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HS1R Anode Rotator
[HIGH SPEED STARTER]

INSTALLATION AND SERVICE MANUAL

JAN 1996

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A. INSTALLATION PLANNING DATA

The system consists of a standard 19 inch rack of electronics (approximately. 10 pounds) .

Power Requirements:
208 to 240 VAC
50/60 Hz Single Phase
15 Amp "R" stator only

Mounting: To be mounted in a suitable enclosure by the OEM installer, with the fuse panel to the left. If the unit is to be mounted vertically, the fuse end must be mounted down. Either mounting position allows for the power capacitors vent hole to be in the correct position.

It is recommended that a multi-conductor cable be used for interface connections. Four conductor for high speed only interface, five to six conductor for dual speed interface. The interface wiring or cable can be class 2 insulation (32V). Recommended wire size for interface 22 Gauge maximum.

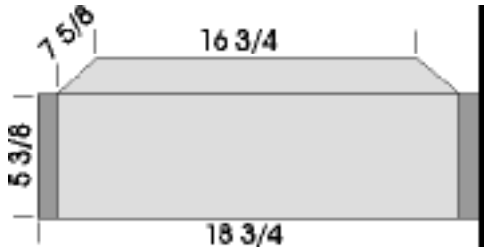
The proper sequence of installation steps are as follows.

1. Measure line voltages set dip switch and connect mains.
2. Turn on power and verify lights OK.
3. Connect stators.
4. Connect inputs and outputs.
5. Program DIP switches.

The proper manner to perform these steps is explained in the pages following.

!!!!!!CAUTION!!!!!!

Remove power (pull both line fuses 1F1 and 1F2) prior to pulling any boards or making any connections. When making stator connections, the stator cable should already be properly terminated to the tube housing. Remember, a momentary touch of the stator wires to ground can cause excessive damage to the starter and is not covered under warranty!



HS1R DIMENSIONS

B. INSTALLATION CONNECTIONS

1. Power.

The HS1R Anode Rotator comes pre-wired with a 6' tail on the power leads. Connect to a suitable location in the equipment rack. The Green wire is chassis ground, the white wire is neutral or line, and the black is line. Measure the mains voltage. Set the dip switch on the uP Board according to the following table:

MAINS	SW2- 4	3	2	1
248	ON	ON	ON	ON
245	ON	ON	ON	OFF
242	ON	ON	OFF	ON
239	ON	ON	OFF	OFF
236	ON	OFF	ON	ON
233	ON	OFF	ON	OFF
230	ON	OFF	OFF	ON
227	ON	OFF	OFF	OFF
224	OFF	ON	ON	ON
221	OFF	ON	ON	OFF
218	OFF	ON	OFF	ON
215	OFF	ON	OFF	OFF
212	OFF	OFF	ON	ON
209	OFF	OFF	ON	OFF
206	OFF	OFF	OFF	ON
203	OFF	OFF	OFF	OFF

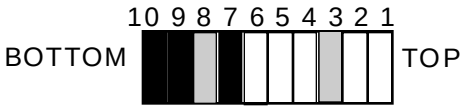
Mains Table

This table is a guide. Final setting should be set to obtain 220-240VAC Low Speed acceleration voltage. The higher the setting, the lower the accelerate voltage.

2. Verify Lights & Power

After applying power, the uP measures the line frequency, turns on the line relay (K1), and applies phase shift to the power board (charging C3-C4 to 260-290Volts DC). The voltage should be verified either by measuring the voltage on C3-C4 (series capacitors) or measuring the voltage on the 10K 10W resistor 'R14' on the mother board. The following LED's should be lit:

1. On the Inverter Driver Board (CB525) the >190Volt 'LE2' should be lit.
2. On the uP board (CB534) the light Bar should be lit as shown in this power-up figure:

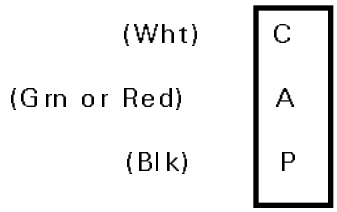


#3 50 Hz Line indication
#7 Line Relay (K1)
#8 Dim (indicates phase shift)
#9 Flashes at 1 Hz intervals
#10 5 volt Supply (always lights)

B. INSTALLATION CONNECTIONS CONTINUED

3. Stator Connections

Connect the stator cable to the .250 push-on terminals located on the back of the mother board. Secure the cable to the HS1R chassis utilizing the strain relief provided.



TB1 (MOTHER BOARD CONNECTIONS)
CB-527-1

Typical Stator Resistance

C-P (White to Black) 15-20 Ohms (minimum resistance)
P-A (Black to Green or Red) 45-70 Ohms (maximum resistance)
C-A (White to Green or Red) 30-50 Ohms (middle resistance)

Red or Green is now commonly being used for the phase or shifted winding.

P = Black
(**P**rincipal Winding or Main)
A = Green or Red
(**A**uxilary or Phase Shifted)
C = White
(**C**ommon winding)

Please note:
Any Green wire with a yellow stripe is not a stator wire but a ground wire!

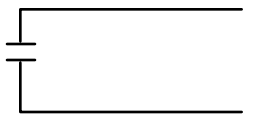
4. Outputs

All generator logic inputs and outputs are made to the J1 connector located on the mother board between CB534 and CB525. Using the connector and pins supplied, make a harness.

The interface outputs of this starter are all relay contacts. They will carry a maximum 2 amps at 30 VDC.

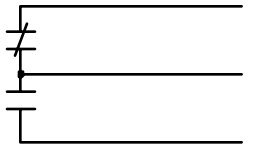
Installation Connections

J1- Terminals



X-Ray Interlock.

Contacts close when rotor is up to speed and exposures are then permitted.



K6 (aux)

J3- Terminals

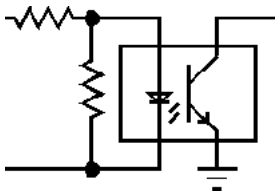
K6 Closes at High Speed Run.

