2020-09-08 Revision 1 note

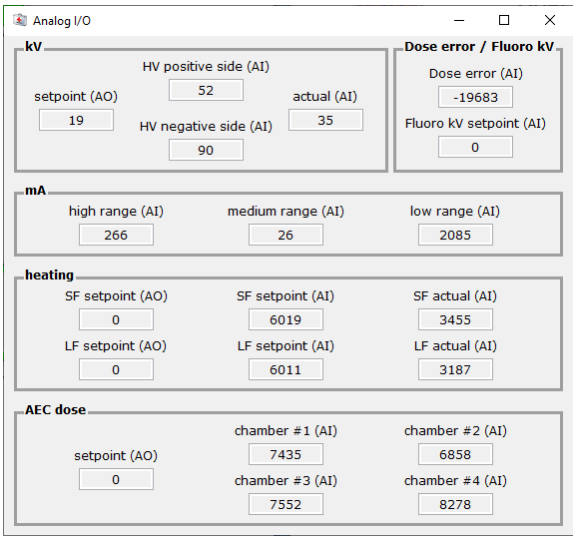
After upgrading EEN-045 with informations related to ARM based generator, this document present the alarm and the way to inspect the generators on this generator class only in order to do not have sparse informations

INITIAL NOTE

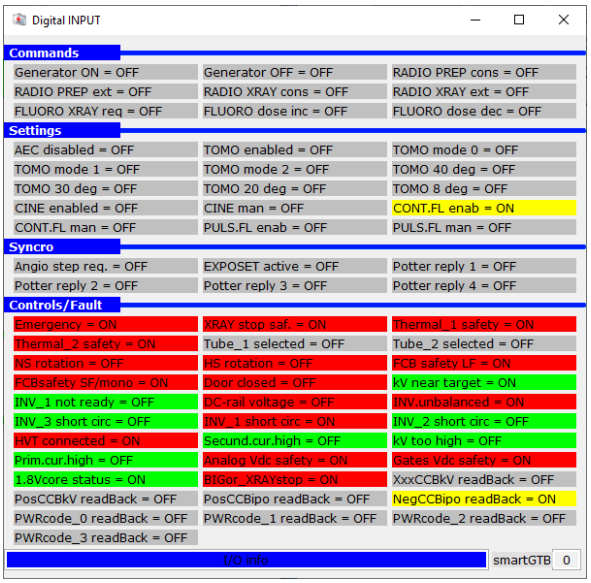
It is a good practic to always connect a Service Computer based on Windows (Win7 and UP)on Generator's Main Computer USB Port in order to have several information about the status of the generator, the status of the Analog and Digital input and output, the history log of failures in the generator, the history log of generator work, the possibility to set a VIRTUAL SETUP SWITCH and the possibility to mask alarm in order to proceed with inspection.

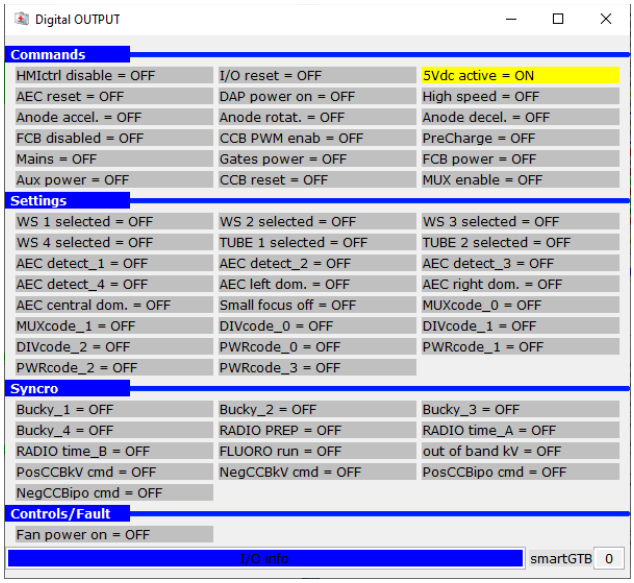
I/O INSPECTION

ANALOG VALUES

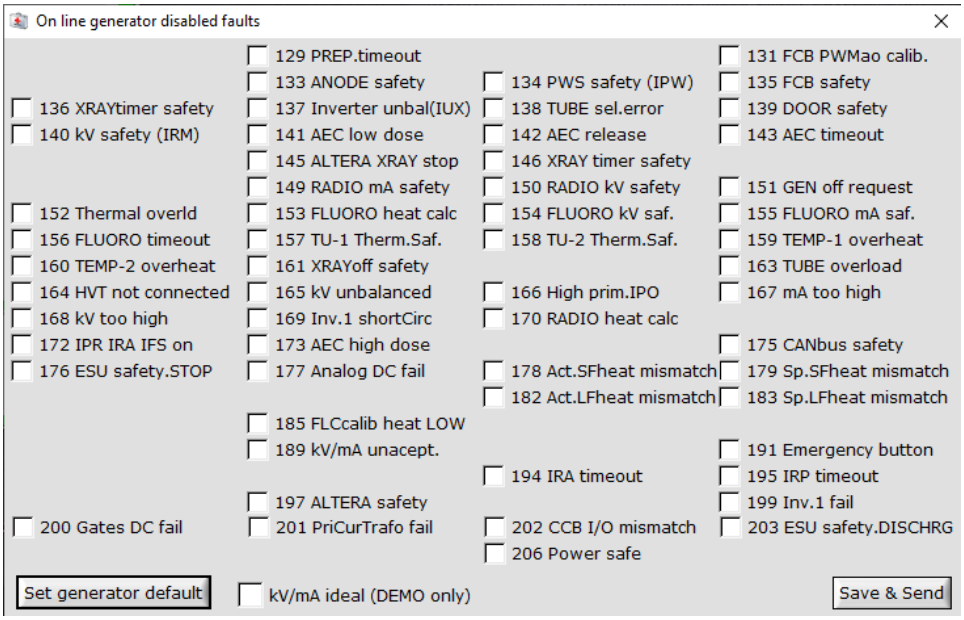


DIGITAL VIEW





ALARM MASKING WINDOW



Note that those generators shares most of the alarms with the previous Intel x86 based generators, so description of the alarm is the same, inspection methods can vary.

ALARM 127

"IONIZING RADIATIONS CAN BE DANGEROUS FOR PATIENT AND OPERATOR"

DESCRIPTION

This is not an alarm, this is a message than appears on ODEL control consoles, addressed to the operator when powering on the generator, reminding the hazards of ionizing radiation.

After the presentation of this alarm, the generator can evolve automatically to stand-by status or wait for the operator action to use the generator: it depends on configuration status of the control console

USER ENTRY: If C306.4x touch screen control console is configured in this way, generator wait the pressure on 

key to evolve in "STAND-BY" status

AUTOMATIC ENTRY after showing the initial message, the control console software simulate a pressure on OK key to evolve automatically in "STAND-BY" status

VERIFICATION

Set through NavGEN the virtual SETUP Switch ON while generator is in IDLE SUSPENDED mode.

Than turn ON the generator: after boot session, the control console will freeze on CONTROL CONSOLE SETUP screen

The first screen turns to setup screen, here locate the key with "ENTER" label.

Pressing it the startup mode cycles between MANUAL ENTER and AUTOMATIC ENTER.

When selected the mode switch off the generator, turn the switch in work mode (or remove the setup jumper on GCU) and start generator.

ALARM 128

“NOT EXISTENT ANATOMIC PROGRAM”

DESCRIPTION

ARM generators do not need an anatomic program as a start point anymore, This message will not appear.

Generator always uses data from last correct X-Ray emission as a starting point.

ALARM 129

"IRPT: TIMEOUT WHILE WAITING EXTERNAL BUCKY REPLY"

DESCRIPTION

Generator, after I AND II step are pressed AND filaments are correctly lit AND Anode is turning correctly, is ready to emits and produce an "Output Bucky Start" signal to the external accessory according to the Bucky table for the Working Station selected

Generator waits up to 60" that accessory is ready through Digital Input / Message (depending on Potter table configuration).

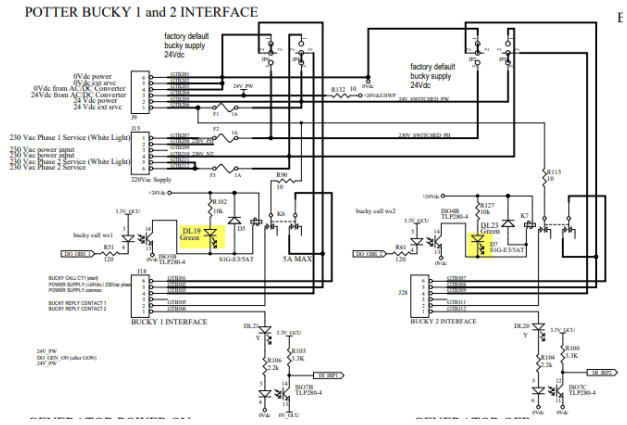
Signal from external accessory is not arriving within 60" this alarm is generated

VERIFICATION

R212

EGTB based

CALL

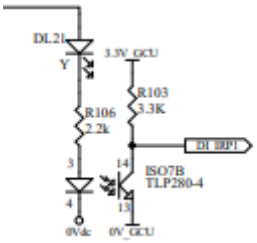


Check that Relay is Driven after correct preparation
Check that LED in parallel to relay is LIT after correct preparation

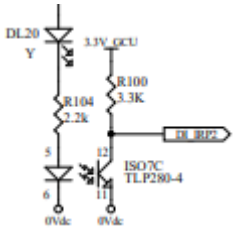
In case of 230Vac interface check the status of the fuse

REPLY

Check the status of the reply led:

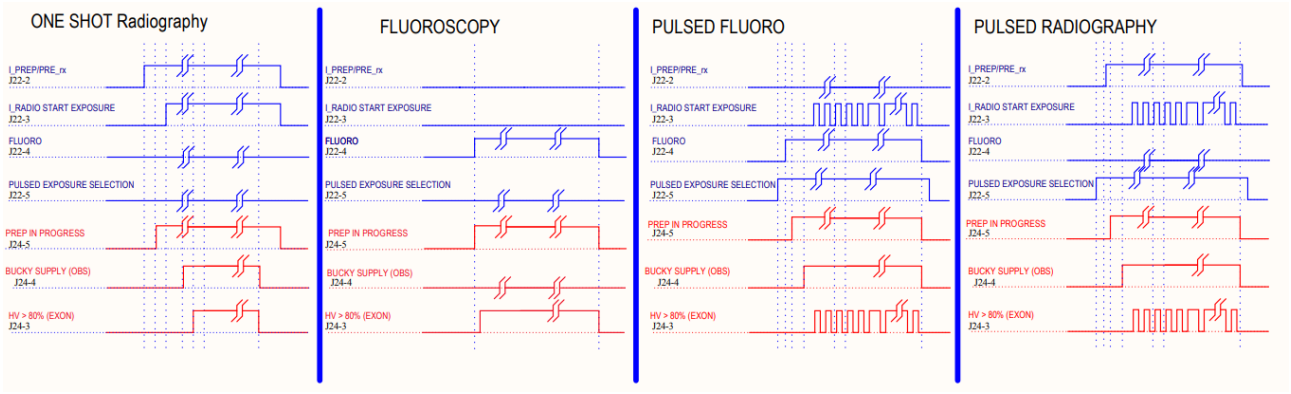


or



CARDIO INTERFACE based

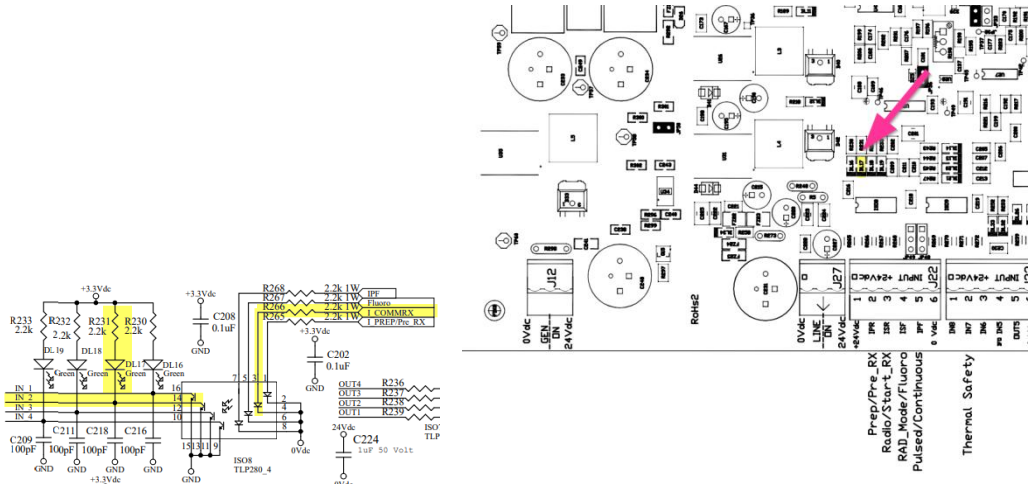
Emission schema for cardiac system follows:



CALL

Check the status of DL30, it must be lit when generator is ready to expose

REPLY



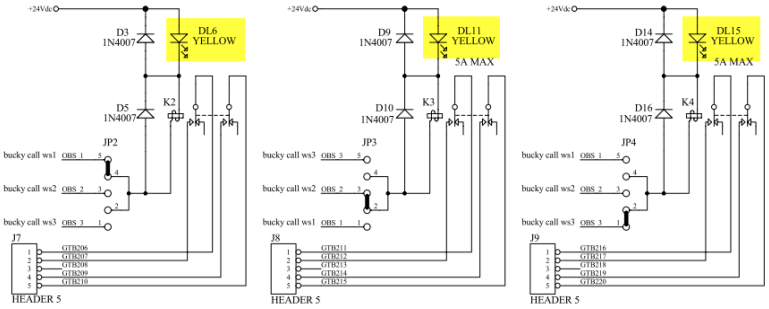
DL17 shows the reply status as well as IRPT1 in NavGEN

R306.4X

Endeavour GTB based

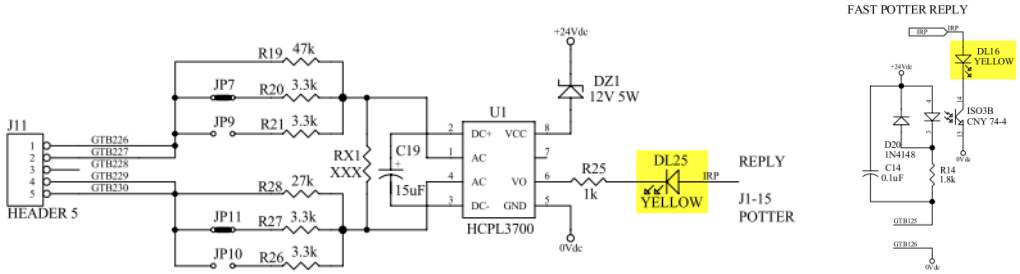
CALL

It uses 3 OBS signal, one for each working station OBS1, OBS2, OBS3



REPLY

IRPT signal (Bucky Reply on GTB200 or Fast Bucky Reply on GTB100)



2 TUBE EGTB based

Even if EGTB is full assignable, a standard convention when used with or without a Digita Device Plug & Play dougterboard is:

Bucky 1: demanded to Remote Tilting Table

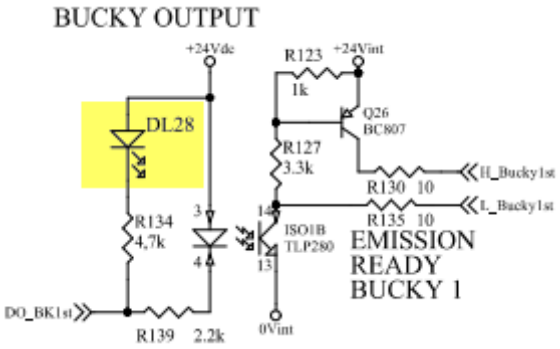
Bucky 2: demanded to Imaging Digital Device

Bucky 3: Remote receptor 1

Bucky 4: remote receptor 2

Here is present the Hardware visual status of the output / Input, in general, for slow signals, it is easier to inspect the status using NAVGen in Digita Input / Digital Output section

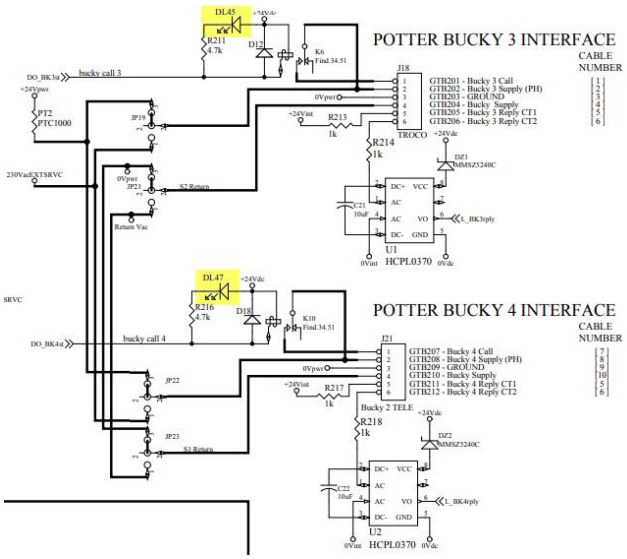
CALL



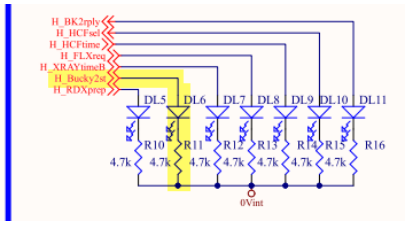
Bucky Output section for bucky call 1,2,3,4 on screw terminal can be either active High or active Low depending on position of related jumper.

In both case the visual status of the output is demanded to DL28 for Bucky 1, DL31 for Bucky 2 DL36 for Bucky 3 and DL40 for Bucky 4

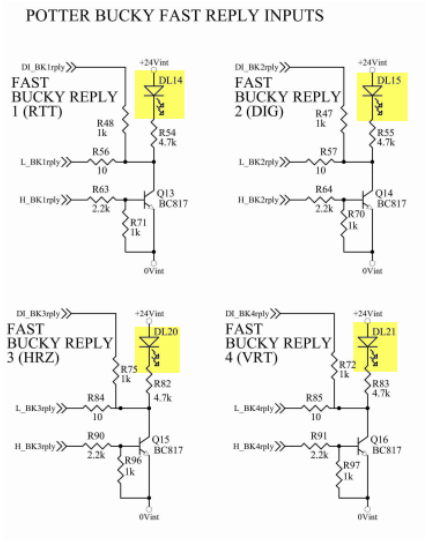
In case it is used the standard bucky interface, the same signal for Bucky 3 and Bucky 4 are DL45 and DL47:



In case it is used a Digital Device Plag&Play interface, Bucky 1 Call (Remote Tilting Table) is shown on EGTB, Bucky 2 Call is shown also on DDP&P board to inspect the status of Digital Device:

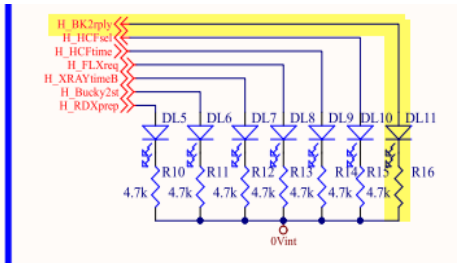


REPLY



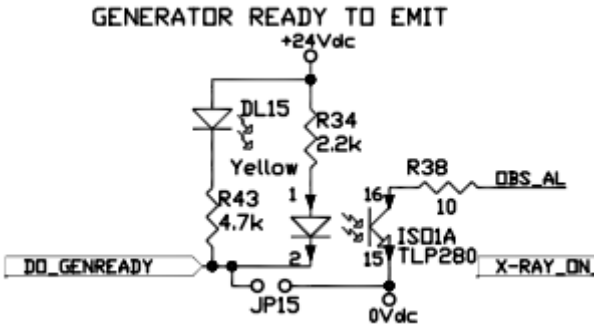
One led for every bucky reply is present on EGTB showing the status of accessory reply.
They can be both Active High or Active Low.

In case it is used a Digital Device Plag&Play interface, Bucky 1 Reply (Remote Tilting Table) is shown on EGTB, Bucky 2 reply is shown also on DDP&P board to inspect the status of Digital Device:

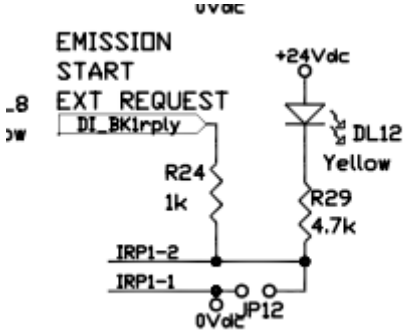


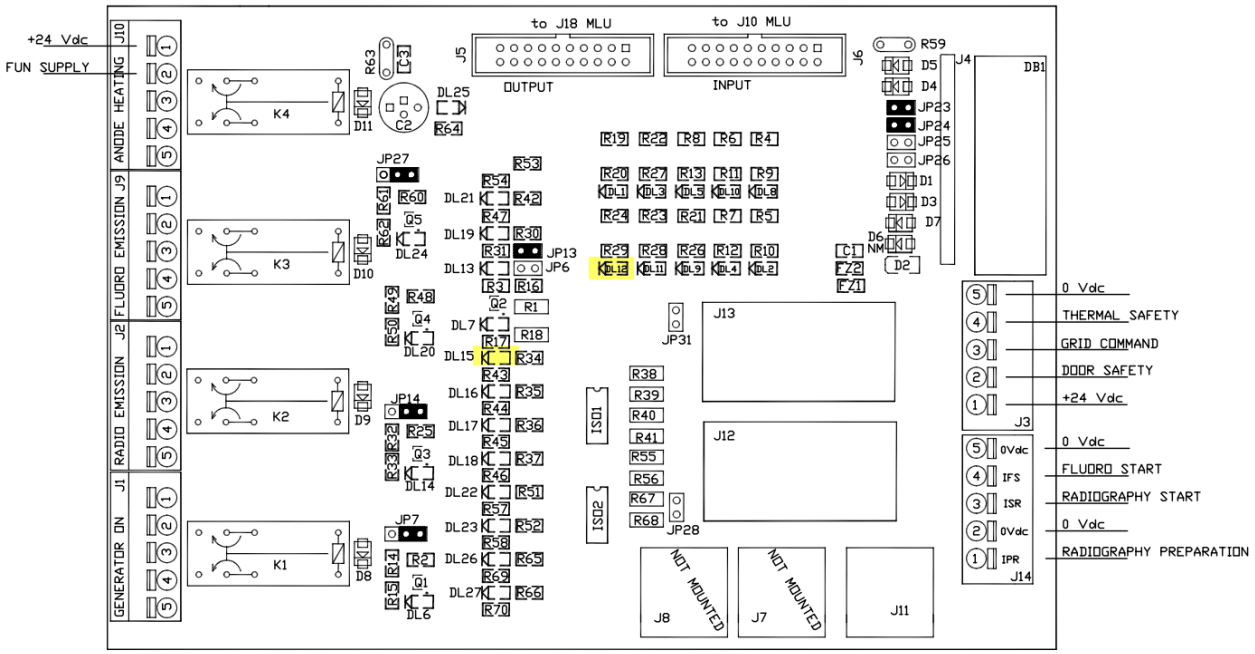
CARDIO INTERFACE based

CALL



REPLY





VERIFICATIONS

FOR ALL THE INTERFACES

- Check that selected accessory is powered ON
- Verify that OBS, OBSx are correctly generated (through related LED switch ON in General Terminal Board
- Be sure that cable connecting Generatror to accessory are not interrupted
- In case of moving grids, be sure that the grid moves when OBS signal is produced and received in accessory side
- Verify that external accessory replies (closing relay/or energizing an optocoupler)
- Be sure that cables connecting accessory's replyto generator input are not interrupted
- Be sure that Input LED is lighted
- Test input LED closing manually the bucky reply on GTB

ALARM 130

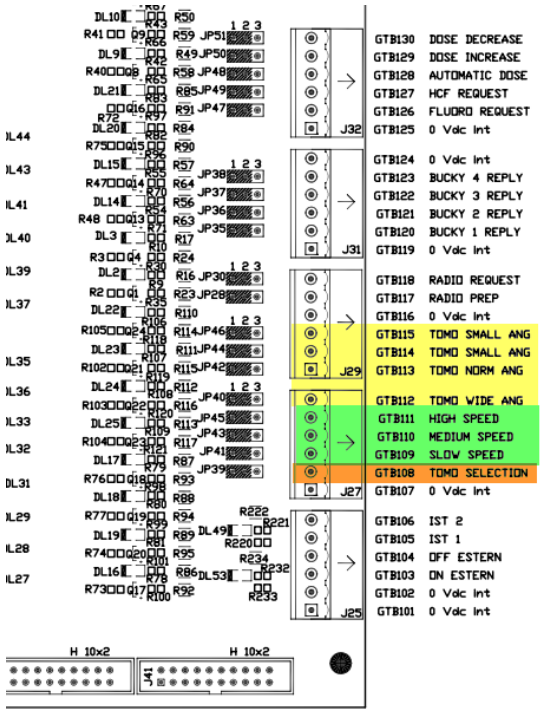
"INTOM: WRONG TOMOGRAPHY INPUT"

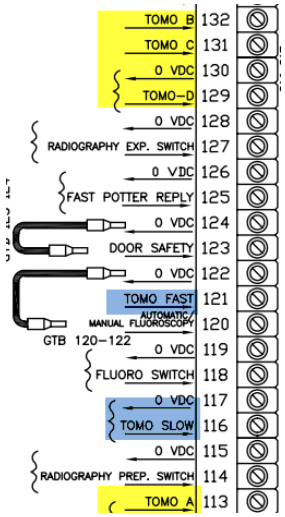
DESCRIPTION

Input combination of signals generated from external tomographic accessory is wrong:

Generator uses following signal to switch to Tomography scan mode:

R306.4x "PROGRAM H.F. US 3"
R306.3x "Endeavour"





In case Selection is not DECODED:
TOMO ANGLE (ONLY ONE between possible selectable angles)
TOMO SPEED ((ONLY ONE between possible selectable speeds)
In case one ANGLE e SPEED digit is missing, ore more than one ANGLE or SPEED are selected this alarm is produced

VERIFICATIONS

Check the input LED against previous description when this error appears.
Verify the cable connection between generator and tomographic accessory
Verify the signal generation on tomographic accessory

ALARM 131

"ACG: Unable to compute filament lighting"

DESCRIPTION

When filament current feedbacks from Filament Inverter Driver boards are different from the ones requested by main computer board in preparation phases for both radiographic or fluoroscopic emission alarm 131 is produced.

