
Time-to-Digital Converter

SC-TDC-1100 Series

(Release 212, 312 & 322)



Manual



SURFACE
..... **CONCEPT**

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User Manual for the
SC-TDC-1100 Series
Releases: 212, 312 & 322
Manual Version 2.3
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2 General Information

2.1 General Information

This manual is intended to assist users in the operation of the Releases 212, 312 and 322 of the SC-TDC-1100 series. It is divided into 4 chapters. The chapter "General Information" contains a brief overview of the devices as well as the safety instructions. The chapter "Installation" refers to installation and cabling. The other chapters contain amongst others technical details and the description of the device layout.

2.2 Safety Instructions

Please read this manual carefully before performing any electrical or electronic operations and strictly follow the safety rules given within this manual. Surface Concept declines all responsibility for damages or injuries caused by an improper use of the module due to negligence on behalf of the User.

The following symbols may appear throughout the manual:



Note

The "note symbol" marks text passages, which contain important information/hints about the operation of the detector. Follow these information to ensure a proper functioning of the detector.



Caution

The "caution symbol" marks warnings, which are given to prevent an accidental damaging of the detector or the readout system. Do **NOT** ignore these warnings and follow them **strictly**. Otherwise no guarantee is given for arose damages.



The "high voltage symbol" marks warnings, given in conjunction with the description of the operation/use of high voltage supplies and/or high voltage conducting parts. Hazardous voltages are present, which can cause serious or fatal injuries. Therefore only persons with the appropriate training are allowed to carry out the installation, adjustment and repair work.



Note

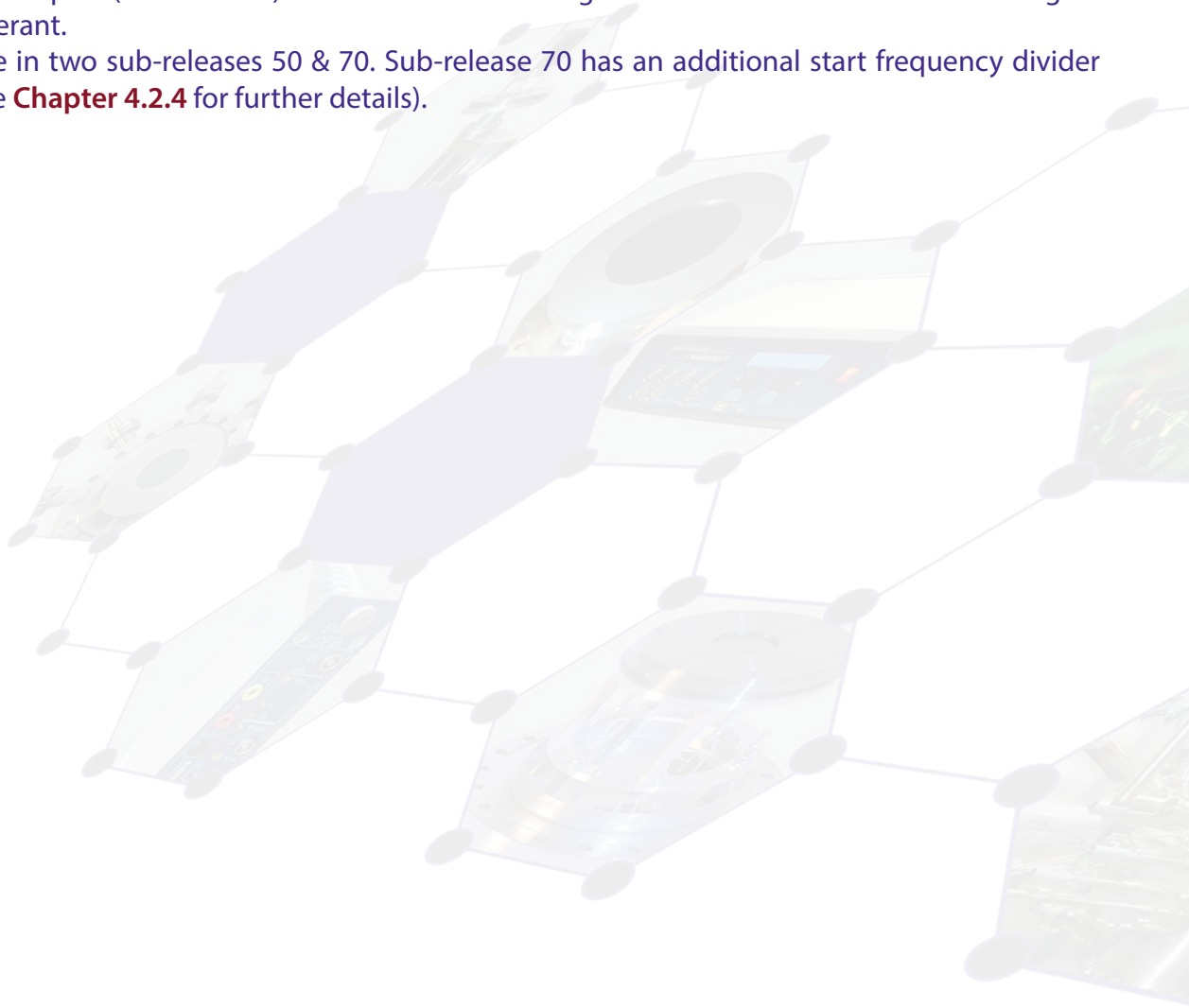
Please also respect the Surface Concept Device Safety Instructions Manual in addition and all given safety rules within it.