K6 Is typically wired to provide separate high and low speed interlocks to the generator. The interlock contacts (J1-1 or J1-2) would be routed through K6 in order to supply the appropriate signals.

5. Inputs

All inputs go into opto-isolators. The standard manner of making a command is to apply 5,12 to 24 volts DC. The command signals must be provided from the generator.

A typical input is as follows:



Logic Level to CPU

The input resistor must be selected dependent on the control voltage. For 5 volt use 470 Ohms, 12 Volt use 1K, 24 Volt use 2.7K. This is a dip resistor network socketed for ease of installation. All input signals shall be

B. INSTALLATION CONNECTIONS CONTINUED

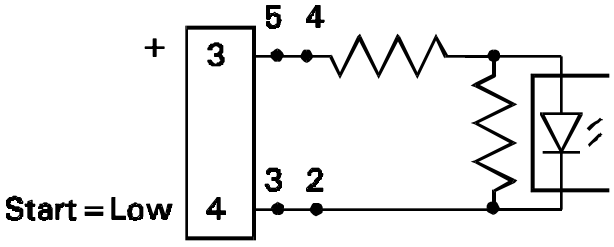
5. Inputs Continued

of the same magnitude.

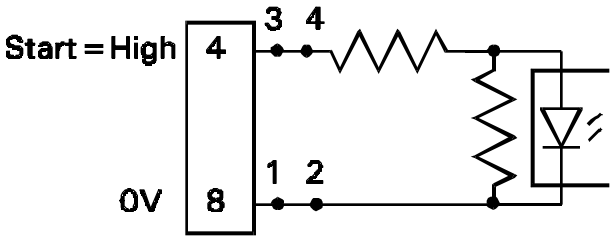
The input circuits have program jumpers which allow for the setting of pull-up or pull-down command signals. See main schematic 'HS1R' for a diagram of the input circuits. The connections on J1 are as follows:

J1-1	{	EXPOSURE
J1-2	{	INTERLOCK
J1-3		External '+' Volts
J1-4		Start (S)
J1-5		High Speed (H)
J1-6		Coast (C)
J1-7		Option (O)
		FLUORO INPUT SOFTWARE VER HS1_FL
J1-8		External '-' or '0' Volts (signal ground)

J1 CONNECTIONS



Typical Pull-down Circuit

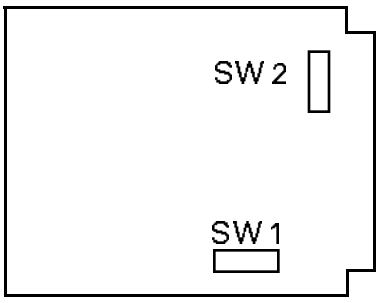


Typical Pull-up Circuit

Input Configuration

6. DIP Switch Programming

There are two dip switch banks on the microprocessor boards (CB534). They are called SW1 and SW2.



SW1,1-4 This switch group selects the accelerate/brake times for Low Speed. See Acceleration Table on page 7

SW1,5-8 This switch group selects the accelerate/brake times for High Speed. See Acceleration Table on page 7

SW2,1-4 This switch group controls the Accelerate/Run Voltages of both Low & High Speeds based on a 50 or 60Hz phase shift look-up table. See Mains Table on page 3.

SW2,5-8 This switch group controls the various options as follows:

SW2-5 [ON] = Service Mode. Disables safety checking for trouble shooting, but does not enable the x-ray interlock at run.

SW2-6 [ON] = DC Brake Option Disables Brake for Low Speed and shortens High Speed Brake duration (the tube slows to Low Speed about 3000 RPM).

B. INSTALLATION CONNECTIONS CONTINUED

SW2-7 [On] allows continuous rotor. SW2-7 [Off] 60 second maximum rotor run time. This feature intended for applications where the rotor is not expected to be on for prolonged periods of time.

SW2-8 [On] causes High Speed 'H' to initiate rotation. ('S' or Start command not necessary for high speed).

NOTE: This starter is not capable of a standard 'RF' application as the starter will overheat and fail! Maximum starts per minute is about 4.

Software Version HS1_FL

Fluoro rotation mode utilizes the 'O' or option input**Software Version HS1_FL**. This is intended for **low use applications** such as a therapy simulator. The low speed hold is enabled for 90 seconds whenever the option input is commanded, and reset to 90 seconds as long as the option input is active. After a completed high speed start, if there are 2 or more seconds of low speed hold remaining, then the shorter brake time is used and low speed is maintained until the fluoro hangover time runs out. No high speed hangover time is enabled at this time.

Note for X-ray Tube calibration:

When many rotation commands are needed, such as when calibrating the x-ray tube, it is highly recommended that the switch on the mother board (SW1) be used to initiate and maintain rotation while calibrating. This will prevent excessive heat build-up in both the starter and the x-ray tube housing. When the unit is turned on, the starter will apply power to the stator and maintain power until the switch is turned off.

The switch can be actuated by use of a pencil or other long skinny probe and is located to the right of the uP board.

Starter Setup for X-ray Tube Calibration:

To setup the starter for calibration, set SW2-7 of the microprocessor board to on (continuous rotor allowed). If low speed rotation is needed during calibration, turn on the switch SW1-1 on the mother board. If high speed rotation is needed during calibration, turn on the switch SW1-2 (and SW1-1 if SW2-8 is off on the microprocessor board).

To remove rotor power, both SW1-1 and SW1-2 must be turned off on the mother board.

