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Glossary

Term	Definition
BF LED	BUS Failure (BF) LED.
DCP	PROFINET Discovery and Configuration Protocol.
EOAT	End Of Arm Tool (end effector).
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	The output supplied to the ATI Master module to couple the Tool Changer.
LLDP	Link Layer Discovery Protocol
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
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.
SNMP	Simple Network Management Protocol
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.
TSI	The Tool Stand Interlock feature is a custom ATI safety solution and circuit designed to only allow the Tool Changer to release while in the stand or storage location.
Unlatch Enable	Indicates it is safe to proceed with an unlatch request.
Unlatch	The output supplied to the ATI Master module to uncouple the Tool Changer.
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

C. Control and Signal Modules

CYP1—PROFINET® Control/Signal Module

1. Product Overview

The modules enable the customer to control and communicate with the Tool Changer through a PROFINET network. A PROFINET node is established on the Master only. Control of the Tool Changer is achieved through the Master node along with the reporting of the various Tool Changer I/O. The Tool module supports Tool-ID and functions as a pass-through for PROFINET network and power to the customer tooling.

A card edge connector is used to transmit the Latch/Unlatch requests from the Control Module to the Valve Module.

In addition to supporting the standard Tool Changer input signals (Locked, Unlocked, and Ready-to-Lock proximity sensors) the modules support advanced diagnostic and fault reporting.

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. When the modules are coupled, the V-ring seal forms a water resistant but not waterproof seal around the pin block.

The Unlock signal to the integrated solenoid valve is routed through a Tool Stand Interlock (TSI) safety circuit that prevents the robot from unlocking the Tool from the Master, when the Tool is not in the tool stand. Refer to *Section 2.4—Tool Side TSI* for additional information regarding TSI.

1.1 CYP1 Master Module

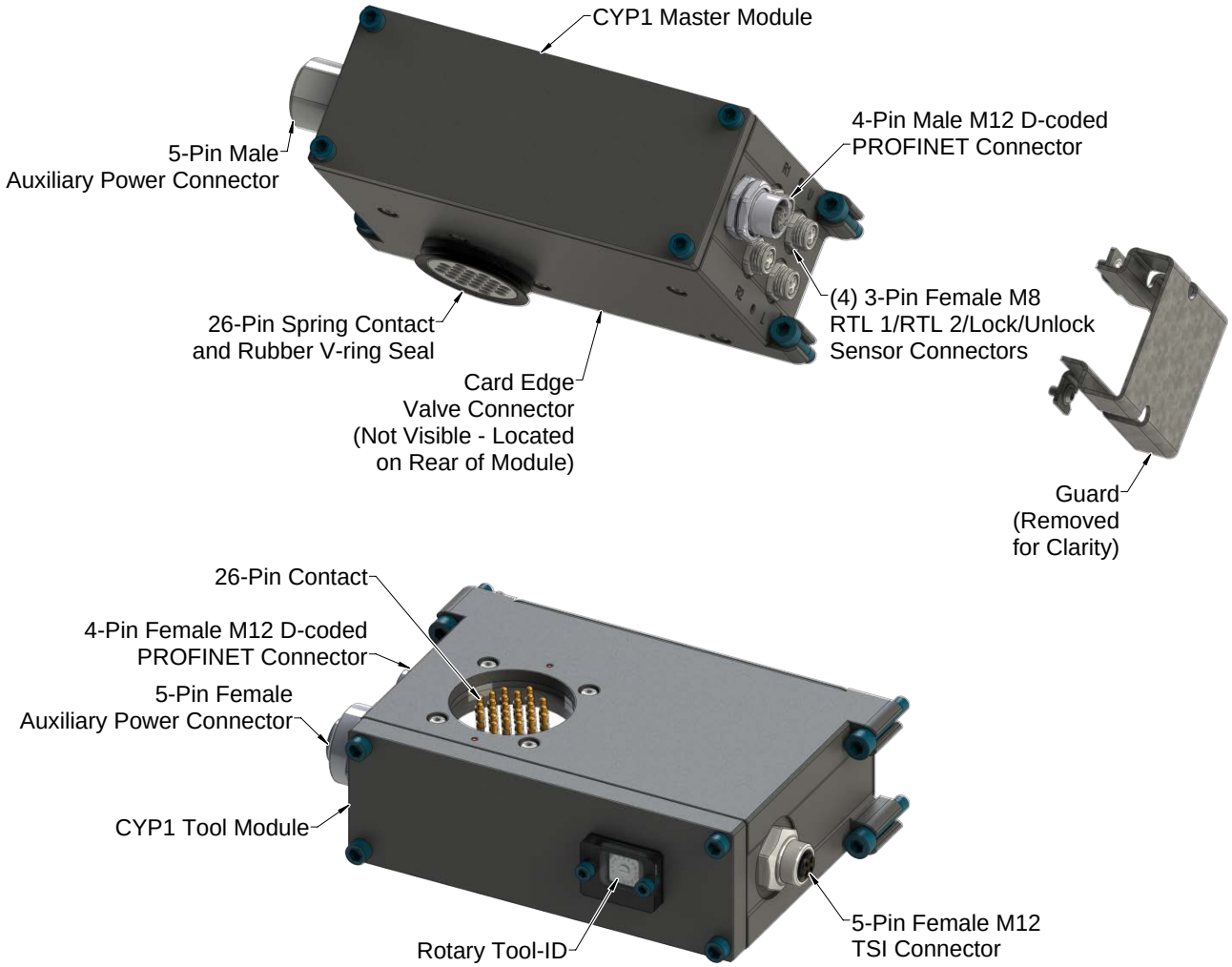
The module has the following connections:

- (1) 4-pin female M12 D-coded PROFINET connector.
- (1) 5-pin male Mini-Fast (7/8”) auxiliary power connector.
- (4) 3-pin female M8 connectors for RTL1, RTL2, Lock, and Unlock sensor connections.
- (1) card edge connector that mates with the VY Series Valve Module.

The Master module also incorporates ATI’s exclusive Arc Prevention Circuit which extends the life of all 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* for additional information regarding the Arc Prevention Circuit.

The module provides status LEDs to visually indicate its operation. A reset button provides the ability to return to factory default settings. Refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* and *Section 2.1.6—Ethernet 1 and Ethernet 2 LEDs*.

Figure 1.1—CYP1 Modules



1.2 CYP1 Tool Module

The module has the following connections:

- (1) 4-pin female M12 D-coded PROFINET connector.
- (1) 5-pin female 7/8” auxiliary power connector.
- (1) 5-pin female M12 A-Coded TSI connector. (refer to *Section 2.4—Tool Side TSI*).

The Tool module employs a 0-F Rotary Switch for setting of the Tool-ID input that allows the customer to distinguish between the different tools that are used in a robotic cell or on a production line. The Tool-ID is reported through the Master module bitmap. See *Section 2.1.1—PROFINET Interface Information* for PROFINET bitmap and detailed I/O information.

2. Product Information

This section provides more detailed information on the behavior of the CYP1 modules.

2.1 Master Module

2.1.1 PROFINET Interface Information

Table 2.1 lists the PROFINET interface parameters employed in the CYP1 Master module.

Table 2.1—PROFINET Interface Parameters

Parameter	Description
DCP	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: GSDML file 9031-20-1100

Robot input and output bitmaps for the Master node are provided in *Table 2.2* and *Table 2.3.*

2.1.2 Integrated Web Server

The module's integrated web server hosts the following web pages:

- **Overview** - The 'Overview' page is the first that comes up. It reports the module name, serial number, firmware (FW) version, uptime, and CPU load of the module. Refer to *Figure 2.1*.
- **Parameters** - This page is used to change Input and Output values. The Latch and Unlatch outputs cannot be activated via this web page. Refer to *Figure 2.2, Figure 2.3,* and *Figure 2.4*.
- **Module Status** - This page contains current IP Address, Ethernet Status, Interface Counters, and Media Counters. Refer to *Figure 2.5*.
- **Configuration** - This page is used to change IP Configuration. Refer to *Figure 2.6*.
- **SMTP** - This page is used to change SMTP (server, username, and password) configuration. Refer to *Figure 2.7*.

