ELECTRONICS & DEFENSE

MRO SERIES

Evaluation Kit Manual

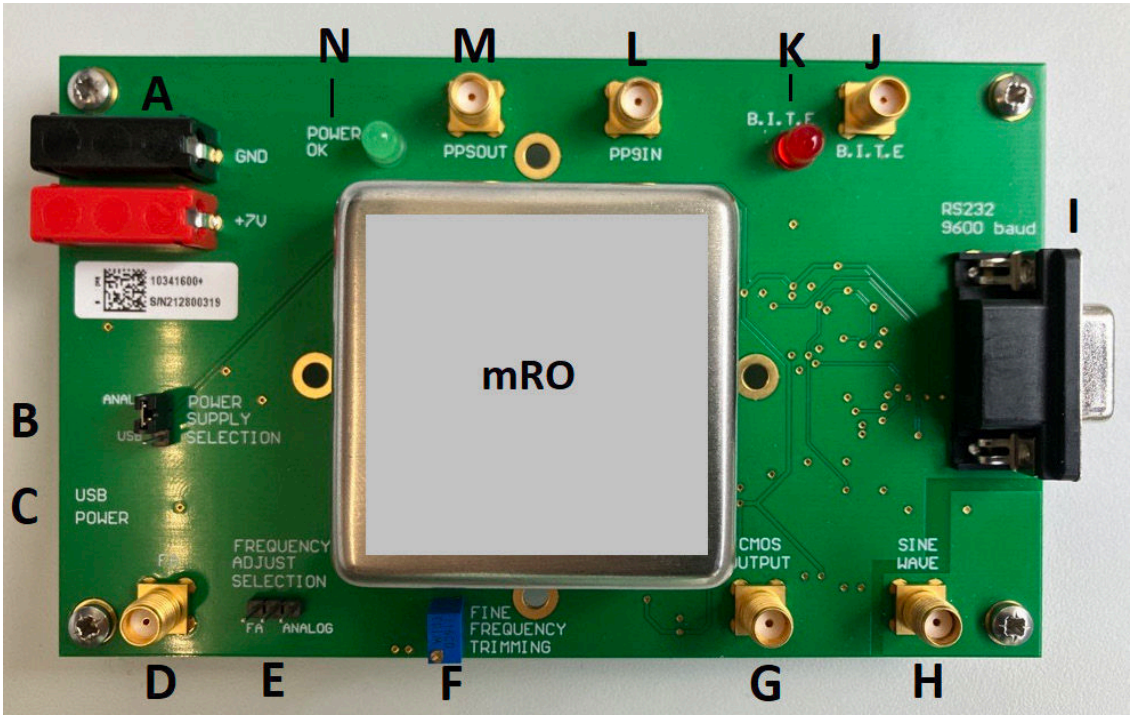
1. Introduction

The mRO-Series Evaluation Kit allows users to quickly interface an mR0-50 or mRO-50 Ruggedized miniaturized Rubidium Oscillator. Through the RS232 serial interface, the user can communicate with the mRO.

1.1. Designer Kit Serial

The mRO can connect to a PC via the RS232 port. During warmup time, which takes about 70 seconds, the mRO delivers data in calibration mode. The PC interrogates the mRO, which sends back data, allowing for evaluation of the system.

2. Board Description



Evaluation board with mRO

A. Power supply with stabilized power unit +7Volts
B. Power selector: give the ability to supply the mRO with a stabilized power supply unit(A) or from an USB PORT (C) coming from a personal computer
C. USB power to supply the mRO with a personal computer (USB voltage is around +5V)
D. Voltage frequency shift (from 0.5V min to 2.5V max) allows a +/- 8 ppb shift
E. Frequency adjust selector (Mechanical trimming (F) or external voltage frequency shift input (D))
F. Mechanical frequency trimming allows a +/- 10 ppb shift
G. CMOS OUTPUT (0Vmin-5Vmax)
H. SINE WAVE OUTPUT (+5 dBm)
I. RS232 9600 Bauds
J. B.I.T.E OUTPUT (TTL logic)
K. B.I.T.E OUTPUT LIGHT: light off when lock
L. PPS IN (0V-5V): not used
M. PPS OUT (0V-3V not loaded): not used
N. POWER SUPPLY LIGHT

3. Operating & Hardware System Requirements

The following supplies are required:

1. Microsoft Windows operating systems requirements:
   - Windows 10-64 Bits or Windows 11-64 Bits
   - Screen Resolution: at least 1680x1050
   - A free serial port (RS232, 9 pin Sub-D)
2. A 7V/0.5A properly filtered power supply, and a power cable with two wires of different colors.
3. USB socket coming from the PC is strong enough to supply the mRO even during warmup time if there is no power supply available.
4. A serial cable with 9 pin Sub-D connectors. One connector male, the other female.
   - Pin 2 connected to pin 2.
   - Pin 3 connected to pin 3.
   - Pin 5 connected to pin 5.
5. A frequency counter with an external reference input.

4. Installation Procedure

4.1. Safety

Warning: Use proper ESD precautions.

Warning: Ensure that all cables are properly connected.

The equipment contains small quantities of rubidium metal hermetically sealed inside the glass lamp and cell assemblies, hence, any dangers arising from ionizing radiation are caused for human health (exemption set in article 3 to Council directive 96/29/Euratom).

Handling the product in reasonably foreseeable conditions does not cause any risk for human health, exposure to the SVHC (substances of very high concern) would require grinding the component up.

4.2. Environmental Responsibility

The equipment contains materials, which can be either re-used or recycled.

Do not deposit the equipment as unsorted municipal waste. Leave it at an authorized local WEEE collection point or return to Safran to ensure proper disposal. In case of disposal by Safran, the costs related to return freight will be charged to the sender.

