SIEMENS

VL Circuit Breakers

Communication Application Guide

Answers for infrastructure and cities

Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger. This equipment contains hazardous voltages. Death, serious personal injury, or property damage can result if safety instructions are not followed. Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, and

Danger
For the purpose of this manual and product labels, DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Warning
For the purpose of this manual and product labels, WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution
For the purpose of this manual and product labels, CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Attention
Draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel
For the purpose of this manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he or she has the following qualifications: (a) Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices. (b) Is trained in the proper care and use of protective equipment, such as rubber gloves, hard hat, safety glasses or face shield, arc flash clothing, etc., in accordance with established safety practices. (c) Is trained in rendering first aid.

Correct Usage

Note the following:

Warning
This device and its components may only be used for the applications described in the catalog or the technical descriptions, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

NOTE - These instructions do not purport to cover all details or variations in equipment, or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise, which are not covered sufficiently for the purchaser’s purposes, the matter should be referred to the local Siemens sales office. The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

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VL Circuit Breakers Communication Application Guide

Introduction and Overview

VL Circuit Breaker

This manual is aimed at those who want to find out more about the application benefits of communication capable circuit breakers in power distribution systems. It also contains a detailed guide to commissioning, operating,

Introduction and overview
Businesses are becoming increasingly more intelligent about the way they consume energy. Industrial and commercial energy consumers are continuously looking for practical and efficient methods of measuring their current usage while simultaneously minimizing any downtime. At Siemens we understand those needs and we have developed products and solutions to help our customers exceed their goals. The real power and benefit of modularity begins with our VL Circuit Breakers. The VL family of breakers is a Siemens design that combined decades of patented circuit breaker protection experience with the latest technology in circuit breaker performance, modularity, and communication. Siemens VL Circuit Breakers are designed on the principal of contact magnetic repulsion. This allows the current limiting effect of the breakers to help protect the system components from the thermal and dynamic magnetic effects of short circuit currents in the event of an electrical fault. VL Circuit Breakers feature both thermal magnetic and electronic trip units across the entire product line, assuring compatibility for virtually any application. All of the VL Trip Units are UL listed for field installation and measure true RMS current. This type of measurement ensures the most accurate means of measuring currents in today's harmonic filled electrical distribution systems.

VL Trip Units are available for the following applications:

- Line Protection – time current curves are matched to protect cables, wiring and non-motorized loads.
- Motor Circuit Protection – equipped with adjustable instantaneous short circuit protection, trip characteristics are designed for optimum protection and isolation in combination starter applications (consisting of a motor circuit protector, contactor, and overload relay).
- Molded Case Switch (MCS) – can be used as supply, main or non-automatic switches without overload protection. They are fitted with fixed self-protective instantaneous settings.

Efficient solution
VL circuit breaker ratings range from 30-1600 amperes. Seven frame sizes are used to cover the entire range in order to allow users a common platform of breakers that are interchangeable and reconfigurable. Most of the options and accessories are also common between breakers providing a seamless means of system integration and expansion. Providing efficiency through modularity isn't unique. But providing the right component technology that allows you to send PROFIBUS® or MODBUS® data over your network or the Internet for integrated power management and protection is.

Options include:

- Thermal Magnetic Trip Unit (Model 525): Uses a bimetallic element to have thermal memory
- Electronic Trip Unit (Model 555): Contains no thermal or magnetic element. The 555 uses a waveform algorithm to simulate thermal memory allowing for more fine tuning of time current curves with tighter tolerances.
- Electronic Trip Unit with LCD (Model 586): Similar to Model 555, the 586 is an electronic trip unit. Unlike the 555, the 586 has an LCD display and the ability to adjust all the parameters (the 555 has some fixed settings)

Overview of the Bus Systems

Communication bus systems are used to connect distribution devices with varying levels of intelligence. With their different structures and mechanisms, certain bus systems are designed for highly specific applications, while others are better suited for more open applications. The following section describes bus systems used in various SCADA (supervisory control and data acquisition) systems.

PROFIBUS
PROFIBUS-DP is an open, standardized, multi-vendor field bus system. Standardized to DIN (E) 19424 Part 3 / EN 50170, it is ideally suited to fulfill the stringent requirements for exchanging data in distributed peripheral and field devices.

A PROFIBUS device can be easily integrated in and connected to standard automation systems. Many major manufacturers of programmable control systems offer PROFIBUS-DP master modules. The high transmission rates of up to 12 MBaud ensure virtually real-time system operation.

The protocol used by the PROFIBUS-DP stations supports communication between the complex, equal-priority programmable controllers (masters). Each station completes its communication task within a defined time frame.

In addition, straightforward, cyclic and acyclic data exchange is carried out for communication between a master and the simple peripheral devices (slaves) assigned to it.

PROFIBUS-DP achieves this using a bus access control mechanism comprising a central token passing procedure between the active stations (masters) and a central master-slave procedure for exchanging data between the active and passive stations.

Bus access control enables the following system configurations to be implemented:

- Pure master-slave system
- Pure master-slave system with token passing
- A system combining both types

Figure 1 shows an example with three master modules and seven slaves. The three master devices form a logical ring. The MAC (medium access control) monitors the token, creates the token in the rampup phase, and monitors whether just one token is really circulating in the ring.

Each slave that communicates cyclically via the PROFIBUS-DP is assigned a class one master. Cyclic data exchange is carried out to the standard DP profile (DPV0).
A class one master is mainly used for automation tasks. In addition to cyclic data exchange, a class one master can also establish an acyclic communication connection to its slaves, which enables it to use the extended slave functionality.

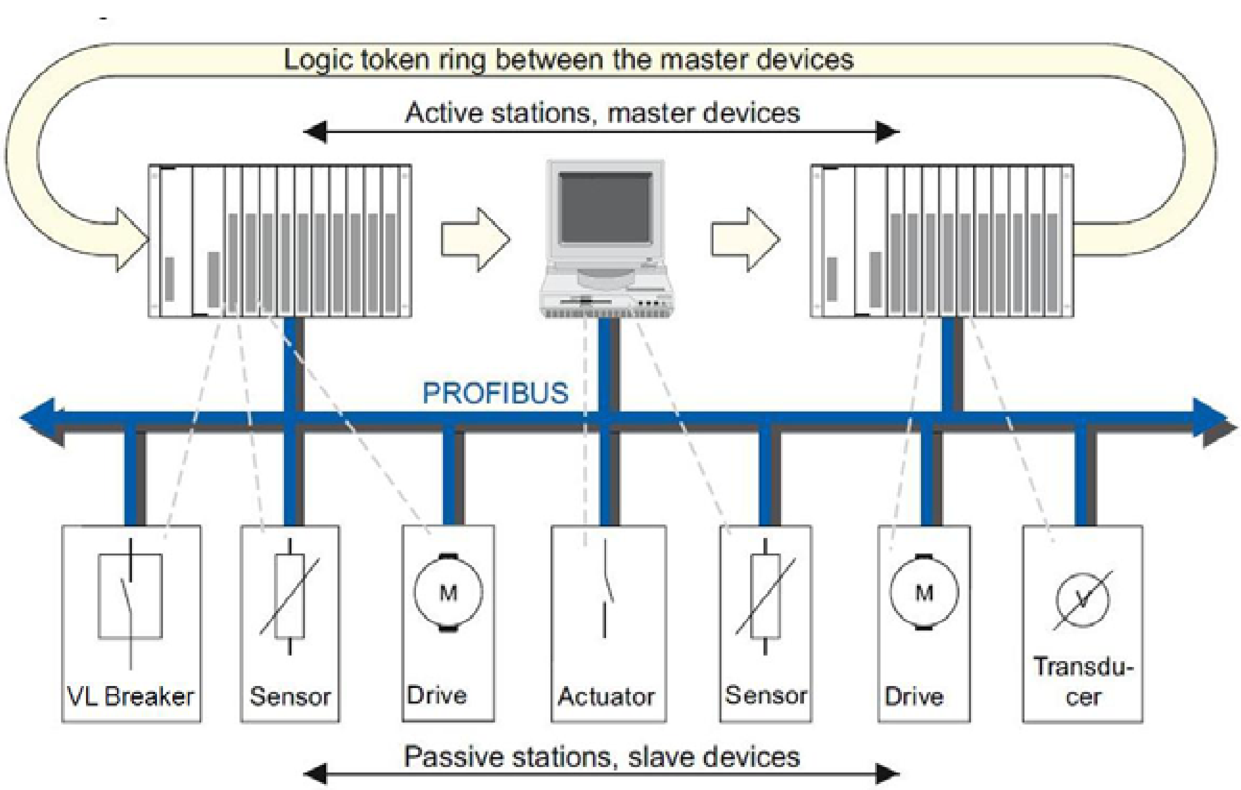


Figure 1 Communication on the PROFIBUS: token passing between the masters; polling between the master and slave stations



A class two master is particularly suitable for commissioning, diagnosis, and visualization tasks. In addition to the class one master, it is connected to the PROFIBUS-DP and can access slaves and exchange data using acyclic services (providing the slaves allows this).

Acyclic data transmission is carried out via DPV1. The existing PROFIBUS standard has been extended to include DPV1 with a number of additional functions. This enables the slave to be reparameterized during operation, for example, an acyclic data transmission to be carried out. DPV1 also allows data to be read directly from the slave by a class two master, even though this is still logically connected to a class one master. Both DPV1 and DP standard transmission takes places across one line.

Acyclic data transmission can be used when an operator control and monitoring system, such as WinCC, is implemented. The PC used with an integrated PROFIBUS-DP interface card then takes on the role of the class two master, from which the data records are transmitted via DPV1 and new values set, for example, if the tripping current value is changed. Cyclic data exchange between the circuit breaker and the PLC continues as normal.

Communicating with the Circuit Breaker

Ethernet
Industrial Ethernet is a high-performance network that conforms to IEEE 802.3 (ETHERNET). The highly successful 10Mbit/s technology, which has been used for over a decade, and the new 100Mbit/s technology (Fast Ethernet to IEEE 802.3U) in conjunction with Switching Full Duplex and Autosensing enable the required network performance to be adapted to different requirements. The appropriate data rates are selected as required because complete compatibility enables the technology to be implemented on a step-by-step basis.

Used in 80% of networks, Ethernet is currently the best of its kind in LAN environments.

Ethernet does not function according to a master-slave principle. All the stations have equal priority on the bus, which means that any station can be the sender or receiver. A sender can only send on the bus if no other station is sending at that time. This is due to the fact that the stations are always "listening in" to find out whether any messages are being sent to them or any senders are currently active. If a sender has started sending, it checks that the message it has sent is not corrupt. If the message is not changed, the send operation continues.

If the sender detects that its data is corrupt, another sender must have already started sending data. In this case both senders abort their respective send operations.

After a random time has elapsed, the sender restarts the send operation. This is known as CSMA/CD and, as a "random" access procedure, does not guarantee a response within a certain time frame. This largely depends on the bus load, which means that real-time applications cannot yet be implemented with Ethernet.

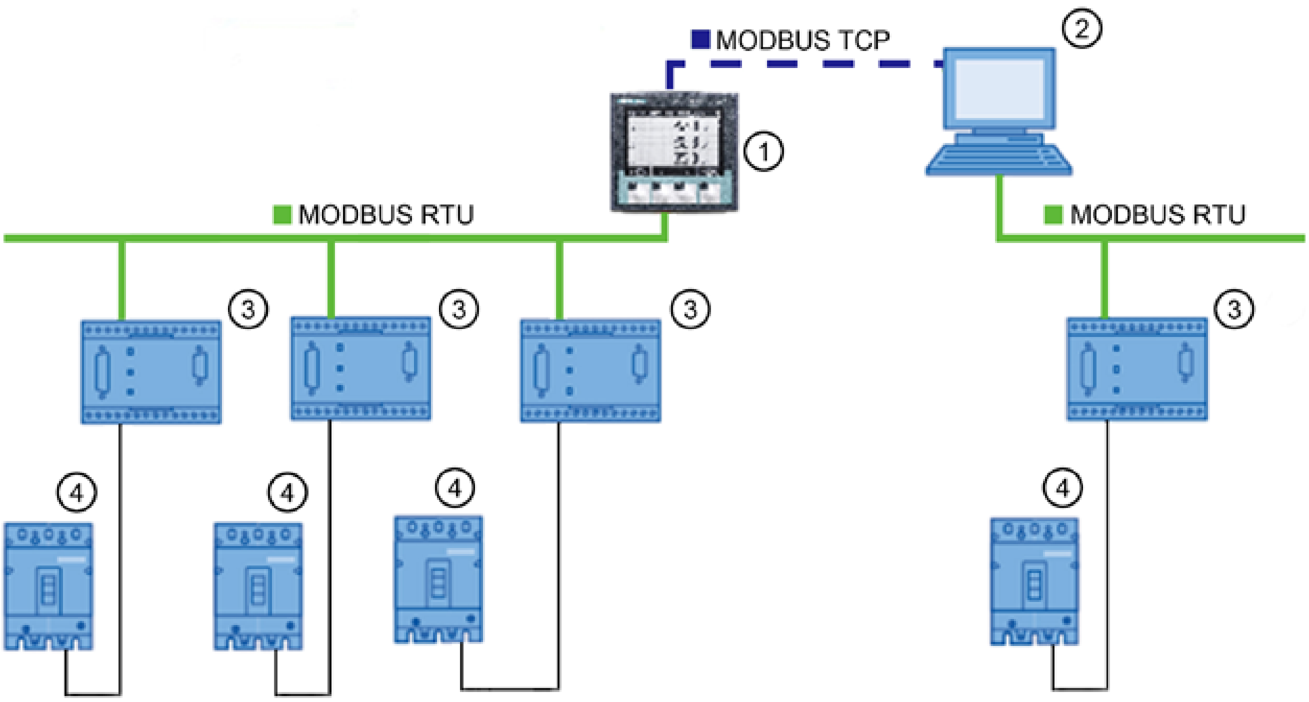
MODBUS
MODBUS is an open, serial communications protocol based on a master-slave architecture. Since it is very easy to implement on any kind of serial interface, it can be used in a wide range of applications. MODBUS comprises a master and several slaves, whereby communication is controlled exclusively by the master. MODBUS features two basic communication mechanisms.

