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C. Control and Signal Modules

SC7—Discrete Control/Servo Module

1. Product Overview

The SC7 Discrete Control and Servo module is designed to provide control of the Tool Changer, pass electrical power and signal connections to a transgun servomotor, and pass field bus data (DeviceNet, Interbus, etc.) to the end-of-arm tooling. The connectors on the SC7 module have been selected such that power and signal cables can be routed separately. By design, power and signal circuits are electrically isolated both from each other and the Tool Changer. The wiring has EMI/RF shielding to protect it from noise.

Compliant spring probes are provided on the Master and fixed contact pins on the Tool (refer to Figure 1.1). When the Tool Changer is coupled, the Master and Tool modules transfer signals and power across the spring probes and contact pins. Flexible boots surround the pin blocks to seal the connections from moisture and liquid while coupled.

To avoid unintentional human contact, the Master spring pins are recessed below an insulated surface on both the power and signal circuits.

> **WARNING:** To avoid damage to the contacts, never uncouple the unit without first disconnecting and discharging the power that passes through these pins. This is especially true if high voltage circuits are involved.

A Harting 10B connector is provided on the SC7 Master module to support Tool Changer I/O, Servo power and signal connections, and field bus data lines. Additional customer specific I/O is also supported, refer to Section 7 for the module specifications and Section 8 for electrical interface drawings and connector details. The Harting interface is compatible with some ABB robot dress packages. In the event that DeviceNet field bus signals are utilized, a 5-Pin M12 connector is also provided on the Master module to permit the connection of a terminating resistor.

An electrical interface is provided on the Master module for support of an integrated solenoid valve. The integrated valve can be supplied from ATI as part of the valve adapter block (such as 9121-JR2-M). Refer to the valve adapter block manual for more information (9620-20-C-Jxx Air and Valve Adapters). Electrical interface drawings and connector details are provided in drawings in Section 8.

The Tool Module is also equipped with a Harting 10B connector. Servo power and signal connections, as well as field bus signals are interfaced through this connector.

The Tool-ID feature on the SC7 Tool module allows the customer to distinguish between the different Tools that are being coupled by the Tool Changer. Setting of Tool-ID is facilitated using a push button switch provided on the Tool modules. Ten unique tool ID values are available (0-9).

The SC7 module is designed with special features to afford the user the opportunity to operate the Tool Changer in the safest manner possible. In addition to providing the standard Lock, Unlock, and Ready-to-Lock sensor inputs, the modules are outfitted with Tool Stand Interlock (TSI). The TSI feature consists primarily of a physical break in the unlatch solenoid valve circuit. The TSI circuit is designed to allow Tool Changer release ONLY when the Tool is in the stand or storage location. Refer to Section 3.3 for additional information regarding TSI.

