EKSMA OPTICS

TG10

Timing Generator

User's manual

Vilnius
2022

CONTENTS

1.0 GENERAL INFORMATION

This document covers essential features and specifications of the TG10 device.

1.1 Short description

The TG10 module is a timing generator dedicated to the synchronization of laser components: AOM drivers, Pockels cell drivers, laser diode and flash lamp drivers, detectors, data acquisition systems, etc.

1.1.1 Applications

- Passive or active mode locked, Q-switched lasers, pulsed or QCW
- Data acquisition system triggering
- General purpose pulse generator
- Precise system clock source
- Laser pulse train converting to the clean clock source
- All functions above at once

1.1.2 Highlights

The following are the key features of the TG10 module in addition to standard pulse generator features:

- Ability to lock to an external clock source, usually photo-diode pulse train. Triggering system is locked to the laser oscillator then, and trigger time is always in phase with the optical pulse.
- Instant switch between two configurations in delay blocks. Burst counter, gate input, frequency divider or software commands may serve as the configuration

switching signal sources. Configuration switch is used to control optical pulse pickers (EO or AOM) in a highly flexible manner.

- Low jitter sync pulse output used for high-speed acquisition systems like streak camera triggering. Typical jitter is 3...5 ps with respect to the optical pulse.
- Control connector. Software-controllable multiplexer may divert any of the output signals to this connector to sniff what is on other connectors without disturbing them.
- Clock output: 1:1, 1:2 frequency.
- Up to 4 pulse outputs can be combined to single signals by OR, AND, NOT logical operations.
- DAC output, controlling, e.g., AOM pass though.

1.2 Digital control interface

The digital control interface is a CAN bus.

Protocol: proprietary EKSMA Optics protocol. Protocol description is provided on request.

1.3 General safety features

Do not open covers of the units. Warranty void if covers are removed without agreement from manufacturer. All service is done on manufacturer facilities.

Note: Cover of the device may reach up to 40° C in normal operation conditions.

2.0 GETTING STARTED

2.1 Hardware

2.1.1 Front panel

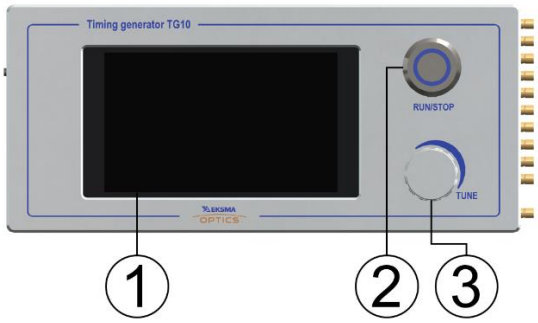


Figure 2.1 Front panel of TG10 device

1. **LCD touch screen:** Used to display and change parameters.
2. **RUN/STOP button with LED:** Used to start or stop the propagation of pulses. LED indicates the status of timing generator.
3. **TUNE knob:** Used to adjust selected value from the touch screen.

2.1.2 Back panel

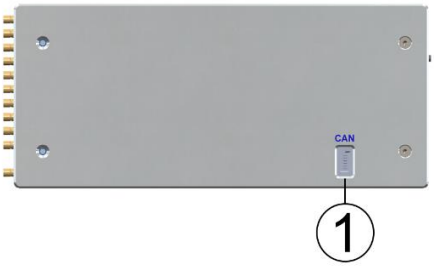


Figure 2.2 Back panel of TG10 device

1. **CAN bus:** Digital control interface. Protocol description is provided on request.

