Getting Started

Contents of this Chapter

Manual Overview

Overview of This Publication

The NITRA Pneumatic Automation Link (PAL) User Manual describes the installation, configuration, and methods of operation of the NITRA Pneumatic Automation Link (PAL) system.

Who Should Read This Manual

This manual contains important information for those who will install, maintain, and/or operate the NITRA Pneumatic Automation Link (PAL) system.

Supplemental Publications

Additional PAL system documentation can be downloaded at www.automationdirect.com. For information about using the PAL Configuration Software, refer to the online help file available in the software.

Technical Support

- *By Telephone: 770-844-4200*
  (Mon.-Fri., 9:00 a.m.-6:00 p.m. E.T.)
- *On the Web: www.automationdirect.com*

Our technical support group is glad to work with you in answering your questions. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call technical support at 770-844-4200. We are available weekdays from 9:00 a.m. to 6:00 p.m. Eastern Time.

We also encourage you to visit our web site where you can find technical and non-technical information about our products and our company. Visit us at www.automationdirect.com.

Special Symbols

NOTE: When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note.

WARNING: When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death (in extreme cases).

PAL System Introduction

Overview of the System

The NITRA Pneumatic Automation Link (PAL) system is a highly versatile electro-pneumatic system for industrial automation applications. A full range of high-performance compact solenoid valves can be combined with configurable input and output (I/O) modules into a robust assembly with an IP65 rating. The assembly communicates with a PLC or other controller through an EtherNet/IP fieldbus connection. Simpler systems without I/O can be directly wired.

The system is powered by 12 or 24 VDC and can be mounted on DIN rail or surface mounted using optional adapters. Fieldbus systems can support up to 128 solenoids, 128 digital inputs, 128 digital outputs*, 16 analog inputs, 16 analog outputs and 16 temperature inputs. Wired systems support either 4, 8, 21 or 38 solenoids depending on the unit.

Solenoid valve bases come with ¼" push-to-connect tubing connections. If needed, each connector can be changed out to either 4mm(5/32"), 6mm, or 8mm(5/16") tubing sizes using optional replacement connectors. Solenoid valve options include 3-way, 2-position (2 valves per body) either (2) normally closed, (2) normally open, or one of each. 5-way valves are available in 2-position, single or double solenoid and 3-position, center closed.

8-point Digital Input and Output Modules have 3-pin M8 connections. The Analog Inputs, Outputs, and Temperature Modules have 4-pin M8 connections. Optional caps seal any unused connections. For systems that do not need the IP65 rating, there are digital input and output modules with 16 points per module and an IP40 rating. All I/O modules are configured using the PAL Configuration Software.

Fieldbus systems support local expansion and can be separated into smaller assemblies which all share one IP address and are configured as a single system in software. This allow valves and I/O to be located as needed on a machine.

To assist with the selection of your components for your PAL system, we recommend you use our online selector tool located at this link. www.automationdirect.com/selectors/pal

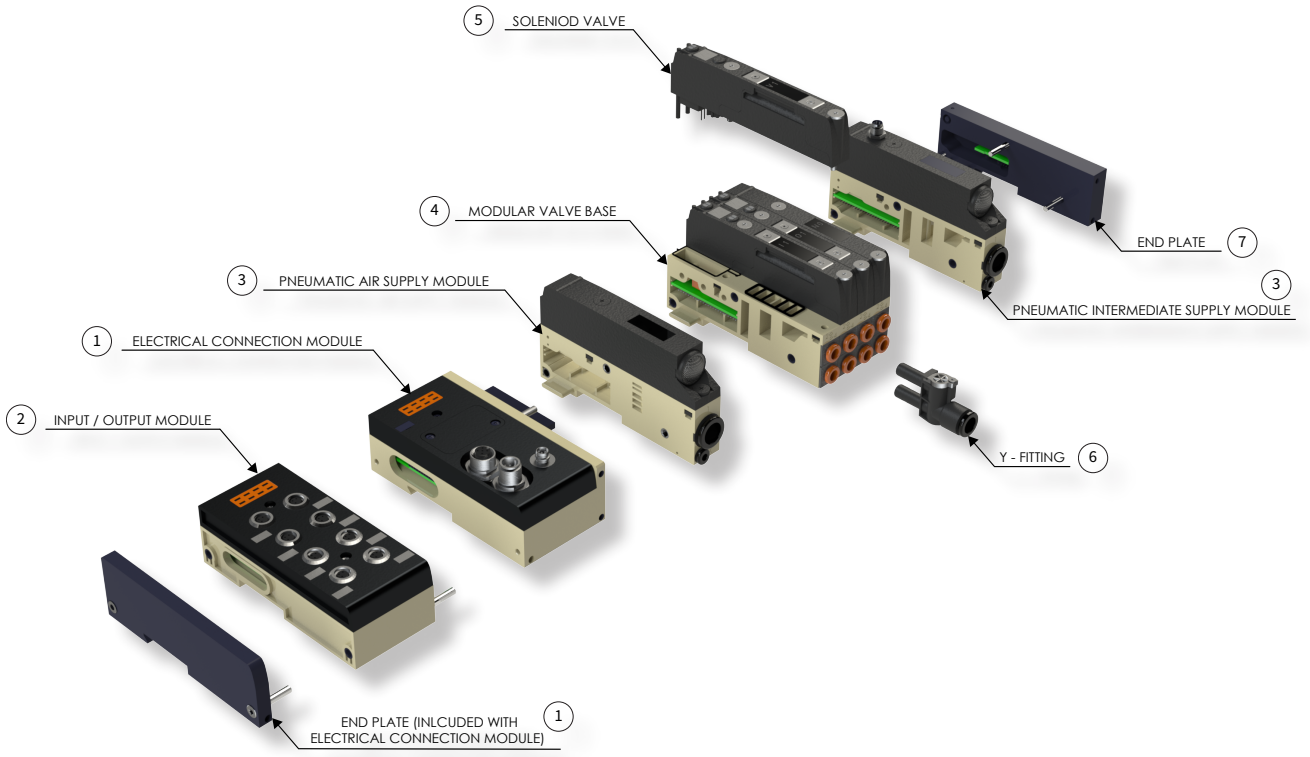
NOTE: The total number of Digital Outputs is 128, unless the assembly is using all 22 possible 6-point Digital Output modules, in which case the total count is 132.