2.3 General Overview

The Surface Concept SC-TDC-1100 device in Release 312 is a 2 stop input channel (02D), in Release 322 a 4 stop input channel (04D) and in Release 212 a 8 stop input channel (08S) Time-to-Digital Converter with an integrated FPGA board and a USB3.0 interface in a 2/12 NIM cassette. The SC-TDC-1100 device in Release 312 and 322 is laid out for NIM signals on LEMO 00 type connectors, in Release 212 it is laid out for low voltage (LV)TTL signals on BNC connectors for all stop and the start inputs.

All other additional inputs (like SYNC IN) are laid out for LVTTTL signals on BNC connectors. All LVTTTL signal inputs are TTL tolerant.

The devices come in two sub-releases 50 & 70. Sub-release 70 has an additional start frequency divider implemented (see [Chapter 4.2.4](#) for further details).



3 Installation

3.1 Initial Inspection

Visual inspection of the system is required to ensure that no damage has occurred during shipping. Should there be any signs of damage, please contact our provider immediately. Please check the delivery according to the packing list (see **Table 1**) for completeness.

- SC-TDC-1100 (R212, R312, R322)
- 1x USB cable
- 1x power cable

Table 1: Packing list for the SC-TDC-1100 (R212, R312, R322)

3.2 Cabling

The general connection scheme of the SC-TDC-1100 devices is given in **Figure 1**.

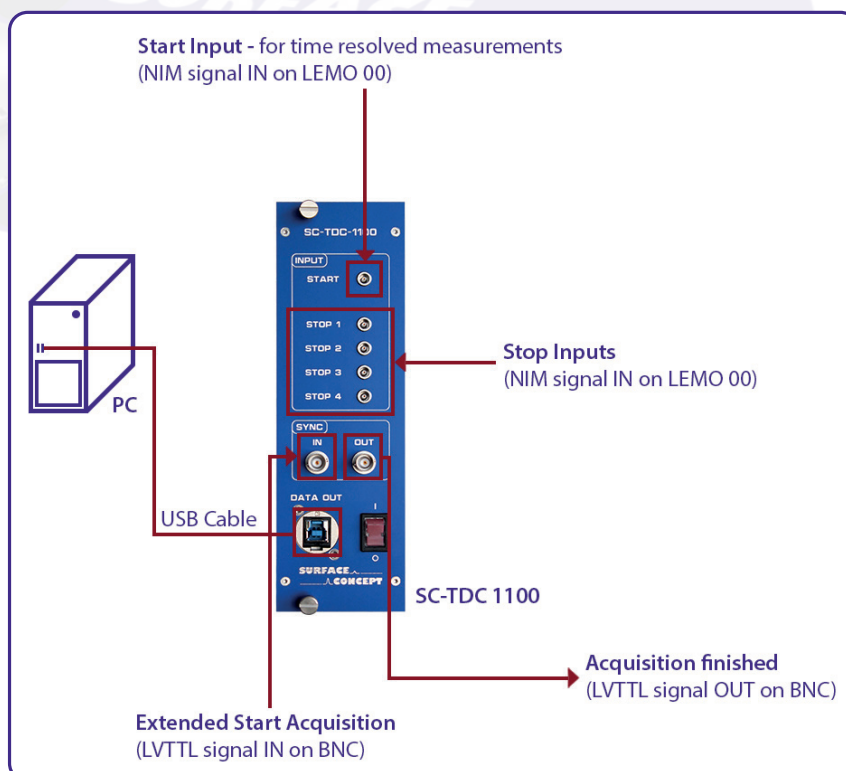


Figure 1: General connection scheme of the SC-TDC-1100 devices.

