

SIPROTEC 5 Devices and Fields of Application

Transformer Differential Protection – SIPROTEC 7UT87

Description

The SIPROTEC 7UT87 transformer differential protection has been designed specifically for the protection of multi-winding transformers (up to 5 sides). Furthermore, it is to be used where numerous measuring points (up to 7 3-pole current measuring points) are required. Another application is simultaneous protection of two parallel transformers (additional fast backup protection). The SIPROTEC 7UT87 is the main protection for the transformer and contains many other protection and monitoring functions. The additional protection functions can also be used as backup protection for protected downstream objects (such as cables, line). With its modular structure, flexibility and the powerful DIGSI 5 engineering tool, SIPROTEC 7UT87 offers future-oriented system solutions with high investment security and low operating costs.

Main function	Up to 3 differential protection functions with additional stabilization (in different transformer function groups); up to 5 ground fault differential protection functions. For auto transformer applications, two differential protection functions can be processed in an Auto transformer function group.
Usable measuring points	9 x 3-phase current measuring points, 5 x 1-phase current measuring points, 5 x 3-phase voltage measuring points
Inputs and outputs	2 predefined standard variants with 20 current transformers, 4 voltage transformers, 15 to 27 binary inputs, 22 to 38 binary outputs
Hardware flexibility	Flexibly adjustable and expandable I/O quantity structure within the scope of the SIPROTEC 5 modular system.
Housing width	2/3 x 19" - 2/1 x 19"



[SIP5_GD_SS_LED_W3, 1, --, --]

Figure 2.11/11 SIPROTEC 7UT87 transformer differential protection (2/3 device = standard variant Q1)

Functions

DIGSI 5 permits all functions to be configured and combined as required. In SIPROTEC 7UT87, two transformer function groups can be used.

- Transformer differential protection for multi-winding transformers with versatile, additional protection functions (multi-winding transformers are typical in power converter applications (such as HVDC))
- Transformer differential protection for phase-angle regulating transformers of the single core and two core types, and special transformers
- Transformer protection applications with up to seven 3-phase current measuring points
- Simultaneous differential protection for two parallel transformers (such as two 2-winding transformers)
- Universal usability of the permissible measuring points
- Applicable from average up to extra-high voltage
- Protection of standard power transformers, auto transformers and motors
- Typical properties of a transformer differential protection such as flexible adaptation to the transformer vector group, control of inrush and overexcitation processes, safe behavior in the case of current-transformer saturation with different degrees of saturation

- Arc protection
- Voltage controller function ANSI 90V for two-winding transformers, three-winding transformers and grid coupling transformers
- Adaptive adaptation of the operate curve to the transformer tap position
- Increased sensitivity with near-neutral-point ground faults through a separate ground fault differential protection
- Additional current and voltage inputs can be supplements for standard protection functions, such as overcurrent, voltage frequency, etc.
- Graphical logic editor to create powerful automation functions in the device
- Up to 4 pluggable communication modules, usable for different and redundant protocols (IEC 61850, IEC 60870-5-103, IEC 60870-5-104, DNP3 (serial and TCP), Modbus TCP)
- Redundancy protocols PRP and HSR
- Cyber security in accordance with NERC CIP and BDWE White-paper requirements
- Secure serial protection data communication, also over great distances and all available physical media (fiber-optic cable, 2-wire connections and communication networks)
- Capturing operation measured variables and protection function measured values to evaluate the plant state, to support commissioning, and to analyze faults
- Phasor measurement unit (PMU) for synchrophasor measured values and IEEE C37.118 protocol
- Powerful fault recording (buffer for a max. record time of 80 s at 8 kHz or 320 s at 2 kHz)
- Auxiliary functions for simple tests and commissioning
- Flexibly adjustable I/O quantity structure within the scope of the SIPROTEC 5 modular system

Application templates

All application templates that were described for the SIPROTEC 7UT85 and SIPROTEC 7UT86 devices can be used in SIPROTEC 7UT87.