General Specifications

PAL System - General Specifications				
Nominal Supply Voltage	12 or 24 VDC			
Minimum Operating Voltage	10.8 V *			
Maximum Operating Voltage	31.2 V			
Maximum Admissible Voltage	32V **			
Power for Each Controlled Pilot	3W for 15ms, then holding 0.3 W			
Drive (for multi-pole)	PNP or NPN			
Solenoid Rating	100% ED			
Protection	Overload and short-circuit protected solenoid pilot Output			
Maximum Number of Solenoid Pilots	21 or 38 multi-pole connection; field bus 128			
Ambient Temperature	-10°C to + 50°C (at 8 bar) 14°F to 122°F (at 8 bar)			
Operating Pressure			5/2 and 5/3	3/2
	Common supply	Port 1	3 to 8 bar (43 to 116 psi)	3.5 to 8 bar (51 to 116 psi)
	Separate pilot supply	Assisted valves	Vacuum to 10 bar (Vacuum to 145psi)	
		Pilot pressure	3 to 8 bar (43 to 116 psi)	
Actuation Response Time (TRA) / Reset Response Time (TRR) at 6 bar	TRA/TRR valve 2/2 and 3/2		14 / 28 ms	
	TRA/TRR valves 5/2 monostable and shut-off valve		12 / 45 ms	
	TRA/TRR valve 5/2 bistable		12 / 14 ms	
	TRA/TRR valve 5/3		15 / 45 ms	
	TRA/TRR valve 3/2 high flow		13 / 36 ms	
Fluid	Unlubricated air			
Air Quality Required	ISO 8573-1 class 4-7-3			
Degree of Protection	IP65 (with connectors connected or plugged if not used)			
Agency Approvals	CE, cURus			

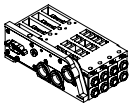
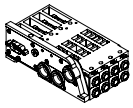
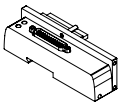
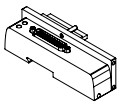
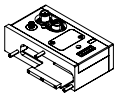
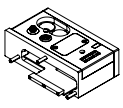
** Minimum voltage 10.8V required at solenoid pilots.*
*** IMPORTANT! Voltage greater than 32VDC will damage the system irreparably.*

Components Overview



1 Electrical Connection Modules

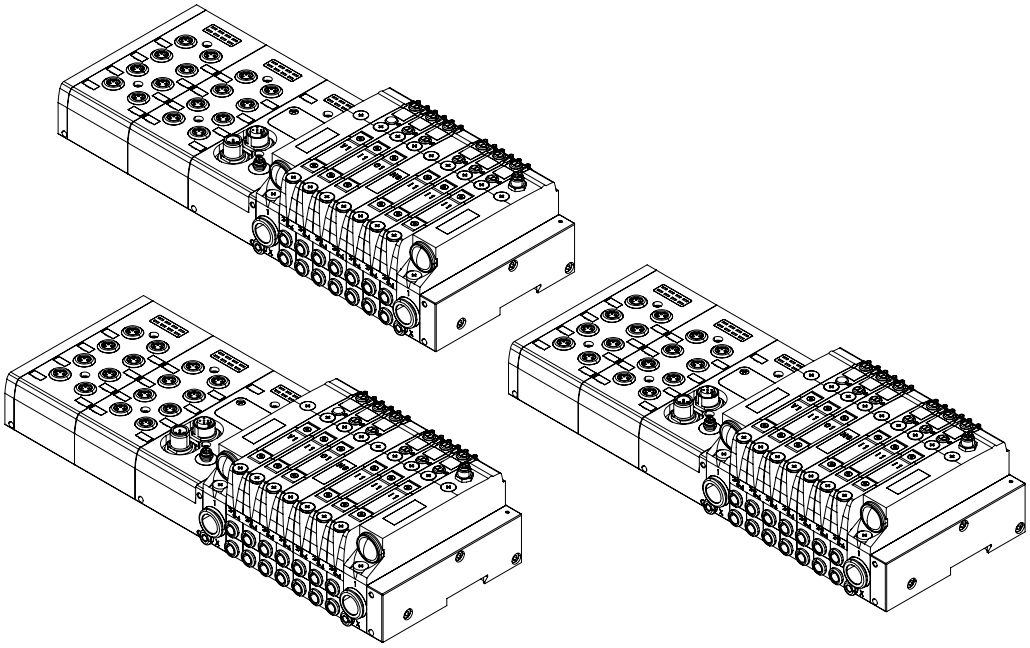
There are three different types of electrical connection modules available for use with the PAL system. PAL-EIP supports EtherNet/IP protocol at 10/100 Mbps. PAL-EAD is used to physically separate PAL assemblies while using a common IP address. For pneumatic only systems, with no I/O, PAL-E25 or PAL-E44 may be used. PAL-CB4414 and PAL-CB4814 are 4-position electro-pneumatic manifold bases for PAL valves with 4 or 8 controls for solenoid pilots. Up to 4 valves with one solenoid pilot can be installed on PAL-CB4414, and up to 4 valves with one or two solenoid pilots can be installed on PAL-CB4814.

