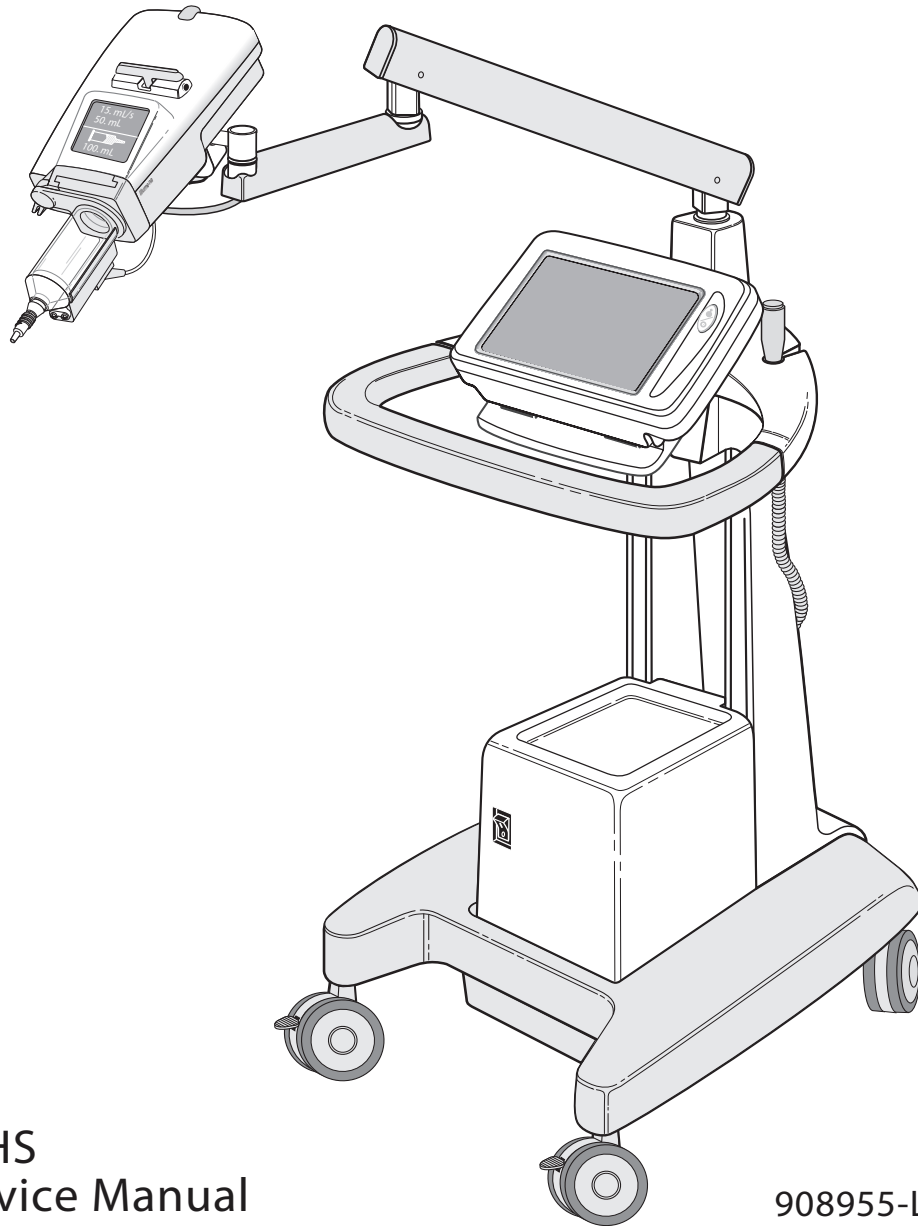




Angiomat[®] Illumena[®]

CONTRAST DELIVERY SYSTEM



RoHS
Service Manual

908955-L

CONTACT INFORMATION**Liebel-Flarsheim Company LLC**

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FOREWORD

Congratulations on the purchase of your Liebel-Flarsheim Company LLC AngiomaTM IllumenaTM Contrast Delivery System. The Angioma Illumena Contrast Delivery System represents our effort to provide a quality product to support better health care throughout the world.

Regardless of how well equipment is designed, misuse or abuse will deny its owner the expected quality of service. Misuse or abuse may occur unintentionally because the proper method of operating the equipment is unknown. Read this manual carefully before operating the Angioma Illumena Contrast Delivery System. Retain this manual for future reference.

Information regarding installation of the equipment can be found in 900808, Angioma Illumena Service: Installation Section. Information for operating the equipment can be found in 904006, Angioma Illumena Operator's Manual / 900958 Operator's Manual translations.

RECORDING SERIAL NUMBERS AND SOFTWARE VERSIONS

To facilitate requests for information, replacement parts or optional accessories, please record the serial numbers (**SN**) located on the components along with the listed data.

Unit **SN** _____
(located on powerpack)

Powerhead **SN** _____

Console **SN** _____

Date of Installation _____

Installing Company _____

Address _____

Phone Number _____

Software version numbers may be accessed via the System Info key on the Configuration screen.

Console _____

Powerhead _____

Powerpack _____

AngiomaTM IllumenaTM is a registered trademark of Liebel-Flarsheim Company LLC.

PATENT INFORMATION

This product is covered by one or more U.S. patents.
See www.guerbet.com/patents for details.

MEANINGS OF SYMBOLS USED IN THIS MANUAL

Please regard any message that follows a Caution symbol!

CAUTION! 



Dangerous Voltage.



Non-Anesthetic proof



Caution.



A.C. (alternating current).



Protective earth (ground).



POTENTIAL EQUALIZATION CONDUCTOR: Terminal for the connection of an Equipotential Ground connector per EN 60601-1 located in the rear of the powerpack

MEANINGS OF SYMBOLS USED ON THE INJECTOR



Injector enabled identifier (light on=enabled).



Manual fill knob identifier (clockwise rotation=expel).



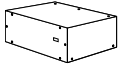
Direction indicator for the fill-control knob.



Console connection identifier or console software version identifier.



Powerhead connection identifier or powerhead software version identifier.



Powerpack connection identifier or powerpack software version identifier.



Handswitch connection identifier.



Universal Interface connection identifier.



Serial Port connection identifier.



Auxiliary Port connection identifier.



Heater connection identifier.



Air Detector connection identifier.



OFF/ON (only for the console and powerhead).



ON/OFF.



Shown on powerhead display to indicate air detected in syringe.



Refer to instruction manual.

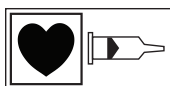


(01) 1074619000XXXX
(21) 123ABCdefG

UDI (Unique Device Identification) located on rating label.



Medical Device.

CLASSIFICATION IN ACCORDANCE WITH EN 60601-1**TYPE OF PROTECTION AGAINST ELECTRIC SHOCK***Class I equipment***DEGREE OF PROTECTION AGAINST ELECTRIC SHOCK**

Type CF applied part. (Syringes and Tubing).

DEGREE OF PROTECTION AGAINST INGRESS OF WATER*Equipment IP Classification is IPX0***HIGH INTEGRITY CHARACTERISTIC COMPONENTS***Based on the IEC 60601-1 definition of high integrity components, high integrity components were not needed to ensure safety of the device.***UL/CSA CLASSIFICATION NAME**

ANGIOMAT[™] ILLUMENA[™] INJECTION SYSTEM
 (MEDICAL EQUIPMENT)
 WITH RESPECT TO ELECTRIC SHOCK,
 FIRE AND MECHANICAL HAZARDS ONLY
 IN ACCORDANCE WITH UL60601-1, IEC60601-1,
 CAN/CSA C22.2 No. 601.1

**EC REP** GUERBET

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APPENDIX A ELECTROMAGNETIC COMPATIBILITY TABLES..... A-1

APPENDIX B SERVICE CHECKLIST B-1

1

OVERVIEW OF THE ANGIOMAT ILLUMENA CONTRAST DELIVERY SYSTEM

The purpose of this manual is to provide instructions for installation, service and calibration of the Angiomat Illumena Contrast Delivery System. For further information about operation and daily maintenance of the unit, refer to the Angiomat Illumena Contrast Delivery System Operator's Manual.

1.1 INTENDED USE

The Angiomat Illumena Contrast Delivery System is designed to inject a radiopaque contrast medium into the vascular system for Angio-graphic or CT procedures as prescribed by qualified health care professionals. Contra-indications for the use of this device are determined by the prescribing physician at the time of use based upon the contrast media package inserts.

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1.2 CONFIGURATION OF UNIT

Your particular unit may be configured as a Rack Mount, Wall Mount, Table Top or a Pedestal unit. In any configuration, the powerhead, console and power-pack will operate in the same manner.

CAUTION!

No modification of this equipment is allowed.

CAUTION!

No parts of the equipment shall be serviced or maintained while in use with a patient.

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1.3 SERVICE TECHNICIAN QUALIFICATIONS

**CAUTION! **

The Angiomat Illumena Contrast Delivery System should be installed, serviced and calibrated **ONLY** by qualified personnel who are completely familiar with the unit, have read and understood the Installation, Service and Parts Manual, and are otherwise trained in the service of equipment and procedures of this type. Failure to follow these guidelines could result in serious injury to the service technician.

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1.4 SYSTEM OPTIONS

1.4.1 AIR DETECTION AID AND WARNING SYSTEM—ADAWS

This system looks for air in the neck of the syringe before and during the Enable process. **It does not effectively detect air during an injection.** For more information, refer to Chapter 8.

1.4.2 SYRINGE HEATER

The syringe heater fits snugly against the pressure sleeve. It minimizes the loss of heat from preheated contrast. For more information, refer to Chapter 8.

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1.5 SPECIFICATIONS

1.5.1 DIMENSIONS

- Console 12"W x 8.5"H x 2.25"D (304.8 mm x 209.5 mm x 57.2 mm)
- Powerpack 17"W x 7.25"H x 11"D (431.8 mm x 184.2 mm x 279.4 mm)
- Pedestal 21.52"W (base) x 41.94"H x 23.54"D (base) (546.6 mm x 1065.3 mm x 597.9 mm)
- Powerhead 18"W x 6.6"H x 5"D (457.2 mm x 167.6 mm x 127 mm)

1.5.2 WEIGHT

- Control Console 5.8 lb. (2.6 kg)
- Powerpack 40 lb. (18.14 kg)
- Powerhead 17 lb. (7.71 kg)
- Pedestal 160 lb. (75.57 kg)—with console, powerhead, arm and powerpack

1.5.3 POWER REQUIREMENTS

- Voltage 100-127 / 220-240 V~
- Frequency 50/60 Hz
- Current 10 A
- Power 1500 W

1.5.3.1 POWER CABLES (POWERPACK)

- 120 VAC, Length 14.8 Ft (4.5 m), Part Number 901020
- 230 VAC, Length 14.8 Ft, (4.5 m) Part Number 901021
- 250 VAC, Length 15.0 Ft, (4.6 m) Part Number 901062
- 250 VAC, Length 10.0 Ft, (3.1 m) Part Number 900049

CAUTION! ⚠

If the supplied power cables cannot be used due to non compatibility with country specific outlets, then the following power cable specifications must be met. Failure to follow this caution may result in damage to equipment or cause personnel injury

CAUTION! ⚠

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION! ⚠

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

1.5.3.2 POWER CABLE SPECIFICATIONS

In addition to meeting all applicable electrical codes, substitute power cables must meet the following specifications:

120 VAC

- IEC 60320 C19 Connector
- 3 x 14 AWG Conductors
- Maximum length = 14 Ft 8 in (4.5 m)

230 VAC

- IEC 60320 C19 Connector
- 3 x 1.50 mm² Conductors
- Maximum length = 14 Ft 8 in (4.5 m)

250 VAC

- IEC 60320 C19 Connector
- 3 x 1.50 mm² Conductors
- Maximum length = 15 Ft 4 in (4.7 m)
(P/N 901062)
- Maximum length = 10 Ft 2 in (3.1 m)
(P/N 900049)

NOTE: Power cords for countries outside US, Canada, Brazil, China, and EU may need to meet other specific requirements.

1.5.4 ELECTRICAL LEAKAGE

Chassis less than 500 microamps

CAUTION! ⚠

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION! ⚠

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

1.5.5 ENVIRONMENTAL

- Transport and Storage: -40°F to 158°F (-40°C to 70°C); 10% to 95% relative humidity
- Operation: +50°F to 104°F (10°C to 40°C); 30% to 75% relative humidity;
- Biohazard Disposal: Dispose of biohazards in accordance with the requirements of your hospital, facility or local regulations.
- Disposal of the Angioma[®] Illumena Contrast Delivery System at the end of its useful life: To minimize the risk to the environment associated with the disposal of this equipment, its disposal should be performed in compliance with local, state and federal regulations. Disposal of accessories and consumables associated with this equipment should also be performed in compliance with local, state and federal regulations.
- Electromagnetic Compatibility (EMC): The Angioma[®] Illumena Contrast Delivery System meets EN60601-1-2 for Class A conducted and radiated emissions and EMI immunity.

NOTE: *If any anomalies in the injector performance are noticed, identify devices within the immediate area that are capable of producing electromagnetic interference and call a qualified service representative.*

CAUTION!

Possible explosion hazard if used in the presence of flammable anesthetic.

CAUTION!

The injector may only be operated in an area that is located beyond the 5 gauss limit. Operating the unit within magnetic fields that are higher than this limit may cause the unit to malfunction, resulting in operator or patient injury.

CAUTION!

If fluid is spilled on the console or powerpack, remove the unit from operation and contact your authorized service personnel.

1.5.6 SYRINGE SIZES

- 150 ml
- 200 ml
- 125, 100, 75, 65, 50 ml Prefilled

1.5.7 FILL RATE

- Forward or Reverse— 0.2-25 ml/sec
- Accelerates from zero to maximum in less than 0.5 seconds by rotating the fill-control bar to the fast position.

1.5.8 SYRINGE HEATER (OPTIONAL)

37°C (98°F) nominal. Minimizes the loss of heat from preheated contrast.

1.5.9 FLOW RATE**Angio-Cardiac and Angio-Peripheral**

- 0.1 to 40.0 ml/s in 0.1 ml/s increments up to 9.9 ml/s, 1.0 ml/s increments thereafter
- 0.1 to 999 ml/M in 0.1 ml/M increments up to 9.9 ml/M, 1.0 ml/M increments thereafter

CT Mode

- 0.1 to 10 ml/s in 0.1 ml/s increments
- 0.1 to 600 ml/M in 0.1 ml/m increments up to 9.9 ml/M, 1.0 ml/M increments thereafter

1.5.10 VOLUME

0.1 to volume in syringe 0.1 ml increments up to 9.9 ml, 1.0 ml increments thereafter

1.5.11 PRESSURE LIMIT

Angio-Cardiac and Angio-Peripheral

200 ml syringe:

- 75 to 900 PSI in 1 PSI increments
- 517 to 6205 kPa in 1 kPa increments

All other syringes:

- 75 to 1200 PSI in 1 PSI increments
- 517 to 8273 kPa in 1 kPa increments

CT Mode

- 75 PSI to 300 PSI
- 517 kPa to 2068 kPa

1.5.12 INJECT DELAY

0 to 300 seconds:

if delay is less than 10 seconds the programmable increment is 0.1 seconds.

if delay is greater than or equal to 10 seconds the programmable increment is 1 second.

1.5.13 X-RAY DELAY

0 to 300 seconds:

if delay is less than 10 seconds the programmable increment is 0.1 seconds.

if delay is greater than or equal to 10 seconds the programmable increment is 1 second.

1.5.14 SCAN DELAY (CT MODE)

0 to 300 seconds:

if delay is less than 10 seconds the programmable increment is 0.1 seconds.

if delay is greater than or equal to 10 seconds the programmable increment is 1 second.

1.5.15 RATE RISE

0 to 10 seconds in 0.1 second increments

1.5.16 DURATION (ANGIO MODE W/DURATION SELECTED)

1 to 999 seconds in 1 second increments

1.5.17 PHASE DELAY

0 to 300 seconds:

if delay is less than 10 seconds the programmable increment is 0.1 seconds.

if delay is greater than or equal to 10 seconds the programmable increment is 1 second.

1.5.18 STORED PROTOCOLS

- Angio-graphic mode can store up to 45 protocols.
- CT mode can store up to 45 protocols.

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2

INSTALLATION

2.1 GENERAL

This Chapter details installation of the Angiomat Illumena Contrast Delivery System, addressing topics in the following sequence:

- receiving inspection
- assembly and
- interfacing of the injector with an imaging device.

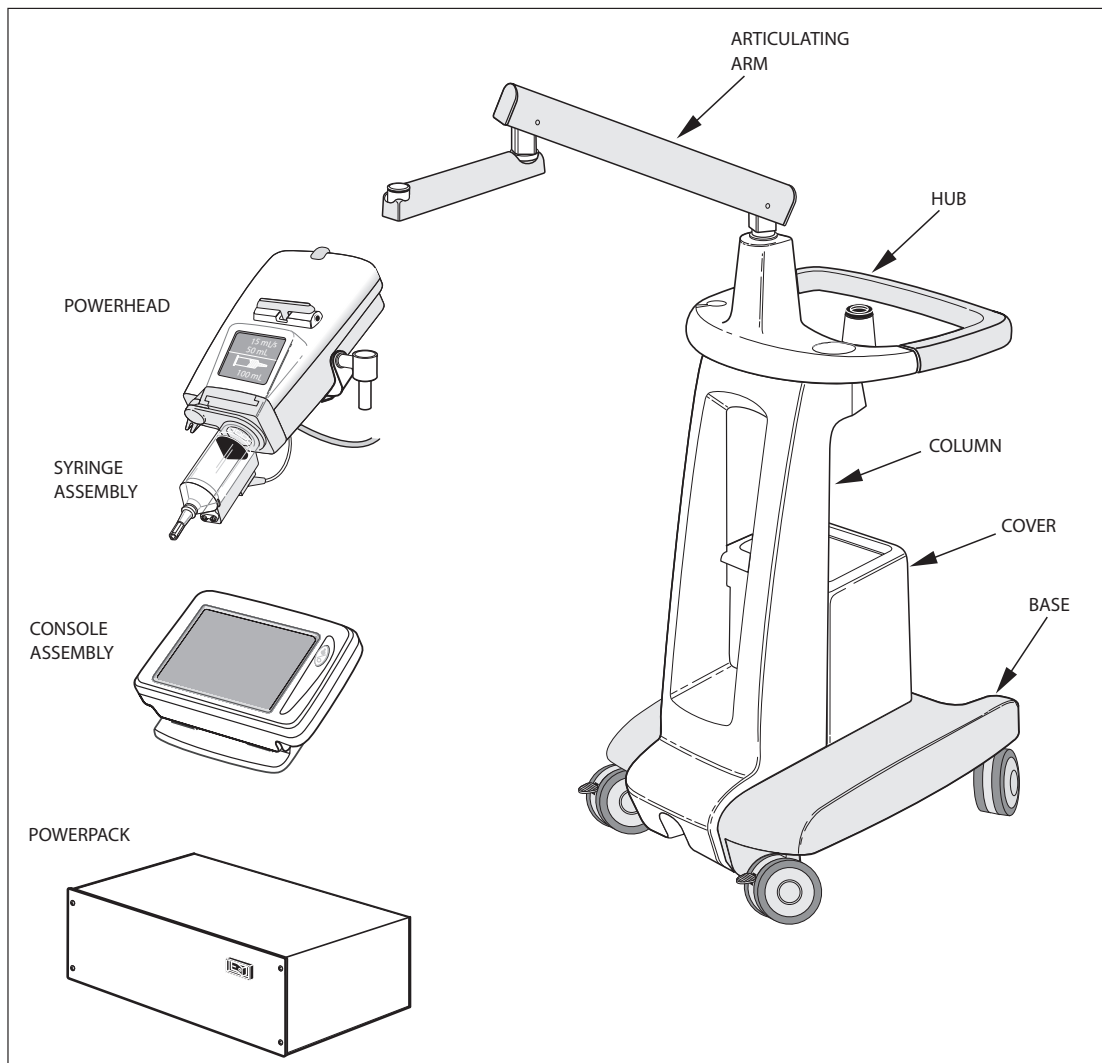


Figure 2-1-1 System Components

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2.2 RECEIVING INSPECTION

The Angiomas IIlumena Contrast Delivery System should be subjected to inspection immediately upon arrival at its shipping destination.

CAUTION! ⚠

Electronic components, contained within the Angiomas IIlumena Contrast Delivery System, may be damaged by impact. Exercise caution while handling the Angiomas IIlumena Contrast Delivery System; avoid dropping the unit or subjecting it to other physical shock.

2.2.1 INSPECTION FOR DAMAGE

All Liebel-Flarsheim Company LLC. products are thoroughly tested prior to shipment and leave our facility in perfect operating condition. If the shipment has been received in undamaged condition and in its entirety, it may be moved either to the installation site or to a temporary storage facility. To determine whether damage may have occurred to the injector during shipment, inspection personnel at the shipping destination should inspect for the following possible types of damage:

2.2.1.1 In-Transit Damage

In-transit damage is apparent even before the shipping container has been opened and may be indicated by such damage to the shipping container as crushing, cutting or puncture. If such signs are obvious upon receipt, do not accept the shipment until the carrier's agent has noted the extent of damage on the freight bill.

You can refuse to accept damaged goods.

2.2.1.2 Concealed Damage

Concealed damage is not apparent until the unit has been unpacked. Immediately upon discovery of such damage, and within fifteen days of receipt of the shipment, the carrier's agent should be contacted and asked to provide a standard form by which such damage is reported. Filing this report is the legal right of the recipient.

2.2.1.3 Processing of Damage Claims

If damage has occurred to the Angiomas IIlumena Contrast Delivery System during shipment and if the above procedures have been followed, then Liebel-Flarsheim Company LLC will assist in the establishment of a claim against the carrier.

Goods returned for credit, exchange or repair will not be accepted by Liebel-Flarsheim Company LLC. unless written authorization has been issued by Liebel-Flarsheim Company LLC.

2.2.2 INSPECTION FOR COMPLETE SHIPMENT

Unpack the system and verify receipt of all components shown on the packing list. See Figure 2-1-1.

2.2.2.1 Pedestal Injector

Verify receipt of the following undamaged components:

- Arm
- Base, Column and Hub Assemblies
- Console
- Powerpack
- Powerhead
- Syringe Holder Assembly
- Miscellaneous Hardware
- Console Extension Cable, Pedestal Length
- Coiled Handswitch Assembly

2.2.2.2 Rack-Mount Injector

Verify receipt of the following undamaged components:

- Console
- Powerpack
- Powerhead
- Console Extension Cable
- Powerhead Extension Cable
- Remote Start Switch Assembly
- Syringe Holder Assembly
- Miscellaneous Hardware
- Mounting Structure (Will contain separate installation instructions and bill of material)

2.2.2.3 Discrepancies

Report any discrepancies to:

Liebel-Flarsheim Company LLC
1034 S Brentwood Blvd
Suite 800
Richmond Heights, MO 63117 USA
1-314-376-4901
1-855-266-5037
LF.PMQuality@guerbet.com

2.3 SITE INSTALLATION TIPS

To ensure the highest operating reliability of the Angiomat Illumena Contrast Delivery System, the following considerations should be heeded.

- To minimize any possible electrical interference between the injector and companion imaging system, the injector's powerpack and the console should be placed as far away as possible from the x-ray generator or and x-ray control cabinets to avoid radiated coupling to the injector. While the injector has been provided with adequate shielding, x-ray generators can emit a considerable amount of interfering radiation, especially during tube arcs.
- Electrically isolate the injector power ground to minimize any effects of conducted emissions from the imaging source.
- Locate the injector's powerpack away from any source of possible contrast contamination. Wet contrast, especially ionic, spilled or splashed on electronics circuits can cause unpredictable or erratic operation of the injector.
- Locate the injector cables away from all high power/high voltage power mains image system cables. Do not place in troughs together or run in parallel on the floor. Loops of excess cables can act as pickup coils to unwanted signals and noise. If cable must meet, try to limit to right angle crossings. Cable cross coupling can be a major source of unwanted interference.
- Verify the electrical integrity of shields on cables, connectors, and mating covers. If custom cutting cables, make sure the shields have been reestablished. Loss of a shield on one end of a cable, even 2-3", can cut the effectivity of the entire shield by up to 95%. Avoid pigtail shields termination if possible. Optimum shields are coupled 360° around a metal connector.
- Ensure that the power source for the injector is well within the specified voltage range of the injector (see section 1.5). Low voltage or brownouts can change the operating performance of the unit.

CAUTION! ⚠

No modification of this equipment is allowed.

CAUTION! ⚠

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION! ⚠

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

2.3.1 SYSTEM CONNECTOR LOCATIONS

The system components of the Angiomat Illumena Contrast Delivery System all connect at the back of the powerpack. The diagram in Figure 2-3-1 shows the location of the various connections. The D-shell connectors use icons to identify the connector function and the mating cable connector shares the same icon. Refer to this drawing for all cable connections.

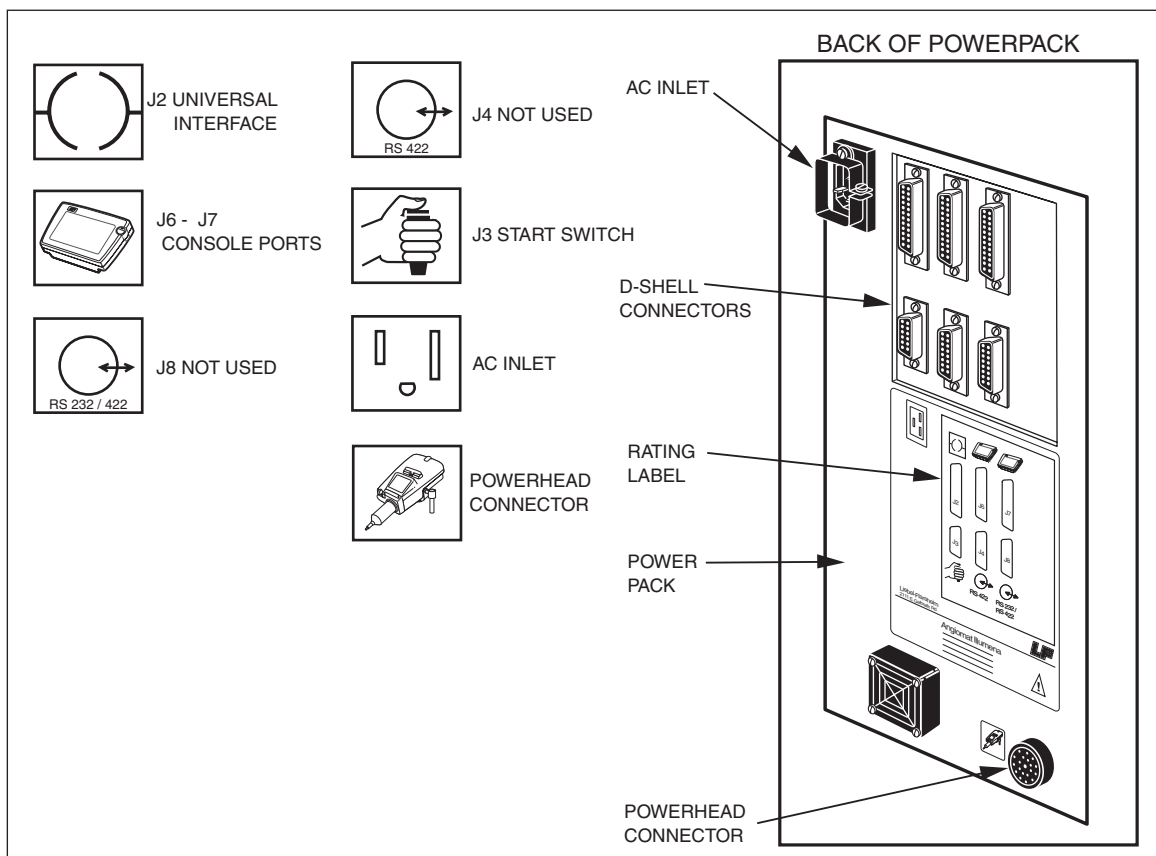


Figure 2-3-1 System Connector Location and Icon

CAUTION! ⚠

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION! ⚠

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

2.4 PEDESTAL CONFIGURATION INSTALLATION

The pedestal assembly is shipped with the assembly instructions including the hardware and tool requirements, drawings and instructions for installation.

Once the pedestal is assembled, continue with the rest of this section.

2.4.1 CONSOLE INSTALLATION

Refer to Figure 2-4-2.

1. Unscrew and remove console knob assembly from the bottom pivot shaft of the console hinge plate assembly.
2. Lower the console assembly into the mounting bushing in the hub assembly aligning the pivot shaft with the bushing opening.
3. Secure the console by inserting the knob assembly upward through the bushing and screwing it in the console pivot shaft.

2.4.2 CONSOLE AND POWERHEAD CABLE ROUTING

1. View the injector from the rear. Route the console extension cable through the bottom of the triangular opening on the hub, located between the console and articulating arm mounting holes, and connect it to the D-shell connector on the back on the console assembly.
2. Place the powerhead next to the base and route the powerhead cable through the top of the triangular opening on the hub assembly and down the left channel of the column assembly.

CAUTION!

Be sure to install the powerpack prior to powerhead assembly to avoid tip over of the pedestal. Failure to install the powerpack before powerhead assembly could result in equipment damage and/or personal injury.

CAUTION!

Do not remove the powerpack with the powerhead installed and the arm extended. This may cause the pedestal to tip over and result in equipment damage and/or personal injury.

2.4.3 POWERPACK INSTALLATION

1. Set the powerpack on the floor near the base of the pedestal and connect powerhead cable to powerpack as shown below.
2. Connect ground strap to powerpack and pedestal column.

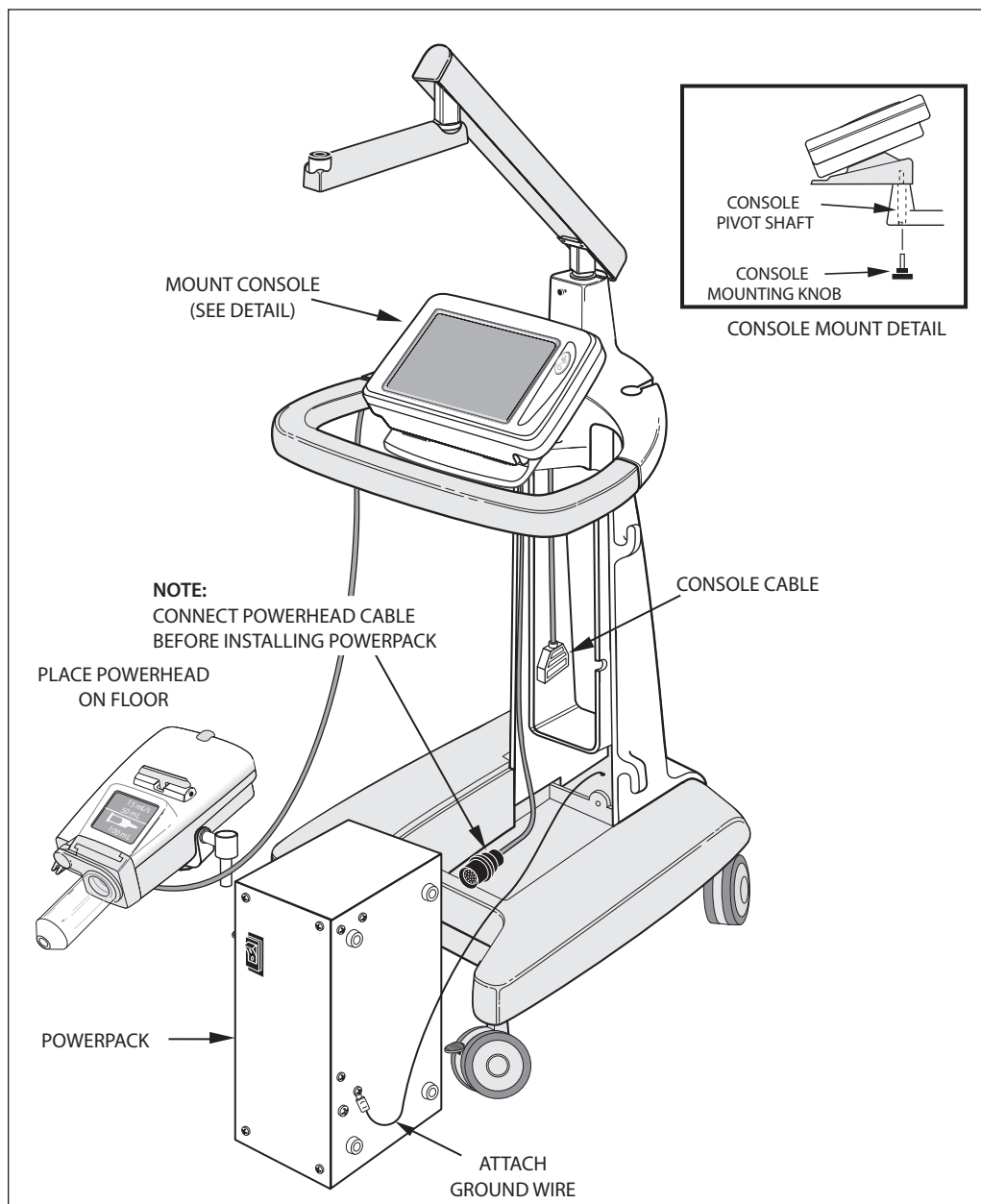


Figure 2-4-1 Pedestal Assembly and Cable Routing

3. Insert powerpack into base as shown in below.

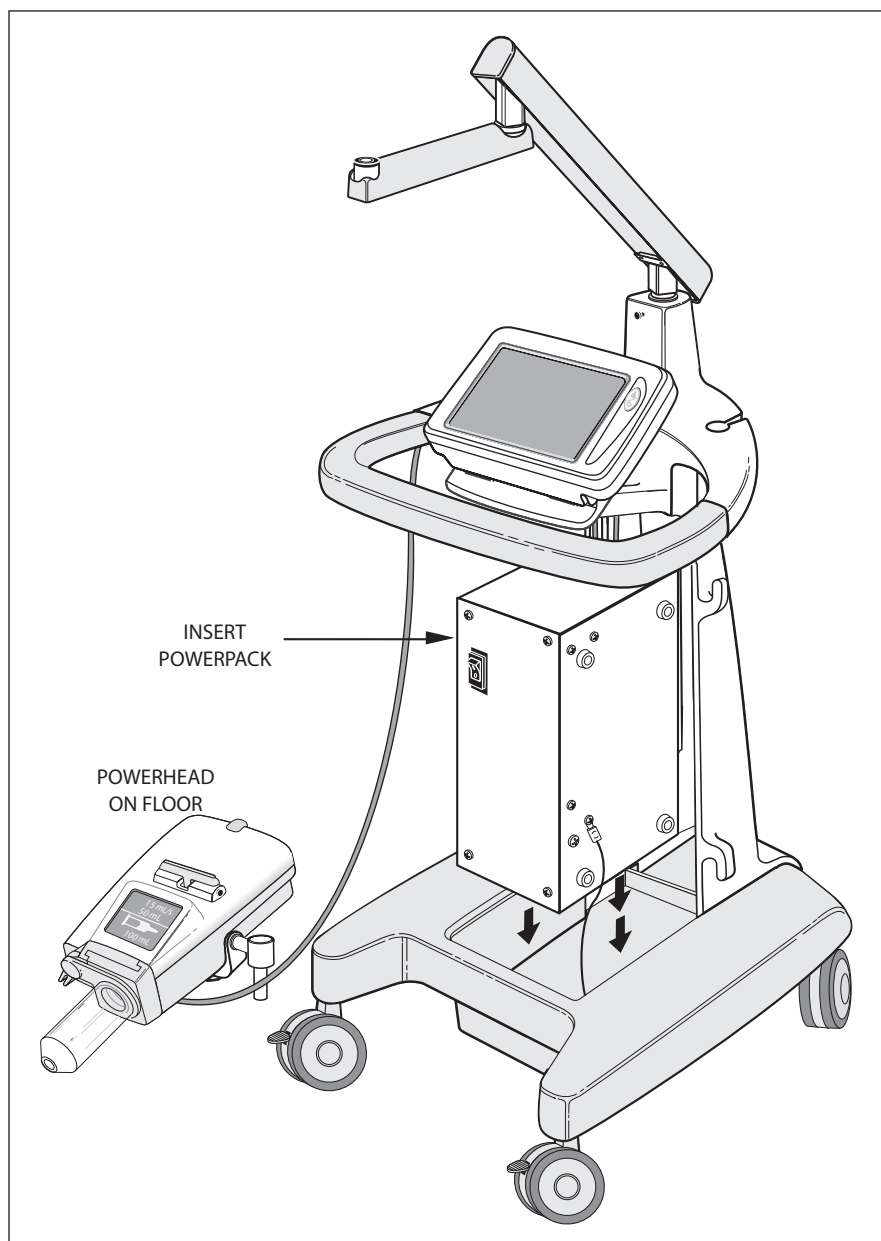


Figure 2-4-2 Powerpack Placement

4. Route the console cable through the notch on the column assembly as shown below and connect it to the console connector J6. See Figure 2-3-1 for connector location.
5. Secure the powerpack to the pedestal with velcro strap as shown in Figure 2-4-3.

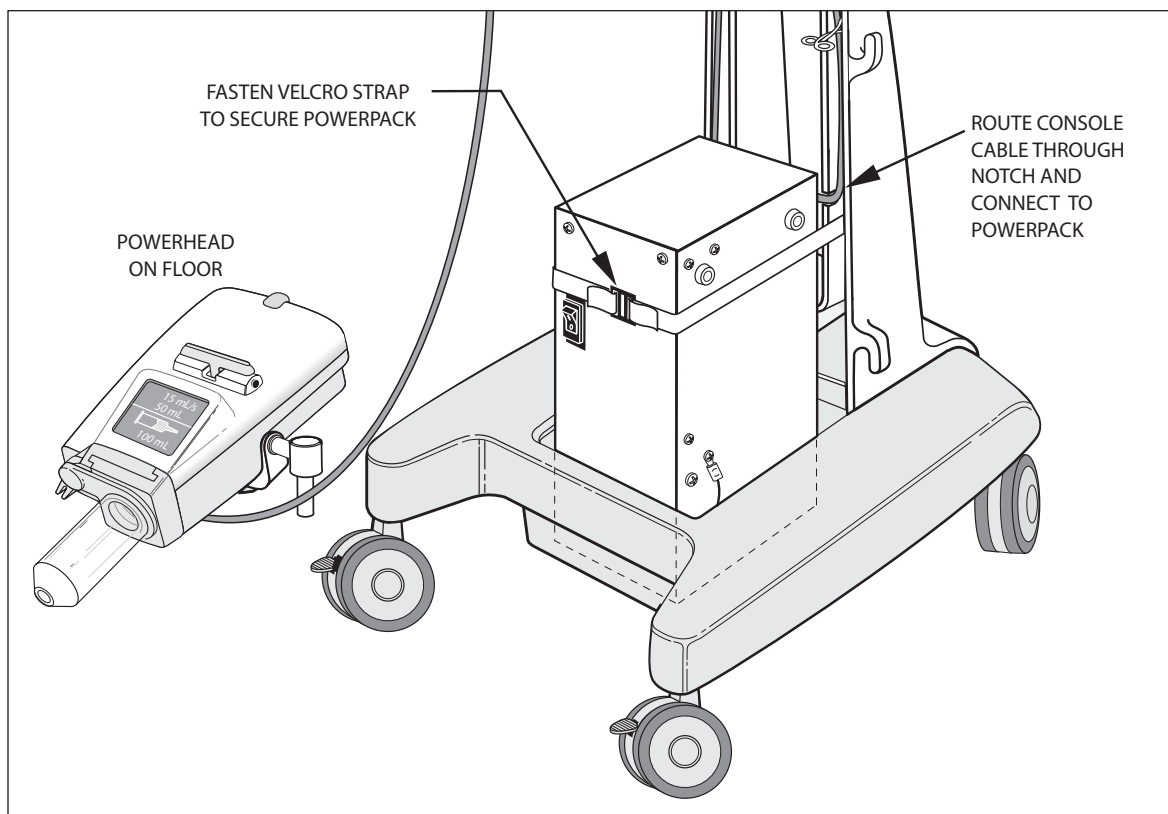


Figure 2-4-3 Securing the Powerpack

2.4.4 ARTICULATING ARM INSTALLATION

Refer to Figure 2-4-4.

1. Align pivot shaft of the articulating arm to the mounting hole on the hub as shown.
2. Lower the arm into the hub.

2.4.5 POWERHEAD INSTALLATION ON THE ARTICULATING ARM

Refer to Figure 2-4-4

CAUTION!

Be sure to install the powerpack prior to powerhead assembly to avoid tip over of the pedestal. Failure to install the powerpack before powerhead assembly could result in equipment damage and/or personal injury.

CAUTION!

Do not remove the powerpack with the powerhead installed and the arm extended. This may cause the pedestal to tip over and result in equipment damage and/or personal injury.

1. Fold the articulating arm toward the center of the hub assembly so the powerhead mounting bushing is close to the console.
2. Unscrew and remove powerhead knob assembly from the bottom of the powerhead pivot assembly.
3. Lower the powerhead pivot assembly into the head bushing in the articulating arm.
4. Secure the powerhead to the arm by inserting the knob assembly upward through the head bushing and screwing it in the powerhead pivot assembly.
5. Secure powerhead cable to articulating arm using velcro straps. Leave enough slack in the cable to ensure full powerhead motion is not restricted

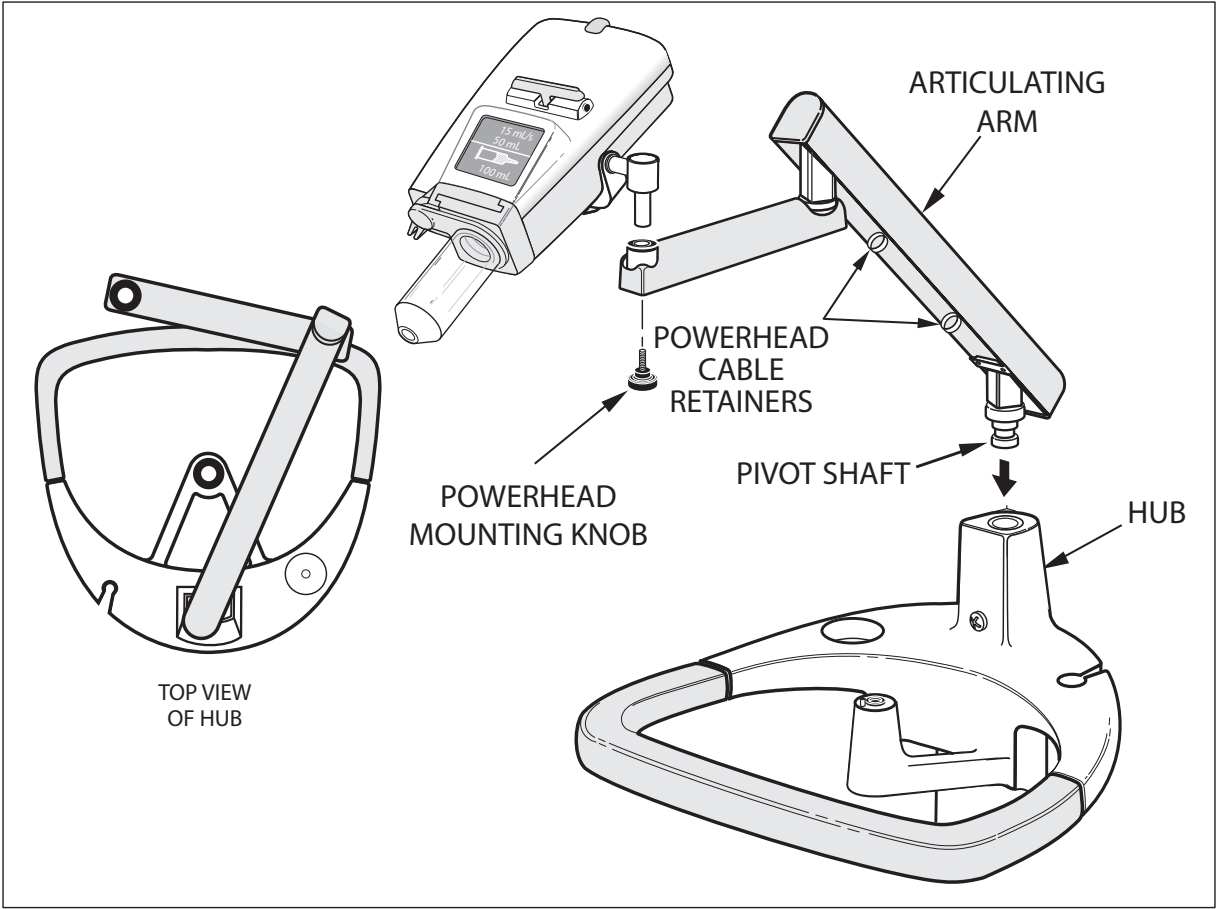


Figure 2-4-4 Articulating Arm Installation To Hub Assembly

2.4.6 SECURING CABLES AND COVER INSTALLATION

1. Secure console and powerhead cables to the column using the cable retainers shown in Figure 2-4-5.
2. Install the powerpack cover over the powerpack and align cover with the powerpack grooved base as shown in Figure 2-4-6.

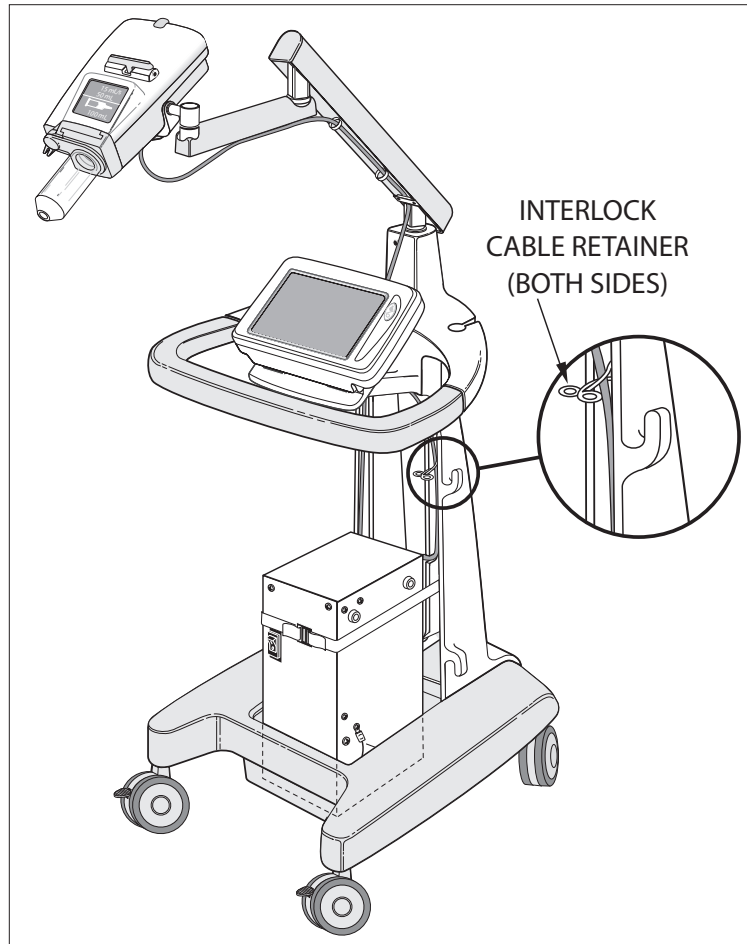


Figure 2-4-5 Securing Cables

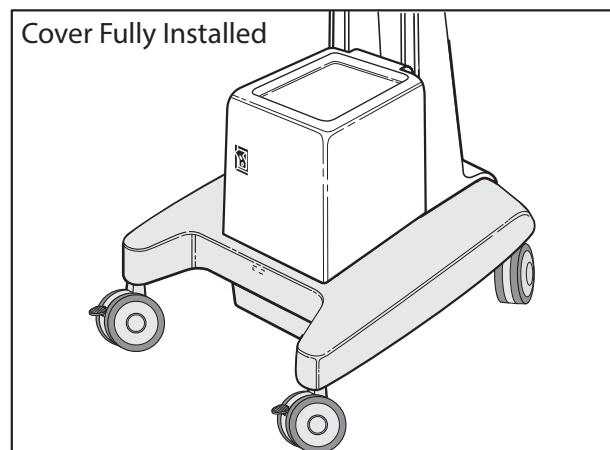


Figure 2-4-6 Powerpack Cover

2.4.7 REMOTE START HANDSWITCH AND POWER CORD INSTALLATION

1. The start switches are installed to the back of the powerpack to the connector identified with the start switch icon shown in Figure 2-3-1. Refer to the Parts manual for available lengths and configurations.
2. The power cord assembly installs to the back of the powerpack to the connector identified on the injectors rating plate shown in Figure 2-3-1. Once inserted, tighten the cable clamp. See section 1.5 for main voltage requirements.

CAUTION!

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION!

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

3. Refer to section 2.9 for optional interfacing cable installation instructions.

2.4.8 INSTALL THE PRESSURE JACKET IN THE FRONT PLATE

Refer to Figure 2-4-7.

2.4.8.1 150 ml and 200 ml Syringe Assembly

1. Align notches in the pressure jacket with the two retaining screws; insert the pressure jacket fully into the front plate.
2. Rotate the pressure jacket counterclockwise (if viewed from behind the plate) until the pressure jacket flange engages the retaining screws and locks in place.

2.4.8.2 125 ml Syringe Assembly

1. Insert the pressure jacket fully into the front plate. Rotate the pressure jacket so the threaded holes for the retaining screws in the front plate are approximately aligned with the midpoint of the cut out areas at the base of the pressure jacket.
2. Install the retaining screw.

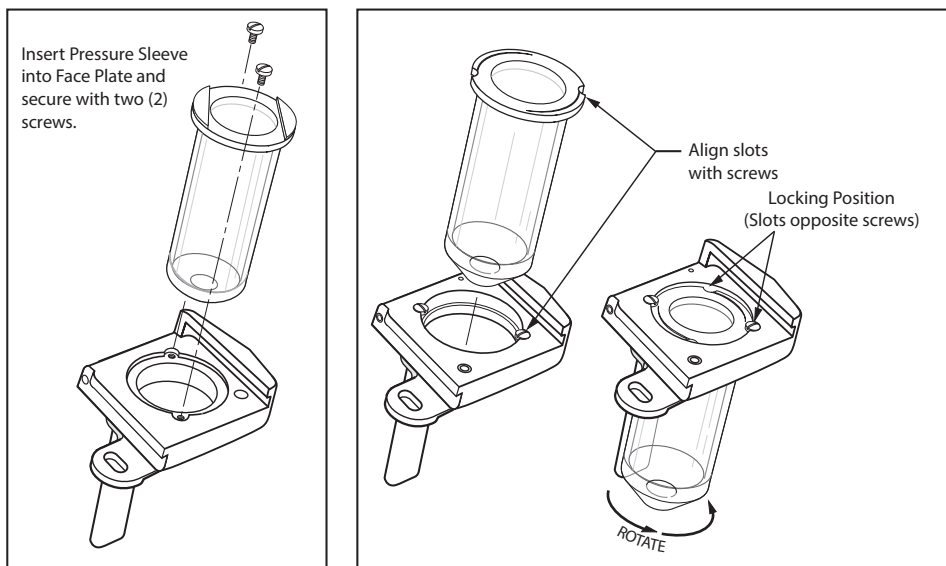


Figure 2-4-7 150 ml and 125 ml Syringe Holder Assemblies

2.4.9 MOUNT THE SYRINGE ASSEMBLY TO POWERHEAD

Refer to Figure 2-4-8.

1. With power on, retract ram completely.
2. Slide syringe assembly onto shaft as shown below.
3. Close the syringe assembly by rotating up past the detent to the full up position.
4. Rotate the syringe lever counterclockwise to secure the syringe assembly to the powerhead

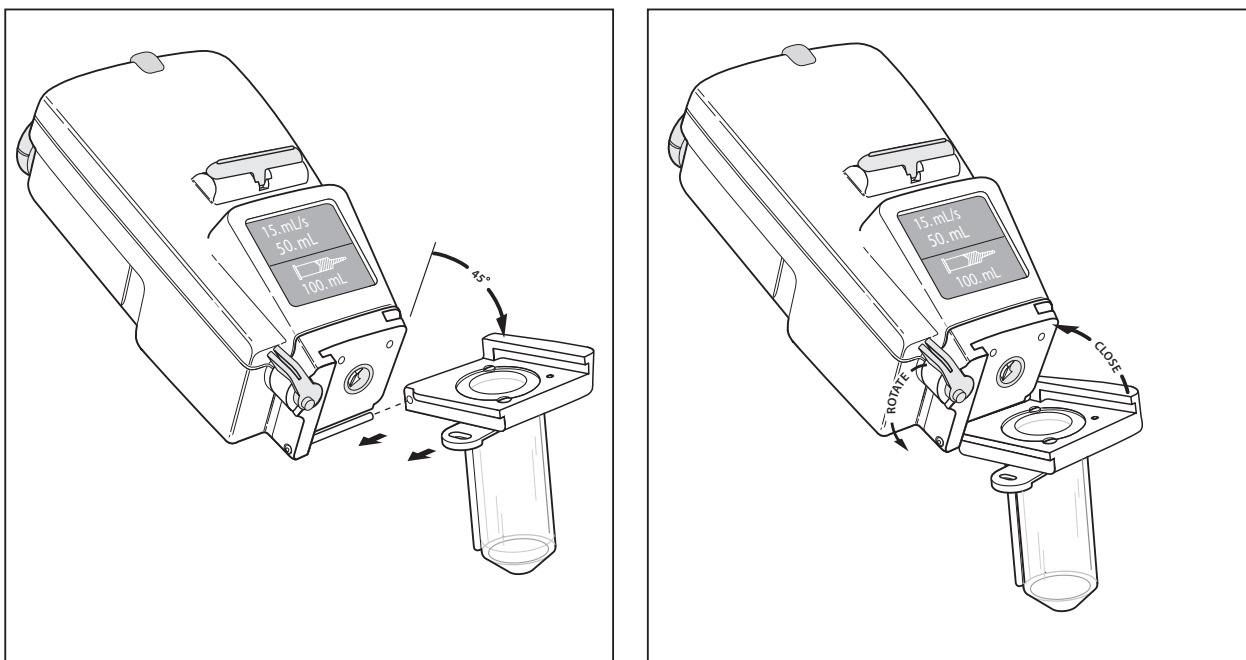


Figure 2-4-8 Mount the Syringe Assembly

2.5 INSTALLATION OF A RACK MOUNT INJECTOR

Components of the rack mounted Angiomat Illumena Contrast Delivery System may be arranged in conformance with the spatial characteristics of the installation site.

The following *optional* equipment may be used in the configuration of a rack mounted Angiomat system.

2.5.1 EXTENSION CABLES

Extension cables are required to connect either a remotely-placed console or powerhead to the powerpack. Refer to Parts Manual for available lengths.

2.5.2 CONSOLE MOUNTING

Refer to Figure 2-5-1.

2.5.2.1 Console Wall Mounting Kit

The console wall mount kit consists of a bracket to mount the console to the wall while maintaining the vertical and horizontal positioning capabilities of a pedestal version. The kit includes the hardware and tool requirements, drawings and instructions for installation.

2.5.2.2 Console Table Top Mount

The console hinge plate assembly is a multi purpose mounting assembly that functions as the table mount for the console. To install it as a table mount, simply remove the shaft of the console hinge plate assembly and set the console in the desired location

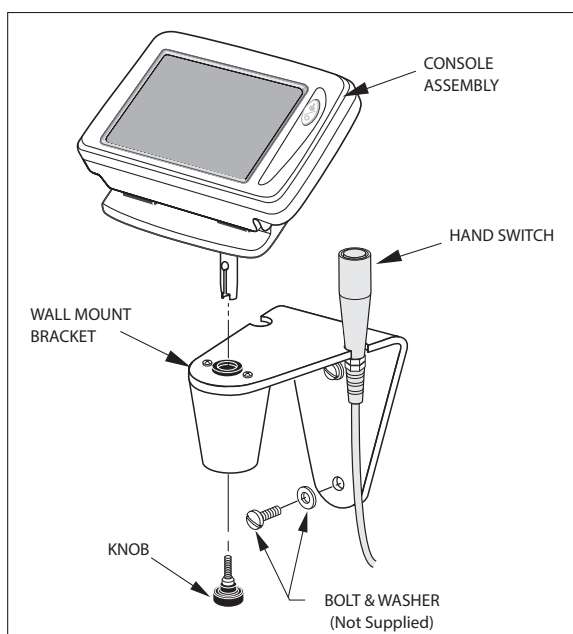


Figure 2-5-1 Console Wall Mount

2.5.3 POWERHEAD MOUNTING

2.5.3.1 Powerhead Table Mount Kit 600150

The powerhead can be mounted to the table with the 600150 Fixed Arm Table Mount Kit.

2.5.3.2 Mounting the Powerhead to the Table Mount

1. Unscrew and remove powerhead knob assembly from the bottom of the powerhead pivot assembly.
2. Lower the powerhead pivot assembly into the head bushing
3. Secure the powerhead to the bracket by inserting the knob assembly upward through the head bushing and screwing it in the powerhead pivot assembly.
4. Connect the end of the powerhead cable to the powerhead extension cable.

2.5.4 CEILING SUSPENSION SYSTEM KITS

CAUTION!

The Suspension Arms are shipped with an internal limiter which is set to restrict the upward travel of the arm to the horizontal position. Always raise the arm to the upward limit of travel before removing any equipment mounted to the arm. THE ARM WILL SPRING UPWARD WITH CONSIDERABLE FORCE UNDER NO LOAD CONDITIONS, AND MAY CAUSE SERIOUS PERSONAL INJURY

Suspension Systems allow the Angiomat powerhead to be flexibly mounted at a distance from the powerpack. Separate instructions for the Suspension System are supplied with each Suspension System shipment. Each kit lists the hardware and tool requirements, and includes drawings and instructions for installation.

NOTE: The suspension system is to only be used with Liebel-Flarsheim Company LLC power injectors. The maximum load capacity of the suspension spring arm should not exceed 32 lbs at full extension. The use of accessories not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the patient vicinity
- evidence that the safety certification of the accessory has been performed in accordance to the appropriate EN 60601-1 and/or EN 60601-1-1 harmonized national standard.

2.5.5 REMOTE STAND ASSEMBLY 601577

Refer to Figure 2-5-2.

The Remote Stand Assembly provides a secure yet mobile support for the Angiomat Illumena Contrast Delivery System powerhead. Separate instructions for the Remote Stand are supplied with each Remote Stand shipment. Each kit lists the hardware and tool requirements, and includes drawings and instructions for installation.

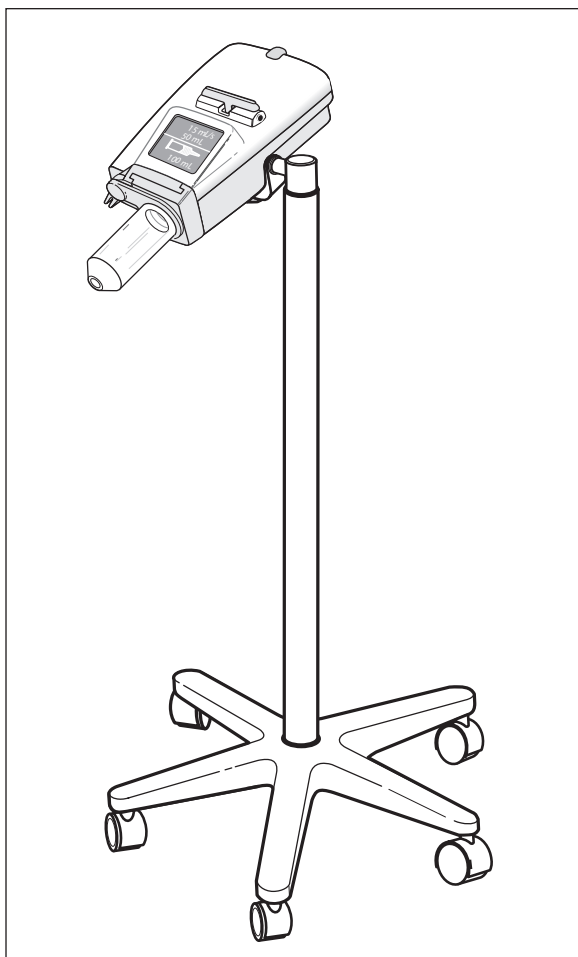


Figure 2-5-2 Remote Stand Assembly

2.5.6 POWERPACK MOUNTING

The powerpack can be mounted in three configurations in addition to the pedestal version. The first is a table mount which requires no additional hardware. The chassis of the powerpack is a self supporting table mount unit with rubber feet already in place on the bottom. The next two configurations, the rack mount and wall mount, provide further flexibility in powerpack mounting options.

2.5.6.1 Powerpack Rack Mount

The rack mount configuration allows the powerpack to be installed in a standard 19 inch component rack as shown in Figure 2-5-3. The kit lists the hardware and tool requirements, and includes drawings and instructions for installation.

CAUTION! ⚠

Be sure powerpack is mounted in a manner such that the power cord remains accessible.

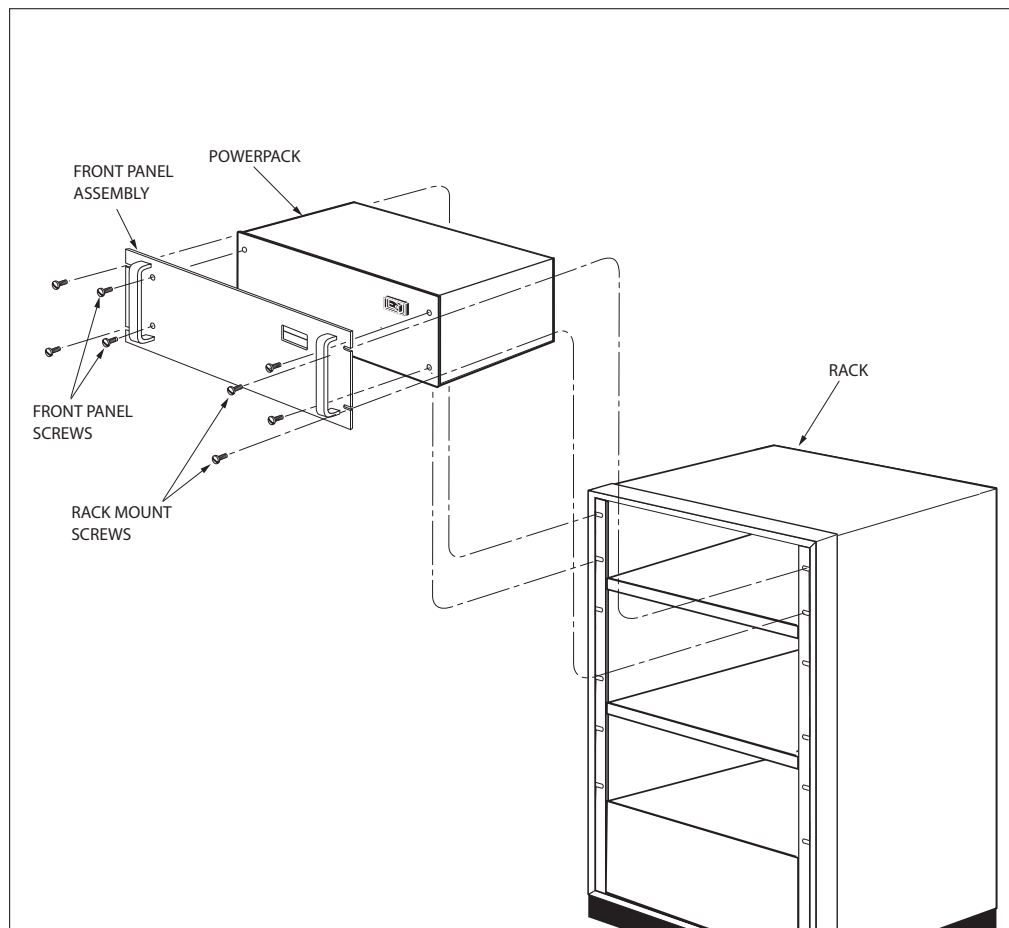


Figure 2-5-3 Powerpack Rack Mount and Instrument Case

2.5.6.2 Powerpack Wall Mount

The wall mount configuration allows the powerpack to be installed vertically on a wall, under a table top or other inconspicuous location as shown in Figure 2-5-4. The kit lists the hardware and tool requirements, and includes drawings and instructions for installation.

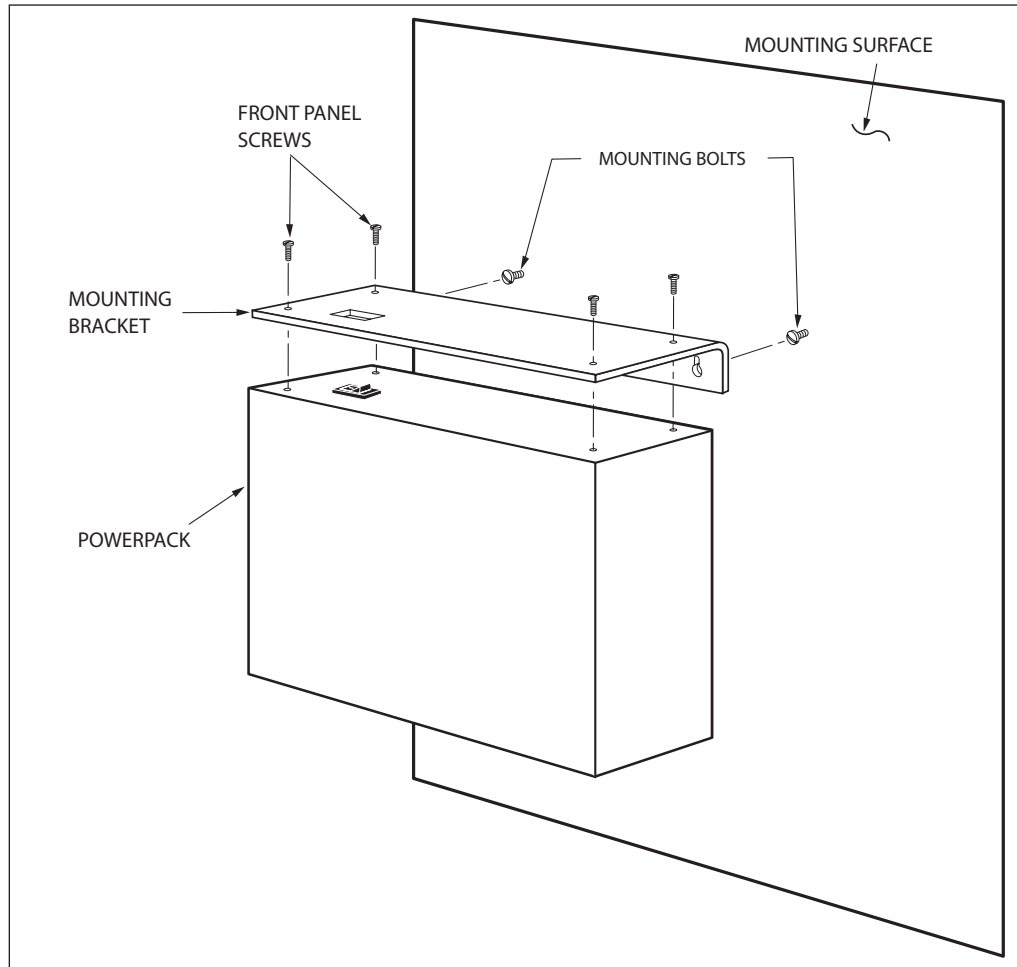


Figure 2-5-4 Powerpack Wall Mount

CAUTION! ⚠

Be sure powerpack is mounted in a manner such that the power cord remains accessible.

2.6 REMOTE START HANDSWITCH AND FOOTSWITCH

The start switches are installed to the back of the powerpack to the connector identified with the start switch icon shown in Figure 2-3-1. Refer to the Parts Manual for lengths and configurations.

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2.7 POWER

The power cord assembly installs to the back of the powerpack to the connector identified with the power cord icon shown in Figure 2-3-1. Once inserted, tighten the cable clamp. See section 1.5 for main voltage requirements.

CAUTION!

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION!

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

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2.8 LANGUAGE

The text can be displayed in English, German, Italian, Spanish, French or Japanese. The default configuration for the unit is English. The language can be changed during power up. The initial screen has selection keys along the bottom of the screen that are active for the count down indicated in the center of the screen.

To change a preset language, cycle power and press the key corresponding to the desired language while the initialization count down is counting.

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2.9 INTERFACING

2.9.1 GENERAL INTERFACING DETAILS

CAUTION! ⚠

Prior to interfacing the Angioma[®]t Illumena Contrast Delivery System to an imaging system, ensure all imaging system inputs and relay/switch outputs are not greater than +24VDC @ 40 ma. See manufacturer's data sheet for I/O specifications before attempting the interface wiring. Some of the older film changers use AC relays which if connected directly to the Angioma[®]t Illumena Contrast Delivery System may cause equipment damage and could result in a hazard causing personal injury or death.

The Universal Interface (UI) Port in the Angioma[®]t Illumena Contrast Delivery System allows you to link the injector to the imaging system or synchronization, control, and to exchange status information. This interface allows the injector and imaging system to trigger each other, and it provides status and control lines between the injector and imaging system. The following is a summary of the connections possible with the Universal Interface. A general wiring diagram is shown in Figure 2-9-1.

NOTE: The Start Config 2 input relay is the only active high input. To activate Start Config 2 input relay, the signal must be pulled to the +24VDC on J2:1 through the imaging system relay/switch instead of injector ground.

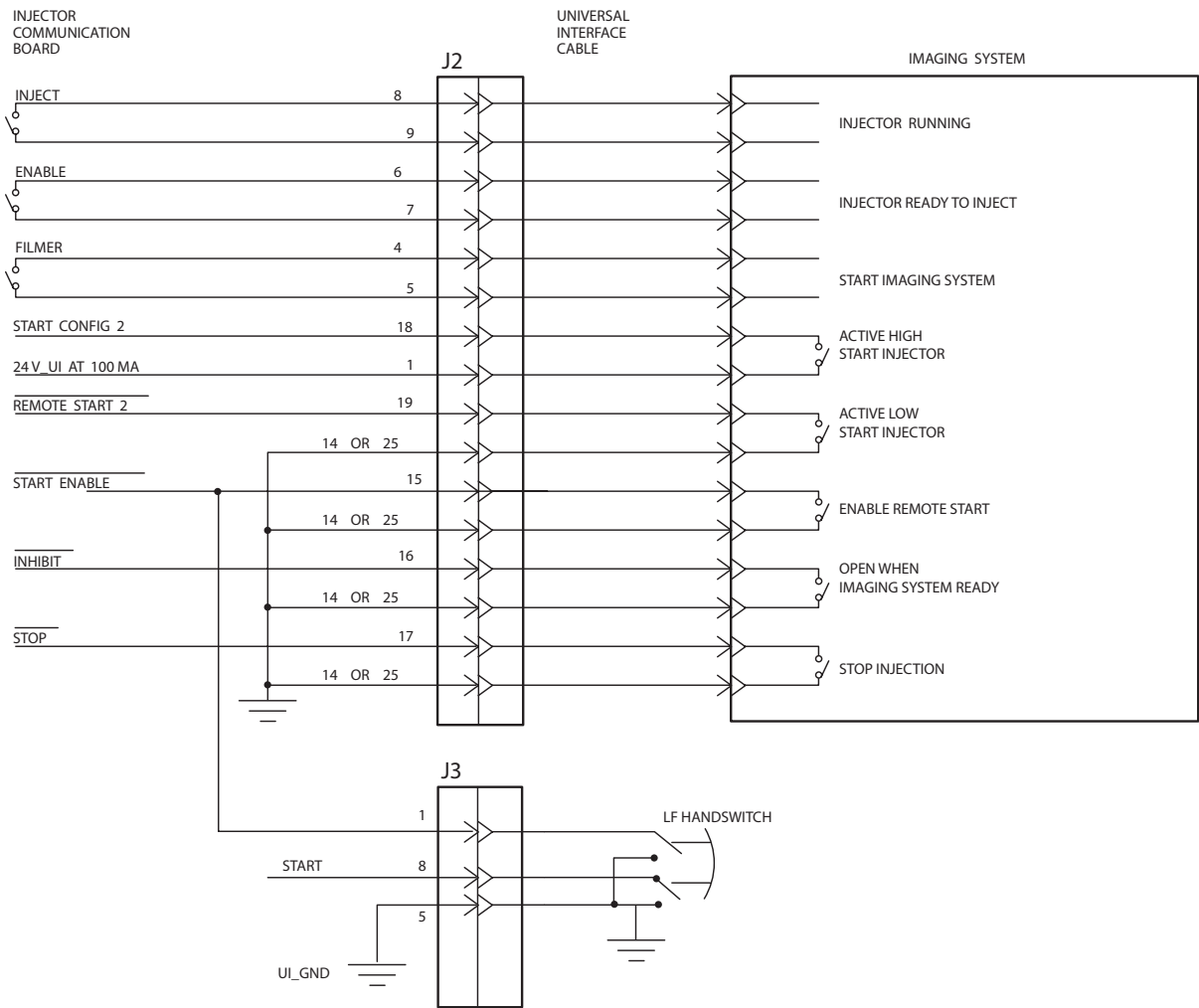


Figure 2-9-1 Standard Universal Interface (UI)

2.9.1.1 Inputs

CAUTION!

When the injector is wired to be started externally, the operator does not have full control of the injector with the standard handswitch. The handswitch may be used to start the injector as normal, but once the external start contacts are closed, the injector's handswitch CANNOT be used to stop the injector. To stop the injection, all start switches must be open, UI_STOP active, or the STOP key depressed on the console. Failure to stop an injection can result in serious patient injury

CAUTION!

The external input functions interfaced to the Angiomat Illumena Contrast Delivery System MUST NOT apply voltage to the corresponding circuits. Only switch contact closures may be provided. Connections other than switch contact closures can cause damage to the equipment and possible injury.

Start Enable

Activated by a relay closure from pin J2:15 to the UI_GND pins J2:14 or J2:25 on the Universal Interface Connector. This function enables the use of the start opto inputs to start an enabled injection. The injector is enabled from the console enable key.

Start Config 2

Activated by a relay closure from pin J2:18 to the 24V_UI supply at pin J2:1 on the Universal Interface Connector. This function starts an enabled injection if START CONFIG 2 and the start enable input circuits are completed as shown in Figure 2-9-1.

Remote Start 2

Activated by a relay closure from pin J2:19 to the UI_GND pins J2:14 or J2:25 on the Universal Interface Connector. This function starts an enabled injection if the REMOTE START 2 and the start enable input circuits are completed as shown in Figure 2-9-1. The injector will stop when the relay opens or the end of injection is reached, whichever occurs first. The exception to this is in CT mode where the injection start latches on and is terminated by either a second start input activation, or the end of injection.

Inhibit

Selectable as active high or active low, this input is activated by a relay closure from pin J2:16 to the UI_GND pins J2:14 or J2:25 on the Universal Interface Connector. This function prevents the start of an enabled injection, or stops a running injection. See section 3-2-40 for active high / active low selection details.

Stop

Activated by a relay closure from pin J2:15 to the UI_GND pins J2:14 or J2:25 on the Universal Interface Connector. This function stops the current injection in process when the circuit is completed as shown in Figure 2-9-1.

2.9.1.2 Outputs

CAUTION!

The output relays are rated for +24VDC at 40 ma maximum. Applying signals in excess of this will cause system damage and possible injury.

CAUTION!

The Angiomat Illumena Contrast Delivery System can supply +24VDC @ 100 ma on pin J2:1 to UI_GND on pins J2:14 or J2:25, on the Universal Interface Connector. To use this feature ensure the maximum current of all external relays being supplied does not exceed 100 ma and do not use any return other than the UI_GND on pins J2:14 or J2:25. Any deviation from this can cause damage to the equipment.

Enable

Relay closure on pins J2:6 to J2:7 of the Universal Interface Connector indicating that the injector has been enabled and is ready to inject.

Inject

Relay closure on pins J2:8 to J2:9 of the Universal Interface Connector indicating that the injector is injecting, except for Configuration #3. When activated in Configuration #12, the Hand Mode, the relay opens and closes simultaneous to the handswitch. The injector determines the mode upon power up as described in the Theory of Operation Chapter 3, Table 3-2-38.

Filmer

Relay closure on pins J2:4 to J2:5 of the Universal Interface Connector. These connections are controlled by the X-Ray Delay timer in the Angiomat Illumena Contrast Delivery System. This programmed delay starts counting down when a valid start condition occurs. The valid start conditions are described in the input section. The relay contacts will close when the delay expires to trigger the imaging system, and open when the start relays are opened.

Sync

Activated in Configuration #14 only, refer to Chapter 3. When Synchronous mode selected from the console the 24V_UI supply is connected to the normally open contact of the Enable relay on J2.

2.9.2 IMAGING SYSTEM INTERFACE CABLES

These cables allow connecting the injector to the imaging system. The universal interface cable is 24 meter cable terminated on the injector side only. Typically this cable will be used for installations requiring the Angiomat Illumena Contrast Delivery System to interface to the imaging system with the following exception.

The exception is if the installation is replacing an existing A6000 or A3000 injector that has already been interfaced to the imaging system. In these cases a universal interface adaptor cable can be used to connect the Angiomat Illumena Contrast Delivery System to the existing LF interface cable.

CAUTION!

Prior to interfacing the Angiomat Illumena Contrast Delivery System to an imaging system, ensure all imaging system inputs and relay/switch outputs are not greater than +24VDC @ 40 ma. See manufacturer's data sheet for I/O specifications before attempting the interface wiring. Some of the older film changers use AC relays which if connected directly to the Angiomat Illumena Contrast Delivery System may cause equipment damage and could result in a hazard causing personal injury or death.

2.9.3 SPECIAL CASE INTERFACES

The Angiomat Illumena Contrast Delivery System can not be directly interfaced to imaging systems that have interfacing signal levels above +24 VDC at 40 ma. Most systems are within this specification, but, some of the older systems use much higher voltage and current levels.

Prior to any interfacing the imaging system signal levels must be verified. Refer to the manufacturers data sheets to obtain this information.

2.9.3.1 High Voltage Signal Interfacing

Interfacing to an imaging system that operates on signal levels greater than +24VDC @ 40 ma requires the following additional hardware supplied by the user.

Injector Output Relay

Relay K1: Single Pole Single Throw - Normally Open.

Relay contacts rated for the imaging system's signal voltage and current.