In addition, the following template is available:

Auto transformer with stabilizing winding in breaker-and-a-half layout

- Differential protection for the complete transformer (auto transformer winding + stabilizing winding)
- Intersection protection for the auto winding for recording ground faults (3-phase recording of the neutral-point current)

- Overload protection, backup protection for the downstream electrical power system
- Circuit-breaker failure protection
- Frequency and voltage protection on the upper-voltage side.

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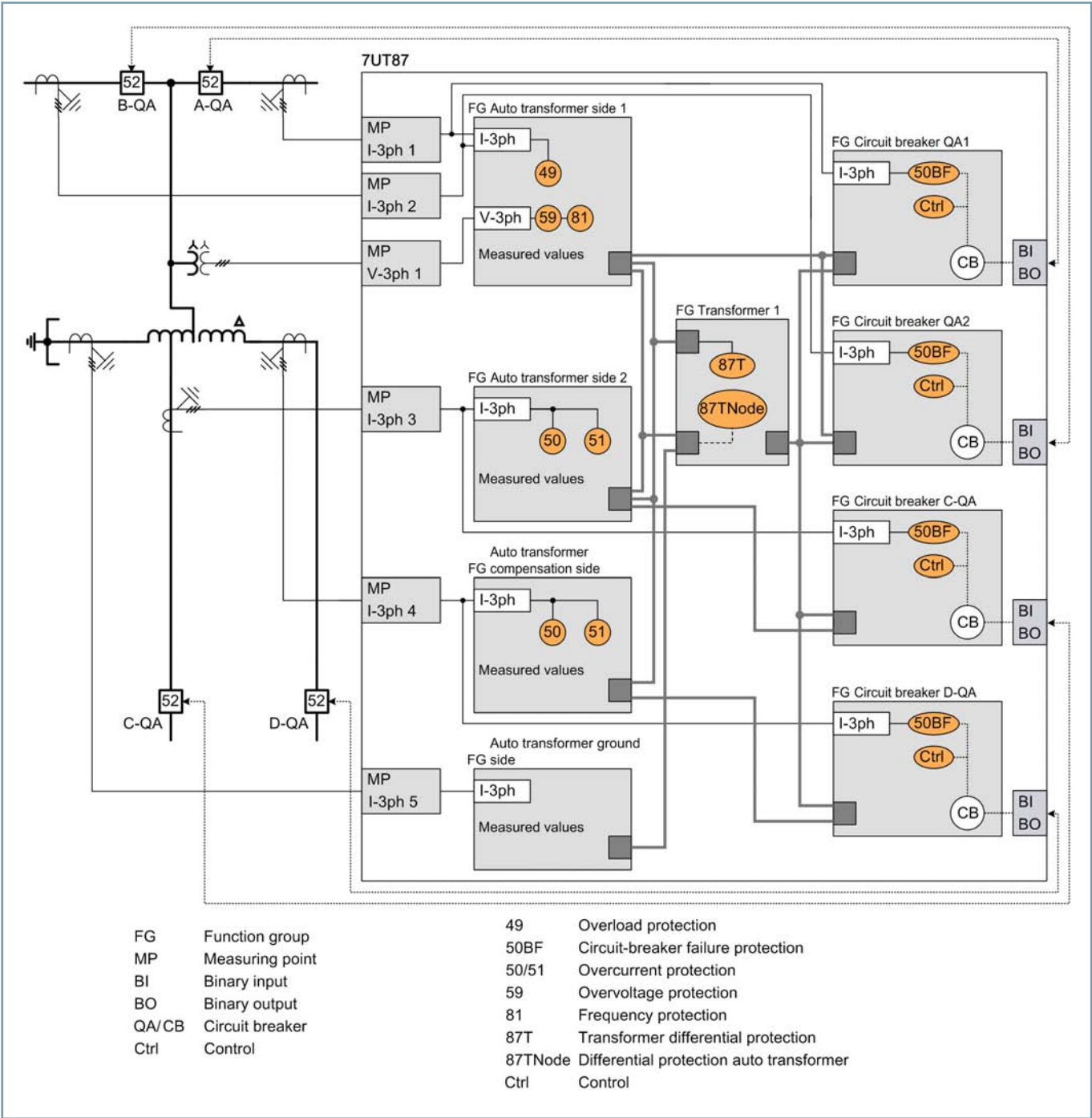


