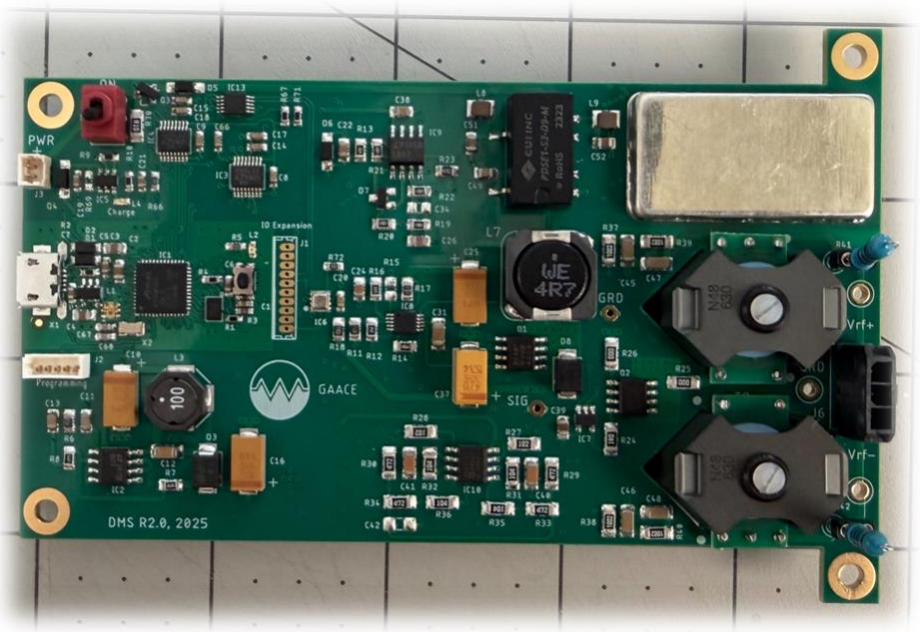
DMS

Operation Manual
Version 1.0 November 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.

Only qualified electrical workers are able to install and test this system. Please follow these recommendations:

1.) Make sure to cover all your connections to protect them from accidental contact.
2.) Do not operate this DMS system until you have read the operating instructions.
3.) Never operate this system in a combustible gas environment.

Table of Contents

Description

Differential Mobility Separation (DMS) is a gas-phase separation technique that separates ions based on their size, shape, and charge in an asymmetric electric field. The DMS module generates the necessary radiofrequency (RF) and direct current (DC) voltages that can be applied to a DMS cell to enable this technique. The DMS module comprises a dual polarity electrometer for signal collection and control software that facilitates scanning, recording, and displaying DMS spectra.

The DMS module is a compact, low-power, portable single-board solution that enables a fully featured DMS system when integrated with your DMS cell.

DMS module features:

- Size, 4.65” x 2.5” x 0.75”
- Weight, 6 ounces
- 120MHz ARM M4 processor
- Power, under 5 watts when generating 1000Vpp Vrf at 1.2MHz
- RF voltage generation, 400 to 1500Vpp Vrf, up to 1.2MHz
- CV voltage generation, +/-24VDC
- Electrometer, Dual channel with programable DC bias level on each channel, 0 to 5V and 0 to -5V
- Electrometer signal acquisition and DSP filtering
- CV voltage scanning over user defined range and speed
- Environmental monitoring, temperature, humidity, pressure altitude
- Single cell li-poly powered, 3.7V nominal
- Built in battery charger
- Limit testing and protection
- USB interface to host computer
- 2MB flash disk for data storage
- Real time clock
- Autonomous collection, can be configured to acquire data at user defined intervals
- Expansion interface
- Host software PC or MAC
    - Monitor and control
    - Plot scans
    - Generate heat maps

