

## COMSCOPE USER & PROGRAMMING MANUAL

### Overview

New FPGA-based digital ComBlock modules are equipped with the **ComScope** data capture capability to help users visualize otherwise hidden digital signals. These modules are identified with

the  icon.

Internal digital signals, whether binary or digital representation of analog signals, can be stored in real-time within the internal memory, then exported to a host computer for plotting, storage and further processing.

The data of interest is captured at speeds up to the FPGA processing speed. The user can select lower sampling rates to expand capture over a longer time period.

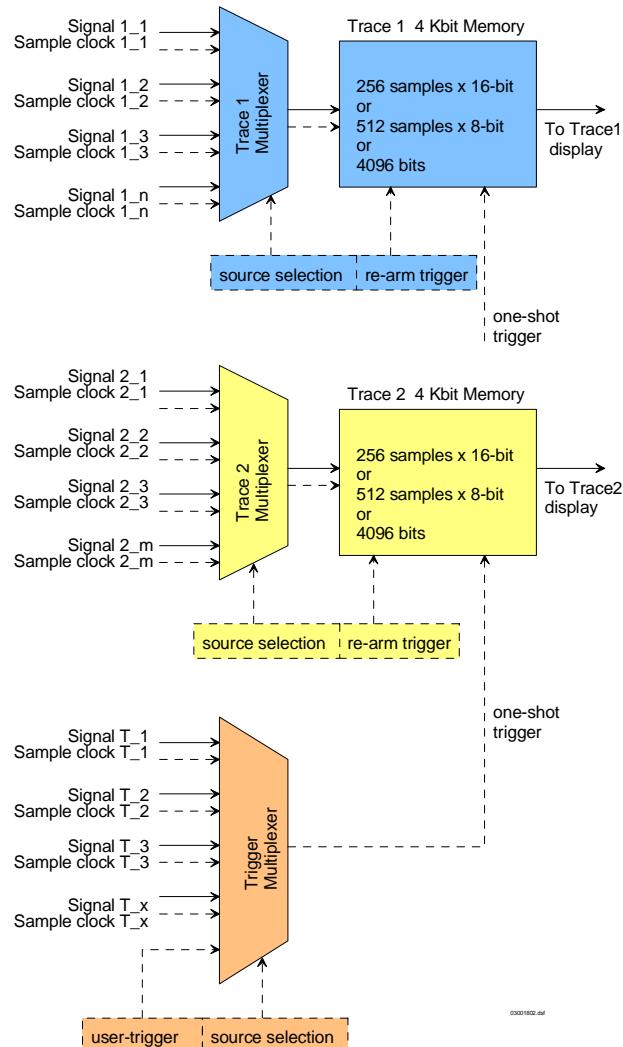
Internal triggers or user (manual) trigger can be selected. Once the memory is full, data capture stops until re-armed by the user.

Up to four data sources (Trace 1, Trace 2, Trace 3 and Trace 4) can be captured simultaneously.

Depending on the source type, the data storage is organized as 4096 binary bits, 512 8-bit samples or 256 16-bit samples. Refer to specific ComBlock module specifications for the definition of signals, triggers and formats.

Most ComScope settings are stored in volatile memory. They are loaded automatically by the ComBlock at power-up or reset.

Several ComScope windows, each pertaining to a distinct ComBlock, can be opened at the same time. However, it should be noted that, in most cases, triggers cannot be synchronized across multiple ComBlocks.



ComScope Functional Block Diagram (2 traces)

# Graphical User Interface

## User Manual

### First Step

The very first step in using ComScope is to consult the ComBlock specifications for definitions regarding the trace signals and trigger signals. For example, the COM-1028 FSK/MSK/GFSK/GMSK modulator specifications include the following trace and trigger signals definitions:

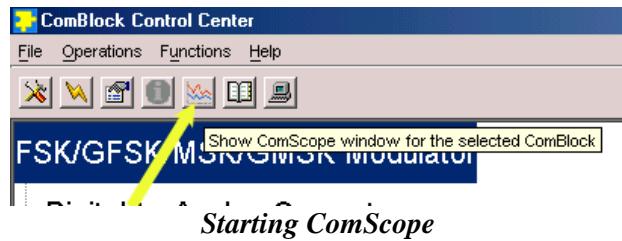
Trace 1 signals	Format	Nominal sampling rate	Buffer length (samples)
1: Data symbols before Gaussian filter	8-bit signed	8 samples /symbol	512
2: Data symbols after Gaussian filter	8-bit signed	8 samples /symbol	512
3: Frequency modulator phase	8-bit signed	8 samples /symbol	512
4: Modulated Signal I-channel	8-bit signed	$f_{clk}$ (80 MHz)	512
Trace 2 signals	Format	Nominal sampling rate	Capture length (samples)
1: Internal PRBS-11 test sequence	Binary	1 sample / bit	4096
2: Modulated Signal Q-channel	8-bit signed	$f_{clk}$ (80 MHz)	512
Trigger Signal	Format		
1: Start of internal PRBS11 test sequence	Binary		

#### Example of Trace/Trigger signals definition (COM-1028)

In this example, trace 1 can capture and display one of four possible signals, all in 8-bit signed format. 512 samples of each signal are captured each time. Likewise, trace 2 can capture one of two signals: either 4096 samples of 1-bit binary data or 512 samples of 8-bit signed samples. Only one trigger signal is offered.

### Starting ComScope

Start the ComBlock Control Center, enumerate the ComBlocks, highlight the desired ComBlock and click on the icon as shown below:

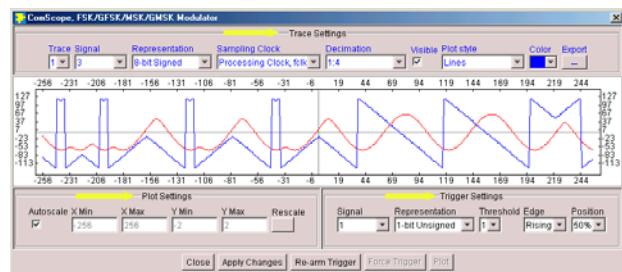


Starting ComScope

### ComScope window

The ComScope window is organized into three distinct control sections:

- (a) Trace settings on top
- (b) Plot settings on the lower left
- (c) Trigger settings on the lower right.



ComScope window 3 control areas

### ComScope Trace Settings



The Trace Settings section provides user control over the following trace attributes:

**Trace:** select trace 1,2,3 or 4 to be configured.

**Signal:** each trace can capture one of several multiplexed signals. Select the multiplexer source.

**Representation:** enter the precision for the selected signal. Ranges from 1-bit binary to 16-bits. Also indicates whether the binary representation is unsigned or signed (2's complement).

**Sampling clock:** select between ‘nominal’ sampling clock as described in the specifications and the FPGA processing clock  $f_{clk}$ . For example, in a digital modulator, waveform signals are typically

sampled at 4 samples per symbol (their ‘nominal’ sampling rate), whereas binary data streams may be typically sampled at 1 sample per bit (their ‘nominal’ sampling rate). When comparing different traces, it is often clearer to select a common clock (i.e. the FPGA processing clock  $f_{clk}$ ) as it ensures the same time scale.

**Decimation:** select the sampling clock decimation. The main purpose of decimation is to ‘stretch’ the time scale, for example when a signal bandwidth is much smaller than the sampling clock frequency. Decimation can be selected by steps of 2 from 1:1 (no decimation) to  $1:2^{31} = 1: 2,147,483,648$ . One should be aware that capture duration increases as decimation factors increase.

All above controls are stored in non-volatile memory within the ComBlock module. They are recalled at power up. User changes are enacted by pressing the “Apply Changes” button in the lower part of the ComScope window. The changes are applied the next time data is captured (i.e. after pressing the “Re-arm Trigger” button).

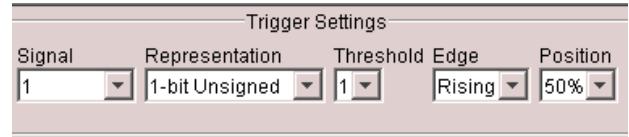
**Visible:** this checkbox allows one to display one trace at a time, or all together. The captured data remains in memory while the trace is not visible. The selection is volatile (i.e. returns to the default value at power on).