2.1.3 Right side panel

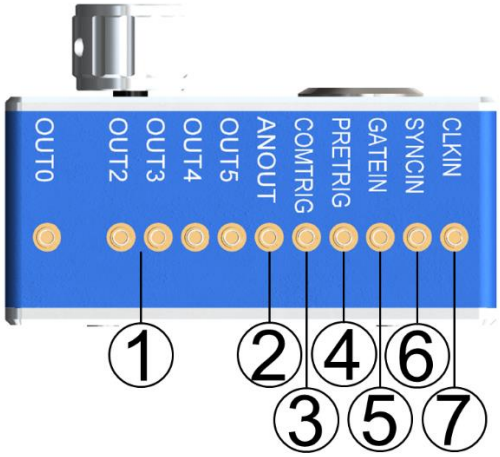


Figure 2.3 Right side of TG10 device

1. **OUTx:** Digital general-purpose output (4.5V @ 50Ω).
2. **AN OUT:** Analog output with 12-bit resolution (1V @ 50 Ω).
3. **COM TRIG:** Common trigger output. Configurable source (2.5V @ 50 Ω).
4. **PRE TRIG:** Precise trigger output. Configurable source (>1.5V @ 50 Ω).
5. **GATE IN:** Configuration switch and burst control input.
   (LVTTL, tolerates 5V. 0.2 mA pull down)
6. **SYNC IN:** Trigger input for DC to 20 MHz frequencies.
   (LVTTL, tolerates 5V. 0.2 mA pull down)
7. **CLK IN:** Clock input for 10 MHz to 100 MHz frequencies.
   (0.5V to 3.3V @ 50 Ω pk-pk, sine or pulses)

2.1.3 Left side panel

Figure 2.4 Left side of TG10 device

① **Power supply input:** Device has to be supplied with 12V±10% DC (10W max).

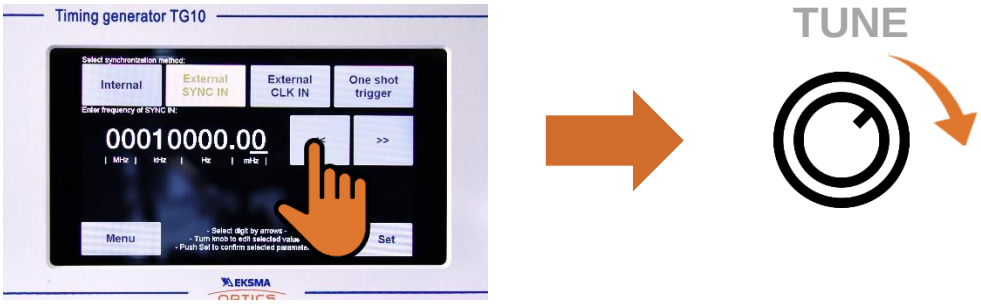
② **Power ON/OFF button:** Push to turn device on or off.

2.2 User interface

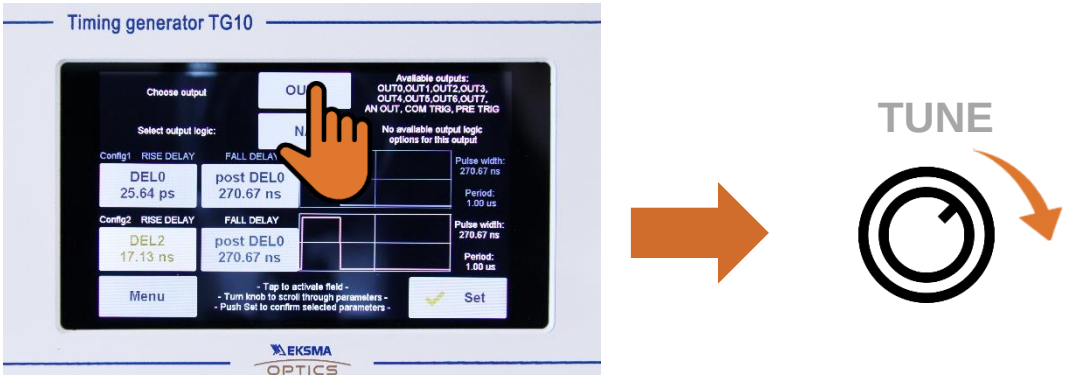
2.2.1 Interfacing the device

Interfacing the device is done via LCD touch screen and encoder knob. Instructions of required actions are always displayed at the bottom of the screen.

In order to change the numeric value in the interface:



In order to change values at the output section:



All other buttons require single tap in order to perform an action.

