KV Fault Troubleshooting Guide for The MP/GX Series X-ray Generators

Introduction

For this design of generator, a KV Fault is indicated by a flashing time display and an early or instantaneous termination of exposure. (In older GX30 models, all the LED Displays on the console blink). To “clear” the error the generator must be turned off and back on.

A “KV Fault” is registered by a circuit on the KV Regulator Board that monitors kV feedback. This circuit uses two window comparators at its input in order to watch the Anode and Cathode feedback circuits separately. If the Anode feedback voltage goes outside of the window value of 1.3 Vdc to 7.0 Vdc (representing 13 to 70 kV) a comparator is tripped. If the Cathode feedback voltage goes outside of the window value of -1.3 Vdc to -7.0 Vdc (representing -13 to -70 kV) a comparator is tripped. If either comparator is tripped during an exposure attempt, a latch is set and cannot be cleared until the unit is turned off and back on again. Once this latch is engaged, the following will occur:

- KV Drive Signals are blocked (to terminate inverter operation).
- A fault signal is sent to the Logic PCB which terminates all “exposure” signals.
- The Logic PCB sends a fault signal to the console.

There are many possible causes for this “Fault” to occur. This document provides a method for checking specific points to determine cause.

There are basically two KV fault categories described in this document:

“Category I - Consistent KV Fault” on page 2 is a list of possible causes for which a KV fault occurs consistently with every exposure.
“Category II - Intermittent KV Fault” on page 4 lists the possible causes for an intermittent KV fault.

Category I - Consistent KV Fault

Check for open F1 inverter fuse.

Step 1: Turn off the generator and wait 10 minutes for the capacitor bank to discharge.

Step 2: Place a voltmeter across one of the inverter capacitors to ensure voltage is zero.

Step 3: Pull the F1 fuse from the fuse holder and check the continuity of the fuse with an ohmmeter. If necessary, replace fuse with the same type and rating.

If this fuse opens again, please see the following:

- "Test for failed inverter components."
- "Check for a shorted commutation capacitor."
- "Check for an insufficient incoming power line that drops below 224 VAC during an exposure."
- "DC rail voltage maybe too low."
- "Check the SCR firing delay adjustment."

Check for a loss of 25 VDC to bias the gate drive transistors on the KV Regulator board.

Step 1: Turn power off to the generator and place the KV Regulator board on a extender card.

Step 2: Connect a voltmeter to the anode of CR5 for the positive lead and the anode of CR3 for the negative lead.

Step 3: Turn on power to the generator. 25-30 VDC should be measured.

Step 4: If not, check if K1 on the power supply is energizing or if F1 on the Power Supply board is open.

Check for a defect on the KV Regulator board with the feedback circuit or the gate drive circuit.

Step 1: Turn off power to the generator.

Step 2: Place KV Regulator on an extender card.

Step 3: Connect a scope between one side of R25 on the KV Regulator and ground and observe 2 or 3 pulses when you make an exposure.

Step 4: See that KV feedback signals are present at R34 and R42 to ground on the KV Regulator using an oscilloscope. (Possible problem with the KV feedback cable.)

Test for failed inverter components.

Step 1: Turn off power to the generator and allow 5-10 minutes for the inverter capacitors to discharge. Verify 0VDC across one of the capacitors with a voltmeter.

Step 2: Check wire terminals on inverter board for loose connections.

Step 3: Measure resistance of gate pulse transformers for opens.

Step 4: Remove SCRs and measure the resistance of each for shorts or opens. Replace board and SCRs if necessary.

Check for a shorted commutation capacitor.

Step 1: Turn power off to the generator and allow 5-10 minutes for the inverter capacitors to discharge. Verify 0VDC with a voltmeter across one of the inverter capacitors.

Step 2: Remove all wires to the commutation capacitors located at the right, left rear wall of the power module.

Step 3: Place an ohmmeter across each capacitor to check for a short.

Check for a breakdown in the high-tension tank with a no load test.

Step 1: Turn off power to the generator.

Step 2: Remove high voltage cables from the high-tension tank.

Step 3: Add two or three inches of transformer oil in the anode and cathode receptacles of the high-tension transformer.

Step 4: Turn on generator and make exposures, increasing KV with each exposure as necessary, to see if a KV fault exists.

If no fault exists and anode and cathode are balanced, the problem is with the X-ray tube or high voltage cables. Otherwise, there is an internal breakdown inside the high-tension transformer and will need to be replaced.

