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Glossary

Term	Definition
Application Processor 1	A board inside the module which controls solenoid outputs, monitors function of the unlatch valves for pressure and position, safety checking and diagnostics, reports sensor status, protects outputs against short circuit overload, detects and reports status of the 24 V power supply, and provides cross monitoring of the pressure processor board.
Application Processor 2	A board inside the module which controls Unlatch Valve 2, reports the pressure inside the valve module, and provides cross monitoring of the Application Processor 1.
BF LED	BUS Failure LED; this is a standard Profibus status LED, similar to the DeviceNet Network Status LED.
Clear Errors	An output supplied to the ATI Master DeviceNet node to clear all applicable error conditions
CL-RPC	Connection Less Remote Procedure Call.
DCP	PROFINET Discovery and Configuration Protocol.
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.
Ethernet Switch	An Ethernet network component connecting multiple communication partners with each other.
FE	Functional Earth
GSDML File	A special kind of XML-based Device Description File used by PROFINET to automatically obtain the device characteristics.
Latch (Lock)	The output supplied to the ATI Master module to couple the Tool Changer.
LLDP	Link Layer Discovery Protocol
Lock/Unlock Sensor Fault	An input indicating that the Locked and Unlocked inputs are high at the same time.
Locked	A proximity sensor input indicating that the coupling mechanism is in the Locked position.The “LOCKED” bit in the PROFINET bitmap will only be set high if the following conditions are on: • LOCKED sensor input is high • UNLOCKED sensor input is low • TOOL PRESENT input is high
PROFINET	A communication system for Industrial Ethernet designed and developed by PROFIBUS International. It uses some mechanisms similar to those of the PROFIBUS field bus
RTL (Ready To Lock)	A proximity sensor input that senses when the ATI Tool is in close proximity.
SF LED	System Failure LED; this is a standard Profibus status LED, similar to the DeviceNet Module Status LED;it has a red part and a green part.
SNMP	Simple Network Management Protocol
SSO1 and SSO2	Inputs from a safety switch, which are high when the Tool Changer is in the stand.

Term	Definition
US2 Power Present	An input indicating the presence of Output Power (US2) at the ATI Master module.
Tool Power is On	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 Input/ Logic Power nor Output power available on the Tool.
Tool Present	A hard connect input (sourced from the Tool) indicating the Master and Tool are electrically connected to each other.
Tool-ID	An input from the Master node reporting the values from the Tool-ID switch on the Tool module.
Unlatch (Unlock)	The output supplied to the ATI Master module to uncouple the Tool Changer.
Unlatch Enable	Indicates it is safe to proceed with an unlatch request.
Unlocked	A proximity sensor input indicating that the coupling mechanism is in the Unlocked position. The “UNLOCKED” bit in the PROFINET bitmap will only be set high if the following conditions are on: • UNLOCKED sensor input is high • LOCKED sensor input is low
Unsafe Unlatch	An input indicating that an Unlatch command was received which would result in an unsafe Tool release and was therefore not processed.
US1 Power Present	An input indicating the presence of Input and Logic Power (US1) at the ATI Master module.
V1Relay and V2Relay	Inputs from relays which should mirror the status of SSO1 and SSO2.

C. Control and Signal Modules

DL12—PROFINET® Control/Signal Module

1. Product Overview

The modules enable the customer to control and communicate with the Tool Changer through a network using a PROFINET interface. A PROFINET node is established on the Master module, but not on the Tool. 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 module and functions as a pass-through for PROFINET network and power to downstream equipment.

The Master module is used in combination with a valve adapter with dual double solenoid valves, for Latch/Unlatch control of the Tool Changer. When used in combination with a dual double solenoid valve adapter, the modules achieves PLd safety reliability in accordance with ISO standard 13849-1. The user is required to provide a pneumatic supply source to the valve adapter. Refer to the appropriate valve adapter or Tool Changer manual for requirements.

In addition to supporting the standard Tool Changer input signals (Locked, Unlocked, etc.) the modules also support advanced diagnostic and fault reporting. Refer to *Section 4.3—Error Conditions.*

A minifast connector is provided on the Master and Tool modules for interfacing with power. The power source for input and output power must be capable of outputting an operating voltage (reverse polarity protected, regulated) of 20.4 to 28.8 VDC. A M12 D-coded connector is provided on the Master and Tool modules for interfacing with PROFINET. When the Tool Changer is coupled, the Master and Tool modules pass signals via spring loaded pin blocks. Flexible V-ring seals surround the pin blocks and are water resistant but not water proof. Refer to *Figure 1.1*.

To avoid unintentional Tool release, the power for the Unlatch valve is routed through a safety switch connector. A safety switch must be connected to support this function. Refer to *Section 2.4—Safety System*.

1.1 Master Module

The module has the following connectors:

- (1) integrated 4-pin valve signal pin block for the Latch and Unlatch signals to the solenoid valves
- (4) 3-pin female M8 RTL sensors (R1 and R2), Lock (L), and Unlock (U) sensor connectors
- (1) 3-pin female M8 valve adapter proximity sensor connector
- (1) 4-pin female M8 valve adapter pressure sensor connector
- (1) 4-pin female M12 D-coded PROFINET connector
- (1) 4-pin male minifast power connector

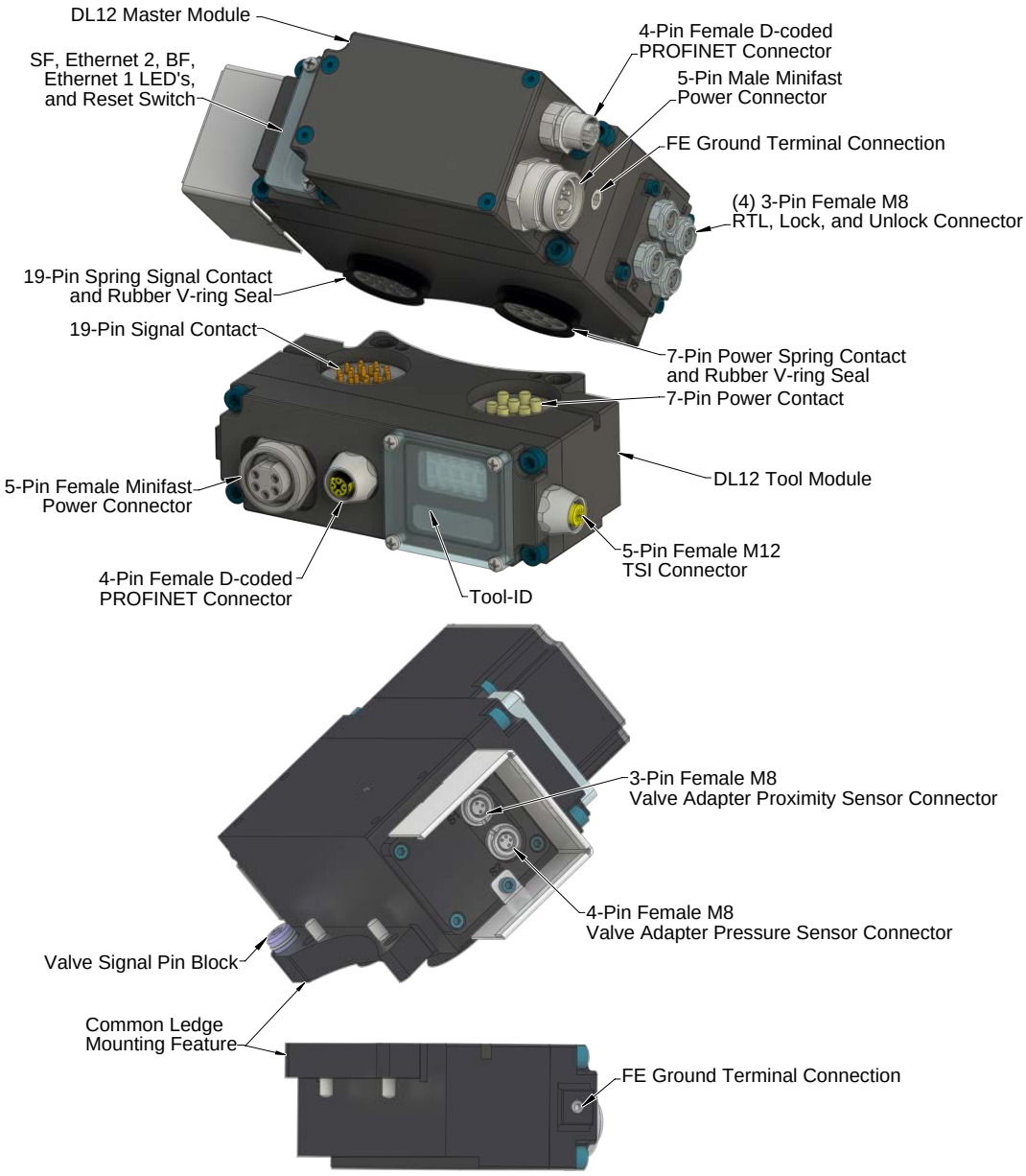
The module also incorporates ATI's exclusive Arc Prevention Circuit which extends the life of electrical power contacts by eliminating arcing caused by inductive loads and high inrush current during coupling/uncoupling. Refer to *Section 2.2—Arc Prevention Circuit.*

The module provides status LED's to visually indicate its operation. A reset button provides the ability to return to default settings. Refer to *Section 2.1.3—System Failure and Bus Failure LEDs* and *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs*.

An electrical interface is provided on the module for support of two integrated double solenoid valves (DC Voltage, sourcing type). The integrated valve is supplied from ATI as part of a dual double solenoid valve adapter. Refer to the Valve Adapter Manual for more information (9620-20-C-Jxx Valve Adapters with Dual Double Solenoid, Valve Pass Through, Proximity and Pressure Sensors). Electrical interface drawings and connector details are provided in drawings in *Section 9—Drawings*.

PROFINET requires a FE ground, the Master module provides a M8 threaded hole for FE ground terminal that is passes FE ground to the Tool Module through the 7-Pin contact block. The M8 set screw must be removed prior to FE ground connection.

Figure 1.1—Modules



1.2 Tool Module

The module has the following connectors:

- (1) 5-pin female M12 safety switch connector
- (1) 4-pin female M12 D-coded PROFINET connector
- (1) 4-pin male minifast power connector

The module requires a JR4-T tool adapter to align the Master and Tool modules, and mounts to the Tool plate of the Tool Changer or Utility Coupler. PROFINET requires a FE ground, the Tool module provides a M5 threaded hole that is passes FE ground to the customer tooling. The M5 set screw must be removed prior to FE ground connection.

The module has a series of push button switches for setting of the Tool-ID input. This allows the customer to distinguish between the different tools that are being used in a robotic cell or on a production line. The Tool-ID is reported through the Master module bitmap. Refer to *Section 2.1.1—PROFINET Interface Information*

2. Product Information

A PROFINET node is established on the Master module but not on the Tool. 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 PROFINET network and power to downstream equipment.

2.1 Master Module

2.1.1 PROFINET Interface Information

Table 2.1 lists the PROFINET interface parameters applied to the Master module.

Table 2.1—PROFINET Interface Parameters

Parameter	Description
DCP	supported
Fast Startup	supported
Used Protocols (subset)	UDP, IP, ARP, ICMP (Ping)
Topology recognition	LLDP, SNMP V1, MIB2, physical device
VLAN- and priority tagging	yes
Context Management	by CL-RPC
Minimum cycle time	2 ms
Baud rate	100 MBit/s
Data transport layer	Ethernet II, IEEE 802.3

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

(*www.ati-ia.com/download/edsfiles*) or by email.

Reference the Part Number: Master node GSDML file 9031-20-1071

Bitmaps for the Master node are provided in *Table 2.2* and *Table 2.3.*

2.1.2 Integrated Ethernet Switch

The Master module provides an integrated 2 port Ethernet switch which supports the following:

- Transmission rate 100 MBit/s
- Interface type 100 BASE-TX, isolated
- Half duplex/Full duplex supported
- Auto Negotiation supported
- Auto Crossover supported.

