SAFTRONICS

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DC6

DC Motor Drives

P/N X010004 REV:2

DC6 SERIES

INSTRUCTION MANUAL CONTENTS

1. DESCRIPTION

1.1 General

SAFTRONICS type DC6 SCR converters are intended to power DC motors ranging from 5HP to 2000 HP.

The basic converter unit consists of:

a) A 6SCR power bridge.

b) A single control card type AA650 mounted on the power bridge assembly. The entire control circuit is accommodated on this card.

c) Synchronizing transformer assembly, upon which is mounted a relay logic PC board type A650-MB-2. This board is connected to the control card via a flat ribbon cable.

1.2 Standard Features

- Impedance-isolated armature feedback for a speed regulation of better than 5%.
- Isolated current feedback using current transformers.
- Visual indication of all important control points within the control card (light emitting diodes - LED's).
- Single control card for quick replacement.
- Phase rotation protection with run interlocking and indication.
- Instantaneous protection against excessive current overload (ICT Current fault trip).
- Automatic resetting of ICT circuit when operating the normal STOP/START circuit.
- Stall-protection where power to the motor will cease after a stall period of longer than 12 seconds under current limit conditions.
- Adjustable maximum voltage with armature feedback.
- Adjustable maximum speed with tachometer feedback.
- Adjustable minimum speed.
- Adjustable acceleration (1-60 seconds).
- Adjustable deceleration (1-60 seconds).
- Adjustable current limit to the motor.
- Adjustable IR compensation.
- Adjustable velocity and current loop stabilities.
- Tachometer feedback loss protection i.e. the control will automatically revert to impedance-isolated armature feedback if the tachometer fails.
- Jogging facility with independent speed adjustment.
- 2-stage current limit for high initial starting torque requirement .
- Tachometer feedback for a speed regulation of better than 1.0%.

1.3 Optional Features

- Parallel 12-pulse operation.
- Multi-drive systems with accurate load sharing better than 3%.
- Input programming for follower drive applications.
- Constant kW/HP operation with a field current regulator.
- Constant current field regulator.
- Remote control station(s).
- Digital speed control for better than 0.1% regulation.

1.4 Power Bridge

Standard Protective Features

- Fast acting fuses.

1.4 Power Bridge cont'd

- Instantaneous protection against excessive current overload (Electronic protection - ICT).
- SCR protection against excessive dv/dt and over-voltage by means of individual R-C circuitry.
- Power bridge overtemperature protection to cut-out when stack temperature exceeds 85 degrees C (+/- 5°).

Optional Protective Features

Blower for cooling the DC motor, supplied via a contactor with thermal overload and using protection interlocked with the run control circuitry.

Power Bridge Rating Data

The DC6 series covers the power range of 5HP to 2000HP. The control circuit, however, remains basically the same for the full range up to 2000HP. The different bridge assemblies are listed in Table 1.

Table 1

BASIC MODEL	MAXIMUM HP			ARMATURE VOLTAGE	MAX DC AMPS
	240V	480V	600V		
DC6-61	15	30	30	240/500	60
DC6-126	30	60	60	240/500	100
DC6-251	75	150	150	240/500	175
DC6-350	100	200	250	240/500/700	350
DC6-500	150	300	400	240/500/700	500
DC6-800	250	500	700	500/700	800
DC6-1000	300	600	800	500/700	1000
DC6-1250	400	800	1100	500/700	1250
DC6-2000	800	1750	2000	500/700	2000

Derating Data

Table 1 lists the maximum continuous DC output current at a maximum ambient temperature of 40° C (104° F) and an altitude of 5,000 feet (2,000 meters). For ambient temperatures in excess of this value all powerstack assemblies must be derated by 1.5% per degree C. (.75°F). For altitudes in excess of 5,000 feet (2,000 meters) above sea level, all power stack assemblies must be derated by 1% for every 250 ft. (100 meters) above 5,000 ft. (2,000 meters).

Field Excitation Supply

Constant field excitation is supplied from a bridge rectifier having the voltage and current ratings listed in Table 2.

Table 2

AC SUPPLY VOLTAGE	DC FIELD SUPPLY VOLTAGE		MAXIMUM DC CURRENT
	Standard	Optional	
240V 3 Phase	150V	220V	10A
480V 3 Phase	300V	440V	10A
600V 3 Phase	300V	440V	10A

2. INSTALLATION

2.1 General

Unless the unit has been specifically designed for poor environmental conditions, it must be installed in an area where the following conditions exist:

a) Ambient temperature does not exceed 40°C (104°F)
b) Ambient temperature is not less than 10°C (50°F)
c) Altitude above sea level in excess of 5,000 ft. (2,000 meters) must be taken into account as in Derating Data, Section 1.4.
d) Ambient air is reasonably clean and dry. It must be free of flammable or combustible vapors, steam or corrosive gases.
e) The clearance around the cabinet must be sufficiently large to:
   i) Provide full accessibility to the front.
   ii) Provide a non-restricted airflow (with a minimum of 1" clearance) from the intake and exhaust ventilation louvers.

2.2 External Cabling

It is most important that the AC supply to the unit is of the correct voltage and current rating. It should be kept in mind that where the specified drive unit voltages and/or currents are not available, an interstage transformer will be necessary. All external connections must be made according to the Engineering drawing supplied. All power and control cable ratings should be referred to the National Electrical Code Handbook.

Cable Current Ratings

Table 3 lists the maximum continuous current which the AC and DC cables must carry for the various drive types. If the system uses a transformer, then the AC ratings are for the transformer secondary. Primary ratings must be determined by the transformer rating.

Table 3

DRIVE TYPE	MAXIMUM ARMATURE AMPS (AVG)	3 PHASE SUPPLY AMPS (RMS)
DC6-61	60	49
DC6-126	125	103
DC6-251	251	204
DC6-350	350	286
DC6-500	500	408
DC6-800	800	653
DC6-1000	1000	816
DC6-1250	1250	1020
DC6-2000	2000	1632

Motor Field Cable Current Ratings

Motor field cable current ratings are determined by the motor being used. This can normally be ascertained by referring to the motor nameplate. A cable rating of 20 amps should be adequate for the full range up to 1500HP. The cable insulation rating should not be less than 600V.