Coil rated for 24 VDC. See NOTE and EXAMPLE for determining nominal relay coil current.

NOTE: Nominal current must not exceed 100 ma total for all relays connected to the Angiomat Illumena's +24 VDC supply (J2:1).

EXAMPLE: If three relays are supplied the nominal current rating of the coil is calculated as follows.

$I_{coil} = 100 \text{ ma} / \# \text{ of relays} = 100 \text{ ma} / 3 = 33.3 \text{ ma nominal per relay}$

CAUTION!

The +24VDC supply voltage on the Angiomat Illumena Contrast Delivery System's universal interface connector can only supply 100 ma maximum. When selecting relays ensure the total current draw of all relay coils does not exceed 100 ma. Any deviation from this could result in improper operation of the imaging system.

Injector Input Relay

Relay K2: Single Pole Single Throw - Normally Open.

Relay contacts rated for +24VDC at 10 ma.

Coil rated for the imaging systems' control signal voltage and current.

The wiring diagram in Figure 2-9-2 shows the wiring of both input and output signals to the Angiomat Illumena Contrast Delivery System. The inject output relay shown is a representation of all injector output relays. Refer to the Communication Board PCB Schematic in chapter 9 for the pin locations of the desired relay.

The inhibit input relay shown is a representation of all injector input relays except Start Config 2 relay input. To activate Start Config 2, the signal must be connected to the +24VDC on J2:1 through the external relay (K2 in Figure 2-9-2) instead of injector ground on J2:14 or J2:25

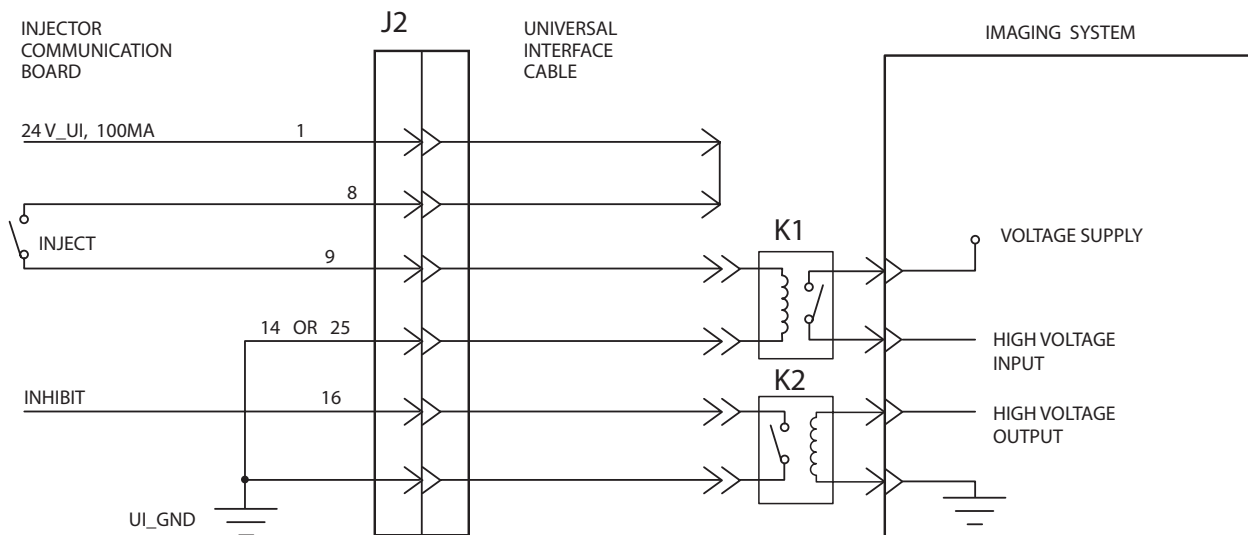


Figure 2-9-2 High Voltage Signal Wiring Diagram

2.9.4 SINGLE CABLE UNIVERSAL INTERFACE (SIEMENS)

CAUTION!

Prior to interfacing the Angioma[®] Illumena Contrast Delivery System to an imaging system, ensure all imaging system inputs and relay/switch outputs are not greater than +24VDC @ 40 ma. See manufacturer's data sheet for I/O specifications before attempting the interface wiring. Some of the older film changers use AC relays which if connected directly to the Angioma[®] Illumena Contrast Delivery System may cause equipment damage and could result in a hazard causing personal injury or death.

The Single Cable Universal Interface (UI) Port in the Angioma[®] Illumena Contrast Delivery System allows you to link the injector to the imaging system or synchronization, control, and to exchange status information. This interface allows the injector and imaging system to trigger each other, and it provides status and control lines between the injector and imaging system. Additionally, the Single Cable Universal Interface provides the mains power to the injector. The following is a summary of the connections possible with the Single Cable Universal Interface. A general wiring diagram is shown in Figure 2-9-3.

NOTE: *The Start Config 2 input relay is the only active high input. To activate Start Config 2 input relay, the signal must be pulled to the +24VDC on P1:8 through the imaging system relay/switch instead of injector ground.*

NOTE: *The Single Cable is jumpered for Configuration #14. Refer to Table 3-23 for details on Configuration #14.*

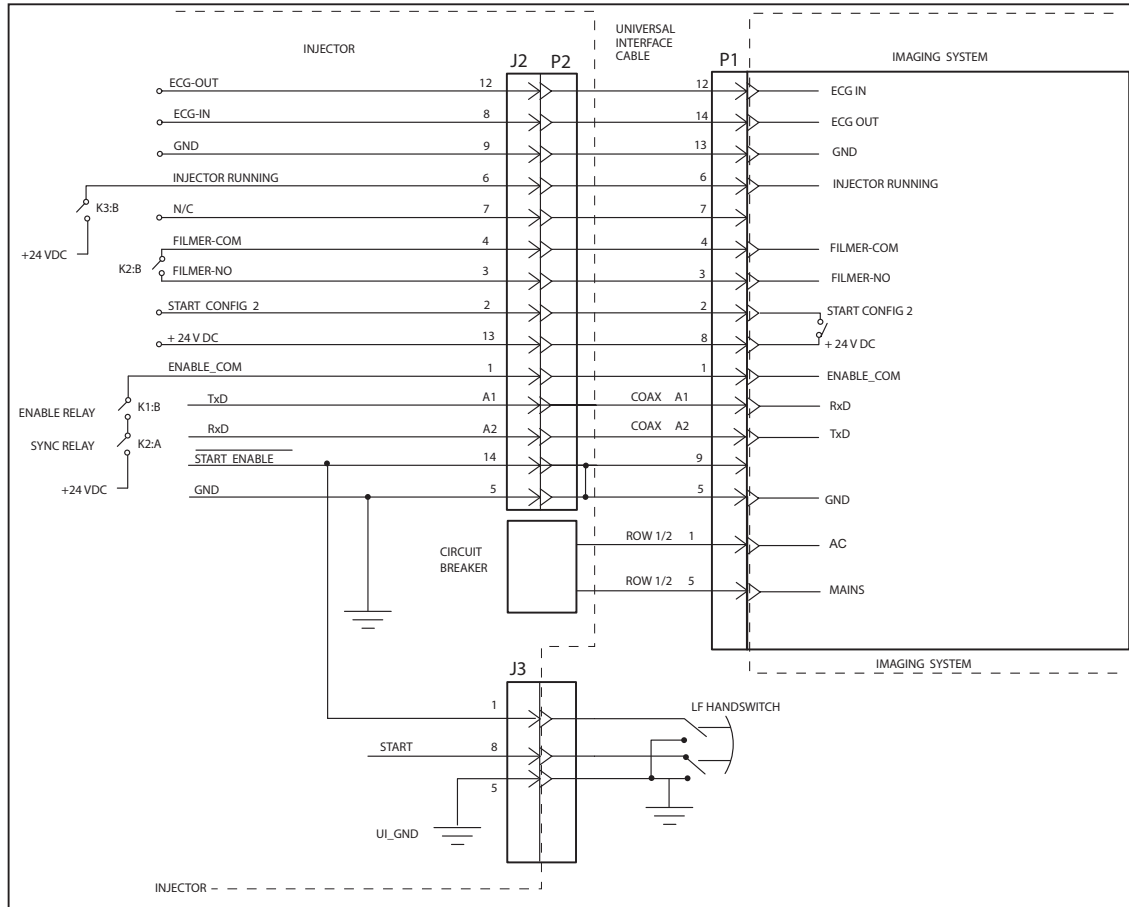


Figure 2-9-3 Single Cable Universal Interface (UI)

2.9.4.1 Inputs

CAUTION!

When the injector is wired to be started externally, the operator does not have full control of the injector with the standard handswitch. The handswitch may be used to start the injector as normal, but once the external start contacts are closed, the injector's handswitch CANNOT be used to stop the injector. To stop the injection, all start switches must be open, or the STOP key depressed on the console. Failure to stop an injection can result in serious patient injury

CAUTION!

The external input functions interfaced to the Angiomat Illumena Contrast Delivery System MUST NOT apply voltage to the corresponding circuits. Only switch contact closures may be provided. Connections other than switch contact closures can cause damage to the equipment and possible injury.

Start Enable

The Start Enable signal is internally tied to ground at J2. This function enables the use of the start opto inputs to start an enabled injection. The injector is enabled from the console enable key.

Start Config 2

Activated by a relay closure from pin P1:2 to P1:8 on the Universal Interface Connector. This function starts an enabled injection.

2.9.4.2 Outputs

CAUTION!

The output relays are rated for +24VDC at 40 ma maximum. Applying signals in excess of this will cause system damage and possible injury

CAUTION!

The Angioma Illumena Contrast Delivery System can supply +24VDC @ 100 ma on pin J2:1 to UI_GND on pins J2:14 or J2:25, on the Universal Interface Connector. To use this feature ensure the maximum current of all external relays being supplied does not exceed 100 ma and do not use any return other than the UI_GND on pins J2:14 or J2:25. Any deviation from this can cause damage to the equipment.

Filmer

Relay closure on pins P1:4 to P1:3 of the Single Cable Universal Interface Connector. These connections are controlled by the X-Ray Delay timer in the Angioma Illumena Contrast Delivery System. This programmed delay starts counting down when a valid start condition occurs. The valid start conditions are described in the input section. The relay contacts will close when the delay expires to trigger the imaging system, and open when the start relays are opened.

Sync

Activated in Configuration #14 only, refer to Chapter 3. When Synchronous mode selected from the console the 24V_UI supply is connected to the normally open contact of the Enable relay on P1.

Enable

When Sync is activated, +24V is present on the enable relay. When the injector is enabled from the console, the enable relay closes and +24V is presented to P1:1. If Sync is not activated, P1:1 is an open circuit.

Injector Running

When the injector is running a programmed injection, Relay K3:B closes and presents +24V to P1:6. Relay K3:B opens when the injection is not running.

2.9.4.3 Mains Power

The Single Cable Universal interface carries the mains power on P1:1 and P1:5, as shown in Figure 2-9-3.

2.10 SYSTEM CHECKS

This procedure checks the performance of the major functions of the Angioma[®] Illumena Contrast Delivery System.

All Angioma[®] Illumena Contrast Delivery System must include a thorough checkout before use.

This checkout is recommended at these times:

- Before using the unit for the first time;
- Included as part of the Preventive Maintenance procedure in Chapter 6.
- If a problem or mis-calibration is suspected;
- After repairs.

Be certain to read through the following steps carefully before performing them. Some steps in this procedure require more than one observation or require a sequence to be timed.

If this procedure cannot be completed or if the Angioma[®] Illumena Contrast Delivery System does not perform as described, stop the checkout and discontinue use of the injector. Call for service.

NOTE: *The tests in this chapter are for the base system only. If any options are installed, complete this section and then proceed to chapter 8 for the options' testing procedures. To check suspension systems, refer to the installation instructions included with the suspension system kit.*

2.10.1 ITEMS REQUIRED

- A stopwatch, or a watch with a digital seconds timer
- An ohmmeter
- A syringe (for the pressure checks)
- LF Pressure Test Fixture (Part Number 900843), consisting of Luer-Lock adapter, gage and valve
- Angioma[®] Illumena Contrast Delivery System Service Checklist

2.10.2 POWER UP CHECK

1. Disconnect all externally interfaced equipment from the injector, remove syringe and close faceplate.
2. Turn on the powerpack breaker and confirm that the switch is illuminated.
3. Turn on the console power switch and observe the screen change from illuminated to the LF logo screen and finally to the main screen. This sequence should take approximately 25 seconds.

CAUTION!

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

CAUTION!

To prevent the possibility of a delayed procedure due to loss of power, the injector must be plugged into a stand-by generator backed power source.

2.10.3 POWERHEAD CHECK

1. The syringe warmer, if connected, should feel warm and the enable/inject indicator light on the upper rear surface of the powerhead turn on then off.
2. Move the ram to the home position, flush with the main frame, using the fill/expel bar. The powerhead display shows the full syringe volume, i.e. 150 ml for the 150 ml syringe holder assembly, and the same values for the programmed volume and flow rate displayed on the console.
3. Rotate the powerhead above then below horizontal. Notice that the orientation of the displayed values change to remain readable.
4. Rotate powerhead so syringe is pointing up.
5. Rotate the fill expel bar to the full forward (i.e., expel) direction and hold until ram stops. The following should occur:
 - The powerhead emits an audible indication, single beep, when the fill/expel bar is rotated off the home (center) position.
 - The ram motion should be smooth and increase in speed as the fill/expel bar rotates.
 - The powerhead display will update the volume remaining during ram motion. The indicator light on the rear of the powerhead will blink at a rate that will increase as ram speed increases.
 - When ram stops fully extended, the volume remaining on the powerhead display will read between 0-1 ml and indicator light is off.

6. Repeat step 5 in the reverse (fill) direction. The additional observation is the detent position that requires additional force to move the fill/expel bar past it. The occurrences should be the same as the forward rotation except for when ram stops fully retracted, the volume remaining on the powerhead display will read the full syringe volume ± 1 ml.
7. Timing with a stop watch, extend the ram from home to fully extended position using the fill bar at maximum speed (fill/expel bar rotated fully forward). The duration is 5 to 7 seconds for the 150 ml syringe and is 4 to 6 seconds for a 125 ml syringe.
8. Time the reverse speed for the duration for ram to travel from fully extended to home. Do this at the optimum fill speed (fill/expel bar rotated to the detent position) and maximum fill speed (fill/expel bar rotated fully backward). The following results are:
 - 150 ml at maximum fill speed is 4-7 seconds
 - 150 ml at detent fill speed is 13-17 seconds
 - 125 ml at maximum fill speed is 4-6 seconds
 - 125 ml at detent fill speed is 11-15 seconds
9. Rotate powerhead so syringe is pointing down at least 30° below horizontal.
10. Timing with a stop watch, extend the ram from home to fully extended position using the fill bar at maximum speed (fill/expel bar rotated fully forward). The duration for the 150 ml syringe is approximately 25 ± 3 seconds and for a 125 ml is 21 ± 3 seconds.
11. Time the reverse speed for the duration for ram to travel from fully extended to home using the fill bar at maximum speed (fill/expel bar rotated fully backward). The duration for the 150 ml syringe is approximately 50 ± 5 seconds and for a 125 ml is 42 ± 4 seconds.

NOTE: *If the above values are out of range, recalibrate the powerhead according to the procedures in Chapter 5. Repeat the powerhead check section above after recalibration is completed.*

2.10.4 CONSOLE CHECK

1. Power up system and allow the injector to initialize. One of the default main screens will be displayed as shown in Figures 2-10-2 through 2-10-5.
2. Press the CONFIGURE SYSTEM key and the screen in Figure 2-10-1 will appear.

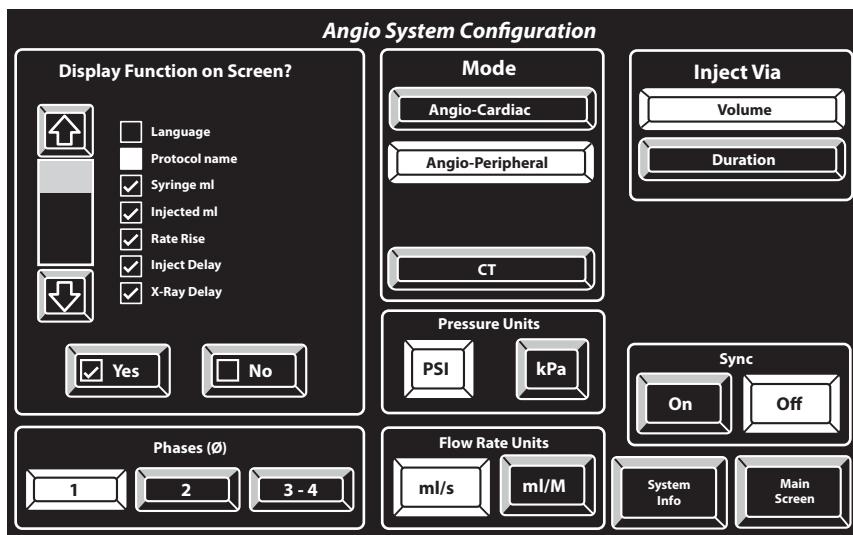


Figure 2-10-1 Configuration Screen

3. Press the ANGIO-CARDIAC mode key and then the SAVE CONFIGURATION key as shown in Figure 2-10-1. The screen in Figure 2-10-2 should appear.

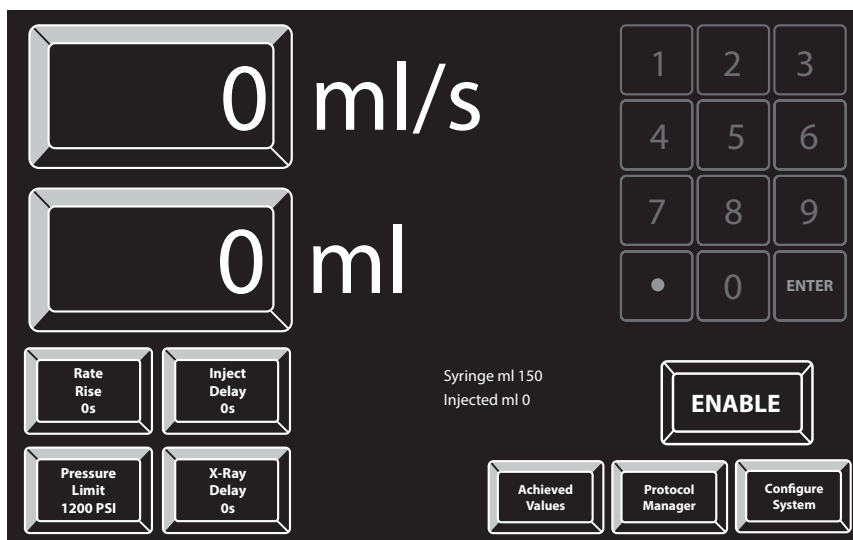


Figure 2-10-2 Angio-Cardiac screen

4. Press the CONFIGURE SYSTEM key shown in Figure 2-10-2 and the screen in Figure 2-10-1 will appear.
5. Press the ANGIO-PERIPHERAL mode key and then the SAVE CONFIGURATION key as shown in Figure 2-10-1. The screen in Figure 2-10-3 should appear.

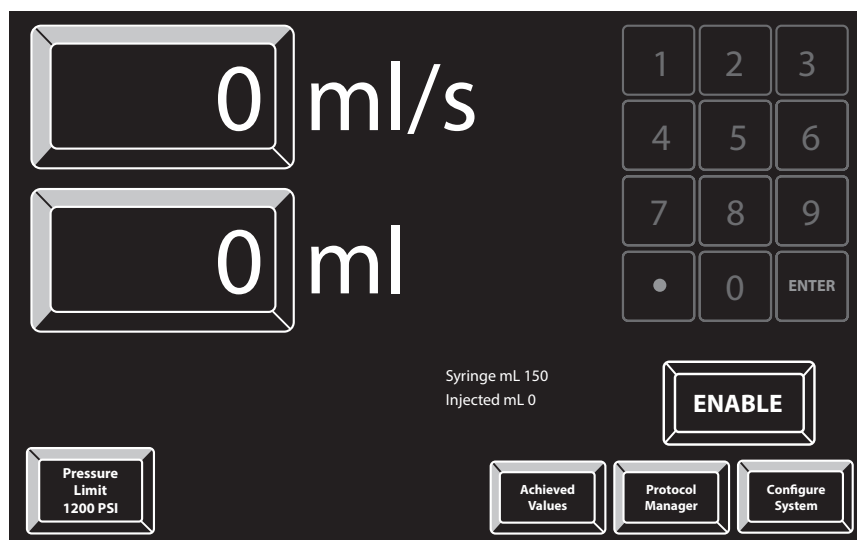


Figure 2-10-3 Angio-Peripheral Screen

6. Press the CONFIGURE SYSTEM key shown in Figure 2-10-3 and the screen shown in Figure 2-10-1 will appear.
7. Press the CT mode key and then the SAVE CONFIGURATION key shown in Figure 2-10-1. The screen shown in Figure 2-10-4 should appear.

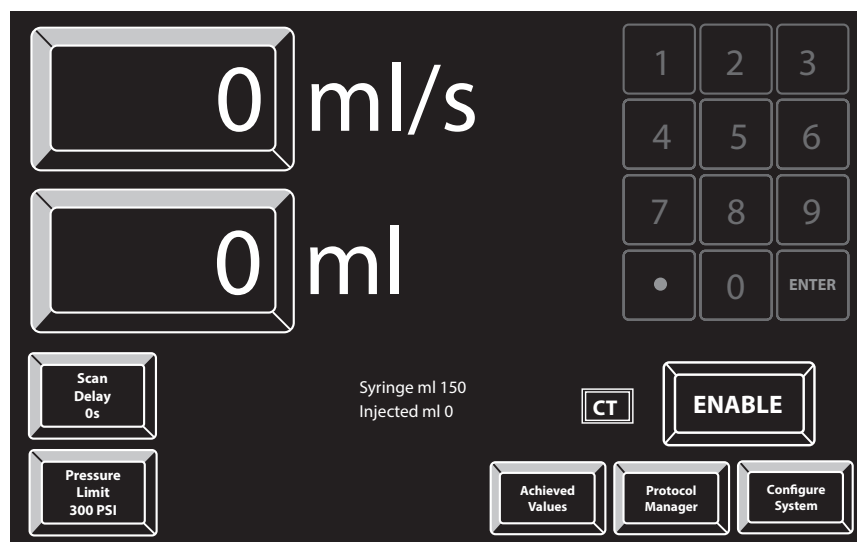


Figure 2-10-4 CT Screen

8. Press the CONFIGURE SYSTEM key as shown in Figure 2-10-4. The screen shown in Figure 2-10-1 will appear.

9. Press the [3-4] key in the Phase window and then the SAVE CONFIGURATION key as shown in Figure 2-10-1. The screen shown in Figure 2-10-5 should appear.

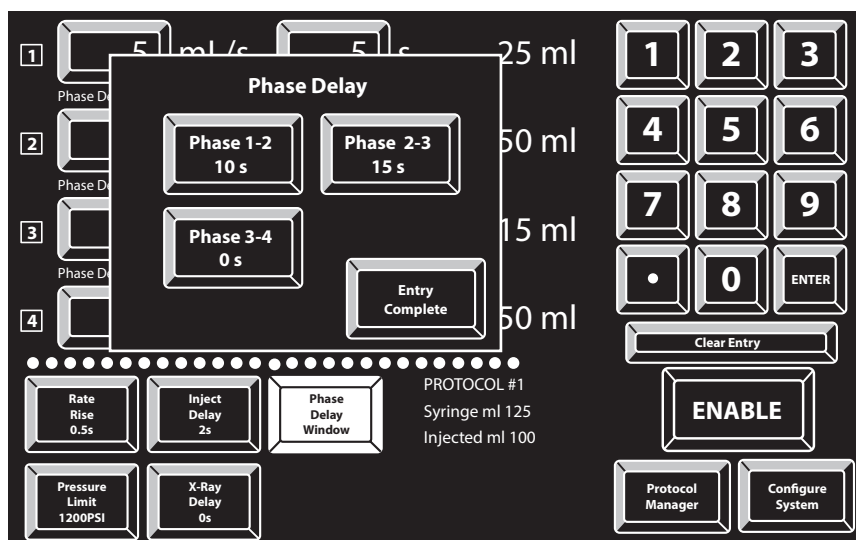


Figure 2-10-5 Multiphasic Screen

10. Press the CONFIGURE SYSTEM key as shown in Figure 2-10-5. The screen shown in Figure 2-10-1 will appear.
11. Press the [1] key in the Phase window and then the ANGIO-PERIPHERAL mode key shown in Figure 2-10-1.
12. Refer to Figure 2-10-1. Move the scroll bar in the Display Function on the Screen window using the up and down arrows. The function highlighted should move up or down with each key press. The scroll bar will move when the top or bottom of the list is reached.
13. Randomly select a set of functions using the YES and NO keys.

NOTE: Only the functions selected with YES will appear on the Angio-Peripheral main screen shown in Figure 2-10-3 when the SAVE CONFIGURATION key is pressed.
14. Press the CONFIGURE SYSTEM key. The screen in Figure 2-10-1 will appear.
15. Press the ANGIO-PERIPHERAL mode key to reset the default functions in the Display Functions window.
16. Change the Pressure units to kPa and Flow Rate units to ml/M. Press the SAVE CONFIGURATION key shown in Figure 2-10-1. The screen shown in Figure 2-10-6 should appear with the new units of measure.

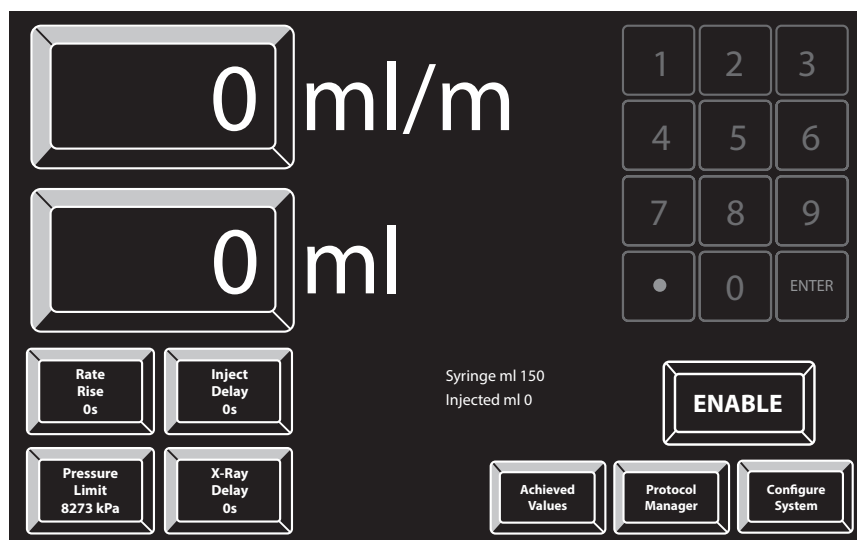


Figure 2-10-6 Updated Angio-Peripheral Screen

17. Press the CONFIGURE SYSTEM key shown in Figure 2-10-6. The screen in Figure 2-10-1 will appear.
18. Reset the Pressure units to PSI and the Flow Rate units to ml/s. Press the SAVE CONFIGURATION key and the original Angio-Peripheral screen, shown in Figure 2-10-3 should appear.

2.10.5 FLOW RATE CHECK

2.10.5.1 ml/s Check

1. Rotate the powerhead with pressure sleeve pointing up and fully retract the plunger. Next, rotate the powerhead to the inject position (i.e., syringe pointing 30° below horizontal).
2. Set flow rate by pressing the Flow Rate Units key shown in Figure 2-10-3. The key and keypad should both be highlighted.
3. Using the keypad select 10.
4. Select the volume by pressing the Volume Units key. The key and keypad should both be highlighted.
5. Using the keypad select 100.
6. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.
7. Press the Start Switch and start timing simultaneously. Stop timing when the ram stops.
8. At the end of the injection, the console should show the following values:

Achieved Flow Rate	10 ml/s $\pm$ 0.5 ml/s
Achieved Volume	100 ml $\pm$ 1 ml
Achieved Pressure	less than 100 PSI
The timed duration:	10 seconds $\pm$ 2 seconds

2.10.5.2 ml/M Check

1. Press CONFIGURE SYSTEM key and change flow rate units to ml/M. Press MAIN SCREEN key.
2. Rotate the powerhead with pressure sleeve pointing up and fully retract the plunger. Next, rotate the powerhead to the inject position (i.e., syringe pointing 30° below horizontal).
3. Set flow rate by pressing the Flow Rate Units key shown in Figure 2-10-3. The key and keypad should both be highlighted.
4. Using the keypad select 40.
5. Select the volume by pressing the Volume Units key. The key and keypad should both be highlighted.
6. Using the keypad select 20.
7. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.
8. Press the Start Switch and start timing simultaneously. Stop timing when the ram stops.
9. At the end of the injection, the console should show these values:

Achieved Flow Rate	39-41 ml/M
Achieved Volume	19-21 ml
Achieved Pressure	less than 100 PSI
The timed duration:	28-32 seconds

2.10.6 INJECTION DELAY AND X-RAY DELAY CHECK

1. Press CONFIGURE SYSTEM key and change flow rate units to ml/s. Press MAIN SCREEN key.
2. Rotate the powerhead with pressure sleeve pointing up and fully retract the plunger. Next, rotate the powerhead to the inject position (i.e., syringe pointing 30° below horizontal).
3. Set flow rate by pressing the Flow Rate Units key shown in Figure 2-10-3. The key and keypad should both be highlighted.
4. Using the keypad select 6.
5. Select the volume by pressing the Volume Units key. The key and keypad should both be highlighted.
6. Using the keypad select 90.
7. Press the INJECT DELAY key. The key and keypad should both highlight.
8. Using the keypad select 15.
9. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.
10. Press and hold the start switch while simultaneously starting a stop watch. The injection should start 14-16 seconds later.
11. Rotate the powerhead with pressure sleeve pointing up and fully retract the plunger. Next, rotate the powerhead to the inject position (i.e., syringe pointing 30° below horizontal).
12. The Filmer relay closure that the x-ray delay controls, can be monitored by two methods.
 - Connecting an ohmmeter to pins 4 and 5 of the Universal Interface Connector (J2 located on the back of the powerpack). This connection should read infinity (open circuit).
 - Open the powerpack cover and use the Filmer relay indicator LED on the Communication Board. The LED should be off. Refer to chapter 4, disassembly and theory of operation sections for cover removal and filmer led location.
13. Press the X-RAY DELAY key. The key and keypad should both highlight.
14. Using the keypad select 15.
15. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.
16. Press the start switch. The meter should continue to read infinity or LED remain off for 14-16 seconds, then the meter should read 0 ohms or LED turn on (closed circuit) until the start switch is released.
17. Set X-RAY DELAY to 0s and press ENTER.

2.10.7 RATE RISE CHECK

1. Rotate the powerhead with pressure sleeve pointing up and fully retract the plunger. Next, rotate the powerhead to the inject position (i.e., syringe pointing 30° below horizontal).
2. Set flow rate by pressing the Flow Rate Units key shown in Figure 2-10-3. The key and keypad should both be highlighted.
3. Using the keypad select 20.
4. Select the volume by pressing the Volume Units key. The key and keypad should both be highlighted.
5. Using the keypad select 100.
6. Press the RATE RISE key. The key and keypad should both highlight.
7. Using the keypad select 6.
8. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.
9. Press and hold the start switch while simultaneously starting a stop watch.
10. The plunger should accelerate for 6 seconds, then continue at a steady rate for 2 more seconds. At the end of the injection, the System Display should show these values:

Achieved Flow Rate	19-21 ml/s
Achieved Volume	98-102 ml
Achieved Pressure	less than 100 PSI
The timed duration:	7.8 - 8.2 seconds
11. Set RATE RISE to 0s and press ENTER.

2.10.8 PRESSURE LIMIT CHECK

1. Install and fill the syringe with water. Attach LF Pressure Test Fixture, P/N 600867, to the syringe.
2. Open valve on gauge assembly.
3. Set parameters to deliver an injection at 20 ml/s, 140 ml volume, 1000 psi.
4. While delivering injection, slowly close valve until a pressure of 750 psi is indicated on the gauge.
5. Refill syringe.
6. Without moving the valve, run the injection again at 750 psi indication. At the end of the injection, the achieved pressure readout in the system display should read approximately 750 psi (+50/- 100 psi).
7. Repeat Steps 3 through 6 adjusting the valve in step 4 for a pressure gauge reading of 1000 psi. At the end of step 6, the achieved pressure readout in the system display should read 1000 psi (+50/- 100 psi) and the Pressure Limit Activated message will appear on the screen after the injection.
8. Retract the plunger. Remove gauge and syringe.

2.10.9 PRE-PROGRAMMED INJECTION CHECKS

1. Enter the following parameters on the Angio-Peripheral screen shown in Figure 2-10-3.

Programmed Flow	10 ml/s
Programmed Volume	20 ml
Pressure Limit	600 PSI

2. To access the Protocol screen, press the PROTOCOL MANAGER key located in the lower right corner of the Main screen. The screen in Figure 2-10-7 will appear with the programmed values in the top window of the screen with the SAVE AS key adjacent to the right side.

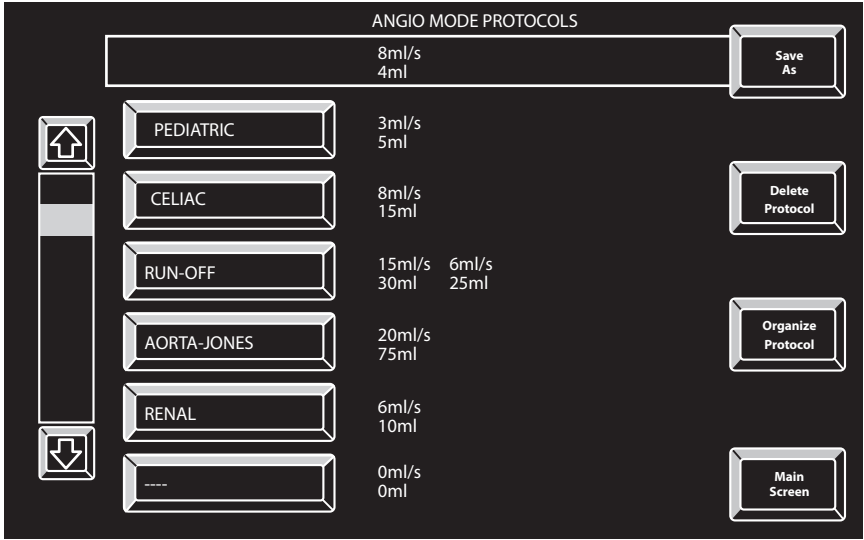


Figure 2-10-7 Protocol Screen

3. To store the parameters under a protocol name, press the SAVE AS key. The screen shown in Figure 2-10-8 allows the operator to enter a 14 character name.

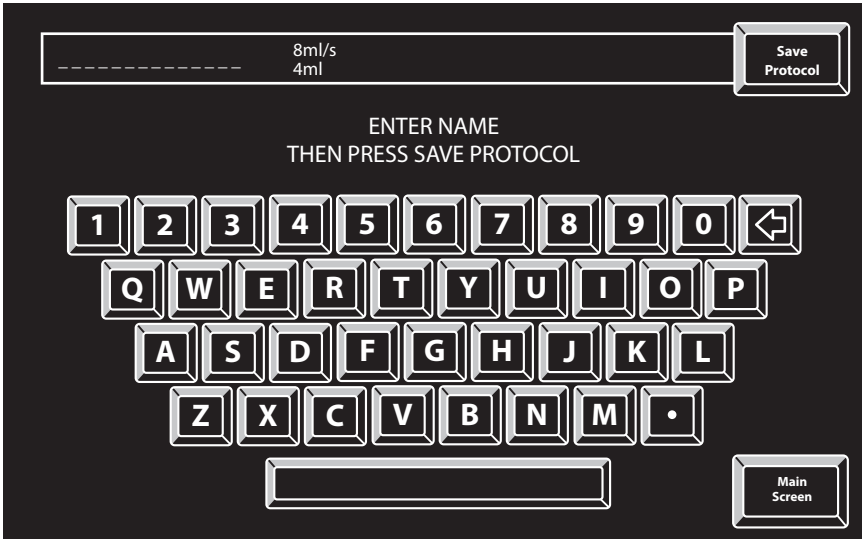


Figure 2-10-8 "Enter Name of Protocol" Screen

4. Using the keyboard, enter the name *Test #1*. If a letter or number has been mistakenly entered, use the key to delete the mistake. When the name has been completely entered, press the SAVE PROTOCOL key to save and return to the protocol screen.

5. The Test #1 protocol should appear in the top window and in the next available slot in the list. If there are many saved protocols it may be necessary to scroll up or down to find Test #1.

6. Press Main Screen key and the screen should display the Test #1 saved injection.

7. Turn unit off. Wait several seconds, then turn on power. After the Power Up and Self Test, Test #1 should appear in the display with the following values for the following parameters:

Programmed Flow	10 ml/s
Programmed Volume	20 ml
Pressure Limit	600 PSI

8. Press ENABLE, then SINGLE INJECTION-ENABLE key. Press the override key on the next several screens until the READY TO INJECT screen appears.

9. Press and hold the start switch while simultaneously starting a stop watch.

10. At the end of the injection, release the remote start switch. The system display should show these values:

Achieved Flow Rate	9.5 -10.5 ml/s
Achieved Volume	19-21 ml
Achieved Pressure	less than 50 PSI
The timed duration:	1.5 - 2.5 seconds

2.11 INSTALLATION KITS

Table 2-11-1 shows a complete list of the instruction sheets provided with each Angiomat Illumena Contrast Delivery System kit.

KIT Part #	Kit Description	Instr. Sheet Part #	Instruction Sheet TITLE	Instruction Sheet DESCRIPTION
900212 900228	Start Ext Assy. 12M Start Ext Assy. 24M	900825	Angiomat Illumena Handswitch Cable Wiring Instructions	Provides a diagram that may be used to wire the Handswitch Cable Assembly.
900681	Console Ceiling Mount	900687	Console Ceiling Mount Bracket Installation Instructions	Describes how to install the console ceiling mount and attach an assembled console with hinge plate.
900680	Console Table Mount	900685	Console Table Rail Mount Installation Instructions	Describes how to install the console table mount.
900606	Power Pack Rack Mount	900821	Electronics Cabinet Rack Mount Installation	Describes how to adapt the Angiomat Illumena electronics cabinet for rack mount installation.
900700	Pedestal Assembly	900837	Angiomat Illumena Pedestal Pre-assembly Instructions	Describes how to pre-assemble the Angiomat Illumena pedestal.
900608	Console Wall Mount	900824	Installation of the Console Wall Mount	Describes how to install the Console Wall Mount.
9896 001 30361	Reusable Syr. Holder Reusable Syringe (Service Only)	900822	Care of Plastic Reusable Syringe	Describes the care of the reusable syringes used with the Angiomat Illumena.
903112 600638S	Long Knob Short Knob	900819	Long and Short Powerhead Mounting Knobs	Helps the user or service person to identify the mounting knob to use for a specific powerhead configuration.
903203 903206 903209 903212 903215 903218 903221 903224 903227 903230	P.H. Cable Ass. 3 M P.H. Cable Ass. 6 M P.H. Cable Ass. 9 M P.H. Cable Ass. 12 M P.H. Cable Ass. 15 M P.H. Cable Ass. 18 M P.H. Cable Ass. 21 M P.H. Cable Ass. 24 M P.H. Cable Ass. 27 M P.H. Cable Ass. 30 M	900826	Powerhead Extension Cable	Describes how to assemble a powerhead extension cable, once the cable has been routed through conduit.

Table 2-11-1. Angiomat Illumena Contrast Delivery System Kits and Instruction Sheets

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3

THEORY OF OPERATION

This chapter describes the design and function of the Angiomat Illumena Contrast Delivery System. Block diagrams for the system are included for each assembly described along with all circuit board input / output signal definitions and connector pinouts.

3.1 SYSTEM OVERVIEW

3.1.1 DESCRIPTION

The drive system of the Angiomat Illumena Contrast Delivery System is controlled by the servo control loop. Communication protocols include RS422 for the sub systems' main processors and RS485 for the PIC processors.

3.1.2 MAJOR CIRCUIT GROUPS

3.1.2.1 Servo Control Loop

The servo control loop controls the motor speed, the resulting injection pressure and volume. The loop also provides the correction values using velocity and pressure feedback. The major components are the powerpack processor, servo controller, servo amplifier, motor with encoder, and the pressure feedback circuit.

The powerpack processor receives the injection parameters from the console and commands the servo controller to move the ram at the specified rate and volume. The servo controller interprets this data and sets the value for the servo amplifier's output to drive the motor. The motor has a quadrature encoder mechanically attached to the motor shaft to provide velocity feedback to the servo controller. The servo controller makes any adjustments to the servo amplifier's output to maintain the programmed injection parameters. The quadrature feedback is also used to determine the volume to deliver. The quadrature pulses are counted by the powerpack's servo processor to calculate the volume being delivered and stop the injector when the programmed value is achieved. The servo amplifier provides the motor drive current along with two feedback signals relating motor current to injection pressure to the pressure feedback circuitry. The feedback circuit sends the pressure to the main processor to evaluate and limit the velocity if necessary so the maximum pressure is not exceeded.

3.1.2.2 PIC (Peripheral Interface Controller) Backup Processor

The PIC redundant processors are used to monitor the system's various states and determine if the main processors are working properly. The powerpack PIC initializes the other three PICs, powerhead, console and auxiliary port. After initialization is complete, the PIC operates in a peer to peer structure. Each PIC compares its current state to the state of its corresponding processor. If at any time a PIC does not agree with its main processor, the system will shut down to prevent patient or operator injury.

3.1.3 BLOCK DIAGRAM

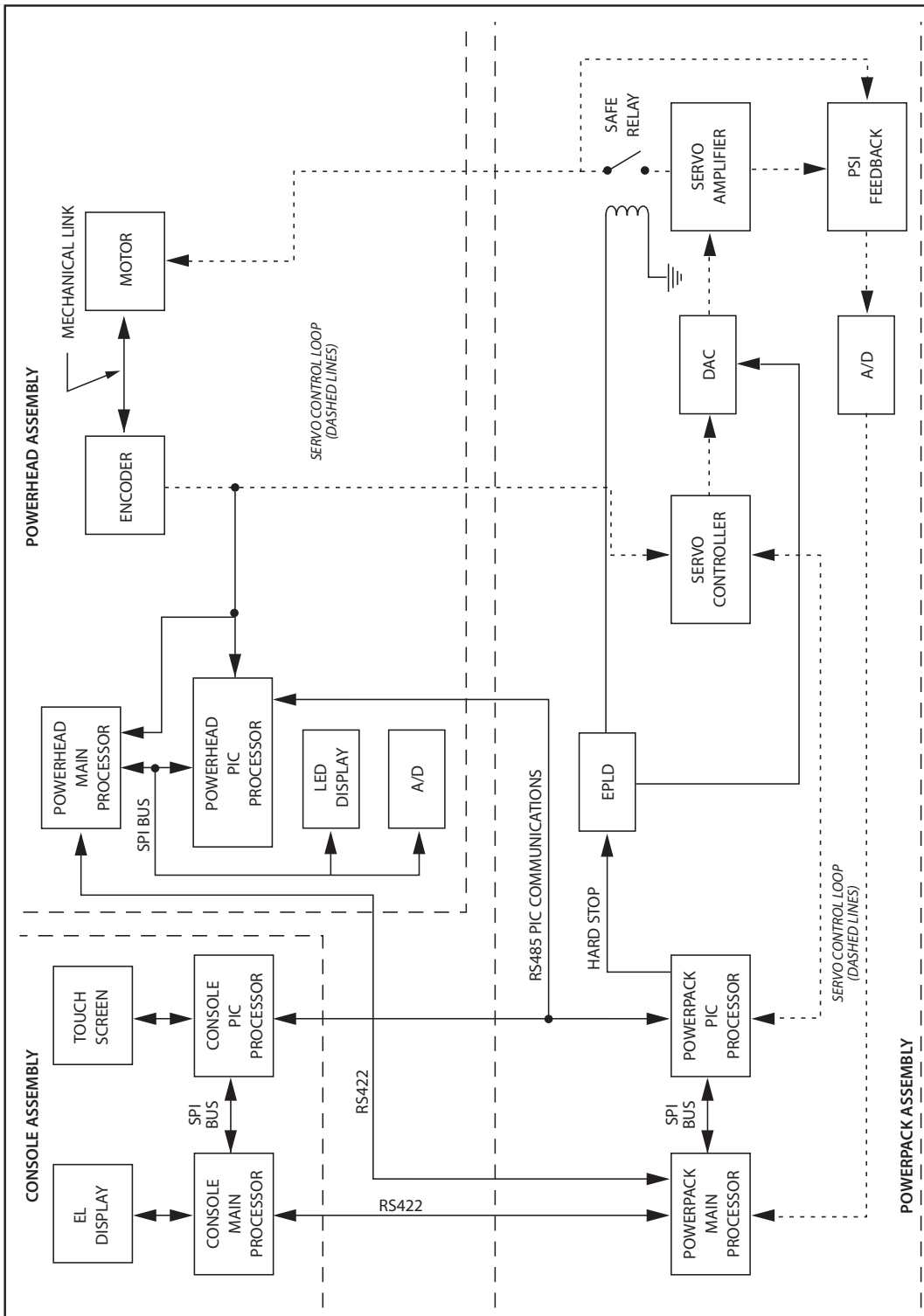


Figure 3-1-1 System Overview Block Diagram

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3.2 POWERPACK OVERVIEW

3.2.1 POWER SUPPLY

3.2.1.1 Functions

- Provides total system logic power, +24VDC at 200 W max.
- Universal AC input.
- Short circuit and output overload protected.
- Medically approved to IEC601-1 Specifications.

3.2.1.2 Inputs and Outputs

This section will define the pinout for each connector on the DC power supply. The pinouts define each signal and its function.

TB1 AC INPUT			
PIN NO	SIGNAL NAME	SIGNAL TYPE	DESCRIPTION
1	LINE	POWER	Line side of AC mains
2	NEUTRAL	POWER	Neutral side of AC mains
3	GROUND	POWER	Chassis ground

Table 3-2-1 Power Supply TB1 AC Input

TB2 DC OUTPUT			
PIN NO	SIGNAL NAME	SIGNAL TYPE	DESCRIPTION
1,2,7,8	24VDC	POWER	+24VDC logic power output
3,4,5,6	GND	POWER	Ground return for +24VDC

Table 3-2-2 Power Supply TB2 DC Output

3.2.1.3 Circuit Descriptions

The DC power supply is a commercially available off-the-shelf medical grade switching power supply. It provides +24VDC output at 7.5A continuous, with +/-2% regulation. The ac input is a single phase, 85-264 VAC, 47-63 Hz. The ac front end is auto adjustable, eliminating the need for manual strapping. The power supply is fully protected against short circuit and output overload. Short circuit protection is a cycling type power limiting with automatic fault recovery. The output is reverse voltage protected up to one times the rated current of the reversed output. The input contains an internal ac fuse. This fuse is designed to blow only if a catastrophic failure of the unit occurs; the fuse will not blow on overload or short circuit.

3.2.1.4 Block Diagram

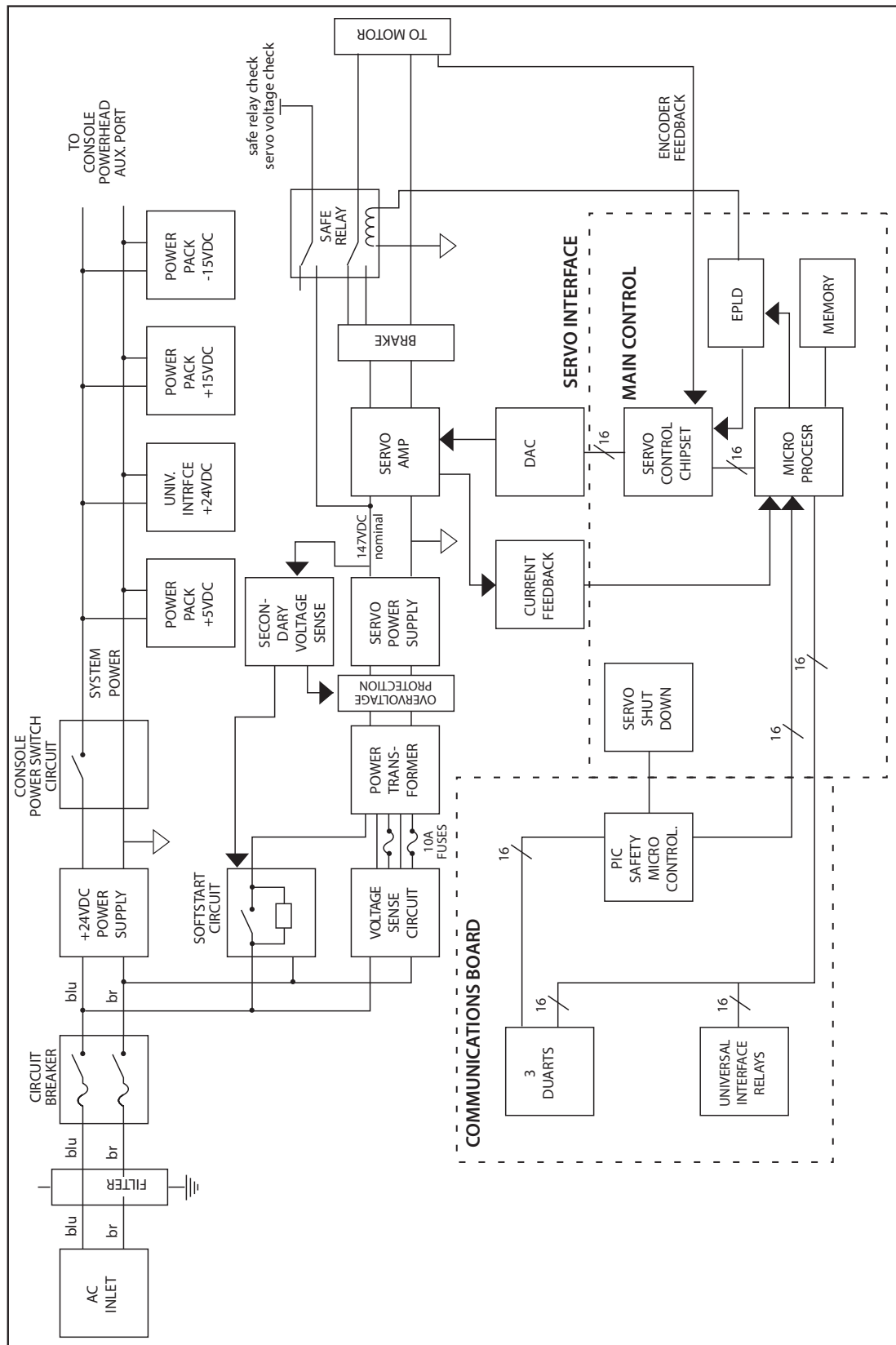


Figure 3-2-1 Powerpack Block Diagram

3.2.2 MAIN CPU BOARD

Refer to Parts Manual and Schematic P/N 901115-2 (RoHS) in Chapter 9.

3.2.2.1 Functions

The main CPU board will provide the following functions:

- Main microprocessor that controls the powerpack systems and subsystems.
- 256K of FLASH memory for program storage.
- 256K of (SRAM) static random access memory.
- 32K of nonvolatile memory for storage of injection protocols, fault history, etc.
- 12-bit A/D converter.
- Programmable logic device (EPLD) which controls much of the servo system I/O.
- Servo control chipset, which is the heart of the servo control system.
- RS422 receiver for quadrature encoder signals from the motor in the powerhead.

3.2.2.2 Inputs and Outputs

This section will define the pinout for each connector on the main CPU board. The pinouts define in detail each signal and its function.

Internal Connectors

Connector J1 is a 10 pin ribbon header that interfaces an emulator or external programming device directly to the microprocessor's BDM (Background Debugging Mode) port. Connectors J2 and J3 are EuroDIN-type connectors that interfaces the main CPU board to the servo interface board. Connectors J4 and J5 are expansion connectors that will allow future daughter cards to be interfaced to the main CPU board. Connector J6 is a 64 pin header that interfaces the main CPU board with the communication board.

J1 BACKGROUND MONITOR PORT

Pin No	Signal Name	Signal Type	Description
1	$\overline{DS}$	OUTPUT	CPU active low data strobe signal.
2	$\overline{BERR}$	OUTPUT	
3	DGND	POWER	System Digital Ground.
4	$\overline{BKPT}$	OUTPUT	
5	DGND	POWER	System Digital Ground.
6	FREEZE	OUTPUT	
7	$\overline{RESET}$	INPUT	System active low reset signal. External devices, such as emulators, can hold the processor in reset.
8	$\overline{IFETCH}$	OUTPUT	
9	+5VDC	POWER	Logic power.
10	$\overline{IPIPE}$	OUTPUT	

Table 3-2-3 Main CPU J1 Background Monitor Port

J2 SERVO INTERFACE

Pin No	Signal Name	Signal Type	Description
6	MUX_SEL_0	OUTPUT	Analog 1 of 8 multiplexer select line.
7	MUX_SEL_1	OUTPUT	Analog 1 of 8 multiplexer select line.
8	MUX_SEL_2	OUTPUT	Analog 1 of 8 multiplexer select line.
11	REMOTE_PWR_UP	OUTPUT	Console power switch signal to sensing and conditioning circuitry for remote power switching.
12	REMOTE_PWR_UP_RET	OUTPUT	Console power switch return to sensing and conditioning circuitry for remote power switching.
17	SAFE_RLY_EN1	OUTPUT	One of two active high signals required to close the safety relay.
19	SAFE_RLY_EN2	OUTPUT	One of two active high signals required to close the safety relay.
20	SERVO_AMP_EN	OUTPUT	Active high signal to enable the servo amplifier.
32	SERVO_STATUS	INPUT	Status line from the servo amplifier, which signifies whether the amplifier is enabled or in a fault condition.
33	ENCODER STATUS	INPUT	Active high signal which signifies whether the encoder signals are functioning correctly in quadrature.
56 57	SERVO_BD_IDL SERVO_BD_IDH	OUTPUT	Active low signals used to latch the servo board ID pattern onto the data bus.
64	R/W	OUTPUT	Read/write signal from main CPU controlling data flow.
65,67, 69,71, 73,75, 77,79	+5VDC	POWER	+5VDC from Servo Interface Board
66,68, 70,72, 74,76, 78,80	DGND	POWER	Digital Ground from Servo Interface Board
81- 96	BD0 - BD15	I/O	Main CPU Data Bus.

Table 3-2-4 Main CPU J2 Servo Interface

J3 SERVO INTERFACE

Pin No	Signal Name	Signal Type	Description
1	R_WAVE_DET	INPUT	R-wave detected pulse from ECG trigger board.
2	MARKER_PULSES	OUTPUT	Marker pulse to be inserted in output ECG waveform on the ECG trigger board.
3	ECG_IN	OUTPUT	ECG input from communications board to ECG trigger board.
4	ECG_OUT	INPUT	ECG signal output from the ECG trigger board, complete with marker pulses, output to the communications board.
5	$\overline{\text{ECG\_ID}}$	INPUT	Active low signal to let the main CPU know whether the ECG trigger board is installed.
6	ECG_CON	INPUT	Analog ECG signal with marker pulses from ECG trigger board to the consoles.
7	ENCODER_A+	INPUT	Differential encoder signal line.
8	ENCODER_A-	INPUT	Differential encoder signal line.
9	ENCODER_B+	INPUT	Differential encoder signal line.
10	ENCODER_B-	INPUT	Differential encoder signal line.
15	AGND	POWER	Analog to digital converter analog ground.
16	ANA_IN	INPUT	Analog input signal from the analog multiplexer to the Analog to Digital Converter.
17	+15VDC	POWER	+15VDC analog power from Servo Interface Board.
18	+15VDC	POWER	+15VDC analog power from Servo Interface Board.
19	-15VDC	POWER	-15VDC analog power from Servo Interface Board.
20	-15VDC	POWER	-15VDC analog power from Servo Interface Board.
24	$\overline{\text{MOTOR\_RUNNING}}$	INPUT	Active low signal to let the PIC microcontroller know that the motor is running.
25	$\overline{\text{SERVO\_DAC\_WR}}$	OUTPUT	Active low signal to latch the data on the DAC bus into the servo DAC.
26	$\overline{\text{RESET\_DAC}}$	OUTPUT	Active low signal to clear the servo DAC and reset its output to zero volts.
27-30, 37-48	DD0-DD15	OUTPUT	Servo Digital to Analog Converter 16 bit data bus.
31	AGND	POWER	Analog to digital converter analog ground.
32	AGND	POWER	Analog to digital converter analog ground.

Table 3-2-5 Main CPU J3 Servo Interface

J4 EXPANSION CONNECTOR 1

Pin No	Signal Name	Signal Type	Description
1	$\overline{\text{CS10}}$	OUTPUT	Active low chip select for future expansion.
2	$\overline{\text{AS}}$	OUTPUT	Active low address strobe for future expansion.
3	PCS0	OUTPUT	SPI bus peripheral chip select 0.
5	PCS2	OUTPUT	SPI bus peripheral chip select 2.
6	PCS3	OUTPUT	SPI bus peripheral chip select 3.
7	$\overline{\text{DS}}$	OUTPUT	Active low data strobe for future expansion.
8	$\overline{\text{R/W}}$	OUTPUT	Read/write signal from main CPU controlling data flow.
9	$\overline{\text{EXP\_IRQ}}$	INPUT	Active low interrupt request signal.
10	$\overline{\text{RESET}}$	OUTPUT	Active low system reset.
11	MISO	INPUT	SPI bus serial data input.
12	MOSI	OUTPUT	SPI bus serial data output.
13	SCK	OUTPUT	SPI bus serial clock.
14	CPU_RXD	INPUT	SCI bus serial data input.
15	CPU_TXD	OUTPUT	SCI bus serial data output.
16	TPU2	OUTPUT	TPU channel from the main CPU.
17	TPU3	OUTPUT	TPU channel from the main CPU.
18	TPU4	OUTPUT	TPU channel from the main CPU.
19	TPU5	OUTPUT	TPU channel from the main CPU.
20	TPU6	OUTPUT	TPU channel from the main CPU.
21,23, 25,27, 29	+5VDC	POWER	+5VDC power from main CPU board.
22,24, 26,28, 30	DGND	POWER	Digital ground to expansion board.

Table 3-2-6 Main CPU J4 Expansion Connector 1

J5 EXPANSION CONNECTOR 2

Pin No	Signal Name	Signal Type	Description
1-16	BD0-BD15	I/O	Main CPU data bus.
17-35	BA0-BA18	I/O	Main CPU address bus.
36-38, 40	DGND	POWER	Digital ground.
39	SYS_CLK	OUTPUT	System 16.78MHz clock.

Table 3-2-7 Main CPU J5 Expansion Connector 2

J6 COMMUNICATION BOARD INTERFACE CONNECTOR

Pin No	Signal Name	Signal Type	Description
1,3, 5,7	+5V	POWER	+5VDC from Main CPU Board.
2,4,6, 8,9	DGND	POWER	Digital Ground from Main CPU Board.
10	Motor_Turning	OUTPUT	Signal from the servo chipset that goes active whenever the motor is turning at a rate greater than about .5 ml/s.
11	Watchdog	OUTPUT	Output of watchdog timer that is used to shut off the interface relays in the event that the watchdog timer times out.
12	PCSI	INPUT	Active low chip select from Main CPU's SPI bus to select the PIC processor, U4.
13	MISO	OUTPUT	Master In Slave Out- Data from PIC processor, U4, to Main CPU
14	MOSI	INPUT	Master Out Slave In- Data from Main CPU to PIC processor, U4.
15	SCK	INPUT	SPI bus clock from Main CPU.
16	-15V	POWER	-15VDC from Main CPU for external ECG Trigger Board
17	+15V	POWER	+15VDC from Main CPU for external ECG Trigger Board
18	MARKER PULSES	INPUT	ECG start and stop marker pulses from the Main CPU to the external ECG Trigger Board at J9. -5vp rectangular wave.
19	HARD STOP	OUTPUT	Active low redundant STOP signal from U4, PIC Processor. Activates if main processor stop fails.
20	STOP	OUTPUT	Active low redundant STOP signal used to back up the stop signal transferred to the Data Bus by the input latch, U44:6.
21	MOTOR RUNNING	INPUT	Active low signal from the Main CPU Board. Used by the PIC processor, U4. Active when the motor is running.
22	R/W	INPUT	Read Write signal from Main CPU controlling data flow.
23	RESET	INPUT	Active low signal from Main CPU. Used to reset DUART's U23, U24, U37, PIC processor, U4, and clear latch, U42.
24	DUART IRQ	OUTPUT	Active low signal to Main CPU from DUART's U23, U24, U37, indicating an event occurred that requires processing.
26	DUART 3	INPUT	Active low signal from the Main CPU. Used to select DUART, U37.
27	DUART 1	INPUT	Active low signal from the Main CPU. Used to select DUART, U23.

Table 3-2-8 J6 Communication Board Interface Connector

J6 COMMUNICATION BOARD INTERFACE CONNECTOR

Pin No	Signal Name	Signal Type	Description
28	DUART 2	INPUT	Active low signal from the Main Board. Used to select DUART U24.
29	INPUT SEL	INPUT	Active low signal from the Main CPU. Activates U44 to transfer the input relays' data to the data bus
30	START IRQ	OUTPUT	Active low signal to the Main CPU. Used to trigger an interrupt in response to any start input.
31	OUTPUT SEL	INPUT	Active low signal from the Main CPU. Activates U42 to latch the data on the data bus to the output relays.
32	R-WAVE DETECT	OUTPUT	R-Wave Detected signal to the Main CPU. +5vp, rectangular waveform indicating the external ECG Trigger Board received an R-Wave.
33	ECG OUT	INPUT	Analog ECG waveform with marker pulses from internal ECG Trigger Board to ECG port J9:7
34	ECG IN	OUTPUT	Analog ECG signal from patient monitor to internal ECG Trigger Board
35,36	REMOTE PWR UP RET, REMOTE PWR UP	OUTPUT	Contact closure from the console on/off switch. Activates the power circuit on the servo interface board
37	ECG CON	INPUT	Analog ECG waveform with marker pulses from internal or external ECG Trigger Board to console J6:20 or J7:20
38	LED2	OUTPUT	See description for pins 42 through 44.
39	SERVO RDY/BSY	INPUT	SERVO READY/BUSY signal from the Main CPU indicates the status of the servo controller to DUART U23 See Servo Interface Board section in this chapter for details.
40	ECG ID	OUTPUT	Active low signal to the Main CPU indicating the ECG port is active.
41	ID SEL	INPUT	Active low signal from the Main CPU. Activates the board ID latches U1 and U2.
42-44	LED5-LED7	OUTPUT	Status indicators on the Main CPU Board from DUART's U23 and U24. Used for troubleshooting. See Main CPU Board section in this chapter for details.
45-48	BA0- BA3	INPUT	Main CPU address bus.
49-64	BD0-BD15	I/O	Main CPU data bus.

Table 3-2-9 Main CPU J6 Communication Board Interface Connector continued

3.2.2.3 Circuit Description

Refer to Parts Manual and Schematic P/N 901115-2 (RoHS) in Chapter 9.

Microprocessor

The main microprocessor, U2, is the Motorola MC68332 CPU. Crystal circuit Y1 and associated resistors and capacitors oscillate at a watch crystal frequency of 32.768 KHz, yielding a clock frequency of 16.78 MHz. System reset is accomplished by U1, which senses VCC and holds the system in reset until VCC is greater than 4.6VDC. Because the microprocessor is not capable of driving many loads, U8, U9 and U10 provide a buffered address bus, capable of driving the various loads in the powerpack. Similarly, U6 and U7 provide a bidirectional buffered data bus. Because speed is important, the memory system is not on the buffered side of the bus. However, the I/O system is buffered. To keep the buffered side of the data bus from crashing into the unbuffered side during memory cycles, U5 is configured as a 5 input AND gate. When any of the chip selects on the input of the AND gates goes active, U6 and U7 are activated to allow data to flow through the buffers. If none of the chip selects are active, the buffers are disabled to allow for local bus activity to take place.

Interrupts occur on the seven available interrupt lines, as well as a few TPU channels being programmed to provide interrupt service for events such as START, or general purpose timing. The highest priority interrupt is IRQ7, which is the non-maskable interrupt. This interrupt is used for the watchdog timer. IRQ6 is the STOP command from the communications board. IRQ5 is the interrupt from the servo control chipset, discussed below. IRQ4 is the interrupt from the three communications DUARTs on the communications board. IRQ3-1 are spare interrupts. Diode D2 ensures that the interrupts power up inactive to allow the microprocessor to come out of reset. The microprocessor will enable the interrupt port after it completes its self test.

On the TPU, TPU channel 1 is the $\overline{\text{START IRQ}}$ from the communications board. Channels 2 and 3 are used internally as timer/counters for software events.

Memory

The powerpack is equipped with one 256 Kx16 FLASH memory device, U15, where the main program is stored. This FLASH device is on-board programmable, eliminating the need for removing and reinstalling an EPROM. U16 and U18 are 128 Kx8 static ram chips. Together, they form 128 Kx16 memory, with the ability to write a byte or a word at a time, and read a word. This is accomplished by using three chip selects to control the enables on the chips. $\overline{CS2}$ controls a word read, where $\overline{CS5}$ controls the writing of the lower byte and $\overline{CS7}$ controls the writing of the upper byte. U19 is a 32Kx8 nonvolatile memory device (NVRAM) that also is the system watchdog timer. The NVRAM is where the protocol storage is located, as well as the service logs and other stored data. The watchdog timer function is part of the system safety system. The CPU resets the timer on a periodic basis to keep the timer from going off. If for some reason the CPU does not reset the timer, the timer will go off and perform a system-wide shutdown of all servo and related functions.

Analog to Digital Converter

U14 is the Analog to Digital Converter (A/D). The A/D takes a variety of analog inputs from the servo interface board's analog multiplexer and converts them to digital for the software to process. U12 and U13 are used to buffer the A/D converter from noise associated with the data bus. When the A/D converter begins to convert the analog signal to digital form, the $\overline{A/D\_BUSY}$ signal goes low. When it is finished converting the data, $\overline{A/D\_BUSY}$ goes high, latching the data on the output of the A/D into latches U12 and U13. The CPU can read the data any time after the latching process is complete. Typical A/D conversion times are 10 us.

Electronically Programmable Logic Device (EPLD)

U3 is an electronically programmable logic device. The device is like an EPROM where it is programmed, but unlike an EPROM, it is not programmed with software code. Instead, it is programmed to emulate hardware devices, such as flip flop, latches, logic gates, etc. The EPLD usage is threefold. First of all, the servo control chipset was designed to interface to an Intel Microprocessor. Therefore the EPLD has logic to convert the Motorola bus signals into signals that the chipset can use. Secondly, the EPLD contains address decoders used to extend the use of the CPU's on-chip chip selects. Many of the devices in the powerpack need only a few bytes of memory space, and since each chip select on the CPU use up 2K of address space at a minimum, $\overline{CS8}$ became a general I/O chip select, with many devices occupying its address space. Thirdly, the EPLD contains control latches for the servo system. All of the control latches are tied to a common reset line which is linked to the system master reset and the output of the watchdog timer. If the master reset goes active at any time, or if the watchdog timer goes off, the servo control latches are cleared, opening the safety relay, disabling the servo amplifier, and clearing the servo digital to analog converter. The EPLD combines all of this functionality into one IC.

Servo Control Chips

U23 and U28 comprise the servo control chip set. U28 of the chipset is a RISC based microprocessor operating at 25 MHz, provided by the clock oscillator Y2. U23 is a custom gate-array that controls the interfacing of the RISC processor with the rest of the system. Quadrature encoder pulses from the motor in the powerhead are received using U17, which is an RS422 differential receiver chip. The encoder signals are fed to U23. The chipset provides complete closed-loop servo control using the encoder position feedback, and outputs the drive signal through latches U26 and U27, which buffer the 16-bit DAC command word. The servo control DAC is located on the Servo Interface Board. Included in the chipset is a PID filter to control the servo. Command and control of the servo chipset is provided on the address and data bus. Communications to and from the chipset is in the form of commands. Each command generates a checksum, which is checked in the software. The main CPU can not only command the servo to perform motor movement, it can also poll the chipset while it is operation to gauge the performance of the servo, as well as having the chipset interrupt the main CPU on IRQ5 for immediate attention of certain conditions, such as end of programmed profile, or servo fault, etc. The servo chipset also monitors the encoder. `MOTOR_TURNING` status will show high activity when the motor is turning faster than the preset threshold. .

Status LEDs

There are eight status LEDs, DS1-DS8, on the main CPU board. Four of the LEDs are controlled from the CPU and four are controlled from one of the output ports on a DUART on the communications board. Currently, error codes are displayed in hexadecimal patterns on the LEDs, with DS1 being the most significant digit, and DS8 being the least. In normal operation, DS1 flashes at about a 1 second rate, controlled by software. This status "heartbeat" is a quick visual indicator that the software is running.

3.2.2.4 Block Diagram

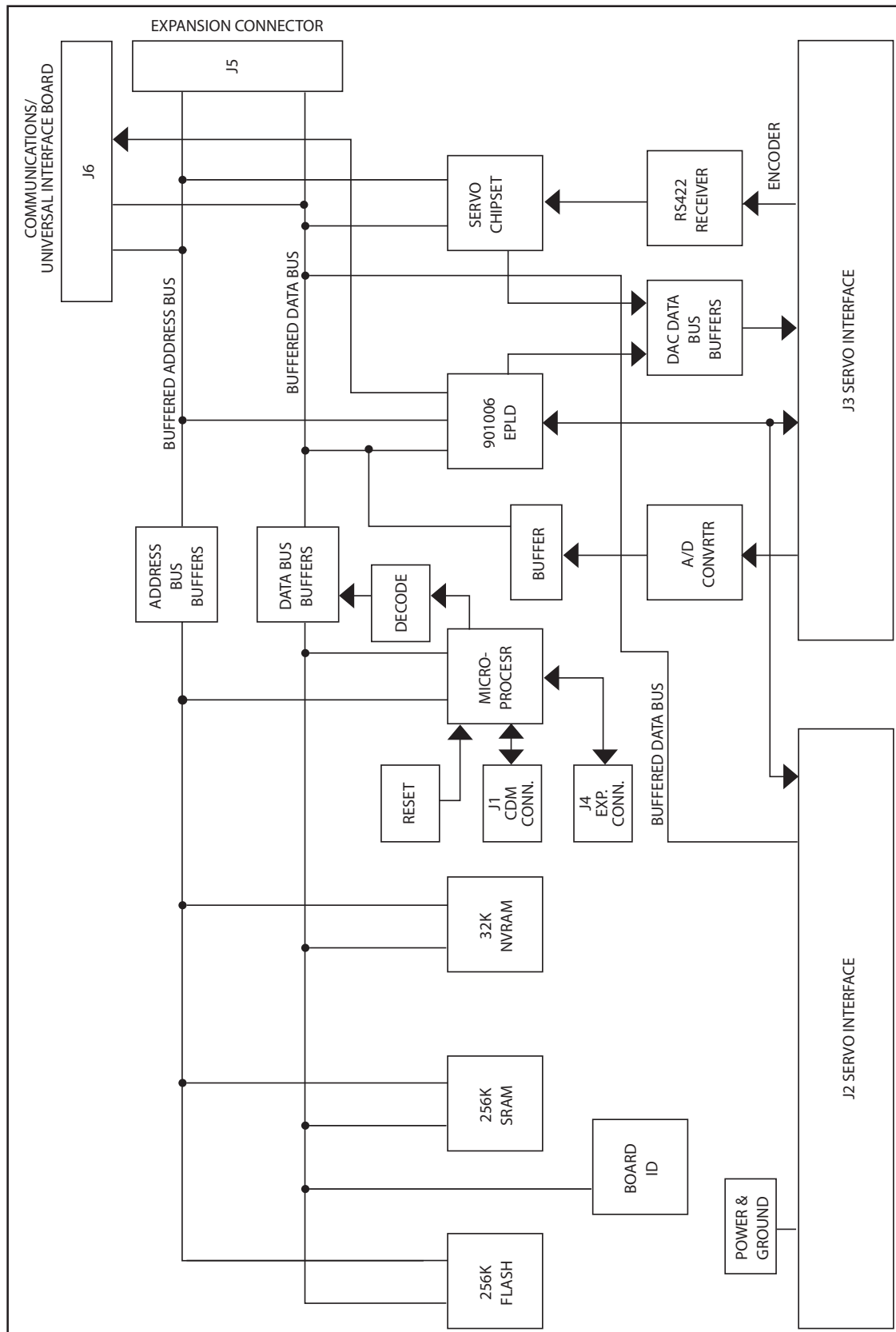


Figure 3-2-10 Main CPU Board Block Diagram 1

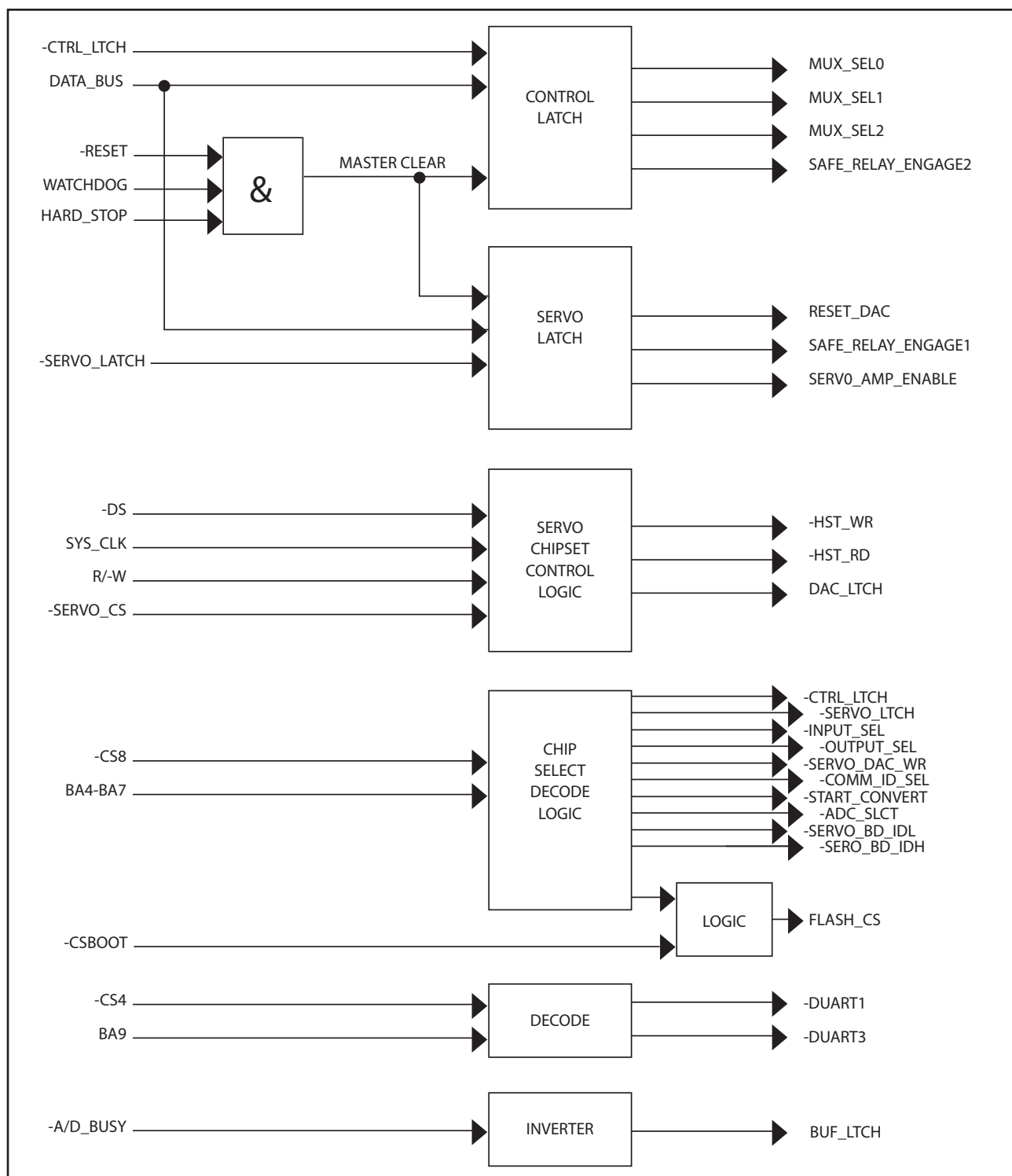


Figure 3-2-11 Main CPU Board Block Diagram 2

3.2.3 SERVO INTERFACE BOARD

Refer to Schematic P/N 901095-2 in Chapter 9.

3.2.3.1 Functions

The servo interface board will provide the following functions:

- Logic power.
- Console power switch sensing and switching.
- Servo power supply.
- Pressure monitoring.
- Safety relay and brake.
- A/D multiplexer and servo D/A.
- Encoder fault detection.
- Safety shutdown circuit.

3.2.3.2 Inputs and Outputs

This section will define the pinout for each connector on the servo interface board. The pinouts define in detail each signal and its function.

Internal Connectors

Connector J1 connects the servo amplifier motor output to the servo interface board. J2 is the main AC power input to the servo power supply. J3 connects the dc logic power supply to the board. J4 and J5 are EuroDIN-type connectors that allow the main control board to plug directly into the servo interface board. J6 is the motor output connector that goes to the powerhead. J7 is the power/encoder connector for the powerhead. J8 is the universal interface power connector. J9 allows an ECG trigger board to be plugged directly into the board. J10 is the servo amplifier's signal connector. J11 is the power supply output to the universal interface board. J12 is where the primary winding of the power/isolation transformer plugs into. J13 is for the secondary of the transformer. J14 is the output of the servo power supply to the servo amplifier. J15 is the fan connector.

External Connectors

There are no external connectors on the servo interface board.

J1 MOTOR INPUT FROM SERVO AMPLIFIER

Pin No	Signal Name	Signal Type	Description
1	MOTOR+	INPUT	Motor+ line from servo amplifier.
2	MOTOR-	INPUT	Motor- line from servo amplifier.

Table 3-2-10 Servo J1 Motor Input from Servo Amplifier

J2 AC MAINS INPUT

Pin No	Signal Name	Signal Type	Description
1	LINE	POWER	AC line voltage.
2	NO CONNECT		
3	NEUTRAL	POWER	AC neutral wire.

Table 3-2-11 Servo J2 AC Mains Input

J3 DC POWER SUPPLY

Pin No	Signal Name	Signal Type	Description
1,2	+24VDC	POWER	24VDC logic power.
3,4	COMMON	POWER	System ground.

