DBS II

Digital Bypass Solid State Starter

MA-0002 • REFRIGERATION DBSII / JUNE 09 / REV 1

Operator's Guide and Instruction Manual

RAM INDUSTRIES LLC

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Symbols

The following list contains an explanation of the symbols used in this document.

NOTE: This symbol is used when there is information you might find especially useful. The information may also warn you about possible problems you could encounter.

CAUTION! This symbol is used when there is important information that can help you avoid potential injury.

DANGER! This symbol is used when there is important information that can help you avoid the risk of serious personal injury or death.

WARNING! This symbol is used when there is important information that can help you avoid the risk of serious personal injury or death.

Refrigeration Solid State Starter

Disclaimers

NOTE:

The information contained herein is not intended as a training manual for unqualified personnel. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased or in personnel safety precautions. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary information supplied with this equipment, the latter shall take precedence.

RAM Industries reserves the right to make changes in specifications shown herein or add improvements at any time without notice or obligation.

WARNING
Disconnect all Sources of Power and Lockout
Before Servicing This Equipment

This equipment should be installed and maintained by qualified personnel only, in accordance with recognized safety standards and applicable electrical or building codes. The manufacturer is not responsible for damages or injuries resulting from improper installation or use.

For the purposes of this manual, a qualified person is one who is familiar with the installation, construction, or operation of the equipment and the hazards involved. In addition, he has the following qualifications:

a) Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

c) Is trained and authorized to work on exposed parts that may be energized.

d) Is trained in rendering first aid.

Handling and Storage

Handling

- Strap or brace the DBS controller prior to moving it.
- Do not top-stack DBS controllers.
- Do not remove DBS controller from skid or unpack it until final installation, if possible.
- Packaged DBS controllers should be moved with a forklift and tethered with safety straps.
- Top-lifting should be done only with suitable lifting eyes attached to mounting brackets when provided.

Storage

If the DBS controller will be stored for an extended period before installation:

- Inspect for possible damage incurred in transit.
- Re-package after inspection.
- Store in clean, dry environment with a uniform temperature to prevent condensation inside the controller.
- Cover the controller to protect from dust, moisture, and falling objects.

Refrigeration Solid State Starter

1.0 Description

1.1 Overview

The DBS (digital bypass solid state) reduced-voltage starter is a microprocessor controlled motor starting device which utilizes six SCRs (silicon controlled rectifiers) to electronically reduce the applied voltage to an AC induction motor, allowing the motor to start at a reduced current. Because the DBS accelerates the motor in a smooth stepless manner, it reduces drop in the supply voltage as well as mechanical shock on the driven equipment, that is normally experienced with two-step, electromechanical, reduced-voltage starting methods.

The DBS can be programmed to provide a gradual build up of torque, from zero to almost full motor locked rotor torque, or to limit starting currents to a constant value, which prevents an excessive voltage drop during motor starting.

1.2 Standard Features

Universal Source Matching: The DBS automatically adjusts itself to any input voltage between 200 and 600 VAC and any frequency from 45 to 65 Hz.

Closed Loop Starting: The DBS starts a motor in a continuous controlled current mode, which eliminates mechanical shock to the motor.

Automatic Bypass: The DBS includes a bypass contactor that is automatically engaged after the motor has reached full speed, or when the bypass delay has expired. The bypass contactor reduces power losses and heat build-up so that the DBS controller, in an unventilated enclosure in a 40°C ambient, can continuously operate a fully-loaded motor.

Electronic Motor Overload Protection: The DBS has integral electronic motor protection. This micro-processor-based feature provides comprehensive motor overload protection as well as monitoring and annunciating system alarm and shutdown conditions. See Section 1.7 for full explanation of motor overload protection features.

LED Diagnostics: The DBS has four LEDs provided on the front of its control board to indicate the operating state of the DBS.

Motor Connection: No special motor is required. Any standard 3-phase motor can be connected to the DBS. See Figure 10 in the Appendix for typical 3-wire connection diagrams.

Starting Modes: Two starting modes provide optimum performance to match the DBS to the motor load characteristics:

a. **Constant Current Mode:** Starting current is limited to a maximum level, adjustable from 200-425% of FLA, until the motor attains full speed. This mode is recommended for light to moderate inertial-type loads. See Figure 6, Section 5.

b. **Step Ramp (Current Ramp) Mode:** After the starting current quickly reaches the current step limit, it can ramp up to 500% FLA. The ramp time allowed can be set from 3-30 seconds. This mode is recommended for heavy inertial and friction-type loads. See Figure 7, Section 5.

Control: A programmer/display unit (KL4) is mounted in the door of the controller's enclosure. The motor's operating conditions are displayed and motor specifications and operating parameters are programmed though the KL4.

UL and CUL Approved: All models have been tested and approved by Underwriters Laboratory per UL 508 Standard, and conform to Canadian National standards.

Refrigeration Solid State Starter

1.3 System Parameters

The motor and load characteristics and the control method define system parameters. These are configured with switches on the control board of the DBS controller.

- Full Load Amps (FLA)
- Constant Current Level (% FLA)
- Ramp Bypass Time (Seconds)
- Control Mode (Display)
- Overload Protection (Enabled / Disabled)
- Starting Mode (Constant Current / Step Ramp)
- Configuration (Inline)

NOTE: System parameters can be changed only when motor is not running. Refer to Figure 8, Section 5, for switch configurations.

1.4 Control Mode

The DBS Refrigeration Solid State Starter is set up to operate in the Display control mode by means of DIP switches located on the DBS control board. Refer to Figure 8, Section 5, for switch configurations.

The KL4 control/display unit, mounted on the front of the enclosure door and connected to the DBS via an RS-232 port, provides the interface to program and monitor the DBS controller.

1.5 Operating States

The operating states, annunciated by means of status codes on the KL4 control/display unit, describe the DBS conditions seen by its microprocessor. - See Section 8.1 for Status Codes.

READY - The DBS is ready to start the motor. The DBS has passed all the preliminary system checks, including verifying there are no shorted SCRs, all internal system tests have passed, and no phase reversal or trip condition is present.

START - The DBS is in the process of starting the motor. Full speed has not been attained, and the bypass contactor has not been turned on.

RUN - The motor has reached full speed, or the end of the bypass time has been reached, and the bypass contactor has been turned on.

TRIP - The DBS has detected a trip condition and stopped the motor.

COOLDOWN - The motor has exceeded its thermal capacity and will not be allowed to start until enough time has elapsed to allow the motor to cool. The time until the motor can be re-started can be viewed in the Monitor Menu under “Time Till Start.”

1.6 LED Annunciation

LEDs, located on the front of the DBS control board, annunciate operating status and assist in troubleshooting while the starter door is open.

READY LED (Green) indicates the DBS is in the READY state.

RUN LED (Green) indicates the DBS is in either the START or RUN state. The LED will blink when in the START state, then turn on steady once the RUN state is reached.

ALARM LED (Yellow) indicates the DBS has detected an ALARM condition. The LED will blink until the alarm is acknowledged (see Section 8.3). When the condition is no longer present, the LED will go out, and normal operation can resume. If the condition is acknowledged, but is still present, the LED will turn on steady and remain on until the alarm condition is removed. The control/display unit or Frick computer will show the cause of the alarm.

TRIP LED (Red) indicates the DBS is in the TRIP state. The LED will blink until the trip is acknowledged (see Section 8.3). When the trip condition is no longer present, the LED will go out, and normal operation can resume. If the condition is acknowledged, but is still present, the LED will turn on steady and remain on until the trip condition is removed. The KL4 control/display unit will show the cause of the trip.

1.7 Electronic Motor Overload Protection and Monitoring

The DBS electronically monitors and protects the motor, during both start and run states, by using, in addition to user presets, a unique model of operating limits for the motor created from three-phase current and voltage input signals. It also records pertinent operating history for troubleshooting and maintenance purposes.

Fault conditions are annunciated and acknowledged through the DBS door-mounted KL4 control/display unit.

The DBS electronic overload affords motor protection against the following conditions:

- Stalling
- Overheating
- Locked Rotor

Additionally the DBS microprocessor will detect the following conditions:

- Jam
- Short Circuit
- Phase Loss
- Current Unbalance
- Phase Reversal

1.7.1 Trip Conditions

Multiple trip conditions can be detected and displayed in either DBS control mode. The detection of a trip condition while the motor is running will cause it to stop. Refer to the Set Point Menu (Section 9, Table 13) for trip set points and defaults.

SHORT CIRCUIT - This trip will occur if the current exceeds 800% FLA while the DBS is in the START state. This condition will activate the circuit breaker shunt trip.

THERMAL OVERLOAD - This trip will occur when the calculated thermal energy stored in the motor exceeds 100% of the motor's thermal capacity. The motor will be allowed to start again when the motor has sufficiently cooled.

SHORTED SCR - This trip will occur if one or more of the SCRs is shorted. A trip will occur if line voltage / 1.73 is not present from line to load across each phase of the starter when the motor is properly connected. This voltage is checked only after a run signal is received. This trip will also occur if current flow is detected when the motor is not running. This current is an indication of a "runaway" motor and will result in the activation of the shunt trip.

PHASE REVERSAL - This trip will occur if phase rotation on the incoming power is not: L1 - L2 - L3. A reversal condition is checked only after a run signal is received and can be corrected by swapping any two line input phases. Control power must be cycled to clear this fault.

PHASE LOSS - This trip will occur if one or more of the incoming voltage phases is lost when the motor is not running. This voltage is checked only after a run signal is received. This trip will also occur if one or more of the current feedback signals on TB2 of the power board is lost when the motor is running.

HEAT SINK OVERTEMPERATURE - This trip will occur when the DBS heat sink temperature has exceeded safe operating conditions.

PLL FAILURE - Indicates poor power quality.
This check is performed only when the DBS is in the START state.

JAM - This trip will occur if the current is above the Jam Current Level and the Jam run delay has expired. This trip will occur only in the run state.

1.7.2 Alarm Condition

An alarm condition will be annunciated on the KL4 control/display unit and cause the yellow Alarm LED on the DBS control board to light. - Refer to Set Point Menu, Section 9, Table 13, for alarm set points and defaults.

CURRENT UNBALANCE - This alarm will be activated when the current unbalance % exceeds the Current Unbalance level and the Current Unbalance Delay has expired.

Example

a $$\frac{33\,A_1 + 29A_2 + 34\,A_3 = 96\,A_{TOTAL}}{3} = 32\,A_{AVERAGE}$$

b
$$33\,A_1 - 32\,A_{AVERAGE} = 1\,A$$
$$29\,A_2 - 32\,A_{AVERAGE} = -3\,A$$
$$34\,A^3 - 32\,A_{AVERAGE} = 2\,A$$
Largest value: $3\,A_{DEVIATION}$

c $$\frac{3\,A_{DEVIATION}}{32\,A_{AVERAGE}} \times 100\% = 9.4\%$$

2.0 Specifications

TABLE 1 **H.P. Ratings**

208 V	230 V	460 V	575 V	DBS CHASSIS SIZE
30	40	75	100	B1
50	50	100	125	B2
60	60	125	150	B3
60	75	150	200	C1
75	100	200	250	C2
100	125	250	300	C3
125	150	300	400	D1
150	200	400	500	D2
200	----	450	----	D3
250	300	600	700	E1
300	350	700	900	E3

TABLE 2 **UL Short Circuit Capacity Ratings of DBS Starters per UL 508 Standard**

STARTER SIZES	WITH MAIN CIRCUIT BREAKER @ 480 VOLTS	WITH MAIN CIRCUIT BREAKER @ 600 VOLTS	WITH MAIN FUSED DISCONNECT @ 600 VOLTS
B	65 KA @ 480 VOLTS	18 KA @ 600 VOLTS	100 KA @ 600 VOLTS
C	65 KA @ 480 VOLTS	30 KA @ 600 VOLTS	100 KA @ 600 VOLTS
D	65 KA @ 480 VOLTS	42 KA @ 600 VOLTS	100 KA @ 600 VOLTS
E	65 KA @ 480 VOLTS	42 KA @ 600 VOLTS	100 KA @ 600 VOLTS

