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Glossary of Terms

Term	Definition
Auxiliary Power	Power Supply interface provided that supports Switched and Un-switched circuits.
Clear Errors	An output supplied to the ATI Master Ethernet node to clear all error conditions
Comm. Error	An input indicating the status of the Tool-ID communication between Master and Tool modules.
EOAT	End-Of-Arm-Tool (end effector).
Error on Latch Output	An input indicating a short circuit overload condition exists with the Latch output.
Error on Unlatch Output	An input indicating a short circuit overload condition exists with the Unlatch output.
Latch	The output supplied to the ATI Master Ethernet node to couple the Tool Changer.
Locked	A proximity sensor input indicating that the coupling mechanism is in the Locked position.
Input and Logic Power Good	An input indicating the presence of Input Power (sourced from the Un-switched Power Supply) at the ATI Master.
RTL	A proximity sensor input that senses when the ATI Tool is in close proximity.
Switched auxiliary power	One circuit of the auxiliary power Supply that is tied into the E-stop circuit and will be switched off when the circuit is broken.
Tool-ID	An input from the Master node reporting the values from the Tool-ID switches on the Tool module.
Tool Present	A hard-wire input (sourced from the Tool) indicating the Master and Tool should be communicating with each other.
Unlatch	The output supplied to the ATI Master Ethernet node to uncouple the Tool Changer.
Unlocked	A proximity sensor input indicating that the coupling mechanism is in the Unlocked position.
Un-switched auxiliary power	One circuit of the auxiliary power Supply that is continuous and is not broken during E-stop conditions.
Valve Power Available	An input indicating the presence of Valve Power at the ATI Master.
Unlatch	The output supplied to the ATI Master node to uncouple the Tool Changer.
Unlocked	A proximity sensor input indicating that the coupling mechanism is in the Unlocked position.
Un-switched auxiliary power	One circuit of the auxiliary power Supply that is continuous and is not broken during E-stop conditions.
Valve Power Available	An input indicating the presence of Valve Power at the ATI Master.

C. Control and Signal Modules

DKD—Ethernet/IP Modules

1. Product Overview

The DKD module enables the user to control and communicate with ATI's Heavy Automation Robotic Tool Changers using EtherNet/IP while passing DeviceNet network and power to the Tool side. This allows utilizing EtherNet/IP on the robot up to the Tool Changer and establishing short connection times to the Tool side equipment by using DeviceNet Quick Connect equipment on the Tool.

Control of the Tool Changer is realized through the Master Node along with the reporting of Tool Changer I/O, such as Lock, Unlock, and Ready-to-Lock signals. The Tool-side module supports Tool-ID reported through the Master-side and functions as a pass through for DeviceNet network and power to downstream equipment.

A single or double solenoid valve is provided with the Master valve adapter for Lock/Unlock control of the Tool Changer. The user is required to provide a pneumatic supply source to the Tool Changer.

When the modules are coupled, the V-ring seal forms a water resistant but not waterproof seal around the pin block. Compliant spring pins are provided on the Master and fixed contact pins on the Tool. To avoid unintentional human contact, the Master spring pins are recessed below an insulated surface on both the power and signal circuits (See *Figure 1.1*).

General fault reporting is supported for the presence of power for Logic/Inputs and the Tool Changer valve. Advanced diagnostic and fault reporting is supported for output short circuit and overload conditions as well as for the presence of Tool-ID. Refer to *Section 2—Product Information* and *Section 4—Operation* for more information on these attributes.

The DKD module incorporates ATI's exclusive Arc Prevention Circuit which extends the life of all electrical power contacts.

1.1 DKD Master

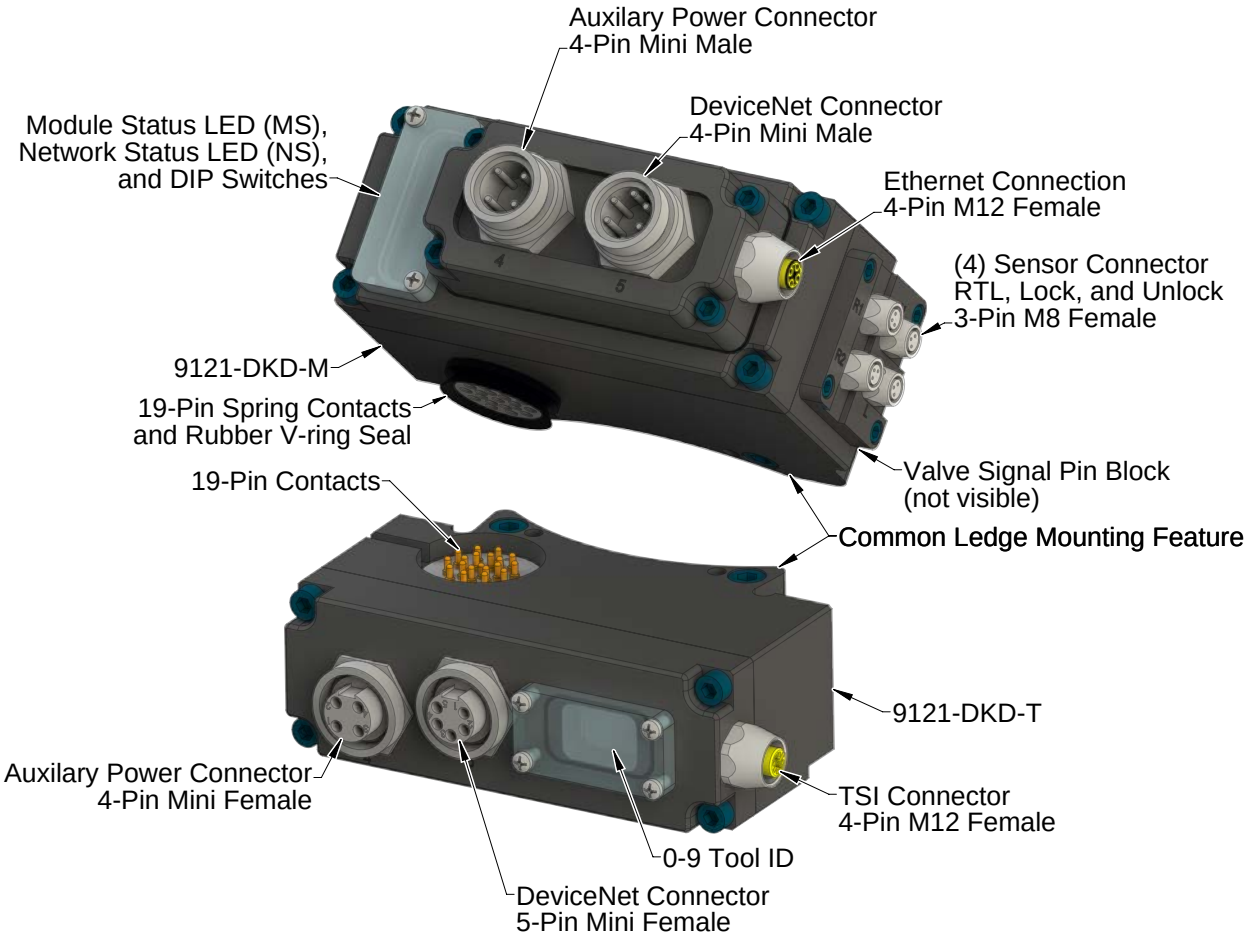
The Master module is designed with Tool Changer input signals (Locked, Unlocked, and Ready-to-Lock proximity sensors). Refer to *Section 2—Product Information* and *Section 4—Operation* for more information on these attributes.

A standard 5-pin Mini connector is provided on the Master module for DeviceNet communications interface to the Master and downstream nodes. A M12 4 pin D-Coded connectors are provided on the Master module for EtherNet/IP communications interface with the Master. A M12 4 pin connector is provided to the customer for interfacing with auxiliary power. Refer to *Section 9—Drawings* for additional information.

1.2 DKD Tool

A standard 5-pin Mini connector is provided on the Tool module for DeviceNet communications interface to the Tool and downstream nodes. A M12 4 pin connector is provided to the customer for interfacing with auxiliary power. A M12 4-pin connector is provided for interfacing with the TSI safety switch. The Tool module employs a series of push-button switches for setting of the Tool-ID input. This allows the customer to distinguish between the different Tools used in a robotic cell or on a production line. The Tool-ID is reported through the Master module bitmap. Refer to *Section 2.4—Software* for bitmap and detailed I/O information.

Figure 1.1—Modules



2. Product Information

An EtherNet/IP node is established on the Master module but not on the Tool module. Control of the Tool Changer is realized through the Master node along with 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 and auxiliary power signals to downstream equipment.

The DKD modules provide a 4-pin Mini connector for auxiliary power, 5-pin Mini connector for DeviceNet, and an M12 D-Coded 4-pin connector for EtherNet/IP communications. Please refer to *Section 9—Drawings* for specific module wiring and connector interface information.

Prior to using the Tool Changer and the EtherNet/IP modules, various hardware settings must be configured. Communicating with the EtherNet/IP modules requires knowledge of EtherNet/IP standards and operation.

2.1 Master Module Node

The module operates as a Server on the EtherNet/IP network. It supports Class 3 Connected Explicit Messaging, UCMM Explicit Messaging, and Class 1 Connected Cyclic I/O Messaging. The Master Node does not support any Client functionality.

2.1.1 Class 1 Connection Information

Table 2.1 lists the Class 1 Connection Information for the Master module.