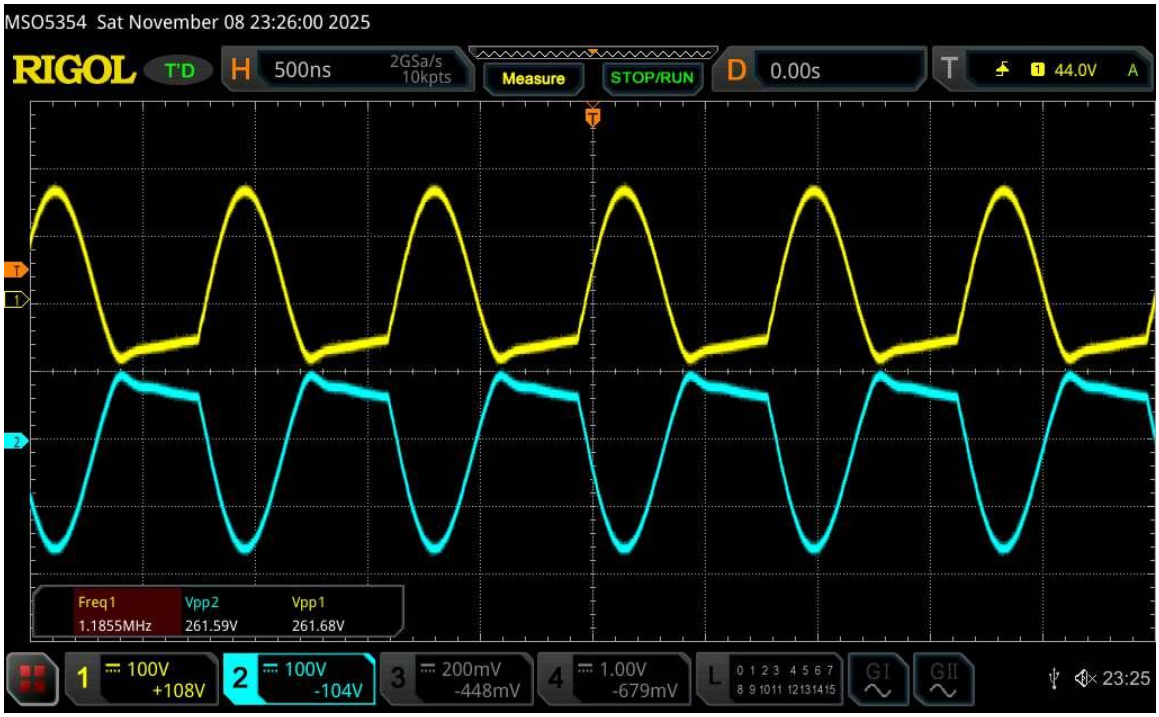
The module has two outputs that are connected to the plates of your DMS device. The system generates a symmetrical set of positive and negative outputs, which are presented on the respective positive and negative outputs (Vrf+ and Vrf-). When you set the DMS RF voltage (Vrf) to 1000 volts, you will observe a +500 volt signal on the positive output and a -500 volt signal on

the negative output. Similarly, the CV voltage has a +1/2CV output and a -1/2CV output superimposed on the Vrf signals.

Exercise caution when measuring the output voltages because your scope may load the system. Minimize cabling length and system capacitance. Increased capacitance raises power requirements and widens the waveform pulse width. The factory setup and testing used 100:1 scope probes with 5pF capacitance.

The DMS module generates Vrf waveforms using a fly-back transformer technique. This technique involves charging the primary of a transformer and then interrupting the primary current to generate the DMS waveform. The interruption of the primary current causes the magnetic field in the transformer to rapidly collapse, inducing a large voltage in the secondary. This is the fly-back transformer technique. The DMS module allows you to control the frequency of the signal charging the transformer primary and its duty cycle (the percentage of time the signal is on in a cycle). By adjusting these two parameters, you can tune the system to your devices' specific characteristics, which in turn defines the DMS waveform duty cycle. When tuning, you'll need a scope to monitor the waveforms. Remember that power increases linearly with frequency and capacitance, but at a much higher rate with voltage.

The output pulse that is generated when the fly-back transformers field collapses is determined by the transformer's inductance and the capacitance of the load. This width will vary significantly depending on your load. The system is designed to drive the DMS cell's low capacitance. To define the waveform duty cycle the waveform frequency will need to be adjusted or the load capacitance changed.



This scope image displays a typical DMS Vrf+ (yellow) and Vrf- (blue) waveform. You can tune this waveform to your specific load by adjusting the duty cycle parameter, which will affect the ripple you see on the flat portion of the waveform. Additionally, you'll find two plug-in resistors whose values can be adjusted to optimize the waveform shape. The default value for these resistors is 1K.

The DMS module features a dual-channel electrometer, capable of detecting both positive and negative ions. Each channel can be biased with a programmable value ranging from 0 to 5 volts. The positive bias is applied to the negative ion channel, while the negative bias is applied to the positive ion channel. Additionally, the DMS module firmware supports zeroing any offset in the electrometers and simultaneously records the readings from both channels.

The DMS module supports multi-dimensional scanning. The CV voltage can be scanned from a user-defined initial value to a user-defined ending value. After each CV scan, the Vrf voltage can be adjusted to its next value within a user-defined range. This allows the generation of a family of CV curves across a specified range of Vrf values. The electrometer channels are recorded at each CV scan point and saved in the ARM M4 memory. Once a scan is complete, the data can be saved to a file on the flash file system, which will then be accessible on a host computer connected via the USB port.

