MiCOM Agile P54A/B/C/E

Multi-ended Current Differential Protection for up to 6 Terminals

The MiCOM Agile P54A/B/C/E range is designed for all overhead line and cable applications up to 6 terminals, interfacing readily with the longitudinal (end-to-end) communications channel between line terminals. Previously, transmission and distribution circuits would have two or three ends only, whereas five or more ends are becoming common to connect renewable generation. All models are now ready for any protection topology from two to six terminals, whether those multi-terminals exist now, or are provisioned for connection in the future.

Multi-ended current differential protection uses a high-speed and innovative biased differential characteristic. Phase-segregated differential elements provide consistent detection of solid and resistive faults.

Applications

- Adapted to suit many different substation and protected feeder topologies: Current differential protection for up to 6 line or cable ends, maximising connection of renewable generation, reducing greenhouse gas emissions

- Highly selective and sensitive unit protection, with capacitive current compensation for long lines or cables

- Ability to locally take any end off-line for maintenance

- Transmission and subtransmission: P54C and P54E use the same hardware as well-proven MiCOM Agile P543 and P545 models, offering scalability for large numbers of binary inputs/outputs

- Distribution: P54A and P54B offer compact feeder differential in a 40TE half-rack case. Simple P54A CT only model offers an economical choice for pilot wire refurbishment when upgrading to fibre

Key Benefits

- Subcycle current differential protection – up to 4 terminals (1.25 cycle for 5-6 ends)

- Easy to set with a single simple matrix of settings for all line ends

- 8 teleprotection logic bits from and to each end via MODEM, fibre, or MUX channel

- Compatibility with modern Ethernet communications equipment

Protection and Control

- Maximises connection of renewables, up to 6 lines or cable ends

- Subcycle tripping time up to 4-ended topology (<1.25 cycle for 5 or 6 ends)

- Highly selective and sensitive unit protection, with capacitive current compensation for long lines or cables

- Full support of SONET/SDH channel switching

- Suitable for direct fibre and multiplexed (IEEE C37.94) networks, including MPLS systems

- Assists with grading/selectivity challenges such as ride-through, arcing limitation and ground potential rise

Application Flexibility

- Ability to take an end off-line for maintenance

- Easy to set with a simple matrix of settings for all the ends

- Extensive binary signaling capability between ends for intertripping, breaker fail, interlocking and control/observation of remote 3rd party substations

Advanced Communications

- Software switchable IEC61850 Ed. 1 / Ed. 2 implementation with IEEE 1588 support

- Redundant communications with zero downtime using optional PRP/HSR protocols

- Wide range of supported protocols: Courier/K-Bus, IEC 60870-5-103, DNP 3.0 (EAI-485 or Ethernet) and IEC 61850

Cyber Security

- Provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, RADIUS, RBAC, Syslog)

Imagination at work

Differential Protection

The P54x provides true, phase-segregated current differential protection. The measurement algorithm is extremely reliable, offering fast detection of internal faults and stability for external faults. The algorithm has a dual slope percentage bias restraint, as shown in Figure 2. An internal fault will generate differential current. The initial slope ensures sensitivity to low current faults, whereas the 2nd slope is raised to counter the effects of Current Transformer (CT) saturation. Capacitive charging current compensation allows the current differential protection to be set according to the fault detection requirements - with no compromise to account for charging currents.
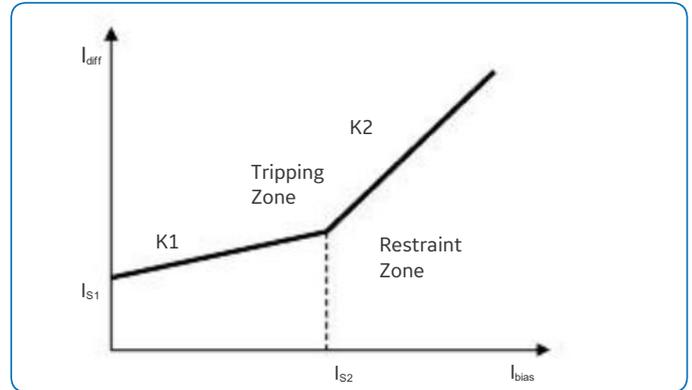