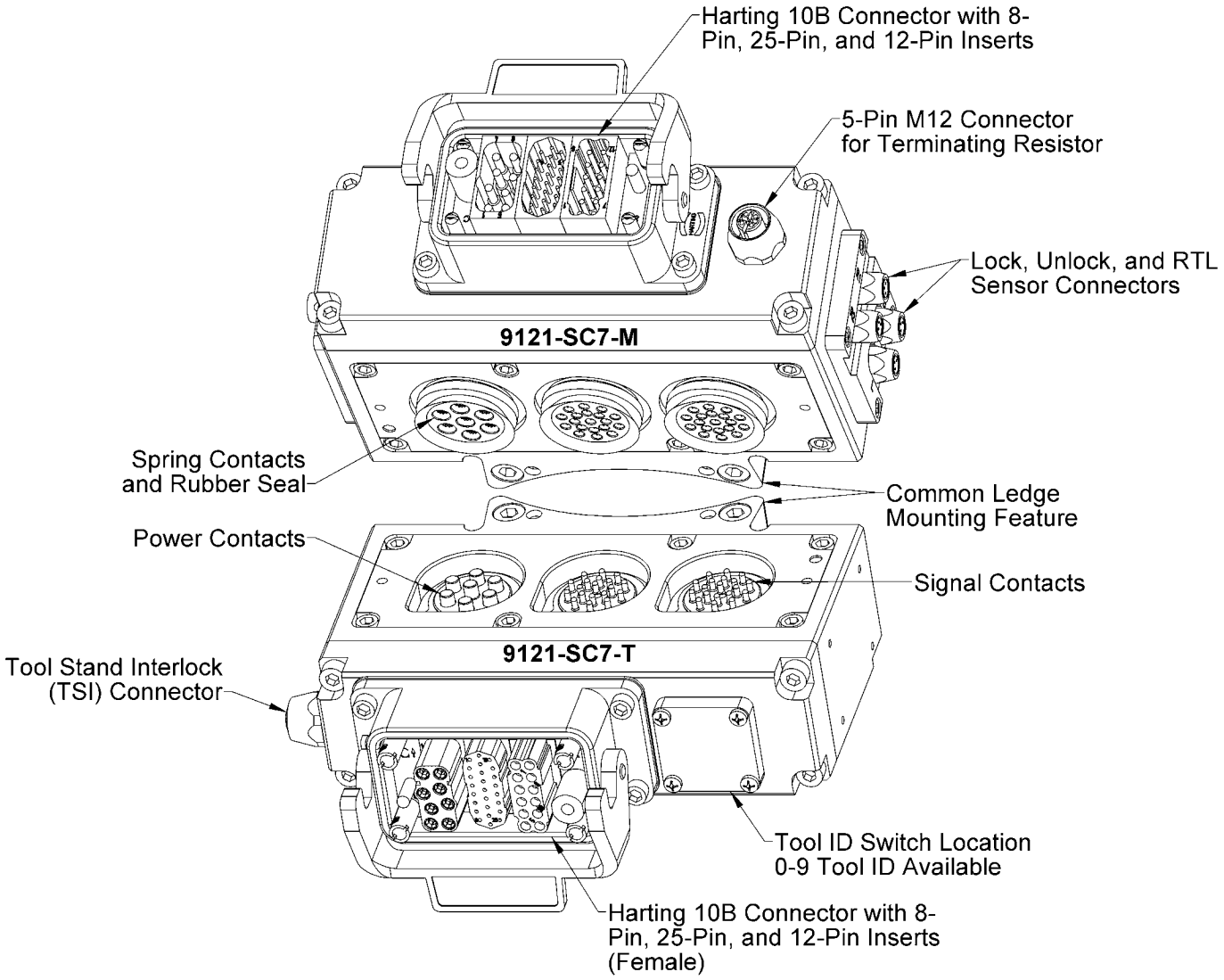


Figure 1.1—SC7 Modules

2. Installation

The SC7 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 the drawings in Section 8.

DANGER: Power and air should always be removed prior to maintenance or repair.

2.1 Installing

1. It may be necessary to clean the mounting surface on the Tool Changer prior to installing the module in order to remove any debris that may be present.
2. Using the ledge feature as a guide place the module into the appropriate location on the Tool Changer body. Align the module with the Tool Changer using the dowels in the bottom of the ledge feature. Apply Loctite 242 to the supplied M6 SHCS fasteners and tighten to 110 in-lbs.
3. Typically, cables need to be connected to the Master-side control module. These connections can be made after attaching the module to the Tool Changer body. Customer connections up to the module can also be made after the module is installed. Ensure that the connectors are cleaned prior to being secured as appropriate.

2.2 Removal

1. Prior to removing the module use a marker pen to scribe a line or indication between the Tool Changer and module body as a reminder where the module is to be re-installed.
2. Depending upon the service or repair being done, customer connections up to the module may or may not need to be disconnected.
3. Remove the socket head cap screws and lift the module from the Tool Changer.

3. Operation

The SC7 Discrete Control and Servo module is designed to provide control of the Tool Changer, pass electrical power and signal connections to a transgun servomotor, and pass field bus data (DeviceNet, Interbus, etc.) to the end-of-arm tooling. The sections below detail the various functional characteristics of the module.

