GE PAOC Analog Output Module

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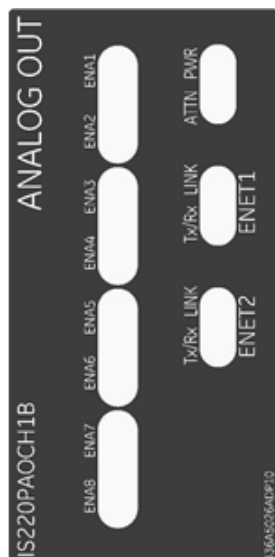
The Analog Output (PAOC) provides the electrical interface between one or two I/O Ethernet networks and an analog output terminal board. The PAOC contains a BPPx processor board and an acquisition board pair specific to the analog output function. The PAOC is capable of providing up to eight simplex 0-20 mA current loop outputs and includes an analog to digital converter for current feedback from each output.

Input to the PAOC is through dual RJ-45 Ethernet connectors and a three-pin power input. Output is through a DC-37 pin connector that connects directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.
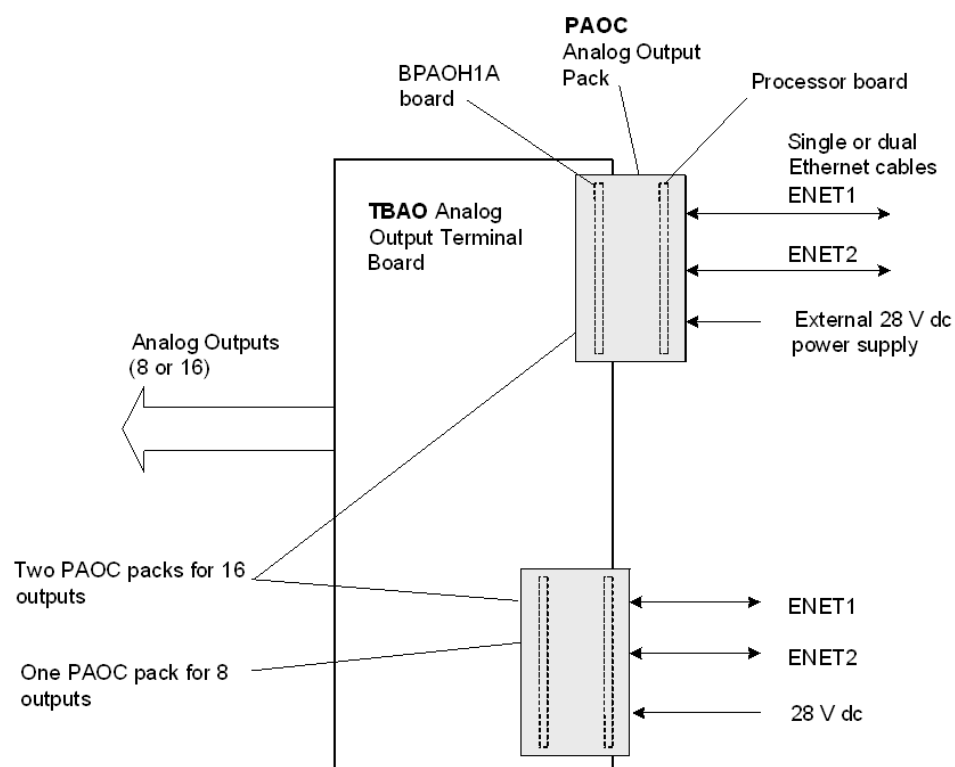
4.1.1   Compatibility

The PAOC I/O pack includes one of the following compatible BPPx processor boards:

- The PAOCH1A contains a BPPB processor board.
- The PAOCH1B contains a functionally compatible BPPC that is supported in the ControlST* software suite V04.06 and later.

The PAOC is only compatible with the analog output terminal boards TBAOH1C and STAOH1A/H2A as listed in the following table.

Terminal Board	Redundancy	# of I/O Packs	# of Analog Outputs
TBAOH1C	Simplex only	2	16
STAOH1A/H2A	Simplex only	1	8

4.1.2   Installation

➢ **To install the PAOC I/O pack**

1. Securely mount the desired terminal board.

2. Directly plug the PAOC I/O pack(s) into the terminal board connector(s).

3. Mechanically secure the I/O pack(s) using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 pin connector between the I/O pack and the terminal board. The adjustment should only be required once in the service life of the product.

Note   The PAOC mounts directly to the terminal board DC-37 pin connector(s). The PAOC is a simplex-only I/O pack.

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4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.

