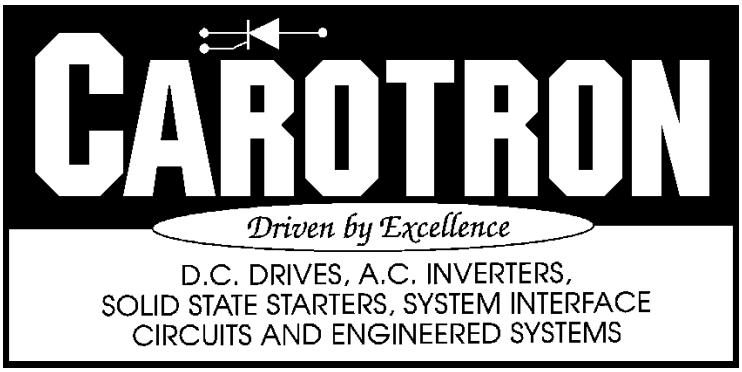
P22194-1
DC DRIVE

Instruction Manual



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1 General Description

The P22194-1 non-regenerative D.C. motor control provides full range speed and torque control of 5-20 HP D.C. motors rated for NEMA type "D" power supplies. It is rated for operation on 230 VAC line supplies and will supply a variable armature voltage up to 240 VDC and a selectable fixed field supply of 150, 240, or 300 VDC.

A semiconductor fuse is provided for armature protection. Also provided is fuse protection for the 230 VAC control voltage input.

Standard logic interfaces with customer supplied operators for Start, Stop, Jog, Override Stop, and Reset functions.

Features

- Insensitive to phase rotation of A.C. input.
- Full 10 ampere rated field supply, 150/240/300 VDC selectable.
- Current transformers for isolated armature current sensing.
- High impedance isolation for armature and line voltage sensing.
- Electrically isolated power modules rated at 1400 volts PIV and 1000 volts/microsecond dv/dt.
- Semiconductor armature fuse for power circuit protection.
- Latching Fault logic provides safety shutdown with form "C" contact output and LED indicators for Low Line/Phase Loss, Field Loss, and Over Current Trip conditions.
- Interlock logic with form “C” contact output and LED indicators for Current Limit and Motor Output.
- 5 jumper selectable armature current (HP) ranges to match motor rated armature current.
- Independently adjustable linear acceleration and deceleration for Run function with range of 0.5 to 30 seconds.
- Adjustable linear acceleration/deceleration for Jog function with range of 0.5 to 30 seconds.
- Speed feedback is jumper selectable for Armature Voltage or D.C. Tachometer voltage (21 VDC/1000 RPM).
- D.C. Tachometer voltage input is insensitive to polarity.
- Inner current loop type control circuit for responsive and precise control of motor speed and torque.
- Zero speed logic for controlled ramp-to-stop.
- Additional LEDs for operating status: Power On, Run, Jog, Current Mode, Armature Feedback, Motor Output, O-Stop.

2 Specifications

2.1 Electrical Specifications

A.C. Line Input
- 195 to 260 VAC, 3 phase, 50/60 Hz ± 2 Hz, 65 Amp Full Load Max

Armature Output
- 0 to 240 VDC, 72 Amp Full Load Max / 90 Amp Overload Max

Field Output
- 150/240/300 VDC, 10 Amp max

Accessory Outputs
- Power Supplies
  + 10 VDC @ 5 mA Run Speed pot reference supply
  + 10 VDC @ 5 mA Jog Speed pot reference supply
  6.4 VDC @ 5 mA Torque Limit pot reference supply
- Fault relay output : SPDT, 3 Amp @ 30 VDC /120 VAC
- Current Mode relay output : SPDT, 3 Amp @ 30 VDC /120 VAC
- Motor relay output : SPDT, 3 Amp @ 30 VDC /120 VAC

Horsepower Range
- 5 to 20 HP @ 240 VDC

Speed Regulation
- Armature Feedback : ± 1% of base speed
- Tachometer Feedback : ± 0.5% of base speed

Torque Regulation
- ± 2% of range selected

Speed Range
- 20:1 motor dependent

Temperature Range
- Chassis : 0 to 50 degrees C

Control Board Adjustments
- P1 Integral Null
- P2 Slope
- P3 IR Comp
- P4 I (Current) Integral
- P5 I (Current) Proportional
- P6 Max Jog Speed
- P7 Jog Accel/Decel
- P8 Max Run Speed
- P9 Over Current
- P10 Min Run Speed
- P11 Velocity Proportional
- P12 Start Accel
- P13 Stop Decel
- P14 Max Torque
- P15 Velocity Integral

2.2 Physical Specifications

Refer to Drawing D11980 for size and mounting dimensions. The P22194-1 control provides clearance holes for 1/4 inch mounting hardware. Shipping weight is 35 lbs.

3 General Installation

3.1 Control Installation

The P22194-1 motor control must be mounted in an upright position in an area that will permit adequate airflow for cooling and ready access for making connections and for servicing.

Enclosures should be sized to provide adequate surface area for dissipating heat or provided with forced ventilation with outside air from a duct system or enclosure fan. They should be mounted to a cool surface not exposed to heat generated by nearby equipment.

Excess ambient temperatures within enclosures can reduce the life expectancy of electronic components. Contact CAROTRON for assistance in sizing enclosures for particular horsepower ratings.

3.2 Wiring Guidelines

To prevent electrical interference and to minimize start-up problems, adhere to the following guidelines and the NEC.

Make no connections to ground other than the designated grounding screw located in the upper left corner of the drive.

Use fully insulated and shielded cable for all signal wiring. This includes all potentiometer (pot) and tachometer wires. The shield should be connected at one end only to circuit common at terminals 15, 18, 23, or 26. The other end of the shield should be clipped and insulated to prevent the possibility of accidental grounding.

Signal level wiring such as listed above should be routed separately from high level wiring such as armature, field, operator control and relay control wiring. When these two types of wire must cross, they should cross at right angles to each other.

Any relay, contactor, starter, solenoid or electro-mechanical device located in close proximity to or connected to the same line supply as the motor control should have a transient suppression device such as an MOV or R-C snubber connected in parallel with its coil. The suppressor should have short leads and should be connected as close to the coil as possible.

4 Terminal Connections and Functions

4.1 A.C. Power Connections and Fusing

Terminals **L1, L2,** and **L3** are the AC line input terminals for the drive. The line must be fused per code requirements. The 100 Amp semiconductor fuse provides protection for the armature circuit only and is sized according to the armature current rating of the control.

Protection is provided for the power supplies by a ½ ampere, 250 VAC fuse on the POWER/TRIGGER BOARD.

Refer to Drawing C11977 for AC power connections. Refer to Drawing D11978 for power component location.

NOTE : Carotron recommends the use of a three phase DIT (drive isolation transformer). While the P22194-1 control does not require this transformer for proper operation, it can be helpful in reducing the effects of line transients on this control and generated by this control on other products and can provide fault current limiting in the event of severe motor or control failure.

TABLE 1: THREE PHASE LINE CURRENT AND TRANSFORMER RATINGS

MOTOR HP	ARM VOLTS	APPROXIMATE FULL LOAD LINE AMPS	3 PHASE DIT KVA RATING
5	240	18	7.5
7.5	240	26	11
10	240	34	14
15	240	50	20
20	240	65	27

Note: TABLE 1 is intended to be a general guide for sizing the AC line supply transformer and wiring.

4.2 Motor Connections

Refer to Drawing C11977 for motor connections.

Field

Most motor field circuits consist of two windings that are connected in parallel for 150 VDC operation or in series for 300 VDC operation. Refer to FIGURE 2 for typical connections to Field Terminals **F+1, F+2,** and **F-**. The winding leads are individually marked and have a polarity that must be observed for proper and safe operation. Since direction of rotation is controlled by field polarity as well as armature polarity, it is sometimes more convenient to use the smaller field leads when making corrections to the direction of rotation during initial installation. An energized field should

never be switched by relay, contactor, switch or any other manual or electro-mechanical device.

The Carotron P22194-1 motor control is designed to sense field current and will indicate an open circuit in the field windings or wiring by initiating a FIELD LOSS fault condition.

Armature

The armature leads are usually the highest current wires associated with the drive and warrant special attention to sizing based on current rating as well as length of run. Extra care should be used where terminations and splices are made. Refer to TABLE 2 for typical armature voltage, current, contactor, and dynamic braking resistor ratings.