Table 2.2—I/O Bit map, Robot Inputs from 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
0	0	Locked	Tool Changer is locked
	1	Unlocked	Tool Changer is unlocked
	2	Latch Enabled	Tool Changer is ready to Latch
	3	Unlatch Enabled	Tool Changer is ready to Unlatch
	4	RTL1	Ready to Lock Prox1 I/P
	5	RTL2	Ready to Lock Prox2 I/P
	6	TOOL_PRESENT	Bit indicating Master and Tool are in electrical contact.
	7	Tool Power Is On	Indicates that Arc Prevention Circuit is turned ON and power is provided to the Tool
1	0	US1_Power_Present	US1 supply voltage on robot side within the allowable range of 20.4 to 28.8 V
	1	US2_Power_Present	US2 supply voltage on robot side within the allowable range of 20.4 to 28.8 V
	2	SSO_1	Input from safety switch that indicates it is safe to unlatch the Tool. Should always agree with SSO_2
	3	SSO_2	Input from safety switch that indicates it is safe to unlatch the Tool. Should always agree with SSO_1
	4	SS Pulse Missing	Is high if the SSO inputs are jumpered or shorted.
	5	UNSAFE_LATCH	User attempted to latch when unsafe.
	6	Unsafe Unlatch	Unlatch Rejected Due to Unsafe Condition Present
	7	SYSTEM_IS_ UNSAFE	Any APx_COMM_ERROR, APx_MISMATCH_ERROR, APx_ SAFETY_ERROR sets this bit.
2	0	V1RELAY	Indicates that safety switch has activated safety relay 1. Should agree with SSO_1.
	1	V2RELAY	Indicates that safety switch has activated safety relay 2. Should agree with SSO_2.
	2	Lock/Unlock Sensor Fault	Locked and Unlocked sensor inputs are ON at the same time or swapped. Indicative of failed sensors or no latch/unlatch motion.
	3	ERROR_ON_ LATCH	Overload or short circuit on Latch Output
	4	ERROR_ON_ UNLATCH1	Overload or short circuit on Unlatch1 Output
	5	ERROR_ON_ UNLATCH2	Overload or short circuit on Unlatch2 Output
	6	TOOL-ID_ERROR	Tool-ID Communication Timeout
	7	EVERYTHING IS OK	Any APx_COMM_ERROR, APx_MISMATCH_ERROR, APx_ SAFETY_ERROR sets this bit.

Notes:

These bits should be mapped for customer use.

These bits should be mapped for ATI diagnostic use.

The pressure reading is a 10-bit ADC. To convert the ADC counts to PSI, multiply the ADC counts by 0.1173. Example: 692 counts x 0.1173= 80 PSI

Table 2.2—I/O Bit map, Robot Inputs from 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
3	0	VALVE_ERROR	Valve or pressure sensor defect. Logical OR of APx_VALVE_ERROR bits.
	1	CROSS_MONITORING_ERROR	Safety System detected mismatch. Logical OR of the APx_INP_MISMATCH, APx_OUTP_MISMATCH, and AP2_COMM_ERROR bits.
	2	PRESSURE_TOO_HIGH	Pressure sensor reports an unlatch pressure higher than the maximum system rating.
	3	PRESSURE_TOO_LOW	Pressure sensor report an unlatch pressure lower than the minimum system rating
	4	Tool-ID Switch1 Bit1	N/A
	5	Tool-ID Switch1 Bit2	
	6	Tool-ID Switch1 Bit4	
	7	Tool-ID Switch1 Bit8	
4	0	Tool-ID Switch2 Bit1	
	1	Tool-ID Switch2 Bit2	
	2	Tool-ID Switch2 Bit4	
	3	Tool-ID Switch2 Bit8	
	4	Tool-ID Switch3 Bit1	
	5	Tool-ID Switch3 Bit2	
	6	Tool-ID Switch3 Bit4	
	7	Tool-ID Switch3 Bit8	
5	0	Tool-ID Switch4 Bit1	
	1	Tool-ID Switch4 Bit2	
	2	Tool-ID Switch4 Bit4	
	3	Tool-ID Switch4 Bit8	
	4	Tool-ID Switch5 Bit1	
	5	Tool-ID Switch5 Bit2	
	6	Tool-ID Switch5 Bit4	
	7	Tool-ID Switch5 Bit8	
6	0	Minor Revision Bit0	uC firmware revision
	1	Minor Revision Bit1	
	2	Minor Revision Bit2	
	3	Minor Revision Bit3	
	4	Major Revision Bit0	
	5	Major Revision Bit1	
	6	Major Revision Bit2	
	7	Major Revision Bit3	

Notes:

These bits should be mapped for customer use.

These bits should be mapped for ATI diagnostic use.

The pressure reading is a 10-bit ADC. To convert the ADC counts to PSI, multiply the ADC counts by 0.1173. Example: 692 counts x 0.1173= 80 PSI

Table 2.2—I/O Bit map, Robot Inputs from 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
7	0	Raw Locked Sensor	Direct mirror of locked proximity sensor.
	1	Raw Unlocked Sensor	Direct mirror of unlocked proximity sensor.
	2	Valve Proximity Sensor	Shows status of valve position.
	3	AP2_Comm_Error	AP1 lost communication to AP2
	4	AP1_VALVE_ ERROR	Valve 2 opening or closing at the wrong time.
	5	AP1_OUTP_ MISMATCH	AP1 detects that AP2 has come to a different decision than AP1 regarding a safety-critical motion, or AP1 sees Unlatch_ valve_control_2 is different than expected.
	6	AP1_INP_ MISMATCH	AP1 detects that AP2 reports different input values than AP1 sees.
	7	MEMORY_FAILURE	N/A
8	0	Reserved	
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Firmware Version Mismatch	
	5	Reserved	
	6	Reserved	
	7	Reserved	
9	0	AP2_Mismatch_ Error	
	1	AP2_Comm_Error	AP1 lost communication to AP2
	2	AP2_Memory_ Failure	N/A
	3	AP2_VALVE_ ERROR	Position sensor does not meet expectations
	4	ERROR_ON_ UNLATCH2	Overload on Unlatch 2 output was detected.
	5	PRESSURE_ SENSOR_ DISCONNECTED	Internal bit indicating that the pressure sensor is disconnected and/or that there are broken wires in the sensor cable
	6	Memory_Tests_ Complete	N/A
	7	Safe_to_Unlatch_ AP2	

Notes:

These bits should be mapped for customer use.

These bits should be mapped for ATI diagnostic use.

The pressure reading is a 10-bit ADC. To convert the ADC counts to PSI, multiply the ADC counts by 0.1173. Example: 692 counts x 0.1173= 80 PSI

Table 2.2—I/O Bit map, Robot Inputs from 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
10	0	AP2_SSO_2	N/A
	1	V1Relay	
	2	V2Relay	
	3	AP2_SSFAULT	
	4	Unlatch_Valve_ Control_2	
	5	Valve_Position	
	6	AP2_Version_Error	
	7	AP2_Safety_Error	
11	0	Pressure Reading Bit 8	
	1	Pressure Reading Bit 9	
	2	Unused	
	3		
	4		
	5		
	6		
	7		
12	0	Pressure Reading Bit 0	
	1	Pressure Reading Bit 1	
	2	Pressure Reading Bit 2	
	3	Pressure Reading Bit 3	
	4	Pressure Reading Bit 4	
	5	Pressure Reading Bit 5	
	6	Pressure Reading Bit 6	
	7	Pressure Reading Bit 7	

Notes:

These bits should be mapped for customer use.

These bits should be mapped for ATI diagnostic use.

The pressure reading is a 10-bit ADC. To convert the ADC counts to PSI, multiply the ADC counts by 0.1173. Example: 692 counts x 0.1173= 80 PSI

Table 2.2—I/O Bit map, Robot Inputs from 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
13	0	Unused	Unused
	1		
	2		
	3		
	4		
	5		
	6		
	7		
14	0	Major Version Number of AP2 [0:4]	AP2 Firmware Revision Number
	1		
	2		
	3		
	4	Minor Version Number of AP2 [0:4]	
	5		
	6		
	7		
15	0 to 7	Reserved	

Notes:

These bits should be mapped for customer use.

These bits should be mapped for ATI diagnostic use.

The pressure reading is a 10-bit ADC. To convert the ADC counts to PSI, multiply the ADC counts by 0.1173. Example: 692 counts x 0.1173= 80 PSI

Table 2.3—I/O Bitmap, Robot Outputs to 9121-DL12-M			
Byte	**Bit#**	**Name**	**Description/Function**
0	0	Latch	Request Lock
	1	Unlatch	Request Unlock
	2	(Unused - Does not need to be mapped)	
	3	Clear Errors	Reset errors, allow affected I/O to be reactivated
	4	Reserved	
	5	(Unused - Does not need to be mapped)	
	6	Direct Power Control Enable	Arc Prevention Override
	7	(Unused - Does not need to be mapped)	
1 to 7	(Unused - Does not need to be mapped)		

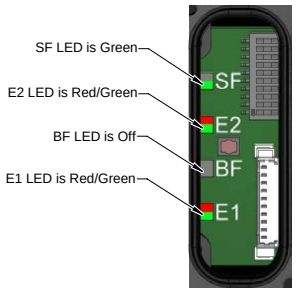
Notes:

These bits should be mapped for customer use.

2.1.3 System Failure and Bus Failure LEDs

When the modules are coupled and communicating properly on the network, the LEDs should When the modules are coupled and communicating properly on the network, the LEDs should display as shown in *Figure 2.1*, with the E1 and E2 LEDs RED (solid) and Green (solid) based on the PROFINET communication.

Figure 2.1—LED Display of Properly Functioning Coupled Modules



The System Failure (SF) status LED is identified on the module as "SF". It provides device status for power and proper operation. Refer to *Table 2.4* for an outline of this LED's operation.

The Bus Failure (BF) status LED is identified on the module as "BF". It provides PROFINET status information. Refer to *Table 2.5* for an outline of this LED's operation.

Table 2.4—SF status LED

Status	LED Function		Note
No Power		Off	No power applied. Check if the voltage is between 20.4 and 28.8 VDC.
Operational[1]		Green (solid)	Normal operation.
Fault		Red (solid)	The fault Internal Diagnostic Error has occurred.
Fault		Red (flashing)	Reset To Factory Push Button was pressed or one of the following faults has occurred: - Communication error with tool module - Input power failure

Note:
1. The LED will be green even if no network connection is established.

Table 2.5—BF status LED

Status	LED Function		Note
Operational[1]		Off[1]	No error (Normal operation).
Not OK		Green (solid)	Watchdog timeout; channel, generic or extended diagnosis present; system error.
		Green (flashing)	DCP signal service is initiated via the bus.
		Red (solid)	No configuration.
		Red (flashing)	No data exchange.

Note:
1. If the LED is off it may also indicate the device may be powered off.

2.1.4 Ethernet 1 and Ethernet 2 LEDs

The Ethernet LEDs provide information about link status and activity on the ports of the integrated Ethernet switch.

The Ethernet 1 (E1) LED will display the status of the robot side Ethernet port. The Ethernet 2 (E2) LED will display the status of the Tool side Ethernet port. The module status listed in *Table 2.6* and *Table 2.7* will be indicated by the specified LED color and state.

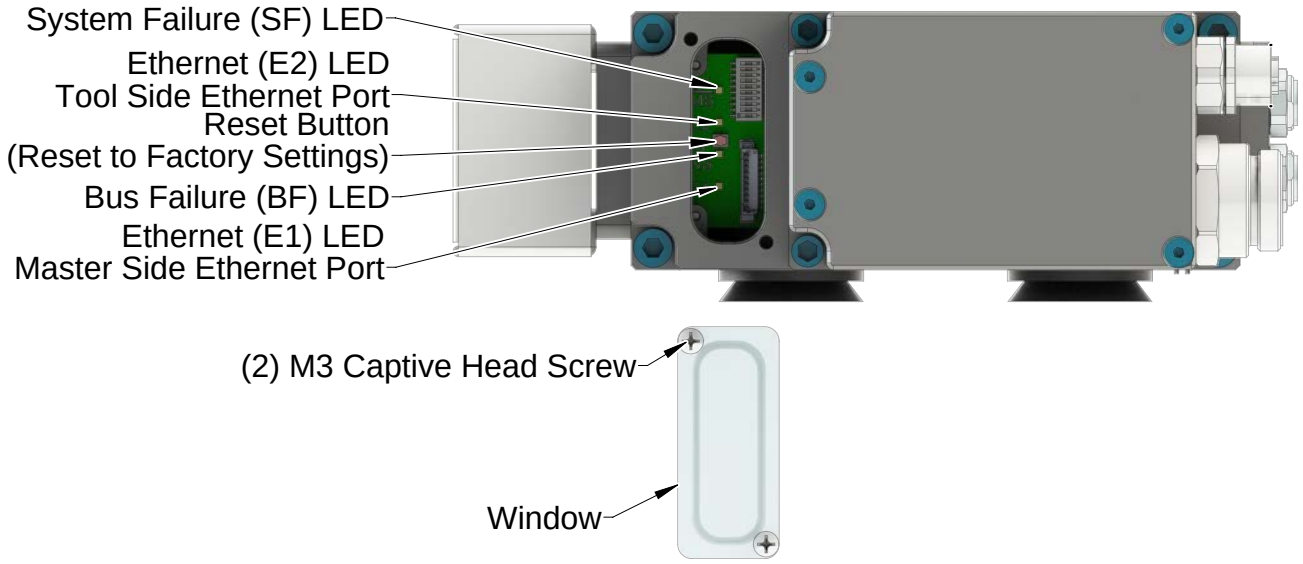
Table 2.6—Ethernet 1 (E1) Robot Side LED

Status	LED Function		Note
No Link		Off	The Master module has no connection to the Ethernet.
Link		Green (solid)	The Master module is connected to the Ethernet but there is currently no data exchange activity.
Active RX/TX		Red (flashing) Green (solid)	There is sporatic data exchange activity with the Ethernet.
PROFINET connection established		Red (solid) Green (solid)	There is continuous data exchange activity with the Ethernet.

