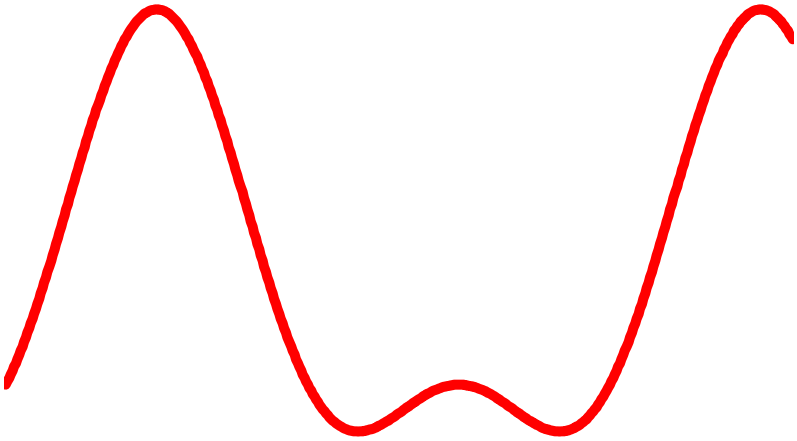
MIPS-FAIMS

Modular Intelligent Power Sources

Operations Manual
Rev 3.0, November 21, 2025



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

WARNING
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.

The FAIMS power supply is capable of developing over 5,000 volts of RF output signal; please use extreme caution when working with this system. Only qualified electrical workers are able to install and test this system. Please follow these recommendations:

1.) Never operate the system with the covers removed.
2.) Make sure all the electrical connections are complete between the FAIMS power supply and your FAIMS device.
3.) Make sure to cover all your connections to protect them from accidental contact.
4.) Place the FAIMS power supply in a position that will provide clearance for its intake fans and air exit openings.
5.) Do not operate this FAIMS power supply until you have read the operating instructions and tuning instructions.
6.) There are no user serviceable parts inside the FAIMS power supply so do not remove the covers.
7.) Only replace fuses with the specifications defined on the rear panel of the MIPS system.
8.) Never operate this system in a combustible gas environment.

Table of Contents

Introduction

The FAIMS power supply comprises two subsystems housed in separate enclosures. The MIPS controller, located in the first enclosure, manages the user interface and the power and signal sources required to generate and control the FAIMS bisinusoidal waveform. The second enclosure houses the FAIMS RF deck, which contains the RF tuned circuits responsible for generating the high voltage FAIMS signal. The RF deck connects to the MIPS controller via a 25-pin D cable and a 15-pin D cable. These are robust cables, provided with your system. Connection to the FAIMS device is facilitated by specialized connectors on the rear panel.

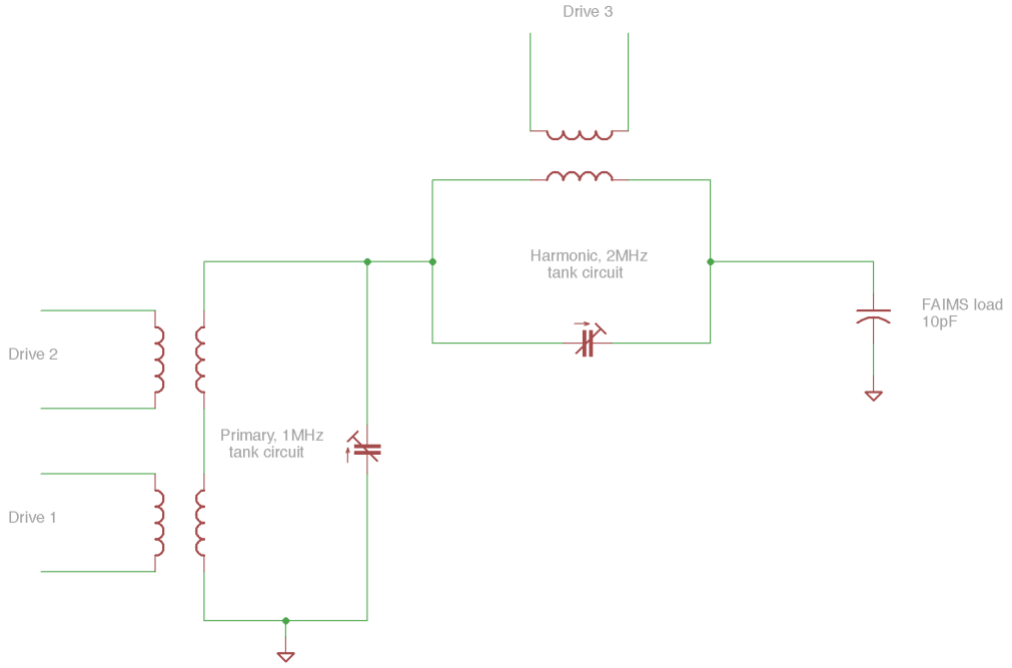


Figure 1, Simplified diagram of the FAIM dual resonate RF driver.

The FAIMS system generates the bisinusoidal waveform using a dual resonate circuit within the RF deck. Figure 1 illustrates a simplified circuit diagram of this dual resonate circuit. Two tank circuits are connected in series: one at the primary frequency (~1MHz) and the other at the harmonic frequency (~2MHz). The primary tank circuit is driven by two separate sets of drive electronics (Drive 1 and Drive 2), allowing for higher voltage and power distribution across two coils. The harmonic tank circuit is driven by a single driver (Drive 3). By applying the appropriate drive levels and frequencies to these three drivers and controlling the phase difference between Drive 3 and the Drive 1 and 2 pair, the bisinusoidal waveform is developed. The MIPS controller generates all the drive signals and phase control required to produce and monitor the waveform.

The quality factor or Q of the three coils shown in figure 1 determines the power needed to generate the waveform. The coils were made using Litz wire and air cores to minimize losses and power dissipation. The coil Qs are over 100 in this system resulting in total power dissipation of about 40 watts for a 5.5KV waveform.

The MIPS controller allows you to control all the operating parameters needed to generate the FAIMS waveform and also monitor key system parameters. The MIPS controller also will shut down the system in the event an error condition is detected.

FAIMS waveforms are high voltage and caution should be used with working with this system, only trained and qualified electrical workers can install this system and insure its safe operation.

Operation

The MIPS user interface (UI) consists of a multiline color graphics display and a single control knob located on the front panel. The display will show various dialog boxes with parameters you can control and monitor. When a dialog box is displayed you can rotate the control knob to highlight a selection. If you press the knob when a selection is highlighted then the parameter is selected and its value is highlighted. With the parameters value highlighted you can now rotate the control knob to change the parameter. If you rotate the knob quickly the parameter will change with larger steps allowing you to rapidly move through the adjustable parameters range. When you have finished making changes to a parameter press the button to accept your changes.

The FAIMS module is controlled through six dialog boxes of menus that group control parameters together in a logical fashion. The six menus and the parameters that can be controlled and monitored are discussed below:

FAIMS main menu
Tune menu
Environment menu
Drive Menu
Power menu
DC drive menu

With MIPS firmware version 1.19 and later the FIAMS system supports output voltage level locking. In this mode of operation the drive level is adjusted to maintain the output voltage at a user defined level. To use this mode of operation first enable the system and adjust the drive level to achieve the desired output level. Then with the output voltage selected on the main FAIMS menu press the control button. A message will be displayed indicating lock mode is enabled and the text

color will change to green for this main FAIMS menu. Press the control button again to exit the lock mode.

