ELIN DRS-BB

Technical Manual

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1 INTRODUCTION

DRS-BB is a distributed low-impedance busbar differential protection. It is the fruit of over ten years' experience of low-impedance busbar protection.

The DRS-BB combines the main protection features of low-impedance differential protection, using independent discriminating and check zones, with backup overcurrent and circuit breaker fail protection. In addition, the DRS-BB provides information functions with metering, event and disturbance waveform data storage. Supervisory components and self-monitoring features give high confidence of full serviceability. A series of menus provide user-friendly access to settings, meters and fault data.

Short circuits on busbars have severe consequences, due to their central position in the power system. A fault on a busbar endangers system operation more than in any other element. The main purpose of busbar protection is to prevent system blackout by isolating the faulty busbar zone, before other elements drop out.

Due to the complexity of most plants, the rapid selective detection of busbar faults is a challenge to protection techniques. Moreover, short-circuit currents on a busbar are in general very high and lead to serious damages, if they are not interrupted in time. There is also danger for personnel, especially in indoor installations.

This high requirement for sensitivity is matched by an equally high requirement for security, making busbar protection extremely important strategically.

Practical experience has demonstrated, that plant configuration is often modified during erection or even after completion of works. Consequently, the busbar protection configuration also has to be redesigned. A busbar protection that can be adapted in software to changing plant configurations is therefore desirable.

This is achieved by a software plant replica. In case the provided hardware is not sufficient for a larger plant, it is possible to add additional modules.

The distributed arrangement using optical fibres brings the following additional benefits:

- The expensive and time consuming cable works used in traditional centralised busbar protections are avoided, and by the ring-shaped arrangement a minimum cable length can be achieved.
- With a fibre-optic ring configuration, even if both rings are interrupted at a single point, each unit can continue to communicate, allowing uninterrupted operation.
- The field units, which signify the distributed arrangement of the busbar protection, are in addition feeder backup protection units, and as such independent from each other and from the central unit.
- Lower cubicle requirement reducing overall system costs.

2 PROTECTION

Figure 1 shows a sample busbar. It is not a realistic arrangement, but shows the different types of bays for which the DRS-BB can cater.

- Bays 1, 2, 5 and 7 are ordinary feeders. Each can be connected to one of two bus segments through its two isolators, and if both isolators are closed two bus segments will be joined together.
- Bay 3 is a bus section (bus sections and bus couplers are equivalent for DRS-BB) with a circuit breaker and overlapping bus zones with two CTs.

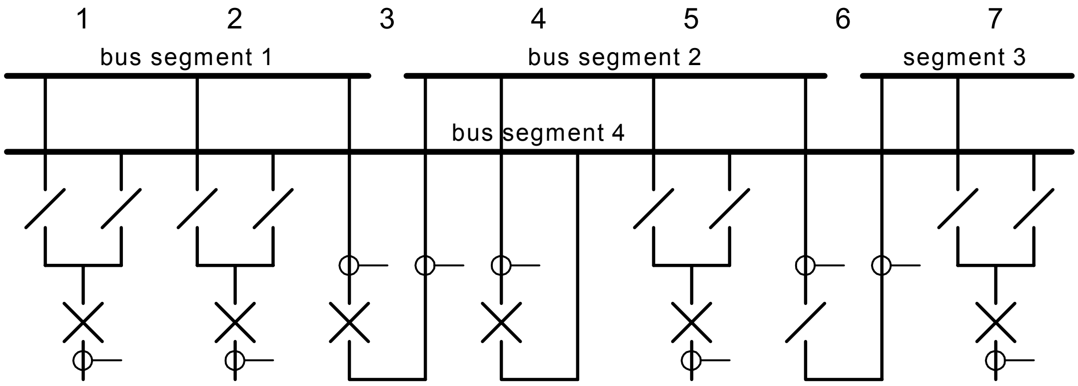

Figure 1 Examples of different busbar bays

- Bay 4 is a bus coupler with a circuit breaker and only one CT.
- Bay 6 is a bus section with only an isolator – no circuit breaker.

The busbar shown is a double busbar, however the DRS-BB can cater for all the common arrangements of single busbar, one-and-a-half breaker, double busbar and meshes. In fact, any arrangement with up to six isolators per feeder can be handled.

2.1 Overview of function

The low-impedance differential protection principle is applied. Each bus zone is provided with its own measuring system in software, in which the instantaneous current values of all feeders, which are either directly or via connections without CT´s indirectly switched on to the respective zone, are summed up, and in which this current sum is checked if it exceeds the reference value.

A plant replica, factory installed into the system, holds an internal equivalent to the actual busbar arrangement.

This replica uses the isolator positions to select the currents that are to be summed by the measuring systems of the zones.

In case a measuring system detects a busbar fault, the trip commands are given via the same plant replica to the circuit breakers of all feeders which are directly or indirectly over connections without C.B. switched to the respective zone.

For redundancy, fast acting current relays in the feeders are used, as well as a check zone, which is built up similarly to the discriminating zones, but covering the whole plant. Therefore, the check zone acts independently of any isolator positions.

Figure 2 provides an overview of the arrangement of the various functions between the different units of the system, and how they interact.

2.2 Summary of the layout

It is possible to create a system that applies up to 80 field units to up to 16 zones.

The busbar protection is built up from a central unit and from peripheral devices, called field units, which are expected to be located in the feeder bays. The field units are connected with the central unit by an optical fibre double ring.

2.2.1 Field units

These devices are of hardware type DRS-LIGHT (designation DRS-LBB). They are equipped with a main board containing the processor, and an additional board that deals with the protection communications. In general, one is applied to each feeder.

The field unit is equipped with a local display and a 6-button-keypad for the application of settings and interrogation of the relay.

The user operation programme DRS-WIN can also be used for application and interrogation of settings, and download and analysis of fault disturbance records.

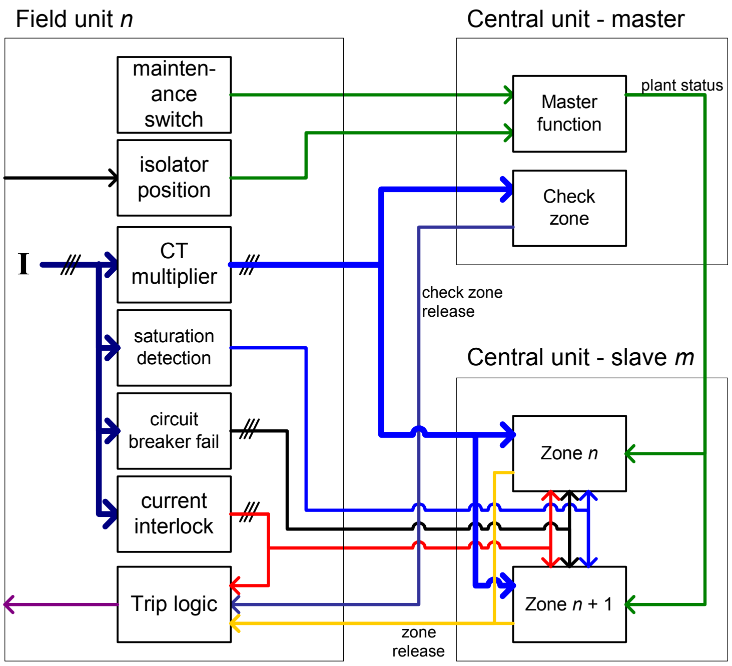

Figure 2 Overview of Busbar Protection Functions

2.2.2 Central unit

The main functions of the central unit are the building-up of the plant replica, and the derivation of the trip commands from the current sums.

The central unit is an expandable module based unit, which can include the following modules:

- Power supply – two power supplies can be included to give redundancy and hot-swapping capability.
- MRB3 microprocessor plus BBM fibre ring connection unit. Up to 11 of these modules may be required, depending on the size of the busbar. One of these modules is the master; the remaining modules are known as slaves.
- The central unit is equipped with a local display and 6-button-keypad similar to the field units. It serves for indicating signals of interest. If required, an additional LED-panel can be provided, which indicates the switching status of the plant as well as signals concerning the protection function (e.g. trip signal zone 4, phase L2 etc.). Some LED´s are hand-reset.

Using the user communication interface setting values, measuring values, fault record curves can be read from the central unit or any of the field units.

2.2.3 Signal transmission

The main transmission path for all protection communications consists of 2 optical fibre rings. All DRS-LIGHT field units and MRB3 central units are connected to both fibre-optic rings. The duplicity provides redundancy for failure of the fibres.

The following protection related information is communicated on the fibres:

- Instantaneous values of all currents for the purpose of summation.
- Signals of current transformer saturation
- Current interlock signal
- Isolator position signals
- Circuit breaker trip commands
- Plant replica, assigning of feeders to zones
- A number of signals outside the main protection function

Setting values, measuring values, and fault records can also be transmitted via the optical fibre ring.

2.2.3.1 Structure of telegrams

The central unit generates a synchronisation pulse every millisecond. One telegram is transmitted by each bay unit for every synchronisation pulse received from the central unit. It contains:

- The current instantaneous values of the 3 phases
- Saturation signals of the 3 phases
- Isolator positions for max. 6 isolators
- Signals: isolator time-out, isolator auxiliary contact discrepancy supervision, field unit failure, circuit breaker failure, current interlock.

2.3 Functions of the field units

2.3.1 Sampling and scaling

The 3 phase currents are sampled every millisecond, then they are digitised by an analogue-to-digital converter. The digitised values are used in the busbar protection function and the feeder protection functions of the field unit.

For the busbar protection the digital values are normalised, controlled by the setting “primary CT factor”. This removes any necessity for each feeder to have the same CT ratio. In this way, all current values used by the busbar protection are normalised to the same primary current.

Each field unit determines its own sampling cycle, for reasons of independence, i.e. they are asynchronous.

In contrast to this, the creation of the normalised values to the optical fibre rings is synchronised to a pulse from the central unit, which is also responsible for the simultaneous sampling of the currents.

2.3.2 Saturation

If CT saturation in any of the three phases is detected by the software algorithm, a respective signal is entered into the telegram. Those current values from telegrams containing a saturation signal are not taken into consideration by the central unit.

For an explanation of the saturation detection algorithm refer to Figure 3.

Figure 3(a) shows a healthy waveform, which is rectified (dashed line). The rectified signal is passed through a decay filter (thick line) and the two compared. Where the decay quantity exceeds the rectified quantity, the busbar protection is blocked. For a healthy waveform this is for a very short time, when the signal level is very low, so the operation of the busbar protection is not affected.

In Figure 3(b), with a saturated current, the period of blocking is much longer, and is throughout the period of the saturated waveform.

If CT saturation is detected by a bay unit, a signal is sent to the respective zone function of the central unit. As a consequence the trip command of that zone is immediately blocked, but only for the period that saturation is detected.

In the case of an in-zone fault, a trip decision would occur before saturation is detected so blocking will not occur.

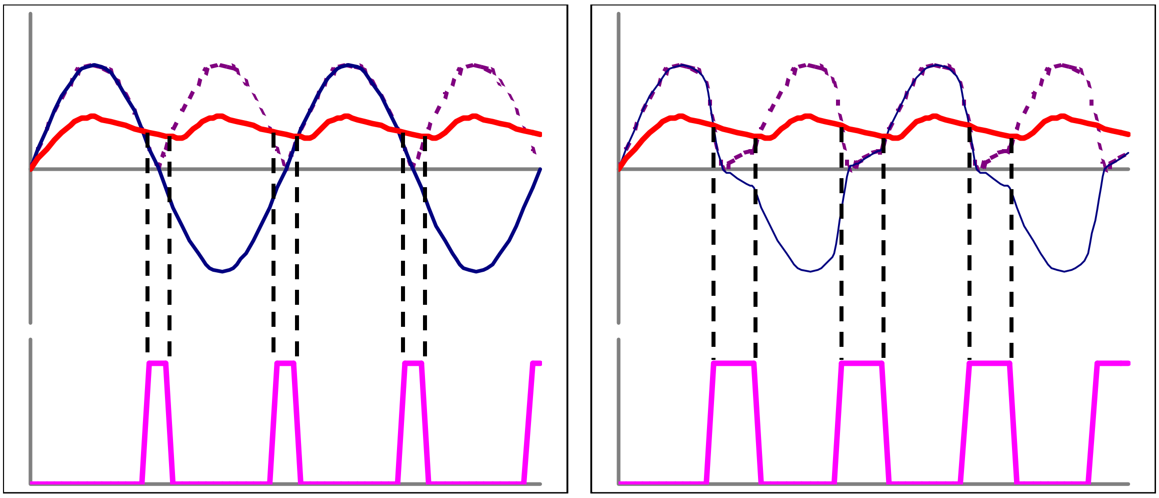

Figure 3 Saturation Detection showing (a) Unsaturated waveform (b) Saturated waveform

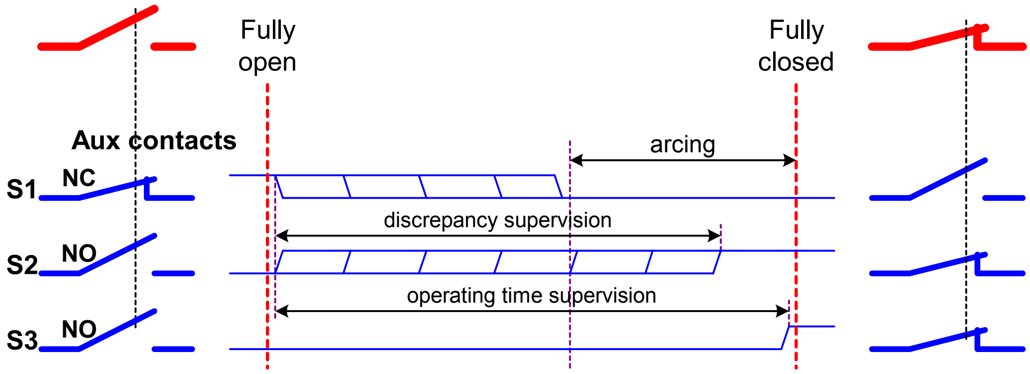

Figure 4 Isolator position monitoring

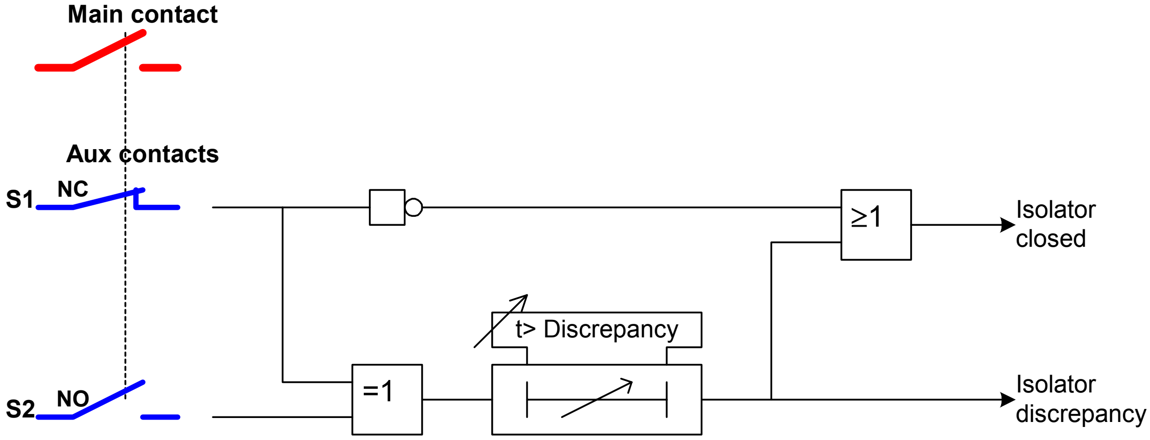

Figure 5 Isolator discrepancy logic

2.3.3 Current interlock criterion

The busbar protection current interlock requires that at least one feeder detects an overcurrent before tripping is released.