To return the appliance:

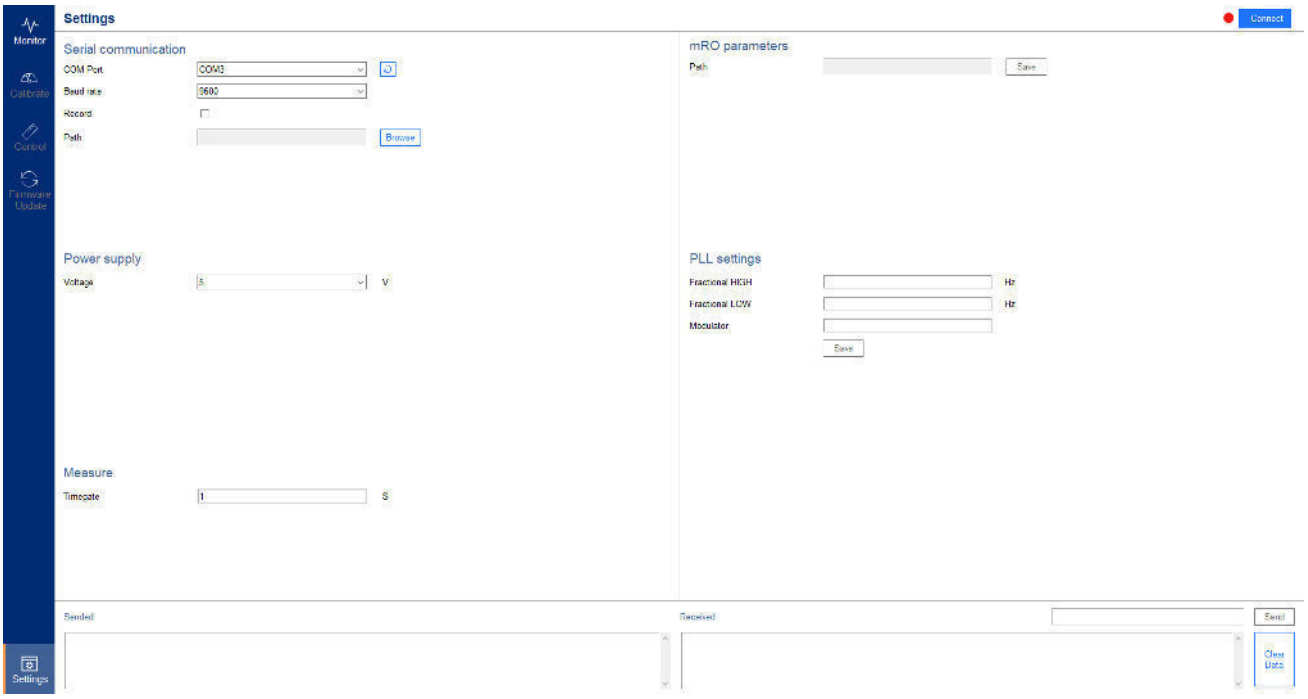
Submit a support ticket at https://safran-navigation-timing.com/support-hub/

We will contact you for more information and/or with shipment process details.

5. Safran mRO application control software

5.1. Setup

Start the executable **SpectraMon v3.0.0.exe** (can take up to 20s to execute) and open the **Settings** window.

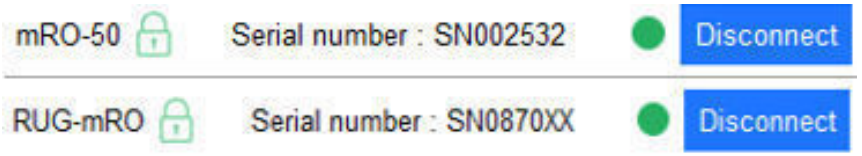


Settings window

Select the available COM port connected to the evaluation board and press Connect:

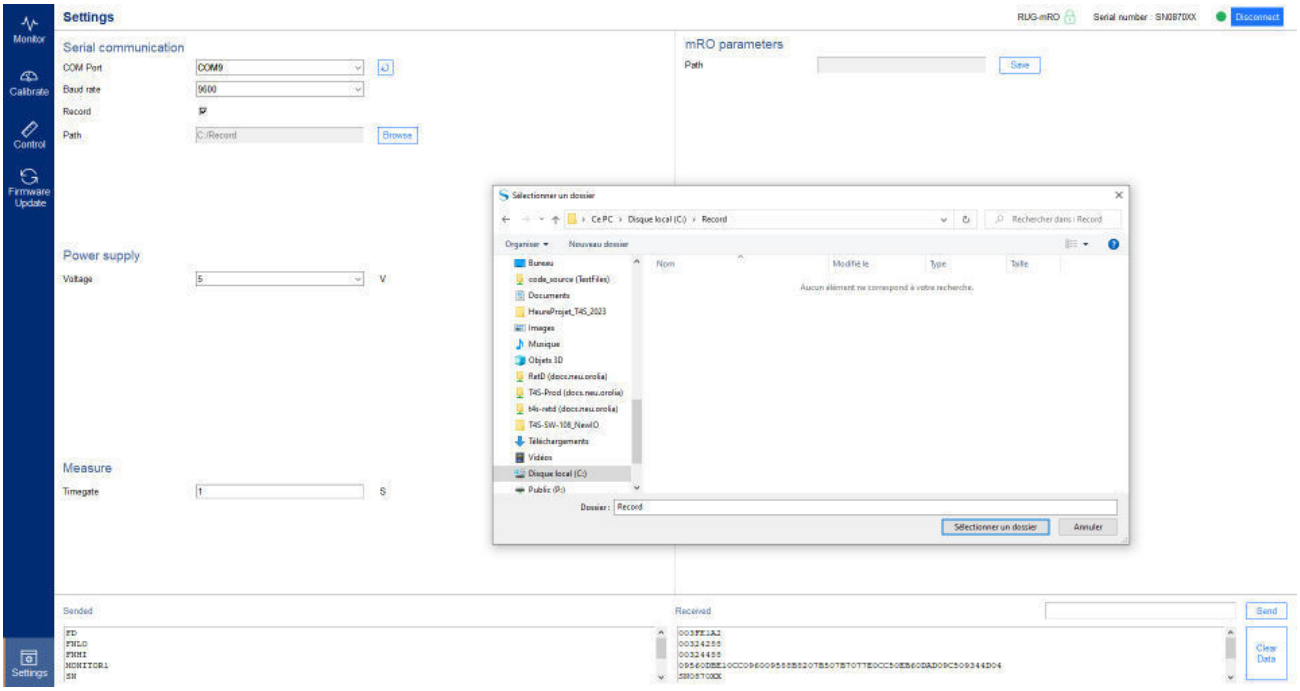
Connect button

The software will automatically detect the type of mRO (mRO-50 or mRO-50 Ruggedized). The type of the mRO and the serial number will be display at the left of **Connection** button.



mRO detection type

To record data coming from the mRO, select the filename path, and check the **Record** box.