Signal path description follows:

Main computer generates an analogue voltage reference addressed to Filament Inverter Driver board.

During Preparations main computer is expecting feedbacks from Filament inverter driver board similar to the reference produced.

If values differ main computer is not getting the expected filament lighting and stops preparations to avoid wrong mA emission values generating this alarm.

VERIFICATIONS

Verify the filament lighting path following those steps:

Value requested by main computer and real filament lighting value can be numerically displaied using service program NAVIGATOR / NEBULA EXPLORER" in I/O SIGNAL window:

Small Focus: osf (Lighting current request) -> isf (real lighting current)

Large Focus: olf (Lighting current request) -> ilf (real lighting current)

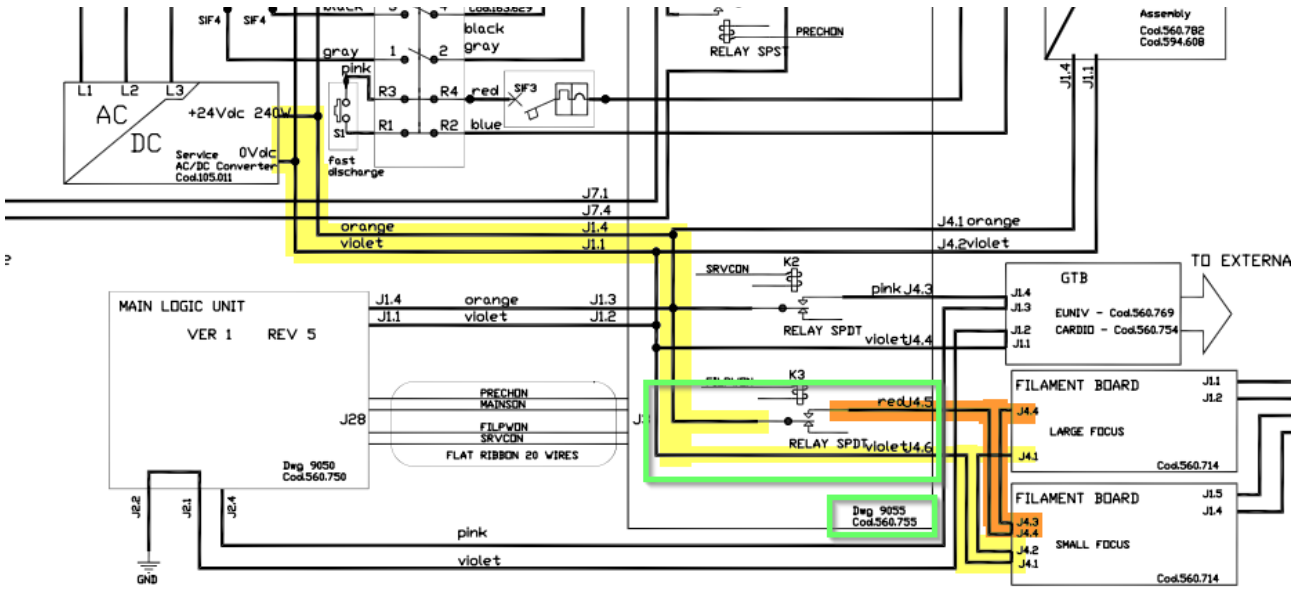
Feedback ZEROED

In case feedback value is ZERO filament inverter driver is not powered, or filament switching is not enabled.

R306.4x "PROGRAM H.F. US 3"

In case both filament feedbacks are zero it is supposed to do not have 24Vdc power supply on filament board – power section.

This power supply is interrupted on Power Distribution board through a Relay commanded by Main Computer:



Check the relay status

Check that electrolitic capacitors after the bridge did not leak eletrolitic fluid from the upper valves or the side breaking lines going into short circuit

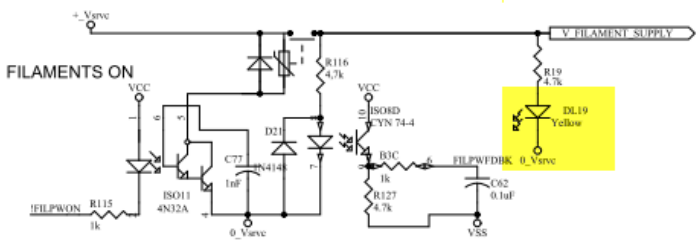
Then check the signal used to enable the filament drivers.

Follows path description in next section

R306.3x "Endeavour"

Here filament power supply is 24Vdc which supplies all the low voltage boards in the generator.

This power supply is handled by Safety Supervisor Board that can decide to cut off the power in hazard situations



Check led on Safety Supervisor board the LED that indicates filament power presence

Check also on cable connected to Filament Inverter Driver Board the presence of 24Vdc.

Single Filament lighting board (Rad Version)

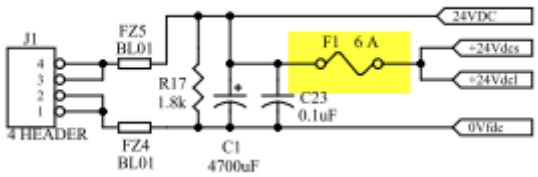
Single filament lighting board power one filament a time, and switches the power to the filaments through an onboard relay.

Filament lighting reference and feedback are produced and read back on Small Focus channel (osf, isf) so, in service software only the small filament seems used also when large filament is select on control console.

Digital signal for small focus selection is PWM controller shut down (like ISTx in R306.4x)

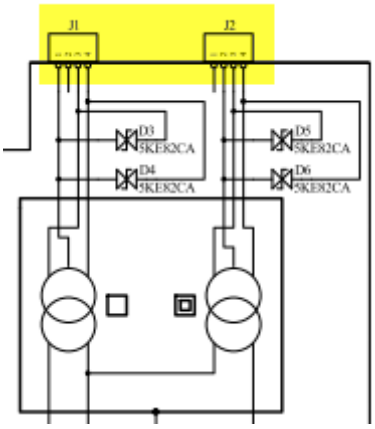
Digital signal for Large focus selection is used to drive relay which selects Small or Large focus power output.

Check, on filament driver board, the fuse F1 which supplies power to the inverter's power MOSFets



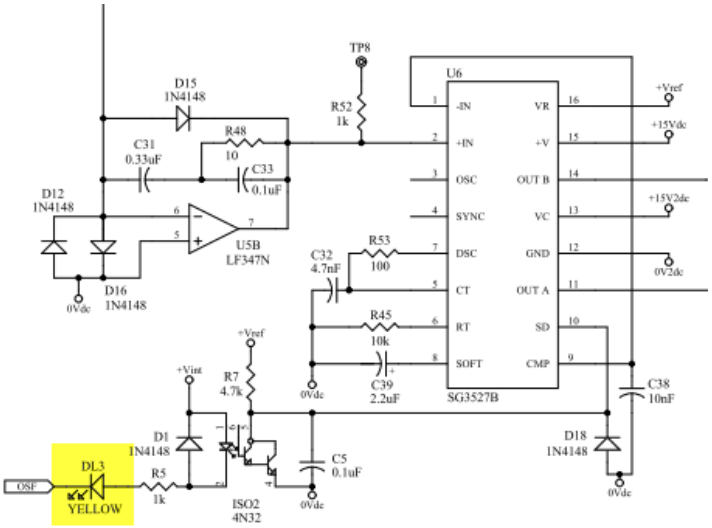
Check that power output connector to High Voltage transformer are not swapped during system installation:

J3 J4 on filament board

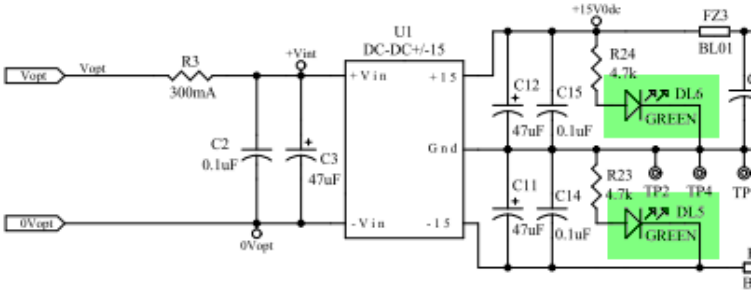


J1, J2 on High Voltage Transformer

Check also that PWM controller is not in forced shutdown state (DL3 LED ON = Correct Working status)



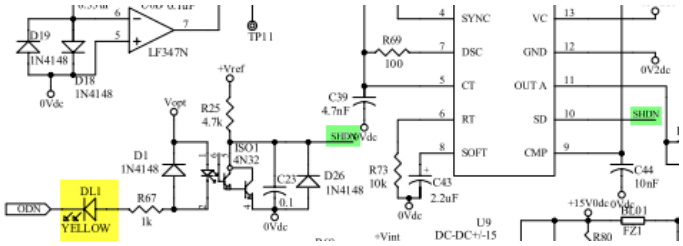
Verify analogue voltage power supply.



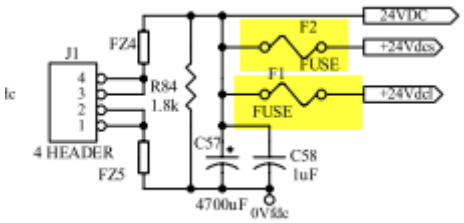
Double Filament Board

Here filaments are lighted contemporary

ISF signal is used to shutdown the board under ODN name, then all the principals of working are exactly the same as single filament inverter driver board



Here two fuses carries power on filament inverter board:



Than follow instruction seen in single filament board regarding Safety Supervisor power out and flat cables checks

Feedback < 1.5A

In case feedback is less than 1.5A the primary circuit is working correctly and the low current flowing is the magnetizing current of the filament transformer when secondary circuit is open.

Remove cathode's High Voltage cable heading in High Voltage transformer side and verify with an Ohmmeter the continuity between the pins (less then 10Ohm).

In order to inspect if the continuity stop is in the cable or in the tube (broken filament) unconnect cathode High Voltage heading on tube side, put all the pins in short circuit and measure the continuity in tube side.

- In case the cable is broken, do the same test on anode cable: if anode cable is ok swap the cable on both side and keep on working
- In case the filament is broken, put this information in service software to instruct the generator to do not use the broken filament.
- In case the filament broken is the one used to make fluoroscopy, do a fluoroscopy calibration on the other focus using service program NAVIGATOR / NEBULA EXPLORER.

Feedback present but not correct

This situation can take origin from

Main computer generating wrong reference value

Reference values are read back from main computer and can be displayed through service program in I/O signal section: in case read value ar different from generated value the problem can be the D/A converter:

The section presents the wanted value, the readback voltage for the desired current and on the right the real current flowing through the filament

Filament board reading wrong current signal from filaments

Check filament board: there are two current transformers in which a cable is passing through the measurement hole.

Turn the board and solder the transformer pins.

FEEDBACK PRESENT BUT UNSTABLE

Verify High Voltage cable connection, clean the headings and in case of old cable enlarge the pin to be sure the contact is granted.

Also a false contact of the cables inside the tube that are connected to the metallic pin which pass through the glass can give this phenomena

FEEDBACK PRESENT BUT UNSTABLE IN PARTICOULAR POSITION OF THE TUBE, OR LOWER EMISSION WITH THE SAME LIGHTING

Verify High Voltage cable pins as per previous description.

In case tube is not metallic, remove the collimator and look the light of the filament, there is the possibility that the filament goes partially into short circuit, so that current flowing is the same, but electrons are fewer and emission is lower.

ALARM 132

"IMA: External Automatic Exposition Controller not ready"

DESCRIPTION

This error refers to generators different from R306.3x "Endeavour", R306.4x "Program H.F. US", R306.5x "Nebula", where AEC electronics is a completely separate box.

In case electronics of the box is not ready to acquire this alarm appears.

VERIFICATIONS

Follow instruction on generator's manual and box schematics to find the reason why the AEC is not ready

ALARM 133

"IAR: Anode Rotation failure"

DESCRIPTION

Identify the situation where main computer, after rotation request to rotor drive board is not informed about correct rotation of the anode.

Rotor driver can be two types:

- mains frequency rotor board "NORMAL SPEED STARTER"
- 60Hz / 180Hz frequency rotation "HIGH/NORMAL SPEED STARTER"

Both the drivers are common to the three classes of generator, so will be inspected together.

VERIFICATIONS

Check, using an Ohmmeter, the continuity between COMMON - MAIN, COMMON – SHIFT wire.

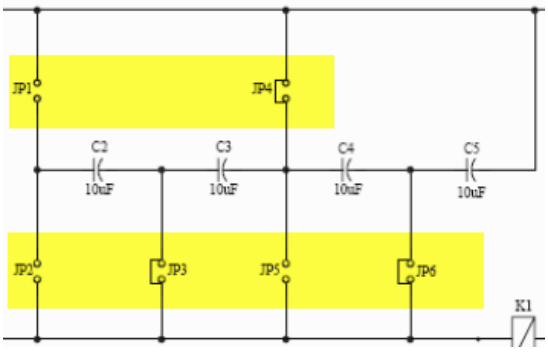
Check also that resistance COMMON - MAIN < COMMON – SHIFT < MAIN – SHIFT.

Verify using tube's technical documentation, that resistance read is similar to the one specified for tube windings, in case no tube technical data are available, check if the tube is present in section 1 of technical manual.

NORMAL SPEED STARTER

Check that wired bridge on Normal Speed Starter Board are the ones described in following table to select the correct shift capacitance:

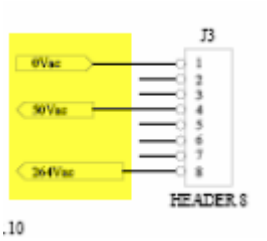
JUMPERS SETTING:			
PHILIPS	40uF	JP1 JP3 JP4 JP6	ON
COMET VARIAN IAE	30uF	JP3 JP4 JP6 FACTORY DEFAULT	ON
CGR	15uF	JP1 JP5 JP6	ON
SIEMENS	10uF	JP1 JP5	ON



(ON = Wire Soldered in Holes)

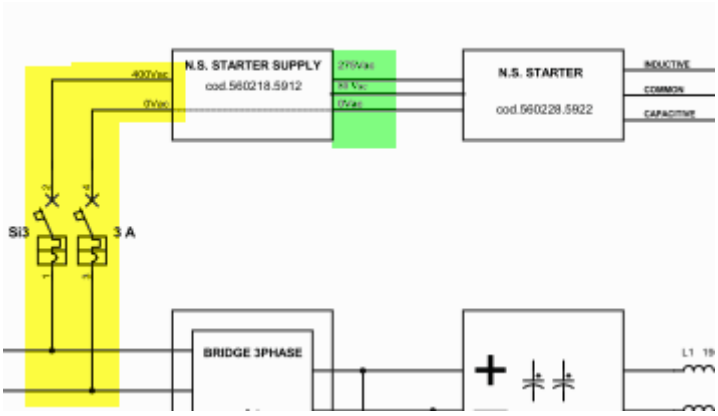
POWER SUPPLY

Verify the presence of board power supply:



Power supply is generated:

R306.3x "Endeavour":



On front Omega Rail is mounted Si3, feeded with two phases as current protection the the autotransformer mounted in between the two metallica wrame holdin on fron the main computer, and in the rear the filament board and the starter board.

- ➔ Verify the switch is ON and 400Vac ion the output of Si1
- ➔ Verify the 260Vac and 50Vac on Starter's connector.

In case 400Vac is present out from Si3 and 264Vac is not present on starter's connector power suply:

Transformer is protected whith a thermistor "clickson" rated 70°,

- ➔ Demount MCU frame and try to understand if transformwr is SO hot to have the clickson OPEN

R306.4x "Program H.F. US":

Verify fuses F3 and F1 for integrity

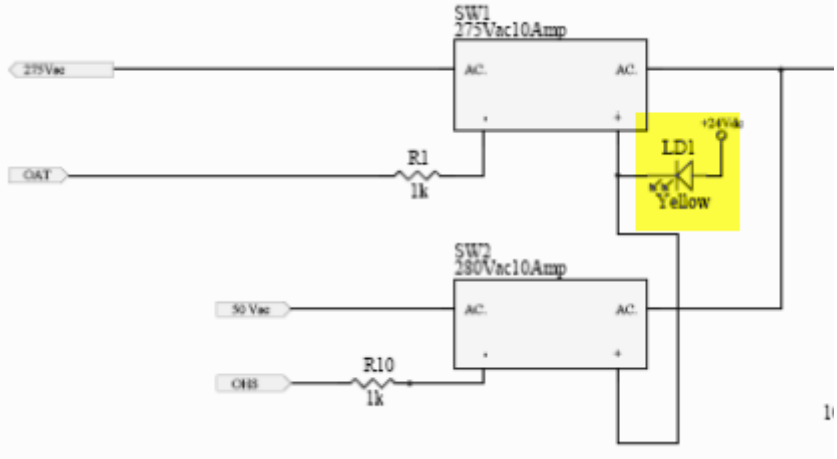
Verify that LB is closed.

Verify 60Vac and 275Vac voltage on power cable which feeds the Normal Speed Starter board.

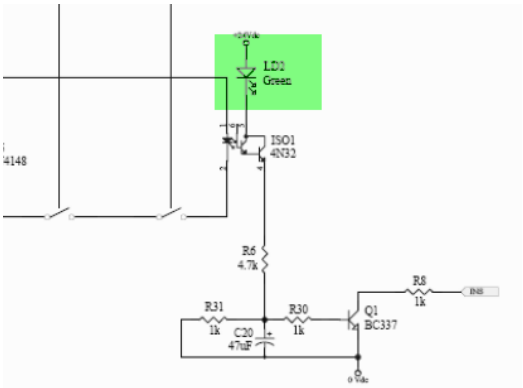
Verify 400Vac is present on Service Transformer

Verify 60Vac and 275Vac voltage used by Normal Speed starter is present on starter's Transformer.

TUBE ROTATION DIGITAL OUTPUT

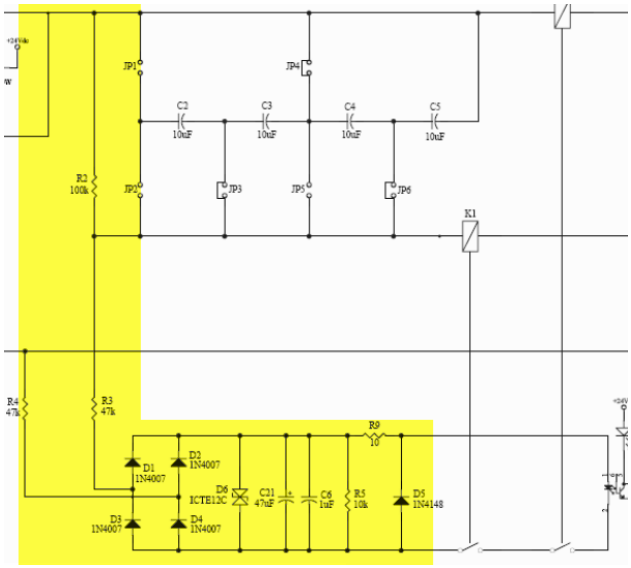


Verify that rotation command (OAT) from main computer to Normal Speed Starteris present looking the relative yellow LED on Normal Speed Starter LD1

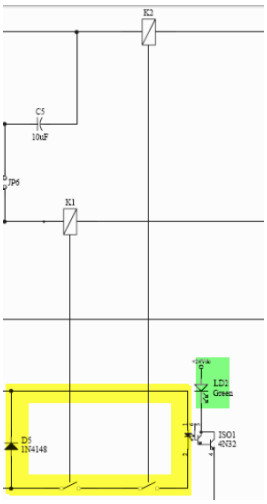


When current is circulating in stator windings, verify the presence of Normal Speed Starter reply to OAT command, looking the green led LD2: it must light in normal condition after Yellow LED LD1 is lit.

In case command is present but No reply is present, take a look on safety circuit used by Normal Starter board to sense tube rotation:



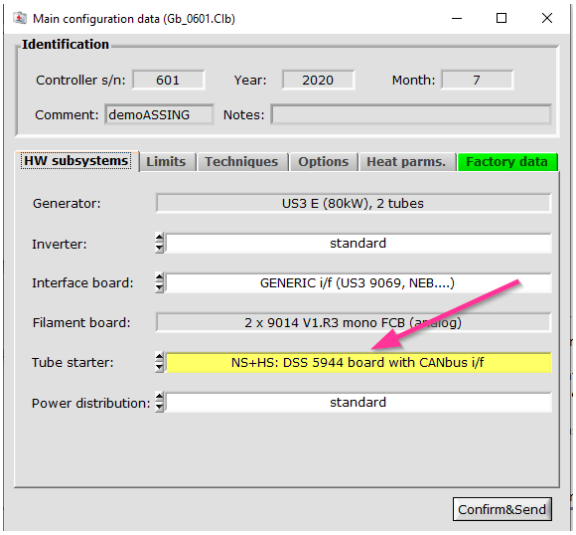
Driving voltage across stator windings produces also a low voltage alternate current, rectified, and present as continuous voltage on diode D5



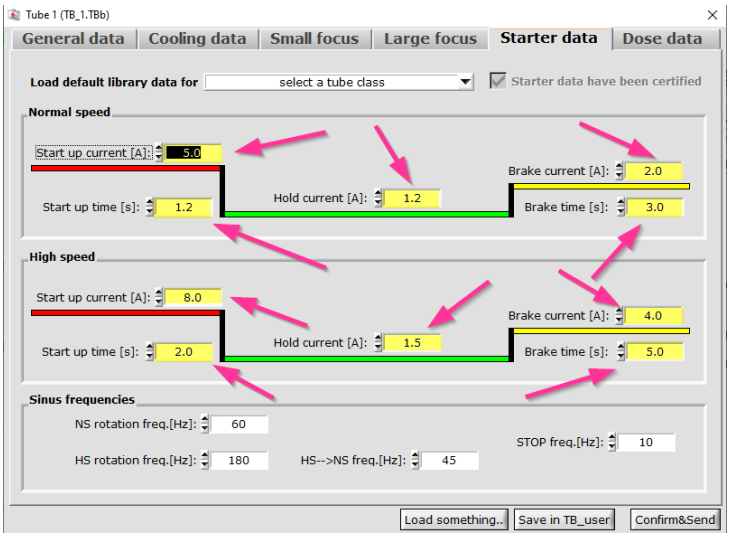
Current circulating is stator closes the two reed relay: MAIN leg (K2) and SHIFT leg (K1) so the voltage on D5 can flow through optocoupler ISO 1 closing the rotation reply to main computer.