Drawing C11977 shows the armature, contactor and brake resistor connections to the **A+** and **A-** terminals.

Note : When present, the Series field winding (S1 and S2) is placed in series with the armature leads. The series field winding polarity must be kept at the same polarity as the shunt field winding, i.e. F1 and S1 the same, F2 or F4 and S2 the same.

Motor Thermostat

Most motors include "J" or "P" leads that connect to an internal normally closed thermostat. Connecting the thermostat in series with the O-Stop circuit at Terminal 12 as shown in Drawing C11977 will allow a motor over-temperature condition to shut down the control as in an O-Stop condition.

TABLE 2: ARMATURE CONTACTOR AND DYNAMIC BRAKE RISISTOR RATING

MOTOR HP	ARM VOLTS	ARM AMPS	CONTACTOR RATING	D.B. RESISTOR RATING
5	240	20	40 Amp	10 Ohms, 300 W
7.5	240	29	40 Amp	5 Ohms, 600 W
10	240	38	40 Amp	4.4 Ohms, 750 W
15	240	55	75 Amp	3 Ohms, 1000 W
20	240	72	75 Amp	2.2 Ohms, 1500 W

4.3 Interlock Connections

Relay contact connections are provided to interface with the Fault, Current Limit, and Motor interlock circuits. Refer to Drawing C11977 for these connections.

TB1 Terminals 1-3 Motor Interlock

The Motor Interlock relay is energized when power is applied and releases when armature voltage is greater than 6% of rated (about 15 VDC). The Motor LED also turns ON at this point.

TB1 Terminals 4-6 Fault Interlock

The Fault Interlock relay is energized when power is applied and releases when a fault condition occurs (Field Loss, Low Line/Phase Loss, or Over Current Trip).

TB1 Terminals 7-9 Current Mode Interlock

The Current Mode Interlock relay is energized when power is applied and during speed control operation. When

the motor current exceeds the level set by the Torque Limit circuit, the control changes to the current control mode. After about one second of current control operation, the relay releases. This one second time delay begins only after any controlled acceleration time due to a start or a speed reference change is completed.

4.4 Operator Connections

Refer to Drawing C11977 for Operator Connections.

TB1 Terminal 10 Run

The drive will start when this terminal is connected to common (terminal 15) provided the O-Stop circuit has been reset and no fault conditions exist. If the Stop circuit (terminal 11) is connected to common, a momentary Run signal will latch the start circuit; the motor will accelerate to the speed selected by the Run Speed potentiometer at the rate determined by the Start Accel adjustment. If the Stop circuit is open, a maintained Run signal is required to start and run the drive.

Operation of the Jog circuit also affects the Run function (see below).

TB1 Terminals 11 Stop

If a momentary Run signal was used to start the drive, then a momentary opening of the Stop circuit will decelerate the motor to zero speed at the rate determined by the Stop Decel adjustment. If either the Run or Jog circuits are maintained closed, the Stop circuit will have no effect.

TB1 Terminals 12 O-Stop

The Override Stop circuit must be closed (connected to common) for the control to operate. If opened during operation, O-Stop will immediately terminate drive operation and the motor will coast to a stop. When O-Stop is reclosed the Reset circuit (Terminal 13) must be closed to resume drive operation.

TB1 Terminal 13 Reset

A momentary closure of the Reset circuit resets the O-Stop function if the O-Stop circuit has been reclosed. If the Reset circuit is connected to common, an automatic reset occurs when the O-Stop circuit is reclosed.

TB1 Terminal 14 Jog

A contact closure between this terminal and common will activate the Jog function, assuming the O-Stop circuit is closed and no fault condition exists. The motor will accelerate to the selected Jog speed at the rate determined by the Jog Accel/Decel adjustment. The Jog circuit does not latch; when the circuit is opened, the motor will decelerate to zero speed at the selected rate.

If the Run circuit is latched when the Jog circuit is closed, the Run function will be released and the motor will ramp to the selected Jog speed. If the Run and Jog circuits are both maintained closed, the larger of the two speed reference signals is selected. If the Run circuit is then opened, the motor will decelerate to the Jog speed (assuming the Jog speed is the lower of the two) at the Run Decel rate.

TB1 Terminal 15 Com

This terminal is the common connection for the above Run, Stop, O-Stop, Reset, and Jog circuits.

4.5 Signal Wiring Connections

All signal level wiring connects to **TB1** on the CONTROL BOARD. Observe the use of shielded cable and other wiring guidelines detailed in Section 3.2. Refer to Drawing C11977.

TB1 Terminals 16, 17, 18 Jog Speed

An external Jog Speed potentiometer, if used, is connected to terminals 16 (CW), 17 (wiper), and 18 (CCW - common). If an external potentiometer is not required, a jumper between terminals 16 and 17 will allow the Jog Speed to be set by internal potentiometer P6, Max Jog Speed (reference section 5.2).

TB1 Terminals 19, 20, 21 Run Speed

An external Run Speed potentiometer is connected to terminals 19 (CW), 20 (wiper), and 21 (CCW). The adjustment range of this signal is determined by internal potentiometers P8, Max Run Speed, and P10, Min Run Speed (reference section 5.2).

TB1 Terminals 22, 23 Tachometer

For DC tachometer feedback connect the 21 VDC /1000 RPM tachometer to terminals 22 and 23. These terminals are not polarity sensitive. The shield should be connected to terminal 23 (common).

TB1 Terminals 24, 25, 26 Torque Limit

An external Torque Limit adjustment potentiometer is connected to terminals 24 (CW), 25 (wiper), and 26 (CCW - common). If an external potentiometer is not required, a jumper between terminals 24 and 25 allows the maximum torque limit to be set by internal potentiometer P14, Max Torque Limit (reference section 5.2).

5 Programming Jumpers

5.1 Programming Jumpers

Programming jumpers J1 through J4 are located on the CONTROL BOARD. Refer to Drawing D11964 for component locations.

J1 OCT

This jumper is associated with internal potentiometer P9, Over Current Trip (reference section 5.2). If the jumper is in the OCT position when the armature current reaches the level set by P9, an Over Current Trip occurs, turning off all power to the motor armature. This condition is indicated by the Over Current LED. The Control Board Reset button must be pressed (or the power turned off momentarily) to reset the drive and allow normal operation. If the jumper is in the $\overline{\text{OCT}}$ position, the drive will not trip and the armature current will be limited to the Over Current Trip level (causing the motor to operate in a constant torque mode). The Fault Interlock relay, K1, will be released in both cases.

J2 Field Loss

With this jumper in the Normal position, motor field current is monitored when the drive is powered; a loss of field current results in a Field Loss fault condition. The circuit is reset by pressing the Control Board Reset button (or by turning power off momentarily). For applications where field current sensing is not appropriate, the jumper must be placed in the Bypass position.

J3 HP Select (reference section 5.2).

The operating range of armature current is determined by the position of this jumper. By selecting the position corresponding to the motor used (5, 7.5, 10, 15, or 20 HP), the limits of the Max Torque Limit and Over Current Trip circuits are properly set.

J4 Velocity Feedback Select

Velocity (speed) feedback can come from either of two sources.

AFB selects armature voltage feedback and must be selected when no tachometer is to be used. Even then it should be selected during initial setup until proper feedback from the tachometer is verified.

TFB is selected when a DC tachometer (21 VDC per 1000 RPM) on the motor being controlled is used for feedback. This is not to be confused with a follower tachometer used on another motor or location to provide a speed reference to the control.

5.2 Adjustment Potentiometers

The CONTROL BOARD potentiometer adjustments are listed in TABLE 3. All potentiometers are multi-turn (20 - 25 turns), screw driver adjust type. Refer to Drawing D11964 for component location.

Note: The description of adjustments is divided into two sections; the first being the more common customer adjustments and the latter those adjustments with more complex functions.