B. INSTALLATION CONNECTIONS CONTINUED

6. DIP Switch Continued

Select the combination which is appropriate for your tube. SW1-1 through SW1-4 are for low speed accelerate to run delay, and SW1-5 through SW1-8 are for high speed accelerate to run delay. To avoid overheating the housing, it is advisable to choose the shortest time combination which fully accelerates the anode. Use a reed tachometer or strobe device to determine correct speed of anode!

combi-nation	LOW SPEED SW1-				time		HIGH SPEED SW1-				timea		lo-high
	1	2	3	4			5	6	7	8			
1	off	off	off	off	1.2		off	off	off	off	1.3		.95
2	on	off	off	off	1.4		on	off	off	off	1.5		1.1
3	off	on	off	off	1.6		off	on	off	off	1.7		1.3
4	on	on	off	off	1.8		on	on	off	off	1.9		1.4
5	off	off	on	off	2.0		off	off	on	off	2.1		1.6
6	on	off	on	off	2.2		on	off	on	off	2.3		1.7
7	off	on	on	off	2.4		off	on	on	off	2.5		1.9
8	on	on	on	off	2.6		on	on	on	off	2.7		2.0
9	off	off	off	on	2.8		off	off	off	on	2.9		2.2
10	on	off	off	on	3.0		on	off	off	on	3.1		2.3
11	off	on	off	on	3.2		off	on	off	on	3.3		2.5
12	on	on	off	on	3.4		on	on	off	on	3.5		2.6
13	off	off	on	on	3.6		off	off	on	on	3.7		2.8
14	on	off	on	on	3.8		on	off	on	on	3.9		2.9
15	off	on	on	on	4.0		off	on	on	on	4.1		3.0
16	on	on	on	on	4.2		on	on	on	on	4.5		3.4

Start-Run Delay Times

7. STATOR VOLTAGES The following voltages should be the typical output voltages of the starter as measured Common to Principle (C-P) utilizing an 'R' Stator.

START	RUN	SPEED
220-240 VAC 60 HZ	~54 VAC 60 Hz	3500 RPM (3300 Minimum)
430-470 VAC 180 Hz	~100 VAC 180 Hz	10000 RPM (9500 Minimum)

Note: It may be necessary to set long time delays for the measurement of the voltages as most electronic meters will take 2.5 to 3 seconds to stabilize readings.
Make low speed command, verify accelerate and run voltages. Make adjustment to line voltage setting dip switch (see section B.1) to correct the start (accelerate) voltage if the voltage is too low. (Average the Low and High Speed to obtain best overall Voltage).
Make high speed request. Verify accelerate and run voltages.

C. FAILURE INDICATION

When a failure is detected, LED3 of the Light Bar on the microprocessor board is flashed to indicate which error number is indicated for failure. There is a one second pause between each flash count. Failures are indicated as follows.

Count	Cause
1	U2 'not Q' outputs low
2	No Feedback (U2) Principle Winding
3	No Feedback (U2) Auxilliary Winding
4	No Feedback both windings
5	Voltage too low on LSStart (190V minimum)
6	Voltage too low on HSSTART (390V minimum)
7	Voltage too high in standby (>390V)
8	Voltage too low in standby
9	Time-out for max run time (if continuous is not enabled)
10	Time-out for max coast time

Failure indication is continued until both 'H' (High Speed) and 'S' (Start) commands are removed and another valid rotation command is received. There will be up to a one second delay on rotation start as the program may take that long to recognize the rotation command during the error indication routine.

D. Failure Trouble Shooting

1 U2 'not Q' output low

A. Check U2 for possible failure. The 'not Q' outputs are checked to verify that they are high at rotation command. This is to insure that current feedback from the reed switches is true. This device is a re-triggerable one-shot, and requires pulses from the reed switch (located inside of the current sensing coils K3 or K4) to trigger U2.
B. Input ports damaged on uP board..obtain new uP Board (CB534)

2 No Feedback Principle (Main Winding)

ROTOR SPINS
A. No feedback from U2 on Mother Board (CB527). Check to see that U2 receives pulses from the reed switch K4 at pin 10. Possible Shorted K4, bad reed switch or Low Current in the Principle winding.
B. If U2 receives regular pulses and the output does not change, then U2 may be bad.
C. Defective uP Board (CB534).

ROTOR DOES NOT SPIN
A. Check for open in stator cable.
B. Defective Driver Board (CB525)
C. Defective Inverter Board (CB526).
D. Defective uP Board (CB534) no drive signals to driver board.

3 No Feedback Auxilliary (Shifted Winding)

ROTOR SPINS
A. No feedback from U2 on Mother Board (CB527). Check to see that U2 receives pulses from the reed switch K3 at pin 2. Possible Shorted K3, bad reed switch or Low Current in the Auxilliary winding.
B. If U2 receives regular pulses and the output does not change, then U2 may be bad.
C. Defective uP Board (CB534)

ROTOR DOES NOT SPIN
A. Check for open in stator cable.
B. Defective Driver Board (CB525)
C. Defective Inverter Board (CB526).
D. Defective uP Board (CB534) no drive signals to driver board.
capacitor C2 and storage capacitors C3-C4). (If standby voltage is good, the SCR's and Opto-couplers are probably OK).

4 No Feedback Both Windings

A. Open common in stator cable.
B. No Inverter Output.
C. Defective U2 on mother board.

D. Failure Trouble Shooting Continued

5 Voltage too low on LSSTART

A. Dip Switch setting SW2,1-4 may be incorrectly set causing low start voltage.
B. Power Board is not passing the current (check doubling.

6 Voltage too low on HSSTART

A. Dip Switch setting SW2,1-4 may be incorrectly set causing low start voltage.
B. Power Board is not passing the current (check doubling capacitor C2 and the storage capacitors C3-C4. (If standby voltage is good, the SCR's and Opto-couplers are probably OK.)

7 Voltage too high in standby

A. Defective measuring circuit on Driver Board (CB525).
B. Defective uP Board (CB534). This can be verified by doing the System Checkout Sequence.
C. Voltage is actually too high, verified by measuring. Bad opto-couplers or SCR's. Possible defective Zero-Crossing circuit (U1) on Mother Board (CB527). uP Board defective (no pulse control of pin 13.
NOTE: When the program is in failure indication mode, the drive to the power board is removed. The output voltage on C3-C4 should begin decaying.