- Question/answer (polling): The master sends an inquiry to a station and waits for a response
- Broadcast: The master sends a command to all the network stations, which execute the command without confirmation

The messages enable process data (input/ output data) to be written and read from the slaves either individually or in groups.

The data can either be transmitted in ASCII or as a package in RTU format. MODBUS can be used over a wide range of RS485 physical bus, a twisted, shielded two-wire cable with terminating resistors.

The MODBUS protocol was originally developed for networking control systems, and is often used for connecting input/ output modules to a central PLC. Due to the low transmission rate of 38.4 kBaud max., MODBUS is recommended for applications with a low number of stations or low response time requirements.



① TCP gateway provided by Siemens advanced power quality meters (PAC4200 shown)

② PC with WinPM.Net Power monitoring and management system

③ COM21

④ VL Circuit Breaker with model 586 LCD ETU

Figure 2 Example MODBUS System Architecture

VL Information

Brief Description of the VL Circuit Breaker

Thanks to their compact design, the VL circuit breakers meet the high requirements of today's electrical distribution systems. They are available both with thermal-magnetic overcurrent trip units (50 A to 1600 A), and with electronic trip units (30 A to 1600 A). Depending on the desired level of diversity of the data, the VL can be connected to PROFIBUS

Properties of the trip units

The electronic overcurrent tripping systems ETU and LCD ETU are suitable for rated currents in the range from 30 A to 1600 A. The difference between the two ETUs is that on the ETU without LCD, the settings for tripping current, delay time, etc. must be made using the rotary coding switch.

By contrast, on the VL with LCD, the settings can be made conveniently using a menu-prompted display that also shows individual phase current values during operation.

Table 1: Trip Unit Properties

Trip Unit Functions	VL Trip Units							
	Model 525	Model 555				Model 586		
	Thermal-magnetic	Electronic LI	Electronic LIG	Electronic LSI	Electronic LSIG	Electronic with LCD LSI	Electronic with LCD LSIG	Electronic with LCD LSI + G alarm only
Continuous Current Setting (Ir)	Fixed	▯	▯	▯	▯	▯	▯	▯
Long Time Delay (tr)	▯	▯	▯	▯	▯	▯	▯	▯
Instantaneous Function	▯	▯	▯	▯	▯	(ON/OFF)	(ON/OFF)	(ON/OFF)
Instantaneous Pickup (Ii)	▯	▯	▯	▯	▯	▯	▯	▯
Short Time Function	▯	▯	▯	▯	▯	(ON/OFF)	(ON/OFF)	(ON/OFF)
Short Time Pick-up (Isd)	▯	▯	▯	▯	▯	▯	▯	▯
Short Time Delay (tsd)	▯	▯	▯	▯	▯	▯	▯	▯
Ground Fault Pick-up (Ig)	▯	▯	▯	▯	▯	▯	▯	▯
Ground Fault Delay (tg)	▯	▯	▯	▯	▯	▯	▯	▯
Ground Fault Alarm Pick-up	▯	▯	▯	▯	▯	▯	▯	▯
Ground Fault Alarm Delay	▯	▯	▯	▯	▯	▯	▯	▯
Alarm & Status Indicator	▯	▯	▯	▯	▯	▯	▯	▯
Built-in Display (LCD)	▯	▯	▯	▯	▯	▯	▯	▯
Pre-Trip Alarm ①	▯	▯	▯	▯	▯	▯	▯	▯
Last Trip Information ①	▯	▯	▯	▯	▯	▯	▯	▯
Zone Selective ①	▯	▯	▯	▯	▯	▯	▯	▯

▯ - Adjustable setting
▯ - This feature is included
▯ - Feature is not included.

Transferable Data
All the available data is read from the trip unit and made available on the bus via the connection. This option provides a direct communication link between the VL and PROFIBUS DP or Modbus RTU. The VL circuit breaker must be equipped with a communication-enabled ETU for connection to COM20/COM21. Table 2 provides an overview of the transferrable data of COM20 and COM21:

COM20(PROFIBUS)/ COM21(MODBUS) Module

PROFIBUS Module COM20
With the COM20, the VL circuit breaker can exchange data via PROFIBUS DP with two masters simultaneously, e.g. class 1 master and class 2 master. This facilitates the use of parameterization tools, diagnostics tools, operator control and monitoring systems (e.g. WinCC) for the VL.

MODBUS Module COM21
The COM21 module enables the VL circuit breakers to be connected to any MODBUS master network.

If security considerations demand it, it is possible to lock control/write access to the circuit breaker via hardware and software using a hardware wire jumper (WE terminal).

All important events receive a time stamp from the integral clock (time stamp for tripping operations (TripLog), no time stamp for alarms (WarningLog), no time stamp for maximum values (Tstamp)), to enable tracing of the precise course of a fault, for example. The clock can be synchronized with the clock of the automation system by means of a simple mechanism.

Table 2: Transferable Data

List	ETU 555	ETU 586
Switching on or off (in conjunction with a motorized operating mechanism)	✓	✓
Delete Local Trip Memory	✓	✓
Delete alarm and tripping operation buffer	✓	✓
Delete max. measured values	✓	✓
Delete maintenance information	✓	✓
ON or OFF status	✓	✓
Tripped signals	✓	✓
Tripped signals with cause of tripping operation, tripping current and time stamp	✓	✓
Alarm (e.g. overload)	✓	✓
Alarm with Timestamp	✓	✓
Max. phase current of a phase	✓	✓
Phase currents with min./ max. value and time stamp	max. only	max. only
Read/write to LCD ETU	read only	
Read ETU	✓	✓
Number and type of LSIG tripping operations	✓	✓
Operating hours	✓	✓
Type of trip unit: LSIG	✓	✓
Current sensor rating	✓	✓
Serial no. of the trip unit	✓	✓
Software version of the trip unit	✓	✓
Time synchronization	✓	✓

HAZARDOUS VOLTAGE
Will cause death or serious injury.

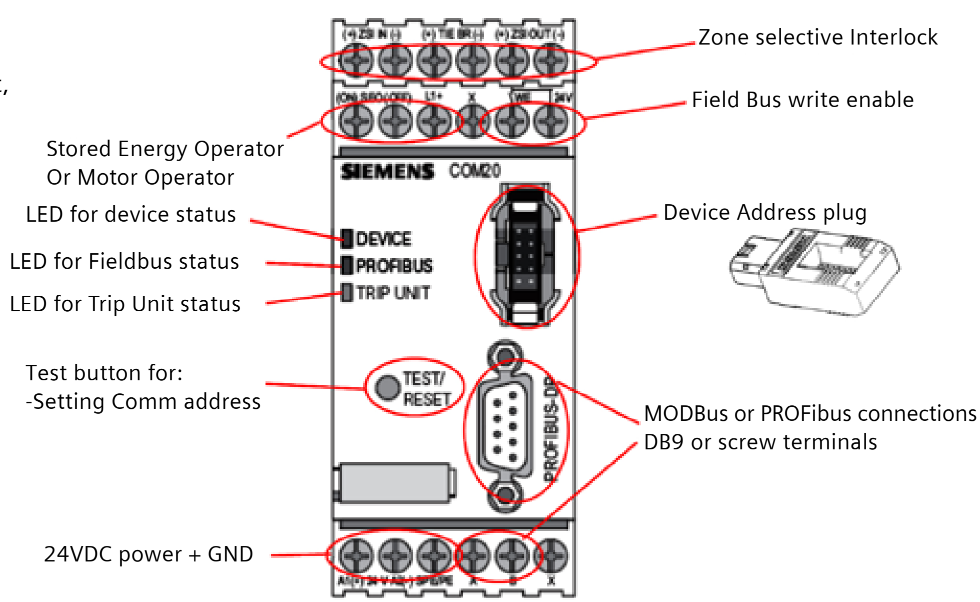


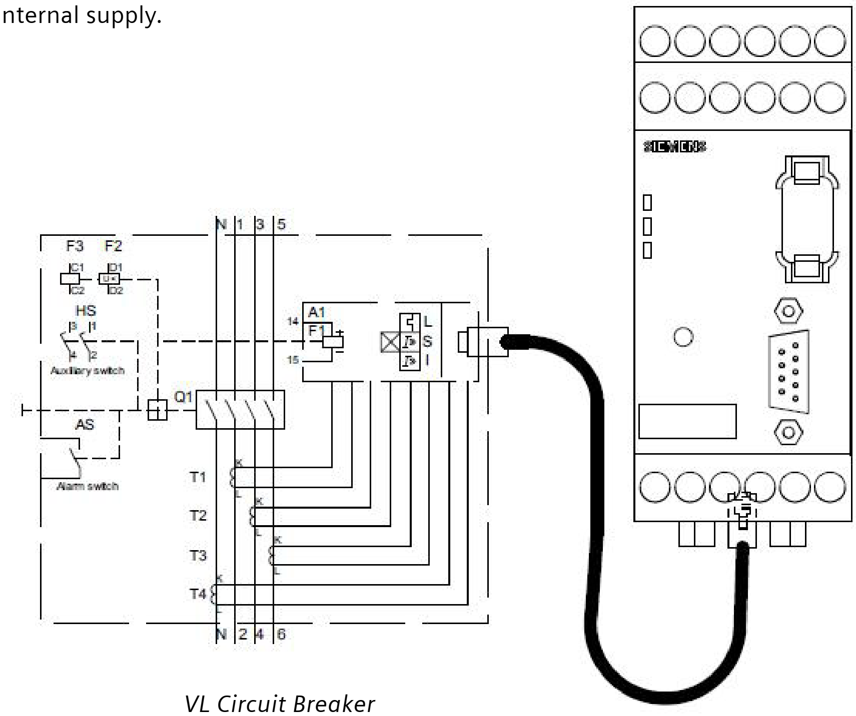
Figure 3 COM20 Device Detail

Pin Configuration

The COM20/COM21 must be supplied with 24 V DC for operations and this must be applied to the terminals A2 (ground) and A1 (+). This voltage is looped-through via the communication cable to the ETU (trip unit) of the VL breaker such that this is also operated when the main contacts are open. Without this supply the ETU would not be able to communicate diagnostics information, such as the reason for the last tripping operation if there is no internal supply.

The auxiliary and alarm switches are not wired to COM20/COM21, but direct to the ETU, and the communication status is forwarded to the modules.

Figure 4 shows the principle of the connection between the COM20/ COM21 and a VL including the LEDs and the PROFIBUS write protection DPWriteEnable.



VL Circuit Breaker

Figure 4 COM20/COM21 Connection to VL

PROFIBUS Installation Guide
The COM20 must be installed in accordance with the installation guidelines for PROFIBUS DP published by PROFIBUS International (PI, www.profibus.com). Of primary importance here are equipotential bonding and shielding.

PROFIBUS/MODBUS Write Protection
In real applications in power distribution, it is necessary to disable write access via PROFIBUS temporarily or permanently, during maintenance work, for example.

You must ensure remote access is possible for setting the address and the trip unit values. For this, the inputs WE and 24 V DC (DPWriteEnable) on the module must be jumpered or closed via a switch.

If this is not the case, no settings can be written to the module and the LCD ETU. In addition, operation of the motorized operating mechanism via PROFIBUS/MODBUS is not possible.

Communication connection to the ETU
The ON/OFF position (auxiliary switch), and the triggered signal (alarm switch) of the switch are signaled via the wiring of the ETU. The auxiliary and alarm switches are supplied with the communication cable kits. Details may be found in the installation instructions of the respective COMKITS.

Different communication cables must be used depending on which VL circuit breaker is used.

These cables are listed with their different lengths and assignments in Table 3. They must be ordered separately.

