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NOTES:

1. USE THIS PROCEDURE TO TROUBLESHOOT PROBLEMS WITH THE THYRATRON CROWBAR (PART NUMBER 451227-01). IT IS NOT ALWAYS NECESSARY TO RETURN THE CROWBAR WHEN IT FAILS. IT IS POSSIBLE TO TROUBLESHOOT MANY PROBLEMS WITH THIS ASSEMBLY IN THE FIELD.
2. OBEY ALL WARNINGS AND PRECAUTIONS MENTIONED IN THIS PROCEDURE.
3. THE IC'S REFERRED TO IN THIS PROCEDURE CAN BE PURCHASED AS A KIT. ORDER KIT #46744355.
4. WHEN RETURNING A CROWBAR FOR SERVICING, IT IS IMPORTANT TO CONVEY THE SERIAL NUMBER AND A DETAILED PROBLEM DESCRIPTION TO THALES PERSONNEL FOR TRACKING PURPOSES.

WARNING:

BIASING VOLTAGE IS PRESENT ON THE THYRATRON TUBE WHEN THE HPA IS IN START MODE OR HIGHER. THIS VOLTAGE CAN EXCEED 160V. DO NOT TOUCH THE THYRATRON TUBE WITH POWER APPLIED TO THE CABINET.

WARNING:

THE THYRATRON TUBE WILL REACH HIGH TEMPERATURES DURING NORMAL OPERATION. DO NOT TOUCH THE THYRATRON TUBE UNTIL IT HAS COOLED TO ROOM TEMPERATURE.

WARNING:

REMOVE ALL POWER FROM THE HPA CABINET BEFORE REMOVING OR INSTALLING THE THYRATRON CROWBAR ASSEMBLY.

B	ECO#5094	AMM	10/10/03	GDC	10/16/03	REVISED FOR U7 MODULE		
A	~	AMM	08/07/03	AMM	8/7/03	ENGINEERING RELEASE		
REV	CHG. ORDER	ISSUED	DATE	AUTH.	DATE	DESCRIPTION		
ISSUED	A. MASIUNAS	08/01/03	PROJECT NO.		ELECTRONIC FILE:			
CHKD	G DelCAMPO	8/7/03			46744354-194B.doc			
ENG	A MASIUNAS	8/7/03	TROUBLESHOOTING PROCEDURE, THYRATRON CROWBAR					
ENG	D SPARANO	8/12/03						
MFG	T JERARD	8/7/03						
EDC	V CRUZ	8/12/03						
THOMSON			DOCUMENT NUMBER		DTC CODE	SIZE	PAGE	
			46744354		194	A	1/11	
OFFICE RESP. <i>Southwick, MA</i>							B	REV A

TROUBLESHOOTING TABLE

Symptom	Problem / Solution
Prefiring	<ul style="list-style-type: none"> • Reservoir voltage too high • Cleanliness • Bad thyatron tube • Bad isolation transformer
Quenching	<ul style="list-style-type: none"> • Reservoir voltage too low • Old thyatron tube (loss of gas pressure) • Bad thyatron tube
Loss of crowbar ready	<ul style="list-style-type: none"> • U5, U6, or U7 latchup • LV PCA resistor values • Isolation transformer wire dressing • Grid supply failure • Grid current PVD • Bad Thyatron Tube
Fails to test trigger	<ul style="list-style-type: none"> • CR1 SCR bad • FO Problem • HPA not in diagnostic mode

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1. PREFIRING

1.1. SYMPTOMS

Prefiring is a condition in which the crowbar fires on its own, without an external arc. Depending on the cause, changes in beam voltage can affect the incidence of prefiring. Usually prefiring will happen more often as the beam voltage increases.

1.2. DIAGNOSIS

1.2.1. Determine if the Fault is in the Crowbar

Prefiring is one of many reasons an HPA will crowbar. Isolate the IOT to determine if the system is tripping off from a breakdown in the high voltage circuit or in the crowbar. If the crowbar events stop after isolating the tube, discontinue this procedure and contact customer service. If there are still crowbar events, continue with this procedure; however, the problem may still be outside the crowbar assembly.

1.2.2. Clean and Inspect the Crowbar and High Voltage Compartment

If the system continues to crowbar, remove all power from the HPA, and inspect the high voltage components. Look for any damaged components or signs of arcing. Using a clean rag and isopropyl alcohol, clean all dirt, dust, and contamination from handling off all insulators and surfaces separating high voltage from ground. It is also critical to clean the voltage divider resistors mounted on the PCB next to the thyatron tube. Be careful around the thyatron tube as it normally runs hot, and this heat will remain for some time. Allow time for the tube to cool before cleaning it. Open up the beam supply, and check for damaged components or signs of arcing there.