For release version 212

- Use the BNC sockets named “Stop” to apply 1 - 8 LVTTTL signals to the TDC stop input channels.
- To perform time measurements with respect to an external clock, provide start pulses to the start input of the TDC. Use the BNC socket named “Start” to apply LVTTTL signals (see **Chapter 4.2.2** for detailed information).
- Use the USB cable to connect the TDC to the PC. Do not use PC front panel USB connectors; they are often restricted in performance (see **Chapter 3.3** for further details).
- Please note that all inputs are internally 50Ohm terminated and are laid out for 50Ohm terminated LVTTTL (low voltage TTL) signal levels.
- Install the TDC device driver or software package prior to switching on the TDC.

For release versions 312 & 322

- Use the LEMO 00 sockets named “Stop” to apply 1 - 2 (R312) and 1 - 4 (R322) NIM signals to the TDC stop input channels.
- To perform time measurements with respect to an external clock, provide start pulses to the start input of the TDC. Use the LEMO 00 socket named “Start” to apply NIM signals (see **Chapter 4.2.2** for detailed information).
- Use the USB cable to connect the TDC to the PC. Do not use PC front panel USB connectors; they are often restricted in performance (see **Chapter 3.3** for further details).
- Use BNC cables to connect your additional signals to the additional inputs of the TDC (e.g. SYNC IN).
- Please note that all additional inputs are internally 50Ohm terminated and are laid out for 50Ohm terminated LVTTTL (low voltage TTL) signal levels.
- Install the TDC device driver or software package prior to switching on the TDC.

Finish the complete cabling before the TDC is turned on and the GUI software is started. Also, close the software and turn off the TDC before performing any changes to the cabling.



This applies especially to the connection and disconnection of the start input of the TDC. The start input of the TDC cannot handle pulses which are arriving in a time interval of smaller than 120ns, as they are produced by e.g. connecting to and disconnecting from the start input respectively.

If two subsequent pulses are applied to the start input of the TDC, the device will still deliver results, but these results will contain wrong timing information.



3.3 Software Installation, Requirements and Interface

All operation functions of the SC-TDC-1100 devices are encapsulated in a dynamic linked library (scTDC1.dll). Data processing and presentation on the PC is realized by an end-user demo software. See the corresponding software manual for detailed information on the software package and the DLL interface.

The delivery package of the SC-TDC-1100 devices includes a storage medium with hardware drivers and a TDC Demo software. Connect the storage medium to your PC and install the software package as described in the Software Installation Manual.

Read-out of the TDC is done with a standard PC via USB3.0. For the PC the following minimum system requirements are highly recommended:

- Processor: Quad Core
- RAM: 4GB
- Windows 7 or higher
- USB (no front panel connector)

Note

Depending on the specific PC system used for the TDC readout (mainly depending on the specific USB3.0 chip used on the PC motherboard), the use of USB3.0 can lead to instabilities in the data communication. For those cases we then recommend the use of USB2.0. The use of USB2.0 is always possible, but there might be limitations in the maximum count rates for certain detector types and/or detector operation modes.

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4 TDC Layout

4.1 Schematic Description

The design of the SC-TDC-1100 series combines the excellent performance of the GPX TDC chip with a high speed USB interface.

A field programmable gate array (FPGA) enables comfortable setups and a variable data stream handling from the TDC via USB.

The main delayline detector readout functionality is permanently programmed. A complex FIFO design makes data losses almost impossible. The user DLL controls the data handling and streaming for the user.

