ROHDE & SCHWARZ

USER MANUAL

Analog Stimulus and Measurement Module

TS-PSAM

User Manual

for ROHDE & SCHWARZ Analog Stimulus and Measurement Module TS-PSAM

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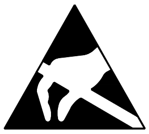

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Electrostatic
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Rohde & Schwarz GmbH & Co. KG

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December 2000 edition

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Appendix to Certificate Registration No.: 001954 QM/ST

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The international and German Road Traffic Law
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No.: 22 Electrical/Electronic Sub Assembly

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Rohde & Schwarz GmbH & Co. KG

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(*) **Rohde & Schwarz GmbH & Co. KG** Mühldorfstrasse 15 81671 München	Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems
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If you have any technical queries about this Rohde & Schwarz equipment, our Hotline at the Support Center of Rohde & Schwarz Sales-GmbH will be glad to help.

Our team will discuss your queries and look for solutions to your problems.

The Hotline is open Mondays to Fridays from 08.00 to 17.00 hrs.

For queries outside office hours, you can leave a message or send a note via fax or email. We will then get back to you as soon as possible.

ROHDE & SCHWARZ

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1 Usage

1.1 General

The TS-PSAM Analog Stimulus and Measurement Module is a measurement module for the CompactTSVP (Test System Versatile Platform) universal test platform. The module is used to perform analog measuring tasks, in-circuit measurements, and the CompactTSVP self-test. The module's floating DC supply voltage is provided via the associated TS-PDC rear I/O module. This is inserted in the appropriate rear I/O slot in the back of the device (same slot number as TS-PSAM).

The TS-PSAM module is inserted in the front of the CompactTSVP chassis. It is based on the cPCI/PXI standard.

The front connector ends flush with the front panel of the CompactTSVP chassis and is used for contacting the test products or measurement sensors. At the back, the TS-PSAM module is connected to the cPCI control bus and the PXI trigger bus. Instead of using the front connector, analog measurement signals can be captured via the CompactTSVP's analog measuring bus.

A LabWindows IVI DMM driver is provided for the DMM functions on the card. All other hardware functions are controlled using specific extensions of the driver. As is typical for a LabWindows CVI driver, Function Panels and Online Help are available.

1.2 Features of the TS-PSAM

1.2.1 Hardware Components

The TS-PSAM modules includes a ground-connected discharge circuit, an floating programmable voltage source, and an floating measurement unit. These components can be switched into the CompactTSVP's analog bus via a relay matrix. Measuring tasks can be synchronized using triggered measurements across the PXI bus and the trigger inputs on the front connector. Two relay multiplexers with four channels each are also provided. The major features of these three function blocks will be explained in detail in the following section:

- **floating DC voltage source (DCS)**
  - adjustable voltage and current limiting
    - ±5 V, 100 mA max.
  - fast settling time
  - four-quadrant operation
  - sense wires
- **floating measurement unit** (MU)
  - Measurement range DC
    - 10 mV - 125 V
    - 1 µA - 1 A
  - Measurement range AC_{rms}
    - 20 mV - 125 V
    - 100 µA - 1 A
  - triggered measurements across the PXI Triggerbus
  - 2 triggers derived from the measurement signal with programmable threshold
  - 4 filters
  - 16-bit converter
    - Sampling rate 200 kHz (max.)
    - Single or „multipoint“ measurement with storage depth up to 8 k samples
- **Discharge circuit** (DCH)
  - Discharge current 400 mA (max.)
  - Discharge voltage 125V (max.)

1.2.2 Applications

On this topic see also Figure 1-1to Figure 1-6

The module is used to perform analog measuring tasks, in-circuit measurements, and the CompactTSVP self-test. In these tests, the module functions as a measuring device with adjustable sampling rate for voltage, current and resistance measurements. The measurement unit and the adjustable DC voltage source are cross-connected with each other in a suitable manner for measuring resistance. If necessary, the source can also be connected with GND. The measurement unit and the DC voltage source can also be operated independently of one another. In the in-circuit test (ICT), the TS-PSAM module performs the following measuring tasks:

- Discharging capacitors
- 2- and 4-wire resistance measurements
  (Figure 1-1 to Figure 1-4)
- Contact test
- Short circuit test
- Connection test

1.2.2.1 Examples of use

On this topic see also Figure 1-1 to Figure 1-4

Resistance measurements are taken with the aid of the DC voltage source and the measurement unit. 2- and 4-wire measurements are possible. Two different procedures may be followed depending on the resistance value to be measured. If necessary, the source can be connected to GND.

- **Mode C** for small resistances
  In this method, a constant current is applied and the voltage is measured. (see Figure 1-1 and Figure 1-2)

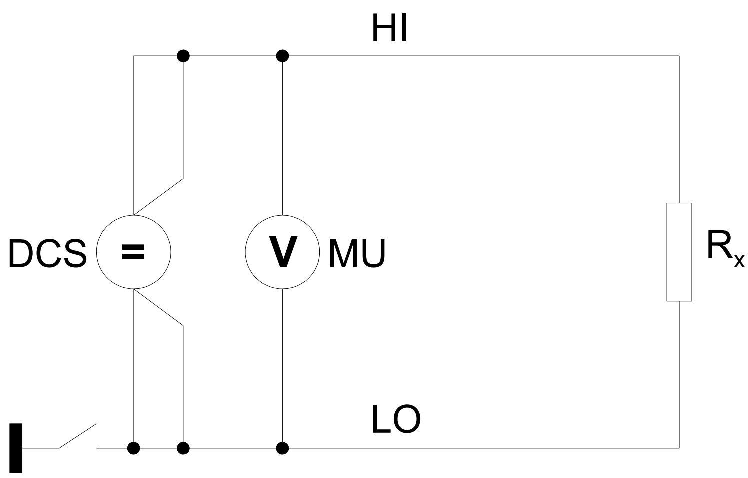

Figure 1-1 Cross-connection for 2-wire resistance measuring in Mode C

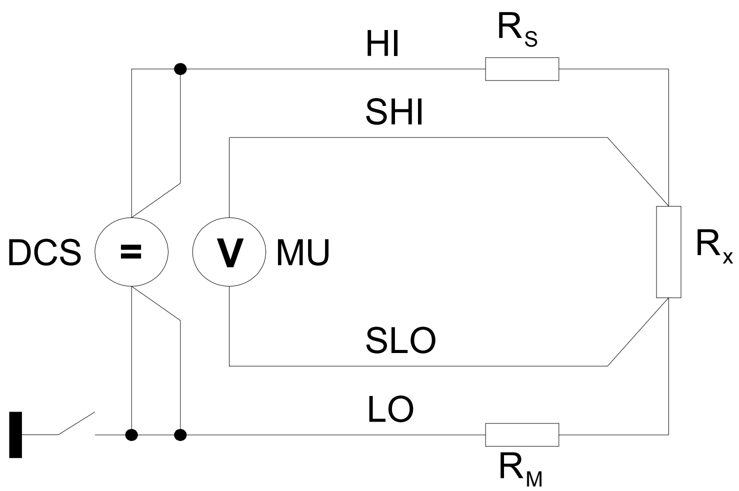

Figure 1-2 Cross-connection for 4-wire resistance measuring in Mode C

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- **Mode V** for large resistances
  In this method, the voltage is applied and the current is measured. (see Figure 1-3 and Figure 1-4)

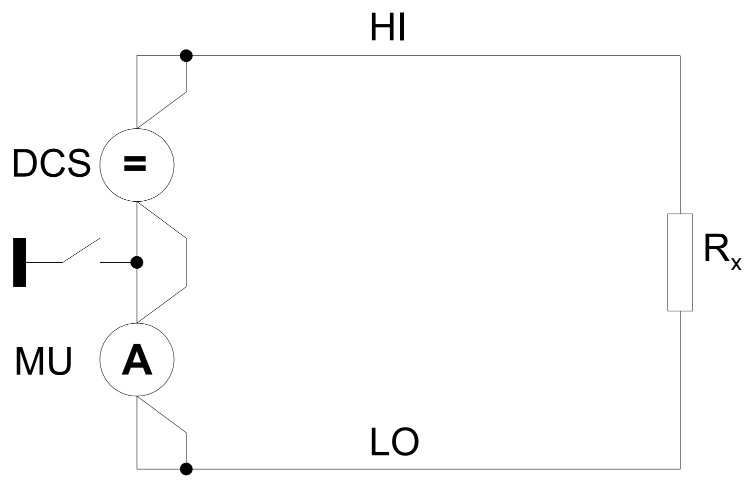

Figure 1-3 Cross-connection for 2-wire resistance measuring in Mode V

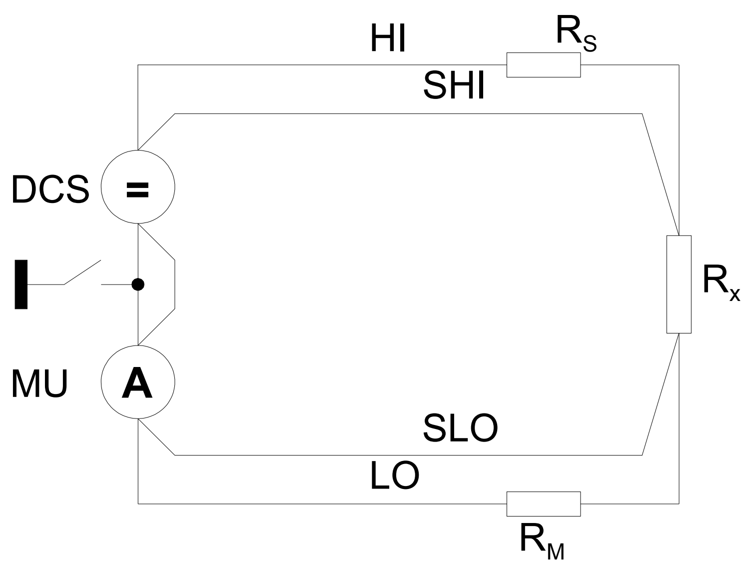

Figure 1-4 Cross-connection for 4-wire resistance measuring in Mode V

1.2.2.2 Expanded applications

On this topic, see also Figure 1-5 and Figure 1-6

Further in-circuit measurements can be made in conjunction with the TS-PICT module (ICT expansion module). These are:

– Diode and transistor test
– Guarded resistance measurements (3, 4 and 6 wires)
– Impedance measurements (3, 4 and 6 wires)

For this purpose, the TS-PICT module provides a special AC voltage source (AOS) and current measurement unit (CMU).

