





6.2 GENERAL TROUBLESHOOTING

	 DANGER
	HIGH VOLTAGE Can cause ELECTRIC SHOCK or BURN

If the cables are connected to the power supply and not connected to the gun, **HIGH VOLTAGE** will be present at the exposed gun end of the cables when the power supply is on.

Do not touch cable end or power supply components when energized

	 DANGER
	HIGH VOLTAGE Can cause ELECTRIC SHOCK or BURN

FOR EMERGENCY SHUT DOWN, DISCONNECT THE POWER CORD FROM THE AC OUTLET.

Some Sections That May Be Useful For Troubleshooting

At any point in the troubleshooting process, Kimball Physics Engineering will be glad to provide technical assistance. Some information which is useful when calling includes: the gun model, serial numbers and other system information listed in front of this manual, the operating conditions when the problem occurs, the settings of the various controls, the vacuum environment.

It is often useful to attempt to **isolate the problem** and determine which part of the system is affected: the gun, the power supply, or the cables. This procedure is especially useful when a short circuit is suspected.

(1) With all gun cables disconnected, the leads on the gun can be checked with an ohmmeter to see if there is a short to ground in the gun or if the filament has burned out. (2) The cables alone can also be checked with an ohmmeter. (3) The power supply can be checked to see if the response on the meters is normal for no gun attached.

Call Kimball Physics Engineering for guidance in troubleshooting the power supply.

If the system requires modification to provide for a new experimental design or due to operating problems, please consult Kimball Physics Engineering before making alterations. Additional components or design options may be available. Modifications by the user (such as cutting wiring or gun parts, substituting electrical components, using non-standard materials, or not adhering to standard high vacuum practices) can invalidate the warranty, make rebuild difficult, and may cause a safety hazard to the user.

The gun, firing unit, and/or power supply can be returned to Kimball Physics for evaluation, disassembly, cleaning, repair and rebuild. It is best to return both the gun and power supply, so they can be tested together as a system. See shipping instructions in Section 2.1.

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3 Theory of Operation: Block diagram, Description of gun elements, Graphs showing how they operate

6.2 General Troubleshooting: Tables of symptoms, causes, and solutions

NOTE: Some instructions may not apply to the user's particular gun system. This is a general section with information for all Kimball Physics electron and ion gun systems.

6.2.1 Main Power Supply

6.2.2 Discharging

6.2.3 Energy

6.2.4 Emission

6.2.5 Beam Current

6.2.6 Individual Power Supplies

6.2.7 Grid and Pulsing

6.2.8 ECC and Source

6.2.9 Spot Size and Shape

6.2.10 Remote Control

6.2.11 Deflection and Rastering

6.2.12 Ion Guns

6.2.13 Cables and Connectors

6.2.14 Other Misc. Problems

6.3 Gun Disassembly/ Reassembly for Firing Unit Replacement: Step-by-step instructions, Pin outs

6.4 Power Supply Driver Boards: Description, Step-by-step instructions, Fuses, Wire code and pin out tables

6.5 Special maintenance procedures for specific gun model: only some manuals

8 Drawing Section: Gun drawings, Block diagram, Pinouts, Power supply overall schematic

9 Data Section: Performance graphs taken during testing

6.2 GENERAL TROUBLESHOOTING cont.

6.2.1 MAIN POWER SUPPLY

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Main Power Supply unit does not turn on.	Power Supply is not plugged in.	Check power cord connection to outlet (labeled LINE or J1 on back panel) and to wall socket. For higher powered guns only: Check connections to H.V. Supply (Gamma or Glassman) and power cord on H.V. Supply.
	Main Power Supply fuse has blown.	Replace fuse on rear panel with a 2 A slo-blo fuse. On FlexPanel units pry open small panel labeled F1 to replace fuse, return in correct position for AC. Check red AC indicator, 115 VAC or 230 VAC. (Also look for problem that caused fuse to blow, ex discharge in gun can cause a backsurge of high voltage.)
Hot electrical smell from the power supply unit.	Power Supply (or cable) has a short.	Call KPI first for advice to isolate the problem. Check individual boards for shorts, see Sect 6.4. H.V. DANGER: DO NOT CHECK VOLTAGE DIRECTLY
	An element in the power supply has overheated/ burned out.	Disconnect power supply. See sine wave driver board troubleshooting, Sect 6.4. Remove cover and inspect elements, check fuses.
	A cable has a short.	Unplug cable at both ends. Check leads with ohmmeter. Clean pins (Chemtronics Ultra Jet Duster or equivalent) Clean insulator with isopropanol.
Interlock LED is on.	H.V. Multiconductor Source cable is not connected correctly.	Disconnect cables and reconnect more tightly. The power supply connector must be screwed tight enough to engage the interlock pin; a click should be heard. Some guns have a separate small interlock cable, next to the source cable, with a lemo connector. On 50-100 keV guns, the interlock is part of the gun connector, so retighten it.
	Power supply case is open, a H.V. hazard.	Keep top and bottom panels closed on unit; tighten screws that secure case.
	Spare interlock is on. (located on back of Power Supply)	If not being used, check that spare interlock terminals are jumpered and screws are tight, as shipped. If user has wired the interlock, check trigger conditions, and check that wiring is a closed loop to the user's system.
Zero LED is on.	Energy (or other supply) is already turned up when H.V. power is first turned on.	Turn Energy potentiometer fully counterclockwise to zero. For FlexPanel controls, call KPI for advice on evaluating program through RS-232 port.