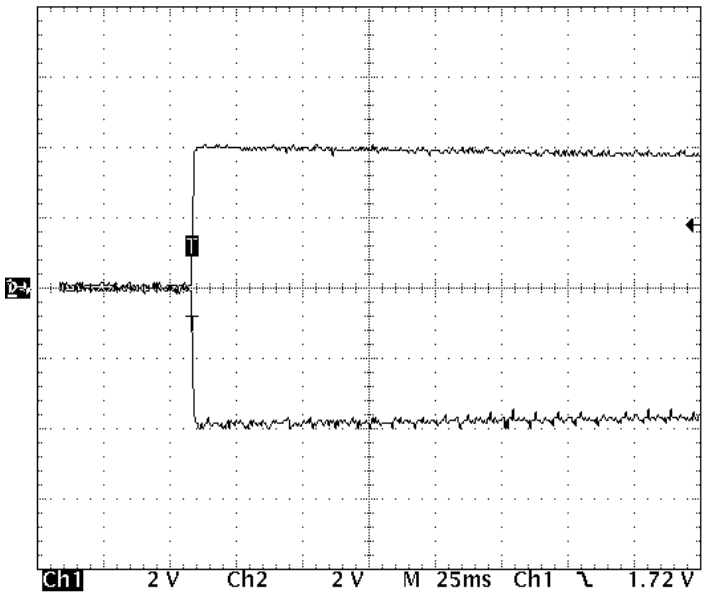

Figure 1: Example No-Load Waveform at 60 kV

Category II - Intermittent KV Fault

On new or re-installations: Ensure the primary cable between the high-tension transformer and power module has not been altered longer from the standard 8-foot length.

Check for a KV imbalance between the anode and cathode feedback waveforms greater than 7 KV. This can be caused by the X-ray tube, high voltage cables or the high-tension transformer.

Step 1: Connect a two-channel oscilloscope to the Motherboard at the cathode of D5 for KV+ and the anode of D4 for KV- with respect to D4 cathode for ground.

Step 2: Make an exposure and observe the amplitudes of the anode and cathode waveforms.

Step 3: If they are not equal, perform a no load test as described in the “Consistent KV Fault” category and observe the kv feedback once again to see if they become equally opposite. **(SEE DIAGRAM BELOW)**

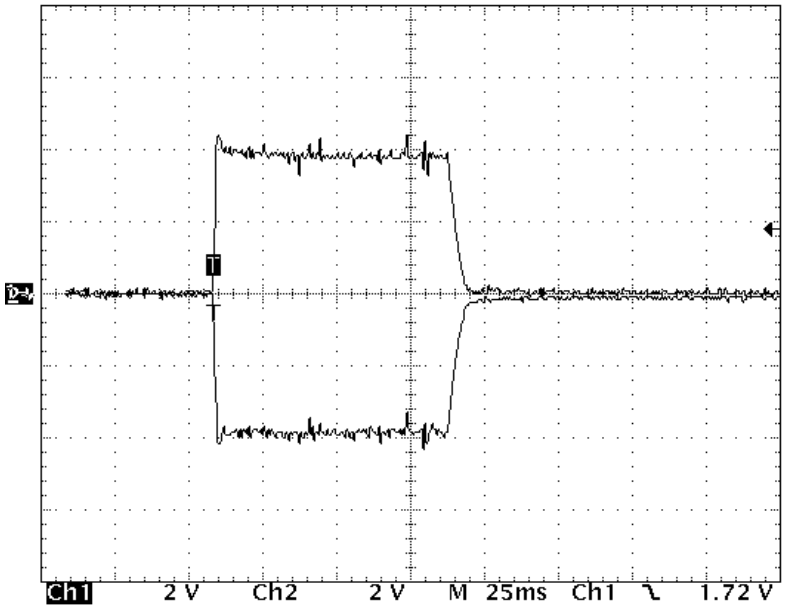

Figure 2: Proper kV Balance Anode to Cathode

Check the SCR firing delay adjustment.

Step 1: Turn power off to the generator.

Step 2: Remove the KV Regulator board.

Step 3: Place an ohmmeter between the wiper and the end leg of R79 that should measure 3 K ohms. Readjust if necessary.

Check filament pre-heat adjustments for small, large or the mA level adjustment on the mA/ Rotor board that maybe set too high.

Step 1: Turn off power to the generator.

Step 2: Connect an oscilloscope across R7 on the I/O board.

Step 3: Select large focal spot; half-power; 60 KV at 10mAs.

