Outputs

Output ports usually have A in their name, e.g. PA, QA, RA, SA, TA.
Except that ports in the multi-IO card can be programmed as outputs or inputs.
All values output on a port can be read back. For example
HEX 55 PA OUT
PA IN X. result is 0055

Inputs

Output ports usually have B in their name, e.g. PB, QB, RB, SB, TB.
Except that ports in the multi-IO card can be programmed as outputs or inputs and that card also has ports ending in C. For example:
PB IN X. result is usually 00FF. However the robot uses the PB port for calibration so you may see a different value.

Standard Outputs and Inputs

	User outputs - 15w D		User inputs - 9w D
1	PA 7	1	PB 6
2	PA 6	2	PB 5
3	PA 5	3	Ovolts
4	PA 4	4	PB 3
5	PA 3	5	+12V
6	PA 2	6	PB 7
7	PA 1 (elec grip)	7	0 volts
8	PA 0 (gripper)	8	PB 4
9	0 volts	9	+12 volts
10	0 volts		
11	+12v		
12	+12v		
13	+12v		
14	+12v		
15	+12v		

PA Outputs

The PA port is the primary output port
All the outputs are open collector Darlingtons with the zero volts being the same ground as the controller. You can connect a load e.g. a solenoid or a relay between the output pin and +12v, for example a relay to be operated by PA 1 would connect between pin 7 and pin 11.

The gripper is usually connected to port PA bit 0.
Type GRIP to close the gripper, UNGRIP to open.
You can also enter
PA 0 ON to close and PA 0 OFF to open.
PA 0 is defined already as GRIPPER so you can enter
GRIPPER ON and GRIPPER OFF
Note: the electric gripper uses PA 0 and PA 1 so ON and OFF can not be used with the electric gripper.

The same philosophy applies to the other output bits, for example suppose you have a pump connected to PA 2. You could enter
PA 2 ON and PA 2 OFF
Or you could define
: PUMP PA 2 **;**
then PUMP ON and PUMP OFF
You can incorporate outputs in a definition that also has robot motion, for example let's assume PA 5 means "warning, robot in motion". You could have connected that output to an illuminated legend with that wording.

For example

```
: WARNING PA 5 ;
: INITIALIZE
START
WARNING ON
CALIBRATE
HOME
WARNING OFF
;
```

Type INITIALIZE to observe that.

PB inputs

The PB port is the primary input port
Bits 0-4 are used by the calibration sensors of the robot, leaving bits 5,6,7 for the user, although some other inputs may be shared.
Each input has a pullup to +5v. When you read the inputs they should all be '1' unless a robot sensor is sensing.
It is most easily monitored with a command
PP
This continually displays the input in binary e.g.
11111110
From right to left is ascending value (as in decimal) so bit 0 is furthest right and bit 7 is furthest left. Bits 0,1,2,3,4 are used by the robot for calibration and the 3 furthest left are for the user. Hence the proper way to show this display is
111xxxxx
To change an input from 1 to 0 simply 'short' it to 0 with a relay or the open collector output of a proximity detector etc. For example connect pin 6 (bit 7) to pin 7 (0v) and you will see
011xxxxx

Words that use these inputs are IN, WAIT and BIT?
BIT? Takes the specified bit and leaves a true or false. A true can be any value but false is 0.
Example use of WAIT

```
: GREEN-BUTTON PB 5 ;
: INITIALIZE
START
GREEN-BUTTON 0 WAIT
CALIBRATE
HOME
;
```

Example use of BIT? (with two PLACEs)

```
: TASK
PB 6 BIT? IF
  JIG1
ELSE
  JIG2
THEN
;
```

Sharing PB inputs between user and robot sensors – R17 ONLY.

As you can see from the controller manual section 12 inputs PB 3 and PB 4 are available on the user 9w D connector but these are used by the robot for calibration of axes 4 and 5 (the hand).

	Robot inputs - 25w D		User inputs - 9w D
1	Sensor 1 (PB 0)	1	PB 6
2	Sensor 2 (PB 1)	2	PB 5
3	Sensor 3 (PB 2)	3	Ovolts
4	Sensor 4 (PB 3)	4	PB 3
5	Sensor 5 (PB 4)	5	+12V
6		6	PB 7
7		7	0 volts
8		8	PB 4
9		9	+12 volts
21	Sensor 6 (PB 5)		

When an axis calibrates the input goes low and then high, and remains high except when an axis goes past a sensor in normal motion. Therefore if you use an input PB 3 or 4 on the 9wD you must ensure:

1. That your inputs on the 9w D are high (open) before the robot can calibrate
2. That when you are polling PB 3 or 4 that the hand is not in such a position that PB 3 or 4 are made low by chance position against its sensors.