2.2 External Cabling cont'd

Control Signal Cable Consideration

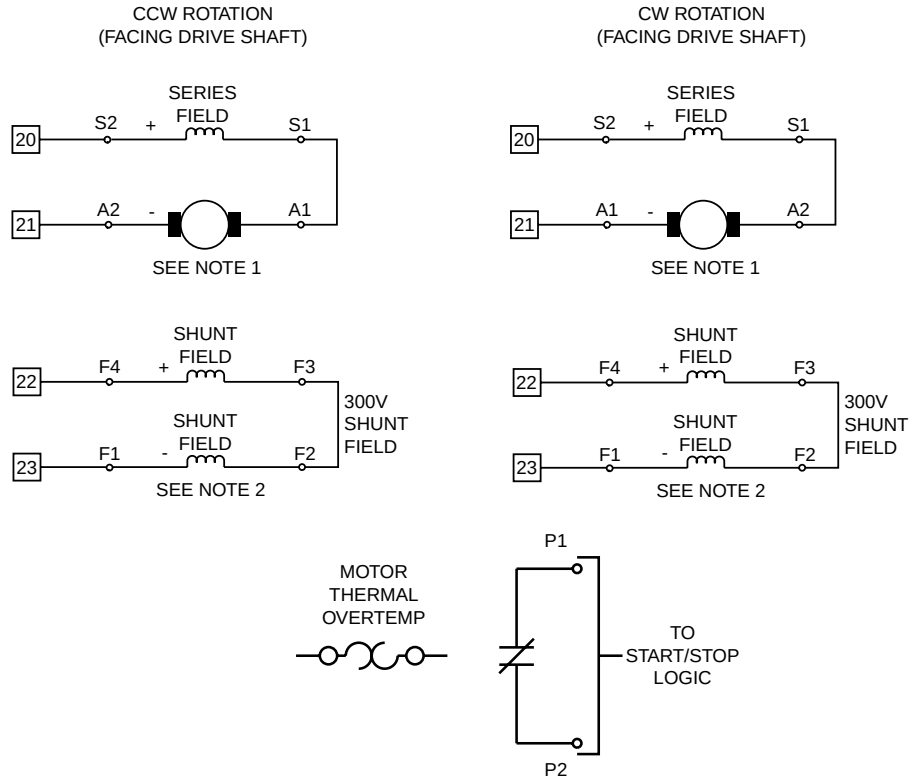
All control signal cables must have a current rating of at least 5 Amps and the insulation rating should be 600V. TACH and SPEED CONTROL signal wiring should be interconnected by means of cables with individually shielded and twisted cables.

For extra protection against electro-magnetic interference and mechanical damage, PVC covered shielded cables should be run completely in steel conduit, separately from power and AC control cables. The shields of the individual cables should then be terminated together at one point in the control cabinet at the control circuit common (where specified). It should be noted that the shields must be grounded at one point only, preferably the control cabinet, to avoid unwanted ground current loops.

NOTE: Shielded cables must be continuous with no breaks in the shield.

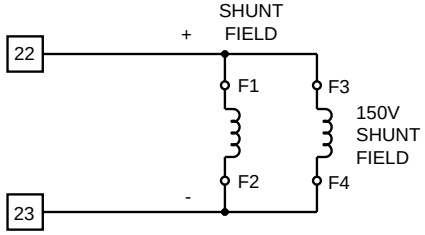
All control cables should be kept away, as far as possible from high power cables, preferably run in a separate channel.

Motor Connections to DC6



NOTE 1: FOR ARMATURE REVERSING DUTY, DO NOT CONNECT THE SERIES FIELD.
IF EXTRA STARTING TORQUE IS REQUIRED, CONNECT THE SERIES FIELD VIA
SEPARATE FULL-WAVE BRIDGE SUCH THAT (S1) IS ALWAYS THE SAME POLARITY AS (F1).

NOTE 2: 150V CONNECTION



3. STARTUP

3.1 Adjustment Prior To Operation

When all cable connections have been thoroughly checked out according to the Engineering drawing, Power may be applied to the drive unit, but the Start circuit must not be operated at this point.

The following adjustments should be made on the AA650 control card:

RV6 - MAXIMUM SPEED (tach feedback)	-Fully counter-clockwise
RV3 - RATE I (Acceleration Rate)	-Fully clockwise
RV4 - RATE II (Deceleration Rate)	-Fully clockwise
RV5 - STABILITY (Speed)	-Mid Position
RV9 - CURRENT LIMIT	¼ clockwise
RV7 - MINIMUM SPEED	-Fully counter-clockwise
RV8 - IR COMPENSATION	-Fully counter-clockwise
RV2 - AV (Max. Armature Voltage)	-Fully counter-clockwise
RV1 - CS (Current Stability - Factory Set)	-Mid position approx.

The state of the LED's on the AA650 control card should be as follows:

-V (-12 Volt Supply)	-Glowing brightly
R (Run indication)	-Off
DV (Speed Reference)	-Off
VA (Speed Error Amplifier Output)	-Off
CA (Current Error Amplifier Output)	-Off
ST (Stall Sensing)	-Glowing brightly
TR (Trip Circuit)	-Off or On*
2S (2-Stage Current Limit Circuit)	-Off
ΦPhase Rotation Indication	-Glowing brightly
+V (+12 Volt Supply)	-Glowing brightly
Φ1, Φ2, Φ3 (Comparator Output Indication)	-Glowing dimly

*The TRIP LED should come on after the run command is applied to the drive.

NOTE: If any of the LED's do not conform to the pre-start list, do not immediately suspect the AA650 card of being faulty. First check out all external connections for short circuits and cross connections etc. The AA650 card has been thoroughly tested at the factory and it will be unlikely that this card would be at fault.

Phase Rotation Correct Indication

If the phase rotation LED is not glowing, the supply should be disconnected and any two phases of the supply reversed. When power is restored, this LED should glow brightly. If this LED remains in the OFF condition, the supply to the drive should be checked for the correct phase to phase voltage.