An auto tune feature was added in firmware version 1.200 and above. Please see the details in the tuning section to use this feature.

FAIMS main menu

The FAIMS main menu will appear after the MIPS system is powered up and the initialization is complete. This menu will allow you to monitor and control key FAIMS parameters as well as select other FAIMS menu options. The FAIMS system will always start with the waveform generation disabled and this menu will allow enabling the system. Below you will find a description of each parameter:

Enable

This parameter is the global or overall system enable. Turning this parameter on will enable all of the drives that have been enabled through the drive menu. When this parameter is set to "on" the FAIMS waveform generation will begin.

The FAIMS RF deck contains an emergency off button, pressing this button will turn this enable parameter off and display a warning message.

Drive

This is the global or overall system drive level. This parameter controls the output voltage level and is adjustable from 25% to 100% (or the value defined by max drive level). Each driver has its own drive level control and can be set in the dive menu, this parameter adjust all drive level proportionally. To change the ratio of the drive levels use the drive menu.

RF, KV

This is a display only parameter that shows the output voltage being developed. Both the positive peak and negative peak voltages are displayed. These values are in KV.

If the control button is pressed when this option is selected the system will enter the output voltage lock mode. In this mode the FAIMS system will automatically adjust the drive level to maintain the voltage level shown at the time the button was pressed. The drive level will be adjusted over a maximum range of +- 10%. When the system is in the lock mode this menu's text color will change to green.

Power

This is a display only parameter that shows the total system power that is being dissipated. This value is in watts.

Tune menu

Selecting this option will select the Tune menu and allow you to control parameters used to tune the resonate tank circuits and control the phase difference between the drivers.

Drive menu

The drive menu allows you to enable and disable individual drivers, set there relative drive levels, and monitor there power levels.

Power menu

The power menu allows you to define limits for power dissipation in each of the three coils as well as setting maximum drive level and maximum system run times.

DC drive menu

This menu allows you to control the output DC levels that are added to the FAIMS waveform and its return path.

Save settings

Selecting this option will save the entire FAIMS configuration data to non-volatile memory chip on the FAIMS module. You will see a popup menu indicating the status of this save operation. You need to use this option to record any changes you have made to the FAIMS parameters or they will be lost when power is cycled or the system is rebooted.

Restore settings

This option will reload FAIMS configuration settings that were saved to non-volatile memory. This function is automatically called when the MIPS system powers up.

Return to main menu

Selecting this option will return to the MIPS main menu.

Tune menu

The Tune menu allows you to control parameters use to optimize the waveform generation and control the phase difference between driver 3 and the driver 1 and 2 pair. This phase control will control the shape of the FAIMS waveform. Each parameter is defined below and you will find a tuning procedure later in this document.

Frequency

This parameter defines the main operating frequency of the primary tack circuit. The frequency can only be changed when the global enable is off and thus the waveform generation is disabled. This value is in Hz.

Coarse phase

The coarse phase adjustment is used to adjust the phase shift between the primary frequency and the harmonic. This parameter allows eight setting from 0 to 7, each increment is 45 degrees of phase shift.

Fine phase

The fine phase adjustment allow 256 steps of phase adjustment, each step is 2 nS so this allows fine control the phase difference between the primary and harmonic signals.

Pri capacitance

This parameter allows you to control the capacitor value used to resonate the primary frequency tank circuit. The value is adjustable between 0 and 100% where 100% indicate the maximum capacitance.

Har capacitance

This parameter allows you to control the capacitor value used to resonate the harmonic frequency tank circuit. The value is adjustable between 0 and 100% where 100% indicate the maximum capacitance.

Environment menu

This option is optional and will only appear if the sensor module has been plugged into the FAIMS MIPS system. If this module is detected when the MIPS systems starts this option will be enabled. Selecting this option will allow you to define how this sensor will adjust the output waveform.

Drive menu

This menu allows you to control the output DC levels that are added to the FAIMS waveform and its return path.

Power menu

The power menu allows you to define limits for power dissipation in each of the three coils as well as setting maximum drive level and maximum system run times.

Auto tune

This menu option will replace the Power menu selection if you are running firmware rev 1.200 or higher and you are using rev 3.0 FAIMS driver hardware. If this option is selected when the FAIMS system is disabled then a full auto tune cycle is started, in this mode the system will be enabled and drive level set to 20% for the tune process. The auto tune process will take several minutes.

If this option is selected when the system is enabled and generating a FAIMS waveform then the system enters a phase lock mode where the waveform is inspected every 30 seconds and the phase adjusted as needed.

Return to FAIMS menu

Selecting this option will return to the FAIMS main menu.

Environment menu

The environment menu allows you to define how the pressure and temperature sensor will automatically adjust the waveform output voltage. This is an option sensor package and this menu will only appear if the system is detected when the FAIMS MIPS controller is powered on. The output voltage control is only enabled when the FAIMS system is operating in the output level lock mode.

When the waveform is enabled the base pressure and temperature is recorded using the sensor module. Then both the temperature and pressure are monitored and compared with the base values. The changes from base values (deltas) are multiplied by user adjustable coefficients to define an overall correction factor used to adjust the output voltage.

Enable comp

The option enables of disable the compensation system. In addition to this option being enabled the FAIMS system must be enabled and in lock mode before the compensation system will adjust the output voltage.

Pressure coeff

The pressure coefficient is multiplied by the delta pressure and summed with the temperature coefficient multiplied by the delta temperature to form the overall correction percentage.

Temp coeff

The temperature coefficient is multiplied by the delta temperature and summed with the pressure coefficient multiplied by the delta pressure to form the overall correction percentage.

Max adj, %

This parameter limits the adjustment range for the compensation system.

Pressure, hPa

This is a display only parameter showing the atmospheric pressure in hectopascal units. This parameter is monitored and updated regardless of the status of the compensation system.

Temp, C

This is a display only parameter showing the temperature in degrees C. This parameter is monitored and updated regardless of the status of the compensation system.

Delta pressure

This is a display only parameter that shows the difference between the base pressure and the current pressure. The base pressure is recorded when the waveform generation is enabled and also when the system powers up.

Delta temp

This is a display only parameter that shows the difference between the base temperature and the current temperature. The base temperature is recorded when the waveform generation is enabled and also when the system powers up.

Correction %

This parameter displays the current compensation percentage calculated using the following equation:

Correction % = (Pressure coeff) * (Delta pressure)+ (Temp coeff) * (Temp pressure)

Return to Tune menu

Selecting this option will return to the Tune menu and allow you to control parameters used to tune the resonate tank circuits and control the phase difference between the drivers.

Drive menu

The drive menu allows you to control and monitor the three coil drivers. Driver 1 and 2 are used for the primary tank circuit while Driver 3 is used for the harmonic tank circuit.

Enable Drv1
Enable Drv2
Enable Drv3
: These parameters allow you to enable and disable each driver, before the driver will actually drive the coil both this enable and the global enable on the main FAIMS menu will need to be enabled.

Drv1 level
Drv2 level
Drv3 level
: These parameters set the drive level for each coil driver; this range of this value is 25% to 100%. The drive levels on this menu are used to define the relative drives for each coil. The global drive level will then increase all three drives proportionally.

