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## F. High-Power Modules

### PA5-M, PA5Z1-M and PA2-T—High-Current Modules

#### 1. Product Overview

##### High-Current Modules

The high-current modules used by the spot-welding tool changer are designed to carry high-current from a power supply to customer tooling. The modules support three rhodium-plated copper contacts. The PA5-M and PA5Z1-M Master modules include a commercial cable connector while the PA2-T Tool module utilizes a fitting plate for a customer supplied strain relief fitting and cables. The connector on the PA5-M and PA5Z1-M Master modules limit the current capability of the PA5/PA2 combination to 180 Amperes. The voltage should not exceed 600 Volts. **To avoid arcing, never uncouple the Tool Changer without first turning off the power supply to the Master.** Power must be off when coupling and uncoupling, the modules are not a switch. In addition, the installation of over-current protection in the primary power supply circuit is recommended.

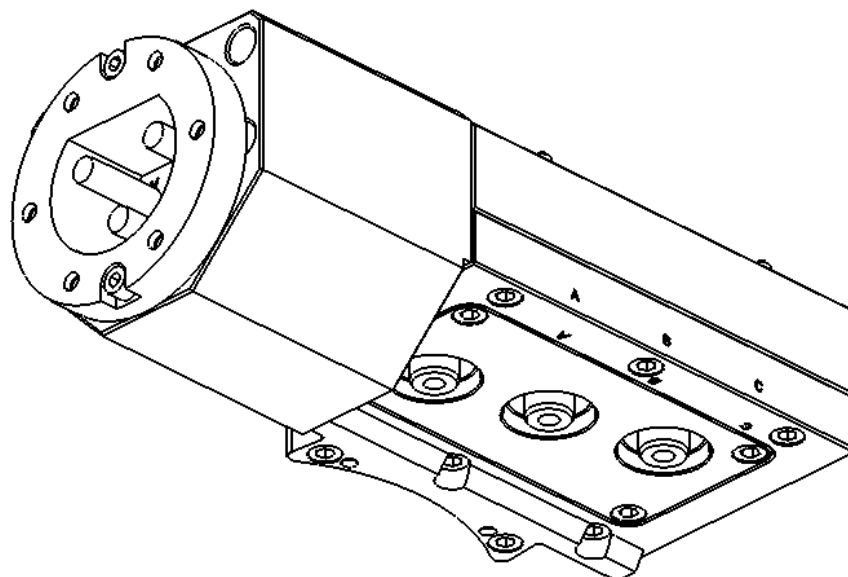


Figure 1.1—High-Current Module—Master (PA5-M and PA5Z1-M)

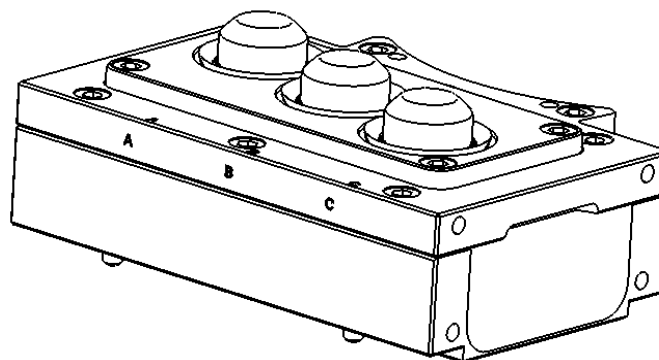
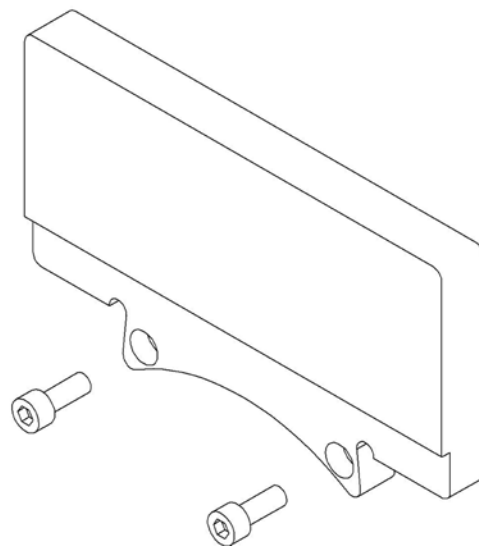
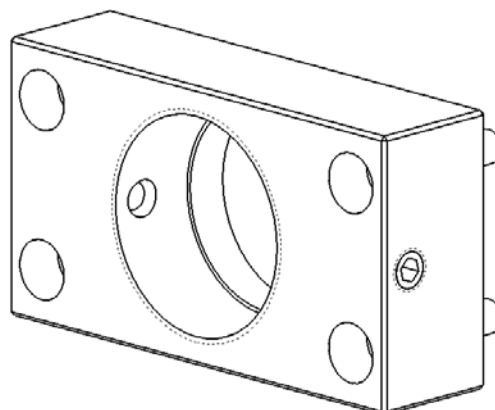