Considerations before Running the Motor

Prior to running the DC motor, ensure that the motor is free to rotate at maximum speed without damage to the machine to which it is coupled. It is preferable to de-couple the motor from the machine if possible, as this will ensure no possible damage to the machine. Where compound motors are used, it is preferable to by-pass the series field winding until the drive unit has been completely set up.

3.2 Initial Operation of the Drive Unit

Before running the drive, it will be necessary to carry out the following:

a) Operator's speed control set to its zero-position. Where motorized potentiometers are used, this can be done by operating the Increase/Decease speed buttons.

b) Where tachogenerator feedback is used, it will not initially be certain whether the signal is of the correct polarity. It is, therefore, suggested that the tachogenerator be electrically disconnected temporarily. The drive will automatically revert to the correct polarity armature feedback, and the drive can be set up initially on this feedback signal.

c) Ensure that the Shunt Field voltage is at the correct maximum value.

NOTE: In de-energized state, the field economy circuit will be operation. The field voltage will be at 2/3 normal level until the DC6 is started.

Press the Start pushbutton and slowly adjust the Operator's Speed control in a clockwise direction until the motor starts to turn and accelerate up to the set speed.

CAUTION: Dangerous voltage will be present if power is not removed.

Check that the motor is turning in the correct direction. If the motor is not turning in the correct direction, switch off the power and reverse the connections to the motor's shunt field.

NOTE: The Trip circuit may operate at 12 second intervals during this procedure and remove power from the motor. This is normal, and the Stop/ Start circuit should be re-activated after such a trip. Once the correct maximum motor current and speed has been set up, the Trip circuit will act correctly, that is only remove power from the motor if it has stalled for a period longer than 12 seconds under maximum current conditions.

Restore power to the drive, and run the motor once more. The motor should now turn in the correct direction.

While the motor is running, check the polarity of the voltage generated by the tach. When this polarity has been determined, switch off the drive unit and re-connect the tach to the drive with the polarity indicated in this manual or in the Engineering Drawing supplied if a standard non-modified DC6 was purchased.

Restore power to the drive and run once more. The motor should be running under the influence of the tach, and the ST light should be glowing brightly.

If the motor accelerates to the absolute maximum speed, regardless of speed setting, this will indicate that the tach voltage polarity is incorrect, and should be rechecked.

3.3 Maximum Speed Adjustment

With Armature Feedback

This adjustment should be carried out with the tach disconnected from the drive unit, if this option is used.

Start the drive and set the operator's speed control to maximum. Adjust the control "AV" (RV2) on the control card for the correct maximum armature voltage indicated on the motor nameplate. Once this adjustment has been carried out, the tach connections can be restored to the drive unit.

With Tach Feedback(Optional)

Set the operator's Speed Control to maximum, and check the motor speed by holding a hand tach to the motor shaft or by checking the tachogenerator voltage. The standard tach type 5PY used by Saftronics is rated at 50 Volts/1000RPM. This should, however, be confirmed by referring to the tach nameplate. It will also be noted that with the Speed Control set at maximum, the DV lamp on the AA650 card will glow brightly. Adjust the Maximum speed control,RV6 on the AA650 card, for the required maximum speed; usually 1750RPM, or 87.5 Volts on the 5PY tach.

Note: If the tachometer is 100V/ 1000 rpm and the motor is 1750 rpm, then put an 82K resistor in series with the tach lead.

3.4 Minimum Speed Adjustment

Set the operator's Speed Control to zero while the drive unit is on, and adjust the Minimum speed control, RV7 on the AA650 card, for the correct minimum speed.

3.5 Tach Loss Protection Check

When steps 2.3.5, 2.3.6, and 2.3.7 have been carried out, it will be possible to check this feature as follows:

With the motor running at half speed, remove one of the tach connections from the drive. The control should now revert to impedance-isolated armature voltage feedback and the motor speed should only change marginally (it can either increase or decrease depending on the setting of "AV", RV2, with respect to the Maximum speed adjustment).

3.6 Speed Stability Adjustment

When in operation, the drive unit regulator may be unstable. This becomes evident when the motor speed is unstable or erratic. The Stab control, RV5 on the AA650 control card, should be adjusted whenever necessary so that the motor speed is smooth and stable, with very little under or overshoot with speed changes.

3.7 Normal Current Limit Adjustment

With the motor running normally, at maximum speed, adjust the Current Limit control towards minimum until the motor speed starts dropping. Stop the drive unit, and switch off the AC supply. Disconnect the field supply from the motor, and jam the shaft to prevent it from turning. Field loss relay protection, FLR must be bypassed in the 120 vac control logic during this set up.

NOTE: The motor may stop completely, but this is quite normal.

Restore power to the drive, set the speed control to minimum and press the Start pushbutton. Slowly increase the speed control to maximum. The motor armature current will rise to a low value, as indicated by an ammeter and the stall LED. ST will go off, indicating that there is a 12-second period in which the current limit can be set before the trip circuit comes into operation. Adjust the Current Limit (CL) control slowly toward motor nameplate full load current rating.

NOTE: Compound Motors generate considerable torque even without SHUNT FIELD excitation, so it is advisable to leave the series field winding disconnected from the armature circuit as previously suggested (see section 3.1).

NOTE: The TRIP circuit may frequently operate during this adjustment, but this is quite normal as it will depend on how long the adjustment takes to be carried out.

The TRIP circuit prevents the motor from drawing high current for excessive periods, while in the stall condition. The Start/Stop circuit should be re-activated to clear this condition.

After set up disconnect power, remove the object jamming the shaft, and re-install field cables and field loss protection circuit.

3.8 Two-stage Current Limit Adjustment (Optional)

With the two-stage current limit feature, it will be essential that the Burden Resistor be sized to give the desired break away current. Standard drives are supplied with Burden Resistors sized for approximately 150% of full load current of the motor, with full clockwise rotation of the current limit potentiometer.