TABLE 3 DBS Specifications

AC POWER SUPPLY	200V TO 600V RMS
HP RATINGS	SEE TABLE 1
CURRENT CAPACITY	69 AMPS - 900 AMPS
CONTROL VOLTAGE	115 VAC, +/-15% NOTE: 115V CONTROL POWER MUST BE DERIVED FROM THE 3 PHASE POWER SOURCE.
LINE FREQUENCY	45 TO 65 HZ
CONTROL VOLTAGE	B1, B2: 150 VA
VA DEMAND	B3, C1, C2, C3: 250 VA
PER CHASSIS SIZE	D1, D2, D3: 500 VA E1, E3: 750 VA
THERMAL OVERLOAD CAPACITY	300% FLA FOR 40 SECONDS 600% FLA FOR 10 SECONDS
OPERATING TEMPERATURE	0 TO 40 DEGREES C
STORAGE TEMPERATURE	-40 TO 65 DEGREES C
STANDARD STARTING MODES	CONSTANT CURRENT - 200% TO 425% FLA STEP RAMP - 200% TO 425% FLA, RAMP UP TO 500% FLA MAX
USER ACCESSIBLE RELAYS	RUN RELAY: (2) SPST NORMALLY OPEN CONTACTS - 10 AMPS @ 25O VOLT AC, INDUCTIVE RATING SHUNT TRIP RELAY: (1) SPST NORMALLY OPEN CONTACT - 10 AMPS @ 250 VOLT AC, INDUCTIVE RATING ALARM RELAY: (1) SPDT 1-NORMALLY OPEN, 1-NORMALLY CLOSED CONTACT - 10 AMPS @ 250 VOLT AC, INDUCTIVE RATING
COMMUNICATION PORTS	DISPLAY PORT (J1) - RS232, 9600 BAUD NETWORK PORT - RS485, 19,200 BAUD; Receive (RX) LED (yellow) and Transmit (TX) LED (green) indicate network activity. Jumpers JP1 (+) and JP3 (-) select 10k bias resistors: 1-2 Enable, 2-3 Disable. Jumper JP2 selects 120ohm termination resistor: 1-2 Enable, 2-3 Disable (See Figure 5).

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Terminal Data (Line and Load)

Line Connections
75 Deg. Copper Only

TABLE 4

Standard Line Terminals

TABLE REVISED 4/8/09

230V MAX HP	380V MAX HP	460V MAX HP	575V MAX HP	ABB BREAKER FRAME SIZE	TRIP AMPS	WIRE RANGE	RAM P/N	MFG P/N
30	50	60	75	S3	150/225	(1) #2–4/0 AWG	CB-0292	K4TC
50	75	100	125	S3	150/225	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
75	125	150	150	S4	250	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
75	129	175	175	T4	250	(1) #6 AWG–350 KCMIL	CB-1086	KT4250-3
100	150	250	250	S5	400	(2) 3/0 AWG–250 KCMIL	CB-0296	K5TG
100	172	250	250	T5	400	(2) 3/0 AWG–250 KCMIL	CB-1091	KT5400-3
150	250	300	350	S6	600	(2) 250–500 KCMIL	CB-0297	K6TH
200	350	400	500	S6	600	(3) 2/0 AWG–400 KCMIL	CB-0298	K6TJ
300	450	600	700	S6	800	(3) 2/0 AWG–400 KCMIL	CB-0298	K6TJ
350	600	700	900	S7	1200	(4) 4/0 AWG–500 KCMIL	CB-0299	K7TK

TABLE 5

TABLE REVISED 4/8/09

Alternate Line Terminals

ABB BREAKER FRAME SIZE	TRIP AMPS	WIRE RANGE	RAM P/N	MFG P/N
S3	150/225	(1) #14–2 AWG	CB-0290	K3TA
S3/S4	150/225	(1) #14–1/0 AWG	CB-0291	K4TB
S3/S4	150/225	(1) #2–4/0 AWG	CB-0292	K4TC
S3/S4	150/225	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
S4	250	(1) #14–1/0 AWG	CB-0291	K4TB
S4	250	(1) #2–4/0 AWG	CB-0292	K4TC
S4	250	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
S4	250	(1) #6 AWG–350 KCMIL	CB-0294	K4TE
S5	400	(1) 250–500 KCMIL	CB-0295	K5TF
T5	400	(1) 250–500 KCMIL	CB-1089	KT5300-3
S5	400	(2) 3/0 AWG–250 KCMIL	CB-0296	K5TG
S6	600/800	(2) 250–500 KCMIL	CB-0297	K6TH
S6	600/800	(3) 2/0 AWG–500 KCMIL	TL-0236	ATK750/3
S7	1200	NO ALTERNATE		

NOTE!

Information subject to change. Please check website for latest data.

www.ramusa.com

TABLE 6

Load Terminals

SEE

TABLE 1

FOR

CHASSIS SIZE

CHASSIS SIZE	TERMINALS T1 - T2 - T3
CSS	#8 AWG - #1 AWG
B1	#14 AWG - #2/0 AWG
B2 - B3	#6 AWG - #3/0 AWG
C1 - C2	#4 AWG - 500 KCMIL
C3	(2) #2 AWG - 600 KCMIL
D1 - D3	(2) #2/0 AWG - 500 KCMIL
E1	(3) #2/0 AWG - 500 KCMIL
E3	(3) #2/0 AWG - 500 KCMIL

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Dimensional Data for Standard Enclosures

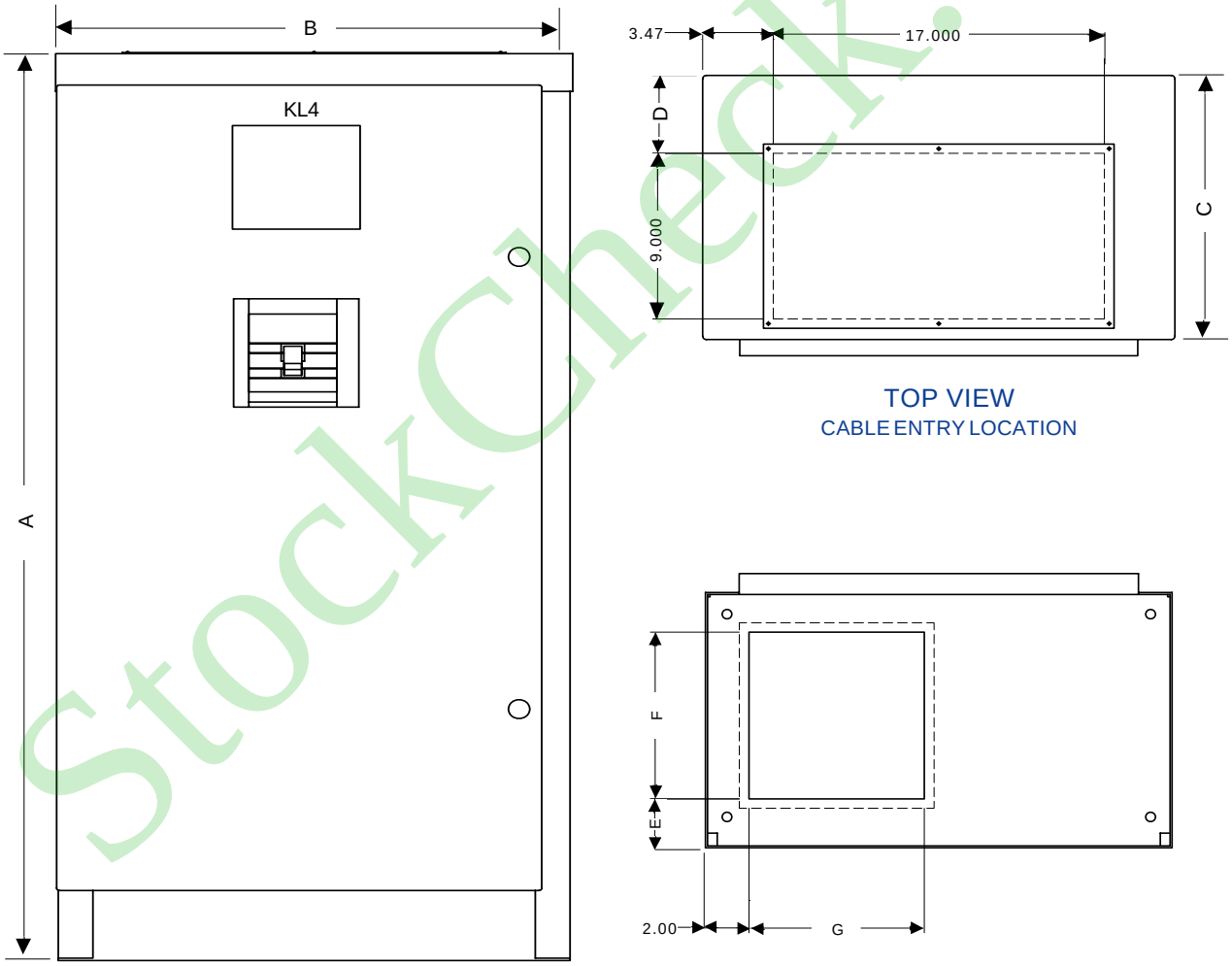
TABLE 7

Standard Enclosure Sizes for Stand-Alone Starters

(in)

HP RANGE PER VOLTAGE					NEMA TYPE 1	CUTOUT DISTANCE FROM REAR		BOTTOM CUTOUT	
208 VOLT	230 VOLT	380 VOLT	460 VOLT	575 VOLT	A B C	D	E	F	G
30 – 50	30 – 60	60 – 100	60 – 125	75 – 150	42 x 24 x 14	4.00	2.60	9.00	9.00
60 – 100	75 – 125	125 – 200	150 – 250	200 – 300	48 x 24 x 14	4.00	2.60	9.00	9.00
125 – 250	150 – 350	250 – 500	300 – 700	350 – 900	72 x 24 x 16	3.52	2.75	10.00	13.00

FIGURE 1



TOP VIEW
CABLE ENTRY LOCATION

BOTTOM VIEW
CABLE ENTRY LOCATION

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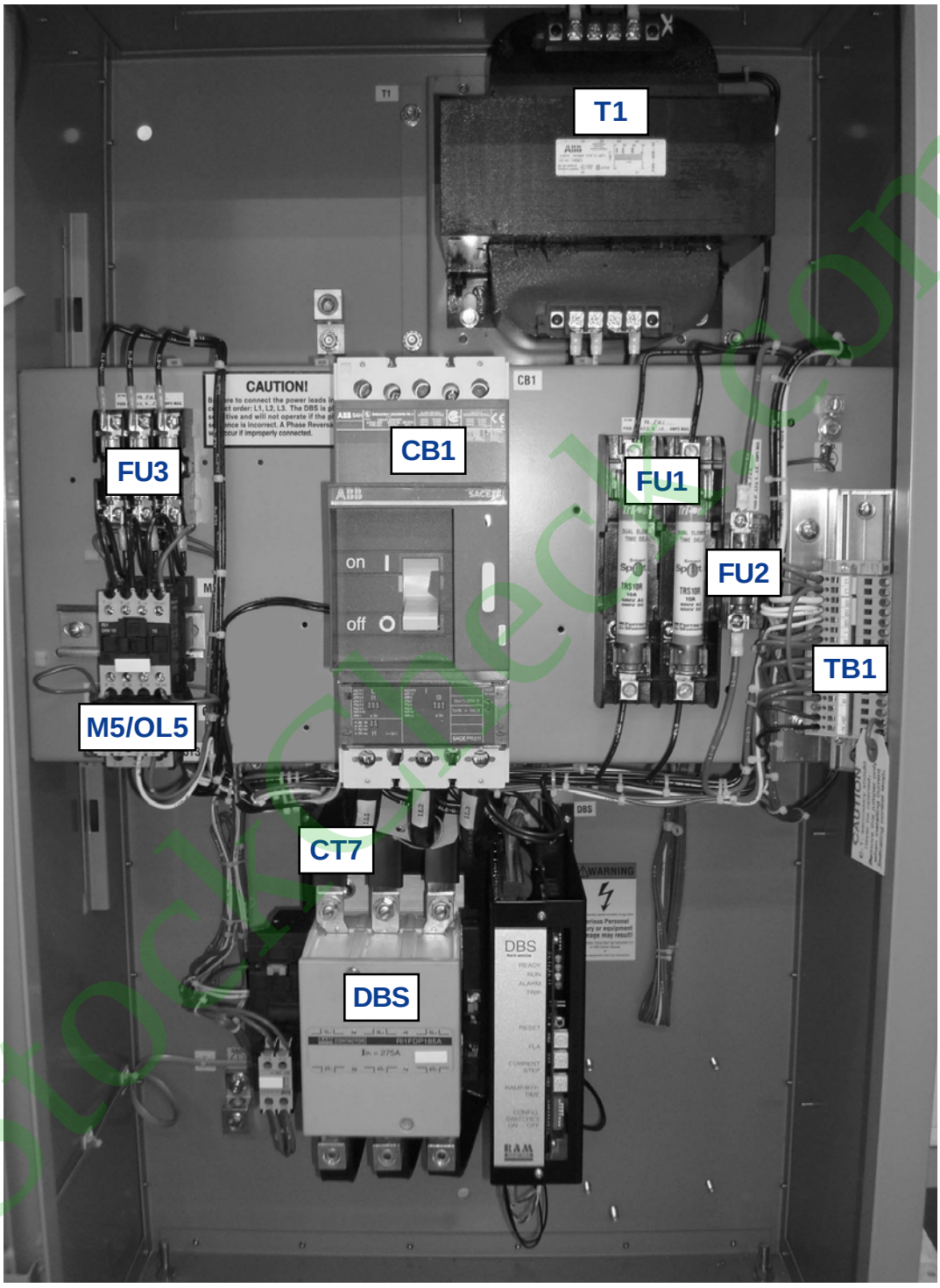
Panel Layout

