TELEMARK

TT CHEETAH SERIES
ELECTRON BEAM POWER SUPPLY

INSTRUCTION MANUAL

CE

March 2018

telemark.com

Current version of this manual can be found at
https://telemark.com/e-beam-power-supplies/tetrode-tube/

WARRANTY

The TT Electron Beam Power Supply is guaranteed against faulty materials, function and workmanship for a period of 12 months after shipment from the Telemark factory. Components which are purchased by Telemark from other manufacturers will be guaranteed for any lesser time that such manufacturer warrants its products to Telemark. This warranty is valid only for normal use where regular maintenance is performed as instructed. This warranty shall not apply if repair has been performed or alterations made by anyone other than authorized Telemark service representatives, or if a malfunction or damage occurs through abuse, misuse, negligence or accident. No charge will be made for repairs made under warranty at a Telemark service facility. Freight costs both ways will be at customer's expense. Telemark reserves the right to determine if the malfunction was caused by faulty materials or workmanship.

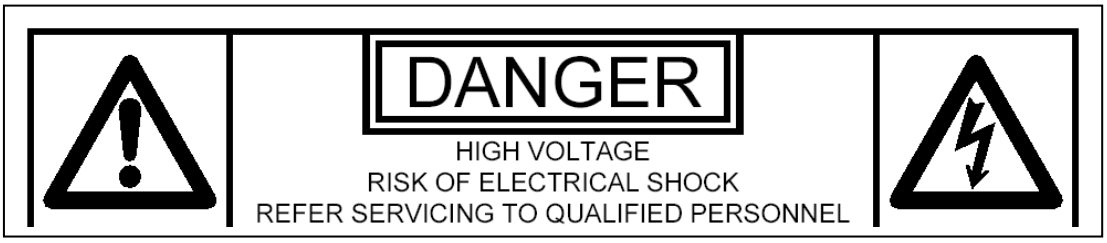
USER RESPONSIBILITY

The user is responsible for proper operation and ordinary maintenance of the equipment, following procedures described in this manual, including reference documents. Proper operation includes timely replacement of parts that are missing, broken or plainly worn. If the user has a reasonable doubt about understanding the use or installation of a component, Telemark Technical Service should be contacted.

It is vitally important that the user properly install the equipment as described in Chapter 4 (Installation) of this manual. **The warranty will be void if the equipment is improperly installed and/or improperly grounded.**

Alteration of the design or any function of the equipment voids the warranty and is entirely the responsibility of the user.

SAFETY WARNINGS



This power supply operates at a high enough voltage and possesses sufficient stored energy to be capable of killing a human.

DO NOT TAKE SAFETY FOR GRANTED

Pay strict attention to safety information and warnings in this manual.

This power supply produces extremely high voltages. DO NOT attempt to adjust any load connection with high voltage on. DO NOT attempt to open the power supply enclosure unless the manual has been thoroughly reviewed and the internal layout is understood. Never reach into the enclosure unless the power has been disconnected and the output is fully discharged. Be certain of safety ground connections.

Assuming that high voltage is always ON is the best way to avoid hazard to personnel. Always shut off the supply circuit breaker(s) and follow an appropriate grounding procedure to discharge the output before touching any exposed connections.

DO NOT rely on the power supply's instrumentation or controls to determine that the output is safely discharged. The sensors are driven by amplifiers, which are powered by an internal low voltage power supply, as are the indicator LEDs. There may be dangerous voltages present on the output, even if the unit appears "dead".

The high voltage output is automatically discharged internally when HV is turned off. Although redundancy is designed into the discharge circuit, in the unlikely event of component failure the output may remain charged long after power is disconnected if not manually discharged!

DO NOT allow anyone who has not reviewed the manual to perform any part of the installation process or to attempt servicing of the power supply. Any questions must be brought to the attention of Telemark's service personnel.

DO NOT obstruct the cooling inlets or outlets. Overheating can result, which may damage the power supply.

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1

UNPACKING

Remove the High Voltage Power Supply (HVPS) and Controller from their crate/carton(s), but do not discard the packing materials; retain the packing materials and carton in case the unit needs to be returned.

Inspect the unit for dents or other damage, which may have occurred during shipping. In the unusual event that shipment damage has occurred, contact the transportation company and Telemark immediately.

The additional material enclosed in the shipping boxes (such as cables etc.) should be inspected as well. Put them aside and DO NOT proceed until this instruction manual has been thoroughly reviewed. After completely unpacking the boxes, you should have the following items: (see also packing list)

1. High Voltage Module
2. Control Module
3. Filament Transformer Box
4. Cable 25pin Sub-D, M-F
5. Cable 9pin Sub-D, M-F
6. HV Coax Cable RG213
7. Filament Power Cable, Hirschmann 3pin, M-F, grey
8. Sweep Power Cable, Hirschmann 2 pin, M-EURO/IEC
9. EMO Connector, Hirschmann 2 pin M
10. HV Cable Set, dual red filament cable, 42" (1m)
11. 15pin Sub-D Connector, M
12. Connector Shell Sub-D 15
13. 37pin Sub-D Connector, M
14. Connector Shell Sub-D 37
15. 2 ea. Strain Relief 3/4" NPT
16. Power Connector Shell, AMP } TT-
17. Cable Clamp for Power Connector, AMP } 3/6/8
18. 5 ea. Crimp Pins for Power Connector, AMP } only

2

GENERAL DESCRIPTION

The TT series of Electron Beam Source Power Supplies are compatible with electron beam sources which use electro-magnetic deflection or a combination of permanent magnet deflection and electro-magnetic focusing.

This High Voltage Power Supply (HVPS) incorporates the latest in fast response Tetrode Tube high voltage regulation and switching technology. Each unit is packaged in a single, 19" rack-mountable chassis (TT-3/6/8) or a stand-alone cabinet on casters (TT-10/15/20) with approximate dimensions as below. Approximately 2" (50mm) are additionally required behind the rack mount chassis for connections.

TT-3: W 19" (483mm) x D 22" (560mm) x H 10.5" (267mm) [6U]

TT-6: W 19" (483mm) x D 25" (635mm) x H 14" (356mm) [8U]

TT-8: W 19" (483mm) x D 29" (740mm) x H 15.75" (400mm) [9U]

TT-10/15/20: W 23" (585mm) x D 27.5" (700mm) x H 35" (890mm)

Operation of the HVPS requires connection to its controller unit, which is housed in a separate 19" chassis 1U high (1.75" or 44,5mm). The Controller permits operation of the HVPS both locally and remotely, while providing visual status indications.

The TT-3/6/8 power supplies will operate only one electron beam source at a time, but multiple supplies may be utilized to operate two or more sources.

The TT-10/15/20 can operate up to three electron beam sources simultaneously (optional).

A series of system safety interlocks are available to protect both operator and the equipment.

3

SPECIFICATIONS

Parameter	TT-3 CE	TT-6 CE 208 VAC	TT-6 CE 400 VAC	TT-8 CE 208 VAC	TT-8 CE 400 VAC
Line Voltage *	208/230VAC	208VAC	400VAC	208VAC	400VAC
Line Frequency	50/60Hz	60Hz	50/60Hz	60Hz	50/60Hz
Line Current	35A	35A	23A	42A	30A
Output Voltage	-5 to -7kV	-6 to -8kV	-6 to -8kV	-6 to -10kV	6- to -10kV
Max Output Ripple	1.5%rms	1.2%rms	1.2%rms	1%rms	1%rms
Voltage Regulation	0.5%	0.3%	0.25%	0.25%	0.25%
Emission Current	500mA	750mA	750mA	800mA	800mA
Filament Current	40A	40A	40A	40A	40A
Parameter	**TT-10 CE 208 VAC**	**TT-10 CE 400 VAC**	**TT-15 CE 208 VAC**	**TT-15 CE 400 VAC**	**TT-20 CE 400 VAC**
Line Voltage *	208VAC	400VAC	208VAC	400VAC	400VAC
Line Frequency	60Hz	50/60Hz	60Hz	50/60Hz	50/60Hz
Line Current	60A	35A	73A	42A	50A
Output Voltage	-4 to -10kV	-4 to -10kV	-4 to -10kV	-4 to -10kV	-4 to -12kV
Max Output Ripple	1%rms	1%rms	1%rms	1%rms	1%rms
Voltage Regulation	0.25%	0.25%	0.25%	0.25%	0.25%
Emission Current	1000mA	1000mA	1500mA	1500mA	1700mA
Filament Current	50A	50A	50A	50A	50A

*) Line voltages +/-5% – Other line voltages on request – TT-3 is single phase, all others are 3 phase

Specifications subject to change without notice

NOTE: Above specified line currents are average maximum currents at full load. Current rating and response curves of circuit breakers (fuses) in the power feed line must allow for some extra current and time delay to deal with inrush / initial surge currents from the HV transformer when it is turned on.

The TT-8/10/15/20 are equipped with a "soft start" feature to eliminate excessive initial surge currents from their large HV transformers.

It is considered good practice to select slow blow circuit breakers (fuses) with at least one step up in current rating (e.g. +5A). Line feed cable size must be chosen accordingly.