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The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.1 MAIN POWER SUPPLY cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
FlexPanel display screen does not come on, when green Power switch is on.	There is an interlock fault.	Check if interlock LED is on. See above.
	Power Supply is set for 230 VAC, but plugged into a 115 VAC power outlet. (If set for 115 VAC and plugged into a 230 VAC outlet, the fuse will blow and circuitry be damaged.)	Check red AC indicator in window by power cord. To switch voltage: pry open F1 fuse panel, pry out red holder, remove fuse, switch fuse and metal clip to opposite sides, replace holder with fuse to outer edge., close panel and check indicator.
	There is a software error.	Call KPI for advice on evaluating program through RS-232 port.
	Auxiliary power supply board has a blown fuse or other problem.	Call KPI for advice on checking voltage at test points on the auxiliary board.
FlexPanel display or controls have erratic operation.	Operation is not as the user expects.	See operating instructions, description of controls, use of FlexPanel controls Sect. 4.1. Note that encoder wheel is a variable control, rate of signal change depends on speed of rotation.
	Discharging in gun or power supply is causing Energy or other metering to fluctuate.	See 6.2.2 Discharging, below
	There is a software error; program may need to be reset.	Call KPI for advice on evaluating program through RS-232 port.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.2 DISCHARGING IN GUN OR POWER SUPPLY

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Discharging in the gun or power supply, (may be seen as spikes in current, heard as popping noises, or felt as a shock).	Minor discharging in gun caused by slight impurities introduced while gun is out of vacuum. (This often occurs briefly at start up.)	Let gun warm up longer; see if discharge is only when gun first at high voltage or only when source is first turned on. If brief this is not a problem, as gun will clean up when heated. (For higher power guns only) repeat conditioning and alignment procedures.
	Vacuum is poor.	Check vacuum level. Check vacuum pump. Wait for better vacuum (10^{-5} torr) before running gun.
	Charge is building up on gun elements due to contaminants (from target or when out of vacuum) or due to misalignment (from mechanical shock).	See if discharge is periodic, result of gradual charging up. Bake out gun. Adjust alignment, focus or deflection. (For higher power guns only) repeat conditioning and alignment procedures.
	Contaminants from target.	Look for phosphors and other debris on gun and in vacuum chamber.
	Cathode/ion source leads are shorting due to thermal expansion.	Disconnect cable from gun. Check filament pins with ohmmeter. Gun may need to be hot to see short. Disassemble gun and bend leads away from each other and tube wall.
	For ION GUNS: Excess ionization gas is present in other parts of gun.	Decrease pressure of gas admitted to be ionized.
	Rough edge, loose screw, etc is a site for charge build up.	For gun, remove from vacuum and check externally, partially disassemble and look in gun tube.
		For Power supply, with power off, remove cover and look inside.
	Power supply (or cable) has a short.	Call KPI first for advice to isolate the problem. See sine wave driver board troubleshooting, Sect.6.4. Check fuses, inspect elements. H.V. DANGER: DO NOT CHECK VOLTAGE DIRECTLY
A cable has a short.	Unplug cable at both ends. Check leads with ohmmeter. Clean pins (Chemtronics Ultra Jet Duster or equivalent) Clean insulator with isopropanol.	

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The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.2 DISCHARGING IN GUN OR POWER SUPPLY cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
<p>When Energy is increased with no Source on, Emission current meter goes up (leakage current). Discharging in gun.</p> <p>WARNING When troubleshooting the Energy supply: For higher-energy guns, do not go above 2000 eV, and for lower-energy guns, do not go above 400 eV.</p>	<p>A short in the gun (or cable), often source (filaments) to ground or grid to ground. If firing unit was just reinstalled, leads may be touching housing or each other. Short may be thermal.</p>	<p>Turn off system; disconnect ALL cables. With ohmmeter, check pins on gun (filament leads should be continuous, others open). Gun may need to be hot to see short; operate gun and check pins while hot. Pinout drawing at end of Sect 6.3. Check firing unit installation and bend leads if necessary, Sect 6.3, or return to KPI for evaluation and rebuild.</p>
	<p>Power supply (or a cable) has a short. If meter pegs (all the way up), there is probably a short.</p>	<p>Call KPI first for advice to isolate the problem. Check individual boards for shorts, see Sect 6.4. Check fuses, inspect elements. H.V. DANGER: DO NOT CHECK VOLTAGE DIRECTLY</p>
	<p>A cable has a short.</p>	<p>Unplug cable at both ends. Check leads with ohmmeter. Clean pins (Chemtronics Ultra Jet Duster or equivalent) Clean insulator with isopropanol.</p>
	<p>Main insulator in gun is contaminated.</p>	<p>(Meter behavior is initial test.) For higher power guns, partially disassemble and look for burn marks on large insulator. Insulator damage may require returning to KPI for rebuild.</p>
	<p>Burrs on firing unit or insulators cause field emission. If firing unit was just reinstalled or gun handled, unseen burrs may have been made which can rise up when high voltage is applied or when gun is heated.</p>	<p>(Meter behavior is initial test.) Run at high Energy for a while to burn off burrs. Remove gun and inspect for scratches.</p>
<p>NOTE: Excessive discharging may have caused further damage.</p>	<p>Backsurge of High Voltage can damage power supply elements.</p>	<p>Check main fuse, check driver boards for fuses or other burnt out elements, Sect 6.4</p>
	<p>Back bombardment by ions can damage cathode, especially coated or LaB₆.</p>	<p>After discharge problem is fixed, check if beam behavior is normal, check V-I characteristic graph. Observe cathode by removing gun from vacuum and looking in tube with microscope.</p>
	<p>For high power guns only: Cable acts like capacitor, charges up and can damage power supply.</p>	<p>Check main fuse, check driver boards for fuses or other burnt out elements, check potting compound in junction box. Check H.V. Supply (Gamma or Glassman) Sect 6.4 and H.V. Supply manual</p>