FIGURE 2



T1: Control Power Transformer
CB1: Circuit Breaker
FU1: Control Power Transformer Primary Fuses
FU2: Control Power Transformer Secondary Fuse
FU3: Oil Pump Starter Fuses
TB1: Terminal Strip
CT7: Current Transformer
DBS: Solid State Starter Chassis
M5/OL5: Oil Pump Starter

3.0 Receiving and Installation

3.1 Receiving

- Upon receipt of the DBS controller, immediately unpack it and look for any shipping damages. If any shipping damages are encountered, file a claim with the freight carrier within 15 days of receipt.
- Verify that the ratings sticker on the DBS chassis matches the motor's HP, current, and voltage rating for the installation.
- Check for loose mechanical connections and assemblies, and wires which may have broken or loosened during shipping and installation.
- Manually exercise all electromechanical devices to make sure they work freely.

3.2 Mounting and Cleaning

- When mounting a "stand-alone" DBS controller, make sure there is sufficient clearance (12" minimum) around the enclosure for cooling, wiring, and maintenance purposes.
- Make sure that the manner in which the controller is mounted meets the latest requirement of the National Electrical Code and any other local code requirements for working space (NEC Code Articles 110-13 and 110-16).
- Freestanding controllers should be securely mounted to a flat, level, base using mounting holes provided. Shim base of enclosure to prevent racking or door misalignment.
- Wall-mount type controllers should be securely mounted to a flat, vertical surface or framework using mounting holes provided using hardware that will adequately support its weight. Shim rear of enclosure to prevent racking or door misalignment.
- When drilling or punching holes in the enclosure, cover the electrical components to prevent metal filings and debris from causing short circuits or reducing electrical clearances.

WARNING! Remove all sources of power before cleaning controller.

- After mounting and wiring is completed, thoroughly clean and vacuum the enclosure, and make sure that all filings, metal chips, and other materials are removed before start-up.

3.3 Environment

The DBS controller may be installed and operated at nameplate rating in an area where the following conditions exist:

- Ambient Temperature shall not exceed 40 degrees C (104 degrees F) with a 15 degree C rise inside the enclosure as maximum.
- Ambient Temperature shall not be less than 0 degrees C (32 degrees F).
- Altitude above sea level shall be 6000-ft. (2000 m.) or less.
- Ambient air is reasonably clean, dry, and free of flammable or combustible vapors, steam, or corrosive gases.

3.4 Derating Factor

WARNING! When a DBS enclosure is mounted in an environment not in accordance with Paragraph 3.3 as described above, it must be derated as follows:

- Derate starter size 1.5% per degree C above 40 degrees C Ambient Temperature or 0.75% per degrees F above 104 degrees F Ambient Temperature.
- Derate starter size 1% for every 100m above 2000m or every 300 ft. above 6000 ft. elevation.

4.0 Wiring

- The DBS controller shall be wired in accordance with the National Electrical Code and any local codes that may apply.
- Copper conductors for 75 deg. C (min.) shall be used for power and control wiring unless specified otherwise.
- Minimum recommended wire sizes are #14 AWG for control voltage and #12 AWG for line voltage.
- Tighten connections per torque values shown on devices. Otherwise, refer to torque values in Table 8.

4.1 Incoming Power

Connect properly sized power wires to the input terminals on the DBS chassis marked L1, L2, & L3.

CAUTION! Incoming power wires must be connected in the correct order: L1, L2, L3. Because the DBS controller is phase sensitive, it will not operate unless the phase sequence is in this order. If not, a Phase Reversal trip will occur.

Avoid routing cable connections near the main circuit board. Refer to the National Electrical Code for wire sizing and lug torque.

TABLE 8 Recommended Tightening Torque

UNLESS OTHERWISE NOTED ON INDIVIDUAL DEVICE

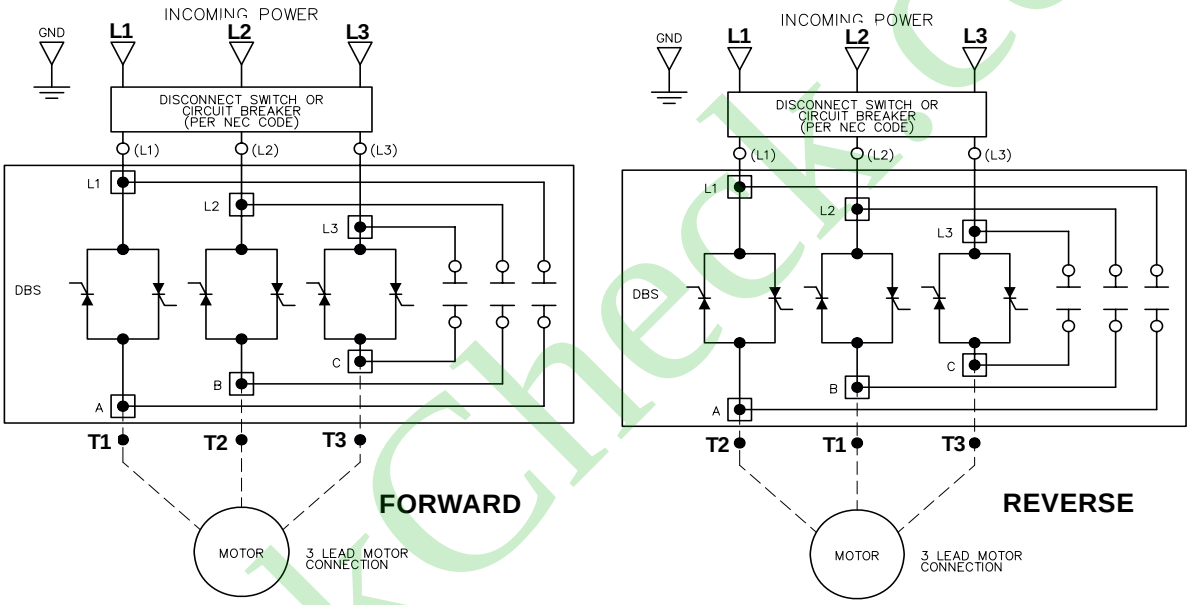
WIRE SIZE (AWG or kcmil)	TORQUE - IN/LB		
	SLOTTED HEAD NO. 10 AND LARGER		HEX HEAD OR SCREWS SOCKET HEAD
	SLOT WIDTH ≤3/64 IN SLOT LENGTH ≤1/4 IN	SLOT WIDTH >3/64 IN SLOT LENGTH >1/4 IN	
18 -10	20	35	75
8	25	40	75
6 -4	35	45	110
3	35	50	150
2	40	50	150
1		50	150
1/0 - 2/0		50	180
3/0 - 4/0		50	250
250 - 400		50	325
500 - 750		50	375

4.2 Motor Connection

Connect properly sized motor leads to terminals T1, T2, and T3 on the DBS bypass contactor. If motor rotation needs to be reversed, swap the position of any two motor leads connected to the DBS bypass contactor. See Figure 3.

NOTE: Do not swap incoming wires to reverse the motor's rotation as this will cause a Phase Reversal trip.

FIGURE 3



4.3 Control

Customer control wiring is to be connected to the controller's main terminal block (TB1) in accordance with RAM wiring diagram supplied.

4.4 Grounding

Connect properly sized ground cable to the starter ground terminal. Refer to the National Electrical Code for proper size, and make sure the ground conductor is connected to a solid earth ground.

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4.5 Field Connected Relay Outputs - TB1

The contacts of two relays on the DBS control board are available for controlling external devices when not being utilized by the starter's basic control circuit. These contacts are connected to TB1 on the DBS control board. - See Figure 5, Section 4, for illustration of contacts and Table 3, Section 2, for contact values.

Run Relay - Energized when a start sequence is initiated.
N.O. Contact connected to terminals 7 and 8 may be used as a dry contact.
N.O. Contact connected to terminals 5 and 6 should be used ONLY as part of the start circuit.

Alarm Relay - Energized when an alarm condition exists.
N.O. Contact is connected to terminals 11 and 12.
N.C. Contact is connected to terminals 12 and 13.

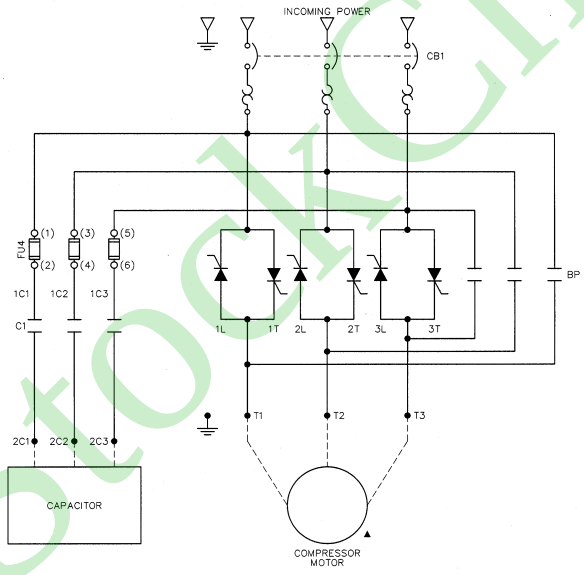
4.6 Communication Ports - J1

Display Port - RJ-45 modular connector provides RS-232 communication for display. Refer to Sections 8 and 9 for control/display unit operation. See Figure 5, Section 4.

4.7 Power Factor Correction Capacitors (Option)

CAUTION! Power factor correction capacitors, when provided, shall always be connected on the line side of the DBS controller.

