Medrad

VISTRON CT™

INJECTION SYSTEM

Service Manual

VSM 600 1
Serial numbers and date of installation information must be supplied when ordering replacement parts, or inquiring about servicing. For convenience, record the following information below:

OWNER: 

DATE INSTALLED: 

INJECTOR HEAD SERIAL NUMBER: 

REMOTE MONITOR SERIAL NUMBER: 

POWER SUPPLY UNIT SERIAL NUMBER: 

The information and specifications included in this publication were in effect at the time of approval for printing. MEDRAD, reserves the right, however, to discontinue or otherwise change specifications or design at anytime without notice, and without incurring any obligation whatsoever.
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Copyright Notice

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Trademarks

MEDRAD Vistron CT™, Qwik-Fit Syringe®, FluiDot®, Quality for Life®, and MEDRAD® are registered trademarks of MEDRAD Incorporated.

Patents

The MEDRAD Vistron CT Injector and related syringes are the subject of the following U.S. patent numbers: 4,677,980 and 5,383,858.

Restricted Sale

Federal (U.S.A.) law restricts the sale of this device on or by the order of a physician.

Disclaimers

MEDRAD makes no warranties on the contents of this manual, and specifically disclaims any implied warranties of merchantability or fitness for any purpose.

MEDRAD reserves the right to change specifications and the contents of this manual without obligation.

External wiring modification disclaimer: MEDRAD disclaims liability for any modifications or interfaces with other equipment which are not in conformity with the specifications and information contained within this manual. Such unauthorized action could jeopardize injector operation, safety, or reliability.

Accessory equipment connected to the analog and digital interfaces must be certified according to IEC 601-1 standards. Furthermore, all configurations shall comply with the system standard IEC 601-1-1. Anyone who connects additional equipment to the signal input or output, configures a medical system, and is therefore responsible that the system complies with the requirements of the system standard IEC 601-1-1. To obtain on-site consulting or consulting references, contact MEDRAD Service.

All drawings in this manual are for reference purposes only, and may not reflect the construction of units produced prior to the publication of this manual. Reproduction quality of these drawings may have been effected by the level of reduction required. Call MEDRAD Service if assistance in drawing interpretation is required.

The MEDRAD Vistron CT Injector is not for portable use.
Problems or Questions
If you experience problems with the MEDRAD Vistron CT System, contact your MEDRAD authorized dealer or:

**MEDRAD Service**
One MEDRAD Drive
Indianola, PA 15051-0780
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Phone: 1-412-767-2400
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**Applicability**
This manual applies to the VCT 600 Series MEDRAD Vistron CT Injection Systems, and is referred to as the MEDRAD Vistron CT Injection System, Vistron CT Injection System, MEDRAD Vistron CT Injector, or Vistron CT Injector throughout this manual.

**Purpose**
The purpose of this manual is intended to provide instructions for servicing the MEDRAD Vistron CT Injection System safely and accurately. It is intended for those qualified to service the injection system, whether they be MEDRAD Service Personnel, Certified Laboratory Service Technicians or MEDRAD authorized international dealers.

**Important Safety Notice**
The information in this manual is intended for people with adequate backgrounds and experience in electronics and electromechanical devices. Any attempt to repair a sophisticated medical device such as the injector may result in personal injury, property damage, or patient injury.

**Intended Use**
This device is designed specifically for the injection of intravenous contrast media into humans for diagnostic studies in Computed Tomography (CT) applications.

**RF Emission Standards**
MEDRAD Vistron CT Injection Systems are equipped to operate at 100-240 VAC, 50/60 Hz, and designed to be in compliance with EN 60601-1 (Safety), and EN 60601-1-2 (EMC/Emissions). The MEDRAD Vistron CT Injector is classified per EN 60601-1 as a Class 1, with a Type BF applied part. The following pictograph is displayed in recognition of this international status:
Symbols and Descriptions

The following international symbols are used on the MEDRAD Vistron CT Injector and throughout this manual.

Attention, consult accompanying instructions.

Attention, indicates hazardous voltages.

Indicates that this device conforms to the requirements of the European Medical Device Directive 93/42/EEC.

Identifies the equipotential ground.

Identifies the earth ground.

Identifies the **ON** switch position.

Identifies the **OFF** switch position.

Indicates alternating current.

**IPX1**

Identifies the degree of protection against fluid as drip proof.

Identifies a type BF applied part complying with EN60601-1 standards.

**CLASS 1**

Indicates the system is Class 1 medical equipment as defined by EN60601-1 standards

Identifies the connection on the Injector Head for the syringe heater.

Identifies connection of the remote **Start/Hold** Switch.

Identifies connection of the injector head cable.

Identifies connection of the remote monitor.
Symbols and Descriptions (cont.)

Identifies the **Standby** key.

Identifies the **Fill Select** key.

Identifies the **Autofill** key.

Identifies the **Retract** key.

Identifies rotation direction on the Manual Knob for manually moving the piston. Clockwise is forward movement.

Identifies the **START** key.

Identifies the **HOLD** key.

Identifies the **SUMMARY** key.

Identifies the **UP Arrow** key. Use to increase values when programming

Identifies the **DOWN Arrow** key. Use to decrease values when programming

**J302** Identifies the AutoLink connector.
INTRODUCTION TO WARNINGS / CAUTIONS

This manual contains important information about safe servicing of the MEDRAD Vistron CT Injection System.

MEDRAD urges the service technician to read this manual carefully, become familiar with the procedures and system functions that it describes, and follow its recommendations to assure proper servicing of the system.

Warning labels on the MEDRAD Vistron CT system or Warning statements in this manual preceded by any of the following words and/or symbols are of special significance:

- **WARNING:** Indicates a potentially hazardous situation. If not avoided, this could result in death or serious injury.

- **WARNING:** Indicates electrical hazards which could result in death or serious injury.

- **CAUTION:** Indicates potential hazards or unsafe practices which could cause product, system, or property damage.

- **NOTE:** Indicates helpful information is being offered.
WARNINGS

Injury may result from exposure to hazardous voltages existing within the system. The system should be opened and serviced by qualified service personnel only. Disconnect the system from line power before cleaning or attempting to perform any maintenance.

Explosion hazard in the presence of flammables. Do not use the system in the presence of anesthetic gases and equipment.

Patient or operator injury can occur from use of worn power cords or control cables. Examine power cords and cables for cuts, frays, or any other visible damage. Do not use the system if any of the cords or cables show signs of damage. Any damaged or worn connection cables or power cords should be replaced.

Patient or operator injury can occur from a falling injector head or pedestal. Do not move the head, pedestal, or counterpoise system by pulling on the injector head or cabling. Move the injector by grasping the center of the pedestal or vertical arm on the counterpoise.

Unsafe operation may result from using improper accessories and replacement parts. Use only accessories, options, and parts provided by MEDRAD, and designed for this system.
CAUTIONS

Damage may occur as a result of failure to follow electrostatic discharge (ESD) protection practices. ESD protection practices must be followed when servicing any component of this system.

Damage could result from improperly handled components. Before touching any of the circuit cards in the system, discharge yourself to grounded metal. If memory components are to be shipped, place the components in conductive carriers (as supplied through MEDRAD).

Damage can occur as a result of incorrect voltages. Check the voltage and frequency marked on the back of the Power Supply. Ensure that the outlet providing power to the injector supplies a voltage, frequency, and volt-ampere rating within the range specified on the unit.

Environmental damage may result from improper disposal of system components or accessories. Electronic assemblies contain potentially hazardous materials. Follow all local regulations for the recycling or disposal of electronic assemblies, or contact MEDRAD Service for assistance.

Damage can occur as a result of abrupt interruption or application of supplies. To avoid damage to sensitive circuits on the boards, disconnect the power cord before removing or replacing PC boards.

Allow system temperature to stabilize before use. To avoid damage to sensitive electronic circuits, allow the system to stabilize to room temperature before servicing when exposed to extreme temperature changes.

Perform regular preventive maintenance. To ensure that your MEDRAD Vistron CT System remains properly calibrated, and that all primary and backup circuits are functioning properly, regular preventive maintenance is recommended. An annual preventive maintenance package is not included in the new machine warranty. Contact your local MEDRAD Service Representative for details.

Damage may result from improper or careless cleaning methods. While cleaning any outside portion of the system, avoid allowing any water to seep inside system components.

NOTE: All relevant guidelines for institutional, local, or national safety recommendations related to cable routing and installation should be followed.
CAUTIONS
(cont.)

⚠️ The injector may disarm or fail to operate when exposed to high magnetic fields. Do not use radio transmitters, cellular phones, or devices generating electrostatic discharge in the vicinity of this system.

⚠️ Condensation may cause electrical damage to the injector. Do not use the injector immediately after it has been brought indoors from extreme outside temperatures. Allow the injector to stabilize at room temperature before use.
2 Maintenance and Checkout Procedures

This section contains recommended procedures for maintenance, and an operational checkout of the MEDRAD Vistron CT Injection System. Routine maintenance and inspection will:

- Ensure continued performance of the injection system
- Reduce the possibility of equipment malfunction

Maintenance

General maintenance of the MEDRAD Vistron CT injection system should consist of four primary procedures: Inspection, cleaning, electrical leakage and ground continuity checks, and operational checkout. This section contains guidelines and recommended methods for each of these procedures:

1. Inspection: This first step should encompass inspection of the entire system, looking for obvious signs of damage, such as; cracks in the housing, frayed or worn cables, and contrast media spills which may have leaked into the system.

2. Cleaning: This procedure involves the thorough cleaning of all system components to remove any deposits of contrast medium. If any substances have leaked into any part of the system, the sub-assembly should be disassembled and thoroughly cleaned.

3. Electrical Leakage / Ground Continuity Checks: To ensure the safety of the patient and hospital personnel in injection system operations.

Your MEDRAD Vistron CT Injection System must be properly maintained to ensure that it is in peak operating condition. Your individual maintenance system and schedule depends upon how your injection system is used; the type of procedures performed, and frequency of use. The following maintenance schedule is recommended for the system:

**Daily:**
The piston rod should be thoroughly cleaned after each use. Before use each day, the system should be cleaned and inspected, using the procedures outlined in this section. Ensure that all system safety and warning labels are in place and are legible.

**Monthly:**
Once a month, the entire system should be thoroughly inspected and cleaned, and an Operational Checkout should be performed.

**Annually:**
Once per year, both Electrical Leakage and Ground Continuity checks should be performed.

NOTE: Local regulations or hospital protocol may require electrical leakage checks at more frequent intervals. If this applies, local regulations for leakage must be followed.

MEDRAD also recommends that a complete system calibration and performance checkout, by a qualified MEDRAD Service Representative or authorized dealer, be performed once a year. Contact MEDRAD Factory Service, or your local MEDRAD office for complete details.

In the United States, Canada, and Europe, the MEDRAD Service Department offers Preventive Maintenance Programs. These annual programs greatly assist in maintaining accuracy and reliability, and can also extend the life of the system. Contact MEDRAD for details. In Europe, contact your local MEDRAD office or your local authorized dealer for further information. Refer to the Introduction Section of this manual for address, telephone and FAX information.

NOTE: Failures which occur due to lack of proper maintenance will not be covered under warranty.
Maintenance and Checkout

Inspection Procedures

The following procedures are recommended for daily inspection of all components in the MEDRAD Vistron CT Injection system. If any defects are detected, either repair the system, or call MEDRAD for service. Do not use the system until the problem is corrected.

Injector Head / Control Panel

1. Inspect the housing for any damage or cracks that could allow fluid to leak inside, or weaken the structural integrity of the unit.

2. Examine the handswitch and cable: Look for cuts, cracks, or worn spots in the cable; look for cracks and loose parts in the switch and housing. Ensure that the switch operates without sticking.

3. Inspect all cables connected to the unit: Look for cuts, cracks, worn spots or other obvious damage to the cables. Ensure that all connectors are properly seated.

4. Inspect for contrast media build-up in the syringe interface area. Follow the cleaning procedures outlined in this section.

5. Verify proper operation of all LED displays.

Syringe Heater

1. Ensure that the device is warm to the touch.

2. Ensure that the LED indicator is not illuminated or flashing.

3. Inspect the cable and connector for cracks, worn areas, or other obvious damage.

System Power Console

1. Inspect all cables connected to the unit: Look for cuts, cracks, or worn spots, or other obvious damage. Ensure that all connectors are properly seated.
Remote Monitor

1. Inspect the housing for any damage or cracks that could allow fluid to leak inside, or weaken the structural integrity of the unit.

2. Inspect the cable connected to the Remote Monitor: Look for cuts, cracks, or worn spots in the cables; look for loose pins or strain reliefs on the connectors. Ensure that the connector is properly seated.

3. Inspect all parts of the wall mounting bracket for cracks or other defects that would weaken the assembly. Ensure that the bracket remains firmly attached to the wall.

Pedestal Mounts

1. Inspect the stand, base, and support arm for cracks and other defects that could weaken the structure.

2. Ensure that all mounting bolts and screws are secure.

3. Ensure that the casters roll smoothly, with no binding or scraping.

4. Ensure that all locking mechanisms on the casters are functional.

5. If applicable, verify that the vertical height adjustment of the column shaft moves freely, without binding or scraping.

6. Inspect the injector head pivots. The head and stand arm must pivot freely. The injector head should rotate no more than 180°. The stand pivot should not rotate more that 350°.

CS Mounting Systems

1. Inspect all parts of the arm and mounting system for cracks and other defects that would weaken the system.

2. Ensure that the mounting system is securely assembled, with no loose parts. The arm should be stable with the head installed.

3. Ensure that the arm moves smoothly in all directions, with no binding or scraping.

4. Verify that all cabling is tied back and does not interfere with the movement of the supporting parts or the injector head.

NOTE: All relevant guidelines for institutional, local, or national safety recommendations related to cable routing and installation should be followed.
Cleaning Procedure

Deposits of contrast media can interfere with proper operation of the *Medrad Vistron CT* Injection System. The following guidelines should be followed when removing deposits, or cleaning any portion of the system.