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.3 ENERGY

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
<p>Energy (read on DVM) does not increase when control is turned up.</p> <p>WARNING When troubleshooting the Energy supply: For higher-energy guns, do not go above 2000 eV, and for lower-energy guns, do not go above 400 eV.</p>	Energy supply not turned on, H.V. switch not on.	Press pushbutton H.V. in (should light, but bulb could be burned out).
	For multi-functional DVM: Function switch is not set correctly for DVM to display Energy supply.	Turn rotary Function switch next to DVM fully counterclockwise, so that LED next to Energy potentiometer is lighted.
	Energy control is set in remote mode.	Check switch inside, behind access panel on back of power supply: left for local manual control, not right for remote.
	Power supply is current limited.	Decrease beam current by reducing Source or increasing Grid, see if Energy returns.
	Power supply (or a cable) has a short. If meter pegs (all the way up), there is probably a short.	Call KPI first for advice to isolate the problem. Check individual boards for shorts, see Sect 6.4. Check fuses, inspect elements. H.V. DANGER: DO NOT CHECK VOLTAGE DIRECTLY
	A cable has a short.	Unplug cable at both ends. Check leads with ohmmeter. Clean pins (Chemtronics Ultra Jet Duster or equivalent) Clean insulator with isopropanol.
	For higher powered guns only: H.V. Supply is not supplying power or is limiting voltage.	H.V. Supply must be on. Check H.V. Supply connections, ON switch, and turn voltage fully clockwise.
Zero LED is on.	Energy is already turned up when H.V. power is first turned on.	Turn Energy potentiometer fully counterclockwise to zero. For FlexPanel controls, call KPI for advice on evaluating program through RS-232 port.
Energy decreases suddenly, when Source is turned up.	Emission current is too high, causing poly-fuse to trip.	Turn off Power Supply to reset poly-fuse, then turn back on. Run with slightly lower emission.
Energy decreases after a length of time running.	Poly-fuse has tripped due to excessive heat.	Turn off Power Supply to allow reset of poly-fuse, then turn back on. If it runs again for a little while, it must be the poly-fuse. Disconnect power supply. Remove cover and inspect elements to see what has overheated. See sine wave driver board troubleshooting, Sect 6.4. Replace poly-fuse on Source/ECC driver board, see Sect 6.4
	Power supply is current limited. Beam current increased as gun warmed up, so now current-limited.	Decrease beam current by reducing Source or increasing Grid, see if Energy returns.
	For higher powered guns only: H.V. Supply is current limited, causing voltage to drop.	Increase H.V. Supply current with its potentiometer (but full current may be too high for cathode). H.V. Supply voltage should be fully on, clockwise.

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The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.3 ENERGY cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
<p>When Energy is increased with no Source on, Emission current meter goes up (leakage current). Discharging in gun.</p> <p>WARNING: When troubleshooting the Energy supply: For higher-energy guns, do not go above 2000 eV, and for lower-energy guns, do not go above 400 eV.</p>	<p>A short in the gun (or cable), often source (filaments) to ground or grid to ground. If firing unit was just reinstalled, leads may be touching housing or each other. Short may be thermal.</p>	<p>Turn off system; disconnect ALL cables. With ohmmeter, check pins on gun (filament leads should be continuous, others open). Gun may need to be hot to see short; operate gun and check pins while hot. Pinout drawing at end of Sect 6.3. Check firing unit installation and bend leads if necessary, Sect 6.3 or return to KPI for evaluation and rebuild</p>
	<p>Power supply (or a cable) has a short. If meter pegs (all the way up), there is probably a short.</p>	<p>Call KPI first for advice to isolate the problem. Check individual boards for shorts, see Sect 6.4. Check fuses, inspect elements. H.V. DANGER: DO NOT CHECK VOLTAGE DIRECTLY</p>
	<p>A cable has a short.</p>	<p>Unplug cable at both ends. Check leads with ohmmeter. Clean pins (Chemtronics Ultra Jet Duster or equivalent) Clean insulator with isopropanol.</p>
	<p>Main insulator in gun is contaminated.</p>	<p>(Meter behavior is initial test.) For higher power guns, partially disassemble and look for burn marks on large insulator. Insulator damage may require returning to KPI for cleaning and rebuild.</p>
	<p>Burrs on firing unit or insulators cause field emission. If firing unit was just reinstalled or gun handled, unseen burrs may have been made which can rise up when high voltage is applied or gun is heated.</p>	<p>(Meter behavior is initial test.) Run at high Energy for a while to burn off burrs. Remove gun and inspect for scratches.</p>

