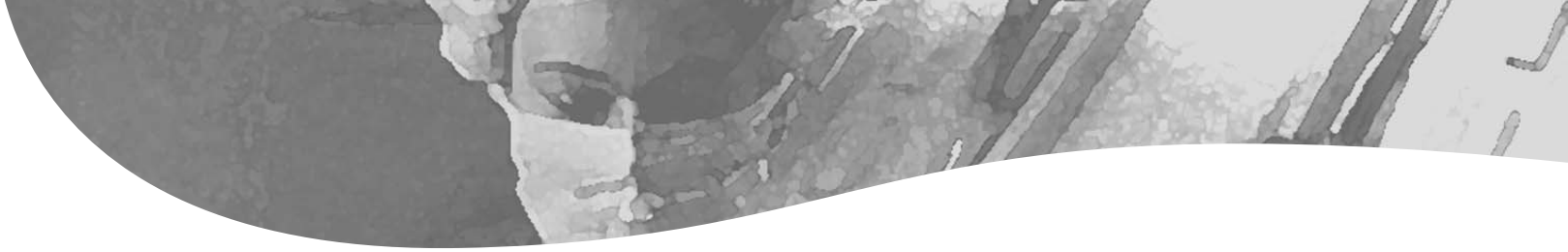

Valleylab™

Service Manual

ForceTriad™

Energy Platform

This manual and the equipment it describes are for use only by qualified medical professionals trained in the particular technique and surgical procedure to be performed. It is intended as a guide for servicing the Valleylab ForceTriad™ energy platform only. Additional users information is available in the ***ForceTriad™ Energy Platform User's Guide***.

Caution

Federal (USA) law restricts this device to sale by or on the order of a physician.

Equipment covered in this manual
ForceTriad™ energy platform

The ***ForceTriad Energy Platform Service Manual*** consists of two parts - the text (part 1 of 2) and a schematics supplement (part 2 of 2), which contains the schematics.

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Effective Date May 2009

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Conventions Used in this Guide

Warning

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

Notice

Indicates a hazard which may result in product damage.

Important

Indicates *an operating tip or maintenance suggestion.*

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The warranty periods for Valleylab products are as follows:

ForceTriad™ Energy Platform	One year from date of shipment
Electrosurgical Generators	One year from date of shipment
RFG-3C™ Plus Lesion Generator	One year from date of shipment
LigaSure™ Vessel Sealing System	One year from date of shipment
LigaSure™ Reusable Instruments	One year from date of shipment
Mounting Fixtures (all models)	One year from date of shipment
Footswitches (all models)	One year from date of shipment
Force Argon™ Units	One year from date of shipment
RapidVac™ Smoke Evacuator	One year from date of shipment
LigaSure™ Sterile Single Use Items	Sterility only as stated on packaging
Sterile Single Use Items	Sterility only as stated on packaging
Patient Return Electrodes	Shelf life only as stated on packaging

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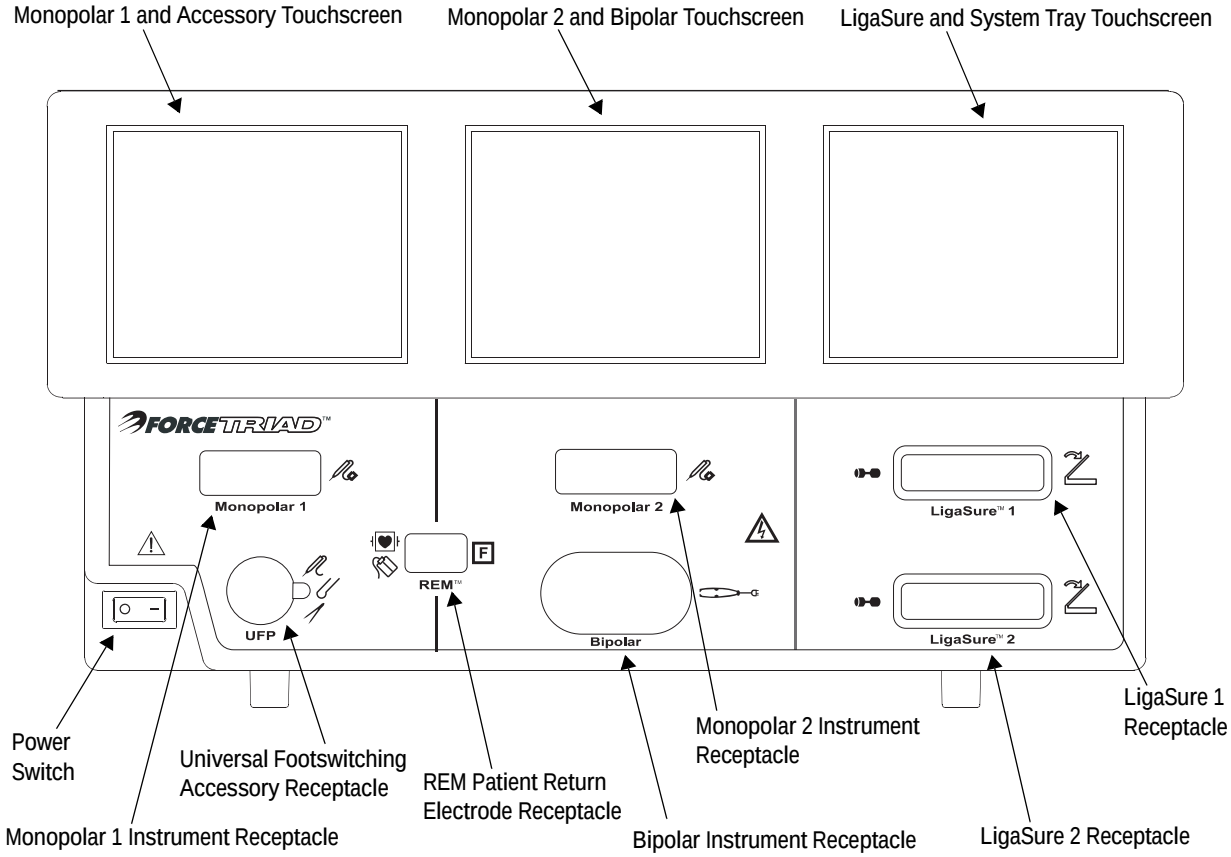
Chapter 1

ForceTriad Energy Platform Overview and General Features

This chapter provides an overview of the features and functions of the ForceTriad energy platform.

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

ForceTriad Energy Platform Front Panel



Introduction

The ForceTriad energy platform is designed to provide RF energy for monopolar and bipolar surgical applications and tissue-fusion applications. It features three touchscreen user interfaces, and has the ability to automatically detect handsets and configure the generator accordingly. Safety and diagnostic functionality include automatic fail-safe functions.

List of Components

The ForceTriad energy platform is a self-contained unit, consisting of a main enclosure (cover and base) and power cord. The main components are:

- Front panel components
- Rear panel components
- Internal components

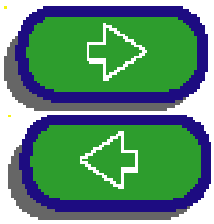
Details about the interaction of the main components and PCBA descriptions are provided in Chapter 5, *Principles of Operation*.

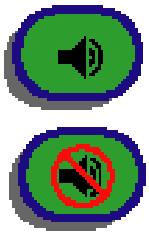
System Conventions

Touchscreens

The ForceTriad energy platform features a user-friendly interface with three touchscreens that allow the user to control system functions. The active touchscreen or touchscreens will illuminate, and the unavailable touchscreens will dim.

Common Symbols

Symbol	Name	Description
	Page Up/Page Down	Scroll through blocks of options that cannot be displayed on a single screen.
	Up/Down	Pressing once increases/decreases the associated value or moves highlighted selection up/down one line. Pressing and holding scrolls up/down.
	Next/Back	Progresses/regresses to the next screen.
	Back Space	Regresses one character.

Symbol	Name	Description
	Bipolar Mute On/Off	Turn on/off the audio tones produced by the system that indicate the increase or decrease of current during a bipolar procedure.
	Cancel	Cancels current screen and returns to the previous screen.
	Enter	Accepts and initiates current selections.
	System Tray	The system tray contains controls that allow you to access and adjust system settings including screen brightness and main menu options.
	Brightness	Each selection of this button adjusts the screen brightness to the next of the two available brightness settings. When maximum brightness is reached, next selection resets to the least bright setting.
	Wrench	Select access to the main menu, which provides user-selected options for language, appearance, and operation.
	Errors Disabled	This icon on a yellow background overlays the screen when error warnings have been disabled using the service menu. The generator will not alarm or give error conditions when this symbol is activated. Touching the screen removes the icon for five seconds.

Note: Additional information on symbols may be found in the *Technical Specifications* chapter in this manual.

Power Modes

As a safety feature to prevent unexpected power delivery spikes, simultaneous activation of multiple instruments is not possible on the ForceTriad energy platform.

Monopolar Modes

The ForceTriad energy platform produces five different modes of power output.

Cut Modes

Pure cut provides a clean, precise cut in any tissue with little or no hemostasis.

Blend cut is a conventional blended waveform that provides slower cutting and additional hemostasis.

Valleylab Mode

Valleylab mode is a unique combination of hemostasis and dissection and allows the user to slow down for more hemostasis and speed up for faster dissection. Thermal spread is equal or superior to Cut or Blend modes.

Coag Modes

Fulgurate coagulates tissue by sparking from the active electrode, through air, to the patient tissue. Since sparks may spray unpredictably from the electrode during fulguration, using fulguration for delicate tissue or in confined areas can complicate surgery. Accidental sparking to adjacent areas can occur as tissue at the surgical site dries and becomes more resistant to current flow.

Spray delivers wider fulguration; penetration is shallower and the affected tissue area is larger than with the Fulgurate mode.

Bipolar Modes

Three bipolar modes are available: Low, Standard, and Macrobipolar.

Low delivers precision and fine control over the amount of desiccation.

Standard is a conventional bipolar output at low voltage.

Macro (Macrobipolar) may be used for bipolar cutting or rapid coagulation. Power remains constant over a wide range of tissue types.

Autobipolar

The autobipolar feature senses tissue impedance between the two bipolar electrodes, then uses the impedance information to automatically start or stop bipolar RF energy delivery. Optionally, the user may choose between footswitch start and auto start, or program a delay between auto start and RF activation.

Note: When using Autobipolar, the tissue in the grasp of the bipolar device must have an impedance within 20 Ω and 1,000 Ω. The activation impedance safety feature will not deliver RF power to the tissue if it is not within the specified range. This is a factory-set value that cannot be reset by the user.

LigaSure Mode

The LigaSure tissue fusion mode can be used on arteries, veins, pulmonary vasculature, and lymphatics up to and including 7 mm in diameter and tissue bundles. This system provides precise energy delivery and electrode pressure to vessels for a controlled time period to achieve a complete and permanent fusion of the vessel lumen. The system has been designed to produce minimal sticking, charring, or thermal spread to adjacent tissue.

Warning

Do not attempt to fuse lung tissue with LigaSure mode or instruments.

LigaSure Instruments

The LigaSure instruments that complete the ForceTriad tissue fusion system include multiple reusable and single use instruments for open and laparoscopic procedures. Each reusable instrument requires a corresponding single use electrode. The LigaSure function is only available when using Valleylab LigaSure instruments.

Chapter 2

Patient and Operating Room Safety

The safe and effective use of electrosurgery depends to a large degree upon factors solely under the control of the operator. There is no substitute for a properly trained and vigilant surgical team. It is important that the operating instructions supplied with this or any electrosurgical equipment be read, understood, and followed.

Electrosurgery has been used safely in millions of procedures. Before starting any surgical procedure, the surgeon should be trained in the particular technique and surgical procedure to be performed, should be familiar with the medical literature related to the procedure and potential complications, and should be familiar with the risks versus the benefits of utilizing electrosurgery in the procedure.

General

Setting Up the System

Warning

Electric Shock Hazard Connect the system power cord to a properly grounded power receptacle. Do not use power plug adapters.

Fire Hazard Do not use extension cords.

Patient Safety Use the energy platform only if the power-up self-test has been completed as described in this manual, otherwise inaccurate power outputs may result.

Caution

When using a smoke evacuator in conjunction with the ForceTriad energy platform, set the system volume control at a level that ensures that the activation tones can be heard.

Connect only Valleylab-approved footswitches. Using footswitches from other manufacturers may cause equipment malfunction.

Warning

Hazardous Electrical Output This equipment is for use only by trained, licensed physicians.

Do not use electrosurgical equipment unless properly trained to use it in the specific procedure being undertaken. Use of this equipment without such training can result in serious, unintended patient injury, including bowel perforation and unintended, irreversible tissue necrosis.

Always use the lowest power setting that achieves the desired surgical effect. The active electrode should be utilized only for the minimum time necessary in order to lessen the possibility of unintended burn injury. Accidental and unintended burn injury has occurred during procedures in small surgical fields and on small appendages. Pediatric applications and/or procedures performed on small anatomic structures may require reduced power settings. The higher the current flow and the longer the current is applied, the greater the possibility of unintended thermal damage to tissue, especially during use on small structures.

Do not wrap the instrument cords or patient return electrode cords around metal objects. This may induce currents that could lead to shocks, fires, or injury to the patient or surgical team.

Electric Shock Hazard Do not connect wet instruments to the energy platform. Ensure that all instruments and adapters are correctly connected and that no metal is exposed at any connection points.

Confirm proper power settings before proceeding with surgery. If the proper power settings are not known, set the power to a low setting and cautiously increase the power until the desired effect is achieved. If increased power settings are requested, check the patient return electrode and all instrument connections before major power setting adjustments.

Warning

Contact between the active electrode and any metal will greatly increase current flow and can result in unintended surgical effect.

While using electrosurgery, the patient should not be allowed to come into direct contact with grounded metal objects (e.g., surgical table frame, instrument table, etc.). If this is not possible during certain procedures (e.g., those in which noninsulated head frames are used), use extreme caution to maximize patient safety:

- Use the lowest power setting that achieves the desired effect.
- Place the patient return electrode as close to the surgical site as possible.
- Place dry gauze between the patient and the grounded object if possible.
- Continually monitor the contact point(s).
- Do not use metal needle monitoring electrodes.

Caution

Read all warnings, cautions, and instructions provided with this energy platform before using.

Read the instructions, warnings, and cautions provided with electrosurgical instruments before using. Specific instructions for electrosurgical instruments are not included in this manual.

For surgical procedures where the current could flow through delicate parts of the body, the use of bipolar techniques may be desirable in order to avoid unwanted coagulation.

Examine all instruments and connections to the system before using. Ensure that the instruments function as intended. Improper connection may result in arcs, sparks, instrument malfunction, or unintended surgical effects.

Do not turn the activation tone down to an inaudible level. The activation tone alerts the surgical team when the energy platform is delivering RF energy.

A non-functioning ForceTriad energy platform may cause interruption of surgery. A backup system should be available for use.

Studies have shown that smoke generated during electrosurgical procedures can be potentially harmful to patients and the surgical team. These studies recommend adequately ventilating the smoke by using a surgical smoke evacuator or other means. [a]

Inadvertent activation may occur while installing, removing, or bending electrodes. Ensure that the instrument cord is not connected to the ForceTriad energy platform or that the system is OFF.

a. U.S. Department of Health and Human Services. National Institute for Occupational Safety and Health (NIOSH). Control of Smoke from Laser/Electric Surgical Procedures. HAZARD CONTROLS, Publication No. 96-128, September, 1996.

Notice

Connect the power cord to a properly grounded power receptacle having the correct voltage. Otherwise, product damage may result.

Important

If required by local codes, connect the energy platform to the hospital equalization connector with an equipotential cable.

Fire/Explosion Hazard

Warning

Danger: Explosion Hazard Do not use electrosurgery in the presence of flammable anesthetics.

Fire Hazard Do not place active instruments near or in contact with flammable materials (such as gauze or surgical drapes). Electrosurgical instruments that are activated or hot from use can cause a fire. When not in use, place electrosurgical instruments in a safety holster or safely away from patients, the surgical team, and flammable materials.

Warning

Fire Hazard Sparking and heating associated with electrosurgery can be an ignition source. Keep gauze and sponges wet. Keep electrosurgical electrodes away from flammable materials and oxygen (O_2) enriched environments.

Use of electrosurgery in O_2 rich environments increases the risk of fire. Therefore, take measures to reduce the O_2 concentration at the surgical site.

Avoid enriched O_2 and nitrous oxide (N_2O) atmospheres near the surgical site. Both O_2 and N_2O support combustion and may result in fires and burns to patients or surgical personnel.

If possible, stop supplemental oxygen at least one minute before and during use of electrosurgery.

Do not activate the energy platform until flammable vapors from skin prep solutions and tinctures have dissipated.

Avoid the accumulation of naturally occurring flammable gases that may accumulate in body cavities such as the bowel.

Prevent pooling of flammable fluids and the accumulation of flammable or oxidizing gases or vapors under surgical drapes or near the surgical site.

Tissue buildup (eschar) on the tip of an active electrode may create embers that pose a fire hazard, especially in oxygen enriched environments. Keep the electrode clean and free of all debris.

Facial and other body hair is flammable. Water soluble surgical lubricating jelly may be used to cover hair close to the surgical site to decrease flammability.

Verify that all anesthesia circuit connections are leak free before and during use of electrosurgery.

Fire Hazard During Oropharyngeal Surgery

Verify endotracheal tubes are leak free and that the cuff seals properly to prevent oxygen leaks.

If an uncuffed tube is in use, pack the throat with wet sponges around the uncuffed tube, and be sure to keep sponges wet throughout the procedure.

Question the need for 100% O_2 during oropharyngeal or head and neck surgery.

If necessary, scavenge excess O_2 with separate suction.

Energy Platform

Warning

Each instrument receptacle on this energy platform is designed to accept only one instrument at a time. Do not attempt to connect more than one instrument at a time into a receptacle. Doing so will cause simultaneous activation of the instruments. Follow the instructions provided with electrosurgical instruments for proper connection and use.

Caution

Do not stack equipment on top of the energy platform or place the energy platform on top of electrical equipment. This is an unstable configuration and does not allow for adequate cooling.

Caution

Provide as much distance as possible between the energy platform and other electronic equipment (such as monitors). Do not cross or bundle electronic device cords. This energy platform may cause interference with other electronic equipment.

Active instruments

Caution

Read the instructions, warnings, and cautions provided with electrosurgical instruments before using. Specific instructions for electrosurgical instruments are not included in this manual.

Inspect instruments and cords for breaks, cracks, nicks, and other damage before every use. If damaged, do not use. Damaged instruments or cords may result in injury or electrical shock to the patient or surgical team.

Use only instruments that can withstand the maximum output (peak) voltage for each output mode as listed in the *Technical Specifications* chapter in this manual. Using an instrument with a voltage rating that is lower than the maximum output voltage may result in injury to the patient or the operator, or damage to the instrument.

All Valleylab instruments have voltage ratings that are greater than the maximum output voltages in the ForceTriad energy platform and are thus fully compatible.

Information on voltage ratings for non-Valleylab instruments should be obtained from the instrument's manufacturer.

Pacemakers and ICDs

Warning

Use electrosurgery and tissue fusion with caution in the presence of internal or external pacemakers. Interference produced by the use of electrosurgical devices can cause a pacemaker to enter an asynchronous mode or can block the pacemaker effect entirely. Consult the pacemaker manufacturer or hospital cardiology department for further information when use of electrosurgery or tissue fusion appliances is planned in patients with cardiac pacemakers.

If the patient has an implantable cardioverter defibrillator (ICD), contact the ICD manufacturer for instructions before performing an electrosurgical or tissue fusion procedure. Electrosurgery or tissue fusion may cause multiple activations of ICDs.

After Surgery

Warning

Electric Shock Hazard Always turn off and unplug the energy platform before cleaning.

Caution

Do not reprocess, reuse or resterilize instruments labeled “disposable” or “single use only.”

Notice

Do not clean the energy platform with abrasive cleaning or disinfectant compounds, solvents, or other materials that could scratch the panels or damage the energy platform.

Monopolar

Warning

Simultaneously activating suction/irrigation and electrosurgical current may result in increased arcing at the electrode tip, burns to unintended tissues, or shocks and burns to the surgical team.

Some surgeons may elect to “buzz the hemostat” during surgical procedures. It is not recommended, and the hazards of such a practice probably cannot be eliminated. Burns to the surgeon’s hands are possible. To minimize the risk take these precautions:

- Do not “buzz the hemostat” with a needle electrode.
- Do not lean on the patient, the table, or the retractors while buzzing the hemostat.
- Activate cut rather than coag. Cut has a lower voltage than coag.
- Firmly grasp as much of the hemostat as possible before activating the energy platform. This disperses the current over a larger area and minimizes the current concentration at the finger tips.
- “Buzz the hemostat” below hand level (as close as possible to the patient) to reduce the opportunity for current to follow alternate paths through the surgeon’s hands.
- Use the lowest power setting possible for the minimum time necessary to achieve hemostasis.
- Activate the energy platform after the instrument makes contact with the hemostat. Do not arc to the hemostat.
- When using a coated or nonstick blade electrode, place the edge of the electrode against the hemostat or other metal instrument.

Patient Return Electrodes

Warning

Do not attempt to use patient return electrodes that disable the REM system. The ForceTriad energy platform's REM system will function correctly only with contact quality monitoring (CQM) split-style patient return electrodes. Any other patient return electrode products may cause patient injury or product damage.

The safe use of monopolar electrosurgery requires proper placement of the patient return electrode. To avoid electrosurgical burns beneath the patient return electrode, follow all directions provided with the product.

Do not cut a patient return electrode to reduce its size. Patient burns due to high current density may result.

A patient return electrode is not necessary in bipolar or LigaSure procedures.

To avoid patient burns, ensure that the patient return electrode firmly and completely contacts the skin. Always check the patient return electrode periodically and after the patient is repositioned and during procedures involving long periods of activation.

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) will increase the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Notice

Capacitive pads and other non-CQM patient return electrodes may not work with the ForceTriad energy platform.

Important

A statement of compatibility from the CQM patient return electrode manufacturer should be obtained prior to the use of a non-Valleylab CQM patient return electrode.

Inadvertent Radio Frequency (RF) Burns

Warning

Electrodes and probes used with monitoring, stimulation, and imaging devices (or similar equipment) can provide a path for high frequency current even if the electrodes or probes are isolated at 50-60 Hz, insulated, and/or battery operated.

Do not use needles as monitoring electrodes during electrosurgical procedures. Inadvertent electrosurgical burns may result.

To reduce the risk of an inadvertent electrosurgical burn at the electrode or probe site, place the electrode and/or probe as far away as possible from the electrosurgical site and/or patient return electrode. Protective impedances (resistors or RF inductors) installed in the monitoring leads may reduce the risk of such burns. Consult the hospital biomedical engineer for further information.

Warning

In some circumstances, the potential exists for alternate site burns at points of skin contact (e.g., between the arm and the side of the body). This occurs when electrosurgical current seeks a path to the patient return electrode that includes the skin-to-skin contact point. Current passing through small skin-to-skin contact points is concentrated and may cause a burn. This is true for ground referenced and isolated output electrosurgical energy systems.

To reduce the potential for alternate site burns, do one or more of the following:

- Avoid skin-to-skin contact points, such as fingers touching leg or knee touching knee when positioning the patient.
- Place insulation, such as dry gauze or towel, between contact points to ensure that contact does not occur.
- Position the patient return electrode to provide a direct current route between the surgical site and the return electrode which avoids skin-to-skin contact areas.
- In addition, place patient return electrodes according to the manufacturer's instructions.

Bipolar

Caution

Bipolar instruments must be connected to the bipolar instrument receptacle only. Improper connection may result in inadvertent system activation.

LigaSure

Warning

LigaSure instruments are intended for use ONLY with the Valleylab ForceTriad energy platform and the Valleylab LigaSure vessel sealing system. Use of these instruments with other Valleylab generators or with generators produced by other manufacturers may not result in electrical output for which these instruments were designed and thus may not result in the desired clinical effect.

If the seal cycle complete tone has not sounded, an optimal seal may not have been achieved. Reactivate the RF energy until a seal complete tone is heard.

The LigaSure tissue fusion function has not been shown to be effective for tubal sterilization or tubal coagulation for sterilization procedures. Do not use this function for these procedures.

Use caution during surgical cases in which patients exhibit certain types of vascular pathology (atherosclerosis, aneurysmal vessels, etc.). For best results, apply the seal to unaffected vasculature.

Do not activate the energy platform in the LigaSure mode until the tissue fusion instrument has been applied with the proper pressure. Activating the energy platform before this is done will result in an improper seal and may increase thermal spread to tissue outside the surgical site.

Warning

Tissue fusion requires the application of RF energy and pressure from the instrument. Tissue to be sealed must be firmly grasped between the instrument jaw electrodes. Tissue in the jaw hinge or outside the instrument jaw will not be sealed even if thermal blanching occurs.

Do not use LigaSure instruments on vessels in excess of 7 mm in diameter.

LigaSure instruments that require single use electrodes must be used with the correct electrode type. Use of these instruments with any other electrodes could result in injury to the patient or surgical team, or cause damage to the instrument.

Conductive fluids (e.g, blood or saline) in direct contact with LigaSure instruments or in close proximity may carry electrical current or heat, which may cause unintended surgical effects or burns.

Caution

Energy based devices, such as electrosurgical pencils or ultrasonic scalpels, that are associated with thermal spread should not be used to transect seals.

Avoid placing fingers in the handle ratchet mechanism. Injury to the user may result.

LigaSure in Laparoscopic Procedures

Warning

For laparoscopic procedures, be alert to these potential hazards:

- The external surfaces of the LigaSure instrument jaws may remain hot enough to cause burns after the RF current is deactivated.
- Inadvertent activation or movement of the activated LigaSure instrument outside of the field of vision may result in injury to the patient.
- Do not activate the instrument while the instrument jaws are in contact with, or in close proximity to, other instruments including metal cannulas, as localized burns to the patient or physician may occur.
- Do not activate the LigaSure function in an open circuit condition. Activate the energy platform only when the instrument is near or in direct contact with the target tissue to reduce the possibility of unintended burns.
- Carefully insert and withdraw LigaSure instruments from cannulas to avoid possible damage to the devices and/or injury to the patient.

Servicing

Warning

Electric Shock Hazard Do not remove the energy platform cover. Contact authorized personnel for service.

Notice

Refer to this system's service manual for maintenance recommendations and function and output power verification procedures.

Shunt Cords

Warning

Some surgical instruments (e.g., colonoscopes) may allow substantial leakage current that could burn the surgeon. If the instrument manufacturer recommends the use of a shunt cord (s-cord) to direct the current back to the energy platform, you must also use a Valleylab E0507-B adapter. To avoid a REM alarm, you must use a REM patient return electrode with the E0507-B adapter.

Procedures Where Conductive Fluid is Introduced into the Surgical Site

Warning

When this energy platform is used in procedures where conductive fluid (saline or lactated Ringers) is introduced into the surgical site for distention or to conduct RF current, higher than normal currents (greater than one amp) may be produced. In this situation, use one or more **adult**-size return electrodes. Do not use return electrodes labeled for children, infants, babies, neonatal use, or pediatric use.

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) will increase the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Laparoscopic Procedures

Warning

For laparoscopic procedures, be alert to these potential hazards:

- Laparoscopic surgery may result in gas embolism due to insufflation of gas in the abdomen.
- The electrode tip may remain hot enough to cause burns after the electrosurgical current is deactivated.
- Inadvertent activation or movement of the activated electrode outside of the field of vision may result in injury to the patient.
- Localized burns to the patient or physician may result from electrical currents carried through conductive objects (such as cannulas or scopes). Electrical current may be generated in conductive objects through direct contact with the active electrode, or by the active instrument (electrode or cable) being in close proximity to the conductive object.
- Do not use hybrid trocars that have a non-conductive locking anchor placed over a conductive sleeve. For the operative channel, use all metal or all plastic systems. At no time should electrical energy pass through hybrid systems. Capacitive coupling of RF current may cause unintended burns.
- When using laparoscopic instrumentation with metal cannulas, the potential exists for abdominal wall burns to occur due to direct electrode contact or capacitive coupling of RF current. This is most likely to occur in instances where the energy platform is activated for extended periods at high power levels inducing high current levels in the cannula.
- Ensure that the insulation of single use and reusable laparoscopic instrumentation is intact and uncompromised. Compromised insulation may lead to inadvertent metal-to-metal sparking and neuromuscular stimulation and/or inadvertent sparking to adjacent tissue.
- Do not activate electrodes while in contact with other instruments as unintended tissue injury may occur.

Do not activate the energy platform in an open circuit condition. To reduce the chances of unintended burns, activate the energy platform only when the active electrode is near or touching the target tissue.

- Use the lowest power setting that achieves the desired surgical effect and use a low voltage waveform (Pure Cut, Blend, or Valleylab mode) to lessen the potential for the creation of capacitive currents.
- Carefully insert and withdraw active electrodes from cannulas to avoid possible injury to the patient or damage to the devices.

Valleylab recommends against the use of laparoscopic surgery on pregnant patients.

Chapter 3

System Setup

This chapter describes the how to set up the energy platform, turn it on, and configure system settings.

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Setup

Before Startup

1. Verify the system is off by pressing the power switch off (O).
2. Place the energy platform on a flat, stable surface such as a table, platform, boom system, or Valleylab cart. Carts with conductive wheels are recommended. Refer to the procedures for your local institution or your local codes.
3. Plug the system power cord into the rear panel receptacle.
4. Plug the system power cord into a grounded power receptacle.

   Note: Do not plug into a power strip or extension cord.

Powering Up the ForceTriad Energy Platform

1. Turn on the system by pressing the power switch on (|). Observe the following during the power-up self test:
   - The ForceTriad logo will appear on all three screens.
   - A status bar indicates activity.
   - An hourglass icon indicates activity after the status bar disappears.
   - A tone will sound upon completion of self-test.
2. If the system does not pass the power-up self test, refer to Chapter 7, *Troubleshooting*.

System Functions

Adjusting Display Brightness

The ForceTriad energy platform screens have two levels of brightness. Touch the brightness icon on the right side of the right touchscreen to adjust the display brightness.

The high and low brightness settings can be changed in Brightness Calibration as explained on page 6-19.

Activation Log

The Activation Log allows the user to view the last 1000 activations and REM alerts.

1. Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.
2. Touch Activation Log in the main menu. The activation log will appear on the center touchscreen.
3. Touch the single up or down arrows to the right of the activation log to scroll through the log one line at a time.

4. Touch the green arrow button on the bottom right corner of the main menu screen to return the ForceTriad energy platform to the previous setup configuration. The last settings will be displayed.

Service Display

Refer to “Maintenance and Repair” on page 9-1 for complete service instructions.

Restore

Select the Restore button in the main menu to restore the ForceTriad energy platform to the previous setup configuration. The touchscreens will display the last settings entered prior to shutting the system off.

Setup

The setup menu allows the user to change the language that the system touchscreens display, set the time and date, and enable or disable the Autobipolar mode.

Language Setup

1. Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.
2. Touch Setup in the main menu. The setup display will appear in the left touchscreen.
3. Touch Language in the setup menu. A list of languages will appear in the left touchscreen.
4. Touch the single up or down arrows to the right of the list to scroll through the list one line at a time.

   or

   Touch the double up or down arrows to scroll through the list one page at a time.
5. Touch the desired language. A confirmation box will appear and request the user to confirm that a language change is desired.
6. To proceed with the language change, touch the green check mark button. The language will be activated and the confirmation box will close.

   or

   To reject the language change, touch the red ‘X’ button. The language setting will return to the previously selected language.
7. Touch the green arrow button to return to the setup menu.
8. Touch the green arrow button below the setup menu to return to the main menu.

Time and Date Setup

1. Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.
2. Touch Setup in the main menu. The setup display will appear in the left touchscreen.
3. Touch the Time and Date button in the setup menu. The time and date display will appear in the left touchscreen.
4. Touch the desired numeric field (minutes, seconds, month, day, or year) to select that field.
5. Touch the up or down arrows next to the time or date row to adjust the selected numeric field.

   Touch and hold the arrows to increase the number once per second. After four seconds, the numbers will increase once per 100 milliseconds.
6. Touch the green check mark button to store the date and time information and return to the setup menu.

   or

   Touch the red 'X' button to return the time and date to the previous settings and return to the setup menu.
7. Touch the green arrow button below the setup menu to return to the main menu.

Enable/Disable Autobipolar

1. Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.
2. Touch Setup in the main menu. The setup menu will appear in the left touchscreen.
3. If the Autobipolar mode is not enabled, the Autobipolar button will display 'Enable Autobipolar'. Touch the Enable Autobipolar button to enable the Autobipolar mode.

   If the Autobipolar mode is enabled, the Autobipolar button will display 'Disable Autobipolar'. Touch the Disable Autobipolar button to disable the Autobipolar mode.
4. Touch the green arrow button below the setup menu to return to the main menu.

Demo Mode

Warning

Demo mode is intended for demonstration purposes only. Demo mode is not intended for clinical use.

Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.

Enable Demo Mode

1. In the main menu, the Demo mode button will display ‘Enter Demo’ if the system is not in Demo mode. Touch the Enter Demo mode button to begin Demo mode. The system operating displays will appear in all the touchscreens with the words ‘DEMO MODE: Not for Clinical Use’ on all three screens.

   Note: Touching the Demo mode screen will remove it briefly from all touchscreens.

2. Proceed with any practice or demonstration scenarios. While in Demo mode, the REM alarm and the dual instrument error alarm are deactivated but RF power will still be delivered.

   Note: In Demo mode the generator will not sense instrument type, so the appropriate tab must be selected manually for the connected instrument.

3. To exit Demo mode, either turn the system off and restart it, or follow the steps in the *Exit Demo Mode* section as follows.

Exit Demo Mode

1. Touch the wrench icon on the right side of the right touchscreen. The main menu display will appear in the left touchscreen.
2. In the main menu, the Demo mode button will display ‘Exit Demo’ if the system is in Demo mode. Touch the Exit Demo button in the main menu to exit the Demo mode. The system touchscreens will display the last settings entered during the Demo mode.

Chapter 4

Technical Specifications

All specifications are nominal and subject to change without notice. A specification referred to as “Typical” is within ± 20% of a stated value at room temperature (25° C / 77° F) and a nominal line input voltage.

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Performance Characteristics

General

Output configuration	Isolated output
Cooling	Natural convection and fan
Display	Three LCD touchscreens
Connector ports	LED illuminated Smart connector readers
Mounting	• ForceTriad energy platform cart (FT900), Universal Mounting cart (UC8009), and/or the UC8010 Overshelf • Operating room boom systems • Any stable, flat surface such as a table or cart top

Dimensions and Weight

Width	45.8 cm (18 in.)
Depth	50.8 cm (20 in.)
Height	25.5 cm (10 in.)
Weight	13.6 kg (30 lbs)

Operating Parameters

Ambient temperature range	+10° C to +40° C
Relative humidity	30% to 75% non-condensing
Atmospheric pressure	700 millibars to 1060 millibars
Warm-up time	If transported or stored at temperatures outside the operating temperature range, allow one hour for the energy platform to reach room temperature before use.

Transport and Storage

Ambient temperature range	-30° C to +65° C
Relative humidity	25% to 85% (non-condensing)
Atmospheric pressure	500 millibars to 1060 millibars
Duration of storage	The ForceTriad energy platform may be stored indefinitely. If the energy platform is stored for over one year, the memory battery must be replaced.

Internal Memory

Nonvolatile, battery-backed RAM	Battery type: Lithium Battery life: 120 mAh
Storage capacity	256 KB

Activation Tone

The audio levels stated below are for activation tones (cut, Valleylab, coag, bipolar, and LigaSure modes) and alarm tones (REM and system alarms) at a distance of one meter.

Volume (adjustable)	45 to 65 dBA
Frequency	Cut: 660 Hz Valleylab: 800 Hz Coag: 940 Hz Bipolar: 940 Hz LigaSure: 440 Hz
Duration	Continuous while the system is activated

Alarm Tone

Volume (not adjustable)	>65 dBA
Frequency	REM: 660 Hz Reactivate/Regrasp, Check Instrument: Two tones: High = 985 Hz, Low = 780 Hz Seal Complete: 985 Hz Error/System Alert: Beep tone = 1421 Hz
Duration	REM: Two 1/ 2 second tones separated by 1/2 second for each REM event Reactivate/Regrasp: Four 175 ms tones — high, low, high, low Check Instrument: Six 175 ms tones — high, low, high, low, high, low Seal Complete: Two 175 ms tones separated by 175 ms for each Seal Complete event Error/System Alert: Three 250 ms tones separated by 250 ms for each Error/System Alert event

REM Contact Quality Monitor

Interrogation frequency	80 kHz ± 10 kHz
Interrogation current	< 100 µA
Interrogation voltage	< 12V RMS

Acceptable Resistance Range

REM resistance measurements are ± 10% during RF activation and ± 5% when RF output is not activated.

REM patient return electrode: 5 to 135 ohms or up to a 40% increase in the initial measured contact resistance (whichever is less).

If the measured resistance is outside the acceptable range(s) noted above, a REM fault condition occurs.

REM Alarm Activation

REM patient return electrode: When the measured resistance exceeds the standard range of safe resistance (below 5 ohms or above 135 ohms) or when the initial measured contact resistance increases by 40% (whichever is less), the REM alarm indicator enlarges and flashes red and yellow, a tone sounds twice, and RF output is disabled. The indicator remains illuminated red and yellow until you correct the condition causing the alarm. Then, the indicator illuminates green and RF output is enabled.

Autobipolar

The ForceTriad energy platform is equipped with an autobipolar feature that allows for automatic activation of bipolar energy.

Note: The autobipolar electrode function requires the use of the Valleylab Reusable Footswitching Bipolar Cord E0020V, E0021S, or E0022W.