The UUT is connected for the in-circuit test (ICT) via the TS-PMB module (matrix module B).

1.2.2.2.1 Examples of use

On this topic, see also Figure 1-5 and Figure 1-6

The following section presents some examples of cross-connection for guarded measurements.

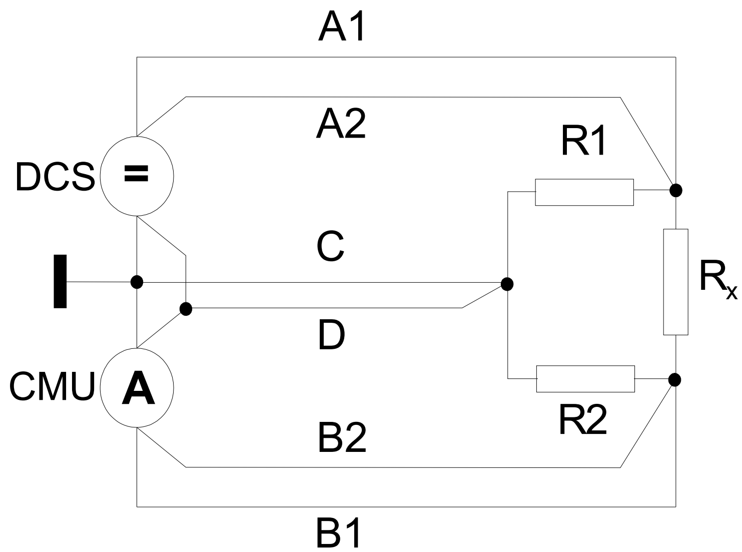

Figure 1-5 Cross-connection in a guarded resistance measurement (6-wire)

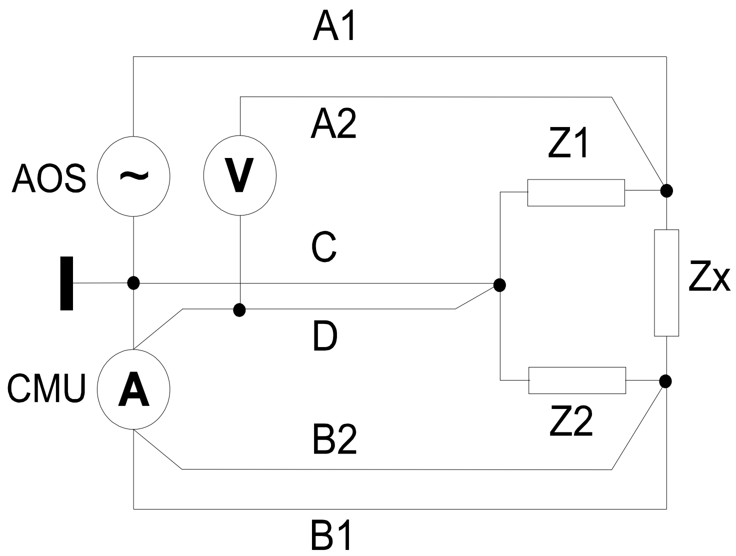

Figure 1-6 Cross-connection in a guarded impedance measurement (6-wire)

1.2.3 Features of the TS-PDC module

The TS-PDC module is used as an floating DC voltage source for the TS-PSAM module. It is configured with two identical DC/DC converters. The following floating direct voltages are obtained from an input voltage of 5 VDC:

– +15 VDC ±5%, 0.5A (2x)
– -15 VDC ±5%, 0.5A (2x)
– +5 VDC ±5%, 0.5A (2x)
– +3.3 VDC ±5%, 0.25A (2x)

2 View

Figure 2-2 shows the TS-PSAM module without the associated TS-PDC rear I/O module. The TS-PDC rear I/O module is shown in Figure 2-2.

Figure 2-1 View of the TS-PSAM module

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Figure 2-2 View of the TS-PDC rear I/O module.

3 Block diagrams

Figure 3-1 shows the block diagram of the TS-PSAM module and Figure 3-2 shows the block diagram of the TS-PDC module. Figure 3-3 is a simplified functional block diagram of both modules in the CompactTSVP.