Overcurrents in the phases L1, L2, L3 are detected, and the respective signals are entered into the telegram.

The overcurrent algorithm uses a combination of instantaneous value and slope to achieve the fast pickup required for busbar protection.

A setting is provided which can prevent overcurrent in the feeder from releasing busbar protection tripping.

2.3.4 Isolator positions

The busbar protection allocates currents to the appropriate zone summations based on the positions of the isolators associated with each feeder.

In addition, position discrepancy and isolator travel time are monitored.

For carrying out these tasks each isolator should have 3 auxiliary contacts with the following functions:

- 1 open when isolator totally open
- 1 closed when isolator totally open
- 1 closed when isolator totally closed.

(The final input is optional, but is required for isolator travel time monitoring.)

The operation of the inputs is shown in Figure 4 and Figure 5.

2.3.4.1 Isolator position

Each bay unit can monitor the positions of up to six isolators using two binary inputs for each. These are entered into the telegram to be communicated with the central unit.

The co-ordination of the physical inputs to the logical function is carried out via a software matrix.

2.3.4.2 Position discrepancy

For each isolator a coincidence detector monitors for isolator position discrepancy, using an XOR gate and a timer.

A setting is provided for the timer, after which a discrepancy signal is entered into the telegram to the central unit.

2.3.4.3 Isolator time-out

For each isolator, if a third digital input is allocated it can be used to monitor the travel time of the isolator.

A setting is provided, and if the travel time exceeds the setting time a signal is entered into the telegram to the central unit.

This function is used for alarm only, and is not acted upon by the busbar protection.

2.3.5 Analogue Input Supervision

Supervision of the analogue inputs prevents any maloperation of the busbar protection because of a hardware failure of the current input circuitry.

The function makes use of a fourth current input channel on the field unit, which should be connected externally to summate the three phase currents. The current measured on this channel is compared with a similar internally derived quantity. If the two quantities differ sufficiently, a channel failure is detected and the busbar protection and circuit breaker fail are blocked. An alarm is also generated.

The detection criteria is a biased characteristic as follows:

$$i_{L1} + i_{L2} + i_{L3} + i_E > Is, \quad \text{and,}$$

$$i_{L1} + i_{L2} + i_{L3} + i_E > K \,.\, (|i_{L1}| + |i_{L2}| + |i_{L3}|)$$

where *Is* is an initial value, and *K* is the bias slope. These values are fixed at *Is* = 0.5xIn and *K* = 0.125 to reflect the expected performance of the current inputs under normal operation and to prevent inadvertent blocking for low load conditions.

2.3.6 Circuit breaker failure

Each field unit can monitor for failure of its circuit breaker to interrupt fault current (Figure 6).

Two timers are provided to retrip the circuit breaker and issue a backtrip. The backtrip can be via an output contact and by tripping the busbar protection zone.

The timers start through activation of one of two digital inputs. If current is above the setting level when the timers expire the appropriate trip is output.

A fast reset time is provided on the overcurrent level detector to prevent a successful trip causing a maloperation of backtrip.

If an external current level detector is used it is possible to bypass the internal level detector using a setting.

The algorithm operates on a phase-by-phase basis, with common trip outputs.

2.3.7 Trip command

Trip signals can be issued by the central unit to the field units.

For security, the trip signal must appear in two successive telegrams.

A trip command received in this way can originate from the busbar protection or circuit breaker fail protections. The conditions that must be fulfilled for a trip output in each of these cases are as follows:

Busbar protection trip
- discriminating zone, and
- check zone, and
- current interlock release

  (The current interlock requirement can be disabled with a setting.)

Circuit breaker fail trip
- discriminating zone, and
- origin is circuit breaker fail

When the fault is cleared, the trip signal in the telegram is also cleared, and the field unit opens the trip contact. However, a minimum contact dwell time of 500ms also applies.

2.3.8 Signal re-routing

2.3.8.1 Interruption of the optical fibres

As discussed above, at an interruption of the optical fibres the operation of the busbar protection is ensured after a short time delay, even when both rings are broken at one point, due to signal re-routing.

This is demonstrated in Figure 7.

2.3.8.2 Failure of a field unit

In this situation, the re-routing function again acts, but in a slightly different way.

At a failure of a field unit, the busbar protection

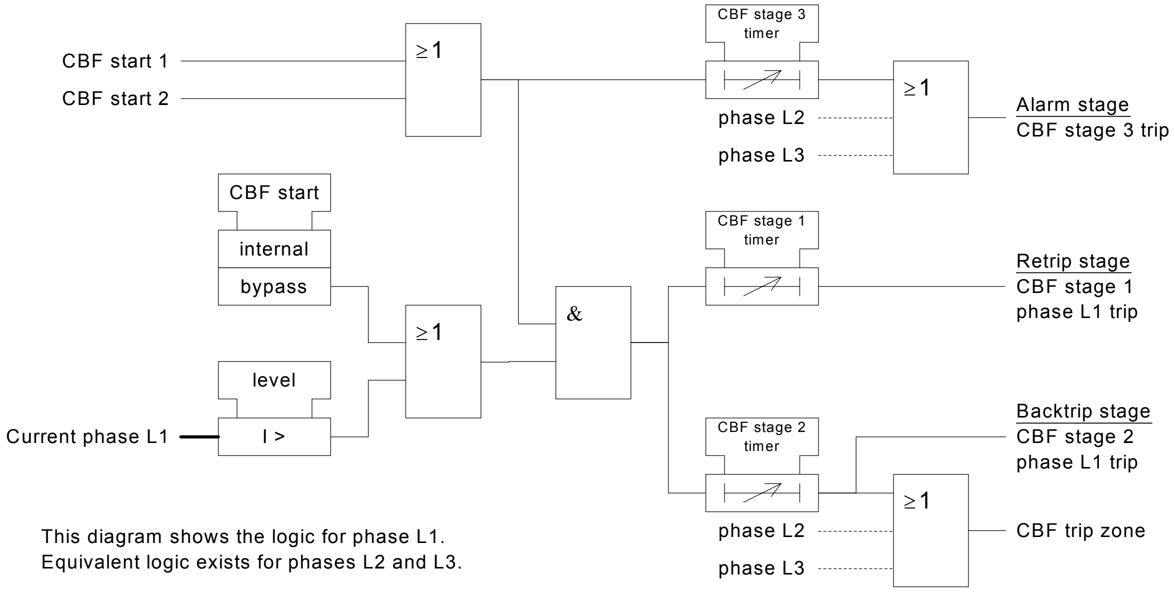

Figure 6 Circuit breaker fail algorithm

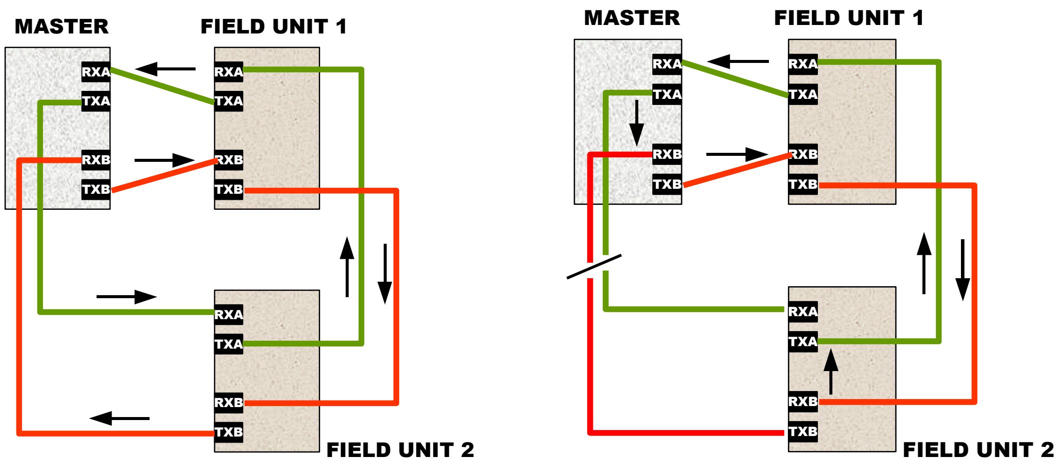

Figure 7 (a) Normal communications paths (b) Signal re-routing following link failure

is immediately blocked, to maintain security and prevent maloperation due to a differential current being incorrectly measured.

At a failure of a field unit, the plant operators have two possibilities:

- the busbar protection remains blocked, until the defect is cleared, or,
- the respective feeder is taken out of operation, until the defect is cleared.

In the second case the effect of re-routing is that after switching the maintenance switch (see section 2.4.1.3) to "maintenance", the busbar protection starts its operation again.

2.3.8.3 Indication of interruption location

When re-routing occurs the point of interruption is displayed on the central unit display, in order to assist repair.

2.3.8.4 Fibre interruptions and security

It should be noted when re-routing has taken place the security of transmission is reduced, since all telegrams are transmitted only one ring, respectively instead on both as in normal service.

If two or more interruptions exist at the same time (at different places), the re-routing function is unable to function, since from the field units situated between the two fault locations no telegrams can arrive. The signal "telegram failure" blocks the busbar protection automatically.

Therefore, if the first interruption is caused by failure of a field unit, it is recommended that, after shutting down the respective feeder, the faulty field unit is bypassed using optical fibre coupling modules. When the next fault appears, the re-routing will function as usual.

2.4 Functions of the central unit

2.4.1 General

2.4.1.1 Co-ordination of functions to devices

The central unit consists of at least one module containing the MRB3 microprocessor unit, together with a BBM communication module for the optical fibre signal transmission. At larger plants, more MRB3/BBMs are required, to a maximum of 7. In this case, the first one is the "Master" and the remaining ones are called "Slaves". In the Master, the "Master Function", the "Check Zone Function", and some "Discriminating Zone functions" are executed, according to the computing time which is still available. In the Slaves the remaining zone functions are executed.

2.4.1.2 Allocation to a zone

According to the differential protection principle, one of the basic functions of the busbar protection is the summation of instantaneous values belonging to the zones of the busbar. The instantaneous values to be summed up are thereby selected according to the "Allocation-to-a-zone". This expression indicates, which feeders are directly or via other zones connected to the respective zone.

The allocations-to-a-zone are determined in the master device by the master function, which contains a plant replica from the isolator positions. These allocations are subsequently transmitted to the zone functions by the optical fibre ring.

2.4.1.3 Maintenance switches and "Plant Status"

In the central unit, a software "maintenance switch" per feeder is provided. When in the state of maintenance all "isolator on" signals of the respective feeder are suppressed. Consequently no more attention is paid to the feeder with respect to summations nor to any other function, i.e. its current signals have no effect, and no trip commands are sent to it. The signal voltage for the isolator auxiliary contacts can be switched off.

The condition of the maintenance switches is known as the "Plant Status". Using this plant status, the connection module of the master is continuously checking if all telegrams arrive from the feeders that are in operation.

When a feeder shall be taken into maintenance, first it must be shut down on its primary side, then its software maintenance switch can be activated.

2.4.2 Master-function

2.4.2.1 Plant replica

Up to six isolator position signals are received from each feeder, from which the allocations-to-a-zone is determined, independently for each busbar zone. These represent which feeders are connected with the zone either directly, or indirectly via paths without CTs and/or circuit breakers.

Issues that are taken into account when the allocations-to-a-zone are determined, are:

- Currents in bus couplers or sections, which have parallel paths without CTs, should not be included in the measurement (e.g. currents in the bus coupler of a double busbar, when both isolators of a feeder are closed).

When couplings with isolators (no CT or circuit breaker) join two bus segments together, all feeders connected to either zone will be allocated to both zones. Both zones will separately evaluate the differential summations without change to their setting levels and, in the event of a trip, indication of trip will be given for both zones.

2.4.2.2 Circuit breaker failure

If a telegram arrives from one of the feeder units which contains the C.B. failure signal, then all zone functions are informed of the feeder identity via optical fibre ring. Using the allocations to a zone this information is evaluated and transformed into trip commands to those feeders that are connected directly or indirectly to the zone with the faulty circuit breaker.

2.4.2.3 Plant status

The master function checks for missing telegrams from a field unit, bearing in mind the maintenance switch positions. If a telegram is missing, the busbar protection is blocked immediately. When the telegrams arrive again, the protection is unblocked again after a short time delay.

2.4.2.4 Synchronisation pulse

The master function sends over the optical fibre ring every millisecond a synchronisation pulse for simultaneous sampling of the instantaneous values by the field units.

2.4.3 Check-zone function

2.4.3.1 General

The check-zone represents a differential protection over the total plant, not influenced by the switching status and therefore not requiring isolator position signals. It is a special zone function, that sums all feeder currents of the plant and releases the trip commands from the discriminating zones, when the operate value exceeds the restraint value.

Two differential stages are provided: stage 1 is used for the main busbar protection and provides a biased differential element. Stage 2 is a sensitive stage for isolated networks, filtered for fundamental frequency only, and includes a time delay.

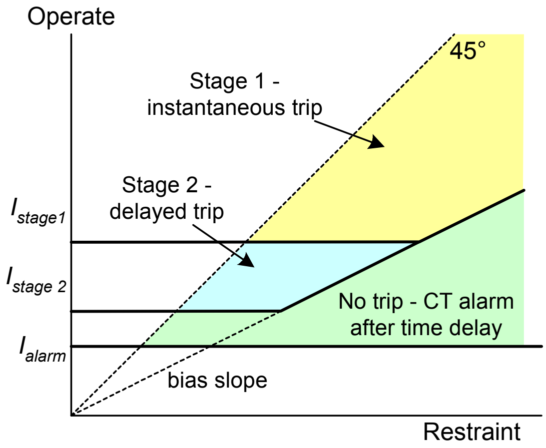

Figure 8 Stage 1, Stage 2 and Alarm Differential Elements

A sensitively set, unbiased alarm stage is also provided, to detect a failure of the CT secondary wiring. The interaction between these stages is shown in Figure 8. (Note that the restraint value cannot exceed the operate value.)

The check zone function is always located in the same MRB3 module as the master function.

2.4.3.2 Check zone summation – stage 1

On a phase-by-phase basis the currents on each feeder not in maintenance (according to the “plant status”) are used for the check zone summation.

The currents are applied to a biased-differential algorithm as follows:

$$\left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{I}_{\mathrm{stage1}} \quad \text{and} \quad \left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{K}.\left|i_{max}\right|$$

where i is the current in feeder r, n is the number of feeders in the check zone, $\mathrm{I}_{\mathrm{stage1}}$ is the check zone differential setting for stage 1, K is the check zone bias slope and I_{max} is the largest feeder current.

The function of the check-zone measuring system is similar to that of the zone function, described later in section 2.4.4.3.

The only differences are that the absolute value of the largest CT current is used for the bias effect, and not the sum of the absolute values. The reason is that the sum of the normal operation currents of the zones that are not affected by the busbar short circuit would lead to a very high stabilisation effect at plants with a high number of feeders.

The second difference is that the check zone itself is not dependent on any other blocking or release signals.

2.4.3.3 Check zone summation – stage 2

This stage provides sensitive detection is for use with isolated networks, on a phase-by-phase basis. It includes a low-pass filter to remove all but the fundamental frequency, adding an inherent delay of 100ms. The stage is followed by a settable time delay.

The biased-differential algorithm as follows:

$$\left|\sum_{r=1}^{n} i_r\right| \geq I_{stage2} \quad \text{and} \quad \left|\sum_{r=1}^{n} i_r\right| \geq K.\left|i_{max}\right|$$

where I_{stage2} is the check zone differential setting for stage 2.

