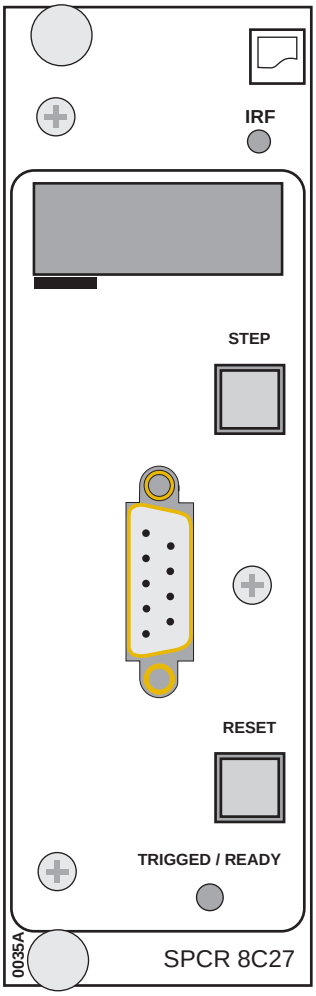
SPCR 8C27
Disturbance recorder

User´s manual and Technical description



1MRS 750511-MUM EN

Issued 96-12-02
Version A (replaces 34 SPCR 2 EN1)
Checked L-W U
Approved TK

SPCR 8C27
Disturbance recorder

Contents

Features

Recording capability; three phase-to-phase voltages, three phase currents, one residual voltage, one neutral current and eight on/off signals

Total recording time 12 seconds, of which 0… 100% may proceed the triggering. Several recordings available within the 12 s total recording time

Adjustable undervoltage, overvoltage, overcurrent, residual overvoltage and neutral overcurrent triggering levels

Recordings can be started manually, by analogue or binary channels or with a command given via the serial bus

Serial communication capability. The recordings can be transmitted via the RS 232 C bus on the front panel of the module or via the SPA bus of the host relay

Records the minimum and maximum values of the phase-to-phase voltages, the phase currents, the residual voltage and the neutral current

Recordings, maximum values and minimum values are provided with date and time stamps

Timer synchronization to substation data communication equipment and system clock

Optional menu-driven easy-to-use PC program for performing settings, for downloading recordings to a PC and for plotting curves on a screen or writing to a matrix printer

---

Application

The disturbance recorder SPCR 8C27 is intended to be used for verifying the proper operation of protection relays and circuit breakers and for analysing protection problems in electrical power systems.

The disturbance recorder captures the curve forms of the monitored quantities of the supervised object, both under normal service conditions and when the protection relay operates. Thus the relay settings can be based on the recorded information.

Monitoring of the maximum and minimum values also makes the disturbance recorder suitable for analyzing network operation quantities, for instance, under certain unnormal loading or voltage conditions. The disturbance recorder thus offers a way to collect basic information about a certain network object. This information facilitates network planning and operation.

Description of operation

The disturbance recorder SPCR 8C27 is designed to be inserted into any unoccupied relay module location of a SPACOM relay case. Thus the recorder module measures the same signals as the protection relay modules. The number and type of signals to be recorded depend on the protection relay into which the disturbance recorder module has been inserted.

Triggering

The recorder module may be triggered by phase overcurrent, undervoltage, overvoltage, residual overvoltage or neutral overcurrent. Further it can be triggered by on/off input signals, manual control, automatically and periodically or by a command via the serial bus.

The length of the recording can be selected separately for each of the triggering conditions. When the recorder module triggers, a recording is made and an event message is generated according to the settings made. The recording of the parameters and the generation of an event can be enabled or disabled separately for each triggering condition.

When at least two successive measurements exceed the preset start value, the triggering condition is fulfilled. The undervoltage condition is fulfilled if the value of the two last half cycles falls below the preset undervoltage start value and the undervoltage is not due to a high-speed auto-reclosure going on in the network or any other circuit-breaker operation. If, during two half cycles, the measured voltage falls below 20% of the rated voltage of the relay, the situation is considered to be a circuit-breaker operation and the undervoltage condition is not fulfilled.

The on/off triggering signals are obtained from the internal bus of the host relay. The triggering signals are formed by start and operate signals of the relay modules or by certain external control signals. A change of the status of a monitored signal triggers the recorder according to the set configuration.

The recorder may also be triggered periodically which means that the recorder automatically makes a recording at certain time intervals.

The recorder may also be triggered manually with the push-buttons on the front panel.

The parameters defining the triggering conditions are set via the SPA port of the host relay or via the RS 232 C port on the front panel of the recorder module.

Recording

When the triggering conditions are fulfilled, a recording is made the length of which is max. 12 seconds when all channels are used. 0…100% of the recording may precede the triggering. The recording memory is divided into 0.5 seconds blocks. When the shortest possible recording time, i.e. 0.5 seconds, is used, there is enough memory for 24 consecutive recordings.

The recording memory is used as a buffer storage. When the available recording capacity has been exceeded no further recordings are made, unless the recorder module has been otherwise configured.

The clock and the recording memory of the disturbance recorder module have been provided with a ten years battery back-up to maintain information over an auxiliary voltage outage.

The sampling rate for each recording channel is 500 Hz.

Recording of maximum and minimum values

The module records the maximum and minimum values of the measured phase-to-phase voltages and the associated time stamps. In the same way the module records the max. values of the phase currents and the associated time stamps. Further, the module records the maximum value of the residual voltage and the maximum value of the neutral current, and their associated time stamps. For status signals the time of the last status change is recorded. For analog signals the recorded value and time change once a new maximum or minimum value is detected.

The recording of the maximum value is based on instantaneous values and therefore possible spikes and the dc component of the measured signal appear in the recording. The recorded maximum and minimum values can be read via the RS 232 C port or the SPA bus.

Event register

The event register is a log-book containing a list of the events generated. The events, which are to be recorded are selected separately in an event log mask. Any start-up of the recorder module and any event register overflow situation are also recorded as events. The register also holds date and time stamps of the recorded events.

Unloading of recordings

The recordings can be unloaded via the serial buses. The recordings can be erased, even before they have been unloaded, with a command via the serial buses or manually by means of the push-buttons on the front panel.

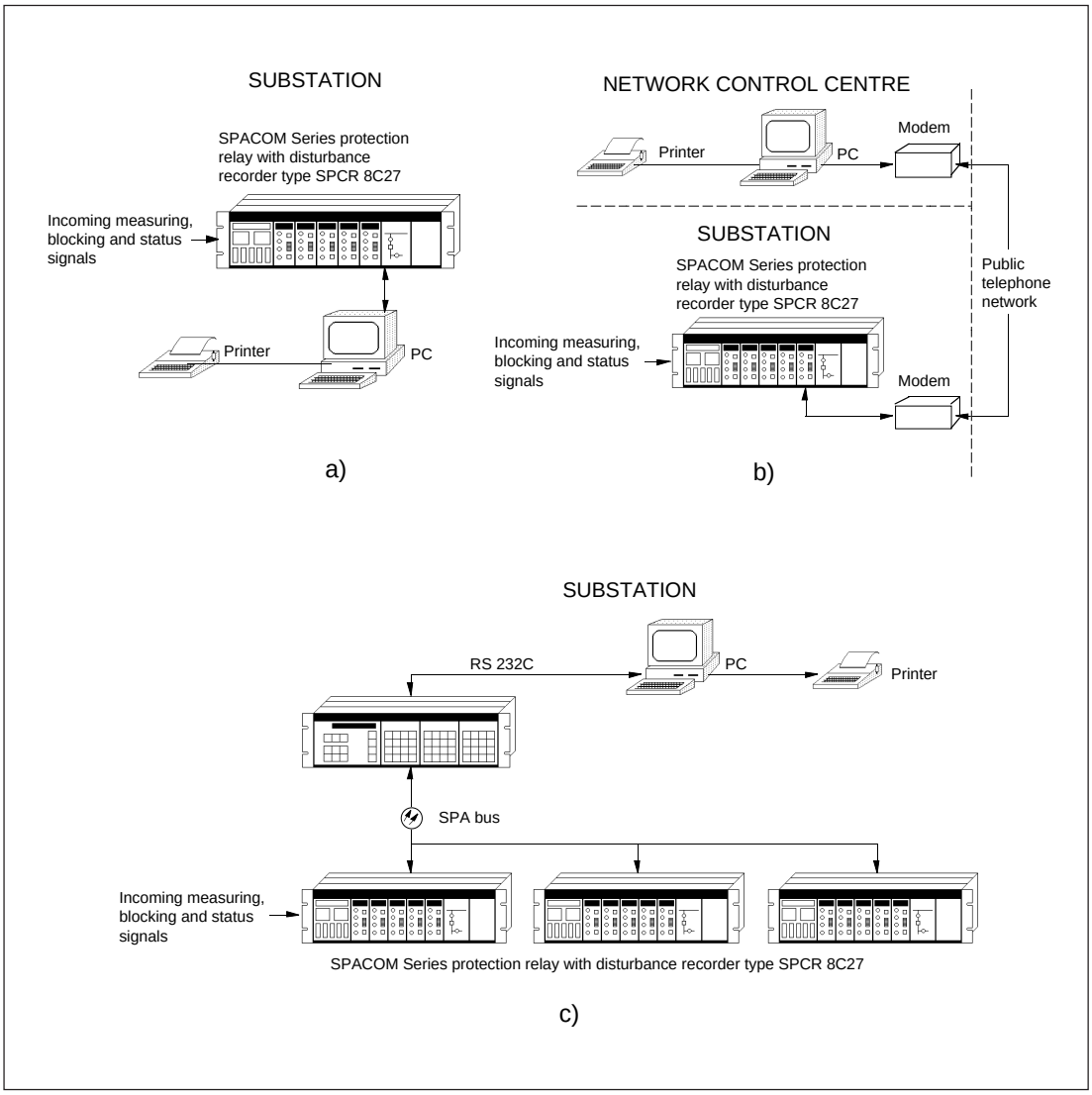


Fig. 1. Connection of the disturbance recorder SPCR 8C27 to its environment.
a) Direct connection to a PC via the RS 232 C port on the front panel.
b) Connection to a PC in the control room via the RS 232 C port on the front panel and a modem.
c) Connection to a local substation PC via the SPA bus.