1.2.3. Measure and Adjust the Thyatron Filament and Reservoir Voltage

Once the inspection and cleaning is complete, remove the screws holding the cover to the crowbar, and reapply power to the HPA. With the cabinet in HPA start tip mode, the cover up, and use an AC voltmeter to measure the thyatron's filament and reservoir voltage. This voltage should be between 6.00 and 6.60Vac. If it is outside of this range, shut off the cabinet and remove the crowbar. Place the assembly on its side, and refer to the marking plate on the isolation transformer. If the voltage was below 6.00Vac, move the tap on the isolation transformer in the negative direction: - to -5% if it was on zero, to zero if it was on +5%. If the voltage was above 6.60Vac, move the tap on the isolation transformer in the positive direction: - to +5% if it was on zero, to zero if it was on -5%. Place the crowbar back into the cabinet, reapply power to the HPA, go back into HPA start mode, and measure the voltage again. It should now be between 6.00 and 6.60Vac. Remove power from the HPA, and replace the screws in the top cover of the crowbar. Reapply power to the HPA, and bring the unit back to Beam mode with the tube isolated.

1.2.4. Swap the Crowbar Assembly

If the crowbar continues to prefire, it is still possible that a high voltage fault exists elsewhere in the system. If it is convenient, swap this assembly with another, and see if it solves the problem. If the original HPA continues to trip with the new crowbar, the problem is likely elsewhere in the high voltage circuit. If this is the case, discontinue this procedure and contact customer service. If the high voltage breakdown follows the crowbar assembly, likely causes are the thyatron tube itself or the crowbar's isolation transformer. Again, swapping these with known working parts may help in troubleshooting. Should all of these efforts fail to resolve the problem, return the crowbar assembly and thyatron tube to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as prefiring, including the frequency of prefiring events.

2. QUENCHING

2.1. SYMPTOMS

Quenching is a condition in which the crowbar does not fire fully. This condition, as a rule, is a problem within the thyatron tube. It is important to make a distinction between quenching, where beam voltage drops by only a few kilovolts, and failure to test fire, where the test button is used and there is no

indication that the crowbar ever fired. If there is no indication on the 'triggered' light when performing a crowbar test, it may be due to a controller not in maintenance mode or a failure in the test circuit.

Quenching is a dangerous situation requiring immediate attention. Failure to attend to a quenching situation could place the IOT in serious jeopardy. Currently, the only method to detect quenching in a thyatron crowbar is to test fire it at regular intervals.

2.2. DIAGNOSIS

2.2.1. Measure and Adjust the Thyatron Filament and Reservoir Voltage

Should the thyatron quench, check the reservoir voltage to assure it is in the proper range. To do this, remove the screws holding the cover to the crowbar and reapply power to the HPA. With the cabinet in HPA start mode, tip the cover up and use an AC voltmeter to measure the thyatron's filament and reservoir voltage. This voltage should be between 6.00 and 6.60Vac. If it is outside of this range, shut off the cabinet and remove the crowbar. Place the assembly on its side and refer to the marking plate on the isolation transformer. If the voltage was below 6.00Vac, move the tap on the isolation transformer in the negative direction: - to -5% if it was on zero, to zero if it was on +5%. If the voltage was above 6.60Vac, move the tap on the isolation transformer in the positive direction: - to +5% if it was on zero, to zero if it was on -5%. Place the crowbar back into the cabinet, reapply power to the HPA, go back into HPA start, and measure the voltage again. It should now be between 6.00 and 6.60Vac. Remove power from the HPA and replace the screws in the top cover of the crowbar. Reapply power to the HPA, bring the unit back to Beam mode with the tube isolated, and retest for quenching.

2.2.2. Replace the Thyatron Tube

If the crowbar continues to quench, replace the thyatron tube. Should all of these efforts fail to resolve the problem, return the crowbar assembly and thyatron tube to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as quenching.

3. LOSS OF CROWBAR READY

3.1. SYMPTOMS

There are many reasons a thyatron crowbar can lose its ready signal. This procedure covers some of the more common reasons. It is important to pay attention to the details surrounding this situation; these details are critical to troubleshooting the cause of the problem.

If the loss of crowbar ready is continuous or is after a crowbar event, it may be due to the latch-up of devices in the control circuit. Refer to section 3.2 and the block diagram in Figure 1 for troubleshooting this problem.

If the crowbar operates normally when the cabinet is cool and fails as the cabinet temperature increases (either through room temperature changes or operation at full power), and there have been no crowbar events, then the system has a problem with temperature sensitivity. Refer to section 3.3 for troubleshooting this problem.

If crowbar ready is lost immediately or soon after the application of high voltage, but there is no crowbar event, refer to section 3.4.

If momentary power interruptions (much less than 30 seconds) cause the crowbar ready to drop out for 10 minutes, refer to section 3.5.

3.2. DIAGNOSING EVENT RELATED OR CONTINUOUS LOSS OF READY

3.2.1. Ensure the Crowbar Assembly is at the Latest Revision

There have been a number of circuit changes that correct continuous or event-related loss of ready issues. Before troubleshooting this problem, upgrade the crowbar to the latest revision. Contact Thales customer service for upgrade parts and instructions.