3.1 Tool Changer Control and Lock, Unlock, and Ready-to-Lock Sensor Input Signals

Various Tool Changer I/O are provided to the customer through the Harting 10B connector on the Master module. Lock, Unlock, and Ready-to-Lock proximity sensor inputs are provided for confirmation of the Tool Changer and locking mechanism positions. Other, customer-assigned discrete I/O points are also available through the Harting connector.

Output signals need to be provided to the SC7 Master module to actuate the solenoid valve in order to provide pneumatic pressure to lock and unlock the Tool Changer.

Note that 0 and 24 VDC supply lines are required to be on certain pin locations of the customer interface connector. Reference drawings in Section 8 for pin out information and location of the I/O signals.

Refer to the specific Tool Changer manual for details on the operation of the Tool Changer and recommended procedure for coupling.

3.2 Servomotor Power and Signals

The SC7 is designed to work with specific industrial servomotors and drives, providing a separable joint in the power and signal wiring. To maximize the service life of these components the following points should be observed:

1. Do not couple or uncouple the SC7 Master and Tool modules unless electrical power has been disconnected and discharged both upstream and downstream from the modules. Arcing and contact damage will occur if this is not observed.
2. Properly route and secure all cables, particularly on the Master side. Failure to observe this point may result in premature failure of the industrial electrical connectors. Poor cable routing can also result in wires and cables being pinched in the joint between the Tool Changer halves.

3.3 Tool-side TSI

The Tool Stand Interlock (TSI) circuit is provided to ONLY allow tool release while in the stand or storage location as indicated by actuation of a customer-integrated switch. It is suggested that the customer integrate a single throw, single pole (Normally Open, spring return) limit switch to work with this feature (reference Figure 3.2). The limit switch should be mounted to the end effector in such a way that the switch is "made" only when the tool is in the stand or storage location.

The TSI feature consists primarily of a physical break in the unlock solenoid valve circuit. The broken circuit is made available to the customer via a TSI connector on the Tool module. Using this connector, a mechanical switch and trip dog can be integrated by the customer to allow the unlock solenoid valve circuit to be completed only when the Tool is in the Tool Stand. A momentary action single-pole, single-throw switch is suggested.

In order to allow the Tool Changer to uncouple when a Tool is not present, a relay circuit in parallel with the TSI circuit is utilized. This relay circuit is located in the Master module and is triggered by the RTL sensor. If the RTL sensor is low, indicating no Tool Presence, then the Relay circuit is closed, thus allowing the unlock solenoid valve circuit to be completed. If the RTL sensor is high, indicating Tool Presence, then the relay circuit is open and the TSI circuit on the Tool-side must be closed in order to complete the unlock solenoid valve circuit.

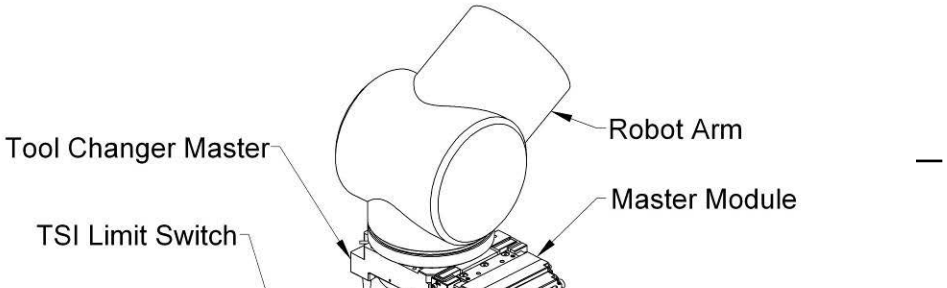
Monitoring of the Relay circuit is achieved through the RTLV input. Refer to Table 3.1 for suggested fault monitoring conditions.

Input1	State 1	Input2	State 2	Comment
RTL1	OFF	Tool Module	Present*	RTL1 Not Operating Properly**.
RTL1	OFF	RTLV	ON	Relay or RTL1 Not Operating Properly**.
RTL1	ON	RTLV	OFF	Relay or RTL1 Not Operating Properly.

