



MultiChannel RF Driver Users Manual

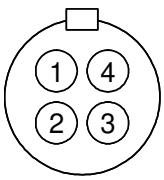
Overview:

The MultiChannel RF Driver is a 32 channel RF amplifier / signal generator and is intended for use with the Harris 32 channel AO modulator. The driver includes the following features:

- ☐ Selectable internal or external source
- ☐ Independent internal or external modulation
- ☐ USB and optional Ethernet control
- ☐ Channel / AO cell temperature monitoring
- ☐ RF power monitoring with programmable overpower limit
- ☐ Independent frequency, phase, amplitude, gain control
- ☐ Internal or external reference
- ☐ Alarm output



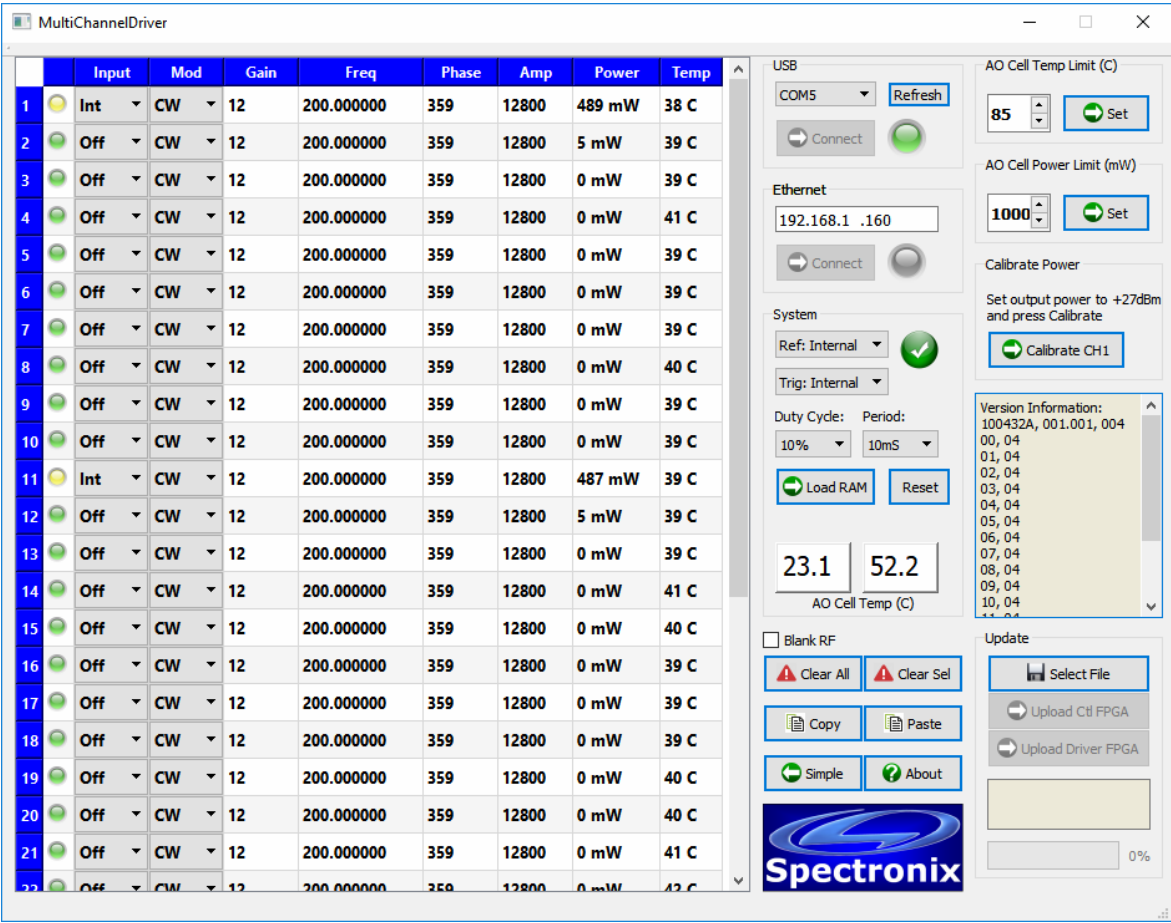
Connections and Indicators

Controller	Description
Chassis LED	System Status Green: Normal Red: Over temperature or system fault
Driver LED	Combined Driver Status Green: All channels normal Red: Over power fault on any channel
Fault Out	3.3V logic level, high indicates RF over power condition on any channel (RF outputs have been shut off).
Trigger In	3.3V logic level, Optional user supplied on/off modulation trigger. If external modulation source is selected, a high gates the RF power on.
Sync Out	3.3V logic level, Modulation output signal.
Ref In	3.3V logic level, Optional 10MHz frequency reference for the frequency synthesizers.
Ref Out	3.3V logic level, 10MHz frequency reference.
Optional Ethernet	Computer interface allowing control and monitoring.
Program button	Recessed programming button under Ethernet port. See the software programming guide for more information.
USB	Computer interface allowing control and monitoring.
Therm 	Thermistor connection to the AO cell. The recommended mating connector is Lemo, FGG.0B.304.CLAD52 and the recommended thermistor type is Omega ON-950-44005-30. Thermistor A should be connected to pins 1 and 2, and thermistor B should be connected to pins 3 and 4.
Driver	Description
LED	Channel Indicator: Green: RF off Yellow: RF on Red: Overpower fault
In	External RF input signal, +10dBm max.
Out	Amplified RF output signal.
A	Channel A external trigger input
C	Reserved for future use
B	Channel B external trigger input