Figure 1.2—High-Current Module—Tool (PA2-T)

When a PA2-T module is not used on the Tool side, a PAA-T may be supplied (per customer request) to protect the Master side power module from dust, debris, and weld spatter.



**Figure 1.3—Protective Cover for Tool Side (PAA-T)**



**Figure 1.4—Fitting Plate**

The high-current modules use advanced, patented, cone-mating technology to transfer current from the Master to the Tool. The mating conical surfaces provide a large contact area, excellent misalignment capability, and allow efficient coupling/uncoupling without high spring forces or excessive wear. If required, the contact tips on either the Master or Tool can be easily replaced without removing the wiring.

Additional safety features have been designed into the PA5 and PA2 modules shown here. The contact tips on the Master side are recessed well below the surface and contain a central insulated post. The modules were designed so that the finger of an average human adult cannot touch the metallic parts. The center contact is designed to engage first and break last to insure, and is intended as, a ground connection. The center contact of the PA5-M and PA5Z1-M modules are connected to the ground pin of their connector.

## 2. Installation

### 2.1 General Installation

The PA5 and PA2 modules have three high-current electrical contacts. A tool side fitting plate may be specified at the time of order to support a customer supplied strain relief fitting. Once the fitting plate is installed on the tool module, the prepared cable ends are fed through the strain relief and into the module where the conductors are attached to the contact bases. The center contact is designed to engage first and break last and is intended for use as a ground contact. For ease of cable installation it is recommended that the PA2-T Tool module be removed from the tool changer.



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

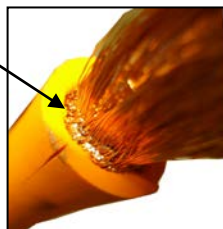
The high-current modules are typically installed by ATI prior to shipment. The steps below outline field installation or removal as required. These steps also detail connecting cables to the tool side contacts.

### 2.2 Module Removal/Mounting and Tool Side Cable Installation

The PA5-M and PA5Z1-M Masters come pre-wired from the factory and it is only necessary to plug in and secure the master side cables. The steps below cover removal of either module from the tool changer and the steps required for the customer to wire the PA2-T Tool.

1. Remove the (2) M6 socket head screws securing the module to the tool changer.
2. After removing these screws lift the module assembly off the tool changer body.
3. Insert the customer supplied strain relief fitting (with lock nut) into the tool side fitting plate.
4. Orient the fitting as desired, then tighten the (2) M8 set screws against the fitting's threads.
5. Use an appropriate tool and tighten the strain relief lock nut to the front face of the fitting plate. (This will provide more fitting retention than the set screws alone).
6. Use (2) M6 socket head screws to attach the fitting plate to the desired end of the module mounting plate (aluminum plate with dowel pins and curved mounting profile). Leave these screws slightly loose at this time.
7. To access the inside of the housings remove the (6) M6 socket head screws securing the module cover to the module mounting plate.
8. Feed the cable(s) through the customer supplied strain relief fitting and prepare the cable ends by stripping the insulation back approximately 3/4" (19mm). Be careful not to cut individual strands while stripping the cable jacket.