NORMAL/HIGH SPEED STARTER

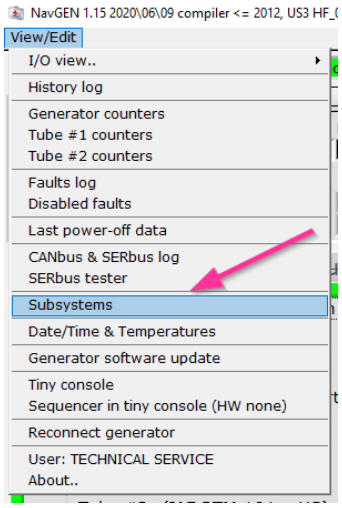
Verify that starter in Hardware Description is the CANBus driven device:

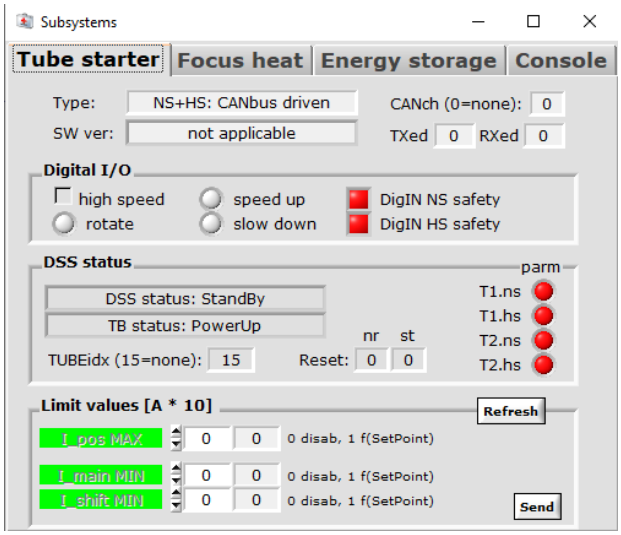


Verify in TUBE descriptor that stator configuration in NavGEN is in accordance to the tube used:



Alarm 133 can be inspected in detail in SUBSYSTEMS WINDOW:





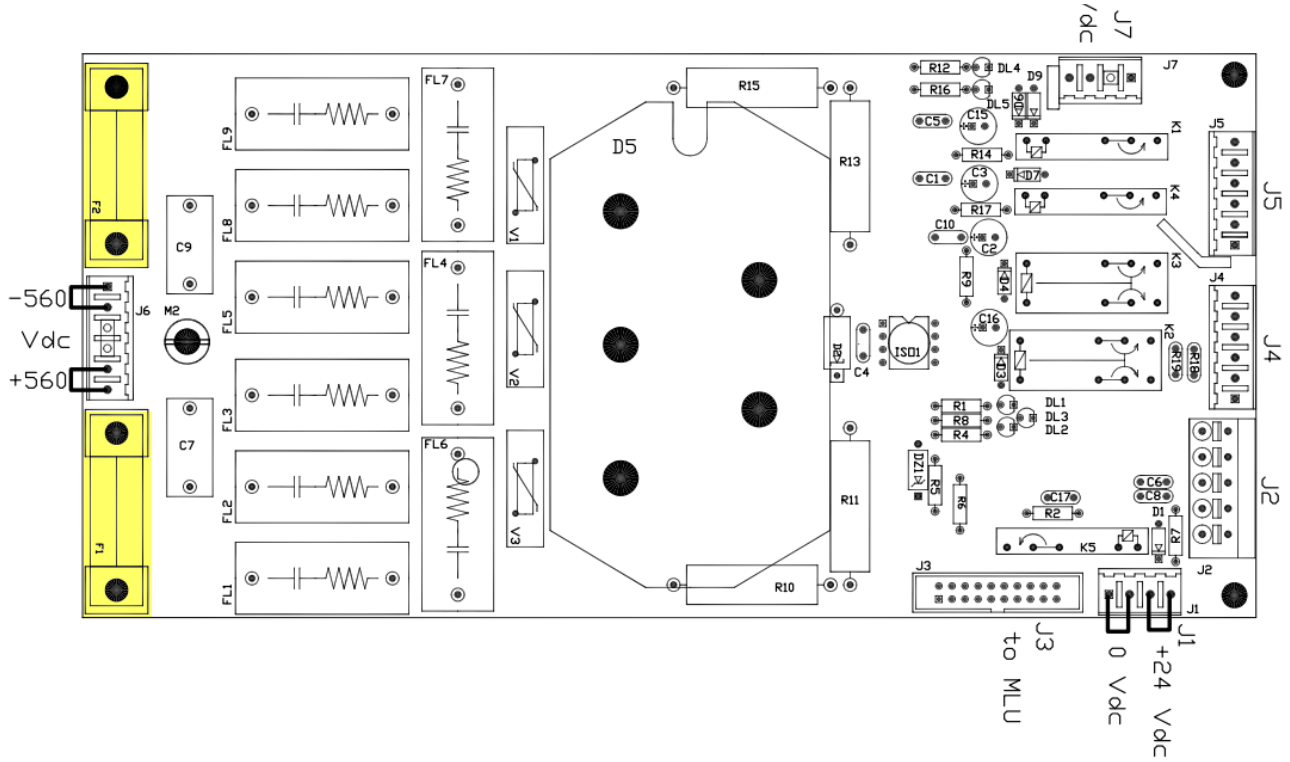
CASE 1: NO ROTATION DETECT

In this case main computer do not receive the NS / HS safety depending on the speed selected by load.

Possible causes can be:

POWER SUPPLY ON STARTER INVERTER

Switch ON generator and set it in Stand-By mode, here verify the 560Vdc voltage presence in the starter power input connector: power connection passes through protection fuses located on POWER DISTRIBUTIONBOARD, so, in case of no power supply on starter, switch off the generator and check for fuses integrity.



STATOR CIRCUIT VERIFICATION

Switch off generator and, using an Ohmmeter, verify continuity of the three cables that powers the stator, directly on general terminal board or directly on the starter in case of single tube generators.

Measurement is in Ohm, typically from 11 Ohm in common to main winding in a Philips tube, up to 110Ohm, maximum resistance measured on CGR tube between Common to Shift.

Verify the measurement with tube technical characteristics.

As a general rule:

In case of resistance lower than the nominal stator resistance present on technical documentation implies short circuit on windings layers

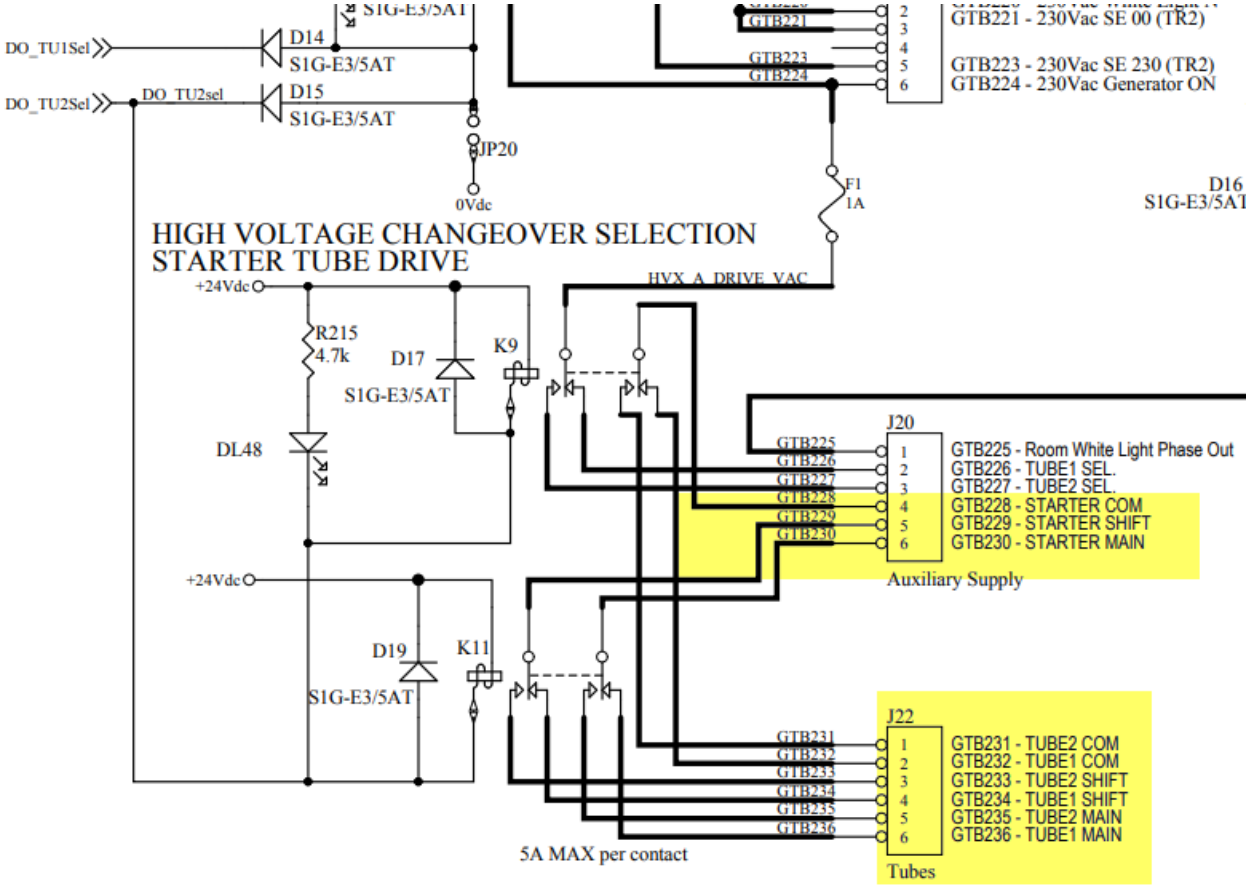
Open circuit generally implies cable bended up to conductor crack or statoric winding open due to high current drive while a wrong jumper set was configuring the starter.

One Tube Generators

Cables are connected directly on the Normal/High speed starter, no further inspection are needed to verify stator circuit continuity.

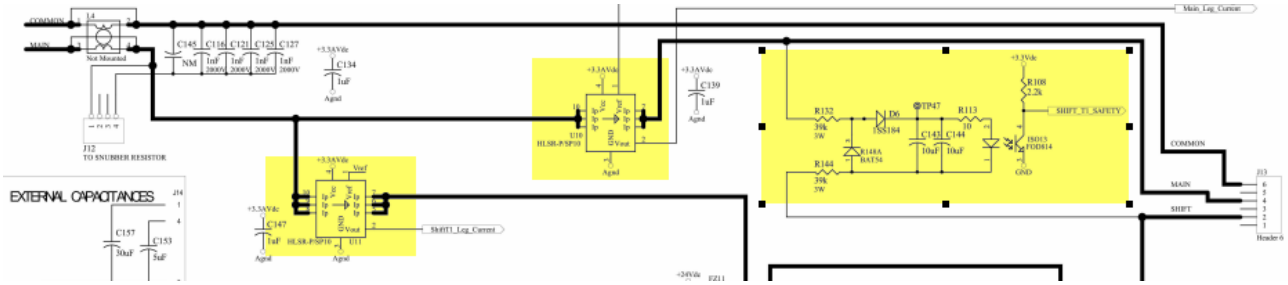
Multi tubes generators

Stator cables are connected to general Terminal Boards:



Inspect DL48 lit for tube 2 selection

CURRENT FLOW MEASUREMENT ERROR

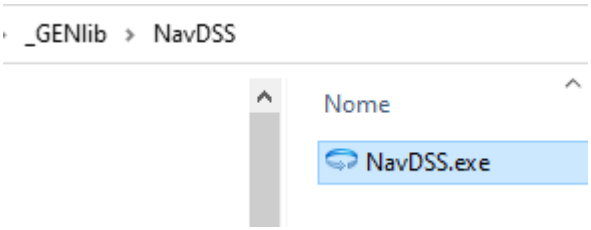


Current flow is sensed by two different circuits:

LEM current sensor to measure and regulate the drive current

HOLD current circuit to sense the low current in shift leg

VALUE of the current cannot be seen in Starter Subsystem panel in NavGEN, but there is the possibility to use a specific software called NavDSS present in NavGEN installation and connecting the USB cable directly

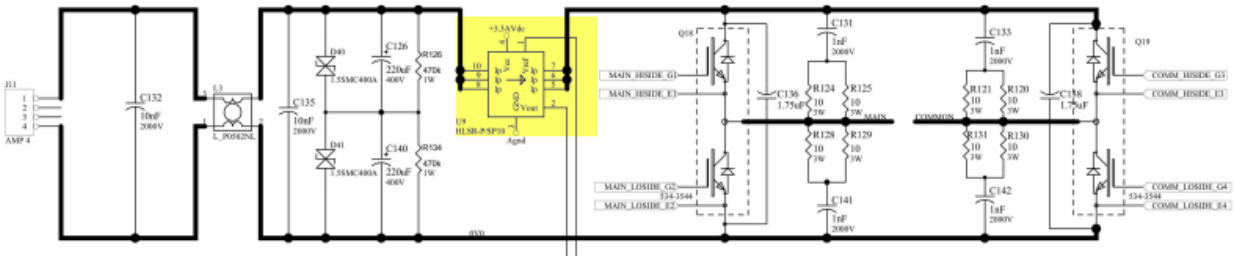


on the starter.

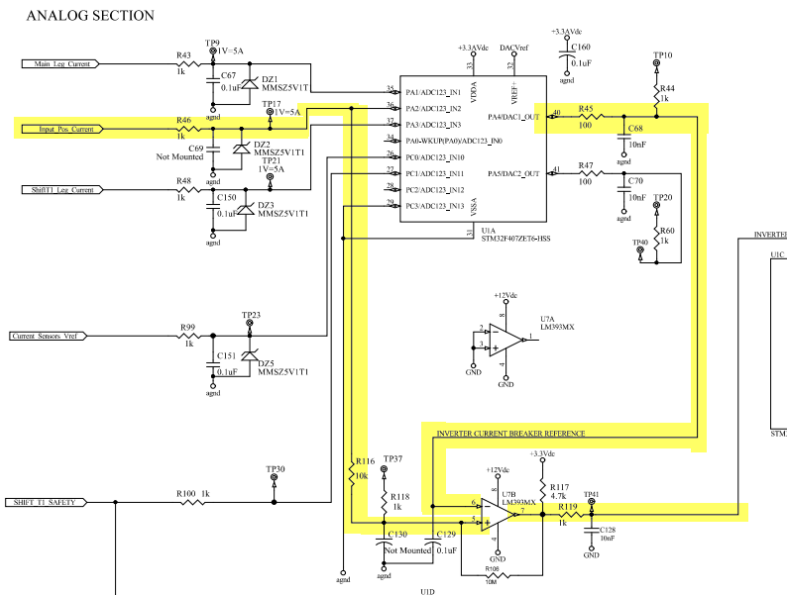
CASE 2 SHORT CIRCUIT DETECT

In this case,there is another current sensor which senses the current flowing across the inverter.

In case of over-current in the inverter, it automatically trip off the sinusoidal synthesizer.



This sensor drives a sensing circuit which trigges the safety against a limit value set by microcontroller according to the limits set in firmware:



Possible causes:

TUBE's STATOR INTO SHORT CIRCUIT

Verify the resistance of the winding using an ohmmeter

STATOR CABLE INTO SHORT CIRCUIT

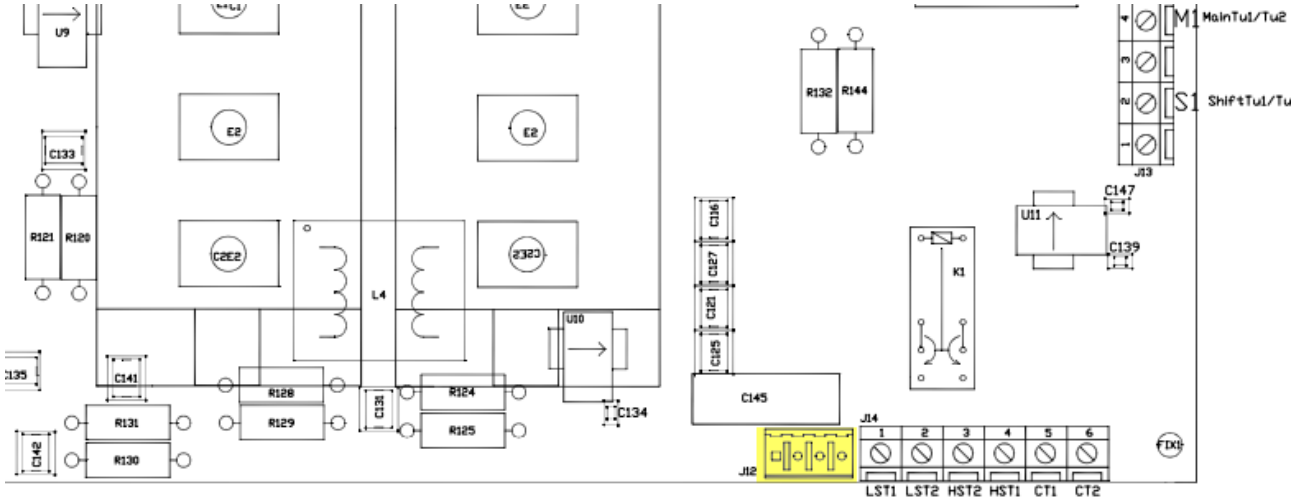
Disconnect cable on both side of the cable and verify that the three conductors insulation, verify also the insulation of the three cable against the cable shield.

In old system verify also the insulation between the two shields.

SNUBBER INTO SHORT CIRCUIT

Verify Snubber resistences (metallic resistors mounted below power board on an heat sink to not be destroyed due to high power out or grounded through metallic body.

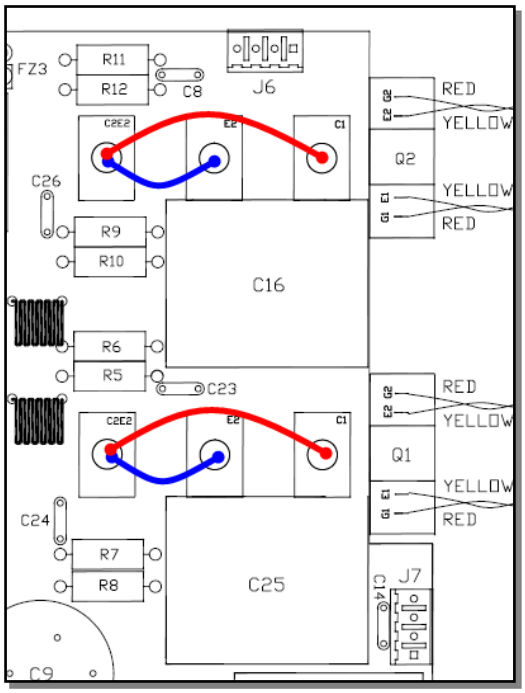
In case snubber resistors are found in short circuit it is possible temporary to keep on working unconnecting the snubber's resistances removing connector J12



INVERTER INTO SHORT CIRCUIT

Switch OFF the generator and verify IGBT junction using an Ohmmeter:

- A correctly working IGBT measures a charging capacitance, i.e. a resistance growing (capacitive charge offect of the junction).
- A shorted IGBT generally has a fixed resistance lower than 500Ohm.



Simply using an ohmmeter check the blue and the red connection, the resistance you'll find is like a capacitance charging, in case of IGBT short circuit the resistence do not rise over 500Ohm

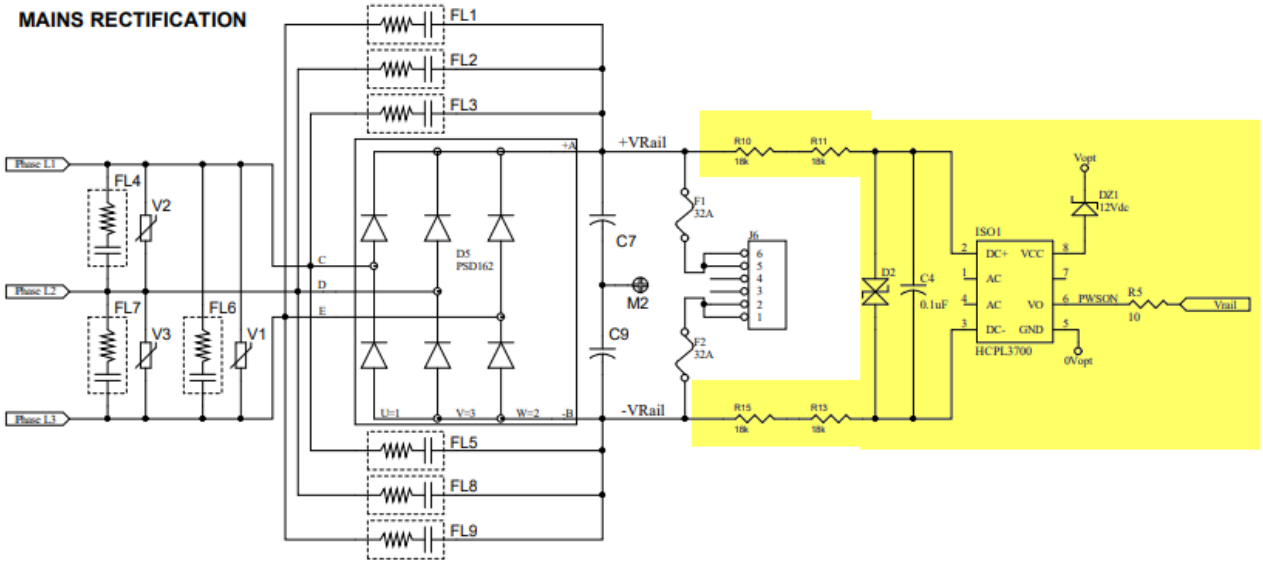
- CABLE IN SHORT CIRCUIT: simply check with an Ohm-meter the three windings impedence according to data shown in tube datasheet, on HSS side after removing the pin from the HSS power board, for example in Varian tube You'll find 15 Ohm between Common and Main and 35 Ohm between Common and Shift;
- Check for insulation between inner and outer screen and in any case remove the inner screen connection to the negative supply and connect with the outer screen to ground to make further test.

ALARM 134

"IPW: Not enough power on Main Inverter"

DESCRIPTION

IPW signal/alarm shows the status of the nominal 560Vdc on POWER DISTRIBUTION BOARD.
It is also functionally used as a check input to drive the whole power on main inverter.



The rectified line voltage is measured on POWER DISTRIBUTION BOARD using R10, R11, R15, R13, resistances and ISO1 photo coupler.

If Line voltage exceeds 480 vdc, the Vrail signal is switched to GND by the photo coupler.