***** Tool Module Present as evidenced by ability to read Tool-ID

** Dangerous situation where an unintentional Unlock command could result in Tool release.

Table 3.1—Fault Monitoring



Tool Stand Interlock Safety Feature:

The Tool Stand Interlock (TSI) Feature is provided with this Tool Changer.

A 4-Pin M12 connector found on the Tool module is designed for use with a Tool Stand present switch. It is recommended that the customer integrate a single-pole, single-throw (Normally Open, spring return) limit switch to work with this feature. This switch should be integrated onto the EOAT to sense when the Tool is in the stand.

If an Unlatch command is given and the Tool is not docked properly, the Unlatch command will not be recognized. This prevents the accidental release of the Tool outside of the Tool Stand.

A teach plug is available to override the TSI safety feature during initial setup and maintenance situations.

Please refer to the manual for specific details regarding the TSI feature.

Figure 3.2—Fault Monitoring

3.4 Tool-ID Switch

A pushbutton switch is provided on the Tool module for setting the Tool-ID number. There are ten possible Tool-ID values available. To change the Tool-ID value, remove the four screws that attach the clear window over the Tool-ID switch. Use the pushbuttons to set the Tool-ID to the desired value. After adjustment is completed, ensure that the seal and window are re-positioned correctly to prevent a leakage path to inside the module.

3.5 Operation Flow Chart

Refer to the flow chart in Figure 3.3 for a logical description of Tool Changer operation, lock/unlock procedures, and diagnostic checks.