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.4 EMISSION

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
NO emission current when the source is turned up.	Filament is not hot enough.	Wait longer for warm up. Gradually turn Source higher. Reactivate cathode by "hot shot" by turning Source to 10% over normal for a few minutes. Do not exceed recommended limit except briefly. Higher source currents cause a shorter lifetime. Call KPI to reset Zener limit.
	Grid is cutting off emission.	Turn grid to zero while setting source current, adjust grid to low value after emission is stable. (Guns with dual grid pulsing only) Check TTL input signal, and pulse toggle switch or invert switch if present.
	Vacuum is poor.	Check vacuum pump; wait for better vacuum (10^{-5} torr) before running gun.
	Energy is not high enough for potential to extract electrons/ions from emitter region.	Increase Energy. Adjust Anode if variable, not grounded.
	Cathode/ ion source (filament) is burnt out.	Monitor Source Volts and Source Amps meters, if voltage increases, but current is zero, an open filament is likely. (With higher voltage guns, current may not be zero, but V-I characteristics will be different than normal, compare with V-I graph in Data Section.) Check filament pins on gun connector with an ohmmeter to see if filament is no longer a closed loop. See pinout drawing at end of Sect 6.3. See also gun disassembly for firing unit replacement instructions, Sect 6.3.
	Cathode/ ion source is near end of its lifetime.	Check V-I characteristics. Vary Source Volts, record Source Amps, and compare with V-I graph in Data Section.
	Cathode/ ion source is contaminated.	Bake out gun. For some high power guns, repeat conditioning. Burn off contaminants by "hot shot", by turning Source to 10% over normal for a few minutes. Do not exceed recommended limit except briefly. Higher source currents cause a shorter lifetime. Call KPI to reset Zener limit.
	For coated cathodes only: Coating has been damaged by physical shock or back bombardment of ions during discharge or (for BaO) by atmosphere.	Remove gun and inspect cathode. See also gun disassembly for firing unit replacement instructions, Sect 6.3. Refer to BaO instruction sheet for care and handling of BaO cathodes; reactivation may be possible.
	For Alkali metal ION GUNS only: Solid chemicals in ion source cartridge are used up.	Gradual degradation of beam current should have been observed during previous operation. See gun disassembly for firing unit replacement instructions, Sect 6.3
	For Gas ION GUNS only: Ionization gas pressure is too low or not stable.	Check valves, lines, and gas meters. Increase pressure slowly. not too high. Let stabilize for 5 to 10 min, then recheck. Gas is too high if beam begins to jump around or has glow discharge.

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6.2 GENERAL TROUBLESHOOTING cont.

6.2.4 EMISSION cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Overcurrent LED is on.	Source current is too high, excessive current through cathode/ ion source.	Turn down Source. Check appropriate level for the cathode/ion source type. Call KPI to reset Zener limit.
Emission or Beam is drifting or is not stable.	Cathode/ ion source is still warming up.	Wait longer for warm up. For some high power guns, repeat conditioning procedures. For gas ion guns, go very slowly when adjusting admitted gas. Make small changes, and wait 5 to 10 min between.
	Energy, Source or Grid supply is fluctuating.	Observe meters. Ensure cables are well connected. If using remote, check that program signal is stable. Call KPI.
	Cathode/ ion source is contaminated.	Burn off contaminants by "hot shot", by turning Source to 10% over normal for a few minutes. Do not exceed recommended limit except briefly. Higher source currents cause a shorter lifetime. Bake out gun. For some high power guns, repeat conditioning procedures.
When Energy is increased with no Source on, Emission Current meter goes up (leakage current). Discharging in gun.	A short in the gun (or cable), often source (filaments) to ground or grid to ground. If firing unit was just reinstalled, leads may be touching housing or each other. Short may be thermal.	Turn off system; disconnect ALL cables. With ohmmeter, check pins on gun (filament leads should be continuous, others open). Gun may need to be hot to see short; operate gun and check pins while hot. Pinout drawing at end of Sect 6.3. Check firing unit installation and bend leads if necessary, Sect 6.3, or return to KPI for evaluation and rebuild.
	Main insulator in gun is contaminated.	(Meter behavior is initial test.) For higher power guns, partially disassemble and look for burn marks on large insulator. Insulator damage may require returning to KPI for rebuild.
	Burrs on firing unit or insulators cause field emission. If firing unit was just reinstalled or gun disassembled, unseen burrs may have been made which can rise up when high voltage is applied or when gun is heated.	(Meter behavior is initial test.) Run at high Energy for a while to burn off burrs. Remove gun and inspect for scratches.
Energy decreases suddenly, when Source is turned up.	Emission current is too high, causing poly-fuse to trip.	Turn off Power Supply to reset poly-fuse, then turn back on. Run with slightly lower emission.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.5 BEAM CURRENT

