DRS-LLD

Device Description

Protection

Identification	DRS-LLD_ENG
Version.Revision	1.00
Release Date	06.03.2009

This document is valid for the product(s) :

DRS-LLD	from V3.34

Warning

Hazardous voltages are present in the electrical equipment during operation and standstill.

Death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Please refer to plant and device manuals for safe operation of the equipment.

Qualified personnel

Only qualified personnel shall work on and in the vicinity of this equipment. The personal must be thoroughly familiar with all warnings and maintenance procedures of the manuals as well as the safety regulations.

Qualified personnel must be trained and authorized to energize, de-energize, clear ground and tag circuits and equipment in accordance with established safety practices.

Qualified personnel must be trained and instructed for switching, grounding and designating devices and systems.

Qualified personnel must be trained in rendering first aid.

General installation and safety regulations

Of particular importance are the general installation and safety regulations for work in a high-voltage environment, for example VDE, IEC; EN, DIN, or other national and international regulations. These regulations must be observed.

Table of contents

1. Introduction 7

2. Mode of Operation 8

2.1. Functional Overview 8
2.2. Construction 9
2.2.1. Master Device 9
2.2.2. Slave Devices 9
2.2.3. Device Addressing 9
2.2.4. Signal Transmission 10
2.2.4.1. Device Synchronization 11
2.2.4.2. Telegram Traffic 11
2.3. Device Functions 12
2.3.1. Distributed Differential Protection 12
2.3.1.1. Differential Protection 12
2.3.1.2. Saturation Detection 12
2.3.1.3. Transfer Function 14
2.3.1.4. High-Set Sättigung 15
2.3.2. Back-up Functions 15
2.3.3. Device Fault or Device Halt 15
2.3.4. Trip Logic 15
2.3.5. Communication Topology, Change-over of the Topology 16
2.3.5.1. Internal Communication Interruption 16
2.3.5.2. Device Halt 17
2.3.5.3. Location of Communication Break 17
2.3.5.4. Communication Break and Reliability 17

3. Additional Functions 18

3.1. Metering 18
3.2. Data Recording 18
3.2.1. Disturbance Record 18
3.2.2. Event Lists 19
3.3. Serial Communication 19
3.4. Self Monitoring 19
3.5. Password 19
3.6. Input Mapping 20
3.7. Configuration of the Output Relays 20
3.8. LED Display 20
3.8.1. Operation LED (green) 20
3.8.2. Fault LED (red) 20
3.8.3. Programmable LEDs 20
3.9. Local Operation 20
3.10. Communications Interface 20
3.10.1. Service Interface 20
3.10.2. Control System Interface 21
3.10.3. Internal Communication 21
3.10.4. Time Stamping 21

4. Hardware 22

4.1. Case 22
4.2. Output Contacts 22
4.3. Digital Inputs 22
4.4. Analog Inputs 22

4.5. Communications Interfaces 22
4.6. Serial communication 24
4.7. Device View 25

5. Technical Data 26
5.1. CE Conformity 26
5.2. Weights 26
5.3. IP Ratings 26
5.4. Characteristic Energizing Quantity 26
5.5. Auxiliary Energizing Quantity 26
5.5.1. Power Supply 26
5.5.2. Binary Inputs 26
5.5.3. Binary Input Performance 27
5.6. Protection Characteristics 27
5.6.1. Accuracy reference conditions 27
5.6.2. Differential protection 27
5.6.3. Configurable protective functions 27
5.7. Accuracy influencing factors 28
5.7.1. Temperature 28
5.7.2. Frequency 28
5.8. Thermal Withstand 28
5.9. Burdens 28
5.10. Output Contacts 28
5.11. Serial Interfaces 29
5.11.1. Interfaces for internal communication (as per selection) 29
5.11.2. Service interface 29
5.11.3. Substation Informative Communications 29
5.12. Environmental 30
5.12.1. General 30
5.12.2. Immunity 30
5.12.3. Mechanical 31

Table of Illustrations

Fig. 1 Principle 8
Fig. 2 Chain connection 10
Fig. 3 Ring connection 10
Fig. 4 Signal without saturation 13
Fig. 5 Signal with saturation 13
Fig. 6 Characteristics of the differential protection 14
Fig. 7 Scheme of Transfer Function 14
Fig. 8 Signal path in ring mode 16
Fig. 9 Signal path in chain mode 16
Fig. 10 Connection of Interface Modules 23
Fig. 11 Pin definition X.21 interface plug 23

1. Introduction

The ELIN DRS-LLD is a decentralized differential protection for protection objects with up to 6 ends. With DRS-LLD, as per devices ordered, a simple line differential protection with 2 ends or a transformer differential protection with up to 6 ends can be built up. DRS-LLD is the result of more than 40 years of experience in electronic protection technology and more than 20 years of experience in digital protection technology.

Besides to the primary function of the 3-phase differential protection, implementing of additional back-up protective functions in the DRS-LLD is possible. In addition ELIN DRS-LLD contains informative functions as on-line measured values, disturbance records and event logging. Diagnosis and self monitoring functions make the whole system utmost reliable. A menu-driven operation via the local operation panel and the full-graphic user interface DRS-WIN ensure user-friendly access to setting-parameters, measurement and disturbance records.

The differential protective function of the DRS-LLD operates on earth short-circuits and phase short-circuits in the protected zone and trips out all incoming breakers to the protected zone. Transformer inrush or transformer saturation are detected reliable and faulty trips due those transients are effectively prevented. In addition to the actual protective functions, four binary informations of every terminal device can be transferred to every other terminal device, which can be used e.g. for transfer trip functions.

The communication between the terminal devices is supported for different transmission media through different interface-modules. The reliability of the data transfer can be increased by redundancy concepts this way, that a communication line interruption between two devices do not require a blocking of the differential protective function.

Different device models allow space-saving and cost-saving construction of a distributed differential protection. Adapted onto the respective topology of the protected object, devices with 3 current transformer inputs (one line end) or 6 current transformers (two line ends) can be combined with each other.

Subsequent extensions are normally slightly possible within the framework of the limit of 6 branches.

As DRS-LLD is part of the DRS family, the already known DRS system features are supported,

- Local device operation via display and keyboard
- Cases for 19'' rack-, flush- and projected mounting
- Serial communication via IEC60870-5-103 or 104
- Remote maintenance by means of modem or Telnet-connection via LAN/WAN
- Real-time synchronization by means of DRS-LTS
- Parameterization, evaluation and diagnosis by means of DRS-WIN

2. Mode of Operation

Fig. 1 show the simplest application of the DRS-LLD as differential protection for 2 ends. The fundamental working method of the differential protective function is simply to be described here.

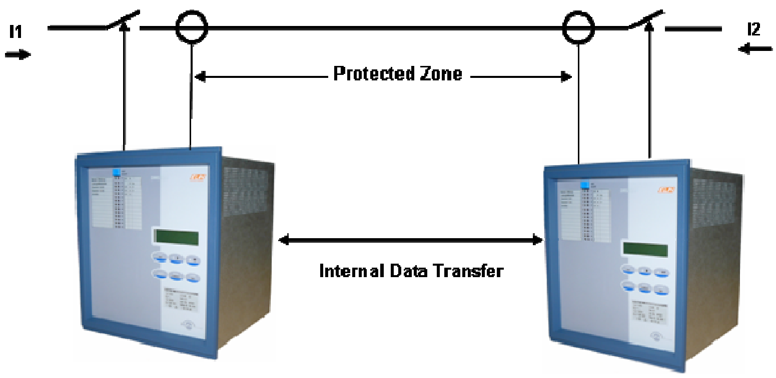


Fig. 1 Principle

Each of the two terminal devices samples the 3 phase current values to an own device-specific time. The sample interval is always 1/12 of the current line frequency. The magnitude and the phase is calculated for every current then. Since for the differential protective function it is essential that these calculated values are determined to a completely time-synchronous moment, by a phase correction in every terminal device the different sampling times of the two devices are compensated. The compensated data (magnitude and phase of every line current phase) are dispatched now via the communication interfaces and the data buses onto the other terminal device. The transfer cycle time, and in this way also the minimum response time of the differential protection, depends on the bandwidth of the transfer media between the devices.