4

INSTALLATION

Introduction

The TT-3/6/8 Electron Beam Source Power Supply is designed to be mounted in a standard 19 inch electronic instrument rack. Any suitable place on a vacuum system with a standard 19 inch opening may be used.
The TT-10/15/20 Electron Beam Source Power Supply is designed in a stand-alone cabinet on casters and can be placed in any free space conveniently close to the vacuum system.

The control module could, for example, be set directly on a system cabinet top for easy access or be mounted in a 19 inch electronic instrument rack. The installation procedures are described below.

Figure 4-A HVPS Front Panel (TT-8 shown, with Controller)

Figure 4-B HVPS Front Panel (TT-10 shown, with Controller and Sweep)

Mechanical

The High Voltage module (HVPS) of the TT-3/6/8 must be placed in a level 19 inch rack or other suitable cabinet that is capable of supporting a minimum of the following weights.

TT-3: 100 lbs (45 kg)

TT-6: 200 lbs (90 kg)

TT-8: 300 lbs (135 kg)

The HVPS must be secured in the cabinet before electrical connections are made.

System Grounding Practice

A good ground is necessary to assure safe and proper operation of the power supply (see page 15, #1. and section 7, Figures 8-A through 8-E).

Grounding

Proper grounding is the single most important aspect of the installation of the E-beam. During arcing events, RF noise is generated that must be properly driven to ground to avoid interference/damage. For this reason, the E-beam ground must be separate from the electronics rack ground and ideally as short as possible. Improper grounding can lead to poor performance, interference with other equipment, damage to E-beam electronics or other equipment, or even shock potential.

Do not depend on water pipes for the system ground connection. Because of multiple joints and sealing compounds, water pipes typically do not make an earth ground. Keep in mind this is a high frequency as well as a DC ground.

Regardless of the method of grounding, the first point of connection for the ground cable/strap is always the E-beam chamber. There should be a specially designed ground bar welded to the chamber for this purpose. The strap, if used, should be "sandwiched" between two bars to ensure a broad area connection.

Connecting to Building Steel

The best method known for grounding the E-beam is to tie the ground bar to building steel as close as possible using the appropriate grounding strap (varies based on the distance - see details below). One must verify that the building steel has a good connection to ground for this to be a viable solution. Be sure to remove any paint, rust, etc from under the connection point to the building steel.

Because the connection is for an RF ground, surface area is more important than cross-sectional area. It is critical to have a wide surface area of connection between the grounding strap and the building steel.

Distance Between E-Beam Chamber and Grounding Point	**Minimum Recommended Strap/Cable**
< 10 Feet « 3 meters)	#6 Gauge or larger gauge copper cable
10-20 Feet (3-6 meters)	#4 Gauge or larger gauge copper cable
20-60 Feet (6-18 meters)	2 inch by .035 inch thick copper strap
> 60 Feet (> 18 meters)	Contact Telemark for recommendations

Table 4-1: Ground Strap Size

When in doubt, always go with the larger ground connection. You can never have too good of a connection!

Do not use braided wire. Be sure that the connection is made to clean metal.

The power supply is connected to ground using the HV cable's shield connection. The power supply may sustain major damage if power is applied before the ground is connected.

High Voltage

Use decals or other warning labels on the high voltage shield, at the front of the E-beam chamber and on the door to the room to provide warning that lethal voltages are present. Do not put any part of the body under a chamber while a source is running. Always use a grounding hook as a matter of habit before touching any potentially high voltage area, even when power supply is off. Always keep one hand in a pocket. Always maintain a respectful fear of high voltages: familiarity does not make high voltages safe.

Ground Connections

In addition to the critical building (earth) ground described above, there are 6 other ground leads that will attached to the ground bar on the E-beam chamber:

1. Source Transformer Box - connected using 6 AWG gauge wire
2. E-beam power supply - connected using 6 AWG wire
3. Safety cover over high voltage feedthrus - connected using 12 AWG gauge wire
4. Sweep controller - connected using 12 AWG gauge wire
5. TT-Controller - connected using 12 AWG gauge wire
6. Sweep cable ground connection - connected using 12 AWG gauge wire

There is not a required order for the above; simply connect each ground lead securely to an open ground lug location on the ground bar. Ensure connections are secure prior to turning on the power to the E-beam. Operating without one or more grounds properly connected may cause damage to equipment or even harm to the operator.

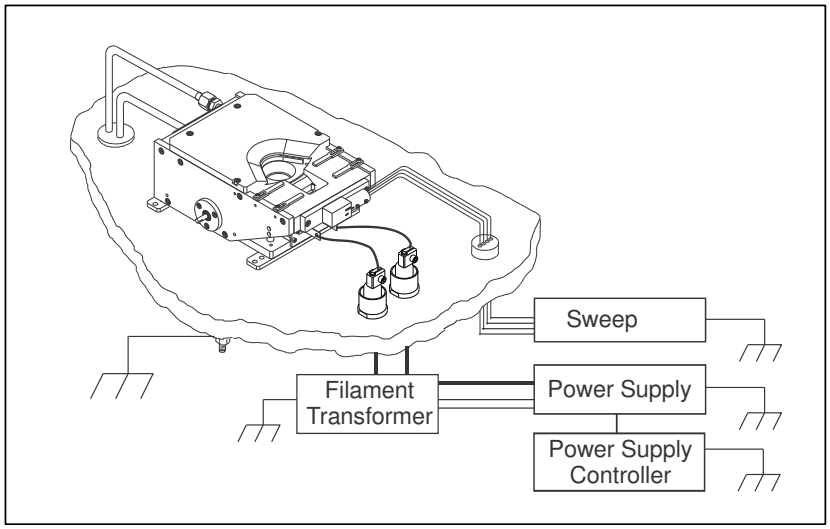


Figure 4-C Suggested Ground Installation

Interlock Connections

It is extremely important for operator and equipment safety that the external interlocks are appropriately installed (see page 20 and section 7, Figures 8-A through 8-E).

Symbol Definitions

Protective Conductor Terminal

Indicates where to connect safety ground conductor for AC line source and system ground.

Caution: Risk of Electric Shock

Indicates that high voltages, capable of causing injury, are present on the output connector.

Caution: Refer to Manual for Further Instructions

Directs user to manual for further detailed instructions on installation and operation.

CAUTION!!!

The instrument rack (for TT-3/6/8) must not block air passages located on the unit's front and rear panels. Fans in the lower center of the rear panel pull in air for the power tube and fans in the upper corners extract air from the unit. Allow for ample clearance for adequate air flow. The rear of the instrument rack in the area of the HVPS MUST NOT be closed in order not to obstruct air flow to/from the fans.

The HVPS cabinet (TT-10/15/20) must be placed in such a way that neither the air intake at the front panel, nor the air intakes and exhausts by the fans on the rear panel are obstructed. Ample clearance (at least 20 inches or 500mm) must be kept from both front and rear panel.

Power Tube Installation

The TT-3 and TT-6 are equipped with an indirectly heated oxide cathode power tetrode that can be left in the power supply during shipping.

These power supplies do have the tube already properly installed.

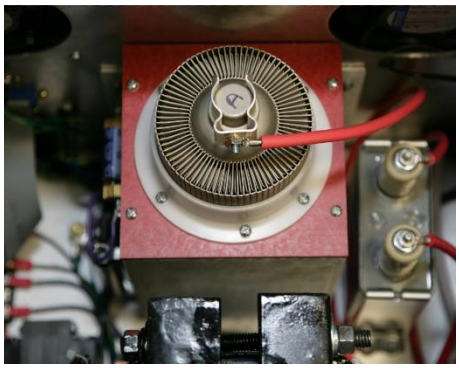


Figure 4-D Power Tetrode installed in TT-6

The TT-8/10/15/20 are equipped with a directly heated power beam tetrode that requires separate shipping in a dedicated container to avoid damage.

These tubes need to be installed in the power supply prior to installation and start-up of the HVPS.

Open the top cover of the HVPS chassis (TT-10/15/20 requires disconnecting of the ground wire to the top cover). Locate the tube socket (concentric silver plated contact rings in a grey air guiding chimney).

Carefully remove the power tetrode from its shipping container and its protective bag. Set it loosely into the socket from top, straight and centered. The tube for the TT-8 now sits with about ½" (12mm) clearance from the heat sink to the air chimney, whereas the tubes for the TT-10/15/20 come with two marking lines. The lower line indicates the position in the chimney when loosely sitting on top of the socket, the upper one the fully inserted position.

