Digital Quad Rod Driver, +/-250V

Operations Manual
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WARNING

TO REDUCE THE RISK OF FIRE OR ELECTRICAL SHOCK DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOSITURE.

WARNING

Only qualified electrical workers should operate and install this system.
Avoid spilling liquids onto/into the unit.
Do not expose to excessive heat or moisture.
Do not open – there are no user serviceable parts inside.
Do not block the chassis vent slots or the fan inlet.
Do not operate in an explosive environment.

Introduction

The Digital Quad Rod Driver (DQRD) is a crucial component of a digital quad system, designed to receive signals from Astraea's low-voltage waveform generator and amplify them to drive quadrupole rods. It employs power MOSFETs to generate two distinct outputs, enabling the control of the two rod pairs of the quadrupole.

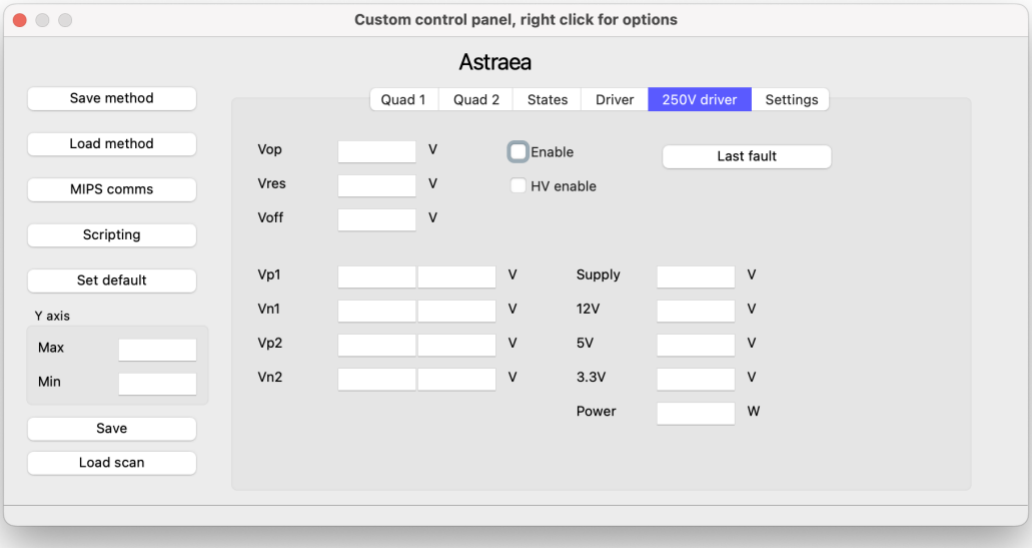
The Digital Quad Rod Driver offers user-definable output peak voltage ranges from 20 to 250 volts. The system comprises four independent voltage regulators, each responsible for supplying positive and negative voltages to the respective output channels. This enables users to precisely set the positive and negative voltage levels for each output.

A microcontroller, responsible for controlling system operating parameters and monitoring critical system parameters, incorporates various safety features that automatically shut down the system in case of any detected failures. Additionally, a USB interface facilitates control of the driver and setting the desired operating parameters.

Appendix B provides a list of user commands that can be used to control the system.

Operation

The USB interface and host commands, as outlined in Appendix B, can be used to control the Rod Driver. The MIPS host application, utilizing the Astraea control panel, will offer a user-friendly interface that seamlessly integrates with the Astraea low-voltage waveform generator. The Rod Driver interface is presented and described below.



HV enable

This checkbox enables the internal +/-250 volt supply, which powers the four voltage regulators that control the output voltages. Before using the Rod Driver, ensure that the HV enable is checked.

Enable

This checkbox enables the Rod Driver. When checked, the system sets the output voltages and generates signals on Output A and B. The front panel On LED will illuminate when the Rod Driver is enabled.

Vop

This control enables the user to specify the desired peak output voltage. When the system is enabled, this voltage determines the output voltages for each of the four regulators responsible for defining the positive and negative levels on outputs A and B. For instance, if Vop is set to 100, Vp1 is automatically set to 100, and Vn1 is automatically set to -100, indicating the output voltage for output A. Similarly, Vp2 is set to 100, and Vn2 is set to -100 for output B.

Vres

The Vres setting is applied to the rod pairs to generate a resolving DC level. If Vres is set to 10 volts, Vp1 and Vn1 are increased by 10 volts, while Vp2 and Vn2 are decreased by 10 volts.

Voff

The Voff setting applies a DC offset to both rod pairs. If Voff is set to 10, all four regulators are increased by 10 volts.

Vp1

This control enables you to set the positive voltage supplied to output A by the regulator. It also includes a second value representing the actual output voltage detected by monitoring circuitry in the Rod Driver.

Vn1

This control enables you to set the negative voltage supplied to output A by the regulator. It also includes a second value representing the actual output voltage detected by monitoring circuitry in the Rod Driver.

Vp2

This control enables you to set the positive voltage supplied to output B by the regulator. It also includes a second value representing the actual output voltage detected by monitoring circuitry in the Rod Driver.