Drv1 power
Drv2 power
Drv3 power
: This is a display only parameter and it shows the power level being dissipated for the driver and its coil.

Tune menu
: Selecting this option will select the Tune menu and allow you to control parameters used to tune the resonate tank circuits and control the phase difference between the drivers.

Return to FAIMS menu
: Selecting this option will return to the FAIMS main menu.

Power menu

The power menu allows the user to define power limits, drive limits, and maximum FAIMS on time limits for the system. These limits are designed to protect the system.

Drv1 power limit
Drv2 power limit
Drv3 power limit
: These parameters allow you to define power level limits in watts for each driver and its coil. If this power level is exceeded the FAIMS controller will reduce the global drive level until the power level is under the limit.

Total power limit

This parameter allows you to define the total power level limit in watts for all drivers and coils. If this power level is exceeded the FAIMS controller will reduce the global drive level until the power level is under the limit.

Max drive level

This parameter limits the maximum drive level that can be set with the global drive level on the FAIMS main menu. This provides a level of safety to prevent accidental over voltage to your system.

Max time, hrs

This parameter allows you to define the maximum number of hours that the FAIMS system can be enabled before its automatically disabled. This parameter will prevent the system from remaining on indefinitely if someone walks away and forgets to turn it off.

Return to FAIMS menu

Selecting this option will return to the FAIMS main menu.

DC drive menu

The FAIMS controller provides two DC output voltages that the user can control. The DC bias output is added to the FAIMS bisinusoidal output signal and the DC cv is available on the FAIMS return connection on the rear panel of the FAIMS RF deck. Each of these DC output are adjustable from -250 to 250 volts. Additionally an offset is provided to allow you to define the center of this adjustable range from -250 to 250 volts. This allows you to achieve -500 to 500 volts range on each output.

The DC cv voltage can be scanned from the CV start to CV end voltage values over the duration, in seconds, defined.

DC bias

Sets the DC bias output DC voltage that is added to the FAIMS bisinusoidal output signal.

DC cv

Sets the DC cv output DC voltage that is available on the FAIMS return connection on the rear panel of the FAIMS RF deck.

Offset

This parameter defines the center of the voltage range for the DC bias and DC cv output voltages.

CV start

The DC cv value can be scanned linearly and this parameter defines the starting voltage for this scanning capability.

CV end

The DC cv value can be scanned linearly and this parameter defines the ending voltage for this scanning capability.

Duration

The DC cv value can be scanned linearly and this parameter defines the duration, in seconds, for a scan from the CV start to CV end values.

Scan

This parameter allows you to turn on and off a scan operation; A scan can also be triggered using the Trig input on the rear panel of the MIPS controller. This trigger input is positive edge sensitive.

Loops

The loops parameter allows you to define the number of scans you wish to perform. If the loops value is greater than 1 then as soon as a scan finishes a new scan will start. When the system is scanning this value will display the number of scans remaining.

Calibrate channel

This option allows calibration of each output channel and its read back monitor. This is not an option you would normally use and its used at the factory when the system is initially fabricated. The calibration procedure is defined in more detail in the appendix of the MIPS operations manual.

Return to FAIMS menu

Selecting this option will return to the FAIMS main menu.

Connecting the FAIMS device

The FAIMS device is connected to the FAIMS RF deck using two banana plugs on the rear panel of the chassis. The bisinusoidal waveform with the added DC bias is available on the red plug located in the center of a 3" round shielded tube. Use care when connecting this signal to your FAIMS device both to shield the system from capacitance changes and electrical break down as well as providing a safe operating environment.

Your system includes supplies to make this connection, these supplies include:

1.) 3" diameter flexible metal tube.
2.) 3 spacers to hold the signal in the center of the tube.
3.) 5 feet of Teflon ¼" tubing that will fit in the center hole of the spacers and protect the signal.
4.) Banana jacks and wire
5.) 2 Hose clamps to hold the flexible metal tube in place on the RF deck and at your FAIMS device.

Its our recommendation that you engineer a connection system at your FAIMS device that is similar to the one on the rear panel of the FAIMS RF deck. This will provide and safe and stable signal connection.

The FAIMS signal return with the DC cv voltage is provided on a black banana plug and should be connected to the FAIMS device return signal plate. This connection can have up to 500 volts of DC and has been decoupled in the RF deck to remove any AC signal.

Tuning the system

The FAIMS controller supports automatic and manual tuning options. The following sections describe each of the tuning modes.

Automatic tuning

Starting with MIPS firmware version 1.200 automatic tunning of the FAIMS system is supported. Make sure the FAIMS device is properly connected and all the cable shielding is in place before starting this procedure.

Auto tuning has two modes of operation. If the FIAMS system is disabled when auto tune is selected then a full tune cycle is performed. If the FAIMS system is enabled when auto tune is selected then every 30 seconds the waveform is tested and the phase is adjusted to maintain the optimal waveshape.

Full auto tune cycle

Start a full auto tune cycle by first making sure your FAIMS device is properly connected and the cables installed and shielding in place. Select the Auto tune options from the Tune menu on the FAIMS controller or using the host application. The auto tune cycle will take several minutes to complete. While the system is tuning you will see a popup text box on the MIPS controller indicating the system is in tune mode.

You can use a scope connected to the monitor output BNC to monitor the systems progress. It is a good idea to monitor this output to make sure the auto tune cycle completed without error. The auto tune cycle is performed at 20% drive level and should result in a waveform with about 2KV peak output voltage. The system does not determine if the auto tune cycle was successful, the user must evaluate the waveform to confirm the proper waveshape.

The tune settings must be saved after a auto tune process or the settings will be lost when the power is cycled. Make sure you select the save options to save the tuning setting after you have evaluated the auto tune results.

The auto tune algorithm will adjust for a positive FAIMS peak output. If you would like a negative peak you can adjust the phase after the tune cycle has completed. To make this change go to the Tune page and adjust the phase while monitoring the output on the scope, adjust the phase until to see the proper negative peak.

You can tune and operate the FAIMS system with no FAIMS device connected, in fact we ship the system tuned and ready to run with no load when it leaves the factory. So you can enable the FAIMS system when you receive and connect the two modules to make sure it is operating properly.

Phase auto tune

If the FIAMS system is enabled and generating a waveform when the auto tune option is selected then the system will start monitoring the phase and making adjustments to maintain an optimal waveform. The waveform is inspected every 30 seconds and adjusted as needed. This feature is useful when generating waveform over 4KV peak. This feature takes care of phase changes due to heating. This feature will be disabled when the FAIMS output is disabled and will need to be reselected when the system is enabled.

Make sure you have adjusted the waveform as needed before selecting this feature, for example if you want a negative peak waveform make that adjustment before selecting the auto tune feature.

Manual tuning

The procedure outlined in this section defines how to tune the RF deck after the initial installation and setup of the FAIMS device. This procedure will need to be repeated if you make any significant changes to the system setup.

Throughout the following tuning procedure attach a scope to the monitor output BNC on the FAIMS RF deck front panel.

