synaptec
powered by Megger

Installation manual

Passive Secondary Converter Single-Phase (PSC-1) Gen 1

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1. Introduction

1.1 Chapter overview

This chapter provides some general information about the technical manual and an introduction to the device(s) described in this manual.

This chapter contains the following sections:

- Chapter overview
- Foreword

1.2 Foreword

This technical manual provides a functional and technical description of Synaptec's single-phase Passive Secondary Converter (PSC-1), as well as a comprehensive set of instructions for installation and use of the device. The level at which this manual is written assumes that you are already familiar with power systems instrumentation and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product.

The technical content presented in this document is based on an actual case or as-designed parameters, and therefore should not be relied upon for any specific application and does not constitute a performance guarantee for any projects. Actual results are dependent on variable conditions. Accordingly, Synaptec does not make representations, warranties, or assurances as to the accuracy, currency or completeness of the content contained herein. If requested, we will provide specific technical data or specifications with respect to any customer's particular applications. Our company is constantly involved in engineering and development. For that reason, we reserve the right to modify, at any time, the technology and product specifications contained herein.

We would therefore be very pleased to hear from you if you discover any errors or opportunities for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain and eventually dispose of this product. We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

All feedback should be sent to us via info@synapt.ec.

1.2.1 *Target audience*

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment and fibre optics.

1.2.2 *Nomenclature*

Due to the technical nature of this manual, many special terms, abbreviations and acronyms are used throughout. Some of these terms are well-known industry-specific terms, while others are product-specific terms used by Synaptec. The first instance of any acronym or term used in a particular chapter is explained. In addition, a glossary is included in Section 1.2.3.

British English is used throughout this manual.

1.2.3 *Glossary*

For the purposes of this document, the following definitions apply:

- CT – Current Transformer
- DES – Distributed Electrical Sensing
- OHLS – Overhead Line Sensor
- OTDR – Optical Time-Domain Reflectometry
- PSC – Passive Secondary Converter
- PSC-1 – Passive Secondary Converter – Single-Phase
- PSC-1-C – Passive Secondary Converter – Single-Phase – Current
- PSC-1-V – Passive Secondary Converter – Single-Phase – Voltage
- PSC-3 – Passive Secondary Converter – Three-Phase
- PSC-3-C – Passive Secondary Converter – Three-Phase – Current
- PSC-3-V – Passive Secondary Converter – Three-Phase – Voltage
- PST – Passive Strain Transducer
- PTT – Passive Temperature Transducer
- VT – Voltage Transformer

2. Product scope

This document is valid for the following product(s):

- PSC-1-C gen1
- PSC-1-V gen1

2.1 Chapter overview

This chapter provides information on the product and its use.

This chapter contains the following sections:

- Product overview
- Features and functions
- Compliance
- Functional overview

2.2 Product overview

The PSC retrofits Synaptec's passive photonic sensing technology to the secondary circuits of new or existing CTs or VTs to deliver reliable, centralised power system instrumentation. The PSC-1 is a single-phase measurement device.

The PSC, in combination with Synaptec's unique optical sensing architecture, allows standard instrument transformers in the substation to be digitised without recourse to multiple powered Merging Units and digital telecoms.

The PSC also allows new instrument transformers to be installed beyond the substation fence and monitored passively via the same optical fibre network. The PSC may be configured as an IEC 60044- or IEC 61869-compliant protection class device.

Synaptec's photonic sensing technology allows the PSC-1 to operate without ancillary power or communications networks: no electronics, batteries, data communications, power supplies or time synchronisation is required at the measurement location.

Each PSC-1 is installed in combination with Synaptec's Distributed Electrical Sensing (DES) Interrogator measurement device. Multiple single-phase PSC-1 units may be installed in series on a single optical fibre, connected to the Interrogator at a single end (typically in a substation environment). The PSC-1 may also be interoperated with Synaptec's other electrical and mechanical sensors to provide comprehensive local and remote infrastructure monitoring, protection, and metering. The distance from the Interrogator to the final PSC-1 in the chain may be as much as 60 km (with larger distances possible on request).

2.3 Features and functions

The PSC-1 is shown in Figure 2.1, with numbered items described in Table 2.1.

Table 2.1: Key components of the PSC-1, with reference to the numbering in Figure 2.1.