Table 3: Communication Cables Available for Order

1.5 m (4.9 ft) for DG, FG frames	**COMKIT3**
1.5 m (4.9 ft) for JG, LG frames	**COMKIT4**
1.5 m (4.9 ft) for MG, NG, PG frames	**COMKIT5**
3.0 m (9.8 ft) for DG, FG frames	**COMKIT6**
3.0 m (9.8 ft) for JG, LG frames	**COMKIT7**
3.0 m (9.8 ft) for MG, NG, PG frames	**COMKIT8**

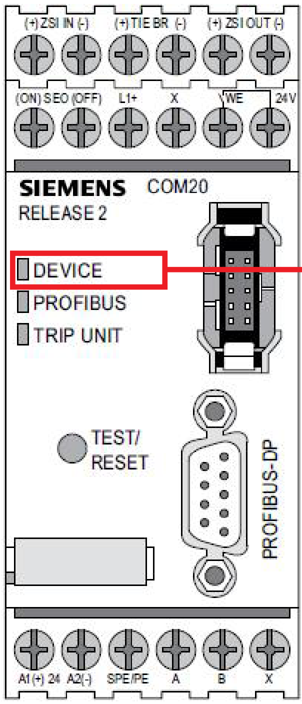
Table 4: COM20/COM21 Technical Data

Permissible ambient temperature	In operation	-25 °C...+70 °C, no condensation
	During storage and transportation	-40 °C...+80 °C
Installation altitude above sea level		< 2000 m
	Permissible max. ambient temperature +50 °C (no safe isolation)	< 3000 m
Weight		approx. 0.28 kg / 0.62 lbs
Degree of protection according to IEC 60529		IP20
Shock resistance (sine pulse)		100 m/s² 20 ms 220 m/s² 11 ms
Mounting position		Arbitrary
Immunity to electromagnetic interference according to IEC 60947-1	Conducted interference; burst according to IEC 61000-4-4	2 kV (power ports) 2 kV (signal ports)
	Conducted interference; high-frequency according to IEC 61000-4-6	10 V
	Conducted interference; surge according to IEC 61000-4-5	1 kV (line to ground)
	Electrostatic discharge; ESD according to IEC 61000-4-2	8 kV (air discharge) 4 kV (contact discharge)
	Field-based interference suppression; radiated immunity according to IEC 61000-4-3	10 V/m
Immunity to electromagnetic interference according to IEC 60947-1	Conducted and radiated interference emission	DIN EN 55011, A /DIN EN 55022, A
Safe isolation according to IEC 60947-1	All circuits are safely isolated from the control circuit for the motor operator in accordance with IEC 60947-1 (terminal SEO (ON), SEO (OFF), L1+), that is, dimensioned with double creepages and clearances	
Mounting	Snap-mounted to 35 mm DIN rail or screw mounted via additional lugs	

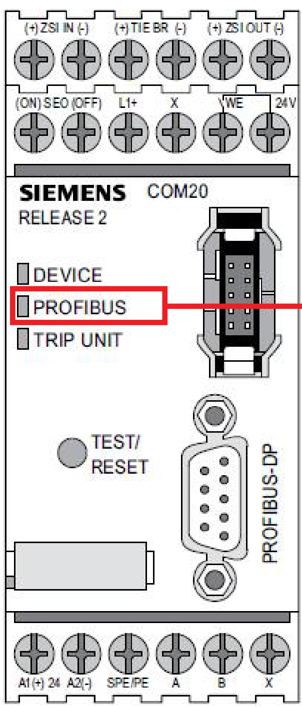
Table 4: COM20/COM21 Technical Data (continued)

TEST/RESET button		Setting of the communication address of the side box
		ZSI function test
		Reset of the side box back to the start sequence
System interface	Front	10-pin system interface for connecting the addressing plug
	Bottom	RJ45 socket for communication link to ETU
PROFIBUS DP interface (COM20)		Connection of PROFIBUS DP cable via terminal connection A, B (max. 1.5 MBaud) or 9-pin SUB-D socket (max. 12 MBaud)
MODBUS interface (COM21)		Connection of the MODBUS cables via terminal connection A, B or 9-pin SUB-D socket
Operating voltage	V_S in accordance with DIN EN 61131-2 0.85 ... 1.2 x V_S	24 V DC
Power consumption		1.2 W
Current consumption	V_S = 24 V DC	Max. 50 mA
Rated insulating voltage	V_I	300 V (pollution degree 3)
Rated peak withstand voltage	V_{Imp}	4 kV
Relay outputs for controlling a motorized operating mechanism (3VL9x00-3Mx00) for VL160x and VL160-VL1600	Number	
	ON duration	
	Rated short-circuit capacity	
	Specified short-circuit protection	
Output	ZSI OUT - Output for Zone Selective Interlocking (ZSI); max. 8 circuit breakers	
Inputs (binary)	1 input with its own supply (24 V DC) from the device electronics for the WE function (write protection for PROFIBUS DP/Modbus RTU)	
	H signal	V_{In}: 15...30 V; I_{In}: Typically 5 mA for 24 V
	L signal	V_{In}: 0...5 V; I_{In}: Typically 0.75 mA for 5 V
	ZSI IN - Input for Zone Selective Interlocking (ZSI); max. 20 circuit breakers	
Conductor cross-sections	Tightening torque	0.8...1.2 Nm
	Solid	1 x 0.5...4 mm^2; 2 x 0.5...2.5 mm^2
	Finely stranded with end sleeve	1 x 0.5...2.5 mm^2; 2 x 0.5...1.5 mm^2
	AWG cable (solid)	1 x AWG 20 to 12; 2 x AWG 20 to 14
	AWG cable (finely stranded)	1 x AWG 20 to 14; 2 x AWG 20 to 16

COM20 / COM21 - LED definitions

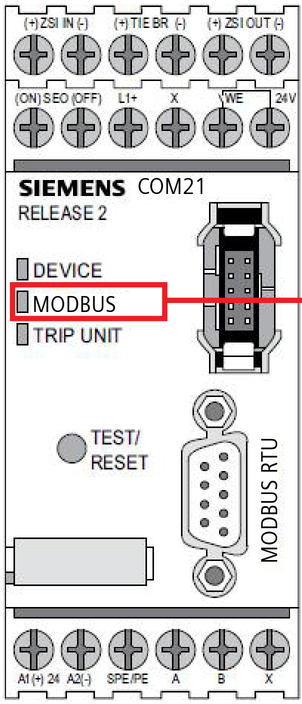


Device LED	Descriptions
Off	No Power on the module
Static Green	Module is being powered and no error in module and no address. Plug connected to module
Static Yellow	AddressPlug is connected to module; the address is not yet read from the AddressPlug and not stored in non-volatile memory of the module
Flashing Yellow	AddressPlug is plugged into the module and module has successfullly read tbe address from the AddressPlug and stored into non-volatile memory (either on startup of the module or buttton pressed on the module)
Flashing Red	AddressPlug is plugged into the module and AddressPlug is defective
Fast Flashing Red (with error code) (the error code is coded in n*blink – break" code)	Module has internal fatal error (the error code can be identified by the customer and helps trouble shooting problems at customer site)

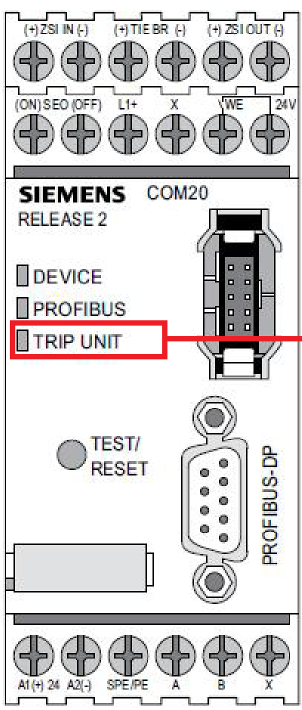


Profibus LED	Descriptions
Off	No Power on the module-DP, or module-DP is being powered and module-DP with no PROFIBUS master class 1 (cycle data exchange) or PROFIBUS master class 2 (a-cyclic data (DP-V1) exchange)
Static Green	Module-DP is being powered by ext. 24VDC power supply; PROFIBUS master class 1 (cycle data exchange) connection established (PROFIBUS in data_ex mode)
Flashing Green	Module-DP is being powered by ext. 24VDC power supply; PROFIBUS master class 2 (a-cyclic data (DP-V1) exchange) connection established; no PROFIBUS master class 1 connection established

COM20 / COM21 - LED definitions



Modbus LED	Descriptions
Off	No Power on the module-DP, or module-DP is being powered and module-DP with no PROFIBUS master class 1 (cycle data exchange) or PROFIBUS master class 2 (a-cyclic data (DP-V1) exchange)
Static Green	Module-DP is being powered by ext. 24VDC power supply; PROFIBUS master class 1 (cycle data exchange) connection established (PROFIBUS in data_ex mode)
Flashing Green	Module-DP is being powered by ext. 24VDC power supply; PROFIBUS master class 2 (a-cyclic data (DP-V1) exchange) connection established; no PROFIBUS master class 1 connection established



Trip Unit LED	Description
Off	No Power on the module; or there is no communication or a communication error between the 3VL Trip Unit and the module
Static Green	Module is being powered by ext. 24VDC power supply; communication to the 3VL Trip Unit is OK

ZSI
Zone Selective Interlocking

Zone Selective Interlocking (ZSI) is a method which allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with a minimum time delay. The primary goal of ZSI is to limit stress on the distribution system by clearing a fault in the shortest time without sacrificing coordination. The benefits of ZSI are lower potential costs of system damage due to the reduced time to clear faults and increased uptime because coordination is not sacrificed.

Time Selectivity
One method of achieving this aim in the short-circuit or ground fault is time selectivity (see Figure 5).

This means each level of the circuit breaker receives another time delay (t_{sd}) that rises in the direction of the incoming supply. Tripping of the circuit breakers that are further removed from the short-circuit is thus delayed and the circuit breaker closest to the short-circuit is given time to switch the short-circuit off.

ZSI function
ZSI offers selectivity with an extremely short delay time (tZSI) regardless of the number of grading levels and the location of the fault in the distribution system in the short-time-delayed S range and G range of the trip characteristic.

S range = short-time-delayed short-circuit protection	=> t_{ZSI} = 50 ms
G range = ground fault protection	=> t_{ZSI} = 100 ms

The benefit of ZSI becomes apparent with increases in the number of grading levels in meshed networks as the resulting delay times for standard time grading become larger.

By shortening the break time, the ZSI function significantly reduces stress in the event of a short-circuit and/or ground fault.

Note - The ZSI function is only effective in the case of short-time-delayed short-circuit protection (S) up to the level of the preset maximum short-time-delayed short-circuit protection. If the short-circuit current exceeds this permissible maximum value, the short-circuit current is so great that instantaneous tripping of the circuit breaker always takes place in order to protect the system.

COM20/COM21
To use the ZSI function with the VL Circuit Breaker, the external communication module COM20 (Profibus DP) or COM21 (Modbus RTU) and an ETU or LCD ETU with communication capability must be used.

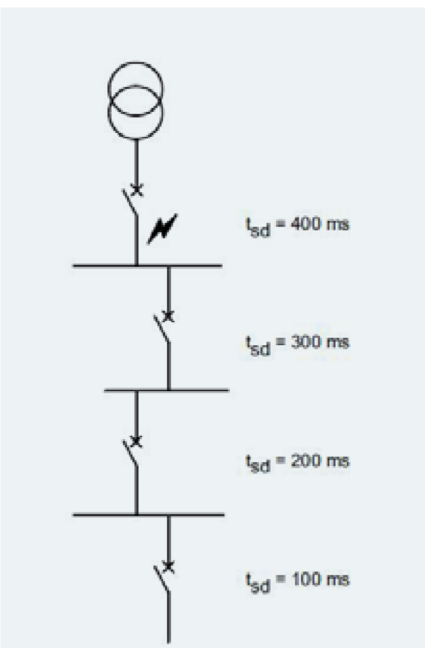


Figure 5 Example of Time Selectivity

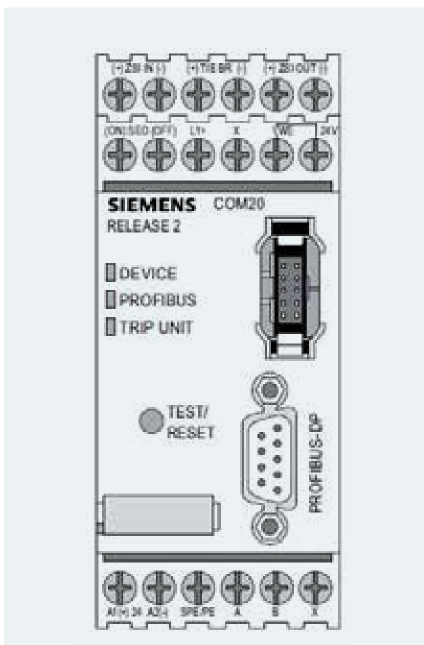


Figure 6 COM20 Device Detail

Technical Data:

Operating voltage min./max. (V)	20.4 / 28.8
Current consumption max. (mA)	50 mA
Automatic resetting of the outputs after a maximum of	3 s
Shortest time that blocking signal is pending at the outputs LV	100 ms
Typical tripping time including all delays approx.	80 ms
Maximum number of switches that can be connected to ZSI IN	20
Maximum number of switches that can be connected to ZSI OUT	8
Maximum cable length with 2 x 0.75 mm2	400 m
Power losses typ. [W]	1.2
Dimensions W/H/D (mm)	45 / 106 / 86
Weight (kg)	0.28

Operating Principle
If the COM20/COM21 module is used in a distribution system comprising of several levels, each circuit breaker affected by a short-circuit communicates with the circuit breaker directly downstream, to ascertain whether the short-circuit also occurred in the next level below:

- If the short-circuit did occur in the downstream level, the upstream circuit breaker delays tripping to ensure that the circuit breaker directly upstream of the short-circuit has enough time to interrupt the short-circuit
- If the circuit breakers in the downstream level do not report a short-circuit, the short-circuit occurred between the two levels in question. In this case, one of the two upstream circuit breakers interrupts the short-circuit once the programmed delay time of tZSI = 50 ms has elapsed.

Example
This shows ZSI wiring and the set delay times in a mixed system with WL and VL

Short-circuit at SC3:
Circuit breakers Q6, Q4, and Q1 establish that a short-circuit has occurred. Q6 blocks Q4 by means of the ZSI signal and, as a result, Q1 too, so that they do not trip in 50 ms. Since Q6 does not receive a blocking signal from a subordinate circuit breaker, it is responsible for interrupting the short-circuit as quickly as possible. If this does not take place, because the circuit breaker is no longer operational due to an overcurrent, Q4, as a backup, trips after the time-discriminating response time of 150 ms.

Short-circuit at SC2:
Q1 and Q4 establish that a short-circuit has occurred; Q6 does not. For this reason, Q4 does not receive a blocking signal from Q6, but provides a blocking signal for Q1. This information tells Q4 that it is closest to the short-circuit and trips with a delay of tS = 50 ms instead of tsd = 150 ms. Time saved = 100 ms.

Short-circuit at SC1:
Only Q1 establishes that a short-circuit has occurred and does not receive a blocking signal from a subordinate level. For this reason, it trips after tZSI = 50 ms. Time saved = 250 ms.

The ZSI function can be used for short-circuits between the phases (S), with respect to ground (G), or for both simultaneously (S+G).