1.) The first step in tuning a new installation is to resonate both the primary and harmonic tank circuits.
    a. Use the drive menu to enable drive 1 and drive 2 if resonating the primary take circuit or enable drive 3 if resonating the harmonic tank circuit. First resonate the primary tank circuit and then the harmonic. These two will interact a little bit so this needs to be repeated a least one time. The drive levels for each driver should be set at 25% and the global drive level should be set at 25%. Do not enable all three drivers when resonating the tank circuits just the drivers for the tank circuit you are tuning.
    b. Turn on the global enable and adjust the primary capacitance value or harmonic value while monitoring the output on the scope. Adjust the capacitance value until you have seen a peak in the output voltage. Adjust the capacitance value to achieve a peak. This procedure resonates the tank circuits; complete the primary tank circuit and then the harmonic tank circuit. Repeat this procure at least one time to remove any interaction of the two tank circuits.

    c. If you are unable to achieve resonance you will need to change the operating frequency. The system is very sensitive to frequency changes and you should make small changes. The frequency can only be changed when the global enable is off. If the output signal increases as you increase capacitance but does not peak before you reach 100% of the capacitance value you will need to reduce the frequency, try reducing by 1000 Hz and repeating the procedure.

2.) After both tank circuits have been resonated the waveform symmetry will be adjusted.
    a. Use the drive menu to enable all three drivers and set the drive level to 25%.
    b. Set the global drive level to 25% and set the global enable to on. This will start the system generating the bisinusoidal waveform.
    c. Adjust the coarse phase adjustment to generate as good a waveform as possible. The coarse phase adjustment only needs to get you close to the proper shape.
    d. Adjust the fine phase control to achieve optimal symmetry.

    The symmetry adjustment will not interact with the resonate frequency tuning from step 1 so you should not have to repeat step 1. The symmetry is very sensitive to minor system changes so you may need to adjust the symmetry as the system warms up.

After you have completed the system tuning make sure to save the parameters so the system will startup using the values you have set.

Operation recommendations

This section contains some general recommendations about the operation of the FAIMS power supply system.

1.) The system will automatically startup with the global enable off and the global drive level set to the highest coil drive level found. Its good practice to slowly increase the drive level and monitor the power and voltage. If anything seems out of normal power the system off and investigate.
2.) The drive menu allows you to control the individual coil drivers. Please keep these values low, around 25%. Driver 1 and driver 2 should always be set the same and driver 3 may differ if needed to obtain the desired amplitude relationship.
3.) The system should produce a 5.5KV signal at 1MHz using about 40 watts of total power. If your results are significantly different it could indicate a problem.
4.) When you have the system running at your desired operating point make note of the drive levels and the power levels, both total power and individual

driver power levels. Its good practice to then set the power limits and drive limits 20 to 30% above your operating point. This will allow the monitoring logic to protect the system in the event of a failure of some kind.

5.) The system has a maximum enabled time value that is set at 0.5 hours by default. This value is likely too short, please enter reasonable times but don't disable this feature by entering a ridiculous value like 10,000 hours. It's a good idea to not operate the system unattended until you have some experience with your system and have established system reliability.
6.) If you stop the system by turning off the global enable or pressing emergency stop please reduce the drive level before you re enable the system.
7.) Do not shut the system down by powering off the MIPS box, first turn the global enable off and then power off the MIPS box.
8.) If you turn off the MIPS box leave it off for at least 15 seconds before powering back up.

Appendix A, Host Computer Interface

Below is a list of FAIMS-specific host commands that enable an USB-connected application to control most of the FAIMS functions. The MIPS operation manual provides additional general MIPS instructions.

The USB interface to the FAIMS system offers a virtual serial communication interface. This section explains the protocol and commands used by the USB virtual serial communication interface.

All commands are ASCII text. When sent to the FAIMS system, they are terminated with a carriage return (CR) and line feed (LF) character. Similarly, all messages sent from the FAIMS system are also terminated with a CR and LF.

After receiving a command (after the CR or LF is received), FAIMS responds with an ASCII ACK (0x06) followed by a CR or an ASCII NAK (0x15), then a "?" character, and finally a CR. A NAK indicates that the command or its arguments were not understood. If the command sent to FAIMS results in a message from FAIMS to the host, an ACK (0x06) is sent before the message.

When a NAK is sent, the "?" character is sent to inform users communicating with a terminal emulator that the command was not understood.

Many commands are described as pairs: a set value command starting with a S and a get value command starting with a G.

General commands

SFMENA,TRUE or FALSE

Enables or disables the FAIMS waveform generation.

GFMENA

Returns TRUE if FAIMS is enabled, else returns FALSE.

SFMDRV, Drive level in percent

Sets the FAIMS waveform generation drive level between 5 to 100, the units are percent.

GFMDRV

Returns the current drive level in prevent.

GFMPWR

Returns the FAIMS waveform generation power level, this is the power being used to generate the waveform.

GFMPV

Returns the waveform positive peak output voltage in KV.

GFMNV

Returns the waveform negative peak output voltage in KV.

SFMLOCK, TRUE or FALSE

Enabled output voltage locking if TRUE. When set to TRUE the system will hold at the current voltage level and then automatically control drive to hold the voltage level constant.

GFMLOCK

Returns TRUE is system is in lock mode.

SFMSP, Output voltage setpoint in KV

Allows the user to adjust the output voltage setpoint when in lock mode. The voltage is in KV.

GFMSP

Returns the waveform lock voltage setpoint in KV.

SFMFREQ,frequency

This command sets the FAIMS system primary frequency in Hz.

GFMFREQ

This command returns the FAIMS system primary frequency in Hz.

SFMPCAP,position

This command sets the position of the primary tuning capacitor in percentage, ranging from 0 to 100. The command is disabled when the drive level exceeds 25%.

GFMPCAP

This command returns the primary tuning capacitor's position as a percentage, ranging from 0 to 100.

SFMHCAP, position

This command sets the position of the harmonic tuning capacitor in percentage, ranging from 0 to 100. The command is disabled when the drive level exceeds 25%.

GFMHCAP

This command returns the harmonic tuning capacitor's position as a percentage, ranging from 0 to 100.

Auto tune commands

SFMTUNE

Enables the system auto tune mode.

SFMTABRT

Aborts any auto tune operation that is in process.

GFMTSTAT

Returns the state string of the auto tune process. This state string provides the user with information about the progress of the auto tune procedure. The following values are returned and output during a full system auto tune procedure:

- Idle
- Tune requested
- FAIMSabort
- Finding frequency
- Adjusting frequency
- Setting primary C
- Setting harmonic C
- Setting phase
- Adjusting phase

SFMTPOS,TRUE or FALSE

This command sets the auto-tune mode to tune for a positive Vrf peak voltage. If TRUE, it configures for a positive peak. If FALSE, it configures for a negative peak. The default value is TRUE, and this value must be set before the auto-tune process begins.

GFMTPOS

This command returns TRUE if the auto-tune mode is in positive peak mode, and FALSE if it is in negative tune mode.

SFMTDRV,drive

This command sets the global drive level used during the auto-tune process. The default value is 20 percent.

GFMTDRV

This command returns the auto-tune drive level as a percentage.

SFMATSTRF,frequency

The auto-tune process identified the system's resonant frequency by sweeping over a specified range. This command sets the starting frequency in Hertz, with a default value of 500,000 Hz.

GFMATSTRF

This command retrieves the frequency at which auto-tune begins.

SFMATSTPF,frequency

The auto-tune process identified the system's resonant frequency by sweeping over a specified range. This command sets the ending frequency in Hertz, with a default value of 1,500,000 Hz.