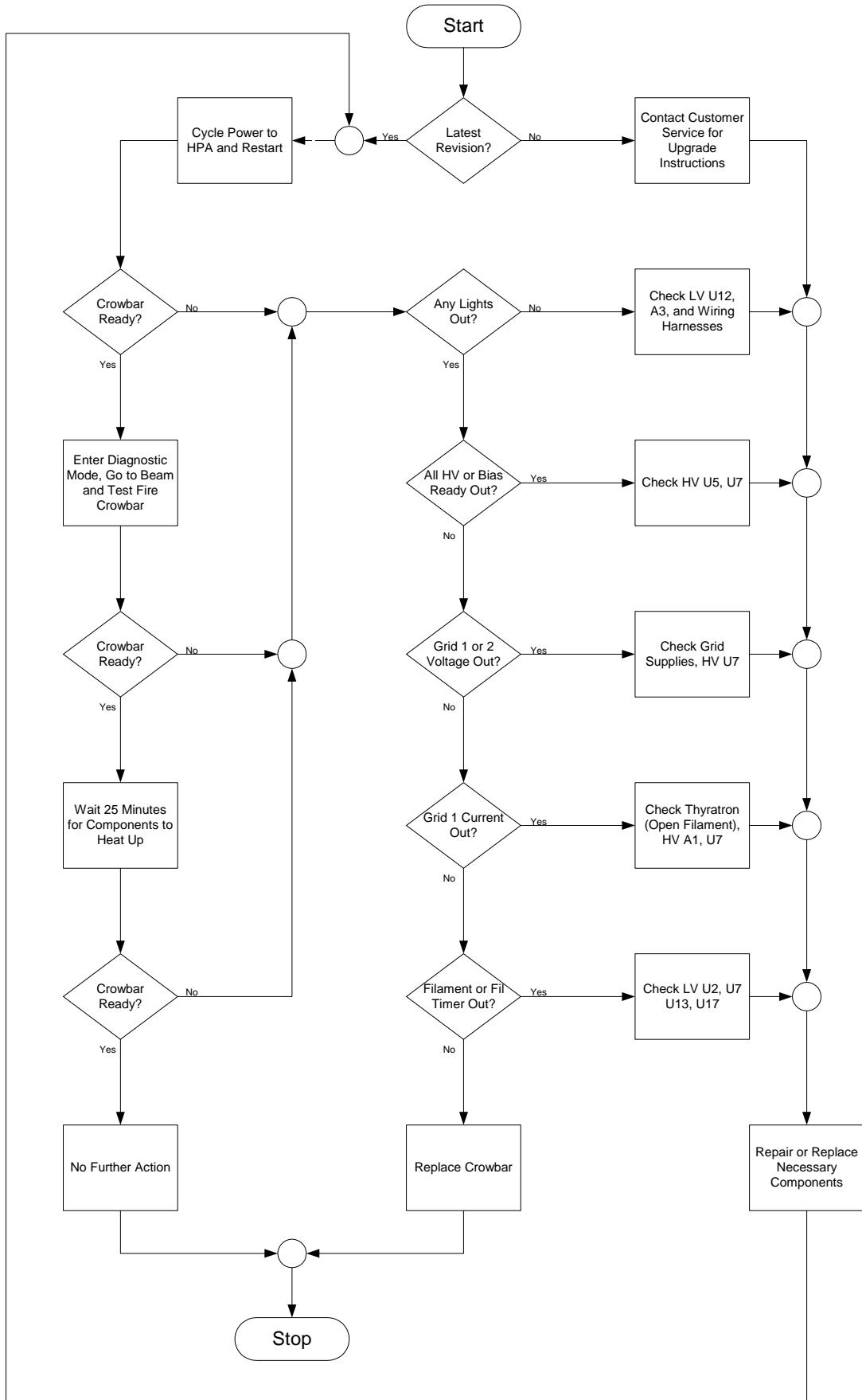


Figure 1: Flow Chart for Section 3.2

3.2.2.Cycle Power

Should the crowbar be at the latest revision, bring the HPA to stop mode and cycle power to the cabinet. Place the HPA in start mode and wait 10 minutes for the crowbar to warm up. If the crowbar does not come ready, go to section 3.2.5. Otherwise, continue with the procedure.

3.2.3.Test Fire the Crowbar

If the crowbar reports ready, the next step would be to cause a crowbar event and see how the system reacts. To do this, place the HPA into diagnostic mode. With the HPA in beam, press the crowbar test button. The beam supply should shut off with a loud noise. After ten seconds, the crowbar should report ready again. If not, go to section 3.2.5.

3.2.4.Let the System Warm Up

If the crowbar reports ready after the test firing, return the HPA to beam mode. It may take time for the problem to appear as the affected components heat up. Wait up to an hour to see if the crowbar will fail out of ready. When this occurs, it should not be associated with a crowbar event.

3.2.5.Find the Failed Component

If the crowbar fails to go ready, open the high voltage enclosure and look at the lights on the crowbar assembly. The 'NOT FIRED' light will be off for ten seconds after a crowbar event; otherwise, all lights except "FILAMENT TD BYPASS" should be on. If all indicators are correct, go to section 3.2.6.

Record which lights are out and remove the crowbar assembly. Figure 2 shows the HV control board components mentioned in this procedure.

