Spectratime mRO-50 - Evaluation Kit
1. Board description

A → Power supply with stabilized power unit +7Volts
B → Power selector
   Give the ability to supply the Spectratime mRO-50 with a stabilized power supply unit(A) or from an
   USB PORT (C) coming from a Personal Computer
C → USB power in order to supply the Spectratime mRO-50 with a Personal Computer (USB Voltage is around +5V)
D → Voltage frequency shift (from 0.2 min to 0.8 Volts max) allows a +/- 10 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 → Sinewave OUTPUT (+5 dBm)
I → RS232 9600 Bauds
J → LOCK OUTPUT (0Vmin-5Vmax)
K → LOCK OUTPUT LIGHT
L → POWER SUPPLY LIGHT
2. Introduction
The kit allows users to quickly interface a Spectratime mRO-50. Through the RS232 serial interface, the user can communicate with the Spectratime mRO-50.

2.1. Designer Kit Serial
The mRO-50 can connect to a PC via the RS232 port. During warmup time, which takes about 70 seconds, the mRO-50 delivers data in calibration mode. The PC asks interrogates the Spectratime mRO-50 and the Spectratime mRO-50 is sends back data. During the warmup time, which takes 70 seconds, the Spectratime mRO-50 is in a calibration mode and delivers data.

3. Operating & Hardware System Requirements
The following Microsoft Windows operating systems requirements are needed:
- Windows 10–64 Bits.
- Screen Resolution: at least 1680x1050
- A free serial port (RS232, 9 pin Sub-D)

A 7V/0.5A properly filtered power supply. A power cable with two wires of different colors.

USB socket coming from the PC is enough strong in order to supply the Spectratime mRO-50 even during warmup time if there is no power supply available.

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.

A frequency counter with an external reference input.

4. Installation Procedure

4.1. Safety!
- Handling the product in a reasonably foreseeable conditions do 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 Orolia Switzerland SA to ensure proper disposal.
- To return the appliance:
5. Spectratime mRO-50 application control software

5.1. Setup

Open the Setting sheet.

The first thing to do is to select:

The available COM port connected to the evaluation board

and press Connect:
In order to record DATA coming from the Spectratime mRO-50, select the filename path, and check the box Record.
All Data parameters coming from the Spectratime mRO-50 rev A 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 Spectratime mRO-50, 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): is the voltage supply of the unit powering the laser diode of the Spectratime mRO-50
8. Laser_Voltage(int): Laser voltage, measured by the Spectratime mRO-50
9. MiniRb_Temperature(int): temperature signal of the Spectratime mRO-50
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): Polarisation 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: Spectratime mRO-50 status
19. Rb_cell_temperature_setting point(°C): Temperature of the Rubidium cell.
21. MiniRb_Temperature(°C): temperature of the Spectratime mRO-50
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 in order 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 heating system of the Laser
The power supply of the Spectratime mRO-50 revA 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.

It is possible to set the timegate in seconds, the Spectratime mRO-50 revA will be asked according to the timegate.

All the memory of the Spectratime mRO-50 can be recorded inside a dedicated “Spectratime mRO-50 parameters” file. Press “Save” in order to record parameters.
5.2 Spectratime mRO-50 application control presentation

Open the Monitor tab

Press “Start Measurement”
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.

On this graph, nine mains parameters are presented. All presented data are in a range going from 0 to 4096. Satom15 and Satom31 are samplings taken from the output of the photodiode amplifier used to center the Spectratime mRO-50 on the Rb line. Both values must be in the same range.

IPHOT is the signal level output coming from the photodiode.
HLASER is the heating system’s level output, which drives the laser diode temperature.
HCELL is the heating system’s level output, which drives the Rubidium Cell temperature.
Laser VPIL is the power stage level output, which drives the laser diode.
Laser PIL is the laser diode voltage.
TPCB is the Temperature of Spectratime mRO-50.
DAC VC is the 10 MHz TCXO voltage control input, which drives the atomic clock. It can be positive or negative, centered on 2048.

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 visualise or hide respectively.