Differential current and restraint current now is calculated per phase in every terminal device and according the parameter setting of the device the local CB is tripped autonomous or not.

In case of errors in the measured values transmission or problems with the synchronization of the terminal devices, the differential protection function and the transfer function are blocked automatically. All other protective functions (back-up functions) still remain in operation in this case.

2.1. Functional Overview

Main function is a differential protection according to the low impedance principle for up to 6 ends of the protected zone. A transformer can be included in the protected zone.

Adaptations to different current transformer ratios, vector group compensation and zero-phase sequence system filters for an included transformer are adjustable by parameterization. A harmonic restraint function (for 2nd and 5th Harmonic) and additional stabilization in the case of current transformer saturation provide utmost reliability. A 4-channel transfer function is integral part of the differential protective function.

As back-up protection overcurrent-, overload or other current functions are configurable from the DRS-LIGHT Function Library. In the standard devices the back-up functions are selected according the maximum operating frequency of the devices.

While the differential protective function is being blocked in the case of communication problems between the terminal devices (automatic blocking), the back-up protective functions remain active in case of communication errors.

2.2. Construction

The distributed differential protection is composed of a master device and from one or more slave devices. Devices with 3 current transformers and with 6 current transformers are available. Onto devices with 3 current transformers a three-phase current transformer set (50/60 Hz) can be connected or one two-phase current transformer set (16,7 Hz). Devices with 6 current transformer inputs are designed for the connection onto two 3-phase current transformer sets or two 2-phase current transformer sets. Up to 2 interface modules for the communication between the terminal devices can be plugged in a device. These interface units are to be selected according to the available transmission media. Different transmission media within a system are possible. The communication topology between the terminal equipment can be carried out as a chain or as a ring. With a ring topology, in the case of loss of a communication path between two terminal equipment, data transfer is automatically switched-over onto a communication chain, without a permanent blocking of the differential protective function occurring.

2.2.1. Master Device

The master device differs in some special features from the other devices of a distributed differential protection. These special features do not exist in the protection functionality itself, but this device cares for the synchronization of the measured values by constantly controlling and is readjusting the synchronizing interrupts. In addition also the real-time management of the protection system is done from the master device.

For the marking, which device the master device is in a compound, this device always gets
Chain address 1.

2.2.2. Slave Devices

Slave devices are identical from the protection functionality to master devices. They are synchronized from the master device so, that a compensation and correction of the different sampling times in the slave devices is possible. In the same way they receive clock time adjustment information from the master device.

Only the chain addresses 2 to 6 may be assigned to slave devices of a compound.

2.2.3. Device Addressing

If the correct operation of a protective function depends on several devices of a compound, it's obvious, that the members of the compound must be localizable. That is, every device must have knowledge over how many devices are shared at the system, to how many and which devices the protection data are sent and from which and/or how many devices the measured values must be received before the differential protection calculation can be started.

The chain address defined in the DRS is used to the identification of the devices of a distributed differential protection. The master device of a compound receives **always** the chain address 1. The slave devices are assigned with chain addresses ascending from 2 as per rule:

Devices for one current transformer set: Chain address ascending from 2 without gap
Devices for 2 current transformer sets: Chain address ascending from 2, with an address as a gap

This addressing rule is necessary, because actually devices with 2 current transformer sets of the design represent 2 terminal devices here and get also 2 chain addresses internal, however, for the sake of the clarity only the lower address is indicated.

E.g. a system with 5 ends and a mixture of a device for one current transformer set and two devices for 2 current transformer setscould have the following addressing:

Device for two current transformer sets: Addr. 1 (simultaneously master)
Device for one current transformer set: Addr. 3
Device for two current transformer sets: Addr. 4

This method of the device addressing requires, that 2 distributed differential protection systems must never be connected to the same RS485 device loop.

2.2.4. Signal Transmission

For the function of the distributed differential protection a transmission of protection data is necessary between the terminal equipment. From the communication point of view, the devices can be connected in chain or in ring. Every terminal device can be equipped with at the most 2 interface modules, which connect the device to the respective transmission medium. These interface modules are available for:

Optical fibre 820nm, 62,5/150µ multimode fibre
X.21 acc. CCITT, 64 Kbit/S
G.703 acc. ITU-T, to 512 Kbit/S
Twisted-pair connection via private telephone wires

In a device compound different transmission media can be used. The transfer cycle duration, and in this way the minimum response time of the differential protection function, is depending on the slowest transmission medium used.

The sequence, in which the devices are joined with each other can be chosen completely independently of their device address (Chain address).

Two conductor connections, as e.g. optical fibres must be crossed out to the neighbor devices. In the case of multiple conductor connections (as e.g. G.703) a cross-linking is set by the used cable.

As a precondition for one correct function of the differential protection, the communication between the terminal equipment must be symmetrical and with more or less unchangeable transmission time between the terminal equipment. Symmetrical communication means same delay in transmit and receive direction between the terminal equipment.

An example of a system in chain topology Fig. 2 shows, an order in the ring is in
Fig. 3 represented.

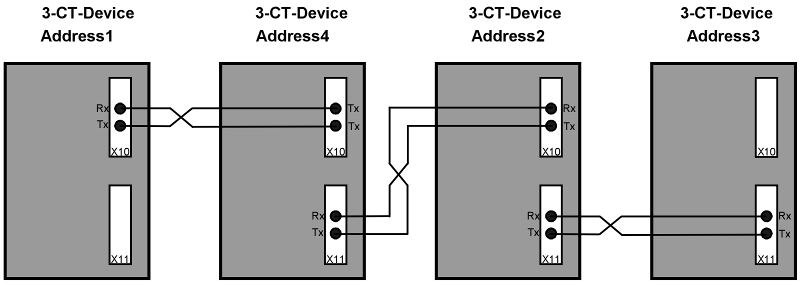


Fig. 2 Chain connection

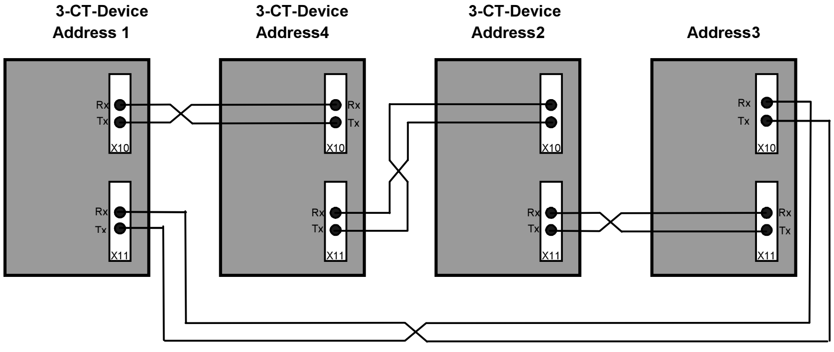


Fig. 3 Ring connection

Following protection-specific information is transferred via the communication:

- Magnitude and phase of the phase currents
- Signals for transformer saturation and harmonic restraint
- Signals of the transfer function
- System information

Also engineering data during the system engineering by means of DRS-WIN (Setting-values, measured values and disturbance records) are transferred via the communication path too.

