


 odel  x-ray	<h1>Odel X-ray</h1>	EEN0006 Eng. to Eng.Note 2003-08
	NORMAL/HIGH SPEED STARTER Inside	

594025.5837 "NORMAL/HIGH SPEED STARTER (HSS in the rest of the document) lets rotate up to 3 rotor of X-Ray tube with independent stator characteristics, i.e. independent shifting leg requirements. This is possible through the use of Sinusoidal PWM power control and Programmable Shifting Capacitance bank. To reduce as possible the heat of the tube, HSS discriminate the commands for rotations in Fluoroscopy Mode, in Radiography Mode, in Normal Speed Mode (60 Hz) and in High Speed Mode (180 Hz). HSS uses the X-Ray generator's DCRail (560Vdc) All the command signals in Input or Output from HSS are optocoupled.

ASSEMBLY DESCRIPTION

HSS for both Program H.F. US or Endeavour X-ray generators is divided into two boards:
 PCB5847 "The Computer"
 PCB5848 "The Frequency Converter"

PCB5847 "The Computer" is connected to MPU/MCU through flat ribbon cable connector J1 which carries the low voltage power supply, the digital input signal and the digital output signal.

The Computer is connected to PCB5848 "The Frequency Converter" through several connector:

- J5 <-> J3, a flat ribbon cable used to drive the relays and sense the current flowing through the windings
- J6 which holds the IGBT gates signals
- TR1 (J7 <- TR1 -> J6) which senses the current flowing from the DCRail to the IGBT bridge.
- J3 connector holds the 24Vdc power supply to be use in factory for first power up test and is left unconnected while the assembly is in the generator.

The frequency Converter have 3 more cable connectors:

- J5, connected through a couple of 32 A. Fast Silicon Fuses to the generator's DCRail
- J8 used to connect the possive snubber's resistors in the bottom of the assembly
- J2 connected to the tubes through the Generator's General Terminal Board (Program US) or direct to the double shielded cable (Endeavour) which holds the power sinusoidal currents.

SIGNAL DESCRIPTION

J1

POWER SUPPLY

0_Vext = 0Vdc power supply
 +Vext = 24Vdc Power Supply

BOARD INPUT SIGNALS

IST-1 = Tube n. 1 selection (Active to Gnd when Tube 1 is selected – DL7 lit)
 IST-2 = Tube n. 2 selection (Active to Gnd when Tube 2 is selected – DL8 lit)
 IST-3 = Tube n. 3 selection (Active to Gnd when Tube 3 is selected – DL9 lit)
 ORR = Radiography Rotation Request (Active to Gnd when Rotation in Radiography Mode is requested – DL10 lit)
 OFR = Fluoroscopy Rotation Request (Active to Gnd when Rotation in Fluoroscopy Mode is requested – DL11 lit)
 OHS = High Speed Rotation Request for both ORR or OFR (Active to Gnd when 160Hz is requested – DL14 lit or unactive when 60Hz rotation is requested – DL14 off)
 OAT = Acceleration Hold Time (Active to Gnd when acceleration extended holding time is requested – DL12 lit)
 OSD = Slow Down Hold Time (Active to Gnd when deceleration extended holding time is requested – DL13 lit)

BOARD OUTPUT SIGNALS

INS = Tube Running in Normal Speed (Active to Gnd when tube is correctly running at 60Hz after a correct acceleration after ORR or OFR assertion and OHS unactive – DL15 lit)
 IHS = Tube Running in High Speed (Active to Gnd when tube is correctly running at 180Hz after a correct acceleration after ORR or OFR assertion and OHS active – DL16 lit)

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J5

- ORC1 .. ORC5 = Power Relays Configuration selectors (K1..K5 on Frequency Converter Board)
- ORT1, ORT2 = Tube Selector (not used on Program US)
- ROKOK = Current Flowing Through the tube windings

J6

- DRVG1, DRVE1 = Insulated Upper Left Gate Signal for power H-bridge
- DRVG3, DRVE3 = Insulated Upper Right Gate Signal for power H-bridge
- DRVG2, DRVE2, DRVG4, DRVE4, = Insulated Lower Left and Right Gate Signal for power H-bridge

LED DESCRIPTION

POWER GOOD GREEN LEDS

- DL4 = 24Vdc General Power Supply
- DL5 = 24Vdc Limited Power Supply to Gate Drive Present (if not present check R13)
- DL6 = 15Vdc Limited Power Supply to Gate Drive Present (if not present check the LM7825 Linear Regulator)
- DL1 = +15Vdc Analog Power Supply present (if not present check U3 DC/DC Converter)
- DL3 = -15Vdc Analog Power Supply present (if not present check U3 DC/DC Converter)
- DL2 = +5Vdc Digital Power Supply present (if not present check U2 DC/DC Converter)

INPUT SIGNAL YELLOW LED BAR

- DL7 = IST-1 (if not present when requested check the connection on the tube transformer in case of a 3 tube transformer, then check the presence of the signal on GTB, then the presence of the signal on R24, on ISO1 pin 15, on U4 pin 1 and pin 2)
- DL8 = IST-2 (if not present when requested check the connection on the tube transformer in case of a 3 tube transformer, then check the presence of the signal on GTB, then the presence of the signal on R25, on ISO1 pin 14, on U4 pin 3 and pin 4)
- DL9 = IST-3 (if not present when requested check the connection on the tube transformer in case of a 3 tube transformer, then check the presence of the signal on GTB, then the presence of the signal on R26, on ISO1 pin 11, on U4 pin 5 and pin 6)
- DL10 = ORR (if not present when requested check the presence of the signal on R27, on ISO1 pin 10, on U4 pin 9 and pin 8)
- DL11 = OFR (if not present when requested check the presence of the signal on R28, on ISO2 pin 15, on U5 pin 1 and pin 2)
- DL14 = OHS (if not present when requested check the presence of the signal on R29, on ISO2 pin 14, on U5 pin 3 and pin 4)
- DL12 = OAT (if not present when requested check the presence of the signal on R30, on ISO2 pin 11, on U5 pin 5 and pin 6)
- DL13 = OSD not used in Program US and in Endeavour generators

STATUS LED BAR

The Status LED Bar is driven directly from the microcontroller.

