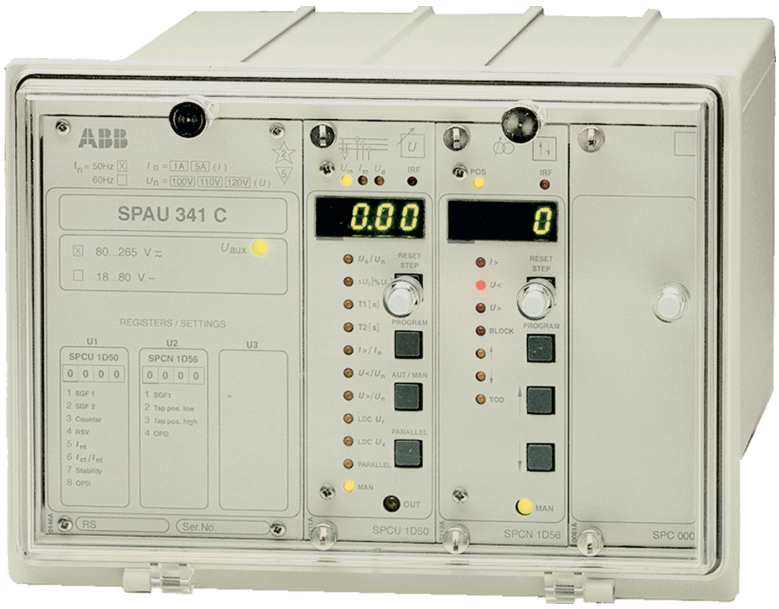
Voltage Regulator

SPAU 341 C

Product Guide



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Features

- Comprehensive voltage regulation for power transformers with on-load tap-changers in distribution substations
- 1 A and 5 A tappings on the energizing phase current inputs
- Selectable rated energizing input voltage of phase-to-phase voltage measurement: 100 V, 110 V, 120 V
- Three-phase overcurrent and undervoltage blocking
- Line-drop compensation
- Maximum three transformers can be operated in parallel when the minimizing circulating current principle is used. Master/slave and negative reactance principles can be used with an unlimited number of transformers in parallel.
- Tap changer position measurement
- Local man-machine communication via push-buttons and digital display on the front panels of the regulator modules
- Serial interface for connecting the regulator to higher-level data acquisition systems, local/remote control systems or other host systems
- High immunity to electrical and electromagnetic interference
- Continuous self-supervision of regulator hardware and software for enhanced system reliability
- Auto-diagnostic fault indication to facilitate fault location and repair
- Powerful software support for parameterizing the regulator, for reading measured values, events, etc., and for storing set values
- CE marking according to the EC directive for EMC

Application

The voltage regulator SPAU 341 C is intended to be used in distribution substations for automatic and manual voltage regulation for power transformers with on-load tap-changers. The regulator can be used in association with a single power transformer by measuring voltage alone. When two or three power transformers are run in parallel and more sophisticated regulating principles are used the voltage regulators need to measure both voltage and current. Further, a means of communication between the regulators must be provided. When two transformers are running in parallel three operating principles can be selected, i.e. the master/slave principle, the negative reactance principle or the minimizing circulating current principle.

Design

The fully equipped voltage regulator includes four modules: a connection module, an I/O module, an automatic voltage regulating module and a manual voltage regulating module. The regulator modules are multi-functional microprocessor-based plug-in units. The voltage regulator is available in two versions: with or without the manual voltage regulating module. The regulator modules are provided with local man-machine communication interfaces.

Automatic voltage regulator module SPCU 1D50

The automatic voltage regulator module is used for automatic control of the tap changers of power transformers. The module can control parallel transformers in three different ways, i.e. using the master/slave, the negative reactance and the minimizing circulating current principle.

When the master/slave principle is used the number of parallel power transformers is unlimited. One regulator acts as the master and calculates the voltage drop on the basis of its own measurements, assuming that the power transformers are equally loaded. In this application a direct wiring is required between the voltage regulators.

When the negative reactance principle is used the module compares the actual phase shift with the set load phase shift and by measuring the current the compensating value that affects the regulator control voltage, can be calculated. The negative reactance principle can be used for controlling power transformers with different ratings and step voltage values. Since, in this principle, no connection is required between the regulators, even transformers located in different substations can be operated in parallel.