A web browser, such as Internet Explorer or Mozilla Firefox, is required to access the web server. The module's web pages use simple HTML and do not require any plug-ins.

To bring up the main page of the web server, type "http://" and then type the module's IP address into the browser's address field and then press enter.

Figure 2.1—Module Overview

Figure 2.2—Module Parameters Page 1

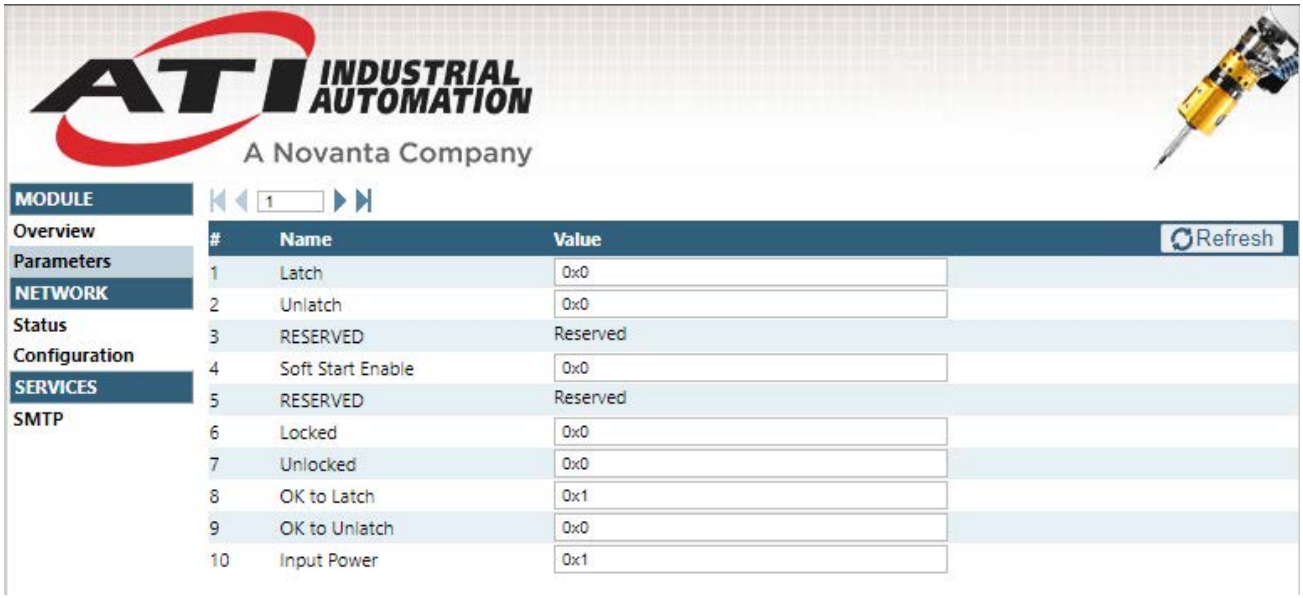


Figure 2.3—Module Parameters Page 2

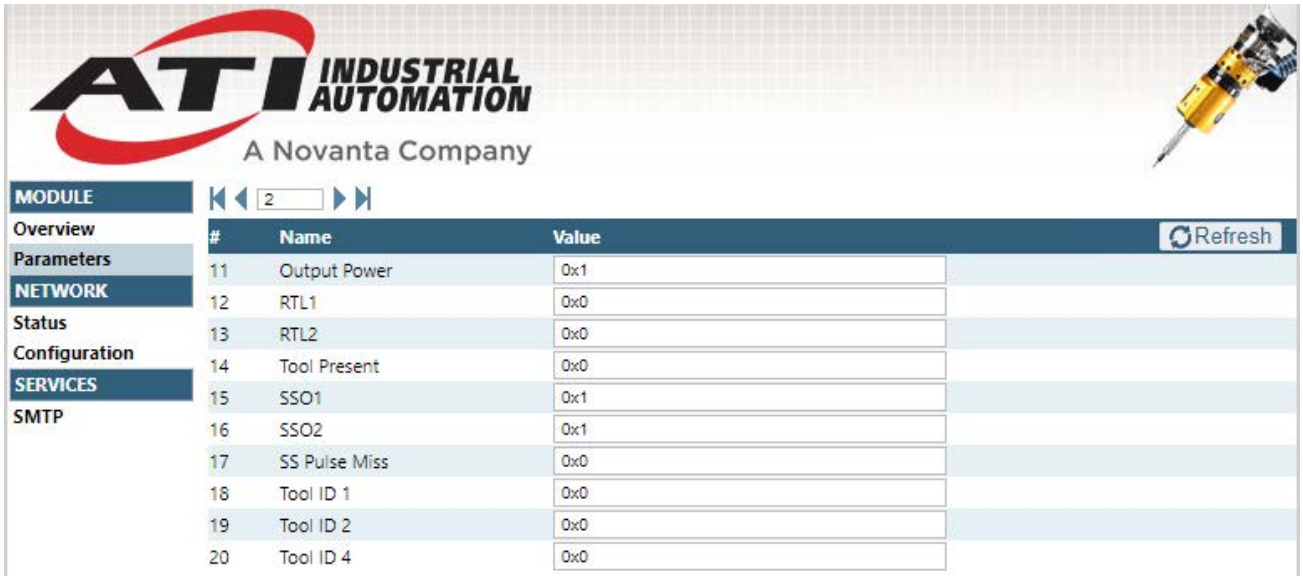


Figure 2.4—Module Parameters Page 3

Figure 2.5—Module Status

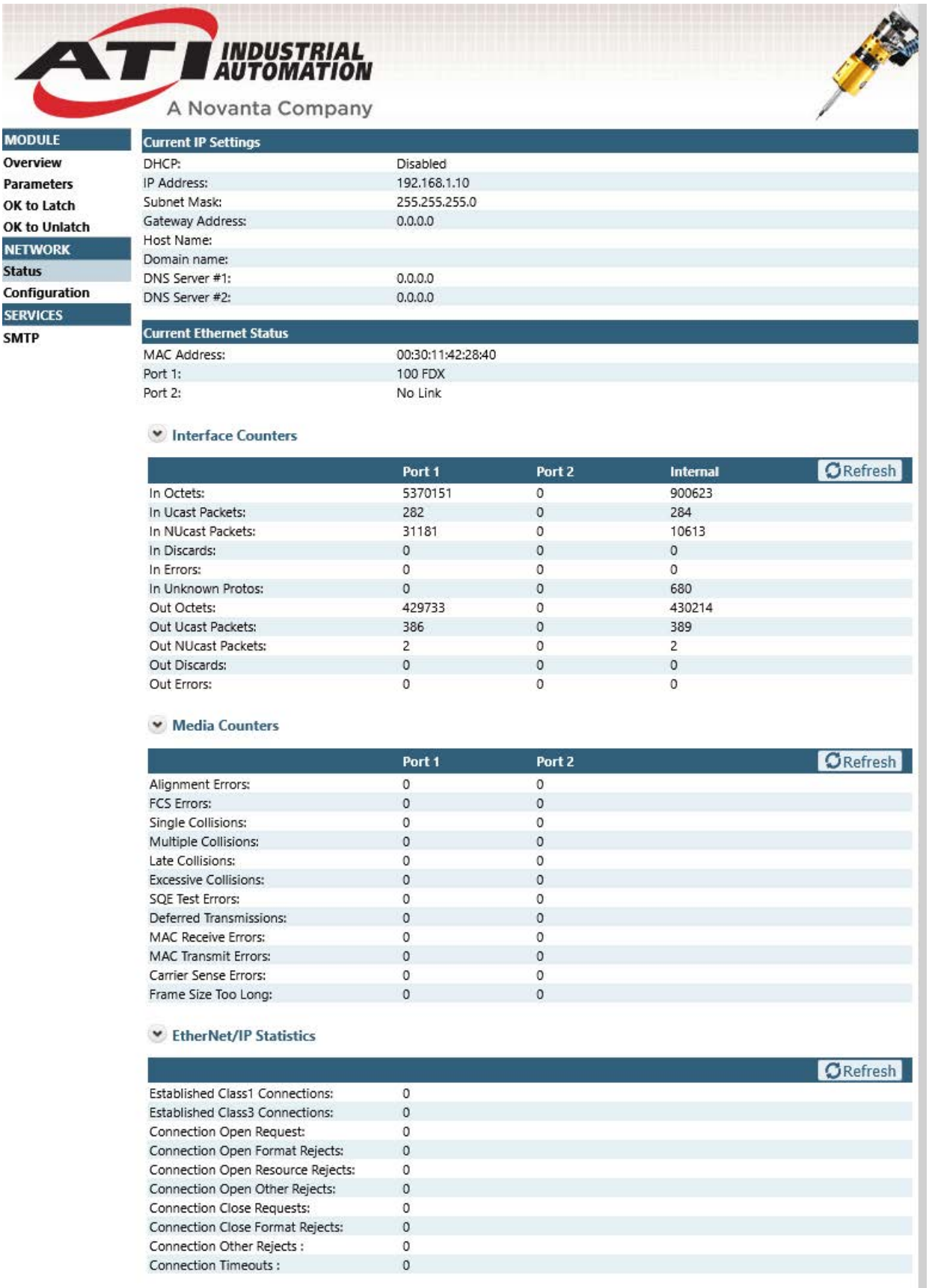
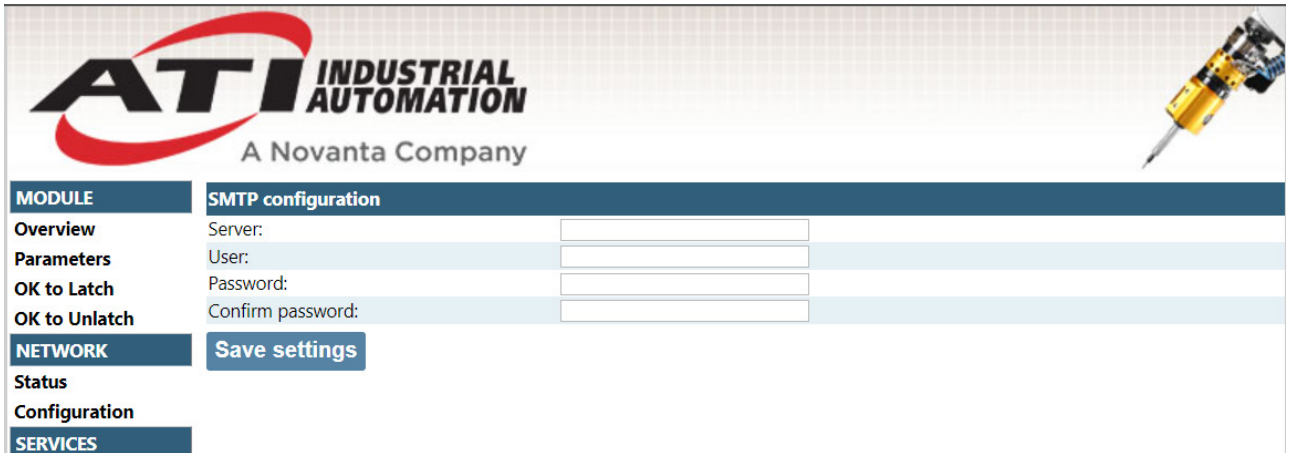


Figure 2.6—Module Configuration

Figure 2.7—Module SMTP



2.1.3 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
- Auto Negotiation
- Auto Crossover

2.1.4 Network

The following information contains Network Switch Configurations (Robot and Tool side ports) and Network Counters. The CYP1 module has an integrated Profinet switch. The CYP1 module is shipped with the following switch settings. Default settings can be changed within the **Network Configuration** web page.

2.1.4.1 Robot Side Port:

Robot Side Port default settings:

- Auto-Negotiation: Enabled
- Auto-MDIX: Enabled
- MDI Setting: Enabled

2.1.4.2 Tool Side Port:

Tool Side Port default settings:

- Auto-Negotiation: Disabled
- Speed: 100 MPS
- Duplex: Full Duplex
- Auto-MDIX: Disabled
- MDI Setting: MDI-X

Table 2.2—I/O Bitmap, Inputs to Master Module			
Byte	**Bit#**	**Name**	**Description/Function**
0	0	Latch	Request Lock.
	1	Unlatch	Request Unlock.
	2	Reserved	
	3	Reserved	
	4 to 7	Reserved	

Table 2.3—I/O Bit map, Outputs from Master Module			
Byte	**BitNumber**	**Name**	**Description/Function**
0	0	Locked	Tool Changer is locked.
	1	Unlocked	Tool Changer is unlocked.
	2	OK to Latch	Input indicating that all required criteria are met to allow the Tool Changer to latch.
	3	OK to Unlatch	Input indicating that all required criteria are met to allow the Tool Changer to unlatch.
	4	US1 Power OK	US1 voltage must be greater than 21V.
	5	US2 Power OK	US2 voltage must be greater than 20V.
	6	RTL1	Ready-to-Lock Prox1 Input
	7	RTL2	Ready-to-Lock Prox2 Input
1	0	Tool Present	Master and Tool are in electrical contact.
	1	SSO1	Input from safety switch that indicates it is safe to unlatch the tool. Should always agree with SSO2
	2	SSO2	Input from safety switch that indicates it is safe to unlatch the tool. Should always agree with SSO1
	3	Pulse Missing	On if SSO is ON and does not pulse within 2s
	4	Tool ID (1)	0-15 Tool-ID Input.
	5	Tool ID (2)	
	6	Tool ID (4)	
	7	Tool ID (8)	
2	0	Tool Power is on	Indicates that the Arc Prevention Circuit is sending power to the Tool