The DMS module can be configured to perform scheduled scans on a specified interface and automatically save the data to the flash file system. To enable this mode of operation, the SCHEDULE command should be used.

The DMS module is equipped with the capability to measure various environmental parameters, such as temperature, humidity, pressure, and altitude.

The DMS module can be fully controlled via the USB interface using the host commands outlined in Appendix A. These commands enable your application to conveniently control and configure the DMS system. Furthermore, Appendix B presents an interactive user interface integrated with the DMS module. This UI utilizes our MIPS application and control panel designed to interface with the DMS module. It facilitates scanning and plotting data and includes the capability to generate heatmaps displaying features in multi-dimensional scans.

Battery

A battery has not been included with your system due to shipping restrictions. Please use a single-cell Li-poly battery with a nominal voltage of 3.7 volts. We recommend a battery with a minimum capacity of 2000mAh. When the USB port is connected to the host computer or a power supply module, the DMS system will charge the battery. The battery can charge while the power switch is on or off. The maximum change current for the battery is 800mA.

The DMS module comes with a short cable that plugs into the battery connector on the PCB. This connector and cable can be used to connect your chosen battery or power supply. However, the DMS module lacks reverse polarity protection, so exercise caution when connecting a power source.

A battery of power supply must be connected to enable the full functionality of the DMS module, even though the USB power will provide power to the microcontroller.

Quick start

This section outlines the essential steps and connections required to initiate the DMS module and conduct initial testing. Please follow these steps:

1.) Place the DMS module on an insulated surface for testing. Ideally, use a standoff and attach it to the provided mounting holes on a conductive plate that will also serve as a shield.
2.) Connect a power supply battery using the provided connector and cable. Ensure the supply voltage does not exceed 4.2 volts and can provide at least 3 amps of current.
3.) Connect a scope using two probes, one for each Vrf output. Preferably, use 100:1 probes with 5pF capacitance. You can attach the probes to the pogopin holes as a convenient location.
4.) Connect the USB port to your host computer using a USB micro cable.
5.) Turn on the DMS power switch.
6.) Launch the MIPS app on your computer and load the DMS.cfg control panel.

Updating the DMS firmware

The firmware in the DMS module can be updated by the user without the need for any special tools. Before performing the update, it's essential to save the system settings and calibration parameters to the flash memory file system. To save the parameters, enter the following commands:

- SAVEF
- SAVECAL

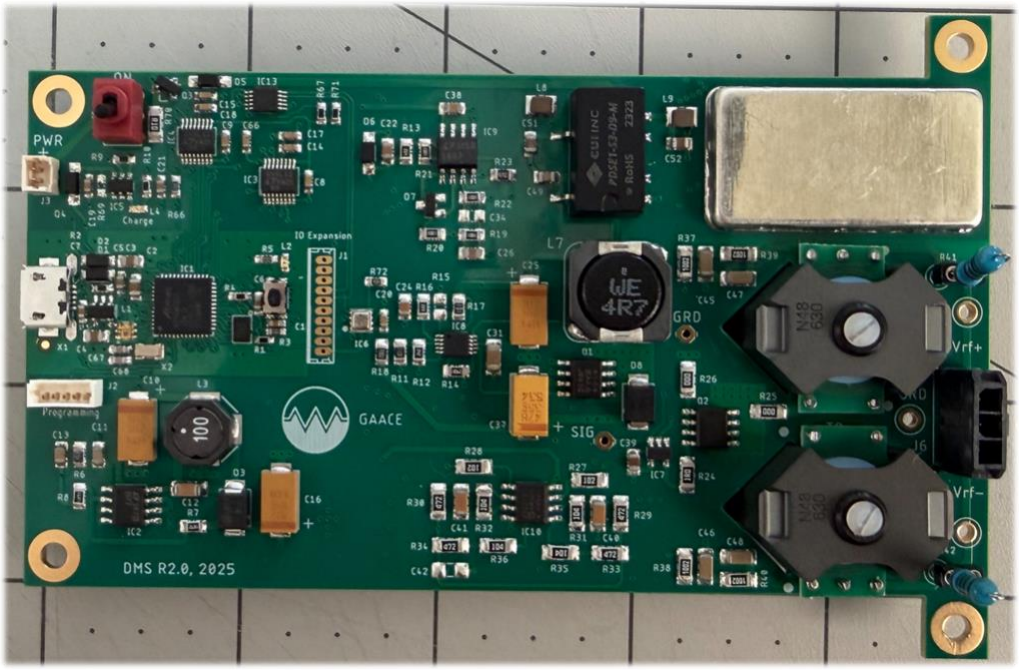
Next, you can start the bootloader. There are two methods to do this: enter the command BLOAD or press the reset button twice in rapid succession. When the bootloader is running, the L2 LED will start strobing, and you'll also notice a new thumb drive appearing on your host computer.

