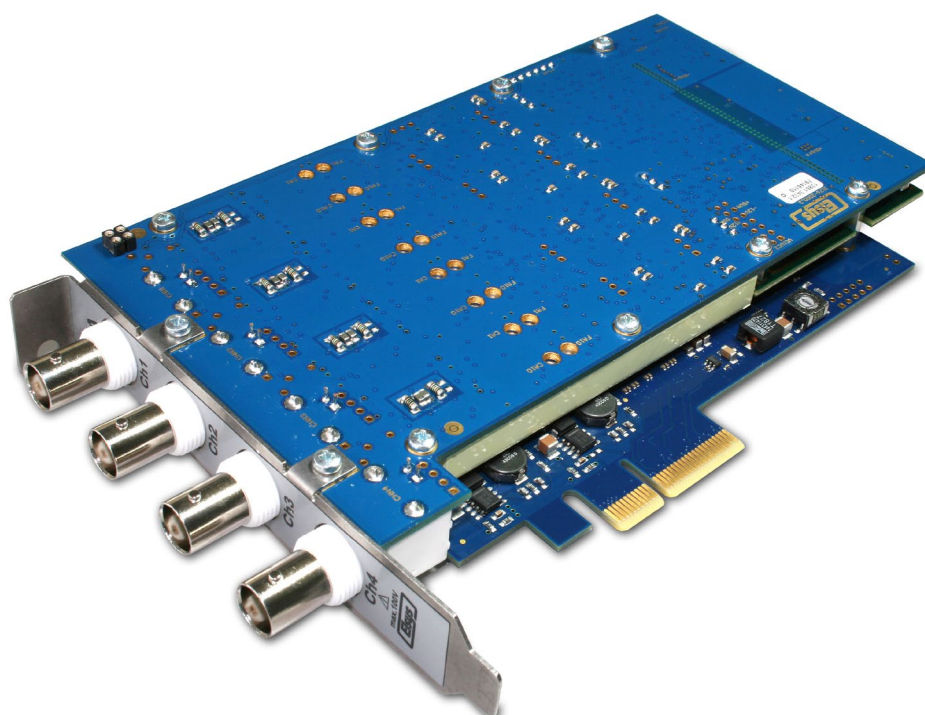




# User Guide for TPCX, TPCE, TPCE-LE and TPCE-I



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## Personal safety when installing in your computer

High voltages may be present inside computer equipment. Before installing any of the hardware in this package, or removing the protective covers of any computer equipment, turn off power switches and disconnect power cords. Do not reconnect the power cords until the hardware is installed and the system cover is closed.



## Attention

The boards must not be installed into industrial PC's, which do not keep the necessary EMC standards.



## ESD (Electrostatic Discharge) precautions

To avoid damaging computer components and accessories when installing or removing an Elsys Instruments Data Acquisition module, follow standard electrostatic discharge (ESD) precautions:

- When your computer case is open and its internal parts are exposed, do not touch any internal parts unnecessarily.
- Always wear a grounded strap or work on an ESD-protective mat.
- Do not remove the Data Acquisition module from its protective bag until you are properly grounded.
- Handle the Data Acquisition module by its edges or by the metal bracket.
- Do not touch any pin, contact, lead or component on the Data Acquisition module.

## Thank you!

Thank you for purchasing Elsys High Precision Data Acquisition Equipment. For more information, please visit [www.elsys-instruments.com](http://www.elsys-instruments.com)

## Notice

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## 1. Quick Installation

- Before installing the TPCX/TPCE module into the computer, the correct channel group must be set with the small rotary switch. See Chapter „Board Number Configuration“.
- If sufficient free PCI/PCIe card slots are available, single places can remain empty between the modules. Thus the heat dissipation improves. Besides the BNC plugs are better accessible.
- If more than one board is installed, a StarHub synchronisation board must be connected to all installed boards.
- For precise measurements, good ground contact between the boards and the chassis is needed.
- Close the computer and turn it on
- Install the TpcServer Setup which installes all device drivers and services needed for proper operation.

## 2. SYSTEM REQUIREMENTS

### 2.1 TPCX PCI Boards

The TPCX cards require the following minimal computer configuration:

- Industrial PC or compatible
- CPU Intel i5 or better
- 17 inch Screen with a resolution of 1280x720 or higher
- RAM minimum 2GB, recommended 4 GB
- One half size slot (PCI-BUS) each per 4-channel board
- 8-channel boards need two slots. With differential modules the number of required slots has to be doubled.
- Windows XP, Win7/32Bit, Win7/64Bit
- Power supply inside of the PC with enough power.

### 2.2 TPCE PCIe Boards

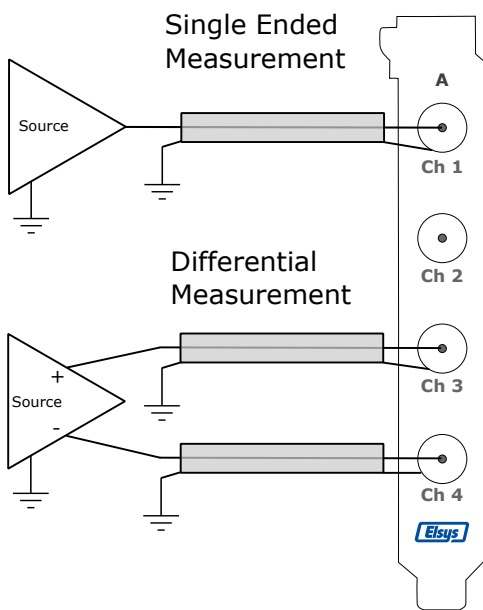
The TPCE cards require the following minimal computer configuration:

- Industrial PC or compatible
- CPU Intel i5 or better
- 17 inch Screen with a resolution of 1280x720 or higher
- RAM minimum 2 GB, recommended 4 GB
- TPCE: One x4 PCIe slot each per 4-channel board
- TPCE-LE: One x1 PCIe slot each per 4-channel board
- 8-channel boards need two slots. With differential modules the number of required slots has to be doubled.
- Windows 7 - 10, 32/64 Bit
- Power supply inside of the PC with enough power.

### 3. Hardware

#### 3.1 Signal Inputs, Connector Pin Assignments

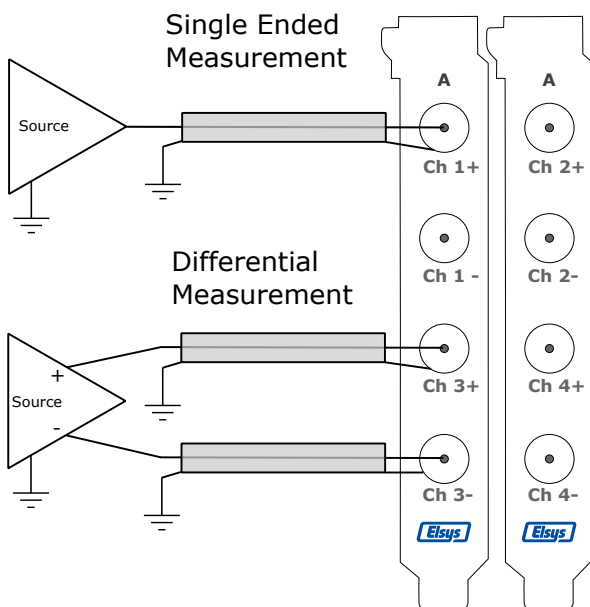
##### 3.1.1 Single Ended Analog Inputs



Single Ended boards have one BNC connector per channel where the outside shielding is connected to chassis/protective Ground.

Two neighboring channel can be configured per software as differential input stage. In this case the signal must be connected as shown aside.

##### Differentielle Analog-Eingänge



Differential boards have two BNC connector per channel where the outside shielding is connected to chassis/protective Ground.

Single ended measurement can be performed by just using the + input of the BNC pair.

### 3.1.2 Input Ranges

| 0% Offset  | 50% Offset | 100% Offset | TPCX, TPCE | TPCE-LE | TPCE-I |
|------------|------------|-------------|------------|---------|--------|
| 0 - 100 mV | ± 50 mV    | -100 - 0 mV | ✓          | ✗       | ✗      |
| 0 - 200 mV | ± 100 mV   | -200 - 0 mV | ✓          | ✓       | ✓      |
| -          | ± 200 mV   |             | ✗          | ✗       | ✓      |
| 0 - 500 mV | ± 250 mV   | -500 - 0 mV | ✓          | ✓       | ✓      |
| 0 - 1 V    | ± 500 mV   | -1 - 0 V    | ✓          | ✓       | ✓      |
| 0 - 2 V    | ± 1 V      | -2 - 0 V    | ✓          | ✓       | ✓      |
| 0 - 5 V    | ± 2.5 V    | -5 - 0 V    | ✓          | ✓       | ✓      |
| 0 - 10 V   | ± 5 V      | -10 - 0 V   | ✓          | ✓       | ✓      |
| 0 - 20 V   | ± 10 V     | -20 - 0 V   | ✓          | ✓       | ✗      |
| -          | ± 12.5 V   | -           | ✗          | ✗       | ✓      |
| 0 - 50 V   | ± 25 V     | -50 - 0 V   | ✓          | ✓       | ✓      |
| 0 - 70 V   | ± 50 V     | -70 - 0 V   | ✓          | ✗       | ✗      |

Offset setting can be changed per channel in 0.1% steps from 0% to 100%. For TPCE-I, Offset is fixed at 50%.

### Attention

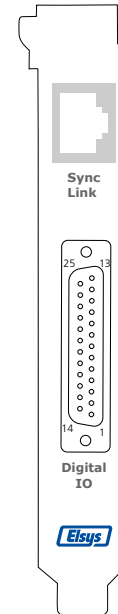


- Max. Input Voltage ± 100 VDC
- 7 V<sub>rms</sub> with 50 Ω input switched on.