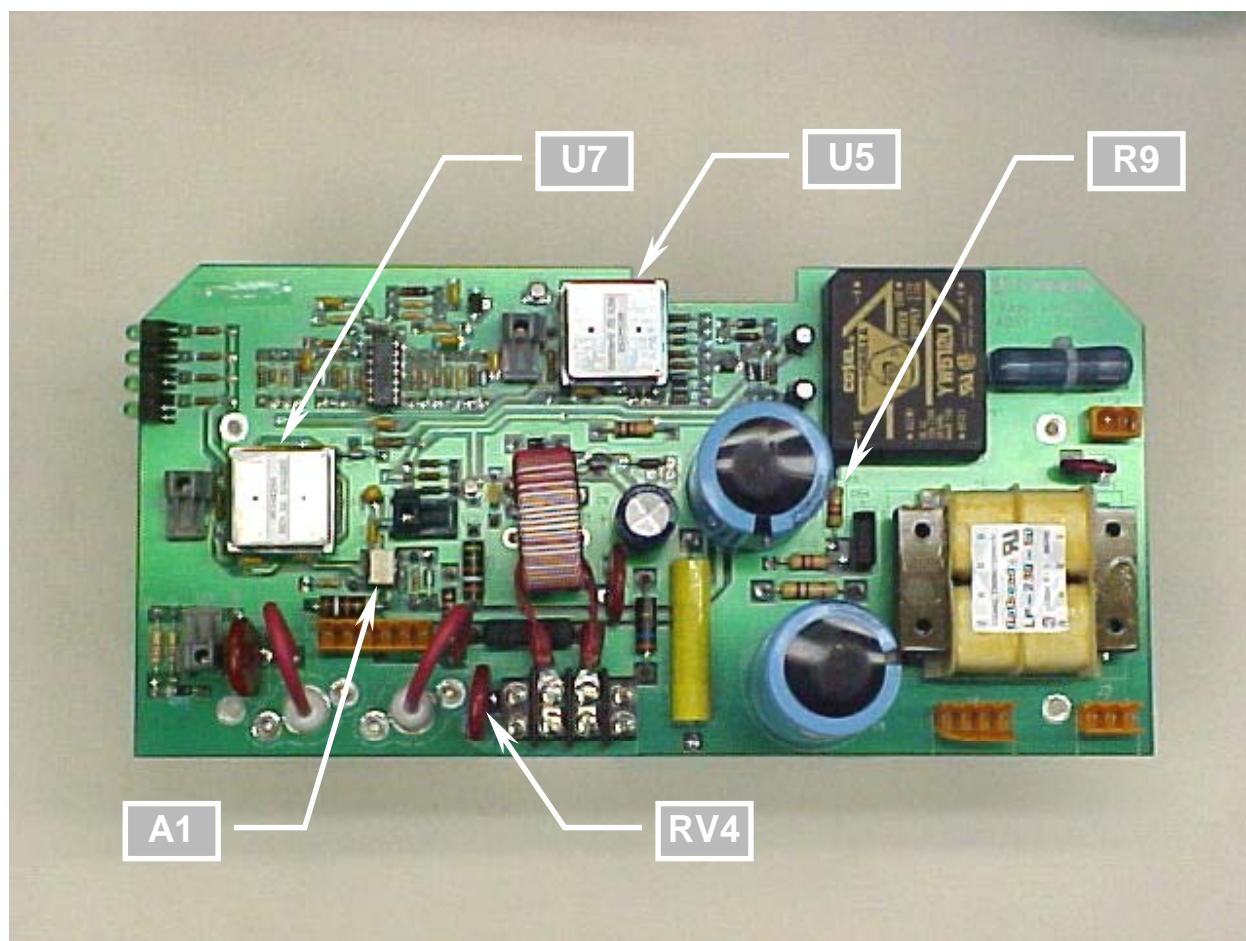


Figure 2: HV Control Board

If all of the lights on the top (HV) section of the crowbar are out, and/or the 'BIAS READY' on the lower (LV) section is out, replace U7 (P/N 46744352) on the HV control board. If the problem still exists, replace U5 (P/N 46744258) on the HV board.

If only the 'GRID 1 I' and 'BIAS READY' lights are out, check that the thyatron does not have an open filament. To do this, disconnect the filament (yellow) lead and measure the resistance between it and the top case. If the thyatron filament is good (approximately 4Ω), replace A1 (P/N 603976-01) on the HV control board. If the problem still exists, replace U7 (P/N 46744352) on the HV board.

If only the 'GRID 1 V', 'GRID 1 I', and 'BIAS READY' lights are out, check the supply for grid 1. The voltage out of this supply, as measured across R9, should be over 120Vdc. If the bias supply is good, replace U7 (P/N 46744352) on the HV control board.

If only the 'GRID 1 V' and 'BIAS READY' lights are out, replace U7 (P/N 46744352) on the HV control board.

If only the 'GRID 2 V', and 'BIAS READY' lights are out, check the supply for grid 2. The voltage out of this supply, as measured across RV4, should be over 120Vdc. If the bias supply is good, replace U7 (P/N 46744352) on the HV control board.

If only the 'FILAMENT ON', 'GRID 1 I', and 'BIAS READY' lights are out, check the filament voltage on the thyatron. Note that there is an electrical interlock on the connector for the fan on cover of the HV section. If this interlock is open (the fan is not plugged in), there is no power on the filament.