8 Voltage too low in standby

A. Defective measuring circuit on Driver Board (CB525).
B. Defective uP Board. (See System Checkout)
C. Defective Power Board..bad opto-couplers or SCR's. Possible defective Zero-crossing circuit (U1) on Mother Board (CB527).

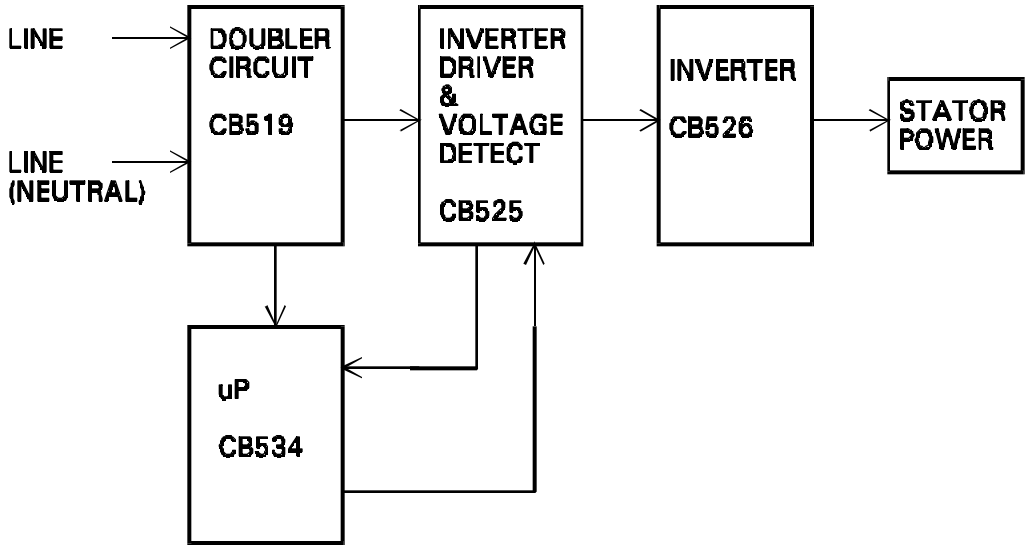
9 Timeout out for max run time

This was caused by excessive prep duration if 'Continuous' rotor was not enabled as an option.

10 Time out for max Coast time

This was caused by exceeding maximum coast time.

E. SYSTEM OPERATION



Power Block Diagram

The operation of the HS1-MPX is straight forward. There is a phase shift controlled voltage doubler power supply (CB519). The power feeds the inverter driver board (CB525) as well as the Inverter (CB526).

The start and run voltages are directed into the phase shift capacitor(s) and current sensing relays.

During braking the inverter is operated at .5Hz to slow the tube down.

The control of all functions is achieved by a combination of relays and solid state controls driven by the microprocessor. The microprocessor responds to commands from the generator. With its memory and the input data, all functions are monitored and current operating status is indicated on LED'S.

Refer to the over all schematic:
NOTE: Any time the words 'phase shift' occur, this references the relationship of the drive phase (pin 22 of the power board) to the line voltage zero crossover (U1 pin 1). In other words, phase shifting the drive signal to the power board produces controlled voltages at the power supply output capacitors C3-C4.

Input data, from the generator, is isolated by opto-isolators (U3) to protect the microprocessor from external noise. The data is passed through input ports to the microprocessor and software routine. Output ports control Driver transistors and operating status LED's.

E. SYSTEM OPERATION (Continued)

At power-up, the line safety relay (K1) is turned on and the phase shift is set to charge the supply capacitor to approximately 250-280 Volts. If the >190 Volt signal goes low from CB525, the program proceeds to the standby mode waiting for a rotation command. If the >190 signal does not go low, then the program enters the safety mode (see Error Indication section).

Low Speed (S)
With START ('S') command, low speed relay K2 is turned on (selects 25ufd. capacitor), phase shift is set to start voltage (220V), the inverter is driven, and after 32 milliseconds the >190 volts signal is monitored to insure that sufficient voltage is present during the accelerate period. After the acceleration delay set by SW1,1-4, then phase shift to the power board is set to run voltage (54V), U2 is enabled, U2 outputs are checked, if the not Q outputs are low, K5 (exposure interlock) is enabled. After removal of the start command, the phase shift is set to the brake voltage (about 80 Volts) and the inverter is switched at .5Hz rate to slow the tube down. The brake for low speed is optional (see brake description).

High Speed (H)
With High Speed ('H') command (SW2-8=ON) or with H+S (High Speed + Start) command, phase shift is set to High Speed start voltage (~440V), the inverter is driven, and after 32 milliseconds the >390 volts signal is monitored to insure that sufficient voltage is present during the accelerate period. After the acceleration delay set by SW1,5-8, then phase shift to the power board is set to run voltage (~100V), U2 is enabled, U2 outputs are checked, if the not Q outputs are low, K5 (exposure interlock) and K6 are enabled. After removal of the start command, the phase shift is set to the brake voltage (about 80 Volts) and the inverter is switched at .5Hz rate to slow the tube down. The brake duration for high speed is shorter if the low speed brake is disable (SW2-6=ON).

COAST (C)
This feature is enabled by one of the input commands. When enabled, after the program determines that U2 outputs are correct, then the inverter is disabled and U2 is pulsed under program control for 10 seconds. (The coast time maximum may be altered by OEM specifications). If coast duration exceeds back-up time, the interlock will be removed and the tube will brake (see brake description) and then error #9 will be indicated.

OPTION (O)
The option command is reserved at this time for future OEM requirements.

DC BRAKE is achieved by setting the phase shift to the brake voltage ,and the microprocessor turns on 1/2 of the inverter during the brake period. This applies about 80VDC to the stator "Principal" or "Main" winding.
If the Low Speed brake is disabled (SW2-6=ON), then the High Speed brake duration is shortened.

