TOSHIBA

# GR Series Relay

Numerical Relay

# GRZ100

## DISTANCE PROTECTION

## FEATURES

- Fully numerical distance protection relay
- High speed operation typically 20ms
- Time-stepped distance protection with four forward zones, two reverse zones, and one non-directional zone
- Zone 1 extension protection
- Command protection distance schemes (PUP, POP, BOP and UOP with week infeed and current reversal logic)
- Command protection DEF schemes (POP, BOP and UOP)
- Single- and/or three-phase trip
- High-resistance earth fault protection
- Overcurrent backup protection
- Thermal overload protection
- Overvoltage and undervoltage protection
- Switch-on-to-fault (SOTF) and stub protection
- Broken conductor detection
- Breaker failure protection
- Out-of-step trip protection
- Power swing blocking
- VT failure detection
- Single-shot (single/three/single+three phase) or multi-shot (three phase) autoreclose
- Fault location
- Configurable binary inputs and outputs
- Programmable logic for I/O configuration, alarms, indications, recording, etc.
- Automatic supervision
- Metering and recording functions
- Menu-driven user interfaces
- Front-mounted RS232C port for communication to a local PC and rear-mounted RS485, Fibre optic or Ethernet LAN serial ports for communication to a remote PC
- IRIG-B port for external clock
- The IEC60870-5-103 protocol is provided for communication with substation control and automation systems.

GRZ100 can be provided with integral digital communication channels for teleprotection signalling. Either one or two communication channels are provided, suitable for relay-to-relay connection via fibre-optic links, or via electrical interfaces to a digital communication network. GRZ100 can be configured using the integral communication channels to support the following functions:

- Phase-segregated command protection distance schemes (PUP, POP, BOP and UOP with week infeed and current reversal logic).
- Phase-segregated command protection DEF schemes (POP, BOP and UOP).
- Command protection signalling for tripping during a power swing.
- Command protection for 2- or 3-terminal applications.
- Phase-segregated transfer trip (intertripping).
- Transmission of binary signals for user-configurable applications.
- Transmission of measured values to be displayed at the remote terminals.
- Synchronisation of the clocks at the various terminals.
- Enhanced fault-location accuracy by use of remote- end data in the case of 3-terminal applications.
- Continuous monitoring of the communication channels, with capability to provide dual-redundant channels in the case of a 2-ended system, and automatic re-routing of signals in the event of a communication channel failure in a 3-ended system.

## APPLICATION

GRZ100 is a full-scheme high-speed numerical distance relay for application to transmission lines in solidly earthed networks.

GRZ100 provides the following protection schemes.

- Time-stepped distance protection
- Zone 1 extension protection
- Command protection (distance protection using telecommunication)
- Overcurrent protection for SOTF and stub fault
- Out-of-step trip protection
- Breaker failure protection

As a backup protection for high-resistance earth faults, GRZ100 provides the following four functions.

- Directional earth fault protection
- Directional earth fault protection using telecommunication
- Directional or non-directional inverse time overcurrent and earth fault protection
- Definite time overcurrent and earth fault protection

GRZ100 can initiate high-speed single-shot autoreclose or multi-shot autoreclose.

GRZ100 provides the following metering and recording functions.

- Metering
- Fault recording
- Event recording
- Disturbance recording

GRZ100 provides the following user interfaces for relay setting or viewing of stored data.

- Relay front panel; LCD, LED display and operation keys
- Local PC
- Remote PC

A local PC can be connected to the relay via the RS232C port on the front fascia of the relay. Either one or two rear ports (RS485 or fibre optic) are provided for connection to a remote PC and for IEC60870-5-103 communication with a substation control and automation system. Further, an Ethernet LAN port (TCP/IP) can be provided.

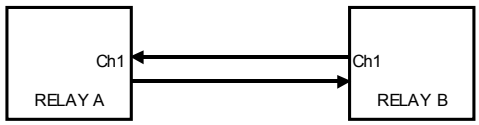
GRZ100 has four models which differ depending on whether or not the autoreclose or fault detector provided with independent MPU and trip contact for fail-safe function have been included.

| | |
|---|---|
| Model 200 series | - With autoreclose for single breaker scheme |
| Model 300 series | - With autoreclose for one-and-a-half breaker scheme |
| Model 400 series | - With autoreclose for single breaker scheme<br>- With fault detector |
| Model 500 series | - With autoreclose for one-and-a-half breaker scheme<br>-With fault detector |

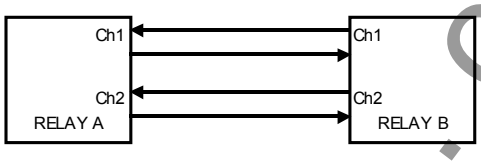
The following GRZ100 models provide integral digital communication channels for protection signalling. These models can also be applied using standard, external teleprotection equipment.

| | |
|---|---|
| Model 211B, 214B, 216B | - 2-terminal line application (one communication channel)<br>- With autoreclose for single breaker scheme |
| Model 311B | - 2-terminal line application (one communication channel)<br>- With autoreclose for one-and-a-half breaker scheme |
| Model 221B, 224B, 226B | - 2- / 3-terminal line application (two communication channels)<br>- With autoreclose for single breaker scheme |
| Model 321B, 323B | - 2- / 3-terminal line application (two communication channels)<br>- With autoreclose for one-and-a-half breaker scheme |

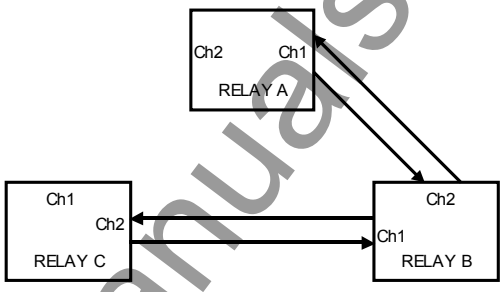
In the GRZ100 models provided with an integral digital communication channel for protection signaling, four communication topologies are available depending on the model. Models 211/214/216/311B support configuration (a) only in Figure 1. Models 221/224/226/321/323B can support all configurations. Configuration (b) and (d) offer security against failure of a communication link.



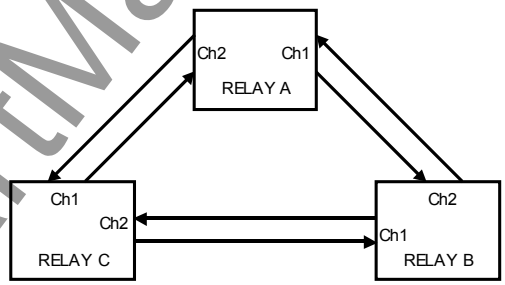

(a) Two-ended system, single channel




(b) Two-ended system, dual redundant channels




(c) Three-ended system, chain topology




(d) Three-ended system, ring topology

Figure 1 Communication System Topologies

## RELAY FUNCTIONS

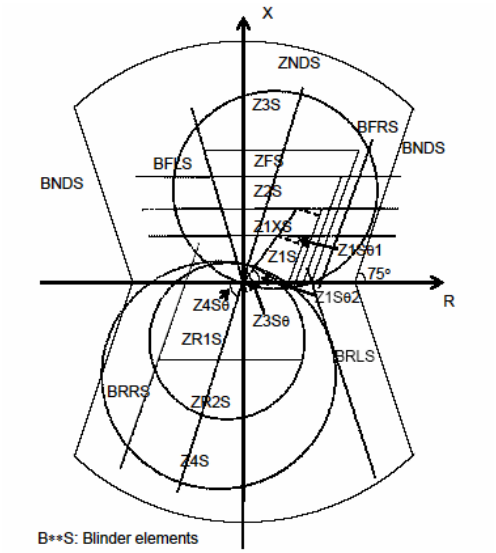
### ■ Time-Stepped Distance Protection

GRZ100 provides maximum four-zone distance protection (Z1, Z2, Z3, ZF) for forward faults, two-zone distance protection (ZR1, ZR2) for reverse faults and one non-directional distance protection (ZND) for both forward and reverse faults.

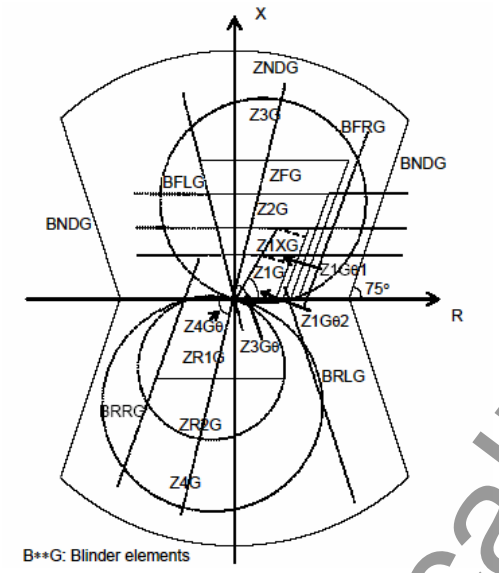
GRZ100 provides individual phase-fault measuring elements and earth-fault measuring elements for all types of fault. Direction measurement in GRZ100 is based on cross polarization with voltage memory to ensure dependable fault detection. GRZ100 uses an advanced distance measurement algorithm which achieves accurate fault impedance measurement over a wide range of frequencies. This superior algorithm also minimizes the effect of CT saturation and gives stable performance with CVT transients.

The GRZ100 provides measuring zones with mho-based characteristics or quadrilateral characteristics, as shown in Figures 2 and 3.

As shown in Figure 2, mho-based characteristics are composed of mho element, offset mho element, reactance element, and blinder element for phase fault protection and earth fault protection.

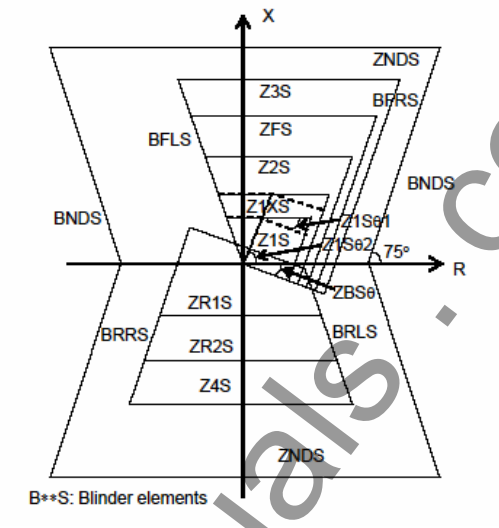



(a) Phase fault measuring element

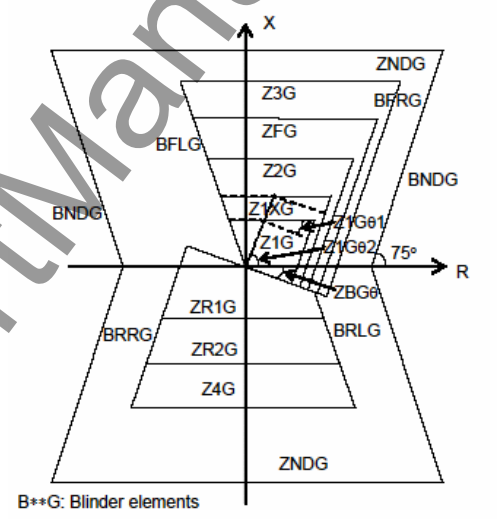



(b) Earth fault measuring element

Figure 2 Mho-based Characteristics




(a) Phase fault measuring element




(b) Earth fault measuring element

Figure 3 Quadrilateral Characteristics

As shown in Figure 3, quadrilateral characteristics are composed of reactance element, directional element and blinder element. Reverse zones for phase fault use the offset directional element to ensure reverse close-up fault detection.

Z1 is applied to Zone 1 protection. The reactance line of Z1 can be configured to take a negative gradient when the terminal is sending power, which prevents Z1 from overreaching for remote end faults.

To ensure that GRZ100 can provide reliable time-delayed tripping for close-up three-phase faults, the phase fault elements are reverse offset following Z1 operation.

Z2 is applied to Zone 2 which provides protection for the rest of the protected line not covered by Zone1 and backup protection for the remote end busbar.

Z3 is applied to Zone 3 which provides remote back-up protection for adjacent lines. Z3 is also used for detection of forward faults in command protection. If Z3 is dedicated to command protection, then ZF can be used for Zone 3 instead of Z3 in time-stepped distance protection.

ZR1 and ZR2 are reverse looking elements applied to Reverse Zone 1 and Zone 2, and used for local back-up protection for busbar faults or transformer faults.

Z4 is used for detection of reverse faults in command protection.

Z4S has an offset characteristic in order to assure detection of close-up phase faults.

## ■ Zone 1 Extension

When telecommunications cannot be applied, a Zone 1 extension (Z1X) protection is provided for high-speed protection of any fault along the whole length of the protected line.

The reactance line of Zone 1 extension can take a negative gradient when the terminal is sending loads, which prevents Zone 1 extension from overreaching.

## ■ Command protection

The following four schemes are available for distance protection using telecommunication.

- Permissive Underreach Protection (PUP)
- Permissive Overreach Protection (POP)
- Unblocking Overreach Protection (UOP)
- Blocking Overreach Protection (BOP)

POP and UOP are equipped with echo logic and weak infeed tripping functions and can be used in the protection of lines with weak infeed or no infeed terminals. An undervoltage element is incorporated for the weak infeed tripping function.

## ■ Earth Return and Mutual Coupling Compensation

Z1G, Z2G, Z1XG and ZR1G for earth fault protection adopt vectorial zero sequence current compensation to eliminate distance measuring errors due to the earth return of zero sequence current. When the GRZ100 is applied to a double circuit line, in order to eliminate the influences of zero sequence mutual coupling, the zero sequence current for the parallel line can be introduced. ZR1G is not provided with zero sequence mutual coupling compensation for the parallel line.

## ■ Application to long and short lines

The large capacitance of a long transmission line can adversely affect the measurement of fault impedance. GRZ100 employs an advanced charging current compensation technique which gives significant improvement in impedance measurement for long transmission lines.

The suitability of a distance relay for application to short lines is not determined by its minimum setting but rather by its measuring accuracy for high SIR conditions. GRZ100 provides highly accurate measuring elements suitable to be applied to short lines.

## ■ Fault Phase Selection

GRZ100 provides single- and/or three-phase tripping functions.

In order to perform extremely reliable single-phase tripping, an undervoltage element with current compensation is used for fault phase selection.

The undervoltage element with current compensation can operate correctly even for a fault with a strong power source and small voltage drop at the relay installation point.

The characteristics of the phase selection element are as shown in Figure 4.

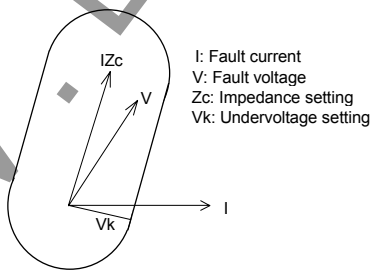



Figure 4 Phase selection element

## ■ Switch-on-to-fault Protection and Stub Protection

Switch-on-to-fault (SOTF) protection is provided in order to detect faults that are present when a line or busbar is energized.

For 500 ms following circuit breaker closure, this function is effective to protect against any switch-on-to-fault. A non-directional overcurrent element or distance measuring elements perform the SOTF protection.

Stub protection operates for a fault in a stub zone using an overcurrent element.

## ■ Voltage Transformer Failure Supervision

Failure in the voltage transformer (VT) secondary circuit may cause false tripping by voltage dependent measuring elements. Therefore, the following voltage dependent protections are blocked instantaneously when VT failure is detected.

- Distance protection
- Directional earth fault protection
- Protection using telecommunications
- Out of step protection

VT failure is detected in any of the following cases.

- If residual voltage is detected when residual current is not detected.
- If undervoltage is detected when a current change is not detected.

## ■ Power Swing Blocking

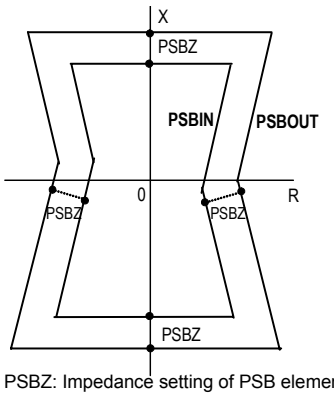
The relay provides a power swing blocking (PSB) function to prevent false tripping by distance measuring elements during a power swing.

When a power swing is detected, all distance protection zones and protection using telecommunications can be blocked independently. The non-directional zone, ZND, is not blocked.

A power swing condition is detected using two PSB elements with quadrilateral characteristics shown in Figure 5. The outer PSB element PSBOUT encloses the inner element PSBIN, the two elements being separated by a width of PSBZ. Further, GRZ100 provides PSBSZ and PSBGZ for phase fault measuring elements and earth fault measuring elements respectively. Their functions and characteristics are identical. PSBGZ provides phase-segregated characteristics.

If the impedance locus enters the PSBZ zone for more than a predetermined time (20 to 60ms), the PSB function will block the selected zones. The PSB function is reset after 500 ms when the impedance locus has moved outside the PSB elements.

GRZ100 can provide high speed tripping for faults which occur during a power swing condition, by utilising a well-proven, dedicated negative sequence directional element and any of the PUP, POP, UOP and BOP command schemes.




PSBZ: Impedance setting of PSB element

Figure 5 Characteristics of power swing blocking element

## ■ Out-of-step Trip Protection

The out-of-step tripping function is used to execute power system separation at the optimum point when an out-of-step occurs.

An out-of-step is detected by using two distance measuring elements with quadrilateral characteristics as shown in Figure 5. The element operates when the out-of-step locus passes from Zone A → Zone B → Zone C (or Zone C → Zone B → Zone A) and remains in Zones A and C for the detection time (TOST).