5. Apply power to the I/O pack by plugging in the connector on the side of the PAOC. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.

6. Use the ToolboxST* application to configure the I/O pack as necessary. From the Component Editor, press F1 for help.
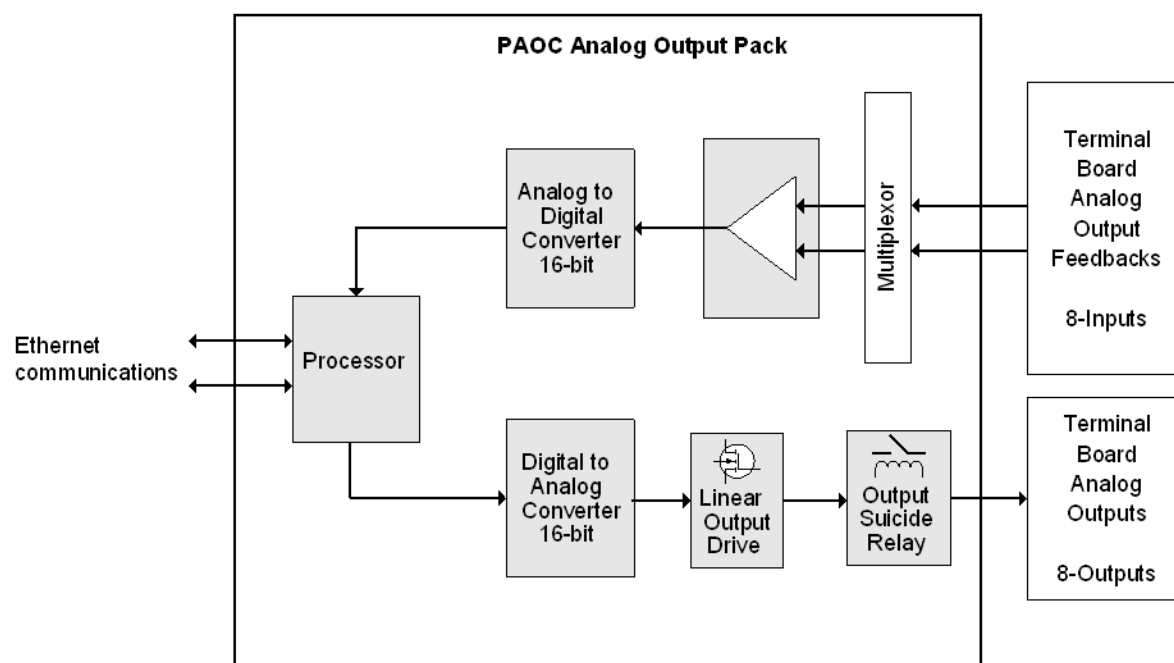
4.1.3   Operation

The following features are common to the distributed I/O modules:

- BPPx Processor
- Processor LEDs
- Power Management
- ID Line
- I/O Module Common Diagnostic Alarms

4.1.3.1   Analog Output Hardware

The PAOC includes eight simplex 0-20 mA analog outputs capable of 18 V compliance. A 16-bit digital-to-analog converter (DAC) commands and drives the output current with an external transistor amplifier. A board temperature sensor is included to warn the control if the pack's internal temperature becomes excessive.

Each analog output circuit also includes a normally open mechanical relay to enable or disable operation of the output. When the disable relay is de-activated, the output opens through the relay, open-circuiting that PAOC's analog output from the customer load that is connected to the terminal board. The mechanical relay's second normally-open contact is used as a status signal to indicate position of the relay with an LED.