2.2.4.1. Device Synchronization

As already further above-mentioned, the ultimate condition for the function of the differential protection is, that the measured values of the phase currents in all devices of one compound are referenced to a synchronized time tag – error in synchronization must not be more than some microseconds.In case of greater errors in synchronization, the errors in he calculation of the differential current increase and will finally cause faulty trips, especially when using more terminal devices. The master device of the distributed differential protection cares for this synchronization of the remote terminal devices.

Precision Time Protocol IEEE 1588 is used for synchronization in a modified form to trigger time-synchronous interrupts in the terminal devices. The calculation of the characteristic signal parameters is referenced to this trigger event.

During the start sequence of the distributed system (power-Up, reset...) the synchronization of the topologically next devices is carried out from master device. If these devices are synchronous, they start to synchronize their respective neighbor, and so on. When finally all devices of a compound are locked in this way, the system changes into the normal mode of operation and the differential protective function is active.

In normal operation, the synchronization of the devices is controlled every second and if necessarily adjusted. If the system loses the synchronization (due problems in the communication, device malfunction...) the differential protective function is blocked in all terminal devices and an alarm is executed. The remaining functions configured in the terminal equipment (Back-Up protective functions) keep in service as far as they are not dependent on signals of the transfer function.

2.2.4.2. Telegram Traffic

The data exchange between the terminal equipment is carried out in a fixed cycle of some few milliseconds, depending on the installed device types and the bandwidth of the communication media. If only device types are installed in the device compound with 3 current transformers, so-called short messages are used in the telegram traffic. If a device with 6 current transformers is installed in the system, so-called long telegrams are used.

The bandwidth of the used communication system is determining value for the cycle time of the measured data transfer. So e.g. the transmission time of a short message lasts at 64 KBaud around the 5ms, at 512 KBaud, however, only 0,65ms. Since, for understandable reasons, the cycle time must be longer than the transmission time, a suitable cycle time for the actual system is set during commissioning of the distributed system.

Within a transfer cycle the measured values, status information and additional control information of every terminal equipment are transmitted to the other devices of the system. Checks of the telegram guarantee, that only correct telegrams are accepted. Telegram errors, missing telegrams or missing information of devices in the compound block the differential protection function and generate an alarm.

Every minute and/or spontaneous in the case of clock time setting of the master device, the system time onto all slave devices is distributed additionally. It is in this way guaranteed, that all terminal equipment have the same time exactly onto the millisecond and the event list entries and disturbance records, generated in the different devices, can be related in a correct sequence.

Also the information which are exchanged during the service with DRS-WIN between PC and the terminal devices are part of the telegram traffic. The service of the entire device compound is possible from any terminal device. As the different device of the whole compound are identified by their chain addresses (see "device addressing"), the communication ports configuration settings in the operating software DRS-WIN must be configured for search of chain devices (Profile:"Chained devices" or "All"), so the operating software can find the devices when making a scan for attached devices.

2.3. Device Functions

2.3.1. Distributed Differential Protection

The primary function of the devices of the type DRS-LLD is that of the distributed differential protection. The differential protective function consists of some sub-functions, which are determined by the parameters of the function "Line differential 3" resp. "Line differential 6" in their entirety.

The tripping-characteristics of the differential protection are freely selectable and provide dual slope line sets for the optimal adaptation to the properties of the protection object and the characteristics of the current transformers. In the case of CT saturation an automatic change over from the operation characteristic to a second, less sensitive, saturation characteristic is made. The time, how long the "saturation characteristic" is active, can be limited per parameter.

Inrush blocking, by parameters optional single phase- or cross-blocking, in every terminal device allow to switch on a transformer in the protected zone. Activation of the inrush-blocking, resp. activation of the cross-blocking feature is limited in time by parameters of the function.

Parameters for matching to the current transformer ratios and CT wiring, transformer vector group and transformer neutral connection are integral part of the function.

2.3.1.1. Differential Protection

In the system clock, that is 12 times per period, the connected phase currents are sampled, then digitalized by an ADC and normalized by multiplication with the parameter "CT Ratio Compensation". If a transformer is included in the protected zone, arithmetic operations regarding to the vector group rotation and, where appropriate, zero-sequence system elimination are used for these measured values. Subsequently by harmonic analysis the fundamental wave (magnitude and phase) as well as 2nd and 5th harmonic (magnitude) is calculated. From the ratios fundamental wave/2.harmonic resp. fundamental wave/5. harmonic according to the parameter "2nd Harmonic" and/or. "5th Harmonic" per phase is calculated, whether a blocking of the differential protection must occur due to a transformer inrush or transformer saturation. These blocking-information are transmitted to the other terminal devices next to other values in the communication cycle. The values of the fundamental wave of the line currents are corrected for phase with the synchronizing mechanism mentioned above and then are sent during the transmission cycle to all other terminal equipment.

After every terminal device has received the necessary information from all the other devices of the distributed system, the value of the differential current and the restraint current is calculated in every terminal device autonomously.

The differential current I_{Dk} of the phase L_k (k = 1, 2, 3) is calculated by

$$I_{Dk} = \left| \sum_{j=1}^{n} \vec{I}_{jk} \right|$$

n....number of the terminal devices

The restraint current I_{Hk} of the phase L_k (k = 1, 2, 3) is calculated by

$$I_{Hk} = \sum_{j=1}^{n} \left| \vec{I}_{jk} \right|$$

n....number of the terminal devices

If the so calculated operating point of the differential protection is located in the operating area of the parameterized characteristic and no inhibiting signals, as saturation detection or harmonic restraint are present, the trip signal of the affected phase is set.

2.3.1.2. Saturation Detection

The saturation detection must operate very quickly since in the case of heavy CT saturation only few milliseconds a saturation-free signal exists. The scanning of the saturation detection occurs therefore with the double system clock, that is 24 times per period. The finding of a CT saturation occurs according to the procedure already used in the busbar protection DRS-BB successfully for many years. The principle of the saturation detection is shown Fig. 4 and Fig. 5.

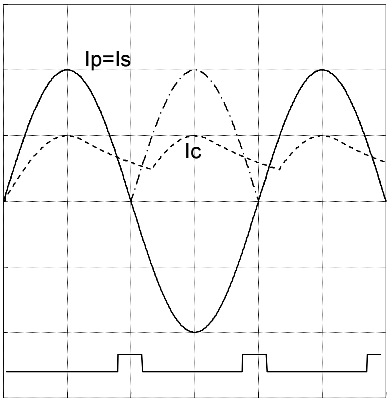


Fig. 4 Signal without saturation

The conditions of a non saturated CT is shown in Fig. 4. This figure shows a sinusoidal signal of the current transformer currents (primary current I_p and secondary current I_s are uniform). The rectified signal is filtered as at a condenser discharge and evaluated (see signal I_c). Through comparison of the two signals in the manner of $I_c > |I_s|$, the signal "SAT" as a binary information in time is derived.

In the case of CT saturation and currents with $I_s \neq I_p$ according to Fig. 5 the time in which the "SAT" signal is produced, becomes clearly larger according to the degree of the saturation.