Table 2.7—Ethernet 2 (E2) Tool Side LED

Status	LED Function		Note
No Link		Off	The Tool module has no connection to the Ethernet.
Link		Green (solid)	The Tool module is connected to the Ethernet but there is currently no data exchange activity.
Active RX/TX		Red (flashing) Green (solid)	There is sporatic data exchange activity with the Ethernet.
PROFINET connection established		Red (solid) Green (solid)	There is continuous data exchange activity with the Ethernet.

Figure 2.2 —Master Module LED and Reset Button



2.1.5 Reset To Factory Push Button

A push button, located under the LED window cover between the E2 and BF LED allows the user to perform a "Reset To Factory" function which clears the PROFINET Name Of Station and the module's IP address. This is useful when already configured devices get swapped or a broken device gets replaced by an already configured device. See *Section 6.2.2—DL12 Device Replacement Procedures* for a detailed device replacement procedure.

After the push button was pressed the SF LED will blink red, indicating that with the next power cycle the Name of Station and IP address will be cleared.

Make sure to re-apply the LED window cover after access to the push button is not needed anymore.

2.2 Arc Prevention Circuit

The DL12 module incorporates 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. The Arc Prevention Circuit makes it possible to couple/uncouple without switching power off and prevents damage to the contacts.

In the DL12 module, the Arc Prevention Circuit controls the ON/OFF status of the following two power signals:

-Input and Logic power US1+

-Output power US2+

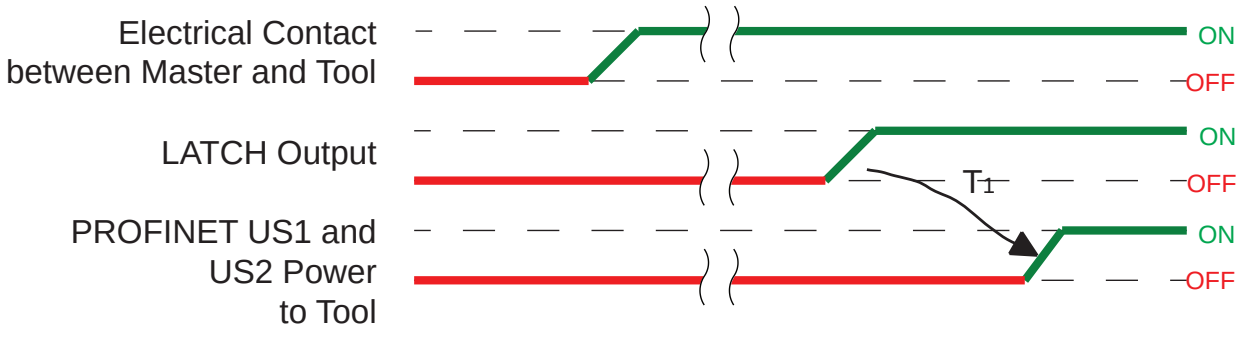
2.2.1 Arc Prevention Circuit Behavior During Coupling

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 Tool Changer.

When the robot and Master approach the Tool for pick up, electrical contact between the Master and Tool pin contacts occurs. Soon after the LATCH command is turned ON, the Arc Prevention Circuit will turn on US1 and US2 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 20 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



T_1 = Power Switch ON-delay

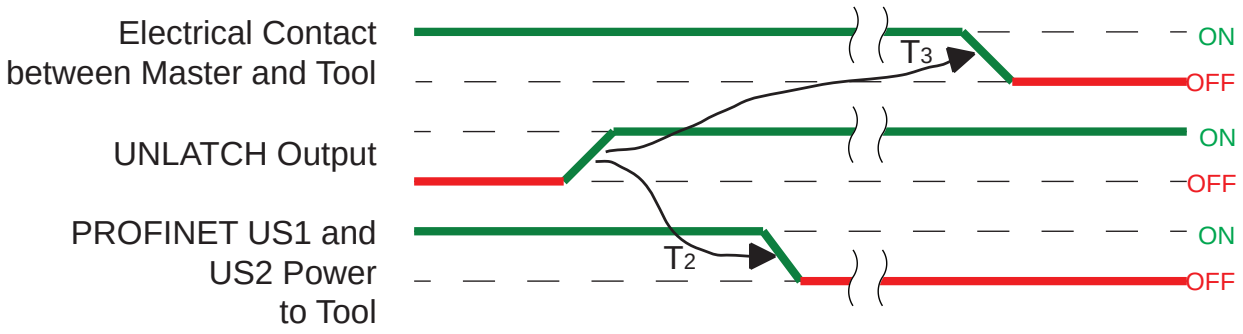
2.2.2 Arc Prevention Circuit Behavior During Uncoupling

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 US1 and US2 power. The power-off time delay between the UNLATCH command and the switching off of power (designated T_2 in the diagram) is less than 100 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 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 Master and Tool alignment pins, etc. but is usually not shorter than 300 ms.

Figure 2.4—Power-Off Timing



T_2 = Power Switch OFF-delay
T_3 = Tool Changer Unlock Time

2.3 Tool Module

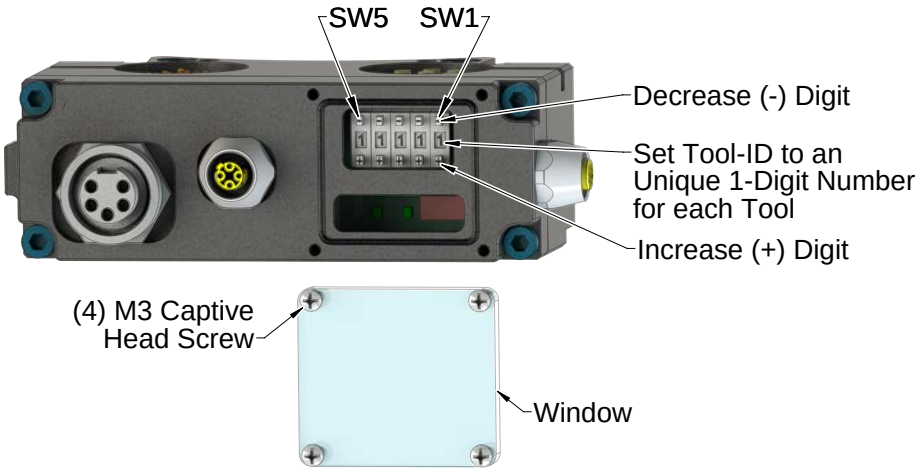
The Tool module utilizes a rapid communication method to report the Tool-ID information from the push button switches to the Master module as soon as the Tool Changer or Utility Coupler is coupled. Typically the Tool-ID information is available to the Master within 150 ms from the time the Tool Changer or Utility Coupler is coupled.

(5) push button switches are provided on the Tool module for setting of a Tool-ID number.

If the plastic window and seal above the Tool-ID switches are removed, ensure the seal and window are re-positioned correctly to prevent a leakage path to the module inside.

The Tool-ID is available to the Master within 250 ms from the time the changer is coupled; otherwise a Tool-ID_Error shall be set in the bit map. If a Tool is not present the Tool-ID is set to FFFFF. If the Master and Tool are coupled and the Tool-ID fails to be reported, a Tool-ID_Error shall be set.

Figure 2.5—Tool-ID Switch Settings



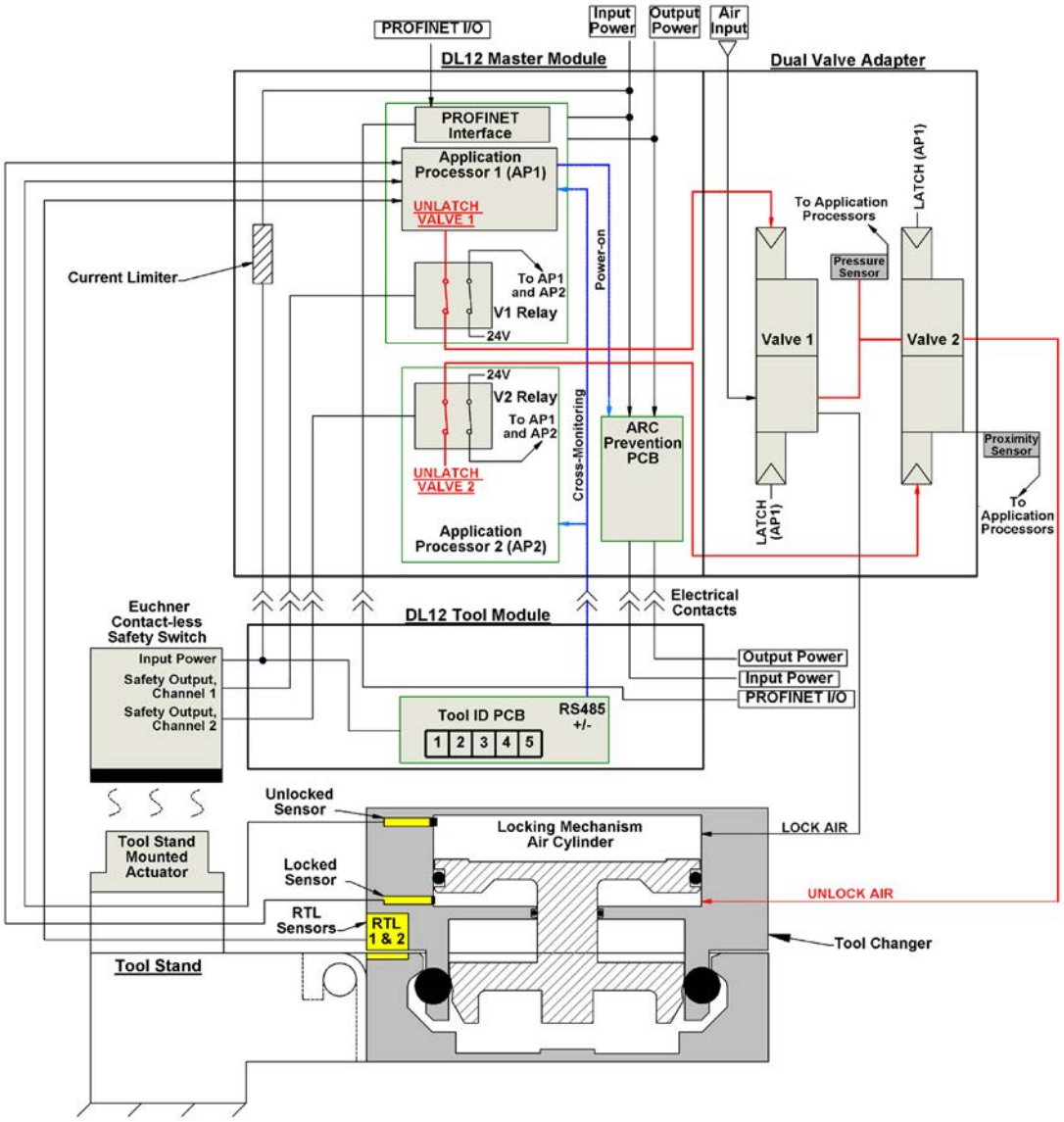
2.4 Safety System

The safety system is designed to avoid unintentional Tool release, by integrating a non-contact safety switch, (2) pneumatically interconnected solenoid valves, dual relays, and (2) cross monitoring processors into the safety circuit.

The (2) cross monitoring processors in the Master module determine, based on the status of all the safety related inputs and outputs, when it is safe to execute an Unlatch command. The processors are linked by hardwired I/O. If one processor detects a condition that differs from the other processor, its control logic declares a fault preventing the Unlatch output. When the Tool is positioned safely in the tool stand or storage location, the safety switch outputs close the V1 and V2 Relays that allows the Unlatch command to pass from the Application Processors to the solenoid valves.

A second set of contacts on the V1 and V2 Relays also provide diagnostics to the Application Processors. The valve adapter is equipped with (2) double solenoid valves. Valve adapter pressure and proximity sensor outputs are evaluated by the Application Processors for diagnostic purposes.

