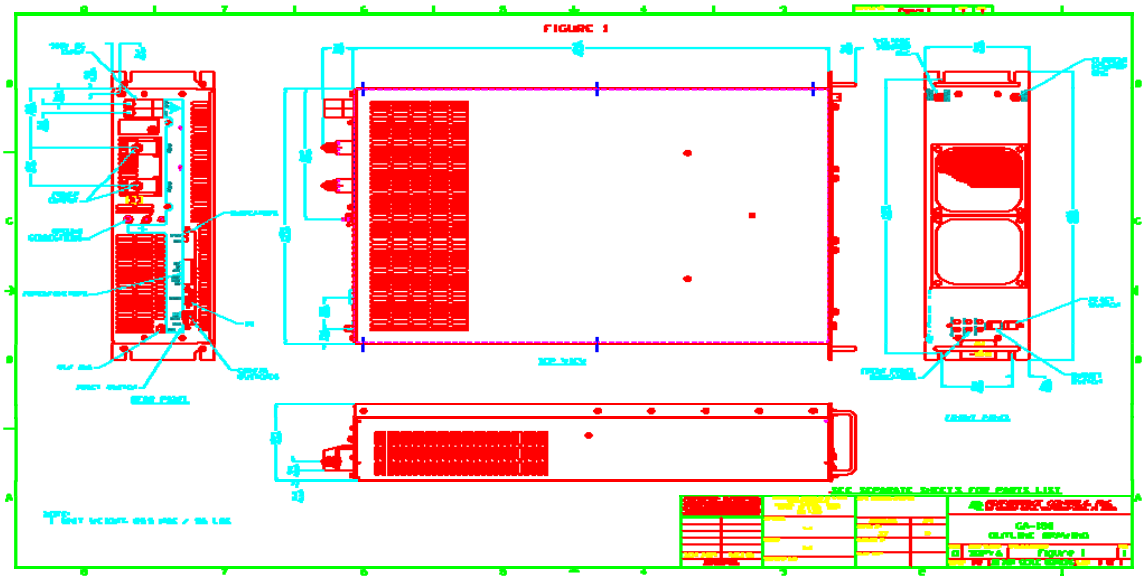
PERFORMANCE CONTROLS, INC.
151 Domorah Drive – Montgomeryville, PA 18936
Phone: +1 (215) 619-4920 www.pcipa.com



1. Product Overview

The GA-150 is a 150 VDC, 75 Arms, 150 Apk pulse width modulated power amplifier, intended for use in precision control systems. The amplifier operates from a single source of power and provides a precisely controlled, high fidelity output current. The amplifier is packaged to fit in a standard 19" rack width with a 5.25" height (3U) and 25.75" depth penetration into the rack. This Power Amplifier has been designed to operate in a controlled environment and to be enclosed within the overall system enclosure.

GA-150 Amplifier

Control Electronics

- Command processing
- Current loop & modulation control
- Synchronization
- Analog & digital I/O
- Controls & status indicators
- Pre-set and adjustable tuning

Power Electronics

- Power stage topology
- Power management
- Electrical isolation
- System capacitance
- Thermal management
- Instantaneous power device protection

Internal Power Supply

- Input powered directly from the high voltage DC Bus
- Provides all housekeeping power supplies
- Provides fan power +24V
- Provides isolation from high voltage DC bus

Power Interface

- EMI / RFI suppression
- Linear current sensing
- Optional full galvanic isolation to chassis
- Load and amplifier protection
  - Over Current vs Time
  - Over Peak Current
  - Bridge Over Current
  - Under / Over Voltage Protection
  - Over Temperature Protection

2. Specifications

2.1 Load Specifications

- Adaptable LR Range: 60 µH to 8H & 0.04 Ω to Open
- Maximum Load Capacitance 1.0 µF Output to GND
- Maximum Load Capacitance 1.0 µF Output to Output

2.2 Voltage & Current

- Input Voltage Range: 100 to 170 VDC
- Output Voltage: 150 Vpk-pk @ Vbus = 160 VDC
- Output Current (with Vbus = 330 VDC):
  - Continuous RMS (0 Amps DC): 75 ARMS
  - Continuous DC (0 Amps AC): 50 ADC
  - Absolute Peak: 150 Apk

2.3 Small Signal Bandwidth

The small signal bandwidth 7.0 kHz (500uH @ 150V)

2.4 Output Current Noise Spectrum

- 1 Hz to 1.0 kHz < 15 µA RMS / √Hz
- 2 Hz to 100 kHz < 10 mA RMS

2.5 THD

The Total Harmonic Distortion plus Noise < 0.2 % @ 200Hz (85% A RMS)

2.6 DC Stability

- Self-heating Drift (85A) < 60 mA / 10 min.
- Current Offset vs. Ambient Temperature < 4 mA / °C
- Scale Factor < 30 ppm / °C

2.7 Command Signal Processing

- Differential input impedance: 50 kΩ
- CMRR (circuit performance): > 70 dB @ 1.0 kHz
- Max input voltage - input to ground +/- 17V
- Max input voltage - differential input +/- 17V

