

7SG13 Delta

Protection and Control Relays

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Software Revision History

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Section 1: Performance Specification

1.1 General

1.1.1 CE Conformity

CE This product is CE compliant to relevant EU directives.

1.1.2 Reference

This product complies with IEC 60255-3, IEC 60255-6 and IEC 60255-12.

1.1.2.1 Accuracy Reference Conditions

This product has been tested under the following conditions, unless specifically stated otherwise.

Parameter	Value
Auxiliary supply	nominal
Frequency	nominal
Ambient temperature	20 °C

1.1.3 Dimensions and Weights

Refer to document P20015 section 3.3.

1.2 Energising Quantities

1.2.1 Characteristic Energising Quantities

Thermal Withstand

Overload Period	Overload Current			
	Phase and Earth		SEF/REF	
	1A	5A	1A	5A
Continuous	3.0 x In		2.0 x In	
10 minutes	3.5 x In			
5 minutes	4.0 x In			
3 minutes	5.0 x In			
2 minutes	6.0 x In			
3 seconds	57.7A	230A	37.5A	202A
2 seconds	70.7A	282A	46A	247A
1 second	100A	400A	65A	350A
1 cycle	700A	2500A	120A	600A

AC Voltage

	Nominal	Operating Range
Vn	110 V	300 V continuous

1.2.2 Auxiliary Energising Quantity

1.2.2.1 Auxiliary Power Supply

	Nominal	Operating Range
V_{AUX}	30 VDC	24 to 37.5 VDC
	48 / 110 VDC	37.5 to 137.5 VDC
	220 VDC	175 to 290 VDC
	110 VAC	82.5 to 137.5 VAC

1.2.2.2 Status (Digital) Inputs

	Nominal	Operating Range
V_{ST}	30/34 VDC	24 to 37.5 VDC
	48/54 VDC	37.5 to 60 VDC
	110/125 VDC	87.5 to 137.5 VDC
	220/250 VDC	175 to 280 VDC

To meet the requirements of ESI 48-4 at the higher voltage levels, then 48V status inputs should be ordered together with external dropper resistors as follows:-

Status Input External Dropper Resistors

Nominal Operating Voltage	Resistor Value; Rating
110 / 125 V	2K7 \pm 5 %; 2.5 W
220 / 250 V	8K2 \pm 5 %; 6.0 W

Performance

Attribute	Value	
Minimum DC current for operation	$V_{ST} = 30 - 54 \text{ V}$	10 mA
	$V_{ST} = 110 - 250 \text{ V}$	< 5 mA
Reset/Operate voltage ratio	$\geq 90 \%$	
Typical response time	< 5 ms	
Fixed slow response time	15 ms	
Typical response time when programmed to energise an output relay contact	< 15 ms	
Minimum pulse duration	40 ms	

Each status input, other than the three on the power supply module which are fixed slow, can provide immunity to AC by selection of a suitable time delay setting. When set to reject AC these inputs will not respond to the following:

- **250V RMS 50/60Hz applied for two seconds through a 0.1 μ F capacitor.**
- **500V RMS 50/60Hz applied between each terminal and earth.**
- **Discharge of a 10 μ F capacitor charged to maximum DC auxiliary supply voltage.**

The status inputs with nominal voltage of 30 V to 54 V meet the requirements of ESI48-4 ESI 1.

1.2.3 Burdens

D.C. Burden

Attribute	Value	
DC Burden	Quiescent (typical)	12 W
	Quiescent (back light)	19 W

CT. Burden

Attribute	Value			
	Phase and Earth		SEF/REF	
	1A	5A	1A	5A
AC Burden	≤ 0.1 VA	≤ 0.3 VA	≤ 0.15 VA	≤ 0.25 VA

VT. Burden

Attribute	Value
AC Burden	≤ 0.01 VA at 110 V

1.3 Output Contacts

Contact rating to IEC 60255-0-2

Attribute	Value
Carry continuously	5 A AC or DC
Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	for 0.5 s 20 A AC or DC
	for 0.2 s 30 A AC or DC
Break (≤ 5 A and ≤ 300 V)	AC resistive 1250 VA
	AC inductive 250 VA at p.f. ≤ 0.4
	DC resistive 75 W
	DC inductive 30 W at L/R ≤ 40ms 50 W at L/R ≤ 10ms
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 W at minimum of 10mA or 5V

1.4 Functional Performance**1.4.1 Instrumentation**

	Instrument Value	Reference	Typical accuracy
<i>I</i>	Current	$I \geq 0.1 \times I_n$	± 1 % I_n
<i>V</i>	Voltage	$V \geq 0.8 \times V_n$	± 1 % V_n
	Power, real and apparent	$V = V_n, I \geq 0.1 \times I_n, pf \geq 0.8$	± 3 % P_n , where $P_n = V_n \times I_n$
<i>pf</i>	Power factor	$V = V_n, I \geq 0.1 \times I_n, pf \geq 0.8$	± 0.05

1.4.2 IEC 60870-5-103 Communication Interface

Attribute	Value
Physical layer	Fibre-optic
Connectors	ST TM (BFOC/2.5)
Recommended fibre	62.5/125 μm glass fibre with ST connector
Launch power (into recommended fibre)	-16 dBm
Receiver sensitivity	-24 dBm

1.4.3 Real Time Clock**1.4.3.1 Internal Clock**

The specification below applies only while no external synchronisation signal (e.g. IRIG-B, IEC 60870-5-103) is being received.