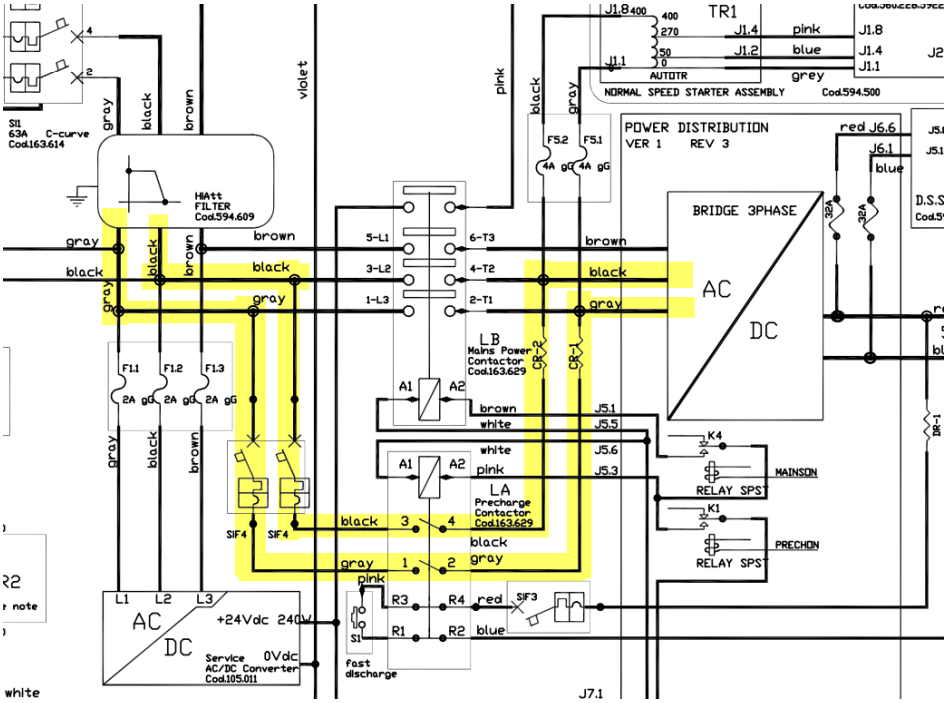
VERIFICATION

Verify voltage on main inverter.

In case voltage is OK but alarm 134 appears on control console the sensing circuit can be damaged.

In that case, JUST FOR TEST PORPOUSE, you can mask the alarm:

BE VERY CAREFUL:



Voltage CANNOT RISE because the CAPACITOR'S PRECHARGE CIRCUIT is open.
This can happen because the resistor are broken OR the magnetothermal switch is open due to a short circuit on inverter.
IN THIS CASE, MASKING THE SAFETY, MICROCONTROLLER WILL DIVE LB ON A SHORT CIRCUIT AND THIS CAN DAMAGE THE RECTIFYING BRIDGE.

NEVER MASK THIS SAFETY IF YOU ARE NOT SHURE THAT THE VOLTAGE ON INVERTER RISE ABOVE 480Vdc WHILE MICROCONTROLLER IS TRYING TO LOAD THE INVERTER CAPACITANCES

Power supply Voltage

Generator nominal power supply is 400Vac -10%.

Verify that at least 360Vac. Are in line input

Verify the presence of the three phases

In case of One missing phase 134 error can appear on generator while loading a biphases power supply on

ALARM 135

"ICF: Digital Filament Safety"

DESCRIPTION

On R306.3x "Endeavour", R306.4x "Program H.F. US", ICF safety changes to OBF safety and it is managed directly by Main Controller

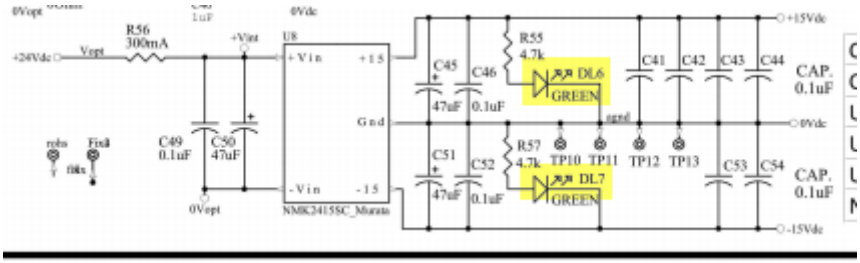
It is produced when a fault is sensed on Filament Driver boards, or an overcurrent on filament drive happens.

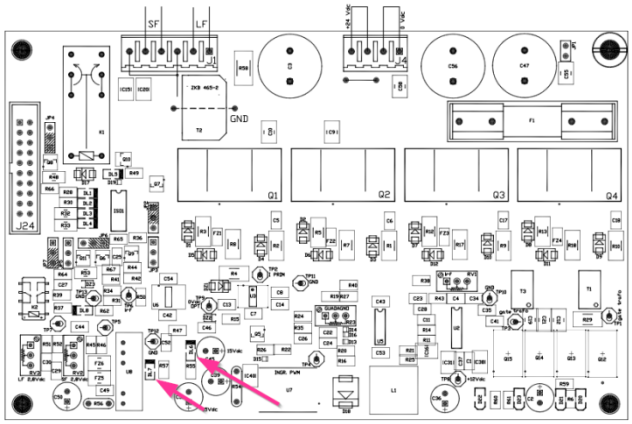
In this case the supervisor system switches off the power supply to filament and main inverter to avoid damages on tube's filament

VERIFICATIONS

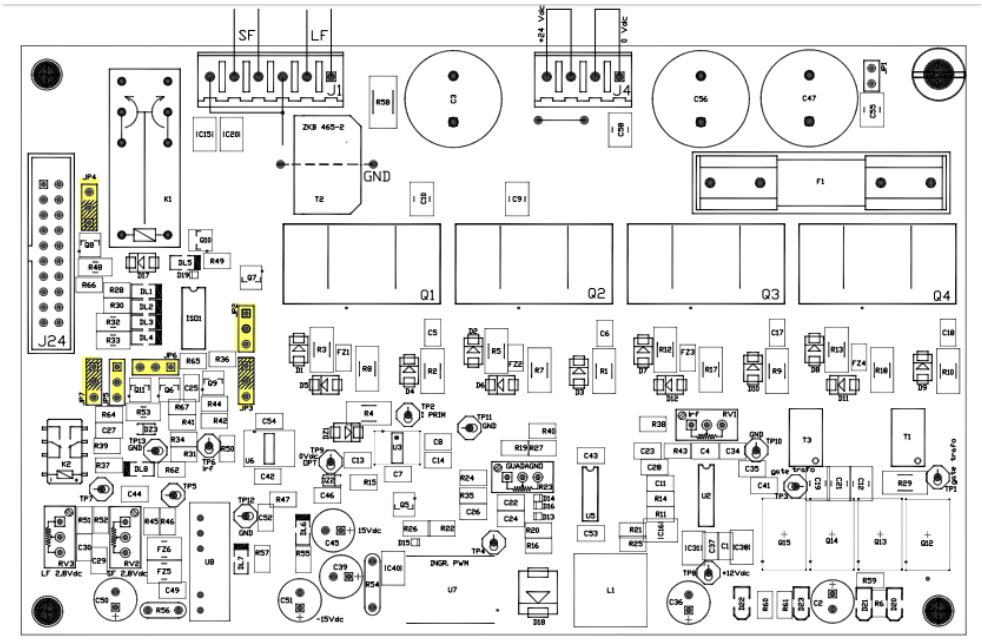
When generator is OFF remove filament supply cable on High Voltage transformer to avoid filament overheating in case of failure.

Mask the alarm, switch on the generator and check analogue power supply :





NOTE: Filament board are two, similar, the difference is in jumper set.
In case of necessity it is possible to swap the boards jumperset to inpsect if problem is in board or in filament circuit.



VERSIONE US3 LF

1-2	NM	NM	1-2	1-2	NM	US3 LF
JP7	JP6	JP5	JP4	JP3	JP2	

VERSIONE US3 SF

2-3	1-2	NM	1-2	NM	1-2	US3 SF
JP7	JP6	JP5	JP4	JP3	JP2	

ALARM 136

"X-RAY TIMER Safety"

DESCRIPTION

In microcontroller firmware there is a task which acts as the Safety Supervisor board in previous generator.

The task check also the correct termination of any exposure against digital signals AND X-Ray pre-set time.

In case the main software do not close the inverter command within the X-Ray preload timer, OR in case the commands to the inverter are stopped but kV do not decreaseit will remove any command to inverter AND drive down LA and LB contactors to cut any power on main inverter.

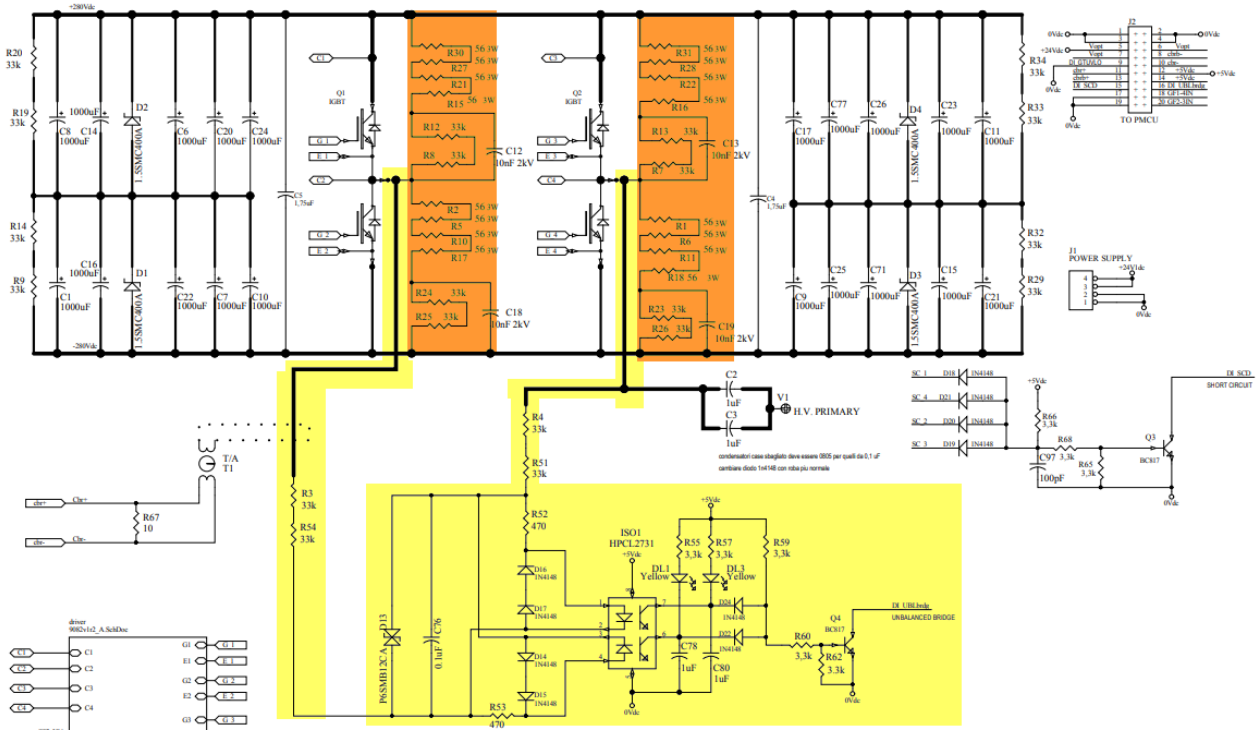
At the same time it will shutdown the filaments boards

In an electromagnetic front resets the main computer without producing error 136 suspect a high voltage arc.

ALARM 137

"IFI / IUB: Unbalanced Inverter Safety"

DESCRIPTION



On MAIN POWER INVERTER board the snubber resistence balances the output of the bridge at the same voltage (orange section).

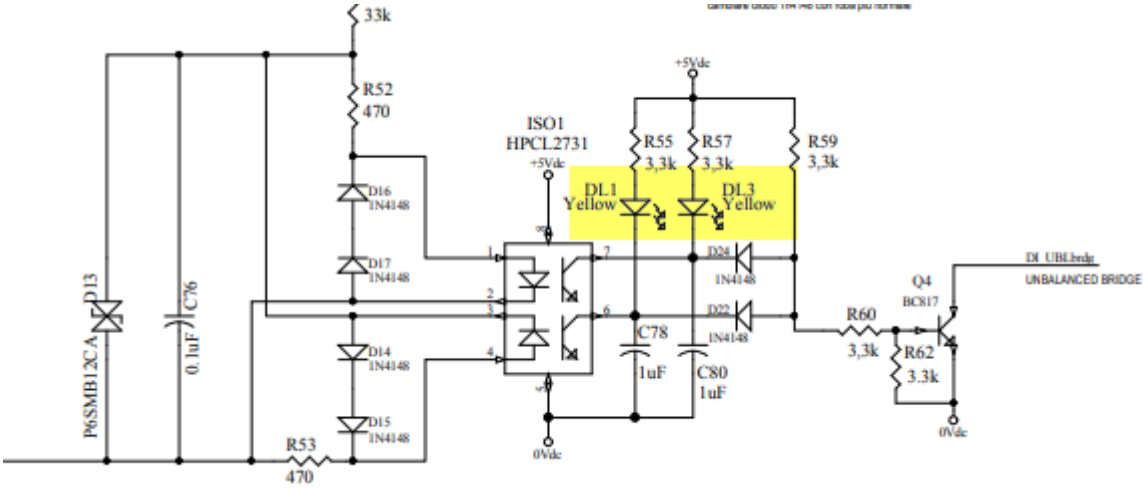
Those two point are processed by a special optocoupler which senses the different voltages between those two points (yellow section).

In case one IGBT remain closed for a destructive cause, the two points are not at the same voltage, and this will produce the IUB signal to inform Main Computer to NEVER drive the IGBTs because there is the possibility to close the opposite junction to the one damaged causing a DCRail short circuit.

NEVER MASK THIS SAFETY, FOR ANY REASON

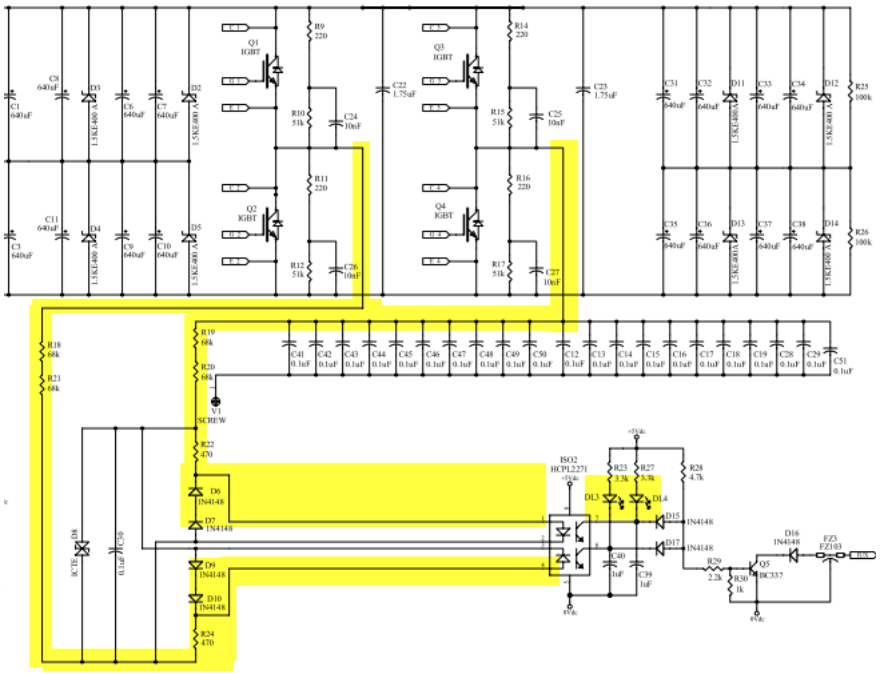
VERIFICATIONS

On MAIN POWER INVERTER check DL1 and DL3:



THOSE LED ARE OFF in standard condition, will blink during exposure, one of the two led ON in case one IGBT is shorted, OR snubber resistence is burn.

Measure the snubber resistence and IGBT junction resistence to determinate who's producing the signal.



ALARM 138

"OST: Tube Selection Error Safety"

DESCRIPTION

Main computer activate the correct tube request on selected working station and is waiting the activation of ISTn input from, and only from, the tube driven.

In case the reply is not present, or is coming also from another tube, this error is generated.

During installation

It is possible to make a wrong connection on High Voltage transformer of the cable that carries the signals from the transformer micro-switches to GTBs, in this case check labels on micro-switches cables

During normal operativity

It is possible that

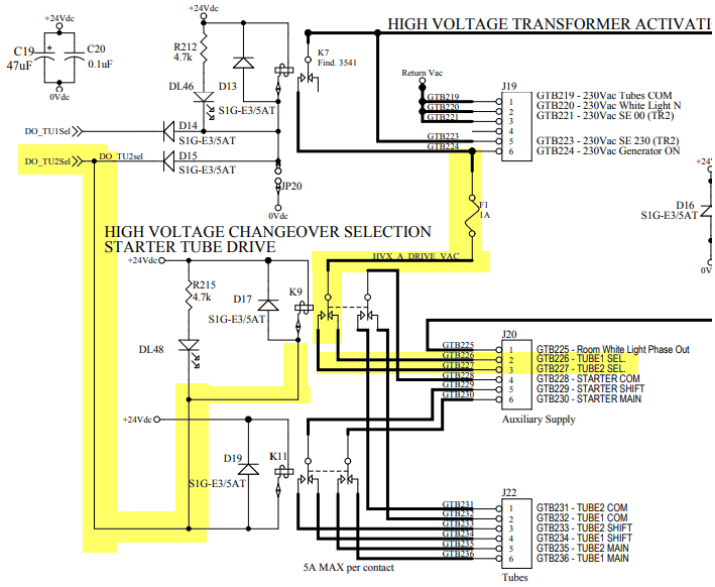
- Main computer is not able to activate the tube selection
- High Voltage exchanger cannot be driven
- Feedback circuit is not working
- Input circuit doesn't work

VERIFICATION

- Check that High Voltage transformer's micro-switches are connected
- Check that High Voltage transformer's tube selection connector is inserted in High Voltage transformer.
- Check that tube selection voltage is present and correct: it is produced by service transformer (230Vac) and switched through relay on GTBs
- Verify that relay that switched tube selectors are driven:

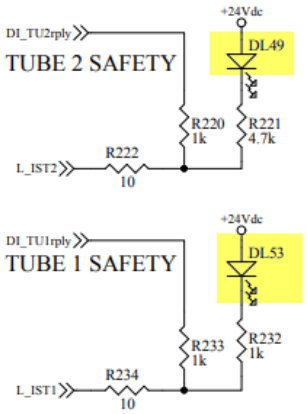
K1 on GTB100/GTB200/GTB300

TUBE SELECTION



- Un multitubes Selection Board check that DL46 LEDs is ON OFF while selecting tube 1, and LED DL48 is ON for tube T2 selection.
- Verify that current returns on both filaments are correct: in case feedback current is lower than 1,5A when 2.5A are requested in Sand-By secondary circuit may be open.
- Verify that when tube exchanger is driven, the pinrod covered by rubber cover is closing the micro-switch in the middle between Anode and Cathode.
- Verify closing manually the micro-switch that the relative LED on GTB is ON while all the other tube replies are OFF

TUBE SELECTED REPLY



ALARM 139

"ISP/IDS: Door Open Safety"

DESCRIPTION

During

- Radiography Preparation
- Radiographic Sequences
- Continuous Fluorsocpy Emission
- Pulsed Fluoroscpy emission

Main computer check the status of Door Safety input

In case it is not driven (in case external interlock is OPEN) stops emission and produces alarm 139

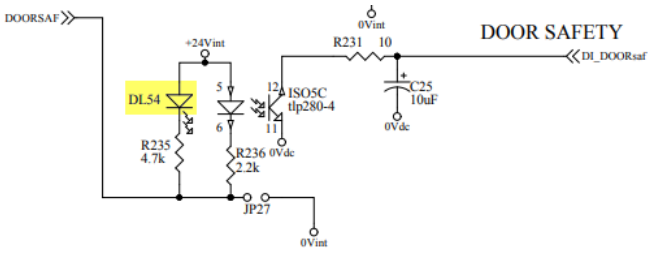
VERIFICATION

It is suggested to verify door interlock safety every time the generator is powered on preparing radiography with door interlock open befor a standard job session to be compliant with local standards.

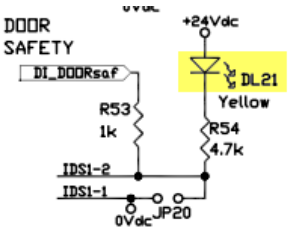
In case external interlock circuit is closed do following test:

EGTB

Verify that DL54 LED is on when interlock circuit is closed



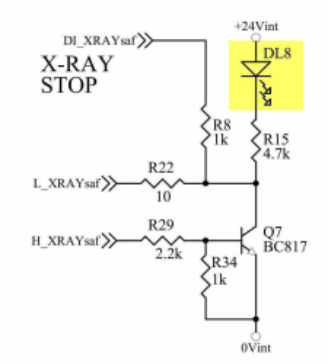
CARDIO INTERFACE



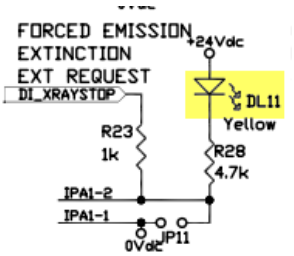
NOTE

In case it is request to stop emission during single radiography after radiography start, put in series to external interlock circuit also the GTB interlock signal:

EGTB



CARDIO INTERFACE



ALARM 140

"IRM: High Voltage Digital Safety"

DESCRIPTION

IRM digital signal is generated when High Voltage feedback signal crosses the 80% of the reference signal.

This digital safety is the interrupt signal to main computer to start counting exposure time

In case there is not this signal within the first milliseconds, main inverter is stopped and 140 alarm is generated on Control Console.

No High Voltage, or Low value of High Voltage have several sources such as No power, load in short circuit, wrong ramp circuits, High Voltage arc …

In case, for example, LB on R306.$x or R306.5x is not closed, radiography is made through limiting resistors, so no power output is reached

Another causes can be the hardware interlock.

VERIFICATION

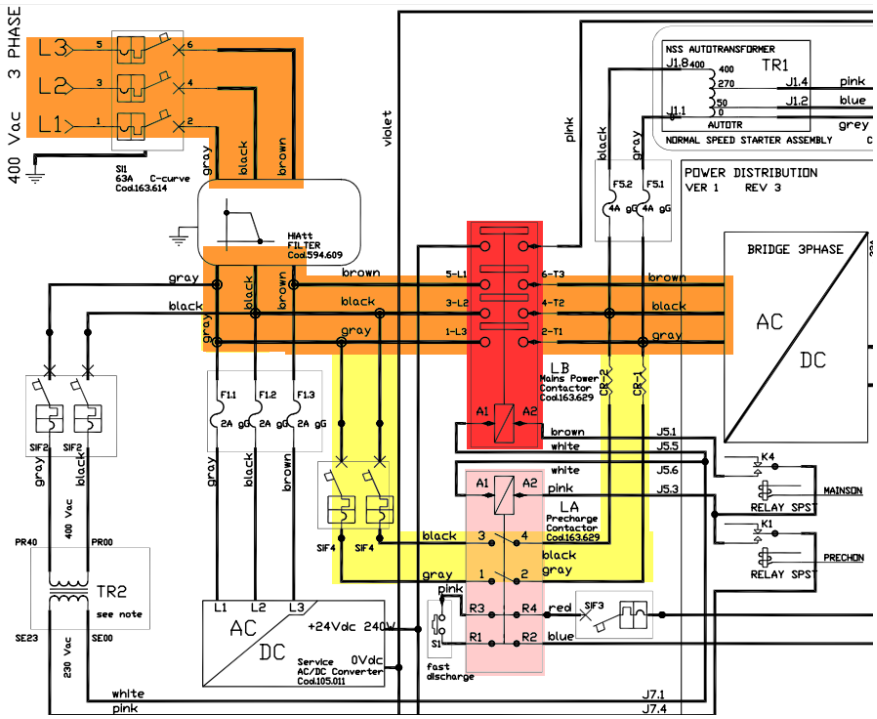
Check that power circuit is in whole power condition.

Check that resonant capacitor in resonant circuit is not open.

Check that transformer power input cables are connected and are not loose.

- Mains power supply have to be equal or greater than 360Vac in load condition (not only correct line voltage but also correct line resistence)
- Check for the presence of the threephase lines
- Check that LB is driven
- Check that a minimum of 500Vdc is present on power inverter
- Check that resonant capacitance is at least 1.9uF

One thing to be check follows:



In order to pre-charge the DCrail capacitors, there is a small contactor on the switch bar called LA (pink).

It charges the capacitance through two 52Ohm resistors(pink).

When the DCRail is charged with controlled current, the main contactor LB (red) is driven to bypass the resistors.

Both the contactors are managed by Main Computer through POWER DISTRIBUTION BOARD.