Serial port

The RS 232 C port on the front panel of the module and the SPA-bus is used for unloading recordings, for setting module parameters and for an extended use of the module.

The serial port on the front panel is intended to be used for the connection of a data communication modem, or if the distance is short, for the connection of an IBM compatible PC.

When the module recordings are unloaded into a PC the data can be processed later. A modem connection allows the recordings to be unloaded via a telephone line to the control room or any other place.

An available optional menu-driven PC program facilitates setting of the module and downloading and plotting of the records. The program features versatile possibilities for plotting the recorded signals. An ordinary matrix writer can be used as a hard copy output device.

The PC support program incorporates features facilitating the use of the program and making it easy to change and update recorder parameters. The recorder parameters and the plot parameters can be recorded in a file, a feature that facilitates work that may occur repeatedly.

Operating modes

Start-up

When the auxiliary supply has been connected the recorder module can be started in two ways, that is by performing a warm start-up or a cold start-up.

Normally the event recorder performs a warm start-up. But if the module memory contents have been lost because of a supply failure, the module perfoms a cold start-up, which means that the the memory will be initialized with default values. At a cold start-up the module loses any earlier set values and any recorded information, if any.

At a cold start-up the leftmost red display element initially indicates "-" and the rightmost green display element shows a number within the range 01…15 as long as the module is starting up.

Following both a warm start-up and a cold start-up the recorder performs a display test by switching on the digits from zero to nine in each element of the display. The numbers are displayed five times.

The module always performs a cold start-up when the STEP and RESET push-buttons are pressed during start-up.

After the start-up the recorder enters the measuring mode and the display turns dark. In this mode the measuring signals and the communication parameters of the module can be scanned and set by means of the STEP and RESET push-buttons, in the same way as the SPC type relay modules are set.

Setting mode

In the setting mode e.g. the triggering conditions are specified for the module. The settings are made via the SPA bus or via the RS 232 C port. The setting mode is entered with the command V17:1 via the serial bus. A flashing indication "- - - -" on the display indicates that the recorder module is in the setting mode. Exit from the setting mode is obtained with command V17:0.

The module performs no measurements as long as it is in the setting mode. Therefore, it is important to leave the setting mode when the setting procedure has been finished. The display cannot be scanned in the setting mode.

When the settings have been made, the PC connected to the RS 232 C port can be moved to another place. If no modem or PC is connected to the RS 232 C port on the front panel, the recorder responds to commands coming via the SPA bus.

If a device providing a DSR handshaking signal has been connected to the RS port of the recorder module, the recorder automatically changes for communication via RS-bus. The recorder module cannot receive messages from both buses at the same time.

An optional menu-driven PC program considerably facilitates the setting procedure. The settings can also be saved on a floppy disk for later use.

The push-buttons on the front panel of the module can only be used for setting the data communication parameters. In the setting mode the recorder module performs no measurements.

Measuring mode

The recorder module is normally in the measuring mode. It enters the measuring mode after start-up. The module also automatically enters the measuring mode, when an output device connected to the RS 232 C port is disconnected.

In the measuring mode the recorder measures the input signals, monitors the triggering conditions and records data. Data, that is the curve forms of the supervised signals are constantly recorded into the history memory of the recorder. As the module triggers, a specified part of the history recording preceding the triggering is moved into the recording memory and the post-triggering recording starts.

When the measuring mode is left the history memory is erased. After the module has been switched over into the measuring mode a new history is collected. Should the module triggers until the history has been completely collected, the history part of the recording would be inaccurate.

Normally the operation indicator of the recorder is dark. When the module makes a recording, the operation indicator turns green. When the recording has been finished, the operation indicator turns red. Then the module is still in the measuring mode. If there is an old recording in the memory and the module is triggered again, the indicator is lit with both red and green colour.

The contents of the recording memory, the recorded maximum and minimum values, the date and time information of the recordings remain in the memory. However, all information is lost at a cold start-up.

Unload mode

In the unload mode the curve forms of the signals stored in the recording memory are transmitted from the recorder via the SPA bus or the RS 232 C port. This mode is indicated by a flashing "U" in the rightmost element of the display.

The recordings are always unloaded starting from the oldest one. Access to the younger recordings is admitted only after removing the older ones.

The recordings are unloaded and erased in the setting mode using the commands V15, "unloading of the oldest recording" or V16, "erasing of the oldest recording", which are transmitted over the RS bus. In this state the recorder performs no measurement or recording functions.

When data is unloaded via the RS 232 C port the information is transmitted in the form of messages of max. 80 characters each, according to the SPA protocol. The entire recording is transmitted after command V15, i.e. "unloading of the oldest recording". Proceeding the measured data a few lines of information about the recording is transmitted, such as an output information heading, a code of the event causing triggering, input headings, rated values etc. The sample values are related to the peak value of the sinusoidal signal, that is the peak value of the nominal sinusoidal signal equals 1. RMS values can be calculated from individual sample values by multiplying the values by the factor $\sqrt{2}$.

Each line of measured data (= one measured value per signal) forms a separate message. The unloading of a recording ends with an empty message. The unloading can be interrupted by transmitting any message to the recorder.

At a 1200 baud data transfer rate via the RS 232 C port, unloading of a one second recording takes about 5 minutes. The same data transfer takes about 40 s at a data transfer rate of 9600 baud.

The unloading via the SPA bus is made in the so called SPA unloading mode (V20). Then the records are unloaded piece by piece by reading one line of measured data at a time. Thus the SPA bus is occupied for unloading recordings only for short periods at a time.

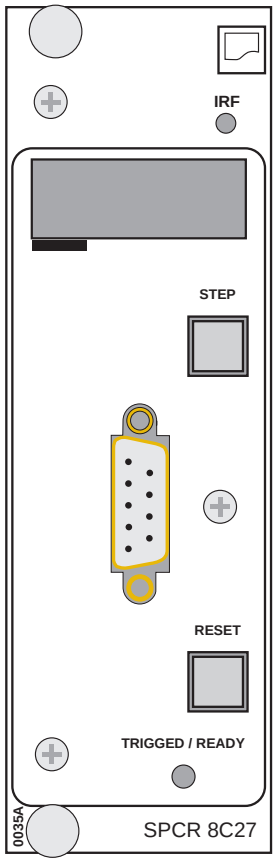
In the SPA-unloading mode the recorder measures the input signals but performs no recordings.

The same command as with the RS 232 C port is used for removing the oldest recording.

The optional PC program makes it possible to read the recordings, display them grafically on a monitor or to produce hard copy outputs. With the PC program signals can be expanded and shifted in time and value to show all information in detail. It is also possible to save the records on a floppy disk.

Front panel

From the front panel it is possible to check the measured values and to do certain settings required for the data communication. Information associated with the operation states of the module is also displayed on the front panel.



Simplified device symbol

Self-supervision alarm indicator

Digital display for measured values

Display STEP push-button

9-pin female D-type connector of the RS 232 C port

RESET push-button

Operation indicator

Module type designation

Fig. 2. Front panel of the disturbance recorder SPCR 8C27.

Indicators

The state of the recorder is shown by the LED indicator in the right-hand bottom corner of the front panel. The operation indicator shows that the module has triggered (Trig) and is making or has already made a recording. Under normal service conditions the indicator is dark indicating that the recorder is prepared for recording (Ready) and that there are no recordings in the memory.

The red light will remain on until all the recordings have been read and/or erased. The red light does not prevent the recording function.

The self-supervision alarm indicator IRF in the upper right-hand corner of the front panel is lit when the self-supervision system has detected a permanent hardware or software fault in the recorder module. In most fault situations an auto-diagnostic fault code appears on the display. The fault code consists of a red number "1" and a green code number.

When the self-supervision system detects an internal fault an automatic self-recovery attempt is made. If the self-recovery attempt proves unsuccessful a renewed start-up or a cold start-up should be performed.