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
NO final beam current at the target.	No initial emission.	Check that Source is at usual setting, then see 6.2.4 above for Emission problems.
	Beam is not properly aligned. Beam is present, but not observable at target.	Check deflection, raster, rocker, or magnetic alignment settings. Adjust position of gun or Port Aligner. Move phosphor screen to see where beam is aimed.
	Near-by electromagnetic fields are deflecting beam.	Remove metal tools, magnets, etc. Shield gun with μ -metal (mu-metal).
	Energy is not high enough to set up enough potential to pull electrons/ions through the lenses.	Increase Energy. Check emission and beam graphs for different Energies in Data Section.
	A lens is acting as a mirror, reversing the electron/ion flow.	Adjust Focus and other bias voltages.
	Faraday cup assembly attached to gun is not retracted.	Cycle Faraday cup manipulator or pneumatic actuator to move cup in and out of beam line. Remove gun from vacuum with cup in closed position, move cup, and check linkage wire and Faraday cup alignment. Check hinge connections. See photo in Sect. 6.3.
	Beam blanker is shutting off (deflecting) beam.	Turn off blanker with pushbutton. If beam comes on, adjust blanker and TTL controls, if needed.
	A lens element is charging up and interfering with beam.	Look for signs of discharging, such as spikes in current.
Contamination is blocking beam path.	Bake out gun. Remove gun from vacuum and look down tube with a light, may be difficult to see. Return to KPI for evaluation and rebuild.	

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The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.5 BEAM CURRENT cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
LESS final beam current than expected.	Not enough emission current.	For most guns, the normal ratio of emission to beam is not 1:1. Increase SOURCE to increase emission current. (Higher currents mean shorter lifetime.) Refer to Data Section for graphs of Emission and Beam vs Source Current. See 6.2.4 above for Emission problems.
	Parameters, such as Focus, Grid etc, are not adjusted optimally so part of beam is being lost.	Adjust parameters. When one parameter is changed, others need to be adjusted, ex Focus varies with Energy. Refer to Data Section.
	It is not possible to achieve maximum beam current under all operating conditions.	Adjust parameters. Check performance graphs in Data Section.
	Beam is not properly aligned. Beam current is present, but not maximized at target.	Check deflection, raster, rocker, or magnetic alignment settings. Adjust position of gun or Port Aligner. Move phosphor screen to see where beam is aimed.
	Near-by electromagnetic fields are deflecting beam.	Remove metal tools, magnets, etc. Shield gun with μ -metal (mu-metal).
	For higher powered guns only, H.V. Supply is current limiting the main supply.	Adjust current potentiometer on H.V. Supply. If supply is current limiting, Energy will have dropped also.
	For coated cathodes only: Coating has been damaged.	Check if there has been physical shock, discharge, etc. recently. Remove gun and inspect cathode.

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The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.5 BEAM CURRENT cont.

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Beam or Emission is drifting or is not stable.	Cathode/ion source is still warming up.	Wait longer for warm up. For some high power guns, repeat conditioning procedures. For gas ion guns, go very slowly when adjusting admitted gas. Make small changes, and wait for 5 to 10 min between changes.
	Energy, Source or Grid supply is fluctuating.	Observe meters. Ensure cables are well connected. If using remote, check that program signal is stable. Call KPI.
	Cathode/ion source is contaminated.	Burn off contaminants by "hot shot", by turning Source to 10% over normal for a few minutes. Do not exceed recommended limit except briefly. Higher source currents cause a shorter lifetime. Bake out gun. For some high power guns, repeat conditioning procedures.
	For gas ion guns: Gas pressure has not stabilized or is too high. Excess gas may cause discharging.	Go very slowly when adjusting admitted gas. Reduce pressure.
Beam is unstable. Spot moves unexpectedly.	Insufficient ground on system.	Make sure entire system has good ground connections, especially with Viton gaskets.
	An exposed insulator in the vacuum system is charging up.	Remove any coated wires, glass, ceramic, or Teflon from near the beam path.
	Target not grounded, e.g. phosphor screen charging up.	Ensure that target is grounded.
	Raster or beam rocking is on.	Turn off Raster or Beam Rocking unit.
Problems with beam spot size or shape		See 6.2.9 Spot Size and Shape, below
Problems measuring beam with gun-mounted Faraday cup		See 6.2.14 Other Misc. Problems, below

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.6 INDIVIDUAL POWER SUPPLIES