The normal running current limit point can be set by inserting a resistor of a specified value in place of the 0 ohm Resistor supplied with the standard card. This resistor is **R214** on the AA650 control card.

For a 200% break away current, the normal running current limit can be set by choosing a resistor from the table below:

% Running Current	Resistance ohms
200	0
150	330
130	560
120	680
100	1000

To set current limit with this option (two stage current limit) follow the proceedure laid out in section **3.7** above.

After the current limit has been set to the break away current, the drive automatically adjusts the current limit setting to the normal running limit after the **2S** led has turned on.

3.9 IR Compensation

General

IR compensation must **only** be used with Armature Feedback control and **should never** be used with Tach Feedback control. Therefore, where tach feedback is used, this control must remain in the full counter-clockwise position. Furthermore, the motor **must** be coupled to the machine before this adjustment is carried out. The purpose of IR Compensation is to compensate for IR losses in the motor such that low speed holding capability is improved with armature feedback control.

IR Compensation Adjustment

With the drive in operation at half speed, slowly adjust the IR compensation control (RV8) clock-wise until there are signs of instability with quick speed changes from 25% to 75%. Slowly adjust the IR compensation control towards minimum again until all signs of instability have disappeared. This will be the maximum amount of the IR compensation that the machine will allow with good stability. It should be kept in mind that where the machine is new or reconditioned, it may be “tight” initially, and it may be found necessary to reduce the amount of IR compensation at a later stage to prevent instability.

3.10 Acceleration/ Deceleration Adjustment

The acceleration and deceleration control RATE I and RATE II respectively, can be adjusted for the required acceleration and deceleration to suit the application.

3.11 Jog Speed Adustment

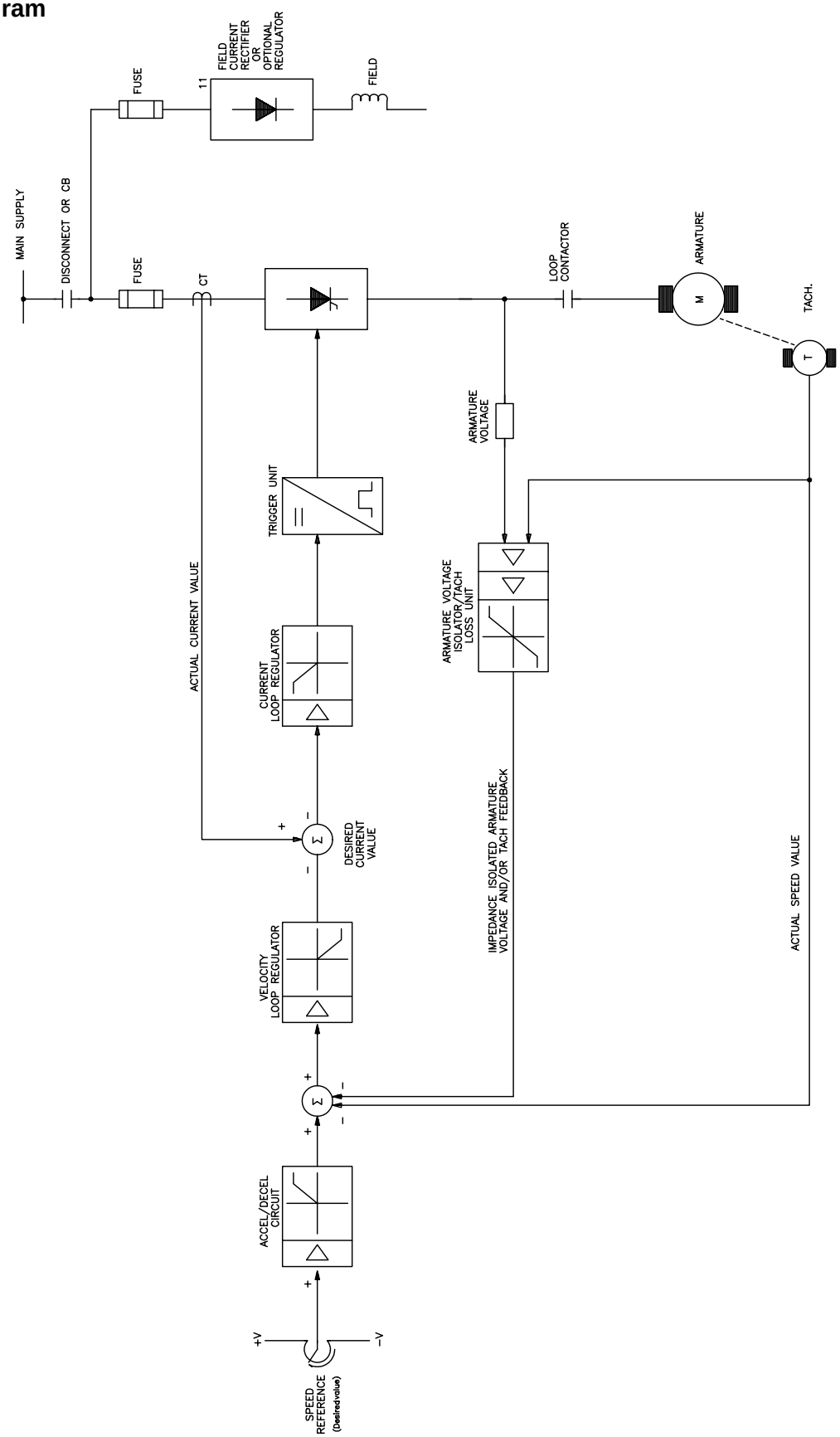
Where this feature is supplied, the Jog pushbutton must be pressed and the Jog Speed control on the A650-MB-2 control board must be adjusted for the desired jog speed.

