KV Fault Troubleshooting Guide for RV 50 & AP/ATC 50 KW (max) X-ray Generators

Introduction

For this design of generator, a KV Fault is indicated by a text statement in the display and an early or instantaneous termination of exposure. To “clear” the error the generator must be “reset or 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 categories of causes for a KV Fault.:

“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 which lists the possible causes for an intermittent KV fault.

Category I - Consistent KV Fault

Check for open inverter fuse.

Step 1: Turn off power to the generator and wait 5-10 minutes for the inverter capacitors to discharge. Verify that 0VDC measured with a voltmeter across an inverter capacitor.

Step 2: Remove F1 fuse and use an ohmmeter to determine if the fuse is open.

Note: IF THIS FUSE CONTINUES TO OPEN, ESPECIALLY ON HIGHER mAs EXPOSURES, CHECK THE CAPACITANCE OF THE COMMUTATION CAPACITORS OR THE SCR HOLD-OFF TIME DESCRIBED IN THIS TROUBLESHOOTING GUIDE. Also: See “AP Generator Fuse Blowing Possibilities” on page 6.

Check for a KV Imbalance greater than 7KV

An imbalance between the anode and cathode feedback waveforms can be caused by the balance resistor behind the power module being out of adjustment, X-ray tube, high voltage cables or the high-tension transformer can be faulty.

Step 1: Connect 2 channels of an oscilloscope to KV+/- to TP-12 on the Motherboard.

Step 2: Make an exposure. Based on a voltage interpretation of 1V=10KV, the anode and cathode waveforms should be equal in amplitude. See Figure 1,”Proper kV Balance Anode to Cathode”.

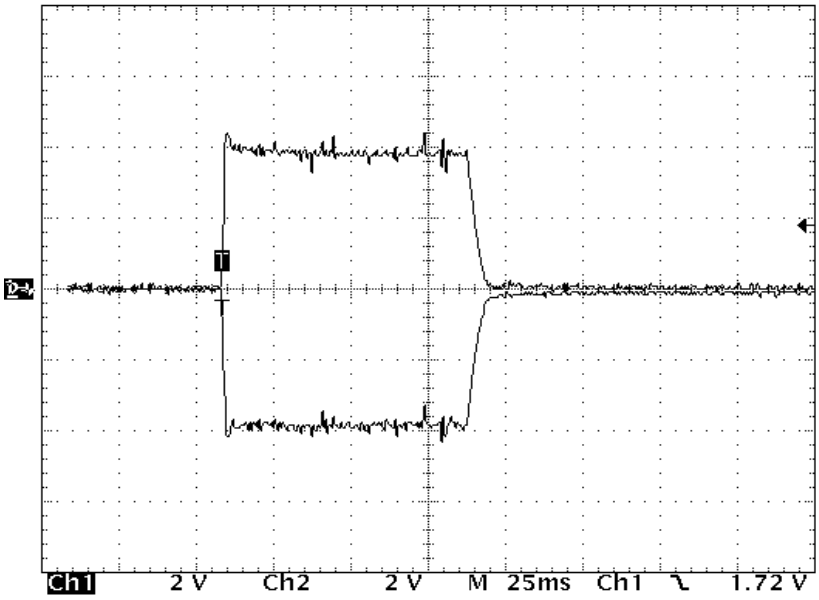

Figure 1: Proper kV Balance Anode to Cathode

Step 3: Turn power off to the generator and try to balance the anode and cathode by adjusting the balance resistor located on the back side of the power module, behind the screened box

Step 4: Turn on the generator and make an exposure. Take note of the change and repeat step 3 as necessary.

Step 5: If adjustment is not possible, check to see if the imbalance still occurs during a No-Load test. See "No Load Test" on page 6. If the imbalance persists, the high tension transformer is likely to be defective.

Check for a loss of 26 VDC at the power supply board that supplies the SCR gate transistors on the KV Regulator Board

Step 1: Turn power off to the generator

Step 2: Place the KV Regulator board on an extender card.

Step 3: Connect a voltmeter positive lead to the anode of CR-5 and the negative lead to the anode of CR3.

Step 4: Turn-on generator and measure the voltage that should be approximately 26 VDC.

Check for a shorted commutation capacitor.

Step 1: Turn off power to the generator and allow 5-10 minutes for the inverter capacitors to discharge. Verify with a voltmeter that 0VDC is measured across the inverter capacitors as well as the commutation capacitors. (Terminals on outside of rear power module panel).

Step 2: Disconnect the wires and copper straps from both commutation capacitors.

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

Check for missing input or defect on the KV Regulator board feedback circuit or the gate drive circuit.

Step 1: Turn off power to the generator.

Step 2: Place the KV Regulator on an extender card and connect an oscilloscope to R4 and logic ground, setting the time base for 100 microseconds.

Step 3: Make an exposure and check for 2 – 3 pulses 80 microseconds in duration. If pulses are not present, the KV Regulator board may be the problem.

Step 4: Connect a 2-channel oscilloscope to R44 and R45 on the KV Regulator and note the feedback during an exposure. If no feedback, the KV feedback cable may be defective or may have a bad connection at the high-tension tank or power module.