Table 2.1—Class 1 Connection Information

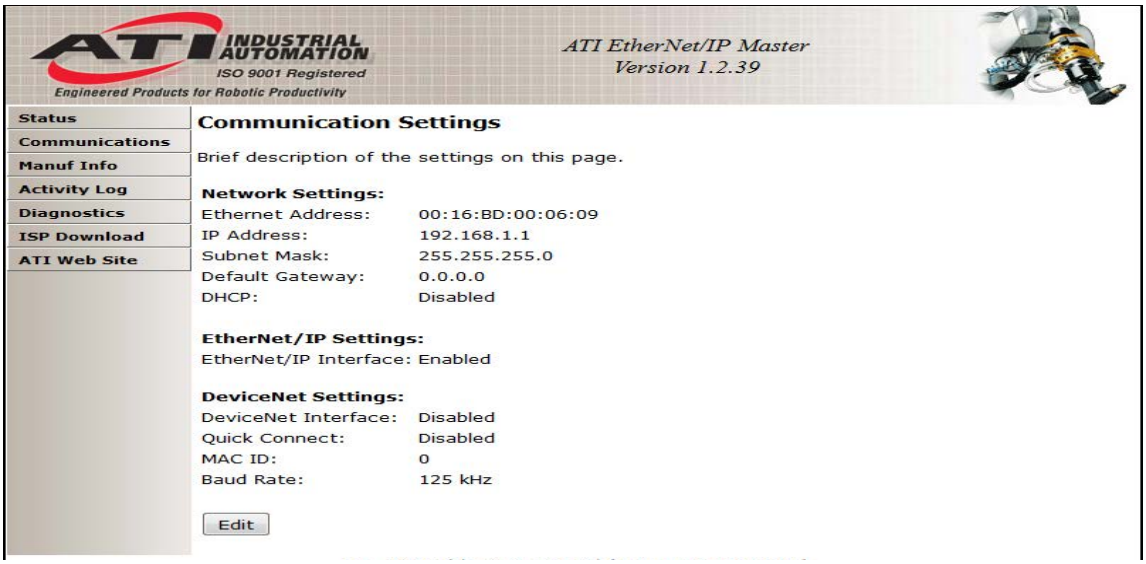
	Instance	Size in Bytes
Configuration	128	0
Input	7	8
Output	37	8

2.1.2 IP Address

The IP address is factory set to a default value of 192.168.1.1. A new IP address can be configured through the integrated web server using the following procedure:

1. Click on the upper “Edit” button,
2. Change the IP address and click on the “Apply” button,
3. Cycle power to make the change effective.

Figure 2.1—Changing IP Address



2.1.3 Module and Network Status LED's

The module status LED is identified on the module as "MS". It provides device status for power and operation. Refer to *Figure 2.2* for location of LED's. Refer to *Table 2.2* for an outline of this LED's operation. The network status LED is identified on the module as "NS". It provides network status for power and communication. Refer to *Table 2.3* for an outline of this LED's operation.

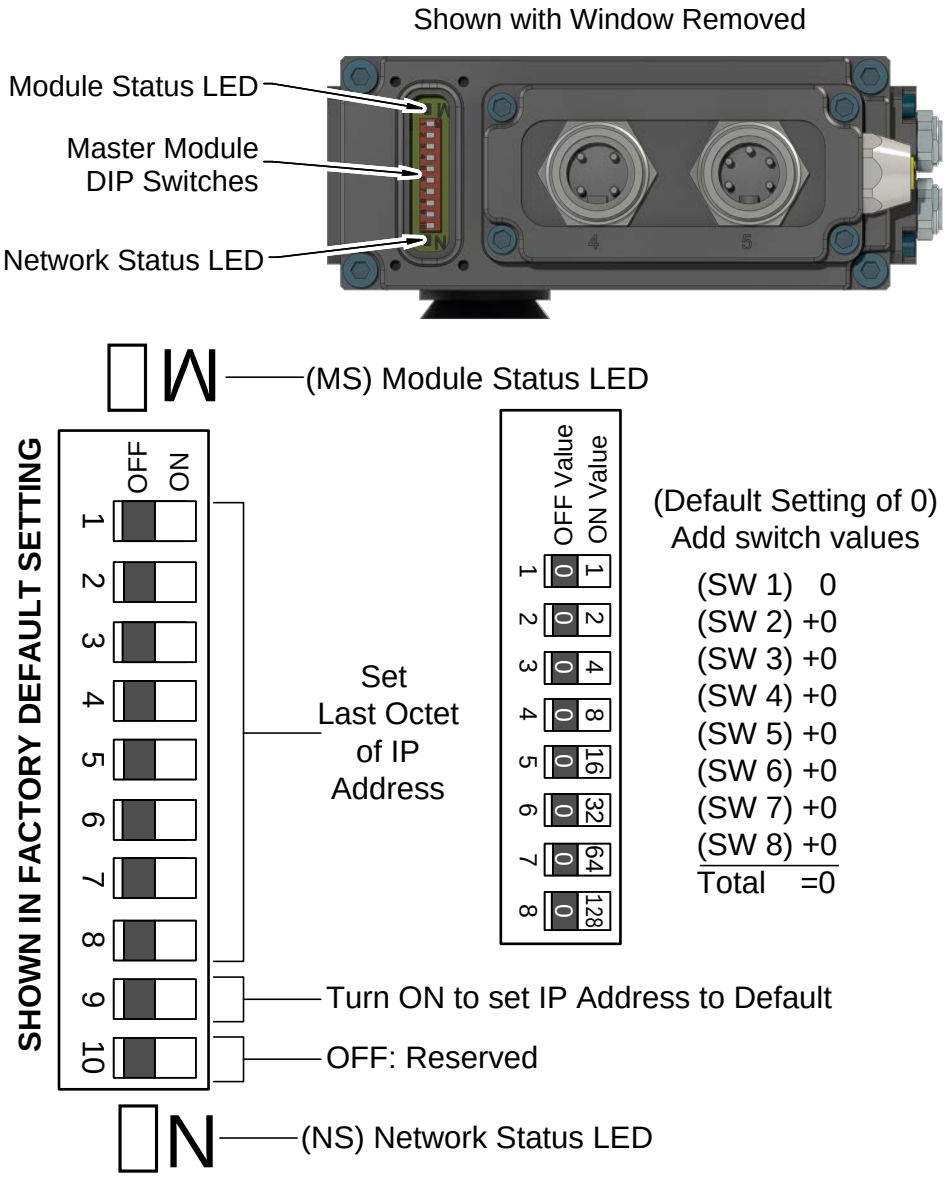
Table 2.2—Master module Status LED

Color	State	Indication
None	OFF	No Power
Red	Solid	Unrecoverable Fault
	Flashing	Recoverable Fault
Green	Solid	Normal Runtime Operation
	Flashing	No Tool module attached. Tool-ID in bitmap not available. Configuration missing, incomplete or incorrect.
Green-Red	Flashing	Device is performing a self-test.

Table 2.3—Master Network Status LED

Color	State	Indication
None	OFF	No Power/ Off Line/No IP Address
Red	Solid	Device has detected that its IP address is already in use.
	Flashing	One or more I/Os are timed out.
Green	Solid	Device is on line with connections established. Device is allocated to a Master.
	Flashing	Device is on line but connection is not established. Device not allocated to a Master.
Green-Red	Flashing	Device is performing a self-test.

Figure 2.2—Master Module DIP Switches and LED's



2.2 Arc Prevention Circuit

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

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

1. DeviceNet Power (CAN V+)
2. Switched auxiliary power V+
3. Unswitched auxiliary power V+

The behavior of the Arc Prevention circuit is more fully described in the following sections.

2.2.1 Arc Prevention Circuit Behavior during Coupling

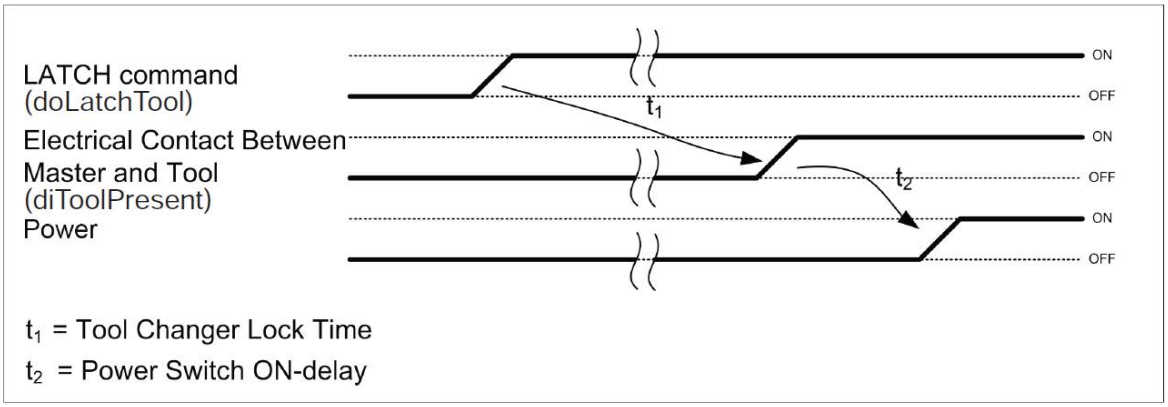
The behavior of the Arc Prevention circuit during coupling can be more clearly understood by referring to *Figure 2.3*, which shows the power on timing diagram for the Arc Prevention Circuit. Starting at the top of the diagram, the LATCH command is issued thus initiating locking of the Master and Tool.

Soon after locking is initiated, electrical contact between Master and Tool pin contacts occurs (this time is designated t1 in the diagram). The magnitude of time t1 is a function of many factors including the weight of the EOAT, the distance between the Master and Tool when the LATCH command is issued, how well the Master and Tool are aligned during pick up, etc.

As soon as electrical contact is made and the LATCH command is issued, the Arc Prevention Circuit will turn on Input and Output Power. The time delay between when the electrical contacts become fully engaged to when power is actually available to the EOAT (time t2 in the diagram) is less than 100 ms.

Important: The Arc Prevention Circuit will only allow power to pass to the Tool after the LATCH command has been issued **and** the Master and Tool module's electrical contacts are fully engaged.