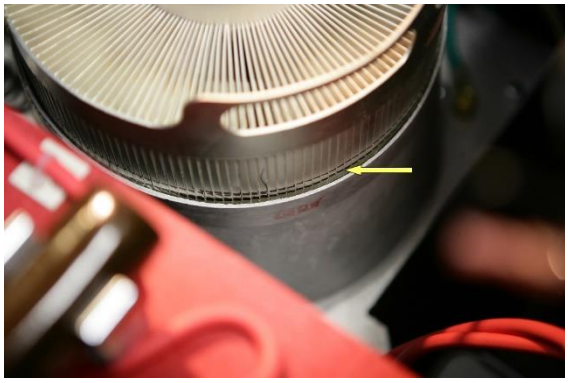
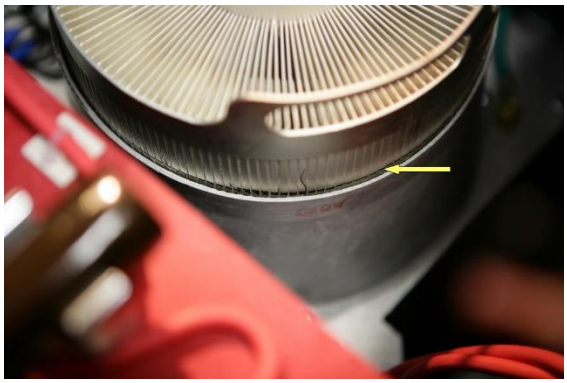


Figure 4-E TT-10/15/20 Tube sitting loosely on Socket

Insert the tube into its socket by firmly pushing it down straight and level until feeling a solid stop. This may require some force and a slight wiggle. Do not twist! Check for the proper position of the tube to make sure it is fully engaged in the socket.



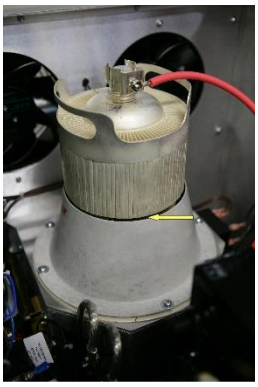


Figure 4-F Tube fully inserted into Socket, left TT-10/15/20, right TT-8 (~ ¼" or 6mm gap)

Proper seating of the tube in its socket is essential for good current transfer for the heater filament (75A for TT-8, 160A for TT-10/15/20 !!!), preventing the socket contact rings from overheating and eventually burning out.

Make the anode connection with the red high voltage wire by attaching the contact clip to the anode hub on top of the tube's heat sink.

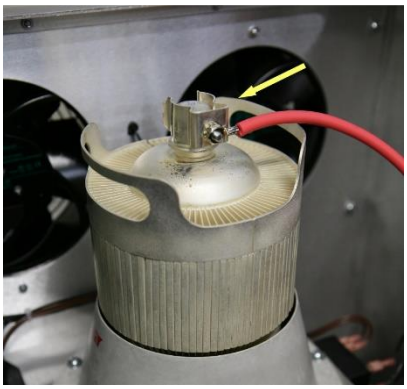


Figure 4-G Anode Connection clipped to power tube, left TT-10/15/20, right TT-8

This completes the installation of the power tetrode.

Close the top cover of the HVPS (do not forget to put back the ground connection to the top cover in the TT-10/15/20).

Input Voltage Selection

Before the HVPS may be installed, it is critical that the input AC line voltage being supplied to it conforms to the marking on the serial number label on the rear panel (see Figure 4-G). No neutral connection is required for 208VAC units. The HVPS is not sensitive to phase rotation. Double check your power line wiring configuration before proceeding with the installation.

HVPS Rear Panel Connectors

Figure 4-H HVPS Rear Panel Connectors (TT-6 shown)

Interconnection Procedure

Figure 4-I Controller Rear Panel Connectors

1. Turn OFF all front panel circuit breakers.
2. Connect the ground stud on the rear panel of the HVPS chassis to a common ground on the vacuum system. Use a 0.5 inch or 10mm wide metal earthling braid or #10 AWG / 6mm² insulated stranded wire with properly crimped ring terminals where required. Heavier gauge conductors may be used. This vacuum system ground must be the common point of all ground connections. Run grounding connections from here to the Controller and Filament Transformer Box as well. In rack mount systems run the grounding for the Controller the short way directly to the HVPS ground stud.
   If no common grounding point is available on the vacuum system, the ground stud of the HVPS may be used as common ground instead.
   See section 7, Figures 7-A through 7-E.
3. Connect the supplied HV Output cable (RG213 Coax) between J5 HV OUT on the HVPS and the mating connector on the supplied Filament Transformer Box. It is good practice to keep the HV cable away from sharp objects, machinery, and high traffic areas. This will minimize the possibility of damage to the cable.
4. Connect the supplied Hirschmann cable between J3 FIL(AMENT) XFMR on the HVPS and the mating connector on the Filament Transformer Box.
5. If desired, connect an external EMO (Emergency Off) switch with the supplied 2-pin Hirschmann connector to J7 EXT EMO on the HVPS (not available on TT-3/6). Jumper JP1 on the HVPS main board must be set to OFF (2-3) for activation of the external EMO (contact Telemark Service for details)
6. Connect the supplied 25pin Sub-D M-F cable between J1 HV CONTROL on the HVPS and J1 on the Controller.
7. Connect the supplied 9pin Sub-D M-F cable between J2 SOURCE CTRL on the HVPS and J2 on the Controller.
8. **TT-3/6/8:**
   With input AC line voltage **OFF,** terminate the AC line feed wires to the supplied terminals (P/N 124-1440-1), connector shell (P/N 124-1441-1), and cable clamp (P/N 124-1442-1). It is mandatory to use 600V insulated stranded wire of sufficient gauge (min. #12AWG /

4mm² for 208VAC,
min. #14AWG / 2.5mm² for 400VAC). Strip about 0.4 inch (~10mm) of insulation from the wires before crimping them to the terminals.
Connect the completed connector assembly to J6 POWER IN on the HVPS.

TT-10/15/20: With input AC line voltage **OFF,** terminate the AC line feed wires with ferrules. It is mandatory to use 600V insulated stranded wire of sufficient gauge (min. #10AWG / 6mm² for 208VAC, min. #12AWG / 4mm² for 400VAC; except for TT-15 208VAC: min. #8AWG / 10mm²).
Strip about 0.4 inch (~10mm) of insulation from the wires before crimping them to the ferrules. Connect the completed cable to the terminal block at the rear of the HVPS cabinet and tighten the strain relief.

9. Connect the safety interlocks to J7 INTERLOCKS of the controller as described on page 20 and in section 6, Figures 6-A through 6-E.
10. Install the two supplied ¾" NPT flexible Strain Relieves 110-0052-4 in the openings of the Filament Transformer Box, run the supplied red HV Cable Set 122-0031-1 through them, connect the ring lugs to the output bolts of the Filament Transformer (see Figure 4-J), and connect the shields to the internal GND bolt. Keep the shield wires away from the HV.
    The other ends need to be custom configured to connect to the High Voltage Feedthroughs for the E-Beam Source. Make sure to strip back the shield by at least 2" (50mm) and keep it away from the hot conductor.
11. When all connections have been double checked, apply AC power from the AC line input and turn both rear panel circuit breakers ON. The unit is now ready for operation.

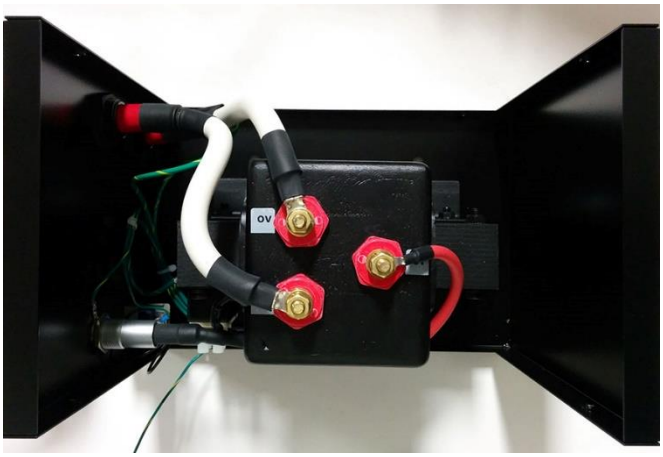


Figure 4-J Filament Transformer Connections

Connector and Pin Definitions

HVPS

J1 – HV CONTROL >>> connects to J1 of Controller

J2 – SOURCE CTRL >>> connects to J2 of Controller

J3 – FIL(AMENT) XFMR >>> connects to Filament Transformer Box

J4 – SWEEP POWER >>> connects to Analog Sweep (see separate Manual)

J5 – HV OUT >>> connects to Filament Transformer Box

J6 – POWER IN – AC Line Input TT-3/6/8 (Amphenol 7-pin F-series circular)

Pin#	Name	Description
1	Phase 1	AC Phase 1
3	GND / PE	AC GND / PE
4	Neutral	AC Neutral, **on 400VAC units only**
5	Phase 2	AC Phase 2
6	Phase 3	AC Phase 3

AC Line Input TT-10/15/20 (Terminal Block, pin count from left)

#	Name	Description
1	P1	AC Phase 1
2	P2	AC Phase 2
3	P3	AC Phase 3
4	GND	AC GND / PE
5	N	AC Neutral, **on 400VAC units only**

J7 – EXT EMO – not on TT-3/6 (Hirschmann 2-pin rectangular)

Pin#	Name	Description
1	External EMO Interlock	Contact closure to pin 2 to enable HVPS, open will disable HVPS
2	External EMO Interlock	Contact closure to pin 1 to enable HVPS, open will disable HVPS

Controller

J1 – HVPS – HV CONTROL >>> from J1 of HVPS

J2 – HVPS – SOURCE CTRL >>> from J2 of HVPS

J3/J4 – SUB CONTROL #2/#3 >>> to J3/J4 of Sub Controller (see section 6)