3.12 General

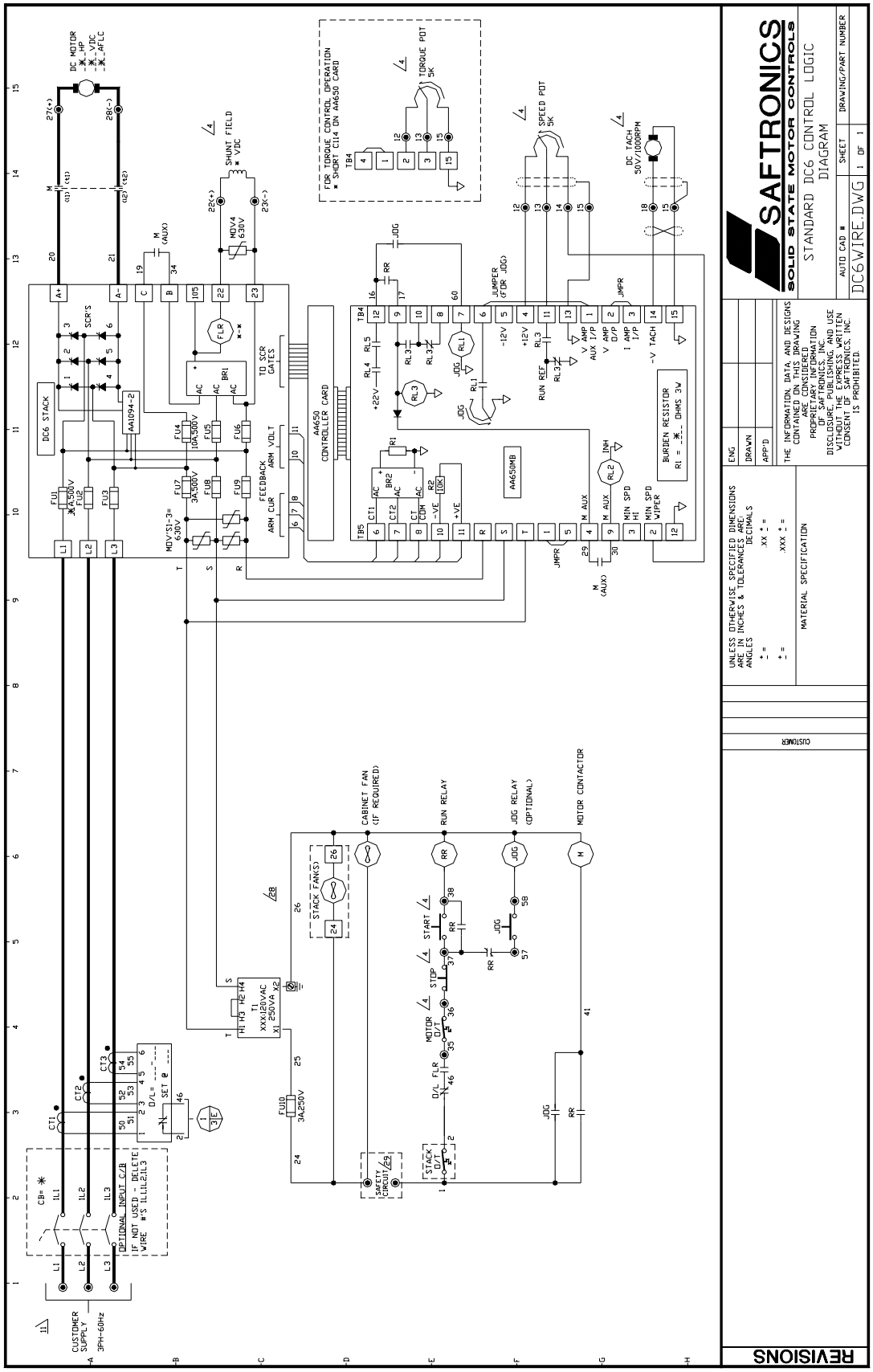
When all adjustments have been carried out, reconnect the series (compound) field (see p4). It must be ensured that the series field is correctly connected such that it assists the main shunt field of the motor and not oppose it.

