2 NORMAL MAINTENANCE

Only minor adjustments should be necessary on initial start-up of the *MELLTRONICS 2300RG*, depending on the application. Standard maintenance procedures need to be followed.

***·Keep It Clean***

The control should be kept relatively free of dust, dirt, oil caustic atmosphere, and excessive moisture. External cabinet filters should be checked and cleaned periodically. Do not use high pressure air to blow the control or cabinet clean--use a small brush and vacuum cleaner to limit dust being stirred up during cleaning.

***·Keep Connections Tight***

Keep the equipment away from high vibration areas that could loosen connections or cause chafing of wires. Also, all interconnections should be re-tightened at the time of initial start-up and at least every six months.

***·Follow Motor Maintenance Instructions***

The brushes and commutator should be inspected for excessive wear or arcing. Motor wiring should be inspected for wear and the connections should be checked for tightness. For more detail, consult the instructions supplied with the motor for more detail.

***·Keep It Cool***

The control should be located away from machines having a high ambient temperature. Only chassis models, airflow across heat-sinks must not be restricted by other equipment.

**WARNING**

**DC MOTOR: THE MOTOR MAY BE AT LINE VOLTAGE EVEN WHEN IT IS NOT IN OPERATION, THEREFORE, NEVER ATTEMPT TO INSPECT, TOUCH OR REMOVE ANY INTERNAL PART OF THE DC MOTOR WITHOUT FIRST MAKING SURE THAT ALL AC POWER TO THE CONTROL AS WELL AS THE MOTOR HAS BEEN DISCONNECTED.**

The motor should be inspected at regular intervals and the following checks must be made:

A. See that both the inside and outside of the motor are not excessively dirty. This can cause added motor heating and shorten motor life.
B. If a motor blower is used, make sure that the air passages are clean and the impeller is free to rotate. If air filters are used, they should be cleaned at regular intervals or replaced if they are disposable. Any reduction in cooling air will increase motor heating.
C. Inspect the commutator and brushes. Replace the brushes if needed. Make sure that the proper brush grade is used.
D. The motor bearing should be greased per the manufacture's instructions as to type of grease and frequency. Over greasing can cause excessive bearing heating and failure. Consult the instructions supplied with the motor for more details.

## 6.3 TROUBLESHOOTING OVERVIEW

Fast and effective troubleshooting requires well-trained personnel supplied with the necessary test instruments as well as a sufficient stock of recommended spare parts. Capable electronic technicians who have received training in the control operation and who are familiar with the application are well qualified to service this equipment.

### 6.3.1 SUGGESTED TRAINING

A. Study the system instruction manual and control drawings.
B. Obtain practical experience during the system installation and in future servicing.
C. Train in the use of test instruments.
D. For additional help, contact the Melltronics factory.

### 6.3.2 MAINTENANCE RECORDS

The user should keep records of down time, symptoms, results of various check, meter readings, etc. Such records will often help a service engineer locate the problem in the minimum time, should such services be required.

### 6.3.3 GENERAL TROUBLESHOOTING

The most frequent causes of drive failure are:

- A broken wire or loose connection.
- Circuit grounding within the interconnections or the power wiring.
- Mechanical failure at the motor, or tachometer.

Do **NOT** make adjustments or replace components before checking all wiring. Check all indicator lights before proceeding with troubleshooting checks. Also check for blown fuses.

It should be noted that modern solid state electronic circuitry is highly reliable. Often problems which appear to be electrical are actually mechanical. It is advised that the motor be checked in the event of any drive problems. Refer to the motor owner's manual for maintenance and repair procedures.

### 6.3.4 NOTES FOR TROUBLESHOOTING TECHNICIAN

A minimum knowledge of system operation is required, but it is necessary to be able to read the system schematics and connection diagrams.

An oscilloscope may be needed to locate problem areas and to make adjustments. The majority of the problems can be solved by using a multi-meter and by parts substitution.

Should board replacement become necessary, check that the Voltage at TB2-8 on the drive relative to common TB2-10, is 0.00 volts (using a digital voltmeter). This voltage must be as close as practical to zero for proper operation. The zero offset pot on the current feedback board can be adjusted slightly to achieve 0 volts, with the motor not running.

**WARNING**

**CARE MUST BE TAKEN WHEN TEST INSTRUMENTS ARE BEING USED, TO INSURE THAT ITS CHASSIS IS NOT GROUNDED EITHER BY A GROUNDING PLUG CONNECTION OR BY ITS CASE BEING IN CONTACT WITH A GROUNDED SURFACE. EXTREME CARE MUST BE TAKEN WHEN USING THE OSCILLOSCOPE SINCE ITS CHASSIS WILL BE ELECTRICALLY HOT TO GROUND WHEN CONNECTED TO THE CONTROL SYSTEM.**

Multimeters having a sensitivity of 1,000 ohms per volt or more on the DC scale are recommended.

**WARNING**

**DO NOT USE THE OHMMETER PORTION OF A MULTIMETER TO CHECK TRANSISTORS, EXCEPT WHERE ADVISED TO DO SO IN THIS MANUAL. NEVER USE A MEGGER TO CHECK ANY PORTION OF THE CONTROL CIRCUITRY. BEFORE TROUBLESHOOTING THE DRIVE SYSTEM, READ THE WARNING SECTION AND NOTES ON THE USE OF TEST INSTRUMENTS.**

### 6.3.5 BASIC TROUBLESHOOTING

Included in this section are a basic list of symptoms of an improperly functioning control along with possible causes and corrective measures for each SYMPTOM described.

NOTE: Be sure to check jumper programming when replacing a PC board. It may be necessary to readjust potentiometers.

A. Control appears to be dead (no light or fans):

1. No AC power - apply AC power.
2. Blown line fuses - replace line fuses.
3. blown fuses on interconnect board - replace fuses
4. Loose connections - turn off AC power and tighten connections.
5. Control incorrectly wired - recheck all wiring
6. Interconnect harnessing disconnected or damaged - reconnect or replace interconnect harnessing.

B. Line fuses blown or main circuit breaker trips when applying AC power

1. External short in AC wiring - locate and remove short.
2. AC input shorted at control - locate and remove short.
3. Control wired to AC voltage exceeding control rating - rewire control to proper AC voltage or use step-down transformer.
4. Interconnect board is improperly wired or is damaged - check wiring to power section or replace interconnect board.
5. Damaged(shortened) power blocks - replace bad power blocks.

C. Control momentarily comes on with AC power but then dies (fuses on interconnect board blow):

1. Voltage input jumpers improperly connected - reprogram voltage input jumpers (located on interconnect board).
2. External short in motor field connections - locate and remove short.
3. Field connections shortened at field regulator board - locate and remove short.
4. Field diodes or SCR shorted - replace bad power device.
5. Fans or power supply transformer shorted - replace bad fans or power supply transformer.

D. No voltage at field terminals (F+ and F-):

1. Damaged field diodes or SCR - replace bad power device.
2. Interconnect harness disconnected or damaged - reconnect or replace interconnect harness.- Damaged field regulator
3. Damaged field regulator board - replace field regulator board
4. Blown fuses on interconnect board - replace fuses.

E. No voltage at armature terminals (A+ and A-):

1. Armature connections improperly wired - rewire armature connections.
2. Damaged power block - replace power block.
3. Armature shorted to motor housing - locate and remove short.
4. Speed pot improperly wired or faulty - require or replace speed pot.
5. Curr limit pot is fully counterclockwise turn Curr limit pot clockwise.
6. Motor field not connected - connect motor field.
7. Plug disconnect from J8 on firing circuit board - reinsert plug into J8.
8. Damaged printed circuit board - replace printed circuit board.

F. Fuses blow when speed pot is advanced from zero:

1. Drive motor is overloaded - correct overload condition
2. Damaged power block - replace power block
3. Damaged current feedback board - replace current feedback board
4. Damaged interconnect harness - replace interconnect harness

G. Motor will not reach rated speed:

1. Motor is overloaded - corrected overload condition
2. Control is improperly shunted for desired horsepower - reshunt control
3. Incorrect control jumper programming - reprogram jumpers
4. Max speed power is set too low - adjust max speed pot clockwise
5. Curr limit pot is set too low - adjust Curr limit pot clockwise
6. Low AC line voltage (more than 10% below nominal) - check AC line voltage and correct

H. Motor runs too fast:

1. DC tachometer wires reversed, loose or damaged - check tachometer wires
2. Armature feedback jumper is missing - install armature feedback jumper
3. Incorrect control jumper programming - reprogram jumpers
4. Damaged speed pot - replace speed pot
5. Damaged printed circuit board - replace printed circuit board 1 A+ and 1A- fast-ons disconnected from interconnect board - reconnect fast-ons. Load compensation

I. Motor does not come to full stop:

1. Vel bias pot out of adjustment - readjust vel bias pot.
2. Faulty speed pot - replace speed pot
3. External generated speed reference does not go to zero. - examine circuitry used to generate speed reference.

J. Control trips out:

1. Curr limit pot is set too high - adjust Curr limit pot counterclockwise
2. Loose field connections - tighten field connections
3. Jumper JP9 is missing (with external field supply) - install jumper JP.
4. Current feedback is imbalanced - adjust Curr stability pot
5. Insufficient airflow from fans - check for blockage of fan rotation.
6. Pot P1 on field regulator board improperly adjusted - adjust pot P1 (CCW)
7. Severe dips in AC power line - check AC power line and correct
8. Damaged printed circuit board - replace printed circuit board

K. Motor speed oscillates:

1. IR Comp pot set too high - adjust IR Comp pot counterclockwise.
2. Control not dynamically turned for application - tune the control.
3. Load is loosely coupled to motor - check and correct load coupling.
4. Loose wire connections - tighten connections (to motor.)
5. Loose gate lead connectors or interconnect harnessing - check all interconnect harnessing, mating connectors and fast-on connections in control.