When the minimizing current principle is used the number of parallel power transformers maximum is three. Each voltage regulator module transmits its own current and phase shift values to the other modules operating in parallel. The modules calculate the total value of the busbar current and the phase shift and compare this value with their own values.

Manual voltage regulating module SPCU 1D56

When the voltage regulator is set for manual operation the tap changer of the power transformer can be controlled via the push-buttons of the manual voltage regulating module. If a raise or lower command cannot be executed because of an overcurrent situation or external blocking, the operator will be notified by means of the LED indicators marked I> or BLOCK. The display of the module shows setting values, tap-changer positions and measured values.

Data communication

The relay is provided with a serial interface on the rear panel. By means of a bus connection module type SPA-ZC 17 or SPA-ZC 21 the relay can be connected to the fibre-optic SPA bus. The bus connection module type SPA-ZC 21 is powered from the host relay, whereas the bus connection module SPA-ZC 17 is provided with a built-in power unit, which can be fed from an external secured power source. The relay communicates with higher-level data acquisition and control systems over the SPA bus.

When several voltage regulators are to be operated in parallel, bus connection modules type SPA-ZC 100 are used.

Self-supervision

The regulator incorporates a sophisticated self-supervision system with auto-diagnosis, which increases the availability of the equipment and the reliability of the system. The self-supervision system continuously monitors the hardware and the software of the device. The system also supervises the operation of the auxiliary supply module and the voltages generated by the module.

When a permanent internal relay fault is detected, the IRF indicator on the relay front panel is lit. At the same time the output relay of the self-supervision system operates and a fault message is transmitted to the higher-level system over the serial bus. Further, in most fault situations, a fault code is shown in the display of the protection relay module. The fault code indicates the type of the fault that has been detected.

Auxiliary supply voltage

The auxiliary supply of the relay is obtained from an internal plug-in type power supply module. Two auxiliary power module versions are available: type SPGU 240A1 for the supply voltage range 80…265 V ac/dc and type SPGU 48B2 for the supply voltage range 18…80 V dc. The power supply module forms the internal voltages required by the protection relay and the I/O module.

Technical data

Table 1: Energizing inputs, voltage inputs

Rated voltage U_n, selectable	100 V (110 V, 120 V)
Terminal numbers	X0/13-14
Continuous voltage withstand	$2 \times U_n$
Rated burden of voltage input at U_n	<0.5 VA
Rated frequency f_n, according to order	50 Hz or 60 Hz

Table 2: Energizing inputs, current measuring inputs

Rated current I_n		1 A	5 A
Terminal numbers		X0/1-3, 4-6, 7-9	X0/1-2, 4-5, 7-8
Thermal current withstand	continuously	4 A	20 A
	for 10 s	25 A	100 A
	for 1 s	100 A	500 A
Dynamic withstand	half-wave value	250 A	1250 A
Input impedance		<100 mΩ	<20 mΩ

Table 3: Output contact ratings

Type of contact		Tap-changer control	Signalling
Terminal numbers		X2/1-2, 3-4	X2/5-6, 7-8, 9-10-11, 14-15-16
Nominal voltage		250 V ac/dc	
Thermal withstand capability	Carry continuously	5 A	5 A
	Make and carry for 0.5 s	30 A	10 A
	Make and carry for 3 s	15 A	8 A
Breaking capacity for dc, when the control circuit time constant L/R ≤ 40 ms, at the control voltage levels	220 V dc	1 A	0.15 A
	110 V dc	3 A	0.25 A
	48 V dc	5 A	1 A

Table 4: External control inputs

Terminal numbers	X1/1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14
External control voltage	18…250 V dc or 80…250 V ac
Typical control current of input circuit	2…20 mA

Table 5: External mA input

Terminal numbers	X1/15-16
External control current	0…20 mA
Input resistance	300 Ω

Table 6: Auxiliary supply modules

Power module SPGU 240A1	rated voltages U_n	110/120/230/240 V ac 110/125/220 V dc
	operative voltage range	80…265 V ac/dc
Power module SPGU 48B2	rated voltages U_n	24/48/60 V dc
	operative voltage range	18…80 V dc
Power consumption, quiescent/operation conditions		~10 W/~15W