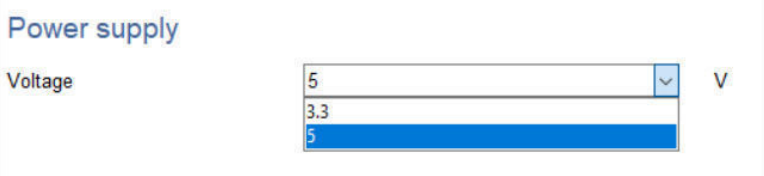


Data record

All data parameters coming from the mRO can be recorded inside a dedicated "record file" according to the timegate. The software records 27 parameters:

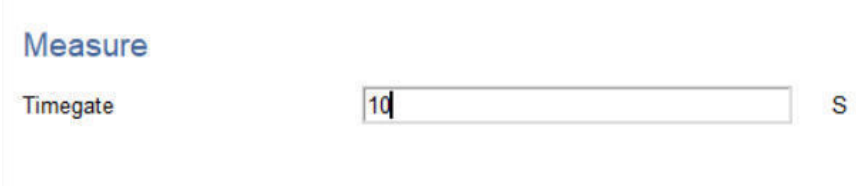
1. Unix_Timestamp: System (PC) time in seconds
2. IPhot(int): Photodiode data measured by the mRO, this is an int value
3. Atomic_SIGNAL_MIDDLE_RANGE (int) Satom 15: signal level data on the first side of the Rubidium line
4. Atomic_SIGNAL_UPPER_RANGE (int) Satom 31: signal level data on the second side of the Rubidium line
5. Heating_Power_Laser (int): heating power dissipated in order to warm the laser diode
6. Heating_Power_Rb_cell (int): heating power dissipated in order to warm the Rb cell.
7. Laser_source (int): voltage supply of the unit powering the laser diode of the mRO
8. Laser_Voltage (int): laser voltage, measured by the mRO
9. MiniRb_Temperature (int): temperature signal of the mRO
10. Voltage_control_TCXO (int): DAC value connected to the 10 MHz TCXO voltage control input
11. CFIELD (micro-Amp): current flowing through the magnetic coil in micro-Amp
12. Temperature cell setting (int): temperature setting point of the Rb Cell
13. Temperature laser setting (int): temperature setting point of the laser
14. Pil Laser (int): polarization of the power amplifier which drive the laser
15. PIL_CFIELD (int): polarization of the power stage which drive the current flowing through the magnetic coil
16. PIL Polar AOP (int): pre-polarization of the power stage which drive the laser
17. PIL VC: TCXO voltage control input
18. Status: mRO status
19. Rb_cell_temperature_setting point (°C): temperature of the rubidium cell
20. Laser_temperature_setting point (°C): temperature of the laser
21. MiniRb_Temperature (°C): temperature of the mRO
22. Laser_current (micro-Amp): current flowing through the laser diode.
23. Photodiode current (nano-Amp): current flowing through the photodiode.
24. Heating_Power_Rb_cell (mWatt): heating power dissipated to warm the Rubidium cell
25. Heating_Power_Laser (mWatt): heating power dissipated in order to warm the Laser
26. Cell heating current (mA): Current in milliAmp flowing through the heating system of the Rb cell
27. Laser heating current (mA): Current in milliAmp flowing through the laser heating system.

The **Power supply** of the mRO can be selected, it gives the ability to the software to compute the right power dissipated by the Rb-cell heating system and laser heating system.



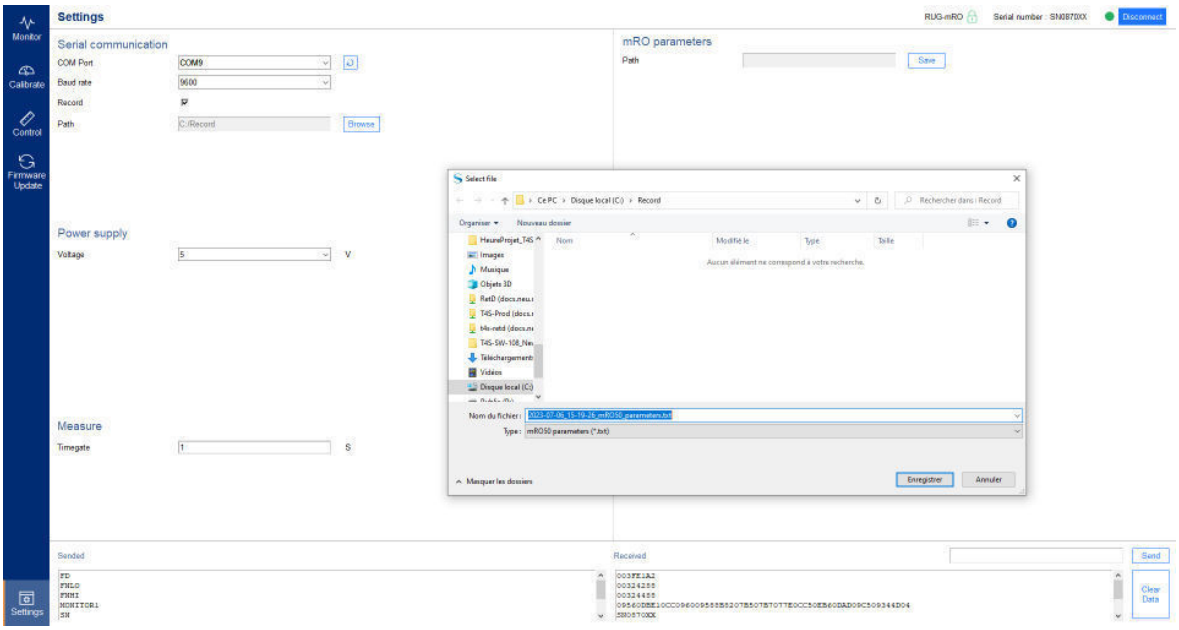
Power supply selection

The mRO will be contacted according to the Timegate parameter (configured in seconds).



Timegate selection

The mRO memory can be recorded inside a dedicated "mRO parameters" file. Select **Save** to record these parameters.