To load the new firmware, drag and drop the .uf2 file onto the thumb drive that appears on your host computer. Please only use .uf2 firmware files provided by GAACE.

After new firmware has been loaded it will contain factory default setting including default calibration parameters. The LOADF command will load all the previous firmware setting and calibration data. If the firmware update has changed the internal data storage structure then the LOADF command will fail and return and error message, if this happen issue the LOADCAL command to load only the calibration data from the previous firmware version.

Finally, ensure you enter the SAVE command to save the setting to the microcontroller's flash memory. This will automatically load the parameter when the system starts.

DMS module connections, top of board



Power

The power connector is a Molex Picoblade 2-pin connector. The module includes a mating connector with pigtails. This mating connector is a Molex part number 0151340200. The positive pin is marked on the PCB. Please exercise caution when connecting a power source, as the input is not reverse polarity protected.

The power input is designed to accept a single cell Li-poly battery with a nominal voltage of 3.7V.

USB

The USB connector accepts a USB micro-style connector and is designed to connect to a host PC or MAC computer. This USB 2 interface supports serial communications and a thumb drive interface, enabling the host computer to read data files collected by the DMS module.

The USB interface can charge the attached Li-poly battery. The battery will charge regardless of whether the power switch is on or off.

Even when the power switch is off, the USB interface powers the control and the 3.3V logic of the DMS module.

Power switch

The power switch is situated in the upper left corner of the printed circuit board (PCB), marked with the “On” position. This switch supplies battery power to the dual electrometer, the CV voltage drivers, and the Vrf high voltage drive system.

Charge LED

An orange charge LED, situated near the power switch, will illuminate when the battery is being charged via the USB interface.

Status LED

A multi-colored LED, situated near the USB connector, serves as a status indicator for the DMS module. When the system is initialized and ready for operation, this LED will display a green light.

L2 LED

The red L2 LED will flash once when the DMS system starts up. It will also strobe on and off when the DMS controller is in the bootloader mode.

Vrf output connector

The Vrf output signals are available on a 3-pin Molex connector. The center pin is grounded, while Vrf+ is on pin 1 and Vrf- is on pin 3. The matting connector, a Molex part number 0436450300, uses Molex crimp pins 0430300007. The matting connector and its pins are included with the DMS module.

Pogo pin option

PCB mounting holes are provided for spring-loaded contact pins (pogo pins). These pins can be installed in the factor in pace of the Vrf output connector if this option better suits your application.

Mounting holes

The DMS module features four mounting holes, which can be utilized to securely attach the module to your system. These mounting holes are equipped with conductive pads that are connected to the circuit ground of the DMS system.

Programming

The 5-pin picoblade programming connector is used in the factory to program the bootloader into the ARM M4 microcontroller. This is a JTAG port that is exclusively intended for initial system setup in the factory.