When generator starts a radiography, the IPW signal is present (this signal inform the MPU that DCRail is charged, even if LB is not driven).

If LB is not driven, the High Speed starter can discharge partially the DCRail because the power is feed through the 52Ohm resistors.

After the preparation is done the radiography is started, but if LB contactor is not closed, there is not enough power in the DCRail capacitors to ramp the kV and you get this error.

LB is not driven until MPU do not see POWER DISTRIBUTION voltage sensor circuit driven (See error 134).

the path is this:

- MAIN COMPUTER drives LA to switch on the sevices and start preloading the inverter capacitances

- MAIN COMPUTER checks for IPW signal, produced on POWER DISTRIBUTION BIOARD, until it is present.
- When present, MAIN COMPUTER drives LB

OR, another thing that can stop radiography is the following:

ALARM 141

"DEXP: Exposimeter Dose too low"

DESCRIPTION

During emission, instantaneous dose is controlled.

The value of instantaneous dose is numerically checked against a minimum dose threshold expressed in milliVolt and set up on each working station using the service software Navigator / Nebula Explorer under the name "Minimum Dose Threshold".

VERIFICATION

Signal can be lower than minimum dose threshold for following causes:

AEC Detector misaligned with tube

Verify that collimator is open on the field selected

Verify that tube is rotated to the AEC Chamber used

Verify that compensation sand bags are not blinding the chamber selected fields

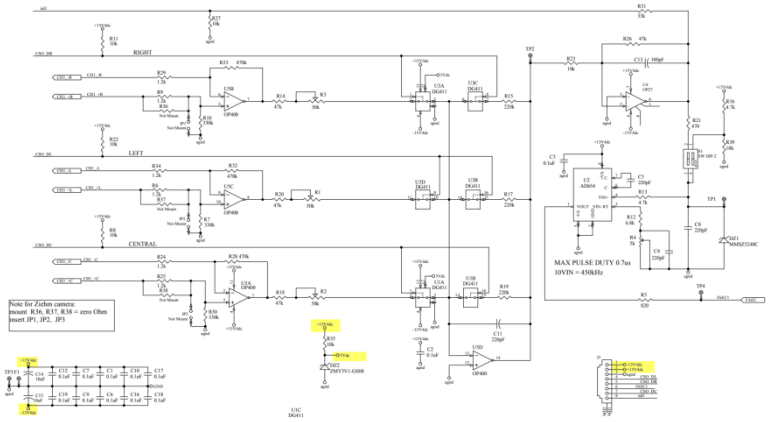
Terget Density too high and beam energy too low

Rise Energy (kV).

Rise Dose (mA).

AEC Chamber failure

Be sure that cable in not interrupted, then using a voltmeter read the signal on amplifier while emitting in fluoroscopy (high kV suggested)mode without targets between tube and AEC chamber:

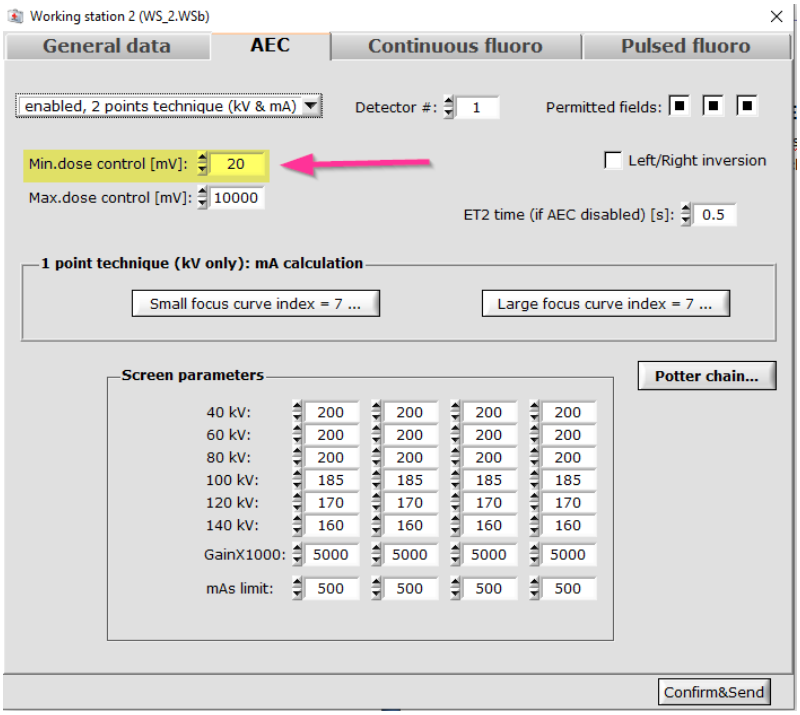


, .

Connection Cable interrupted, AEC field not connected inside chamber

Test cable visually to determinate bending or scretching, than test the presence of a diode on every field on generator arrival when using semiconductor chambers.

Furthers



In case it happens only in certain condition, set the threshold level to zero

NOTE

Two way to check the dose:

- mV = EVEN VALUE -> check for signal level against minimum level written in this field
- mV = ODD VALUE -> Based on actual dose after “n” ms project the final time based on actual dose and compere this value agains maximum backup time for this radiography to determinate if it is possible to terminate the exposure correctly

ALARM 142

"IRAEXP: AEC Exposure Switch released during exposure"

DESCRIPTION

Automatic exposre driven emission need the presence of following signals:

- Radiography Preparation
- Radiography Emission
- Bucky reply
- Instantaneous dose on chamber higher than a programmable minimum dose and lower than saturation threshold

Those signal have to be present for the entire radiography.

The signal that determinate the end of radiography is integrated dose reached the preselected.

On NON AEC technique, releasing one of the commands do not generate error messages.

In Automatic Exposure mode releasing one of the command signals before radiography ends on correct integrated dose produces this alarm

VERIFICATIONS

Check that bucky reply is long enough

Check that bucky reply has no bouncing phenomena

NEVER connect mechanical bucky reply to fast reply input on GTB: mechanical bounce starts a new radiography that is very short and, due to AEC selected, is generally shorter that correct dose integration end, and this on the end of the bouncing exposure generate error

Instruct operator to release hand-switch command only AFTER the end of radiography acoustic signal is produced on control console.

ALARM 143

"TOEXP: Timeout on AEC backup time"

DESCRIPTION

Radiography in Automatic Exposition Mode provides a backup time that can be fine tuned by user in therm of exposure maximal mAs.

In case the correct dose is not reached and maxima mAs are expired, film can be underexposed and this alarm notification informs the user that correct dose was not cumulated.

Generally rising X-ray beam energy (kV) or X-ray beam istantaneous dose (mA) solves the situation, unless a fault in AEC chamber or Amplifier is present.

VERIFICATIONS

Alarm 141 analysis gives a method to check the whole exposimeter chain.

ALARM 144

Not present

ALARM 145

Main computer internal check in glue logic

ALARM 146

"X-RAY TIMER Safety"

DESCRIPTION

In microcontroller firmware there is a task which acts as the Safety Supervisor board in previous generator.

The task check also the correct termination of any exposure against digital signals AND X-Ray pre-set time.

In case the main software do not close the inverter command within the X-Ray preload timer, OR in case the commands to the inverter are stopped but kV do not decreaseit will remove any command to inverter AND drive down LA and LB contactors to cut any power on main inverter.

At the same time it will shutdown the filaments boards

In an electromagnetic front resets the main computer without producing error 136 suspect a high voltage arc.

Clone of 136

ALARM 147

Not present

ALARM 148

Not present

ALARM 149

"MAG: High Voltage Current outside compliant interval"

DESCRIPTION

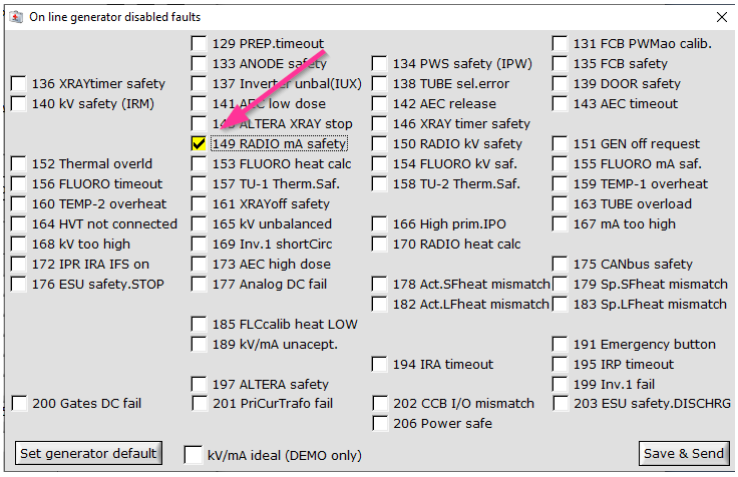
During emission, High Voltage current is tested and regulated adjusting filament heating on-the-run.

In case mA read value is outside 20% of interval centered on nominal value main computer stops emission and generate alarm 149.

Most of case it is a calibration problem: first try redoing the tube calibration.

In other case, when tube is old and emits less that when is new, still is a calibration problem that should be checked and corrected in yearly checks.

For a correct inspection, temporary mask 149 to see after at least 30ms the real mA value.



VERIFICATIONS

After calibration checked and adjusted, if Alarm 149 is still present, read **EEN-031 V1 R1 Filament Current derive** to understand if Filament Board or Tube are working in the correct way or there is a thermal drift on Filament Board IC.

ALARM 150

"IKV: High Voltage Analogue readout alarm"

DESCRIPTION

Analog value of High Voltage must be within a 5% of interval accross set data.
In case if is out of compliant value, emission is stopped and alarm 150 is generated.

Origin of wrong kV can be different:

- Main computer A/D conversion failure during reading
- Main computer D/A conversion failure when kV is requested to Digital Controller
- Effective Different kV produced due to low energy transfer
- Interlock open
- other

VERIFICATION

It is necessary in most of case to visually inspect the High Voltage waveform to understand what is happening, and the best way to do it is connecting an oscilloscope to kV feedbacks signals.

Indirectly, in case of arching or low transfer situation, it can be speculate making measures that doesn't involve the use of an oscilloscope.

…I personally use a cheap USB oscilloscope connected to service computer that's enough to inspect all the useful waveforms, from line voltage using a 100X probe to reference/feedback signal, to H.V waveforms up to CANBus packet…

kV feedback readout error

Inspection is made masking the alarm generation in Global Configuration when using the service software NavGEN.

This let generator make the whole radiography also in case of kV/mA outside compliant value.

Ratio for Feedback signals are expressed on schematics closed to test points

Value can be read and waveform can be displayed through NavGEN service software.

In case there is a fixed difference between external measurement and generator data it is possible to apply a calibration correction factor; see service software manual for details.

Difference in High Voltage due to Low Power Transfer

In this case checks are oriented on power schematics:

Checks on power Contactors grants the whole power to the input of main inverters.

Checks on resonant circuits grants the whole power transfer to load, main check is on resonant capacitors.

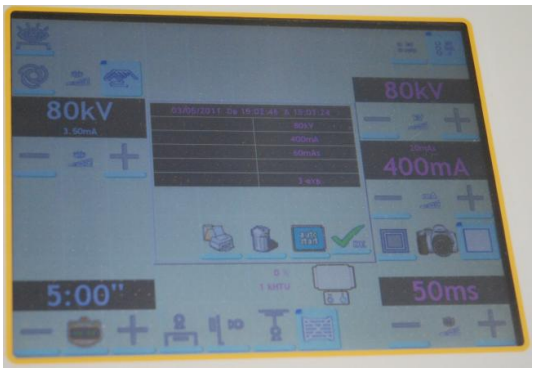
- Check mains line voltage, it have to be greater than 360Vac
- Check that the three phases are present
- Check that contactors LA and LB are active
- Check on power inverters for the presence of DC voltage, and value is at least 500Vdc
- Switch off generator and using a multimeter that can measure capacitance check resonsnt capacitor value: it is composed by a parallel of 20 capacitors rated 0.1uF: At least 1,9uF is required in measurement to transfer the whole power.

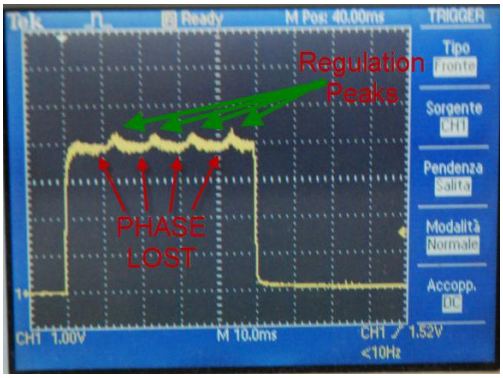
Verify that interlock is CLOSED. It is used on Converter Control Board directly to interlock gate signal to IGBTs

FURTHER

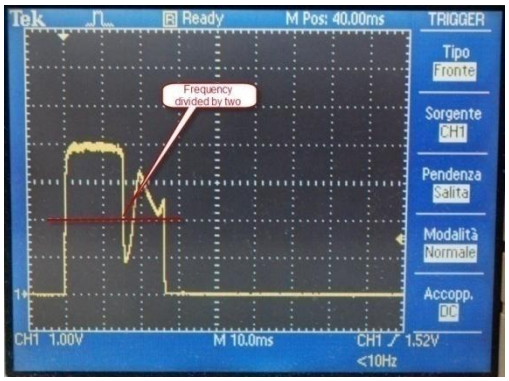
Simulation of the single phase fault has been conducted in factory to face a problem faced in a small studio installation in which have been installed a threephase line power supply, but all the single phase users where not shared on the three phases but connected on a single phase too much loaded during high power exposure.

In those condition, radiography up to 32kW (80kV, 400mA, 50ms) looks like diagram reported below:





When Power is higher the frequency required is higher than the maximum switching frequency allowed, and the bridge controller will divide by two the pulses. This will reduce to half the output voltage.



ALARM 151

"OAB: GEN OFF request"

DESCRIPTION

In ARM based main computer and safety supervisor shares the same hardware and are different tasks running on the same processor.

The interprocess communication do the same as per physical digital i/o and power is released producing on control console this alarm.

VERIFICATIONS

"OAB – GEN Off Rerquest" error can happen during STAND-BY or at the end of an exposure either in Radiography mode, Fluoroscopy mode, HCF mode.

DURING INSTALLATION

The High Voltage Cables can be inverted:

Always check the tube's glass window, before exposing the first time, that at least one filament is visibly lighted in stand-by.

The High Voltage Cable can be damaged:

It can have the COMMON pin unconnected, in this case, making a preparation and looking inside the glass window of the tube, ONLY ONE FILAMENT have to be lighted

END OF EMISSION

At the end of an emission, two concurrent condition must be verified:

1) Analog value of High Voltage must be below the 50% of the emission value within 25ms in Radiography, HCF and within 200ms in Fluoroscopy
2) High Voltage digital Signal (IRM) must be unactive within the same time

INSPECTION

- ➔ Mask the OAB switch off signal in Safety supervisor board (Jumper in Program HF US, Software Switch in R306.3x "Endeavour") to leave the generator on even if the alarm occur
- ➔ Be sure the emission current is correct, a lower or no emission at all can enlong the duration of high voltage tail
- ➔ Using a scope visualize the High Voltage signal, IRM signal to understand if there is a fault in high voltage or in the generation and propagation of IRM signal.

STAND-BY:

In Stand-By state, MPU/MCU checks for analog power supply voltage (presence) and filament lighting current feedback (300mA over minimum radiography lighting current as maximum).

INSPECTION:

- ➔ Disconnect the filament connector on the High Voltage Transformer to avoid over-current in filament ONLY IF OAB SHUT DOWN HAPPENS IN STAND-BY.
- ➔ Mask the OAB switch off signal in Safety supervisor board (Jumper in Program HF US, Software Switch in R306.3x “Endeavour”) to leave the generator on even if the alarm occur
- ➔ Check for analog power supply on MPU/MCU (+15Vdc and -15Vdc), the faulty part can be a DC/DC converter or an electrolytic capacitor
- ➔ Check ILF and ISF signal (on Navigator or MPU LCD), the faulty can be either in DAC (command signal) chip output or in ADC (feedback signal read) chip input.
- ➔ Check the filament board power supply (+15Vdc, -15Vdc)
- ➔ Check V/F and RMS chip on filament board

IDLE:

In Idle state, MPU/MCU checks for analogue power supply voltage (presence).

ALARM 152

"FKHU: Tube Thermal overload"

DESCRIPTION

During fluoroscopy main computer computes the heat produced on the anode.

Generally in low load fluoroscopy the standard tubes reaches a steady state, and heat produced is the same than heat transferred to the housing, but in small anode tube the steady state may be at very high anode temperature.

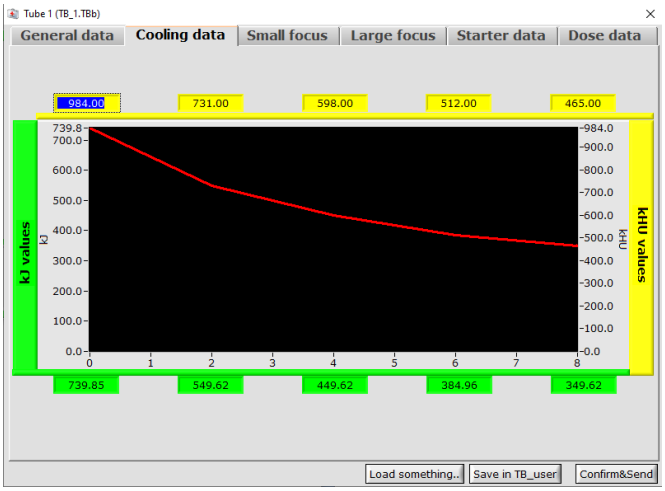
When heat loaded in anode is closed to the maximum this alarm is generated.

In this case wait till the tube is a little colder.

VERIFICATION

To check maximum heat capability the tube's technical documentation is need.

Check for Anode Cooling Curve and compare it to the one stored in the generator for the selected tube using service programs.



ALARM 153

"ACS: Fluoroscopy – Filament lighting outside compliant value"

DESCRIPTION

During Fluoroscopy preparation main computer checks for filament boards feedback in order to establish that the current flowing in the filament(s) is the current required.

In case the current read from feedback signals is different from the one requested main computer produces this alarm.

VERIFICHE

Verification is similar to the one described for Alarm 150, see this alarm for further checks.

Different feedback can be produced by:

- Wrong D/A generation of reference signal on main computer (-> measure with a voltmeter)
- Wrong A/D readout for feedback signal on main computer (-> measure with a voltmeter)
- Failure in filament board (MOSfet not working: MOSfet working is hot, not working is cold)
- Failure in filament power cable connections (unconnected pin can saturate filament transformer)
- High Voltage Cables with loose connection (inspect High Voltage Cable headings)
- Ferrites in H.V tank broken (during shipment can happen, not in normal job)
- Filament in tube unstable (when tube is old or in particular tube positions, if possible remove the collimator and look the filament light)

Feedback returns can be inspected using the service:
NavGEN. -I/O Signal section and the signal to be inspected are ISF/OSF – ILF/OSF

NOTE
In case of single board filament is possible to make test emission in fluoroscopy.
Remember that only the SF channel is used and LFO is a digital signal used to switch the focus selection relay.
In this case inspection is made only on SFO SFI

ALARM 154

"KVSC: Fluoroscopy – High Voltage outside compliant value"

DESCRIPTION

During emission in fluoroscopy mode main computer checks High Voltage (kV) feedback signal values from High Voltage transformer.

In case the value differs from the pre-set value main computer generates this error.

VERIFICATIONS

Verification is similar to the one described for Alarm 150, see this alarm for further checks.

ALARM 155

"DIFC: Fluoroscopy – High Voltage Current out of tolerance interval"

DESCRIPTION

During emission in fluoroscopy mode main computer checks high Voltage Current (mA) feedback signal from High Voltage transformer.

In case the value differs from the preset value main computer try regulating it moving filament lighting.

In case regulation is not possible because mA are too far or there is a too low emission main computer generates this error.

VERIFICATIONS

During installation always perform a Fluoroscopy Automatic Filament Calibration using navigator / nebula Explorer.

Check high Voltage cable, in case clean the headings and look that there are no creepages in the headings

Using service program to perform a Fluoroscopy Automatic Filament Calibration.

Look feedbacks from filament inverter board and, in case the current fluoroscopy focus has non similar feedbacks make a calibration on the other focus.

In case values are not stable, see Alarm 131 for suggested further checks.

ALARM 156

"NFLTO: Patient Time Limit in Fluoroscopy"

DESCRIPTION

R306.4x "Program H.F. US" in Control Console V25, US1 and US0 software, Fluoroscopy Timer stops emission when cumulated time reaches the configuration time limit (5' o 90').

A timer reset is need and operator can start a new fluoroscopy session.

In R306.4x generators equipped with US2 (Touch Screen) software, R306.3x and R306.5x the only timer that stops emission is a backup timer of 10' of continuous, not cumulated, time according to IEC 60.601.2.7 III edizione.

Control Console timer is only use to advice the operator that time is expiring/expired.

VERIFICATIONS

In case the footswitch is not released for 10' emission stops: RELEASE THE FOOTSWITCH AND PRESS IT AGAIN TO RESTART EMISSION.

ALARM 157, 158

"TERM1: Thermal Safety Tube n°1"

"TERM2: Thermal Safety Tube n°2"

DESCRIPTION

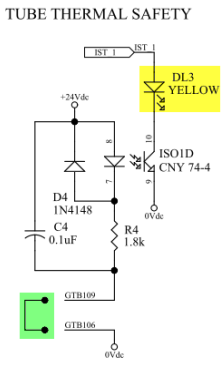
Input for Tube Thermal Safety are present on general terminal Boards to stop emission when tube thermal protection is open.

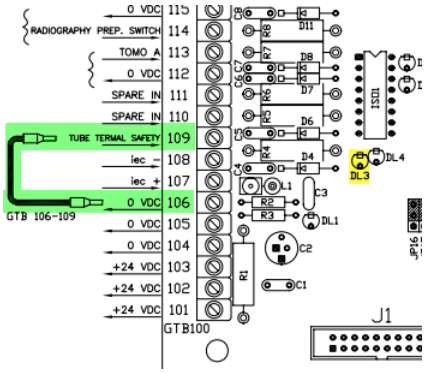
Safety is not unactivable or maskable, so, generator default is a wire jumper to be removed during installation and replaced with real tube thermal contact.

When tube n° X is select, opening contact for Tube n°X produces this alarm (TERMX).

VERIFICATIONS

R306.3x GTB





Be sure, using an Ohmmeter, that resistance between GTB106 and GTB109 is zero.

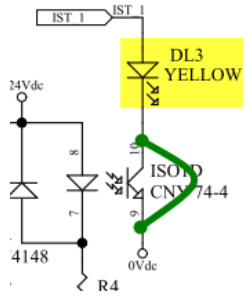
In case resistance is NOT zero, i.e. the circuit is open, inspect cable and tube safety to see where the circuit opens (cable inspection is made shorting on tube side the two terminals)

In case the cable is conducting but when tube connected the circuit is open, AND the tube is not hot, suspect a failure in tube's micro-switch/clickson.

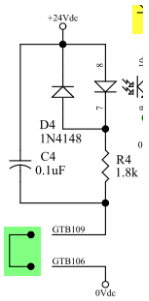
In case GTbB106 to GTB109 measure a short circuit, verify LED DL3. It sholud to be ON

In case LED DL3 is ON the problem can be located in MCU input of Flat ribbon cable from Mcu to General terminal Board:

Switch OFF the computer, remove the cables and clean the contacts with a contact cleaner spray.

