TOSHIBA

GR Series Relay

Numerical Relay

GRL100

LINE DIFFERENTIAL
PROTECTION

GRL100

FEATURES

- Fully numerical line protection for use with digital telecommunication systems, including networks that employ SDH (Synchronous Digital Hierarchy) technology
- Intra-system synchronisation and GPS-based synchronisation

  GPS-based synchronisation is particularly suited to switched telecommunication networks employing the SDH (Synchronous Digital Hierarchy) standard, whose split path message routing can cause maloperation of traditional differential protections.
- Operating time typically 1 cycle
- Master/master design
- Automatic transmission delay compensation
- CT ratio correction
- Applicable to various lines such as two-terminal or three-terminal lines, overhead lines or underground cables, etc.
- Phase-segregated differential protection
- Zero-sequence current differential protection for high resistance earth faults
- Charging current compensation
- Backup distance protection with independent three forward and one reverse zone
- Backup directional earth fault command protection with forward and reverse looking element
- Overcurrent backup protection
- Overvoltage protection
- Thermal overload protection
- Stub fault protection for one-and-a-half busbar system
- Transfer tripping
- Out-of-step protection
- Broken conductor detection
- Breaker failure protection
- Fail-safe overcurrent scheme
- Autoreclose function
- CT fail detection
- Accurate fault location using all terminal currents and voltages
- Configurable binary inputs and outputs
- Programmable logic for I/O configuration, alarms, indications, recording, etc.
- Automatic monitoring
- Metering and recording functions
- Menu-driven user interfaces
- RS232C port for a local PC and RS485, Fibre optic or Ethernet LAN serial ports for a remote PC
- IRIG-B port for external clock
- The IEC60870-5-103 protocol is provided for communication with substation control and automation systems.

APPLICATION

GRL100 provides high-speed and phase-segregated line differential protection for use with telecommunication systems.

For telecommunication systems, dedicated optical fibre, 64 kbps multiplexed communication channels or microwave links are employed.

GRL100 system is a master/master design. Each terminal has a differential calculation function and performs arithmetical operation independently and simultaneously.

GRL100 measures the transmission delay automatically and compensates the delay time continuously to perform correct differential calculation.

The relay can be applied in various EHV/HV network configurations.

- Overhead lines or underground cables
- Two-terminal or three-terminal lines
- Lines with weak or no-infeed
- Single or parallel lines
- Lines with heavy load current
- Short or long distance lines

GRL100 provides the following protection schemes:

- Phase-segregated current differential protection (DIF) provides high reliability and security for diverse faults including single-phase and multi-phase faults and double-faults on double-circuit lines and developing faults.
- Zero-sequence current differential protection (DIFG) enables sensitive protection for high impedance earth faults.
- Distance protection provides three forward and one reverse protection zone for phase and earth faults.
- Directional earth fault protection provides protection for earth fault with carrier scheme protection.
- Non-directional overcurrent backup protection provides both inverse time overcurrent and definite time overcurrent protection for phase faults and earth faults.
- Thermal overload protection provides protection for cables and other plants
- Stub fault protection for one-and-a-half breaker scheme
- Out-of-step protection performs phase comparison of the local and remote voltages and operates only when the out-of-step loci cross the protected line.
- Breaker failure protection provides a re-tripping and/or backup tripping function for circuit breaker failure.

For current differential protection, a charging current compensation function is provided.

For through-fault current in one-and-a-half circuit breaker configurations, a countermeasure for CT saturation is provided. (Model 503 and 513)

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GRL100 can provide high-speed single-shot autoreclose or multi-shot autoreclose.

GRL100 provides the following metering and recording functions:

- Metering
- Fault recording
- Event recording
- Fault location
- Disturbance recording

GRL100 provides the following user interfaces for relay setting or viewing stored data:

- Relay front panel: LEDs, LCD display and operation keys
- Local PC

- Remote PC

The relay can be accessed from a local PC or a remote PC through communication ports.

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, Ethernet LAN port (TCP/IP) can be provided.

Table 1 and Table 2 show all of the functions that can be incorporated in GRL100 models applied to two-terminal line and three-terminal line or two terminal line with dual communication.