**WARNING:** Injury may result from exposure to hazardous voltages existing within the system. Disconnect the system from line power before cleaning or attempting to perform any maintenance.

**CAUTION:** Improper or careless cleaning methods may result in equipment damage. Do not soak or immerse any part of the injection system in water. While cleaning any outside portion of the system, avoid allowing any water to leak inside system components.

- If contrast medium has leaked inside any component of the system, the effected subassembly should be disassembled and cleaned. This cleaning procedure can be done in the field by trained Medrad Service personnel, or returned to Medrad Factory Service. If the cleaning will be performed in the field, do not disturb any internal wiring or components.

- Care must be taken not to get water or cleaning solutions inside any system components. Do not use strong industrial cleaning agents or solvents such as acetone. Warm water and a mild disinfectant such as antibacterial hand soap are all that is required.

- To clean the syringe interface area of the injector head, fully retract the piston. Using a paper towel moistened with warm water or a mild disinfectant, gently wipe the inner syringe installation area. Do not insert any sharp instruments into this area during the cleaning process.

- The 100 ml syringe adaptor plate and piston extensions may be removed and soaked or submerged in water or mild cleaning solution. Ensure that the adaptor plate is completely dry before installing onto the injector head.

- Check all System Safety and Warning Labels for legibility. Ensure that the labels are not damaged or missing.

**WARNING:** Injury may result from exposure to hazardous voltages existing within the system. Ensure that the system is completely dry before connecting to the power source and applying power.
Electrical Leakage Check

To ensure safe operation of the *Medrad Vistron CT* Injection System, an electrical leakage check must be part of regular maintenance.

Use a commercial leakage tester such as one of the following:

<table>
<thead>
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<th>MANUFACTURER</th>
<th>MODEL</th>
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<tr>
<td>Bio-Tek Instruments, Inc.</td>
<td>Model 601 PRO</td>
</tr>
<tr>
<td>Electrical Safety Analyzer</td>
<td></td>
</tr>
<tr>
<td>Bender</td>
<td>Unimet 1000 ST</td>
</tr>
<tr>
<td>Bapco</td>
<td>IEC601L</td>
</tr>
</tbody>
</table>

1. With the AC ground open, power applied, and the line at normal, leakage should be less than 100 micro amps at 110V, or 300 micro amps at 220V.

2. With the AC ground open, power applied and the line reversed, leakage should be less than 100 micro amps at 110V, or 300 micro amps at 220V.

3. Disconnect the leakage test device.

Ground Continuity Check

A ground continuity check must also be part of regular maintenance of the *Medrad Vistron CT* system.

1. Disconnect the system from the power source.

2. Using an ohm meter, measure the resistance between the ground terminal on the power cord and the Power Supply housing. The resistance measured must be less than 0.2 ohms.

Operational Checkout

A basic functional checkout of the *Medrad Vistron CT* Injection System should be included as part of regular maintenance. Verifying proper operation of the injection system will help in detection of any problems that may not be noticed in day to day operation. The following procedure represents a suggested series of activities which encompass typical operation of the system. Read the following procedure carefully before beginning the checkout. If problems are detected, refer to the General Troubleshooting Procedures found in Section 3.

**NOTE:** Any problems detected during this or any other procedure should be corrected before using the injection system in patient procedures.
Ensure that all system safety and warning labels are in place and legible.

Apply power to the injector. Verify that the injector beeps and that all indicators on the injector head and remote monitor illuminate. After the injector completes the diagnostic tests, use the Enable key and the Forward/Reverse motion controls to fully advance and reverse the piston.

1. Enter the following protocol. Verify that all of the increment/decrement keys function properly.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Flow Rate</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>9.9 ml/sec</td>
<td>40 ml</td>
</tr>
<tr>
<td>Phase 2</td>
<td>6.5</td>
<td>30</td>
</tr>
<tr>
<td>Phase 3</td>
<td>3.0</td>
<td>20</td>
</tr>
<tr>
<td>Phase 4</td>
<td>1.0</td>
<td>10</td>
</tr>
</tbody>
</table>

Pressure Limit: 200 psi

2. Press the Summary key to verify that the total and maximum values display on the control panel.

3. Install a 125 or 200 ml Qwik-Fit syringe.

4. Fully advance the piston plunger.

5. Use Fill Select to select 100 ml.

6. Use the Autofill key to reverse the piston plunger to the 100 ml position.

7. ARM in the Single Injection mode. Start the injection by pressing the Start key on the injector head.

8. Verify that the Scan Delay timer beeps during the last 10 seconds of the countdown, and when the countdown completes.

9. During one of the phases, press the Hold key to pause the injection for at least 10 seconds. Press the Hold key again to resume the injection.

10. Verify that the injection progresses and completes normally.

11. Remove the syringe and press the Retract key to fully retract the piston.

12. Use the Disarm/Reset key to delete the entire protocol.
13. Enter the following protocol (with a Scan Delay of 15 seconds):

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1:</td>
<td>2.0 ml/sec</td>
</tr>
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Pressure Limit: 200 psi

14. Reinstall the syringe and arm in the Multi Injection mode.

15. Press the remote **Start** switch to start the injection.

16. Verify that the injection completes successfully and that the injector remains armed.

17. Use the remote monitor the start another injection. Verify that the **Scan Delay** timer on the remote monitor beeps during the last 10 seconds of the countdown and when the countdown is complete.

18. Verify that the injection completes successfully, and that the injector remains armed.

19. Disarm the injector by pressing the **Disarm** key on the remote monitor.

20. Remove power from the unit.

**AutoLink Check**

1. Enter an injection protocol in which the injector will start and stop the CT scanner. Verify that the scanner will start and stop in response to the injector scanner relay signal.

2. Enter an injection protocol in which the CT scanner will start and disarm the injector. Verify that the injector will start and disarm in response to the AutoLink control on the CT scanner.
## Troubleshooting

### System Malfunction Codes

Conditions can occur which will prevent the injection system from being armed, or even interrupt an injection that is in progress. These conditions may be operator induced or caused by a system malfunction. Error Codes which inform the user of these conditions are displayed on the control panel.

### General Troubleshooting Guidelines

Consider the following guidelines before troubleshooting any condition. These guidelines may help in resolving the condition quickly: Remember, try the simple things first.

- **CAUTION:** Damage may occur as a result of failure to follow electrostatic discharge (ESD) protection practices. ESD protection practices must be followed when servicing any component of this system.

- **CAUTION:** Damage could result from improperly handled components. Before touching any of the circuit cards in the system, discharge yourself to grounded metal. If memory components are to be shipped, place the components in conductive carriers (as supplied through MEDRAD).

- **CAUTION:** Disconnect the power cord before removing or replacing PC boards. Sensitive circuits on the boards can be damaged by abrupt interruption or application of supplies.

- Try removing power for one minute. Allow the system to reset completely, then reapply power and retry. The condition could be intermittent, or caused by a voltage transient. If the condition persists, continue troubleshooting.

- To verify the existence of a condition, attempt to re-create the problem. Follow the Checkout Procedure outlined in Section 2 of this manual to check for proper (or improper) operation of the system.

- Some faults can be caused by a noisy electrical environment. If these conditions persist, contact MEDRAD Factory Service* for further assistance.

* Indicates contact MEDRAD Factory Service or an Authorized Dealer.
Message Codes

[U] Message Codes
Identify conditions which require attention. These messages will clear the control panel within 5 seconds (press any key to clear the message after 2 seconds). The [U] code list is on page 3 - 3.

[P] Message Codes
Identify conditions which require action. These messages will clear the control panel when the operator responds to the condition which caused the message to appear. The [P] code list is on page 3 - 4.

[d] Message Codes
Identify conditions which cause the system to disarm. These messages will clear the control panel within 5 seconds (press any key to clear the message after 2 seconds) when the condition which causes them to appear is corrected. The [d] code list is on page 3 - 4.

[C] Message Codes
Identify errors that require additional attention. These errors fall into two categories: errors that may be operator correctable, and errors that indicate the activation of an injector safety back-up system. The [C] message code list and troubleshooting instructions begin on page 3 - 5.
<table>
<thead>
<tr>
<th>[U] Codes</th>
<th>Display Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U103</td>
<td>Cannot continue with injector head operation - Invalid piston or manual knob movement detected.</td>
</tr>
<tr>
<td>U110</td>
<td>Cannot arm - Total Volume of the protocol exceeds syringe capacity. Attach a larger syringe or adjust volume.</td>
</tr>
<tr>
<td>U121</td>
<td>Cannot continue injector head operation - Syringe or adapter is not fully engaged. This message will also appear if the Retract key is pressed while a syringe is engaged.</td>
</tr>
<tr>
<td>U122</td>
<td>Cannot continue injector head operation - Syringe or adapter plate has been installed.</td>
</tr>
<tr>
<td>U131</td>
<td>Cannot activate Autofill. Press Enable/Forward Motion control or use manual knob to extend piston fully (0 - 1 ml syringe volume).</td>
</tr>
</tbody>
</table>
| U132      | 100 ml Systems: Cannot activate Autofill - 100 ml adapter is attached.  
Non-100 ml systems: A system failure occurred. Disconnect the patient and contact MEDRAD Service*. |
| U133      | Cannot activate Autofill - The system has detected a pre-filled syringe attached. |
| U141      | Cannot continue with injector head operation - Operator pressed a control panel key or Start switch. |
| U153      | Cannot Arm - ISI Injector Start Input/Disarm Control is active (J302 pins 20 and 25 are shorted). |
| U161      | Cannot program Duration before programming Volume. |
| U162      | Cannot change phases with an invalid or incomplete phase. |
| U171      | Cannot arm with an incomplete or invalid phase. |
| U172      | Cannot arm - Scroll to highest phase before proceeding. |
| U175      | Cannot arm - Syringe volume is 0 ml. |
| U321      | Arming - System diagnostics in progress. Press any key to interrupt process. |
### [P] Codes  Display Description

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P100</td>
<td>Is air expelled from syringe and fluid path? Press <strong>Disarm/Reset</strong> key to cancel or Arm/Yes to continue.</td>
</tr>
</tbody>
</table>
| P123 | 100 ml syringe adapter is detected. Press **Inject Mode** key to confirm that an adapter plate has been installed.  
* (100 ml configurations only) |
| P124 | 100 ml syringe adapter is not detected. Press **Inject Mode** key to confirm that adapter plate has been removed.  
* (100 ml configurations only) |
| P123, 124 | *(Non-100 ml configurations)*  
A system failure occurred. Disconnect patient and contact MEDRAD Service. |
| P125 | Cannot continue self diagnostics with syringe attached. Remove syringe to continue. |
| P151 | AutoLink available? Press **Inject Mode** key to confirm that the system is interfaced with the scanner. |
| P152 | AutoLink not available? Press **Inject Mode** key to confirm that the system is not interfaced with the scanner. |

### [d] Codes  Display Description

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>d101</td>
<td>System disarmed - Control panel key or <strong>Disarm/Reset</strong> key was pressed.</td>
</tr>
<tr>
<td>d108</td>
<td>System disarmed - Injector stalled.</td>
</tr>
<tr>
<td>d115</td>
<td>System disarmed - Hold time exceeded 10 minutes.</td>
</tr>
<tr>
<td>d116</td>
<td>System disarmed - Start switch was inserted or removed.</td>
</tr>
<tr>
<td>d117</td>
<td>System disarmed - Manual knob was rotated.</td>
</tr>
<tr>
<td>d118</td>
<td>System disarmed - Syringe or adapter was detached.</td>
</tr>
<tr>
<td>d119</td>
<td>System disarmed - Backlash timer expired. Syringe pressure was greater than backlash pressure.</td>
</tr>
<tr>
<td>d120</td>
<td>System disarmed - AutoLink Start/Disarm input (J302 pins 20 and 25) opened during an injection.</td>
</tr>
</tbody>
</table>
[C] Codes

C500  Check Remote Start/Hold Switch

This error code typically indicates a problem with the remote start switch (VHS 600) connected at J102. If a remote start switch is not present, contact MEDRAD Service. If one is present, take the following steps to attempt to return the injector to service:

1. Check the remote start switch connection at the head to assure the connector is fully seated. If the connection is loose, remove and reattach the connector.

2. Press the Standby key on the injector head to reset the system.

3. Disconnect the patient and perform a trial injection using the remote Start/Hold switch. If the system performs correctly, return the system to use.

4. If the error code reappears, remove the Start/Hold switch from the injector head.

5. Press the Standby key, and perform another trial injection, using the Start/Hold switch on the injector head. If the system performs correctly, contact MEDRAD Service for a replacement remote Start/Hold switch.

6. If the error persists, contact MEDRAD Service.

C510  Check Remote Monitor

This error code typically indicates a problem with the Remote Monitor (VRM 600). If a Remote Monitor is not present, contact MEDRAD Service*. If a Remote Monitor is present, take the following steps to attempt to return the injector to operating status:

1. Check the remote monitor connection at the system power console to assure the connector is fully seated. If the connection is loose, turn off the AC power at the system power console, remove and reattach the connector.

2. Turn on the AC power to the system, or press the Standby key on the injector head.

3. Disconnect the patient and perform a trial injection using the Start/Hold key on the remote monitor. Observe the remote monitor displays during the injection. If the system performs correctly, return the system to use.
4. If the error code reappears, turn off the AC power and disconnect the remote monitor from the system power console.

5. Apply the AC power and perform another trial injection using the Start/Hold key on the injector head. If the system performs correctly, contact MEDRAD Service* for a replacement remote monitor.

6. If the error persists, contact MEDRAD Service*.

Error codes **C520**, **C530** and **C540** indicate that the safety back-up subsystems in the Vistron CT injector have detected a pressure (C520), volume (C530), or flow rate (C540) in excess of the specification limits for the programmed value. Disconnect the patient immediately and examine the patient for injury. Contact MEDRAD Service* before using the system again.