Ensure individual strands  
of wire are NOT cut during  
the stripping process

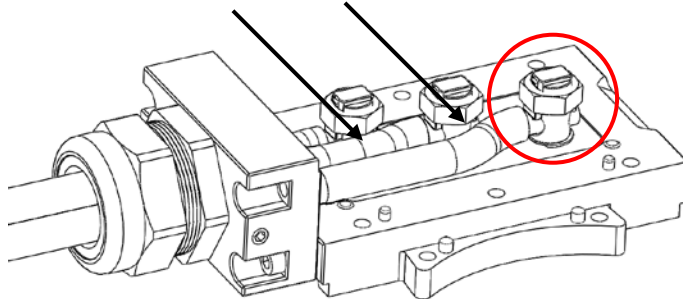


**Figure 2.1**

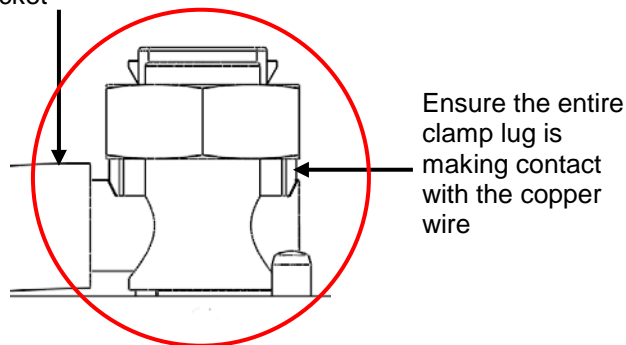
9. To attach the cables to the contact bases, loosen the split-bolt nuts to retract or remove them.

10. Insert the prepared cable end into the split-bolt contact base and replace the nut. Tighten securely [torque to 90 lb-in. (10 Nm) max.] after you have made sure that no loose wire filaments are protruding. Ensure that the clamping lug does not clamp on the cable jacket and that the entire clamp lug is contacting the copper cable.

Ensure cable jacket is NOT  
pinched by clamp lug



Ensure the clamp lug is NOT  
clamping the cable jacket



**Figure 2.2**

11. Once the cables are secured to the contact bases refit the housing cover and secure it to the mounting plate using the six M6 socket head screws.
12. Insert the remaining two M6 socket head screws into the fitting plate and tighten all four fitting plate screws securely. (NOTE: Tighten the fitting plate screws AFTER the module cover is installed and tightened in place).
13. Remount the assembled module to the tool changer using the two remaining M6 socket head screws removed in Step 1.
14. Re-tighten the strain relief fitting's gland nut if applicable.

### 3. Operation

The high-current modules are designed to carry large currents to various industrial devices, providing a separable joint in the power wiring. To maximize the service life of these components the following points must be observed:

1. Do not couple or uncouple the 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. The contacts are not, and should not be used as, a switch.
2. Properly route and secure all cables, particularly on the Master. 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. Always protect the un-used Tool modules when not coupled to a Master module. Dust, debris, and weld spatter can contaminate the contact tips resulting in arcing and a significant decrease in contact life.



**DANGER:** The contacts are not a switch. For safety and to prevent equipment damage disconnect and drain all power before uncoupling the tool changer.

### 4. Maintenance

Once installed, the operation of the primary current modules is generally trouble-free. Periodically, the condition of the contacts should be checked. Any contamination should be removed with industrial contact cleaner. During inspection, insure that the fasteners attaching the modules to the Quick Change bodies are still secure.

The modules may be field serviced as needed. The following list describes how to perform various operations.



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

#### V-Ring Seals

1. To replace the V-ring seals, use a small screwdriver or similar to gently pry the seal away from the insulator block on the master-side then pull the seal off the block.
2. To install a new seal, stretch it over the shoulder on the block and use a small screwdriver to push the seal's hub down fully against the recess in the insulator block.

#### Contact Tips

1. To replace a Master contact tip, locate the socket head cap screw in its center insulator post. Remove this screw to extract the contact and insulator.
2. To fit or re-fit a Master contact, apply a thin film of non-hardening, conductive, grease with a volume resistivity of 0.001 ohm-cm or better to the mounting surface of the contact (ATI #0290-70-0000-50-008, 2cc Syringe, AI Technology, Inc. #ELGR8501, or McMaster-Carr #1219K57). Replace the contact in the FR-4 block and refit the center insulator and socket head cap screw. Apply Loctite 222<sup>®</sup> (or similar) to the screw prior to installation, tighten to 6 in-lb [0.68 Nm].
3. To replace the Tool contact tips, follow the instructions above noting there is no center insulator post. Apply Loctite 222 (or similar) to the screw prior to installation, tighten to 6 in-lb [0.68 Nm].
4. ALWAYS replace Master and Tool contact tips at the same time. Failure to change both halves of a mating pair will result in decreased life of the new components.