2.4.3.4 Check zone summation – alarm stage

This stage is used to detect CT wiring failure using a sensitive setting, on a phase-by-phase basis. The stage is unbiased and is followed by a settable time delay.

2.4.3.5 Blocking signals

Rapid blocking

Rapid blocking is initiated for any failure of telegram transmission on the optical fibre ring. In this case all release signals coming from the check zone function or from the circuit breaker failure function are stopped immediately.

Delayed blocking

The origins of delayed blocking are:
- An allocation-to-a-zone is missing
- CT secondary wiring alarm
- Discrepancy failure
- Field unit failure
- Hand blocking of the busbar protection
- Hand blocking of the C.B. failure protection

These signals are collected in the check-zone function and are transmitted on the optical fibre ring to each zone function.

In the first four of the cases listed above it is possible to select by a parameter, if a blocking plus an alarm or an alarm only shall be initiated for the condition described.

2.4.4 Zone functions

2.4.4.1 General

Each zone function represents a differential protection for the particular busbar discriminating zone to which it is related. It is the summation of the currents in those feeders that are connected directly or indirectly with the zone.

It gives a trip command to the field units of the respective feeders, when the operate value exceeds the restraint value.

Some zone functions may be located in the master MRB3/BBM module (depending on the number of field units), with the remainder located in the slaves.

2.4.4.2 Allocation-to-a-zone

Each zone function receives its allocation of feeders cyclically from the master function.

2.4.4.3 Discriminating zone current summation

On a phase-by-phase basis the currents on each feeder in the zone (according to the allocation-to-a-zone) and not in maintenance (according to the “plant status”) are used for the discriminating zone summation.

Within the discriminating zone summation there are three stages – stage 1, stage 2 and alarm – equivalent to the check zone, so Figure 8 applies. However, the biased-differential algorithm is calculated differently as follows:

Stage 1:

$$\left|\sum_{r=1}^{n} i_r\right| \geq I_{stage1} \quad \text{and} \quad \left|\sum_{r=1}^{n} i_r\right| \geq K.\sum_{r=1}^{n}\left|i_r\right|$$

Stage 2:

$$\left|\sum_{r=1}^{n} i_r\right| \geq I_{stage2} \quad \text{and} \quad \left|\sum_{r=1}^{n} i_r\right| \geq K.\sum_{r=1}^{n}\left|i_r\right|$$

where i is the current in feeder r, n is the number of feeders in the discriminating zone, I_{stage1} is the discriminating zone differential setting for stage 1, I_{stage2} is the discriminating zone differential setting for stage 2, and K is the discriminating zone bias slope.

This biased differential algorithm represents the stabilisation at high through fault currents.

When the operate value exceeds the restraint value in three consecutive protection cycles, a trip signal is initiated.

If a saturation signal is received from one of the relevant feeders, the whole respective protection cycle is invalidated and not counted. In order to achieve a trip signal it is furthermore necessary, that a current interlock signal is received from at least one of the relevant feeders, and that no blocking signal exists.

2.4.4.4 Trip signals

The zone function selects those feeders to which a trip signal shall be dispatched according to its allocation-to-a-zone. These trip signals are transmitted on the optical fibre ring to the field units, which pass them on to the respective circuit breakers under the conditions listed in section 2.3.7.

3 OTHER FEATURES

3.1 Metering

The following metering displays are provided in the field units:

- Phase L1 current
- Phase L2 current
- Phase L3 current

These currents can be displayed in primary or secondary values.

3.2 Data Storage

Events and fault disturbance records are stored. All records are stamped with time and date derived from the relays' real time clock and calendar.

3.2.1 Waveform Records

The Waveform Record feature stores digitised analogue system current and digital information for all status inputs and output relays.

Waveform storage in the field units is triggered by any trip output, and in the central unit by a busbar protection trip. In addition, a record can be triggered remotely via user communications interface.

Each waveform record is 55 cycles long, with 5 cycles pre-trigger and 50 cycles post-trigger (equivalent to 1.1 seconds for a 50 Hz system).

There is capacity to store four waveform records, with any new record over-writing the oldest. All records are time and date stamped.

3.3 Event Records

The Event recorder function stores each change of state (Event - Raised or Cleared) within the relay. As it occurs, the actual event condition is logged into an event record that is time tagged with full date and time to a resolution of 1ms.

The following events are available as standard from the central unit using the IEC 60870-5-103 interface and with the listed parameterisation:

Function type: **20**

Event Description	Information Number
BB-Protection Alarm	1
BB-Protection Alarm Phase L1	2
BB-Protection Alarm Phase L2	3
BB-Protection Alarm Phase L3	4
BB-Protection Trip	5
BB-Protection Trip Phase L1	6
BB-Protection Trip Phase L2	7
BB-Protection Trip Phase L3	8
CBF Trip	9
Overcurrent Stage 1 Trip (Backup-Protection, Sum Info.)	10
Overcurrent Stage 2 Trip (Backup-Protection, Sum Info.)	11
Isolator Discrepancy (Sum Info.)	12
Isolator Time Limit (Sum Info.)	13
Isolator Aux. Voltage Failure (Sum. Info.)	14
Maintenance Switch operated (Sum Info.)	15
BB-Protection Blocked	16
CBF Blocked	17
Telegram Failure (Protection Failure)	18
Bay Unit Failure (Sum Info.)	19
FO-Ring Faulty (Ring A)	20
FO-Ring Faulty (Ring B)	21
FO-Ring Failure (Ring A and Ring B)	22
Trip Busbar Zone 1	23
Trip Busbar Zone 2	24
Trip Busbar Zone 3	25
Trip Busbar Zone 4	26
Trip Busbar Zone X	27
Central Unit Aux. Voltage Faulty (one of the two DC/DC-Conv.)	30
Central Unit Aux. Voltage Failure (internal voltage)	31
Central Unit Watchdog	32

Other events are also possible on request, and it is possible to change the parameters. Possible requirements for further events include individual alarms each isolator and maintenance switch.

The Event Recorder holds up to 256 records. When the event buffer is full, then any new records over-writes the oldest.

3.4 Self Monitoring

The DRS-BB incorporates a number of self-monitoring features. Each of these generates an alarm output while the fascia provides appropriate LED indication. In addition, an appropriate message can be displayed on the LCD in the 'system/DRS fault status' menu area.

A critical failure will cause the device fault LED to be energised (steady), and the 'device fault' relay normally-closed contact to close. The protection will no longer operate.

A non-critical failure will cause the device fault LED to be energised (flashing), and the 'device fault' relay normally-closed contact to close. The protection will continue to operate, but the capabilities may be reduced.

In both cases the indication will remain until reset by holding the 'reset' key until the columns of LEDs flash alternately, or until the unit is powered down.

3.5 Password

The programmable password feature allows a 10 character alpha-numeric password to be entered to protect settings from unauthorised change.

It is possible to see all setting values without entering the password.

The default password supplied is 'A'.

As soon as the user attempts to change a setting the password is requested before any setting alterations are allowed. Once the password has been validated, the user may change settings without re-entering the password. If no more changes are made within a programmable time period the user will be 'logged out', re-enabling the password feature.

3.6 Input Assignments

In the field units, there are four analogue inputs, I1 to I4. There are 15 digital inputs, IN1 to IN15.

Within each function block, analogue and digital inputs can be allocated to the required signals for the protection function.

Within the isolator supervision function block, the digital inputs can be allocated to the isolator position information.

3.7 Output Relay Programming

On the field units, the following output signals are available for programming to the output relays OUT1, OUT2 and OUT3.1 and 3.2:

- Busbar protection trip
- Isolator supervision, isolator 1
- Isolator supervision, isolator 2
- Isolator supervision, isolator 3
- Isolator supervision, isolator 4
- Isolator supervision, isolator 5
- Isolator supervision, isolator 6
- Circuit breaker fail, stage 1, phase L1, trip
- Circuit breaker fail, stage 1, phase L2, trip
- Circuit breaker fail, stage 1, phase L3, trip
- Circuit breaker fail, stage 2, phase L1, trip
- Circuit breaker fail, stage 2, phase L2, trip
- Circuit breaker fail, stage 2, phase L3, trip
- Circuit breaker fail, stage 3, trip
- Backup overcurrent, stage 1, starter
- Backup overcurrent, stage 1, trip
- Backup overcurrent, stage 2, starter
- Backup overcurrent, stage 2, trip
- Analogue input supervision alarm
- Maintenance

3.8 LED Indications

Each field unit and the central unit contains an LED arrangement in two vertical lines, with a total 10 LEDs, see Figure 9. Four red and four yellow LEDs can be co-ordinated to the outputs of the protection functions by a 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.

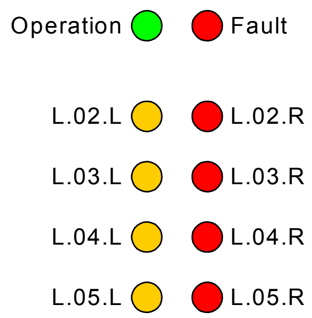

Figure 9 LED referencing

3.8.1 Operation LED

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

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 L.05.L and L.05.R can be programmed with the same output signals as for the output relays (see section 3.7).

3.9 Central Unit Alarms

On the central unit, output signals can be programmed to LED indication and alarm relay modules. The signals are chosen from the table of events given in section 3.3.

3.10 Local Operation

For local operation, the field unit and the central unit provide a fascia equipped with 2 line LCD, 6 keys, 10 LEDs and a communications port.

The elements of the fascia are more fully described in section 4.1, while navigation of the menu system is fully described in Part 2 of this manual (User Interface).

3.11 Communications

A number of communications ports are available on the field units and the central unit.

3.11.1 Field Unit

3.11.1.1 Interface to the control & instrumentation equipment

There is an interface type SIP for serial transmission of alarms using the protocol IEC 60870-5-103.

In the control direction, time synchronisation can be given from control & instrumentation to the field unit.

3.11.1.2 Communication

As described in section 3.11.2.1 for the central unit, the setting values, the actual measuring values and the fault disturbance records can be accessed using a PC using an RS485 interface.

Additionally the field unit is able to give the above data sets to the optical fibre ring for transmitting to the central unit, where they can be visualised on a PC via its RS232 interface. This means, that no additional optical fibres or wires in the plant are necessary for the communication purposes mentioned above.

3.11.2 Central unit

3.11.2.1 Remote Communication

Setting values, measuring values, and fault disturbance records from the field units can be observed at the central unit, using a PC. The data sets are transmitted on the optical fibre ring from the field units to the master unit, where they can be visualised on a PC via interface RS232, or sent to remote locations via a modem. In addition, the central unit provides several data, e.g. the current sums and the fault disturbance records of the current sums.

3.11.2.2 Time stamping

The central unit can receive a time stamp from a LAN (Local Area Network) or from a GPS device and transmits it to the field units on the optical fibre ring by a dedicated telegram.

4 HARDWARE DESCRIPTION

4.1 Field Units – DRS-LBB

Each field unit is housed in a 6U high modular size 4 case.

Features of the fascia are:
- 2 line 16 character liquid crystal display
- 6 keys for menu navigation and settings entry
- 4 amber and 4 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 as shown on Figure 10.
- X1 provides the CT connections
- X2 provides the auxiliary power input, the protection healthy (device fault) contact and the output relays
- X3 provides 4 digital inputs and the RS485 interface
- X8 provides a further 11 digital inputs
- Finally, a number of fibre-optic receiver transmitter pairs are provided, all using ST bayonet connectors: 2 off protection communications (labelled ‘busbar’) , the IEC 60870-5-103 (labelled ‘IEC’) and an private communications interface (labelled ‘CAN’).

4.1.1 Output Contacts

Four output relays are provided. One of these (‘DEVICE FAULT’) provides changeover contacts and is dedicated as the device failure alarm. The remaining three relays are freely programmable by the user. ‘OUT1’ and ‘OUT2’ 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 element outputs, as described in section 3.7.

The three programmable relays are all trip rated (as specified in Part 3 – Performance Specification).

4.1.2 Digital Inputs

11 digital inputs are provided. Six of these (IN1, IN2, IN3 , IN4, IN14 and IN15) are fully isolated from each other while the remaining nine have a common negative.

Each digital input is programmable, as described in section 3.6.

4.1.3 Analogue Inputs

Four current inputs are provided, each with a 1A and a 5A rated input, labelled I1, I2, I3.and I4. The labels for these inputs, and their functions can be assigned, as described in section 3.6.

4.2 Central Unit – DRS-MBB

The central unit is housed in one or two 6U high 19” racks, depending on the number of slave units required. In addition a 4U high “top rack” is required.

Being of modular construction, the hardware provided depends on the requirements of the system. Available modules are as follows:

4.2.1 “Top rack”

- Power supply – two can be included to provide redundancy and hot swapping capability.
- OK8 Isolated input modules
- RN0624BB Alarm relay modules, each providing 8 alarm outputs.
- AB2 LED indication modules, each providing 8 indication LEDs

4.2.2 Main racks

- DC/DC converter module
- Master, consisting of:
  - Local interface, similar to the bay unit fascia.
  - MRB3 microprocessor units
  - BBM protection communication interfaces.
  - DE32 input modules fed from OK8s
  - DA32 output modules to RN0624BB and AB2s
- Slaves, consisting of:
  - MRB3 microprocessor units
  - BBM protection communication interfaces.

The power supply, I/O and local signalling requirements should be specified with order.

4.3 Product Information

4.3.1 Central Unit

DRS-MBB/*AA*/*CD*/*E*/*F*/*I*/*GH*/*S*/**--**/*ZZZ*

Above lettering in italics is replaced as follows:

AA System frequency
50 – 50 Hz
60 – 60 Hz

CD Auxiliary supply
00 – no DC converter
11 – 220 VDC
22 – 110 VDC
33 – 24 VDC
44 – 60 VDC

(Note. These two digits allow redundant supplies to be specified – any combination of C and D are possible, e.g. *CD*=20 specifies one input of 110 VDC; *CD*=13 specifies redundant supplies – one input 220 VDC, the second input 24 VDC.)

E Number of slave modules
0 to **6**

(Note. If E > 3 a second 6u high 19” rack is required.)

F Number of digital input optocoupler modules, type OK8
0 to **3**

I Digital input voltage
1 – 220 VDC
2 – 110 VDC
3 – 24 VDC
4 – 60 VDC

G Number of LED indication modules, type AB2
0 to **3**

H Number of LED indication modules, type RNO624BB
0 to **3**

S IEC 60870-5-103 events
0 default events as section 3.3
1 events as per customer specification

ZZZ Software configuration (plant replica) – number allocated by VA TECH
100 to **499** – 50 Hz systems
500 to **899** – 60 Hz systems

4.3.2 Field Unit

DRS-LBB*YY***/E/***B***/***XXZ*

Above lettering in italics is replaced as follows:

YY Software configuration
11 – standard configuration
12 to **99** – customer specific configuration (number allocated by VA TECH)

B Auxiliary and binary input voltage
1 – 220 VDC
2 – 110 VDC
3 – 24 VDC
4 – 60 VDC

XX System frequency
50 – 50 Hz
60 – 60 Hz

(Note. These two digits allow redundant supplies to be specified – any combination of C and D are possible, e.g. *CD*=20 specifies one input of 110 VDC; *CD*=13 specifies redundant supplies – one input 220 VDC, the second input 24 VDC.)