4. DIAGRAMS

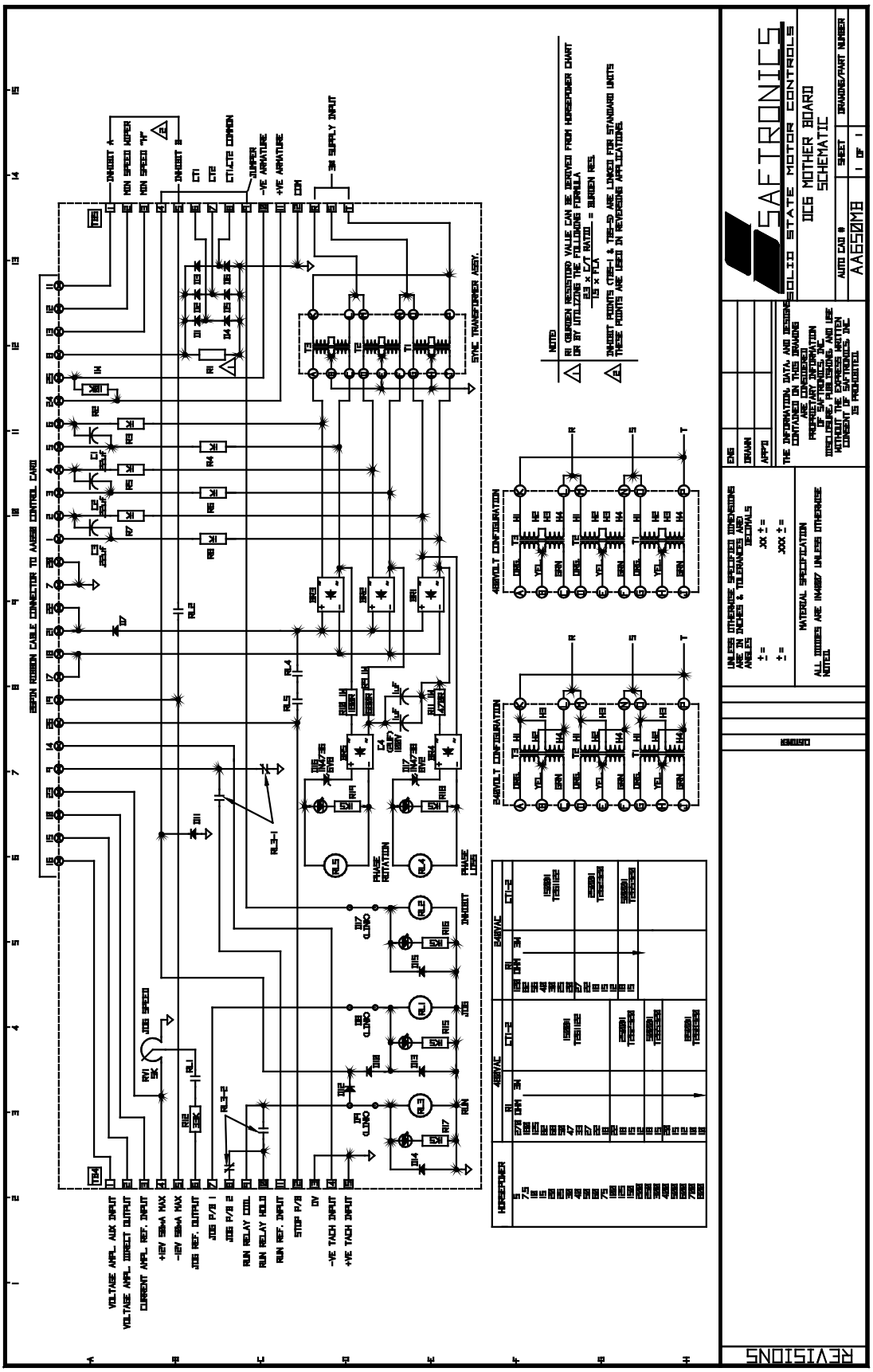
4.1 Block Diagram



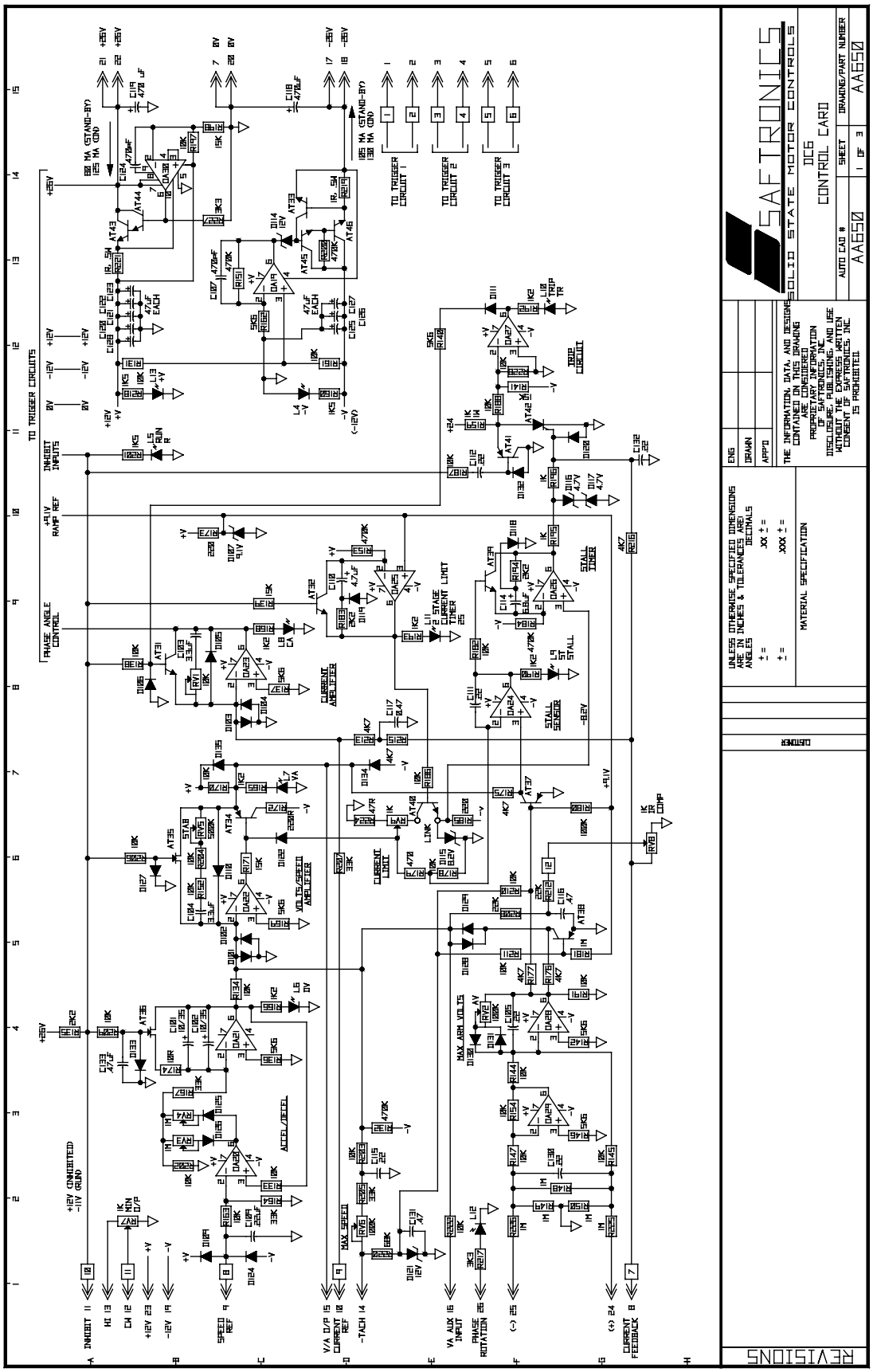
4.2 Typical Wiring Diagram



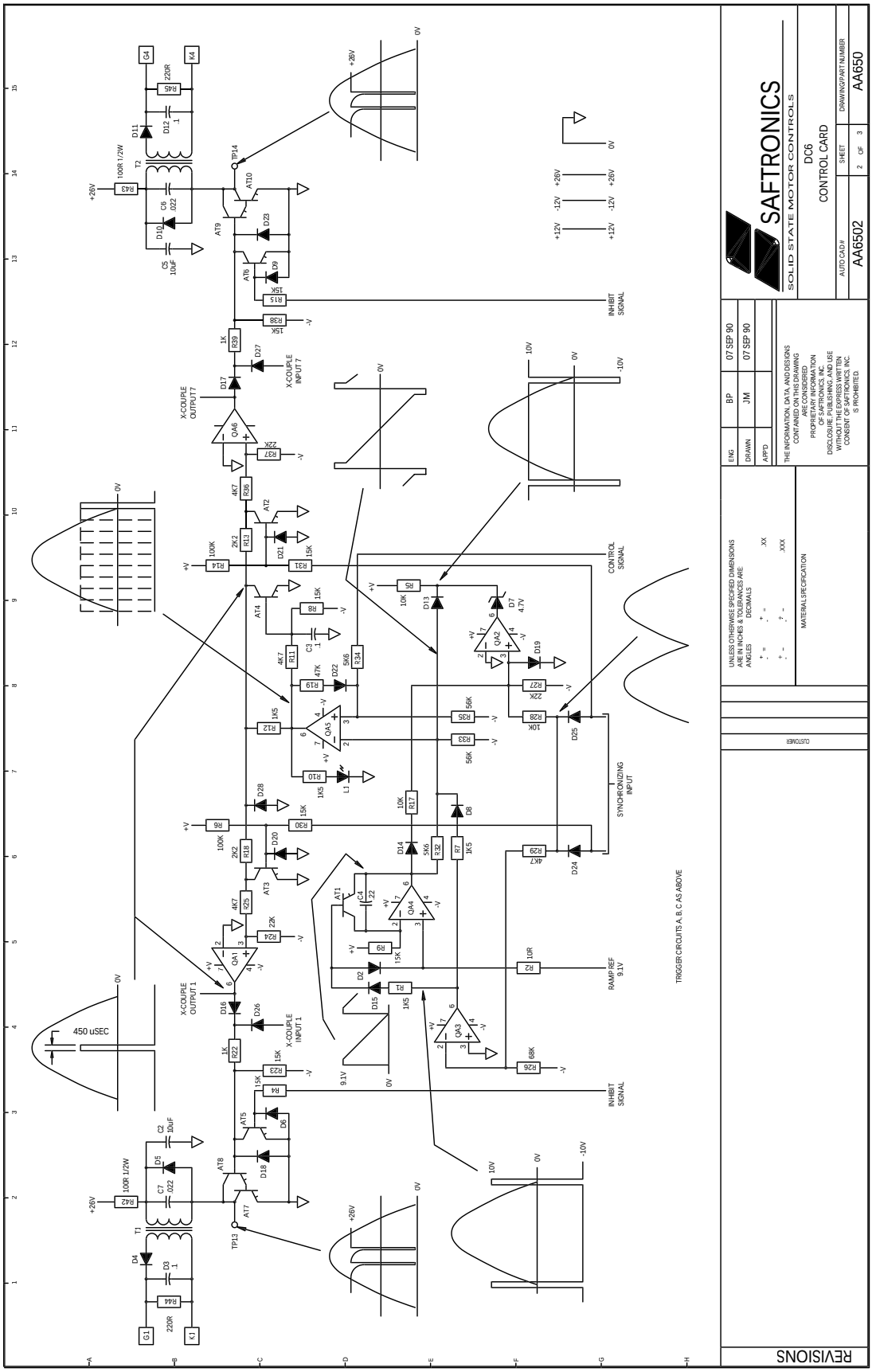
4.3 AA650MB Schematic



4.4 A650 Control Schematic



4.4 A650 Control Schematic cont'd



5. BURDEN RESISTORS

	240 VAC				480 VAC			
HP	Current F/B CT	Burden resistor ohms	O/L CT	O/L Heater or Setting	Current F/B CT	Burden resistor ohms	O/L CT	O/L Heater or Setting
5	1500:1	120	-	FH46	1500:1	270	-	FH38
7.5	1500:1	82	-	FH50	1500:1	180	-	FH43
10	1500:1	56	-	FH54	1500:1	125	-	FH46
15	1500:1	40	-	FH83	1500:1	82	-	FH49
20	1500:1	30	-	FH86	1500:1	68	-	FH53
25	1500:1	25	-	FH89	1500:1	50	-	FH55
30	1500:1	20	-	FH90	1500:1	47	-	FH82
40	2500:1	27	250:5	2.3	1500:1	33	-	FH85
50	2500:1	22	250:5	2.9	1500:1	27	-	FH88
60	2500:1	18	250:5	3.3	1500:1	22	-	FH89
75	2500:1	15	250:5	4.2	1500:1	18	-	FH92
100	2500:1	12	500:5	2.8	2500:1	22	250:5	2.6