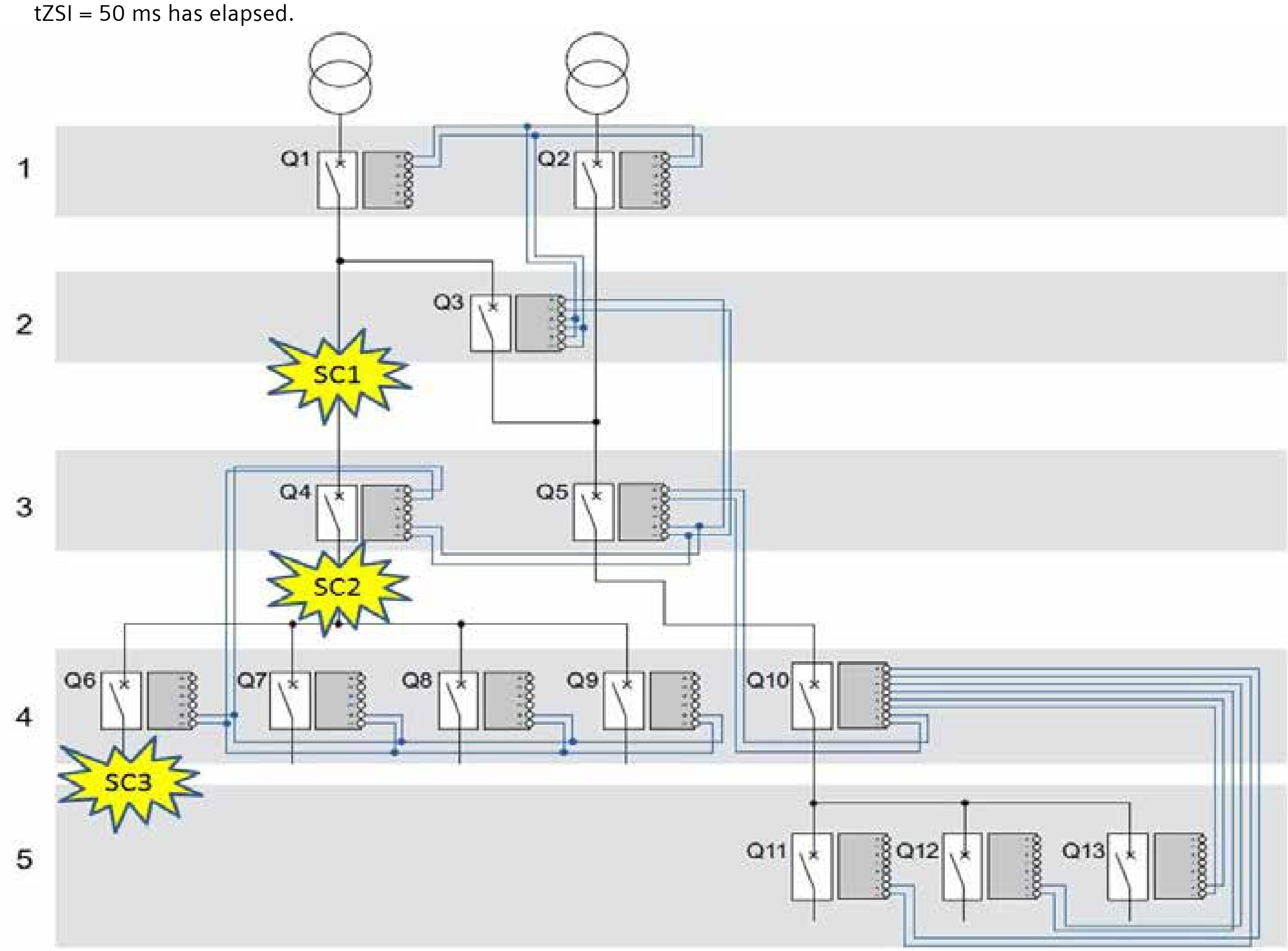


Figure 5 ZSI Wiring Example in a Mixed System of WLs and VLs

Connectivity
Both COM20/COM21 support ZSI functionality. The ZSI functionality is compatible to the current existing ZSI function of the WL circuit breaker as well as the current VL COM10/COM11.

Table 5: COM20/COM21 ZSI Connectivity

Terminal Connection	Connection
TIE BRKR (+ / -)	Only for special applications; Allows complete ZSI-functionality in systems with bus-couplers without additional components
ZSI IN (+ / -)	ZSI-modules of lower-level circuit-breakers

Connectivity Special Notes:

- The ZSI terminals at the module are polarity sensitive
- It is recommended to transfer the ZSI signal via a twisted-pair signal line with a cross-section of at least 18 AWG. The maximum length must not exceed 400 m. (Exception: If the higher level breaker is equipped with a COM10, the maximum cable length is limited to 20 m).
- The ZSI-module allows parallel connection of up to:
  - 20 circuit-breakers at the ZSI IN input and
  - 8 circuit-breakers at the ZSI OUT output
- COM2Xs in one grading level are switched in parallel
- If the ZSI function is activated, the Trip Unit LED on COM2X flashes green

Test Function
To test the ZSI interface at the customer site, perform the following:

1. Press and hold the “Test/Reset” button for a minimum of 5 seconds.
2. After 5 seconds the module sends a control command (via SEAbus communication) to the connected Trip Unit to assert the ZSI (OUT) signal.
3. If ZSI wiring is correct, the upstream breaker (with module connected) recognizes the ZSI signal on ZSI (IN).
4. The TripUnit of the upstream breaker sends the ZSI status of the ZSI (IN) signal via SEAbus communication to the connected module
5. The module (Upstream breaker) indicates the asserted ZSI (IN) signal with a blinking green “TripUnit LED”.

Profibus Profile for VL

A wide range of options are available for integrating VL circuit breakers in SCADA systems. New users will appreciate the straightforward and quick start-up options, while experienced users

Communication Options
The PROFIBUS COM20 module acts as an interface between the circuit breakers and the information environment. A joint device master file (GSD) can be used for integration in PROFIBUS-DP systems for all VL circuit breakers. A distinction between individual breakers and/or frame ratings cannot and does not have to be drawn. Of course, with an identical PROFIBUS-DP profile, the circuit breaker that is addressed can be accurately identified (e.g. device description order number, inspection date, etc.).

Figure 8 shows a chart of the different communication options. A class 1 master is the "configuration master," which transmits either the settings from the GSD file to the slave during start-up.

Another advantage of a joint communication profile is that the same software can be used for the automation systems, PCs, and operator control and monitoring software (e.g. WinCC, STEP 7). The profile is based on the PROFIBUS profile for low voltage switchgear (LVSG) of the PROFIBUS user organization (order no. 3.122)

Communication with a PROFIBUS-DP Class 1 Master
A class 1 master is the "configuration master," which, during start-up, determines the mode that the slave is to use for communication. In most cases, a class 1 master is a PLC, such as a SIMATIC S7 with a PROFIBUS-DP interface.

It is possible to integrate an additional communication system at any point in time, with DPV1 and read or write data records acyclically.

Communication with a PROFIBUS-DP Class 2 Master
PCs with PROFIBUS-DP cards are usually class 2 masters.

Communication with a class 2 master always takes place via DPV1.

Integration with the GSD file
The current version of the GSD file for the VL circuit breakers can be downloaded from the Service and Support Homepage:

1. Navigate to Service and support (http://support.automation.siemens.com)
2. Enter "sentron gsd" in the area "Search for product information" and select "GO." In the search result, the file "3WL_3VL.zip" contains all the necessary files.

The device parameters are configured using a configuration tool, which is available with every PROFIBUS-DP master. If you are using a SIMATIC S7 as the master, this is the HWConfig tool provided with the SIMATIC STEP7 package. If you are not using a SIMATIC S7, configuration can be carried out, for example, with COM PROFIBUS, depending on the master.

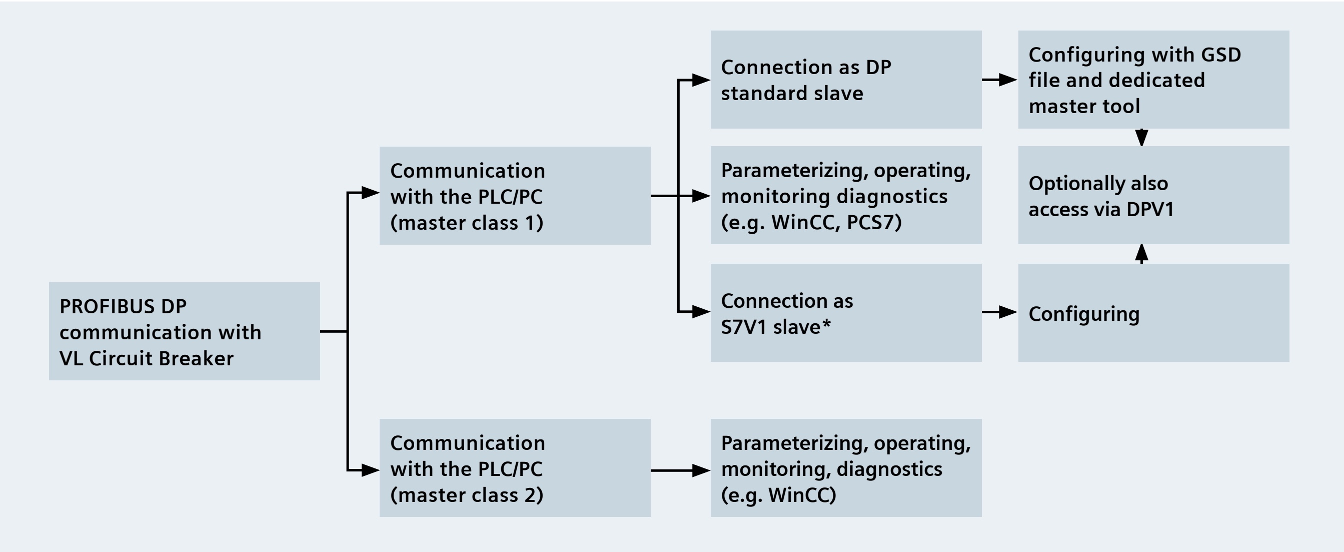


Figure 8 Communication Options of PROFIBUS with VL Circuit Breaker

Installing the GSD

If the GSD file that contains the generic station description of the circuit breaker has not yet been installed, this must be integrated in advance into the configuring tool.

You integrate the GSD file into the SIMATIC development environment with the hardware configuration editor "HW Config" as follows:

1. Open the "Hardware" object in the SIMATIC Manager
2. From the "Options" menu, choose "Install New GSD ...".
3. Select the source and the file "Siem80C0.gs*". The place holder "*" represents the relevant language index, g = German, e = English.

Following this, the VL is available for further configuring in the HW catalog under "PROFIBUS DP\Other field devices\Switchgear".

Example

The figure below shows the configuration tool of STEP7 HW Config with which both the automation system of S7 and its fieldbuses can be configured. To insert a VL circuit breaker, either a CPU with integral PROFIBUS DP interface or a PROFIBUS DP CP card in the rack must be configured and assigned to PROFIBUS DP.

Creating a master system

To create a DP master system using the HWConfig editor:

- Assign a master address between 1-125 (e.g. 11)
- Select the required transmission rate (e.g. 1.5 Mbit/s)
- Select the PROFIBUS-DP profile

Note - Depending on the PROFIBUS-DP configuration, you may need to make further settings in the master system.

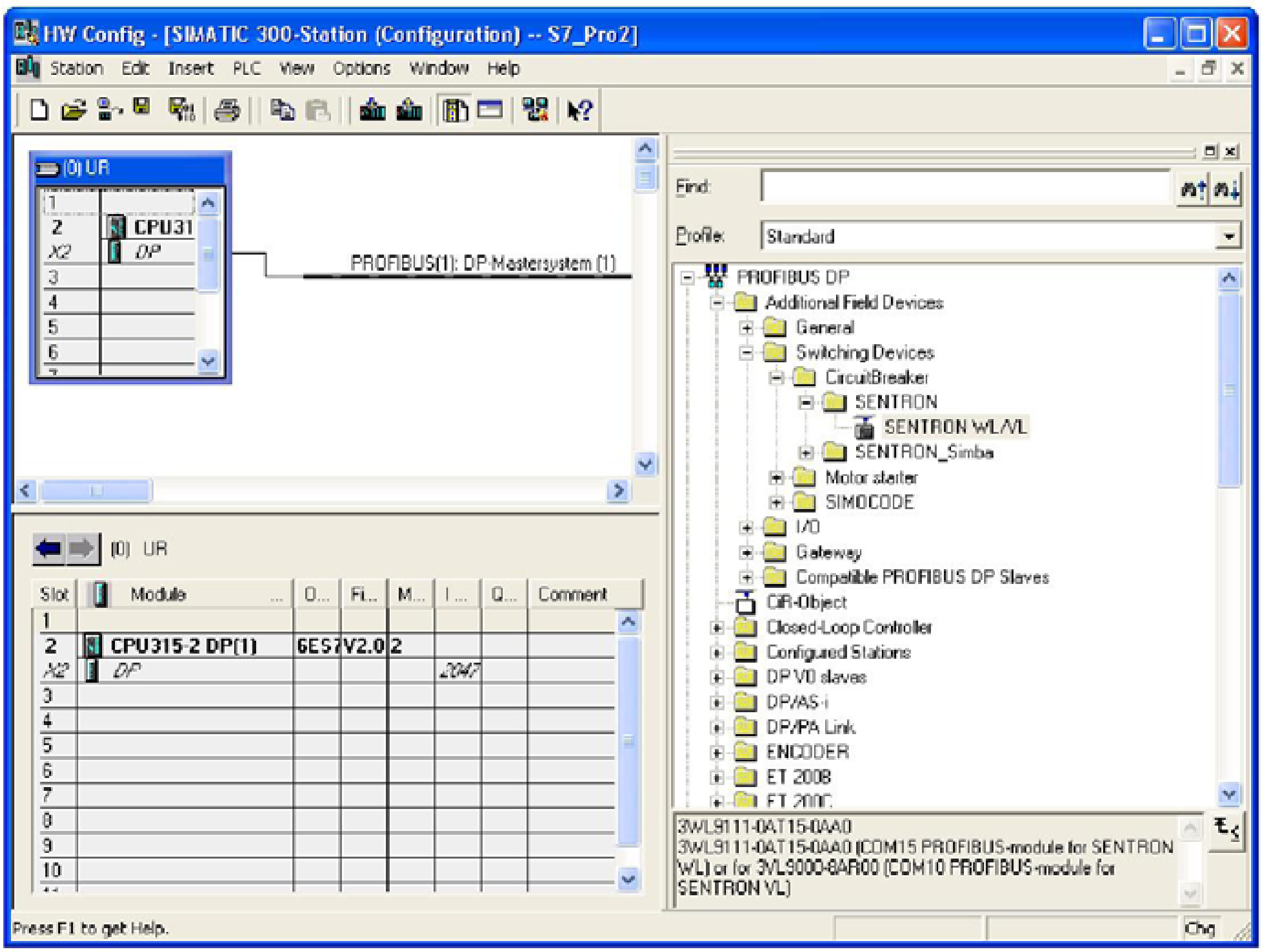


Figure 9 Configuration tool of STEP7 HW Config

Inserting and addressing the slave

First, select "SENTRON WL/VL" in the "Hardware Catalog" and drag it to the master system.