**Plot style:** select between small dots, big dots, lines and big dots and lines. The selection is volatile (i.e. returns to the default value at power on).

**Color:** select the trace color from the palette. The selection is volatile (i.e. returns to the default value at power on).

**Export:** export the trace samples to a decimal format text file for further processing using other applications, for example MS Excel (open or Data|Get external data| import text file) or Matlab (‘load’ command).

## ComScope Trigger Settings



The Trigger Settings section provides user control over the following trigger-related attributes:

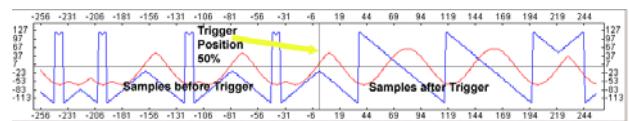
**Signal:** the trigger signal can be selected among several signals through a multiplexer. Alternatively, the trigger function can be disabled.

**Representation:** enter the precision for the selected trigger signal. Ranges from 1-bit binary to 16-bits. Also indicates whether the binary representation is unsigned or signed (2’s complement).

**Threshold:** enter the trigger threshold / level.

**Edge:** enter the trigger edge / slope (rising or falling).

**Position:** the trigger position determines how much data is captured before a valid trigger condition occurs. A vertical line at 0%, 10%, 50% or 90% of the displayed time identifies the trigger time.



All above controls are stored in non-volatile memory within the ComBlock module. They are recalled at power up. User changes are enacted by pressing the “Apply Changes” button in the lower part of the ComScope window. The changes are applied the next time data is captured (i.e. after pressing the “Re-arm Trigger” button).

## ComScope Plot Settings

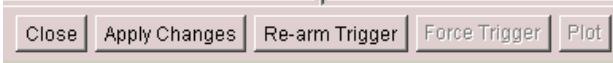


The display scale is automatically set when the ‘Auto scale’ checkbox is on. Otherwise, users can specify the display scale by entering the  $X_{\min}$ ,  $X_{\max}$ ,  $Y_{\min}$  and  $Y_{\max}$  values, then by clicking on the Rescale button.

The time axis (X-axis) is relative to the trigger: negative values represent samples captured before the trigger condition occurred and vice-versa. The time axis is expressed in ‘number of samples since the trigger’ units.

All above controls are stored in non-volatile memory within the ComBlock module. They are recalled at power up.

## ComScope Operations



The key difference between a conventional oscilloscope and ComScope is that ComScope capture and display is always started manually. There is no automatic refresh.

**Re-arm Trigger:** orders the ComBlock to capture a new batch of samples. If the capture is complete within approximately one second, the captured data is automatically displayed. If capture is incomplete or if the trigger condition did not yet occur, the user is invited to press either the ‘Force Trigger’ button (if trigger did not occur) and/or the ‘Plot button’ (if the capture is too slow).

**Force Trigger:** manual substitute to the automatic trigger condition. Must be used when the trigger is disabled.

**Plot:** ask the ComBlock to provide the captured data. Keep pressing this button until the capture is complete.

## Programming Interface

This section is intended for designers who want to design their own graphical user interface. It can be skipped by ComBlock Control Center users.

All ComScope-related commands are register-mapped within the ComBlock. Registers 237 through 251 are reserved to this effect. All registers are 8-bit wide. Register mapping is as follows:

Command	Definition
Trace $n$ signal selection	0 = disable trace $n$ . 1-127 = signal selection. ComBlock-specific definition. See specifications. Non-volatile storage. $n = 1$ : REG240 bits 6-0 $n = 2$ : REG242 bits 6-0 $n = 3$ : REG244 bits 6-0 $n = 4$ : REG246 bits 6-0
Trace $n$ sampling clock selection	0 = use nominal sampling clock as described in the specific ComBlock specifications. 1 = use the ComBlock $f_{clk}$ processing clock (typically 40MHz or 80 MHz or 120 MHz) as sampling clock. This allows to compare multiple signals on the same time scale.  In either case, the sampling clock can be further decimated to stretch the time scale. (see decimation control below) $n = 1$ : REG240 bit 7 $n = 2$ : REG242 bit 7 $n = 3$ : REG244 bit 7 $n = 4$ : REG246 bit 7
Trace $n$ sampling clock decimation	Decimate selected signal sampling clock by $2^n$ , where $n = 0$ through 31. 0 means no decimation. Non-volatile storage. $n = 1$ : REG241 bits 4-0 $n = 2$ : REG243 bits 4-0 $n = 3$ : REG245 bits 4-0 $n = 4$ : REG247 bits 4-0