GFMATSTPF

This command retrieves the frequency at which auto-tune ends.

SFMATBPC,TRUE or FALSE

This command bypasses the primary capacitance tune adjustment during the auto-tune process if the value is TRUE. The default value is FALSE.

GFMATBPC

This command retrieves the current state of the primary capacitance turn bypass parameter.

DC bias commands

These commands control the CV and bias voltage outputs.

SFMCV, Voltage setpoint

Sets the CV output DC voltage in volts.

GFMCV

Returns the CV output voltage setpoint in volts.

GFMCVA

Returns the CV output voltage readback in volts.

SFMBIAS, Voltage setpoint

Sets the Bias output DC voltage in volts.

GFMBIAS

Returns the Bias output voltage setpoint in volts.

GFMBIASA

Returns the Bias output voltage readback in volts.

SFMOFF, Voltage setpoint

Sets the Offset output DC voltage in volts.

GFMOFF

Returns the Offset output voltage setpoint in volts.

GFMOFFA

Returns the Offset output voltage readback in volts.

Scanning commands

These command control the FAIMS system scanning functions.

SFMCVSTART, Voltage

Sets the CV scan start voltage in volts.

GFMCVSTART

Returns the CV scan start voltage in volts.

SFMCVEND, Voltage

Sets the CV scan ending voltage in volts.

GFMCVEND

Returns the CV scan ending voltage in volts.

SFMDUR,Seconds

Sets the scan duration in seconds.

GFMDUR

Returns the scan duration in seconds.

SFMLOOPS,Number of loops

Sets the number of times (or loops) the scan will repeat.

GFMLOOPS

Returns the number of times (or loops) the scan will repeat.

SFMSTRTLIN, TRUE or FALSE

Starts a linear scan when set to TRUE.

GFMSTRTLIN

Returns the linear scan state.

SFMSTPTM, Time in mS

Sets the duration time is mS for the step scan mode.

GFMSTPTM

Returns the duration time is mS for the step scan mode.

SFMSTEPS, Number of steps

Sets the number of step to use in the step mode scan.

GFMSTEPS

Returns the number of step to use in the step mode scan.

SFMSTRTSTP, TRUE or FALSE

Starts a step based scan is TRUE.

GFMSTRTSTP

Returns the step mode scan status.

Calibration commands

These commands control the system's behavior when using a curtain supply and the response to an arc detection. Calibration commands are also included in this section, but the calibration functions are for factory use only.

SRFHPCAL,m,b

The command allows you to define the Vrf positive output linear calibration slope (m) and offset (b).

SRFHNCAL,m,b

The command allows you to define the Vrf negative output linear calibration slope (m) and offset (b).

SARCDIS,TRUE or FALSE

The command will disable the arc detection system if the value is set to TRUE. The default value is FALSE.

FMISCUR

This command will return TRUE if a curtain HV supply is available in the system.

SFMCCUR,TRUE or FALSE

This command controls the enable and disable behavior of the curtain supply. If set to TRUE, the curtain supply will be enabled and disabled in sync with the FAIMS system's state (enabled or disabled). If set to FALSE, the curtain supply's enable will operate independently.

GFMCCUR

This command returns the state of the curtain supply's enable behavior.

SFARCR,tries

This command enables the arc detection system to make multiple attempts to restart after detecting an arc. The value of tries specifies the number of attempts to be made. The default value is 0.

GFARCR

This command will return the number of retries that will be performed to restart after an arc is detected.

SFMMDIS,TRUE or FALSE

This command automatically dismisses the arc detection message when an arc is detected and performs a restart attempt if the value is set to TRUE. The default value is TRUE.

GFMMDIS

This command returns the automatic arc message dismissal status, which is either TRUE or FALSE.

CALFMPWL,POS or NEG

This command generates a piecewise linear calibration table with a maximum of 10 entries. It's used in the factory for system calibration and should not be used by customers.

SFMUSEPWL,TRUE or FALSE

If this command is true, the system will use the piecewise linear calibration table when calculating the Vrf levels. The default value is TRUE.

GFMUSEPWL

This command returns the status of the piecewise linear calibration table mode. TRUE indicates that the mode is enabled.

Appendix B, User Interface

The FAIMS system comes with a MIPS host application that features an interactive user interface for controlling most FAIMS functionalities, including scanning and automatic tuning.

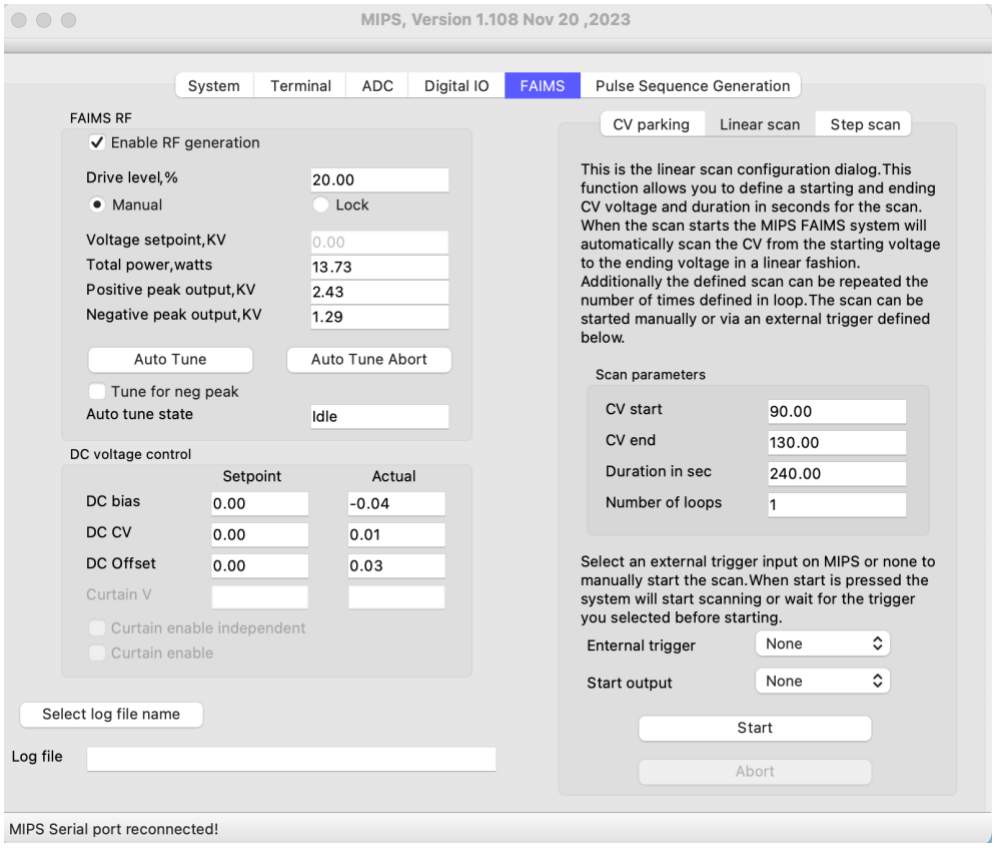
To install the host application, copy the MIPS folder and its contents to the C drive of your PC. Open the MIPS folder and double-click on the MIPS application. Ensure the MIPS system is powered on and connect the USB cables to your PC. Then, press the "Find MIPS and connect" button. The application will establish a connection with your system.