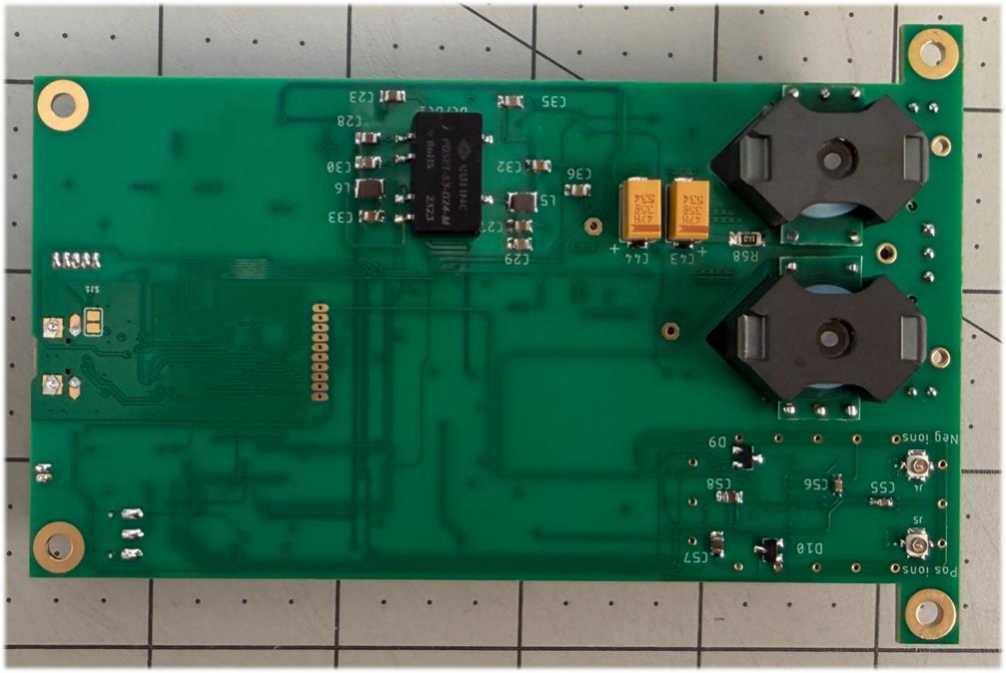
Reset button

The reset button, located near the Expansion connector, is used to restart the DMS application and initiate the bootloader. Pressing the reset button once will restart the DMS application, while pressing it twice in rapid succession will start the bootloader. If the bootloader has successfully started, the L2 will strobe on and off.

IO Expansion

The IO expansion port, a 10-pin picoblade connector, provides a variety of control signals and a communication port for interfacing with external systems.

DMS module connections, Bottom of board



Pos ions

Neg ions

The Pos and Neg ion connectors serve as inputs to the two electrometer channels. These inputs utilize miniature coax connectors, specifically the TE Connectivity Linx part number CONMHF1-SMD-T. Cable assemblies are available in various lengths, including options to transition to other connector types. It is crucial to shield the electrometer signal to minimize noise pickup.

Appendix A, Host Computer Interface

The USB interface to the DMS module has two interfaces connected to the host computer: a virtual serial communication interface and a thumb drive interface. When the USB interface is connected to your host system, you will see a disk drive named DMS. This section explains the protocol and commands used by the USB virtual serial communication interface.

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

After receiving a command (after the CR or LF is received), DMS 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 DMS results in a message from DMS 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

GVER

Returns the firmware 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.

SNAME,*name*

This command will set the DMS module 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.

GNAME

Returns a string that contains the name of the DMS module system.

RESET

This command will cause the DMS module microcontroller to reboot.

GCMDS

This command will cause the DMS module to report a list of valid commands that it understands with a short description of the command.

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

The DMS module saves its parameters to flash memory, which is the same flash memory that stores the application firmware on the ARM M4 microcontroller. When the system powers up, the parameters are automatically loaded from this memory. However, any changes made to the system parameters must be saved, as they will be lost when the system restarts.

The parameters can also be saved to an external non-volatile flash memory chip, separate from the microcontroller. This memory chip is configured as a file system and becomes accessible to your host computer when the USB port is connected. This offers an alternative storage location for both the complete set of parameters and a copy of the system calibration parameters.

SAVE

This command saves the parameters of the DMS module to the flash memory.

RESTORE

This command reads the current settings from the flash memory. This restore operation is automatically performed when the system starts.

FORMAT

This command initializes the flash storage area and sets all its parameters to their default values. However, executing this command will result in the loss of the system calibration data, as this data is also stored in flash memory. Therefore, this command is intended solely for initial factory system setup.

SAVEF

This command saves the parameters of the DMS module to a non-volatile flash memory chip that is external to the microcontroller. This memory is not erased when the microcontroller firmware is updated.

LOADF

This command reads saved DMS module parameters from the non-volatile flash memory chip attached to the microcontroller. It loads the parameters saved using the SAVEF command.

SAVECAL

This command saves the calibration parameters of the DMS module to an external non-volatile flash memory chip, which is not erased when the microcontroller firmware is updated.

LOADCAL

This command reads the saved DMS module calibration parameters from the non-volatile flash memory chip, which is external to the microcontroller. It loads the parameters that were saved using the SAVECAL command.

FORMATFS

This command formats the non-volatile flash memory chip and initializes the file system. Consequently, all data saved on the flash file system will be lost. This command is intended for initial system setup in the factory and should never be used.

Time and date functions

The DMS module houses a crystal-controlled time and date clock that operates only when the DMS system is powered on. The following command enables setting and retrieving the time and date.

STIMEDATE,*value*

This command sets the time or date based on the user's input format. The expected time format is hh:mm:ss, and if the input matches this format, the time will be set. The expected date format is dd/mm/yyyy, and if the input matches this format, the date will be updated.

GTIME

This command returns the current time in the format of hh:mm:ss.

GDATE

This command returns the current date in the format of dd/mm/yyyy.

GTIMEDATE

This command will return a time and date string in the format of DDD, DD MMM YYYY hh:mm:ss.

DMS general commands

This section outlines general DMS commands used to configure and monitor DMS operating parameters.

ON

This command will turn on or apply power to the electrometer system, the CV voltage generation system, and the Vrf voltage generation system.

OFF

This command will turn off or remove power to the electrometer system, the CV voltage generation system, and the Vrf voltage generation system.