Refer to Figure 3 for the LV Control components mentioned in this procedure.

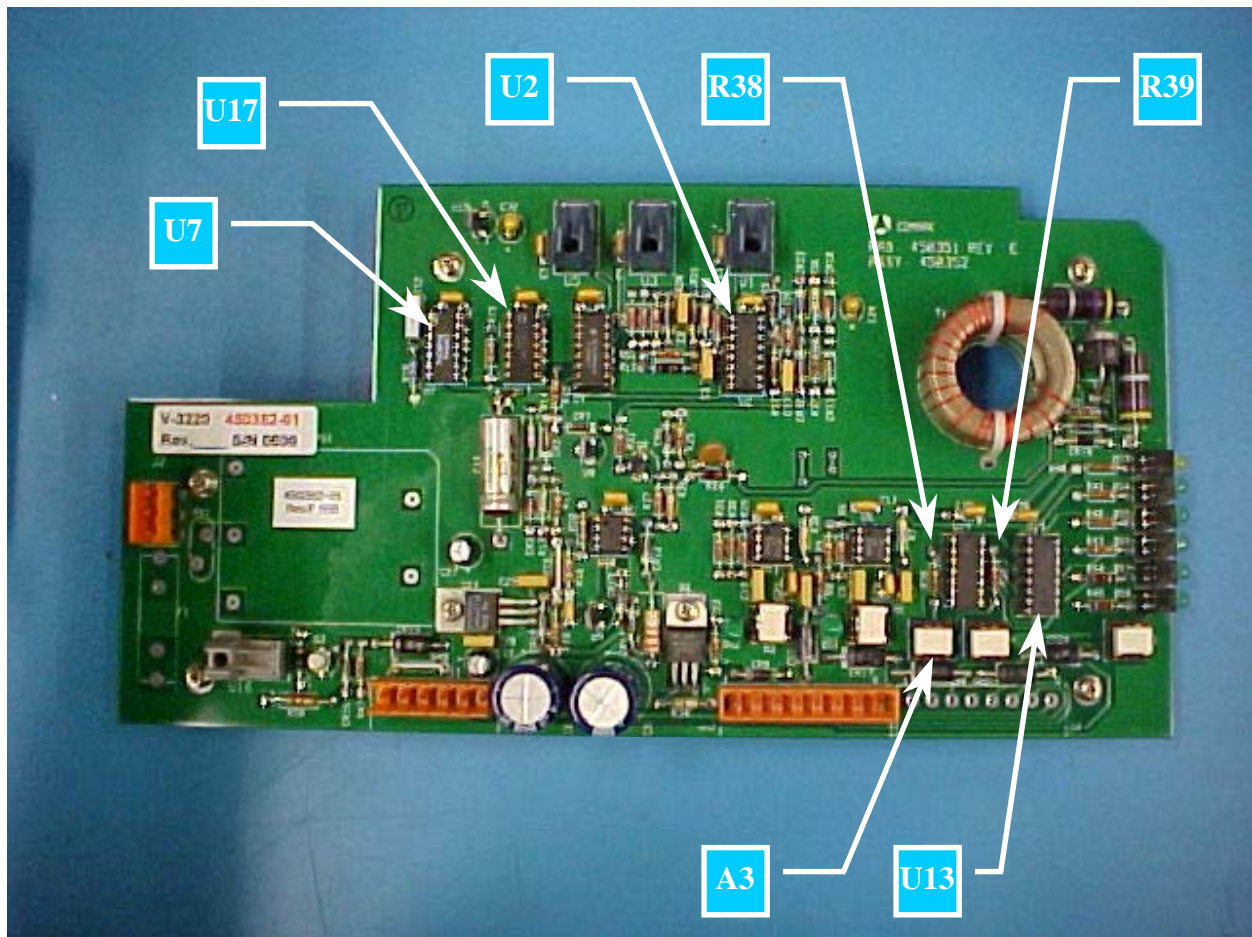


Figure 3: LV Control Board

If only the 'FILAMENT ON' and the 'FILAMENT TIME DELAY' and/or the 'NOT FIRED' lights are out, replace U2 (P/N 701021-01) on the LV control board. If the problem still exists, replace U13 (P/N 601510-01) on the LV control board.

If only the 'FILAMENT TIME DELAY' light is out, replace U7 (P/N 604348-01) on the LV control board. If the problem still exists, replace U17 (P/N 604925-01), and then replace U13 (P/N 601510-01) on the LV control board.

If these efforts should fail to solve the problem, record which lights are out, and return the crowbar to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as 'latch-up', including the lamps that are extinguished.

3.2.6. Troubleshooting when there is No Indication

If all lights are on (with the exception of the 'Filament TD Bypass'), and the crowbar is still not ready, inspect the connection to the control system, J1. A pin not properly seated in this connector can cause the connection to break as plastic connector expands under temperature. This problem can also exist in the intermediate connection on the ceiling of the high voltage compartment. If this does not fix the problem, replace A3 (P/N 603976-01) and U12 (P/N 604703-01) on the low voltage control board.