Navigate to the FAIMS tab to manage and monitor your system's operation.

We can assist you in setting up the software and demonstrating its capabilities. Please call or email us to schedule a time.

This document includes screenshots of the user interface. The MIPS application is a 64-bit application designed to run under Windows 10 or 11.

The following screenshot shows the graphical user interface (GUI) that appears when the MIPS application is loaded and the FAIMS tab is selected. This GUI utilizes the commands specified in Appendix A to communicate with the FAIMS system, providing a user-friendly interface for system interaction.



FAIMS control tab

The FAIMS tab enables you to control and monitor the FAIMS controller from your host computer. The interface is divided into three sections: FAIMS RF, which allows for the generation of Vrf and system tuning; DC voltage control, which enables the definition of CV and bias voltage generation; and the three tabs on the right side of the interface, which provide various scanning options.

FAIMS RF

This section allows you to enable and disable the RF generation of the FAIMS system and set the drive level in percent, ranging from 0 to 100%. The critical system parameters are displayed, including the Vrf peak positive and negative output voltages and the total power the system consumes to generate the Vrf output. The user can put the system in lock mode using the options provided. In lock mode, the system automatically adjusts the drive to maintain the Vrf level set by the setpoint value.

This section also includes the auto-tune controls. Before performing auto-tune, the system should be in manual mode, and the user should select the “tune for neg peak” option if they want to generate negative Vrf levels. If the system is

disabled, pressing the auto-tune button initiates a full auto-tune procedure. If the system is enabled when the auto-tune button is pressed, it enters phase lock mode, where the phase is automatically adjusted to maintain optimal waveform generation. The autotune status is also disabled to inform the user of the actions being performed during the tune.

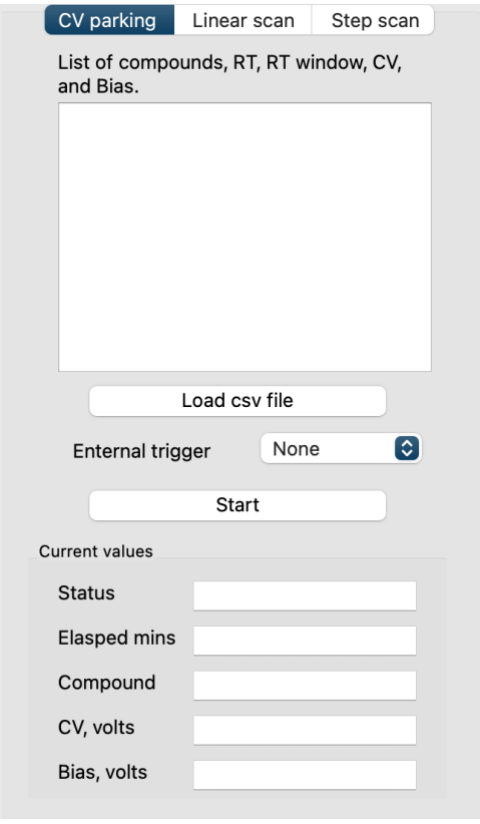
DC voltage control

This section enables users to manually set the CV voltage level and the DC bias level. The DC bias level is added to the Vrf output, while the CV voltage is provided on a BNC output connector and applied to the FAIMS cell. Additionally, this output voltage includes readback values to verify the proper functioning of the DC voltage control system.

The offset value allows you to define the range for CV and bias. Changing the offset does not alter the output voltage; it only changes the range. With the offset set at 0, the CV and BIAS channels have a range of -250 to 250V. The offset enables you to center this range around any value between -250 and 250V. For instance, if you set the offset to 100V, the range will be -150 to 350V.

Scanning options

The scanning section offers three distinct CV scanning options: CV parking, Linear scan, and Step scan. Each scanning mode is thoroughly explained in the subsequent sections.



CV parking

This section allows you to define a list of targets, and the system will automatically adjust the CV and DC bias values as the LC separation progresses. The first large text box labeled “List of compounds, RT, RT window, CV and Bias” contains the data the system needs to run a LC experiment and automatically adjust values. You can manually enter data into this window by typing your values, or you can use the Load CSV file button to load the data from a file on your computer. Below is an example of the values that can appear in this window:

Compound 1, 12.3, 2, 150, 200
Compound 2, 15.5, 2, 175, 210

In this example, we have a target list of two compounds. After the system starts, it will wait for 11.3 minutes and then set the CV to 150 volts and the bias to 200 volts. The system will then stay at these settings for 2 minutes before it looks for the next target. The important point to remember is that the system reads the targets from this window, so if nothing is in the window, nothing will happen!

The best way to load this window is by using the Load CSV file button. Pressing this button will open a file selection box that allows you to select a file on your computer. The file must be a comma-separated variable file, and the first record must contain a header that defines the column names. The system will search the header for the following names to identify the needed data:

Compound
Retention Time
RT Window
Compensation Voltage
Bias

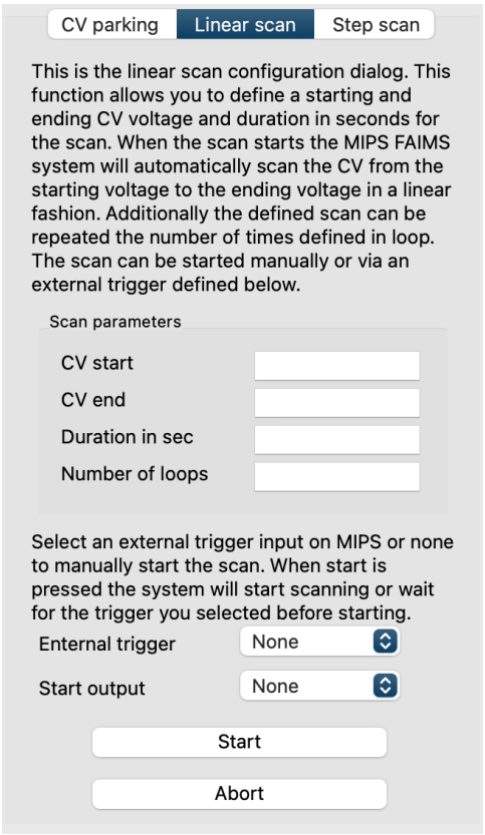
The order of these parameters is not important, but these records must be present. It's okay if additional records are present in the header; they will be ignored. If the needed parameters are found, the system will read the file, sort the data, and then populate the window. This is the best way to set up the list of targets. Excel can be used to edit and update the CSV file as needed for your research.

With the list of targets defined, you're ready to initiate an experiment. Synchronizing the software's start with your LC separation is crucial. You have two options: manually press the Start button when your LC separation begins or externally trigger the system. The External trigger selection box lets you choose manual (None) or one of the TTL inputs on the FAIMS controller's back (Q through T). If you select a TTL input, you'll still need to press the start button, but the system will display a message indicating it's waiting for a trigger. Your mass spectrometer must be configured to provide a TTL logic level high pulse when the LC separation starts.

While the system is running, the status box communicates the system state, and the elapsed time box shows how long it's been operational. The Compound, CV, and Bias boxes display the current system target.

This software version lacks the ability to save or restore settings on this tab. However, you can copy the contents of the target window to a text file using standard computer copy and paste operations. This allows you to save any manual entries or edits you've made.