SENA,TRUE or FALSE

This command enables or disables the DMS system's Vrf generation. If set to TRUE, Vrf generation is enabled; if set to FALSE, it is disabled.

GENA

This command returns the state of Vrf enable, which is either TRUE or FALSE.

SMODE, TRUE or FALSE

This command toggles the Vrf closed-loop voltage control mode. When enabled, the system automatically adjusts the drive level to maintain a constant output voltage. When disabled, the Vrf level is determined solely by the drive level.

GMODE

This command returns a boolean value (TRUE or FALSE) indicating whether the Vrf is in closed-loop voltage control mode.

SFREQ,*value*

GFREQ

These commands allow you to set or retrieve the Vrf frequency in Hertz. The parameter *value* specifies the desired frequency.

SDUTY,*value*

GDUTY

These commands enable you to configure and monitor the fly-back transformer drive duty cycle. The duty cycle is expressed as a percentage and should typically range from 35 to 60 percent for normal operation. It's crucial to understand that this duty cycle pertains to the pulse driving the fly-back transformer's primary winding, not the Vrf output waveform. Modifying this value will influence the ripple of the Vrf waveform.

SDRV,*value*

GDRV

These commands enable you to specify the drive level applied to the Vrf generation fly-back transformer. This drive level is expressed as a percentage, with higher values resulting in higher output voltages.

SVRF,*value*

This command sets the Vrf output voltage to the requested value in Vpp. The output drive level is adjusted accordingly to achieve the desired voltage.

SVRFF,*value*

This command sets the Vrf output voltage to the requested value in Vpp. It utilizes a lookup table generated during the calibration process to rapidly achieve the desired voltage level.

GVRF

This command retrieves the requested VRF value entered using the SVRF or SVRFF command.

GVRFV

This command returns the actual Vrf voltage level detected by the level sensing electronics on the DMS module, expressed in Vpp.

GVBAT

This command displays the battery voltage in volts.

GPWR

This command returns the power in watts that is being drawn from the battery.

GCUR

This command displays the current in amperes being drawn from the battery.

Electrometer commands

The following commands enable the reading of data from the dual electrometers, setting bias levels, and executing the zero function.

RPOSELEC

This command will return the positive channel current of the electrometer in pA.

SPOSOFF,*value*

GPOSOFF

These commands set and report the electrometer's positive channel bias voltage. This voltage, adjustable from 0 to 5V, draws ions to the detection plate. The positive bias voltage is applied to the electrometer's input pin.

SPOSZERO,*value*

GPOSZERO

These commands set and report the offset voltage control used to zero any offset current on the positive electrometer channel. This voltage is automatically set when the electrometer zero function is executed.

RNEGELEC

This command will return the negative channel current of the electrometer in pA.

SNEGOFF,*value*

GNEGOFF

These commands set and report the electrometer's negative channel bias voltage. This voltage, adjustable from 0 to 5V, draws ions to the detection plate. The negative bias voltage is applied to the electrometer's input pin. Please note that the entered 0 to 5V represents the absolute value, while the actual bias voltage ranges from 0 to -5V.

SNEGZERO,*value*

GNEGZERO

These commands set and report the offset voltage control used to zero any offset current on the negative electrometer channel. This voltage is automatically set when the electrometer zero function is executed.

ELTMTRZERO

This command performs the zero function for both the positive and negative channels of the electrometer. By adjusting the positive and negative zero voltages, the measured current is reduced to a few pA.

DMS Limits

SMAXDRV,*value*

GMAXDRV

These commands enable you to set and report the maximum permissible drive level in percentage that can be applied in generating the Vrf waveform. This parameter is initially set to a safe level, so exercise caution when adjusting this limit.

DMS DC bias commands

SCV,*value*

GCV

These commands allow setting and reporting the CV voltage level, which is displayed on top of the Vrf outputs. The CV voltage range is -24 to 24V.

GCVV

This command will report the actual CV voltage detected by the DMS electronics.

SBIAS,*value*

GBIAS

These commands allow setting and reporting the Bias voltage level, which is superimposed on the Vrf outputs. The Bias voltage is a common voltage applied to both the Vrf+ and Vrf- outputs. The Bias voltage range is -24 to 24V.

GBIASV

This command will report the actual Bias voltage detected by the DMS electronics.

DMS scanning commands

SCVSTRT,*value*

GCVSTRT

These commands set and report the starting CV voltage used in a CV scan.

SCVEND,*value*

GCVEND

These commands set and report the ending CV voltage used in a CV scan.

SVRFSTRT,*value*

GVRFSTRT

These commands set and report the starting VRF voltage used in a multi-dimensional scan, where VRF is changed between each CV scan.