The autobipolar specifications are:

Interrogation frequency	80 kHz ± 10 kHz
Interrogation current	< 100 µA
Interrogation voltage	< 12V RMS

Activation impedance	20 Ω to 1000 Ω
Deactivation impedance	User selectable: 1,500 Ω, 1,800 Ω, 2,000 Ω or 2,200 Ω
Keying delay	User selectable in 500 ms increments from 0 sec to 2.5 sec

Measurement accuracy

Inactive

± 5% of Full Scale activation impedance while keying inactive

Active

Mode: BP Low

Load/Power	< 30 W	≥ 30 W
1—500 ohms	± 20% or ±25 ohms (Whichever is greater)	± 20% or ±25 ohms (Whichever is greater)
501—1000 ohms	± 40%	± 20%
1001—2500 ohms	+100%/-50%	± 20%
> 2500 ohms	Reads > 2200 ohms	Reads > 2200 ohms

Mode: BP Standard

Load/Power	< 50 W	≥ 50 W
1—500 ohms	± 20% or ±25 ohms (Whichever is greater)	± 20% or ±25 ohms (Whichever is greater)
501—1000 ohms	± 40%	± 20%
1001—2500 ohms	+100%/-50%	± 20%
> 2500 ohms	Reads > 2200 ohms	Reads > 2200 ohms

Mode: BP Macro

Load/Power	All power levels
1—2500 ohms	± 20% or ±25 ohms (Whichever is greater)
> 2500 ohms	Reads > 2200 ohms

Duty Cycle

Under maximum power settings and rated load conditions, the ForceTriad energy platform is capable of operating a duty cycle of 25%, defined as 10 seconds active and 30 seconds inactive, in any mode for a period of 4 hours.

Caution

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) will increase the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Low Frequency (50/60 Hz) Leakage Current

Enclosure source current, ground open	< 300 µA
Source current, patient leads, all outputs	Normal polarity, intact ground: < 10 µA Normal polarity, ground open: < 50 µA Reverse polarity, ground open: <50 µA Mains voltage on applied part: < 50 µA
Sink current at high line, all inputs	< 50 µA

High Frequency (RF) Leakage Current

	Measured with leads recommended by Valleylab	**Measured directly at the energy platform terminals**
Bipolar RF leakage current	< 59.2 mA $_{rms}$	< 59.2 mA $_{rms}$
Monopolar RF leakage current	< 150 mA $_{rms}$	< 100 mA $_{rms}$
LigaSure leakage	<132 mA $_{rms}$	< 100 mA $_{rms}$

Input Power

100–120 Volt	220–240 Volt
Maximum VA at nominal line voltage: Idle: 52 VA Bipolar: 450 VA Cut: 924 VA Coag: 530 VA	Maximum VA at nominal line voltage: Idle: 52 VA Bipolar: 450 VA Cut: 924 VA Coag: 530 VA
Input mains voltage, full regulation range: 90–132 Vac	Input mains voltage, full regulation range: 208–264 Vac
Input mains voltage, operating range: 85–132 Vac	Input mains voltage, operating range: 170–264 Vac
Mains current (maximum): Idle: 0.4 A Bipolar: 2.0 A Cut: 7.0 A Coag: 4.0 A LigaSure: 5.0 A	Mains current (maximum): Idle: 0.2 A Bipolar: 1.0 A Cut: 3.5 A Coag: 2.0 A LigaSure: 2.5 A
Mains line frequency range (nominal): 50 Hz to 60 Hz	Mains line frequency range (nominal): 50 Hz to 60 Hz
Fuses (2): 5 mm x 20 mm 8A, 250 V fast blow	Fuses (2): 5 mm x 20 mm 8A, 250 V fast blow
Power cord: 3-prong hospital grade connector	Power cord: 3-prong locally approved connector

Power Cord Specification

This unit was equipped from the factory with a 110 VAC hospital grade NEMA 5-15 power cord. Should the AC power cord need to be replaced to match another plug configuration, the replacement plug/cable/receptacle configuration must meet or exceed the following specifications:

100-120 VAC

Cable - SJT16/3, IEC color code, maximum length 15 ft (5 m)
Plug - minimum 10 A - 125 VAC
Unit receptacle - IEC female, minimum 10 A - 125 VAC

220-240 VAC

Cable - H05VVF3G1.0 VDE, maximum length 15 ft (5 m)
Plug - minimum 6 A - 250 VAC
Unit receptacle - IEC female, minimum 6 A - 250 VAC

Input Frequency

The ForceTriad energy platform operates within specification at all line input frequencies between 48 Hz and 62 Hz. The User does not need to reconfigure the ForceTriad energy platform for different line frequencies.

Input Current

The ForceTriad energy platform draws no more than 10A at any line input voltage.

Backup Power

The ForceTriad energy platform retains all user programmed features, calibration, and statistical data when switched off and unplugged. The ForceTriad energy platform operates within specification when switched over to a supplied line power by hospital backup systems.

Equipotential Ground Connection

An equipotential ground connection is provided to allow connection of the ForceTriad energy platform to ground.

ECG Blanking

An ECG blanking port is provided to signal other devices that the ForceTriad energy platform is active. The receptacle is a 2.5 mm mono jack. It is electrically isolated from the internal ground referenced electronics with the shell electrically connected to the chassis for ESD protection.

Standards and IEC Classifications

The ForceTriad energy platform meets all pertinent clauses of the IEC 60601-1 second edition and IEC 60601-2-2 third edition.

ATTENTION
Consult accompanying documents

The generator output is floating (isolated) with respect to ground.

DANGER
Explosion risk if used with flammable anesthetics

To reduce the risk of electric shock, do not remove the cover. Refer servicing to qualified service personnel.

Unit produces non-ionizing radiation

Classified with respect to electrical shock, fire, and mechanical hazards only in accordance with UL60601-1 and CAN/CSA C22.2 No. 601.1

Symbols

Monopolar instrument receptacle

Monopolar footswitching receptacle

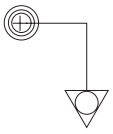
Bipolar instrument receptacle

LigaSure related receptacle or footswitch

Color-coded LigaSure footswitch symbol for matching rear panel connector to front panel receptacle

REM patient return electrode receptacle

Volume adjustment for activation tones



Equipotential grounding point

Equipment should not disposed in trash

Class I Equipment (IEC 60601-1)

Accessible conductive parts cannot become live in the event of a basic insulation failure because of the way in which they are connected to the protective earth conductor.

Type CF Equipment (IEC 60601-1)/Defibrillator Proof

This generator provides a high degree of protection against electric shock, particularly regarding allowable leakage currents. It is type CF isolated (floating) output and may be used for procedures involving the heart.

This generator complies with the ANSI/AAMI HF18 specifications for “defibrillator proof” designation and IEC 60601-2-2.

Liquid Spillage (IEC 60601-2-2 Clause 44.3)

The ForceTriad energy platform is constructed so that liquid spillage in normal use does not wet electrical insulation or other components which when wetted are likely to adversely affect the safety of the equipment.

Voltage Transients (Emergency Energy Platform Mains Transfer)

The ForceTriad energy platform continues to operate normally with no errors or system failures when transfer is made between line AC and an emergency energy platform voltage source. (IEC 60601-2-2 sub-clause 51.101 and AAMI HF18 sub-clause 4.2.2)

Electromagnetic Compatibility (IEC 60601-1-2 and IEC 60601-2-2)

The ForceTriad energy platform complies with the appropriate IEC 60601-1-2 and 60601-2-2 specifications regarding electromagnetic compatibility.

Notice

The ForceTriad energy platform should not be used adjacent to or stacked with equipment other than specified in the ForceTriad energy platform user guide and service manual. If adjacent or stacked use is necessary, the ForceTriad energy platform should be observed to verify normal operation in the configuration in which it will be used.

The ForceTriad energy platform intentionally applies RF energy for diagnosis or treatment during activation. Observe other electronic medical equipment in the vicinity during the ForceTriad energy platform activation for any possible adverse electromagnetic effects. Ensure adequate separation of electronic medical equipment based on observed reactions.

The use of accessories, other than specified in the ForceTriad energy platform user guide and service manual, may result in increased emissions or decreased immunity of the ForceTriad energy platform.

The ForceTriad energy platform meets the following requirements:

ESD Immunity (IEC 60601-1-2 Sub-Clause 36.202 and IEC 61000-4-2)

Radiated Immunity (IEC 60601-1-2 sub-clause 36.202.2 and IEC 61000-4-3)

Electrical Fast Transient/Burst (IEC 60601-1-2 sub-clause 36.202.3.1 and IEC 61000-4-4)

Surge Immunity (IEC 60601-1-2 sub-clause 36.202.3.2 and IEC 61000-4-5)

Emissions (IEC 60601-1-2 sub-clause 36.201.1, IEC 60601-2-2 sub-clause 36 and CISPR 11 Class A)

Harmonic distortion (IEC 60601-1-2 sub-clause 36.201.3.1 and IEC 61000-3-2)

Conducted disturbances (IEC 60601-1-2 sub-clause 36.202.6 and IEC 61000-4-6)

Power frequency magnetic fields (IEC 60601-1-2 sub-clause 36.202.8.1 and IEC 61000-4-8)

Voltage dips, short interruptions and variations (IEC 60601-1-2 sub-clause 36.202.7 and IEC 61000-4-11)

Guidance and manufacturer's declaration - electromagnetic emissions		
The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the ForceTriad energy platform should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 2	The ForceTriad energy platform must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
RF emissions CISPR 11	Class A	The ForceTriad energy platform is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC61000-3-3	Complies	

Guidance and manufacturer's declaration - electromagnetic immunity			
The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the ForceTriad energy platform should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	+/-6 kV contact +/-8 kV air	+/-6 kV contact +/-8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/ burst IEC 61000-4-4	+/-2 kV for power supply lines +/-1 kV for input/ output lines	+/-2 kV for power supply lines +/-1 kV for input/ output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	+/-1 kV differential mode +/-2 kV common mode	+/-1 kV differential mode +/-2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% Ut (>95% dip in Ut) for 0,5 cycle 40% Ut (>60% dip in Ut) for 5 cycles 70% Ut (>30% dip in Ut) for 25 cycles <5% Ut (>95% dip in Ut) for 5 sec	<5% Ut (>95% dip in Ut) for 0,5 cycle 40% Ut (>60% dip in Ut) for 5 cycles 70% Ut (>30% dip in Ut) for 25 cycles <5% Ut (>95% dip in Ut) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user of the ForceTriad energy platform requires continued operation during power mains interruptions, it is recommended that the ForceTriad energy platform be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE: Ut is the a.c. mains voltage prior to the application of the test level.			

<table>
<tr><th colspan="4">Guidance and manufacturer's declaration - electromagnetic immunity</th></tr>
<tr><td colspan="4">The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the ForceTriad energy platform should assure that it is used in such an environment.</td></tr>
<tr><th>Immunity test</th><th>IEC 60601 test level</th><th>Compliance level</th><th>Electromagnetic environment - guidance</th></tr>
<tr><td>Conducted RF
IEC 61000-4-6

Radiated RF
IEC 61000-4-3</td><td>3 Vrms
150 kHz to 80 MHz

3 V/m
80 MHz to 2.5 GHz</td><td>3 V

7 V/m</td><td>Portable and mobile RF communications equipment should be used no closer to any part of the ForceTriad energy platform, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.

Recommended separation distance

$d=0.5\sqrt{P}$

$d=0.5\sqrt{P}$ 80 MHz to 800 MHz
$d=\sqrt{P}$ 800 MHz to 2.5 GHz

Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than the compliance level in each frequency range.

Interference may occur in the vicinity of equipment marked with the following symbol:  </td></tr>
<tr><td colspan="4">NOTE 1 At a 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</td></tr>
<tr><td colspan="4">a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the ForceTriad energy platform is used exceeds the applicable RF compliance level above, the ForceTriad energy platform should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the ForceTriad energy platform.

b. Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 7 V/m.</td></tr>
</table>

Recommended separation distances between portable and mobile RF communication equipment and the ForceTriad energy platform

The ForceTriad energy platform is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The Customer or the user of the ForceTriad energy platform can help prevent electromagnetic interferences by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the ForceTriad energy platform as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter (W)	**Separation distance according to frequency of transmitter (m)**		
	150 kHz to 80 MHz $d=0.5\sqrt{P}$	**80 MHz to 800 MHz $d=0.5\sqrt{P}$**	**800 MHz to 2.5 GHz $d=\sqrt{P}$**
0.01	0.05 m	0.05 m	0.1 m
0.1	0.16 m	0.16 m	0.32 m
1	0.5 m	0.5 m	1 m
10	1.6 m	1.6 m	3.2 m
100	5 m	5 m	10 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Output Characteristics

Maximum Output for Bipolar, Monopolar, and LigaSure Modes

Power readouts agree with actual power into rated load to within 15% or 5 watts, whichever is greater.

Mode	Open Circuit Peak Voltage (max)	Open Circuit P–P Voltage (max)	Rated Load (max)	Power (max)	Crest Factor*	Duty Cycle
Bipolar						
Low	250 V	500 V	100 Ω	95 W	1.42	N/A
Standard	175 V	350 V	100 Ω	95 W	1.42	N/A
Macro	250 V	500 V	100 Ω	95 W	1.42	N/A
Monopolar Cut						
Cut	1050V	2100V	300 Ω	300 W	1.42	N/A
Blend	1485 V	2970 V	300 Ω	200 W	2.7	50%
Valleylab (HWD)	2365 V	4730 V	300 Ω	200 W	4.3	25%
Monopolar Coag						
Fulgurate	3050 V	6100 V	500 Ω	120 W	5.55	6.5%
Spray	3625 V	7250 V	500 Ω	120 W	6.6	4.6%
LigaSure	287.5 V	575 V	20 Ω	350 W	1.42	N/A

** An indication of a waveform's ability to coagulate bleeders without a cutting effect.*

Available Power Settings in Watts

Autobipolar (All Modes)

				5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95									

Bipolar (All Modes)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95									

Monopolar Cut

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95	100	110	120	130	140	150	160	170	180
190	200	210	220	230	240	250	260	270	280
290	300								

Monopolar Blend

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95	100	110	120	130	140	150	160	170	180
190	200								

Valleylab

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95	100	110	120	130	140	150	160	170	180
190	200								

Monopolar Coag

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
45	50	55	60	65	70	75	80	85	90
95	100	110	120						

Output Waveforms

Tissue Sensing Technology, an automatic adjustment, controls all modes. As tissue resistance increases from zero, the energy platform outputs constant current followed by constant power followed by constant voltage. The maximum output voltage is controlled to reduce capacitive coupling and video interference and to minimize sparking.

Bipolar

Low	472 kHz sinusoid continuous
Standard	472 kHz sinusoid continuous
Macro	472 kHz sinusoid continuous

Monopolar Cut

Cut	472 kHz sinusoid continuous
Blend	472 kHz bursts of sinusoid, recurring at 26.21 kHz intervals. 50% duty cycle.

Valleylab

Valleylab	472 kHz bursts of sinusoid, recurring at 28.3 kHz intervals. 25% duty cycle.

Monopolar Coag

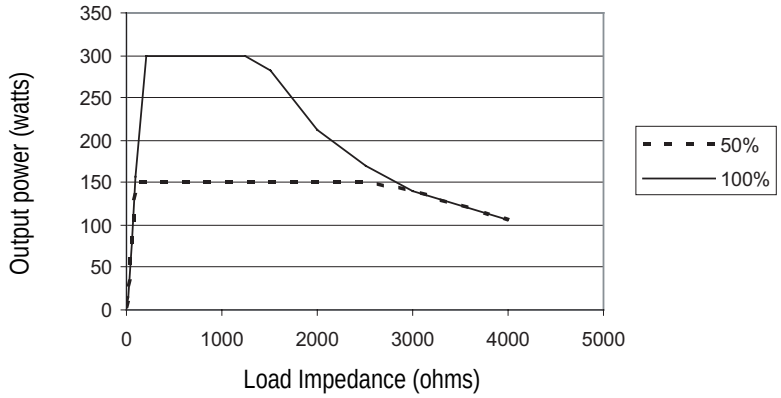
Fulgurate	472 kHz damped sinusoidal bursts with a repetition frequency of 30.66 kHz. 6.5% duty cycle.
Spray	472 kHz damped sinusoidal bursts with a randomized repetition centered at 21.7 kHz. 4.6% duty cycle.

Output Power vs. Resistance Graphs

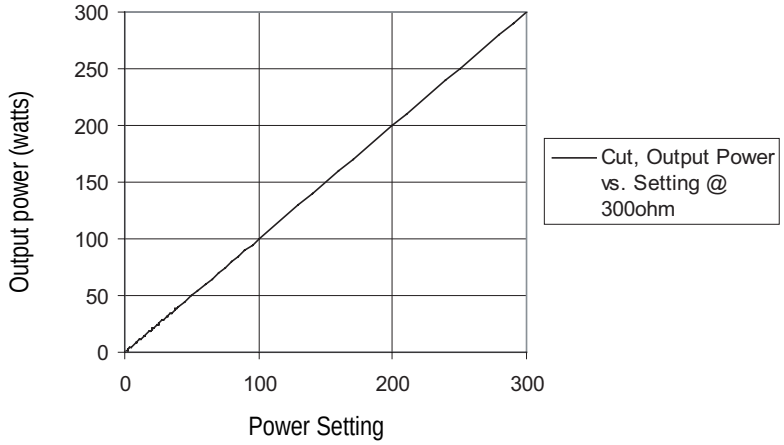
Monopolar Graphs

Pure Cut

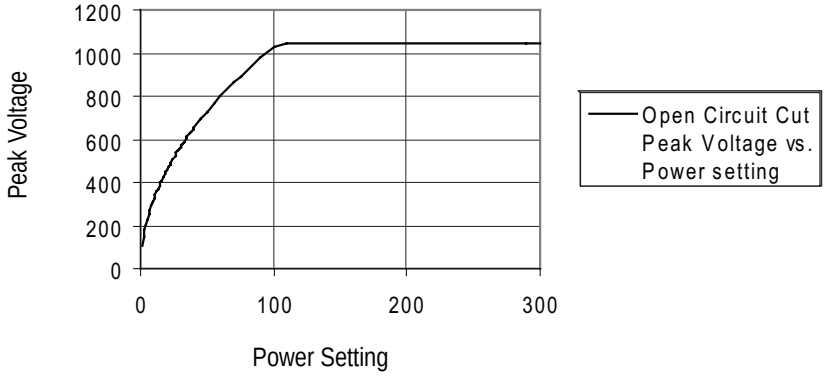
Output power versus impedance for Pure cut power



Output power versus power setting for Pure cut power

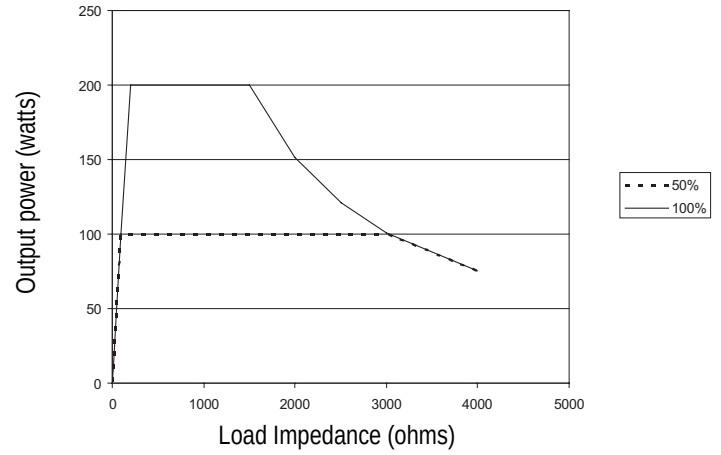


Peak voltage versus power setting for Pure cut power

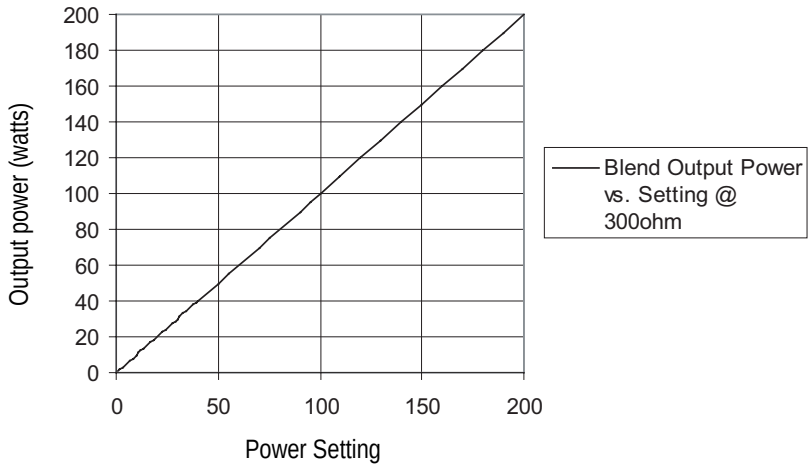


Blend

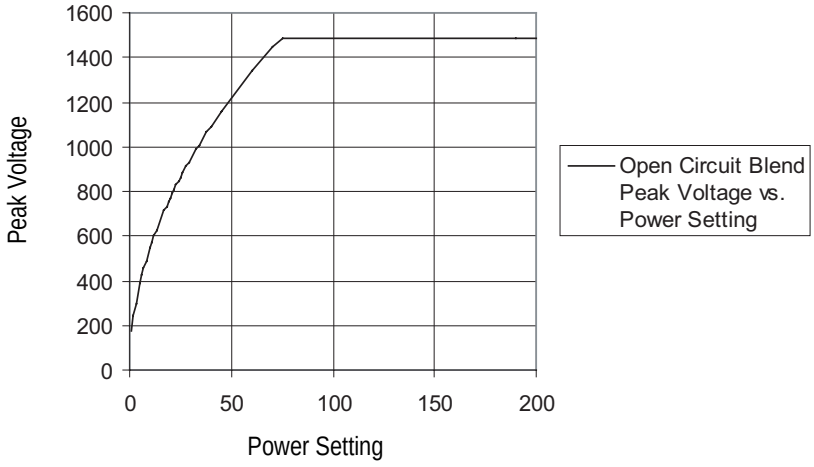
Output power versus impedance for Blend power



Output power versus power setting for Blend power

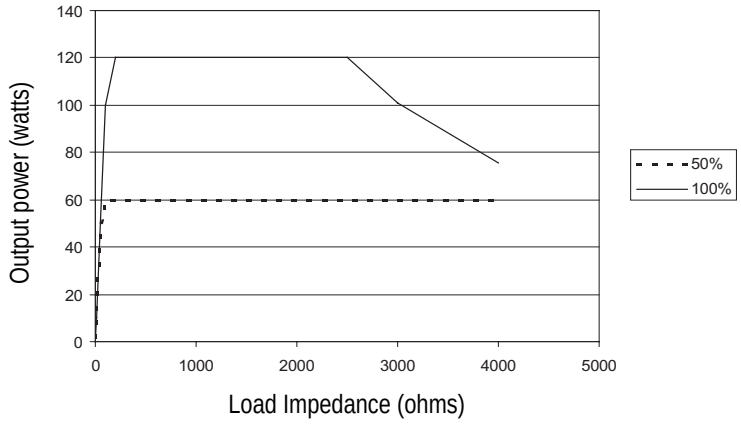


Peak voltage versus power setting for Blend power

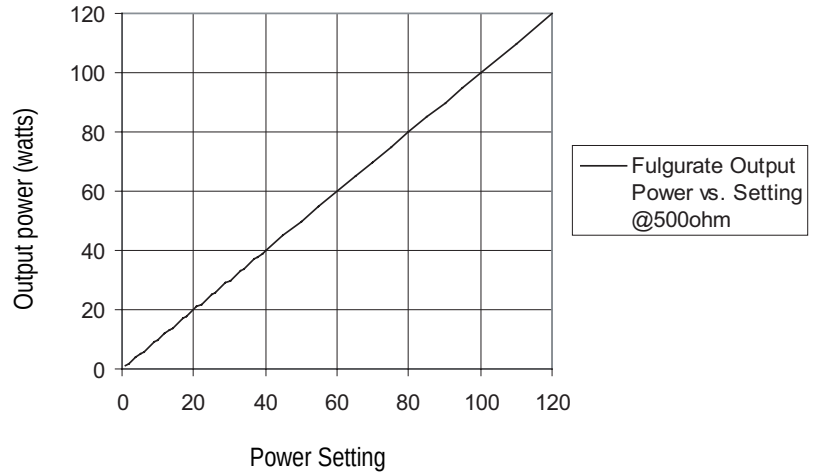


Fulgurate

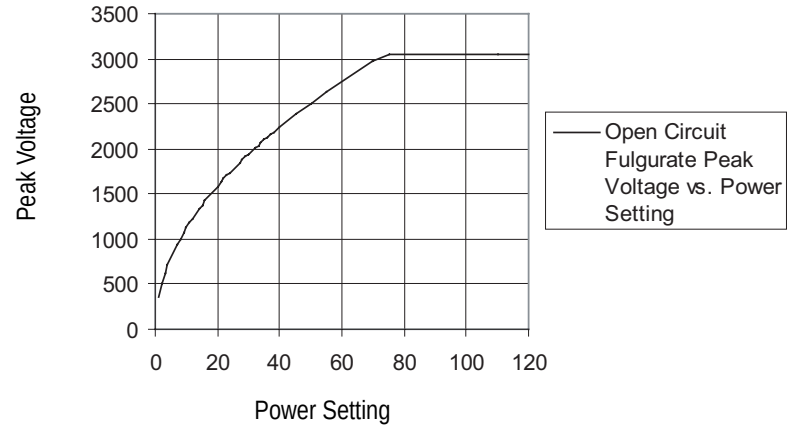
Output power versus impedance for Fulgurate power



Output power versus power setting for Fulgurate power

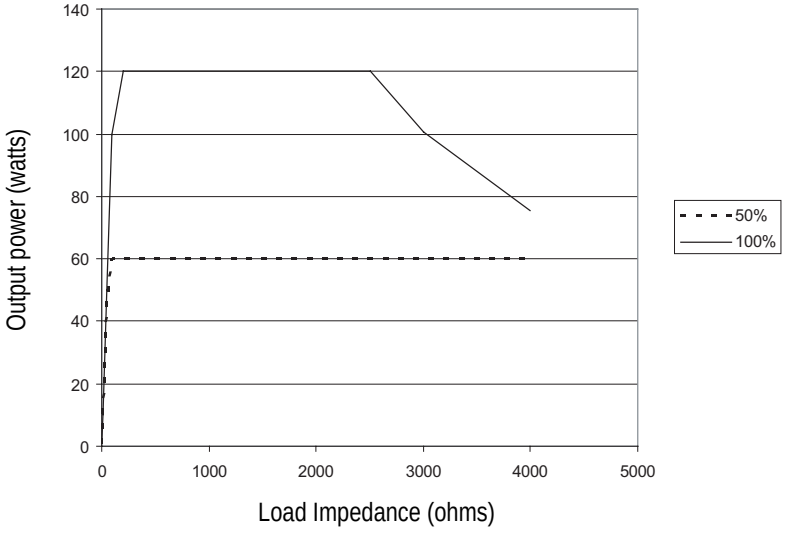


Peak voltage versus power setting for Fulgurate power

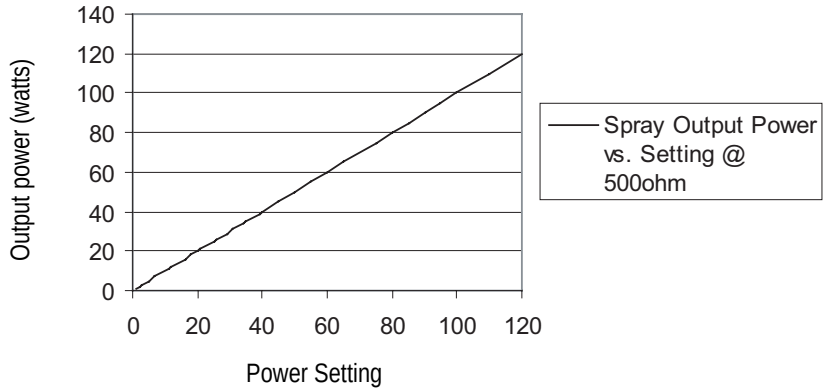


Spray

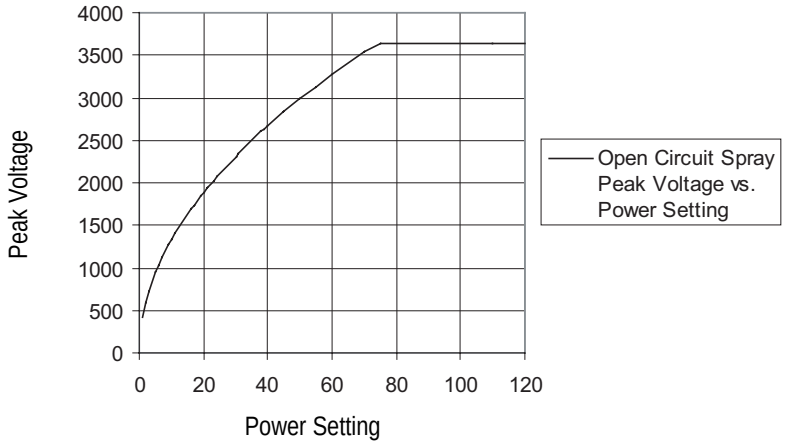
Output power versus impedance for Spray power



Output power versus power setting for Spray power

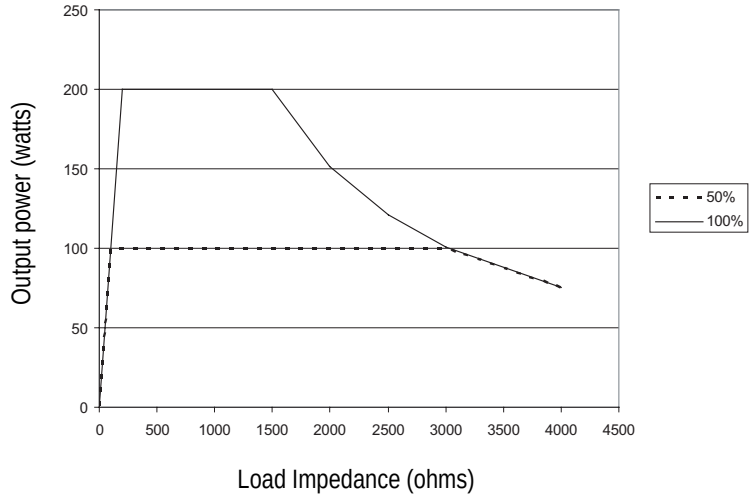


Peak voltage versus power setting for Spray power

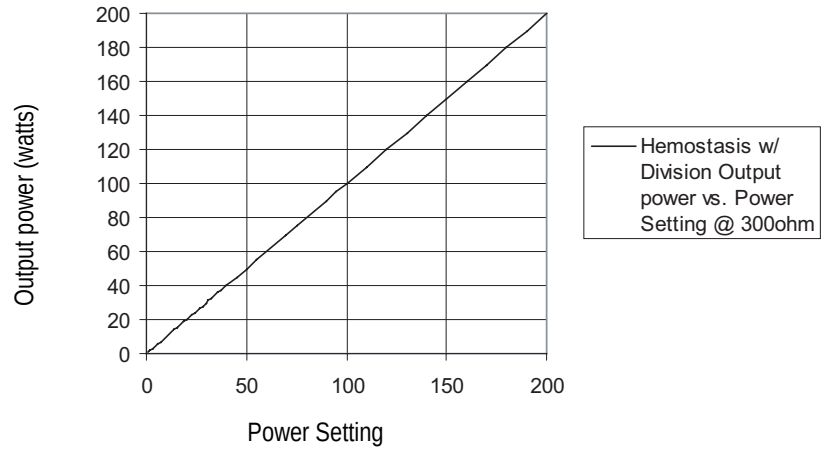


Valleylab

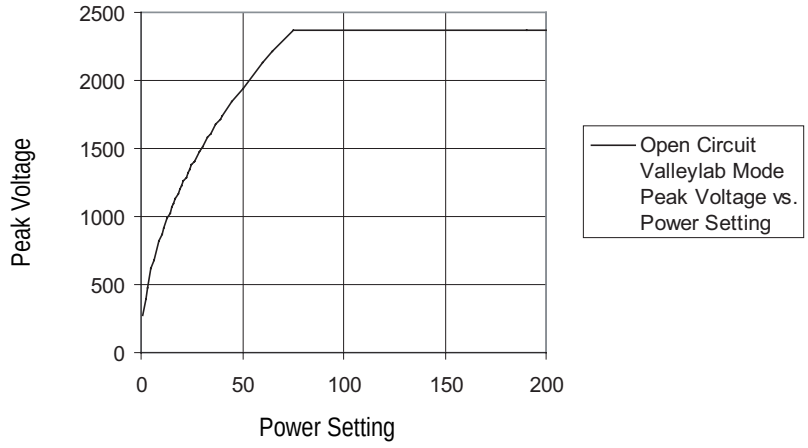
Output power versus impedance for Valleylab power



Output power versus power setting for Valleylab power



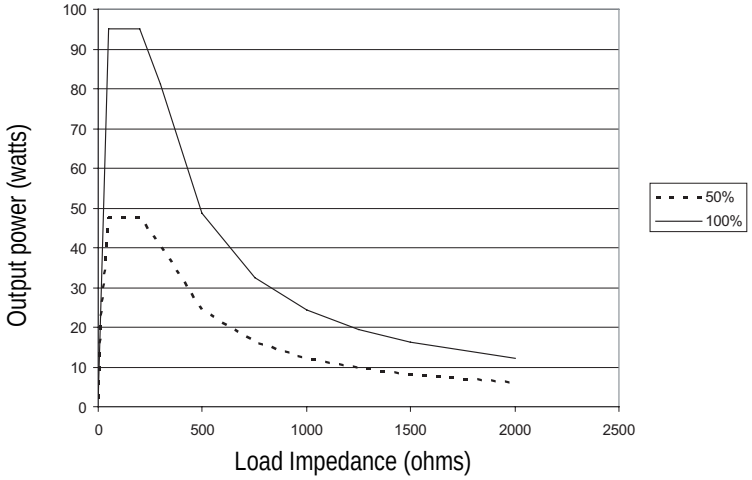
Peak voltage versus power setting for Valleylab power



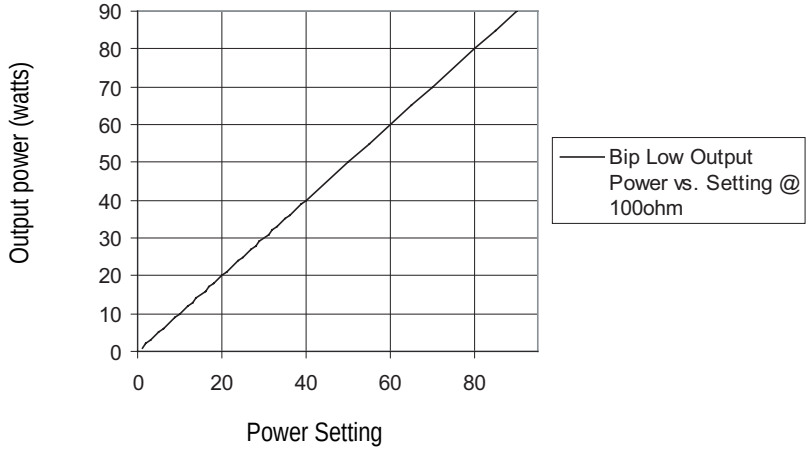
Bipolar Graphs

Bipolar Low

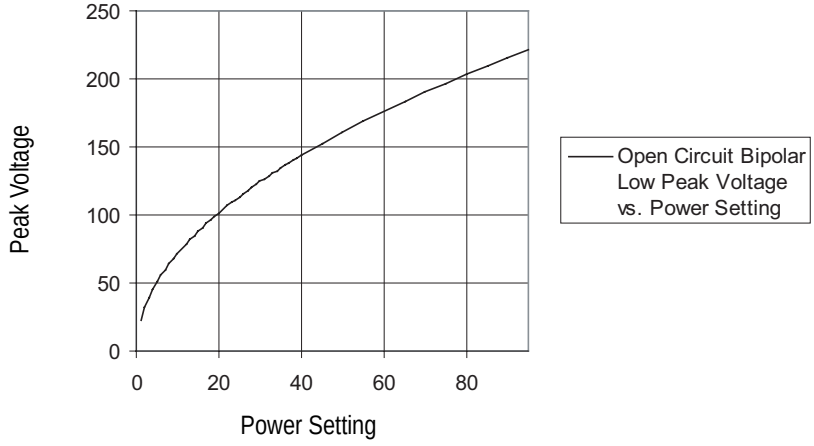
Output power versus impedance for Bipolar Low power



Output power versus power setting for Bipolar Low power

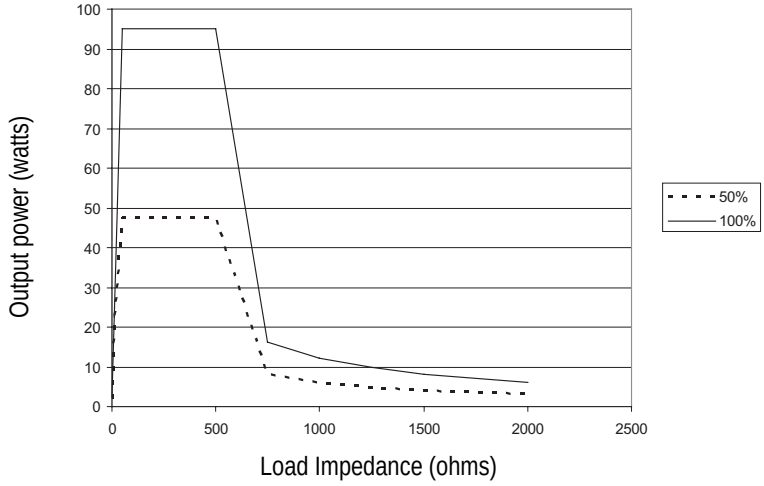


Peak voltage versus power setting for Bipolar Low power

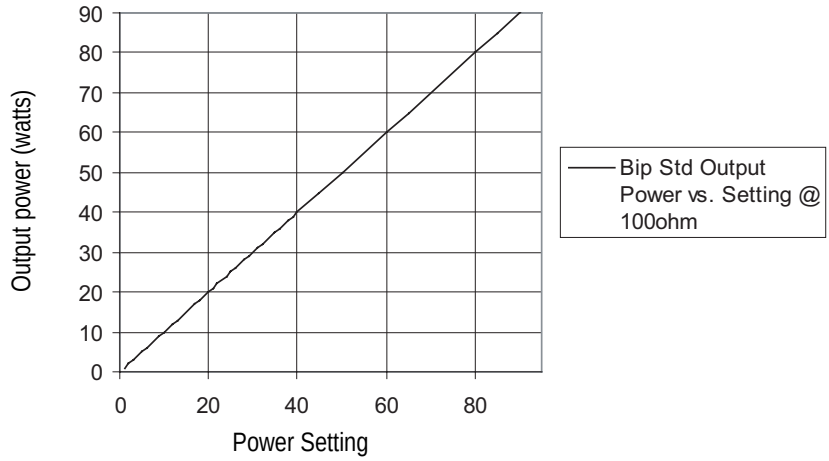


Bipolar Standard

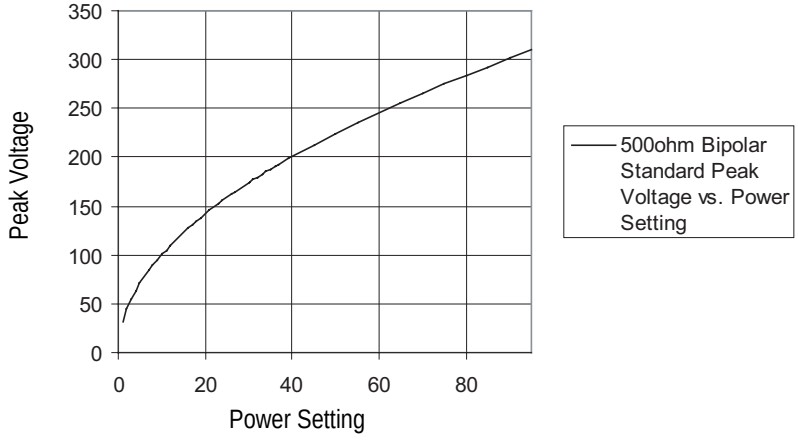
Output power versus impedance for Bipolar Standard power



Output power versus power setting for Bipolar Standard power



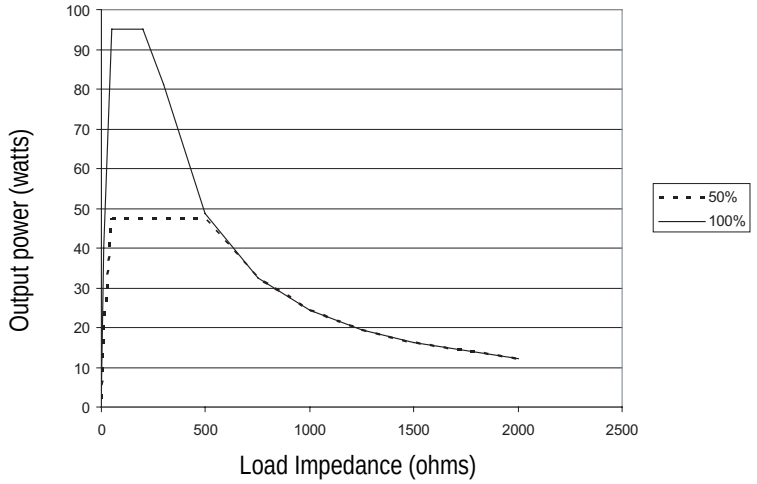
Peak voltage versus power setting for Bipolar Standard power



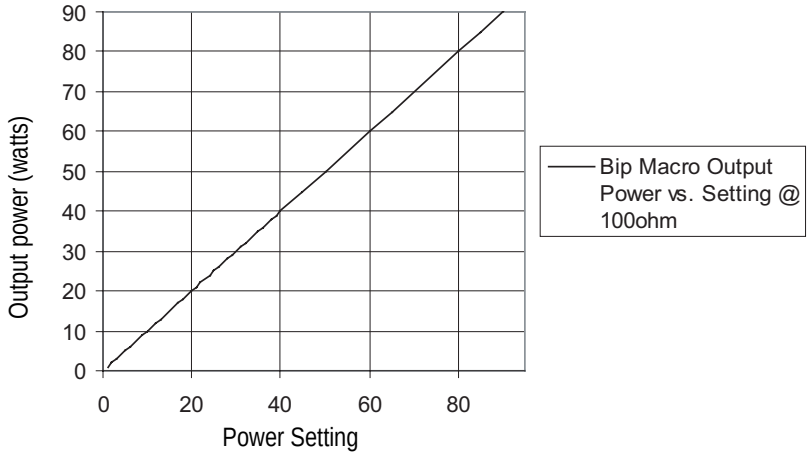
Note: Maximum peak voltage in the Bipolar Standard mode occurs at 500 Ω, not open circuit.