2.2.2 Menu screen

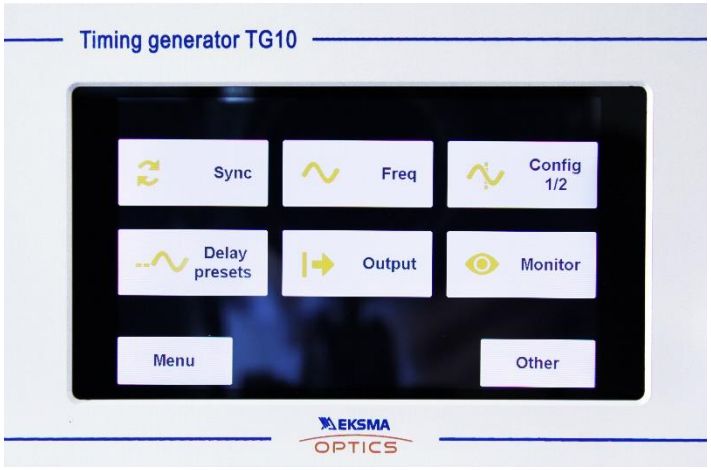


Figure 2.5 Menu window of the user interface

Menu screen presented in Figure 2.5 consists of segments:

- Sync – where desired clock and triggering system configurations can be set.
- Freq - where desired output frequency can be set.

- Config 1/2 – where ON/OFF control configuration can be set. ON/OFF control feature allows creating two pulse control configurations (Config1 and Config2) for each digital output (OUTX) and alternating them on the fly. Alternating can be done via GATE, Burst or FREQUENCY DIVIDER.
- Delay presets – where values of delay generators can be set. It contains 8 delay generators (presets) which are used for timing of rising and falling edges of the digital output (OUTX) pulse.
- Output - where output specific settings can be changed.
- Monitor – where all current device settings can be monitored.
- Menu – returns to main menu screen. Visible on all setting screens.
- Other – where external device presets and push trigger (software trigger) can be set.

2.2.3 Clock and triggering system configurations (Sync)

When Sync button is pressed four clock and triggering options appear:

- Internal – internal 100 MHz clock.
- External SINGLE IN – synchronization with single external signal source.
  - CLK IN – external clock source supplied through the CLK IN. Frequency of external signal source must be 10 MHz to 100 MHz.
  - SYNC IN – external trigger supplied through the SYNC IN. Frequency of external signal source must be 0.01 Hz to 20 MHz.
- External DUAL IN – external clock source supplied through the CLK IN and externally triggered by SYNC IN. SYNC IN signal supplied to the rate divider and reclocked to CLK IN. This feature is used when trigger with stable phase relation to the CLK IN is required (synchronization of multiple devices).
- One shot trigger – software forced internally clocked one-shot trigger. Two options available:
  - Software trigger – one shot software trigger. Button to force software trigger can be found in Other → Push trigger section.
  - Smart trigger – OR gate function on signals: OUT0, SYNC IN and Software trigger.

2.2.4 Output frequency (Freq)

When Freq button is pressed two options appear:

- Frequency – entered as frequency in hertz.
- Period – entered as period in seconds.

2.2.5 ON/OFF configuration (Config 1/2)

When Config 1/2 button is pressed ON/OFF control configuration options appear. This feature allows to have two pulse control configurations (Config1 – idle mode and Config2 - fire mode) and alternating them on the fly. Control configuration options available:

- Normal – steady state of Config2.
- Gate – altering between idle and firing by GATE IN logic. Two options available:
    - GATE – when GATE is low - Config1, if GATE is high - Config2.
    - nGATE – (inverted GATE) when GATE is low - Config2, if GATE is high - Config1.
- Burst – fire number of pulses set by the counter. Config2is active during burst, pause between burst – Config1.
    - SYNC IN - trigger on rising edge of SYNC IN pulse.
    - GATE - trigger on rising edge of GATE pulse.
    - nGATE - trigger on falling edge of GATE pulse.
    - Software - one shot software trigger. Button to force software trigger can be found in Other → Push trigger section.
- Frequency divider – division of output frequency. While count down Config1, overflow – Config2.

2.2.5 Delay generator configurations (Delay presets)

When Delay presets button is pressed window presented in Figure 2.6 appear.