YELLOW LEDs

- DL17 = ACTIVE SENSE LED – This LED must blink, if not the microcontroller isn't running. (check the 5Vdc Digital Power Supply, try pressing the ICs in their socket, if still not blinking inform ODEL)
- DL20 = RUN LOW SPEED – This LED is lit After ORR/OFR is asserted, OHS is inactive, OAT is inactive and an acceleration ended without errors.
When lit the selected rotor is running at 60Hz.
If not light after an acceleration check the red led in this bar as described below.
- DL19 = ACCELERATION LS/HS – This LED is lit during acceleration period, after ORR/OFR is asserted, (OHS, OAT active or inactive).
- DL21 = RUN HIGH SPEED – This LED is lit After ORR/OFR is asserted, OHS is active, OAT is inactive and an acceleration ended without errors.

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When lit the selected rotor is running at 180Hz.
If not light after an acceleration check the red led in this bar as described below.

DL22 and DL23 are reserved for in-factory testing.

RED LEDs

- DL25 = SHORT CIRCUIT DETECT an overcurrent across the bridge has been detected, see blue note later in this document for details
- DL24 = NO ROTATION DETECT – ROTOK signal not present after an acceleration. See green note later in this document for details.

RUNNING THE TUBE

In order to run the tube in RADIOGRAPHY mode the following conditions are necessary:

- 1) THE TUBE IS SELECTED, i.e. one of the following signal is ACTIVE (LED ON):
IST-1 (DL7) or IST-2 (DL8) or IST-3 (DL9)
- 2) THE ROTATION REQUEST IS ON, i.e. the signal ORR (DL10) is Active (LED ON)
- 3) In case High Speed is requested from the main computer, the signal OHS is ACTIVE (LED DL14 ON)

Normally the RELAYS position is for NORMAL SPEED, so, if it is requested a Normal Speed Rotation, nothing changes on the power Board, the Relay position is put in evidence by the relevant leds over the relays, and depending on the stator configured by jumpers, the position is described in section n. 1 of the technical manual (installation).
If High Speed Rotation is requested there will be a change of relays configuration.

After that the computer board switch on the frequency converter.
LED DL19 (*Acceleration LS/HS* on the sticker) lits along the acceleration time.
During acceleration time the current flowing through the frequency converter is checked.

In case of a short circuit across the stator or the frequency converter, the analog current sensing autonomously shuts down throught the glue logic the sinusoidal generator.

The computer detects this condition and lits the LED DL25 (*Short Circuit Detect* on the sticker).

After the short circuit is detected a cool down pause is required, so 1 minute is waited before accepting a new acceleration request.

This error can be related to following causes:

- wrong stator configuration can cause an overcurrent on the frequency converter
- main winding in the stator with winding insulation leaks (lower resistance than the nominal) that causes higher current accross the stator
- main or shift stator's winding, or cable double-shield insulation-to-ground leak that causes overcurrent spikes at every cycle
- one of the two half bridge IGBT is in short circuit
- the +-15 Vdc Analog Power Supply is not present
- ...

If there is a short circuit, no rotation can be detected, so at the end of the cool down period, also the LED DL24 (*No Rotation Detect* on the sticker) is lit.



MPU/MCU, waits for the presence of INS or IHS signal: after a time-out period the non presence of INS or IHS signal produce a “ANODE ROTATION SAFETY” on the Control Console.

After the Acceleration Time selected by jumpers is expired the computer checks for the the signal OAT (DL 12 *Custom Acceleration Time* on the Sticker) to check if the Main Computer (MPU or MCU) requests a longer acceleration time (the acceleration time variable is adjusted in Tube Setup). While OAT signal is active, the acceleration power is kept.

At the end of the acceleraton, the computer checks for the rotation signal.

In case the rotation signal is present, MPU/MCU is informed trough two different signals depending on the speed selected:

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If Normal Speed is selected (OHS input INACTIVE or DL14 OFF) the signal INS (DL15) become active
 If High Speed is selected (OHS input ACTIVE or DL14 ON) the signal IHS (DL16) become active.

In case there is not enough current flowing across the current window circuit none of the two signal become active, in this case the led DL24 (*No Rotation Detect*) is lit;

The causes for low current flow can be;

- wrong stator configuration, too low current flowing through the windings
- the stator main or shift winding is interrupted (check for the right tube impedance on tube side)
- one of the conductors of the double shield cable is interrupted (check for the right tube impedance on GTB side)
- one or more of the shifting capacitors are in short circuit
- one or more relays contacts are collated
- ...

MPU/MCU, waits for the presence of INS or IHS signal: after a time-out period the non presence of INS or IHS signal produces an “ANODE ROTATION SAFETY” on the Control Console.

In order to run the tube in FLUOROSCOPY mode the path is as above, except for the ORR signal that become OFR (DL11 – *Fluoroscopy Run Request* on the sticker) and the acceleration time is fixed to 200ms.

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