The following fault codes may appear on the display on detection of an internal fault:

Fault code	Explanation
1	Random Access Memory (RAM) fault
2	Program memory (EPROM) fault
3	Stack overflow
4	Parameter memory (EEPROM) fault

Menu chart

The measured voltages and currents, the state signals and communication parameters can be read from the display. The STEP push-button is used to select the value to be displayed.

The left-most red digit indicates the data type (i.e. display address). The actual value is shown by the three right-hand green digits.

The main menu and the submenus are presented in Fig. 3. The display returns to the basic state from position A. From a dark display it is possible to step in the forward direction only (in Fig. 3 downwards). Should the panel push-buttons not be used for 5 minutes, the display returns to normal, i.e. dark state.

When the display is dark two special functions can be performed. Pressing the RESET push-button for 10 seconds erases all the recordings and switches off the indicator, when it is lit with red colour. Pressing the STEP and RESET push-buttons simultaneously causes a manual triggering, if the manual triggering has been enabled.

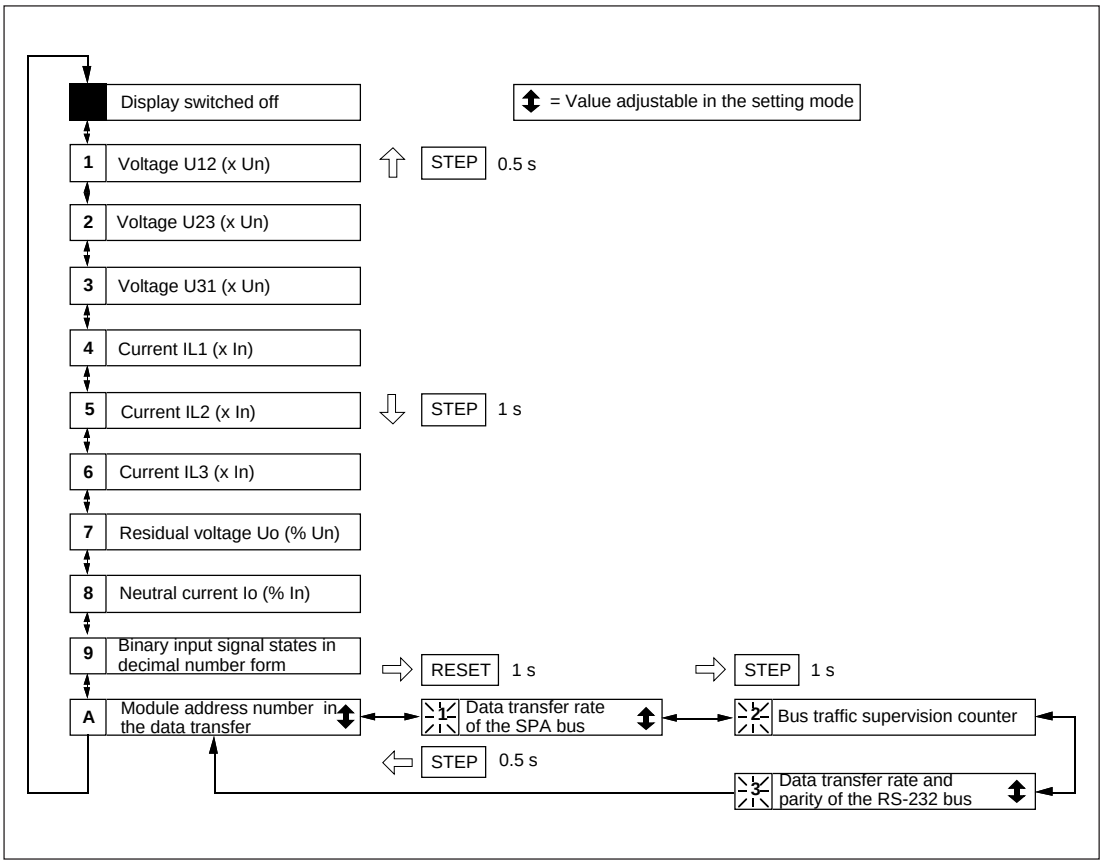


Fig. 3. Main menu and submenus of the display. The measures required for entering the submenus are described in the data sheet "General characteristics of C type relay modules".

Displayed data

Measured data

There are eight analog input signals: for three phase-to-phase voltages, three main currents, one residual voltage and one neutral current. The data are displayed in the display address locations 1…8, see Fig. 3.

When the recorder module is plugged into a three-phase differential relay for power transformers all the six phase currents, that is three on the high-voltage side and three on the low-voltage side of the transformer can be measured. This can be done after the phase-to-phase voltage inputs have been changed from voltage inputs to current inputs by means of jumpers on the PC board of the recorder module. (See W 3, 4, 5 in Fig. 5, 6 and 7).

The measured data are not updated at the same rate as the measurements would allow. An average value function forms the measured value to be displayed. This method yields a more stable display but, consequently, the display does not fully respond to rapid changes.

The measured data are presented as relative values of the set rated values interpreted from the maximum value that has occurred during a half cycle. For sinusoidal input signals the display ratio factor also corresponds to the relative RMS value of the input signal.

The phase-to-phase voltages and the phase currents are presented as multiples of the rated voltage (x U_n) or the rated current (x I_n). The measured values of the residual voltage channel and the neutral current channel are presented as percentages of the rated voltage U_n and the rated current I_n.

Status signals

The eight status signals are coded to decimal numbers within the range 0…255 and presented on the display in the address location 9. The number is formed by adding the values, representing the different states, in the same way as the checksum of switchgroup SG1 of the relay modules is calculated. The same coding is used for the status data read over the serial communication.

By splitting the displayed number into the elements which form the number, the relevant status data are retrieved. The coding method is based on the principle of presenting positive integers in binary form. This method makes it possible to use a calculator capable of decimal-binary conversions for retrieving the states.

The numbers representing the different status data are shown in the table below.

Status data	Number representing the status data
Status data 1	1
Status data 2	2
Status data 3	4
Status data 4	8
Status data 5	16
Status data 6	32
Status data 7	64
Status data 8	128

Data communication parameters

The modules' address code, which is the same on the SPA bus and the RS 232 bus, is shown in address A. The address code may have a value within the range 001…899. The default code after a cold start-up is 001. The address code of the recorder module is set in the setting mode, one number at a time, starting from the rightmost digit.

The data transfer rate for the SPA bus, the bus traffic monitor value and the data transfer rate and the parity of the RS 232 C bus are to be found in the submenues of address location A.

The data transfer rate of the SPA bus, which is connected to the D-type connector on the rear plate, is expressed in thousand bits/second (kBd). Alternative values are 0.3 kBd, 1.2 kBd, 2.4 kBd, 4.8 kBd and 9.6 kBd. Even parity is always used and shown as a number 2 in front of the data transfer rate value.

The bus traffic monitor shows whether the recorder module receives messages via the communication buses or not. The counter runs from 0 to 255, one step a second. Any message received resets the counter. If the counter value remains 0, it indicates that messages are arriving at a rate higher than once a second.

The parity of the RS 232 C bus is presented as a number in front of its data transfer rate value. The number may be 0 (parity none) or 2 (parity even). The number of data bits is 8. The recorder does not approve of odd parity.

After a cold start-up the RS 232 C bus has no parity and the data transfer rate is 1.2 kBd. The other available baud rates are the same as those of the SPA bus. The data transfer rate is set in the same way as for the SPA bus.

PC programs

Two PC programs for MS-DOS or PC-DOS based microcomputers have been developed for the use together with the disturbance recorder. The programs facilitate parametrization of the module and unloading of recordings either via the RS 232 C port on the front panel or via the SPA bus. The PC programs are not part of the recorder delivery but they are available on request as optional products. The SPCR EVAL type designation includes the English language versions of both programs and a 3 m cable which connects the recorder module to a PC.

The first program is a easy-to-use communication program for operating the recorder module. The program runs using SPA protocol commands recognised by the recorder module. The program also transmits and receives messages based on the SPA protocol.

The second menu-driven program facilitates parameter setting and downloading of recordings. In addition, this program allows the curve forms unloaded from the recorder module to be presented on the PC screen, written down on paper or recorded on a disk.

The current versions of the two programs require a microcomputer with the following features:

- microcomputer IBM/PC, IBM/XT, IBM/AT or compatible
- at least 384 kB conventional RAM
- at least 1 MB XMS or free hard disk space
- display drivers:
  - EGA, VGA or SVGA colour display
  - Hercules single-colour display
  - Toshiba T2100/T3100 plasma display
  - AT & T single-colour display (Olivetti single-colour display)
  - MikroMikko 3 single-colour display
  - Wyse GDA single-colour display
- operating system MS-DOS 2.11 or later version.

Should a printer be used, it has to be a 9-pin IBM compatible or a 24-pin Epson LQ-2500 compatible version. Most of the 24-pin printers on the market are compatible with the Epson LQ-2500 printer.

MS-DOS is a registered trade mark of Microsoft Corp. IBM is a registered trade mark of International Business Machines Corp. PC-DOS, IBM/PC, IBM/XT, IBM/AT are registered trade marks of International Business Machines Corp.