Table 1: Relay model and function

Model	10X / 11X	20X / 21X	30X / 31X	40X / 411	501 / 511	503 / 513	70X / 71X
DIF	x	x	x	x	x	x	x
DIST							x
DEF							x
ARC		1CB	2CB	1CB	2CB	2CB	1CB/2CB
FD				x	x	x	
TFC						x	
DIFG		x	x	x	x	x	x
CCC		x	x	x	x	x	x
BF		x	x	x	x	x	x
OST		x	x	x	x	x	x
FL		x	x	x	x	x	x
OV							x

Model X0X: For two-terminal end application

Model X1X: For three-terminal end application or two-terminal end application with dual communication

Legend		
	DIF:	Phase-segregated current differential protection
	DIST:	Backup distance protection
	DEF	Directional earth fault protection
	ARC:	Autoreclose
	FD:	Fault detector provided with independent MPU and trip contact for fail-safe function
	TFC:	Through-fault current countermeasure
	DIFG:	Zero-phase current differential protection
	CCC:	Charging current compensation
	BF:	Breaker failure protection
	OST:	Out-of-step protection
	FL:	Fault locator
	OV:	Overvoltage protection

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RELAY FUNCTIONS

■ Phase-segregated Current Differential Protection

GRL100 provides high-speed phase-segregated current differential protection for both phase-to-phase faults and phase-to-earth faults. The phase-segregated current differential protection exhibits high selectivity and sensitivity for various types of faults. It has the percentage ratio differential characteristic as shown in Figure 1.
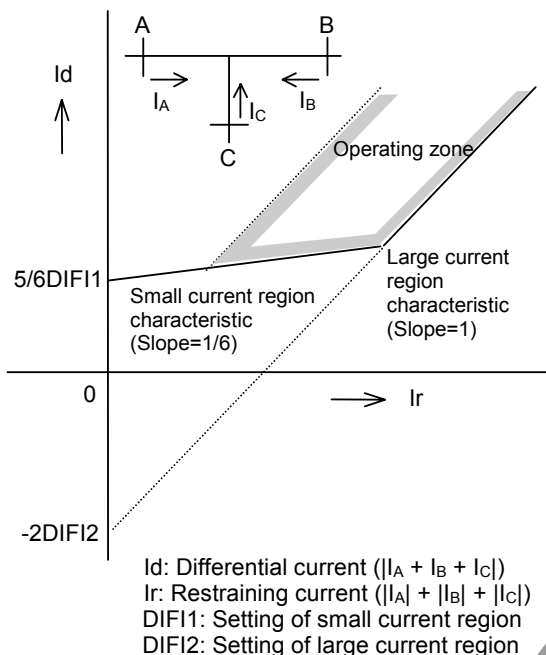

Id: Differential current ($|I_A + I_B + I_C|$)
Ir: Restraining current ($|I_A| + |I_B| + |I_C|$)
DIFI1: Setting of small current region
DIFI2: Setting of large current region

Figure 1 Percentage ratio differential element

The characteristic is composed of a small current region and a large current region. When the fault current is large, a large ratio is employed in the large current region of the characteristic since it is affected by CT saturation.

Since a high level of sensitivity can be attained with the current differential relay, it can also detect high impedance faults provided that the load current is not too large.

■ Zero-sequence Current Differential Protection for High Impedance Earth Faults (Models 200 through 700)

Zero-sequence current differential protection can detect high impedance earth faults even with heavy load current. It has the percentage ratio differential characteristic shown in Figure 2. As the restraining current is the scalar sum of the zero-sequence current at each terminal, the relay sensitivity is not affected by load current. When the zero-sequence current differential protection operates, it performs time-delayed three- phase tripping.
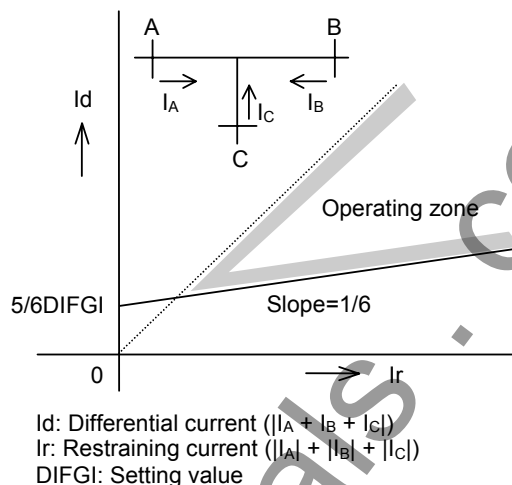

Id: Differential current ($|I_A + I_B + I_C|$)
Ir: Restraining current ($|I_A| + |I_B| + |I_C|$)
DIFGI: Setting value

Figure 2 Zero-phase current differential element

■ Charging Current Compensation (Models 200 through 700)

When current differential protection is applied to underground cables or long-distance overhead lines, the charging current of the lines cannot be ignored. It appears as an erroneous differential current in the no-fault condition and under external fault conditions. If the charging current is included within the setting, the fault detection sensitivity deteriorates for an internal fault.

To suppress the effect of the charging current and maintain its high fault detection sensitivity, the GRL100 has a charging current compensation function which derives the charging current component from the phase current.