L. Control won't go into run or jog:

1. Operator push-buttons improperly wired - require push-buttons.
2. Fault trip condition exists - check fault trip lights and clear fault.
3. Plug disconnected from J5 on main control board - reinsert plug into J5.
4. Plug disconnected from J3 on main control board - reinsert plug into J3.
5. Damaged power supply transformer - replace power supply transformer.
6. Armature contactor is improperly wired or is damaged - rewire or replace armature contactor.
7. Control voltage is overloaded - locate and correct overload condition.
8. Damaged printed circuit board - replace printed circuit board.

M. Motor runs in wrong direction:

1. Speed pot improperly wired - rewire speed pot.
2. Armature leads reversed - switch armature leads.
3. Field leads reversed - switch field leads.

N. Motor instability observed:

The DC motor stabilizing series winding may not be compatible in this particular MELLTRONICS 2300RG application, contact Field Service Department at:

Melltronics Industrial Inc.
3479 Gribble Road
Matthews, NC 28104-8114
704-821-6651

### 6.4 SCR REPLACEMENT

Refer to Figure 25 for component identification.

A. Remove and lockout AC power to the controller.

B. Remove field regulator board by unscrewing upper chassis cover from the control and unplugging fast-on connectors from the interconnect board to the field regulator board.

| NOTE: Do not allow loose hardware to fall into heat sink assembly. |
|---|

C. Remove interconnect board by unscrewing stand-off screws, and unplug all detachable wire harnessing from the control to the interconnect board.

D. Remove the 6 bus bar mounting screws from the armature bus bar to loosen the bus bar. (NOTE: screws are metric.)

E. Remove the two AC line bus bar screws over the SCR that you wish to remove and twist the AC line bus bar to the side in order to reach the SCR mounting screws at the base of the SCR. (NOTE: AC line bus bar screws are metric at each end only.)

| NOTE: If you are still unable to reach the SCR mounting screws, loosen the center AC line bus bar screw. |
|---|

F. Label and remove SCR gate leads

G. Remove SCR mounting screws and remove the power block

H. Place new SCR on heatsink assembly and attach to panel with the SCR mounting screws.

I. Place new SCR on heat-sink assembly and attach to the panel with the SCR mounting screws

J. Reconnect the SCR gate leads as before

K. Place AC line bus bars across SCR appropriately and attach with AC line bus bar screws

L. Attach armature bus bar with the 6 bus bar mounting screws

M. Attach interconnect board to control by plugging in all attachable wire harnessing and screwing in stand off screws

N. Attach field regulator board by plugging in fast-on connections from interconnect board to field regulator board and attaching the upper chassis cover of the field regulator board with the appropriate screws.

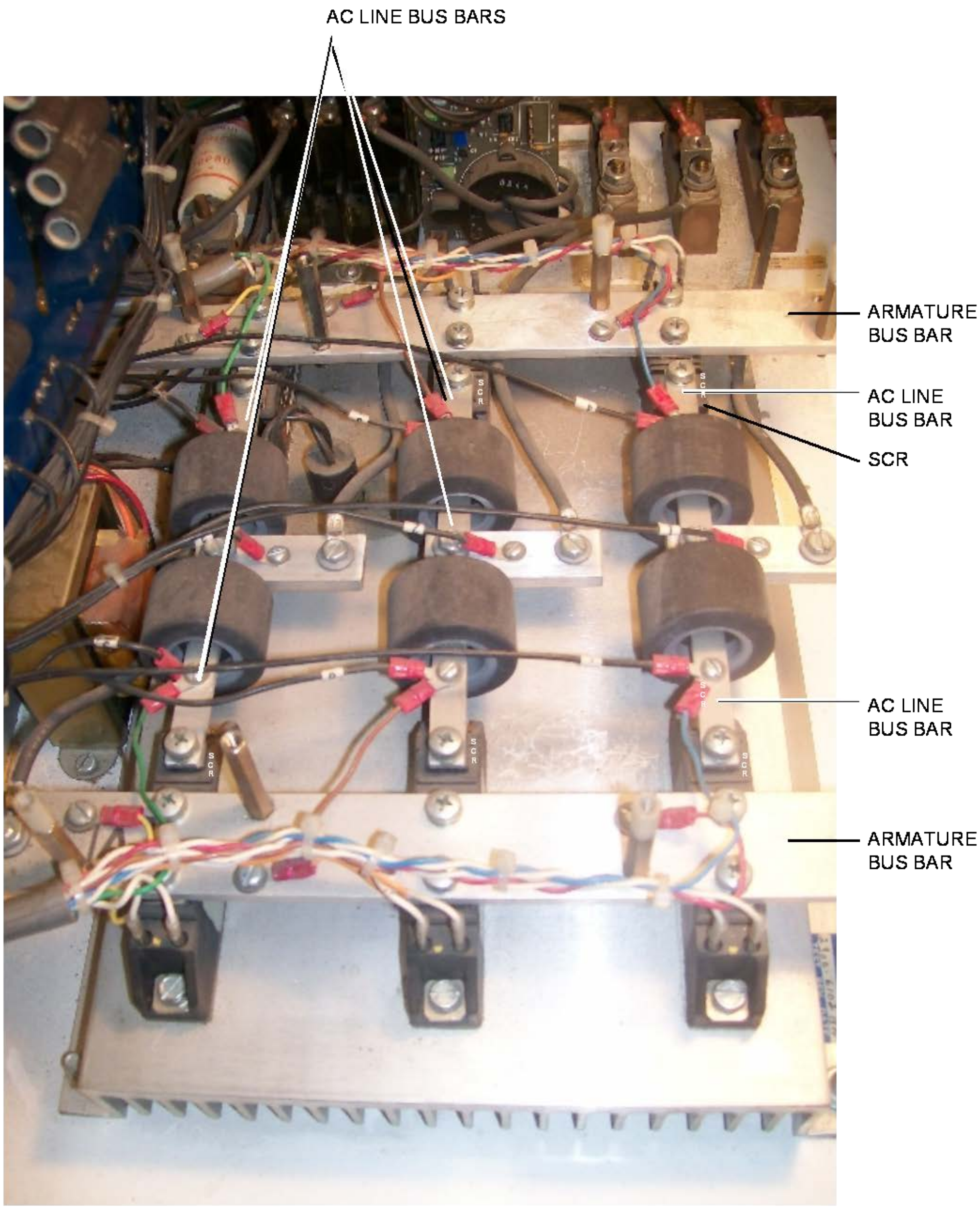



Figure 25: SCRs

# SECTION 7
# ORDERING SPARE PARTS

Recommended spare parts for the ***MELLTRONICS 2300RG.***

### LINE/LEG FUSES (QTY 3)

| CONTROL | RATING | PART NUMBER |
|---|---|---|
| 232-8100 | 60A, 500V | 20-003-060 |
| 232-8101 | 125A, 500V | 20-003-125 |
| 232-8101 | 200A, 500V | 20-003-200 |
| 232-8103 | 400A, 500V | 20-003-400 |

### FIELD REGULATOR/ POWER SUPPLY FUSES (QTY 3)

| CONTROL | RATING | PART NUMBER |
|---|---|---|
| ALL | 15A, 600V (KTK) | 20-005-150 |

### CONTROL PC BOARDS (QTY 1)

| PC BOARD | CONTROL | PART NUMBER |
|---|---|---|
| **Main | All | 232-4101 |
| **Firing Circuit | All | 232-4105 |
| Interconnect | All | 232-4115 |
| Field Regulator | All | 232-4135 |
| | 232-8100 | 232-4120 |
| Current | 232-8101 | 232-4121 |
| Feedback | 232-810 | 232-4122 |
| | 2232-8103 | 232-4123 |

**These control PC boards are supplied with Parts Kit 'B' for each model of the ***MELLTRONICS 2300RG***

For customer convenience the most common components are available in Kit form. When ordering spare parts, please refer to the table below:

**KIT 'A'**

3 Complete set of fuses
1 Complete set of SCRs

**KIT 'B'**

3 Complete sets of fuses
1 Complete set of SCRs
1 main PC board (regulator circuitry)
1 SCR firing circuit PC board (P/N 232-4105)

| CONTROL | KIT'A' PART NUMBER | KIT'B 'PART NUMBER |
|---|---|---|
| 232-8100 | 232-9901 | 232-9902 |
| 232-8101 | 232-9903 | 232-9904 |
| 232-8101 | 232-9905 | 232-9906 |
| 232-8103 | 232-9907 | 232-9908 |

### ARMATURE FUSE

| CONTROL | QTY | RATING | PART NUMBER |
|---|---|---|---|
| 232-8100 | 1 | 80A, 700V | 20-004-080 |
| 232-8101 | 1 | 175A, 700V | 20-004-175 |
| 232-8101 | 1 | 250A, 700V | 20-004-250 |
| 232-8103 | 2 | 250A, 700V | 20-004-250 |

### FIELD DIODES AND SCR (ALL CONTROLLERS)

| COMPONENT | QTY | RATING | PART NUMBER |
|---|---|---|---|
| Diode | 2 | 35A, 1500V | 60-009-002 |
| SCR | 1 | 63A, 1200V | 63-006-001 |

### CONTROL POWER FUSE (QTY 1)*

| CONTROL | QTY | RATING | PART NUMBER |
|---|---|---|---|
| All | 0.25A | 3AG | 20-001-025 |

*Included on Main PCB

# SECTION 8
# APPENDICES

## APPENDIX A

### *MELLTRONICS 2300RG* Main Board Test Points

1. COMMON
2. 2. Ø REFERENCE
3. VELOCITY ERROR OUTPUT
4. RECTILINEARITY OUPUT
5. CURRENT ERROR OUTPUT
6. V ARM FEEDBACK
7. I ARM FEEDBACK
8. EMF TRACKING OUTPUT
9. REVERSE BRIDGE ENABLE
10. FORWARD BRIDGE ENABLE
11. FAULT TRIP CLOCK
12. +15V
13. I ARM FEEDBACK
14. RECTILINEARITY INPUT
15. CONT. CURR. REV. CLAMP INPUT
16. +15V
17. CONT. CURR. FWD CLAMP INPUT
18. –15V
19. RUN SPEED REFERENCE
20. ACCEL/DECEL
21. VELOCITY STABILITY
22. ACCEL/DECEL
23. JOG SPEED REFERENCE
24. .
25. } QUADRANT DISABLE
26. .
27. ACCEL/ DECEL
28. IR COMP INPUT
29. I ARM FEEDBACK
30. NOT USED
31. .
32. .
33. } EXTERNAL SYSTEM ACCESS
34. POINTS 1-8 ON TB-3
35. CONNECTED TO SYSTEM BY
36. JUMPERS JP11-JP18
37. .
38. .
39. –10V
40. +10V
41. RUN COMMAND
42. RUN LATCH