Figure 2.3—Power On Timing



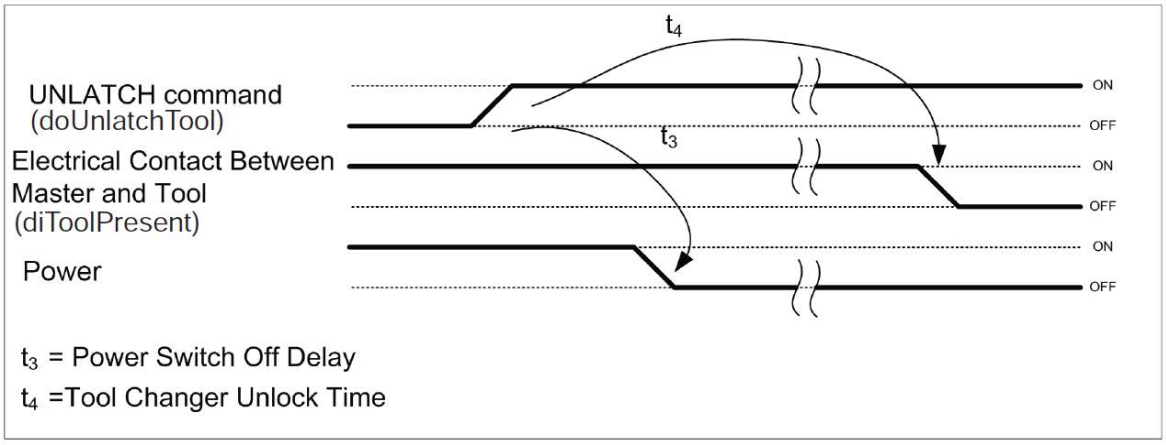
2.2.2 Arc Prevention Circuit Behavior during Uncoupling

The behavior of the Arc Prevention Circuit during uncoupling can be more clearly understood by referring to *Figure 2.4*, which shows the power off timing diagram for the Arc Prevention Circuit. Starting at the top of the diagram, the UNLATCH command is issued thus initiating uncoupling of the Master and Tool.

Immediately after the UNLATCH command is issued, the Arc Prevention Circuit will turn off Input and Output Power. The power off time delay between the UNLATCH command and the switching off of power (designated t3 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 Master and Tool pin contacts will be lost. This occurs with a delay, designated t4 in the diagram, after the UNLATCH command is issued. The magnitude of time t4 is a function of many factors, including the weight of the EOAT, the friction between Master and Tool alignment pins, etc. but is usually not shorter than 100 ms.

Figure 2.4—Power Off Timing

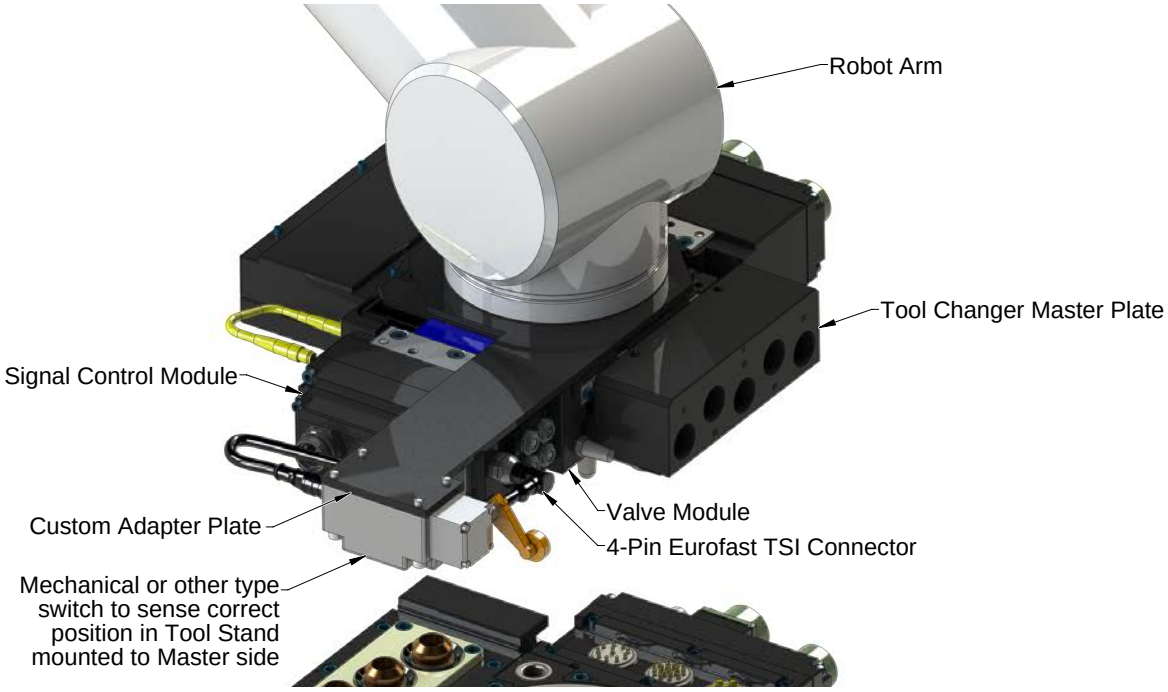


2.2.3 Tool Side TSI

The tool stand Interlock (TSI) circuit is provided to ONLY allow Tool release while in the stand or storage location as indicated by actuation of a customer-integrated switch. It is suggested that the customer integrate a single throw, double pole (Normally Open, spring return) limit switch to work with this feature (reference *Figure 2.5*). The limit switch should be mounted to the end effector in such a way that the switch is "made" only when the Tool is in the stand or storage location.

An interface to the TSI circuit is made available to the customer via a 4-pin M12 connector on the master module. An off the shelf cord set can be utilized to connect this interface to the limit switch assembly. The 4-pin connection is factory supplied with a teach plug to override the TSI circuit during setup and integration. Reference the drawings in *Section 9—Drawings* for additional details.

Figure 2.5—TSI Safety Switch



2.2.3.1 TSI Overview

The DKD module relies on the status of the Ready-to-Lock (RTL) sensors and the TSIV input to determine when it is appropriate to unlatch the Tool. The RTL sensors indicate if the Master and Tool are coupled while the TSIV input indicates when the TSI mechanical switch on the Tool is actuated, thereby indicating that the Tool is in the stand.

For example, if the DKD module receives an UNLATCH command and the RTL sensor signals indicate that Master and Tool are coupled but the TSIV indicates that the Tool is not in the tool stand then the UNLATCH command is ignored. The logic employed to determine when to enable the UNLATCH command is detailed in *Table 2.4*.

Table 2.4—UNLATCH Enable Logic and Truth Table

RTL1 & RTL2	TSIV	UNLATCH Enabled	Status of Master Body
0	0	1	No Tool, positioned in free air
0	1	1	No Tool, positioned in tool stand (this is a transient state which is only true just prior to RTL being made)
1	0	0	Tool is present, positioned in free air
1	1	1	Tool is present, positioned in tool stand

When UNLATCH is enabled it will be reported in the bitmap in the form of the "Unlatch Enabled" bit (refer to *Section 2.4—Software*).

As an additional safety measure, a "hard-wired" interrupt of the UNLATCH signal is provided when the RTL sensors indicate that Master and Tool are coupled and the Tool is not in the tool stand.

The following TSI status signals are also reported in the bitmap (refer to *Section 2.4—Software*):

RTLV (Ready To Lock Verify): Ready To Lock Verify status of RTL bypass relay in the Master module.

TSIV (TSI Limit Switch Verify): Status of 2nd contact of the limit switch that is located on the Tool.

TSRV (TSI Relay Verify): Status of the TSI Relay in the Tool module.

The Sequence of Operations in Appendix A of this manual describes in detail the behavior of the RTLV, TSIV, and TSRV bits during the operation of the Tool Changer.

2.3 Tool Module

An Ethernet node is not established on the Tool module. The Tool module utilizes a patented, rapid communication method to report the Tool-ID information from the push-button switches to the Master module as soon as the Tool Changer is coupled. Typically the Tool-ID information is available to the Master within 250 ms from the time the changer is coupled. Diagnostic capability is provided for Tool-ID via the Comm. Error input supported in the Master bitmap. If the Tool Present input is high, then a valid Tool-ID should follow and if it does not then the Comm. Error is made high.

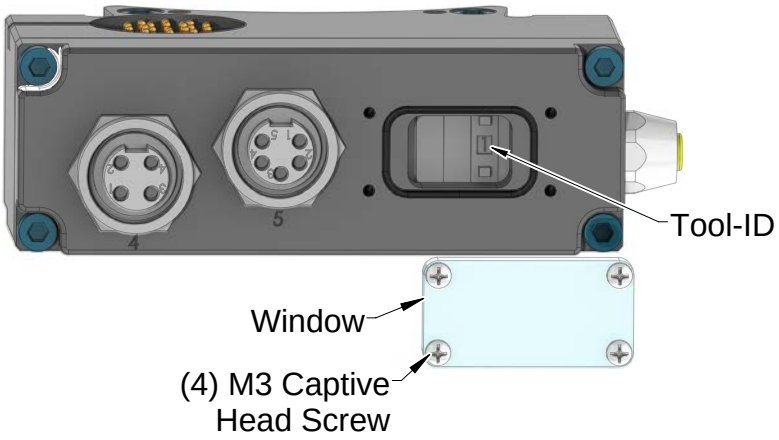
In addition to providing Tool-ID the Tool module also functions as a pass through for DeviceNet and auxiliary power signals to downstream equipment, reference drawings in Section 9.

2.3.1 Tool-ID Switches

A push-button switch is provided on the Tool module for setting of a Tool-ID number.

Figure 2.6 shows the location of the Tool-ID push-button switches. After adjustment is completed, ensure that the seal and window are re-positioned correctly to prevent a leakage path to inside the module

Figure 2.6—Tool-ID Switch Settings



2.4 Software

A working EDS file for the Master node is available from our website:

(*www.ati-ia.com/download/edsfiles*) or by e-mail, reference the following part number.

DKD-M Node EDS file 9030-20-1016

An I/O bitmap for the Master node is provided in the *Table 2.5* and *Table 2.6*.