PAOC Analog Output Pack
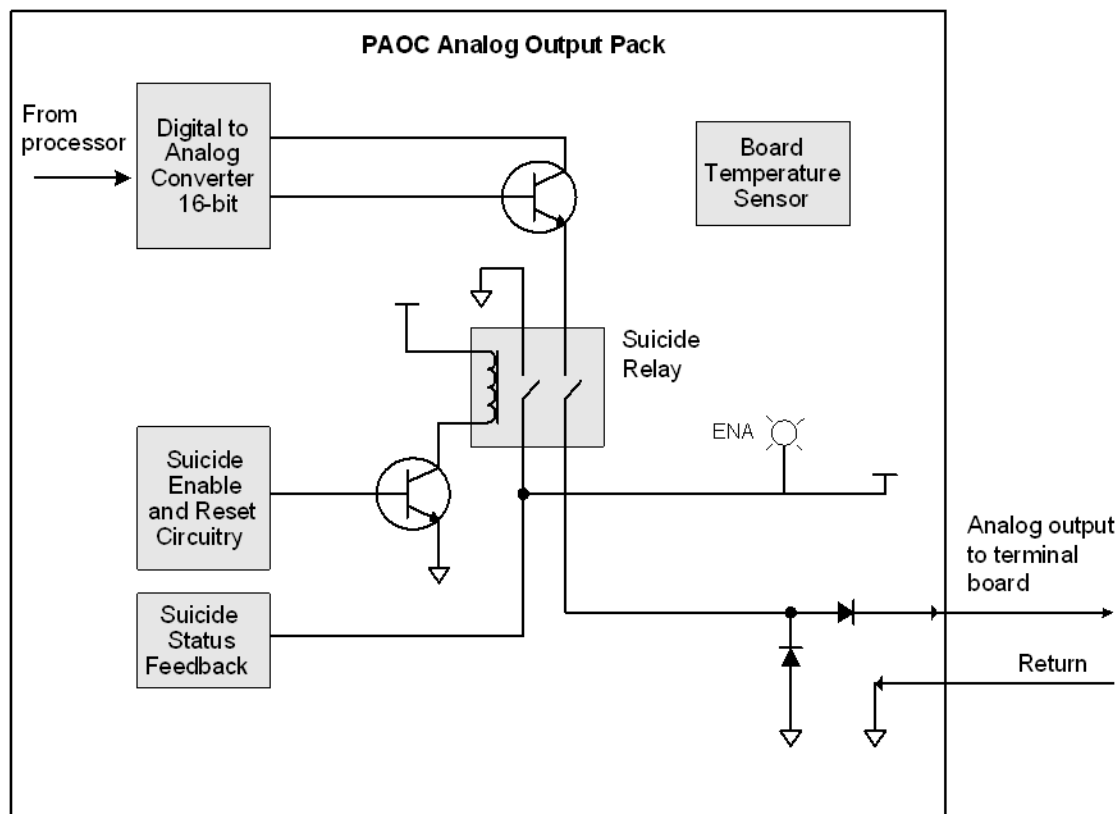
4.1.3.2 Current Feedback Hardware

The PAOC includes current feedback monitoring for each of the eight simplex 0-20 mA analog outputs. A 50 Ω resistor on the terminal board and a 16-bit analog to digital converter is used to sense and monitor the output current.
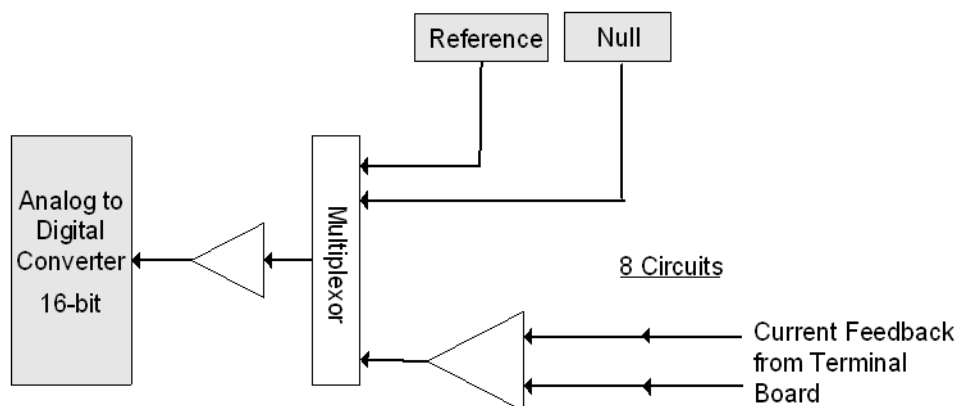
4.1.3.3   Thermal De-rating Guidelines

Note This is the I/O pack external temperature inside the cabinet, not cabinet external temperature.

With eight linear, high-compliance analog outputs, the PAOC I/O pack is subject to application limitations depending on its potential ambient environment. PAOCH1B packs are specified to have an operating temperature range of -40 to as high as 70ºC (-40 to 158 ºF), as measured external to the pack.

Depending on the application, and due to its dense triple board configuration, the PAOC's ambient environment maximum must be de-rated. The following is a list of output configurations and the appropriate de-rating that must be applied. The minimum output impedance is defined as the minimum series equivalent resistance of the customers load, as seen by the terminal board screws across the output range of 0-20 mA.