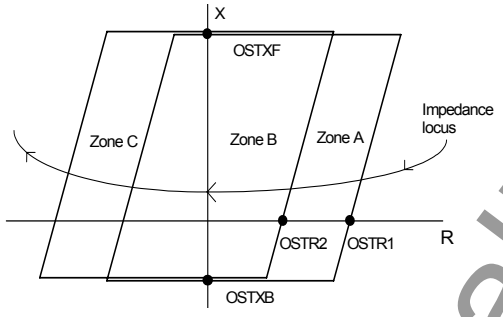



Figure 6 Characteristics of out of step trip element

## ■ Breaker Failure Protection

When an overcurrent element remains in operation longer than a pre-determined length of time following the output of a trip signal the associated circuit breaker is judged to have failed and adjacent circuit breakers can be tripped as a back-up measure.

Two independent timers are available, one of which can be used to control the RETRIP of the original circuit breaker(s). The second timer is used to control the backtripping of adjacent circuit breakers.

For high-speed protection, an overcurrent element with high-speed reset time is used to prevent a spurious re-trip or backtrip following a successful trip or re-trip action.

## ■ Overcurrent Backup Protection

The IDMT(inverse definite minimum time) overcurrent element is provided for non-directional inverse time overcurrent protection. The IDMT element is available in conformity with either of three IEC Standard characteristics (Standard inverse, Very inverse, Extremely inverse) or a Long-time inverse.

The characteristics of each IDMT are shown in Figure 8.

The IDMT element has a reset feature with definite time reset.

If the reset time is set to instantaneous, then no intentional delay is added. As soon as the energising current falls below the reset threshold, the element returns to its reset condition.

If the reset time is set to some value in seconds, then an intentional delay is added to the reset period. If the energising current exceeds the setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising current falls below the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

## ■ Definite time overcurrent protection

Definite time overcurrent protection is enabled by the instantaneous overcurrent element and pick-up delay timer.

## ■ Broken Conductor Detection

The unbalance condition caused by an open circuited conductor is detected by the broken conductor detection function. An unbalance threshold with programmable definite time delay is provided.

## ■ High-resistance Earth Fault Protection

This protection provides high-resistance earth fault protection using the directional earth fault (DEF) element and the earth fault overcurrent element as follows.

## ■ Directional Earth Fault Protection

DEF element is used for time-delayed backup protection for high-resistance faults.

## ■ Directional Earth Fault Protection using Telecommunication

High-speed DEF protection using telecommunications is provided by using a forward looking DEF element and a reverse looking DEF element. POP, UOP, and BOP schemes can be selected with DEF protection using telecommunications.

To enable single phase tripping for a high impedance earth fault, GRZ100, when equipped with the optional integral communication channels, is provided with phase selection logic to obtain phase segregated trip permission signals.

The characteristics of the forward and reverse looking DEF elements are as shown in Figure 7.

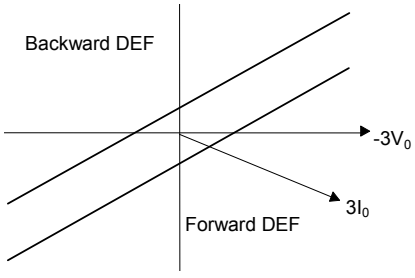


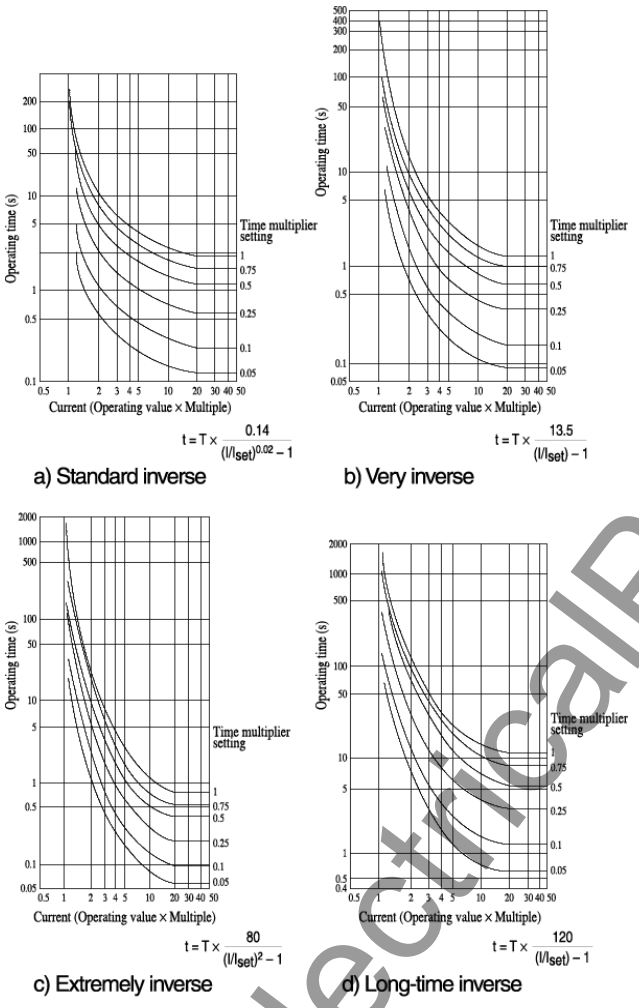

Figure 7 Characteristics of directional earth fault element

## ■ Inverse Time Overcurrent Earth Fault Protection

Directional or non-directional inverse time overcurrent earth fault protection is provided using a combination of the IDMT (inverse definite minimum time) overcurrent earth fault element and DEF element. The IDMT element is available in conformity with either of three IEC Standard characteristics (Standard inverse, Very inverse, and Extremely inverse) or a Long-time inverse.

The characteristics of each IDMT are shown in Figure 8.

The IDMT element for earth fault also has a reset feature with definite time reset.




$I_{set}$: Overcurrent element setting
T: Time multiplier setting
I: Input current
t: Operating time

Figure 8 IDMT operating time characteristics

## ■ Definite Time Overcurrent Earth Fault Protection

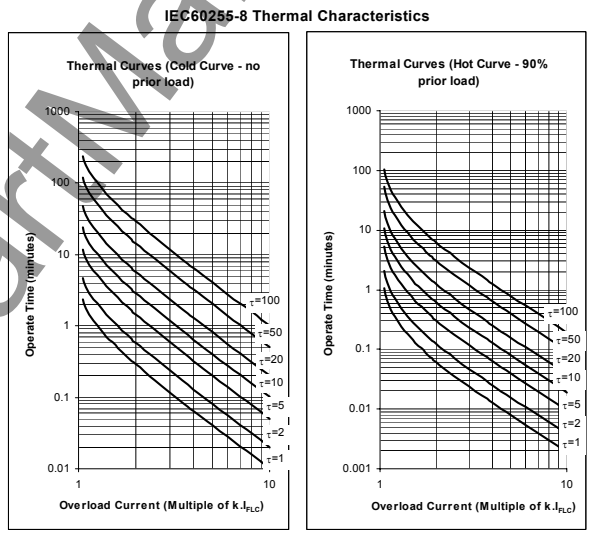
Definite time overcurrent earth fault protection is provided using the instantaneous overcurrent element and pickup-delay timer.

The definite time earth fault (EF) can be configured to issue either an alarm and/or trip signal.

## ■ Thermal Overload Protection

The thermal overload feature provides protection for cables and other plant against the effects of prolonged operation under excess load conditions. A thermal replica algorithm is applied to create a model for the thermal characteristics of the protected plant. Tripping times depend not only on the level of overload current, but also on the level of prior load current, the thermal replica providing 'memory' of previous conditions.

The thermal characteristics of the system are defined by entering settings for full load current and thermal time constant. The GRZ100 issues a trip according to the 'cold' and 'hot' curves specified in IEC60255-8 (see Figure 9), to prevent the protected system from exceeding its thermal capacity. The cold curve tripping times are applicable when the system is first energised, while the hot curves are relevant when the system has already been carrying some prior load for a period of time. An alarm output is also available to give early warning of high load current, set as a percentage of thermal capacity.




t = time to trip for constant overload current I (seconds)
I = overload current (largest phase current) (pu)
$I_P$ = previous load current (pu)
k.$I_{FLC}$ (or $I_0$) = thermal overload current setting (pu)
τ = thermal time constant (seconds)
Ln = natural logarithm

Figure 9 IEC60255-8 thermal characteristics

## ■ Overvoltage and Undervoltage Protection

GRZ100 provides two-stage overvoltage protections for both phase-to-phase voltage input and phase-to-neutral voltage input. The first stage can be set for inverse time or definite time operation, and the second stage set for definite time operation. In total, therefore, GRZ100 provides four independent overvoltage thresholds.

GRZ100 also provides four independent undervoltage thresholds with two-stage undervoltage protection for phase-to-phase voltage input and two-stage undervoltage protection for phase-to-neutral voltage input. The undervoltage protection is provided with an undervoltage blocking function to prevent undervoltage tripping in the case of a dead line.

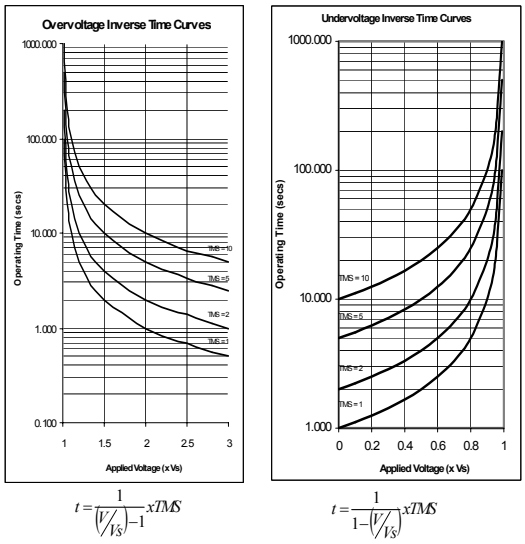



Figure 10 Inverse time characteristics

## ■ Autoreclose

Most faults on HV and EHV overhead transmission lines are transient faults, which are removed following line de-energization. After a short time, the hot gases disperse and the air de-ionizes. After clearing the fault and deionizing the fault arc, reclosing can be performed. GRZ100 provides two autoreclose schemes, single-shot autoreclose and multi-shot autoreclose.

The GRZ100 autoreclose function can be initiated by any of the following high-speed protections.

- Protection using telecommunication
- Zone1 extension protection

## ■ Single-shot autoreclose

Single-shot reclosing can provide any of three auto-reclose modes; single-phase autoreclose, three-phase autoreclose, and single-and three-phase autoreclose.

In the single-phase autoreclose mode, only a faulted phase is tripped, and then reclosed if a single-phase earth fault occurs.

In the three-phase autoreclose mode, all three phases are tripped, and then reclosed regardless of the fault mode, whether a single-phase fault or a multi-phase fault has occurred.

In the single- and three-phase autoreclose mode, the single-phase is reclosed if a single-phase is tripped and the three phases are reclosed if three phases are tripped.

## ■ Multi-shot autoreclose

In a multi-shot autoreclose, two- to four-shot reclosing can be selected. The first shot is selected from any of the four autoreclose modes available in the single-shot autoreclose scheme.

If reclosing by the first shot fails, three-phase tripping and reclosing is applied for the second to fourth shots.

## ■ Synchronism Check

For the correct operation of three-phase autoreclose, voltage and synchronism check are necessary. Characteristics of the synchronism check element are shown in Figure 11.

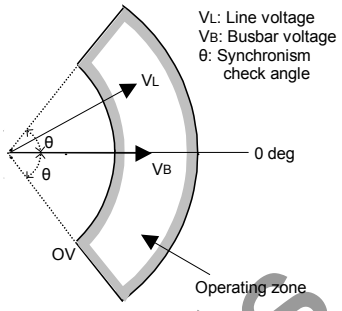



Figure 11 Synchronism check element

A detected slip cycle is determined by the following equation:

$$f = \frac{\theta}{180° \times TSYN}$$

where,

f: slip cycle

θ: synchronism check angle setting

TSYN: synchronism check timer setting

## ■ One-and-a-half Breaker Scheme (Models 300 and 500)

GRZ100 performs two-breaker autoreclose in a one-and-a-half breaker scheme.

Only single-shot autoreclose is available in Models 300 and 500. Single-phase autoreclose, three-phase autoreclose or single and three-phase autoreclose can be applied to the two circuit breakers.

## ■ Fault Detector (Models 400 through 500)

For ultra-critical applications, where security is the over-riding concern and a two-out-of-two tripping philosophy is specified, GRZ100 can be provided with an independent fault detector. This fault detector contains its own main processing unit (MPU) and trip contacts. The trip contacts of the main protection are connected in series with the fault detector trip contacts to ensure completely fail-safe operation.

The fault detector incorporates the following six fault detection elements.

- Multi-level overcurrent element
- Current change detection element
- Earth fault overcurrent element
- Undervoltage element for earth fault detection
- Undervoltage element for phase fault detection
- Undervoltage change detection element

## ■ Interfaces for Integral Communication

GRZ100 can be provided with the following interface(s) and linked to a dedicated optical fibre communication circuit or multiplexed communication circuit (multiplexer) shown in Figure 12.

The electrical interface supports CCITT G703-1.2.1, -1.2.2, -1.2.3, X.21(RS530) and RS422. Twisted pair cable is used for connecting the relay and multiplexer. In the case of an

optical link via a multiplexer, the optical interface unit G1IF1 (optical to electrical converter) is required for connecting to the multiplexer. The electrical interface between the converter and the multiplexer supports CCITT G703 -1.2.1, -1.2.2, -1.2.3, and X.21(RS530).

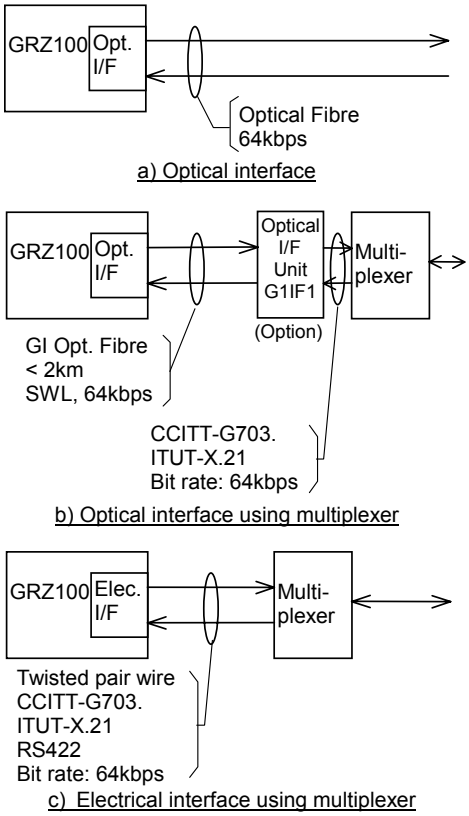



Figure 12 Telecommunication system

## METERING AND RECORDING

### ■ Metering and Monitoring

The following power system data is measured continuously and can be displayed on the LCD on the relay fascia, at the local PC, and the remote PC when connected.

- Voltages (phase, phase to phase, symmetrical components)
- Currents (phase, phase to phase, symmetrical components)
- Active power and reactive power
- Frequency

Currents and voltages can be indicated as primary or secondary values. Active power and reactive power are indicated as primary values.

The user can monitor the following output and status on the LCD and at local/remote PCs.

- Relay element output
- Binary input/output
- CB status

### ■ Event Record

The most recent 480 time-tagged events are stored with 1ms resolution.

The event recorder can be triggered by a Trip signal, by Overcurrent trigger elements (OC) and by Undervoltage trigger elements (UV). In case of 'Trip', the trigger is performed whenever tripping occurs. In case of OC/UV, On(used) or Off(not used) is selectable.

Event trigger is freely selectable by using PLC.

Events recorded are as follows.

- Tripping and reclosing
- Alarms
- Change of binary input signal
- Change of relay setting
- Relay failure

### ■ Fault Record

A relay trip initiates fault recording. Time-tagged fault data can be stored for the 8 most recent faults. Fault record items are as follows.

- Date and time
- Faulted phase
- Phases tripped
- Tripping mode
- Fault location
- Pre-fault and post-fault current and voltage data (phase, phase to phase, symmetrical components)
- Autoreclose operation

### ■ Fault Location

Fault location is initiated by relay tripping signals excluding breaker failure, overcurrent backup and out-of-step tipping. It can also be started on receipt of a start signal from external relays.

Fault location is indicated in km and % for the whole length of the protected line. The fault location is highly accurate for parallel lines due to the implementation of zero-sequence mutual impedance compensation.

The result of the fault location is stored as fault record data.

In GRZ100 with integral communication, improved fault location accuracy is achieved for 3-ended applications by use of data received from the remote terminals.

### ■ Disturbance Record

The relay can record 8 analog and 32 binary signals. The disturbance recorder is initiated by operation of the overcurrent element, undervoltage element and/or relay tripping.

In respect to analog data, phase voltage and current, residual voltage and current, and the residual current of the parallel line are recorded. The data can be transformed into the COMTRADE format.

Pre-fault recording time is fixed at 300ms, post-fault recording time can be set from 100 ms to 3 s. The maximum number of stored records depends on the post-fault recording time. In the case of a post-fault recording time of 500ms, up to 20 disturbance records can be stored. The record number of the recorded data is displayed on the LCD.

### ■ Calendar and Time

The calendar and time are provided for the time-tagging of recorded data. Synchronisation with GPS (Global Positioning System) is achieved via the IRIG-B port.

## USER INTERFACE

### ■ Relay Front Panel

The relay front panel incorporates the following user interfaces. Setting the relay and viewing stored data are possible using the Liquid Crystal Display (LCD) and operation keys.

- 40 character, four line LCD with back light
- Eight Light Emitting Diodes (LED) including four that are configurable
- Operation keys
- RS232C port
- Monitoring jacks

Figure 13 shows the relay front panel.


Figure 13 Relay front panel

The following items can be displayed on the LCD.

- Setting
- Metering
- Event records
- Fault records
- The number of disturbance records
- Fault location
- Any failure code detected by the automatic supervision

Password protection can be provided from the setting menu on the LCD to provide security for relay setting changes. After the password has been set, the password must be entered to access the setting menu from a local or remote PC as well as on the LCD.