Attribute	Value
Accuracy	± 20 ppm (equivalent to ± 72 ms per hour)

1.4.3.2 IRIG-B

Attribute	Value
Connector	BNC
Signal Type	IRIG-B 120, 122 or 123
Applied signal level	minimum 3 V, maximum 6 V, peak-to-peak
Signal : carrier ratio	≥ 3

1.5 Environmental Performance

1.5.1 General

1.5.1.1 Temperature

IEC 60068-2-1/2

Type	Level
Operating range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

1.5.1.2 Humidity

IEC 60068-2-3

Type	Level
Operational test	56 days at 40 °C and 95 % relative humidity

1.5.1.3 Insulation

IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	
Across normally open contacts	1.0 kV AC RMS for 1 min

1.5.1.4 IP Ratings

Type	Level
Installed with cover on	IP 51
Installed with cover removed	IP 30

1.5.2 Immunity

1.5.2.1 Auxiliary DC Supply Variation

Quantity	Value
Allowable superimposed ac component	≤ 12% of DC voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20ms

1.5.2.2 High Frequency Disturbance

IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤ 5 %
Series (transverse) mode	1.0 kV	

1.5.2.3 Electrostatic Discharge

IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

1.5.2.4 Radiated Immunity

IEC 60255-22-3 Class III

Type	Level	Variation
80 MHz to 1000 MHz	10 V/m	≤ 5 %

1.5.2.5 Fast Transients

IEC 60255-22-4 Class IV

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4kV	≤ 5 %

1.5.2.6 Surge Immunity

IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth, or between any two independent circuits	4.0 kV, 1.2/50 μs or 8/20 μs	≤ 10 %

1.5.2.7 Conducted Radio Frequency Interference

IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

1.5.3 Emissions

IEC 60255-25

1.5.3.1 Radiated Radio Frequency

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(μV)
230 to 10000 MHz	47 dB(μV)

1.5.3.2 Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(μV)	66 dB(μV)
0.5 to 30 MHz	73 dB(μV)	60 dB(μV)

1.5.4 Mechanical

1.5.4.1 Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration endurance	1.0 gn	

1.5.4.2 Shock and Bump

IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %

Type	Level	Variation
Shock withstand	15 gn, 11 ms	
Bump test	10 gn, 16 ms	

1.5.4.3 Seismic

IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1 gn	≤ 5 %

1.5.4.4 Mechanical Classification

Type	Level
Durability	> 10 ⁶ operations

Section 2: Functional Description

2.1 Introduction

This section describes features of Modular II products that are commonly found across a number of products in the range.

Separate documents are available, which specify and describe protection functions. The Diagrams and Parameters document for a product lists explicitly the functions that are provided within the product, and provides references to the appropriate reference document for that function.

2.1.1 Document Organisation

The remainder of Section 2: Functional Description is organised as follows:

Table 2-1 Overview of Functional Description Sections

Section		Description
2.2	Configuration	Configuration of for system requirements: system frequency, CT/VT ratios, identifiers, password etc.
2.11	Status Inputs and Relay Outputs	Pick-up and drop-off timers, inversion, latching and minimum energise time.
2.12	Communications	Communication with PC or control system.
2.13	Data Storage	Event, fault and waveform records.
2.14	Maintenance	Assistance for maintenance of circuit breakers, protection schemes and the relay.

Notes

- Within Section 2: Functional Description the following notational and formatting conventions are used:
 - Setting:** Elem Setting name
 - Setting value:** value
 - Alternatives:** [1st] [2nd] [3rd]
- The purpose of this document is to describe the generic capabilities and functionality of the Modular II platform. Separate User Manual documents describe how to set up and operate products, while individual Technical References describe each protection function in detail.

2.2 Configuration

This section provides advice for configuring the product to suit the overall requirements of the system and the protection scheme: system frequency, CT/VT ratios, identifiers, date/time, password etc.

2.2.1 Multiple Settings Groups

Settings are used to parameterise the relay protection and configuration. Multiple sets of setting values can be stored in the relay with one set active at any time. Uses of these multiple setting groups include summer and winter settings, embedded generation in/out, earthing transformer switched in/out etc.

It is possible to edit one setting group while a different setting group is active, specified by **Active Group** and **View/Edit Group**.

Note that not all settings are duplicated in each group, e.g. status input and output relay configurations are common across all groups. This will be indicated on the relay LCD when the setting is displayed.

Table 2-2 Typical Settings for Settings Groups

Sub-menu: **System Config**

Setting name	Range (bold = default)	Units	Notes
Active Group	1,2...8		
View/Edit Group			

2.2.2 Current and Voltage Inputs

Most products require settings to correctly calculate primary current and voltage quantities. These may include the input (e.g. 1, 2 or 5 A) and CT/VT ratio.

The text of these settings is product dependent, e.g. for a transformer protection there will be multiple settings to cater for each winding, but typical settings are given in Table 2-3.

2.2.2.1 Current Inputs

Each 3-phase or single-phase CT set will require the following settings. The **Elem** prefix specifies to what the settings apply, e.g. **Phase**, **Earth**, **Aux** etc.

Elem CT specifies the CT ratio. This setting is normally used for calculation of primary quantities for instrumentation and waveform record purposes. On most products, multiple inputs are provided to allow use with CTs with 1 and 5 A secondary windings; **Elem Input** specifies the input used.

Table 2-3 Typical Settings Current Inputs

Setting name	Range (bold = default)	Units	Notes
Elem Input	1, 5	A	Not required on single range inputs.
Elem CT Ratio	5, 10, 15... 300 ...10000	: 1, 2, 5	Range is typical only – some products may differ.
Earth Fault Mode	SEF , REF		Models with SEF element only

2.2.2.2 Voltage Inputs

Used only in products with a voltage input – refer to Diagrams and Parameters document.

Each 3-phase or single-phase VT set will require the following settings. The **Elem** prefix specifies to what the settings apply, e.g. **Phase**, **Aux** etc.

Elem VT specifies the VT ratio. This setting is normally used for calculation of primary quantities for instrumentation and waveform record purposes.

Some products apply voltage undervoltage and overvoltage settings in direct voltage, while others apply them relative to a nominal reference voltage. With this latter type, **Nominal Voltage** allows the reference voltage to be applied.

Products with 3-phase VT inputs may also have a Voltage Config setting that allows selection of the VTconnection between 3 phase-earth and 3 phase-phase with separate neutral voltage input.

Table 2-4 Typical Settings Voltage Inputs

Setting name	Range (bold = default)	Units	Notes
Elem VT	3300, 3400...10000, 10500...13000, 14000 ... 132000 ...140000 , 145000...200000, 210000...500000, 550000...1000000	40.0, 40.5 : ... 110.0 ...160.0	Range is typical only – some products may differ.
Voltage Config	Van,Vbn,Vcn ; Vab,Vbc,3Vo ; Va,Vb,Vc		

2.2.3 Settings Group Select

2.2.3.1 Temporary Activation of Setting Group

The active group can be temporarily changed to a new one, specified by **Sett Grp Select**, by energising the **Select Sett Grp** status input. When the status input is de-energised, the settings group reverts to the previously active group, specified by **Active Group**. This group change can be inhibited by energising the **Inhibit Sel Grp** status input.