FIGURE 4

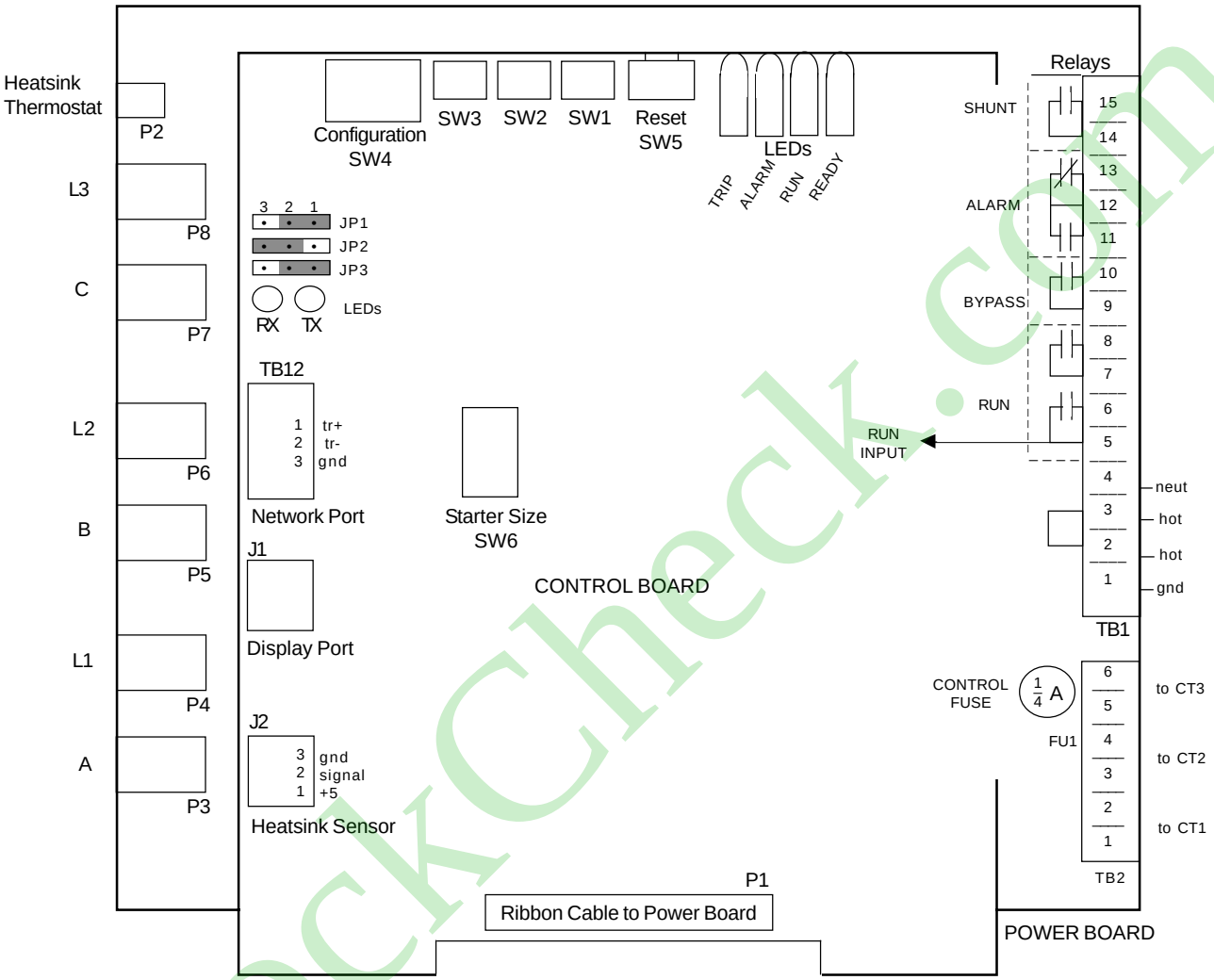


4.8 Lightning Arrestor (Option)

A lightning arrestor is recommended in areas where frequent lightning occurs. It should be installed on the line side of the controller's circuit breaker.

4.9 Circuit Board Connections

FIGURE 5 **External Connections to Boards**



5.0 Set-Up Instructions

CAUTION! Equipment is at possibly lethal AC line voltage when AC power is connected. All phases must be disconnected by shutting down main power feed to this unit before it is safe to touch motor terminals or control equipment parts.

5.1 Inspection

- Ensure that the starter has been installed according to the preceding guidelines.
- Ensure that the controller has been wired according to the schematics and all electrical codes.
- Check that all connections are tight. Ensure that motor shaft rotates freely.

CAUTION! Before power is applied to the starter, the following settings and adjustments should be reviewed and appropriate changes made as required.

5.2 Setup Switches

The DBS chassis has been factory set for normal operation via switches SW1, SW2, SW3, SW4, and SW6, on its control board - See Figure 8.

5.2.1 Motor FLA - SW1

This 16-position rotary switch setting is based on DBS chassis size and the FLA rating of the motor. Per Table 9, Section 5, select the value closest to the Motor Full Load Current from the box that corresponds to the DBS chassis size.

5.2.2 Current Step - SW2

This 10-position rotary switch sets the initial current step of the controller when in either **Constant Current** or **Step Ramp** mode. This switch is adjustable from 200-425% FLA in increments of 25%. - See Table 15, Section 9.

When the controller mode is set for **Constant Current**, the maximum current the motor can draw during starting is limited until the motor reaches full speed.

When the controller mode is set for **Step Ramp**, the initial current drawn during starting is limited. The Step Ramp mode then allows the motor to draw up to 500% FLA to attain full speed over a set time range.

5.2.3 Ramp / Bypass Time - SW3

In the **Step Ramp** mode this 10-position rotary switch sets the amount of time the current draw is allowed to increase from its initial Current Step level (set by SW2) to a maximum of 500% FLA. The maximum time until the bypass contactor is energized is 5 seconds, plus the programmed ramp time. - See Table 15, Section 9.

In the **Constant Current** mode, this switch sets the maximum time until the bypass contactor is energized.

SW3 is adjustable from 3-30 seconds, in 3-second increments.

FIGURE 6 **Constant Current Mode**

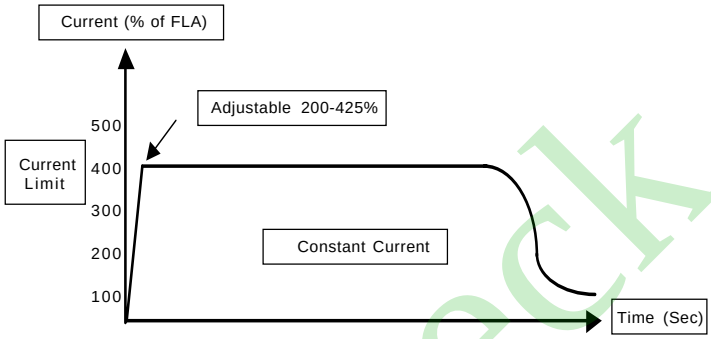
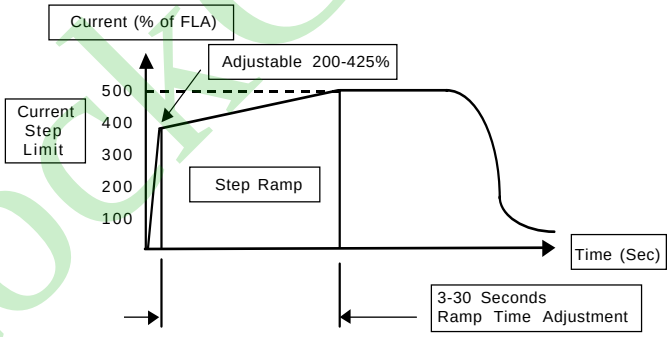


FIGURE 7 **Step Ramp Mode**



5.2.4 System Configuration - SW4

This 8-position DIP switch defines the operation of Control Mode, Overload Protection, Step Ramp/ Constant Current Mode and Chassis Configuration. The DBS system parameters are factory preset and require no changes for normal operation. - See Figure 8, Section 5 factory default settings.

5.2.5 Reset - SW5

This pushbutton allows the operator to acknowledge a fault condition at the DBS control board when the controller door is open.

The DBS will not allow the motor to start until all trip conditions are cleared.

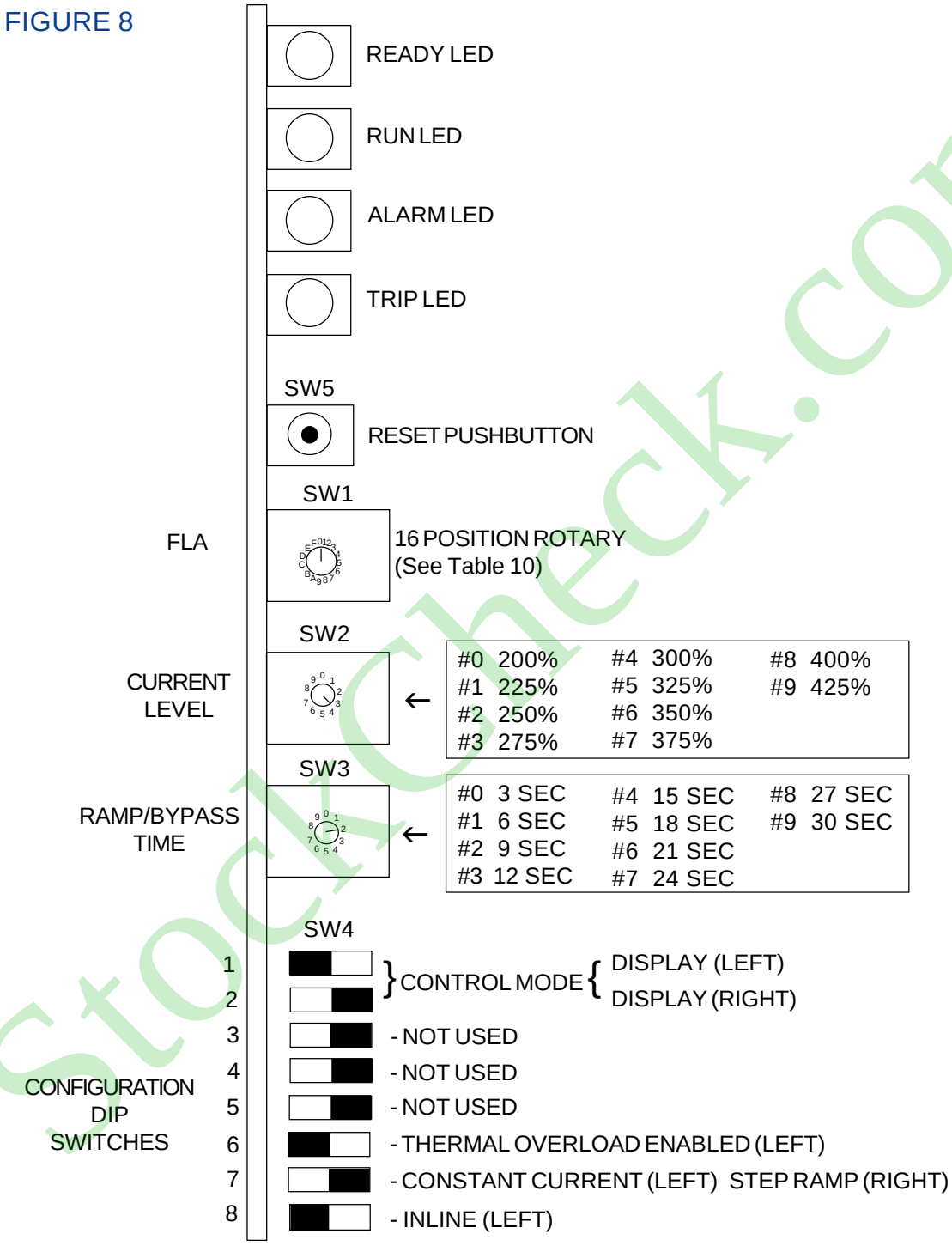
See Section 1.6 for LED functions.

5.2.6 Starter Size - SW6

This factory pre-set 8-position DIP switch configures the DBS software for the size of the chassis which is designated for the application according to either horsepower or current at a given voltage. If the DBS control board is being replaced, SW6 must be set on the new board per Figure 9 in the Appendix.

5.3 DBS Control Board

FIGURE 8



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5.4 FLA Set-Point Tables

TABLE 9

Values shown are 100% FLA. Use value which most closely matches the motor nameplate current.

NOTE: Maximum Service Factor of 125% for FLA Switch #0-8, 115% for FLA Switch #9-B, 100% for FLA Switch #C-F.