CURRENT DETECTION As the program shifts from accelerate to run voltage, U2 (on the mother board) is enabled via pin A of the microprocessor board. The two reed relay contacts K3 and K4 are monitored via U2. If both reed relays are being pulsed, the 'not Q' outputs of U2 will both be low. Then the interlock relay is enabled via pin 16 of the microprocessor board. The X-ray interlock relay is interlocked with U2 so that in the event of a microprocessor malfunction, the X-ray interlock relay cannot be accidentally turned on. The outputs of U2 are 'ANDed' together using D3 and D4 to the base of Q1. Please Note: Only current is detected by this method. If incorrect Stator connections are made, then the tube anode may not spin. It is up to the installer to insure that proper

stator connections are made.

RESET During Operation

HARDWARE RESET: This reset is generally caused by arcing of connections during a start, run or brake sequence. Check all stator and power connections for secure fit.

SOFTWARE RESET: This reset will occur if the I/O ports are determined to have lost their programming. Usually caused by intermittent 5V supply.

RESET DURING STANDBY

If the uP board resets during standby, check the 5 volt supply. If the 5 volt supply is stable, the uP board is likely defective and needs replacing.

F. SYSTEM CHECKOUT SEQUENCE

!!!CAUTION!!!
WHENEVER THE POWER BOARD STORAGE CAPACITORS ARE CHARGE TO MORE THAN 35 VOLTS, THEY MUST BE DISCHARGED BEFORE SERVICING THE POWER, DRIVER OR INVERTER BOARDS!

Whenever instructed to remove or insert boards, remove both line fuses prior to doing so. Insure that the storage capacitors are sufficiently discharged. The storage capacitors on the power board may remain charged for up to four minutes after removing power.

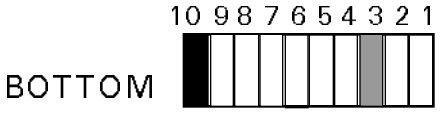
The starter should be checked in the following order:

1. uP (processor board)
2. Power Board
3. Inverter Driver Board
4. Inverter

1. uP Board: Turn the power off and remove all boards. Set service mode to on (SW2-5 = ON) on the uP board (CB534), insert it and turn the power on. The uP board should come on with the light bar lit as follows:

#3 50 Hz Line indication
#7 Line Relay (K1)
#8 Dim (indicates phase shift)
#9 Flashes at 1 Hz intervals
#10 5 volt Supply (always lights)

Turn the power off. With only the uP board in and the service switch set to off, the board should come on with the light bar lit as follows:



#3 Flashes to indicate error #8(> 190 volts signal not low).

2. **Power Board:** Turn the power off. Insert the power board (CB519). On the uP board set the service switch (SW2-5) to on. Turn the power on. The power board should charge C3-C4 to 260-280Volts DC. If C3-C4 fail to charge see Section D. Power Board.

3. **Driver Board:** Turn the power off and observe the caution statement. Insert the Driver Board (CB525) utilizing the extender card. On the uP board set the service switch (SW2-5) to on. Turn the power on. The power board should come up charging the main capacitors. The driver board 16 Volt power supplies should all be charged. Check each of the 16 Volt supplies by measuring the voltage across Z1, Z2 and Z3. NOTE: These supplies are not referenced to signal or power ground. **Do not use a grounded test instrument to measure these points!** Check that each of the drive signals are low. [pin 4 to 5, pin 8 to 9, pin 12 to 14 and pin 13 to 14]. If the board fails, repair before continuing.
Turn the power off, set the service switch to off. Turn the power on. If the Driver board fails to send the > 190 Volts signal to the uP Board then the program will enter the safety mode and flash led 3 on the light bar.
If the Driver board fails any of these checks, repair as needed before continuing.

Driver Board Dynamic Test
Turn the power off. On the uP board set the option switch SW2-7 to on, set service mode to on (SW2-5) . On the mother board set SW1-1 to on (service start) and turn the power on. The unit should enter low speed accelerate run mode. 16 Volt square waves (~9VAC using a DVM) should be coming from the driver board at pins 4-5,8-9, 12-14 and 13-14.

Failure of Inverter (CB526):

Using an Ohmmeter, measure the resistance of the four power transistors (IGBT's). They should all be similar in resistance checks. Generally, the Inverter transistors will short base to collector. If any power transistor block checks shorted, replace it. In the event of a failure of the inverter do a dynamic check of the Driver Board (CB525).

If repeat failures occur, check the snubber networks for open 15 Ohm resistors or open .1 microfarad capacitors. Also, check that there is no possibility of the stator wires shorting to each other or to ground as one single arc will instantly destroy the inverter. An intermittent drive signal from the driver board may cause failures.

Inverter Failure Symptoms

1. High speed is commended.
2. Blows line fuses 1F1 and/or 1F2.
3. No high speed inverter signal to tube stator.
4. The storage capacitor will probably be charged to about 500 VDC during the High Speed start cycle if the cause is failure of the inverter section and the inverter is not shorted.

Driver Board Static Test (CB525)

Remove the Inverter Board. Put the driver board on the extender card and turn the power on. With the power board (CB519) having charged C3-C4 to 250-300 volts, each of the three 16 volt zener diodes should have 16 volts across them. All drive outputs from the opto-isolators should be low. Alternately connect pins 20 (drive1) and 21 (drive2) to pin 22 (signal ground) and verify that each of the drive signals goes to +15 Volts (+-.8Volts). If all four of the output drives switch high and low, the driver board is probably OK.