Table 2-5 Typical Settings for Settings Group SelectionSub-menu: **System Config**

Setting name	Range (bold = default)	Units	Notes
Sett Grp Select	1,2...8		

Sub-menu: **Status Inputs**

Setting name	Range (bold = default)	Units	Notes
Select Sett Grp	_, 1 for each status input		
Inhibit Sel Grp			

2.2.4 Real Time Clock

The date and time can be programmed and are then maintained by the internal real time clock, while the device is powered, and while it is de-energised. Additionally, in order to maintain synchronism within a substation, all devices can be synchronised to the nearest second or minute using the IRIG-B input or using the IEC 60870-5-103 protocol.

The default date is set at 01/01/1980 deliberately to indicate the date has not yet been set. When editing the **Time**, only the hours and minutes can be edited. When the user presses **ENTER** after editing the seconds are zeroed and the clock begins counting.

In addition, on some products, synchronisation can occur through energisation of a status input. **Clock Sync. From Status** specifies whether the clock will be synchronised to the nearest minute or second when the status input is activated.

Table 2-6 Typical Settings Real Time Clock

Setting name	Range (bold = default)	Units	Notes
Date	DD/MM/YY (01/01/1980)		
Time	HH:MM:SS (00:00:00)		
Clock Sync. From Status	Disabled, Minutes , Seconds		<i>Not provided on all products</i>
Sub-menu: Status Inputs			
Clock Sync.	_, 1 for each status input (default: _ _ _ _ _ _ _ _)		

2.2.5 Backlight Timer

When a user leaves the relay the backlight will turn off to conserve the substation battery. The time before this occurs is programmable with **Backlight Timer**.

Table 2-7 Typical Setting Backlight Timer

Setting name	Range (bold = default)	Units	Notes
Backlight Timer	Off, 1, 2, 5 , 10, 15, 30, 60	min	

2.2.6 Default Screens

When a user leaves the relay it will switch to default screens, whereby a selected number of screens (typically instruments) are displayed in turn without user intervention. The time before this occurs is programmable with **Default Screens Timer**.

The instruments which are displayed in the default metering cycle are individually selected on each instruments screen using the **ENTER** key. This is described in detail in the User Manual document.

Table 2-8 Typical Setting Default Screens

Setting name	Range (bold = default)	Units	Notes
Default Screens Timer	Off , 1, 2, 5, 10, 15, 30, 60	min	

2.2.7 Password

All settings on Modular II products can be password protected using the Alpha character set. When the user leaves the device untouched for an hour, the password protection is enabled. The setting is changed using the **Change Password** setting.

Table 2-9 Typical Setting Password

Setting name	Range (bold = default)	Units	Notes
Change Password	ABCDEFGHJKLMNOPQRSTU WXYZ for 4 characters (NONE)		

2.2.8 Identifier

Identifying text can be programmed into the relay using the **Relay Identifier** setting. This text is displayed on the title screen and is used in communications with ReyDisp to identify the device.

Table 2-10 Typical Setting Identifier

Setting name	Range (bold = default)	Units	Notes
Relay Identifier	ABCDEFGHJKLMNOPQRSTU WXYZ0123456789-+ ' ' for 16 characters		

2.3 Status inputs, Relay Outputs and Flag LEDs

Status inputs and relay outputs are all user programmable. The settings related to each function are described in the relevant section of this document.

The operation of the status inputs and output relays is described below and shown in Figure 2-1 and Figure 2-2 respectively.

Output Relay Configuration

Each output relay can be operated from any of the output elements. The **Elem** prefix specifies to what the settings apply, e.g. **Prot Healthy**, **General Trip**, **General Starter**, **Phase A Trip**, **Phase B Trip**, etc. Any of the output elements can be set to operate any of the output relays. To set an output relay move to the required output element and select the relay(s) required. Where no output is selected the word **NONE** is indicated.

Hand Reset Output Relays

Relay outputs are self-resetting by default; however each relay output can be individually set to hand reset through the **O/P Relay Config.:Hand Rst Outputs** setting. In this case, the relay latches on operation, and can be released by using the TEST/RESET key on the relay fascia (from the **Relay Identifier** screen), by the communications link, or by energising a status input, as mapped by **O/P Relay Config.:Reset Leds & Relays**.

Output Relay Minimum Energise Time

All relay outputs have a minimum energise time, specified by the **O/P Relay Config.:Min Op Time n** settings.

Status Input Inversion and Delays

Each status input can be programmed for reverse action (i.e. it becomes active when de-energised and inactive when energised) using the **Status Config.:Inverted Inputs** setting.

Each status input can also be programmed with a pick-up and drop-off delay, using the **Status Config.:Status n P/U Delay** and **Status Config.:Status n D/O Delay** settings. The pick-up and drop-off delays are applied following the inversion, i.e. pick-up delay applies to the input becoming active, while drop-off applies to it becoming inactive.