Operation

The MultiChannel RF Driver is monitored and controlled using the supplied Windows application shown below. The user can use either USB or optional Ethernet connection. Upon launching the

application or pressing the “Refresh” button, the software will search for the amplifier and populate the USB dropdown list accordingly. Press either the USB or Ethernet connect button to connect to the amplifier. Upon connection, the channel table will be populated with a list of all connected channels and their associated settings and measurements. Note, only one interface (either USB or Ethernet) should be connected at the same time.



User Interface Descripton:

System	Description
USB area	The refresh button searches for connected devices and refreshes the port list. Select the desired port and press connect to use USB. The LED indicates the connection.
Ethernet area	Enter the desired IP address and press connect to use the Ethernet connection. The LED indicates the connection. See the software programming guide for information on changing the IP address.
Ref Dropdown	Selects between the internal and external 10MHz frequency reference.
Trig Dropdown	Selects between the internal and external modulation sources.
Duty Cycle	Sets the duty cycle of the internal trigger source to 10% or 50%.
Period	Sets the period of the internal trigger source between 312.5uS and 10mS.
Fault Indicator	Reflects the controller chassis front panel indicator.

System	Description
Load RAM (Rev 4 and below)	Allows the user to load a channel modulation table from a .csv file. See the modulation section below for a description of the file format.
Reset	Resets all RAM modulation tables to their starting sample.
Cell temperature	Reports the two temperature sensor values on the cell.
Blank RF	Check this box to blank all RF outputs.
Clear All	Clears all driver faults.
Clear Sel	Clears the selected driver fault.
Copy / Paste	To copy a setting of one channel to other channels, select the setting to be copied and press "Copy". Highlight the destination channel(s), this can be a single channel or a range of channels, and press "Paste".
Simple / Advanced button	Pressing advanced expands the window to reveal the advanced controls described below.
Advanced	Description
AO Cell Temp Limit	Allows the user to set the cell temperature that will cause a warning indication. This value is retained between power cycles.
AO Cell Power Limit	Allows the user to set the maximum RF output power (at each output). This value is retained between power cycles. Setting this value to zero will disable the protection feature.
Calibrate Button	Pressing the calibrate button calibrates the indicated RF output power sensor relative to +27dBm. This value is retained between power cycles.
Version Information box	Firmware and logic version information is displayed for the controller and each of the driver cards.
Update Area	Description
Select File	Allows the user to select an FPGA image file for either the controller or the driver module. The controller image should be named "100443.bin" and the driver image should be named "100444.bin".
Upload buttons	Depending on the file name either the controller FPGA or driver FPGA button will become active. When pressed, the selected image will be flashed to internal memory and automatically used to configure the FPGA on subsequent start-ups.
Channel Table	Description
Indicator	Reflects the front panel indicator of the corresponding channel.
Input	Selects the input source (off, external, or internal DDS)
Mod	Selects between CW, direct modulation based on the trigger, or RAM table modulation (Rev 4 and below).
Gain	Allows the user to adjust the gain of each channel from 0dB to 23dB in 1dB steps. These gain settings are factory adjusted for an overall gain of 32dB. These values are retained between power cycles.
Freq	Allows the user to adjust the internal DDS frequency of each channel. These values are retained between power cycles.

System	Description
Phase	Allows the user to adjust the internal DDS phase of each channel. Since the channels are not synchronized, phase settings are relative. These values are retained between power cycles.
Amp	Allows the user to adjust the DDS amplitude of each channel from 0 to 16383. These amplitude settings are factory adjusted so that the internal and external sources are closely matched in amplitude at the RF output. These values are retained between power cycles.
Power	Displays the RF output power in mW.
Temp	Reports the temperature of the RF power amplifier.

Protection Features:

Since the AO cell can be damaged with excessive RF drive levels, over power protection features have been implemented. A fast acting over power shutdown circuit is included on each channel to turn off the RF output in the event the RF power level exceeds the maximum power setting. Upon a fault condition the RF output is latched off and the alarm output goes to a logic high; a manual reset must be performed to clear the fault. The recommended over power setting is 800mW. In order for the over power protection circuit to function correctly, each power sensor must be accurately calibrated. The overpower protection circuit works at the card level; if either channel's power on a particular card exceeds the maximum threshold, both RF outputs are disabled.

Since the AO cell can also be damaged by excessive temperatures, it incorporates two temperature sensors which are monitored by the MultiChannel RF Driver. If the temperature of either sensor exceeds the maximum setting, the controller's front panel LED will turn red and the system fault icon will change to a red exclamation mark. An over temperature condition does not correct itself; it is up to the user to correct the condition before damage occurs.