Item	Designation	Description	Qty
1	Housing	Weatherproof enclosure for passive secondary converter	1
2	Transformer secondary connection	Electrical connection to transformer secondary circuit	1
3	Fibre optic cable	Duplex cable for connection of optical sensor into the wider sensor network	1
4	Earth bonding point	For earthing of the enclosure	1
5	Mounting points	Mounting points for M6 bolts	4

Figure 2.1: PSC-1 design. Numbered items are identified in Table 2.1.

2.4 Optical fibre routing

The PSC-1 is designed to be monitored by Synaptec's DES Interrogator, utilising existing or new single-mode fibre to make series connection to each PSC-1 in the fibre network. Each PSC-1 is connected into the optical fibre network via a local fibre splice enclosure. A general approach to fibre routing and connection is shown in Figure 2.2. Final fibre routing shall be agreed with the customer at the design stage of each project, but will follow this same general principle.

Figure 2.2: Example fibre routing between PSC-1 units and central DES Interrogator.

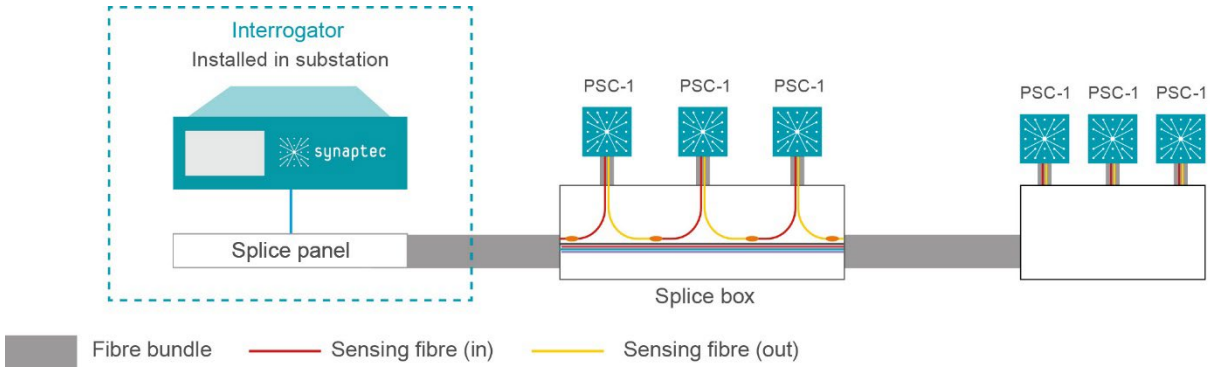
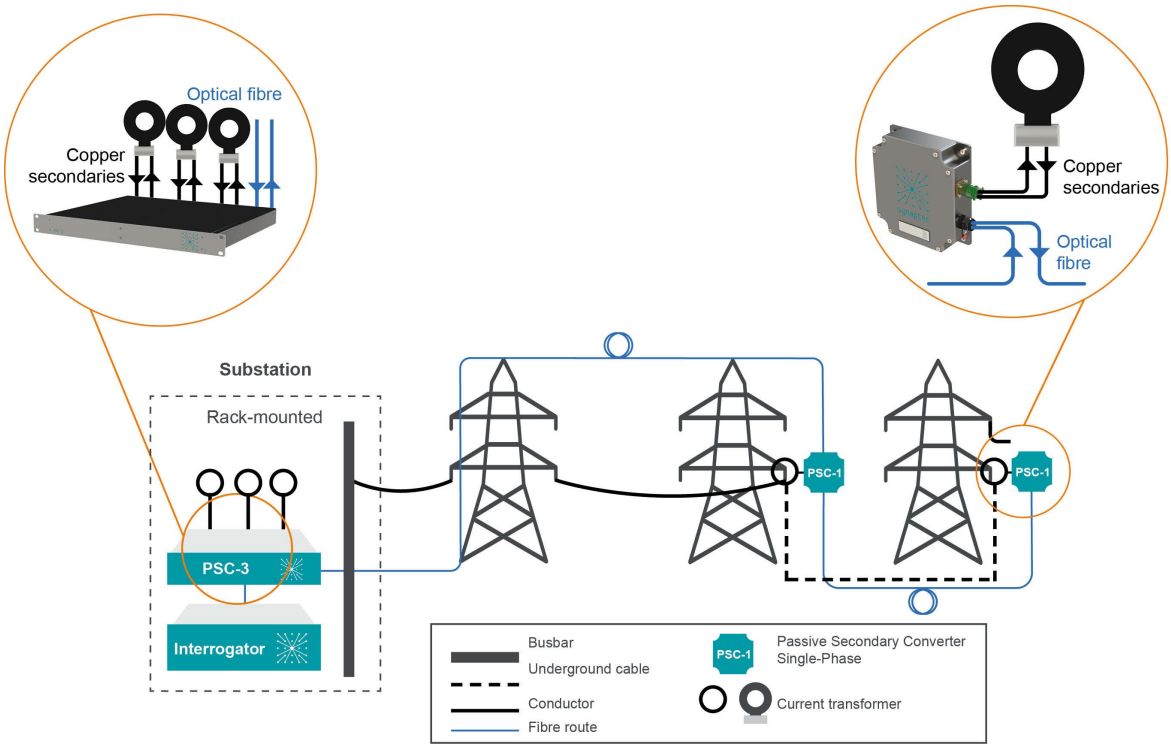