Table 2.5—Robot Input From ATI Master

Byte	Bit#	Name	Description/Function
1	0	Locked	Tool Changer Locked Proximity Sensor Input
	1	Unlocked	Tool Changer Unlocked Proximity Sensor Input
	2	Input and Logic Power Good	Input and Logic Power Present Input
	3	Valve Power Available	Valve Power Present Input
	4	RTL1	Ready-to-Lock 1 Proximity Sensor Input
	5	RTL2	Ready-to-Lock 2 Proximity Sensor Input
	6	RTLV	Ready-to-Lock Verify Input
	7	-	(Reserved)
2	0	Tool-ID 1	Tool-ID
	1	Tool-ID 2	Tool-ID
	2	Tool-ID 4	Tool-ID
	3	Tool-ID 8	Tool-ID
	4	TSIV	TSI Limit Switch Verify
	5	TSRV	TSI Relay Verify
	6	Unlatch Enabled	Unlatched Enabled Status Information
	7	Tool Present	Hard-Connect Tool Present Input
3	0	-	(Reserved)
	1	-	(Reserved)
	2	Error on Latch Output	Latch output overloaded
	3	Error on Unlatch Output	Unlatch output overloaded
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)
4	0	-	(Reserved)
	1	-	(Reserved)
	2	-	(Reserved)
	3	-	(Reserved)
	4	-	(Reserved)
	5	-	(Reserved)
	6	COMM OK	Indicates EtherNet/IP Connectivity is Established
	7	Tool Power Is ON	Indicates that Arc Prevention Circuit is turned ON and power is provided to the Tool

Table 2.5—Robot Input From ATI Master			
Byte	**Bit#**	**Name**	**Description/Function**
5	0	-	(Reserved)
	1	-	(Reserved)
	2	-	(Reserved)
	3	-	(Reserved)
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)
6	0	-	(Reserved)
	1	-	(Reserved)
	2	-	(Reserved)
	3	-	(Reserved)
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)
7	0	-	(Reserved)
	1	-	(Reserved)
	2	-	(Reserved)
	3	-	(Reserved)
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)
8	0	-	(Reserved)
	1	-	(Reserved)
	2	-	(Reserved)
	3	-	(Reserved)
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)

Table 2.6—Robot Outputs to ATI Master			
Byte	**Bit#**	**Name**	**Description/Function**
1	0	Latch (Lock)	Latch Solenoid Valve Output
	1	Unlatch (Unlock)	Unlatch Solenoid Valve Output
	2	-	(Reserved)
	3	Clear Errors	Reset errors, allow affected I/O to be reactivated
	4	-	(Reserved)
	5	-	(Reserved)
	6	-	(Reserved)
	7	-	(Reserved)
2 - 8	-	-	(Reserved)

3. Installation

The control/signal modules are typically installed by ATI prior to shipment. 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.

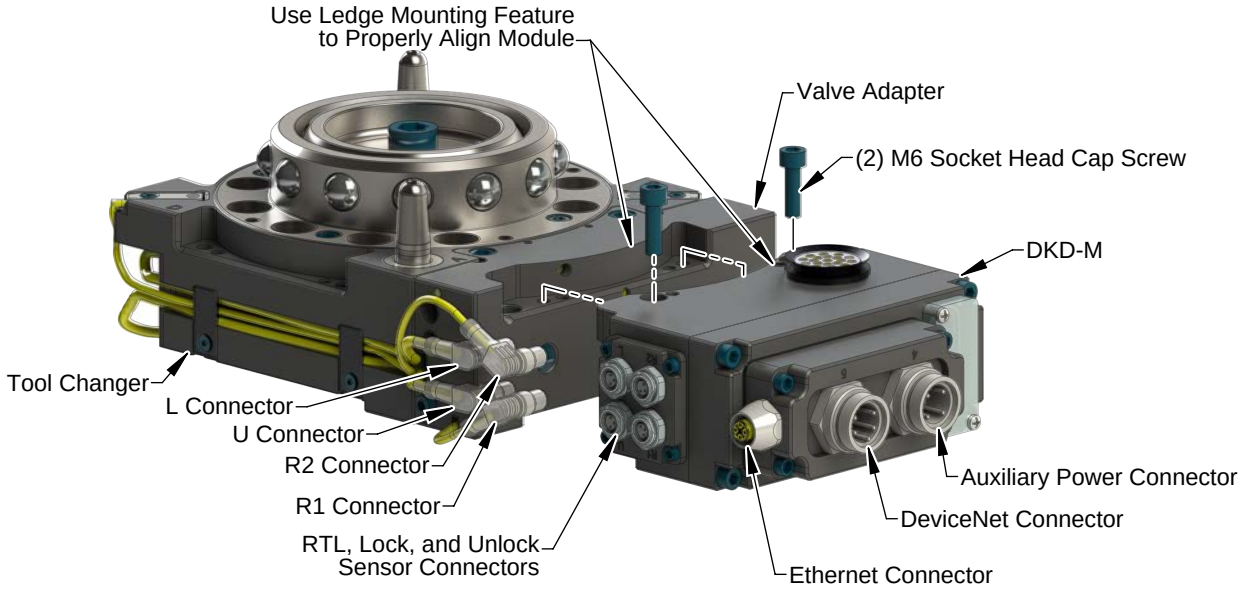
3.1 Master Module Installation

Tools required: *5 mm Allen wrench (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. Using the ledge feature, place the module 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 M6 socket head cap screws. Install the (2) M6 socket head cap screws securing the module to the valve adapter and tighten to 70 in-lbs (7.9 Nm) using a 5 mm Allen wrench.
7. Set the DIP switches. Refer to *Section 3.5—Setting the Master DIP Switches*.
8. Connect the (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors to the module.
9. Customer interface, auxiliary power and Ethernet cables to the module. Ensure that the connectors are cleaned prior to being secured.
10. After the procedure is complete, resume normal operation.

Figure 3.1—Master Module Installation and Removal



3.2 Master Module Removal

Refer to *Figure 3.1*

Tools required: *5 mm Allen wrench (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 (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors from the module.
5. Disconnect the auxiliary power and Ethernet cables from the module.
6. Support the module and remove the (2) M6 socket head cap screws using a 5 mm Allen wrench. Lower the module until it clears the guide pin.

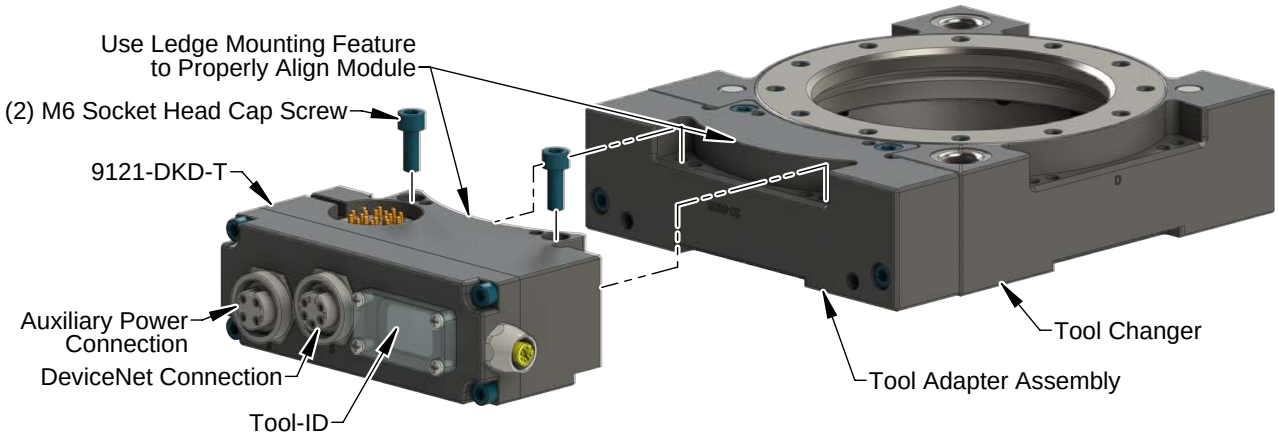
3.3 Tool Module Installation

Tools required: *5 mm Allen wrench (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. Using the ledge feature, place the module on the valve adapter spacer. Align the module with the valve adapter spacer using the dowels in the bottom of the ledge feature.
6. Apply Loctite 242 to the supplied M6 socket head cap screws. Install the (2) M6 socket head cap screws securing the module to the valve adapter spacer and tighten to 70 in-lbs (7.9 Nm) using a 5 mm Allen wrench.
7. Connect the power cable and Ethernet/DeviceNet cable connectors to the module.
8. Set the Tool-ID. Refer to *Section 3.6—Setting the Tool-ID.*
9. After the procedure is complete, resume normal operation.

Figure 3.2—Tool Module Installation and Removal



3.4 Tool Module Removal

Tools required: *5 mm Allen wrench (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 auxiliary power and Ethernet cables from the module.
5. Support the module and remove the (2) M6 socket head cap screws using a 5 mm Allen wrench. Lift up on the module until it clears the guide pin.

3.5 Setting the Master DIP Switches

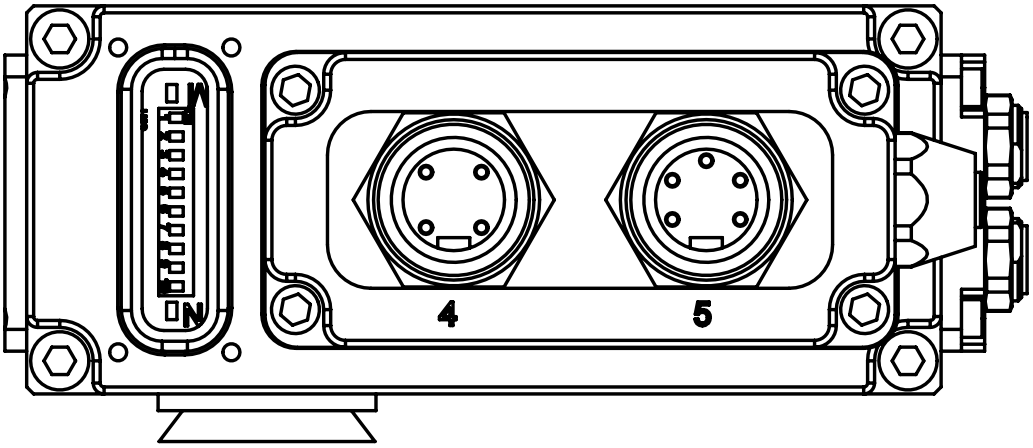
Tools required: *Phillips screwdriver*

1. Using a Phillips screwdriver, loosen the (2) M3 pan head captive screws and remove the window.
2. Set the DIP switches as needed, refer to *Figure 3.3* for details.