J5 – REMOTE USER I/O (37pin Sub-D M)

Pin #	Name	Input/ Output/ Power	Signal Range	Function Description
1	User +24VDC	Power	+24VDC	Source for user +24VDC control (200mA max output)
2	HV Ready/OFF Indicator	Output (O.C.)*	0 to +Vcc	Low = HV ready/off High = HV not ready
3	Arc Indicator	Output (O.C.)*	0 to +Vcc	Low = HV arcing/not regulating High = HV regulating
4	Air/Timer Indicator	Output (O.C.)*	0 to +Vcc	Low = Air Flow not OK Low/High pulsing = Time Delay High = Air Flow / Time Delay OK

5	HV ON Indicator	Output (O.C.)*	0 to +Vcc	Low = HV is on High = HV is off
6	Source ON Indicator	Output (O.C.)*	0 to +Vcc	Low = Source is on High = Source is off
7	Voltage Reference Select	Input	Jumper only, do not apply voltage	Open = always front panel pot GND = kV reference selected by Control Select switch
8	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34
9	HV ON Control	Input	0 to +24VDC	+5VDC to +24VDC = HV ON 0VDC = HV OFF
10	Source ON Control	Input	0 to +24VDC	+5VDC to +24VDC = Source ON 0VDC = Source OFF
11				Unused
12	F.P. ON in Remote	Input	Jumper only, do not apply voltage	Open = ON signals from PLC GND = F.P. ON switches are active in remote mode
13	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34
14	Remote Voltage Reference	Input	0 to +10VDC	0 to +10VDC = 0 to -10kV 0 to +8VDC = 0 to -8kV (TT-6) 0 to +7VDC = 0 to -7kV (TT-3)
15	Remote Emission Current Reference	Input	0 to +10VDC	0 to +10VDC = 0 to 100% current (500 / 750 / 800 / 1000 / 1500 / 1700 mA)
16	Isolated GND (GND_ISO)	Power		Reference for pins 2 thru 6, 9, 10, 24, 31 (isolated from GND)
17	Isolated GND (GND_ISO)	Power		Reference for pins 2 thru 6, 9, 10, 24, 31 (isolated from GND)
18	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34
19	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34

J5 – REMOTE USER I/O (continued)

Pin#	**Name**	**Input/ Output/ Power**	**Signal Range**	**Function Description**

20				Unused
21				Unused
22				Unused
23				Unused
24	All Interlocks OK Indicator	Output (O.C.)*	0 to +Vcc	Low = All Interlocks satisfied High = Not all Interlocks satisfied
25				Unused
26	Source Ready/OFF Indicator	Output (O.C.)*	0 to +Vcc	Low = Source is ready/off High = Source is not off
27				Unused
28				Unused
29	User +10VDC (Emission)	Power	+10VDC	Source (if used) for remote Emission reference input (2mA maximum output)
30	User +10VDC (kV)	Power	+10VDC	Source (if used) for remote kV reference input (2mA maximum output)
31	+Vcc	Input	+5 to +24VDC	External user isolated digital control power (clamping)
32	Voltage Monitor	Output	0 to +10VDC	0 to +10VDC = 0 to -10kV 0 to +8VDC = 0 to -8kV (TT-6) 0 to +7VDC = 0 to -7kV (TT-3)
33	Emission Current Monitor	Output	0 to +10VDC	0 to +10VDC = 0 to 100% current (500 / 750 / 800 / 1000 / 1500 / 1700 mA)
34	Filament Current Monitor	Output	0 to +10VDC	0 to +5VDC = 0 to 50A
35	Isolated GND (GND_ISO)	Power		Reference for pins 2 thru 6, 9, 10, 24, 31 (isolated from GND)
36	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34
37	Digital GND (GND)	Power		Reference for pins 1, 7, 12, 14, 15, 30, 32, 33, 34

*) O.C. denotes Open Collector

Note 1: Open Collector outputs require external pull-up resistors. When connecting “User +24VDC” to pull-up resistors, their resistance value must not be lower than 2kOhm.

Note 2: If using “User +24VDC” as control supply for pins 2-6, 9 and 10, then GND and GND_ISO **must be shorted externally** (e.g. pins 17 and 18 or 35 and 36)

J6 – HANDHELD (26pin HD Sub-D M)

For Handheld Remote Controller (Pendant, optionally available)

J7 – INTERLOCKS – External Safety Interlocks (15pin Sub-D M)

Pin #	Name	Input/ Output/ Power	Signal Range	Function Description
1	VAC Interlock	Input	Contact only	Return for pin 2, GND
2	VAC Interlock	Input	Contact only	Contact closure to pin 1, +15VDC
3	TANK Interlock	Input	Contact only	Return for pin 4, GND
4	TANK Interlock	Input	Contact only	Contact closure to pin 3, +15VDC
5	AUX1 Interlock	Input	Contact only	Return for pin 6, GND
6	AUX1 Interlock	Input	Contact only	Contact closure to pin 5, +15VDC
7	HVAC Interlock	Input	Contact only	Return for pin 8, GND
8	HVAC Interlock	Input	Contact only	Contact closure to pin 7, +15VDC
9	H20 Interlock	Input	Contact only	Return for pin 10, GND
10	H20 Interlock	Input	Contact only	Contact closure to pin 9, +15VDC
11	AUX2 Interlock	Input	Contact only	Return for pin 12, GND
12	AUX2 Interlock	Input	Contact only	Contact closure to pin 11, +15VDC
13	Digital GND	Power		GND
14	Digital GND	Power		GND
15	Digital GND	Power		GND, Cable shield

Note: In case that **interlock inputs need to be paralleled** (e.g. only one safety switch is available for two interlock inputs) it must be made sure that the Contact closure pins (+15VDC) are wired together and the Return pins (GND) are wired together (or only one

Return pin used). Failure to do so will compromise correct functioning of the interlocks (always satisfied).

Example: One safety switch to be used for VAC and HVAC interlocks: Connect one side of contact to pins 2 and 8 and the other side to pins 1 and 7 (or to only one of the two).

5

OPERATION

Controller Functions

Figure 5-A Controller Front Panel

Switch Functions

Section	Name	Type	Function
CONTROL POWER	CONTROL POWER	2 Position	Turns “auxiliary power” on/off to HVPS and Controller circuitry
HIGH VOLTAGE	OFF	Pushbutton Yellow	Press to turn HV off Illuminated when HV is ready Unlit when HV is not ready
HIGH VOLTAGE	ON	Pushbutton Green	Press to turn HV on Illuminated when HV is on Unlit when HV is off
CONTROL SELECT	REMOTE LOCAL HANDHELD	3 Position	Selects control from either Local (front panel) or Remote (PLC) or Handheld (optional pendant)
SOURCE	OFF	Pushbutton Yellow	Press to turn Source off Illuminated when Source is ready Unlit when Source is not ready
SOURCE	ON	Pushbutton Green	Press to turn Source on Illuminated when Source is on Unlit when Source is off
SOURCE	Display Select (DSP SEL)	2 Position	Selects between Emission or Filament current for source current meter

Potentiometer Functions

Section	Name	Type	Function
HIGH VOLTAGE	VOLTAGE	10-turn	Sets HV output level in Local (and in Remote, if selected with jumper at J5)
SOURCE	EMISSION	10-turn	Sets emission output current in Local
SOURCE	BIAS	10-turn trim	Sets 'pre-heat' filament bias current

Meter Functions

Section	Name	Type	Function
HIGH VOLTAGE	DC OUTPUT VOLTAGE	3.5-digit LCD	HV voltage output (in kV)
SOURCE	EMISSION / FILAMENT CURRENT	3.5-digit LCD	Emission current (in mA) or filament current (in A)

LED Functions

Section	Name	Function
CONTROL POWER	PWR	Lit when Control Power is present (Main Power of HVPS is turned on)
HIGH VOLTAGE	AIR/CAB	Lit when Air Flow is OK, blinking when Time Delay is running (TT-3/6 only)
HIGH VOLTAGE	ARC	Lit or flashing when HV is out of regulation or arcing
HIGH VOLTAGE	VAC	Lit when VAC interlock is closed
HIGH VOLTAGE	TANK	Lit when TANK interlock is closed
HIGH VOLTAGE	AUX1	Lit when AUX1 interlock is closed
CONTROL SELECT	HV REMOTE	Lit when remote HV setting is selected
CONTROL SELECT	HV HANDHELD	Lit when HV setting from Handheld is selected
CONTROL SELECT	SOURCE REMOTE	Lit when remote Source current setting is selected
CONTROL SELECT	SOURCE HANDHELD	Lit when Source current setting from Handheld is selected

SOURCE	HVAC	Lit when HVAC interlock is closed
SOURCE	H20	Lit when H20 interlock is closed
SOURCE	AUX2	Lit when AUX2 interlock is closed

Operation

Initial Start-Up

When all connections have been made as described on pages 15 and 16 the power supply is ready to use.

Make sure that the Control Power switch on the controller is off (down), the Control Select toggle switch is in center position (Local) and both Voltage and Emission potentiometers are all the way down at 0 (zero).

Turn on the main breakers (Control & High Voltage) on the front panel of the HVPS, the green power LED (PWR) on the controller will come on.