**C520  System Pressure Exceeded Pressure Limit**

This may occur as a result of injecting into a blockage or a small catheter/needle with the maximum pressure limit selected. Check the fluid path for blockages, then press the **Standby** key to restart the injector. If no blockage exists, reduce the flow rate or pressure limit according to the instructions of the physician.

**C530  Injected Volume Exceeded Programmed Value**

**C540  Flow Rate Exceeded Programmed Value**

**C560  Head Overlay Failure Detected**

This error indicates that an overlay key press was detected during power-up or arming when none should have been present. This may have been due to an accidental key press from the operator, or a fault in the overlay itself. Restart the system by pressing the **Standby** key, and do not press any keys until self diagnostics are complete. If the error code is displayed again, Contact MEDRAD Service*.
Troubleshooting

C570  A Failure Occurred in the AutoLink Interface

This error may occur when the interface cable and circuit are being tested. This condition can be caused by a loose or improper connection. Verify the connection of the cable at the power supply and scanner. If all cable connections are secure and this code persists, disconnect the interface cable and contact MEDRAD Service. The injection system will function, but AutoLink will not be operational.

C599  System Error, Call MEDRAD Service*

A C599 error indicates that a failure has occurred within the system. Disconnect the patient, and contact MEDRAD Service*.

OTHER MALFUNCTIONS

If after pressing the Standby key to power up the system the injector head or remote monitor displays are blank:

- Check the power cord, all cables, and connections.
- Verify that the Main Power switch on the System Power Console is in the ON position
- If the problem persists, call MEDRAD Service*.

Failure of individual displays or keys, damage to system components, or any other misoperation should also be brought to the attention of MEDRAD Service*.
Disassembly and Reassembly Procedures

This section contains recommended procedures for the disassembly and reassembly of those portions of the injection system that can be readily repaired in the field. If through troubleshooting and diagnosis, a repair or replacement procedure which is not outlined in this section is required, contact MEDRAD Service, or your local MEDRAD Service Representative.

For complete assembly diagrams and replacement part number information, refer to Section 6 of this manual.

**WARNING:** Injury may result from exposure to hazardous voltages existing within the system. The system should be opened and serviced by qualified service personnel only. Disconnect the system from line power before cleaning or attempting to perform any maintenance or repairs.

**CAUTION:** Damage may occur as a result of failure to follow electrostatic discharge (ESD) protection practices. ESD protection practices must be followed when servicing any component of this system.

**NOTE:** When servicing any portion of the injector head assembly, MEDRAD Service recommends removal of the injector head from the injector head pedestal, allowing easy access and handling of all related components. Release the injector head from the pedestal at the pivot knuckle, then position on a flat, stable, static-free surface.

**NOTE:** Replacement of the MPU board, injector head potentiometers, or injector head motor, require re-calibration of system parameters. Calibration can only be performed using a calibration kit supplied by MEDRAD. Contact MEDRAD Service for details.

**NOTE:** When installing injector head covers after any of the following procedures, ensure that all foam seals are in place and properly seated.
INJECTOR HEAD  -  Covers

Cover Removal

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   NOTE: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

Cover Replacement

NOTE: If the bottom cover is to be replaced, inspect the new cover for a small alignment ridge on the inside of the cover. If the rear plate does not have an alignment notch, remove the alignment ridge from the bottom cover.

1. Position the bottom cover on the assembly.

2. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

3. Ensure that the Armed Indicator lens in properly positioned in the keyed cover recess. Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

4. Connect the injector head cable, then secure with the attached screws.

5. Install the injector head cable access plate and secure with the two screws previously removed.

   NOTE: These screws must be no longer than 1/4” (6.3 mm) in length.
INJECTOR HEAD - *Pivot Knuckle Adjustment*

**Adjustment Procedure**

1. Remove the cap from the side of the pivot knuckle.
2. Using a 7/16” nut driver, adjust the nut inside the pivot knuckle for the desired tension (50 in-lbs. max).
3. Replace the cap on the side of the pivot knuckle.
INJECTOR HEAD - *Armed Indicator Lens*

**Lens Removal**

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   **NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

3. Remove the motor knob.

4. Lift the lens from the top cover recess.

**Lens Replacement**

1. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

2. Install the injector head cable access plate and secure with the two screws previously removed.

   **NOTE:** These screws *must* be no longer than 1/4” (6.3 mm) in length.

3. Install the motor knob previously removed.
INJECTOR HEAD - *Armed Indicator Lamp*

**Lamp Removal**

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   **NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

3. Remove the motor knob.

4. Lift the lens from the bottom cover recess.

5. Remove the defective bulb from the socket.

**Lamp Replacement**

1. Carefully install the replacement bulb in the socket.

2. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o'clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

3. Install the injector head cable access plate and secure with the two screws previously removed.

   **NOTE:** These screws *must* be no longer than 1/4” (6.3 mm) in length.

4. Install the motor knob previously removed.
INJECTOR HEAD - Keypad Overlay

Overlay Removal

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   NOTE: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

3. Peel the adhesive keypad overlay from the switch card.

Overlay Replacement

1. Remove the backing from the replacement overlay to expose the mounting adhesive.

2. Noting the pins provided for proper alignment, carefully place the overlay in position on the switch card, working from left to right. When properly positioned, ensure that the overlay adheres firmly to the surface.

3. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

4. Install the injector head cable access plate and secure with the two screws previously removed.

   NOTE: These screws must be no longer than 1/4” (6.3 mm) in length.
INJECTOR HEAD - **PC Boards**

**PC Board Removal**

**NOTE:** Replacement of the MPU card requires re-calibration of system potentiometer and pressure constants. Calibration can only be performed using a calibration kit supplied by MEDRAD. Contact MEDRAD Service for details.

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

**NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Lift to remove the Graphic Overlay Assembly.

5. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, pull the shield away from the boards. *It is not necessary to remove the RF shield completely.*

6. **Display Processor Card (DPU):**

   Loosen the two captive screws that secure the DPU to the front and rear plates.

   Carefully lift the DPU card from the assembly. The slight resistance felt is the extended pin connector disengaging beneath the card.
7. **Main Processor Card (MPU):**

   Remove the DPU card

   Disconnect P/J522 (at the upper right side) from the MPU card

   Disconnect P/J515 (at the lower center) from the MPU card

   Disconnect P/J514 (at the lower right) from the MPU card

   Remove the four screws that secure connectors P500 and P520 at the rear of the MPU card, then disconnect the connectors.

   Loosen the captive screw that secures the MPU to the front plate, then carefully lift the card from the assembly. The slight resistance felt is the extended pin connector disengaging from the card.

8. **Power Card (PCU):**

   Remove the DPU and MPU cards

   Loosen the two captive screws that secure the Power card to the front and rear plates.

   Lift the Power card from the assembly.
PC Board Replacement

NOTE: Replacement of the MPU card requires re-calibration of system potentiometer and pressure constants. Calibration can only be performed using a calibration kit supplied by MEDRAD. Contact MEDRAD Service for details.

1. **Power Card (PCU):**
   
   Position the Power card in the assembly, ensuring that it is properly aligned with the alignment pin on the rear plate, then secure to the front and rear plates with the two captive screws.

2. **Main Processor Card (MPU):**
   
   Ensure that the Power card is properly installed
   
   Carefully position the MPU card in the assembly, ensuring that all interboard connectors align correctly and completely.
   
   Connect and secure connectors P520 and P500 at the rear of the MPU card.
   
   Secure the MPU card to the front plate with the captive screw.
   
   Connect P/J514 at the lower right of the MPU card.
   
   Connect P/J515 at the lower center of the MPU card.
   
   Connect P/J522 at the upper right side of the MPU card.

3. **Display Processor Card (DPU):**
   
   Ensure that the Power and MPU cards are properly installed
   
   Carefully position the DPU in the assembly, ensuring that all interboard connectors align correctly and completely, then secure to the front and rear plates with the two captive screws.

4. **Re-position the RF shield on the head assembly, securing the top of the shield over the two mounting pins (one each on front and rear plates), then snapping the bottom edge into position.**

5. **Install the Graphic Overlay Assembly, ensuring that all interboard connectors align correctly and completely, and that the assembly is hooked onto the pins at the top of the end plate.**
6. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

7. Position the head assembly into the bottom cover, then ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

8. Install the injector head cable access plate and secure with the two screws previously removed.

**NOTE:** These screws *must* be no longer than 1/4” (6.3 mm) in length.
INJECTOR HEAD - Head Extension Cable

Head Extension Cable Removal
1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. At the Power Supply, loosen the two thumbscrews at P/J300 that secure the head extension cable, then carefully disconnect the cable.

Head Extension Cable Replacement
1. Connect the replacement head extension cable at P/J300 on the Power Supply, then secure with the two captive thumbscrews.

2. Connect the injector head cable to the mating connector in the injector head and secure the connector screws.

3. Install the injector head cable access plate and secure with the two screws previously removed.

NOTE: These screws must be no longer than 1/4” (6.3 mm) in length.
NOTE: This procedure is applicable only to systems without the injector head flex circuit interconnect.

**HHC Card Removal**

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   **NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

3. Remove the screw that secures the HHC card to the bottom head cover, then remove the card from the assembly.

4. Disconnect P/J521 from the HHC card.

**HHC Card Replacement**

1. Connect P/J521 to the HHC card.

2. Position the bottom cover on the assembly.

3. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

4. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

5. Install the injector head cable access plate and secure with the two screws previously removed.

   **NOTE:** These screws must be no longer than 1/4” (6.3 mm) in length.
**Drive Belt Removal**

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   **NOTE**: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

3. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

4. Remove the motor knob and Armed Indicator lens.

5. Remove the two screws that secure the Arm Lamp card to the assembly, then gently pull the card to one side.

6. Gently remove the drive belt from the large drive pulley by walking the belt outward, then disengage the belt from the motor pulley.

**Drive Belt Replacement**

1. Position the replacement drive belt around the motor gear, then carefully engage the belt on the large drive pulley.

2. Place the Arm Light card in position and secure with the two screws previously removed.

3. Position the bottom cover on the assembly.

4. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

5. Install armed indicator lens and motor knob.

6. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

7. Install the injector head cable access plate and secure with the two screws previously removed.

   **NOTE**: These screws must be no longer than 1/4” (6.3 mm) in length.
INJECTOR HEAD - Motor

Motor Removal

NOTE: Replacement of the motor requires re-calibration of system potentiometer and pressure constants. Calibration can only be performed using a calibration kit supplied by MEDRAD. Contact MEDRAD Service for details.

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

NOTE: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

5. Remove the Keypad Overlay PC card.

6. Remove the screws that secure the internal head cable to the RF shielding case.

7. (If applicable) Slide the internal head cable wires from the recess on the edge of the rear plate.

8. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, slide the case over the rear plate to remove from the head.

9. Carefully note the orientation of the motor and motor leads, disconnect the red and black wires, then disconnect P/J525 (encoder wires at in-line connector) from the motor.

10. Remove the motor knob and arm lens.

11. Remove the E-clip (with drive belt in position) from the motor shaft.

12. Remove the two screws from the rear plate that secure the motor to the plate. Carefully slide the motor/encoder from the assembly.
INJECTOR HEAD - Motor (cont.)

Motor Replacement

1. With the motor/encoder oriented as removed above, insert the motor into the recess of the rear plate while installing the motor pulley (with belt positioned on the pulley) onto the motor shaft. Rotate the motor into position.

2. Secure the motor to the rear plate with the two screws previously removed, then install the E-clip on the motor shaft.

3. Connect the positive and negative motor leads (red to red #1 and black to black #2) to the motor terminals and the in-line encoder connector at P/J525.

4. Install the arm lens and motor knob.

5. While gently holding the ends of the RF shield apart, slide the shield onto the head assembly from the rear plate end. Ensure that the RF shield is properly secured to the mounting pins before fully seating.

6. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

7. Route the internal head cable and position the cable connector on the mounting bracket of the RF shield case. Secure the connector to the bracket with the two standoffs previously removed.

8. Install the Keypad Overlay PC card.

9. Position the bottom cover on the assembly, then position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

10. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

11. Connect the injector head cable to the mating connector in the injector head and secure the connection screws.

12. Install the injector head cable access plate and secure with the two screws previously removed.

    **NOTE**: These screws must be no longer than 1/4” (6.3 mm) in length.

13. Recalibrate system potentiometer and pressure constants.
INJECTOR HEAD - *Potentiometer*

**Potentiometer Removal**

**NOTE:** Replacement of the potentiometer requires re-calibration of potentiometer constants. Calibration can only be performed using a calibration kit supplied by MEDRAD. Contact MEDRAD Service for details.

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

**NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

5. Remove the Keypad Overlay PC card.

6. Remove the screws that secure the internal head cable to the RF shielding case.

7. *(If applicable)* Slide the internal head cable wires from the recess on the edge of the rear plate.

8. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, slide the case over the rear plate to remove from the head.

9. Remove the motor knob and Armed Indicator lens.

10. Remove the two screws that secure the Arm Light card, then move card to one side.

11. Using a 7/16” nutdriver, remove the nut that secures the large drive gear and washers.

12. Remove the drive belt from the large drive gear, then remove the gear.
Disassembly and Reassembly

INJECTOR HEAD - *Potentiometer (cont.*)*

13. Remove the combination gear from the assembly

14. Using a flat blade screwdriver, *carefully* remove the potentiometer gear by alternately prying at opposite edges of the gear.

15. *Carefully note the orientation of all potentiometer leads*, then disconnect connector P/J523 from the pot cable.

16. Using a 1/2" nut driver, remove the nut that secures the potentiometer to the rear plate. Remove the potentiometer from the rear plate.

**Potentiometer Replacement**

1. Insert the replacement potentiometer (pot) into the rear plate assembly. Align the pot terminals with the recessed notch on the rear plate. Secure with the supplied 1/2" nut and star washer.