TABLE 3: CONTROL BOARD POTIOMETERS		
BOARD DESIGNATION	ADJUSTMENT NAME	FACTORY SETTING
P1 INT NULL	Integral Null	Full CCW
P2 SLOPE	Slope (or Taper)	Full CCW
P3 IR COMP	IR Compensation	Full CCW
P4 CURRENT INT	Current Integral	10 Turns CW
P5 CURRENT PROP	Current Proportional	10 Turns CW
P6 MAX JOG	Maximum Jog Speed	5% Speed
P7 JOG AC/DC	Jog Mode Accel/Decel	10 Seconds
P8 MAX SPEED	Maximum Run Speed	240 VDC Output
P9 OVER CURRENT TRIP	Over Current Trip	6.4 VDC @ TP15
P10 MIN SPEED	Minimum Run Speed	10% Speed
P11 VELOCITY PROP	Velocity Proportional	5 Turns CW
P12 START ACCEL	Run Mode Acceleration	10 Seconds
P13 STOP DECEL	Run Mode Deceleration	5 Seconds
P14 MAX TORQUE	Maximum Torque Limit	-4.3 V @ TB1-24
P15 VELOCITY INT	Velocity Intergral	10 Turns CW

5.2.1 Common Customer Adjustments

P6 Max Jog

The Max Jog pot sets the maximum range of the external Jog Speed pot. If no external pot is used and a jumper is connected to TB1-16 and 17, the Max Jog pot sets the drive jog speed. The range of adjustment is from 0 to 100% of base speed; clockwise rotation increases the speed.

P7 JOG AC/DC

The Jog AC/DC pot controls the acceleration and deceleration times in the Jog mode. It is adjustable from ½ to 30 seconds for a 0 to 100% transition; clockwise rotation increases the time.

Note : On the P22194-1 model, deceleration time can be controlled only when the desired stopping time is to be longer than the time inherently caused by the friction or load dynamics. Since negative running torque is not provided, decel time on can only be extended, not shortened.

P8 Max Speed

The Max Speed pot determines the maximum Run mode speed (with the external speed adjust pot at the maximum position). The range of adjustment is from 55 to 110% of base speed; clockwise rotation increases the speed.

P10 Min Speed

The Min Speed pot determines the minimum Run mode speed (with the external speed adjust pot at the minimum position). The range of adjustment is from 0 to 55% of the Max Speed setting; clockwise rotation increases the speed.

P12 Start Accel

The Start Accel pot controls the acceleration time in the Run mode. It is adjustable from ½ to 30 seconds for a 0 to 100% transition; clockwise rotation increases the time.

P13 Stop Decel

The Stop Decel pot controls the deceleration time in the Run mode. It is adjustable from ½ to 30 seconds for a 100% to 0 transition; clockwise rotation increases the time.

Note : On the P22194-1 model, deceleration time can be controlled only when the desired stopping time is to be longer than the time inherently caused by the friction or load dynamics. Since negative running torque is not provided, decel time on can only be extended, not shortened.

P14 Max Torque

The Max Torque pot sets the maximum allowable torque in the speed control mode. When the required torque exceeds this level, the drive operates in the current control mode (indicated immediately by the Current Mode LED and after a one second time delay by the release of the Current Mode Interlock relay K2). The range of adjustment is from 0 to the specified maximum for each horsepower range (reference Table 4 - set the negative voltage at TB1-25 for desired level). As additional torque is required, the drive speed will be reduced according to the setting of the Slope pot, P2.

Note: If the Max Torque level is exceeded during motor acceleration, the Current Mode Interlock relay K2 does not release until one second after the acceleration is complete.

P2 Slope

The Slope pot works in conjunction with the Max Torque pot to determine the speed reduction associated with operating torque above the Max Torque level. When the Slope pot is set full CCW, the motor speed will decrease from full speed to stall for a torque increase of 3% beyond the Max Torque level.

P9 Over Current Trip

The Over Current Trip pot determines the maximum level of torque (armature current) allowed for each horsepower range (reference Table 4 - set voltage at TP15 for desired level). When armature current reaches the set level the Fault Interlock relay K1 releases, the Over Current LED turns on, and any further increase of current is prevented. If the J1 jumper is in the $\overline{\text{OCT}}$ position, the drive will continue to operate in a constant torque mode. If the J1 jumper is in the OCT position, the drive will trip when the current reaches the set level. This trip condition is reset by the Control Board Reset button or by turning power off momentarily.

P3 IR COMP

The IR Compensation pot signal is automatically added when AFB is selected by J4. The signal is proportional to load current and is added to the reference to keep speed from dropping with an increase in load. This is not required when a velocity feedback device such as a tachometer is used. The pot range is 0 to 6% of the current feedback signal and is scaled by J3 HP Select jumper position. The amount of compensation required is dependent on motor characteristics and must be adjusted with the actual motor and load used. Refer to Section 6.4 for calibration information.

TABLE 4: OVER CURRENT SETTINGS – P9				
J3 HP SELECT	FULL LOAD AMPS DC	FULL LOAD TP15 VDC	MAX CURRENT AMPS DC	MAX CURRENT TP 15 VDC
5	20	4.3	30	6.4
7.5	29	4.1	45	6.4
10	38	4.0	60	6.4
15	55	4.7	75	6.4
20	72	5.1	90	6.4

5.2.2 Complex Adjustments

P1 Integral Null

The Integral Null pot can be used to alter control performance when the speed reference is maintained at zero with the control started. The high gain of the velocity integral circuit can cause motor creeping under some load conditions. The INTEGRAL NULL counter-acts the high gain by using a limited amount of the current loop output as a negative feedback. This causes a low gain area around zero that eliminates these problems.

P15 Velocity Integral

The Velocity Integral pot allows a 20 to 1 change in the velocity loop integral time constant. Clockwise rotation increases the time or decreases the response rate.

P11 Velocity Proportional

The Velocity Proportional pot allows a 4 to 1 change in the velocity loop proportional gain. Clockwise rotation increases the gain.

The Velocity Integral and Velocity Proportional signals are summed to produce the Torque Demand signal.

P4 Current Integral

The Current Integral pot allows a 10 to 1 change in the current loop integral time constant. Clockwise rotation increases the time or decreases the response rate.

P5 Current Proportional

The Current Proportional pot allows a 2 to 1 change in the current loop proportional gain. Clockwise rotation increases the gain.

The Current Integral and Current Proportional signals are summed to produce the VCO Ref signal (TP1).

5.3 Circuit Test Points

Refer to TABLE 5 for a listing of the circuit test points on the P22194-1 drive. Detailed information in each Test Point follows the table.

TP1 : VCO REFERENCE

The VCO Reference is the precisely rectified current loop output signal which controls the frequency of the oscillator input to the trigger circuit.

TP3,4,5,6 : -15, +6, +15, and -6 VDC

These are regulated power supplies that will vary no more than 5% with a $\pm$10% change in line voltage.

TABLE 5: TEST POINTS		
TEST POINT	DESIGNATION	CIRCUIT MONITORED
TP1	VCO REF	VCO reference to trigger circuit
TP2	COM	Circuit common
TP3	-15V	-15VDC Power Supply
TP4	+6V	+6VDC Power Supply
TP5	+15V	+15VDC Power Supply
TP6	-6V	-6VDC Power Supply
TP7	-24V	-24VDC Power Supply
TP8	+24V	+24VDC Power Supply
TP9	AFB	Scaled Armature Voltage -4.36V @ 240V
TP10	IFB	Scaled Armature Current 6.4V @ Max. I
TP11	CI	Current Integral
TP12	CP	Current Proportional
TO13	I ERROR	Current Loop Error
TP14	I DEMAND	Current Demand (Velocity Loop Out)
TP15	OC	Over Current Set
TP16	VP	Velocity Proportional
TP17	VI	Velocity Integral
TP18	TFB	Scaled Tach Voltage 5V @ 36.75 V
TP19	START AC/DC	Start (Run) Accel/Decel Output
TP20	JOG AC/DC	Jog Accel/Decel Output

TP7,8 : -24 VDC and +24 VDC

As unregulated power supplies, these voltages can normally deviate $\pm$ 4 VDC with line voltage and load variations.

TP9 : AFB - SCALED ARMATURE VOLTAGE

The armature voltage signal is scaled to a 5 volt level and used for velocity feedback in the AFB mode and for zero speed sensing.

TP10 : IFB - SCALED CURRENT FEEDBACK

The armature current signal is scaled according to the control rating and position of J3, HP Select. The scaled signal is summed with the CURRENT DEMAND signal to produce the current loop error input.

TP11 : CI - CURRENT INTEGRAL

This is the current loop integral signal before it is combined with the current proportional signal to give the VCO signal.

TP12 : CP - CURRENT PROPORTIONAL

This is the current loop proportional signal before it is combined with the current integral signal to give the VCO signal.