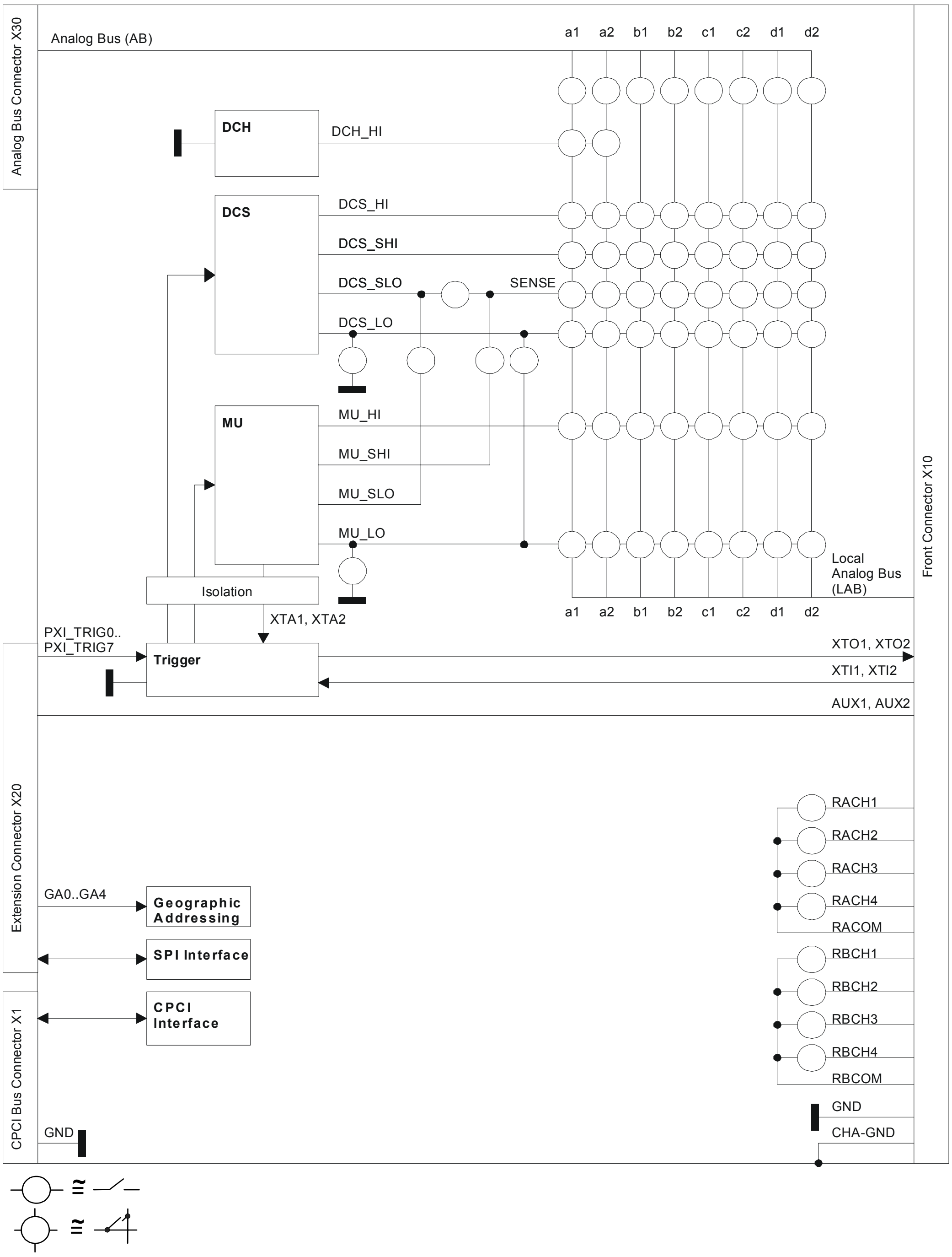

Figure 3-1 Block Diagram of TS-PSAM

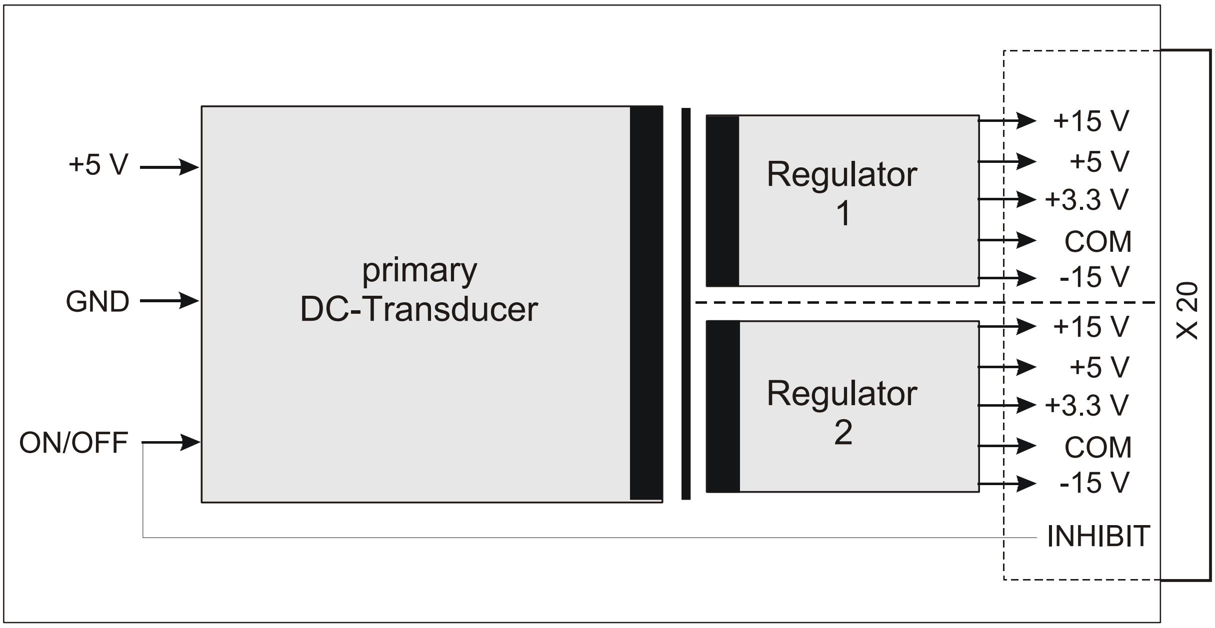

Figure 3-2 Block Diagram of TS-PDC

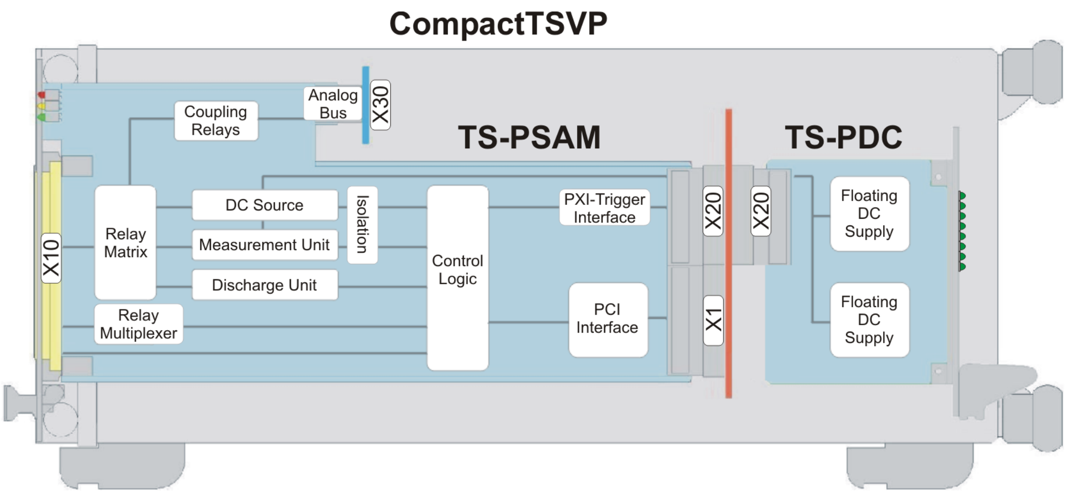

Figure 3-3 Functional block diagram of TS-PSAM with TS-PDC in the CompactTSVP

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4 Layout

4.1 Mechanical construction of the TS-PSAM

On this topic, see also Figure 4-1

The TS-PSAM module is designed as a **long cPCI plug-in module** for mounting in the front of the CompactTSVP. The board height of the module is 3 HU (134 mm). In order to ensure that it is inserted correctly into the Compact TSVP, the front panel is furnished with a locating pin. The module is secured in place with the two retaining screws on the front panel. Front connector X10 is used for connecting the UUTs. Connector X30 connects the TS-PSAM module to the analog bus backplane in the CompactTSVP. Connectors X20/X1 connect the TS-PSAM module to the cPCI backplane/PXI control backplane.

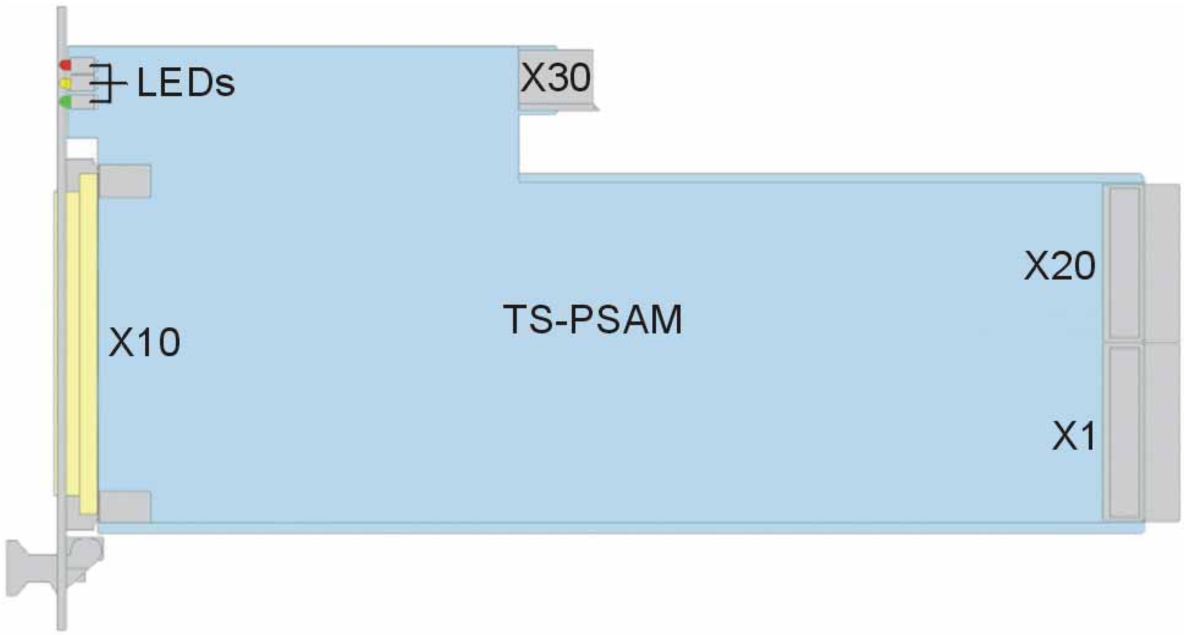

Figure 4-1 Arrangement of connectors and LEDs on the TS-PSAM module

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Symbol	Use
X1	cPCI Bus
X10	UUT
X20	Extension (PXI), Rear I/O
X30	Analog Bus

Table 4-1 Connectors on the TS-PSAM module

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4.2 Display elements on the TS-PSAM module

On this topic, see also Figure 4-2

Three light-emitting diodes (LEDs) are located on the front of the TS-PSAM module to show the current status of the module. These LEDs have the following meanings:

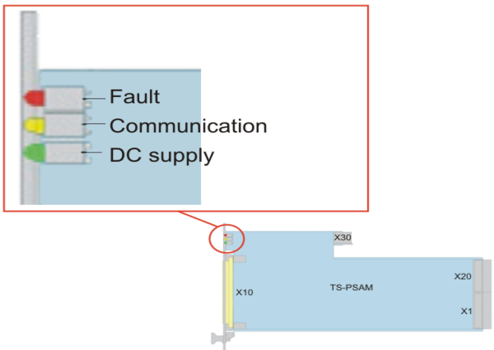

Figure 4-2 Arrangement of LEDs on the TS-PSAM module

LED	Description
red	Fault condition (ERR): Lights up when a fault is detected on the TS-PSAM module during the power-on test after the supply voltage is switched on. This means that there is a hardware problem on the module. (see also Section 8 “Self-test“)
yellow	Communication (COM): Lights up when data is exchanged across the inter-face.
green	Supply voltage OK (PWR): Lights up when all necessary supply voltages are present (inc. the TS-PDC voltages).

Table 4-2 LEDs on the TS-PSAM module

4.3 Mechanical construction of the TS-PDC

On this topic, see also Figure 4-3

The TS-PDC module is a **rear I/O module** for mounting in the back of the CompactTSVP. The board height of the module is 3 HU (134 mm). The module is secured in place with the two retaining screws on the front panel. Connector X20 connects the TS-PDC module to the extension backplane in the CompactTSVP. The TS-PDC module must always use the corresponding rear I/O slot for the main module (e.g. TS-PSAM module).

WARNING!

The TS-PDC module must always be inserted in the corresponding rear I/O slot (same slot code) of the TS-PSAM module.
If modules are inserted incorrectly (e.g. cPCI/PXI standard modules in the front), both modules may be damaged irreparably.

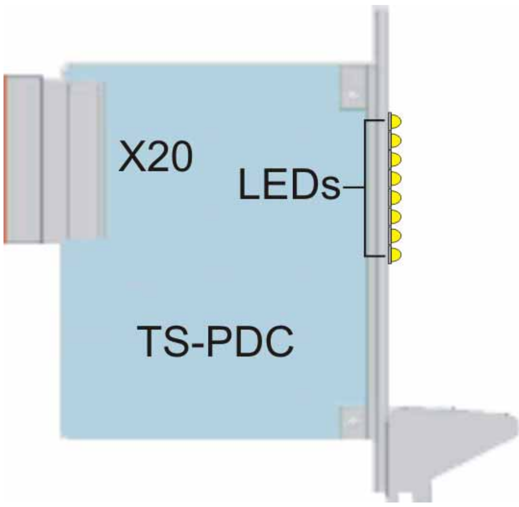

Figure 4-3 Arrangement of the connector and LEDs on the TS-PDC module

Symbol	Use
X20	Extension (Rear I/O)

Table 4-3 Connector for the TS-PDC module

4.4 Display elements of the TS-PDC module

On this topic, see also Figure 4-4

Eight light-emitting diodes (LEDs) are located on the front of the TS-PDC module to show the current status of the generated supply voltages. The individual LEDs have the following meanings:

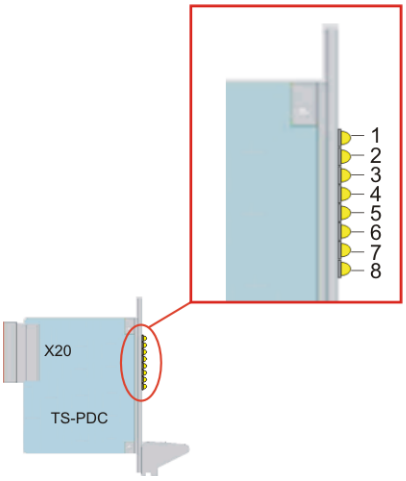

Figure 4-4 Arrangement of LEDs on the TS-PDC module

LED	Description
1, lights up	+15 VDC (DCS), present
2, lights up	+5 VDC (DCS), present
3, lights up	+3.3 VDC (DCS), present
4, lights up	-15 VDC (DCS), present
5, lights up	+15 VDC (MU), present
6, lights up	+5 VDC (MU), present
7, lights up	+3.3 VDC (MU), present
8, lights up	-15 VDC (MU), present

Table 4-4 Display elements on the TS-PDC module

5 Function Description

5.1 Function description of the TS-PSAM module

On this topic, see also Figure 5-1 and Figure 5-2

5.1.1 Primary matrix and analog measuring bus

On this topic, see also Figure 5-1

The stimulus and measurements can be cross-connected in any permutation through a full matrix to a local analog bus (8-wires LABx). The discharge circuit can only be connected to wires a1 and a2. Cross-connection to the TSVP's analog measuring bus is possible via separate bus coupling relays.