Note - When the 'SENTRON WL/VL' slave is selected, only a machine-readable product designation number (e.g. 3WL9111-0AT15- 0AA0) is displayed for information purposes. This does not affect the system function. You then have to select a basic type, which you can confirm with OK. To run the slave on PROFIBUS-DP, you still have to assign and set a unique address on this PROFIBUS-DP line.

If the properties are to be changed, select the slave and choose "Properties-DP slave."

Note - The settings on the "Hex Parameterization" tab do not need to be considered here. The PROFIBUS DP addresses 0 and 126 cannot be assigned. Address 0 is intended for the PG (class 2 master) and 126 is used predominantly for startup purposes or is also frequently used as the address of DP slaves as delivered. Through integration with the GSD file, the VL is always incorporated as a DP standard slave. It is optionally possible to transfer additional data via DPV1 and, for example, to change parameters.

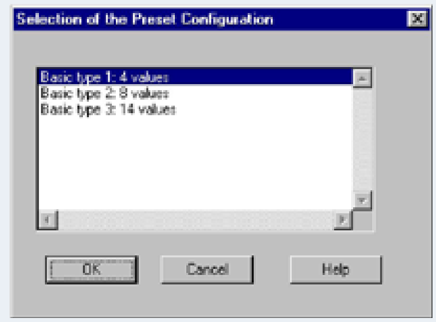


Figure 10 Selecting the preset configuration

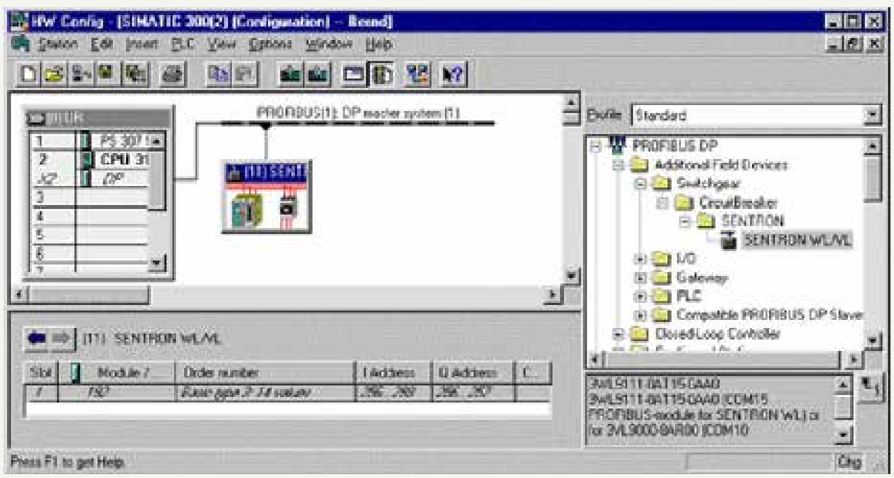


Figure 11 Setting the input address and the output address of the S7

Setting the input address/output address of the S7

After selecting the basic type, a VL circuit breaker symbol is shown on PROFIBUS DP. In the lower area of the split window, the input address/output address of the S7 which can be accessed in the STEP7 program can/must be set.

Reading out the diagnostics address for S7 functions

For certain functions (e.g. reading out diagnostics), the diagnostics address is subsequently necessary. You obtain this using the context menu (right-click on the slave) and the function "Object properties". You can then close the window again by clicking the "OK" button.

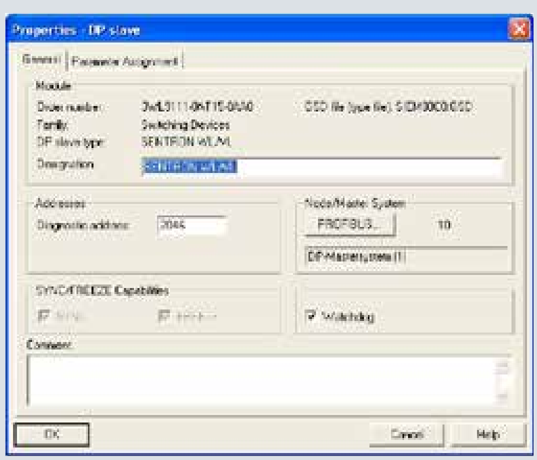


Figure 12 Reading Out the Diagnostics Address

The three communication paths

This concept enables you to get started quickly and simply with PROFIBUS DP communication with VL circuit breakers. The figures below show the three possible communication paths that enable you to get started simply and quickly and allow you to adapt to complex applications.

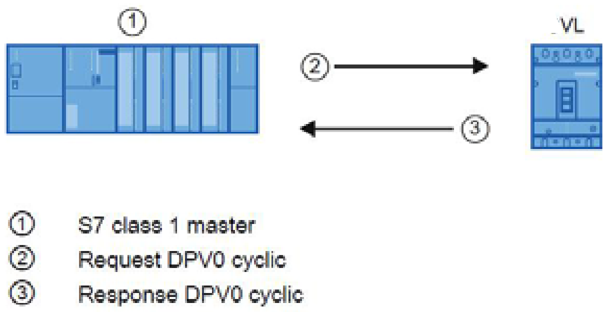


Figure 13 Path 1

Path 1 enables fast and simple entry to PROFIBUS DP communication. This path contains sufficient data to meet most requirements. Communication with path 1 always takes place with a class 1 master. With cyclic data, certain contents are predefined. These can be changed in the three basic types and thus easily adapted to requirements (e.g. replacement of the

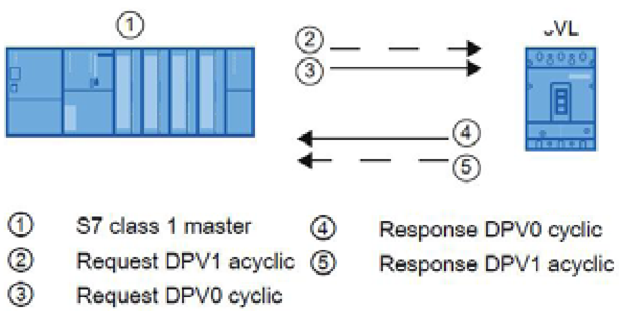


Figure 14 Path 2

With this, the VL can also be used to read or write acyclic data sets from a class 1 master. This is useful, for example, to request extremely extensive data

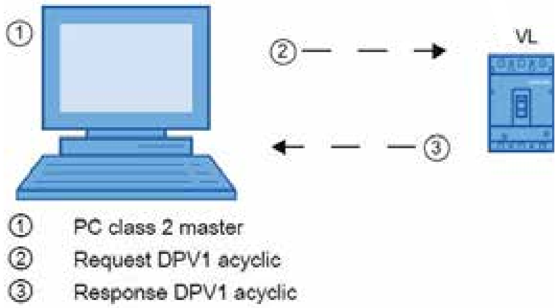


Figure 15 Path 3

With this, the VL can be used to read or write acyclic data sets from a class 2 master. This is useful, for

Setting the PROFIBUS Address for the COM20 Module
The PROFIBUS-DP address is stored in the COM20 PROFIBUS-DP module on the circuit breaker. The system is shipped with the default address 126. All the stations on the PROFIBUS-DP must have a unique address, which means that a new address must be assigned when the PROFIBUS-DP modules are commissioned.

If there is no cyclic data exchange with a class 1 master, the changed address becomes effective immediately. In the case of Switch ES Power this manifests itself as follows:

When downloading parameters with a new address, these are adopted and activated and thus the connection with Switch ES Power is immediately interrupted. The slave can be accessed under the new address from now on. Switch ES Power must be restarted.

The address is set or changed via the “addressing plug” (3UF7910-0AA0). For this, the addressing plug is connected with the COM20 (above the PROFIBUS interface) and the TEST/ RESET key on the COM20 is pressed for approximately 3 seconds. As soon as the address has been transferred, the PROFIBUS LED flashes and the addressing plug can be removed again

Changing the PROFIBUS address via PROFIBUS DP
Note - To change the PROFIBUS DP address using Switch ES Power, you must first ensure that the current address (e.g. 126 at initial startup) has only been assigned once. For this reason, all new modules must never be connected simultaneously to PROFIBUS DP, because otherwise all modules with the same address will be overwritten. It is therefore necessary for the new modules to be connected to PROFIBUS DP gradually and each addressed individually.

Proceed as follows to change the address:
From the “Switching device” menu select “Online Open”.

1. A dialog box then opens in which you can select, via the relevant application access point and the selected PROFIBUS DP interface, the currently effective PROFIBUS DP address of the slave whose address is to be changed. 126 must be selected on the new COM20.
2. Click on OK to load all parameters including the communication parameters from the device into Switch ES Power where they can be changed.
3. In the tree on the left side, select the point “Communication” and select the desired new address in the drop-down field.
4. In the “Target System” menu, select the entry “Load in Switching Device”. This transfers all parameters currently displayed in Switch ES Power to the circuit breaker.

Figure 16 shows how the PROFIBUS address and the content of the cyclic data traffic can be set with the help of Switch ES Power.

Changing the address via STEP7 (Set_Slave_Address)
The COM20 PROFIBUS module supports the PROFIBUS-DP function Set_Slave_Add. This class 2 master function can be used to change the address of a PROFIBUS-DP slave. The address can be changed either in the SIMATIC Manager (e.g. Switch ES Power) or in HWConfig in the STEP7 software package.

To change the address, choose the “Assign PROFIBUS address” option in the “Target system” menu in either of the programs. A window is then displayed that enables you to change the DP salve addresses once the system has recognized the stations that are connected.

The address can only be changed in the Wait_Prm status; in other words, the slave must not be cyclically connected to a class 1 master. The address is changed immediately.

Changing the Address Via DS160
The PROFIBUS-DP address of the appropriate slave is located in data set 160 at byte position 5. This can not only be read but also changed by writing to DS160; in other words, the address can be changed by triggering a single command to write to DS160 acyclically in the PLC user program.

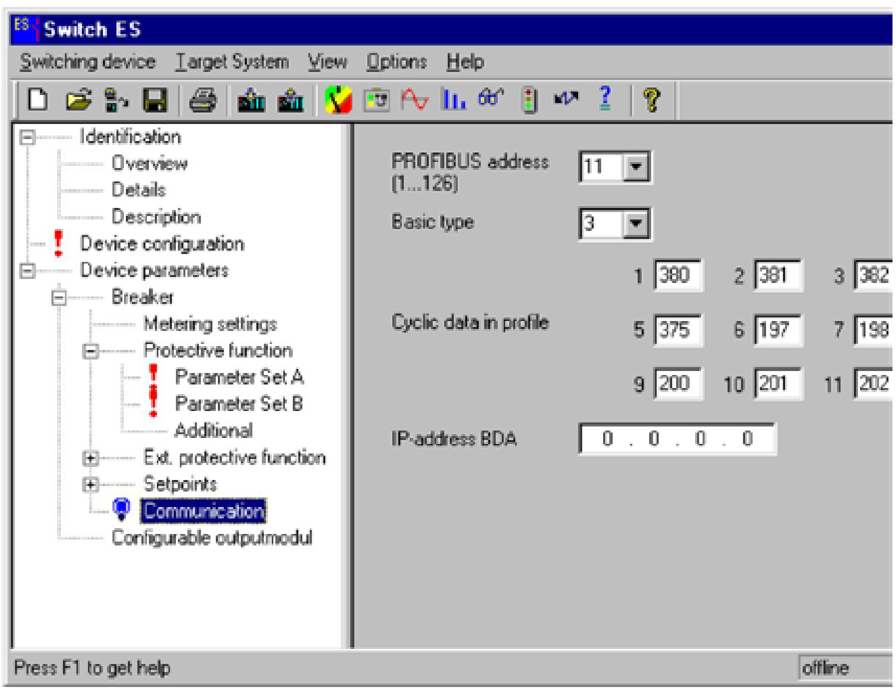


Figure 16 Setting the PROFIBUS address with SWITCH ES Power (here Version V1.0)

PROFIBUS Profile

The PROFIBUS User Organization promotes the use of joint, multi-vendor profiles for different device

Cyclic Data Transmission
With cyclic data transmission, a defined quantity of user data is transmitted with each message. When the slave (in this case, the VL circuit breaker) is parameterized, the quantity of data to be transmitted cyclically between the circuit breaker and PLC must be defined. Cyclic data transmission is the best method of transferring information that is needed quickly and on a continuous basis. The interval between two values depends on the number of stations involved, the quantity of data, and the baud rate. The quantity of data cannot be changed during operation. For this reason, data transmission that is exclusively cyclic is suitable for communication that generally handles small volumes of user data. Cyclic data transmission, however, is not suitable when larger data packages are to be transmitted, for example, for occasional setting and maintenance checks. This type of transmission is only required occasionally and should be taken into account for each message, because the messages would become very long and take a long time to transmit.

Basic Types for Cyclic Data Transmission
Because of the large amount of data provided by VL circuit breakers, a compromise had to be reached between the data volume and performance on PROFIBUS-DP. If only a small amount of information is used every time a large amount of data is transmitted in each exchange (Data_Exchange), the performance of PROFIBUS-DP can be affected.