The contents of metering, fault records, and relay failures can be monitored by pressing the VIEW key. The VIEW key can be pressed without removing the relay front cover.

Arbitrary signals can be assigned to the four user configurable LEDs.

Two monitoring jacks are operable when the test mode is selected in the LCD window. An oscilloscope can be connected to the relay through these jacks. Selection of output signals on the monitoring jacks can be set from the menu.

### ■ Local PC

The user can communicate with the GRZ100 from a local PC via the RS232C port on the relay fascia. The following data can be viewed or analysed on the local PC with RSM100 software.

- Setting
- Metering
- Event records
- Fault records
- Disturbance records
- Fault location

### ■ Relay Setting and Monitoring (RSM)

GRZ100 can be connected to the RSM system via the RS485 interface at the rear of the relay. The user can operate the relay from a remote PC in the same way as from a local PC.

Figure 14 shows the configuration of the RSM system via the protocol converter G1PR2 (option). The G1PR2 can be provided with maximum 8 ports and each port supports 32 relays addressing.

A maximum of 32 x 8 relays can be connected to the remote PC in multi-drop mode, via the protocol converter.

The RSM100 software is also used to communicate with the relay and to view or analyze disturbance records on the remote PC.

The data transmission rate between relays and the protocol converter is 64kbps.

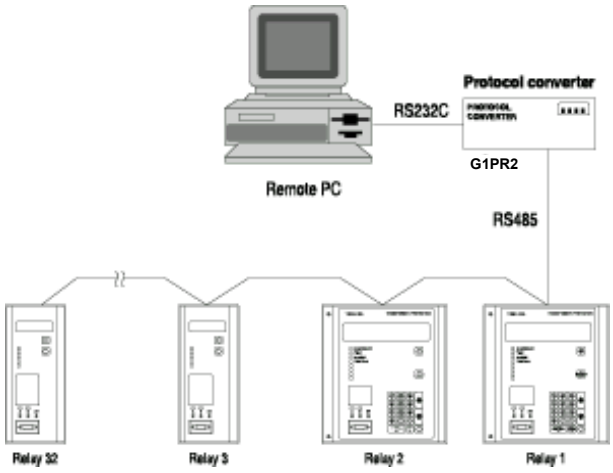



Figure 14 Relay setting and monitoring system

### ■ IEC60870-5-103 Communication

The relay can support the IEC60870-5-103 communication protocol. This protocol is mainly used when the relay communicates with a control system and is used to transfer the measurand data, status data and general command from the relay to the control system.

### ■ Relay Setting

The user can input or change settings using the operation keys on the relay fascia or via a local or remote PC with the RSM system.

Password protection is provided to change settings.

Eight active setting groups are provided. This allows the user to set one group for normal operating conditions while other groups may be set to cover alternative operating conditions.

### ■ Configurable Binary Output Contacts

GRZ100 is provided with 13 to 41 user configurable normally open output contacts used for indication and alarm. The number of outputs varies according to the relay model.

### ■ Configurable Binary Inputs

GRZ100 is provided with 18 to 28 user configurable binary inputs.

The number of inputs varies according to the relay model.

### ■ PLC Function

GRZ100 is provided with a PLC (Programmable Logic Control) function allowing user-configurable sequence logics on binary signals. Configurable binary inputs, binary outputs and LEDs are programmed by the PLC function.

## AUTOMATIC SUPERVISION

### ■ Automatic Monitoring Function

The automatic monitoring function will detect failures, should they occur, that might cause unwanted operation. The items monitored include the following:

- Analog input circuits
- Analog-to-digital converter
- Watchdog Timer
- Binary output circuits
- DC power supply circuits
- CPU
- Telecommunication circuit
- Relay address monitoring

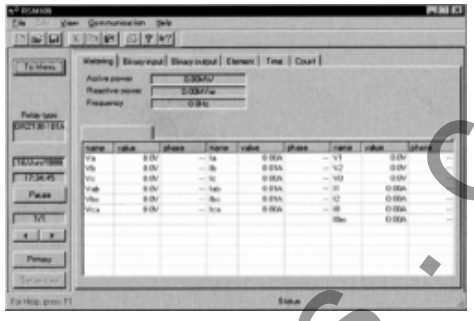
### ■ Automatic Test Function for External Communication

In the BOP scheme, a signal check-back test function is provided to check the integrity of the signalling channels.

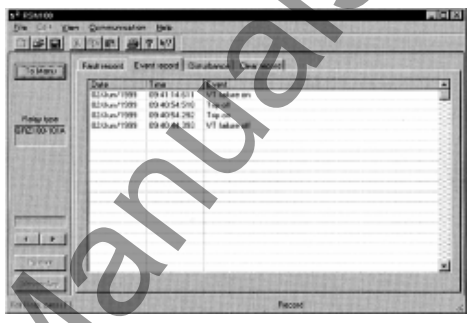
### ■ Alarms

In the unlikely event that a relay failure should occur, this is detected by automatic monitoring and the LED ALARM on the relay fascia is illuminated. A binary "RELAY FAILURE" output is simultaneously operated and the date/time of any such failure would be stored in the event record.

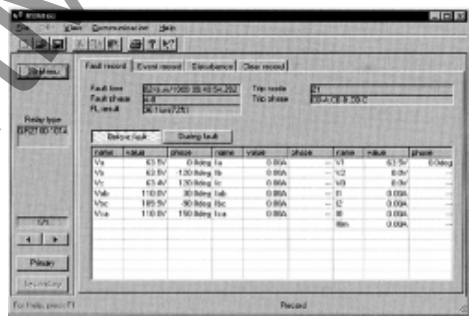
## PC DISPLAY



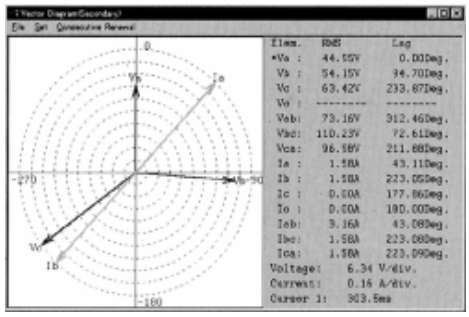
Metering



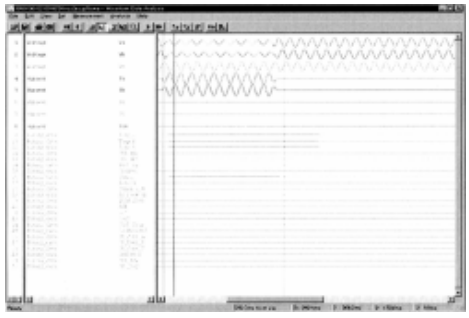
Event record



Fault record



Vector record



Data analysis

## TECHNICAL DATA

| | |
|---|---|
| **Ratings** | |
| AC current $I_n$: | 1A or 5A |
| AC voltage $V_n$: | 100V, 110V, 115V, 120V |
| Frequency: | 50Hz or 60Hz |
| DC power supply: | 110Vdc/125Vdc (Operative range: 88 - 150Vdc)<br>220Vdc/250Vdc (Operative range: 176 - 300Vdc)<br>48Vdc/54Vdc/60Vdc (Operative range: 38.4 - 72Vdc)<br>24Vdc/30Vdc (Operative range: 19.2 – 36Vdc) |
| AC ripple on DC supply IEC60255-11 | maximum 12% |
| DC supply interruption IEC60255-11<br>Permissive duration of DC supply voltage interruption to maintain normal operation:<br>Restart time: | <br><br>less than 50ms at 110V<br>less than 10s |
| Binary input circuit DC voltage | 110Vdc/125Vdc<br>220Vdc/250Vdc<br>48Vdc/54Vdc/60Vdc<br>24Vdc/30Vdc |
| **Overload Ratings** | |
| AC current input | 4 times rated continuous<br>100 times rated for 1s |
| AC voltage input | 2 times rated continuous<br>2.5 times rated for 1s |
| **Burden** | |
| AC current input | 0.2VA per phase (at rated 5A)<br>0.4 VA at zero-sequence circuit (at rated 5A)<br>0.1VA per phase (at rated 1A)<br>0.3 VA at zero-sequence circuit (at rated 1A) |
| AC voltage input | 0.1VA (at rated voltage) |
| DC power supply: | less than15W (quiescent)<br>less than 25W (operation) |
| Binary input circuit: | ≤ 0.5W/input at 110Vdc |
| **CT Ratio Setting** | |
| CT ratio | 1 to 20000 in 1 steps |
| **Full Scale of Current for Measurement** | |
| Current | 65 times rated current |
| **Phase Fault Distance Measuring Element** | |
| Z1S, Z2S and Z1XS | 0.10 to 250.00Ω in 0.01Ω steps (1A relay)<br>0.01 to 50.00Ω in 0.01Ω steps (5A relay) |
| Z1S θ1 | 0° to 45° in 1° steps |
| Z1S θ2 | 45° to 90° in 1° steps |
| ZFS, ZR1S and ZR2S | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| Z3S and Z4S | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| Z1S and Z4S offset | 7.5Ω fixed (1A relay)<br>1.5Ω fixed (5A relay) |
| ZNDS | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| Blinder (BFRS1, BFRS2, BFRS3, BRRS, BNDS)<br>BRLS: Linked with BRRS<br>Characteristic angle: (BFRS1, BFRS2, BFRS3, BRRS, BNDS)<br>Characteristic angle (BFLS) | 0.5 to 100.0Ω in 0.1Ω steps (1A relay)<br>0.10 to 20.00Ω in 0.01Ω steps (5A relay)<br>75° fixed<br>90° to 135° |

| | |
|---|---|
| **Earth Fault Distance Measuring Element** | |
| Z1G, Z2G and Z1XG | 0.10 to 250.00Ω in 0.01Ω steps (1A relay)<br>0.01 to 50.00Ω in 0.01Ω steps (5A relay) |
| Z1G θ1<br>Z1G θ2 | 0° to 45° in 1° steps<br>45° to 90° in 1° steps |
| ZR1G | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| ZFG, Z3G, ZR2G and Z4G | 0.1 to 500.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 100.00 in 0.01Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| ZNDG | 0.1 to 500.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 100.00 in 0.01Ω steps (5A relay) |
| Blinder (BFRG1, BFRG2, BFRG3, BRRG, BNDG)<br>BRLG: Linked with BRRG | 0.5 to 100.0Ω in 0.1Ω steps (1A relay)<br>0.10 to 20.00Ω in 0.01Ω steps (5A relay) |
| Characteristic angle (BFRG1, BFRG2, BFRG3, BRRG, BNDG)<br>Characteristic angle (BFLG) | 75° fixed<br>90° to 135° |
| **Time Setting for Zone Protection** | |
| Time setting of Z1S, Z2S, Z3S, ZFS, ZR1S, ZR2S, ZNDS, Z1G, Z2G, Z3G, ZFG, ZR1G, ZR2G, ZNDG | 0.00 to 10.00s in 0.01s steps |
| **Command Protection** | |
| Coordination time for BOP scheme | 0 to 50ms in 1ms steps |
| **Operating and Resetting Time of Distance Measuring Element** | |
| Typical operating time | 20ms |
| Operating time curve (SIR curve) | Refer to Figure 13. |
| Resetting time for tripping output | Typical 30ms (Adjustable by PLC function) |
| **Accuracy of Distance Measuring Element** | |
| Static accuracy | ±5% under SIR < 30, ±10% under 30 < SIR < 50 |
| Static angle accuracy | ±5° |
| Transient overreach | +5% |
| **Minimum Operating Current** | |
| Current | 0.08A (1A relay)<br>0.4A (5A relay) |
| **Residual Current Compensation** | |
| Residual current compensation for reactance element of Z1G, Z1XG, Z2G, ZFG, ZR1G | Adjustable as follows: |
| Earth return compensation | 0 to 1000% in 1% steps |
| Mutual coupling compensation (ZR1G excluded) | 0 to 1000% in 1% steps |
| **Phase Selection Element** | |
| Undervoltage | 10 to 60V in 1V steps |
| Impedance | 0.0 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.0 to 50.0Ω in 0.1Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| Residual current compensation | Automatically set according to residual current compensation setting of reactance element |
| **Switch-on-to-fault and Stub protection** | |
| Overcurrent | 0.4 to 3.0A in 0.1A steps (1A relay)<br>2.0 to 15.0A in 0.1A steps (5A relay) |
| **Broken Conductor Detection** | |
| Broken conductor threshold ($I_2/I_1$): | OFF, 0.10 to 1.00 in 0.01 steps |
| DTL delay: | 0.00 to 300.00s in 0.01s steps |

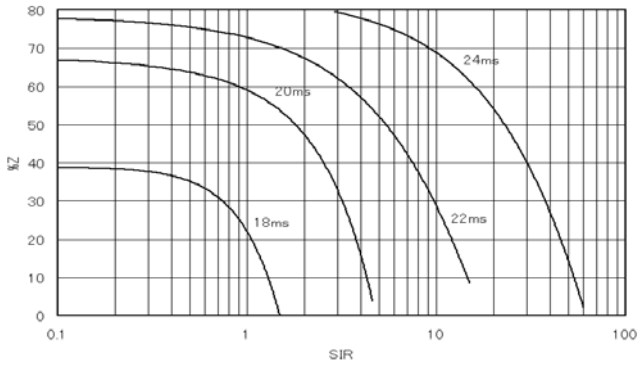
| | |
|---|---|
| **Voltage Transformer Failure Supervision** | |
| Undervoltage element (phase-to-phase) | 50 to 100V in 1V steps |
| Undervoltage element (phase-to-earth) | 10 to 60V in 1V steps |
| Current change detection element | 0.1A fixed (1A relay)<br>0.5A fixed (5A relay) |
| Residual voltage element | 20V fixed |
| Residual current element | Common use with earth fault detection element |
| **Power Swing Blocking** | |
| Detection zone (PSBZS, PSBZG) | 2.5 to 75.0Ω in 0.1Ω steps (1A relay)<br>0.50 to 15.00 in 0.01Ω steps (5A relay) |
| Current change detection element | 0.1 to 2.0A in 0.1A steps (1A relay)<br>0.5 to 10.0A in 0.1A steps (5A relay) |
| Detection time | 30 to 60ms in 1ms steps |
| Resetting time | 500ms fixed |
| **Out-of-step Protection** | |
| Resistive reach (OSTR1) | 15 to 150Ω in 1Ω steps (1A relay)<br>3.0 to 30.0Ω in 0.1Ω steps (5A relay) |
| Resistive reach (OSTR2) | 5 to 50Ω in 1Ω steps (1A relay)<br>1.0 to 10.0Ω in 0.1Ω steps (5A relay) |
| Resistive reach (OSTXF) | 5 to 250Ω in 1Ω steps (1A relay)<br>1.0 to 50.0Ω in 0.1Ω steps (5A relay) |
| Resistive reach (OSTXF) | 1 to 50Ω in 1Ω steps (1A relay)<br>0.2 to 10.0Ω in 0.1Ω steps (5A relay) |
| Detection time (TOST) | 0.01 to 1.00s in 0.01s steps |
| **Breaker Failure (BF) Protection** | |
| Overcurrent element | 0.1 to 2.0A in 0.1A steps (1A relay)<br>0.5 to 10.0A in 0.1A steps (5A relay) |
| BF timer for retry-trip of failed breaker | 50 to 500ms in 1ms steps |
| BF timer for related breaker trip | 50 to 500ms in 1ms steps |
| Operating time of overcurrent element | less than 20ms at 50Hz or less than 17ms at 60Hz |
| Resetting time of overcurrent element | less than 15ms at 50Hz or less than 13ms at 60Hz |
| **Inverse Time Overcurrent Protection** | |
| Overcurrent | 0.10 to 5.00A in 0.01A steps (1A relay)<br>0.5 to 25.0A in 0.1A steps (5A relay) |
| Time multiplier | 0.05 to 1.00 in 0.01 steps |
| Characteristic | Refer to Figure 8. |
| Accuracy of inverse time characteristics | Standard, Very and Long-time: IEC60255-3 class 5<br>Extremely inverse: IEC60255-3 class 7.5 |
| Reset definite time | 0.0 to 10.0s in 0.1s steps |
| **Definite Time Overcurrent Protection** | |
| Overcurrent | 0.1 to 20.0A in 0.1A steps (1A relay)<br>0.5 to 100.0A in 0.1A steps (5A relay) |
| Time for delayed trip | 0.00 to 10.00s in 0.01s steps |
| Operating time of overcurrent element | less than 20ms |
| Accuracy of pick-up value | ±5% |
| **Directional Earth Fault Protection** | |
| Characteristic angle | 0 to 90° in 1° steps (3I0 lags for −3V0) |
| Polarising voltage (3V0) | 1.7 to 21.0V in 0.1V steps |
| Zero-sequence current (3I0) | 0.10 to 1.00A in 0.01A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| Time for backup trip | 0.00 to 10.00s in 0.01s steps |
| Accuracy of pick-up value | ±5% |

| | |
|---|---|
| **Directional Earth Fault Command Protection** | |
| Time for delayed trip | 0.00 to 0.30s in 0.01s steps |
| Coordination time | 0 to 50ms in 1ms steps |
| **Inverse Time Earth Fault Protection** | |
| Earth fault | 0.10 to 1.00A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| Time multiplier | 0.05 to 1.00 in 0.01 steps |
| Characteristic | Refer to Figure 8. |
| Accuracy of inverse time characteristics | Standard, Very and Long-time: IEC60255-3 class 5<br>Extremely inverse: IEC60255-3 class 7.5 |
| Reset definite time | 0.0 to 10.0s in 0.1s steps |
| **Definite Time Earth Fault Protection** | |
| Earth fault | 0.10 to 1.00A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| Time for delayed trip | 0.00 to 10.00s in 0.01s steps |
| Accuracy of pick-up value | ±5% |
| **Weak Infeed and Echo Protection** | |
| Phase-to-phase undervoltage element | 50 to 100V in 1V steps |
| Phase-to-earth undervoltage element | 10 to 60V in 1V steps |
| **Thermal overload Protection** | |
| Thermal setting (THM = k.$I_{FLC}$) | OFF, 0.40 – 2.00A in 0.01A steps (1A rating)<br>OFF, 2.0 – 10.0A in 0.1A steps (5A rating) |
| Time constant ($\tau$) | 0.5 – 300.0mins in 0.1min steps |
| Thermal alarm | OFF, 50% to 99% in 1% steps |
| Pre-load current setting | 0.00 – 1.00A in 0.01A steps (1A rating)<br>0.0 – 5.0A in 0.1A steps (5A rating) |
| **Overvoltage Protection** | |
| 1st, 2nd Overvoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps (for both phase-to-phase and phase-to-neutral voltage) |
| Delay type: | DTL, IDMTL(1st threshold only) |
| IDMTL Time Multiplier Setting TMS: | 0.05 – 100.00 in 0.01 steps |
| DTL delay: | 0.00 – 300.00s in 0.01s steps |
| DO/PU ratio | 10 – 98% in 1% steps |
| Reset Delay (1st threshold only): | 0.0 – 300.0s in 0.1s steps |
| **Undervoltage Protection** | |
| 1st, 2nd Undervoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps (for both phase-to-phase and phase-to-neutral voltage) |
| Delay type: | DTL, IDMTL(1st threshold only) |
| IDMTL Time Multiplier Setting TMS: | 0.05 – 100.00 in 0.01 steps |
| DTL delay: | 0.00 – 300.00s in 0.01s steps |
| Reset Delay (1st threshold only): | 0.0 – 300.0s in 0.1s steps |
| **Fault Locator** | |
| Line reactance and resistance setting | 0.0 to 999.9Ω in 0.1Ω steps (1A relay)<br>0.00 to 199.99Ω in 0.01Ω steps (5A relay) |
| Line length | 0.0 to 399.9km in 0.1km steps |
| Correction factor of impedance between lines | 80 to 120% in 1% steps |
| Correction factor of impedance between in each phase | 80 to 120% in 1% steps |
| Accuracy | ±2.5km (up to 100km)<br>±2.5% (up to 399.9km) |
| Minimum measuring cycles | 2.5 cycles |