SVRFEND,*value*

GVRFEND

These commands set and report the ending VRF voltage used in a multi-dimensional scan, where VRF is changed between each CV scan.

SVRFSTEPS,*value*

GVRFSTEPS

These commands configure and provide information about the number of Vrf steps between the start and end of a multi-dimensional scan.

SSTEPDUR,*value*

GSTEPDUR

These commands set and report the step duration in milliseconds. This is the time the system will pause or delay at each CV point during a CV scan.

SNUMSTP,*value*

GNUMSTP

These commands set and report the number of voltage steps during a CV scan.

SCNSTRT

This command will start a scan.

SCNSTP

This command will stop a scan than is in progress.

SCANSTAT

This command will provide the status of a scan. It will output one of the following strings:

Idle	Indicates the scan system is in the idle state.
Finished	Indicates a scan has been completed.
Active	Indicates a CV scan is in progress.
Complete	Indicates a CV scan has completed.
Abort	Indicates an abort command stopped a scan.
Allocation failed	Indicates that memory could not be allocation for a scan.

Scan data read commands

DMS scan data is stored in the RAM memory of the ARM M4 microcontrollers. The following commands enable the host computer to access this data and inquire about its availability.

RSCNPOS,*scanNum,scanPoint,numValues*

This command reports positive electrometer data recorded during a scan. The *scanNum* parameter specifies the scan number to query, while the *scanPoint* parameter determines the starting index in the electrometer data array for reporting. The *numValues* parameter specifies the number of data points to report.

This command will output the requested data in ASCII format, separated by commas. The first number reported indicates the number of electrometer values that will follow.

RSCNNEG,*scanNum,scanPoint,numValues*

This command reports negative electrometer data recorded during a scan. The *scanNum* parameter specifies the scan number to query, while the *scanPoint* parameter determines the starting index in the electrometer data array for reporting. The *numValues* parameter specifies the number of data points to report.

This command will output the requested data in ASCII format, separated by commas. The first number reported indicates the number of electrometer values that will follow.

RNUMSCANS

This command reports the number of CV scans that have been recorded.

RSCNPTS,*scanNum*

This command provides the count of data points captured during the scan specified by *scanNum*.

Scan file IO command

SSCAN,*filename*

This command saves a completed scan that is currently in RAM to a data file specified by the *filename*.

RSCAN,*filename*

This command loads the scan data from a specified data file into RAM.

DIR,*filespec*

This command will display the files stored on the flash file system. The parameter *filespec* is optional and allows for wildcard searching, such as data.*.

DEL,*filespec*

This command will delete the files defined by the *filespec* parameter from the flash file system. The *filespec* parameter allows for wildcard file definitions, such as data.*.

MORE,*filename*

Schedule a scan and auto save

SCHEDULE,*basename,interval,number*

This command schedules a series of multi-dimensional scans. The parameter *basename* specifies the filename for saving the scan data to the flash file system. This filename will be appended with a numeric 4-digit extension corresponding to the scan number. The parameter *interval* specifies the time in seconds between scans. The parameter *number* specifies the total number of scans to acquire.

The status LED will turn blue while the scan data is being collected and stored.

STOP

This command will halt a scheduled set of scans.

ISSCH

This command returns TRUE if a scheduled scan operation is currently in progress, and FALSE otherwise.

GSCNNUM

The command will return the count of scans that have been completed in a scheduled scan process.

Environmental sensor commands

RENV

This command generates a report that displays all the environmental data available from the onboard sensor.

GTEMP

This command returns the temperature in degrees Celsius.

GPRESS

This command will provide the atmospheric pressure in hectopascals.

GHUM

This command returns the humidity percentage.

GALT

This command provides the pressure altitude in meters.

SALT,*meters*

This command enables the user to calibrate the pressure altitude by entering the current altitude in meters.

DMS calibration commands

CALDCBREF
CALDCB1
CALDCB2
CALVRF
CALDRV2VRF
SGAIN,*value*
GGAIN

Debug commands

TCC
TC1
ADCS

Appendix B, User Interface

The DMS system comprises a MIPS host application and a control panel designed to offer an interactive user interface for the DMS system. This interface enables users to control most DMS features, including scanning and displaying graphical data.