TP13 : I ERROR - CURRENT LOOP ERROR

This signal is the summation of the CURRENT DEMAND and the CURRENT FEEDBACK signals.

TP14 : I DEMAND - CURRENT DEMAND

The summation of the Speed Reference and Speed Feedback signals produces the Current Demand signal.

TP15 : OC - OVER CURRENT SETPOINT

This signal is the setting of P9, Over Current Trip.

TP16 : VP - VELOCITY PROPORTIONAL

This is the velocity loop proportional signal before it is combined with the velocity integral signal to give the Torque reference signal.

TP17 : VI - VELOCITY INTEGRAL

This is the velocity loop integral signal before it is combined with the velocity proportional signal to give the Torque reference signal.

TP18 : TFB - SCALED TACHOMETER VOLTAGE

The tachometer voltage is scaled to a 5 volt level at motor base speed and used for velocity feedback in the TFB mode.

TP19 : START (RUN) ACCEL/DECEL

The Start Accel/Decel circuit output shows the RUN reference as rate controlled by the P12, ACCEL and P13, DECEL pots.

TP20 : JOG ACCEL/DECEL

The Jog Accel/Decel circuit output shows the Jog reference as rate controlled by the P7, ACCEL/DECEL pot.

6 Start-up Procedure

6.1 Adjustment and Programming

Presets

The P22194-1 control is functionally tested and calibrated with motor load and should require further calibration only to tailor operation for a specific application. The potentiometer adjustment presets are listed in TABLE 3, Section 5.2, in the event that the condition of the control and its adjustments are unknown or in doubt. Refer to Section 5.2 for detailed information on the potentiometers.

Programming Jumper Presets

Jumpers J1, J2, and J3 should be placed in positions appropriate for the motor rating and application requirements. J4 should be placed initially in the AFB position until proper tachometer operation is verified.

Refer to Section 5.1 for detailed information on the programming jumpers.

6.2 Initial Pretest and Power-up

Pretest

Power should not be applied to the control until proper input voltage level and connections are verified. Input voltage should be checked ahead of the supplying circuit breaker, disconnect switch, etc. before it is switched on.

Connections should be visually inspected and checked for tightness. An ohmmeter can be used to check for **ground faults**. Even though the P22194-1 control circuit is isolated and can be grounded, it is not necessary and is generally undesirable because other circuits connected to it may not be isolated and because of the possibility of ground loops, noise conditions caused by shields being connected at more than one place. **Ground faults** in un-isolated circuits for the armature and field can cause fuse blowing and damage to the motor and control.

To check for grounds with an ohmmeter, select a high resistance scale such as R x 100K ohms or greater. Test from each connection terminal (including shields) to chassis ground and be suspicious of any resistance reading less than 500K ohms.

NOTE : An exception to this test would be made where the A.C. line supply is connected to a grounded "Y" type transformer secondary.

Power-up

Step 1

Apply A.C. power to the control. **DO NOT RUN OR JOG AT THIS TIME**. The POWER ON and ARM FEEDBACK LEDs should be on. The MOTOR, FAULT, and CURRENT MODE interlock relays should be energized.

Step 2

Verify proper field voltage at F+1, F+2, and F- (150, 240, or 300 VDC depending on motor requirements and connections).

6.3 Motor Start-up

During the following steps the motor will be rotated. If excessive speed or incorrect direction of rotation could damage the load, it may be wise to de-couple the load until proper control is verified. Output can be monitored with a voltmeter by measuring SCALED ARMATURE VOLTAGE at TP9 or by measuring armature voltage.

Step 3

Turn the external speed pot to zero or full CCW and press the RUN pushbutton. The RUN LED should be ON.

Increase the speed pot setting to 20% and observe acceleration to set speed. The MOTOR LED should turn ON at approximately 6% output. Observe the direction of rotation; if necessary, correct by removing control power and reversing the motor armature or field leads. If used, observe proper polarization of the series field winding per the instructions in Section 4.2.

Proper tachometer operation can be checked while running in AFB mode and comparing the SCALED TACHOMETER VOLTAGE signal at TP18 to the SCALED ARMATURE VOLTAGE signal at TP9. If the tachometer feedback signal level is close to the AFB level, it can be safely used for feedback.

Step 4

Stop and O-Stop functions should be tested initially from a low operating speed. Refer to Section 4.4 for descriptions of these stopping methods.

Step 5

Increase the speed pot setting to maximum. Use the P8, MAX SPEED pot to adjust for rated armature voltage (240 VDC), or desired motor maximum speed. After the desired maximum speed has been set, decrease the speed pot setting to minimum and set the desired minimum speed with P10, MIN SPEED.

Step 6

Test the JOG function and set desired JOG speed.

6.4 Calibration and Fine Tuning

Refer to the description of adjustment potentiometers in Section 5.2. Most of the P22194-1 adjustments are straightforward and self-explanatory. Those discussed below have more complex functions or adjustment procedures.

IR COMPENSATION

As mentioned before, the IR COMP is functional only in the AFB mode and is used to keep motor speed from decreasing as load is increased. Adjustment is best done when the motor or machine can be loaded normally. If the motor is normally operated at a particular speed, adjust the P3, IR COMP pot while running at that speed. If the motor operates under load over a wide speed range, pick a speed near mid-range to make the adjustment. Adjust as follows:

Operate the **unloaded** motor at the normal or mid-range speed and note the exact speed. While monitoring speed, apply normal load. The reduction in speed of a fully loaded motor will

usually fall between 2 and 13% of rated or "Base" speed. Slowly increase the IR COMP adjustment clockwise until the loaded speed equals the unloaded speed measured in the previous step. Making this adjustment may now cause the unloaded speed to be slightly higher. Repeat this procedure until there is no difference between loaded and unloaded speed levels.

Use care not to set the adjustment too high or speed increase with load and instability may result.

NOTE : For this adjustment, do not use SCALED ARMATURE VOLTAGE to measure speed. Armature voltage is not an exact indication of loaded motor speed!

INTEGRAL NULL

Adjustment of the INTEGRAL NULL pot is sometimes required when the control is continually operated in the RUN mode with a zero speed reference. With maintained zero reference, creeping can occur. If this condition exists, increase the INTEGRAL NULL in the clockwise direction to minimize the symptoms.

CURRENT PROPORTIONAL AND CURRENT INTEGRAL VELOCITY PROPORTIONAL AND VELOCITY INTEGRAL

The PROPORTIONAL and INTEGRAL adjustments P11, P12, P16, and P17 as preset by CAROTRON will provide stable and responsive performance under most load conditions. Therefore, any observed instability should first be evaluated as a possible load induced condition. Cyclic variation in armature current and in motor speed can indicate mechanical coupling or machine loading conditions. If mechanically induced, the instability repetition rate or frequency can usually be related to a motor or machine rotation rate or loading cycle. In this situation, the instability frequency will change in coincidence with any motor speed change.

Instability in the control output due to incorrect adjustment would usually be present over a range of speed and would not usually change frequency in coincidence with speed. Because the response of the control can sometimes be altered to partially compensate for mechanically induced instability, it is sometimes difficult to determine if the load change is affecting control output stability or if control output is affecting the load stability. De-coupling the load from the motor can help make this determination.

If fuse blowing or tripping of breakers should occur, it may be due to unbalanced operation of the power bridge. This would usually be noticeable when rapid changes in output or surges of torque are being called for as opposed to steady state operation. An example would be when quickly accelerating a load up to speed. Excessive proportional gain settings and/or too fast integral settings might cause such unbalanced operation.

Typically the settings that provide the most stable and balanced bridge operation under all conditions do not give the fastest response. In general, low proportional gains (too far ccw rotation) and too slow integral time constants (too far cw) would cause instability. Bridge unbalance would usually result from just the opposite set-

up, too high (cw) proportional gains and too fast (ccw) integral time.

The loop adjustment pots are approximately 20-25 turns total and have no mechanical stops. The factory presets these pots at about 10 turns clockwise, approximately 50% of their range. If the set position of a pot is unknown, rotate the pot at least 30 turns CCW, then carefully count 10 turns CW to obtain the factory setting.

When loop adjustments are required, start first with the I (current) loop adjustments.

I INTEGRAL

The I INTEGRAL pot controls a 10 to 1 change in the current loop integral time constant. Clockwise rotation increases the time or decreases the response rate.