1) Cell Temperature window

<table>
<thead>
<tr>
<th>Cell temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Pil HCell</td>
</tr>
<tr>
<td>Photodiode</td>
</tr>
<tr>
<td>Heating current</td>
</tr>
<tr>
<td>Heating power</td>
</tr>
</tbody>
</table>

This window shows 4 parameters.
1. Temperature: the setting point temperature of the Rubidium cell
2. Photodiode: the current flowing through the Photodiode, which collects light going through the Rubidium cell.
3. Heating Current: the current used by the heating system in order to warm the Rubidium cell.
4. Heating Power: the total power dedicated to warm the Rubidium cell.
2) VCSEL temperature window

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>88 °C</td>
</tr>
<tr>
<td>Pil HLaser</td>
<td>3315 nA</td>
</tr>
<tr>
<td>Current</td>
<td>1199 mA</td>
</tr>
<tr>
<td>Heating current</td>
<td>20 mA</td>
</tr>
<tr>
<td>Heating power</td>
<td>100 mW</td>
</tr>
<tr>
<td>Servo loop</td>
<td>Closed</td>
</tr>
</tbody>
</table>

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

3) Laser Lock control window.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCSEL current setting</td>
<td>4300</td>
</tr>
<tr>
<td>Pil ILaser</td>
<td>4300</td>
</tr>
<tr>
<td>Polar AOP</td>
<td>2400</td>
</tr>
<tr>
<td>Servo loop</td>
<td>Closed</td>
</tr>
</tbody>
</table>

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

4) Atom lock window.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo loop</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Shows the status of the digital loop, which drives the VCTCXO 10MHz.
5) Coarse and Fine frequency monitoring

<table>
<thead>
<tr>
<th>Coarse frequency</th>
<th>CField</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulator</td>
<td>4186420</td>
</tr>
<tr>
<td>CField</td>
<td>2304</td>
</tr>
<tr>
<td>Pil CField</td>
<td>2285</td>
</tr>
<tr>
<td>Current</td>
<td>1047 μA</td>
</tr>
<tr>
<td>Servo loop</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Coarse frequency window: this window shows the modulator value of the Digital PLL which drives the signal used in order to set the Spectratime mRO-50 rev A output frequency according to the Rb line.
CField window: CField is the relative offset value used for the fine frequency adjustment.
Pil CField: the setting value of the power stage, which drives the current flowing through the magnetic coil.
Current: the current value of the magnetic coil.
Servo loop: the status of the CField loop.
5.3. Frequency setting

Open the Calibrate Tab, and navigate to the Frequency settings Menu

1) The Command window gives the ability to the Spectratime mRO-50 rev A to lock automatically on the Rb line after power ON.

![Command window with options]

2) The cell temperature window set the temperature of the Rb cell is set.

![Cell temperature window with values]

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 Spectratime mRO-50.

**Save:** saves the Value of the RAM inside the ROM of the microprocessor.
3) Coarse frequency setup window

This window provides to the user the ability to change the Spectratime mRO-50 frequency by 1.2 ppb step.

**ATTENTION:** 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.

Buttons + and – are increasing or decreasing the modulator value.

Buttons + and – are acting immediately on the frequency output of the Spectratime mRO-50.

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

Wait at least 6 seconds after each change new modification, the Spectratime mRO-50 system requires to change the frequency output because of the high quality factor of the atomic loop.

The PLL modulator can set the Spectratime mRO-50 frequency output in a range of 9 999 995.00 to 10 000 005.00 Hz (+/- 500 ppb) without any stability degradation.

When the frequency output is set in a range of 9 999 999.99 to 10 000 000.01 Hz, the button **PLL Save** is activated.

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

4) CField window

This window provides the user with the ability to modify the Spectratime mRO-50 frequency by 3 ppt step. (0.003 ppb). CField is the current flowing through the magnetic coil.

**ATTENTION:** 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.

Buttons + and – are increasing or decreasing the CField value.

Buttons + and – are decreasing or increasing the frequency output of the Spectratime mRO-50.

The CField value can be written and the **Apply** button can be pressed in order 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 do not exceed +/- 500 steps relative to the original default value.
5) Servo loop window

This box gives the ability to the user to open the 4 mains digitals loops of the Spectratime mRO-50 revA. The vcsel Compensation loop can be opened without any condition, 10 minutes after Power ON. The 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.

Refresh button inquires the Spectratime mRO-50 on the status of the 4 mains digitals loops.
5.4. Update of the Spectratime mRO-50's firmware

It is possible to erase and load a new firmware without erasing the Data relative to the operating mode of the Spectratime mRO-50 revA.

Open the Firmware update sheet.

Select the path to the new firmware.

Select a path in order to save all parameters of the Spectratime mRO-50.
Press **Start**.

Update ongoing.

Firmware update ongoing, firmware is written inside the microprocessor. It takes around 4 minutes maximum in order to update the new firmware of the Spectratime mRO-50.
The Spectratime mRO-50 restarts automatically after the update.