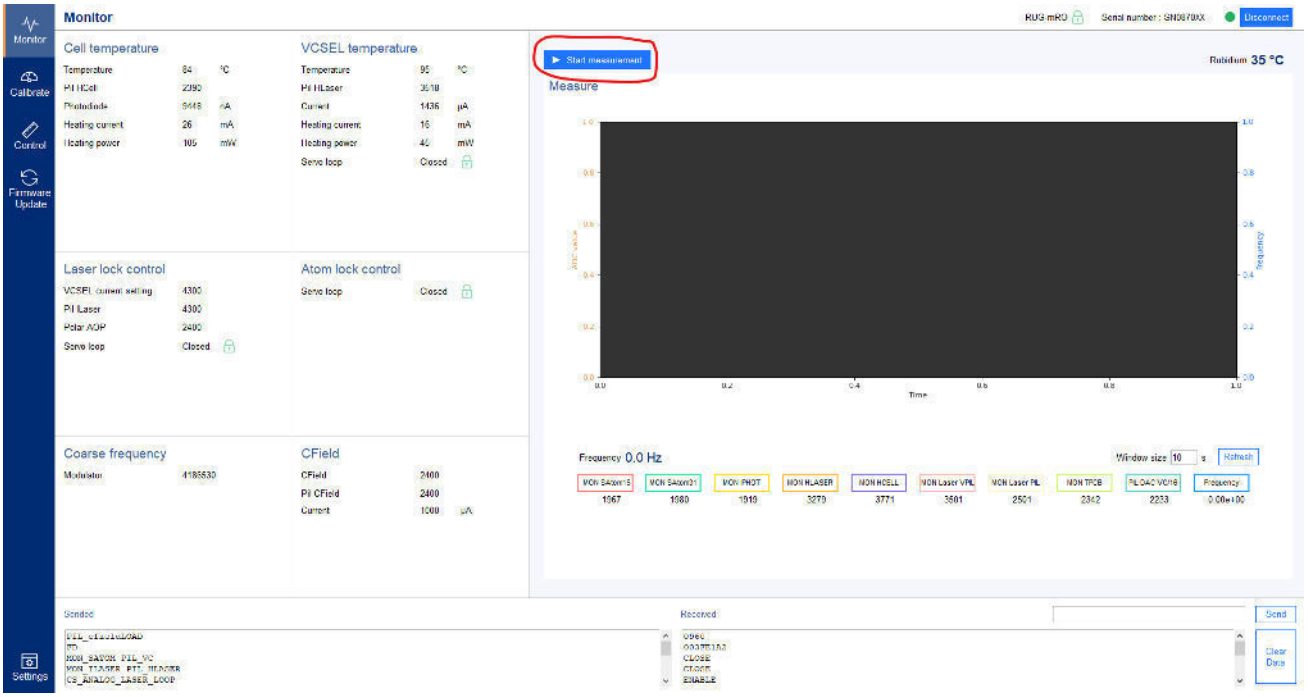


Memory record

When the software is executed, an **ApplicationControlSettings.ini** file is created in the same path as the executable. This file saves the settings in the **Settings** window, so that when you restart the software, the settings configured will be the last settings used.

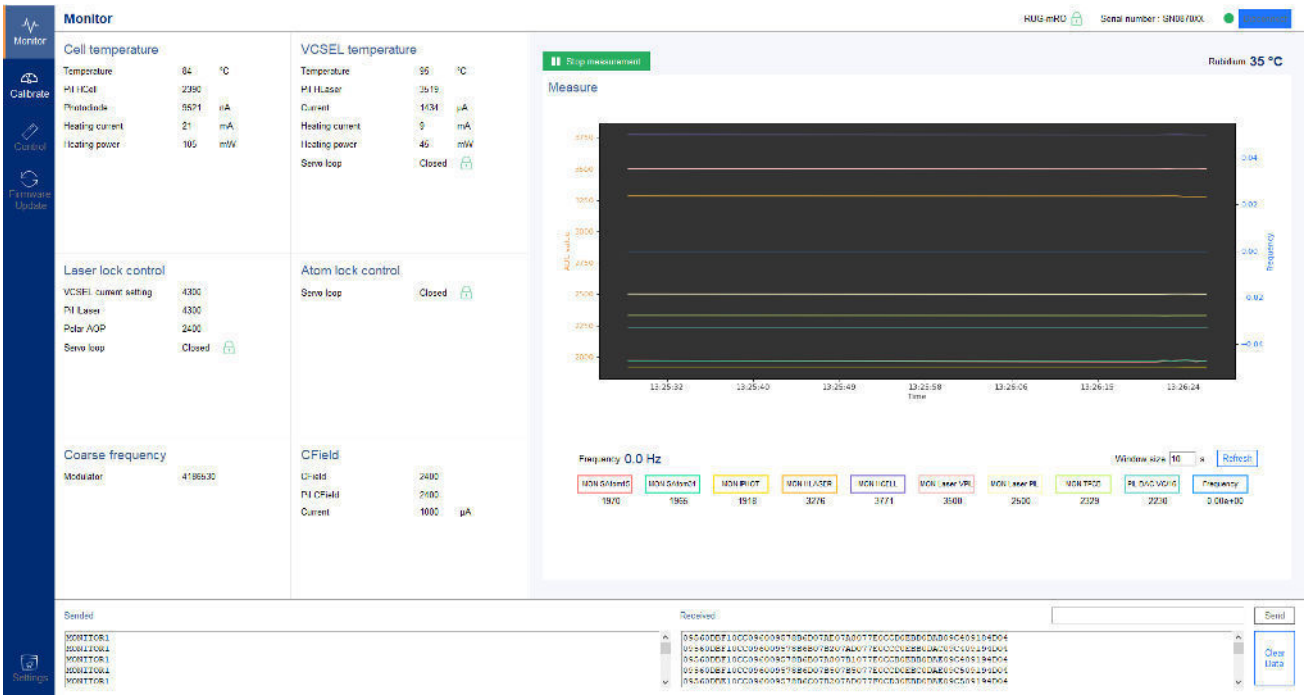
5.2. Safran mRO series application control monitor

To begin monitoring the mRO, open the **Monitor** window and select **Start Measurement**.



Monitor window

When the start button has been selected, data monitoring will plot to a graph in the **Measure** window.



Measurement ON

At the bottom left monitor box, the status of the commands sent to the mRO appears.

On the bottom right monitor box, items received by the mRO in HEX appear.

The content of both windows can be cleared by pressing **Clear Data** on the right side.

There is a moving graph on the right of the main window, with a sliding time window equals to 3 minutes (180 seconds).

The **Window size** can be set between 10 and 600 seconds.

Window size

On this graph, nine parameters are presented. All presented data are in a range going from 0 to 4095.