Figure 2.11/12 Application example: Protection of an auto transformer with stabilizing winding in breaker-and-a-half application system

Figure 2.11/12 shows the template for the protection of an auto transformer that is connected to a breaker-and-a-half arrangement. The special feature of this application is that per phase the neutral point side current is directly recorded. A separate node point differential protection via the auto winding reliably records ground faults and turn-to-turn faults. The classic differential protection is assigned over the entire transformer (auto and stabilizing winding). Both functions run in the Auto transformer function group. This type of execution gives you a redun-

dundant differential protection with supplementing sensitivity. A separate ground fault differential protection is not required. In addition, a voltage transformer is available on the upper-voltage side. Here, for example, voltage and frequency limits can be monitored. The required protection settings are made as required by the system.

Since the SIPROTEC 7UT87 is intended to be used for special applications, you must create your own application template as

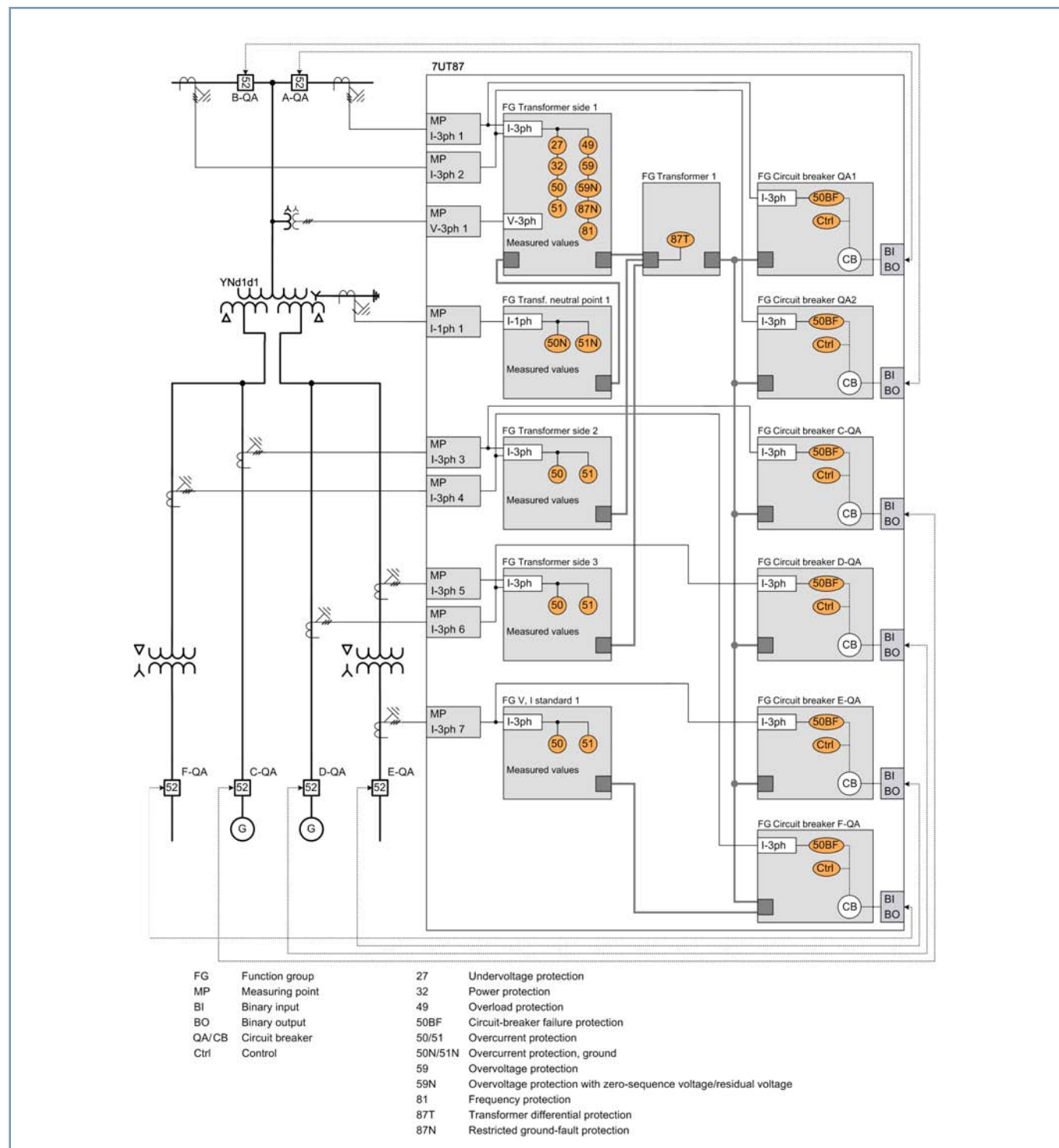
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a function of the application. Save this template with the device.
To make your work easier, you can use an available template and modify it as required. The following examples may help you:

Example 1:

This example requires a large number of three-phase current measuring points for a complex application in the power plant field. **Figure 2.11/13** shows a possible configuration.



[dw_7-messstellen, 1, en_US]

Figure 2.11/13 Possible application of SIPROTEC 7UT87 in a power plant (up to seven 3-phase current measuring points)

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Example 2:

Another example is a powerful functional redundancy with parallel transformers. The differential protection function is doubled. One protection device is used for each transformer. Two differential protection functions run in each protection

device. The second differential protection function is the backup protection for the parallel transformer. For example, start here with an application template of the two-winding transformer, and duplicate it. An alternative cost-optimized variant is the use of one device to protect both transformers.

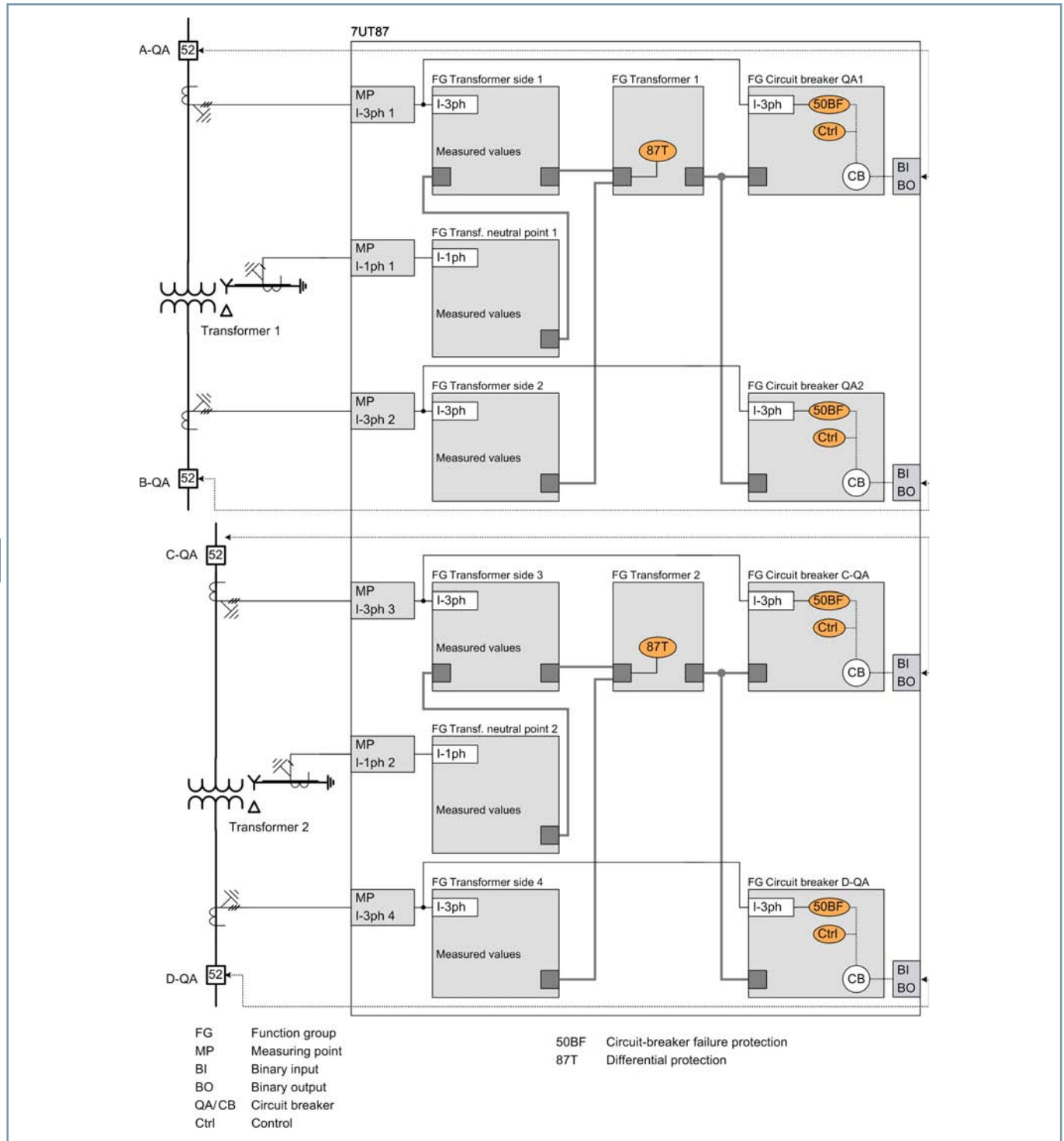


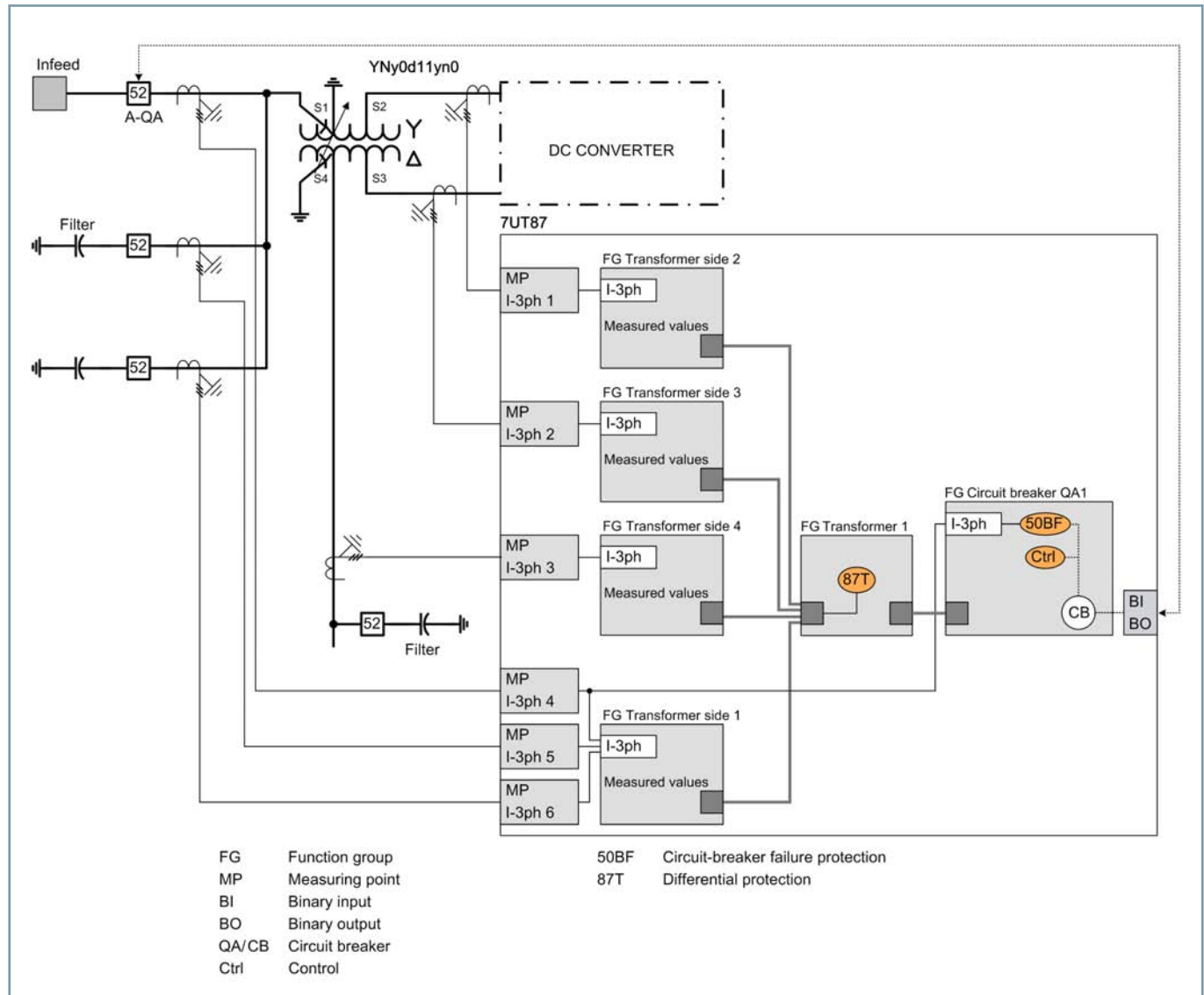
Figure 2.11/14 Protection of two parallel transformers with one SIPROTEC 7UT87