The following brief description of the internal structure of the measurement unit is only informative:

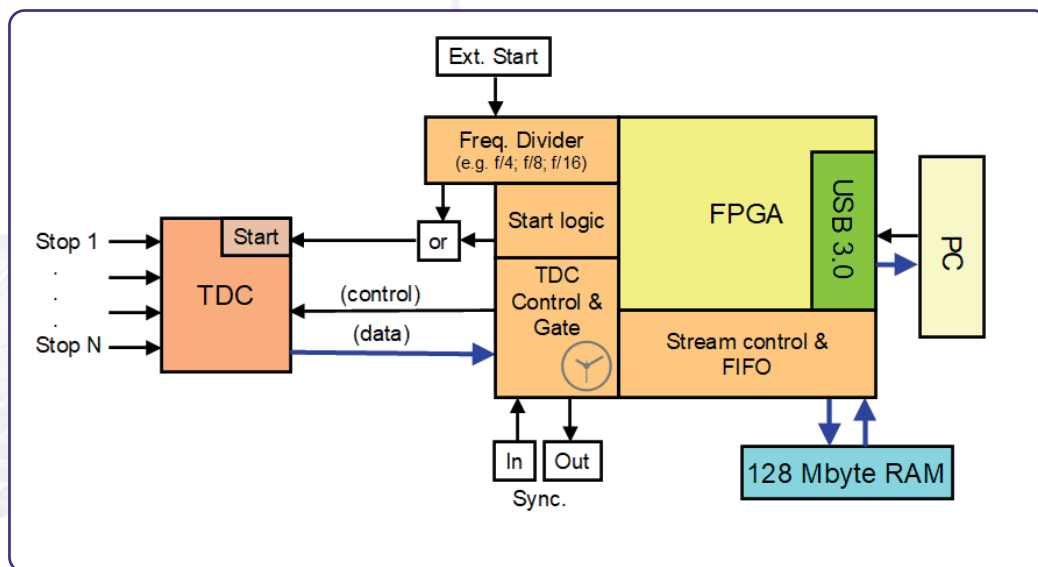
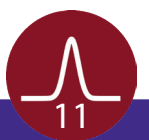


Figure 2: Schematic sketch of TDC functioning.

Arrival times of pulses at the stop inputs are measured by the TDC with respect to either an internal reference start signal, provided by the FPGA, or an external start signal. An internal electronics provide the TDC start signal to an additional BNC socket for further extended measurement use. The measurement dwell times for data from the TDC are settled within the FPGA by a quartz stabilized time gate in an interval from 1ms to 1193h.

The synchronization pulse for the external acquisition start (Sync. In) is transferred directly into the FPGA that controls the acquisition process. The FPGA also sends out a synchronization pulse for marking the end of an acquisition (via the Sync. Out socket).



4.2 Layout of the SC-TDC-1100 Series

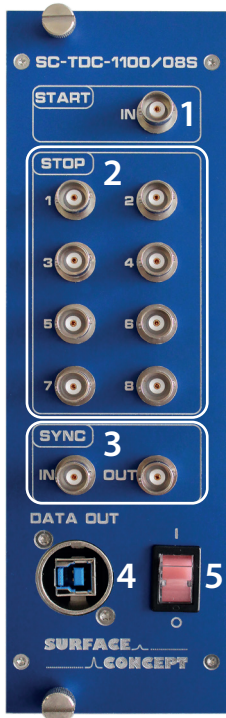


Figure 3: Front Panel of SC-TDC-1100/085 (R212) and 1100/04D (R322)



Figure 4: Back Panel of SC-TDC-1100

1. BNC/LEMO 00 Socket for Start Input
2. BNC/LEMO 00 Sockets for Stop Inputs
3. BNC Sockets for Device Synchronization Signal IN and OUT
4. USB Connection Socket
5. Power switch to turn the TDC ON/OFF. Lighted when set to ON
6. Power Socket

4.2.1 TDC Stop Inputs

The SC-TDC-1100 devices come with 2 (R312), 4 (R322) or 8 (R212) stop input channels. For Releases R312 and 322 all stop signals must be applied as NIM signals to the "stop" inputs (LEMO 00 socket), for Release R212 as LVTTTL signals to the "stop" inputs (BNC socket).

4.2.2 TDC Start Input

An external start signal must be provided to the TDC for real time resolved measurements. The external start signal must be applied either as a NIM signal to the "start" input (LEMO 00 socket) for Release R312 & R322 or as LVTTTL signal to the "start" input (BNC socket) for Release R212. In addition the software must be set to accept external start signals, by changing the corresponding entry in the tdc_gpx3.ini file.