2.8 Command Scaling (Gain Adjustment)

Scaling adjustment range: 0 to >20 A/V

2.9 Output Offset (Offset Adjustment)

Output offset adjustment range: +/- 0.3 A

2.10 Peak Current Limiter (I limit Adjustment)

Peak current limit range: +/- 14 Apk to +/- 150 Apk

2.11 Current Loop: Compensation / Gain Adjustment

The current control compensation network is configurable via a DIP switch called “CONFIG”. One function of the CONFIG switch is to select one of eight possible compensation settings (Load Matching). Seven of the eight settings are pre-defined; factory set for specific load impedances and performance requirements based on user supplied data of coil inductance and resistance. The eighth position allows fully adjustable control using three potentiometers (P, I & D). Using this position permits PCI or user personnel to fine tune the matching between the amplifier and the load for optimal performance. Measurement points are provided to allow measurement and control of field adjustments.

2.12 Pulse Width Modulation Technique

- Base switching frequency 51 kHz +/-7%
- Effective switching frequency 102 kHz +/-7%

2.13 Clock Synchronization

Provisions for clock synchronization are provided. A qualified clock synchronization signal is a TTL level square wave with the following characteristics:

- Frequency between: 95 kHz and 109 kHz
- Duty cycle between: 20% and 80%

2.14 Front Panel Switches & Indicators

A control panel interface is provided on the face of the GA-150 to indicate status and provides means for resetting faults and inhibiting the amplifier from operation.

Name	Switch / Indicator Type	Comment
INHIBIT	Switch w/ integral LED (push-button toggle)	Holds amplifier in the disabled state. Yellow LED on the Inhibit switch is lit when the amplifier is in the INHIBIT state.
RESET	Switch (momentary)	Resets fault conditions. Momentary push will toggle the bussed RESET signal.
POWER	Green LED	The green LED is lit when normal voltage is applied to the amplifier.
STATUS	Bi-color LED	Illuminates GREEN when faults are not present AND the amplifier is enabled. Illuminates YELLOW when faults are present. No illumination - OFF if no faults are present and amplifier is disabled.
THERM	Yellow LED	Illuminates when heat sinks, filter inductors, or filter resistors, are over temperature.
DESAT	Yellow LED	Illuminates when an internal fault is detected.
PEAK	Yellow LED	Illuminates when an Over-Peak current fault occurs.
RMS	Yellow LED	Illuminates when an Over-Average current fault occurs.

2.15 Rear Panel Pots & Indicators

The following tables outline various potentiometers, indicators, and jumpers, associated with amplifier control and system configuration and to be located on the rear panel:

Miscellaneous Switches, Pots, & Indicators		
Name	**Type**	**Comment**
Reset Switch	Switch: Momentary	Resets fault conditions.
SCALE	Potentiometer	Used to adjust current gain scaling.
Offset	Potentiometer	Used to adjust current loop offset.
I Lim	Potentiometer	Used to adjust peak current clamp level.
PROP (Proportional)	Potentiometer	Used for tuning adjustment of Proportional gain.
INT (Integral)	Potentiometer	Used for tuning adjustment of Integral gain.
DERIV (Derivative)	Potentiometer	Used for tuning adjustment of Derivative Feed-Forward gain.

2.16 Signal Connector Definition

Signal connector style and location is defined in the below table:

Connector Name	Connector Type	Location	Comment
P1	Male, D-type, 15 pin	Rear panel	Analog & Digital I/O Signals
DC BUS	2 - Wire Terminal	Rear panel	High Voltage DC Input
AMP OUT	2 - M8 Studs	Rear panel	Output Current
GND	M4 & M6 Studs	Rear panel	Functional Earth Ground
CLK	BNC	Rear panel	Clock Output - Optional Clock Input
I-MON	BNC	Front panel	Output Current Monitor
V-MON	BNC	Front panel	Output Voltage Monitor
TUN	Test Point	Rear panel	Tuning Monitor
P	Test Point	Rear panel	Potentiometer Measurement Point
I	Test Point	Rear panel	Potentiometer Measurement Point
D	Test Point	Rear panel	Potentiometer Measurement Point
A GND	Test Point	Rear panel	Reference Measurement Point

2.17 Analog & Digital I/O Interface Signals

Analog and digital input/output (I/O) signals are provided to control and to monitor the status of the GA-150.