125	5000:1	18	500:5	3.5	2500:1	18	250:5	3.3
150	5000:1	15	500:5	4.1	2500:1	15	250:5	3.9
200	-	-	-	-	2500:1	12	500:5	2.6
250	-	-	-	-	5000:1	18	500:5	3.2
300	-	-	-	-	5000:1	15	500:5	3.9
400	-	-	-	-	8500:1	20	1000:5	2.6
500	-	-	-	-	8500:1	15	1000:5	3.3
600	-	-	-	-	8500:1	12	1000:5	4.0
700	-	-	-	-	8500:1	10	1000:5	4.7
800	-	-	-	-	8500:1	10	1500:5	3.6

Burden resistor calculation:
R=1.53 x CT / FLA
Where R = burden resistor in ohms,
CT = Current F/B ratio
FLA = Motor full load amps
Example: FLA = 100, CT = 1500:1, then
R= 1.53 X 1500 / 100 = 23 ohms, use 22 ohm, 3 watts.

6. TROUBLESHOOTING

The three most frequent causes of a drive system or major component malfunction are:

1. Fuse failure.
2. Discontinuity in a circuit, caused by a broken or loose connection of the wiring.
3. Circuit grounding, caused by faulty or damaged insulation or wiring or a loose component coming in contact with ground.