Table 3-2-12 Servo J3 DC Power Supply

J4 MAIN CONTROL BOARD

Pin No	Signal Name	Signal Type	Description
6	MUX_SEL_0	INPUT	Analog 1 of 8 multiplexer select line.
7	MUX_SEL_1	INPUT	Analog 1 of 8 multiplexer select line.
8	MUX_SEL_2	INPUT	Analog 1 of 8 multiplexer select line.
11	REMOTE_PW_UP	INPUT	Console power switch signal to sensing and conditioning circuitry for remote power switching.
12	REMOTE_PWR_RET	INPUT	Console power switch return to sensing and conditioning circuitry for remote power switching.
17	SAFE_RLY_EN_1	INPUT	One of two active high signals required to close the safety relay.
19	SAFE_RLY_EN_2	INPUT	One of two active high signals required to close the safety relay.
20	SERVO_AMP_EN	INPUT	Active high signal to enable the servo amplifier.
32	SERVO_STATUS	OUTPUT	Status line from the servo amplifier, which signifies whether the amplifier is enabled or in a fault condition.
33	ENCODER_STATUS	OUTPUT	Status line from the Decoder Fault Detection Circuit. Operating properly when signal is high.
56	SERVO_BD_IDL	INPUT	Active low servo board identification and configuration select for the low byte of the configuration word.
57	SERVO_BD_IDH	INPUT	Active low servo board identification and configuration select for the high byte of the configuration word.
64	R/W	INPUT	Read/write signal from main CPU controllin data flow.
65,67, 69,71, 73,75, 77,79	+5VDC	POWER	+5VDC to main control board.
66,68, 70,72, 74,76, 78,80	DGND	POWER	Digital Ground to main control board.
81-96	BD0-BD15	I/O	Main CPU Data Bus.
1-5, 9, 10, 13-16, 18, 21-31, 33-55, 58-63	NO CONNECT		

Table 3-2-13 Servo J4 Main Control Board

J5 MAIN CONTROL BOARD

Pin No	Signal Name	Signal Type	Description
1	R_WAVE_DET	OUTPUT	R-wave detected pulse from ECG trigger board.
2	MARKER_PULSES	INPUT	Marker pulse to be inserted input ECG waveform on the Ecg trigger board.
3	ECG_IN	INPUT	ECG input from communications board to ECG trigger board.
4	ECG_OUT	OUTPUT	ECG signal output from the ECG trigger board, complete with marker pulses, output to the communications board.
5	ECG_ID	OUTPUT	Active low signal to let the main CPU know whether the ECG trigger board is installed.
6	ECG_CON	OUTPUT	Analog ECG signal with marker pulses from ECG trigger board to the consoles.
7	ENCODER_A+	OUTPUT	Differential encoder signal line.
8	ENCODER_A-	OUTPUT	Differential encoder signal line.
9	ENCODER_B+	OUTPUT	Differential encoder signal line.
10	ENCODER_B-	OUTPUT	Differential encoder signal line.
16	TO_ADC	OUTPUT	Analog output signal from the analog multiplexer to the Analog to Digital Converter.
17,18	+15VDC	POWER	+15VDC analog power.
19,20	-15VDC	POWER	-15VDC analog power.
24	MOTOR_RUNNING	OUTPUT	Active low signal to let the PIC microcontroller know that the motor is running.
25	SERVO_DAC_WR	INPUT	Active low signal to latch the data on the DAC bus into the servo DAC.
26	RESET_DAC	INPUT	Active low signal to clear the servo DAC and reset its output to zero volts.
27-30, 37-48	DD0-DD15	INPUT	Servo Digital to Analog Converter 16 bit data bus.
15,31, 32	AGND	POWER	Analog to digital converter analog ground.
11-14, 21-23 33-36	NO CONNECT		

Table 3-2-14 Servo J5 Main Control Board

J6 MOTOR CONNECTOR TO POWERHEAD

Pin No	Signal Name	Signal Type	Description
1,4	MOTOR1	OUTPUT	Positive motor connection.
3,6	MOTOR-	OUTPUT	Negative motor connection.
2,5	NO CONNECT		

*Table 3-2-15 Servo J6 Motor Connector to Powerhead***J7 POWERHEAD POWER AND ENCODER**

Pin No	Signal Name	Signal Type	Description
1	+24VDC	POWER	Fused +24VDC power to powerhead
2	DGND	POWER	Digital ground to powerhead.
3	CDNG	POWER	Chassis ground for powerhead.
4	ENCODER_A+	INPUT	Encoder channel A+ differential input
5	ENCODER_A-	INPUT	Encoder channel A- differential input.
6	ENCODER_B+	INPUT	Encoder channel B+ differential input.
7	ENCODER_B-	INPUT	Encoder channel B- differential input.
8	NO CONNECT	INPUT	

*Table 3-2-16 Servo J7 Powerhead Power and Encoder***J8 UNIVERSAL INTERFACE/COMMUNICATIONS POWER**

Pin No	Signal Name	Signal Type	Description
1-6	DGND	POWER	Digital ground.
7-10	+24VDC_C	POWER	Console +24VDC power.
11,12	+24VDC	POWER	+24VDC power

*Table 3-2-17 Servo J8 Universal Interface
Communications Power*

J10 SERVO AMPLIFIER SIGNAL

Pin No	Signal Name	Signal Type	Description
4	SERVO_DAC_OUT	OUTPUT	Analog -10VDC to +10VDC output of servo digital to analog converter to drive amplifier.
8	SERVO_I_MON	INPUT	Analog voltage of approximately 2.85 A/V. This signal is proportional to the current being drawn by the motor.
11	AMP_ENABLE	OUTPUT	Active low enabled signal which allows the amplifier to connect the output transistors to the motor.
14	SERVO_STATUS	INPUT	Status signal of amplifier. TTL high level indicates a disabled amplifier or fault condition, while a TTL low level indicates that the amplifier is enabled and operational.
2,5 12,13	DGND	POWER	Digital ground.
1,3 6,7, 9,10, 15,16	NO CONNECT		

*Table 3-2-19 Servo J10 Servo Amplifier Signal***J11 UNIVERSAL INTERFACE +24VDC**

Pin No	Signal Name	Signal Type	Description
1	+24VDC ISOLATED	POWER	+24VDC power for universal interface.
2	DGND	POWER	Ground for universal interface.

*Table 3-2-20 Servo J11 Universal Interface +24VDC***J12 POWER TRANSFORMER PRIMARY COILS**

Pin No	Signal Name	Signal Type	Description
1	110	POWER	110 side of lower coil.
2	0	POWER	0 side of upper coil.
3	110	POWER	110 side of upper coil.
4	0	POWER	0 side of lower coil.
5	TC	POWER	Connection to thermal cutout.

Table 3-2-21 Servo J12 Power Transformer Primary Coils

J13 POWER TRANSFORMER SECONDARY COILS

Pin No	Signal Name	Signal Type	Description
1	100	POWER	100 side of secondary coil.
2	0	POWER	0 side of secondary coil.

*Table 3-2-22 Servo J13 Power Transformer Secondary Coils***J14 AMPLIFIER POWER**

Pin No	Signal Name	Signal Type	Description
1	AMPLIFIER_ POWER	POWER	
2,3,4	PGND	POWER	

*Table 3-2-23 Servo J14 Amplifier Power***J15 FAN**

Pin No	Signal Name	Signal Type	Description
1	+24VDC	POWER	+24VDC power for fan.
2	PGND	POWER	Digital ground.

Table 3-2-24 J15 Fan Connector

3.2.3.3 Circuit Descriptions(PCB P/N 901095-1, Schematic P/N 901095-2)

Refer to Parts Manual and Schematic P/N 901095-2 in Chapter 9.

Logic Power

The powerpack and other subsystems derive their working logic voltages from the main logic +24VDC power supply. Main power enters the board on J3. The +24VDC is down-regulated to three working voltages for the powerpack: +5VDC, +15VDC and -15VDC. +5VDC is derived by U5, a switching regulator module. C11, C17 and C22 are bulk and bypass capacitors, while D24 provides over voltage protection on regulator start-up. +24VDC is also fed into U6 to derive +15VDC and -15VDC. U6 is also a switching regulator. C12, C14, and C20 provide bulk and bypass capacitance for the regulator, while D2 provides over voltage protection. DS3, DS4 and DS9 are indicator LEDs for each voltage derived on the board.

Console Power Switch Sensing And Switching

When the main circuit breaker on the front panel is switched on, power is applied to the logic switching power supply to provide all of the “non-switched” power to the board. However, the system remains off until the push-push membrane power switch is pressed on the console. The circuit consisting of U13, U4, U9, K1, and K2 provide remote sensing, filtering and switching of the voltages to the powerpack and to the rest of the system. +24VDC is fed to the console through the voltage divider R46 and R47. Switch SW1 provides a local power switch which mimics the console power switch. When the switch (either console or SW1) is pressed, the signal REMOTE_POWER_UP is pulled low. It is filtered through the 2-pole butterworth filter to filter out switch bounce and spurious noise. The filter is made of U13, R48, R68, C25, C26 and R69. The output of the filter is fed through the comparator circuit U13. R74 and R77 provide approximately 3 volts of reference for U13. When the filter output exceeds 3V, the output of U13 goes high. This will turn on the gate of Q7 which will pull down the clock input of U4, a J-K flip-flop set up as a toggle flip-flop. When U4 sees a falling edge, the output toggles, turning on the gates of Q9 and Q10. This allows current to flow through K1 and K2's coils, closing the contacts and providing +24VDC to the system, and +5 and +/-15VDC to the powerpack. The entire sensing circuit derives its power from D4 and D23. D4 provides 5.6VDC to U9. It is tapped off through one diode drop of D23 to provide 5VDC to the sensing circuit.

K1 and K2 power up off (relaxed) when the circuit breaker is switched on because of the power-on reset circuit made up of U24. R30 and C23 provide a timed delay on power up to the power up reset chip U24. When U24 pin 2 is less than 4.6V, U24 pin 1 is low, keeping U4 cleared and K1 and K2 off and open. When U24 pin 2 is greater than 4.6V, U24 pin 1 goes high, allowing U4 to operate. U4 is now cleared and ready for the console power switch (or SW1) to be pressed.

Servo Power Supply

The servo power supply provides power to the servo amplifier to run the motor. The power supply outputs approximately 147VDC, which is unregulated. The servo amplifier compensates for the unregulated supply, and can handle relatively high amounts of ripple.

The servo power supply is made up of four main sections: 110/220VAC voltage detection, soft start, secondary power, and over voltage protection.

AC mains power enters the servo interface board through J2.

The transformer has two primary coils, with each primary coil protected by fuses F5 and F6 respectively. When the ac mains voltage is in the 120 volt range, the primary coils are in parallel to each other to generate the secondary output voltage of about 103VAC. When the ac mains voltage is in the 240 volt range, the primary coils are in series with each other to generate the secondary voltage of about 103VAC. This switching is accomplished by the primary coil configuration circuit. AC mains voltage is applied across step-down transformer T2 at a 230:28 ratio. T2 is protected by fuse F7. The secondary of T2 is applied across bridge rectifier D15, which is protected by thermistor RT1. D15 and C49 provide a working voltage to the sensing circuit. The dc voltage from D15 is divided by R40 and R34 to provide a threshold voltage to under-voltage detector U21. When the input to U21 is less than 4.6VDC, the output pin 1 of U21 sinks current. When the input to U21 is greater than 4.6VDC, the output is off. When the ac mains voltage is less than approximately 135 Vrms, the input to U21 is below 4.6 volts and the output is sinking current. This turns the base of Q12 on. When Q12 turns on, voltage from the voltage divider R41, R66, and R67 is applied to the base of Q14, turning it on. Q14 turns on relay K5, which switches the primary coils of the main power transformer. The default relaxed position of K5 is to configure the transformer for 220 volt (coils in series) operation. This is to ensure that if the coil configuration circuit fails at 110 volts, the secondary voltage will be half of the total voltage because the coils are in series instead of in parallel. Also, if the circuit fails at 220 volts, the coils are already configured for 220 volt operation. If the relaxed position was the parallel mode, a failure could double the voltage at 220 volts, causing an over-voltage condition. A turn-on delay to the relay is accomplished by R103, R104, C6 and Q17. After the voltage on C6 rises above the gate threshold voltage of Q17, Q17 turns on to let Q14 turn on. The reason for the delay is to ensure that K5 is held relaxed until the input voltage has reached equilibrium, and to keep K5 from momentarily switching as the input voltage rises to 220 volts. Q2 and D29 discharge C6 when the main circuit breaker is switched off to ensure that a fast switching off then on of the circuit breaker won't force K5 into the wrong state.

Soft start is accomplished by fuse F2, thermistor RT2 and resistor R101. When the capacitor voltage across C46, C47 and C48 exceeds 80VDC, the solid state relay K4 switches on. These components limit the inrush current, when capacitors C46, C47, and C48 are discharged. If fuse F2 opens, there will be no secondary voltage to turn on K4, keeping the secondary power supply off.

Secondary power is provided by bridge rectifier D14 and capacitors C46, C47 and C48. This provides the power to the servo amplifier, nominally 147VDC. When the capacitor voltage rises above about 80VDC, the voltage across resistors R76, R120, R121, R37 and R38 is high enough to turn on relay K4. These resistors form a voltage divider. This voltage divider is also used to sense an over voltage condition. If the voltage on U22 pin 2 is greater than 4.6VDC (when AMPLIFIER_POWER voltage is greater than about 180VDC), U22 pin 1 turns off, allowing the voltage from R26 to be applied to U19 pin 1. U19 is an optically isolated triac driver that controls the over voltage crowbar triac Q13. When U19 turns on, the secondary voltage is routed through the triac and R125 and R126. This forward biases the gate of triac Q13, which shorts the secondary winding. This will blow fuses F5 and F6 in an over voltage condition. Under normal voltage conditions, U22 is turned on, sinking the voltage away from R26, keeping the crowbar inactive.

Pressure Monitoring

The microprocessor utilizes the current feedback from the motor to determine how much apparent pressure is being generated in the syringe. The theory is that the more current the motor needs for a given flow rate, the more pressure is being built up in the syringe. The microprocessor also looks at the commanded torque that the servo chipset is generating to also determine how much pressure is there. The current feedback comes directly from the servo amplifier current feedback pin. The fuses F14, F15, and the over voltage protection devices D26 and D27 are used to protect the system if the servo amplifier has a catastrophic failure. The current feedback from the amplifier is scaled to output 2.85 volts for every ampere generated at the amplifier's output to the motor. Since the motor can run in two directions, it must be ensured that the output of the monitoring circuit cannot go negative. The circuit made up of U2 is a conditioning circuit that scales the output and clamps the output to a positive signal. The current feedback signal is summed with the 2.5VDC reference signal at the input to U2A. This, along with the feedback resistor R12, force the no current signal to output -1VDC at pin 1. U2B is a unity gain inverter to ensure that the output at pin 7 to the A/D converter multiplexer is positive. The gain of U2A changes the 2.85A/V feedback signal to a 1A/V signal at the output of U2B. This makes the range of current feedback use more of the operational range of the A/D converter, since the motor will never use more than 9A of current. D28 is a clamp to ensure that the signal does not go negative. C51 is a noise filter to help filter out spurious noise spikes.

The microprocessor uses the motor torque feedback from the servo chipset on the main control board as a primary pressure limit feedback. The motor is torque limited, meaning that the servo chipset will not let the servo amplifier generate any more than an allowable amount of torque for a given pressure and flow rate. The current feedback is really the secondary pressure monitor/limit circuit. The microprocessor compares the current feedback to ensure that the current feedback agrees with the torque feedback. If it appears that the motor is putting out too much torque due to some problem with the amplifier, the microprocessor can sense this with the current feedback, and take action to limit the pressure or shut down if necessary.

Safety Relay And Brake

The safety relay, K3, when closed, allows current to flow to the motor. The relay was sized to open an inductive load operating up to 10 amps. It has a built-in arc suppression magnet to ensure that the relay will open under the most severe loads without contact welding. The relay has contacts in a 2 form C configuration. One set of contacts is used to test the relay closure and the other set of contacts is used to switch the motor between the amplifier and the brake.

Amplifier power, approximately 147VDC, is fed to pin 4 of the safety relay. Pin 8 is the normally closed pin of this contact. Pin 6, the normally open pin of this contact is connected to the voltage divider of R116, R27, R28 and R29. This divides the voltage down to about 7.5VDC, which is fed to the A/D converter to be read by the microprocessor. During hardware testing by the software, the microprocessor reads the voltage on pin 6 while the relay is open and closed. This way, it is assured that the relay can close and open under microprocessor control.

The second contact is the amplifier/brake contact. When the relay is open, pin 7 connects the motor pin, pin 3, to the top of the dynamic brake. When the microprocessor wants to run the motor, K3 is closed, connecting pin 3 to pin 5, which is the output of the LC filter from the amplifier.

The brake is made up of the triac Q1 and resistor R1. When the safety relay is open, the triac is connected across the motor and the amplifier is out of the circuit. If the motor is turning, it is generating a voltage, the back-EMF, which is across Q1 when the relay is open. R1 acts as a threshold resistor, such that when the current on the gate exceeds approximately 300 mA, the triac turns on and “shorts” out the motor, dynamically braking it. The brake is most effective in the motor reverse direction, which is the fill direction. It would be most effective if, under a sudden stop condition, the relay opened to remove power from the motor. If the syringe is under high pressure, it would tend to try to drive the motor backward to relieve the pressure. When the motor started moving backward, the brake would turn on, limiting its motion.

The relay is switched under microprocessor control using Q2 and Q3. The microprocessor has two independent control lines available. Both Q2 and Q3 have to be on in order for K3 to close. The microprocessor can test the integrity of Q2 and Q3 by turning them on one at a time to see if the relay closes. If only one transistor is on and the relay closes, the other transistor must be on also, indicating either a shorted transistor or a problem in the control of that transistor. DS1 and DS2 are indicators for each transistor. When Q2 is on under microprocessor control, DS1 will be illuminated. When Q3 is on, DS2 will be illuminated.

Diode D1 is a snubber for K3. It keeps high reverse voltages from occurring during relay operation.

A/D Multiplexer And Servo D/A

Analog feedback to the microprocessor is accomplished by using an analog to digital (A/D) converter. The powerpack has a 12 bit A/D converter located on the main control board. The A/D converter is a single channel converter which can operate with input voltages ranging from 0 to 10V. Since there are several analog sources of interest to the microprocessor, an analog multiplexer is used to allow the microprocessor to switch between up to 8 analog channels. U8 is an 8 channel analog multiplexer which operates off of +/- 15 VDC. The channels are switched using a binary decode on pins 9, 10 and 11. Since U8 is a CMOS part, its switching thresholds for pins 4 - 6 are different than for the select signals coming from the microprocessor. Therefore, the level translation circuit made up of Q5, Q6 and Q8 is used to allow the microprocessor's 0 - 5 volt swing to switch the multiplexer's 0 - 15 volt inputs. During level translation, inversion of the signals occur, i.e. when MUX_SEL_0 goes high, Q5 turns on, and select line A goes low. Resistors R73, R79 and R85 are current limiting resistors for the transistors.

Of the 8 channels available, 6 are in use at this time, with two channels reserved if needed in the future.

- Multiplexer channels 0 and 1:
Channels 0 and 1 are the +24VDC output of K1 and K2 respectively. The voltages are divided down by resistors R81, R83, R89 and R90 to approximately 7.5VDC. The microprocessor can use these channels to ensure that K1 and K2 closed properly and that the logic power supply is putting out the correct voltage for proper operation.
- Multiplexer channels 2:
Channel 2 is the pressure monitor output of the circuit made up of U2. The microprocessor reads this channel during an injection to monitor the apparent pressure in the syringe, which is analogous to the current in the motor. The microprocessor reads this channel during the enable sequence to capture the zero current offset of the channel before the motor begins to run. This value is added to or subtracted from the current readings to give a zero offset reading to the pressure monitor software.
- Multiplexer channels 3 and 4:
These channels are currently pulled to zero volts by R122 and R127 and are reserved for future use.
- Multiplexer channels 5:
This channel is the relay check signal from voltage divider R27, R28 and R29. The servo amplifier voltage of approximately 147VDC is divided to about 7.5VDC for reading by the A/D converter. The voltage has to be within approximately 10 percent of 147VDC for the microprocessor to allow the motor to run.
- Multiplexer channels 6:
This channel is the output of the servo DAC. The servo DAC can output a voltage that can swing from +10VDC to -10VDC. However, the A/D converter can only accept voltages from 0 to +10VDC. Therefore, the input to the A/D converter is clamped to positive voltage by D17. R33 limits the load on the output of the servo DAC. To allow the multiplexer to behave accurately around 0 volts input, the VEE line is pulled to approximately -1.5VDC through voltage divider R107 and R115.

- Multiplexer channels 7:

This channel is the precision reference. D5 is a precision reference IC that outputs 2.5VDC. The microprocessor reads this channel to ensure that the multiplexer and A/D converter are working correctly. Also, since D5 is a precision reference, the microprocessor can determine how much offset is in the multiplexer and A/D converter. This offset is added to or subtracted from all readings from the A/D converter.

The output of the multiplexer is fed through a unity gain buffer U14. U14 buffers the input impedance of the A/D converter from the loads making up each signal. If the buffer was not there, the input impedance of the A/D converter would act like a voltage divider with any resistors in the signal path, thus giving inaccurate readings.

The servo D/A converter is a 16 bit, bipolar converter whose output drives the servo amplifier directly. The input data bus is driven directly by the servo control chipset located on the main control board. The control signals SERVO_DAC_WR and RESET_DAC are controlled by the main servo latch on the main control board. The most significant bit, D15 on the DAC is inverted by U12 to match the binary code of the DAC to the binary code of the servo control chipset.

Encoder Fault Detection

The encoder fault detection circuit detects when the encoder feedback has a fault, such as an open wire or broken driver. The encoder has two channels, channel A and channel B, which operate in quadrature, that the servo controller uses to derive position, velocity, and direction of the motor. Two channels are sent from the motor encoder to the powerpack in a differential mode, via RS422. RS422 signals are also differential, meaning one signal has two signal lines, a "+" line and a "-" line. When the "+" and "-" lines are received, a differential receiver uses both lines to reconstruct the signal, and the differential nature of the signal greatly increases noise immunity. The very nature of differential lines means that the "+" and the "-" signal lines are opposite in polarity. If the "+" line is high and the "-" line is high, it could mean that one or both lines are open. This is detected using the exclusive "OR" gate U18. As long as the differential lines are different, the output of U18 remains high. If both of the differential lines are the same, the output of U18 goes low, causing the output of U17A to go high. R15 and C37 act as a low pass filter to filter out spurious noise. U17B and U17C make up an SR flip-flop that powers up with "Q" low, turning on Q 18 and DS12. If a fault is detected with U17A going high, U12F inverts it and causes the flip-flop to switch states. DS12 will turn off and "Q" will go high. The output of U17C, "Q" controls the gates of Q15 and Q16. These are series transistor FETs that have to be on in order for the safety relay to engage and the servo amplifier to enable. During operation, if an encoder fault is detected, Q15 and Q16 will turn off, opening the safety relay and disabling the servo amplifier. R17, C3 and U23 offer a time delayed reset to the flip-flop to ensure that the circuit is in the correct state on power-up. The only way to recover from the circuit detecting a bad encoder is to cycle power on the machine once the problem is fixed. Once the circuit latches off, it cannot be reset without cycling power.

Safety Shutdown Circuit

On the communications board resides a backup safety micro controller, called a PIC. One of the PIC's duties is to monitor the state of the injector for unsafe conditions, such as the motor running when it is not supposed to. The PIC can monitor whether there is current flowing to the motor by using the circuit made up of D10 - D13, U3, U17 and U1. The motor output of the servo amplifier is current limited with R11 and R13. It is then rectified using the full wave bridge D10, D11, D12, and D13. A full wave bridge is required because the motor polarity can be reversed. The output of the bridge is applied to the opto-gate U3. When no signal is present at the input resistors because the amplifier is disabled, the output of the opto-gate is high, causing the output of the inverter U17D to be low which allows counter U1 to count at the frequency generated by R8, R10 and C2. When a motor signal of 500 ns or greater is detected at the bridge rectifier, the output of U3 goes low, which, when inverted makes the master reset input to U1 go high. The internal counter of U1 is reset and the MOTOR_RUNNING signal is asserted for approximately 10 ms for each input pulse detected. The MOTOR_RUNNING signal is sent to the PIC, which analyses the state of the machine. If the motor is detected running when it is not supposed to be, the PIC can override all hardware and shut down all motor signals. The PIC also uses the MOTOR_TURNING signal from the servo control chipset on the main control board to detect motor motion.

3.2.3.4 Block Diagram

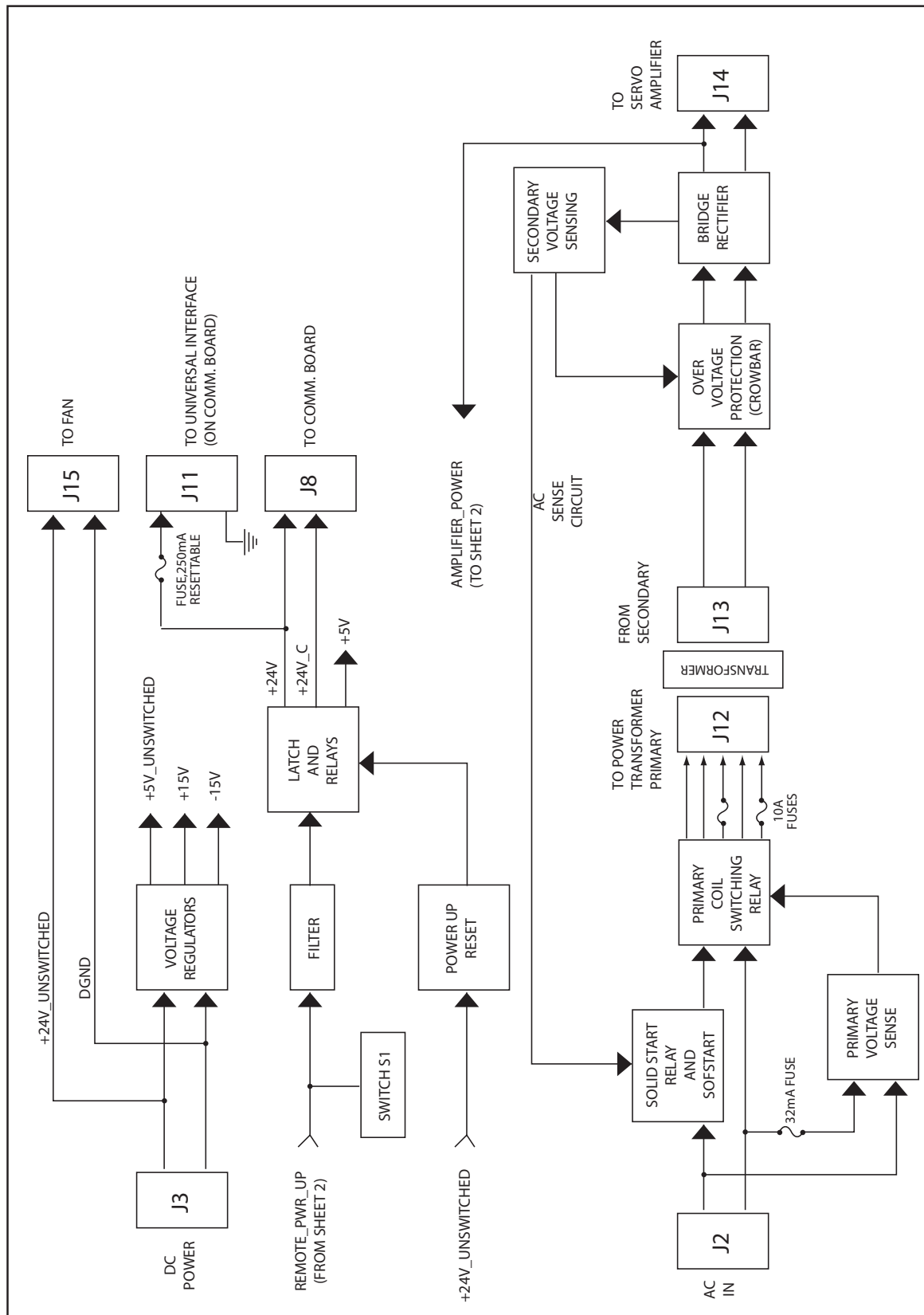


Figure 3-2-4 Servo Interface Board Block Diagram 1/2

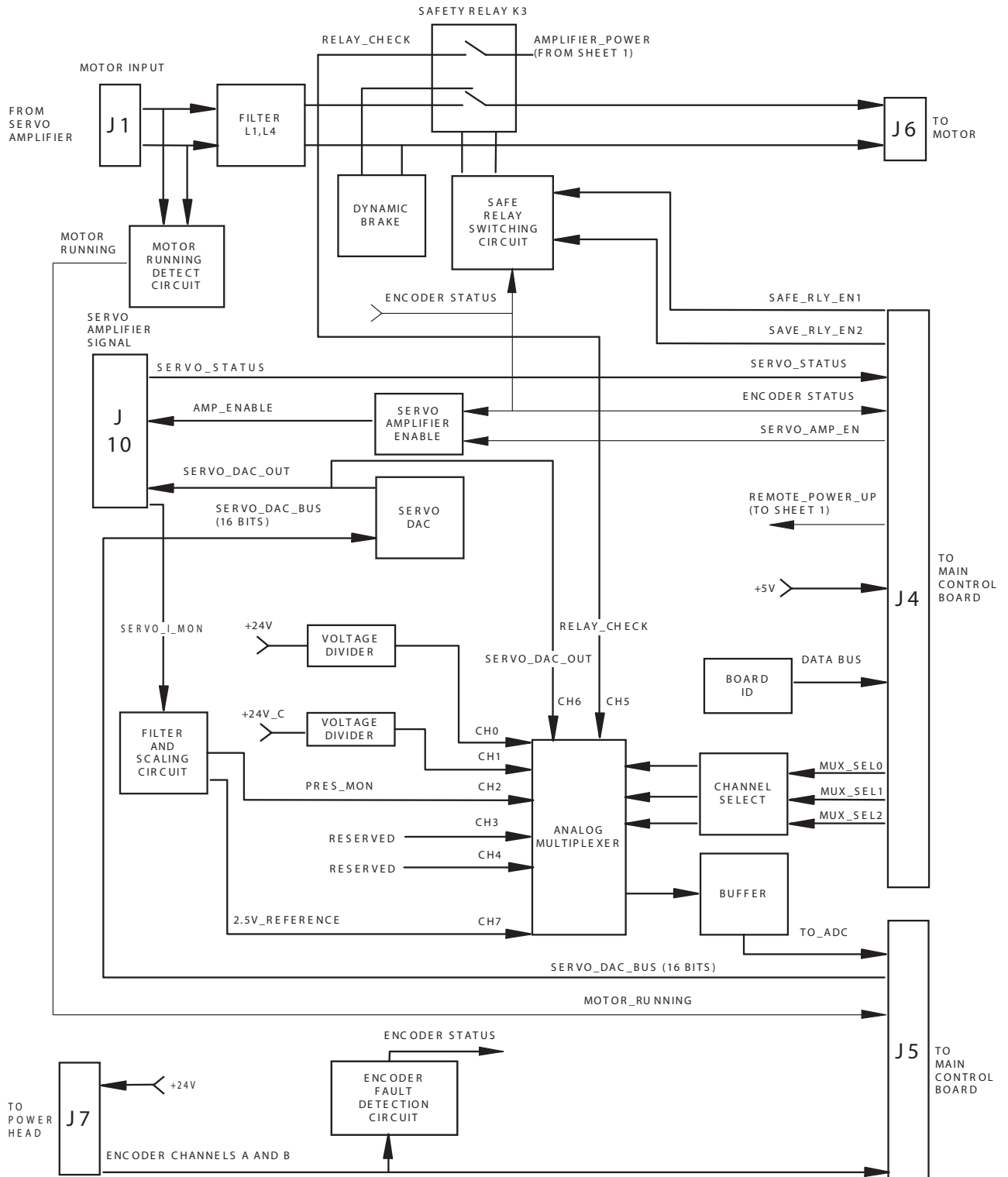


Figure 3-2-5 Servo Interface Board Block Diagram 2/2

3.2.4 COMMUNICATION BOARD

Refer to Parts Manual and Schematic P/N 901107-2 in Chapter 9.

3.2.4.1 Functions

The communication board will provide the following functions:

- Simple I/O interface to allow exchange of control between the injector and the x-ray system (opto-coupled relay inputs and outputs).
- Remote start handswitch port.
- The PIC redundant processor for the powerpack, and associated PIC communications hardware.

3.2.4.2 Inputs and Outputs

This section will define the pin out for each connector on the communication board. The pin outs define in detail each signal and its function.

Internal Connectors

Connector J1 is a 64 pin header that interfaces the communication board to the main CPU board. Data and address lines, logic power, +/- 15V supply and control signals all reside here. Connectors J10 and J11 provide power for the consoles, auxiliary port and input relays K4:B through K10:B. Connector J12 provides the powerhead communications.

External Connectors

The D-shell connectors J2 and J6 provide interfacing to all external devices, handswitch and consoles. These connectors are located on the back panel of the powerpack.

J1 MAIN CPU BOARD INTERFACE CONNECTOR

Pin No	Signal Name	Signal Type	Description
1,3,5,7	+5V	POWER	+5VDC from Main CPU Board.
2,4,6,8,9	DGND	POWER	Digital ground from Main CPU Board.
10	MOTOR_TURNING	OUTPUT	Signal from the servo chipset that goes active whenever the motor is turning at a rate greater than about .5ml/s
11	Watchdog	OUTPUT	Output of watchdog timer that is used to shut off the interface relays in the event that the watchdog timer times out.
12	PCSI	INPUT	Active low chip select from Main CPU's SPI bus to select the PIC processor, U4.
13	MISO	OUTPUT	MASTER IN SLAVE OUT- Data from PIC processor, U4, to Main CPU
14	MOSI	INPUT	MASTER OUT SLAVE IN- Data from Main CPU to PIC processor, U4.
15	SCK	INPUT	SPI bus clock rom Main CPU.
16	-15V	POWER	-15VDC from Main CPU for external ECG Trigger board.
17	+15V	POWER	+15VDC from Main CPU for external ECG Trigger board.
18	MARKER_PULSES	INPUT	ECG start and stop marker pulses from the Main CPU to the external ECG Trigger Board at J9. -5vp rectangular wave.
19	HARD_STOP	OUTPUT	Active low redundant STOP signal from U4, PIC Processor. Activates if main processor stop fails.
20	STOP	OUTPUT	Active low redundant STOP signal used to back up the stop signal transferred to the Data Bus by the input latch, U44:6.
21	MOTOR RUNNING	INPUT	Active low signal from the Main CPU Board. Used by the PIC processor, U4. Active when the motor is running.
22	R/W	INPUT	Read Write signal from Main CPU controlling data flow.
23	RESET	INPUT	Active low signal from Main CPU. Used to reset DUART's U23, U24, U37, PIC processor, U4, and clear latch, U42.
24	IRQ4	OUTPUT	Active low signal to Main CPU from DUART's U23, U24, U37, indicating an event occurred that requires processing.
26	DUART_SELECT	INPUT	Active low signal from the Main CPU. Used to select DUART, U37.
27	CS4	INPUT	Active low signal from the Main CPU. Used to select DUART, U23.

Table 3-2-25 J1 Main CPU Board Interface Connector

J1 MAIN CPU BOARD INTERFACE CONNECTOR

Pin No	Signal Name	Signal Type	Description
28	CS6	INPUT	Active low signal from the Main Board. Used to select DUART U24.
29	INPUT_SEL	INPUT	Active low signal from the Main CPU. Activates U44 to transfer the input relays' data to the data bus.
30	START_IRQ	OUTPUT	Active low signal to the Main CPU. Used to trigger an interrupt in response to any start input.
31	OUTPUT_SEL	INPUT	Active low signal from the Main CPU. Activates U42 to latch the data on the data bus to the output relays.
32	R-WAVE_DETECT	OUTPUT	R-Wave Detected signal to the Main CPU. +5vp, rectangular waveform indicating the external ECG Trigger Board received an R-Wave.
33	ECG_OUT	INPUT	Analog ECG waveform with marker pulses from internal ECG Trigger Board to ECG port J9:7.
34	ECG_IN	OUTPUT	Analog ECG signal from patient monitor to internal ECG Trigger Board.
35 36	REMOTE_PWR UP_RET,	OUTPUT	Contact closure from the console on/off switch. Activates the power circuit on the servo interface board.
37	REMOTE_PWR_UP ECG_CON	INPUT	Analog ECG waveform with marker pulses from internal or external ECG Trigger Board to console J6:20 or J7:20.
38	LED2	OUTPUT	See description for pins 42 through 44.
39	SERVO_RDY/BSY	INPUT	SERVO READY/BUSY signal from the Main CPU indicates the status of the servo controller to DUART U23 See Servo Interface Board section in this chapter for details.
40	ECG_ID	OUTPUT	Active low signal to the Main CPU indicating the ECG port is active.
41	ID_SEL	INPUT	Active low signal from the Main CPU. Activates the board ID latches U1 and U2.
42-44	LED5-LED7	OUTPUT	Status indicators on the Main CPU Board from DUART's U23 and U24. Used for troubleshooting. See Main CPU Board section in this chapter for details.
45-48	BA0-BA3	INPUT	Main CPU address bus.
49-64	BD0-BD15	I/O	Main CPU data bus.

Table 3-2-26 J1 Main CPU Board Interface Connector continued

J2 UNIVERSAL INTERFACE CONNECTOR

Pin No	Signal Name	Signal Type	Description
1	+24VISOLATED	POWER	Isolated power supply from the Servo Interface for use by the input relays and external devices.
2,3	UNUSED 1NO UNUSED 1COM	OUTPUT	Contacts of unused output relay K3:A.
4,5	FILMER NO, FILMER COM	OUTPUT	Contacts of filmer relay K2:B. When closed, signals the X ray system to start. Can program a delayed closure.
6,7	ENABLE NO ENABLE COM	OUTPUT	Contacts of enable the relay K1:B .When closed, indicates that the injector has been enabled and is ready to inject. NOTE: In Configuration #2 the 24V Isolated is supplied to the normally open contact when Synchronous mode is selected from the console.
8,9	INJECT NO INJECT COM	OUTPUT	Contacts of inject relay K1:A When in Configuration #3, the hand switch activates the relay, otherwise, closes when the injector is injecting.
10-13	OEM ID1 - OEM ID4	INPUT	Activates relays K9:A-K10:B by connecting to ISO GND. Four bits to identify the OEM configuration.
14,25	ISO GND	POWER	Isolated ground used to activate input relays and the return for the +24V ISOLATED supply.
15	START ENABLE	INPUT	Activates relay K8:B by connecting to ISO GND. En-ables use of start inputs to start an enabled injection.
16	INHIBIT	INPUT	Activates relay K8:A by connecting to ISO GND. If J13 on the 901107-1SR Communication board is in the "Active Low" (STD) position, activation of K8:A will prevent the start of an enabled injection. If J13 is in the "Active High" (Non-STD) position, activation of K8:A will allow the start of an enabled injection. Communication boards that are Rev. F or earlier are always "Active Low".
17	STOP IN	INPUT	Activates relay K7:A by connecting to ISO GND. Will stop the current injection in process.
18	START CONFIG2	INPUT	Activates relay K6:B by connecting to 24V Isolated supply. With start enable active, starts enabled injection
19	REMOTE 2	INPUT	Activates relay K6:A by connecting to ISO GND. With start enable active, starts an enabled injection without latching. Latches in CT or autorepeat mode.
20,21	UNUSED 3COM UNUSED 3NO	OUTPUT	Contacts of unused output relay K4:A.
22, 23	UNUSED 2ND UNUSED 2COM	OUTPUT	Contact of unused output relay K3:B.
24	UNUSED IN	INPUT	Active low input of unused input relay K4:B.

Table 3-2-27 J2 Universal Interface Connector

J3 LF HAND SWITCH CONNECTOR

Pin No	Signal Name	Signal Type	Description
1	START_ENABLE	INPUT	Activates relay K8:B by connecting to ISO GND. En-ables use of start inputs to start an enabled injection.
2	REMOTE_1	INPUT	Activates relay K6:B by connecting to ISO GND. With start enable active, starts an enabled injection without latching. Latches in CT or autorepeat mode.
5	ISO_GND	POWER	Isolated ground used to activate input relays.
8	START	INPUT	Activates relay K5:A by connecting to ISO GND. With start enable active, starts an enabled injection without latching. Latches in CT or autorepeat mode.
9	HAND_SW_ID	INPUT	Activates relay K7:B by connecting to ISO GND. Signals the injector that the hand switch is connected.

*Table 3-2-28 J3 LF Handswitch Connector***J6 CONSOLE 1 AND J7 CONSOLE 2**

Pin No	Signal Name	Signal Type	Description
1-4	+24V_CON	POWER	Console power supply
5,6	TXD_TO_CON(X)+ TXD_TO_CON(X)-	OUTPUT	TRANSMIT DATA- Power pack sends data to console on these outputs.
7,8	RXD_FR_CON(X)+ RXD_FR_CON(X)-	INPUT	RECEIVE DATA- Console sends data to power pack on these inputs.
9,10	CTS_FR_CON(X)+ CTS_FR_CON(X)-	INPUT	CLEAR TO SEND- Console signals power pack data can be sent.
11,12	RTS_TO_CON(X)+ RTS_TO_CON(X)-	OUTPUT	READY TO SEND- Power pack signals console device that data is ready to send.
13,22	INT_PIC + INT_PIC -	I/O	PIC processor communication lines
14-17	DGND	POWER	Digital Ground.
18,19	REMOTE_PWR _UP RET REMOTE_PWR _UP	INPUT	Console on/off switch. Activates the power circuit on the servo interface board.
20	ECG_CON	OUTPUT	Analog ECG waveform with marker pulses from internal or external ECG Trigger Board.
23-25	CGND	SHIELD	Chassis ground.

Table 3-2-31 J6 Console 1 and J7 Console 2

J10 COMMUNICATION BOARD POWER

Pin No	Signal Name	Signal Type	Description
1,2	+24V	POWER	+24V power supply from Servo Interface board.
3,6	+24V_CON	POWER	+24V console power supply from Servo Interface board.
7-10	DGND	POWER	Digital ground.

Table 3-2-34 J10 Communication Board Power

J11 ISOLATED POWER SUPPLY

Pin No	Signal Name	Signal Type	Description
1	+24V ISOLATED	POWER	+24V isolated power supply from Servo Interface board.
2	ISO_GND	POWER	Isolated ground.

Table 3-2-35 J11 UI Power Supply

J12 POWER HEAD COMMUNICATIONS

Pin No	Signal Name	Signal Type	Description
1,2	INT_PIC- INT_PIC+	I/O	PIC processor communication lines.
3,4	PH_TXD+ PH_TXD-	OUTPUT	TRANSMIT DATA- Power pack sends data to power head on these outputs.
5,6	PH_RXD+ PH_RXD-	INPUT	RECEIVE DATA- Power head sends data to power pack on these inputs.
7,8	PH_RTS+ PH_RTS-	OUTPUT	READY TO SEND- Power pack signals power head that data is ready to send.
9,10	PH_CTS+ PH_CTS-	INPUT	CLEAR TO SEND- Power head signals power pack data can be sent.

Table 3-2-36 J12 Powerhead Communications

LED STATUS INDICATORS

LED NO	LED Name (ON PCB ASSY)	STATUS
DS1	START	Lites when input relay, K5:A is on.
DS2	REMOTE 1	Lites when input relay, K5:B is on.
DS3	REMOTE 2	Lites when input relay, K6:A is on.
DS4	START 2	Lites when input relay, K6:B is on.
DS5	STOP IN	Lites when input relay, K7:A is on.
DS6	HAND SW ID	Lites when input relay, K7:B is on.
DS7	INHIBIT	Lites when input relay, K8:A is on.
DS8	START EN	Lites when input relay, K8:B is on.
DS9	INJECT	Lites when input relay, K1:A is on.
DS10	ENABLE	Lites when output relay, K1:B is on.
DS11	SYNC	Lites when output relay, K2:A is on.
DS12	FILMER	Lites when output relay, K2:B is on.
DS13	UN 1	Lites when output relay, K3:A is on.
DS14	UN 2	Lites when output relay, K3:B is on.
DS15	UN 3	Lites when output relay, K4:A is on.
DS16	UNUSED IN	Lites when input relay, K4:B is on.
DS17	OEM ID4	Lites when input relay, K9:A is on.
DS18	OEM ID3	Lites when input relay, K9:B is on.
DS19	OEM ID2	Lites when input relay, K10:A is on.
DS20	OEM ID1	Lites when input relay, K10:B is on.
DS21	DS21	Indicates the state of the PIC processor.
DS22	DS22	
DS23	DS23	
DS24	DS24	
DS25	DS25	

Table 3-2-37 LED Status Indicator

3.2.4.3 Circuit Descriptions

Refer to Parts Manual and Schematic P/N 901107-2 in Chapter 9.

Power Supplies

The power supplied to the Communication Board originates on the Main CPU Board and the Servo Interface Board.

From Main CPU Board:

- +5VDC logic supply located on J1:1-9 provides power to the logic and serial communications circuits.

From Servo Interface Board:

- +24VDC supply located on J10:1-2 provides power to the output relay driver U41 and the auxiliary port J4:9.
- +24V_CON supply located on J10:3-6 provides power to both console ports J6:1-4 and J7:1-4.
- +24V_UI supply located J11:1-2 provides power to the isolated relay outputs on K1A-K4A and isolated relay inputs on K4:B-K10B. The supply is also routed to the universal interface connector J2:1 with an UI_GND at J2:14. The remote handswitch port uses the isolated relay inputs and requires the UI_GND. This is provided at J3:5.

Universal Interface

The universal interface J2 provides the hardware I/O for the injector, OEM ID, and +24V, 100 ma isolated power supply interfaces. The output relays enable the injector to start the x-ray system. The input relays allow the x-ray system to start an enabled injection, interface the remote start switch at J3, and detect the status of the OEM ID lines. The relay functions are described in Tables 3-2-38 and 3-2-39. The injector configurations for the corresponding OEM ID inputs are also defined in Tables 3-2-38 and 3-2-39.

OEM ID TRUTH TABLE

CONFIGURATION	J2 INPUT PINS 10 - 13			
	13 OEM ID4	12 OEM ID3	11 OEM ID2	10 OEM ID1
1	0	0	0	0
2	0	0	0	1
3	0	0	1	0
4	0	0	1	1
5	0	1	0	0
6	0	1	0	1
7	0	1	1	0
8	0	1	1	1
9	1	0	0	0
10	1	0	0	1
11	1	0	1	0
12	1	0	1	1
13	1	1	0	0
14	1	1	0	1
15	1	1	1	0
16	1	1	1	1
1 = INPUT PIN IS FLOATING AND IS INACTIVE. 0 = INPUT PIN IS TIED TO ISOLATED GROUND AND IS ACTIVE.				

Table 3-2-38 OEM ID Truth Table

INTERFACE FUNCTION	CONFIGURATION						
	#1, #2	#8	#12	#13	#14	#15	#16
INPUTS							
Start Enable	X	X	X	X	X	X	X
Start	X	X	X	X	X	X	X
Start Config 2					X		
Remote Start 2		X	X	X	X	X	
Inhibit		X	X	X	X	X	
Stop		X	X	X	X	X	
OUTPUTS							
Enable		X	X	X	X	X	
*Inject		INJECT	HAND	INJECT	INJECT	INJECT	
FilmChanger		X	X	X	X	X	
24V Isolated Relay					X		
X designates the available functions for the corresponding configuration. * The inject relay operates in two mutually exclusive modes. INJECT mode, the relay closes when the injection starts and opens upon completion. HAND mode, the relay opens and closes following the hand switch activation.							

Table 3-2-39 Configuration vs. Interface Function

OEM Configurations #1 and #2, Service Mode

The service mode is used for calibration, diagnostics, software downloading and software upgrades. The output relays are not operational in this mode to prevent inadvertent interface signals to the x-ray equipment.

OEM Configuration #8, A6000 Universal Interface Adaptor Mode

Configuration #8 is initiated when the Angiomat Illumena Contrast Delivery System is installed in a site that has an A6000 universal interface cable and still wishes to use. Interface adaptor cable assembly #900204 is required for installation and Configuration ID.

Enable Function

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1SR Communication board is in the "Active Low" position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the "Active High" position, the enabled injection cannot be started. Communication boards that are Rev. F or earlier are always "Active Low".
 - One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector handswitch opens. All other output relays return to their relaxed state.
 - Return to idle state.

OEM Configuration #12, Handswitch Mode**Hand Mode Function**

- In the Hand Mode the inject relay, K1:A, opens and closes simultaneously with the handswitch. Normally the inject relay closes when the injector is injecting.

Enable Function

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.

Enable Relay Function

- The following lists conditions that will temporarily prevent the injector from starting an injection after it is Enabled:
 - Fillbar activation
 - During the 2 second holding period that follows a Test Injection
 - While the [Use Available Volume] key is displayed after a Test Injection is delivered, leaving inadequate volume to deliver the full injection
 - While a [Flow] or [Volume] key is highlighted.

During these conditions, the Enable Relay will be OFF. After the necessary conditions are met for the injection to occur, the Enable Relay will be turned back ON.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1 Communication board is in the “Active Low” position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the “Active High” position, the enabled injection cannot be started. Communication boards (PN 901007) that are Rev. F or earlier are always “Active Low”.
 - One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector hands witch opens. All other output relays return to their relaxed state.
 - Return to idle state.

OEM Configuration #13, OEM Mode**Enable Function**

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.
 - Parameter data sent to serial port.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1SR Communication board is in the "Active Low" position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the "Active High" position, the enabled injection cannot be started. Communication boards (PN 901007) that are Rev. F or earlier are always "Active Low".
 - One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector hands witch opens. All other output relays return to their relaxed state.
 - Return to idle state.

OEM Configuration #14, Sync Mode**Sync Function**

- When Synchronization is selected from the console the Sync relay, K2:A, will energize and apply the 24V_UI supply to the enable NO contact, K1:B, pin 5. When Non-Synchronization is selected, the Sync relay will be in its relaxed state.

Enable Function

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.
 - Parameter data sent to serial port.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1SR Communication board is in the "Active Low" position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the "Active High" position, the enabled injection cannot be started. Communication boards that are Rev. F or earlier are always "Active Low".
 - One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector hands witch opens. All other output relays return to their relaxed state.
 - Return to idle state.

OEM Configuration #15, Standard Interface Cable**Enable Function**

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.
 - Parameter data sent to serial port.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1SR Communication board is in the "Active Low" position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the "Active High" position, the enabled injection cannot be started. Communication boards that are Rev. F or earlier are always "Active Low".
 - One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - Status data is sent to the serial port J8.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector hands witch opens. All other output relays return to their relaxed state.
 - Return to idle state.

OEM Configuration #16, Universal Interface Not Present

Configuration #16 will still activate the relays indicated in the following section, even though there is no cable connected. This will provide diagnostic information from the status LED's defined in the LED Status Indicator table.

Enable Function

- Enable button on the console is activated.
 - CPU will read stop relay, K7:A, and if it is active, the injector will not enable. If it is not active, close Enable relay, K1:B.
 - Parameter data sent to serial port.

Inject Function

- If the inhibit relay K8:A is active, and J13 on the 901107-1SR Communication board is in the "Active Low" position, the enabled injection cannot be started. If the inhibit relay K8:A is NOT active and J13 is in the "Active High" position, the enabled injection cannot be started. Communication boards that are Rev. F or earlier are always "Active Low".
- One of the four start signals, defined in Table 3-2-39, will be activated by either the LF Handswitch on J3, or other external device on J2. This signal must be accompanied by the start enable input, J2:15 or J3:1, to be a valid start signal.
 - This sends a start interrupt request from the start IRQ logic circuit, U6 and U8, to the Main CPU, J1:30. The Main CPU responds by reading the opto input latch U44 to verify the start input and start the injection.
 - Inject and Filmer relays, K1:A and K2:B, close according to delays, if any, programmed in by user.
 - Enable relay, K1:B, remains closed.
 - If the stop relay, K7:A, becomes active any time during inject phase, the injection will be terminated by sending the stop interrupt request signal at J1:20 and over the data bus at U44:14, to the main CPU.
 - If the inhibit relay becomes active any time during a single phase injection, or the first phase of a multiphasic injection, the injector will stop until the signal is removed. For all phases other than phase one, the injection will terminate.

Injection complete

- Enable and filmer relays remain closed until the injector hands witch opens. All other output relays return to their relaxed state.
 - Return to idle state.

Start IRQ Circuit

The start interrupt signal is active low and alerts the main CPU that a valid start condition has occurred. The circuit consists of logic gates U8:B,C and D, and U6:B. If any of the four start signals at the inputs of U8:B and C is pulled low, the output at U8:D goes low. The output signal is combined with the start enable signal at the input of U6:B. Both must be low to activate the start IRQ at the output of U6:B. If either signal is not present, the injection will not start. If either signal is lost during an injection, the injector will stop the injection and return to the disabled state.

The start IRQ also is routed to the PIC processor at U4:26. This signal, along with several others, is used to determine the state of the injectors operation and determine if it is functioning properly. The PIC is used as a redundant processor to monitor the main CPU in case of a failure. If a failure occurs then a hard stop signal is generated. This is discussed in the Stop Circuit section to follow.

Start and Start Enable Circuits

The start and start enable circuits consist of input relays start, K5:A, remote 1 and 2, K5:B and K6:A and start config 2, K6:B and the start enable relay, K8:B. To start an enabled injection, any of the four start signals can be activated in parallel to the activation of the start enable relay. The interaction of the start signals and start enable is through the start IRQ circuit previously described. The active states of these signals are defined in the OEM ID Truth table. When a valid start is generated the start IRQ signals the main processor to read the input latch, U44, to determine which start has been activated. According to the OEM configuration selected, the injecting function will start as defined on the OEM Configuration section earlier in this chapter.

The start and start enable signals from relays K5:A and K8:B, are also routed to the PIC processor at U4:28 and U4:27. These signals, along with several others, are used to determine the state of the injectors operation and determine if it is functioning properly. The PIC is used as a redundant processor to monitor the main CPU in case of a failure. If a failure occurs then a hard stop signal is generated. This is discussed in the Stop Circuit section to follow.

Inhibit Circuit

The inhibit circuit consists of the input relay K8:A and input latch U44 and J13. The inhibit input at J2:16 is selectable as active low or active high with J13. When connected to ISO GND (J2:14), the inhibit relay (K8:A) closes. If J13 is set to the "Active Low" position, this will prevent an enabled injection from starting. If J13 is set to the "Active High" position, this will allow an enabled injection to start. Conversely, when the inhibit input at J2:16 is allowed to float high K8: A opens. If J13 is set to the "Active Low" position this will allow an enabled injection to start. If J13 is set to the "Active High" position, this will prevent an enabled injection from starting.

The inhibit signal also is routed to the PIC processor at U4:11. This signal, along with several others, is used to determine the state of the injectors operation and determine if it is functioning properly. The PIC is used as a redundant processor to monitor the main CPU in case of a failure.

Stop Circuit

The stop circuit consists of the stop input relay, K7:A, and the input latch U44. When the STOP IN signal on J2:17 is connected to the ISO GND, J2:14, the stop relay closes and sends a signal to the input latch at U44:6 and to the main CPU at J1:20. The main CPU upon receiving the signal at J1:20 reads the output of U44 to verify the condition. The main CPU stops the injection if both conditions are satisfied. If the STOP signal is only detected by the main CPU on the output of U44:14, the injection will stop and an error message will appear on the console to call service. If the signal is only detected at J1:20, a hard stop condition will occur.

The HARD STOP is handled by the PIC processor, U4. The STOP signal is also routed to the PIC at U4:5, directly from the stop relay, K7:A. The PIC will delay 100 milliseconds after before outputting the hard stop signal. This allows the main CPU time to perform a normal ramp down of the motor as in a normal stop condition. Hard stop will clear a latch on the Main CPU Board that will stop the motor (refer to Main CPU section in this chapter for details on this function). Parallel to this, the HARD STOP clears the output latch U42 to clear all output relays and stop operation of any external devices controlled by the injector.

Handswitch ID Circuit

The handswitch ID circuit consists of input relay K7:B and the input latch U44. The relay is closed when an LF remote handswitch is present at J3. The handswitch has a jumper built in to connect the handswitch ID input at J3:9, to ISO GND at J3:5. This signal is then latched to the data bus at U44:13 from the input relay. The relay closure informs the injector the correct cable is connected to J3. The purpose is to add protection if the printer cable, which also used a 9 pin d-shell connector, or other non handswitch cable from starting an injection if connected to J3.

3.2.4.4 System Communications

The Angiomat Illumena Contrast Delivery System communicates within the injector subsystems via three channels of RS422 serial communication structure. The channels are for console and powerhead. The PIC processor communications, RS485, are also present on these three ports.

The control of the system communications is from the main CPU determines the active channels from the response of each channel's test and initiates the appropriate communication scheme.

Serial Communications Timing

Signal definitions

TXD - Transmit data line

RXD - Receive data line

RTS - Output used to initiate communications with an external device and define the Data Packet envelope.

CTS - Input used to prepare the receiving device that data is present

The hardware handshaking format and timing for data transfer is shown in Figures 3-2-7 and 3-2-8.

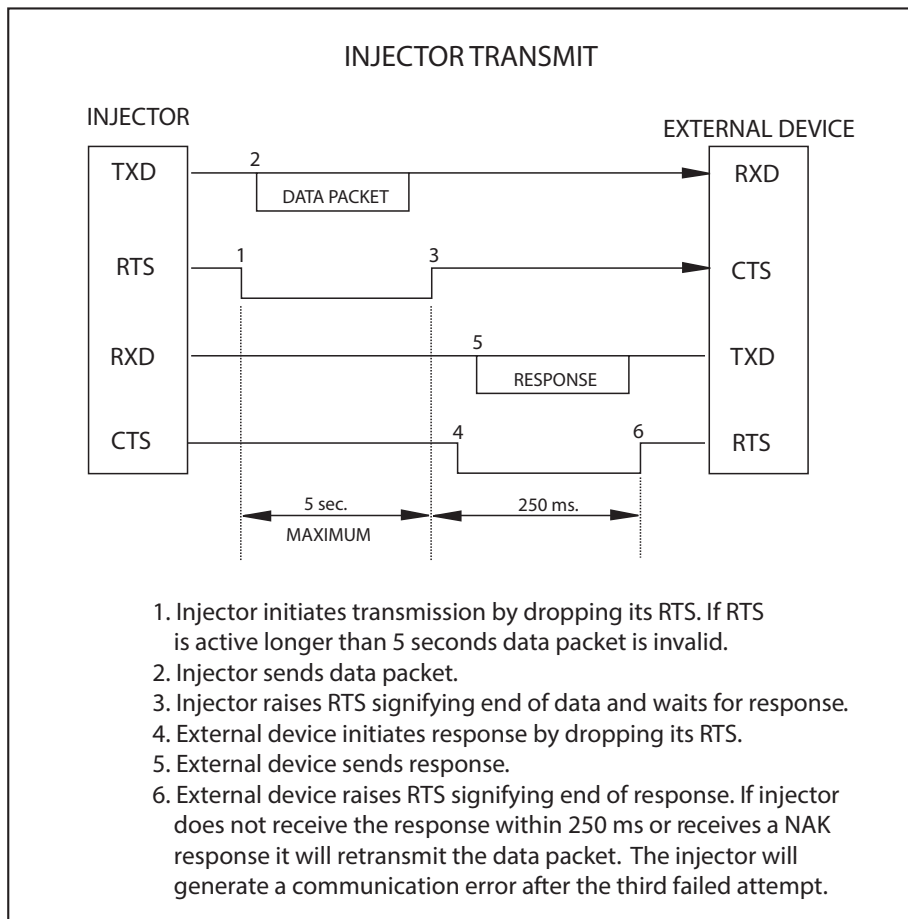


Figure 3-2-6 Transmit Timing Diagram

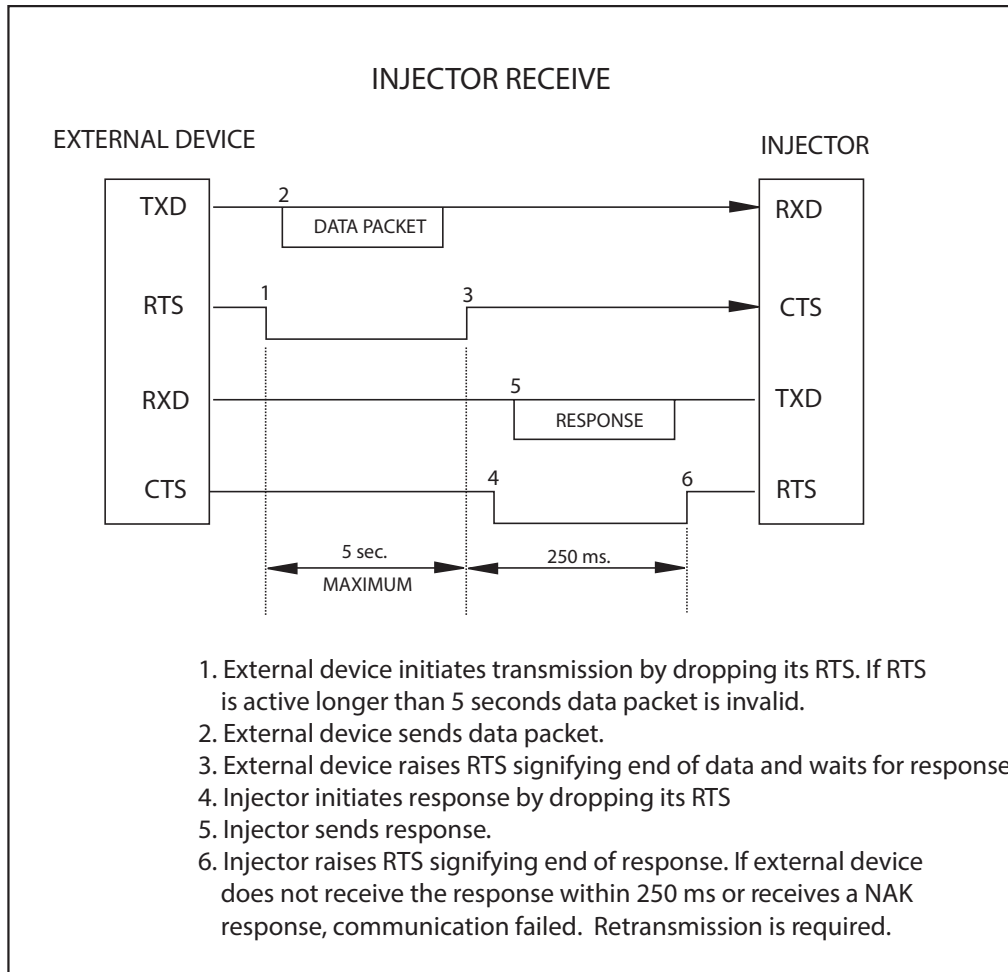


Figure 3-2-7 Receive Timing Diagram

- The response command can be ACK (i.e., acknowledge) or NAK (i.e., non-acknowledge).
- If ACK is received within 250 ms of RTS release, data transfer is completed successfully.
- If NAK is received within 250 ms of RTS release, data is re-transmitted. Communication error occurs after the third successive transmission without an ACK response.
- If no response is received within 250 ms of RTS release, data is re-transmitted. Communication error occurs after the third successive transmission without an ACK response.

Console Communications

The circuits consist of DUART U23, line drivers of U26 and receivers of U22

Powerhead and Auxiliary Communications

The circuits consist of DUART U24, line drivers of U21 and receivers of U25.

PIC Processor Communications

The circuit consists of the PIC processor, U4, RS485 transceiver, U5, and status LED's, DS21 through DS25. The PIC is a backup to the main CPU that monitors the injectors status and compares it to the main CPU's status. There is a PIC in each subsystem with a dedicated PIC communication bus for inter PIC communications. The PIC functions in the powerpack are to monitor the STOP, START IRQ, START ENABLE, START, INHIBIT and MOTOR RUNNING signals to determine the correct status. If the status is incorrect, the PIC generates a HARD STOP signal. There is more information in this chapter, specific to these signals, in the sections titled with the signal's circuit name, i.e. Stop Circuit section.

Board ID Circuit

The circuit consists of bus transceivers U1 and U2, and pull up / pull down resistors R17 through R37. The CPU pulls ID SEL low on U1:1 and U2:1 during the system power up diagnostics and reads the data bus. The placement of the resistors provides a 16 bit code that identifies the board and some attributes to the main CPU.

3.2.4.5 Block Diagram

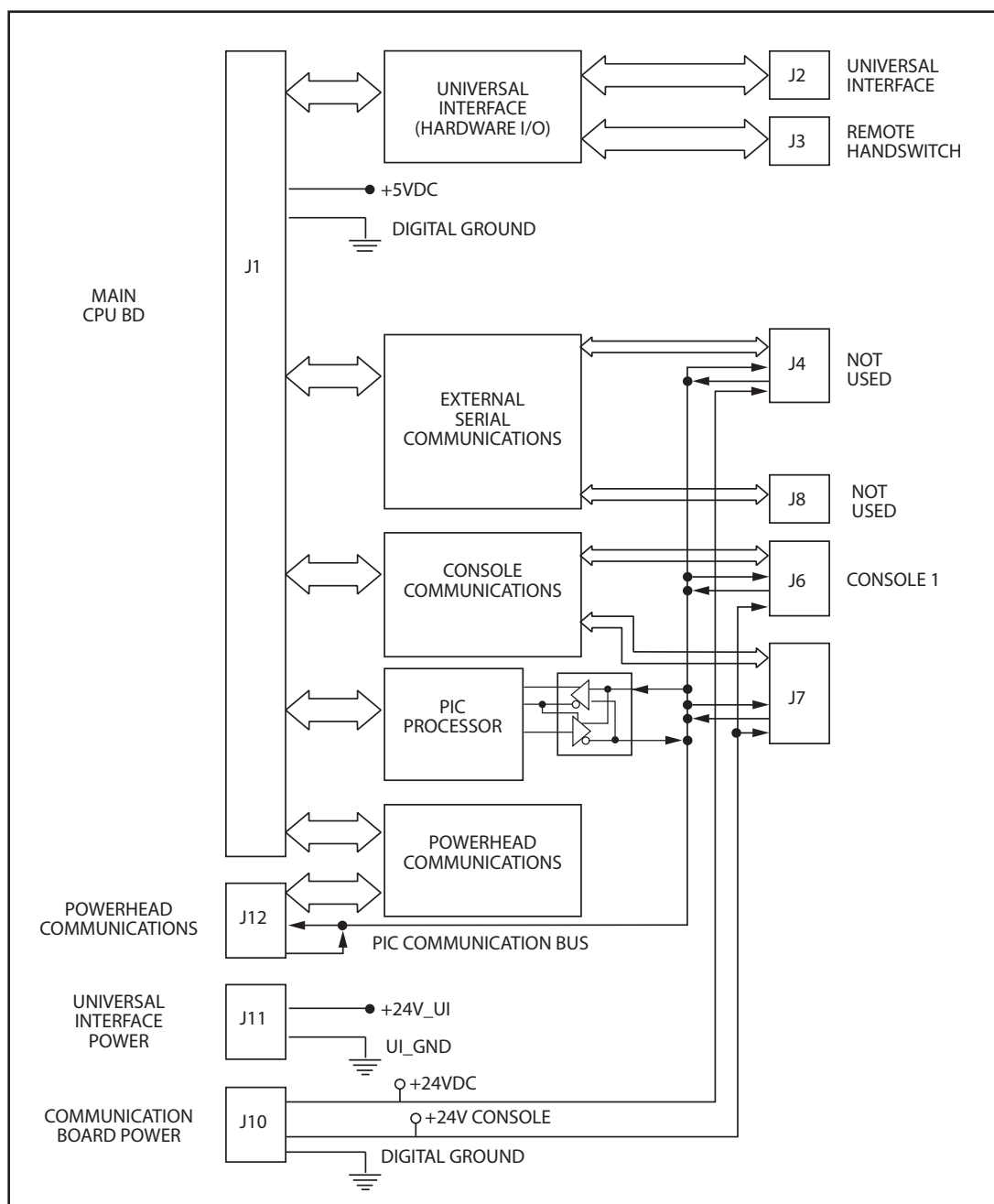


Figure 3-2-8 Communication Board Block Diagram 1/2

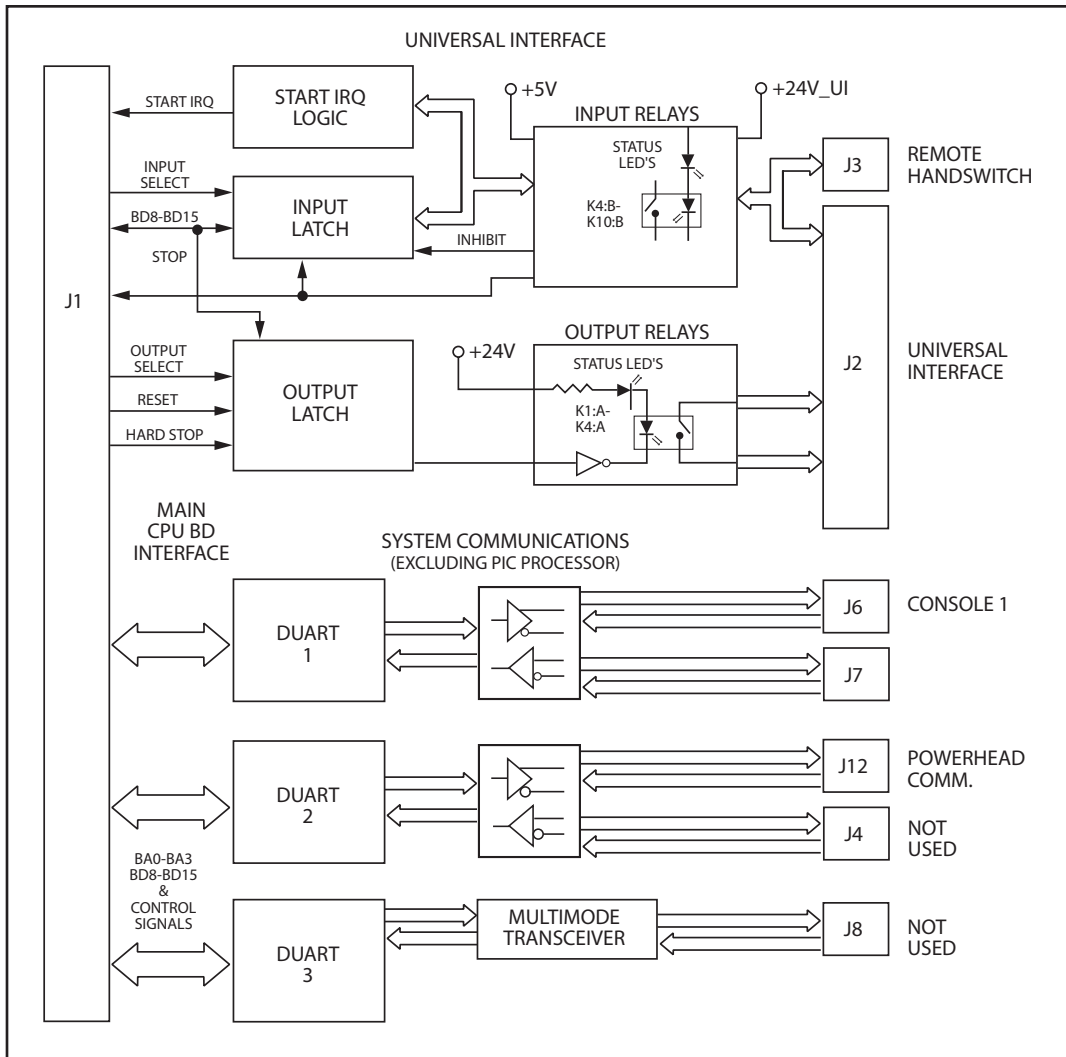


Figure 3-2-9 Communication Board Block Diagram 2/2

3.2.5 POWERPACK DIAGNOSTICS

At power up, all of the following tests are run. During the enable sequence for a programmed injection, tests 4 - 12 are run.

3.2.5.1 Watchdog timer test.

This test will check the watchdog timer's operation. The microprocessor will turn on the watchdog timer with a very short time out period and check whether or not the timer actually timed out.

3.2.5.2 NVRAM check.

This test will verify that the operating mode of the machine is correct. It will also verify whether or not any software has ever been loaded in the machine. If not, it will initialize the NVRAM, which contains the protocol library, injection logs, and the fault history log.

3.2.5.3 Communications check.

This test has two purposes. First, it establishes communications with all subsystems to ensure that at least one console and a powerhead are present. Second, it verifies the operation of the safety backup micro controller (PIC). The main microprocessor will send a special diagnostic code to the PIC to let it know that a motor test is about to be performed. The main microprocessor will enable the servo amplifier (turning DS11 ON), which will force the PIC to think that the motor is running. The PIC will then assert the asynchronous hardware stop line to shut off the servo amplifier (turning DS11 OFF). The PIC will return to the main microprocessor a status code after the test is complete.

3.2.5.4 Analog-to-Digital Converter check.

This test will check the operation of the A/D converter, the analog multiplexer, and the precision voltage reference. The value of the precision voltage reference is read and verified that it is within tolerance. Since the reference is precise, the difference between the measured value and the theoretical value becomes the system offset. This offset is added to or subtracted from all subsequent A/D readings.

3.2.5.5 Console +24VDC power check.

This test will verify that the relay K2 has switched, providing +24VDC to the consoles. It is also used to verify that the +24VDC power supply is within tolerance.

3.2.5.6 Powerhead +24VDC power check.

This test will verify that the relay K1 has switched, providing +24VDC to the powerhead and powerpack. It is also used to verify that the +24VDC power supply is within tolerance.

3.2.5.7 Pressure monitor check.

This test will verify operation of the servo amplifier current feedback channel on the A/D converter. When the motor is not running, a zero current output equals approximately 1VDC into the analog multiplexer.

3.2.5.8 Servo amplifier enable check.

This test verifies operation of the servo amplifier's enable/disable line. When the main microprocessor enables the amplifier for operation, the enable line engages the output transistors and a status line is feed back to the microprocessor to allow the microprocessor to verify operation.

3.2.5.9 Safety Relay check.

This test will verify operation of the safety relay. The safety relay has redundant control circuitry to allow the relay to close and open. If any section of the redundant control fails, the relay will open and not be allowed to close. The test will attempt to close the relay with one circuit open and the other closed. If the relay closes, one circuit has failed and the injector is shut down. Then the test will open the first circuit and close the other circuit. Again, if the relay closes, the test fails. Finally, both circuits are closed and the relay should close. Then both circuits are opened and the relay should open.

3.2.5.10 Servo Digital-to-Analog Converter check.

The servo digital to analog converter is the control link between the servo control chipset and the servo amplifier. The servo D/A can output +/- 10VDC. The test will ensure that the servo amplifier is disabled first. Then, the servo D/A is commanded to output various voltages, each of which are verified through the analog multiplexer and the A/D. The voltages ramped through are: 0VDC, +10VDC, +2.5VDC, +5VDC, and +7.5VDC. Since the A/D converter is unipolar, only positive voltages can be checked.

3.2.5.11 Servo Power Supply check.

The voltage of the servo power supply is fed to the A/D converter through a voltage divider. This voltage is used during the relay check to see if the relay opens and closes. It is also verified to be within tolerance for safe operation. This test will verify that the power supply voltage is within limits and toggle DS11 ON then OFF.

3.2.5.12 Servo Control chipset check.

The servo control chipset is a modified version of an available off the shelf chipset. Therefore, it has a unique serial number stored in an internal register that can be read by the main microprocessor. This serial number is verified against a hard coded serial number in the injector's software. If these two numbers do not match, the machine will fault out and not allow the motor to run. In addition, communications between the main microprocessor and the servo control chipset are verified for error-free operation.

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3.3 CONSOLE OVERVIEW

The console provides the user interface through the color LCD and the touch screen. Also, the console provides the system ON/OFF switch that is operable only with the powerpack circuit breaker in the ON position.

3.3.1 CONSOLE CPU

Refer to Schematic P/N 802101-2 or P/N 846101-2 in Chapter 9.