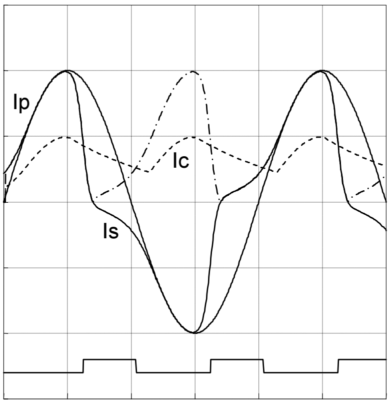


Fig. 5 Signal with saturation

The saturation detection function analyzes per phase the time response of the signals "SAT" and sets, in case of saturation, a blocking signal per phase for one period. This process is repeated in the next period and so on. The status of the saturation detection is sent to all other terminal equipment with the transmission cycle, next to other information. When CT saturation is detected by this process, all terminal devices switch to a second, less sensitive characteristic of the differential protection. When saturation has passed (no saturation signals transmitted), the terminal devices switches back again onto the normal operational characteristic (see Fig.6).

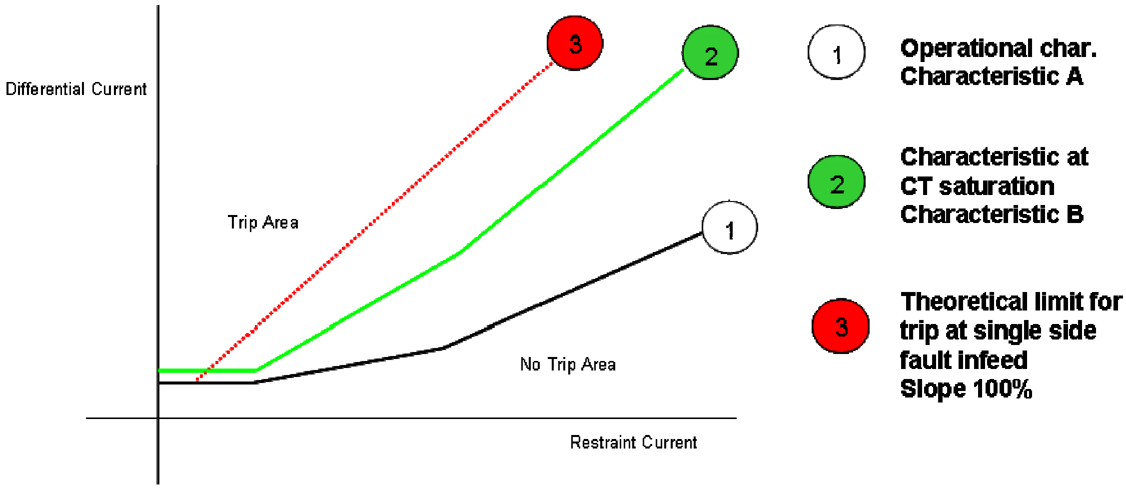


Fig. 6 Characteristics of the differential protection

2.3.1.3. Transfer Function

By means of the transfer function, the status of 4 binary signals of a terminal device can be transferred to the other terminal devices of the compound and used there for indications, alarms or trip-purposes. Input signals for the function can be binary, hardware supported device inputs (BI) or internal virtual inputs (VI). In the local terminal device these input signals are assigned onto the virtual outputs VO13 to VO16 and sent then to the other terminal devices within the transmission cycle.

In the transfer function on the receiving ends the signal obtained from the selected device address (terminal device selected) with selectable delay is used. for indication, alarms or trip-purposes on the LED matrix or trip matrix as per parameterization.

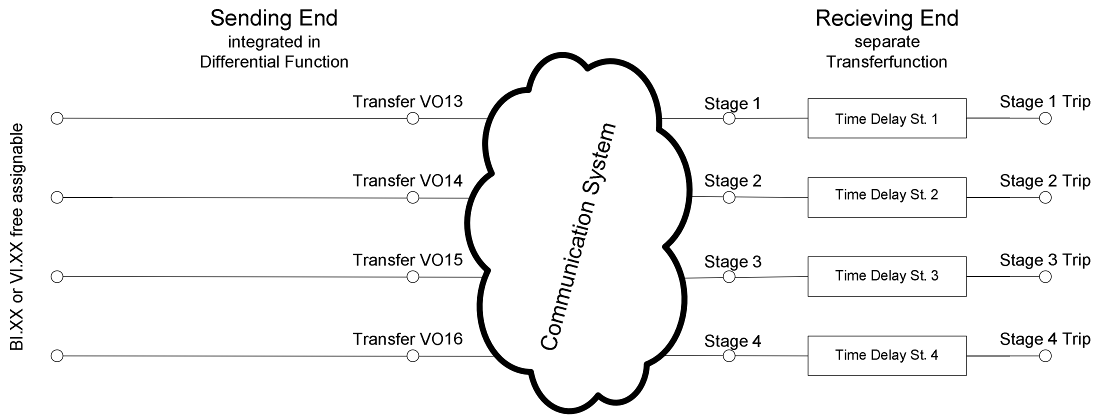


Fig. 7 Scheme of Transfer Function

2.3.1.4. High-Set Sättigung

The integrated "High Set OC"-feature, adjustable by parameter "High-Set OC" should guarantee selective trip of the differential protection in the case of extreme CT saturation. During the first some milliseconds with a high current fault outside the protected zone, the differential current remains negligible small and the restraint current increases to high values. At a high current fault inside the protected zone, differential current and restraint current rise simultaneously. Due to CT saturation in the following periods at an outside fault, the differential current increases and the restraint current decreases and at an inside fault both, differential current and restraint current decrease. Thus the operating point of the differential protection can move to the trip area resp. no-trip area.

If one of the phase current exceeds the parameter setting "High-Set OC", an internal logic operates and the state of the differential protection on the eve of CT saturation is stored as long as CT saturation is present. thus enabling the differential protection to operate selective under bad saturation conditions.

Use of the "High Set OC"-Feature is only recommended for plain lines and should be set to maximum at use for transformer differential.

2.3.2. Back-up Functions

For back-up protection some special current functions from the DRS-LIGHT function library are configurable from our experts. In the standard devices the back-up functions are selected with respect to the maximum operating frequency the protection system is designed for.

In the case of errors in the communication between the terminal devices, the differential protection function is blocked automatically, but the back-up protection functions will continue to operate.

The mode of operation of the back-up protective functions configured in the device is specified in the "DRS protective function library".

2.3.3. Device Fault or Device Halt

The supervision of the program sequence (watchdog) and the hardware self monitoring routines watch the proper function of the device. In the case of a detected problem, an entry in the local event list is made, the status LED on the device front are switched on and an alarm contact is closed for remote signalisation. The automatic diagnoses can, as usual in the DRS, either signal only a minor fault (Device Fault, the device keeps in operation) or a heavy fault, which stops operation of the device (Device Halt). In the case of heavy device fault (Device Halt), the local device stops operation (no protective functions available) and a blocking signal for the differential function to all other terminal devices is transmitted. As in the case of an error in the communication between the terminal devices, only the differential protective function is blocked, but the back-up protective function in the remaining devices of the compound keep in service.

2.3.4. Trip Logic

The trip command for the local CB is generated in each of the terminal devices autonomous and the CB is tripped from the local relay output. As usual for DRS-devices, the mapping of the trip and alarm signals to output relays is possible via the window "Output matrix" in the operating software DRS-WIN. Relay outputs for trip and/or alarm of the back-up protective functions and the transfer function from remote devices can be parameterized in this window as well.