Observed Symptom	Possible Problem	Test / Solution
Individual power supply (e.g. Grid, Focus, Deflection) does not turn on or its meter does not increase when its control is turned up.	Individual pushbutton or switch is need to energize system, before using potentiometer / control.	Use pushbutton or rocker switch: H.V. (for Energy & Focus), DEFL or DEF ON/OFF, SOURCE or ECC ON/OFF, BLANKER, PULSE (toggle switch) Button or switch should light when on.
	For multi-functional DVM: Function switch is not set correctly for DVM to display particular supply (Energy, Focus, X Deflection, Y Deflection, etc).	Turn rotary Function switch next to DVM so that LED next to potentiometer of desired supply is lit.
	Control is set in remote mode.	With terminal block remote, check switch inside unit, behind panel on back of power supply: LEFT for local manual control, not right for remote control. With small PROGRAMMING slide switches on back panel, check switch position LOCAL (down) not remote (up), for 50-pin external interface or 68-pin National Instruments.
	Fuse for individual driver board has blown.	Open rear access panel, slide out board, replace glass fuse (1 A, 0.5 A or 0.3 A). With FlexPanel unit, open top cover, replace surface mount fuse in mother board next to board See Sect. 6.4.
	Element on board is faulty.	See sine wave driver board troubleshooting, Sect. 6.4.
	Meter or meter protection circuit is faulty.	See if the gun responds to voltage change normally (by observing beam or spot), but there is no response on the individual meter.
After troubleshooting, supply does not provide usual output.	Boards were removed and replaced incorrectly	See sine wave driver board troubleshooting, Sect. 6.4. Check jumper position on board, and order of boards in slots.
Problems with Grid supply		See also 6.2.7 Grid and Pulsing, below
Problems with Source supply		See also 6.2.8 ECC and Source, below

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.7 GRID and PULSING

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Grid does not cut off the beam	Grid voltage is not high enough.	Gradually increase voltage. Check grid sweep graph in Data sect. Grid cutoff depends on Energy and other parameters
	Grid control is set in remote mode.	With terminal block remote, check switch inside unit, behind panel LEFT for local manual control, With small PROGRAMMING slide switches on back panel, check switch position LOCAL (down).
	The gun is not designed for grid cutoff.	Check grid sweep graph in Data section to see if cut off shown. Read theory section. Some electron guns have positive grid. Some guns produce too much current to cutoff completely, and so require Blanker.
Less emission or beam current than expected.	Grid is cutting off emission.	Turn grid to zero while setting source current, adjust grid to low value after emission is stable. (Guns with dual grid pulsing only) Check TTL and invert switch.
Pulsing not working.	Grid voltage not set correctly for cut-off. Required voltage varies with conditions, Energy.	Adjust Grid voltage. See Data for grid sweeps graphs.
	Pulse input (remote computer program, or TTL or pulse generator) not set up correctly	See sect 4.7 for how pulse input and grid control produce pulse for different types of pulsing
	Pulsing is working correctly, but pulse width or rep rate of pulse generator may too fast to see if trying to observe pulsing on phosphor screen.	Try longer pulses or slower rep rates. Observe using Faraday cup detector with oscilloscope.
	The gun is not designed for pulsing (no grid cutoff).	Check grid sweep graph in Data section to see if cut off shown. Read theory section. Some electron guns have positive grid (so require positive/negative power supply) . Some produce too much current to cutoff completely (so require Blanker).
With pulsing, grid volts or emission meter fluctuates or is not accurate.	(This is normal.) Meter may give averaged value or vary with pulse. With dual grids, only variable control grid value is shown.	Check meters with pulsing off. To see pulsed beam, use Faraday cup detector with oscilloscope.
Capacitive pulsing used to work, but grid no longer cuts off beam.	Insulator between cathode and Grid is contaminated.	Remove Pulse Junction Box (or cable or cylinder) and see if Grid cuts off normally with manual control.
	Pulse Junction Box or cable has faulty part or connection	Provide two known inputs to box and check that output is the sum. Call KPI.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.8 ECC and SOURCE

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Emission does not increase when Source/ECC is turned up.	Emission current has reached Zener limit set at factory to protect cathode/ion source. (This is normal.)	Check appropriate level for the cathode/ion source type. Change to Source mode, but do not exceed recommended limit. Call KPI to reset Zener limit.
ECC does not work when beam is pulsed.	ECC must not be used with pulsing. The varying emission can cause the circuitry to go into a positive feedback loop.	Use Source mode with pulsing.
Source/ECC does not go up as high as expected.	The full range of the potentiometer is set to be less than the meter, eg. Source Volts meter may have a 2 V face, but control is only 0 to 1.5 V.	See Drawing section schematics for supply ranges. Limited source is to protect cathode/ion source.
(For gas ion guns only) Ion emission varies even though ECC is being used.	ECC is designed to control the electron emission which then ionizes the gas, but other factors, especially gas pressure, also affect ion emission and ion beam current.	Set up conditions first without ECC. Wait for warm up and adjust gas pressure gradually, not too high. Let stabilize for 5 to 10 min, then recheck. Then use ECC when stable. Carefully regulate introduced gas pressure, as above.
Operating parameters have changed drastically over time; more Source is needed for a given emission level.	Cathode/ion source is near end of its lifetime. Depletion of emitting material has occurred.	Check V-I characteristics. Vary Source Volts, record Source Amps, and compare with V-I graph in data section. See also gun disassembly for firing unit replacement instructions, Sect 6.3.
	Contaminants have built up on apertures.	Bakeout gun, and see if improve. Look for phosphors and other debris on gun and in vacuum chamber. Disassemble gun and clean, or send to KPI for rebuild. See gun disassembly instructions, Sect 6.3, some guns also Sect 6.5.
Cathode/ ion source burns out quickly	Source current is too high, so filament is running too hot.	Check parameters and compare with graphs in Data Section. Use lowest Source Amps possible, keep current below recommended limit.
	Zener limit on ECC board is set incorrectly for that particular cathode/ ion source, so source current is running too high and filament is too hot.	When cathode or ion source is replaced, Zener limit may need to be recalibrated. Call KPI to reset Zener limit. Check parameters in Source mode before using ECC mode.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.9 SPOT SIZE and SHAPE