## APPENDIX B

## JUMPER PROGRAMMING TABLE

The use of programming jumpers has been incorporated into the control's circuitry to increase its adaptability to diverse applications. These jumpers are located with the circuitry of the main control board

Table 5: Jumper Programming Table

### PROGRAMMING JUMPERS AND THEIR BASIC FUNCTIONS

| | |
|---|---|
| JP1 | Jumper for 1K ohm input (cut for 10K ohm input) to velocity error amplifier |
| JP1A | Jumper to A for 8100, 8101, 8103. Jumper to B for 8102 |
| JP1C | Jumper for anti-plug bypass |
| JP2 | Jumper for 0.2 to 4 seconds (cut for 2 to 30 seconds) ACCEL/DECEL times |
| JP3 | Jumper to D for 10% current (jumper to E for none) in disabled direction |
| JP4 | Jumper to A to disable reverse direction. Jumper to B for full operation. Jumper to C to disable forward direction. |
| JP4A | Cut for external input to current error amplifier that is controllable by internal current limit circuit (input becomes TB3,pin 8) |
| JP5 | Cut for external input to current error amplifier (input becomes TB3, pin 1) |
| JP6 | Jumper to +IR for positive (jumper to -IR for negative ) IR compensation |
| JP7 | Jumper for 200% (cut for 150%) current limit |
| JP7A | Cut for current rate feedback (jumper for normal IR compensation) |
| JP8 | Cut for 240VDC motors (jumper for 500VDC motors) |
| JP9 | Jumper to defeat field loss (cut for field loss function) |

**The jumpers listed below are located at the customer strip TB1:**

| | |
|---|---|
| 8 AND 9 | Jumper for maintained jog (thread mode) |
| 24 TO 25 | Jumper to connect ACCEL/DECEL output to velocity error amplifier |
| 26 TO 28 | Jumper for current regulation (and remove armature feedback jumper) |

**The jumpers listed below select the type and the scaling of the voltage feedback and are located on terminal strip TB2**

| | |
|---|---|
| 1 TO 2 (LO) | Tachometer feedback range of 65 to 130 Volts (at maximum RPM) |
| 2 TO 3 (MED) | Tachometer feedback range of 94 to 188 Volts (at maximum RPM) |
| 3 TO 4 (HI) | Tachometer feedback range of 131 to 262 Volts (at maximum RPM) |
| 4 TO 5 (ARM) | Jumper for armature feedback |

ADDITIONAL JUMPER PROGRAMMING

In addition to jumper programming on the main control board, there are also six jumpers (JP1, JP2, JP3, JP3A, JP4 and JP5) on the firing circuit board. JP1-5 should normally be installed for 60Hz operation but should be removed for 50Hz operation. JP3A when cut, will disable the high AC line frequency detector.

There are two jumpers located on the interconnected board, which are used to program the input line voltage on the control chassis. For 480VAC input, jumper B to C and D to C. For 240VAC, jumper B to E and D to A.

There are two jumpers on the field supply board. A jumper for D1 to either L3-B or L3-C determines field voltage range. Jumper JP1, when installed, selects feedback for a 150 Volt field. Normal connections are L3-B and JP1 removed.

# APPENDIX C

## CONTROL LIGHT INDICATORS

There are ten (10) LED's on the Main Control Board. These LED's indicate the various conditions that may exist in the control. These LED's and their meanings when lit are listed below:

| LED | INDICATES (WHEN LIT) |
|---|---|
| AC | AC input power is applied to the control |
| DC | The control is active |
| RUN | The control is in the RUN mode |
| JOG | The control Is in the JOG mode |
| CURR LIM | The current reference is greater than the current limit level |
| FIELD LOSS | Field current is too low |
| HEAT SINK THERM | The control's heatsink is too hot |
| PHASE LOSS | There was an input power line loss or dip |
| IOC | A very large current pulse was detected |
| DC OVRLD | The armature current is too great or is imbalanced |
| AP | Anti-plug circuit is in operation |

# APPENDIX D

## Terminal Block Reference

**TB1**

| | |
|---|---|
| **1** | 120 VAC CONTROL POWER |
| **2** | 120VAC CONTROL POWER-FUSE SIDE |
| **3** | 120 VAC SWITCHED THROUGH CRFT CONTACT FOR OPERATOR DEVICES |
| **4** | MOTOR THERMAL CONNECTION |
| **5** | NC STOP PUSH-BUTTON |
| **6** | NO RUN PUSH-BUTTON |
| **7** | JOG CONTROL |
| **8** | NO JOG PUSH-BUTTON |
| **9** | MAINTAINED JOG |
| **10** | N.O CRFT CONTACT |
| **11** | FORM C FAULT TRIP RELAY CONTACT |
| **12** | NC CRFT CONTACT |
| **13** | FAST CONTACTOR DROP-OUT OPTION |
| **14** | M CONTACTOR AUX & COIL |
| **15** | 8102 CONTACTOR CONNECTION |
| **16** | M CONTACTOR COIL |
| **17** | M CONTACTOR AUX |
| **18** | NO RUN/JOG CONTACT (FROM MB) |
| **19** | NO RUN/JOG CONTACT (FROM MB) |
| **20** | -10VDC |
| **21** | SPEED REFERENCE INPUT |
| **22** | +10VDC |
| **23** | COMMON |
| **24** | ACCEL/DECEL CIRCUIT OUTPUT |
| **25** | VELOCITY ERROR AMPLIFIER INPUT |
| **26** | CURRENT REGULATION |
| **27** | JOG REFERENCE INPUT |
| **28** | CURRENT ERROR AMPLIFIER INPUT |
| **29** | DC TACHOMETER INPUT- |
| **30** | DC TACHOMETER INPUT+ |
| **31** | REMOTE CURRENT LIMIT INPUT |

**TB-2**

| | |
|---|---|
| **1** | TACH VOLTAGE SCALING INPUT |
| **2** | LOW TACH VOLTAGE SELECTION |
| **3** | MEDIUM TACH VOLTAGE SELECTION |
| **4** | HIGH TACH VOLTAGE SELECTION |
| **5** | ARMATURE VOLTAGE FEEDBACK SELECTION |
| **6** | +24VDC |
| **7** | -24VDC |
| **8** | HORSEPOWER SELECTION SHUNT |
| **9** | HORSEPOWER SELECTION SHUNT |
| **10** | COMMON |

**TB-7**

| | |
|---|---|
| **1** | AMMETER SCALING RESISTANCE |
| **2** | OPTIONAL AMMETER CONNECTION |
| **3** | OPTIONAL AMMETER CONNECTION |
| **4** | AMMETER SCALING RESISTANCE |