Figure 2: Differential protection characteristic

Functional Overview

ANSI	IEC 61850	Features	P54A	P54B	P54C	P54E
		Relay size	40TE	40TE	60TE	80TE
	OptGGIO	Opto coupled logic inputs	8	8	16	32
	RlyGGIO	Standard relay output contacts	8	8	16	32
		Optional high-speed, high-break output contacts*			4	8
		Clockwise and anticlockwise phase rotation	•	•	•	•
	PTRC	Tripping	3	3	1&3	1&3
87P	PhsPDIF	Phase segregated	•	•	•	•
	PSOF	Switch on to fault	•	•	•	•
50/51	OcpPTOC /RDIR	Phase overcurrent stages	4	4	4	4
50N/51N	EfdPTOC /RDIR	Earth/ground overcurrent stages	4	4	4	4
67P		Directional phase overcurrent		•	•	•
67N		Ground fault directional		•	•	•
51N/67N/SEF	SenEftPTOC/RDIR	Sensitive earth fault (SEF) stages			4	4
64	SenRefPDIF	High-impedance restricted earth fault protection			•	•
46	NgcPTOC/RDIR	Negative sequence overcurrent stages (Non Directional in P54A only)	4	4	4	4
46BC		Broken conductor	•	•	•	•
49	PTTR	Thermal overload	•	•	•	•
27	PTUV	Undervoltage protection stages		2	2	2
59	PhsPTOV	Overvoltage protection stages		2	2	2
59N	ResPTOV	Residual voltage protection stages		2	2	2
		Compensated overvoltage protection stages		2	2	2
81U	PTUF	Underfrequency protection		4	4	4
81O	PTOF	Overfrequency protection		2	2	2
81R	PFRC	Rate of change of frequency protection		4	4	4
50BF	RBRF	High-speed breaker fail	•	•	•	•
79	RREC	Autoreclose - shots supported		4	4	4
25	RSYN	Check synchronising		•	•	•
		Alternative setting groups	4	4	4	4
FL	RFLO	Fault locator (Fault records)		•(15)	•(15)	•(15)
SOE		Event records	1024	1024	1024	1024
	RDRE	Disturbance recorder: samples per cycle	48	48	48	48
		Number of channels: Analogue/Digital	16/64	16/64	16/64	16/64
VTS		Voltage transformer supervision		•	•	•
CTS		CT supervision (including patented differential CTS)	•	•	•	•
	XCBR	Circuit-breaker condition monitoring	•	•	•	•
		InterMiCOM64 teleprotection	•	•	•	•

Key: * High-speed, high break contacts occupy double the space of the conventional, which reduce in number accordingly

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Network Extensions

Multi-ended line differential can offer applications up to six terminal lines. All models are now ready for any protection topology from two to six terminals, whether those multi-terminals exist now, or are provisioned for connection in the future. The P54x multi-ended line differential compensates for line CT ratio mismatches, even for 1 A and 5 A differences between line ends. This facilitates easier retrofitting and network extensions.
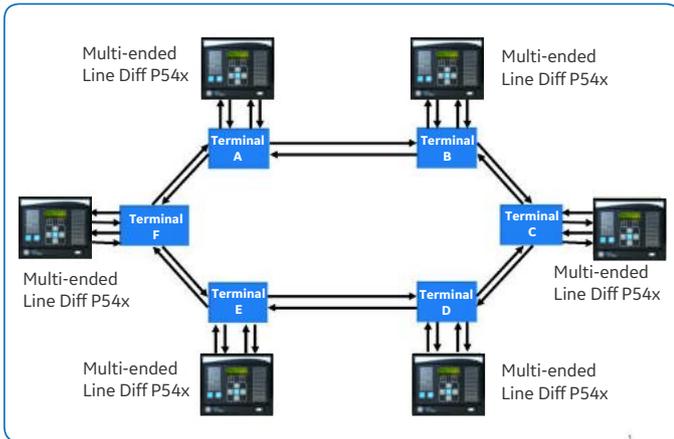

Figure 3: *Multi-ended Line Diff P54x connection*

Protection Communications

Communications Interfacing

To ensure compatibility with standard communications equipment, the MiCOM P54x Agile multi-ended line differential series is designed to work with IEEE C37.94™. A direct fibre optic connection to a MUX is possible if the MUX is IEEE C37.94™ compliant.

In direct fibre optic applications, 1300 nm and 1550 nm channel options are available. The transmitters are designed with a large "optical budget" to support up to 120 km.

Communications Supervision

Dependable communications are essential for high-performance differential protection. Each active longitudinal channel is independently monitored and reports error statistics in line with guidance from ITU-T G.821.