The corresponding entry in the tdc_gpx3.ini file is:

Ext_Gpx_Start = X

X is either NO or YES. **The default setting is YES.**

"Ext_Gpx_Start" = YES must be set for the TDC to accept the external start signal.

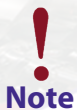
In addition the following entries in the tdc_gpx3.ini must be set as follows:

StartCounter = YES

StartPeriod = 0x800000

Measurements are performed in respect to an internal start signal of the TDC when "Ext_Gpx_Start" = NO. This internal start signal has no time correlation to any external clock and therefore also not to the incoming stops. Any external start signal must be disconnected from the start input of the TDC, when working with the internal start signal.

The rise time of the start signal is of great importance, the faster the rise time, the better the time resolution. The maximum frequency of the start pulse must not exceed 9MHz (for R312 & R322) and 7MHz (for R212).



Note

Do not forget to save the ini file after any changes you make and restart the software. For further information check the software manual.



Take care that measurements are performed either with the internal start signal (Ext_Gpx_Start = NO) and no signal applied to the Start Input or with an external start signal (Ext_Gpx_Start = YES) applied to the Start Input. In all other cases the TDC is not working correctly.



The start input of the TDC cannot handle pulses which are arriving in a time interval of smaller than 120ns (e.g. as produced by connecting/disconnecting the start signal during TDC operation). If two such subsequent pulses are applied to the start input of the TDC, the device will still deliver results, but these results might contain wrong timing information.

The TDC does also not work with start signals of frequencies larger than 7 MHz (R212) and 9MHz (R312 & R322). For this reason, the TDCs are equipped with an internal frequency divider. Larger start pulse frequencies must be divided down by an appropriate dividing factor (e.g. dividing factor of 16 for 80MHz start pulse frequency). For start frequencies smaller than 100kHz (R212) and 25kHz (R312 & R322) the user must make sure that all stop signals are provided within a time window of 10.7µs (R212) and 40µs (R312 & R322) after each start. Otherwise the TDC will deliver wrong time results, which are not easy to be identified as such.

For applications with time distances larger 10.7µs (R212) and 40µs (R312 & R322) use the start counter or the extended measurement range (see [Chapter 4.2.5](#)).



The temporal resolution is mainly influenced by the quality of the start signal because the TDC measures the time of a rising or a falling edge using a constant voltage threshold. Lower precision than expected may be observed for slow rise or fall times of the signals or in case of any ripple/jitter on the switching edge of the signals. In particular, the time resolution may distinctively depend on any voltage variation of the ground level of the measured start signal.

Therefore, if the signals are varying in amplitude, one needs to process them by external electronics components (e.g. constant fraction discriminators, CFDs).

4.2.3 Device Synchronization Signal IN/OUT

The data acquisition can be synchronized to an external signal for various measurement application linked to external devices. This device synchronization signal has to be applied as LVTTTL signal to the "SYNC IN" BNC socket of the TDC. This functionality is switched on/off within the tdc_gpx3.ini file.

The corresponding entry in the tdc_gpx3.ini file is:

Ext_trigger = X

X is either NO or YES. **The default setting is NO.**

The TDC ignores any external synchronization signals if "Ext_trigger" = NO. In case that "Ext_trigger" = YES and the "SYNC IN" signal is not provided, the device will not come to operation at all.

The TDC provides always a LVTTTL signal on the "SYNC OUT" BNC socket after the end of each acquisition, independent on the setting of "Ext_trigger".



Do not forget to save the ini file after any changes you make and restart the software. For further information check the software manual.

4.2.4 Start Frequency Divider (sub-R 70 and 80 only)

The maximum start frequency for the SC-TDC-1100 devices is restricted to 9MHz. To cope with larger start frequencies the SC-TDC-1100 devices are equipped with an internal start frequency divider for external start frequencies of up to 150MHz (this mode only works when using the external start input). Herewith the frequency divider can operate with different dividing factors, which can be set within the software, to always guarantee a start frequency of below 9MHz.

The frequency divider is switched on/off within the tdc_gpx3.ini file, in which also the dividing factors are set.

The corresponding entry in the tdc_gpx3.ini file is:

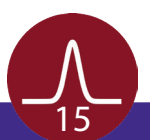
Start_Divider = X

X is an integer value and must be one of the following values: 0, 2, 4, 8, 16 or 32. The value 1 is not allowed.