ELECTRICAL CONNECTION MODULES					
PAL-CB4414	***PAL-CB4814***	***PAL-E25***	***PAL-E44***	***PAL-EIP***	***PAL-EAD***
					
Stand-alone, 4-solenoids, 4-stations, 1- female NPT inlet, 8-outlets, 2-exhausts	Stand-alone, 8-solenoids, 4-stations, 1- female NPT inlet, 8-outlets, 2-exhausts	25-pin electrical connection	44-pin electrical connection	EtherNet/IP electrical connection EtherNet/IP	Additional electrical connection

PAL-EAD Application

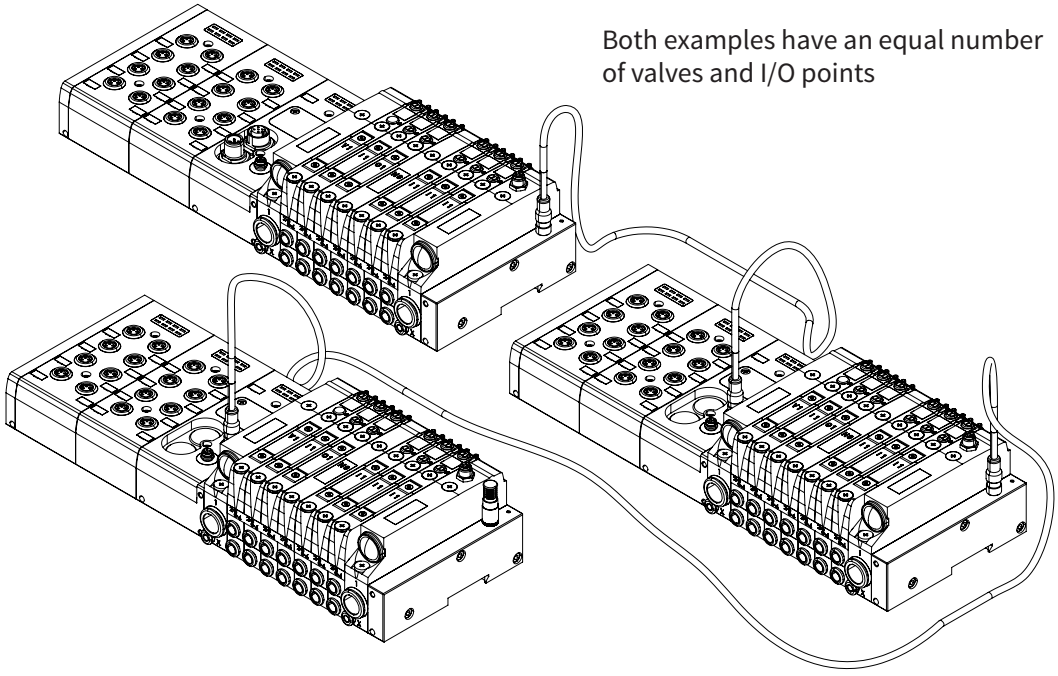
In larger systems, it is often desirable to locate valves and I/O modules close to their respective machine components. There are two main ways that this can be done with the PAL system. Smaller subassemblies of valves and I/O can be assembled using a PAL-EIP bus coupler and PAL-C2 end plate for each subassembly. These subassemblies will each be assigned separate IP addresses and treated as independent units by the PLC. The second option is to use local expansion. One PAL-EIP bus coupler and PAL-C3 end plate is joined by an expansion cable with a second subassembly with a PAL-EAD local expansion coupler. Subassemblies can be "daisy chained" in this manner up to the limits of I/O points and solenoids. The end plate on the last subassembly should be a PAL-C2 unless the possibility of future expansion is desired. If so, a PAL-C3 end plate with a PAL-ACC18 terminator can be used. When using local expansion, the overall system has one IP address and is treated as a single assembly by the configuration software tool and by the PLC.

(3) Independent PAL Systems



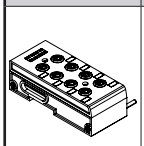
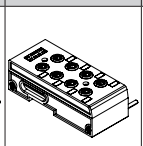
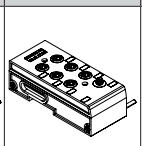
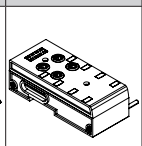
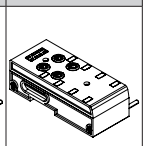
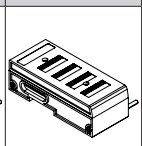
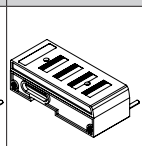
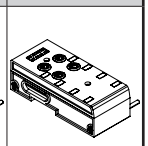
(3) Daisy chained PAL assemblies acting as (1) PAL system

Both examples have an equal number of valves and I/O points



2 *Input / Output Modules*

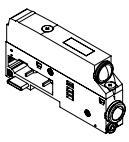
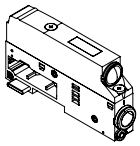
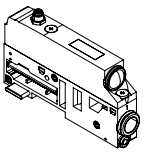
The PAL system can be configured with a variety of input or output signal modules, which can be mounted on systems with fieldbus electrical connection and no additional systems. The signal modules can be added at any time. You only need to unscrew the aluminium plate to the left side of the electrical connection module and install the signal modules (ready fitted with fixing tie rods) and retighten the end plate to the left. There is a small button under the access panel of the PAL-EIP that has to be depressed during power up to discover initial assembly or when modules have been added or removed. See PAL Configuration Software help topic PAL004 for further details.

INPUT / OUTPUT MODULES							
PAL-S01	***PAL-S02***	***PAL-S03***	***PAL-S04***	***PAL-S05***	***PAL-S06***	***PAL-S07***	***PAL-S08***
							
8 M8 digital inputs	8 M8 digital outputs	6 M8 digital outputs + electrical supply	4 M8 analog inputs	4 M8 analog outputs	16 digital terminal block inputs	16 digital terminal block outputs	4 M8 analog inputs for temperature measurement

3 *Compressed Air Connection Modules*

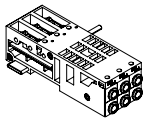
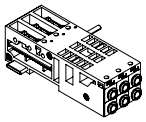
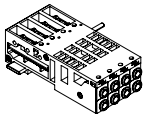
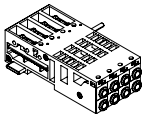
The PAL-P12 compressed air connection module is the primary interface for the compressed air supply and PAL system solenoid valves. It features a 1/2” push-to-connect main supply and 5/32”(4mm) pilot supply. Used in the default configuration, pilot pressure of 3 to 8 bar (43 to 116 psi) is supplied to port X, allowing the main supply to be in the range of vacuum to 10 bar (145 psi). If the total system is operated in the range of 3.5 to 8 bar (51 to 116 psi), the PAL-P12 can be easily converted to require only the single main supply connection for complete operation. See chapter 5 for details on converting the PAL-P12.