	STARTER B1
SWITCH #	F.L.A.
0	69
1	71
2	73
3	76
4	78
5	81
6	83
7	86
8	89
9	91
A	94
B	97
C	100
D	104
E	107
F	110

	STARTER C1
SWITCH #	F.L.A
0	131
1	135
2	139
3	144
4	148
5	153
6	158
7	163
8	168
9	174
A	179
B	185
C	191
D	197
E	203
F	210

	STARTER D1
SWITCH #	F.L.A.
0	250
1	258
2	266
3	275
4	283
5	292
6	302
7	311
8	321
9	331
A	342
B	353
C	364
D	376
E	388
F	400

	STARTER E1
SWITCH #	F.L.A.
0	485
1	500
2	516
3	533
4	550
5	567
6	585
7	604
8	623
9	643
A	663
B	684
C	706
D	729
E	752
F	776

	STARTER B2
SWITCH #	F.L.A.
0	94
1	97
2	100
3	103
4	107
5	110
6	113
7	117
8	121
9	125
A	129
B	133
C	137
D	141
E	146
F	150

	STARTER C2
SWITCH #	F.L.A.
0	169
1	174
2	180
3	186
4	192
5	198
6	204
7	210
8	217
9	224
A	231
B	238
C	246
D	254
E	262
F	270

	STARTER D2
SWITCH #	F.L.A.
0	313
1	323
2	333
3	344
4	355
5	366
6	378
7	390
8	402
9	415
A	428
B	442
C	456
D	470
E	485
F	500

	STARTER E3
SWITCH #	F.L.A.
0	563
1	581
2	599
3	618
4	638
5	658
6	679
7	701
8	723
9	746
A	770
B	794
C	820
D	846
E	873
F	900

	STARTER B3
SWITCH #	F.L.A.
0	110
1	113
2	117
3	121
4	125
5	129
6	133
7	137
8	141
9	146
A	150
B	155
C	160
D	165
E	171
F	176

	STARTER C3
SWITCH #	F.L.A.
0	203
1	209
2	216
3	223
4	230
5	237
6	245
7	253
8	261
9	269
A	278
B	286
C	296
D	305
E	315
F	325

	STARTER D3
SWITCH #	F.L.A.
0	375
1	387
2	399
3	412
4	425
5	439
6	452
7	467
8	482
9	497
A	513
B	529
C	546
D	563
E	581
F	600

6.0 Start-Up Instructions

6.1 Preliminary Inspection

DANGER! **Hazard of Burn or Electrical Shock. Make certain that all incoming sources of power have been disconnected, locked out, and tagged prior to working on this equipment.**

1) Verify that the stated incoming supply voltage matches the voltage rating of the DBS controller.
2) Inspect all incoming conductors for abrasion that may have occurred during installation.
3) Verify adequate space exists between current carrying conductors and ground as well as between conductors of opposite phases. Test wiring for possible shorts and/or grounds. Check for loose connections.
4) Verify circuit breaker settings match those on data sheet inside controller.
5) Verify that the full load amps (FLA) of the motor do not exceed the FLA rating of the DBS chassis. See Table 9, Section 5.
6) Follow the set-up instructions in Section 5.0. Verify the 8-position DIP switch (SW4), located on the DBS control board, is set correctly for the application. - See Compressor Starter Data Sheet attached to inside of DBS controller.
7) Verify that the 16-position switch (SW1), located on the DBS control board, is set in the position that corresponds to the DBS chassis size and FLA of the motor being used. DBS chassis size is shown on the chassis nameplate. - See Compressor Starter Data Sheet.
8) Verify that the Current Step switch (SW2), located on the DBS control board, is set correctly for the application. (See Compressor Starter Data Sheet) This switch is adjustable from 200% to 425% of FLA.
9) When the DBS chassis is set to operate in the Step Ramp mode, the Ramp Switch (SW3) setting controls the time (in seconds) for the current to rise from its initial current setting to 500% FLA. (See Compressor Starter Data Sheet) When the DBS chassis is set to operate in the Constant Current mode, the Ramp Switch controls the bypass time (Ref. Section 5.2.3).
10) Verify that the incoming power wires connected to terminals L1, L2, and L3 on the control panel circuit breaker (CB1) are sized properly.
11) Verify that the ground wires connected to the ground lugs on the control panel back plate are sized properly.
12) Inspect the motor lead connections and verify that the motor wires are connected to the DBS chassis in the right order for correct motor rotation per Figure 3, Section 4.
13) Verify that the control wire connections are made per the RAM wiring diagram.

6.2 Start-Up

When starting the DBS controller, it is recommended that a clamp-on AC ammeter be used to continuously monitor current during the start-up procedure. A voltmeter placed across the starter output terminals (T1, T2, and T3) is also recommended.

6.2.1 Power-Up

1) Pre-start adjustments have been checked and confirmed.
2) Make certain all personnel, tools, and equipment are clear of controller and motor-driven moving parts.
3) If the motor is remotely located, it is essential to have another person stand by the motor to verify direction of motor rotation.
4) Apply power; close feeder switch then main circuit breaker (CB1). Confirm with voltmeter that voltage to line side of DBS is within 10% of the starter's rated voltage.
5) DBS control board performs preliminary system diagnostics.
6) Green "READY" LED illuminates confirming all internal system tests have passed and there are no shorted SCRs, phase reversal, or other faults.

6.2.2 Starting

WARNING! **Do not manually operate contactor to jog motor. SERIOUS PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT! To jog motor, follow Starting Instruction below and equipment start-up instructions that apply.**

1) Make sure the motor is ready to be started in an unloaded condition.
2) Set up voltmeter to measure for possible voltage drop during starting. Voltage should not drop more than 10% of voltage rating of DBS controller.
3) Energize the “Start” circuit; motor will begin to accelerate; green “RUN” LED will blink.
4) Motor reaches full speed; green “RUN” LED remains on steady.

CAUTION! **Do not allow motor to remain energized if it stalls. If the motor fails to accelerate, immediately de-energize the motor by local, remote, or manual stop control.**

5) If at any time during the starting cycle the motor does not accelerate or stops, disconnect power to the control circuit and open the line disconnect.
6) Make necessary adjustments and repeat starting procedure.
7) Should the motor still fail to start, consult Section 7.0, Troubleshooting.

6.3 Re-adjustments

After the motor has been started, fine adjustments may be required. The DBS chassis settings should be adjusted so that the motor reaches full speed in the minimum amount of time without causing any appreciable power dip or excessive mechanical stress.

7.0. Troubleshooting

CAUTION! **Equipment is at possibly lethal AC line voltage when AC power is connected. All Phases must be disconnected by shutting down main power feed to this unit before it is safe to touch motor terminals or control equipment parts.**

7.1. Start-Up Problems

TABLE 10 Diagnostics and Troubleshooting

START-UP SYMPTOM	POSSIBLE CAUSE	SOLUTION
1. Motor will not start.	No start input signal.	Confirm 115V exists between terminals 4 and 5 on DBS control board.
2. Controller does not make transition to RUN	Motor connected for wrong voltage or connected incorrectly.	Connect motor per motor nameplate.
3. Cannot enter EDIT mode to change setpoint values.	DBS controller is in "Start" or "Run" state.	Setpoint values cannot be changed while motor is running. Status code "rdy", "trip", or "cool" must appear on display.
4. Circuit breaker trips about 5 seconds after energizing controller.	Motor not connected or not connected properly.	Motor leads must be properly configured and connected to DBS controller for it to operate.
5. No display text and/or lights on front of DBS boards.	Blown fuse FU1 on DBS control board. No voltage output from control power transformer.	Replace with slo-blo type fuse FU-0081. See Figure 6. Check primary and secondary voltage on control power transformer. Remove power before replacing fuse(s).
6. No display text and "ready" LED is on.	Defective display or display cable.	Determine condition by interchanging cable or display with those from another controller; replace if necessary.
7. Motor does not stop when run signal is removed.	Leakage from solid state output modules on customer's micro keeps DBS input turned on.	Output module on customer's micro could be shorted.

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TABLE 10 (continued) **7.2 Trip Conditions**

TRIP CONDITION	POSSIBLE CAUSE	SOLUTION
1. Jam	Current exceeded Jam Trip level set point longer than time delay set point while in RUN state.	Confirm Jam trip and trip delay setpoints.
	Driven equipment may be bound or set up improperly.	Resolve mechanical problems of driven equipment.
2. Short Circuit	Current exceeded 800% of FLA set point while motor was starting.	Verify DBS controller settings; prevent excessive loading during start.
	Short in starter or motor junction box: phase-to-phase, phase-to-ground.	Remove cause of short or ground.
	Motor incorrectly connected.	Reconfigure connections.
3. Thermal Overload	Calculated thermal capacity of motor exceeded 100% of limit.	Allow motor to cool then re-start.
	Excessive motor current detected.	Compare reading from clamp-on ammeter with readout on display unit to confirm accurate sensing by DBS.
	Motor is "short-cycling".	Motor should be started less frequently.
	DBS settings not within design parameters.	Confirm setpoints: • FLA (SW1) • Locked rotor current • Stall time • Service factor • Chassis Size (SW6)
4. Shorted SCR (circuit breaker trips about 5 seconds after energizing controller).	Defective SCR; Current measured when motor is not running.	Check SCRs per test procedure. (See Appendix) Call RAM if defective. Do not replace in field.
	Defective circuit board.	If SCRs are OK, replace circuit board.
	Defective bypass contactor; welded contacts.	Repair or replace contactor.
	Gate plug P3, P5, or P7 may be loose.	Repair gate plug connection or connector.
	Motor connections incorrect.	Reconfigure connections.
	Motor not connected to starter.	Connect motor to starter.

(continued)

TABLE 10 (continued) **7.2 Trip Conditions**

TRIP CONDITION	POSSIBLE CAUSE	SOLUTION
5. Phase Loss	Loss of at least one phase of supply voltage.	Restore power.
	CT connector TB2 on DBS control board may be loose.	Repair CT connection at TB2 on DBS control board.
	DBS control board is defective.	Replace DBS control board.
	Gate plug P4 or P6 may be loose. When the start signal is given, if P4 is loose, LED DS1 will be off; if P6 is loose, LED DS2 will be off.	Check gate lead connections P3 thru P8 on DBS control board. Repair gate plug connection or connector. If connections are OK, replace DBS.
	Defective bypass contactor.	Check operation of contactor by connecting coil to remote source of control power.
	Bypass contactor not energizing.	Check continuity between terminals 2 and 3 on 15-pin connector on DBS control board; If none, call RAM Technical Services.
6. Phase Reversal		**NOTE:** Control power must be cycled OFF then ON to reset trip.
	Incorrect phase order at DBS chassis input terminals.	Reverse L1 and L2 power wires at DBS chassis input.
	Control power is out of phase with main power supply to controller.	Verify control power not derived from source outside controller.
	If fault will not clear fault, gate connector P8 may be loose.	Repair gate plug connection or connector.
7. Heat Sink Overtemperature	Temperature of heat sink has exceeded maximum safe operating temperature of 85 deg. C.	Allow starter to cool, then re-start motor. Assure ambient temperature does not exceed 40 deg. C. **NOTE:** Controller load capacity must be derated when ambient temperature exceeds 40 deg. C.
	Heat sink cable connection P2 is loose.	Replace defective heat sink cable (P/N HA-0879, Chassis B & C; HA-0880, Chassis D & E).
	Defective thermostat.	Replace thermostat (P/N SW-0345).
8. PLL Failure	Poor quality of incoming power.	Test power quality; consult facility engineer or utility.

TABLE 10 (continued)

7.3 Alarm Conditions

ALARM CONDITION	POSSIBLE CAUSE	SOLUTION
1. Current Unbalance	Current between two phases exceeds the setpoint value longer than the time delay setpoint.	Check for voltage balance between phases. Customer must consult power supplier if balance is abnormal.
		Compare current reading on DBS display to reading of clamp-on ammeter for accuracy.
	Electrical loads on power supply not distributed equally among phases.	Load balance on customer's system must be re-distributed.
	DBS setpoints not set correctly or according to actual conditions.	Adjust current unbalance and current run delay setpoints. See Table 13, Section 9.
	Abnormal SCR operation due to defective DBS control board.	Replace DBS control board.