Signal Description	Pin No.	Signal Type	Comment
User Ref. (GND)	1	Ground Reference	Common with Control Ground
Current Command (-)	2	Analog Differential Input	Input: Analog Command
NC	3	NC	No Connection - Reserved
Voltage Monitor	4	Analog Output	Output: Voltage Monitor
Isolated Enable (+)	5	Digital Differential Input	Input: 5V on pin 5 referenced to pin 6 enables
Isolated Enable (-)	6	Digital Differential Input	Input: Reference for pin 5
External Enable	7	Digital Input	Ground pin to enable.
User Ref. (GND)	8	Ground Reference	Common with Analog Ground
Current Command (+)	9	Analog Differential Input	Input: Analog Command
NC	10	NC	No Connection - Reserved
Fault Reset	11	Digital I/O CMOS	Input: Ground to reset internal faults
Enable Bus	12	Digital I/O CMOS	Input: 5V on pin 12 referenced to pin 1 enables Output: Driven to +5 V when enabled
Current Monitor	13	Analog	Output: Current monitor
Status	14	Digital Output CMOS	Output: High logic level = no faults
102 kHz Sync	15	Digital I/O CMOS	Output: Clock output Input: Optional sync input

2.18 Rear Panel Switches

The following tables outline various switches, potentiometers, indicators, and jumpers, associated with amplifier control and system configuration and to be located on the rear panel:

Compensation Configuration Switch (CONFIG)		
Name	**Type**	**Comment**
TUNE 0	DIP switch 1.1	Bit 1: Used to select current control compensation configuration.
TUNE 1	DIP switch 1.2	Bit 2: Used to select current control compensation configuration.
TUNE 2	DIP switch 1.3	Bit 3: Used to select current control compensation configuration.
EXT SYNC	DIP switch 1.4	Selects asynchronous or synchronous clocking. ON for free run, OFF for frequency locked.

2.19 Fault Protection

The following table outlines the various faults, trigger thresholds, resulting action to the fault, and fault reset requirements:

Fault Name	Trigger Threshold	Action
Over Peak Current	Ipk > 220 A	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow. • Indicator "PEAK" asserted.
Over Current vs. Time	Irms = 200A > 0.3S Irms = 150A > 1.4S Irms = 120A > 5 Idc > 100A > 10S	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow. • Indicator "RMS" asserted.
Bridge Over Current	Desaturation (DESAT) Detected	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow. • Indicator "Mod Fault" asserted.
Over Temperature	$T_{Heat\ Sink}$ > 85 °C $T_{Filter\ Inductor}$ > 100 °C $T_{Filter\ Resistor}$ > 130 °C	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow. • Indicator "THERM" asserted.
Over Voltage	Vbus > 385 V	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow.
Under Voltage	Vbus < 85 V	• Power stage disabled (all transistors OFF). • Indicator "Normal" illuminates yellow.

3. Physical Specifications

The amplifier package consists of a 19" rack-mount style enclosure.

Front Panel Outer Dimensions:

- Width 19"
- Height 5.1"

Enclosure Outer Dimensions:

- Width 17"
- Depth 24"
- Height 5.0"

Mounting Holes:

- Horizontal 0.43" in from side edges
- Vertical 0.85" in from top & bottom edges

Weight:

- <52 lbs.

3.1 Environmental

- Operating temperature: +20 to +35 °C ambient
- Storage temperature: -30 to +70 °C ambient
- Humidity (RH): ≤ 95% non-condensing
- Non-Operating Vibration: 1g
- Shock (packaged): 10g

3.2 Thermal Management & Fan Power Supply Requirements

The power semiconductors are mounted to an air cooled heat sink. Three DC muffin fans are provided for forced air cooling. The fans are powered from an internally generated power supply.

3.3 Electrical Isolation

The GA-150 has the negative DC bus terminal tied to the amplifier chassis (Earth ground). This Amplifier provided superior RF containment and have been tested by ITS and listed by ETL to be compliant to UL 60601.

4. Quality Assurance

4.1 Requirements

- Reliability: The GA-150 calculated MTBF (Mean Time Between Failure) of 30,000 hrs has been verified by HALT (Highly Accelerated Life Testing) and service experiences. Supporting documentation is available upon request.
- Life Time: The GA-150 is designed to have a usable life of ten years.
- Infant Mortality: Testing and product burn-in are applied with the intent to ensure infant mortality failures are eliminated prior to delivery. The PCI goal is zero out of box defects and zero failures.

4.2 Quality Program

- The GA-150 was designed and is manufactured in accordance with an ISO 9000 compliant and audited quality program.

4.3 Burn-in

The GA-150 Top Assembly is subjected to a rigorous burn-in process. The burn-in process consists of the following actions:

- Cycle between full rated output power and zero output power for a minimum duration of 24 hours. The burn-in wave form exercises the full peak and RMS rating of the GA-150 at the maximum voltage rating + 5% nominal voltage rating.
- Mild mechanical vibration of the entire assembly.
- Thermal cycling.

5. Environmental and Standards Requirements

5.1 Standards

The GA-150 is designed to comply with the UL Medical Requirement of UL 60601-1, CAN/CSA C22.2 No 601.1 – M90 (R1997) and IEC 60601 -1. The GA-150 is CE marked in accordance with Low Voltage Directive (73/23/EEC), the EMC Directive (89/336/EEC) and the CE Marking Directive (93/68/EEC).

5.2 Shipping Container

The GA-150 is packaged for international shipment by ocean or air freight. The shipping container over all size is 32 1/2" x 25 1/2" x 10" and the shipping weight is 63 lbs.