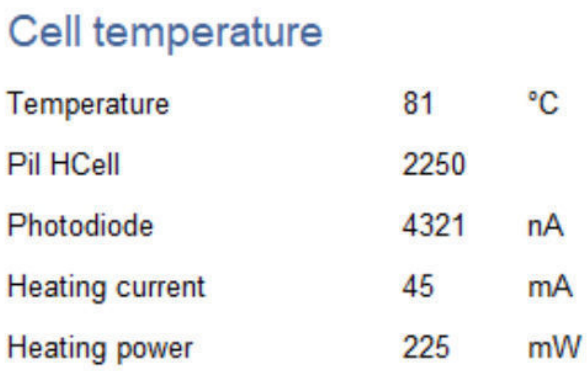
- **MON Satom15** and **MON Satom31** are samplings taken from the output of the photodiode amplifier used to center the mRO on the Rb line. Both values must be in the same range.
- **MON IPHOT** is the signal level output coming from the photodiode.
- **MON HLASER** is the heating system's level output, which drives the laser diode temperature.
- **MON HCELL** is the heating system's level output, which drives the Rubidium Cell temperature.
- **MON Laser VPIL** is the power stage level output, which drives the laser diode.
- **MON Laser PIL** is the laser diode voltage.
- **MON TPCB** is the temperature of mRO.
- **PIL DAC VC** for the mRO-50 is the 10 MHz TCXO voltage control input, which drives the atomic clock.
- **PIL DAC VC/16** for the mRO-50 Ruggedized is the 10 MHz TCXO voltage control input, which drives the atomic clock. It is divided by 16 for correct display in the graph.

All parameters presented on the graph can be toggled on and off by clicking on the corresponding parameter label at the bottom of the graph pane, that the user needs to visualize or hide respectively.

5.2.1. Cell temperature window

This window shows 5 parameters:

1. **Temperature**: the setting point temperature of the Rubidium cell
2. **Pil HCell**: the hexadecimal value of **Temperature**
3. **Photodiode**: the current flowing through the Photodiode, which collects light going through the Rubidium cell.
4. **Heating Current**: the current used by the heating system in order to warm the Rubidium cell.
5. **Heating Power**: the total power dedicated to warm the Rubidium cell.

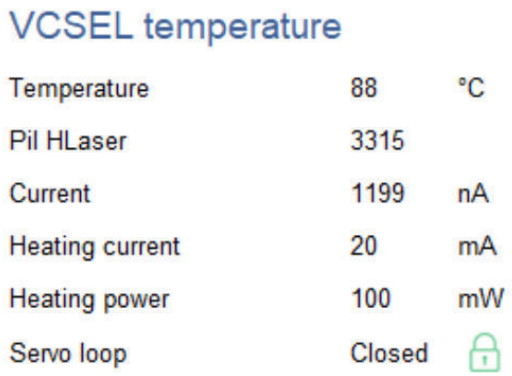


Cell temperature window

5.2.2. VCSEL temperature window

This box shows 5 parameters:

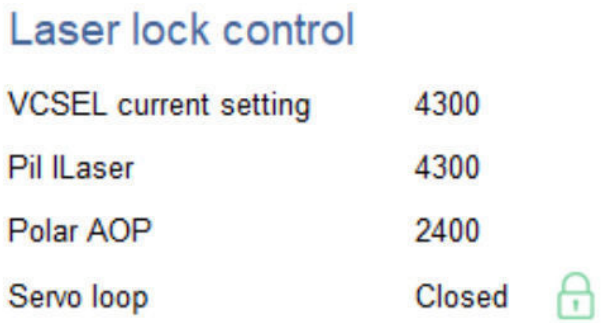
1. **Temperature**: the setting point temperature of the laser diode
2. **Pil HLaser**: the hexadecimal value of **Temperature**
3. **Current**: the current flowing through the laser diode, which emits the light going to the Rubidium cell.
4. **Heating current**: the heating used by the heating system in order to warm the laser diode.
5. **Heating Power**: the total power dedicated to warm the laser diode.
6. **Servo loop**: the Padlock shows the state of the laser loop.



VCSEL temperature window

5.2.3. Laser lock control window

This box shows the settings of the power amplifier, which is driving the laser diode. The padlock shows the state of the laser loop.



Laser lock control window

5.2.4. Atom lock control window

This box shows the status of the digital loop, which drives the VCTCXO 10MHz.

Atom lock control window

5.2.5. Coarse frequency window

This window shows the **Modulator** value of the digital PLL which drives the signal used in order to set the mRO output frequency according to the Rb line.

Coarse frequency box

5.2.6. CField window

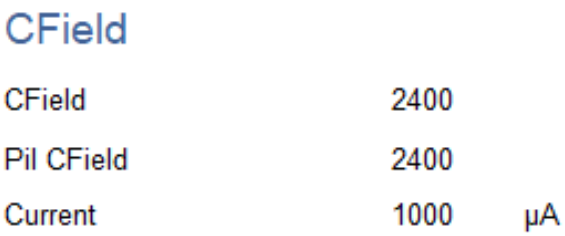
The mrO-50 **CField** window shows 4 parameters:

1. **CField** is the relative offset value used for the fine frequency adjustment.
2. **Pil CField** is the setting value of the power stage, which drives the current flowing through the magnetic coil.
3. **Current** is the current value of the magnetic coil.
4. **Servo loop** is the status of the CField loop

CField box window mRO-50

The mRO-50 Ruggedized **CField** window shows 3 parameters:

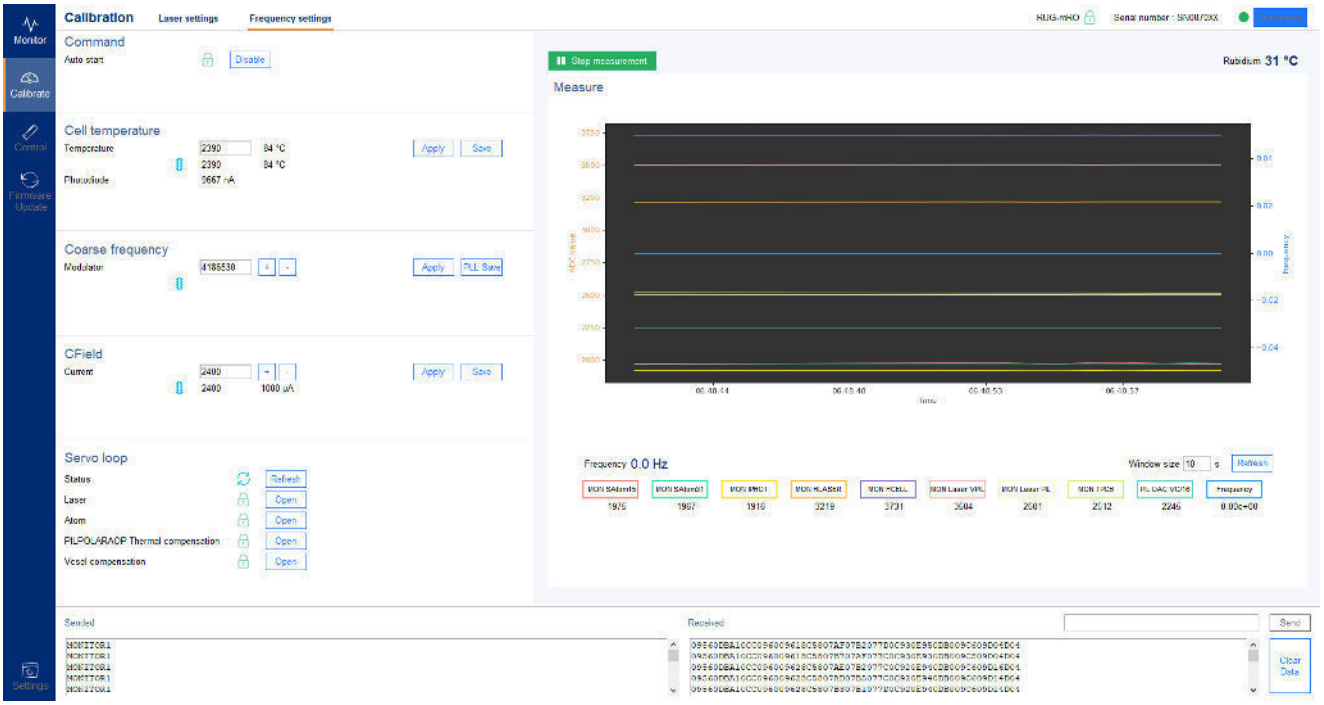
1. **CField** is the relative offset value used for the fine frequency adjustment.
2. **Pil CField** is the setting value of the power stage, which drives the current flowing through the magnetic coil.
3. **Current** is the current value of the magnetic coil.