# SECTION 9
# SUPPLEMENTAL TECHNICAL INFORMATION

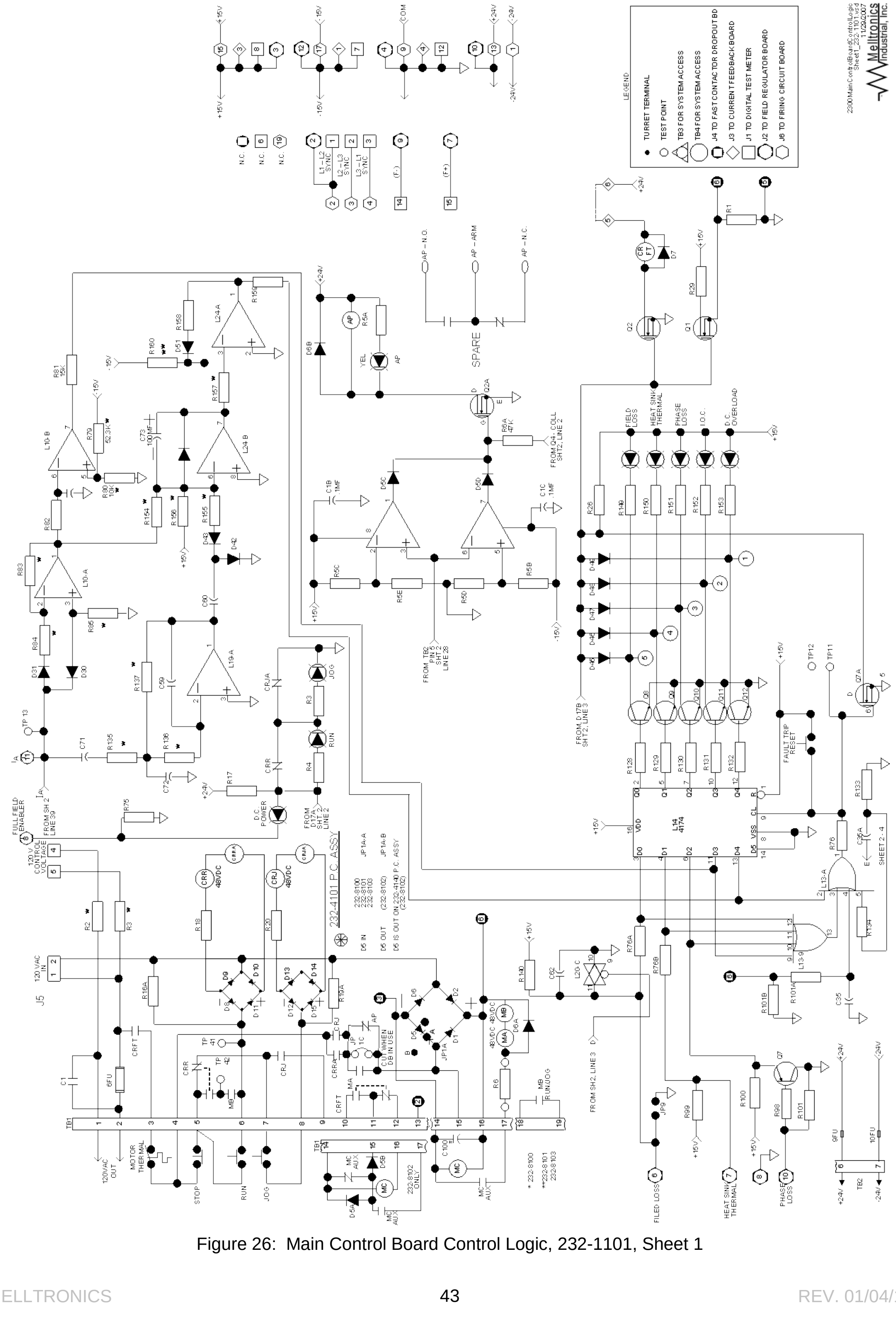


Figure 26: Main Control Board Control Logic, 232-1101, Sheet 1

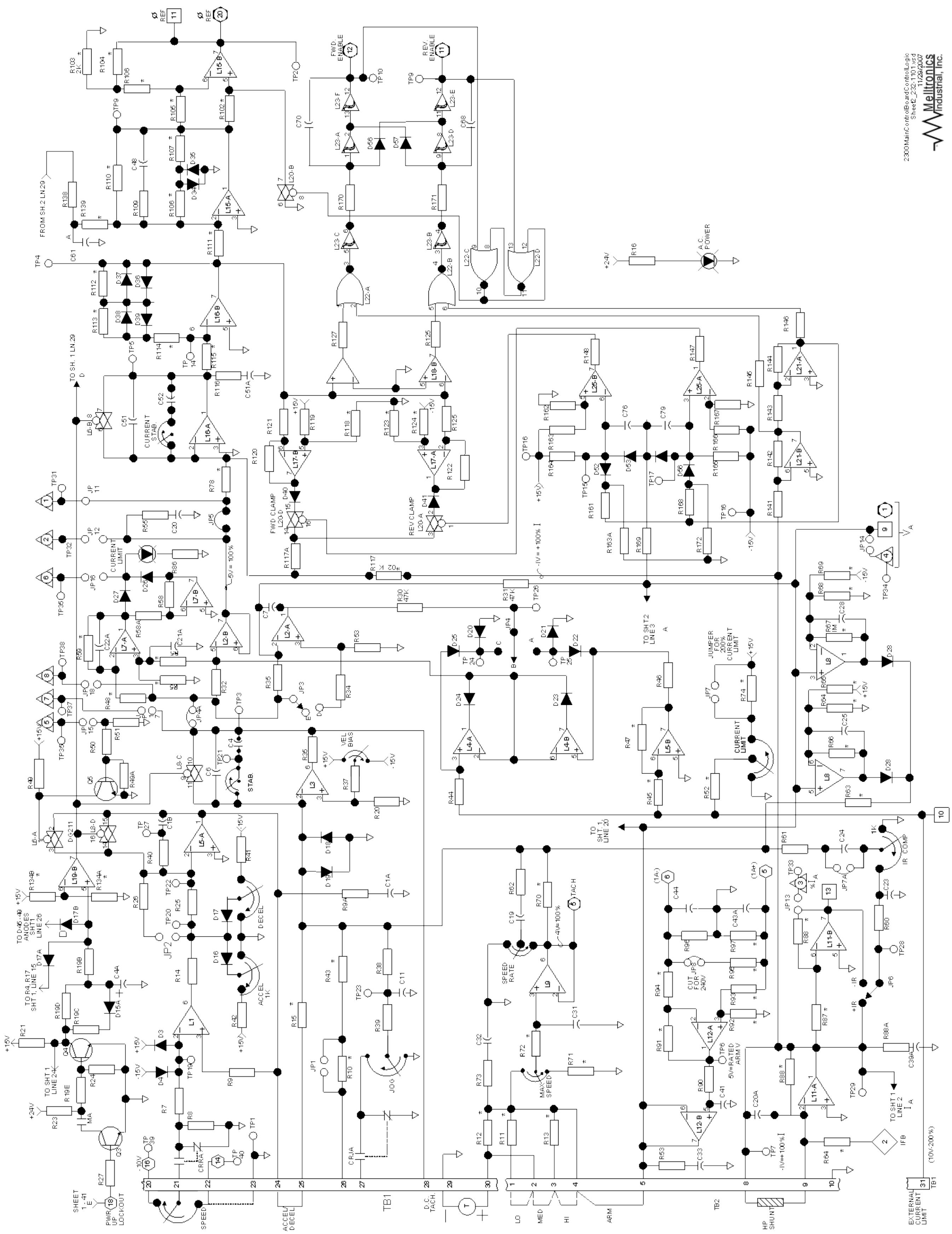


Figure 27: Main Control Board Control Logic, 232-1101, Sheet 2

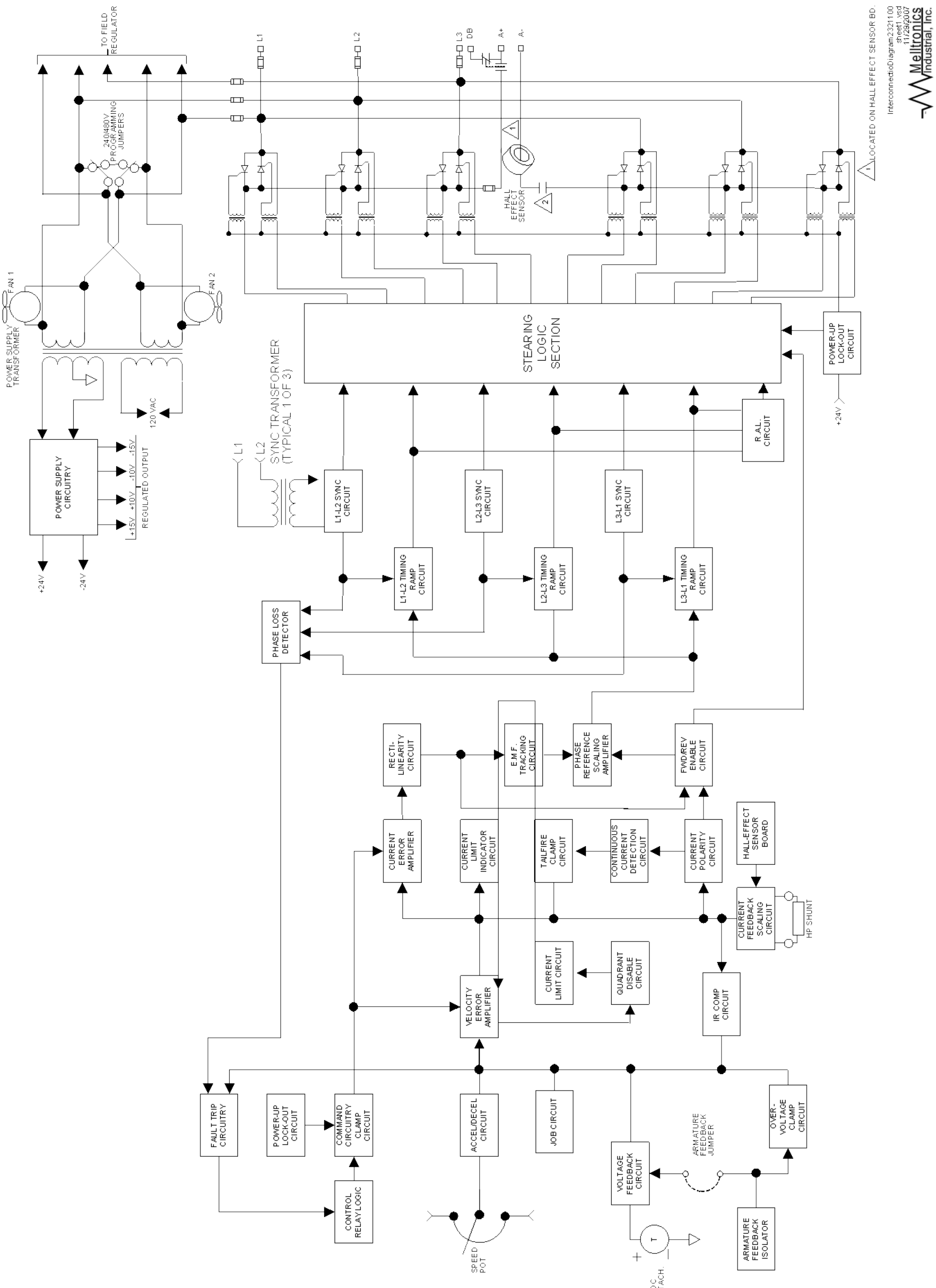