For this reason, three base types are available to enable efficient and flexible data transmission. Depending on the application, the most suitable base type and accompanying bus configuration can be selected during configuration. This is carried out using a PROFIBUS-DP configuration tool, such as COM PROFIBUS for HWConfig in SIMATIC S7. The base types are pre-assigned and enable rapid commissioning without the need for additional configuration or parameterization.

A user-defined configuration can also be created within a base type using the BDA.

Note - Data that is not required all the time can also be transmitted via DPV1.

PROFIBUS User Organization Profile
The PROFIBUS-DP communication profile for VL circuit breakers was included in the profile for low-voltage switchgear and control gear (circuit breakers) by the PROFIBUS User Organization and adopted accordingly.

As a result, VL circuit breakers communicate using state-of-the-art technology.

The document can be downloaded from the PROFIBUS User Organization at: *http://www.profibus.com*.

Pre-Assignment of the Three Basic Types
Once a basic type has been selected with the PROFIBUS-DP master configuration tool, the configured slave is requested by the master to communicate in this basic type at start-up.

Each VL circuit breaker can be configured individually with a different basic type.

Selecting the basic type first defines the quantity of data and, therefore, the length of the message.

The key circuit breaker data can now be transmitted without the need to make any additional settings. The status of the circuit breaker is the same for all three basic types. This information field is 2 bytes in size and will be explained in more detail later. In line with the status field, the basic types comprise between 4 and 14 data blocks, which are all pre-assigned.

The format for all the pre-assigned measured values is a one-word integer. This must be interpreted in Motorola format, which can be regarded as the “standard” for PROFIBUS-DP.

Basic Type 1
In line with the 2-byte status information, basic type 1 comprises four data blocks. These are pre-assigned in such a way that they are designed for use with a VL circuit breaker without the Metering Function. The most important phase currents are transmitted here.
This preassignment can be changed if necessary.

The content can be reconfigured or the default values changed using the BDA or Profibus DP configuration software (e.g. Switch ES Power).

Basic Type 2
Basic type 2 comprises 8 data blocks, which are pre-assigned for a VL breaker with the Metering Function. Not all of the voltages are transmitted in full, only the main values are transmitted, which is sufficient in most cases.

Basic Type 3
With basic type 3, the 14 data blocks are assigned measured values. This basic type has also been pre-assigned in such a way that it is only practical to use it with the VL with a metering function if the pre-assigned values are not modified. As described above, however, basic type 3 can be selected and the pre-assigned measured values that are not available (e.g. phaseto-phase voltage) can be replaced by maintenance or parameter data as required. The pre-assigned data can be replaced with any information that is no more than 2 bytes long. All the other values are ”cast,” or, truncated and adapted so that only the 2 least significant bytes are transmitted.

Property Byte (PB)
In each of the basic types, the assigned data blocks are followed by the accompanying property bytes. Each data block has its own property byte.

The property byte provides additional information on the accompanying data block. Although it does not have to be analyzed, it may contain important information for the application. A property byte is also available for each data point in the DPV1 data records. If the content of one or more data blocks in the cyclic message is replaced, the property byte is adapted automatically. Property bytes can be used to determine whether a value is available.

Table 6: Basic Type 1

Byte	Definition	Default	Data Point
0 / 1	Binary status info	Binary status info	
2 / 3	Data block 1	Current in phase 1	380
4 / 5	Data block 2	Current in phase 2	381
6 / 7	Data block 3	Current in phase 3	382
8 / 9	Data block 4	Max. current in phase under highest load	374
10	PB of data block 1	PB of current phase 1	
11	PB of data block 2	PB of current phase 2	
12	PB of data block 3	PB of current phase 3	

Table 7: Basic Type 2

Byte	Definition	Default	Data Point
0 / 1	Binary status info	Binary status info	
2 / 3	Data block 1	Current in phase 1	380
4 / 5	Data block 2	Current in phase 2	381
6 / 7	Data block 3	Current in phase 3	382
8 / 9	Data block 4	Max. current in phase under highest load	374
10 / 11	Data block 5	Current in neutral conductor	375
12 / 13	Data block 6	Mean value of the phase-to-phase voltages	203
14 / 15	Data block 7	Mean value of power factors of 3 phases	168
16 / 17	Data block 8	Total active energy of 3 phases	238
18	PB of Data block 1	PB of current phase 1	
19	PB of Data block 2	PB of current phase 2	
20	PB of Data block 3	PB of current phase 3	
21	PB of Data block 4	PB of max. current in phase under highest load	
22	PB of Data Block 5	PB of current in neutral conductor	
23	PB of Data Block 6	PB of mean value of the phase-to-phase voltages	
24	PB of Data Block 7	PB of the mean value of the three power factors	

Tabe 8: Basic Type 3

Byte	Definition	Default	Data Point
0 / 1	Binary status info	Binary status info	
2 / 3	Data block 1	Current in phase 1	380
4 / 5	Data block 2	Current in phase 2	381
6 / 7	Data block 3	Current in phase 3	382
8 / 9	Data block 4	Max. current in phase under highest load	374
10 / 11	Data block 5	Current in neutral conductor	375
12 / 13	Data block 6	Phase-to-phase voltage L_{12}	197
14 / 15	Data block 7	Phase-to-phase voltage L_{23}	198
16 / 17	Data block 8	Phase-to-phase voltage L_{31}	199
18 / 19	Data block 9	Neutral point voltage L_{1N}	200
20 / 21	Data block 10	Neutral point voltage L_{2N}	201
22 / 23	Data block 11	Neutral point voltage L_{3N}	202
24 / 25	Data block 12	Mean value of power factors of 3 phases	168
26 / 27	Data block 13	Total active energy of 3 phases	238
28 / 29	Data block 14	Total apparent power of 3 phases	217
30	PB of Data Block 1	PB of Current in phase 1	
31	PB of Data Block 2	PB of Current in phase 2	
32	PB of Data Block 3	PB of Current in phase 3	
33	PB of Data Block 4	PB of Max. current in phase under highest load	
34	PB of Data Block 5	PB of Current in neutral conductor	
35	PB of Data Block 6	PB of Phase-to-phase voltage L_{12}	
36	PB of Data Block 7	PB of Phase-to-phase voltage L_{23}	
37	PB of Data Block 8	PB of Phase-to-phase voltage L_{31}	
38	PB of Data Block 9	PB of Neutral point voltage L_{1N}	
39	PB of Data Block 10	PB of Neutral point voltage L_{2N}	
40	PB of Data Block 11	PB of Neutral point voltage L_{3N}	
41	PB of Data Block 12	PB of the mean value of the three power factors	
42	PB of Data Block 13	PB of total active energy	
43	PB of Data Block 14	PB of total apparent power	

Table 9: Property Bytes

Bit	Value	Description
0 / 1	0	Read/write
	1	Read only, but can be reset (e.g. maintenance)
	2	Read only, can only be written at the factory
	3	Read only
2		Not used
3		Not used
4		Value in the valid range
5		Option switched on
6		Option available

Binary Status Information in the Cyclic Channel
The binary status information in the cyclic channel is transmitted each time data is exchanged. The status information is always identical and always transmitted at the start of the data message, irrespective of the basic type that has been selected. The binary status information comprises two bytes (not one word, that is, the bytes do not have to be reversed so that they can be displayed in Motorola format).

Table 10 contains a description of the binary status information in the cyclic frame.

Control bytes
All three basic types contain a 2-byte block with the most important binary information for controlling the circuit breaker. This is transferred with each frame. The three basic types differ in the scope and content of the data reported by the circuit breaker to the class 1 master (e.g. PLC) with each Data_Exchange. From the perspective of the PLC, this data is by definition input data.

The output data of the class 1 master is identical in all three basic types. The control bytes in the direction of the switch are always 2 bytes in length. The switch can be switched on and off, trips acknowledged, and memory contents reset via these control bytes. For all controllers, it is sufficient to set the relevant bits for 0.5 to 5 seconds because setting of the outputs is edge-triggered. Following this, these control bits must be reset to avoid subsequently triggering any undesired actions.

Table 11 contains a description of the control bytes for the VL.

Table 10: Binary Status Information in the Cyclic Frame

Byte	Bit	Value	Meaning for VL
n	2/3	0..3	Status of the circuit breaker
		0	Not Ready
		1	OFF
		2	ON
		3	Switch has tripped
	7		Overload Warning Present

Table 11: Control Bytes for the VL

Byte	Bit	Value	Meaning for VL
N	0/1	0..3	Switching the VL
		0	Not defined (no action)
		1	Switch OFF
		2	Switch ON
		3	Not defined (no action)
	2		A currently active tripping operation is acknowledged and reset
n+1	2		Delete tripping and event log
	3		Reset all minimum/maximum value memories
	6		Reset all maintenance information and counters which can be reset

SYNC and FREEZE

The PROFIBUS-DP features the control commands SYNC (synchronize outputs) and FREEZE (freeze inputs) to enable data exchange to be coordinated. A DP master with the appropriate functionality can send the SYNC and/or FREEZE control commands (broadcast messages) to a group of DP slaves simultaneously. For this purpose, the DP slaves are arranged in SYNC and FREEZE groups. A maximum of 8 groups can be created for a master system. Each DP slave, however, cannot be assigned to more than one group. SFC11 DPSYNC_FR is used to trigger the control commands from the S7 user program. Not every master supports this function.

The SYNC control command enables users to synchronize the outputs on several slaves simultaneously. When the control command SYNC is received, the addressed DP slaves switch the data from the last Data_Exchange message from the DP master in their transfer buffer to the outputs. This enables output data to be activated (synchronized) simultaneously on several DP slaves. The UNSYNC control command cancels the SYNC mode of the addressed DP slaves.

The DP slave then resumes cyclic data transmission, that is, the data sent from the DP master is immediately switched to the outputs.

The FREEZE control command enables the user to “freeze” the input data of DP slaves. If a FREEZE command is sent to a group of DP slaves, all of these slaves simultaneously freeze the signals currently present at their inputs. These can then be read by the DP master. The input data in the DP slaves is not updated until a new FREEZE command has been received.

The UNFREEZE control command cancels the FREEZE mode of the addressed DP slaves so that they resume cyclic data transmission with the DP master. The input data is immediately updated by the DP slave and can then be read by the DP master.

Note that once a DP slave has been restarted or is started for the first time, it does not switch to SYNC or FREEZE mode until it has received the first SYNC or FREEZE command from the DP master.

The VL circuit breaker supports both SYNC and FREEZE mode.

Time Synchronization
Each VL circuit breaker is equipped with an internal clock integrated in the COM20 PROFIBUS-DP module. The system time cannot be buffered during a power failure.

This internal clock must be set accurately and synchronized with all other devices in the system so that if several trips occur, the source of error can be identified. For example, the saved messages and the minimum/ maximum values are also assigned a time stamp and saved. Without an accurate system time in the COM20, events could only be assigned time stamps by a connected PLC with limited accuracy.

To ensure that an accurate time stamp is provided in conjunction with all the other circuit breakers, the clock in each device must be synchronized periodically with the other circuit breakers to the correct time. This is carried out as follows:

First import the current time from the PLC to each circuit breaker. To do so, send data set 68 with the current system time to all the circuit breakers via the acyclic DPV1 channel services. At this point, the time does not have to be precisely accurate because it will be corrected during synchronization.

Shortly before 30 minutes have elapsed (29:50), a SYNC command is sent to all the devices in question. The bit for synchronizing the clocks (bit 7 of byte 1 of the control byte) is then set (29:55). With millisecond accuracy, a SYNC command is sent again on the half hour (30:00). In this way, the clocks for all the devices within the SYNC group are rounded up or down to the half hour. Synchronization is not carried out on the hour because clocks that are fast would then be one hour ahead of clocks that are slow.An UNSYNC command must then be sent and the synchronization bit (bit 7 of byte 1 of the control byte) reset so that data exchange can continue. This procedure should be carried out regularly on a time-controlled basis, for example, by GPS in an S7.

Diagnostic Message
By requesting the diagnostic data, the DP master checks at start-up whether the DP slave exists and is ready to be parameterized. The diagnostic data from the DP slave comprises a diagnostic data part defined in EN50170 and specific DP slave diagnostic information. The DP slave uses the diagnostic data to report its operating status (PROFIBUS-DP) to the DP master and, in the event of a diagnosis, the reason for the diagnostic message. A DP slave can report a local diagnostic event to the DP master via the layer-2 message priority “high prio” of the Data_Exchange response message in layer 2. The DP master then requests the diagnostic data from the DP slave for analysis. If no current diagnostic events are present, the Data_Exchange response message is “low prio.” The diagnostic data of a DP slave can be requested at any time by a DP master without necessarily reporting diagnostic events.

Diagnostic Message for S7 Stations
Diagnostics-capable modules in distributed peripheral devices can report events, such as a partial station failure, wire breakage in a signal module, periphery channel shortcircuit/ overload, or a load voltage supply failure, using a diagnostic alarm. With an incoming and outgoing diagnostic alarm, the organizational block for diagnostic alarm OB82 is called by the CPU operating system. If a diagnostic alarm occurs and OB82 is not programmed, the CPU switches to the STOP status.

A failure (incoming event) or restoration (outgoing event) of a DP slave is reported by the operating system of the S7 CPU via OB86. If OB86 has not been programmed, the S7 CPU switches to the STOP status if an event occurs.

Table 12 explains the structure of the diagnostics of the circuit breaker.

Diagnostics of the VL Circuit Breaker

The following messages are available:

- There are no diagnostic messages
- The COM20 is out of service
- The communication connection between COM20 and VL has been interrupted

Diagnostic interrupt in S7 and S7V1 operating mode
If the VL breakers are configured using the object manager, they are activated in operating mode S7V1. A diagnostic message here does not automatically result in execution of OB 82. Diagnostic interrupts are not supported. The diagnostic information can be read by the slave at any time using SFC 13.