H. PARTS LISTS

CB534-5
MICROPROCESSOR BOARD

REFERENCE	DESCRIPT	PART_N
534-1	CIRCUIT BOARD	CB534-PWB
534-1-C1	CAPACITOR, TANTALUM	1.0MFD @ 35VDC T/.1
534-1-C2	CAPACITOR, TANTALUM	1.0MFD @ 35VDC T/.1
534-1-C3	CAPACITOR, TANTALUM	1.0MFD @ 35VDC T/.1
534-1-C4	CAPACITOR, MYLAR	.1MFD @ 63VDC M/.2
534-1-C5	CAPACITOR, MYLAR	.1MFD @ 63VDC M/.2
534-1-C6	CAPACITOR, TANTALUM	1.0MFD @ 35VDC T/.1
534-1-C7	CAPACITOR, DISC	100PFD @ 50VDC D/.1
534-1-DS1	LIGHT BAR	10 SEG LIGHT BAR, RED
534-1-EJ1	EJECTOR LEVER	S-202
534-1-EJ2	EJECTOR LEVER	S-202
534-1-Q1	TRANSISTOR, TO92	PN2222A
534-1-R1	RESISTOR, 1/4W	2K OHM
534-1-R2	RESISTOR, 1/4W	3K OHM
534-1-R3	RESISTOR, 1/4W	390 OHM
534-1-R4	SIP RESISTOR	CTS770-101-391
534-1-R5	RESISTOR, 1/4W	3K OHM
534-1-SW1	SWITCH, DIP	8 POS. DIP SWITCH
534-1-SW2	SWITCH, DIP	8 POS. DIP SWITCH
534-1-TPG	TEST POINT (WHITE)	151-201
534-1-U1	IC, RESET	DS1232
534-1-U10	IC, I/O TIMER	R6522
534-1-U11	IC, ADC CONVERTER	ADC0820
534-1-U11-S	SOCKET, IC 20 PIN	20 PIN DIP /.3
534-1-U2	IC, DECODER	74S288 (CB534.U3)”1C76"
534-1-U3	IC, OSCILLATOR	OSC 1.000 MHZ
534-1-U3-S	SOCKET, IC 16 PIN	16 PIN DIP /.3
534-1-U4	IC, MICROPROCESSOR	R65(C)02
534-1-U5	IC, EPROM	27C64 (PROGRAMMED)
534-1-U5-S	SOCKET, IC 28 PIN	28 PIN DIP /.6
534-1-U6	IC, RAM	2K X 8 (24 PIN)
534-1-U7	IC, I/O TIMER	R6522
534-1-U8	IC, OCTAL BUFFER	74LS541
534-1-U9	IC, OCTAL RELAY DRIVER	ULN2803
534-1-U9-S	SOCKET, IC 18 PIN	18 PIN DIP /.3

H. PARTS LISTS CONTINUED

CB519-1
POWER BOARD

REFERENCE	DESCRIPT	PART_N
CB519-C1	CAPACITOR	.1MFD @ 630VDC PF/.6
CB519-C2	CAPACITOR, POWER	1900MFD @ 350V CAN
CB519-C3	CAPACITOR, POWER	3800MFD @ 250V CAN
CB519-C4	CAPACITOR, POWER	3800MFD @ 250V CAN
CB519-C5	CAPACITOR	.1MFD @ 630VDC PF/.6
CB519-D1	RECTIFIER	6 AMP 600V
CB519-PWB	CIRCUIT BOARD	CB519-PWB
CB519-R1	RESISTOR, 1/4W	330 OHM
CB519-R10	RESISTOR, 1/4W	1K OHM
CB519-R11	RESISTOR, 1W	39 OHM 1W METAL
CB519-R12	RESISTOR, 2W	56K OHM 2W METAL
CB519-R13	RESISTOR, 2W	56K OHM 2W METAL
CB519-R2	RESISTOR, 1/4W	47K OHM
CB519-R3	RESISTOR, 1/4W	47K OHM
CB519-R4	RESISTOR, 1/4W	47K OHM
CB519-R5	RESISTOR, 1/4W	47K OHM
CB519-R6	RESISTOR, 1W	39 OHM 1W METAL
CB519-R7	RESISTOR, 1/4W	100 OHM
CB519-R8	RESISTOR, 1/4W	1K OHM
CB519-R9	RESISTOR, 1/4W	100 OHM
CB519-SC1	SCR	MCR264
CB519-SC1HS	HEAT SINK, TO220 (AAVID)	5741-02-B00000
CB519-SC2	SCR	MCR264
CB519-SC2HS	HEAT SINK, TO220 (AAVID)	5741-02-B00000
CB519-U1	OPTO ISOLATOR, SCR	H11C4
CB519-U1S	SOCKET, IC 6 PIN	6 PIN DIP /.3
CB519-U2	OPTO ISOLATOR, SCR	H11C4
CB519-U2S	SOCKET, IC 6 PIN	6 PIN DIP /.3
CB519-U3	OPTO ISOLATOR, SCR	H11C4
CB519-U3S	SOCKET, IC 6 PIN	6 PIN DIP /.3
CB519-U4	OPTO ISOLATOR, SCR	H11C4
CB519-U4S	SOCKET, IC 6 PIN	6 PIN DIP /.3