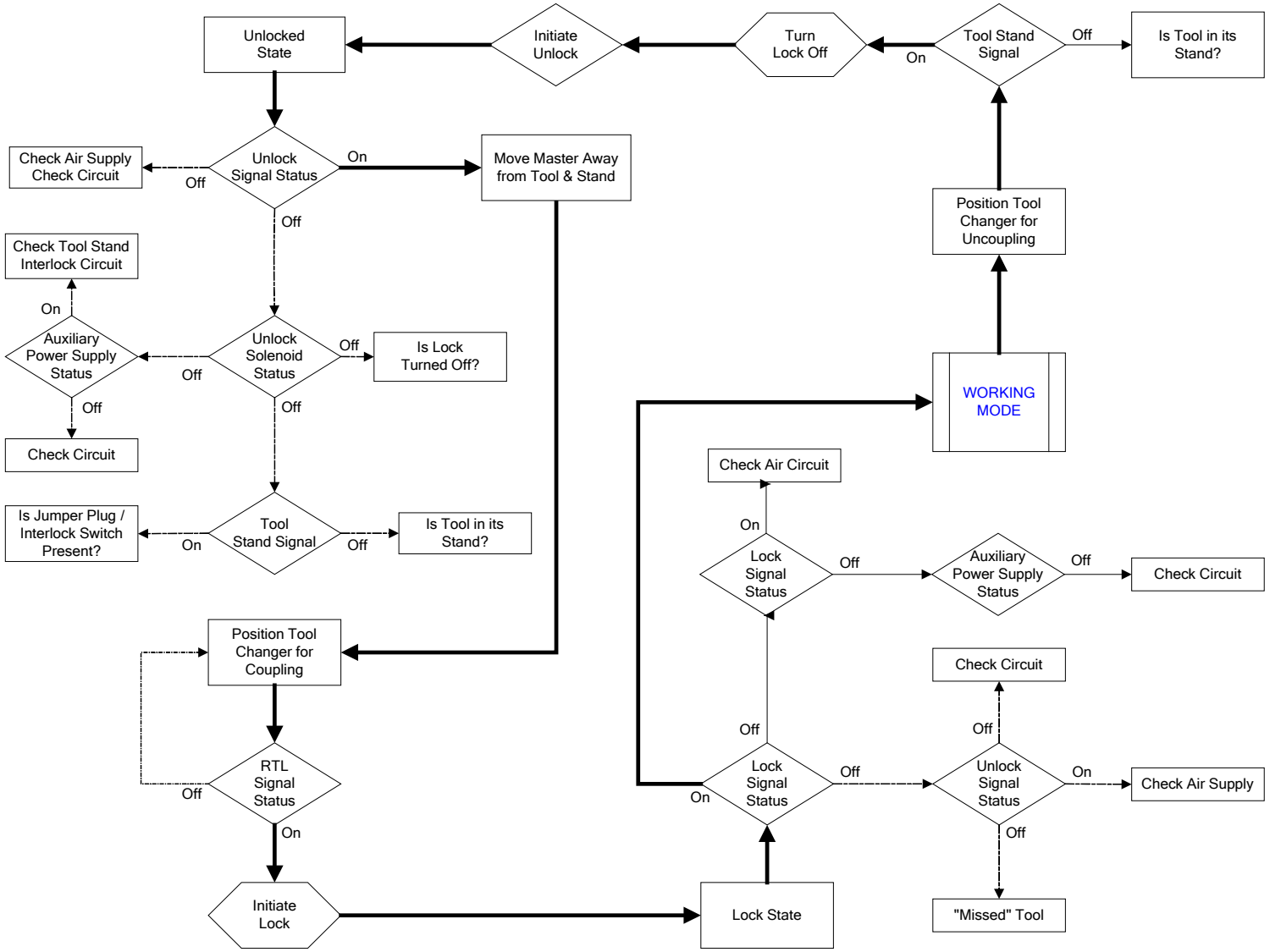


Figure 3.3—Logical Operation and Diagnostics Maintenance

4. Maintenance

Contact pins on the Tool module should be inspected and cleaned periodically to ensure electrical contact is maintained. A vacuum is recommended to remove and clear debris from the module mating surfaces. Care should be taken not to bend or pull out the contacts when cleaning. Do not use an abrasive media to clean the contact pins as erosion may occur to the contact surface. Do not use contact cleaner or solvents on Master pins.

Cable connections should be inspected during maintenance periods to ensure they are secure. Loose connections should be cleaned and re-tightened as appropriate. Loose connections are not expected and may indicate improper routing and/or strain relieving.

If the Tool Changer is being used in dirty environments (e.g., welding or deburring applications), care should be taken to 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.

Detailed assembly drawings are provided in Section 8 of this manual.

5. Troubleshooting

Refer to Table 5.1 to help diagnose and correct problems related to Tool Changer control and sensor input.

Symptom	Possible Cause / Correction
Unit will not lock or unlock	Verify that ball bearings are moving freely. Clean and lubricate as needed. Check air supply. Check that exhaust port is properly vented (check muffler). Check valve for proper operation. Verify that discrete signals are mapped and are communicating properly. Verify that the Master and Tool are within the specified No-Touch zone when attempting to lock.
Sensors not operating properly	Verify that cables are connected correctly. Verify that the sensors are set correctly. Ensure that the Tool Plate is securely held to the Master Plate, that nothing is trapped between their surfaces, and that there is no air trapped in the Unlock (U) air port.
Loss of Communication	Check/Replace signal cabling up- and down-stream of Tool Changer modules. Inspect module contact pins for debris/wear/damage. Check product up- and downstream of Tool Changer for failure. This failure can “appear” to be caused by the Tool Changer or affect Tool Changer performance.

Table 5.1—Troubleshooting Tool Changer Control Related Issues

The SC7 modules provide a separable joint in the cabling between a servomotor and its controller/drive. Failure of the motor to operate for any reason must be diagnosed electrically. Use Table 5.2 to aid in diagnosing and correcting servomotor related problems.

Symptom	Possible Cause	Correction
Cable Damage	Pinched, torn, or fatigued cables	Replace cables.
Obstruction	Object trapped between modules	Remove object, re-attempt coupling.
Servo Module Contact Damage	Coupling/Uncoupling under load	Revise operating procedures to only couple/uncouple with power disconnected and discharged. Field replacement of module contacts is not possible.
Servo Module Contact Contamination	Environment	Clean Master and Tool side module contacts with contact cleaner

Table 5.2—Troubleshooting Servomotor Related Issues

The following sequence is recommended for troubleshooting servo motor problems.