3.3.1.1 Functions

- Serial communications to the powerpack
- Stores all screen information
- Processes touch screen inputs
- Provides console PIC processor for system redundant processor state machine
- Manages screen generation
- Provides BDM port for console software downloading

3.3.1.2 Inputs and Outputs Main Console CPU

J1 IN-CIRCUIT SERIAL PROGRAMMER

Pin No.	Signal Name	Signal Type	Description
1	PIC Reset	Input	PIC processor reset
2	Vcc +5V	Power	Power Supply
3	Ground	Power	Ground
4	Program Data	Input	Data to program PIC
5	Program Clock	Input	Clock to control PIC programming

Table 3-3-1 Console Connector J1
In-Circuit Serial Programmer

J3 RGB OUTPUT

Pin No.	Signal Name	Signal Type	Description
1	VRTC	Output	Vertical retrace
2	HRTC	Output	Horizontal retrace
3	B	Output	Blue color signal
4	G	Output	Green color signed
5	R	Output	Red color signal
6	AGND	Signal Ref.	Ground

Table 3-3-2 Console Connector J3 RGB Output

J4 BDM

Pin No.	Signal Name	Signal Type	Description
1	No Connect (NC)		
2	Breakpoint	Input	Hardware break point request
3	Ground	Signal Ref.	
4	Data Clock	Input	Debug module clock for Data I/O
5	Ground	Signal Ref.	
6	No Connect (NC)		
7	BDMR	Input	Master reset input
8	Data In	Input	Debug Serial Data output
9	No Connect		
10	Data Out	Output	Debug Serial Data output
11	Ground	Signal Ref.	
12	PST	Output	Processor status
13	PST	Output	Processor status
14	PST	Output	Processor status
15	PST	Output	Processor status
16	Data Bit 3	In/Out	Debug data buss
17	Data Bit 2	In/Out	Debug data buss
18	Data Bit 1	In/Out	Debug data buss
19	Data Bit 0	In/Out	Debug data buss
20	Ground	Signal Ref.	
21	Bias	Output	Debug Module enable - Tied low
22	No Connect		
23	Ground	Signal Ref.	
24	PST Clock	Output	Transfer clock for PST & Data
25	Vcc + 3.3v		Power
26	TA	Output	

Table 3-3-3 Console Connector J4 BDM

J5 SYSTEM CPU CONNECTOR

Pin No.	Signal Name	Signal Type	Description
1	Ground	Power Ref	Ground return for +5 out
2	Ground	Power Ref	Ground return for +5 out
3	NC		
4	NC		
5	$\overline{\text{SYSPUP}}$	Input	Normally open output going low to trigger Power On
6	X3EN	Input	Norm, low, going + to enable PIC RS485 transceiver
7	TXDR3	Input	Transmit data for PIC RS485 Comm.
8	RXDR3	Output	Receive data for PIC RS485 Comm.
9	CANL	In/Out	Return for CAN serial link @ mini-DIN (not used)
10	CANH	In/Out	Data for CAN serial link @ mini-DIN (not used)
11	TXD0	Input	Transmit Data for system RS422 comm.
12	RXD0	Output	Receive Data for system RS422 comm.
13	$\overline{\text{RTS0}}$	Output	Request to send input to CPU UART Ø (not used)
14	$\overline{\text{CTS0}}$	Input	Clear to send output from CPU UART Ø (not used)
15	TXD1	Output	Transmit Data from CPU UART1 *
16	RXD1	Output	Receive Data for CPU UART1 *
17	Vcc+5v	Power	5v $\pm$ 5% @ < 200 ma out
18	Vcc+5v	Power	
19	$\overline{\text{RTS1}}$	Output	Programmable input for CPU UART1 *
20	$\overline{\text{CTS1}}$	Input	Programmable output from CPU UART1 *
21	$\overline{\text{DIAG0}}$	In/Out	General purpose I/O - reserved for future handswitch
22	$\overline{\text{DIAG1}}$	In/Out	General purpose I/O - reserved for future handswitch
23	NC		No Connection
24	NC		No Connection
25	GP2	In/Out	General Purpose I/O reserved for future handswitch
26	GP1	In/Out	General Purpose I/O reserved for future ECG signal input
27	Ground	Power Ref	Ground return for power
28	Ground	Power Ref	Ground return for power
29	Ground	Power Ref	Ground return for power
30	Ground	Power Ref	Ground return for power
31	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
32	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
33	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
34	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)

* unused

Table 3-3-4 Console Connector J5 System CPU

J6 POWER INDICATION / CONTROL

Pin No.	Signal Name	Signal Type	Description
1	Vcc +5	Power	Logic power supply
2	AWAKE	Output	Output indication for system running (active low)
3	$\overline{\text{SYSPUP}}$	Input	Input signal for system power on (- to trigger)
4	Ground	Power Ref	Logic ground
5	AWAKE	Output	Output indication for system running (active low)

*Table 3-3-5 Console Connector J6 Power Indication/Control***J7 BACKLIGHT CONTROL**

Pin No.	Signal Name	Signal Type	Description
1	ON / OFF	Output	On/off control for logic voltage brightness control (- is On)
2	Brightness 1	Output	Logic voltage brightness control (-V is max.)
3	Brightness 2	Output	Impedance output for brightness control (4.6K - max.)
4	ON / OFF	Output	On/off control for impedance control of brightness (open is On)
5	Ground	Power Ref	Logic ground
6	Ground	Power Ref	Logic ground
7	V+ 12v	Power Out	Backlight power
8	V+ 12v	Power Out	Backlight power

Table 3-3-6 Console Connector J7 Backlight Control

J8 LCD VGA PANEL

Pin No.	Signal Name	Signal Type	Description
1	Ground		Ground
2	FP SHIFT	Output	Pixel shift clock
3	FP LINE	Output	Flat panel line complete signal
4	FP FRAME	Output	Flat panel frame complete signal
5	Ground	Signal Ref.	Ground
6	NC		No connection
7	FPD10	Output	Flat Panel Data 10 Red Data for Color LCD
8	FPD9	Output	Flat Panel Data 9 Red Data for Color LCD
9	FPD2	Output	Flat Panel Data 2 Red Data for Color LCD
10	FPD1	Output	Flat Panel Data 1 Red Data for Color LCD
11	FPD0	Output	Flat Panel Data 0 Red Data for Color LCD
12	Ground	Signal Ref.	Ground
13	FPD13	Output	Flat Panel Data 13 Green Data for Color LCD
14	FPD12	Output	Flat Panel Data 12 Green Data for Color LCD
15	FPD11	Output	Flat Panel Data 11 Green Data for Color LCD
16	FPD5	Output	Flat Panel Data 5 Green Data for Color LCD
17	FPD4	Output	Flat Panel Data 4 Green Data for Color LCD
18	FPD3	Output	Flat Panel Data 3 Green Data for Color LCD
19	Ground	Signal Ref.	Ground
20	NC		No Connection
21	FPD15	Output	Flat Panel Data 15 Blue Data for Color LCD
22	FPD14	Output	Flat Panel Data 14 Blue Data for Color LCD
23	FPD8	Output	Flat Panel Data 8 Blue Data for Color LCD
24	FPD7	Output	Flat Panel Data 7 Blue Data for Color LCD
25	FPD6	Output	Flat Panel Data 6 Blue Data for Color LCD
26	Ground	Power Ref.	Ground
27	DRDY	Output	Data Ready
28	Vcc	Power Out	Panel power (Selectable by J10) normally +3.3v 500 ma max
29	Vcc	Power Out	Panel power (Selectable by J10) normally +3.3v 500 ma max
30	NC		No Connection
31	Ground	Power Ref.	Ground

Table 3-3-7 Console Connector J8 LCD VGA Panel

3.3.1.3 Inputs and Outputs CPU Interface Board

Refer to Schematic P/N 902206-2

J1 SYSTEM CONNECTOR TO POWERPACK

Pin No	Signal Name	Signal Type	Description
1-4	+24V_CON	POWER	Console power supply
5,6	RXD_TO_CON(X)+ RXD_TO_CON(X)-	INPUT	RECEIVE DATA- Power pack sends data to console on these outputs.
7,8	TXD_FR_CON(X)+ TXD_FR_CON(X)-	OUTPUT	TRANSMIT DATA- Console sends data to power pack on these inputs.
9,10	RTS_FR_CON(X)+ RTS_FR_CON(X)-	OUTPUT	READY TO SEND- Console signals power pack data can be sent.
11,12	CTS_TO_CON(X)+ CTS_TO_CON(X)-	INPUT	CLEAR TO SEND- Power pack signals console device that data is ready to send.
13,22	INT_PIC + INT_PIC -	I/O	PIC processor communication lines
14-17	DGND	POWER	Digital Ground.
18,19	REMOTE_PWR UP RET REMOTE_PWR UP	INPUT	Console on/off switch. Activates the power circuit on the servo interface board.
20	ECG_CON	OUTPUT	Analog ECG waveform with marker pulses from internal or external ECG Trigger Board.
23-25	CGND	SHIELD	Chassis ground.

Table 3-3-10 System J1 Connector to Powerpack

J2 Handswitch

Pin No.	Signal Name	Signal Type	Description
1	N.O.		Normally open contact input, closed for start
2	GND	Signal Ref.	Ground
3	SW_PRESENT	input	Switch present
4	NC		No connection
5	NC		No connection
6	N.C.	Input	Normally closed contact input, open for start
7	NC		No connection
8	NC		No connection

Table 3-3-11 Interface Board J2 Connector

J5 SYSTEM CPU CONNECTOR

Pin No.	Signal Name	Signal Type	Description
1	Ground	Power Ref	Ground return for +5 out
2	Ground	Power Ref	Ground return for +5 out
3	NC		
4	NC		
5	$\overline{\text{SYSPUP}}$	Input	Normally open output going low to trigger Power On
6	X3EN	Input	Norm, low, going + to enable PIC RS485 transceiver
7	TXDR3	Input	Transmit data for PIC RS485 Comm.
8	RXDR3	Output	Receive data for PIC RS485 Comm.
9	CANL	In/Out	Return for CAN serial link @ mini-DIN (not used)
10	CANH	In/Out	Data for CAN serial link @ mini-DIN (not used)
11	TXD0	Input	Transmit Data for system RS422 comm.
12	RXD0	Output	Receive Data for system RS422 comm.
13	$\overline{\text{RTS0}}$	Output	Request to send input to CPU UART Ø (not used)
14	$\overline{\text{CTS0}}$	Input	Clear to send output from CPU UART Ø (not used)
15	TXD1	Output	Transmit Data from CPU UART1 *
16	RXD1	Output	Recieve Data for CPU UART1 *
17	Vcc+5v	Power	5v $\pm$ 5% @ < 200 ma out
18	Vcc+5v	Power	
19	$\overline{\text{RTS1}}$	Output	Programmable input for CPU UART1 *
20	$\overline{\text{CTS1}}$	Input	Programmable output from CPU UART1 *
21	$\overline{\text{DIAG0}}$	In/Out	General purpose I/O - reserved for future handswitch
22	$\overline{\text{DIAG1}}$	In/Out	General purpose I/O - reserved for future handswitch
23	NC		No Connection
24	NC		No Connection
25	GP2	In/Out	General Purpose I/O reserved for future handswitch
26	GP1	In/Out	General Purpose I/O reserved for future ECG signal input
27	Ground	Power Ref	Ground return for power
28	Ground	Power Ref	Ground return for power
29	Ground	Power Ref	Ground return for power
30	Ground	Power Ref	Ground return for power
31	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
32	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
33	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)
34	Vin	Power In	Main console power input - (18 Vdc - 35 Vdc)

* unused

Table 3-3-12 Interface Board J3 Connector

3.3.1.4 Circuit Descriptions

Refer to Schematic P/N 802101-2 or P/N 846101-2 in Chapter 9.

Interface Connection

The interface connector provides the means for the console to obtain power from the powerpack as well as provide the path for the console to communicate with the system.

RS422 Drivers and Receivers

The communication channel to and from the powerpack is accomplished using RS422 drivers and receivers (MC3487 and MC3486 or equiv). The communications channel operates at a BAUD rate of 38400 bps with 1 start and 1 stop bit. A communication packet is started by a start of command hardware signal (RTS) and completed by this signal being de-asserted. For every command packet, there must be an acknowledgment of validity.

DUART FUNCTION

The CPU is responsible for actually sending and receiving the communications data in addition to providing a DIP switch input and status LED's. The DIP switch (S1) allows for various developmental modes, options or special functions to be enabled or disabled. However, for normal operation, all DIP switch positions on switch S1 have been set to the OFF position. If the 846101-1 PCB is installed, on DIP switch S2, switch 1 must be in the off position for software V9.09 or earlier.

NOTE: *Do not change the dip switch settings. Changing the dip switch settings will disrupt normal operation of the console.*

The data described above is communicated to and from the main microprocessor via the address bus and data bus along with the control signals.

Touch Screen Electronics/PIC Controller

The touch screen electronics is shared between 2 major functions. The first is to control all aspects of the touch screen panel and the second is to provide a redundant backup to the main microprocessor.

Touch Screen Control

The quiescent state assumes the screen is not touched. Signal X+ is driven high and X-, Y+ and Y- are high impedance. During this time the line SY- is monitored by a comparator. If the screen is touched the comparator's output will generate an interrupt to the PIC (Peripheral Interface Control). Upon receipt of the interrupt, the X- line is driven low thus creating a voltage gradient across the X-axis. The X coordinate is defined by the value digitized on the SY- channel corrected by the difference between 5 volts and the value found on the SX+ channel. Then X lines are allowed to float and Y+ is driven high and Y- is driven low. The Y coordinate is then defined as the digitized value for the SX- channel corrected by the difference between 5 volts and the value found on the SY+ channel. The BYTEME signal is asserted and the X and Y coordinates are placed the SPI transmit buffer.

PIC Control (Peripheral Interface Control)

The PIC controller is used to provide a redundant backup to the main CPU. This is accomplished by continual monitoring of the machine state between the PIC and the MCF5307. This machine state is transferred via the I²C communications channel. The 75176 provides both the transmit and receive functions. The machine state can be monitored by the PIC status LED's DS14-DS18. The binary code for the state shall be displayed using DS14 as the LSB and DS18 as the MSB. The CONSOLE PIC can not initiate a state change.

RAM

The console PCB has a total of 4M bytes of memory organized as 1M x 32. The RAM is the heart of the console control variables and data storage. All data within these devices are lost when system power is removed.

FLASH

The console contains 4M of FLASH memory which consists of 2-2 MB chips. Each FLASH device is divided up into 32-64 KB sectors which are loaded with various sections of the console software.

These devices contain the product software and the RTOS, all of the bit mapped images used on the display screens, the basic set of languages used and the fonts sets for all displayed text. Also, these devices contain the object records which are used to build the screens. Objects are the devices which combine images, text, and functionality. The screen records are simply the list of objects and locations.

CPU

The console uses an MCF5307 as its main microprocessor. In addition to the normal uses of a microprocessor, data flow to and from memory and peripheral devices, the CPU communicates directly with the SED1355 graphic's LCD panel controller. The SED1355 gathers the information from the CPU to build the various screen images. Once the data is organized the SED1355 will generate the necessary control signals for the LCD display and display the image. The image will be maintained by the SED1355 until the CPU provides a new or updates the current set of images.

The diagram illustrates the system architecture of the MC5307e. At the core is the CPU (U8), which interfaces with several key components:

- System Interface (J5):** Provides power (+24V, GND) and communication (ILL., +24-, GND-, PUP-, SAFE-, (485), COMM-, (422)).
- Power Regulation:** Includes a PUP (U14) for +3.3V and +5V, and voltage regulators (U11, U12, U13) for +5V, +12V, and +3.3V. A Reset SW3 is also shown.
- Communication:** Features a CAN interface (U4 & U21) with a 16MHz clock (Y1), RS422/232 (U22), and GP I/O.
- Control and Timing:** Includes a PIC 16F873 (U3) for control, a 40MHz clock (Y2), and a 16MHz clock (Y1).
- Display and I/O:** A Display Controller (U7) manages the Display Mem (U6) and interfaces with an LCD Color (J8), INV (J7), and Aux RGB output (J3).
- Memory and Storage:** Includes RTC And Batt back SRAM (U16), PROG & DATA MEM (U19, U20), and a 4 Mbyte total DRAM (U17, U18).
- Other Components:** Includes a Panel J6, On/Off switch, Isolator (U22), Aux Spkr (J9), SPK Dvr., Switch & Jumper Inputs (Config. Options), and a DBUG (J4).

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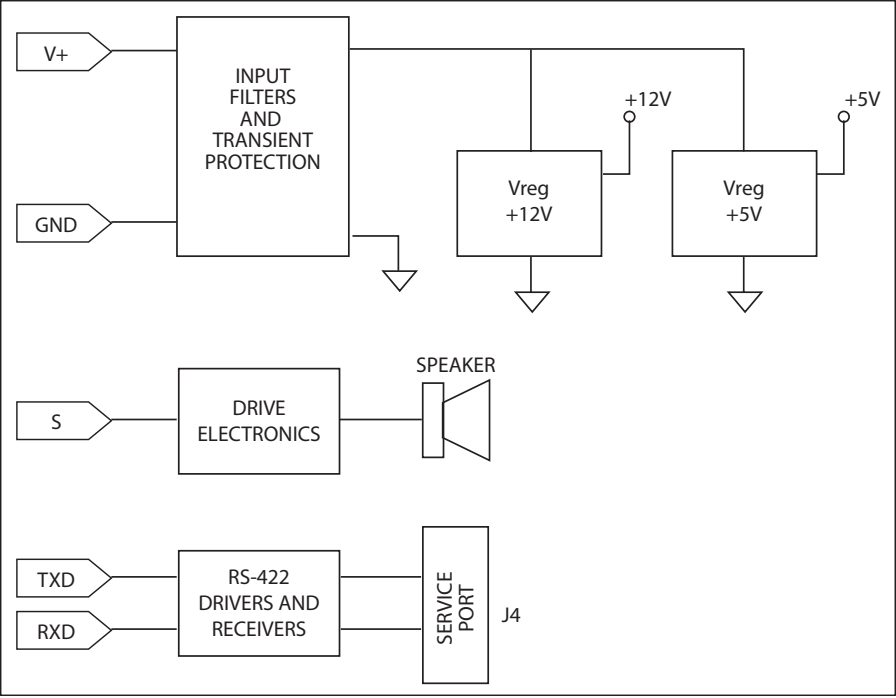


Figure 3-3-2 Console Block Diagram 2/2

3.4 POWERHEAD OVERVIEW

The powerhead houses the syringe drive system that is controlled by the powerpack. It also provides the manual knob and fill control bar functions to manipulate the ram for filling and purging the syringe. The powerhead display provides the following for user feedback: syringe volume, programmed volume and programmed flow rate. The powerhead also controls the ADAWS (Air Detection Aid and Warning System), faceplate identification and heater functions.

3.4.1 POWERHEAD CONTROL BOARD

Refer to Parts Manual 11 and Schematic P/N (MN), 903040-2 (RoHS) in Chapter 9.

3.4.1.1 Functions

The powerhead provides the following system interfaces:

- Syringe Detection - The type of syringe in use is automatically detected via faceplate magnets.
- Fill / Expel - Manual filling and expelling of contrast may be accomplished via an external manual knob or by utilizing the control bar. The PCB monitors and/or requests ram movement for these functions.
- Procedural Checks - Monitors if fill and purge sequences have been correctly performed and alerts the powerpack accordingly.
- Local Display - Controls the display updating it with the data from the powerpack.
- Contrast Warmer - Control electronics regulate the temperature of the contrast fluid.
- ADAWS - Software and signal conditioning to support air detection are resident in the powerhead. Sends status to the powerpack to be processed.

3.4.1.2 Inputs and Outputs

J1 FILL/EXPEL POTENTIOMETER

Pin No	Signal Name	Signal Type	Description
1	REF5	POWER	Analog +5V reference.
2	WIPER	INPUT	Fill-control bar position feedback.
3	AGND	POWER	System ground.

Table 3-4-1 Powerhead J1 Fill/Expel Potentiometer

J2 LINEAR STROKE POTENTIOMETER

Pin No	Signal Name	Signal Type	Description
1	REF5	POWER	Analog +5V reference.
2	WIPER	INPUT	Ram position feedback.
3	AGND	POWER	System ground.

*Table 3-4-2 Powerhead J2 Linear Stroke Potentiometer***J3 EXTERNAL THERMISTORS (not implemented at this time)**

Pin No	Signal Name	Signal Type	Description
1	THERMISTOR1	INPUT	Temperature control.
2	AGND	POWER	System ground.
3	THERMISTOR2	INPUT	Temperature control.
4	AGND	POWER	System ground.

*Table 3-4-3 Powerhead J3 External Thermistors***J4 HEATER AND ADAWS OPTION PORT**

Pin No	Signal Name	Signal Type	Description
1		OUTPUT	Heater current +.
2		OUTPUT	Heater current return.
3	AIR_CNTRL	OUTPUT	Current source to infrared LED.
4	AIR_SIGNAL	INPUT	Open collector output from ADAWS.
5	AIR_V+	OUTPUT	Programmable excitation voltage.
6	AGND	POWER	System ground.
7	SPARE		
8	HEAT_OPTION	INPUT	Heater shorts input to GND when option is installed.
9	AIR_TRIG	INPUT	Synchronous current sink.
10	AIR_OPTION	INPUT	ADAWS shorts input to GND when option is installed.

Table 3-4-4 Powerhead J4 Heater and ADAWS Option Port

J5 ENCODER INPUTS

Pin No	Signal Name	Signal Type	Description
1	+5V	POWER	Logic +5V supply.
2	AGND	POWER	System ground.
3	CHANNEL A	INPUT	Encoder quadrature pulses from encoder.
4	CHANNEL A	INPUT	Encoder quadrature pulses from encoder.
5	CHANNEL B	INPUT	Encoder quadrature pulses from encoder.
6	CHANNEL B	INPUT	Encoder quadrature pulses from encoder.
7	INDEX	INPUT	1/REV pulse.
8	INDEX	INPUT	1/REV pulse.

*Table 3-4-5 Powerhead J5 Encoder Inputs***J6 POWERPACK COMMUNICATION I**

Pin No	Signal Name	Signal Type	Description
1	CHANNEL A	POWER	Buffered encoder quadrature output to powerpack.
2	CHANNEL A	POWER	Buffered encoder quadrature output to powerpack.
3	CHANNEL B	INPUT	Buffered encoder quadrature output to powerpack.
4	CHANNEL B	INPUT	Buffered encoder quadrature output to powerpack.
5	INIT_PIC -	INPUT	RS-485 communications between PIC's.
6	INIT_PIC +	INPUT	RS-485 communications between PIC's.

Table 3-4-6 Powerhead J6 Powerpack Communications I

J7 POWERPACK COMMUNICATION II

Pin No	Signal Name	Signal Type	Description
1	CPU_TXD +	OUTPUT	Transmit RS-422 data to powerpack.
2	CPU_TXD -	OUTPUT	Transmit RS-422 data to powerpack.
3	RTS +	OUTPUT	READY TO SEND
4	RTS -	OUTPUT	READY TO SEND
5	CPU_RXD +	INPUT	Receive RS-422 data from powerpack.
6	CPU_RXD -	INPUT	Receive RS-422 data from powerpack.
7	CTS +	INPUT	CLEAR TO SEND
8	CTS -	INPUT	CLEAR TO SEND

*Table 3-4-7 Powerhead J7 Powerpack Communications II***J8 BACKGROUND DEBUGGER PORT**

Pin No	Signal Name	Signal Type	Description
1	SPARE		
2	BERR	I/O	Bus error.
3	AGND	POWER	System ground.
4	BKPT	I/O	Breakpoint.
5	AGND	POWER	System ground.
6	FREEZE	I/O	
7	RESET	INPUT	External reset input.
8	IFETCH	I/O	
9	+5V	POWER	Logic +5V supply.
10	IPIPE	I/O	

Table 3-4-8 Powerhead J8 Background Debugger Port

J9 FILL/EXPEL SWITCH INTERFACE

Pin No	Signal Name	Signal Type	Description
1	+5V	POWER	Logic +5V supply.
2	SAFE	INPUT	Fill/Expel spings are grounded in normal operation. Spring may be broken if at +5V.
3	DETENT	INPUT	Signal goes low when detent fill position is achieved.
4	HOME	INPUT	Photo-interrupter switch indicates when fill-control bar is not in use.
5	AGND	POWER	System ground.

*Table 3-4-9 Powerhead J9 Fill/Expel Switch Interface***J10 INPUT POWER**

Pin No	Signal Name	Signal Type	Description
1	+24V	POWER	Input voltage to subsystem DC/DC converter.
2	AGND	POWER	System ground.
3	SPARE		
4	SHIELD	POWER	
5	SHIELD	POWER	
6	CHASSIS GND	POWER	

*Table 3-4-10 Powerhead J10 Input Power***J11 LED/LCD INTERFACE**

Pin No	Signal Name	Signal Type	Description
1	+5V	POWER	Logic +5V supply.
2	SDA	OUTPUT	Serial data out.
3	SCL	OUTPUT	Serial clock out.
4	AGND	POWER	System ground.
5	CONTRAST	OUTPUT	For LCD displays only.
6	PCS2	OUTPUT	Chip select.
7	BACKLIGHT	OUTPUT	Backlight current for LCD displays.
8	AGND	POWER	System ground.

Table 3-4-11 Powerhead J11 LED/LCD Interface

3.4.1.3 Circuit Descriptions

Refer to *Parts Manual and Schematic P/N (MN), 903040-2 (RoHS)* in Chapter 9.

Micro controllers

The powerhead uses an MC68332 as its main micro controller. All sensors are interfaced to the MC68332. A Microchip PIC16C63A is used to provide a redundant backup to the MC68332. The PIC monitors encoder pulses, faceplate transitions during motion, and system state transitions. The system state machine has 15 legal states. The PIC displays the present state in a binary format on status LED's DS6 - DS10. State transitions are serially transmitted via RS485 to other PIC micro controllers in the system.

Memory

PCB 903040-1 (RoHS) is equipped with 128K of FLASH memory, 128K of static RAM, and 8K of nonvolatile static RAM. The nonvolatile FLASH memory contains the product software, and the nonvolatile static RAM contains the calibration parameters.

External Status Light

The powerhead contains one amber status light, which is physically located above the manual knob. The output of one yellow and one orange LED are optically mixed to illuminate the indicator lens. Both LEDs illuminate when the injector is enabled. Both LEDs flash when the motor is running.

Faceplate Sensors

There are four sensors which pertain to the faceplate. An optical sensor detects when the faceplate is open or latched. Three hall effect sensors detect the presence or absence of magnets embedded in the faceplate. The embedded magnets encode the syringe size and whether the faceplate is equipped with ADAWS (Air Detection Aid and Warning System). The printed circuit board reference designators for the three hall effect sensors are U17, U18, and U20. See Table 3-4-12 for a description of how syringe size is encoded.

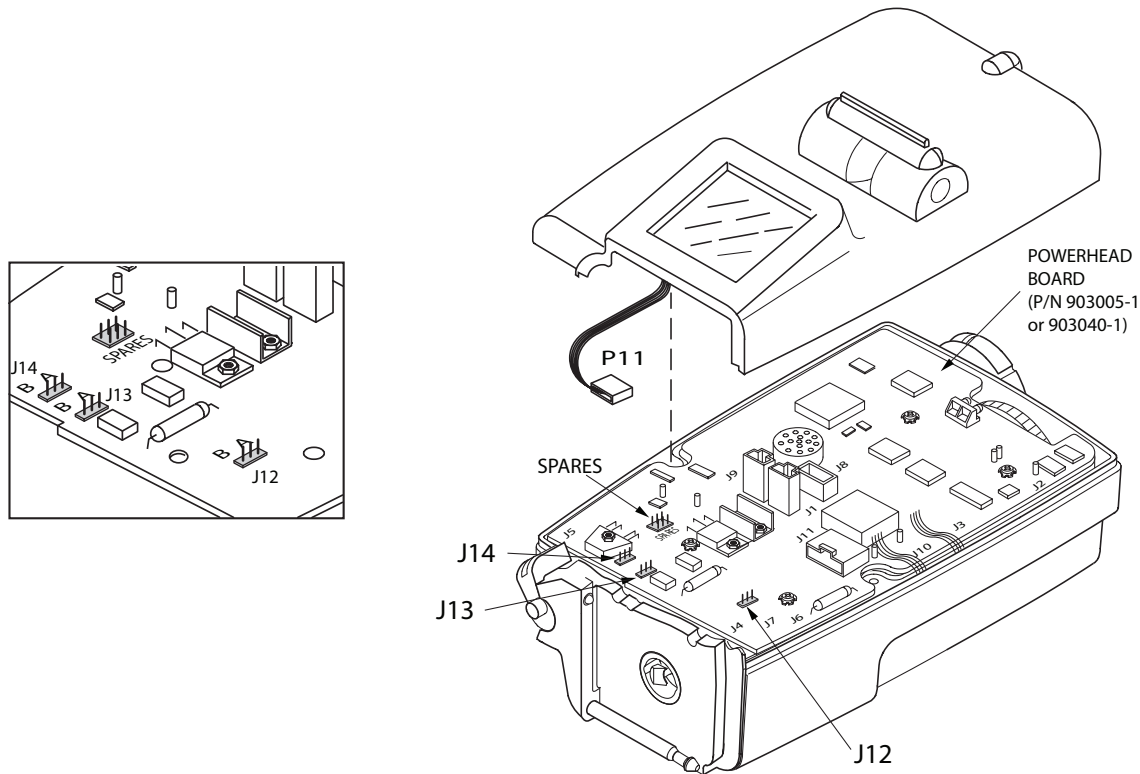
At power up and each time the faceplate sensor transitions from open to latched, the state of the hall effect sensors will be read and stored into memory. All volume remaining calculations will be based upon the magnet states stored in memory, rather than real-time data. It is important to base calculations upon the latched state. Otherwise, the volume remaining field of the powerhead display will update with large step changes, each time the faceplate is opened or closed with a 125 ml syringe.

<u>U17</u>	<u>U18</u>	<u>U20</u>	
Off	Off	Off	150 ml without ADAWS
Off	Off	On	150 ml with ADAWS
Off	On	Off	Pediatrics
Off	On	On	200 ml without ADAWS
On	Off	Off	125 ml without ADAWS
On	Off	On	125 ml with ADAWS
On	On	Off	Spare
On	On	On	Spare

Table 3-4-12 Faceplate Sensors

Faceplate Sensor Jumpers

Powerhead board (P/N's 903005-1, 903040-1) has three jumpers, (J12, J13, and J14), that deal with the Faceplate hall effect sensors. Jumper settings for standard Angioma Illumena Contrast Delivery System models, including Siemens and Non-OEM models, are preset at the factory and should not be moved. Refer to the "STANDARD UNIT" column in the table in Figure 3-4-1 below for jumper positions.



		MN UNITS				STANDARD UNIT
SYRINGE SIZE		150	150 ADAWS	200	125	
JUMPER CONDITION	J14	OUT	POS A	POS A	OUT	POS B
	J13	OUT	OUT	POS A	OUT	POS B
	J12	OUT	OUT	OUT	POS A	POS B
"suitcases" used		0	1	2	1	3

Figure 3-4-1 Jumper Settings

Tilt Sensor

The powerhead incorporates an accelerometer which functions as an inclinometer or tilt sensor. The tilt sensor software will detect the following regions of operation. Ram speeds, controlled by the Fill/Expel bar, display orientation, and the LED display mode are functions of the operating region, as noted below:

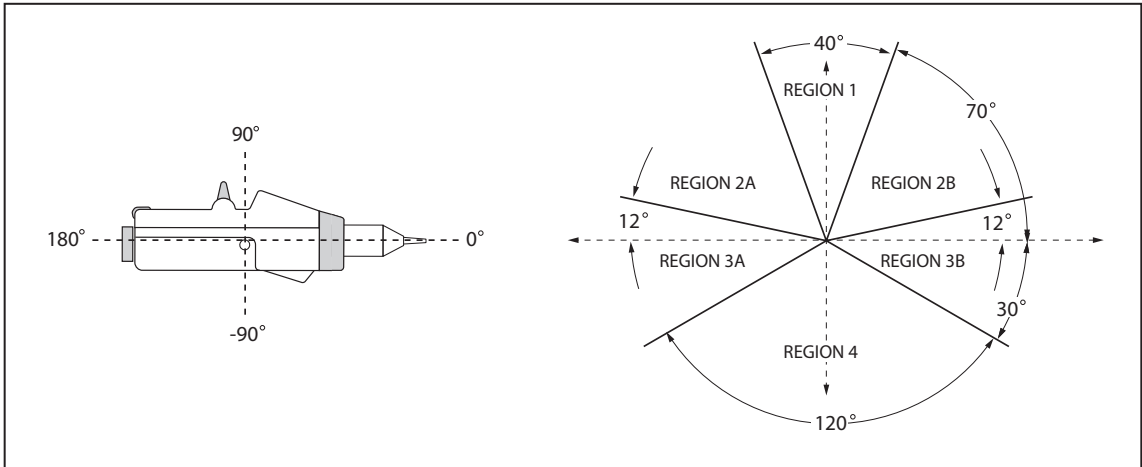


Figure 3-4-2 Tilt Sensor

Region	Fill-Expel Bar (Ram Speed)	Display Orientation
Region 1	Fast	Inverted
Region 2A	Fast	Inverted
Region 2B	Fast	Inverted
Region 3A	Slow	Non-Inverted
Region 3B	Slow	Non-Inverted
Region 4	Slow	Non-Inverted

Region 1 represents the “Fill” region. Region 4 represents the programmed “Inject” region. If an obese patient or other obstacle prevents the technologist from operating the equipment in the “Inject” (-30 to -150 degrees) region, a software override may be entered via the console.

Fill / Expel Control Bar Rotary Potentiometer

The control bar provides 5 different and distinct functions to the user. Under normal operation, the distinct functions are fill syringe, purge air, "scout" injections, and drawback. If the injector is performing a programmed injection, and the operator touches the control bar a fifth function is invoked: Emergency Stop. The powerhead software polls the control bar rotary pot to measure angular position. If the powerhead tilt sensor senses that the unit is in the fill region, and the control bar is rotated backwards (away from the syringe tip) then the powerhead will transmit a serial message to the powerpack, commanding a negative expel rate. [FILL] If the tilt sensor senses that the unit is in the fill region, and the control bar is rotated forwards (towards the syringe tip) then the powerhead will transmit a serial message commanding a positive expel rate. [Purge Air]

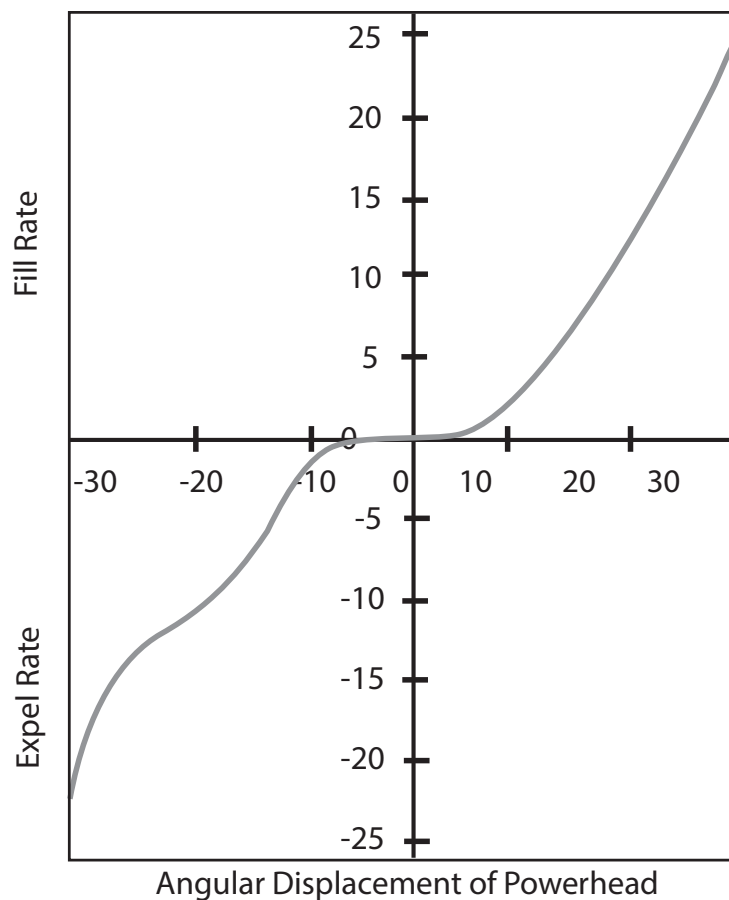


Figure 3-4-3 Command Expel Rate vs. Angular Position
Powerhead in "Fill" Region

When the powerhead tilt sensor senses that the unit is no longer in the inject region, all motion commanded via the control bar will be at a significantly reduced rate. When the control bar is rotated forwards (towards the syringe tip) then the powerhead will transmit a serial message commanding a small positive expel rate. [Scout injection] When the control bar is rotated backwards (away from the syringe tip) then the powerhead will transmit a serial message to the powerpack, commanding a small negative expel rate. [Drawback]

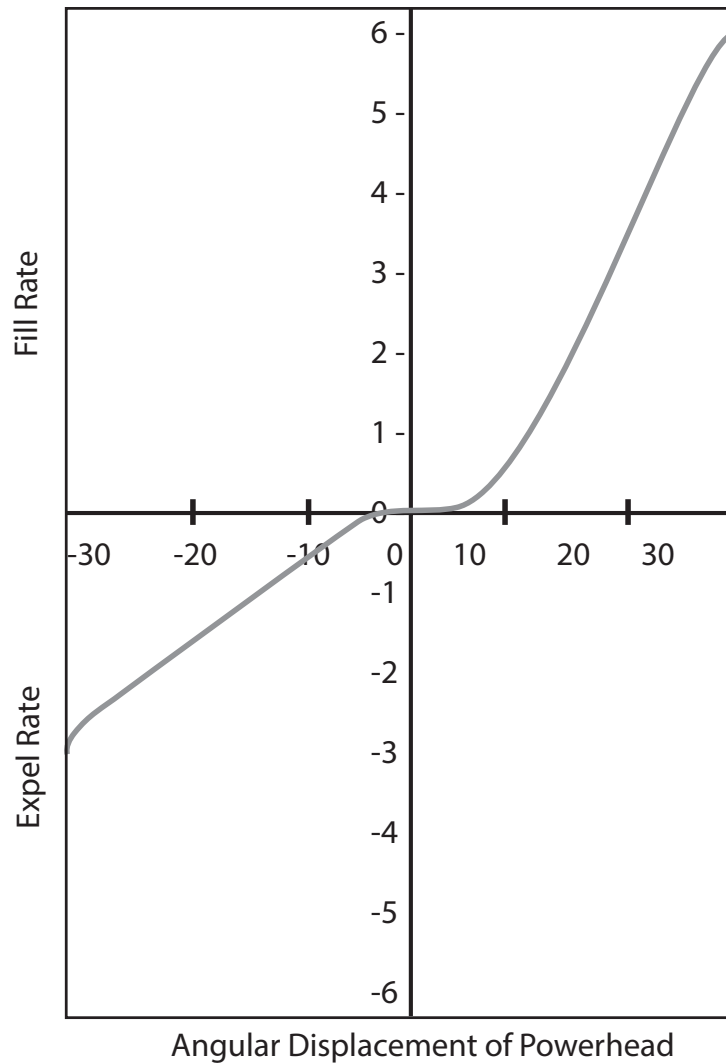


*Figure 3-4-4 Command Fill Rate vs. Angular Position
Powerhead in "inject" Position*

The powerpack deactivates a "SAFE Relay" when no motion is commanded. Figure 3-4-5 illustrates logic to preclude the powerpack from opening the "SAFE Relay" when the control bar is in transition from the first to third quadrants of Figures 3-3-1 and 3-3-2.

Typically, the initial state is "Fill-control bar HOME". The powerhead control bar contains an optoelectronic switch, labelled Home_SW, which is an input to the state diagram. When the control bar is moved forward from its rest position, Home_SW is FALSE, and the software state machine enters the "Command Rate" state. If the operator releases the control bar, the software will command a zero expel rate, and transition to the "Wait_1", "Wait_2" and "Command STOP" states.

If the software is in the "Command Rate" state, and the operator moves the control bar to change the direction of motion, the state machine should transition to "Wait_1", and potentially to "Wait_2" and "Command STOP", but the final state should return to "Command Rate".

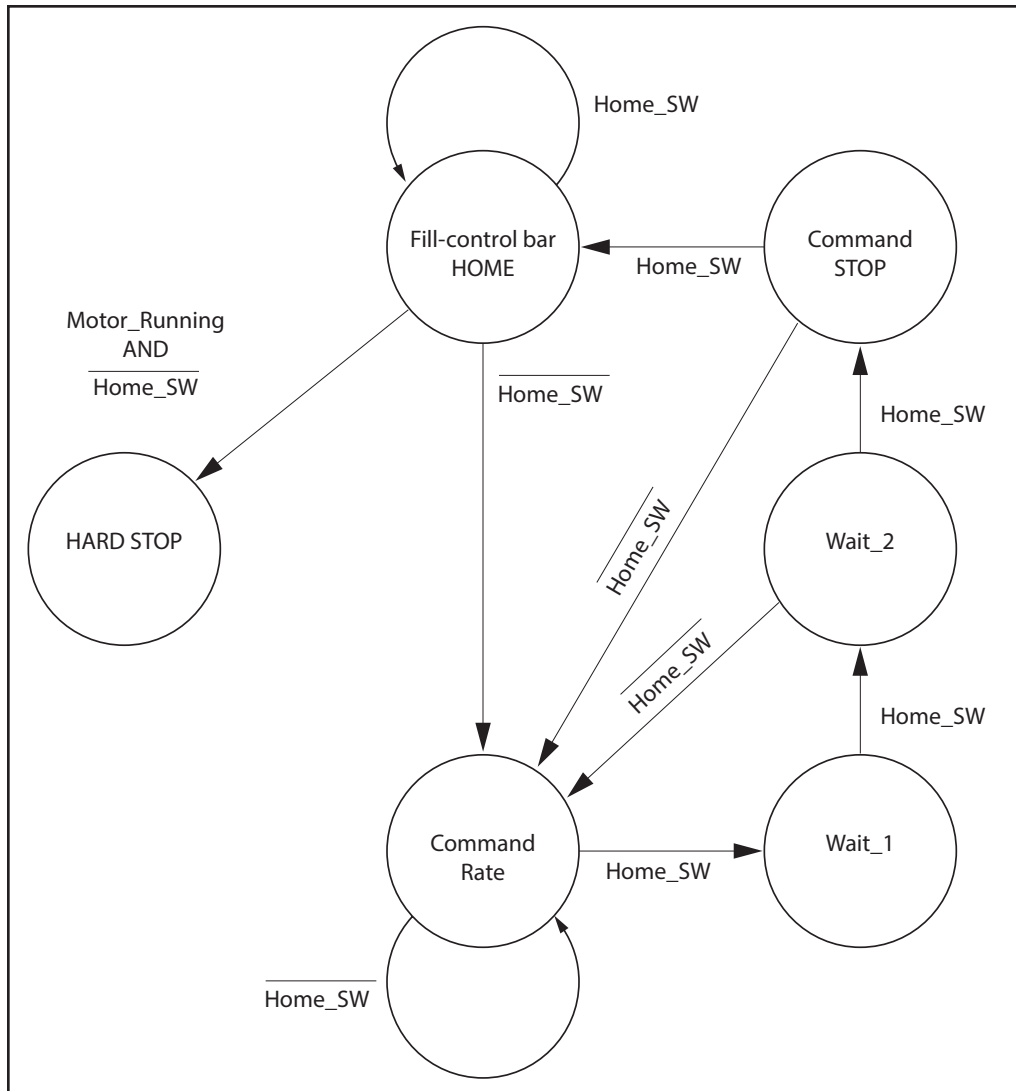


Figure 3-4-5 Logic to Preclude
"SAFE Relay" from Opening

Fill / Expel Control Bar Calibration

Calibration software must store into nonvolatile memory, the minimum and maximum voltage output from the rotary potentiometer, when the control bar is operated to each of the mechanical stops. The calibration software must also store the minimum and maximum potentiometer voltage when the control bar is in the home position. (The home position is a 10 degree dead-zone.)

Contrast Warmer

Functional Requirement - Given an ambient temperature between 18°C and 40°C and an initial contrast temperature of 37°C, the contrast warmer subsystem shall not let the contrast temperature fall below 32°C, within the first hour of operation. Additionally, there will be sufficient redundancy and design restrictions upon the output power, to guarantee that the contrast temperature shall never exceed 40°C, when the initial contrast temperature is 37°C.

Micro controller software will monitor the presence of a heater. The heater may be installed at any time. Software will poll a digital input to detect heater installation. Thermistor tracking, heater blanket current, and heater blanket voltage will be monitored for fault detection. The entire contrast warmer subsystem may be disabled under software control. Variable output power is programmed via TPU pulse width modulation. The PWM frequency > 2 kHz.

If the heater blanket is removed while the injector is still turned on, an overridable error shall be transmitted to the console.

Linear Pot

At power-up, software polls the linear potentiometer to calculate the initial ram position. The calculated value is then converted into an approximate number of encoder pulses from the fully retracted ram location (a.k.a. the ram “home” position). After the initial number of pulses has been calculated, all other volume measurements will be determined by counting encoder pulses.

There is a second use for the linear pot. During all motion, the MC68332 polls the linear pot and the TPU counts encoder pulses. The software continually verifies that the encoder counts and potentiometer resistance are both changing in direct proportion to one another. This is a safety feature that will ensure the motor, gears, ball screw, ram, linear pot, and connecting mechanisms are still working properly.

Encoder

The powerhead drive mechanism utilizes a 512 count/revolution encoder. The encoder provides complementary quadrature outputs and complementary index (1/rev) pulses. The 68332 utilizes 2 channels of the TPU to implement a fast quadrature decode counting algorithm.

A/D Converter

The powerhead utilizes a 12-bit successive approximation topology A/D converter. A precision +5 Volt reference provides excitation to the A/D converter, thermistors, potentiometers, and tilt sensor. Each of these analog sensors is wired to the A/D converter. In addition, heater voltage and current is wired to the A/D converter.

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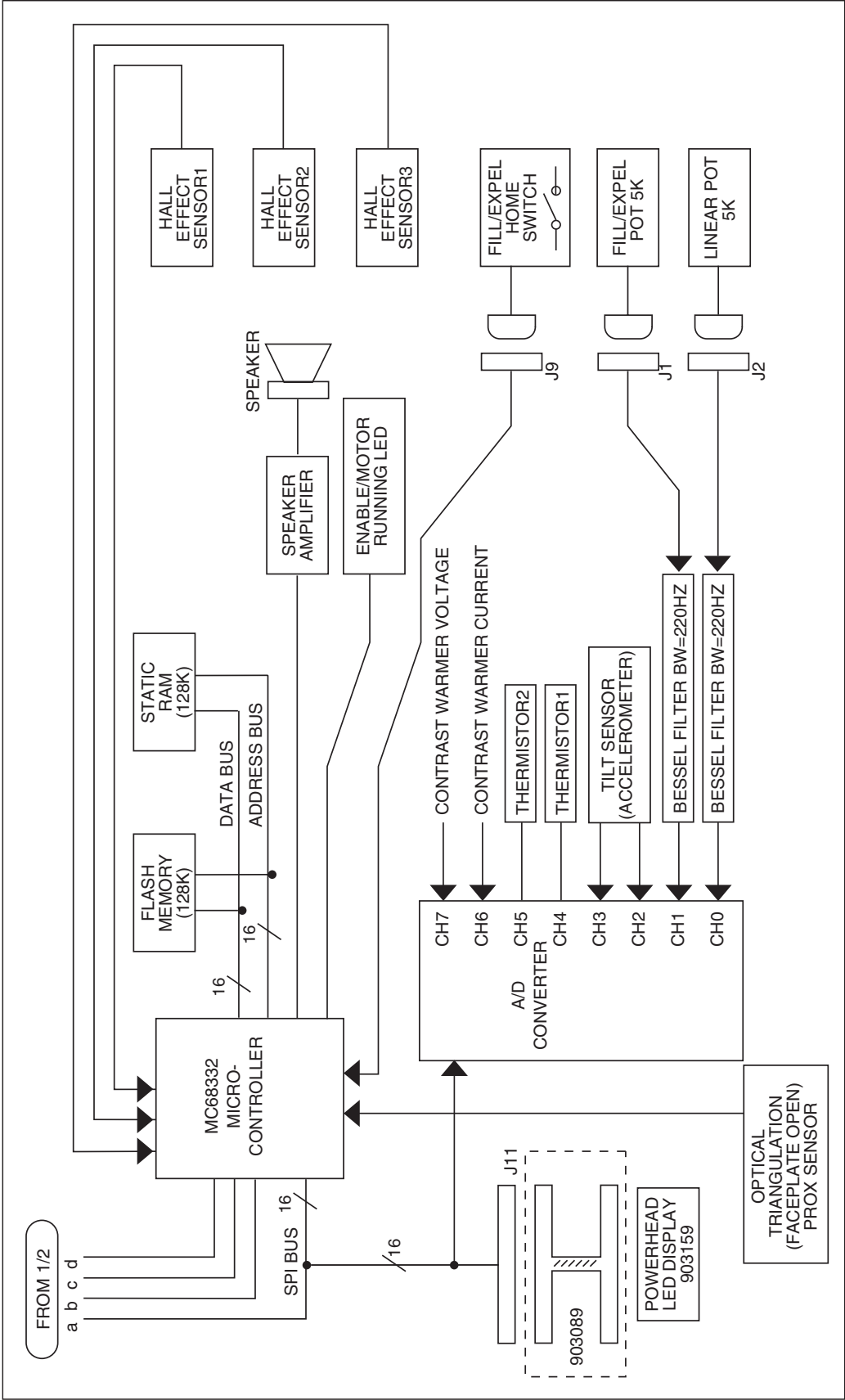


Figure 3-4-7 Powerhead Block Diagram 2/2

4

TROUBLESHOOTING

4.1 GENERAL

The intent of this Chapter is to deliver information to the service technician in order to track a problem to a board or subassembly so it can be replaced or repaired. The Angioma Illumina Contrast Delivery System was designed to display an error number and message, whenever possible, for all error conditions. The error data will be displayed on the console display and powerhead LED display allowing the error to be defined by the injector even if one of the displays is not operational. The console displays the error message and number from the tables in this section. Some error numbers are immediately followed by a two-digit alpha suffix. This suffix is used by Engineering in their analysis of difficult-to-find design errors. It is unlikely the suffix will assist you in troubleshooting the injector. These suffixes are NOT recorded in the Fault History. Please record these suffixes and notify the Service department. The powerhead will display PH for powerhead, PP for powerpack and CON for console errors, along with the error number from the tables.

The powerpack can display only powerpack errors using LEDs, DS1-DS8, on the main CPU board. Error codes are displayed, only if an error has occurred, in hexadecimal patterns on the LEDs, with DS1 being the most significant digit, and DS8 being the least. In normal operation, DS1 flashes at about a 1 second rate, controlled by software. This status "heartbeat" is a quick visual indicator that the software is running.

The Angioma Illumina Contrast Delivery System will encounter fault situations where displaying a message may be impossible or can not be detected by the system. These faults are also addressed in a similar format as the detectable errors. With each fault a summary of the symptoms, probable cause, and corrective action are supplied.

The faults that do not generate messages will be covered first, the second section are the message generating faults and the third section describes the status LEDs on the Servo Interface Board.

The tables in this chapter provide a complete listing of the error numbers or status conditions for the LEDs, probable causes and corrective actions. The assembly and disassembly instructions in this chapter, along with the schematics in Chapter 9 and assembly drawings in Chapter 10, may be required for some of the corrective actions to be performed.

The faults outlined in this chapter are the latest as of the date of this manual. The addition of new faults detected by the Angiomat Illumena Contrast Delivery System may be implemented prior to the release of the next manual update. Whenever possible there will be a message with instructions. If this situation is encountered, or an error message is displayed that is not included in this manual, call the Liebel-Flarsheim Company LLC Service department for further instructions or Order Entry Department to order the latest revision.

4.2 TOOLS AND TEST EQUIPMENT REQUIRED

These tools are required to gain access to the boards and wiring in the Angiomat Illumena Contrast Delivery System for troubleshooting and calibration.

- Metric Hex (Allen) wrench, set
- 1/4 flat blade screwdriver
- Medium Phillips head screwdriver #2
- Metric Nut drivers, set
- Metric Box or Open End wrenches, set
- Oscilloscope, 100 MHz, dual-trace
- Digital Voltmeter, 3-1/2 digit
- 900843, Pressure Test Fixture (Calibration)

CAUTION!

Unplug power cord to disconnect the powerpack from supply mains.

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4.3 GENERAL TROUBLESHOOTING GUIDELINES

1. **Disconnect external equipment.** Be sure to disconnect any film changer, programmer, or other external equipment from the Angiomaat Illumena Contrast Delivery System.
2. Verify the problem. Check the injector under the same conditions and settings that it had when the problem occurred. Then try the injector in an isolated setting, in a different room, to see if the problem can be duplicated.
3. Try different settings. Check the injector with different control settings than it had when the problem occurred. Change the flow rate, volume, and pressure. If another size syringe is available, try it.
4. Perform the System Checks section in Chapter 2 Installation. This is a relatively quick way to check the major functions. This is especially helpful if the accuracy is in question.
5. Visually inspect the subassemblies and components. Before performing electrical tests or calibration procedures, open the powerpack cover and visually inspect all boards and cables. Specifically make sure the integrated circuits are firmly in their sockets; the cable plugs are tight on the boards; connectors are tight, with their wires firmly attached. If the trouble is in the powerhead, open the cover and inspect the powerhead while it operates. Look for loose parts, loose connections, interference, and wear.
6. Isolate the fault. While trying different settings, and under different conditions, try to isolate the specific problem.

CAUTION! ⚠

SHOCK HAZARD.

Be extremely careful when the Angiomaat Illumena Contrast Delivery System is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged in. **DISCONNECT THE POWER CORD BEFORE REMOVING OR REPLACING BOARDS AND HARNESSSES.**

CAUTION! ⚠

SHOCK HAZARD—HIGH VOLTAGE SERVO.

Be extremely careful when troubleshooting the servo section. Lethal voltages are exposed. Be careful when making measurements and inspections. **DISCONNECT THE POWER CORD BEFORE TOUCHING ANY COMPONENTS AND BEFORE REMOVING OR REPLACING THE SERVO INTERFACE BOARD.**

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4.4 FAULTS WITHOUT MESSAGES

ERROR	CORRECTIVE ACTION
Powerpack does not power up.	1. Check power cord. 2. Refer to 'Servo Interface Power Supply Status LED's table in this section. Reference LED # DS3 for corrective action.
Console does not power up system.	1. Check console cable. 2. Check console power switch for momentary contact closure.
Console LCD display does not turn on at power up.	1. Cycle power and verify DS1 is blinking. If not, replace console CPU PCB, download console software and calibrate touchscreen. 2. Check interface harness between LCD PCB and J8 on the console CPU PCB for continuity and board connections. Replace harness if damaged. 3. Check 3.3V LCD power supply at J8 on the console CPU and 12V supply for inverter on J7 PCB. If both are present, replace LCD display assembly. If either or both are missing, replace console CPU PCB, download console software and calibrate touchscreen. If 12V and 3.3 Voltage is good, check inverter On/O⁻ control on J7 pin 1, this should be low. If low carefully check inverter output. If inverter output is good (greater than 900VAC), change LCD module. 4. If the 846101-1 board is installed, verify that DIP switch S2 switch 1 is in the OFF position if using software V9.09 or earlier.
Console touchscreen does not operate.	1. Check interface harness connection from the touchscreen at J3 on the console CPU. 2. Verify touchscreen operation as described: A) Check for open circuits with an ohm meter between Y+ and Y- (pins 4 and 1), SY+ and SY- (pins 3 and 2), X+ and X- (pins 5 and 8) and SX+ and SX- (pins 6 and 7). If any circuits are open, replace touchscreen. B) Check for varying resistance with an ohm meter between Y+ and X+ (pins 3 and 5) while running your finger across the surface of the screen. Repeat for Y- and X- (pins 1 and 8), SY+ and SX+ (pins 3 and 6), and SY- and SX- (pins 2 and 7). If resistance does not vary with finger movement, replace the touchscreen.
Powerhead display blank.	1. Check powerhead display harness for continuity and connection at J11 of the powerhead control PCB and J1 of the LED display PCB. Replace harness if damaged. 2. Check 5V power to the display at J11:1 to AGND at TP4, on the powerhead control PCB. If signal is missing, replace the powerhead control PCB, download powerhead software and calibrate.
Powerhead speaker does not operate.	Replace the powerhead control PCB. Download powerhead software and calibrate.

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4.5 FAULTS WITH MESSAGES

4.5.1 CONSOLE FAULT

ERROR #	MESSAGE	CORRECTIVE ACTION
CON 1000	Console S-record checksum error. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.
CON 1001	Console .software corrupt. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for a new copy.
CON 1002	Invalid CRC value for Console code CYCLE POWER. If problem persists, call service.	Download software, if problem persists replace Console board, download software and calibrate the touch screen.
CON 1003	Console .memory integrity check failed CYCLE POWER. If problem persists, call service.	Download software, if problem persists, replace Console Board, download software and calibrate the touch screen.
CON 1050 thru 1072	Console software corrupt. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.
CON 1073	Powerpack did not respond to enable request. Check Console cable. CYCLE POWER. If problem persists, call service.	Download a valid version of software. If problem persists, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download power pack software. 3. Console Board and download Console software. Calibrate touchscreen. 4. Powerhead Main Control Board, download power head software, and recalibrate injector.
CON 1074	Power Pack sent invalid enable response Check console cable and cycle power. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.
CON 1075	Invalid pressure limit units. Verify displayed pressure value corresponds with units. CYCLE POWER. If problem persist, call service.	If user input is correct, download software. If problem persists replace Console Board, download software and calibrate touchscreen.
CON 1076	Console .software corrupt. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.

RROR #	MESSAGE	CORRECTIVE ACTION
CON 1077	Console detected communication error with the Powerpack. Check cables. CYCLE POWER. If problem persists, call service.	Check cables. If problem persists, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download power pack software. 3. Console Board and download Console software. Recalibrate touchscreen.
CON 1078	Unable to receive protocol list from Powerpack. Check Console cable. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # CON 1073.
CON 1079	Powerpack did not process protocol name correctly. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # CON 1073.
CON 1080	Console software corrupt. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.
CON 1081	Powerpack did not respond to disable request. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # CON 1073.
CON 1082	Console did not receive volume remaining. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # CON 1073.
CON 1083	Console software corrupt. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # CON 1073.
CON 1084	Powerpack did not send achieved values to console. Check cables. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.
CON 1085	Invalid number of phases are being requested. CYCLE POWER. If problem persists, call service.	External equipment interfaced to serial port software error. See manufacturer's data sheets.
CON 1086	Invalid command code was received. CYCLE POWER. If problem persists, call service.	External equipment interfaced to serial port software error. See manufacturer's data sheets.
CON 1087	Powerpack sent corrupt achieved values to console. Check cables. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy.

ERROR #	MESSAGE	CORRECTIVE ACTION
CON 1088	Console did not receive PIC state from Powerpack during power up. Check cables. CYCLE POWER. If problem persists, call service.	Check cable continuity. If cable is operational, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download Powerpack software. 3. Powerhead Main Control Board, download Powerhead software and calibrate injector. 4. Console Board and download Console software and calibrate touch screen.
CON 1089	Console PIC initialized to an improper state. CYCLE POWER. If problem persists, call service.	Check Cables. If problem persists, replace Console CPU Board and download software. If problem persists, replace Communication Board in the Powerpack.
CON 1090	Console PIC has detected an invalid state for the requested action. Check cables. CYCLE POWER. If problem persists, call service.	Check Cables. If problem persists, replace Console CPU Board and download software. If problem persists, replace Communication Board in the Powerpack.
CON 1091	Console software corrupt. CYCLE POWER. If problem persists, call service.	Reload Console Screen Records portion of software.

4.5.2 POWERHEAD FAULTS

ERROR #	MESSAGE	CORRECTIVE ACTION
PH 2001	Powerhead detected open linear position potentiometer. CYCLE POWER. If problem persists, call service.	Check linear pot connection to the Powerhead Main Control Board. If problem persists, replace the linear pot and calibrate injector.
PH 2003	Position pot and encoder tracking failure. CYCLE POWER. If problem persists, call service.	1. Check encoder channels A and B on the Powerhead Control PCB at J5, then J6, with respect to AGND, TP4. The CHANNEL A+ and A- signals are 5vp square waves with respect to ground, TP3, 180 degrees out of phase. The same is true for CHANNEL B+ and B-. If signals fail at J5, the encoder is bad. Call service for recommended replacement assembly. If signals pass at J5 and fail at J6, replace Powerhead Control PCB and calibrate. 2. Check linear pot's resistance range and connection to the Powerhead Main Control Board. If the linear pot is bad, replace and calibrate the Power head. If both are operating properly, re-calibrate Powerhead. If problem persists, replace Main Powerhead PCB and recalibrate.
PH 2004	Powerhead detected open fill-control bar potentiometer. CYCLE POWER. If problem persists, call service.	Either electronically center pot or replace the pot.
PH 2005	Powerhead detected shorted fill control bar potentiometer. CYCLE POWER. If problem persists, call service.	Replace the pot.
PH 2010	Powerhead detected that the A/D reference voltage is out of range. CYCLE POWER. If problem persists, call service.	Replace Powerhead Main CPU PCB, download software and calibrate injector.
PH 2011	Powerhead detected that the till sensor is out of calibration. CYCLE POWER. If problem persists, call service.	Calibrate Powerhead. If problem persists, replace the 903040-1 circuit board. Download software and calibrate the injector.
PH 2015	Powerhead PIC detected an open faceplate. Close and press OVERRIDE key to continue. If problem persists, call service.	Check the syringe door locking lever assembly for the flag rotating into the opto interrupter channel. If problem persists, replace Powerhead Main Control Board, download software and calibrate injector.
PH 2016	PIC detected a runaway motor condition. CYCLE POWER. If problem persists, call service.	Cycle power. If problem persists, replace Powerhead Main Control Board, download software, and recalibrate injector.

ERROR #	MESSAGE	CORRECTIVE ACTION
PH 2017	Powerhead detected an invalid PIC state. CYCLE POWER. If problem persists, call service.	Cycle power. If problem persists, replace Powerhead Main Control Board, download software and calibrate injector.
PH 2018	Powerhead received an illegal code from PIC. CYCLE POWER. If problem persists, call service.	Cycle power. If problem persists, replace Powerhead Main Control Board, download software and calibrate injector.
PH 2019	Powerhead detected a failure in the fill-control mechanism. CYCLE POWER. If problem persists, call service.	Check rotary pot coupling for signs of slippage. Tighten assembly and recalibrate. If problem persists, replace rotary pot and calibrate the injector.
PH 2020	Powerhead memory integrity check failed. CYCLE POWER. If problem persists, call service.	Download software. If problem persists, replace Powerhead Main Control Board, download software and calibrate the injector.
PH 2021	Invalid CRC value for Powerhead code. CYCLE POWER. If problem persists, call service.	Download software, if problem persists replace Powerhead Main Control board, download software and calibrate power head.
PH 2022	Volume delivered exceeded programmed volume. CYCLE POWER. If problem persists, call service.	Refer to 'Servo Interface Power Supply Status LED's' table in this section. Reference LED # DS 12 for corrective action in Section 4.6.
PH 2023	Actual flow rate delivered exceeded programmed rate. CYCLE POWER. If problem persists, call service.	Refer to 'Servo Interface Power Supply Status LED's' table in this section. Reference LED # DS 12 for corrective action in Section 4.6.
PH 2025	Powerhead Calibration not within safe range. Call Service.	Recalibrate injector. If problems persists replace Powerhead Control Board and calibrate.
PH 2026	Defective tilt sensor. CYCLE POWER. If problem persists, call service.	Replace Powerhead main CPU PCB, download software and calibrate injector.
PH 2027	Powerhead did not receive PIC state from Powerpack during power up. Check cables. CYCLE POWER. If problem persists, call service.	Check cable continuity. If cable is operational, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download Powerpack software. 3. Powerhead Main Control Board, download power head software and calibrate injector. 4. Console Board and download Console software and calibrate touch screen.

ERROR #	MESSAGE	CORRECTIVE ACTION
PH 2028	Powerhead detected the motor moving in the wrong direction. CYCLE POWER. If problem persists, call service.	Troubleshoot encoder and motor wiring.
PH 2029	Powerhead detected invalid faceplate I.D. Remove faceplate, close faceplate lever then cycle power. If problem persists, call service.	Cycle power. If problem persists replace Powerhead Main Control circuit board, download software and calibrate.
PH 2030	Powerhead lost communication with the Powerpack. Check Powerhead cable and cycle power. If problem persists, call service.	Verify cable continuity. If problem persists: 1. Replace the Communications Board and retry. 2. Replace the Powerhead Control Board, download software and retry. If problem is fixed, calibrate injector, else replace the Powerpack Control Board, download software and calibrate injector.
PH 2031	Powerhead PIC is not in the state than the main CPU expected. CYCLE POWER. If problem persists, call service.	Cycle power. As a test trial, run a programmed injection. If PH2031 persists, troubleshoot wiring to connector J6, pins 5 and 6 of Powerhead Main Control assembly. If no shorts/opens are found in PIC communication cabling, replace Powerhead Main Control circuit board.
PH 2032	Fill/Expel bar pressed at power up. Cycle Power. If problem persists, call service.	Troubleshoot Fill/Expel Switch circuitry. Replace Fill/Expel Switch.

4.5.3 POWERPACK FAULTS

ERROR #	MESSAGE	CORRECTIVE ACTION
PP Control Board LEDs 10101010	Watchdog activated. Injector inoperable. Call Service.	Reload software. If failure persists, software may be corrupt. Call service for new copy. If problem persists, replace Powerpack Main Control Board and download software.
PP 0001a PP 0001b PP 0001a PP 0001b	Communication with other Console has been lost. Check cables. CYCLE POWER. If problem persists, disconnect failed Console, CYCLE POWER, and call service. <i>CON1 did not return to the Main screen within 25 minutes after an injection. This Alarm is usually the result of a previous Alarm occurring during an injection.</i> <i>Regular Lost Communication with CON1 Alarm</i>	Verify cable continuity. If problem persists turn power off, switch Console port connections and retry. If the same Console fails replace its Console Board. If the working console fails: 1. Replace the Communications Board and retry. 2. Replace the Powerpack Control Board and download software.
PP 0002a PP 0002b PP 0002a PP 0002b	Communication with other Console has been lost. Check cables. CYCLE POWER. If problem persists, disconnect failed Console, CYCLE POWER, and call service <i>CON2 did not return to the Main screen within 25 minutes after an injection. This Alarm is usually the result of a previous Alarm occurring during an injection.</i> <i>Regular Lost Communication with CON2 Alarm</i>	Verify cable continuity. If problem persists turn power off, switch Console port connections and retry. If the same Console fails replace its Console Board. If the working console fails: 1. Replace the Communications Board and retry. 2. Replace the Powerpack Control Board and download software.
PP 0003	Communication between the Powerpack and Powerhead has been lost. Check cables. CYCLE POWER. If problem persists, call service.	Verify cable continuity. If problem persists: 1. Replace the Communications Board and retry. 2. Replace the Powerhead Control Board, download software and retry. If problem is fixed, calibrate injector, else replace the Powerpack Control Board, download software and calibrate injector. 3. If a PP 0003 error occurs and all of the Powerhead Display LED's are also turned ON and not flashing, then the Powerhead Board ID Resistors are not in a valid range. Replace the Powerhead Control Board.
PP 0004	Servo DAC failed. CYCLE POWER. If problem persists, call service.	Replace Servo Interface Board.
PP 0005b %V PP 0005c %V PP 0005d %V PP 0005e %V PP 0005b %V PP 0005c %V PP 0005d %V PP 0005e %V	Safe relay failure. CYCLE POWER. If problem persists, call service. <i>Safe Relay failure while Enabling where %V is the Servo Voltage</i> <i>Safe Relay failure on power-up during hardware_check() where %V is the Servo Voltage</i> <i>Safe Relay failure re-enabling in Angio Mode where %V is the Servo Voltage</i> <i>Safe Relay failure re-enabling in CT Mode where %V is the Servo Voltage</i>	See "Servo Interface Board power supply status LEDs" table in section 4.6. Reference DS 1 and DS 2.

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0006	+24VDC Powerpack and Powerhead power supply failure. CYCLE POWER. If problem persists, call service.	See "Servo Interface Board power supply status LEDs" table in Section 4.6. Reference DS7"
PP 0007	+24VDC Console power supply failure. CYCLE POWER. If problem persists, call service.	Turn power off and remove Console cable and verify the Console cable continuity. Replace cable if faulty. If cable passes, verify power output from the Communication Board. With cable still removed, turn on main power. Using a non conductive rod, activate SW1 on the Servo Interface Board. If DS3 through DS10 are not on, see "Servo Interface Board power supply status LEDs" table in this section, reference DS6. If LEDs are on, continue. Verify 24VDC on the Communication Board at J6 and J7, pins 18 and 19 to grounds on pins 14-17. If voltage is not present the problem is either the supply harness to the Communication Board at J10, or the Communication Board. If 24V is present, remove power, disconnect and check the Console power switch for a momentary contact closure with each press and release of the button. If switch fails, replace it and if switch passes, the problem is either the Console Board or the Console communication harness assembly. Replace failed component. If Console Board was replaced, re-calibrate the touch screen.
PP 0008	Powerpack A/D failure. CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board and download software. If problem persists, replace Servo Interface Board.
PP 0009	Servo Controller Chipset failure CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board and download software.
PP 0010	Powerpack never established communication with the Console. Check cables. CYCLE POWER. If problem persists, call service.	Verify cable continuity. If problem persists turn power off, connect the Console to the unused console port on the Powerpack and power up the injector. If Console operates replace the Communications PCB. If Console does not: 1. Replace the Communications Board and retry. 2. Replace the Powerpack Control Board, download software and retry. 3. Replace the Console Board, download software and calibrate injector.

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0011	Powerpack lost communications with the Auxiliary Port. Check cables. CYCLE POWER. If problem persists, call service.	Check auxillary device for proper operation as specified in the product documentation. If problem persists, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download Powerpack software
PP 0012a PP 0012b PP 0012c PP 0012d	Encoder pulses not received by Powerpack. Turn off power, check cable connections, turn on power. If problem persists call service.	See PP26 for corrective action.
<i>PP 0012a</i>	<i>Servo Error when starting ram movement with Fillbar when not Enabled</i>	
<i>PP 0012b</i>	<i>Servo Error while moving ram with Fillbar when not Enabled</i>	
<i>PP 0012c</i>	<i>Servo Error when starting ram movement via Programmed Injection or Fillbar when Enabled</i>	
<i>PP 0012d</i>	<i>Servo Error while moving ram via Programmed Injection or Fillbar when Enabled</i>	
PP 0013	Powerpack never established communications with the Powerhead. Check cables. CYCLE POWER. If problem persists, call service.	Check cable continuity. If cable is operational, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download Powerpack software 3. Powerhead Main Control Board, download power head software and calibrate injector. 4. Console Board and download Console software and calibrate touch screen.
PP 0014	Servo current feedback has failed CYCLE POWER. If problem persists, call service.	Replace Servo Interface Board.
PP 0015	Secondary pressure limit circuit failed. CYCLE POWER. If problem persists, call service.	Replace Servo Interface Board.
PP 0016	Actual flow rate exceeded programmed rate. CYCLE POWER. If problem persists, call service.	Refer to 'Servo Interface Power Supply Status LED's' table in Section 4.6. Reference LED # DS12 for corrective action.

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0017La %V PP 0017Ha %V PP 0017Lb %V PP 0017Hb %V PP 0017Lc %V PP 0017Hc %V PP 0017La %V PP 0017Ha %V PP 0017Lb %V PP 0017Hb %V PP 0017Lc %V PP 0017Hc %V	Servo supply voltage out of tolerance. Turn off circuit breaker, wait 10 seconds, then power up the injector. If problem persists, call service. <i>Servo voltage too Low during PIC Test on power-up where %V is the Servo Voltage</i> <i>Servo voltage too High during PIC Test on power-up where %V is the Servo Voltage</i> <i>Servo voltage too Low during check_safe_rly() Test on power up where %V is the Servo Voltage</i> <i>Servo voltage too High during check_safe_rly() Test on power up where %V is the Servo Voltage</i> <i>Servo voltage too Low during check_servo_power() Test on power up where %V is the Servo Voltage</i> <i>Servo voltage too High during check_servo_power() Test on power up where %V is the Servo Voltage</i>	Replace Servo Interface Board.
PP 0018a PP 0018b PP 0018c PP 0018d PP 0018e PP 0018a PP 0018b PP 0018c PP 0018d PP 0018e	Servo Amplifier failure. CYCLE POWER. If problem persists, call service. <i>Servo Amp failure during comm_check() on power up. Servo Power Supply Is OK.</i> <i>Servo Amp failure during hardware_check() when Enabling</i> <i>Servo Amp failure during hardware_check() on power up</i> <i>Servo Amp failure during hardware_check() when re-enabling in Angio Mode</i> <i>Servo Amp failure during hardware_check() when re-enabling in CT Mode</i>	Refer to 'Servo Interface Power Supply Status LED's' table in this section. Reference LED # DS 12 for corrective action.
PP 0019	Watchdog timer failed at power up CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board, reload software and check calibration.
PP 0020	Powerpack Flash memory check failed. CYCLE POWER. If problem persists, call service.	Download software, if problem persists, replace Powerpack Main Control board and download software.
PP 0021	Powerpack NVRAM check failed CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board and download software and verify calibration.
PP 0022	Powerpack RAM check failed CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control board and download software and verify calibration.
PP 0023	Invalid CRC value for powerpack code. CYCLE POWER. If problem persists, call service.	Download software, if problem persists replace Powerpack Main Control Board, download software and calibrate power head.

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0024	Actual volume delivered exceeded programmed volume. CYCLE POWER. If problem persists, call service.	Refer to 'Servo Interface Power Supply Status LED's' table in this section. Reference LED # DS 12 for corrective action.
PP 0026a PP 0026b PP 0026c PP 0026d PP 0026e PP 0026a <i>Encoder Status failure during comm_check() on power up. PIC Test failed first.</i> PP 0026b <i>Encoder Status failure during hardware_check() when Enabling</i> PP 0026c <i>Encoder Status failure during hardware_check() on power up</i> PP 0026d <i>Encoder Status failure during hardware_check() when re-enabling in Angio Mode</i> PP 0026e <i>Encoder Status failure during hardware_check() when re-enabling in CT Mode</i>	Encoder pulses not received by Powerpack. Turn off power, check cable connections, turn on power. If problem persists call service.	Refer to 'Servo Interface Power Supply Status LED's' table in this section. Reference LED # DS 12 for corrective action.
PP 0040	Powerhead did not return ram position and face plate ID. Check Powerhead cable and cycle power. If problem persists, call service.	Reload software in Powerpack and Powerhead. If problem persists, software may be corrupt. Call service for new copy. If problem persists, replace Powerpack Main Control Board and download software. If problem persists, replace Powerhead Main Control Board, download software and calibrate.
PP 0041	Powerhead did not return system information. Check Powerhead cable and cycle power. If problem persists, call service.	
PP 0042	Powerhead did not return enable status. Check Powerhead cable and cycle power. If problem persists, call service.	
PP 0043	Powerhead did not return calibration values. Check Powerhead cable and cycle power. If problem persists, call service.	
PP 0044	Powerhead reported invalid faceplate ID or out of range RAM position. Remove faceplate, close faceplate latch, position ram flush with frame and cycle power. If problem persists, call service.	

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0045	Pressure calibration values are corrupt. CALIBRATION REQUIRED. CYCLE POWER. If problem persists, call service.	Calibrate pressure. If problem persists: 1. Replace Powerhead Main Control Board, download software calibrate injector and retry. 2. Download Powerpack software and retry. 3. Replace Powerpack Main Control Board, download software and calibrate injector.
PP 0050	Powerpack PIC state did not agree with Powerpack CPU state or illegal transition of states occurred. CYCLE POWER. If problem persists, call service.	Reload software. If failure persists, software may be corrupt. Call service for new copy. If problem persists, replace boards one at a time and check injector function between each installation. 1. Communication Board. 2. Powerpack Main Control Board and download power pack software. 3. Powerhead Main Control Board and download console software and calibrate.
PP 0051a PP 0051b PP 0051c PP 0051d	Powerpack PIC fault on power up test. CYCLE POWER. If problem persists, call service.	1. If DS 12 is OFF, refer to DS 12. 2. Check harness between Communication and Main Control PCBs in the Powerpack.
PP 0051a	<i>PIC Test Failure. The Motor_Running signal was not present during the PIC test.</i>	3. Connect scope to the Motor Running signal on the Servo Interface PCB at TP5 to ground, TP3, and cycle power. The signal is correct if it toggles low for approximately 100mS, then high. If signal is present at TP5, replace Communication PCB.
PP 0051b	<i>PIC Test Failure. PIC communications failed to occur within the 2 second timeout window.</i>	If signal toggles and remains low until failure occurs, replace boards one at a time and check for failure between each installation.
PP 0051c	<i>PIC Test Failure. The Motor_Running signal was present during the PIC test, but the Servo Amp could not be disabled.</i>	A. Communication PCB.
PP 0051d	<i>PIC Test Failure. Pass one and pass two of the PIC test resulted in different failures.</i>	B. Main Control PCB and download software. If signal does not toggle low, remains high, check the Servo Amplifier's MOTOR+ referenced to MOTOR- on P2. Cycle power and watch the scope for a pulse, may be as narrow as .5uS, at a frequency of 22kHz. If signal is present, replace Servo Interface PCB, if not, replace Servo Amplifier.

ERROR #	MESSAGE	CORRECTIVE ACTION
PP 0052	Powerpack PIC detected a fault. CYCLE POWER. If problem persists, call service.	1. Cycle power. 2. If error PP 51 occurs, see Corrective Action of Error # PP 51. 3. If error PP 52 occurs again, see Corrective Action of Error # PP 50.
PP 0053	Powerhead PIC detected a fault CYCLE POWER. If problem persists, call service.	1. Cycle power. 2. Actuate fill-control bar. If error persists, reload software in Powerhead and Powerpack.
PP 0054	Motor turning signal generated by the servo chipset is not active. CYCLE POWER. If problem persists, call service.	1. Replace powerpack main control board. Reload software and check calibration. 2. If PP54 persists, replace Communications Board.
PP 0055	Powerpack PIC detected a fault. CYCLE POWER. If problem persists, call service.	1. Cycle power. 2. If error PP 51 occurs, see Corrective Action of Error # PP 51. 3. If error PP 55 occurs again, see Corrective Action of Error # PP 50.
PP 0090	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Reload software in Powerpack. If failure persists, software may be corrupt. Call service for new copy. If failure persists, replace Powerpack Main Control Board and download software. If failure persists, replace Powerhead Main Control Board, download software and calibrate.
PP 0091	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # PP 90.
PP 0092	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # PP 90.
PP 0093	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # PP 90.
PP 0094	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # PP 90.
PP 0095	Servo State Machine Error. CYCLE POWER. If problem persists, call service.	Refer to Corrective Action of Error # PP 90.
PP 0099	Machine mode corrupt. CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board, reload software and check calibration.
PP 0100	Protocol library corrupt. Powerpack NVRAM error. CYCLE POWER. If problem persists, call service.	Replace Powerpack Main Control Board, reload software and check calibration.

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4.6 SERVO STATUS LED'S

SERVO INTERFACE BOARD POWER SUPPLY STATUS LEDs				
Prior to performing any corrective action in this section, verify the main power switch / breaker, on the power pack, indicator light is on. If indicator is off, replace the failed component between the AC power cord up to the switch/breaker.				
LED #	FUNCTION	OPERATION	PROBLEM	CORRECTIVE ACTION
DS 1 DS 2	Safe relay active	On power up DS 1 flashes then DS 2 then both. When both are on a momentary relay closure of K3 should occur, then both turn off with the relay relaxing.	No LED on power up	EPLD failure, replace Main CPU board.
			One LED on power up	Replace Servo Interface board
			Relay does not close when both LEDs are on	Check DS 12. If DS 12 is on. Bad relay K3, replace Servo Interface board. If DS 12 is off, see DS 12 corrective action.
DS 3	+5VDC	With main power on, DS 7, DS 8 and DS 14 are on, DS 3 through DS 6, DS 9 and DS 10 should turn on when either the Console switch or SW1 on the Servo Interface Board are activated.	DS 3 does not light	1. If all LEDs DS 7, DS 8 and DS 14 are off with the main circuit breaker on, verify 24V DC supply output is present at the Servo Interface Board at J3. If the 24VDC is present, replace the Servo Interface Board. If 24VDC is not present, verify LINE VOLTAGE is present at the 24V DC supply input. If LINE VOLTAGE is present, replace 24V supply or DC Supply harness to the Servo Interface Board, whichever failed. If voltage is not present, trace LINE VOLTAGE from the AC Inlet through the breaker, line filter to the 24VDC supply and replace failed component. 2. If only one or two of the LED's DS 7, DS 8 and DS 14 are on with the main circuit breaker on, replace Servo Interface Board. 3. If all LEDs DS 7, DS 8 and DS 14 are on and any of the LEDs, DS 3 through DS 6, DS 9 and DS 10, are off after SW1 or Console switch is activated, check corresponding relay (K) and replace if failed. Check if coil is energized first, then for contact closure. DS to K relation: DS 3, DS 4, DS 5, DS 9 and DS 10, check K 1 DS 6, check K 2 4. All Relays function, replace the Servo Interface Board.