Configuration relays

The following relays are used for internal configuration:

- Ground relays
- MU and DCS configuration relays

Voltage and current measurement unit (MU)

(MU = Measurement Unit)

AC and DC voltages and currents are measured with the MU. Both MU inputs can be switched into the local 8-wire analog bus via the full matrix.

DC voltage measurement

The DC voltage measurement unit (MU) is a floating measuring device with programmable pre-filtering and adjustable input voltage ranges. Analog/Digital conversion is performed with a serial A/D converter whose output data are stored in a FIFO memory.

Low Pass Filter (-3 dB): (MU Filter)	4 ranges, 400 Hz, 4 kHz, 40 kHz, 100 kHz (the same applied for current measurements)
Voltage ranges:	see specifications
Overvoltage protection:	200 V max.
Analog bandwidth (-3 dB):	>500 kHz

A/D converter:	Resolution: 16-bit sampling rate: 200 kHz max.
FIFO:	8 k

AC voltage measurement

AC voltage is measured using an RMS-to-DC converter. AC voltage that is present at the inputs is converted to a DC output voltage that is proportional to the real RMS value of the input signal. The converted DC output voltage is processed by the A/D converter.

DC current measurement

The measurement unit for current is capable of taking readings in a range from a few hundred nanoamperes to a 1 A. It can be switched into the 8-wire analog bus without limitation through a full matrix. Currents larger than 100 mA are measured using a shunt resistor. On the other hand, currents smaller than 100 mA are measured actively using a current-voltage converter (I/U converter).

AC current measurement

The AC current is converted to an AC voltage using a shunt or I/U converter; the AC voltage is converted to a DC voltage with an RMS-to-DC converter, and the DC voltage is processed by the A/D converter.

DC stimulus source (DCS)

(DCS = DC Source)

The DCS is a potentialless, programmable DC voltage source with adjustable current limiting and sense wires for compensating voltage drops in circuits to the load. Depending on the test requirements, it can function either in voltage mode or in current limiting mode.

DC stimulus source specification

Voltage mode

Voltage range:	0 ... ±5 V
Current:	0 ... ±100 mA max.

Current limiting mode

Voltage range:	±0.1 V ... ±5 V max.
Current limit ranges:	±100 mA, 10 mA, 1 mA, 0.1 mA

Resistance measurement

With the DC Stimulus (DCS) and current measurement unit (MU), resistances can be measured in the following ways:

- A known DC voltage Vs is applied to the resistor that is to be measured and the resulting current Ix is measured with the MU.
- A known DC current Is is applied to the resistor via the DCS and the resulting drop in voltage Vx at the resistor is measured with the MU.

5.1.2 Discharge unit DCH

(DCH = Discharge Unit)

The discharge unit is provided to enable the controlled discharge of capacitors on the UUT, to prevent the circuit relays in the test system from being irreparably damaged or the UUT from becoming charged as a result of the test procedure. For this purpose, a constant discharge current is generated with an active current limiter. The circuit is protected against overload by an integrated heat cutout. The residual voltage after discharge is typically less than 100 mV. The DCH can be connected to the local analog bus via relays.

In order to minimize loading on the circuit relays, the circuit path should be set first, before the DCH is activated.

Specifications

Discharge current ranges: (typical)	400 mA, 275 mA, 150 mA and 10 mA
Discharge mode:	Constant current
Maximum voltage:	±125 VDC
Discharge residual voltage:	<100 mVDC
Discharge power: (average)	2 W max.
Overvoltage protection:	200 VDC max.
Overload protection:	Thermal sensor

5.1.3 Trigger logic

On this topic, see also Figure 5-2

The TS-PSAM module can be synchronized with other system components by trigger signals from the PXI trigger bus, or by local trigger events or “software triggers“ . In all such events, the TS-PSAM module can function as a “trigger master“ or “ a trigger slave“.

Trigger inputs

The internal FPGA Hardware uses the global trigger input signals from the PXI trigger bus (PXI_TRIG0 ... PXI_TRIG7) and the local TTL trigger inputs on the front connector (XTI1, XTI2). In addition, the trigger signals (XTA1, XTA2) derived from the analog input signal and the four internal feedback trigger circuits of the trigger logic blocks (IT01 ... IT04) are all used to detect a trigger event. The signals to be considered and their levels (high/low) are selected in configuration registers.

Trigger logic blocks

The FPGA contains four independently functioning trigger logic blocks for generating complex trigger sequences:

1. Multiple trigger pulses with various delay periods and the same time reference
2. Cascade triggers
3. Multiple trigger pulses with adjustable duty factor
4. Trigger logic blocks 3 and 4 are reserved for internal use (DCS, ADC), blocks1 and 2 are available to the user

Trigger outputs

The outputs from the trigger logic blocks can be switched to the trigger outputs on the front connector (XTOx) and to the PXI trigger bus (PXI_TRIGx). The polarity of the trigger signal is programmable. The trigger output signals are TTL compatible and are buffered using driver circuits.