Z Software
0 – backup overcurrent definite time (use with *YY*=11)
1 – backup overcurrent inverse time (use with *YY*=11)
9 – customer specific configuration (use with non-standard configuration *YY*)

Figure 10 Bay Unit Fascia and Rear Connections

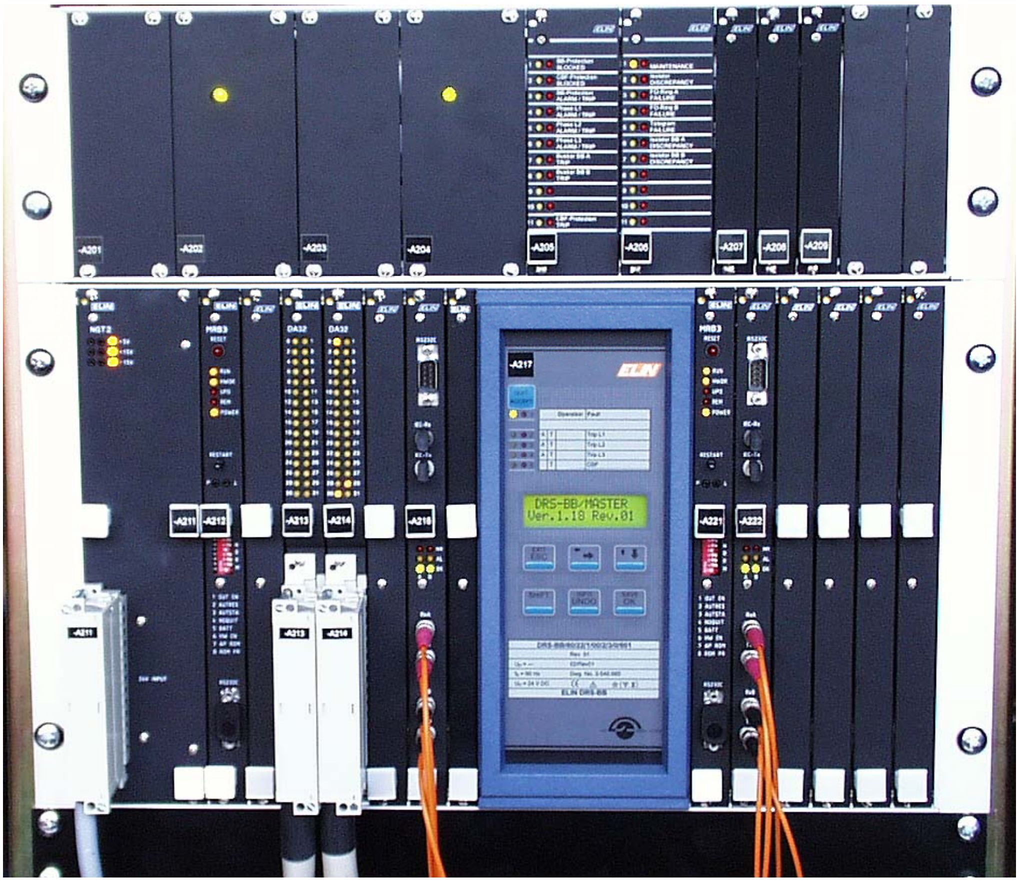

Figure 11 Example Central Unit arrangement

The user interface is described in the following document “ELIN DRS-LIGHT Local Operation via Keypad and Display”.

It applies equally to the bay units (hardware type DRS-LIGHT), and to the central unit, which uses the same user interface.

CONTENTS

1 GENERAL

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

1.1 CE Conformity

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

"The product DRS-BB 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."

1.2 Weights

Unit	Weight
Central unit	14 to 17 kg
Field unit	3 kg

1.3 IP Ratings

Unit	IP Rating
Central unit	IP 40
Field unit	IP 51

2 CHARACTERISTIC ENERGISING QUANTITY

System Frequency: 16.7, 50, 60 Hz

AC Current	Measuring Range
1 A	up to 300 A

This input may be applied to CTs with 2 A and 5 A secondary ratings, however the measuring range will remain 300 A, and settings applied using xIn values will be relative to 1 A.

3 AUXILIARY ENERGISING QUANTITY

3.1 Power Supply

3.1.1 Central unit

Nominal Voltage	Operating Range
24 V	20 to 36 V dc
48 V	20 to 60 V dc
60V	40 to 100 V dc
110, 125 V	50 to 150 V dc
220 V	90 to 270 V dc

3.1.2 Field unit

Nominal Voltage	Operating Range
24, 48, 60 V	20 to 72 V dc
110, 125, 220 V	80 to 350 V dc or ac rms 50/60 Hz

3.2 Binary Inputs

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

3.2.1 Binary Input Performance

Parameter	Value
Approx. current at operation	2.5 to 3 mA

4 PROTECTION CHARACTERISTICS

4.1 Accuracy reference conditions

Parameter	Reference or Value
General	IEC 60255-3 and IEC 60255-13
Auxiliary Supply	Nominal
Frequency	50 Hz
Ambient Temperature	20 °C

4.2 Differential protection

4.2.1 Level

Setting range	0.20 to 10.00 A step 0.05 A
Operate accuracy	±10% of setting
Reset accuracy	≥90% of operate value
Repeatability	±10%

4.2.2 Operating Time (Stage 1)

Operating time	typically ≤18 ms

4.2.3 Delay (Stage 2)

Setting range	0.200 to 10.000 s step 0.025 s
Delay accuracy	±1% or 30 ms
Repeatability	±1%

4.2.4 Current Interlock Level

Setting range	0.20 to 25.00 A step 0.05 A
Operate accuracy	±10% of setting
Reset accuracy	≥90% of operate value
Repeatability	±10%

4.3 Backup overcurrent protection

Definite time characteristics are supplied by default. Inverse time characteristics can be specified with order.

4.3.1 2-stage definite time

4.3.1.1 Level

Setting range	0.30 to 5.00 A step 0.05 A
Operate accuracy	±3% of setting or ±100mA
Reset accuracy	≥97% of operate value

4.3.1.2 Delay

Setting range	0.0 to 10.00 s step 0.05 s

4.3.2 Inverse time with highset

Operate times are calculated from:

$$t = Tm \times \left[\frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \right]$$

I = fault current
Is = current setting
Tm = time multiplier

NI: K = 0.14 α = 0.02

VI: K = 13.5 α = 1.0

EI: K = 80.0 α = 2.0

LTI: K = 120.0 α = 1.0

4.3.2.1 IDMTL level

Setting range (Is)	0.05 to 2.00 A step 0.05 A
Operate accuracy	±3% of setting or ±100mA
Reset accuracy	≥97% of operate value

4.3.2.2 IDMTL delay

Time multiplier	0.050x to 1.000x step 0.025x

4.3.2.3 Highset level

Setting range	1.0 to 31.0 xIs step 0.05 A
Operate accuracy	±3% of setting or ±100mA
Reset accuracy	≥97% of operate value

4.3.2.4 Highset delay

Setting range	0.0 to 10.00 s step 0.05 s

4.4 Circuit breaker fail

4.4.1.1 Level

Setting range	0.10 to 5.00 A step 0.05 A
Operate accuracy	±7.5% or ±20mA
Reset accuracy	≥85% of operate value
Repeatability	±3%

4.4.1.2 Delay

Setting range	0.01 to 1.00 s step 0.01 s
Delay accuracy	±1% or 2 ms
Reset time	≤15 ms
Repeatability	±1%

4.5 CT Supervision

4.5.1 Feeder Residual

4.5.1.1 Level

Setting range	0.10 to 0.50 A step 0.01 A
Operate accuracy	±3% or 20 mA
Reset accuracy	≥97% of operate value
Repeatability	±1%

4.5.1.2 Delay

Setting range	0.00 to 10.00 s step 0.05 s
Delay accuracy	±1% or 1.5 cycles
Repeatability	±1%
Operate Time	≤ 3 cycles

4.5.2 Zone Residual

4.5.2.1 Level

Setting range	0.10 to 1.00 A step 0.01 A
Operate accuracy	±10% of setting
Reset accuracy	≥90% of operate value
Repeatability	±10%

4.5.2.2 Delay

Setting range	0.200 to 10.000 s step 0.025 s
Delay accuracy	±1% or 30 ms
Repeatability	±1%
Operate Time	≤ 5%

4.6 Accuracy influencing factors

4.6.1 Temperature

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

4.6.2 Frequency

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

5 THERMAL WITHSTAND

Current Level	Time
20 A	Continuous
30 A	10 minutes
100 A	1 minute
250 A	Half cycle

6 BURDENS

Input	Condition	Burden
Analogue input	Per phase at In	≤ 0.1 VA
Central unit auxiliary input	Typical	50 to 75 W
	Maximum	100 W
Field unit auxiliary input	Typical	10 W
	Maximum	16 W

7 OUTPUT CONTACTS

Contact rating to IEC 60255-0-20

7.1 Trip Contacts

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	≥ 1000 W
Break	L/R ≤ 40ms	30 W

7.2 Alarm Contacts

at operating voltage of 220V AC/DC

Action	Level
Carry continuously	1 A
Make or break	20 W/VA

8 SERIAL INTERFACES

8.1 Protection Communications

Parameter	Value
Method	820nm optical fibre
Media	62.5/125µm multimode fibre
Connection	ST connector on rear of case
Baud rate	2 Mbit/s
Maximum distance between units	1.1 km
Maximum loop distance	5 km
Permissible attenuation	≤8dB

8.2 Dialogue Communications

Protection settings and interrogation

8.2.1 Central Unit

Parameter	Value
Method	RS232
Connection	9-pole SUB-D ISO2110 on rear of case
Baud rate	1200 to 38400

8.2.2 Field Unit

Parameter	Value
Method	RS485
Connection	terminals
Baud rate	1200 to 38400

8.3 Substation Informative Communications

Control system communications

Parameter	Value
Method	IEC 60870-5-103 over 820nm optical fibre
Media	62.5/125μm multimode fibre
Connection	ST connector on rear of case

9 ENVIRONMENTAL

9.1 General

9.1.1 Temperature IEC 68-2-1/2 and IEC 60255-6

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

9.1.2 Humidity 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

9.1.3 Transient Overvoltage IEC 60255-5

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

9.1.4 Insulation IEC 60255-5

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

9.1.5 High energy pulse/surge test IEC 61000-4-5 Level 3

5 pulses with positive and 5 pulses with negative polarity

Test	Levels
Common mode	2.0 kV
Differential mode	1.0 kV

9.2 Immunity

9.2.1 Auxiliary DC Supply IEC 60255-11

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

9.2.2 High Frequency Disturbance 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

9.2.3 Electrostatic Discharge IEC 60255-22-2 Class IV

Type	Level
Contact discharge	8 kV
Air discharge	15kV

9.2.4 Radio Frequency Interference IEC 60255-22-3 Class III

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

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

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

9.2.6 Conducted RFI IEC 60255-22-6

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

9.3 Mechanical

9.3.1 Vibration (Sinusoidal) IEC 60255-21-1 Class 2

Type	Level
Vibration response	1 gn
Vibration endurance	2 gn

9.3.2 Shock and Bump 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

9.3.3 Seismic IEC 60255-21-3 Class 2

Type	Level
Seismic Response	2 gn

CONTENTS

1 CENTRAL UNIT

Plant: . . . .

Identity: . . . . Serial Number: . . . .

1.1 Parameter ('↓' key from main menu)

1.1.1 Check Zone

Setting	Range (**default**)	Applied value
Operate Value Stage 1 *Check zone differential setting (main stage)*	0.20, 0.25…**2.00**…10.00 A	2.00 A
Bias *Check zone bias slope (main stage)*	0.0, 1.0…**70.0**…80.0 %	70.00 %
Operate Value St age 2 *Check zone differential setting (sensitive stage for isolated networks)*	0.20, 0.25…**2.00**…5.00 A	2.00 A
Time Delay Stage 2 *Check zone time delay (sensitive stage for isolated networks)*	0.200, 0.225…**5.000** …10.000 s	5.000 s
Operate Value Alarmstage *Check zone CT supervision alarm differential setting*	0.10, 0.11…**0.20**…1.00 A	0.20 A
Time Delay Alarmstage *Check zone CT supervision alarm time delay*	0.000, 0.025…**5.000** …10.000 s	5.000 s

1.1.2 Zone

These settings apply to all discriminating zones.

Setting	Range (**default**)	Applied value
Operate Value Stage 1 *Discriminating zone differential setting (main stage)*	0.20, 0.25…**2.00**…10.00 A	2.00 A
Bias *Discriminating zone bias slope (main stage)*	50.0, 51.0…**70.0**…80.0 %	70.00 %
Operate Value Stage 2 *Discriminating zone differential setting (sensitive stage for isolated networks)*	0.20, 0.25…**2.00**…5.00 A	2.00 A
Time Delay Stage 2 *Discriminating zone time delay (sensitive stage for isolated networks)*	0.200, 0.225…**5.000** …10.000 s	5.000 s
Operate Value Alarmstage *Discriminating zone CT supervision alarm differential setting*	0.10, 0.11…**0.20**…1.00 A	0.20 A
Time Delay Alarmstage *Discriminating zone CT supervision alarm time delay*	0.000, 0.025…**5.000** …10.000 s	5.000 s

1.1.3 Blockings

Setting	Range (**default**)	Applied value
Block BB-Protection *Disables busbar protection trip outputs*	**Yes**, No	
Block CBF *Disables circuit breaker fail zone trip outputs*	Yes, **No**	
Block if Isol. Discrepancy *When set to 'Yes', if isolator position discrepancy is detected the busbar protection is blocked; when set to 'No', if isolator position discrepancy is detected the busbar protection operates on discriminating zone only*	Yes, **No**	
Block if Alarmstage *Prevents operation of the busbar protection if the CT supervision detects a CT wiring failure*	Yes, **No**	

1.1.4 Configuration

Setting	Range (**default**)	Applied value
Block Stage 2 *Disables stage 2 of the busbar protection (sensitive stage for isolated networks)*	Yes, **No**	

2 FIELD UNIT

Plant: . . . .

Identity: . . . . Serial Number: . . . .

The following settings apply to Field Units of the type DRS-LBB with V3.19B software installed.

A variety of functions can be provided in the field units. The customer configuration (provided with order) will determine which of these are available within the relay. Additionally, it is possible to enable and disable each function (see section 2.1), in which case the settings relating to the function will be hidden.

Please note all textual descriptions are as appear in DRS-WIN. For some settings, abbreviated descriptions are used on the LCD display.