### **Contact Bases**

1. To remove the contact bases, refer to the installation section and remove the module(s) from the Tool Changer.
2. Remove the cables by reversing the steps outlined in the installation section. For the PA5-M and PA5Z1-M Masters, it will also be necessary to loosen the (2) M5 socket head screws securing the connector to its housing so the cables and connector can be withdrawn from the module.
3. Remove the FR4 (fiberglass) contact insulator plate from the module mounting plate by extracting the four M6 socket head screws.
4. Remove the three socket set (grub) screws from the back side of the fiberglass insulator plate.
5. Remove the three 3mm dowel pins from the holes along the side of the insulating plate. (These holes are perpendicular to those from which the set screws were removed.) Removal of these pins is simplified by use of a magnet.
6. Use snap-ring pliers to remove the circular clip from the back side of the contact base.
7. Remove the contact base by pushing it out of the insulator block. Replace as necessary.
8. To refit the contact base, reverse the steps above and apply conductive, silver bearing grease to the interface with the contact tips. **NOTE:** The Tool contact spring must be compressed to fit the circular clip. When compressing the spring to fit the circular clip to the contact base, place the contact tip on a clean hardwood or plastic block and apply downward pressure. (DO NOT use metal objects to push on the contact tip or contact base.)

### **Springs**

1. The Tool contacts provide axial compliance using wave springs. To remove or replace these springs, remove the Tool contact bases as described above.
2. Remove the old springs from the contact bases and fit new springs.
3. To reassemble, reverse the steps above. When compressing the spring to fit the circular clip to the contact base, place the contact tip on a clean hardwood or plastic block and apply downward pressure. (DO NOT use metal objects to push on the contact tip or contact base.)

## 5. Troubleshooting

The high-current modules provide a separable joint in the cabling between various power sources and loads. Failure of the load to operate for any reason must be diagnosed electrically.

Load Fails to Operate		
Possible Problem	Cause	Remedy
Cable Damage	Pinched, torn, or fatigued cables.	Replace Cables
Obstruction	Object trapped between modules	Remove object and re-attempt coupling.
Module Contact Damage	Coupling/Uncoupling under load.	Revise operating procedures to only couple/uncouple with power disconnected and discharged. Replace module contacts
Contact Contamination	Environment	Clean master and tool side module contacts with contact cleaner.

The following sequence is recommended for troubleshooting primary current problems.

1. First examine all the cables, cable connectors, and power sources for problems and correct as necessary.
2. Use a known good cable to bypass the modules and directly connect the supply to the load.
3. If the load does not operate properly with known good cables, the problem is in the supply or load. Troubleshoot these components using that manufacturer's procedures.
4. If the load operates properly, use the known good cables from step 2 to connect between the supply and Master module. Use a second set of known good cables to connect the Tool module to the load.
5. If the load operates properly, the problem is in the old cables, which must be repaired or replaced.
6. If the load does not operate properly, the problem is in the high-current modules.
7. Externally, examine the modules for loose, missing, or damaged contacts replacing and tightening as necessary.
8. Remove the covers from the modules and insure that the cables have not come loose from the contact bases. Re-secure the cables as necessary. Torque the nuts holding the cables in the split-bolts to 90 lb-in. (10 Nm) max.
9. Use a hardwood dowel or other non-metallic, soft rod to push axially on the tool side contacts to verify free axial motion. If the springs under these contacts do not allow axial motion of the contacts, replace the springs accordingly as outlined above in the maintenance section.

If the above steps fail to restore proper operation contact ATI for service.



## 6. Recommended Spare Parts

See drawings in Section 8 of this manual.

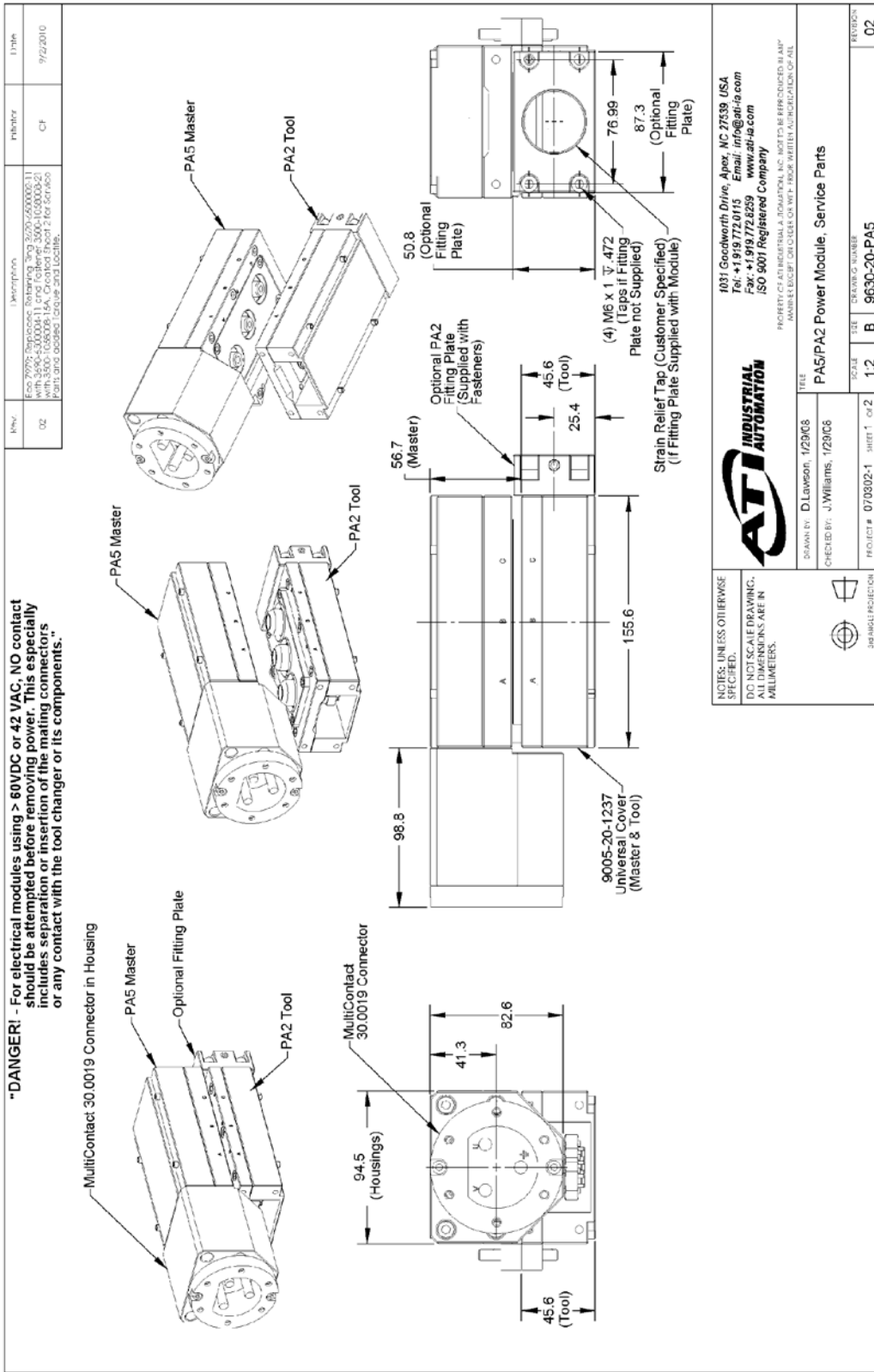
## 7. Specifications

<b>High-Current Module</b>	<b>PA5-M, PA5Z1-M/PA2-T or PAA-T</b>	
Weight	6.0 lbs (2.7 kg) 2.9 lbs (2.0 kg) 0.5 lbs (0.23 kg)	PA5-M and PA5Z1-M PA2-T PAA-T
(# Contacts) Current and Voltage Specification	(3) @ 180A, 600V Max.	Rhodium-plated, conical contacts No-Touch on Master side.
Cable Sizes Supported	PA5-M and PA5Z1-M: Connector	MultiContact: 30.0019 3-Pin Connector for 35mm <sup>2</sup> (#2 AWG) Cable (See MultiContact's Roboticline catalog for compatible connectors)
	PA2-T: # 4 Thru #2 AWG (Others, Contact ATI)	Split-bolt terminals are used to attach the conductor to the contact post.
Connection Options	PA2-T Optional Flanges	Custom fitting plates available.

PA5-M / PA2-T Pin Out Table				
Multi-Contact Pin		Master ATI Contact		PA2 Tool ATI Contact
U	>--->	C	>--->	C
Gnd	>--->	B	>--->	B
V	>--->	A	>--->	A

PA5Z1-M / PA2-T Pin Out Table				
Multi-Contact Pin		Master ATI Contact		PA2 Tool ATI Contact
U	>--->	A	>--->	A
Gnd	>--->	B	>--->	B
V	>--->	C	>--->	C

## 8. Drawings



	Rev.:		Instructor:		Date:
		Description: See Sheet1			

**MASTER PARTS**

1. M3 x 8mm SHCS M/B, ND Microspheres  
 2. Set Screw M4 x 5 Cup Point  
 3. 3mm x 12mm Dowel Alloy Steel  
 4. Low-Clearance C-Style Ring for 5/8" Shaft Dia.  
 5. Contact Tip, Master  
 6. CONTACT BASE, MASTER  
 7. INSULATOR POST, MASTER  
 8. SPLIT-BOLT CABLE CLAMP  