Don't forget you can check the state of the PB inputs with
PP
(press escape to exit PP)

You would be advised to insert the following code in your text file. This redefines CALIBRATE so as to check the shared inputs first:

```
: CALIBRATE
PB 3 BIT? 0=
PB 4 BIT? 0=
OR IF
   ." Shared input prevents calibration "
ELSE
   CALIBRATE
THEN
;
```

16-bit I/O expansion card

This card has 8 bits of opto-isolated and Darlington buffered outputs and 8 bits of opto-isolated inputs.
There is a jumper on the PC card. With the jumper fitted the ports are SA and SB and with the jumper removed the ports are TA and TB.
If you are not sure which one you have here is a quick check:
HEX 55 SA OUT
SA IN X. result 0055
If the result is 00FF then try TA

The outputs are in 2 separate groups of 4 each with 1A Darlington drivers which pull down to the common ground for each group. The positive supplies must also be brought to the connectors.

The inputs are on a 25 way socket which connects to a 16 way 2 row HE14 connector J4 on the card.

OUTPUTS (SA/TA)

25w D skt	Function
1	output 7
2	output 6
3	output 5
4	output 4
5	output 3
6	output 2
7	output 1
8	output 0
14	positive supply for outputs 4,5,6,7
15	common ground for outputs 4,5,6,7
16	common ground for outputs 4,5,6,7
17	common ground for outputs 4,5,6,7
18	positive supply for outputs 0,1,2,3
19	common ground for outputs 0,1,2,3
20	common ground for outputs 0,1,2,3
21	common ground for outputs 0,1,2,3

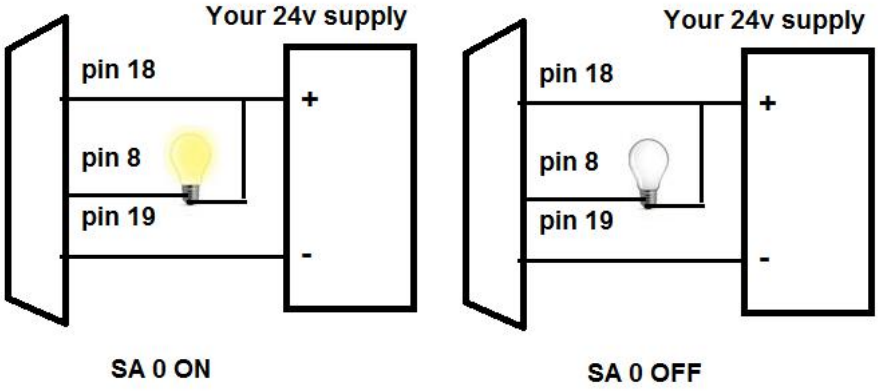
INPUTS (SB/TB)

25w D plug	Function
1	input 7 neg
2	input 6 neg
3	input 5 neg
4	input 4 neg
5	input 3 neg
6	input 2 neg
7	input 1 neg
8	input 0 neg
14	input 7 pos
15	input 6 pos
16	input 5 pos
17	input 4 pos
18	input 3 pos
19	input 2 pos
20	input 1 pos
21	input 0 pos

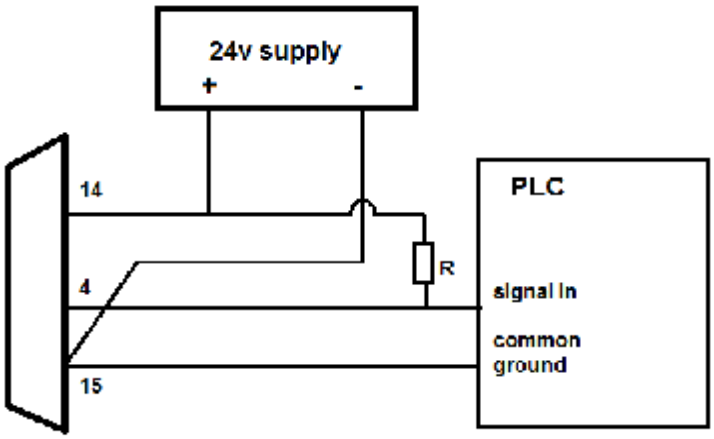
SA/TA Outputs
All the outputs are open collector Darlingtons with their ground returns isolated from the controller. You need a separate external 12 or 24v DC supply. There are two sets of 4 outputs each with its own 0v and +v connections. Therefore you can use two separate supplies if you wish or connect one supply to both sets. Connect the + terminal of your supply to pins 14,18 and the – terminal of your supply to pins 15 (and/or16,17) and 19 (and/or 20,21).

You can connect a load e.g. a solenoid or a relay between the output pin and your +v.

Example: 24v lamp to be operated by SA 0 would connect between pin 8 and 18 (24v).



Example: connection to other logic device or PLC via SA 4.



