

Reflex

Ultrafast protection for complex and remote circuits and assets

MCP
Mixed circuit protection

RTP
Remote transformer protection

Differential protection using current measured at transition towers and remote transformers, with nothing powered at the measurement sites.

synaptec

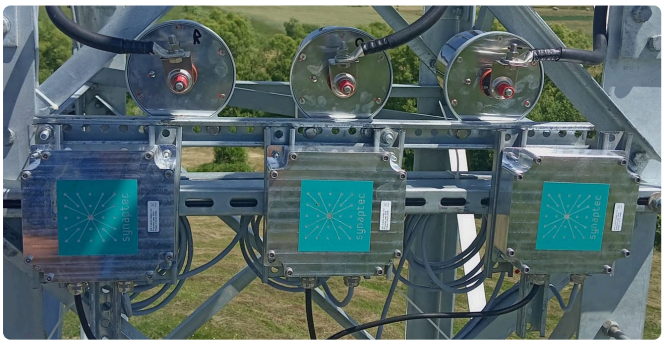
Protection for remote circuits and assets

Reflex is Synaptec's range of ultrafast power system protection for complex and remote circuits and assets. It identifies the faulted zone in milliseconds, using passive optical sensors with no power, active electronics, or communications at the measurement sites. The range includes MCP for mixed overhead and cable circuits and RTP for remote transformers.

Introduction

Unit protection needs a current measurement at each end of the protected zone. Inside a substation that is routine. At a cable sealing end on a transition tower, a transformer on a remote tap, or a cable landing point, there is usually no auxiliary supply, no communications link fit for protection, and no time source. Building them costs more than the asset often justifies, so many of these sites are left with slower and less selective protection than the asset deserves.

Reflex keeps every active device in the substation. Passive Secondary Converters (PSCs) on the secondary of standard current transformers encode the current as light on a spare fibre back to a DES Interrogator. The Interrogator reads every sensor on one time base, runs differential protection across the zones you define, blocks or permits auto-reclose, and passes Sampled Values to your own relays. Nothing at the remote site needs power, maintenance, or recalibration.



Passive sensors on a 110 kV transition tower in Romania

Key benefits

- **Unit protection with no substation at the far end.** Differential protection across cable sections, lines, and transformers whose ends have no relay, power supply, or communications.
- **Fault identified in under 10 ms.** Mixed circuit schemes in service identify the faulted zone and issue the auto-reclose block in under 10 ms, before the breaker opens.
- **More than 60 km from the substation.** One Interrogator reads sensors along a single fibre, in series or in parallel, to more than 60 km from the substation.
- **Nothing to maintain at the remote site.** The sensors need no power, batteries, data network, or time source, and are designed for more than 30 years in service without recalibration.
- **Works with the relays you have.** Dry contacts, IEC 61850 GOOSE, and IEC 61850-9-2 Sampled Values connect Reflex to conventional and digital substations alike.
- **Standard current transformers.** Sensors connect to any industry-standard CT with a 1 A or 5 A secondary, existing or new, including split-core CTs fitted around cables already in service.
- **Nothing to attack at the remote site.** Only optical signals leave the substation fence. There are no IP addresses, radios, or active electronics at the measurement sites.

The Reflex range

Mixed circuit protection (MCP)

Tells the protection scheme whether a fault on a mixed circuit is in a cable section or on the overhead line, and blocks auto-reclose for cable faults before the breaker opens. Overhead faults reclose as normal.

Remote transformer protection (RTP)

Unit protection for a transformer far from any substation. The HV line, the transformer, and the LV line each have their own zone, measured from the substation, with the transformer zone run by your choice of 87T relay.

MCP

Mixed circuit protection

MCP tells the protection scheme whether a fault on a mixed circuit is in a cable section or on the overhead line, in time to block auto-reclose for a cable fault before the breaker opens.

The industry challenge

Circuits that combine overhead line and underground cable are becoming common at 110 to 400 kV. Undergrounding programmes, planning constraints on new overhead routes, weather resilience, and new loads such as metros and data centres beside existing corridors all add cable sections, often as loop-in, loop-out cable tails.

Most overhead line faults are transient, so auto-reclose restores supply in under a second. Cable faults, on the other hand, are almost always permanent. Reclosing onto a faulted cable cannot restore supply: instead, it adds to the damage, can spread it to adjacent cables and connected equipment, and puts people near the cable at risk. The repair then takes weeks.