H. PARTS LISTS CONTINUED

CB525-1
IGBT DRIVER BOARD

REFERENCE	DESCRIPT	PART N
CB525-C1	CAPACITOR, AE/R	33MFD @ 35VDC AE/R/.1
CB525-C2	CAPACITOR, AE/R	33MFD @ 35VDC AE/R/.1
CB525-C3	CAPACITOR, AE/R	33MFD @ 35VDC AE/R/.1
CB525-C7	CAPACITOR, MYLAR	.1MFD @ 63VDC M/.2
CB525-C8	CAPACITOR, AE/R	33MFD @ 35VDC AE/R/.1
CB525-C9	CAPACITOR, TANTALUM	1.0MFD @ 35VDC T/.1
CB525-D1	DIODE	1N4148
CB525-D2	DIODE	1N4148
CB525-D3	DIODE	1N4148
CB525-D4	DIODE	1N4148
CB525-D5	RECTIFIER	1N4007
CB525-D6	RECTIFIER	1N4007
CB525-D7	RECTIFIER	1N4007
CB525-D8	ZENER DIODE, 1W 16V	1N4745A
CB525-LE1	LED	3MM RED
CB525-LE2	LED	3MM RED
CB525-PWB	CIRCUIT BOARD	CB525-PWB
CB525-Q1	VOLTAGE REG, .5 AMP 6V	78L06
CB525-R1	RESISTOR, 1/4W	510 OHM
CB525-R10	RESISTOR, 1/4W	200 OHM
CB525-R11	RESISTOR, 5W	25K OHM 5W WW
CB525-R12	RESISTOR, 1/4W	200 OHM
CB525-R13	RESISTOR, 5W	25K OHM 5W WW
CB525-R2	RESISTOR, 1/4W	510 OHM
CB525-R25	RESISTOR	100K OHM 2W METAL
CB525-R26	RESISTOR, 1/4W	1K OHM
CB525-R27	RESISTOR	50K OHM 5W WW
CB525-R28	RESISTOR	50K OHM 5W WW
CB525-R29	RESISTOR	20K OHM
CB525-R3	RESISTOR, 1/4W	510 OHM
CB525-R30	RESISTOR	20K OHM
CB525-R31	RESISTOR, 1/4W	18K OHM
CB525-R32	RESISTOR	1MEG OHM
CB525-R33	RESISTOR	1MEG OHM
CB525-R34	RESISTOR, 1/4W	1K OHM
CB525-R4	RESISTOR, 1/4W	510 OHM
CB525-R40	RESISTOR, 1/4W	1K OHM
CB525-R5	RESISTOR, 1/4W	200 OHM
CB525-R6	RESISTOR, 5W	25K OHM 5W WW
CB525-R7	RESISTOR, 1/4W	200 OHM
CB525-R8	RESISTOR, 5W	25K OHM 5W WW
CB525-R9	RESISTOR	50K OHM 5W WW
CB525-U1	OPTO ISOLATOR, DUAL	2501-2
CB525-U1S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-U2	OPTO ISOLATOR, DUAL	2501-2
CB525-U2S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-U3	OPTO ISOLATOR, DUAL	2501-2
CB525-U3S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-U4	OPTO ISOLATOR, DUAL	2501-2

H. PARTS LISTS CONTINUED

CB525-1
IGBT DRIVER BOARD

CB525-U4S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-U7	IC, COMPARATOR	LM393N
CB525-U7S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-U9	OPTO ISOLATOR, DUAL	2501-2
CB525-U9S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB525-Z1	ZENER DIODE, 1W 16V	1N4745A
CB525-Z2	ZENER DIODE, 1W 16V	1N4745A
CB525-Z3	ZENER DIODE, 1W 16V	1N4745A

H. PARTS LISTS CONTINUED

CB526-1
(CB510)INVERTER BOARD

REFERENCE	DESCRIPT	PART N
CB526-1	CIRCUIT BOARD	CB510-PWB
CB526-1-C1	CAPACITOR	.1MFD @ 630VDC PF/.6
CB526-1-C2	CAPACITOR	.1MFD @ 630VDC PF/.6
CB526-1-C3	CAPACITOR	.1MFD @ 630VDC PF/.6
CB526-1-C4	CAPACITOR	.1MFD @ 630VDC PF/.6
CB526-1-EJ1	EJECTOR LEVER	S-202
CB526-1-EJ2	EJECTOR LEVER	S-202
CB526-1-PB1	POWER BLOCK, DUAL IGBT	FF25R12KF
CB526-1-PB2	POWER BLOCK, DUAL IGBT	FF25R12KF
CB526-1-R1	RESISTOR, 5W	15 OHM 5W WW
CB526-1-R10	RESISTOR	1.8M OHM
CB526-1-R11	RESISTOR	1.8M OHM
CB526-1-R12	RESISTOR	1.8M OHM
CB526-1-R2	RESISTOR, 5W	15 OHM 5W WW
CB526-1-R3	RESISTOR, 5W	15 OHM 5W WW
CB526-1-R4	RESISTOR, 5W	15 OHM 5W WW
CB526-1-R5	RESISTOR, 2W	56K OHM 2W METAL
CB526-1-R6	RESISTOR, 2W	56K OHM 2W METAL
CB526-1-R7	RESISTOR, 2W	56K OHM 2W METAL
CB526-1-R8	RESISTOR, 2W	56K OHM 2W METAL
CB526-1-R9	RESISTOR	1.8M OHM
CB526-1-W1	2" WIRE, .110 PUSH-ON	2" WIRE, .110 PUSH-ON
CB526-1-W2	2" WIRE, .110 PUSH-ON	2" WIRE, .110 PUSH-ON
CB526-1-W3	2" WIRE, .110 PUSH-ON	2" WIRE, .110 PUSH-ON
CB526-1-W4	2" WIRE, .110 PUSH-ON	2" WIRE, .110 PUSH-ON
NOTE: DRILL	OUT WIRE HOLES	ON BOARD TO .250