SERVO INTERFACE BOARD POWER SUPPLY STATUS LEDs

Prior to performing any corrective action in this section, verify the main power switch / breaker, on the power pack, indicator light is on. If indicator is off, replace the failed component between the AC power cord up to the switch/breaker.

LED #	FUNCTION	OPERATION	PROBLEM	CORRECTIVE ACTION
DS 4	+15VDC	Same as DS3	DS 4 does not light	Same as DS 3
DS 5	+24VDC		DS 5 does not light	
DS 6	24VDC Console		DS 6 does not light	
DS 7	24VDC Unswitched	With power on DS 7, DS 8 and DS 14 should be on and remain on when SW1, on Servo Interface Board or the console switch are activated.	DS 7 does not light	Verify 24V DC supply output is present at the Servo Interface Board at J3. If 24VDC is present, replace board. If 24VDC is not present, verify LINE VOLTAGE is present at the 24V DC supply input. If LINE VOLTAGE is present, replace 24V supply or DC Supply harness to the Servo Interface Board, whichever failed. If voltage is not present, replace harness assembly between the breaker and 24VDC supply.
DS 8	5VDC Unswitched		DS 8 does not light	
DS 9	-15VDC	Same as DS 3	DS 9 does not light	Same as DS 3
DS 10	Communication Bd. 24V	Same as DS 3	DS 10 does not light	Same as DS 3 plus check fuse F3
DS 11	Servo Amplifier Enable	DS 11 should be on whenever the motor is moving. When DS 11 is on, Servo amplifier status LED should be green. DS 11 is off, Servo amplifier status LED should be red.	DS 11 not on	1. Check DS 12, if off go to DS 12 procedure, else continue. 2. Turn power off and wait for status LED on Servo Amplifier to turn off (30 to 45 seconds). Connect the positive input of a volt meter or scope to TP4. and the negative probe to TP3 or the chassis. Turn power on and wait for injector to initialize. Use the fill bar to start and stop the motor while watching the scope/meter. The signal should toggle as the fill bar passes through the home (rest) position. If there is no change in the signal state, the most likely failed board is the main Control Board. There is still a slight chance a trace is broken on the interface board, but not likely. If the signal toggles, replace the Servo Interface Board.

SERVO INTERFACE BOARD POWER SUPPLY STATUS LEDs

Prior to performing any corrective action in this section, verify the main power switch / breaker, on the power pack, indicator light is on. If indicator is off, replace the failed component between the AC power cord up to the switch/breaker.

LED #	FUNCTION	OPERATION	PROBLEM	CORRECTIVE ACTION
DS 11 and Servo Amplifier Status LED	Servo Amplifier Enable	Same as DS 11	Servo amplifier status LED not on	Verify 100VDC on P2 of the Servo Amplifier (signal names printed on amplifier). If 100VDC is present, replace the Amplifier and if not, replace the Servo Interface Board.
			DS 11 and Servo Amplifier status LED out of sequence	1. Check AMP_ENABLE signal at J10:11, it should read low when DS 11 is on. If not, replace Servo Interface board.
			DS 11 is on but servo Amplifier status LED does not change state	2. Check signal on servo amplifier P1:11 for same condition. If present replace Servo Amplifier, else replace harness.
DS 12	Encoder Status	DS 12 on when encoder is connected and operating properly	DS 12 off	1. Check Powerhead cable connection to Powerpack. 2. Check Powerpack connection of harness and encoder signals at J7:4 - J7:7. The ENCODER A+ and A- signals are 5vp square waves with respect to ground, TP3, 180 degrees out of phase. The same is true for ENCODER B+ and B-. If above conditions pass, replace Servo Interface Board. 3. Trace encoder signals through Powerhead harness mounted to the Powerpack chassis. If signals are present, replace harness. 4. Check encoder channels A and B on the Powerhead Control PCB at J5, then J6, with respect to AGND, TP4. Signals should be the same as in step 2. If signals fail at J5, the encoder is bad. Call service for recommended replacement assembly. If signals pass at J5 and fail at J6, replace Powerhead control PCB and calibrate. If signals pass at both, replace Powerhead cable assy.
DS 14	Remote Power Up Circuit	Same as DS 7.	DS 14 does not light	Same as DS 7

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5

CALIBRATION

THIS SECTION REFERENCES ENGLISH MODE ONLY

5.1 OVERVIEW

5.1.1 USE OF THE SERVICE KEY

The “Service Key” is connected to the Universal Interface to access the System Calibration screens. See Section 5.2 for instructions on how to install the “Service Key” on your injector.

5.1.2 FREQUENCY OF CALIBRATION

The Angiomat Illumena Contrast Delivery System should be calibrated at least every 2 years or whenever a part or component that is used for pressure limiting or ram location has been replaced. This system calibration is used for all models.

CAUTION! ⚠

The 900843 Calibration Fixture should be dried after every use. Open each valve individually and run several injections of air through each orifice. Then open all valves and run a few more air injections. After the Fixture is dry, store the Fixture with all valves open.

NOTE: If a new powerhead board, (P/N 903005-1 and 903040-1), has been installed, ensure that the Faceplate Sensor Jumpers are in the “STANDARD UNIT” configuration. Refer to section 3.4.1.3 for additional information.

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5.2 ACCESSING SERVICE MODE OF THE INJECTOR

The Angiomat Illumena Contrast Delivery System is calibrated through the use of the System Calibration screens in the Service Mode. To access these screens:

1. Turn the injector OFF by toggling either the main breaker located on the front of the powerpack or the console switch located in the upper right corner of the console.
2. Model 900002 and 900006 (powerpack REF # 901100): Remove the cover on the powerpack. Insert the 16-pin single-row "Service Key" (P/N 904061) into the Universal Interface connector located inside the powerpack on the back of the Communications Board.

All other models (powerpack REF # 901000): Insert the 25-pin D-shell "Service Key" connector (P/N 904019) into the Universal Interface connector (J2) located on the rear of the powerpack.

3. Return power to the injector by toggling the main breaker and turning the console ON. The screen in Figure 5-2-1 will be displayed. **NOTE:** The injector should be serviced only when the System Calibration Screen is in English. If the System Calibration Screen is not in English, remove the Service Key, cycle power, set the language to English, re-install the Service Key and power back up in Service Mode.

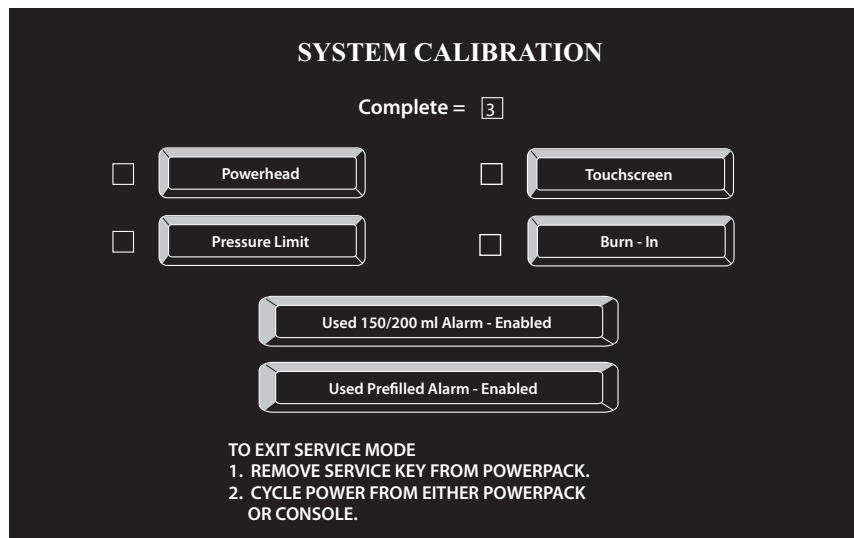


Figure 5-2-1 System Calibration Screen in the Service Mode

NOTE: As of V9.06 software, information located on the powerhead display will no longer flip when the powerhead is rotated below the horizontal when in Service Mode.

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5.3 CALIBRATING THE CONSOLE SCREEN

1. To start the console calibration sequence, press the [Touchscreen] key located in the upper right hand corner of the System Calibration Screen (see Figure 5-2-1).

NOTE: *To prevent damage to the console during screen calibration, use a dull lead pencil or a ball point pen with a medium point.*

2. Gently touch the point of the pencil or pen to the intersection of the half cross (i.e., screen calibration point) and press lightly against the screen. A new half cross will appear on the screen. In all, four calibration points will appear in the following sequence: left, right, bottom, and top.

NOTE: *If you touch the screen in an area that is out of the range of the calibration point, the console will emit an audible beep. This beep indicates that another touch is required for accurate screen calibration. If a third attempt to touch the screen at a particular calibration point results in an "out of range" reading, a "typical" point will be assigned, and the next calibration point will be displayed.*

3. After all four calibration points have been touched, the screen will automatically change to a check board pattern and then revert to the System Calibration Screen.



Figure 5-3-1 Calibrating the Screen

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5.4 CALIBRATING THE POWERHEAD

1. To start the powerhead calibration sequence, press the [Powerhead] key located in the upper left hand corner of the System Calibration Screen (see Figure 5-2-1). Follow the instructions on the screen in Figure 5-4-1. When you have completed these instructions, press the [Continue] key.

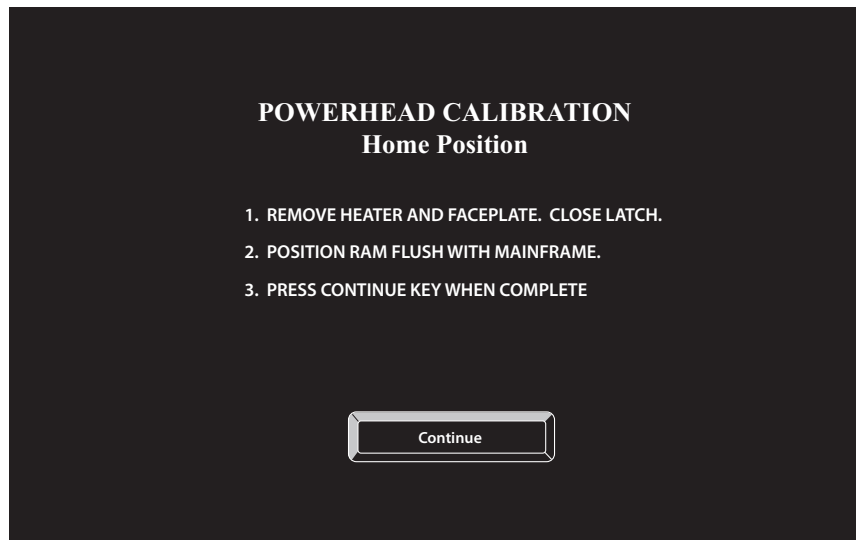


Figure 5-4-1 Home Position Calibration (Powerhead)

2. The 90° Position Powerhead Calibration screen, shown in Figure 5-4-2, will then be displayed. Follow the instructions on the screen in Figure 5-4-2 and then press the [Continue] key.

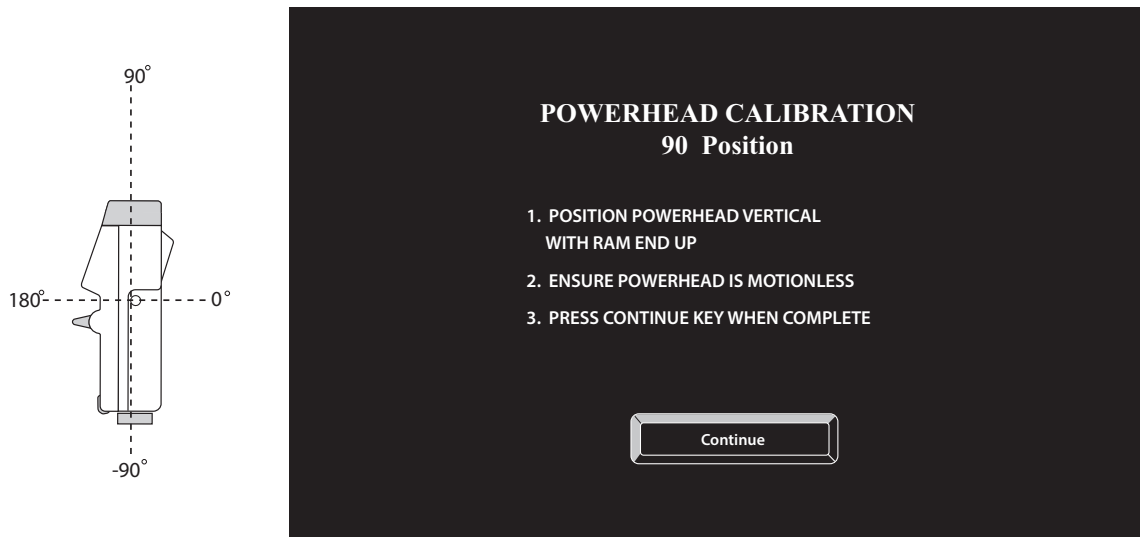


Figure 5-4-2 90° Position Calibration (Powerhead)

3. The -90° Position Powerhead Calibration screen, shown in Figure 5-4-3, will then be displayed. Follow the instructions contained in Figure 5-4-3 and then press the [Continue] key.

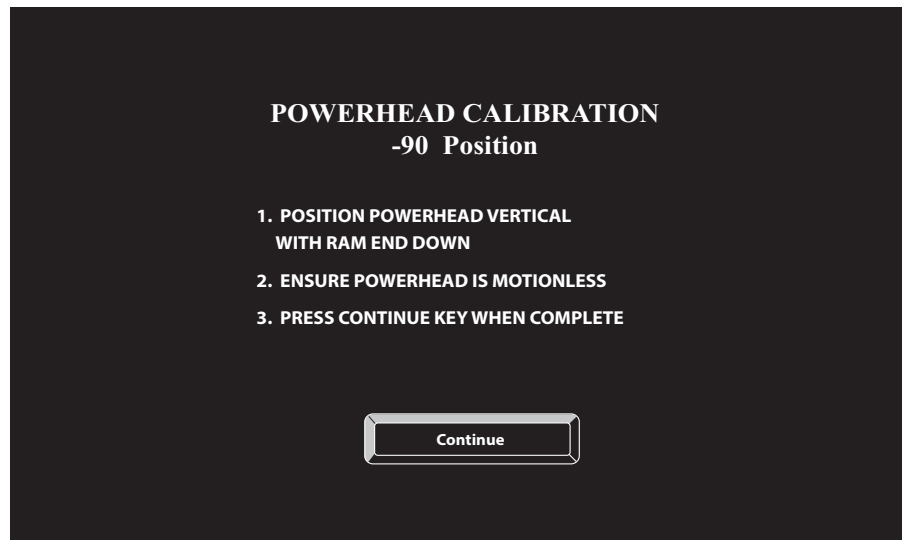
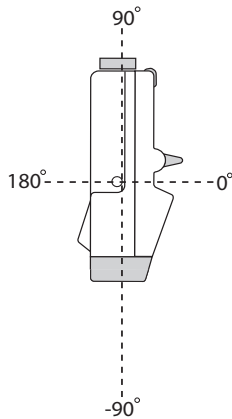


Figure 5-4-3 -90° Position Calibration (Powerhead)

4. The Forward Limit Powerhead Calibration screen shown in Figure 5-4-4 will then be displayed. Follow the instructions contained in Figure 5-4-4 and then press the [Continue] key.

NOTE: Ensure that the Position Gauge is placed over the powerhead ram as shown in Figure 5-4-5.

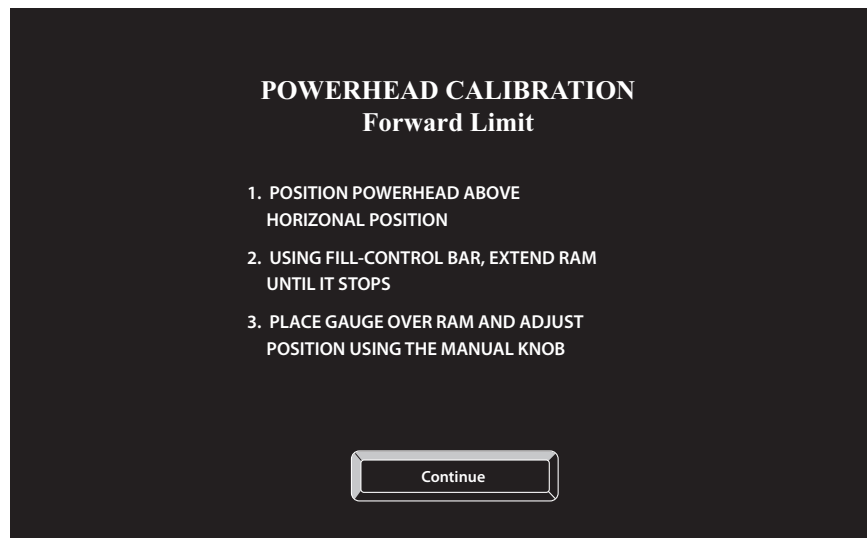
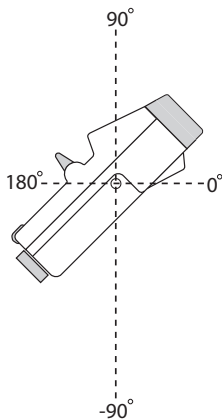


Figure 5-4-4 Forward Limit Calibration (Powerhead)

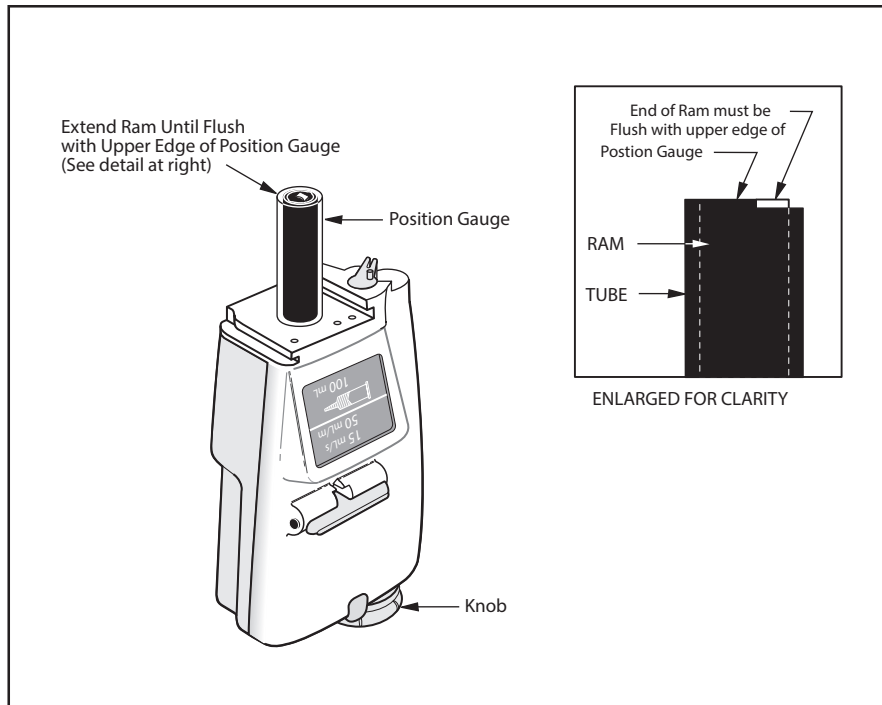


Figure 5-4-5 Using the Ram Position Gauge

5. The Fill/Expel Position Powerhead Calibration screen, as shown in Figure 5-4-6, will then be displayed. Follow the instructions contained in Figure 5-4-6 and then press the [Complete] key.

NOTE: During steps 2 and 3 in Figure 5-4-6, slowly move the Fill-Control bar from its home position to the full reverse and full forward position so that complete movement in either direction takes approximately 3 seconds. During step 4, rock the Fill-Control bar back and forth approximately half the distance between its full reverse and full forward positions. Use this “half-distance” rocking motion to cycle the Fill-Control bar 2 to 3 times.



Figure 5-4-6 Fill/Expel Calibration (Powerhead)

6. The System Calibration screen, as shown in Figure 5-4-7, will then be displayed with the box to the left of powerhead checked. If not checked, repeat the procedure.

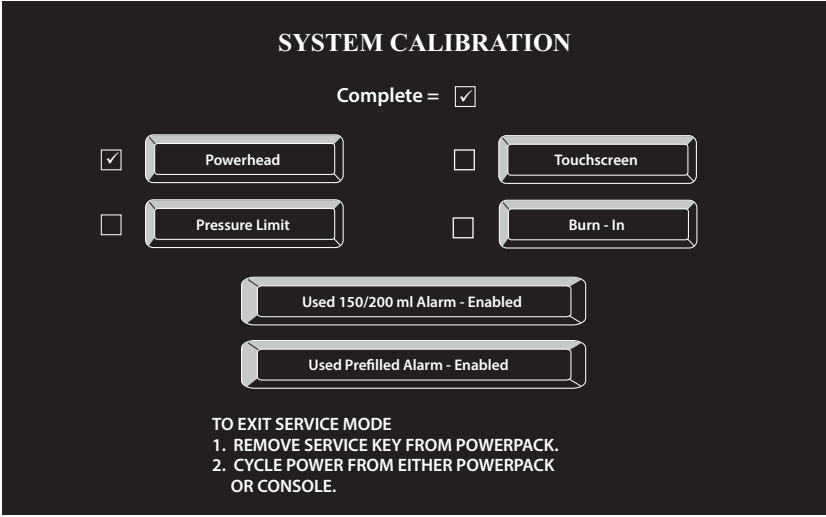


Figure 5-4-7 System Calibration Screen in the Service Mode: Box to the Left of Powerhead Checked

5.5 PRESSURE CALIBRATION PROCEDURE OVERVIEW

From the main screen touch the [Configure System] key.

Touch the [System Info] key.

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5.6 PRESSURE CALIBRATION FOR SOFTWARE V9.09 OR LATER

5.6.1 OVERVIEW

CAUTION!

Pressure limit calibration requires running the injector at pressures higher than those occurring in normal use. Safety goggles should be worn at all times, and ensure the pressure guard is in place.

Pressure calibration takes place by establishing a flow rate to pressure relationship. To achieve this relationship, the flow rate is measured through fixed orifice openings simulating #18, #20 and #24 gauge needles, or through an externally-mounted flow-control valve. The purpose of this procedure is to simulate pressure and flow rates over the expected range of use for the injector, using nine calibration points to ensure sufficient accuracy.

Before performing these procedures, carefully read all instructions. Also, take note of the bullet items listed below:

- **Use the three fixed orifices whenever possible.** These fixed orifices should replace the need to use an adjustable flow-control valve. However, if one of these orifices becomes clogged or unusable, replace the orifice, or use the flow-control valve on the side of the fixture. Careful and prudent adjustment of the flow-control valve on injection 1/9, will save time. For example, if the flow-control valve is correctly set, then steps 2/9 and 3/9 can be performed without any additional adjustments.
- During calibration, when the volume remaining exceeds the required volume for the next step the system will automatically enable and moving the fill bar will no longer cause the ram to move. In some instances, manually reducing the volume remaining below the required volume will allow the fill bar to work again.
- After each calibration injection, 1 – 9, the achieved flow rate field will update when the ram completes its stroke.

CAUTION!

Only Qualified Service Personnel should perform this procedure.

5.6.2 MAINTAINING THE FIXTURE

Required Tools

- 1 Service Key (P/N 904019, or P/N 904061 for models 900002 and 900006).
- 1 Angiomat Illumena Contrast Delivery System Pressure Calibration Fixture (P/N 900843)
- 1 150 mL Reusable Syringe/Faceplate for Service Use Only (P/N 9896 001 30361) – **Preferred**
- or-
- 1 150 mL Faceplate (P/N 900490).

NOTE: *The ADAWS version of this faceplate (P/N 900491) may be used, but requires some disassembly of the detector using a Phillips head screwdriver.)*

Fixed Orifices

The Angiomat Illumena Contrast Delivery System Pressure Calibration Fixture consists of three fixed orifices, two of which are stainless steel needles. Careful handling and storage prevents these needles from becoming bent and unusable. Clogged needles may be cleaned with a fine wire. Bent or permanently clogged needles should be discarded and replaced.

Only replace needles with those listed below. Do not replace with needles from other sources, due to differences in restrictions from various needle manufacturers. Replacement orifices and needles are:

- P/N 900862: #18 equivalent orifice
- P/N 900863: #21 x 1.25" stainless steel needle
- P/N 900864: #24 x 0.75" stainless steel needle

5.6.3 PRESSURE GAUGE

We recommend that this 1500 psi gauge be re-calibrated at least annually months using a NIST traceable method, or equivalent national standard. If removed, the gauge should be reattached to the fixture using PTFE tape or equivalent, nonpermanent sealant.

5.6.4 REUSABLE SYRINGE/FACEPLATE FOR SERVICE USE ONLY

While not part of the fixture, the 150 mL reusable syringe can deteriorate with use, particularly at the high pressures used during this calibration. Refer to the Caution on Page 5-6-1.

Refer to the Angiomat Illumena Contrast Delivery System Part manuals for a complete description of replaceable parts. For reference, the most commonly replaced parts are:

P/N 9896 001 30361: 150ml Reusable Syringe Assembly

P/N 302111: Connector, Luer Lock Assembly

P/N 900450: Pressure Sleeve

5.6.5 ACTIVATING SERVICE MODE

If the Service Mode System Calibration screen is not active, proceed as follows:

1. Turn the injector OFF by toggling either the main breaker located on the front of the powerpack or the console switch located in the upper right corner of the console.
2. For most models (powerpack REF #901000): Insert the 25-pin D-shell "Service Key" connector (P/N 904019) into the Universal Interface connector (J2) located on the rear of the powerpack.

For models 900002 and 900006 **only** (powerpack REF # 901100): Remove the cover on the powerpack. Insert the 16-pin single-row "Service Key" (P/N 904061) into the Universal Interface connector located inside the powerpack on the back of the communications board.

3. Return power to the injector by toggling the main breaker and turning the console ON. The screen in Figure 5-6-1 will be displayed.

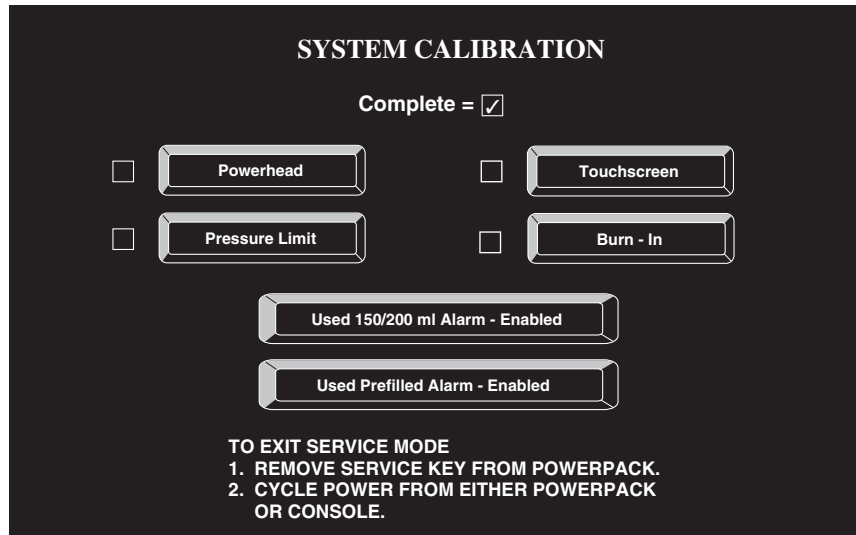


Figure 5-6-1. Service Mode System Calibration Screen

5.6.6 FIRST, READY A SYRINGE

The software sequence works best if the syringe is filled with water before the first Calibration injection.

1. Install the 150 mL syringe and faceplate.
2. Install the Pressure Calibration Fixture according to Figure 5-6-2, and ensure guard is in place. Do not use plastic extension tubing between the fixture and the syringe, although use of a male-female adapter is recommended. Use of tubing will lead to increased pressure drops and significant measurement errors.
3. Open the flow-control valve, and close all three shut-off valves. The flow-control valve has a built-in check valve that allows filling at any time, whether the valve is open or closed. To purge through this valve, leave the valve open until most of the air removed.
4. Fill and purge the syringe with the fill bar. Fill the syringe completely full. A minor amount of air is acceptable.
5. Close the flow-control valve.

CAUTION!

Always inspect the pressure sleeve and reusable syringe for crazing, opacity, scratches and other damage. Also inspect the connector on the reusable syringe for cracks, bulges and other damage. The damaged item must be replaced if any of these defects are found. Pressure sleeves, reusable syringes and reusable connectors should be replaced after two (2) years of use, or between 500 and 1,000 injections, depending on the physical condition. Use of a damaged or deteriorated pressure sleeve, reusable syringe, or reusable connector may result in rupture during an injection.

NOTE: Inspect the plunger backplate and button for damage or deterioration. Replace regularly, depending on the physical condition. Continual application of high pressure, as found during pressure calibration, can deform the backplate and button. A damaged or deteriorated plunger can blow-by during an injection or fail to properly latch to the ram during filling.

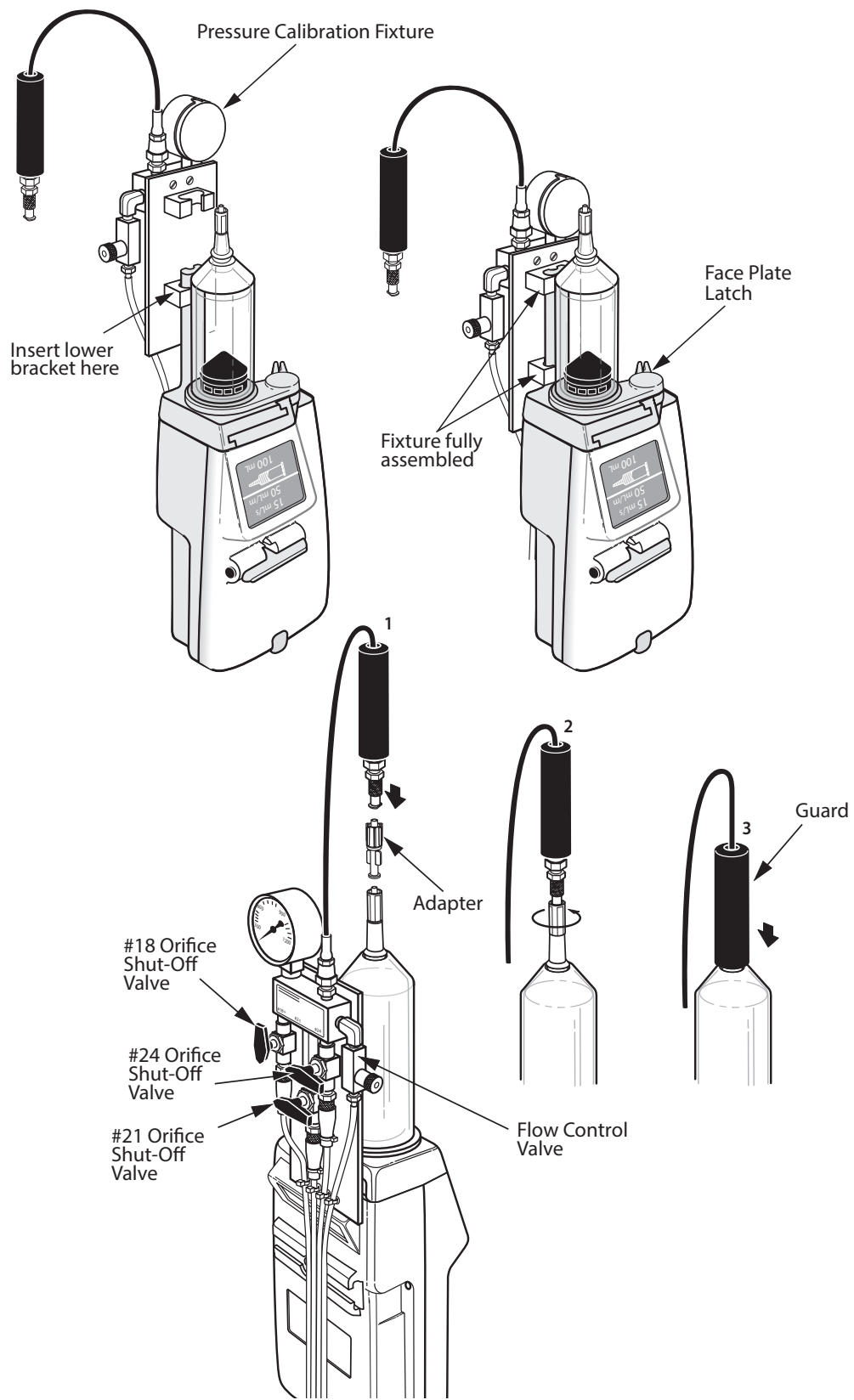


Figure 5-6-2. Pressure Gauge Installation for Powerhead Calibration

5.6.7 CALIBRATING THE PRESSURE LIMIT

On the System Calibration Screen Press the [Pressure Limit] screen button. The screen shown in Figure 5-6-3 will appear.

SCREEN 1/9; #18 ORIFICE CALIBRATION

1. Open the shut-off valves labeled **#18** and **#24**. The **#21** shut-off valve and the Flow-Control Valve must remain completely closed. Run the injection and watch the pressure gauge, especially during the last second of the injection. To obtain an accurate pressure calibration, the injection must be run to completion. All injections will complete within 30 seconds.
2. Confirm the Achieved Flow rate is 40 ml/s +/-1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged, bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 1200 PSI as possible to obtain 40 ml/s +/- 1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

PRESSURE LIMIT CALIBRATION
1/9; #18 Orifice

Field Service must open #18+ and #24 valves

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

1 2 3
4 5 6
7 8 9
• 0 ENTER
Clear Entry

Exit

Figure 5-6-3. Pressure Limit Calibration, Screen 1/9

SCREEN 2/9; #18 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. Close all shut-off valves while refilling the syringe, then reopen the **#18** and **#24** valves. The **#21** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 31 ml/s +/- 1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 650 PSI as possible to obtain 31 ml/s +/- 1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION
2/9; #18 Orifice

Field Service must open #18+ and #24 valves

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

Keypad: 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, ENTER, Clear Entry

Navigation: Previous Injection, Exit

Figure 5-6-4. Pressure Limit Calibration, Screen 2/9

SCREEN 3/9; #18 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. Close all shut-off valves while refilling the syringe, then reopen the **#18** and **#24** valves. The **#21** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 13 ml/s +/- 1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 100 PSI as possible to obtain 13 ml/s +/- 1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION
3/9; #18 Orifice

Field Service must open #18+ and #24 valves

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

1 2 3
4 5 6
7 8 9
• 0 ENTER
Clear Entry

Previous Injection Exit

Figure 5-6-5. Pressure Limit Calibration, Screen 3/9

SCREEN 4/9; #20 ORIFICE CALIBRATION

1. Close all shut-off valves while refilling the syringe, then reopen the **#21** and **#24** valves. The **#18** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 20.5 ml/s +/- 1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 1200 PSI as possible to obtain 20.5 ml/s +/- 1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: The [Previous Injection] key is used to return to a previous injection calibration procedure.

PRESSURE LIMIT CALIBRATION
4/9; #21 Orifice

Field Service must open #21 and #24 valves

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

1 2 3
4 5 6
7 8 9
• 0 ENTER
Clear Entry

Previous Injection Exit

Figure 5-6-6. Pressure Limit Calibration, Screen 4/9

SCREEN 5/9; #20 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. Close the all shut-off valves while refilling the syringe, then reopen the **#21** and **#24** valves. The **#18** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 15.4 ml/s +/- 1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 650 PSI as possible to obtain 15.4 ml/s +/- 1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION

5/9; #21 Orifice

Field Service must open #21 and #24 valves

GAUGE READING: 0 PSI

ACHIEVED FLOWRATE: 0 ml/s

1	2	3
4	5	6
7	8	9
.	0	ENTER
Clear Entry		

Previous
Injection

Exit

Figure 5-6-7. Pressure Limit Calibration, Screen 5/9

SCREEN 6/9; #20 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. Close all shut-off valves while refilling the syringe, then reopen the **#21** and **#24** valves. The **#18** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 6.1 ml/s +/- .2 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged, bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 100 PSI as possible to obtain 6.1 ml/s +/- .2 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION
6/9; #21 Orifice

Field Service must open #21 and #24 valves

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

Keypad: 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, ENTER, Clear Entry

Buttons: Previous Injection, Exit

Figure 5-6-8. Pressure Limit Calibration, Screen 6/9

SCREEN 7/9; #24 ORIFICE CALIBRATION

1. Close all shut-off valve while refilling the syringe, then reopen the **#24** valve. The **#18** and **#21** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 5.1 ml/s +/- .2 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 1200 PSI as possible to obtain 5.1 ml/s +/- .2 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: The [Previous Injection] key is used to return to a previous injection calibration procedure.

PRESSURE LIMIT CALIBRATION

7/9; #24 Orifice

Field Service must open #24 valve only

GAUGE READING: 0 PSI

ACHIEVED FLOWRATE: 0 ml/s

1	2	3
4	5	6
7	8	9
•	0	ENTER
Clear Entry		

Previous
Injection

Exit

Figure 5-6-9. Pressure Limit Calibration, Screen 7/9

SCREEN 8/9; #24 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. Close all shut-off valve while refilling the syringe, then reopen the **#24** valve. The **#18** and **#21** shut-off valve and the flow-control valve should remain closed. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 3.8 ml/s +/- .2 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 650 PSI as possible to obtain 3.8 ml/s +/- .2 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION
8/9; #24 Orifice

Field Service must open #24 valve only

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

Keypad: 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, ENTER, Clear Entry

Buttons: Previous Injection, Exit

Figure 5-6-10. Pressure Limit Calibration, Screen 8/9

SCREEN 9/9; #24 ORIFICE CALIBRATION

NOTE: *If you are using the flow-control valve instead of a fixed orifice, then keep all three shut-off valves closed. If the orifice was carefully adjusted in the previous step, no additional orifice adjustment is required.*

1. After injection #8 is completed, there should be enough volume remaining to perform injection #9. The injector should enable automatically after you enter the pressure from injection #8. If sufficient volume is not remaining, simply refill syringe as before then continue. Run the injection, and watch the pressure gauge. To obtain an accurate pressure calibration, the injection must be continued until the ram reaches its fully extended position.
2. Confirm the Achieved Flow rate is 1.5 ml/s +/- .1 ml/s. If the Achieved Flow Rate is not within the specified range, then the orifice(s) may be clogged , bent, or otherwise unusable. Replace the defective orifice(s) and repeat step 1.

Alternate Method:

Or, if absolutely necessary, close all fixed orifices and use the Flow Control Valve instead. Adjust the Flow Control Valve to obtain a pressure as close to 100 PSI as possible to obtain 1.5 ml/s +/- .1 ml/s.

3. Using the keypad, enter the steady-state gauge pressure reading that occurred during the last second of the injection. Press Enter. If the entered pressure does not fall within the expected range, a pop-up window will appear. See Section 5.6.9 Troubleshooting.

NOTE: *The [Previous Injection] key is used to return to a previous injection calibration procedure.*

PRESSURE LIMIT CALIBRATION
9/9; #24 Orifice

Field Service must open #24 valve only

GAUGE READING: 0 PSI
ACHIEVED FLOWRATE: 0 ml/s

1 2 3
4 5 6
7 8 9
• 0 ENTER
Clear Entry

Previous Injection Exit

Figure 5-6-11. Pressure Limit Calibration, Screen 9/9

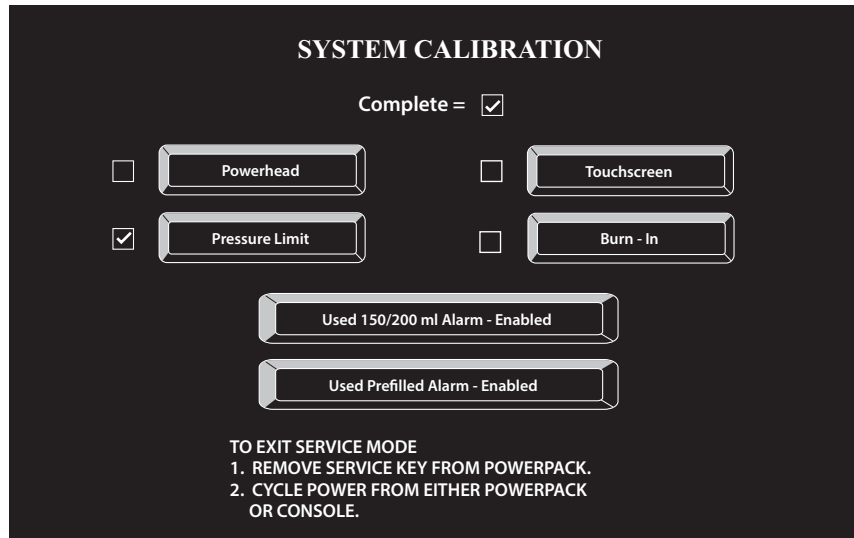


*Figure 5-6-12. System Calibration Screen in the Service Mode:
Pressure Limit Check box Checked*

If a check mark is absent from the pressure limit check box, there are two probable causes.

- a. One of the 9 steps was skipped. (i.e. – The operator depressed “ENTER” on one of the 9 steps without actually performing the step.)
- b. The operator changed the type of faceplate in use in the middle of the calibration procedure. (At present only 150 ml faceplates are supported by the software.)

5.6.8 VERIFYING CALIBRATION

1. After completing the calibration of the powerhead and the pressure limit, exit the Service Mode by turning the injector OFF and removing the Service Key.
2. Turn the injector back on.
3. Set the pressure limit to 1000 psi.
4. Program in a 13 mL/s injection for 140 mL.
5. Close all three shut-off valves, and open the flow control valve.
6. During the injection, adjust the flow control valve so that the pressure on the fixture's gauge reads approximately 750 psi. Repeat the injection until you have the flow control valve properly adjusted.
7. Perform an injection to verify the achieved pressure is close to the actual pressure, around 750 psi.
8. Without adjusting the flow control valve, reprogram the injection to run at 20 mL/s.
9. Run the injection. Confirm that the injection pressure limits at 1000 psi +/- 50 psi, according to the fixture's gauge.

5.6.9 TROUBLESHOOTING

When a pressure does not fall into an expected range a pop-up window will appear. The pop-up window will indicate the expected pressure range and prompt for another pressure value. The pop-up window can be responded to in four ways:

- A. If the shut-of valves are in the wrong state or if an orifice is clogged, bent, or leaking press the Enter Key a second time. Then press the Previous Injection Key, fix the valve or orifice problem, and repeat this injection.
- B. If a typographical error was made in entering the first gauge reading, reenter the correct pressure value and press the Enter Key again. Continue with the next injection.
- C. Press the Enter Key a second time. Then press the Previous Injection Key and repeat this injection.
- D. If steps A or B or C did not resolve the problem and the pressure is still out of range, use your own experience and judgement and press the Enter Key a second time to accept the original gauge pressure. Or call Service.

SUMMARY OF SHOTS (FOR EXPERIENCED USERS ONLY)

SCREEN NAME	ORIFICE GAUGE	REQ'D FLOWRATE RANGE (ml/s)	ESTIMATED PRESSURE RANGE (psi)
1	18+ and 24	40 +/-1	1000-1325
2	18+ and 24	31 +/-1	550-750
3	18+ and 24	13 +/-1	75-130
4	21 and 24	20.5 +/-1	1100-1450
5	21 and 24	15.4 +/-1	550-750
6	21 and 24	6.1 +/-0.2	75-130
7	24 only	5.1 +/-0.2	1200-1450
8	24 only	3.8 +/-0.2	550-750
9	24 only	1.5 +/-0.1	75-130

6

MAINTENANCE

6.1 GENERAL

This chapter contains maintenance procedures for the Angiomatic Illumena Contrast Delivery System. Guidelines for periodic inspections, testing, and cleaning are included. Information about assembly and disassembly of the unit is contained in Chapter 10.

A checklist is included in the front pocket of this manual. Fill in the necessary information on a copy of the checklist and return to your service center.

6.1.1 MAINTENANCE SCHEDULE

Preventive Maintenance should be performed every 12 months.



SHOCK HAZARD. Be extremely careful when the Angiomatic Illumena Contrast Delivery System is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged in. **DISCONNECT THE POWER CORD BEFORE DISASSEMBLING THE SYSTEM, AND BEFORE REMOVING OR REPLACING BOARDS.**



SHOCK HAZARD-HIGH VOLTAGE SERVO. Be extremely careful around the servo. Lethal voltages are exposed. **DISCONNECT THE POWER CORD BEFORE TOUCHING ANY COMPONENTS ON THE SERVO BOARD, AND BEFORE REMOVING OR REPLACING THE SERVO BOARD.**

CAUTION! ⚠

Disconnect any external equipment from the Angiomatic Illumena Contrast Delivery System before any disassembly.

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6.2 QUALIFICATIONS

CAUTION!

Preventive Maintenance on any unit must be performed by a Qualified Technician who is completely familiar with the use and operation of the Injector, trained by a Liebel-Flarsheim Company LLC instructor in the area of preventive maintenance for the Injector and familiar with the content of the Operator's manual and the Installation and Service manual.

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6.3 DAILY INSPECTION

Check the pressure sleeve daily for signs of stress, crazing lines, or cracks and replace immediately when any of these symptoms are found. Pressure sleeves and reusable syringes should be replaced after two (2) years of use, or between 500 and 1,000 injections, depending on the physical condition. Their life is a function of pressures encountered and injection cycles.

CAUTION!

CHECK PRESSURE SLEEVE FREQUENTLY! Syringe pressure sleeves must withstand high pressures generated during injection delivery. Defective sleeves may shatter or explode under these conditions. Always inspect pressure sleeve closely before using injector. Rotate the pressure sleeve while viewing all areas; look for stress cracks (around the front or at the shoulder area), discard any pressure sleeve exhibiting signs of stress, crazing lines or cracks. The use of such parts may cause injury and/or an aborted injection. Pressure sleeves should be replaced after two (2) years of use, or between 500 and 1,000 injections, depending on the physical condition.

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6.4 POWERHEAD

6.4.1 VISUAL INSPECTION

1. With unit power on, heater should feel warm, remove assembly from faceplate post and visually inspect blanket and cable for damage.
2. Retract the ram until the ram is flush with the mainframe. Remove the faceplate from the powerhead and visually inspect for contrast build up on the faceplate. Visually inspect the pressure jacket for stress cracks or crazing as stated in section 6.3 Daily Inspection and 6.10 Cleaning.

CAUTION!

Syringe pressure jackets must withstand pressures generated during injection delivery. Defective jackets may shatter or explode under these conditions. Always inspect pressure jacket closely before using injector. Rotate the pressure jacket while viewing all areas; look for stress cracks (around the front or at the shoulder area), discard any pressure jacket exhibiting signs of stress, crazing lines or cracks. The use of such parts may cause injury and/or an aborted injection.

3. Visually inspect sensor lenses for contrast build up. Carefully clean the sensor lenses if necessary. Check the cable and connector for damage.

CAUTION!

When cleaning the lenses be sure to use scratch-proof material. Scratching the lenses will cause the sensor to become inoperable.

4. The syringe gripper should not be loose and the rubber ball should not be loose or missing. Clean any contrast build up that will inhibit proper gripper operation.
5. Visually inspect the display overlay for cuts or nicks that would allow fluids to seep into the powerhead electronics.
6. Visually inspect cable for cuts, nicks or exposed wires. Make certain that strain relief is used to secure the cable at both ends. Check the connector for cracks or broken/protruding pins.

6.4.2 OPERATIONAL CHECK

1. Verify that assembly is not loose or damaged. Move the powerhead to several different positions. Verify that the powerhead remains in the position it has been oriented.
2. Verify proper Fill/Expel operation per Chapter 2 section 2.10.3 steps 5 through 8.
3. Verify that all lights on the display are functioning and that the display orientation changes when the powerhead is rotated. Verify that the display updates with ram movement.

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6.5 CONSOLE

6.5.1 VISUAL INSPECTION

1. Visually inspect the cable for cuts, nicks or exposed wires. Check connector for cracks or broken/protruding pins. Verify shielding ground by performing continuity check from connector to connector. **Note** that the reading should be 2 ohms or less.
2. Ensure that the housings, touchscreen or display are not cracked or broken.

6.5.2 OPERATIONAL CHECK

1. Verify that the entry windows highlight when touched and changes can be made.
2. Verify that any changes made on Configure System screen are reflected on Main Screen. Reference Chapter 2 section 2.10.4 in this manual.
3. Verify the "Save" and "Delete" functions of the Protocol manager. Refer to Chapter 2 section 2.10.9 in this manual.

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6.6 POWERPACK

6.6.1 VISUAL INSPECTION

CAUTION!

Be sure that the power cord is unplugged before proceeding. Lethal voltages are exposed when the power cord is plugged in and the injector is disabled.

1. Visually inspect the power cord for cuts, nicks, or exposed wires.
2. Visually inspect Start Switch and its cable for cuts, nicks or exposed wires. Check connector for cracks or broken/protruding pins.
3. Visually inspect any optional equipment cables for cuts, nicks or exposed wires. Check connector for cracks or broken/protruding pins.
4. Check fan filter. Remove and clean filter if needed.

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6.7 PEDESTAL

6.7.1 VISUAL INSPECTION

1. Verify that the Hub Assembly is securely mounted to the Pedestal Column. Tighten as needed.
2. Verify that counter weights, mounted under base, are secure. Verify that each caster lock will engage and disengage and that the caster rolls freely.
3. For aluminum pedestals, ensure that the ground lead that connects from the powerpack cabinet to the pedestal base is secure at both connection points.
4. Verify that the arm assembly will hold the powerhead assembly where it has been positioned, and that the arm assembly does not drift up or down.

6.7.2 PEDESTAL ARM ASSEMBLY TENSION ADJUST

1. Remove the powerhead assembly from the Arm Assembly. Next, remove the Arm Assembly from the pedestal and place on a clean flat surface.
2. While wearing protective eyewear, use a large flat head screwdriver to rotate the brass adjustment gear as shown in Figure 6-7-1. Rotate the adjustment gear in the clockwise direction to increase spring tension and counterclockwise to decrease spring tension.
3. To test for appropriate tension, re-attach the Arm Assembly to the Pedestal and reinstall the powerhead assembly. Verify that the Arm Assembly will hold the powerhead assembly where it has been positioned, and that the arm assembly does not drift up or down. Re-adjust tension if needed using procedures described in steps 1 and 2 above.

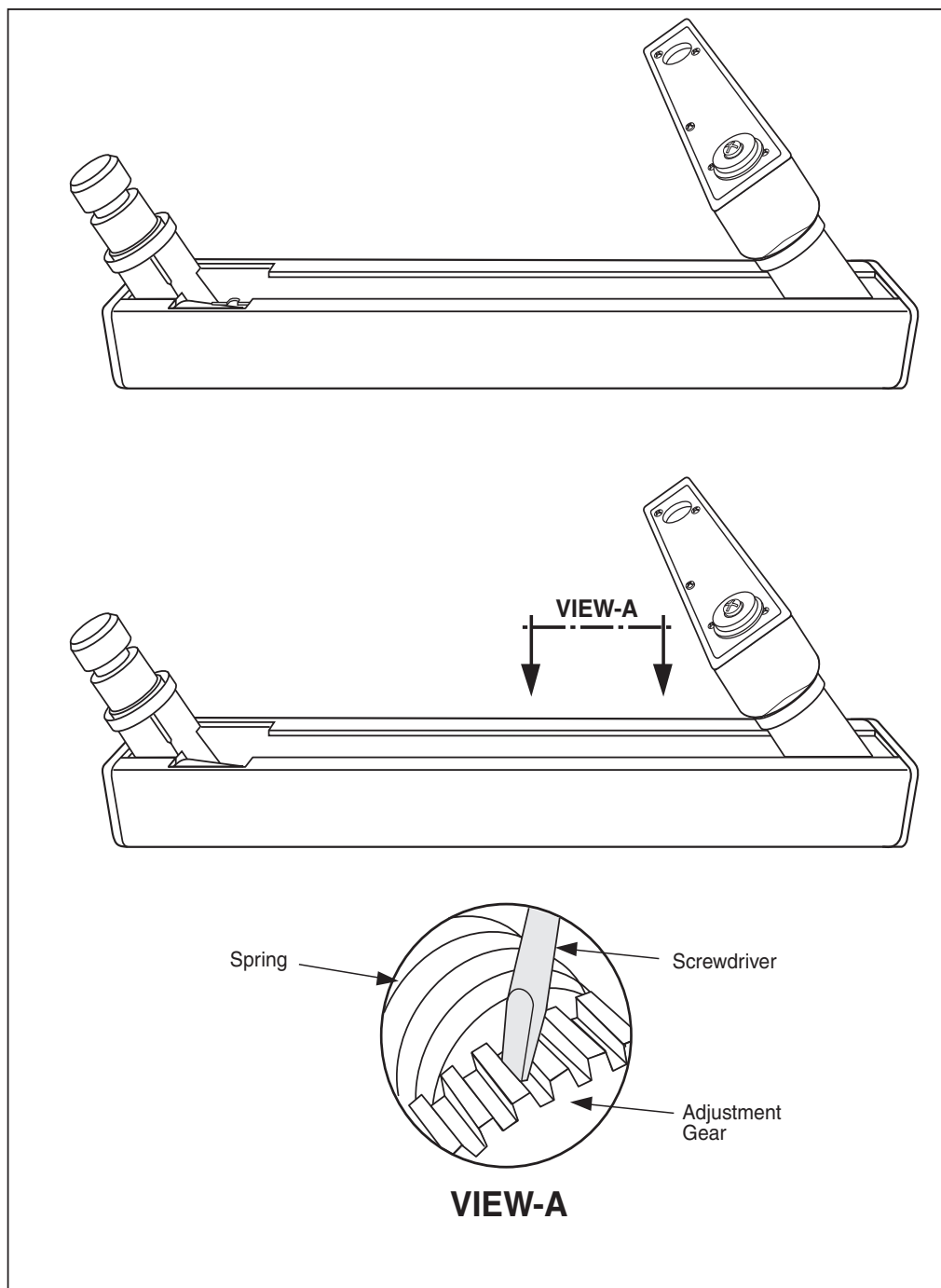


Figure 6-7-1 Arm Assembly Tension Adjustment

6.8 ELECTRICAL CHECKS

6.8.1 GROUND CONTINUITY

1. Using the continuity/Diode checker function on a DMM or similar indicating device, ensure continuity exists between the AC plug ground pin and any exposed (unpainted) metal surface that is conductively connected to all other accessible metal.

CAUTION! ⚠

If ground continuity is nonexistent, do not use the injector, contact an authorized service representative. Failure to follow this instruction can result in serious injury.

6.8.2 ELECTRICAL LEAKAGE

NOTE: This test is optional, and is intended as an example for facilities where internal procedures may dictate its performance. The following information is intended for qualified biomedical engineers or trained electrical technicians at the facilities (install site).

1. Check the electrical leakage meter, or use an AC voltmeter with the attenuation network shown in Figure 6-8-1. Check the leakage through the power cord ground with ground open. The leakage should be less than 500 microamperes. If higher, check for the cause and repair.

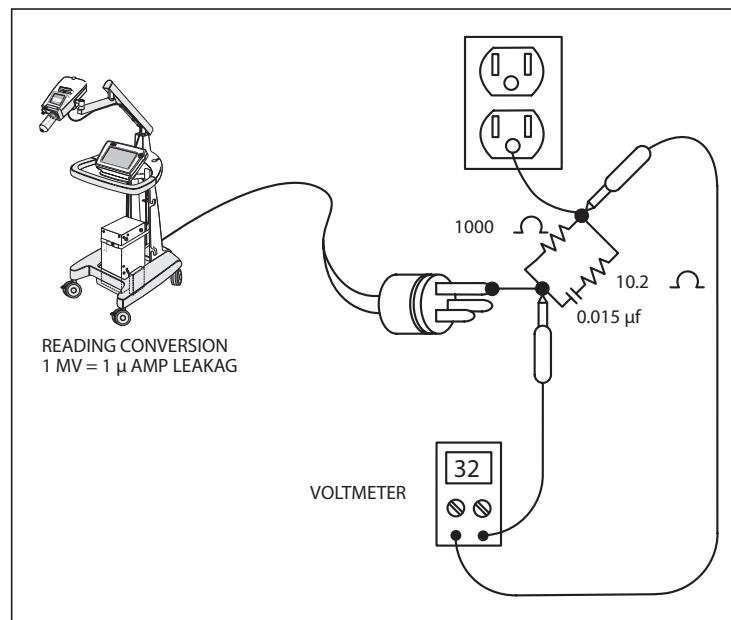


Figure 6-8-1 Leakage Test Set-Up

CAUTION! ⚠

If system leakage remains above 500 microamperes, do not use the injector as it may be a shock risk for the operator. Contact an authorized service representative.

2. Disconnect the leakage test equipment.

6.8.3 GROUND IMPEDANCE

NOTE: This test is optional, and is intended as an example for facilities where internal procedures may dictate its performance. The following information is intended for qualified biomedical engineers or trained electrical technicians at the facilities (install site).

1. Refer to Figure 6-8-2. Run a current of 25 A (50 or 60 Hz) with a no-load voltage (not to exceed 6 V) for at least 5 seconds through the protective earth pin in the mains plug and face plate hinge pin on the powerhead.
2. The measured ground impedance must not exceed 0.1 ohms

CAUTION! ⚠

Do not use the injector if the system ground impedance exceeds 0.1 ohms. Use of injector when ground impedance exceeds 0.1 ohms may pose a shock risk for the patient. Contact an authorized service representative.

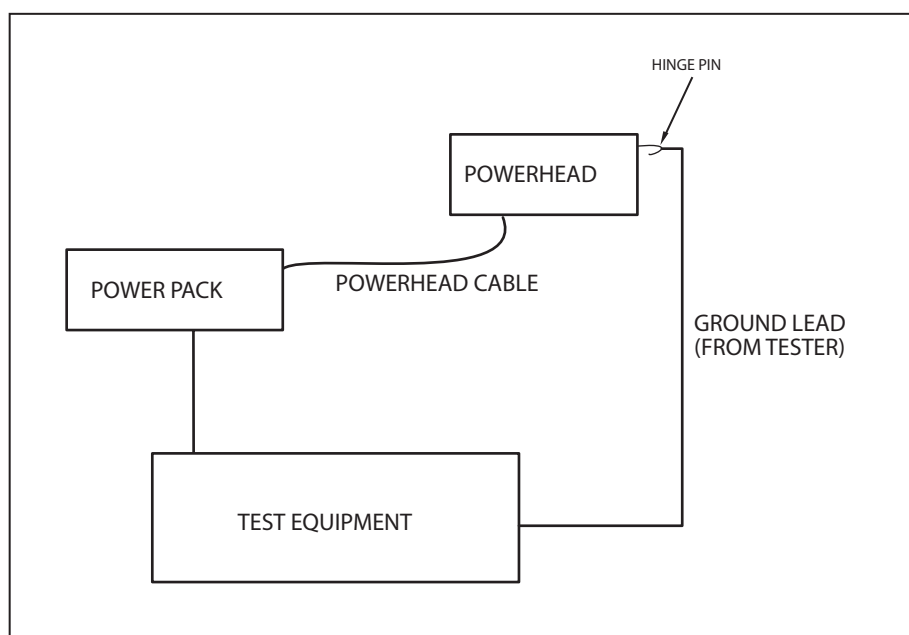


Figure 6-8-2 Ground Impedance Test Set-Up

6.9 SYSTEM

6.9.1 FUNCTIONAL CHECK

6.9.1.1 PRESSURE LIMIT CHECK

1. Install a 150 ml Faceplate Assembly. Next, install the Pressure Gage Assembly as described in Chapter 5, section 5.6.
2. Enter the following parameters:

 Flow Rate: 13 ml/s
 Volume: 140 ml
 Pressure: 1200 psi
3. Enable and run a single injection. While the injection is running, close valve until gage shows a reading of 725 to 750 psi.
4. Once the valve is set, run the following Pressure Limit injections to verify Pressure Limit Calibration:

Flow: 10 ml/s	Flow: 15 ml/s	Flow: 25 ml/s
Volume: 140 ml	Volume: 140 ml	Volume: 140 ml
Pressure: 300 psi	Pressure: 600 psi	Pressure: 1200 psi
5. Each injection must be completed in full and achieved values for pressure must be within +50/- 100 psi. If any Pressure Limit injection is not within specified tolerance, the injector must be calibrated according to procedures described in Chapter 5, section 5.4 of this manual.

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6.10 CLEANING

A cloth dampened with warm water can be used to remove contrast.

6.10.1 PRESSURE SLEEVE AND PLATE

On a daily basis, move the ram to the retract position and wipe out the inside of the pressure sleeve with a damp, lint-free towel.

The entire syringe plate and pressure sleeve may be placed or soaked in warm water with a mild soap to remove any hardened contrast. *Do not use alcohol-based detergents.* This procedure is also helpful if the locking lever is hard to rotate.

All components may also be cleaned by washing with a soft brush and pipe cleaner in warm tap water and an enzymatic surgical detergent (suitable for cleaning surgical instruments). The water should NOT contain the following substances, even in trace amounts:

- esters
- chlorides
- ethers
- alcohol (other than ethyl alcohol)
- ketones
- Cleaners and Disinfectants (such as: SaniZide, and TB-Cide Quat)

These substances, if present in water used to clean the pressure sleeve, will cause the poly-carbonate to craze, crack or become cloudy. Rinse with warm tap water to remove soap residue. Dry with a soft cloth or air dry.

6.10.2 POWERHEAD FILL-CONTROL BAR AND SYRINGE LEVER

The fill-control bar and syringe lever may be removed by pulling straight up. Remove any collected contrast medium that may have built up under the fill-control bar or syringe lever with a damp cloth.

6.10.3 CONSOLE

The console may be dusted by using a lint-free cloth. To clean the touch screen, use a damp *nonabrasive* cloth towel and any commercially available *non-ammonia* window cleaner to regularly clean the surface. *The cleaning solution should be applied to the towel rather than the surface of the touch screen.* The touch screen has air vents and is not designed with water tight bezels so fluid ingress may occur from behind the panel if not cleaned carefully.

6.10.4 POWERHEAD AND POWERPACK

Clean the exterior of the powerpack by spraying a cloth with an all-purpose household cleaner, then gently wipe clean.

6.10.5 HANDSWITCH

Clean the handswitch cord with an antibacterial / germicidal disposable wipe taking care not to get the ends of the cord wet where it joins to the connector or handswitch.

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6.11 REPLACING THE PRESSURE SLEEVE

6.11.1 REMOVING/REPLACING THE 150 mL PRESSURE SLEEVE

1. Open the syringe assembly to remove the existing 150 mL pressure sleeve.
2. Hold the syringe assembly to allow an unobstructed view of the underside of the faceplate as shown in Figure 6-11-1. Rotate the pressure sleeve clockwise to align the notches to the screws.
3. Pull the pressure sleeve up through the faceplate.
4. Install new pressure sleeve by following steps 1-3 in reverse order.

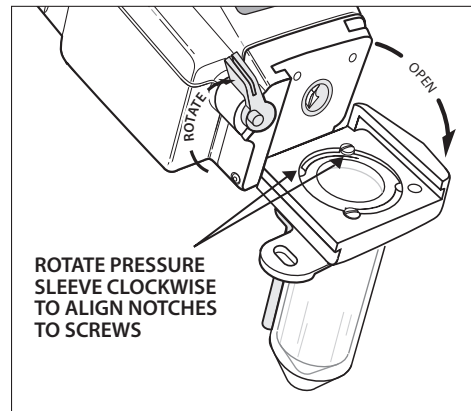


Figure 6-11-1 Replacing the 150 mL Pressure Sleeve

6.11.2 REMOVING/REPLACING THE 125 ML PRESSURE SLEEVE

1. Open the syringe assembly to remove the existing 125 mL pressure sleeve.
2. Hold the syringe assembly to allow an unobstructed view of the underside of the faceplate. Remove and retain the two screws as shown in Figure 6-11-2.
3. Pull the pressure sleeve through the faceplate.
4. Install new pressure sleeve by following steps 1-3 in reverse order.

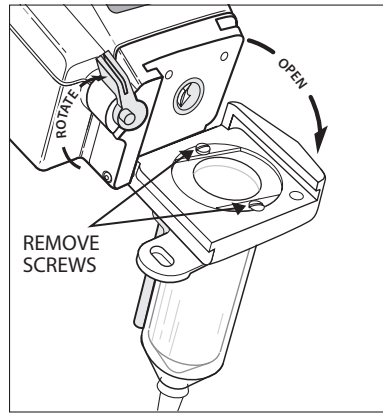


Figure 6-11-2 Replacing the 125 mL Pressure Sleeve

6.12 CEILING SUSPENSION

6.12.1 SUSPENSION ARM OPERATIONAL CHECKS

Check the Suspension Arm for movement. If adjustment is required, follow the instructions below:

CAUTION! ⚠

The Suspension Arms are shipped with an internal limiter which is set to restrict the upward travel of the arm to the horizontal position. Always raise the arm to the upward limit of travel before removing any equipment mounted to the arm. THE ARM WILL SPRING UPWARD WITH CONSIDERABLE FORCE UNDER NO LOAD CONDITIONS, AND MAY CAUSE SERIOUS PERSONAL INJURY

SUSPENSION ARM TRAVEL ADJUSTMENT

To increase range motion, insert a 5 mm hex wrench into the opening at the location shown in Figure 6-12-1. There is a cover which fills the opening which will move out of the way when the tool is inserted.

Turning the wrench counterclockwise will increase the vertical travel. When the wrench no longer turns freely, the maximum travel of 45 degrees will be obtained. Full clockwise adjustment will return the limit to the horizontal setting.

NOTE: Always return the limit to the horizontal setting (full clockwise) before removing the suspension device or before removing the arm from the column.

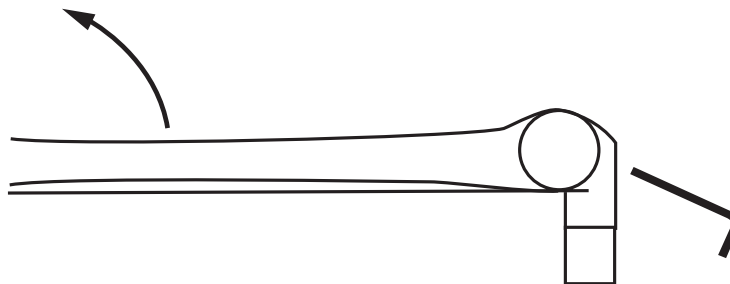


Figure 6-12-1 Vertical Travel Adjustment

6.12.2 SUSPENSION ARM BALANCE ADJUSTMENT

NOTE: The suspension system is to only be used with Liebel-Flarsheim Company LLC power injectors. The maximum load capacity of the suspension spring arm should not exceed 30 lbs at full extension. The use of accessories not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the patient vicinity
- evidence that the safety certification of the accessory has been performed in accordance to the appropriate EN 60601-1 harmonized national standard.

NOTE: The following steps are to be done only after the powerhead has been properly installed. The arm should remain stable in position, yet be able to be moved easily. Adjustments are only necessary if the arm moves easily in one direction than the other direction.

To adjust the balance of the arm, insert a 5 mm hex wrench into the hole at the position shown in Figure 6-12-2. Turning the wrench counterclockwise will increase the lift force of the arm.

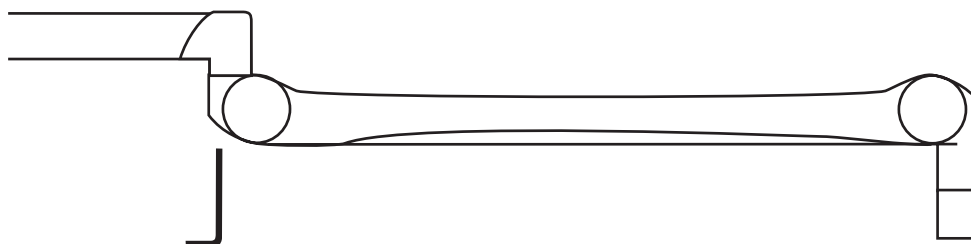


Figure 6-12-2 Lift Force Adjustment

6.12.3 SUSPENSION SYSTEM CHECKS

J-Bow Arm Visual Inspection

Ensure the three fasteners attaching the J-Bow to the Mounting Spindle are present and are tight (Torque - 39 lb-in, 4.5 N-m). Refer to Figure 6-12-3.

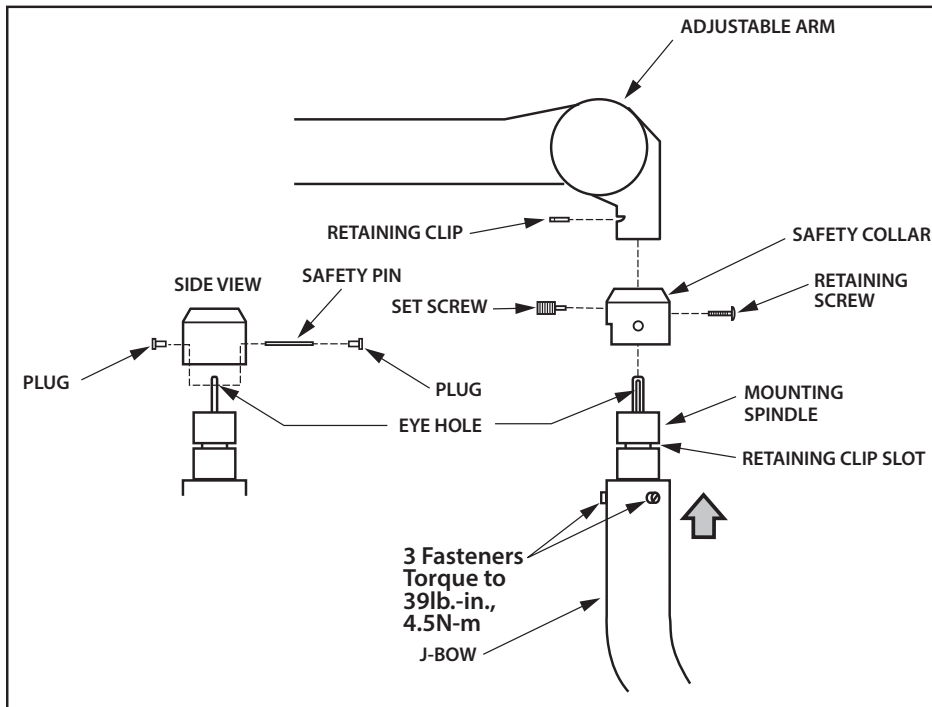


Figure 6-12-3 J-Bow Fastener Attachment

Suspension System Visual Inspection

Inspect the vertical column, horizontal arm assembly and J-Bow arm for damage that may have occurred during use that may weaken the system. This includes dents and cracks of the components, cracks around fasteners of the exposed portions of the vertical column and J-Bow arm, and cracks of the factory installed covers on the horizontal arm assembly.

Vertical Column Inspection

Inspect the stability of the suspension system vertical column by holding the tube near the bottom and firmly rocking in a back and forth motion. If the vertical column does not appear to stable, ensure the mounting bolts are tight. Tighten to 220 lb-in, 25 N-m.

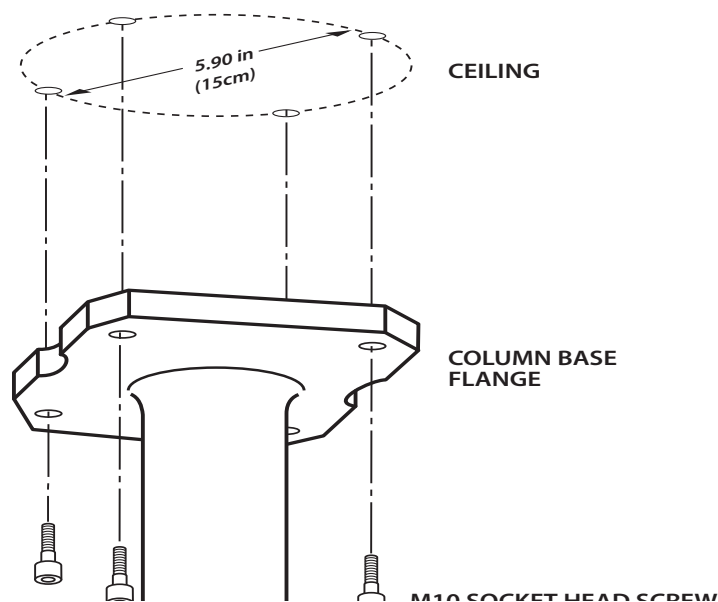


Figure 6-12-4 Vertical Column Inspection

7

SOFTWARE DOWNLOAD AND UPGRADE

7.1 OVERVIEW

The Angiomat Illumena Contrast Delivery System's software resides in FLASH memory that can be reprogrammed without chip removal and replacement. This configuration uses a personal computer to download the code to the memory ICs via a 10 pin serial port.

The minimum requirements to perform the software download via a USB port on a Windows 7/8/10 computer are as follows.

- 904250, USB-ML-UNIVERSAL-FX Programmer Kit, which includes:
 - One (1) 904251, USB-ML-UNIVERSAL-FX Programmer
(Contact P&E Micro if you need a replacement Download Programmer.)
 - One (1) USB High Speed Cable, Type A to Type B
(Contact P&E Micro if you need a replacement USB Cable.)
 - One (1) 10-pin 0.100" Pitch Ribbon Cable for powerpack and powerhead
 - One (1) 26-pin 0.100" Pitch Ribbon Cable for the console
(Replacement ribbon cables can be purchased from LF under P/N 904253 or P&E Micro.)
 - One (1) "LF-FX-32-CF-CD" (CD-ROM) containing:
 - PROG32Z.EXE to download the powerpack and powerhead software
 - PROGCYZ.EXE to download the console software.
 - * INJECTOR SOFTWARE (CD-ROM)

NOTE: *Main injector software is composed of three software sub-versions.*

All three major components powerhead, powerpack, and console must have a compatible combination of software sub-versions in order for the injector to function properly.

To check compatibility, compare the software sub-versions on the SYSTEM INFO SCREEN with the **readme.txt** file supplied with the software.

To select the SYSTEM INFO SCREEN proceed as follows:

1. From the Main Injector Screen, press the Configure System button.
2. Press the System Info button. The SYSTEM INFO SCREEN will be displayed.

7.1.1 INJECTOR SOFTWARE TRANSFER FROM CD

Using My Computer, Open and view the contents of the Injector Software CD.

Highlight the folder on the CD with the name of the software version you are installing (for example, V9.00). Then copy the entire folder to the root directory on the C: drive by dragging the folder and dropping it on the C: drive. (You may also use Copy and Paste.) When you are finished with this copy, there should be a folder called "C:\V9.00" (for example) on your hard drive.

Open the new folder containing the new software (For example, C:\V9.00).

Click Edit, then Select All from the Windows drop down menu.

Right click on one of the selected files and select Properties.

Deselect the Read-only Box. Then click Apply, then OK.

7.1.2 PROGXXX SOFTWARE INSTALLATION FROM CD

The newest versions of PROGCFZ and PROG32Z software (V3.24.00.00 or Later) are compatible with the new USB-based download adapter (904251) . Replace your older versions of PROGxxx software with the newest versions found on the CD named "LF-FX-32-CF-CD". You will receive your first copy of this CD inside the 904250, USB-ML-UNIVERSAL-FX Programmer Kit.

If the newest PROG32z.exe and PROGcfz.exe programs are already installed on your computer, skip to Chapter 7.2. Otherwise, continue with these instructions.

7.1.2.1 To install the newest PROGxxx programs onto your computer from the "LF-FX-32-CF-CD" CD

Insert this CD into your computer. If the CD does not automatically run the Setup Program, open the CD using Windows Explorer and run the "CD_setup.exe" program by double-clicking the file name. This will install the PROG32z and PROGcfz files on your hard drive into the C:\pemicro folder.

Click "Uninstall" to remove previous versions of the PROG programs. The installation process will complete shortly after the second PROG program is uninstalled.

Remove the CD.

Run PROG32Z. A License Activation window will appear.

Enter the "Installation Code" printed on the CD.

Enter your email address.

Press the "Automatic Activation" button.

Close PROG32Z.

Run PROGCFZ and repeat the License Activation.

7.2 DOWNLOAD AND UPGRADE PROCEDURES

Procedures defined in this section will assume you have completed the instructions in Sections 7.1.1 and 7.1.2.

7.2.1 POWERPACK DOWNLOAD

1. Using the powerpack ON/OFF switch, ensure that the power to the injector is off.
2. Remove the powerpack's cover as described in Chapter 10.2A.
3. Connect the USB- cable of the 904251 USB-based download adapter to a USB port on the PC.
4. Connect the software download adapter cable to the Main Control board as shown in Figure 7-2-1.

CAUTION! ⚠

Ensure the red stripe on the ribbon cable goes to Pin-1 of J1 on the Main Control Board.