I PROPORTIONAL

The I PROPORTIONAL pot controls a 2 to 1 change in the current loop proportional gain. Clockwise rotation increases the gain and response.

VELOCITY INTEGRAL

The VELOCITY INTEGRAL pot controls a 20 to 1 change in the velocity loop integral time constant. Clockwise rotation increases the time or decreases the response rate.

VELOCITY PROPORTIONAL

The VELOCITY PROPORTIONAL pot controls a 4 to 1 change in the velocity loop proportional gain. Clockwise rotation increases the gain.

The VELOCITY INTEGRAL and VELOCITY PROPORTIONAL signals are summed to produce the TORQUE DEMAND signal.

The I INTEGRAL and I PROPORTIONAL signals are summed to produce the VCO REF signal.

7 Fault Conditions

The P22194-1 drive has three latching type FAULT conditions which cause a control safety shutdown with form "C" contact output and LED indication of the condition. The fault conditions are Low Line/Phase Loss, Field Loss, and Over Current.

The Fault Interlock Relay contact outputs are at TB1 terminals 4, 5, and 6. When a FAULT condition occurs, the relay de-energizes and the control is disabled. The control cannot be restarted until the FAULT is corrected and the RESET button on the CONTROL BOARD is pressed or the power is turned off momentarily.

Note: The external Reset circuit (TB1 terminal 13) is used only for the O-Stop reset function.

The FAULT protection circuits operate as follows:

Low Line/Phase Loss

A low line condition (below 195 VAC) or a momentary loss (approximately 2 cycles) of any of the three phase line inputs will activate the Low Line/Phase Loss fault.

Field Loss

Discontinuity of the motor field current due to blown fuses, open wiring, open windings, etc. will cause a Field Loss fault. Reference Section 5.1 for additional information.

Over Current Fault

The Over Current Fault is controlled by the J3 HP jumper and the P9 Over Current Trip pot. Reference Section 5.1 for additional information.

8 Spare Parts

8.1 Printed Circuit Board Assemblies

Control Board D11964-000

Power Supply / Trigger Board
.....…… D11955-000

CT (Current Transformer) Board
……..... C11958-000

8.2 Fuses

FU1 : 100 ampere, Semiconductor Fuse, 500 VAC
(located on the Chassis)
CAROTRON FUS1009-01
BUSSMANN ..... FWH 100
LITTELFUSE L50S 100

FU2 : ½ ampere, 250 VAC, time delay
(located on the Power Board)
CAROTRON …..... FUS1006-05
BUSSMANN ..... MDA-½
LITTELFUSE 313.500

8.3 Power Components

Armature Bridge

The armature bridge devices (PMD5, PMD6, and PMD7) are isolated dual SCR power modules rated at 56 Amp, 1400 volts repetitive peak off state and reverse voltage and have 1000 V/μS dv/dt rating.

CAROTRON …..... PMD1026-00
AEG/EUPEC TT56N14KOF
SEMIKRON SKKT56/14E

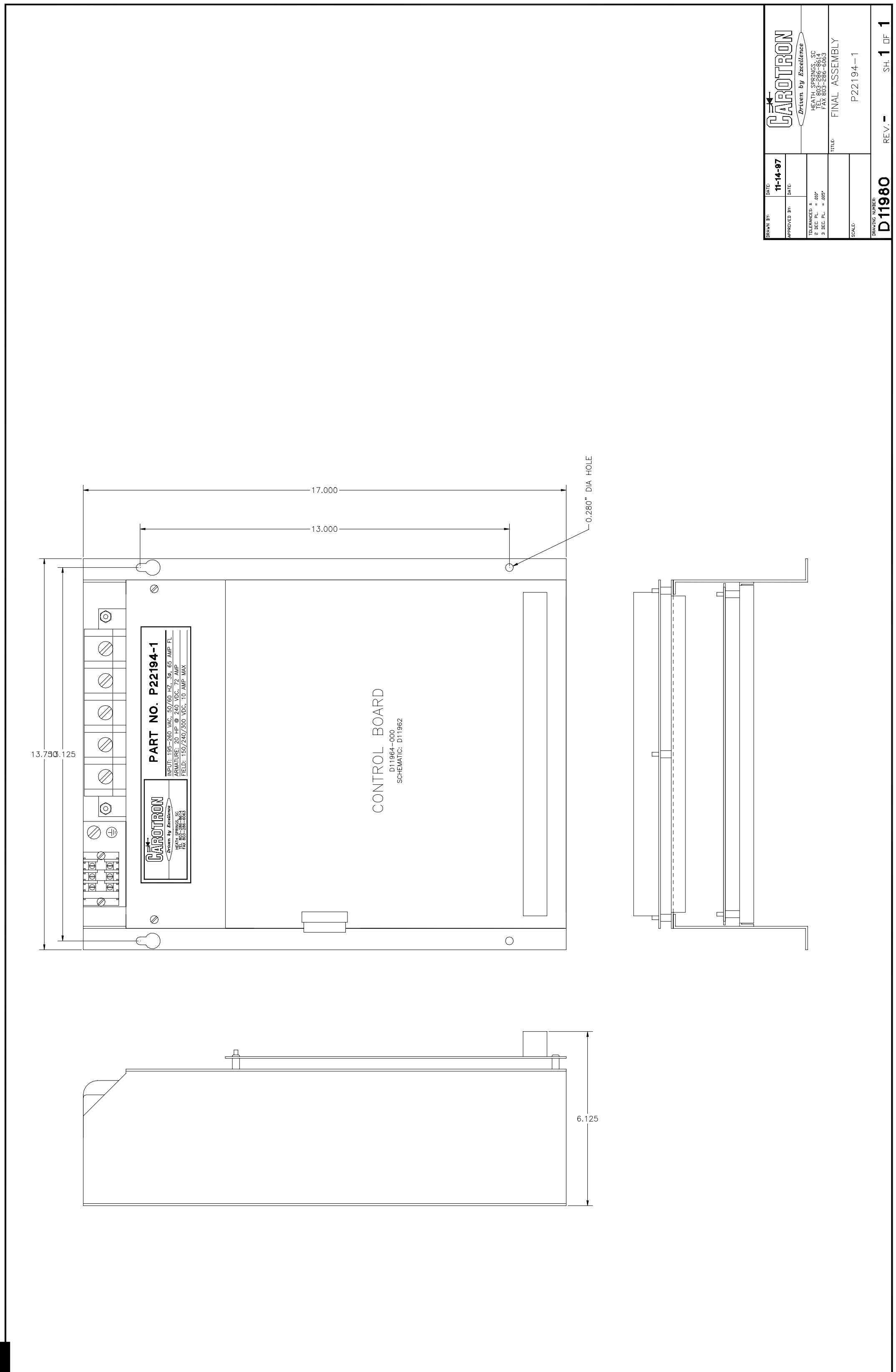
NOTE : IR (International Rectifier) and CRYDOM have similar power module ratings but are not pin-for-pin compatible with the above listed parts. The gate and cathode signal leads are reversed on the second SCR device. Consult the factory for assistance in making substitutions for the recommended spares listed above.