## 3.2 Digital In/Out and Markers

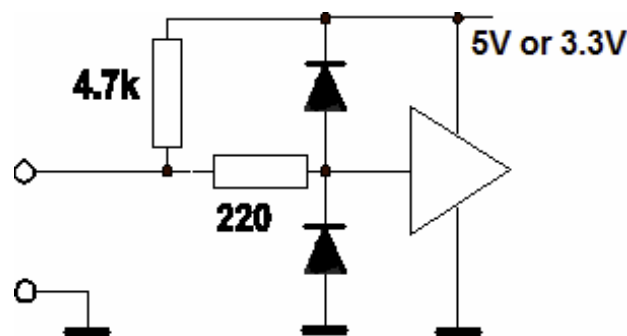
### 3.2.1 Pin Out

| Function             | Description   | Pin # | Input / Output |
|----------------------|---|-------|----------------|
| Trigger Out          | TTL Pulse when device has triggered   | 1     | Output         |
| Armed Sync Clock Out | High when device is ready for trigger / Synchronization Clock Output (Configured in TranAX)   | 14    | Output         |
| !Disarm              | Deactivate any trigger when low   | 15    | Input          |
| Start Recording      | Start Recording at negative slope   | 3     | Input          |
| Trigger In           | TLL Trigger input<br><br>Note: There is no hysteresis. Therefore the trigger signal must have a minimum slewrate of 4 V/us. Otherwise, the triggering can take place on the wrong edge. | 16    | Input          |
| Timebase In / PPS    | External Timebase input or GPS PPS Input  | 4     | Input          |
| +5V                  | Power Output (max 500 mA)   | 17    | Power Output   |
| GND                  | Chassis Ground  | 5     |                |
| Marker A1            | Digital Inputs Board A<br>TTL Level (with internal Pull-Up)   | 18    | Input          |
| Marker A2            |   | 6     | Input          |
| Marker A3            |   | 19    | Input          |
| Marker A4            |   | 7     | Input          |
| Marker A5            |   | 20    | Input          |
| Marker A6            |   | 8     | Input          |
| Marker A7            |   | 21    | Input          |
| Marker A8            |   | 9     | Input          |
| Marker B1            | Digital Inputs Board B<br>TTL Level (with internal Pull-Up)   | 22    | Input          |
| Marker B2            |   | 10    | Input          |
| Marker B3            |   | 23    | Input          |
| Marker B4            |   | 11    | Input          |
| Marker B5            |   | 24    | Input          |
| Marker B6            |   | 12    | Input          |
| Marker B7            |   | 25    | Input          |
| Marker B8            |   | 13    | Input          |



**Input Protection:**  $\pm 10$  V at the TTL inputs and outputs.

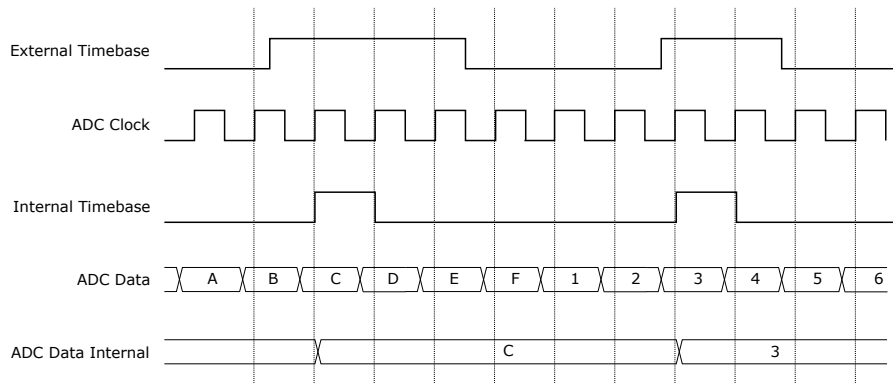
Digital Marker inputs are captured synchronous with the ADC clock and are available when 14 bit resolution is used. In 16 bit mode, additional memory bits are needed and therefore no Marker are available.