	1	Reserved	
	2		
	3		
	4		
	5		
	6		
	7		

2.1.5 System Failure (SF) and Bus Failure (BF) LEDs

When the modules are coupled and communicating properly on the network, the CYP1-M LEDs should display as shown in *Figure 2.8*, with the E1 and E2 LEDs flashing red based on the PROFINET communication.

Figure 2.8—LEDs on the Master Module

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—Master Module SF status LED

Status	LED		Note
No Power		Off	No power applied. Check if the voltage is greater than 21 volts
Operational[1]		Green (solid)	Normal operation.
Network Reset		Green (flashing)	The Reset-to-Factory pushbutton has been pressed, and a reset operation is in progress

Table 2.5—Master Module BF status LED

Status	LED		Note
Operational[1]		Green (solid)	Online (RUN) - Connection with I/O Controller established - I/O Controller in RUN state
Not OK		Off	- No power - No connection with I/O controller
		Green (1 flash)	Online (STOP) - Connection with I/O Controller established - I/O Controller in STOP state or I/O data bad
		Red (solid)	Major internal error
		Red (1 flash)	Station Name not set
		Red (2 flashes)	IP address not set
		Red (3 flashes)	Configuration Error: Expected Identification differs from Real Identification

2.1.6 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 displays the status of the robot side Ethernet port. The Ethernet 2 (E2) LED displays the status of the tool side Ethernet port. The module status is indicated by the specified LED behavior in the following tables.

Table 2.6—Master Module Ethernet 1 (E1) LEDs

Status	LED		Note
No Link		Off	No link to the master module, no communication present
Link		Green (solid)	Ethernet link to the master module established, no communication present
Activity		Green (flickering)	Ethernet link to the master module established, communication present

Table 2.7—Master Module Ethernet 2 (E2) LEDs

Status	LED		Note
No Link		Off	No link to the tool module, no communication present
Link		Green (solid)	Ethernet link to the tool module established, no communication present
Activity		Green (flickering)	Ethernet link to the tool module established, communication present

Figure 2.9—Master Module Reset (RST) Button

2.1.7 Reset-To-Factory (RST) Push-Button

A push button, located under the socket head cap screw 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—CYP1 Device Replacement Procedures* for a detailed device replacement procedure.

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

Make sure to re-apply the socket head cap screw after access to the push button is no longer needed. The torque on the reset button screw should be 4 in-lbs (0.45 Nm).