Considerations when using the Internal DDS Source

When using the internal DDS source blanking, over power protection, and modulation functions operate differently than when using an external source. In each of these three cases, instead of disabling the RF output the source is switched to the external input, therefore it is recommended that no external input be connected when using the DDS source to achieve the desired operation.

Modulation

Each output can be on/off modulated using either the external trigger input or the programmable internal trigger source. When using external modulation, either the global trigger input on the controller can be used to modulate all outputs simultaneously or the A/B trigger inputs on the RF drivers can be used to modulate channels individually. In direct modulation mode, the RF output state of any channel is the logical OR of the global trigger and the A/B channel trigger.

On select models (Rev 4 and below), a RAM modulation table can be loaded into each channel, thus creating customizable RF waveforms. Each channel can store up to 16,384 on/off states which are stepped through synchronous to the rising edge of the selected trigger source. Once the end of the table is reached, the pattern starts from the first sample and repeats indefinitely. The Reset button can be used at any time to reset all RAM table pointers to the first sample thus synchronizing the channels.

RAM Modulation File Format (Rev 4 and below)

The RAM tables are loaded into the driver through the use of a .CSV. A single .CSV file can be used to load data for all channels or a subset of channels. All channels do not all need to contain the same

number of samples, each channel will repeat independently of the others once it reaches its last sample. Loading all 32 channels with the maximum number of samples takes approximately 10 seconds over the USB and 5 seconds over the Ethernet port. The RAM tables are retained until they are either overwritten or powered down.

Rules and notes for RAM table .CSV files:

1. Any line containing “#” is treated as a comment and ignored.
2. Each column contains modulation data for one channel; the file may contain any number of columns between 1 and 32.
3. The first non-comment row represents the channel numbers for the columns in decimal format between 1 and 32. Channel numbers may be in any order but must start with the first column; there cannot be any unused columns. Any channel number not between 1 and 32 will cause loading to abort and an error indicator.
4. Each data cell represents 8 data samples and must contain a hex coded number between “0” and “FF” (spaces and other characters are not allowed). Empty spaces will be ignored; invalid values will be ignored and will be indicated by a warning. Channels may contain different numbers of samples but this will result in a mismatch in their sample positions during modulation.
5. Spaces and other non-data characters are only allowed on comment lines.

An example .CSV file is described below. Note, spaces are added for illustrative purposes and should not be included.

```
# Sample RF Driver CSV File,,,
# illustrating data for 4 channels,,,
1, 32, 13, 14
80, AA, FF, 55
00, , , 55
00, 00, , 00
1, , 00, 00
```

Channels will be loaded with the following patterns:

- Channel 1: 10000000 00000000 00000000 00000001
- Channel 32: 10101010 00000000
- Channel 13: FFFFFFFF 00000000
- Channel 14: 01010101 01010101 00000000 00000000

Channel 1 is loaded with 4 bytes of data; a leading zero is added to the last data cell so it can be treated as a full byte. Since data cells 2 and 4 of channel 32 and data cells 2 and 3 of channel 13 do not contain hex characters, they are skipped resulting in only 16 samples.

After loading is complete, the RAM table counters for each of the 4 channels are reset and synchronized; samples are clocked out starting with the MSB of the first byte and ending with the LSB of the last byte. Each pattern will repeat once it reaches the end of its record; channels 32 and 13 will repeat at twice the rate of channels 1 and 14. Note, the newly loaded channels will not have any predictable time relationship to the other channels; the “Reset” button can be used to reset all RAM table counters to the first sample thus synchronizing all channels. Table counters continuously increment remaining synchronous regardless of changes in settings such as modulation, input, etc. Several example .csv files are provided in the installation directory.

Calibration

The MultiChannel RF Driver power sensors must be calibrated to ensure proper readings and correct operation of the over power protection circuitry. To calibrate a sensor, select the desired channel, adjust the RF output power to +27dBm, and press the calibrate button. This value will be stored in NV memory and retained across power cycles.

Instant On Version

In 2022 (Rev 5 and above) “Instant on” versions of the controller and driver CCAs (indicated by blue PCBs) were introduced. The new designs are compatible with existing cards with the following limitations:

- The instant on driver does not support RAM modulation.
- When an old style controller is used with instant on drivers, the chassis must have at least one old style driver card installed.

Revision and Compatibility Table

Date	Controller Firmware	Controller FPGA	Driver FPGA	Software	Description
11/8/2022	2.0	016	016		Instant on version
12/7/2017	1.002		005	1.2	Added RF blanking status from controller so that the GUI reads the actual blanking status upon startup. Added code so that GUI remembers the last IP address and restores it upon startup.
12/6/2017			004		Corrected RF blanking behavior with modulation turned on.
11/2/2017	1.001	004	004	1.1	Added individual A/B channel trigger inputs and programmable RAM table modulation capability.
6/9/2017	1.000	003	001	1.0	Increased cell temperature measurement to 1 decimal place, added the ability to change internal trigger timing, changed DDS AUX DAC from 10 to 20mA full scale.
2/9/2017	0.003	002	001	0.3	Initial release