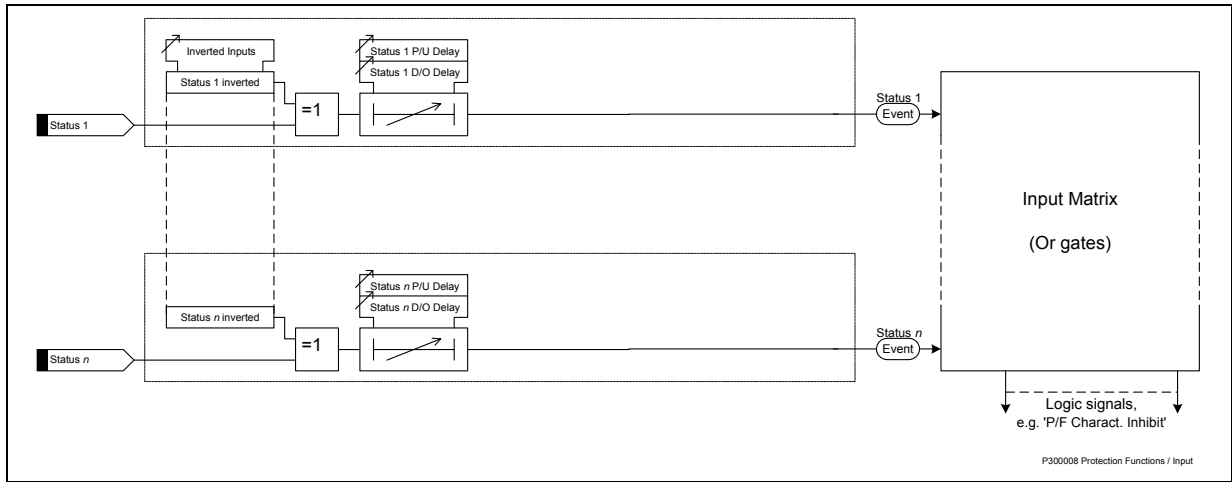


Figure 2-1 Status Input Logic

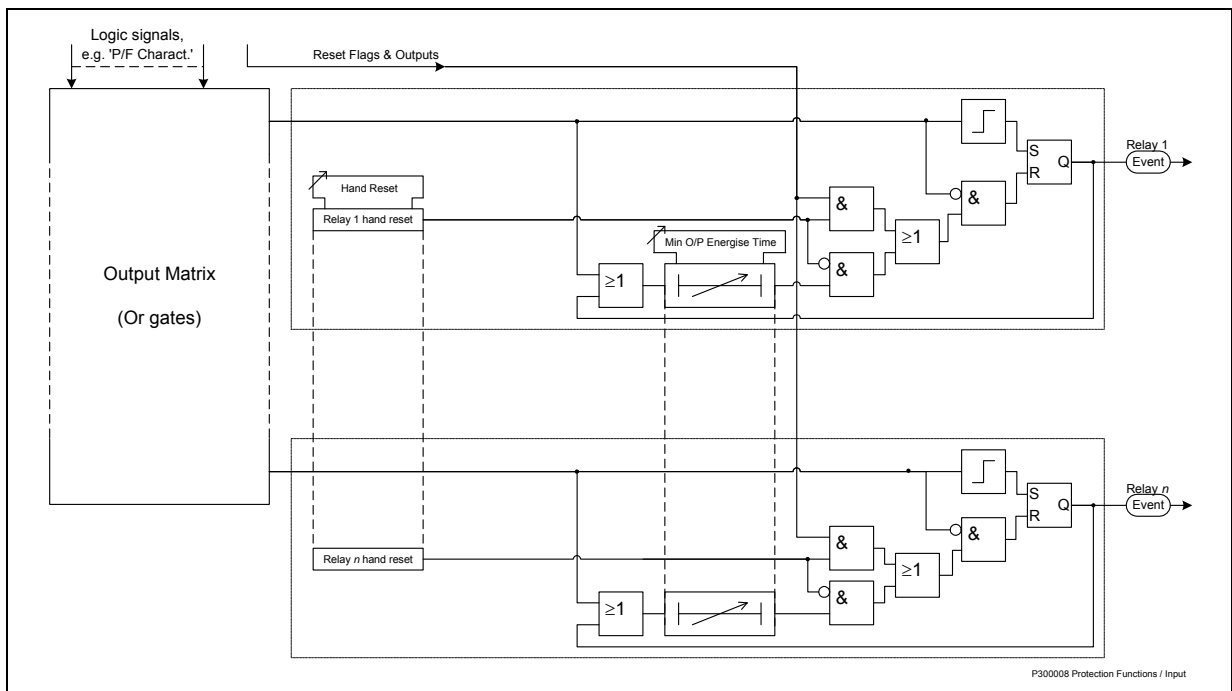


Figure 2-2 Output Relay Logic

Table 2-11 General Output Relay and Status Input Settings

Sub-menu: **Output Relays**

Setting name	Range (bold = default)	Units	Notes
Elem, R= 1..n	1 for each output contact (default: _____)		<i>n</i> is the number of output relays present
Hand Rst Outputs R= 1..n	1 for each output contact (default: _____)		<i>n</i> is the number of output relays present
Min Op Time n	0.10 , 0.12...2.0, 2.1...20, 21...60	sec	<i>n</i> is the individual output relay identifier

Sub-menu: **Status Inputs**

Setting name	Range (bold = default)	Units	Notes
Elem, S= 1..n	1 for each status input (default: _____)		<i>n</i> is the number of status inputs present

Setting name	Range (bold = default)	Units	Notes
I/P P/U Time <i>n</i>	0.00 , 0.01... 2.0, 2.1...20, 21...60	sec	Settings of 0.02 for pick-up should be applied to give AC rejection.
I/P D/O Time <i>n</i>			<i>n</i> is the individual status input identifier
Invert inputs S= 1.. <i>n</i>			<i>n</i> is the individual status input identifier

2.4 Communications

All settings and information relating to communications with Modular II products, are given in Section 3: Communication Interface.

2.5 Data Storage

Modular II products store three types of data to assist the user in fault evaluation: events, waveforms and faults. Demand meter data is also stored.

Fault records provide textual information on the source of the trip, i.e. the element that tripped, and any elements that were picked up at the time of trip. This gives the first indication of the type of fault.

However, the fault record should be examined in coordination with the event records to see the full sequence of events leading to a trip. It is possible to identify developing and flashing faults using the event records.

If a waveform record is available, the current waveforms (and voltage waveforms in some models) allow the type of fault to be easily identified. However, the waveform record covers a maximum of only 5 seconds, whereas the event records will cover many seconds or minutes. If a fault is of a flashing nature this will be apparent from the event records, however the waveform record may show only the final overcurrent leading to trip.

2.5.1 Event Storage

When an event occurs, a date and time tagged entry is added to the storage buffer. Some of the events that can be stored are indicated in the function diagrams throughout this functional description section. Up to 500 events are stored in a rolling buffer, with the oldest events overwritten. The buffer can be cleared using the **Data Storage:Clear Events** setting.

All events can be obtained through the communications link and are displayed in the ReyDisp package in chronological order, allowing the user to see the sequence of events surrounding a trip. They are also made available spontaneously to an IEC 60870-5-103 compliant control system.

For a complete listing of events available in each model, refer to the appropriate Diagrams and Parameters document.