2.3.5. Communication Topology, Change-over of the Topology

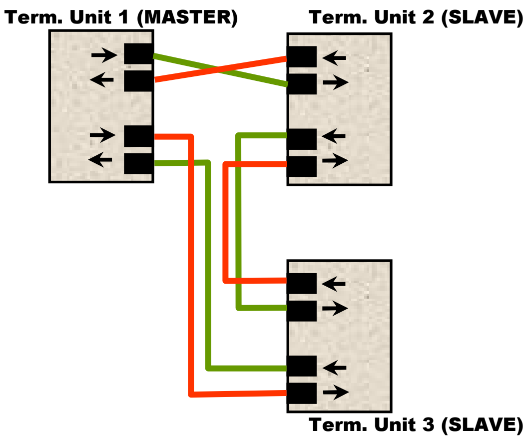


Fig. 8 Signal path in ring mode

As already mentioned, the communication between the terminal devices can be configured as a ring (Fig. 8) or as a chain (Fig. 9).

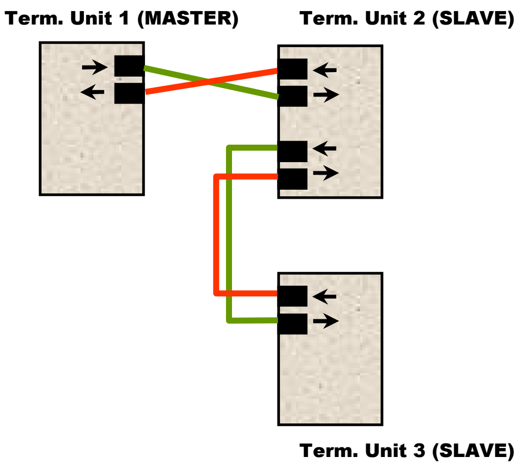


Fig. 9 Signal path in chain mode

A ring-shaped communication system has the advantage, that single interruptions of the communication path (not working interface, broken conductor, ...) do practically not lead to any functional restriction of the differential protection. In order to configure devices in ring-shaped communication, **all** terminal devices must be equipped with 2 interface modules. For chain-like communication, the respective devices at the beginning and end of the chain have only one interface module.

2.3.5.1. Internal Communication Interruption

As mentioned above, in the case of a ring shaped communication system, a single interruption of the communication path do not affect the operation of the differential protection severely, as after a short delay for switch-over to a chain configuration the differential protection continues to operate. An alarm is issued to inform the operators of the switching-over procedure and to call their attention to restore the previous ring communication configuration. Response time of the differential protective function is not influenced by the shape of the communication system.

2.3.5.2. Device Halt

In the case of a serious device fault (Device Halt), the differential protection function is automatically blocked, to prevent faulty trips due missing measured current values of the local, faulty device. The affected feeder in this case is not protected by this terminal device any more. The remote feeders are still protected by the back-up functions of their assigned terminal devices.

2.3.5.3. Location of Communication Break

The failure of a communication interface module or a break in the communication path is recorded in the eventlists of the affected devices. By evaluating this information, the location of the break or the faulty module can be localized.

2.3.5.4. Communication Break and Reliability

The signal path in ring resp. chain configuration is shows in Fig. 8 and Fig. 9.

When communication topology has switched–over from ring to chain, only one way is available for transmission of data between the terminal devices. Functionality and performance of the differential protection function is valid without any restriction.

If more than one break in communication happens in ring mode or one break in chain mode, no switch-over is possible and the differential protection function is to be blocked immediately, as information interchange (transfer of sampled values, binary information,…) between the terminal devices is not possible any more. The alarm "Line Differential XX….X St.2 Alarm" is entered to the eventlist in addition to the blocking signal of the differential protection function, to avoid a faulty trip under these conditions.

When a break in the communication happens, additional information regarding the status of the interface modules are entered to the event list, to ease a detailed post mortem analysis.

3. Additional Functions

3.1. Metering

Following measured values are displayed at the field units:

Devices with 3(4) current transformers
- Phase A Current
- Phase B Current
- Phase C Current
- Current I4

Devices with 6 current transformers:
- Phase A Current System 1
- Phase B Current System 1
- Phase C Current System 1
- Phase A Current System 2
- Phase B Current System 2
- Phase C Current System 2

Additional the internal protective function measured values of the differential protective function:
- Diff. Cur. A
- Diff. Cur. B
- Diff. Cur. C

and the operating-values calculated from the restraint current and the parameter setting:
- Operate Value Ph. A
- Operate Value Ph. B
- Operate Value Ph. C

are displayed, either in primary or in secondary or in relative values.

Also indicators aboutthe quality of the communication can be indicated at the device
- LDiff CQ (Minute)
- LDiff CQ (Hour)

indicate the quality of the data communication in percent in the last minute and/or in the last hour.

3.2. Data Recording

Disturbance records and event lists are stored in every terminal device. All records are time tagged with date and time of day from the internal clock of the devices.

3.2.1. Disturbance Record

In this record the oscillograph information of the connected phase currents and the status of the relay outputs are recorded.

Depending on parameterization, the records are triggered by any pick-up or trip of a protective function. In addition a record can be started via the operation interface using DRS-WIN operation program.

Every records has 55 periods length, with 5 periods pre and 50 periods post trigger time. The total length of one record is 1.1 seconds at 50Hz system frequency.

Up to four records can be stored. If the memory for records is filled up, a new record overwrites the oldest one. Each record is marked with a tag of date and time of day.

Disturbance records can be read out of the devices with operating software DRS-WIN and then stored in COMTRADE-format on data medium.

For communication according protocol IEC 60870-5-103(104) disturbance records are available in COMTRADE-format too.

3.2.2. Event Lists

The event logging stores every change in protective function outputs (come/go) and other operating status of the device. All entries in the event list are marked with date and time of the event in resolution of the system cycle (1/12 of the period).

A maximum of 256 entries in the event list is possible. Further events wipe out the oldest entries form the event list memory.

The entries regarding the operational status of the device (selfsupervision,…) in the event list allow easy diagnostics of the equipment in the case of a device fault.

The event list can be read out from the device with operating software DRS-WIN and can be stored as csv-file on the notebook.

3.3. Serial Communication

Like all other members of the DRS-Family, DRS-LLD has the option to communicate via international standard protocols as IEC 60870-5-103 or IEC 60870-5-104. As per order-code protocol IEC 60870-5-103 or IEC 60870-5-104 is supported and the devices are equipped with the necessary interface module for serial communication. For both protocols the transmission of alarm and diagnosis messages, operational measured values and disturbance records are supported.

3.4. Self Monitoring

The ELIN DRS-LLD is monitored by a number of self-supervisions. In case of a detected problem, the alarm "Device Fault" (device terminals X2: 8, 9, 10) and the corresponding display of the status LED is created. In addition the cause of the fault is displayed on the device LCD under "System/DRS Error Status".

A critical fault makes the red "Fault LED" in steady light and the contact "Device Fault" closes. All protective function on this device are blocked, the relay is not in service.

At a minor fault, the red "Fault LED" is blinking and the contact "Device Fault" is closed. The device keeps in service, but functionality might be reduced (e.g.faulty output relay,…).

To reset the display of the "Fault LED", the blue "ACCEPT"-Button must be pressed, till the rows of the yellow and red LED begin to toggle. When the device is switched off and on, the "Fault LED" is reset too.

All errors, detected by the self monitoring cause an entry in the event list of the device, to enable a detailed analysis of a device error.

3.5. Password

Not authorized parameter changes are effectively prevented by an integrated password protection. The password can contain up to 10 alphanumeric characters.

It is, however, possible to see all setting-values without password input.

The default password (factory set) is 'A'.