Turn on the Control Power switch on the controller, the green interlock LEDs (if interlocks are satisfied) and the two LCD meters will come on.

With all interlocks satisfied, both yellow OFF push buttons for HV and Source will be lit which indicates "ready". It may take a few moments before proper air flow to the tube is established and the AIR/CAB interlock is satisfied.
For the TT-3 and TT-6 the time delay will now start, indicated by a blinking AIR/CAB LED, the HV OFF button still not being illuminated (HV not ready).

The TT-3 and TT-6 design is based on indirectly heated oxide cathode tetrode tubes which require a few minutes of heat-up for adequate electron generation. A built-in time delay circuit (~ 3 minutes) disables HV during the heat-up time of the tube.

The TT-8/10/15/20 with their directly heated power beam tetrode tubes do not require any heat-up time, and HV becomes ready as soon as the AIR/CAB interlock is satisfied.

When HV is ready (yellow OFF push button illuminated), HV can be turned on by pressing the green ON push button. This will be light up instantly, indicating that HV is on.

Slowly dial up the Voltage potentiometer, watching the DC Output Voltage LCD meter. Keep increasing HV up to maximum voltage, paying attention to any arcing that may occur in the vacuum chamber (instability of HV reading, flashing of ARC LED).

When HV is stable at maximum kV, leave potentiometer in this position, or set to desired HV level, depending on e-beam source type and application.

Turn off HV.

Set the Display Select toggle switch next to the Source LCD meter to Filament (down).

Turn on Source by pressing the green ON push button, this will light up instantly, indicating that power is supplied to the filament. After a few seconds of source filament heat-up, the Source meter will read a bias (preheat) filament current of around 18A.

A good range for setting the bias for Telemark sources is some 17 to 20A, settings for other sources need to be determined by trial (yellow glow of the filament, but still a few amps below emission point, see next step below) but should be very similar.

Flip Display Select toggle switch to Emission (up), turn ON HV, then slowly turn up the Emission potentiometer, watching the Source meter (reads mA in the Emission mode). Check for correct position of the beam in the pocket, and bring up emission further to heat the material to evaporation point.

This completes the initial test of the power supply.

Turn down the Emission potentiometer to zero and turn off Source and HV.

Allow a few moments of cool-down for the tube before turning off Controller Power and the main breakers of the HVPS.

The power supply is now ready for use.

Standard Operation

When operating the power supply it is considered good practice to ***first*** turn on the source filament (Source ON) and allow it to heat up to preheat level (Bias) for at least 10 to 15 seconds and ***only then*** turn on high voltage
(HV ON).

This will extend filament life time, allow for more precise control in the low emission current range, and prevent from initial rate spikes from emission current overshoot on evaporation materials requiring very low power levels such as subliming materials.

It is absolutely safe to turn on and off HV with the potentiometer set at the desired HV operating level.

IMPORTANT NOTE:
Always allow for a few minutes of cool-down for the tube
before shutting down the power supply.
This is especially important after longer deposition runs
and for the smaller tubes in the TT-3 and TT-6.

When shutting down the power supply, always turn off Control Power first,
and then the main breakers of the HVPS.

Remote Operation (from Process Controller)

Flipping the Control Select Toggle switch to Remote (up) is handing over all ON/OFF controls as well as the settings for HV and Emission to connector J5. In this mode HV and emission can be turned on and off remotely from a Process Controller, and HV and emission levels can also be set remotely. See the pin description for J5, pages 18 and 19, and section 7, Figure 7-F).

The digital control signals can either be "active", i.e. an external (isolated) voltage source or "passive", that is via dry contacts by using the internal +24VDC at pin 1 as a voltage source. Refer to Figure 7-F for more details.

If the Process Controller is not only to remotely control emission current but also HV level, then a jumper needs to be installed on pins 7 & 8 of J5, otherwise HV level setting will always be from the front panel potentiometer.

The green LEDs left and right of the Control Select switch indicate which of the settings are remotely controlled (illuminated = active).

For an operation from a Deposition Controller (Rate Controller) where no digital ON/OFF signals are available, the ON/OFF push buttons on the front panel can be enabled in the Remote mode by installing a jumper on J5
pins 12 & 13.

NOTE: For safety reasons the OFF push buttons, both HV and Source, are always enabled regardless of the Control mode selection.

J5 also provides a number of status and analog signal feedbacks to the Process Controller for complete process control. See pages 18 and 19, and section 7, Figure 7-F for more details.

Handheld Remote Operation (from Pendant)

An optional Handheld Pendant is available for convenient control of the power supply in front of the vacuum system.

To operate the power supply from the pendant the Control Select toggle switch needs to be flipped to Handheld (down).

Current limits

There are three different current limits built into the Controller:

- **Cut-Back:** This is the current limit where "cut-back" kicks in. This limit protects the power supply from damage from excessive output currents like from short circuits or from arcing in the vacuum chamber by turning off HV via the power tube. It also handles arcing of the electron beam source by quickly turning off the HV output for an extremely short instance to extinguish arcs. HV fully recovers within milliseconds when over-current is gone.
  This limit is adjusted to about 5% above maximum output current.
- **Total Current Limit:** This limit works on the emission current control loop and cuts in when a control voltage higher than 10.00VDC is applied.
  This limit is set to about 2% above maximum output current.
- **Reference Voltage Limit:** This limits the reference voltage feeding the front panel potentiometer for Source current as well as the reference voltage available at pin 29 of J5 for remote use.
  This limit is set to about 2mA above maximum output current.

6

PREVENTIVE MAINTENANCE

Preventive maintenance is to be done with main power turned off and locked out/tagged out, following your company's safety program.

- Check and confirm power supply earth ground is clean and secure at power supply ground terminal and at the facility earth ground point.
- Check that power supply is clean of any buildup of dust or dirt. Vacuum out/ blow out main cabinet of power supply to remove this build up.
- Remove Tetrode tube, check for dirt / dust in the fins of the tube. Blow out /vacuum out as required. Check the silver connection rings around the tube in the lower ceramic area of the tube. Confirm these are not corroded or tarnished. Clean as needed using a mild abrasive cloth or pad.
- Look in Tetrode tube socket, checking for dirt and confirm the contact fingers are not broken or bent. Adjust as needed.
- Check and confirm all electrical wires, connections and contactors in the main power supply cabinet are clean and showing no sign of overheating or other damage. If there are signs of overheating, replace damaged components. Check all mechanical connections and terminal block connections, to assure they are clean and connections are tight.
- Confirm the High Voltage connection in the power supply is clean and tight. Clean any oxidation, as needed, and tighten connection.
- Confirm the mechanical connections at the filament source transformer are clean and tight and free of oxidation. This is located, in most cases, under the chamber, near the high voltage feedthroughs. Also confirm good connection of the cables to the high voltage feedthroughs.
- Confirm the power supply controller cables are secure and screw terminals are tight. Confirm the earth ground is connected to the provided ground point. Confirm ground point is clean and tight.

Replace all covers which were removed and secure with proper screws.

Confirm all components are safe and remove the lock out / tag out lock, before turning power back on to system.

7

MULTI-SOURCE OPERATION

(optional for TT-10/15/20)

Introduction

The TT-10/15/20 allow for operation of up to 3 electron beam sources simultaneously (optional). Each source output has its own Source Module plugged in at the rear of the HVPS cabinet. The Source Module supplies HV to an electron beam source, drives the filament transformer and measures and controls emission current for this particular source.

Connector and Pin Definitions

Sub-Controller

J2 – HVPS – SOURCE CTRL >>> from J2 of HVPS, 2nd/3rd Source Module

J3/J4 – SUB CONTROL #2/#3 >>> from J3/J4 of Main Controller

J5 – REMOTE USER I/O (37pin Sub-D M)

Pin #	Name	Input/ Output/ Power	Signal Range	Function Description
1	User +24VDC	Power	+24VDC	Source for user +24VDC control (200mA max output)
6	Source ON Indicator	Output (O.C.)*	0 to +Vcc	Low = Source is on High = Source is off
8	Digital GND (GND)	Power		Reference for pins 1, 12, 15, 33, 34
10	Source ON Control	Input	0 to +24VDC	+5VDC to +24VDC = Source ON 0VDC = Source OFF

12	F.P. ON in Remote	Input	Jumper only, do not apply voltage	Open = ON signals from PLC GND = F.P. ON switches are active in remote mode
13	Digital GND (GND)	Power		See pin 8
15	Remote Emission Current Reference	Input	0 to +10VDC	0 to +10VDC = 0 to 100% current (500 / 750 / 800 / 1000 / 1500 / 1700 mA)
16	Isolated GND (GND_ISO)	Power		Reference for pins 6, 10, 24, 31 (isolated from GND)
17	Isolated GND	Power		See pin 16
18	Digital GND (GND)	Power		See pin 8
19	Digital GND (GND)	Power		See pin 8
24	All Interlocks OK Indicator	Output (O.C.)*	0 to +Vcc	Low = All Interlocks satisfied High = Not all Interlocks satisfied
26	Source Ready/OFF Indicator	Output (O.C.)*	0 to +Vcc	Low = Source is ready/off High = Source is not off
29	User +10VDC (Emission)	Power	+10VDC	Source (if used) for remote Emission reference input (2mA maximum output)
31	+Vcc	Input	+5 to +24VDC	External user isolated digital control power (clamping)
33	Emission Current Monitor	Output	0 to +10VDC	0 to +10VDC = 0 to 100% current (500 / 750 / 800 / 1000 / 1500 / 1700 mA)
34	Filament Current Monitor	Output	0 to +10VDC	0 to +5VDC = 0 to 50A
35	Isolated GND	Power		See pin 16
36	Digital GND (GND)	Power		See pin 8
37	Digital GND (GND)	Power		See pin 8