Table 7: Automatic voltage regulating module SPCU 1D50

Operate time setting range	0.0…300 s
Operate time accuracy at definite time characteristic	±1% of set value or ±250 ms
Operate time accuracy at inverse time characteristic	±250 ms and the inaccuracy appearing when the measured voltage varies ±0.3%
Minimum operate time at inverse time characteristic	1 s

Table 8: Manual voltage regulating module SPCN 1D56

Accuracy, mA input signal	±1% of FSR
Output pulse duration, selectable	0.50…10 s in 0.1 s steps

Table 9: Data communication

Transmission mode		Fibre-optic serial bus
Data code		ASCII
Data transfer rate, selectable		4800 or 9600 Bd
Optical bus connection module	for plastic core cables	SPA-ZC 21BB
	for glass fibre cables	SPA-ZC 21MM
Optical bus connection module powered from the internal power source	for plastic core cables	SPA-ZC 17BB
	for glass fibre cables	SPA-ZC 17MM
Optical bus connection module for parallel operation	for plastic core cables	SPA-ZC 100BB
	for glass fibre cables	SPA-ZC 100MM

Table 10: Tests and standards

Test voltages	Insulation resistance voltage (IEC 60255-5)	>100 MΩ, 500 V dc
	Impulse test voltage (IEC 60255-5)	5 kV, 1.2/50 μs, 0.5 J
	Dielectric test voltage (IEC 60255-5)	2 kV, 50 Hz, 1 min
Interference tests	High-frequency (1 MHz) disturbance test (IEC 60255-22-1), common mode	2.5 kV
	High-frequency (1 MHz) disturbance test (IEC 60255-22-1), differential mode	1.0 kV
	Fast transients (IEC 60255-22-4, class III and IEC 61000-4-4, level 4), power supply inputs	4 kV, 5/50 ns
	Fast transients (IEC 60255-22-4, class III and IEC 61000-4-4, level 4), other inputs	2 kV, 5/50 ns
	Electrostatic discharge (IEC 60255-22-2 and IEC 61000-4-2, class III), air discharge	8 kV
	Electrostatic discharge (IEC 60255-22-2 and IEC 61000-4-2, class III), contact discharge	6 kV
Environmental conditions	Service temperature range	-10…+55°C
	Transport and storage temperature range (IEC 60068-2-8)	-40…+70°C
	Temperature influence – voltage measurement	<0.025%/°C
	Temperature influence – tap-changer position measurement	<0.025%/°C
	Temperature influence – current measurements	<0.1%/°C
	Damp heat test (IEC 60068-2-30)	93…95%, +55°C, 6 cycles
	Degree of protection by enclosure of flush mounting regulator case according to IEC 60529	IP 54
	Weight of fully equipped regulator	~5.5 kg