During the attempt of the user to change a setting-value, the input of the password is required, before any changes can be carried out. After input of the correct password, the customer can carry out different changes of the parameters without recent password input. If the device is parameterized via the local keypad, the password is only valid for a certain time without activity on the keypad, to disable not authorized access to the device. So, after this time has elapsed, the password input procedure has to be repeated.

3.6. Input Mapping

The devices are equipped with 4 resp. 6 current transformer inputs, I1 to I4 (only three inputs are used for differential protection).resp. I1 to I6, and 12 digital inputs IN1 to IN12.

For every protective function these analog and digital inputs can be assigned to the input signals of the specific protective function.

3.7. Configuration of the Output Relays

The 11 output relays OUT1 to OUT11 of the device can be assigned unrestricted by parameterization to the function outputs of the installed protective functions. The output relays can be used for alarms and trips as well. Generally one NO-contact per output relay is available, only OUT3 offers the possibility of double-pole switching (OUT3.1, OUT3.2).

3.8. LED Display

Each terminal unit contains an LED arrangement in two vertical lines, with a total 28 LEDs. 13 red and 13 amber LEDs can be co-ordinated to the outputs of the protection functions by the software "LED matrix". One green and one red LED are reserved for operation and failure indication of the unit itself. In general, the LEDs are hand reset by a push button.

3.8.1. Operation LED (green)

This green LED provides the following indication:

- Steady – normal supply voltage and fully operating
- Flashing – unit in operation but protective functions inactive, e.g. not yet configured.
- Extinguished – no supply voltage

3.8.2. Fault LED (red)

This refers to a device fault, not a power system fault. The red LED provides the following indication:

- Extinguished – no unit failure, normal operation
- Flashing – a non-critical failure has been detected, but the protection is still in service
- Steady – a critical failure has been detected, the protection is out of service

3.8.3. Programmable LEDs

The programmable LEDs are numbered L.02.L and L.02.R to L14.L and L.14.R can be programmed with the same output signals as for the output relays.

3.9. Local Operation

For local operation, the terminal unit provides a fascia equipped with 2 line LCD, 6 keys, 28 LEDs and a communications port. Reset of the LED indication is done by the blue "ACCEPT" button.

3.10. Communications Interface

According to ordering-options the devices are equipped with different interface modules for internal and external communication. An interface for service according to standard RS485 is always available as a default.

3.10.1. Service Interface

For efficient and comfortable service and setting of the device with a PC, the service interface acc. standard RS485/RS422 (X2: 11-16) on the rear of the terminal units is provided. For connection to a PC, a special connection cable (Item No. GID-014--) is necessary. More terminal units can be connected in chain to one group and service on those devices can be made via the same service interface. The local service interface operates with 38,5 kbps.

Service to all devices of the distributed system can be done from the local interface of any device without any further measures.

For remote service, as usual for DRS protective systems, all devices can be accessed by modem or LAN/WAN (e.g. via converter MOXA IA5150/5250) using operating software DRS-WIN and its fully integrated remote access features.

3.10.2. Control System Interface

For serial communication with control systems, different interface modules are available. As per order-code, communication acc. international standards IEC60870-5-103 or IEC60870-5-104 is supported. For both interface module types direct or optical coupling is provided (as per order).

3.10.3. Internal Communication

For the internal communication between the parts of the distributed system the interfaces X10 and/or X11 are installed in the devices. According to communication topology up to two communication interfaces are installable in the devices.

Communication interfaces are available for

Optical fibre 820nm, 62,5/150µ Multimode
X.21 acc. CCITT, 64Kbit/s
G.703 acc. ITU-T, up to 512Kbit/s
Twisted-Pair connection via separate telephone wires

Different transmission media are possible in one distributed compound. The selected transmission cycle time, and by this, the response time of the differential protection function, depends on the transmission medium with the lowest bandwidth.

3.10.4. Time Stamping

With serial communication acc. protocol IEC60870-5-103(104) a time stamp is received from the control system via dedicated telegrams.

Without any serial communication to a control system, time stamping is possible from time-server DRS-LTS.

4. Hardware

4.1. Case

DRS-LLD is housed in a 6U high case with ½ 19"-rack width.

Features of the fascia are:
- 2 line 16 character liquid crystal display
- 6 keys for menu navigation and settings entry
- 13 amber and 13 red user-programmable LEDs
- 1 green and 1 red healthy LED and legend
- Fault accept button

The rear of the case provides a number of connectors, which can be unplugged, except for the CT inputs.
- X1: CT connections I1 – I4(I6)
- X2: auxiliary power supply, the protection healthy (device fault) contact and the output relays OUT1 - OUT3
- X3: 4 digital inputs (IN1 – IN4) and the RS485 interface
- X4: VT connections (for future extension, not supported up to now)
- X5: additional output contacts OUT5 – OUT12
- X6: additional digital inputs IN5 – IN12
- X7: communication interface acc. IEC60870-5-104
- X8(X9): communication interface acc. IEC60870-5-103
- X10: internal communication interface 1
- X11: internal communication interface 2

4.2. Output Contacts

12 output relays are provided. One of these (‘DEVICE FAULT’) provides changeover contacts and is dedicated as the device failure alarm. The remaining 11 relays are freely programmable by the user. ‘OUT1’, ‘OUT2’ and , 'OUT5' to 'OUT12' provide normally open contacts, while the ‘OUT3’ provides two normally open contacts (suffix ‘.1’ and ‘.2’).

The programmable relays can be mapped by the user to operate from any one, or more, of the protection functions outputs.

The 12 programmable relay output contacts are all trip rated.

4.3. Digital Inputs

12 digital inputs (IN1 to IN12) are provided. All digital inputs are fully isolated from each other and the operating voltage of each digital input can be selected for 24V, 60V, 110V and 240V DC by jumper setting.

4.4. Analog Inputs

Depending on the device type ordered, four current inputs, each with a 1A and a 5A rated input, labelled I1, I2, I3.and I4 or six current inputs, each with a 1A and a 5A rated input, labelled I1 to I6 are provided. The labels for these inputs, and their signals can be assigned to the analog inputs of the installed protective functions.

4.5. Communications Interfaces

For data exchange between the terminal units of the distributed system up to 2 interface modules can be mounted in one device.

Communication interfaces are available for

Optical fibre 820nm, 62,5/150µ Multimode
X.21 acc. CCITT, 64Kbit/s
G.703 acc. ITU-T, up to 512Kbit/s
Twisted-Pair connection via separate telephone wires

Different transmission media are possible in one distributed compound.