2.5.2 Fault Storage

Fault storage is a time-tagged textual record of the fault. This contains the phase-neutral current and (if fitted) voltage levels, and LEDs status at the time the fault occurred.

Up to 5 faults are stored in a rolling buffer, with the oldest faults overwritten. The fault storage can be cleared with the **Data Storage:Clear Faults** setting.

2.5.3 Waveform Storage

Waveform storage is a graphical record of analogue current and voltage inputs, status inputs and relay outputs.

The total waveform storage space is 5 seconds, but a setting **Data Storage:Record Duration** can be used to define how many records this relates to. A waveform record can be externally triggered via the **O/P Relay Config:Waveform Trig** input.

When a record is triggered some pre-trigger waveform is provided, the percentage of which is specified by the **Data Storage:Pre-Trigger Storage** setting.

Up to 5 waveforms are stored in a rolling buffer, with the oldest waveforms overwritten. The waveform storage can be cleared with the **Data Storage:Clear Waveforms** setting.

2.5.4 Demand Storage

The maximum, minimum and average values for the primary phase A, B and C currents during the previous 24 hrs are stored. Each value is continuously updated over a 5 minute window which is then stored to provide a 24 hr graphical record. Two records are available, one giving the previous 24 hrs and the other recording from midnight to midnight.

Table 2-12 Data Storage Settings

Sub-menu: **Status Config.**

Setting name	Range (bold = default)	Units	Notes
Waveform Trig	<u>, 1</u> for each status input (default: _____)		

Sub-menu: **Data Storage**

Setting name	Range (bold = default)	Units	Notes
Pre-Trigger Storage	10, 20 ...90	%	
Record Duration	5 Records x 1 Second , 2 Records x 2 Seconds, 1 Record x 5 Seconds		
Trigger Waveform	NO, YES		<i>Yes/No confirmation required</i>
Clear Waveforms			
Clear Events			
Clear Faults			
Reset Demand			
Reset WHr Met			
Reset Varhr Met			
Energy Ev Level	OFF , MW, GW, TW, PW, EW, ZW		
Energy Ev Time	OFF , 1.2..60,120..7200,10800..86400	sec	

2.6 CB Maintenance

This section covers features to assist in the maintenance of circuit breakers, the protection scheme and the device itself.

2.6.1 Circuit Breaker Operations

Trip counts and I^2t summation occur for each protection trip. The I^2t summation can also be updated from an external protection trip via a status input.

2.6.1.1 Trip Counter

A trip counter is provided which increments on each trip. This would normally be used to count the number of trip operations performed in total by the Relay.

A suitable maintenance limit value can be chosen from the circuit breaker manufacturer's data and entered into the **CB Maintenance:Trip Count Alarm** setting. When the alarm setting is exceeded, the output relays mapped by **O/P Relay Config:Ops Count Alarm** are raised.

The count can be reset using **CB Maintenance:Reset Trip Cnt**.

2.6.1.2 Delta Trip Counter

This provides an additional counter, which can be reset independently of the Trip Counter described above. This can then be used, for example, for recording trip operations between visits to a substation.

Its operation is similar to the Trip Counter above, however a different limit setting (**CB Maintenance:Delta Trip Alarm**), and output (**O/P Relay Config:Delta Count Alarm**) are provided.

The delta trip counter can be reset using **CB Maintenance:Reset Delta**.

2.6.1.3 Sum of I^2t

Circuit breaker contact wear increases with energy broken, therefore I^2t summation provides a good estimation for maintenance purposes. A suitable maintenance limit value can be chosen from the circuit breaker manufacturer's data and entered into the **CB Maintenance:I²t Alarm Limit** setting

The current flowing at the time of trip is added to individual summations for each phase. If any of these exceed the alarm setting, the output relays mapped by **O/P Relay Config:I²t Count Alarm** are raised. An instrument shows the I^2t summation for individual phases.

The time (t) used in the I^2t calculation is derived from the difference of the settings, **CB Maintenance: Separation Time** and **CB Maintenance:Clearance Time**. Separation time is defined as the time from the closure of the relay trip contact(s) to the point at which the CB contacts open. Clearance time is defined as the time from when the CB contacts open to when the fault current is extinguished.

The summation can be reset using **CB Maintenance:Reset I²t Count**.

2.6.2 Output Relay Test

The output relay test allows the device to activate each output relay contact, as selected in the **O/P Relay Config:O/P Relay Test** setting.

The test is initiated by the **CB Maintenance:IO Test** setting.

Table 2-13 CB Maintenance Menu

Sub-menu: **Status Config.**

Setting name	Range (bold = default)	Units	Notes
I²t Cnt Update	_, 1 for each status input (default: _____)		

Sub-menu: **Trip Counter**

Setting name	Range (bold = default)	Units	Notes
Trip Count Alarm	OFF, ON		
Delta Trip Alarm			
Reset Trip Cnt	NO, YES		
Reset Delta Cnt			

Sub-menu: **I²t CB Wear**

Setting name	Range (bold = default)	Units	Notes
I²t Counter	Disabled , Enabled		
Alarm Limit	10, 20..100, 200..20000, 21000..100000	MA ² s	
Separation Time	0, 0.001.. 0.020 , 0.021..0.100	sec	
Clearance Time	0, 0.001.. 0.040 , 0.021..0.100	sec	
Reset I²t Count	NO , YES		

Sub-menu: **I/O Test**

Setting name	Range (bold = default)	Units	Notes
Test O/P Relays	NO , YES		

2.6.3 Internal Supervision

The device employs comprehensive supervision of its internal operation, both hardware and software. In the event of any failure, all outputs are de-energised and the relay is shut down in a controlled manner.

Supervision includes a power supply watchdog, code execution watchdog, memory checks by checksum, and processor / ADC health checks.

While the relay is healthy, an output can be given, as specified by the **O/P Relay Config:Prot Healthy** setting. By allocating this output to a normally closed contact, i.e. output relays 1 to 3, an alarm can be generated on relay de-energisation or failure.

Section 3: Communication Interface

3.1 Introduction

Modular II products can communicate with control and automation systems, or with PCs running ReyDisp software, to provide operational information, post-fault analysis and settings interrogation and editing. This section describes how to use the IEC 60870-5-103 compliant Informative Communication Interface with a control system or interrogating computer. Appropriate software within the control system or on the interrogating computer (e.g. ReyDisp Evolution) is required to access the interface.