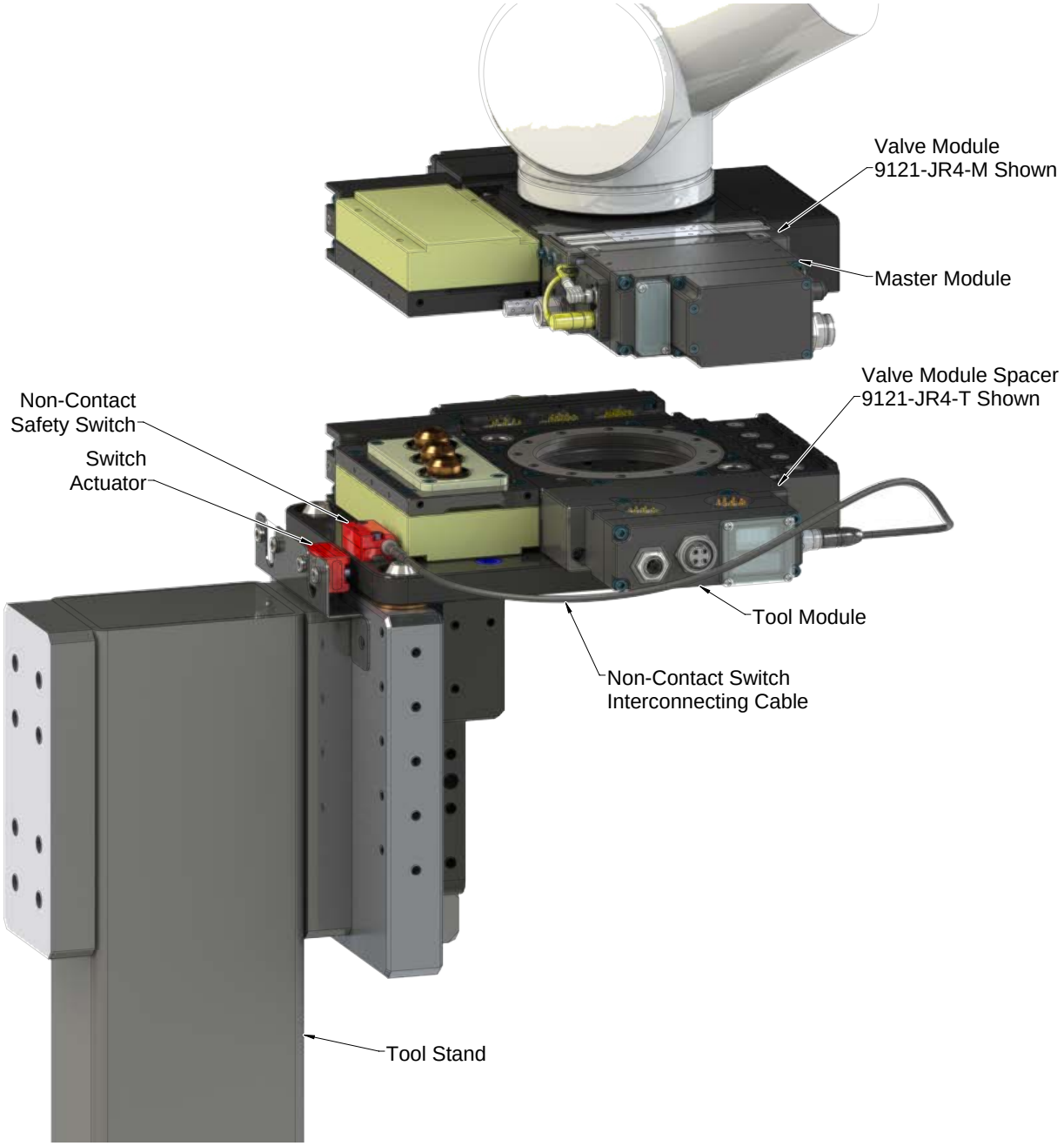
Figure 2.6—Safety Circuit Diagram



The safety switch (not included with module) is mounted on Tool side of the module. The actuator is mounted to the tool stand. The safety switch is connected to the Tool module by a five conductor M12 cable. Refer to the dual double solenoid valve adapter manual (9620-20-C-Jxx Valve Adapters with Dual Double Solenoid, Valve Pass Through, Proximity and Pressure Sensors) for detailed information on the dual double solenoid valve functionality.

CAUTION: It is required to use a PLe rated non-contact safety switch such as the Euchner CES-AP with the module. Use of unapproved switches will void the PLd safety rating. Contact ATI before using another safety rated switch.

Figure 2.7—Safety Switch (Modules Shown for Reference Only)



3. Installation

The modules are typically installed by ATI prior to shipment. The steps below outline the field installation or removal as required. 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

NOTICE: If module being installed is not new “out of the box” and has been previously commissioned refer to *Section 6.2.2—DL12 Device Replacement Procedures* for instructions.

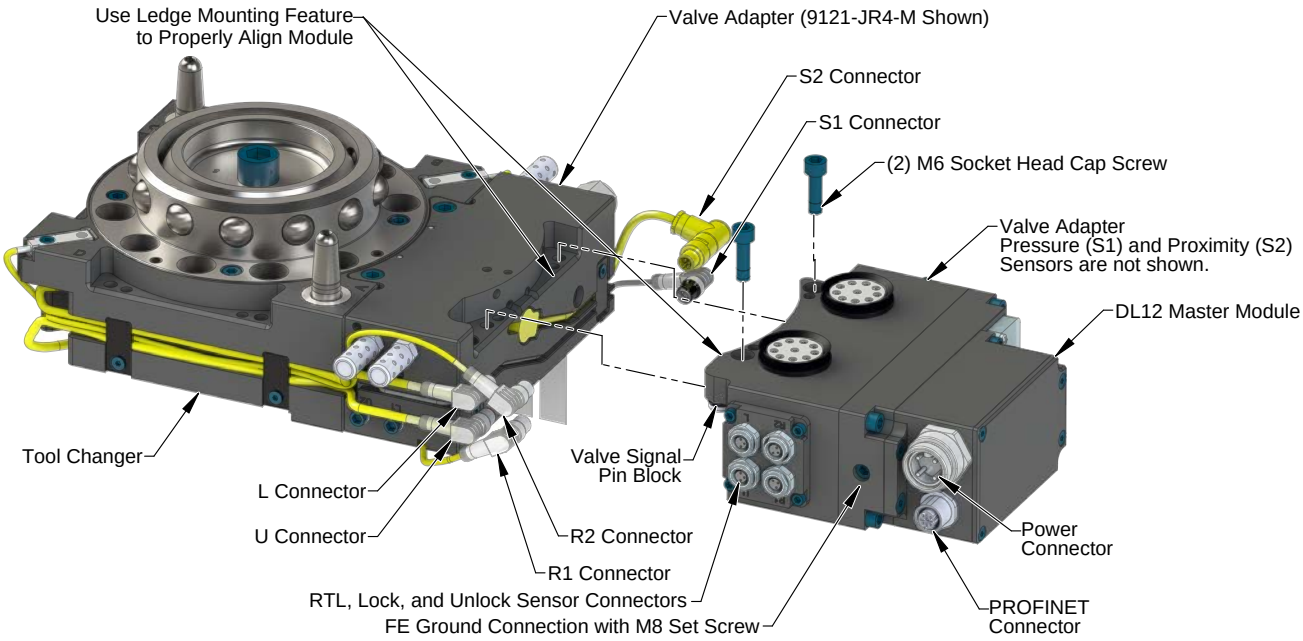
Refer to *Figure 3.1*

Tools required: *5 mm Allen wrench (hex key)*

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. Install the (2) M6 socket head screws securing the module to the valve adapter using a 5 mm Allen wrench. Tighten to 70 in-lbs (7.9 Nm).
7. If fasteners do not have pre-applied adhesive, 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).
8. Connect the valve adapter proximity sensor cable to (S1) and valve adapter pressure sensor cable to (S2) connections on the module.
9. Connect the (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors to the module.
10. Connect the 5-pin power cable and PROFINET cable connectors to the module.
11. Remove the 8 mm set screw from the FE ground terminal using a 5 mm hex key.
12. Connect the ground to the FE grounding terminal using a M8 customer supplied fastener.
13. The module will automatically get the name and IP address assigned.
14. After a few seconds, it should be operating on the network.
15. After the procedure is complete, resume normal operation.

Figure 3.1 —Master Module Installation



3.2 Master 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 (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors from the module.
5. Disconnect the 5-pin power cable and PROFINET cable connectors from the module.
6. Disconnect the valve adapter Proximity Sensor Cable from (S1) and valve adapter Pressure Sensor Cable from (S2) connections on the module.
7. Disconnect the ground from the FE grounding terminal.
8. Support the module and remove the (2) M6 socket head cap screws and lower the module until it clears the guide pin.

3.3 Tool Module Installation

Refer to *Figure 3.2*

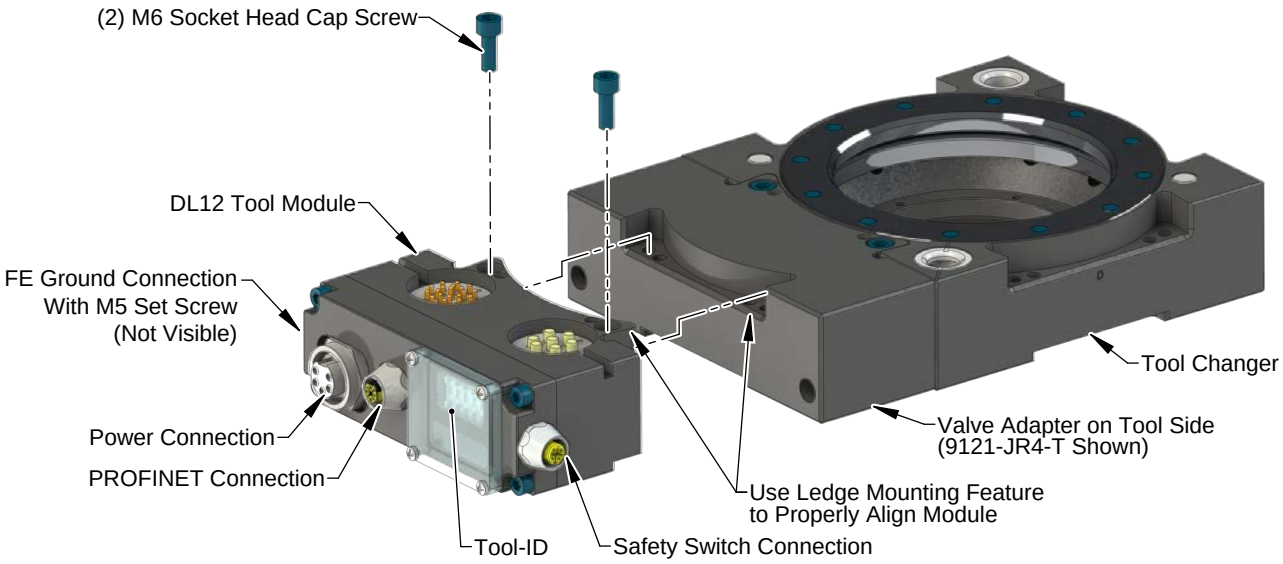
Tools required: *3 mm and 5 mm hex key*

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 into the appropriate location on the tool adapter. Align the module with the tool adapter using the dowels in the bottom of the ledge feature.
6. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the supplied (2) M6 socket head cap screws. Install the (2) M6 socket head cap screws that secure the module to the tool adapter and tighten to 70 in-lbs (7.9 Nm).
7. Connect the safety switch cables to the module.

8. Connect the 5-pin power cable and PROFINET cable connectors to the module.
9. Remove the 5 mm set screw from the FE ground terminal using a 3 mm hex key.
10. Connect the ground to the FE grounding terminal using a M5 customer supplied fastener.
11. Set the Tool-ID. Refer to *Section 3.8—Setting the Tool-ID.*
12. After the procedure is complete, resume normal operation.

Figure 3.2 —Tool Module Installation



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 safety switch cables from the module.
5. Disconnect the 5-pin power cable and PROFINET cable connectors from the module.
6. Disconnect the ground from the FE grounding terminal.
7. Set the Tool-ID. Refer to *Section 3.8—Setting the Tool-ID*.
8. Support the module and remove the (2) M6 socket head cap screws and lift up on the module until it clears the guide pin.