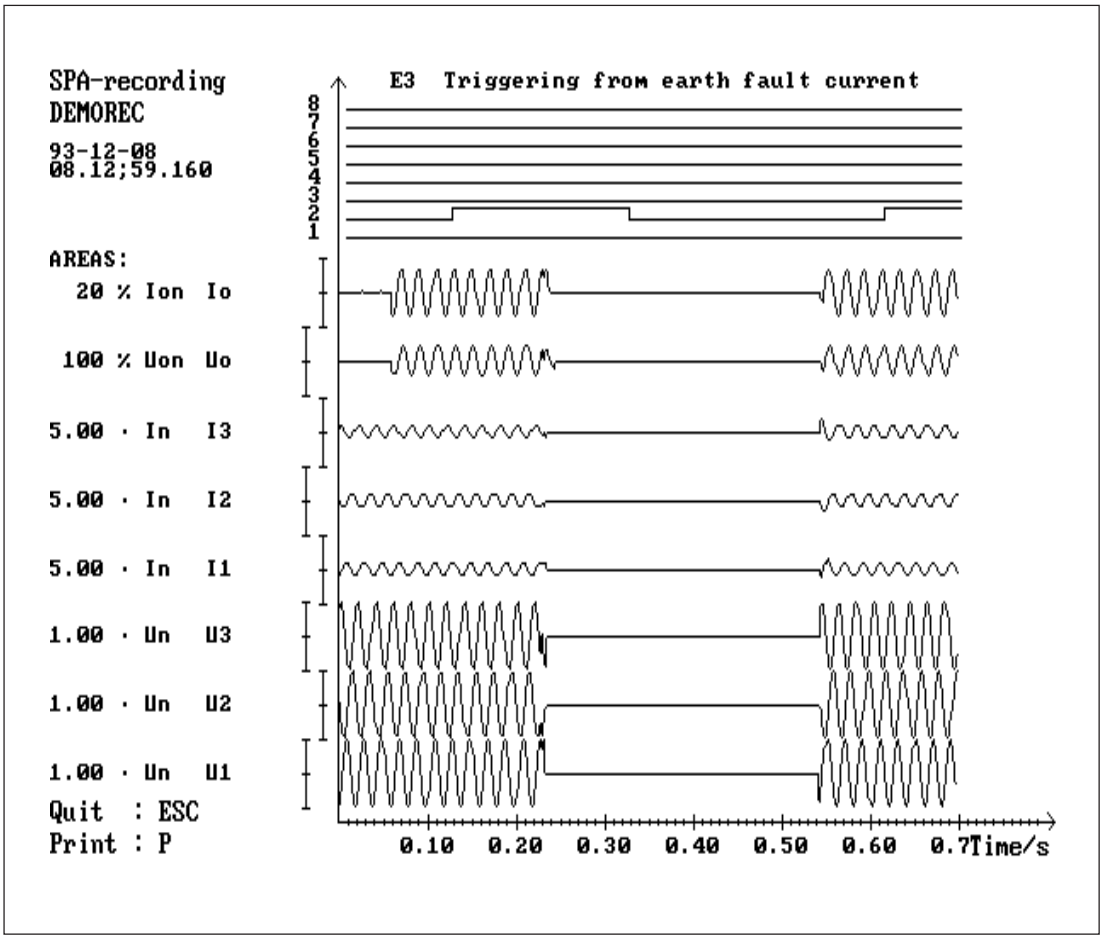


Fig. 4. Example of the curve display made by SPCR EVAL software.

Technical data

Number of input channels	8 analogue inputs 8 on/off inputs
Sampling frequency/channel	500 Hz (default)
A/D converter	11 bit
Time difference between sampling of adjacent input channels	250 µs (default)
Recording capacity	
- 1 MB SRAM	Max. 24 recordings Max. 224 blocks
- 4 MB SRAM (option)	Max. 26 recordings Max. 992 blocks (1 block = 1 recorded channel x 0.5 s)
Analogue channels	
Measuring ranges	
- Phase-to-phase voltages; analogue inputs 1…3	0.0…2.5 x U_n or 0.0…21 x U_n
- Phase currents; analogue inputs 4…6	0.0…2 x I_n or 0.0…20 x I_n
- Residual voltage; analogue input 7	0.0…102% U_n
- Neutral current, analogue input 8	0.0…20% I_n or 0.0…102% I_n
Measuring accuracy of individual samples (value >0.2 x range, f = 0…60 Hz)	±2%
Triggering limits:	
- Undervoltage condition; for analogue inputs 1…3	0.2…overvoltage condition x U_n
- Overvoltage condition; for analogue inputs 1…3	Undervoltage condition… …21 x U_n
- Overcurrent condition; for analogue inputs 4…6	0.0…20.4 x I_n
- Residual voltage condition; for analogue input 7	0.0…102% U_n
- Neutral current condition; for analogue input 8	0.0…102% I_n
- Status signal inputs	Triggering on rising or falling edge
Clock resolution	5 ms
Clock accuracy	<1 min/month
Optional PC program	SPCR EVAL (3 1/2" disk)
Ambient temperature	-10…+55°C
Storage temperature	-40…+70°C
EMC-Tests	
Fast transients IEC 255-22-4	2 kV, 5/50 ns
Electrostatic discharge IEC 255-22-2, class III	
- air discharge	8 kV
- contact discharge	6 kV

Connection of measuring signals

The pins of the PCB connector of the SPCR 8C27 module have been designated according to the table below. The signal names are the same as those used in the instruction manuals for the SPACOM relays.

Input	Terminal number	Name of signal in the SPACOM system
Analogue input 1	4a(8a)	Phase-to-phase voltage U_{12} (or IL1')
Analogue input 2	5a(8c)	Phase-to-phase voltage U_{23} (or IL2')
Analogue input 3	6a(9a)	Phase-to-phase voltage U_{31} (or IL3')
Analogue input 4	4c	Phase current I_{L1}
Analogue input 5	5c	Phase current I_{L2}
Analogue input 6	6c	Phase current I_{L3}
Analogue input 7	7a	Residual voltage U_0
Analogue input 8	7c	Neutral current I_0
Status signal inputs		
Status data 1	9c	Autoreclose initiation via AR2
Status data 2	10a	Autoreclose initiation via AR3
Status data 3	10c	Autoreclose initiation via AR1
Status data 4	11a	Autoreclose blocking and interruption via ARINH
Status data 5	11c *)	Circuit-breaker position via CBPOS
Status data 6	12a	
Status data 7	12c *)	Blocking of circuit-breaker closing via CBINH
Status data 8	13a	Selection of basic angle for E/F relays via BACTRL
Status data 5x	13c	
Status data 6x	14a *)	Blocking signal BS1
Status data 7x	14c	
Status data 8x	15a *)	Blocking signal BS2

5x…8x alternatives to status datas 5…8. Programming is made with resistors R49 (a, b, c, d) and R50 (a, b, c, d), see fig. 6 and 7. *) Factory programming.

Programming with W_ jumpers or PC poard

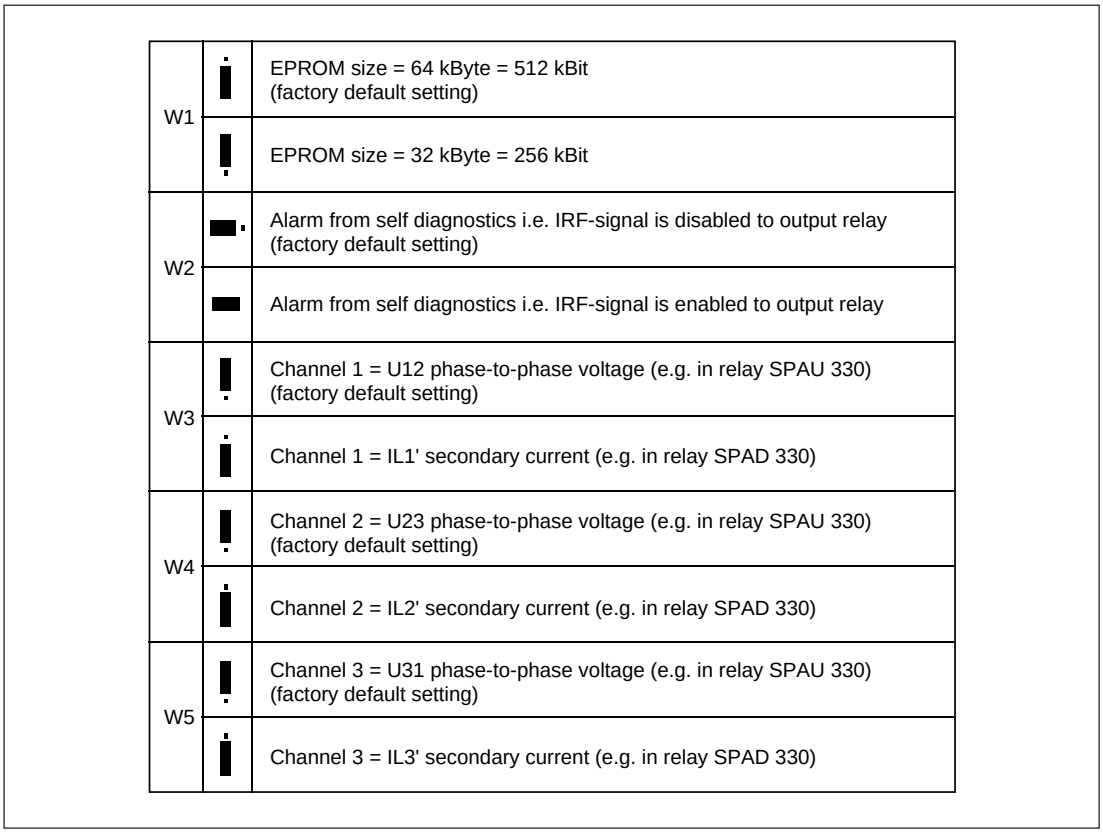


Fig. 5. Programming using the W_ jumpers.