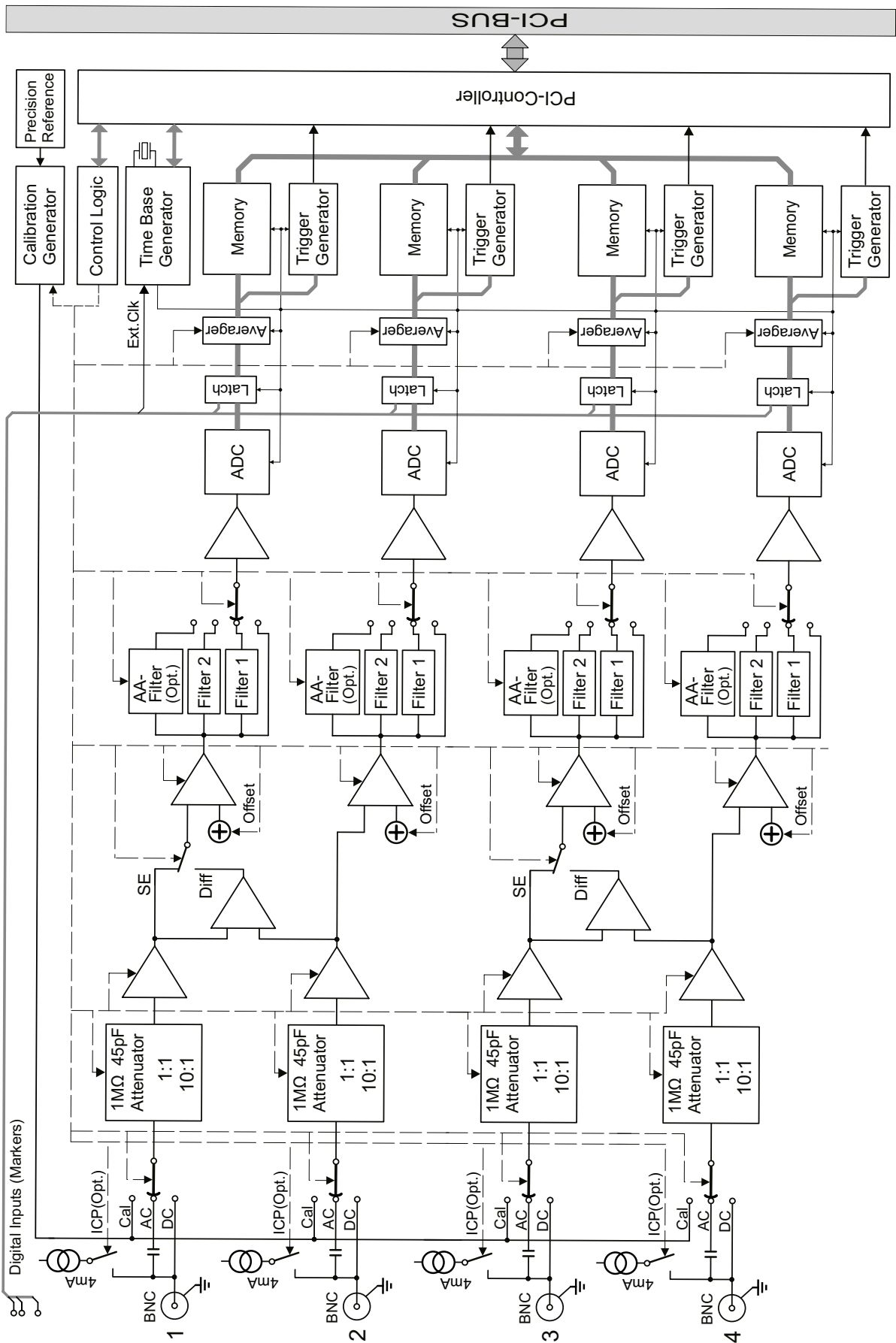


### 3.2.2 External Timebase

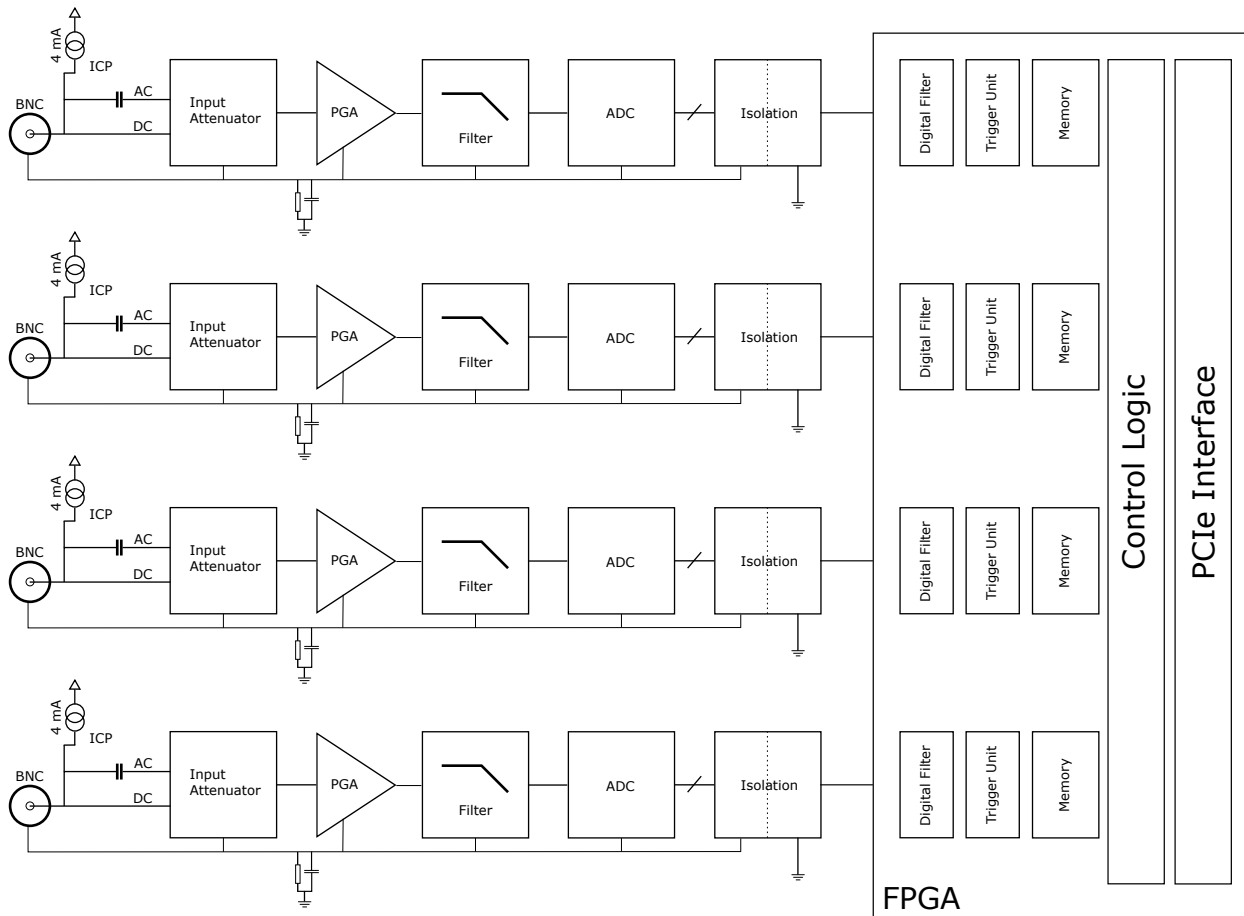
The External Timebase can be used for capturing the measurement data at a specific moment. The external timebase is not a reference clock but will be synchronized to the internal ADC sampling clock. Therefore the external timebase must be at least two time slower than the ADC clock.



### 3.3 TPCX/TPCE/TPCE-LE Block

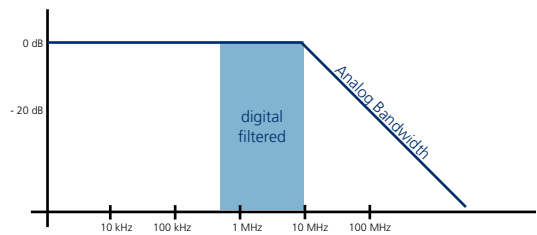


### 3.4 Diagram TPCE-I Block Diagram



### 3.5 Standard Filter

On each channel a Low-Pass First Order Filter with 100 kHz or 1 MHz (10 KHz, 100 kHz for TPCE-I) bandwidth can be activated.



The analog bandwidth of the amplifier itself is set around the half of the maximum sampling rate, eg. 10 MHz for a 20 MHz board.

When the cards are used below the maximum sampling rate an internal digital filtering is done. Therefore an Anti-Aliasing Filter is not needed in the most situations. The picture above shows a 20 MHz card used at 1MHz. High frequency noise above 10 MHz is filtered by the analog bandwidth of the amplifier with 20 dB/dec. Noise between 500 kHz and 10 MHz is digital filtered and will not produce any mirror signals at lower frequencies.

### 3.6 Anti-Aliasing Filter Module

Anti-Aliasing Filters are an option and must be installed at fabrication time. (TPCX/TPCE Option AAF-4 or AAF-8).

| Filter Pos. | Cut-off<br>(-3 dB) $f_0$ | f0 Tol.<br>[±%] | Filter Type | Order | Stopband<br>Attenuation<br>@ $f > 4 \cdot f_0$ | Passband Ripple<br>(max.) @ $f < 0.6 \cdot f_0$ | Additional Gain and<br>Offset |                   |
|-------------|--------------------------|-----------------|-------------|-------|--|---|-------------------------------|-------------------|
|             |                          |                 |             |       |  |   | Error [±%]                    | Drift<br>[ppm/°C] |
| 1           | 200 Hz                   | 5               | Butterw.    | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 2           | 300 Hz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 3           | 500 Hz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 4           | 700 Hz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 5           | 1 kHz                    | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 6           | 1.5 kHz                  | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 7           | 2 kHz                    | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 8           | 3 kHz                    | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 9           | 5 kHz                    | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 10          | 7 kHz                    | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 11          | 10 kHz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 12          | 15 kHz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 13          | 20 kHz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 14          | 30 kHz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.2 dB  | 0.1                           | 50                |
| 15          | 50 kHz                   | 5               | Butterw     | 6     | > 54 dB  | ± 0.3 dB  | 0.1                           | 50                |
| 16          | 70 kHz                   | 10              | Butterw     | 6     | > 54 dB  | ± 0.4 dB  | 0.1                           | 50                |
| 17          | 100 kHz                  | 10              | Butterw     | 6     | > 54 dB  | ± 0.5 dB  | 0.1                           | 50                |
| 18          | 200 kHz                  | 10              | Butterw     | 6     | > 54 dB  | ± 0.5 dB  | 0.1                           | 50                |
| 19          | 500 kHz                  | 20              | Elliptic    | 5     | > 48 dB  | ± 0.5 dB  | 0.3                           | 200               |
| 20          | 1 MHz                    | 20              | Elliptic    | 5     | > 42 dB  | ± 0.5 dB  | 0.3                           | 200               |
| 21          | 2 MHz                    | 10              | Butterw     | 4     | > 42 dB  | ± 0.5 dB  | 0.2                           | 100               |
| 22          | 5 MHz                    | 10              | Butterw     | 4     | > 42 dB  | ± 0.5 dB  | 0.2                           | 100               |

There two different Anti-Aliasing Modules available:

- AAF..200kHz - 200 Hz to 200 kHz
- AAF-.5MHz - 200 Hz to 5 MHz

## 4. Trigger Logic

Elsys DAQ cards comes with two different trigger packages, the standard trigger package and the Advance Trigger package:

### Standard Trigger

- Positive/Negative Slope
- Window In/Out

### Advance Trigger

- all Standard Trigger
- Pulse > & Pulse <
- Delay > & Delay <
- Slew Rate Trigger
- State Trigger
- AND Trigger linking
- Trigger on multiplied signals (Power Trigger)
- Trigger on Marker Inputs (TPCE only)
- Serial Protocol Trigger for I2C and CAN (TPCE only)

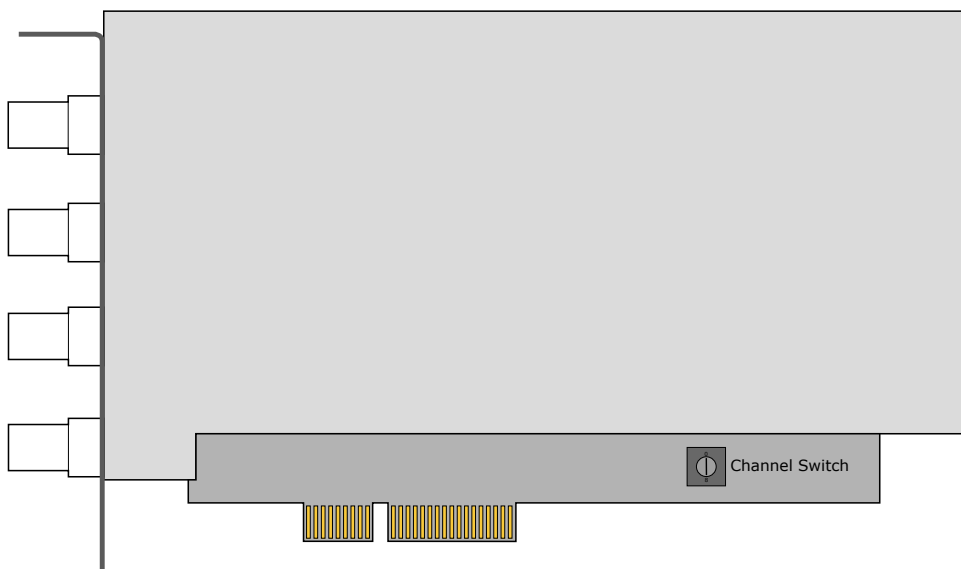
Each channels can be the trigger source at once. The first channel which detects a trigger will trigger the measurement. One external Slope trigger is available on the 25-Pol D-SUB connector on the Star-Hub board.

## 5. Multi-Board Systems

Based on all Elsys DAQ cards, large data acquisition systems can be build-up. Depending on the host system, instruments up to 64 channel in one device can be realized. Larger or distributed systems can be build-up by synchronizing several instruments together. The maximum number of channel is 1024 by taking 16 devices with 64 channel per device.