2.2 Arc Prevention Circuit

The CYP1 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 CYP1 Module, the Arc Prevention Circuit controls the ON/OFF status of the following (2) power signals:

- Input and Logic power US1+
- Output power US2+

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

2.2.1 Arc Prevention Circuit Behavior during Coupling

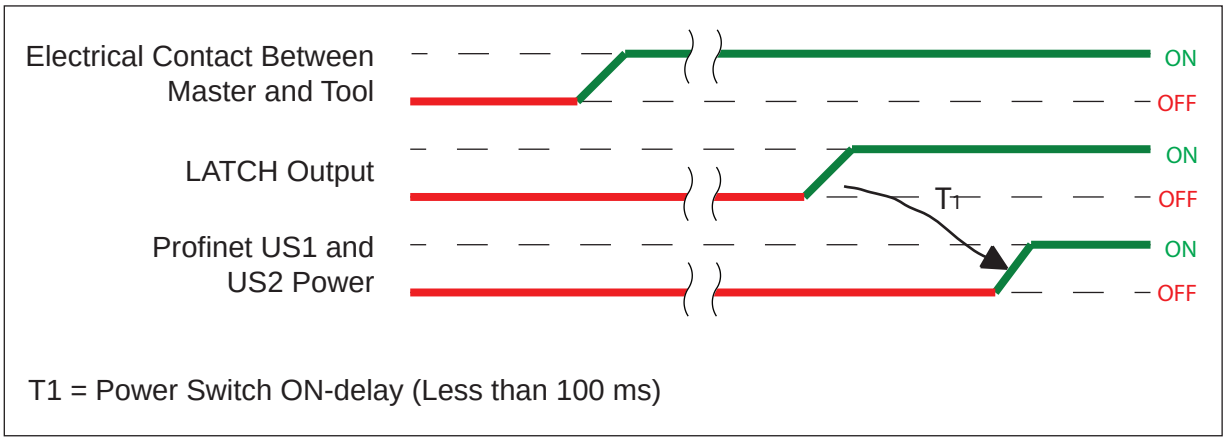
The Master module incorporates ATI's Arc Prevention Circuit, which extends the life of all electrical power contacts by eliminating arcing caused by inductive loads and high inrush current during coupling/uncoupling. The Arc Prevention Circuit makes it possible for the customer to couple/uncouple without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

The behavior of the Arc Prevention circuit during coupling can be more clearly understood by referring to *Figure 2.10*.

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 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 2.10—Power On Timing



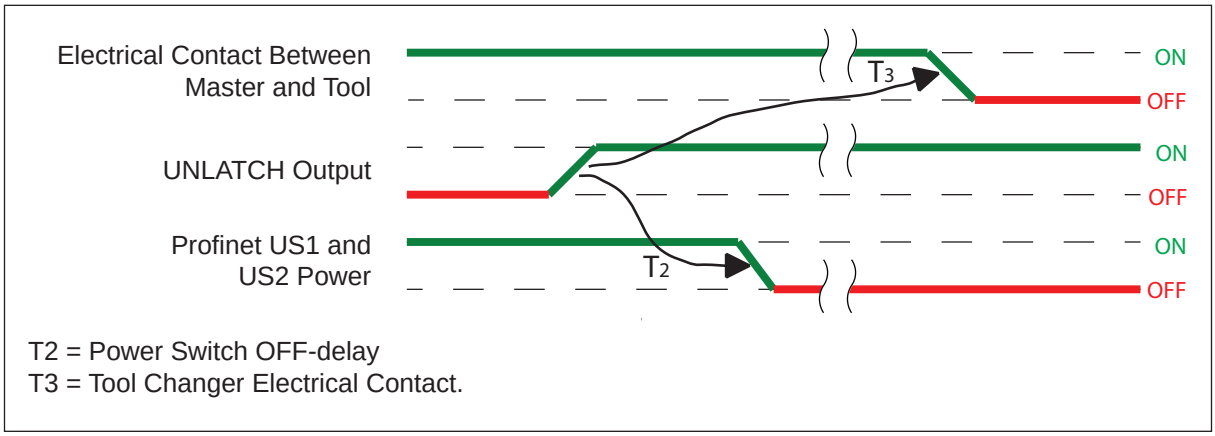
2.2.2 Arc Prevention Circuit Behavior during Uncoupling

The behavior of the Arc Prevention Circuit during uncoupling can be more clearly understood by referring to *Figure 2.11*.

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 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 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 100 ms.

Figure 2.11—Power Off Timing



2.3 Tool Module

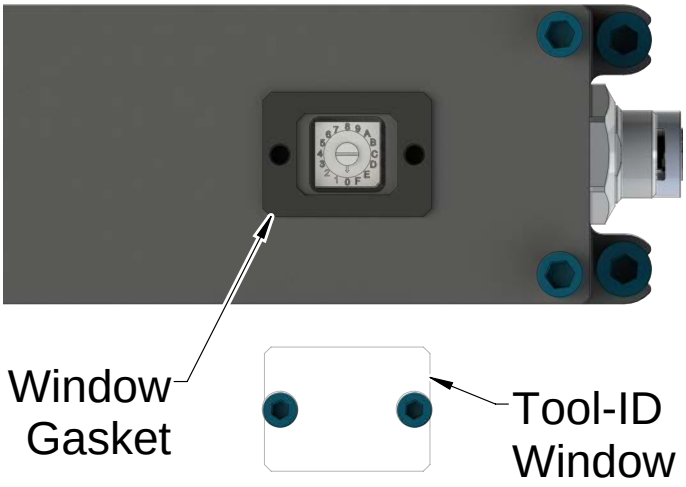
In addition to providing Tool-ID and Tool side TSI, the Tool module is a pass-through for PROFINET signals and power to downstream equipment. For details, refer to *Section 9—Drawings*.

2.3.1 Tool-ID

0-F rotary switch is 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. Tighten socket head cap screws to 4 in-oz (34 cmN).

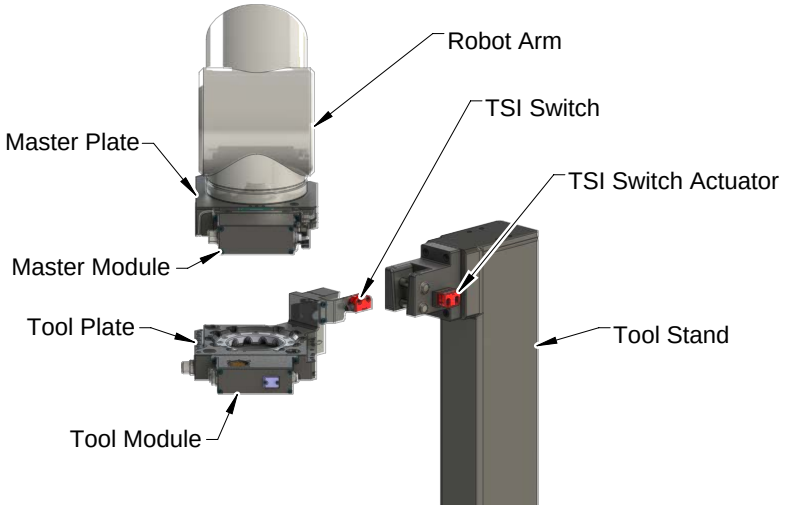
Figure 2.12—Tool Module, Tool-ID Switch Settings



2.4 Tool Side TSI

The Tool Stand Interlock (TSI) circuit ONLY allows Tool release in the stand or storage location as indicated by actuation of a customer integrated safety switch. The Safety Sensor is powered by US1 (Input) Power (reference *Figure 2.13)*. The safety 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.

Figure 2.13—(CYP1) Tool Stand Interlock (TSI) with a RFID Safety Switch



Both the CYP1 Control Module and VY Series Valve Module play a role in determining whether it is safe to unlatch (refer to *Figure 2.14*). The safety critical inputs from the Safety Switch, SSO1 and SSO2, are first transmitted from the CYP1 Tool module to the CYP1 Master module via the pin block and then to the VY Valve Module via the Card Edge connector.

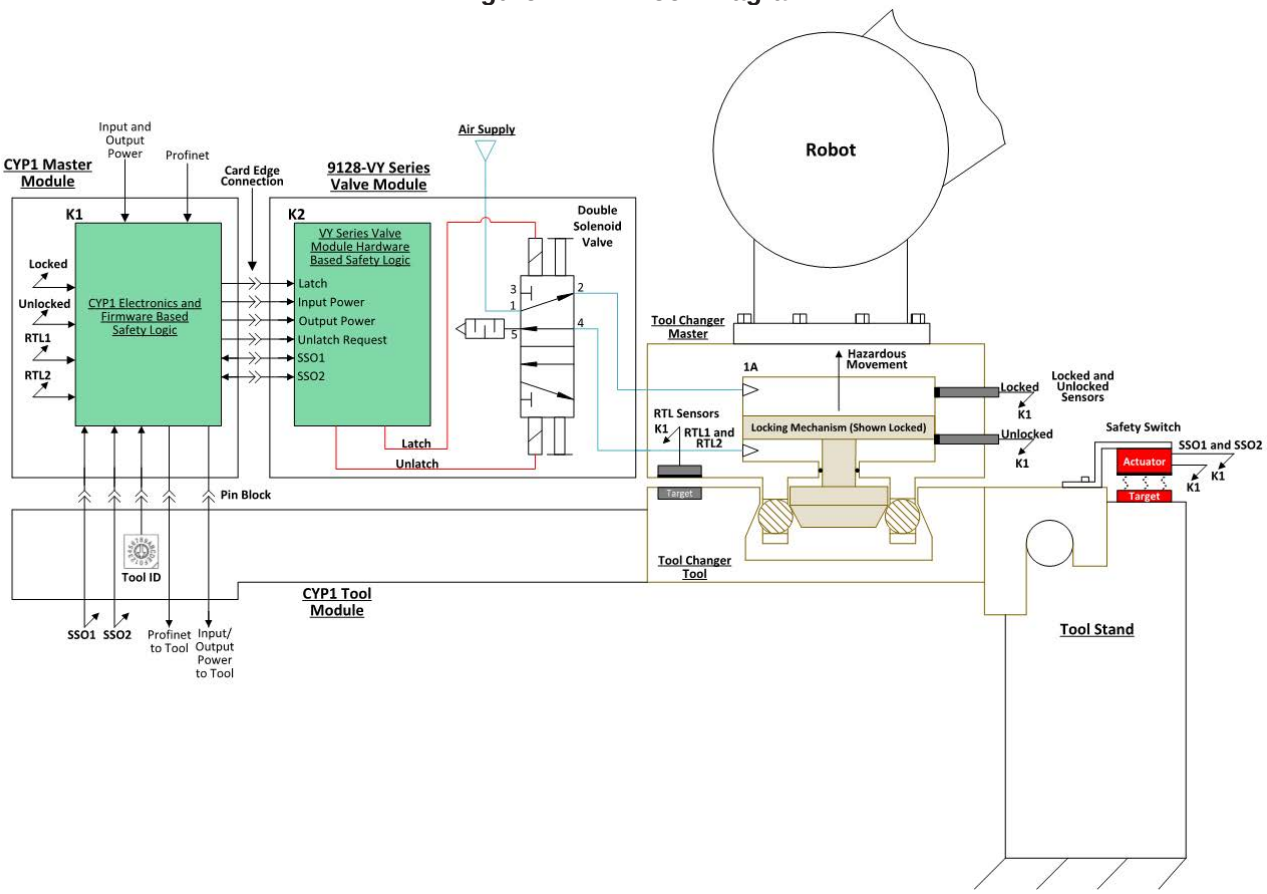
The CYP1 Master module firmware evaluates the SSO1 and SSO2 inputs to determine if it is safe to unlatch. Only when the following conditions are met will the CYP1 determine that it is safe to unlatch:

- Both SSO1 and SSO2 inputs must be ON.
- US1 and US2 power must be within the specified voltage range

The CYP1 will switch the OK to Unlatch bit ON when the conditions for unlatching have been met and will then send an unlatch request to the VY Valve Module.

The VY Valve Module contains hardware logic that processes the same SSO1 and SSO2 safety switch inputs as the CYP1 Master Module. Only when the SSO1 and SSO2 inputs are both ON will the VY Valve Module send the unlatch output to the double solenoid pneumatic valve.

Figure 2.14—Block Diagram



Section 4.2—Recommended Sequence of Operation describes in detail the behavior of the OK to Unlatch and SSO1 and SSO2 bits during the operation of the Tool Changer.

The CYP1 module can support the following types of safety switches:

1. Mechanical safety rated limit switches that have two sets of normally open contacts.
2. Magnetically Coded Non-contact Interlock Switches such as the Allen-Bradley Ferroguard or Sipha switches that have two sets of NO contacts.

3. Non-contact RFID safety switches, including:
   - Euchner CES-I-AP such as ATI P/N 9120 TSL SS 9025. Note, these are not capable of series connection.
   - Euchner CES-I-AR series connected PLe rated safety switches. The CYP1 can support a maximum of four (4) non-contact type RFID safety switches connected in series.
   - SICK STR1 series connected PLe rated safety switches.
   - PILZ PSEN cs3.1p/M12 series connected PLe rated safety switches
   - ABB JOKAB Adam OSSD-Info M12-8 series connected PLe rated safety switches

The safety switches listed above are not included with the CYP1. If selecting a safety switch that is not listed above, ensure that the selected safety switch meets the following requirements:

1. Meets PLd or PLe safety standards.
2. Includes a 5-pin M12 A-coded connector pin-out matching that shown in *Figure 2.15*.

Figure 2.15—Safety Switch Connector Pinout

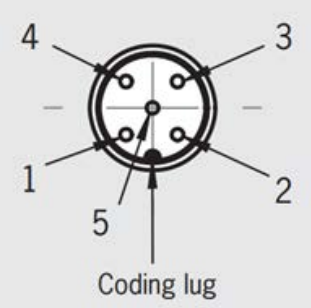


Table 2.8—Safety Switch Connector Pinout	
Pin Number	**Description**
1	24V+
2	Safety Switch Output Channel 1
3	0V
4	Safety Switch Output Channel 2
5	N/C

3. Installation

The control/signal modules are typically installed by ATI prior to shipment. The following procedure 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 Control/Signal Module Installation

Refer to Figure 3.1.

Tools required: *3 mm and 4 mm hex keys*

Supplies required: *Clean rag, Loctite® 242*

NOTICE: If module being installed is not new “out of the box” and has been previously commissioned refer to *Section 6.2.2—CYP1 Device Replacement Procedures* for instructions.

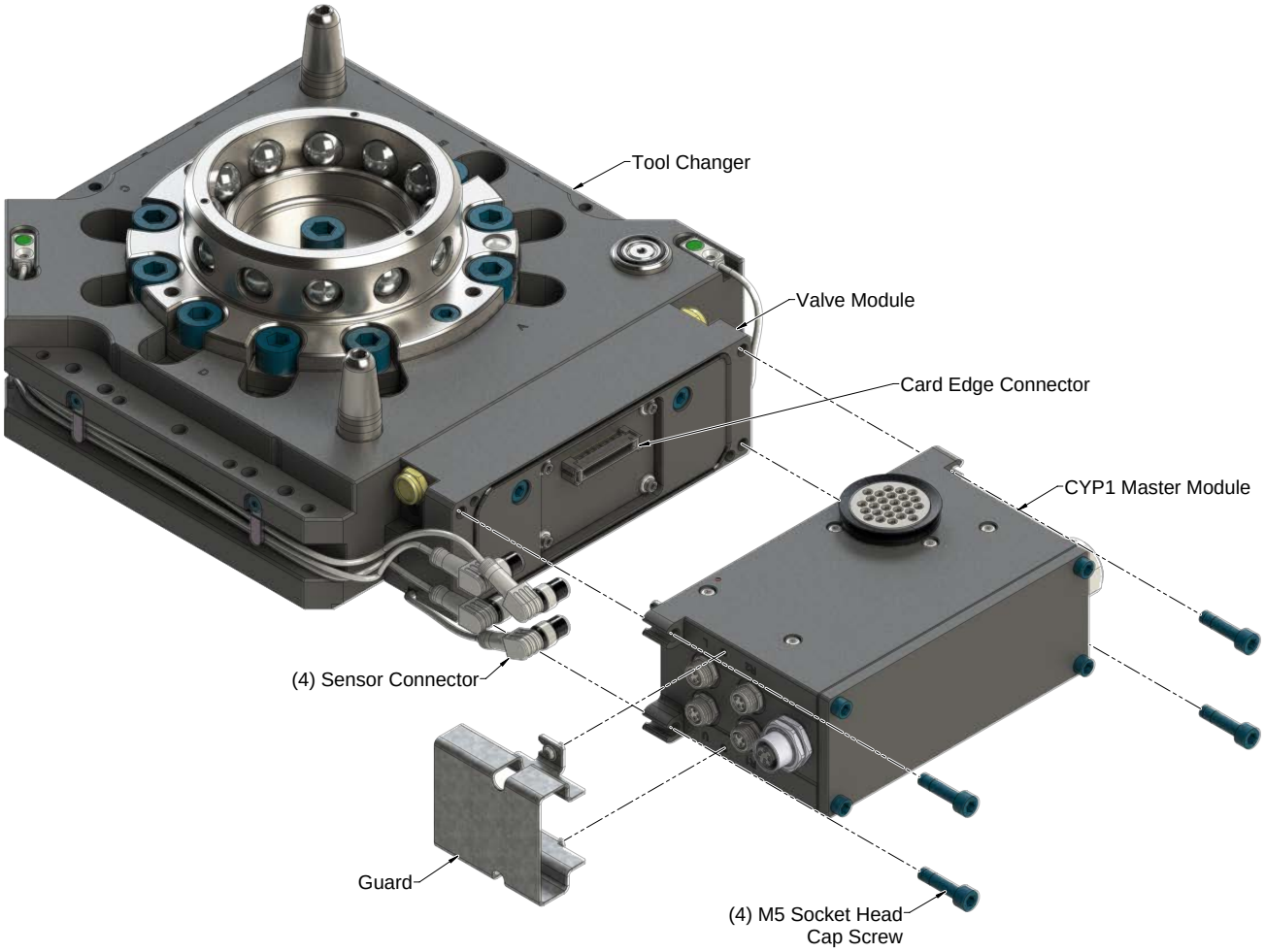
NOTICE: Avoid contact with the card edge connector. Debris and contaminants on the connector can impede signals.

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. Wipe down the mounting surfaces with a clean rag.
5. Place the module into the appropriate location on the valve module. Align card edge with mating connector on valve module. Refer to *Figure 3.1*.
6. Apply Loctite 242 to the (4) M5 socket head cap screws. Install the (4) M5 socket head cap screws securing the module to the valve module and tighten to 45 in-lbs (5.1 Nm).
7. Connect the (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors to the Master module.
8. Install guard over connectors.
9. Connect the power cable and PROFINET cable connectors to the Master module.

NOTICE: The module will automatically get the name and IP address assigned if the system is enabled to support device replacement without exchangeable medium.

10. Safely resume normal operation.

Figure 3.1—Master Module Installation



3.2 Master Control/Signal Module Removal

Tools required: *4 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Remove guard over connectors.
5. Disconnect the (L) Lock, (U) Unlock, and (R1 and R2) RTL sensor cable connectors from the Master module.
6. Disconnect the power cable and PROFINET cable connectors from the Master module.
7. Support the control/signal module and remove the (4) M5 socket head cap screws and lower the module until it clears the dowel pins.

3.3 Tool Control/Signal Module Installation

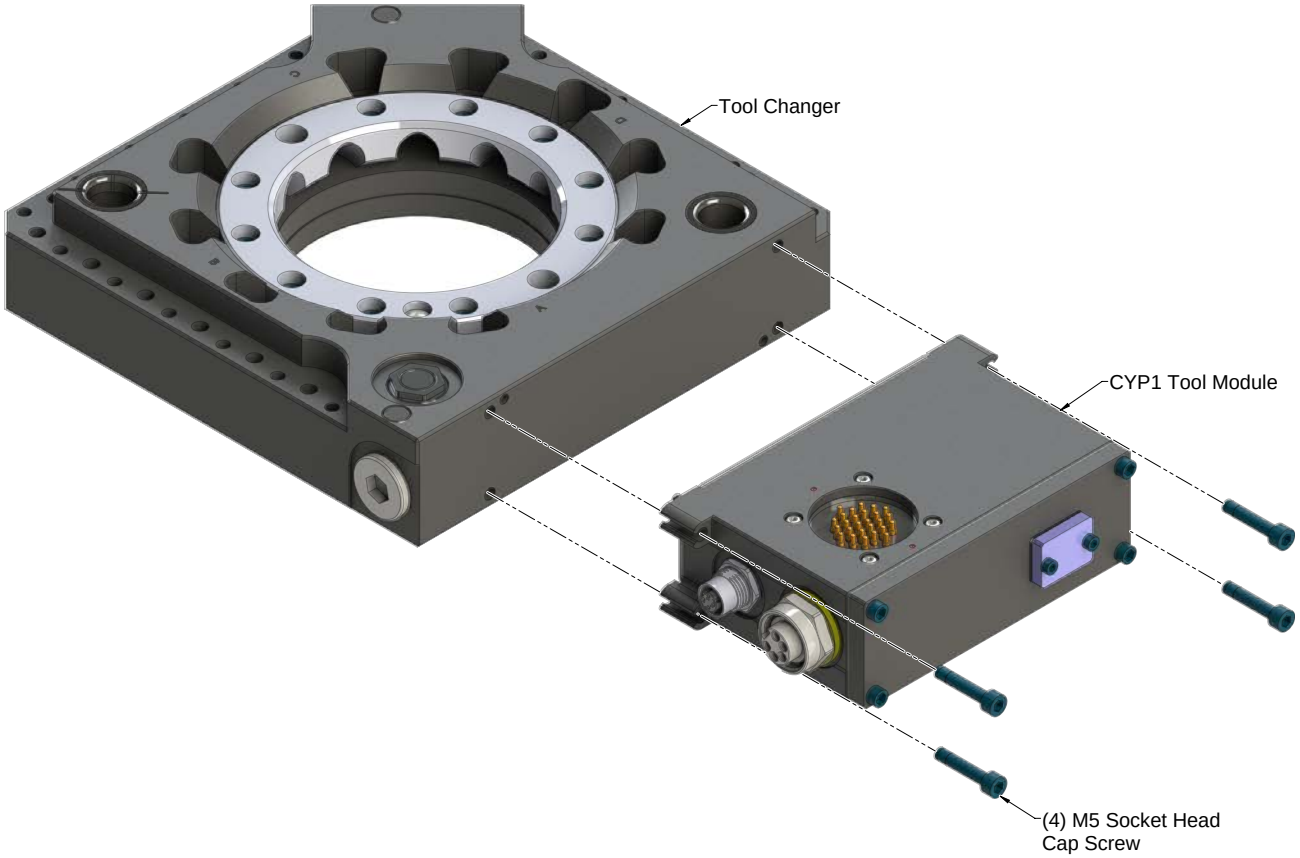
Refer to Figure 3.2.

Tools required: *3 mm and 4 mm hex keys*

Supplies required: *Clean rag, Loctite 242, M5 fastener for grounding terminal*

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. Wipe down the mounting surfaces with a clean rag.
5. Set the Tool-ID. Refer to *Section 3.5—Setting the Tool-ID.*
6. Place the module into the appropriate location on the valve module spacer. Align the module with the valve module spacer using the card edge connector and the dowels. Refer to *Figure 3.2*.
7. Apply Loctite 242 to the supplied M5 socket head cap screws. Install the (4) M5 socket head cap screws securing the module to the valve module spacer and tighten to 45 in-lbs (5.1 Nm).
8. Connect the TSI safety switch cable to the Tool module.
9. Connect the power cable and PROFINET cable connectors to the Tool module.
10. Safely resume normal operation.

Figure 3.2—Tool Module Installation (CYP1-T Shown)



3.4 Tool Control/Signal Module Removal

Tools required: *4 mm hex key*

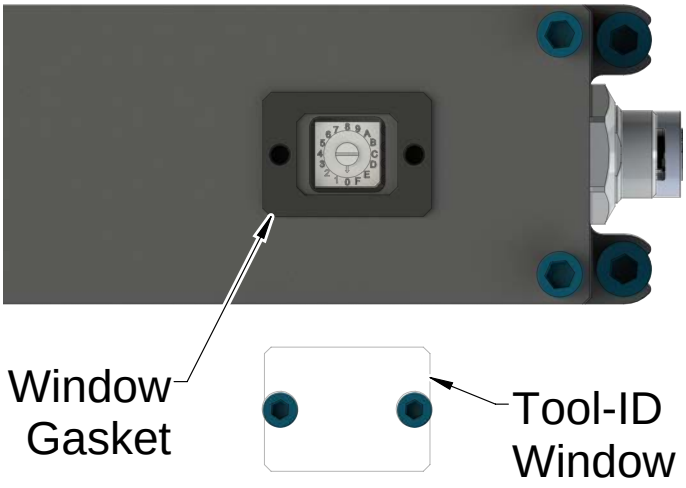
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Disconnect the TSI safety switch cable from the Tool module.
5. Disconnect the power cable and PROFINET cable connectors from the Tool module.
6. Support the Tool module and remove the (4) M5 socket head cap screws using a 4 mm hex key. Lift up on the module until it clears the guide pin. Refer to *Figure 3.2*.

3.5 Setting the Tool-ID

A rotary 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.

Tools required: *2 mm hex key, small slotted screwdriver*

Figure 3.3—Setting the Tool ID



1. Loosen the (2) M3 socket head cap screws and remove the Tool-ID window.
2. Use a small slotted screwdriver, turn rotary switch.
3. Ensure that window gasket is intact.
4. Re-install the Tool-ID window and tighten the M3 socket head cap screws to 48 in-oz (34 cmN).

3.6 PROFINET Interface

The PROFINET interface parameters and I/O bitmaps 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 4.2—Recommended Sequence of Operation.*

3.7 Electrical Connections

Refer to drawings in *Section 9—Drawings* for the electrical connections and pin/signal information.

4. Operation

A recommended Sequence of Operations is provided in *Section 4.2—Recommended Sequence of Operation* of this manual. This procedure 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.

CAUTION: Improper cable routing can result in wires and cables being pinched in the joint between the Tool Changer plates and premature failure of the electrical connectors. Properly route and secure all cables, particularly on the Master side.

NOTICE: Grounding and power supply lines are required to be on certain pin locations of the customer interface connector. See the drawings for pin out information and location of the I/O signals.

Refer to the specific Tool Changer manual for coupling conditions of the Tool Changer and *Section 4.2—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 Inputs

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

4.1.1 Locked

An input indicating that the coupling mechanism is in the Lock position.

4.1.2 Unlocked

A proximity sensor input indicating that the coupling mechanism is in the Unlocked position.

4.1.3 US1 Power OK

An input indicating the presence of Input and Logic Power (US1) at the ATI master module. US1 voltage must be between 21V to 30V.

4.1.4 US2 Power OK

An input indicating the presence of Output Power (US2) at the ATI master module. US2 voltage must be between 20V to 30V; otherwise, the Tool Changer may not properly latch or unlatch.

4.1.5 RTL1 and RTL2

RTL proximity sensor inputs indicate that the Tool Changer Master and Tool are close enough to couple. These proximity sensors are installed in the Master plate. They sense targets which are installed in the Tool plate to indicate the Master is adjacent to the tool (within ~ 0.06” or 1.5 mm). RTL signals are not required to be ON before latching.

4.1.6 Tool Present

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

4.1.7 Tool Power Is On

The Tool Power Is On bit indicates that the Arc Prevention circuit has activated and power is passed to the tool side.

4.1.8 OK to Latch

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

- US1/Input supply voltage must be in the specified range
- US2/Output supply voltage must be in the specified range
- The Latch command must not be asserted

4.1.9 OK to Unlatch

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

- SSO1 and SSO2 must be active
- US1/Input supply voltage must be in the specified range
- US2/Output supply voltage must be in the specified range
- The Unlatch command must not be asserted

4.2 Recommended Sequence of Operation

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

- Input and Output Auxiliary power is available and within acceptable range
- Air is supplied to the integrated valve and within acceptable range (60 - 120 psi)

Figure 4.1—Master Free with Tool In the Tool Stand

NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* or *Section 2.1.6—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. OK to Latch
      iii. US1 Power OK
      iv. US2 Power OK

   b. The following inputs are OFF:
      i. Locked
      ii. Tool Present
      iii. RTL1 and **RTL2**
      iv. Tool Power is ON
      v. SSO1 and SSO2
      vi. OK to Unlatch

   c. The following output is OFF:
      i. Latch

2. If the Master is locked, unlock the Master.

Figure 4.2—Master Moves into Tool and is parallel at 0.06” (1.5 mm)

NOTICE: If the LEDs don’t match what is shown, refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* or *Section 2.1.6—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

3. Robot and Master move into the Tool are parallel and within 0.06” (1.5 mm) of the Tool.

   a. The **RTL1** and **RTL2** sensors are ON, indicating that its ok to couple the Tool.
   b. The **OK to Latch** bit is ON.

Figure 4.3—Master Coupled with Tool

NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* or *Section 2.1.6—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

4. Couple the Tool Changer.

   a. If ON, turn the **Unlatch** output OFF and turn the **Latch** output 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 turns OFF and a short time later the **Locked** input turns ON and remains ON, indicating that the Tool Changer locking mechanism latch operation is complete. After the **Locked** input turns ON, the **Latch** output can be turned OFF.
   d. Sometime thereafter, communications should be established with the downstream PROFINET device(s) (The time it takes to establish connection with a downstream PROFINET node depends on the power up and reconnect time of the individual PROFINET equipment that is installed on the Tool.)
   e. Read **Tool-ID** inputs.

Figure 4.4—Master Coupled with Tool Moves Out of the Stand

NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* or *Section 2.1.6—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

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

   a. The TSI Switch is deactivated, and the **SSO1** and **SSO2** input goes OFF.
   b. The **OK to Unlatch** turns OFF.

6. Normal operation.

   a. The following inputs are ON:
      ii. Locked
      iii. US1 Power OK
      iv. US2 Power OK
      v. RTL1 and **RTL2**
      vi. Tool Present
      vii. Tool Power is On
   b. The following inputs are OFF:
      i. Unlocked

ii. **SSO1** and **SSO2**
iii. **OK to Unlatch**

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

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

Figure 4.5—Master Coupled with Tool Returned to Stand

NOTICE: If the LEDs don't match what is shown, refer to *Section 2.1.5—System Failure (SF) and Bus Failure (BF) LEDs* or *Section 2.1.6—Ethernet 1 and Ethernet 2 LEDs* for possible issues.

7. The robot moves into the tool stand with the Tool Changer coupled.
   a. When the tool is returned to the stand, the TSI Switch is activated and the **SSO1** and **SSO2** go ON.
   b. The **OK to Unlatch** is ON, indicating that it is safe to uncouple the Tool Changer.
8. Uncouple the Tool Changer.
   a. If ON, turn the **Latch** output OFF and turn the **Unlatch** output ON.
   b. The **Tool Power is ON** input is OFF and the power on the Tool turns off.
   c. Communication is lost with downstream device(s).
   d. The **Locked** input turns OFF and a short time later the **Unlocked** input turns ON and remains ON, indicating that the Tool Changer locking mechanism unlatch operation is complete. After the **Unlocked** input turns ON, the **Unlatch** output can be turned OFF.
9. The Robot and Master are in free space.
   a. The following inputs are ON:
      i. **Unlocked**
      ii. **US1 Power OK**
      iii. **US2 Power OK**
      iv. **OK to Latch**
   b. The following inputs are OFF:
      i. **Locked**
      ii. **Tool Present**
      iii. **RTL1** and **RTL2**
      iv. **SSO1** and **SSO2**
      v. **Tool-ID** invalid (all zeros)
   c. The following output is ON:
      i. **Unlatch**

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

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

5. Maintenance

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

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

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

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

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

5.1 Pin Block Inspection and Cleaning

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

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

Figure 5.1—Inspect Master and Tool Pin Blocks

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

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

Figure 5.2—Clean Pin Blocks with a Nylon Brush

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

Figure 5.3—Stuck Pin and Pin Block Damage

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

6. Troubleshooting and Service Procedures

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

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

6.1 Troubleshooting

Troubleshooting information is provided in 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 are secure and does not protrude above the mating surfaces.
	Ball bearings are not moving freely	Verify ball bearings are moving freely, clean and lubricate as needed (refer *to Maintenance section of 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.*
	Card edge connection is dirty	Card edge connection must be cleaned.
	SSO1 and/or SSO2 are ON, to unlock. Not required to lock	SSO1 and SSO2 must be OFF.
	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 signals are mapped and communicating properly (refer to *Section 9—Drawings* for electrical schematic).
	Master and Tool are not 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 damaged or incorrectly connected	Verify cables are connected correctly and not damaged, replace if damaged (refer *to Troubleshooting Section of Tool Changer manual).*
	Sensor is malfunctioning	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 Tool plate is securely held to Master plate and nothing is trapped between plates.
	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.*

Table 6.1—Troubleshooting		
Symptom	**Possible Cause**	**Correction**
Loss of communication	Contaminated or loose cable connections.	Ensure all cable connections are clean and tight.
	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.
No power on the Tool side	Latch command not issued	Verify that the Latch command has been issued.
	The Tool Power is On bit is OFF.	Verify that the **Tool Power is On** bit is **ON**.
	The Tool Present bit is OFF.	Verify that the **Tool Present** bit is **ON**.
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

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

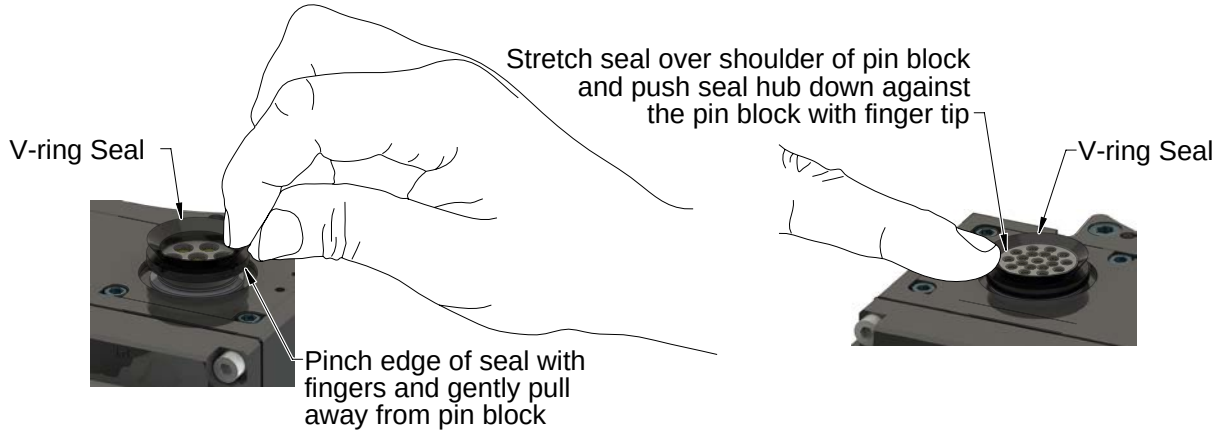
6.2.1 Seal Replacement

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 CYP1 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 Master Module Replacement Procedures

1. Remove the “old” module from the valve module, refer to *Section 3.2—Master Control/Signal Module Removal* for removal procedure.
2. Install new module on the valve module, refer to *Section 3.1—Master Control/ Signal Module Installation* for installation procedure.

6.2.2.2 Replace a Master Module with an Already Commissioned Master Module

Tools required: *5 mm hex key, plastic stylus*

Supplies required: *Clean rag, Loctite 242*

1. Remove the “old” module from the valve module, refer to *Section 3.2—Master Control/Signal Module Removal* for removal procedure.
2. Install the replacement module to the valve module, refer to *Section 3.1—Master Control/Signal Module Installation* for installation procedure.
3. The reset button (RST) is located under the screw on the side of the module. Remove this screw.
4. Use a non-conductive tool (for example: plastic stylus) to press on the Reset Button; The station name of the module can be blanked by depressing the button for three seconds This clears the station name to “” and also resets the static IP address to 0.0.0.0. If this procedure is done, then the change will take effect after the next power cycle. The MS LED will flash for three seconds after the button has been depressed for three seconds.
5. The reset button screw must be reinstalled. Tighten to 4 in-lbs.

Figure 6.2—Reset (RST) Button

6. 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.
7. Disconnect the 5-pin Mini-Fast power cable to the Master module.
8. Connect the 4-pin M12 Ethernet cable and the 5-pin Mini-Fast power cable to the connectors on the Master module.

NOTICE: Within a few seconds after configuring, the Master module is operating on the network. The SF and BF LEDs are GREEN, when the network is operating without errors. Refer to *Section 2.4—Tool Side TSI*.

9. Safely resume normal operation.

7. Serviceable Parts

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

7.1 Master Module Serviceable Parts

Table 7.1—Master Module Mounting Fasteners		
Part Number	**Qty**	**Description**
3500-1064020-15A	4	M5X20 Socket Head Cap Screw, 12.9, ISO4762/DIN912, Corrosion Protection Coating, YL M-spheres/IFI 525

7.2 Tool Module Serviceable Parts

Table 7.2—Tool Module Mounting Fasteners		
Part Number	**Qty**	**Description**
3500-1064025-15	4	M5X25 Socket Head Cap Screw, 12.9, ISO4762/DIN912, ES-ATI-007
3500-1058010-15A	2	M3X10 Socket Head Cap Screw, 12.9, ISO4762/DIN912, ES-ATI-007

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—CYP1 Master Specifications	
9128-CYP1-M	PROFINET Master module with integrated Ethernet switch, D-Coded 4-Pin M12 connector for PROFINET communication, 5-Pin Mini Connector for US1 and US2 power, TSI on the Tool, Arc Prevention applied to US1 and US2 power. Lock, Unlock, and RTL sensing. Tool ID from the Tool module also supported. Mates with CYP1-T
Connector(s)	(1) 5-Pin male Mini-Fast Connector for auxiliary power (1) 4-Pin female M12 D-Coded Connector for PROFINET (4) 3-Pin female M8 Connector supporting Tool Changer Locked, Unlocked, and Ready-to-Lock Proximity sensors
Electrical Rating	Power: • US1 Voltage: 21V to 30V, 4A • US2 Voltage: 20V to 30V, 6A Note: The power source for input and output power must be capable of outputting an operating voltage that is overcurrent protected and regulated. Signal: 3A, 30VDC maximum
Current Draw	US1 Power: 220mA @ 24VDC: Master and Tool with Locked, RTL1, and RTL2 sensors “on” and Limit Switches/ TSI Circuits made US2 Power: 250mA @ 24VDC (Solenoid Valve).
Operating Temperature	32°F to 120°F (0 to 50°C)
Enclosure	IP65
Weight	2.23 lbs (1.01 kg)

Table 8.2—CYP1 Tool Specifications	
9128-CYP1-T	PROFINET Tool module provides one Ethernet port and supports Tool-ID through the Master module. D-Coded 4-Pin M12 connector for PROFINET communication, 5-Pin Mini Connector for US1 and US2 power, 5-pin M12 connector for TSI switch, 0-F Tool-ID. Supports Arc Prevention on the Master. Mates with CYP1-M.
Connector(s)	(1) 5-Pin female Mini-Fast Connector for auxiliary power (1) 4-Pin female M12 D-Coded Connector for PROFINET (1) 5-Pin female M12 Connector for TSI
Electrical Rating	Power: • US1 Voltage: 21V to 30V, 4A • US2 Voltage: 20V to 30V, 6A Note: The power source for input and output power must be capable of outputting an operating voltage that is overcurrent protected and regulated. Signal: 3A, 30VDC maximum
Tool-ID	0-F rotary switch
Enclosure	IP65
Weight	1.42 lbs (0.64 kg)

9. Drawings

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