Maximum PAOCH1B I/O pack ambient temperature in degrees Celsius (degrees Fahrenheit) inside cabinet:

PAOCH1B Derating

Number of outputs	Minimum Output Resistance (per output, ohms)			
	0	250	500	1000
1	70º (158 ºF)	70º (158 ºF)	70º (158 ºF)	70º (158 ºF)
2	66º (151 ºF)	68º (154 ºF)	69º (156 ºF)	70º (158 ºF)
3	62º (144 ºF)	64º (147 ºF)	66º (151 ºF)	70º (158 ºF)
4	58º (136 ºF)	61º (142 ºF)	64º (147 ºF)	69º (156 ºF)
5	54º (129 ºF)	58º (136 ºF)	61º (142 ºF)	67º (153 ºF)
6	50º (122 ºF)	54º (129 ºF)	59º (138 ºF)	66º (151 ºF)
7	46º (115 ºF)	51º (124 ºF)	56º (133 ºF)	64º (147 ºF)
8	42º (108 ºF)	48º (118 ºF)	53º (127 ºF)	63º (145 ºF)

Maximum PAOCH1A I/O pack ambient temperature in degrees Celsius (degrees Fahrenheit) inside cabinet:

PAOCH1A Derating

Number of outputs	Minimum Output Resistance (per output, ohms)			
	0	250	500	1000
1	65º (149 ºF)	65º (149 ºF)	65º (149 ºF)	65º (149 ºF)
2	60º (140 ºF)	65º (149 ºF)	65º (149 ºF)	65º (149 ºF)
3	60º (140 ºF)	60º (140 ºF)	60º (140 ºF)	65º (149 ºF)
4	55º (131ºF)	60º (140 ºF)	60º (140 ºF)	65º (149 ºF)
5	55º (131 ºF)	55º (131 ºF)	60º (140 ºF)	60º (140 ºF)
6	50º (122 ºF)	55º (131 ºF)	55º (131 ºF)	60º (140 ºF)
7	50º (122 ºF)	50º (122 ºF)	55º (131 ºF)	60º (140 ºF)
8	45º (113 ºF)	50º (122 ºF)	55º (131 ºF)	55º (131 ºF)

4.1.3.4   Connectors

The I/O pack contains the following connectors:

- A DC-37 pin connector on the underside of the I/O pack connects directly to the Analog output terminal board. The connector contains the eight analog output signals, ID signal, and analog output feedback signals.
- An RJ-45 Ethernet connector named ENET1 on the side of the pack is the primary system interface.
- A second RJ-45 Ethernet connector named ENET2 on the side of the pack is the redundant or secondary system interface.
- A 3-pin power connector on the side of the I/O pack is for 28 V dc power for the I/O pack and terminal board.

4.1.4   Specifications

The following table provides information specific to the PAOC.

Item	Specification
Number of channels	Eight current output channels, single-ended (one side connected to common)
Analog outputs	0-20 mA, up to 900 Ω burden (18 V compliance) Response better than 50 rad/sec
Accuracy	±0.5% over -30 to 65ºC (-22 to 149 ºF) temperature and 0 to 900 Ω load impedance ±0.25% typical at 25ºC (77 ºF) and 500 Ω load
D/A converter resolution	16-bit resolution
Frame rate	100 Hz on all eight outputs
Size	8.26 cm high x 4.19 cm wide x 12.1 cm deep (3.25 in x 1.65 in x 4.78 in)
Technology	Surface mount
Ambient rating for enclosure design †	PAOCH1B is rated from -40 to as high as 70°C (-40 to 158°F). PAOCH1A is rated from -30 to as high as 65°C (-22 to 149°F). Follow the *Thermal De-rating Guidelines*.

Note   † For further details, refer to the *Mark VIe and Mark VIeS Control Systems Volume I: System Guide* (GEH-6721_Vol_ I), the chapter *Technical Regulations, Standards, and Environments*.

4.1.5   Diagnostics

The PAOC I/O pack performs the following self-diagnostic tests:

*   A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
*   Continuous monitoring of the internal power supplies for correct operation
*   A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
*   Analog output current is sensed on the terminal board using a small burden resistor. The I/O pack conditions this signal and compares it to the commanded current to confirm health of the digital to analog converter circuits.
*   The analog output suicide relay is continuously monitored for agreement between commanded state and feedback indication.

Details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RSTDIAG signal if they go healthy.