Figure 2.3: Example of electrical connection to CTs



3. Installation

3.1 Chapter overview

This chapter provides a generic guide for installation of the PSC-1. The PSC-1 will always be supplied as part of a wider Synaptec Distributed Electrical Sensing (DES) system, and therefore installation should be completed with reference not only to this document, but to the DES Installation Manual[1] and to the installation manuals for other products in the same sensor network. Guidance on verification and troubleshooting is provided, as well as a checklist to be completed by the installer to guide and evidence successful installation.

[1] TD-014 DES Installation Manual

This chapter contains the following sections:

- Chapter overview
- Competencies
- Tools
- Receipt of hardware and documentation
- Preparation of the installation environment
- Mechanical mounting
- Secondary (electrical) connection
- Fibre optic connection

3.2 Competencies

Installation of the PSC-1 requires no specialist competencies that are unfamiliar to installation of measurement or telecoms hardware in the power sector.

All mechanical and electrical installation works should be carried out by qualified installers. Typical skills required for mechanical and electrical installation works will include:

- Mechanical mounting of components to a suitable structure identified during project design
- Mechanical mounting of split- or solid-core CTs, or mechanical installation of a voltage transformer or divider
- Wiring of CT secondary terminals, or of voltage transformer or divider secondary terminals

All fibre optic work should be carried out by qualified fibre optic engineers. Synaptec systems use only single-mode fibre. Typical skills required for fibre optic works during PSC-1 installation will include:

- Fibre end inspection and cleaning
- Single-mode fibre splicing
- Fibre optic routing and the use of splice boxes and patch panels
- Optical time-domain reflectometry (OTDR) and splice loss measurement

For additional competencies related to the wider DES system installation, refer to TD-014 DES Installation Manual.

3.3 Tools

For the purposes of installation, it is presumed that the installer has access to the following tools:

- Tools necessary for stripping, crimping, and connecting wires of up to 2.5 mm^2 cross-section, for connection between the PSC-1 and the instrument transformer
- M6 bolts and appropriate hex key or screwdriver, for mounting the PSC-1 per the arrangement described in Section 3.6
- Fibre optic inspection equipment
- Fibre optic fusion splicer
- Any other tools and components necessary for preparing the fibre and protecting the splice (e.g., fibre stripping tools, fibre cleaver, fibre optic cleaning wipes and/or fluid, splice protectors, etc.)
- Any other tools and components necessary for preparing the mounting arrangement

3.4 Receipt of hardware and documentation

Synaptec's products are of robust construction but require careful handling and treatment until installation is complete. This section discusses requirements for receiving and unpacking the goods, as well as associated considerations regarding product care and user safety.

3.4.1 *Receipt*

On receipt, confirm the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor and notify Synaptec promptly.

If the product is not intended for immediate installation, repack it in its original delivery packaging.

Refer to TD-14 DES Installation Manual for further information related to receipt of DES system hardware.

3.4.2 *Unboxing and handling*

The PSC-1 is ruggedised for installation in substation environments, in remote, outdoor locations, and offshore. However, care must nevertheless be taken when unboxing the hardware to ensure that no damage is incurred. After initial unboxing of the hardware to confirm receipt, any PSC-1s should be re-packed in the same manner which they were found for transport to final installation locations and should not be removed again from packaging until the time of installation.