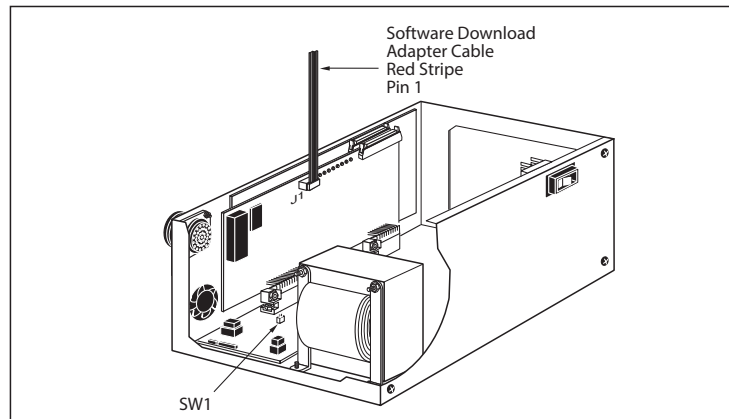


Figure 7-2-1 Powerpack BDM (Debugger) cable assembly orientation

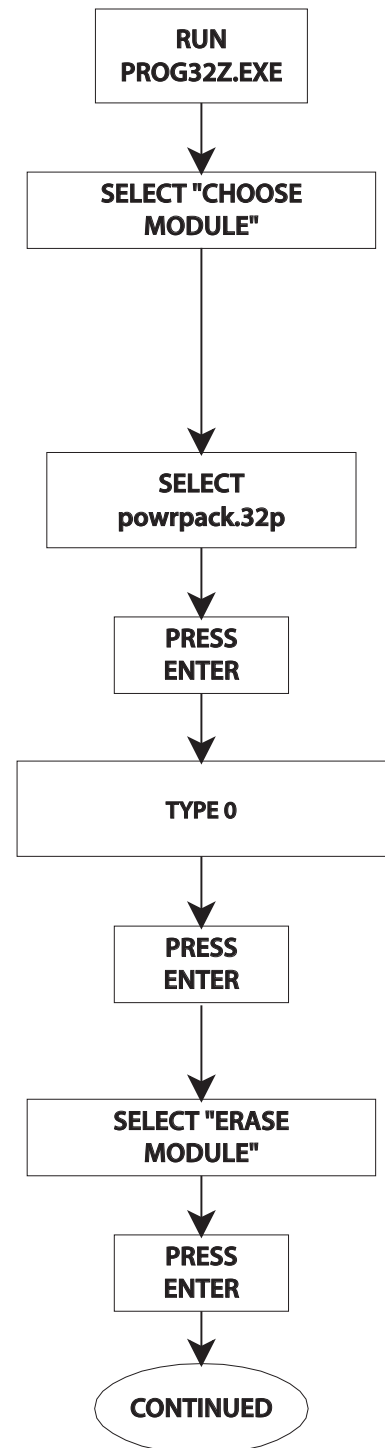
5. Turn on power to the PC and powerpack.
6. Turn system power on using the console power switch. If a console is not available, turn on system power using a non conductive rod, i.e. plastic or rubber approximately the size of a pen, press and release SW1 on the Servo Interface Board. Ignore any messages that appear on the console screen.

CAUTION! ⚠

Do not attempt to activate SW1 with any metallic, electronically conductive device, or with your hand. The main contact relay is exposed and carries high voltage on its contacts. Any contact with this relay or other high voltage components in close proximity to SW1 can result in personal injury or death.

7. Run the PROG32z.exe file from C:\pemicro. May also be found using the “Start”, then “Programs” pull down menus.
If using the USB download adapter for the first time, select the following settings. **NOTE:** Most settings are automatically determined by PROG32z after the Interface setting is configured:
Interface: USB CPU32 Multilink (USB-ML-32)
Port: USB1: Multilink Universal FX Rev-B or later
CPU: CPU32 Processor (332_Chip)-Default for all 683xx
Debug Shift Speed: (12)...
MCU Internal Bus Frequency (For programming): Auto-Detect
Reset Options: Not Checked
Provide power to target: Not Checked
Show this dialog before attempting to contact target (Otherwise only display on Error): Not Checked.

8. Verify “CHOOSE MODULE .32P” is selected.
9. Using the mouse, select the powerpack.32p file and press enter.
10. Type a 0 (zero) in the “Base Address” pop up window and press enter.
11. Using the arrow keys on the PC keyboard select “ERASE MODULE” and press enter. The status section at the bottom of the screen will prompt the user when the task is complete.



12. Using the arrow keys on the PC keyboard select "SPECIFY OBJECT FILE" and press enter.

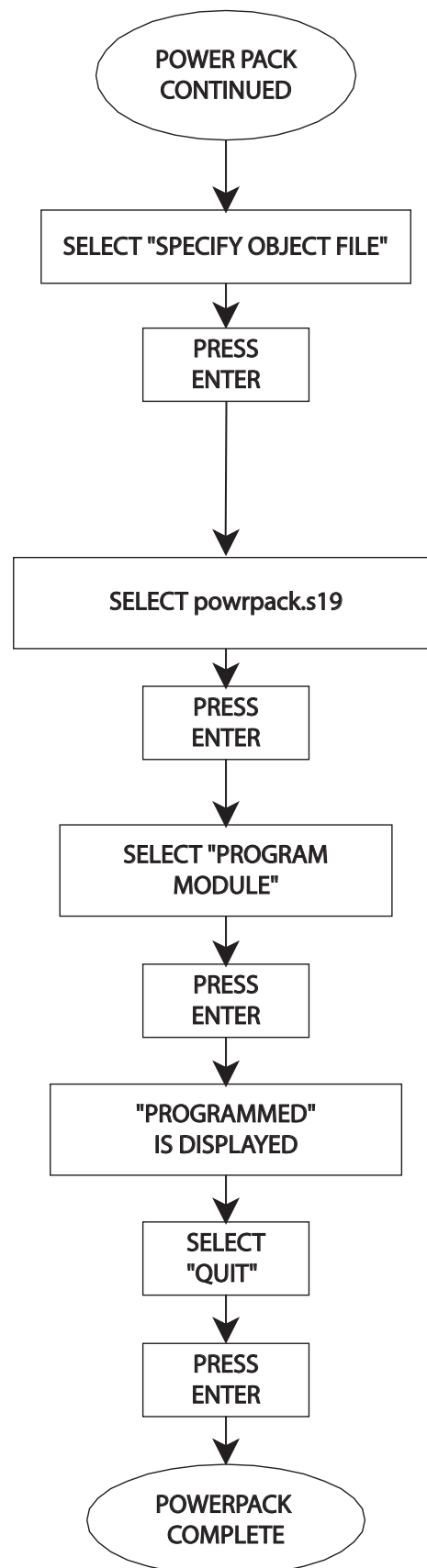
13. Using the mouse, select the powerpack.s19 file and press enter again.

14. Using the arrow keys on the PC keyboard select "PROGRAM MODULE" and press enter. The status section at the bottom of the screen will display "PROGRAMMED" when the task is complete.

15. Using the arrow keys on the PC Keyboard select "QUIT" and press enter

16. Remove power using the ON/OFF switch on the powerpack.

17. When powerpack download is complete, reassemble the powerpack as specified in Chapter 10. If powerhead software has been downloaded, recalibrate as specified in Chapter 5.



7.2.2 POWERHEAD DOWNLOAD (903040-1 PCB'S ONLY)

NOTE: The powerhead must be connected to the powerpack to complete this procedure.

1. Ensure that power to the injector is off.
2. Remove the powerhead's cover as described in Chapter 10.4A.
3. Connect the USB- cable of the 904251 USB-based programmer to a USB port on the PC.
4. Connect the software download adapter cable to the powerhead's Main Control board as shown in Figure 7-2-2.

CAUTION! ⚠

Ensure the red stripe on the ribbon cable goes to Pin-1 of J8 on the powerhead Main Control Board.

5. Turn on power to the PC, powerpack, and then to the console. Ignore any messages that appear on the console screen.

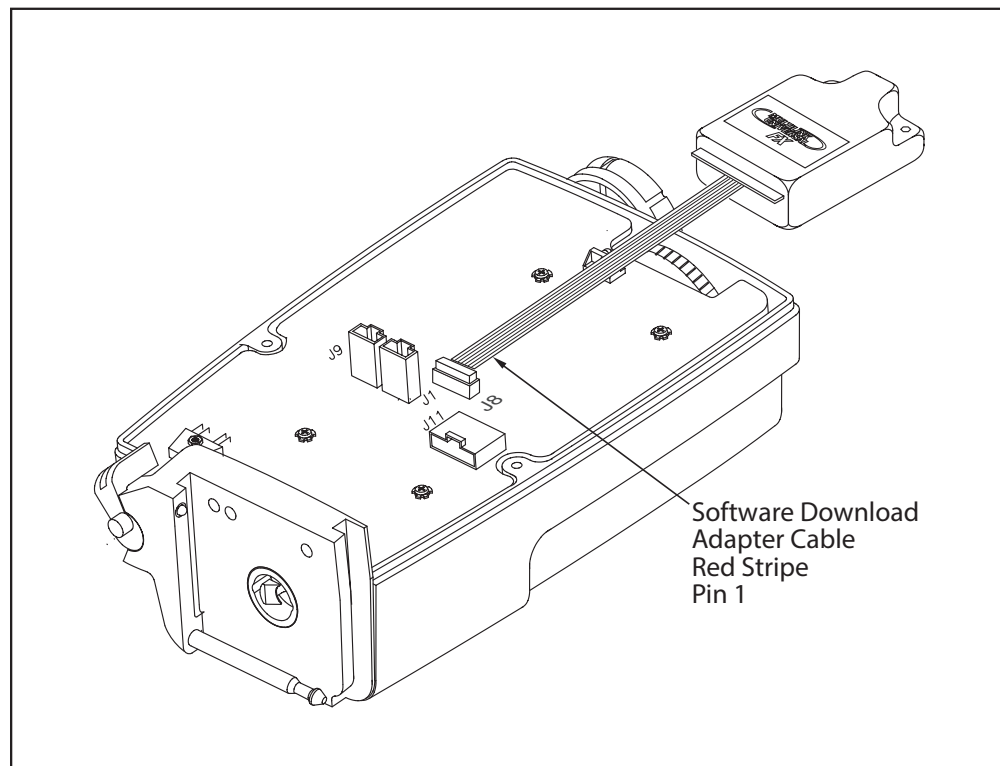


Figure 7-2-2 Powerhead Download Adapter Cable orientation

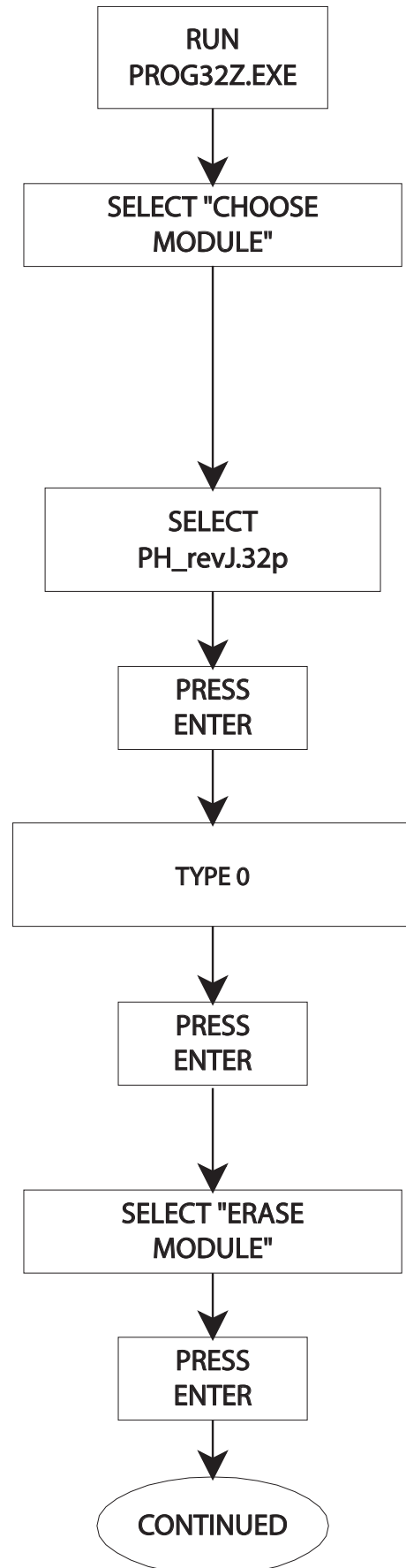
6. Repeat Step 6 from section 7.2.1 Powerpack Download..

7. Verify "CHOOSE MODULE .32P" is selected.

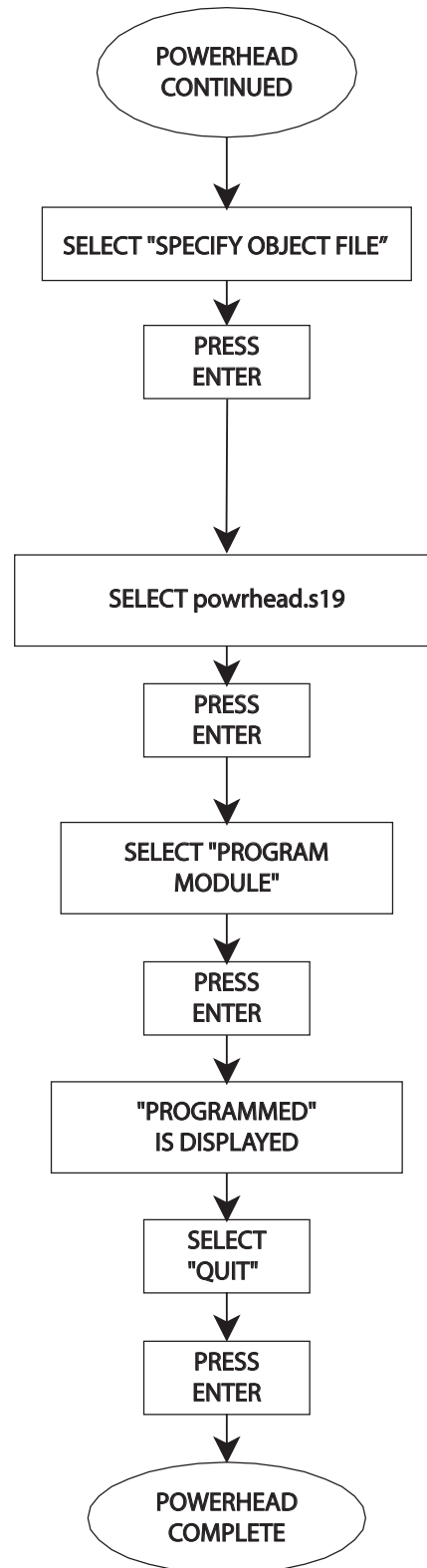
8. Select the PH_revJ.32p file and press enter.

9. Type a 0 (zero) in the "Base Address" pop up window and press enter.

10. Using the arrow keys on the PC keyboard select "ERASE MODULE" and press enter. The status section at the bottom of the screen will prompt the user when the task is complete.



11. Using the arrow keys on the PC keyboard select "SPECIFY OBJECT FILE" and press enter.
12. Using the mouse, select the powerhead.s19 file and press enter again.
13. Using the arrow keys on the PC keyboard select "PROGRAM MODULE" and press enter. The status section at the bottom of the screen will display "PROGRAMMED" when the task is complete.
14. Using the arrow keys on the PC Keyboard select "QUIT" and press enter
15. Remove power using the ON/OFF switch on the powerpack.
16. When the powerhead download is complete, reassemble the powerhead as specified in Chapter 10. If no other software needs to be downloaded, verify that the powerhead remains in calibration using the pressure limit check procedure specified in Chapter 2.



7.2.3 CONSOLE DOWNLOAD

NOTE: The console must be connected to the powerpack to complete this procedure. The programmer can be connected directly to J4 on the console PCB assembly.

1. Ensure power to the injector is off.
2. Remove the console's back cover as described in Chapter 10.3A.
3. Connect the USB- cable of the 904251 USB-based download adapter to a USB port on the PC.
4. Connect the Software Programmer cable to the console CPU board as shown in Figure 7-2-3.

CAUTION! ⚠

Ensure the red stripe on the ribbon cable goes to Pin-1 of J4 on the console CPU Board.

5. Turn on power to the PC and powerpack, then to the console. Ignore any messages that appear on the console screen, or powerhead during the downloading process.

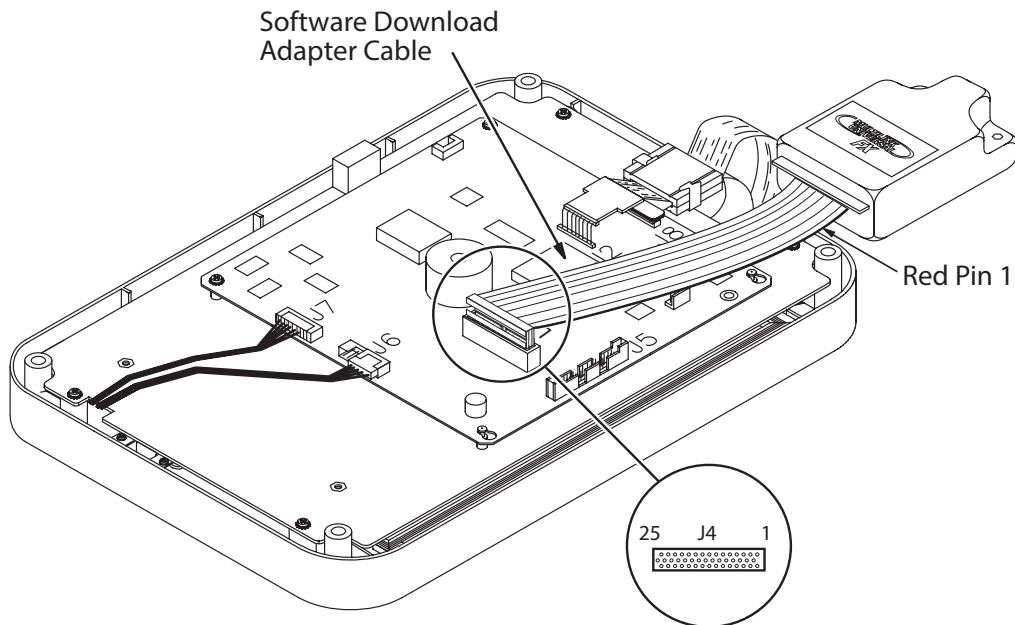


Figure 7-2-3 Console Software Download Cable orientation

6. Run the PROGCFZ.exe file from C:\pemicro. May also be found using the “Start”, then “Programs” pull down-menus.

If using the USB download adapter for the first time, select the following settings. **NOTE:** Most settings are automatically determined by PROGcfz after the Interface setting is configured:

Interface: USB Multilink, USB Multilink FX, or Embedded OSJTag

Port: USB1: Multilink Universal FX Rev-B or later

CPU: ColdFire Processor - Autodetect

Debug Shift Speed: (4)...

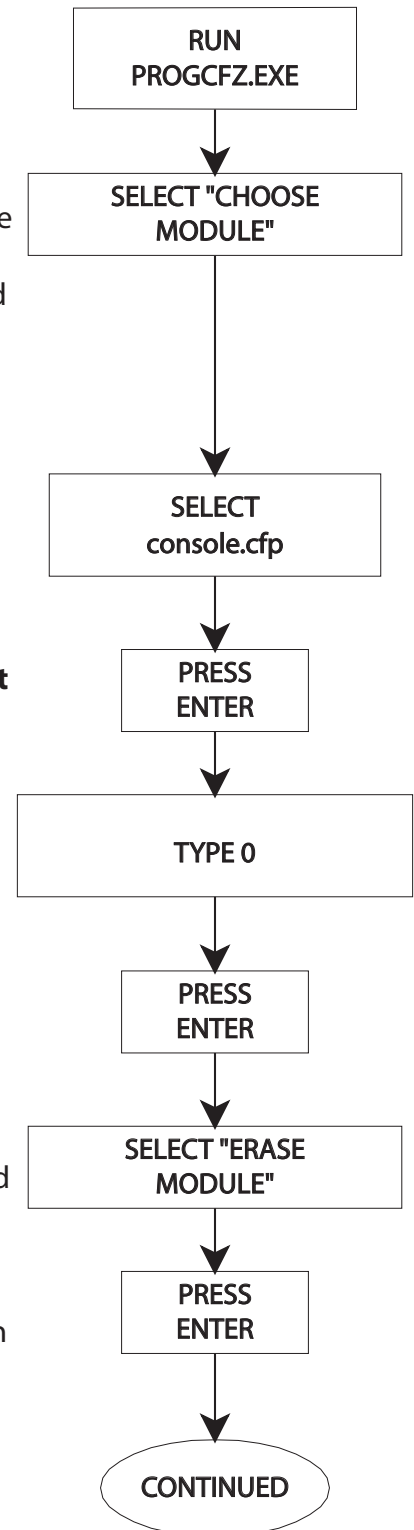
MCU Internal Bus Frequency (For programming):
Auto-Detect

Reset Options: Use PST signals to determine device state. (Default=Checked) - Checked

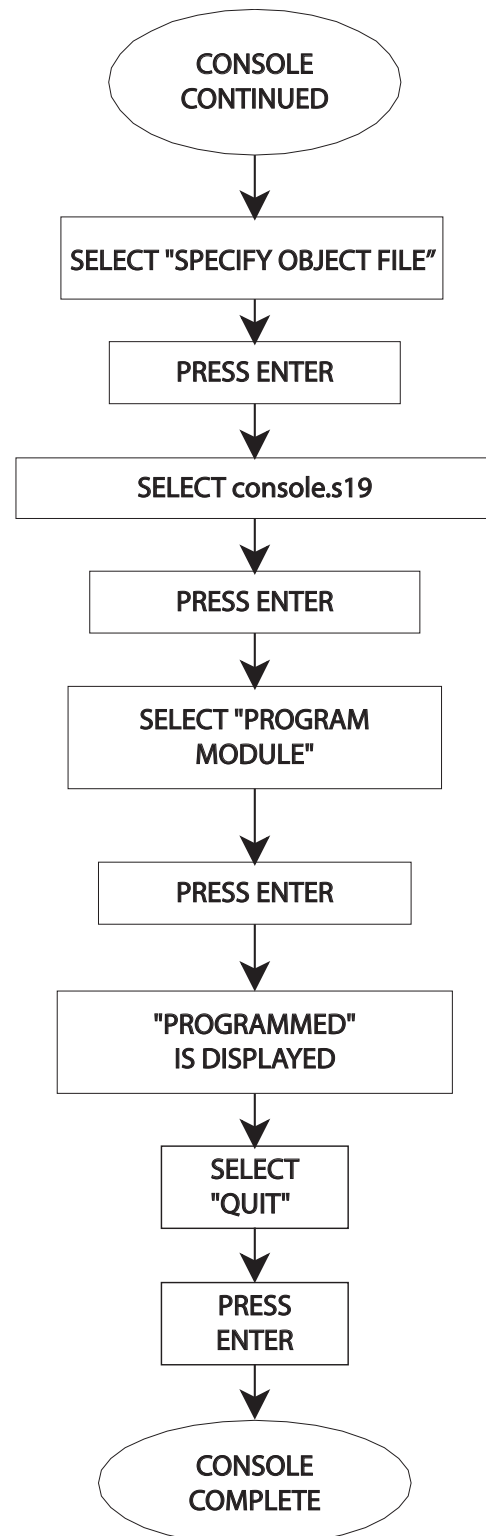
Provide power to target: Not Checked

Show this dialog before attempting to contact target (Otherwise only display on Error): Not Checked.

7. Verify “CHOOSE MODULE.CFP” is selected.
8. Using the mouse, select the console.cfp file and press enter.
9. Type a 0 (zero) in the “Base Address” pop up window and press enter.
10. Using the mouse or arrow keys on the PC keyboard select “ERASE MODULE” and press enter. The status section at the bottom of the screen will prompt the user when the task is complete. The erase command may take 30 seconds. Actual erase time will depend on the speed of your PC.



11. Using the mouse or arrow keys on the PC keyboard select "SPECIFY OBJECT FILE" and press enter.
12. Using the mouse or arrow keys on the PC keyboard select the console.s19 file and press enter again.
13. Using the mouse select "PROGRAM MODULE" and press enter.
14. The program module command may take 160 seconds. Actual programming time will depend on the speed of your PC.
15. Using the mouse or the arrow keys on the PC Keyboard, select "QUIT" and press Enter.
16. Remove power using ON/OFF switch on the powerpack.
17. Disconnect software download setup from injector. Switch injector on and verify correct software versions from the System Info screen.
18. Upon completion of download, verify against Service Checklist (Appendix B)



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8

OPTIONS INSTALLATION

8.1 ADAWS: AIR DETECTION AID AND WARNING SYSTEM**8.1.1 INSTALLATION**

1. With power on, retract ram completely.
2. Remove current syringe holder assembly, if it is still installed. Open syringe holder assembly, pivot 90 degrees in reference to the powerhead and slide the assembly off of the shaft by reversing the installing process in Figure 8-1-1.
3. Turn injector power off at the console or powerpack.
4. Install Syringe Holder Assembly with ADAWS by orienting the syringe assembly at a 45° angle to the powerhead as shown in Figure 8-1-1. Slide the assembly onto the exposed shaft as shown.

NOTE: The syringe assembly cannot be removed or installed in the fully open position.

5. Close the syringe assembly by rotating up past the detent to the full up position.
6. Rotate the syringe lever counterclockwise to secure the syringe assembly to the powerhead.

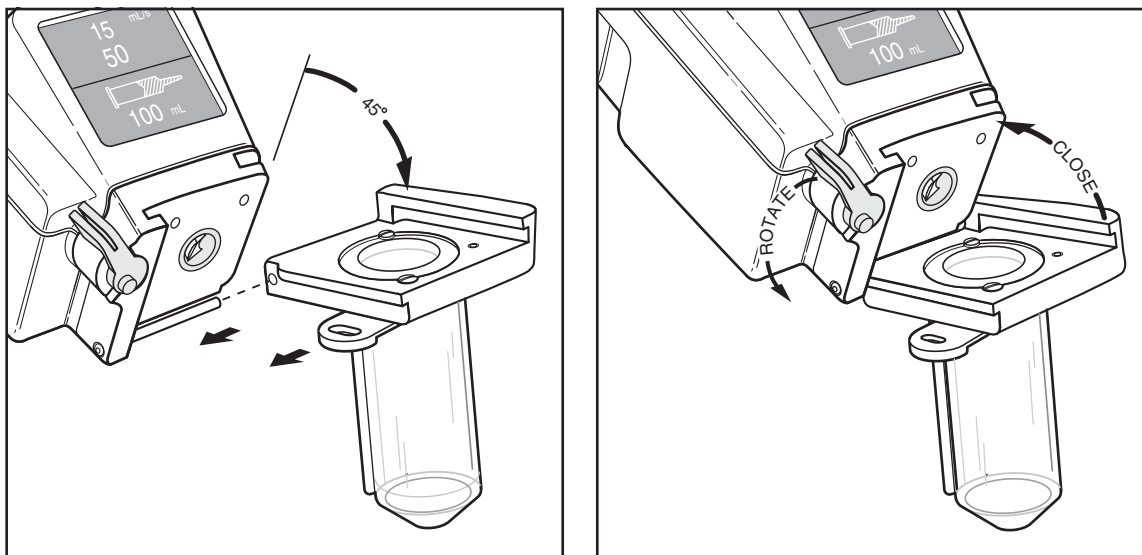


Figure 8-1-1 Installing the Syringe Assembly

7. Connect ADAWS connector to the receptacle on the bottom side of the powerhead marked with the ADAWS icon as shown in Figure 8-1-2.
8. If current system also has the Heater Assembly, install it to the mounting post as shown in Figure 8-1-2.

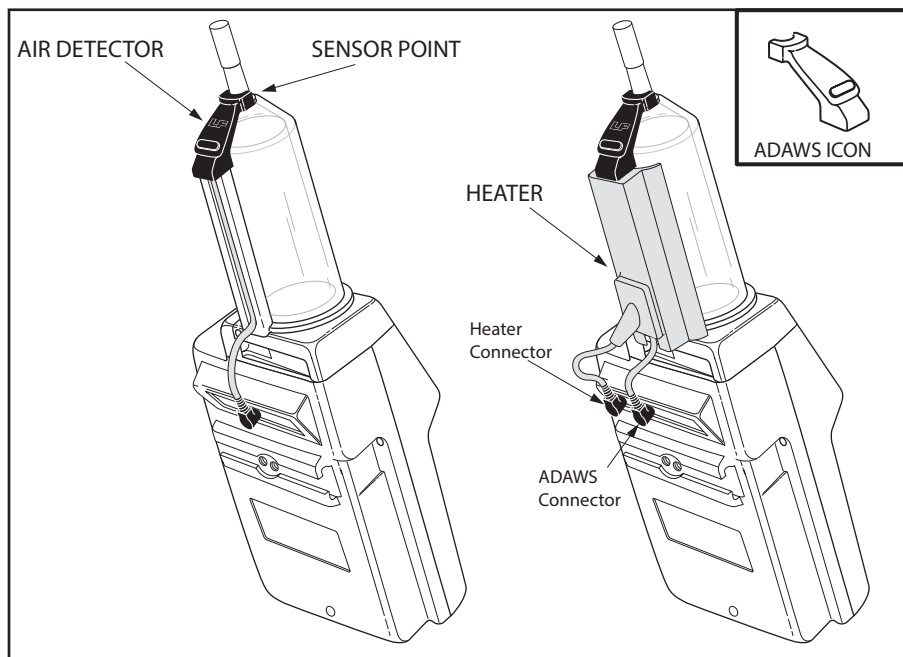


Figure 8-1-2 ADAWS Installed without Heater and with Heater

8.1.2 SYSTEM TEST

With installation complete, apply power to the injector and wait for main screen to appear.

8.1.2.1 ADAWS Detected Air in the Vertical Position

1. Fill a 150 ml syringe with 50 ml of water and 50 ml of air and install it into the syringe holder assembly with the powerhead pointing up.
2. Rotate the syringe past 30° below horizontal allowing all air to pass to the plunger end of the syringe.
3. Program a 50 ml injection and press the [Enable] key.
4. Press the [Single Injector-Enable] key.
5. The screen shown in Figure 8-1-3 should appear.



Figure 8-1-3 Detection of Air Message

6. Press the [BLOOD ONLY] key and the injector should continue with the enable sequence. The Main Screen will be displayed.

7. To test the air present system, press the [NO BLOOD] key, the following menu will appear.

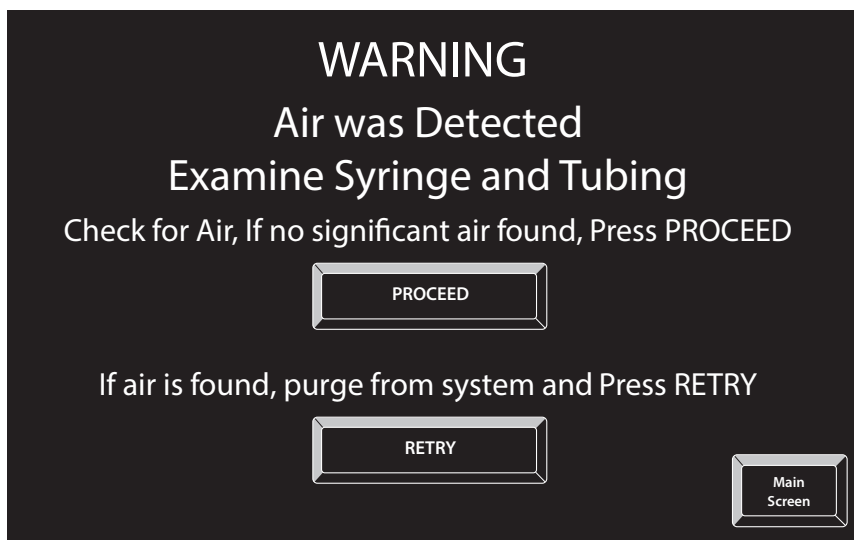


Figure 8-1-4 Detection Air Message

8. Rotate the powerhead so the syringe is pointing up. Using the manual knob, purge the air from the syringe. **NOTE:** You must purge at least 2 mL.
9. Rotate the syringe past 30° below horizontal the air should already be purged to the plunger end of the syringe.

NOTE: *Ensure there is no air in the tip of the syringe.*

10. Press the [RETRY] key. The injector should enable with the Main Screen displayed.

8.1.2.2 ADAWS Detected Air in the Inject Position

1. Install an empty 150 ml into the syringe holder assembly.
2. Program a 50 ml injection and press the [Enable] key.
3. Press the [Single Injector-Enable] key.
4. Press the [Overridden] key. After fill sequence screens are overridden, the screen shown in Figure 8-1-3 should appear.
5. Press the [BLOOD ONLY] key and the injector should continue with the enable sequence.
6. Press the [NO BLOOD] key. The screen shown in Figure 8-1-5 should appear.

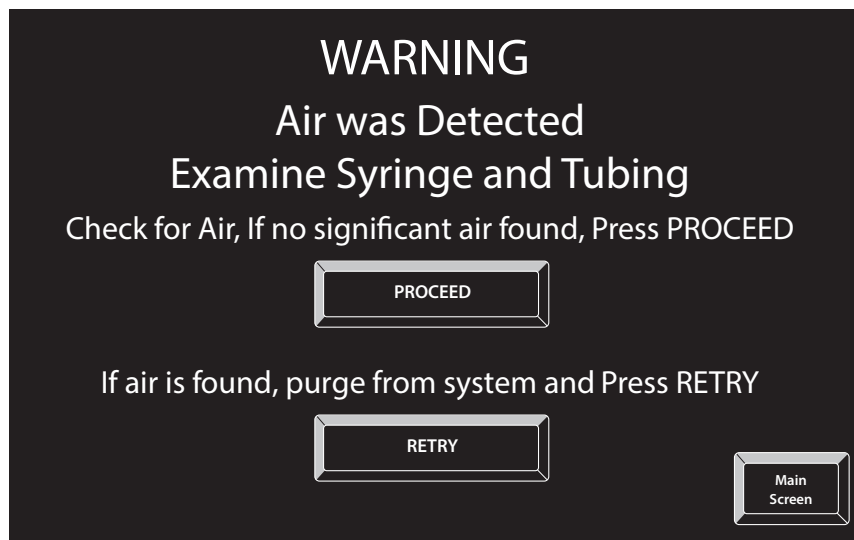


Figure 8-1-5 Detection of Air Message

7. Press the [Main Screen] key to conclude this test.

8.1.2.3 ADAWS Detected Air Bubble Passed into Syringe

1. Fill a 150 ml syringe with 50 ml of water and 0 ml of air and install it into the syringe holder assembly and purge the air out of the syringe.
2. Program a 40 ml injection.
3. Rotate the syringe past 30° below horizontal.

NOTE: *Ensure there is no air in the tip of the syringe.*

4. With syringe in the inject position and before the Enable key is pressed, use the manual knob to draw 20 or more air bubbles into the syringe. The powerhead should beep each time a bubble passes. Once the bubbles pass the ADAWS press the Enable key.
5. Press the [Single Injection-Enable] key. The screen shown in Figure 8-1-3 will appear.
6. Press the [BLOOD ONLY] key and the injector should continue with the enable sequence. The Main Screen will be displayed.
7. To test the air present system, press the [NO BLOOD] key, the following menu will appear.

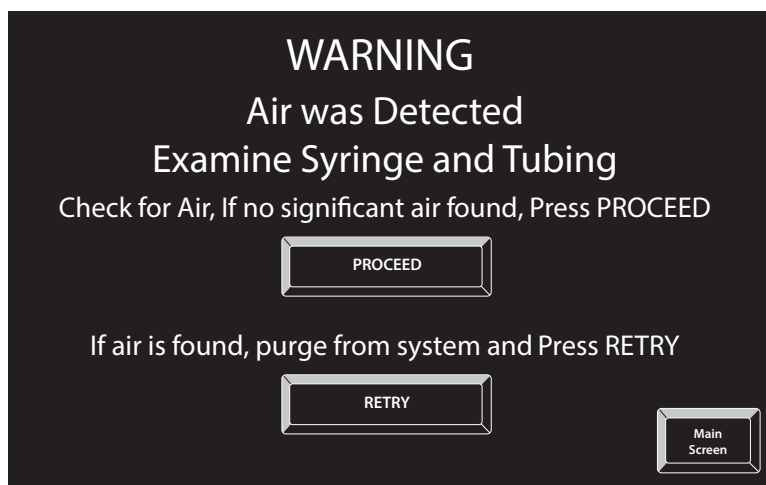


Figure 8-1-6 Detection Air Message

8. Rotate the powerhead so the syringe is pointing up, use the manual knob to purge air out.
9. Rotate the syringe past 30° below horizontal allowing all air to pass to the plunger end of the syringe.

NOTE: *Ensure there is no air in the tip of the syringe.*

10. Press the [RETRY] key. The injector should enable with the Main Screen displayed.

8.1.2.4 ADAWS Detected Air During an Injection, Injector Disabled

1. Fill a 150 ml syringe with 50 ml of water and 50 ml of air and install it into the syringe holder assembly.
2. Program a 75 ml injection.
3. Rotate the syringe past 30° below horizontal allowing all air to pass to the plunger end of the syringe. Press the [Enable] key.
4. Press the [Single Injection-Enable] key. The screen shown in Figure 8-1-3 will appear.
5. Press the [BLOOD ONLY] key, the enable sequence should continue. The Main Screen will be displayed.
6. Start the injection.
7. When ADAWS detected air during an injection, the screen shown in Figure 8-1-7 appears. Once ADAWS detects air, it immediately stops the injection.

NOTE: *It is very likely that some or a large amount of air will have exited the syringe.*

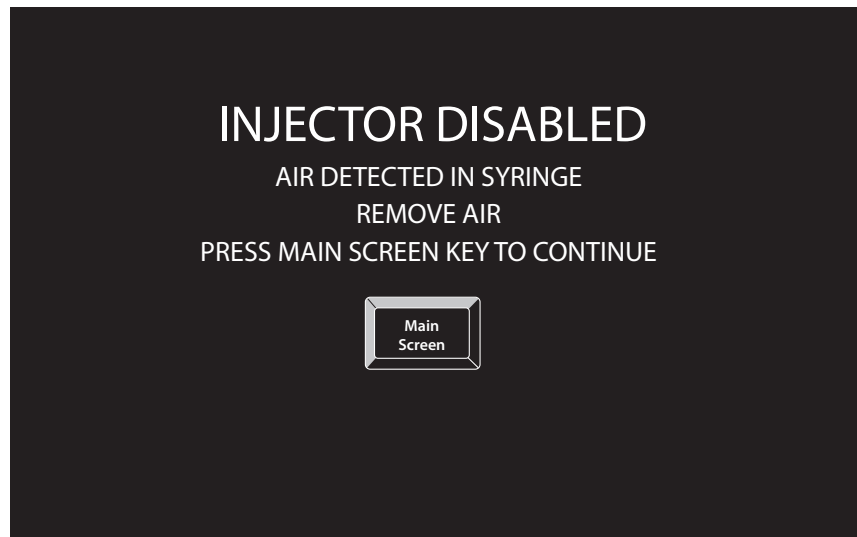


Figure 8-1-7 Injector Disabled Message

8.1.2.5 ADAWS Malfunction Messages: Component Failure

1. Unplug the ADAWS with the injector power on. The screen shown in Figure 8-1-8 should appear.

The following warning will be displayed for a system malfunction.

NOTE: *If this message appears during any of the test cases, replace the ADAWS assembly.*



Figure 8-1-8 ADAWS Malfunction Message

8.2 SYRINGE HEATER

The syringe heater minimizes the loss of heat from preheated contrast.

8.2.1 INSTALLATION

To install the syringe heater, hold the syringe heater parallel to the heater bracket as shown in Figure 8-2-1. Gently snap the heater onto the post. The heater will fit snugly against the syringe when properly attached. Connect the heater cord to the powerhead at the location shown.

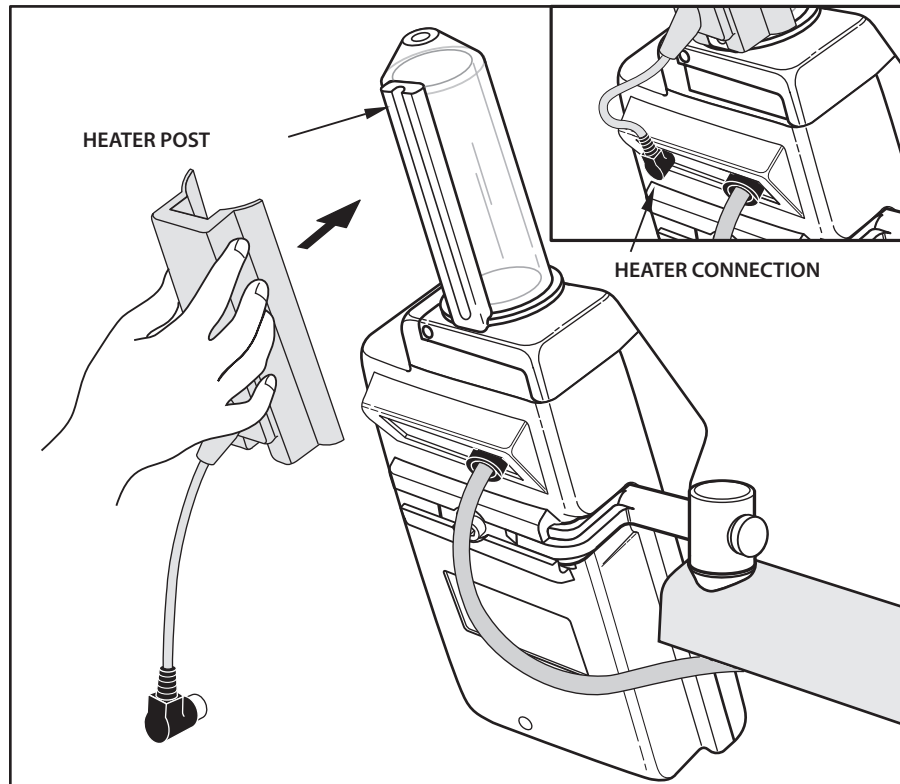


Figure 8-2-1 Installing the Heater

8.2.2 REMOVAL

To remove the syringe heater, unplug the heater connector, then carefully twist and pull the heater off of the heater post as shown in Figure 8-2-2.

CAUTION! ⚠

Do not pull on the heater cord. Damage to the heater may occur.

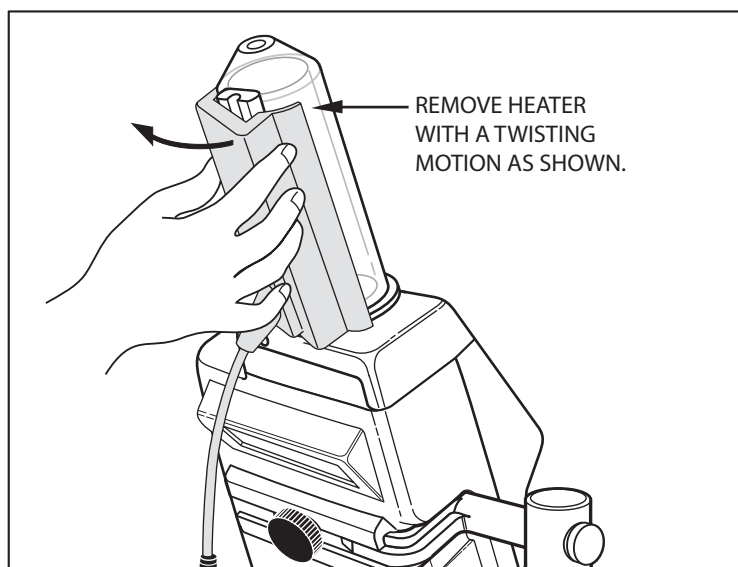
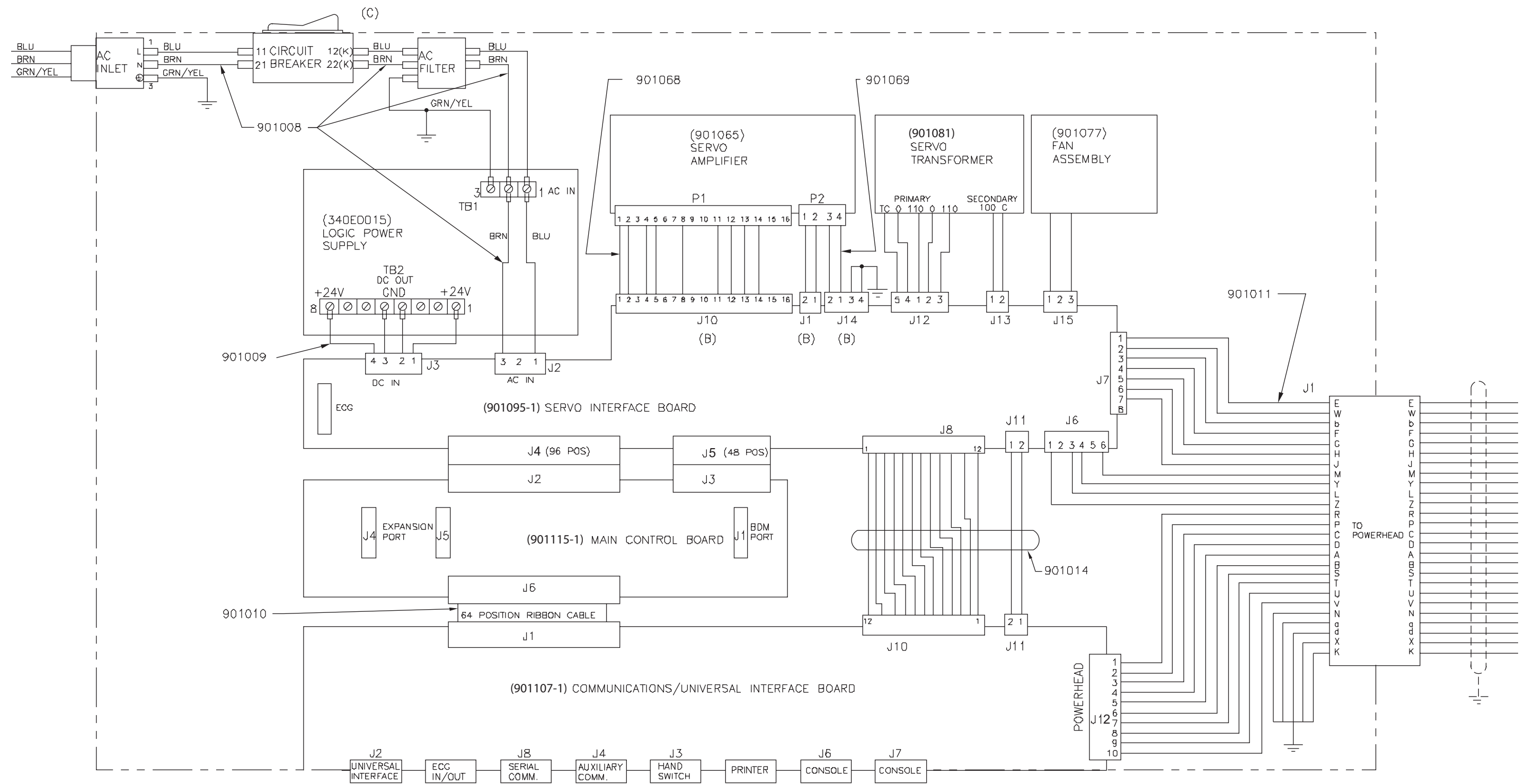


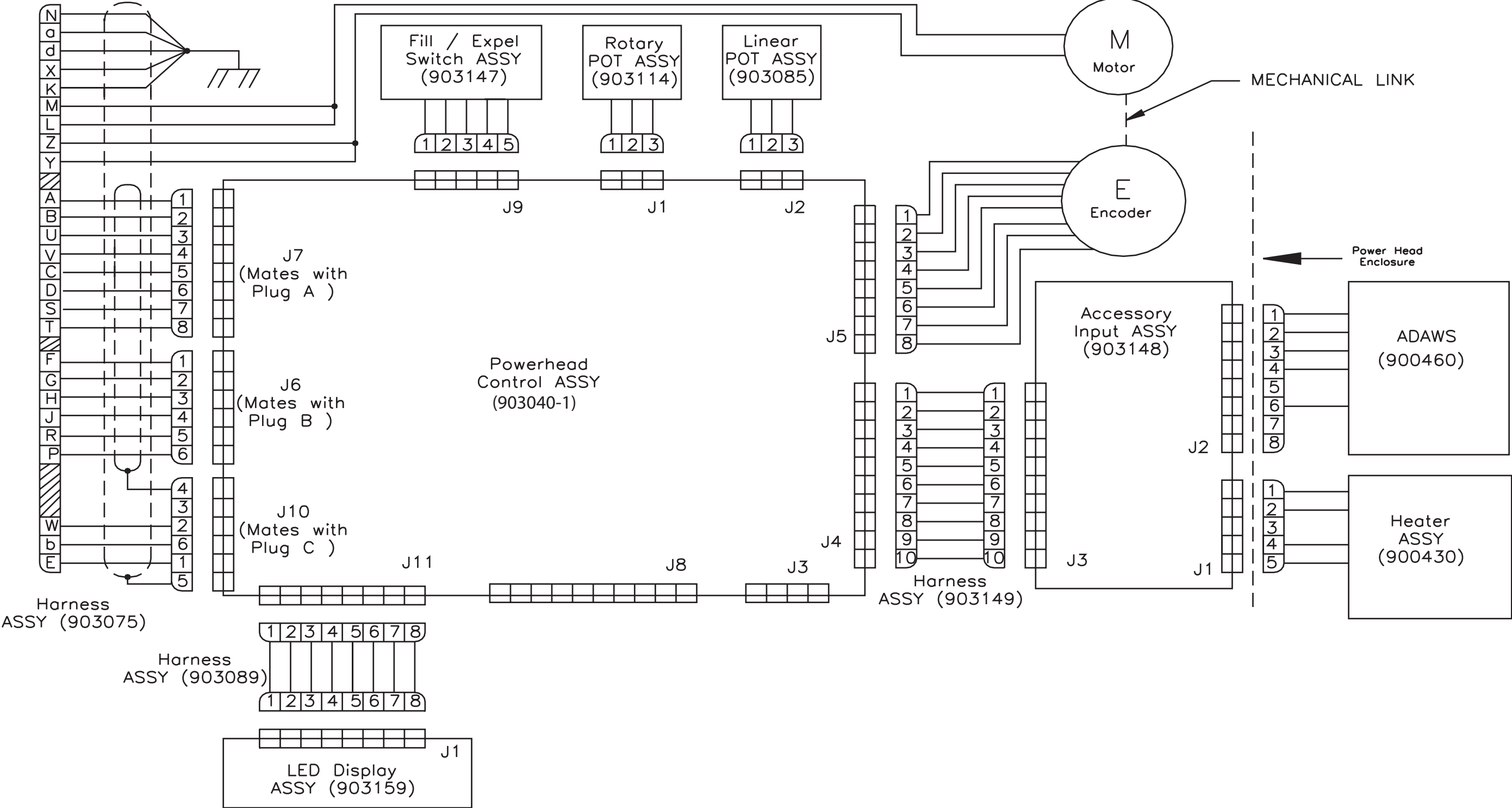
Figure 8-2-2 Heater Blanket Removal

SCHEMATICS

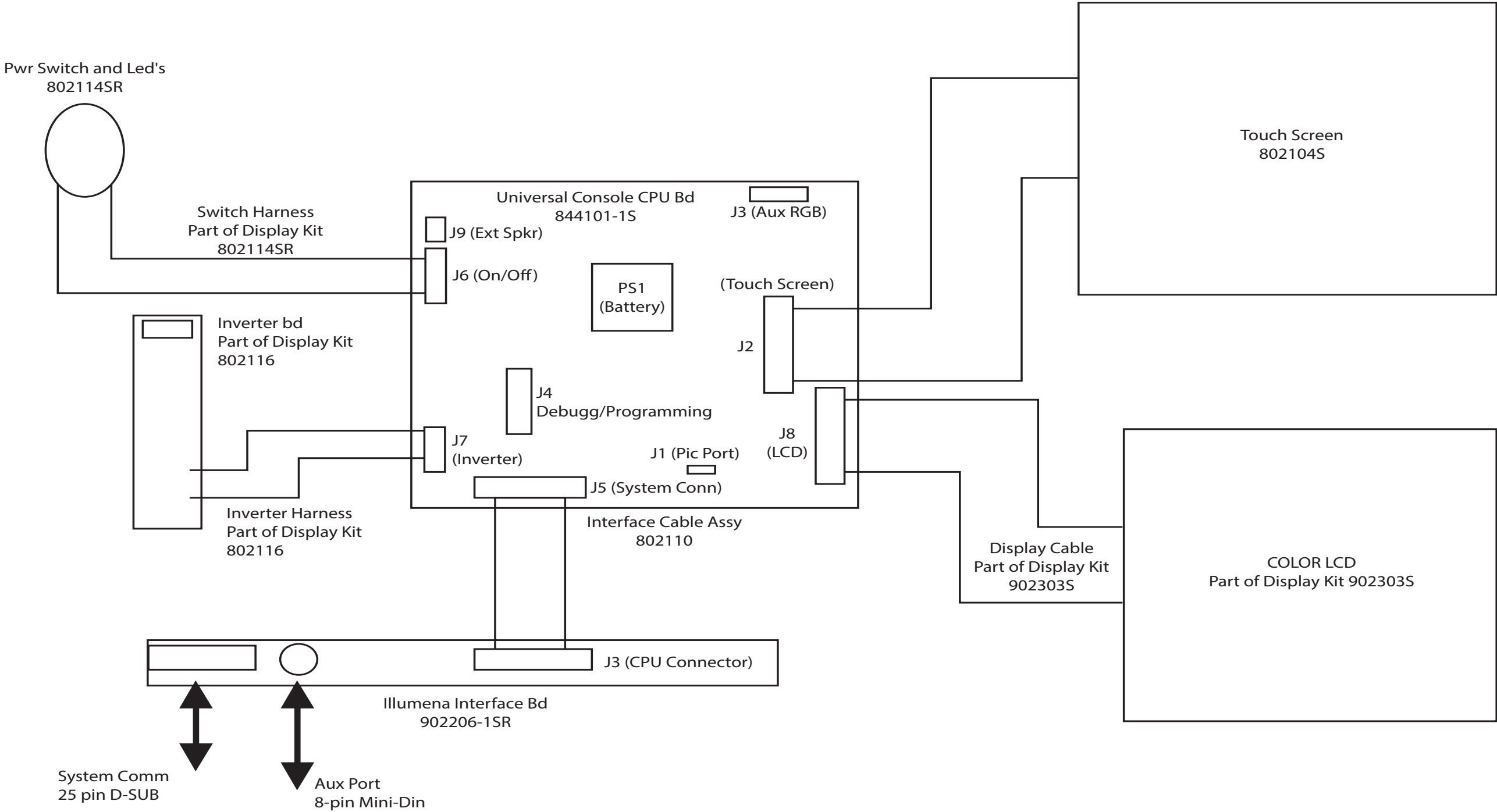
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900050	Powerpack Wiring Diagram	9-1-2
900052	Powerhead Wiring Diagram	9-1-3
900053	Console Wiring Diagram	9-1-4
901115-2 (4 sheets)	Main Control Schematic	9-1-6
901107-2 (4 sheets)	Communications Board	9-1-10
901095-2 (4 sheets)	Servo Interface	9-1-14
802101-2 (5 sheets)	Console Schematic	9-1-18
846101-2 (5 sheets)	Console Schematic	9-1-23
902206-2	Console Interface Schematic	9-1-28
903040-2 (9 sheets)	Powerhead Schematic	9-1-29
903151-2	LED Display Board	9-1-38
903118-2	Fill / Expel Schematic	9-1-39
903136-2	Accessory Input Schematic	9-1-40
901125-2 (4 sheets)	OEM Communications Board	9-1-41



POWERPACK WIRING DIAGRAM 900050-C



POWERHEAD WIRING DIAGRAM 900052-A



CONSOLE WIRING DIAGRAM 900053-A
(For Consoles 902300 & 902330)

Pwr Switch and Led's
802114SR

Switch Harness
Part of Display Kit
802114SR

Universal Console CPU Bd
846101-1S

J3 (Aux RGB)

J9 (Ext Spkr)

J6 (On/Off)

PS1
(Battery)

(Touch Screen)

J2

J4
Debugg/Programming

J7
Backlight

J1 (Pic Port)

J8
(LCD)

J5 (System Conn)

LED Backlight Harness
Part of
802116

Interface Cable Assy
802110

Display Cable
Part of Display Kit
846116S

COLOR LCD
Part of Display Kit 846116S



Illumena Interface Bd
902206-1SR

J3 (CPU Connector)

System Comm
25 pin D-SUB

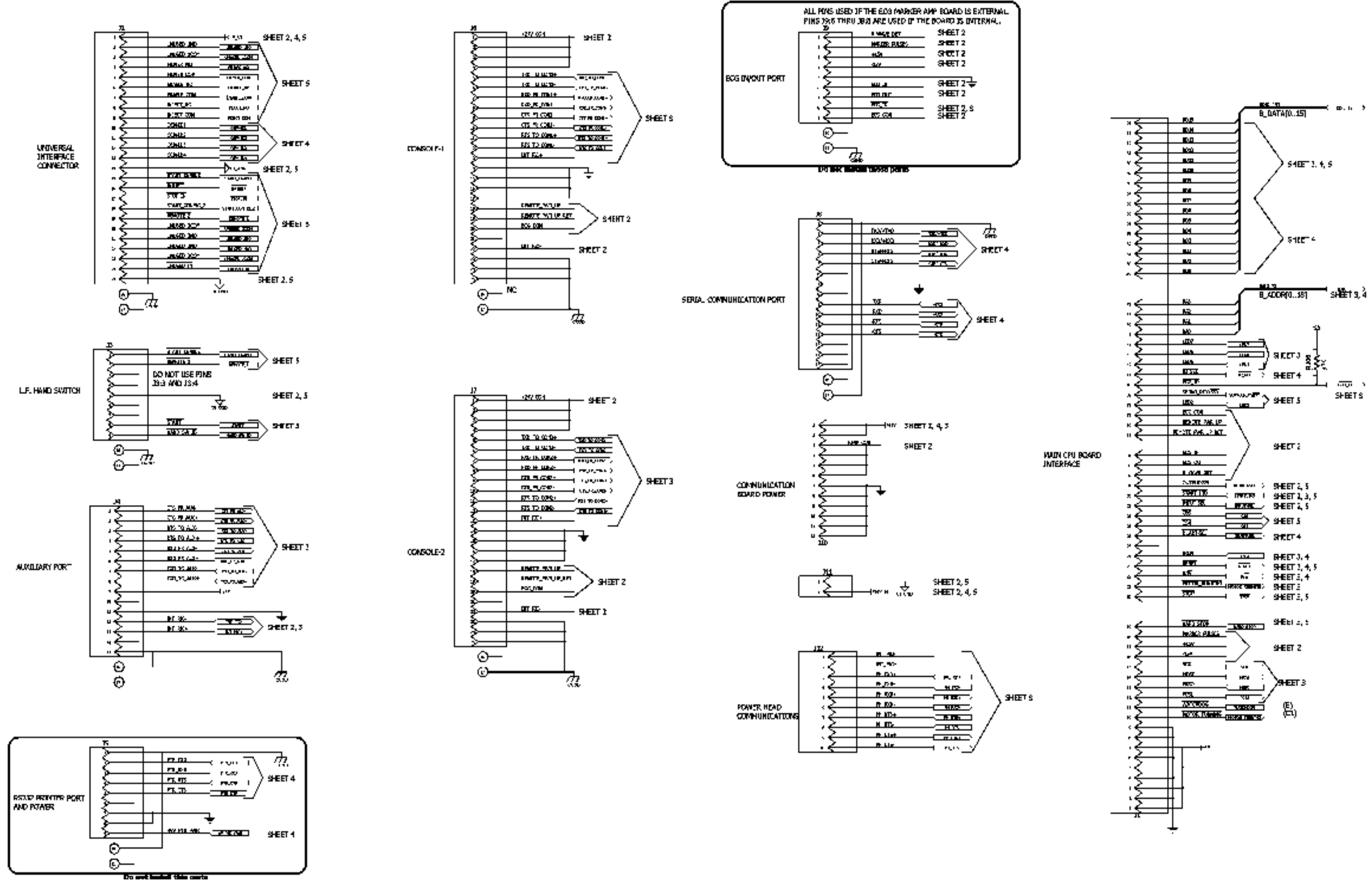
Aux Port
8-pin Mini-Din

CONSOLE WIRING DIAGRAM 900053-A
(For Consoles 902340 & 902401)

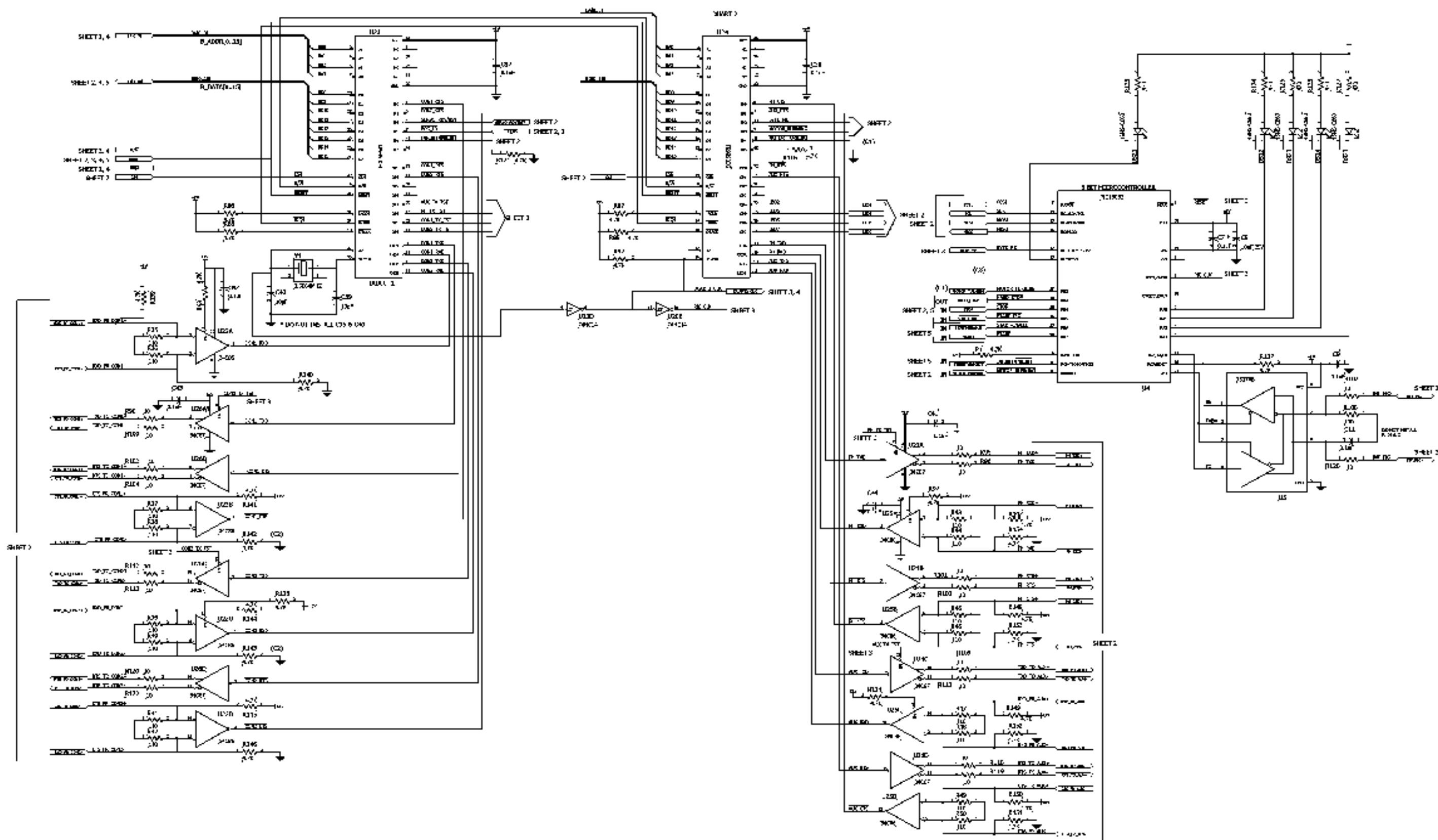






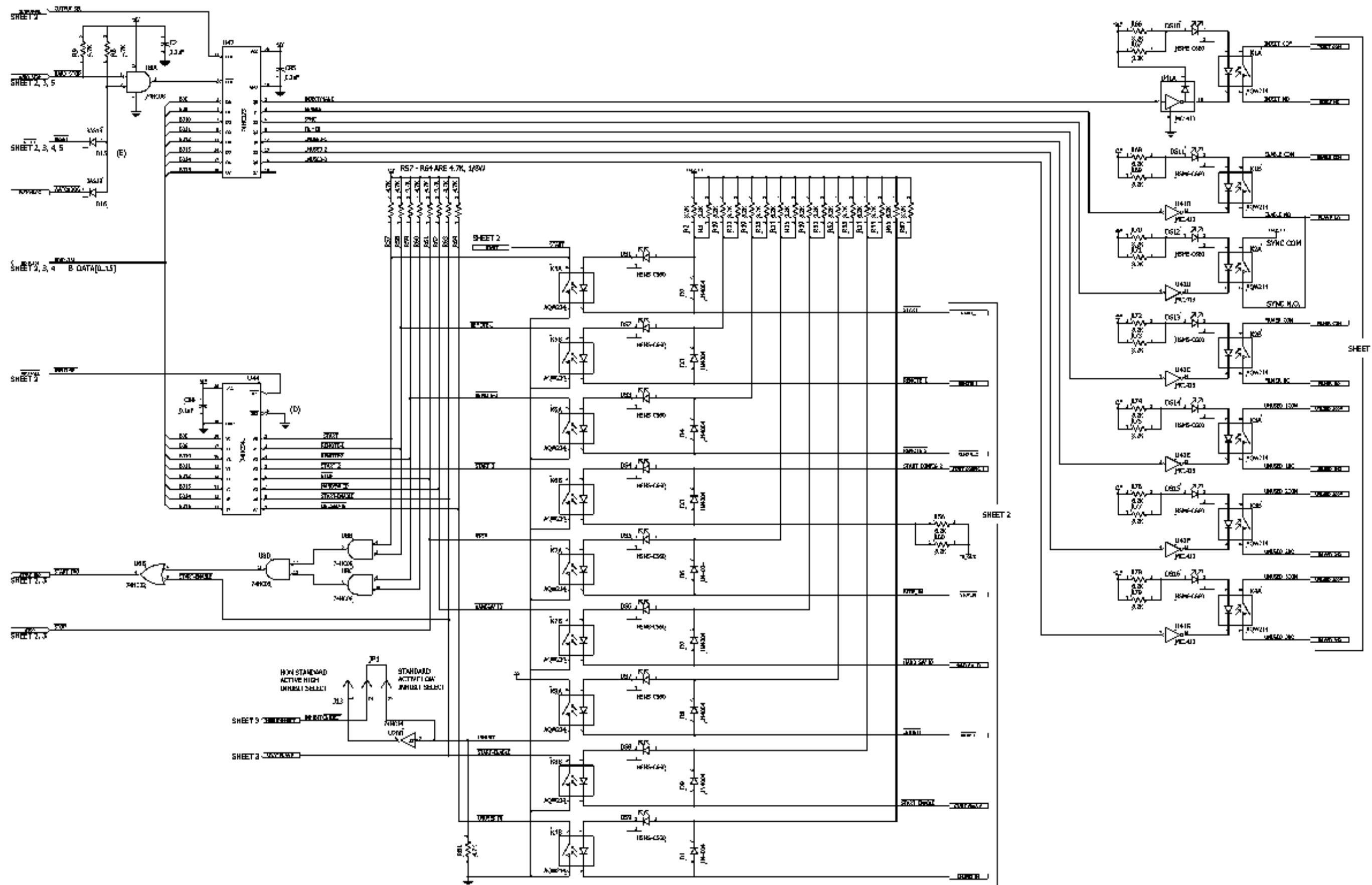


COMMUNICATION BOARD 901107-2 REV F (1 OF 4)



COMMUNICATION BOARD 901107-2 REV F (2 OF 4)

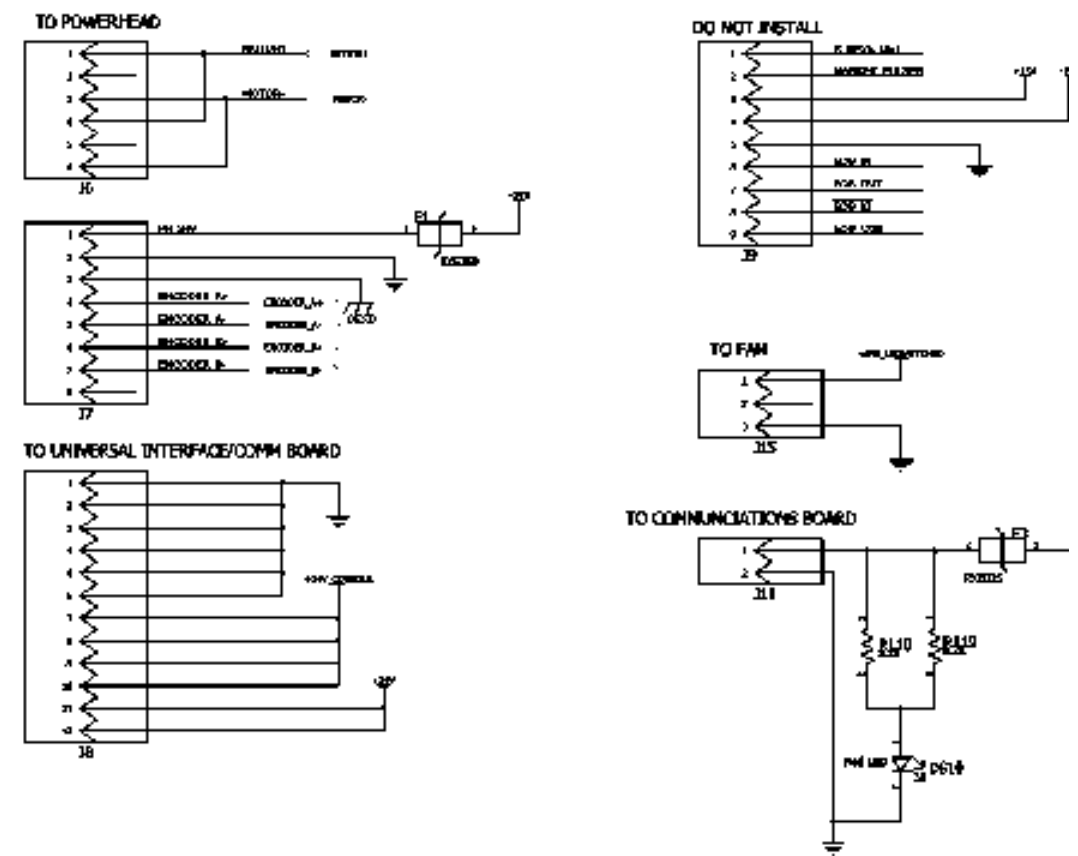




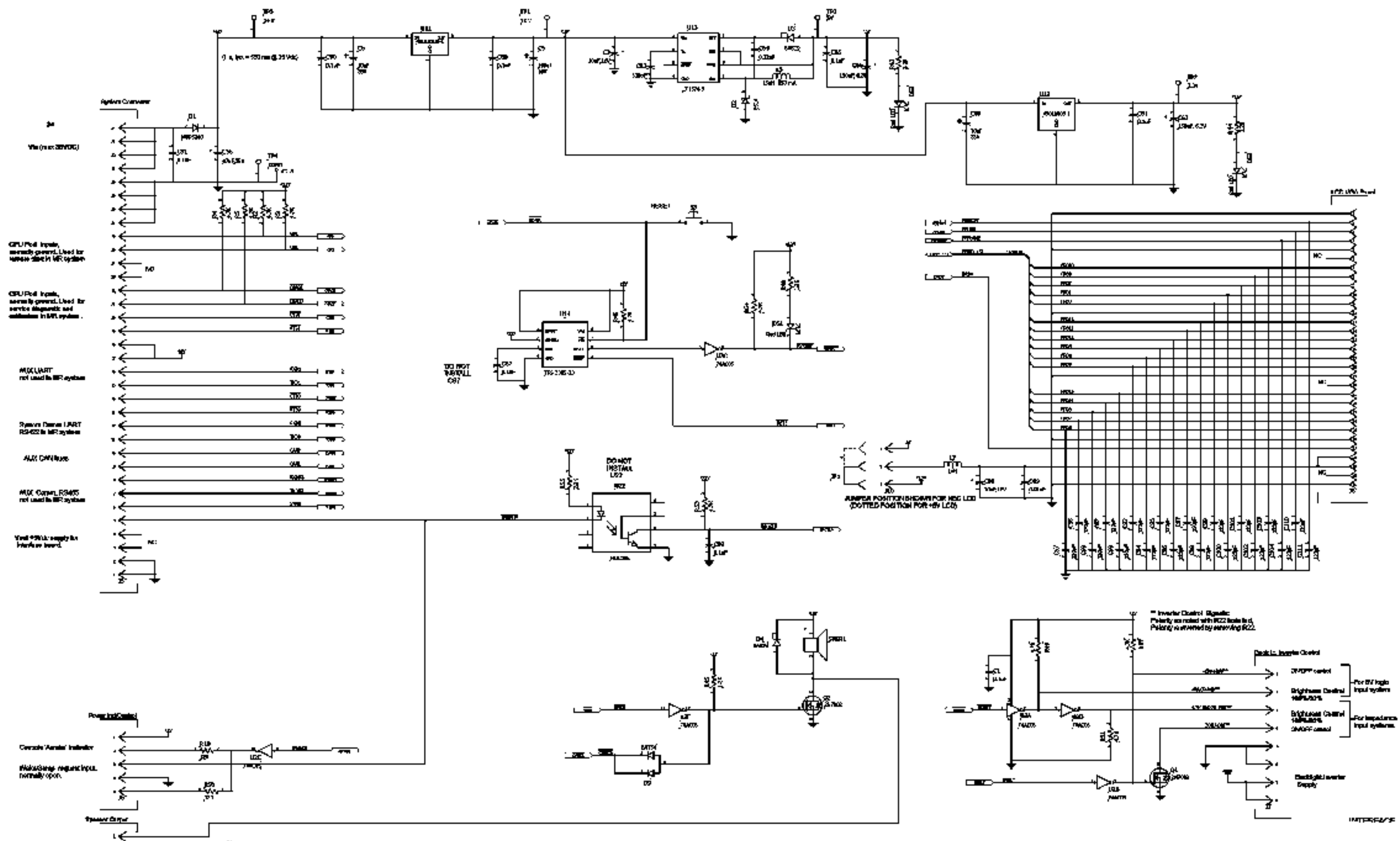
COMMUNICATION BOARD 901107-2 REV F (4 OF 4)



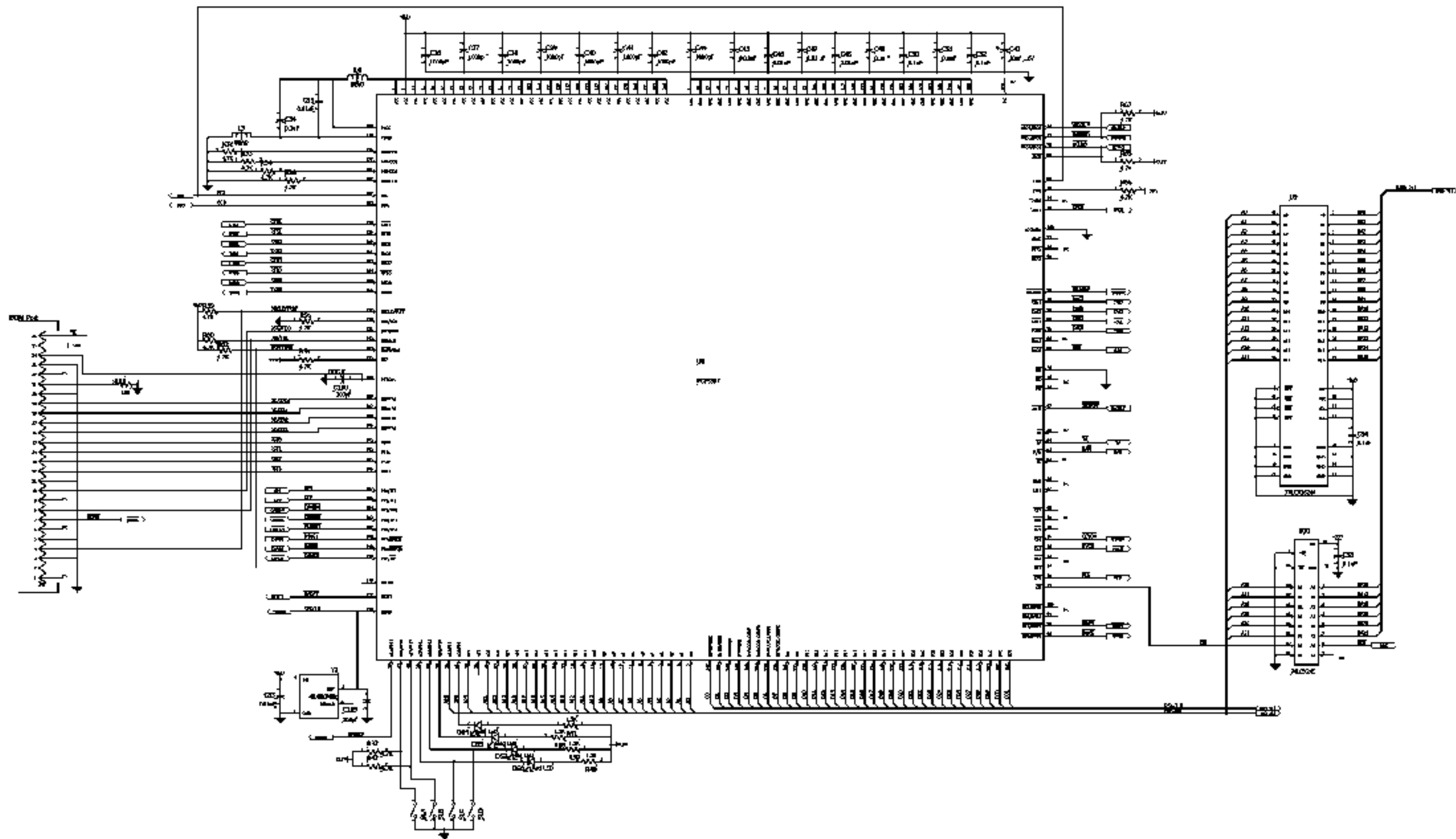




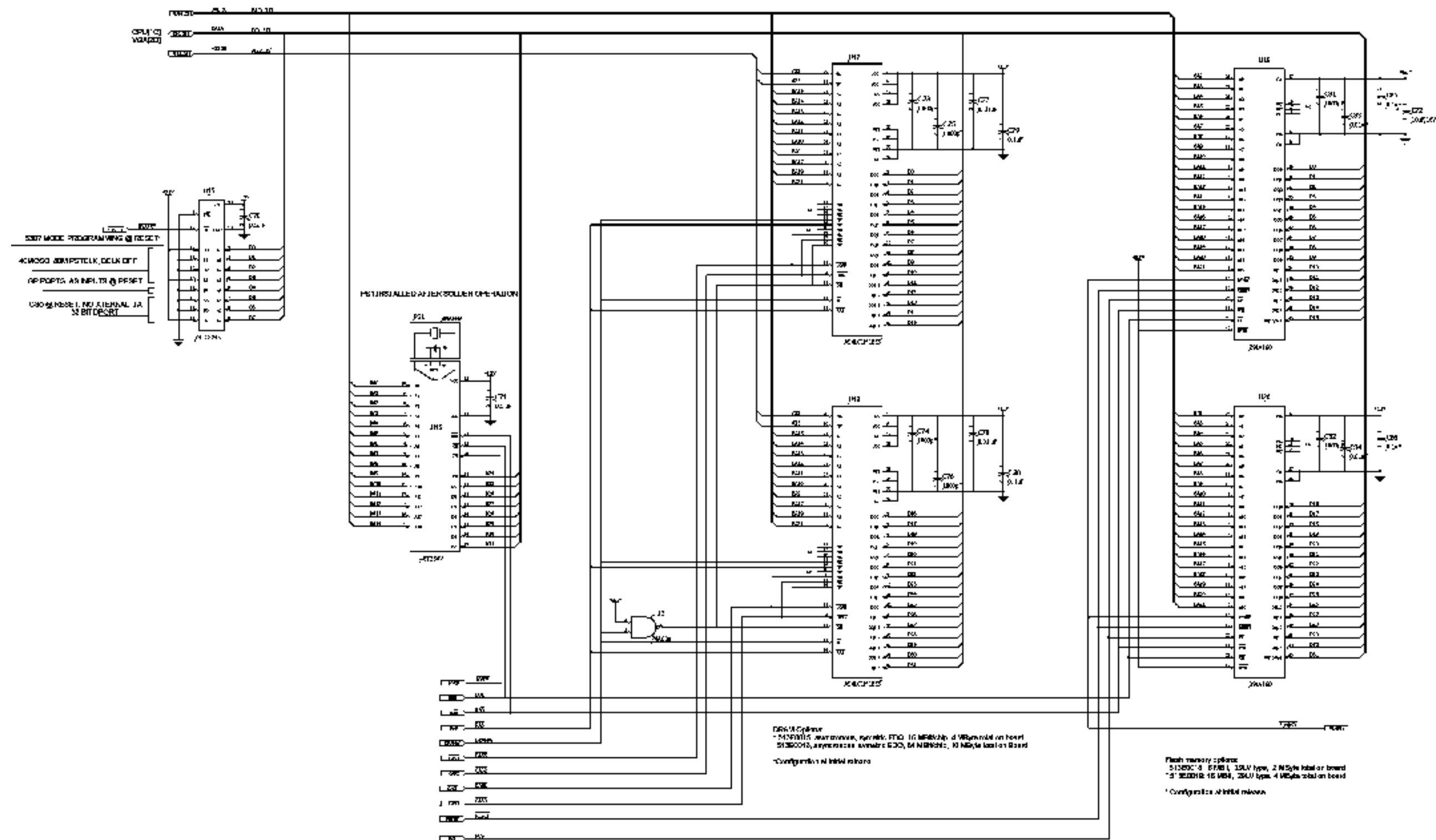




CONSOLE SCHEMATIC 802101-2 REV M (1 OF 5)