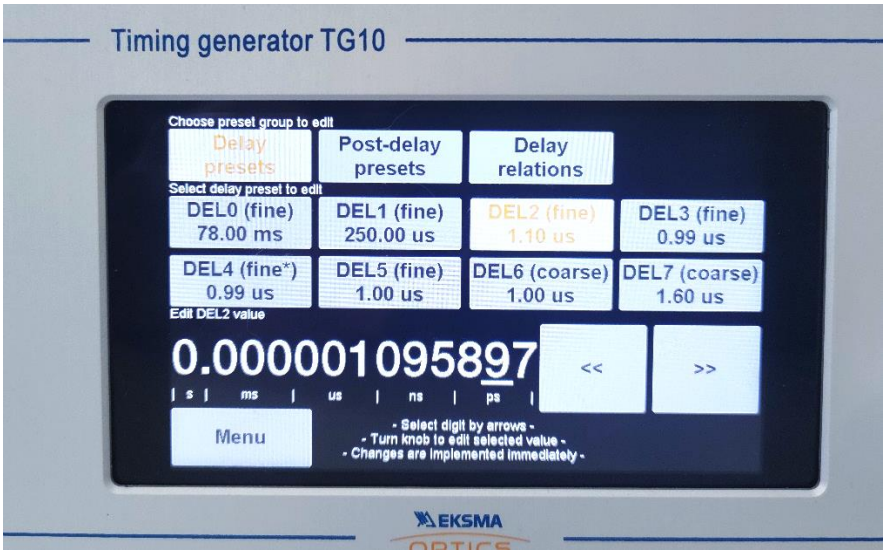


Figure 2.6 Delay preset window of the user interface

Delay generator produces pulses with programmable delay. Every delay period starts with the system trigger (T_0) signal and lasts for programmable time interval. 8 delay presets are available of which DEL0, DEL1, DEL2, DEL3 an DEL5 is full featured. DEL4 has a different clock frequency in relation to the other delay presets. DEL6 and DEL7 have separate coarse delay counters (resolution 9.4 ns) and share fine delay counter (resolution 25 ps).

Each delay counter has a post-delay counter Post counter starts to count after delay counter has reached '0'. If a post counter has to be used, output number should match the delay number. Example: If OUT2 has a rise delay set as DEL2, for the fall delay post DEL2 can be used.

Delay relations is a feature which allows the change of single delay preset have an impact on multiple other delay presets. This feature is software defined and as a result change of related delay presets are slow compared to using post-delay presets (which may result in unexpected preset-to-preset delay shifting if changes are made while pulses are propagating).

If external clock is used, clocks frequency is tied to external reference, therefor expect delay floating together with reference frequency. In this case, delay and phase is fixed in relation with reference clock.

2.2.6 Output specific configuration (Output)

When Output button is pressed window presented in Figure 2.7 appears.

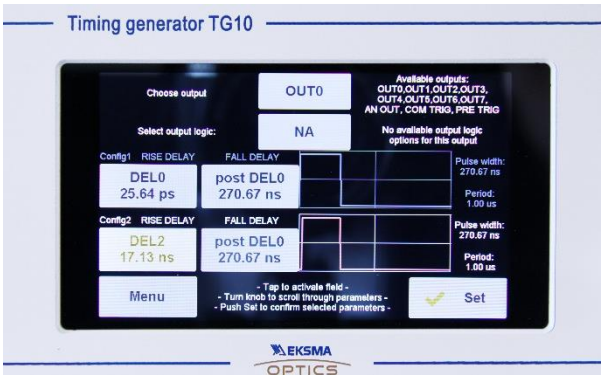


Figure 2.7 Delay preset window of the user interface

Available outputs are:

- OUTX – digital output;
- OUTX (internal) – digital output routed only internally.
- AN OUT - DAC output;
- COM TRIG – common trigger;
- PRE TRIG – precise trigger, locked to the optical clock.

Each digital output (OUTX) has two configurations (Config1 and Config2). They are enabled if ON/OFF control configuration uses both. Each configuration is composed of pulse rising edge and falling edge condition buttons (displayed as rise/fall delay). Current setting of condition button is displayed on the button. Simulated oscillogram of single period is shown of each configuration.

If condition buttons are pressed tune knob can be used to select desired value.