2. Connect the potentiometer cable at P/J523.

3. Place the potentiometer gear on the potentiometer shaft, then rotate the gear to the counter-clockwise limit.

4. Place a mark on the potentiometer gear that coincides with either reference mark etched into the rear plate.

5. Rotate the ballscrew driveshaft until the assembly is as close to the rear plate as possible.

6. Rotate the potentiometer gear until the mark (from step 4 above) is aligned with the mark that is 180° from the original reference mark.

7. Install the combination gear previously removed.

8. Install the belt retaining washer, large drive gear, and spacer, then secure with the 7/16" nut previously removed.

9. Install the drive belt onto the drive pulleys, gently working the belt over the gear cogs.

10. Install the Arm Lamp card and secure with the two screws previously removed.
11. While gently holding the ends of the RF shield apart, slide the shield onto the head assembly. Ensure that the RF shield is properly secured to the mounting pins before fully seating.

12. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

13. Route the internal head cable and position the cable connector on the mounting bracket of the RF shield case. Secure the connector to the bracket with the two standoffs previously removed.

14. Install the Keypad Overlay and PC card.

15. Position the bottom cover on the assembly.

16. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

17. Install the Armed Indicator lens and motor knob.

18. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

19. Connect the injector head cable to the mating connector in the injector head and secure the connection screws.

20. Install the injector head cable access plate and secure with the two screws previously removed.

   **NOTE:** These screws *must* be no longer than 1/4” (6.3 mm) in length.

21. Recalibrate the head potentiometers using the calibration kit available from MEDRAD. Call MEDRAD Service for details.
INJECTOR HEAD - Front Seal

Front Seal Removal

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   NOTE: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

5. Remove the Keypad Overlay PC card.

6. Remove the screws that secure the internal head cable to the RF shielding case.

7. *(If applicable)* Slide the internal head cable wires from the recess on the edge of the rear plate.

8. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, slide it over the rear plate to remove from the head.

9. Using a long shaft phillips head screwdriver, remove the front cap from the assembly by removing the five front cap mounting screws.

   NOTE: With the five mounting screws removed, the front cap may require a slight pull to remove from the head assembly.

10. If necessary, remove the syringe sensor plate by gently prying with a flat blade screwdriver from both sides of the recess.

11. Carefully note the orientation of the seal in the syringe interface plate, then, with a small flat blade screwdriver, pry the seal from the assembly.
INJECTOR HEAD - *Front Seal (cont.)*

**Front Seal Replacement**

1. Install the replacement seal in the syringe interface plate as oriented in the removal procedure above.

2. Install the syringe sensor plate in the front plate of the head assembly, ensuring that the holes in the plate line up with the syringe size sensors.

3. Position the front cap assembly on the head assembly and secure with the five screws previously removed.

4. Re-position the RF shield on the head assembly, securing the top of the shield over the two mounting pins (one each on front and rear plates), then snapping the bottom edge into position.

5. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

6. Route the internal head cable and position the cable connector on the mounting bracket of the RF shield case. Secure the connector to the bracket with the two standoffs previously removed.

7. Install the Keypad Overlay and PC card.

8. Position the bottom cover on the assembly.

9. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

10. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

11. Connect the injector head cable to the mating connector in the injector head and secure the connection screws.

12. Install the injector head cable access plate and secure with the two screws previously removed.

**NOTE:** These screws *must* be no longer than 1/4” (6.3 mm) in length.
INJECTOR HEAD - Syringe Size Sensors

Syringe Size Sensor Removal

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its’ internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   NOTE: Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover, then remove the bottom cover from the assembly.

5. Remove the Keypad Overlay PC card.

6. Remove the screws that secure the internal head cable to the RF shielding case.

7. (If applicable) Slide the internal head cable wires from the recess on the edge of the rear plate.

8. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, slide the case over the rear plate to remove from the head.

9. Using a long shaft phillips head screwdriver, remove the front cap from the assembly by removing the five front cap mounting screws.

   NOTE: With the five mounting screws removed, the front cap may require a slight pull to remove from the head assembly.

10. If necessary, remove the syringe sensor plate by gently prying with a flat blade screwdriver from both sides of the recess.

11. Note the orientation of the sensor flex circuit, disconnect the defective syringe sensor from the appropriate connector on the SSB card, then remove the sensor from the front plate.
1. Apply high vacuum grease to the replacement sensor around the surface shown.

2. Install the replacement sensor in the front plate. Be sure to observe proper orientation of the cable.

3. Install the syringe sensor plate in the front plate of the head assembly.

4. Position the front cap assembly on the head assembly and secure with the five screws previously removed.

5. Re-position the RF shield on the head assembly, securing the top of the shield over the two mounting pins (one each on front and rear plates), then snapping the bottom edge into position.

6. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

7. Route the internal head cable and position the cable connector on the mounting bracket of the RF shield case. Secure the connector to the bracket with the two standoffs previously removed.

8. Install the Keypad Overlay PC card.

9. Position the bottom cover on the assembly, then position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

10. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

11. Connect the injector head cable to the mating connector in the injector head and secure the connection screws.

12. Install the injector head cable access plate and secure with the two screws previously removed.

**NOTE:** These screws must be no longer than 1/4” (6.3 mm) in length.
**INJECTOR HEAD - Syringe Sensor (SSB) Card**

**SSB Card Removal**

1. Remove the two screws that secure the injector head cable access plate, then remove the access plate from the injector head.

2. Loosen the two screws that secure the injector head cable to its internal mating connector, then disconnect the cable.

3. Carefully remove the five screws that secure the head covers, then remove the top cover from the assembly.

   **NOTE:** Ensure that the bottom cover does not fall from the injector head if working with the injector head on the pedestal support arm.

4. Remove the screw that secures the HHC card to the bottom cover.

5. Remove the bottom head cover from the assembly.

6. Remove the Keypad Overlay and PC card.

7. Remove the screws that secure the internal head cable to the RF shielding case.

8. *(If applicable)* Slide the internal head cable wires from the recess on the edge of the rear plate.

9. Release the bottom of the RF shield, then remove the shield from the mounting pins above the PC boards. While gently holding the ends of the RF shield apart, slide the case over the rear plate to remove from the head.

10. Carefully remove the SSB card from the head assembly.

11. Disconnect the ribbon cable from the SSB card at P/J522.

12. Disconnect the syringe size sensors from the SSB card at Ziff connectors P/J510 through P/J513.
SSB Card Replacement

1. Connect the syringe size sensors at P/J510 through P/J513 on the replacement SSB card.

2. Connect the interconnect ribbon cable at P/J522 of the SSB card.

3. Carefully slide the replacement SSB card into the slots on the alignment bar.

4. Re-position the RF shield on the head assembly, securing the top of the shield over the two mounting pins (one each on front and rear plates), then snapping the bottom edge into position.

5. *(If applicable)* Route the internal head cable wires through the recess on the edge of the rear plate.

6. Route the internal head cable through the bracket on the RF shield case and secure to the bracket with the two standoffs previously removed.

7. Install the Keypad Overlay PC card.

8. Position the bottom cover on the assembly.

9. Position the HHC card in the bottom cover recess. Ensure that the connectors seat properly and completely into the recesses. Secure with the screw previously removed.

10. Ensure that the Armed Indicator lens is properly positioned in the keyed cover recess (keys at the 3 and 9 o’clock positions). Carefully position the top head cover on the head assembly, then secure the head covers with the five screws previously removed.

11. Connect the injector head cable to the mating connector in the injector head and secure with the connection screws.

12. Install the injector head cable access plate and secure with the two screws previously removed.

**NOTE:** These screws *must* be no longer than 1/4" (6.3 mm) in length.
Remote Monitor - *Cable*

**Cable Removal**

1. Disconnect the cable from the Power Supply at connector P/J301.
2. Remove the four screws that secure the rear cover, then lift the cover from the assembly.
3. Remove the mounting screws then disconnect the cable from P/J200.

**Cable Replacement**

2. Install the rear cover and secure with the four screws previously removed.
**Overlay Switchcard Removal**

1. Remove the four screws that secure the rear cover, then lift the cover from the assembly.

2. Disconnect the cable from P/J200.

3. Lift the cover of the RF Shield upward to remove.

4. Remove the two screws that secure the upper end of the CPU card.

5. Remove the two standoffs that secure connector P/J200 to the RF shield.

6. Loosen (do not remove) the heat sink screw.

7. Lift the CPU card from the assembly (with overlay cable still connected).

8. Disconnect the overlay cable at connector P/J3.

9. Disconnect the ground strap from the RF shield ground post.

10. Carefully peel the adhesive overlay from the assembly.

11. Remove the Overlay Switchcard.

**Overlay Switchcard Replacement**

1. Route the overlay connector and ground strap of the replacement Overlay Switchcard through the slot in the top cover. Remove the adhesive backing from the overlay, and carefully position on the top cover.

2. Remove the adhesive backing from the overlay and carefully position on the top cover, ensuring that the overlay adheres properly.

3. Connect the overlay ground strap to the RF shield ground post.

4. Connect the overlay cable to P/J3 on the CPU card.

5. Carefully position the CPU card in the assembly. Ensure that the card is fully seated, with connector P/J201 making proper contact, and that the heat sink mounting screw is properly positioned.
Remote Monitor - *Overlay Switchcard (cont.)*

6. Secure connector P/J200 to the RF shield with the two standoffs previously removed.

7. Secure the CPU card to the assembly by installing the two screws previously removed from the upper end of the card.

8. Install the cover of the RF shield can.

9. Connect the Remote Monitor cable at P/J200 and secure with the two screws previously removed.

10. Install the rear cover and secure with the four screws previously removed.
Remote Monitor - *PC Cards*

**Card Removal**

1. Remove the four screws that secure the rear cover, then lift the cover from the assembly.

2. Disconnect the cable from P/J200.

3. Lift the cover of the RF Shield upward to remove.

4. Remove the two screws that secure the upper end of the CPU card.

5. Remove the two standoffs that secure connector P/J200 to the RF shield.

6. Loosen (do not remove) the heat sink screw.

7. Lift the CPU card from the assembly (with overlay cable still connected).

8. Disconnect the overlay cable at connected P/J3.

9. Remove the CPU card from assembly.

*To Remove the Display Card:*

10. Using a 1/4” nut driver, disconnect the ground strap from the RF shield.

11. Remove the four standoffs that secure the RF shield and Display card to the assembly, then remove the RF shield.

12. Lift the Display card from the assembly.
Card Replacement

1. Position the Display card in the assembly.

2. Install the RF shield and secure with the four standoffs previously removed.

3. Connect the ground strap to the RF shield.

4. Connect the overlay cable to P/J3 on the CPU card.

5. Carefully position the CPU card in the assembly. Ensure that the card is fully seated, with connector P/J201 making proper contact, and that the heat sink mounting screw is properly positioned.

6. Secure connector P/J200 to the RF shield with the two standoffs previously removed.

7. Secure the CPU card to the assembly by installing the two screws previously removed from the upper end of the card.

8. Install the cover of the RF shield can.


10. Install the rear cover and secure with the four screws previously removed.
Remote Monitor - Covers

Cover Removal

1. Remove the four screws that secure the rear cover, then lift the cover from the assembly.

   *If only the bottom cover is being replaced, skip to Step 10 of the Replacement procedure*

2. Disconnect the cable from P/J200.

3. Lift the cover of the RF Shield upward to remove.

4. Remove the two screws that secure the upper end of the CPU card.

5. Remove the two standoffs that secure connector P/J200 to the RF shield.

6. Loosen (do not remove) the heat sink screw.

7. Lift the CPU card from the assembly (with overlay cable still connected).

8. Disconnect the overlay cable at connector P/J3.

9. Remove the CPU card from assembly.

To Remove the Display Card:

10. Using a 1/4” nut driver, disconnect the ground strap from the RF shield.

11. Remove the four standoffs that secure the RF shield and Display card to the assembly, then remove the RF shield.

12. Lift the Display card from the assembly.
Remote Monitor - **Covers (cont.)**

**Cover Replacement**

*If the top cover is being replaced, a replacement keypad Overlay Switchcard must be installed. Refer to the procedure on Page 4 - 26.*

1. Position the Display card in the assembly, then install the RF shield and secure with the four standoffs previously removed.

2. Connect the ground strap to the RF shield.

3. Connect the overlay cable to P/J3 on the CPU card.

4. Carefully position the CPU card in the assembly. Ensure that the card is fully seated, with connector P/J201 making proper contact, and that the heat sink mounting screw is properly positioned.

5. Secure connector P/J200 to the RF shield with the two standoffs previously removed.

6. Secure the heat sink screw.

7. Secure the CPU card to the assembly by installing the two screws previously removed from the upper end of the card.

8. Install the cover of the RF shield can.


10. Install the rear cover and secure with the four screws previously removed.
SPC - Power Supply

Power Supply Removal

1. Disconnect the system from the AC power source.
2. Remove the six screws that secure the top cover to the Power Supply case, then remove the cover.
3. Carefully disconnect connectors P/J1 and P/J3 from the power supply.
4. Remove the four screws that secure the power supply from the underside of the case.
5. Note the orientation of the power supply in the housing, then carefully remove the power supply.

Power Supply Replacement

1. Position the replacement power supply in the housing, then carefully secure with the four mounting screws previously removed from the underside of the housing.
2. Connect power supply connectors P/J1 and P/J3.
3. Position the top cover on the Power Supply housing, and secure with the six screws previously removed.
SPC - Power Switch

Power Switch Removal
1. Disconnect the system from the AC power source.
2. Remove the six screws that secure the top cover to the Power Supply case, then remove the cover.
3. Remove the wire tabs from the terminals on the rear of the power switch.
4. Remove the power switch by squeezing the locking flare tabs and pushing the switch out of the case.

Power Switch Replacement
1. Install the replacement power switch with the “OFF” position toward the edge of the power supply housing. Press firmly to ensure that the locking flare tabs snap into place.
2. Connect the wire tabs to the rear of the power switch as follows:

![Power Switch (Rear View)](image)

3. Position the top cover on the Power Supply housing, and secure with the six screws previously removed.
SPC - Interface Card

**Interface Card Removal**

1. Disconnect the system from the AC power source.
2. Remove the six screws that secure the top cover to the Power Supply case, then remove the cover.
3. Disconnect all cables from the rear of the Power Supply case.
4. Disconnect the connector at P/J3 on the Interface card.
5. Remove the Interface card from the assembly by removing the six screw locks that secure the PC board to the assembly.