NOTICE: When replacing the window, ensure that the seal is positioned correctly to prevent fluid leakage into the module and damaging the electronics.

3. Re-install the window and tighten the (2) M3 pan head captive screws.

Figure 3.3—Master module DIP Switches and LED's



3.6 Setting the Tool-ID

Tools required: *Phillips screwdriver*

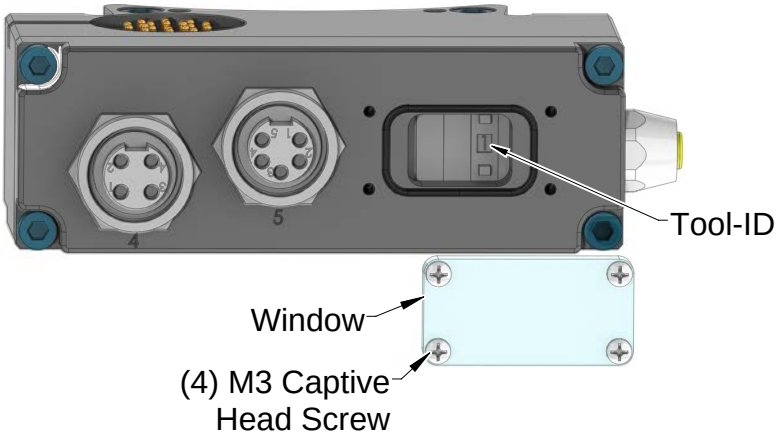
A push button switch is provided on the Tool module for setting of a Tool-ID number. Each Tool must have a unique single digit Tool-ID number.

1. Using a Phillips screwdriver, loosen the (4) M3 pan head captive screws and remove the Tool-ID window.
2. Use a non-conductive tool (e.g., plastic stylus) to press on the Tool-ID push buttons to increase (+) or decrease (-) the digit values.

NOTICE: When replacing the window, ensure that the seal is re-positioned correctly to prevent fluid ingress.

3. Re-install the Tool-ID window and tighten the M3 pan head captive screws.

Figure 3.4—Tool-ID Switch Settings



3.7 Utility Schematic

Refer to *Section 9—Drawings* of this manual for customer interface and wiring details for the modules.

WARNING: All pneumatic fittings and tubing must be capable of withstanding the repetitive motions of the application without failing. The routing of electrical and pneumatic lines must minimize the possibility of over stressing, pullout, or kinking the lines. Failure to do so can cause some critical electrical and/or pneumatic lines not to function properly and may result in injury to personnel or damage to equipment. Follow the robot manufacturer's guidelines and carefully route hoses and cables to avoid damage.

4. Operation

A procedure in *Section 4.3—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 control/signal modules. This procedure is intended for "automatic" modes used during normal application processes. Recommendations for operation in "teach" or "manual" modes where the operator has the teach pendant in-hand will be addressed in a separate Troubleshooting Guide. A thorough understanding of the advanced diagnostic and fault reporting capability is required to proficiently operate this product.

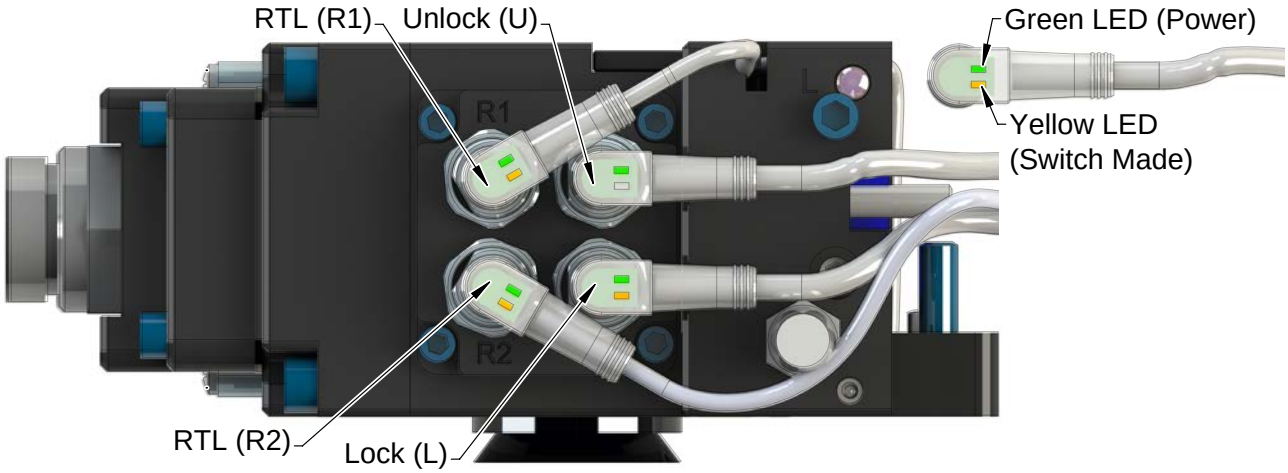
4.1 Lock, Unlock, and RTL Sensor Cable LED Behavior

The Lock, Unlock, and RTL sensor cables are equipped with two 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.

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) Sensor	ON / OFF	ON / ON	Unlock (U) Sensor
	RTL (R2) Sensor	ON / OFF	ON / OFF	Lock (L) Sensor
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) Sensor	ON / ON	ON / ON	Unlock (U) Sensor
	RTL (R2) Sensor	ON / ON	ON / OFF	Lock (L) Sensor
Locked (Tool Changer Master plate with Tool plate attached in fully locked position)	RTL (R1) Sensor	ON / ON	ON / OFF	Unlock (U) Sensor
	RTL (R2) Sensor	ON / ON	ON / ON	Lock (L) Sensor
Missed Tool (Tool Changer Master plate locked with no Tool plate attached)	RTL (R1) Sensor	ON / OFF	ON / OFF	Unlock (U) Sensor
	RTL (R2) Sensor	ON / OFF	ON / OFF	Lock (L) Sensor

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



(Control module shown for reference only)

4.2 Diagnostic Functions and Error Handling

There are several diagnostic functions that can have an effect on the input bitmap and influence the Tool Changer control.

4.2.1 DeviceNet Power Status

The DKD module continuously monitors the voltage of the DeviceNet power supply. If the voltage is between 11V and 25V the “Input and Logic Power Good” bit will be high. If the voltage falls outside of this range the “Input and Logic Power Good” bit will be low and will remain low until the voltage is between 11V and 25V and the Clear Errors output has been set from low to high.

Note: The Tool Changer will not Unlatch while the “Input and Logic Power Good” bit is low.

4.2.2 Valve Power Status

The DKD module continuously monitors the voltage of the switched AUX power which is used to supply the lock and unlock solenoid valves of the Tool Changer. If the voltage stays above 21V the “Valve Power Available” bit will be set high. If the voltage falls below the 21V threshold the bit will be set low. It will become high again as soon as the voltage rises above 21V.

4.2.3 Error on Latch or Unlatch Output

The valve control outputs of the DKD module are protected against overload conditions such as those created by a short circuit. During an overload condition the LATCH and/or UNLATCH output is turned off and the corresponding error bit “Error on Latch Output” or “Error on Unlatch Output” is turned on. The output cannot be set high again until the overload condition is removed and the “Clear Errors” bit is set from low to high.

4.2.4 “COMM OK” bit

The “COMM OK” is set high as soon as Ethernet/IP communication is established.

4.2.5 “Tool Power is On” bit

The “Tool Power is ON” bit is set high when the Arc Prevention Circuit has activated power on the Tool-side. If this bit is low there will be neither DeviceNet nor Switched or Unswitched Auxiliary power available on the Tool.

4.2.6 “Unlatch Enabled” bit

The “Unlatch Enabled” bit is set high when the DKD module determines that the necessary preconditions for unlatching the Tool have been met (i.e., Master and Tool are Coupled, Tool is in the tool stand, etc.). A Tool can only be released if the “Unlatch Enabled” bit is high. For additional details refer to *Section 2.2.3—Tool Side TSI*.

4.3 Recommended Sequence of Operations

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). The Tool is by itself in the tool stand. No error or fault conditions exist.

    a. The **RTL** inputs (RTL1 & RTL2) are OFF.
    b. The **RTLV** input is OFF.
    c. The ATI Tool and any downstream device are offline.
    d. The **Input and Logic Power Good** is ON. The **Valve Power Available** input is ON the provided the Switched auxiliary power supply is on.
    e. The **Tool Power Is ON** input is OFF.
    f. The **TSIV** input is OFF.

2. Unlock the Master. (This must be done prior to the Master entering the Tool to prevent the ball bearings from impinging on the Tool bearing race.)

    a. Turn the **Latch** output OFF and turn the **Unlatch** output ON.
    b. The **Locked** input turns OFF and a short time later the **Unlocked** input goes ON and remains ON, indicating that the Tool Changer locking mechanism is fully retracted and the Unlatch operation is complete.

3. Robot and Master move into the tool, are parallel and within 0.15” of the tool (i.e., the module contact pins meet but the **RTL** sensors have not yet sensed the targets on the tool).

    a. The **Tool Present** and **TSIV** inputs are ON, indicating that the Master and Tool are in the close proximity of each other and verifying the operation of the **TSI limit switch**.
    b. When the **Tool Present** input is ON, **Tool-ID** is available within 50 ms.
    c. Power is not yet available on the Tool. The bit **“Tool Power is On”** is OFF.