Linear scan



In linear scan mode, the FAIMS system gradually increases the CV voltage from the user-defined starting value to the user-defined ending value. The scan duration, specified in seconds by the user, determines the total time for the scan. The FAIMS system updates the CV voltage 10 times per second, creating a smooth linear transition from the start to the end value. The number of loops parameter specifies the total number of scan cycles to be performed.

The scan can be initiated by applying an external TTL level trigger signal to one of the MIPS digital inputs, Q through T. The external trigger box provides options to select the trigger input or opt out of it. Additionally, the MIPS system can generate an output trigger signal when the scan begins. The scan output box allows the selection of one of the MIPS output digital signals, A through D, or opt out if this option is not desired.

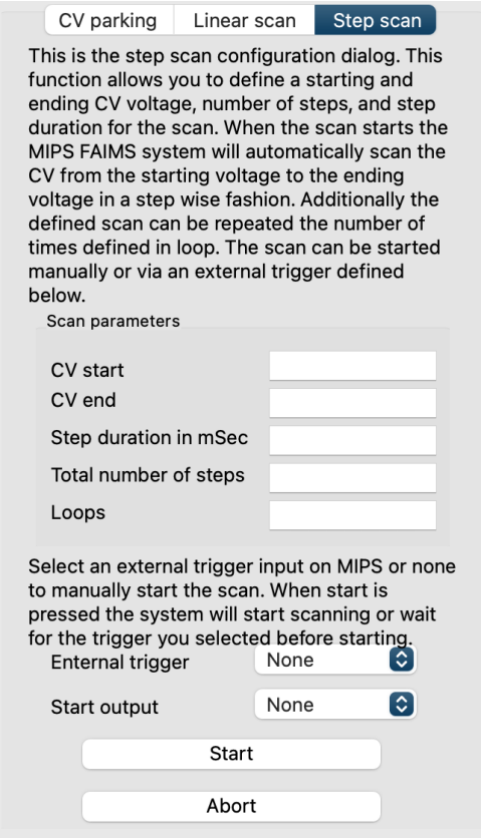
Pressing the Start button initiates a scan or prepares the system to accept a start trigger if enabled. A scan can be terminated at any time by pressing the abort button.

Step scan

In step scan mode, the FAIMS system gradually increases the CV voltage from the user-defined starting value to the user-defined target value by incrementing the CV voltage in discrete steps. The user specifies the total number of steps and the duration of time (in milliseconds) to be held at each step. It's important to ensure that the step duration exceeds 100 milliseconds. Additionally, the number of loops parameter determines the total number of scan cycles to be executed.

The scan can be initiated by applying an external TTL level trigger signal to one of the MIPS digital inputs, Q through T. The external trigger box provides options to select the trigger input or opt out of it. Additionally, the MIPS system can generate an output trigger signal when the scan begins. The scan output box allows the selection of one of the MIPS output digital signals, A through D, or opt out if this option is not desired.

Pressing the Start button initiates a scan or prepares the system to accept a start trigger if enabled. A scan can be terminated at any time by pressing the abort button.



Warrantee

GAA Custom Electronics, LLC warrantees the MIPS 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,

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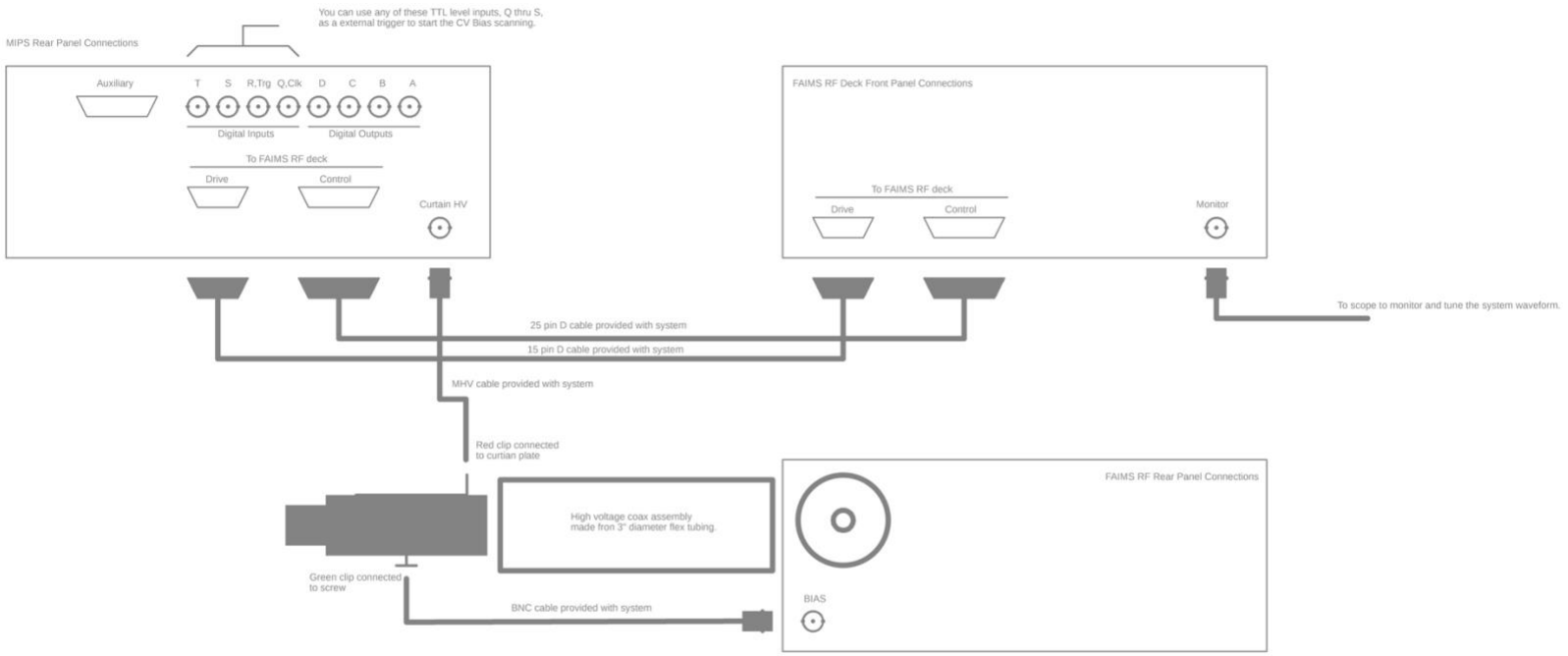