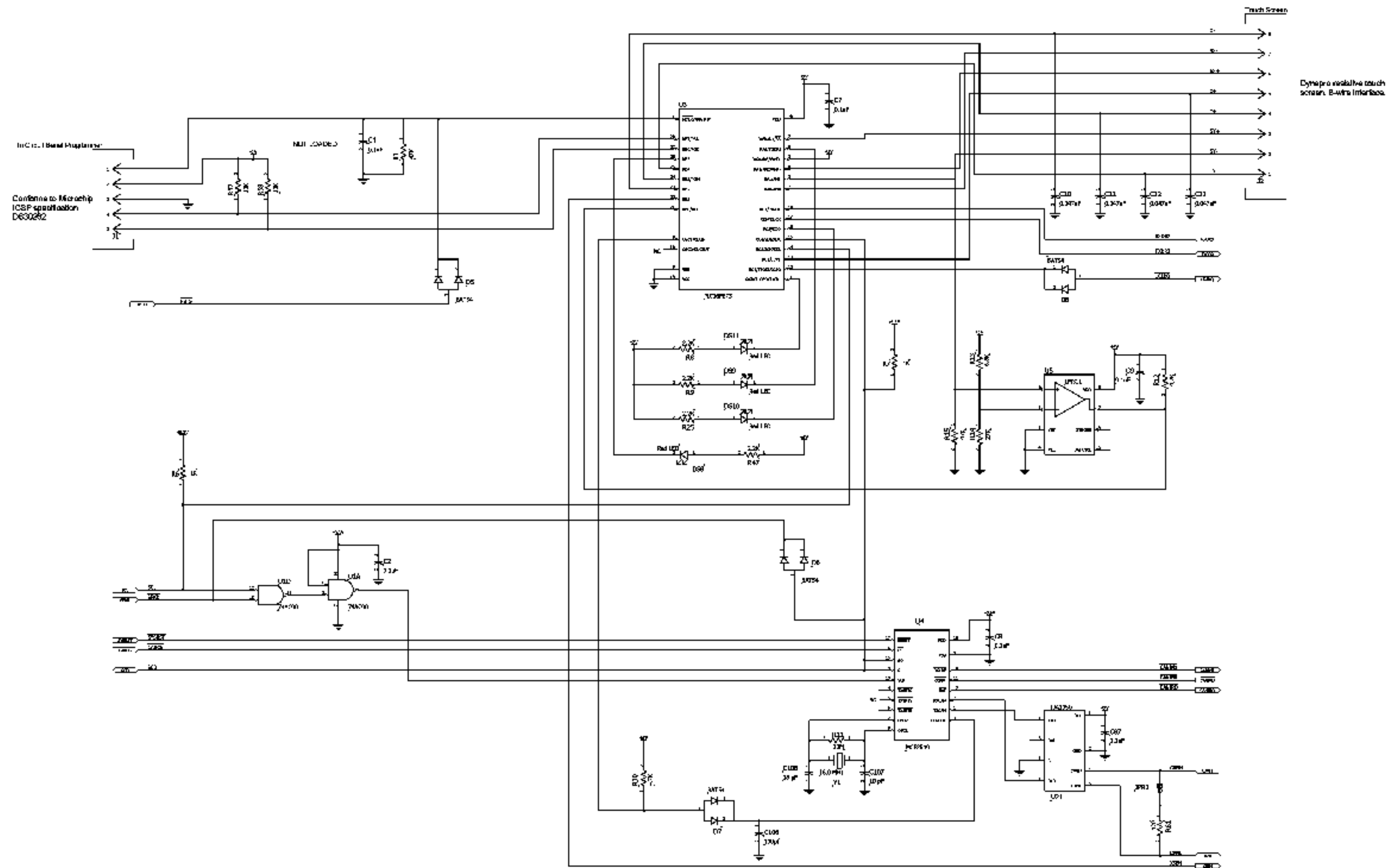


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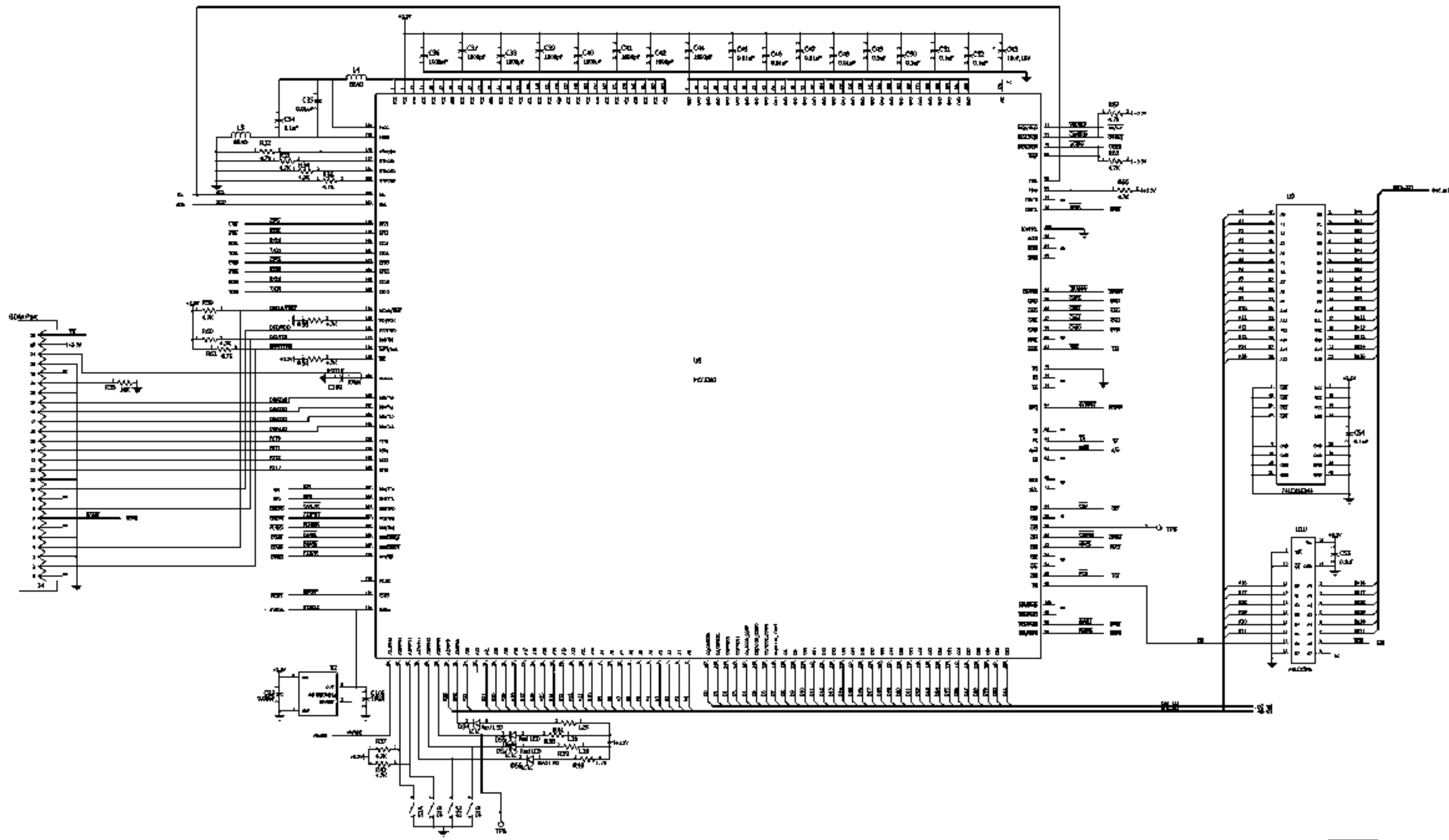
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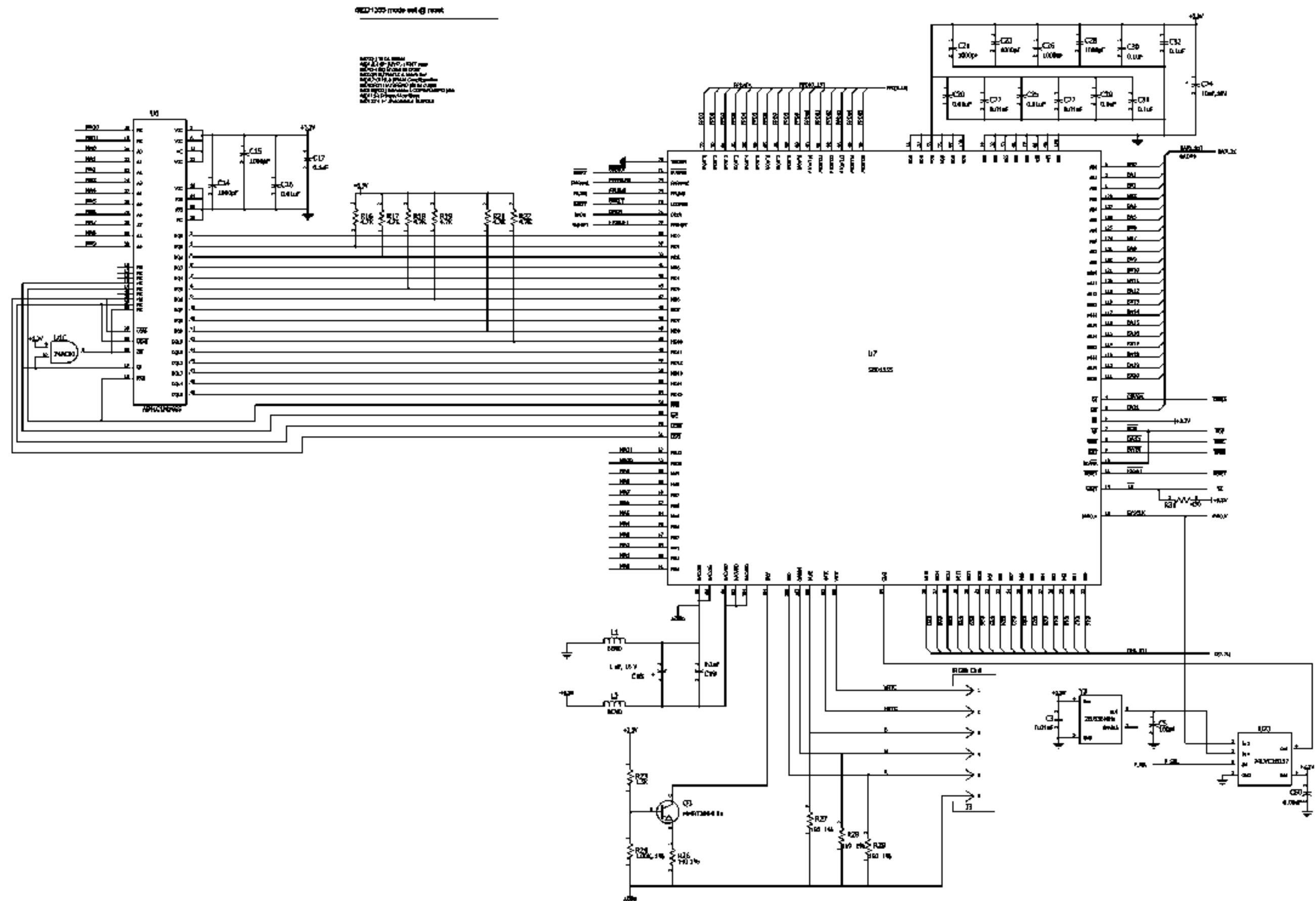
CONSOLE SCHEMATIC 802101-2 REV M (5 OF 5)





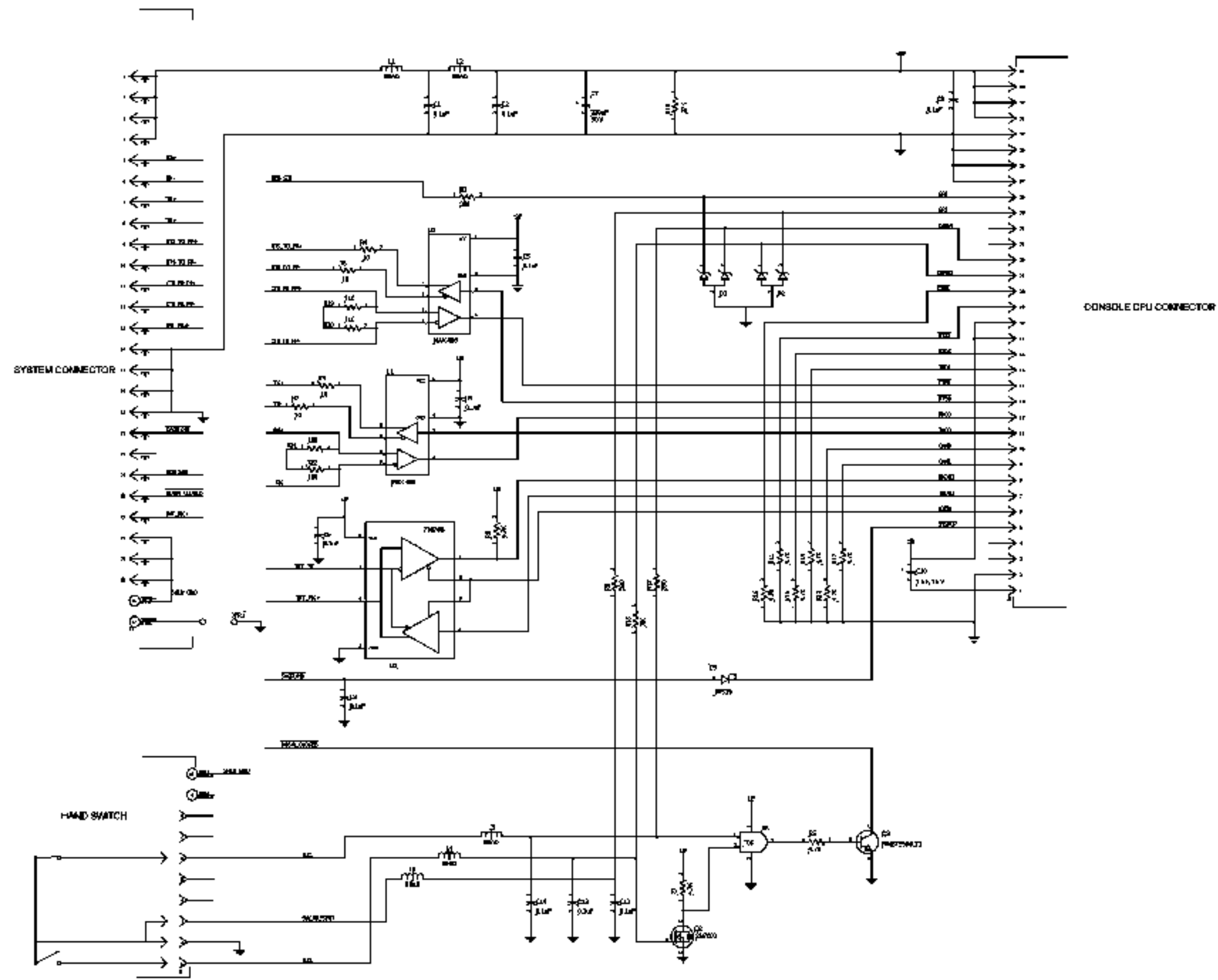
CONSOLE SCHEMATIC 846101-2 REV G (2 OF 5)





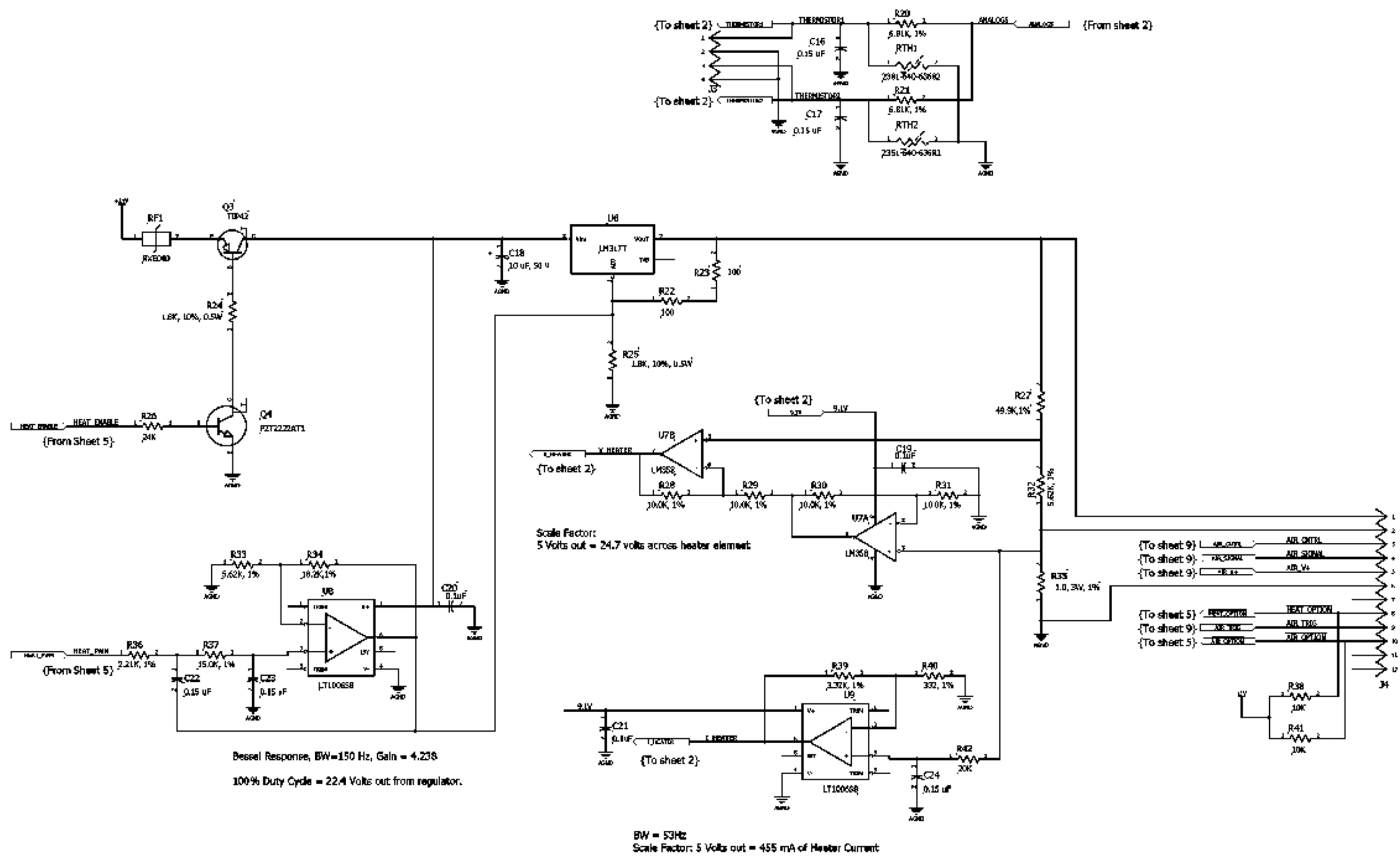
CONSOLE SCHEMATIC 846101-2 REV G (4 OF 5)



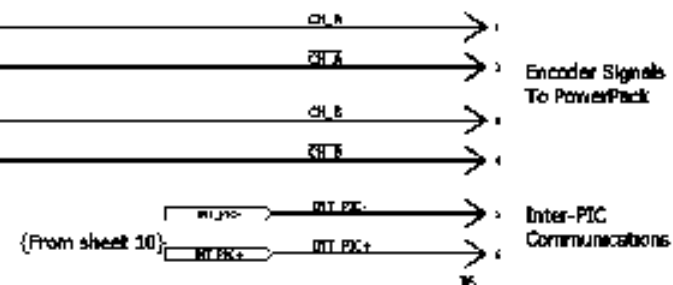


CONSOLE INTERFACE 902206-2 REV C

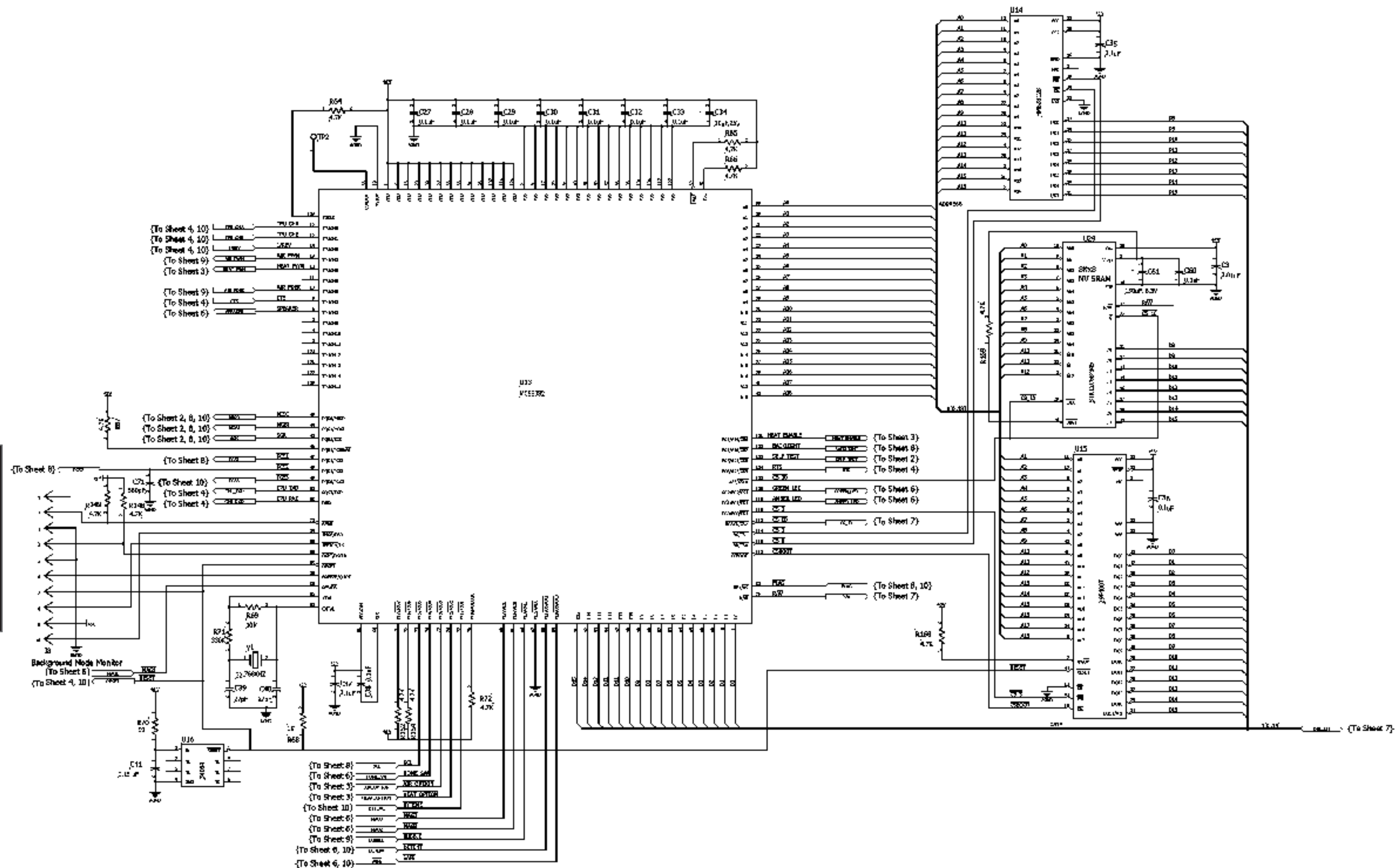




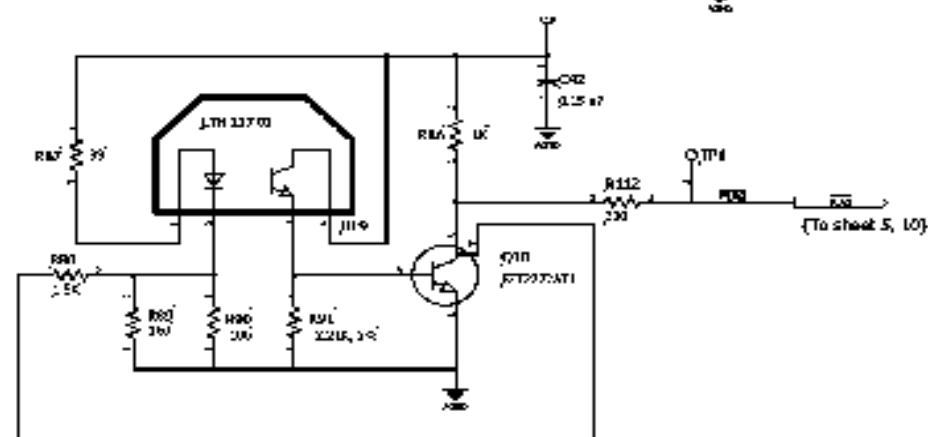
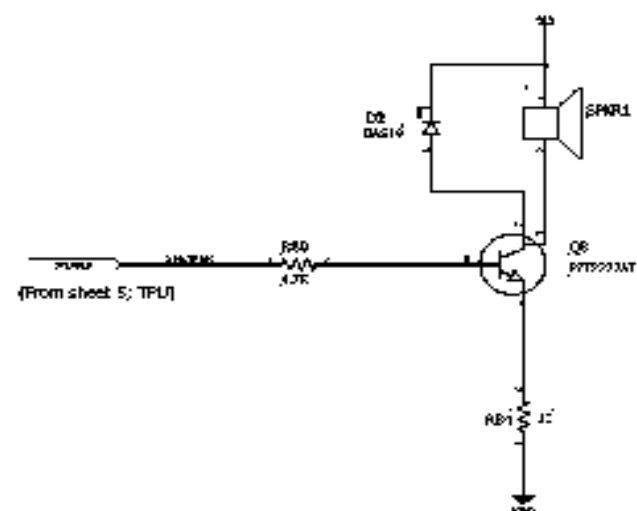
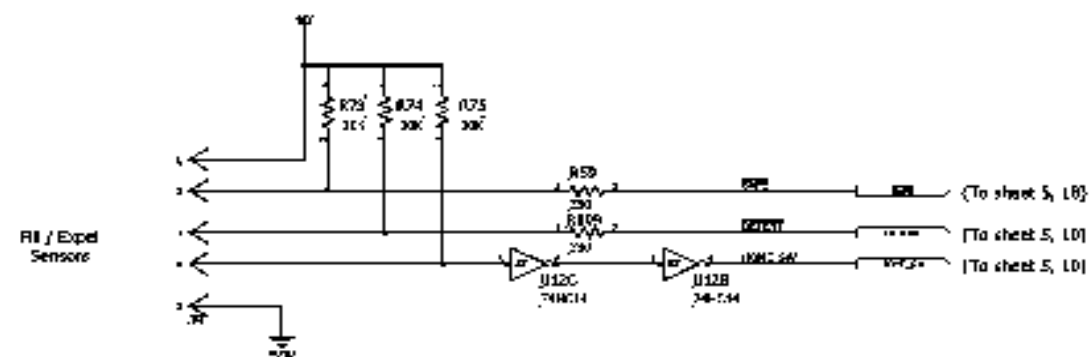
POWERHEAD SCHEMATIC 903040-2 REV F (2 OF 9)



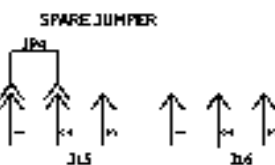
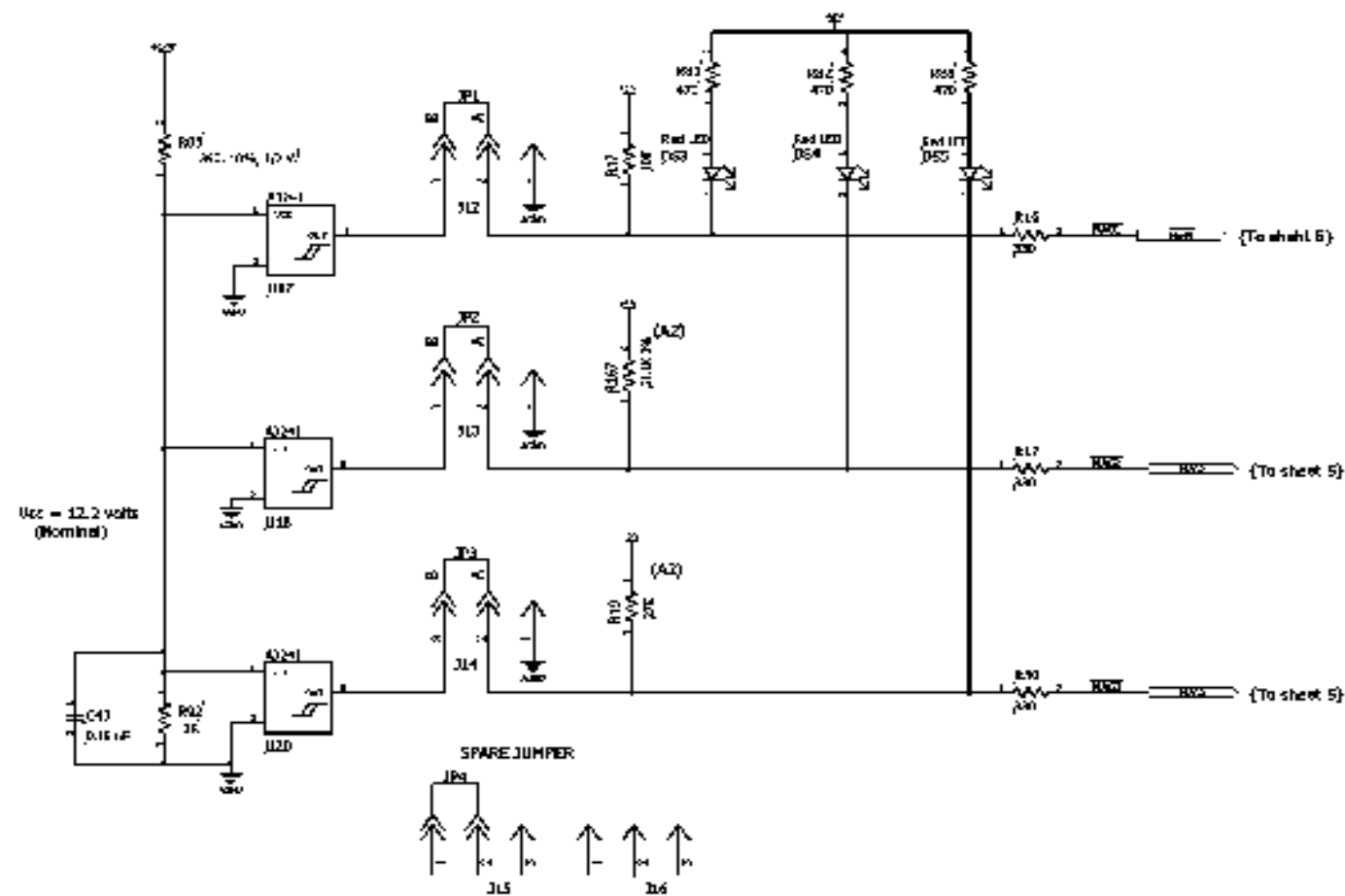
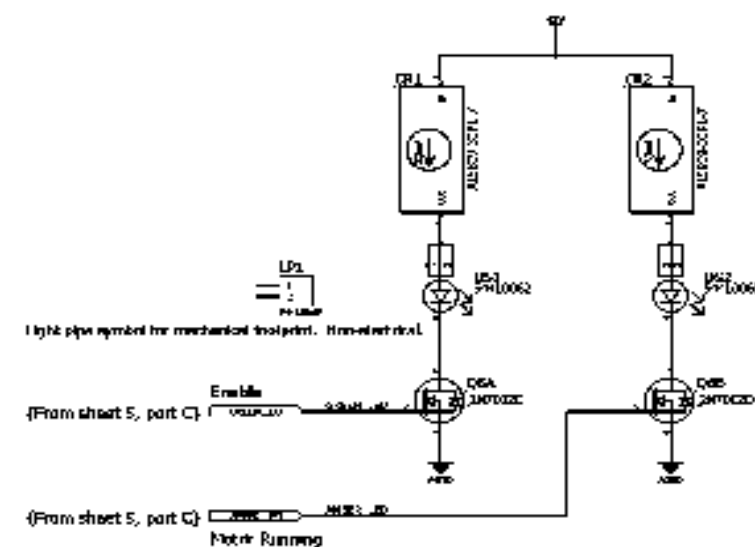
908955-L 2021-06-01



POWERHEAD SCHEMATIC 903040-2 REV F (4 OF 9)

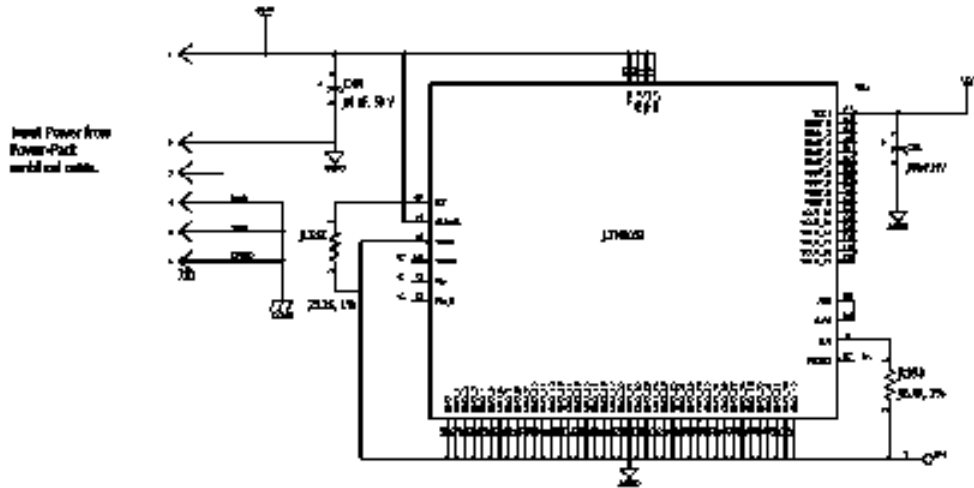


The 1.5 K-ohm resistor provides hysteresis to this reflective, triangulation type of optical sensor.



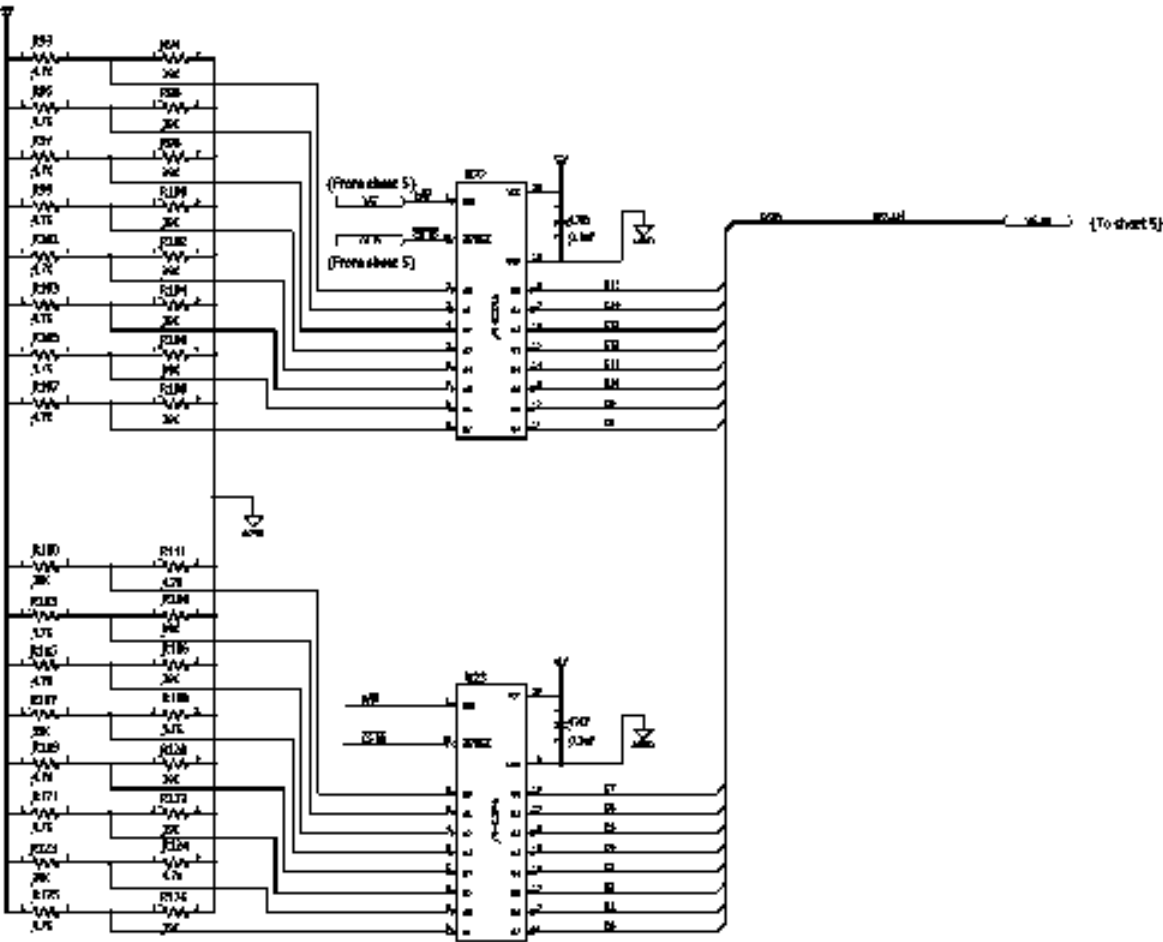
FOR HOLDING SPARE JUMPERS

Jumpers J12-J14 used Stereotax systems.
Jumpers J15 & J16 used to hold spare jumper.
See Dumas Service Manual 900955 Rev A page 3-4-8
for detailed usage of jumpers.
Review for removal at next update as the Stereotax
systems are obsolete with the last unit sold in 2011.



Revision Table

Revision	R107	R108	R110	R111	R113	R114	R115	R116	R117	R118
A	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out
B	Out	4.7K	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out
C	Out	4.7K	Out	4.7K	4.7K	Out	4.7K	Out	4.7K	Out
D	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out	Out
E	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out	Out
F	Out	4.7K	Out	4.7K	4.7K	Out	Out	4.7K	4.7K	Out
G	Out	4.7K	4.7K	Out	4.7K	Out	Out	4.7K	4.7K	Out
H	4.7K	Out	4.7K	Out	4.7K	Out	Out	4.7K	4.7K	Out
I	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out
J	4.7K	Out	Out	4.7K	Out	4.7K	Out	4.7K	4.7K	Out
K	4.7K	Out	Out	4.7K	Out	4.7K	Out	4.7K	4.7K	Out
L	4.7K	Out	Out	4.7K	4.7K	Out	Out	4.7K	4.7K	Out
M	4.7K	Out	Out	4.7K	4.7K	Out	Out	4.7K	4.7K	Out
N	4.7K	Out	Out	4.7K	4.7K	Out	Out	Out	4.7K	4.7K
O	4.7K	Out	Out	4.7K	4.7K	Out	Out	4.7K	4.7K	Out
P	4.7K	Out	Out	4.7K	4.7K	Out	Out	Out	4.7K	4.7K
Q	4.7K	Out	Out	4.7K	4.7K	Out	Out	Out	4.7K	4.7K
R	4.7K	Out	4.7K	Out	Out	4.7K	Out	4.7K	Out	4.7K
S	4.7K	Out	4.7K	Out	4.7K	Out	Out	4.7K	Out	4.7K
T	Out	4.7K	4.7K	Out	4.7K	Out	Out	4.7K	Out	4.7K
U	Out	4.7K	Out	4.7K	4.7K	Out	Out	4.7K	Out	4.7K
V	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K	Out	4.7K
W	Out	4.7K	Out	4.7K	4.7K	Out	Out	Out	4.7K	4.7K
X	Out	4.7K	Out	4.7K	4.7K	Out	Out	Out	4.7K	4.7K
Y	Out	4.7K	4.7K	Out	4.7K	Out	Out	Out	4.7K	4.7K
Z	4.7K	Out	4.7K	Out	4.7K	Out	Out	Out	4.7K	4.7K

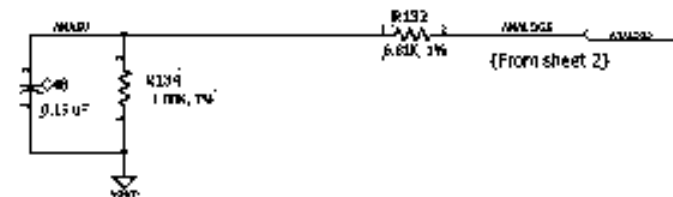
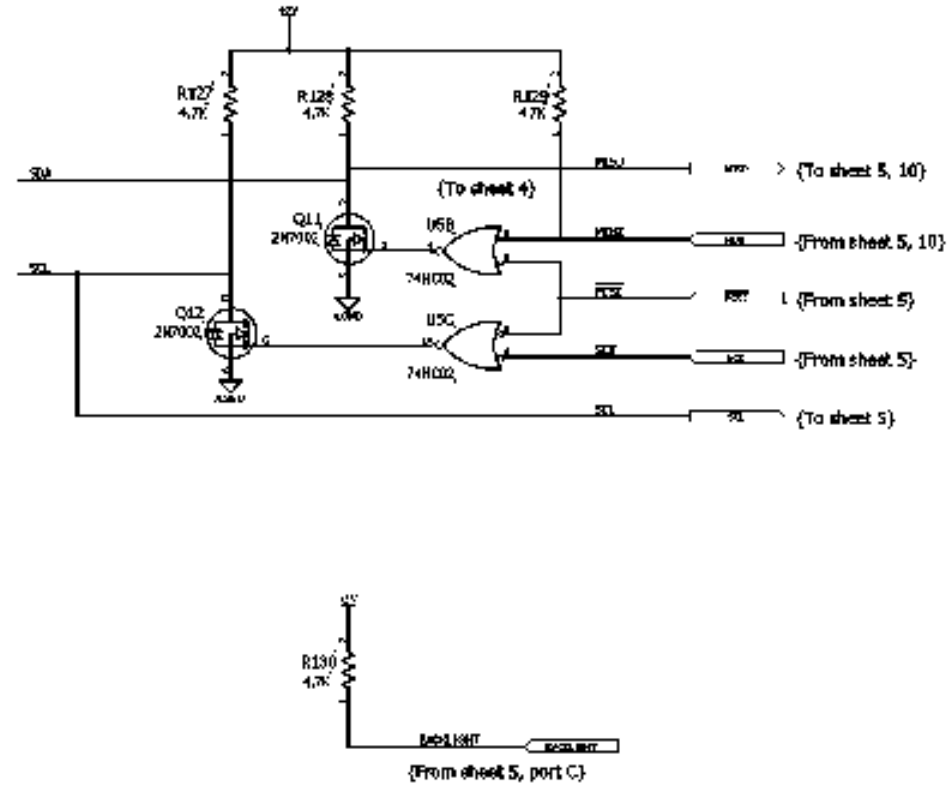


Board ID Notes

- 1.) No HOT (small) SMT resistors. [They are shown on that a PCB pattern will exist for them.]
- 2.) As board revisions are made, some 4.7K resistors may move from a pull-up to a pull-down position. See Revision Table.
- 3.) Revision M configuration shown.



LCD Interface



LCD Interface Notes:

- 1.) Open drain interface is required to meet I²C bus interface.
- 2.) Two lines make up the I²C bus: Serial Data Line (SDA) Serial Clock Line (SCL)
- 3.) Both data (SDA) and clock (SCL) lines remain HIGH when the bus is idle.
- 4.) A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the start condition.
- 5.) A LOW-to-HIGH transition of the data line, while the clock is High is defined as the stop condition.
- 6.) Each transmitted data word of 8 bits must be acknowledged by the slave receiver. The transmitter asserts a 9th clock pulse and the receiver pulls the SDA line low to acknowledge reception of the data word.
- 7.) The receiver may be able to receive bits at a fast rate, but need additional time to store each received data word. The receiver (slave) may hold the SCL line low after reception and acknowledgement of the data word to force the master into a wait state. The receiver releases the SCL line when it is ready for the next data word.

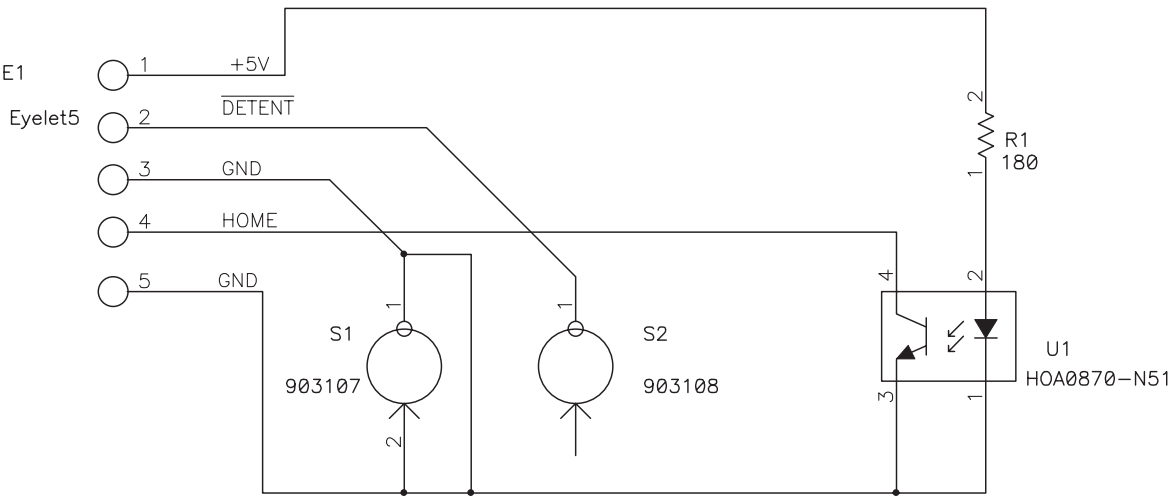
LED Interface Notes:

- 1.) This circuit has been revised to support an LED interface.
- 2.) The LED display uses a serial synchronous interface. It does not support the I²C protocol.







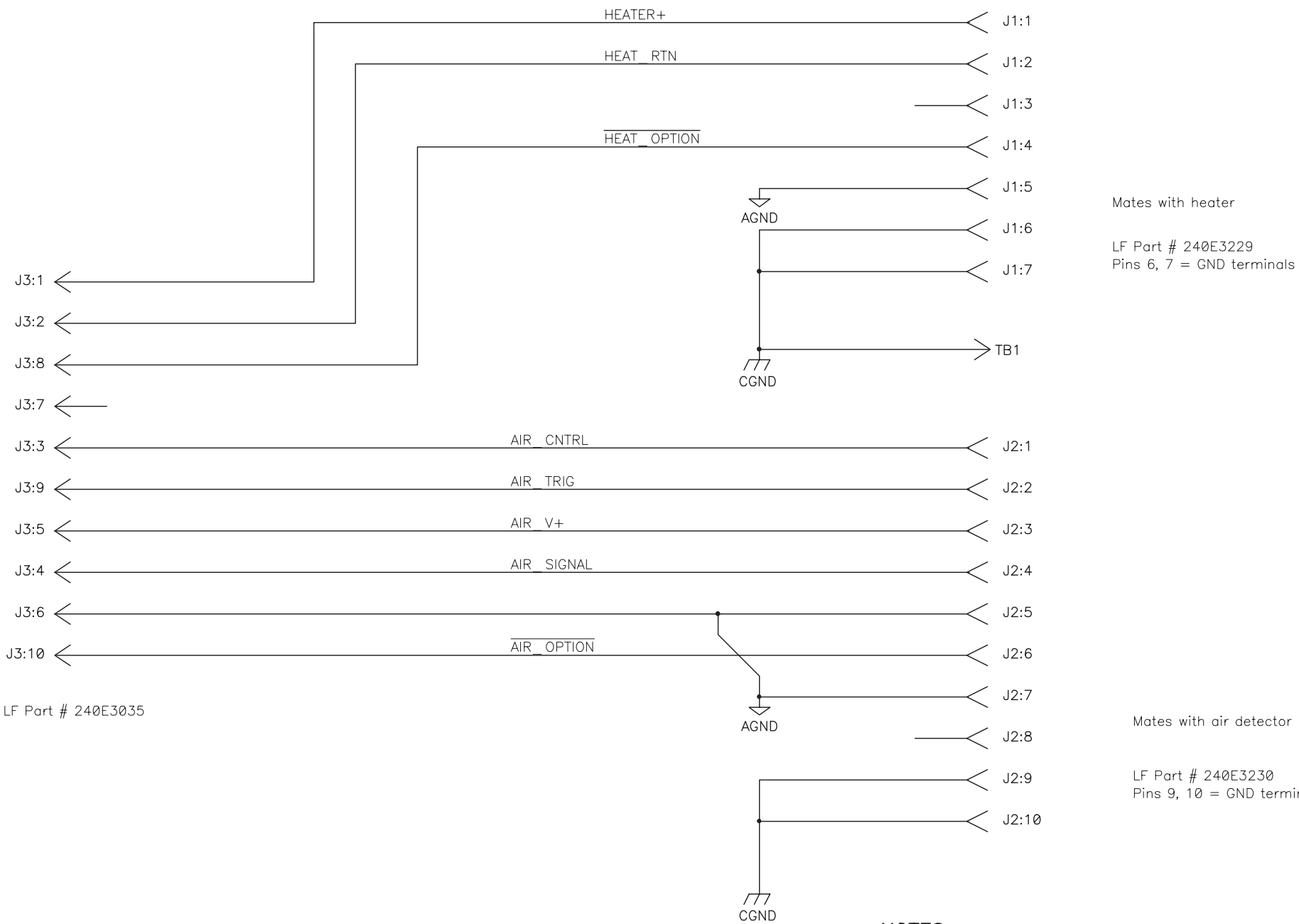


Note: The Detent spring makes a GND connection off-board.

- NOTES:**
- 1) ALL RESISTORS ARE SPECIFIED IN OHMS, AND ARE 5% TOLERANCE UNLESS OTHERWISE SPECIFIED.
 - 2) ALL THROUGH HOLE RESISTORS ARE 1/4W, AND ALL SURFACE MOUNT RESISTORS ARE 1/8W UNLESS OTHERWISE SPECIFIED.
 - 3) ALL RELAYS AND SWITCHES ARE DRAWN IN THEIR RELAXED STATE.

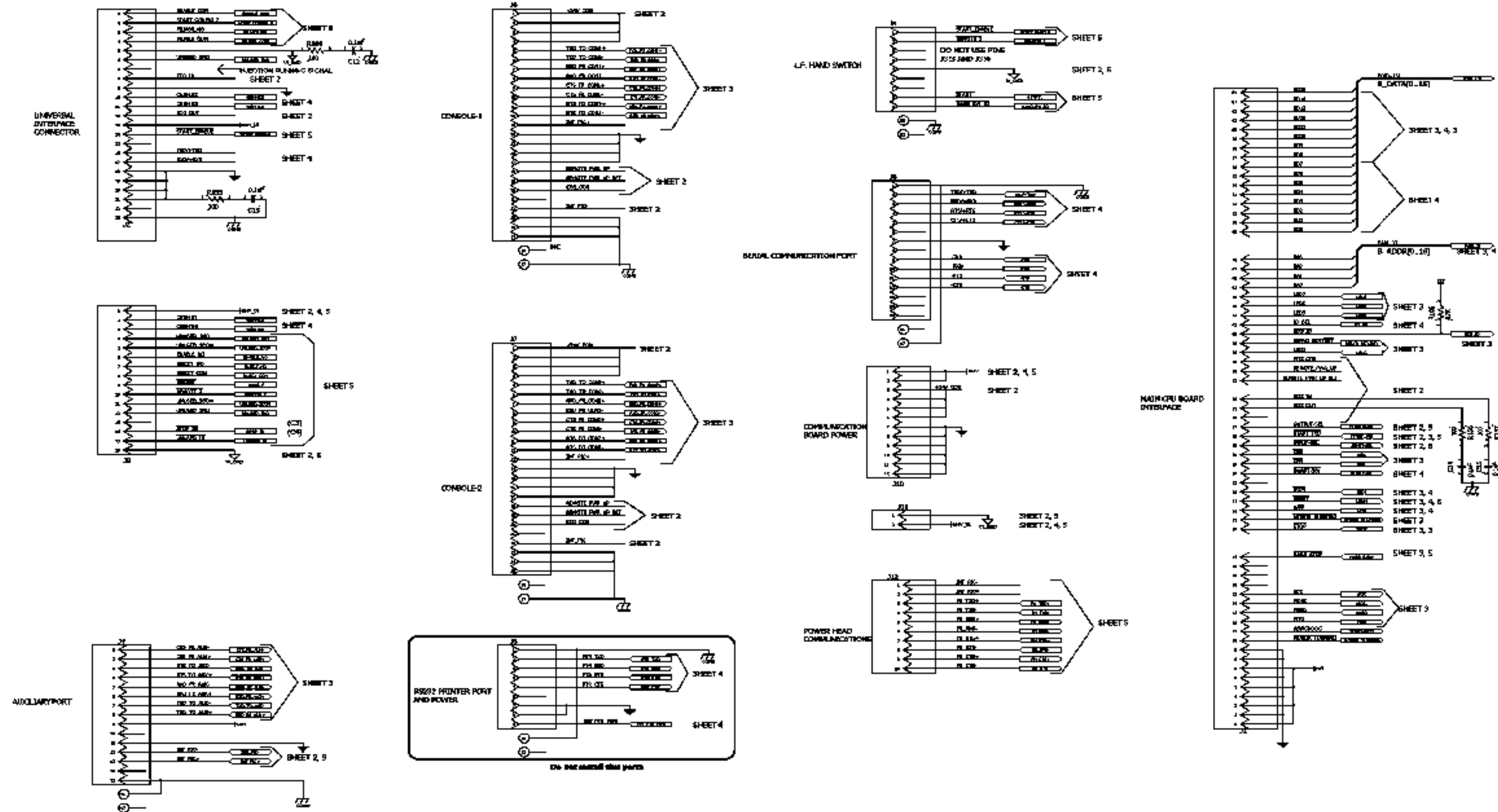
UNUSED GATES:

Mating cable goes to J4 of 903001.

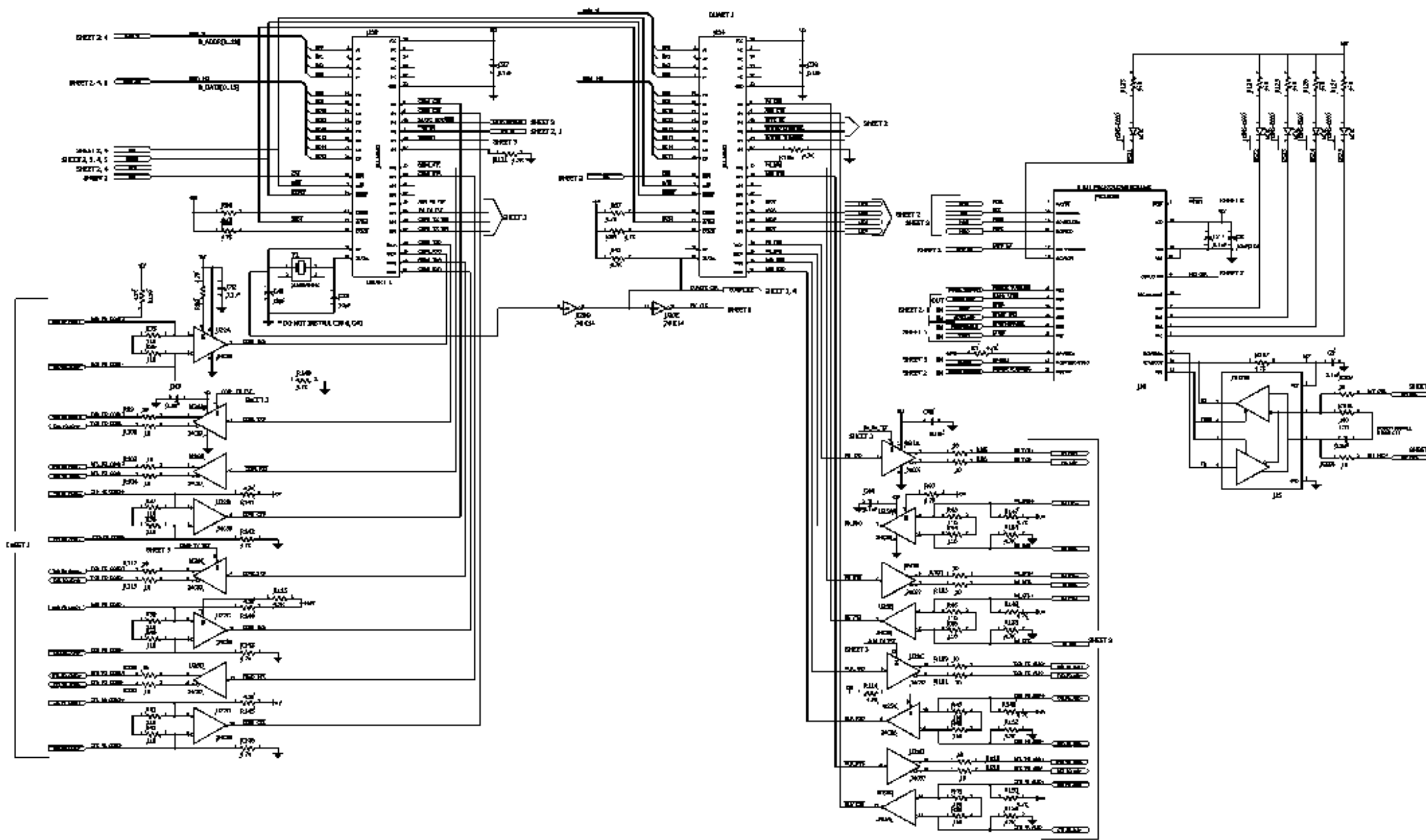


- NOTES:**
- 1) ALL RESISTORS ARE SPECIFIED IN OHMS, AND ARE 5% TOLERANCE UNLESS OTHERWISE SPECIFIED.
 - 2) ALL THROUGH HOLE RESISTORS ARE 1/4W, AND ALL SURFACE MOUNT RESISTORS ARE 1/8W UNLESS OTHERWISE SPECIFIED.
 - 3) ALL RELAYS AND SWITCHES ARE DRAWN IN THEIR RELAXED STATE.

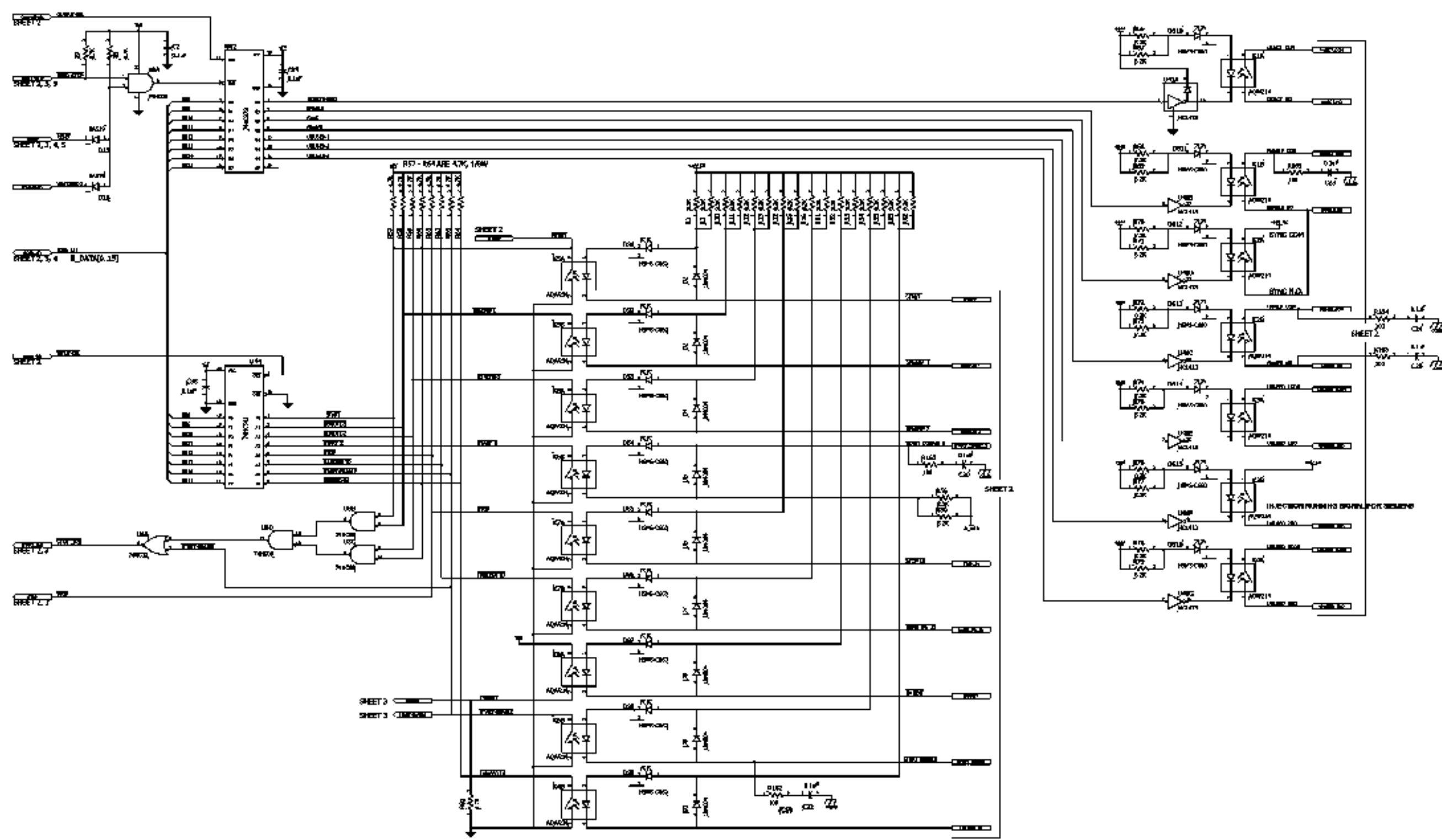
UNUSED GATES:



OEM COMM. BOARD 901125-2 REV C (1 OF 4)







10

ASSEMBLY AND DISASSEMBLY

This chapter provides complete instructions for the assembly and disassembly of the Angiomat Illumena Contrast Delivery System's major components: console, powerhead and powerpack. When removing a specific item, follow the DISASSEMBLY instructions up to the point where the removal of that particular item is discussed. To replace the item, refer to the ASSEMBLY section containing the instructions describing how to re-assemble this item. Follow these assembly instructions until the unit is completely reassembled.

For assembly drawing part numbers; refer to your Parts Manual.

CAUTION! 

Unplug power cord to disconnect the powerpack from supply mains.

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10.2D POWERPACK DISASSEMBLY

Refer to Parts Manual **Powerpack** section Figure 1-1-a thru 1-1-c for part numbers.

10.2D.1 POWERPACK COVER REMOVAL

1. Place the powerpack on a flat surface and remove the eight screws (item 30) that secure the cabinet cover.
2. To remove the cover (item 14), slide it one inch to the rear of the powerpack, then pull upward.

NOTE: If you intend to service the software, go to the SOFTWARE DOWNLOAD section in Chapter 7.

10.2D.2 MAIN CONTROL BOARD, COMMUNICATION BOARD AND COMMUNICATIONS HARNESS REMOVAL.

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Remove the communications harness (item 9) from connector J6 of the Main Control PCB (item 5) and the ribbon connector of the Communications PCB (item 6).
3. Remove the bracket assembly (item 46) from the power supply bracket by removing 2 screws (item 26) and the screw on the vertical standoff (item 45).
4. Disconnect the Main Control PCB (item 5) from connectors J4 and J5 of the Servo Interface PCB by lifting vertically.

NOTE: If you intend to service the Main Control PCB, reverse steps 1-4 for re-assembly.

5. Dismount the Communications PCB (item 6) by removing the 4 screws and lockwashers (item 37) on the back side of the chassis (item 13). Carefully pull the PCB off of the snap stud, applying pressure as close to the stud as possible.
6. Move the Communications PCB (item 6) away from the back wall of the chassis so the harnesses at connectors J10, J11 and J12 are visible.
7. Disconnect the harnesses from connectors J10 and J11 of the Communications PCB (item 6). Disconnect the remaining connector of the powerhead harness (item 10) from J12 of the Communications PCB. Remove the board (item 6).

NOTE: If you intend to service the Communications PCB, reverse steps 1-7 for re-assembly.

8. Disconnect the connectors of the communications harness (item 11) from J8 and J11 of the Servo Interface PCB (item 15).

10.2D.3 FAN AND FILTER REMOVAL

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Disconnect the fan assembly (item 31), filter assembly (item 32) and washers (item 43) from outside of the chassis by removing the 4 screws (item 27).
3. Disconnect the fan harness from the Servo Interface board at J15. Pull the fan assembly (item 31) out from the back of the chassis (item 13).

NOTE: *If you intend to service the fan or filter, reverse steps 1-3 for re-assembly.*

10.2D.4 POWERHEAD HARNESS REMOVAL

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Disconnect the 5 ground leads of the powerhead harness (item 10) from 2 ground studs, located directly under harness flange, by removing the 2 nuts and lockwashers (item 34).
3. Disconnect the 6-position powerhead harness (item 10) connector from J6 of Servo Interface PCB (item 15). Disconnect the 8-position powerhead harness connector from J7 of Servo Interface PCB.
4. Disconnect the remaining connector of the powerhead harness (item 10) from J12 of the Communications PCB.
5. Disconnect the powerhead harness (item 10) from the chassis by removing the 4 nuts and lockwashers (item 35).

NOTE: *If you intend to service the powerhead harness, reverse steps 1-5 for re-assembly.*

10.2D.5 TRANSFORMER REMOVAL

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Disconnect the transformer's harnesses from J12 and J13 on the Servo Interface Board (item 15). Remove the ground lead from the ground stud located directly above the power supply by removing the nut and lockwasher (item 34).

NOTE: Dismount of the power supply subassembly may be necessary for removal of the transformer's harnesses from J12 and J13 on the Servo Interface Board. Refer to 10.2D.8 steps 1-9.

3. Place chassis assembly onto its side so power supply and amp are at top end.
4. Remove transformer assembly (item 17) from chassis assembly by and removing 4 screws (item 36). Retain screws and u-nuts.

NOTE: *If you intend to service the transformer, reverse steps 1-4 for re-assembly.*

10.2D.6 AC INLET AND CLAMP REMOVAL

Refer to Figures 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Disconnect the three leads of the power entry set (item 7) from the rear of the AC inlet (item 2).
3. Remove the AC inlet (item 2) and power cord clamp (item 21) from chassis by removing 2 screws (item 28). Disconnect the ground lead from the bottom of the terminal tab.

NOTE: *If you intend to service the AC inlet, reverse steps 1-3 for re-assembly.*

10.2D.7 SERVO AMPLIFIER REMOVAL

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Remove the servo signal harness (item 19) from P2 of the servo amp (item 16), and remove the servo power harness (item 20) from P1 of the servo amp.
3. Remove the servo amp (item 16) from the power supply bracket by removing the 4 screws with lockwashers (item 26).

NOTE: *If you intend to service the servo amp, reverse steps 1-3 for re-assembly.*

10.2D.8 DC POWER SUPPLY, SERVO INTERFACE BOARD, SERVO SIGNAL HARNESS, SERVO POWER HARNESS, ACP3 AND ACP4 HARNESS AND LINE FILTER REMOVAL

Refer to Figures 10-2-1 and 10-2-3.

1. Perform Powerpack Cover Removal 10.2D.1.
2. Disconnect the power entry harnesses ACP1 and ACP2 (item 7) from the terminals of circuit breaker switch (item 1).
3. Disconnect the power entry harness ACP2 (item 7) and ground lead from the terminals of line filter (item 44).
4. Remove the circuit breaker power switch (item 1) from the front panel of the chassis.
5. Remove the servo signal harness (item 19) from P2 of the servo amp (item 16), and remove the servo power harness (item 20) from P1 of servo amp.
6. Disconnect the power entry harness ground lead (item 7) from the ground stud located directly above the power supply by removing the nut and lockwasher (item 34).
7. Remove the DC supply harness (item 8) from connector J3 of the Servo Interface PCB (item 15).
8. Remove the bracket assembly (item 46) from the power supply bracket by removing the 2 screws (item 26) and the screw on the vertical standoff (item 45).

9. Dismount the power supply subassembly from the chassis by removing 3 screws and lockwashers (item 37) from the bottom of the chassis. Disconnect the remaining harness, ACP4 (item 7) from J2 of Servo Interface PCB (item 15).

NOTE: *If you intend to service components on the subassembly, reverse steps 1-8 for re-assembly.*

10. Disconnect 2 connectors of the servo power harness (item 20) from connectors J1 and J14 of the Servo Interface PCB (item 15). Disconnect 2 ground leads.
11. Disconnect the servo signal harness (item 19) from connector J10 of the Servo Interface PCB (item 15).
12. Remove the communications harness (item 9) from connector J6 of the Main Control PCB (item 5) and ribbon connector of Communications PCB (item 6).
13. Disconnect the Main Control PCB (item 5) from connectors J4 and J5 of the Servo Interface PCB by lifting vertically.
14. Disconnect the connectors of the communications harness (item 11) from J8 and J11 of the Servo Interface PCB (item 15).
15. Disconnect the 6-position powerhead harness (item 10) connector from J6 of the Servo Interface PCB (item 15). Disconnect the 8-position powerhead harness connector from J7 of the Servo Interface PCB.
16. Disconnect the transformer's harnesses from J12 and J13 of the Servo Interface PCB (item 15)
17. Disconnect the ground lead from the rear of the AC inlet (item 2).
18. Disconnect the Servo Interface PCB (item 15) from the chassis. Remove 2 screws with lockwashers (item 37) and the vertical standoff (item 45). Lift PCB off of 3 snap studs by applying pressure as close as possible to the stud. Lift the board (item 15) out of the chassis.