3.5 PROFINET Interface

The PROFINET interface parameters and I/O bitmaps employed in the modules are found in *Section 2.1.1—PROFINET Interface Information* of the manual. These should be thoroughly understood prior to operating the Tool Changer. A detailed operational sequence is provided in *Section 4.4—Recommended Sequence of Operation.*

3.6 Utility Schematic

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

3.7 Electrical Connections

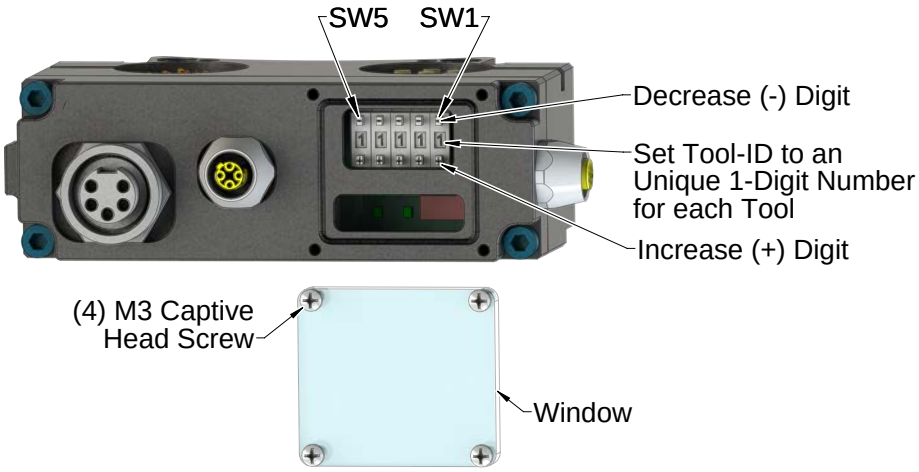
Refer to drawings in *Section 9—Drawings* of this manual for electrical connection and pin/signal information.

3.8 Setting the Tool-ID

There are (5) push button switches are provided on the Tool module for setting of a Tool-ID number. Each Tool must have an unique 5 digit Tool-ID number.

Tools required: *Phillips screw driver*

Figure 3.3—Setting the Tool-ID



1. Loosen the (4) M3 pan head captive screws and remove 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 value from 0 to 9. Set the Tool-ID to the desired unique 5 digit number from 00000 to 99999 for each Tool.
3. Re-install the Tool-ID window and tighten the M3 pan head captive screws.

4. Operation

A thorough understanding of the advanced diagnostic and fault reporting capability is required to proficiently operate this product. The following information is provided to help define the behavior of the Master/ Tool modules.

Refer to the specific Tool Changer Manual for conditions for coupling and *Section 4.4—Recommended Sequence of Operation*. When coupled, the Tool module can be communicated with, Tool-ID can be read (if equipped), and attached end effectors can be used.

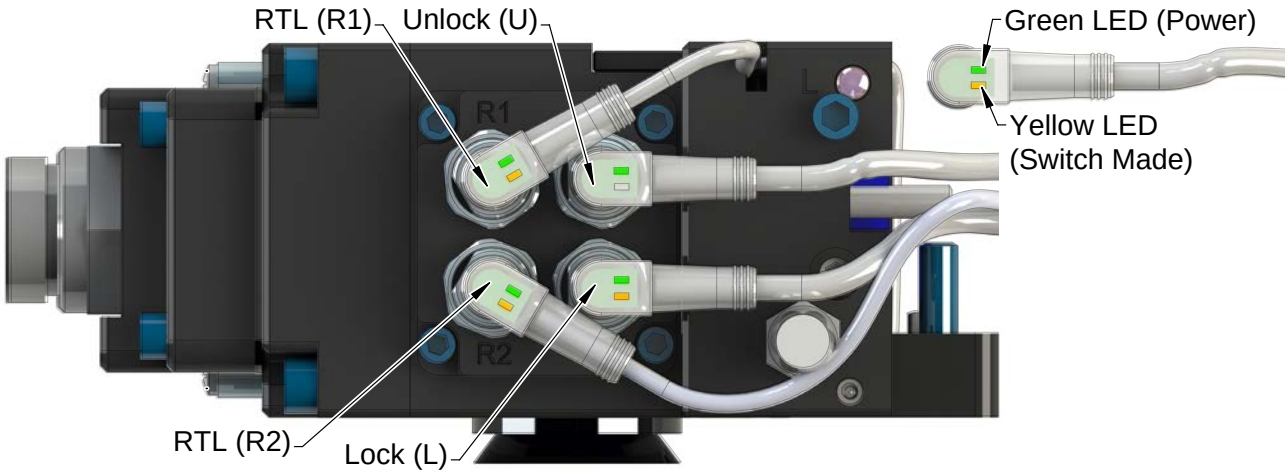
4.1 Lock, Unlock, and RTL Sensor Cable LED Behavior

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 Inputs

The following describes the most critical inputs from the ATI Master module.

4.2.1 EVERYTHING IS OK

This is an overall status bit that indicates if there is an error condition that will block an unlatch request. This bit is high as long as there are no errors.

4.2.2 Locked

An input indicating that the coupling mechanism is in the Lock position. The “LOCKED” bit in the PROFINET bitmap will only be set high if the following conditions are on:

- LOCKED sensor input is high
- UNLOCKED sensor input is low
- TOOL PRESENT input is high

4.2.3 Latch Enabled

The Latch Enabled bit indicates when the preconditions for latching the Tool Changer have been met. The preconditions include:

- No Errors
- Input and Output Power within operating range (20.4-28.8 V).
- Air pressure within operating range (60-100 psi).
- UNLATCH bit is off
- LATCH bit is off

4.2.4 RTL1 and RTL2

Proximity sensor inputs that indicate the Tool Changer Master is close to the Tool. It is recommended that these inputs be used to indicate when it is okay to couple the Tool Changer. These proximity sensors are installed in the Master body and sense targets in the Tool body that indicate the Master is adjacent to the Tool (within ~ 0.06” or 1.5 mm).

4.2.5 SSO 1 and SSO 2

Discrete inputs from the safety switch, which are high when the Tool Changer is in the stand.

4.2.6 SS Pulse Missing

A bit indicating the TSI Safety Switch is bypassed or SSO_1 is shorted to 24 volts. This bit will clear when the bypass is removed or the SSO_1 short is fixed. This bit does not prevent latching or unlatching.

4.2.7 Tool Power Is On

The Tool Power Is On bit indicates that the Arc Prevention circuit has turned power on to the Tool side.

4.2.8 Tool Present

An input indicating the Master module is electrically connected to the Tool.

4.2.9 Unlatch Enabled

The Unlatch Enabled bit indicates when the preconditions for unlatching the Tool Changer have been met. The preconditions include:

- No Errors
- US1 and US2 Power within operating range
- Air pressure within operating range
- UNLOCKED bit is OFF
- LATCH bit is OFF
- The Tool is in the tool stand as indicated by SSO1, SSO2, V1RELAY, and V2RELAY bits being ON

4.2.10 Unlocked

A proximity sensor input indicating that the coupling mechanism is in the Unlocked position. The "UNLOCKED" bit in the PROFINET bitmap will only be set high if the following conditions are on:

- UNLOCKED sensor input is high
- LOCKED sensor input is low

4.2.11 US1 Power Present

An input indicating the presence of Input and Logic Power (US1) at the ATI Master module. US1 power must be between 20.4 V and 28.8 V otherwise the Tool Changer will NOT latch or unlatch.

4.2.12 US2 Power Present

An input indicating the presence of Output Power (US2) at the ATI Master module. US1 power must be between 20.4 V and 28.8 V otherwise the Tool Changer will NOT latch or unlatch.

4.2.13 V1 Relay and V2 Relay

V1 Relay is a normally open relay driven to closure by Channel 1 of the Safety Switch (SSO1). Similarly, the V2 Relay is driven to closure by Channel 2 of the Safety Switch (SSO2). Both of these inputs must be high when the Tool Changer is in the tool stand, otherwise the Tool Changer will NOT unlatch.

4.3 Error Conditions

The following describes the reported error conditions and explains how to reset the condition.

4.3.1 AP2 COMM ERROR

This bit indicates that the (2) Application Processors in the Master module have stopped communicating. The error condition can be reset with Clear Errors bit. If this error is re-occurring, contact ATI for service.

4.3.2 CROSS MONITORING ERROR

The (2) Application Processors monitor the various safety related inputs and outputs. If the processors are not in agreement on the status of these inputs and outputs the CROSS_ MONITORING_ERROR bit will be set. The error condition can be reset with the Clear Errors bit.

4.3.3 ERROR ON LATCH

This bit indicates that a short circuit or overload condition on the LATCH output has been detected. The error condition can be reset with the Clear Errors bit.

4.3.4 ERROR ON UNLATCH1

This bit indicates that a short circuit or overload condition on the UNLATCH output to Valve 1 has been detected.

The error condition can be reset with the Clear Errors bit.

4.3.5 ERROR ON UNLATCH2

This bit indicates that a short circuit or overload condition on the UNLATCH output to Valve 2 has been detected. The error condition can be reset with the Clear Errors bit.

4.3.6 Lock/Unlock Sensor Fault

This error bit will be set if the Locked and Unlocked Sensors are on at the same time or if the latch/unlatch motion of the Tool Changer is incomplete or faulty. If the condition is not on anymore then the bit shall be automatically reset.

4.3.7 PRESSURE DISCONNECTED

The PRESSURE_DISCONNECTED bit indicates that the pressure sensor is disconnected and/or that there are broken wires in the sensor cable.

If the pressure sensor is left disconnected then a SYSTEM_IS_UNSAFE error will be generated. The error condition can be reset with the Clear Errors bit.

4.3.8 Pressure Too High

If the module detects the air pressure above 100 psi then the Pressure Too High bit is set. The error can be reset by supplying air at the correct pressure and then applying the Clear Errors. See Notes section of *Table 2.2* for pressure determination.

4.3.9 Pressure Too Low

If the module detects the air pressure below 60 psi then the Pressure Too Low bit is set. The error can be reset by supplying air at the correct pressure and then applying the Clear Errors. See Notes section of *Table 2.2* for pressure determination.

4.3.10 SYSTEM IS UNSAFE

Any safety related error (Application Processor communication errors, input/output mismatch errors, safety switch error, valve error, etc.) will set the SYSTEM_IS_UNSAFE error. If the SYSTEM_IS_UNSAFE error bit is set the UNLATCH and LATCH outputs shall be frozen. Refer to *Table 4.2* for the errors that will trigger a SYSTEM_IS_UNSAFE error.

The error condition can be reset with the Clear Errors bit.

4.3.11 TOOL-ID ERROR

The Tool-ID shall be available to the Master within 250 ms from the time the changer is coupled; otherwise a TOOL-ID ERROR is set in the bit map. If the Master and Tool are coupled and the Tool-ID fails to be reported, a TOOL-ID ERROR is set. The error condition can be reset with a rising edge of TOOL PRESENT or the Clear Errors bit.

4.3.12 UNSAFE LATCH

A LATCH command shall only be performed if the following conditions are met:

- LATCH command is received
- UNLATCH bit is OFF
- US1 and US2 Power Present are ON
- PRESSURE_TOO_LOW and PRESSURE_TOOL_HIGH are OFF
- SYSTEM_IS_UNSAFE bit is OFF

If the LATCH command is received and the above conditions are not all met, the UNSAFE_ LATCH error bit shall be set. This error condition will be reset when a new LATCH command is recieved and the LATCH_ENABLE conditions are met.

4.3.13 UNSAFE UNLATCH

An UNLATCH command shall only be performed if the following conditions are met:

- SSO1, SSO2, V1RELAY, and V2RELAY must be ON indicating that the Tool Changer is nested safely in the Tool Stand.
- Everything is OK bit must be ON indicating no errors.
- The LATCH bit must be OFF.
- The UNLOCKED bit must be OFF.
- US1_Power_Present bit must be ON.
- US2_Power_Present bit must be ON.

The UNSAFE_UNLATCH bit will be set when the user sends an unsafe unlatch command. This condition is monitored immediately after an UNLATCH command and will disable the Unlatch and turn off Unlatch immediately. If UNLATCH is inadvertently held high during a power cycle the UNSAFE_UNLATCH error will be generated. This error bit will be reset when a new UNLATCH command is received (UNLATCH command removed and reapplied) and the UNLATCH_ ENABLE conditions are met or with the rising edge of the Clear Errors bit.

4.3.14 VALVE ERROR

If the module detects an error in the function of either valve, a VALVE_ERROR bit shall be set. Reference the 9620-20-C-Jxx Valve Adapters with Dual Double Solenoid, Valve Pass Through, Proximity and Pressure Sensors for potential valve failure modes. Valve errors set the SYSTEM_ IS_UNSAFE bit so the Clear Errors bit required to clear.