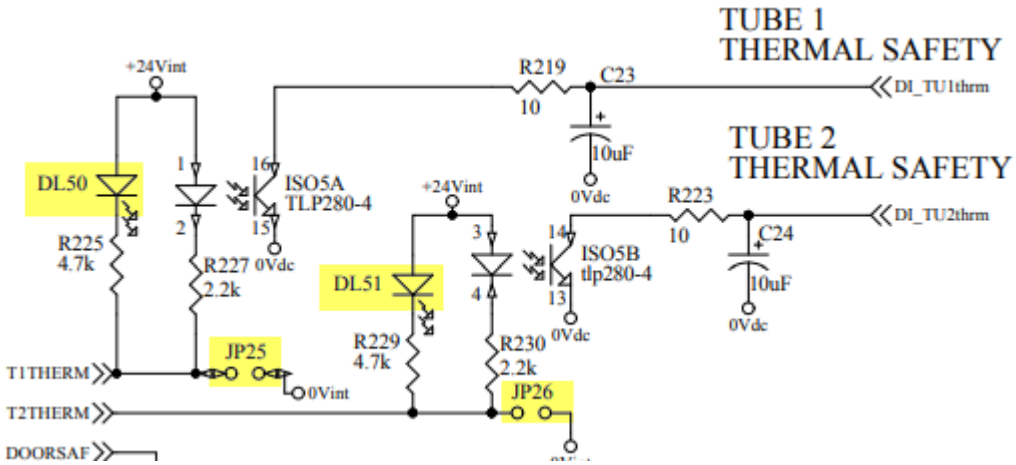
In case the LED is OFF thry shorting temporary the optotransistor junction to inspect for led light: if LED is ok it must lit 

; in case it doesn't turn ON try shorting it and check on navigator if Thermal Safety input is changing status while changing the input

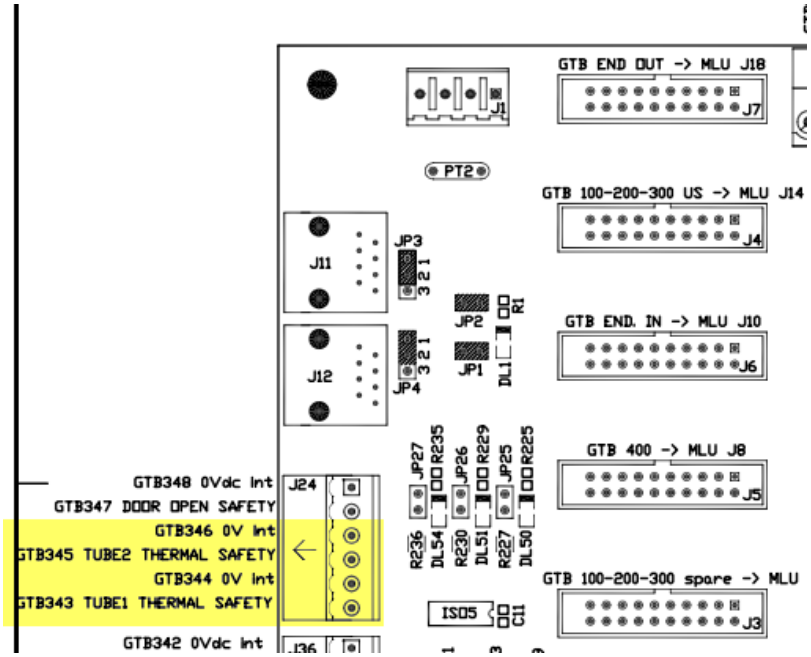
Check also the series resistor using an Ohmmeter and try removing the protection diode in case on diode a short is measured 

R306.4x EGTB

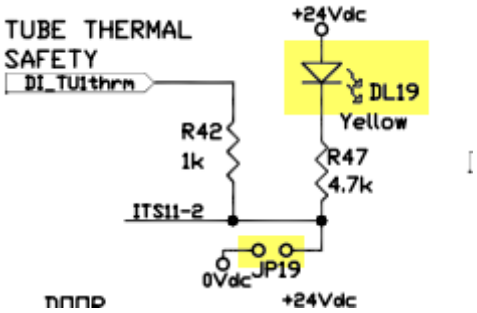
Input circuit is analogous to R306.3x circuit

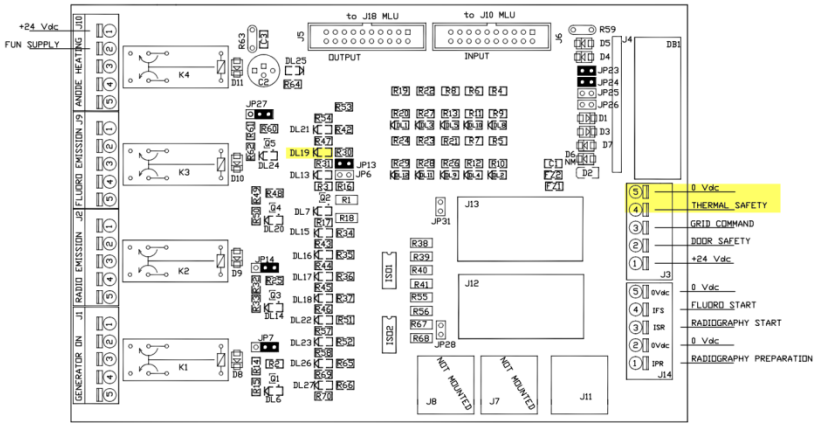


Use JP25 and JP26 to bypass the safety when not connected, or make a wire-jumper on GTB:



R306.4x CARDIO INTERFACE





ALARM ALARM 159 and 160

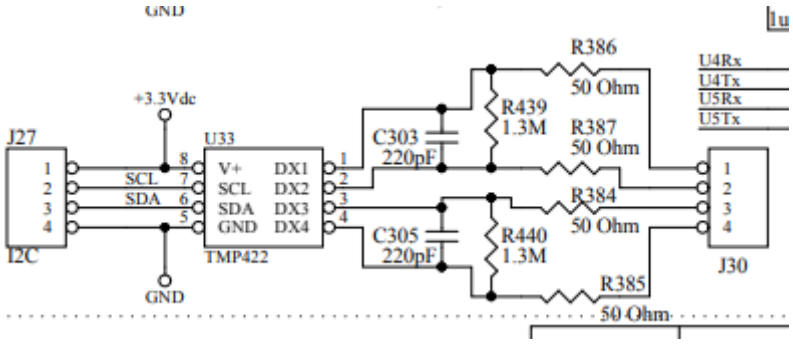
Temperature -1 and Temperature -2 Overheat

DESCRIPTION

There are two temperature sensors in the generator.

Actually are both mounted in the main inverter but only one is used to start the inverter ventilation.

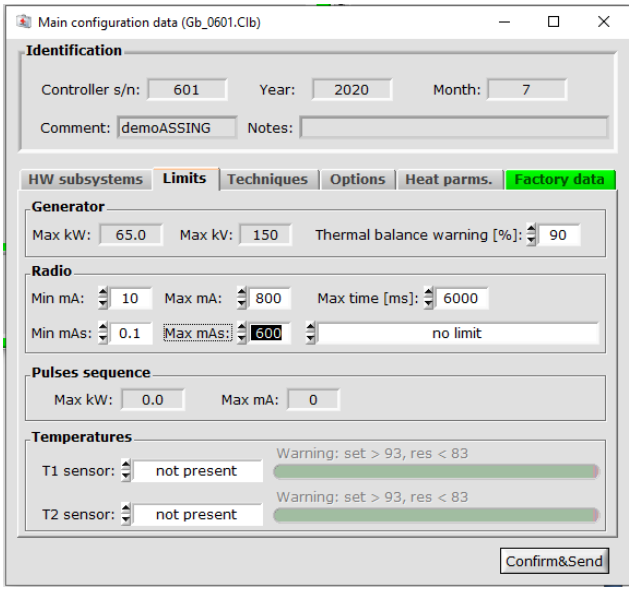
The temperature port is located directly on main computer board:



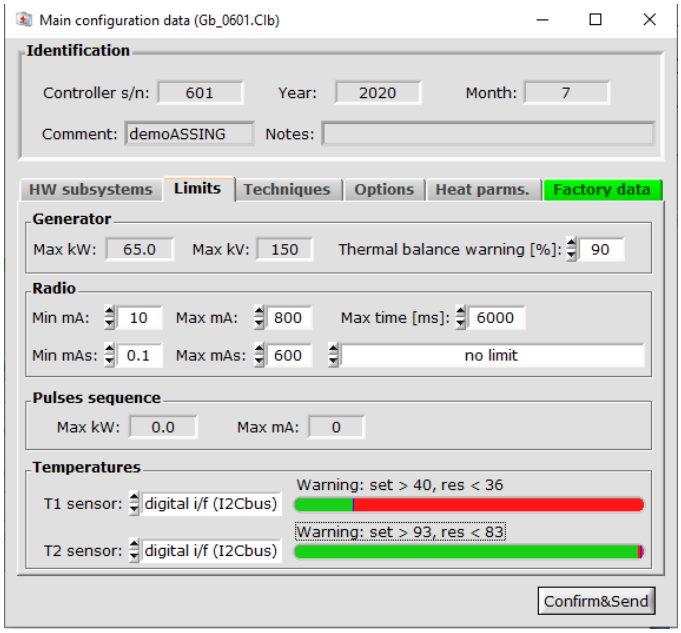
In case the sensore are disconnected the sensed temperature rise at the maximum so main computer produces the error, if enabled:

CHECK FOR CORRECT CONFIGURATION

DISABLED



ENABLED:



In this exampleT1 is enabled and works as VENTILATION ABOVE 40°C

T2 is enabled just to test the presence of the sensor.

In case there is an overheat alarm but the system is cold, you can swap the sensors or disable temporary to test with a new sensor board

ALARM 161

"IXSA: External Emission Interlock"

DESCRIPTION

In ARM Based generator IPD is used as X-ray interlock managed by remote tilting tables.

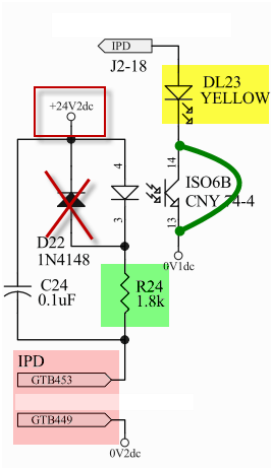
VERIFICATIONS

ENDEAVOUR GTB

Check on External Device that Interlock is closed when X-Ray emission is request.

Check that cable which carries this signal to GTB400 is not an open circuit

In casethe signal arrives properly to GTB400 check following items:



Check 24vdc presence on interface.

Manually short GTb453 to ground to see if it works

Check resistor R24 value for correctness.

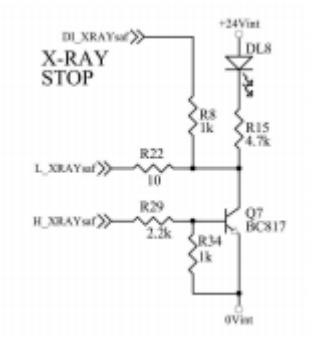
On GTB400 check LED DL23 temporary shorting pin 13 and 14 of ISO6.

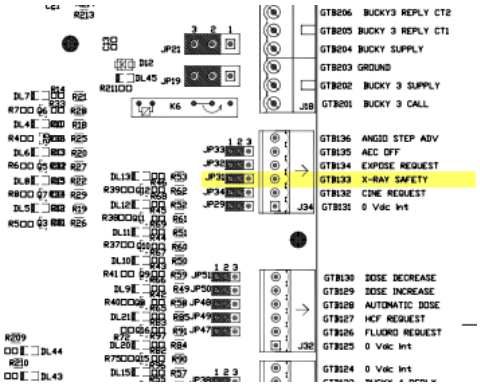
In case DL23 is not lighting, maybe 24vdc between A and K are present (LED OPEN) try shorting it and check on navigator, i/O section, if IPD signal respond to open/close activity.

In case DL23 is lighting shorting the output of the optocoupler, the problem can be on optocoupler itself or the protection diode in parallel to the photoled.

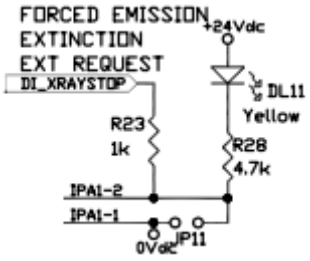
The protection diode can be removed for test.

EGTB





CARDIO INTERFACE



to be connected on JP11 hot pin

NOTE

Test on EGTB and CARDIO INTERFACE hardare as described before in ENDEAVOUR GTB description

ALARM 162

Not provided

ALARM 163

"TOVLD: Tube Thermal Overload during Radiographic Sequence"

DESCRIPTION

On every radiographic pulse, both in Cinematographic sequence or in Angiographic/Radiographic sequence, with or without AEC the main computer computes updates the Anode model to elaborate the effective Anode Thermal load.

When 80% of Maximum Anode thermal load is reached, the user is informed that soon the sequence will stop automatically due to maximum heat storage .

If user keeps on emitting, when anode reach 100% of heat loaded in the anode the generator stops the sequence to prevent tube damage and generate this alarm.

Resetting the Alarm the sequence does not restart till 80% of thermal load is reached.

In this case the only thing to do is waiting that heat stored in anode is transmitted to the housing.

In the while it is possible to start emission in fluoroscopy in case there is the need to end the exam in emergency.

VERIFICATIONS

When this alarm appears during the exam procedure review the Tube Data to be in accordance with tube characteristics and also review the exam protocol according to tube characteristics.

In case the exam procedure is correct, check the tube characteristics memorized in generator to match the tube technical data.

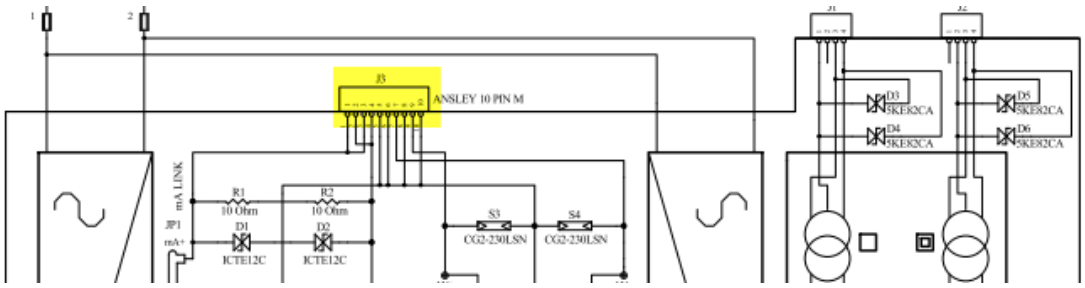
In this case analyze the anode dissipation curve and heat storage against tube technical data from tube manufacturer
NOTE:
Tube thermal characteristics are memorized in tube model present in default library and are loaded when tube is load from library.
In CINE mode the curve is automatically computed.
It is also computed the TRACK heat, i.e. the instantaneous heat of the surface of the anode when loaded with high power, this can produce the error even if the anode is cold but the instantaneous power is high, so to preserve the anode surface.

ALARM 164

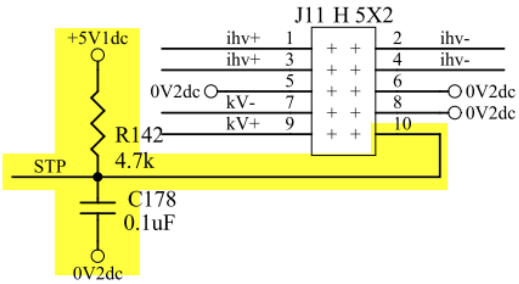
"ISTP: High Voltage Feedback signal not connected on Transformer"

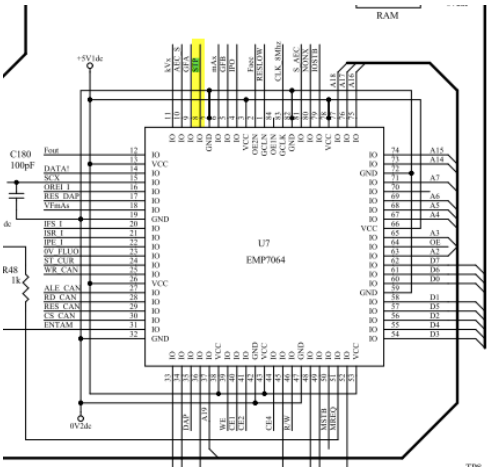
DESCRIPTION

On ARM generators a digital input in main computer senses the insertion of feedback signals (kV mA) flat ribbon cable (or RJ45 in R306.5x) in High Voltage Transformer (or in main computer).



Connecting flat cable connector in High Voltage transformer, signal STP is activated



Signal SPT is then processed into Digital Controller logics  and informs main computer of correct insertion of feedback cable in High Voltage transformer.

VERIFICATIONS

STP signal is verified in every generator status and don't let exiting from Alarm status until the signal STP is active.

NOTE:
In case STP signal error is appearing not in Stand-By but during or at the end of a radiography the error is due to an electromagnetic peak caused an error in STP signal readout (it is the digital signal closest to high Voltage).

This is a symphtom of High Voltage discharge.

So when generator is OFF remove High Voltage cables from both Tube and H.V. transformer side, clean the headings, being sure that no dirty or carbonized silicon or creepage in the headings.

After it, in case the problem is representing back, suppose an high voltage arc in tube and follow instructions seen in other high voltage related alarms for tips to check this possible cause.

ALARM 165

"IBLX: High Voltage Unbalanced"

DESCRIPTION

Unbalanced High Voltage generally IS NOT a symphtom of Tube arching because there is no ground reference between Anode and Cathode, but it can be related to H.V. cables, H.V: transformer, or computer analogue converstions.

VERIFICATIONS

The possible sources are enumerated below:

1) *kV feedback is measured on MCU.*

in this case set fluoroscopy manually to 40kV, place a voltmeter on high voltage tank and verify that your kV feedback is balanced as per following procedure WITHOUT REMOVING THE HIGH VOLTAGE CABLES:
in case you see High Voltage Balanced but still you've the error 165 maybe the problem is in MCU - Feedback read circuit.

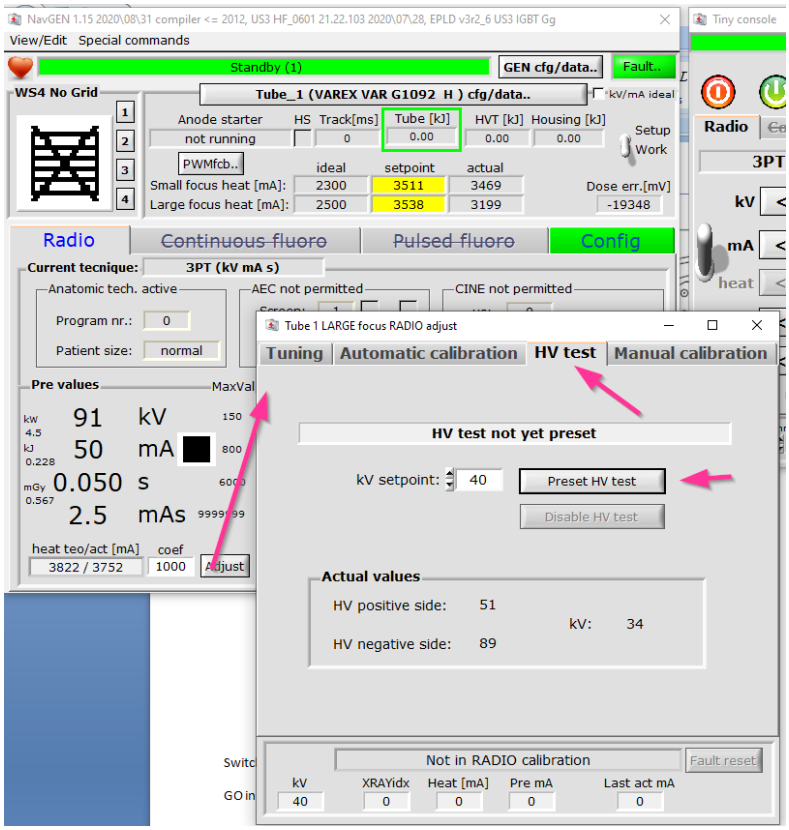
2) *kV error is a Real High Voltage unbalance, this means one of the two pole is shorted to ground*.

in this case the origin of the fault can be:
- High Voltage Transformer: the rectifying diode inside the transformer are in short circuit
- One high voltage cable shorted to shield

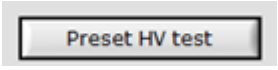
in case of effective high voltage unbalancing follow the procedure WITOUT HIGH VOLTAGE CABLE

BE EXTREMELY CAREFUL!!!

Remove the High Voltage Cables from High Voltage Transformer (better is to fill the head with 1 cm of dielectric oil)

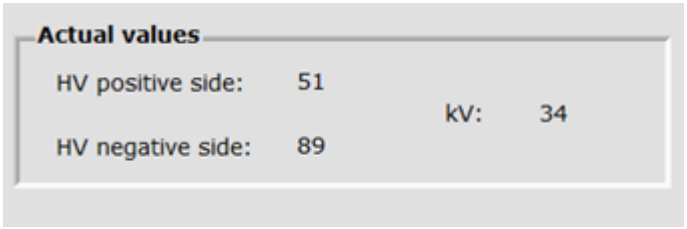


Select ADJUST and HVTest Radio

Press 

leaving the value at 40kV

Closing GTB118 to GTB119 you can start making test with filaments OFF.

In display 

on the right side there are the total kV, on left side the readout of the anodic and cathodic values.

In normal condition anodic and cathodic value should be half of the total value.

ALARM 166

"IPO: Maximal Current allowed in Resonant Circuit"

DESCRIPTION

If current flowing in resonant circuit, i.e. in Inverter resonant capacitor, resonant inductor, primary side of High Voltage Transformer, cross a fixed threshold means that a power overload is sensed on secondary side of the High Voltage Transformer.

Current overload on secondary side is reflected on primary side overcurrent.

This Primary side overcurrent is due generally to an High Gap of Voltage in High Voltage secondary side, to be filled without ramping, i.e. with kV controller in stady state phase and not in ramp-up phase.

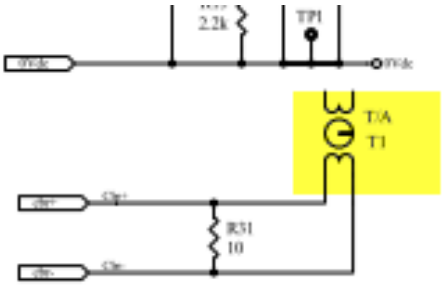
In rump-up phase (kV rising interval) current is controlled controlling the reference kV ramp, in steady state, reference if for final high Voltage.

In case of short circuit on secondary side, voltage drop down, and if discharge is in vacuum, at a certain value of kV dropped, arc stops and vacuum reset its dielectric costant (no ionization phenomena present).

In this while, the kV controller forces a frequency rise (or drop in case of R306.5x generator) without a current limiting ramp and this overload the resonant circuit till the safety circuits stops it before the power senmiconductor are damaged.

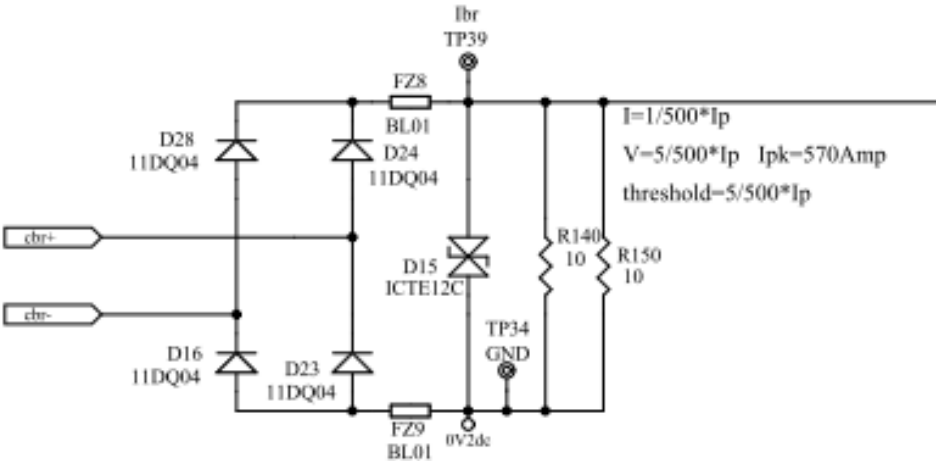
On R306.3x "Endeavour" e R306.4x "Program H.F. US" primary side current flowing into resonsnt circuit is sensed inside the main inverter through corrent sensors:

R306.3x "Endeavour"

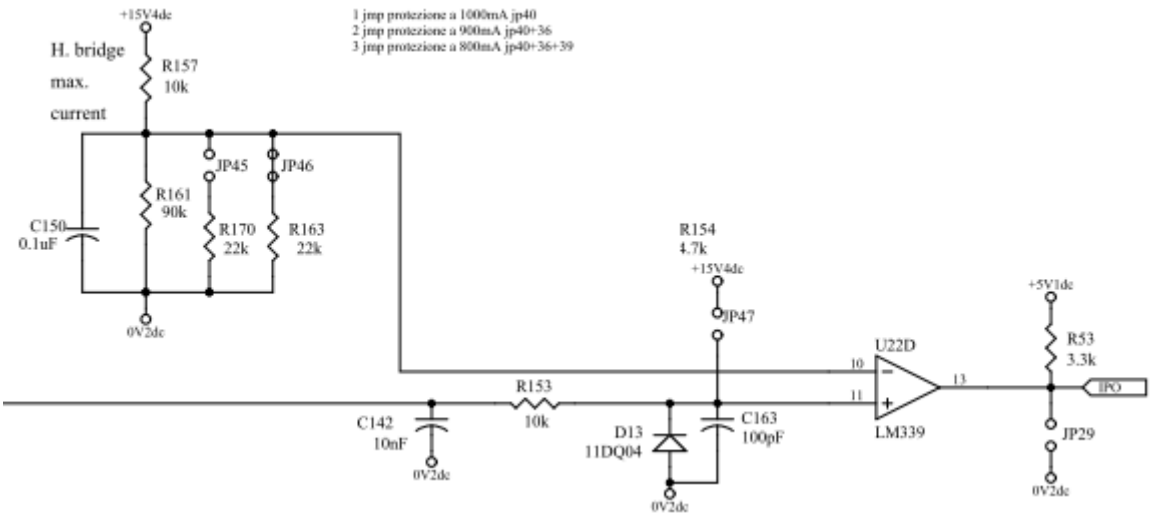


The current in transit on transformer's primary side is divided with a 1:500 ratio using two series current transformer.