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Spot is not the desired size.	For FLOOD guns only: By design, spot size is not directly controllable, depends on parameters and working distance.	Adjust grid (may also change beam current). Move target to change working distance.
	For FOCUSABLE guns only: Focus is not adjusted optimally, needs to be readjusted when other parameters changed.	Adjust Focus or 1st Anode (G-2) or Extract control. Also adjust Grid. See Theory section and spot size graphs in Data section. Focus varies with Energy and other parameters. For some guns, there are two values which produce the minimum spot for given conditions.
	It is not possible to achieve the minimum spot size under all operating conditions.	Adjust parameters. Check performance graphs in Data Section.
	Near-by electromagnetic fields or 60-cycle noise are vibrating beam so it covers larger area.	See if spot appears fuzzy. Temporarily turn off near-by equipment, ex fans, or run gun at different time of day. Shield gun with μ -metal (mu-metal).
Beam spot shape is not round.	The gun elements are out of alignment or tilted.	Vary spot size and move beam, see if edge of spot is cut off by a curve. Look in end of gun to see the positions cathode/ion source and lens if possible; use an otoscope.
	Near-by electromagnetic fields are distorting beam.	Remove metal tools, magnets, etc. Shield gun with μ -metal (mu-metal).
	Deflection lens is distorting spot shape.	Vary Deflection and/or Focus. Use less Deflection.
	Part of phosphor screen is not emitting light.	Deflect beam relative to screen. Replace or recoat screen
	Debris on the cathode/ion source or lenses.	Deflect beam; see if spot has a rough edge or dark spot that moves with it. See also gun disassembly instructions sect 6.3 to disassemble gun for cleaning, blow off apertures.
	For LaB ₆ cathodes only: Edges of the crystal are interfering, forming a Maltese Cross pattern.	Adjust alignment, grid and focus to get a small spot; the cross is seen only with a large, unfocused spot.
Beam is unstable. Spot moves unexpectedly.	Insufficient ground on system.	Make sure entire system has good ground connections, especially with Viton gaskets.
	An exposed insulator in the vacuum system is charging up.	Remove any coated wires, glass, ceramic, or Teflon from near the beam path.
	Target not grounded, e.g. phosphor screen charging up.	Ensure that target is grounded.
	Raster or beam rocking is on.	Turn off Raster (RGDU) or Beam Rocking unit.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.10 REMOTE CONTROL

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
A remote or computer signal to power supply has NO effect.	Control is set in manual (local) mode.	<p>With small PROGRAMMING slide switches on back panel, check switch position--REMOTE (up), for 50-pin external interface or 68-pin National Instruments, LOCAL (down) for front FlexPanel controls and for RS-232 or RS-422/RS-485.</p> <p>With terminal block remote, check switch inside unit, behind panel on back of power supply--RIGHT for remote control, not left for local manual control.</p>
	Connections are needed to COM terminals or ground pins, as well as PROG, for each supply being programmed.	Connect COM terminals or ground pins to ground.
	For RS-232, RS-422 or RS-485, control is set in remote (external) mode.	With small PROGRAMMING slide switches on back panel, check switch position-- LOCAL (down) for communication with internal FlexPanel, not remote.
	For RS-232, RS-422 or RS-485, program type does not match serial port setting.	Standard setting is RS-232. Check indicator LED, if unit has option of RS-422/RS-485
A remote or computer signal to power supply does not have desired effect.	Program input is incorrect.	<p>Check tables for power supply ranges in Sect 4.4. Check program. Calculate input using following proportion, Input volts : 10 V = desired output : range</p>
	Standard cable is used with RS-232 nine-pin D-sub.	Use null-modem cable for RS-232, Use standard for RS-422/RS-485.
	FlexPanel internal programming needs updated revision.	<p>Check software version# installed; use MENU, then Display system info. Consult KPI for any updates, load new software through serial port.</p>

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.11 DEFLECTION and RASTERING

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Deflection does not center beam.	Near-by electromagnetic fields are distorting beam path.	Remove metal tools, magnets, etc. Temporarily turn off near-by equipment or run gun at a different time of day. Shield gun with μ -metal (mu-metal).
Deflection does not move the beam far enough.	Deflection voltage is designed to make only slight change in beam path, a few degrees.	Check specifications. Too much change would affect spot size and shape. Mechanical method may be needed for positioning.
	Optional Hi/Low Deflection switch is set at Low	Change switch to High.
Raster will not turn on.	Switch inside RGDU is set incorrectly.	Unplug RGDU, open cover and check switch position Synchronized / Off / Non-synchronized mode, Sect 4.6
Raster pattern is not synchronized.		
Raster or Deflection is not giving usual results.	Incorrect cable is being used. Deflection and Raster cables have same pinout, but different construction (PVC-coated wire for deflection; coaxial cable for raster).	Check cables, should have label attached.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.12 ION GUNS