Table 4.2—Error Conditions			
Error Bit	**Error Description**	**TRIGGERS SYSTEM_IS_ UNSAFE ERROR**	**Reset with**
AP2_COMM_ERROR	Communication failure between Application Processor 1 and 2	Yes	Clear Errors Bit
CROSS_MONITORING_ ERROR	Application Processor safety related inputs and outputs do not match	Yes	Clear Errors Bit
ERROR_ON_LATCH	Short circuit detection on LATCH output	No (Yes only during Latch)	Clear Errors Bit
ERROR_ON_ UNLATCH1	Short circuit detection on UNLATCH output to Valve 1.	No (Yes only during Unlatch)	Clear Errors Bit
ERROR_ON_ UNLATCH2	Short circuit detection on UNLATCH output to Valve 1.	No (Yes only during Unlatch)	Clear Errors Bit
LOCK/UNLOCK Sensor Fault	LOCKED and UNLOCKED Sensor on at the same time	No (Yes only during Unlatch)	Correct error or Clear Errors Bit
PRESSURE_ DISCONNECTED	Pressure Sensor not connected	Yes	Clear Errors Bit
PRESSURE_TOO_HIGH	Air supply to valve adapter too high	No (Yes only during Unlatch)	Clear Errors Bit
PRESSURE_TOO_LOW	Air supply to valve adapter too low	No (Yes only during Unlatch)	Clear Errors Bit
TOOL_ID_ERROR	TOOL-ID timeout error	No	Rising edge of TOOL_ PRESENT; Clear Errors Bit
UNSAFE_LATCH	Latch requested under unsafe conditions	No	Rising edge of LATCH or Clear Errors Bit
UNSAFE_UNLATCH	Unlatch requested under unsafe conditions	No	Rising edge of UNLATCH or Clear Errors Bit
VALVE_ERROR	Valve module pressure and/or position error	Yes	Clear Errors Bit

4.3.15 Error Recovery Sequence

If the Tool is unable to be unlatched due to a fault condition it can be reset either by a power cycle or following the steps in the recovery sequence.

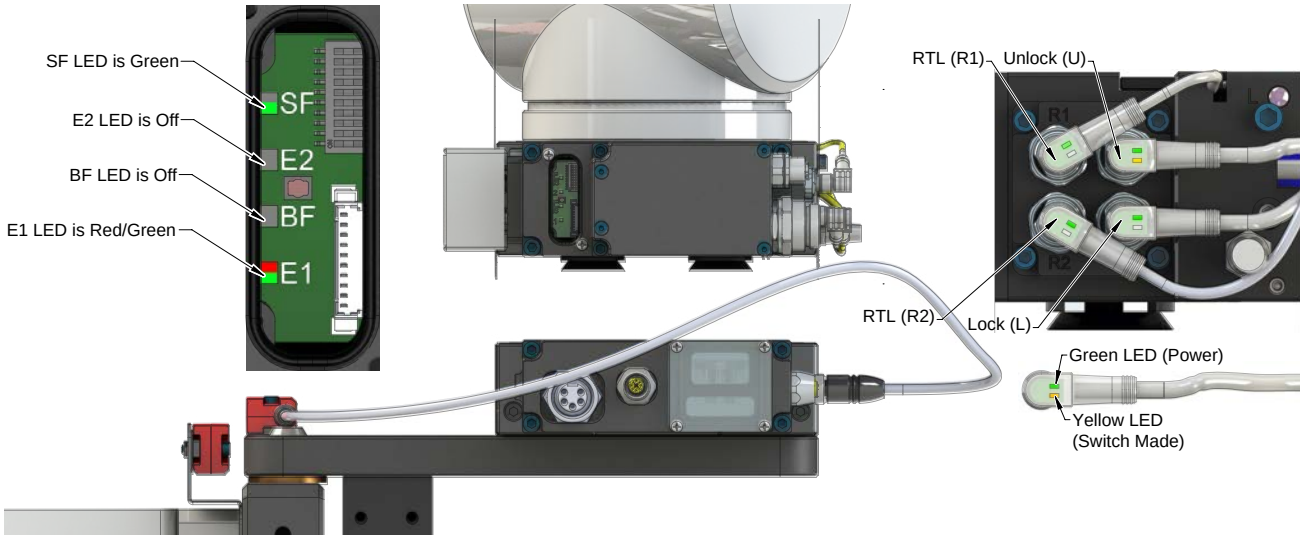
1. Turn off Latch and Unlatch commands.
2. Pulse Clear Errors for minimum 50 ms
3. Wait for Latch Enabled or Unlatch Enabled
4. If error does not reset, troubleshoot.

4.4 Recommended Sequence of Operation

Before programing can take place, the following condition must be met:

- Input and Output Auxiliary 24 VDC power is available and within acceptable range (20.4 - 28.8 VDC).
- Air is supplied to the integrated valve and within acceptable range (60 - 100 psi).

Figure 4.2—Master Free with Tool In the Tool Stand



NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

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 following inputs are ON:
      i. Unlocked
      ii. US1 Power Input Power and **US2 Power** Output Power (Must remain on at all times).
      iii. Tool-ID invalid (all 1→ 0xFFFF)
      iv. Everything is OK

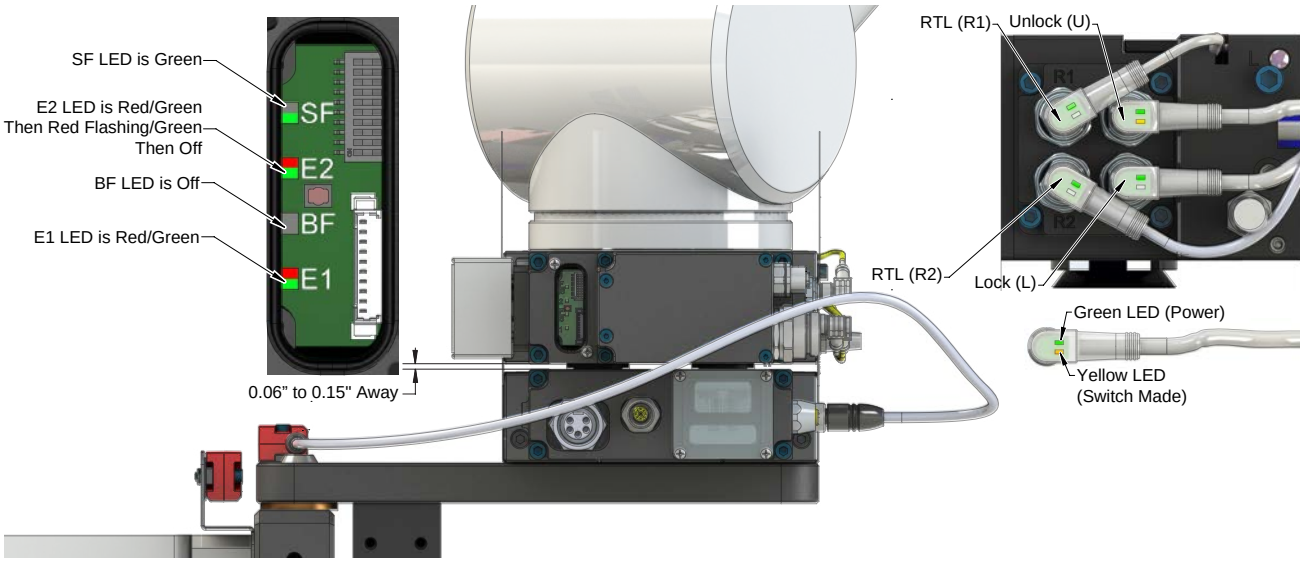
   b. The following inputs are OFF:
      i. Unlatch Enabled
      ii. Locked
      iii. RTL1 and RTL2
      iv. Tool Present
      v. SSO_1 and SSO_2
      vi. **V1RELAY** and **V2RELAY**
      vii. Tool Power is On

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

   d. The ATI Tool and any downstream PROFINET device(s) are offline.

CAUTION: The Master locking mechanism must be fully retracted prior to the Master entering the Tool. Failure to do so will cause ball bearings to damage the Tool Bearing Race. If the Tool Changer is locked or in a missed Tool condition, use the solenoid valve manual override procedure (refer to the valve adapter manual) to unlock the Tool Changer before attempting to latch Master with Tool.

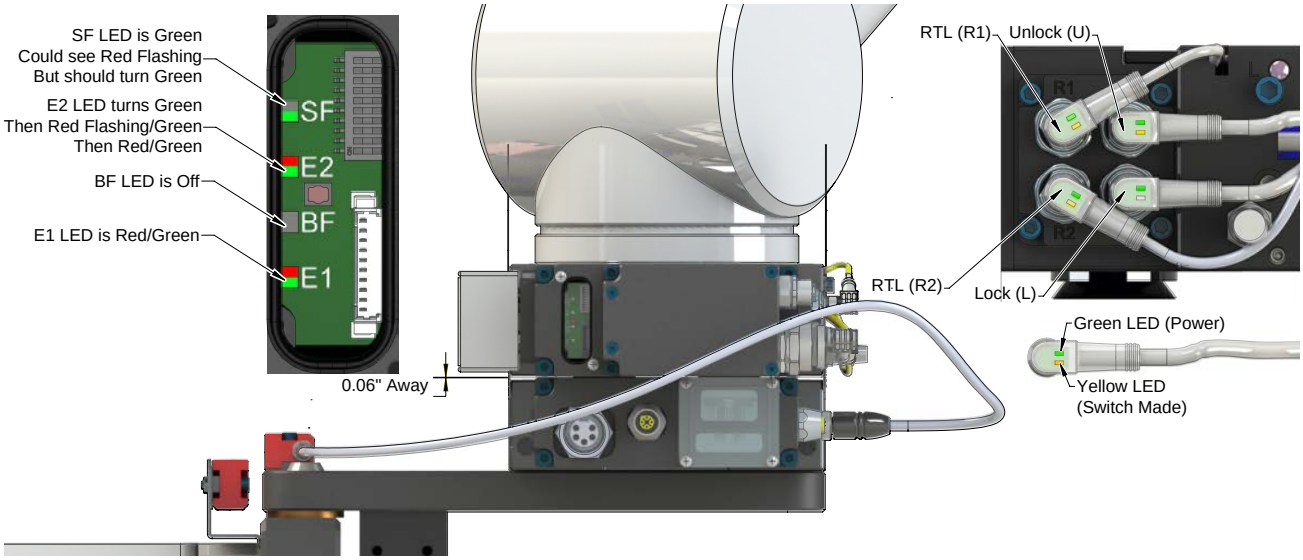
Figure 4.3—Master Moves into Tool and is parallel within 0.06” to 0.15”



NOTICE: If the LEDs don’t match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

2. Robot with Master move into the Tool and are parallel within 0.06” to 0.15” of the Tool. The module contact pins are touching but the **RTL** sensors have not sensed the targets on the Tool.

Figure 4.4—Master Moves into Tool and is parallel at 0.06”



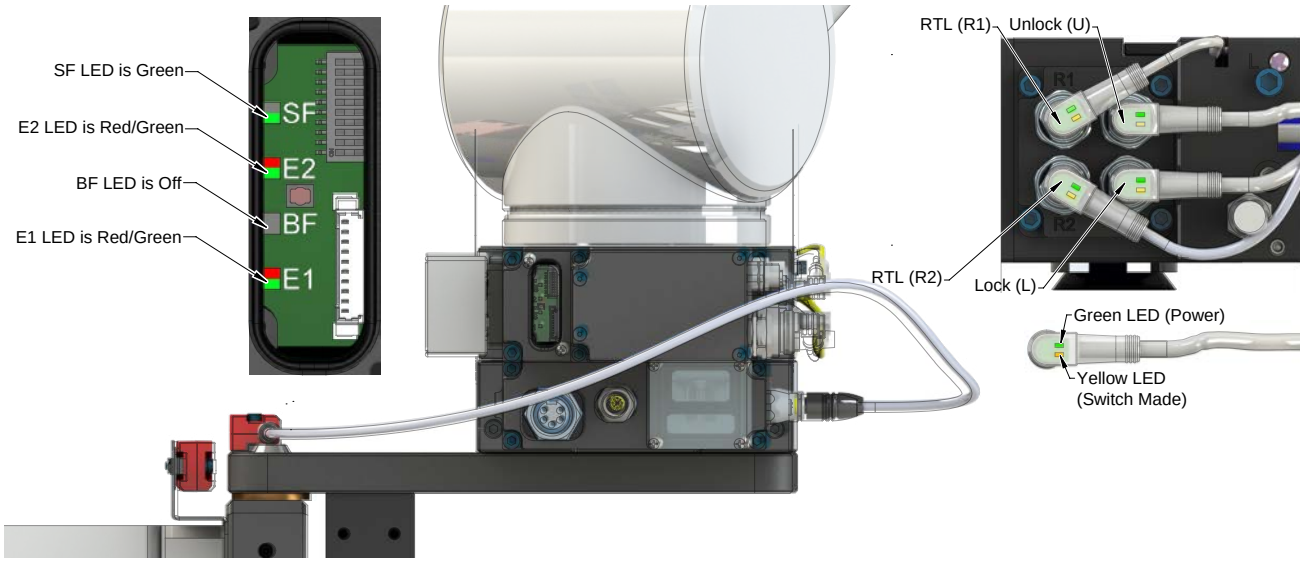
3. Robot and Master move within 0.06” of the Tool and safety switch is within range.

   a. The **RTL1 and RTL2** inputs are ON, indicating that it is ok to couple the Tool.

   b. The **Tool Present input** turns ON, indicating that the Master and Tool are in close proximity of each other.

   c. Everything is OK bit is ON.