When additional air and/or power is needed that exceeds the capacity of the primary connections, an intermediate module can be installed anywhere in the valve bank. PAL-M12 provides an additional 1/2” push-to-connect inlet and silenced exhaust while the PAL-M12P also include a 4-pin M8 power connection.

PNEUMATIC AIR SUPPLY MODULE	PNEUMATIC INTERMEDIATE SUPPLY MODULE	
PAL-P12	***PAL-M12***	***PAL-M12P***
		
Compressed air supply - Silenced relief	Intermediate module - Silenced relief	Intermediate module - Silenced relief w/power

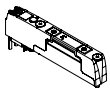
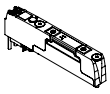
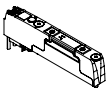
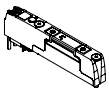
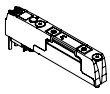
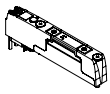
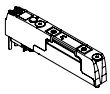
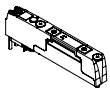
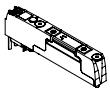
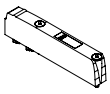
4 *Modular Valve Bases*

PAL modular valve bases are available with 3 or 4 positions. A version is available with an electrical connection for a single control of each position, suitable for 5/2 single solenoid valves or 3/2 high flow valves (physically impossible to install other valves). Another version comes with two electrical connections for each position and is suitable for all types of valves. The electronics in the base controls the signal coming from both the multi-pole connector and the fieldbus, so the base is the same, regardless of the control system of the island. The air delivery ports (ports 2 and 4) are made up of cartridge-type push-in fittings. The cartridge can be replaced, for example when the tube diameter needs to be changed, by pulling out the clip placed under the base.

MODULAR VALVE BASES			
PAL-B3314	***PAL-B3614***	***PAL-B4414***	***PAL-4814***
			
3-solenoids, 3-stations, 6-tubing outlets	6-solenoids, 3-stations, 6-tubing outlets	4-solenoids, 4-stations, 8-tubing outlets	8-solenoids, 4-stations, 8-tubing outlets

5 *Solenoid Valves*

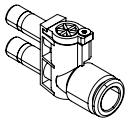
Solenoid valves in the PAL system are designed to ensure high flow while using only one small size valve (14 mm wide), without the need of installing a larger size one, to the benefit of component standardization. Versions are available with all the main air supply diagrams - from 3/2 to 5/3. The valves are secured to the base with two sturdy M4 captive screws. They come with all the accessories that facilitate their use: manual control, LED light, plate with air supply diagram and technical data and white ID tags.

SOLENOID VALVES									
PAL-V2-32C*	***PAL-V2-32A****	***PAL-V2-32C32A****	***PAL-V1-52***	***PAL-V2-52****	***PAL-V2-53C****	***PAL-V1-32C***	***PAL-V1-32A***	***PAL-V1-SR*****	***PAL-V0-PLUG***
									
2 valves 3/2 NC (valid as 5/3 OC)	2 valves 3/2 NO (valid as 5/3 PC)	3/2 NC + 3/2 NO	1 valve 5/2 spring return	1 valve 5/2 2 solenoids	5/3 center closed 2 solenoids	3/2 NC high flow	3/2 NO high flow	Shut-off valve	Blanking plug

** Requires a base with 2 solenoid connections per station.*
*** Requires bank main inlet port to be plugged.*

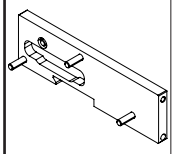
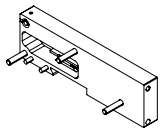
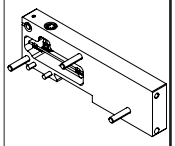
6 *Y-fitting*

The Y-fitting is a reinforced technopolymer pneumatic fitting used to accomplish various air flow combinations between one or two solenoid valves. See Chapter Five - Pneumatic Modules for further explanation.

Y-FITTING
PAL-Y38

Y-fitting

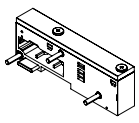
7 *End Plates*

The closed end-plate is the last element on the right end of each PAL system. A version for banks with multi-pole connector is available. One for banks with fieldbus, containing a small electronic board; one for connection to other additional PAL banks (only for systems with fieldbus). The end plate houses the system for mechanically mounting the base to external supports i.e. DIN rail.

END-PLATES		
PAL-C4	***PAL-C2***	***PAL-C3***
		
Closed end-plate for banks with multi-pole connector	Closed end-plate for banks with fieldbus	Closed end-plate for electrical connection of banks with fieldbus to additional banks

Closed End Spacer module (not shown in diagram)

To use the PAL system bank without pneumatics this module is needed. Only one module per bank is required.