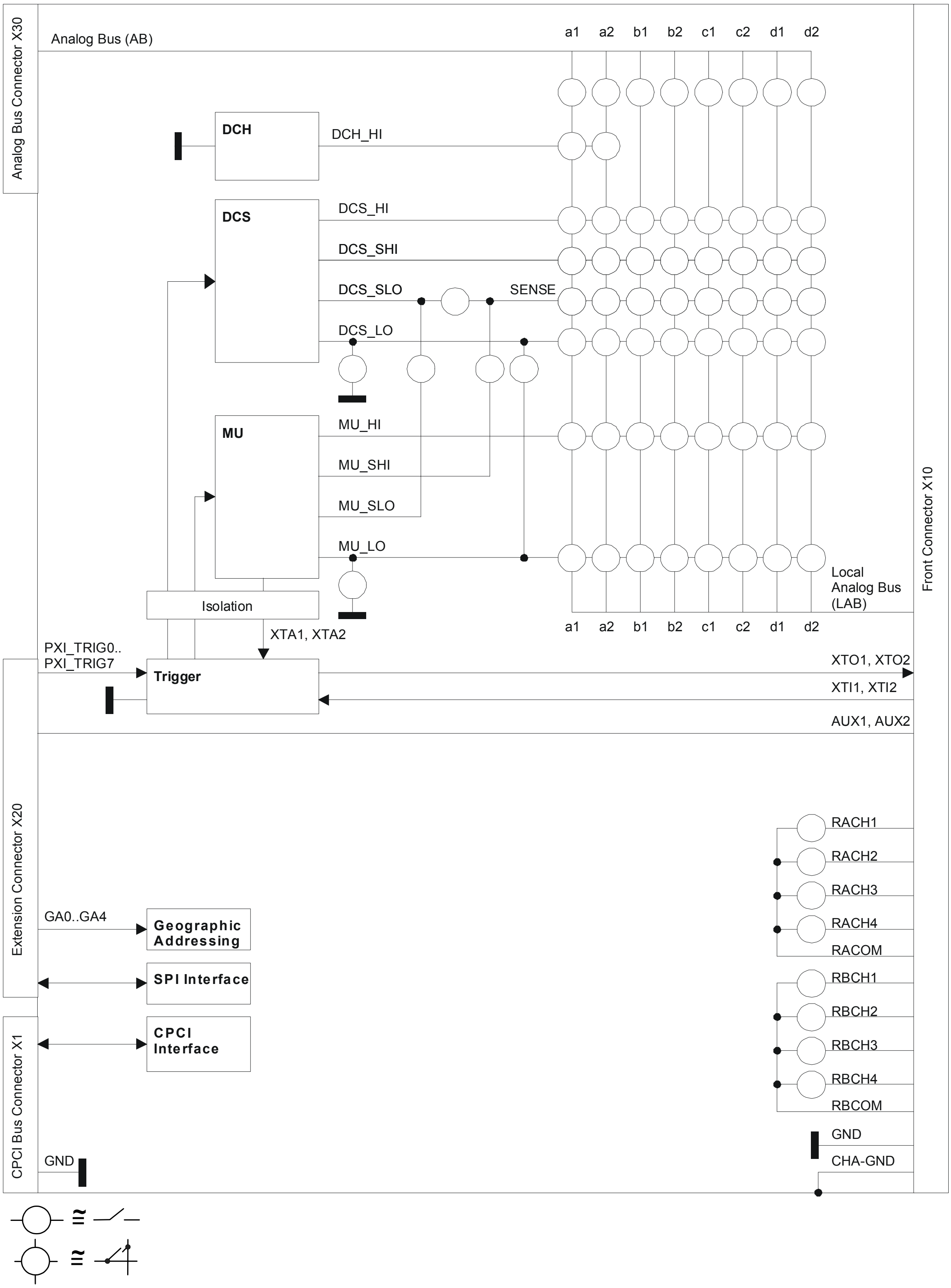

Figure 5-1 Block Diagram of TS-PSAM

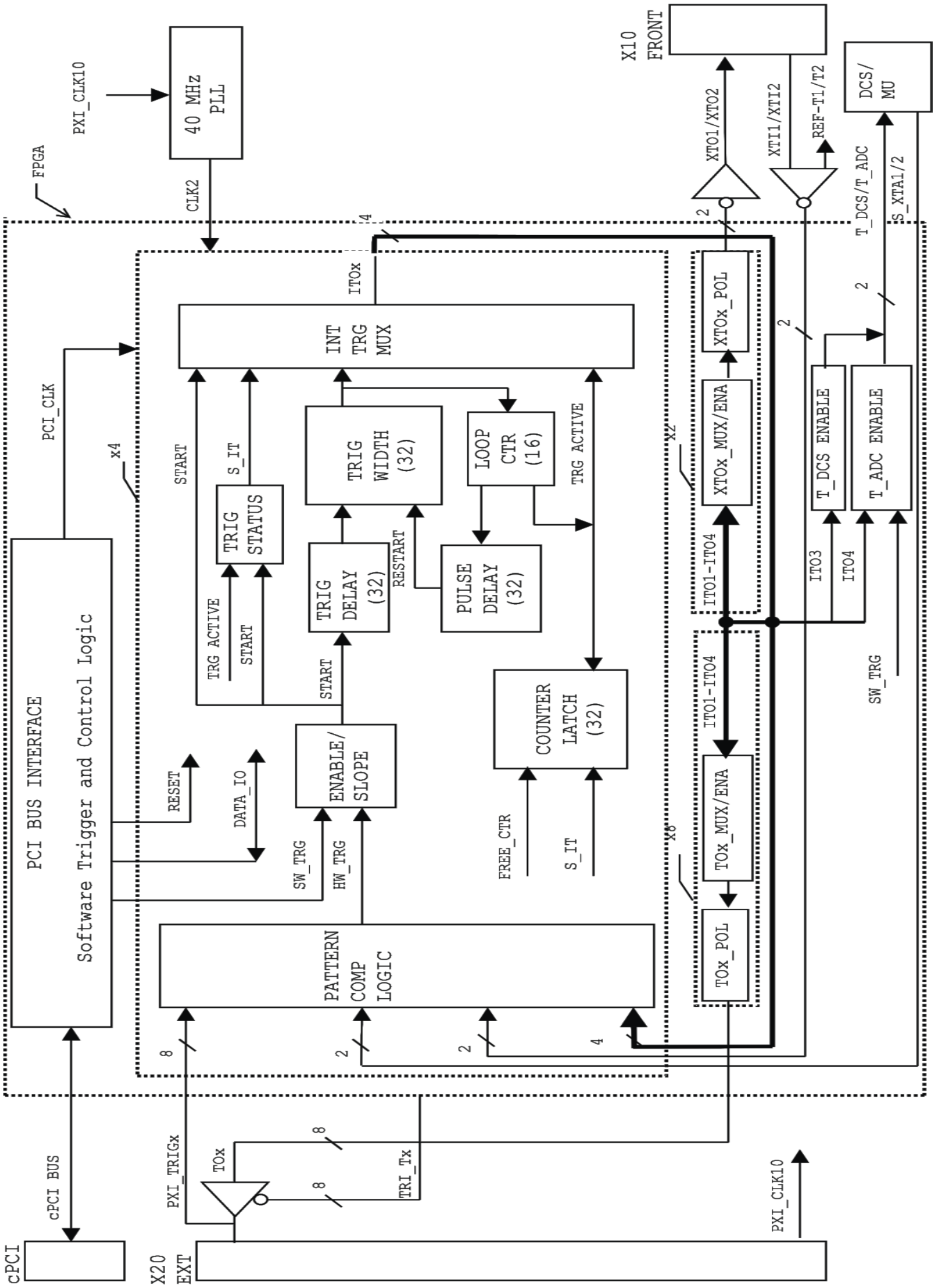

Figure 5-2 Block Diagram of the Trigger Hardware

5.2 Function Description of the TS-PDC Module

On this topic, see also Figure 5-3

The DC/DC converter is configured as a primary reference DC/DC converter. The input voltage (5 VDC) is transfered to two secondary potentials and rectified to the nominal voltage by line controllers. The status of the output voltage is displayed in each case by an LED.

The following DC voltages are generated:

- +15 VDC, 0.5A (2x)
- -15 VDC, 0.5A (2x)
- +5 VDC, 0.5A (2x)
- +3.3 VDC, 0.25A (2x)

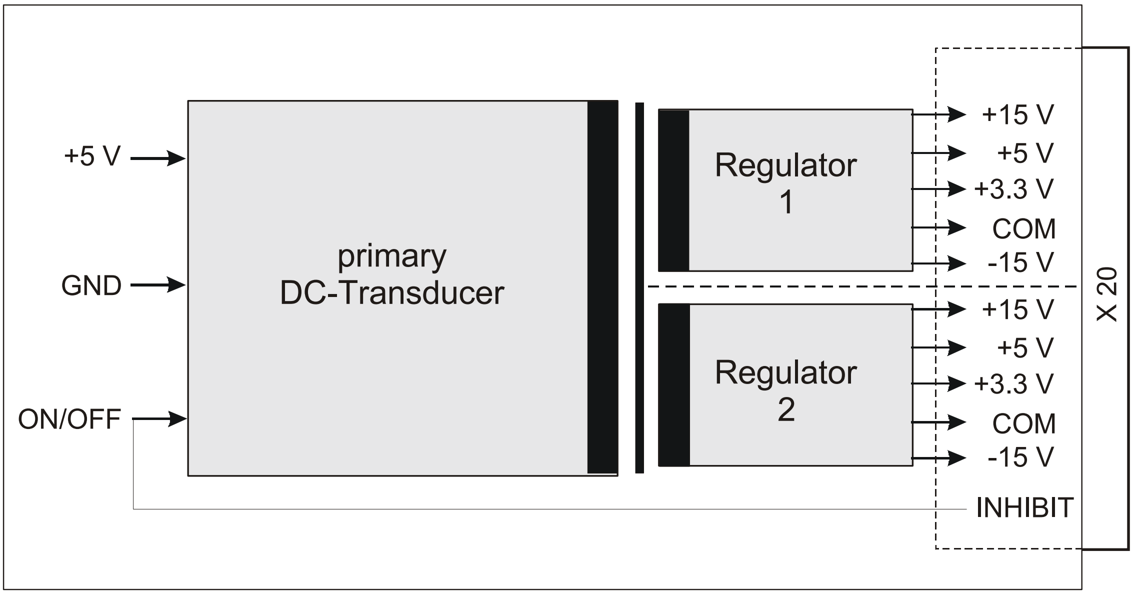

Figure 5-3 Block Diagram of TS-PDC

6 Commissioning

6.1 Installing the TS-PSAM Module

To install the plug-in module, proceed as follows:

- Power down and switch off the CompactTSVP
- Select a suitable front slot (slots 5-15 possible, preferably slot 8). TS-PSAM should be connected to slot 8 and TS-PICT to slot 9 for an in-circuit test configuration.
- Remove the corresponding front panel portion from the TSVP chassis by loosening the two screws

WARNING!

Check the backplane connectors for bent pins! Any bent pins must be straightened!
Failure to do this may permanently damage the backplane!

- Apply moderate pressure to insert the plug-in module (use locating pin to attach)

WARNING!

To insert the plug-in module, use both hands to guide carefully into the backplane connectors.

- The module is correctly located when a distinct 'stop' can be felt.
- Tighten the two retaining screws on the front panel of the module.

WARNING!

Install the associated TS-PDC rear I/O module as described in Section 6.2.

6.2 Installing the TS-PDC Module

To install the plug-in module, proceed as follows:

- The TS-PSAM module must have been installed beforehand
- Select the corresponding rear I/O slot for the TS-PSAM module
- Remove the corresponding rear panel portion from the CompactTSVP chassis by loosening the two screws

WARNING!

Check the backplane connectors for bent pins! Any bent pins must be straightened!
Failure to do this may permanently damage the backplane!

- Push in the plug-in module using moderate pressure

WARNING!

To insert the plug-in module, use both hands to guide carefully into the backplane connectors.

- The module is correctly located when a distinct 'stop' can be felt.
- Tighten the two retaining screws on the front panel of the module.

7 Software

7.1 Driver Software

A LabWindows IVI DMM driver is provided for the DMM functions on the card. All other hardware functions are controlled using specific extensions of the driver. The driver is part of the ROHDE & SCHWARZ GTSL software. All the functions of the driver are described fully in the on-line help and in the LabWindows CVI Function Panels.

The following software modules are installed during driver installation:

Module	Path	Remarks
rspsam.dll	<GTSL Directory>\Bin	Driver
rspsam.hlp	<GTSL Directory>\Bin	Help file
rspsam.fp	<GTSL Directory>\Bin	LabWindows CVI Function Panel File, Function Panels for CVI Development Environment
rspsam.sub	<GTSL Directory>\Bin	LabWindows CVI Attribute File. This file is needed by some „Function Panels“.
rspsam.lib	<GTSL Directory>\Bin	Import Library
rspsam.h	<GTSL Directory>\Include	Header File for the Driver

Table 7-1 Driver InstallationTS-PSAM

NOTE:

The IVI and VISA libraries produced by National Instruments are needed to run the driver.

7.2 Soft Panel

On this topic, see also Figure 7-1

A soft panel TS-PSAM is provided for the module. The soft panel is based on the LabWindows CVI driver. It enables the measurement module to be operated interactively. The measurement values are output in digital or graphical format (Multipoint Measurements).

