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# Glossary

| Term | Definition |
|---|---|
| Arc Prevention | Arc Prevention extends the life of all electrical power contacts by eliminating arcing caused by inductive loads and high inrush current during coupling and uncoupling. |
| Auxiliary Power Available | An input indicating the presence of auxiliary power supply to the ATI Master module. |
| Coupling | The physical action of locking the Master and Tool plates together. |
| DeviceNet® | A fieldbus communication network used mostly by devices in industrial settings, that communicates using CAN. DeviceNet is a trademark of ODVA. |
| EOAT | End-Of-Arm-Tool (end effector). |
| Latch | The output supplied to the ATI Master DeviceNet node to couple the Tool Changer (only valid for double solenoid valve equipped units). |
| Lock | A proximity sensor input indicating that the coupling mechanism is in the Lock position. |
| RTL | A proximity sensor input that senses when the ATI Tool is positioned for coupling. |
| Solenoid Energized | An input indicating electrical current draw from the valve and the solenoid coil. |
| Tool-ID | An input from the Master node reporting the values from the Tool-ID switches on the Tool module. |
| TSI | The Tool Stand Interlock feature is a custom ATI safety solution and circuit that only allows Tool Changer release while in the stand or storage location. |
| TSI Switch | A switch installed on the EOAT and is used to indicate that the EOAT is in the stand or storage location. |
| Uncoupling | The physical action of unlocking the Master and Tool plates. |
| Unlatch | The output supplied to the ATI Master DeviceNet node to uncouple the Tool Changer. |
| Unlock | A proximity sensor input indicating that the coupling mechanism is in the Unlock position. |

# C. Control and Signal Modules

# DA4—DeviceNet® Control/Signal Modules

## 1. Product Overview

These modules allow communication with and control of the Tool Changer on a DeviceNet network. Refer to *Section 2—Product Information* for detailed DeviceNet programming information and operational capability.

Power and signal connectors enable interfacing on the Master and Tool modules. When the Tool Changer is coupled, the Master and Tool modules interface using a spring-loaded pin block. A V-ring seal surrounds the pin block and is water resistant but not waterproof when the modules are coupled. Refer to *Figure 1.1*.

In addition to providing the standard Lock, Unlock, and Ready-to-Lock sensor inputs, the Master module has a Tool Stand Interlock (TSI) connector that is wired into the unlatch solenoid valve circuit. Using this connector, a switch can be integrated that allows the solenoid valve circuit to uncouple the Tool Changer only when the Tool is in the stand or storage location. Refer to *Section 2.3—Master Side TSI* for more information regarding TSI. A teach plug is factory-supplied with the connector to close the solenoid valve circuit when not used.

The DeviceNet Modules also incorporate ATI's exclusive Arc Prevention Circuit, which extends the life of electrical power contacts by eliminating arcing caused by inductive loads and high inrush current during coupling and uncoupling. Refer to *Section 2.2—Arc Prevention Circuit* for additional information.

### 1.1 DA4 Master

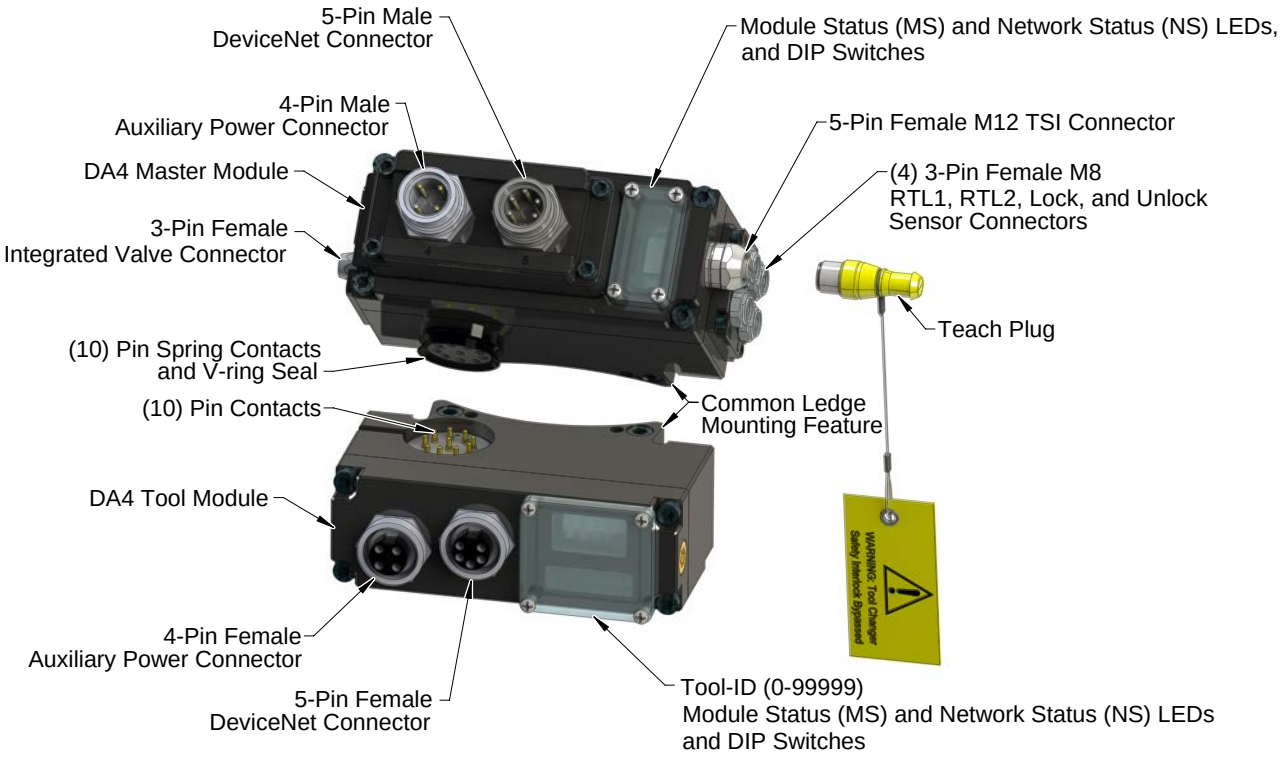
The Master module has the following connectors:

- (1) 5-pin male auxiliary power connector
- (1) 4-pin male DeviceNet connector
- (4) 3-pin female M8 for RTL, Lock, and Unlock sensors connectors.
- (1) 5-pin female M12 TSI connector
- (1) 3-pin female integrated valve connector

The electrical interface supports only an integrated double solenoid valve (single-solenoid valve is not supported). A double solenoid valve is provided with the Master valve adapter for Lock/Unlock control of the Tool Changer. The integrated valve can be supplied from ATI as part of the valve adapter block. Refer to the valve adapter manual for more information. The user must provide a pneumatic supply to the valve adapter. Electrical interface drawings and connector details are provided in drawings in *Section 9—Drawings*.

The Master module provides DIP switches for setting Mac ID and Baud Rate. Refer to *Section 2.1.1—DIP Switches on the Master Module*.

**Figure 1.1—DA4 Modules**




## 1.2 DA4 Tool

The Tool module is equipped with the following connectors:

- (1) 5-pin female DeviceNet connector.
- (1) 4-pin female auxiliary power connector to the end of arm tooling.

Electrical schematics and connector details are provided in *Section 9—Drawings*.

The (5) digit Tool-ID feature identifies tools used by the Tool Changer. Use the push-button switches to set the Tool-ID. Refer to *Section 3.7—Setting the Tool-ID and DIP Switches on the DA4 Tool Module*. See *Section 2.5—Software* for DeviceNet bitmap and I/O information.

The Tool module provides DIP switches for setting Mac ID and Baud Rate. Refer to *Section 2.4.2—DIP Switches on the Tool Module*.

# 2. Product Information

DeviceNet nodes are established on the Master and the Tool module. The Master node enables control of the Tool Changer and the reporting of various Tool Changer I/O. The Tool module supports Tool-ID reported through the Master and functions as a pass-through for DeviceNet, power, and signals to downstream equipment.

ODVA® is a trade and standards development organization for various technologies including DeviceNet. Refer to their website (*www.odva.org*) for more information about DeviceNet standards.

## 2.1 Master Module Information

The Master node operates as a Group 2-Only Server on the DeviceNet network. The Master node supports Explicit Messages, Polled, Strobe and Change of State/Cyclic of the predefined Master/Slave Connection set. The Master node supports Quick Connect operation as defined by ODVA (refer to the EDS file for specific information). The Master node does not support the Unconnected Message Manager (UCMM). MAC ID, Baud Rate, and Termination Resistor settings for the Master node are configured through a DIP switch. (2) LED's provide network and module status.

### 2.1.1 DIP Switches on the Master Module

The DA4 Master module has 10 DIP switches, which have the following functions:

| | |
|---|---|
| DIP 1 through 6: | Sets MAC ID. |
| DIP 7 and 8: | Sets Communication Baud Rate. |
| DIP 9: | Connects to Termination Resistor. |
| DIP 10: | Must always be in the OFF position. |

### 2.1.2 MAC ID

The MAC ID is set by either a hardware or software configuration. The range is 0-63. For the MAC ID to be set by software, all DIP switch positions (1-6) must be on. If the MAC ID is set by software, the Baud Rate must also be set by software. Refer to *Figure 2.1* for detailed information on DIP switch setup.

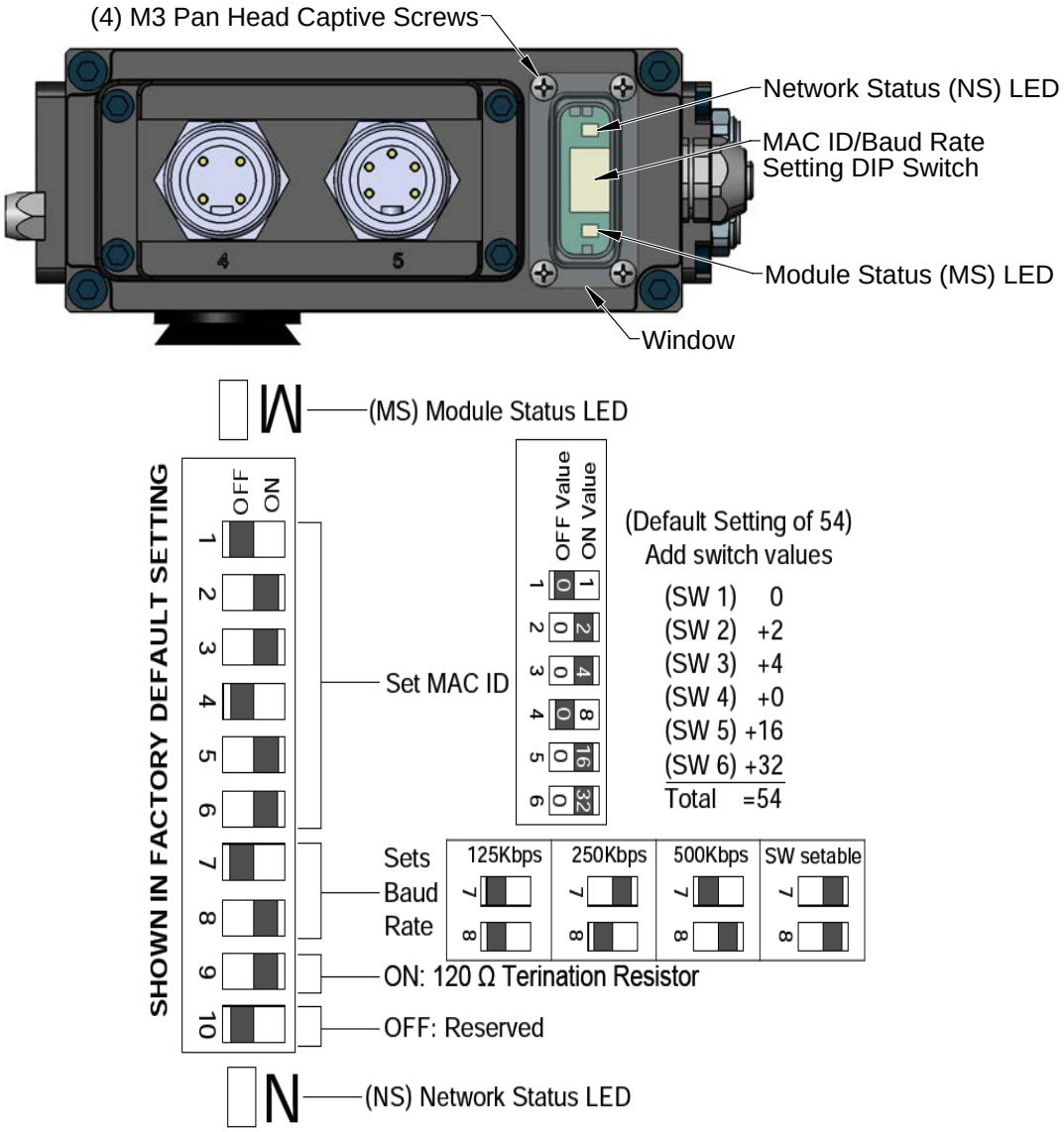
### 2.1.3 Baud Rate

Baud Rate is set by either hardware or software configuration. The possible settings are 125, 250, or 500 Kbps. For the Baud Rate to be set by software, DIP switch positions 7 and 8 must be on. See *Figure 2.1* for DIP switch setup.

### 2.1.4 Termination Resistor

When DIP switch position 9 is on, a 120 Ω resistor is placed across the CAN High and Low lines and termination to the CAN network is provided. If switch 9 is off, termination must be supplied by another device or through a termination cap at the end of the network cable.

**Figure 2.1—DeviceNet® Master Module LEDs and DIP Switch Settings**



### 2.1.5 Module Status LED

The module status LED is identified on the device board as “MS”. It provides device status for power and proper operation.

| Table 2.1—Module Status LED | | |
|---|---|---|
| **Status** | **LED Function** | **Note** |
| No Power | Off | No power applied. Check supply voltage is 24 VDC. |
| Operational | Green | Normal operation. |
| Standby | Flashing Green | Device needs commissioning/standby state.<br>Configuration missing, incomplete or incorrect. |
| Recoverable Fault | Flashing Red | Recoverable fault. |
| Unrecoverable Fault | Red | Unrecoverable fault. |
| Self Test | Flashing Green-Red | Device is performing self tests. |

### 2.1.6 Network Status LED

The network status LED is identified on the device board as “NS”. It provides network status for power and communication.

| Table 2.2—Network Status LED | | |
|---|---|---|
| **Status** | **LED Function** | **Note** |
| No Power/ Off Line | Off | Device is not online. Check Baud Rate.<br>Device has not completed the duplicate MAC ID test.<br>Module Status is On. Check for termination resistor.<br>Device is not powered. See Module Status. |
| On Line, Not Connected. | Flashing Green | Device is online but connection is not established.<br>Device not allocated to a Master. |
| OK<br>On line, Connected | Green | Device is on line with connections established.<br>Device is allocated to a Master. |
| Connection Timeout | Flashing Red | One or more I/Os are timed out. |
| Critical Link Failure | Red | Failed communication. Error detected and incapable of communication.<br>Duplicate MAC ID or Bus off. |
| Communication Faulted and Received and Identify Communication Fault Request – Long Protocol Message | Flashing Green-Red | A specific Communication Faulted Device. Device has received and accepted an Identify Communication Faulted Request – Long Protocol message. |

## 2.2 Arc Prevention Circuit

The DeviceNet Modules incorporate ATI's exclusive Arc Prevention Circuit. The Arc Prevention Circuit extends the life of electrical power contacts by eliminating arcing caused by inductive loads and high inrush current during coupling/uncoupling of the modules. The Arc Prevention Circuit makes it possible to couple/uncouple without switching power off and prevents damage to the contacts.

In the modules, the Arc Prevention Circuit controls the ON/OFF status of the following three power signals:

- Device Net Power (CAN V+)
- Switched Auxiliary 1 Power V+
- Unswitched Auxiliary 2 Power V+

The Arc Prevention Circuits turn off CAN V+, AUX1 V+, and AUX2 V+, during coupling and uncoupling of the master and Tool. The switching function is controlled by the Latch/Unlatch commands and the Arc Switch Enable signal. The Arc Switch Enable signal is transmitted through a recessed pin in the Tool side pin block. A recessed pin ensures that all of the spring probes and contact pins are touching when power is turned on. The behavior of the Arc circuit is described in the following sections.

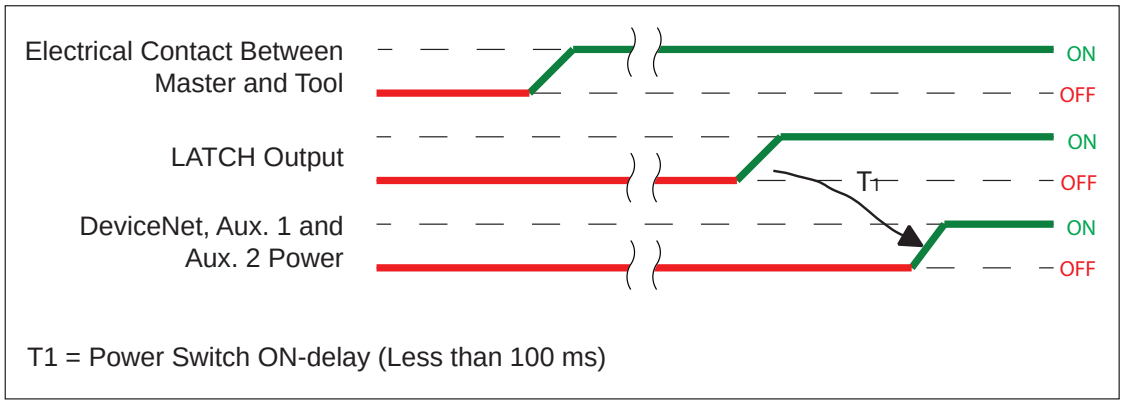
### 2.2.1 Arc Prevention Circuit Behavior during Coupling

The behavior of the Arc Prevention circuit during coupling is described here: *Figure 2.2*.

When the robot and Master approach the Tool for pick up, electrical contact between the Master and Tool pin contacts occurs. After the Latch command is turned ON, the Arc Prevention Circuit turns on DeviceNet (CAN V+), Auxilary 1, and Auxiliary 2 Power. The time delay between when the LATCH output is turned ON to when power is actually available to the EOAT (time $t_1$ in the diagram) is less than 100 ms.

**NOTICE:** The Arc Prevention Circuit only allows power to pass to the Tool after the LATCH command is issued and the Master and Tool module's electrical contacts are fully engaged.

**Figure 2.2—Power-On Timing**



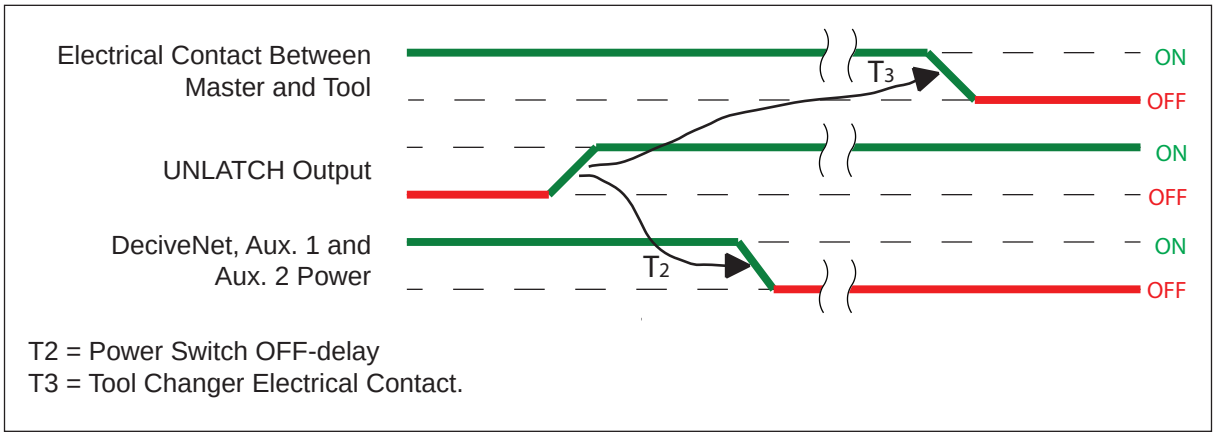
### 2.2.2 Arc Prevention Circuit Behavior During Uncoupling

The behavior of the Arc Prevention Circuit during uncoupling can be more clearly understood by referring to *Figure 2.3*.

Immediately after the UNLATCH command is issued, the Arc Prevention Circuit powers off DeviceNet, Auxiliary 1, and Auxiliary 2. The power-off time delay between the UNLATCH command and the switching off of power (designated $t_2$ in the diagram) is less than 50 ms.

Some time after power is turned off and the Master and Tool begin to separate, electrical contact between the Master and Tool pin contacts is lost. This occurs with a delay, designated $t_3$ in the diagram, after the UNLATCH command is issued. The magnitude of time $t_3$ is a function of many factors, including the weight of the EOAT, the friction between the Master and Tool alignment pins, etc. but is usually not shorter than 100 ms.

**Figure 2.3—Power-Off Timing**



## 2.3 Master Side TSI

To prevent an unintended Tool release, the electrical power to the unlatch valve circuit is routed through a safety switch that is mounted to the Master. With the actuator or trip dog mounted on the tool stand, the safety switch insures that a Tool can only be released at the tool stand.

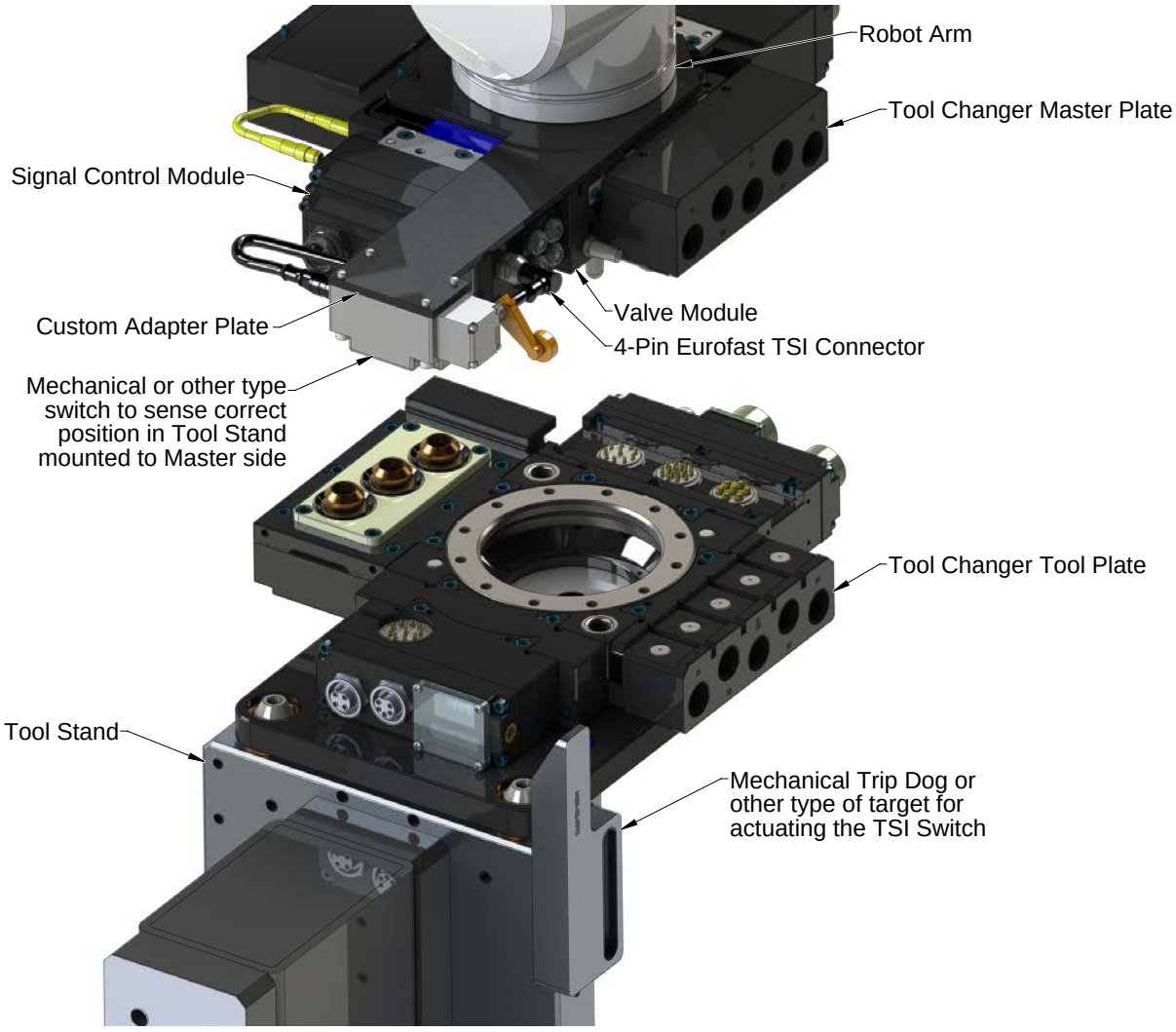
The safety switch is connected to the Master module through a 5-pin M12 connector that is mounted to the side of the module. A teach plug can be connected to the 5-pin M12 TSI connector to override the TSI circuit during setup and integration. Refer to *Figure 1.1*.

Two pins of the TSI connector are wired in-line with the valve "unlock" circuit. A mechanical or other type switch can be integrated to sense the Tool when in the stand and therefore make the circuit.

If an unlock solenoid command is given and the Tool is not placed in the stand, the unlock command is not recognized. The TSI feature prevents the accidental release of a Tool from outside of the tool stand.

**NOTICE:** The Master module has a Tool Stand Interlock (TSI) feature that physically breaks the unlatch solenoid circuit. Use of the TSI prevents any unwanted unlock software commands from being recognized until the circuit is made.

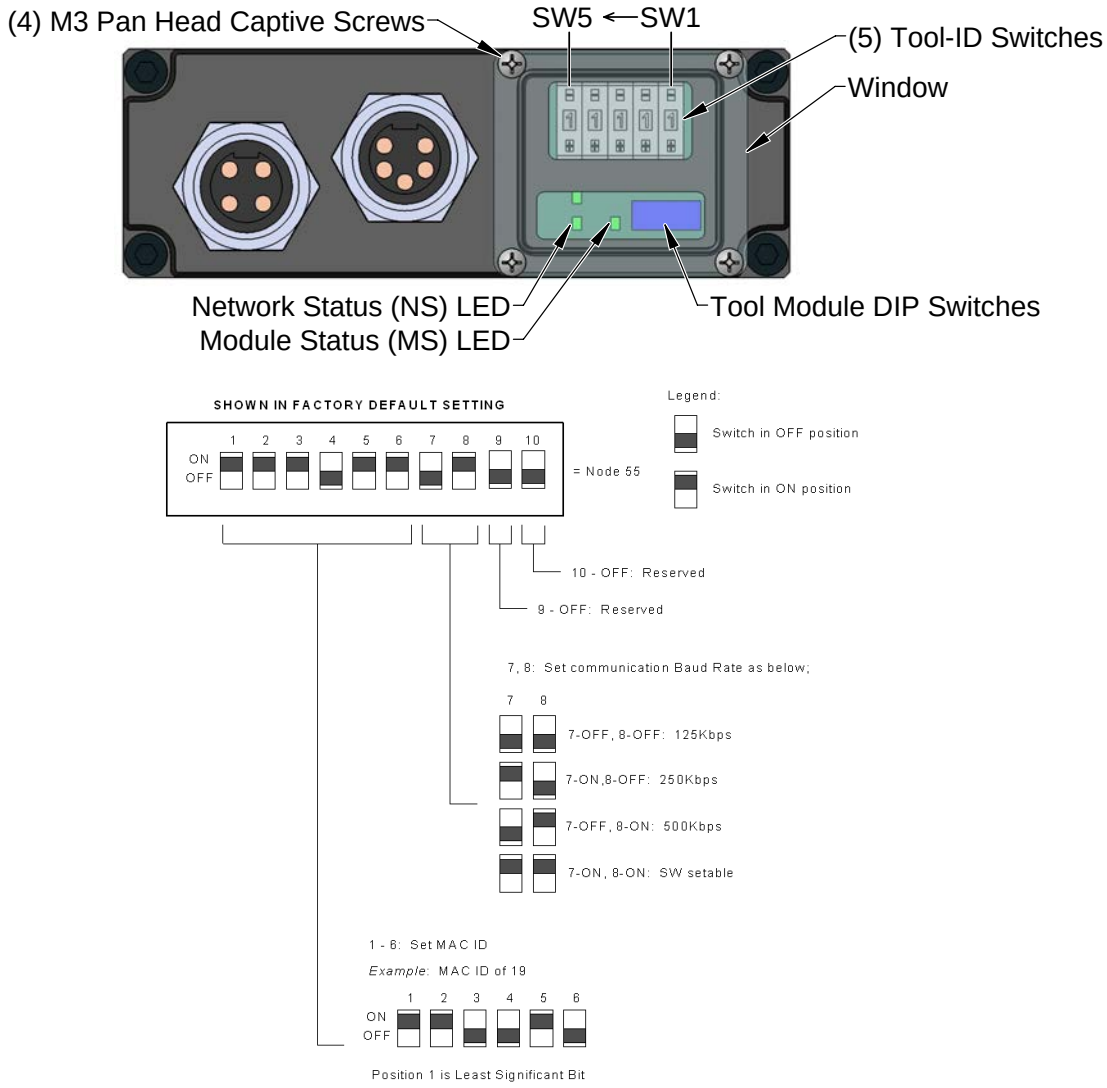
**Figure 2.4— Master Side, Tool Stand Interlock (TSI)**



## 2.4 Tool Module

The Tool node operates as a Group 2-Only Server on the DeviceNet network. The Tool node supports Explicit Messages, Polled and Strobe of the predefined Master/Slave Connection set. The Tool node supports Quick Connect operation as defined by ODVA (refer to the EDS file for specific information). The Tool Node does not support the Unconnected Message Manager (UCMM). The MAC ID and Baud Rate settings for the Tool node are configured through a DIP switch. Tool-ID is set using (5) push-button switches. (2) LED's provide network and module status. For more details, refer to *Section 9—Drawings.*

**Figure 2.5—Tool Module LEDs, Tool-ID Switch, and DIP Settings**




### 2.4.1 Tool-ID

The Tool-ID for a particular tool is assigned using (5) push-button switches with options for each switch. Each Tool must have a unique Tool-ID number.To set the Tool-ID refer to *Section 3.7—Setting the Tool-ID and DIP Switches on the DA4 Tool Module.*

### 2.4.2 DIP Switches on the Tool Module

The DA4 Tool module has 10 DIP switches which have the following functions:

| | |
|---|---|
| DIP 1 through 6: | Sets MAC ID. |
| DIP 7 and 8: | Sets Communication Baud Rate. |
| DIP 9 and 10: | Must always be in the OFF position. |

### 2.4.3 MAC ID

The MAC ID is set by either hardware or software configuration. The range is 0-63. For the MAC ID to be set by software, all DIP switch positions (1-6) must be on. If the MAC ID is set by software, the Baud Rate must also be set by software. Refer to *Figure 2.5* for detailed information on DIP switch setup.

### 2.4.4 Baud Rate

Baud Rate is set by either hardware or software configuration. The possible settings are 125, 250, or 500 Kbps. In order for the Baud Rate to be set by software, DIP switch positions 7 and 8 must be on. See *Figure 2.5* for DIP switch setup.

### 2.4.5 Termination Resistor

Internal termination resistance is not supported in the Tool module. Termination must be provided through the Master module or externally.

### 2.4.6 Module Status LED

The module status LED (*Figure 2.5*) is identified on the device board as “MS”. It provides device status for power and proper operation. Refer to *Table 2.1* for the module status LED’s functions.

### 2.4.7 Network Status LED

The network status LED (*Figure 2.5*) is identified on the device board as “NS”. It provides network status for power and communication. Refer to *Table 2.2* for the network status LED’s functions.

### 2.4.8 Quick Connect

The Quick-Connect feature can be enabled in the ATI Tool module. With the Quick-Connect feature enabled, the ATI Tool Changer module can reconnect to the DeviceNet network within 1 second when power is applied to the pin block during tool change.

Tool Modules with Quick Connect enabled do not check for duplicate MAC addresses. If the DeviceNet network includes duplicate MAC addresses, this will cause communication faults. See *Section 6.1—Troubleshooting* for fault causes and correction.

The Quick Connect feature can only be disabled during commissioning and module replacement. Contact ATI if you need additional help disabling this attribute.

## 2.5 Software

Working EDS files for the Master and Tool nodes are available from our website (*www.ati-ia.com/download/edsfiles*) or by email, reference the following part numbers:

DA4-M Node EDS file 9030-20-1007

DA4-T Node EDS file 9031-20-1008

I/O bitmaps for the DeviceNet nodes are provided in the following tables. The default settings are Node 54 for the Master module and Node 55 for the Tool module.

**Table 2.3—I/O Bitmap, Robot Input From Master DeviceNet Node 54 (DA4-M module)**

| Byte | Bit# | Name | Description/Function |
|---|---|---|---|
| 0 | 0 | Locked | Tool Changer Lock Prox Input. |
| | 1 | Unlocked | Tool Changer Unlock Prox Input. |
| | 2 | Unlatch Solenoid Energized | Solenoid Energized Input turns ON when the Unlatch circuit is complete. |
| | 3 | Auxiliary Power Available | Auxiliary Power Present Input. |
| | 4 | RTL | Ready-to-Lock Prox Input. |
| | 5 | Reserved. | |
| | 6 | | |
| | 7 | | |

**Table 2.4—I/O Bitmap, Robot Output To Master DeviceNet Node 54 (DA4-M module)**

| Byte | Bit# | Name | Description/Function |
|---|---|---|---|
| 0 | 0 | Latch | Tool Changer Valve Latch Output. |
| | 1 | Unlatch | Tool Changer Valve Unlatch Output. |
| | 2 | Reserved. | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | | |

| Table 2.5—I/O Bitmap, Robot Input From Tool DeviceNet Node 55 (DA4-T module) | | |
|---|---|---|
| **Byte** | **Bit#** | **Name** |
| 0 | 0 | Tool Number Bit 1. |
| | 1 | Tool Number Bit 2. |
| | 2 | Tool Number Bit 4. |
| | 3 | Tool Number Bit 8. |
| | 4 | Tool Number Bit 16. |
| | 5 | Tool Number Bit 32. |
| | 6 | Tool Number Bit 64. |
| | 7 | Tool Number Bit 128. |
| 1 | 0 | Robot Number Bit 1. |
| | 1 | Robot Number Bit 2. |
| | 2 | Robot Number Bit 4. |
| | 3 | Robot Number Bit 8. |
| | 4 | Line Number Bit 1. |
| | 5 | Line Number Bit 2. |
| | 6 | Line Number Bit 4. |
| | 7 | Line Number Bit 8. |

# 3. Installation

The following steps outline the installation or removal. For wiring information refer to *Section 9—Drawings*.

**WARNING:** Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

**CAUTION:** Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.

## 3.1 Master Module Installation

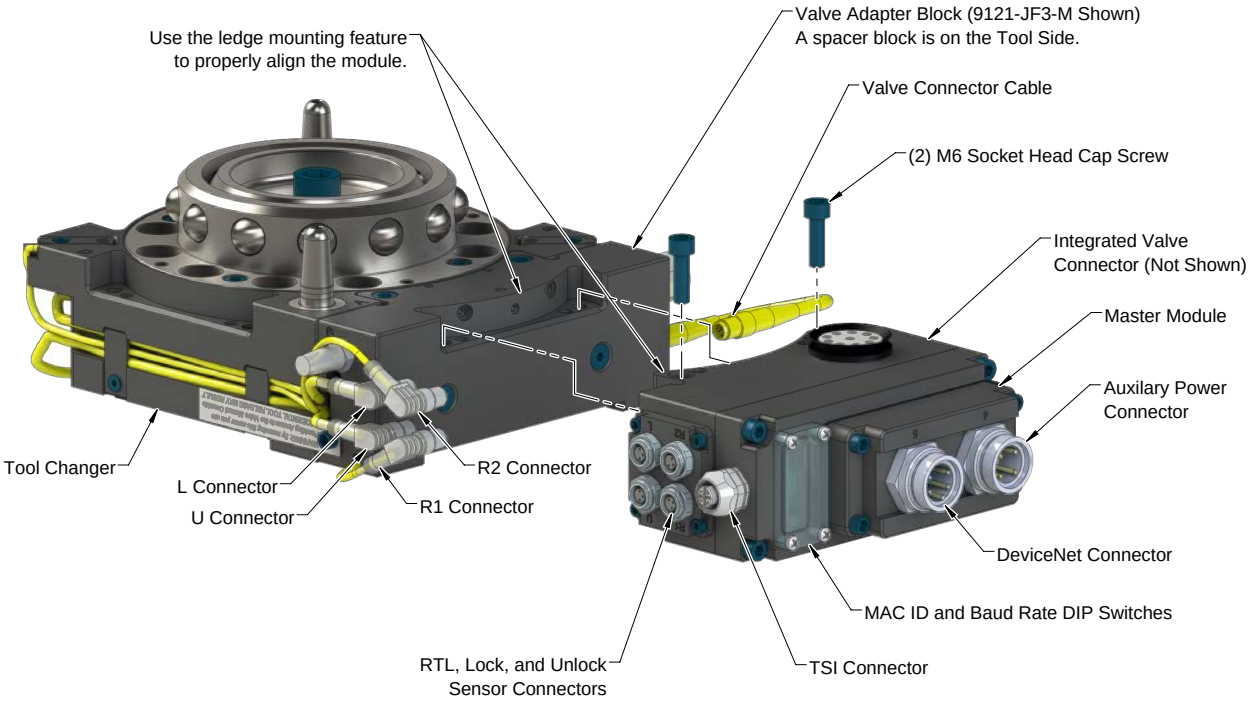
Refer to *Figure 3.1*.

***Tools required:*** *5 mm hex key, torque wrench*

***Supplies required:*** *clean rag, LOCTITE® 242*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Clean the mounting surfaces.
5. Place the module into the appropriate location on the valve adapter. Align the module with the valve adapter using the dowels in the bottom of the ledge feature.
6. Apply Loctite 242 to the supplied (2) M6 socket head cap screws.
7. Using a 5 mm hex key, install the (2) M6 socket cap head screws that secure the module to the valve adapter and tighten to 70 in-lbs (7.9 Nm).
8. Connect the Lock (L), Unlock (U), RTL (R1), and RTL (R2) sensor cables from the Tool Changer to the control/signal module. Ensure that the connectors are cleaned prior to being secured as appropriate.
9. Connect the power, signal, and TSI switch cables to the module. Ensure that the connectors are cleaned prior to being secured.
10. Set the MAC ID and baud rate DIP switches, refer to *Section 3.5—DeviceNet Configuration for the DA4 Master Module*.
11. Safely resume normal operation.

**Figure 3.1—DA4 Master Module Installation and Removal**




## 3.2 Master Module Removal

***Tools required:*** *5 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Disconnect the Lock (L), Unlock (U), RTL (R1), RTL (R2) sensor cables from the DA4-M module.
5. Disconnect the power, signal, and TSI cables from the DA4-M module.
6. Support the module and remove the (2) M6 socket head cap screws using a 5 mm hex key. Lower the module until it clears the guide pin.

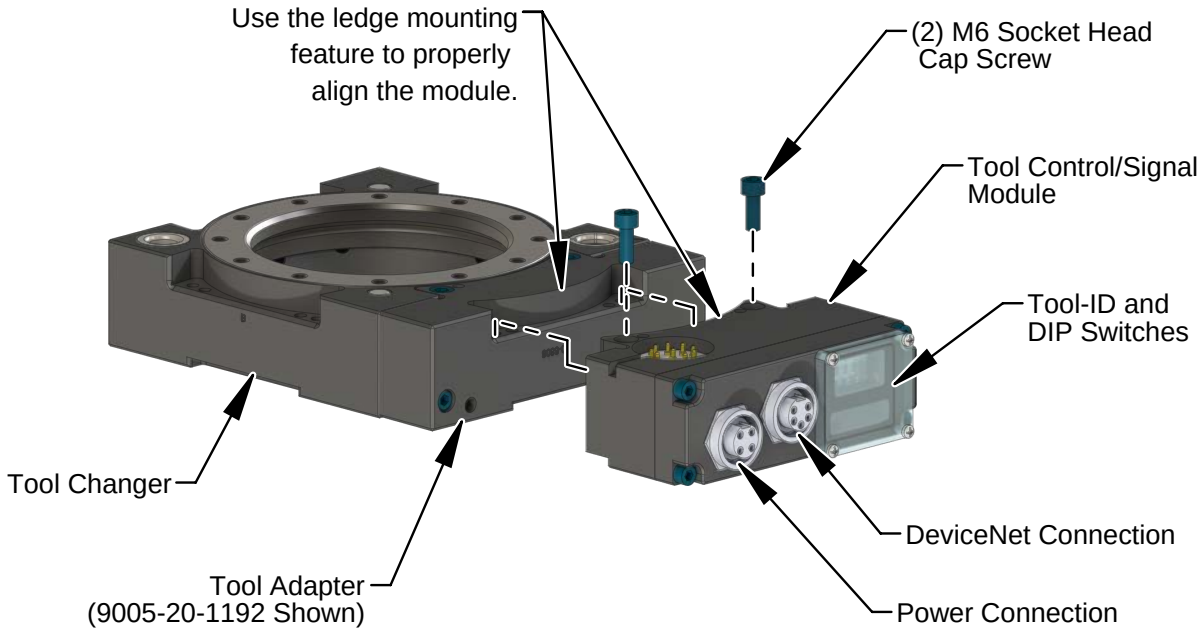
## 3.3 Tool Module Installation

***Tools required:*** *5 mm hex key, torque wrench*

***Supplies required:*** *clean rag, LOCTITE® 242*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Clean the mating surfaces.
5. Place the module into the appropriate location on the tool adapter or spacer block. Align the module with the tool adapter using the dowels in the bottom of the ledge feature.
6. Apply Loctite 242 to the supplied (2) M6 socket head cap screws.
7. Using a 5 mm hex key, install the (2) M6 socket cap head screws that secure the module to the tool adapter and tighten to 70 in-lbs (7.9 Nm).
8. Connect the power and signal cables to the Tool module. Ensure that the connectors are cleaned prior to being secured.
9. Set the Tool-ID and DIP switches on the Tool module. Refer to *Section 3.7—Setting the Tool-ID and DIP Switches on the DA4 Tool Module.*
10. Safely resume normal operation.

**Figure 3.2—DA4 Tool Module Installation and Removal**




## 3.4 Tool Module Removal

***Tools required:*** *5 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Disconnect the power, signal, and TSI switch cables from the Tool module.
5. Remove the (2) M6 socket head cap screws using a 5 mm hex key. Lift the module until it clears the guide pin.

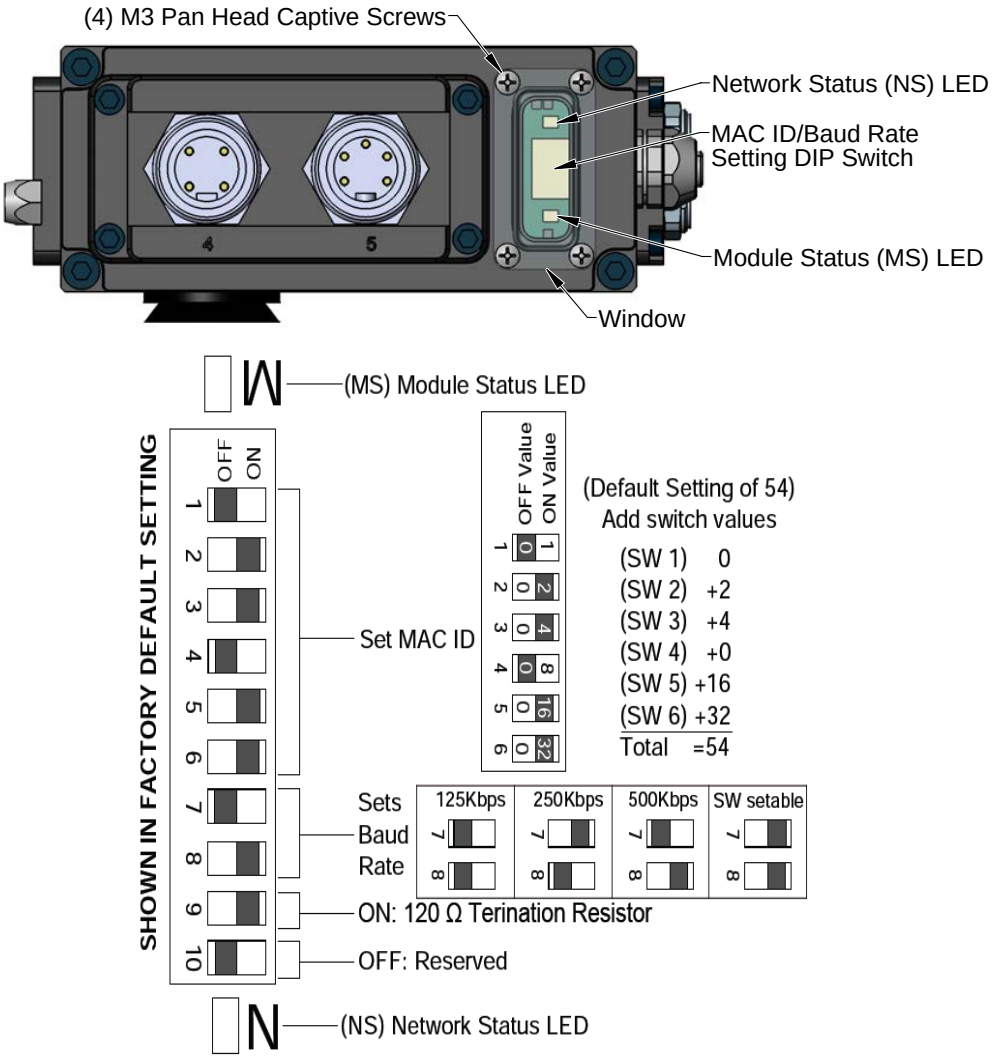
## 3.5 DeviceNet Configuration for the DA4 Master Module

Various parameters for the DeviceNet modules need to be configured prior to operating the Tool Changer. Refer to *Section 2—Product Information* for detailed information on installation and operation of the DeviceNet modules.

***Tools required:*** *Phillips screwdriver*

1. Loosen (4) M3 pan head captive screws and remove the window.

**Figure 3.1—Set the MAC ID and Baud Rate DIP Switches on the Master Module**




**NOTICE:** After adjustment is completed, ensure that the seal and window are re-positioned correctly to prevent a leakage path to inside the module.

2. Set the DIP switches. Refer to *Section 2.1—Master Module Information*.
3. Re-install the window and tighten the (4) M3 pan head captive screws.

## 3.6 Utility Schematic

Refer to drawings in *Section 9—Drawings* for customer interface and wiring details for the DA4 Master and DA4 Tool modules.

## 3.7 Setting the Tool-ID and DIP Switches on the DA4 Tool Module

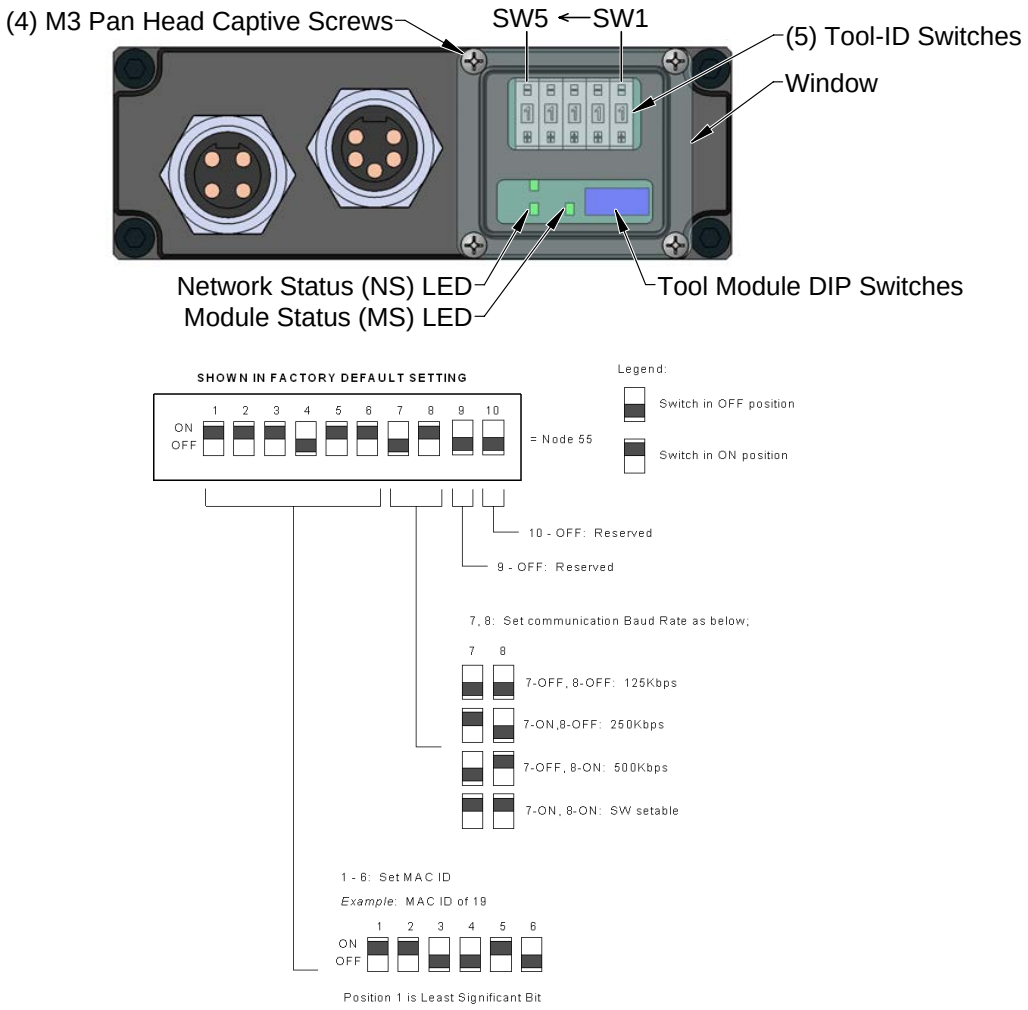
***Tools required:*** *Phillips screwdriver*

Push button switches are provided on the Tool module for setting Tool-ID numbers from (0-9).

**NOTICE:** The first (3) switches, SW1, SW2, and SW3 set the tool number within a range from 0-255. The fourth switch, SW4, sets the Robot Number from 0-9. The fifth switch, SW5, sets the line number from 0-9.

1. Loosen the (4) M3 pan head captive screws and remove Tool-ID window.

**Figure 3.1—Set Tool-ID**




2. Use a non-conductive tool (e.g., plastic stylus) to press on the Tool-ID push buttons to increase (+) or decrease (-) the digit value. Set the Tool-ID to the desired number. Refer to *Section 9—Drawings* for Tool-ID output tables.

**NOTICE:** After adjustment is completed, ensure that the seal and window are re-positioned correctly to prevent a leakage path to inside the module.

3. Set the DIP switches. Refer to *Section 2.4.2—DIP Switches on the Tool Module*.
4. Re-install the Tool-ID window and tighten the (4) M3 pan head captive screws.

# 4. Operation

The following recommended sequence of operations is to be used as a general guide when programming a robot or PLC for use with a Tool Changer and DA4 control/signal modules. This procedure is intended for "automatic" modes used during normal application processes.

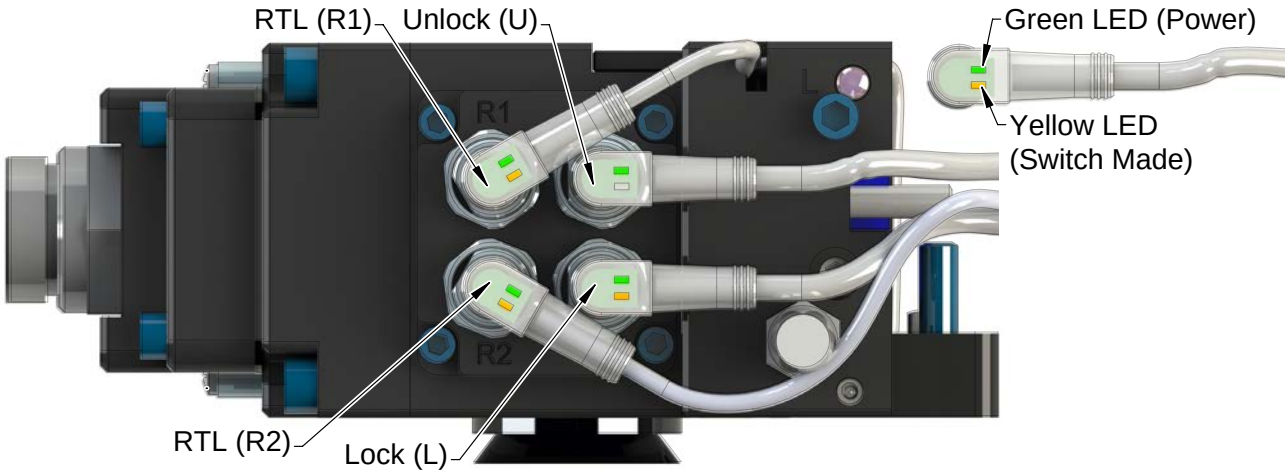
## 4.1 Lock, Unlock, and RTL Sensor Cable LED Behavior

The Lock, Unlock, and RTL sensor cables are equipped with (2) LEDs. The green LED indicates the sensor has power and the yellow LED indicates the switch has been made, The LED behavior is affected by the control/signal module. The behavior shown is specific for the Tool Changer with a control/signal module equipped with RTL sensors wired in series.

**Table 4.1—Sensor Cable LED Behavior for Common Tool Changer Positions**

| Tool Changer Position | Sensor Cable LED Behavior | | | |
|---|---|---|---|---|
| **Unlocked** (Tool Changer Master plate free of stand with no Tool plate attached) | RTL (R1) | OFF<br>OFF | ON<br>ON | Unlock (U) |
| | RTL (R2) | ON<br>OFF | ON<br>OFF | Lock (L) |
| **Ready to Lock** (Tool Changer Master plate with Tool plate parallel and at a distance of 1.22 mm or less from each other) | RTL (R1) | ON<br>ON | ON<br>ON | Unlock (U) |
| | RTL (R2) | ON<br>ON | ON<br>OFF | Lock (L) |
| **Locked** (Tool Changer Master plate with Tool plate attached in fully locked position) | RTL (R1) | ON<br>ON | ON<br>OFF | Unlock (U) |
| | RTL (R2) | ON<br>ON | ON<br>ON | Lock (L) |
| **Missed Tool** (Tool Changer Master plate locked with no Tool plate attached) | RTL (R1) | OFF<br>OFF | ON<br>OFF | Unlock (U) |
| | RTL (R2) | ON<br>OFF | ON<br>OFF | Lock (L) |

**Figure 4.1—Lock, Unlock, and RTL Sensor Cable LED Behavior (Shown in Locked Position)**




**(Control module shown for reference only)**

## 4.2 Recommended Sequence of Operation

1. The robot and Tool Changer Master are free of the stand or storage location, the Tool Changer is uncoupled and the Tool Changer locking mechanism is fully retracted (unlocked condition). No error or fault conditions exist.

   a. The ATI Tool and any downstream device are offline.
   b. The following inputs are ON:
      i. **Unlocked**
      ii. **Auxiliary Power Available** provided the Auxiliary Power 1 power supply is on.
   c. The following inputs are OFF:
      i. **Solenoid Energized**
      ii. **Locked**
      iii. **RTL**
      iv. **Tool-ID invalid**
   d. The following outputs are ON:
      i. **Unlatch**

      **NOTICE:** The **Unlatch** ouput can be turned OFF, after the **Unlocked** input indicates the Tool Changer is in an unlocked state.
   e. The following outputs are OFF:
      i. **Latch**

      **NOTICE:** If Tool Changer is locked without a Tool, it must be unlocked using the manual override button on the valve, refer to *Section 6.1.1—Solenoid Valve Manual Override Procedure.*

2. The robot and Master move into the Tool. They are parallel and within 0.06” of the Tool.

   a. Power is not yet available on the Tool.
   b. The **RTL** input is ON, indicating that it is okay to couple the Tool.

3. Couple the Tool Changer.

   a. The **Solenoid Energized** input is ON.
   b. Turn the **Unlatch** output OFF and turn the **Latch** output ON.
   c. The Arc Prevention circuit makes power available to the Tool.
   d. The **Unlocked** input goes OFF, indicating piston travel. Subsequently, the **Locked** input goes ON and remains ON, indicating that the coupling operation is complete. It is recommended that the **Latch** command be turned OFF after the **Locked** input goes ON.
   e. Tool-ID becomes available and communications are established with the downstream DeviceNet device(s).

4. The robot moves away from the tool stand with the Tool Changer coupled.

5. Normal operation.

   a. The following inputs are ON:
      ii. **Locked**
      iii. **Auxiliary Power Available**
      iv. **RTL**
      v. **Tool-ID**

   b. The following inputs are OFF:
      i. **Solenoid Energized**
      ii. **Unlocked**

      **NOTICE:** The **Latch** output can be turned OFF, after the Locked input has indicated the Tool Changer is in the locked state.

   c. The following outputs are OFF:
      i. **Latch**
      ii. **Unlatch**

6. The robot moves into the tool stand with the Tool Changer coupled.

7. Uncouple the Tool Changer.

   a. Turn the **Latch** output OFF and turn the **Unlatch** output ON.
   b. Arc Prevention powers off. Power on the Tool turns off.
   c. Communication is lost with the downstream devices.
   d. The **Tool-ID** becomes unavailable.
   e. The **Locked** input OFF a short time later and subsequently the **Unlocked** input turns ON, indicating that the uncoupling operation is complete. For units with double solenoid valves, after the **Unlocked** input turns ON, the **Unlatch** output can be turned OFF.

8. The robot and Master move away from the Tool, are parallel and between 0.125” to 0.06” of the Tool.

   a. The **RTL** inputs turn OFF.

9. The robot and Master move away from the tool, are parallel at a distance greater than 0.15” from the tool.

10. The robot and Master are in free space.

    a. The following inputs are ON:
       i. **Unlocked**
       ii. **Auxiliary Power Available**

    b. The following inputs are OFF:
       iii. **Solenoid Energized**
       i. **Locked**
       ii. **RTL**
       iii. **Tool-ID invalid**

    c. The following outputs is ON:
       i. **Unlatch**

       **NOTICE:** The **Unlatch** ouput can be turned OFF, after the **Unlocked** input indicates the Tool Changer is in an unlocked state.

    d. The following output is OFF:
       i. **Latch**

# 5. Maintenance

The modules are not designed to be field serviced as all point-to-point wiring connections are soldered. Component replacement is limited to the V-ring seal on the Master.

**WARNING:** Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

If the Tool Changer is used in dirty environments (for example: welding or deburring applications), limit the exposure of the Tool Changer. Idle Tool assemblies should be covered to prevent debris from settling on the mating surface. Also, the Master assembly should be exposed for only a short period of time during Tool change and down time.

Under normal conditions, no special maintenance is necessary; however, perform periodic inspections to assess for unexpected damage and assure long-lasting performance. Perform the following visual inspection monthly:

- Inspect mounting fasteners to verify they are tight and if loose, then tighten to the proper torque. Refer to *Section 3—Installation.*
- Cable connections should be inspected during maintenance periods to ensure they are secure. Loose connections should be cleaned and re-tightened. Inspect cable sheathing for damage, repair or replace damaged cabling. Loose connections or damaged cabling are not expected and may indicate improper routing and/or strain relieving.
- Inspect the Master and Tool pin blocks for any pin damage, debris or darkened pins. Refer to *Section 5.1—Pin Block Inspection and Cleaning*.
- Inspect V-ring seals for wear, abrasion, and cuts. If worn or damaged, replace. Refer to *Section 6.2.1—Seal Replacement*.

## 5.1 Pin Block Inspection and Cleaning

***Tools required:*** *Nylon Brush (ATI part number 3690-0000064-60)*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Inspect the Master and Tool pin blocks for debris or darkened pins.

**Figure 5.1—Inspect Master and Tool Pin Blocks**

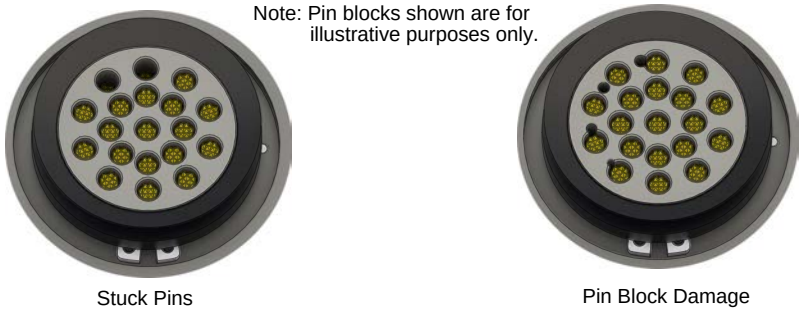

5. If debris or darkened pins are present, use a vacuum to remove the debris, and clean using a nylon brush (ATI part number 3690-0000064-60).

**NOTICE:** Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number 3690-0000064-60).

**Figure 5.2—Clean Pin Blocks with a Nylon Brush**

6. Inspect the Master and Tool pin blocks for stuck pins or pin block damage.

**Figure 5.3—Stuck Pin and Pin Block Damage**




7. If pins become stuck or if there is damage to the pin block, contact ATI for either a possible pin replacement procedure or module replacement.
8. Safely resume normal operation.

# 6. Troubleshooting and Service Procedures

The following section provides troubleshooting information to help diagnose conditions with the Tool Changer and service procedures to help resolve these conditions.

**WARNING:** Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

## 6.1 Troubleshooting

Refer to the following table for troubleshooting information.

**Table 6.1—Troubleshooting**

| Symptom | Possible Cause | Correction |
|---|---|---|
| Unit will not lock or unlock | Debris caught between the Master and Tool plates. | Clean debris from between Master and Tool plates. Verify mounting fasteners is secure and does not protrude above the mating surfaces. |
| | Ball bearings are not moving freely. | Verify the ball bearings are moving freely. Clean and lubricate as needed. Refer to the *Maintenance section of the Tool Changer manual* for instructions. |
| | Air supply not to specifications. | If Air Supply Pressure Available bit OFF, check air supply. Refer to the *Installation section of the Tool Changer manual* for specifications. (must have at least 60 PSI, this should turn the Air Supply Pressure bit ON). |
| | | If Air Supply Pressure Available bit still OFF, valve adapter air pressure switch malfunctioning, refer to *valve adapter manual* for replacement instructions. |
| | Valve adapter exhaust muffler clogged. | The valve adapter exhaust muffler may be clogged. Refer to the *valve adapter manual* for more information. |
| | TSI switch not functioning properly. | Verify the TSI switch is functioning and properly adjusted. |
| | Signals are mapped incorrectly. | Verify signals are mapped and are communicating properly. Refer to *Section 9—Drawings* for electrical schematic. |
| | Master and Tool are within the specified No-Touch zone. | Verify the Master and Tool are within the specified No-Touch zone when attempting to lock. *Refer to the Installation – tool stand Design Section of the Tool Changer manual for specifications.* |
| | Solenoid valve not functioning. | The valve adapter exhaust muffler may be clogged. Refer to the *valve adapter manual* for more information. |

| Table 6.1—Troubleshooting | | |
|---|---|---|
| **Symptom** | **Possible Cause** | **Correction** |
| Sensors not operating properly (but DeviceNet is operating correctly). | Tool plate is not secured properly or debris is trapped between surfaces. | Ensure that the Tool plate is securely held to the Master plate, that nothing is trapped between their surfaces. |
| | Valve adapter exhaust muffler clogged. | The valve adapter exhaust muffler may be clogged. Refer to the *valve adapter manual* for more information. |
| | Sensor cables damage or incorrectly connected. | Verify the cables are connected correctly and not damaged, replace if damaged. Refer to the Troubleshooting Section of the Tool Changer manual. |
| | Sensors are not functioning. | Verify the sensors are functioning. Refer to the Troubleshooting Section of the Tool Changer manual. |
| Loss of DeviceNET Communication | Damaged signal cabling | Check/Replace signal cabling upstream and downstream of Tool Changer modules. |
| | Worn dirty, or damaged contact pins. | Inspect module contact pins for debris/wear/ damage. Refer to *Section 5.1—Pin Block Inspection and Cleaning*. |
| | Product upstream and downstream of Tool Changer failed or damaged | Check product upstream and downstream of Tool Changer for failure. This failure can “appear” to be caused by the Tool Changer or affect Tool Changer performance. |
| No Power on the Tool side | Latch command not issued | Verify the Latch command has been issued by the robot. |
| | Loss of DeviceNet power on the Master. | Restore DeviceNet Power to the Master. |
| | Worn dirty, or damaged contact pins. | Inspect module contact pins for debris/wear/ damage. Refer to *Section 5.1—Pin Block Inspection and Cleaning*. |
| Tool Changer is locked or in a missed tool condition. (without the Tool plate attached). The Tool Changer cannot be Unlocked using the Unlatch command. | The Latch command was sent to the robot without the Tool plate in position to be Locked. | Unlock Tool Changer manually refer to *Section 6.1.1—Solenoid Valve Manual Override Procedure.* |

### 6.1.1 Solenoid Valve Manual Override Procedure

The manual override procedure should be used when the Tool Changer is locked without the Tool plate attached. The control module safety circuit does not allow the Tool Changer to be unlatched without the Tool plate attached and the tool in the tool stand.

**WARNING:** Do not use the solenoid valve manual override if the tool is locked to the Master. Using the manual override will release the Tool and may cause bodily injury or damage to equipment. If the Tool is attached to the Master, it must be secured in the tool stand or in a location where the tool weight is supported before using the manual override.

**CAUTION:** The manual override is not intended for normal operations. Manual override is to be used in situations where no alternative is available to unlock the Master. Do not execute the Latch command unless the Master and the Tool are ready to be coupled.

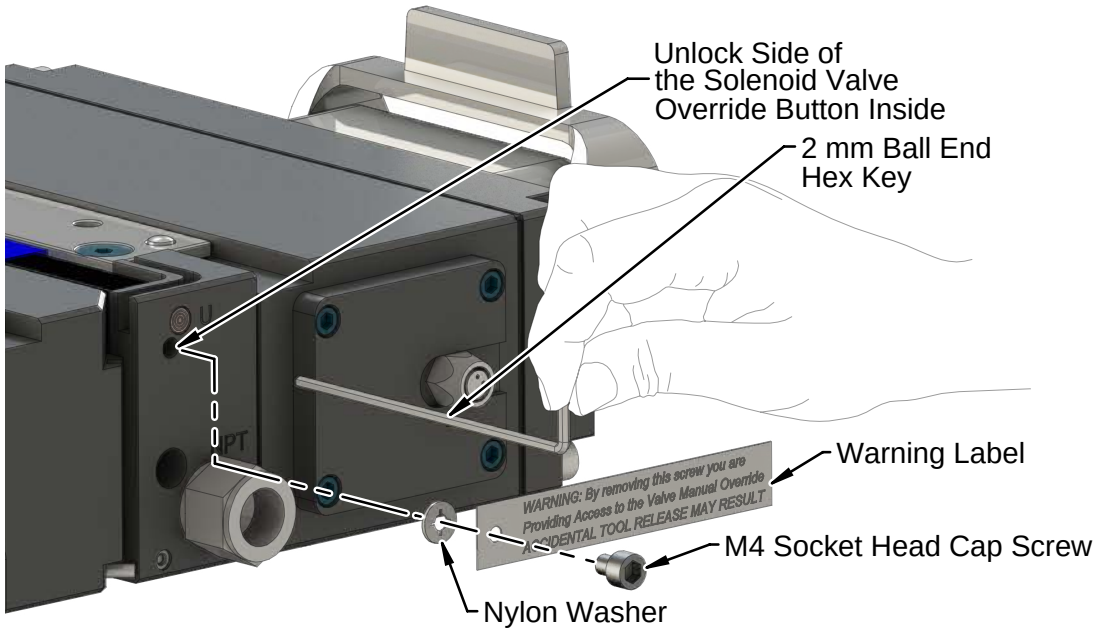
***Tools required:*** *3 mm hex key, 2 mm ball end hex key*

1. Using a 3 mm hex key, remove the M4 socket head cap screws, warning label, and nylon washer from the Unlock side of the solenoid valve. The Unlock side is marked with a “U”.

**CAUTION:** Applying excess force can damage the solenoid or cause the override button to stick in one position. Actuation of valve override buttons requires about 1 mm of travel and minimal of force. Use a non-sharp object, similar to ball nose 2 mm hex key, to gently depress the override button; an air release should be heard when the solenoid is activated.

2. Insert a 2 mm ball end hex key in the unlock valve screw hole and gently depress the valve override button. An air release should be heard when the solenoid is actuated. Make sure the locking mechanism is fully retracted.
3. Using a 3 mm hex key, replace the M4 socket head cap screws, warning label, and nylon washer and tighten the screw.

**Figure 6.1—Manual Override**



## 6.2 Service Procedures

The following service procedures provide instructions for component replacement and adjustment.

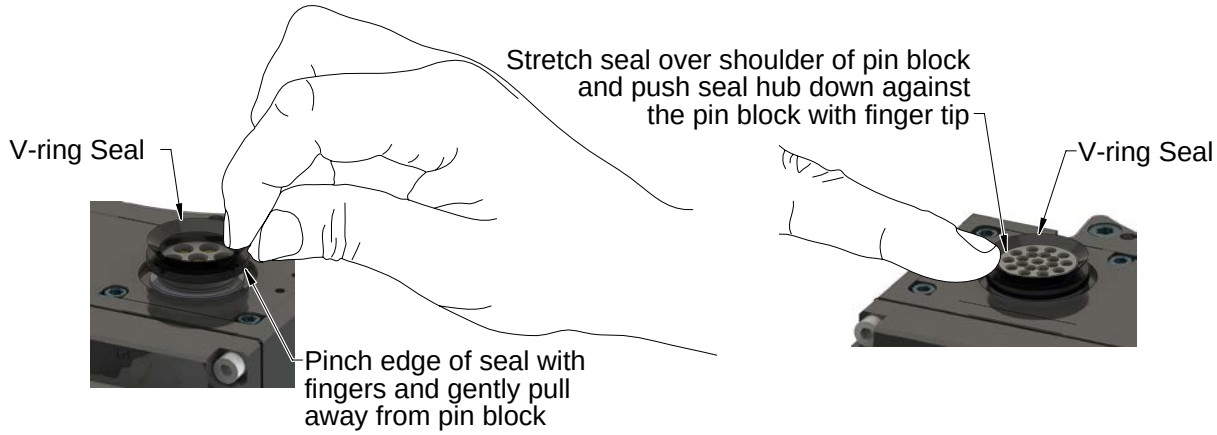
### 6.2.1 Seal Replacement

***Parts required:*** *Refer to Section 9—Drawings.*

The seal protects the electrical connection between the Master and Tool module. Replace the seal if it becomes worn or damaged.

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. To remove the existing seal, pinch the edge of the seal and pull the seal away from the pin block on the Master module.
5. To install a new seal, stretch the new seal over the shoulder of the pin block.
6. Push the seal hub down against the pin block.
7. Safely resume normal operation.

**Figure 6.2—V-ring Seal Replacement**



# 7. Serviceable Parts

Refer to *Section 9—Drawings* for additional serviceable parts that are not listed in the following tables.

## 7.1 Master Module Serviceable Parts

| Table 7.1—Master Module Mounting Fasteners | | |
|---|---|---|
| **Part Number** | **Qty** | **Description** |
| 3500-1066020-15A | 2 | M6 x 20 Socket Head Cap Screw, 12.9, ISO4762/DIN912, Corrosion Protection Coating, YL M-spheres/IFI 525 |

## 7.2 Tool Module Serviceable Parts

| Table 7.2—Tool Module Mounting Fasteners | | |
|---|---|---|
| **Part Number** | **Qty** | **Description** |
| 3500-1066016-15A | 2 | M6 x 16 Socket Head Cap Screw, 12.9, ISO4762/DIN912, Corrosion Protection Coating, YL M-spheres/IFI 525 |

## 7.3 Accessories

| Table 7.3—Accessories | |
|---|---|
| **Part Number** | **Description** |
| 3690-0000064-60 | Brush, Blue Nylon All Purpose (Contact Pin Cleaning) |

# 8. Specifications

| Table 8.1—DA4 Master Module Specifications | |
|---|---|
| 9121-DA4-M | DeviceNet Master Module with 10-pin pass-through. Supports Auxiliary Power, DeviceNet Communication, integrated Tool Changer L/U/R1/R2 Sensors, Master Side TSI, and Integrated valve connection. |
| Factory Default Configuration | MAC ID 54, Baud 500 Kbps, termination resistance “on”. |
| Connector(s) | (1) 4-pin male auxiliary power connector<br>(1) 5-pin male DeviceNET connector<br>(1) 5-pin female M12 TSI connector<br>(4) 3-pin female M8 connectors supporting Tool Changer Locked, Unlocked, and Ready-to-Lock proximity sensors. RTL sensors are connected in series.<br>(1) 3-pin female integrated valve connector that is used to transmit Latch and Unlatch signals to the solenoid valve. |
| Electrical Rating | Power:<br>• Aux1 V+ and Aux2 V+ power[1]: 5 A, 12-30 VDC<br>• CAN V+ (DeviceNet) Power1: 5 A, 12-30 VDC<br>Signal: 3 A, 30 VDC max.<br>Lock, Unlock, and Ready-to-Lock sensors: 10-30 VDC operational voltage[2].<br>Latch/Unlatch integrated solenoid valve: 21-26 VDC operational voltage[3].<br>Valve Control Power:<br>• Latch and Unlatch Valve control: 19-29 VDC operational voltage. |
| Current Draw[4] | 63 mA typical[5] |
| Weight | 2.15 lbs (0.98 kg) |

Notes:

1. Arc prevention is applied to CAN V+, Aux1 V+ and Aux V+ power.
2. CAN V+ power provides power to the L, U, and RTL sensors.
3. Aux1 V+ power provides power to the latch and unlatch solenoid valve.
4. Current Draw totals for DeviceNet-powered circuits, not including downstream I/O devices and Auxiliary powered valves. Refer to the module manufacture for these specifications.
5. Does not include solenoid, which uses auxiliary power.

| Table 8.2—DA4 Tool Module Specifications | |
|---|---|
| 9121-DA4-T | DeviceNet Tool Module with 10-pin pass-through. Supports Auxiliary Power, DeviceNet communication, (5) Independent Tool-ID switches, each reading a (0-9) position. |
| Factory Default Configuration | MAC ID 55, Baud 500 Kbps, No termination resistance. (5) Independent Tool ID switches, each reading a (0–9) position (all factory set to Tool Position 1). |
| Connector(s) | (1) 4-pin female auxiliary power connector<br>(1) 5-pin female DeviceNET connector |
| Electrical Rating | Power:<br>• Aux1 V+ and Aux2 V+ power[1]: 5 A, 12-30 VDC<br>• CAN V+ (DeviceNet) Power1: 5 A, 12-30 VDC<br>Signal: 3 A, 30 VDC max. |
| Current Draw[2] | 61 mA typical |
| Tool-ID | 0-99999 |
| Weight | 1.41 lbs (0.64 kg) |
| Notes:<br>1. Arc prevention is applied to CAN V+, Aux1 V+ and Aux V+ power.<br>2. Current Draw totals for DeviceNet-powered circuits, not including downstream I/O devices and Auxiliary powered valves. Refer to the module manufacture for these specifications. | |

# 9. Drawings

Drawings are available on the *ATI website* or by contacting an ATI representative.