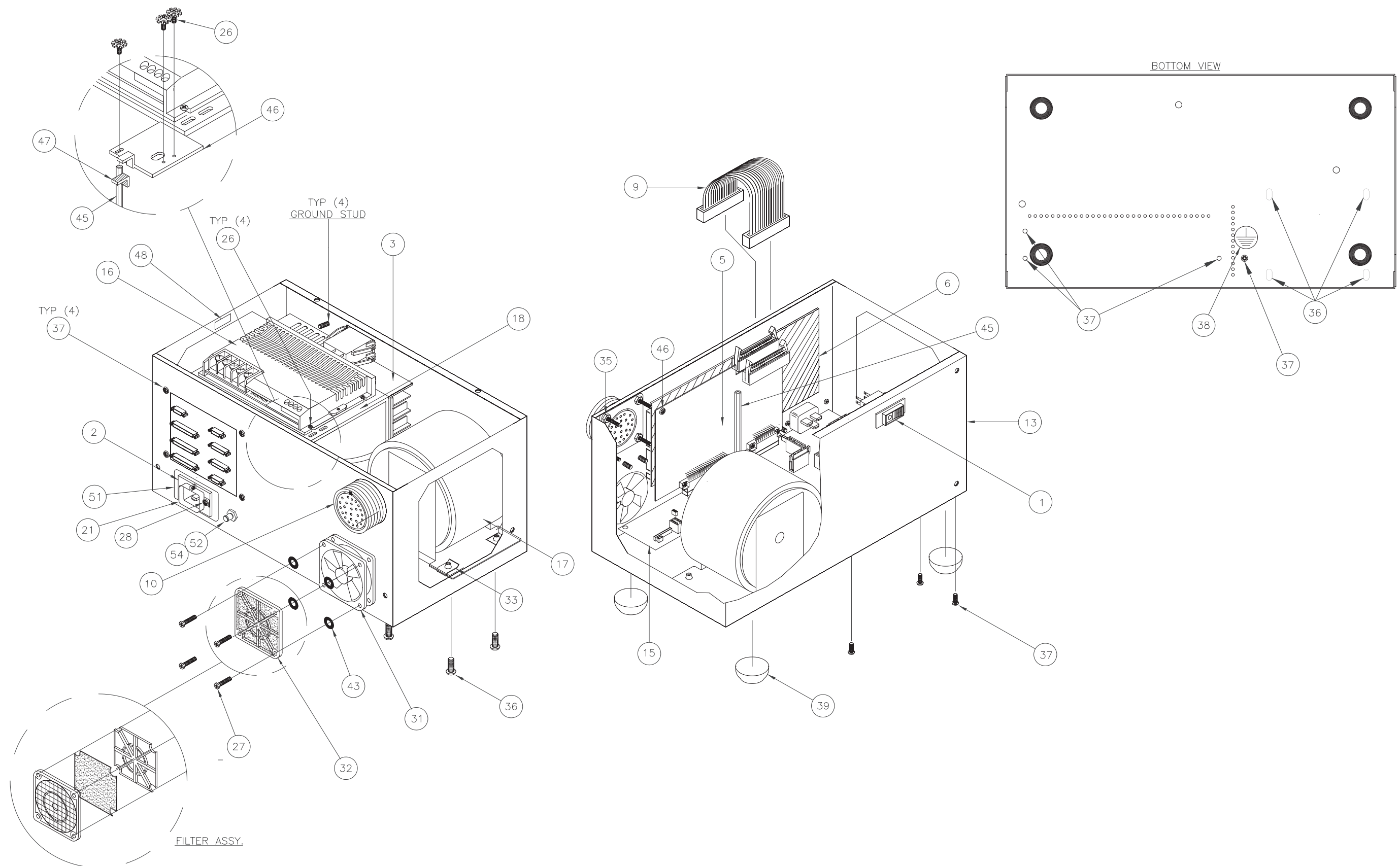


Figure 10-2-1 Powerpack Assembly

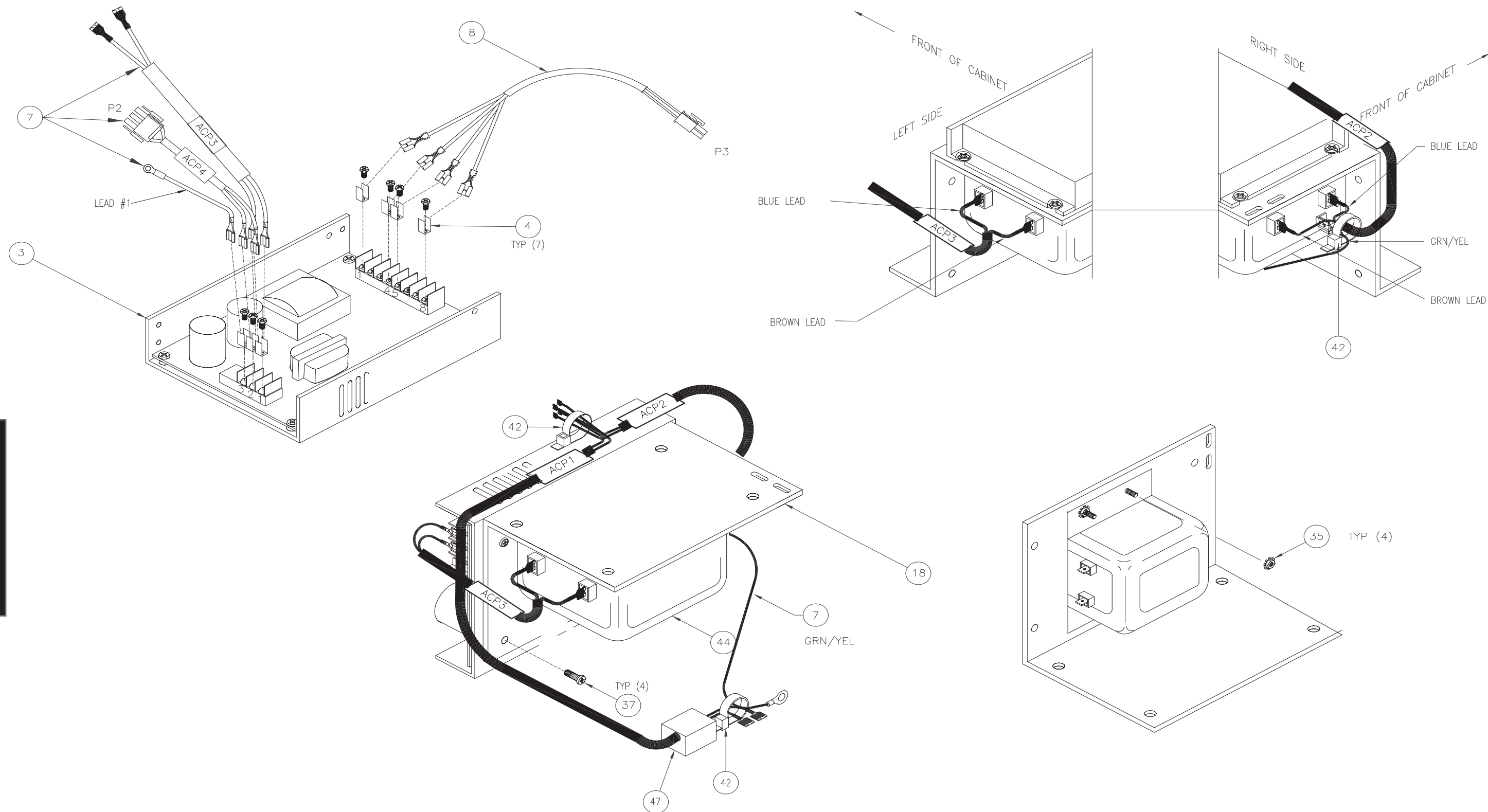


Figure 10-2-2 Powerpack Power Supply

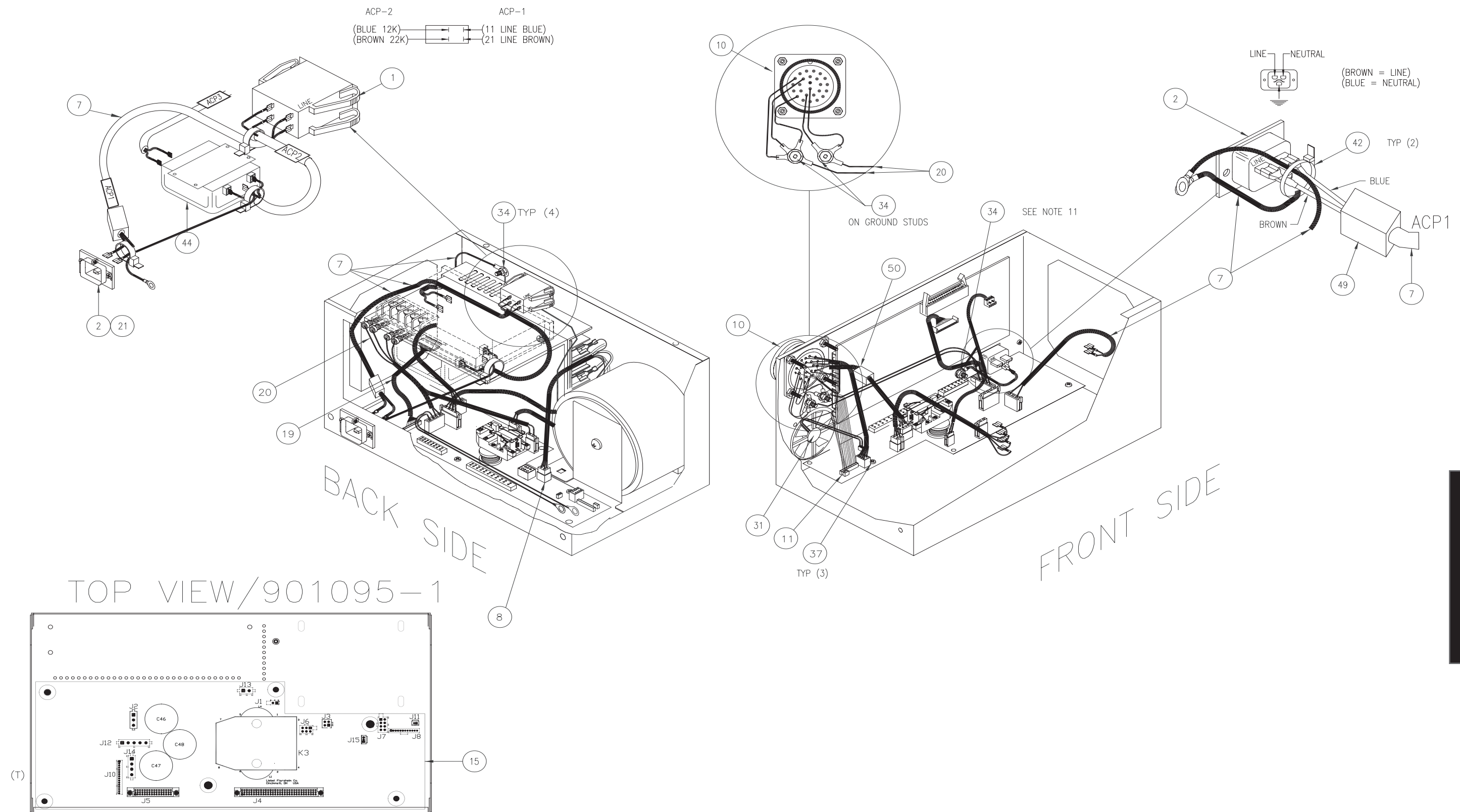


Figure 10-2-3 Powerpack Wiring

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10.3D CONSOLE DISASSEMBLY FOR CONSOLES 902330, 902300, 902401, 902340

Refer to Parts Manual **Console** section for part numbers.

10.3D.1 CONSOLE COVER REMOVAL

Refer to Figure 10-3-1.

1. Place the console, with hinge plate attached, face down on a soft, clean surface to prevent damage to the finish (i.e., table top with soft cloth in between console and table).
2. To remove the hinge plate (item 19), remove the six screws (item 22) and lockwashers.

NOTE: *If the hinge plate is not the item being serviced it can remain attached to the back cover.*

Refer to Figures 10-3-1, 10-3-2 and 10-3-3.

3. To remove the back cover (item 7), remove the four screws (item 1) and slowly lift away from the front half without fully extending the D-shell harness assembly (item 10).

NOTE: *The harness assembly (item 10) must be disconnected from the console CPU board at J5 before the back cover can be completely separated from the front half of the console.*

10.3D.2 CONSOLE CPU REMOVAL

For use with 844101-1S and 846101-1S.

Refer to Figures 10-3-2 and 10-3-3.

1. Perform Console Cover Removal procedure 10.3D.1.
2. Disconnect the following four connectors at the console CPU board (item 3):
 - Touchscreen cable from J2
 - Display cable from J8
 - Switch assembly (item 8) from J6
 - Backlight/Inverter cable from J7
3. Remove two (2) screws retaining Console CPU PCB, lift Console CPU PCB (item 3) off (2) retaining pegs.

10.3D.3 DISPLAY SUBASSEMBLY REMOVAL

For use with 802116SR, 846116S, and 902303S.

Refer to Figures 10-3-2 and 10-3-3

1. Perform removal procedure 10.3D.1, and 10.3D.2.
2. **For 902401 and 902340 Consoles only:** Remove ferrite (item 30) by removing clips.
3. Remove four (4) retaining screws securing the Display Subassembly (item 12) to the front cover.
4. Remove Display Subassembly. Cable may be secured to subassembly with silver tape. Remove silver tape first.

10.3D.4 TOUCHSCREEN REMOVAL

For use with 802104S and 814104S.

Refer to Figures 10-3-2 and 10-3-3

1. Perform removal procedure 10.3D.1, 10.3D.2, and 10.3D.3.
2. Lift Touchscreen from front cover.

10.3D.5 CONSOLE POWER SWITCH REMOVAL

For use with 802114S or 802114SR.

Refer to Figures 10-3-1, 10-3-2 and 10-3-3

1. Place the console, with hinge plate attached, face down on a soft, clean surface to prevent damage to the finish (i.e., table top with soft cloth in between console and table).
2. To remove the back cover (item 7), remove the four screws (item 1) and slowly lift away from the front half without fully extending the D-shell harness assembly (item 10) to expose the Display Subassembly.
3. Disconnect harness assembly (item 10) from console CPU board.
4. Disconnect the console power switch cable (item 8) at the CPU board J6 connector.
5. Remove four (4) screws (item 21) retaining the Display Subassembly (item 12) and gently move it aside until the console power switch is exposed.
6. Remove four (4) retaining screws from the console power switch mounting plate (item 11) and remove button mounting plate. Then remove console power switch assembly.

10.3D.6 CONSOLE SWITCH BUTTON REMOVAL

Refer to Figures 10-3-1, 10-3-2 and 10-3-3.

1. Perform removal procedure 10.3D.5 to expose the console switch button.
2. Remove the console switch button from the front cover seat.

10.3D.7 INTERFACE BOARD REMOVAL

For use with 902206-1SR.

Refer to Figures 10-3-2 and 10-3-3

1. Perform removal procedure 10.3D.1.
2. Remove harness assembly (item 10) from Interface board (item 4), disconnect at the Interface board (item 4) J3 connector.
3. Remove two (2) mounting bracket retaining screws and (2) brass spacers from the mounting bracket (item 13). Gently prise mounting bracket from back cover (edge A on Figure 10-3-2 and 10-3-3) to remove Interface Board (item 4) with mounting bracket (item 13).
4. Separate mounting bracket (item 13) from Interface Board (item 4) by removing two (2) screws.

NOTE: *Be sure to retain mounting bracket (item 13). This bracket must be installed to the Interface Board (item 4) when it is replaced.*

10.3A CONSOLE ASSEMBLY FOR CONSOLES 902330, 902300, 902401, 902340

Refer to Figures 10-3-1 thru 10-3-5.

1. Place the top cover on a soft, clean surface to prevent damage to the finish (i.e., table top with soft cloth in between cover and table). Position the cover so that its inside surface faces up and the switch assembly is now in the upper left corner.

2. Push console switch button into the opening provided until seated.

NOTE: *Clean mounting surface with alcohol before mounting switch.*

3. Place console power switch assembly (item 8) over the console switch button. Install power switch mounting plate (item 11).

4. Position the touch screen (item 5) over the large opening in the top cover so the harness and connector are at the right side.

5. Move the console power switch cable to side, then place the display subassembly (item 12) over the touch screen so the harness and connector are at the right side. Secure assembly with four (4) mounting screws (item 21).

CAUTION!

Do not over-tighten screws. Over-tightening the screw will damage the unit.

6. Mount the console CPU board (item 3) on the standoffs provided. Install two (2) retaining screws to secure the CPU board. Install the following cables:

Touchscreen cable to J2

Display cable to J8

Switch assembly cable (item 8) to J6

Backlight/Inverter cable (item 8) to J7

7. **For 846101-1S console CPU boards only:** Set the Console CPU switches as follows:

Switch S1, set all switches to "OFF"

Switch S2, 1 to "OFF" and all others to "ON" for software v9.09 or earlier.

8. The software can be downloaded to the console if required. Refer to the download process described in Chapter 7, Software Installation.

NOTE: *While the software is downloading, the back cover may be re-assembled.*

9. Place the back cover (item 7) on a bench with the inside surface facing up.

10. Install Interface Board (item 4) and mounting bracket (item 13) in the slots provided. Secure mounting bracket to back cover with two (2) retaining screws.

11. Install harness assembly (item 10) to the Interface Board J3 connector.

12. Move back cover close to the front cover. Install Interface Board cable (item 10) to J5 on the CPU board.

13. Place back cover onto front cover and install four (4) retaining screws.

14. Install two torque hinges (item 20) onto the back cover mounting pads using provided screws and lockwashers (item 22).

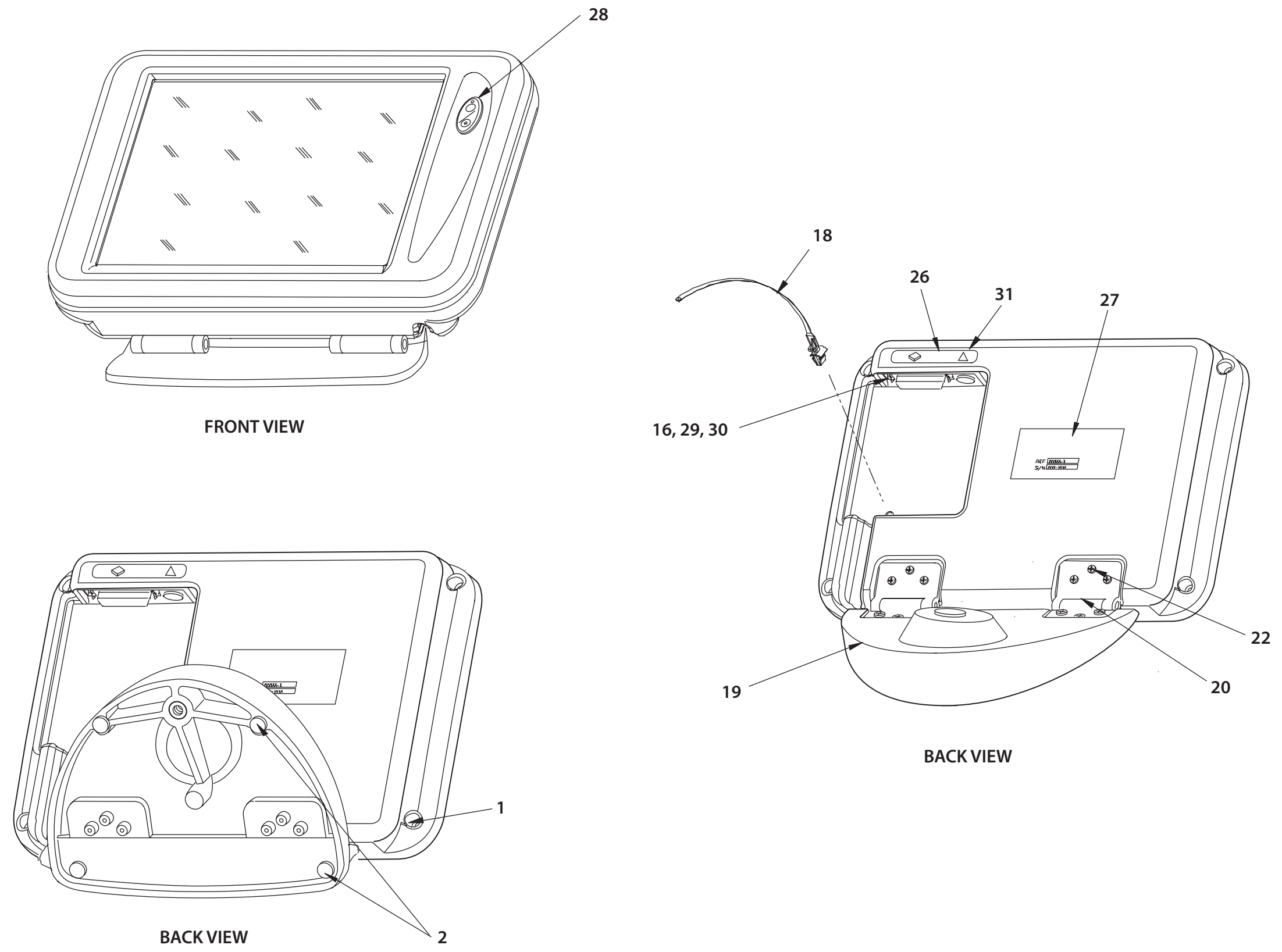
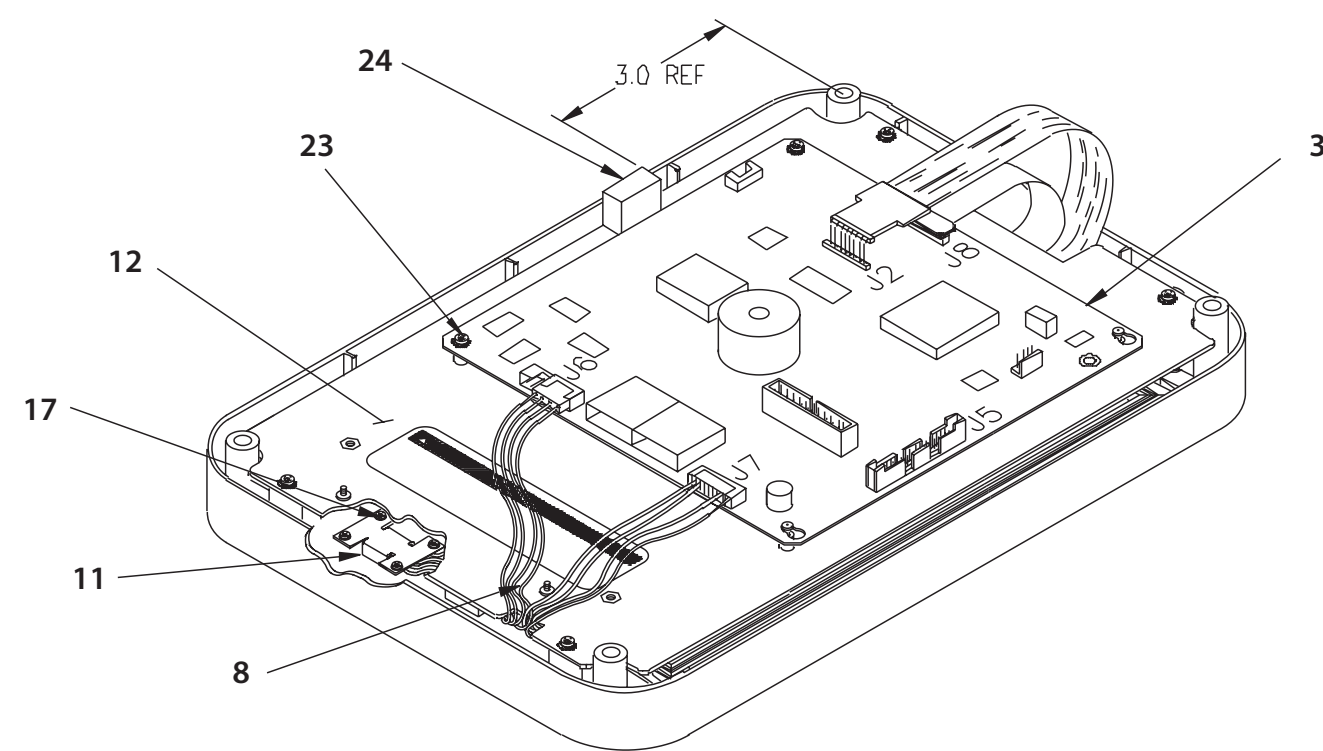
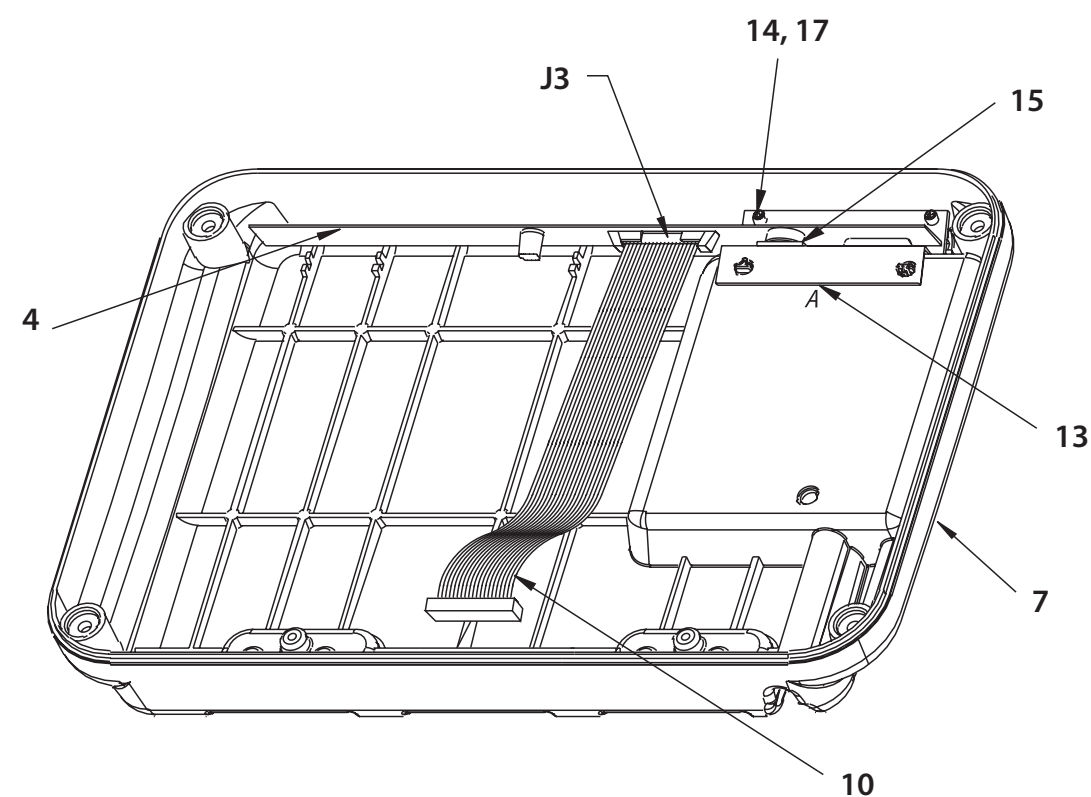


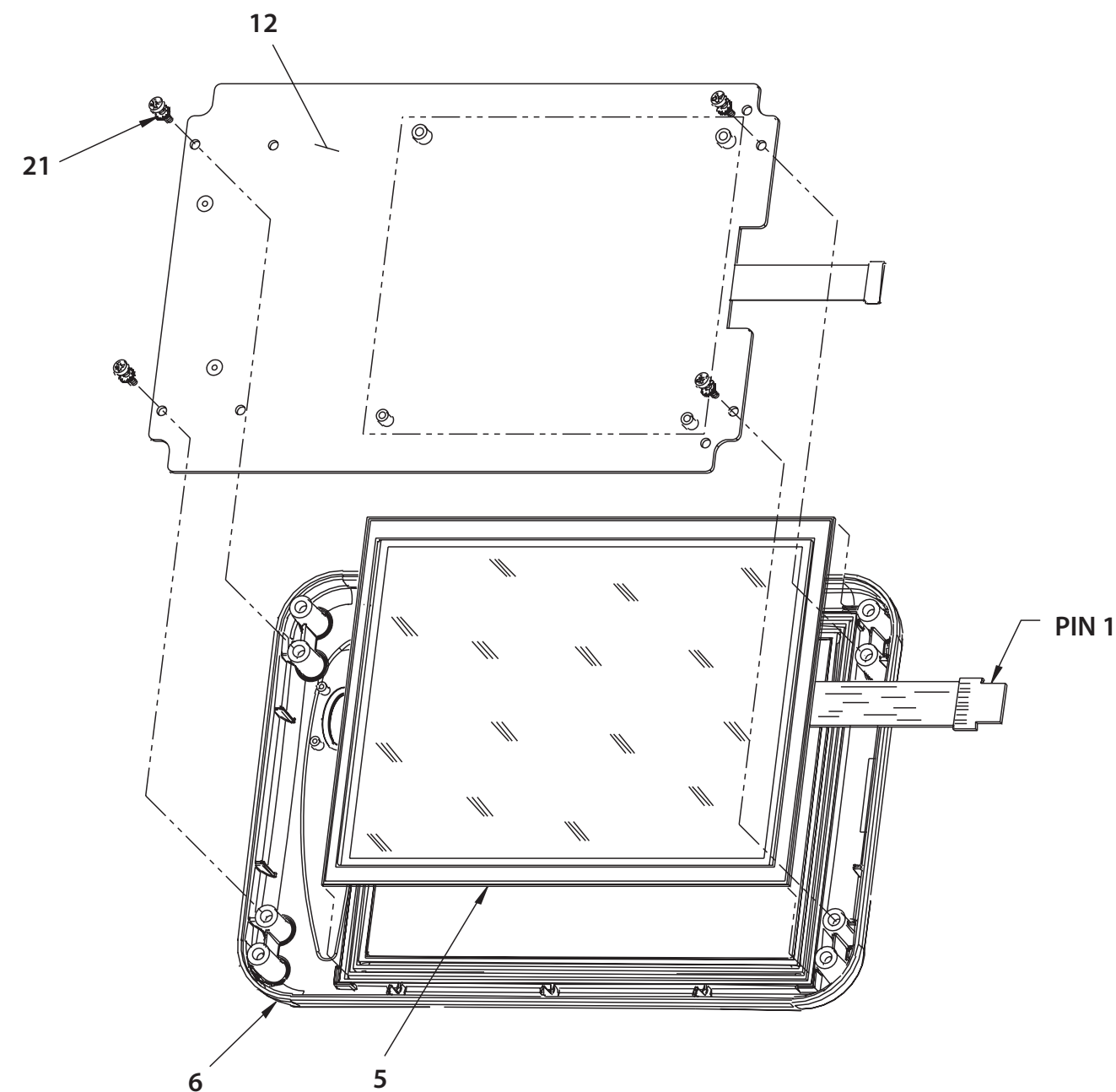
Figure 10-3-1 Console Assembly



FRONT COVER ASSEMBLY
(shown with 844101-1S console cpu board)



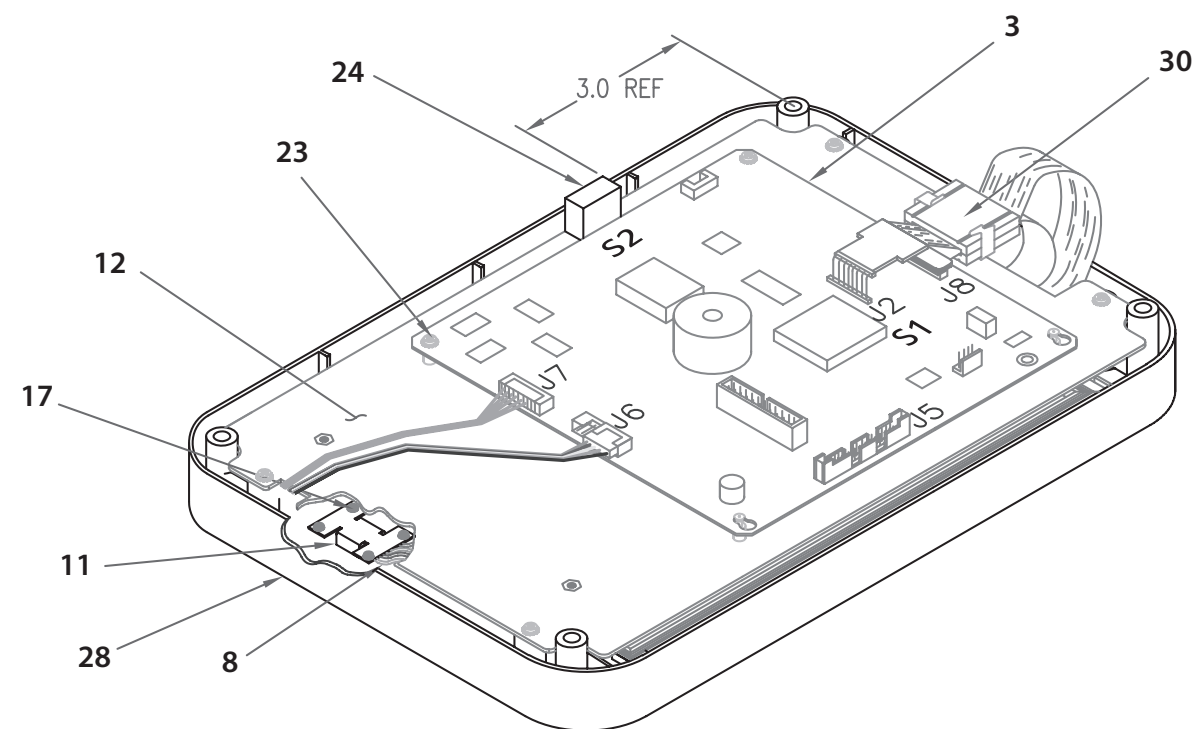
BACK COVER ASSEMBLY



TOUCHSCREEN ASSEMBLY
(shown with 802104S touchscreen)

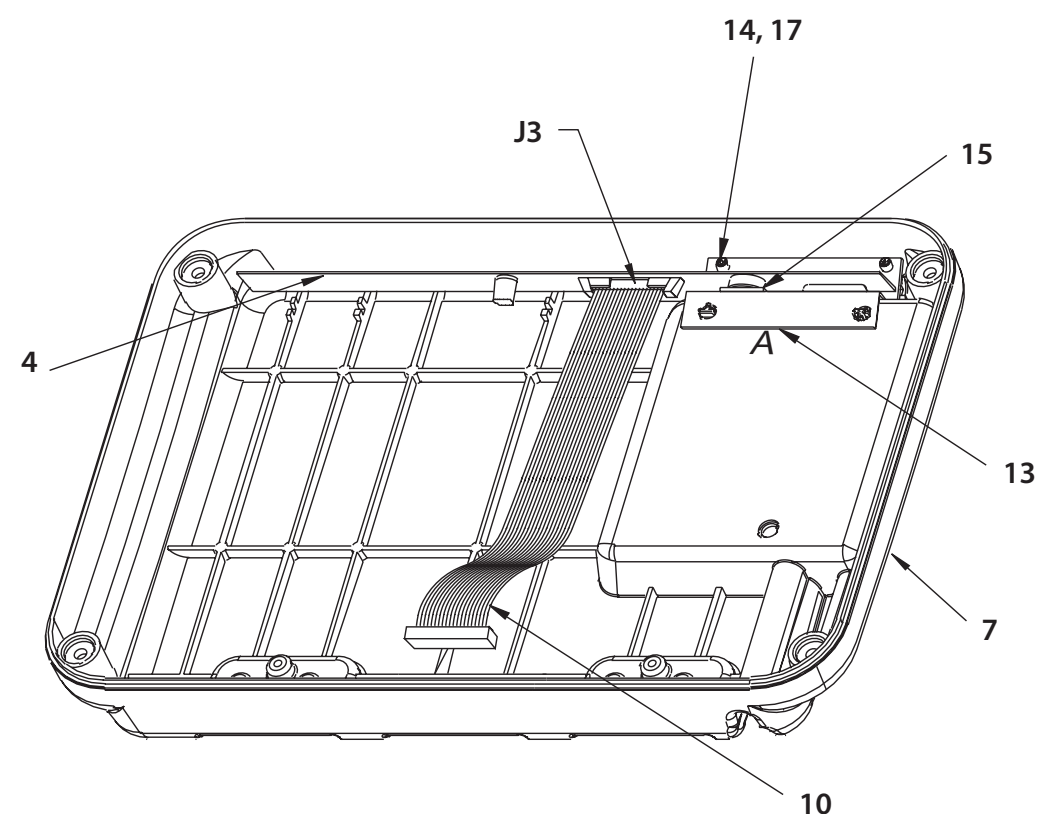
FOR CONSOLES 902300 AND 902330

Figure 10-3-2 Console Components

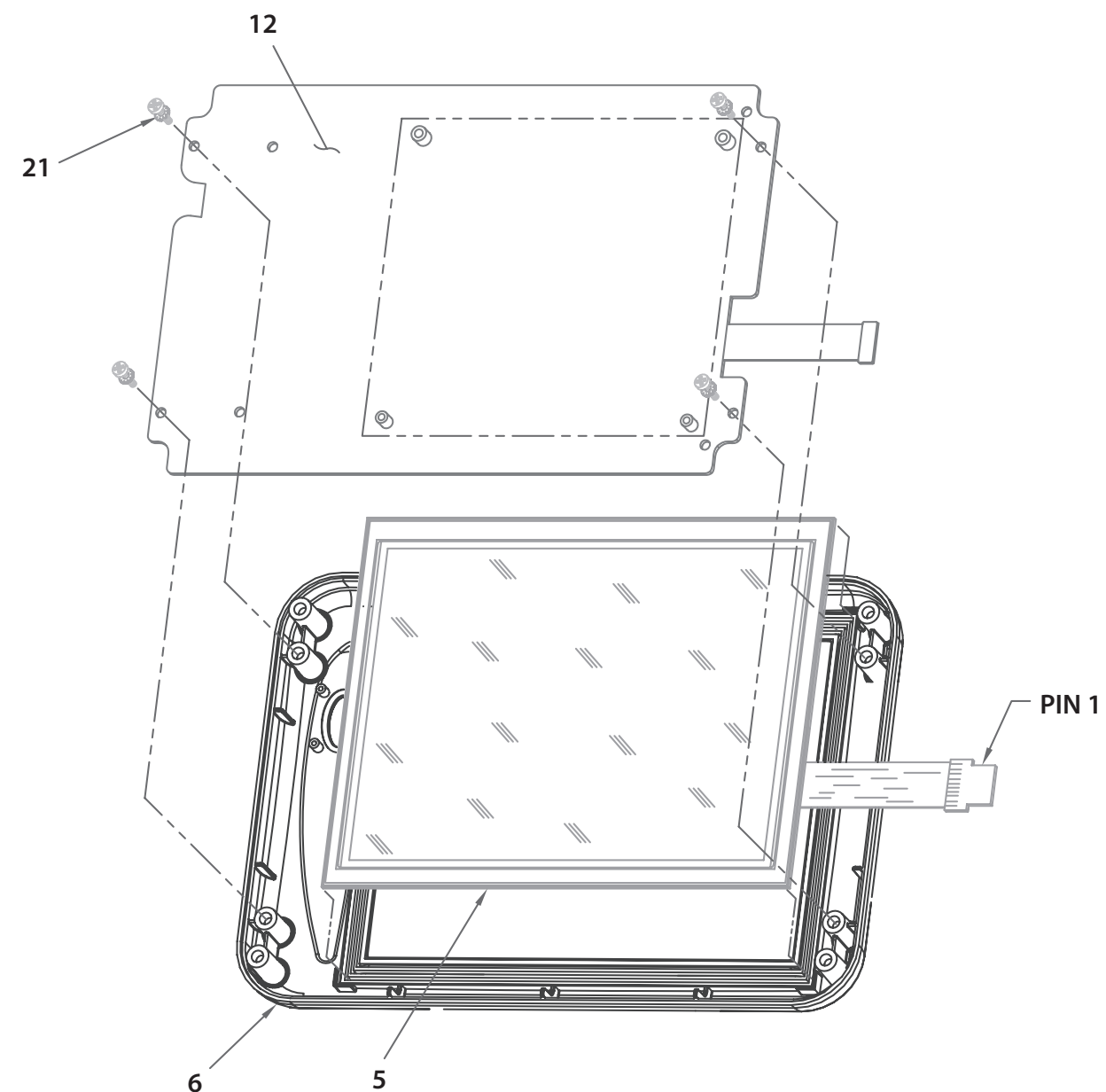


FRONT COVER ASSEMBLY

(shown with 846101-1S console cpu board)

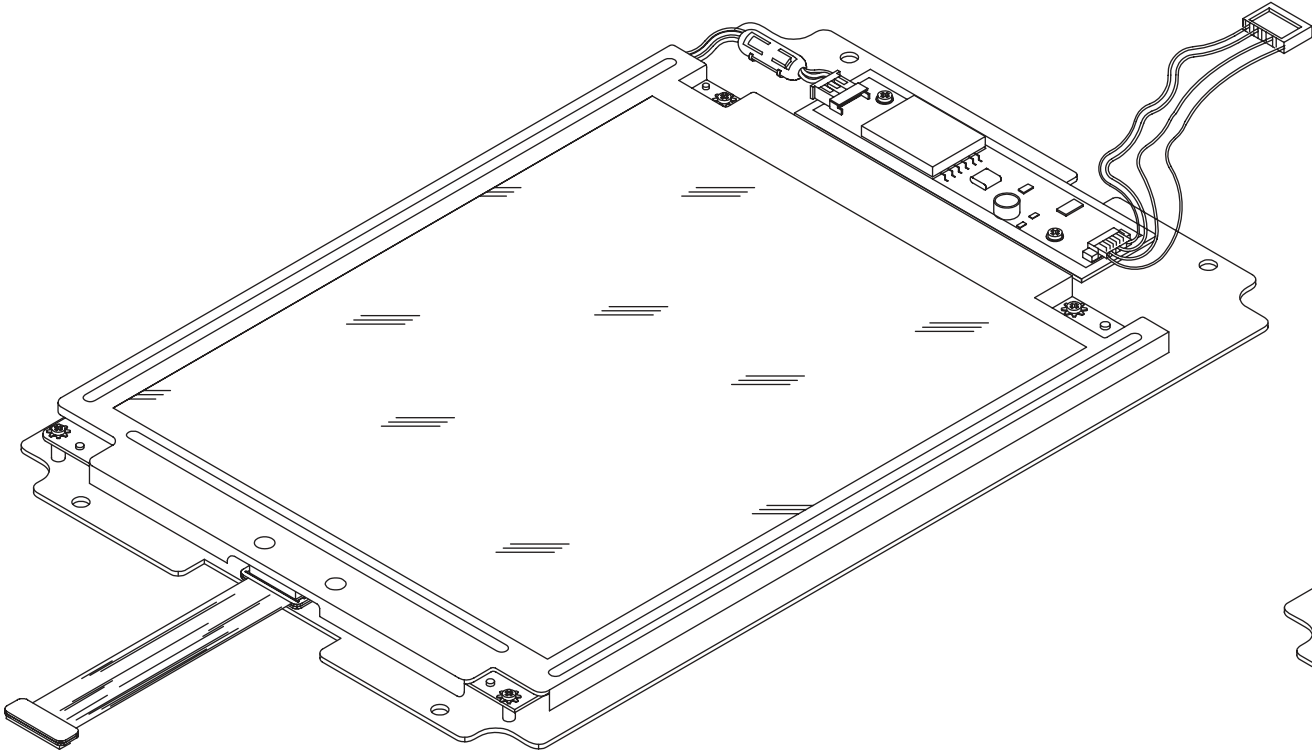


BACK COVER ASSEMBLY

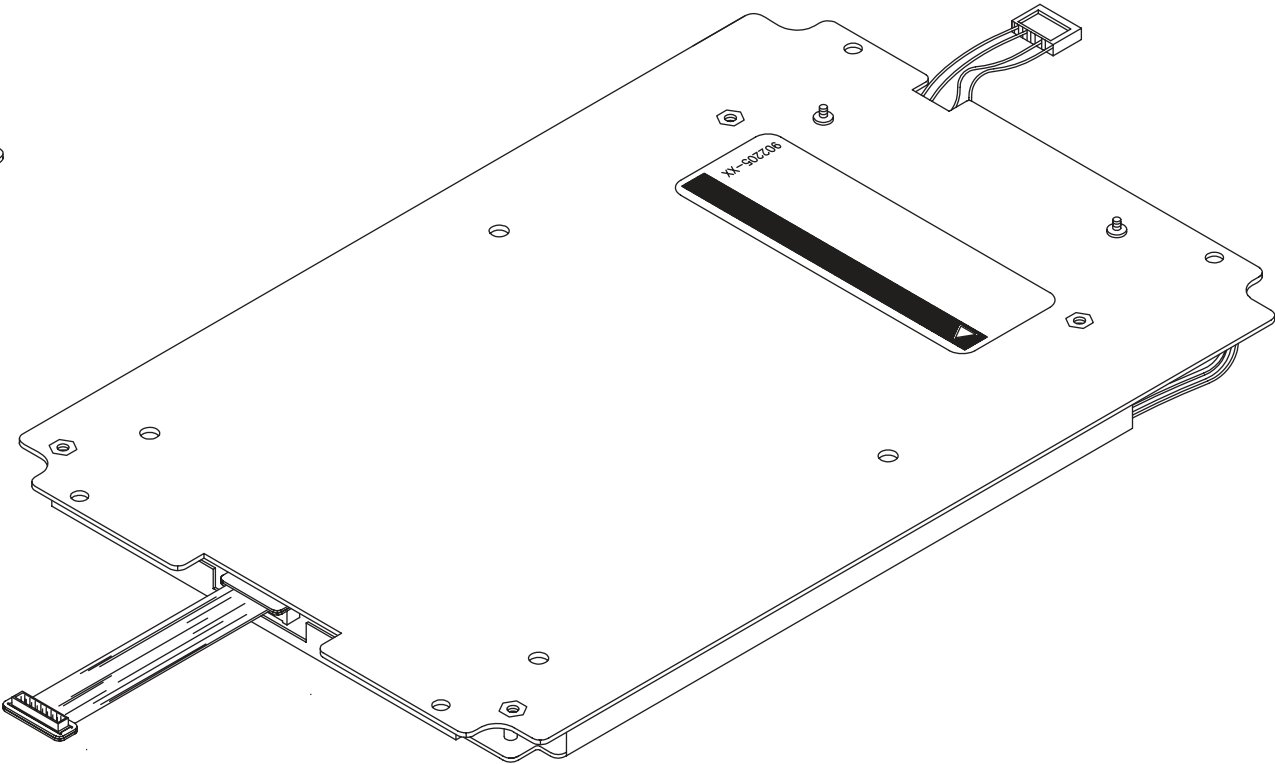


TOUCHSCREEN ASSEMBLY
(shown with 814104S touchscreen)

FOR CONSOLE 902401 and 902340



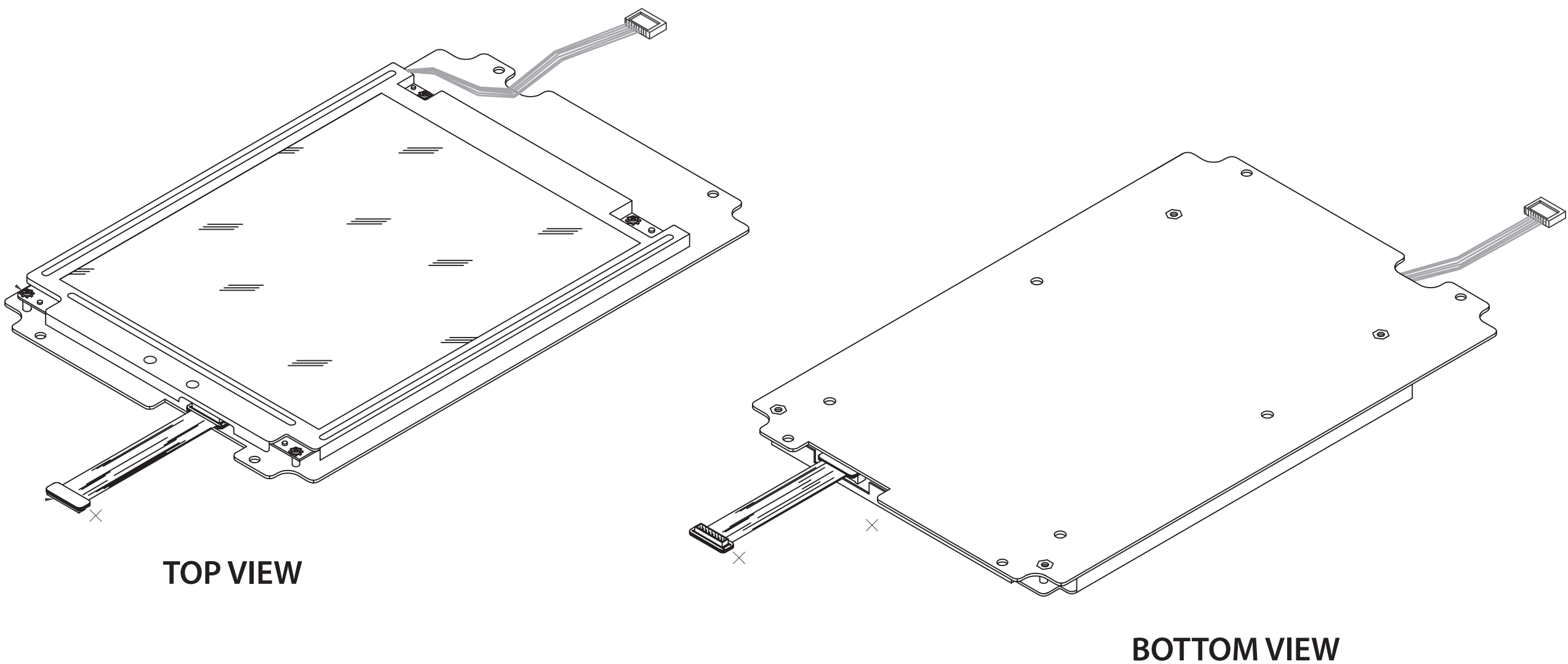
TOP VIEW



BOTTOM VIEW

FOR CONSOLES 902300 AND 902330

Figure 10-3-4 Console Display Subassembly (shown with 802116S display)



FOR CONSOLE 902401 and 902340

Figure 10-3-5 Console Display Subassembly (shown with 846116S display)

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10.4D POWERHEAD DISASSEMBLY

Refer to Parts Manual Powerhead section for part numbers.

Refer to Figures 10-4-2.

1. To remove the fill/expel actuator lever (Item 12), pull the lever away from the pin and shaft (items 2 and 4).

Refer to Figure 10-4-3

2. To remove the manual knob (item 38), pull knob off of the gear box shaft (item 29).
3. To remove the hinge shaft (item 39) from main frame, remove screw (item 49) and pull the shaft out of the mounting hole.
4. To remove the translation knob (item 20) pull the knob away from the translation shaft (item 19).

Refer to Figure 10-4-2

Use steps 5 through 10 with 903040S.

5. To remove the top cover assembly (item 1), remove three screws (items 3 and 4) while securing the top cover to prevent dropping and damage.

Refer to Figure 10-4-1

6. Disconnect the three harness connectors, P1, P9 and P11, from the mating PCB connectors.
7. Software can be downloaded to the powerhead if required. Refer to the software download process described in Chapter 7, Software Installation.

NOTE: *If item to be serviced is located in the top cover assembly go to the section titled Top Cover Assembly heading in this chapter.*

Refer to Figure 10-4-4

8. To remove the powerhead control PCB (item 44), remove the four screws with lockwashers (item 32) and lift PCB out of the lower half of assembly until cables are accessible.
9. Disconnect the five powerhead cable connectors P4, P5, P7, P6 and P10, from the mating PCB connectors.

NOTE: *If the linear pot is not the item to be serviced, it can remain attached to the powerhead PCB and step 6 can be excluded.*

10. To remove the linear pot (item 26) from the of powerhead PCB (item 44), first disconnect P2 from the mating PCB connector, then remove the two screws, lockwashers and nuts (items 45, 46, and 47).

NOTE: *Use caution not to mar or finger print linear pot scale.*

Refer to Figure 10-4-3

11. To remove the translation shaft (item 19), remove the nut (item 25) and translation actuator (item 21) from the shaft and pull the translation knob (item 20), wave washer (item 41) and shaft out from the front of the main frame assembly (item 1).

10.4D.1 MAIN FRAME DISASSEMBLY

Refer to Figure 10-4-3.

1. To remove the back cover (item 2) from the mainframe (item 1), remove two screws (item 36). While separating the back cover from the mainframe, disconnect the powerhead cable leads, marked “red” and “black”, from the motor terminals.
2. To remove the accessory board harness assembly (item 54), disconnect it from the connector of the Accessory Input PCB.
3. To remove the powerhead cable (item 24), remove the ground rings from the ground boss of the back cover by removing the screw with lockwasher (item 55). Compress the strain relief (item 42) from the inside of the back cover (item 2) while pushing the strain relief outward until free. Pull cable out while feeding conductors through the accessory input assembly (item 17).
4. To remove the accessory input assembly (item 17) from the back cover (item 2), remove the two screws with lockwashers (item 32) and lift the bracket/PCB assembly from cover.

10.4D.2 TOP COVER DISASSEMBLY

NOTE: *If the display and top cover do not require service, steps 1 and 2 can be skipped.*

Refer to Figure 10-4-2.

1. To remove the display cable (item 10), disconnect it from the overlay/display assembly (item 9) connector.
2. To remove the overlay/display assembly (item 9) from the top cover (item 1), remove the two screws with lockwashers (item 11). Flip the top cover assembly over so the outer surface is visible and push the display out of the cover. The display gasket has double sided adhesive and may be difficult to remove.
3. To remove the fill/expel switch assembly (item 8) from the top cover (item 1), remove the two screws and lockwasher (item 11) and lift out of the cover.
4. To remove the fill/expel shaft (item 2) or rotary pot (item 5):
 - a. Pull the actuator clip (item 7) away from the fill/expel shaft (item 2).
 - b. Pull the fill/expel actuator lever (item 12) away from the fill/expel shaft (item 2).
 - c. Unscrew the actuator pin (item 4), from the fill/expel shaft (item 2).
 - d. Remove the hub clamp (item 6) from the fill/expel shaft (item 2).
 - e. Pull the fill/expel shaft away from the rotary pot shaft (item 5).
 - f. Lift the pot assembly out of the top cover (item 1).

10.4A POWERHEAD ASSEMBLY

Refer to Parts Manual Powerhead section for part numbers.

10.4A.1 MAINFRAME ASSEMBLY

Refer to Figure 10-4-3

1. Cut a 13" length of gasket (item 8) and apply to mainframe (item 1), ensuring the joint of the gasket is on the bottom side of the mainframe. Trim off any excess so gasket will lay flat on applied surface.
2. Install the translation knob (item 20) onto translation shaft (item 19). Slide wave spring washer (item 41) onto other end of the translation shaft then insert shaft into the mainframe.
3. Mount translation actuator (item 21) onto the translation shaft (item 19), then secure in place using the nut and lockwasher (item 25).

NOTE: *Align D cutout on actuator with D shape on the shaft.*

4. Install the hinge shaft (item 39) into the mainframe and secure using the screw with small amount of screwlock (items 49 and 52).

NOTE: *With the mainframe top facing up and the hinge shaft on left side, the wedge shape should be in the upper left quadrant as shown.*

5. Install the accessory input assembly (item 17) into the back cover (item 2). Secure using two screws with lockwashers (item 32).
6. Install the powerhead cable assembly (item 24) into the accessory input using strain relief (item 42).

NOTE: *Approximately 1/8" of the cable jacket should extend past the strain relief.*

7. Connect the harness assembly (item 54) to the connector of the accessory input.
8. Mount the six ground rings to the ground boss of the back cover using screw with lockwasher (item 55).

NOTE: *Refer to the mounting detail shown in Figure 10-4-3 View C.*

9. Connect the powerhead cable leads, marked "red" and "black", to the same color motor terminals.
10. While positioning the back cover to mount it to the frame, feed the remaining cable leads to the opposite side of cover from the motor leads. While aligning the connectors, mount the cover to the mainframe using two screws (item 36), ensuring that no wires are pinched between the cover and frame.

NOTE: *When positioning the leads refer Figure 10-4-3 for orientation. Connectors should be in for ease of PCB connection at next level assembly.*

11. Install manual knob (item 38) as shown on print.

Refer to Figure 10-4-4.

NOTE: Use steps 12 through 18 with 903040-1S.

12. Install the linear pot (item 26) onto the solder side (i.e., side opposite components), of powerhead PCB (item 44) using the two screws, lockwashers and nuts (items 45, 46 and 47). Position the linear pot so that the pot connector end P2 is close to its mating connector J2.

CAUTION!

Do not touch the linear pot scale with your bare hands. Touching the linear pot scale with your bare hands will damage its subcomponents and seriously degrade its functionality.

13. Position the bottom half of the powerhead assembly so that it is horizontal.
14. Connect the encoder cable P5 to the mating board connector J5. Fold excess encoder cable and tuck between motor and cover.
15. Position the linear pot wiper so the two screw heads align with the slot in the bracket (item 6) mounted on ram flange.
16. Connect the remaining four powerhead cable connectors to the mating PCB connectors (P4 to J4; P6 to J6; P7 to J7; P10 to J10). Again, tuck the excess leads between the mainframe and the cover.
17. Position the PCB over the mounting holes, making certain that the linear pot wiper is mating with the slotted bracket, and linear pot harness is not pinched between the PCB and the mainframe. Secure the PCB using four screws with lockwashers (item 32).
18. The software can be downloaded to the powerhead at this point, if required. Refer to the download process described in Chapter 7, Software Installation.

10.4A.2 TOP COVER ASSEMBLY

Refer to Figure 10-4-2.

1. Position the top cover (item 1) on a soft surface to protect the finish, with inside of the cover facing up.
2. Install the overlay/display assembly (item 9) into the top cover by removing the paper backing from the gasket and sliding the end of PCB, opposite connector, into the slots located just below the display opening in the cover.

NOTE: *Be careful not to roll the gasket when positioning the display.*

3. After making certain that the display is centered and straight, secure the display in place using 2 screws with lockwashers (item 11). Attach the display cable (item 10).
4. Install the rotary pot assembly (item 5) by inserting the pot shaft through the inner most hole in the top cover. The mounting holes in the bracket should line up with the threaded holes in the top cover.
5. Using a small bladed screwdriver, adjust the rotary pot to electrical center.

NOTE: *Adjust pot so that the meter reading is between 2.25 k and 2.75 k ohms.*

6. Apply a light coat of grease in the 3 fill/expel shaft mounting holes in the top cover (item 1). Insert shaft (item 2) through all three holes and onto the rotary pot shaft. Secure the shaft to the pot using the hub clamp (item 6).

NOTE: *Press the rotary pot and shaft lightly together when securing with screw.*

7. Thread the actuator pin (item 4) into the fill/expel shaft. Then install the fill/expel actuator lever (item 12) onto the actuator pin and fill/expel shaft.
8. Snap the actuator clip (item 7) onto the milled section of the fill/expel shaft, with tab of actuator positioned toward the outer wall of the top cover.
9. Install the fill/expel switch assembly (item 8) onto the actuator clip, then secure the switch and pot bracket using two screws with lockwashers (item 11).

NOTE: *Do not attempt to align or adjust the return springs on the fill/expel switch assembly (item 8).*

NOTE: *The lever must return to the center position freely and quickly when the lever is moved up or down and released.*

10. Install the lens indicator (item 13) into the top cover using a clear silicon adhesive. THIS SEAL MUST BE WATERPROOF.

NOTE: *The three flat surfaces of the lens mount to the three walls of the top cover.*

10.4A.3 FINAL ASSEMBLY

Refer to Figure 10-4-2.

1. Position the top cover assembly (item 1) and connect the three harness connectors to the mating PCB connectors (P1 to J1; P9 to J9; P11 to J11).
2. Align and secure the top cover assembly (item 1) to the bottom half of the powerhead using two screws and lockwashers (item 4, shorter screws) in the front mounting holes and one screw and lockwasher (item 3, longer screw) in the rear mounting hole.

NOTE: *Do not pinch the wires between covers.*

NOTE: *The powerhead may need to be repositioned to reach the screw hole behind the pivot bracket.*

3. Clean entire assembly with a medical grade cleaning solution.

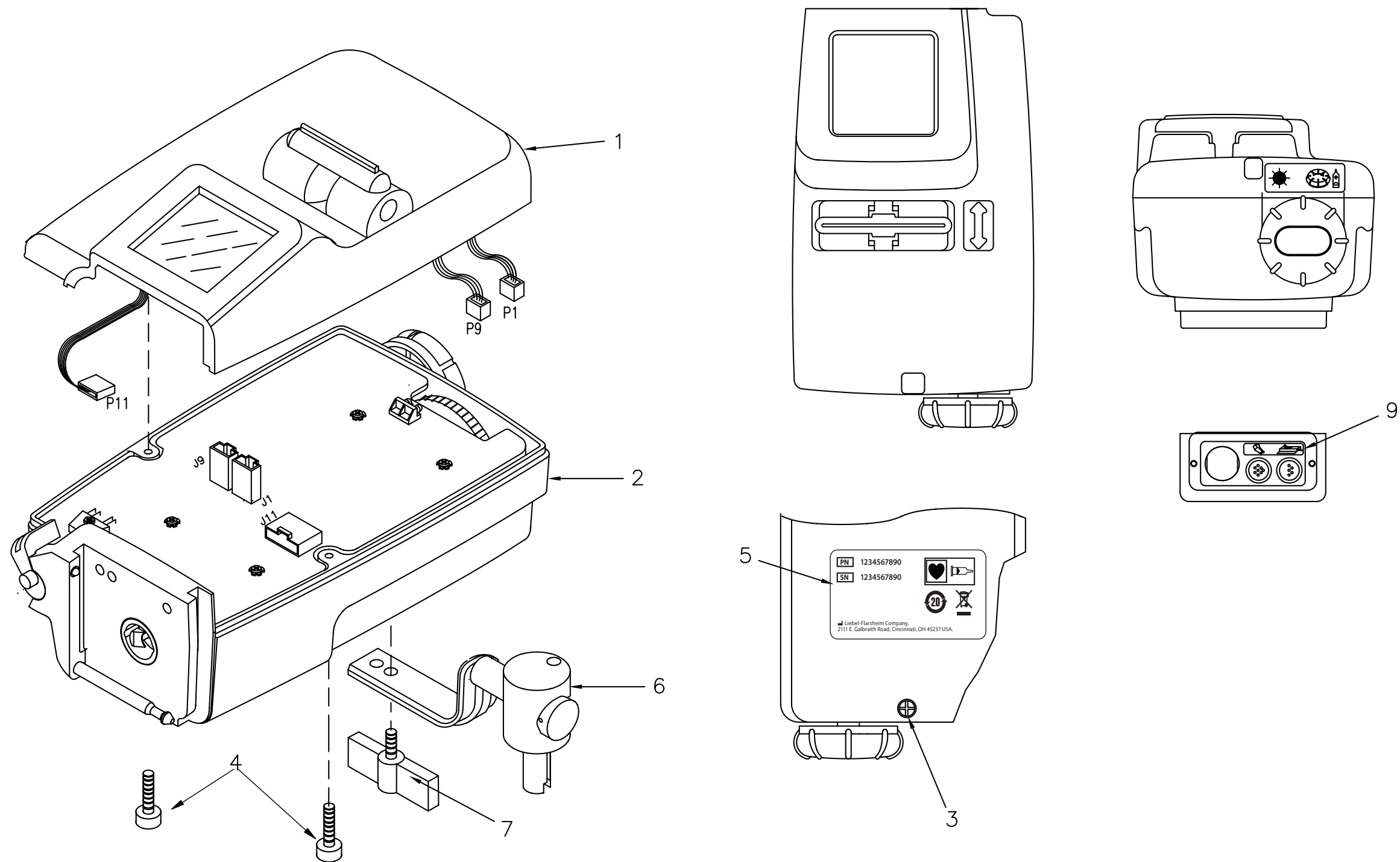


Figure 10-4-1 Powerhead Assembly

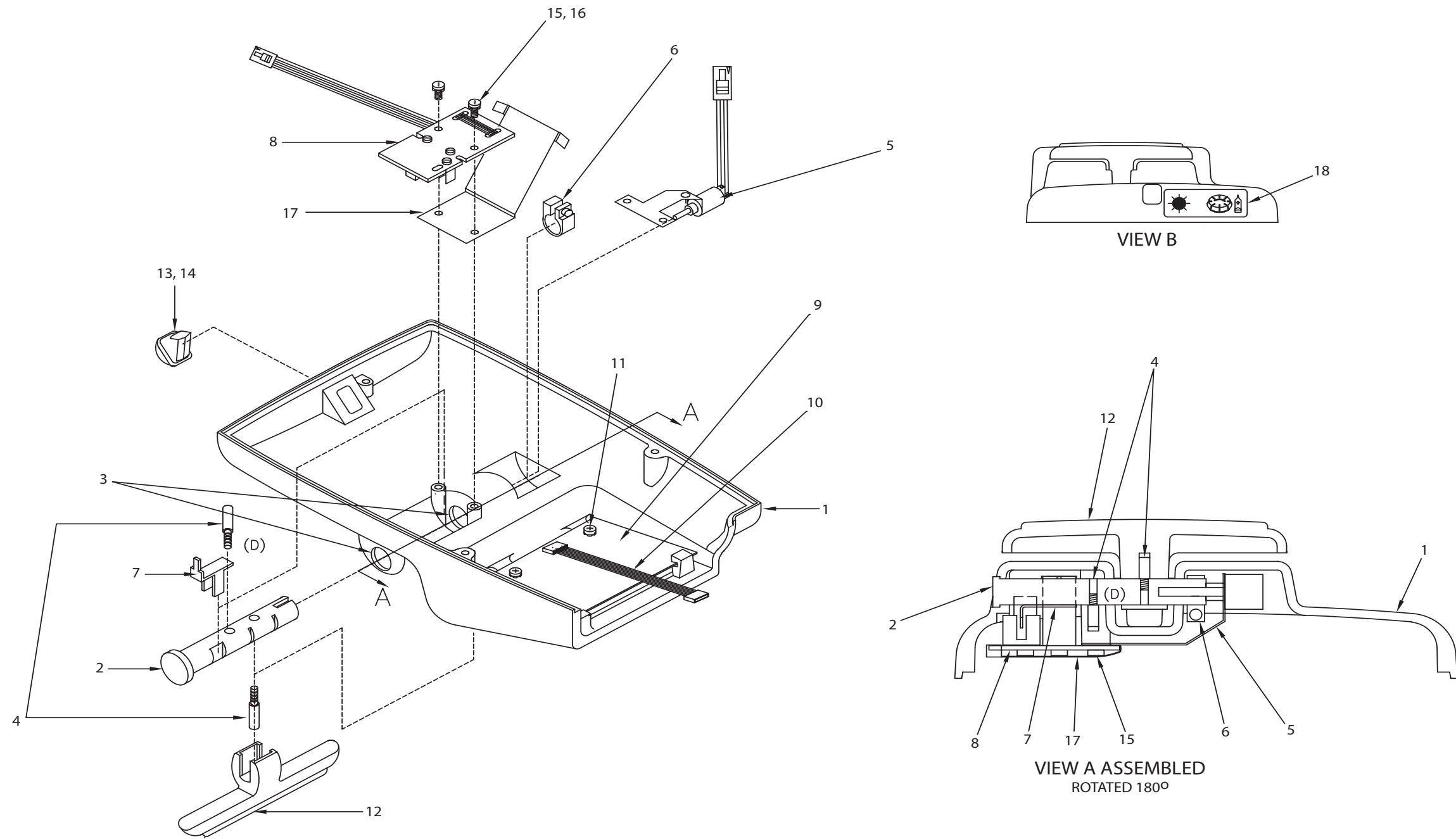


Figure 10-4-2 Powerhead Top Cover Assembly

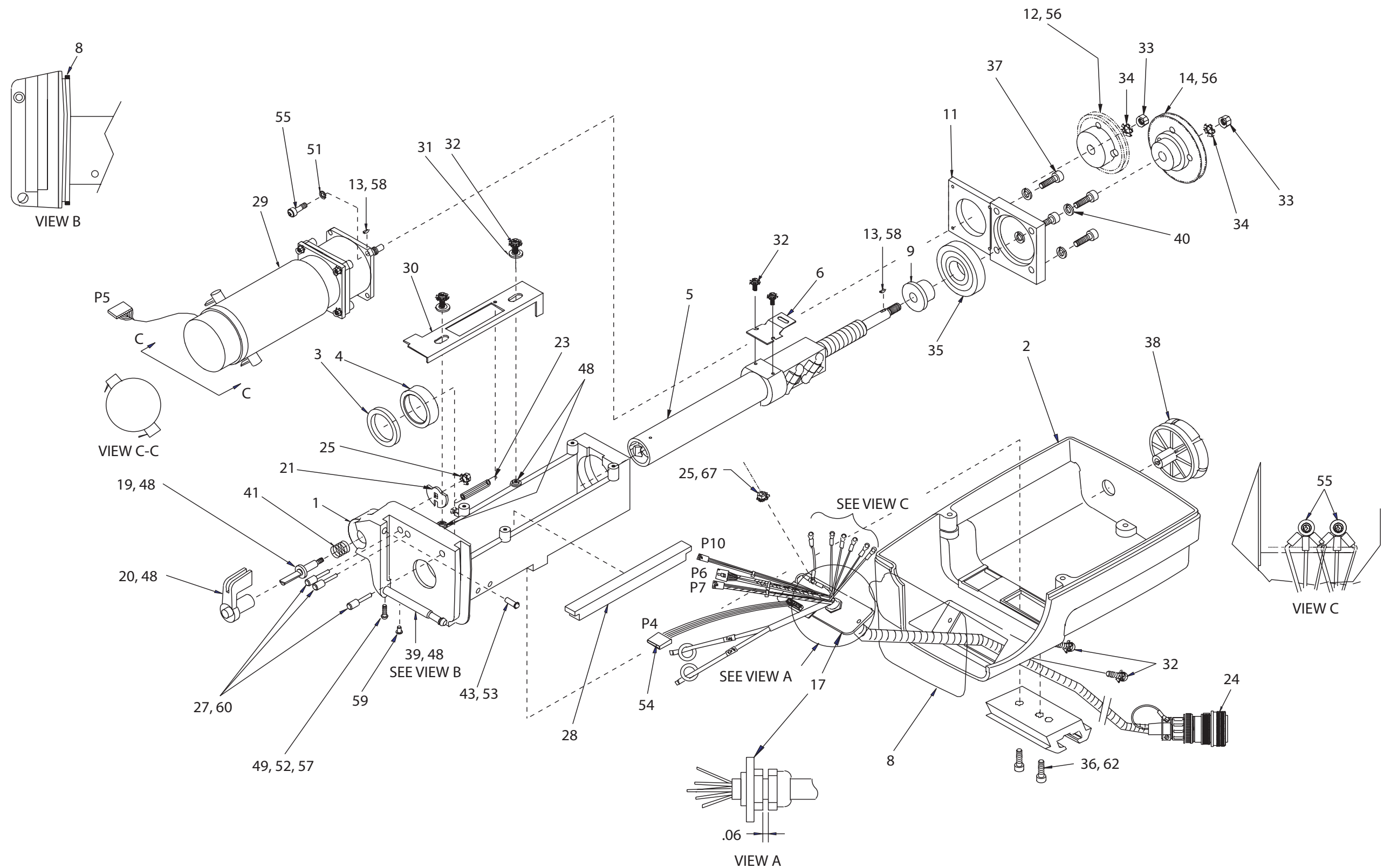


Figure 10-4-3 Powerhead Main Frame Assembly

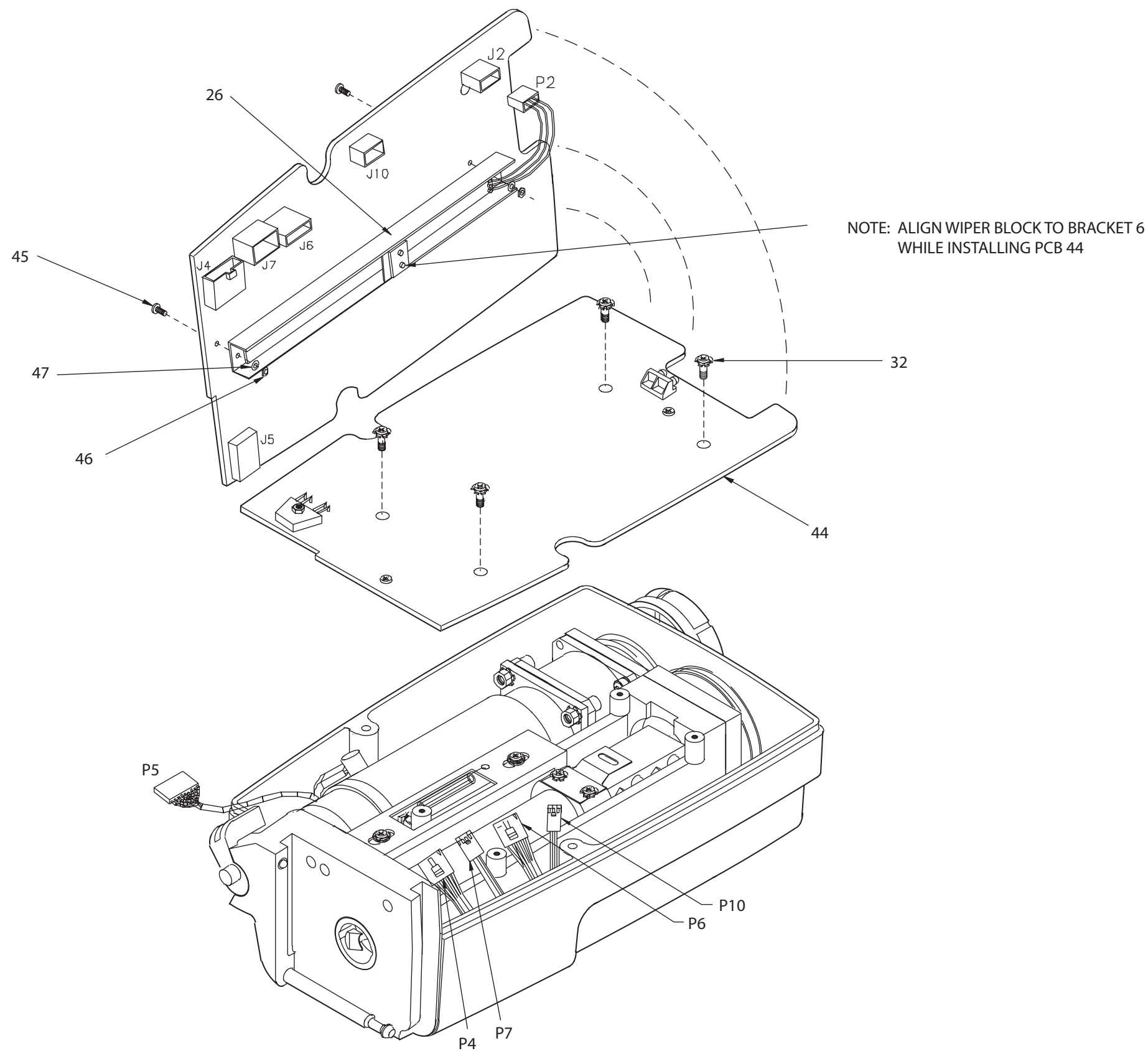


Figure 10-4-4 Powerhead Main Frame Assembly

A

APPENDIX A ELECTROMAGNETIC COMPATIBILITY TABLES

The Angiomas Illumena Contrast Delivery System meets EN 60601-1-2 for Class A conducted and radiated emissions and EMI immunity.

CAUTION! ⚠

The Angiomas Illumena Contrast Delivery System should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the system should be observed to verify normal operation in the configuration in which it will be used.

CAUTION! ⚠

Use of accessories, transducers and cables other than those specified or provided by the manufacturer of this equipment could result in increased electromagnetic emissions or decreased electromagnetic immunity of this equipment and result in improper operation.

CAUTION! ⚠

Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of the Angiomas Illumena Contrast Delivery System, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result.

CAUTION! ⚠

Portable and mobile RF communication equipment can affect operations of the Angiomas Illumena Contrast Delivery System .

CAUTION! ⚠

Maintaining programmed flow rate (unless pressure limited) and delivered volume are essential performance features of the Angiomas Illumena. Interference from other equipment could cause degradation of these functions resulting in improper operation.

Guidance and manufacturer's declaration - electromagnetic emissions

The Angiomat Illumena is intended for use in the electromagnetic environment specified below. The customer or the user of the Angiomat Illumena should assure that it is used in such an environment.

Emissions Test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The Angiomat Illumena uses RF energy only for the internal function. Therefore, the RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The EMISSIONS characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions	Complies	

Guidance and manufacturer's declaration - electromagnetic immunity

The Angiomat Illumena is intended for use in the electromagnetic environment specified below. The customer or the user of the Angiomat Illumena 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 less than 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	± 1 kV differential 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% U_T (>95% dip in U_T) for 0.5 periods 40% U_T (>60% dip in U_T) for 5 periods 70% U_T (>30% dip in U_T) for 25 periods <5% U_T (>95% dip in U_T) for 5 s	<5% U_T (>95% dip in U_T) for 0.5 periods 40% U_T (>60% dip in U_T) for 5 periods 70% U_T (>30% dip in U_T) for 25 periods <5% U_T (>95% dip in U_T) for 5 s	Mains power quality should be that of a typical commercial or hospital environment. If the user of the Angiomat Illumena requires continued operation during power mains interruptions, it is recommended that the Angiomat Illumena be powered from an uninterruptible power supply or 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 U_T is the a.c. mains voltage prior to application of the test level.

Guidance and manufacturer's declaration - electromagnetic immunity			
The Angiomat Illumena is intended for use in the electromagnetic environment specified below. The customer or the user of the Angiomat Illumena should assure that it is used in such an environment.			
Immunity Test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6	3 Vrms 0.15 to 80 MHz	3 Vrms	Portable and mobile RF communications equipment should be used no closer to any part of the Angiomat Illumena, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance $d = 1.2 \sqrt{P}$ $d = 1.7 \sqrt{P}$ $d = 1.2 \sqrt{P}$ (80 MHz to 800 MHz) $d = 2.3 \sqrt{P}$ (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 in meters (m). Field strengths from fixed RF transmitters as determined by an electromagnetic site survey^a should be less than the compliance level in each frequency range^b. Interference may occur in the vicinity of equipment marked with the following symbol: 
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	
NOTE 1 At 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. a Field strengths from fixed transmitters, such as base stations for radios (cellular/cordless) telephones and land mobile radios, amateur radio, AM, 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 Angiomat Illumena is used exceeds the applicable RF compliance level above, the Angiomat Illumena should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the Angiomat Illumena. b Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.			

Recommended separation distances between portable and mobile RF communications equipment and the Angiomat Illumena

The Angiomat Illumena is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Angiomat Illumena can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Angiomat Illumena 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	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 1.2\sqrt{P}$	$d = 1.2\sqrt{P}$	$d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

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.

B

APPENDIX B SERVICE CHECKLIST

FOR LATEST REVISION, CONTACT YOUR SERVICE PROVIDER

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FOR USE WITH ANGIOMAT ILLUMENA AND ILLUMENA HÉO

Clear Form

Test and Inspection Data

CAUTION! ⚠

Service on any Injector must be performed by a Qualified Technician who is completely familiar with its use and operation; trained by the manufacturer in the area of servicing the Injector; and familiar with the content of the Operator's and the Installation and Service manual.

Service Ticket Number

Call Type	N/A	Service Work Performed	Field Service Engineer Information	
		Preventive Maintenance	Date	☐ I attest to the accuracy and integrity of this document.
		Installation	Name	
		Repair	Signature	

Injector Information

Injector Component	Serial Number	System Software Version	
Console Serial Number		Console Software Version	
Power-Head Serial Number		Power-Head Software Version	
Power-Pack Serial Number		Power-Pack Software Version	

POWER-PACK LOCK: PLEASE CHECK THE APPROPRIATE BOX CORRESPONDING TO THE MODEL NUMBER AND FILL IN THE SERIAL NUMBER

☐ 900001	011074619000255021
☐ 900001C	011074619000279621
☐ 800002	011074619000256721
☐ 900003	011074619000287421
☐ 900005	011074619000258821
☐ 000000	011074619000256221
☐ 900008C	011074619000260421
☐ 900008	011074619000261121
☐ DE900001	011074619000404221
☐ DS900001	011074619000405921
☐ DL900001	011074619000406821
☒ DS900008	011074619000407321
☐ OL900006	011074619000408021

Power - Pack Serial Number

Calibrated Controlled Test Equipment

Used	N/A	Test Equipment	Serial	Calibration Due Date
		Torque Wrench (In-Lbs)		
		Pressure Gauge		
		Digital Volt Meter		

Test and Inspection Data

The number preceding the heading corresponds to the test procedure instructions located in the appropriate Service Manual 908955 - 903955 - 908955

☐ 6.4 POWERHEAD VISUAL / OPERATIONAL ☐ 6.5 CONSOLE VISUAL / OPERATIONAL ☐ 6.6 POWER-PACK VISUAL / OPERATIONAL ☐ 6.7 PEDESTAL VISUAL / OPERATIONAL ☐ NO PEDESTAL SYSTEM	☐ 6.8 ELECTRICAL GROUND CONTINUITY ☐ 6.12 CEILING SUSPENSION ☐ NO SUSPENSION SYSTEM

Note: This section of Test and Inspection Data only needs to be completed if one or more of the following conditions occurred during the service event,

Select appropriate Check Box

☐ N/A ☐ Installation Request ☐ Preventive Maintenance ☐ System Component Covers Removed	☐ Quality Regulatory Request ☐ Extension Cables Replaced ☐ Major Component Replacement	☐ Software Download ☐ System Calibration

☐ **2.10.5.1 FLOW RATE CHECKS - DISPLAYED VALUES**

	PROGRAM	Achieved Range	ACHIEVED
FLOWRATE (ML/S)	10	10 +/- 0.5	
VOLUME (ML)	100	100 +/-1	
PRESSURE (PSI)	N/A	< 100	
DURATION (SEC)	N/A	10 +/- 2	

☐ **2.10.7 RATE RISE CHECK - DISPLAYED VALUES**

	PROGRAM	Achieved Range	ACHIEVED
FLOW RATE (ML/S)	20	19 - 21	
VOLUME (ML)	100	98 - 102	
PRESSURE (PSI)	N/A	< 100	
RATE RISE	6	N/A	N/A
DURATION (SEC)	N/A	7.5 - 8.2	

☐ **2.10.5.2 ml/min CHECK - DISPLAYED VALUES**

	PROGRAM	Achieved Range	ACHIEVED
FLOWRATE (ML/S)	30	30 - 41	
VOLUME (ML)	20	19 - 21	
PRESSURE (PSI)	N/A	< 100	
DURATION (SEC)	N/A	25 - 32	

☐ **2.16.6 PRESSURE LIMIT CHECK**

(Achieved Pressure Readout)		
Programmed Flow Rate & Volume	Programmed Pressure Limit	Achieved Pressure Cell Sensor Readings
(20 ml/s) Flow Rate (1-40 ml) volume	750	+50/- 100psi
(20 ml/s) Flow Rate (1-40 ml) volume	1000	+50/- 100psi

- ☐ NO ADDITIONAL SERVICE REQUIRED ☐ CUSTOMER DECLINES SERVICE
☐ ASSOCIATED SERVICE TICKET _____

NOTES

Liebel-Flarsheim Company LLC

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