### 5.1 Board Number Configuration

When more than one board is installed in an instrument, each board must be configured with a different board letter. This can be done by configuring the channel switch on the DAQ board.



| Switch Position | Board Letter | Channels          |
|-----------------|--------------|-------------------|
| 0               | A            | A1 - A4 / A1 - A8 |
| 1               | B            | B1 - B4 / B1 - B8 |
| 2               | C            | C1 - C4 / C1 - C8 |
| ...             | ...          | ...               |
| F               | P            | P1 - P4 / P1 - P8 |

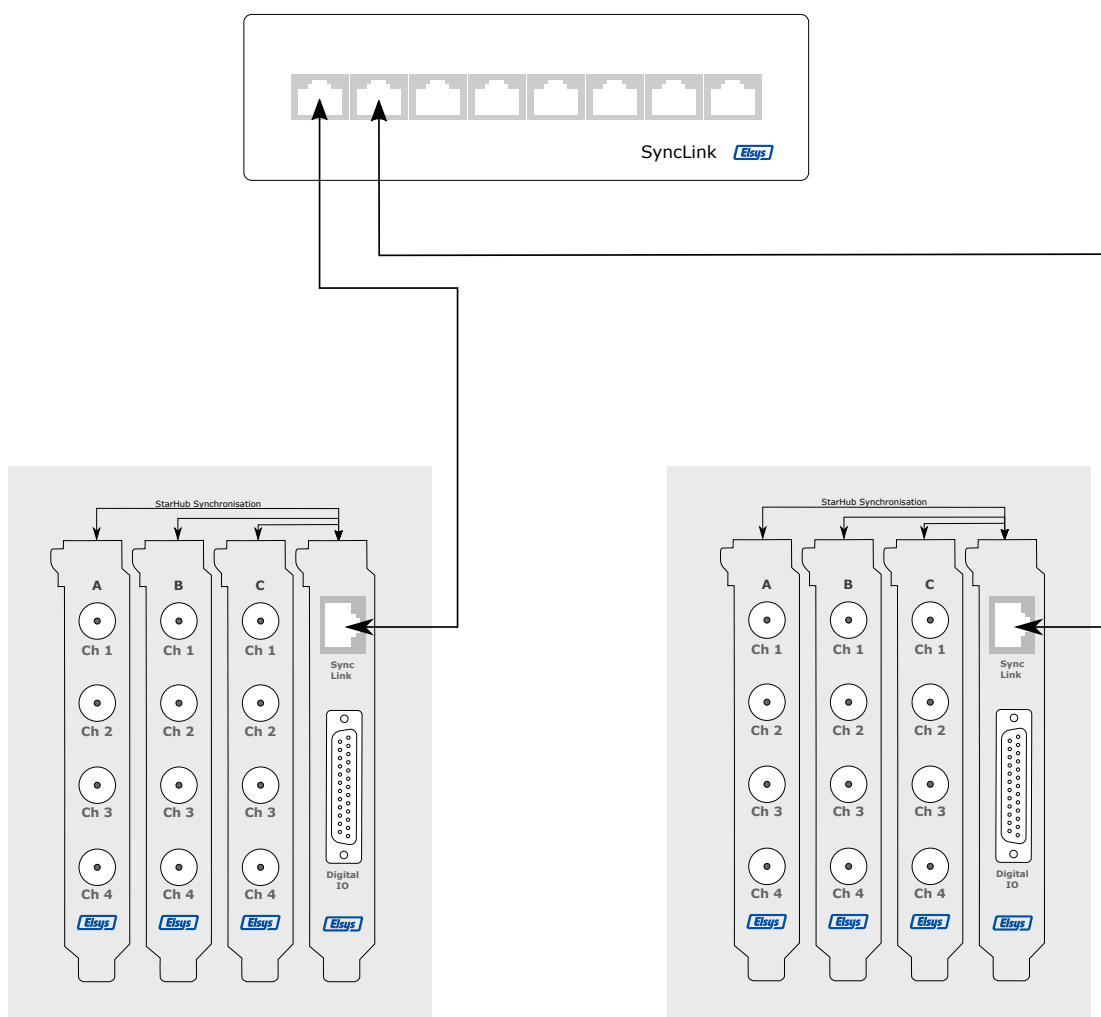
## 5.2 Star-Hub

The Star-Hub synchronization board allows to synchronize up to 16 Boards inside of an instruments. The Star-Hub generates a master Clock and distributes any Trigger event from and to all connected boards. This way every board in the system can be source and destination of any trigger event. The synchronization precision is one sample over all connected boards.

## 5.3 Sync-Link

The Sync-Link is the next higher level of synchronization and allows to synchronize up to 16 instruments. The connection is made over standard Cat. 6 Ethernet cables up to 10 m length. When connected, the SyncLink act as master clock generator and distributes any trigger event from and to all devices. Any device can be the source of the trigger.

**Note:** No measurement data are transmitted over the Sync-Link connection. Therefor an Ethernet connection must be established in addition.



## 6. Operation Modes

There are four different operation modes in which the data acquisition cards can be used. Any of these operation modes are ready to use in all driver interfaces or Application software.

### 6.1 Scope

In this mode the board runs like an Oscilloscope. Incoming data from the ADC are written into the on-board memory until a trigger condition occurs. After the trigger condition, the measurement continuous until the post-trigger time is over and stops. The length of the measurement is limited by the maximum memory available on the board.

### 6.2 Multi-Block

Multi-Block Mode works like the Scope mode but with the addition that the available on-board memory is splitted up in several blocks. On each trigger, a new part of the memory is used. This way, the on-board memory can be used more effective than in the Scope mode. The maximum number of blocks is limited by the block size and the available memory.

### 6.3 Continuous

In the Continuous mode incoming data from the ADC's are buffered on the on-board memory an then transfered immediately to the hard disk. The maximum recording length is only limited by the hard disk size. The amount of data produced per second depend on the used sampling rate and the number of activated channels. If the data rate is higher than the PCI or PCIe interface or the hard-disk write throughput, some data from the on-board buffer get lost.

### 6.4 ECR (Event Controlled Recording)

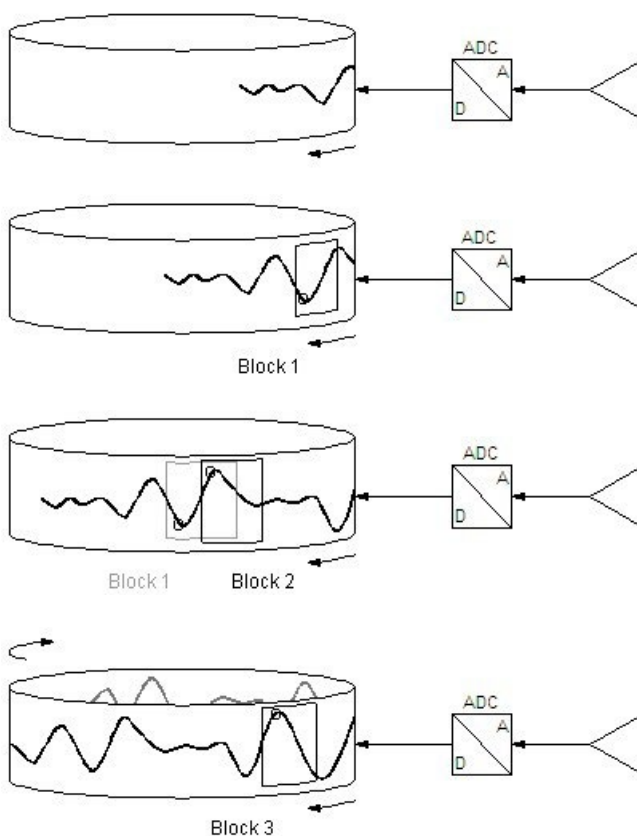
*This mode is optional!*

The ECR mode allows targeted acquisition of cyclic or sporadically arising events. This implies that the registration of measuring data only occurs if certain signal conditions (trigger, time window, repetitions, etc.) are fulfilled. Thus many unwanted and unneeded signal data will not be stored



### 6.4.1 ECR - Mode of Operation

- The digitalized signal will be stored to the on-board memory which acts as a ring buffer.
- As soon as the trigger is released, a block of samples will be read from the ring buffer and will be saved to the hard disk.
- If a new trigger event within the actual block occurs, a new overlapping block will be saved.
- If the ring buffer is full, the oldest measurement data will be overwritten with new incoming data. Usually, the overwritten data would be transferred to the hard disk before this happens. If too many events occur in a period of time, the ring buffer may overflow.



### 6.4.2 ECR Dual Mode

An other feature of ECR is the “Dual Mode”. It allows to store a continuous measurement at a slower sampling rate than the captured blocks. For example fast transient can be captured at 10 MS/s by the triggered blocks while storing slower signals at 100 kHz over a long period of time.

## 7. Specification

### 7.1 Power Consumption

#### 7.1.1 TPCX

| Power Rail         | 4 Channel |       | 8 Channel |        | 4 Channel<br>120 & 240 MHz |        |
|--------------------|-----------|-------|-----------|--------|----------------------------|--------|
|                    | Typ.      | Max.  | Typ.      | Max.   | Typ.                       | Max.   |
| + 3.3 V            | -         | -     | -         | -      | -                          | -      |
| +5 V               | 1.6 A     | 2.2 A | 2.3 A     | 2.9 A  | 1.2 A                      | 1.6 A  |
| + 12 V             | 0.4 A     | 0.7 A | 0.8 A     | 1.4 A  | 0.8 A                      | 1.4 A  |
| - 12V              | 0.2 A     | 0.3 A | 0.4 A     | 0.6 A  | -                          | -      |
| <b>Total Power</b> | 15.2 W    | 23 W  | 25.9 W    | 38.5 W | 15.6 W                     | 24.8 A |

#### 7.1.2 TPCE

| Power Rail         | 4 Channel |       | 8 Channel |        | 4 Channel<br>120 & 240 MHz |        |
|--------------------|-----------|-------|-----------|--------|----------------------------|--------|
|                    | Typ.      | Max.  | Typ.      | Max.   | Typ.                       | Max.   |
| + 3.3 V            | -         | -     | -         | -      | -                          | -      |
| +5 V               | -         | -     | -         | -      | -                          | -      |
| + 12 V             | 1.3 A     | 2.0 A | 2.2 A     | 3.3 A  | 1.4 A                      | 2.2 A  |
| - 12V              | -         | -     | -         | -      | -                          | -      |
| <b>Total Power</b> | 15.6 W    | 24 W  | 26.4 W    | 39.6 W | 16.8 W                     | 26.4 W |

### 7.2 Operating Conditions

- 0 - 45° C, 0 - 60° width active air circulation
- Max. Operating Altitude: 2000m

## 7.3 Mechanical Specification

### 7.3.1 TPCX

PCI-Bus (half size PC board, approx. 185x105 mm). 8-channel boards need 2 slots. With differential modules the number of required slots has to be doubled.

### 7.3.2 TPCE

4 Lane PCIe Bus (x4), size approx. 185x105 mm. 8-channel boards need 2 slots. With differential modules the number of required slots has to be doubled.

### 7.3.3 TPCE-LE

1 Lane PCIe Bus (x1), size approx. 185x105 mm. 8-channel boards need 2 slots. With differential modules the number of required slots has to be doubled.

### 7.3.4 TPCE-I

1 Lane PCIe Bus (x1), size approx. 185x105 mm. 8-channel boards need 2 slots.

## 7.4 TPCE Specification

| Module Type   | TPCE-24016-4   | TPCE-12016-4  | TPCE-8016-4   | TPCE-4016-4   |    |
|---|--|---|---|---|----|
| Number of Input Channels SE Module  | 4 single ended or 2 differential software switchable   |   | 4 single ended or 2 differential software switchable                              |   |    |
| Number of Input Channels DIF Module   | 4 single ended or <b>4 differential</b> software switchable  |   | 4 single ended or <b>4 differential</b> software switchable                       |   |    |
| Max. Sample Rate<br>(all channels are sampled simultaneously)   | <b>240 MHz</b>   | <b>120 MHz</b>  | <b>80 MHz</b>   | <b>40 MHz</b>   |    |
| Amplitude Resolution  | 16 Bit up to 60 MHz<br>14 Bit up to 240 MHz  | 16 Bit up to 60 MHz<br>14 Bit up to 120 MHz                                       | 16 Bit up to 20 MHz<br>14 Bit up to 80 MHz  | 16 Bit up to 10 MHz<br>14 Bit up to 40 MHz  |    |
| Memory (per Module)   | Standard: 4 x 32 MWords (= 256 MByte)<br>Optional: 4 x 128 MWords (= 1 GByte)  |   |   |   |    |
| <b>Input Amplifier</b>  |  |   |   |   |    |
| Measurement Ranges  | $\pm 50$ mV – $\pm 50$ V rsp. 0.1 V – 100 V (100 V limited to 70 V) in 1, 2, 5 Steps   |   |   |   |    |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |   |   |   |    |
| Input Impedance   | 1 M $\Omega$ ( $\pm 0.2$ %) or 50 $\Omega$ ( $\pm 0.5$ %)<br>// 26 pF ( $\pm 5$ %)   |   | 1 M $\Omega$ ( $\pm 0.2$ %) // 35 pF ( $\pm 5$ %)                                 |   |    |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |   |   |   |    |
| Bandwidth at Range $\geq 1$ V   | 120 MHz  | 60 MHz  | 30 MHz  | 18 MHz  |    |
| Bandwidth at Range < 1 V  | 80 MHz   | 50 MHz  | 8 MHz   | 7 MHz   |    |
| Slew Rate (10 – 90 %) @ Range $\geq 1$ V  | 4 ns   | 6 ns  | 13 ns   | 25 ns   |    |
| Slew Rate (10 – 90 %) @ Range < 1 V   | 6 ns   | 9 ns  | 50 ns   | 60 ns   |    |
| Settling Time to 1%   | < 200 ns   | < 200 ns  | < 200ns   | < 200 ns  |    |
| Low Pass Filter (RC-Filter)   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |   |   |   |    |
| Antialiasing-Filter (optional)  | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |   |   |   |    |
| Common Mode Range   | Differential-Mode: $\pm 8$ V or $\pm 80$ V at ranges. > 5 V  |   |   |   |    |
| Common Mode Rejection   | > 74 dB (DC – 1 kHz); > 60 dB ( – 100 kHz); > 40 dB ( – 5 MHz)   |   |   |   |    |
| Range Error ( $\pm$ )   | max. 0.1 % typ. 0.07 %<br>(after autocalibration)  |   | max. 0.1 % typ. 0.03 %<br>(after autocalibration)                                 |   |    |
| Offset Error ( $\pm$ )  | max. 0.1 % typ. 0.07 %<br>(after autocalibration)  |   | max. 0.1 % typ. 0.02 %<br>(after autocalibration)                                 |   |    |
| Offset Drift ( $\pm$ )  | max. (0.0100 % + 0.1 mV) per $^{\circ}$ C, typ. (0.0050 % + 0.03 mV) per $^{\circ}$ C<br>(will be compensated by autocalibration)  |   |   |   |    |
| Input Noise:<br>@ max. Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate                                       | < 0.250 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.025 mVrms  | < 0.200 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.025 mVrms | < 0.200 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.020 mVrms | < 0.180 mVrms<br>< 0.110 mVrms<br>< 0.060 mVrms<br>< 0.040 mVrms<br>< 0.015 mVrms | *2 |
| Signal to Noise Ratio SNR:<br>@ max. Sample Rate<br>@ 10 MHz Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate | 59 dB<br>62 dB<br>66 dB<br>69 dB<br>79 dB<br>89 dB   | 62 dB<br>68 dB<br>70 dB<br>74 dB<br>82 dB<br>90 dB                                | 67 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | 70 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | *3 |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V   | > 80 dB<br>> 60 dB   |   |   |   |    |
| Special : Autocalibration   | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |   |   |   |    |
| <b>Trigger</b>  |  |   |   |   |    |
| Number of Trigger Channels  | 4 coupled to analog inputs, pos./neg.Edge, with or without hysteresis, Window IN, Window OUT   |   |   |   |    |
| Advanced Trigger (Option)   | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long = Missing Event), State (above / below), AND link, Product (trigger signal is calculated from 2 channels) |   |   |   |    |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |   |   |   |    |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |   |   |   |    |
| <b>Miscellaneous</b>  |  |   |   |   |    |
| Digital Inputs (Marker)   | 8 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |   |   |   |    |
| Ext. Control Inputs (TTL)   | Trigger, Arm/Disarm, Ext. Sampling (fmax = 10 MHz), external command to start recording  |   |   |   |    |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |   |   |   |    |
| ICP® Sensor Supply (Option)   | 4mA Integrated Current Power for piezo sensors   |   |   |   |    |

| Module Type   | TPCE-2016-4/8  | TPCE-1016-4/8   | TPCE-0516-4/8   | TPCE-0216-4/8   |          |
|---|--|---|---|---|----------|
| Number of Input Channels SE Module  | 4-Channel Modules: 4 single ended or 2 differential<br>8-Channel Modules: 8 single ended or 4 differential   |   |   |   |          |
| Number of Input Channels DIF Module   | 4-Channel Modules: 4 single ended or <b>4 differential</b><br>8-Channel Modules: 8 single ended or <b>8 differential</b>   |   |   |   |          |
| Max. Sample Rate<br>(all channels are sampled simultaneously)   | <b>20 MHz</b>  | <b>10 MHz</b>   | <b>5 MHz</b>  | <b>2 MHz</b>  |          |
| Amplitude Resolution  | 16 Bit up to 5 MHz<br>14 Bit up to 20 MHz  | 16 Bit up to 5 MHz<br>14 Bit up to 10 MHz   | 16 Bit up to 5 MHz  | 16 Bit up to 2 MHz  |          |
| Memory 4 Channel Module   | Standard: 4 x 32 MWords (= 256 MByte)<br>Optional: 4 x 128 MWords (= 1 GByte)  |   |   |   |          |
| Memory 8 Channel Module   | Standard: 8 x 16 MWords (= 256 MByte)<br>Optional: 8 x 64 MWords (= 1 GByte)   |   |   |   |          |
| <b>Input Amplifier</b>  |  |   |   |   |          |
| Measurement Ranges  | ±50 mV – ±50 V rsp. 0.1 V – 100 V (100 V limited to 70 V) in 1, 2, 5 Steps   |   |   |   |          |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |   |   |   |          |
| Input Impedance   | 1 MΩ (± 0.2 %) // 35 pF (± 5 %)  |   |   |   |          |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |   |   |   |          |
| Bandwidth at Range ≥ 1 V  | 10 MHz   | 5 MHz   | 2.5 MHz   | 1 MHz   |          |
| Bandwidth at Range < 1 V  | 6 MHz  | 4 MHz   | 2.5 MHz   | 1 MHz   |          |
| Slew Rate (10 – 90 %) @ Range ≥ 1 V   | 40 ns  | 70 ns   | 80 ns   | 180 ns  |          |
| Slew Rate (10 – 90 %) @ Range < 1 V   | 70 ns  | 80 ns   | 80 ns   | 180 ns  |          |
| Settling Time to 1%   | < 200ns  | < 200 ns  | < 300 ns  | < 500 ns  |          |
| Low Pass Filter (RC-Filter)   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |   |   |   |          |
| Antialiasing-Filter (optional)  | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |   |   |   |          |
| Common Mode Range   | Differential-Mode: ±8 V or +/-80 V at ranges. > 5 V  |   |   |   |          |
| Common Mode Rejection   | > 74 dB (DC – 1 kHz); > 60 dB ( – 100 kHz); > 40 dB ( – 20 MHz)  |   |   |   |          |
| Range Error (±)   | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |   |   |   |          |
| Offset Error (±)  | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |   |   |   |          |
| Offset Drift (±)  | max. (0.0100 % + 0.1 mV) per °C, typ. (0.0050 % + 0.03 mV) per °C<br>(will be compensated by autocalibration)  |   |   |   |          |
| Input Noise:<br>@ max. Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate                                       | < 0.080 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms  | < 0.080 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | < 0.060 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | < 0.060 mVrms<br>-<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | *2       |
| Signal to Noise Ratio SNR:<br>@ max. Sample Rate<br>@ 10 MHz Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate | 67 dB<br>70 dB<br>72 dB<br>79 dB<br>84 dB<br>90 dB   | 70 dB<br>70 dB<br>72 dB<br>79 dB<br>84 dB<br>90 dB                                | 72dB<br>-<br>72 dB<br>79 dB<br>84 dB<br>90 dB                                     | 72 dB<br>-<br>-<br>79 dB<br>84 dB<br>90 dB                            | *3<br>*4 |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V   | > 80 dB<br>> 60 dB   |   |   |   |          |
| Special : Autocalibration   | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |   |   |   |          |
| <b>Trigger</b>  |  |   |   |   |          |
| Number of Trigger Channels  | 4 or 8, coupled to analog inputs, pos./neg.Edge, with or without hysteresis,<br>Window IN, Window OUT  |   |   |   |          |
| Advanced Trigger (Option)   | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long<br>= Missing Event), State (above / below), AND link, Product (trigger signal is calculated from<br>2 channels) |   |   |   |          |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |   |   |   |          |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |   |   |   |          |
| <b>Miscellaneous</b>  |  |   |   |   |          |
| Digital Inputs (Marker)   | 8 rsp. 16 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |   |   |   |          |
| Ext. Control Inputs (TTL)   | Trigger, Arm/Disarm, Ext. Sampling (fmax = ¼ of the max sample rate), external command<br>to start recording   |   |   |   |          |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |   |   |   |          |