If it is convenient, swap this assembly with another and see if it solves the problem. If the original HPA continues to exhibit loss of crowbar ready with the new crowbar, the problem is likely in the HPA controller or the wiring between the controller and the crowbar. Contact customer service for assistance.

If the problem follows the crowbar, or it is not convenient to swap, return the crowbar to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as 'Fails to come ready, all indicators normal'.

3.3. DIAGNOSING TEMPERATURE-RELATED LOSS OF READY

3.3.1. Ensure the Crowbar Assembly is at the Latest Revision

There have been circuit changes that correct temperature-related loss of ready issues. Before troubleshooting this problem, upgrade the crowbar to the latest revision. Contact Thales customer service for upgrade parts and instructions.

3.3.2. Find the Temperature-Sensitive Component

If the crowbar is at the latest revision, the problem may lie in one of a few areas. When the ready signal is lost, open the high voltage compartment and see if any of the indicator lights are off.

If the 'Grid 1 I' (current for grid 1) light on the top section of the crowbar is out, check the voltage between grid 1 and the cathode of the thyatron tube. If this voltage is higher than 50Vdc, and the thyatron has been operating for more than 10 minutes, check the filament voltage. If the filament voltage is abnormally high (above 6.7V), it may be possible the thyatron's filament is open. If the grid voltage is below 50Vdc, replace A1 (P/N 603976-01) on the HV control board. This opto-coupler can be temperature sensitive.

If the lights on the top section of the crowbar are all on, but the 'Bias Ready' light on the lower section is out, check the fiber optic cable between U8 on the high voltage control board and U3 on the low voltage control board. The fiber should be flush with the end of the plastic connector on both ends of the cable. If it is not, thermal expansion of the plastic connector can increase the gap between the fiber and the optical port beyond a critical point and interrupt the signal. If the fiber is not flush, replace the cable (P/N 604917-01). Likewise, if the 'Filament On' or 'Not Triggered' lights are out on the lower section, a fiber optic cable can be the problem.

If all lights are illuminated (with the exception of the 'Filament TD Bypass'), and the crowbar is still not ready, inspect the connection to the control system, J1. A pin not properly seated in this connector can cause the connection to break as plastic connector expands under temperature. This problem can also exist in the intermediate connection on the ceiling of the high voltage compartment. If this does not fix the problem, replace A3 (P/N 603976-01) on the low voltage control board. This opto-coupler can be temperature sensitive.

If it is convenient, swap this assembly with another and see if it solves the problem. If the original HPA continues to exhibit loss of crowbar ready with the new crowbar, the problem is likely in the HPA controller or the wiring between the controller and the crowbar. Contact customer service for assistance.

If the problem follows the crowbar, or it is not convenient to swap, return the crowbar to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as 'Temperature-sensitive loss of ready'.

3.4. DIAGNOSING HIGH VOLTAGE RELATED LOSS OF READY

If the crowbar loses ready when high voltage is applied, but does not actually fire, remove the crowbar and check the routing of the high voltage wire from the secondary of the isolation transformer. If these wires touch the low voltage control board, or are within roughly a half-inch of the board, the electrical field of the wire can affect the control circuitry. If this is the case, tie the wire back from the low voltage board by securing them to the transformer's mounting stud with a tie-wrap.