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FAIMS MIPS Connection Details GAA Custom Electronics, LLC	
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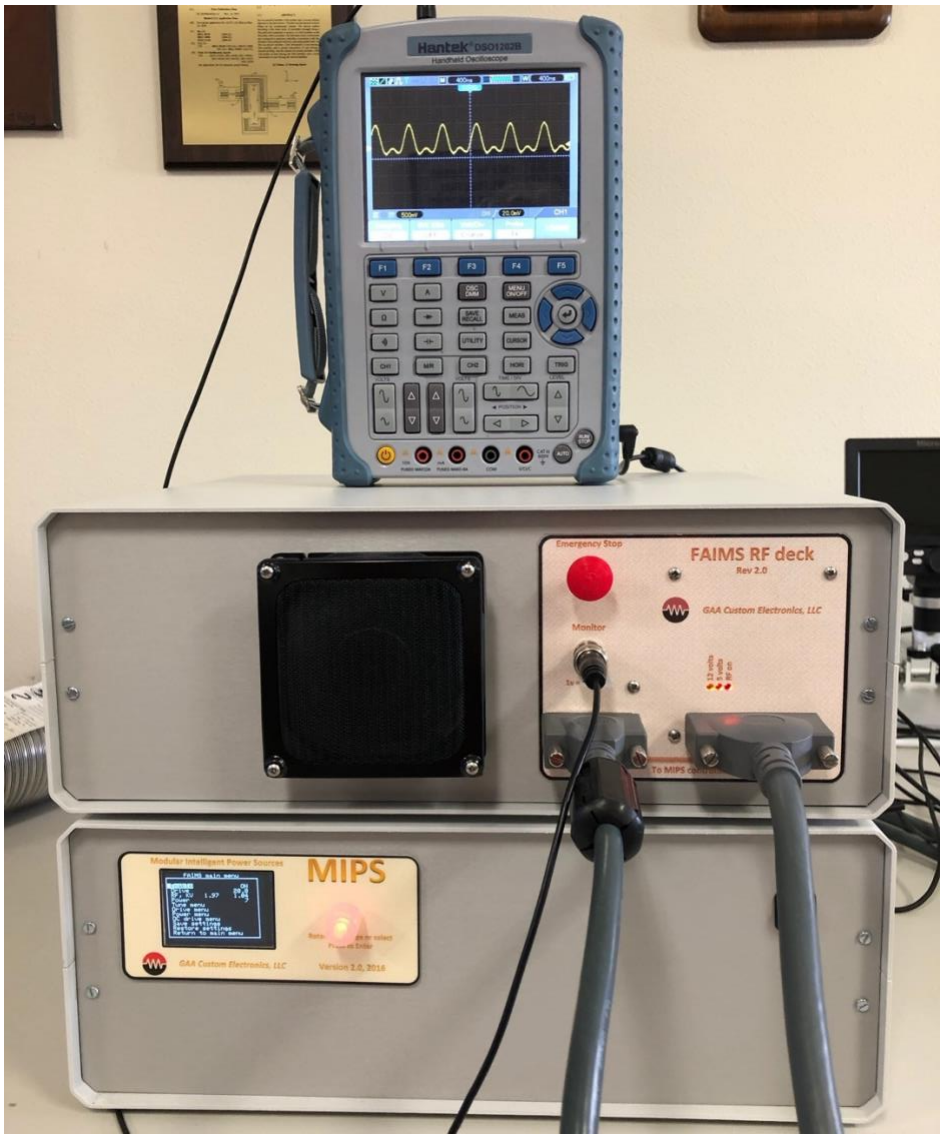
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Handheld Oscilloscope
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FAIMS RF deck
Rev 2.0
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Monitor
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Modular Intelligent Power Source
MIPS
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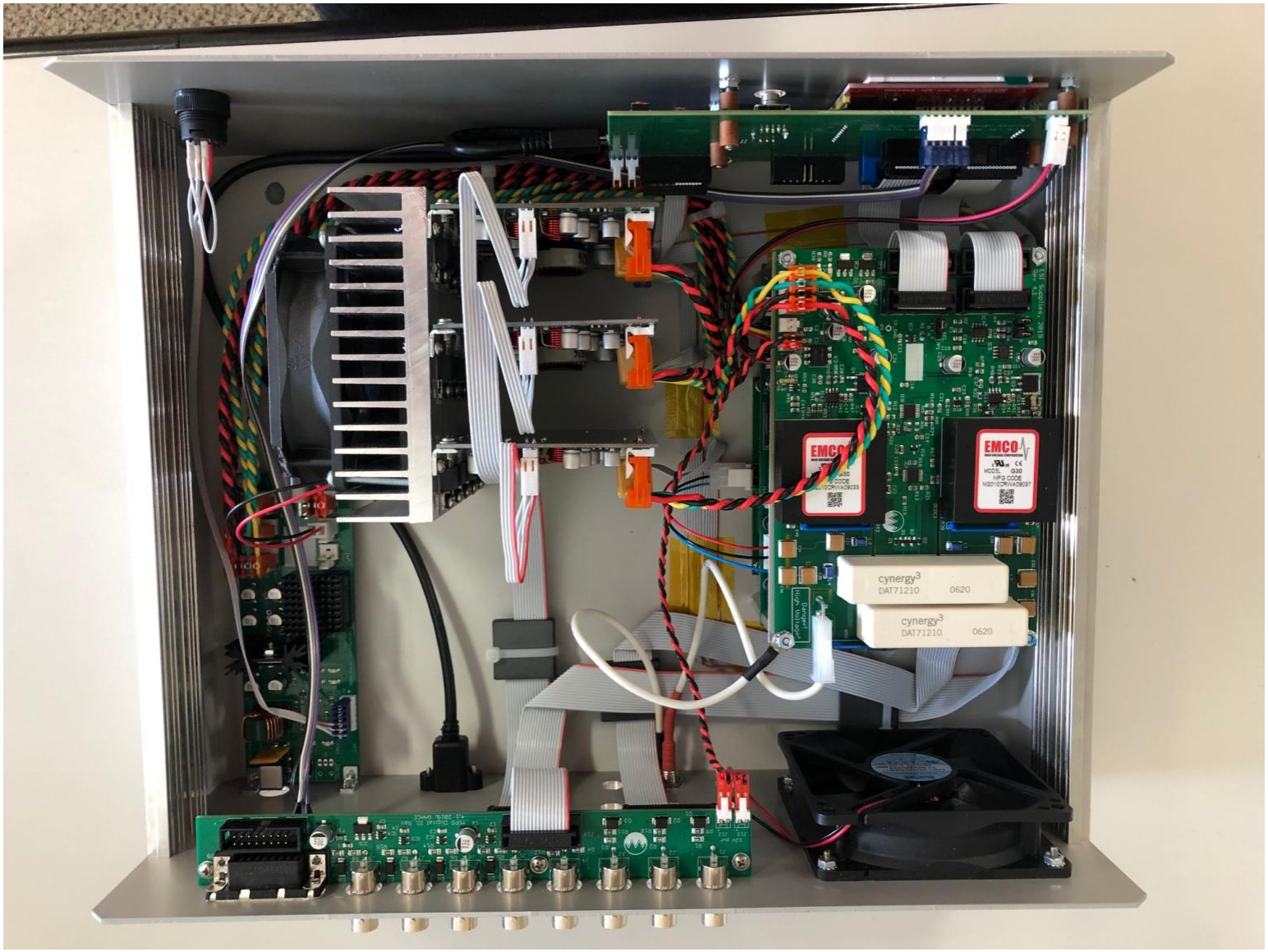
Version 2.0, 2016


WARNING
Electrical hazard. Authorized personnel only.
DANGER
Electrical hazard. Turn off power and lock out before servicing.
BIAS
WARNING
Auxiliary
Digital Inputs
T
S
R Trg
CLck
Digital Outputs
D
C
B
A
Pressure / temperature sensor
To FAIMS RF deck
Drive
Control
DANGER
24VDC Input Power
5 Amp Class I
Curtain Supply
-3KV to 3KV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