- \*2) The input noise depends on the sample rate.
- \*3) At 14 bit modules the SNR will be reduced by 2 dB
- \*4) At 8-channel modules the SNR will be reduced by 3 dB

## 7.5 TPCE-LE Specification

| Module Type   | TPCE-LE-24014-4  | TPCE-LE-12014-4   | TPCE-LE-8014-4  | TPCE-LE-4014-4  |    |
|---|--|---|---|---|----|
| Number of Input Channels SE Module  | 4 single ended or 2 differential software switchable   |   | 4 single ended or 2 differential software switchable                              |   |    |
| Number of Input Channels DIF Module   | 4 single ended or <b>4 differential</b> software switchable  |   | 4 single ended or <b>4 differential</b> software switchable                       |   |    |
| Max. Sample Rate<br>(all channels are sampled simultaneously)   | <b>240 MHz</b>   | <b>120 MHz</b>  | <b>80 MHz</b>   | <b>40 MHz</b>   |    |
| Amplitude Resolution  | 14 Bit up to 240 MHz<br>(16 Bit up to 60 MHz optional)   | 14 Bit up to 120 MHz<br>(16 Bit up to 60 MHz optional)                            | 14 Bit up to 80 MHz<br>(16 Bit up to 20 MHz optional)                             | 14 Bit up to 40 MHz<br>(16 Bit up to 10 MHz optional)                             |    |
| Memory (per Module)   | Standard: 4 x 32 MWords (= 256 MByte)<br>Optional: 4 x 128 MWords (= 1 GByte)  |   |   |   |    |
| <b>Input Amplifier</b>  |  |   |   |   |    |
| Measurement Ranges  | ±100 mV – ±25 V rsp. 0.2 V – 50 V in 1, 2, 5 Steps   |   |   |   |    |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |   |   |   |    |
| Input Impedance   | 1 MΩ (± 0.2 %) or 50 Ω (± 0.5 %) // 26 pF (± 5 %)  |   | 1 MΩ (± 0.2 %) // 35 pF (± 5 %)   |   |    |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |   |   |   |    |
| Bandwidth at Range ≥ 1 V  | 120 MHz  | 60 MHz  | 30 MHz  | 18 MHz  |    |
| Bandwidth at Range < 1 V  | 80 MHz   | 50 MHz  | 8 MHz   | 7 MHz   |    |
| Slew Rate (10 – 90 %) @ Range ≥ 1 V   | 4 ns   | 6 ns  | 13 ns   | 25 ns   |    |
| Slew Rate (10 – 90 %) @ Range < 1 V   | 6 ns   | 9 ns  | 50 ns   | 60 ns   |    |
| Settling Time to 1%   | < 200 ns   | < 200 ns  | < 200ns   | < 200 ns  |    |
| Low Pass Filter (RC-Filter)   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |   |   |   |    |
| Antialiasing-Filter (optional)  | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |   |   |   |    |
| Common Mode Range   | Differential-Mode: ±8 V or +/-80 V at ranges. > 5 V  |   |   |   |    |
| Common Mode Rejection   | > 60 dB (DC – 1 kHz); > 54 dB ( – 100 kHz); > 40 dB ( – 20 MHz)  |   |   |   |    |
| Range Error (±)   | max. 0.1 % typ. 0.07 %<br>(after autocalibration)  |   | max. 0.1 % typ. 0.03 %<br>(after autocalibration)                                 |   |    |
| Offset Error (±)  | max. 0.1 % typ. 0.07 %<br>(after autocalibration)  |   | max. 0.1 % typ. 0.02 %<br>(after autocalibration)                                 |   |    |
| Offset Drift (±)  | max. (0.0100 % + 0.1 mV) per °C, typ. (0.0050 % + 0.03 mV) per °C<br>(will be compensated by autocalibration)  |   |   |   |    |
| Input Noise:<br>@ max. Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate                                       | < 0.250 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.025 mVrms  | < 0.200 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.025 mVrms | < 0.200 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.020 mVrms | < 0.180 mVrms<br>< 0.110 mVrms<br>< 0.060 mVrms<br>< 0.040 mVrms<br>< 0.015 mVrms | *2 |
| Signal to Noise Ratio SNR:<br>@ max. Sample Rate<br>@ 10 MHz Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate | 59 dB<br>62 dB<br>66 dB<br>69 dB<br>79 dB<br>89 dB   | 62 dB<br>68 dB<br>70 dB<br>74 dB<br>82 dB<br>90 dB                                | 67 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | 70 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | *3 |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V   | > 80 dB<br>> 60 dB   |   |   |   |    |
| Special : Autocalibration   | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |   |   |   |    |
| <b>Trigger</b>  |  |   |   |   |    |
| Number of Trigger Channels  | 4 coupled to analog inputs, pos./neg.Edge, with or without hysteresis, Window IN, Window OUT   |   |   |   |    |
| Advanced Trigger (Option)   | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long = Missing Event), State (above / below), AND link, Product (trigger signal is calculated from 2 channels) |   |   |   |    |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |   |   |   |    |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |   |   |   |    |
| <b>Miscellaneous</b>  |  |   |   |   |    |
| Digital Inputs (Marker)   | 8 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |   |   |   |    |
| Ext. Control Inputs (TTL)   | Trigger, Arm/Disarm, Ext. Sampling (fmax = 10 MHz), external command to start recording  |   |   |   |    |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |   |   |   |    |
| ICP® Sensor Supply (Option)   | 4mA Integrated Current Power for piezo sensors   |   |   |   |    |