SPACER FOR I/O BANK ONLY
PAL-SPC

Module for electric version only - Electrical I/O only

Assembly

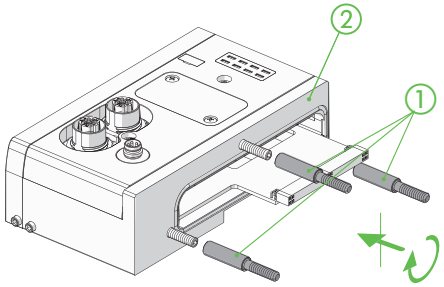
Required Tools

When assembling the Pneumatic Automation Link (PAL) system we recommend using the following tools:

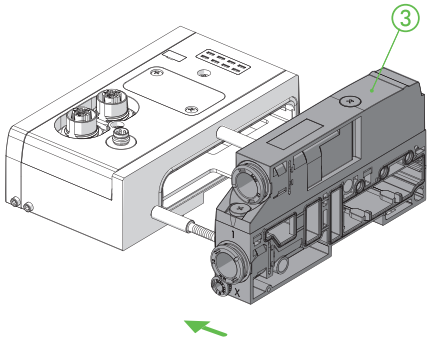
- *M4 open end wrench*
- *PH1 screwdriver*
- *4mm hex wrench*
- *3mm hex wrench*
- *2mm hex wrench*
- *3mm slotted screwdriver*

Assembling the Bank

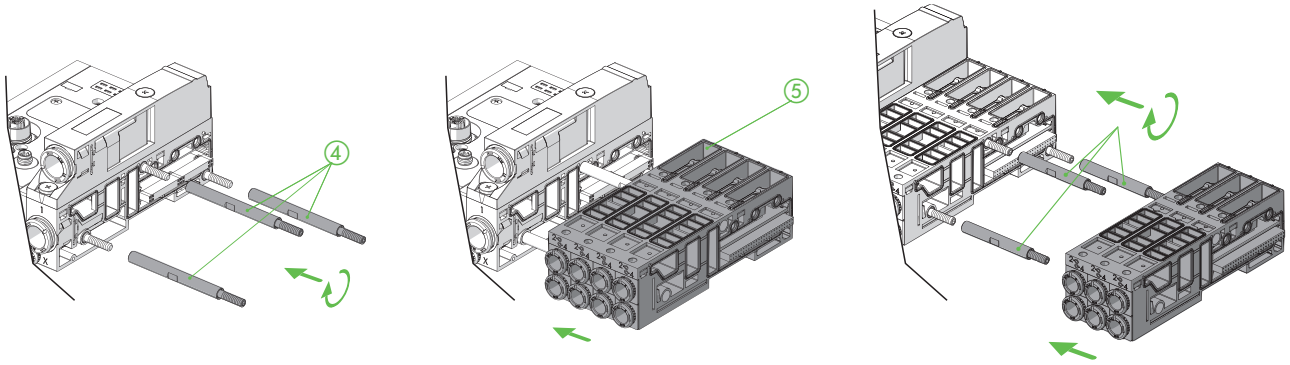
Hand tighten the three tie rods (1) of the compressed air supply input/output module for connection to the bus coupler (2).



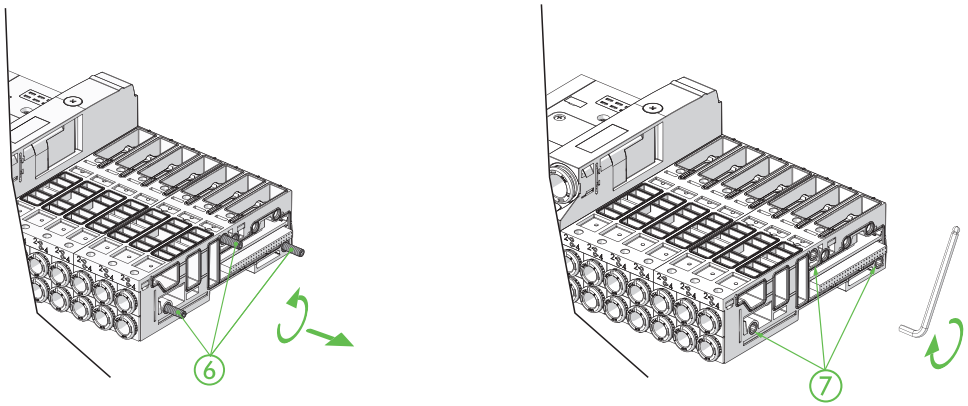
While aligning the tie rods, carefully mate the compressed air module (3) onto the electrical module. Make sure the electronic board fits into the slots provided. **DO NOT FORCE!**



Hand tighten the three tie rods (4) and mate the base (5). Make sure the electronic board is fitted properly. Should there be any binding, gently move the board to facilitate its insertion or gently push the end plate board downwards. Repeat the operation for all the bases.

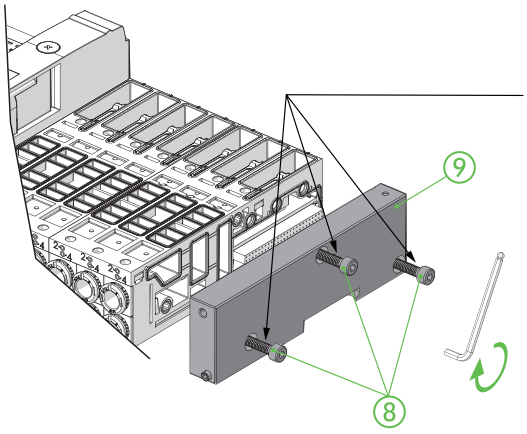


Unscrew the three M4 set screws on the end base (6).
Tighten the three tie rods (7) using a 4mm hex wrench at a torque of 2Nm [18 lb-in].

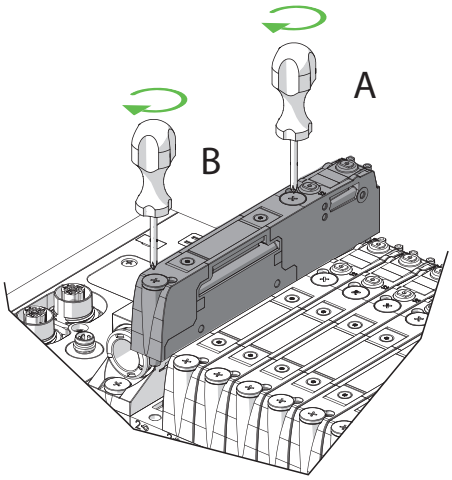


NOTE: For the optimal alignment of the boards, it is advisable to install the bases WITHOUT the valves assembled.