Field Supply

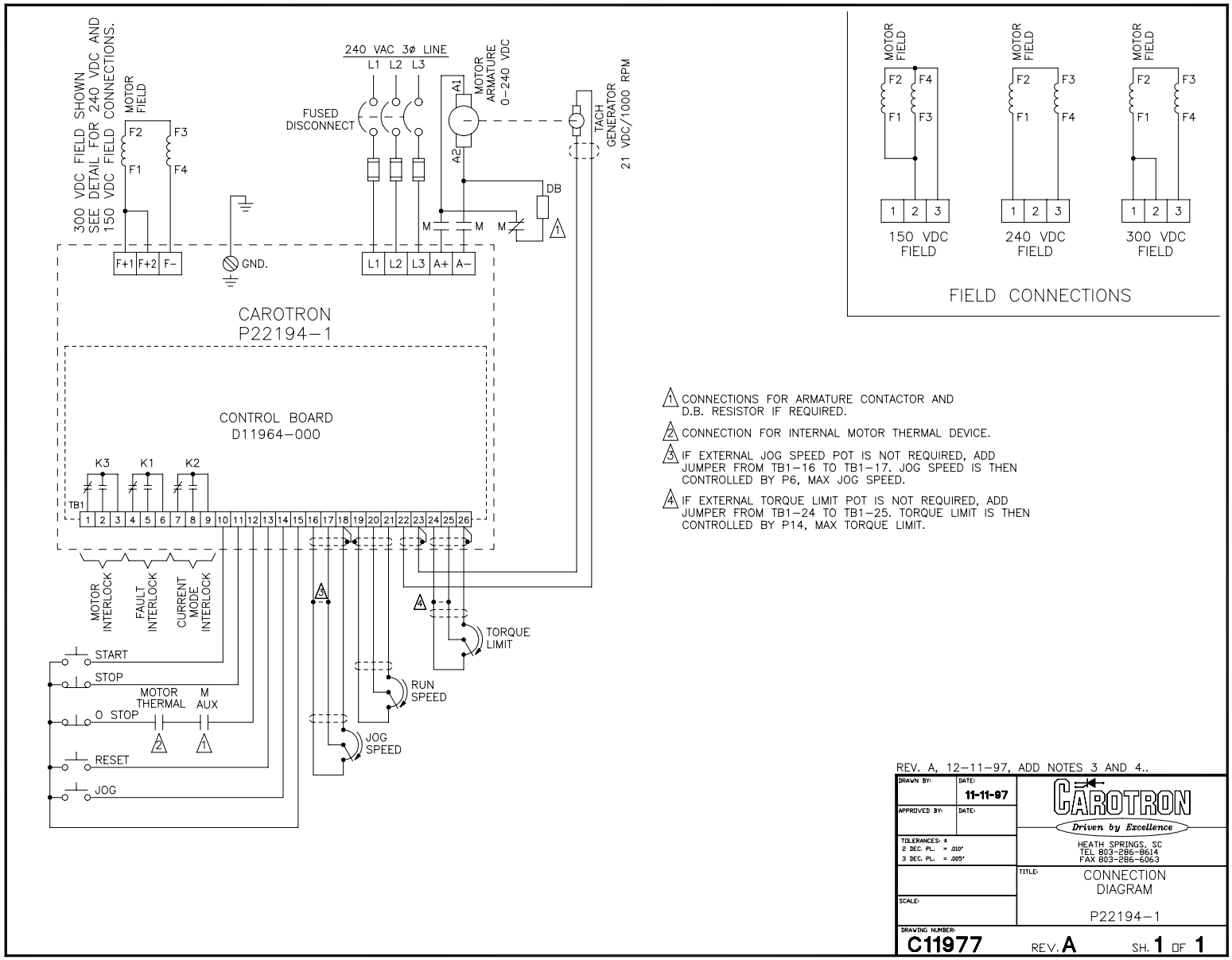
PMD1 and PMD2, Full Wave Diode Bridge, 25 Amp, 600 V
CAROTRON DIO3002-00
GEN INST…..... GPBC25-06

PMD3 and PMD4, diode doubler, 25 ampere, 50 volts
CAROTRON PMD1009-00
EDI FPID2505

9 Drawings



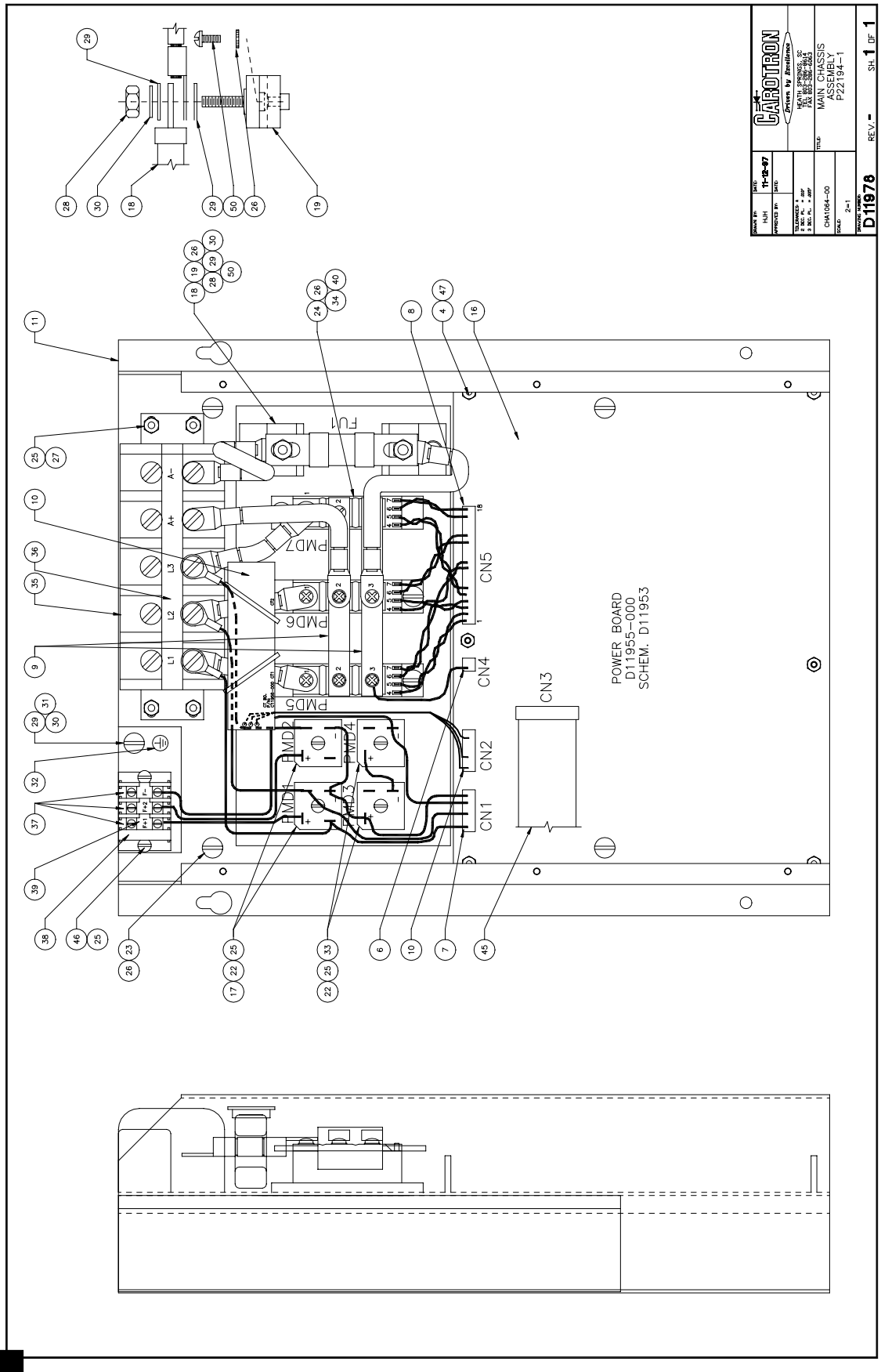
CAROTRON
Driven by Excellence
HEATH SPRINGS, SC
FINAL ASSEMBLY
P22194-1
11-14-97
D11980
17.000
13.000
0.280" DIA HOLE
13.750
13.125
6.125
PART NO. P22194-1
CONTROL BOARD
D11964-000
SCHEMATIC: D11962



1. CONNECTIONS FOR ARMATURE CONTACTOR AND D.B. RESISTOR IF REQUIRED.
2. CONNECTION FOR INTERNAL MOTOR THERMAL DEVICE.
3. IF EXTERNAL JOG SPEED POT IS NOT REQUIRED, ADD JUMPER FROM TB1−16 TO TB1−17. JOG SPEED IS THEN CONTROLLED BY P6, MAX JOG SPEED.
4. IF EXTERNAL TORQUE LIMIT POT IS NOT REQUIRED, ADD JUMPER FROM TB1−24 TO TB1−25. TORQUE LIMIT IS THEN CONTROLLED BY P14, MAX TORQUE LIMIT.

REV. A, 12−11−97, ADD NOTES 3 AND 4..