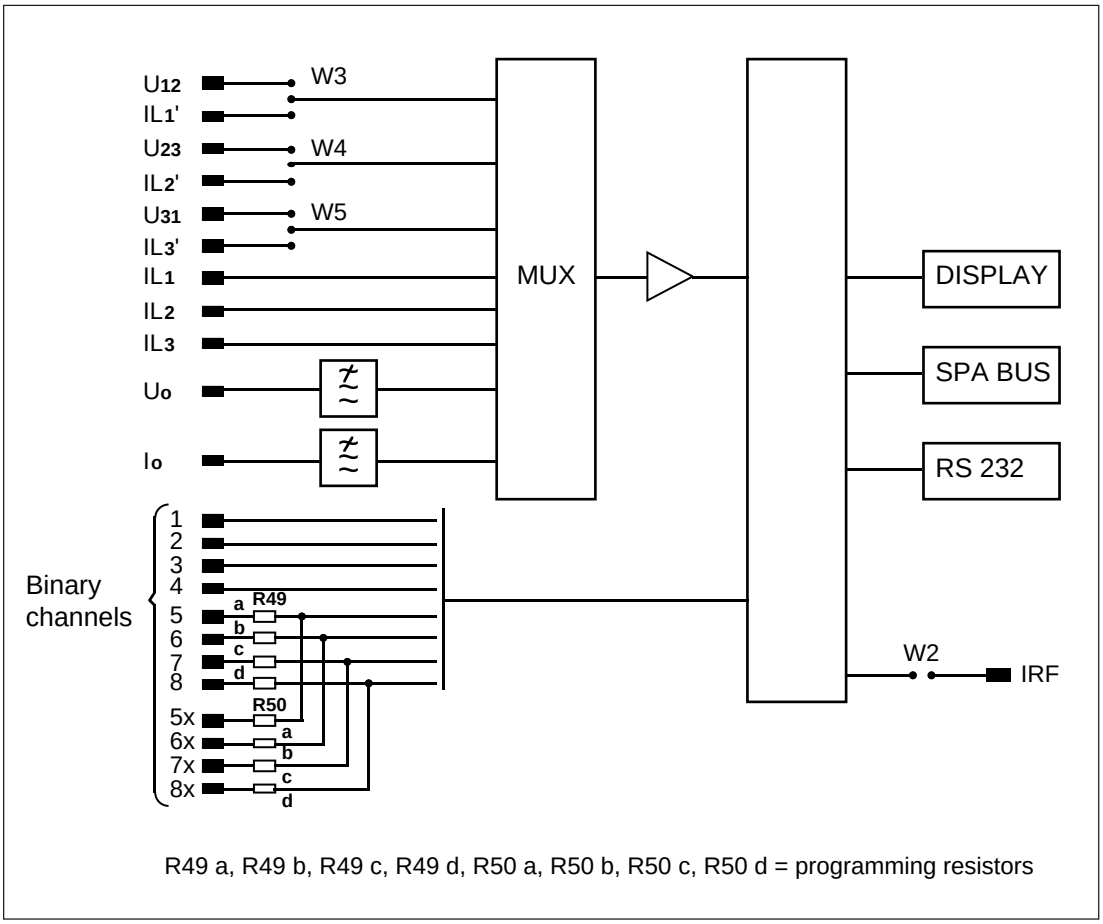


Fig. 6. Signal block diagram of the SPCR 8C27 recorder module.

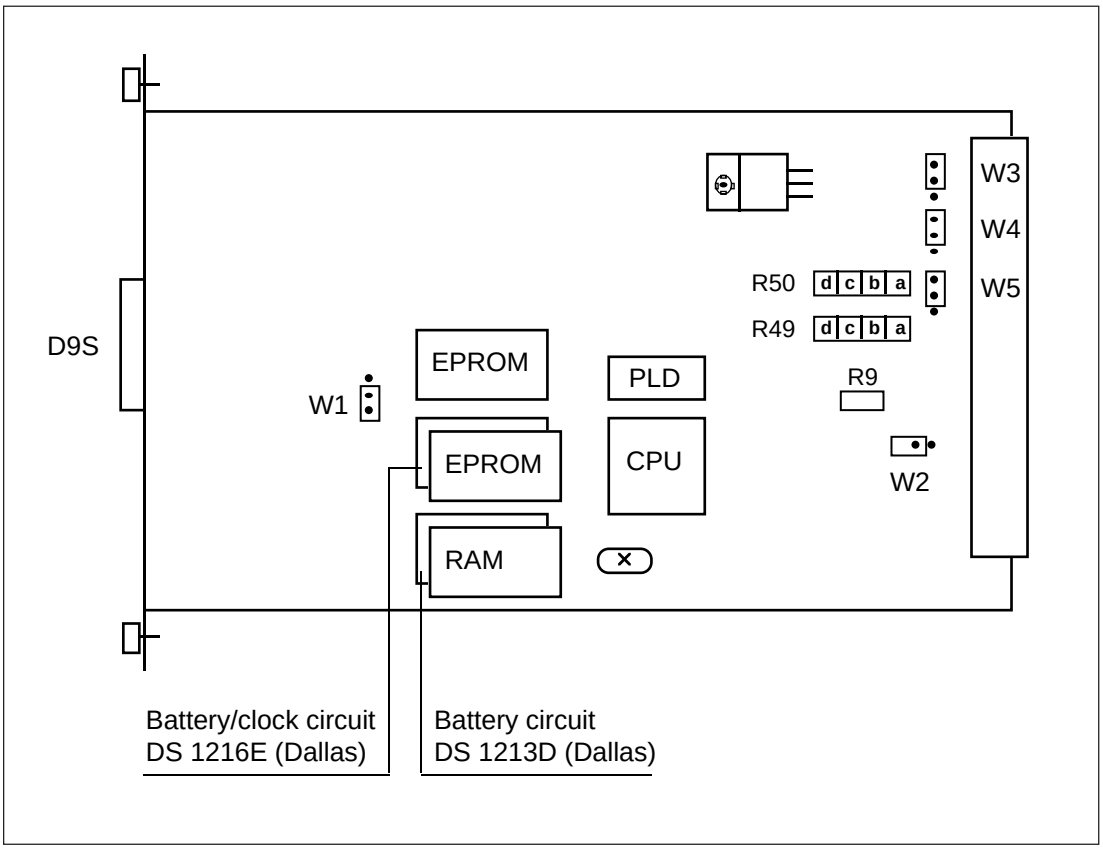


Fig. 7. PC board lay-out showing the location of jumpers and resistors.

Connection cables

Cables suited for connecting the disturbance recorder SPCR 8C27 to the output device, via the RS 232 C port of the front panel, are listed in the table below. The left column refers to the connection of the cable connector on the disturbance recorder side and the other columns to the connection of the output device or modem side connector. The pins not mentioned in the table are left unconnected.

SPCR 8C27	
9-pin connector	Signal and direction
1	DCD<---
2	RxD <---
3	TxD --->
4	DTR/+11 V--->
5	GND
6	DSR <---
7	RTS --->
8	CTS <---
9	No connection

IBM PC-AT or corresp.		IBM PC or correspond.		Modem	
9-pin connector	Signal and direction	25-pin connector	Signal and direction	25-pin connector	Signal and direction
-		-		-	
2	- - -> RxD	3	- - -> RxD	2	- - -> TxD
3	<- - - TxD	2	<- - - TxD	3	<- - - RxD
8	- - -> CTS	5	- - -> CTS	4	- - -> RTS
7	<- - - RTS	4	<- - - RTS	5	<- - - CTS
1, 4	<- - - DCD, DTR	8, 20	<- - - DCD, DTR	6	<- - - DSR
5	GND	7	GND	7	GND
6	<- - - DSR	6	<- - - DSR	8	<- - - DCD
6	- - -> DSR	6	- - -> DSR	20	- - -> DTR

A 9-pin male D-type connector is always used on the disturbance recorder side. When the disturbance recorder is connected to an IBM PC-AT or a compatible device, a 9-pin female D-type connector is normally used on the PC side. Correspondingly, a 25-pin femaleconnector is used for an IBM PC or a compatible device, and a 25-pin male connector for connecting the cable to a modem.

Examples of cables to be used between a modem and a PC are given in the table below. The left column refers to the connection of the cable in the cable on the modem side and the other columns to the connection of the cable on the output device side. The pins not mentioned are to be left unconnected.