Figure 28: Interconnect Diagram, 232-1100-I, Sheet 1

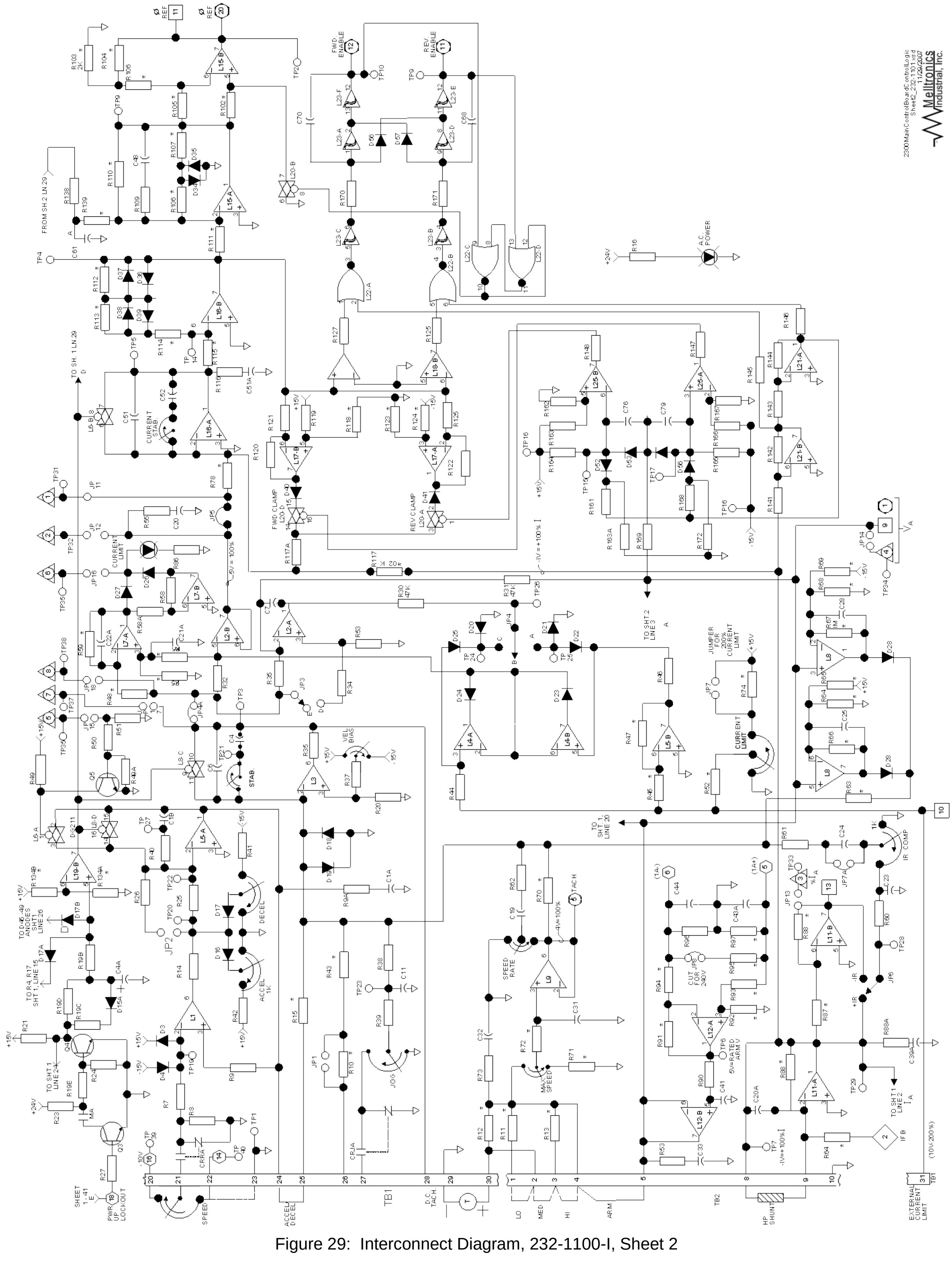


Figure 29: Interconnect Diagram, 232-1100-I, Sheet 2

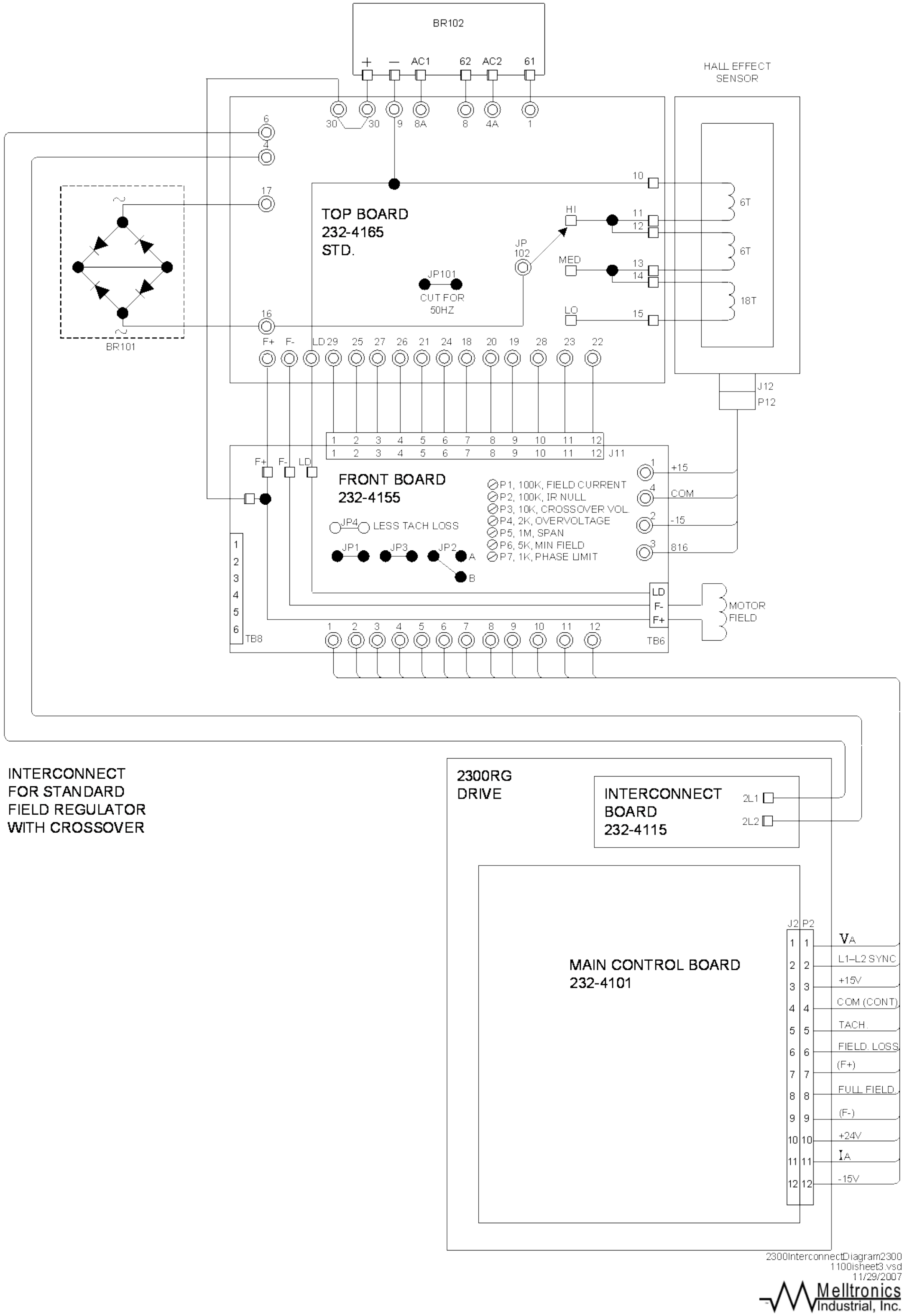



Figure 30: Interconnect Diagram, 232-1100-I, Sheet 3

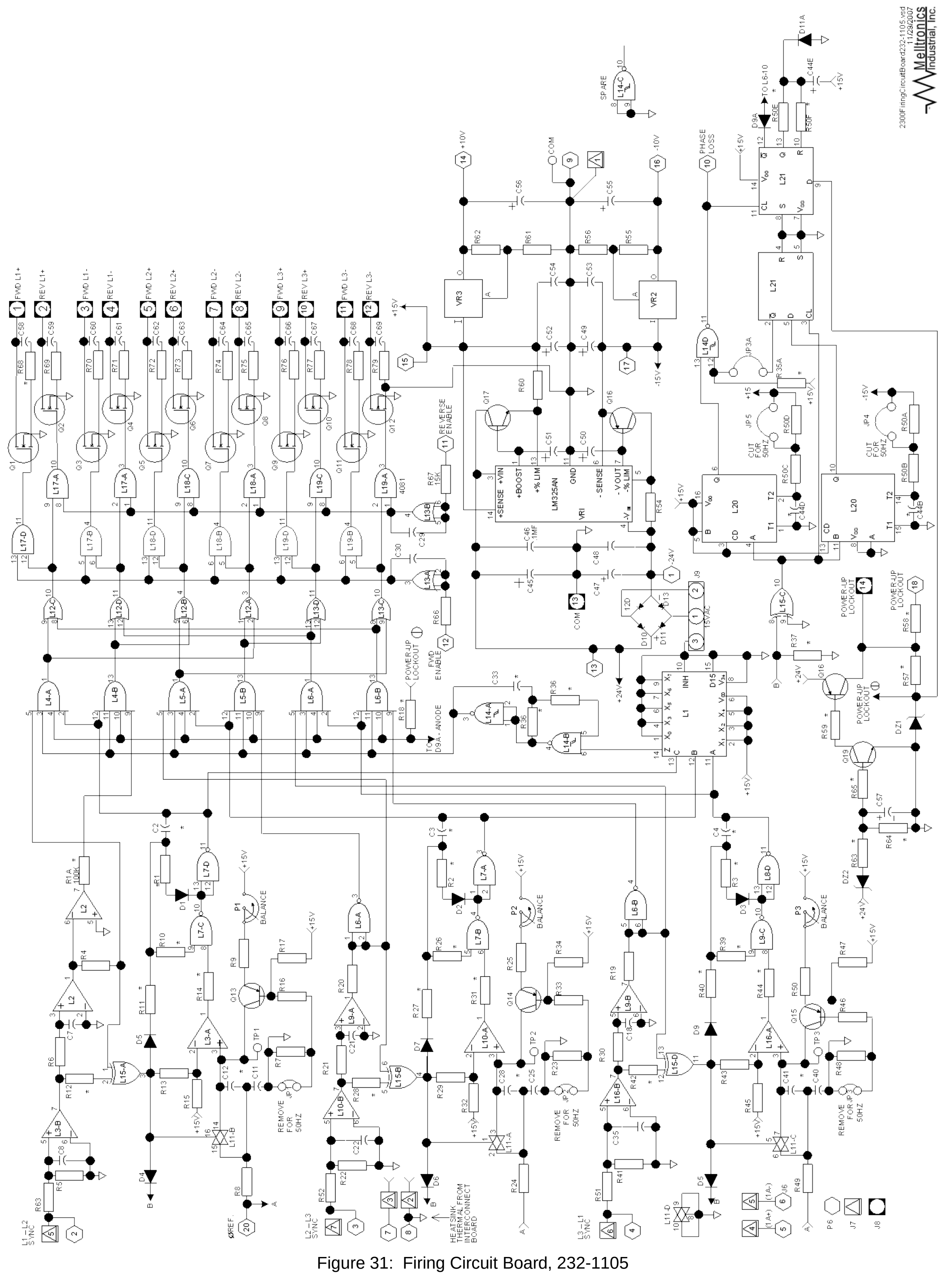