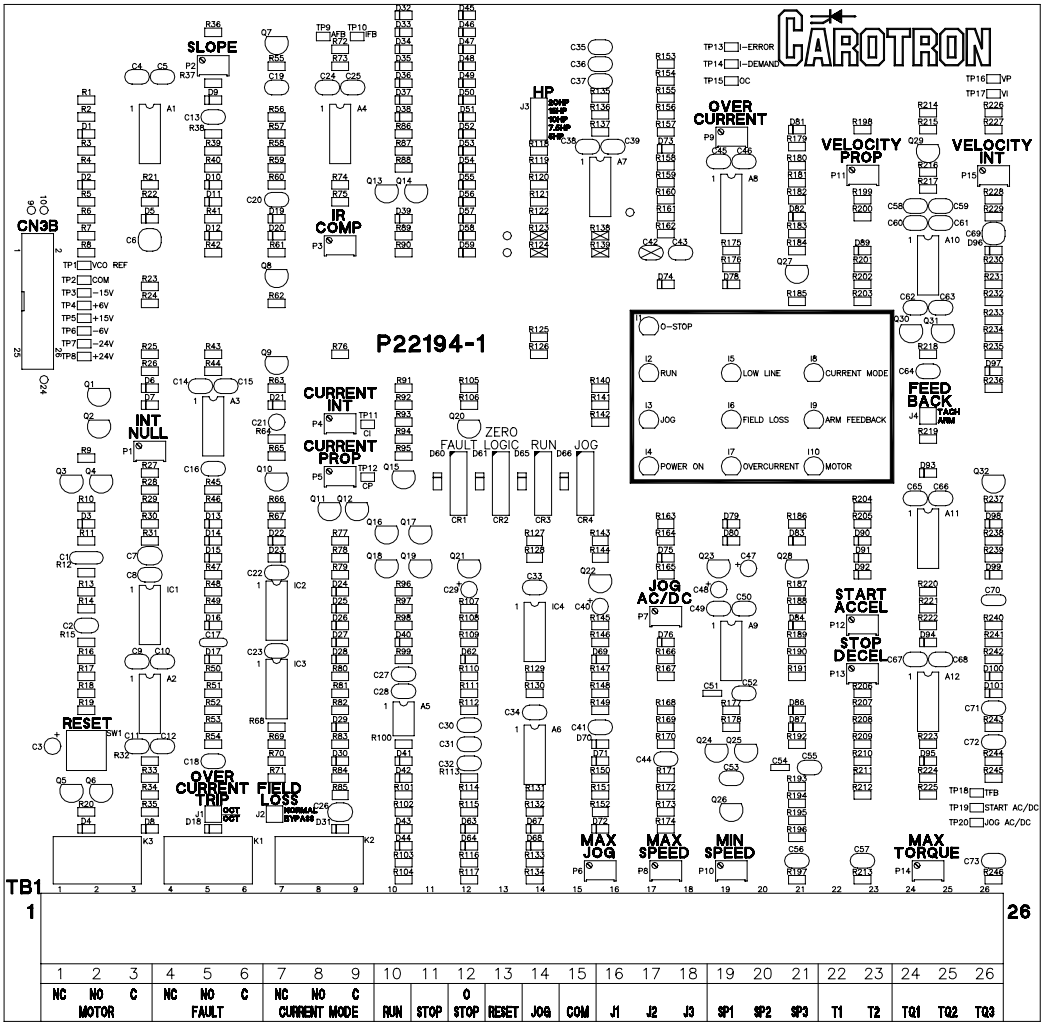
DRAWN BY:	DATE: 11-11-97
APPROVED BY:	DATE:
TOLERANCES: ± 2 DEC. PL. = .010" 3 DEC. PL. = .005"	CAROTRON Driven by Excellence
	HEATH SPRINGS, SC TEL 803-286-8614 FAX 803-286-6063
SCALE:	TITLE: CONNECTION DIAGRAM P22194−1
DRAWING NUMBER: C11977	REV. A SH. 1 OF 1

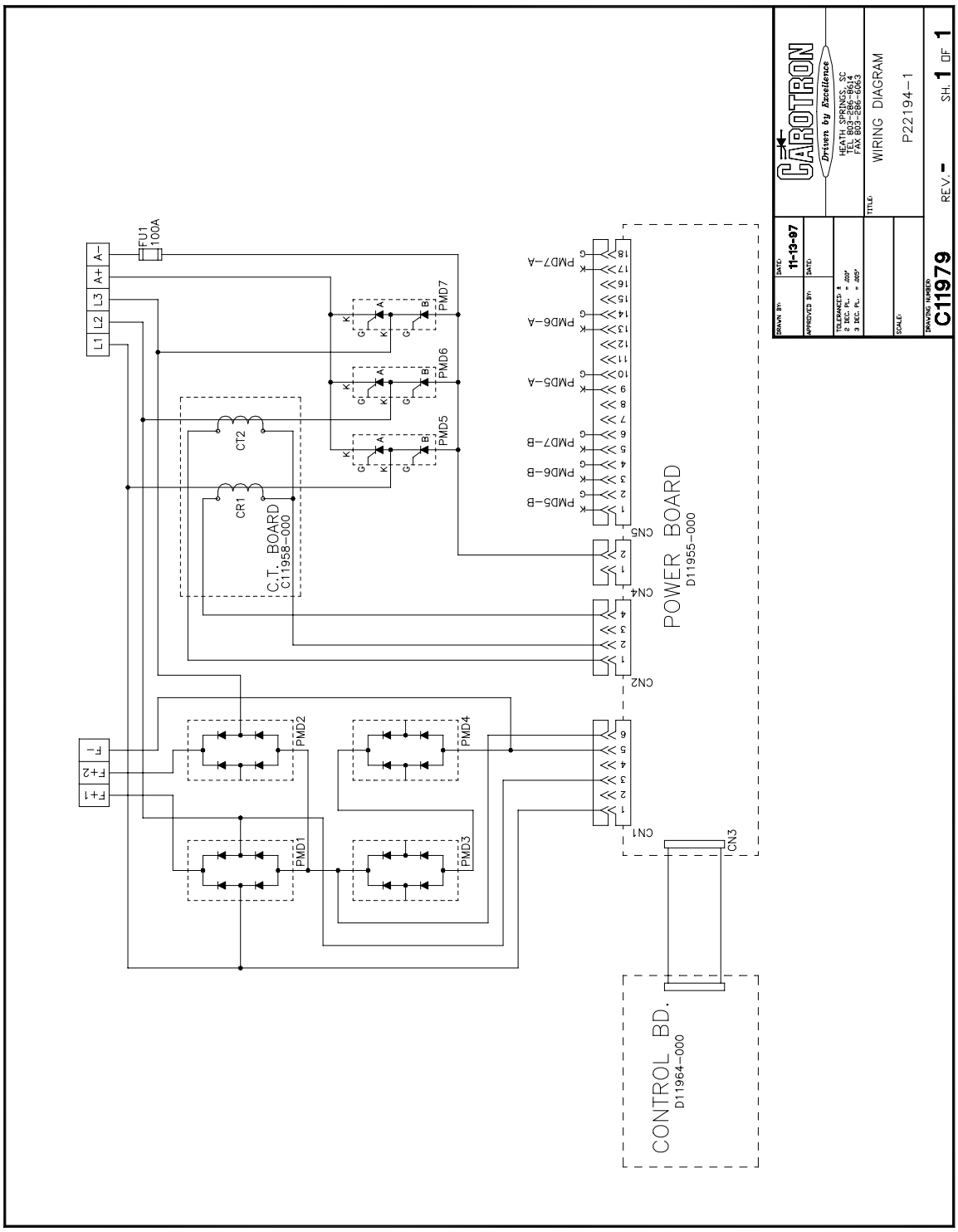

CARDTRON
Drivers by Excellence
HEATH SPRINGS, SC
TEL 803-386-6063
FAX 803-386-6063
MAIN CHASSIS
ASSEMBLY
P221194-1
CH41064-00
2=1
D11978
REV. -
SH. 1 OF 1
POWER BOARD
D11955-000
SCHEM: D11953
FU1
PMD7
PMD6
PMD5
PMD2
PMD1
PMD4
PMD3
CN5
CN4
CN3
CN2
CN1
A-
A+
L3
L2
L1

NOTES:
1. REF. SCHEMATIC D11962
2. REF. B.O.M. D11964–000.