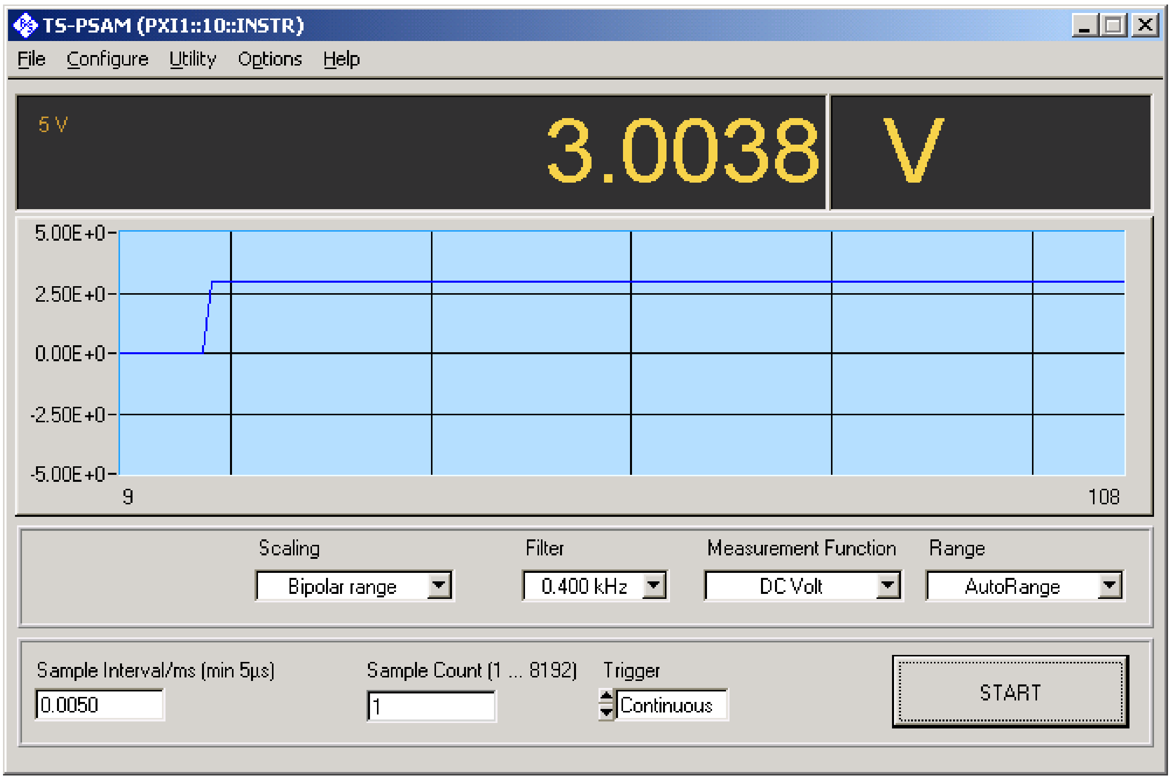

Figure 7-1 Soft PanelTS-PSAM

7.3 TS-PSAM Programming Example

```
/*
    Simple voltage measurement with TS-PSAM
*/

#include "rspsam.h"


main()
{
    ViSession handle;
    ViReal64  result;

    rspsam_InitWithOptions ("PXI1::14::0::INSTR", VI_TRUE, VI_TRUE, "",
    & handle);


    rspsam_Connect (handle, "DMM_HI", "ABa1");
    rspsam_Connect (handle, "DMM_LO", "ABc1");

    rspsam_ConfigureMeasurement(handle,RSPSAM_VAL_DC_VOLTS,
    RSPSAM_VAL_AUTO_RANGE_ON, 0.0001);

    rspsam_Read (handle, 5000, & result);

    rspsam_close (handle);
}
```

8 Self-Test

The Analog Stimulus and Measurement Module TS-PSAM has integrated self-test capability. The following tests are possible:

- LED Test:
- Power-on test
- TSVP self-test

8.1 LED Test:

When the device is switched on, all three LEDs are lit for about one second. This indicates that the 5 V supply voltage is present and all LEDs are working, also that the power-on test was successful. The following statements can be made about the different LED statuses in this power-on phase:

LED	Description
One LED does not light up	Hardware problem on the module LED faulty
No LED's light up	No +5V supply

Table 8-1 Statements about the LED Test

NOTE:

If diagnostics suggest a problem with the supply voltage, the LEDs for the associated rear I/O module, TS-PDC, must be inspected visually. If a supply voltage failure is confirmed, the TS-PDC module must be replaced.

8.2 Power-on test

The power-on test runs at the same time as the LED test. In this test, the result of the FPGA loading process is calculated. The following statements can be made about the different statuses of the red and green LEDs:

LED	Description
Green LED on	all supply voltages present
green LED off	at least one supply voltage from TS-PSAM module or the TS-PDC module is not present
red LED off	no errors were detected
red LED on	The FPGA/µP was not successfully loaded

Table 8-2 Statements about the power-on test

NOTE:

If diagnostics suggest a problem with the supply voltage, the LEDs for the associated rear I/O module, TS-PDC, must be inspected visually. If a supply voltage failure is confirmed, the TS-PDC module must be replaced.

8.3 TSVP Self-Test

The TSVP self-test runs an in-depth test on the module and generates a detailed log. This is done with the “Self-Test Support Library“.

The TS-PSAM module is used as a measurement unit of R&S modules in the TSVP. The correct operation of the modules is ensured by measurements on the analog bus.

NOTE:

You will find information about starting the self-test and on the sequence of necessary steps in the GTSL soft ware description or the GTSL on-line help.

9 Interface description

Below the interface description for the TS-PSAM module and the TS-PDC module is shown.

9.1 Interface description for TS-PSAM

9.1.1 Connector X10 (Front Connector)

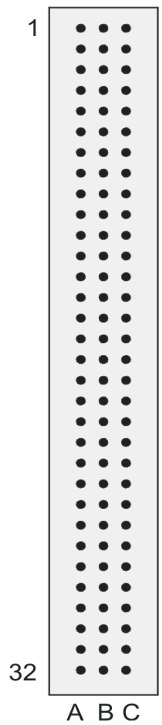

Figure 9-1 Connector X10 (mating side)

Pin	A	B	C
1	LABA1	GND	LABA2
2	LABB1	GND	LABB2
3	LABC1	GND	LABC2
4	LABD1	GND	LABD2
5	GND	GND	GND

Table 9-1 Pin assignment for connector X10

Pin	A	B	C
6	IL1	GND	IL2
7	GND	GND	GND
8			
9	RACH1		RBCH1
10	RACH2		RBCH2
11	RACH3		RBCH3
12	RACH4		RBCH4
13	RACOM		RBCOM
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24	GND	GND	GND
25		GND	
26	GND	GND	GND
27	AUX1	GND	AUX2
28	GND	GND	GND
29	XTO1	GND	XTO2
30	XTI1	GND	XTI2
31	GND	GND	GND
32	GND	GND	**CHA-GND**

Table 9-1 Pin assignment for connector X10

The **CHA-GND** signal is connected to the front panel of the TS-PSAM. The front panel is capacitively coupled to GND.

9.1.2 Connector X20 (Extension Connector)

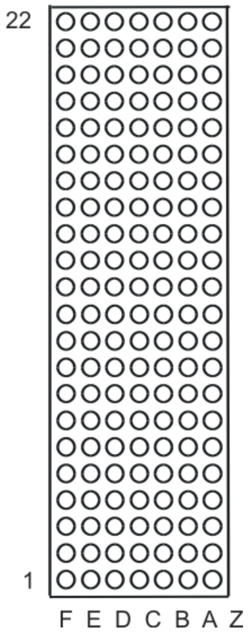

Figure 9-2 Connector X20 (mating side)

Pin	F	E	D	C	B	A	Z	
22	GND	GA0	GA1	GA2	GA3	GA4	GND	
21	GND	PXI_LBR3	PXI_LBR2	PXI_LBR1	GND	PXI_LBR0	GND	
20	GND	PXI_LBL1	GND	PXI_LBL0	AUX1	AUX2	GND	
19	GND	AUX1	AUX2	PXI_LBL3	GND	PXI_LBL2	GND	
18	GND	PXI_TRIG6	GND	PXI_TRIG5	PXI_TRIG4	PXI_TRIG3	GND	
17	GND	PXI_CLK10			GND	PXI_TRIG2	GND	X20
16	GND	PXI_TRIG7	GND		PXI_TRIG0	PXI_TRIG1	GND	
15	GND				GND		GND	
14	NC						NC	C
13	NC						NC	O
12	NP	COM_DCS	+3.3V_DCS	+5V_DCS	-VCC_DCS	+VCC_DCS	NP	N
11	NP						NP	N
10	NC	COM_MU	+3.3V_MU	+5V_MU	-VCC_MU	+VCC_MU	NC	E
9	NC						NC	C
8	NC						NC	T
7	NC						NC	O
6	NC						NC	R
5	NC						NC	
4	NC						NC	
3	GND	RSA0	RRST#		GND	RSDO	GND	
2	GND		RSDI	RSA1		RSCLK	GND	
1	GND				GND	RCS#	GND	

Table 9-2 Pin assignment for connector X20

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9.1.3 Connector X30 (Analog Bus Connector)

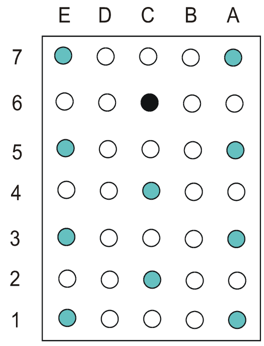

Figure 9-3 Connector X30 (mating side)

	E	D	C	B	A
7	IL2				IL1
6			GND		
5	ABC1				ABA1
4			ABB1		
3	ABC2				ABB2
2			ABA2		
1	ABD2				ABD1

Table 9-3 Pin assignment for connector X30

9.1.4 Connector X1 (cPCI Bus Connector)

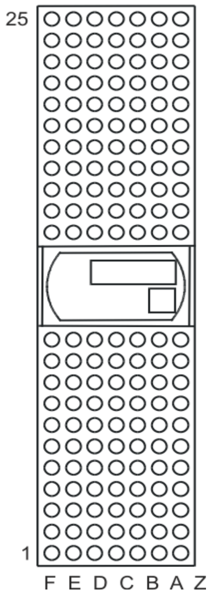

Figure 9-4 Connector X1 (mating side)

Pin	F	E	D	C	B	A	Z	X1 CONNECTOR
25	GND	5V	3.3V	ENUM#	REQ64#	5V	GND	
24	GND	ACK64#	AD[0]	V(I/O)	5V	AD[1]	GND	
23	GND	AD[2]	5V	AD[3]	AD[4]	3.3V	GND	
22	GND	AD[5]	AD[6]	3.3V	GND	AD[7]	GND	
21	GND	C/BE[0]#	M66EN	AD[8]	AD[9]	3.3V	GND	
20	GND	AD[10]	AD[11]	V(I/O)	GND	AD[12]	GND	
19	GND	AD[13]	GND	AD[14]	AD[15]	3.3V	GND	
18	GND	C/BE[1]#	PAR	3.3V	GND	SERR#	GND	
17	GND	PERR#	GND	IPMB_SDA	IPMB_SCL	3.3V	GND	
16	GND	LOCK#	STOP#	V(I/O)	GND	DEVSEL#	GND	
15	GND	TRDY#	BD_SEL#	IRDY#	FRAME#	3.3V	GND	
12..14				Key Area				
11	GND	C/BE[2]#	GND	AD[16]	AD[17]	AD[18]	GND	
10	GND	AD[19]	AD[20]	3.3V	GND	AD[21]	GND	
9	GND	AD[22]	GND	AD[23]	IDSEL	C/BE[3]#	GND	
8	GND	AD[24]	AD[25]	V(I/O)	GND	AD[26]	GND	
7	GND	AD[27]	GND	AD[28]	AD[29]	AD[30]	GND	
6	GND	AD[31]	CLK	3.3V	GND	REQ#	GND	
5	GND	GNT#	GND	RST#	BSRSV	BSRSV	GND	
4	GND	INTS	INTP	V(I/O)	HEALTHY#	IPMB_PWR	GND	
3	GND	INTD#	5V	INTC#	INTB#	INTA#	GND	
2	GND	TDI	TDO	TMS	5V	TCK	GND	
1	GND	5V	+12V	TRST#	-12V	5V	GND	