Figure 31:  Firing Circuit Board, 232-1105

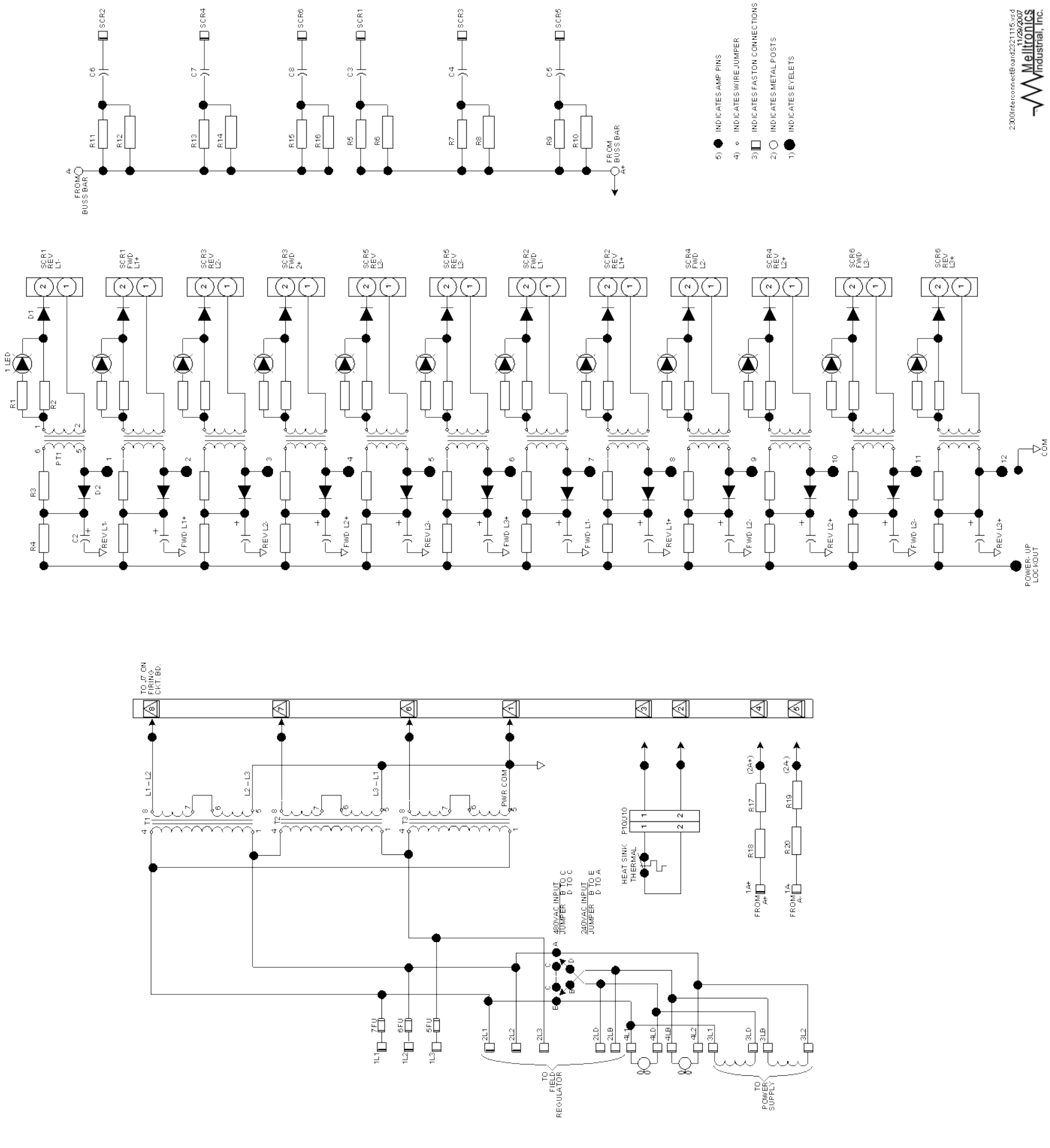


Figure 32:  Interconnect Board, 232-1115

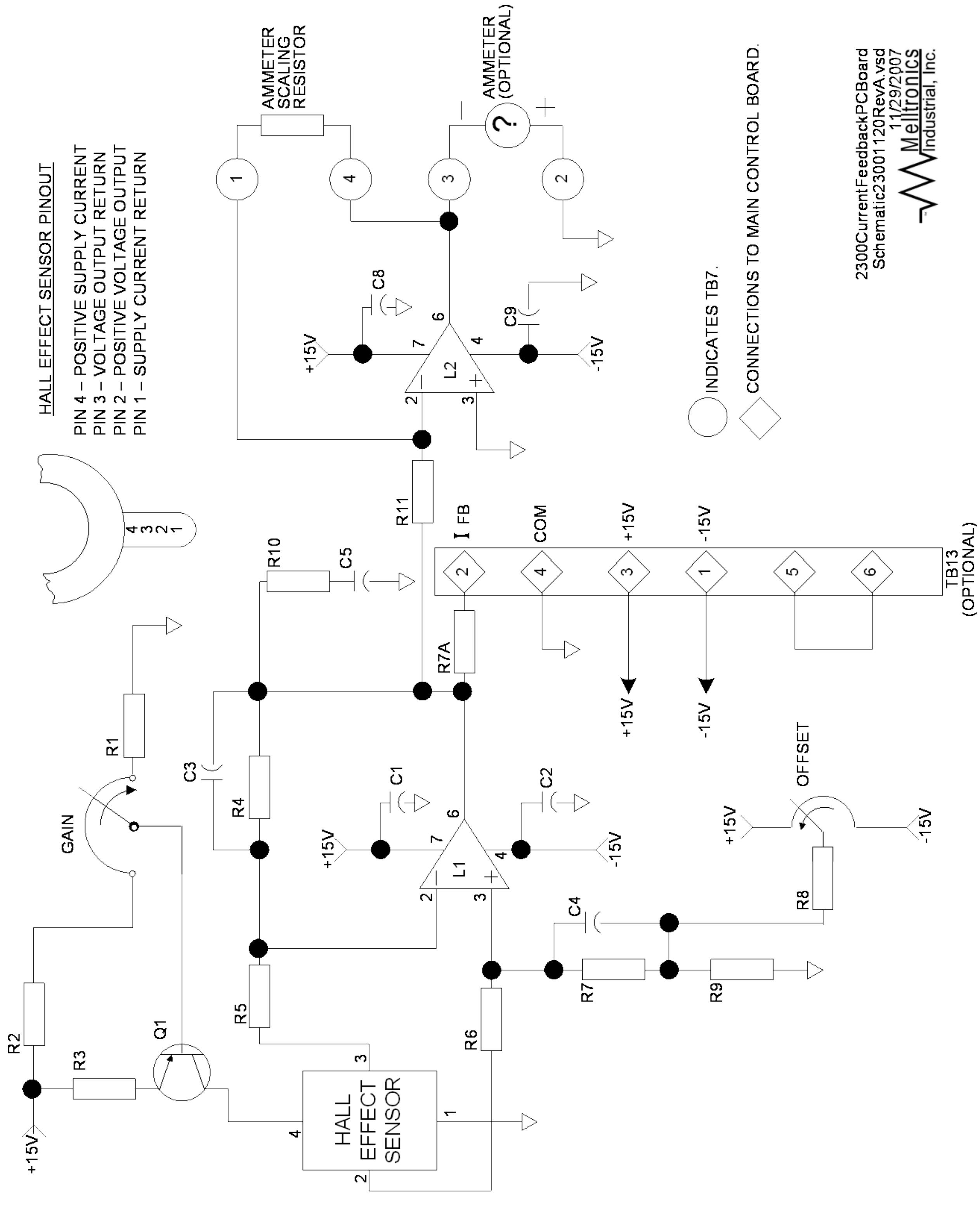



Figure 33:  Current Feedback PC Board Schematic, 232-1120

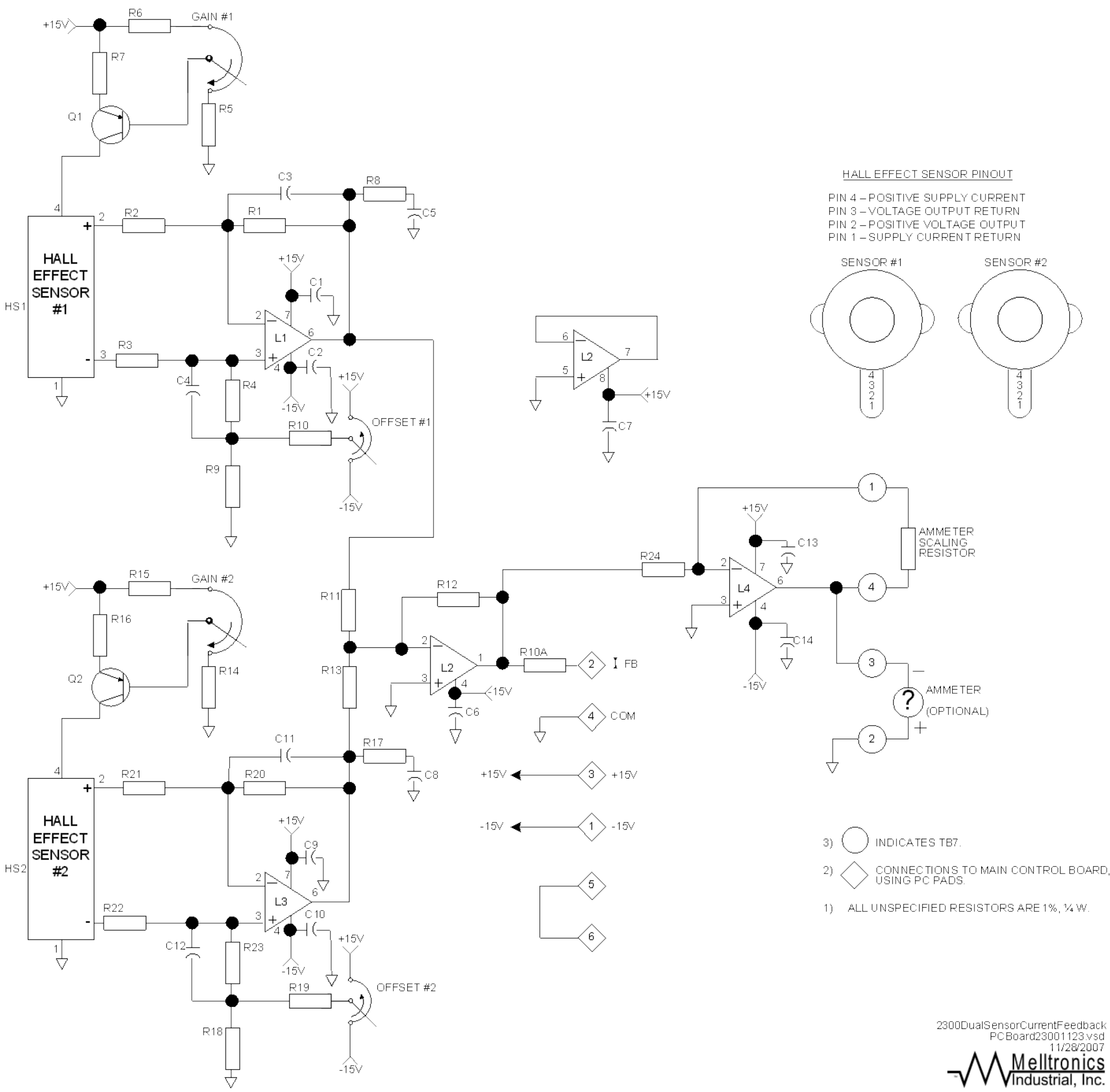