This signal is sent directly to MCU to be processed.



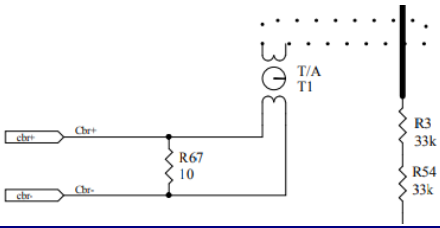
Current is rectified ad and a 5 ohm dropdown resistor translate it in Voltage signal.



Signal is then compared with a fixed current threshold fixed by jumper in factory according to Inverter Power output capabilities, i.e. according to generator's power.

In case the measure crosses the limit reference it is produced the IPO signal that enters in Digital Regulator logics and stops the gate signals immediately to preserve the IGBTsand puts generator in Alarm Status.

R306.4x "Program H.F. US"

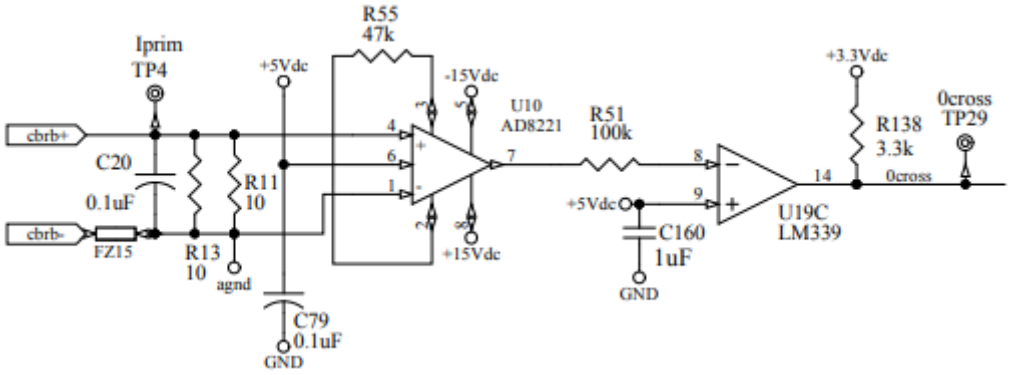


The current measured here, multiplied by the number of capacitors is the current flowing in the inverter module.

Transformer ratio is 500:1 thus grants 25V for a 1000A current in the module.

The inverter produces a balanced signal analyzed by GCU.

Then GCU circuit to sense current flow in resonant circuit is processed by the number of inverters present in the system and enters in the Digital Regulator in the same way as CCB or MCU



VERIFICATIONS

Using an Ohmmeter, or better a Mega-Ohmmeter, measure the insulation between primary side and Ground to be sure that a the over-current is not driven by a burn of insulation between primary and ground shield inside the transformer.

Smell inside the transformer through the fill cap to be sure that no acrid smell of burnt oil is sensed

Then suspect a High Voltage discharge and follow instruction to understand if it is produced in tube or in high voltage transformer.

Notice, even if you hear a dry noise in the transformer the arc can be produced in the tube:

The noise origin is the instantaneous dilatation of a resistor put in series to the load that, when tube is arching, support the whole voltage still present in the high voltage capacitors inside the transformer.

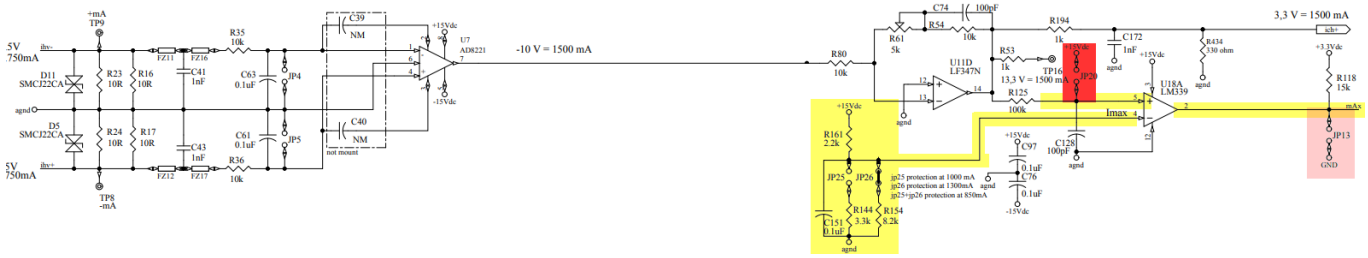
If the radiography is long enough there is the possibility to see the waveform in NavGEN

ALARM 167

"IMAX: Maximal High Voltage Current limit crossed"

DESCRIPTION

High Voltage value is compared to a fixed threshold to stop the Main Inverter in case of High Voltage Arching or completely wrong tube calibration.



Yellow path is the reference value for the comparator, RED JUMPER is the comparator test, rose jumper is the microcontroller input test

VERIFICATIONS

Suspect a High Voltage discharge and follow instruction to understand if it is produced in tube or in high voltage transformer.

Notice, even if you hear a dry noise in the transformer the arc can be produced in the tube:

The noise origin is the instantaneous dilatation of a resistor put in series to the load that, when tube is arching, support the whole voltage still present in the high voltage capacitors inside the transformer.

If the radiography is long enough there is the possibility to see the waveform in NavGEN

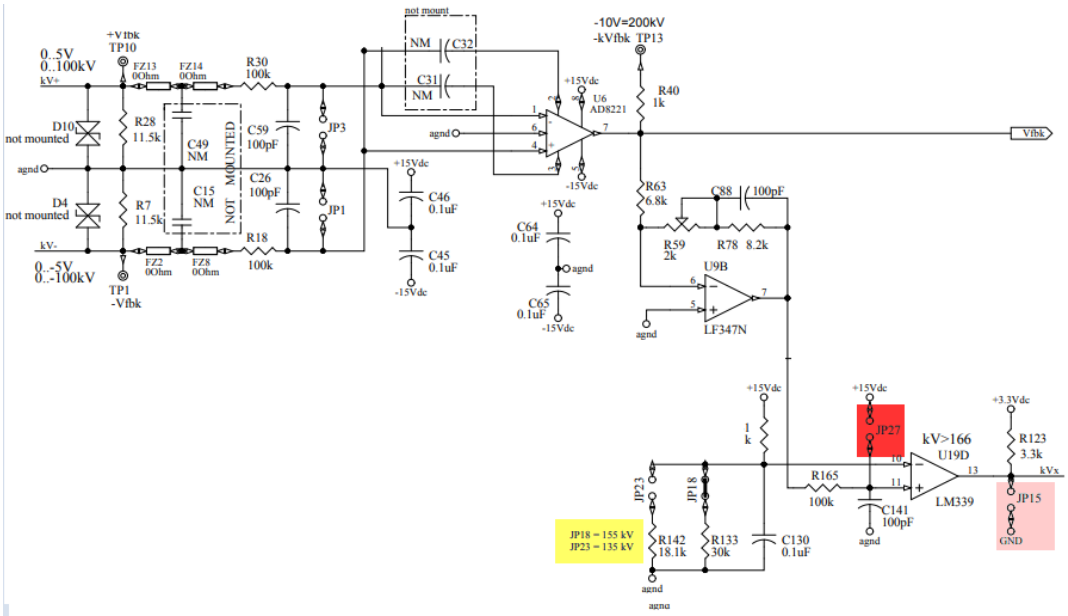
ALARM 168

"IKVX: High Voltage crossed 166kV fixed limit"

DESCRIPTION

High Voltage value is compared to a fixed threshold to stop the Main Inverter in case of High Voltage out of control.

kV+ and kV- signals, coming from High Voltage Transformer's Voltage Dividers are summed.



This signals are compared with a programmable fixed threshold at 135kV for cardiac generators and 155kV for standard generators.

RED jumper to test the comparator, PINK jumper to test the generator input.

NOTE:
The same signal is used for kV loop control and regulation, so the Alarm 169 generation DOESN'T means that kV feedback is unconnected (STP SIGNAL does it and alarm is 164).

VERIFICATIONS

In this case it is suspected a failure present on operation amplifier which realize the safety due to the presence of kV signal, and regulation.

The only case in which it is possible to have this alarm and no error on alarm's comparator is a slow regulation with absolutely no load

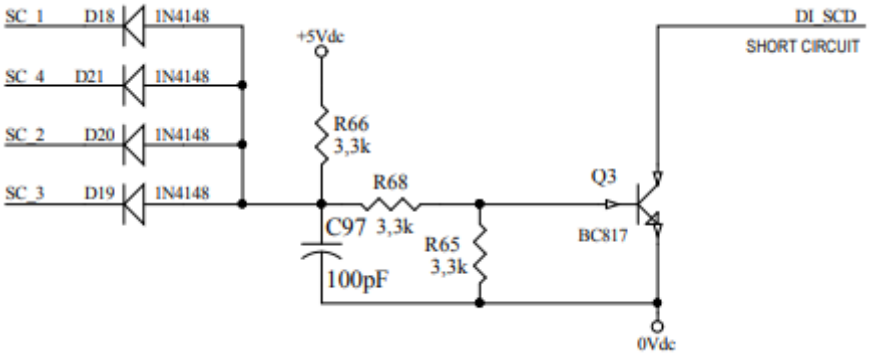
In this case suspect oil inside the tube's vacuum or cathode cable in short circuit or filament in short circuit: even if there is the correct current circulating into the filament circuit, the filament is cold, so no load. Operating an high current radiography with high kV, the ramp regulator can override the limit.

Inspection can be made checking with an oscilloscope the real voltage output and the real current load .

ALARM 169

"ISCX: Inverter in Short Circuit"

DESCRIPTION



IGBT Drivers checks the current flowing in every power module when the power module is switched ON as voltage drop on gate's resistor.

All the checks (4) are OR'ed in one signal that represent the logic status of the IGBT before and while emitting. (This can be used during emission, IBLX cannot be used because the bridge is unbalanced when inverting..)

In case one IGBT is damaged it can short Gate to Emitter and this keeps the gate supply voltage closed to ZERO instead of -10Vdc while in OFF state.

This situation while IGBT is OFF, or an over-current in IGBT while IGBT is ON produces signal SCD which stops immediately (via hardware, not software) and on Control Console is displayed error 169.

It is possible to measure the voltage produced by this oscillator, or using an oscilloscope it is possible to see if the alternate current is flowing on primary and secondary side

ALARM 170

"TAR: Calibration table corrupted"

DESCRIPTION

Current focus filament lighting computation according to data currently visible on Control Console has returned a faulty value.

A faulty value can be a division by zero in case data are completely not existent, or can over-cross the maximum radiography lighting parameter.

This condition can be produced by a manual calibration not ended or Volatile Ram corrupted.

This condition can also appear when Calibration Fast Tuning parameter is very high (closed to 1100) for high value of mA emissions (40kV 500mA for example)

VERIFICATIONS

It is possible to graphically display the calibration curves to check if there are irregularities using service manual (Navigator / Nebula Explorer).

In case of non monotonic growing data calibration can present emission points lacunae.

In those cases it is suggested to perform a complete Automatic Calibration on the erroneous focus to reset the adjust coefficient to 1000 according to calibration procedure described in section 3 of the Technical manual

ALARM 171

"TAREND: Calibration Radiography ended in correct way"

DESCRIPTION

In order to follow a different software path while calibrating the radiography emission in the generator using NavGEN it is produced a false alarm managed by main computer and service program, invisible to Control Console.

VERIFICATIONS

No verification are need, it is a system generated false error.

ALARM 172

"FISW: Active Emission Command while changing status"

DESCRIPTION

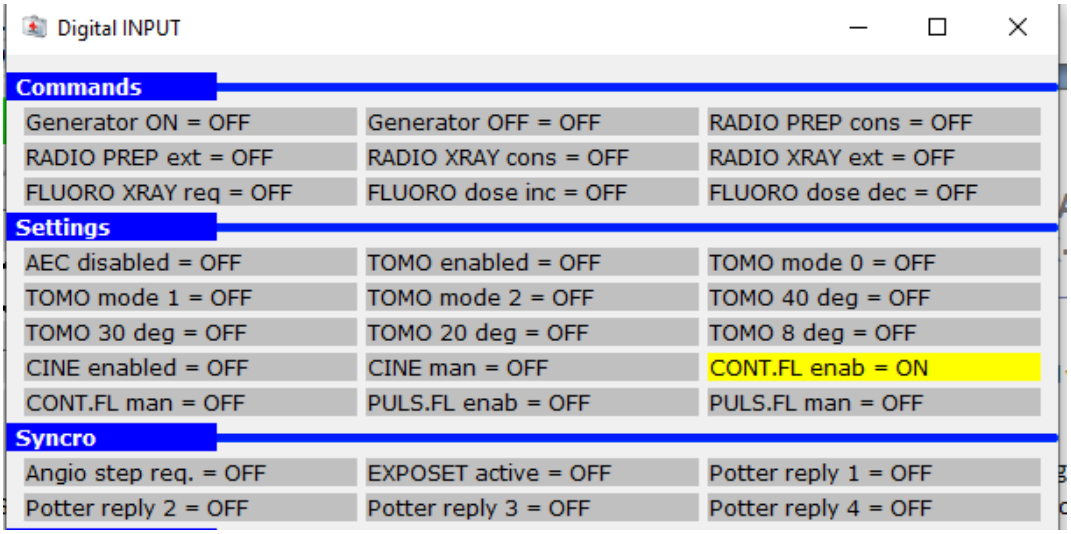
When generator changes status (inner working status IDEL->STBY or ERROR->STBY for exaple) or changes Working Station main computer checks also the status of following inputs

- Control Console Preparation Key
- Control Consol Exposure Key
- Preparation Input on General Terminal Board
- Exposure Input on General Terminal Board
- Fluoroscopy Input on general Terminal Board
- Bucky reply on General Terminal Board

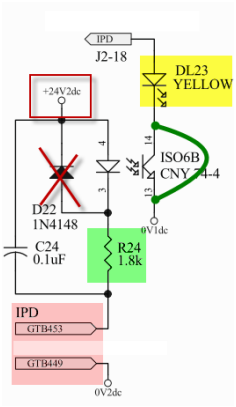
In case one or more of those input are found ACTIVE, generator produces alarm 172.

VERIFICATIONS

Verify handswitches or footswitches not mechanically stacked.



Through NavGEN it is possible to inspect also digital input status in I/O Section to verify if inputs changes when a different status of that input is imposed by external temporary shorts



Digital input verification method is described in Alarm 161 explanation

ALARM 173

"HEXP: AEC detector output closed to saturation"

DESCRIPTION

AEC dose is routed to a digital comparator / integrator comapartor to stop emission when correct dose level is reached.

AEC dose is read also in analog way from main computer to check for minimum/maximum instantaneous dose.

In first milliseconds of radiography emission, when in AEC technique, main computer can stop emission in case the dose is too high, cloesed to camera/amplifier saturation.

This because a saturated chamber/amplifier has a longer exposur result and most of time the film is overexposed.

VERIFICATIONS

It is possible to measure the istantaneous dose on aplifiers using an oscilloscope.

A dose closed to 10V produces error 173.

Dose level have to be zero while generator is in stand-by state.

Different value of dose than zero indicates a wrong functionality of dose Amplifiers

Dose amplifier should be at ambient temperature, hot amplifiers indicate failure in chips.

Point used to check dose is shown in following image (the sum of the three doses; for a deeper inspection it is possible to determinate also which is the field that has the ampilier which gives a wrong dose output).

NOTE

It is possible to select the other channel to make the same dose test (changing the configuration also on Navigator / Nebula Explorer) to determinate if the error appears again or not.

ALARM 174

Not provided

ALARM 175

"CANB: CANBus Alarm"

DESCRIPTION

When local CANBus is in error, on control console appears error n. 175.

After that Control console goes in IDLE state because in CANBus error mode there I no data exchange between control console and generator, or it is deifficolut and system is goin in timeout on most of the packet reducing the data transfert speed.

VERIFICATIONS

- Using an Ohmeter verify that CANBus Power Supply ZERO is connected to Ground.
- Verify that Control Console ground cable is connected on Ground Node over High Voltage Transformr and connection is not loose.
- Using a Voltmeter verify the CANBus Optoinsulated bus power supply:
  it works properly if 4.90V < Power Supply < 5.1Vdc
- Verify, using a finger in case you have no temperature probe, that CANBus transcievers (genearally 82C250, or in new project a TJ1000) the temperature: it should be ambient temperature: an Hot transcienver generally means that transceiver is not working properly
- Do the same test on SJA1000 CANBus controller on MPU, MCU, GCU
- Do the same test on MCP2510 on Touch Screen Control Console and (R306.3x) on Safety Supervisor Board

On both generators the BUS power supply is produced on main computer board, verify:

Power Supply = 5Vdc
Line impedence = 60Ohm
Disconnect line protector
Check Control Console cable path
Check that chips are not hot

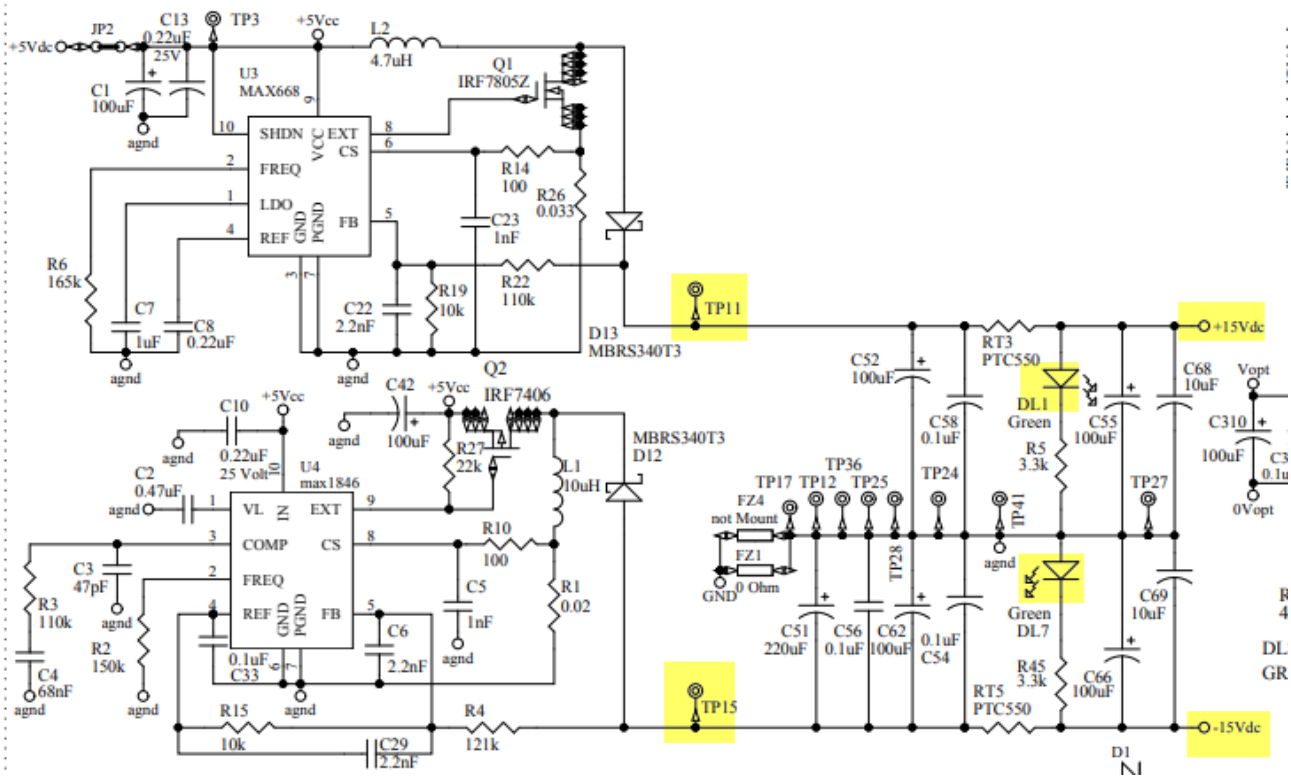
ALARM 176

Not provided

ALARM 177 - Analog Power Supply failure

This alarm intercepts a BAD ANALOG POWER SUPPLY on MAIN COMPUTER.
In this condition MPU cannot keep on working until the DC/DC converter, or one analog chip which draw down +-15vdc, is replaced (...read this as "until MPU is replaced").

It is possible to inspect the problem with a voltmeter:



In case Voltage is present you can inspect the sensing circuit:

Yellow line checks the presence of negative analog power supply, violet line checks the presence of positive analog power supply:

ALARM 178: SMALL FILAMENT LIGHTING FEEDBACK OUTSIDE COMPLIANT INTERVAL

This alarm intercepts a WRONG HIGH FEEDBACK from Filament board on SMALL FOCUS (Fluoroscopy)
In this condition it is not recommended to keep on working on this focus.
In this case the source of alarm can be located in FILAMENT board (generation of bad "current" / "current feedback" signal) or on MPU board (Analog readout of feedback wrong through ADC converter)

ALARM DESCRIPTION:

- ZEROs the SMALL FILAMENT reference (to prevent the reference to filament board generates a bad feedback in Filament Board)
- DO NOT OPEN K1 (to let user the possibility to use Large Focus for CINE mode)
- SET SMALL FOCUS temporary (until the generator is OFF) to "BROKEN FILAMENT STATUS" (this let start CINE without looking small filament feedback)
- GENERATES ALARM 178 on Control Console with "KEEP ON WORKING ONLY IN CINE MODE"
- ONCE ALARM IS ACCEPTED (OK pressed on Control Console) generator DO NOT SHUTs DOWN and keep on working ONLY on LARGE FOCUS (cine)SOFTWARE MODIFICATION TO BE INSPECTED

ALARM INSPECTION

Signal path is the one described here:

- MPU GENERATES A REFERENCE FOR SMALL FOCUS LIGHTING: 0..10Vdc equals 0..10A
- MPU READS BACK ITS GENERATED SIGNAL TO BE SURE IT IS REQUIRING THE CORRECT CURRENT
- SIGNAL IS CONVERTED INTO CURRENT IN FILAMENT INVERTER BOARD
- CURRENT IS INSULATED IN H.V. TRANSFORMER
- CURRENT IS CARRIED THROUGH H.V. CABLES TO H.V: TUBE
- CURRENT IS LIGHTING THE FILAMENT
- CURRENT IS MEASURED IN FILAMENT BOARD AND USED TO FEEDBACK THE PWM CONTROLLER
- CURRENT IS CONVERTED IN FEEDBACK ALSO TO MPU
- MPU READS BACK THE REAL CURRENT FLOWING THROUGH AD CONVERTION

SO, actors involved into path are:
MPU (ADC Feedback read may be wrong: try swapping the ADCs to test if error is solved)
FILAMENT BOARD (Look the feedback on LCD to check if SFI is different from SFO)
H.V. CABLE (using an Ohmmeter check that COMMON wire is not broken)
TUBE (in case of NON metallic tube, inspect the length of the filament: in case the length is reduced check if turning the tube the filament turns into correct length).