4. Robot and Master move into the tool, are parallel and within 0.06” of the Tool

    a. The **RTL** sensors are ON, indicating that its ok to couple Tool.
    b. The **RTLV** is true.

5. Couple the Tool Changer.

    a. Turn the he **Unlatch** output OFF and turn the **Latch** output is made ON. (Note: Even for units with single solenoids the **Latch** output must be turned ON.)
    b. With the **Latch** output ON, Power is available on the Tool and the **“Tool Power is ON”** input turns on.
    c. The **Unlocked** input is OFF a short time later, indicating piston travel. Subsequently, the **Locked** input is on and remains ON, indicating that the coupling operation is complete.
    d. Sometime thereafter, communications should be established with the downstream Ethernet device(s). (The time it takes to establish connection with a downstream EtherNet/IP node depends on the power up and reconnect time of the individual EtherNet/IP equipment that is installed on the tool.)

6. Robot moves away from the tool stand with the Tool Changer coupled.

    a. The **TSI Limit Switch** is deactivated, and the **TSIV** input goes OFF.
    b. The **Unlatch Enabled** turns OFF.

7. Normal operation

   a. The following inputs are ON:
      i. Locked
      ii. Input and Logic Power Good
      iii. Valve Power Available
      iv. RTL (RTL1 & RTL2)
      v. Tool Present
      vi. Tool Power is On
      vii. RTLV
   b. The following inputs are OFF:
      i. Unlocked
      ii. TSIV
      iii. Unlatch Enabled
   c. The following output is ON:
      i. Latch
   d. The following output is OFF:
      i. Unlatch

8. Robot moves into the tool stand with the Tool Changer coupled.

   a. When the tool is returned to the stand, the **TSI Limit Switch** is activated and the TSIV input goes ON.
   b. The **Unlatch Enabled** is ON, indicating that it is safe to uncouple the Tool Changer.

9. Uncouple the Tool Changer.

   a. Turn the **Latch** output OFF and the **Unlatch** output ON.
   b. The **Tool Power Is ON** input turns OFF and power on the Tool turns off.
   c. Communication is lost with downstream device(s).
   d. The **Locked** input turns OFF a short time later the **Unlocked** input turns ON, indicating that the uncoupling operation is complete.

10. Robot and Master move away from the tool, are parallel at a distance greater than 0.15” from the tool.

    a. The **Tool Present** and **TSIV** inputs turn OFF.
    b. The **Tool-ID** is unavailable (all 1 → 0xF).

11. Robot and Master are in the free space

    a. The following inputs are ON:
       i. Unlocked
       ii. Input and Logic Power Good
       iii. Valve Power Available
       iv. Unlatch Enabled
    b. The following inputs are OFF:
       i. Locked
       ii. RTL (RTL1 & RTL2)
       iii. RTLV
       iv. TSIV
       v. Tool Present
    c. The following output is ON:
       i. Unlatch
    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 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—V-ring Seal Replacement*.

5.1 Pin Block Inspection and Cleaning

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

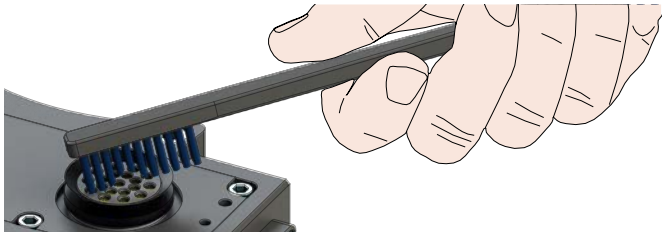
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Inspect the Master and Tool pin blocks for debris or darkened pins.

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).

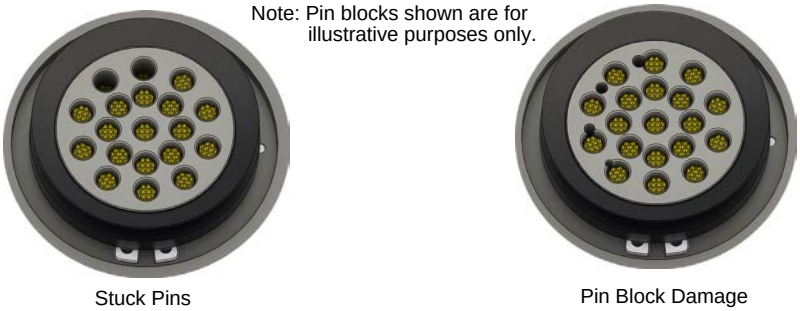
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Table 6.1—Troubleshooting

Pre-Troubleshooting Checklist:

- Check the product upstream and downstream of the Tool Changer for failure. This failure can "appear" to be caused by the Tool Changer or affect Tool Changer performance.
- Check for debris between the mating surfaces or contact pins. Refer to *Section 5.1—Pin Block Inspection and Cleaning*.
- Check for damaged cables or connectors.
- Check the appropriate power being supplied to the modules. Refer to *Section 8—Specifications*.
- Check the appropriate air pressure is supplied to the valve adapter. Refer to Valve Adapter manual.
- Check that the command was issued (Latch or Unlatch).

Symptom	Possible Cause	Correction
Unit will not lock or unlock.	Ball bearings are not moving freely.	Refer to the Maintenance section of the Tool Changer manual for instructions.
	Valve adapter exhaust muffler is clogged.	Replace the valve adapter muffler. Refer to the valve adapter manual for more information.
	TSI switch malfunctioning.	Replace the TSI switch.
	Signals are mapped incorrectly.	Refer to *Section 9—Drawings* for electrical schematic.
	Master and Tool are not within the specified No-Touch zone.	Adjust the Master and Tool within No-Touch zone before locking. Refer to Tool Changer manual for more information.
	Solenoid valve is not functioning.	Replace the valve or valve adapter. Refer to the valve adapter manual.
Sensors are not operating but EtherNet/IP is operating.	Valve adapter exhaust muffler is clogged.	Replace the valve adapter muffler. Refer to the valve adapter manual for more information.
	Sensors are not set correctly or malfunctioning.	Refer to the Troubleshooting Section of the Tool Changer manual.
	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.

Table 6.1—Troubleshooting

Pre-Troubleshooting Checklist:

- Check the product upstream and downstream of the Tool Changer for failure. This failure can "appear" to be caused by the Tool Changer or affect Tool Changer performance.
- Check for debris between the mating surfaces or contact pins. Refer to *Section 5.1—Pin Block Inspection and Cleaning*.
- Check for damaged cables or connectors.
- Check the appropriate power being supplied to the modules. Refer to *Section 8—Specifications*.
- Check the appropriate air pressure is supplied to the valve adapter. Refer to Valve Adapter manual.
- Check that the command was issued (Latch or Unlatch).

Loss of communication with the modules.	No DCA power to the Master module.	Verify that DCA (input and logic) power is connected and available (Input and Logic Power Good bit is ON).
	Worn or damaged contact pins.	Contact ATI representative.
No power on the Tool module.	Latch output was not issued.	Verify the Latch output is ON.
	Tool Present bit is OFF.	Verify the **Tool Present** bit is ON.
		TSI cables or switch needs replaced.
	Tool Power is ON bit is OFF.	Verify the **Tool Power is ON** bit is ON. Contact ATI representative.
	Loss of DCA power on the Master will cause loss of auxiliary power to the Tool.	Restore DCA power to the Master.

6.2 Service Procedures

The following service procedures provide instructions for inspection, adjustment, test or replacement of components.

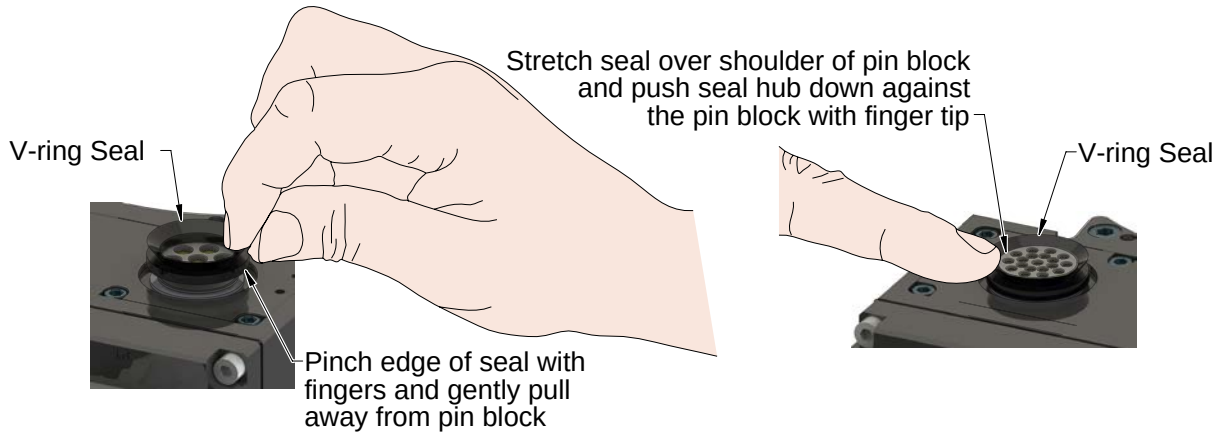
6.2.1 V-ring Seal Replacement

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 6.1—V-ring Seal Replacement



7. Serviceable Parts

See *Section 9—Drawings* for serviceable parts directly associated with the modules.