Modem	
25-pin connector	Signal and direction
1	
2	TxD <- - -
3	RxD - - ->
4	RTS <- - -
5	CTS - - ->
6	DSR - - ->
7	GND
8	DCD - - ->
20	DTR <- - -

IBM PC-AT or corresp.		IBM PC or corresp.	
9-pin connector	Signal and direction	25-pin connector	Signal and direction
-		-	
3	<- - - TxD	2	<- - - TxD
2	- - -> RxD	3	- - -> RxD
7	<- - - RTS	4	<- - - RTS
8	- - -> CTS	5	- - -> CTS
6	- - -> DSR	6	- - -> DSR
5	GND	7	GND
1	- - -> DCD	8	- - -> DCD
6	<- - - DSR	20	<- - - DTR

A 25-pin male D-type connector is always used in the cable end towards the modem, whereas a 9-pin female D-type connector is normally used for the cable end connecting an IBM PC-AT or a compatible device. A 25-pin female D-type connector is used for the cable end connecting an IBM PC or a compatible device.

A cable type SPA-ZP17A_ is available for connection of the recorder module to a PC provided with a 9-pin D-type connector.

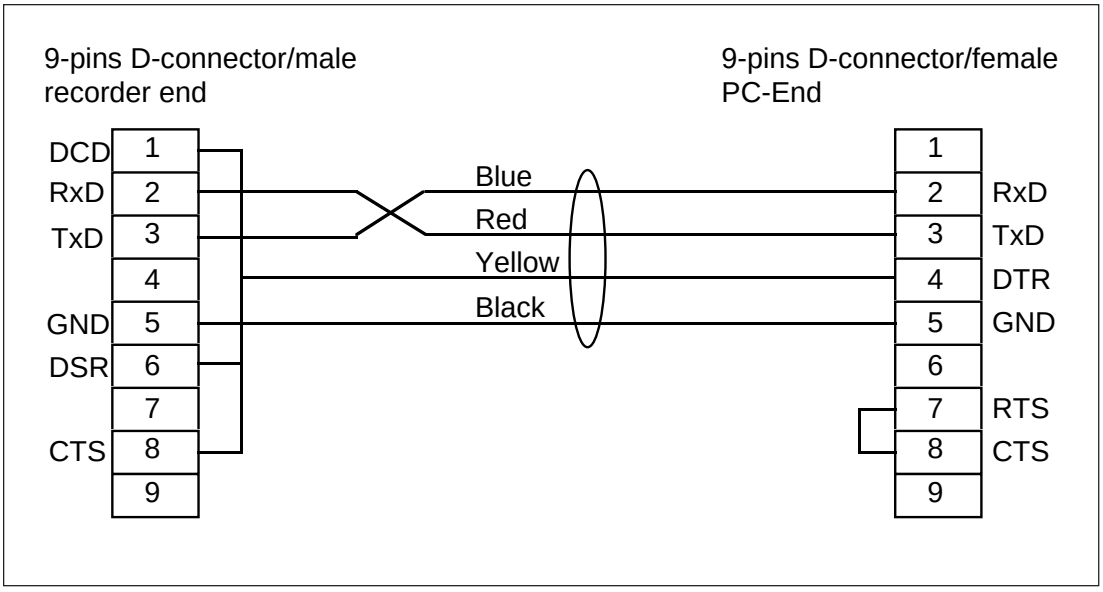


Fig. 8. Connection cable type SPA-ZP17A_.

Event codes

The event monitoring functions of the disturbance recorder memorize the code of each event and the time at which the event occurred. The triggerings of the recorder are regarded as events. On request the module prints out the event data over the SPA bus in the format: time (ss.sss, a so called short clock time) and event code. The event data transmitted over an RS 232 C bus includes the event code and a long-clock time (yy-mm-dd hh.mm; ss.sss).

The event codes of the module are E1…E16 and E50 and E51. The codes E1…E16 and the events represented by these can be included in or excluded from the event reporting by writing an event mask (V155) to the module. The event mask is a binary number coded to a decimal number. The event codes E1…E16 are represented by the numbers 1, 2, 4…32768. The event mask is formed by multiplying the above numbers either by 0 (event not included in the reporting) or 1 (event included) and adding up the numbers received (cf. the calculation of the checksum).

The event mask may take a value in the range 0…65535. The default value of the disturbance recorder is 65535, which means that all the events that have caused triggering are included in the event reporting. The events E52…E54 are included only in the data communication over the SPA bus. These codes are formed by the substation control data communicator and cannot be excluded from the event reporting.

The event codes of the disturbance recorder SPCR 8C27 are as follows:

Code	Event	Weighting coefficient	Default setting
E1	Triggering on overcurrent (I_{L1}, I_{L2} or I_{L3})	1	1
E2	Triggering on residual voltage (U_0)	2	1
E3	Triggering on neutral current (I_0)	4	1
E4	Triggering on overvoltage (U_{12}, U_{23} or U_{31})	8	1
E5	Triggering on undervoltage (U_{12}, U_{23} or U_{31})	16	1
E6	Triggering on change of signal 1 status	32	1
E7	Triggering on change of signal 2 status	64	1
E8	Triggering on change of signal 3 status	128	1
E9	Triggering on change of signal 4 status	256	1
E10	Triggering on change of signal 5 status	512	1
E11	Triggering on change of signal 6 status	1024	1
E12	Triggering on change of signal 7 status	2048	1
E13	Triggering on change of signal 8 status	4096	1
E14	Manual triggering or triggering on external control signal	8192	1
E15	Triggering on remote command (V21)	16384	1
E16	Automatic periodical triggering (V22, V23)	32768	1
	Defalt value of event mask V155		65535

E50	Unacknowledged reset (status word = 1)	*	-
E51	Overflow of event register (status word = 2)	*	-
E52	Temporary interruption in data communication	*	-
E53	No response from the relay module over the data communication bus	*	-
E54	The relay module responds again over the data communication bus	*	-

0 not included in event reporting
1 included in event reporting
* no code number, always included in event reporting
- cannot be set

Note!
In the SPACOM system the event codes E52…E54 are generated by the substation data communicator.

Short parameter specification

The parameters readable and settable via serial communication can be grouped in the following way:

Programming mode

The parameters can be read while the recorder is in the measuring mode, but the parameters are chiefly set in the setting mode. The settting mode is entered and exit using parameter V17, see chapter "Setting mode" in the manual, (page 5).

Instantaneous values

The signals measured by the recorder module, i.e. the currents, voltages and status signals, are read using parameters I1…I8 and I10. The values obtained from the recorder module are values dating to the moment of measurement and scaled to the rated values I_n and U_n. The scaling factors can be altered using parameters M36 and M37, see passage "Rated values".

Maximum and minimum values supervision

The recorder module continuously searches for and records the max. and min. values of the monitored signals. The limit values can be read using parameters V2…V14. The values are scaled to the corresponding rated values.

A value or a value and a time tag are obtained on reading. The three phase-to-phase voltages and the three phase currents refer to the same measuring moment, i.e. for voltages when one of the voltages reaches its maximum or minimum value or for currents when one of the currents reaches its peak value. Only one value can be written for the different phase-to-phase voltages and the phase currents. When a new value is written, all the old values are reset. Writing always resets the time. If the search for a maximum and minimum value is to be started all over, the desired start level must be written to the variable.

The status channel contains only the time record of the last change. According to parameters S1 and S10, writing of any permitted character to variables V7…V14 will erase the time record.

Triggering conditions

For the recorder module to make a recording, the following conditions must be fulfilled:

- the recorder module is in the measuring mode
- enough unused recording memory is available
- a triggering condition is fulfilled
- a recording from the particular triggering condition is permitted, see variable V24
- the length of the recording from the particular triggering condition has been set greater than 0 blocks using parameter M27.

The triggering conditions are set with parameters S1…S6 and S10.

The triggering conditions for the analog signals are defined directly as current and voltage values.

The triggering conditions for the status signals are given as binary coded values, all eight signals with one parameter as described in chapter "Displayed data/Status signals" of the manual, (page 9).

Triggering from a status signal can be obtained from the rising edge or the falling edge of a status signal as defined with parameter S10. Parameter value 0 = triggering on falling edge and parameter value 1 = triggering on rising edge. The triggering conditions for all the eight channels 1, 2, 3,…8 are given in the same parameter one by one after each other. The setting 00001111, for instance, means that the channels 1…4 are triggered on a falling edge and the channels 5…8 on a rising edge.

Periodical triggering

The recorder module can be set to automatically execute triggerings at certain time intervals, i.e. a so called periodical triggering. The required time interval in seconds is written to variable V22. When a new value is written to parameter V22, the timer starts counting seconds from the set value backwards. When the counter reaches zero, a triggering occures, the counter setting is re-established and the backwards counting starts again. The counter value can be read from parameter V23. The counter value can be altered by writing a new value to parameter V23.

If the value of parameter V22 is 0, no periodical triggering is obtained.

Remote triggering

The recorder module can be triggered via the serial bus using parameter V21. The parameter is first given the value 0 which then is changed to 1.