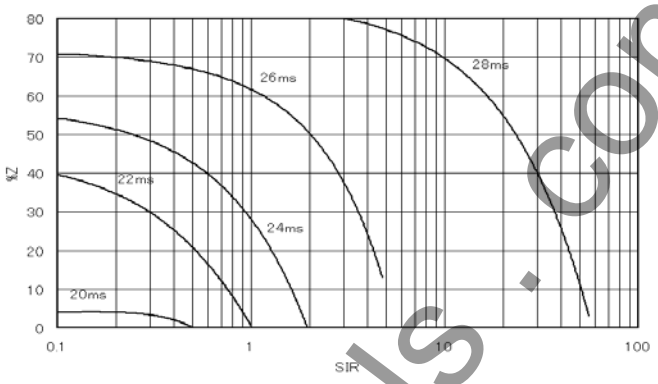
| Autoreclose Function | |
|---|---|
| Number of shots | 1 to 4 shots |
| **Timer settings** | |
| Dead time for single-phase autoreclose | 0.01 to 10.00s in 0.01s steps |
| Dead time for three-phase autoreclose | 0.01 to 100.00s in 0.01s steps |
| Multi-shot dead line time | 5.0 to 300.0s in 0.1s steps |
| Multi-shot reset time | 5.0 to 300.0s in 0.1s steps |
| Reclaim time | 5 to 300s in 1s steps |
| Pulse width of reclosing signal output | 0.1 to 10.0s in 0.1s steps |
| Autoreclose reset time | 0.01 to 100.00s in 0.01s steps |
| Reset time for developing fault | 0.01 to 10.00s in 0.01s steps |
| **One-and-a-half breaker scheme** | |
| Follower breaker autoreclose delay time | 0.1 to 10.0s in 0.1s steps |
| **Voltage and synchronism check element** | |
| Synchronism check angle | 5 to 75° in 1° steps |
| UV element | 10 to 150V in 1V steps |
| OV element | 10 to 150V in 1V steps |
| Busbar or line dead check | 10 to 150V in 1V steps |
| Busbar or line live check | 10 to 150V in 1V steps |
| Synchronism check time | 0.01 to 10.00s in 0.01s steps |
| Voltage check time | 0.01 to 1.00s in 0.01s steps |
| Operating time of synchronism check element | less than 50ms |
| Operating time of UV and OV elements | less than 40ms |

| Integral Communication Interface (Protection Signalling) | |
|---|---|
| Electrical interface (Telecomm. equipment link) | |
| Applicable standard | CCITT-G703-1.2.1<br>CCITT-G703-1.2.2 or 1.2.3<br>X.21 |
| Type of code | NRZ (Non-Return to Zero) |
| Connector type | D-sub connector |
| Optical interface (2 km class) | |
| Type of fibre | Graded-index multi-mode 50/125μm or 62.5/125μm |
| Connector type | ST type |
| Wave length | 820nm |
| Optical transmitter | LED, more than −19dBm |
| Optical receiver | PIN diode, less than −24dBm |
| Optical interface (30 km class) | |
| Type of fibre | Single mode 10/125μm |
| Connector type | SC type (PC polish) |
| Wave length | 1310nm |
| Optical transmitter | Laser, more than −13dBm |
| Optical receiver | PIN diode, less than −37dBm |
| Optical interface (80 km class) | |
| Type of fibre | Single mode 10/125μm |
| Connector type | Duplex LC |
| Wave length | 1550nm |
| Optical transmitter | Laser, more than −5dBm |
| Optical receiver | PIN diode, less than −34dBm |

| | |
|---|---|
| **Disturbance Record Initiation** | |
| Overcurrent element | 0.1 to 50.0A in 0.1A steps (1A relay)<br>0.5 to 250.0A in 0.1A steps (5A relay) |
| Undervoltage element | 0 to 132V in 1V steps (for phase fault)<br>0 to 76V in 1V steps (for earth fault) |
| Pre-fault time | 0.3s fixed |
| Post-fault time | 0.1 to 3.0s in 0.1s steps |
| **Communication Port** | |
| Front communication port (local PC) | |
| Connection | Point to point |
| Cable type | Multi-core (straight) |
| Cable length | 15m (max.) |
| Connector | RS232C 9-pin D-subminiature connector female |
| Rear communication port (remote PC) | |
| RS485 I/F: | |
| Transmission data rate for RSM system | 64kbps |
| Connection | Multidrop mode (max. 32 relays) |
| Connector | Screw terminals |
| Cable and length | Twisted pair cable, max. 1200m |
| Isolation | 2kVac for 1min. |
| Fibre optic I/F: | ST connector, graded-index multi-mode 50/125μm or 62.5/125μm type optical fibres |
| Ethernet LAN I/F: | 10BASE-T, RJ-45 connector |
| **IRIG-B Port** | |
| Connection | BNC connector |
| Cable type | 50 ohm coaxial cable |
| **Binary Inputs** | |
| Operating voltage | Typical 74Vdc(min.70Vdc) for 110V/125Vdc rating<br>Typical 138Vdc(min.125Vdc) for 220V/250Vdc rating<br>Typical 31Vdc(min.28Vdc) for 48V/54V/60Vdc rating<br>Typical 15Vdc(min.14Vdc) for 24Vdc rating |
| **Contact Ratings** | |
| Trip contacts | |
| Make and carry | 5A continuously,<br>30A, 290Vdc for 0.5s (L/R=10ms) |
| Break | 0.15A, 290Vdc (L/R=40ms) |
| Auxiliary contacts | |
| Make and carry | 4A continuously,<br>10A, 220Vdc for 0.5s (L/R≧5ms) |
| Break | 0.1A, 220Vdc (L/R=40ms) |
| Durability | |
| Make and carry | 10,000 operations minimum |
| Break | 100,000 operations minimum |
| **Mechanical design** | |
| Weight | 10kg (Type-A), 13kg (Type-B) |
| Case colour | Munsell No. 10YR8/0.5 |
| Installation | Flush mounting or rack mounting |

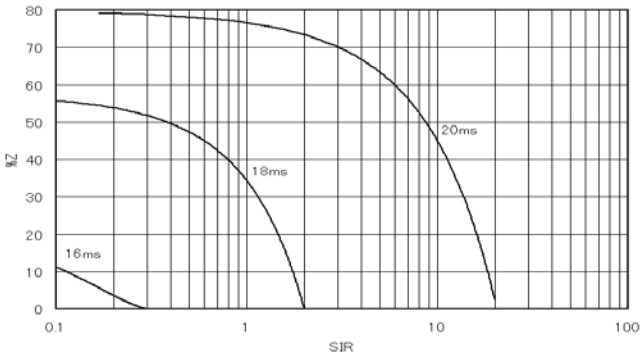



a) Minimum operating time (50Hz)

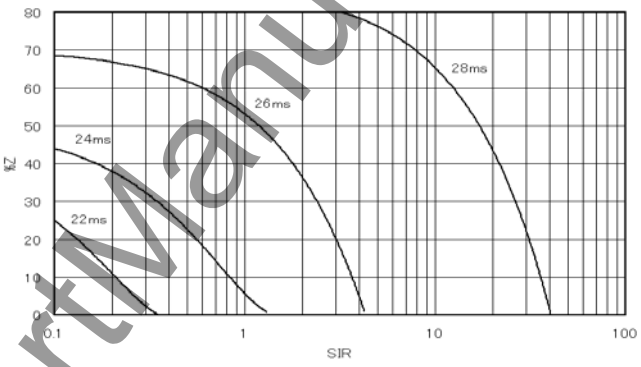



b) Maximum operating time (50Hz)

**Phase to phase fault**




a) Minimum operating time (50Hz)




b) Maximum operating time (50Hz)

**Phase to earth fault**

Note: In the case of a 60Hz relay the operate time is reduced by approximately 15% to 20%.

Figure 15 Operating time curve

## ENVIRONMENTAL PERFORMANCE

| Test | Standards | Details |
|---|---|---|
| **Atmospheric Environment** | | |
| Temperature | IEC60068-2-1/2 | Operating range: -10°C to +55°C.<br>Storage / Transit: -25°C to +70°C. |
| Humidity | IEC60068-2-78 | 56 days at 40°C and 93% relative humidity. |
| Enclosure Protection | IEC60529 | IP51 (Rear: IP20) |
| **Mechanical Environment** | | |
| Vibration | IEC60255-21-1 | Response - Class 1<br>Endurance - Class 1 |
| Shock and Bump | IEC60255-21-2 | Shock Response Class 1<br>Shock Withstand Class 1<br>Bump Class 1 |
| Seismic | IEC60255-21-3 | Class 1 |
| **Electrical Environment** | | |
| Dielectric Withstand | IEC60255-5 | 2kVrms for 1 minute between all terminals and earth.<br>2kVrms for 1 minute between independent circuits.<br>1kVrms for 1 minute across normally open contacts. |
| High Voltage Impulse | IEC60255-5 | Three positive and three negative impulses of 5kV(peak), 1.2/50μs, 0.5J between all terminals and between all terminals and earth. |
| **Electromagnetic Environment** | | |
| High Frequency Disturbance / Damped Oscillatory Wave | IEC60255-22-1 Class 3, IEC61000-4-12 / EN61000-4-12 | 1MHz 2.5kV applied to all ports in common mode.<br>1MHz 1.0kV applied to all ports in differential mode. |
| Electrostatic Discharge | IEC60255-22-2 Class 3, IEC61000-4-2 / EN61000-4-2 | 6kV contact discharge, 8kV air discharge. |
| Radiated RF Electromagnetic Disturbance | IEC60255-22-3 Class 3, IEC61000-4-3 / EN61000-4-3 | Field strength 10V/m for frequency sweeps of 80MHz to 1GHz and 1.7GHz to 2.2GHz. Additional spot tests at 80, 160, 450, 900 and 1890MHz. |
| Fast Transient Disturbance | IEC60255-22-4, IEC61000-4-4 / EN61000-4-4 | 4kV, 2.5kHz, 5/50ns applied to all inputs. |
| Surge Immunity | IEC60255-22-5, IEC61000-4-5 / EN61000-4-5 | 1.2/50μs surge in common/differential modes:<br>HV ports: 2kV/1kV (peak)<br>PSU and I/O ports: 2kV/1kV (peak)<br>RS485 port: 1kV (peak) |
| Conducted RF Electromagnetic Disturbance | IEC60255-22-6 Class 3, IEC61000-4-6 / EN61000-4-6 | 10Vrms applied over frequency range 150kHz to 100MHz. Additional spot tests at 27 and 68MHz. |
| Power Frequency Disturbance | IEC60255-22-7, IEC61000-4-16 / EN61000-4-16 | 300V 50Hz for 10s applied to ports in common mode.<br>150V 50Hz for 10s applied to ports in differential mode.<br>Not applicable to AC inputs. |
| Conducted and Radiated Emissions | IEC60255-25, EN55022 Class A, IEC61000-6-4 / EN61000-6-4 | Conducted emissions:<br>0.15 to 0.50MHz: <79dB (peak) or <66dB (mean)<br>0.50 to 30MHz: <73dB (peak) or <60dB (mean)<br>Radiated emissions (at 30m):<br>30 to 230MHz: <30dB<br>230 to 1000MHz: <37dB |
| **European Commission Directives** | | |
| CE | 89/336/EEC | Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to EN 61000-6-2 and EN 61000-6-4. |
| | 73/23/EEC | Compliance with the European Commission Low Voltage Directive is demonstrated according to EN 50178 and EN 60255-5. |

## Optical Interface Unit G1IF1 (Option)

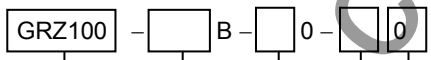
| | | |
|---|---|---|
| **Ratings** | | |
| Power supply: | | 110Vdc/125Vdc (Operative range: 88 - 150Vdc)<br>220Vdc/250Vdc (Operative range: 170 - 300Vdc)<br>48Vdc (Operative range: 38.4 - 72Vdc) |
| Burden: | | less than 8W |
| **Interface** | | |
| Communication interface: | | CCITT-G703-1.2.1<br>CCITT-G703-1.2.2 or 1.2.3<br>X.21 |
| Operative Range: | | less than 1.2km with 62.5/125μm GI fibre (3dB/km) |
| Wavelength: | | 820nm |
| Connector type: | | ST |
| Fibre type: | | 62.5/125μm glass fibre |
| **Atmospheric Environment** | | |
| Temperature | IEC60068-2-1/2 | Operating range: -10°C to +55°C.<br>Storage / Transit: -25°C to +70°C. |
| Humidity | IEC60068-2-78 | 56 days at 40°C and 93% relative humidity. |
| Enclosure Protection | IEC60529 | IP40 (without outer-case, excluding terminal parts)<br>IP50 (with outer-case) |

## Protocol Converter G1PR2 (Option)

| | | | |
|---|---|---|---|
| **Ratings** | | | |
| Power supply: | 110Vdc/100Vac | Operative range: | 88 - 150Vdc of 110Vdc rated voltage<br>80 - 120Vac of 100Vac rated voltage |
| | 220Vdc/200Vac | Operative range: | 170 - 300Vdc of 220Vdc rated voltage<br>200 - 240Vac of 200Vac rated voltage |
| | 48Vdc | Operative range: | 38.4 - 72Vdc |
| Burden: | less than 20W | | |
| **Communication port** | | | |
| RS232C interface | | | |
| Connector type | RS232C 9-pin D-subminiature connector female | | |
| Cable type | Multi-core (straight) | | |
| RS485 interface | | | |
| Connector | Screw terminals (Phoenix Contact, FRONT type) | | |
| Cable type | Twisted pair cable | | |
| Optical interface | | | |
| Operative Range: | less than 1.2km with 62.5/125μm GI fibre (3dB/km) | | |
| Wavelength: | 820nm | | |
| Connector type: | ST | | |
| Fibre type: | 62.5/125μm glass fibre | | |
| IRIG-B | | | |
| Connector | Screw terminals (Phoenix Contact, FRONT-MSTB type) | | |
| **Mechanical design** | | | |
| Enclosure Protection | IEC60529, IP20 | | |
| Weight | 5 kg | | |
| Installation | Flush mounting | | |
| **Atmospheric Environment** | | | |
| Temperature | IEC60068-2-1/2 | Operating range: -10°C to +55°C.<br>Storage / Transit: -25°C to +70°C. | |
| Humidity | IEC60068-2-78 | 56 days at 40°C and 93% relative humidity. | |

## ORDERING

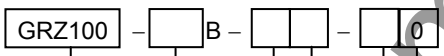
### 1. Distance Relay




| | |
|---|---|
| Relay Type: | |
| Distance protection relay | GRZ100 |
| Relay Model: | |
| -Model200: With autoreclose for single breaker scheme | |
| 18 BIs, 23 BOs, 6 trip BOs | 201 |
| 24 BIs, 41 BOs, 6 trip Bos | 203 |
| 22 Bis (12-independent), 18 BOs, 3 trip BOs | 204 |
| 28 BIs (12-independent), 37 BOs, 3 trip BOs | 206 |
| -Model300: With autoreclose for one and a half breaker scheme | |
| 18 BIs, 23 BOs, 6 trip BOs | 301 |
| 21 BIs, 27 BOs, 6 trip BOs | 302 |
| 24 BIs, 41 BOs, 6 trip BOs | 303 |
| -Model400: With autoreclose for single breaker and redundant fault detector scheme | |
| 21 BIs, 35 BOs, 6 trip Bos | 401 |
| -Model500: With autoreclose for one and a half breaker and redundant fault detector scheme | |
| 21 BIs, 35 BOs, 6 trip BOs | 501 |
| Ratings: | |
| 1A, 50Hz, 110V/125Vdc | 1 |
| 1A, 60Hz, 110V/125Vdc | 2 |
| 5A, 50Hz, 110V/125Vdc | 3 |
| 5A, 60Hz, 110V/125Vdc | 4 |
| 1A, 50Hz, 220V/250Vdc | 5 |
| 1A, 60Hz, 220V/250Vdc | 6 |
| 5A, 50Hz, 220V/250Vdc | 7 |
| 5A, 60Hz, 220V/250Vdc | 8 |
| 1A, 50Hz, 48V/54V/60Vdc | A |
| 1A, 60Hz, 48V/54V/60Vdc | B |
| 5A, 50Hz, 48V/54V/60Vdc | C |
| 5A, 60Hz, 48V/54V/60Vdc | D |
| 1A, 50Hz, 24V/30Vdc | E |
| 1A, 60Hz, 24V/30Vdc | F |
| 5A, 50Hz, 24V/30Vdc | G |
| 5A, 60Hz, 24V/30Vdc | H |
| Communications: | |
| RS485 | 1 |
| Fibre optic | 2 |
| Dual RS485 | 3 |
| Dual fibre optic | 4 |
| RS485 + fibre optic | 9 |
| Note: Fibre optic is available for model 203, 206, 302, 303, 401, 501<br>10BASE-T option is available for specific configuration | |
| Miscellaneous: | |
| None | 0 |