Multi-ended line differential works in a ring connection, which provide comms redundancy. In the event of degraded communications, the ring communications channels will continue to provide protection, thus providing duplicated links via diverse communications paths.

Alternatively, back-up overcurrent elements can be switched into service, either as permanent parallel main protection, or temporary protection only during channel outages.

Fast Protection Trip Times

P54A/B/C/E achieves subcycle operating times for differential protection up to 4 terminals, and 1.25 cycle operating times for 5-6 terminals.

Backup Protection

- Four stages of both phase and earth (ground) fault protection
- Negative sequence overcurrent
- Phase under/overvoltage protection
- Broken conductor protection
- Two stage high speed circuit-breaker failure protection with fast reset (<0.75 cycles) for improved system stability

Supervisory Functions

CT Supervision

Current transformer supervision is provided to detect loss of phase CT inputs. Using a patented differential CTS feature, the relay performs an intelligent comparison of the negative sequence current imbalance at line ends to determine which, if any, CTs have failed. The CTS ensures real-time stability of the differential elements, in the same manner as the VTS ensures directional protection security.

Control

User Interface

Integrated user function keys and tri-colour programmable LEDs provide a cost-effective solution for full feeder scheme applications.
The ten function keys operate in two modes, normal and toggled, with an associated LED for clear indication of the logic status (P54C/E).

Autoreclose

Autoreclose with check synchronism (P54B/C/E) where the user may select a single, two, three or four shot autoreclose cycle.

Programmable Scheme Logic

Powerful graphical logic allows the user to customise the protection and control functions. The logic includes 32 timers, gates (OR, AND, MAJORITY) and set/reset latch functions, with the ability to invert the inputs and outputs and provide feedback. The system is optimised to ensure that the protection outputs are not delayed by PSL operation. The programmable scheme logic is configured using the graphical S1 Agile software. The relay outputs may be configured as latching (lockout) or self-reset. All aspects of MiCOM P40 IED configuration are managed using the S1 Agile software.

Hot Key Menu

Trip and close commands are facilitated from front panel "hotkeys", to allow direct CB control without the need to navigate a menu. Other in/out, on/off and enable/disable controls are easily programmed.

Post-Fault Analysis

Fault Location

A fault location algorithm is available on models with a VT. It provides distance to fault in miles, kilometres, ohms or percentage of the line length. The proven algorithm employed tolerates pre-fault loading and fault arc resistance.

Event Records

Up to 1024 time-tagged event records can be stored. An optional modulated or demodulated IRIG-B port is available for accurate time synchronisation.

Fault Records

The last 15 fault records are stored.

Disturbance Records

The oscillography has 16 analogue channels, 64 digital and 1 time channel, all at a resolution of 48 samples/cycle.

Plant Supervision

Circuit-Breaker Condition Monitoring

- Monitors the number of breaker trip operations.
- Records the sum of broken current quantity (wear, interruption duty)
- SI^x, $1.0 =< x =< 2.0$
- Monitors the breaker operating time

Quality Built-In (QBi)

Grid Solutions' QBi initiative has deployed a number of improvements to maximise quality. Harsh environmental coating is applied to all circuit boards to shield them from moisture and atmospheric contamination. Transit packaging has been redesigned to ISTA standards and the third generation of CPU processing boosts not only performance, but also reliability

Communications with Remote Operators and Substation Automation

Rear Scada Communication

The wide range of communications options, including IEC 61850, provides interfacing with almost any type of substation automation system or SCADA system.

The following protocols are available:

- Courier/K-Bus
- IEC 60870-5-103
- DNP 3.0 (EAI-485 or Ethernet)
- IEC 61850 Edition 2

P54x devices can be enhanced with an optional redundant Ethernet board. The redundancy is managed by the market's fastest recovery time protocols: IEC 62439-3 PRP and HSR allowing bumpless redundancy and RSTP, offering multi-vendor interoperability. The redundant Ethernet board supports either modulated or demodulated IRIG-B and the SNTP protocol for time synchronisation. The redundant Ethernet board also has a watchdog relay contact to alarm in case of a failure.

Second Rear Courier Port

An additional second rear port can be ordered as an option, designed typically for dial-up modem access by protection engineers/operators when the main port is reserved for SCADA traffic. This port also offers the option of -103 communications when IEC 61850 is the chosen first port protocol.

For more information please contact
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