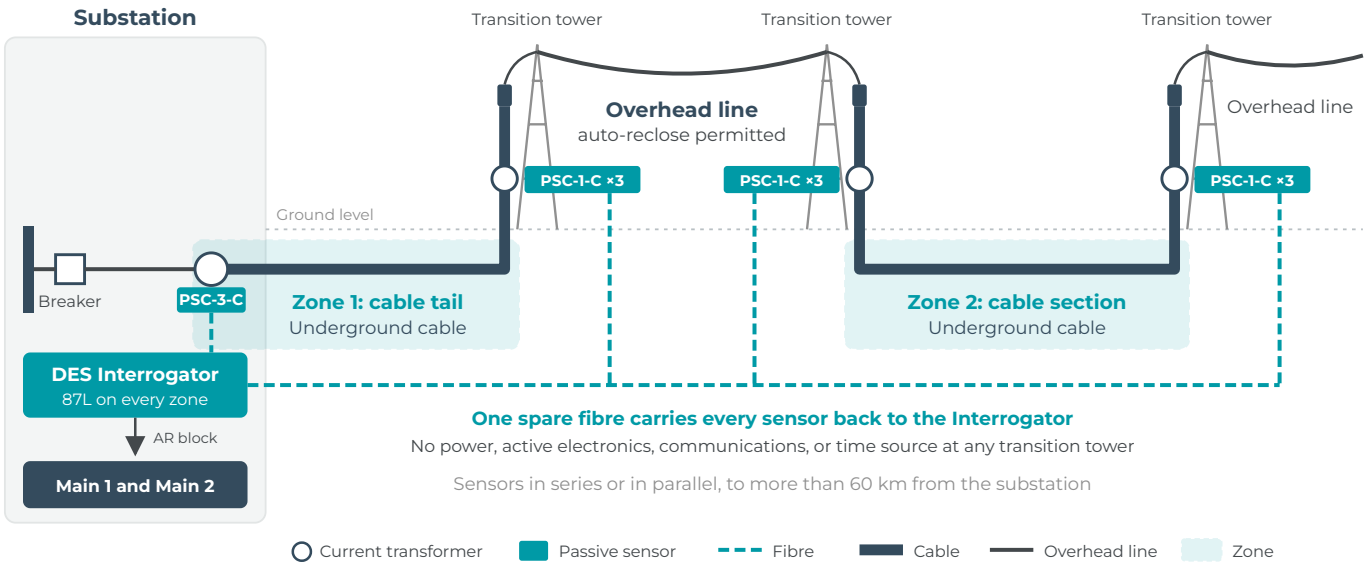
Distance protection cannot reliably tell which section is faulted. A cable's impedance to a fault does not vary linearly with distance, its charging current is high, its sheath bonding adds circulating currents, and every transition reflects travelling waves. Differential protection at each transition would solve it, but traditionally needs a relay, a power supply, a communications link, and a time source at every tower.

Auto-reclose policies on mixed circuits

Policy	Consequence
Block auto-reclose on the whole circuit	Every transient overhead fault becomes a sustained outage, with line patrols, manual restoration, and lost customer minutes
Allow auto-reclose on the whole circuit	A cable fault is reclosed onto, adding to the damage, spreading it to adjacent cables and connected equipment, putting people at risk, and turning a short interruption into a repair lasting weeks
Allow auto-reclose only where the cable is a small share of the route	Less exposure, but the relay still does not know where the fault is
MCP	**Auto-reclose blocked for cable faults and permitted for overhead faults**, decided zone by zone in under 10 ms

Our solution

Passive sensors at each cable sealing end form protection zones around every cable section. The DES Interrogator in the substation runs line differential protection (ANSI 87L) on every zone. A fault inside a cable zone produces an auto-reclose block to your Main 1 and Main 2 relays by dry contact or IEC 61850 GOOSE. A fault outside every cable zone is on the overhead line, and auto-reclose proceeds as normal.