When unpacking and installing the product, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packaging or lost. Do not discard any technical documentation. These should accompany the product to its installation destination and be stored in a dedicated safe location.

The site should be well-lit to aid inspection, and should be clean, dry, and reasonably free from dust and excessive vibration. This particularly applies where installation is being carried out at the same time as construction work.

The PSC-1 should be handled carefully during installation. Special care should be taken with the connected optical fibre. The fibre should not be subject to tight bends, crushing, or significant tensile force. Care should also be taken to avoid damage to the electrical cable.

3.4.3 *Storage*

If the product is not intended for immediate installation, store it in a place free from dust and moisture in its original packaging.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations of high humidity or outside the permitted temperature range. Refer to the product technical specifications for further information.

3.4.4 *Documentation and communication*

Documentation related to the PSC-1 and supplied to the installer prior to installation shall include:

- The PSC-1 Installation Manual (this document); and
- The detailed system design pack for the full DES system, signed by Synaptec and the end-user/client.

The detailed system design pack shall include system specifications, topology and fibre routing diagrams, bill of materials, and any exceptions to the standard product installation guides. This information will indicate the installation location of each PSC-1 sensor, indexed by serial number, and other relevant information related to its installation and operation. Particular attention should be given to the location of each PSC-1 by serial number, as any deviations from this design during installation will impact system performance. Where no exceptions are listed to the installation information provided in this manual, that information should be followed.

3.5 Preparing for installation

The PSC-1 should be mounted in a location with suitable access to the secondary wiring of the instrument transformer with which it will interface. Depending on the chosen location, a suitable adaptor may be required to mount the PSC-1 to the chosen support structure. The arrangement of mounting holes on the PSC-1 base is shown in Figure 3.1, to be used as a reference when designing any adaptor necessary for mounting. Any adaptors should be designed to provide a secure mounting for the PSC-1 and should not impede its operation or the safe routing of fibre or instrument transformer wiring.

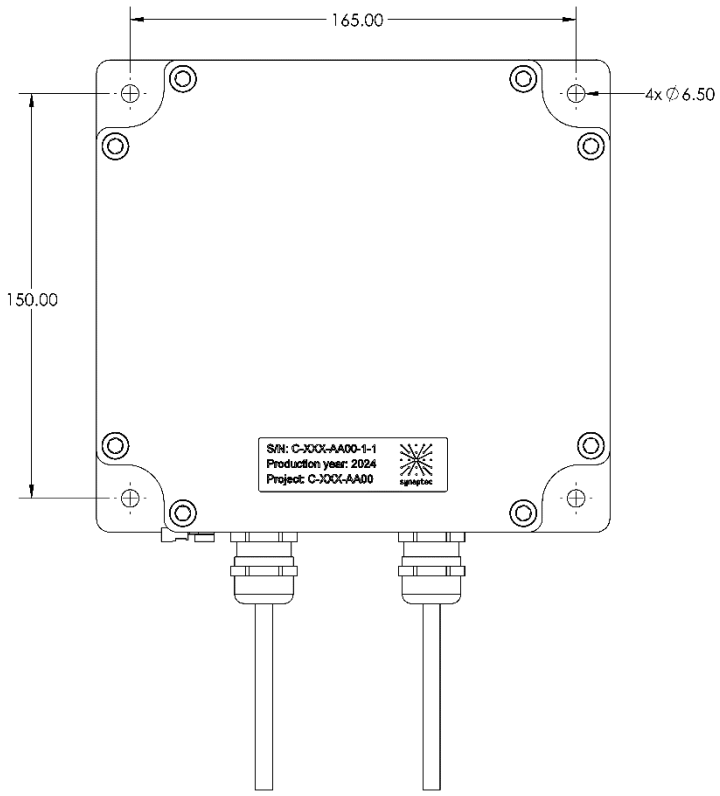
Figure 3.1: Arrangement of mounting holes on the PSC-1 base.

In advance of installation, the installation location should be cleared of mess and debris. It is at the client and installer's discretion whether an electrical outage should be arranged for installation of this equipment, since this will depend on the complete scope of work and the electrical safety protocols under which the work will be taking place.