The default setting is 0

X = 0 switches off the start divider and leads to normal operation without dividing the start frequency.

The time histogram will appear X times in series, when using a dividing factor of X. This is due to the fact that only each 1st start pulse out of a sequence of X start pulses will be accepted as start signal, while all stop signals are detected. This leads to the multiple time histograms that appear sequentially in time. The multiple histograms can be resorted to one single time histogram by a MODULO-operation during data analysis.



4.2.5 Extended Measurement Range

The measurement range in the normal start-stop operation mode is 10.7µs (R212) and 40µs (R312 & R322). The SC-TDC-1100 devices come with an extended measurement range functionality, to cope with larger measurement ranges. The reference measurement is switched on/off within the tdc_gpx3.ini file.

The corresponding entry in the tdc_gpx3.ini file is:

ReferenceMeasurement = X

X is either NO or YES. **The default setting is NO.**
X = NO switches the reference measurement off.

The extension of the measurement range is working in such a way, that start signals are internally counted up to extend the global time axis. For this the TDC is operating with its internal start signal, while the external start signal is given to one of the stop signals in addition to the regular stop signals. Time results are then provided as reference results of the external start and the stop signals on basis of the internal extended time axis.

Therefore one of the stop inputs of the TDC must be used to apply the external start signal, which reduces the number of available stop inputs by one.

Additional changes in the tdc_gpx3.ini file must be made for the extended measurement range to function.

The corresponding entries in the tdc_gpx3.ini file to be made are:

Ext_Gpx_Start = NO
StartCounter = NO
StartPeriod = 0

It must also be defined in the tdc_gpx3.ini file which of the stop input channels provide the reference signal for calculating the times of the other stop signals. The need of defining the reference channel also allows to define different reference channels for the different stop channels.

The corresponding entry in the tdc_gpx3.ini file is:

ReferenceChannelX = Y

X corresponds to the specific number of the stop channel. Y defines the specific stop channel which is used for stop channel X as reference channel. The channel numbering starts with 0. Single channels can also be switched off in case that signals on that channel should not be measured itself, but only be used as reference channel. In this case X can be set to -1.

The reading of this entry is: "the reference of channel X is channel Y".

Example 1

ReferenceChannel0 = -1
ReferenceChannel1 = 0
ReferenceChannel2 = 0

ReferenceChannel# = 0

represents the maximum available channel number.

With this definition all applied stop signals are measured in reference to the signal applied to channel 1 (0 in the software channel counting), while the signals of channel 1 themselves are not measured.

Example 2

ReferenceChannel0 = -1
ReferenceChannel1 = 0
ReferenceChannel2 = 2
ReferenceChannel3 = 2

With this definition the stop signal on channel 2 is measured in reference to the signal applied to channel 1 while the stop signal on channel 4 is measured in reference to the signal applied to channel 3. Also the signals of channel 1 themselves are not measured, but the signals of channel 3 are measured in reference to themselves. With such definition the results from channel 3 provide the time between two subsequent signals on channel 3 (in case that this signal is a periodic signal, the time result represents exactly that period).

It can happen that the use of more than one stop channel can lead to a wrong sorting of events within the data stream in respect to their time while using the extended measurement range functionality. This behaviour can be corrected by a sorting algorithm that resorts neighbouring signals within a certain "depth". This depth can be adjusted in the tdc_gpx3.ini file.

The corresponding entry in the tdc_gpx3.ini file is:

ChronoDepth = X

X is an integer value and must be set between 0 and 8.

The default setting is 0

X = 0 switches off the sorting algorithm.

The sorting algorithm works better at higher selected values, but higher values significantly increase the load on the PC CPU.



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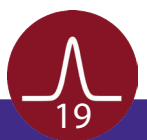
5 Technical Data

SC-TDC-1100/08S - Release 212-50

- 2/12 NIM module
- Number of Stop Inputs: 8
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 82.3ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger frequency (max.): 7MHz
- Measurement range: 0ns – 10.7 μ s in start-stop operation (measurement range of 10.7 μ s corresponds to a start frequency of 93.5kHz)
- Extended measurement range of up to 82.3ps x 64bit (>17000d) in reference mode
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel
- 40MHz internal device measurement rate
- Stop Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Output: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer

SC-TDC-1100/08S - Release 212-70

- 2/12 NIM module
- Number of Stop Inputs: 8
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 82.3ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger frequency (max.): 7MHz



- Measurement range: 0ns – 10.7 μ s in start-stop operation (measurement range of 10.7 μ s corresponds to a start frequency of 93.5kHz)
- Internal start frequency divider (2-, 4-, 8-, 16- and 32-fold divider)
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel
- 40MHz internal device measurement rate
- Stop Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Output: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer

SC-TDC-1100/08S - Release 212-80

- 2/12 NIM module
- Number of Stop Inputs: 8
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 82.3ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger frequency (max.): 7MHz
- Measurement range: 0ns – 10.7 μ s in start-stop operation (measurement range of 10.7 μ s corresponds to a start frequency of 93.5kHz)
- Extended measurement range of up to 82.3ps x 64bit (>17000d) in reference mode
- Internal start frequency divider (2-, 4-, 8-, 16- and 32-fold divider)
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel
- 40MHz internal device measurement rate
- Stop Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Input: Low voltage TTL on 50Ohm BNC socket
- External Start Signal Output: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer



SC-TDC-1100/02D - Release 312-50

- 2/12 NIM module
- Number of Stop Inputs: 2
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 27.4ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger rate (max.): 9MHz
- Measurement range: 0ns – 40 μ s in start-stop operation (measurement range of 40 μ s corresponds to a start frequency of 25kHz)
- Extended measurement range of up to 27.4ps x 64bit (>5000d) in reference mode
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel
- 40MHz internal device measurement rate
- Stop Signal Input: NIM on LEMO 00 socket
- External Start Signal Input: NIM on LEMO 00 socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer

SC-TDC-1100/02D - Release 312-70

- 2/12 NIM module
- Number of Stop Inputs: 2
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 27.4ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger rate (max.): 9MHz
- Measurement range: 0ns – 40 μ s in start-stop operation (measurement range of 40 μ s corresponds to a start frequency of 25kHz)
- Internal start frequency divider (2-, 4-, 8-, 16- and 32-fold divider)
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel



- 40MHz internal device measurement rate
- Stop Signal Input: NIM on LEMO 00 socket
- External Start Signal Input: NIM on LEMO 00 socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer

SC-TDC-1100/04D - Release 322-80

- 2/12 NIM module
- Number of Stop Inputs: 4
- Number of Start Inputs: 1 (common start input usable as reset of the internal clock resolution adjust mode: quartz-accurate, adjustable resolution, insensitive to temperature variations, adjustable via software (no calibration necessary))
- Digital time bin resolution per channel: 27.4ps
- 5.5ns pulse-pair resolution on one channel and 0ns between two channels
- Trigger to rising edge
- Start retrigger rate (max.): 9MHz
- Measurement range: 0ns – 40 μ s in start-stop operation (measurement range of 40 μ s corresponds to a start frequency of 25kHz)
- Extended measurement range of up to 27.4ps x 64bit (>5000d) in reference mode
- Internal start frequency divider (2-, 4-, 8-, 16- and 32-fold divider)
- Dynamic range: 2E19
- All channels provide precisely an equal resolution
- 32-fold multi-hit capability per channel
- 80MHz internal device measurement rate
- Stop Signal Input: NIM on LEMO 00 socket
- External Start Signal Input: NIM on LEMO 00 socket
- Device Synchronization Signal Input: Low voltage TTL on 50Ohm BNC socket
- Device Synchronization Signal Output: Low voltage TTL on 50Ohm BNC socket
- USB Interface for Data Transfer

Line Input

| | |
|-------------------------|---------------|
| Electrical Input (LINE) | +6V DC |
| Power | 12Watt (max.) |