How it works

Passive sensors

At each transition tower, a split-core current transformer fits around each cable below the termination bushing, and a single-phase Passive Secondary Converter (PSC-1-C), rated IP68, connects to its secondary. Where measurements are required in the substation, a rack-mounted three-phase PSC-3-C connects to spare cores of the existing line CTs. Each PSC encodes the CT secondary current as a shift in the wavelength of light, which electromagnetic interference cannot alter, and returns it on standard single-mode fibre. There is no fibre to wind around the conductor and no specialist work at the tower.

DES Interrogator

A single 3U rack-mounted DES Interrogator in the protection and control room reads every sensor on the fibre, sampling at 4.8 kHz. All measurements are synchronised to within one microsecond by the Interrogator itself, with no satellite or network time source at any sensor. Synaptec's patented time-of-flight correction keeps phase and time-stamp accuracy within IEC limits at any practical fibre length.

The Interrogator runs line differential protection (ANSI 87L) on every zone, with overcurrent and earth fault (ANSI 50 and 50G) where required. It issues auto-reclose block signals by dry contact or IEC 61850 GOOSE, publishes IEC 61850-9-2 Sampled Values to your relays, and records time-synchronised fault data at every sensor.

Zones that follow your network

A zone is formed between any two sets of sensors, so it can hold one cable section or several, in series or in parallel. Single cable tails, double circuits, multi-ended circuits, and routes with several cable sections can all be protected, with up to three protection zones per Interrogator. Commissioning is carried out centrally from the substation, without test sets at the tower.



PSC-1-C single-phase Passive Secondary Converter, rated IP68



Split-core CT for fitting around a cable in service



DES Interrogator, 3U rack-mounted

MCP at a glance

Item	MCP
Protection	Multi-zone line differential (87L); overcurrent and earth fault (50, 50G)
Fault identification	Under 10 ms in service
Reach	More than 60 km from the substation to the furthest sensor
Capacity	Up to three protection zones per Interrogator
Accuracy	Class 1/10TPM to IEC 61869-13
Outputs	Dry contacts; IEC 61850 GOOSE; IEC 61850-9-2 Sampled Values
Sensors	PSC-1-C single-phase, IP68; PSC-3-C three-phase, 1U rack-mounted

RTP

Remote transformer protection

RTP gives unit protection to a transformer far from any substation, with your choice of 87T relay running its own settings. The transformer site needs only standard CTs, passive sensors, and a single fibre back to the substation.

The industry challenge

Many transformers sit well away from any substation: step-down units on mid-route taps, supply points for mines and pumping stations, and transformers at the landing points of island links. Without a substation of their own, they rarely have unit protection. They rely on time-graded overcurrent protection from the feeding end and on mechanical devices such as Buchholz and pressure relief relays, which respond to the consequences of a fault rather than its onset.

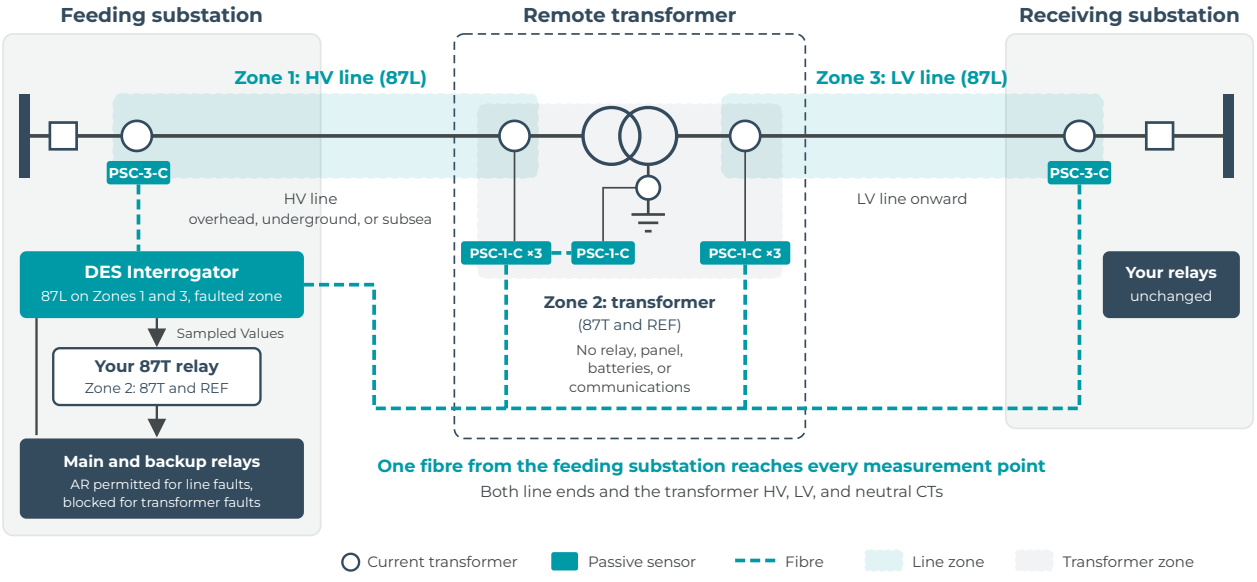
Overcurrent protection clears in grading time rather than unit time, and cannot tell a line fault from a transformer fault. The longer an internal fault persists, the more likely the transformer needs replacing rather than repairing, and replacement lead times for large transformers now run to years. Where remote sites have been connected at all, it has usually been over pilot wires or telephone circuits, which are now being withdrawn.