Any delay discussed in "Delay generator configurations (Delay presets)" chapter can be used as delay of the rising or falling edge. As well as few other options are available:

- post DELx – if a post counter will be used, delay and output numbers should match. Post counter starts to count after delay counter has reached '0'.

- No change – do not change the output state.
- Force set/reset – force set/reset of the output state.
- Trigger – trigger signal, very first pulse. All delays are calculated in respect to the pulse.
- Latch set/reset – set by software trigger. One shot trigger force button found in in Other → Push trigger section.
- GATE – GATE IN signal.
- nGATE – Inverted GATE IN signal.
- Delayed set/reset – signal from rising/falling edge condition delayed by several tens of nanoseconds. It allows generating shortest possible pulse at the output.

Additionally, digital outputs OUT2...OUT5 are connected to output multiplexers which allow performing OR, AND, NOT logic operations with OUT2...OUT5 output signals. For OR, AND, NOT logic operations multiplexers inputs are connected from neighboring (OUTX-1) output. One of possible uses of this feature is combining several pulses to the pulse train where delay and with of individual pulses may be adjusted. Up to 5 pulses can be combined into a train.

COM TRIG and PRE TRIG can be connected to any of OUTX outputs. In addition, OPT CLOCK and OPT CLOCK/2 are available at mux inputs.

PRE TRIG is locked to the optical clock. Delay is adjustable in optical clock period time units. Jitter in respect to the optical pulse is ~4 ps RMS, almost independent on delay.

DAC module allows having amplitude modulated pulses at AN OUT. Two amplitude levels are possible to program: DAC1 for Config1 and DAC2 for Config2.

Amplitude control word is loaded at the rising edge of the DAC data register trigger.

2.2.7 Parameter monitoring (Monitor)

When Monitor button is pressed window presented in Figure 2.8 appears.

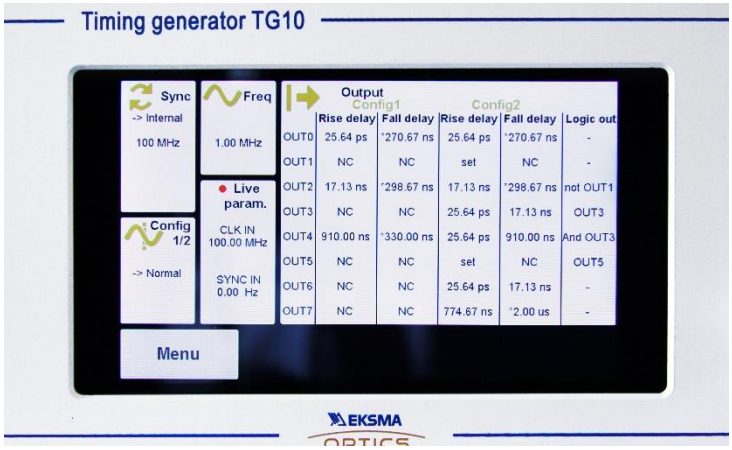
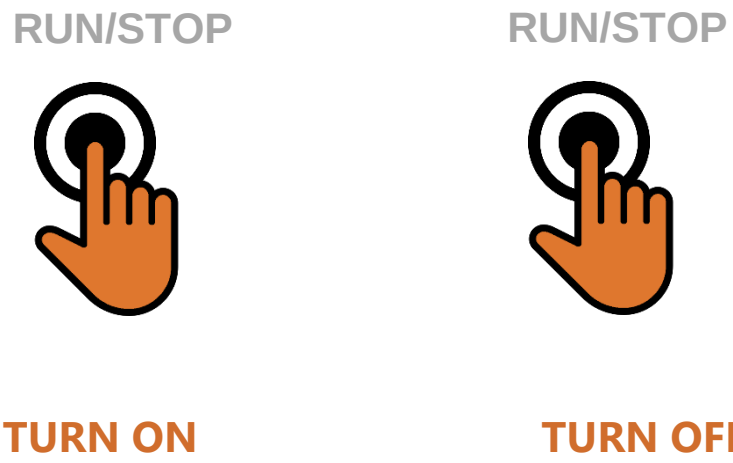


Figure 2.8 Monitor window of the user interface

Monitor window is split into sections: Sync, Freq, Output, Config, Live param. In each section current settings are displayed. Live parameters display frequencies at the input channels. Delays with '*' symbol are referred to post-delay.