This section specifies connection details and lists the events, commands and measurands provided in each product as detailed in Diagrams and Parameters section. For further information regarding the interface, reference should be made to the separate Informative Communications Interface manual (reference 434/TM/5), which covers all Reyrolle Protection products.

The same communications interface is used to provide control system connections and for dialogue communications by the Protection Engineer. An appropriate IEC 60870-5-103 control system interface will be required for the former application, while the latter is provided by ReyDisp Evolution software.

3.2 Physical Connection

The Reyrolle Modular II relay range provides two rear communications interfaces COM1 & COM2. COM2 is multiplexed with an RS232 port mounted on the Fascia.

1. COM1: this port is used for IEC60870-5-103 communications to a substation SCADA or integrated control system by default.
2. COM2: this port can also be used for IEC60870-5-103 communications to a substation SCADA or integrated control system. Note however that only one port can be mapped to the IEC60870-5-103 protocol at any one time. (The **COMMS INTERFACE** submenu includes a setting “**IEC60870 on port**”, which maps the protocol to either COM1 or COM2). COM2 can also be accessed through an isolated RS232 (female 25-pin D-type) connector on the relay fascia. This provides facilities for access to the relay from a laptop or PC when commissioning or interrogating relays. A “**COM2 Direction**” setting is available which, when set to “**AUTO-DETECT**” automatically allows the front port to take control away from the rear port when a computer is plugged into the D-type connector.

3.2.1.1 Sigma Fibre-optic to RS232 Converters

Siemens Protection Devices Ltd. can provide a range of fibre-optic to RS232 converter devices:

- Sigma 1 – a panel mounting fibre-optic star coupler, for up to up to 29 devices. An RS232 port is available at the front of the device. By default, communication is to the master fibre connections on the rear, however, communication is automatically switched to the front RS232 port when a communicating programme is activated. Each fibre-optic port can be individually selected between ‘Light On’ and ‘Light Off’ (see section 3.3.5).
- Sigma 3 – a panel mounting fibre-optic to RS232 converter. Two RS232 ports are available: one at the rear for connection to a modem, and one at the front for connection to a local PC. By default the rear port is active, however, communication is automatically switched to the front port when a communicating programme is activated. The fibre-optic port can be selected between ‘Light On’ and ‘Light Off’ (see section 3.3.5).
- Sigma 4 – a portable fibre-optic to RS232 converter.

Full details of the above devices can be found by referring to the website www.reyrolle-protection.com.

3.2.2 Recommended cable

Selection of fibre-optic cable is important. Fibres must be terminated with STTM (BFOC/2.5) connectors.

The recommended type is 62.5/125µm glass fibre. Communication distances over 1 km are achievable using this type of fibre.

3.2.3 Network Topology

Communication networks can be connected in star or ring format

Figure 3-1 to Figure 3-4 illustrates a number of network arrangements.

3.3 Settings

Communication parameters of **Communications Interface:Comms Baud Rate**, **Communications Interface:Comms Parity**, **Communications Interface: Line Idle** and **Communications Interface: Data Echo** should match those of the communicating device.

3.3.1 Station (Relay) Address

Each relay on a network must have a unique address, between **1** and **254**, as set by the **Communications Interface: Station Address** setting. A relay with the default address of **0** will not be able to communicate.

3.3.2 IEC 870 on port

This allocates IEC 60870-5-103 communication protocol to the selected port. When selected to **AUTO** the relay will monitor Com port 1, if there is no activity it will then check Com port 2. The setting **Line Switch Time** sets the time after which no activity has taken place to switch to the other port.

3.3.3 Baud Rate

Various rates are provided in bits per second. However, only **19200** and **9600** are defined in IEC 60870-5-103, the additional rates are provided for local or modem communications.

The **Communications Interface:Comms Baud Rate** setting should match that of the communicating device.

3.3.4 Com Parity

IEC 60870-5-103 defines transmission as using **Even** parity, however, in some instances an alternative may be required. The **Communications Interface:Comms Parity** setting also allows parity of **ODD** or **None** to be selected. This setting should match that of the communicating device.

3.3.5 Line Idle

The communication medium is fibre-optics, and the IEC60870-5-103 protocol defines a line idle state of **Light On**. Binary '0' is represented by light on, binary '1' is represented by light off and when a device is not communicating it idles with the light on (sending '0').

The above allows detection of a broken fibre condition. When the line is idling, a binary '0' should be received constantly. If binary '1' is received constantly, then no light is being received, hence the fibre may be broken.

The **Communications Interface: Line Idle** setting must be set to be either **ON** or **OFF** to be compatible with the communicating device connected to the relay.

3.3.6 Data Echo

Modular II products may be connected in a ring, e.g. as shown in Figure 3-3. The optical ring architecture requires data to be passed from one relay to the next, therefore when using this method, all relays in the ring must have the **Communications Interface:Data Echo** setting to **ON**.

For devices with individual connections (e.g. Figure 3-1), or connected in a star topology (Figure 3-4), the setting should be set to **OFF**.

3.3.7 COM 2 Direction

The relay communications port COM 2 has a dual output this can be selected to be either a F/O connection at the rear of the relay or it can be directed to the electrical RS232 port at the front of the relay. If set to **AUTO-DETECT** the relay will check either connection for communications activity. If a connection is made to the front port, i.e. Laptop computer, whilst the rear port is connected to a SCADA or similar system the front port will take priority.

Table 3-1 Communications Settings

Sub-menu: **Communications Interface**

Setting name	Range (bold = default)	Units	Notes
Station Address	0 , 1...254		
IEC 870 on port	NONE, COM 1 , COM 2, AUTO		See <i>Line Switch Time</i>

Setting name	Range (bold = default)	Units	Notes
Line Switch Time	1,2,.. 30 , 31..60	sec	Only available when IEC 870 on port is set to AUTO
COM 1 Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200 , 38400, 57600, 115200	baud	
COM 1 Parity	NONE, ODD, EVEN		
COM 1 Line Idle	LIGHT ON, LIGHT OFF		
COM 1 Data Echo	OFF , ON		
COM 2 Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200 , 38400, 57600, 115200	baud	
COM 2 Parity	NONE, ODD, EVEN		
COM 2 Line Idle	LIGHT ON, LIGHT OFF		
COM 2 Data Echo	OFF , ON		
COM 2 Direction	AUTO-DETECT , REAR PORT, FRONT PORT		
IEC 870 UPDATE			See Sub Menu IEC 870 UPDATE

3.3.7.1 IEC 870 Update

This is a sub-menu of the Communications Settings Menu and is used to set the Measurand properties.