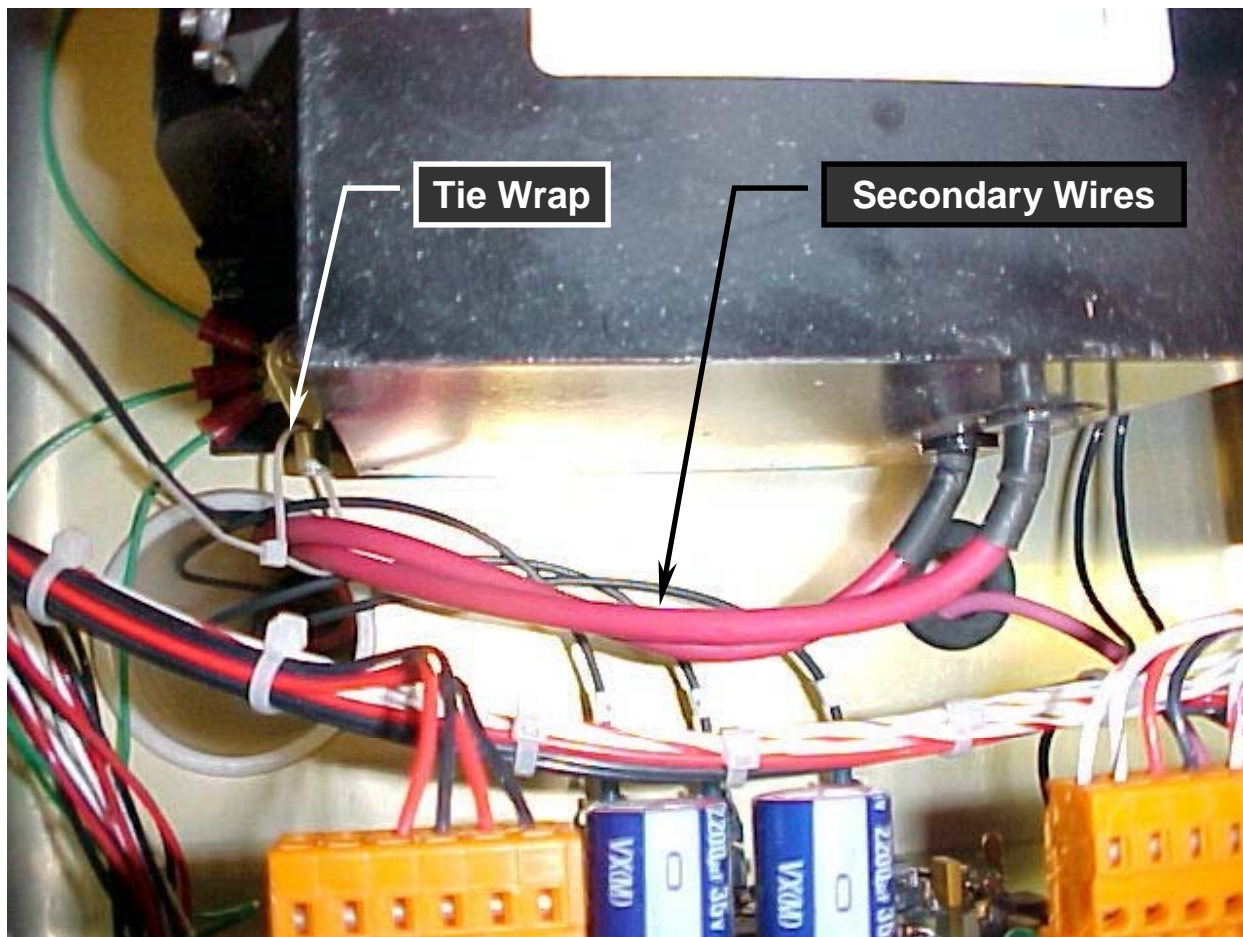


Figure 4: Transformer Secondary Wire Routing

3.5. DIAGNOSING POWER LOSS RELATED LOSS OF READY

If the crowbar loses ready for ten minutes after a brief power interruption (less than 15 seconds), it is an indication that the bypass timer has failed. If this is the case, replace the low voltage control board.

4. FAILS TO TEST TRIGGER

4.1. SYMPTOMS

No reaction in the crowbar when the test button is pressed may indicate a failure in the test trigger. A failure in the test trigger circuit does not affect the ability of the system to react to normal arc events. The best test to determine if the test trigger is working is to place the HPA into diagnostic mode and press the crowbar test button. If there is no reaction by the HPA then the test function is not working. A typical reaction to a test trigger is for the beam supply to shut off, provided the unit is in diagnostic and beam mode. A minimal reaction to a test trigger is the toggling of the triggered lamp on the HPA controller front panel.

4.2. DIAGNOSIS

The easiest thing to check when the crowbar fails to test trigger is the fiber optic cable that sends the test signal from the low voltage control board to the high voltage board. Check the fiber optic cable between U16 on the low voltage control board and U2 on the high voltage control board. The fiber should be flush with the end of the plastic connector on both ends of the cable. If it is not, thermal expansion of the plastic connector can increase the gap between the fiber and the optical port beyond a critical point and interrupt the signal. If the fiber is not flush, replace the cable (P/N 604917-01).

If the cable is fine, and it is convenient, swap this assembly with another and see if it solves the problem. If the original HPA still fails to test trigger with the new crowbar, the problem is likely in the HPA controller or the wiring between the controller and the crowbar. Contact customer service for assistance.

If the problem follows the crowbar, or it is not convenient to swap, return the crowbar to Thales for servicing. Make sure that both the repair tag and RA paper work are clearly marked as 'Fails to test trigger'.

5. OTHER PROBLEMS**5.1. HPA CONTROLLER DOES NOT SHOW CROWBAR EVENT OR INCREMENT COUNTER**

If the HPA will not show a crowbar-fired event or increment the crowbar counter when there is an actual event, try powering down HPA controller and rebooting. If this does not fix the issue, swap the CPU card in the controller.