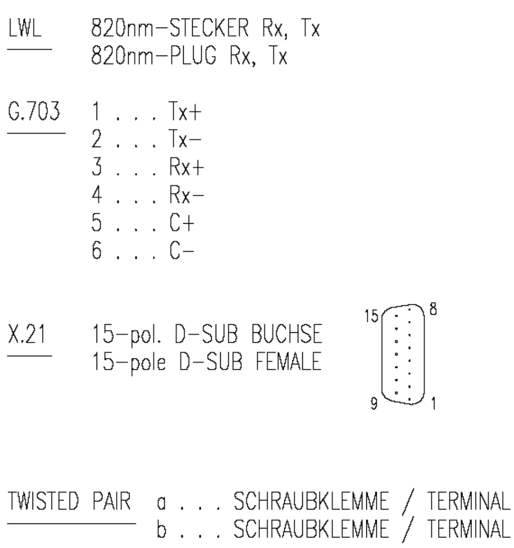


Fig. 10 Connection of Interface Modules

Pin Nr.	X.21 / V.11	Funktion
1		
2	Txd(+)	transmit data
3	Ctrl(+)	control
4	Rxd(+)	receive data
5	Ind(+)	indicate
6	Set(+)	signal element timing
7		
8	GND	signal ground
9	Txd(-)	transmit data
10	Ctrl(-)	control
11	Rxd(-)	receive data
12	Ind(-)	indicate
13	Set(-)	signal element timing
14		
15		

Fig. 11 Pin definition X.21 interface plug

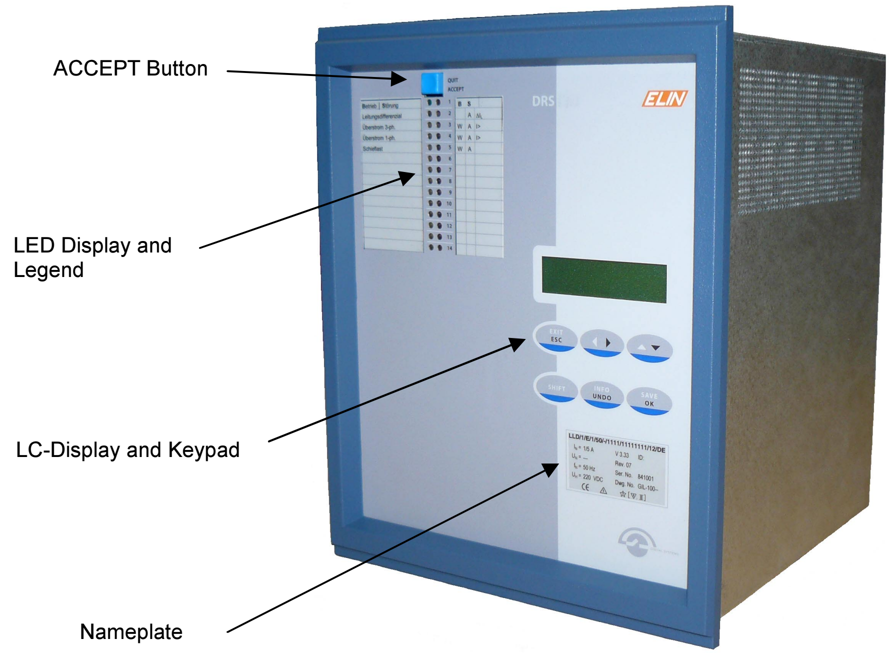
4.6. Serial communication

For serial communication with control systems, different interface modules are available. As per order-code, communication acc. international standards IEC60870-5-103 or IEC60870-5-104 is supported. For both interface module types direct or optical coupling is provided (as per order).

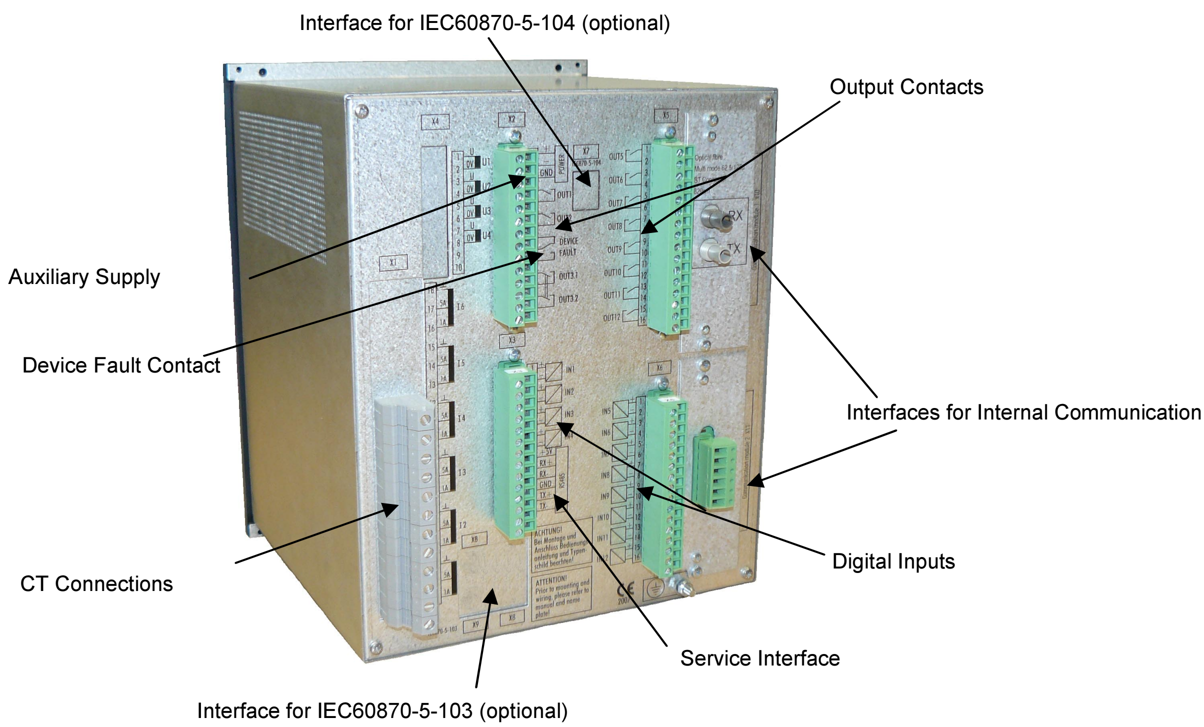
For communication acc. IEC60870-5-104 with direct or optical interface connector X7 is used.

For communication acc. IEC60870-5-103 with direct interface connector X8, with optical interface X8 and X9 is used.

4.7. Device View



Front View



Rear View

5. Technical Data

Performance data to IEC 60255-3 and IEC 60255-13

5.1. CE Conformity

Manufacturer's Statement, CE Conformity (article 10 of EU-directive 73/23/EEC)

“The product DRS-LLD has been developed and manufactured in accordance with the international standard of the series IEC 255, the national standard DIN VDE 57 435, section 303 (September 1984), according to the stipulations of the low-voltage directive of the European Community of February 19, 1973. There is also conformity with EC directive 89/336/EEC ("EMC-introductions"). This conformity is the result of tests done by ÖFPZ Arsenal Ges.m.b.H. - Vienna, according article 10 of the above mentioned guideline in agreement with the basic subject standards EN 50081-2 and EN 50082-2.”

5.2. Weights

Unit	Weight
Type 1 (3xI)	4 kg
Type 2 (6xI)	5 kg

5.3. IP Ratings

Unit	IP Rating
Type 1 (3xI)	IP 51
Type 2 (6xI)	IP 51

5.4. Characteristic Energizing Quantity

Rated frequency: 16.7, 50, 60 Hz

AC Current Inom	Measuring Range
1/5 A	Up to 80 x Inom

5.5. Auxiliary Energizing Quantity

5.5.1. Power Supply

Nominal voltage	Spannungsbereich
24, 48, 60 V	20 to 72 V dc
110, 125, 220 V	80 to 250 V dc or ac rms 50/60 Hz

5.5.2. Binary Inputs

Nominal Voltage	Operating Threshold (approx.)
24 V	16.8 V
60 V	42.0 V
110 V	77.0 V
220V	154.0 V

5.5.3. Binary Input Performance

Parameter	Value
Approx. current at operation	2.5 bis 3 mA

5.6. Protection Characteristics

Please note:
For internal, systematically reasons the internal reference current of the device is 1,67 times the rated current, stated on the device nameplate. When entering the CT data during device parameterization, the primary and secondary currents have to be multiplied by 1,67 accordingly.