 9. Master Cleat Sub-Assembly

**TOOL PARTS**

1. Pre / 10 in-lbs  
 2. Note 1  
 3. Note 2  
 4. Note 1  
 5. Note 1  
 6. Note 1  
 7. Note 1  
 8. Note 1  
 9. Note 1  
 10. Note 1

**\*Field Service Kit: 9121-PA2-M-Contactkit**  
 contains items identified with asterisks.

ITEM NO.	PART NUMBER	DESCRIPTION
*	3500-1056008-15A	M3 x 8mm SHCS M/B, ND Microspheres
*	3500-1962005-11	Set Screw M4 x 5 Cup Point
*	3540-0103012-11	3mm x 12mm Dowel Alloy Steel
*	3690-6500004-11	Low-Clearance C-Style Ring for 5/8" Shaft Dia.
*	3700-20-1544	Contact Tip, Master
*	3700-20-4152	CONTACT BASE, MASTER
*	3700-20-4153	INSULATOR POST, MASTER
*	3700-20-4162	SPLIT-BOLT CABLE CLAMP
*	9005-20-1198	Master Cleat Sub-Assembly

**\*Field Service Kit: 9121-PA2-T-Contactkit**  
 contains items identified with asterisks.

ITEM NO.	PART NUMBER	DESCRIPTION
*	3500-1056008-15A	M3 x 8mm SHCS M/B, ND Microspheres
*	3500-1962005-11	Set Screw M4 x 5 Cup Point
*	3540-0103012-11	3mm x 12mm Dowel Alloy Steel
*	3610-1902501-21	VIAVE SPRING, 6" I.D., 2.98#/in
*	3690-6500004-11	Low-Clearance C-Style Ring for 5/8" Shaft Dia.
*	3700-20-4157	CONTACT BASE, TOOL
*	3700-20-4158	CONTACT TIP, TOOL
*	3700-20-4162	SPLIT-BOLT CABLE CLAMP
*	4010-0000041-01	V-RING
*	9005-20-1199	Tool Cleat Sub-Assembly

**Notes:**

- Apply 7649-222 and install flush with surface to .010" below.
- Apply conductive silver grease to large flat surface.