Table 7.1—Master Module Mounting Fasteners	
Part Number	**Description**
3500-1066020-15	M6X20 Socket Head Cap Screw, 12.9, ISO4762/DIN912, ES-ATI-007

Table 7.2—Tool Module Mounting Fasteners	
Part Number	**Description**
3500-1066016-15	M6x16 Socket Head Cap Screw, 12.9, ISO4762/DIN912, ES-ATI-007

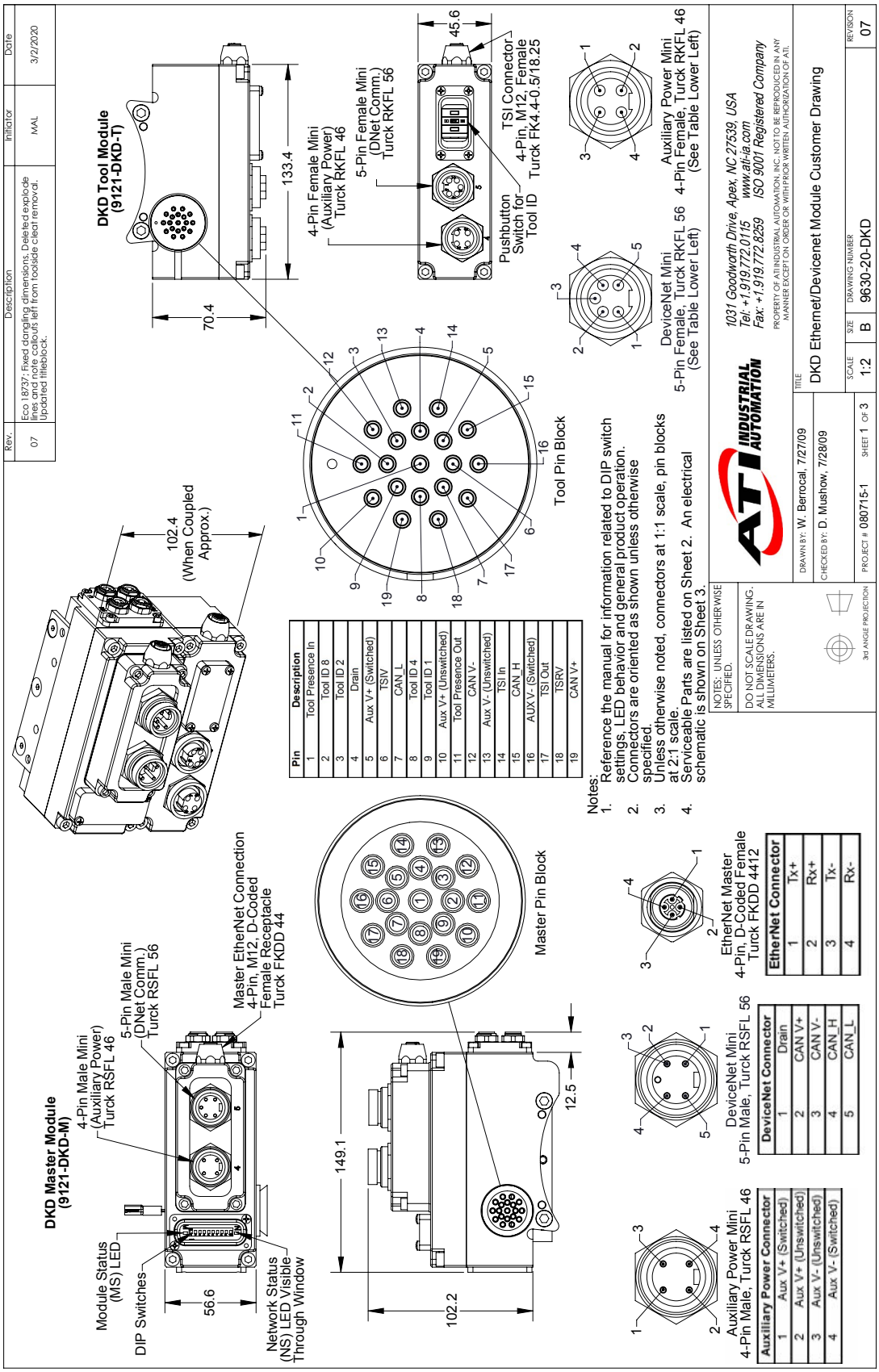
Table 7.3—Accessories	
Part Number	**Description**
3690-0000064-60	Brush, Blue Nylon All Purpose (Contact Pin Cleaning)
3690-0000049-00	Closure Cap for Female Mini Receptacles

8. Specifications

Table 8.1—DKD Master Module	
9121-DKD-M	EtherNet/IP Master module supports DHCP functionality and DeviceNet pass through. M12 D-coded Female Connector for Ethernet communication, Mini 5-pin Male Connector for DeviceNet, Mini 4-pin Male Connector for Switched and Un-Switched Auxiliary Power circuits, an M12, 4-pin Male Connector for Safety PLC control of the Tool Changer valve. Lock, Unlock and RTL sensing with LED cables on the Master and Tool ID from the Tool module are also supported. ARC Prevention Circuit applied to Auxiliary Switched, Auxiliary Unswitched, and DeviceNet Power
Factory Default Configuration	I/P Address: 192.168.1.1 Subnet Mask: 255.255.255.0 Gateway: 192.168.1.1 Note: The DKD modules conform to the EtherNet/IP Adaptation of CIP Specification, Edition 1.1; © 2005, ODVA The DHCP option is factory set to enabled.
Interface Connectors	Auxiliary Power: Mini, 4-pin Male supporting Switched and Unswitched circuits. DeviceNet: Mini, 5-pin Male. Ethernet: M12 D-Coded, 4-pin Female Integrated Tool Changer I/O: (4) @ 8 mm, 3-pin Female supporting Tool Changer Locked, Unlocked and Ready-to-Lock proximity sensors, internal 3-pin pin block to transmit latch and unlatch signal to the solenoid Valve. 24 VDC for control signals, 5 A/24 VDC for pass through signals.
Electrical Rating	Power Pass through: Auxiliary Power: 100 mA, 24 V Valve Power: 250 mA, 24 V
	Signal Pass through: 3 Amp, 30 V maximum.
	Tool Changer Control: Lock, Unlock, and Ready-to-Lock sensors: 10-30 V operational voltage Latch/Unlatch integrated solenoid valve: -19 to -29 V operational voltage
Current Draw	180 mA @ 24 V (Locked and RTL sensors “on”)
Weight	1.88 lbs (0.85 kg)

Table 8.2—DKD Tool Module	
9121-DKD-T	EtherNet/IP Tool module supports Tool-ID through the master module and pass through for DeviceNet and Auxiliary power. Mini 5-pin Female Connector for DeviceNet, Mini 4-pin Female Connector for Switched and Un-switched Auxiliary Power circuits
Factory Default Configuration	Tool-ID set to 1
Interface Connectors	Auxiliary Power: Mini, 4-pin, Female DeviceNet: Mini, 5-pin, Female TSI connector: M12, 4-pin, Female 24 VDC for control signals, 5 A/24 VDC for pass through signals Tool-ID: Push button switch reading 0–9 positions (i.e., ten unique ID values).
Electrical Rating	Power Pass through: Auxiliary Power: 100 mA, 24 V Valve Power: 250 mA, 24 V
	Signal Pass through: 5 A, 24 V maximum.
	Tool-ID: 0.1 A, 30 V
Current Draw	180 mA @ 24 V
Weight	1.3 lbs (0.59 kg)