3.6 Mechanical mounting

The PSC-1 should be mounted to the intended surface or any required adaptor using M6 bolts, as shown in Figure 3.2. M6 bolts of appropriate length for interface with any adaptor elements should be inserted through the enclosure mounting holes and secured to the mounting surface.

Figure 3.2: PSC-1 mounting arrangement.



3.7 Connection to earth

After the product is mechanically mounted, and before the equipment is energised, the enclosure earth bonding point (M4x0.7, 8mm max) should be reliably connected to earth.

The earthing conductor should have a cross-sectional area no smaller than 3.3mm^2 and be in accordance with appropriate standards for the specific application.

The mounted surface should be secure and free from excessive vibration.

3.8 Secondary (electrical) connection

All work involving CTs should be done following best practices and applicable operational procedures.

Connection to the instrument transformer is made via a two-core cable pre-installed on the PSC-1. Standard wiring gauge is 2.5 mm^2. By standard, 2m of cable is provided between the instrument transformer and PSC-1, however customers are welcome to specify a different length according to their requirements.

Connection to the instrument transformer and cable routing should be performed according to the operator and installer's best practices and safety protocols.

Phase current CTs should be installed with the sheath conductor routed back through the CT in the opposite direction. This is to subtract the screen current from the total currents flowing through all conductors in the cable, providing a measure of the load current. Sheath current CTs should be installed on the screen conductor directly. Appropriate supports for the CTs may be required.

CT Secondary circuits are not connected to ground within or at the PSC-1. CT secondary circuits should be reliably connected to ground in one location only, for example at one of the CT secondary terminals. This is done at the customer's sole discretion.

Preparation of the electrical cable:

- The electrical cable should be cut and the outer sheath stripped. The stripping length depends on the specific dimensions of the CT.
- The conductive EMC braid should be trimmed and wrapped in electrical tape to prevent contact with the CT electrical contacts.
- Some variants feature a supplementary cable bedding. This should be stripped back.
- The two cores should be stripped and ring terminals applied. No loose copper strands should be permitted. Terminals should be appropriate for use with stranded 2.5mm^2 conductors and the stripping length should be in accordance with the terminal manufacturer's recommendations.

To ensure the correct sensor polarity, PSC-1 electrical cables should be connected according to the following:

CT terminal	Identification option 1	Identification option 2
S1	Marked with "1"	Brown
S2	Marked with "2"	Blue

Please note:

- Terminals and fasteners should be used in accordance with the CT manufacturer's recommendations
- Cable glands are selected by the customer. They should be appropriate for use with cables from 7mm up to 12mm, at least

Suggested tools:

- Knipex 16 30 135 – Stripping the outer jacket
- Knipex 95 05 10 – Trimming the EMC braid
- Knipex 16 30 135, Jokari 10270 – Stripping the bedding (if applicable)
- Knipex 12 62 180 – Stripping the primary insulation

3.9 Fibre optic connection

As standard the PSC-1 is supplied with 25 m of fibre optic cable pre-installed on the PSC-1. The available end of the fibre cable is unterminated for connection into the sensor network. The fibre cable typically

contains 4 fibres. The fibres coloured blue and green should be used to connect into the sensor network at the local splice box, and other fibre should be left unterminated. The following convention should be followed for all PSC-1 installations:

- The blue (input) fibre should be connected into the fibre network in the direction of the previous sensor in the chain, in the direction of the Interrogator;
- The green (output) fibre should be connected into the fibre network in the direction of the next sensor in the chain, away from the Interrogator.

Figure 3.3 Fibre Cable with blue. and green fibre identified.

Fibre optic splices should be performed by trained individuals using a suitable fusion splicer. Fibre optic cabling should be routed and protected per the installer and operator's best practices and to ensure reliable connection with minimal loss, and the dB loss of each splice should be measured and reported in the TD-016 PSC-1 Checklist..

For typical optical loss guidelines, and instructions on verification of the complete sensor fibre network following installation of a DES system, refer to TD-014 DES Installation Manual.

3.10 Troubleshooting

Issue	Resolution
Splice exhibits losses >-0.1dB, or > custom limit specified in design documentation	Cut and re-do splice. Repeat until loss is in an acceptable range.
Received electrical signal following commissioning is 180° out of phase	Re-wire CT secondaries with correct polarisation

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