Note: Please inform us which is ordered flush mount type or 19-inch rack mount type.
In 19 inch rack mount type, please order optional attachment kit.
- for relay case Type-A attachment kit: EP101
- for relay case Type-B attachment kit: EP102

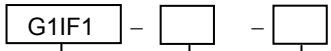
**2. Distance Relay with integral communications**




| | |
|---|---|
| Relay type: | |
| Distance relay | GRZ100 |
| Relay Model: | |
| For 2-terminal line application (one communication channel) / with autoreclose for single breaker scheme | |
| -Model 211: 6 trip contacts / 18 binary outputs / 22 binary inputs | 211 |
| -Model 214: 3 trip contacts / 18 binary outputs / 22 binary inputs | 214 |
| -Model 216: 3 trip contacts / 36 binary outputs / 25 binary inputs | 216 |
| For 2-terminal line application (one communication channel) / with autoreclose for one-and-a-half breaker scheme | |
| -Model 311: 6 trip contacts / 22 binary outputs / 18 binary inputs | 311 |
| For 2- / 3-terminal line application (two communication channels) / with autoreclose for single breaker scheme | |
| -Model 221: 6 trip contacts / 18 binary outputs / 22 binary inputs | 221 |
| -Model 224: 3 trip contacts / 18 binary outputs / 22 binary inputs | 224 |
| -Model 226: 3 trip contacts / 36 binary outputs / 25 binary inputs | 226 |
| For 2- / 3-terminal line application (two communication channels) / with autoreclose for one-and-a-half breaker scheme | |
| -Model 321: 6 trip contacts / 22 binary outputs / 18 binary inputs | 321 |
| -Model 323: 6 trip contacts / 40 binary outputs / 18 binary inputs | 323 |
| Ratings: | |
| 1A, 50Hz, 110V/125Vdc | 1 |
| 1A, 60Hz, 110V/125Vdc | 2 |
| 5A, 50Hz, 110V/125Vdc | 3 |
| 5A, 60Hz, 110V/125Vdc | 4 |
| 1A, 50Hz, 220V/250Vdc | 5 |
| 1A, 60Hz, 220V/250Vdc | 6 |
| 5A, 50Hz, 220V/250Vdc | 7 |
| 5A, 60Hz, 220V/250Vdc | 8 |
| 1A, 50Hz, 48V/54V/60Vdc | A |
| 1A, 60Hz, 48V/54V/60Vdc | B |
| 5A, 50Hz, 48V/54V/60Vdc | C |
| 5A, 60Hz, 48V/54V/60Vdc | D |
| 1A, 50Hz, 24V/30Vdc | E |
| 1A, 60Hz, 24V/30Vdc | F |
| 5A, 50Hz, 24V/30Vdc | G |
| 5A, 60Hz, 24V/30Vdc | H |
| Integral communication interface (Protection signaling): | |
| Electrical interface (CCITT-G703-1.2.1) | 1 |
| Electrical interface (CCITT-G703-1.2.2 or 1.2.3) | 2 |
| Optical interface (Short wavelength light: GI: 2km class) | 3 |
| Optical interface (Long wavelength light: SM: 30km class) | 5 |
| Optical interface (Long wavelength light: SM: 80km class) | 7 |
| Electrical interface (RS530, X.21) | 9 |
| Communications (User data): | |
| RS485 | 1 |
| Fibre optic | 2 |
| Dual RS485 | 3 |
| Dual fibre optic | 4 |
| RS485 + fibre optic | 9 |
| Note:<br>Fibre optic is available for model 216, 226, and 323<br>10BASE-T option is available for specific configuration | |
| Miscellaneous: | |
| None | 0 |

Note: Please inform us which is ordered flush mount type or 19-inch rack mount type.
In 19 inch rack mount type, please order optional attachment kit.
- for relay case Type-A attachment kit: EP101
- for relay case Type-B attachment kit: EP102

### 3. Optical Interface Unit (Option)




| Type: | |
|---|---|
| Communication interface box | G1IF1 |
| Model: | |
| For X.21 with outer case | 01 |
| For CCITT-G703-1.2.1 contradirectional | 02 |
| For CCITT-G703-1.2.2 or 1.2.3 contradirectional | 03 |
| For X.21 | 04 |
| Auxiliary power supply: | |
| DC 48V / 54V / 60V | 01 |
| DC 110V / 125V | 02 |
| DC 220V / 250V | 03 |

### 4. Protocol Converter (Option)


| Type: | |
|---|---|
| Protocol converter | G1PR2 |
| Model: | |
| 1 port, Electrical signal (RS485) | 101 |
| 4 ports, Electrical signal (RS485) | 104 |
| 8 ports, Electrical signal (RS485) | 108 |
| 8 ports, Electrical signal (RS485): Max. 8, Optical signal: Max. 1 | 118 |
| 8 ports, Electrical signal (RS485): Max. 8, Optical signal: Max. 4 | 148 |
| 8 ports, Electrical signal (RS485): Max. 4, Optical signal: Max. 8 | 184 |
| 1 port, Electrical signal (RS485) or Optical signal | 111 |
| 1 port, Optical signal | 110 |
| 4 ports, Optical signal | 140 |
| 8 ports, Optical signal | 180 |
| Auxiliary power supply rating: | |
| AC 100 / DC 110V | 10 |
| AC 200 / DC 220V | 50 |
| DC 48V | A0 |
| External time synchronisation: | |
| None. | 00 |
| IRIG-B port | 10 |

## RELAY OUTLINE

### Flush Mount

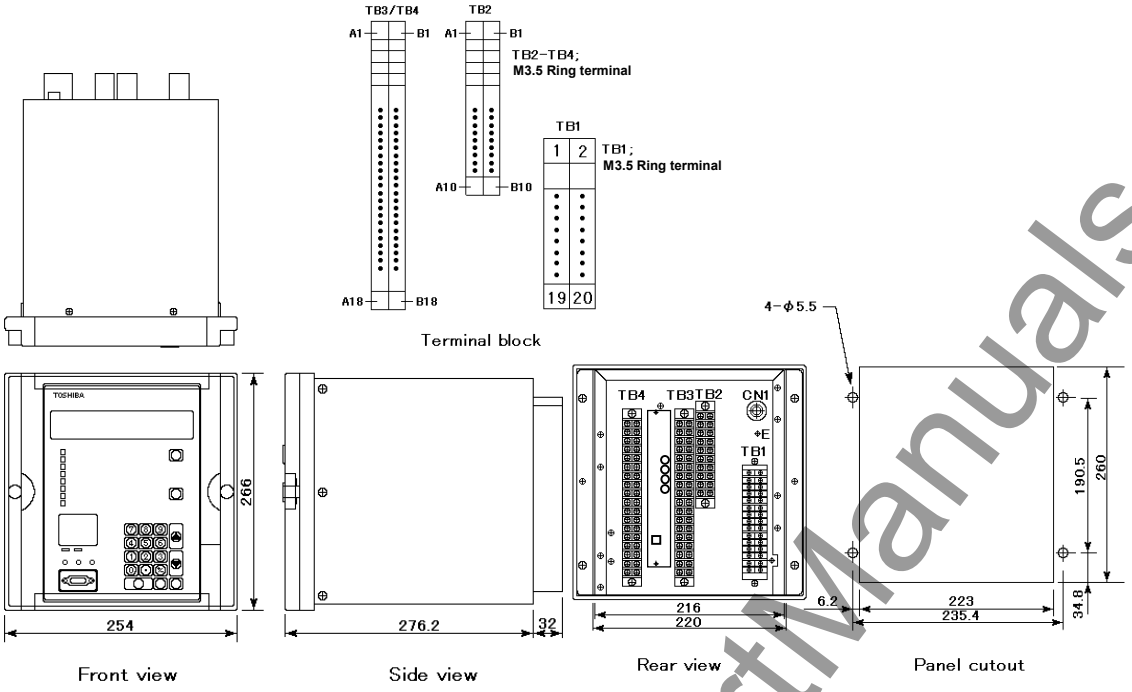



Figure 16 Relay case Type-A outline(for models 201, 204, 211, 214, 221, 224, 301, 311, 321)

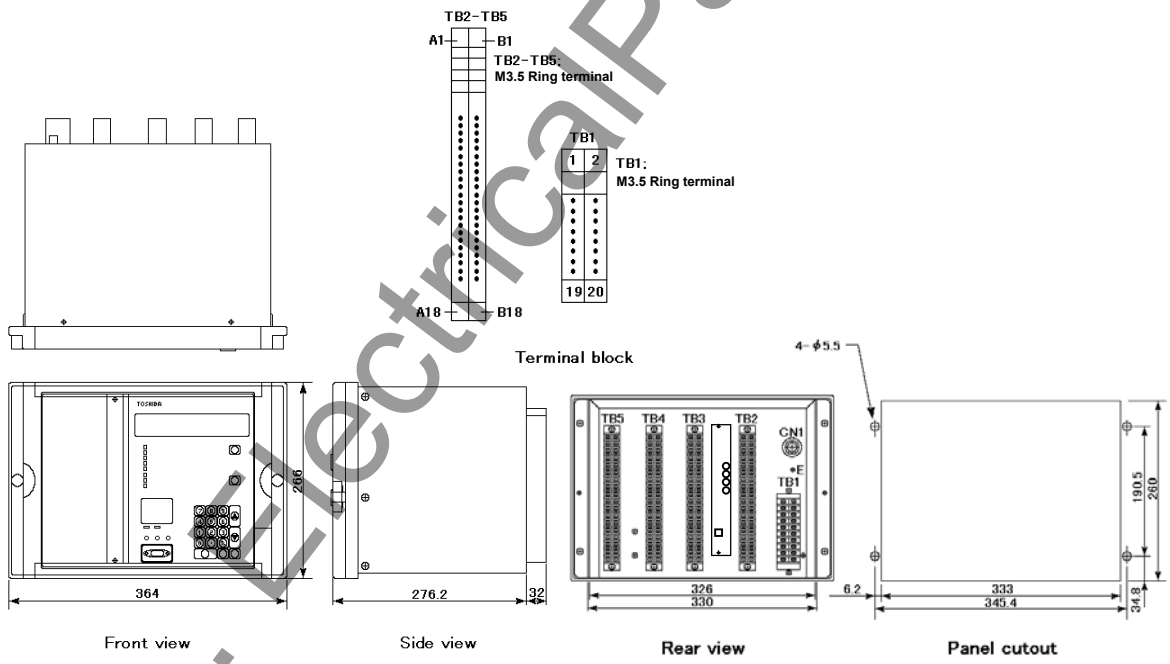



Figure 17 Relay case Type-B outline(for models 203, 206, 216, 226, 302, 303, 323, 401, 501)

**19-inch Rack Mount**

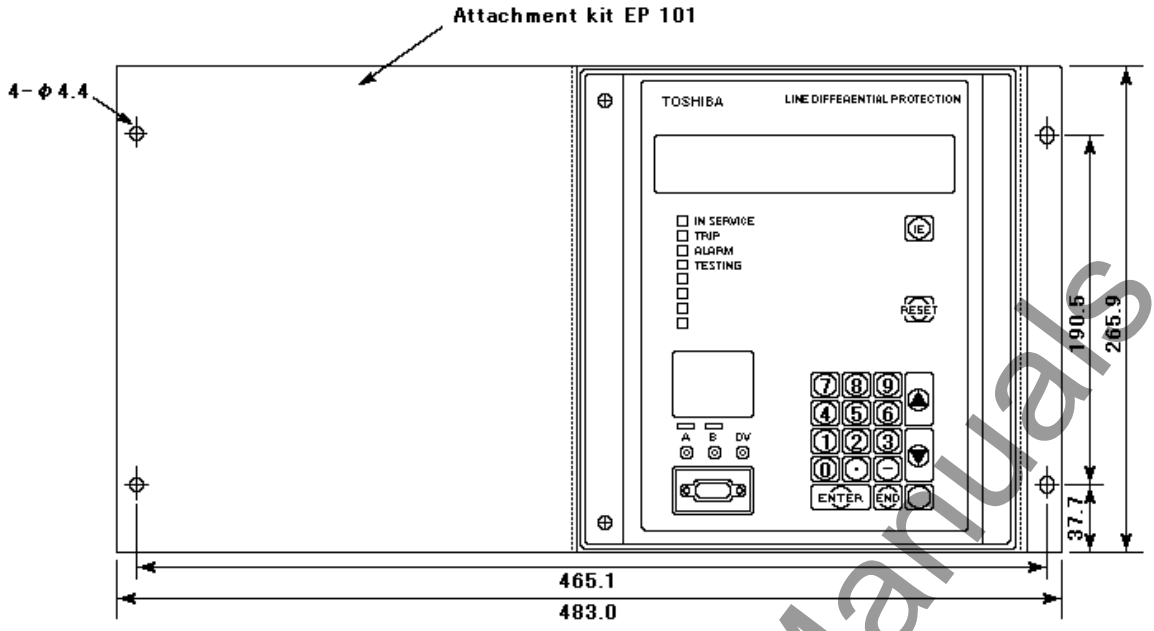



Figure 18 Relay case Type-A outline(for models 201, 204, 211, 214, 221, 224, 301, 311, 321)

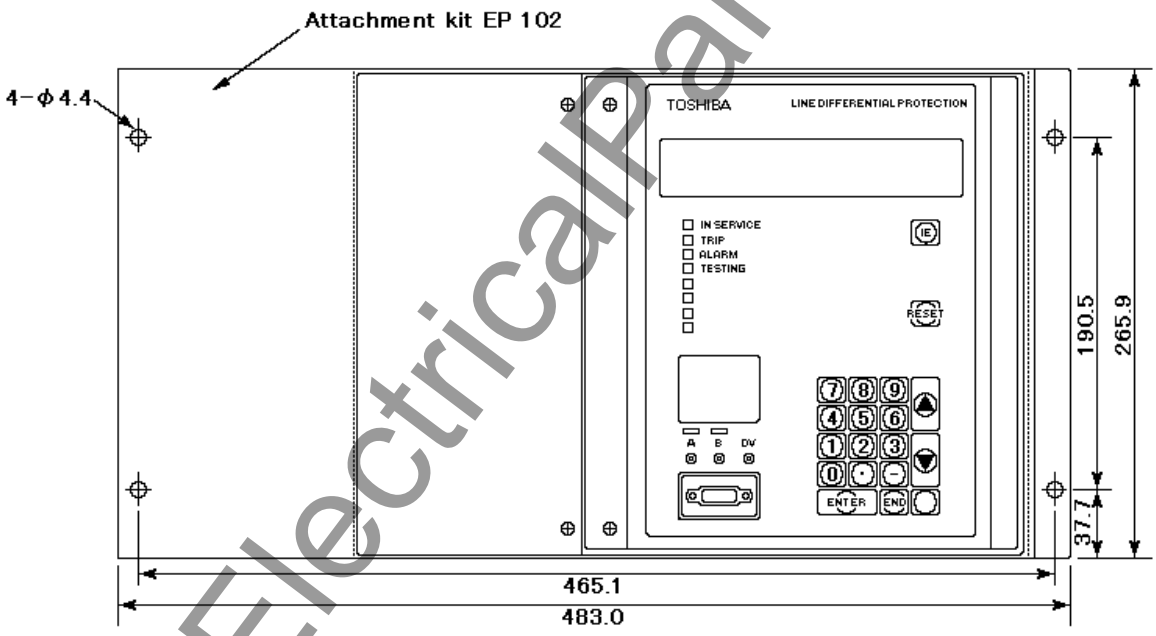



Figure 19 Relay case Type-B outline(for models 203, 206, 216, 226, 302, 303, 323, 401, 501)

## Outline of Optical interface unit

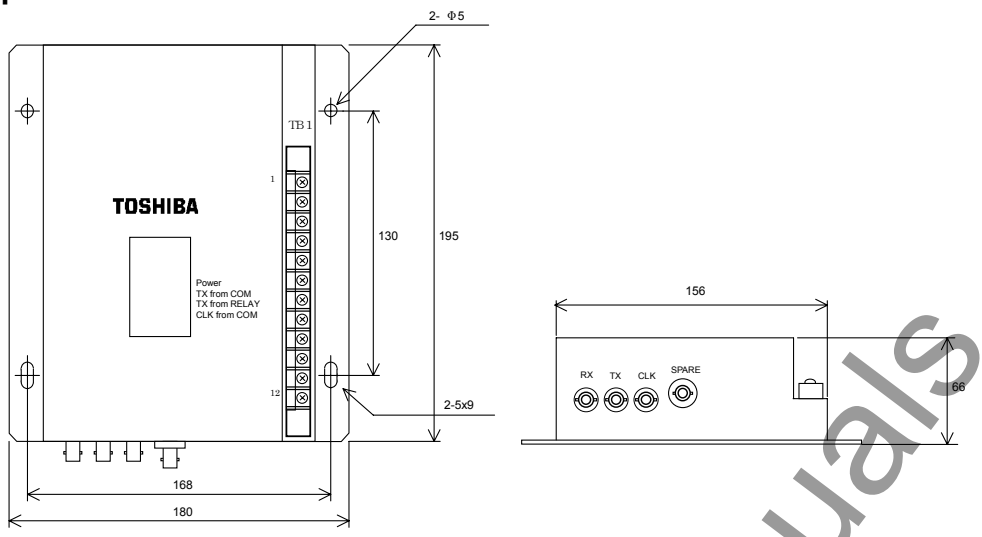



Figure 20 Outline of optical interface unit G1IF1 (without outer case)