Block diagram

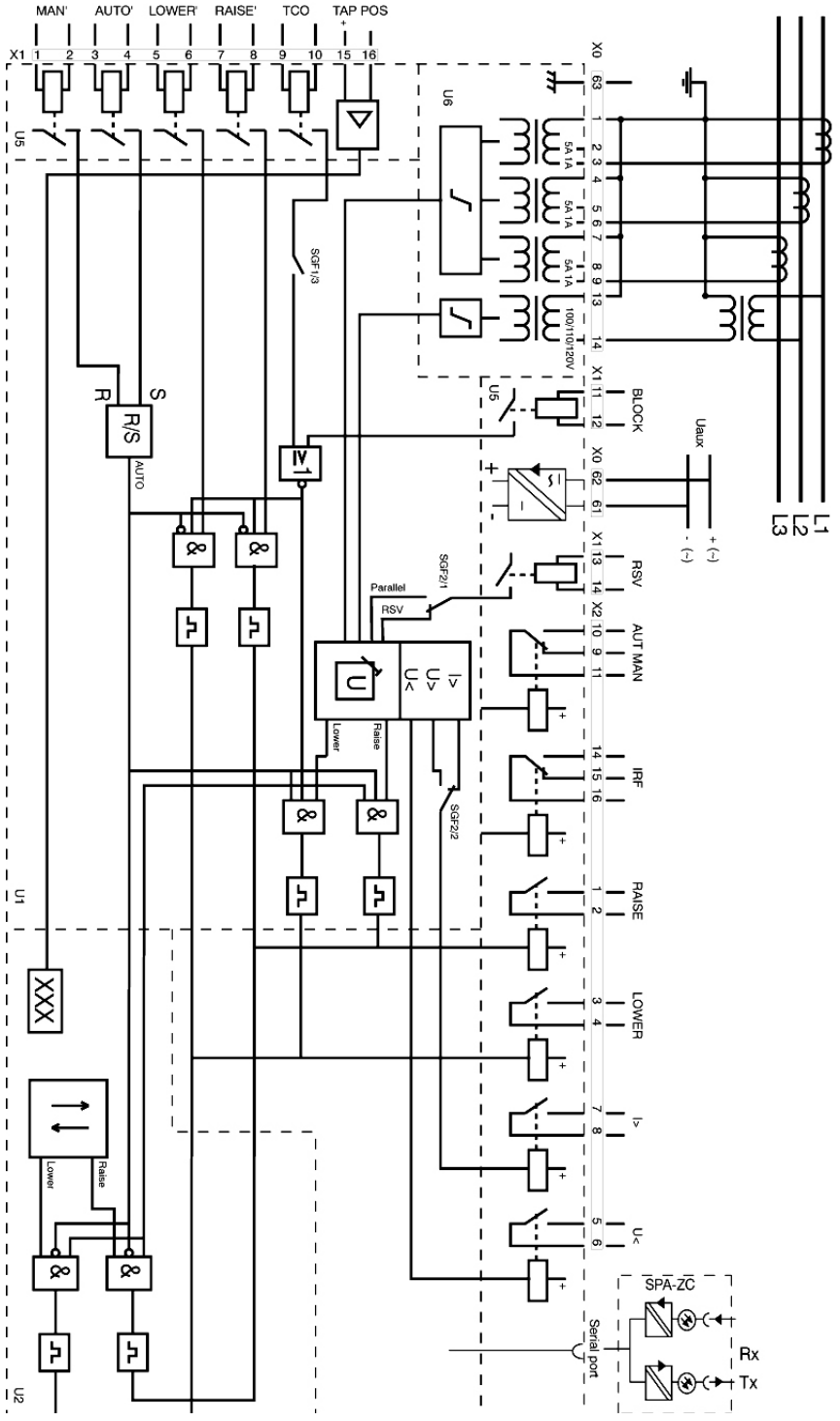

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Fig. 1 Block diagram and sample connection diagram

Mounting and dimensions

Flush mounting

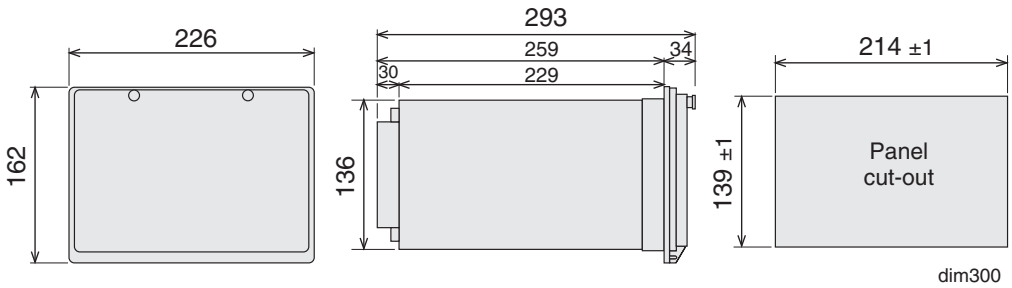
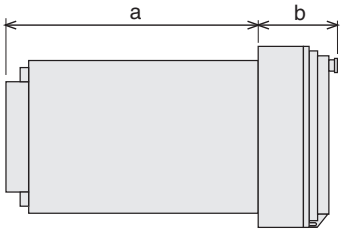


Fig. 2 Flush-mounting relay case (dimensions in mm)

Semi-flush mounting



Raising frame	a	b
SPA-ZX 301	219	74
SPA-ZX 302	179	114
SPA-ZX 303	139	154

SFM300_1

Fig. 3 Semi-flush mounting relay case (dimensions in mm)

Mounting in 19 inch cabinets and frames

An ancillary mounting plate, height 4U (~177 mm), is recommended to be used when the protection relays are to be mounted in 19 inch frames or cabinets. The ancillary mounting plate type SPA-ZX 304 accommodates two size 300 relays and type SPA-ZX 305 one size 300 relay.