2.1 Selection ('OK' key from main menu)

These settings allow each function provided in the relay to be enabled or disabled

Setting	Range (**default**)	Applied value
Overcur. 3-ph.2-st. *3-phase overcurrent 2 definite-time stages*	**Active**, Not active	
Overcur. 1-ph.2-st *single-phase overcurrent (typically earth-fault) 2 definite-time stages*		
IDMT Overcur. 3-ph.2-st. *3-phase overcurrent 1 IDMT and 1 definite time stage*		
Busbar protection *differential protection*		
Isolator supervision *isolator position monitoring*		
CBF *circuit breaker fail*		
Blind Spot *used when single CTs cover two zones*		
C.T. Monitoring 3-ph. Delta *provides CT supervision*		
Signal Function 1 *timer function*		
Signal Function 1 *duplicate timer function*		

2.2 Parameter ('↓' key from main menu)

2.2.1 Overcur. 3-ph.2-st.

Setting	Range (**default**)	Applied value
Operate Value St.1 *3-phase overcurrent stage 1 current operate level*	0.30, 0.35…**1.20**…5.00 A	
Time Delay St.1 *3-phase overcurrent stage 1 definite-time delay*	0.00, 0.05…**3.00**…10.00 s	
Operate Value St.2 *3-phase overcurrent stage 2 current operate level*	0.30, 0.35…**5.00**…30.00 A	
Time Delay St.2 *3-phase overcurrent stage 2 definite-time delay*	0.00, 0.05…**1.00**…10.00 s	

2.2.2 Overcur. 1-ph.2-st.

Setting	Range (**default**)	Applied value
Operate Value St.1 *3-phase overcurrent stage 1 current operate level*	0.30, 0.35…**1.20**…5.00 A	
Time Delay St.1 *3-phase overcurrent stage 1 definite-time delay*	0.00, 0.05…**3.00**…10.00 s	
Operate Value St.2 *3-phase overcurrent stage 2 current operate level*	0.30, 0.35…**5.00**…30.00 A	
Time Delay St.2 *3-phase overcurrent stage 2 definite-time delay*	0.00, 0.05…**1.00**…10.00 s	

2.2.3 IDMT Overcur. 1-ph.2-st.

Setting	Range (**default**)	Applied value
Oper. Val. St.1 Ph.A *3-phase overcurrent stage 1 phase A current operate level*	0.10, 0.15…**1.10**…2.00 A	
TMS St.1 Ph.A *3-phase overcurrent stage 1 phase A time multiplier*	0.050, 0.075…**1.000**	
Characteristic Ph.A *3-phase overcurrent stage 1 phase A IDMT characteristic*	**Extremly**, Very, Normal, Long	
Oper. Val. St.1 Ph.B	ranges as phase A equivalents	
TMS St.1 Ph.B		
Characteristic Ph.B		
Oper. Val. St.1 Ph.C		
TMS St.1 Ph.C		
Characteristic Ph.C		
Oper. Val. St.2 Ph.A *3-phase overcurrent stage 2 phase A current operate level*	0.10, 0.15…**10.00**…31.00 A	
Time Delay St.2 Ph.A *3-phase overcurrent stage 2 phase A definite-time delay*	0.00, 0.05…**1.00**…10.00 s	
Oper. Val. St.2 Ph.B	ranges as phase A equivalents	
Time Delay St.2 Ph.B		
Oper. Val. St.2 Ph.C		
Time Delay St.2 Ph.C		

2.2.4 Busbar protection

Setting	Range (**default**)	Applied value
Bay Address *Specifies the identity of the field unit*	**1**, 2…80	
Primary CT Ratio *Ratio compensation setting to allow different CT ratios on different feeders. This specifies the relative primary values of the CTs, not a CT multiplier*	0.050, 0.055…**1.000**	
I> Interlock *Specifies the current level at which the busbar protection overcurrent interlock is released*	**0.20**, 0.25…25.00 A	
Enable I> Interlock *When set to 'Yes', this feeder allows the busbar protection overcurrent interlock to be released. When set to 'No', a current on this feeder above the interlock level will not release the busbar protection overcurrent interlock*	**Yes**, No	
I>Trip Release *When set to 'Yes', the current in the feeder must be above the interlock level in order for a busbar protection trip to occur on this feeder. When set to 'No', the busbar protection trip is not qualified by the current level*	Yes, **No**	

Setting	Range (**default**)	Applied value
Current Direction *When set to 'Direction 1', the CTs are earthed on the side remote from the busbar. When set to 'Direction 2', the CTs are earthed on the busbar side. (For a bus coupler/section CT applying to two zones this sense refers to the lowest numbered zone.)*	**Direction 1**, Direction 2	
Input Supervision *If the fourth current input has been wired up, analogue input supervision can be activated setting to 'on'.*	**On**, Off	
Current Dir. Neutral *This setting is used to reverse the connection of the fourth current input for the analogue input supervision*	**Direction 1**, Direction 2	

2.2.5 Isolator supervision

Setting	Range (**default**)	Applied value
t> Discrepancy *Time setting after which any isolator position discrepancy will be notified to the central unit and alarmed*	0.01, 0.02…**0.50**…10.00 s	
Isolator Timeout *Time setting for isolator travel time monitoring*	0.1, 0.2…**5.0**…200.0 s	
Save Isolator Status *When set to 'Yes', if a discrepancy is detected, and the energising voltage is still present, the last correct isolator position is used (discrepancy is still alarmed). When set to 'No', if a discrepancy is detected, the busbar protection will be degraded (check zone only) or blocked*	Yes, **No**	

2.2.6 CBF

Setting	Range (**default**)	Applied value
I> CBF *Circuit breaker fail current setting*	0.10, 0.15…**0.30**…5.00 A	
t> CBF Trip Feeder *Circuit breaker fail retrip (feeder) (stage 1) time setting*	0.01, 0.02…**0.20**…1.00 s	
t> CBF Trip Zone *Circuit breaker fail (backtrip) (zone) (stage 2) time setting*	0.01, 0.02…**0.50**…1.00 s	
CBF Internal I> *When set to 'Used', during circuit breaker fail detection the current must be above setting. When set to 'Bypassed', it is assumed that current level detection is carried out externally – only the timers apply*	**Used**, Bypassed	
CBF Start Superv. *Circuit breaker fail alarm time (stage 3) setting*	1, 2…**5**…180 s	

2.2.7 Blind Spot

Setting	Range (**default**)	Applied value
Blind Spot Prot. *Set this to 'On' when a single CT is used on a bus coupler/section – if tripping one zone does not clear the fault after a time delay the other zone is also tripped. Set this to 'Off' when overlapping zones (two CTs) are used for the bus coupler/section.*	Off, **On**	
Time Delay *The delay before tripping the second zone, when tripping the first zone does not clear the fault and the bus coupler/section circuit breaker is closed*	0.00, **0.01**…1.00 s	

2.2.8 C.T. Monitoring 3-ph. Delta

Setting	Range (**default**)	Applied value
Operate Value *The three phase currents are summated. This setting specifies the value of summated current above which an alarm is generated,*	0.10, **0.20**…0.50 A	
Time Delay *The delay before the alarm is given.*	1.00, 1.05…**6.00**…10.00 s	

Setting	Range (**default**)	Applied value
Phase Rotation *Set 'Right' for phase rotation A, B, C; set 'Left' for rotation A, C, B*	**Right**, Left	

2.2.9 Signal Function 1

Setting	Range (**default**)	Applied value
Time Delay *The delay before an output occurs*	**0.00**, 0.05…10.00 s	
Active Edge *Set 'Rising' to start the timer on a low-high transition; set 'Trailing' to start the timer on a high-low transition*	**Rising**, Trailing	

2.2.10 Signal Function 1 (duplicate)

Setting	Range (**default**)	Applied value
Time Delay *The delay before an output occurs*	**0.00**, 0.05…10.00 s	
Active Edge *Set 'Rising' to start the timer on a low-high transition; set 'Trailing' to start the timer on a high-low transition*	**Rising**, Trailing	

2.3 Matrices ('↑' key from main menu)

This menu contains all input and output allocations.

The following abbreviations are used:

Analogue Inputs

AI: Analogue input – current input on rear of case
CUR: Current signal – used for selecting which physical input is used for which function.

Digital Inputs

BI: Binary input – digital input on rear of case
VI: Virtual input – logic signal which originates internally
CHK: Check (test signal) – not used on most functions.
AXI: Auxiliary signal – various other digital inputs used by some functions.
BLK: Blocking signal – used to block functions.

Output Relays

BO: Binary output – relay contact on rear of case
VO: Virtual output – logic signal which is used internally
WNO: Warning (alarm signal) – energised on element pick-up (overcurrent only).
TRO: Trip signal – energised on element trip.
AXO: Auxiliary output signal – various other outputs used by some functions.

LEDs

L: LED on fascia
.L: Left column of LEDs (yellow)
.R: Right column of LEDs (red)
WNL: Warning (alarm signal) – energised on element pick-up (overcurrent only).
TRL: Trip signal – energised on element trip.
AXL: Auxiliary indication signal – various other indications used by some functions.

2.3.1 Overcur. 3-ph.2-st.

Setting		Range (**default**)	Applied value
Current inputs *Selects which current inputs to use for each phase of overcurrent protection.*	CUR: Phase A	AI.01, AI.02, AI.03, AI.04	
	CUR: Phase B		
	CUR: Phase C		
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use for blocking and test of overcurrent protection.*	BLK: Stage 1 Block	BI.10, VI.21, VI.28	
	BLK: Stage 2 Block		
	CHK: Stage 1 Test	BI.09, VI.20	
	CHK: Stage 2 Test		
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	WNO: Stage 1 Alarm	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	TRO: Stage 1 Trip		
	WNO: Stage 2 Alarm		
	TRO: Stage 2 Trip		
LEDs *Allocates trips and alarms to LEDs*	WNL: Stage 1 Alarm	L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Stage 1 Trip		
	WNL: Stage 2 Alarm		
	TRL: Stage 2 Trip		

2.3.2 Overcur. 1-ph.2-st.

Setting		Range (**default**)	Applied value
Current inputs *Selects which current input to use for overcurrent protection.*	CUR: Current Input	AI.01, AI.02, AI.03, AI.04	
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use for blocking and test of overcurrent protection.*	BLK: Stage 1 Block	BI.10, VI.21, VI.28	
	BLK: Stage 2 Block		
	CHK: Stage 1 Test	BI.09, VI.20	
	CHK: Stage 2 Test		
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	WNO: Stage 1 Alarm	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	TRO: Stage 1 Trip		
	WNO: Stage 2 Alarm		
	TRO: Stage 2 Trip		
LEDs *Allocates trips and alarms to LEDs*	WNL: Stage 1 Alarm	L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Stage 1 Trip		
	WNL: Stage 2 Alarm		
	TRL: Stage 2 Trip		

2.3.3 IDMT Overcur. 3-ph.2-st.

Setting		Range (**default**)	Applied value
Current inputs *Selects which current inputs to use for each phase of overcurrent protection.*	CUR: Phase A	AI.01, AI.02, AI.03, AI.04	
	CUR: Phase B		
	CUR: Phase C		
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use for blocking and test of overcurrent protection.*	BLK: Stage 1 Block	BI.10, VI.21, VI.28	
	BLK: Stage 2 Block		
	CHK: Stage 1 Test	BI.09, VI.20	
	CHK: Stage 2 Test		
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	WNO: Stage 1 A(L1) Alarm	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	TRO: Stage 1 A(L1) Trip		
	WNO: Stage 1 B(L2) Alarm		
	TRO: Stage 1 B(L2) Trip		

Setting		Range (**default**)	Applied value
	WNO: Stage 1 C(L3) Alarm		
	TRO: Stage 1 C(L3) Trip		
	WNO: Stage 2 A(L1) Alarm		
	TRO: Stage 2 A(L1) Trip		
	WNO: Stage 2 B(L2) Alarm		
	TRO: Stage 2 B(L2) Trip		
	WNO: Stage 2 C(L3) Alarm		
	TRO: Stage 2 C(L3) Trip		
LEDs *Allocates trips and alarms to LEDs*	WNL: Stage 1 A(L1) Alarm	L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Stage 1 A(L1) Trip		
	WNL: Stage 1 B(L2) Alarm		
	TRL: Stage 1 B(L2) Trip		
	WNL: Stage 1 C(L3) Alarm		
	TRL: Stage 1 C(L3) Trip		
	WNL: Stage 2 A(L1) Alarm		
	TRL: Stage 2 A(L1) Trip		
	WNL: Stage 2 B(L2) Alarm		
	TRL: Stage 2 B(L2) Trip		
	WNL: Stage 2 C(L3) Alarm		
	TRL: Stage 2 C(L3) Trip		

2.3.4 Busbar protection

Setting		Range (**default**)	Applied value
Current inputs *Selects which current inputs to use for each phase of overcurrent protection.*	CUR: Phase A	AI.01, AI.02, AI.03, AI.04	
	CUR: Phase B		
	CUR: Phase C		
	CUR: Current input		
Digital inputs *Selects digital inputs and internal logic signals (virtual inputs) for various functions of the busbar protection.*	BLK: Block input	BI.10, VI.21, VI.28	
	CHK: Test input	BI.09, VI.20	
	AXI: Maintenance	BI.01…BI.08, BI.11…BI.15, VI17…VI.19, VI.22…VI.24	
	AXI: CB ON		
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	TRO: Stage 1 Trip	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	WNO: St.2 AI-Failure		
LEDs *Allocates trips and alarms to LEDs*	TRL: Stage 1 Trip	L.02.L, L.02.R…L.05.L, L.05.R	
	WNL: St.2 AI-Failure		

2.3.5 Isolator supervision

Setting		Range (**default**)	Applied value
Digital inputs *Selects digital inputs and internal logic signals (virtual inputs) for various functions of the isolator supervision.*	BLK: Block input	BI.10, VI.21, VI.28	
	CHK: Test input	BI.09, VI.20	
	AXI: IsolatorAuxVolt	BI.01…BI.08, BI.11…BI.15, VI17…VI.19, VI.22…VI.24	
Output relays *Allocates isolator closed signals to digital outputs and internal logic signals (virtual outputs)*	AXO: Isolator 1	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	AXO: Isolator 2		
	AXO: Isolator 3		
	AXO: Isolator 4		

Setting		Range (**default**)	Applied value
	AXO: Isolator 5		
	AXO: Isolator 6		
LEDs *Allocates trips and alarms to LEDs*	AXL: Isolator 1	L.02.L, L.02.R…L.05.L, L.05.R	
	AXL: Isolator 2		
	AXL: Isolator 3		
	AXL: Isolator 4		
	AXL: Isolator 5		
	AXL: Isolator 6		
Isolator position input matrix *Selects digital inputs and internal logic signals (virtual inputs) for isolator position monitoring.*	Tr1 Open N/C	BI.01…BI.16, VI.17, VI.18	
	Tr1 Open N/O		
	Tr1 Close N/O		
	Tr2 Open N/C		
	Tr2 Open N/O		
	Tr2 Close N/O		
	Tr3 Open N/C		
	Tr3 Open N/O		
	Tr3 Close N/O		
	Tr4 Open N/C		
	Tr4 Open N/O		
	Tr4 Close N/O		
	Tr5 Open N/C		
	Tr5 Open N/O		
	Tr5 Close N/O		
	Tr6 Open N/C		
	Tr6 Open N/O		
	Tr6 Close N/O		

2.3.6 CBF

Setting		Range (**default**)	Applied value
Current inputs *Selects which current inputs to use for each phase of circuit breaker fail protection.*	CUR: Phase A	AI.01, AI.02, AI.03, AI.04	
	CUR: Phase B		
	CUR: Phase C		
Digital inputs *Selects digital inputs and internal logic signals (virtual inputs) for various functions of the circuit breaker fail protection.*	BLK: Stage 1 Block	BI.10, VI.21, VI.28	
	BLK: Stage 2 Block		
	CHK: Stage 1 Test	BI.09, VI.20	
	CHK: Stage 2 Test		
	AXI: A CBF Start 1	BI.01…BI.08, BI.11…BI.15, VI17…VI.19, VI.22…VI.24	
	AXI: A CBF Start 2		
	AXI: B CBF Start 1		
	AXI: B CBF Start 2		
	AXI: C CBF Start 1		
	AXI: C CBF Start 2		

Setting		Range (**default**)	Applied value
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	TRO: Stage 1 A (L1) Trip	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
	TRO: Stage 1 B (L2) Trip		
	TRO: Stage 1 C (L3) Trip		
	TRO: Stage 2 A (L1) Trip		
	TRO: Stage 2 B (L2) Trip		
	TRO: Stage 2 C (L3) Trip		
	TRO: Stage 3 Trip		
LEDs *Allocates trips and alarms to LEDs*	TRL: Stage 1 A (L1) Trip	L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Stage 1 B (L2) Trip		
	TRL: Stage 1 C (L3) Trip		
	TRL: Stage 2 A (L1) Trip		
	TRL: Stage 2 B (L2) Trip		
	TRL: Stage 2 C (L3) Trip		
	TRL: Stage 3 Trip		