## Outline of Protocol Converter

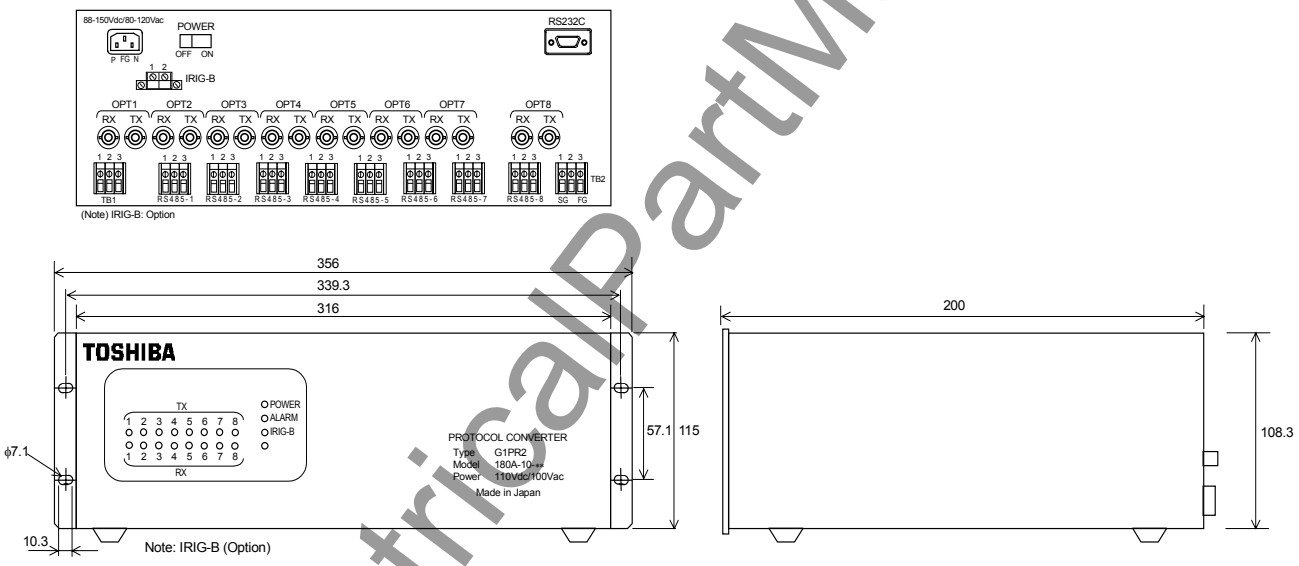



Figure 21 Outline of protocol converter G1PR2

## EXTERNAL CONNECTION DIAGRAM

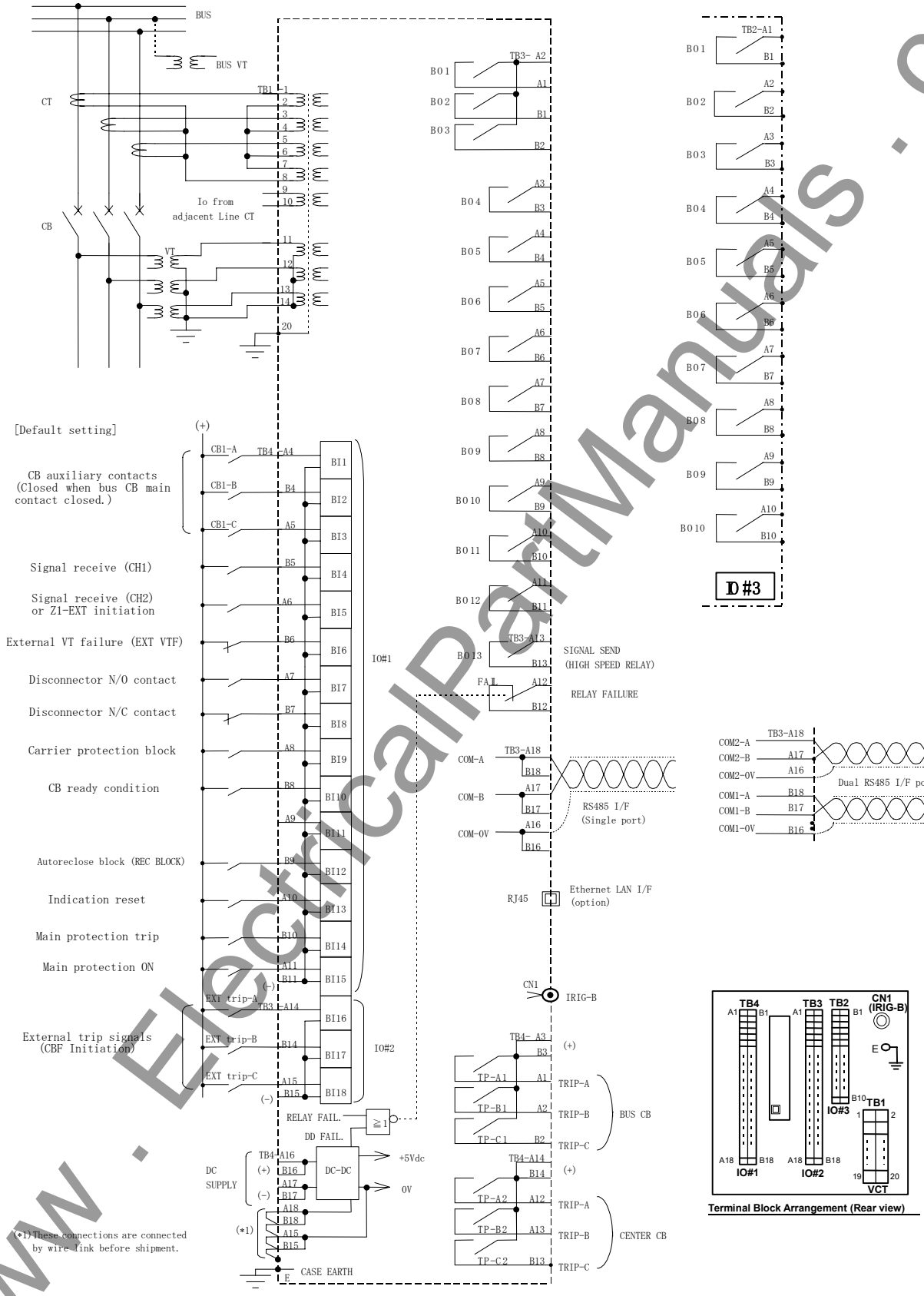



Figure 22 Typical external connection of Model 201

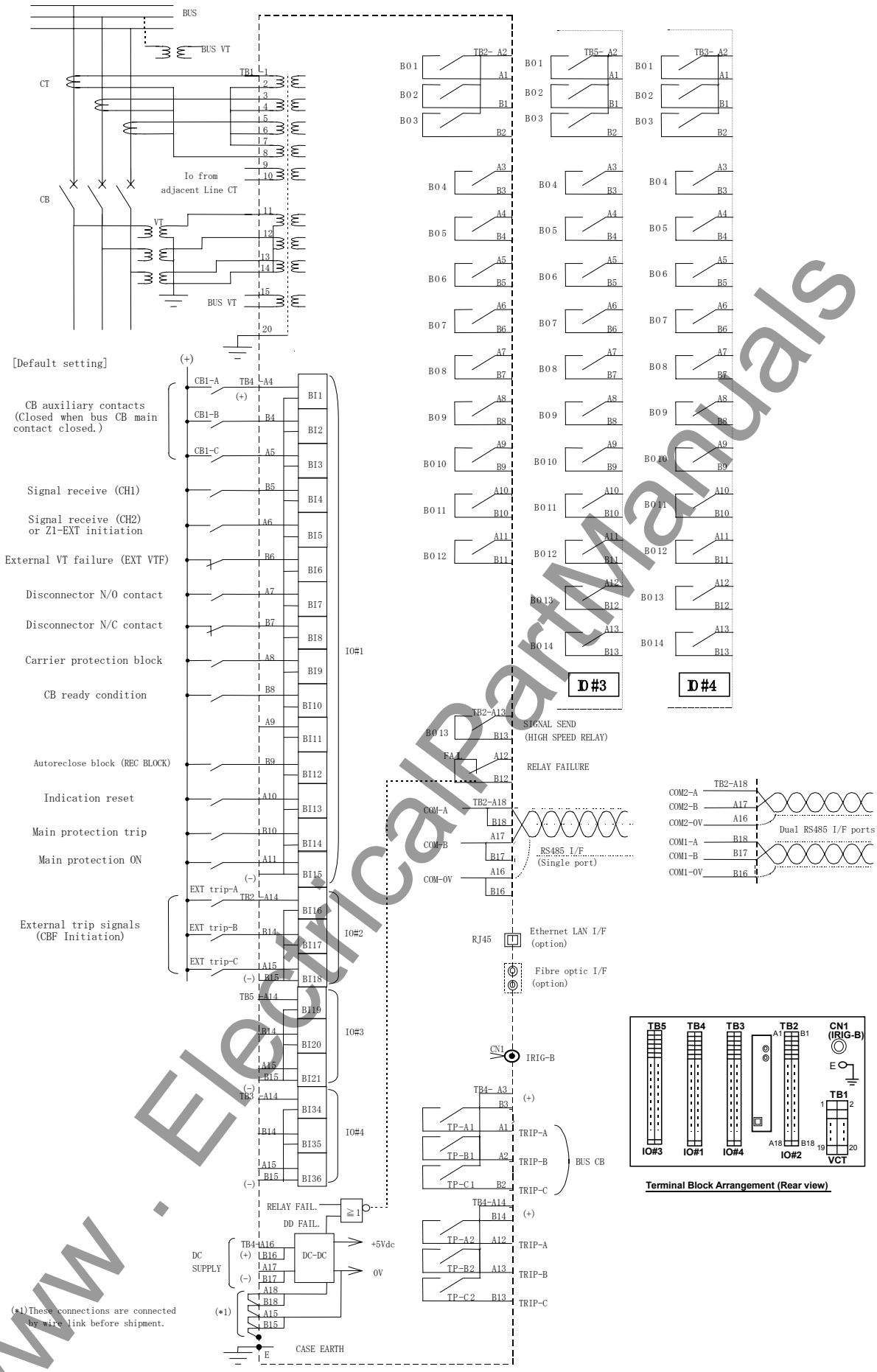
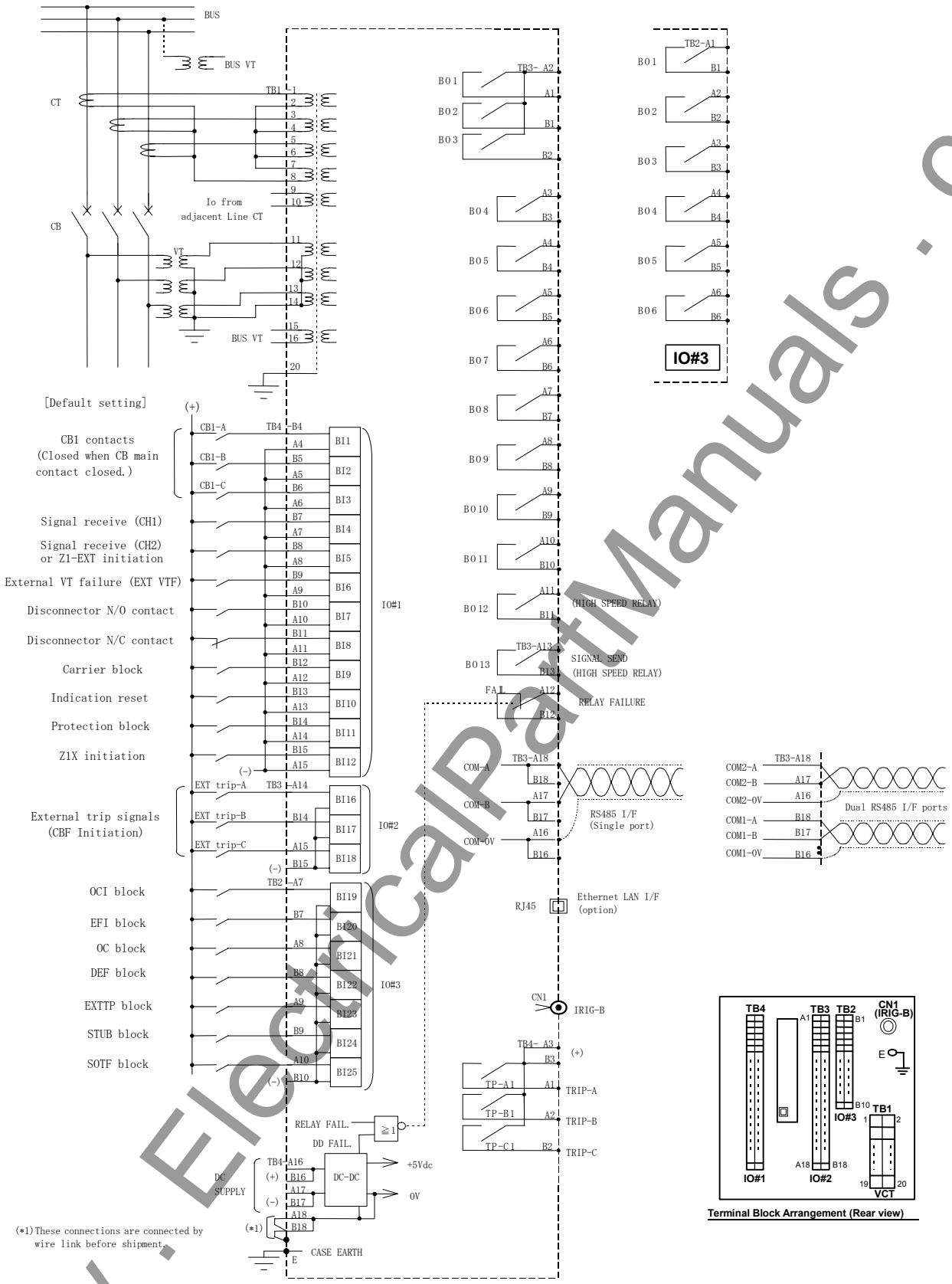



Figure 23 Typical external connection of Model 203




Terminal Block Arrangement (Rear view)