2.2.8 Running and stopping the device



Push RUN/STOP button to start or stop the propagation of pulses.

3.0 SYSTEM SUMMARY

3.1 Technical Specifications

3.1 table. Device specifications

Parameter	***Specification***
Time base	
Internal source	100 MHz 0.2 ppm TCXO
External source, Optical clock	20…100 MHz
External source, Pulse width	>300 ps
External source, Amplitude	>100 mV
Internal rate generator	
Sources	100 MHz clock, Optical clock, SYNC IN, Software command
Rate (T0 period)	50 ns…100 s (0.01 Hz to 20 MHz)
Resolution	10 ns or 1 Optical period or 1 SYNC IN period
RMS jitter	<350 ps
External trigger, SYNC IN input	
System modes	Direct SYNC IN, SYNC IN re-clocked to Optical clock
Rate	DC to 20 MHz
Threshold	1.3 V
Input range	0…5 V
Trigger slope	rising edge
Pulse width	> 10 ns
RMS jitter, Direct SYNC IN	<120 ps
RMS jitter, SYNC IN re-clocked	<5 ns
Insertion delay	<80 ns
Delay generators	
Channels, total	8
High res channels	6
High res channels, resolution	25 ps
Low res channels	3

Parameter	***Specification***
Low res channels, resolution	<10 ns
Delay	0…150 ms
Pulse width	4 ns…150 ms
Accuracy, High res channel	2.5 ns + 0.000001 setpoint
Accuracy, Low res channel	≤10 ns + 0.000001 setpoint
RMS jitter, channel to channel	<30 ps TTL output, <4 ps PRET output
Configuration switch	
System modes	Single shot, burst, continuous, frequency divider, GATE IN, inverted GATE IN
Burst counter	1…65535
Frequency divider	1…32767
Outputs, TTL/COMS	
Voltage @50 Ω load	2.5 V or 4.5 V
Voltage @1 MΩ load	5 V or 9 V
Voltage selection 5V/9V	internal jumper
Impedance	50 Ω
Rise time	1.5 ns typ
Output, PRET	
Pulse amplitude @50 Ω load	>1 V
Impedance	50 Ω
Rise time	200 ps typ
Output, analog	
DAC resolution	12 bit
Max amplitude @50 Ω	1 V
Powering and physical specifications	
Voltage	12 V±10%
Power	15 W max
Dimensions	See Figure 3.1

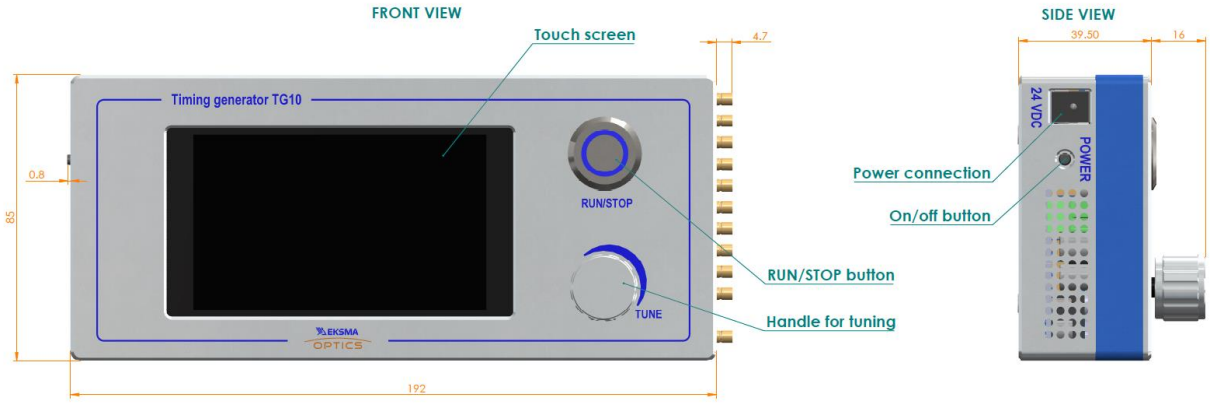


Figure 3.1 TG10 outside dimensions

3.2 Shutting Down

In order to stop the device, make sure that output pulses are not generated (RUN/STOP buttons led indicator is off). Device will turn off if the POWER button is pressed.