REV. A, ECO 481, 1-8-98

DRAWN BY:	DATE: 11-7-97	CAROTRON *Driven by Excellence*	HEATH SPRINGS, SC TEL 803-286-6614 FAX 803-286-6063
APPROVED BY:	DATE:	TOLERANCES: ± 2 DEC. PL. = .010" 3 DEC. PL. = .005"	TITLE: ASSEMBLY DRAWING MARK ANDY CONTROL BOARD
		SCALE:	DRAWING NUMBER: D11964 REV. A SH. 1 OF 1




L1 L2 L3 A+ A–
FU1 100A
F+1 F+2 F–
PMD1 PMD2 PMD3 PMD4 PMD5 PMD6 PMD7
CT2 CR1
C.T. BOARD C11958–000
POWER BOARD D11955–000
CN1 CN2 CN3 CN4 CN5
PMD5–B PMD6–B PMD7–B PMD5–A PMD6–A PMD7–A
CONTROL BD. D11964–000
CROTRON Driven by Excellence
HEATH, SPRINGS, SC
TEL 803-286-6564
FAX 803-286-6063
WIRING DIAGRAM
P22194–1
DRAWN BY:
DATE: 11-13-97
APPROVED BY:
DATE:
TOLERANCES: 1 DEC. PL. = .010" 2 DEC. PL. = .005" 3 DEC. PL. = .005"
SCALE:
DRAWING NUMBER C11979
REV. –
SH. 1 OF 1

Standard Terms & Conditions of Sale

1. General

The Standard Terms and Conditions of Sale of Carotron, Inc. (hereinafter called "Company") are set forth as follows in order to give the Company and the Purchaser a clear understanding thereof. No additional or different terms and conditions of sale by the Company shall be binding upon the Company unless they are expressly consented to by the Company in writing. The acceptance by the Company of any order of the Purchaser is expressly conditioned upon the Purchaser's agreement to said Standard Terms and Conditions. The acceptance or acknowledgement, written, oral, by conduct or otherwise, by the Company of the Purchaser's order shall not constitute written consent by the Company to addition to or change in said Standard Terms and Conditions.

2. Prices

Prices, discounts, allowances, services and commissions are subject to change without notice. Prices shown on any Company published price list and other published literature issued by the Company are not offers to sell and are subject to express confirmation by written quotation and acknowledgement. All orders of the Purchaser are subject to acceptance, which shall not be effective unless made in writing by an authorized Company representative at its office in Heath Springs, S.C. The Company may refuse to accept any order for any reason whatsoever without incurring any liability to the Purchaser. The Company reserves the right to correct clerical and stenographic errors at any time.

3. Shipping dates

Quotation of a shipping date by the Company is based on conditions at the date upon which the quotation is made. Any such shipping date is subject to change occasioned by agreements entered into previous to the Company's acceptance of the Purchaser's order, governmental priorities, strikes, riots, fires, the elements, explosion, war, embargoes, epidemics, quarantines, acts of God, labor troubles, delays of vendors or of transportation, inability to obtain raw materials, containers or transportation or manufacturing facilities or any other cause beyond the reasonable control of the Company. In no event shall the Company be liable for consequential damages for failure to meet any shipping date resulting from any of the above causes or any other cause.

In the event of any delay in the Purchaser's accepting shipment of products or parts in accordance with scheduled shipping dates, which delay has been requested by the Purchaser, or any such delay which has been caused by lack of shipping instructions, the Company shall store all products and parts involved at the Purchaser's risk and expense and shall invoice the Purchaser for the full contract price of such products and parts on the date scheduled for shipment or on the date on which the same is ready for delivery, whichever occurs later.

4. Warranty

The Company warrants to the Purchaser that products manufactured or parts repaired by the Company, will be free, under normal use and maintenance, from defects in material and workmanship for a period of one (1) year after the shipment date from the Company's factory to the Purchaser. The Company makes no warranty concerning products manufactured by other parties.

As the Purchaser's sole and exclusive remedy under said warranty in regard to such products and parts, including but not limited to remedy for consequential damages, the Company will at its option, repair or replace without charge any product manufactured or part repaired by it, which is found to the Company's satisfaction to be so defective; provided, however, that (a) the product or part involved is returned to the Company at the location designated by the Company, transportation charges prepaid by the Purchaser; or (b) at the Company's option the product or part will be repaired or replaced in the Purchaser's plant; and also provided that Cc) the Company is notified of the defect within one (1) year after the shipment date from the Company's factory of the product or part so involved.

The Company warrants to the Purchaser that any system engineered by it and started up under the supervision of an authorized Company representative will, if properly installed, operated and maintained, perform in compliance with such system's written specifications for a period of one (1) year from the date of shipment of such system.

As the Purchaser's sole and exclusive remedy under said warrant in regard to such systems, including but not limited to remedy for consequential damages, the Company will, at its option, cause, without charges any such system to so perform, which system is found to the Company's satisfaction to have failed to so perform, or refund to the Purchaser the purchase price paid by the Purchaser to the Company in regard thereto; provided, however, that (a) Company and its representatives are permitted to inspect and work upon the system involved during reasonable hours, and (b) the Company is notified of the failure within one (1) year after date of shipment of the system so involved.

The warranties hereunder of the Company specifically exclude and do not apply to the following:

a. Products and parts damaged or abused in shipment without fault of the Company.

b. Defects and failures due to operation, either intentional or otherwise, (l) above or beyond rated capacities, (2) in connection with equipment not recommended by the Company, or (3) in an otherwise improper manner.

c. Defects and failures due to misapplication, abuse, improper installation or abnormal conditions of temperature, humidity, abrasives, dirt or corrosive matter.

d. Products, parts and systems which have been in any way tampered with or altered by any party other than an authorized Company representative.

e. Products, parts and systems designed by the Purchaser.

f. Any party other than the Purchaser.

The Company makes no other warranties or representation, expressed or implied, of merchantability and of fitness for a particular purpose, in regard to products manufactured, parts repaired and systems engineered by it.

5. Terms of payment

Standard terms of payment are net thirty (30) days from date of the Company invoice. For invoice purposed, delivery shall be deemed to be complete at the time the products, parts and systems are shipped from the Company and shall not be conditioned upon the start up thereof. Amounts past due are subject to a service charge of 1.5% per month or fraction thereof.

6. Order cancellation

Any cancellation by the Purchaser of any order or contract between the Company and the Purchaser must be made in writing and receive written approval of an authorized Company representative at its office in Heath Springs, S.C. In the event of any cancellation of an order by either party, the Purchaser shall pay to the Company the reasonable costs, expenses, damages and loss of profit of the Company incurred there by, including but not limited to engineering expenses and expenses caused by commitments to the suppliers of the Company's subcontractors, as determined by the Company.

7. Changes

The Purchaser may, from time to time, but only with the written consent of an authorized Company representative, make a change in specifications to products, parts or systems covered by a purchase order accepted by the company. In the event of any such changes, the Company shall be entitled to revise its price and delivery schedule under such order.

8. Returned material

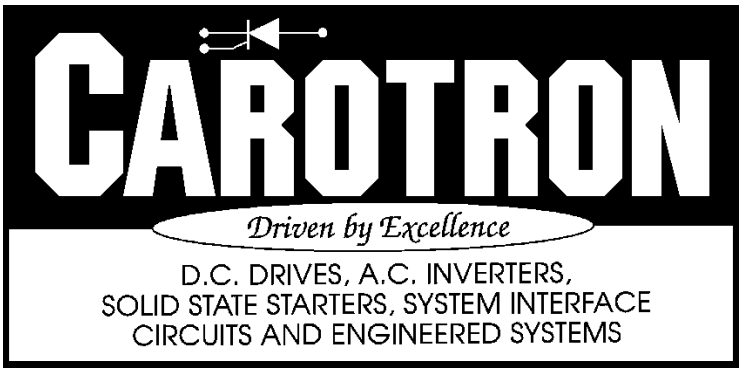
If the Purchaser desires to return any product or part, written authorization thereof must first be obtained from the Company which will advise the Purchaser of the credit to be allowed and restocking charges to be paid in regard to such return. No product or part shall be returned to the Company without a "RETURNTAG" attached thereon which has been issued by the Company.

9. Packing

Published prices and quotations include the Company's standard packing for domestic shipment. Additional expenses for special packing or overseas shipments shall be paid by the Purchaser. If the Purchaser does not specify packing or accepts parts unpacked, no allowance will be made to the Purchaser in lieu of packing.

10. Standard transportation policy

Unless expressly provided in writing to the contrary, products, parts and systems are sold f.o.b. first point of shipment. Partial shipments shall be permitted, and the Company may invoice each shipment separately. Claims for non-delivery of products, parts and systems, and for damages thereto must be filed with the carrier by the Purchaser. The Company's responsibility therefor shall cease when the carrier signs for and accepts the shipment.



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