Step 4: Adjust R72 on the mA/Rotor board to reduce the pre-heat until exposures are possible and continue to adjust the pre-heat until you achieve a flat waveform. (SEE DIAGRAM BELOW)

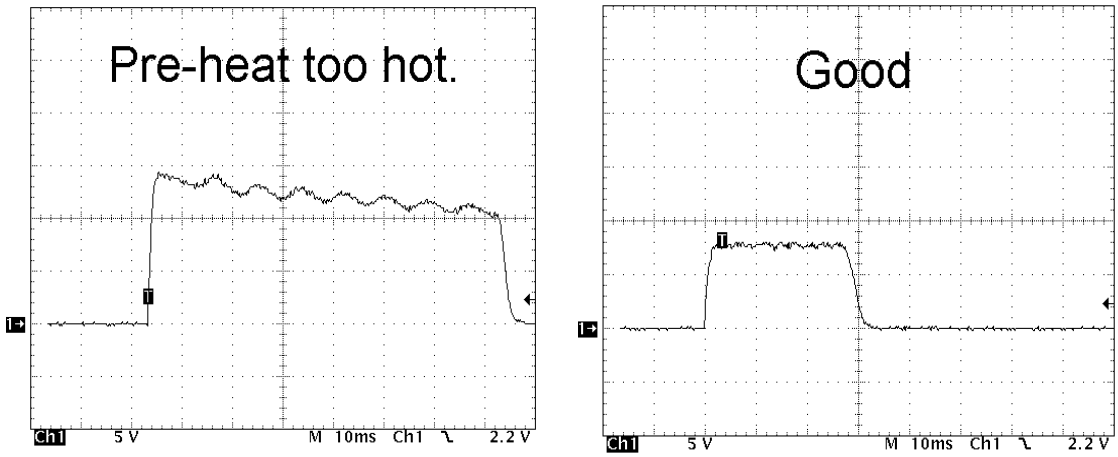

Figure 3: Example Pre-Heat Waveforms

Step 5: Adjust the amplitude of the mA waveform for proper level adjusting R62. Scale is 2V = 100mA.

(You may have to repeat steps 4 and 5 to achieve satisfactory results.)

Step 6: Select small spot for the same settings as above and adjust R63 for a flat waveform. (Do not adjust R62.) SEE CALIBRATION IN THE SERVICE MANUAL FOR FURTHER DETAILS.

If proper adjustments cannot be achieved, settings maybe too far out of range. Set the following for initial settings:

- R63 = 2.7K ohms
- R62 = 39.6K ohms
- R72 = 2.7K ohms

Check for an insufficient incoming power line that drops below 224 VAC during an exposure.

Step 1: Turn off the generator and wait 5-10 minutes for the inverter capacitors to discharge. Connect a voltmeter across one of the inverter capacitors to be sure voltage measures 0VDC.

Step 2: Connect an oscilloscope isolated from earth ground to the line input relay contactor.

Step 3: Turn on the generator and make an exposure noting the voltage drop. If it drops below 224 VAC, the wire size may be insufficient or a line-matching transformer will be necessary. Review power requirements documentation. If the power requirements cannot be satisfied, the generator will have to be derated.

DC rail voltage is too low.

Step 1: Turn off generator and wait 5-10 minutes for the inverter capacitors to discharge. Connect a voltmeter across one of the inverter capacitors to ensure 0 VDC.

Step 2: Connect a dc voltmeter across one of the inverter capacitors.

Step 3: Turn on the generator and wait for the voltage to stabilize. This voltage should not be less than 360VDC. If low, line voltage may be below 224 VAC or possibly the line contactor contacts are pitted, a defective diode pack or open capacitor in the inverter power supply.

A poor connection at the high voltage cable ends.

Step 1: Turn off power to the generator.

Step 2: Remove high voltage cables from high-tension transformer and X-ray tube ends.

Step 3: Spread all pins at each cable end and re-install the cable ends.

If the problem still persists, swap the anode and cathode cables with each other at both ends to determine if there is an open in the cathode cable.

Check for excessive ripple on the dc rail power supply due to a defective filter capacitor or defective diode pack.

Step 1: Turn off the generator and wait 5-10 minutes for the inverter capacitors to discharge. Connect a voltmeter across one of the inverter capacitors to insure 0VDC.

Step 2: Connect an oscilloscope isolated from ground across one of the inverter capacitors.

Step 3: Adjust the scope to measure up to 400 VDC.

Step 4: Turn power on to generator and measure a dc level typically between 360-400 volts and should not have any evidence of ripple. You can also set the scope for ac and determine the amplitude of the ripple if present.

Commutation capacitor relay changeover circuit is not switching or contacts pitted.

Step 1: Turn off generator and allow 5-10 minutes for inverter power supply capacitors to discharge. Verify 0VDC with a voltmeter across one of the inverter capacitors.

Step 2: Check if M1 contacts are welded closed.

Step 3: Turn on the generator and check K1 on the Motherboard if it is energizing temporarily while increasing mAs from minimum.

Step 4: If the M1 relay is not energizing, can 25 VDC be measured across the coil?