The two conventional options

Accept slow clearance	Build infrastructure at the transformer
Faults cleared in grading time rather than unit time	Relay, panel, auxiliary supplies, and batteries at the transformer
Fault damage increases with clearing time	A new communications channel to the site, fit for protection
Line and transformer faults cannot be told apart at the feeding end	Testing and maintenance visits for the life of the scheme
Transformer replacement lead times measured in years	Civil works to house the equipment at a site with no building

Our solution

RTP forms three differential zones from one set of passive sensors, all measured at the feeding substation. Zone 1 covers the HV line from the feeding substation to the transformer HV terminals. Zone 2 covers the transformer from its HV to LV terminals, with a neutral CT for restricted earth fault protection. Zone 3 covers the LV line to the receiving substation. The DES Interrogator runs line differential protection (87L) on Zones 1 and 3, using the same element as MCP, and identifies which zone a fault is in, so auto-reclose can proceed for a line fault. The transformer zone runs in your choice of 87T relay, which receives the HV, LV, and neutral currents as IEC 61850-9-2 Sampled Values and blocks auto-reclose for a transformer fault. Your main and backup protection remain conventional relays.



Three zones from one fibre: the line zones in the DES Interrogator, the transformer zone in your chosen 87T relay

How it works

At the transformer

Single-phase PSC-1-C sensors, rated IP68, connect to the secondaries of standard CTs: three on the HV side, three on the LV side, and one on the neutral. They are spliced into a spare fibre and need no further attention.

In the feeding substation

The DES Interrogator reads every sensor over the fibre on a common time base and runs line differential protection on Zones 1 and 3. For a fault in either line zone it allows auto-reclose. It also publishes the transformer's HV, LV, and neutral currents to the process bus, from which your 87T relay runs Zone 2 exactly as it would from a conventional merging unit and blocks auto-reclose for a transformer fault. Your main and backup protection remain conventional relays.

At the receiving substation

Three further sensors on the existing line CTs complete Zone 3. The relays in the existing panel are unchanged.

Protection functions

Function	Zone	Runs in
Line differential (87L)	Zone 1, HV line; Zone 3, LV line	DES Interrogator
Auto-reclose permitted for line faults	Zones 1 and 3	DES Interrogator
Transformer differential (87T)	Zone 2, HV to LV terminals	Your 87T relay (Sampled Values)
Restricted earth fault	Zone 2, using the neutral CT	Your 87T relay
Auto-reclose blocked for transformer faults	Zone 2	Your 87T relay
Faulted zone indication and synchronised fault records	Every measurement point	DES Interrogator
Main and backup protection	Feeding and receiving substations	Your relays, unchanged

Performance

- Accuracy class 1/10TPM to IEC 61869-13
- Faulted zone identified in under 10 ms
- All measurements on one time base, synchronised to within one microsecond, with no satellite timing at the transformer
- Only optical signals beyond the substation fence, immune to electromagnetic interference

Integration

- The transformer is protected by your chosen 87T relay and its settings
- IEC 61850-9-2 Sampled Values to any compliant relay, and GOOSE or dry contact into your existing auto-reclose logic
- Your main and backup protection remain conventional relays, unchanged
- Site acceptance tests are carried out from the substations, without access to the transformer site

Where it applies

Rural and island supplies

A step-down transformer on a long line feeding a village, island, or rural network. Faults on either line and in the transformer, including restricted earth faults, are identified separately.