| Module Type   | TPCE-LE-2014-4/8   | TPCE-LE-1014-4/8                                     | TPCE-LE-0514-4/8            | TPCE-LE-0214-4/8            |          |
|---|--|--|-----------------------------|-----------------------------|----------|
| Number of Input Channels SE Module                            | 4-Channel Modules: 4 single ended or 2 differential<br>8-Channel Modules: 8 single ended or 4 differential   |  |                             |                             |          |
| Number of Input Channels DIF Module                           | 4-Channel Modules: 4 single ended or <b>4 differential</b><br>8-Channel Modules: 8 single ended or <b>8 differential</b>   |  |                             |                             |          |
| Max. Sample Rate<br>(all channels are sampled simultaneously) | <b>20 MHz</b>  | <b>10 MHz</b>  | <b>5 MHz</b>                | <b>2 MHz</b>                |          |
| Amplitude Resolution  | 14 Bit up to 20 MHz<br>(16 Bit up to 5 MHz optional)   | 14 Bit up to 10 MHz<br>(16 Bit up to 5 MHz optional) | 14 Bit<br>(16 Bit Optional) | 14 Bit<br>(16 Bit Optional) |          |
| Memory 4 Channel Module                                       | Standard: 4 x 32 MWords (= 256 MByte)<br>Optional: 4 x 128 MWords (= 1 GByte)  |  |                             |                             |          |
| Memory 8 Channel Module                                       | Standard: 8 x 16 MWords (= 256 MByte)<br>Optional: 8 x 64 MWords (= 1 GByte)   |  |                             |                             |          |
| <b>Input Amplifier</b>  |  |  |                             |                             |          |
| Measurement Ranges  | ±100 mV – ±25 V rsp. 0.2 V – 50 V in 1, 2, 5 Steps   |  |                             |                             |          |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |  |                             |                             |          |
| Input Impedance   | 1 MΩ (± 0.2 %) // 35 pF (± 5 %)  |  |                             |                             |          |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |  |                             |                             |          |
| Bandwidth at Range ≥ 1 V                                      | 10 MHz   | 5 MHz  | 2.5 MHz                     | 1 MHz                       |          |
| Bandwidth at Range < 1 V                                      | 6 MHz  | 4 MHz  | 2.5 MHz                     | 1 MHz                       |          |
| Slew Rate (10 – 90 %) @ Range ≥ 1 V                           | 40 ns  | 70 ns  | 80 ns                       | 180 ns                      |          |
| Slew Rate (10 – 90 %) @ Range < 1 V                           | 70 ns  | 80 ns  | 80 ns                       | 180 ns                      |          |
| Settling Time to 1%   | < 200ns  | < 200 ns   | < 300 ns                    | < 500 ns                    |          |
| Low Pass Filter (RC-Filter)                                   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |  |                             |                             |          |
| Antialiasing-Filter (optional)                                | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |  |                             |                             |          |
| Common Mode Range   | Differential-Mode: ±8 V or +/-80 V at ranges. > 5 V  |  |                             |                             |          |
| Common Mode Rejection   | > 60 dB (DC – 1 kHz); > 54 dB ( – 100 kHz); > 40 dB ( – 1 MHz)   |  |                             |                             |          |
| Range Error (±)   | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |  |                             |                             |          |
| Offset Error (±)  | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |  |                             |                             |          |
| Offset Drift (±)  | max. (0.0100 % + 0.1 mV) per °C, typ. (0.0050 % + 0.03 mV) per °C<br>(will be compensated by autocalibration)  |  |                             |                             |          |
| Input Noise:  |  |  |                             |                             |          |
| @ max. Sample Rate  | < 0.080 mVrms  | < 0.080 mVrms  | < 0.060 mVrms               | < 0.060 mVrms               | *2       |
| @ 5 MHz Sample Rate   | < 0.060 mVrms  | < 0.060 mVrms  | < 0.060 mVrms               | -                           |          |
| @ 1 MHz Sample Rate   | < 0.030 mVrms  | < 0.030 mVrms  | < 0.030 mVrms               | < 0.030 mVrms               |          |
| @ 100 kHz Sample Rate   | < 0.020 mVrms  | < 0.020 mVrms  | < 0.020 mVrms               | < 0.020 mVrms               |          |
| @ 10 kHz Sample Rate  | < 0.010 mVrms  | < 0.010 mVrms  | < 0.010 mVrms               | < 0.010 mVrms               |          |
| Signal to Noise Ratio SNR:                                    |  |  |                             |                             |          |
| @ max. Sample Rate  | 67 dB  | 70 dB  | 72dB                        | 72 dB                       | *3<br>*4 |
| @ 10 MHz Sample Rate  | 70 dB  | 70 dB  | -                           | -                           |          |
| @ 5 MHz Sample Rate   | 72 dB  | 72 dB  | 72 dB                       | -                           |          |
| @ 1 MHz Sample Rate   | 79 dB  | 79 dB  | 79 dB                       | 79 dB                       |          |
| @ 100 kHz Sample Rate   | 84 dB  | 84 dB  | 84 dB                       | 84 dB                       |          |
| @ 10 kHz Sample Rate  | 90 dB  | 90 dB  | 90 dB                       | 90 dB                       |          |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V         | > 80 dB<br>> 60 dB   |  |                             |                             |          |
| Special : Autocalibration                                     | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |  |                             |                             |          |
| <b>Trigger</b>  |  |  |                             |                             |          |
| Number of Trigger Channels                                    | 4 or 8, coupled to analog inputs, pos./neg.Edge, with or without hysteresis,<br>Window IN, Window OUT  |  |                             |                             |          |
| Advanced Trigger (Option)                                     | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long<br>= Missing Event), State (above / below), AND link, Product (trigger signal is calculated from<br>2 channels) |  |                             |                             |          |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |  |                             |                             |          |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |  |                             |                             |          |
| <b>Miscellaneous</b>  |  |  |                             |                             |          |
| Digital Inputs (Marker)                                       | 8 rsp. 16 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |  |                             |                             |          |
| Ext. Control Inputs (TTL)                                     | Trigger, Arm/Disarm, Ext. Sampling (fmax = ¼ of the max sample rate), external command<br>to start recording   |  |                             |                             |          |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |  |                             |                             |          |

- \*2) The input noise depends on the sample rate.
- \*3) At 14 bit modules the SNR will be reduced by 2 dB
- \*4) At 8-channel modules the SNR will be reduced by 3 dB

## 7.6 TPCX Specification

| Module Type   | TPCX-24016-4   | TPCX-12016-4   | TPCE-8016-4   | TPCXE-4016-4  |    |
|---|--|----------------|---|---|----|
| Number of Input Channels SE Module  | EOL<br>see TPCE  |                | 4 single ended or 2 differential software switchable                              |   |    |
| Number of Input Channels DIF Module   |  |                | 4 single ended or <b>4 differential</b> software switchable                       |   |    |
| Max. Sample Rate<br>(all channels are sampled simultaneously)   | <b>240 MHz</b>   | <b>120 MHz</b> | <b>80 MHz</b>   | <b>40 MHz</b>   |    |
| Amplitude Resolution  |  | 1              | 16 Bit up to 20 MHz<br>14 Bit up to 80 MHz  | 16 Bit up to 10 MHz<br>14 Bit up to 40 MHz  |    |
| Memory (per Module)   | Standard: 4 x 16 MWords (= 128 MByte)<br>Optional: 4 x 64 MWords (= 512 MByte)   |                |   |   |    |
| <b>Input Amplifier</b>  |  |                |   |   |    |
| Measurement Ranges  | ±50 mV – ±50 V rsp. 0.1 V – 100 V (100 V limited to 70 V) in 1, 2, 5 Steps   |                |   |   |    |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |                |   |   |    |
| Input Impedance   |  |                | 1 MΩ (± 0.2 %) // 35 pF (± 5 %)   |   |    |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |                |   |   |    |
| Bandwidth at Range ≥ 1 V  |  |                | 30 MHz  | 18 MHz  |    |
| Bandwidth at Range < 1 V  |  |                | 8 MHz   | 7 MHz   |    |
| Slew Rate (10 – 90 %) @ Range ≥ 1 V   |  |                | 13 ns   | 25 ns   |    |
| Slew Rate (10 – 90 %) @ Range < 1 V   |  |                | 50 ns   | 60 ns   |    |
| Settling Time to 1%   |  |                | < 200ns   | < 200 ns  |    |
| Low Pass Filter (RC-Filter)   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |                |   |   |    |
| Antialiasing-Filter (optional)  | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |                |   |   |    |
| Common Mode Range   | Differential-Mode: ±8 V or +/-80 V at ranges. > 5 V  |                |   |   |    |
| Common Mode Rejection   | > 74 dB (DC – 1 kHz); > 60 dB (– 100 kHz); > 40 dB (– 5 MHz)   |                |   |   |    |
| Range Error (±)   |  |                | max. 0.1 % typ. 0.03 %<br>(after autocalibration)                                 |   |    |
| Offset Error (±)  |  |                | max. 0.1 % typ. 0.02 %<br>(after autocalibration)                                 |   |    |
| Offset Drift (±)  | max. (0.0100 % + 0.1 mV) per °C, typ. (0.0050 % + 0.03 mV) per °C<br>(will be compensated by autocalibration)  |                |   |   |    |
| Input Noise:<br>@ max. Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate                                       |  |                | < 0.200 mVrms<br>< 0.120 mVrms<br>< 0.070 mVrms<br>< 0.040 mVrms<br>< 0.020 mVrms | < 0.180 mVrms<br>< 0.110 mVrms<br>< 0.060 mVrms<br>< 0.040 mVrms<br>< 0.015 mVrms | *2 |
| Signal to Noise Ratio SNR:<br>@ max. Sample Rate<br>@ 10 MHz Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate |  |                | 67 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | 70 dB<br>70 dB<br>72 dB<br>76 dB<br>84 dB<br>92 dB                                | *3 |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V   |  |                | > 80 dB<br>> 60 dB  |   |    |
| Special : Autocalibration   | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |                |   |   |    |
| <b>Trigger</b>  |  |                |   |   |    |
| Number of Trigger Channels  | 4 coupled to analog inputs, pos./neg.Edge, with or without hysteresis, Window IN, Window OUT   |                |   |   |    |
| Advanced Trigger (Option)   | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long = Missing Event), State (above / below), AND link, Product (trigger signal is calculated from 2 channels) |                |   |   |    |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |                |   |   |    |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |                |   |   |    |
| <b>Miscellaneous</b>  |  |                |   |   |    |
| Digital Inputs (Marker)   | 8 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |                |   |   |    |
| Ext. Control Inputs (TTL)   | Trigger, Arm/Disarm, Ext. Sampling (fmax = 10 MHz), external command to start recording  |                |   |   |    |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |                |   |   |    |
| ICP® Sensor Supply (Option)   | 4mA Integrated Current Power for piezo sensors   |                |   |   |    |