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Example 3:

The last example shows the protection of a converter transformer. Four sides and six measuring points are required here.



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Figure 2.11/15 Protection of a converter transformer

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Functions and application templates

ANSI	Functions	Abbr.	Available	Template									
				1	2	3	4	5	6	7	8	9	10
	Hardware quantity structure expandable	I/O	■										
21/21N	Distance protection	$Z<, V< /I>/\angle (V,I)$	■							■			
21T	Impedance protection for transformers	$Z<$	■										
87L	Line differential protection for 2 line ends	ΔI	■										
24	Overexcitation protection	V/f	■										
25	Synchrocheck, synchronizing function	Sync	■										
27	Undervoltage protection: "3-phase" or "pos.seq. V1" or "universal Vx"	$V<$	■										■
32, 37	Power protection active/reactive power	$P<>, Q<>$	■										
32R	Reverse power protection	$- P<$	■										
37	Undercurrent	$I<$	■										
38	Temperature Supervision	$\theta>$	■										
46	Negative sequence overcurrent protection	$I2>$	■										■
46	Unbalanced-load protection (thermal)	$I2^2 t>$	■										
47	Overvoltage protection, negative-sequence system	$V2>$	■										
47	Overvoltage protection, negative-sequence- / positive-sequence system	$V2/V1>$	■										
49	Thermal overload protection	$\theta, I^2 t$	■	■	■	■	■		■	■	■	■	■
49H	Hot spot calculation	$\theta_h, I^2 t$	■										
50/51 TD	Overcurrent protection, phases	$I>$	■	■	■	■	■		■	■	■	■	■
50N/ 51N TD	Overcurrent protection, ground	$IN>$	■		■								
50HS	High speed instantaneous overcurrent protection	$I>>>$	■										
	Instantaneous tripping at switch onto fault	SOTF	■										
50N/ 51N TD	Overcurrent protection, 1-phase	$IN>$	■			■			■	■	■		
50Ns/ 51Ns	Sensitive ground-current protection for systems with resonant or isolated neutral	$INs>$	■										
	Intermittent ground fault protection	$lie>$	■										
50BF	Circuit-breaker failure protection, 3-pole	CBFP	■		■	■	■		■	■	■	■	■
50RS	Circuit-breaker restrike protection	CBRS	■										
51V	Voltage dependent overcurrent protection	$t=f(I,V)$	■										
59, 59N	Overvoltage protection: "3-phase" or "zero seq. V0" or "pos.seq. V1" or "universal Vx"	$V>$	■				■		■	■		■	■
59	Overvoltage protection: "3-phase" or "pos.seq. V1" or "universal Vx"	$V>$	■										
67	Directional overcurrent protection, phases	$I>, \angle(V,I)$	■										
67N	Directional overcurrent protection for ground faults in grounded systems	$IN>, \angle(V,I)$	■										
67N	Directional overcurrent protection, ground	$IN>, \angle(V,I)$	■										■
67Ns	Dir. sensitive ground-fault detection for systems with resonant or isolated neutral incl. a) $3I0>$, b) $V0>$, c) $\cos/\sin\Phi$, d) Transient fct., e) $\Phi(V,I)$, f) admittance		■										
	Directional intermittent ground fault protection	$lie\ dir>$	■										
68	Power-swing blocking	$\Delta Z/\Delta t$	■										
74TC	Trip circuit supervision	TCS	■	■	■	■	■	■	■	■	■	■	
79	Automatic reclosing, 3-pole	AR	■										
81	Frequency protection: "f>" or "f<" or "df/dt"	$f>,<; df/dt>,<$	■						■	■		■	■
85/21	Teleprotection for distance protection		■										
85/27	Weak or no infeed: Echo and Tripping	WI	■										