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Emission or beam is not stable.	For GAS ion guns: Gas pressure has not stabilized.	Go very slowly when adjusting admitted gas. Make small changes, and wait for 5 to 10 min between changes.
	For GAS ion guns: Gas pressure is too high, causing unstable electron emission or interfering with ion extraction. Excess gas may cause discharging.	Reduce pressure of gas admitted. Check Data Section for typical pressures (if measured at a different site, pressures may not be comparable).
	For GAS ion guns: Pressure regulators on tanks, tubes, or valves etc are faulty. Swagelock on gas inlet can be damaged by over tightening.	Check gas system. Redo connections. Inspect gas inlet valve; if copper gasket is cut it was over tightened, replace it.
	For GAS ion guns: Optional Variable leak valve is delicate and easily damaged.	See enclosed Variable leak valve manual for instructions.
	For ALKALI METAL ion guns: It takes time to reach full emission due to heat capacity of solid cartridge. ECC responds faster than cartridge heats so emission may oscillate.	When adjusting Source or ECC make small changes and wait 1 to 2 min. If large changes are made wait 5 min.
Emission and beam fluctuates rapidly. Discharging in gun.	For GAS ion guns: If there is excessive gas pressure, un-ionized gas can be present in the gun column and cause discharging or become ionized. These ions will not have the same energy or path as those emitted normally from the ion source.	Adjust gas pressure. Glow discharge may be visible.
Problems with optional Variable Leak Valve		See enclosed Variable leak valve manual for instructions.
For problems common to all guns.		See other tables

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.13 CABLES and CONNECTORS

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Cable is not supplying power.	Connections are poor.	With system turned off, disconnect cable at both ends. Check connectors for bent or loose pins. Clean pins (with Chemtronics Ultra Jet Duster or equivalent). Clean insulators with isopropanol and lint-free cloth. Reconnect cable, check that connections are tight, but do not force. On some guns, it is difficult to line up key, so connector may not be all the way in.
	Cable has a short. Wiring can be broken by cable being sharply bent or connector end being twisted.	With system off, disconnect cable at both ends. Check leads at opposite ends with ohmmeter. See Drawing section for pinouts in block diagram.

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

6.2 GENERAL TROUBLESHOOTING cont.

6.2.14 OTHER MISC. PROBLEMS

(Gun Color, Faraday Cups, Power Supply Lighting)

OBSERVED SYMPTOM	POSSIBLE PROBLEM	TEST / SOLUTION
Gun has discolored over time.	Repeated bakeouts can discolor stainless steel. (This is normal.)	Color is brownish. Gun can be disassembled and cleaned (with solution such as Micro-90 and distilled water). This does not affect performance.
	Material from target or phosphor screen has coated gun. This can affect cathode/ion source or apertures.	Phosphorescence or appearance is like target material. Bake out gun. Gun can be disassembled and cleaned, or returned to KPI for rebuild.
Faraday cup assembly on gun will not move in or out of beam line.	Fragile hinge has broken or become disconnected, due to extended use or being knocked.	Carefully remove gun from vacuum. Inspect hinge connections. See photo in Sect. 6.3. Also check linkage wire and Faraday cup alignment.
	Not enough room for Faraday cup to move.	Check clearance in vacuum chamber.
	Faraday cup pneumatic actuator is not functioning.	If manual control is available, try cycling several times. Check tubing. Remove gun from vacuum, check connections and activate. Actuator can be damaged by bakeout (over 65°C) and should be removed.
	Faraday cup rotary feedthrough is not connected to linkage wire.	Remove gun from vacuum, push wire into feedthrough tightly, check connections and rotate.
Faraday cup used to work, but no longer measures current.	Faraday cup or electrical connections have been damaged, possibly by excessive power.	Remove gun from vacuum with cup in the closed position. Inspect cup and wires for melting.
	Connections are loose or shorted.	Remove gun from vacuum with cup in the closed position. Check cup and connections. See photo in Sect. 6.3.
All meters are too bright or too dim.	For analog meters, brightness potentiometer is not set for room conditions.	Adjust potentiometer with screwdriver through small hole next to meters.
	For Flexpanel display, screen brightness is not set for room.	Click red menu button, choose set brightness, and reset (scale 1 to 4)
Analog meter does not light up.	Bulb is burnt out.	Unplug Power Supply, remove front panel and remove entire meter. For supplies with adjustable lighting, return meter to KPI to replace light/calibrate. (With older-style power supplies, remove front panel and replace 28 V bulb.)
A pushbutton/switch does not light up.	Bulb is burnt out.	Pull off plastic pushbutton cover, and replace 28 V incandescent bulb (14 V on some units). Rocker switches do not have bulbs, call KPI

The gun and/or power supply can be returned to Kimball Physics for evaluation and rebuild.

This completes the Troubleshooting Tables.