CField window for mRO-50 Ruggedized

5.3. Frequency setting

Open the **Calibrate** window and navigate to the **Frequency settings** tab.



Frequency settings tab

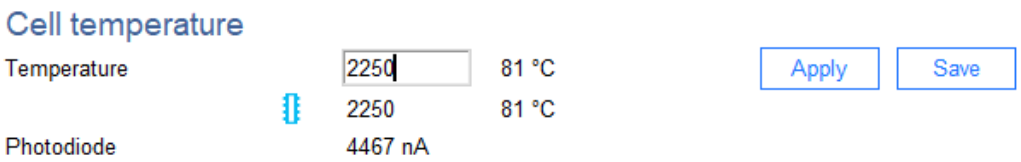
5.3.1. Command window

The **Command** window gives the ability to the mRO to lock automatically on the Rb line after power ON.

Command window

5.3.2. Cell temperature window

The **Cell temperature** window set the temperature of the Rb cell is set.



Cell temperature window

The higher is the temperature of the Rb cell, the lower is the photodiode current.

Apply: applies the value of the temperature box to the RAM of the microprocessor of the mRO.

Save: saves the value of the RAM inside the ROM of the microprocessor.

5.3.3. Coarse frequency window

This window allows the user to change the mRO frequency by 1.24 ppb step.

Coarse frequency window

Warning: It is highly recommended to set the frequency adjust selector of the evaluation board on FA and to let the SMA connector (D) free of any coaxial cable when the coarse and fine frequency setting are used.

The **+** and **–** buttons increase or decrease the modulator value, and act immediately on the frequency output of the mRO.

The **Modulator** value can be written and the **Apply** button can be pressed to apply the new **Modulator** value. It is highly recommended to not exceed +/- 500 steps relative to the original default value.

Wait at least 6 seconds after each new modification, as the mRO system needs time to change the frequency output due to the high-quality factor of the atomic loop.

The PLL modulator can set the mRO frequency output in a range of 9 999 995.00 to 10 000 005.00 Hz (+/- 500 ppb) without any stability degradation.

Select the **PLL Save** button to save the **Modulator** value inside the ROM of the microprocessor.

5.3.4. CField window

This window allows the user to modify the mRO frequency by about 2.5 ppt step. (0.0025 ppb). The CField value represents the current flowing through the magnetic coil.

CField window

Warning: It is highly recommended to set the frequency adjust selector of the evaluation board on FA and to let the SMA connector (D) free of any coaxial cable when the coarse and fine frequency setting are used.

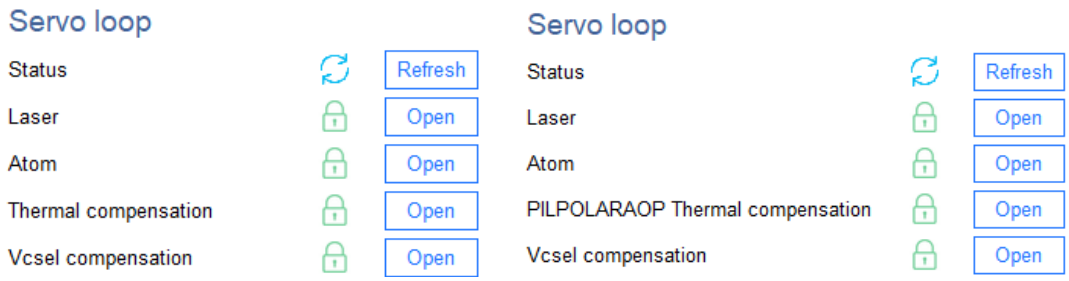
The **+** and **–** buttons increase or decrease the **CField** value, and also affect the frequency output of the mRO.

The **CField** value can be written and the **Apply** button can be pressed to apply the new **CField** value. When the frequency output is set in the appropriate range, the **Save** button is activated.

It is highly recommended to not exceed +/- 500 steps relative to the original default value.

5.3.5. Servo loop window

This box allows the user to open the 4 mains digitals loops of the mRO.



Servo loop window for mRO-50 (left) and mRO-50 Ruggedized (right)