Table 12: Structure of the PROFIBUS Diagnostic Function

Part of the Diagnosis	Byte.Bit	Meaning for VL
DP Standard	0	Station status 1
	1	Station status 2
	2	Station status 3
	3	PROFIBUS master address
	4	Identification number High Byte (0x80)
	5	Identification number Low Byte (0xC0)
Additional Header	6	0x42 fixed
	7.0	Device-specific diagnostics available
	8	0x05 fixed
	9	0x82 fixed
	10	0x00 fixed
	11	0x00 fixed
	12	0x00 fixed
	13	0x0F fixed
	14	0x81 fixed
	15	0x01 fixed
	16	0x00 fixed

MODBUS Communication

Communication with the VL Breaker

VL Circuit Breaker
The VL Circuit Breaker supports the industry standard MODBUS protocol through the COM21 interface. Data traffic between the master and the slave and between the slave and the master begins with the address of the slave. The job message frame consists of the following elements: address of the MODBUS slave (byte), function code (byte), data of the message frame (n byte), and checksum of the message frame (2 byte). The structure of the data field depends on the function code used.

Note:

- *A node address of 0 is called a broadcast message frame and is processed by each node without a response*
- *Address range for circuit breakers limited to 1 to 126*

If no characters are transferred for the space of 3.5 bytes this is taken as the end of the message frame. A check is made to determine the validity of the message frame.

Data is exchanged between the VL and the MODBUS master via the serial interface in an 11-bit character frame. Depending on the setting of the "PARITY" communication parameter in the circuit breaker, the 1st stop bit may be replaced by the "parity bit" as in Figure 17.

The VL Circuit Breaker can be configured remotely using the WinPM.Net software.

Function Codes:
Function codes control the data exchange. In doing so, a function code tells the node what action it is to take.

Function "03 – Read value buffer area"
This function gets values from the value buffer area of the circuit breaker.

Communication parameter settings

In the delivery condition the circuit breaker has the following parameter settings for communication purposes:

- Address: 126
- Baud rate: 19200 bps
- Parity: Even

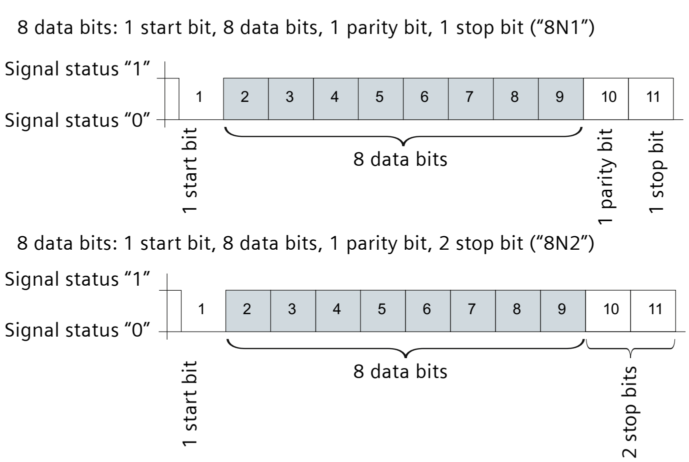


Figure 17 11-bit character frame

Table 13: Function 03 Request to Node

Bytes	Name of Byte	Description
0x07	Node address	MODBUS address 7
0x03	Function code	"03 – Read value buffer area"
0x00	Start address (high)	Address 0 onwards
0x00	Start address (low)	
0x00	Number of registers (high)	Read 2 registers (4 bytes)
0x02	Number of registers (low)	

Table 14: Function 03 Response from Node

Bytes	Name of Byte	Description
0x07	Node address	MODBUS address 7
0x03	Function code	"03 – Read value buffer area"
0x04	Number of bytes	2 bytes => 16 bits
0x□□	Data byte 1 (high)	1st register
0x□□	Data byte 2 (low)	
0x□□	Data byte 3 (high)	2nd register
0x□□	Data byte 4 (low)	

Function "16 – Write value buffer area"

This command can be used to write complete data areas or complex data types and transfer them to the value buffer area.

Request to node

The system time area for communication modules COM16 was chosen for this example.

The command below sets the time of the circuit breaker (system time) to the following date and time:

- Wednesday. May 27, 2009, 11:15:30:000

Note - The time of communication module COM21 is located in a different area, so the command would have to be changed accordingly:

- *Register start address: 0x142A*

Summary of exception messages

With the exception of broadcast message frames, the requestor expects to receive a response. There are four possible events that can occur following a request:

1. The node receives the request without communication errors and can process the request, so the normal response is sent by the node.
2. The node does not receive the request because of a communication error. The node does not send a response. The master should install a TIMEOUT for such situations.
3. The node receives an invalid request (parity or CRC). Once again no response is sent. The master should install a TIMEOUT for such situations.
4. The node receives a request which it cannot process (e.g. reading a non-existent output or value range). It responds with an exception message. The exception code in this exception message indicates the cause of the problem.

The exception message contains two fields which differ from a normal response:

- Field for function code: In a normal message the node repeats the requested function code. In an exception message the most significant bit indicates that an error has occurred (= addition of 0x80). This information enables the master to interpret the error code in the next field.
- Field for data: In a normal response the content is dependent on the function code. In exception messages only the error code is returned. This contains the reason for/status of the exception message.

Table 15: Function 16 Request to Node

Bytes	Name of Byte	Description
0x07	Node address	MODBUS address 7
0x10	Function code	"16 – Write value buffer area"
0x44	Register start address (high)	Write from system time
0x02	Register start address (low)	DS 68 (0x44); Offset 2nd register
0x00	Register number (high)	Number to be written
0x04	Register number (low)	Register (4 - system time only)
0x08	Number of bytes	Number of data bytes (8)
0x09	Data byte 1 (low) -> year	Register 1
0x05	Data byte 2 (high) -> month	
0x27	Data byte 3 (low) -> day	Register 2
0x11	Data byte 4 (high) -> hour	
0x15	Data byte 5 (low) -> minute	Register 3
0x30	Data byte 6 (high) -> second	
0x00	Data byte 7 (low) -> . . .	Register 4
0x04	Data byte 8 (high) -> . . .	

Table 16: Function 16 Response from Node

Bytes	Name of Byte	Description
0x07	Node address	MODBUS address 7
0x10	Function code	"16 – Write value buffer area"
0x44	Register start address (high)	Write from system time
0x02	Register start address (low)	DS 68 (0x44); Offset 2nd register
0x00	Register number (high)	Number to be written
0x04	Register number (low)	Register (4 - system time only)
0x□□	CRC check code "low"	Check calculation value (CRC16)

Table 17: Example of Exception Messages

Bytes	Name of Byte	Description
0x07	Node address	MODBUS address 7
0x83	Function code + error code (0x80)	Error code + "03 – Read value buffer area"
0x02	Error code	02 - Illegal address

Table 18: Error Code for Exception Messages

Code	Name	Explanation
0x01	Illegal function	The function code received in the request is an illegal function for the node
0x02	Illegal address	The data address received is not in a legal address range for the node
0x03	Illegal value	A value transferred in the request is not in the legal range for the node
0x04	Node error	An unknown error occurred during processing of the request at the node
0x05	Confirmation	The request is being processed and a certain processing time is required. This message is used to prevent a timeout error and to allow processing of the request to be completed
0x06	Node busy	The node is still processing and the request is rejected. A new request will have to be sent when the node is not busy

Table 19: Trip Unit Data

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit ETU555	Trip Unit ETU586
5000	Circuit Breaker Status	UINT16	0,1	Circuit Breaker Position	Always read as a 1	RO	RO
			2,3	Circuit Breaker State	0 = Not initialized 1 = Circuit Breaker OFF 2 = Circuit Breaker ON 3 = Circuit Breaker TRIPPED		
			4,5,6	Reserved			
			7	Overload Warning	0 = Warning not active 1 = Warning active		
			8,9	Reserved			
			10	Write Protect	0 = Writes not allowed 1 = Writes allowed		
			11	Trip Unit Mode	0 = Normal mode 1 = Arc Flash mode		
			12, 13, 14	Trip Function	0 = no trip 1 = Long Time 2 = Instantaneous 3 = Short Time 4 = Ground Fault 5 = Thermal		
			15	Reserved			
5001	RMS Current Phase A	UINT16	0..15		Amps	RO	RO
5002	RMS Current Phase B	UINT16	0..15		Amps	RO	RO
5003	RMS Current Phase C	UINT16	0..15		Amps	RO	RO
5004	RMS Maximum Current	UINT16	0..15	Between phase A, B, C	Amps	RO	RO
5005	Neutral Current	UINT16	0..15		Amps	RO	RO
5006	Ground Fault Current	UINT16	0..15		Amps	RO	RO
5007	Trip Unit Warnings	BOOL	0..15		0x0001 = Overload 0x0002 = Overload Neutral 0x0040 = Ground Fault	RO	RO
5008	Trip Current	UINT16	0..15		Amps	RO	RO
5009	Trip Phase	UINT16	8..15		0 = Phase A 1 = Phase B 2 = Phase C 3 = Neutral 4 = Ground Fault (0 sent when data cleared)	RO	RO
	Trip Unit Status		0..7		0 = Not initialized 1 = Ok 2 = EEPROM Error 3 = RAM Error 4 = ROM Error 15 = Thermal warning		
5010	ZSI Settings & Status	UINT16	8..15		0 = Short Time Off & Ground Fault Off 1 = Short Time On & Ground Fault Off 2 = Short Time Off & Ground Fault On 3 = Short Time On & Ground Fault On 16 = ZSI Input Active 32 = ZSI Output Active	RO	RO
	Reserved		0..7				
5011	Overload Status	UINT16	8..15		0 = No overload 1 = Phase A overload 2 = Phase B overload 3 = Phase C overload 4 = Phase N overload	NA	RO
	Prealarm Status		0..7		0 = No pre-alarm 1 = Phase A pre-alarm 2 = Phase B pre-alarm 3 = Phase C pre-alarm 4 = Phase N pre-alarm		

Table 19: Trip Unit Data (continued)

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit ETU555	Trip Unit ETU586
5012	Breaker State	BOOL16	8..15		0x01 = Circuit Breaker OFF 0x02 = Circuit Breaker ON 0x04 = Circuit Breaker TRIPPED	RO	RO
	Trip Function		0..7		0x00 = No Trip 0x01 = Long Time Trip 0x02 = Instantaneous Trip 0x04 = Short Time Trip 0x08 = Ground Fault Trip 0x80 = Thermal Trip		
5013	Maximum Current Phase	UINT16	8..15	Number Maximum Phase (refers to register 0001-0003)	0 = Phase A 1 = Phase B 2 = Phase C 3 = Neutral 4 = Ground Fault	RO	RO
	Reserved		0..7		Always read as a 1		
5014	Average Current	UINT16	0..15	Between phase A, B, C (refers to register 0001-0003)	Amps	RO	RO
5015	Averge Current Demand	UINT16	0..15	Sub-interval = 1 minute Period = 15 minutes	Amps	RO	RO
5016	Current Unbalance	UINT16	8..15	Percent current unbalance between A, B, C	0 - 200 %	RO	RO
	Max Unbalance Current (Stored in nonvolatile memory)		0..7	Maximum % current unbalance between A, B, C	0 - 200 %		
5017	Max Average Current (Stored in nonvolatile memory)	UINT16	0..15		Amps	RO	RO
5018	Max Neutral Current (Stored in nonvolatile memory)	UINT16	0..15		Amps	RO	RO
5019	Max Ground Fault Current (Stored in nonvolatile memory)	UINT16	0..15		Amps	RO	RO
5020	Max Phase Current (Stored in nonvolatile memory)	UINT16	0..15		Amps	RO	RO
5021	Max Current Demand (Stored in nonvolatile memory)	UINT16	0..15		Amps	RO	RO
5022	Communication Errors	UINT16	8..15	COM21 error	0 = no Error 1 = Error	RO	RO
			0..7	ETU communication error	0 = Communication valid 1 = No communication detected between COM21 and ETU	RO	RO
5023	Flags (Data Information Changed)	BOOL16	0..15	Flag Indication for bus-Master Information changed	0x0001 = Cyclic Data 0x0002 = Protection Settings 0x0004 = Diagnostic/Counters 0x0008 = TripUnit Configuration 0x0010 = TripLog 0x0020 = SideBox Settings 0x0040 = SideBox Description 0x0080 = Trip Unit Identification 0x0100 = SideBox Identification (COM21clears flag for block when any register in the block is read)	RO	RO