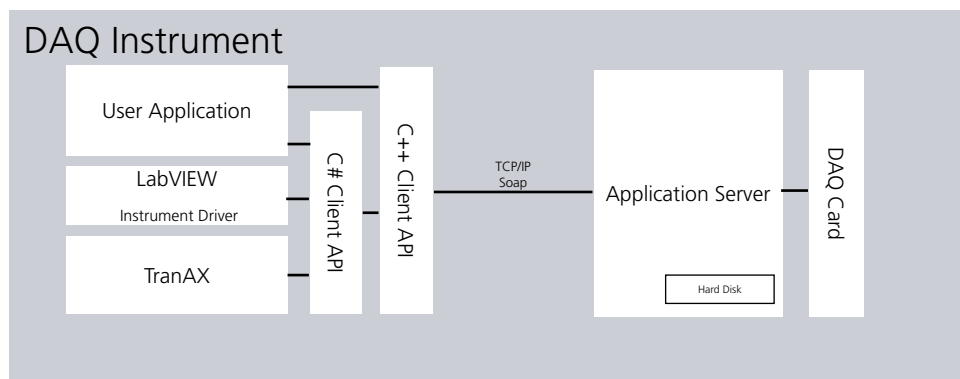


| Module Type   | TPCX-2016-4/8  | TPCX-1016-4/8   | TPCX-0516-4/8   | TPCX-0216-4/8   |          |
|---|--|---|---|---|----------|
| Number of Input Channels SE Module  | 4-Channel Modules: 4 single ended or 2 differential<br>8-Channel Modules: 8 single ended or 4 differential   |   |   |   |          |
| Number of Input Channels DIF Module   | 4-Channel Modules: 4 single ended or <b>4 differential</b><br>8-Channel Modules: 8 single ended or <b>8 differential</b>   |   |   |   |          |
| Max. Sample Rate<br>(all channels are sampled simultaneously)   | <b>20 MHz</b>  | <b>10 MHz</b>   | <b>5 MHz</b>  | <b>2 MHz</b>  |          |
| Amplitude Resolution  | 16 Bit up to 5 MHz<br>14 Bit up to 20 MHz  | 16 Bit up to 5 MHz<br>14 Bit up to 10 MHz   | 16 Bit up to 5 MHz  | 16 Bit up to 2 MHz  |          |
| Memory 4 Channel Module   | Standard: 4 x 32 MWords (= 256 MByte)<br>Optional: 4 x 128 MWords (= 1 GByte)  |   |   |   |          |
| Memory 8 Channel Module   | Standard: 8 x 16 MWords (= 256 MByte)<br>Optional: 8 x 64 MWords (= 1 GByte)   |   |   |   |          |
| <b>Input Amplifier</b>  |  |   |   |   |          |
| Measurement Ranges<br>(1-2-5 Steps)   | ±50 mV – ±50 V rsp. 0.1 V – 100 V (100 V limited to 70 V)  |   |   |   |          |
| Offset  | 0 – 100 % in steps of 0.1% (Resolution 0.01 %)   |   |   |   |          |
| Input Impedance   | 1 MΩ (± 0.2 %) // 35 pF (± 5 %)  |   |   |   |          |
| Coupling  | AC / DC software switchable (AC: -3 dB at < 5 Hz), Inputs invertible   |   |   |   |          |
| Bandwidth at Range ≥ 1 V  | 10 MHz   | 5 MHz   | 2.5 MHz   | 1 MHz   |          |
| Bandwidth at Range < 1 V  | 6 MHz  | 4 MHz   | 2.5 MHz   | 1 MHz   |          |
| Slew Rate (10 – 90 %) @ Range ≥ 1 V   | 40 ns  | 70 ns   | 80 ns   | 180 ns  |          |
| Slew Rate (10 – 90 %) @ Range < 1 V   | 70 ns  | 80 ns   | 80 ns   | 180 ns  |          |
| Settling Time to 1%   | < 200ns  | < 200 ns  | < 300 ns  | < 500 ns  |          |
| Low Pass Filter (RC-Filter)   | 2 Steps ( 1 MHz and 100 kHz) software switchable   |   |   |   |          |
| Antialiasing-Filter (optional)  | 200 Hz – 5 MHz, min. 4. order Butterworth, software setable  |   |   |   |          |
| Common Mode Range   | Differential-Mode: ±8 V or +/-80 V at ranges. > 5 V  |   |   |   |          |
| Common Mode Rejection   | > 74 dB (DC – 1 kHz); > 60 dB (– 100 kHz); > 40 dB (– 20 MHz)  |   |   |   |          |
| Range Error (±)   | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |   |   |   |          |
| Offset Error (±)  | max. 0.1 % typ. 0.03 %<br>(after autocalibration)  |   |   |   |          |
| Offset Drift (±)  | max. (0.0100 % + 0.1 mV) per °C, typ. (0.0050 % + 0.03 mV) per °C<br>(will be compensated by autocalibration)  |   |   |   |          |
| Input Noise:<br>@ max. Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate                                       | < 0.080 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms  | < 0.080 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | < 0.060 mVrms<br>< 0.060 mVrms<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | < 0.060 mVrms<br>-<br>< 0.030 mVrms<br>< 0.020 mVrms<br>< 0.010 mVrms | *2       |
| Signal to Noise Ratio SNR:<br>@ max. Sample Rate<br>@ 10 MHz Sample Rate<br>@ 5 MHz Sample Rate<br>@ 1 MHz Sample Rate<br>@ 100 kHz Sample Rate<br>@ 10 kHz Sample Rate | 67 dB<br>70 dB<br>72 dB<br>79 dB<br>84 dB<br>90 dB   | 70 dB<br>70 dB<br>72 dB<br>79 dB<br>84 dB<br>90 dB                                | 72dB<br>-<br>72 dB<br>79 dB<br>84 dB<br>90 dB                                     | 72 dB<br>-<br>-<br>79 dB<br>84 dB<br>90 dB                            | *3<br>*4 |
| Channel Isolation (Crosstalk) @ 10 kHz<br>Ranges < 1V   | > 80 dB<br>> 60 dB   |   |   |   |          |
| Special : Autocalibration   | Auto adjustment of gain and offset in all measurement ranges. (Initiated by software)  |   |   |   |          |
| <b>Trigger</b>  |  |   |   |   |          |
| Number of Trigger Channels  | 4 or 8, coupled to analog inputs, pos./neg.Edge, with or without hysteresis,<br>Window IN, Window OUT  |   |   |   |          |
| Advanced Trigger (Option)   | On all analog inputs: Slew Rate, Pulse Width, Pulse Pause or Period (too short or too long<br>= Missing Event), State (above / below), AND link, Product (trigger signal is calculated from<br>2 channels) |   |   |   |          |
| External Trigger input  | 1 per System (TTL), pos. or neg. Edge  |   |   |   |          |
| Trigger Delay   | -100 % (Pretrigger) to +200 % (Posttrigger) in 1 % steps   |   |   |   |          |
| <b>Miscellaneous</b>  |  |   |   |   |          |
| Digital Inputs (Marker)   | 8 rsp. 16 (2 per analog channel) (TTL)<br>Optocoupler Connection Box (5 to 48 V) as additional option  |   |   |   |          |
| Ext. Control Inputs (TTL)   | Trigger, Arm/Disarm, Ext. Sampling (fmax = ¼ of the max sample rate), external command<br>to start recording   |   |   |   |          |
| Status Outputs (TTL)  | Trigger Output, Armed (=True during recording)   |   |   |   |          |
| ICP® Sensor Supply (Option)   | 4mA Integrated Current Power for piezo sensors   |   |   |   |          |

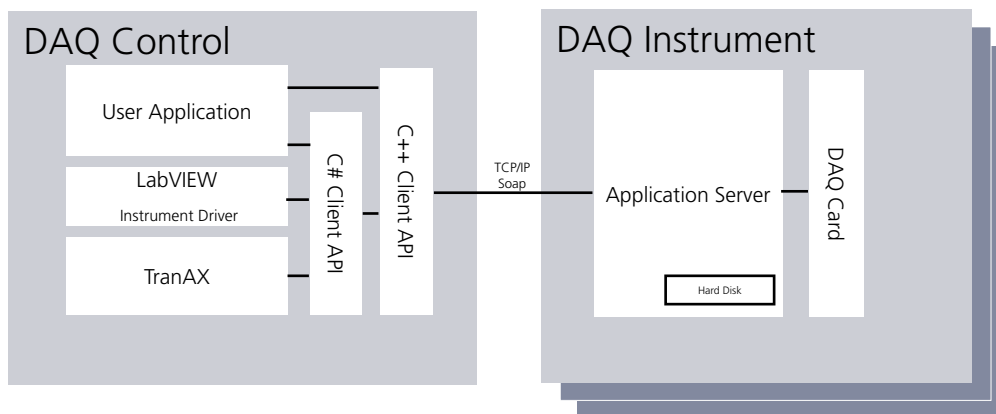
- \*2) The input noise depends on the sample rate.
- \*3) At 14 bit modules the SNR will be reduced by 2 dB
- \*4) At 8-channel modules the SNR will be reduced by 3 dB

## 8. Software API

All DAQ cards as also the TraNET devices are based on the same Server-Client Software architecture. Any client application can access the data acquisition device over an IP address either locally or over a network. This way distributed measurement set-ups can be easily built-up.



Control/DAQ Software runs on machine where the DAQ cards are installed



Control/DAQ Software runs on a different machine and controls multiple DAQ instruments.

The lowest level accessible from a user application is a C++ interface. This interface handles all network communication between the Application and the Application Server.

C# Applications can access a high level API for easy software integration. Several application can access the same device on the same time and get updated about any status change of the device automatically.

For more information visit:

[https://elsys-instruments.com/en/support/software\\_api.php](https://elsys-instruments.com/en/support/software_api.php)

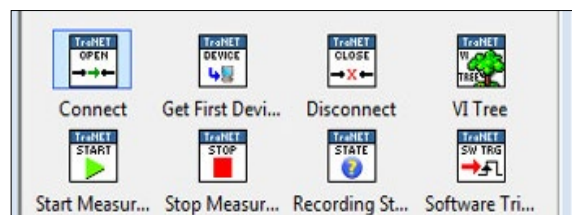
## 8.1 LabVIEW

Elsys provides a LabVIEW instrument driver which is fully compliant with the NI driver design guidelines.

The application server encapsulates all necessary task for controlling the different measurement modes described above, including data streaming to the hard drive. Therefore no challenging programming is needed for streaming application as this is already integrated into the Server software.

For more information visit:

[https://elsys-instruments.com/en/support/labview\\_instrument\\_driver.php](https://elsys-instruments.com/en/support/labview_instrument_driver.php)



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