Figure 4.5—Master Coupled with Tool

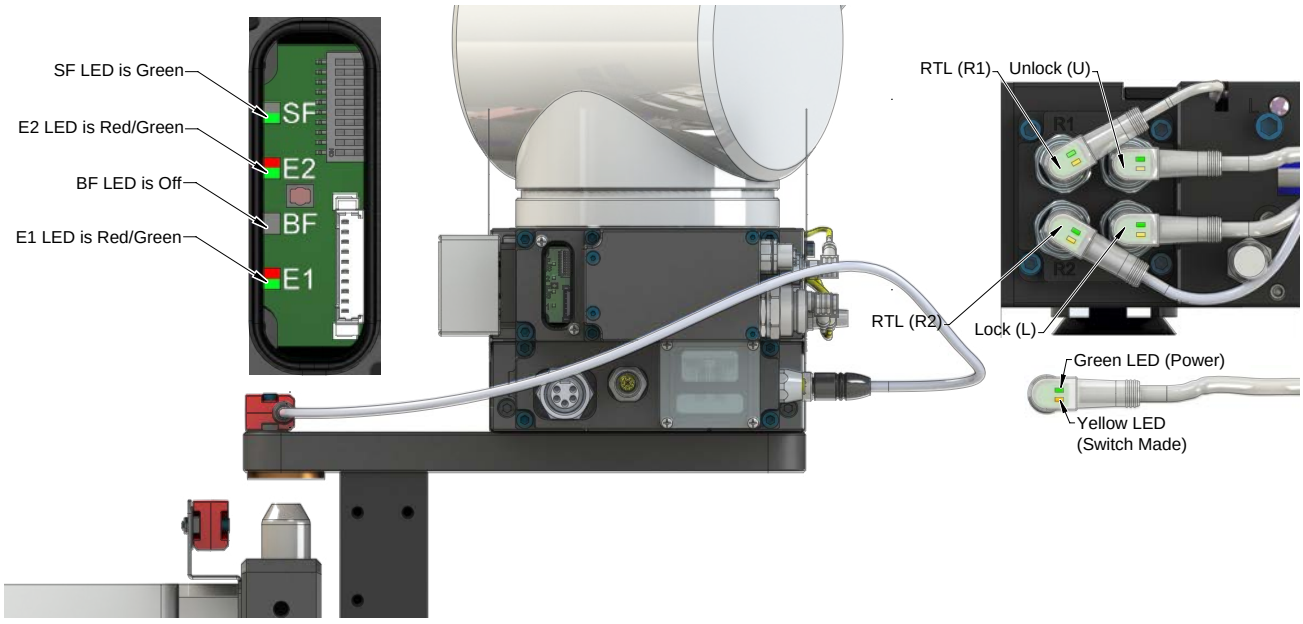


NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

4. Couple the Tool Changer.

   a. Pulse the **Latch** ON minimum 500 ms.
   b. The **Unlocked** input turns OFF a short time later, indicating piston travel. Subsequently, the **Locked** input turns ON, indicating that the coupling operation is complete.
   c. Power becomes available on the Tool and the **Tool Power is On** bit becomes ON.
   d. Everything is OK input is ON.
   e. Tool-ID becomes available.
   f. Shortly thereafter, communications should be established with downstream devices.
   g. The **SSO_1, SSO_2, V1RELAY, and V2RELAY** are ON (Subsequently **Unlatch Enable** is ON).

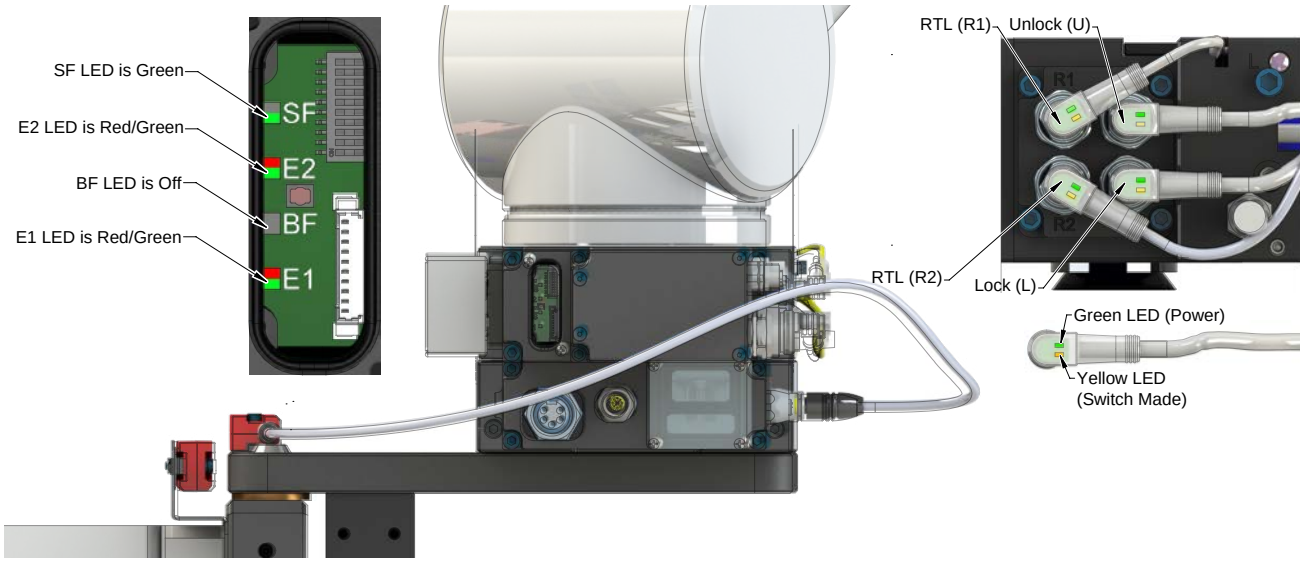
Figure 4.6—Master Coupled with Tool Moves Out of the Stand



NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

5. Robot moves away from the Tool stand with the Tool Changer coupled.
   a. The **Safety Switch** becomes deactivated, and the **SSO_1, SSO_2, V1RELAY, and V2RELAY** inputs turn OFF.
   b. **Unlatch Enabled** input turns OFF.
   c. Everything is OK bit is ON.
6. Normal operation (with Tool attached)
   a. The following inputs are ON:
      i. Locked
      ii. US1 Power (Input Power) and **US2 Power** (Output Power)
      iii. RTL1 and RTL2
      iv. Tool Power is On
      v. Tool Present
      vi. Everything is OK
   b. The following inputs are OFF:
      i. Unlocked
      ii. SSO_1 and **SSO_2**
      iii. **V1RELAY** and **V2RELAY**
      iv. Unlatch Enabled
   c. The following outputs are OFF:
      i. Unlatch
      ii. Latch

Figure 4.7—Master Coupled with Tool Returned to Stand



NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

7. Robot moves into the Tool stand with the Tool Changer coupled. **Everything is OK** bit is ON.

   a. When the Tool is returned to the stand, the **Safety Switch** becomes activated and the **SSO_1, SSO_2, V1RELAY, and V2RELAY** inputs turn ON.

   b. **Unlatch Enabled** turns ON, indicating that it is safe to uncouple the Tool Changer.

8. Uncouple the Tool Changer. Check that **Unlatch Enabled** is ON. If **Unlatch Enabled** is OFF, reset errors according to procedure *Section 4.3.15—Error Recovery Sequence.*

   a. Pulse **Unlatch** ON minimum 500 ms.

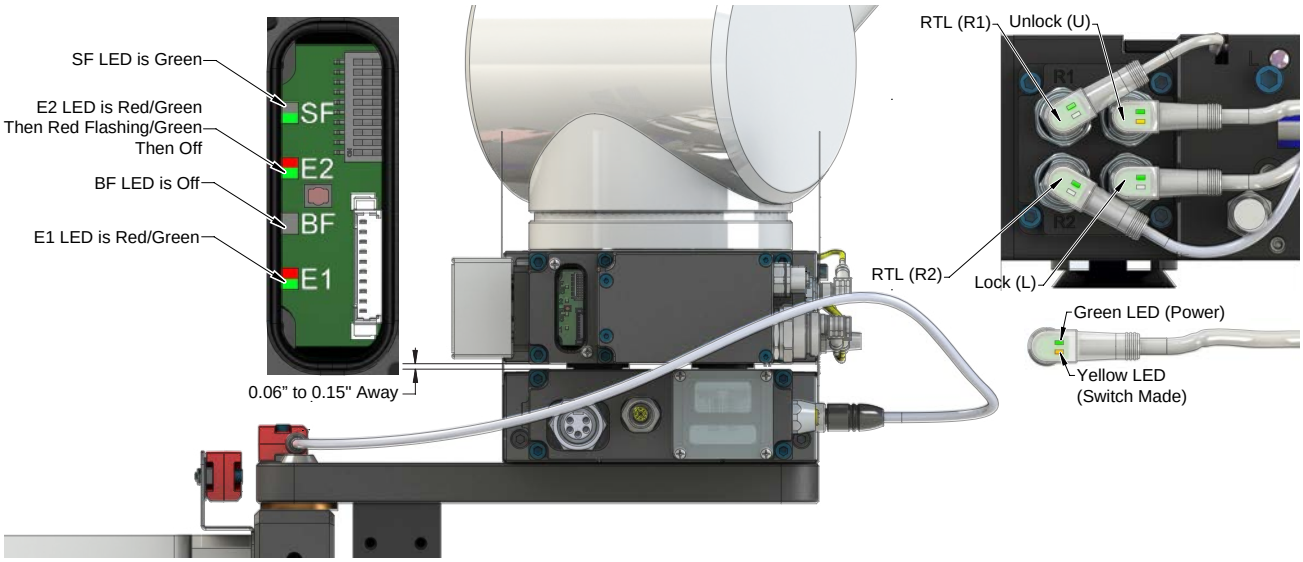
   b. The **Tool Power is On** bit turns OFF.

   c. Communication is lost with downstream device(s).

   d. The **Locked** input turns OFF a short time later and subsequently the **Unlocked** input goes ON, indicating that the uncoupling operation is complete.

   e. **Everything is OK** input is ON.

Figure 4.8—Master Uncoupled, Moves away from Tool and is parallel within 0.06” to 0.15”



NOTICE: If the LEDs don’t match what is shown, refer to *Section 2.1.3—System Failure and Bus Failure LEDs* or *Section 2.1.4—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

9. Robot and Master move away from the Tool, are parallel and between 0.06” to 0.15” of the Tool.

    a. The **Safety Switch** becomes deactivated, and the **SSO_1, SSO_2, V1RELAY, and V2RELAY** inputs turn OFF.

    b. Everything is OK input is ON.

10. Normal operation (With Tool In stand)

    a. The following inputs are ON:
    - **i. Unlocked**
    - **ii. US1 Power** Input Power and **US2 Power** Output Power (Must remain on at all times).
    - **iii. Tool-ID invalid (all 1→ 0xFFFF)**
    - **iv. Everything is OK**

    b. The following inputs are OFF:
    - **i. Unlatch Enabled**
    - **ii. Locked**
    - **iii. RTL1 and RTL2**
    - **iv. Tool Present**
    - **v. SSO_1 and SSO_2**
    - vi. **V1RELAY** and **V2RELAY**
    - **vii. Tool Power is On**

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

    d. The ATI Tool and any downstream PROFINET device(s) are offline.

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 as appropriate. 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).

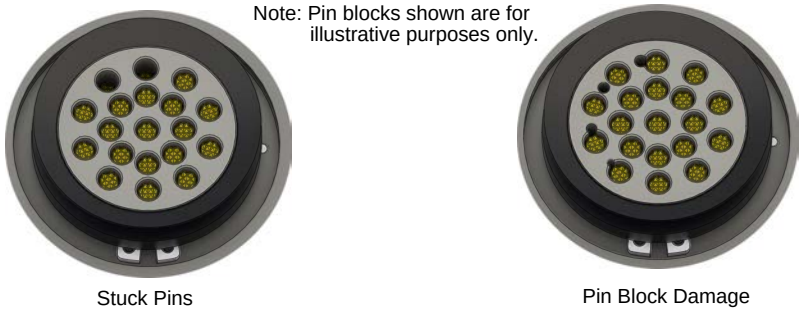
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Troubleshooting information and service procedures are covered in the following section to help diagnose and resolve conditions with the Tool Changer or Utility Coupler.

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

For troubleshooting information refer to the following table.