Projecting mounting

When projecting mounting is preferred, a relay case type SPA-ZX 317 is used. The relay case for projecting mounting is provided with front connectors.

SPA-ZX304
SPA-ZX305
SPA-ZX201

SPA-ZX306
SPA-ZX307
SPA-ZX317
SPA-ZX318

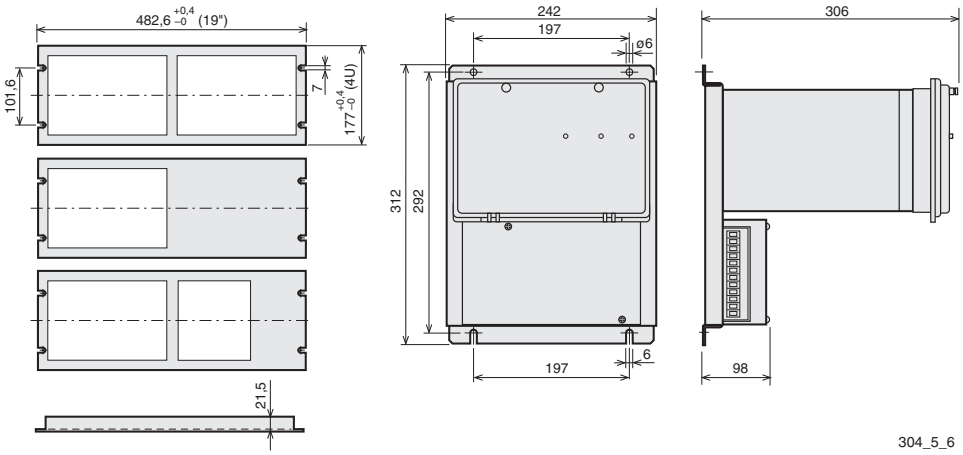


Fig. 4 Mounting cabinets and frames as well as projecting mounting (dimensions in mm)

Ordering

When ordering, please specify:

Ordering information	Ordering example
1. Type designation and quantity	SPAU 341 C1, 5 pieces
2. Order number	RS 488 003-AA
3. Rated frequency	I_n=5 A, U_n=110 V, f_n=50 Hz
4. Auxiliary voltage	U_{aux}=110 V dc
5. Accessories	-
6. Special requirements	-

Order numbers

Voltage regulator SPAU 341 C_ without test adapter	
SPAU 341 C1, incl. modules SPCU 1D50 and SPCN 1D56	RS 488 003-AA, CA, DA, FA
SPAU 341 C3, incl. module SPCU 1D50	RS 488 005-AA, CA, DA, FA
The last two letters of the order number indicate the rated frequency f_n and the auxiliary voltage U_{aux} of the relay as follows:	AA equals f_n = 50 Hz and U_{aux} = 80…265 V ac/d
	CA equals f_n = 50 Hz and U_{aux} = 18…80 V dc
	DA equals f_n = 60 Hz and U_{aux} = 80…265 V ac/dc
	FA equals f_n = 60 Hz and U_{aux} = 18…80 V dc

Voltage regulators SPAU 341 C_ including test adapter RTXP18	
SPAU 341 C1, incl. modules SPCU 1D50 and SPCN 1D56	RS 488 203-AA, CA, DA, FA
SPAU 341 C3, incl. module SPCU 1D50	RS 488 205-AA, CA, DA, FA
The last two letters of the order number indicate the rated frequency f_n and the auxiliary voltage U_{aux} of the relay as follows:	AA equals f_n = 50 Hz and U_{aux} = 80…265 V ac/d
	CA equals f_n = 50 Hz and U_{aux} = 18…80 V dc
	DA equals f_n = 60 Hz and U_{aux} = 80…265 V ac/dc
	FA equals f_n = 60 Hz and U_{aux} = 18…80 V dc

References

Additional information

User’s manual and technical description “Voltage regulator SPAU 341 C”	1MRS 750110-MUM EN

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