Figure 24 Typical external connection of Model 204

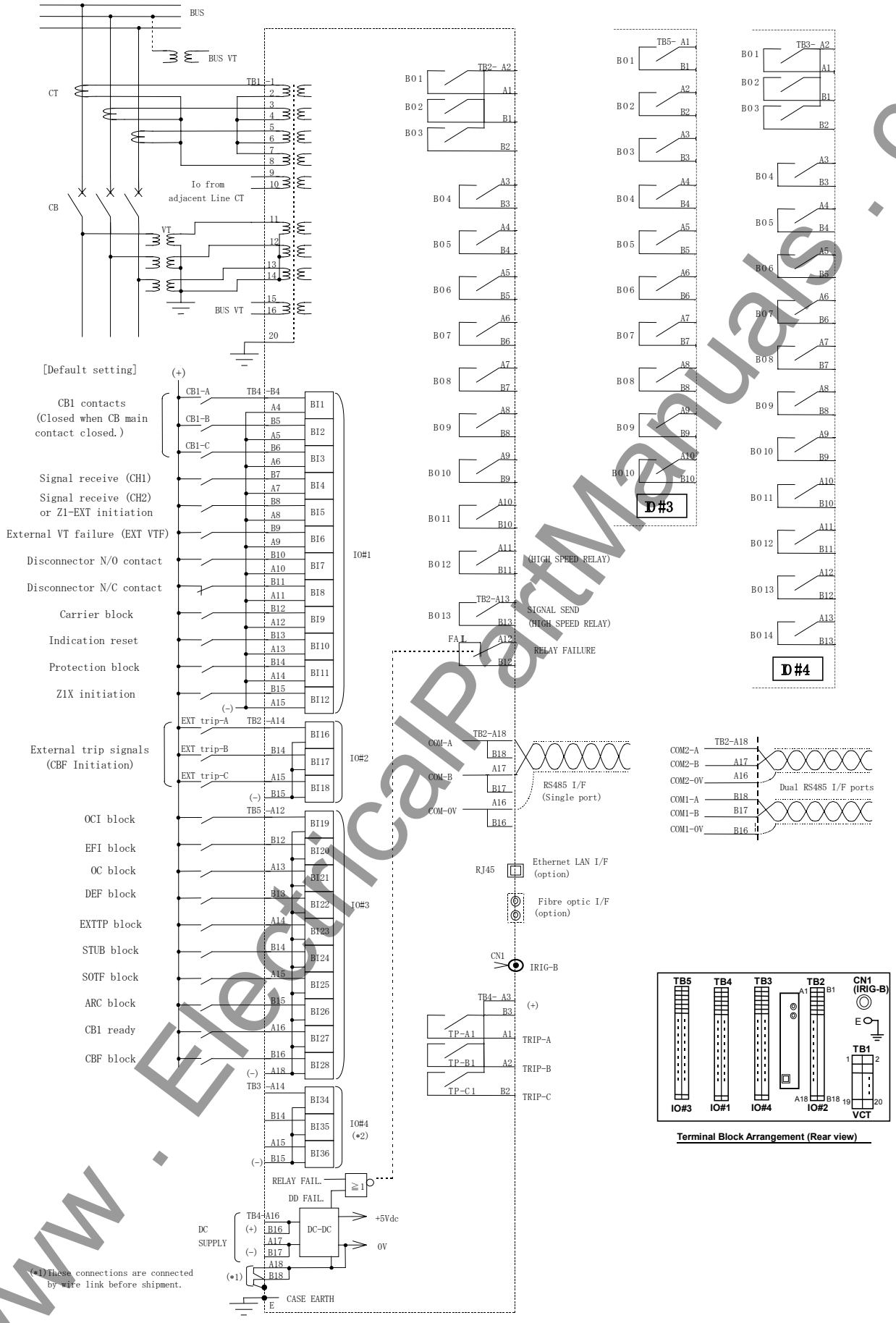



Figure 25 Typical external connection of Model 206

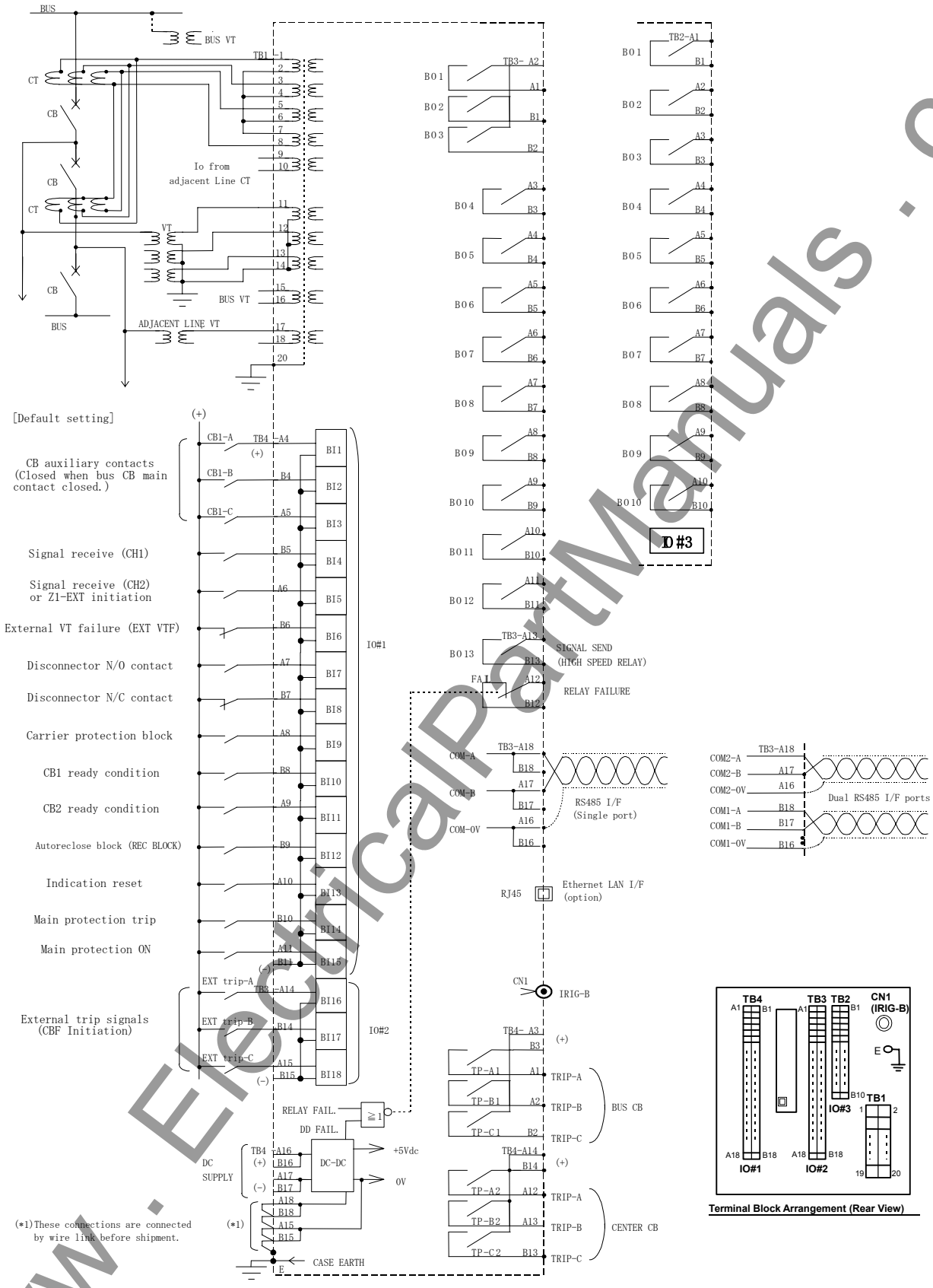



Figure 26 Typical external connection of Model 301

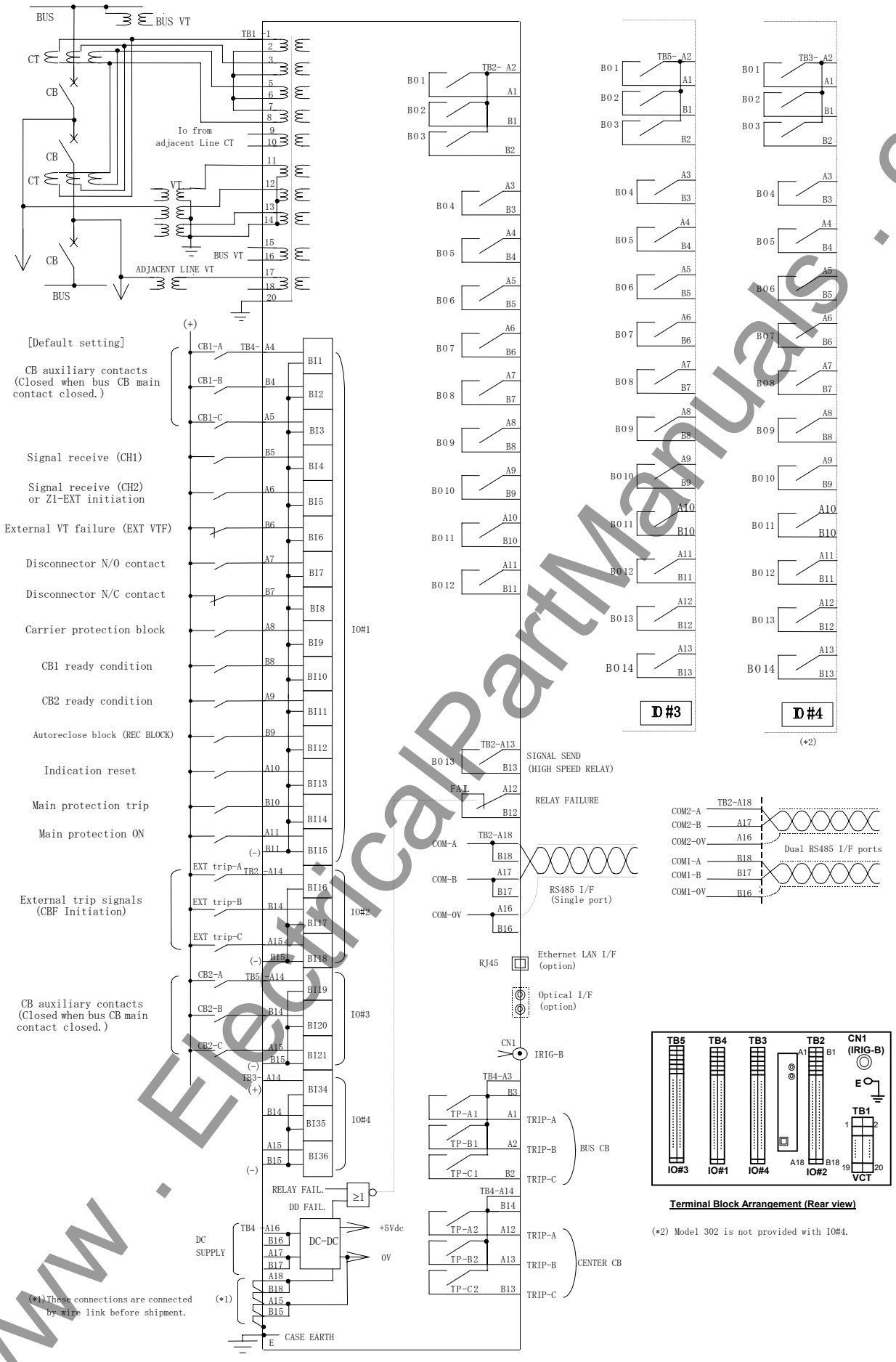



Figure 27 Typical external connection of Model 302/303

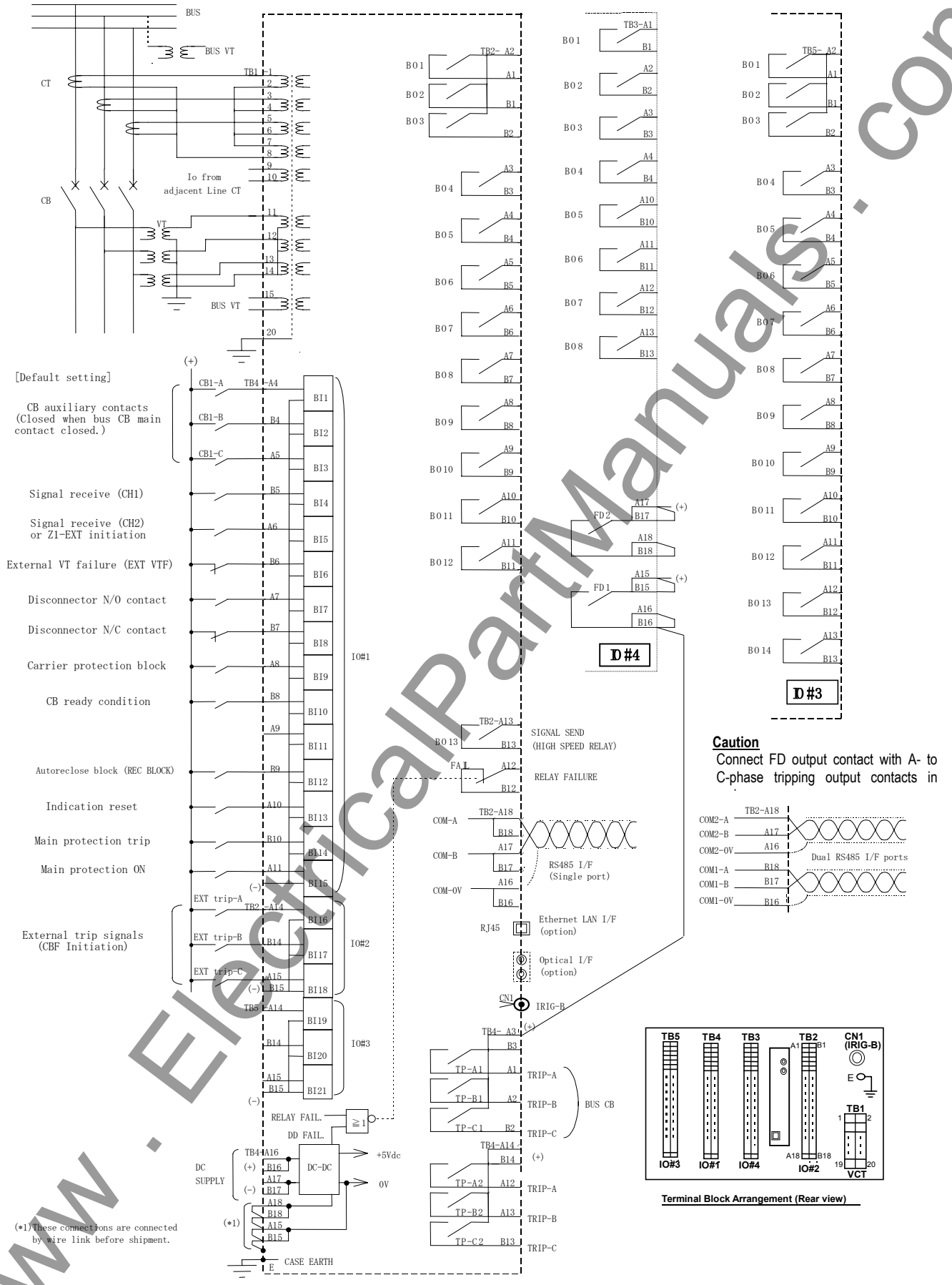



Figure 28 Typical external connection of Model 401

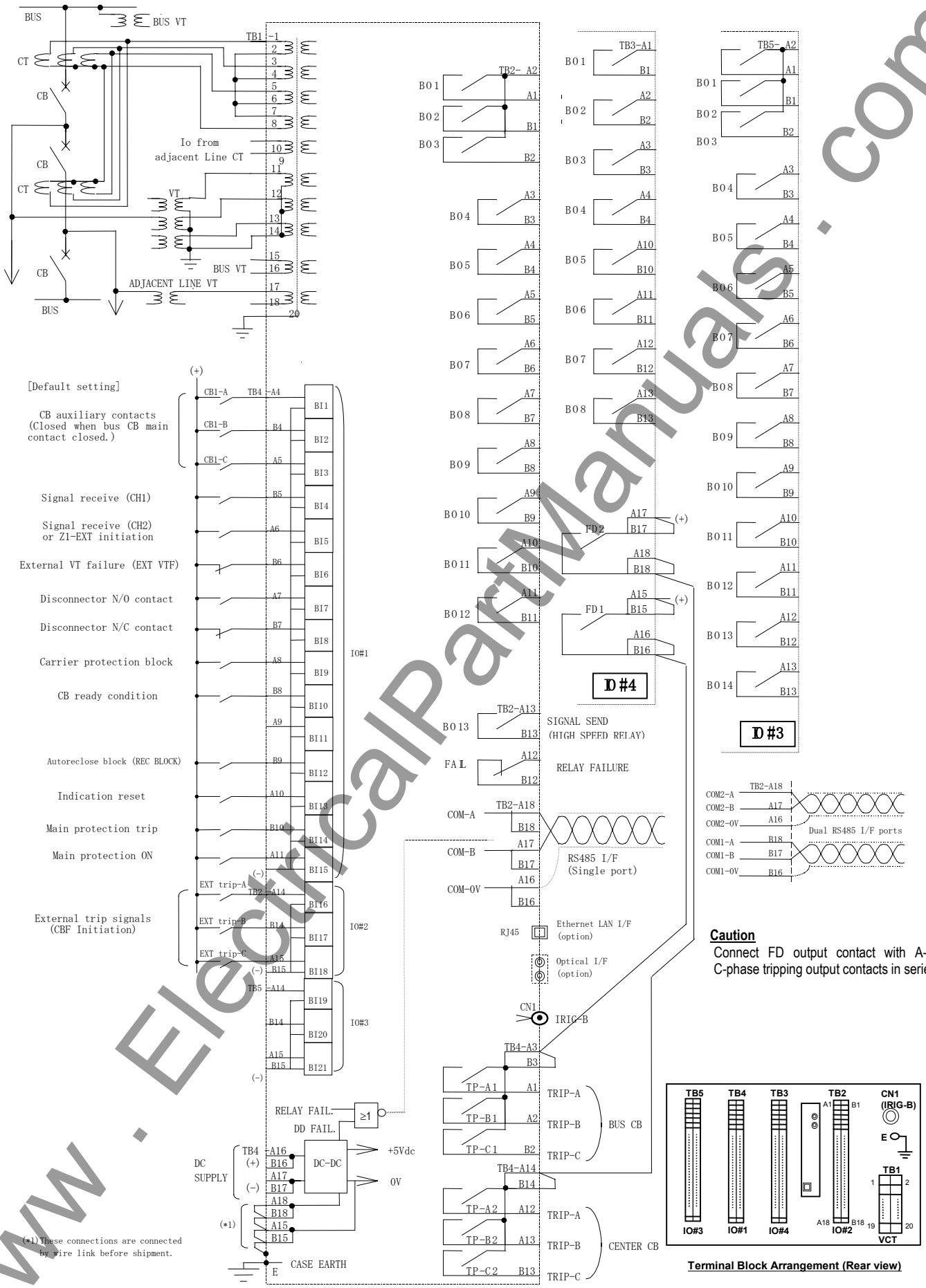



Figure 29 Typical external connection of Model 501

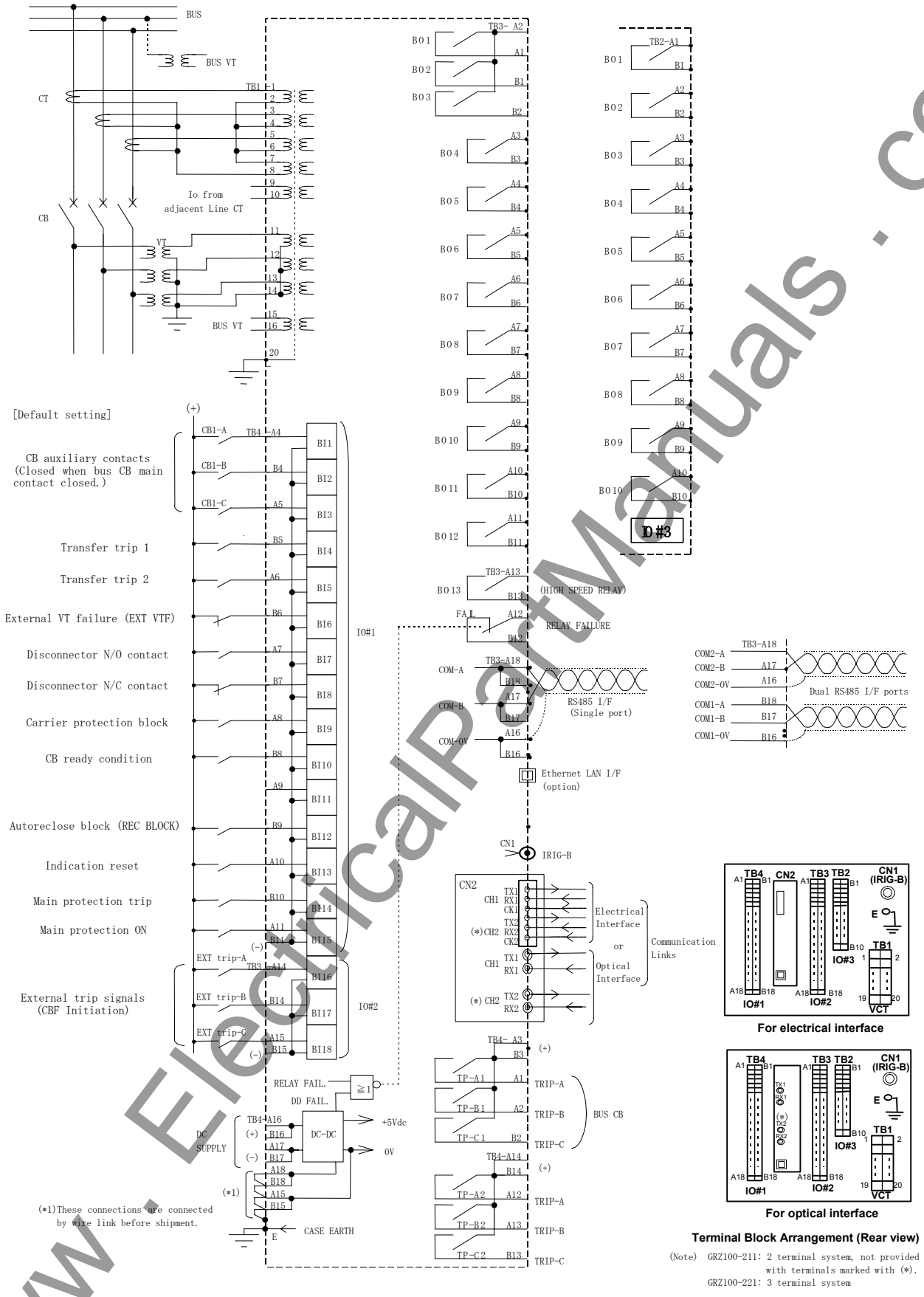



Figure 30 Typical external connection of Models 211/221

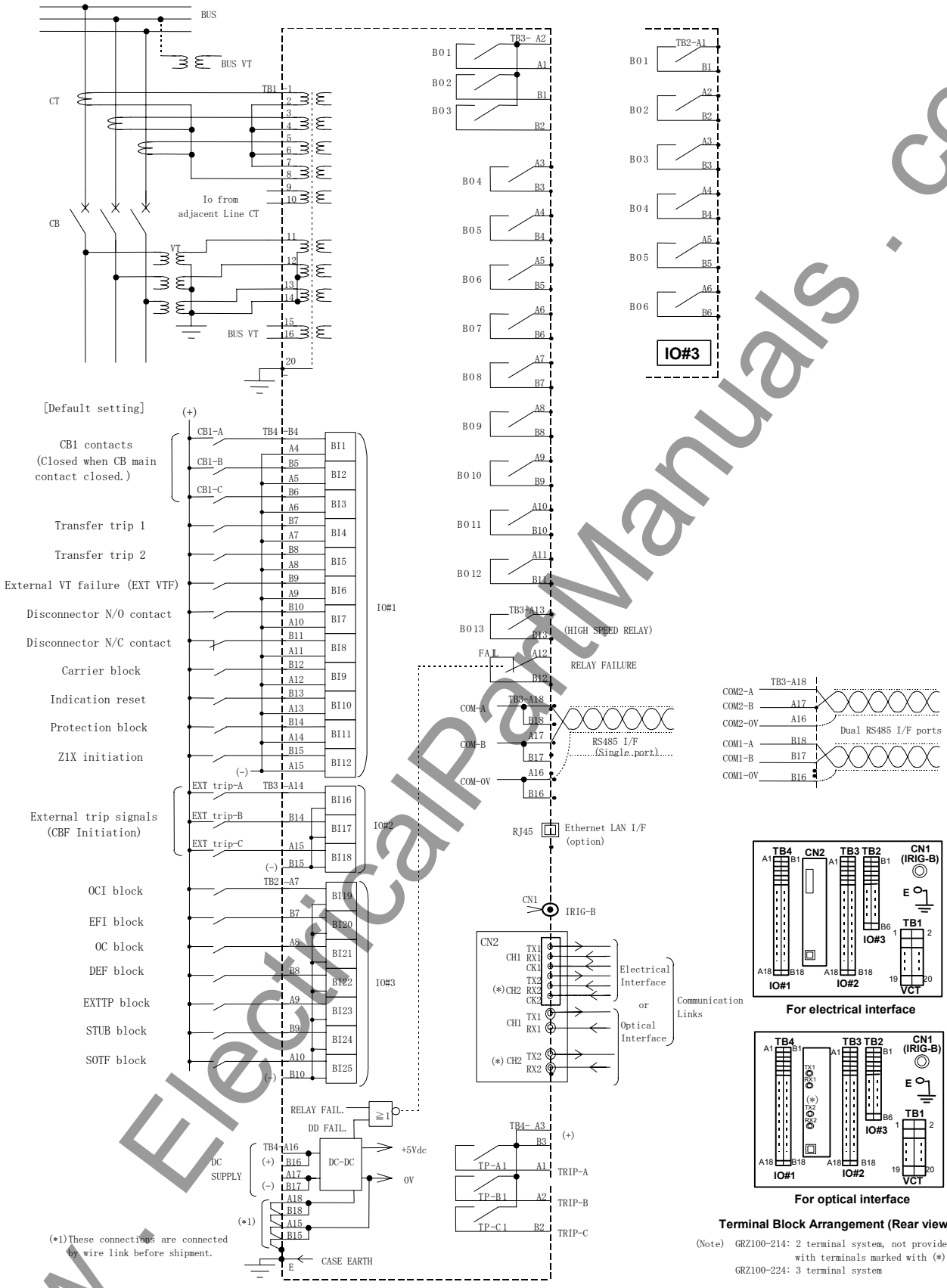



Figure 31 Typical external connection of Models 214/224