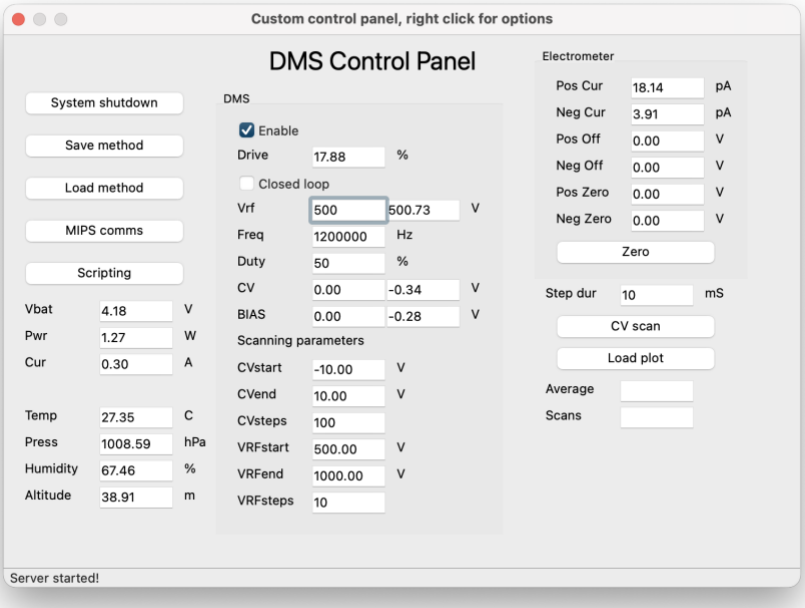
To install the host application, copy the MIPS folder and its contents to the C drive on your PC. Open the MIPS folder and double-click on the MIPS application. Ensure the MIPS system is powered up and attach the USB cables to your PC. Then, press the “Find MIPS and connect” button. The application will connect to your system.

To load the control panel, use the “Tools” -> “Load configuration…” menu option and select the DMS.cfg file from your MIPS folder. You can automate this loading process by using the properties dialog under the “Help” menu option.

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 screen captures of the control panel and some notes specific to your system. The MIPS application is a 64-bit application designed to run under Windows 10 or 11.

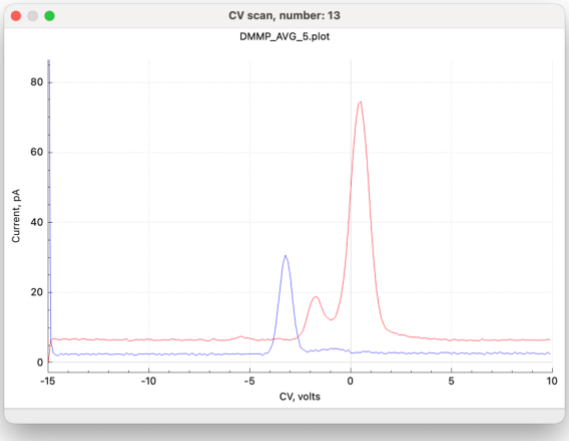
The following screenshot illustrates the graphical user interface (GUI) that appears when the DMS.cfg control panel is loaded by the MIPS application. This GUI utilizes the commands specified in Appendix A to communicate with the DMS module, offering a user-friendly interface for system interaction.

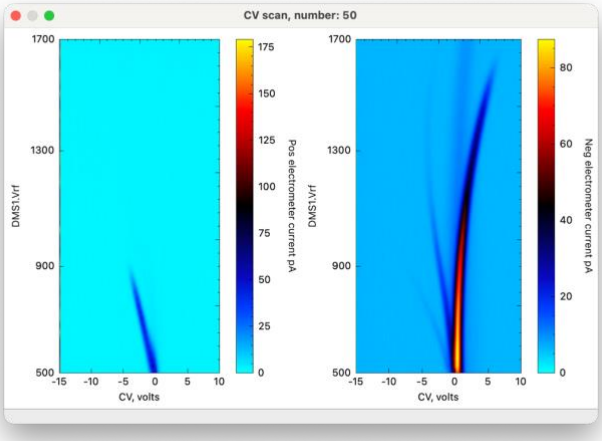


The MIPS comms button, when pressed, will display a terminal dialog box. This dialog enables the user to send any of the commands defined in Appendix A to the DMS module and displays the response. However, please note that when this dialog box is displayed, the GUI communication with DMS will be temporarily halted.

The DMS.cfg control panel contains scripts that enable the reading of multi-dimensional scan data from the DMS module and its display as either individual CV scans or as a headmap that visualizes all the data in a single presentation. The CV scans are presented as shown in the left image below. The keyboard arrow keys can be used to navigate through all the CV scans in the multi-dimensional scan. Right-clicking the display will present a selection menu that offers various options, including filtering and converting the data to a heatmap, as shown in the right image.

Pressing the CV scan button initiates a scan on the DMS module, and the data is displayed once the plot is complete. The plot data can be saved by right-clicking on the display and selecting the save option. Additionally, the Load plot button enables the user to load and display a previously saved plot.





Warrantee

GAA Custom Electronics, LLC warrantees the DMS module 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.

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