Recording from triggering

The triggerings from which a recording is permitted are selected with parameter V24. The parameter is set in the same way as parameterV155, the setting of which is described in chapter "Event codes" (page 17).

The length of the recording is defined with parameter M27, separately for each triggering. Note! The history part of each recording has the same length for all triggerings. If attempts are made to set history parts of different lengths, the recorder module, however, equalizes the history parts for the different triggerings. The length of the history part is determined by the last setting value. When parameter M27 is read the lengths of all triggerings are obtained at the same time, but when new values are written the values must be given separately for each triggering. The message to be written shall have the form: A B Ex, where A denotes the history length in blocks, B denotes the length of the recording in blocks, counted from the triggering moment and Ex is the code of the concerned triggering. For instance, by writing 1 5 E1 the recorder module is programmed to make a six block recording including one history block on triggering on overcurrent (E1). Further it must be noted that the values A and B together must not exceed the maximum recording capacity of the recorder module.

If a recording has been made from one of the triggerings E1…E5 of the analog channels, a new triggering of the same channel is prevented for a time interval defined by parameter M35. However, any other triggering than the one which started the last recording, starts an immediate recording.

Event reporting

The triggerings which are to be included in the event reporting are defined with parameter V155, i.e. the event mask parameter. This parameter does not affect the recording procedure. The event register can be read once with the L command. If, for instance, a fault arises in the communication system, the contents of the event register once read with the L command can be re-read by using the B command. If required, the B command can be repeated.

Range selections

Each analogue quantity, except for the residual voltage, have two selectable measuring ranges, which are selected with parameter M34. If the signal to be measured exceeds the measuring range, the measured signal will be cut. The form of the parameter is Ix Io Ux, where Ix denotes the ranges of the phase current channels, Io the range of the residual current channel and Ux the ranges of the voltage channels. The different phases of the voltage channels and the current channels cannot be given different measuring ranges. If the recorder module is going to be plugged into a differential relay the voltage channels are transformed into current channels by means of jumpers, in which case Ux determines the measuring range for the low-voltage side phase currents.

M34	Phase currents (Ix)	I_0 current (I_0)	Phase-to-phase voltages (Ux)
0 0 0	0…20 x I_n	0…20% I_n	0…2.5 x U_n
0 0 1	0…20 x I_n	0…20% I_n	0…21 x U_n
0 1 0	0…20 x I_n	0…102% I_n	0…2.5 x U_n
0 1 1	0…20 x I_n	0…102% I_n	0…21 x U_n
1 0 0	0…2 x I_n	0…20% I_n	0…2.5 x U_n
1 0 1	0…2 x I_n	0…20% I_n	0…21 x U_n
1 1 0	0…2 x I_n	0…102% I_n	0…2.5 x U_n
1 1 1	0…2 x I_n	0…102% I_n	0…21 x U_n

Rated values

The rated values used for scaling the recorder module can be altered with parameters M36 and M37. The values of parameter M36 function on the normal ranges (the corresponding range of M34 = 0) and M37 on the alternative ranges (the corresponding range of M34 = 1). The values correspond to the value of the A/D converter at a 100% input signal level. By changing these values only the scaling of the measuring range is affected and changes are not to be recommended.

Management of recording resources

The default setting of the recorder module permits no further recordings, when the capacity of the recording memory has been fully used. With parameter M38 the recorder module can, however, be given a mode of function, where the recorder module automatically creates the necessary amount of free recording capacity by erasing the oldest recordings from the memory.

The currently available amount of free recording memory of the recorder module can be read with parameter M32.

Both parameters have the form: REC CHA BLO, where REC is the number of free recording headers. Each recording needs one recording header. CHA denotes the number of free channel headers. Each recording requires as many channel headers as the number of monitored channels (all channels = 9 pcs). BLO denotes the number of recording blocks. The number of recording blocks needed per channel is defined with parameter M27.

Note! The recording resources needed for collecting history parts are not seen in parameter M32, unless the recorder module is in the setting mode. Therefore the recorder module may be able to perform a recording, although the recording resource seems to be zero.

Recorder mode

Parameter C can be used for determining, if the recorder module has performed an unreset start or if the event register is full (overflow). Both states are also seen in the reading of the event buffer. The states are reset by writing 0 to the parameter.

The number of recordings made by the recorder module (cumulative counter) and the number of recordings currently in the memory can be read with parameter V1. Any value written to the parameter makes the cumulative counter show the number of recordings still in the memory.

With parameter V25 the state of the recorder module can be read. The V25 parameter shows whether the recorder module is in the measuring mode, whether the recorder module has succeeded in collecting the necessary number of history parts and whether the recorder module currently is making a recording. The collection of history recordings is explained in chapter "Measuring mode" (page 6).

Unloading of recordings

The recordings are unloaded via the bus interface on the front panel using parameters V20 and V15. The recordings are unloaded via the SPA bus using parameters V20, M28…M31.

The recordings are maintained in the memory of the recorder module after they have been unloaded. The recordings are erased with parameter V16.

Data included into recordings

The monitored quantities of the recorder module which are to be included in the recording are determined with parameter M33. The default setting is that all the measured quantities (channels) are included in the recording. Those channels which are not used (no measurement) can be excluded from the recording with parameter M33. Any excluded channel will obtain a fixed value of zero, which will increase the recording capacity of the module. If, for instance, only half of the channels are included in the recording the recording capacity is doubled. The parameter value is written in binary form as follows:

Channel	Weighting coefficient
1 (U12)	1
2 (U23)	2
3 (U31)	4
4 (I1)	8
5 (I2)	16
6 (I3)	32
7 (U_0)	64
8 (I_0)	128
9 (8 status channels)	256

Further, among other things the following settable data are part of the recording:

- Main heading of the recording (M21)
- headings of the measuring channels (M22)
- primary values of the measured quantities (M23…M25)

These values are not utilized by the recorder module and they do not affect the function of the recorder module in any other way than that they are included in the recordings. Parameters M21 and M22 define the heading of the recording and the headings of the various channels (quantities). When parameter M22 is read all the channel headings are obtained at once, but when the headings are written the headings of the channels are preferrably written one by one. The write message should be composed of the channel number and the channel heading. Example: 4 L1, which means that channel 4 will obtain the heading L1. The characters < > : / nor & must not be included in the headings written by parameters M21 and M22. The primary values of the corresponding quantities are written with parameters M23…M25.

Communication settings

The communication address of the recorder module is given with V200 and the data transfer rate with parameter V201. The same parameters are used for both communication ports (the front panel port and the SPA port). Parameter V201 affects only the settings of the communication port used for setting, while the other port remains unchanged.

Other parameters

Parameter V102 can be used for restarting the recorder module.

Parameter V165 can be used for testing the self-supervision function (IRF) of the recorder module.

Parameter F can be used for reading the type designation and parameter V205 for reading the program version indicator of the recorder module.

Parameters T and D are used for setting the date and time of the recorder module.

Setting example

The recorder module has been inserted into the feeder terminal type SPAC 531 C.

Parameter	Parameter specification	
S1	7	Status signals 1…3 are used for triggering
V24	224	Recording permitted from triggering of status signals 1…3 (32 + 64 + 128 = 224)
M21	K5 plant	Main heading of recording (cubicle name)
M22	4 I1	Channel heading of recording
M22	5 I2	Channel heading of recording
M22	6 I3	Channel heading of recording
M22	7 U_0	Channel heading of recording
M22	8 I_0	Channel heading of recording
M23	20	Primary value of voltage (kV)
M24	1000	Primary value of current (A)
M25	70	Primary value of earth-fault current (A)
M27	1 4 E6	Length of recording
M27	1 4 E7	Length of recording
M27	1 1 E8	Length of recording
M33	504	Selection of channels (the voltage channels are excluded)
M34	0 1 0	For channel I_0 the bigger range is selected
M35	10	Dead time between triggerings
M38	2 12 60	Old recordings are deleated so that capacity is always available for two new recordings

In the above example the recorder module has been inserted into a feeder terminal type SPAC 531 C. On operation the protection relay modules initiate autoreclose functions via the starting signals AR1…AR3. By programming the recorder module to be triggered via these signals (status signals 1…3) a recording is obtained any time the relay operates.

The lengths of the recordings triggered with the AR2 and AR3 signals are set to be 2.5 s of which 0.5 s is history. This time normally reaches over one high-speed autoreclosure. The length of the recording triggered with the AR1 signal is shorter (0.5 s + 0.5 s) because the AR1 signal is (normally) obtained from the high-set stage of the overcurrent protection module.

The phase-to-phase voltages are not measured, which increased the available recording capacity with approx. 30%. Thus the total recording capacity will be 37 blocks, that is max. 7 recordings. Further only the last five recordings are kept in the recording memory, as selected with parameter M38. The recorder module always provides recording capacity for two recordings, i.e. 2 x 6 channels x 5 blocks = 60 blocks.

Remote transfer data

In addition to the event codes it is possible to read over the SPA or RS 232 C bus all the input data (I data), setting values (S data), recorded data (V data) and some other data of the disturbance recorder. Further, part of the information can be altered with commands given over the SPA bus.