Bipolar Macro

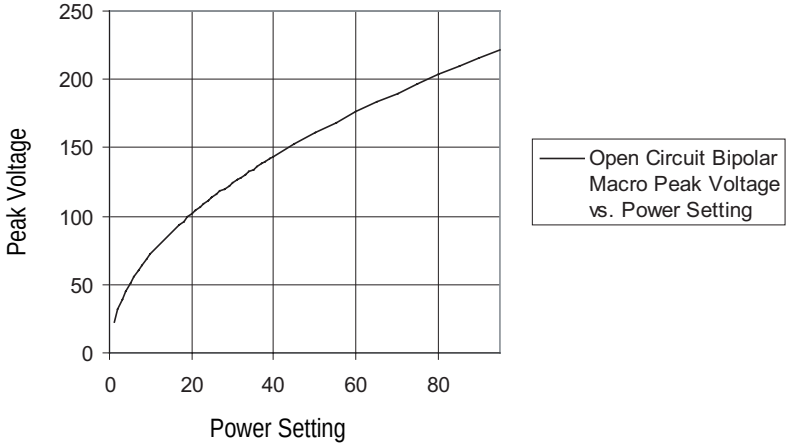
Output power versus impedance for Bipolar Macro power



Output power versus power setting for Bipolar Macro power

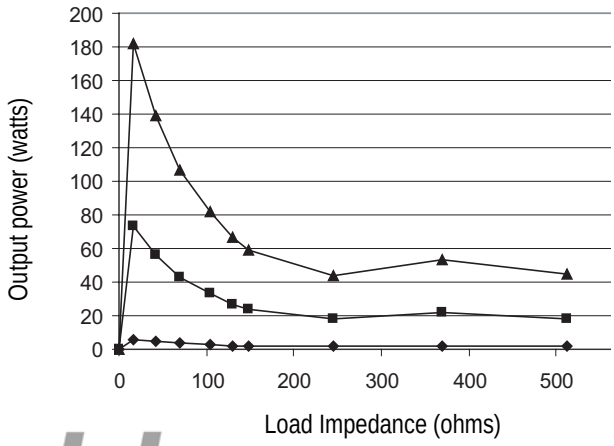


Peak voltage versus power setting for Bipolar Macro power

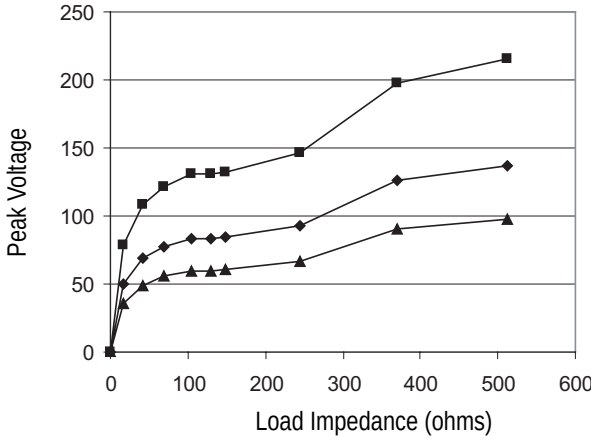


LigaSure

Output power versus impedance for LigaSure power



Peak voltage versus impedance for LigaSure power



Chapter 5

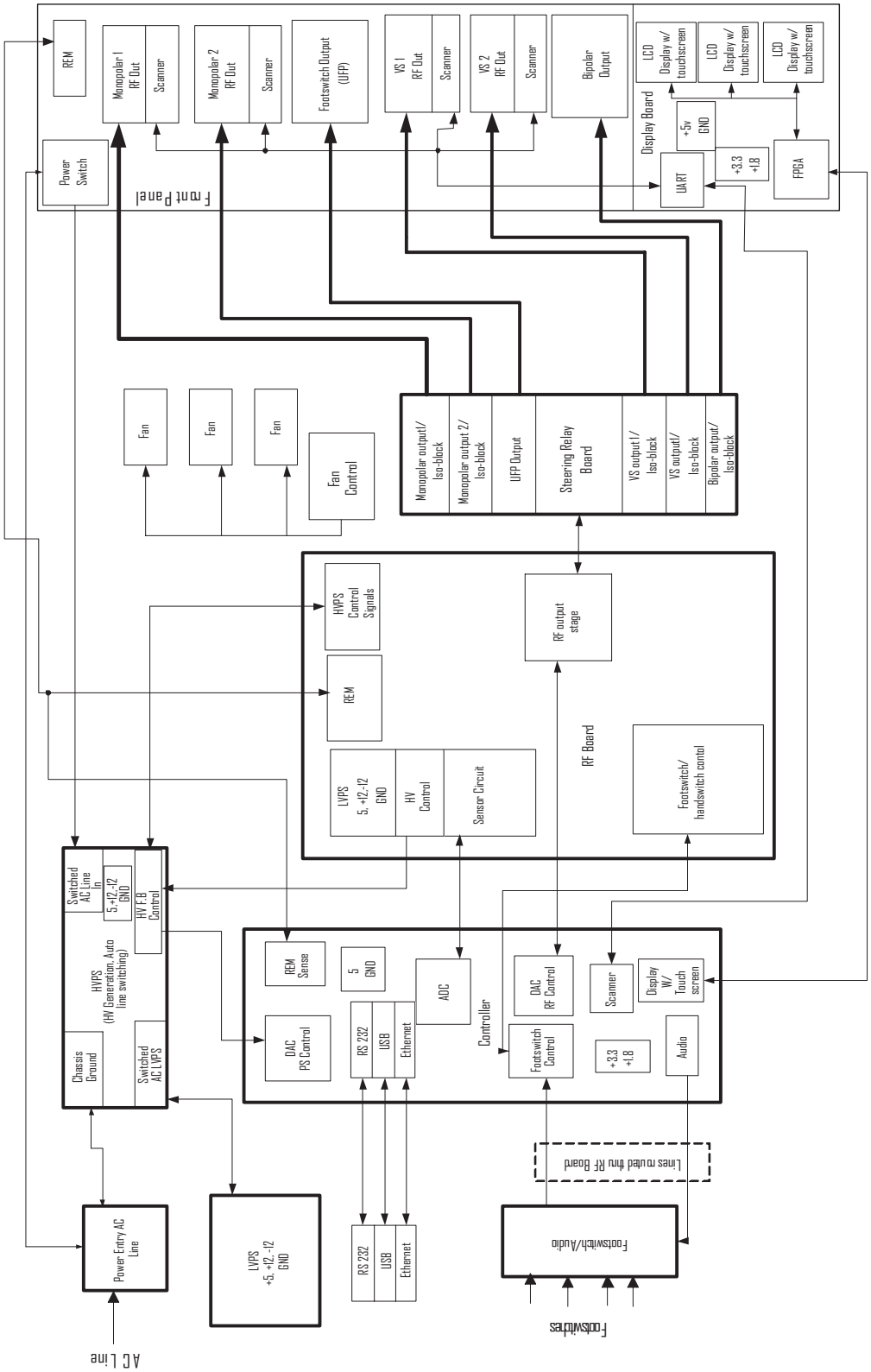
Principles of Operation

This chapter provides detailed information about how the ForceTriad energy platform functions and how the internal components interact.

This chapter includes the following information:

- A block diagram that illustrates how the energy platform functions
- A general description of how the generator works
- Detailed descriptions of the circuitry for the printed PCBAs

Block Diagram



Functional Overview

The ForceTriad energy platform is a combination of a full-featured general surgery electrosurgical unit and a LigaSure vessel sealing system. The monopolar and bipolar sections of the ForceTriad are isolated electrosurgical outputs that provide the appropriate power for cutting, desiccating, and fulgurating tissue during monopolar and bipolar surgery. The LigaSure section of the ForceTriad provides power for vessel sealing.

During monopolar electrosurgery, radio frequency (RF) current flows from the generator to an active electrode, which delivers the current to the patient. The resistance to the current, provided by the patient's tissue and/or the air between the active electrode and the tissue, produces the heat that is necessary for the surgical effect. The RF current flows from the active electrode, through the patient's body tissue to the return electrode, which recovers the current and returns it to the generator.

The LigaSure vessel sealing system provides precise energy delivery and electrode pressure to vessels for a controlled time period to achieve a complete and permanent fusion of the vessel lumen.

TissueFect Tissue Sensing Technology

The ForceTriad energy platform automatically senses resistance and adjusts the output voltage to maintain a consistent tissue effect across different tissue impedance. This adjustment is based on the selected mode, the power setting, and the level of tissue resistance.

REM Contact Quality Monitoring System

The ForceTriad energy platform uses the Valleylab REM Contact Quality Monitoring system to monitor the quality of electrical contact between the patient return electrode and the patient. The REM system is designed to minimize the risk of burns at the return electrode site during monopolar electrosurgery.

When you connect a REM patient return electrode to the Patient Return Electrode receptacle, you activate the REM system. When you activate monopolar output, the generator connects the patient return electrode path. If you activate bipolar output while a return electrode is connected to the patient, the return electrode circuit is deactivated automatically to eliminate the possibility of current dispersal.

The REM system continuously measures resistance at the return electrode site and compares it to a standard range of safe resistance (between 5 and 135 ohms), thus minimizing intermittent false alarms that could result from small changes in resistance. The REM system also adapts to individual patients by measuring the initial contact resistance (baseline resistance) between the patient and the patient return electrode. If the tissue impedance at the return electrode decreases during electrosurgery, the REM system resets the baseline resistance.

REM Alarm Activation

The REM Alarm indicator flashes red, a tone sounds, and the generator stops producing output power when either of the following occurs:

- The measured resistance is below 5 ohms or above 135 ohms, the limits of the standard range of safe resistance.
- An increase in contact resistance is greater than 40% from the initial measurement (baseline resistance).

The REM Alarm indicator remains illuminated red until you correct the condition causing the alarm. Then, the indicator illuminates green and RF output is enabled.

Electrodes Without the REM Safety Feature

Return electrodes without the REM safety feature cannot be used on the ForceTriad energy platform.

High Voltage DC (HVDC) Power Supply Principles of Operation

The HVDC power supply will regulate an output DC voltage to a desired level that is proportional to a 0 to 5V analog logic signal called Voltage Control (ECON). The AC input range is 85VAC to 264VAC with line frequencies from 47Hz to 63Hz. The HVDC can be simplified into two sections, the AC section and DC section.

The AC section rectifies the AC input into the rectified +Bus and –Bus voltages. For line voltages of 150VAC or less, the rectified AC voltage is doubled. The rectified voltage is monitored and will be flagged if the voltage starts to drop too low or if the rectified voltage exceeds 400VDC. As a safety feature, the HVDC will be shut down when it exceeds 400VDC. The AC section also incorporates a soft start circuit that will reduce the inrush AC current at power up.

The DC section is a phase-shifted full-bridge typology and uses a Pulse Width Modulator (PWM) from Texas Instruments, part number UCC3895. For information on this particular typology, the data sheet **(available at ti.com)** for this part contains a full dialogue of the theory of operation. The DC section consists of limits that help protect the HVDC from fault conditions. These limits include over voltage, over current, over power, and short circuit. Each limit sends a flag to the controller card if it is triggered and will shut down the HVDC. Another feature of the HVDC is an active discharge circuit; this circuit will place a load across the output. This allows the output of the HVDC to discharge quickly no matter what the load attached to the HVDC.

RF Principles of Operation

The primary purpose of the ForceTriad RF PCBA is to convert the DC voltage coming from the HVDC PCBA into a 470 kHz RF signal that is sent to the Steering Relay PCBA to be distributed to the appropriate output. A push-pull typology is used to accomplish this voltage conversion. Two gate drive signals that are 180° out of phase are used to drive the high voltage Field Effect Transistors (FETs), called T ON and T ON 180. The gate drive signals turn on each of the FETs at opposite times to deliver a waveform at the specified power requested from the user. The RF PCBA is capable of several different outputs ranging from 5.5Arms in LigaSure tissue fusion modes to over 7KVpp in coag modes. Relays throughout the RF PCBA switch in the appropriate tuning elements required to achieve these various outputs.

Primary and redundant sense circuits detect the RF output voltage and current. An accurate scaled down AC voltage representative of each of these is sent to the Controller PCBA, which in turn will keep the output at levels appropriate for the mode in use. Four sense relays per circuit correspond to specific modes and switch in voltage dividers tuned to divide the output signals to levels that are manageable for the Controller card. Three relays per voltage sense circuit divide down the output voltages from 425Vpk - 5000Vpk to around 1Vpk, depending on the mode selected by the user. The current sensors use 1 relay per circuit; this relay kicks in for currents higher than 1Arms. The sensor signals are passed through a multiplier which uses a gain control signal from the controller card. After this multiplier stage, the signal is filtered and routed to the controller card. RF voltage and current foldback circuits use the ranges selected on the sensors to determine if a limit has been hit. These circuits will fold back the ECON signal going to the HVDC, reducing the DC output to the RF PCBA. This in turn reduces the RF output amplitude.

REM

The Return Electrode Monitor (REM) circuit monitors the resistance between the two return areas on a REM electrode using a 80 kHz signal generated by the controller card.

Autobipolar

The Autobipolar (ABP) circuit consists of an 80 kHz signal, also generated by the controller card. It is used to monitor the bipolar output impedance.

Leakage Current Monitor

The RF PCBA also features a leakage current monitor circuit, which measures the active and return of the generator and puts out a DC voltage that represents the difference between the two. If this voltage exceeds a limit, the RF will be folded back to prevent excess leakage current.

Sensor Circuit

The sensor circuit provides RF output voltage and current monitoring to software in order to deliver the correct energy dosage during a surgical procedure. Two identical sensory circuit paths, composed of a primary and backup, are implemented to provide fail-safe mitigation in the event of circuit failure. Since each primary and backup sensor circuit mirrors the other, the sensed output voltages, which are monitored by software, are equal when the sensory system maintains proper operation. In the event of primary or backup sense circuit failure, dissimilar outputs are present and software detection stops delivery of RF and notifies the user with an error message displayed on the front panel of the ForceTriad energy platform.

Each primary and backup sensory circuit consists of four processing elements to ensure that the correct RF is delivered. In the description that follows, the primary sensory path is identified for the voltage sense circuitry, with reference designation only provided to the backup circuit. Backup circuit operation is identical to the primary circuit that is described here. RF current sense circuit process is symmetrical to the voltage sense description in that it also uses four processing elements. The only notable difference between voltage and current sensing is the different transfer gains required to adequately address the dynamic range of individual generator operating modes.

First: Transformer T6, along with resistors R110 and R119, provide RF output voltage monitoring by generating a proportionately scaled, secondary sense voltage, which is correlated to the delivered RF output voltage. Backup referenced components are T1, R95, and R111.

Second: Coupled to the secondary of transformer T6, a software controlled switched pad network is implemented to provide proper impedance scaling to address the dynamic sensory range required for all operating modes of the ForceTriad energy platform. This pad impedance switched network is used to develop the proportionately scaled secondary sense voltage of T6. Resistors R103 and R107 provide the initial impedance termination, paralleled by resistor paired components R104 and R105, R94 and R106, and R85 and R100, which are switched independent on the selected generator Cut, Blend, and Coag operating modes respectively. Paired resistor switching is accomplished by electronic switch components RL12, RL11, and RL10 respectively. Backup referenced terminating components are R89 and R93; paired components are R90 and R91, R88 and R92, and R81 and R84; and switch components are RL9, RL8, and RL7, which are used respectively.

Third: The Pad network output of T6 is then differentially fed to a gain control module, U18, which provides continuous gain control to normalize the sensed voltage output, independent of generator operating modes and delivered RF power levels. Amplifier, U19, buffers the signal received from software which is used to precisely control the gain of U18, while amplifier U17 provides a scaled differential output voltage, a result of U18 gain processing. Backup referenced components are gain control module U40, buffer amp U31, and difference amp U30 respectively.

Fourth: The output of amplifier U17 is now delivered to the last stage for sensory signal processing. An anti-alias filter device, U16, receives the difference signal from U17. The last stage of sensor processing provides a benefit to the RF monitored output; it increases the accuracy of the delivered RF by minimizing noise to the sensed signals. Backup components U29, R190, and R216 are used.

Steering Relay PCBA Principles of Operation

To accommodate the need for high isolation between the patient and ground referenced voltages during use, the ForceTriad Steering Relay PCBA design incorporates several different types of relays designed for very high voltage standoff. In addition, cut-outs on the PCBA increase distances at strategic locations to help reduce creepage issues.

Multiple functions are performed by the Steering Relay PCBA. The main function is to route the 470 kHz from the RF PCBA to one of the six outputs. The outputs are as follows: Ligasure 1, Ligasure 2, Bipolar, Mono 1, Mono 2, and Footswitch Controlled outputs. Because only one output can be active at any given time, the Steering Relay PCBA plays an important role in maintaining the isolation between all the outputs and their respective circuits. During mono and footswitch modes, a return path, called Mono return, is required. Mono return is monitored with a Return Electrode Monitor (REM) circuit. This circuit monitors the resistance between the two return areas on a REM electrode. The actual REM circuit is on the RF PCBA, but this 80 kHz signal is routed through the Steering Relay PCBA to the Mono return. Another signal that is routed from the RF PCBA to the Steering Relay PCBA is the Autobipolar (ABP) signal. This 80 kHz signal monitors the bipolar output impedance.

Another important function of the Steering Relay PCBA is hand-switching detection. The circuits used to detect hand-switching requests are powered from individual, highly isolated power supplies. These power supplies use transformers that convert ground referenced +12V to an isolated +8V or +5V, each referenced to its corresponding output. Five handswitching power supplies are available: Ligasure 1, Ligasure 2, Bipolar, Mono 1, and Mono 2. When an active hand switch signal is detected, the detection signal is transferred across an optocoupler and is sent to the microprocessor.

The final function of this PCBA is footswitch and bipolar sense. These circuits determine if an instrument is connected to any of the receptacles.

Circuit Descriptions for the Force Triad Display PCBA

Hotlink Transceiver U1

The Cypress Hotlink II transceiver U1 handles all communications between the Display PCBAs Field Programmable Gate Array (FPGA) U28 and the Controller PCBA. A single IC handles bi-directional communication.

Liquid Crystal Display (LCD) Driver Inside the FPGA U28

The LCD driver receives video data from the Controller PCBA and outputs it to the displays. Data is written into a 16-pixel deep First In/First Out (FIFO) when received from the serial link. Data is read out of the FIFO and presented to the displays at the pixel rate. For the ForceTriad energy platform, this yields a display refresh rate of ~46 Hz. In either case, the pixel rate must be derived from the receive clock to keep the display output in sync with the display data generation on the Controller PCBA and prevent overflowing or under flowing of the pixel FIFO.

Touchscreen Driver

Reading user input from the touchscreens is performed by the touchscreen driver. Three touchscreens are attached to the Display PCBA, each through its own 5-wire interface. The touchscreen driver polls each screen in turn to determine whether the user is pressing on it. If so, then the X and Y position of the touch are detected. On the Force Triad Display PCBA, load switching FETs are used to drive voltages onto the four electrical drive connections, and the voltage on the sense connection is read by an Analog Digital Converter (ADC) U4. The drive circuitry normally drives +3.3V to all four drive connections, while the sense connection is pulled weakly to ground. The FPGA repeatedly reads the analog voltage on the sense line. As long as it is closer to ground than to +3.3V, it registers a “no touch” read. If, however, the sense line is closer to +3.3V than to ground, it initiates a read cycle. In the read cycle, the FPGA first applies +3.3V to the X and (right side) drive connections and ground to the Y and L (left side) drive connections. The voltage on the sense line is sampled to obtain the X position. Then, the Y and (top side) drive connection are driven to +3.3V while the X and L (bottom side) drive connections are grounded. The sense line voltage is recorded as the Y position. This process is repeated for each of the three touchscreens.

LCD Brightness DAC Control

The brightness for each Quarter Video Graphics Array (QVGA) display can be controlled individually by feeding an analog value between 0 and 5V to its inverter. This is accomplished by use of a Digital/Analog Converter (DAC) U24. The LCD brightness DAC control block takes DAC values from the serial link and writes them to the DAC.

Barcode Driver

The Display PCBA supports communication with four barcode readers through a quad-Universal Asynchronous Receiver/Transmitter (UART) U14. One channel of the serial interface side of the UART is connected to each barcode reader, while the control side is connected to the display FPGA. The barcode driver reads data bytes out of the UART as they are received from the barcode readers and sends them to the Controller PCBA. It also writes data and control bytes to the UART as specified by the Controller PCBA.

Power Supply

The power supply is dual DC to DC converter U16. The power supply has an input of 5 Volts and converts it down to 3.3 and 1.8 Volts outputs.

Footswitch/Audio PCBA Circuitry Description

Overview

The primary function of the audio circuitry is to receive commands from the Interface Control Logic (ICL) FPGA on the Controller PCBA via a serial, two-wire SMBus data link. The FPGA on this PCBA processes that data to determine three parameters; wave file, volume, and duration. Based on these parameters, the FPGA accesses corresponding parallel data from flash memory, serializes it and passes it out to the DAC. Control data is also passed to the DAC that sets the volume level of the output amplifier stage. Footswitch data is collected and sent to the Controller PCBA as well. Finally, the expansion port has an RS-232 and EKG/blanking relay interface that connects directly to the Controller PCBA and DAC controlled by this FPGA. The following diagram illustrates signal interconnect.

Power Supplies

This PCBA requires 2 power supplies: 5V and 12V. From those input voltages it also generates 2.5V, 3.3V, and isolated supplies of +12V, -12V and +5V. 5V and 12V are delivered to this PCBA via the RF PCBA connector. The 2.5V and 3.3V supplies are regulated down from the 5V supply on this PCBA. The 5V rail should draw approximately 100mA. The 12V rail should draw approximately 500mA at full volume with no expansion port peripherals connected. The 12V supply is used by the audio amplifier, TPA1517, and also generates all of the isolated power supplies. The isolated power supply can source approximately 250mA on each, +12V ISO and -12V ISO, and 500mA on +5V ISO.

Communications

All communications between the Controller PCBA and the Footswitch/Audio PCBA are conducted over a two-wire System Management Bus (SMBus). The master of this bus is the Controller PCBA.

Audio Data

Three commands can be received from the Controller PCBA; reset, parameter write and parameter read. The reset command resets all internal state machines inside the FPGA. It will also immediately stop a running audio stream. The parameter commands allow the controller to write and read three internal parameters that control sending out audio data.

These parameters are *wave file, duration,* and *volume*. The *wave file* parameter selects a particular wave file in the flash memory by selecting a base memory address from a look up table. The *duration* parameter selects how many times to repeat the wave file. Since each wave file is a fixed length, that file can be repeated up to 30 times, or it can be told to be sent out continuously until another command is received. Finally, the *volume* parameter simply selects a volume level between 0 (mute) and 1024 (highest volume, approx. 60dBA).

When a command is received, the FPGA processes that command only once. For example, if a particular wave file is selected to be played twice, the FPGA will play that wave file twice and then stop until a new command is received. If a wave file is to be played continuously, it can be set via the *duration* field.

Footswitch Data

Footswitch data is polled in this FPGA and, when a footswitch register read is received from the ICL FPGA, the footswitch register data is sent to the ICL FPGA and then cleared. After being cleared, the FPGA immediately polls the footswitches for new footswitch activations. If an activation is detected, the FPGA holds a corresponding bit in the footswitch register until it is read by the ICL FPGA, even if the footswitch is depressed before that event occurs.

Expansion Port DAC Data

The ICL FPGA sends DAC data to this FPGA, which is then serialized and sent out to the expansion port DACs. Four DAC registers can be written to in this FPGA; each corresponds to a RF statistic: power, current, voltage, and load impedance.

DAC Amplifier

The DAC is an Analog Device AD1854. It is controlled by two serial interfaces. One interface streams left and right channel audio data. The other interface sends control data to the DAC, including amplification settings. The volume parameter is passed directly to the DAC via this interface. The amplifier is an Analog Device TPA1517. It is a 6-watt amplifier and runs off 12 volts. For both the DAC and the amplifier, only one of the two channels is used since the Footswitch/ Audio PCBA only has one speaker.

Isolated Footswitch and Expansion Port Circuitry

The footswitch circuit provides an isolated footswitch detection circuit that passes footswitch data directly to this PCBA's FPGA. The FPGA, as noted above, polls the footswitches for activations. The expansion port has an EKG/blanking relay that is directly controlled by the Controller PCBA. The expansion port also has an RS-232 interface that links directly to the controller. And finally, it has a DAC that outputs analog data that corresponds to RF parameters.

Host Processor

The host has FLASH, SDRAM, and SRAM memory blocks. All memory devices are directly connected to the address and data bus. The SRAM is a battery-backed device that also supports the system's real-time clock function. The host processor is also capable of external communication through two RS232 ports, an Ethernet port, and a USB port.

Digital Signal Processor (DSP) Controlled Data Converters

DSP1

The first Analog Devices ADSP-21161N DSP is the main control system processor. Its primary responsibility is control of the High Voltage Power Supply (HVPS) setting (via an on-board DAC), as well as the keying signal for the FR FETs (T_ON, T_ON_180). It also reads a set of voltage and current sensors that complete the feedback loop of the control system. DSP1 has FLASH and SDRAM memories directly connected to its address and data bus.

DSP2

The second 21161 in the system is the dosage-error processor. It reads a redundant set of the same sensors that DSP1 reads. Through a direct-connect serial channel (or through the ICL), the two DSPs are able to compare sensor results. DSP2 has FLASH and SDRAM memories directly connected to its address and data bus.

Interface Control Logic PLD

The purpose of the ICL is to act as Hardware Abstraction Layer (HAL) for the processors. Those peripherals not directly connected to the processors are connected to the ICL. The ICL also provides a communication channel for the three processors via a tri-port RAM. The peripherals connected to the ICL are:

- Footswitch/Audio PCBA
- PCBA ID bus
- Display PCBA (LCDs, barcode readers, and touchscreens)
- Low Voltage Power Supply (LVPS) power fail circuit
- REM and HVPS sensor circuits
- RF relays

Data Converters

There are four high-speed Analog-to-Digital Converters (ADCs) on the PCBA for voltage and current sensor data. There is also one slow-speed ADC for reading REM voltage as well as the HVPS output. There are three Digital-to-Analog Converters (DACs) on the PCBA as well. One DAC is not used. The other two DACs are used by the DSPs to drive the gain of their respective voltage and current sensors. DSP1's DAC also drives the voltage level of the HVPS. The following figures show how the on-board and off-board data converters are connected.

External Peripherals

The Controller PCBA has ports for talking to external peripherals through the following protocols: RS232, USB 1.1, and Ethernet.

Chapter 6

Setup, Tests, and Adjustments

After unpacking or after servicing the ForceTriad energy platform, set it up and verify that it functions correctly.

If the generator does not satisfactorily complete the self-test, calibrate it to ensure its accuracy.

Setting Up the Generator

Warning

Electric Shock Hazard Connect the generator power cord to a properly grounded receptacle. Do not use power plug adapters.

Fire Hazard Do not use extension cords.

Caution

Do not stack equipment on top of the generator or place the generator on top of electrical equipment. These configurations are unstable and/or do not allow for adequate cooling.

Provide as much distance as possible between the electrosurgical generator and other electronic equipment (such as monitors). An activated electrosurgical generator may cause interference with them.

Notice

If required by local codes, connect the generator to the hospital equalization connector with an equipotential cable.

Connect the power cord to a wall outlet having the correct voltage. Otherwise product damage may result.

1. Verify the generator is off by pressing the power switch off (O).
2. Place the generator on a stable flat surface, such as a table, platform, or Valleylab cart. Carts with conductive wheels are recommended. For details, refer to the procedures for your institution or to local codes.

   Provide at least four to six inches of space from the sides and top of the generator for cooling. Normally, the top, sides, and rear panel are warm when the generator is used continuously for extended periods of time.

   Ensure that the generator rests securely on the cart or platform. The underside of the generator contains four rubber feet and additional holes that allow you to reposition the feet to ensure stability. Use a Phillips screwdriver to remove the rubber feet from the generator. Then, reinstall the feet in the preferred location.
3. According to the procedures used by your institution, connect an equipotential grounding cable to the grounding lug on the rear panel of the generator. Then, connect the cable to earth ground.
4. Plug the generator power cord into the rear panel receptacle.
5. Plug the generator power cord into a grounded receptacle.
6. Turn on the generator by pressing the power switch on (|). Verify the following:
   - All visual indicators and displays on the front panel illuminate
   - Activation tones sound to verify that the speaker is working properly

7. *If the self-test is successful*, a tone sounds. Verify the following:
   - The three LCD touch screens illuminate and show the appropriate operating screen.
   - Each display shows a power setting of one watt.
   - The REM alarm indicator illuminates red.
8. *If the self-test is not successful*, an alarm tone sounds. An error screen appears on each of the LCD touchscreens. Note the information on this display and refer to Chapter 7, *Troubleshooting*.

Periodic Safety Check

Perform the following safety check every six months to verify that the generator is functioning properly. Record the test results for reference in future tests. If the generator fails to meet any of the checks, refer to Chapter 7, *Troubleshooting*.

Warning

Electric Shock Hazard When taking measurements or troubleshooting the generator, take appropriate precautions, such as using isolated tools and equipment, using the “one hand rule, etc.

Electric Shock Hazard Do not touch any exposed wiring or conductive surfaces while the generator is disassembled and energized. Never wear a grounding strap when working on an energized generator.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Important

When testing RF equipment, follow these test procedures to duplicate manufacturer test data. Keep test leads to the minimum length usable; lead inductance and stray capacitance can adversely affect readings. Carefully select suitable ground points to avoid ground loop error in measurements.

The accuracy of most RF instruments is approximately 1–5% of full scale. Using uncompensated scope probes causes large errors when measuring high voltage RF waveforms.

The summary of safety checks:

- Inspect the generator and accessories
- Inspect the internal components
- Test the generator
- Verify REM function
- Confirm outputs
- Check leakage current and ground resistance

Recommended Test Equipment

- Stylus pencil (for calibrating touch screen)
- 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000, 2000, 5000 ohm, all 250 watt, 1% tolerance, noinductive (Dale NH-250, or equivalent)
- Current transformer - Pearson model 411, or equivalent
- True RMS voltmeter - Fluke 8920A, or equivalent
- Decade resistance box (for REM testing)
- REM plug
- Oscilloscope - Tektronix 2445, or equivalent
- X10 and X100 oscilloscope probes
- X1000 high voltage probe
- Digital voltmeter (3.5 digit minimum)
- Handswitching electrosurgical pencils
- Force Triverse electrosurgical device (barcode)
- LigaSure instrument (dot code)
- Valleylab footswitch pedals (bipolar, monopolar, LigaSure)
- Potentiometer adjustment tool
- Low frequency test circuit

Inspecting the Generator and Accessories

Equipment required:

- Bipolar footswitch or monopolar footswitch
- Bipolar instrument cords (handswitching and footswitching)
- Monopolar instrument cords (handswitching and footswitching)
- LigaSure instrument cords (handswitching and footswitching)

Turn off the generator, and disconnect the power cord from the wall receptacle.

Rear Panel

1. Check the rear panel footswitch receptacles for obstructions or damage. Check for a secure fit by inserting the bipolar footswitch or monopolar footswitch connector into the appropriate receptacle.
2. Remove the fuse and verify correct voltage and current rating. Refer to *Performance Characteristics* in Chapter 4.
3. If either connection is loose, replace the Footswitch/Audio PCBA. Refer to *Footswitch/Audio PCBA Replacement* in Chapter 8.

Front Panel

1. Check the Universal Footswitching Port (UFP) for obstructions or damage. Check for a secure fit by inserting the monopolar footswitch connector into the receptacle. Verify the UFP properly detects instrument insertion.

   If the connection is loose, replace the receptacle. Refer to *Output Receptacle Replacement* in Chapter 8.
2. Check the Bipolar instrument receptacle for obstructions or damage. Insert the bipolar instrument connector (footswitching and handswitching) into the appropriate receptacle to verify a secure fit. Verify the Bipolar instrument receptacle properly detects instrument insertion.

   If the connection is loose, replace the receptacle assembly. Refer to *Output Receptacle Replacement* in Chapter 8.
3. Check the Monopolar instrument receptacles for obstructions or damage. Insert the Monopolar instrument connector into the appropriate receptacle to verify a secure fit. Ensure the barcode readers detect and read the handswitching electrosurgical pencil and Force Triverse electrosurgical device.

   If any of the connections are loose, replace the receptacle assembly. Refer to *Output Receptacle Replacement* in Chapter 8.
4. Check the Patient Return Electrode receptacle for a broken pin or an obstruction.

   If the receptacle is damaged or obstructed, replace the receptacle assembly. Refer to *Output Receptacle Replacement* in Chapter 8.
5. Check the LigaSure instrument receptacles for obstructions or damage. Insert the LigaSure instrument connector into the appropriate receptacle to ensure a secure fit. Verify the barcode readers detect and read the LigaSure instrument.

   If any of the connections are loose, replace the receptacle assembly. Refer to *Output Receptacle Replacement* in Chapter 8.

Footswitches

1. Remove the footswitch from the generator.
2. Inspect the connector for damage or corrosion.
3. Inspect the footswitch for damage.
4. Reconnect the footswitch to the generator.

Power Cord

1. Remove the power cord from the unit and ensure that it is unplugged from the wall receptacle.
2. Inspect the power cord for damage.
3. Reconnect the power cord to the generator and wall receptacle.

Inspecting the Internal Components

Equipment required:

- Phillips screwdriver

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the generator.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover aside for reinstallation.
3. Verify that all connectors are firmly seated.
4. Inspect each PCBA for damaged components, wires, cracks, and corrosion.
   - If you find evidence of damage on the Controller PCBA, Steering Relay PCBA, Display PCBA, or Footswitch/Audio PCBA, replace the PCBA. Refer to *Controller PCBA Replacement*, *Steering Relay PCBA Replacement*, *Display PCBA Replacement*, or *Footswitch/Audio PCBA Replacement* in Chapter 8.
   - If you find evidence of damage on the HVDC Power Supply PCBA or the RF PCBA, replace the PCBA only if the damage is severe. Refer to *High Voltage DC (HVDC) PCBA Replacement and RF PCBA Replacement* in Chapter 8.
5. Reinstall the cover on the generator. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Testing the Generator

Turning on the generator initiates an internal self-test to verify the calibration. The self-test also checks the operation of the speaker, all indicators, and the displays.