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 that 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.	Check air supply. *Refer to Pneumatic Connection section of the Tool Changer Manual for specifications.*
	Exhaust port is not properly vented.	Check that exhaust port is properly vented. *Refer to Pneumatic Connection section of the Tool Changer Manual for valve requirements.*
	Incorrect valve operation.	Check valve for proper operation. *Refer to Pneumatic Connection section of the Base Tool Changer Manual for valve requirements.*
	Signals are mapped incorrectly.	Verify that 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 that the Master and Tool are within the specified No-Touch zone when attempting to lock. *Refer to the Operation Section of the Tool Changer manual for specifications.*
Sensors not operating properly (but PROFINET is operating correctly).	Sensor cables damage or incorrectly connected.	Verify that cables are connected correctly and not damaged, replace if damaged. *Refer to the Troubleshooting Section of the Tool Changer manual.*
	Sensors are not set correctly.	Verify that the sensors are set correctly. *Refer to the Troubleshooting Section of the Tool Changer manual.*
	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.
	Air trapped in the unlock (U) air port.	Ensure that there is no air trapped in the Unlock (U) air port. *Refer to Pneumatic Connection section of the Tool Changer Manual for valve requirements.*
Loss of communication.	Robot Output bit set incorrectly.	Check to make sure **Robot Output Bit #4 is set to OFF**, If Bit #4 is ON set bit to OFF.
	Damaged signal cabling.	Check/replace signal cabling upstream and downstream of Tool Changer modules.
	Worn or damaged contact pins.	Inspect module contact pins for debris/wear/damage. Contact ATI for contact pin replacement.
	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.

Table 6.1—Troubleshooting		
Symptom	**Possible Cause**	**Correction**
No power on the Tool side.	Latch command not issued.	Verify that the Latch command has been issued.
	Tool Power is On bit.	Verify that the **Tool Power is On** bit is **HIGH**.
	Tool Present bit.	Verify that the **Tool Present** bit is **HIGH**.
Loss of auxiliary power on the Tool side.	US1 power loss.	Loss of US1 (Logic) power on the Master side will cause loss of US2 (Auxiliary) power to the Tool. The Arc Prevention Circuit relies on US1 power to operate. Restore US1 power to the Master to restore US2 power to the Tool.

6.2 Service Procedures

Inspection, adjustment, and replacement procedures are covered in the following section.

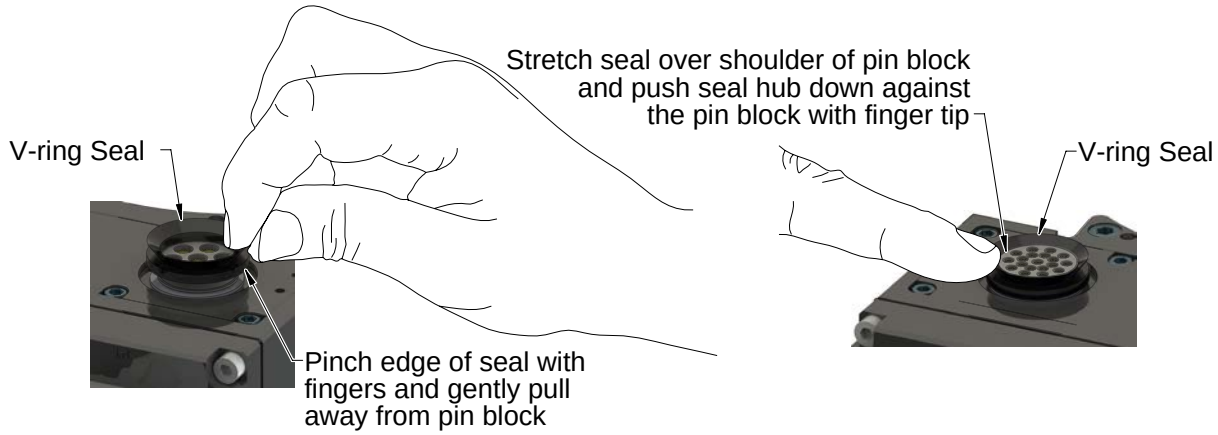
6.2.1 Seal Replacement

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 6.1—V-ring Seal Replacement



6.2.2 DL12 Device Replacement Procedures

The device replacement procedures are based on the following assumptions:

- The topology of the PROFINET network was properly defined with the PROFINET engineering tool.
- The PROFINET controller supports automatic device replacement.

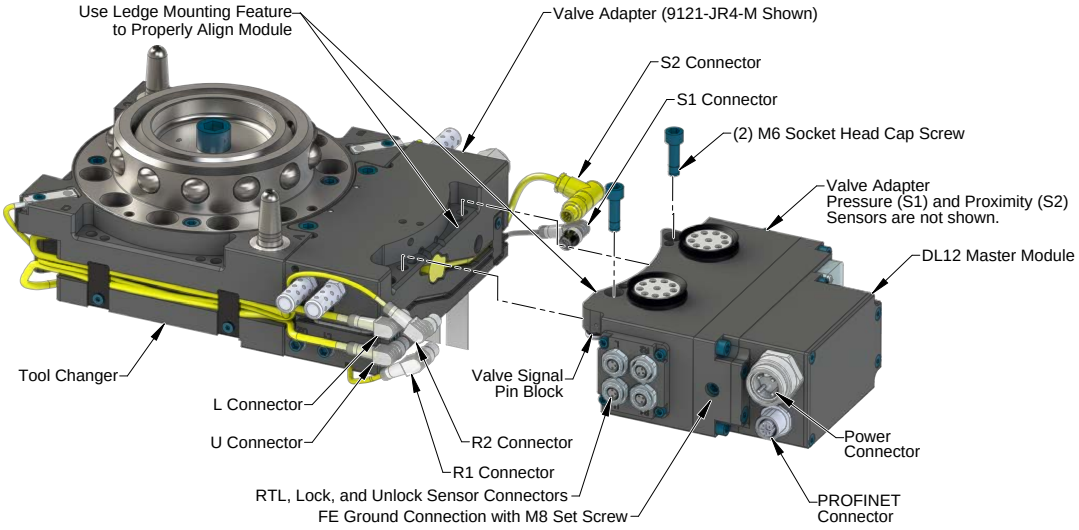
6.2.2.1 DL12 Master Module Replacement Procedures

1. Remove the "old" module from the Tool Changer or Utility Coupler, refer to *Section 3.2—Master Module Removal* for removal procedure.
2. Install new module on Tool Changer, refer to *Section 3.1—Master Module Installation* for installation procedure.

6.2.2.2 Replace DL12 Module with an Already Commissioned DL12 Module

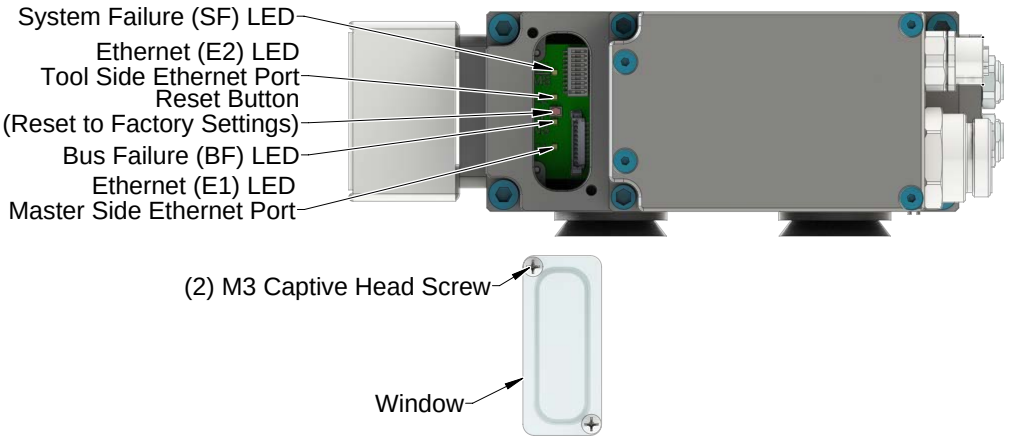
1. Remove the "old" module from the Tool Changer or Utility Coupler, refer to *Section 3.2—Master Module Removal* for removal procedure.
2. It may be necessary to clean the mounting surface on a dual double solenoid valve adapter prior to installing the module in order to remove any debris that may be present.
3. Using the ledge feature, place the module to a dual double solenoid valve adapter mounting surface. Align the module with the valve adapter using the dowels in the bottom of the ledge feature.
4. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the supplied M6 socket head cap screws. Install the (2) M6 socket head screws securing the module to the valve adapter and tighten to 70 in-lbs (7.9 Nm).
5. Connect the pressure sensor and proximity sensor cables to the connectors on the module.
6. Connect the RTL1, RTL2, Lock, and Unlock sensor cables to the connectors on the module.
7. Connect the 5-pin power cable to the connectors on the module.

Figure 6.2 —Master Module Installation



8. Loosen the (2) M3 pan head captive screws and remove LED window.
9. Locate reset button between BF and E2 LED.
10. Use a non-conductive tool (e.g. plastic stylus) to press on the reset button -> the SF LED will change from GREEN to blinking RED, indicating that the module will clear its name and IP address after the next power cycle.

Figure 6.3—Reset Button



11. Re-install the window and tighten the M3 pan head captive screws.
12. Disconnect the 5-pin power cable to the connectors on the module.
13. Connect the M12 cable and the 5-pin power cable to the connectors on the module.
14. The new module may be found using the default PROFINET station name and configured to the appropriate station name for your application, or the network controller may be configured to automatically rename the module when it detects the default name.
15. Within a few seconds after configuring, it should be operating on the network.
16. The SF and BF LED should be GREEN when the network is operating without errors.
17. After repair is complete, return all circuits to normal operation (e.g. electrical, air, water, etc.).

7. Serviceable Parts

Refer to *Section 9—Drawings*

7.1 Master Module Mounting Fasteners

Table 7.1—Master Module Mounting Fasteners	
Part Number	**Description**
3500-1066020-21A	M6 x 20 Socket Head Cap Screw, SS, ND Microspheres, 0-3 uncoated lead thds. 5-7 coated thds. IFI525

7.2 Tool Module Mounting Fasteners

Table 7.2—Tool Module Mounting Fasteners	
Part Number	**Description**
3500-1066016-15A	M6 x 16 Socket Head Cap Screw, DIN 912 A4 S/S (316) ND Ind. Microspheres Epoxy, Yellow. 0-3 uncoated lead thds. 5-7 coated thds.

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—Master Specifications	
9121-DL12-M	Profinet Master module with integrated Ethernet switch. D-Coded 4-Pin M12 connector for Profinet communication, 5-pole Mini Connector for Switched and Unswitched Auxiliary power. Arc Prevention applied to Switched and Unswitched Auxiliary power. Lock, Unlock, and RTL sensing with LED cables on the Master. Tool-ID from the Tool module also supported. Mates with DL12 Tool. Safety circuit meets ISO13849 PLd.
Connector(s)	Power: 5-Pin Minifast (7/8") Male PROFINET: 4-Pin D-Coded M12 Female Integrated Tool Changer I/O: • (4) M8, 3-pin female connectors supporting Tool Changer Locked, Unlocked, and Ready to Lock proximity sensors. Integrated Connection to valve adapter Diagnostic Sensors: • M8, 3-pin female connectors supporting Valve Adapter proximity sensor • M8, 4-pin female connectors supporting Valve Adapter pressure sensor Integrated Connection to Valve Adapter: • 4-pin Pin Block supporting Latch and Unlatch signals
Electrical Rating	Power Pass Through: • US1+ and US2+ Power: 10 A, 20–29 VDC **Note:** Arc prevention is applied to US1 and US2 power. Signal: 3 A, 30 VDC maximum
Current Draw	US1: Coupled, safety switch on and activated: 0.28 A Coupled, safety switch deactivated: 0.24 A Coupled, safety switch disconnected: 0.22 A Uncoupled: 0.14 A US2: Latching and Unlatching are the same: 0.48 A(peak)
Enclosure	IP65
Temperature	32°F to 120°F (0 to 49°C).
Weight	2.63 lbs (1.19 kg)

Table 8.2—Tool Specifications	
9121-DL12-T	Profinet Tool module. D-Coded 4-Pin M12 Connector for Profinet, 5-pole Mini Connector for Auxiliary power. Supports Arc Prevention. 5-Pin M12 to support TSI on the Tool and 5-Independent Switch Tool-ID. Mates with DL12 Master.
Default Configuration for Tool-ID	(5) Independent Tool-ID switches, each reading a (0–9) position (all factory set to Tool Position 1)
Connector(s)	Power: 5-Pin Minifast (7/8”) Male PROFINET: 4-Pin D-Coded M12 Female Connection to Switch: • M12, 5-pin female connector supporting connection to RFID based Safety Switch
Electrical Rating	Power Pass Through: • US1+ and US2+ Power: 10 A, 20–29 VDC Signal: 3 A, 30 VDC maximum
Enclosure	IP65
Temperature	32°F to 120°F (0 to 49°C).
Weight	1.43 lbs (0.65 kg)

9. Drawings

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