Industrial and infrastructure supply points

Mines, pumping and compressor stations, rail feeder sites, and similar loads supplied from a tap on a transmission or distribution line.

Island links

A subsea cable to a transformer at the landing point, with a line onward into the island network. Cable, transformer, and island-side faults are identified separately, so crews are sent knowing where the fault is.

Shunt reactors

The same arrangement protects a shunt reactor, with a reactor zone in your 87R relay in place of the transformer zone.

Proven in service

MCP and RTP use the same DES Interrogators and passive sensors that Synaptec supplies for protection and cable systems monitoring worldwide. In more than 1.5 million sensor-hours of operation, no Synaptec sensor has ever failed in service.

Region	Protection in service and in delivery
India	**Tata Power:** MCP on two 110 kV circuits at Mandale substation, Mumbai, supplying the metro. **Adani Electricity Mumbai:** MCP on a 220 kV circuit at Chandivali substation
Europe	**Swissgrid:** auto-reclose blocking on three 220 kV mixed circuits, with 48 passive sensors in eight protection zones. **Distribuție Energie Electrică România:** MCP on a 110 kV mixed circuit at Remetea substation. **SP Energy Networks** (UK), **RTE** (France), and **EDP** (Portugal): projects and trials in delivery
Middle East	**Dubai Electricity and Water Authority:** MCP on mixed circuits, the first commissioned in 2026, with further circuits in delivery. **National Grid SA** (Saudi Arabia): trial in delivery
Development with network operators	**SSEN:** unit protection of a multi-ended 132 kV circuit, co-published at PAC World 2022. **Statnett:** busbar protection across six feeders from one DES system at Furuset substation, near Oslo

In service: Tata Power, 110 kV Mandale substation, Mumbai

MCP was commissioned on two 110 kV mixed circuits in January 2026, protecting the loop-in, loop-out cable sections that feed the Mumbai metro traction supply. By June 2026 the circuits had seen three overhead line faults. Each time the scheme remained stable and the line auto-reclosed successfully.

"The deployment of Synaptec's MCP system has demonstrated reliability and effectiveness in providing auto-reclose functionality for the 110 kV Mandale–Dharavi–Vikhroli hybrid circuit."

Girish Jawale, Head, Technical Services (T&D, MO), Tata Power, June 2026. Full case study available on request.

>1.5 million
sensor-hours of operation (October 2026)

0
sensor failures in service

<10 ms
to identify a faulted zone on mixed circuits in service

>60 km
from the substation to the furthest passive sensor



Cable sealing ends fitted with passive sensors at a 220 kV transition yard in Switzerland

Published and peer reviewed

In CIGRE Technical Brochure 587 (2014), Working Group B5.23 found fibre Bragg grating sensing, the principle behind DES, to be the only method assessed that combined full discrimination between cable and line faults with no power supply at the transition and one system for every cable section. Synaptec's work with SSEN, SEL, and Ørsted has been published at PAC World and CIGRE, including the PAC World 2025 Best Paper.

How Reflex is delivered

Design
Synaptec reviews your single-line diagram and fibre route and proposes a design with a budget price, at no cost.

Supply
Synaptec supplies the passive sensors, the DES Interrogator, and the software.

Installation
Your contractor or Synaptec's local partner fits the CTs and sensors and splices them into the spare fibre.

Commissioning and support
Synaptec commissions the scheme from the substation and supports it, with local first-line cover where a partner is in place.

Talk to us about your circuits and assets

Start with one circuit. Send us the single-line diagram and the fibre route, and we will propose a protection design with a budget price, at no cost. Your preferred contractor or Synaptec's local partner installs the equipment, and Synaptec commissions it.

Monitoring on the same fibre. The passive sensors and Interrogators used in MCP and RTP also carry Greenlight®, Synaptec's cable systems monitoring, which measures current and temperature at joints and terminations and gives early warning of developing faults.

synapt.ec/solutions/reflex

Synaptec designs and manufactures passive optical sensing for power networks. Founded in Glasgow in 2015, Synaptec supplies protection and monitoring systems to transmission and distribution operators and offshore wind operators across Europe, the Middle East, Asia, and beyond.

Reflex. Powered by DES.

synaptec

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