Warning

Use the generator only if the self-test has been completed as described. Otherwise, inaccurate power outputs may result.

1. Turn on the generator by pressing the front panel On (|) switch. Verify the following:
   - All visual indicators and displays on the front panel illuminate.
   - Activation tones sound to verify that the speaker is working properly.
2. *If the self-test is successful*, a tone sounds. Verify the following:
   - The three LCD touch screens illuminate and show the appropriate operating screen.
   - Each display shows a power setting of one watt.
   - The REM alarm indicator illuminates red.
3. *If the self-test is not successful*, an alarm tone sounds. An error screen appears on each of the LCD touchscreens. Note the information on this display and refer to Chapter 7, *Troubleshooting*.

Verifying REM Function

Equipment required:

- REM plug and resistance substitution box

1. Set the resistance substitution box to 120 ohms. Connect the resistance box to the generator and confirm that the REM indicator illuminates green.
2. Slowly increase the resistance and verify that the REM alarm sounds at 135 ± 5 ohms.
3. Decrease the resistance to 60 ohms and verify that the REM indicator illuminates green.
4. Increase the resistance to 100 ohms and verify that the REM alarm sounds.
5. Decrease the resistance to 30 ohms and verify that the REM indicator illuminates green.
6. Decrease the resistance to 10 ohms and verify that the REM indicator illuminates green.
7. Decrease the resistance to 3 ohms and verify that the REM alarm sounds.

Confirming Outputs

Important

The output of any receptacle equipped with a barcode scanner may only be verified using an appropriate barcode or dot code accessory.

The generator must be in the Demo mode to confirm outputs.

The ForceTriad is designed to function only as Return Electrode Contact Quality Monitor (RECQM) equipped unit. To disable the RECQM circuit, see the following instructions for enabling the Demo mode.

Enable Demo Mode

1. To enter demo mode, touch the wrench icon on the right side of the right touchscreen. The Main Menu display will appear in the left touchscreen.
2. In the Main Menu, the Demo mode button will display ‘Enter Demo’ if the system is not in Demo mode. Touch the Enter Demo mode button to begin Demo mode. The system operating displays will appear in all the touchscreens with the words ‘DEMO MODE: Not for Clinical Use’ on all three screens.

Note: While in Demo mode, the REM alarm and the dual instrument error alarm are deactivated, but RF power will still be delivered. The generator will not sense the instrument type, so the appropriate tab must be selected manually for the connected instrument.

3. To exit Demo mode, either turn the system off and restart it, or follow the steps in the *Exit Demo Mode* section as follows.

Exit Demo Mode

1. Touch the wrench icon on the right side of the right touchscreen. The Main Menu display will appear in the left touchscreen.
2. In the Main Menu, the Demo mode button will display ‘Exit Demo’ if the system is in Demo mode. Touch the Exit Demo button in the Main Menu to exit the Demo mode. The system touchscreens will display the last settings entered during the Demo mode.

Checking the Bipolar Output

1. Verify that the generator successfully completes the self-test as described in *Testing the Generator* in this chapter.
2. Connect the test equipment for bipolar output.
   - **a.** Connect the two test cables to the Bipolar Instrument receptacle. Ensure the test cables depress both the sensing switches of the receptacle.
   - **b.** Pass one test cable through the current transformer and connect the current transformer to the voltmeter.
   - **c.** Connect the 100 ohm power resistor across the output jacks at the end of the test cables.
   - **d.** Connect the bipolar footswitch to the Bipolar Footswitch receptacle on the rear panel.
3. Press the Low button and set the bipolar power to 10 watts.
4. Test the output current for the selected Bipolar mode.
   - **a.** Press the footswitch pedal and, while activating the generator, note the output on the voltmeter.
   - **b.** Release the footswitch pedal.
   - **c.** Based on the voltmeter setting and the current transformer you are using, calculate and record the output current.
5. Press the Med (Standard) button and repeat step 4.
6. Press the Macro (Macrobipolar) button and repeat step 4.
7. Verify that the generator output for each mode is 315 ± 24 mA rms.

   If the output is outside the specified range, calibrate the bipolar output as described in calibration steps 1, 5, 6, and 9 then repeat this procedure. If the output for one or more modes remains outside the specified range, call the Valleylab Service Center.

Checking the Monopolar Output for the Cut Modes

1. Verify that the generator successfully completes the self-test as described in *Testing the Generator* in this chapter.
2. Connect the test equipment for monopolar output.
   a. Connect a handswitching instrument in the Monopolar 1 Instrument receptacle. Pass the test cable through the current transformer and connect the current transformer to the voltmeter.
   b. Use a test cable to short the two pins on the Patient Return Electrode receptacle.
   c. Connect the second test cable from the voltmeter to both pins of the Patient Return Electrode receptacle.
   d. Connect the 300 ohm resistor across the output jacks at the end of the test cables.
3. Press the Pure button on the far left screen.
4. Press the Cut up (Δ) or down (∇) arrow buttons to set the cut power to 75 watts.
5. Test the monopolar cut output.
   a. Press the handswitch cut button and, while activating the generator, note the output on the voltmeter.
   b. Release the handswitch button.
   c. Based on the voltmeter setting and the current transformer you are using, calculate and record the output current.
6. Press the Blend button and repeat step 5.
7. Verify that the generator output for each mode is 499 ± 38 mA rms.

   If the output is outside the specified range, calibrate the monopolar output as described in calibration steps 1, 5, 6, and 9 then repeat this procedure. If the output for one or more cut modes remains outside the specified range, call the Valleylab Service Center.

Check the Output for the Coag Modes

1. Verify that the generator successfully completes the self-test as described in *Testing the Generator* in this chapter.
2. Connect the test equipment for monopolar output.
   a. Connect a handswitching instrument in the Monopolar 1 Instrument receptacle. Pass the test cable through the current transformer and connect the current transformer to the voltmeter.
   b. Use a test cable to short the two pins on the Patient Return Electrode receptacle.
   c. Connect the second test cable from the voltmeter to both pins of the Patient Return Electrode receptacle.
   d. Connect the 500 ohm resistor across the output jacks at the end of the test cables.
3. Press the Fulgurate button.
4. Press the Coag up (Δ) or down (∇) arrow buttons to set the coag power to 30 watts.
5. Test the monopolar coag output.
   a. Press the handswitch coag button and, while activating the generator, note the output on the voltmeter.
   b. Release the handswitch button.
   c. Based on the voltmeter setting and the current transformer you are using, calculate and record the output current.
6. Press the Spray button and repeat step 5.
7. Verify that the system output for each mode is 245 ± 19 mA rms.

   If the output is outside the specified range, calibrate the monopolar output as described in calibration steps 1, 5, 6, and 9 then repeat this procedure. If the output for one or more coag modes remains outside the specified range, call the Valleylab Service Center.

Checking the LigaSure Output

1. Verify the generator successfully completes the self-test as described in *Testing the Generator* in this chapter.
2. Connect the test equipment for LigaSure output.
   a. Connect the two test cables to the LigaSure instrument receptacle.
   b. Pass one test cable through the current transformer and connect the current transformer to the voltmeter.
   c. Connect the 30 ohm power resistor across the output jacks at the end of the test cables.
3. Setup the generator for testing LigaSure output.
   a. Select the ‘Wrench’ button on the right side of the right screen.
   b. Select the ‘Service’ button.
   c. Enter password ‘423213’ and select the ‘Enter’ button.
   d. Select the ‘Diagnostics’ button.
   e. Select the ‘Debug Mode’ button.
   f. Select the ‘LigaSure Test’ button from the drop down list (Mode Selection).
   g. Select ‘LigaSure 1 Port’ button from the drop down list (Port Selection).
   h. Select the ‘Closed Loop’ button.
   i. Set level to 5.5 Amps using the ‘Up’ button.
4. Test the LigaSure output current.
   a. Select the ‘Start RF’ button.
   b. Note the output on the voltmeter.
   c. Depress the “Stop RF” button.
   d. Based on the voltmeter setting and the current transformer you are using, calculate and record the output current.
5. Verify that the system output is 2130 mA - 2880mA rms.

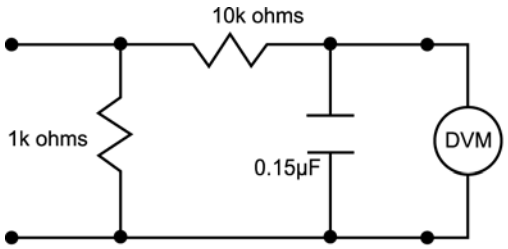
   If the output is outside the specified range, calibrate the LigaSure output as described in calibration steps 1, 5, 6, and 9 then repeat this procedure. If the output for one or more modes remains outside the specified range, call the Valleylab Service Center.

Checking Low Frequency Leakage Current

Check the low frequency leakage current before returning the ForceTriad to clinical use.

Equipment required:

- DVM
- Leakage current tester



1 millivolt = 1 microamp

Leakage current test circuit per IEC 60601-1

Output Receptacles and REM Source Current

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the generator.
3. Measure between all the output receptacles (including the Patient Return Electrode receptacle) and earth ground. Record the largest reading.
4. Determine the leakage current using the conventional 1 microamp per 1 millivolt.
5. Verify under normal conditions (ground closed, normal polarity) the leakage current is less than 10 microamps. If the leakage current is greater than 10 microamps, call the Valleylab Service Center.
6. Verify single fault conditions (ground open) the leakage current is less than or equal to 50 microamps. If the leakage current is greater then 50 microamps, call the Valleylab Service Center.

Chassis or Earth Leakage

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the generator.
3. Measure between the chassis and earth ground.
4. Determine the leakage current using the conventional 1 microamp per 1 millivolt.
5. Verify under normal conditions (ground closed, normal polarity) the leakage current is less than 100 microamps. If the leakage current is greater than 100 microamps, call the Valleylab Service Center.
6. Verify single fault conditions (ground open) the leakage current is less than or equal to 300 microamps. If the leakage current is greater than 300 microamps, call the Valleylab Service Center.

Output Receptacles and REM Sink Current

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the generator and connect the end of the leakage current test circuit to mains voltage through a 120 k¾ resistor.
3. Connect the other side of the IEC leakage load to all of the output receptacles (including the Patient Return Electrode receptacle)
4. Determine the leakage current using the conventional 1 microamp per 1 millivolt.
5. Verify the leakage current is less than or equal to 20 microamps. If the leakage current is greater than 20 microamps, call the Valleylab Service Center.

Checking High Frequency Leakage Current

Check the high frequency leakage current and ground resistance before returning the ForceTriad to clinical use. Check the leakage current:

- After calibrating the generator
- Every six months

Equipment required:

- 200 ohm, 250 watt, noninductive resistor
- Current transformer
- True RMS voltmeter (Fluke 8920 or equivalent)
- Bipolar and monopolar footswitches
- Leakage table - per IEC 601-2-2, Figure 104

Checking Monopolar High Frequency Leakage Current

1. Connect the 200 ohm load from the UFP through the current transformer to the equipotential ground lug on the rear of the generator.
2. Connect the current transformer to a true RMS voltmeter.
3. Connect a monopolar footswitch to the UFP Footswitch receptacle on the rear panel.
4. Activate the footswitch in each Monopolar mode at the maximum control setting. Record the leakage current. If using the leakage table, leakage current should not exceed 150 mA for any mode.
5. If the high frequency leakage exceeds 150 mA, call the Valleylab Service Center for further instructions.

Checking Bipolar High Frequency Leakage Current

1. Remove the monopolar accessories and connect the 200 ohm load from one side of the bipolar output through the current transformer to the equipotential ground lug on the rear of the generator.
2. Connect the current transformer to the true RMS voltmeter.
3. Connect a bipolar footswitch to the Bipolar Footswitch receptacle on the rear panel.
4. Activate the footswitch in each mode at maximum control setting. Record the leakage current. It should not exceed 60 mA for any mode using either the leakage table or short lead configuration.
5. If the high frequency leakage exceeds 60 mA, call the Valleylab Service Center for further instructions.

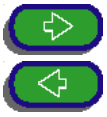
Calibrating the ForceTriad Energy Platform

There are 10 calibration steps. During calibration you verify information specific to the ForceTriad energy platform, adjust the date, and adjust the clock. You also adjust the REM circuit and several values, or factors, that ensure the proper operation of the generator.

Notice

After completing any calibration step, proceed to the next step to save the values from the completed calibration step.

Common Calibration Symbols

	Wrench
	Enter
	Up/Down
	Page Up/Page Down
	Next/Back
	Cancel

Step 1 - LC Filter Tuning

1. Turn off the generator.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover aside for reinstallation.
3. Connect a cable through a Pearson current monitor from the REM port to the ground lug in the back of the generator.
4. Turn the generator on.
   - **a.** Select the ‘Wrench’ button on the right side of the right screen.
   - **b.** Select the ‘Service’ button.
   - **c.** Enter password ‘423213’ and select the ‘Enter’ button.
   - **d.** Select the ‘Diagnostics’ button.
   - **e.** Select the ‘Debug Mode’ button.
   - **f.** Select the ‘Mono Blend’ button from the drop down list (Mode Selection).
   - **g.** Select the ‘Mono 1’ button from the drop down list (Port Selection).
   - **h.** Select the ‘Open Loop’ button.
   - **i.** Set level to 20% using the ‘Up’ button.
   - **j.** Select the ‘Start RF’ button.
5. Adjust the inductor potentiometer (L2) located on the HVDC PCBA to get the lowest possible reading on the external True RMS meter.
6. Select the ‘Stop RF’ button when the optimal current value has been reached.
7. Turn the generator off.
8. Apply loctite, or equivalent, to the inductor potentiometer.
9. Reinstall the cover on the generator. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Step 2 - Set Date and Time

1. Turn the generator on.
2. Select the ‘Wrench’ button on the right side of the right screen.
3. Select the ‘Setup’ button.
4. Select the ‘Time and Date’ button.
5. Adjust time and date using up and down arrow keys and select the ‘Enter’ button.
6. Select the ‘Back’ button to return to the Main Menu.

Step 3 - Touch Screen Calibration

1. Select the ‘Service’ button.
2. Enter password ‘423213’ and select the ‘Enter’ button.
3. Select the ‘Maintenance’ button.
4. Select the ‘Calibrate’ button.
5. Use the up and down arrows to scroll through the calibration menu list and select the ‘Touch Screen’ button.
6. Follow the on-screen instructions and press the ‘Next’ button to continue with calibration.
7. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 4 - Scanner Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘Scanner’ button. Allow the generator to perform an initial scan on all ports.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 5 - Voltage Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘Voltage Cal’ button.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 6 - Current Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘Current Cal’ button.
2. Follow the on-screen instructions and select the ‘Right Arrow’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 7 - REM Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘REM’ button.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 8 - Autobipolar Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘AutoBip’ button.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.

Step 9 - RF Leakage Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘Leakage’ button.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the ‘Cancel’ button to exit.
4. Turn the generator off, then back on to reboot the system.

Step 10 - Brightness Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the ‘Brightness’ button.
2. Follow the on-screen instructions and select the ‘Next’ button to continue with brightness calibration.
3. When the on-screen calibration instructions for each of the three touchscreens have been completed and saved, select the ‘Next’ button to view the Brightness Calibration Parameters.

Chapter 7

Troubleshooting

If the system is not functioning properly, use the information in this chapter to perform the following tasks:

- Identify and correct the malfunction
- If a system error was displayed, take the appropriate action to correct the condition.

Inspecting the ForceTriad Energy Platform

If the ForceTriad energy platform malfunctions, check for obvious conditions that may have caused the problem:

- Check the system for visible signs of physical damage.
- Verify that all accessory cords are properly connected.
- Check the power cord. Replace the power cord if you find exposed wires, cracks, frayed insulation, or a damaged connector.
- Open the fuse drawer and inspect the fuse housing and fuses for damage and corrosion. Verify that the fuses are firmly seated.

  An internal component malfunction in the system can damage the fuses. You may need to replace the fuses if the generator fails the self-test or stops functioning.

Responding to System Errors

Example

- E277 is the error identification number.
- SELF_TESTS identifies the file name within the code where the error occurred.
- H identifies the processor in which the error occurred.
  (H = Host, 1 = Main Digital Signal Processor, 2 = Backup Digital Signal Processor)
- 0.0014 identifies the version of code.
- L1603 identifies the line of code at which the error occurred.

Important

When contacting Valleylab Service, include all screen information.

System Error Descriptions

When system errors occur, the system is no longer functional. The only way to recover is to recycle power.

Non-Recoverable Error Descriptions

When non-recoverable errors occur, the system will have limited functionality, but will not allow RF output. The system will allow qualified service personnel to access the diagnostic service menu to aid in troubleshooting the unit. Software downloads can be performed and some limited capability is permitted within the main menus.

When the Diagnostic menu is selected, the user can choose to disable errors. When errors are disabled, the user has access to the full capability of the system and further non-recoverable errors will not limit this capability. However, because errors have occurred, the system may not function per specifications. The user can only enable errors by recycling power.

Some system and non-recoverable errors are corrected automatically, however most require some action by the user to correct the condition. When an error occurs, record all screen information then cycle (turn off, then turn on) the generator. After correcting an error condition, verify the generator completes the self test. If the error persists, call the Valleylab service center.

The table below describes system errors that can be reported by the ForceTriad energy platform.

System Error Identifications	Description	Recommended Action
E 2 ERR_SE_ICL_ERROR	Unable to communicate to hardware using the Host ICL registers	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 3 ERR_SE_APP_ROM_FAIL	DSP application ROM check failed at startup	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 4 ERR_SE_BOOT_ROM_FAIL	DSP boot ROM check failed at startup	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 5 ERR_SE_RAM_FAIL	DSP RAM check failed at startup	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 6 ERR_SE_RTOS_FAIL	Software error - A real time operating system failure. **Example:** During startup, the Host software failed to create a thread necessary for the system to function.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 7 ERR_SE_GEN_FAIL	General system error failure **Example:** During startup, an error occurred while performing initialization or setup of some of the Host application software.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 8 ERR_SE_CRITICAL_DATA	Software error - Critical data has been corrupted. **Example:** The data store was not initialized.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 9 ERR_SE_ASSERT	Software error - A software failure has occurred that has generated an assertion. **Example:** A pointer that has not been assigned is about to be used.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

System Error Identifications	Description	Recommended Action
E 10 ERR_SE_INVALID_DATA	Software error - A software failure occurred because of invalid data. **Example:** Invalid configuration data resulted in the inability of the user interface to function properly.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 11 ERR_SE_MACHINE_CHECK_EXCEPTION	A Host processor machine check exception has occurred. **Example:** The Host processor is trying to access an address location that does not exist.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 12 ERR_SE_DATA_STORAGE_EXCEPTION	A Host processor data storage exception has occurred.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 13 ERR_SE_ISI_EXCEPTION	A Host processor data storage exception has occurred.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 14 ERR_SE_ALIGNMENT_EXCEPTION	A Host processor alignment exception has occurred. **Example:** The operand of a load/store instruction is not word aligned.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 15 ERR_SE_PROGRAM_EXCEPTION	A Host processor program exception has occurred.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 16 ERR_SE_FP_UNAVAILABLE_EXCEPTION	A Host processor floating point unavailable exception has occurred. **Example:** Execution of a floating point instruction was attempted.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 17 ERR_SE_SYS_CALL_EXCEPTION	A Host processor system call exception has occurred. **Example:** A system call instruction (sc) has been executed.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 18 ERR_SE_TRACE_EXCEPTION	A Host processor trace exception has occurred. **Example:** When single step tracing is enabled, this exception is generated after the successful completion of each instruction. Instruction RFI is excluded.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

System Error Identifications	Description	Recommended Action
E 19 ERR_SE_FP_ASSIST_EXCEPTION	A HOST processor floating point assist exception has occurred.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 20 ERR_SE_MEM_ALLOC_FAIL	A memory allocation failure has occurred.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 21 ERR_SE_UNKNOWN_EXCEPTION	The Host processor has generated an unknown exception. The exception vector is not a valid vector.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 22 ERR_SE_STACK_OVERFLOW	A thread on the host has overflowed it's stack.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

The following table describes all of the non-recoverable error identifications for the ForceTriad.

Non-Recoverable Error Identifications	Description	Recommended Action
E 257 ERR_NR_DOSAGE	General RF dosage error	1. Turn off, then turn on the generator. 2. Calibrate the generator. 3. If the error persists, call the Valleylab service center.
E 258 ERR_NR_MEM_ALLOC_FAIL	Software Error - Memory allocation failures **Example:** Unable to allocate a memory block from the operating system memory pool	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 259 ERR_NR_INVALID_DATA	Software Error - Invalid data **Examples:** Invalid DSP Identifier Invalid audio tone ID	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 260 ERR_NR_COM_ERROR	Various communication errors **Example:** An error occurred in communications between a DSP and the Host.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 261 ERR_NR_HW_ERROR	Hardware setup/control error **Examples:** Unable to fully disable RF while attempting to deactivate	1. Turn off, then turn on the generator. 2. Calibrate the generator. 3. If the error persists, call the Valleylab service center.
E 262 ERR_NR_ACT_DENIED	Activation denied error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 263 ERR_NR_INVALID_STATE	Software Error - Invalid state **Example:** Invalid system state	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Non-Recoverable Error Identifications	Description	Recommended Action
E 264 ERR_NR_UNSUPPORTED_CMD	Software Error - Unsupported command **Example:** A Host thread has been sent a command from another thread that is undefined.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 265 ERR_NR_ACCESS_FUNCTION	Software Error - Access function error **Examples:** A thread is unable to interface with another thread to carry out a system function. A user interface object is unable to interface with another user interface object to complete a user interface function.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 266 ERR_NR_TIMEOUT_ERROR	A timeout occurred. **Example:** The Host timed out waiting for flash download to a DSP.	**1.** Reboot the unit and retry flashing. **2.** Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 267 ERR_NR_GEN_ERROR	General NR failure source unknown top level reporting **Example:** Activation has been denied during calibration	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 268 ERR_NR_SELF_TEST_ERROR	Self test error After successful completion of the Host POST self tests, the status of all self tests is verified as passed as a double check. If at least one status indicates a failure, this error is reported.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 270 ERR_NR_AUDIBLE_ERROR	Audio self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Non-Recoverable Error Identifications	Description	Recommended Action
E 271 ERR_NR_STUCK_BUTTON_ERROR	Stuck Button self test error	**1.** Ensure that footswitch pedals are not inadvertently activated during boot-up. **2.** Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 273 ERR_NR_INTER_PROC_COMM_ERROR	Inter-processor communication self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 274 ERR_NR_CRITICAL_DATA_ERROR	Critical data self test error	**1.** Turn off, then turn on the generator. **2.** Calibrate the generator. **3.** If the error persists, call the Valleylab service center.
E 275 ERR_NR_MULTI_TASKING_ERROR	Multitasking self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 276 ERR_NR_ANALOG_SENSOR_ERROR	Analog Sensor self test error	**1.** Turn off, then turn on the generator. **2.** Calibrate REM and autobipolar. **3.** If the error persists, call the Valleylab service center.
E 277 ERR_NR_RF_SHUT_DWN_1_ERROR	RF gen/shutdown self test #1 error	**1.** Turn off, then turn on the generator. **2.** Calibrate voltage, current, leakage. **3.** If the error persists, call the Valleylab service center.
E 278 ERR_NR_RF_SHUT_DWN_2_ERROR	RF gen/shutdown self test #2 error	**1.** Calibrate voltage, current, leakage. **2.** Replace the HVPS PCBA.

Non-Recoverable Error Identifications	Description	Recommended Action
E 279 ERR_NR_RF_SHUT_DWN_3_ERROR	RF gen/shutdown self test #3 error	**1.** Calibrate voltage, current, leakage. **2.** Replace the HVPS PCBA.
E 280 ERR_NR_TIMEBASE_ERROR	Timebase comparison self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 281 ERR_NR_SYS_WATCH_DOG_ERROR	System watch dog self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 282 ERR_NR_ICL_PROG_ERROR	ICL chip programmed self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 283 ERR_NR_RAM_MEMORY_ERROR	Ram memory self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 284 ERR_NR_FLASH_MEMORY_ERROR	FLASH memory self test error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 285 ERR_NR_INVALID_CONFIG_DATA	Software Error - Configuration data is not valid (checksum error)	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 286 ERR_NR_NULL_PTR	Software Error - Null pointer detected **Example:** DSP detected un-initialized data	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 287 ERR_NR_AIE	Absolute integral error	**1.** Turn off, then turn on the generator. **2.** Calibrate voltage, current, leakage. **3.** If the error persists, call the Valleylab service center.
E 288 ERR_NR_SENSOR_CLIP	DSP sensor clipping error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Non-Recoverable Error Identifications	Description	Recommended Action
E 289 ERR_NR_SENSOR_COMPARE	DSP sensor comparison error	**1.** Turn off, then turn on the generator. **2.** Calibrate voltage, current. **3.** If the error persists, call the Valleylab service center.
E 290 ERR_NR_DATA_SAMPLE_ERROR	VI data sampling error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 291 ERR_NR_COMM_WD_ERROR	Communication watchdog error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 292 ERR_NR_DSP_SW_ERROR	Software Error - Generic DSP software failure	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 293 ERR_NR_FLASH_ERROR	Error occurred writing to FLASH	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 294 ERR_NR_OS_ERROR	Software Error - Real time operating system error **Example:** Failed to start an operating system timer	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 295 ERR_NR_NV_STORE_ERROR	Error occurred storing data to NV store	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 296 ERR_NR_ICL_HB_ERROR	ICL heartbeat error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 297 ERR_NR_MSG_VIEWER_CTOR_FAIL	Software Error - Message viewer class construction failure	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 298 ERR_NR_SYS_CTLR_REQ_FAIL	Software Error - System controller unexpectedly denied request to bring up main menus	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Non-Recoverable Error Identifications	Description	Recommended Action
E 299 ERR_NR_LKG_LIMIT	DSP2 Leakage sensor compare error	**1.** Turn off, then turn on the generator. **2.** Calibrate leakage. **3.** If the error persists, call the Valleylab service center.
E 300 ERR_NR_BAD_SCANNER	Scanner failed self test failure	**1.** Replace the barcode scanners. **2.** Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 301 ERR_NR_LOW_BATTERY	Battery self test failure	**1.** Replace the battery. **2.** Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 302 ERR_NR_IO_ERROR	Memory-mapped I/O error **Example:** The Host Memory-mapped register runtime self test verifies that the HVPS, steering relays, and RF enable registers are set properly for the currently running state. If not, this error is reported.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 303 ERR_NR_DSP_VERIFY_ERROR	DSP configuration verify failure	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 304 ERR_NR_SCREEN_STACK_ERROR	Software Error - Error in screen stack manipulation in AppScreenBase **Example:** The user will see unexpected screen behavior.	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Non-Recoverable Error Identifications	Description	Recommended Action
E 305 ERR_NR_ROM_ERROR	ROM self test failure	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 306 ERR_NR_ICL_COMM_LINK_ERROR	ICL communication link test failure	**1.** Check the cable between the RF PCBA and the FTSW PCBA. **2.** Check the cable between the Controller PCBA and the Display PCBA. **3.** Program the FTSW FPGA. **4.** Program the Display FPGA. **5.** Turn off, then turn on the generator. If the error persists, call the Valleylab service center.
E 307 ERR_NR_RF_TEST4_ERROR	RF gen/shutdown self test #4 error	Turn off, then turn on the generator. If the error persists, call the Valleylab service center.

Chapter 8

Replacement Procedures

Follow the procedures in this chapter when you need to replace the parts listed below:

- Fuses
- Battery
- Low Voltage Power Supply
- Footswitch/Audio PCBA
- Controller PCBA
- High Voltage DC PCBA
- Front Panel
- Steering Relay PCBA
- Display PCBA
- Barcode Scanner
- Output Receptacles

The parts used in these procedures are listed in Chapter 10, *Service Parts.*

Fuse Replacement

Equipment required:

- Small flathead screwdriver

Warning

Fire Hazard For continued protection against fire hazard, replace fuses only with fuses of the same type and rating as the original fuse.

1. Turn off the generator. Disconnect the power cord from the wall receptacle and the rear panel of the generator for easier access to the adjacent fuse drawer.
2. To release the fuse drawer, insert a small flathead screwdriver into the slot on the drawer below the power cord receptacle then slide the drawer out.
3. Replace each fuse with one of the same type and rating.
4. Slide the fuse drawer into its slot until it snaps into place.
5. Connect the power cord to the rear panel.

Battery Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new battery. Calibration values are lost when the battery is replaced. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the battery on the left side of the Controller PCBA.
4. Grasp the battery and remove it from the socket.
5. Install the new battery.
6. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Low Voltage Power Supply (LVPS) Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the LVPS on the left rear of the unit and disconnect the cable assemblies from the LVPS.
4. Remove the three screws securing the LVPS to the chassis. Note that the lower right screw is non-conductive nylon.
5. Remove the LVPS.
6. Install the new LVPS in the correct orientation.
7. Replace the three screws, ensuring the nylon screw is installed in the lower right corner.
8. Reconnect the cable assemblies.
9. Position the cover above the chassis and slide it down. Install the four screw that secure the cover to the chassis.

Footswitch/Audio PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the Footswitch/Audio PCBA on the right rear of the generator and disconnect the cable assemblies from the Footswitch/Audio PCBA.
4. Remove the two screws securing the Footswitch/Audio PCBA to the chassis. On the rear of the generator, remove the four screws securing the Monopolar and Bipolar Footswitch receptacles to the chassis.
5. Remove the Footswitch/Audio PCBA.
6. Install the new Footswitch/Audio PCBA.
7. Replace the two screws securing the Footswitch/Audio PCBA to the chassis. Replace the four screws securing the Monopolar and Bipolar Footswitch receptacles to the chassis.
8. Reconnect the cable assemblies.
9. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Controller PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you replace the Controller PCBA. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the Controller PCBA on the right side of the generator and disconnect the cable assemblies from the Controller PCBA.
4. Remove the single screw securing the Controller PCBA to the chassis.
5. Remove the Controller PCBA, taking care not to damage the RF PCBA connector.
6. Install the new Controller PCBA in the correct orientation, taking care to align the RF PCBA connector properly.
7. Replace the single screw securing the Controller PCBA to the chassis.
8. Reconnect the cable assemblies to the Controller PCBA.
9. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

High Voltage DC (HVDC) PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new HVDC PCBA. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the HVDC PCBA on the left side of the generator and disconnect the cable assemblies from the HVDC PCBA.
4. Remove the single screw securing the HVDC PCBA to the chassis. This screw is inserted from the chassis side of the assembly.
5. Remove the HVDC PCBA, taking care not to damage the RF PCBA connector.
6. Install the new HVDC PCBA in the correct orientation, taking care to align the RF PCBA connector properly.
7. Replace the single screw securing the HVDC PCBA to the chassis.
8. Reconnect the cable assemblies to the HVDC PCBA.
9. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Front Panel Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new Front Panel. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the three screws attaching the Front Panel assembly to the top rail of the chassis. Remove the four screws at the sides of the Front Panel attaching it to the chassis.
4. Disconnect cable assemblies:
   a. Steering Relay PCBA to RF PCBA
   b. Display PCBA to Controller PCBA
   c. Power Switch to Power Receptacle
5. Rotate the top of the Front Panel assembly downwards until the Steering Relay PCBA clears the chassis top rail. Lift the Front Panel assembly away from the chassis.
6. Install the new Front Panel:
   a. Hold the assembly at an angle with the top away from the generator.
   b. Set the bottom of the Front Panel assembly into the chassis, taking care to line up the alignment tabs.
   c. Rotate the Front Panel assembly towards the chassis, ensuring the fan cables are not pinched.
   d. Slide the top of the Steering Relay PCBA under the top rail of the chassis until the screw holes align.

7. Replace the three screws securing the Front Panel assembly to the chassis top rail. Reinstall the four screws attaching the Front Panel to the chassis.
8. Reconnect cable assemblies:
   a. Steering Relay PCBA to RF PCBA
   b. Display PCBA to Controller PCBA
   c. Power Switch to Power Receptacle
9. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

RF PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new RF PCBA. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the following components:
   a. Controller PCBA; see the *Controller PCBA Replacement* section
   b. HVDC PCBA; see the *High Voltage DC (HVDC) PCBA Replacement* section
   c. Front Panel assembly; see the *Front Panel Replacement* section
4. Disconnect cable assemblies:
   a. Footswitch/Audio PCBA to RF PCBA
   b. LVPS PCBA to RF PCBA
   c. Fan and Temperature Sensor
5. Remove the nine screws securing the RF PCBA to the chassis.

6. Remove the RF PCBA by lifting and sliding forward.
7. Install the new RF PCBA by lowering and sliding backwards.
8. Reinstall the nine screws securing the RF PCBA to the chassis.
9. Reconnect cable assemblies:
   a. Footswitch/Audio PCBA to RF PCBA
   b. LVPS PCBA to RF PCBA
   c. Fan and Temperature Sensor
10. Reinstall components:
    a. Front Panel assembly; see the *Front Panel Replacement* section
    b. HVDC PCBA; see the *High Voltage DC (HVDC) PCBA Replacement* section
    c. Controller PCBA; see the *Controller PCBA Replacement* section
11. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Steering Relay PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new Steering/Relay PCBA. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the Front Panel assembly; see the *Front Panel Replacement* section. Place the Front Panel assembly on a non-scratch surface to protect the touch screens.

4. With the top of the Front Panel facing away, disconnect the following:
   a. Barcode scanner cables
   b. Zero Insertion Force (ZIF) connectors, then the shield ground connectors
   c. Steering Relay PCBA to Display PCBA cable assembly
5. Remove the four screws securing the Steering Relay PCBA to the side brackets. Remove the three screws attaching the bracket to the top of the Steering Relay PCBA.
6. Carefully lift the Steering Relay PCBA off of the Front Panel until sufficient space to disconnect the cable assemblies is available. Disconnect the cable assemblies attaching the Steering Relay PCBA to the output receptacles. Finish removing the Steering Relay PCBA.
7. Install the new Steering Relay PCBA:
   a. Position the Steering Relay PCBA above the Front Panel in the correct orientation.
   b. Reconnect the cable assemblies attaching the Steering Relay PCBA to the output receptacles.
   c. Reconnect the cable assembly connecting the Steering Relay PCBA to the Display PCBA.
   d. Verify that the Barcode Scanner cable assemblies are not trapped between the two assemblies.
   e. Lower the Steering Relay PCBA onto the Front Panel making sure the Barcode Scanner assemblies align with the slots in the Steering Relay PCBA.
8. Reinstall the four screws securing the Steering Relay PCBA to the Front Panel side brackets.
9. Reconnect the four Barcode scanner cable assemblies taking care to fully insert and align the ZIF cables. Verify the shield ground connectors are completely connected.
10. Reinstall the top bracket using three screws, verifying the Barcode Scanner cable assemblies are captured in the proper slots.
11. Reinstall the Front Panel assembly; see the *Front Panel Replacement* section.
12. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Display PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the Front Panel assembly; see the *Front Panel Replacement* section. Place the Front Panel assembly on a non-scratch surface to protect the touch screens.
4. Remove the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.
5. Remove the four screws in the center of the Display PCBA securing it to the Front Panel. Carefully lift the Display PCBA out of the Front Panel.
6. Install the new Display PCBA by carefully lowering it into the Front Panel in the correct orientation.
7. Replace the four screws securing the Display PCBA to the Front Panel.
8. Reinstall the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.
9. Reinstall the Front Panel assembly; see the *Front Panel Replacement* section.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Barcode Scanner Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the generator after you install a new Barcode Scanner. Refer to *Calibrating the ForceTriad Energy Platform* in Chapter 6 for instructions.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the Front Panel assembly; see the *Front Panel Replacement* section. Place the Front Panel assembly on a non-scratch surface to protect the touch screens.
4. Remove the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.
5. Remove the two screws at the bottom of the Barcode Scanner assembly. Slide the Barcode Scanner and shield out of the receptacle assembly.
6. Slide the new Barcode Scanner into the shield, ensuring the shield ground tab mates correctly.
7. Slide the Barcode Scanner and shield into the receptacle assembly. Reattach the two screws securing the Barcode Scanner to the receptacle assembly.
8. Reinstall the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.
9. Reinstall the Front Panel; see the *Front Panel Replacement* section.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Output Receptacle Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The generator contains electrostatic-sensitive components. When repairing the generator, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized generator. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the generator. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the Front Panel assembly; see the *Front Panel Replacement* section. Place the Front Panel assembly on a non-scratch surface to protect the touch screens.
4. Remove the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.

Monopolar 1 Receptacle

a. Remove the three screws securing the Monopolar 1 receptacle to the Front Panel.

b. Remove the Monopolar 1 cable assembly from the receptacle.

c. Install the new Monopolar 1 receptacle in the Front Panel using the three screws.

d. Install the Monopolar 1 cable assembly.

Monopolar 2 Receptacle

a. Remove the three screws securing the Monopolar 2 receptacle to the Front Panel.

b. Remove the Monopolar 2 cable assembly from the receptacle.

c. Install the new Monopolar 2 receptacle in the Front Panel using the three screws.

d. Install the Monopolar 2 cable assembly.

LigaSure 1 Receptacle

a. Remove the three screws securing the LigaSure 1 receptacle to the Front Panel.

b. Remove the LigaSure 1 cable assembly from the receptacle.

c. Install the new LigaSure 1 receptacle in the Front Panel using the three screws.

d. Install the LigaSure 1 cable assembly.

LigaSure 2 Receptacle

a. Remove the three screws securing the LigaSure 2 receptacle to the Front Panel.

b. Remove the LigaSure 2 cable assembly from the receptacle.

c. Install the new LigaSure 2 receptacle in the Front Panel using the three screws.

d. Install the LigaSure 2 cable assembly.

Universal Footswitching Port

a. Remove the four screws securing the Universal Footswitching Port to the Front Panel.

b. Remove the Universal Footswitching Port cable assembly from the receptacle.

c. Install the new Universal Footswitching Port in the Front Panel using the four screws.

d. Install the Universal Footswitching Port cable assembly.

Bipolar Receptacle

a. Remove the three screws securing the Bipolar receptacle to the Front Panel.

b. Remove the Bipolar receptacle cable assembly from the receptacle.

c. Install the new Bipolar receptacle in the Front Panel using the three screws.

d. Install the Bipolar receptacle cable assembly.

REM Receptacle

a. Remove the two screws securing the REM receptacle to the Front Panel. Note the length of each screw. Remove the REM retaining bracket.

b. Install the new REM receptacle in the Front Panel. Replace the REM retaining bracket. Secure the REM receptacle and bracket using the two screws.