TABLE 11

LED and Relay Status for Alarms and Trip Conditions

CONDITION	LED STATUS				RELAY STATUS			
TRIP	**READY** (Green)	**RUN** (Green)	**ALARM** (Yellow)	**FAULT** (Red)	**RUN**	**BYPASS**	**ALARM**	**SHUNT TRIP**
SHORT CIRCUIT	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	**ON**
THERMAL OVERLOAD	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF
SHORTED SCR	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	**ON**
PHASE REVERSAL	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF
PHASE LOSS	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF
JAM PROTECTION	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF
HEATSINK OVERTEMPERATURE	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF
PLL FAILURE	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
ALARM								
CURRENT UNBALANCE	N/A	N/A	**ON**	OFF	N/A	N/A	**ON**	OFF

8.0 DBS Control Display Unit - KL4

8.1 Description

The DBS Control/Display Unit is mounted in the door of the controller's enclosure. All aspects of motor operation and control can be performed via this interface. The KL4 Control/Display unit is connected to the DBS control board by cable to its RS-232 port.

DISPLAY - The backlighted liquid crystal display screen has 2 lines of 20-characters. The display screen shows the current menu selection, operating mode, associated values, and units of measurements.

MENUS - Four menus enable the operator to view motor, operating, and historical data for the application, as well as edit the operating parameters. The menus are MONITOR, SET POINT, SYSTEM SETUP, and FAULT HISTORY.

NAVIGATION - Four keypad buttons are used to move through the menus, to edit set point values, and to acknowledge alarm and trip conditions.

ALARM - An LED on the face of the KL4 Control/Display unit alerts the operator to an alarm or trip condition. The LED will blink until the alarm or trip condition is acknowledged.

STATUS CODES - A status code denoting the operating state of the DBS controller is displayed continually in the lower left of the display screen. These codes are:

1. **run** = RUN
2. **rdy** = READY
3. **strt** = START
4. **trip** = TRIP
5. **cool** = COOL-DOWN
6. **edit** = EDIT MODE

8.2 Operation

- When power is applied, the display screen will read "RAM Industries." After the DBS chassis performs preliminary system diagnostics, "MONITOR MENU" will appear on the display screen.
- During normal operation the MONITOR menu should be selected. From this menu the operator can acknowledge alarm or trip conditions, monitor the current operating status of the system, and view the motor operating conditions.
- Press SELECT key to choose an alternate menu.
- Pressing the SELECT key while in any one of a menu's parameters will cause the display screen to revert to the title of that menu.
- To view the contents of a menu, press the UP/DOWN keys.
- Pressing the ENTER key while in the any of the main menus, or while viewing parameters in the MONITOR or FAULT HISTORY menus will have no effect.

8.3 Acknowledging Trips and Alarms

- If an alarm or trip condition occurs, it will be displayed regardless of the menu selected at the time it occurs.
- The display screen will read “Alarm - Enter = Ack” or “Trip - Enter = Ack”.
- To acknowledge a trip or alarm condition, press the ENTER key.
- A message on the display screen will confirm the TRIP/ALARM has been acknowledged.

8.4 Editing Set Points

- Set points cannot be edited while in the START or RUN operating states.
- Select the SET POINT menu.
- Press the UP/DOWN keys to go to the desired parameter, then press the ENTER key to enter the “Edit” mode. The edit code (8.1.5.6.) will flash on the display screen.
- Press the UP/DOWN keys to increase or decrease the set point value. If a subsequent key is not pressed within 30 seconds, the previously stored value will be retained.
- To abort the edit and return to the stored value, press the SELECT key.
- To save the new value as the set point, press the ENTER key.

8.5 Confirming System Setup

- Select SYSTEM SETUP menu.
- To view the values of the settings on the DBS control board, press the UP/DOWN keys.

8.6 System Override Functions

- In the SYSTEM SETUP menu there are three functions that can be reset by an authorized operator or technician: CLEAR THERMAL CAPACITY, CLEAR FAULT HISTORY, and LOAD FACTORY SETUP.
- To clear the memory of a function, select the function via the UP/DOWN keys, then press ENTER.
- Press the SELECT key to go to confirm selection.

9.0 DBS Display Unit

TABLE 12 Monitor Menu

This menu is used to display the current system conditions of the DBS controller.

SELECTION	UNITS	DESCRIPTION
Average Current	Amps	Current measured by the three current inputs averaged together and displayed as an rms value.
Current Phase A	Amps	"Live" current reading for phase A.
Current Phase B	Amps	"Live" current reading for phase B.
Current Phase C	Amps	"Live" current reading for phase C.
Elapsed Run Time	Hr:Min	Time since last start.
Thermal Capacity Used	%Cap	Calculated thermal capacity used by the motor.
Heatsink Temperature	DegC	DBS chassis heat sink temperature.
Time Till Start	Minutes	Time remaining before the thermal capacity drops low enough for the motor to be allowed to start.
Alarm - Enter = Ack		Prompt to acknowledge alarm.
Trip - Enter = Ack		Prompt to acknowledge trip.

TABLE 13 Set Point Menu

This menu displays the set point values programmed into the DBS controller. Changes to system set points in this menu must be made from the "edit" mode.

SELECTION	RANGE	DEFAULT	UNITS	DESCRIPTION
Locked Rotor Current	300 - 800	600	%FLA	Motor manufacturer's specified current draw for a stalled motor.
Stall Time	1 - 60	10	Seconds	Length of time the motor can draw lock rotor current and not experience damage.
Jam Current Level	100 - 600	300	%FLA	Current limit allowed for an abnormally sudden increase in motor load.
Jam Run Delay	0 - 60	10	Seconds	Length of time the jam current level can be exceeded before an alarm.
* Service Factor	75 - 125	115	%FLA	Service factor shown on the motor nameplate
Current Unbalance Level	2 - 25	25	%FLA	Amount of current one phase is allowed to exceed the average current of all three phases.
Current Unbalance Delay	0 - 240	5	Seconds	Length of time the current unbalance level can be exceeded before an alarm.

☑ *** NOTE: Maximum Service Factor of 125% for FLA Switch #0-8, 115% for FLA Switch #9-B, 100% for FLA Switch #C-F.**

9.0 DBS Display Unit (continued)

TABLE 14 Fault History Menu

This menu displays the fault history of the system. Refer to this menu when troubleshooting.

SELECTION	UNITS	DESCRIPTION
Last Trip Condition		Type of trip last recorded.
Last Trip Current	Amps	Average RMS current measured at time of trip.
Last Trip Heatsink Temperature	DegC	Temperature of DBS chassis heat sink at time of trip
Last Trip Thermal Capacity	%Cap	Amount of motor's thermal capacity remaining at time of trip
Last Trip FLA	Amps	FLA setpoint at time of trip.
Last Trip Current Step	%FLA	Current step - setpoint at time of trip.
Last Trip Ramp Time	Seconds	Ramp time - setpoint at time of trip.
Last Trip Bypass Time	Seconds	Bypass time - setpoint at time of trip.
Last Trip Run Time	Hr:Min	Amount of time motor ran before trip.
Total No. of Starts		Number of times motor was started.
Total Run Time	Hr:Min	total motor run time unit has measured.
Total No. of Jam Trips		Number of jam trips.
Total No. of Short Circuit Trips		Number of short circuit trips.
Total No. of Phase Loss Trips		Number of phase loss trips.
Total No. of Phase Reversal Trips		Number of phase reversal trips.
Total No. of Current Unbalance Alarms		Number of current unbalance alarms.
Total No. of Heatsink Overtemperature Trips		Number of heat sink trips.
Total No. of Thermal Overload Trips		Number of overload trips

TABLE 15 System Setup Menu

This menu displays the current system setup in the DBS controller.

SELECTION	PARAMETERS	DEFAULT
*Full Load Amps	Motor nameplate full load current (SW1)	See FLA - Starter Size Table 9
*Starting Mode	Constant Current/Step Ramp (SW4)	Factory set for Step Ramp - See Section 5.2.4.
*Constant Current Level	200 - 425% in 25% increments (SW2)	Factory set for 250% - See Section 5.2.2.
*Ramp Time	3 - 30 Sec. in 3 sec. increments (SW3)	Factory set for 6 Sec. - See Section 5.2.3.
*Bypass Time	3 - 30 Sec. in 3 sec. increments (SW3)	Factory set for 11 Sec. - See Section 5.2.3.
*Starter Size	DBS chassis size (B, C, D, E) (SW6)	Factory set.
*Thermal Overload Protection	Enable - Disable (SW4)	Factory set for Enable.
*Configuration	(SW4)	Factory set for In-Line.
*Control Mode	Display/Network (SW4)	Factory set for application.
Software Version		
Clear Fault History	Yes - No	Deletes fault history.
Clear Thermal Capacity	Yes - No	Resets calculated motor temperature to zero.
Load Factory Setup	Yes - No	Restores default set points. (See Table 13)

*Indicates setting is controlled by circuit board switches on main control board.

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10.0 DBS Log

Serial Number_____

Switch Settings

(Copy settings as currently set on main control board)

Switch 1 - FLA	(Sw Pos) _____
Switch 2 - Current Step	(Sw Pos) _____
Switch 3 - Ramp Time	(Sw Pos) _____

Switch 4 - Configuration Dip Switch

(Circle Switch Position)

Pos 1	LEFT/RIGHT
Pos 2	LEFT/RIGHT
Pos 3	LEFT/RIGHT
Pos 4	LEFT/RIGHT
Pos 5	LEFT/RIGHT
Pos 6	LEFT/RIGHT
Pos 7	LEFT/RIGHT
Pos 8	LEFT/RIGHT

Fault History Menu

	Setting	
Last Trip Condition	_____	
Last Trip Current	_____	Amps
Last Trip Heatsink Temperature	_____	Deg C
Last Trip Thermal Capacity	_____	% Cap
Last Trip FLA	_____	Amps
Last Trip Current Step	_____	% FLA
Last Trip Ramp Time	_____	Seconds
Last Trip Bypass Time	_____	Seconds
Last Run Time	_____	Minutes
Total No. of Starts	_____	
Total Run Time	_____	Hours
Total No. of Jam Trips	_____	
Total No. of Short Circuit Trips	_____	
Total No. of Phase Loss Trips	_____	
Total No. of Phase Reversal Trips	_____	
Total No. of Current Unbalance Alarms	_____	
Total No. of Heatsink Temperature Trips	_____	
Total No. of Thermal Overload Trips	_____	

Set Point Menu

	Setting	
Locked Rotor Current	_____	% FLA
Stall Time	_____	Seconds
Jam Current Level	_____	% FLA
Jam Run Delay	_____	Seconds
Service Factor	_____	% FLA
Current Unbalance Level	_____	% FLA
Current Unbalance Run Delay	_____	Seconds

System Setup Menu

	Setting	
FLA	_____	Amps
Start Mode	_____	
Constant Current Level	_____	% FLA
Ramp Time	_____	Seconds
Bypass Time	_____	Seconds
Starter Size	_____	
Thermal Overload	_____	
Motor Configuration	_____	
Control Mode	_____	
Software Version	_____	

11.0 Maintenance

WARNING: Disconnect all incoming power to this equipment and lock-out and tag circuits prior to performing preventive maintenance. Discharge capacitors, if present. Positively ascertain that the equipment is totally de-energized, including possible foreign sources by using appropriate metering.

- For equipment to operate properly, and to reduce unscheduled down-time, a periodic maintenance program should be established. NFPA Publication 70B (Electrical Equipment Maintenance) may be used as a guide.
- It is recommended that at least once each year the following steps be taken.

Enclosures

- Carefully inspect all enclosure surfaces for signs of excessive heat. As a general rule of thumb, any temperature which the palm of the hand cannot stand for about 3 seconds may indicate a problem.
- Check all cabinet doors to assure proper operation and that all door latching and/or locking devices are in proper working order.
- Look inside cabinets for any signs of moisture, dripping, or condensation. Seal off any conduits which may have dripped condensate or provide an alternate means for drainage. Seal off any cracks or openings which may have allowed moisture to enter the enclosure and eliminate the source of moisture on the outside of the enclosure.
- Thoroughly dry all cabinet surfaces which may be damp or wet. If accumulated deposits are apparent, conduct an electrical insulation test to assure proper insulation integrity.
- If there is an accumulation of dust, remove with a vacuum cleaner or clean with lint-free rags. Do not attempt to use compressed air as it may contaminate other internal components.

Wiring

- Inspect all accessible wiring for signs of looseness or overheating. Re-tighten to proper torque values as required. If major discoloration of wire insulation or cable damage is apparent, replace the affected cable.
- Identify and re-mark all cables in accordance with equipment drawings where required.