Table 20: Trip Unit Protection Settings

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5040	Continuous Current Setting	UINT16	0..15		Amps	RO	RW
5041	Long Time Delay Setting	UINT16	0..15		Sec x 10	RO	RW
5042	Instantaneous Pickup Setting	UINT16	0..15		Amps	RO	RW
5043	Short Time PickUp Setting	UINT16	0..15		Amps	RO	RW
5044	Short Time Delay Setting	UINT16	0..15		Sec x 1000 *0 sent when data not valid*	RO	RW
5045	Short Time Delay Mode	UINT16	8..15		0 = I2t Off 1 = I2t On *0 sent when data invalid*	RO	RW
	Ground Fault Delay Mode		0..7		0 = I2t Off 1 = I2t On *0 sent when data invalid*		
5046	Ground Fault PickUp Setting	UINT16	0..15		Amps *0 sent when data invalid*	RO	RW
5047	Ground Fault Delay Setting	UINT16	0..15		Sec x 1000 *0 sent when data invalid*	RO	RW
5048	Reserved	UINT16	8..15			RO	RO
	ZSI Settings		0..7		0x00 = ZSI Disabled 0x11 = Short Time (in & out) 0x12 = Ground Fault (in & out) 0x13 = ST & GF (in & out) 0x21 = Short Time (out only) 0x22 = Ground Fault (out only) 0x23 = ST & GF (out only)		
5049	Reserved	UINT16	0..15			NA	NA
5050	Reserved	UINT16	8..15			RO	RW
	Thermal Memory		0..7		0 = Disabled 1 = Enabled		
5051	Pre Alarm Enable	UINT16	8..15		0 = Disabled 1 = Enabled	RO	RW
	Short Time Enable		0..7		0 = Disabled 1 = Enabled		
5052	Pre-Alarm Pickup Setting	UINT16	0..15	% of the Continuous Current Setting	80-100% * 10 *0 sent when data not valid*		RW
5053	Ground Fault Type	UINT16	8..15		0 = Ground Return 1 = Residual	RO	RW
	Reserved		0..7				
5054	Instantaneous Enable	UINT16	8..15		0 = Disabled 1 = Enabled	NA	RW
	Ground Fault Alarm Enable		0..7		0 = Disabled 1 = Enabled		
5055	Ground Fault Alarm Setpoint	UINT16	0..15		Amps	NA	RW
5056	Ground Fault Alarm Delay	UINT16	0..15		Sec x 1000 *0 sent when data invalid*	NA	RW
5540	Continuous Current Setting	UINT16	0..15		Amps	NA	WO
5541	Long Time Delay Setting	UINT16	0..15		Sec x 10	NA	WO
5542	Instantaneous Pickup Setting	UINT16	0..15		Amps	NA	WO
5543	Short Time PickUp Setting	UINT16	0..15		Amps	NA	WO
5544	Short Time Delay Setting	UINT16	0..15		Sec x 1000	NA	WO
5545	Short Time Delay Mode	UINT16	8..15		0 = I2t Off 1 = I2t On	NA	WO
	Ground Fault Delay Mode		0..7		0 = I2t Off 1 = I2t On		
5546	Ground Fault PickUp Setting	UINT16	0..15		Amps	NA	WO
5547	Ground Fault Delay Setting	UINT16	0..15		Sec x 1000	NA	WO
5548	Reserved	UINT16	0..15			NA	
5549	Reserved	UINT16	0..15			NA	
5550	Reserved	UINT16	8..15			NA	WO
	Thermal Memory		0..7		0 = Disabled 1 = Enabled		
5551	Pre Alarm Enable	UINT16	8..15		0 = Disabled 1 = Enabled	NA	WO
	Short Time Enable		0..7		0 = Disabled 1 = Enabled		
5552	Pre-Alarm Pickup Setting	UINT16	0..15	% of the Continuous Current setting	80-100% * 10	NA	WO
5553	Ground Fault Type	UINT16	8..15		0 = Ground Return 1 = Residual	NA	WO
	Reserved		0..7				

Table 20: Trip Unit Protection Settings (continued)

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5554	Instantaneous Enable	UINT16	8..15		0 = Disabled 1 = Enabled	NA	WO
	Ground Fault Alarm Enable		0..7		0 = Disabled 1 = Enabled		
5555	Ground Fault Alarm Setpoint	UINT16	0..15		Amps		WO
5556	Ground Fault Alarm Delay	UINT16	0..15		Sec x 1000		WO

Table 21: Trip Unit Diagnostic Counters

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit ETU555	Trip Unit ETU586
5060	Count of Instantaneous & Short Time trips	UINT16	0..15		#	RO	RO
5061	Reserved	UINT16	0..15			NA	NA
5062	Count of Long Time Trips	UINT16	0..15		#	RO	RO
5063	Count of Ground Fault Trips	UINT16	0..15		#	RO	RO
5064	Total number of Trips	UINT16	0..15		#	RO	RO
5065-5066	Operating Hours	UINT32	0..31		#	RO	RO
5067	Counter of Modbus Communication Errors	UINT16	0..15		#	RO	RO
5068	Counter of COM21/ETU Communication Errors	UINT16	0..15		#	RO	RO

Table 22: Trip Unit Configuration

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5080	Unit Sensor Rating	UINT16	0..15	Current Sensor Rating (internal use only)	Amps	RO	RO
5081	Unit Current Rating	UINT16	0..15		60A Rating = 0x003C 100A Rating = 0x0064 150A Rating = 0x0096 250A Rating = 0x00FA 400A Rating = 0x0190 600A Rating = 0x0258 800A Rating MG Frame = 0x5320 800A Rating NG Frame = 0x0320 1000A Rating = 0x03E8 1200A Rating = 0x04B0 1600A Rating = 0x0640	RO	RO
5082	Unit Configuration	UINT16	8..15		30 = ETU555 (LI) 31 = ETU555 (LSI) 35 = ETU586 (LSI) 37 = ETU586 (LSIGalarm)	RO	RO
	Ground Fault Protection		0..7		0 = Disabled 1 = Enabled		
5083	Reserved	UINT16	0..15			RO	RO
5084	Number of Poles	UINT16	8..15		1 = 3 pole circuit breaker 2 = 4 pole circuit breaker	RO	RO
	Reserved		0..7				
5085	Max Instantaneous Setting	UINT16	0..15		Amps	RO	RO
5086	Market Type	UINT16	8..15		1 = IEC 2 = UL	RO	RO
	Reserved		0..7				

Table 23: Sidebox Trip Log

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit ETU555	Trip Unit ETU586
5100	Trip Log #1 (most recent trip)	UINT16	8..15	Year	0x00...0x99	RO	RO
			0..7	Month	0x01...0x12		
5101		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5102		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5103		UINT16	8..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5104		UINT16	0..15	Type of Trip	1 = Long Time Trip 2 = Instantaneous Trip 3 = Short Time Trip 4 = Ground Fault Trip 5 = Reserved 6 = Neutral Trip 8 = Thermal Trip		
5105		UINT16	0..15	Reserved			
5106	Trip Log #2	UINT16	8..15	Year	0x00...0x99	RO	RO
			0..7	Month	0x01...0x12		
5107		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5108		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5109		UINT16	8..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5110		UINT16	0..15	Type of Trip	1 = Long Time Trip 2 = Instantaneous Trip 3 = Short Time Trip 4 = Ground Fault Trip 5 = Reserved 6 = Neutral Trip 8 = Thermal Trip		
5111		UINT16	0..15	Reserved			

Table 23: Sidebox Trip Log (continued)

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit	
						ETU555	ETU586
5112	Trip Log #3	UINT16	8..15	Year	0x00...0x99	RO	RO
			0..7	Month	0x01...0x12		
5113		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5114		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5115		UINT16	8..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5116		UINT16	0..15	Type of Trip	1 = Long Time Trip 2 = Instantaneous Trip 3 = Short Time Trip 4 = Ground Fault Trip 5 = Reserved 6 = Neutral Trip 8 = Thermal Trip		
5117		UINT16	0..15	Reserved			
5118	Trip Log #4	UINT16	8..15	Year	0x00...0x99	RO	RO
			0..7	Month	0x01...0x12		
5119		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5120		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5121		UINT16	8..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5122		UINT16	0..15	Type of Trip	1 = Long Time Trip 2 = Instantaneous Trip 3 = Short Time Trip 4 = Ground Fault Trip 5 = Reserved 6 = Neutral Trip 8 = Thermal Trip		
5123		UINT16	0..15	Reserved			

Table 23: Sidebox Trip Log (continued)

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data / Units	Trip Unit ETU555	Trip Unit ETU586
5124	Trip Log #5 (oldest trip)	UINT16	8..15	Year	0x00...0x99	RO	RO
			0..7	Month	0x01...0x12		
5125		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5126		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5127		UINT16	08..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5128		UINT16	0..15	Type of Trip	1 = Long Time Trip 2 = Instantaneous Trip 3 = Short Time Trip 4 = Ground Fault Trip 5 = Reserved 6 = Neutral Trip 8 = Thermal Trip		
5129		UINT16	0..15	Reserved			

Table 24: Sidebox and Trip Unit Commands

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5140	Clear Counters	UINT16	8..15		0x00 = No Action 0x04 = Clear Trip Counters 0x10 = Clear Max Parameters 0x20 = Sync Time Stamp 0x40 = Clear Trip Log 0x80 = Clear Address Lock	WO	WO
	Open/Close Circuit Breaker		0..7		0x00 = No action 0x04 = Open Circuit Breaker 0x08 = Close Circuit Breaker		
5141	Clear Trip Unit Data	UINT16	0..15		0x0000 = No Action 0x0002 = Clear last trip stored in trip unit (Clears the trip function and time of the LAST TRIP STATUS in the trip unit. Also sets the following registers to zero: 5000 (bits 12-14), 5008, 5009 (high byte) and 5012) 0x0022 = Clear Diagnostic Counters (register 5060-5064)	WO	WO
5142	ZSI Test	UINT16	8..15		0x00 = No Action 0x01 = Set ZSI Output (timeout 30sec) 0x02 = Reset ZSI Output 0x03 = Reset ZSI-Output	WO	WO
	ZSI Enable		0..7		0x00 = ZSI Disabled 0x11 = Short Time (in & out) 0x12 = Ground Fault (in & out) 0x13 = ST & GF (in & out) 0x21 = Short Time (out only) 0x22 = Ground Fault (out only) 0x23 = ST & GF (out only)		

Table 25: Sidebox Settings and Status

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5160	COM21 MODBus Address	UINT16	8..15		1 - 126 (default: 126)	RW	RW
	Reserved		0..7				
5161	Baud Rate		8..15		1=2400 Baud 2=4800 Baud 3=9600 Baud 4=19200 Baud (default) 5=38400 Baud	RW	RW
	Parity	UINT16	0..7		0=No Parity 1=Odd Parity 2=Even Parity (default)		
5162	System Time	UINT16	8..15	Year	0x00...0x99	RW	RW
			0..7	Month	0x01...0x12		
5163		UINT16	8..15	Day of Month	0x01...0x31		
			0..7	Hour	0x00...0x23		
5164		UINT16	8..15	Minute	0x00...0x59		
			0..7	Seconds	0x00...0x59		
5165		UINT16	8..15	Low Byte of Milliseconds	Not Used		
			4..7	High Bits of Milliseconds	Not Used		
			0..3	Day of Week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday		
5166	Com21 Status	UINT16	8..15		0 = Not initialized 1 = Ok 2 = EEPROM Error 3 = RAM Error 4 = ROM Error 5 = Peripheral Error 15 = Thermal warning	RO	RO
	Bus Write Enable		0..7	Write Protect Input on COM21	0 = Writes not allowed 1 = Writes allowed		

Table 26: Sidebox Description

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5200 - 5231	Free User Text (Stored in nonvolatile memory)	UCHAR64	0..511	64 Byte User Text	Character	RW	RW

Table 27: Trip Unit Identification

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5240	Trip Unit Serial Number	UCHAR8	8..15		Character #1	RO	RO
		UCHAR8	0..7		Character #2		
5241		UCHAR8	8..15		Character #3		
		UCHAR8	0..7		Character #4		
5242		UCHAR8	8..15		Character #5		
		UCHAR8	0..7		Character #6		
5243		UCHAR8	8..15		Character #7		
		UCHAR8	0..7		Character #8		
5244		UCHAR8	8..15		Character #9		
		UCHAR8	0..7		Character #10		
5245		UCHAR8	8..15		Character #11		
		UCHAR8	0..7		Character #12		
5246		UCHAR8	8..15		Character #13		
		UCHAR8	0..7		Character #14		
5247		UCHAR8	8..15		Character #15		
		UCHAR8	0..7		Character #16		
5248	Trip Unit Software Version	UCHAR8	8..15	V (0x56)	Character #1	RO	RO
		UCHAR8	0..7	0 (0x30)	Character #2		
5249		UCHAR8	8..15	6 (0x36)	Character #3		
		UCHAR8	0..7	. (0x2E)	Character #4		
5250		UCHAR8	8..15	Major Version	Character #5		
		UCHAR8	0..7		Character #6		
5251		UCHAR8	8..15		Character #7		
		UCHAR8	0..7	. (0x2E)	Character #8		
5252		UCHAR8	8..15	Minor Version	Character #9		
		UCHAR8	0..7		Character #10		
5253		UCHAR8	8..15	Spaces (0x00)	Character #11		
		UCHAR8	0..7		Character #12		
5254		UCHAR8	8..15		Character #13		
		UCHAR8	0..7		Character #14		
5255		UCHAR8	8..15		Character #15		
		UCHAR8	0..7		Character #16		

Table 28: Sidebox Identification

Modbus Register	Register Name	Format	Bit Addr.	Data Description	Data/Units	Trip Unit ETU555	Trip Unit ETU586
5260	COM21 Serial Number	UCHAR8	8..15		Character #1	RO	RO
		UCHAR8	0..7		Character #2		
5261		UCHAR8	8..15		Character #3		
		UCHAR8	0..7		Character #4		
5262		UCHAR8	8..15		Character #5		
		UCHAR8	0..7		Character #6		
5263		UCHAR8	8..15		Character #7		
		UCHAR8	0..7		Character #8		
5264		UCHAR8	8..15		Character #9		
		UCHAR8	0..7		Character #10		
5265		UCHAR8	8..15		Character #11		
		UCHAR8	0..7		Character #12		
5266		UCHAR8	8..15		Character #13		
		UCHAR8	0..7		Character #14		
5267		UCHAR8	8..15		Character #15		
		UCHAR8	0..7		Character #16		
5268	COM21Software Version	UCHAR8	8..15	Checksum	Character #1	RO	RO
		UCHAR8	0..7		Character #2		
5269		UCHAR8	8..15		Character #3		
		UCHAR8	0..7		Character #4		
5270		UCHAR8	8..15	Spaces (0x00)	Character #5		
		UCHAR8	0..7		Character #6		
5271		UCHAR8	8..15	0 (0x30)	Character #7		
		UCHAR8	0..7	7 (0x37)	Character #8		
5272		UCHAR8	8..15	. (0x2E)	Character #9		
		UCHAR8	0..7	Major Version	Character #10		
5273		UCHAR8	8..15		Character #11		
		UCHAR8	0..7		Character #12		
5274		UCHAR8	8..15	. (0x2E)	Character #13		
		UCHAR8	0..7	Minor Version	Character #14		
5275		UCHAR8	8..15		Character #15		
		UCHAR8	0..7	Space (0x00)	Character #16		

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