5. Reinstall the Steering Relay PCBA; see the *Steering Relay PCBA Replacement* section.

6. Reinstall the Front Panel assembly; see the *Front Panel Replacement* section.

7. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

Chapter 9

Maintenance and Repair

This chapter presents the following information:

- The manufacturer’s responsibility
- Routine maintenance
- Returning the energy platform for service
- Service centers

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Responsibility of the Manufacturer

Valleylab is responsible for the safety, reliability, and performance of the energy platform only if all of the following conditions have been met:

- Installation and setup procedures in this manual are followed.
- Assembly, operation, readjustments, modifications, or repairs are carried out by persons authorized by Valleylab.
- The electrical installation of the relevant room complies with local codes and regulatory requirements, such as IEC and BSI.
- The equipment is used in accordance with the Valleylab instructions for use.

For warranty information, refer to *Preface* chapter in this manual.

Routine Maintenance

When should the energy platform be checked or serviced?

Valleylab recommends that the energy platform be inspected by qualified service personnel at least twice a year. This inspection should include adjusting the system to factory specifications.

When should the power cord be checked or replaced?

Check the power cord each time you use the energy platform or at the intervals recommended by your institution. Replace the power cord if you find exposed wires, cracks, frayed edges, or a damaged connector.

When should the fuses be replaced?

An internal component malfunction can damage the fuses. You may need to replace the fuses if the system fails the self-test or if the energy platform stops functioning, even though it is receiving power from a wall outlet. Refer to *Fuse Replacement* in Chapter 8 for instructions.

Cleaning

Warning

Electric Shock Hazard Always turn off and unplug the energy platform before cleaning.

Notice

Do not clean the energy platform with abrasive cleaning or disinfectant compounds, solvents, or other materials that could scratch the panels or damage the energy platform.

1. Turn off the system and unplug the power cord from the wall outlet.
2. Thoroughly wipe all surfaces of the energy platform and power cord with a damp cloth and mild cleaning solution or disinfectant. The energy platform will withstand the effects of cleaning over time without degrading the enclosure or display quality.

Product Service

Valleylab recommends that authorized Valleylab personnel service the ForceTriad energy platform, however some service operations can be performed by qualified biomeds.

Returning the Energy Platform for Service

Before you return the energy platform, call your Valleylab sales representative for assistance. If you are instructed to send the energy platform to Valleylab, do the following:

1. Obtain a return authorization number.

   Call the Valleylab Customer Service Center for your area to obtain a Return Authorization Number. Have the following information ready when you call:

   - Hospital/clinic name/customer number
   - Your telephone number
   - Department/address, city, state, and zip code
   - Model number
   - Serial number
   - Description of the problem
   - Type of repair to be done

2. Clean the energy platform.
   See the *Cleaning* section above.

3. Ship the energy platform.
   a. Attach a tag to the energy platform that includes the return authorization number and the information (hospital, phone number, etc.) listed in step 1.
   b. Be sure the energy platform is completely dry before you pack it for shipment. Package it in its original shipping container, if available.
   c. Ship the energy platform, prepaid, to the Valleylab Service Center.

Adjustment to Factory Specification (Calibration)

Valleylab recommends that only Valleylab-authorized personnel calibrate the ForceTriad energy platform. The energy platform incorporates automatic calibration where possible to reduce the required equipment and manual steps.

Software Upgrades

Software upgrades must be performed by authorized personnel only.

Service Centers

For a complete list of service centers worldwide, please refer to the Valleylab website:

http://www.valleylab.com/valleylab/international/service-world.html

Chapter 10

Service Parts

Replacement parts for the ForceTriad energy platform are listed in this chapter. If the part number is not listed for a specific item, a replacement for that item is not available.

All components must be replaced with parts of identical construction and value. Replacement ratings and tolerances must be equal to or better than the original. Valleylab does not recommend field replacement of surface mount components.

Ordering Replacement Parts

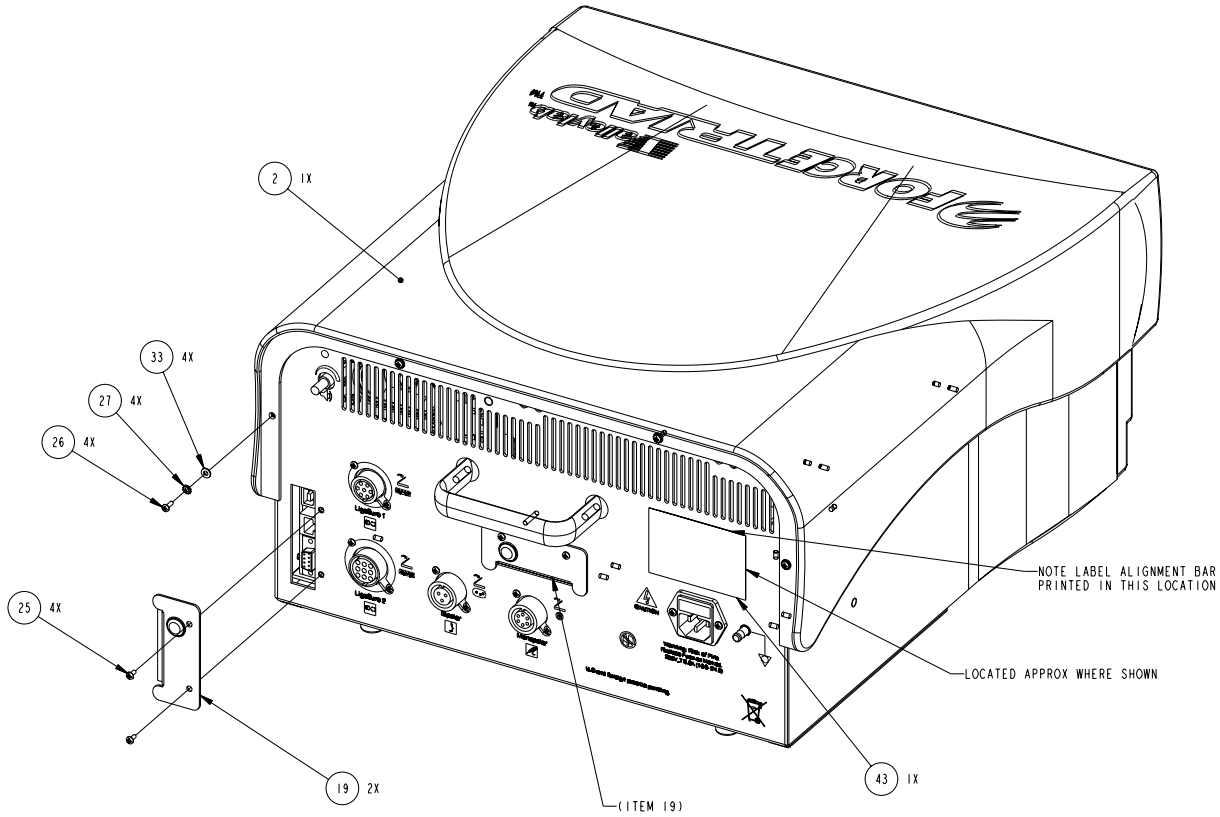
Parts may be ordered from the Valleylab Service Center for your location.

When ordering replacement parts, include this information:

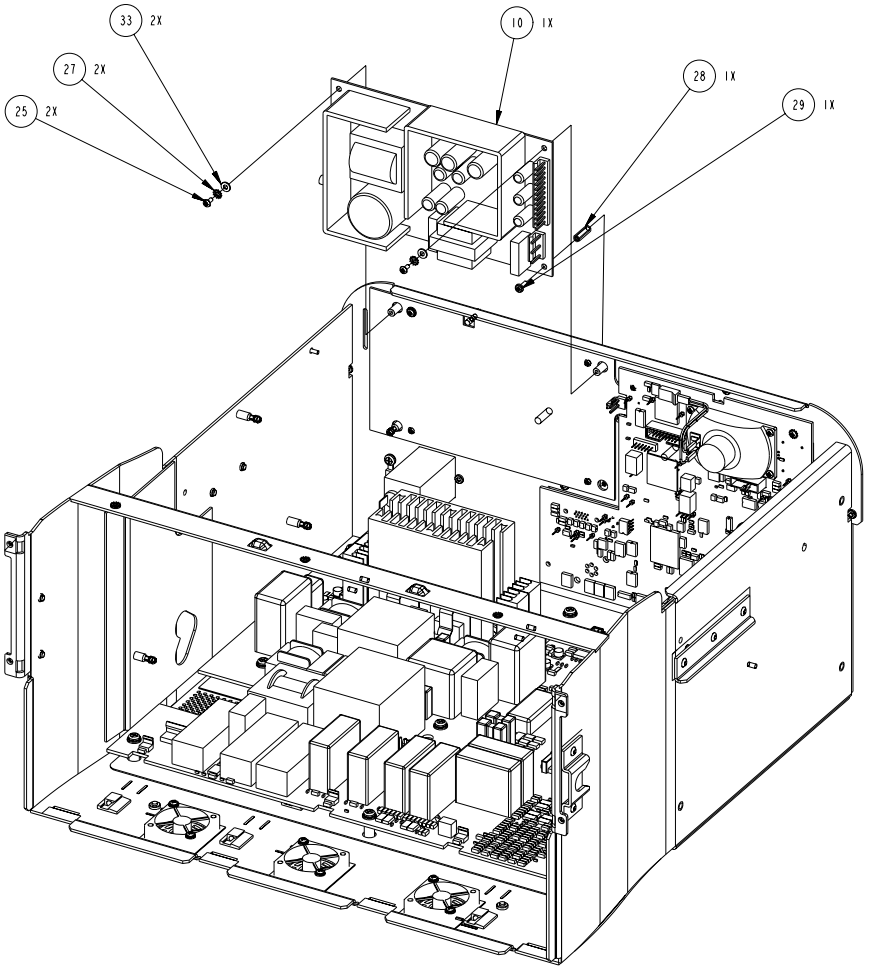
- Model number (located on the rear panel of the generator)
- Serial number (located on the rear panel of the generator)
- Part number (for the part you are ordering)
- Modification number, if applicable.

If you do not know the part number or if you wish to order spare parts, call the Valleylab Service Center for assistance.

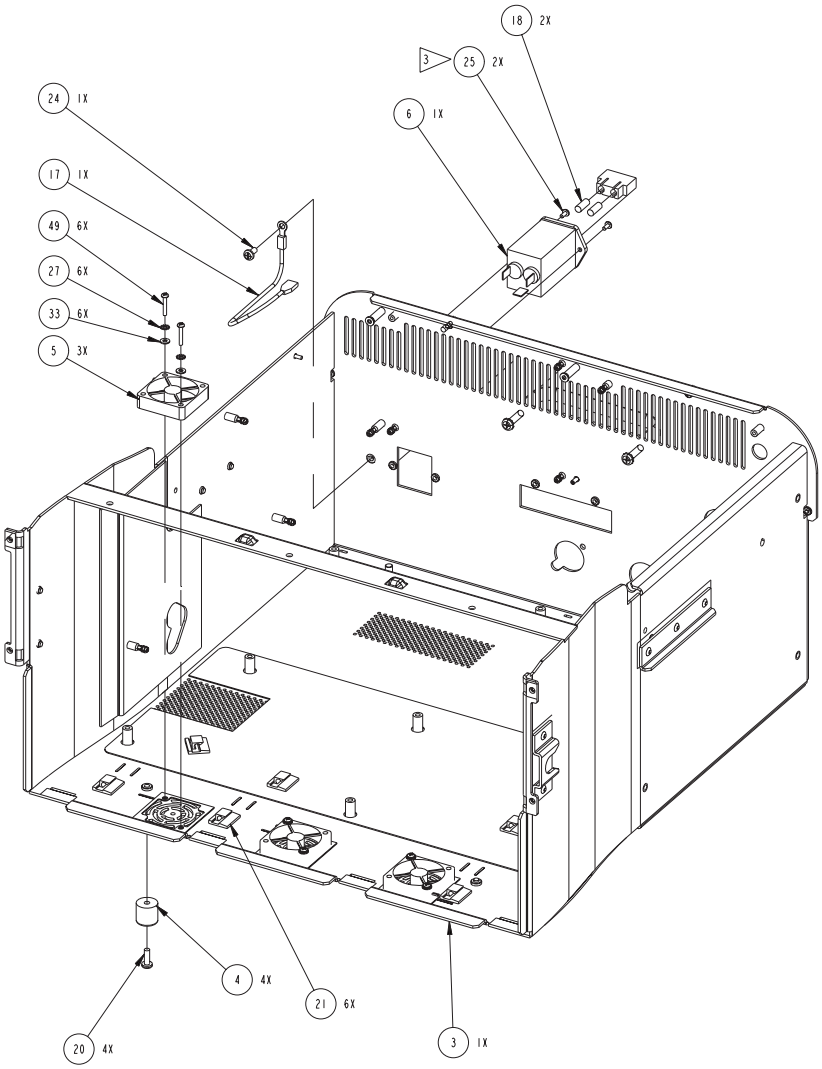
Chassis Assembly



Chassis Assembly (continued)



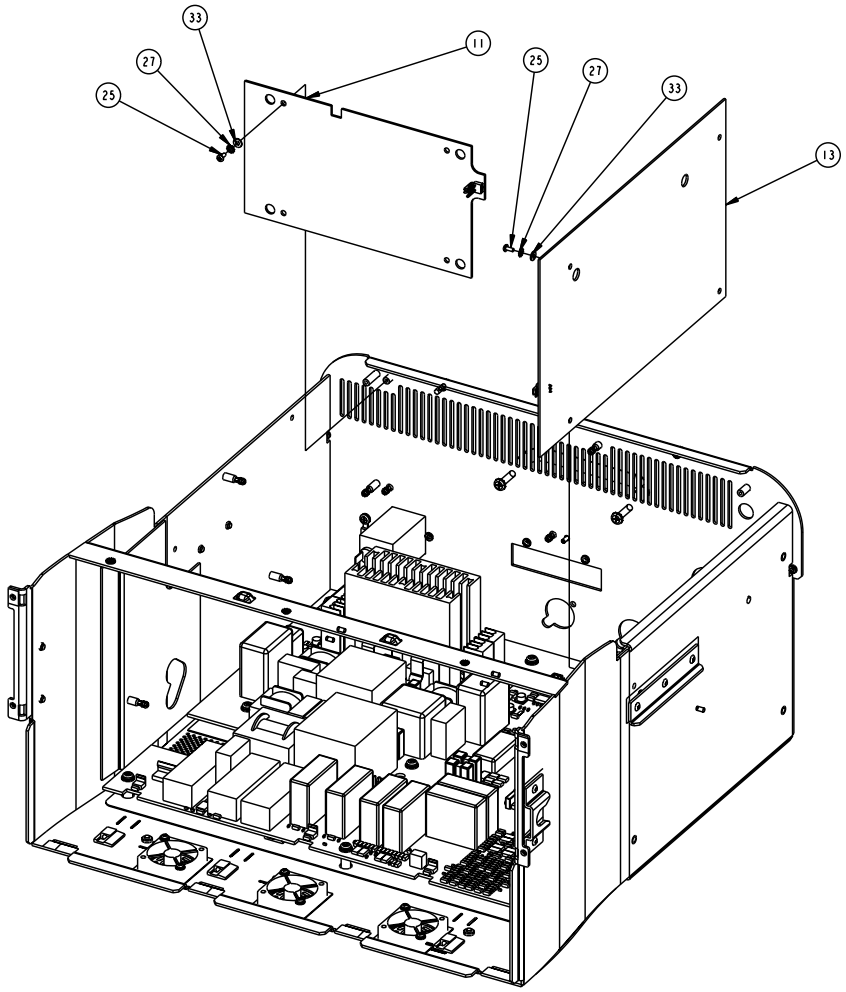
Chassis Assembly (continued)



Chassis Assembly Parts List

Reference Designator	Description	Part Number
10	PWR SPLY LV 75 WATT	207000252
42	CD PWR AC	207002060
28	STANDOFF, 4.5MM, HEX, M3, 16LG, NYL	213110652
30	STANDOFF, 6MM HEX, M3, 14LG	213110655
31	STANDOFF, 6MM HEX, M3, 14LG, NYL	213110656
4	FT RBR	1005706
18	FUSE 8A 250V 5MM	215100090
2	TOP COVER FORCETRIAD GEN	223200716
3	CHASSIS ASSY FORCETRIAD GENERATOR	1003656
	LUG GNDG	1001922
19	PLATE COVER FORCETRIAD CHASSIS	223200733
24	SCR PNH PHH M4X0.7X8MM	237050113
29	SCR NYL PHIL M3X0.5X8	237050126
32	SCR PNH M3 10MM	237050138
20	SCR PNH PHIL M4X0.7X12 ZINC	237050141
25	SCREW, PH, PHILLIPS, M3 X6, ST	237050197
6	FLTR EMI	251400007
47	WSHR METRIC M4	253300005
48	WSHR E.T. M4 STL	253300024
27	LK WASH INTRNL METRIC M3.0	253300044
33	WASHER FLAT M3 REDUCED OD	253300056

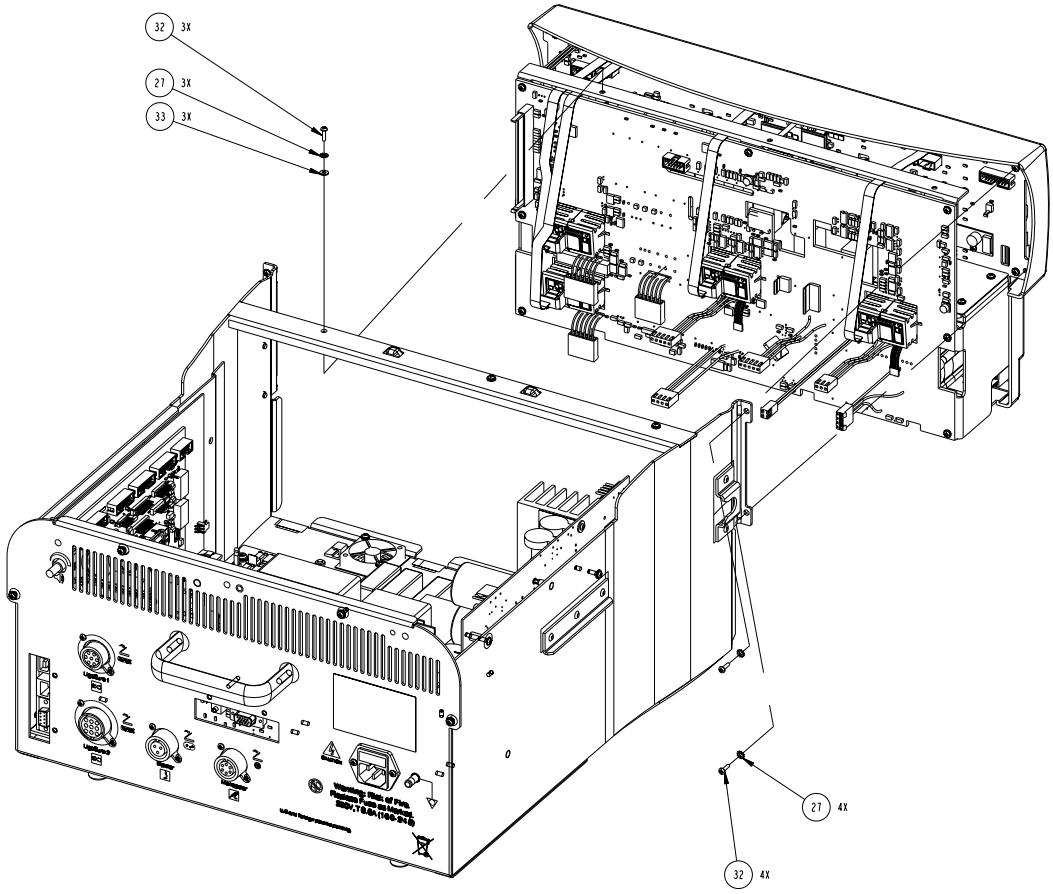
Shield PCBAs



Shield PCBAs Parts List

Reference Designator	Description	Part Number
13	PCB ASSY FORCETRIAD RF SHIELD	1000443
11	PCB ASSY FORCETRIAD LVPS RF SHIEL	1000447

Front Panel



Front Panel Parts List

Reference Designator	Description	Part Number
1	FRONT PANEL FORCETRIAD	1000001
2	OVERLAY FORCETRIAD GENERATOR	207500882
9	PL RETG REM	223301239
19	RAIL MOUNTING STR-RELAY FORCETRIAD	1000510
18	BRACKET PLATE RIGHT FORCETRIAD	1000419
31	BRACKET PLATE LEFT FORCETRIAD	1000418
3	GASKET, FOAM, TCHSCRN, DSPL, FORCETRIAD	232302043
21	SCR PNH M3 10MM	237050138
29	SCR PNH M3 X 0.5 X 8 ZINC	237050149
22	SCR PNH PHIL M3 X 0.5 X 16	237050179
23	SCREW, PH, PHILLIPS, M3 X 6, ST	237050197
24	SCREW PH PHILLIPS M3 X 50 ST	237050198
4	SW DP 120AMP SRG	243025037
27	LKWASH INTRNL METRIC M3.0	253300044
28	WASHER FLAT M3 REDUCED OD	253300056

Display LCD PCBA

Display LCD PCBA Parts List

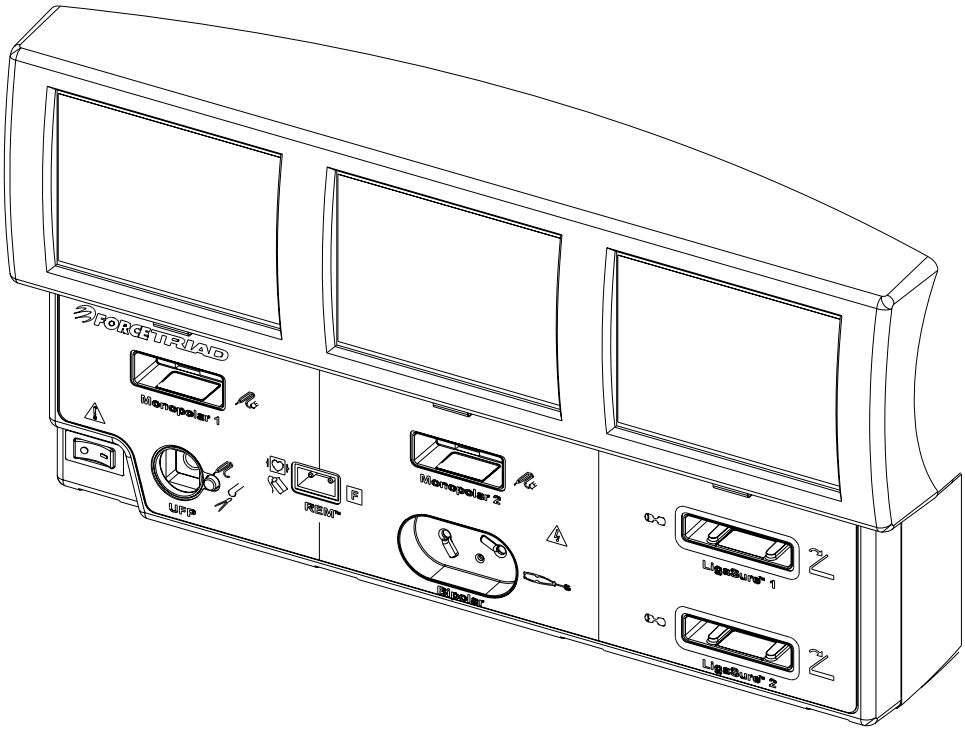
Reference Designator	Description	Part Number
14	ASSY, FORCETRIAD DISPLAY PCB	1004788
	ASSY DISPLAY LCD FORCETRIAD	1003926
8	WASHER FIBER M3	1000358
2	INVERTER, LCD, FORCETRIAD ERG 8M05	207000279
1	PCB DISPLAY FORCETRIAD ASSEMBLY	1001211
5	FLAT FLEX CABLE 33COND	207500890
11	NUT HEX M2 STEEL	224300043
9	SCREW, PH, PHILLIPS, M2 X14, ST	237050195
7	SCREW, TAPPING, PH, PHIL, M3X13, ST	1003797
6	LKWASH INTRNL METRIC M3.0	253300044
10	WSHR FLAT M2	253300054
14	WASHER M2 SPLIT LOCK	253300057

Steering Relay PCBA

Steering Relay PCBA Parts List

Reference Designator	Description	Part Number
	PROGRAMED STR-RLY FORCETRIAD	1003242
20	PCB ASSY FORCETRIAD STEERING RELAYS	1003161
K4, K5, K6, K7	RLY COTO-9442	230017003
K10, K2, K3, K8, K9, K11, K1	RELAY REED HIGH VOLTAGE	230017019
OP9, OP2, OP3, OP4, OP12, OP13, OP1, OP8, OP18, OP19, OP20, OP16, OP15, OP11, OP17, OP7, OP6, OP5, OP10, OP14	PCB SGLE MT ISLTR OPTO	1004440
T3, T4, T1, T5, T2	XFMR SQ CORE REM	251300045
U2, U21	IC TRANS DARL ARRAY HI V	M210100095
U11, U13, U19, U3	IC MOSFET DRVR INV LOW-SIDE	M210100098
U20, U18, U5, U9	IC TIMER SINGLE BIPOLAR PREC	M210100099
Q2, Q8, Q6, Q4, Q5	IC FET N-CH DC-DC CONV 200V	M210100110
Q9, Q1, Q3, Q7	TRANSISTOR, AMP 40V NPN SOT23	M239200094
CR13, CR18, CR2, CR3, CR4, CR6, CR7, CR8, CR9, CR12, CR14, CR16, CR10, CR15	DIODE REF SHUNT 2.5V 1%	M239350023
CR5, CR17, CR19, CR1, CR11	DIODE SWITCHING 150V 250MW	M239350024

Receptacles

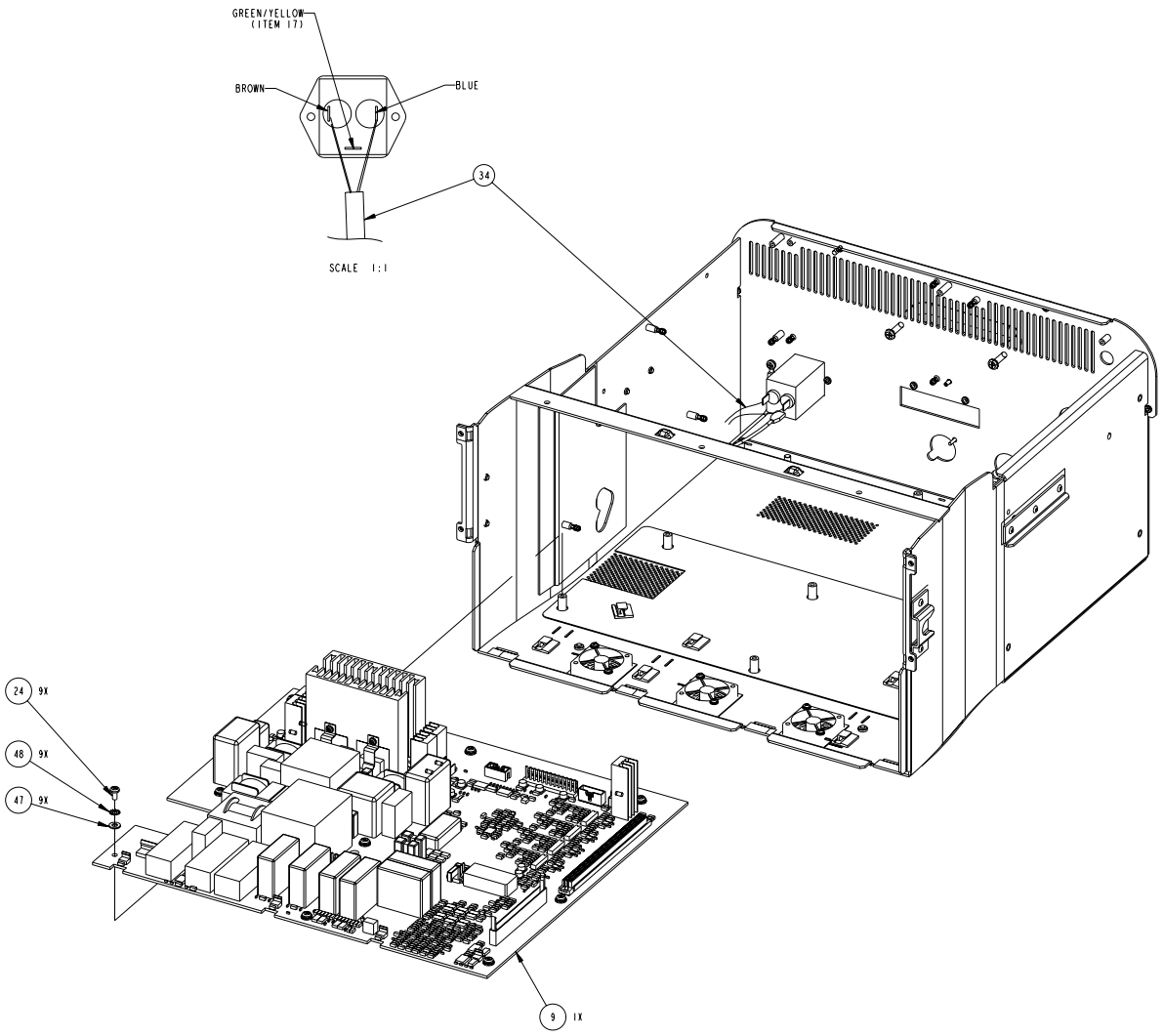


Receptacles Parts List

Reference Designator	Description	Part Number
7	ASSY BI-POLAR RECEPTACLE	1004518
2	CABLE BIP OUTPUT FORCETRIAD	207500863
1	RECEPTACLE BIP MECH ASM	1004517
3	ASSY CABLE BIP SENSE	207500883
1	RECEPTACLE BI-POLAR	1004508
2	ACTUATOR SWITCH BI-POLAR	223150564
10	UFP ASSEMBLY	1002119
2	ASSY CABLE UFP POWER	207500880
1	UFAP MECH ASSEMBLY	1002108
10	ASSY CABLE UFP SENSE	207500879
17	SCR PNH PHIL M3 X 0.5 X 16	237050179
8	ASSY REM CABLE FORCETRIAD	202750291
13	RECEPTACLE ASM FORCETRIAD MONOPOLAR	1002128
3	LABEL BARCODE NULL CODE FORCETRIAD	1001508
4	ASSY CABLE MONO 1 MODE	207500886
2	ASSY CABLE MONO 1 OUTPUT	207500887
1	RECEPTACLE ASM MONOPOLAR	1003763
1	RECEPTACLE MONOPOLAR CONNECTOR	1003762
12	RECEPTACLE ASM FORCETRIAD MONOPOLAR 2	1002129
2	ASSY CABLE MONO 2 OUTPUT	207500888
1	RECEPTACLE LIGASURE W/INSERTS	1003767
2	ASSY CABLE LIG 1 OUTPUT	207500873
5	RECEPTACLE ASM FORCETRIAD LIGASURE 2	202750296

Reference Designator	Description	Part Number
1	ASSY, RECEPTACLE, LIGASURE W/MECH	1003768
6	BAR CODE READER ASSY FORCETRIAD	1002416
2	BARCODE SCANNER W/DAUGHTER CARD	1001182
5	SHIELD BAR-CODE SCANNER FORCETRIAD	1001152
3	SCREW PANHD PHIL M2 X 0.4 X 6	1000205
4	WSHR FLAT M2 NYLON	1000215

RF PCBA

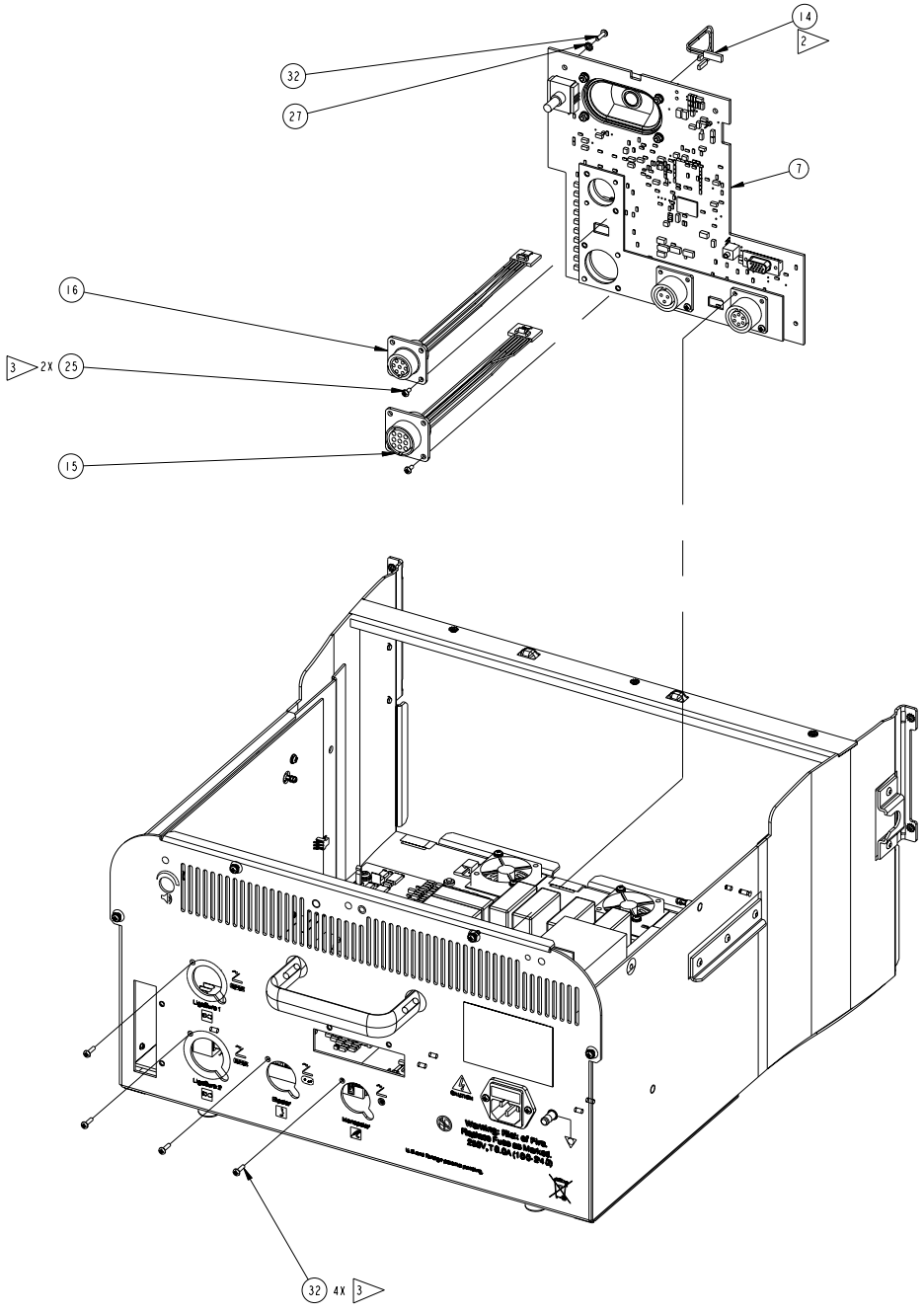

GREEN/YELLOW
(ITEM 17)
BROWN
BLUE
34
SCALE 1:1
24 9X
48 9X
47 9X
9 1X

RF PCBA Parts List

Reference Designator	Description	Part Number
9	PCB ASSY FORCETRIAD RF PROGRAMED	1003685
	ASSY PCB RF FORCETRIAD	1003515
U46, U45, U37, U47	IC MOSFET DRIVER 12A NON-INV	210100096
U40, U51, U18, U23	IC MULT/DIV DUAL CHL LINEAR	210100100
Q3, Q2, Q4, Q1	IC FREDFET N-CHL PWR 800V 52A	210100101
U50	IC VR TO-220 7905CT	210300093
RL3, RL4, RL5	RELAY REED HIGH VOLTAGE	230017019
4	SCR PNH PHIL STL 4-40X.25	237100472
8	SCR, PNH SLT 6-32X.25, NYLON	237300047
D5, D1, D2, D4, D6, D7, D8, D3	DIODE	239500019
RL19, RL18, RL17, RL16, RL6, RL14, RL13, RL15	RELAY DPDT 5KV 10A	243081003
L10, L7	INDUCTOR 90UH	251100180
L11	INDUCTOR, RF OUTPUT 15UH	251100209
L12, L13	INDUCTOR, RF 4.5UH	251100210
T8	TRANSFORMER RF LIG OUTPUT	251200115
T7	TRANSFORMER OUTPUT COAG	251200116
T10	XFMR SQ CORE ABP	251300036
T11, T12	XFMRS G DR	251300039
T9	XFMR SQ CORE REM	1003937
T2, T3, T5, T4	TRANSFORMER RF VOLTAGE SENSE	251300059
T1, T6	TRANSFORMER RF VOLTAGE SENSE	251300060
7	WSHR PL FLAT 6 R	253010001
5	SCR PNH PHIL 6-32 X .375	586005194

Reference Designator	Description	Part Number
U33	IC D-O/A LM2904 SM	M210100059
U38, U29, U21, U16	IC AMP DIFF LP FLTR 2.5 MHZ	M210100092
U8, U44, U1, U43, U9	IC TRANS DARL ARRAY HI V	M210100095
U27, U13	IC MOSFET DRVR 1.5A DUAL N-INV	M210100097
U36, U48	IC AND QUAD 2 INPUT	M210200070
U34	IC REFERENCE LDO MICROPWR	M210300133
U32, U41, U12, U28, U20, U25	IC OPAMP DUAL 160 MHZ R-R	M210400064
U17, U19, U31, U30, U22, U11, U42, U10, U6, U7, U24, U2, U3, U4, U5, U39	IC DUAL OP AMP 325 MHZ SOIC8	M210400065
U35	IC COMPARATOR QUAD DIFF	M210410006
U26	IC INVERTER HEX SCHMITT TRIG	M210510094
U49	IC EEPROM SERIAL 2.7V RoHS	M210720051
U15, U14	IC UPOWER 12-BIT ADC SIOC8	M210740025
RL10, RL11, RL1, RL9, RL8, RL7, RL2, RL12	RLY SOLID STATE 1CH 80V/500MA 450P	1000654
CR1, CR2	DIODE ZENER 10V 500MV	M239350017
D10, D11, D9, D13, D15, D14, D12	DIODE REC. SCHTKY.5A SOD 123	M239700084
L5, L2, L3, L1, L4, L6, L8, L9	IND 120UH SHIELDED MOLDED	1006807
15	ASSY PCB RF REM DETECT FORCETRIAD	1003502