H. PARTS LISTS CONTINUED

CB527-1
HS1R MOTHER BOARD

REFERENCE	DESCRIPT	PART_N
CB527	CIRCUIT BOARD	CB527-PWB
CB527-C1	CAPACITOR, AE/R	1000 @ 16VDC AE/R/.2
CB527-C2	CAPACITOR, MYLAR	.1MFD @ 63VDC M/.2
CB527-C3	CAPACITOR, MYLAR	.1MFD @ 63VDC M/.2
CB527-C5	CAPACITOR, MYLAR	.22MFD @ 63V M/.2
CB527-C6	CAPACITOR, MYLAR	.22MFD @ 63V M/.2
CB527-CR1	BRIDGE RECTIFIER	1 AMP 200V DIP BRIDGE
CB527-D1	RECTIFIER	1N4007
CB527-D2	ZENER DIODE, 5.1V	1N751A
CB527-D3	ZENER DIODE, .4W 5.1V	1N751
CB527-D4	DIODE	1N4148
CB527-D5	RECTIFIER	1N4004
CB527-F1	FUSE, T63MA	T63MA
CB527-F1C	FUSE CLIP, 5MM	44FH052
CB527-F1C	FUSE CLIP, 5MM	44FH052
CB527-F2	FUSE, T63MA	T63MA
CB527-F2C	FUSE CLIP, 5MM	44FH052
CB527-F2C	FUSE CLIP, 5MM	44FH052
CB527-J1	JACK, 8 PIN	538-22-23-2081
CB527-J2	CONNECTOR, (CINCH)	50-44SN-1 22X156 DUAL
CB527-J3	JACK, 3 PIN	538-22-23-2031
CB527-J4	CONNECTOR, (CINCH)	50-22SN-5 22X156 SINGLE
CB527-J5	CONNECTOR, (CINCH)	50-22SN-5 22X156 SINGLE
CB527-J6	CONNECTOR, (CINCH)	50-22SN-5 22X156 SINGLE
CB527-K1	RELAY, PC 12VDC	G4W-2214P-US-TV5-HP12VDC
CB527-K2	RELAY, CHASSIS 12VDC	G4W-22123T-US-TV5-HP12VDC
CB527-K3	COIL, CURRENT SENSE (A)	5709
CB527-K3SW	REED SWITCH	44F8357
CB527-K4	COIL, CURRENT SENSE (A)	5709
CB527-K4SW	REED SWITCH	44F8357
CB527-K5	RELAY, PC 12VDC	HB1E-DC12V
CB527-K6	RELAY, PC 12VDC	HB1E-DC12V
CB527-LE1	LED	3MM RED
CB527-P1	PLUG HOUSING, 8 PIN	538-22-01-3087
CB527-P3	PLUG HOUSING, 3 PIN	538-22-01-3037
CB527-Q1	TRANSISTOR, TO92	2N5307
CB527-R1	RESISTOR	2K OHM 1%
CB527-R10	RESISTOR	220K OHM
CB527-R11	RESISTOR, 1/4W	10K OHM
CB527-R12	RESISTOR, 1/4W	2K OHM
CB527-R13	DIP RES. 470 (5V)	761-1-R470
CB527-R13	DIP RES. 1K (12V)	4116-1-102
CB527-R13	DIP RES. 2.7 (24V)	4116-1-272
CB527-R13S	SOCKET, IC 16 PIN	16 PIN DIP /.3
CB527-R14	RESISTOR, 10W	10K OHM 10W WW
CB527-R15	RESISTOR	3.3K OHM
CB527-R2	RESISTOR	10K OHM 1%
CB527-R3	RESISTOR	30K OHM 1%

H. PARTS LISTS CONTINUED

CB527-1
HS1R MOTHER BOARD

CB527-R4	RESISTOR	10K OHM 1%
CB527-R5	RESISTOR	100K OHM 1%
CB527-R6	RESISTOR, 1/4W	2K OHM
CB527-R7	RESISTOR, 1/4W	4.7K OHM
CB527-R8	RESISTOR, 1/4W	4.7K OHM
CB527-R9	RESISTOR	220K OHM
CB527-ST1	.250 SOLDER TAB	534-1287
CB527-ST2	.250 SOLDER TAB	534-1287
CB527-ST3	.250 SOLDER TAB	534-1287
CB527-ST4	.250 SOLDER TAB	534-1287
CB527-ST5	.250 SOLDER TAB	534-1287
CB527-ST6	.250 SOLDER TAB	534-1287
CB527-ST7	.250 SOLDER TAB	534-1287
CB527-ST8	.250 SOLDER TAB	534-1287
CB527-ST9	.250 SOLDER TAB	534-1287
CB527-T1	TRANSFORMER, POWER	DSW-512
CB527-U1	IC, COMPARATOR	LM393N
CB527-U1S	SOCKET, IC 8 PIN	8 PIN DIP /.3
CB527-U2	IC	74HC423
CB527-U2S	SOCKET, IC 16 PIN	16 PIN DIP /.3
CB527-U3	OPTO ISOLATOR, QUAD	2501-4
CB527-U3S	SOCKET, IC 16 PIN	16 PIN DIP /.3
CB527-VR1	VOLTAGE REG, 1 AMP 5V	7805A

H. PARTS LISTS CONTINUED

HS1R
CHASSIS PARTS

REFERENCE	DESCRIPT	PART_N
CB519	POWER BOARD	CB519/W
CB525	DRIVER BOARD	CB525/W
CB526	INVERTER BOARD	CB526/W
CB527-1	MOTHER BOARD	CB527/W
CB534	MICROPROCESSOR	CB534/W
HS1R-1C1	AC CAP 25MFD @ 370	97F9006
HS1R-1C2	AC CAP 6MFD @ 660	26F6623FA
HS1R-1F1	FUSE, SLO-BLO	MDA 15
HS1R-1F2	FUSE, SLO-BLO	MDA 15
HS1R-1FH1	1 1/4 FUSE HOLDER	HKP
HS1R-1FH2	1 1/4 FUSE HOLDER	HKP
HS1R-1L1	COIL, CHOKE	5544 (15 AMP, .4H)
HS1R-1R1	RESISTOR, 50W	RH50-.3 1%
HS1R-1R2	RESISTOR, 50W	RH50-.3 1%
HS1R-CG	CARD GUIDES (10EA)	3.5 INCH GUIDE (10 EA)
HS1R-CMP	PLATE, CAPACITOR MTG	42-70-1
HS1R-EXT	EXTENDER BOARD	HM4X5EXT
HS1R-FP	FUSE PLATE	42-66-1
HS1R-LH	CARD CAGE LEFT SIDE	42-64-1
HS1R-MTG1	CC MTG	42-69-1
HS1R-MTG2	CC MTG	42-69-2
HS1R-MTG3	CC MTG	42-69-3
HS1R-MTG4	CC MTG	42-69-4
HS1R-MTG5	CC MTG	42-69-5
HS1R-MTG6	CC MTG	42-69-6
HS1R-RH	CARD CAGE RIGHT	42-65-1
HS1R-RP1	RESISTOR MTG PLATE	42-67-1
HS1R-RPHS	RESISTOR HEAT SINK	42-68-1