Table 9-4 Pin assignment for connector X1

9.2 Interface description for TS-PDC

9.2.1 Connector X20 (Extension Connector)

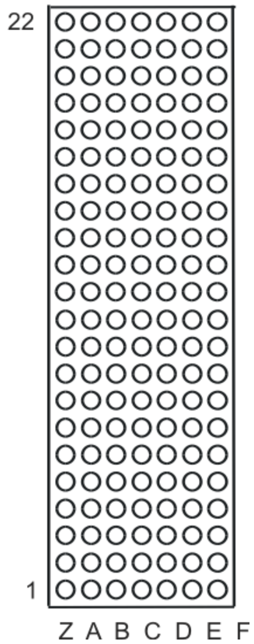

Figure 9-5 Connector X20 (TS-PDC mating side)

Pin	Z	A	B	C	D	E	F	
22	GND						GND	
21	GND		GND or NC *3)				GND	
20	GND			+5V *1)	GND	+5V *1)	GND	
19	GND		GND	+5V *1)			GND	
18	GND				GND		GND	J20
17	GND		GND	+5V *2)	+5V *2)		GND	
16	GND			+5V *2)	GND		GND	
15	GND		GND	+5V *2)	+5V *1)		GND	
14	NC						NC	C
13	NC						NC	O
12	NP	+15V_1	-15V_1	+5V_1	+3.3V_1	COM_1	NP	N
11	NP						NP	N
10	NC	+15V_2	-15V_2	+5V_2	+3.3V_2	COM_2	NC	E
9	NC						NC	C
8	NC	COM_1	COM_1	COM_1	COM_1	COM_1	NC	T
7	NC						NC	O
6	NC	COM_2	COM_2	COM_2	COM_2	COM_2	NC	R
5	NC						NC	
4	NC						NC	
3	GND		GND		RRST#		GND	
2	GND	RSCLK			RSDI		GND	
1	GND	RCS#	GND			+5V *1)	GND	
Pin	Z	A	B	C	D	E	F	

*1) TS-PDC V1.0 is supplied via these pins from +5V, for backplanes up to V3.x
*2) TS-PDC V1.1 is supplied via these pins or pins from *1) , for backplanes V1.x to V4.x
*3) TS-PDC V1.1 and V1.2: GND, for version V1.3: NC (Not Connected)

Table 9-5 Pin assignment for connector X20 (TS-PDC)

10 Specifications

NOTE:

In the event of any discrepancies between data in this manual and the technical data in the data sheet, the data sheet takes precedence.

10.1 Technical Specifications for the TS-PSAM Module

10.1.1 DC voltage source

10.1.1.1 Voltage adjustment

Output voltage:	-5V to +5 V
Resolution:	approx. 200 µV
Accuracy **[1]**:	0.2 + 5 mV
Maximum output current:	100 mA
Source impedance:	see Current limiting

[1] Accuracy: ±(% of adjustment value + absolute value)
Temperature coefficient: ±(0.1 * accuracy) / °C

10.1.1.2 Current limiting

Range	Resolution	Accuracy [1]	Output characteristics (Sense wires not cross-connected)
3 µA ... 100 µA	2 nA	0.25 + 1 µA	max. 10 kΩ
30 µA ... 1 mA	20 nA	0.25 + 5 µA	max. 1 kΩ
300 µA ... 10 mA	200 nA	0.25 + 50 µA	max. 100 Ω
3 mA ... 100 mA	2 µA	0.25 + 100 µA	10 Ω

[1] Accuracy in ±(% of adjustment value + absolute value)
Temperature coefficient: ±(0.1 * accuracy) / °C

10.1.2 Measurement unit

Signal sampling rate: 200 kHz max.

Memory: 8 k sampling points

Triggers: PXI bus, signal with programmable threshold

10.1.2.1 Voltage

Range	Resolution	Input characteristics	Accuracy averaged, [1] [2]	Accuracy unaveraged, [1] [3]
10 mV **[4]**	0.4 µV	>100 MΩ	0.02 + 80 µV	0.02 + 150 µV
20 mV **[4]**	0.8 µV	>100 MΩ	0.02 + 80 µV	0.02 + 150 µV
50 mV **[4]**	2 µV	>100 MΩ	0.02 + 80 µV	0.02 + 150 µV
100 mV	4 µV	>100 MΩ	0.02 + 100 µV	0.02 + 200 µV
200 mV	8 µV	>100 MΩ	0.02 + 100 µV	0.02 + 200 µV
500 mV	20 µV	>100 MΩ	0.02 + 100 µV	0.02 + 250 µV
1 V	40 µV	>100 MΩ	0.02 + 160 µV	0.02 + 400 µV
2 V	80 µV	>100 MΩ	0.02 + 320 µV	0.02 + 800 µV
5 V	0.2 mV	>100 MΩ	0.02 + 0.8 mV	0.02 + 1.6 mV
10 V	0.4 mV	>100 MΩ	0.02 + 1.6 mV	0.02 + 3.2 mV
20 V	0.8 mV	10 MΩ	0.02 + 3.2 mV	0.02 + 6.4 mV
50 V	2 mV	10 MΩ	0.02 + 8 mV	0.02 + 16 mV
100 V	4 mV	10 MΩ	0.02 + 16 mV	0.02 + 32 mV
200 V **[5]**	8 mV	10 MΩ	0.02 + 64 mV	0.02 + 128 mV

[1] Accuracy: ±(% of read value + absolute value)
Temperature coefficient: ±(0.1 * accuracy) / °C

[2] averaged over 100 sampling points, measuring time: 20 ms, 400 Hz filter

[3] Signal recording: 1 ... 8 k sampling points, unaveraged, 40 kHz filter

[4] ground-connected

[5] max. input voltage 125 V_{rms}

10.1.2.2 Current

Range	Resolution	Input characteristics	Accuracy averaged, [1] [4]	Accuracy unaveraged, [1] [5]
1 µA	0.04 nA	**[2]**	0.2 + 2 nA	0.2 + 100 nA
2 µA	0.08 nA	**[2]**	0.2 + 4 nA	0.2 + 100 nA
5 µA	0.2 nA	**[2]**	0.2 + 10 nA	0.2 + 100 nA
10 µA	0.4 nA	**[2]**	0.1 + 10 nA	0.1 + 300 nA
20 µA	0.8nA	**[2]**	0.1 + 20 nA	0.1 + 300 nA
50 µA	2 nA	**[2]**	0.1 + 50 nA	0.1 + 300 nA
100 µA	4 nA	**[2]**	0.1 + 100 nA	0,1 + 500 nA
200 µA	8 nA	**[2]**	0.1 + 200 nA	0,1 + 500 nA
500 µA	20 nA	**[2]**	0,1 + 500 nA	0.1 + 1000 nA
1 mA	40 nA	**[2]**	0.1 + 1000 nA	0.1 + 2000 nA
2 mA	80 nA	**[2]**	0.1 + 2000 nA	0.1 + 4000 nA
5 mA	0.2 µA	**[2]**	0.1 + 5 µA	0.1 + 10 µA
10 mA	0.4 µA	**[2]**	0.1 + 10 µA	0.1 + 20 µA
20 mA	0.8 µA	**[2]**	0.1 + 20 µA	0.1 + 40 µA
50 mA	2 µA	**[2]**	0.1 + 50 µA	0.1 + 100 µA
100 mA	4 µA	**[2]**	0.1 + 100 µA	0.1 + 200 µA
200 mA	8 µA	**[3]**	0.5 + 200 µA	0.5 + 400 µA
500 mA	20 µA	**[3]**	0.5 + 500 µA	0.5 + 1000 µA
1 A	40 µA	**[3]**	0.5 + 1000 µA	0.5 + 2000 µA

[1] Accuracy: ±(% of read value + absolute value)
Temperature coefficient: ±(0.1 * accuracy) / °C

[2] active current measurement with a current / voltage amplifier

[3] 0.5 Ω Shunt

[4] averaged over 100 sampling points, measuring time: 20 ms, 400 Hz filter

[5] Signal recording: 1 ... 8 k sampling points, unaveraged, 40 kHz filter

10.1.2.3 RMS value measurement

The accuracy measurements apply only for sinus signals in the frequency range from 20 Hz to 50 kHz. This accuracy is only achieved if the input level is at least 10% of the measurement range final value.