All information cannot be read or written over both buses. The table shows the bus over which reading or writing is permitted.

All data are available on the SPA protocol based channel 0, except for the unloading of recordings over the SPA bus.

Data	Code	Data direct.	Bus	Values
Measured value of the U_{12} voltage	I1	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the U_{23} voltage	I2	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the U_{31} voltage	I3	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the I_{L1} current	I4	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the I_{L2} current	I5	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the I_{L3} current	I6	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the U_0 voltage	I7	R	SPA/RS	0…102.3% x U_n
Measured value of the I_0 current	I8	R	SPA/RS	0…20.46% x I_n or 0…102.3% I_n
States of the binary inputs, binary coded decimals	I10	R	SPA/RS	0…255
Binary input condition mask, binary coded decimals	S1	R, W	SPA/RS	0…255. Determines the channels which are to be used for triggering. Default value: 255
Overvoltage condition	S2	R, W	SPA/RS	[S3]…999.999 x U_n Default value: 1.20 x U_n S2 and S3 cannot be cross-set
Undervoltage condition	S3	R, W	SPA/RS	0.201…[S2] x U_n Default value: 0.80 x U_n
Overcurrent condition	S4	R, W	SPA/RS	0…999.9 x In Default value 2.00 x I_n
Residual overvoltage condition	S5	R, W	SPA/RS	0…999.9% x U_n Default value: 20.0 % x U_n
Neutral overcurrent condition	S6	R, W	SPA/RS	0…999.9% x I_n Default value: 5.0% x I_n
Triggering of the binary input channels	S10	R, W	SPA/RS	XXXXXXXX, where the X letters stand for the binary input channels 1…8. X = 1 trig. on rising edge X = 0 trig. on falling edge Default value: 11111111
Total number of recordings	V1	R, X	SPA/RS	AB, where A = total number of recordings made B = number of recordings currently in memory Writing any value makes A = B in the device

Data	Code	Data direct.	Bus	Values
Supervision of the maximum value of the phase-to-phase voltage	V2	R, X	SPA/RS	U_{12}, U_{23}, U_{31} date time Voltage notation x U_n Date: yy-mm-dd Time: hh.mm;ss.sss
Supervision of the minimum value of the phase-to-phase voltage	V3	R, X	SPA/RS	U_{12}, U_{23}, U_{31} date time Also see command V2
Supervision of the maximum value of the phase current	V4	R, X	SPA/RS	I_{L1}, I_{L2}, I_{L3} date time Current notation x I_n Also see command V2
Supervision of the maximum value of the residual voltage	V5	R, X	SPA/RS	U_0 date time Voltage notation % U_n Also see command V2
Supervision of the maximum value of the neutral current	V6	R, X	SPA/RS	I_0 date time Current notation x I_n Also see command V2
Time of activation of binary input channels 1…8	V7… V14	R, X	SPA/RS	Date time Writing clears date and time
Unloading of oldest recording	V15	R	RS	Writes the oldest recording to the RS 232 C port
Erasing of oldest recording	V16	W	SPA/RS	When V16 changes from 0 to 1, the oldest recording is deleted
Selection of setting mode	V17	X	SPA/RS	0 = exit setting mode 1 = enter setting mode
Selection of unloading mode	V20	R, X	SPA	0 = no unloading via the SPA bus 1 = unloading via the SPA bus using commands M28…M31. After initiation of unloading the variables M29 and M30 are reset
Remote triggering	V21	R, X	SPA/RS	Change from 0 to 1 causes triggering via event E15
Setting of time interval for periodical recording	V22	R, X	SPA/RS	0…40 000 000 seconds 0 = triggering disabled
Timer for the periodical triggering	V23	R, X	SPA/RS	1…40 000 000 seconds The timer counts down-wards.
Selection of events that are to trigger recordings	V24	R, X	SPA/RS	0…65535, see chapter "Event codes"
Measurement status	V25	R	SPA/RS	0…65535 0 = inoperative (not in measuring mode) 1 = measuring mode, history collecting not ready 3 = measuring mode, history collected 5 = currently recording, uncollected history 7 = currently recording

Data	Code	Data direct.	Bus	Values
Resetting of recorder	V102	X	SPA/RS	1 = warm start-up 2 = cold start-up
Event mask word for event logging	V155	R, W	SPA/RS	0…65535, see chapter "Event codes"
Activation of self-supervision output (IRF)	V165	X	SPA/RS	0 = reset of output 1 = activation of output
Recorder module address	V200	W	SPA/RS	001…899
Data transfer rate	V201	W	SPA	20.3, 21.2, 22.4, 24.8 or 29.6 kBd using 7 data bits, even parity and one stop bit. The first figure means even parity.
		W	RS	0.3, 1.2, 2.4, 4.8, 9.6 or 19.2 kBd using 8 data bits, no parity and one stop bit.
		W	RS	20.3, 21.2, 22.4, 24.8, 29.6 or 219.2 kBd using 8 data bits, even parity and one stop bit. The first figure means even parity.
Program version code	V205	R	SPA/RS	E.g. NDR110
Main heading of recording	M21	R, X	SPA/RS	Character string; max. 64 characters. *Warning!* *Do not use characters reserved by the SPA protocol.*
Channel headings	M22	R, X	SPA/RS	When read, the channel titles are sent in a row separated by slashes. Max. title length is 6 characters. When written, the data field contains channel number and title separated by a blank. One title can be set for each message.
Rated voltage (kV), peak value	M23	R, X	SPA/RS	0…9999.999
Rated current (A), peak value	M24	R, X	SPA/RS	0…9999.999
Rated neutral current (A), peak value	M25	R, X	SPA/RS	0…9999.999 Also see M23
Length of the recordings	M27	R, W	SPA/RS	A B Ex, where A = history length in blocks B = recording length after triggering in blocks. Event codes E1…E16

Data	Code	Data direct.	Bus	Values
Reading of the recording headline of the oldest recording	M28	R	SPA	Ex B C date time, where Ex = letter E and event number B = history length [blocks] C = rec. length [blocks] date = yy-mm-dd time = hh.min;ss.sss Also see command V20.
Block index for unloading of recording via the SPA bus	M29	R, X	SPA	1…blocks in recording
Line index for unloading of recording via the SPA bus	M30	R, X	SPA	1…250 data sample lines
Reading of recording line	M31	R	SPA	Example: >1 R1/10 M31:xx 1/10 = channels 1 to 10 Channels 1…8 = analogue signals Channel 9 = empty Channel 10 = 8 pcs binary signals
Available free recording memory	M32	R	SPA/RS	REC CHA BLO
Selection of channels to be monitored	M33	R, W	SPA/RS	0…511, used as bitmask
Gain setting for the analogue channels	M34	R, W	SPA/RS	Ixgain Iogain Uxgain Three blank separated boolean numbers (0/1). Default value 0 0 0
Dead time between triggerings of the same triggering source	M35	R,X	SPA/RS	0…1000 seconds Default setting: 120 s
Rated value factor for the analogue channels	M36	R,W	SPA/RS	8 blank separated numbers at range 1…65535. Channel order in the vector is U12, U23, U31, IL1, IL2, IL3, U0 and I0
Alternative rated value factor for the analogue channels	M37	R,W	SPA/RS	See M36 command
Recording resource reserver	M38	R,W	SPA/RS	REC CHA BLO This command is used to set the minimum amount of recording memory that the recorder tries to maintain available.
Sampling rate of recording	M40	R	SPA/RS	Rate of each channel command See M31 command
Type designation of the recorder module	F	R	SPA/RS	SPCR 8C27
Short time setting	T	X	SPA/RS	00.000…59.999 s Only to transmission address 900

Data	Code	Data direct.	Bus	Values
Long time reading or setting	T	R, X	SPA/RS	date = yy-mm-dd time = hh.min;ss.sss To the recorder's own address
Long time setting	D	X	SPA/RS	Equal to variable T To transmission address 900 of all modules
Reading of event register	L	R	SPA/RS	Time (short/long), channel number and event code Example: 34.630 0E7/10.780 0E1 This is in long format when reading via the RS bus (date included)
Re-reading of event register	B	R	SPA/RS	See previous code (L)
Reading of module status data	C	R	SPA/RS	0 = normal state 1 = module has restarted 2 = overflow of event register 3 = events 1and 2 together
Resetting of module status data	C	X	SPA/RS	0 = resetting

Explanation of the direction codes:
R = data to be read from the module
W = data to be written in the setting mode (V17 = 1)
X = data to be written (does not require setting mode)

Maintenance

The recorder module is provided with battery support for the clock circuit and the data memory. The calculated life time for the batteries is 10 years but proper operation of the recorder module is guaranteed if the batteries are replaced every fifth year.

The batteries are mounted on IC sockets.

Clock back-up battery type	Dallas DS 1216 E
Data memory battery type	Dallas DS 1213 D

ABB Oy
Substation Automation
P.O.Box 699
FIN-65101 VAASA
Finland
Tel. +358 (0)10 22 11
Fax.+358 (0)10 22 41094
www.abb.com/substationautomation

1MRS 750511-MUM EN