3.3 Warranty

Device is protected by one-year warranty covering labor and parts. The warranty enters into validity since the shipment date. Any evidence of improper use or unauthorized attempts at repair leads to warranty cancellation.

In case of service required or any questions on warranty, please notify:

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Fax.: +370 5 272 92 99

E-mail: info@eksmaoptics.com
Website: www.eksmaoptics.com

4.0 EXAMPLES

4.1 Example No. 1

Internally synchronized single shot on software trigger

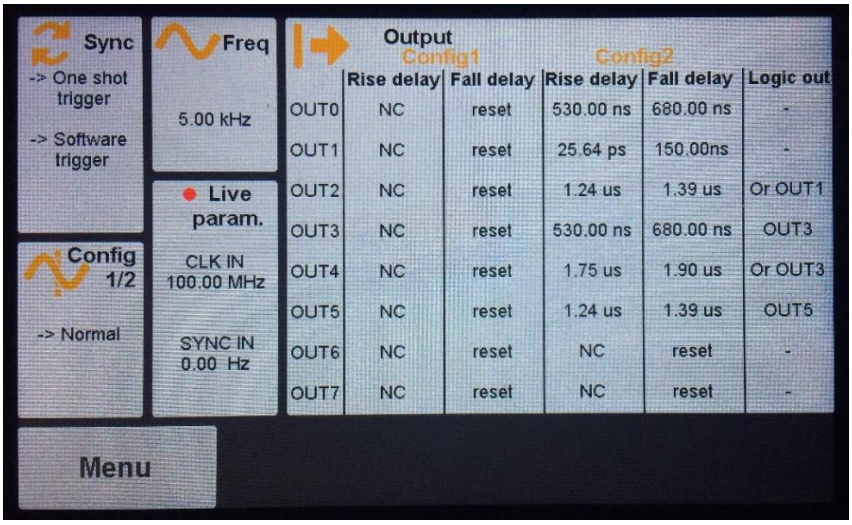

Figure 4.1 Monitor window example No. 1

Make sure device is armed (run button is pressed and glowing green). Once device is set according to Figure 4.1 single shot of pulse is generated (Figure 4.2) when One shot trigger button at Other → Push trigger is pressed.

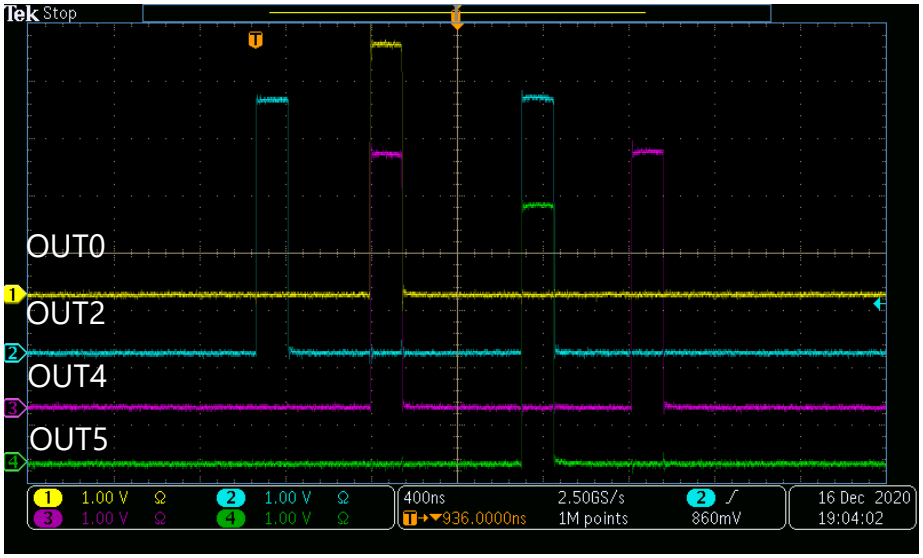

Figure 4.2 Output pulses example1