10.1.2.3.1 AC voltage

Range	Frequency range	Accuracy [1]
20 mV	20 Hz ... 50 Hz	2.5 + 100 µV
	50 Hz ... 10 kHz	1.0 + 100 µV
	10 kHz ... 20 kHz	1.5 + 100 µV
	20 kHz ... 50 kHz	2.5 + 100 µV
50 mV	20 Hz ... 50 Hz	2.5 + 150 µV
	50 Hz ... 10 kHz	1.0 + 150 µV
	10 kHz ... 20 kHz	1.5 + 150 µV
	20 kHz ... 50 kHz	2.5 + 150 µV
100 mV	20 Hz ... 50 Hz	2.5 + 200 µV
	50 Hz ... 10 kHz	1.0 + 200 µV
	10 kHz ... 20 kHz	1.5 + 200 µV
	20 kHz ... 50 kHz	2.5 + 200 µV
200 mV	20 Hz ... 50 Hz	2.5 + 500 µV
	50 Hz ... 10 kHz	1.0 + 500 µV
	10 kHz ... 20 kHz	1.5 + 500 µV
	20 kHz ... 50 kHz	2.5 + 500 µV
500 mV	20 Hz ... 50 Hz	2.5 + 500 µV
	50 Hz ... 10 kHz	1.0 + 500 µV
	10 kHz ... 20 kHz	1.5 + 500 µV
	20 kHz ... 50 kHz	2.5 + 500 µV
1 V	20 Hz ... 50 Hz	2.5 + 1 mV

Range	Frequency range	Accuracy [1]
	50 Hz ... 10 kHz	1.0 + 1 mV
	10 kHz ... 20 kHz	1.5 + 1 mV
	20 kHz ... 50 kHz	2.5 + 1 mV
2 V	20 Hz ... 50 Hz	2.5 + 2,5 mV
	50 Hz ... 10 kHz	1.0 + 2,5 mV
	10 kHz ... 20 kHz	1.5 + 2,5 mV
	20 kHz ... 50 kHz	2.5 + 2,5 mV
5 V	20 Hz ... 50 Hz	2.5 + 5 mV
	50 Hz ... 10 kHz	1.0 + 5 mV
	10 kHz ... 20 kHz	1.5 + 5 mV
	20 kHz ... 50 kHz	2.5 + 5 mV
10 V	20 Hz ... 50 Hz	2.5 + 10 mV
	50 Hz ... 10 kHz	1.0 + 10 mV
	10 kHz ... 20 kHz	1.5 + 10 mV
	20 kHz ... 50 kHz	2.5 + 10 mV
20 V	20 Hz ... 50 Hz	2.5 + 25 mV
	50 Hz ... 10 kHz	1.0 + 25 mV
	10 kHz ... 20 kHz	1.5 + 25 mV
	20 kHz ... 50 kHz	2.5 + 25 mV
50 V	20 Hz ... 50 Hz	2.5 + 50 mV
	50 Hz ... 10 kHz	1.0 + 50 mV
	10 kHz ... 20 kHz	1.5 + 50 mV
	20 kHz ... 50 kHz	2.5 + 50 mV
100 V	20 Hz ... 50 Hz	2.5 + 100 mV
	50 Hz ... 10 kHz	1.0 + 100 mV
	10 kHz ... 20 kHz	1.5 + 100 mV
	20 kHz ... 50 kHz	2.5 + 100 mV
200 V	20 Hz ... 50 Hz	2.5 + 200 mV
	50 Hz ... 10 kHz	1.0 + 200 mV
	10 kHz ... 20 kHz	1.5 + 200 mV

Range	Frequency range	Accuracy [1]
	20 kHz ... 50 kHz	2.5 + 200 mV

[1] Accuracy: ±(% of the read value + absolute value)
Temperature coefficient: ±(0.1 * Accuracy) / °C
averaged over 100 sampling points, measuring time: 20 ms, 40 kHz filter

10.1.2.3.2 AC current

Range	Frequency range	Accuracy [1]
100 µA	20 Hz ... 50 Hz	2.5 + 500 nA
	50 Hz ... 10 kHz	1.0 + 500 nA
	10 kHz ... 20 kHz	1.5 + 500 nA
	20 kHz ... 50 kHz	2.5 + 500 nA
200 µA	20 Hz ... 50 Hz	2.5 + 1.25 µA
	50 Hz ... 10 kHz	1.0 + 1.25 µA
	10 kHz ... 20 kHz	1.5 + 1.25 µA
	20 kHz ... 50 kHz	2.5 + 1.25 µA
500 µA	20 Hz ... 50 Hz	2.5 + 2.50 µA
	50 Hz ... 10 kHz	1.0 + 2.50 µA
	10 kHz ... 20 kHz	1.5 + 2.50 µA
	20 kHz ... 50 kHz	2.5 + 2.50 µA
1 mA	20 Hz ... 50 Hz	2.5 + 5 µA
	50 Hz ... 10 kHz	1.0 + 5 µA
	10 kHz ... 20 kHz	1.5 + 5 µA
	20 kHz ... 50 kHz	2.5 + 5 µA
2 mA	20 Hz ... 50 Hz	2.5 + 12.5 µA
	50 Hz ... 10 kHz	1.0 + 12.5 µA
	10 kHz ... 20 kHz	1.5 + 12.5 µA
	20 kHz ... 50 kHz	2.5 + 12.5 µA
5 mA	20 Hz ... 50 Hz	2.5 + 25.0 µA

Range	Frequency range	Accuracy [1]
	50 Hz ... 10 kHz	1.0 + 25.0 µA
	10 kHz ... 20 kHz	1.5 + 25.0 µA
	20 kHz ... 50 kHz	2.5 + 25.0 µA
10 mA	20 Hz ... 50 Hz	2.5 + 50 µA
	50 Hz ... 10 kHz	1.0 + 50 µA
	10 kHz ... 20 kHz	1.5 + 50 µA
	20 kHz ... 50 kHz	2.5 + 50 µA
20 mA	20 Hz ... 50 Hz	2.5 + 125 µA
	50 Hz ... 10 kHz	1.0 + 125 µA
	10 kHz ... 20 kHz	1.5 + 125 µA
	20 kHz ... 50 kHz	2.5 + 125 µA
50 mA	20 Hz ... 50 Hz	2.5 + 250 µA
	50 Hz ... 10 kHz	1.0 + 250 µA
	10 kHz ... 20 kHz	1.5 + 250 µA
	20 kHz ... 50 kHz	2.5 + 250 µA
100 mA	20 Hz ... 50 Hz	2.5 + 500 µA
	50 Hz ... 10 kHz	1.0 + 500 µA
	10 kHz ... 20 kHz	1.5 + 500 µA
	20 kHz ... 50 kHz	2.5 + 500 µA
200 mA	20 Hz ... 50 Hz	2.5 + 1.25 mA
	50 Hz ... 10 kHz	1.0 + 1.25 mA
	10 kHz ... 20 kHz	1.5 + 1.25 mA
	20 kHz ... 50 kHz	2.5 + 1.25 mA
500 mA	20 Hz ... 50 Hz	2.5 + 2.50 mA
	50 Hz ... 10 kHz	1.0 + 2.50 mA
	10 kHz ... 20 kHz	1.5 + 2.50 mA
	20 kHz ... 50 kHz	2.5 + 2.50 mA
1 A	20 Hz ... 50 Hz	2.5 + 5 mA
	50 Hz ... 10 kHz	1.0 + 5 mA
	10 kHz ... 20 kHz	1.5 + 5 mA

Range	Frequency range	Accuracy [1]
	20 kHz ... 50 kHz	2.5 + 5 mA

[1] Accuracy: ±(% of the read value + absolute value)
Temperature coefficient: ±(0.1 * Accuracy) / °C
averaged over 100 sampling points, measuring time: 20 ms, 40 kHz filter

10.1.2.4 Resistance measurement

Resistance measurements are taken with the aid of the DC voltage source and the measurement unit. 2- and 4-wire measurements are possible. Either of two different methods may be used depending n the range.

Range	Accuracy	Operating mode [3]	Voltage source	Current source
0.1 Ω ... 1 Ω	1 + 5 mΩ **[2]**	CS	0.5 V max.	100 mA
1 Ω... 10 Ω	0.5 **[1]**	CS	0.2 V max.	10 mA
10 Ω... 100 Ω	0.5 **[1]**	VS	0.2 V	25 mA max.
100 Ω... 1 kΩ	0.5 **[1]**	VS	0.2 V	2.5 mA max.
1 kΩ... 10 kΩ	0.5 **[1]**	V	0.2 V	1 mA max.
10 kΩ... 100 kΩ	1 **[1]**	V	0.2 V	0.1 mA max.
100 kΩ... 1 MΩ	1 **[1]**	V	1 V	0.1 mA max.
1 MΩ... 10 MΩ	1 **[1]**	V	5 V	0.1 mA max.

[1] Accuracy: ±(% of read value)
Temperature coefficient: ±(0.1 * accuracy) / °C

[2] Accuracy: ±(% of read value + absolute value)
Temperature coefficient: ±(0.1 * accuracy) / °C

[3] CS 4-wire, current applied, voltage measured
V 2-wire, voltage applied, current measured
VS 4-wire, voltage applied, current measured

10.1.3 Discharge circuit

max. input voltage:	125 V
Overvoltage protection up to:	200 V DC
max. discharge current:	400 mA typ.

10.1.4 Analog bus and relay multiplexer

Analog bus access:	8 buses
Relay scanner:	2 x 4- to-1 multiplex-ers
max. DC/AC voltage:	125 V / 125 V_{rms}
max. current:	1 A / 1 A_{rms}
Max. switching capacity	10 W / 10 VA

10.1.5 General Data

Power consumption:	+5 V / 5.8 A +3.3 V / 0.2 A, 30 W max. inc. TS-PDC
EMC:	according to EMC Directive 89/336/EEC and Standard EN61326
Safety:	CE, EN61010 Part 1
Mechanical strength • Vibration test sinusoidal Sinus 5 Hz ... 55 Hz: Sinus 55 Hz ... 150 Hz:	 2 g, MIL-T-28800D, class 5 0.5 g, MIL-T-28800D, class 5
• Vibration test random 10 Hz ... 300 Hz:	 1.2 g
Shock test:	40 g, MIL-STD-810. Classes 3 and 5

Heat resistance • Nominal temperature range: • Operating temperature range: • Storage temperature range: • Humidity:	 +5 ... +40°C +0 ... +50°C -40 ... +70°C +40°C, 95% rel. humidity
Dimensions in mm:	316 x 174 x 20
Weight:	0.45 kg
Calibration interval (recommended):	1 year

10.2 Technical Specifications for the TS-PDC Module

10.2.1 Electrical Specifications

Input voltage:	5 VDC
Output voltages: (2x output voltages)	+15 VDC, 0.5 A -15 VDC, 0.5 A +5 VDC, 0.5 A +3.3 VDC, 0.25 A
Clock frequency:	200 kHz

10.2.2 General Data

EMC:	according to EMC Directive 89/336/EEC and Standard EN61326
Safety:	CE, EN61010 Part 1
Mechanical strength • Vibration test sinusoidal Sinus 5 Hz ... 55 Hz: Sinus 55 Hz ... 150 Hz:	 2 g, MIL-T-28800D, class 5 0.5 g, MIL-T-28800D, class 5
• Vibration test random 10 Hz ... 300 Hz:	 1.2 g
Shock test:	40 g, MIL-STD-810. Classes 3 and 5

Heat resistance • Nominal temperature range: • Operating temperature range: • Storage temperature range: • Humidity:	 +5 ... +40°C +0 ... +50°C -40 ... +70°C +40°C, 95% rel. humidity
Dimensions in mm:	120 x 95 x 20
Weight:	0.3 kg