Disconnecting Means

- Inspect all terminations for signs of looseness or overheating. Re-tighten to proper torque values as required.
- Operate each device manually to assure proper operation and test manual trip feature, if equipped. Check for proper trip settings and adjust if required. Assure that any insulators or arc barriers are intact and in place.
- Molded case circuit breaker should be kept clean of external contamination.
- If any cracks in its case are visible, the circuit breaker should be replaced.

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Fuses

- Examine all fuse clips and fuse blocks for signs of overheating or looseness. If there is any indication of reduced spring tension or overheating, replace the fuse clips or fuse block assembly.
- Assure that all fuses are the correct type and the proper size as listed on devices and applicable drawings.

Contactors and Relays

- If there is an accumulation of dust, remove with a vacuum cleaner or clean with lint-free rags. Do not attempt to use compressed air as it may contaminate other internal components.
- Check all component terminals for signs of looseness or overheating and re-torque to proper values as required. If terminal is badly discolored, it may indicate that a high resistance joint or contact exists. Remove the arc chutes on the device to inspect contact condition.
- Inspect all accessible devices for breakage, cracks, or signs of sooty deposits, spattering, or carbon tracking. Clean all affected surfaces and replace damaged or cracked components.
- Inspect contact condition for signs of excessive heating, uneven wear, or unequal spring tension. Indications of light sooty deposits, minor pitting, or material displacement do not indicate a problem if all surfaces are worn equally. Do not attempt to file or dress contact surfaces with abrasives, as this will likely increase the wear rate of the contacts.
- Manually operate all power contactors and check wear indicators, if equipped. If wear indicators show 50% or less remaining life, or if contact surfaces indicate excessive or uneven wear, all contacts and spring carriers should be replaced.
- Assure that all contact screws are tightened and all barriers and arc chutes are replaced.

General

- List all component part numbers which may be showing signs of wear, and order replacements for installation at next scheduled shut-down period.
- Note any equipment additions and/or wiring modifications on the appropriate drawings, for maintenance use and troubleshooting.

Electronic Equipment

- Inspect circuit boards for signs of overheating such as discoloration.
- Look for evidence of moisture or corrosion.
- Eliminate any accumulations of dust, especially between connecting terminals, with a vacuum cleaner. Do not use solvents on printed circuit boards.
- Test tightness of screw terminal connections by slightly pulling on the wire.

Maintenance After a Fault Has Occurred

CAUTION! **After a fault has occurred, all equipment must be de-energized, disconnected, and isolated to prevent accidental contact with live parts. Check voltage on all terminals before touching or working on equipment. Only qualified individuals should be involved in the inspection and repair procedures and all safety precautions must be observed.**

- The excessive currents occurring during a fault may result in enclosure, component, and/or conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. After a fault, determine the cause, inspect, and make any necessary repairs or replacements prior to re-commissioning this equipment. The following procedure is recommended for this inspection.

Enclosure

- Check cabinet exterior for any signs of deformation or heat damage. Assure that all hinges and cabinet latching and/or locking mechanisms are in working order. Replace affected parts if required.

Disconnecting Means

- The externally mounted disconnect operator handle must be capable of opening the circuit breaker. Inspect all door interlocks for proper function. Replace operator mechanism, door interlock, and related parts that show signs of binding, warping, or abnormal wear.
- Inspect circuit breakers for any signs of damage or deterioration. If it is suspected that the circuit breaker has opened several short circuits, it should be replaced.
- After replacing damaged components, operate disconnect device several times to assure all mechanisms work properly.

Fuses

- Always replace all three fuses in a three phase circuit, even though only one or two are open. Possible heat damage in the remaining fuse(s) could result in a subsequent shutdown.

Terminals and Internal Conductors

- Replace all damaged parts which show signs of discoloration, melting, or arcing damage.

Contactors and Relays

- Replace all contacts and contact springs if inspection shows signs of welding, displacement of metal, heat damage, or excessive wear. If device shows any signs of binding, or arcing and flash damage, replace the entire component. Perform an insulation resistance test to verify insulation integrity.

Overloads

- Visually inspect all overload devices for signs of arcing or other heat damage. If there is any sign of arcing or burning on the overload, or if burnout of the heater element has occurred, the entire overload device must be replaced.

Restoring to Service

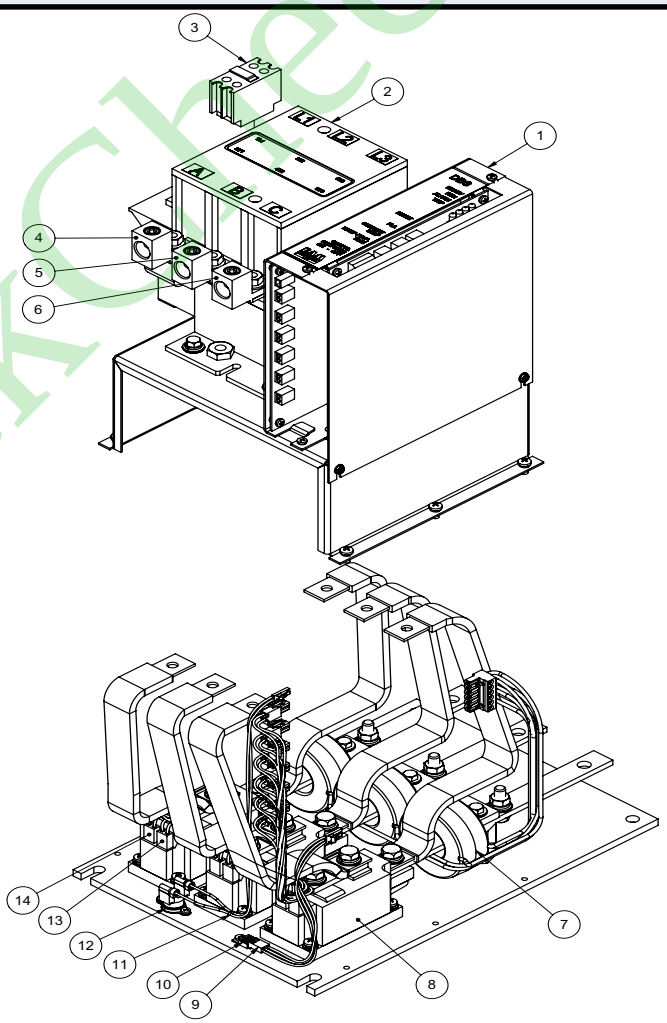
- Before restoring the equipment to service, it is recommended that the steps outlined in procedures for START-UP are followed.

Refrigeration Solid State Starter

12.0 Replacement Parts

DBS Chassis Sizes B1, B2, B3, C1, C2, C3 with RAM Contactor

Item	Replacement Parts	B1	B2	B3	C1	C2	C3
1	Circuit Board Set	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF
2	Bypass Contactor	RI1-F115A-120	RI1-F150A-120	RI1-F185A-120	RI1-F150A-120	RI1-F185A-120	RI1-F265A-120
3	Aux Contact	RI1D-N11	RI1D-N11	RI1D-N11	RI1D-N11	RI1D-N11	RI1D-N11
4	Load Lug (Left)	TL-0243	TL-0244	TL-0244	TL-0255	TL-0255	TL-0258
5	Load Lug (Center)	TL-0243	TL-0244	TL-0244	TL-0253	TL-0253	TL-0256
6	Load Lug (Right)	TL-0243	TL-0244	TL-0244	TL-0254	TL-0254	TL-0257
7	Current Transformer	XF-0196	XF-0198	XF-0198	XF-0199	XF-0302	XF-0303
8	SCR Module (Eupec)	CR-0096	CR-0096	CR-0096	CR-0097	CR-0097	CR-0097
8a	SCR Module (Jinglai)	CR-0140	CR-0140	CR-0140	CR-0141	CR-0141	CR-0141
9	Temp Sensor Harness	HA-0877	HA-0877	HA-0877	HA-0877	HA-0877	HA-0877
10	Temp Sensor	IC-0036	IC-0036	IC-0036	IC-0036	IC-0036	IC-0036
11	Thermostat Harness	HA-0879	HA-0879	HA-0879	HA-0879	HA-0879	HA-0879
12	Thermostat	SW-0345	SW-0345	SW-0345	SW-0345	SW-0345	SW-0345
13	Gate Leads (Eupec-Right)	HA-0872	HA-0872	HA-0872	HA-0881	HA-0881	HA-0881
13a	Gate Leads (Jinglai-Right)	HA-400663-01	HA-400663-01	HA-400663-01	HA-400663-02	HA-400663-02	HA-400663-02
14	Gate Leads (Eupec-Left)	HA-0873	HA-0873	HA-0873	HA-0882	HA-0882	HA-0882
14a	Gate Leads (Jinglai-Left)	HA-400664-01	HA-400664-01	HA-400664-01	HA-400664-02	HA-400664-02	HA-400664-02



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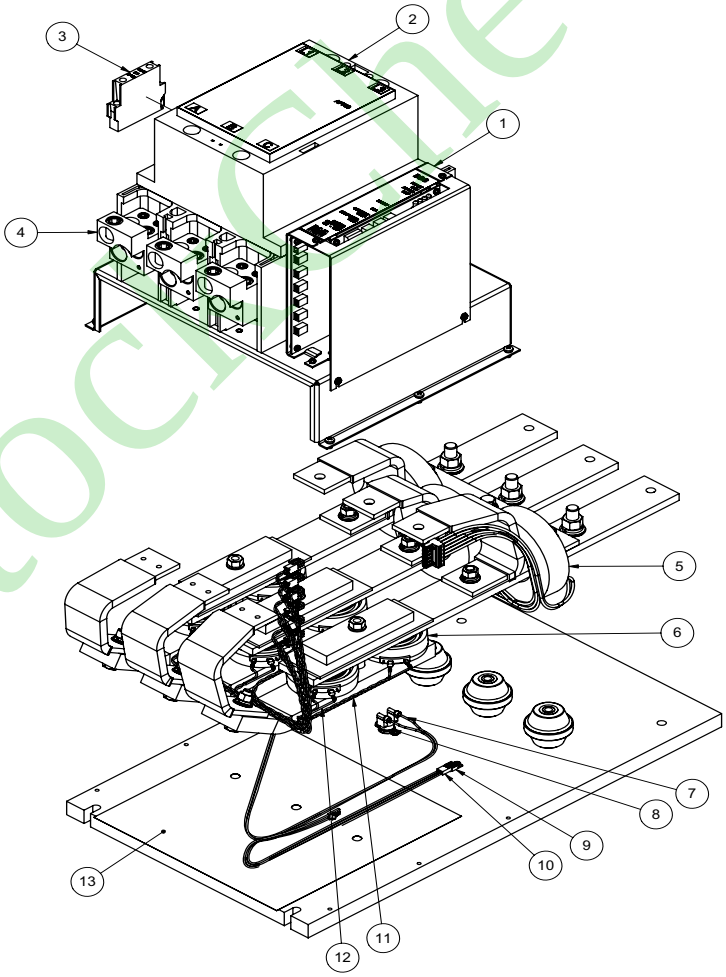
12.0 Replacement Parts (continued)