Check for failure of inverter board components.

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

Step 2: Measure the resistance of each SCR out of circuit in forward and reverse bias mode. Gate to cathode measurements also. Replace components and/or inverter board as necessary.

Step 3: Check for loose wiring connections in the inverter circuit.

Check for Malfunctioning mA/Rotor board

Step 1: Turn off power to the generator.

Step 2: Place the mA/Rotor card on an extender card.

Step 3: Check filament reference signal by connecting a voltmeter or oscilloscope at U23, pin 1 to ground. Turn on generator and prep the unit. Should measure approximately 5 VDC. If voltage is not present, this board or the Data Board may be defective.

Category II - Intermittent KV Fault

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

Check if the exposure button is released before the termination of exposure.

Note: Be sure the exposure button is depressed until the audible exposure indicator terminates! (Bouncing exposure switch contacts can also be the cause.)

Step 1: Turn off generator.

Step 2: Place the logic PCB on an extender card.

Step 3: Connect an oscilloscope to R30 closest to the “M” pin and logic ground.

Step 4: Set the amplitude to measure 12 volts DC and make an exposure to observe the active low pulse. It should be one single low pulse. A multitude of pulses with a single press of this switch is the indication of a bouncing switch.

Check if filament pre-heat adjustments for small or large and/or mA level adjustment on the mA Rotor Board are set too high or low.

Step 1: Turn off the generator.

Step 2: Place the mA/Rotor board on an extender card.

Step 3: Connect an oscilloscope probe to MA+ and MA- on the Mother Board.

Step 4: Set SW1-1 to the off position on the Control CPU board to see indicated mA on the screen.

Step 5: Turn on the generator and select manual mode, large filament, 60 KV and 10 mAs with an exposure time of at least 60 milliseconds.

Step 6: Make an exposure.

Step 7: If the waveform is not flat, adjust R72 as necessary. See Figure 2,”Example of Pre-heat Waveforms”.

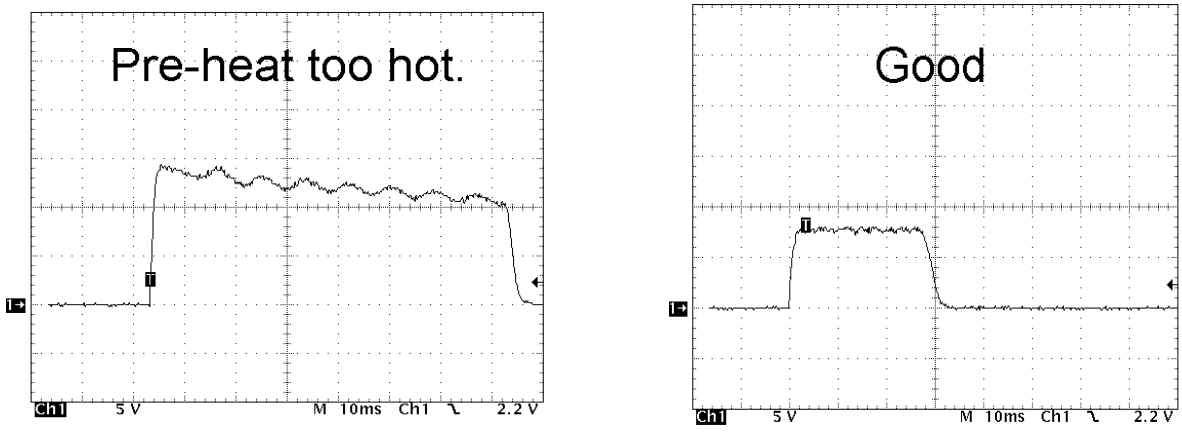

Figure 2: Example of Pre-heat Waveforms

Step 8: Note the amplitude of the waveform and adjust R63 if necessary.

REFER TO THE MA CALIBRATION SECTION OF THE SERVICE MANUAL FOR DETAILS.

Check for a power line input lower than 235VAC.

Step 1: Connect a voltmeter at the input of the line contactor and measure the voltage.

Step 2: If the voltage is low, check the incoming line from the disconnect and re-tap the line matching transformer as necessary.

Check for an insufficient power line dropping below 235 VAC during exposure.

Step 1: Measure incoming line voltage at the line contactor input of the inverter power supply with an oscilloscope isolated from ground.

Step 2: Take note of the voltage during an exposure. If the level drops dramatically the power line is unstable or the wrong wire size may have been used.

Check for a poor conducting high voltage cable.

Step 1: Turn off power to the generator

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

Step 3: Check to make sure the cable pins are sufficiently spread to make good contact

Step 4: Reconnect the cables.

If problems still persist, turn power off to generator and temporarily swap the anode and cathode cables with each other at both ends.

Check for excessive ripple on the DC rail voltage due to a defective filter capacitor or defective diode pack.

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

Step 2: Connect an oscilloscope isolated from earth ground across one of the filter capacitors and adjust the volts/cm to measure 350-400VDC.

Step 3: Turn generator on and observe the DC rail as well as during an exposure and determine if there are any abnormalities. You can set the scope for AC to be able to measure the amplitude of the ripple as well.