Place the bank on a flat surface, insert the closed end plate (9) and tighten the three screws (8) using 3mm hex wrench at a torque of 2Nm [18 lb-in]. In the versions with electronic board (PAL-C2 & C3), make sure the boards are properly aligned. **DO NOT FORCE.**

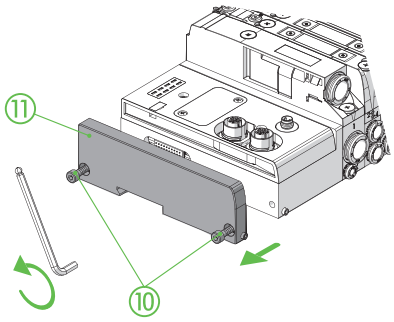


After checking that the seals are positioned properly, install the valves and tighten the Phillips screws with a PH1 driver at a torque of 1.1 - 1.3 Nm [9.7 - 11.5 lb-in]. **First tighten screw A and then screw B.**

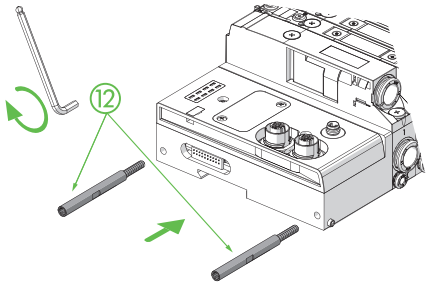


Assembling the I/O Modules

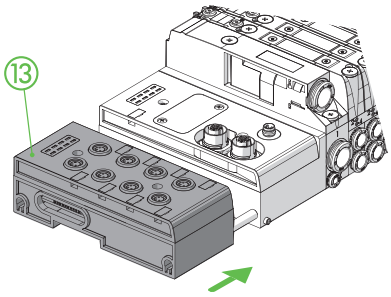
Unscrew the two M4 SHCS (10) on the bus coupler end plate (11) and remove.



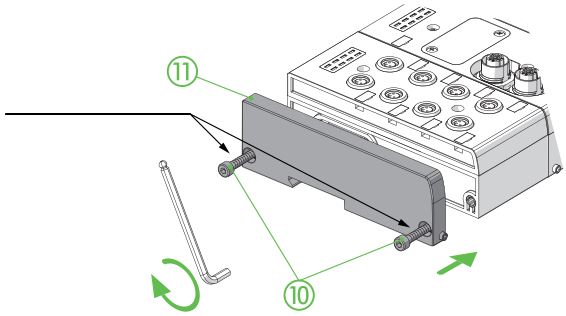
Hand tighten the two tie rods (12) of any I/O module.



Insert the I/O module (13), making sure the electronic board is aligned properly. **DO NOT FORCE.** Repeat the operation for all the I/O modules.

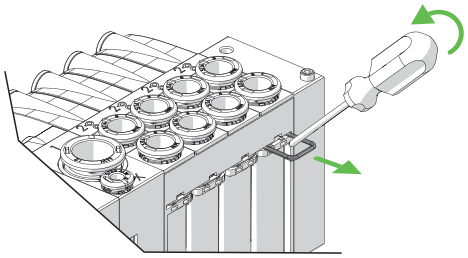


Carefully refit the plate (11), making sure the electronic board is aligned properly. **DO NOT FORCE.** Using a 3mm hex wrench tighten the two M4 SHCS (10) at a toque of 2Nm [18 lb-in].

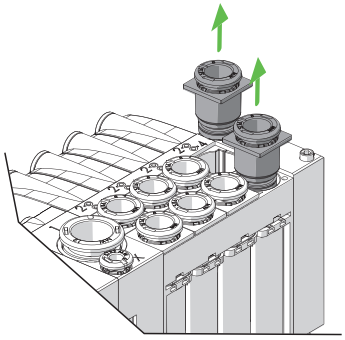


Replacing the fittings

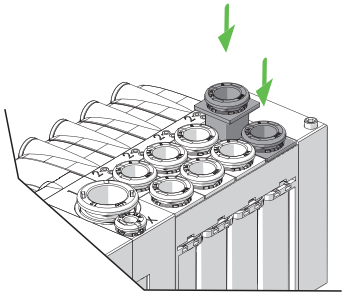
Use a 3mm slotted scewdriver to remove the clips.



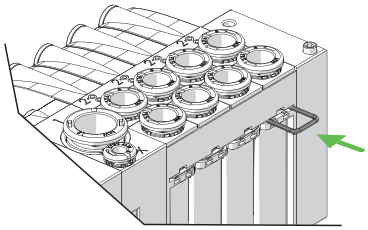
Remove the push-to-connect cartridges.



Insert the new cartridges until they are fully seated into the base.

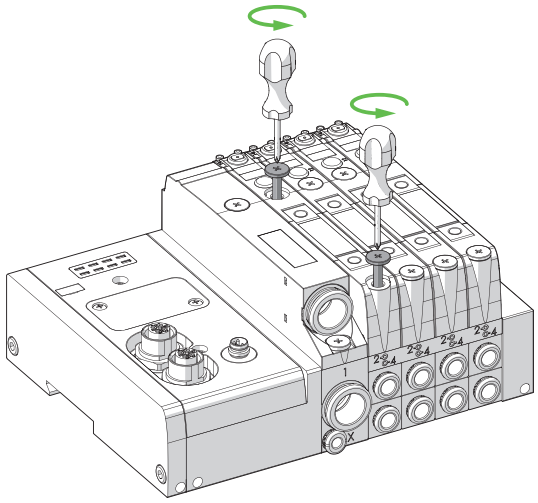


Reinsert the clip completely.