2.3.7 Blind Spot

Setting		Range (**default**)	Applied value
Digital inputs *Selects digital inputs and internal logic signals (virtual inputs) for various functions of the blind spot protection.*	BLK: Block input	BI.10, VI.21, VI.28	
	CHK: Test input	BI.09, VI.20	
	AXI: CB Close Order	BI.01…BI.08, BI.11…BI.15, VI17…VI.19, VI.22…VI.24	
	AXI: CB Off		
Output relays *Allocates the trip signal to digital outputs and internal logic signals (virtual outputs)*	TRO: Trip	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
LEDs *Allocates the trip signal to LEDs*	TRL: Trip	L.02.L, L.02.R…L.05.L, L.05.R	

2.3.8 C.T. Monitoring 3-ph. Delta

Setting		Range (**default**)	Applied value
Current inputs *Selects which current inputs to use for each phase of CT Monitoring protection.*	CUR: Phase A	AI.01, AI.02, AI.03, AI.04	
	CUR: Phase B		
	CUR: Phase C		
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use for blocking and test of CT monitoring.*	BLK: Block input	BI.10, VI.21, VI.28	
	CHK: Test input	BI.09, VI.20	
Output relays *Allocates the trip signal to digital outputs and internal logic signals (virtual outputs)*	TRO: Trip	BO.01…BO.04, V0.05…VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
LEDs *Allocates the trip signal to LEDs*	TRL: Trip	L.02.L, L.02.R…L.05.L, L.05.R	

2.3.9 Signal Function 1

Setting		Range (**default**)	Applied value
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use the timer function.*	BLK: Block input	BI.10, VI.21, VI.28	
	AXI: Signal	BI.01…BI.16, VI.17…VI.24, VI.28	
	WNO: Alarm	BO.01…BO.04, V0.05…	

Setting		Range (**default**)	Applied value
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	WNO: Alarm	VO.13, BO.14…BO.16, VO.17…VO.24, BO.25…BO.30	
Output relays / **LEDs** *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)* / *Allocates trips and alarms to LEDs*	TRO: Trip / WNL: Alarm	VO.13, BO.14…BO.16, VO.17…VO.24, BO.25… BO.30 / L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Trip		

2.3.10 Signal Function 1 (Duplicate)

Setting		Range (**default**)	Applied value
Digital inputs *Selects which digital inputs and internal logic signals (virtual inputs) to use the timer function.*	BLK: Block input	BI.10, VI.21, VI.28	
	AXI: Signal	BI.01…BI.16, VI.17…VI.24, VI.28	
Output relays *Allocates trips and alarms to digital outputs and internal logic signals (virtual outputs)*	WNO: Alarm	BO.01…BO.04, V0.05… VO.13, BO.14…BO.16, VO.17…VO.24, BO.25… BO.30	
	TRO: Trip		
LEDs *Allocates trips and alarms to LEDs*	WNL: Alarm	L.02.L, L.02.R…L.05.L, L.05.R	
	TRL: Trip		

2.4 Terminal Param. ('UNDO' key from main menu)

Setting	Range (**default**)	Applied value
Terminal Lang.	English, **deutsch**	
Display Mode	**Second. Values**, Primary Values, Relative Values	
Edit Mode	**Step Mode**, Input Mode	
Meas. Value Disp		
Actual Time		
Delay Time		
Repeat Rate		
Password Timeout		
Illuminat.Time		

2.5 Device Infos ('INFO' key from main menu)

Setting	Range (**default**)	Applied value
Manufacturer		VA TECH SAT
Softwareversion		
Hardwareversion		
Terminalversion		
IEC-FW-Version		
Language		
Options		
Device Label		
Plant		
BB-Version		

2.6 Additional Funct ('SAVE' key from main menu)

Setting		Range (**default**)	Applied value
CT / VT Ratios	**I L1 pri:**		
	I L2 pri:		
	I L3 pri:		
Modify Password			A
Device Label			BB01
Chain-Address			000
IEC-Device Addr.			
IEC-Funct. Type			
IEC-Info Numbers			
Remote Setting			
BB Remote Set.			

CONTENTS

1 INTRODUCTION

Two user serial communication interfaces are provided in each unit of the DRS-BB system. This part of the manual describes the interfaces, and provides advice on their use.

Note that this section does not deal with the protection communications rings, which are treated as an internal part of the system operation.

2 SUBSTATION COMMUNICATIONS

An IEC 60870-5-103 interface is provided for use with a substation control system.

This interface is available on the field units and the central unit. It is possible to obtain information from the field units via the central unit, so removing the need for individual connections to all field units.

2.1 Connection Specification

2.1.1 Physical Connection

The physical media is fibre-optic.

All units provide ST connectors for the IEC 60870-5-103 interface. These connectors are optimised for 62.5/125µm glass fibre.

For the central unit the interface is located on the master BBM communication module.

For the field units the interface is located on the rear of the case.

2.1.2 Transmission Method

All units use half-duplex serial asynchronous transmission, and act as slaves in a master-slave arrangement. In IEC 60870-5-103 the line idle state is defined as Light On.

2.1.3 Configuration

Communication networks should be connected in a star configuration.

2.2 Communication Parameters

2.2.1 Baud Rate

Baud rates of 19200 and 9600 are possible, as defined in IEC 60870-5-103. The baud rate is automatically detected.

2.2.2 Parity Setting

Communication takes place with parity even.

2.2.3 Address Setting

The address of the relay must be set to a value between 1 and 254, and must be unique to all relays on a network.

The factory setting is 254.

2.2.4 Line Idle Setting

When the line is idle the fibre-optic transmitter is on. This allows the fibres to be supervised.

On request, a light off configuration can be provided.

3 DIALOGUE COMMUNICATIONS

This allows the protection engineer to interrogate settings, apply settings and download fault disturbance records.

To access the interface you will need the DRS-WIN software on the interrogating computer.

It is possible to carry out all operations on the field units via the connection to the central unit and the protection communications ring. Therefore, connections to the field unit are not actually necessary.

3.1 Connection Specification

3.1.1 Field units

3.1.1.1 Physical Connection

The physical layer uses RS485.

Five connection terminals are provided on the rear of the field units. An earthed, shielded, twisted-pair cable should be used with two pairs – transmit and receive.

3.1.1.2 Transmission Method

All field units use half-duplex serial asynchronous transmission, and act as slaves in a master-slave arrangement, with the PC acting as master.

3.1.1.3 Configuration

All field units can be connected to an RS485 bus.

3.1.2 Central unit

3.1.2.1 Physical Connection

The physical layer uses RS232.

A 9-pin RS232 socket is provided on the front of the master MRB3 processor module, wired as DTE.

3.1.2.2 Transmission Method

All field units use half-duplex serial asynchronous transmission, and act as slaves in a master-slave arrangement, with the PC acting as master.

3.2 Communication Parameters

3.2.1 Baud Rate

DRS-WIN can take baud rate parameters of 1200, 2400, 8600, 19200 and 38400 when communicating with the DRS-BB. The DRS-BB will automatically detect the correct rate.

3.2.2 Address Setting

The ‘Chain Address’ of each field unit must be set differently. The central unit does not require an address.

CONTENTS

FIGURES

1 INTRODUCTION

Figure 1 shows a sample busbar. It is not a realistic arrangement, but shows the different types of bays for which the DRS-BB can cater.

- Bays 1, 2, 5 and 7 are ordinary feeders. Each can be connected to one of two bus segments through its two isolators, and if both isolators are closed two bus segments will be joined together.
- Bay 3 is a bus section (bus sections and bus couplers are equivalent for DRS-BB) with a circuit breaker and overlapping bus zones with two CTs.
- Bay 4 is a bus coupler with a circuit breaker and only one CT.
- Bay 6 is a bus section with only an isolator – no circuit breaker.

The busbar shown is a double busbar, however the DRS-BB can cater for all the common arrangements of single busbar, one-and-a-half breaker, double busbar and meshes. In fact, any arrangement with up to six isolators per feeder can be handled.

The sections below will discuss the issues involved in all of the above cases, and the application of the DRS-BB to them.

2 BUSBAR DIFFERENTIAL PROTECTION

2.1 General Requirements

The central unit of the busbar protection holds a “map” of the layout of the busbar, known as the ‘plant replica’, containing the location of the field units, and their associated isolators.

2.1.1 Field unit and isolator allocation

In general, each CT requires a field unit. In Figure 1, each CT has been identified in the form FU*n*, with the number *n* referring to the ‘Bay Address’ setting of the field unit.

The isolator positions must be monitored by the field units, in order that the current state of the plant is known, and the zones can be correctly determined. For example, if the isolator in bay 6 is closed, bus segments 2 and 3 are joined and are evaluated as a single zone.

Each isolator connected to a field unit is allocated a number (between 1 and 6), which, together with the field unit bay address setting, uniquely identifies it within the busbar map.

2.1.2 CT direction

It is important that the busbar protection is aware of the direction of the CT connection in all bays, in order that the currents are summed correctly.

The conventions in most transmission and distribution substations usually lead to the CTs all being orientated in the same direction. However, in generation substations the incomers from the generation transformers often have the CTs connected in the opposite sense to the outgoing feeders.

The ‘Current Direction’ setting is used to apply the sense of the CTs to the field units, and can take values 1 or 2. If all CTs are orientated in the same direction a ‘Current Direction’ of 1 can be used throughout. However, if some feeders on the busbar differ, the convention described below should be used.

Direction = 1 when the CT common connections are on the side of the CT remote from the busbar; direction = 2 when the CT common connections are on the side of the CT closest to the busbar. This is shown in Figure 2.

Conventions for bus couplers/sections with one CT are described in section 2.4.2.2.

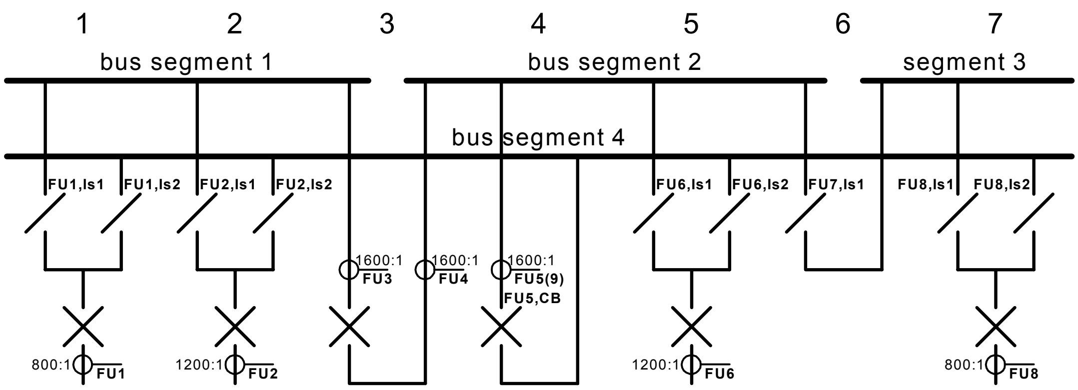

Figure 1 Examples of different busbar bays

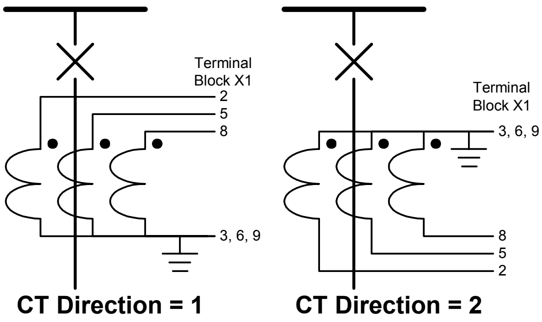

Figure 2 CT Directions

2.2 CT Ratios

The DRS-BB does not require all CTs to have the same ratio. The "Primary CT Factor" setting allows different ratios to be applied across different bays of the substation. For example, an incomer may have higher ratio CTs than outgoing feeders.

The setting applies relative primary current values rather than a multiplier. The primary CT factor is set to the value 1 at the feeder with the highest nominal current. At the feeders with a smaller nominal current this value is less than 1 and is derived from the ratio between the CT primary nominal currents.

So for the CTs in Figure 1, the field units in bays 3 and 4 would have a primary CT factor of 1.00 applied, while the field units in bays 2, 5 and 6 would have 0.75 applied and the field units in bays 1 and 7 would have 0.50 applied.

In this way the currents in all feeders are scaled the same.

2.3 Biased Differential Protection

In order to generate a busbar protection trip it is necessary to have operation of a (discriminating) zone of the busbar and operation of the check zone.

Both the zone and the check zone use biased differential characteristics where operation occurs when one quantity (the operate quantity) exceeds another (the restraint quantity).

The characteristics for the zone and check zone are similar but not identical:

Zone: $\left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{I_{diff}}$ and $\left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{K}.\sum_{r=1}^{n}\left|i_r\right|$

Check Zone: $\left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{I_{diff}}$ and $\left|\sum_{r=1}^{n} i_r\right| \geq \mathrm{K}.\left|i_{max}\right|$

The expression on the left of the '≥' is the operate quantity; the expression on the right is the restraint quantity. The terms are defined as:

i_r = the instantaneous value of the currents
i_{diff} = the differential current setting
i_{max} = the instantaneous value of the largest current
K = the bias slope setting

For the zone the restraint current is the sum of magnitudes of all currents in the zone. For the check zone this could result in an unacceptably high restraint value when the busbar has a large number of feeders, therefore the restraint current is created from the current of the largest feeder instead.

The differential setting should be set beneath the level of the minimum fault current level of all sources of infeed.

For the zone and the check zone, the applied bias slope should be calculated to prevent operation in the case of a through fault. This should be greater than the sum of possible errors in the measuring system. Sources of errors include the primary CTs and the accuracy of the busbar protection.

Selection of bias slope is a compromise between sensitivity and stability.

The setting value of bias slope, K, is limited to a minimum of 50% for the discriminating zone. Values between 60% and 70% are applicable to most substations.

In the case of "weak" zones or plants, where the short circuit current is less than 20 xIn (secondary), a setting between 50% and 60% will result in necessary sensitivity.

2.4 Bus Couplers and Sections

For the purposes of the DRS-BB, bus couplers and bus sections are considered identical, their purpose being to join together two bus segments. In the following discussion the term 'coupler' will be used to describe bus sections (longitudinal) and bus couplers, with or without circuit breakers.

There are three main types of coupler that need to be considered, and these can all be found in Figure 1.

- A coupler with circuit breaker and a CT on each side of the circuit breaker, creating overlapping zones (bay 3).
- A coupler with circuit breaker and one CT to cover both zones (bay 4).

- A coupler with isolator and no circuit breaker (bay 6).

2.4.1 Circuit breaker with two CTs

This is a straightforward arrangement creating overlapping zones in the conventional manner.

Bay 3 in Figure 1 is an example of this type of coupler.

As stated in the general requirements, each CT requires its own field unit, therefore two field units are required for this type of coupler. In Figure 1 field unit 4 (and its associated CT) belong to bus segment 1. Field unit 3 belongs to bus segment 2.

2.4.2 Circuit breaker with one CT

This is a method of reducing plant costs, at the expense of detrimental zoning. A single primary CT and field unit are used to cover two zones – as shown in bay 4 of Figure 1.

A number of issues arise out of this arrangement and these are discussed below.

When this arrangement is in use the ‘Coupling Function’ setting in the coupling section of the protection settings must be set to ‘On’.

2.4.2.1 Field unit bay address

Since there is only one CT, the current measured by the field unit must appear in two zones. To achieve this the field unit is allocated a second bay address. In the plant replica one is then allocated to each zone.

In the example, for bay 4 the bay addresses 5 and 9 are used for bus segments 2 and 4 respectively.

The second ‘Bay Address’ setting appears in the coupling section of the protection settings.