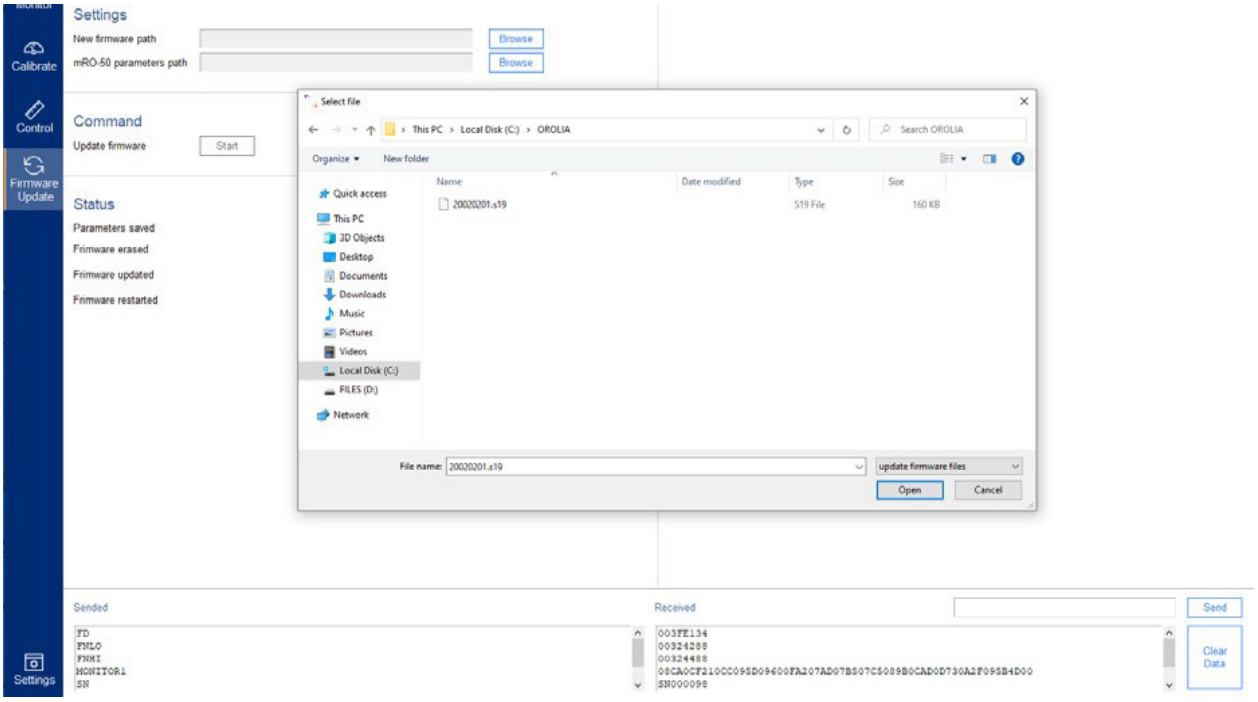
The **Vcsel compensation** loop can be opened without any condition, 10 minutes after power ON. The **Thermal compensation** and **PILPOLARAOP Thermal compensation** loop can be opened without any condition, 10 minutes after Power ON. The **Atom** loop can be opened without any condition, 10 minutes after power ON. It is not recommended to open the Laser loop.

The **Refresh** button requests the status of the 4 mains digitals loops from the mRO.

5.4. Update of the mRO firmware

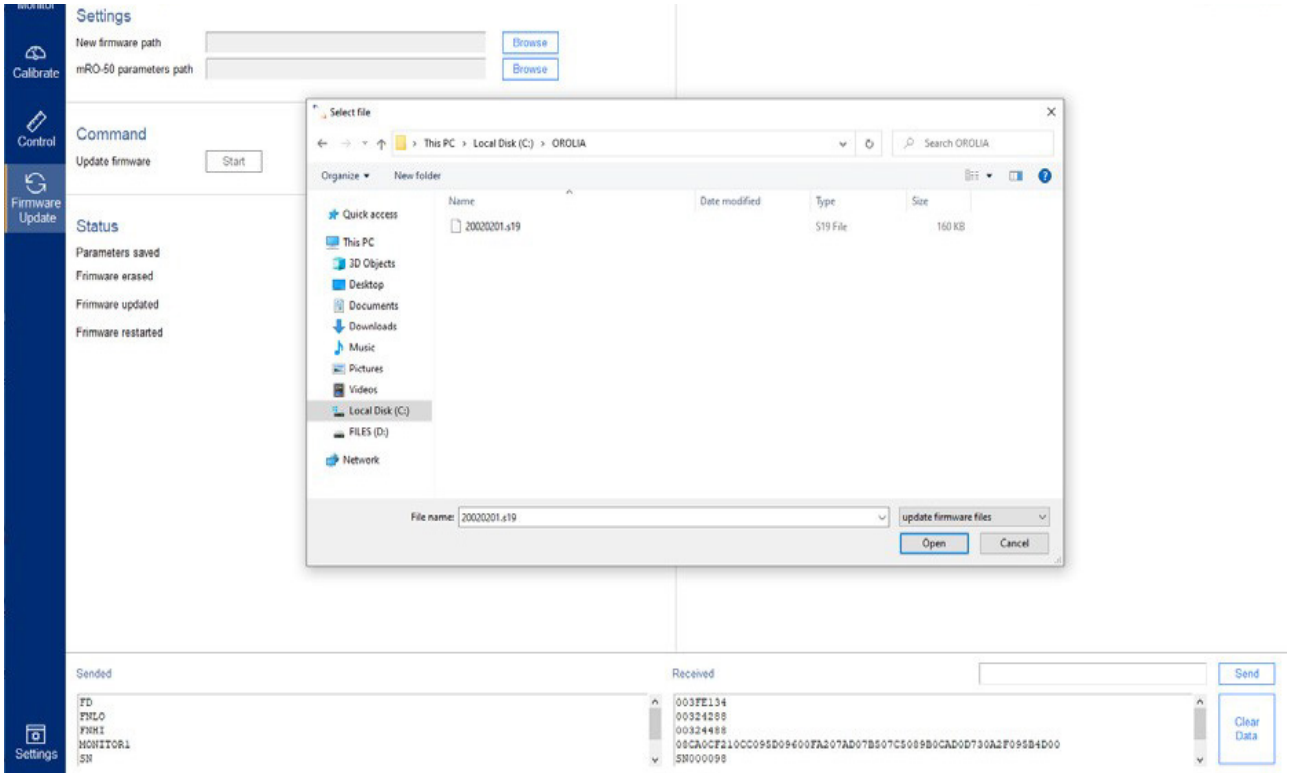
It is possible to erase and load a new firmware without erasing the data relative to the operating mode of the mRO.

To do that open the **Firmware update** window and select the path to the new firmware.