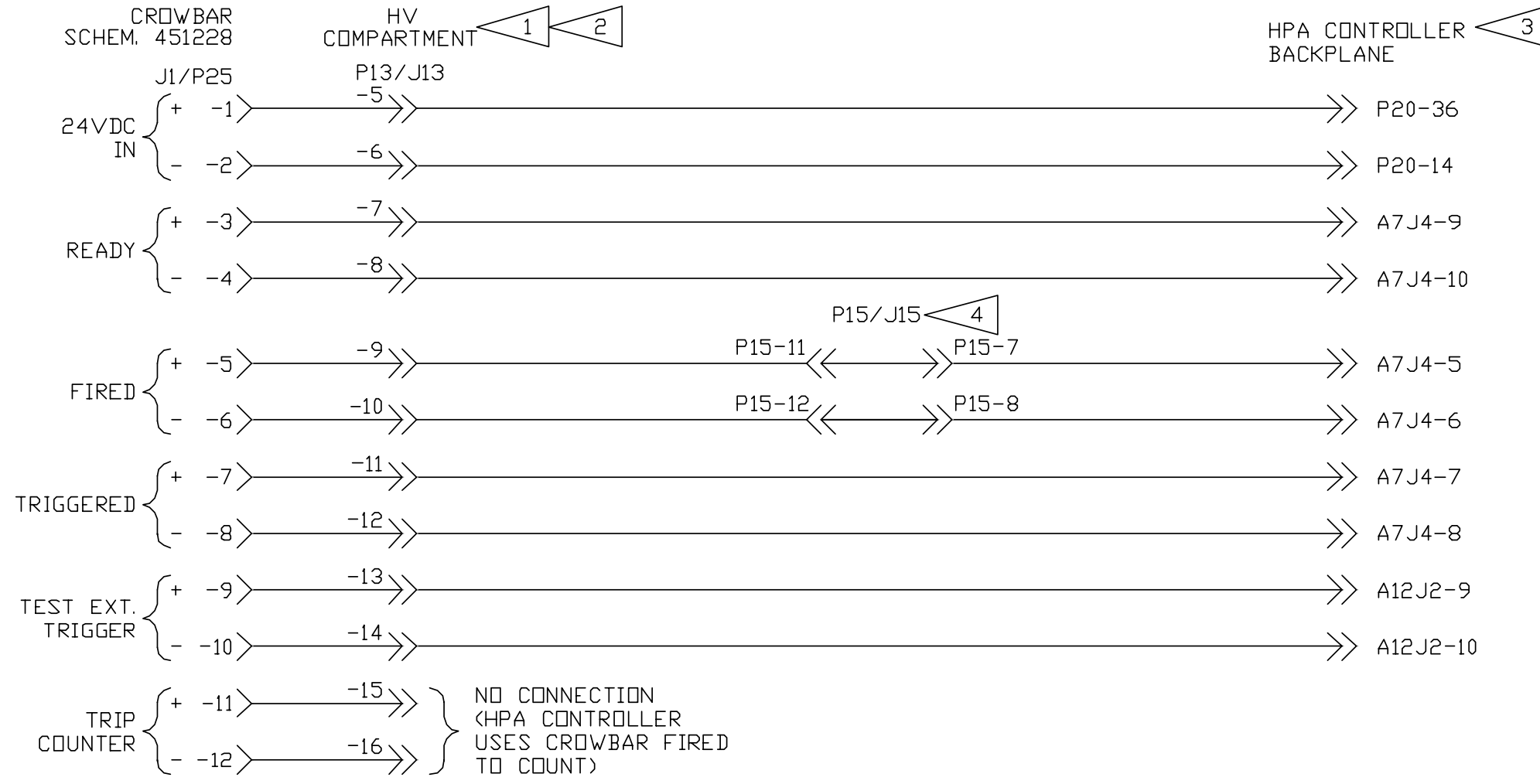
5.2. CROWBAR COMES READY IN LESS THAN TEN MINUTES

If the crowbar comes ready in less than ten minutes, the HPA may have the wrong version of the crowbar. Look at the serial number tag on the front of the lower section, as shown in Figure 5. For IOX and DCX cabinets, the part number on this tag should be 451227-01. Replace the crowbar if the tag is marked 451227-02, it is the wrong version. The 451227-02 version is for Advantage cabinets only.



Figure 5: Front View of Crowbar Showing Serial Number Tag.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ENGINEERING RELEASE	5-4-06	RLC



NOTES:

- 1 IOX/DCX1 SCHEMATIC = 452449
MILLENNIUM SCHEMATIC = 452867
- 2 IOX SCHEMATIC = 451190
DCX1 SCHEMATIC = 452514
MILLENNIUM SCHEMATIC = 46745477-030
- 3 IOX/DCX1 SCHEMATIC = 451186
MILLENNIUM SCHEMATIC = 46745507-030
- 4 JUMPERS IN STEP-START PANEL
SCHEMATIC = 451206

NO CONNECTION
(HPA CONTROLLER
USES CROWBAR FIRED
TO COUNT)

QTY/VERSION	ITEM NO.	PART NO.	DESCRIPTION
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	MATERIAL	~	DRWN	G.DELCAMPD	4-26-06
	FINISH	~	CHKD	MAGDYCZ	4-26-06
	CAD FILE #	453346A1	ENGR	R.COLE	5-4-06
	MANUAL DWG #	~	ENGR		
	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		APPD		
	TOLERANCES ~		APPD	D.TOUGAS	5-4-06
	FRACTIONS		REMOVE BURRS AND SHARP EDGES		
	2 PLACE DECIMALS		YES <input type="checkbox"/> NO <input type="checkbox"/>		
	3 PLACE DECIMALS				
	ANGLES				
	IOX/DCX		SIZE	CODE IDENT	DRAWING NO.
	NEXT ASS'Y.	USED ON	B		453346
	APPLICATION		SCALE	NONE	JOB No.

THALES BROADCAST & MULTIMEDIA INC.
SOUTHWICK, MASSACHUSETTS

SCHEMATIC, CROWBAR TO
HPA CONTROLLER BACKPLANE STATUS

REV. A

SHEET 1 OF 1

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