ALARM 179: SMALL FILAMENT LIGHTING SETPOINT OUTSIDE COMPLIANT INTERVAL

This alarm intercepts a WRONG HIGH REFERENCE READBACK from Filament board on SMALL FOCUS (Fluoroscopy)

In this condition it is not recommended to keep on working on this focus.

In this case the source of alarm can be located in MPU board (generation of bad reference signal)

This alarm:

- ZEROs the SMALL FILAMENT reference (to prevent the reference to filament board generates a bad feedback in Filament Board)
- DO NOT OPEN K1 (to let user the possibility to use Large Focus for CINE mode)
- SET SMALL FOCUS temporary (until the generator is OFF) to "BROKEN FILAMENT STATUS" (this let start CINE without looking small filament feedback)
- GENERATES ALARM 179 on Control Console with "KEEP ON WORKING ONLY IN CINE MODE"
- ONCE ALARM IS ACCEPTED (OK pressed on Control Console) generator DO NOT SHUTs DOWN and keep on working ONLY on LARGE FOCUS (cine)

ALARM INSPECTION

Signal path is the one described here:

- MPU GENERATES A REFERENCE FOR SMALL FOCUS LIGHTING: 0..10Vdc equals 0..10A
- MPU READS BACK ITS GENERATED SIGNAL TO BE SURE IT IS REQUIRING THE CORRECT CURRENT

Alarm 180: kV tail too long in RADIO

It reflects two possible errors:

STATICALLY -> The tube calibration is wrong -> check tube calibration

DYNAMICALLY -> The filament is broken during an exam -> Inspect tube returns on LCD

TEST MODALITY

Follow inspections as per previous error 178.

NOTE

In case of temporary failure, the alarm is managed and recovered pressing OK

In case of continuous ZERO emission in high voltage this is generally due to filament vaporization while the generator was emitting, no more emission start are possible because next emission requires the correct feedback from filament current while preparing the generator: a further "RADIO HEAT?" error will be asserted.

Alarm 181: kV tail too long in FLUORO

Expands timeouts X time to inspect the phenomena.

Also In this case it is possible to put the system in safe mode zeroing the references and opening relay K1 on GTB100 without asserting OAB.

Than, while pressing OK, the generator turns into STAN-BY (the situation is only dynamic)

See alarm 180 inspection

NOTE

In case of temporary failure, the alarm is managed and recovered pressing OK

In case of continuous ZERO emission in high voltage this is generally due to filament vaporization while the generator was emitting, no more emission start are possible because next emission requires the correct feedback from filament current while preparing the generator: a further "FLUORO HEAT?" error will be asserted.

Alarm 182: LARGE FILAMENT LIGHTING FEERBACK OUTSIDE COMPLIANT INTERVAL

NOTE

See alarm 178 for inspection instruction: SFI and SFO turns to Lfi and LFO as per picture above.

Alarm 183: LARGE FILAMENT LIGHTING SETPOINT OUTSIDE COMPLIANT INTERVAL

Follow instruction al per alarm 179 to check MPU board DACs / ADCs

ALARM 185

"FLUORO CALIBRATION HEAT LOW"

DESCRIPTION

Calibration cannot reach the max Fluoro mA programmed.

The fastest way to inspect this alarm follows

Rise the max value in fluoro calibration and redo the calibration:

This will fix a possible loose of convertion efficence of the filament. In case you cannot rise emission even if calibration current is high, suspect that filament has been shortened (in this case, when tube is glass, remove the collimator and look inside the glass window to inspect the filament length)

ALARM 189

"SERD: Unacceptable Serial Radiographic parameter while boosting"

DESCRIPTION

During filament boos (radiography preparation), in order to let parameters transfer from digital devices to generator through digital communication busses such as RS232 port without releasing the fluoroscopic footswitch, generator accept parameter which overrides the actual parameters.

It is not allowed the filament change.

In case of filament change request while boosting the generator produces alarm 189 to notify the operator that data in Digital Device are not correct for the actual exam.

VERIFICATIONS

Check transfer methods and/or tables in Digital Device for proper work according to exam

ALARM 190

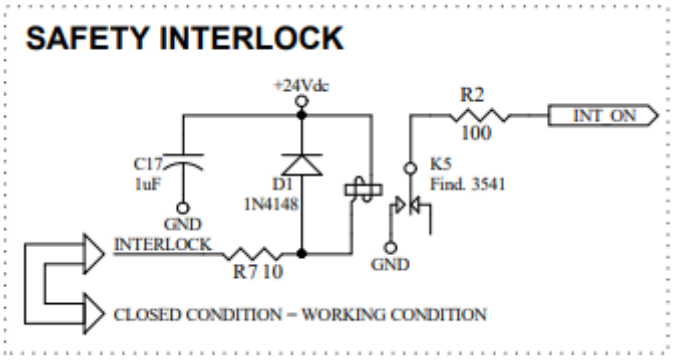
Not provided

ALARM 191

Emergency button

DESCRIPTION

POWER DISTRIBUTION BOARD is provided with an input to sense the status of an optional emergency red button placed in the room.This will act removing the power supply to main inverter



Due to unknown distance of the switch, the signal is a 24Vdc using a galvanic insulation to microprocessor.

TEST

Open the circuit and verify that main computer reads correctly the input through NavGEN and if not masked produces the alarm 191

ALARM 194

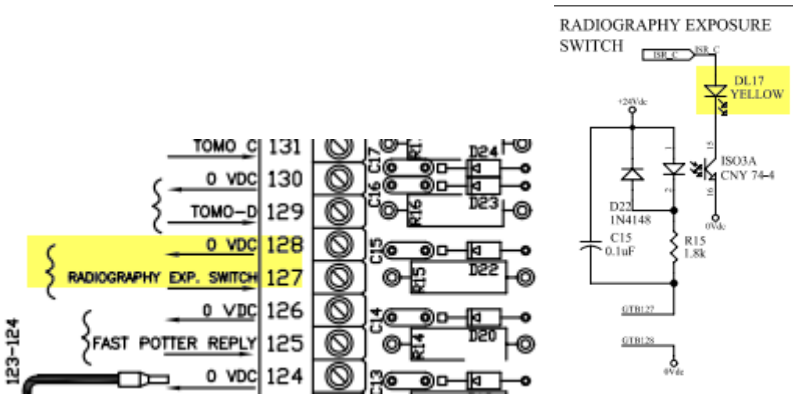
"IRA Timeout"

DESCRIPTION

In order to inspect if II step is arriving within a fixed timeout the alarm is generated if timeout is passed.

VERIFICATIONS

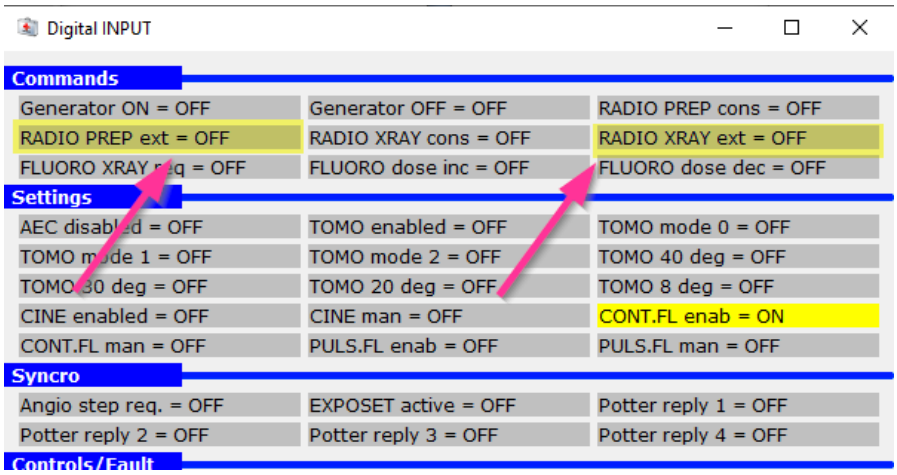
ENDEAVOUR GTB



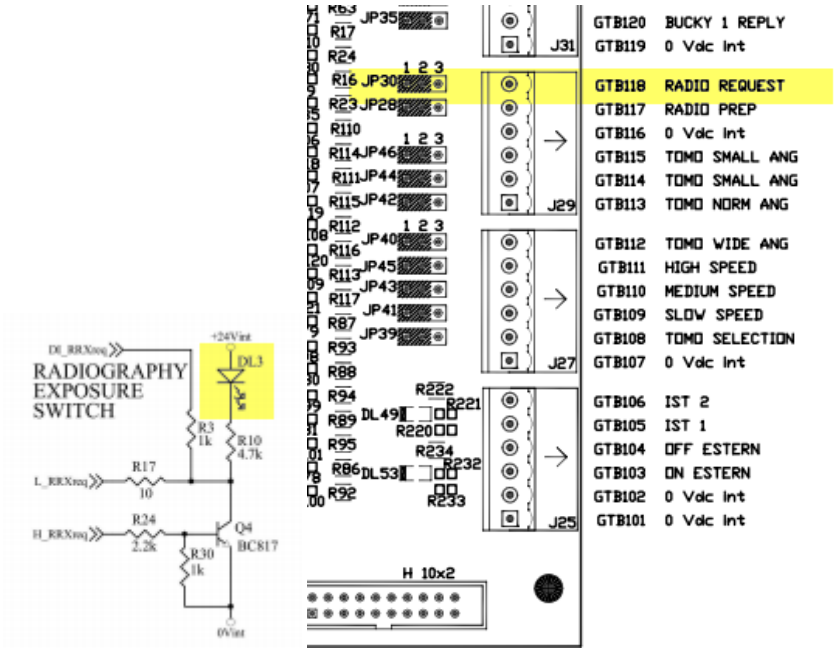
Check DL17 on

Inspect the led status and drive the input manually in order to determinate if problem is a failure in the interface board, or in cable / accessory.

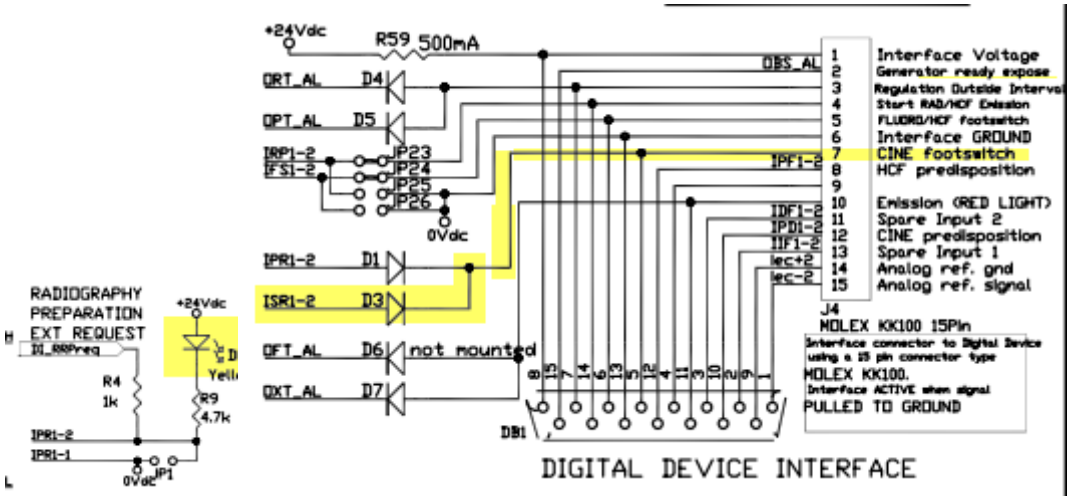
Inspect the driving using NavGEN Digital Input section



EGTB



CARDIO INTERFACE



In this case II step is driven within I step through a diode, so inspect also the diode.

ALARM 195

"IRP Timeout"

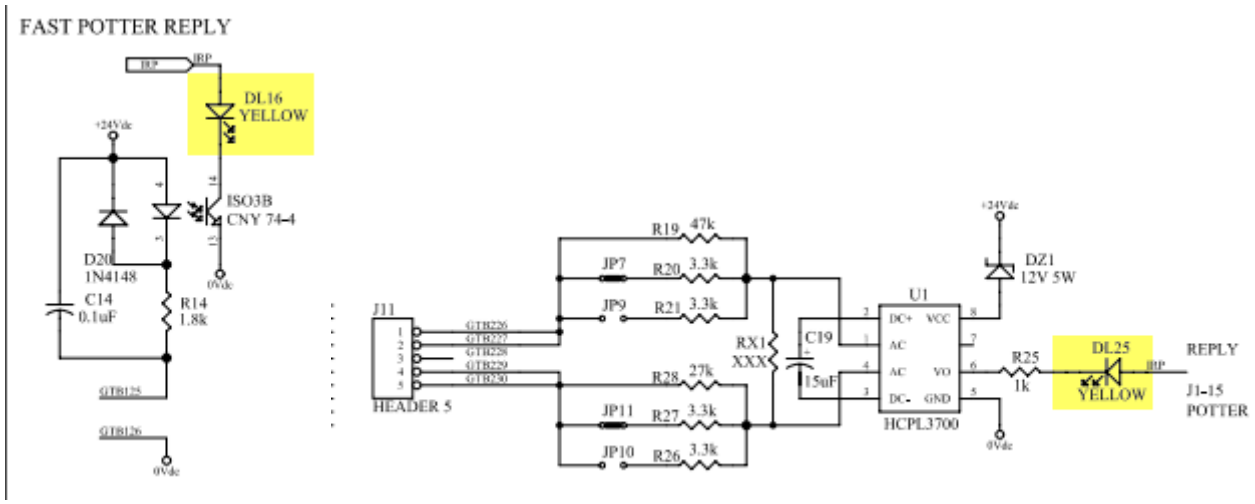
DESCRIPTION

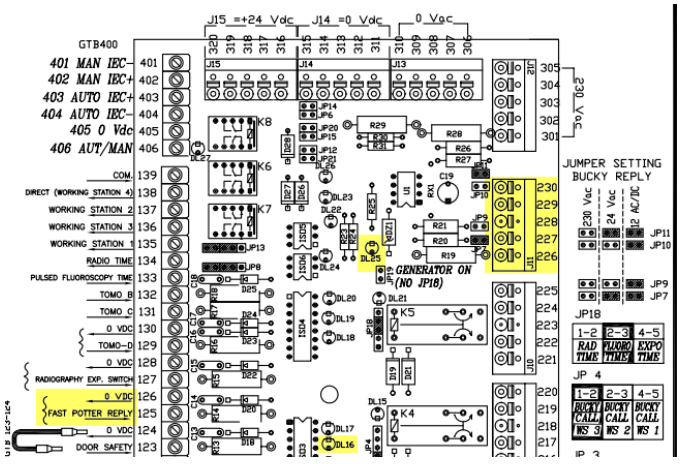
In order to inspect if accessory exmission request (IRP) is arriving within a fixed timeout the alarm is generated if timeout is passed.

VERIFICATIONS

ENDEAVOUR GTB

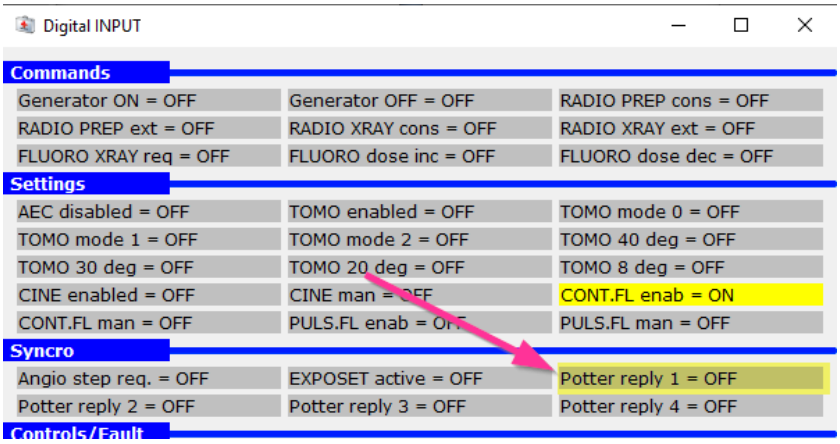
Depending on where the bucky reply has been connected there are two input: one for standard bucky with mechanical reply, another for solid state signal generally from RTT od Digital devices:



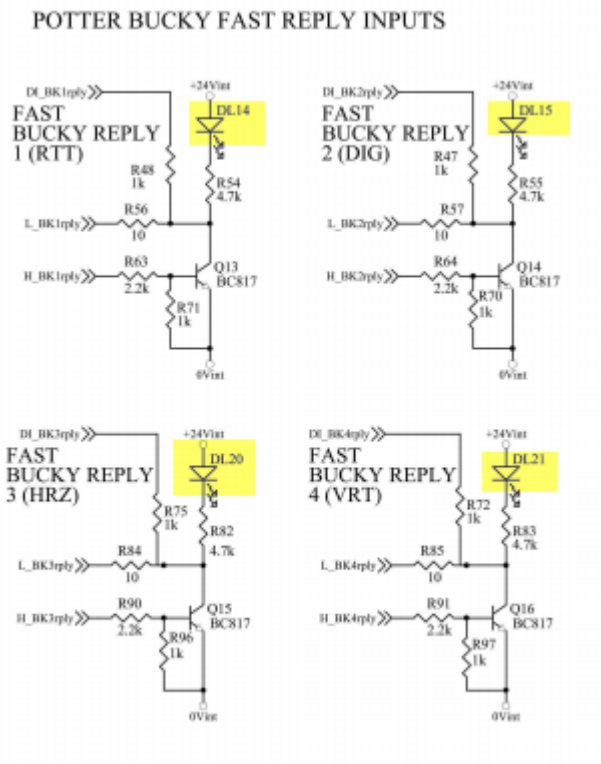


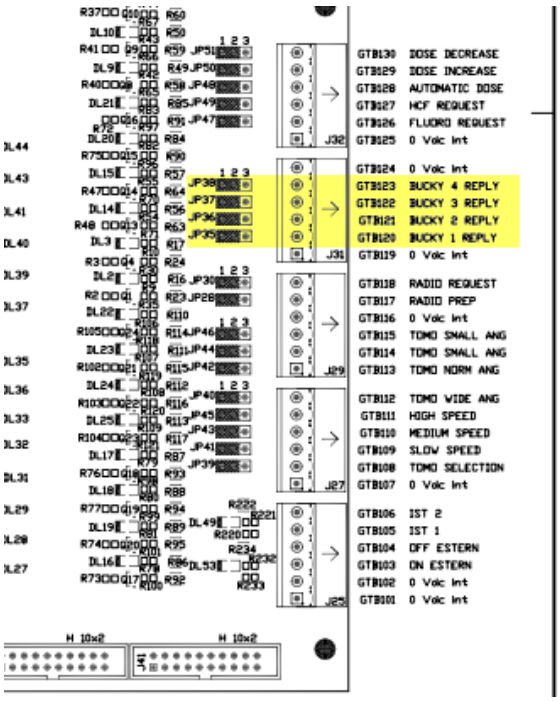
Inspect the led status and drive the input manually in order to determinate if problem is a failure in the interface board, or in cable / accessory.

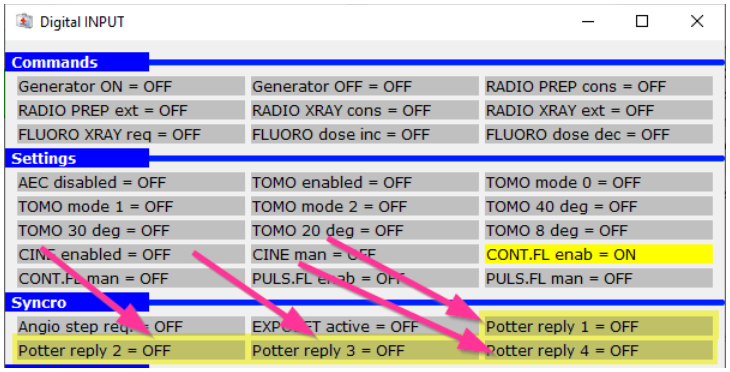
Inspect the driving using NavGEN Digital Input section



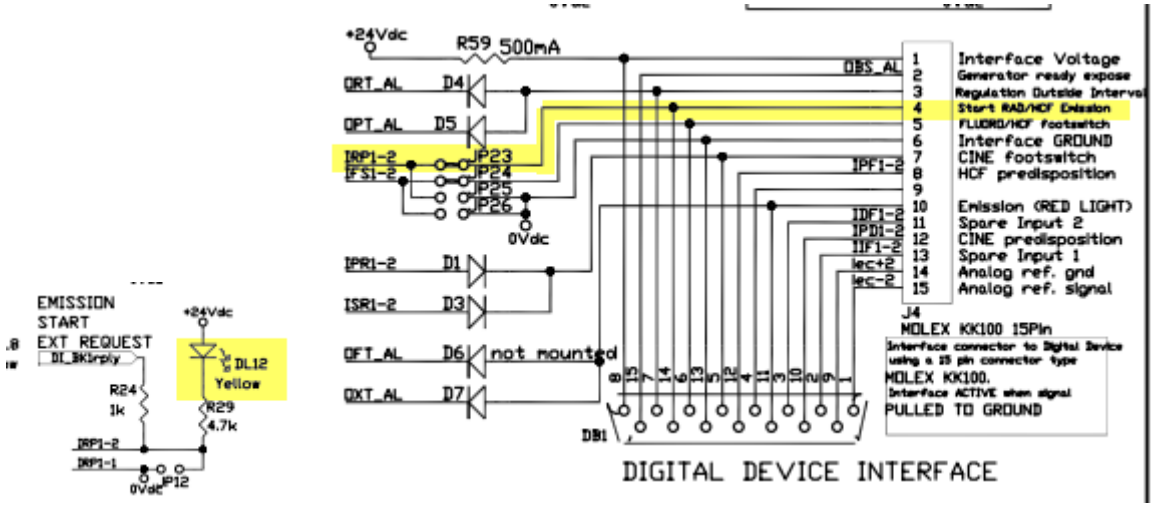
EGTB

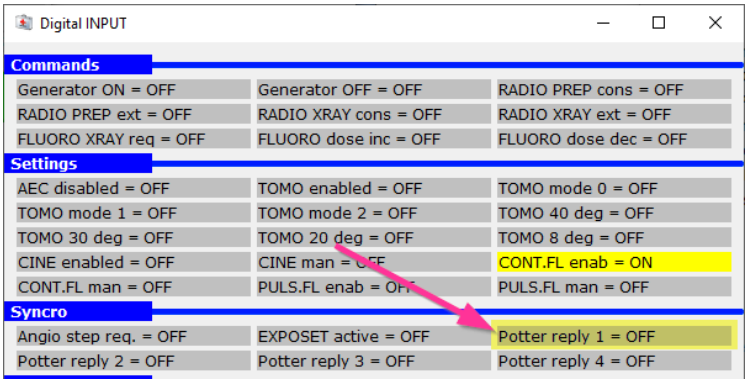






CARDIO INTERFACE





ALARM 197

"ALTERA Safety"

Altera is the Digital I/O processor and POWER INVERTER's BRIDGE CONTROLLER.

Is sends special code to microprocessor to identify itself while booting.

In case there is a mismatch between configuration and Altera codes it is produced a warning in form of alarm to be stored in fault history

ACTIONS

Do nothing, it is in-factory debug feature

ALARMS 199..up

ALARM 199

"Inverter 1 failure"

IN-Factory debug generated alarm for extended tests

ALARM 200

"GATES DC failure"

Not available on INTEGRATED DRIVER based generators

ALARM 201

"PRIMARY CURRENT TRANSFORMER failure"

IN-Factory debug generated alarm for extended tests

ALARM 202

"CCB I/O mismatch"

IN-Factory debug generated alarm for extended tests

ALARM 203

"ESU safety"

Available only on single phase capacitor driven generator

IN-Factory debug generated alarm for extended tests

ALARM 202

"POWER Safety"

IN-Factory debug generated alarm for extended tests