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DRAWN BY: D.Lawson, 1/29/08	CHECKED BY: J.Williams, 1/29/08	TITLE: PA5/PA2 Power Module, Service Parts	
PROJECT # 070302-1 SHEET 2 OF 2		SCALE: 2:3	REVISION: 02



Rev.	Description <i>(See Sheet)</i>	Inventor	Date
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**Master Side Parts**

**Master Module Field Service Kit: 9005-20-2255 contains (1) each of the items below.**

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	3500-1058012-15A	M3 x 12mm SHCS Blue Dyed Magni-565, ND Microspheres
2	1	3500-1962005-11	Set Screw M4 x 5 Cup Point
3	1	3540-0103012-21	3mm x 12mm Dowel, SS (DIN 2338)
4	1	3690-6500004-11	Low-Clearance C-Style Ring for 5/8" Shaft Dia.
5	1	3700-20-1544	High Power Module Contact Tip No-Touch Master
6	1	3700-20-4152	CONTACT BASE, MASTER
7	1	3700-20-4153	INSULATOR POST, MASTER
8	1	3700-20-4162	SPLIT-BOLT CABLE CLAMP

**Notes:**

- Apply Loctite 7649 Primer & Loctite 222. Then install flush with surface to .010" below.
- Apply conductive silver grease to large flat surface. (ATI 0290-70-0000-50-008 or Equivalent)
- Two types of tool-side contact bases and springs have been used. When ordering Field Service Kits as referenced above and below, the headless contact base will be supplied. If only the spring is required, identify the contact base type using the images at the right and order the appropriate spring.

**Tool Side Parts**

**Tool Module Field Service Kit: 9005-20-2253 contains (1) each of the items below.**

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	3500-1058008-15A	M3 X 8 SHCS Blue Dyed Magni-565, ND Microspheres
2	1	3500-1962005-11	Set Screw M4 x 5 Cup Point
3	1	3540-0103012-21	3mm x 12mm Dowel, SS (DIN 2338)
4	1	3610-7301101-21	Wave Spring, .91"OD x .44 Lg. Smalley 14892-08
5	1	3690-6500004-11	Low-Clearance C-Style Ring for 5/8" Shaft Dia.
6	1	3700-20-4158	CONTACT TIP, TOOL
7	1	3700-20-4162	SPLIT-BOLT CABLE CLAMP
8	1	3700-20-7096	Narrow #2 Contact Base, Tool
9	1	4010-0000041-01	V-RING

**Tool Side Contact Bases & Springs**

**See Note 3**

- 3700-20-4157 Headed Contact Base Use with Spring 3610-1902501-21
- 3700-20-7096 Headless Contact Base Use with Spring 3610-7301101-21

**9005-20-1895 Insulator Sheet. Used between fiberglass cover and aluminum plate.**  
 (Use with both 9121-PA5Z1-M and 9121-PA2-T)

**NOTES: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS.**

DO NOT SCALE DRAWING.

**9005-20-1895 Insulator Sheet. Used between fiberglass cover and aluminum plate.**  
 (Use with both 9121-PA5Z1-M and 9121-PA2-T)

**NOTES: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS.**

DO NOT SCALE DRAWING.

**9005-20-1895 Insulator Sheet. Used between fiberglass cover and aluminum plate.**  
 (Use with both 9121-PA5Z1-M and 9121-PA2-T)

**NOTES: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS.**

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DRAWN BY: D.Lawson-4/10/2015  
 CHECKED BY: ---

TITLE: PA5Z1/PA2 Power Module, Service Parts

SCALE: 2:3  
 SHEET: B  
 DRAWING NUMBER: 9630-20-PA5Z1

REVISION: 01

Rev.	Description	Intolator	Date		
01P	Initial Design	BKD	6/28/2005		
02	Released	BKD	9/6/2005		

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SCALE: 1:1  
 WEIGHT: 0.50  
 DRAWING NUMBER: 9121-PAA-T-02

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	3700-20-4159	PA Safety Cover Plate
2	2	3500-1066016-15	M6 x 16mm SHCS Metric Blue

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3rd ANGLE PROJECTION

TITLE: PA Module Safety Assembly  
 DRAWN BY: B. Digeso, 6/28/05  
 CHECKED BY: R. Heavner, 6/28/05  
 PRODUCT RELEASE # 050620-T DATE: SHEET 1 OF 1