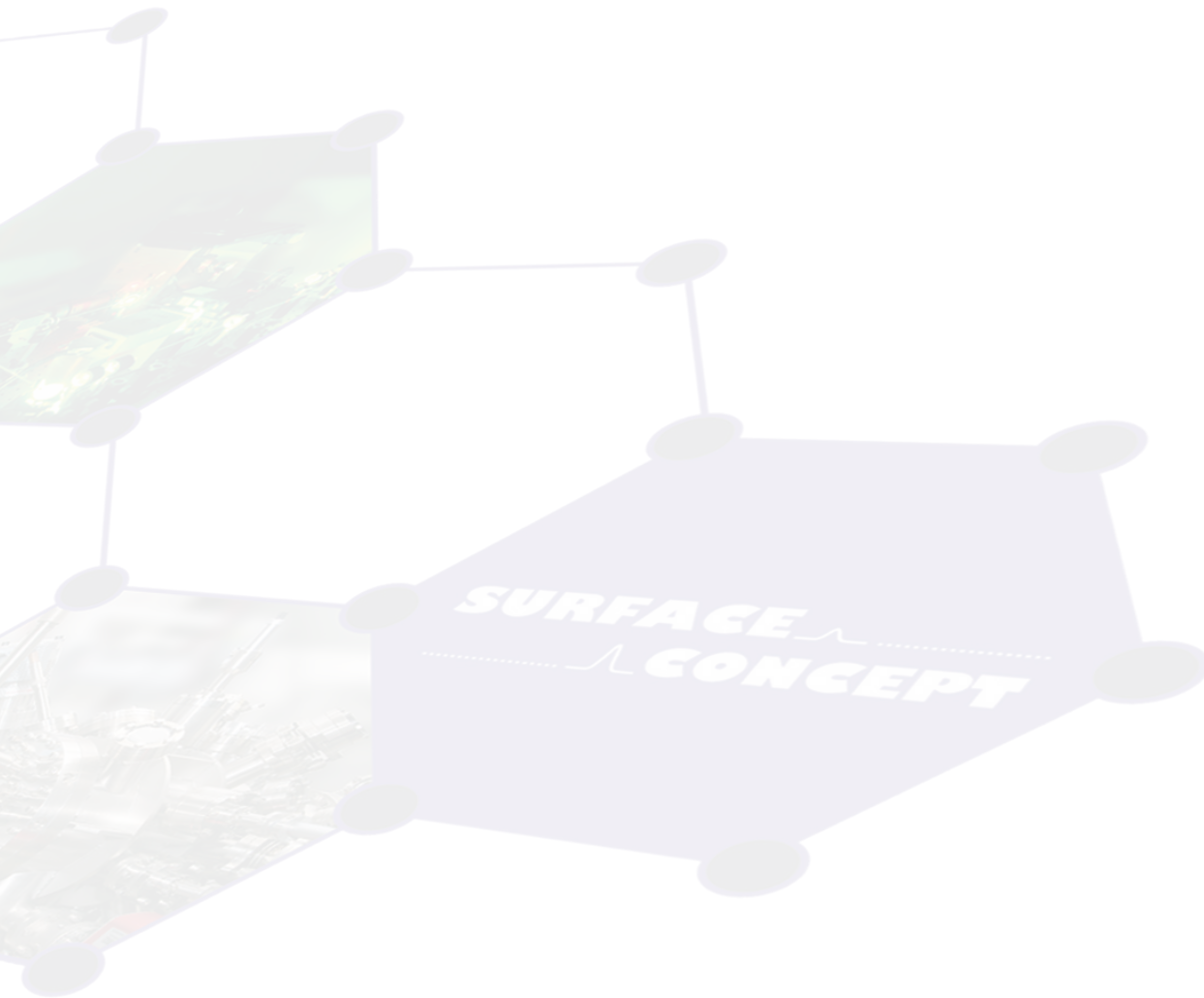
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Figure 4: Back Panel of SC-TDC-1100 12





EC Declaration of Conformity

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Product

SC-TDC-1100 Series

The above named products comply with the following European directive:

89/336/EEC

Electromagnetic Compatibility Directive, amended by 91/263/EEC and 92/31/EEC and 93/68/EEC

73/23/EEC

Low Voltage Equipment Directive, amended by 93/68/EEC

The compliance of the above named product to which this declaration relates is in conformity with the following standards or other normative documents where relevant:

EN 61000-6-2:2005+AC:2005

Electromagnetic compatibility (EMC):
Generic standards - Immunity for industrial environments

EN 61000-6-4:2007+A1:2011

Electromagnetic compatibility (EMC):
Generic standards - Emission standard for industrial environments

EN 61010-1: 2010

Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

For and on behalf of **Surface Concept GmbH**

Mainz,.....01.04.2013.....
(Date)

Legal Signature.....
(Dr. Andreas Oelsner)

This declaration does not represent a commitment to features or capabilities of the instrument. The safety notes and regulations given in the product related documentation must be observed at all times.