**Interface Card Replacement**

1. Install the replacement Interface card, and secure with the six screw locks previously removed.
2. Restore the cable connection at P/J3 on the Interface card.
3. Position the top cover on the Power Supply housing, and secure with the six screws previously removed.
4. Restore all cable connections at the rear connector panel of the Power Supply case.
5. Restore AC power to the system.
5 Theory of Operation

The Injector Head contains the following primary components:

- Power Control Unit (PCU)
- Main Processing Unit (MPU) CPU card
- Display Processing Unit (DPU) CPU card including Display Panel Overlay
- Heater/Handswitch card (HHC)
- Syringe Sensor card (SSB)
- Light card
- Syringe Sensors
- System drive components - Motor, Piston, Ballscrew, Belt
- Supporting electrical components - Encoder, Pots
- Syringe Media Heat Maintainer
- External conventional hand switch (optional)

The Injector Head Display Panel provides the following information:

- Phase (system supports up to 4 phases)
- Flow Rate
- Phase Volume
- Phase Duration
- Pressure Limit (in either PSI or kPa),
- Scan Delay (0 - 99 seconds)
- Syringe Volume - Autofill Volume

The Injector Head Display Panel also allows for manual loading with forward and reverse softpots, requests for Summary display (total volume and duration for all phases), Fill Select, Autofill, Retract, Start/Hold, Single/Multi Inject Mode, Arm, Disarm/Reset, and Standby.

The Power Supply provides the Injector Head and Intelligent Hand Unit* (IHU) with a constant DC voltage supply. It can be located up to 100 feet (30.5 m) from either the injector head or the IHU.

* The Remote Monitor is referred to as the Intelligent Hand Unit (IHU).

The IHU display allows the user to view the injection program through a simple keypad and display with sound capabilities. The IHU can also start and hold the injection, and disarm the injector if required.
Modes of Operation

Power Up

The system power switch is located on the power supply. This switch enables or disables power to all system components. A standby switch on the Head disables functions of certain components, but keeps power supplied to all system microprocessors.

When the main power switch is on, power is applied to all system electrical components. The MPU and DPU microprocessors are completely independent of each other; one is not designated to start before the other. Once logic power is applied to all microprocessors and other components, software controls the power-up sequence.

System Reset

There are several methods to reset the three separate CPUs and hardware devices in the MEDRAD Vistron CT system. One microprocessor and other hardware devices reside on each MPU, DPU, and IHU card.

<table>
<thead>
<tr>
<th>Reset Method</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power On Reset</td>
<td>On power up, each of the three CPUs and PLD/Memory ICs are issued a reset by individual resistor-capacitor networks on their respective reset input pins.</td>
</tr>
<tr>
<td>2</td>
<td>Exiting a Standby State (Master Reset)</td>
<td>If a user momentarily presses the “Standby” key on the front panel overlay, and the system was in the “Standby” state set by a previous press, the MPU and DPU CPUs and PLD/Memory IC devices are issued a reset.</td>
</tr>
<tr>
<td>3</td>
<td>IHU Reset</td>
<td>If communication is lost between the MPU and the IHU for a period of 1 second, the IHU CPU and PLD/Memory IC will remain in a reset condition. The reset will be taken away (deasserted) when communications have been reestablished.</td>
</tr>
<tr>
<td>4</td>
<td>Low AC Line Voltage (Brown Out)</td>
<td>The IHU, DPU, and MPU will reset if the +30V supply drops to approximately 27VDC. The 30V supply will drop with a temporary loss of AC mains. An AC Main drop of 200 milliseconds or greater can trigger a system reset.</td>
</tr>
<tr>
<td>Mode</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Cold-Boot</strong></td>
<td>When executing, the PLD/Memory IC open drain output is set low. The processors go through their internal reset sequence.</td>
<td></td>
</tr>
<tr>
<td><strong>Active Mode</strong></td>
<td>After the boot process is complete, if a Standby key press of at least 3 seconds is detected at the MPU, a software suspended operation begins: disabling active functions, turning off the syringe heater, blanking the displays, etc. When the suspend operation completes, the PLD/Memory IC open drain port floats high, enabling the reset ability of the Standby key.</td>
<td></td>
</tr>
<tr>
<td><strong>Standby Mode</strong></td>
<td>When in the standby mode, the PLD/Memory IC open drain is set high, enabling the Standby button to force a master reset to both the MPU and DPU processors. This starts a cold boot process in both processors, clearing any states or modes that are currently active.</td>
<td></td>
</tr>
</tbody>
</table>
Power Distribution

Source voltage of 100-240 VAC @ 50/60 Hz is converted to +30 VDC by the Power Supply Box to supply the MEDRAD Vistron CT system. The +30 VDC power is routed to the Remote Monitor and the Injector Head through their respective cables. Inside the Injector Head, +30V goes to the MPU, then to the Power Control Unit (PCU). The PCU produces selected MPU DC voltage supplies. These include +15V, +24VL, -15V and +5V-MPU, for use throughout the system. The MPU maintains a +5 volt supply (+5V-REF). The DPU also receives +30V (via the MPU) and maintains +5 volt supply (+5V-DPU) and +5 volt reference (+5REF-DPU). The IHU receives +30V directly from the Power Supply Box to produce +5V-IHU.

Input voltage for the table below is +30V from the Power Supply Box.

<table>
<thead>
<tr>
<th>Voltage (Tolerance)</th>
<th>Origin</th>
<th>Card(s) Used</th>
<th>Circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td>+30V</td>
<td>Main Power Supply</td>
<td>All Cards and IHU</td>
<td>H-bridge source (+30LT); Safe Relay; Brown-out circuits on DPU and IHU; Input for all DC-DC converters</td>
</tr>
<tr>
<td>+5V-DPU (+0.25V)</td>
<td>DPU</td>
<td>DPU</td>
<td>DPU Logic Circuits (CPU, EPROM, etc.)</td>
</tr>
<tr>
<td>+5VREF-DPU (+0.25V)</td>
<td>DPU</td>
<td>DPU</td>
<td>Analog Reference to the Processor; Forward and Reverse soft pots</td>
</tr>
<tr>
<td>+15V (±0.25V)</td>
<td>PCU</td>
<td>MPU</td>
<td>Motor Current Amp (+) supply, Analog Multiplexer, Buffers/Inverters</td>
</tr>
<tr>
<td>+5V-MPU (+0.25V)</td>
<td>PCU</td>
<td>MPU</td>
<td>MPU Logic Circuits (CPU, EPROM, Encoder A and B etc.)</td>
</tr>
<tr>
<td>+30VB (+40V to +45V)</td>
<td>PCU</td>
<td>MPU</td>
<td>H-Bridge FET control voltage (when armed or loading)</td>
</tr>
<tr>
<td>-15V (-8V to -15V)</td>
<td>PCU</td>
<td>MPU</td>
<td>Motor Current Amp (–) supply, Analog Multiplexer, Buffers/Inverters</td>
</tr>
<tr>
<td>+24VL (+22V to +25V)</td>
<td>PCU</td>
<td>HHC</td>
<td>Current Limited by 500 mA PTC.; Syringe Heater, Handswitch Lamp</td>
</tr>
<tr>
<td>+5V-REF (+0.025V)</td>
<td>MPU</td>
<td>MPU</td>
<td>Supply for Head Pots A and B: Analog Reference to the Processor</td>
</tr>
<tr>
<td>+5V-IHU (+0.25V)</td>
<td>IHU</td>
<td>IHU</td>
<td>IHU Logic Circuits (CPU, EPROM, etc.)</td>
</tr>
<tr>
<td>DC Grounds</td>
<td>Several DC grounds are used throughout the system to provide noise immunity. These grounds occupy different areas of the circuit boards, and are tied to one common location on the MPU card.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Digital ground is typically used to ground system logic components, such as the microprocessors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Analog ground, used on voltage sensitive circuits, is designed to eliminate current loops that may cause offsets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hi-current ground is designed to provide an independent ground path (not isolated) for high power devices.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Earth ground is located only at the Power Supply, and is not available at the Injector Head or IHU.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Common System Functions

**Static Protection**  
The MPU, DPU, and IHU boards use the SP720 ESD arrester to protect specific signals from static interference when power is applied. ESD protection is provided to external and sensitive signals to prevent transients from causing injector malfunction.

**System Communications**  
Communication channels exist between the MPU and DPU, and the MPU and IHU. The RS422 protocol is used, running at 19.2K Baud.

Each CPU on the MPU, DPU and IHU obtain timing from their own individual crystals. Communication channels verify timing through communication port synchronization, comparing time bases with communication watchdogs, thus allowing confirmation that all processors are running on the correct time basis.

The IHU provides a unique signal (IHU FAULT #). This signal is asserted if an IHU overlay button is pressed and no communication is received from the IHU. This fault signal opens the safe relay via a hardware path on the MPU, disabling power to the motor.

**Background Monitoring**  
The MPU and DPU are capable of monitoring critical signals. One processor may originate a signal while the other monitors the signal. The monitored signal is a separate signal derived from the control signal. The derived signal originates from the control signal, and is limited by a resistor. This resistor allows the control signal voltage to be monitored, while preventing the derived signal from impacting the device being monitored.
Power Control Unit (PCU)

Diagram:

1. +5V SWITCHING VOLTAGE REG. U2
2. +15V SWITCHING VOLTAGE REG. U1
3. DRIVER/OSCILLATOR U3
4. VOLTAGE BOOST CHARGE PUMP
5. NEGATIVE VOLTAGE CHARGE PUMP
6. SWITCHING VOLTAGE REG. U4
7. THERM 65°C
8. +30V (from Power Supply Box via MPU)
9. +5V-MPU (to MPU)
10. +15V (to MPU)
11. +30VB (to MPU)
12. SW30VS (from MPU)
13. −15 V (to MPU)
14. +24VL (to HHC and Arm Light via MPU)
15. V2P24L-SHDN (from MPU)
16. VP30-SRL (to MPU)
**Power Control Unit (PCU)**

This card, mounted below the MPU, contains all circuitry required to power the MPU card. The PCU contains all of the MPU regulators: 5 volt (+5V-MPU), +15, -15, +24VL and +30VB (FET Boost Voltage).

The PCU has a thermal switch on the VP30-SRL line which opens at 65°C (149°F), disabling power from the high side of the safe relay, preventing motor operation until the temperature in the head is reduced to approximately 40°C (104°F).

**+15 Volt Supply**  
The +15 volt circuit is designed to supply various ICs on the MPU, including MC34152P driver for the lower H-Bridge FETs. The +15V supply is generated from the 30V main supply using a +15 volt switching regulator.

**+30 Volt Boost Supply (+30VB)**  
The upper H-bridge FETs, which control motor velocity, require a boost voltage of +45 volts. To accomplish this, a charge pump on the PCU card adds +30 volts to the +15 volt supply. This charge pump circuit, running at 500 KHz, uses two drivers as an oscillator/driver, generating the sum of +30 and +15 volts for the total required voltage. Boost voltage is switchable between +45V and +15V, controlled by the MPU Load-Enable signal.

A boost voltage is needed to activate the H-bridge FET gates. All FETs in the H-bridge are N channel FETs, two of which are followers. Typically the gates should run 8 volts greater than the supply voltage when followers are being used. A gate-source of greater than 4 volts above the supply voltage ensures a minimum amount of voltage drop over the H-bridge. There is a 2 to 4 volt drop across a FET because of the gate-to-source threshold in a follower configuration. The boost voltage ensures that when the FETs are in follower mode, that the FETs on the high side drop the minimal amount of voltage (saturation).

This same charge pump circuit also supplies -15 volts. An inverter taps off the boost oscillator. It is used by the motor current amp, multiplexer, and comparator on the MPU card.

**+5 Volt Logic Supply (+5V-MPU)**  
Conversion circuitry is located on the PCU card. The logic supply is generated from the main supply of +30 VDC through a +5 volt switching regulator. The resulting voltage is known as +5V-MPU, indicating that the voltage originated and is used by the MPU.
There are also a +5V-DPU and +5REF-DPU supply voltage generated on the DPU card. In addition, there is a +5V-REF generated on the MPU.

**+24 Volts Limited Supply (+24VL)**

Twenty-four volts (+24VL) is provided to drive the syringe heater and conventional hand switch lamp. The +24 volt supply is generated on the PCU card from the system +30 VDC through a current-limiting regulator. Current is limited to 1 amp so that at +24 volts there is a maximum of 24 watts output.

An additional PTC resistor is in series with +24V as a secondary limit, limiting current at 500 mA. This resistor activates within five seconds of a current greater than 500 mA, and will reset when the short circuit is removed, thus limiting output power to peripherals. The resulting voltage is known as +24VL. This circuit uses a high current ground.

A digital shutdown signal for the +24VL supply (VP24-SHDN) is provided by the MPU’s second PLD/Memory IC on Pin 8 of Port B. This control provides shut down of the regulator during Standby operation to remove power from the syringe heater and the handswitch lamp*.