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ANSI	Functions	Abbr.	Available	Template									
				1	2	3	4	5	6	7	8	9	10
85/67N	Teleprotection for directional ground fault protection		■										
86	Lockout		■	■	■	■	■	■	■	■	■	■	
87T	Transformer differential protection	ΔI	■	■	■	■	■	■	■	■	■	■	
87T	Transformer differential protection for phase angle regulating transformer (single core)	ΔI	■										
87T	Transformer differential protection for phase angle regulating transformer (two core)	ΔI	■										
87T	Transformer differential protection for special transformers	ΔI	■										
87T Node	Differential protection (Node protection for Auto-transformer)	ΔI Node	■									■	
87N T	Restricted ground-fault protection	ΔIN	■		■	■			■	■	■		
87M	Motor differential protection	ΔI	■										■
87G	Generator differential protection	ΔI	■										
	Option for line differential protection:charging-current compensation	ΔI	■										
87 STUB	STUB Differential protection (for one-and-half circuit-breaker applications)		■										
90V	Automatic voltage control for 2 winding transformer		■				■						
90V	Automatic voltage control for 3 winding transformer		■										
90V	Automatic voltage control for grid coupling transformer		■										
FL	Fault locator, single-ended measurement	FL-one	■										
PMU	Synchrophasor measurement (1 PMU can be used for max. 8 voltages and 8 currents)	PMU	■										
AFD	Arc-protection (only with plug-in module ARC-CD-3FO)		■										
	Measured values, standard		■	■	■	■	■	■	■	■	■	■	■
	Measured values, extended: Min, Max, Avg		■										
	Switching statistic counters		■				■						
	Circuit breaker wear monitoring	ΣIx, I²t, 2P	■										
	CFC (Standard, Control)		■	■	■	■	■	■	■	■	■	■	■
	CFC arithmetic		■										
	Switching sequences function		■										
	Inrush current detection		■	■	■	■	■		■	■	■	■	
	External trip initiation		■		■	■							
	Control		■	■	■	■	■	■	■	■	■	■	■
	Fault recording of analog and binary signals		■	■	■	■	■	■	■	■	■	■	■
	Monitoring and supervision		■	■	■	■	■	■	■	■	■	■	■
	Protection interface, serial		■										
	Circuit Breaker		■	■	■	■	■	■	■	■	■	■	■
	Disconnecter		■										
	Transformer Side 7UT87		■										
Function-points class:				0	30	30	175	0	50	150	30	30	50
The configuration and function points for your application can be ascertained in the SIPROTEC 5 order configurator under: www.siemens.com/siprotec													

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Table 2.11/4 SIPROTEC 7UT87 - Functions and application templates

- Two winding transformer basic (87T)
- Two winding transformer (87T, 50BF, 87N)

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3	Two winding transformer 1,5CB (87T, 50BF, 87N)
4	Two winding transformer (87T, 50BF, 87N, 90V)
5	Three winding transformer basic (87T)
6	Three winding transformer 1,5CB (87T, 50BF, 87N)
7	Three winding transformer (87T, 50BF, 87N, 21)
8	Autotransformer (87T, 87N, 50BF)
9	Autotransformer 1,5CB (two 87T, 50BF, 59, 27, 81)
10	Motor DIFF (87M, 50BF, 27, 81, 46, 49)