If a drive or major component, that has been operating properly, suddenly malfunctions, do not make any adjustments or replace any components without first checking:

1. For blown fuses.
2. All connections for tightness.
3. All wiring for breaks.
4. All wires for faulty or damaged insulation.

If, after making the above checks, trouble is still encountered, refer to the following trouble shooting table.

SYMPTOM	PROBABLE CAUSES
Contactor will not energize when Start button is pressed	1. Overload relay tripped. 2. No control power. Check for 120 vac supply. 3. Faulty or improper wiring between drive cabinet and operator's control station. 4. Field loss relay contact open. 5. Open contactor coil. 6. Safety circuit open.
Output voltage does not increase as speed pot is turned up.	1. Improper or defective wiring between cabinet and speed pot. 2. Defective speed pot. 3. Defective AA650 card.
Drive unstable.	1. IR drop compensation set too high. 2. Motor series field connected backwards. 3. Defective AA650 card. 4. Stability pot needs adjustment.
Speed drift or poor regulation	1. Current limit set too low. 2. Motor overloaded. 3. Defective AA650 card. 4. Defective A650MB-2 assembly.
Low maximum speed	1. Current limit set too low. 2. Motor overloaded. 3. Max speed pot not adjusted properly. 4. Defective wiring between AA650 card and A650MB-2 assembly. 5. Open scr gate. 6. Low reference voltage

SYMPTOM	PROBABLE CAUSES
Circuit breaker trip	1. Current limit set too high. 2. Ground in motor armature or field. 3. Defective SCR. 4. Defective AA650 card. 5. Defective A650MB-2 assembly.
AC line fuse/fuses blown	1. Shorted or grounded DC output wiring. 2. Grounded motor armature or field. 3. Shorted motor field. 4. Defective SCR.
Control circuit fuse blown	1. Defective wiring or component contacting ground or other circuits. 2. Shorted relay or contactor coil.

State of LED's

When power is applied:

-V	R	DV	VA	CA	Ø1	Ø2	Ø3	ST	TR	2S	Ø	+V
○	●	●	●	●	◉	◉	◉	○	○	●	○	○

When the start pushbutton is pressed:

-V	R	DV	VA	CA	Ø1	Ø2	Ø3	ST	TR	2S	Ø	+V
○	○	◉	◉	◉	◉	◉	◉	○	○	○	○	○

○ LED on

● LED off

◉ LED dim

7. SPARE PARTS

PART DESCRIPTION	MODEL NUMBER					
	DC6-61	DC6-126	DC6-251	DC6-350	DC6-500	DC6-800
Control Card List Price Recommended Quantity	AA650 $1500 1	AA650 $1500 1	AA650 $1500 1	AA650 $1500 1	AA650 $1500 1	AA650 $1500 1
Mother Board 240V 480V List Price Recommended Quantity	A340001 A340002 $600 1	A340001 A340002 $600 1	A340001 A340002 $600 1	A340001 A340002 $600 1	A340001 A340002 $600 1	A340001 A340002 $600 1
Suppression Card List Price Recommended Quantity	AA1094-2 $105 1	AA1094-2 $105 1	AA1094-2 $105 1	AA1094-2 $105 1	AA1094-2 $105 1	AA1094-2 $105 1
Ribbon Cable List Price Recommended Quantity	W2600-36 $35 1	W2600-36 $35 1	W2600-36 $35 1	W2600-36 $35 1	W2600-36 $35 1	W2600-36 $35 1
Stack Overtemp Switch List Price Recommended Quantity	S523002--03 $20 1	S523002--03 $20 1	S523002--03 $20 1	S523002--03 $20 2	S523002--03 $20 2	S523002--03 $20 2
AC Line Fuse List Price Recommended Quantity	F602003--09 $36 3	F602003--11 $54 3	F602003--20 $67 3	F602003--20 $67 3	F602003--23 $93 3	F602003--25 $168 3
SCR List Price Recommended Quantity	N10SP06A $150 3	N10SP06A $150 3	N20SP10 $285 3	N728452 $225 6	N716452 $240 6	N719122 $397 6
Field Bridge List Price Recommended Quantity	D310002 $33 1	D310002 $33 1	D310002 $33 1	D310002 $33 1	D310002 $33 1	D310002 $33 1

FIELD LOSS RELAYS		
RATING	**PART NUMBER**	**LIST PRICE**
0.25 - 1.0 Amps	A450001	$115
1.0 - 4.0 Amps	A450002	$115
4.0 - 10.0 Amps	A450003	$115
2.0 - 6.0 Amps	A450004	$115

8. WARRANTY

Saftronics warrants to buyer that products, and any services furnished hereunder will be free from defects in material, workmanship and title, and will be of the kind and quality specified in the quotation. The foregoing shall apply only to failures to meet said warranties (excluding any defects in title) which appear within one year from the date of shipment hereunder, provided, however, that if buyer, in the course of its regular and usual business, transfers title to or leases such products (including equipment incorporating such products) to a third party, such period shall run until one year from such transfer or lease or eighteen months from shipment by Saftronics whichever occurs first. The warranties and remedies set forth herein are conditioned upon (a) proper storage, installation, use and maintenance, and conformance with any applicable recommendations of Saftronics and, (b) buyer promptly notifying Saftronics of any defects and, if required, promptly making the product available for correction.

If any products or services fails to meet the foregoing warranties (except title), Saftronics shall thereupon correct any such failure either, at its option, (i) by repairing any defective or damaged part or parts of the products, or (ii) by making available FOB Saftronics plant or other point of shipment, any necessary repaired or replacement parts. The preceding paragraph sets forth the exclusive remedies for claims (except as to title) based on defect in or failure of products or services, whether claim in contract or tort (including negligence) and however instituted. Upon expiration of the warranty period, all such liability shall terminate. The foregoing warranties are exclusive and in lieu of all other warranties, whether written, oral, implied or statutory. No implied statutory warranty of merchantability or fitness for particular purpose shall apply and Saftronics will not be liable for any consequential damage arising from any product defect or failure to deliver on time. Saftronics does not warrant any products or services of others which buyer has designated.