Figure 34: Dual Sensor Current Feedback PC Board Schematic, 232-1123

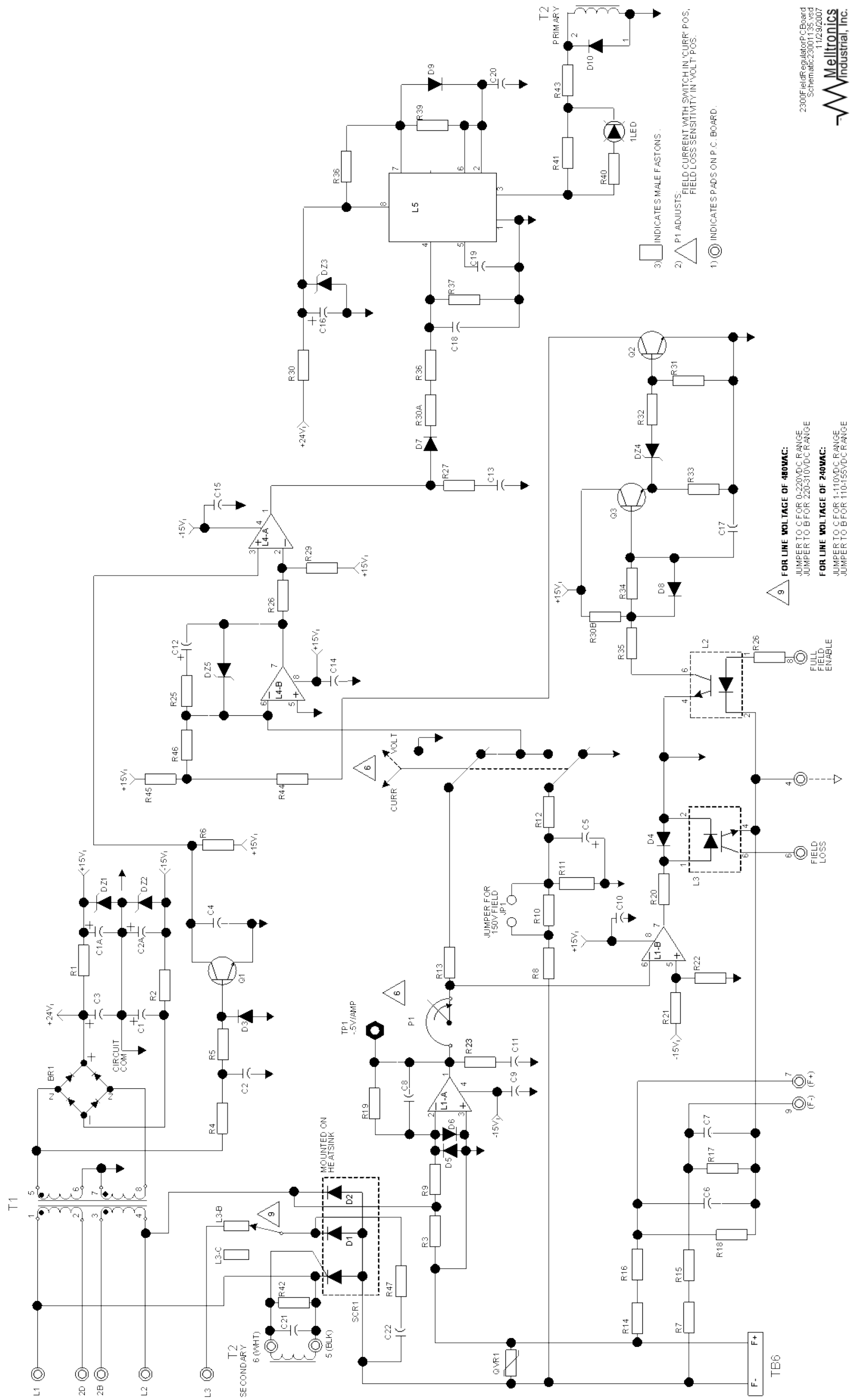


Figure 35: Field Regulator PC Board Schematic, 232-1135

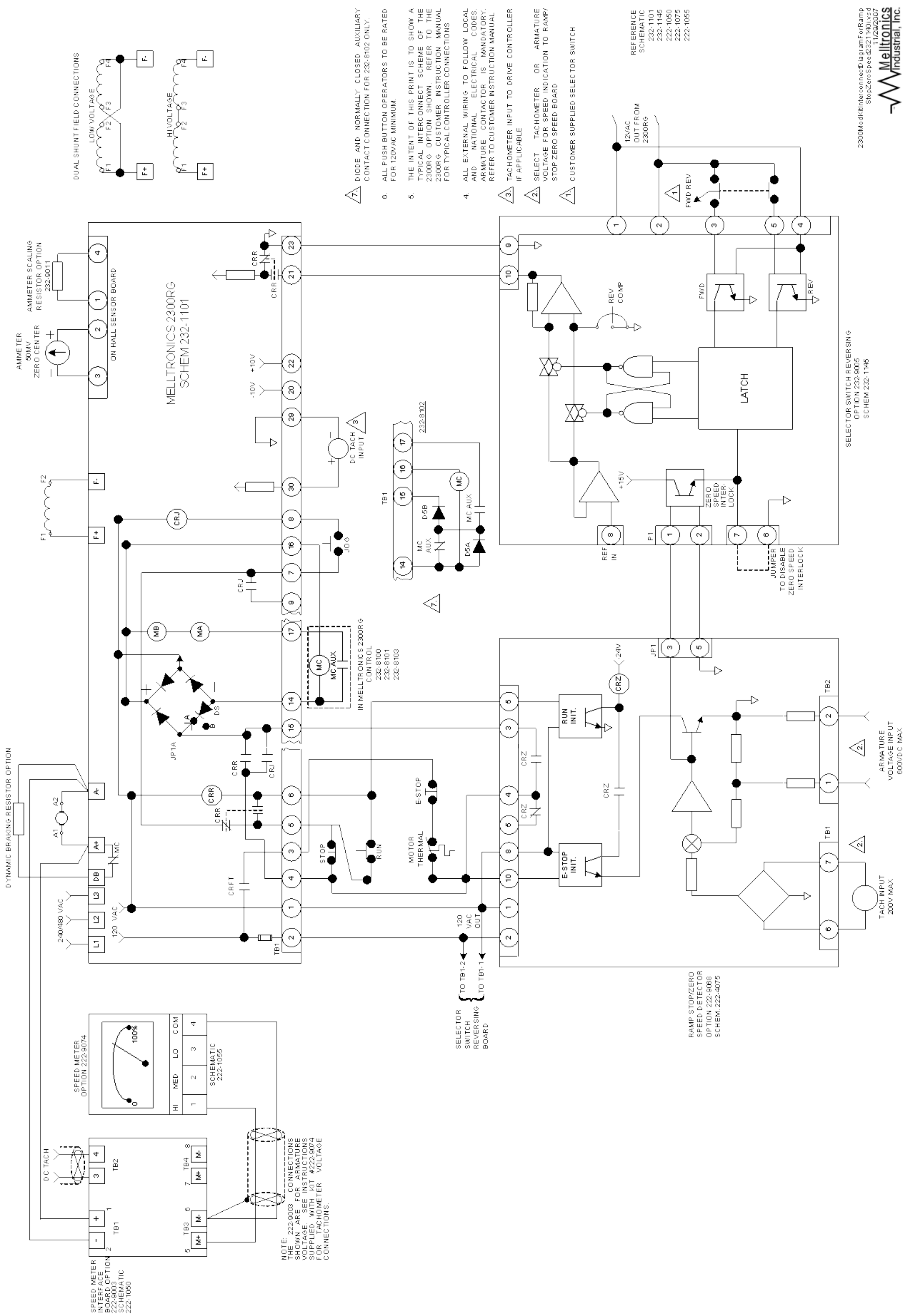



Figure 36: Modification Kit Interconnect Diagram, Ramp/ Stop Zero Speed, 232-1140