Footswitch/Audio PCBA



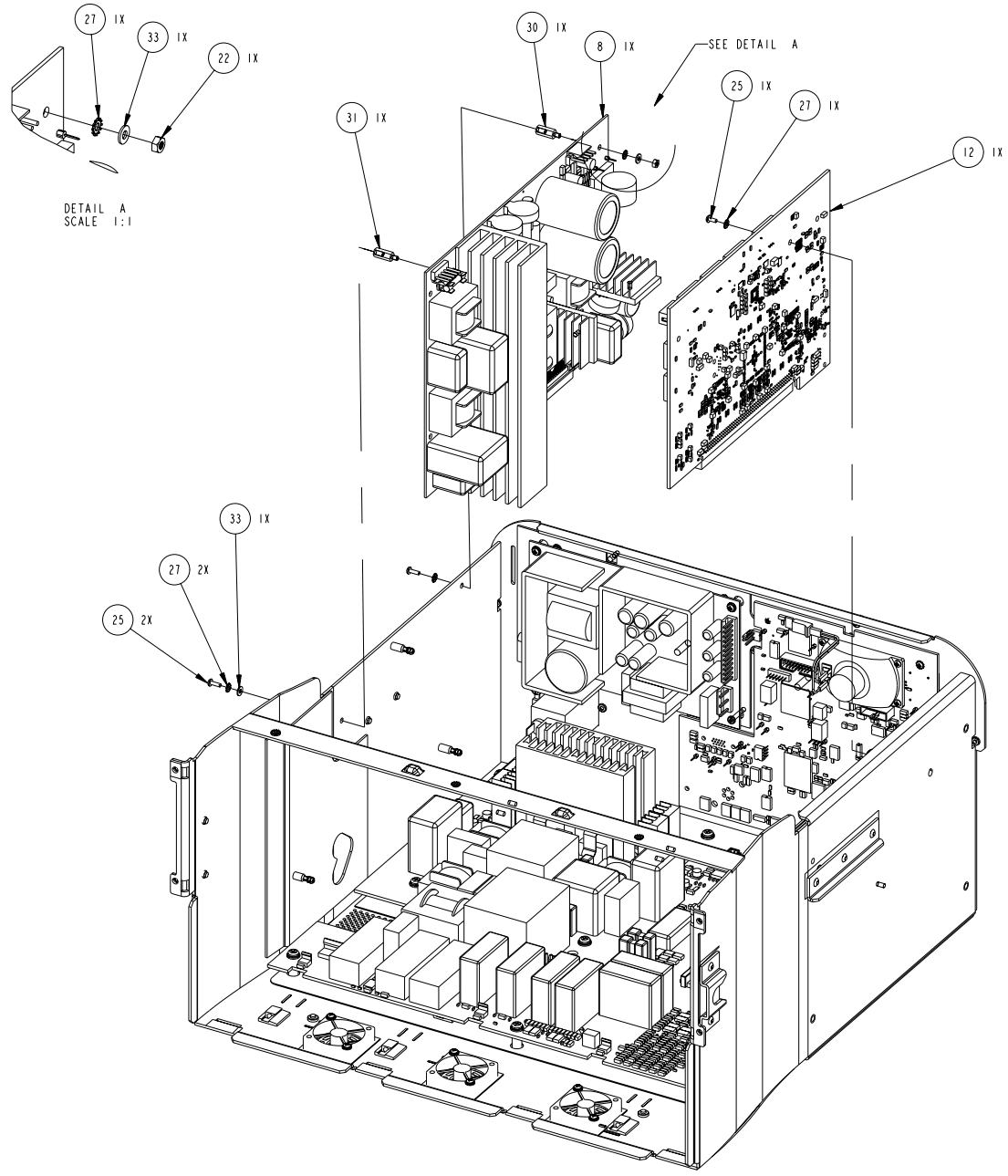
Footswitch/Audio PCBA Parts List

Reference Designator	Description	Part Number
7	PCB ASSY FORCETRIAD FOOTSWITCH PROGRAMED	1004102
	ASSY FOOTSWITCH/AUDIO PCB	1004077
J5	CONN CIRC	208109000
J4	CONN 2 POS 100 RT ANG M HEADER	208300876
J7	CONN 6 P RECEPT CIR F PNL MNT	208300907
J2	CONN 15 POS RECEPT D-SUB VERT	208300913
J12	CONN 2 POS JACK F SUB-MINI	208400142
6	BRKT MOUNTING ASSY FTSW AUD/BRD	223301245
3	NUT HEX STL ZINC PLD M3X0.5	224300004
R14	POT 5K	236200103
4	SCR PNH PHIL M3 X .5 X 10	237050108
7	SCREW, PH, PHILLIPS, M3 X 6, ST	237050197
5	SPKR 8OHM 2W 82DB/W	241100010
2	WSHR FLAT M3.0	253300004
U5	IC AMP AUDIO DUAL 6W	M210100084
U6, U29, U28, U27, U26	IC DIGITAL ISOL 4-CH	M210200071
U22	IC DIGITAL ISOL 4-CH SPLIT INPUTS	M210200272
U73	IC PROGR REFERENCE 2.5-36V	M210300126
U16	IC REG SWTCHR STPDWN .6A 500 KHZ	M210300136
U4	IC 500MA 2.5V LDO REG 8-SOIC	M210350005
U14	IC 500MA 3.3V LDO REG 8-SOIC	M210350006

Reference Designator	Description	Part Number
U23	IC OP AMP DUAL R-R IN/OUT	M210400063
U30, U10, U15, U2	IC COMPARATOR QUAD W REF	M210410011
U69	IC DC/DC CONTROLLER PUSHPUL	M210600012
U8	IC PROM PROGR 1MBIT 3.3V	M210720048
U3	IC MEMORY FLASH 2.7V	M210720049
U21	IC EEPROM SERIAL 2.7V RoHS	M210720051
U1	IC DAC STEREO 96 KHZ	M210750010
U9	IC DAC QUAD 12-BIT R-R	M210750014
U7	IC FPGA 2.5V 100K GATE SPART 2	M210780023
U13	XCVR, RS232, .3V, TSOP16	M210800049
U12, U11	IC ACCELERATOR SMBUS	M210800052
K1	RLY SOLID STATE FORCETRIAD SENSE	M230017018
U71, U70	IC MOSFET N-CHL PWR 30V	M239200092
D27	DIODE ZENER 8.5V 500MV	M239350014
D26, D25, D23, D24	DIODE SCHOTTKY 40V	M239350015
D16, D6, D18, D1, D2, D3, D5, D7, D8, D10, D11, D22, D4, D30, D12, D21, D20, D17, D15, D14, D13, D19	DIODE RECTIFIER ESD 7V 2A	M239350022
D28	DIODE RECT SCHTKY 40V 1.0 A	M239350028
D9	LED 80M 2.0V GRN-CL LED	M239750137
U72	IC OPTOCOUPLER 1CHL	M239750158
D29	DIODE SWITCHING 75V.25A 350MW	M239850042
Y1	OSC 11.2896 MHZ	M250010050

Reference Designator	Description	Part Number
Y3	OSC 12.000 MHZ	M250010051
L14, L11	IND 10UH PWR SW FREQ 1MHZ	M251100195
L1	IND 33UH PWR 0.65A 22 MHZ	M251100217
T12	TRANSFORMER, DC-DC, SM, 5KV ISO	M251200110
T13	TXFMR 100UH 1:1	M251200113

HVDC PCBA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SCALE 1:1
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8 1X
SEE DETAIL A
25 1X
27 1X
31 1X
12 1X
33 1X
27 2X
25 2X

HVDC PCBA Parts List

Reference Designator	Description	Part Number
8	PCB ASSY FORCETRIAD HVDC PROGRAMED	1002401
	ASSY PCB HVDC FORCETRIAD	1001648
U10, U9, U3, U2	IC DRIVER MOSFET NON-INV 6A	210100066
OPT2, OPT1	OPTO PHOTOCOUPLER HI ISO	210100068
Q11	IC MOSFET N-CH PWR 200V	210100113
9	STANDOFF, PCB, PH, 6MM STAINLESS STEEL	213110654
6	SCR PNH M3 10MM	237050138
3	SCR PNH M3 X 0.5 X 8 ZINC	237050149
Q4, Q6	TRANSISTOR 350V NPN TO-02	239200083
Q1, Q5	TRANS MOSFET N-CHL 800V 4.1A	239300042
Q8, Q10, Q15, Q12	TRANS MOSFET N-CH 500V 46A	239300043
D2	DIODE RECT BRIDGE 800V 8A	239700089
U5	DIODE RECT BRIDGE 600V 11A	239700090
R109, R108, R36, R2, R1	THMS INRUSH 5 OHM 6 AMP	240003005
K2, K1	RELAY DPST 110V COIL 10A	243081004
L4, L3, L1	INDUCTOR 90UH	251100180
L2	INDUCTOR ADJ FORCETRIAD HVDC	1001153
T1	XFMR SENSE 5MH 1:50	251200114
T3	TRANSFOMER HVDC POWER	251200118
T4, T2	XFMRS G DR	251300039
4	WSHR FLAT M3.0	253300004
U14, U7	IC D-O/A LM2904 SM	M210100059
U8	IC MULTIPLIER ANOLOG	M210100065

Reference Designator	Description	Part Number
U17	IC DRVR MOSFET N-INV 6A 8SOIC	M210100115
U6	IC PWM PHASE SHIFT CONTROLLER	M210200054
U11, U12	IC OPAMP DUAL RR IN OUT	M210400043
U13	IC COMPARATOR QUAD DIFF	M210410006
U1	IC DUAL DIFFERENTIAL COMP	M210410009
U15	IC INVERTER HEX SCHMITT TRIG	M210510094
U16	IC EEPROM SERIAL 2.7V RoHS	M210720051
K3	RELAY DPDT 12V 1A MICRO POL	M230017017
Q7, Q3, Q2	TRANS NPH HI V 140V 600MA	M239100025
Q18, Q17, Q16	TRANS MOSFET N-CHL 50V 200MA	M239200081
Q14, Q13	TRANS AMP 40V NPN SOT23	M239200094
D9, D10, D30, D1	DIODE ZENER 1.5W 200V	M239350026
D4, D5, D7, D11	DIODE GLASS PASS 1A 1000V	M239500026
D12	DIODE ZENER 10V 350MW	M239600663
D3, D6	DIODE ZENER 15V 350MW	M239600664
D18	DIODE ZENER 27V 350MW	M239600665
D31, D29, D28, D27, D26, D25, D22, D21, D20, D19, D17, D16	DIODE REC. SCHTKY.5A SOD 123	M239700084
D24, D23, D15, D14, D13, D8	DIODE SWITCHING 75V.25A 350MW	M239850042
Q9	TRANS MOSFET N-CHL 50V 200MA	M239200081
DI	DIODE ZENER 180V 3W SMB	1000925

Controller PCBA

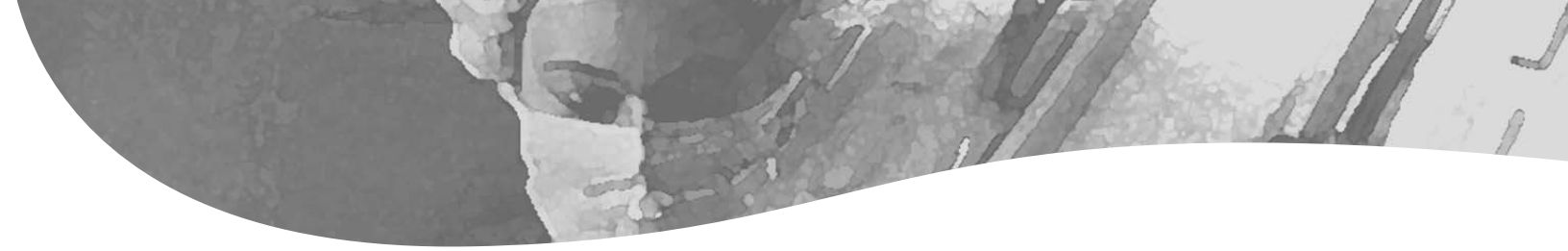
Controller PCBA Parts List

Reference Designator	Description	Part Number
12	PCB ASSY FORCETRIAD CONTROLLER PROGRAMED	1002792
	ASSY PCB CONTROLLER FORCETRIAD	1002791
2	BATRY SNAPHAT TIMEKEEPER SRAM	250020035

Cable Assemblies

Cable Assemblies Parts List

Reference Designator	Description	Part Number
16	ASSY CABLE ETHERNET	207500859
15	CABLE LCD-INVERTER FORCETRIAD	207500865
17	CABLE AC SWITCH HVPS FORCETRIAD	207500868
26	ASSY CABLE DISPLAY POWER	207500872
25	CABLE RIBBON SCANNER FORCETRIAD	1000734
37	ASSY CABLE PANEL-SWITCH FORCETRIAD	207500986
36	CABLE RF FOOTSWITCH FORCETRIAD	1001403
45	CABLE RETURN FORCETRIAD	207500862
38	CABLE RF-LVPS FORCETRIAD	207500867
37	CABLE HVPS-LVPS FORCETRIAD	207500869
17	ASSY CABLE CHASSIS-GND FORCETRIAD	207500870
44	CABLE MONO OUT FORCETRIAD	207500871
40	ASSY CABLE FORCETRIAD AUTO-BIPOLAR	207500874
15	ASSY CABLE LIGASURE 2 FT SWTCH	207500875
16	ASSY LIGASURE 1 FT SWTICH	207500876
41	ASSY CABLE FORCETRIAD RF-STEERING	207500878
14	ASSY CBL FORCETRIAD SPKR	207500881
39	ASSY CABLE FORCETRIAD ACTIVE BIPOLAR	207500949
35	ASSY CABLE FORCETRIAD SHIELD-RF	207500950
34	ASSY CABLE FORCETRIAD FILTER-AC SW	207500985

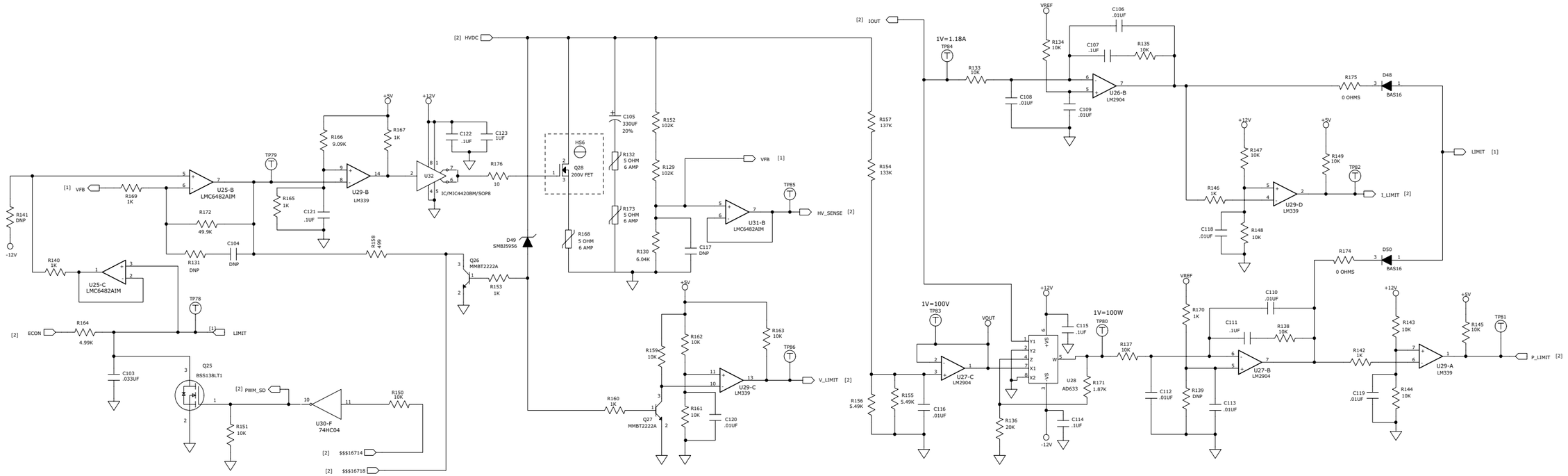


Schematics Supplement

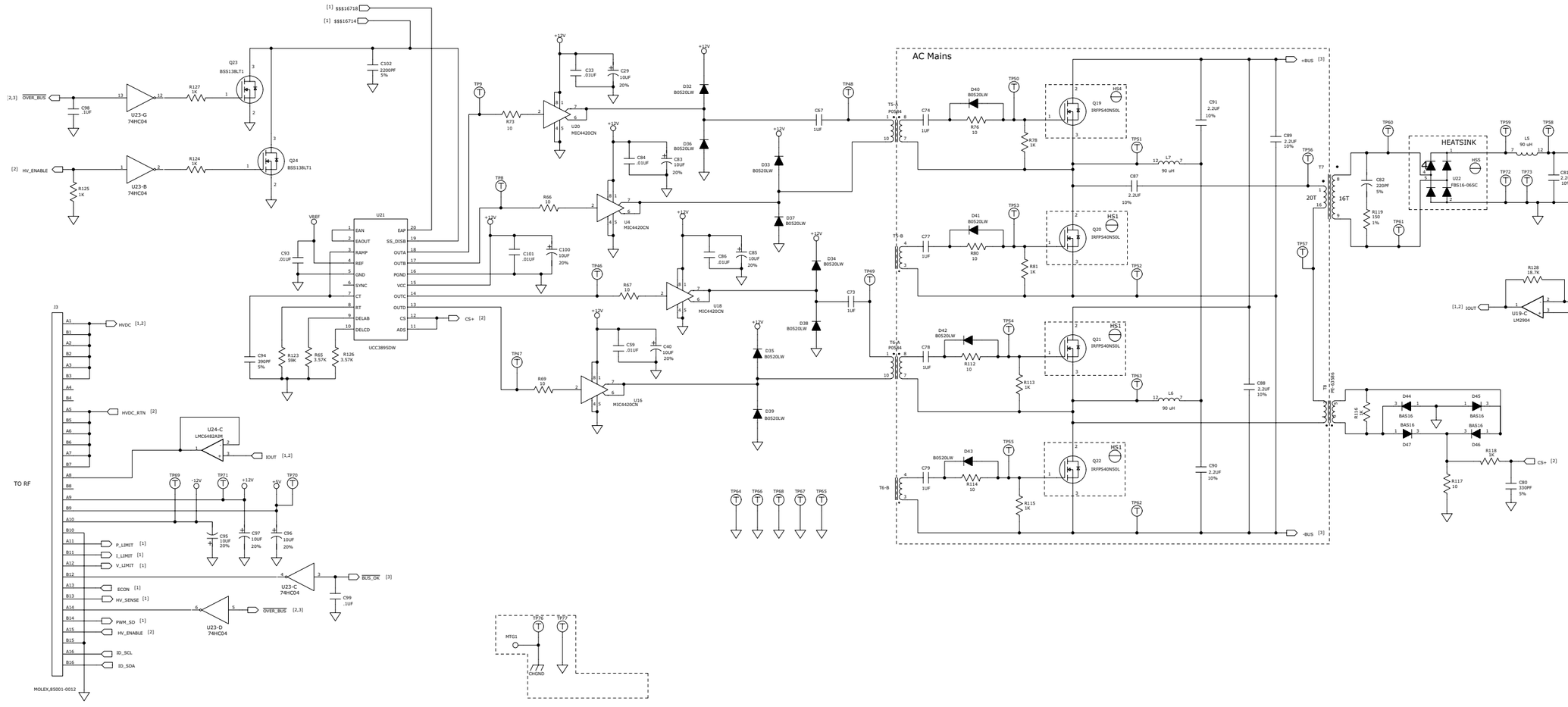
This supplement contains the assembly drawings and schematics for the printed circuit board assemblies listed below:

- HVDC PCBA
- RF PCBA
- Steering Relay PCBA
- Display PCBA
- Footswitch/Audio PCBA
- Controller PCBA