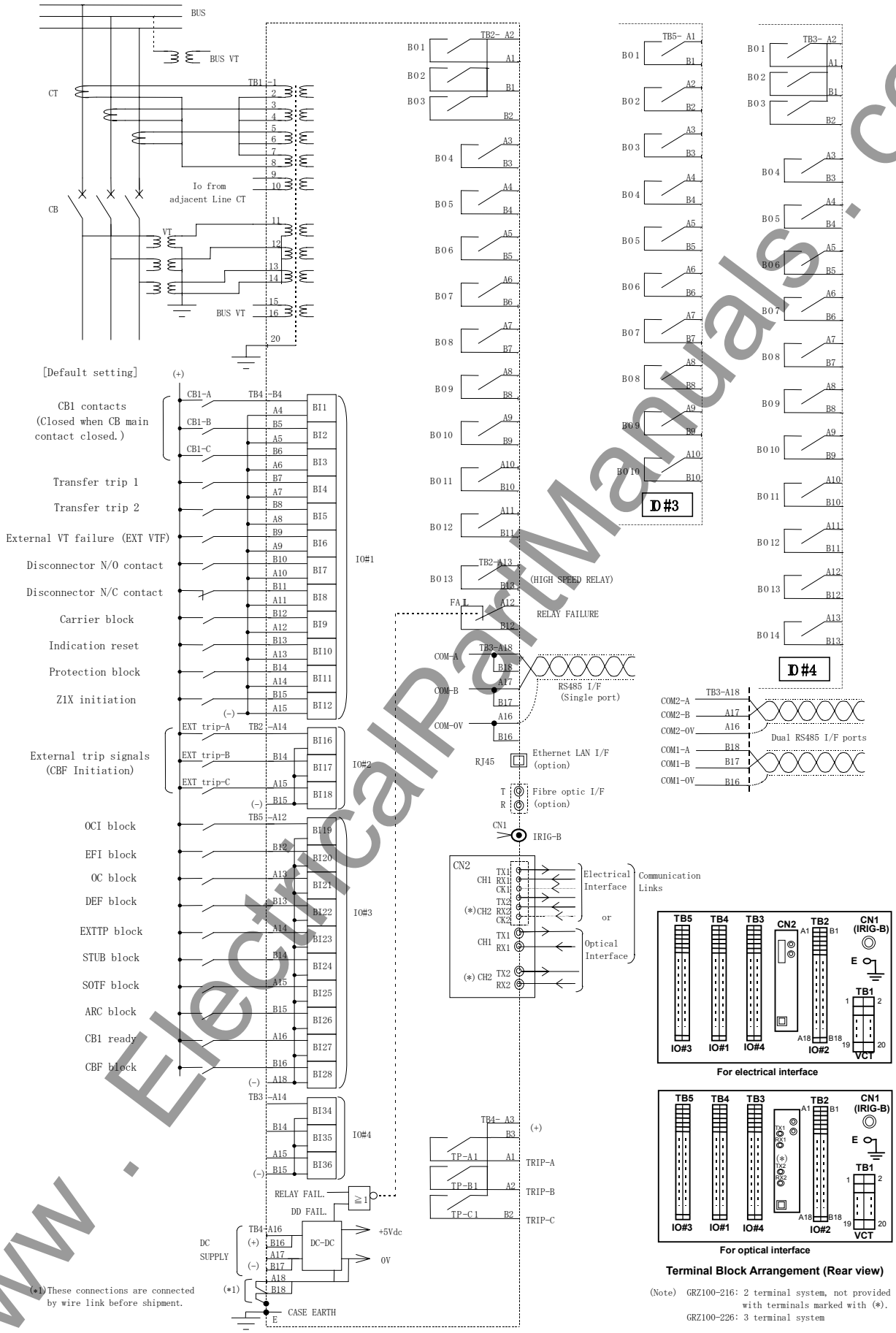
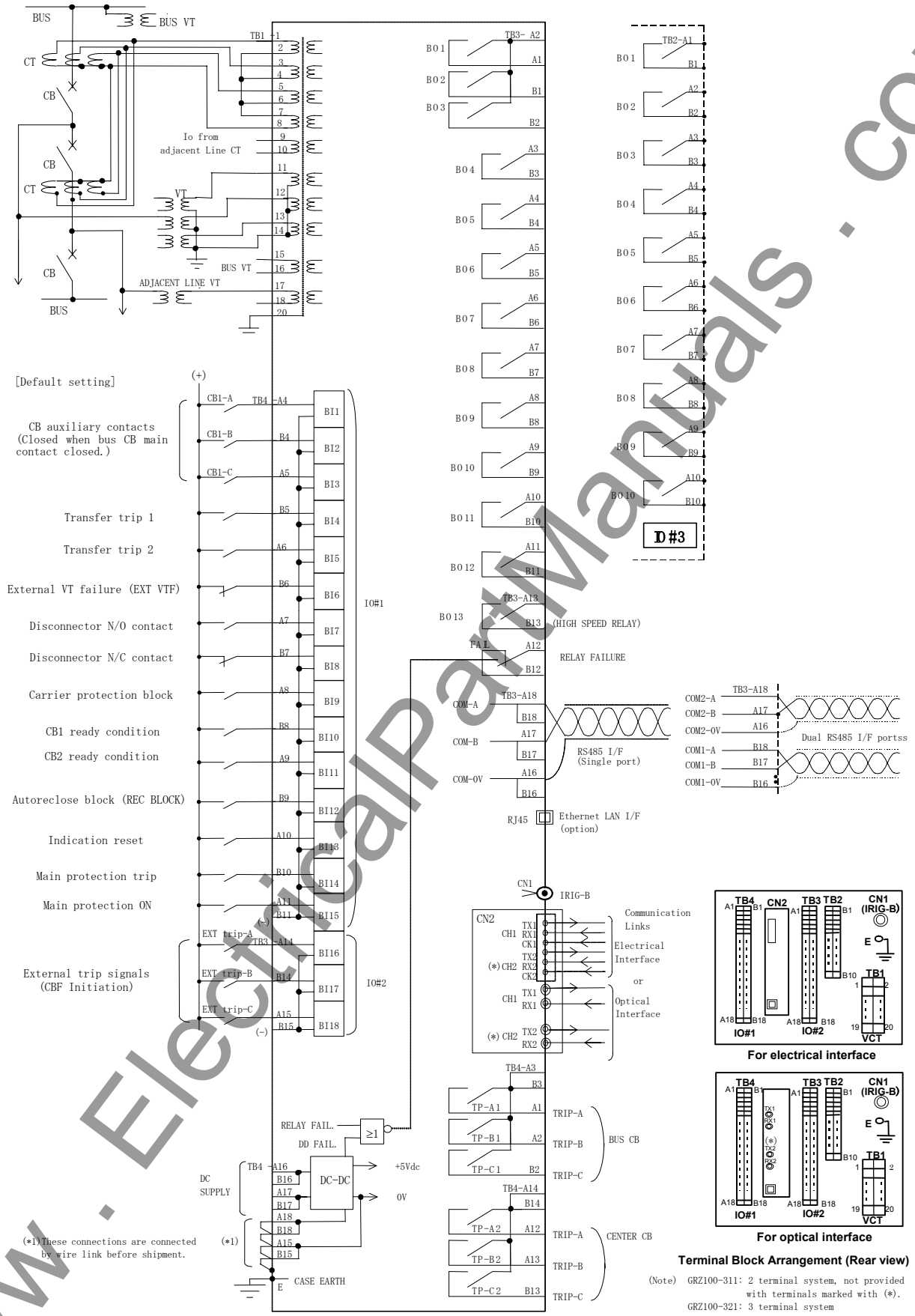



Figure 32 Typical external connection of Models 216/226




(Note) GRZ100-311: 2 terminal system, not provided with terminals marked with (*).
GRZ100-321: 3 terminal system

Figure 33 Typical external connection of Model 311/321

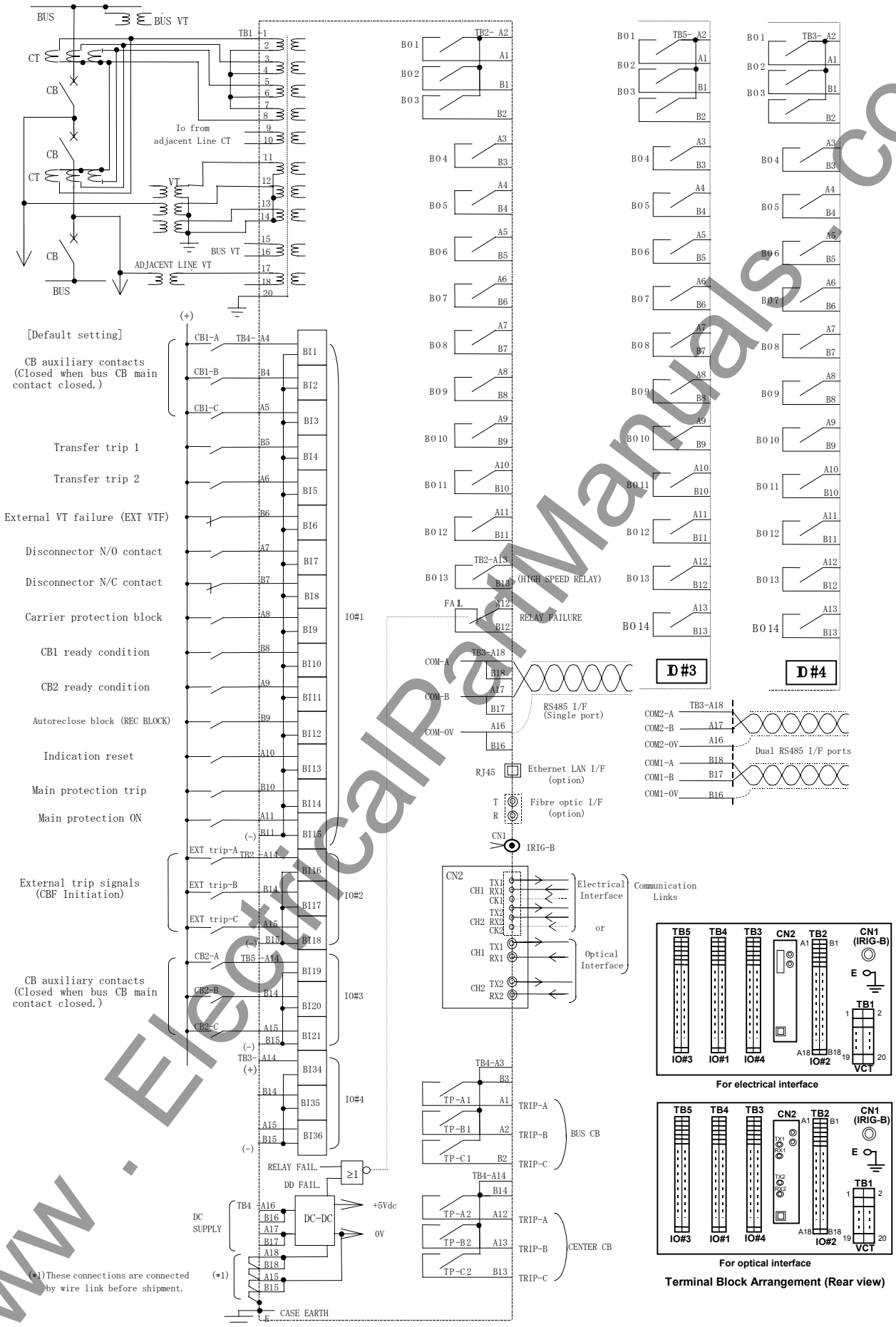



Figure 34 Typical external connection of Model 323

Numerical Relay

# GRZ100

DISTANCE PROTECTION



TOSHIBA

TOSHIBA CORPORATION
Industrial and Power Systems & Services Company
1-1,SHIBAURA 1-CHOME,MINATO-KU, TOKYO 105-8001,JAPAN
PHONE;+81-3-3457-3644 FAX;+81-3-5444-9168
http://www.toshiba.co.jp/f-ene/tands/english/protect/f_pc_top.htm



6641-1 0508T1