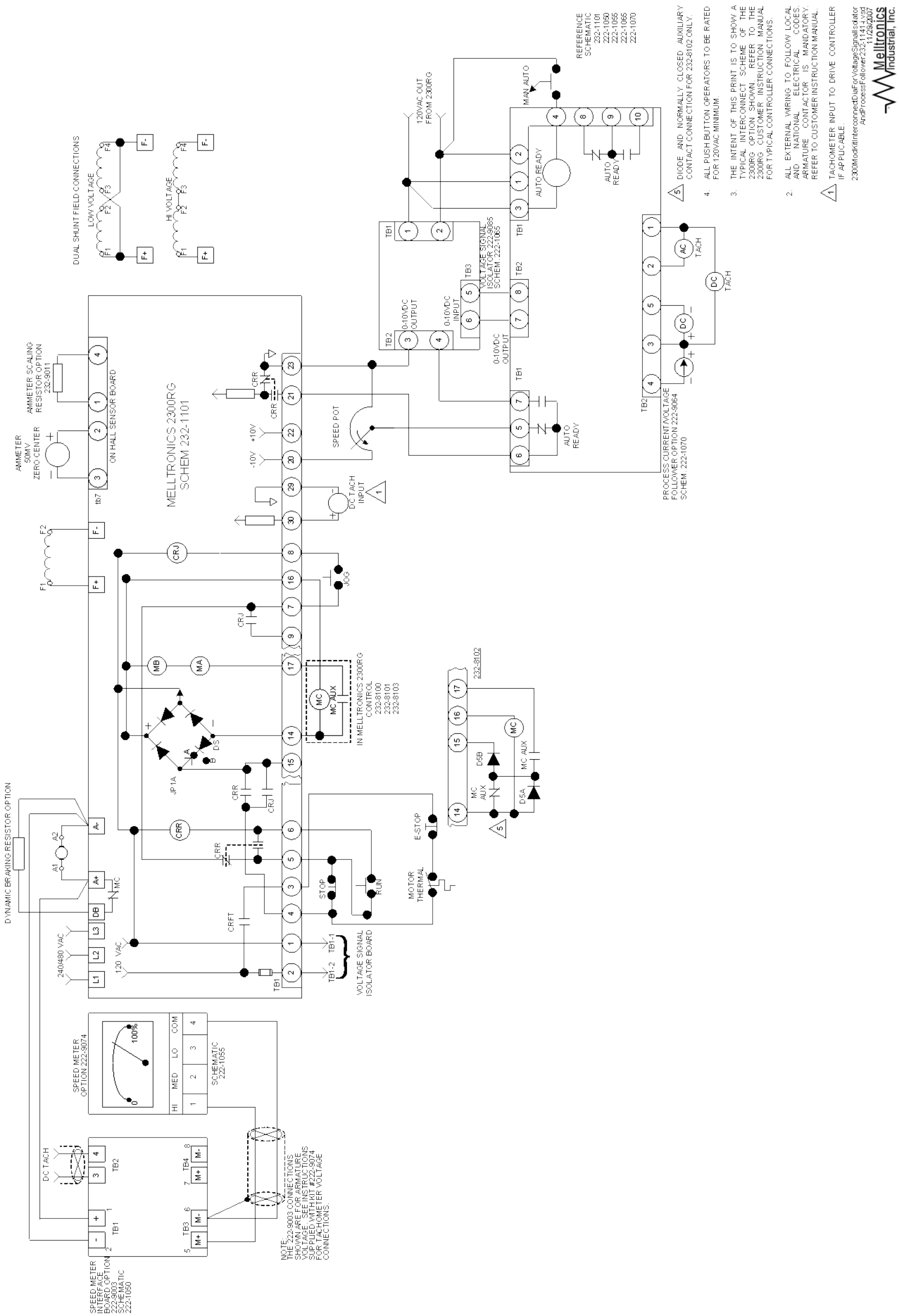



Figure 37: Mod. Kit Inter. Diag, Voltage Signal Isolator & Process Follower, 232-1141-I

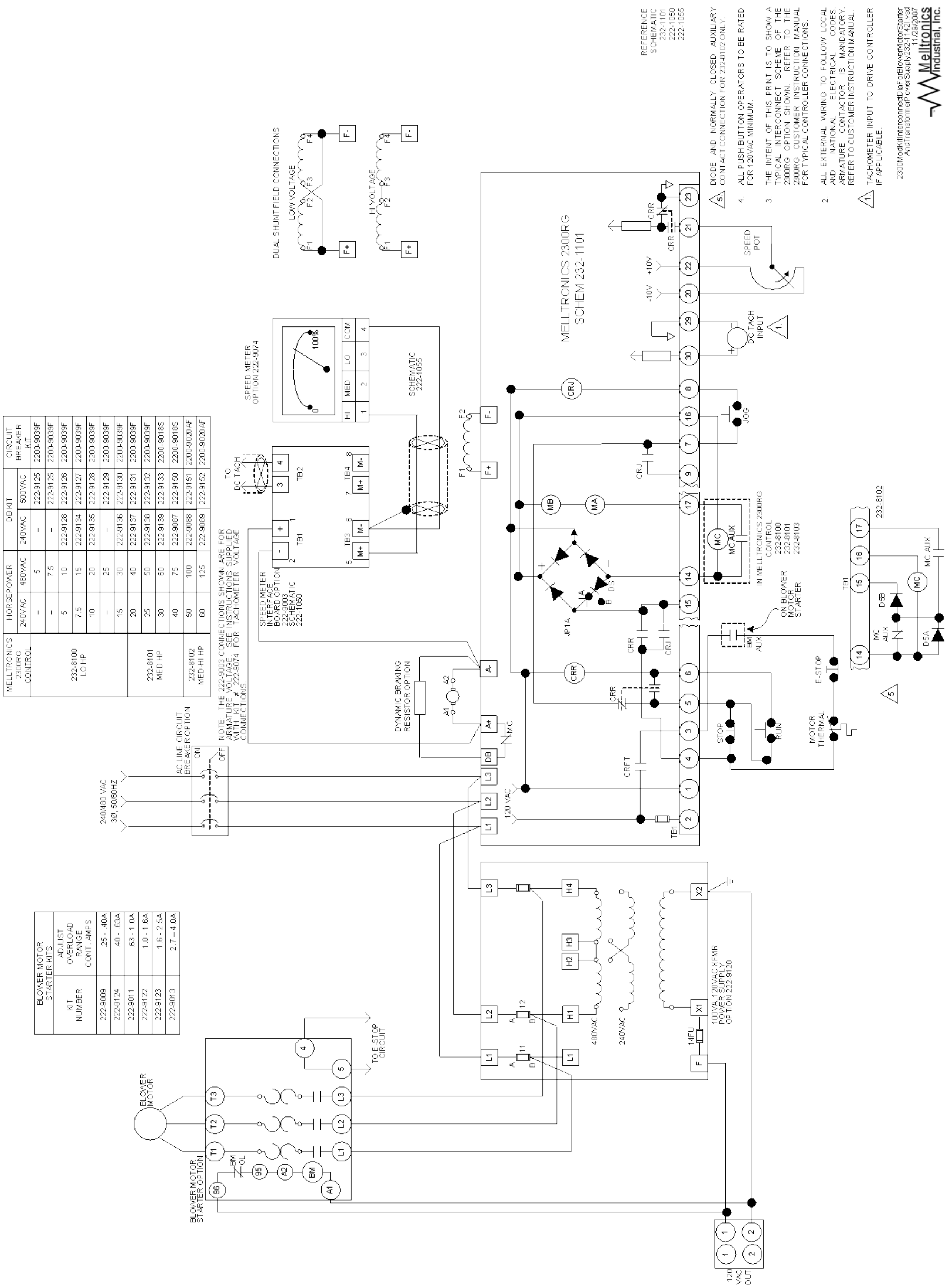



Figure 38: Mod. Kit Inter. Diag, Blower Motor Starter & Transformer Power Supply, 232-1142-I

## REVISION TABLE

| REV | DATE | DESCRIPTION | REVISIONS |
|---|---|---|---|
| NONE | 11/30/2007 | 1ST RELEASE BY MELLTRONICS | NONE |
| A | 6/1/2009 | 2nd RELEASE BY MELLTRONICS | SPELLING & FORMATING<br>Addition of Appendix C |
| B | 1/4/2018 | 3RD RELEASE BY MELLTRONICS | Correct HP shunt location FIG. 23<br>FORMATING |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**NOTES**

**NOTES:**

# SECTION 10
# WARRANTY

**MELLTRONICS** warrants to the Buyer whom purchases for use and not for resale that the equipment described in this instruction manual is sold in accordance with published specifications or the specifications agreed to in writing at the time of sale. Melltronics further warrants that such goods are free of defects in material and workmanship.

The warranty shall apply for a period of twelve months (12) from date of purchase, not to exceed eighteen months (18) from the date of manufacture.

If the goods fail to perform to Melltronics specifications as outlined in the warranty, then Buyer should contact Melltronics to obtain a “Material Return Authorization” (MRA), prepare the goods for shipment and return the goods to Melltronics for repair or replacement at Melltronics option. Buyer will bear all costs of transportation to and from Melltronics factory, risk of loss for goods not at Melltronics factory and any cost required to remove or prepare the goods for shipment to the repair facility, and to reinstall equipment subsequent to repair.

This warranty is effective only if written notification of any claim under this warranty is received by Melltronics at the address indicated below within thirty-days (30) from recognition of defect by Buyer.

The above indicates the full extent of Melltronics liability under this warranty. Melltronics specifically disclaims any liability for: (a) damage or failure due to improper use or installation; (b) damages in shipment; (c) damage or failure due to abnormal operation conditions of load, temperature, altitude or atmosphere whether intentional or unintentional; (d) non-authorized service, repair, modification, inspection, removal, transportation or installation; (e) misapplication or misuse, or; (f) consequential damages arising out of the use, operation or maintenance of the goods.

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