See Notes on page 19

J6 – HANDHELD (26pin HD Sub-D M)

For Handheld Remote Controller (Pendant, optionally available)

J7 – INTERLOCKS – External Safety Interlocks (15pin Sub-D M)

Pin #	Name	Input/ Output/ Power	Signal Range	Function Description
7	HVAC Interlock	Input	Contact only	Return for pin 8, GND
8	HVAC Interlock	Input	Contact only	Contact closure to pin 7, +15VDC
9	H20 Interlock	Input	Contact only	Return for pin 10, GND
10	H20 Interlock	Input	Contact only	Contact closure to pin 9, +15VDC
11	AUX2 Interlock	Input	Contact only	Return for pin 12, GND
12	AUX2 Interlock	Input	Contact only	Contact closure to pin 11, +15VDC
13	Digital GND	Power		GND
14	Digital GND	Power		GND
15	Digital GND	Power		GND, Cable shield

See Note on page 20

OPERATION

Please refer to section 5 for operation. The Sub-Controller offers the same controls and displays as available on the right hand side of the Main Controller (Control Select and Source sections). All respective operation instructions in section 5 do apply.

Please note that the Total Current Limit as described under "Current Limits" on page 29 will influence all source outputs. I.e. it is limiting the sum of all individual source currents to the maximum output current of the power supply.

It is important to understand that this limit will always consider the one source controller requesting more current at the time as the master controller and consequently the other sources will be reduced in their current output so that the sum of all currents does not exceed current limit.

8

ADDENDUM

- Figure 8-A Connections TT-3
- Figure 8-B Connections TT-6/8 – 208VAC
- Figure 8-C Connections TT-6/8 – 400VAC
- Figure 8-D Connections TT-10/15 – 208VAC
- Figure 8-E Connections TT-10/15/20 – 400VAC
- Figure 8-F J5 Remote User I/O Connector
- CE Declaration of Conformity