* During Standby, the Displays also turn off via DPU commands.
Main Processing Unit (MPU)

The MPU, located in the injector head, is responsible for communicating to both the DPU and IHU. The heart of the MPU is the Intel 80196KC microprocessor, which:

- houses two Wafer Scale Integration (PLD/Memory) ICs; one contains MPU software and I/O, the second is used for I/O and syringe sensor decoding
- executes the digital servo application and controls current output to the injector head piston motor
- processes commands and formats data for the service access port
- monitors vital system status information and communications
- stores MPU and IHU error log information
- distributes power to the system
- provides power to the piston motor
- controls activation of the safe relay (low side)
- determines syringe size sensing
- detects presence and operation of conventional hand switch
- maintains and controls absolute position of the piston
- controls injection pressure limiting (primary and back-up)
- stores potentiometer and pressure constants
- processes encoder information for motor control
Main Processing Unit (MPU) - Motor Control
The microprocessor requires +5VDC for logic processing, operates at 11.053 MHz, contains 512 bytes of RAM, and provides:

- a 16-bit address space
- a serial port
- an 8-channel sample-and-hold A/D converter to monitor reference voltages

<table>
<thead>
<tr>
<th>Analog Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 [POTA]</td>
<td>Position Pot A (one of two absolute position feedback mechanisms)</td>
</tr>
<tr>
<td>1 [VP30S]</td>
<td>Switched 30 volts H-Bridge supply (through safe relay) monitored as safety backup of relay.</td>
</tr>
<tr>
<td>3 [ACH3]</td>
<td></td>
</tr>
<tr>
<td>4 [POTB]</td>
<td>Position Pot B (absolute position of feedback)</td>
</tr>
</tbody>
</table>
| 5 [ACHMUX]     | S1 - MFG-LPBK (for Manufacturing use)  
|                | S2 - VP24L(+24V limited)*  
|                | S3 - VP15 (+15V)*  
|                | S4 - VN15(-15V)*  
|                | S5 - VP01 (+2.5V ref.)  
|                | S6 - DAC-MPU (linearity test)*  
|                | S7 - VP05 (+5V logic)*  
|                | S8 - VP30VB (boost voltage)*  
|                | * Divided by resistors |
| 6 [IMOTOR]     | Motor output current used for pressure feedback. |
| 7 [VP30-MPU]   | VP30 monitored for under or over voltage conditions. |

- a high speed I/O unit
- a pulse width modulator unit (PWM) for motor control
- 8-bit digital I/O ports
- ALU register and interrupt handling services.
Communication Ports

The MPU uses an external DUART to communicate to both the IHU as RS-422, and the DPU as logic level. The MPU also utilizes an internal UART to communicate, via RS232, to the Manufacturing Port (MFG-TXD-RS232). The external DUART transmits and receives at a rate of 19.2K Baud.

+5 Volt Reference Supply (+5V-REF)

The analog circuitry of the MPU requires a +5 volt reference (+5VREF). It provides the accuracy for the plunger pots, plunger pot readings, supply voltage measurements and pressure settings. The +5VREF voltage is generated from the +30 VDC supply by a +5 volt reference regulator on the MPU card.

Bus Signals

The CPU address and data are shared on a common bus. During read and write external bus cycles, the address is presented first, latched by the ALE (Address Latch Enable), then the data is presented. During the data portion of the cycle, the read or write control is asserted to direct data flow.

- Address Bus - Lo: The low 8 bits of the multiplexed address and data to and from the CPU
- Address Bus - Hi: The upper 8 bits of the multiplexed address and data to and from the CPU
- Control Bus: Read and write de-multiplexing control of CPU and Memory I/O
- LA (Latched Address) Bus: De-multiplexed address for peripheral register decoding.

Load Controls

The Forward and Reverse load controls that control manual motor positioning are primarily monitored by the DPU.

Motor Current Monitoring

This circuit is responsible for monitoring syringe pressure. This primary channel uses two op amps for filtering and gain. A 0.1 ohm resistor is the normal current sampling resistor used during an injection. This configuration will yield a 0.1V per amp. The resulting current is fed to the first stage of the op amp filter, which has a gain of 10 with an integrator. The cut off frequency for the filter is approximately 159 Hz. The switching frequency off the servo is approximately 21 KHz. The output of the first stage is 1V/amp. The second stage has a 1.59 KHz cut off frequency and is a follow-up filter with a gain of 1 (one). Any remaining ripple from the servo should be removed by the second stage.

A series resistor is added to the output amp to limit current. The motor current is run through static protection where it is clamped at 5 volts from analog ground. A 0-5 volt signal will be approximately 0-5 amps, or 0-500 psi.
A current source circuit feeds the current sampling resistor, and provides a 100 milliampere offset to the current monitoring op amps. The source circuit also provides a check against the 0.1 ohm resistor when switching resistors in and out during current monitoring. It confirms that the 0.1 or 1 ohm resistor is in the circuit when appropriate, and is used to determine if a short exists on the low side current sampling, (the motor lead externally is shorted from the card). If current source reads less than 100 milliamps, a short exists. Even without motor output, the current source offset is present and continuously monitored.

**Motor Control**

Two microprocessor digital I/O bits are used to control motor direction via a DC voltage, while two others, connected internally to the PWM unit of the microprocessor, provide a chopped duty cycle (PWM) that controls motor velocity. For each PWM duty cycle, there is a corresponding motor velocity.

The motor is connected to the piston through gearing. The encoder is attached to the motor shaft, and provides counts to the decoders on the MPU and DPU. The counts represent position change. Two position pots (A and B) are attached to the motor through a second set of gears. Pot voltage is fed to the MPU microprocessor’s A/D, representing piston position.

The MEDRAD Vistron CT system uses four power FETs in an H-Bridge configuration to drive the motor. The two upper FETs control velocity via PWM from the Processor. The lower two FETs control direction. A safe relay switches the motor supply (+30 Volts) which supplies the top of the H-Bridge. A load resistor, PTC element, and blocking diode, are in series with the relay and top of H-Bridge to allow a simulated test current. During Pre-Arm diagnostics, these components are shunted by another FET, controlled by Load-Enable during normal injection operation. The upper PWM FETs are controlled by pre-drivers that convert the processor outputs into a boost voltage to supply the FET gate inputs. The upper FETs also have circuitry that allow the gates to discharge rapidly, and protect from over voltage gate-source. The boost voltage that supplies the upper FET gates is switchable between +15V (nominal) and +45V (nominal). This is to allow reduced drive voltages during the Load Test State of the motor section.

The two lower FETs control the direction of the motor. They are controlled by a pre-driver IC supplied with +15 volts. These pre-drivers convert TTL voltage outputs from the processor into +15 Volt logic. The gates of the FETs have series termination resistance to reduce ringing in the gate drive waveform.

Surrounding the motor are four steering diodes that are responsible for directing motor current during non-commanded operation to flow through the sampling resistor. This allows a comparison of motor current and pressure in the syringe. There is also a MOV across the motor to prevent motor noise spikes from being generated.
The pre-drivers for the Forward and Reverse PWM FETs operate in the following manner:

A high level from the processor, which commands a move, is inverted by the high current driver IC supplied with +15 Volts. The low output of the driver IC activates the common base NPN transistor (due to its emitter being below the base by more than a diode drop). The current is limited by a series resistor which is shunted by a capacitor for increased AC or pulse operation. A diode in parallel with the emitter base is added to prevent the reverse breakdown of the transistor from being exceeded when the driver IC output is in the high state (+15V).

The NPN being active, activates the PNP transistor (due to the base of the PNP dropping below the emitter). Current can then flow from the +30 V supply through the limiting resistor, through the PNP transistor, through the series gate diode, and charge the FET internal gate capacitance (turning the FET on). A 15V zener diode is used to limit the gate to source voltage to 15V.

A low level from the processor yields +15V on the IC pre-driver output. This deactivates the NPN and PNP transistors, causing the base of the discharge transistor to drop below the emitter. Once this occurs, the discharge transistor activates, quickly discharging the gate capacitance to the source of the FET.

Safe Relay

One safe relay is used to switch +30 Volts to the H-Bridge. Multiple digital I/O port bits control the safe relay. One bit is electrically connected to the IHU, allowing the MPU to detect an IHU fault condition. An IHU fault will open the safe relay. By changing the state of these bits from high to low or low to high, the relay may be energized or de-energized as needed.

The relay is a mechanism used by the MPU, DPU and IHU to disable power to the motor if there is a failure. Both sides of the safe relay coil must be energized to supply an output voltage to the H-bridge motor. The +30 Volts switched by the contacts (VP30S) is monitored by both the MPU and DPU. The lower side of the safe relay is controlled by the MPU and IHU fault, the upper side by the DPU and over-current latch.

A secondary method is provided to determine if the safe relay is open or closed. It is SRL-INACTIVE which goes to both the MPU and DPU boards. Primary monitoring is on the actual analog voltage from the safe relay.
This design supports one safe relay and uses the Load Test to simulate pressure and over-pressure conditions. It also provides dynamic motor braking from the MPU, independent of safe relay control. Activating either the high or the low side of the bridge will shunt the motor, whether or not safe relay supplied power is available.

The safe relay has two transistor drives: the high side is controlled by the DPU and over-current latch; the low side is controlled by the MPU and IHU. The MPU sets the relay on; the DPU monitors that signal. The SRL-MPU signal is current limited with a resistor. The IHU has the ability to override the MPU signal if there is a key press fault. The FAULT# signal is conditioned by an opto to remove any DC voltage offsets introduced by cabling, before it is introduced into the low side drive override.

The high side control of the safe relay is controlled by the DPU. It runs through a current limiting resistor before going to an inverter transistor. The transistor inverter converts the TTL voltage from the DPU safe relay control signal (SRL-DPU) to +30 volts to match the high side safe relay control transistor.

A monitoring signal (SRL-DPUR) comes off the main DPU control signal. The MPU can monitor the state of the DPU signal, but cannot change it.

The current limiting resistor on the DPU control line is needed to support an OR circuit which permits an over-current signal to open (off) the safe relay through the DPU signal line. The over-current latch can override the DPU signal and open the safe relay independent of either MPU or DPU processor commands. The latch is driven by a generated over-current detection signal (describe below) and can be cleared with an over-current clear signal from the MPU processor.

During re-initialization, reset, or power-up, the latch can be cleared. Since this is an edge-triggered device, the clear command is only issued once. If the over-current condition remains, the latch will prohibit the safe relay from being closed (on). The output of the safe relay goes into the inverter and to the MPU. The signal to the MPU is limited by a resistor, preventing current override of the hardware in the event of an MPU failure. The output of the latch is also sent back to the DPU. The same design is used on the DPU: the signal goes through a resistor so the signal cannot be overridden, only monitored. The latch is powered by the DPU supply to isolate it from MPU failures.

The over-current detect circuit is powered by the DPU +5 volt supply, providing a secondary control channel if the primary circuit on the MPU fails (IMOTOR). This is a simple comparator which monitors the signals from the motor current op amps (1 volt per amp) and the signal from the DPU DAC signal. The DAC performs a DPU linearity test.
on arming, then sets to the preset current trip point, plus some tolerance value. For example, if the limit is 300 psi (equivalent to approximately 3.2 volts), the DAC will be set to 3.8 volts. The comparator is powered by the DPU supply to isolate it from MPU failures. The result of the comparator feeds the over-current latch, described above.

**Load Enable Test**

This circuit allows software to perform a reduced current test on the H-bridge FETs, and current monitoring checking to simulate full motor current.

In test mode, LOAD-ENABLE is asserted, opening the load resistor shunting FET which provides a simulated load of approximately one tenth of the motor resistance. LOAD-ENABLE also controls whether the +30V boost voltage (+30VB) for the H-Bridge drivers is +15V or +45V. LOAD-TEST is asserted to remove the shunting FET to provide a current sampling resistor 10 times greater than normal. ISAMPLE-TEST is asserted to introduce a small correction current to change the gain of the op amps.

The H-bridge and current path can now be tested at one tenth the power, while still testing the full range of the analog current path.

The load resistor is protected by a series connected PTC (positive temperature coefficient resistor) resistive element. If testing time is greater than 3 to 4 seconds, the PTC opens. In normal operation, the load resistor and higher value sampling resistor are shunted to provide normal current monitoring. In the event of a failure in the load test circuitry, performance would be degraded and detected.

LOAD-ENABLE is protected by an optical isolator. The opto/zener clamp, running off of Vboost controls the gate of the safe relay FET. When the FET is open, current flows through the load resistor, reducing the system current by a factor of 10. A PTC in series with the 75 ohm resistor limits the current if it exceeds current over time. For example, 300 milliamps are expected, but if present for 4-5 seconds, the circuit opens.

The motor typically uses 3.3 - 3.8 amps, to generate 300 psi. If there is a 30 volt supply and 3.3 amps, the motor acts like a 9-10 ohm resistor. If 3.3 amps are typically expected through the circuit, the load test should simulate a 0.33 amp load (30 volts and 75 ohms). A simulated full duty cycle linearity test on the bridge can be performed. One tenth the current is present. Therefore, on the load side in normal mode, the FET on the bottom is shunting the 1 ohm resistor. (10 ohm is now 1 ohm.) Sampling current at ground, the bottom side of the one tenth resistor and high side is on the top side of the one tenth op amp. Reading across one tenth resistor yields 1 amp. One amp equals one tenth volts x 10 equals 1 volt.
LOAD-ENABLE:

LOAD-ENABLE is generated from a WaferScale output on the MPU card. As its name implies, it is a high true signal. The WaferScale device configures this signal as a open drain output. On power-up, it floats to a high impedance state until it becomes initialized. Due to the external pull-up resistor on this pin, the output of the WaferScale will be high on power-up.

When the LOAD-ENABLE signal is high, the associated NPN transistor (U8) is on, the N-channel FET (Q12) is off, and the opto (U23) is on. With the FET off, the associated PNP transistor (Q11) is off, which removes the +30V supply to the boost circuitry on the PCU. In this case, the boost output supply is +15V. With the opto on, the FET that is across the load resistor is off due to no voltage from gate to source. With the FET off, the PTC and load resistor are in the circuit.

The circuitry was arranged in this manner to ensure that if, due to a processor failure or processor emulation, the bridge was inadvertently activated, lower currents would flow through the bridge.

With the load-enable signal low, the boost output voltage is +45V and the load resistor and PTC are shunted by the associated FET.

A/D Reference:

A precision +2.5 volt reference voltage is developed to verify that the A/D is reading properly.

Analog Multiplexor:

An analog multiplexor is in place to switch available analog channels for background monitoring by the microprocessor’s single internal A/D converter. The desired analog channel is selected by setting the select lines (A0-A2) to high. The resulting binary number selects the channel (S1-S8) to be read. The analog reading input is switched to the analog output and sent to the microprocessor A/D. Software can use this mechanism to periodically monitor the defined voltages. The multiplexor output (ACH-MUX) is a common analog channel, run through static protection. Most inputs are also static protected.

Syringe Detection:

The system is capable of detecting MEDRAD 200ml and 125ml disposables, pre-filled syringes, and the 100 ml adaptor plate. Four size sensors are used to provide signals from which the software can interpret the type of syringe loaded on the head. The 100 ml syringe adapter adds a 20 ml offset to compensate for the overall syringe length.

Each sensor is comprised of an emitter (LED) and a detector (photo transistor). When the operator rotates a syringe in the syringe interface adapter on the head, indents on the syringe force detection pins to move in or out. The emitter is blocked or open depending on the position of the pin. This is a static reading which assumes that the present position is the position during operation.
When a pin is “out”, light from the LED emitter passes directly to the photo receptor. The sensor is conducting and, therefore considered CLOSED. When a pin is “in”, light cannot reach the photo receptor. The sensor is not conducting, therefore it is considered OPEN. Because of this design, not only do the pins provide syringe information, they allow the size detection system to be tested.

If a pin is “out” and light passes through to the photo detector, it is possible to read it. Upon power up (with no syringe attached), through transistor logic, the microprocessor can turn the emitter on and off to verify operation of the output of the detector. The size detectors can then be read. The configuration of the detector readings determines if a syringe is place, and what size it is.

<table>
<thead>
<tr>
<th>Action</th>
<th>SENSOR (SLD A)</th>
<th>SENSOR (SLD B)</th>
<th>SENSOR (SLD C)</th>
<th>SENSOR (SLD D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No syringe; Cannot Auto-fill or Arm.</td>
<td>OUT</td>
<td>OUT</td>
<td>OUT</td>
<td>OUT</td>
</tr>
<tr>
<td>Pre-filled Syringe</td>
<td>OUT</td>
<td>IN</td>
<td>IN</td>
<td>OUT</td>
</tr>
<tr>
<td>125 ml in use.</td>
<td>OUT</td>
<td>OUT</td>
<td>IN</td>
<td>OUT</td>
</tr>
<tr>
<td>200 ml in use.</td>
<td>OUT</td>
<td>IN</td>
<td>OUT</td>
<td>OUT</td>
</tr>
<tr>
<td>Partial syringe or error.</td>
<td>IN</td>
<td>IN/OUT</td>
<td>IN/OUT</td>
<td>IN/OUT</td>
</tr>
<tr>
<td>Adapter in place.</td>
<td>OUT</td>
<td>OUT</td>
<td>OUT</td>
<td>IN</td>
</tr>
</tbody>
</table>

- SENSOR SLD A = Pre-filled or Syringe In-Place
- SENSOR SLD B = MEDRAD 125 ml
- SENSOR SLD C = MEDRAD 200 ml
- SENSOR SLD D = MEDRAD 100 ml

Each detector is driven by the +5V-MPU supply voltage and connected through a pull-up resistor.

**Arm Light**

Three long life arm lights are located on the Lamp card in the Head. The bulbs are rated at 28 volts, and are socketed for accessibility.

**Piston Pots**

A piston potentiometer (MPU plunger pots) is gear driven from the ballscrew shaft, and supplies the piston’s absolute reference position (in terms of voltage) to the MPU processor. Pot voltages are terminated by pull down resistors, filter caps, and static protection, then are routed directly to the MPU CPU analog inputs.
Display Processor Unit (DPU)

This card resides in the injector head, above the MPU card. It is connected to the MPU card and Overlay, and is responsible for:

- houses a Wafer Scale Integration (PLD/Memory) IC which contains DPU software and performs I/O and keypad decoding
- displays software versions for the entire system
  - DPU - Flow Rate window
  - MPU - Duration window
  - IHU - Pressure Limit window (when present)
- back-up monitoring of encoder counts (piston position)
- stores and retrieves the last completed injection protocol information
- stores DPU error log information
- controlling activation of the safe relay (high side)
- set overpressure trip level for hardware pressure limit
- controlling segment and discrete LEDs on the overlay
- reading overlay keys, including FWD/REV load controls
- communicating to the MPU
- controlling the speaker.
Intel 80196KC Microprocessor

The microprocessor requires +5VDC for logic processing, and a 5 volt reference for the A/D converter. It operates at 11.053 MHz and has 512 bytes of register RAM. The microprocessor provides:

- a 16-bit external address space
- an internal serial port to communicate to the MPU
- an 8-channel, 10-bit sample-and-hold A/D converter to monitor reference voltages. If monitored voltages exceed a specified tolerance, the DPU detects failures or activity from peripheral devices.

<table>
<thead>
<tr>
<th>Analog Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Spare (to test connector)</td>
</tr>
<tr>
<td>1</td>
<td>[VP30S-DPU] +30 volt switched for monitoring</td>
</tr>
<tr>
<td></td>
<td>safe relay*</td>
</tr>
<tr>
<td>2</td>
<td>[SP-FWD] Forward Softpot Voltage</td>
</tr>
<tr>
<td>3</td>
<td>[SP-REV] Reverse Softpot Voltage</td>
</tr>
<tr>
<td>4</td>
<td>[VP01-DPU] +2.5 volt reference</td>
</tr>
<tr>
<td>5</td>
<td>[DAC-DPU] A/D linearity check voltage to</td>
</tr>
<tr>
<td></td>
<td>DPU DAC*</td>
</tr>
<tr>
<td>6</td>
<td>[VP05-DPU] +5 V DPU logic supply monitor*</td>
</tr>
<tr>
<td>7</td>
<td>[VP30-DPU] +30 VDC system power supply</td>
</tr>
<tr>
<td></td>
<td>voltage*</td>
</tr>
</tbody>
</table>

* Divided by resistors

- a speaker port, high speed I/O
- a keypad port, port 1 is input row matrix, part of PLD/Memory IC as output column
- safe relay control (high side)
- software driven SPI (Serial Peripheral Interface) port, driving the three wire SPI bus. The SPI bus allows the micro to communicate with the DPU DAC, serial EEPROMs, and display LEDs.
- I/O to monitor the status of the high pressure trip circuitry
- an ALU register and interrupt handling services.

**NOTE:** Many signals have a pull-up resistor on both the MPU and DPU, provided for board level testing, ESD protection, and termination.
<table>
<thead>
<tr>
<th><strong>Communications Port</strong></th>
<th>The DPU uses the microprocessor’s internal UART, a digital line, to communicate to the MPU.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>+5V Logic Supply (+5V-DPU)</strong></td>
<td>The DPU generates a local digital component +5 volt supply (+5V-DPU) from the +30V-DPU voltage via a 5 volt switching regulator.</td>
</tr>
<tr>
<td><strong>+5V Reference Supply (+5REF-DPU)</strong></td>
<td>A +5 volt analog reference (+5REF-DPU) is provided specifically for the DPU CPU and DAC. This ensures that the processor has an analog reference for the internal A/D. It is supplied by the +30V-DPU voltage, and uses +5 volt reference regulator on the MPU card. A precision +2.5 volt reference is provided to confirm A/D readings. It is supplied with the +30V-DPU voltage, with typical output of 2.5 volts.</td>
</tr>
<tr>
<td><strong>Serial E²PROM</strong></td>
<td>The serial E²PROM is used to store the last completed injection protocol. Memory is non-volatile 16-bit, and is accessed serially by clocking a 9-bit command instruction, followed by 16 bits of data in or out of the device. It is enabled by SPI-CS2 and SPI-CS3 chip selects. Provided commands are: read, write and erase. Erase and write times require 10 ms per access. The maximum clock transfer is 1 MHz.</td>
</tr>
<tr>
<td><strong>Soft Pots</strong></td>
<td>The Soft Pot switches used in MEDRAD Vistron CT are individual switches with binary weighting. The forward (extend) and reverse (retract) softpots allow the user to manually adjust the position of the piston for loading a syringe. Each voltage level for a given wiper position on the softpot corresponds to a motor velocity command. The soft pots are supplied by the +5V-DPU voltage.</td>
</tr>
<tr>
<td><strong>Safe Relay Control</strong></td>
<td>The DPU generates the signal SRL-DPU which is used to enable the high side drive MPU safe relay. The DPU also monitors the status of the MPU drive signal for the safe relay, SRL-MPU-R.</td>
</tr>
<tr>
<td><strong>Static Protection SP720</strong></td>
<td>All analog channels are protected against static build-up and over voltage when no power is applied to the card using 10K-33K pull downs. This protects sensitive signals during handling. ESD handling precautions should be observed when troubleshooting and replacing boards and components. The SP720 is really only effective while power is applied.</td>
</tr>
</tbody>
</table>
## Display
There are three display drivers: One controls the 3 Syringe Volume 7-segment LEDs and various discrete LEDs on the overlay. The second driver controls 4 Pressure 7-segment LEDs, 1 Phase 7-segment LEDs, and 3 Program Volume 7-segment LEDs. The third driver controls the 4 Duration 7-segment LEDs, 2 scan Delay 7-segment LEDs, and 2 Flow Rate 7-segment LEDs.

Each driver is supplied by +5V-DPU. The CPU SPI outputs control to each driver, arranged in a daisy-chain configuration. Write control only is provided. A 16-bit address/command and data pattern is clocked to the device for control. Commands include brightness, decoding, and sleep.

## Over Pressure Trip Circuitry
The DPU utilizes a digital potentiometer (DAC) which generates a voltage, DAC-DPU, that establishes a trip point for an overpressure comparator on the MPU card.

## Keypad
The keypad is located on the Head overlay. Signals from the keypad are static protected before reaching the CPU.

A 4 column (driven) by 8 row (input) keypad is used. The columns are controlled through Port B on the PLD/Memory IC. Typically, these pins are driven; however, they can be tested to verify their operation. The rows are controlled through Port 1 on the DPU CPU as an 8-bit read.

## Speaker
An electromagnetic, inductive speaker is attached to the high speed I/O port on the microprocessor to provide audible warning and error tones to the operator.

The processor provides a high speed output to the driver with variable frequency control. It can signal the user with different tones ranging between 20 Hz to 20 KHz (standard audible range). A different tone can be generated for different alert conditions. This overcomes the need to use multiple monotone beeps for alerts. Tones and tonal combinations will help the user readily identify a problem or condition. By varying the duty cycle (PWM) of the signal, volume can be controlled to high, medium, and low levels.

## DPU Low AC Line Voltage Detector (Brown-out)
An AC Main drop of 200 milliseconds or greater can trigger a system reset. The +30V supply will drop with a temporary loss of AC mains. This circuit will toggle the reset line (RESET-MSTR#) low to the DPU processor and the MPU if the +30V supply drops below 27VDC.
Intelligent Hand Unit (IHU)

The IHU, or Remote Monitor, is a hand-held unit that allows an operator to interact with the head without being near the head. The IHU CPU card resides in the IHU unit, and is responsible for:

- houses a Wafer Scale Integration (PLD/Memory) IC which contains IHU software
- detecting IHU keypad errors
- communicating with the MPU
- driving a speaker
- displaying injection parameters
- displaying post-injection results (Injected Volume and Injection Duration)
- injection Remote Start and Abort
- AutoLink control functions
Intelligent Hand Unit (IHU)
The microprocessor requires +5VDC for logic processing, operates at 11.53 MHz, and has 512 bytes register of RAM. It provides:

- a 16-bit address space,
- a serial port, to communicate to the MPU through an RS-422 link
- an 8-channel sample-and-hold A/D converter to monitor reference voltages

<table>
<thead>
<tr>
<th>Analog Channel</th>
<th>Signal Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>EXTIN</td>
<td>External Input</td>
</tr>
<tr>
<td>1</td>
<td>+2.5V</td>
<td>+5V Logic Reference divided by two</td>
</tr>
<tr>
<td>2</td>
<td>+2.7V</td>
<td>+30VDC Supply Reference divided by 11</td>
</tr>
<tr>
<td>3</td>
<td>+1.2V</td>
<td>1.23V A/D Reference</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Not Used</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Not Used</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>Not Used</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>Not Used</td>
</tr>
</tbody>
</table>

- 8-bit digital I/O ports
- 4 pins to implement the SPI bus. The SPI bus allows the microprocessor to communicate with the display drivers.
### Theory of Operation

<table>
<thead>
<tr>
<th>Keypad</th>
<th>There are two keypad switches on the IHU. The switches are START/HOLD and DISARM.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications Port</td>
<td>A RS-422 port from the microprocessor allows the IHU to communicate with the MPU. This connection allows the microprocessors in the IHU and the MPU to synchronize time bases and perform back up monitoring.</td>
</tr>
<tr>
<td>+5V Logic Supply (+5V-IHU)</td>
<td>The IHU generates a local digital component +5 volt supply (+5V-DPU) from the +30V-DPU voltage via a 5 volt switching regulator.</td>
</tr>
<tr>
<td>Keypad Fault Detection</td>
<td>The purpose of this circuit is to shut the injector unit down if the key board or IHU processor fails. Both the MPU and DPU monitor the FAULT# signal. If the FAULT# signal is generated from the IHU hardware, the Safe Relay on the MPU card is opened via hardware. In normal operation, when a key is pressed on the IHU overlay, a communication packet is sent to the MPU. The IHU processor also strobes a hardware circuit, disabling the FAULT# signal from being asserted. In a failure condition however, if the IHU processor does not respond to an overlay key depression within 22 mS, the FAULT# signal will be enabled and allowed to be asserted to the MPU. If the +5V supply fails, the Fault# will also be asserted.</td>
</tr>
<tr>
<td>Speaker</td>
<td>This is the same circuit used on the injector head DPU.</td>
</tr>
<tr>
<td>Reset</td>
<td>The IHU utilizes a timing monostable (one-shot) that is triggered by MPU communications. If communications are lost for 1 second, the circuit will time out and issue a reset to the IHU CPU. The CPU will remain in the reset state until communications are re-established.</td>
</tr>
<tr>
<td>IHU Low AC Line Voltage Reset (Brown-out)</td>
<td>An AC Main drop of 200 milliseconds or greater can trigger a system reset. The +30V supply will drop with a temporary loss of AC mains. This circuit will toggle the reset line low to the IHU processor if the +30V supply drops below 27VDC.</td>
</tr>
</tbody>
</table>
AutoLink Interface - ISI

The Vistron CT AutoLink Interface board (ISI) resides within the Vistron CT Power Supply Module. The board acts as an interconnect card for the injector head and IHU modules, and provides an isolated interface connection between the Vistron CT injector and a compatible CT Scanner. The interface consists of one input and one output to the scanner. The input is comprised of two signal lines, and the output is comprised of three signal lines, with all lines fully isolated to provide protection to both the injection system and the scanner. Physical connection to the scanner is provided through the J302 connector. The ISI board is controlled by the IHU through the BITENABLE# / ISI-OUT# and EXTIN1 / ISI-IN signals. An additional FAULT# signal allows interface function testing.