Check for a breakdown in the high-tension tank.

Step 1: Perform a no load test, See “No Load Test” on page 6.

OR

Step 2: Connect a loaner X-ray tube with a different pair of high voltage cables.

Step 3: Turn on power and make an exposure. If problems persist, the problem may be in the high-tension tank. Otherwise, permanently replace the X-ray tube or high voltage cables.

Check SCR delay firing adjustment.

Step 1: Turn off power to the generator.

Step 2: Place the KV Regulator board on an extender card

Step 3: Use an oscilloscope set for a time sweep of 100 microseconds/Div. and connect the probe between U3-10 and ground.

Step 4: Turn generator on. Set 60 kv at the maximum mA (***not mAS***) selectable. Make an exposure and measure the off time between pulses at the very begining of the exposure. It should be 140 microseconds.

Step 5: If necessary, adjust R65 on the board.

Note: If you are not quite sure about how to perform this adjustment it may be better to simply replace the board. Mis-adjustment of R65 can cause severe malfunction and possible permanent damage to the generator! It is rare that this adjustment needs to be made in the field.

Check if commutation capacitor relay changeover circuit is not switching or contacts pitted.

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

Step 2: Check the contacts of K1 or K2 located at the rear left interior of the power module, below the commutation capacitors. If contacts are in poor condition, replace the relays.

Step 3: Turn generator on and increase the mAs from minimum observing the sequence of the relays energizing and de-energizing.

Step 4: If the relays don't energize, check the voltage at each relay coil while repeating step 2. If the voltage is present then change the defective relay.

Step 5: If no voltage is ever present, turn off generator power and place mAs Control board on an extender card and check for switching voltages at Q1, Q2 and Q3. Replace the board if necessary.

AP Generator Fuse Blowing Possibilities

The F1 Fuse blowing could be caused by the following:

- an open in the primary circuit to the high voltage transformer (e.g.: a bad connection or incorrect wiring)
- a short in the primary circuit to the high voltage transformer (perhaps shorted to ground, e.g. the primary connection cover or incorrect wiring)
- a short in the inverter (e.g.: a shorted SCR)
- A short (arcing) in the secondary, HV Cables or X-Ray tube.
- Line Voltage Drop (consult the power requirements documentation)
- Dramatic mis-adjustment of the filament pre heat (unlikely)
- Dramatic mis-adjustment of the SCR hold off adjustment. (unlikely)

To eliminate the HV Cables and X-Ray tube as the problem, try a No Load Test:

No Load Test

Step 1: Turn power to the generator "off".

Step 2: Remove F3 on Power Supply PCB.

Step 3: Remove the Anode and Cathode high voltage cables from the High Voltage Transformer and add a small amount of transformer oil (fill the cable sockets half way for high KV tests) to prevent arcing.

Step 4: Connect a scope to the KV Feedback test points.

Step 5: Turn power to the generator "on" and set a low power technique on the control.

Step 6: Make an exposure and observe the kV waveform. The unit should “expose” and make a ticking sound. The exposure will continue until the button is released and at that time a “Button Fault” should be displayed. The usual high frequency sound will not be heard upon PREP. The KV waveform should be balanced (anode to cathode) and accurate but the ripple will be a very low frequency and greater in amplitude than normal.

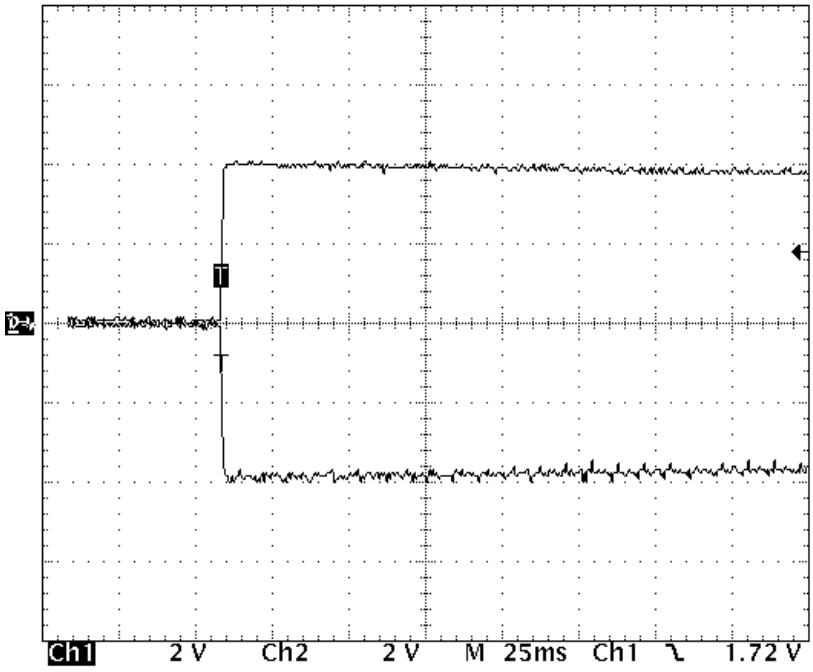

Figure 3: Example No-Load Waveform