2.4.2.2 CT direction

Because the current measured by the field unit is used in two zones, the current must be reversed for one of the zones. The convention shown in Figure 2 is used for the lower numbered zone, and is automatically reversed for the higher numbered zone (bus segments 2 and 4 respectively, in the example).

2.4.2.3 Blind spot protection

Consider Figure 3(a) showing a fault between the CT and coupler circuit breaker (which is closed), for a conventional arrangement with overlapping zones. (The coverage of each zone is showed with different chained lines.) In this example because the fault lies in two zones, both will trip.

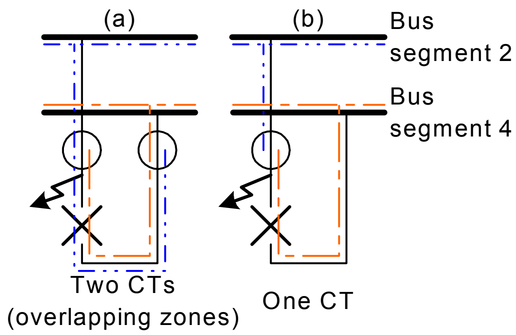

Figure 3 Fault in coupler bay

In Figure 3(b) there is only one CT. In order to allow correct discrimination, the protection will trip zone 4 but, because the fault is not cleared, zone 2 will trip after a time delay. The delay is set using the ‘Time Delay’ setting in the ‘Blind Spot’ section of the field unit protection settings.

The time delay occurs only when the circuit breaker is closed, hence to implement this scheme it is necessary to monitor circuit breaker position.

2.4.3 Isolator

In some installations two bus segments may be joined by an isolator rather than a circuit breaker. In this instance, the two segments can be treated as separate zones when the isolator is open. However, when the isolator is closed the zones will be joined and considered as one.

The isolator position must be monitored by a field unit; however, a field unit does not need to be dedicated to the isolator bay. Any field unit can be used – up to the restriction of 6 isolators per field unit.

Thus, an option is to consider are dedicating a field unit for up to 6 isolator couplers within a substation. Another possibility is to monitor the isolator position with the field unit of an adjoining bay.

2.4.4 Parallel paths

Parallel paths between joined bus segments can occur if multiple isolators and section circuit breakers are closed, and this needs to be taken into account by the busbar protection.

Consider the example of Figure 1, with the circuit breaker of bay 3 open, the circuit breaker of bay 4 closed and the isolator of bay 6 open. Bus segments 2 and 4 are treated as individual zones. However, if the two isolators of bay 5 are also closed a parallel path between the bus segments 2 and 4 are formed. Since there are no CTs and no means of breaking fault current in this path, the zones will be treated as one.

In the event of a fault on one segment (e.g. segment 2) all circuit breakers on the periphery of segments 2 and 4 will be tripped, i.e. the circuit breakers of bays 1, 2 and 5 (if their respective isolators are closed onto segment 4) and the circuit beraker of bay 3. The coupler circuit breaker of bay 4 will **not** be tripped since it is not on the periphery of the enlarged zone.

2.5 Current interlocks

Before tripping of the busbar protection will occur an overcurrent must exist in at least one of the feeders in the zone, as defined by the 'I> Interlock' setting individually for each field unit.

This setting must be set to a value below the minimum fault current level for infeed through that feeder. If possible, it should also be set above the level of current that would flow in that feeder under healthy system conditions, although a level may not exist which enable both of these conditions to be met.

For each field unit individually, it is possible to prevent tripping unless the 'I> Interlock' level is exceeded in that feeder. This is enabled using the 'I> Trip Release' setting. If this is chosen to be set only the bays with an overcurrent flowing will be tripped. Together with correct selection of 'I> Interlock' level, this can be used to trip only the infeed breakers of any zone.

In addition, if a bay is incapable of providing a fault current infeed, the busbar protection can be set to ignore overcurrents on that feeder for releasing the trip. This is set on each field unit using the 'Enable I> Interlock' setting.

2.6 Isolator position monitoring

Each field unit can monitor the position of up to six isolators, bearing mind the restriction of 15 digital inputs.

For each isolator at least two digital inputs are required: one of which is open when the isolator is fully open, and another of which is closed when the isolator is fully open. The isolator position is of prime importance in ensuring that the current is allocated to the correct zone and the busbar protection must act upon any discrepancy between these two signals.

2.6.1 Isolator Discrepancy

If isolator discrepancy is detected the following options are available, but it is clear that normal operation cannot continue.

2.6.1.1 Use last known position

The busbar protection alarms the discrepancy, but uses the last known position of the isolator. For this to be possible, it must be certain that a healthy auxiliary supply is available to the isolator status monitoring circuits.

This option is enabled for each field unit individually, using the 'Save Isolator Status' setting. The digital input used for the position monitoring is set using the 'Isolator Voltage' setting.

2.6.1.2 Block operation

The busbar protection alarms the discrepancy and blocks all operation of the busbar protection. This option is enabled on the central unit, by setting the 'Block by Isolator EXOR' setting to 'Yes'.

2.6.1.3 Trip on check zone only

The busbar protection alarms the discrepancy and allows the busbar protection to trip the whole busbar using the check zone summation only, which does not require knowledge of isolator positions. This option is enabled on the central unit, by setting the 'Block by Isolator EXOR' setting to 'No'.

2.6.2 Isolator Travel Time

Use of a third digital input, which is closed when the isolator is fully closed, can be used to monitor travel time. This is for alarm purposes only and is not acted upon in any other way by the busbar protection.

2.7 Isolated Networks

When operating with isolated networks, a very sensitive detection is required for earth faults.

A second stage is provided for the zone and check zone, which has a more sensitive level setting, provides filtering of all harmonics for more sensitive detection and allows a time delay to be applied. This stage uses the same bias slope as the main (1st) stage.

To enable the second stage the '2nd stage block' setting in the central unit should be set to 'No'.

When applying this to isolated networks bear in mind that measuring inaccuracies in the primary CTs and busbar protection will lead to differential currents for through faults. Therefore, the time delay applied to this stage should be greater than time delays applied to other parts of the system that could result in differential currents, above the setting level, flowing through the busbar.

The differential current level for the stage should be above the level of any differential current which may be detected as a result of measuring inaccuracies in the primary CTs and busbar protection under maximum load conditions.

2.8 CT Requirements

The DRS-BB busbar protection can detect an internal fault within a quarter of a cycle. When saturation occurs the saturation detector will prevent tripping, therefore the CT must not saturate before a fault can be detected. After this point any saturation will be successfully detected and tripping blocked.

Therefore, if the CT satisfactorily transforms the first peak without saturation, the DRS-BB busbar protection is able to detect and trip for an in-zone fault. Because of this, standard class P current transformers (as defined in IEC 60044-6) can be used since there is no requirement for limits of remanence or primary time constant.

The following defines the requirements for selection of CTs to meet the above criterion.

IEC 60044-6 (Instrument Transformers: Requirements for protective current transformers for transient performance) defines the following:

I_{fl} maximum fault level
I_{pn} rated current of the CT
K_{ssc} rated symmetrical short-circuit current factor of the CT ($K_{ssc} = I_{psc} / I_{pn}$)
(I_{psc} = rated primary short circuit current)
R_b rated resistive burden of CT (lead + relay)
R_{ct} secondary winding resistance

We additionally define:

K_{ssc}' actual symmetrical short-circuit current factor of the CT
R_b' actual resistive burden of the CT

The rated symmetrical short circuit current factor is specified with rated burdens and is converted to an actual value, using actual burdens, as follows:

$$K_{ssc}' = \frac{R_{ct} + R_b}{R_{ct} + R_b'} \times K_{ssc}$$

The accuracy limits of the CT will be met while the actual symetrical short-circuit current factor is not exceeded, which leads to the following condition:

$2 \times I_{fl} < K_{ssc}' \times I_{pn}$

The factor '2' in the above equation allows for a DC component, equal to the maximum AC RMS level.

<u>Example</u>: 400kV system with 25kA maximum fault level and a 5P20 2000:1 CT with nominal lead burden of 15VA and CT secondary resistance of 5Ω. The actual lead burden (loop plus protective relays) is 4Ω.

$R_{ct} = 5\Omega$, $R_b = 15 / (1)^2 = 15\Omega$, $R_b' = 4\Omega$
$K_{ssc} = 20$, $I_{fl} = 25000\text{A}$, $I_{pn} = 2000$

$K_{ssc}' \times I_{pn}$ = [(5Ω+15Ω)/(5Ω+4Ω)x20] x 2000
= 44.4 x 2000
= 88800

$2 \times I_{fl}$ = 2 x 25000
= 50000

∴ the condition is fulfilled.

3 CIRCUIT BREAKER FAIL

Circuit breaker fail is provided in all field units and operates independently of the busbar protection. Two external start inputs are provided, either of which triggers the CBF function.

Three time delays are available: an alarm delay, a re-trip delay and a zone or back trip delay.

If the start signal is applied for the alarm delay time an alarm is generated.

If an external current level detector is used ('CBF Internal I>' setting = bypassed), and the start signal is applied for the 't> CBF Trip Feeder' and 't> CBF Trip Zone' times, a re-trip and back-trip respectively will be generated.

If the user wishes to implement the CBF function fully within the DRS-BB field units, the 'CBF Internal I>' setting is set to 'used'. An internal current level detector is then used gated with the start signal before being applied to the re-trip and back-trip timers.

When the back-trip occurs it can produce an output on the field unit (for remote intertripping), but also the relevant busbar protection zone is tripped through the DRS-BB system.

4 BUSBAR DESIGN CONSIDERATIONS

For an item of plant with the central importance of a busbar, it is of prime importance to keep downtime to a minimum. The DRS-BB has been designed to minimise total protection downtime.

The protection can be kept operating during the maintenance of any field unit or fibre link, and if the system design is properly prepared extensions to the system can be installed and energised with full protection coverage.

Before specifying a DRS-BB protection system, thought should be given to the envisaged final layout of the system, following any extensions to the busbar. When the DRS-BB is purchased the busbar layout is factory programmed into the central unit as a ‘plant replica’. To allow for future additions, the plant replica should be programmed as the final busbar layout – although initially not all of the capability might be used.

It is necessary to purchase only those field units required for the plant to be initially installed. As more bays are added to the busbar, additional field units can be purchased, installed and enabled, as described below, all without busbar protection downtime.

The preceding is conditional on the busbar layout maintaining the programmed plant layout – if this is not the case the extension will require some system downtime as described in section 4.1 below.

When additional bays are installed, additional field units can be purchased for use with them. The procedure for entering these units to service is described in part 9 of this manual – maintenance.

4.1 Updating Busbar Replica

If a busbar extension does not match the originally programmed replica it will be necessary to update the replica in the central unit on-site. If additional zones have been created it may also be necessary to purchase additional slave processors for the central unit.

Updating the busbar replica is not possible without some downtime, but this can be kept to a minimum. Updating the busbar replica can be carried out by trained VA TECH representatives only.

The new replica can be programmed, the settings reprogrammed and checked and the busbar protection can then be put into service again. Then the additional field units can be commissioned.

These methods aim to keep system availability to a maximum, however, it is obvious that a clearly thought-out busbar extension plan is desirable to avoid any system downtime.

If a new configuration is required, it will be necessary to request a quotation from VA TECH. Information required for the quotation will include the existing substation configuration information, serial numbers of all existing units along with software versions and existing configuration numbers – see ordering information in part 1 of this manual.

The specified commissioning tests should be carried out on all new field units installed. It is recommended that the Secondary Injection and Primary tests are carried out on the new system.

CONTENTS

1 UNPACKING, STORAGE AND HANDLING

The central unit will be supplied in a cubicle to the customer's specification.

In a distributed system, the field units will be delivered loose, individually packed. On receipt, remove the relay from the container in which it was received and inspect it for obvious damage. To prevent the possible ingress of dirt the sealed polythene bag should not be opened until the relay is to be used.

If damage has been sustained a claim should immediately be made against the carrier, also inform VA TECH Reyrolle ACP Ltd. or VA TECH SAT GmbH and Co.

When not required for immediate use, the relay should be returned to its original carton and stored in a clean, dry place.

The relay contains static sensitive devices, these devices are susceptible to damage due to static discharge and for this reason it is essential that the correct handling procedure is followed.

The relay must not be handled by any of the relay terminals on the rear of the chassis.

Relays must be packed for transport in an anti-static container.

Ensure that anyone else handling the relay is at the same potential.

As there are no user serviceable parts in the relay, then there should be no requirement to remove any cover plates from the relay.

If the relay has been tampered with, then the guarantee will be invalidated. VA TECH reserves the right to charge for any subsequent repairs.

2 RECOMMENDED MOUNTING POSITION

The relay uses a liquid crystal display (LCD) which is used for programming and operation. The LCD has a viewing angle of ±70° and is back lit. The best mounting position is at eye level to optimise the readability of the built in instrumentation features. The contrast is preset and should not normally need to be adjusted. The relay should be mounted on the circuit breaker, or panel, to allow the operator the best access to the relay HMI functions.

3 RELAY DIMENSIONS

3.1 Field Unit

The field units are suitable for mounting 19" racking height 6U, width size 4 (21TE).

Diagrams and dimensions are provided elsewhere in this manual.

3.2 Central Unit

The central unit will be supplied in a cubicle to the customer's specification.

Diagrams and dimensions will be provided on a contract basis.

4 FIXINGS

4.1 Terminal Crimps

4.1.1 Current inputs (connector X1)

The current input terminals can take one wire each of cross-sectional area up to 4 mm^2. The recommended terminating crimps are bootlace ferrules with length 9 mm.

4.1.2 Other terminals

The digital input, output relay, auxiliary supply and RS485 terminals can take one wire each of cross-sectional area up to 2.6 mm^2, or two wires of cross-sectional area up to 1.0 mm^2. The recommended terminating crimps are bootlace ferrules with length 9 mm (or twin crimps with length 8mm.

4.2 Panel Fixing and terminal Screws

Included in the packaging of each Relay is a kit of screws required for mounting the Relay in a 19" rack panel. In case of loss specifications are:

5 FIBRE-OPTIC CONNECTORS

All fibre optic connectors are of bayonet type ST. The transmitters are optimised for 62.5/125µm glass-fibre.

CONTENTS

1 BEFORE TESTING

1.1 Required Test Equipment

- 500V Insulation resistance test set.
- Secondary injection current source rated 10A or greater] Or preferably a computer programmable V & I source
- Time interval meter]
- Primary injection equipment.
- Phase Sequence Indicator.
- A d.c. supply with nominal voltage within the working range of the relay's d.c. auxiliary supply rating.
- A d.c. supply with nominal voltage within the working range of the relays d.c. status input rating.
- Portable PC with RS232 interface and 9-pin to 9-pin null-modem cable. DRS-WIN software.

1.2 Applying Settings

The relay settings for the particular application should be applied before any secondary testing occurs. If they are not available then the relay has default settings that can be used for pre-commissioning tests. See the Relay Settings part of this manual for the default settings. Note that the tripping and alarm contacts must be programmed correctly before any scheme tests are carried out.

Refer to the User Interface and Relay Settings parts of the manual for programming the devices.

1.3 Precautions

Before electrical testing commences the equipment should be isolated from the current transformers and the CT's should be short-circuited in line with the local site procedures, the tripping and alarm circuits should also be isolated where practical. The provision and use of secondary injection test sockets on the panel simplifies the test procedure.

Ensure that the correct auxiliary supply voltage and polarity is applied. See the relevant scheme diagrams for the relay connections.

2 TESTING

2.1 Inspection

Ensure that all connections are tight and correct to the relay wiring diagram and the scheme diagram. Record any deviations. Check that all field units and the central unit is correctly programmed.