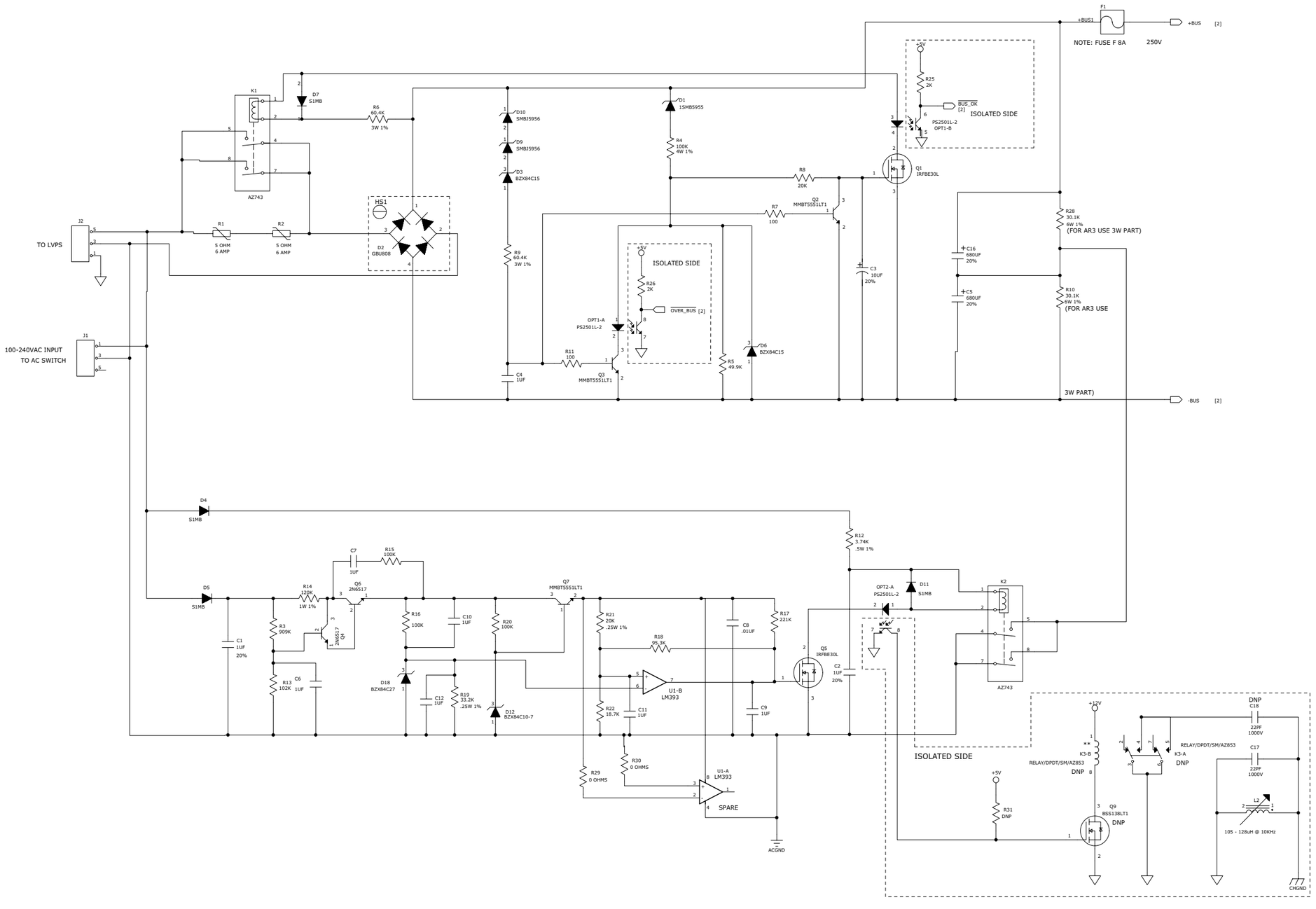
HVDC PCBA



HVDC PCBA Sheet 1 of 3

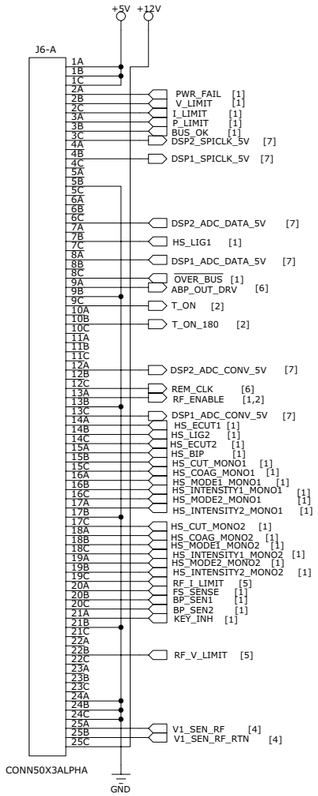


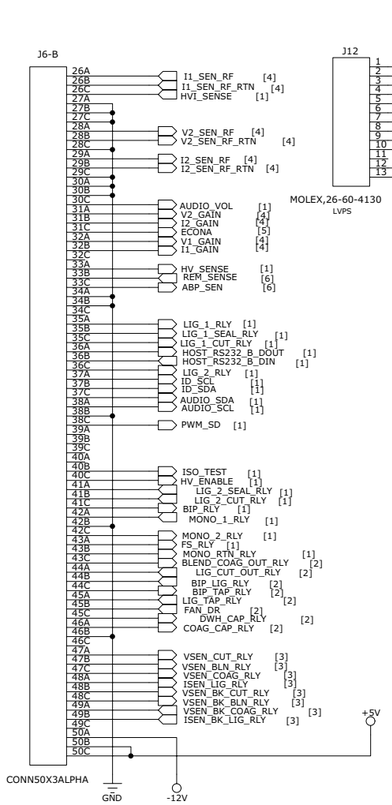
HVDC PCBA Sheet 2 of 3



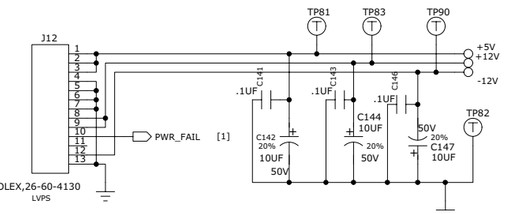
HVDC PCBA Sheet 3 of 3

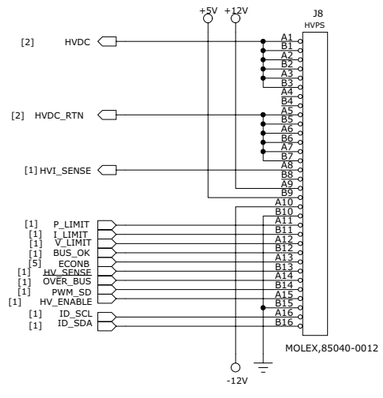
RF PCBA



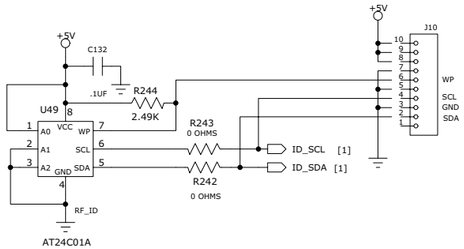


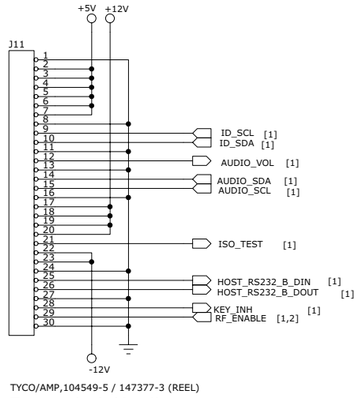
CONTROLLER



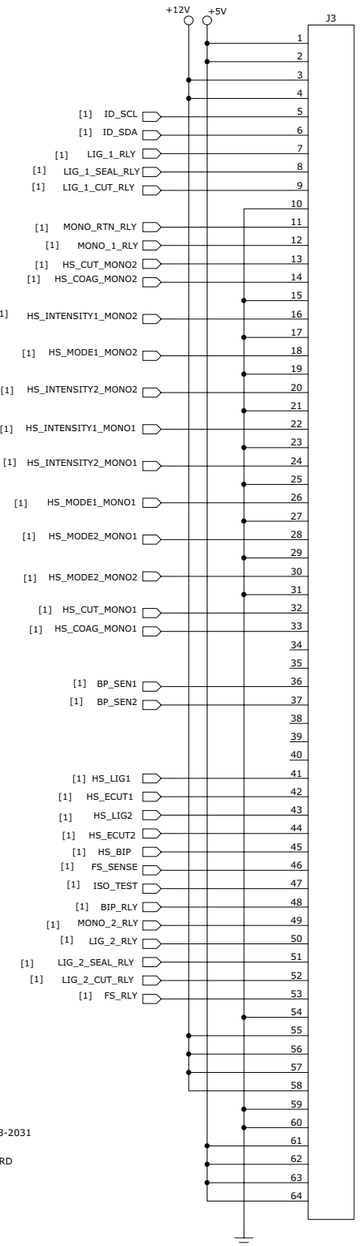


HVDC INTERFACE

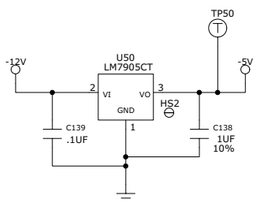


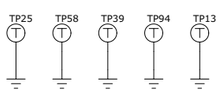


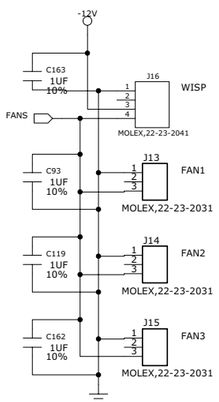
Footswitch/Audio

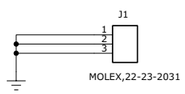


TO STEERING RELAYS

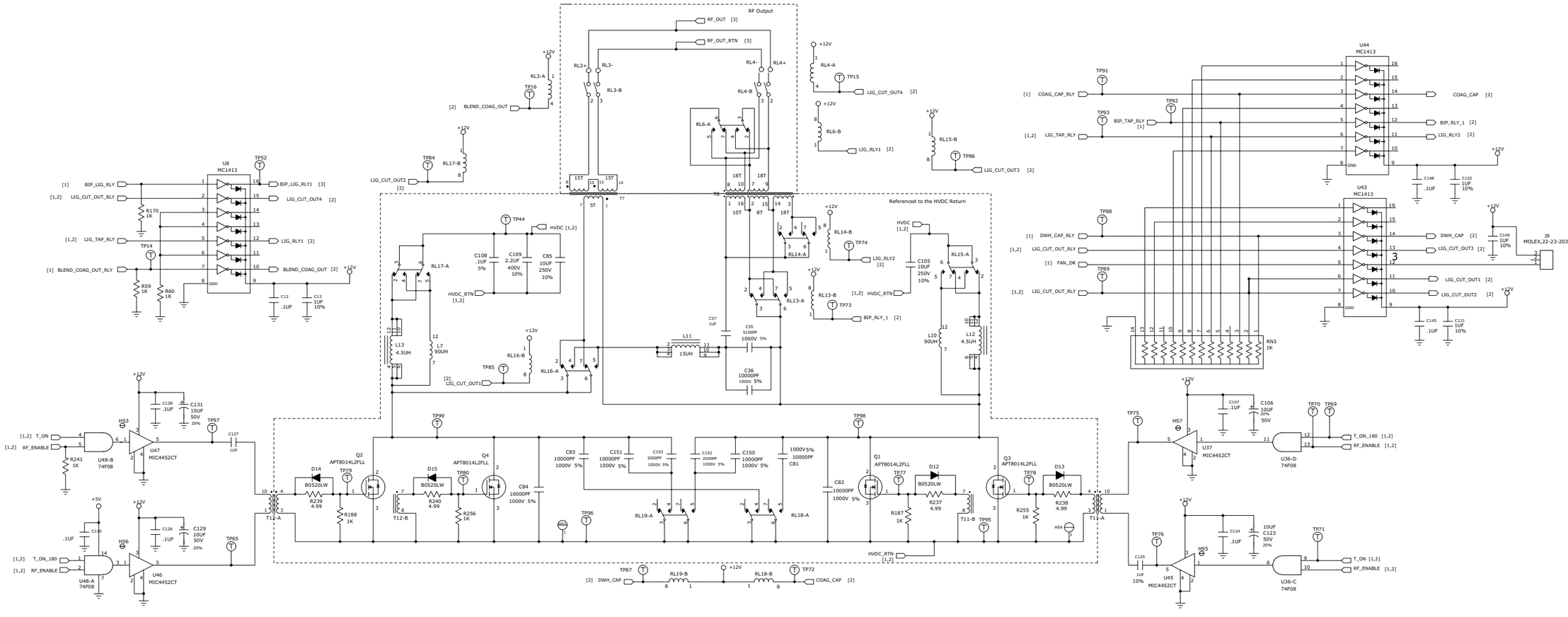




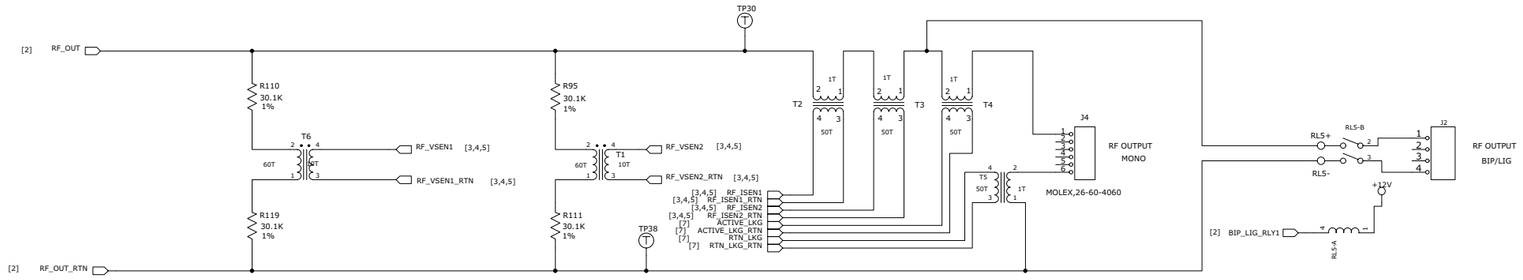


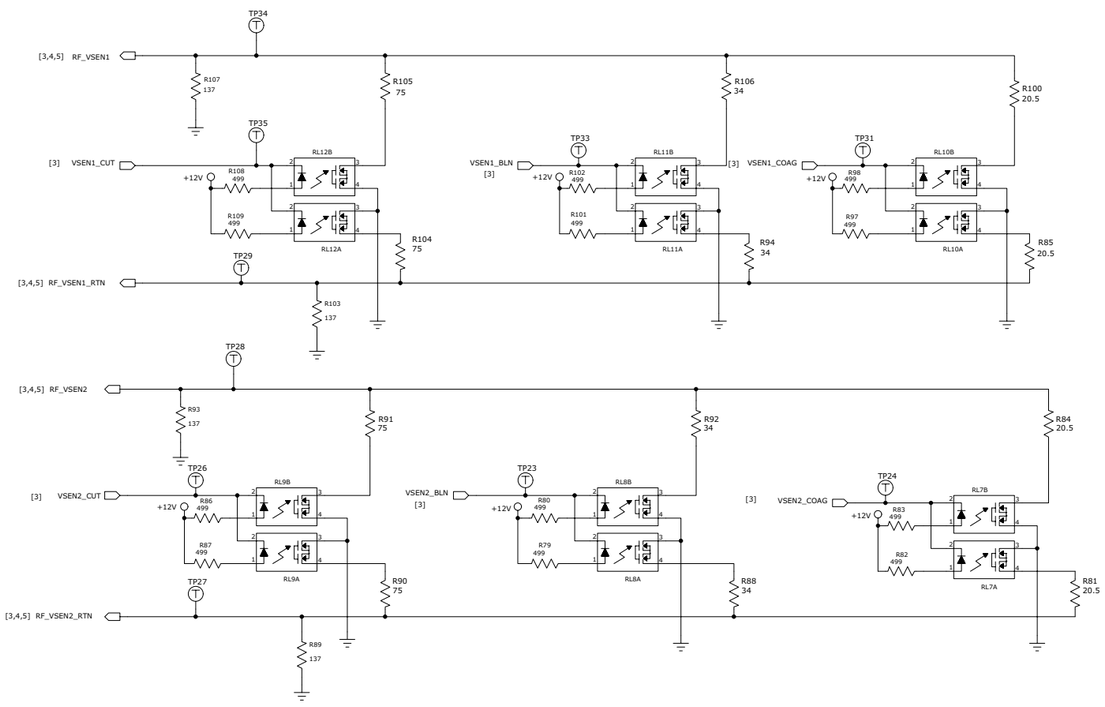


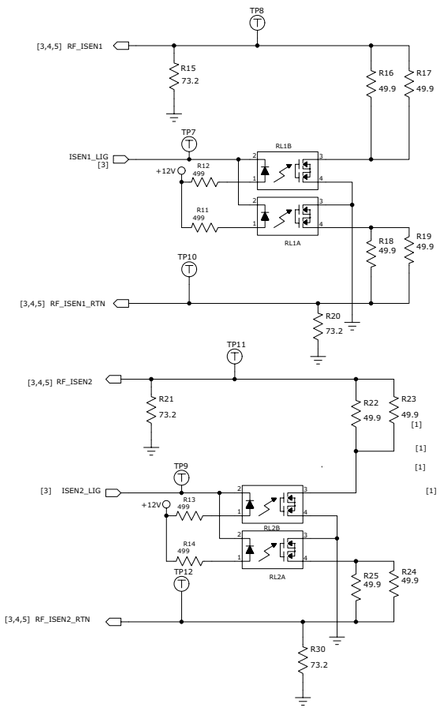
RF PCBA Sheet 1 of 7

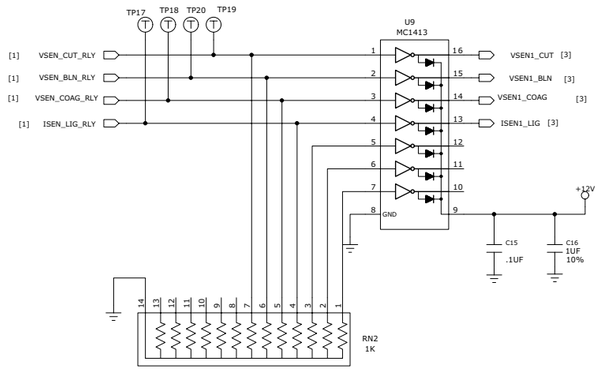


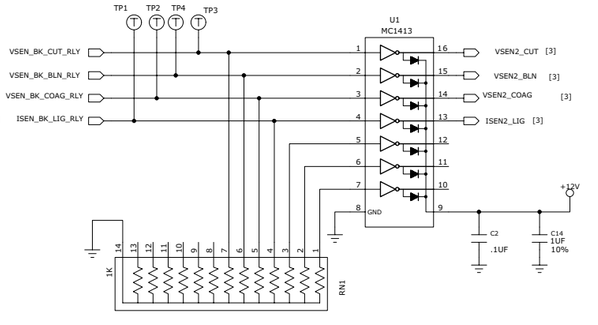
RF PCBA Sheet 2 of 7



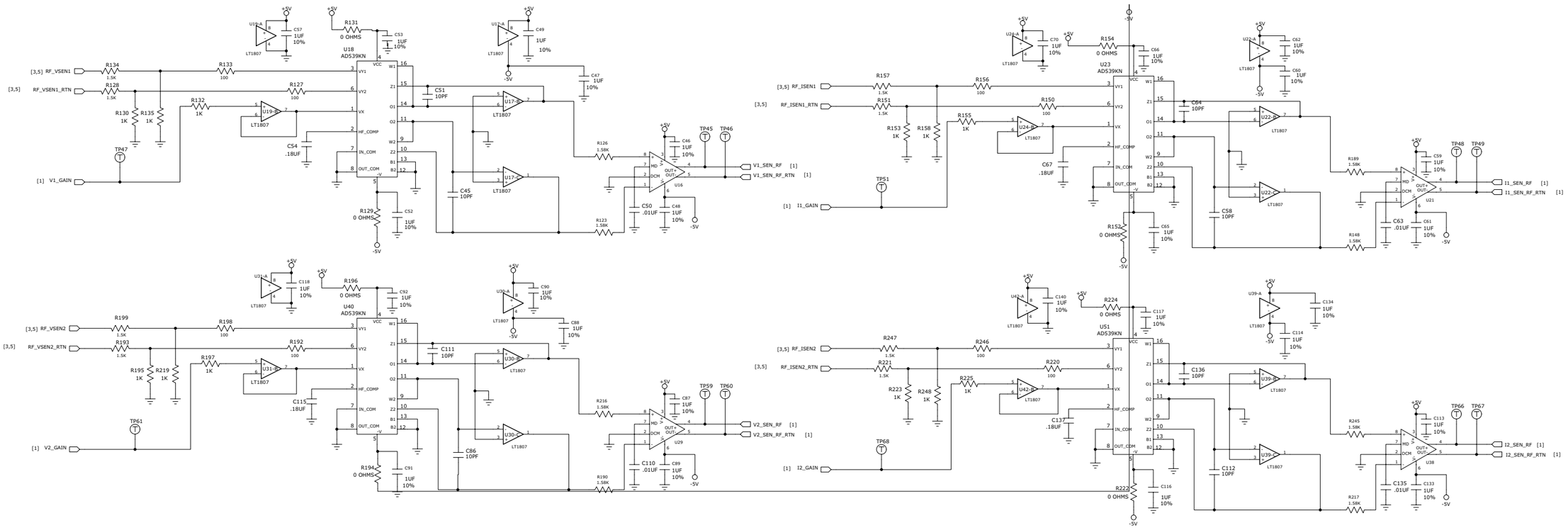




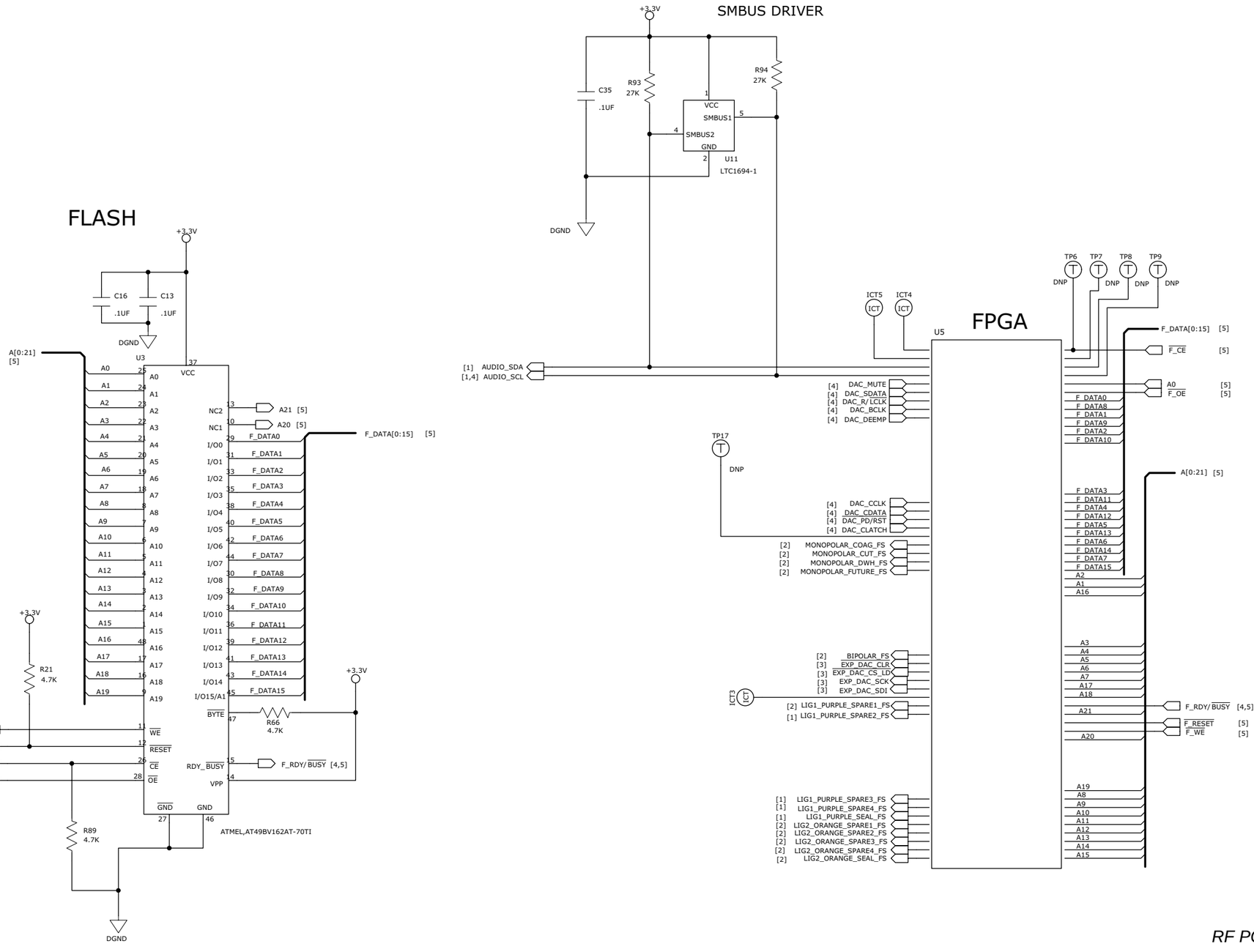




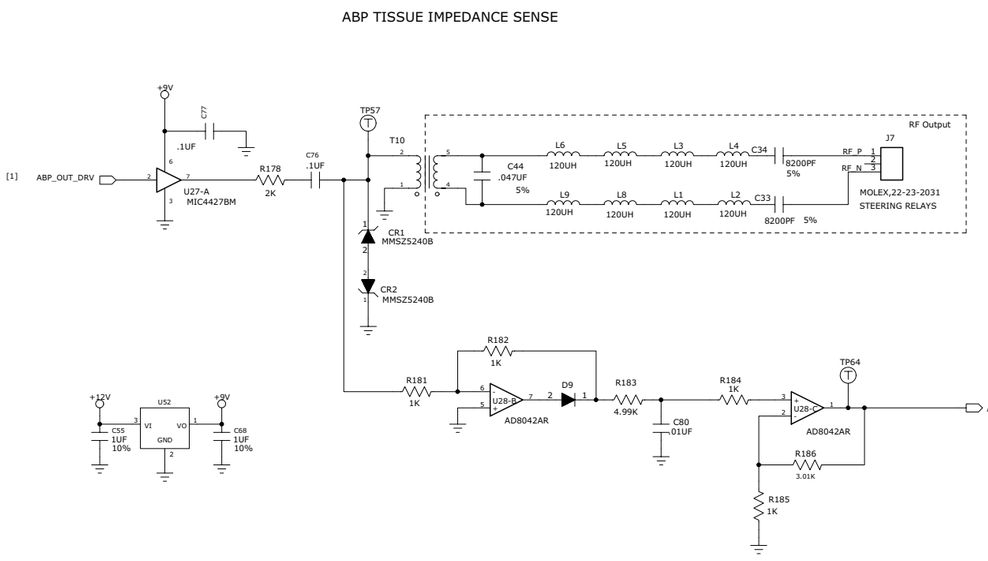
RF PCBA Sheet 3 of 7

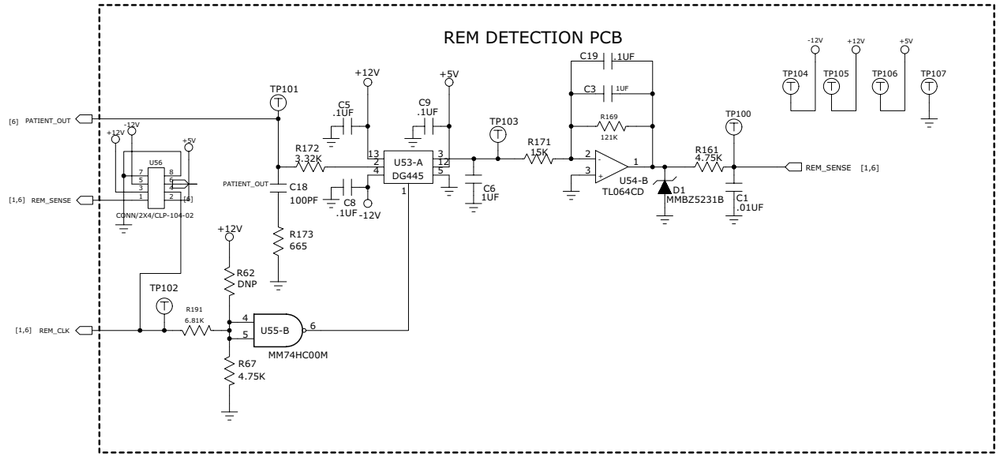


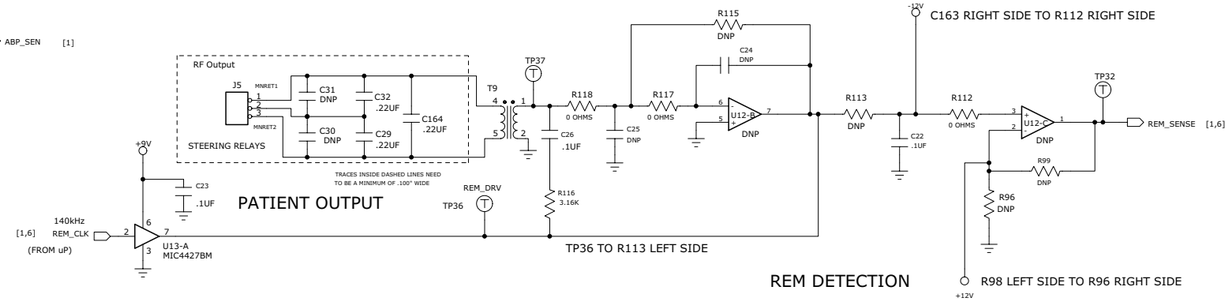
RF PCBA Sheet 4 of 7



RF PCBA Sheet 5 of 7

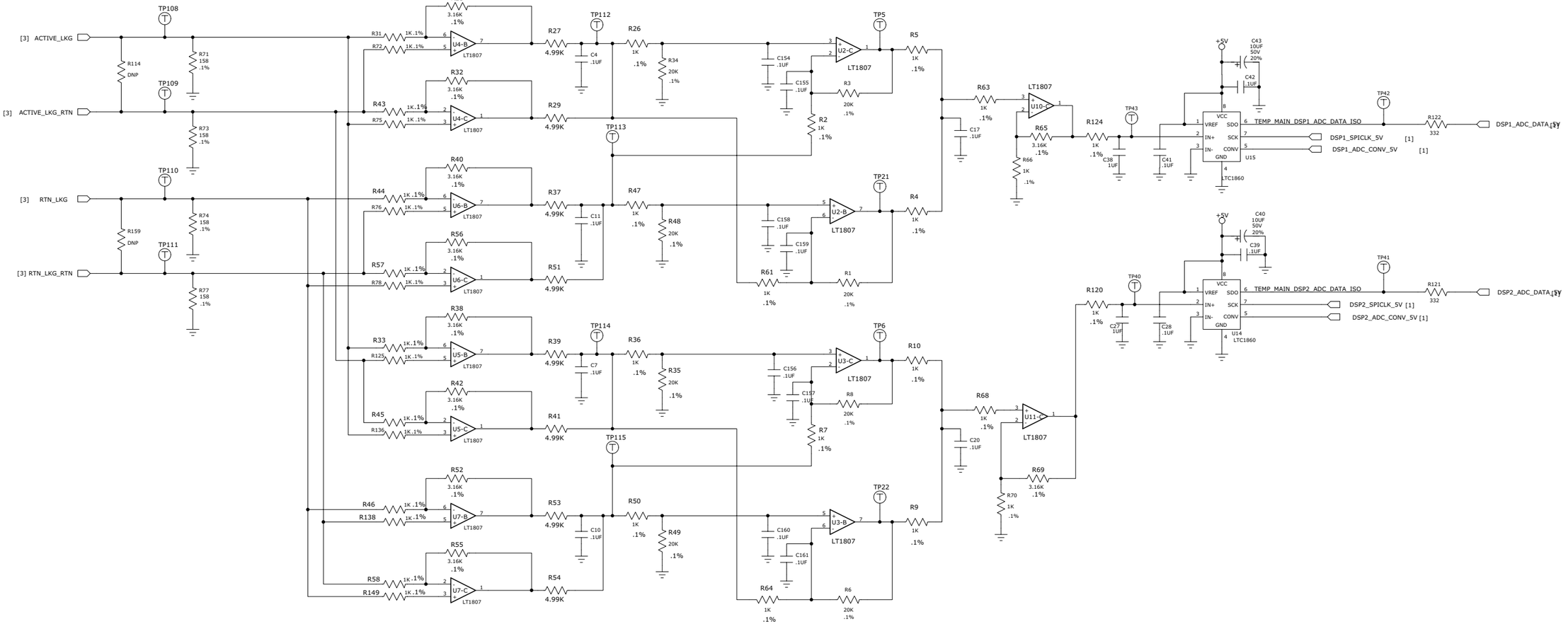






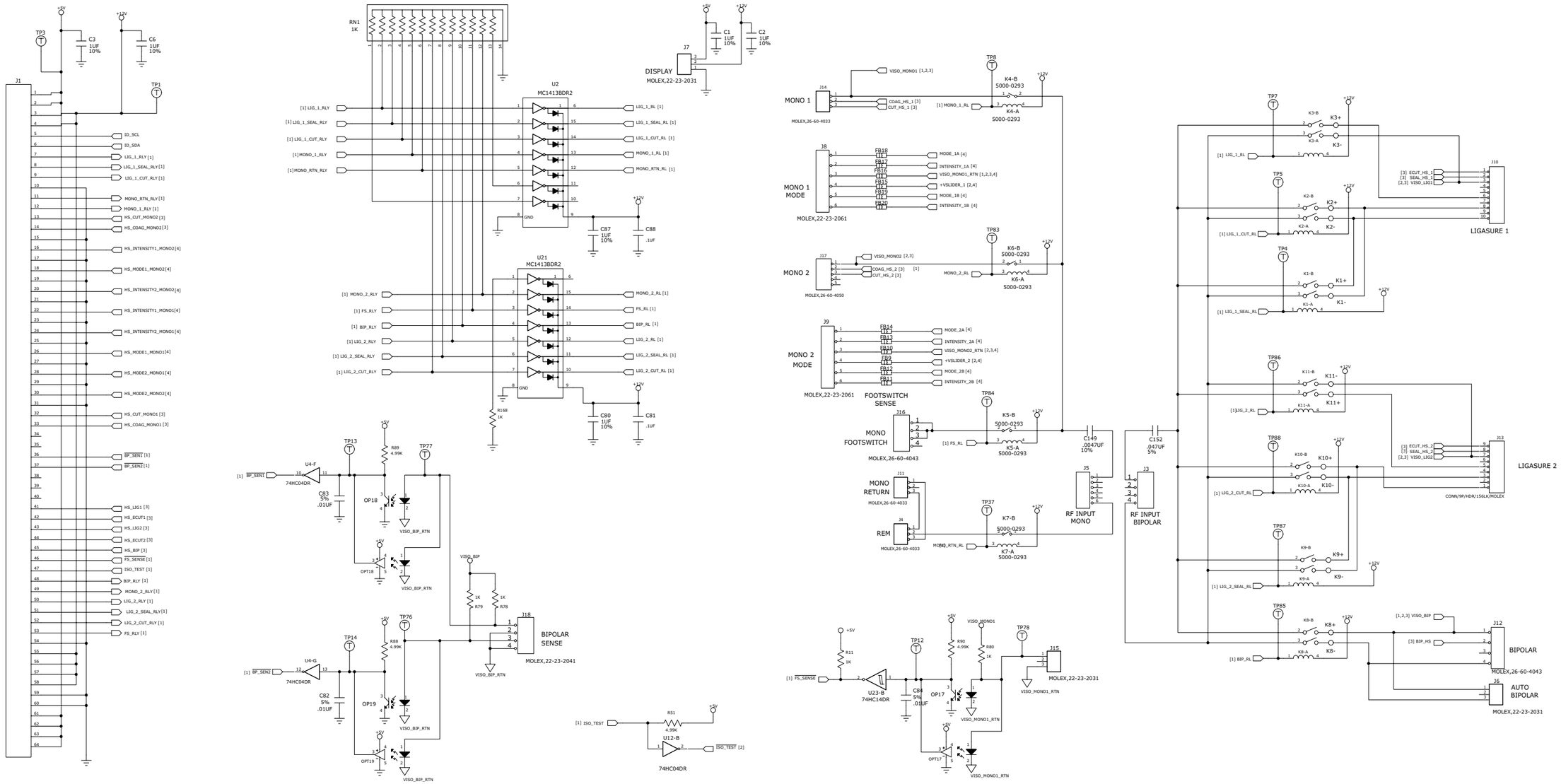
REPLACE U12 WITH 8-PIN MALE VLPN 1002651 SamTec 2x4 Male standoff vendor P/N FW-04-03-G-D-230-070