Depending on the instrument you might need a pullup resistor R, e.g. 4K7

PA 4 ON – sends a 0 to the PLC
PA 4 OFF – sends a 1 to the PLC

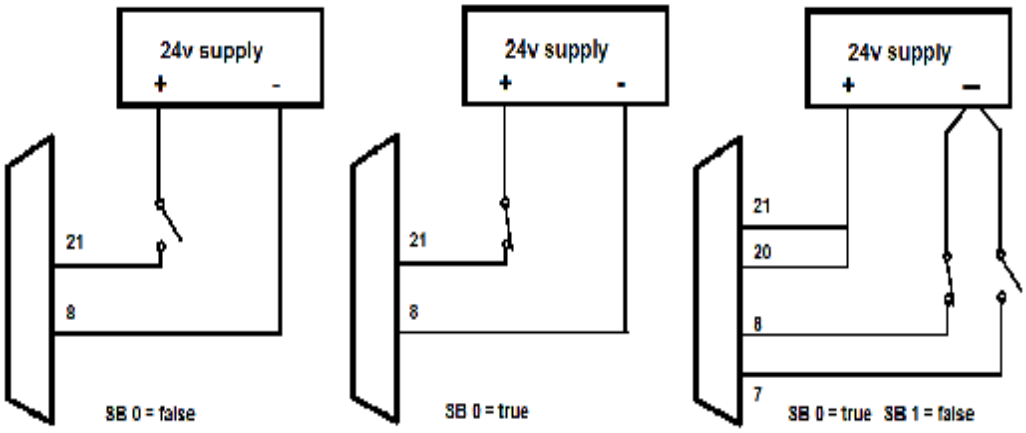
SB/TB inputs
The inputs are likewise isolated and require an external supply. You connect your – terminal to one of the negative pins and your load between your + terminal and an output pin. In other words to make an input on SB bit 0 you apply a voltage to pins 8 and 21, pin 8 being the negative and 21 being positive.

The input is most easily monitored with a command similar to PP but PP only shows PB. Instead use
SB WATCH
This continually displays the input in binary e.g.
11111111
From right to left is ascending value so bit 0 is furthest right and bit 7 is furthest left.

To change an input from 1 to 0 apply a voltage 12-24v between the two pins for that input. For example connect a 24v supply, negative to pin 8, positive to pin 21 and you should see
11111110

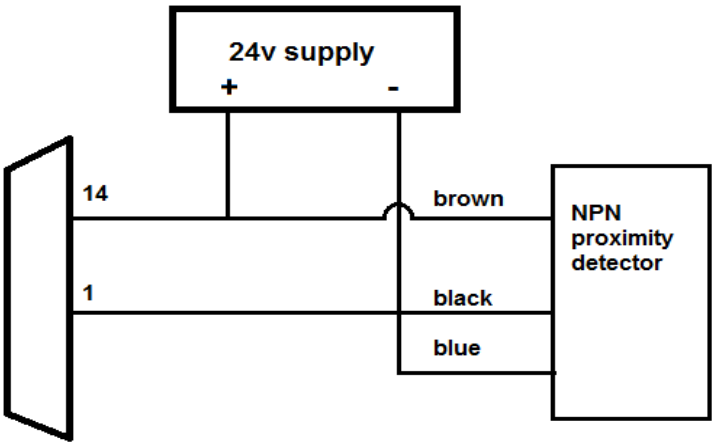
All the inputs are independent opto-isolators so you can common up all the + pins if you wish or all the – pins, or use completely independent sources of voltage.

Example: simplest form of inputs – just switch 12 or 24 volts into the inputs. A voltage going into an input turns on the opto-isolator so is read as a 0.



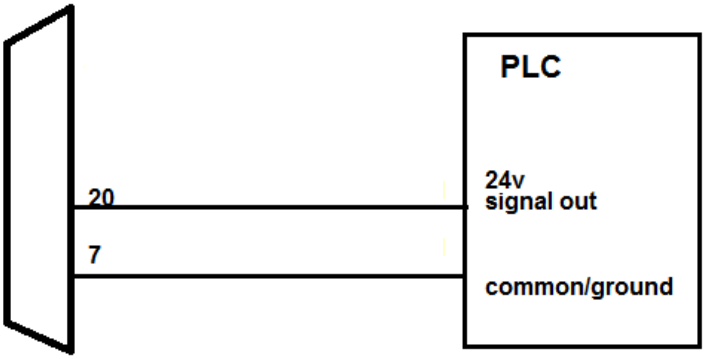
SB 0 0 WAIT
The system will wait for the switch to close
SB 0 1 WAIT
The system will wait for the switch to open.
In the third diagram SB WATCH would show
11111110
Operate both the switches and you would see
11111101
SB 1 BIT? Leaves true if the switch is closed e.g.
SB 1 BIT? . <enter> (remember the dot means print) 0 OK – means switch is open
SB 1 BIT? . <enter> 2 OK – non-zero means switch is closed

Example connect an NPN proximity detector



SB 7 0 WAIT – wait for detector to detect metal.

Example get a 24v signal from PLC to SB 1



Example decision made on the result of this input:

```
: TASK
SB 1 BIT? IF
   ACCEPT
ELSE
   REJECT
THEN
;
```