Trigger position with respect to trace $n$ capture window	<p>0 = trigger set at 0%      1 = trigger set at 10%      2 = trigger set at 50%      3 = trigger set at 90%</p> <p>Note: All trigger positions must be identical. Use same value for all traces.</p> <p>Non-volatile storage.  <math>n = 1</math>: REG241 bits 7-5  <math>n = 2</math>: REG243 bits 7-5  <math>n = 3</math>: REG245 bits 7-5  <math>n = 4</math>: REG247 bits 7-5</p>
Trigger signal selection	<p>0 = trigger is off      1-63 = internal signal selection. ComBlock-specific definition. See specifications.</p> <p>Non-volatile storage.      REG248 bits 5-0</p>
Signed/Unsigned trigger threshold	<p>0 = trigger threshold is unsigned      1 = trigger threshold is signed</p> <p>Non-volatile storage.      REG248 bits 6</p>
Trigger edge	<p>0 = falling edge      1 = rising edge</p> <p>Non-volatile storage.      REG248 bit 7</p>
Trigger threshold	<p>When the selected trigger signal is an <math>m</math>-bit word, then the trigger threshold is given by:</p> <p><math>m = 1</math>: REG249 bit 0  <math>m = 2</math>: REG249 bits 1-0  <math>m = 4</math>: REG249 bits 3-0  <math>m = 8</math>: REG249  <math>m = 10</math>: 4 x REG249  <math>m = 16</math>: 256 x REG249</p>
Force trigger	<p>One-shot trigger originated by the user. Write a '1' once to force the manual trigger. Overrules the trigger signal selection. The trigger must have been re-armed before a force trigger may take place.</p> <p>Volatile.      REG250 bit 0</p>
Trigger re-arm	<p>One-shot command originated by the user. Writing a '1' once will force the traces in use to switch state from "Capture in progress, pre-trigger" to "Capture in progress, waiting for trigger".</p> <p>Volatile.      REG250 bit 1</p>
Capture resume	<p>One-shot command originated by the user. Writing a '1' once starts the capturing again after a capture was completed.</p> <p>REG250 bit 2</p>

Monitoring	Definition
Read data	ComScope trace data can be exported out of the ComBlock by reading at address 250. Stored data is read in sequence, starting at the initial address defined in REG237/238/239, and subsequently autoincremented after byte read at address 250. REG250
Capture in Progress	0 = capture ceased 1 = at least one trace is capturing REG251 bit 0
Trigger Found	0 = trigger not found 1 = trigger found This bit is cleared (set to 0) upon resuming capture (see Read/Write register 250, bit 2). REG251 bit 1
Start Capture Toggle	This bit toggles every time capture is resumed (see Read/Write register 250, bit 2). REG251 bit 2
Trigger Re-arm Toggle	This bit toggles every the trigger is re-armed (see Read/Write register 250, bit 1). REG251 bit 3

The general M&C commands "Set Register SRG" and "Set Register Temporary SRT" are used to send commands to the ComBlock registers. See reference document "ComBlock Monitoring & Control Reference"  
[www.comblock.com/download/M&C\\_reference.pdf](http://www.comblock.com/download/M&C_reference.pdf)

## FPGA/VHDL Development Platforms

The ComBlock family of rapid prototyping modules includes several FPGA/VHDL development platforms ([COM-1000](#), [COM-1100](#), [COM-1200](#), [COM-1300](#), [COM-1400](#), [COM-8000](#)) based on Xilinx FPGAs. VHDL code templates for these development platforms are being updated with basic ComScope source code.

Template source code can be downloaded from  
[www.comblock.com/download/com1000\\_002.zip](http://www.comblock.com/download/com1000_002.zip)