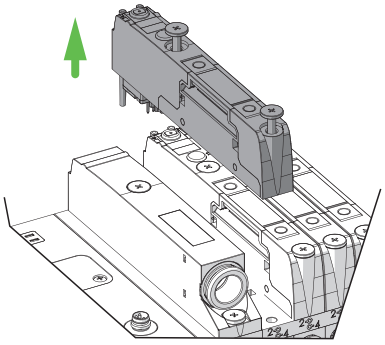


Replacing the Valves

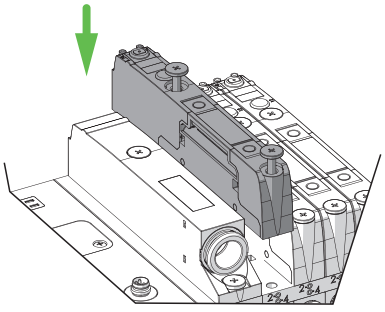
Unscrew the two Phillips head screws using a PH1 driver.



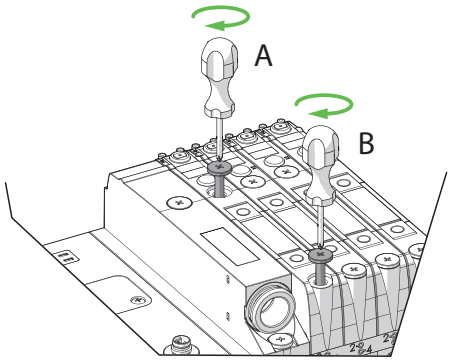
Gently lift the valve, perpendicular to the base, in order to remove the valve.



Check that the seals are positioned properly and lower to insert the new valve.

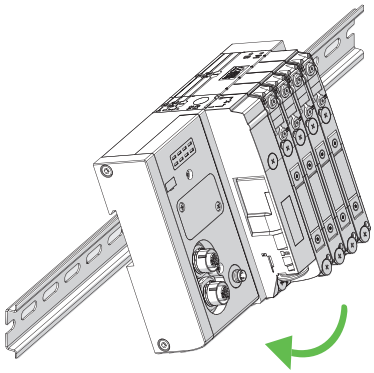


Tighten the two Phillips head screws using a PH1 driver at a torque of 1.1 - 1.3 Nm [9.7 - 11.5 lb-in].
First tighten screw A and then screw B.

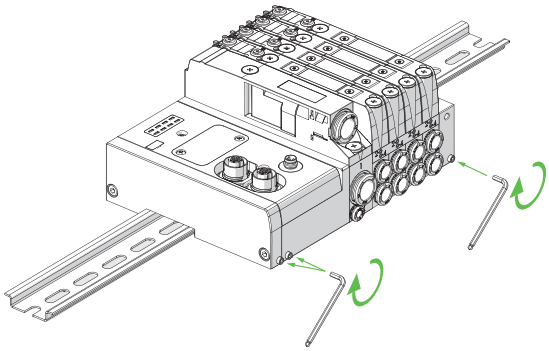


Mounting the Bank to DIN Rail

Mount the bank to the designated side of the DIN rail dovetail first.



Using a 2mm hex wrench tighten the set screws at a torque of 0.5 Nm [4.4 lb-in].



Electrical Connections

Power Wiring

EtherNet/IP Modules

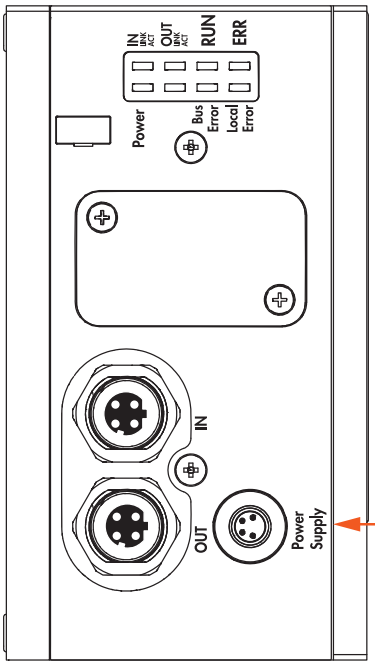
An M8 4-pin female connector is used for the power supply. Pin 1 (brown wire) carries power for the main bus of the system. Pin 2 (white wire) is used to power any auxiliary solenoid valves connected to the system. The auxiliary power supply of the valves is separate from the fieldbus, which means that the valves can be powered off while the bus line remains live.

Input voltage range is 12VDC -10% to 24VDC +30% (minimum 10.8, maximum 31.2 VDC)

Choose an appropriate cable to maintain IP65 rating. See AutomationDirect.com for a large selection of M8 IP65 rated cables.

WARNING: Power off the system before plugging or unplugging the connector (risk of functional damage).
Use fully assembled valve units only.
Use an appropriate power supply for incoming power that complies with IEC 742/EN60742/VDE0551 with at least 4kV insulation resistance (PELV).

WARNING: Supply voltage greater than 32VDC will permanently damage the PAL system.



Power Supply (M8 male connector)

Connection for bus power supply and auxiliary valve power supply

1 = +24V bus (Brown)
2 = +24V valve (White)
3 = GND (Blue)
4 = GND (Black)

NOTE: The module must be grounded using the end plate connection marked with the Symbol PE ⏚.

WARNING: Improper grounding may cause damage to the bus coupler. Proper grounding is necessary to maintain IP65 rating. Unused M12 connections must be covered with a protective cap to maintain IP65 rating.

Electrical Connection Modules

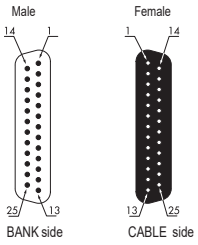
Choose the appropriate Electrical Connection Module power cable for wiring. AutomationDirect part numbers PAL-ACC04, PAL-ACC05 and PAL-ACC06 are for use with Electrical Connection Module PAL-E25. Part numbers PAL-ACC07, PAL-ACC08 and PAL-ACC09 are for use with Electrical Connection Module PAL-E44.