Vn2

This control enables you to set the negative voltage supplied to output B by the regulator. It also includes a second value representing the actual output voltage detected by monitoring circuitry in the Rod Driver.

Supply

Monitors the output voltage of the 24VDC power supply.

12V

Monitors the actual detected voltage of the internal 12V power supply.

5V

Monitors the actual detected voltage of the internal 5V power supply.

3.3V

Monitors the actual detected voltage of the internal 3.3V power supply.

Power

Monitors the total power used by the Rod Driver, in watts.

Front panel controls

24VDC Power

Power is supplied through a 4-pin DIN power connector. Pins 1 and 2 provide +24VDC, while Pins 3 and 4 serve as the return. We have supplied a 120-watt 24-volt supply, specifically the CUI Inc SDI120-24-U-P51 or a compatible model. Please ensure that you use only the supplied power supply. It's important to note that the pin assignment for the DIN power connectors is not consistent across different models. Therefore, using a different model may cause damage to the driver.

Power

A green LED that indicates power is applied to the driver.

Input A

The SMA coax connector accepts a 0 to 5 V logic signal that gates the Output channel a. This input impedance is 50 ohms and is designed to be driven by the Astraea low voltage waveform generator.

Input B

The SMA coax connector accepts a 0 to 5 V logic signal that gates the Output channel B. This input impedance is 50 ohms and is designed to be driven by the Astraea low voltage waveform generator.

Aux RF

This is an optional input that accepts a 2Vpp analog signal, which can be used to modulate outputs A and B. To use this feature, internal jumpers must be removed. Please contact the factory before using this option.

Fault

The Red Fault LED illuminates when the system shuts down due to a detected fault condition. The FAULT command can be used to identify the fault and restart the system.

On

Orange LED: When the driver is enabled and generating output signals, the LED will illuminate.

USB

The USB micro connector offers a USB2 interface to the host control computer.

Rear panel controls

Output B

The BNC connector provides the rod driver signal for rod pair B. The power load on the Rod Driver is affected by the capacitance of the load. To minimize this impact, the coaxial connection from this connector to the quadrupole should be kept as short as possible. A high-impedance, low-capacitance cable is recommended. RG-62 coaxial cable, with a 93-ohm impedance, is an excellent candidate for this application.

Float

The Rod Driver's outputs (A and B) are isolated from ground and can be biased through the float input BNC connector. The float input's maximum range is +/-250 volts. If the system is ground-referenced, a BNC shorting cap should be installed to ground the float input. This input should have the shorting cap installed or a bias voltage applied.

Output A

The BNC connector provides the rod driver signal for rod pair A. The power load on the Rod Driver is affected by the capacitance of the load. To minimize this impact, the coaxial connection from this connector to the quadrupole should be kept as short as possible. A high-impedance, low-capacitance cable is recommended. RG-62 coaxial cable, with a 93-ohm impedance, is an excellent candidate for this application.

Ground

This lug is used to connect the Rod Driver chassis to the earth ground. It's crucial to make this the first connection and the last one when working with the Rod Driver.

Warrantee

GAA Custom Electronics, LLC warrantees the Digital Quad Rod Driver system to be free from defects in materials and workmanship and will repair or replace the unit for a period of one year. This warrantee assumes the system is operated in compliance with the procedures and recommendation outlines in this document. GAA Custom Electronics, LLC will also provide free phone support and firmware bug fixes for up to one year. The addition of new features is not covered in this warrantee.

Liability

The liability of GAA Custom Electronics, LLC hereunder or otherwise is solely and exclusively limited to replacement, repair or credit at the purchase price, as GAA Custom Electronics, LLC may elect, for any product which is returned by Buyer during the applicable warranty period, or services for which timely notice of defect has been given by Buyer, and which are found by GAA Custom Electronics, LLC to be subject to adjustment under this warranty. IN NO EVENT SHALL GAA Custom Electronics, LLC BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSS OF ANTICIPATED PROFIT OR OTHER ECONOMIC LOSS OR FOR ANY DAMAGES ARISING IN TORT WHETHER BY REASON OF STRICT LIABILITY, NEGLIGENCE OR OTHERWISE.

Appendix A, Specifications

Operating temperature range
- 0 to 50 degrees C

Operating Altitude range
- 2000 meters above sea level maximum

Operating Humidity range
- 30 to 70 percent, recommended

Size
- 4” High, 10” long, 8” deep

Weight
- 5.2 pounds

Cooling
- Internal cooling fan, do not block vents and fan inlet

Power
- 24VDC wall supply with 4 pin DIN connector
- 5Amp 120 watt

Inputs
- A and B
  - SMA
  - 0 to 500KHz
  - 0 to 5 volts
  - 50-ohm input impedance

Aux RF
SMA
0 to 2Vpp
10KHz to 500KHz
Float
BNC
0 to +/-250V bias added to the output signals on A and B
Outputs
A and B
BNC
0 to +/- 250V maximum
0 to 500KHz maximum frequency
Host interface
USB 2.0

Appendix B, Host Computer Interface

All commands are ASCII text.
All commands sent to Digital Quad Rod Driver are terminated with a carriage return (CR) or line feed (LF) character.
All messages sent from Digital Quad Rod Driver are terminated with a CR and LF.
After a command is received (after the CR or LF is received) Digital Quad Rod Driver will respond with an ASCII ACK (0x06) then a CR or an ASCII NAK (0x15) then a "?" character and a finally a CR. A NAK indicates the command or its arguments was not understood.
When a NAK is sent the "?" character is sent to inform users communicating with a terminal emulator that the command was not understood.