5.6.1. Accuracy reference conditions

Parameter	Reference or Value
General	IEC 60255-3 and IEC 60255-13
Auxiliary Supply	Nominal
Frequency	50, 60 oder 16,7 Hz
Ambient Temperature r	20 °C

5.6.2. Differential protection

Level

Operate value (A,B)	0.20 to 2,00 A in step 0.05 A (1A) 1,00 to 10,00 A in step 0,25 A (5A)
Slope 1 (A;B)	20 to 150% in step 5%
Cross over current (A;B)	1,00 to 20,00 A in step 0,10 A (1A) 5, 00 to 100,00 A in step 0,50 A (5A)
Slope 2 (A;B)	20 to 150% in step 5%
Operate accuracy	±10% of setting
Repeatability	±10%

Ansprechzeit

Operating time	Minimum 30ms

5.6.3. Configurable protective functions

Depending on available resources, additional protective functions can be configured in DRS-LLD.
For information regarding technical data and functionality of the additional functions we refer to our documentation "Digital Relay System DRS, Protective Function Library" (DID-001-1).

5.7. Accuracy influencing factors

5.7.1. Temperature

Ambient range	Variation
-10 °C to +55 °C	≤ 0.5 % per 10 °C

5.7.2. Frequency

Range	Variation
47 Hz to 52 Hz 57 Hz to 62 Hz	≤ 7.5 % for CBF ≤ 1 % for all other functions

5.8. Thermal Withstand

Current Level	Time
4 x In	Continuous
30 x In	10 seconds
100 x In	1 second
250 x In	Half cycle

5.9. Burdens

CT input	Condition	Burden
Analogue input I1 to I4(I6)	Per phase at In	≤ 0.1 VA

5.10. Output Contacts

Contact rating to IEC 60255-0-20

at operating voltage of 220V AC/DC

Action	Condition	Level
Carry continuously		5 A
Carry for 0.5 s		30 A
Make and carry	L/R ≤ 40ms	≥ 1000W
Break	L/R ≤ 40ms	30W

5.11. Serial Interfaces

5.11.1. Interfaces for internal communication (as per selection)

Data transfer between terminal devices

Type	FO 820nm	G.703	X.21	Twisted Pair
Medium	62.5/125µm Multimode	Wire 6-pol.	Wire 15-pol.	Wire 2-pol.
Connection	ST connector	terminals	15-pol. D-Sub female	terminals
Baud Rate	512kbit/s	Up to 512kbit/s	64kbit/s	64kbit/s
Maximum reach	1-3 km	Depending on the data-network	Depending on the data-network	1-3 km

5.11.2. Service interface

Schutz Einstellwerte und Abfrage

Parameter	Value
Interface	RS485
Connection	terminals
Baud Rate	1200 to 38400

5.11.3. Substation Informative Communications

Control system communications

Parameter	Value
Method	IEC 60870-5-103 over 820nm LWL
Medium	62.5/125µm Multimode fibre
Connection	ST connector on rear of case

Parameter	Value
Method	IEC 60870-5-104
Medium	Optical fibre or CAT5(6) cable
Connection	RJ45 or optical connector on the rear of the case

5.12. Environmental

5.12.1. General

Temperature acc. IEC 68-2-1/2 and IEC 60255-6

Test	Levels
Operating range	-10 °C bis +55 °C
Storage range	-25 °C bis +70 °C

Humidity acc. IEC 68-2-3 and DIN 40050 Class F

Operational test	144 hours, 20 to 55°C (6 hour cycles) and up to 95% RH

Transient Overvoltage acc. IEC 60255-5

Test	Levels
5 pulses with positive and 5 pulses with negative polarity	5 kV 1.2/50µs 0.5 J

Burst Test acc. IEC 60255-5 Class III

5 pulses with positive and 5 pulses with negative polarity

Test	Levels
Common mode	2.0 kV
Differential mode	1.0 kV

Insulation acc. IEC 60255-5

Test	Levels (rms, 1 min)
Between all terminals and earth	2.0 kV
Between independent circuits	2.0 kV
Across normally open contacts	1.0 kV

5.12.2. Immunity

Auxiliary DC Supply acc. IEC 60255-11

Quantity	Value
Admissible ripple at nominal voltage	≤ 12%
Allowable breaks/dips in supply	≥ 100 ms (for Vaux ≥ 60 V)

High Frequency Disturbance acc. IEC 60255-22-1 Class III

1 MHz attenuated oscillation, 400 Hz repeat frequency, duration 2 s, 200 Ohm source impedance

Type	Level
Common (longitudinal) mode	2.5 kV
Series (transverse) mode	1.0 kV

Electrostatic Discharge acc. IEC 60255-22-2 Class IV

Type	Level
Contact discharge	8 kV
Air discharge	15kV

Radio Frequency Interference acc. IEC 60255-22-3 Class III

Frequency Range	Level
30 to 1000 MHz, 80% AM with 1kHz	10 V/m

Fast Transient (Burst) acc. IEC 60255-22-4 Class IV

Type	Level
5/50ns, 2.5 kHz, burst duration 15 ms	4kV

Conducted RFI acc. IEC 60255-22-6

Frequenzbereich	Level
0.15 to 80 MHz, 80% AM with 1kHz	10 V rms prior to modulation

5.12.3. Mechanical

Vibration (Sinusoidal) acc. IEC 60255-21-1 Class 2

Type	Level
Vibration response	1 gn
Vibration endurance	2 gn

Shock and Bump acc. IEC 60255-21-2 Class 2

Type	Level
Shock response, 11 ms	10 gn
Shock withstand, 11 ms	30 gn
Bump, 16 ms	20 gn

Seismic acc. IEC 60255-21-3 Class 2

Type	Level
Seismic Response	2 gn

The data contained in this literature should be considered as product information only. We would like to advise that short term modifications of our production range are possible due to our aim to continuously improve the performance of our products for the benefit of our customers so there may be differences between the products supplied and the corresponding descriptive literature.

According to our experience following the instructions outlined in this document will provide the most satisfactory service performance.

In case of unusual troubles, which cannot be resolved by referring to this literature, please contact our nearest agent or our Head Office.

When commissioning, the operating instructions and also the applicable Local Safety Standards have strictly to be observed.

This edition of the document has been carefully checked regarding up-to-date contents and correctness. Should there be any discrepancies or contradictory information in this descriptive literature, could you please inform us. In case of problems please do not try to solve them on your own but contact our nearest agency or our Head Office, which will be glad to be of any assistance to you.

All agreements, legal rights, obligations, performance and scope of supply for ANDRITZ Hydro GmbH and also conditions, governing the warranty, are without expectation, regulated according to the Contract Agreement and are not, in any way, influenced by the contents of the descriptive literature or operating instructions.

Urgent information will be conveyed by telephone or fax.

Our address:

ANDRITZ Hydro GmbH	Phone:	++43 1 81 195 Ext. 6936
PRT	Fax:	++43 1 81 195 Ext. 6951
Wienerbergstrasse 41		
A-1120 VIENNA	E-mail:	martin.hantsch@andritz-hydro.com
AUSTRIA		http://www.andritz-hydro.com

To

ANDRITZ Hydro GmbH
PRT / attn. Mr. Hantsch
Wienerbergstrasse 41
A-1120 VIENNA

Please inform us at your earliest convenience if you have any additional requests and suggestions or in case of errors.

We thank you for your co-operation.

Drawing No. of the documentation: ___________________ revision (+date):_______________

Remarks:

From:
Address:

Phone:
Fax:
E-mail: