

Technical Service Bulletin 031208
IOT Operational Adjustments: DCX Paragon
(Filament, Bias, Ion, Focus, Beam)

Procedure 031208: IOT Operational Adjustments (Filaments, Bias / Idle, Ion, Focus, Beam)	
Applicability	DCX Paragon transmitters.
Prerequisites	Filament, Bias, Ion sensors calibrated (031211). Focus sensors calibrated (040108). Beam sensors calibrated (040112).
Equipment Required	None.
Comments	Incorrect filament voltage will cause negative grid current (too high) or poor peak signal linearity performance (too low). Filaments and beam voltage must be adjusted before bias voltage / idle current. Incorrect focus current will lower efficiency and may damage tube. Focus current must be readjusted whenever beam voltage is changed. Insufficient beam voltage will cause excessive peak compression and difficulty meeting spectral emission mask.

Filament Adjustment

The correct IOT filament setting varies from unit to unit and is typically specified by the IOT manufacturer on the data sheet provided with the tube. Certain IOT manufacturers specify a certain operating voltage, while others specify a certain operating current.

As with any electron tube, it is a customary practice to slightly reduce IOT filament voltage/current to prolong tube life. Additionally, it is often necessary to reduce the filament voltage/current of a recently installed IOT during its first few months of operation to prevent negative grid current.

An IOT with excessive filament voltage/current will draw an excessive negative grid current. This is a sign that the filaments are too hot and emissive material is boiling off the cathode and landing on the grid, thereby causing it to emit electrons also. An IOT drawing more than -20mA negative grid current should have its filament voltage/current lowered as soon as conveniently possible.

An IOT with insufficient filament voltage/current will experience excessive peak signal compression. For a digital RF signal, this translates to an increase in adjacent channel sideband levels that are difficult to eliminate by nonlinear (LUT) precorrection (...because they are due to a lowered amplifier saturation power level).

Filament management, therefore, consists of always keeping filament voltage/current low enough to prevent excessive negative grid current and lowering the filament voltage/current, as desired, to prolong tube life until a point is reached where uncorrectable adjacent channel sideband levels are unacceptable.

The reader is invited to contact their tube manufacturer to obtain an official filament management procedure.

For tube types specifying IOT filament voltage. (E2V, L3)

1. Press **Meter Select** on HPA control panel until **Filament** meters are selected.
2. Access filament voltage adjustment menu by issuing following commands via HPA control panel: **Information Access > Adjustments > Filament, Bias, Ion > Filament > Filament Voltage**. Default technician password is 4444
3. Use **Up** and **Down** menu options to adjust filament voltage until manufacturer's recommended voltage reading is obtained on display.
4. Once proper voltage is obtained, press **Save** button to save filament voltage setting and return to previous menu.
5. If filament voltage does not achieve full desired voltage, verify that filament supply output is not being limited by programmed current setting. Access filament current setting via following sequence of buttons on LCD screen: **Filament, Bias, Ion > Filament > Filament Current**.

NOTE: The type 46745361 FBI supply will regulate to either the programmed current or voltage setting -- whichever is lower. Accordingly, the filament current setting should be set to maximum (30A) for those tubes designed to operate at a specified voltage. Conversely, the voltage setting should be set to maximum (9V) for those tubes designed to operate at a specific filament current.

6. Procedure complete.

For tube types specifying IOT filament current. (Thales TED, CPI)

1. Press **Meter Select** on HPA control panel until **Filament** meters are selected.
2. Access filament current adjustment menu by issuing following commands via HPA control panel: **Information Access > Adjustments > Filament, Bias, Ion > Filament > Filament Current**. Default technician password is 4444.
3. Use **Up** and **Down** menu options to adjust filament current until manufacturer's recommended current reading is obtained on display.
4. Once proper current is obtained, press **Save** button to save filament current setting and return to previous menu.
5. If filament current does not achieve full desired current level, verify that filament supply output is not being limited by programmed voltage setting. Access filament voltage setting via following sequence of buttons on LCD screen: **Filament, Bias, Ion > Filament > Filament Voltage**.

NOTE: The type 46745361 FBI supply will regulate to either the programmed current or voltage setting -- whichever is lower. Accordingly, the filament current setting should be set to maximum (30A) for those tubes designed to operate at a specified voltage. Conversely, the voltage setting should be set to maximum (9V) for those tubes designed to operate at a specific filament current.

6. Procedure complete.

Bias Voltage / Idle Current Adjustment

The bias voltage / idle current setting has a profound impact on IOT transfer curve linearity. If the transmitter shows signs of poor linearity and/or intermodulation performance (increase in adjacent channel sidebands), first verify that the idle current is at the correct level before attempting any readjustment of the exciter precorrection programming. It is normal for the bias point (bias volts for a given idle current) to shift gradually as a tube ages. A rapid change in bias point may signal internal damage to the tube.

1. Place amplifier in BEAM mode.
2. Press **Meter Select** on HPA control panel until **Beam** meters are selected.
3. Observe idle current on beam current meter. Idle current is the resting (or quiescent) beam current remaining when RF drive is extinguished.
7. Access bias voltage adjustment menu by issuing following commands via HPA control panel: **Information Access > Adjustments > Filament, Bias, Ion > Bias Voltage**. Default technician password is 4444.
4. Use **Up** and **Down** menu options to change bias voltage level until satisfactory idle current level is observed on beam current meter. Consult original readings from transmitter proof of performance for exact desired idle current level.
5. Press **Save** button to save bias voltage adjustment and return to previous menu.
6. Procedure complete.

Ion Voltage Adjustment

The performance of the ion pump is relatively insensitive to changes in the ion voltage setting. The ion pump will function satisfactorily with any voltage between 3kV and 4 kV, with 3.5kV being a typical target setting.

1. Using meter select button on bottom Paragon meter panel, select **Ion**. Observe ion voltage on ion voltage meter.
8. Access ion voltage adjustment menu by issuing following commands via HPA control panel: **Information Access > Adjustments > Filament, Bias, Ion > Ion Voltage**. Default technician password is 4444.

2. Use **Up** and **Down** menu options to change bias voltage level until satisfactory ion voltage level is observed on the meter. A typical ion voltage level is 3.5kV. Consult original readings from transmitter proof of performance for exact desired ion voltage.
3. Press **Save** button to save ion voltage setting and return to previous menu.
4. Procedure complete.

Focus Current Adjustment

The level of focus current determines the strength of the magnetic focusing field produced by the focus coils on the IOT magnet cart assembly. The focus field counteracts the mutual repulsion of the beam electrons and prevents the beam from prematurely spreading and striking the grounded body of the tube -- a source of potential internal damage. Additionally, the degree of beam confinement will affect the ratio at which the beam electrons strike the various collector electrodes at the end of their trajectory. Since collection of the beam at the most negative collector electrodes returns the most energy to the beam supply, the tube efficiency is increased slightly as the collector current distribution skews towards the higher numbered electrodes. The essence of the focus current adjustment, therefore, is to start with the suggested current level provided by the IOT manufacturer and find tune the adjustment to maximize the collector current level at the highest electrodes.

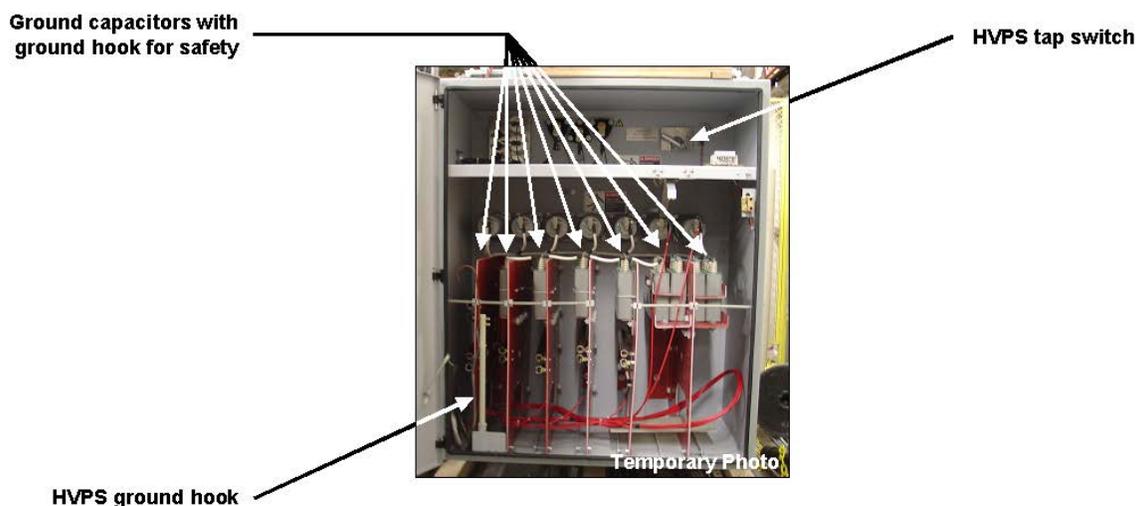
1. Place amplifier cabinet in **STANDBY** mode.
2. Access focus current adjustment menu by issuing following commands via HPA control panel: **Information Access > Adjustments > Focus Current**. Default Technician password is 4444.
3. Use **Up** and **Down** menu options to adjust focus current until desired reading is obtained on display. Consult IOT manufacturer's data sheet for desired focus current setting.
4. When proper current is obtained, press **Save** button to save focus current setting and return to previous menu.
5. OPTIONAL STEP: While HPA is in RF mode, focus current adjustment menu will feature a bar graph display of collector currents 1 through 5. Use **Up** and **Down** menu options to maximize currents of highest numbered collectors while minimizing current of lowest numbered collectors. Final focus current setting should ideally deviate no more than +/- 1A from manufacturer's data sheet value from previous step.
6. Procedure complete.

Beam Voltage Adjustment

The beam voltage adjustment has a significant effect on the peak signal linearity of the IOT. Like more traditional amplifiers, the beam voltage determines the maximum possible output voltage swing and saturation level of the IOT amplifier i.e. the "voltage rail". The output saturation level, in turn, determines the amount of residual (uncorrectable) IMD sidebands present after linearity precorrection is applied in the exciter. Difficulty in achieving the output spectral mask may require that beam voltage be raised as a last resort. This step should only be taken after the power calibrations, filament settings, beam sensors, output tuning, and exciter integrity have all been verified.

Note that for a given output voltage swing, the maximum peak output power level may also be increased by lowering the output cavity impedance in the form of wider bandwidth tuning. This increases the tube saturation level at the expense of lower gain (higher IPA drive power).

1. Place amplifier cabinet in **STANDBY** mode.
2. Place HVPS breaker (CB4) on AC distribution panel in OFF position as a safety precaution.
3. Actuate keys and ground switch to obtain HV ENCLOSURE ACCESS key from key interlock system.
4. Place 480 VAC safety disconnect to high voltage power supply (HVPS) in OFF position. Lock and tag out safety disconnect as appropriate.
5. Use BEAM SUPPLY key and flathead screwdriver to open front door of HVPS.
6. Ground all high voltage points in HVPS enclosure with HVPS grounding hook as a safety precaution. Consult grounding instructions supplied by HVPS manufacturer (placard on unit).



WARNING: High voltage stored energy may be present in HVPS capacitors even after removal of mains power. Accidental contact may cause serious injury or death. Carefully ground all high voltage points per manufacturer's instructions before proceeding.

7. Locate primary tap switch in upper portion of HVPS enclosure.
8. Unscrew fixing bolt on tap switch and move switch to desired setting. Tighten fixing screw to ensure tap switch is correctly seated on desired setting. For a nominal 480 VAC input, collector voltages should be approximately as follows:

Collector	Tap 1	Tap 2	Tap 3	Tap 4	Tap 5	% Depressed
5	30.0	32.0	34.0	36.0	38.0	0.0 %
4	22.1	23.5	25.0	26.5	28.0	73.6 %
3	15.9	16.9	18.0	19.0	20.1	52.9 %
2	13.2	14.1	14.9	15.8	16.7	43.9 %
1	7.1	7.5	8.0	8.5	9.0	23.6 %

NOTE: it is normal for HVPS output voltages to read up to 2kV higher when HVPS is unloaded (HPA in BEAM mode).

9. Take advantage of opportunity to visually inspect HVPS enclosure for signs of oil leaks, bulging capacitors, deteriorating insulators, dust accumulation, or other important maintenance items.
10. Close front door to HVPS.
11. Return 480 VAC safety disconnect and HVPS breaker CB4 to their ON positions.
12. Return key interlock system to original position.
13. Return amplifier cabinet to RF mode to observe change to beam voltage level.
14. Procedure complete.

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