3.3.7.2 Measurand Type

Two types of Measurand can be selected, Public type 148 Measurand or Private Type 200 Measurands. See the relevant Diagrams and Parameters, Section 3.

3.3.7.3 Class 2 refresh

After this time period a new class 2 measurand is made available.

3.3.7.4 High – Low updates

If during the Class 2 refresh period the measurement moves outside of the set limits a new class 2 measurand is made available.

Table 3-2 IEC 870 update

Sub-menu: IEC 870 UPDATE

Setting name	Range (bold = default)	Units	Notes
Measurand Type	Public 148 , Private 200		
Class 2 Refresh	0, 1.. 30 , 31..60	sec	
Curr High Update	1,2.. 5 ,6..20	%	
Curr Low Update	1,2.. 5 ,6..20	%	
Volt High Update	1,2.. 5 ,6..20	%	
Volt Low Update	1,2.. 5 ,6..20	%	
Watt High Update	1,2.. 5 ,6..20	%	
Watt Low Update	1,2.. 5 ,6..20	%	
Vars High Update	1,2.. 5 ,6..20	%	
Vars Low Update	1,2.. 5 ,6..20	%	
Freq High Update	1,2.. 5 ,6..20	%	
Freq Low Update	1,2.. 5 ,6..20	%	
Sync Angle High	1,2.. 5 ,6..20	%	

Setting name	Range (bold = default)	Units	Notes
Sync Angle Low	1,2.. 5 ,6..20	%	

3.4 Modems

The communications interface has been designed to allow data transfer via modems. However, IEC 60870-5-103 defines the data transfer protocol as an 11 bit format of 1 start, 1 stop, 8 data and even parity, which is a mode most commercial modems do not support. High performance modems will support this mode, but are expensive. For this reason, a parity setting is provided to allow use of easily available and relatively inexpensive commercial modems. This will result in a small reduction in data security, and the system will not be compatible with true IEC 60870-5-103 control systems.

3.4.1 Connecting a Modem to the Relay(s)

RS232C defines devices as being either Data Terminal Equipment (DTE) e.g. computers, or data Communications Equipment (DCE), e.g. modems, where one is designed to be connected to the other, see Figure 3-2. In this case, two DCE devices (the modem and the fibre-optic converter) are being connected together, so a null terminal connector is required, which switches various control lines. The fibre-optic converter is then connected to the relay network Tx to Relay Rx and Rx to Relay Tx.

3.4.2 Setting the Remote Modem

The exact settings of the modem are dependent on the type of modem. Although most modems support the basic Hayes 'AT' command format, different manufacturers use different commands for the same functions. In addition, some modems use DIP switches to set parameters, others are entirely software configured.

Before applying the following settings, the modem's factory default settings should be applied, to ensure it is in a known state.

Several factors must be considered to allow remote dialling to the relays. The first is that the modem at the remote end must be configured as auto answer. This will allow it to initiate communications with the relays. Next, the user should set the data configuration at the local port, i.e. baud rate and parity, so that communication will be at the same rate and format as that set on the relay and the error correction is disabled.

Auto-answer usually requires two parameters to be set. The auto-answer setting should be switched on and the number of rings after which it will answer. The Data Terminal Ready (DTR) settings should be forced on. This tells the modem that the device connected to it is ready to receive data.

The parameters of the modem's RS232C port are set to match those set on the relay, set baud rate and parity to be the same as the settings on the relay and number of data bits to be 8 and stop bits 1. Note, although the device may be able to communicate with the modem at say 19200 bps, the modem may only be able to transmit over the telephone lines at 14400 bps. Therefore, a baud rate setting on which the modem can transmit should be chosen. In this example, a baud rate of 9600 should be chosen.

As the modems are required to be transparent, simply passing on the data sent from the controller to the device and vice versa, error correction and buffering is turned off.

If possible, Data Carrier Detect (DCD) should be forced on, as this control line will be used by the Fibre-optic converter.

Finally, these settings should be stored in the modem's memory for power on defaults.

3.4.3 Connecting to the Remote Modem

Once the remote modem has been configured correctly, it should be possible to dial up the modem and make connection to the relay. As the settings on the remote modem are fixed the local modem should negotiate with it on connection choosing suitable matching settings. If it cannot do this, the local modem should be set with settings equivalent to those of the remote modem as described above.

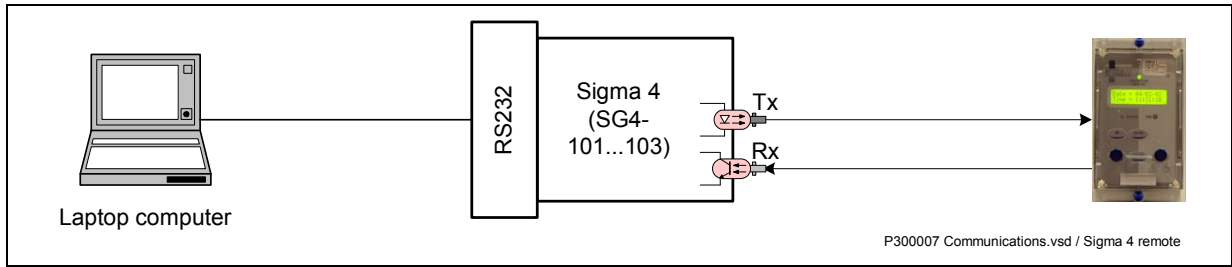


Figure 3-1 Communication to Modular II Device using Sigma 4 (Local Connection)