2.2 Insulation

The insulation of the cubicle containing the central unit will have been tested prior to dispatch. No further testing is recommended.

If it is required to test the insulation of panel wiring once the field units have been installed, it is recommended that the wiring plugs are removed from the rear of each relay prior to the test.

Remember to replace the wiring plugs following the test.

2.3 “Dry” Tests

2.3.1 Field Units

The following tests should be performed on each field unit in turn.

2.3.1.1 Isolator Auxiliary Switches

Check the settings and wiring of the isolators. Check isolator discrepancy timeout setting and position indication at the field unit and central unit by operating each isolator.

If applicable, check the isolator timeout setting.

If applicable, check the save isolator status by switching off the status auxiliary voltage and operating each isolator.

2.3.1.2 Maintenance Switch

If a maintenance switch is connected to the field unit, check operation of the maintenance switch – pickup of binary input, operation of the alarm contact and central unit LED indication.

2.3.1.3 CT wiring

Check the CT wiring.

2.3.1.4 Output relay contacts

Check the output relay contacts by use of the “Binary I/O preset” in the DRS-WIN software.

Check the supervision contact by switching off the field unit auxiliary supply.

2.3.1.5 Digital inputs

Check the CBF start input.

2.3.2 Central Unit

2.3.2.1 Maintenance Switch

If maintenance switches are connected to the central unit, check operation of the maintenance switch – pickup of binary input, and LED indication.

2.3.2.2 System failure alarm

Check relay system failure contact by switching off the auxiliary voltage.

2.3.2.3 Communication failure

Check for communication failure alarm by disconnecting ring A. Check for communication failure alarm by disconnecting ring B.

Disconnect ring A and ring B at the same point. A telegram failure alarm should result.

Disconnect ring A and ring B at different points. Telegram alarm, BB blocked and CBF blocked should result.

2.4 Secondary Injection Tests

These should be performed with tripping links removed.

Carry out the secondary injection tests as listed on the attached secondary injection test sheet (section 4).

During injection, check correct indication on the field units and central unit, as appropriate.

2.5 Primary Tests

These should be performed with tripping links removed.

2.5.1 Primary Injection

Primary injection tests are useful to check the ratio and polarity of the transformers as well as the secondary wiring. If it is not possible to perform these tests, a CT polarity (flick test) may be carried out.

Nominate one feeder as the reference and inject at least 20% of its CT nominal current. Check the measured values at the field unit and central unit.

Inject through load into the reference and each remaining feeder in turn. Check the measured values at the field unit and central unit. Use of these values enables the CT polarity and “current direction” setting for each field unit to be verified.

2.5.2 On-load Tests

2.5.2.1 On-load stability

With the busbar on-load and at least 0.1 A secondary flowing in each feeder, check the measured values on each field unit.

Check the differential values of each discriminating zone and the check zone at the central unit. Each differential value should be less than 0.05 A secondary.

2.5.2.2 On-load current direction test

For each field unit in turn operate the maintenance switch. The current displayed on that field unit (multiplied by “Primary CT” setting) should equal the differential current displayed at the central unit.

3 ENTERING INTO SERVICE

After tests have been performed satisfactorily the system should be put into service as follows:-

Remove all test connections.

Where possible the relay settings should be down loaded to a computer and a printout of the settings produced. This should then be compared against the required settings.

Ensure all maintenance switches are switched off (equipment in service).

Replace all secondary circuit fuses and links, or close m.c.b’s.

4 SECONDARY INJECTION TEST SHEETS

DRS-BB

Test Sheet Field Unit

VATECH

Client: **Plant:**	Project No.	
Field name:	Cubicle Drawing	
Relay type:	In=	Uh=
Serial no.:	fn=	Vers.

Protective function: **Overcurrent** function no. 2008

Test #1:
Single phase secondary injection
Check pick up at setting value + 10%

Is x 1.1=

Is x 1.1=

	Phase	L1(A)	L2 (B)	L3 (C)
Stage 1	Trip contact			
	LED			
	Alarm signals			
Stage 2	Trip contact			
	LED			
	Alarm signals			

Remarks:

Protective function: **Isolator supervision** function no. 2003

Test #2:

	Isolator	1	2
Check of alarm signal (central unit) & LED field unit:	Discrepancy		
Check of alarm signal (central unit) & LED field unit:	Timeout		
Check of position at the central unit:	Isolator ON		
Check of position at the central unit:	Isolator OFF		
Keep isolator position if aux. voltage fails:	Position		

Remarks:

Protective function: **CBF - Breaker Failure** function no. 2004

Test #3:
Single phase secondary injection
Check pick up at setting value + 10%

Is x 1.1=

Feeder for Trip zone:

	Phase	L1(A)	L2(B)	L3(C)
Trip feeder	Trip contact			
	LED			
	Alarm signal			
Trip time at 2xIs	A			
Trip zone	Trip contact			
	LED			
	Alarm signal			
Trip time at 2xIs	A			

Remarks:
Alarm signals (= CBF, Trip phase) to be checked at central unit

Legend:
☑ Test o.k.
☒ Test missed
- not applicable

DRS-BB

Protective function: **Busbar protection** function no. 2011

Test #4: Busbar Protection Trip

Single phase secondary injection
Check pick up at setting value + 10%

Is x 1.1=

	Phase	L1(A)	L2 (B)	L3 (C)
Field Unit	Trip contact			
	Trip time			
Central Unit alarm signals	Trip Busbar			
	Trip Phase			
	Alarm Phase			
Trip time at 3xIs	A			

Remarks:
Is = Maximum(Interlock,CheckZonexCTratio,ZonexCTratio)

Test #5: Internal/External Fault

2nd Feeder:

Fault	Phase	L1(A)	L2 (B)	L3 (C)
Internal	Trip			
External	Trip			

Remarks:
Internal Fault: Feeder 1: 5A, 0° Feeder 2: 5A, 0°
External Fault: Feeder 1: 5A, 0° Feeder 2: 5A, 180°

Test #6: Maintenance Switch

Check of the Maintenance Switch: ☐

Protective function: **Busbar protection - alarm stage**

Test #7a:

Single phase secondary injection
Check pick up at setting value + 10%
Is = Alarm stage/Ctratio

Is x 1.1=

	Phase	L1(A)	L2 (B)	L3 (C)
Central Unit	Alarm signal			
	LED			

Test #7b:

Increase current up to value of Test 5
Busbar trip (YES/NO)

Parameter:	*Block Alarm*	*YES*	*NO*	
	Busbar trip			
	Alarm signal			

Remarks:

Legend:

☑ Test o.k.
☒ Test missed
- not applicable

	Place and date of test:	Tested by:

CONTENTS

1 MAINTENANCE INSTRUCTIONS

The DRS-BB is a maintenance free relay, with no user serviceable parts. During the life of the relay it should be checked for operation during the normal maintenance period for the site on which the product is installed. It is recommended the following tests are carried out:

- Visual inspection of the metering display (every year)
- Operation of output contacts (every 2 years)
- Secondary injection of each element (every 5 years)

1.1 Removing a field unit from service

Should it be necessary to remove a field unit from operation for testing or maintenance the following procedure should be followed.

- Shut down the feeder on its primary side and secure against switching it on again.
- Set the software maintenance switch to “maintenance”. This excludes the feeder from the differential protection current summations.
- Plug out the optical fibres from the field unit and couple them together to reform the ring, in the following order:
- Plug out Ring A from the field unit.
- Couple Ring A (using a fibre coupling device). Ensure that the ring is healthy using the ring status LEDs on the master unit.
- Plug out Ring B from the field unit.
- Couple Ring B. Ensure that the ring is healthy using the ring status LEDs on the master unit.
- Supply voltage of the field unit can be switched off, or testing can occur.

During the whole procedure described above, the busbar protection is in service without any interruption.

1.2 Entering a field unit into service

This applies to either a new field unit or re-energising an existing field unit following maintenance.

It is important that both fibre-optic rings are intact before carrying out this procedure.

- Energise the auxiliary supply to the field unit.
- Break ring A and add the field unit into the ring. Ensure that the ring is healthy using the ring status LEDs on the master unit.
- Break ring Band add the field unit into the ring. Ensure that the ring is healthy using the ring status LEDs on the master unit.
- Carry out any commissioning (re-commissioning) tests on the individual field unit.
- Ensure the correct settings are applied to the field unit.
- Set the software maintenance switch to “in service”. This includes the feeder in the differential protection current summations.
- The primary feeder can now be energised.

Note that if the busbar has been extended it is likely that on the central unit the ‘No. of Feeders’ setting will be set to the number in the original plant layout. After the any additional field units have been installed, but before the maintenance switch is set to “in service”, the ‘No. of Feeders’ setting value should be increased as appropriate. Bear in mind, however, that the field unit ‘bay address’ settings should be contiguous.

2 DEFECT REPORT FORM

Please copy this sheet and use it to report any defect that may occur.

Customers Name & Address:	Contact Name:
	Telephone No:
	Fax No:
Supplied by:	Date when installed:
Site:	Circuit:

Software Version:	Article No:	Report Required: Y/N

Date Found:	During Commissioning:	During Maintenance:	From a System Fault:	Other, please state:

Product Name:	Serial No:

Copy any message displayed by the relay:
Describe Defect:
Describe any other action taken:

Signature:	Please print name:	Date:

For VA Tech Reyrolle ACP Ltd use only:

Date Received:	Contact Name:	Reference No:	Date Acknowledged:	Date of Reply:	Date Cleared:

VA Tech Reyrolle ACP Ltd
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FIGURES

Figure 1 Central Unit "Top Rack" Typical Arrangement and Mounting Dimensions

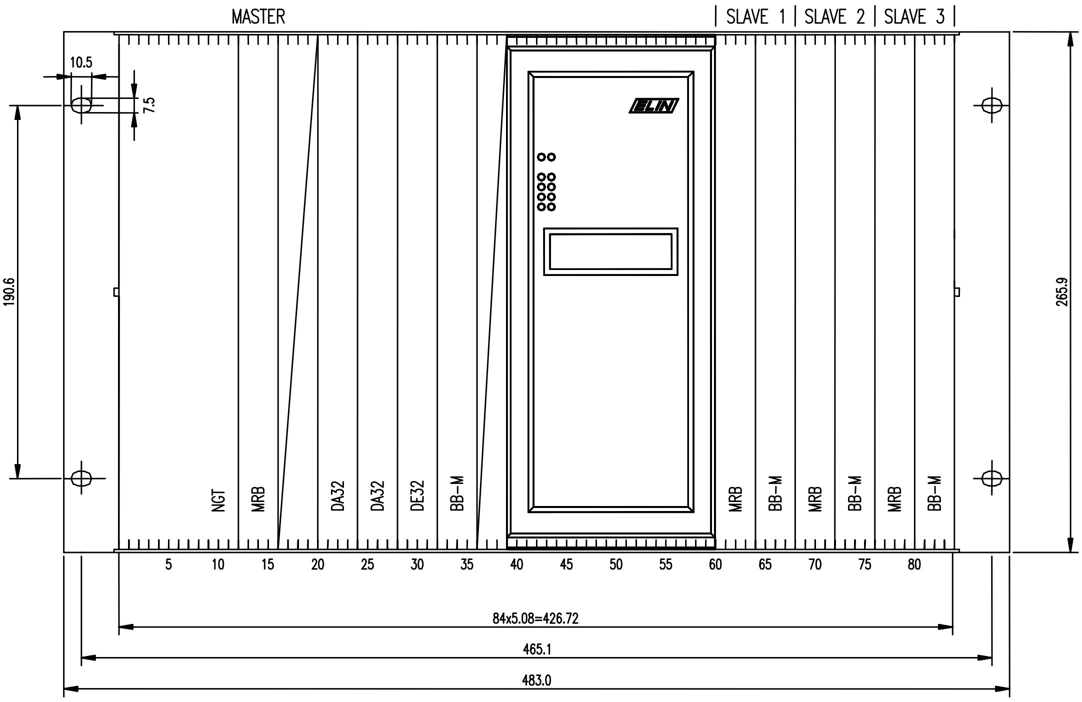

Figure 2 Central Unit Typical Arrangement and Mounting Dimensions

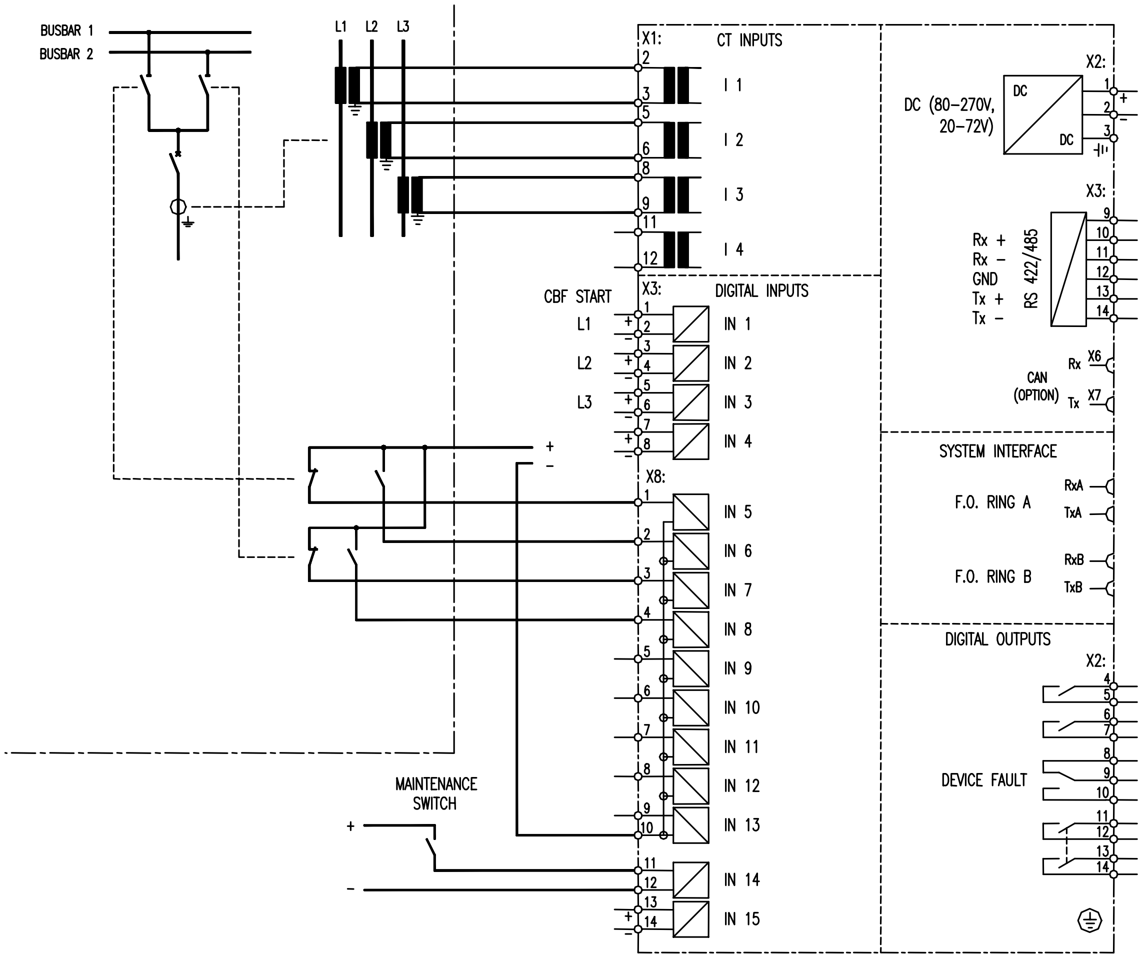

Figure 3 Typical Application Diagram