9. Drawings


DKD Tool Module
(9121-DKD-T)
70.4
133.4
4-Pin Female Mini
(Auxiliary Power)
Turck RKFL 46
5-Pin Female Mini
(DNet Comm.)
Turck RKFL 56
45.6
TSI Connector
4-Pin, M12, Female
Turck FK4.4-0.5/18.25
Pushbutton
Switch for
Tool ID
Tool Pin Block
DeviceNet Mini
5-Pin Female, Turck RKFL 56
(See Table Lower Left)
Auxiliary Power Mini
4-Pin Female, Turck RKFL 46
(See Table Lower Left)
102.4
(When Coupled
Approx.)
DKD Master Module
(9121-DKD-M)
4-Pin Male Mini
(Auxiliary Power)
Turck RSFL 46
5-Pin Male Mini
(DNet Comm.)
Turck RSFL 56
Master EtherNet Connection
4-Pin, M12, D-Coded
Female Receptacle
Turck FKDD 44
Master Pin Block
149.1
102.2
12.5
56.6
Module Status
(MS) LED
DIP Switches
Network Status
(NS) LED Visible
Through Window
EtherNet Master
4-Pin, D-Coded Female
Turck FKDD 4412
DeviceNet Mini
5-Pin Male, Turck RSFL 56
Auxiliary Power Mini
4-Pin Male, Turck RSFL 46
Notes:
1. Reference the manual for information related to DIP switch settings, LED behavior and general product operation.
2. Connectors are oriented as shown unless otherwise specified.
3. Unless otherwise noted, connectors at 1:1 scale, pin blocks at 2:1 scale.
4. Serviceable Parts are listed on Sheet 2. An electrical schematic is shown on Sheet 3.
Rev. 07
Description: Eco 18737: Fixed dangling dimensions. Deleted explode lines and note callouts left from toolside cleat removal. Updated titleblock.
Initiator: MAL
Date: 3/2/2020
Pin | Description
1 Tool Presence In
2 Tool ID 8
3 Tool ID 2
4 Drain
5 Aux V+ (Switched)
6 TSIV
7 CAN_L
8 Tool ID 4
9 Tool ID 1
10 Aux V+ (Unswitched)
11 Tool Presence Out
12 CAN V-
13 Aux V- (Unswitched)
14 TSI In
15 CAN_H
16 AUX V- (Switched)
17 TSI Out
18 TSRV
19 CAN V+
DeviceNet Connector
1 Drain
2 CAN V+
3 CAN V-
4 CAN_H
5 CAN_L
EtherNet Connector
1 Tx+
2 Rx+
3 Tx-
4 Rx-
Auxiliary Power Connector
1 Aux V+ (Switched)
2 Aux V+ (Unswitched)
3 Aux V- (Unswitched)
4 Aux V- (Switched)
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: W. Berrocal, 7/27/09
CHECKED BY: D. Mushow, 7/28/09
PROJECT # 080715-1
SHEET 1 OF 3
TITLE: DKD Ethernet/Devicenet Module Customer Drawing
SCALE: 1:2
SIZE: B
DRAWING NUMBER: 9630-20-DKD
REVISION: 07
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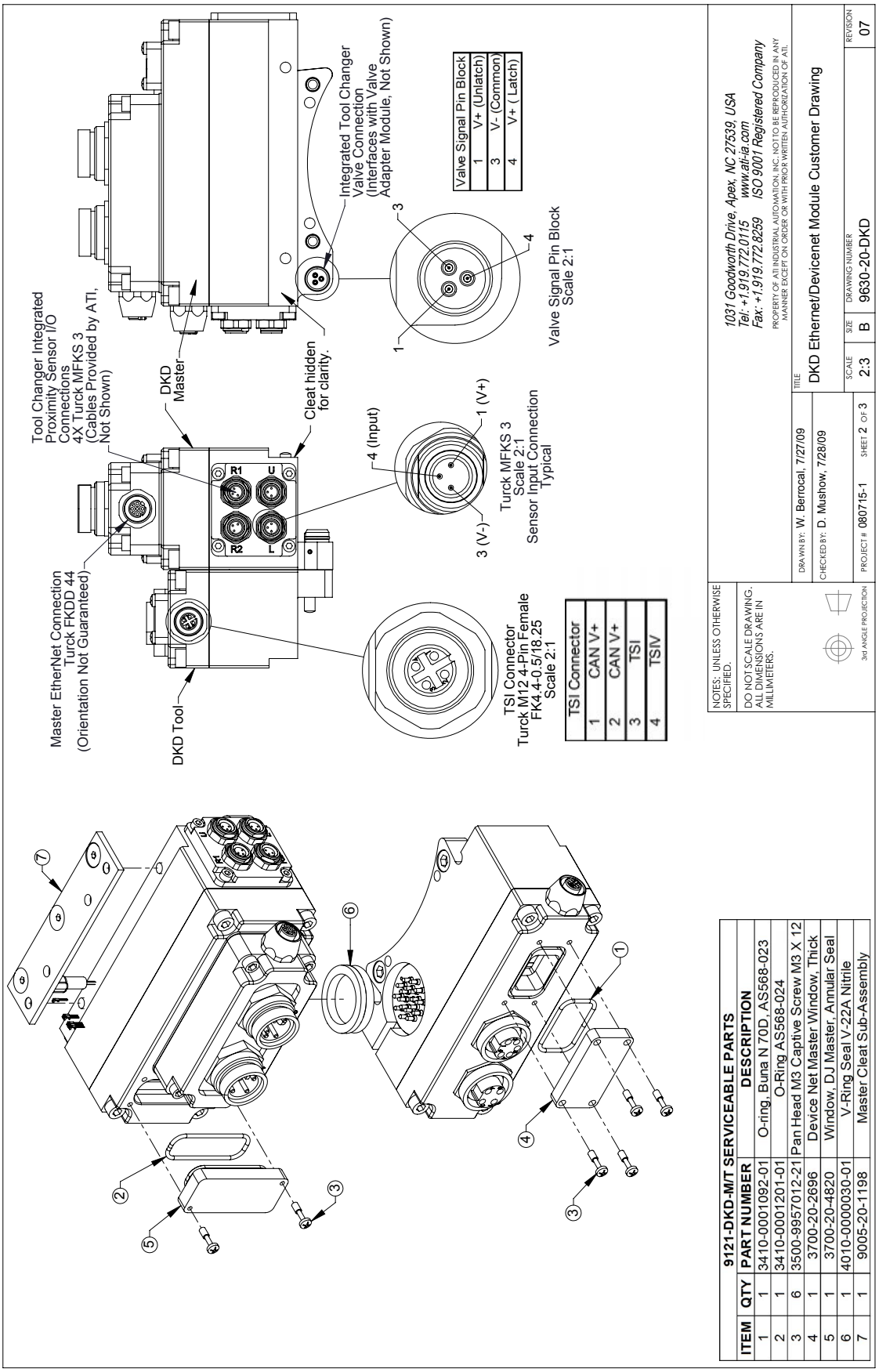
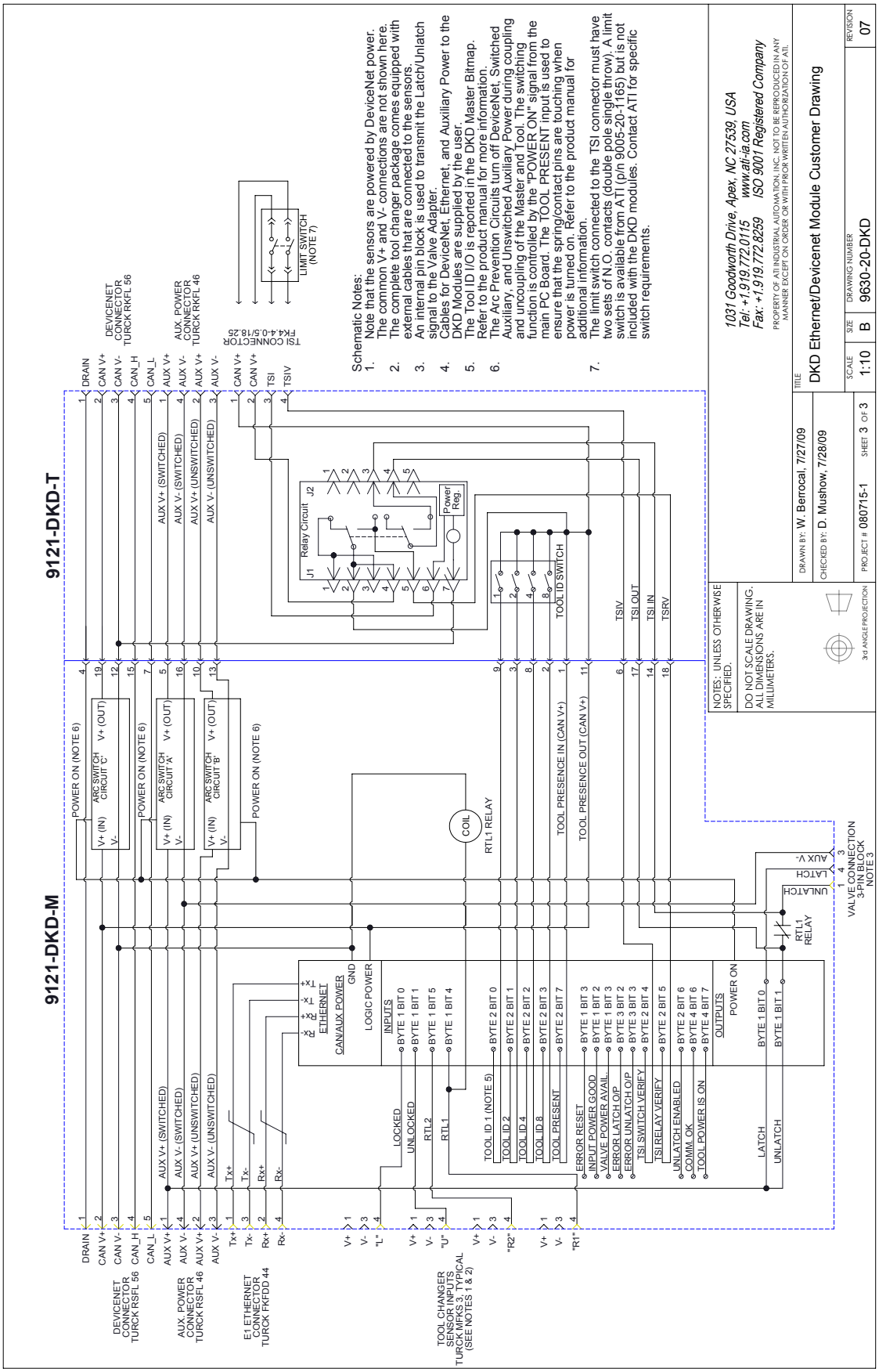


9121-DKD-M/T SERVICEABLE PARTS

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	3410-0001092-01	O-ring, Buna N 70D, AS568-023
2	1	3410-0001201-01	O-Ring AS568-024
3	6	3500-9957012-21	Pan Head M3 Captive Screw M3 X 12
4	1	3700-20-2696	Device Net Master Window, Thick
5	1	3700-20-4820	Window, DJ Master, Annular Seal
6	1	4010-0000030-01	V-Ring Seal V-22A Nitrile
7	1	9005-20-1198	Master Cleat Sub-Assembly


9121-DKD-T
9121-DKD-M
Schematic Notes:
1. Note that the sensors are powered by DeviceNet power.
2. The common V+ and V- connections are not shown here.
3. The complete tool changer package comes equipped with external cables that are connected to the sensors.
4. An internal pin block is used to transmit the Latch/Unlatch signal to the Valve Adapter.
5. Cables for DeviceNet, Ethernet, and Auxiliary Power to the DKD Modules are supplied by the user.
6. The Tool ID I/O is reported in the DKD Master Bitmap. Refer to the product manual for more information.
7. The Arc Prevention Circuits turn off DeviceNet, Switched Auxiliary, and Unswitched Auxiliary Power during coupling and uncoupling of the Master and Tool. The switching function is controlled by the "POWER ON" signal from the main PC Board. The TOOL PRESENT input is used to ensure that the spring/contact pins are touching when power is turned on. Refer to the product manual for additional information.
8. The limit switch connected to the TSI connector must have two sets of N.O. contacts (double pole single throw). A limit switch is available from ATI (p/n 9005-20-1165) but is not included with the DKD modules. Contact ATI for specific switch requirements.
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DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: W. Berrocal, 7/27/09
CHECKED BY: D. Mushow, 7/28/09
PROJECT # 080715-1
SHEET 3 OF 3
TITLE
DKD Ethernet/Devicenet Module Customer Drawing
SCALE 1:10
SIZE B
DRAWING NUMBER 9630-20-DKD
REVISION 07