4.1.6   Configuration

4.1.6.1   Outputs

Parameter	Description	Choices
AnalogOutput01 - AnalogOutput08	First of eight analog outputs - Board Point	Point Edit (Output FLOAT)
Output_MA	Output current, mA selection	Unused, 0-20 mA
Low_MA	Output mA at low value	0 to 20 mA
Low_Value	Output in engineering units at low mA	-3.4082e + 038 to 3.4028e + 038
High_MA	Output mA at high value	0 to 20 mA
High_Value	Output value in engineering units at high mA	-3.4082e + 038 to 3.4028e + 038
D/A_ErrLimit	DA error threshold in percent	0 to 100 %
Suicide_Enab	Suicide enable for faulty output	Enable, disable
OutputState	The state of the outputs when offline. When the PAOC loses communication with the controller, this parameter determines how it drives the outputs: PwrDownMode - Open the output relay and drive outputs to zero current HoldLastVal - Hold the last value received from the controller Output_Value - Go to the configured output value set by the parameter Output_Value	PwrDownMode, HoldLastVal, Output_Value
Output_Value	Pre-determined value for the outputs	
DitherAmpl	Dither in % current of scaled output mA	0 to 10
Dither_Freq	Dither rate in Hertz	Unused, 12.5, 25.033.33, 50.0, 100.0

4.1.6.2   Variables

Variable	Description	Direction Type
L3DIAG_PAOC	I/O diagnostic indication	Input BIT
LINK_OK_PAOC	I/O link okay indication	Input BIT
ATTN_PAOC	I/O attention indication	Input BIT
IOPackTmpr	I/O pack temperature	Input FLOAT
OutSuicide1	Status of suicide relay for output 1	Input BIT
↓	↓	Input BIT
Out1MA	Measure output current in mA	Input FLOAT
↓	↓	Input FLOAT

4.2   PAOC Specific Alarms

The following alarms are specific to the PAOC I/O pack.

32-39

Description   Output [ ] feedback unhealthy

Possible Cause

- Analog output is being driven beyond the valid output range.
- Analog output feedback is out of range.
- Possible hardware failure in pack or terminal board

Solution

- Verify that the analog output command is within the range of 0-20mA.
- Verify that the analog output feedback matches the expected command.
- Verify analog output connections and field wiring.
- If all active analog output feedbacks are unhealthy with a valid command, a board failure is probable. Replace the I/O pack, replace the terminal board.

46-53

Description   Output [ ] feedback current varies from reference current

Possible Cause

- **D/A_ErrLimit** is not configured properly (set too low)
- **DitherAmpl** is not configured properly
- Field wiring problem
- Open-circuit on output or total loop resistance is too high
- Possible hardware failure in pack

Solution

- Check the **D/A_ErrLimit** settings.
- Check the **DitherAmpl** settings.
- Check the field wiring and device.
- Replace the I/O pack.

54-61

Description Output [ ] feedback current is excessive

Possible Cause The analog output current feedback is greater than 30mA. This will typically cause the output to suicide.

- Field wiring problem
- Possible hardware failure in pack

Solution

- Verify the analog output connections and field wiring.
- Replace the I/O pack.

62-69

Description Output [ ] Suicide relay non-functional

Possible Cause The analog output suicide relay command doesn't match the feedback.

- Possible relay failure on the acquisition board
- Possible hardware failure in pack

Solution Replace the I/O pack.

70-77

Description Output [ ] Suicide Active

Possible Cause

- Suicide is enabled (**Suicide_Enab**) for analog output.
- Review any additional diagnostics for possible causes.
- Analog output current feedback is too high (30 mA).
- Field wiring problem
- Command is beyond the range of the output.

Solution

- Verify that the commanded output is within output range.
- Verify the analog output connections and field wiring.

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Description   Output Driver Temperature [ ] deg °F exceeds the max limit ([ ] deg °F)

Possible Cause   The output driver temperature on the PAOC has exceeded the maximum temperature limit of:

- 194 °F (90°C) for PAOCH1B
- 185 °F (85°C) for PAOCH1A

Solution

- Review pack derating guidelines in help documentation.
- Environmental controls applied to the cabinet containing the I/O pack should be checked. Pack operation will continue correctly beyond these temperature limits but long-term operation at elevated temperatures may reduce equipment life.

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Description   Internal +15V Power Supply status Not OK

Possible Cause   The internal power supply that provides analog circuit control power is not operating correctly.

Solution

- Check the I/O pack ground quality through mounting bolts.
- Confirm that the 28 V input power is within 26.6 - 29.4 V range.
- Replace the I/O pack.

80

Description   Internal -15V Power Supply status Not OK

Possible Cause   The internal power supply that provides analog circuit control power is not operating correctly.

Solution

- Check the I/O pack ground quality through mounting bolts.
- Confirm that the 28 V input power is within 26.6 - 29.4 V range.
- Replace the I/O pack.