NOTE: AutoLink functionality is available only if the system is equipped with an Autolink compatible IHU CPU card, MEDRAD part number 3003047.
AutoLink Interface - ISI

12V REGULATOR

ISO +5V

ISCORATED DC/DC CONVERTER U3

START 20

START GND 25

TEST LINES 11

N/O 8

C 9

N/C 7

SCANNER START/INPUT OPTO U4

TESTING OPTO U5

SCANNER RELAY K1

RELAY DRIVE U1

J 3 0 1

FAULT#

AutoLink START (EXT IN 1/ISI-IN#)

AutoLink RELAY DRIVE (BIT_ENABLE#/ISI-OUT#)

+30V
ISI Output

The ISI output consists of an opto isolator and relay with DPDT contact arrangements. The opto isolator provides isolation, and the relay provides normally closed, normally open, and relay common contacts (routed to the AutoLink connector), which provide either a normally open or normally closed current path for the scanner.

**Relay Contact Specifications:**

- **Maximum Operating Current**: 0.75 Amp
- **Minimum Permissible Load**: 10uA, 10mV
- **Total Maximum Switching Capacity**: 31VA or 17 watts
- **Maximum Operating Voltage**: 125 VAC / 110 VDC.

The common contact is not connected to any common within the power supply, thus allowing for full electrical isolation between the injector and the scanner. The common line has a Thermistor in series to limit inrush current through the circuit. Relay activation is supplied via drive circuit on the IHU CPU card. The drive circuit on the IHU CPU is comprised of a VN2222 N-Channel FET. The gate of the FET has a pull down resistor and is controlled via Port A, Channel 0, of the waferscale PSD303. Port A, Channel 0 will be configured via software, after injector power-up, as a CMOS output. When a logic 1 is written to the port, the output will set to approximately 5 volts, which will bias the FET to the on state. When on, current will flow through the FET, energizing the opto, causing the relay to activate. A logic 0 written to the port will set the output to approximately 0 volts, de-energizing the FET, which will deactivate the relay. The FET’s drain is connected to the pre-existing BITENABLE# line of the IHU CPU. A damping diode is also placed across the source and drain of the FET to shunt the counter EMF produced by the relay coil when the relay is deactivated.

ISI Input

Two lines are used for ISI input. A bi-directional transzorb is used across the scanner inputs for protection of overvoltage transients. The circuit is arranged in a fashion that without any input from the scanner, the optoisolator on the ISI board is off. When in this state, the signal ISI_IN to the IHU CPU is pulled high (5.1V) by the combination of Z1, R4, and the +12V supply output. When the scanner provides the input signal, via a connection between J302 pin 20 and J302 pin 25, approximately 10 mA of opto current flows and the signal ISI_IN becomes active. The active voltage level is approximately 2.0V. This is accomplished using R4, +12V, and Z2. The intermediate analog voltage defines the 0V state as NO BOARD PRESENT.

There is a maximum contact resistance specification for the scanner input when the input is active (contact closure on input) to ensure that the opto will conduct. The total loop resistance from J302 pin 20 to J302 pin 25 will not exceed 200 ohms.
Test Mode

A separate cable test function is available for the ISI to ensure proper operation, utilizing two additional signals CBLTST_OUT and CBLTST_COM (J302 pins 11 and 13). These signals are used to simulate a contact closure from the scanner, to test cable integrity and ISI board circuitry. The FAULT# signal from the IHU initiates the test. When this signal is activated low, the U5 optoisolator is activated, allowing the output transistor to act as a saturated switch, simulating a scanner contact closure.

In order for this system to function properly, the following signals must be tied together at the scanner connector: J302 pin 11 to pin 20, and, J302 pin 13 to J302 pin 25.

When the test is initiated, current flows from ISO+5V through R5, through the opto, and the conductor J302 pin 20, to the scanner. This current is then routed back through the conductor at J302 pin 11, to the ISI board opto U5, through conductor J302 pin 13, and back to the scanner. From the scanner again, it is routed through the conductor at J302 pin 25, back to the ISI board to isolated ground, thus completing the current path. With the path complete, U4 is activated and the software verifies proper cable and ISI operation. When the cable test is active, a voltage of approximately 2.0 volts will be present on the ISI_IN line.
MEDRAD Vistron CT Injection System

MEDRAD Vistron CT Interconnection Diagram
When troubleshooting the *Vistron CT* Injection System, it may be necessary to order replacement parts for a given assembly. This section contains information regarding individual assemblies of the system. Each primary assembly has a corresponding Parts List and Parts Diagram, specifying components that may require replacement.

When ordering replacement parts, contact MEDRAD Service, or your authorized MEDRAD dealer.

Parts Lists and Diagrams are arranged in the following sequence:

- Injector Head - External Assembly
- Injector Head - Internal Assembly
- Injector Head - Front Plate Assembly
- Injector Head - Mechanical Assembly
- Remote Monitor
- Power Supply Unit

<table>
<thead>
<tr>
<th>Parts List Components</th>
<th>Each Parts Lists contains the following information:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item Number</strong></td>
<td>This number refers to the labels of all items specified in the parts diagrams.</td>
</tr>
<tr>
<td><strong>Part Description</strong></td>
<td>This information, useful in part identification, is a brief description of all items specified in the parts diagrams.</td>
</tr>
<tr>
<td><strong>Part Number</strong></td>
<td>Used specifically for ordering purposes, these numbers are the primary designators of all system components, and should be used when ordering any MEDRAD replacement parts.</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
<td>This number represents the quantity of like pieces that are used in the represented assembly.</td>
</tr>
</tbody>
</table>
# Injector Head External Assembly

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Part Description</th>
<th>Part Number</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Top Cover (with Gasket)</td>
<td>403002145</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Pivot Knuckle Cap</td>
<td>621-8605-000</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Nylock Hex Nut, #1/4-20</td>
<td>609-1420-999</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Bellville Washer</td>
<td>659-0255-500</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Thrust Race</td>
<td>680-0411-677</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Thrust Roller Assembly</td>
<td>680-1411-677</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Pivot Knuckle</td>
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<td>1</td>
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<td>8</td>
<td>Standoff, #4-40 x .75&quot;</td>
<td>628-3634-440</td>
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<tr>
<td>9</td>
<td>Screw, #4-40 x .50&quot; PNH</td>
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<tr>
<td>10</td>
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<tr>
<td>11</td>
<td>Screw, #4-40 x .25&quot; PNH</td>
<td>602-0440-140</td>
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<tr>
<td>12</td>
<td>Armed Indicating Lamp Lens</td>
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<tr>
<td>13</td>
<td>Piston Advance Knob</td>
<td>401000424</td>
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<tr>
<td>14</td>
<td>Washer</td>
<td>3000771</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Bottom Cover (with Gasket)</td>
<td>403002146</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Screw, #6-32 x .25&quot; PNH</td>
<td>602-0632-140</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>Lamp, Armed Indicating</td>
<td>481-0657-028</td>
<td>3</td>
</tr>
</tbody>
</table>

Not Shown:

- Internal Wiring Harness (Flex Circuit) 403003262 1
- Interconnect Cable, SSB/MPU 403003071 1
- Interconnect Cable, Motor/MPU 403003072 1
- Interconnect Cable, MPU/Encoder/Pots 403003069 1
- Gasket Seal, Top Cover 403003034 1
- Gasket Seal, Top Cover, Arm Lens 403003683 1
- Gasket Seal, Top Cover, Cable Access 403003679 1
- Gasket Seal, Bottom Cover, Arm Lens 403003682 1
- Gasket Seal, Bottom Cover, Cable Access, w/ hole 403003680 1
- Gasket Seal, Bottom Cover, Cable Access, Solid 403003681 1
# Injector Head Internal Assembly

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Part Description</th>
<th>Part Number</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Keyboard Assembly <em>(with English overlay)</em></td>
<td>403002798-40</td>
<td>1</td>
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<tr>
<td></td>
<td>Graphic Overlay - <em>English</em></td>
<td>403002798-1</td>
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<tr>
<td></td>
<td><em>German</em></td>
<td>403002798-2</td>
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</tr>
<tr>
<td></td>
<td><em>French</em></td>
<td>403002798-3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Spanish</em></td>
<td>403002798-4</td>
<td>1</td>
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<tr>
<td></td>
<td><em>Dutch</em></td>
<td>403002798-5</td>
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<tr>
<td></td>
<td><em>Italian</em></td>
<td>403002798-11</td>
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<td></td>
<td><em>Japanese</em></td>
<td>403002798-13</td>
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<td></td>
<td><em>Chinese</em></td>
<td>403002798-14</td>
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<td>2</td>
<td>DPU Card Assembly</td>
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<td>3</td>
<td>MPU Card Assembly</td>
<td>403003156</td>
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<tr>
<td>4</td>
<td>PCU Card Assembly</td>
<td>403002907</td>
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<td>5</td>
<td>RF Shield</td>
<td>403002147</td>
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<td>6</td>
<td>Screw, #4-40 x .25” PNH</td>
<td>602-0440-140</td>
<td>1</td>
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<tr>
<td>7</td>
<td>HHC Card Assembly <em>(component of Flex Circuit)</em></td>
<td>403003262</td>
<td>1</td>
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<tr>
<td>8</td>
<td>Cable Access Cover</td>
<td>403002785</td>
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<td>9</td>
<td>Screw, #6-32 x .25” PNH</td>
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<td>10</td>
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<td>3000569</td>
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<tr>
<td>11</td>
<td>Connector Cover</td>
<td>3000981</td>
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## Injector Head  Front Plate Assembly

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</thead>
<tbody>
<tr>
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<td>SSB Card Assembly</td>
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<td>Syringe Sensor</td>
<td>401000734</td>
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<td>3</td>
<td>Cap Screw, #1/4-20 x .75&quot;</td>
<td>614-1420-340</td>
<td>2</td>
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<tr>
<td>4</td>
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<td>602-0832-100</td>
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<td>5</td>
<td>Front Plate</td>
<td>403003242</td>
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<td>6</td>
<td>Felt Ring</td>
<td>78101-04-SM-33</td>
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<td>7</td>
<td>Sensor Plate</td>
<td>403003241</td>
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<td>8</td>
<td>Wiper Seal</td>
<td>629-9599-000</td>
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<tr>
<td>9</td>
<td>Syringe Interface Gasket</td>
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<tr>
<td>10</td>
<td>Interface Gasket</td>
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<tr>
<td>11</td>
<td>Syringe Interface Plate</td>
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</table>
### Injector Head  Mechanical Assembly

<table>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Rear Plate Assembly</td>
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<td>2</td>
<td>Ballscrew Assembly</td>
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<td>Washer</td>
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<td>Piston</td>
<td>403003000</td>
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<td>5</td>
<td>Alignment Bar</td>
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<td>6</td>
<td>Alignment Bushing</td>
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<td>Alignment Bushing Gasket</td>
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<td>Gear Motor Assembly</td>
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<td>10</td>
<td>Cable Clip</td>
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<td>11</td>
<td>Ballscrew Gear, 40 Tooth</td>
<td>401000422</td>
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<td>Belt Gear</td>
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<td>607-0014-580</td>
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<tr>
<td>15</td>
<td>Potentiometer Assembly</td>
<td>401001468</td>
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<tr>
<td>16</td>
<td>Shim Spacer</td>
<td>401003512</td>
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<td>17</td>
<td>Combination Gear</td>
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<td>18</td>
<td>Motor Pulley</td>
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<td>Screw, #10-32 x .38” PNH</td>
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<td>E-Clip</td>
<td>645-5144-210</td>
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<td>21</td>
<td>Potentiometer Gear, 48 Tooth</td>
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<td>Nylock Hex Nut, #1/4-20</td>
<td>609-1420-999</td>
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<tr>
<td>23</td>
<td>Drive Belt</td>
<td>682-7090-306</td>
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</table>
## Remote Monitor

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Part Description</th>
<th>Part Number</th>
<th>Qty.</th>
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<tbody>
<tr>
<td>1</td>
<td>Rubber Foot</td>
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</tr>
<tr>
<td>2</td>
<td>Screw, Nylon, #4-40 x 1” PHPN HD</td>
<td>3001093</td>
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</tr>
<tr>
<td>3</td>
<td>Screw, #4-40 x .125” Shoulder</td>
<td>3001017</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>IHU Bottom Cover</td>
<td>3000104</td>
<td>1</td>
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- Wall Mount Bracket  3000141  1
- IHU Overlay Switchcard  3000254  1
- IHU Graphic Overlay
  - English  403003926-1  1
  - German  403003926-2  1
  - French  403003926-3  1
  - Spanish  403003926-4  1
  - Dutch  403003926-5  1
  - Italian  403003926-11  1
  - Japanese  403003926-13  1
  - Chinese  403003926-14  1
Replacement Parts
# Power Supply Unit

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Not Shown:

- Input Power to Power Supply Wiring Harness 403002742 1
- Power Supply Output Wiring Harness 3002641 1