Firmware update window

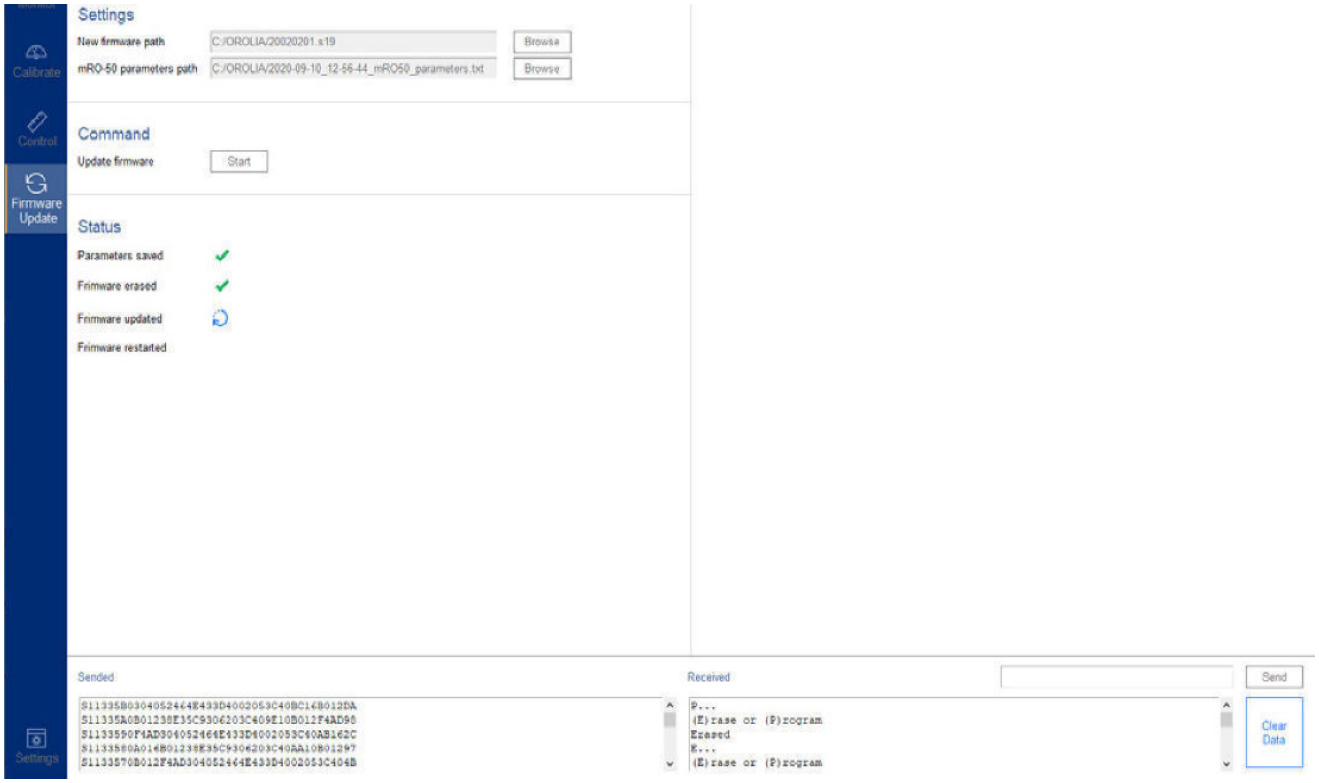
Select a path in order to save all parameters of the mRO and press **Start.**



Firmware update window

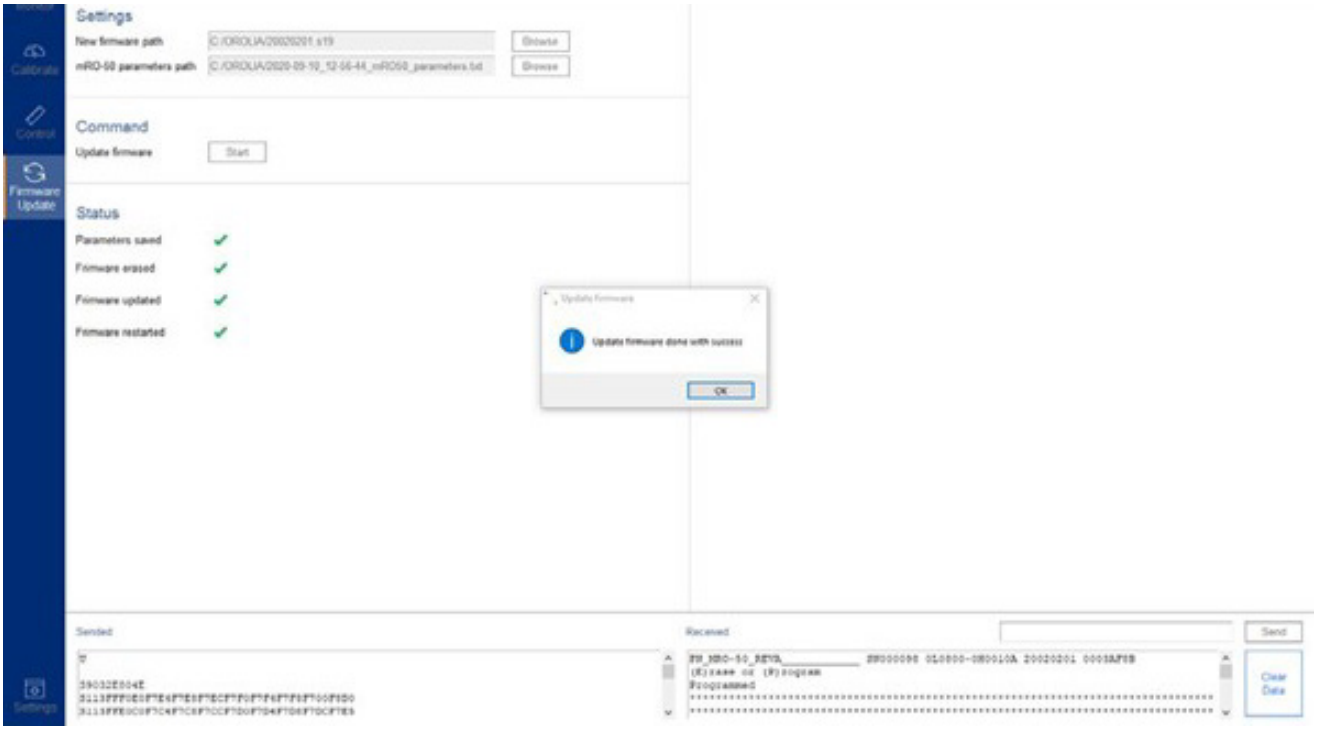
Firmware update ongoing, firmware is written inside the microprocessor.

It takes around 4 minutes maximum to update the mRO to new firmware.



Firmware update window

After that update is done, the mRO restarts automatically.



Firmware update window

6. Safran Technical Support

For technical support, product specifications, and additional documentation, you can visit https://safran-navigation-timing.com/support-hub/mro-50-support-hub/ to submit a support request.

More information on standard unit behavior or any other features or functions of the mRO series can be found on our website at https://safran-navigation-timing.com/product/mro-50/

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