RF PCBA Sheet 6 of 7

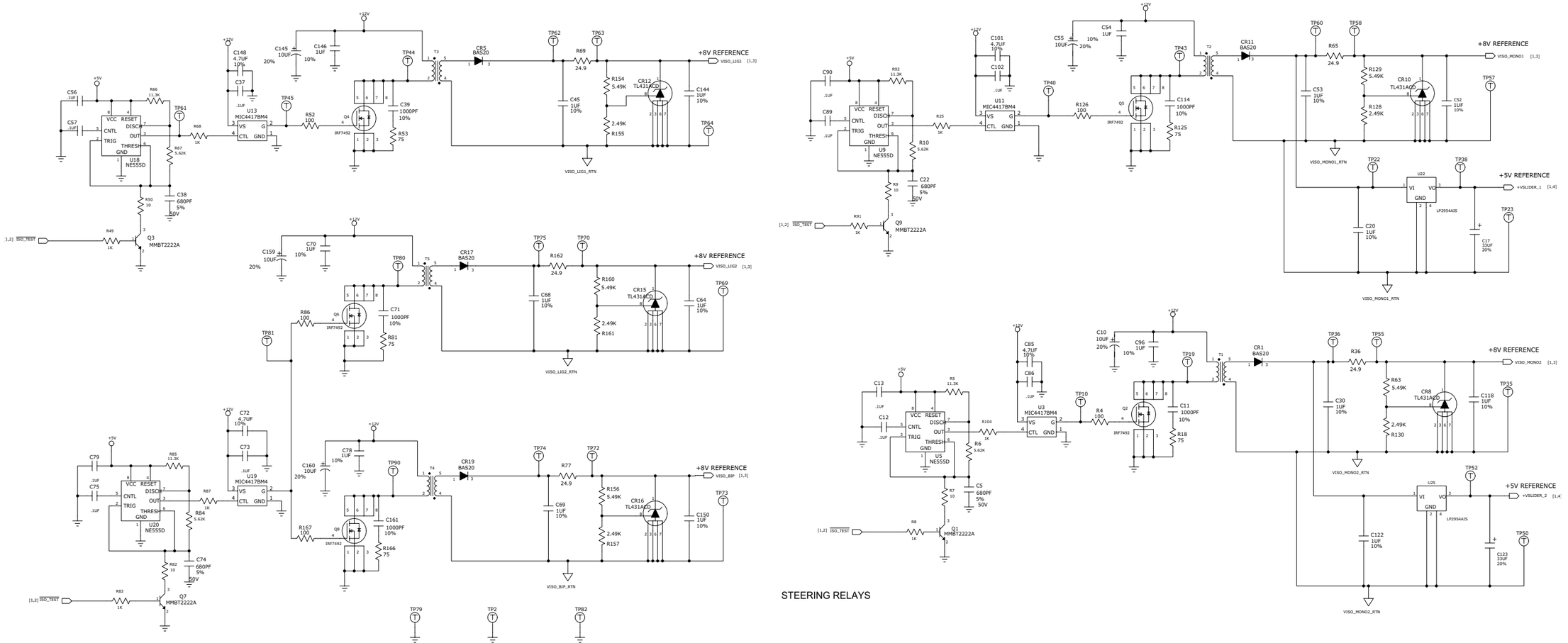


RF PCBA Sheet 7 of 7

Steering Relay PCBA

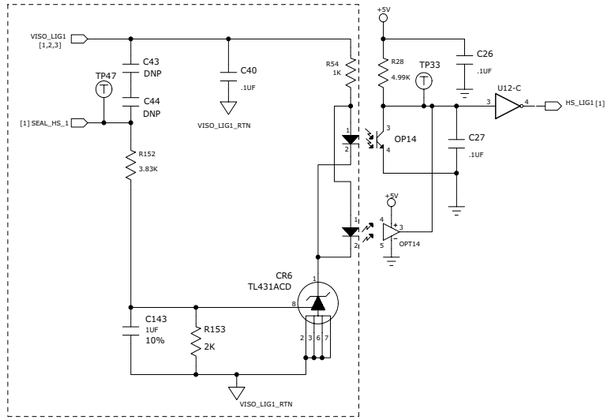


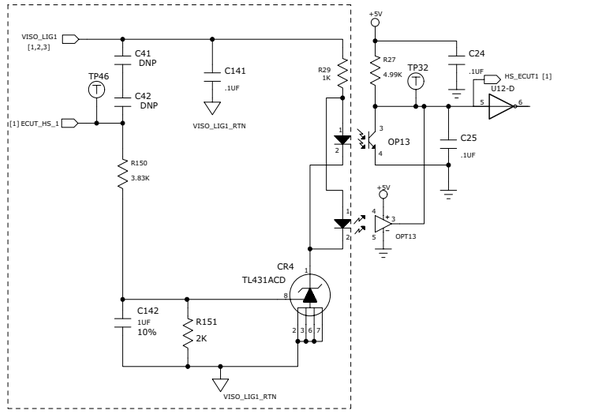
Steering Relay PCBA Sheet 1 of 4

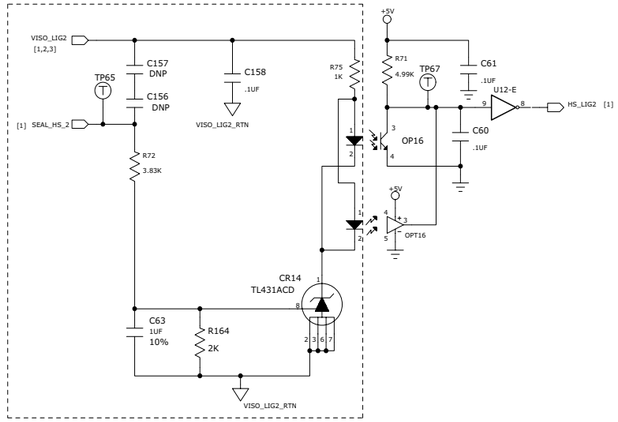


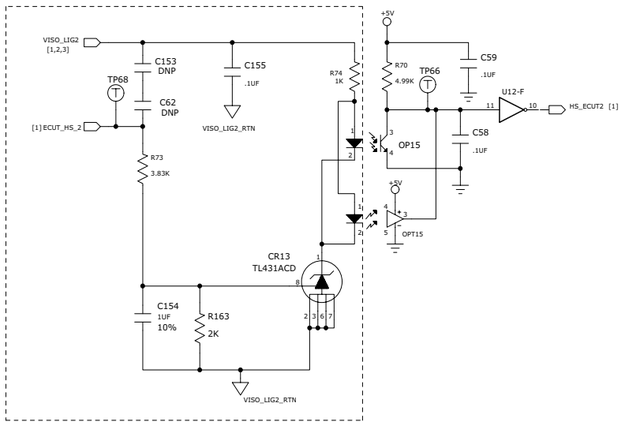
STEERING RELAYS

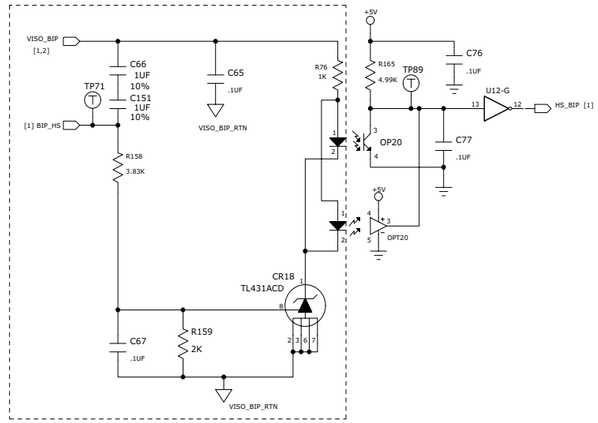
Steering Relay PCBA Sheet 2 of 4

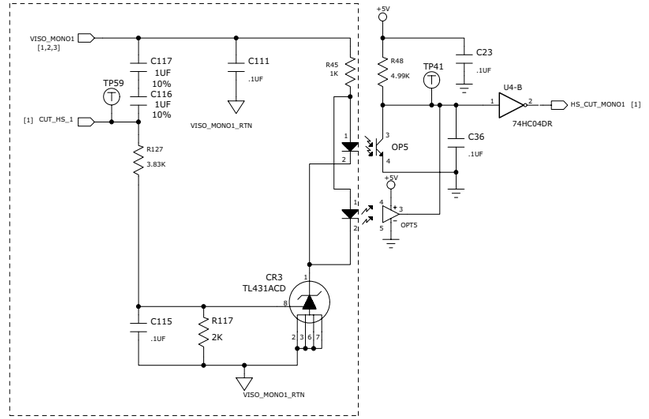


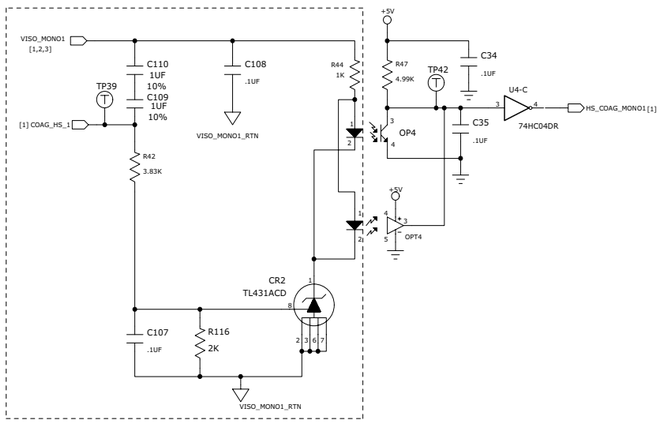


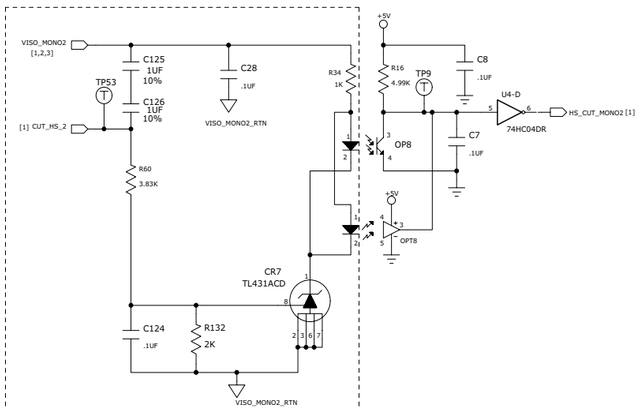


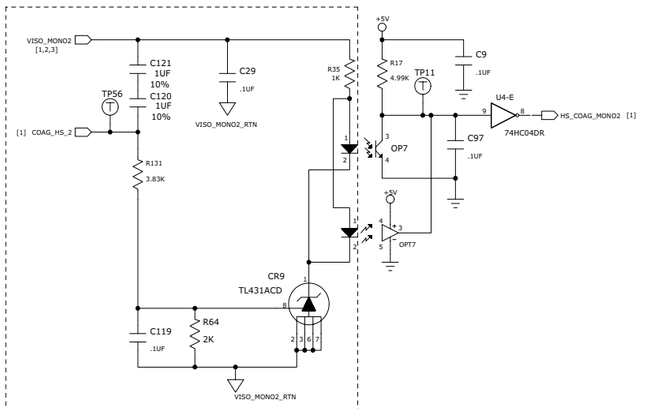




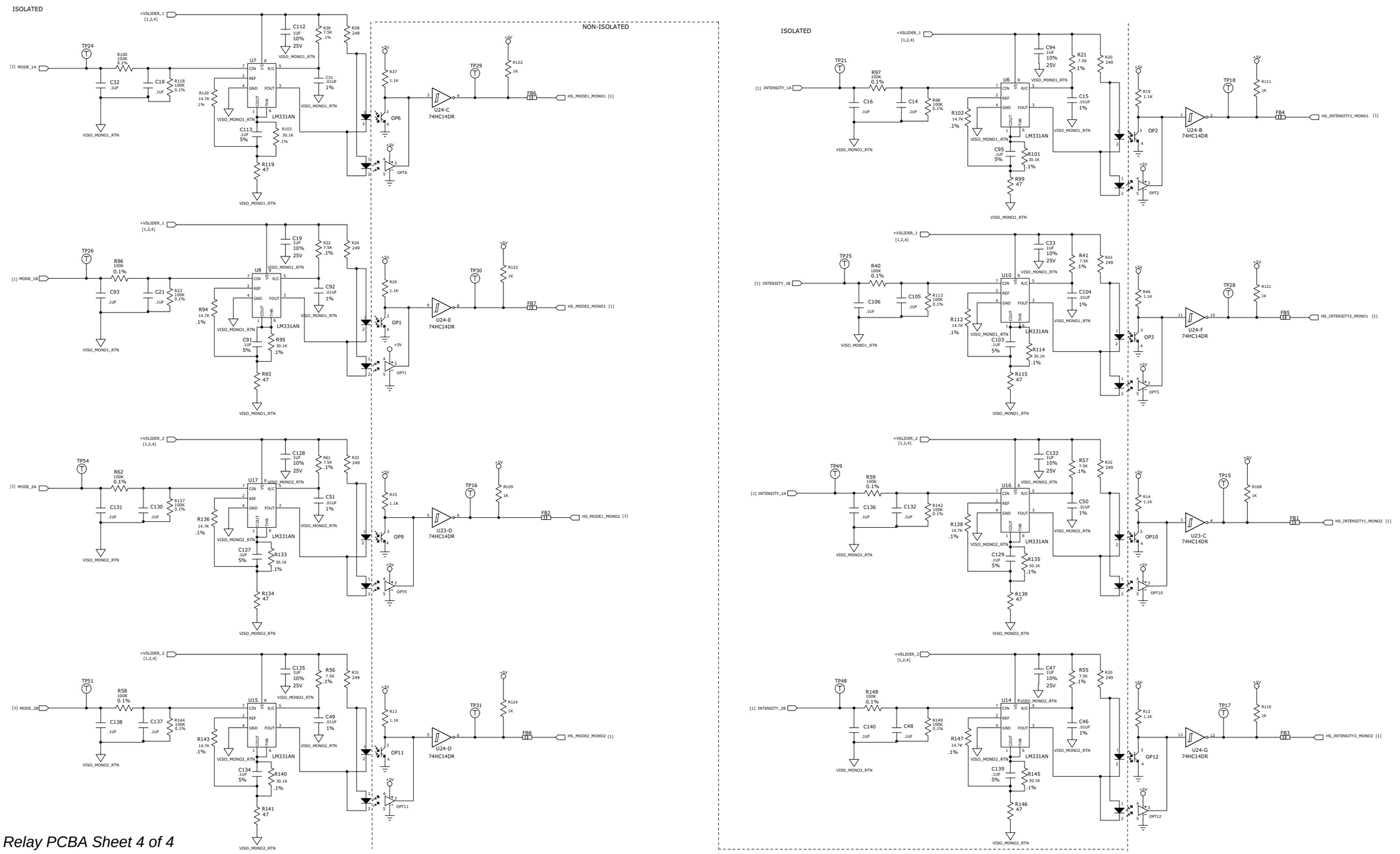








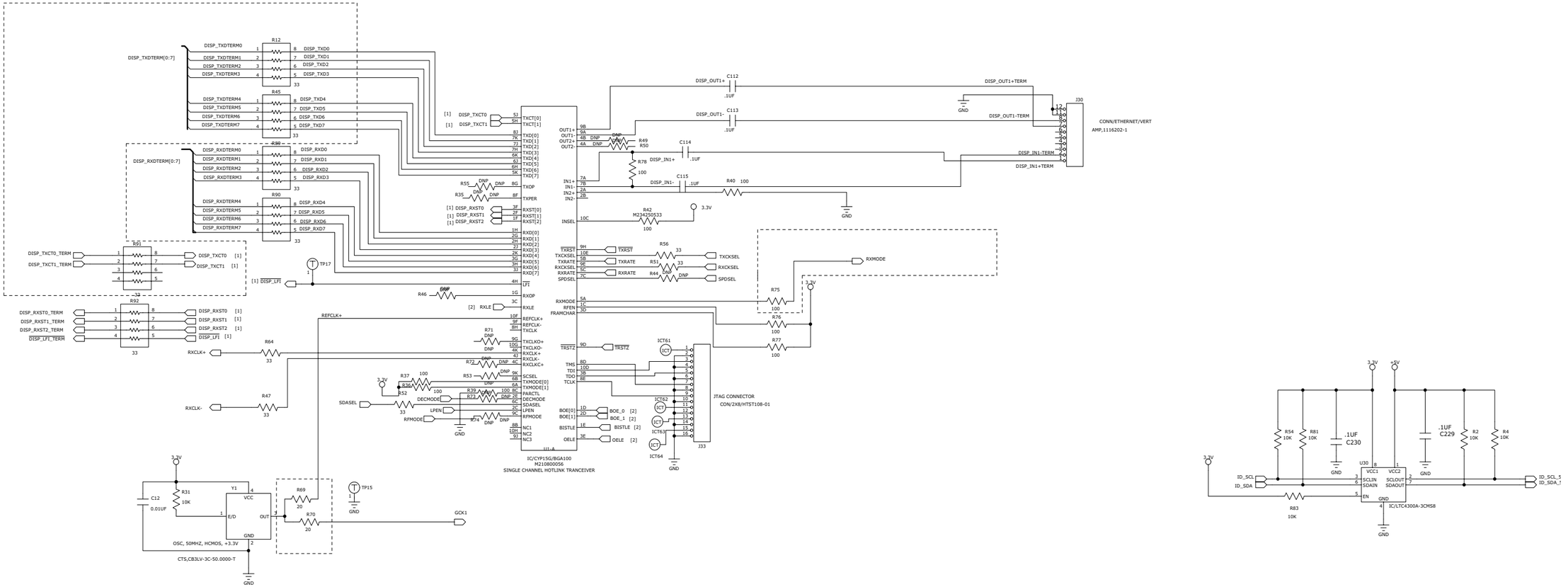
Steering Relay PCBA Sheet 3 of 4



Steering Relay PCBA Sheet 4 of 4

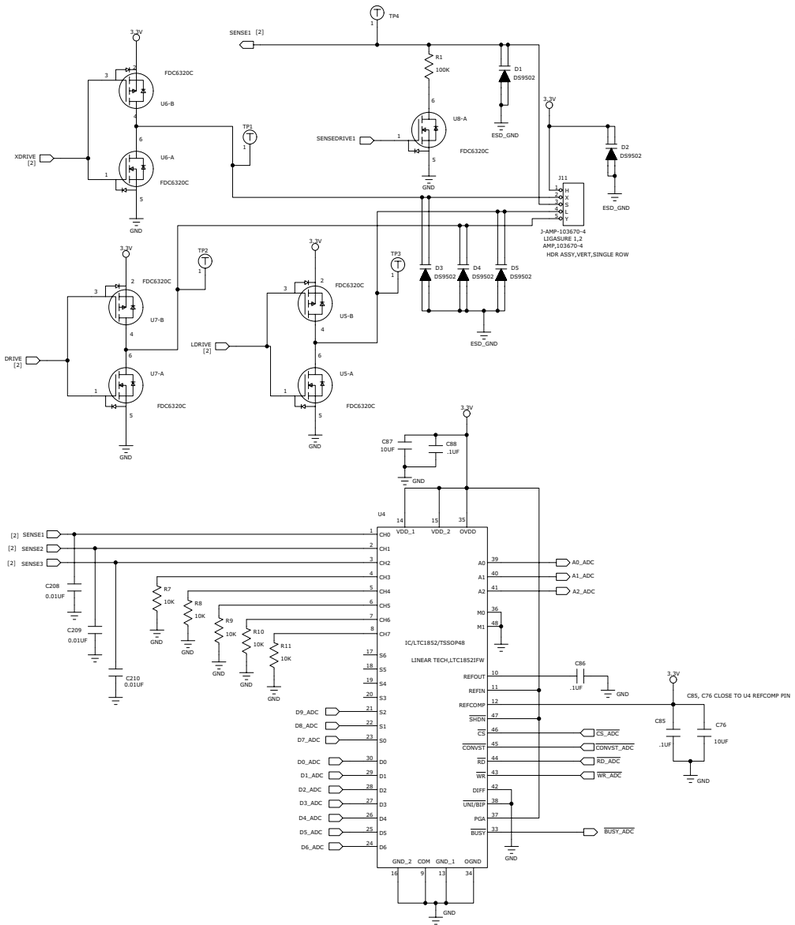
HOTLINK

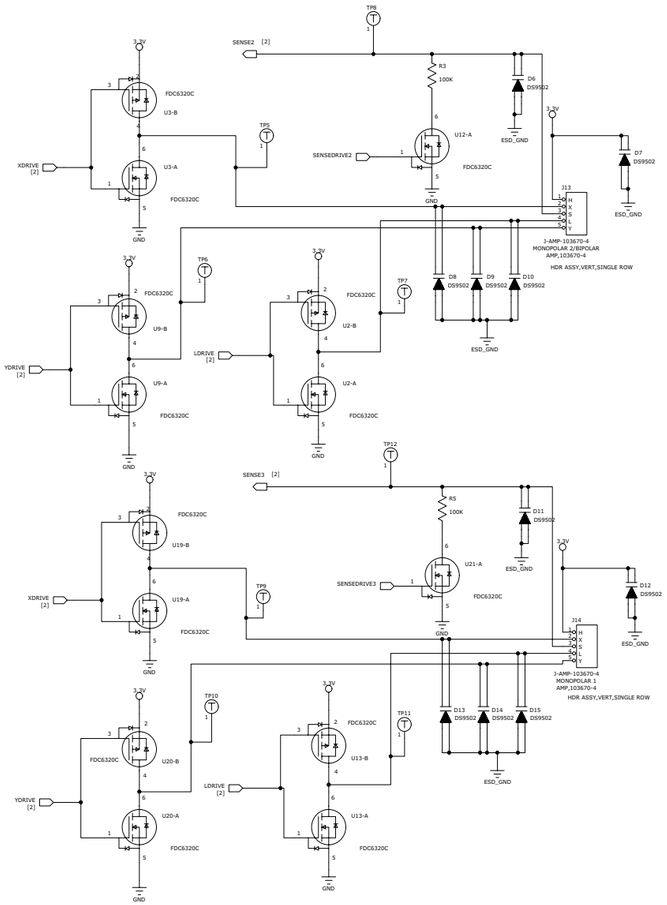
HOTLINK TO FPGA



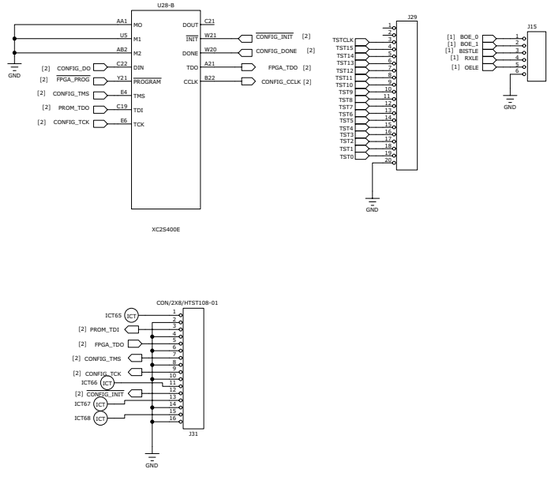
Display PCBA Sheet 1 of 4

TOUCHSCREEN

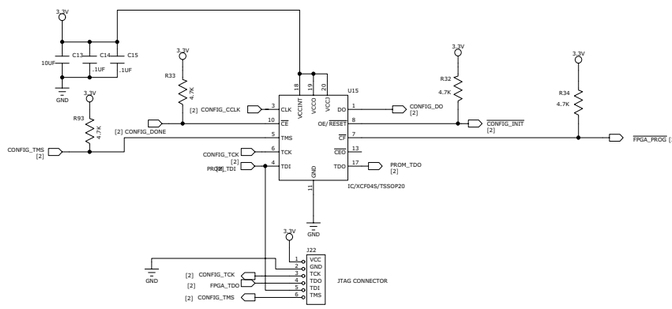




TEST POINTS



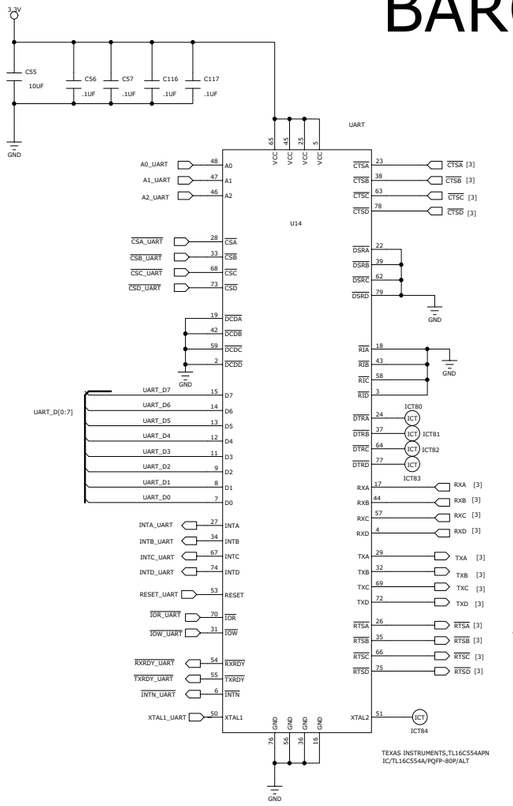
CONFIG FLASH

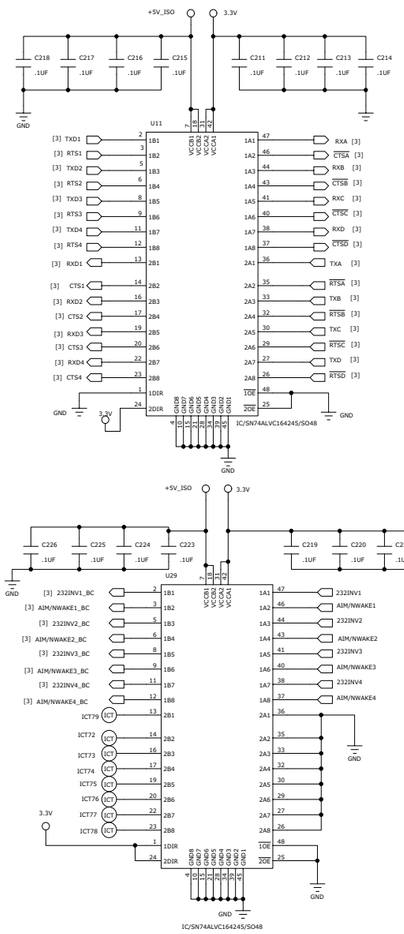


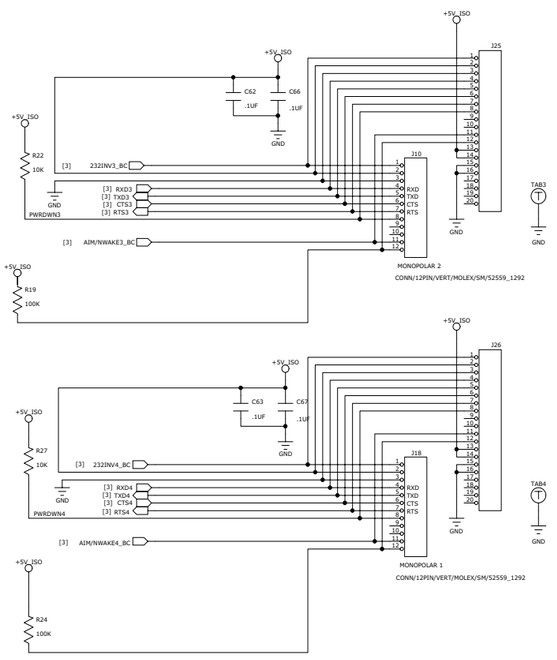
Display PCBA Sheet 2 of 4

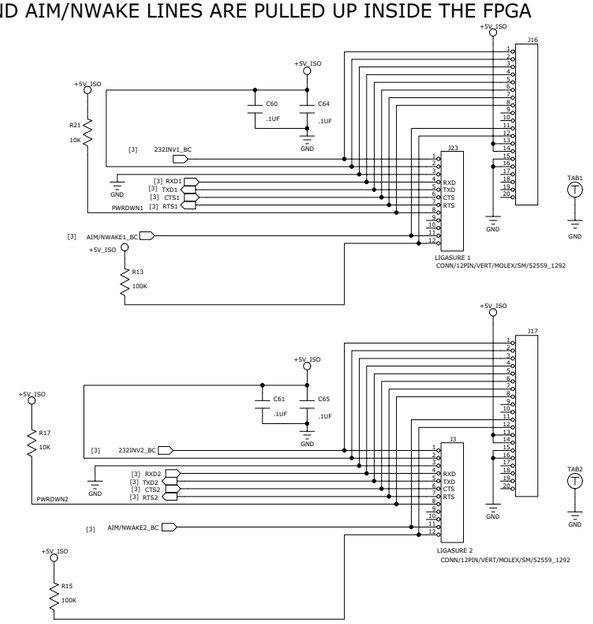
BARCODE

ALL 232INV AND AIM/NWAKE LINES ARE PULLED UP INSIDE THE FPGA







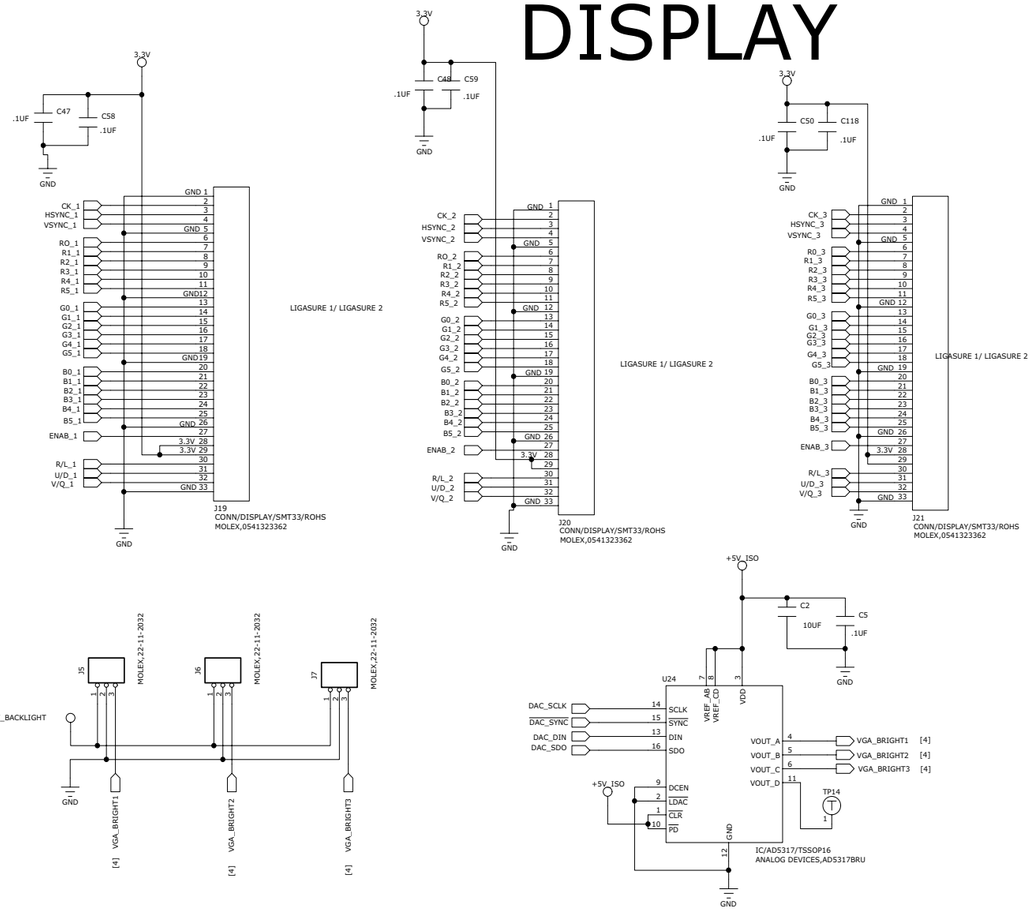


Voltage Translation Table
For each 8 bit section

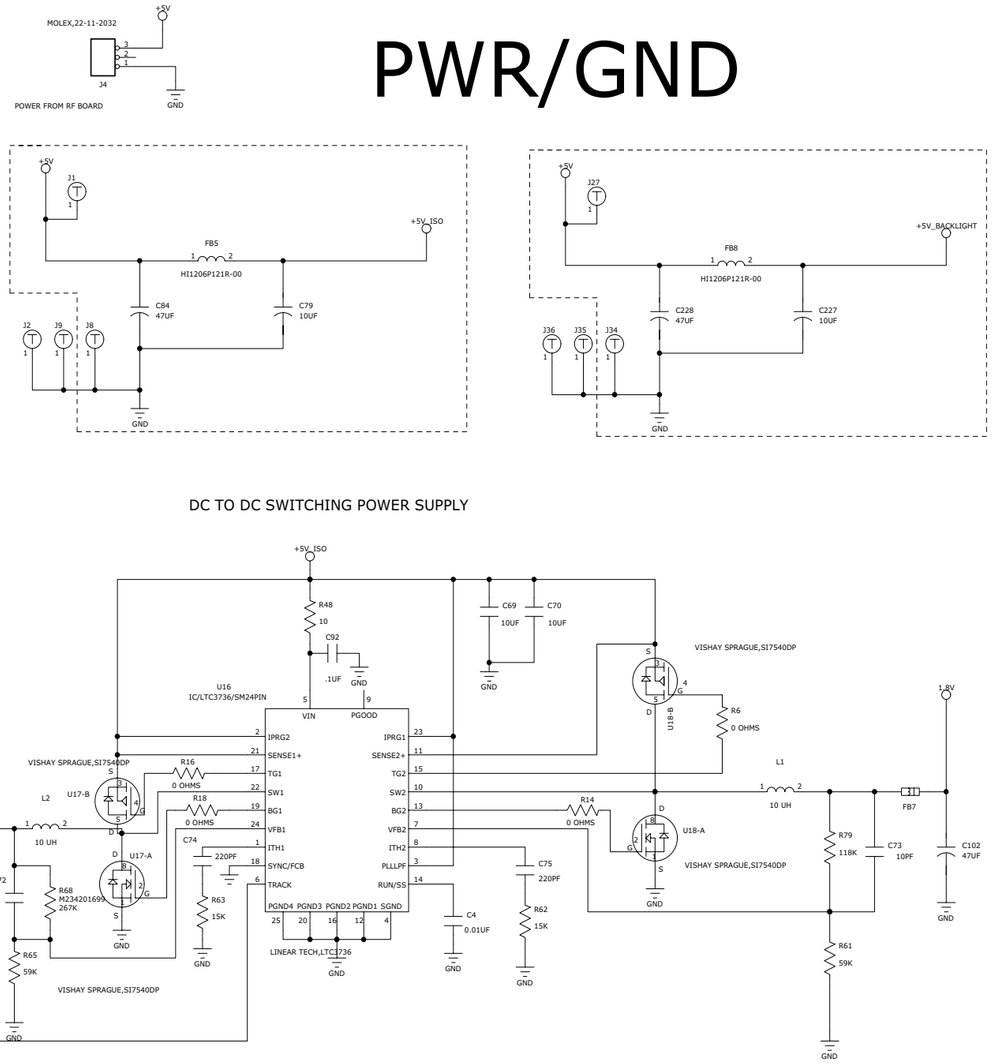
Inputs		OPERATION
$\overline{OE}$	DIR	
L	L	B DATA TO A BUS
L	H	A DATA TO B BUS
H	X	ISOLATION

Display PCBA Sheet 3 of 4

DISPLAY

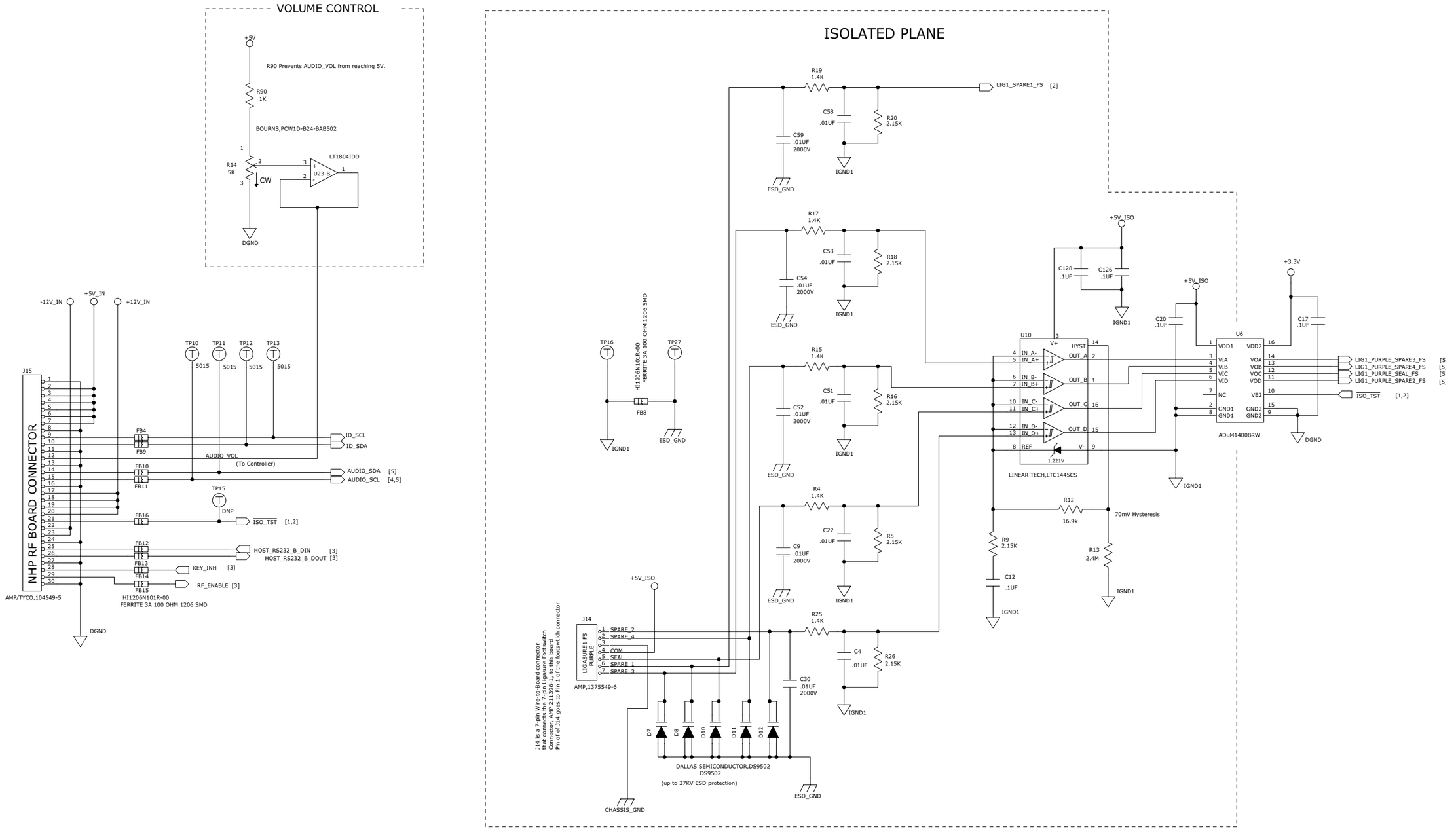


PWR/GND

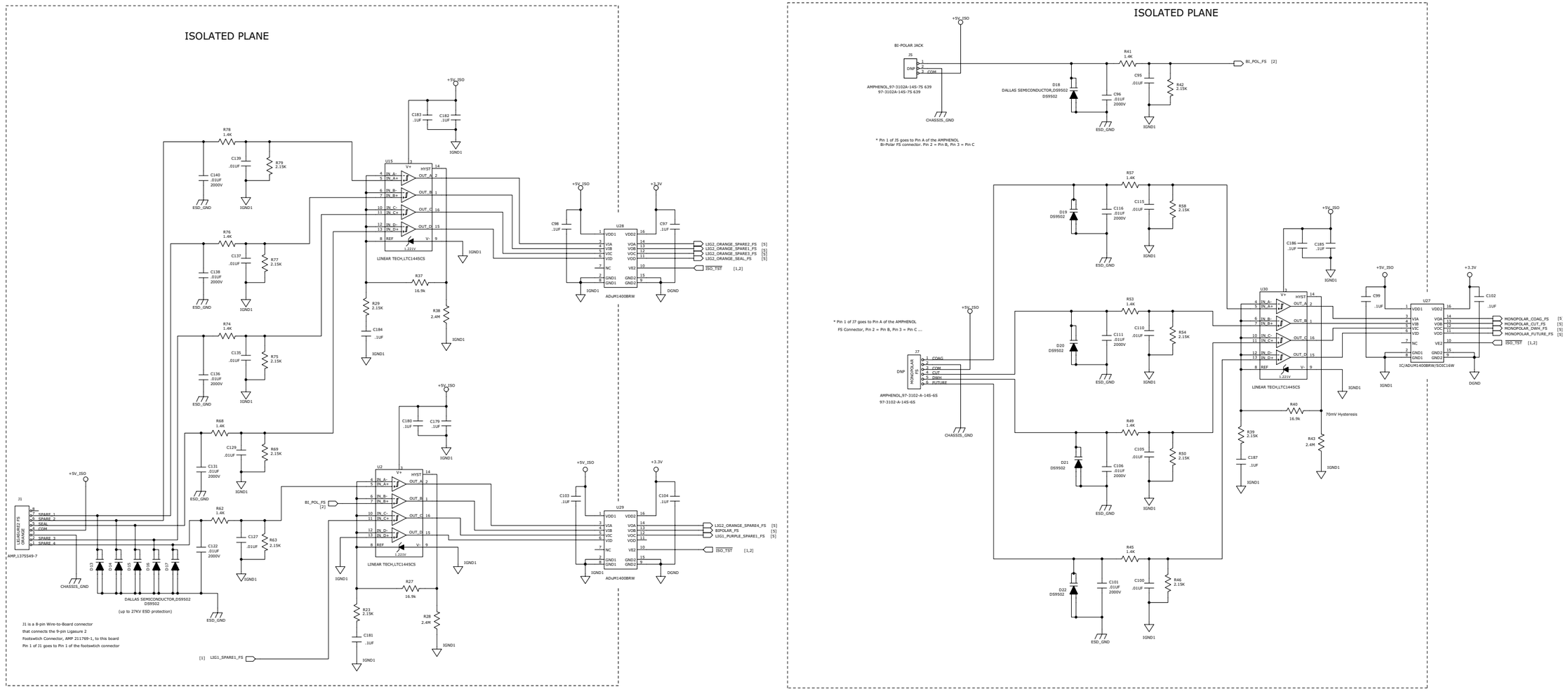


Display PCBA Sheet 4 of 4

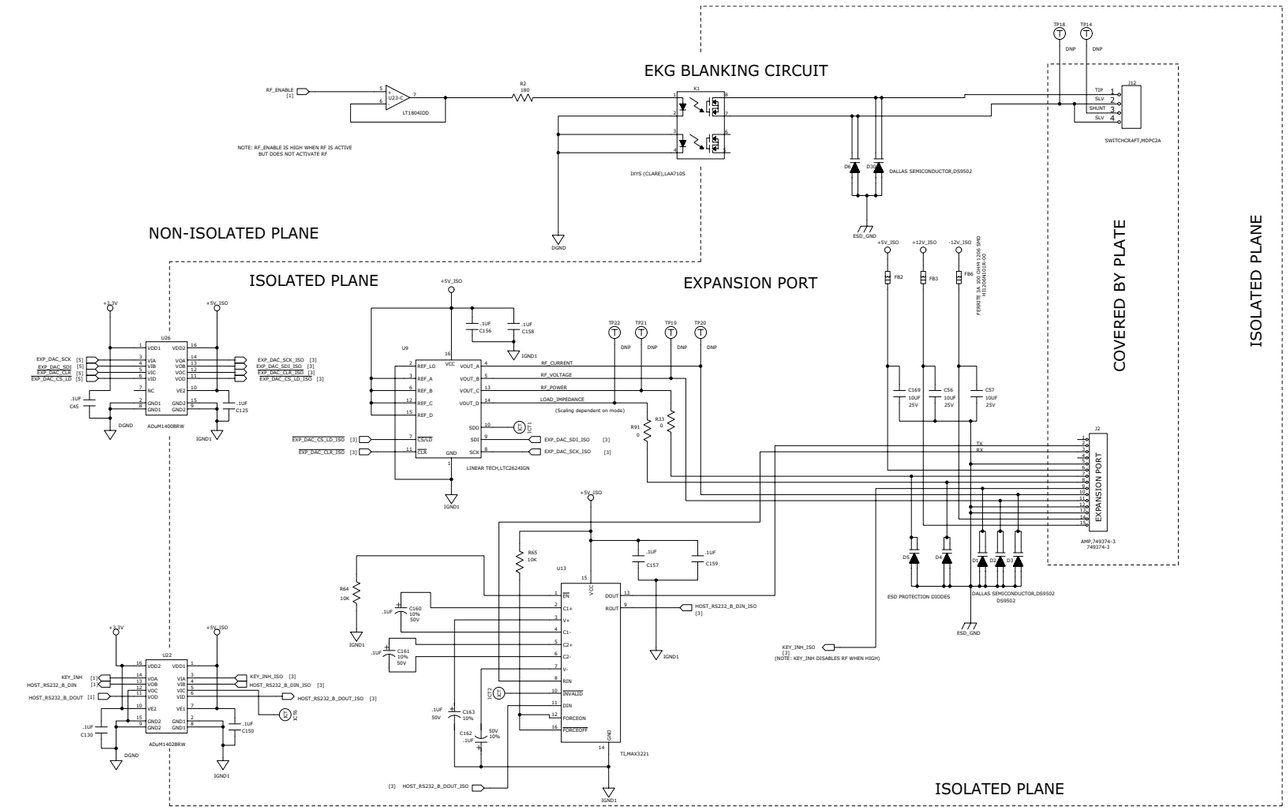
Footswitch/Audio PCBA



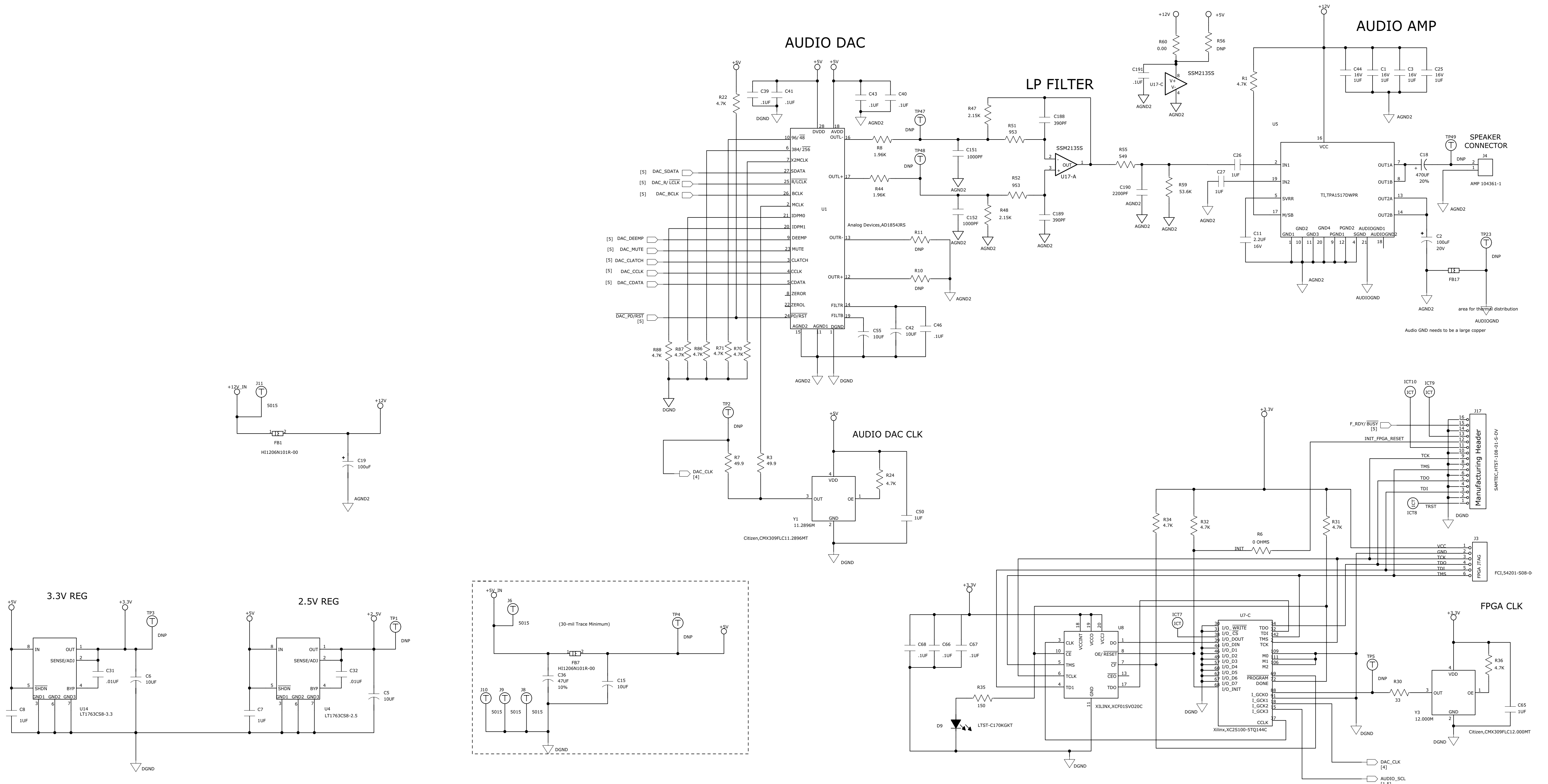
Footswitch/Audio PCBA Sheet 1 of 5



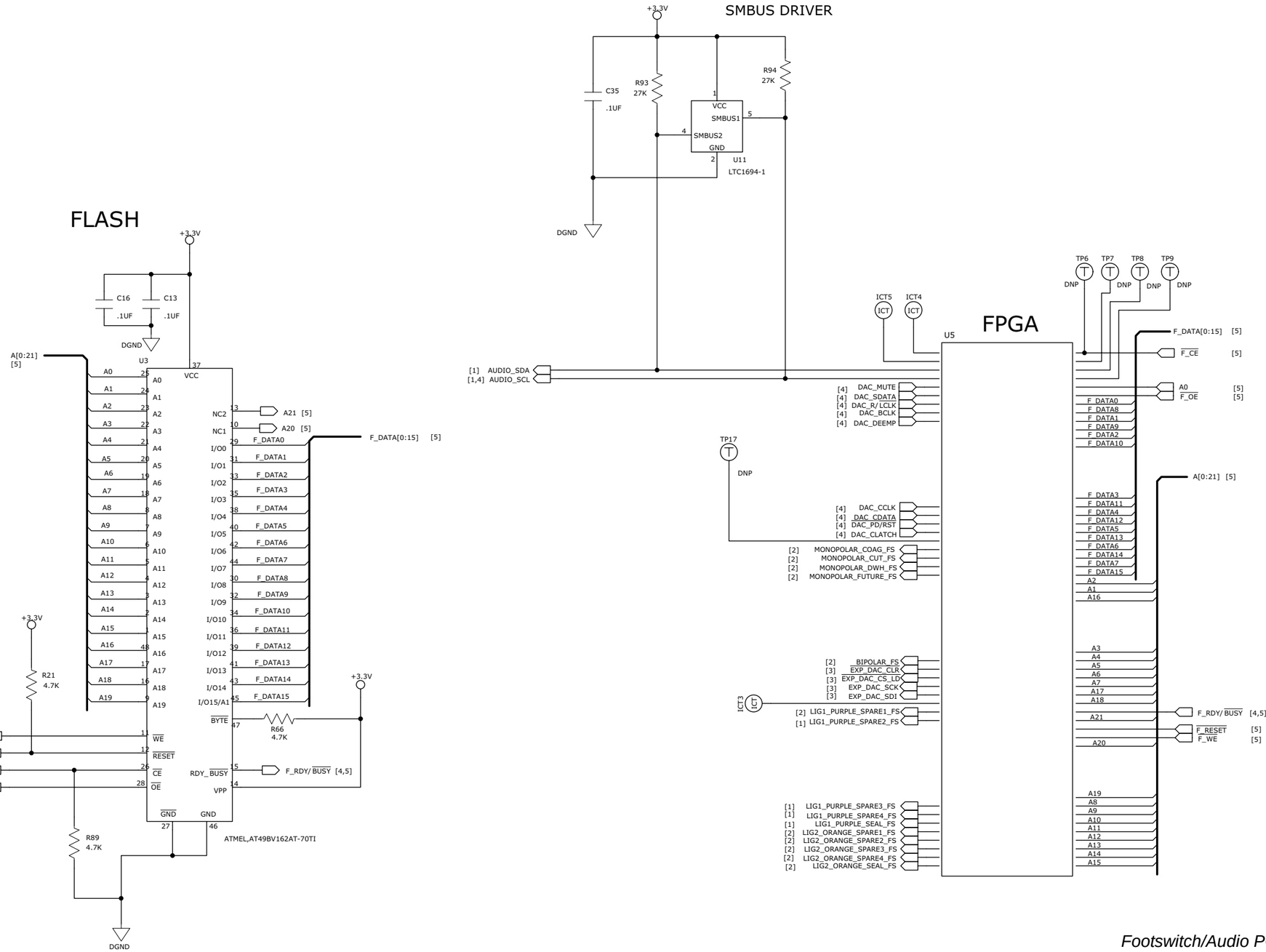
Footswitch/Audio PCBA Sheet 2 of 5



Footswitch/Audio PCBA Sheet 3 of 5

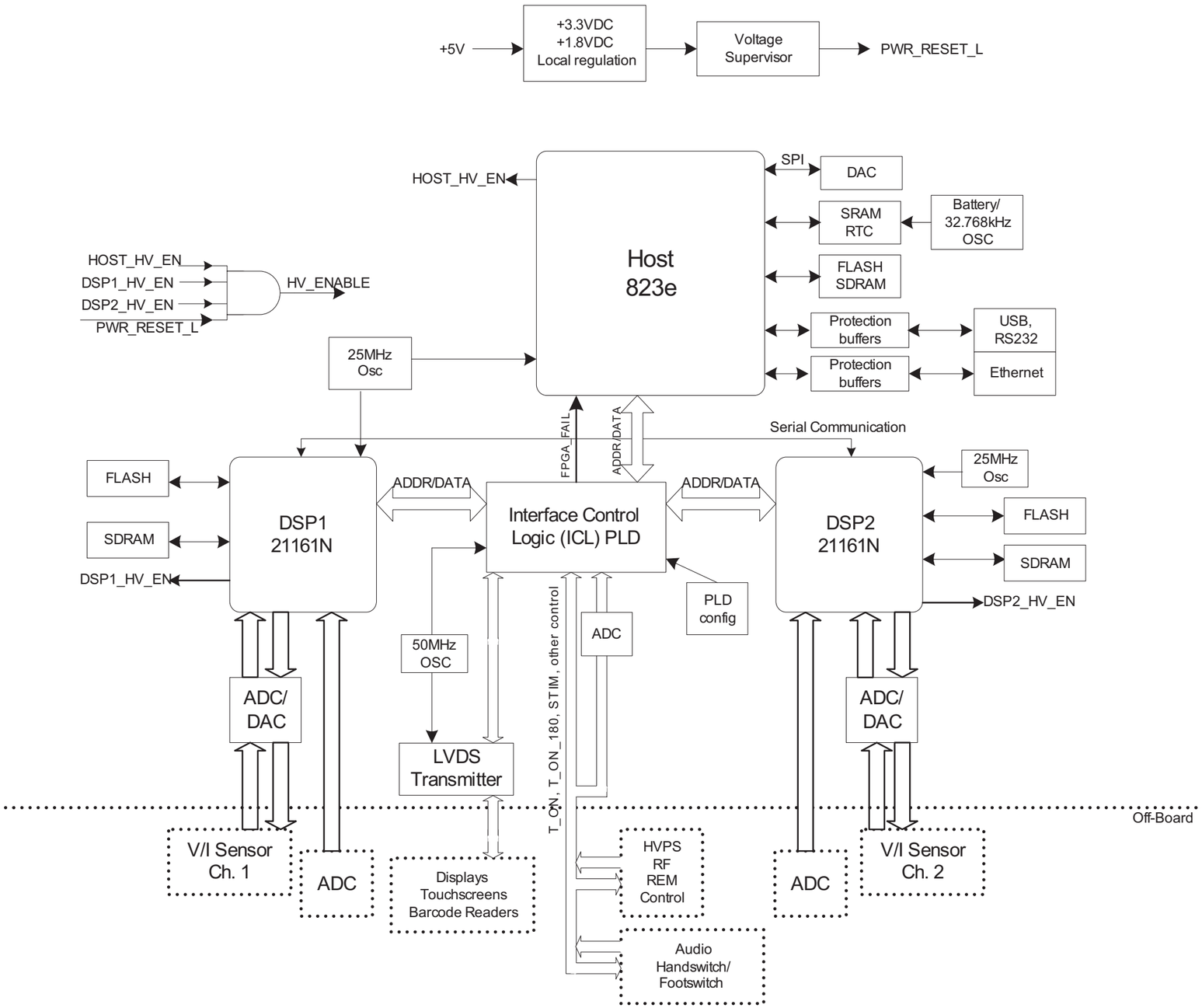


Footswitch/Audio PCBA Sheet 4 of 5



Footswitch/Audio PCBA Sheet 5 of 5

Controller PCBA



Controller PCBA Sheet 1 of 1