1) First examine all the cables, cable connectors, and power sources for problems and correct as necessary.
2) Use a known good set of cables (power and signal) to bypass the servo modules and directly connect the drive to the motor.
3) If the motor does not operate properly with known good cables, the problem is in the drive or motor. Troubleshoot these components using that manufacturer's procedures.
4) If the motor operates properly, use the known good cables from step 2 to connect between the servo drive and ATI Master servo module. Use a second set of known good cables to connect the Tool servo module to the motor.
5) If the motor operates properly, the problem is in the old cables which must be repaired or replaced.
6) If the motor does not operate properly, the problem is in the servo module.
7) Examine the servo modules for damage to their electrical connectors and contact pins. Clean all accessible surfaces, where necessary. Insure that the spring pins on the Master side can move freely and are not bound by debris. Clean the spring pins with contact cleaner to restore free operation.
8) If the above steps fail to restore proper operation, contact ATI for service.

6. Recommended Spare Parts

Description	Part Number
SC7 Master Module Assembly	9121-SC7-M
SC7 Tool Module Assembly	9121-SC7-T
V-Ring Seal	4010-0000030-01
Tool-ID Window	3700-20-5844
Optional Accessories:	
TSI Teach Plug	1700-0545501-01

7. Specifications

9121-SC7-M	Harting Master Module, Supports Servo Power and Encoder Signals, Profibus/DeviceNet Pass Thru, Supports L/U/R1/R2 Sensors and Integrated Valve, Supports TSI on the Tool
Connector(s)	Harting 10B Connector w/ EE, HD, and DD Inserts: • 8-Pin EE Insert (Male): Servo Power • 25-Pin HD Insert (Male): Servo Signal and Tool Changer I/O • 12-Pin DD Insert (Male): Field Bus Signals Turck M12, 5-Pin Female, FK4.5-0.5/18.25: Connector for DeviceNet Terminating Resistor
Weight	3.1 lbs (1.4 kg)
Pass-Through Signals	Power: 7 @ 15A, 500V, Via Harting 10B EE Insert and ATI 7-Pin Block (Gold-Plated) Signal: 14 @ 3A, 24V, Via Harting 10B HD Insert and ATI 19-Pin Block (Gold-Plated) Field Bus: 12 @ 3A, 24V, Via Harting 10B DD Insert and ATI 19-Pin Block (Gold-Plated) Tool Changer (TSI and Tool ID): 6 @ 3A, 24V, Via ATI 19-Pin Block (Gold-Plated)

9121-SC7-T	Harting Tool Module, Supports Servo Power and Encoder Signals, Profibus/DeviceNet Pass Thru, 0-9 Tool ID, TSI on Tool. Mates with SC7 Master.
Connector(s)	Harting 10B Connector w/ EE, HD, and DD Inserts: • 8-Pin EE Insert (Female): Servo Power • 25-Pin HD Insert (Female): Servo Signal and Tool Changer • 12-Pin DD Insert (Female): Field Bus Signals Turck M12, 4-Pin Female, FK4.4-0.5/18.25: TSI Connector
Weight	2.75 lbs (1.25 kg)
Pass-Through Signals	Power: 7 @ 15A, 500V, Via Harting 10B EE Insert and ATI 7-Pin Block (Gold-Plated) Signal: 14 @ 3A, 24V, Via Harting 10B HD Insert and ATI 19-Pin Block (Gold-Plated) Field Bus: 12 @ 3A, 24V, Via Harting 10B DD Insert and ATI 19-Pin Block (Gold-Plated) Tool Changer (TSI and Tool ID): 6 @ 3A, 24V, Via ATI 19-Pin Block (Gold-Plated)
Tool-ID	10 Tool-ID Values Available (0-9), Factory Setting = 1

8. Drawings

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