DBS Chassis Sizes D1, D2, D3, E1, E2, E3 with ABB Contactor

Item	Replacement Parts	D1-1	D1 or D2	D3	E1	E2	E3
1	Circuit Board Set	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF	RAM-400339-AF
2	Bypass Contactor	CT-0794	CT-0795	CT-0796	CT-0797	CT-0798	CT-0798
3	Aux Contact	CT-0895	CT-0895	CT-0895	CT-0895	CT-0895	CT-0895
4	Load Lug Kit (3)	TL-0234	TL-0235	TL-0235	TL-0236	TL-0236	TL-0236
5	Current Transformer	XF-0210	XF-0210	XF-0202	XF-0203	XF-0203	XF-0203
6	SCR (Eupec)	CR-0109	CR-0109	CR-0110	CR-0110	CR-0110	CR-0132
6a	SCR (Jinglai)	CR-0142	CR-0143	CR-0143	CR-0143	CR-0144	CR-0144
7	Thermostat Harness	HA-0880	HA-0880	HA-0880	HA-0880	HA-0880	HA-0880
8	Thermostat	SW-0345	SW-0345	SW-0345	SW-0345	SW-0345	SW-0345
9	Temp Sensor	IC-0036	IC-0036	IC-0036	IC-0036	IC-0036	IC-0036
10	Temp Sensor Harness	HA-0878	HA-0878	HA-0878	HA-0878	HA-0878	HA-0878
11	Gate Leads (Eupec-Long)	HA-0875	HA-0875	HA-0875	HA-0875	HA-0875	HA-0875
11a	Gate Leads (Jinglai-Long)	HA-400665-02	HA-400665-02	HA-400665-02	HA-400665-02	HA-400665-02	HA-400665-02
12	Gate Leads (Eupec-Short)	HA-0876	HA-0876	HA-0876	HA-0876	HA-0876	HA-0876
12a	Gate Leads (Jinglai-Short)	HA-400665-01	HA-400665-01	HA-400665-01	HA-400665-01	HA-400665-01	HA-400665-01
13	Baseplate Insulator (3/8" bolt)	HD-0637	HD-0637	HD-0637	HD-0637	HD-0637	HD-0637
13a	Baseplate Insulator (1/2" bolt)	HD-400506	HD400506	HD400506	HD400506	HD400506	HD400506



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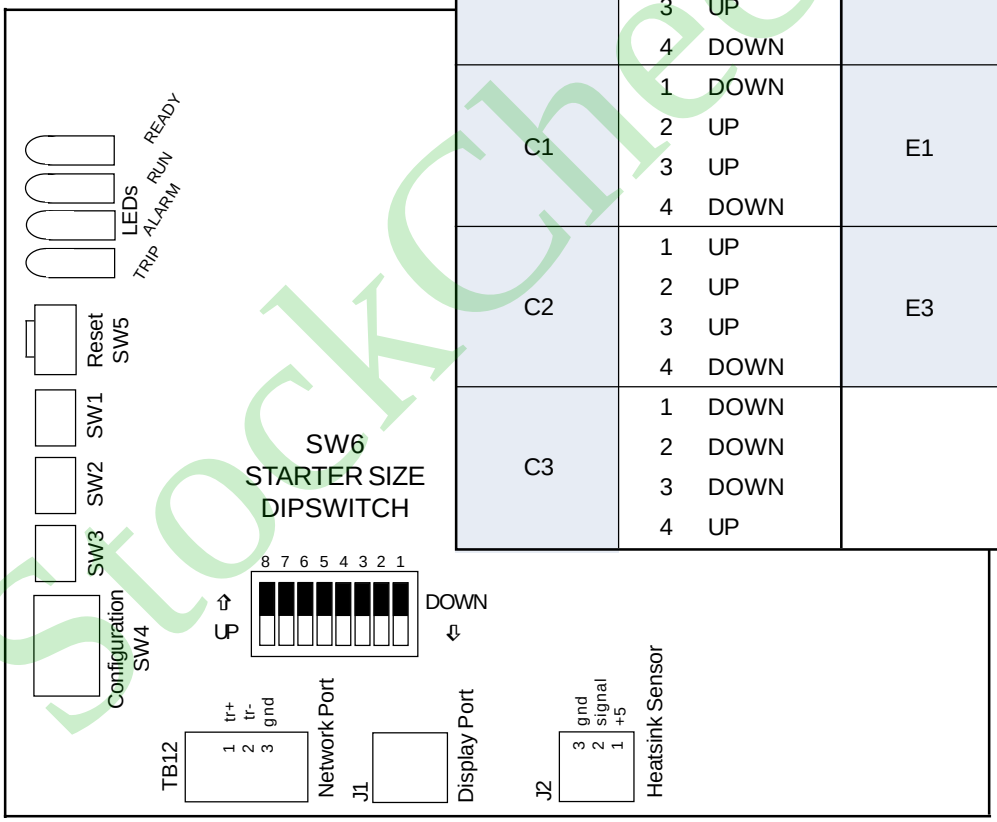
Refrigeration Solid State Starter

Appendix A

FIGURE 9 **Starter Size Dipswitch Positions**

to Determine Starter Size

STARTER SIZE	SWITCH	STARTER SIZE	SWITCH
B1	1 DOWN 2 UP 3 DOWN 4 DOWN	D1	1 UP 2 DOWN 3 DOWN 4 UP
B2	1 UP 2 UP 3 DOWN 4 DOWN	D2	1 DOWN 2 UP 3 DOWN 4 UP
B3	1 DOWN 2 DOWN 3 UP 4 DOWN	D3	1 UP 2 UP 3 DOWN 4 UP
C1	1 DOWN 2 UP 3 UP 4 DOWN	E1	1 DOWN 2 DOWN 3 UP 4 UP
C2	1 UP 2 UP 3 UP 4 DOWN	E3	1 DOWN 2 UP 3 UP 4 UP
C3	1 DOWN 2 DOWN 3 DOWN 4 UP		



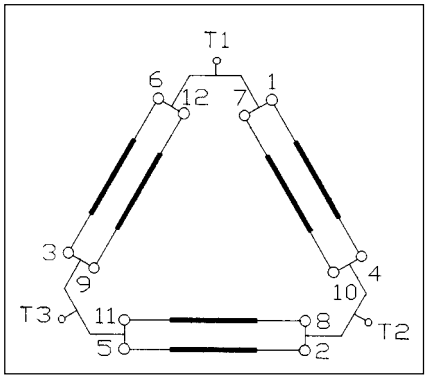
Starter size DIP switch is located on the interior of the board (SW6). SW6 is positioned horizontally toward the bottom of the board. Switch position #1 is farthest from the front edge of the board.

This switch is factory preset and should not be changed without factory approval.

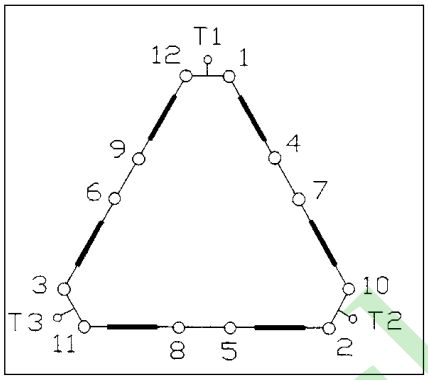
Appendix B

FIGURE 10

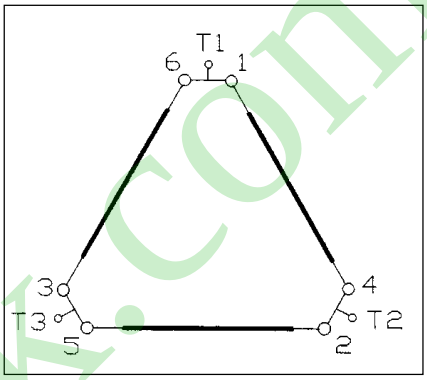
Typical Motor Connections
3 Wire Configuration



12 Lead
Parallel Connection



12 Lead
Series Connection
(Dual Voltage)



Typical
6 Lead Motor

Refrigeration Solid State Starter

Appendix C

SCR Test Procedure

DANGER! **Hazard of Burn or Electrical Shock. Make certain that all incoming sources of power have been disconnected, locked out, and tagged prior to working on this equipment.**

1. Make sure that all power sources are turned off and properly locked out.
2. Remove the motor leads.
3. Remove the cover of the bypass contactor and assure that the contacts are not welded together. The contacts should move freely without any restriction while pushing on the armature of the contactor.
4. Remove the six gate leads from the control board, taking note of their order. They should be numbered from 3 to 8. If the gate lead connectors are not removed, false measurements will result while checking the SCRs.
5. A 500 volt megger or a Simpson analog multi meter is required to properly test the SCRs. If an analog meter is used, select the highest resistance scale (R x 10,000 scale).
6. Start by measuring from L1 to T1. Reverse the polarity of the meter leads and measure again. The readings should be about the same. Repeat the measurements from L2 to T2 and L3 to T3. The measurements should be no lower than 1 megohm.
7. Measure L1, L2, L3, T1, T2, and T3 individually to ground. There should be an open circuit or an infinite reading on the meter.
8. Set the meter on its lowest scale (R x 1 ohm). Carefully measure all six gate leads. Measure the red and white gate lead, switch the polarity of the meter leads and measure again. About 8 to 20 ohms should be measured in both directions. The readings should be within an ohm or two of each other. Be careful not to spread apart the female plug with the meter leads when testing. This could cause the plug to become loose, resulting in the misfiring of the SCRs when in operation.

Refrigeration Solid State Starter

Glossary

Alarm - A warning signal that an undesirable condition has been detected. The alarm LED will blink when an alarm condition is detected. See Section 1.6 for more alarm LED information.

Ambient Temperature - The temperature surrounding a device.

Average Current - The current measured at each of the three current inputs, averaged together, and displayed as an rms value.

Bypass Time - The length of time that must expire after the motor is started to cause the bypass contactor to engage.

Constant Current Mode - In this mode, the starting motor current is maintained at a constant level. When the motor is at full speed, the current is determined by the motor load.

Current Phase A - The "live" current reading for Phase A.

Current Step - The initial current limit value of the controller when the DBS is in either the Constant Current or Step Ramp mode. When in Constant Current mode, this current limit is maintained until the motor reaches full speed. In Step Ramp mode, this value sets the initial ramp level limit and then allows the controller to continue the ramp to 500%.

Current Unbalance - When any one of the three current phases exceeds the average of the three current phases by more than a predetermined percentage.

Elapsed Run Time - The time that has expired since the unit has entered the Start state (Section 9, Table 11).

Fault - An undesirable condition that will cause an Alarm or a Trip to occur.

FLA (Full Load Amps) - The amount of current normally drawn by a motor when at rated load and voltage.

Heatsink - Metal used to dissipate the heat of solid-state components mounted on it.

Inline Configuration - A method of connecting the leads of a three-phase motor which places the SCRs between the connected motor windings and the three lines of incoming power. In this type of arrangement, all of the current to the motor passes through the SCRs (also known as outside connected).

Jam - An increase in motor load which causes the current to rise significantly.

Jam Current Level - The percentage of FLA that the average of the three current phases is allowed to reach during the Run state.

Jam Run Delay - The length of time during the Run state that the current must be above the Jam Current Level to cause a fault.

Refrigeration Solid State Starter

Glossary

LCD (Liquid Crystal Display) - A readout device in which each digit is formed by strips of liquid-crystal material.

LRC (Locked Rotor Current) - The steady-state current taken from the line with the rotor locked (stopped) and with the rated voltage and frequency applied to the motor. This is the motor manufacturer's specified current draw for a stalled motor.

NEMA - National Electrical Manufacturers Association.

Phase Loss - A condition when a loss of current or voltage has been detected in a polyphase circuit.

Phase Reversal - A condition when incorrect phase rotation has been detected in a polyphase circuit.

PLL - A phase-locked loop (PLL) is an electronic circuit that is constantly adjusted to match the frequency of an input signal.

SCR (Silicon Controlled Rectifiers) - A semiconductor device that must be triggered by a pulse applied to the gate before it will conduct.

Service Factor - An allowable overload; the amount of allowable overload is indicated by a multiplier which, when applied to a normal FLA rating, indicates the permissible loading.

Stall Time - The maximum time at which the motor can be at locked rotor current without damage.

Step Ramp Mode - In this mode, the starter provides an initial current that is a percent of FLA. The current is then ramped from its initial current setting to 500% over an adjustable time period. When the motor is at full speed, the current is then determined by the motor load.

Thermal Capacity - The allowable amount of thermal energy that can be absorbed before damage may occur to the motor.

Thermal Capacity Used - The calculated thermal capacity used by the motor.

Thermal Overload Level - The percentage of thermal capacity that has been consumed. This level is calculated using the average of the 3-phase currents and the time that the current level exists. It is also dependent on the Locked Rotor Current, Stall Time, and the FLA settings. NOTE: Heating from motor starting current normally consumes a large percentage of the thermal capacity. Repetitive starts in a short time span can exhaust the thermal capacity.

Trip - An undesirable condition that could result in damage to the motor. A trip condition will stop the motor if it is running and not allow the motor to start until the cause of the trip condition is cleared.

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