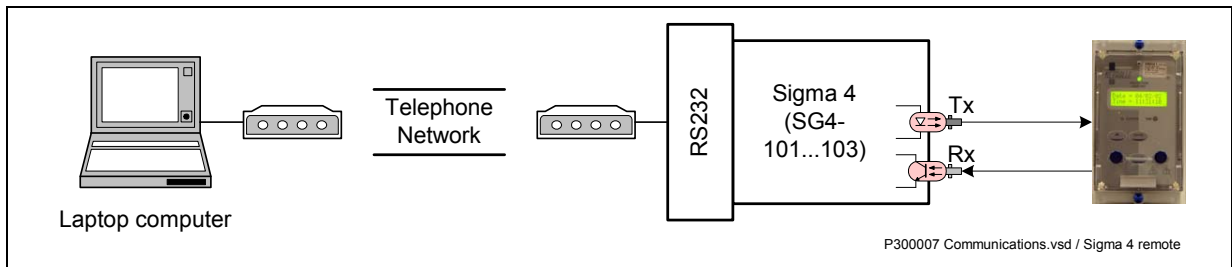


Figure 3-2 Communication to Modular II Device using Sigma 4 and Modem

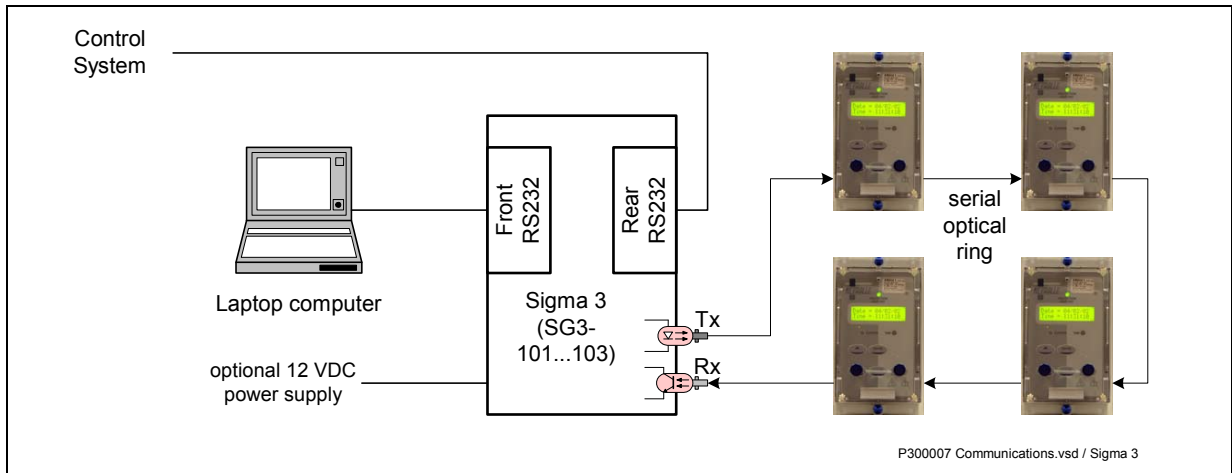


Figure 3-3 Communication to Multiple Modular II Devices from Control System and Laptop with Sigma 3 and Fibre-optic Ring Network

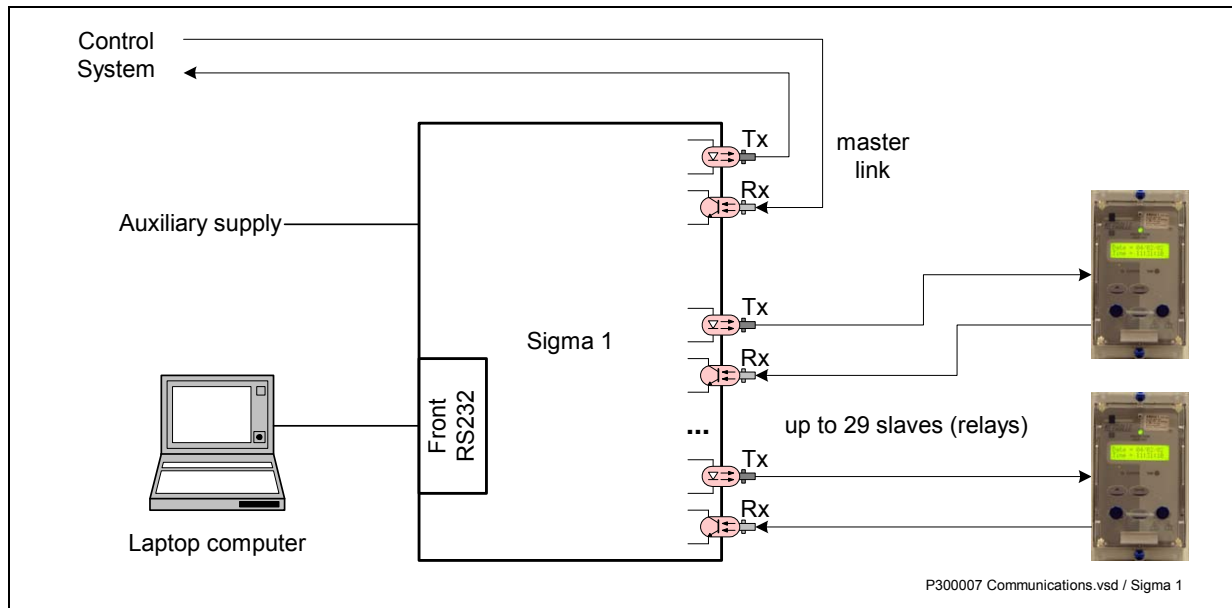


Figure 3-4 Communication to Multiple Modular II Devices from Control System and Laptop with Sigma 1 and Fibre-optic Star Network

3.5 Glossary

Baud Rate

See bits per second.

Bit

The smallest measure of computer data.

Bits Per Second (BPS)

Measurement of data transmission speed.

Data Bits

A number of bits containing the data. Sent after the start bit.

Half-Duplex Asynchronous Communications

Communications in two directions, but only one at a time.

Hayes 'AT'

Modem command set developed by Hayes Microcomputer products, Inc.

Modem

MOdulator / DEModulator device for connecting computer equipment to a telephone line.

Parity

Method of error checking by counting the value of the bits in a sequence, and adding a parity bit to make the outcome, for example, even.

Parity Bit

Bit used for implementing parity checking. Sent after the data bits.

RS232C

Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.

Start Bit

Bit (logical 0) sent to signify the start of a byte during data transmission.

Stop Bit

Bit (logical 1) sent to signify the end of a byte during data transmission.