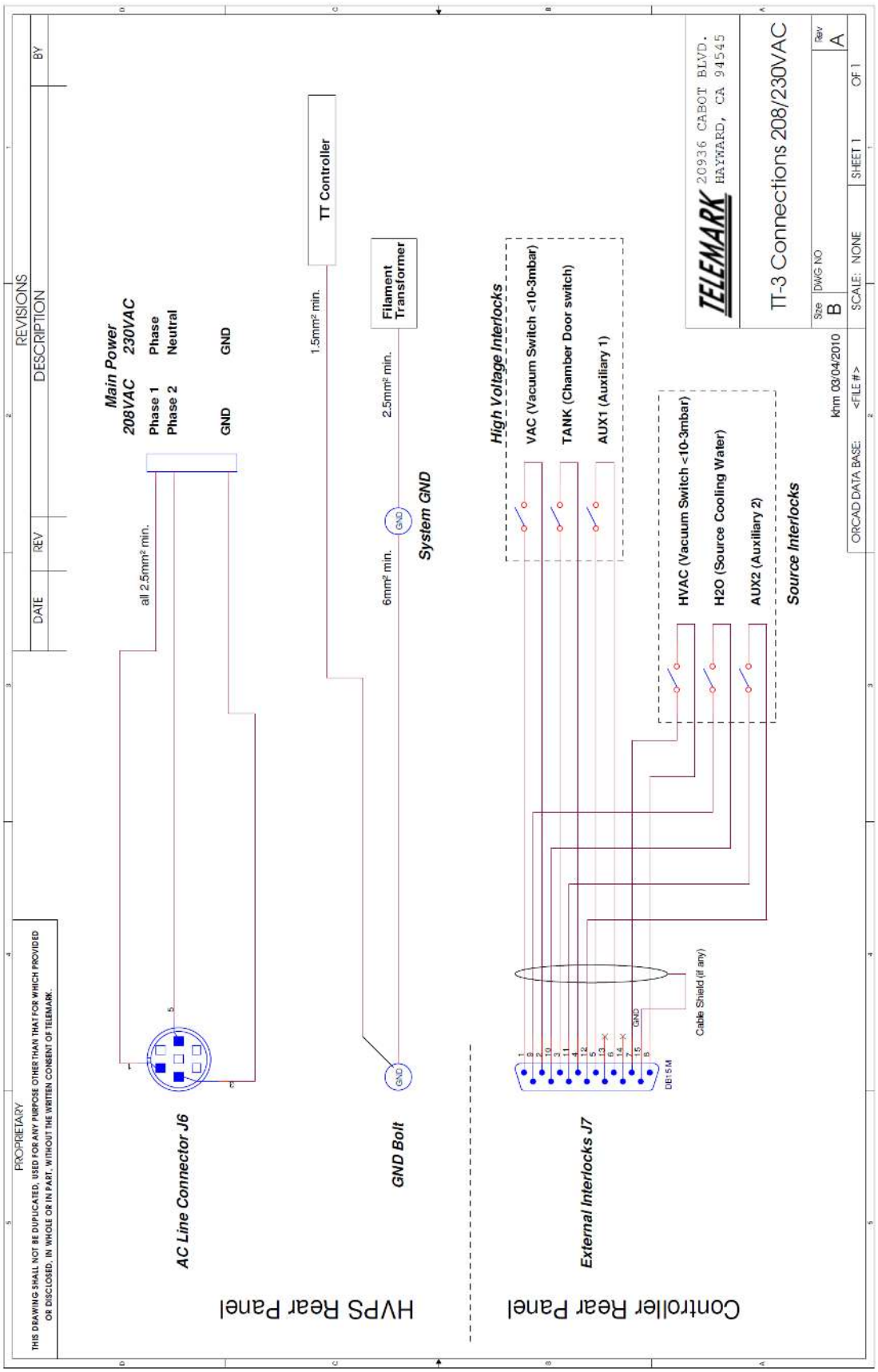


Figure 8-A Connections TT-3

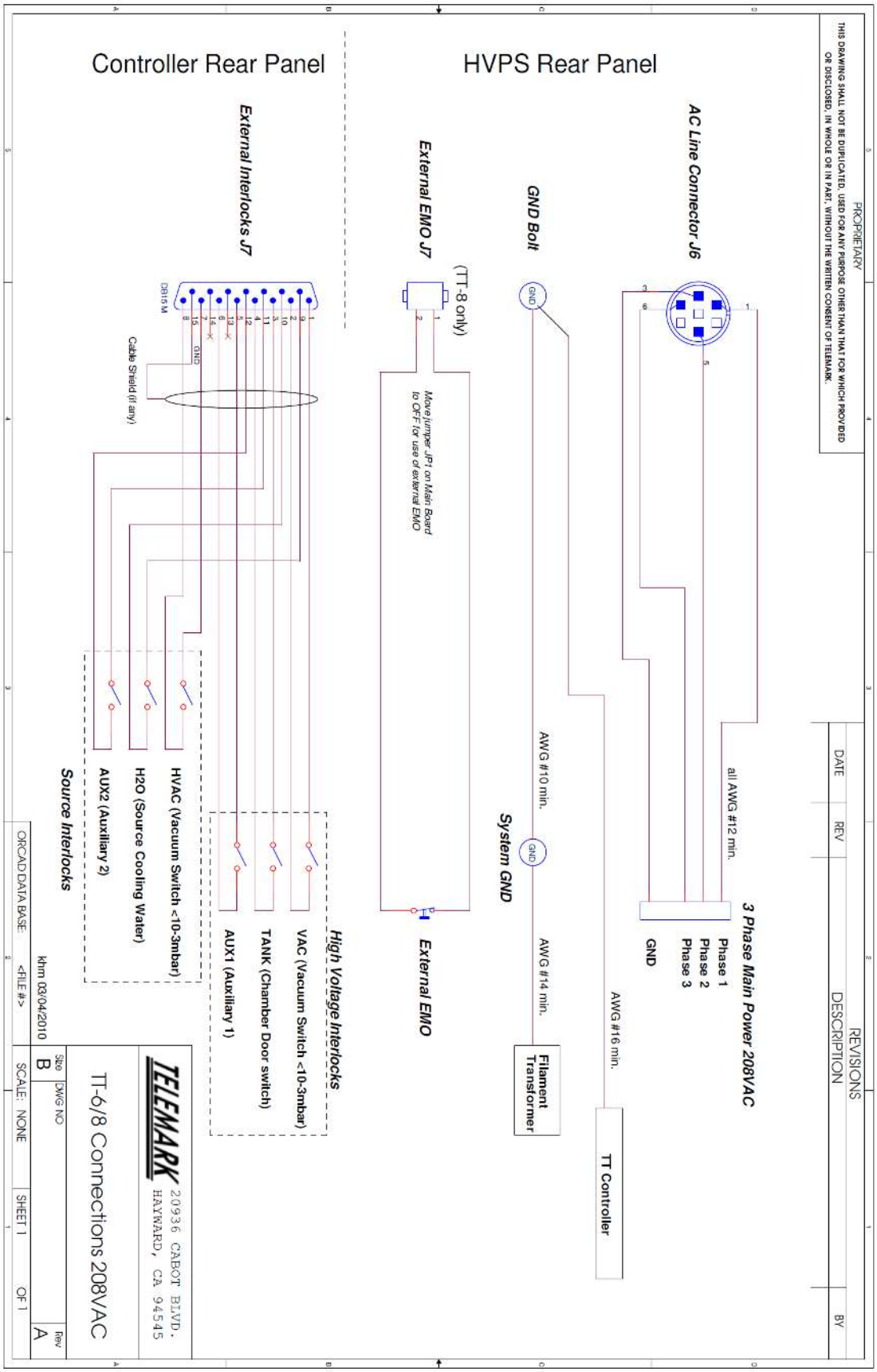


Figure 8-B Connections TT-6/8 – 208VAC Version

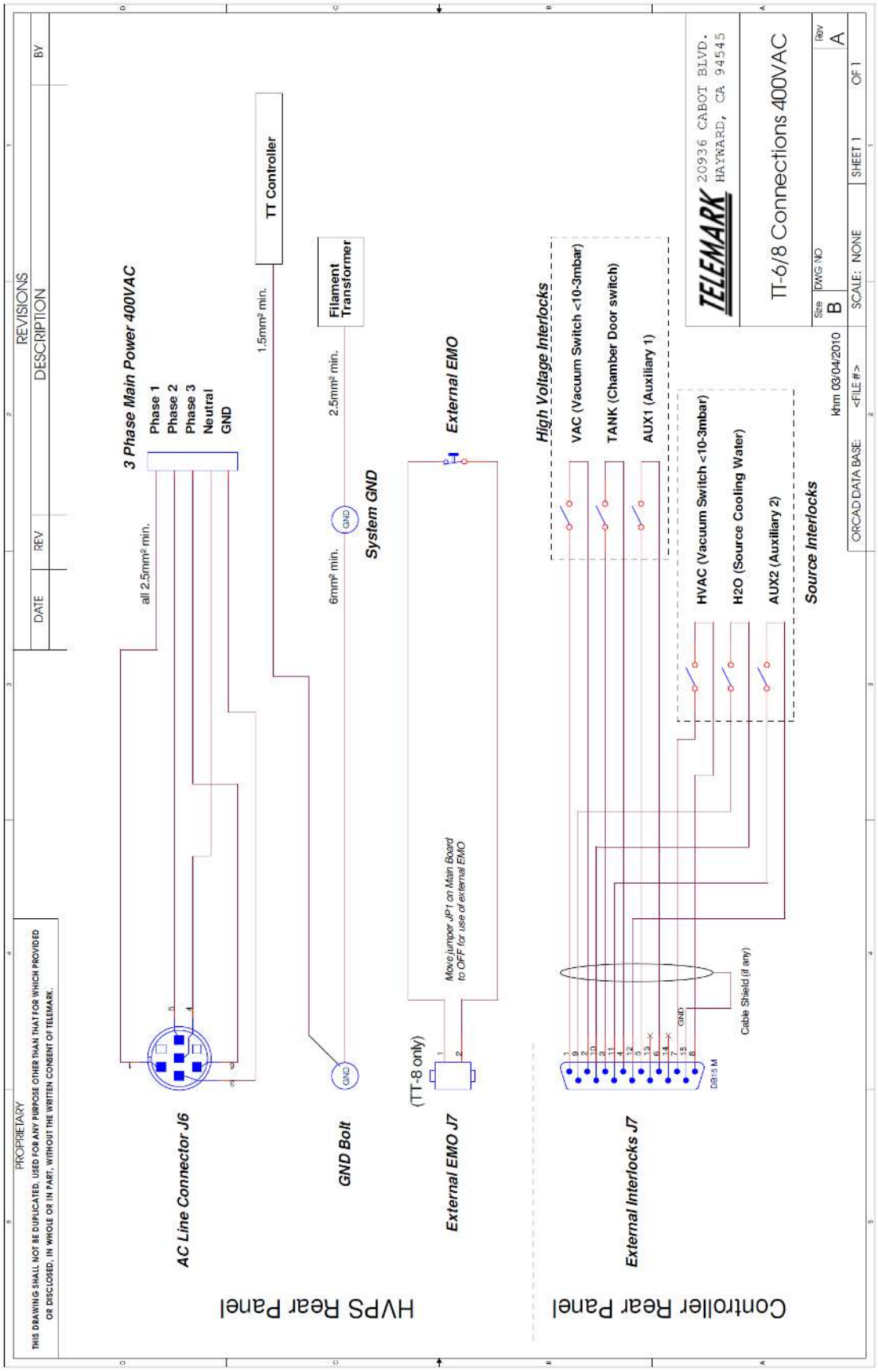


Figure 8-C Connections TT-6/8 – 400VAC Version

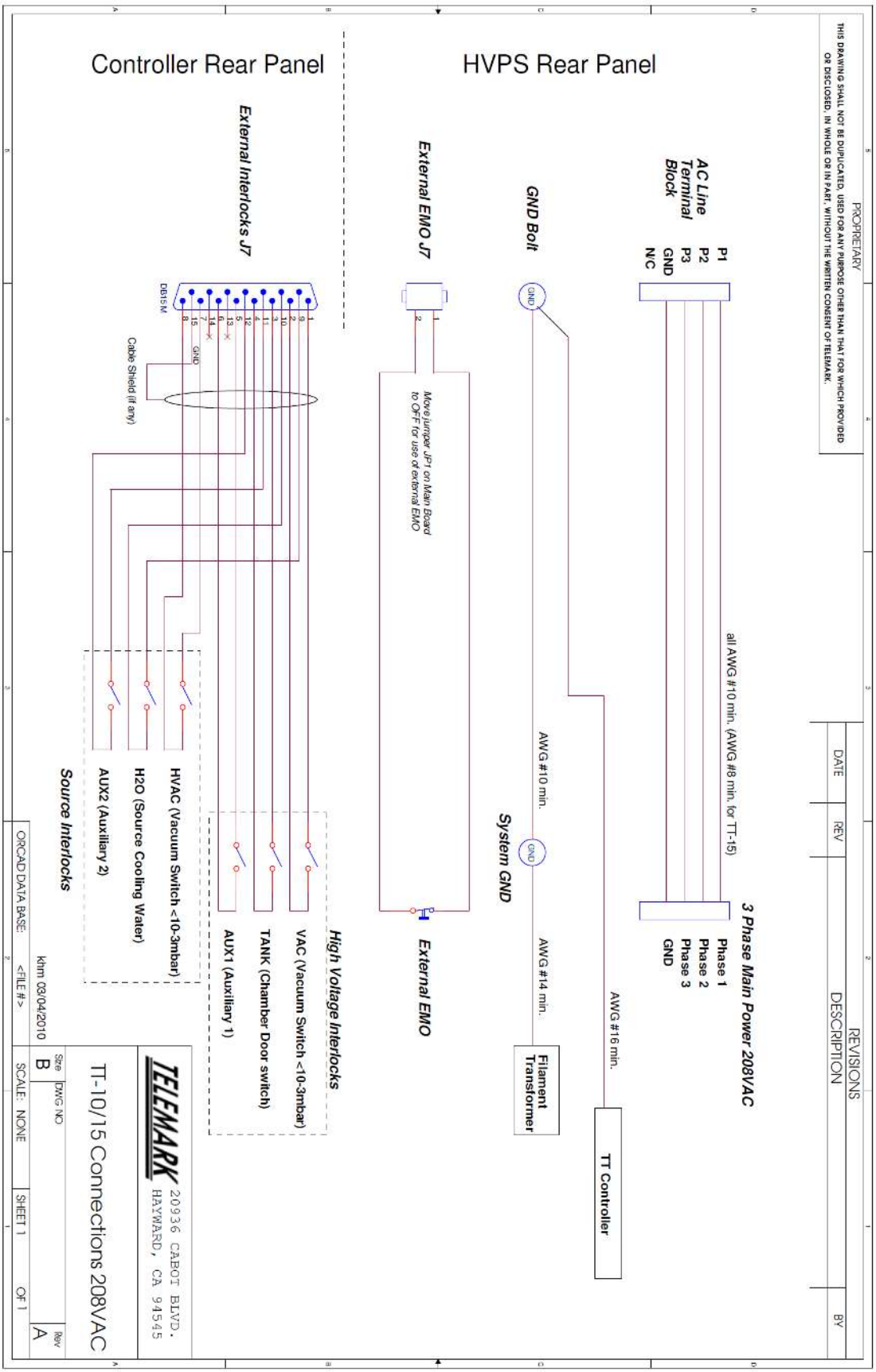


Figure 8-D Connections TT-10/15 – 208VAC Version

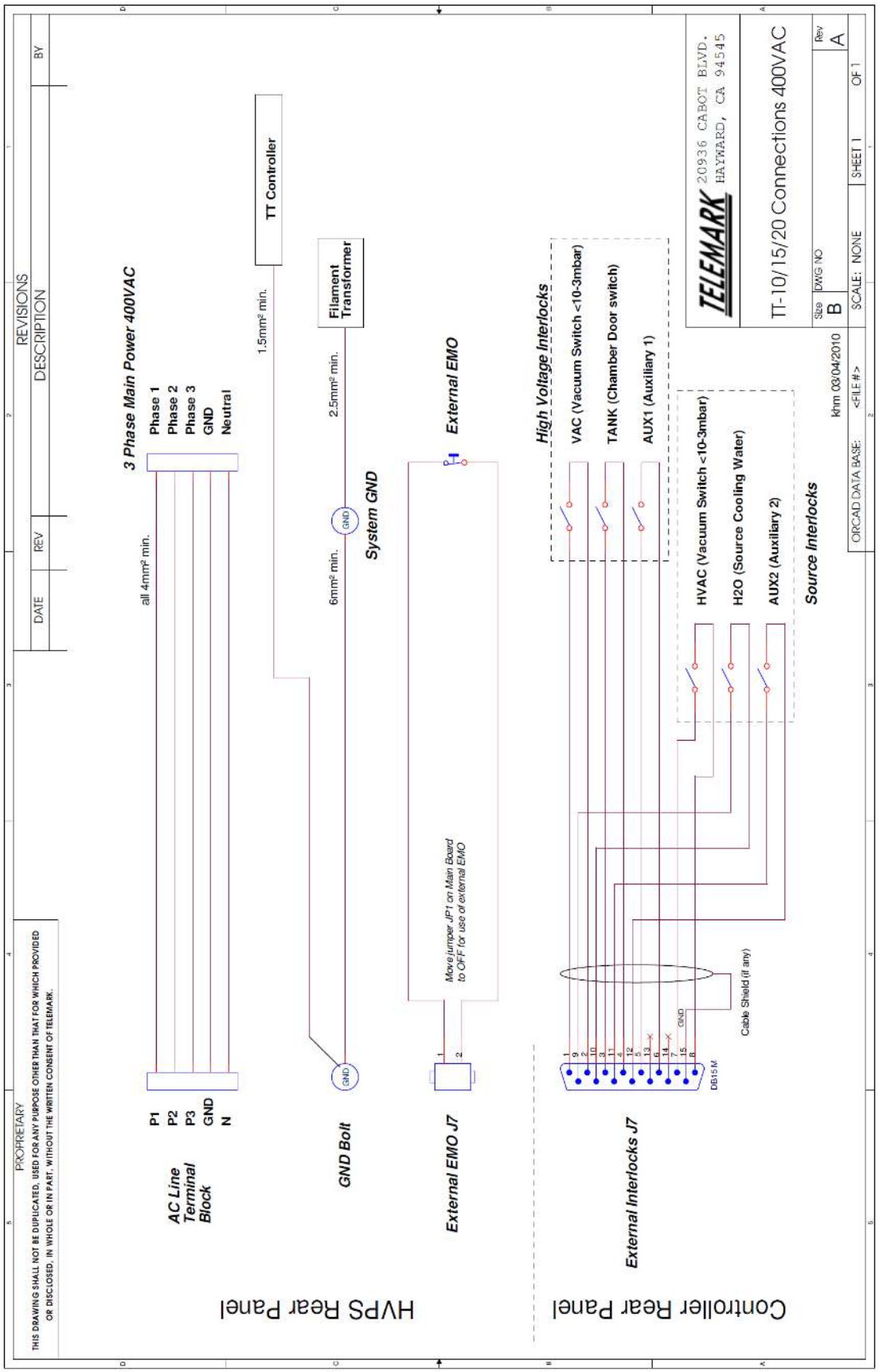


Figure 8-E Connections TT-10/15/20 – 400VAC Version

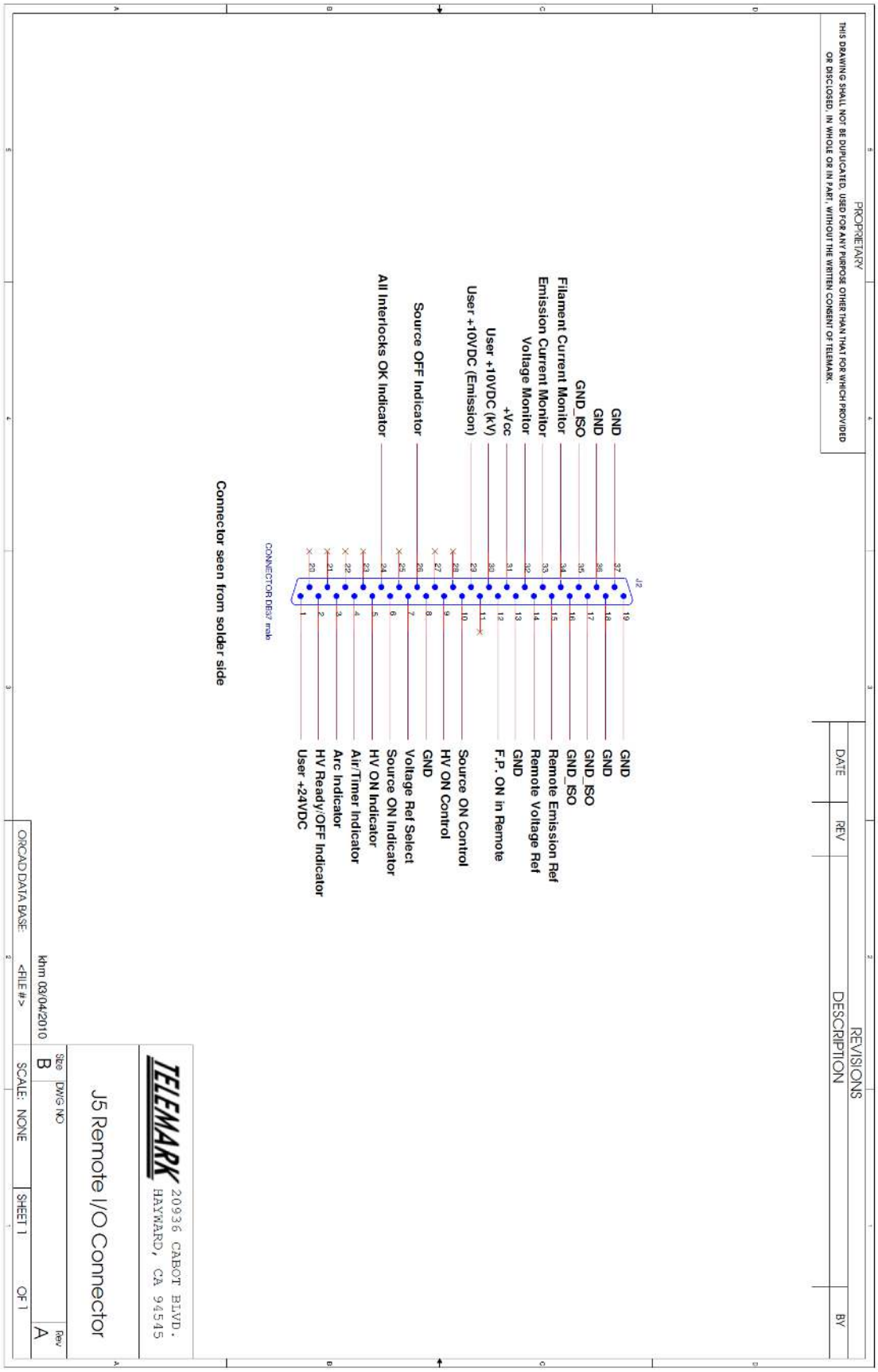


Figure 8-F J5 Remote User I/O Connector

DECLARATION OF CONFORMITY

Telemark

1801 Commerce Ave

Battle Ground, WA 98604, USA

Declares that the products

Product Name:	TT Series High Voltage Power Supply
Model Number(s)	Cheetah TT-3/6/8/10/15 and Cheetah TT-6/8/10/15/20E Incl. Analog X-Y Beam Sweep Module or Digital X-Y Beam Sweep Module and Filament Transformer in protective Metal Enclosure

Conform to the following specifications:

EN 61326:2013

Standard	
EN 61000-6-3:2007, A1	Electromagnetic Compatibility Emissions
EN 61000-6-4:2007, A1	Electromagnetic Compatibility Immunity
EN 61000-4-2: 2009	Electrostatic Discharge Immunity
EN 61000-4-3:2006, A1, A2	Radiated Susceptibility Test
EN 61000-4-4:2012	Electrical Fast Transit/Bursts Immunity
EN 61000-4-6:2009	Conducted RF Susceptibility
EN 61000-4-8:2010	Power Frequency Magnetic Field Immunity

Safety:

EN 61010-1:2010	Safety Requirements: General Requirements

Supplementary Information:

The product described complies with the requirements of the Low Voltage Directive 2006/95/EC // 93/68/EEC and the EMC Directive 2004/108/EC // 92/31/EEC // 93/68/EEC // 91/263/EEC and carries the CE Marking accordingly.

CE

Battle Ground, WA, January 2016