Input voltage range is 12VDC -10% to 24VDC +30% (minimum 10.8, maximum 31.2 VDC)

WARNING: Power off the system before plugging or unplugging the connector (risk of functional damage).
Use fully assembled valve units only.
Use an appropriate power supply for incoming power that complies with IEC 742/EN60742/VDE0551 with at least 4kV insulation resistance (PELV).

WARNING: Supply voltage greater than 32VDC will permanently damage the PAL system.

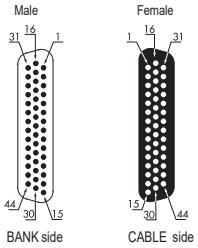
D-SUB 25-PIN CONNECTOR



PIN	Color of the corresponding wire (DIN 47100)	Function
1	White	1
2	Brown	2
3	Green	3
4	Yellow	4
5	Grey	5
6	Pink	6
7	Blue	7
8	Red	8
9	Black	9
10	Violet	10
11	Grey + Pink ring	11
12	Red + Blue ring	12
13	White + Green ring	13

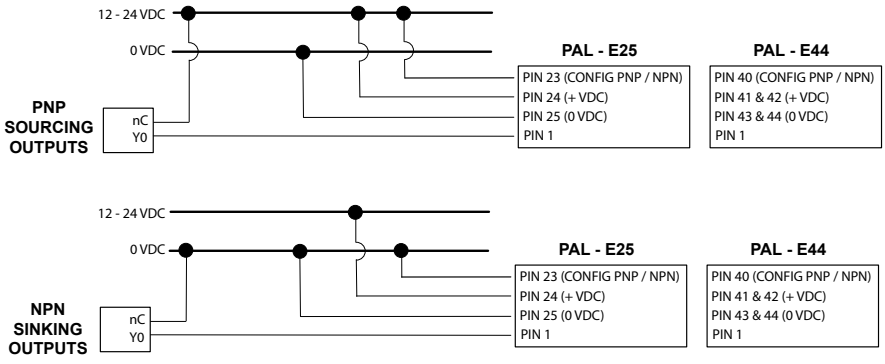
PIN	Color of the corresponding wire (DIN 47100)	Function
14	Brown + Green ring	14
15	White + Yellow ring	15
16	Yellow + Brown ring	16
17	White + Grey ring	17
18	Grey + Brown ring	18
19	White + Pink ring	19
20	Pink + Brown ring	20
21	White + Blue ring	21
22	Brown + Blue ring	Fault reporting
23	White + Red ring	* Config. PNP/NPN
24	Brown + Red ring	+VDC
25	White + Black ring	0VDC

D-SUB 44-PIN CONNECTOR



PIN	Color of the corresponding wire (DIN 47100)	Function
1	White	1
2	Brown	2
3	Green	3
4	Yellow	4
5	Grey	5
6	Pink	6
7	Blue	7
8	Red	8
9	Black	9
10	Violet	10
11	Grey + Pink ring	11
12	Red + Blue ring	12
13	White + Green ring	13
14	Brown + Green ring	14
15	White + Yellow ring	15
16	Yellow + Brown ring	16
17	White + Grey ring	17
18	Grey + Brown ring	18
19	White + Pink ring	19
20	Pink + Brown ring	20
21	White + Blue ring	21
22	Brown + Blue ring	22

PIN	Color of the corresponding wire (DIN 47100)	Function
23	White + Red ring	23
24	Brown + Red ring	24
25	White + Black ring	25
26	Brown + Black ring	26
27	Grey + Green ring	27
28	Yellow + Grey ring	28
29	Pink + Green ring	29
30	Yellow + Pink ring	30
31	Green + Blue ring	31
32	Yellow + Blue ring	32
33	Green + Red ring	33
34	Yellow + Red ring	34
35	Green + Black ring	35
36	Yellow + Black ring	36
37	Grey + Blue ring	37
38	Pink + Blue ring	38
39	Grey + Red ring	Fault reporting
40	Pink + Red ring	* Config. PNP/NPN
41	Grey + Black ring	+VDC
42	Pink + Black ring	+VDC
43	Blue + Black ring	0VDC
44	Red + Black ring	0VDC



NOTE: The module must be grounded using the end plate connection marked with the Symbol PE ⏚.

WARNING: Improper grounding may cause damage to the bus coupler. Proper grounding is necessary to maintain IP65 rating.

PAL-EIP Connections

The network connectors on the PAL-EIP are M12 female D-coded for Ethernet. Pre-wired Ethernet Cat5e cables with M12 male D-coded connector or field-wireable connectors such as AutomationDirect part numbers 7000-14581-0000000 or 7000-14521-0000000 are recommended for connecting the PAL system to the network.

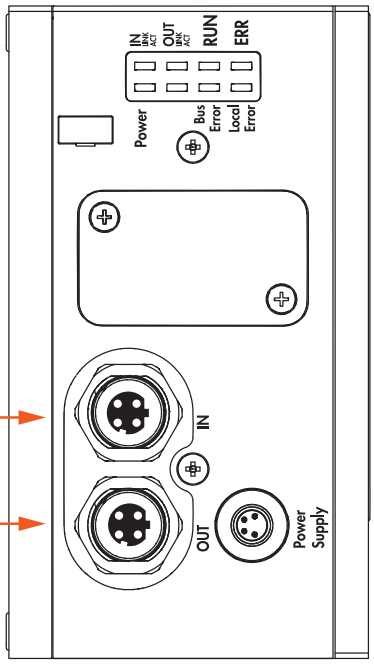
EtherNet/IP Network Connections

IN (M12 Female Connector, D encoding)

1 = TD+
2 = RD+
3 = TD-
4 = RD-
Metal ring nut - Shield

OUT (M12 Female Connector, D encoding)

1 = TD+
2 = RD+
3 = TD-
4 = RD-
Metal ring nut - Shield



WARNING: Improper grounding may cause damage to the bus coupler. Proper grounding is necessary to maintain IP65 rating. Unused M12 connections must be covered with a protective cap to maintain IP65 rating.

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