Many of the commands are described as a pair, a set value command starting with a S and a get value command starting with a G.

General Commands

GVER
Returns the current version string.
GERR
Returns an integer error code indicating the reason for the last NAK. This value is never cleared and always indicates the communications last error.
GNAME
Returns a string that contains the name of the Rod Driver system.
SNAME,*Name*
This command will set the Rod Driver system name. The *Name* value is a user defined string. Make sure you issue a Save command to save the changes to flash memory or this name will be lost when power is cycled.
RESET

This command will cause the Rod Driver computer to reboot.

GCMDS

This command will cause the Rod Driver to report a list of valid commands that it understands.

FAULT

This command will return the last detected fault.

BLOAD

This command starts the bootloader application on the microcontroller and places the system in a mode to accept new firmware.

Save and Restore Commands

SAVE

This command will save the Rod Driver parameters to the flash memory.

RESTORE

This command will read the current settings from the flash memory.

SAVEF

This command saves the Rod Driver parameters to a non-volitive flash memory chip external to the microcontroller. This memory is not erased when the microcontroller firmware is updated.

LOADF

This command will read saved Rod Driver parameters from the non-volitive flash memory chip external to the microcontroller. This loads the parameters saved with SAVEF.

SAVECAL

This command saves the Rod Driver calibration parameters to a non-volitive flash memory chip external to the microcontroller. This memory is not erased when the microcontroller firmware is updated.

LOADCAL

This command will read saved Rod Driver calibration parameters from the non-volitive flash memory chip external to the microcontroller. This loads the parameters saved with SAVECAL.

Operational Commands

GENA

SENA,TRUE or FALSE

This command will enable the Rod Driver and resulting in the generation of output signals if set to TRUE.

GHVENA

SHVENA,TRUE or FALSE

This command will enable the internal +/- 250V power supply used to provide power to the four internal supply regulators if set to TRUE.

GENATST

SENATST,TRUE or FALSE

This command enables readback testing on the four internal supply regulators. If TRUE, the system monitors the actual output voltages and compares them to the

desired values. If an error is detected, the system generates a fault and shuts down.

GVop

SVop,*value*

This command will set the requested output peak voltage, *value* is in volts.

GVres

SVres,*value*

This command will set the requested resolving DC, *value* is in volts.

GVoff

SVoff,*value*

This command will set the requested offset DC, *value* is in volts.

GVpa

SVpa,*value*

This command will set the requested voltage for output A positive level, *value* is in volts.

GVna

SVna,*value*

This command will set the requested voltage for output A negative level, *value* is in volts.

GVpb

SVpb,*value*

This command will set the requested voltage for output B positive level, *value* is in volts.

GVnb

SVnb,*value*

This command will set the requested voltage for output B negative level, *value* is in volts.

Limits Commands

GMAXI

SMAXI,*value*

This command will set the maximum allowed current from the 24V power supply; *value* is in amps. The default level is 5 amps.

GMAXP

SMAXP,*value*

This command will set the maximum allowed power from the 24V power supply; *value* is in watts. The default level is 100 watts.

GMAXV

SMAXV,*value*

This command will set the maximum allowed output peak voltage; *value* is in volts. The default level is 250 volts.

GMAXF

SMAXF,*value*

This command will set the maximum allowed operating frequency; *value* is in Hz. The default level is 600000 Hz.

Monitor Commands

G3P3V

This command returns the level of the 3.3 volt power supply, in volts.

G5V

This command returns the level of the 5 volt power supply, in volts.

G12V

This command returns the level of the 12 volt power supply, in volts.

GSV

This command returns the level of the input power supply, in volts.

GCUR

This command returns the measured input current, in amps.

GPWR

This command returns the measured input power, in watts.

GAVpa

This command returns output A positive voltage regulator's measured level, in volts.

GAVna

This command returns output A negative voltage regulator's measured level, in volts.

GAVpb

This command returns output B positive voltage regulator's measured level, in volts.

GAVnb

This command returns output B negative voltage regulator's measured level, in volts.

GFREQ

This command returns the measured drive frequency, in Hz.

Calibration Commands

The following calibration commands are used in the factory for initial system configuration and should not be used in the field.

CALPOLES,*pole*

This command is used to calibrate each of the four pole voltage regulators. This system should be enabled before executing this command. You will be prompted to enter the measured voltage by this procedure. The regulator to calibrate is selected by *pole*: Vpa, Vna, Vpb, Vnb.

CALSPLYS

This command is used to calibrate the internal voltage monitors, you will be prompted to enter measured voltages.

CALCUR

This command is used to calibrate the current sensor. The Rod Driver should be enabled with at least 100 kHz input signal on the A and B inputs. You will be prompted to enter the measured current in amps and different output voltage levels.

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