The amplitude of the charging current varies with that of the running voltage of the line. When the value of charging current (DIFIC) at the rated voltage is input, the GRL100 calculates and compensates the charging current at the running voltage.

Thus, instead of the phase current Ia, a compensated current I = Ia - DIFIC is used for protection at all terminals.

■ Dual Communication

Three-terminal application models have dual communication mode. By connecting the remote terminal with dual communication routes, even if one of the routes fails, it is possible to continue sampling synchronization and protection by the current differential relay.
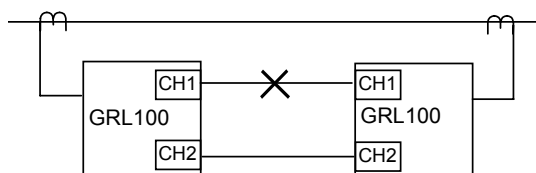

Figure 3 Dual Communication

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■ Countermeasure for Through- Fault Current (Model 503 and 513)

As shown in Figure 4, for an external fault on a one-and-a-half busbar system, a large fault current I_A flows through $CT1_A$ and $CT2_A$. If the saturation levels of $CT1_A$ and $CT2_A$ are different, an erroneous differential current may occur between I_{A1} and I_{A2} as a result of CT saturation.

This may cause terminal B to operate incorrectly if it is a weak infeed terminal and the restraining current is small.

To cope with the through-fault current, GRL100 can be set to output tripping commands under the condition that the differential protection operates at both terminals.
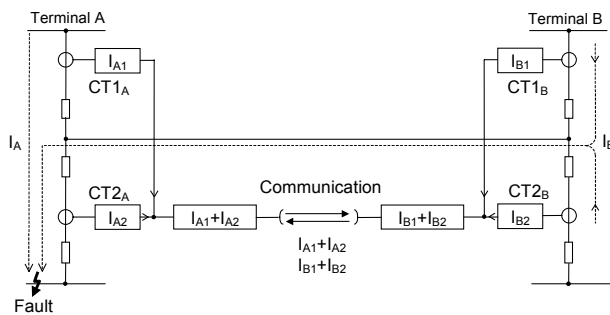
Figure 4 Through-fault current on one-and-a-half busbar system

■ Stub Protection

Stub protection operates for a fault in a stub zone on one-and-a-half busbar system. With the auxiliary contact of the line disconnector open, only the local terminal current is used as the operating quantity by setting the remote terminal current data to zero.

■ Transfer Trip Function

GRL100 provides a transfer trip function which receives a trip signal from the remote terminal and outputs a trip command. Two transfer trip commands are provided. The sending signal is configured by PLC function. If the sending signal is assigned on a per phase basis by PLC, single-phase tripping is available.

■ Out-of-Step Protection (Models 200 through 700)

By transmitting the phase information of the local voltage to the remote terminal, the out-of-step protection can measure the phase difference between the terminals of a transmission line. It detects an out-of-step condition when the difference in the phase angle exceeds $180°$ and trips both terminals.

The out-of-step protection can detect an out-of-step condition even with a high rate of slip.
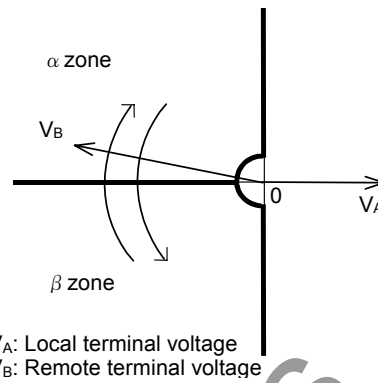
V_A: Local terminal voltage
V_B: Remote terminal voltage

Figure 5 Out-of-step protection element

■ Fail-safe OC/OCD/EFD Scheme

GRL100 provides OC, OCD and EFD elements for fail-safe to prevent unwanted operation caused by error data in communication failure. OC is a phase overcurrent element, OCD is a phase current change detection element, and EFD is a zero-sequence current change detection element.

■ Backup Distance Protection (Model 700)

GRL100 provides backup distance protection scheme to keep reliable line protection under loss or failure of telecommunication channel. It provides independent three zones for forward and one zone for reverse faults protection. The characteristics are shown in the Figure 6 and 7. Individual measurement zone is provided for phase-fault and earth-fault.
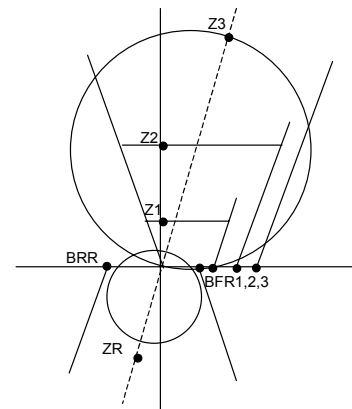
(a) Phase fault measuring element
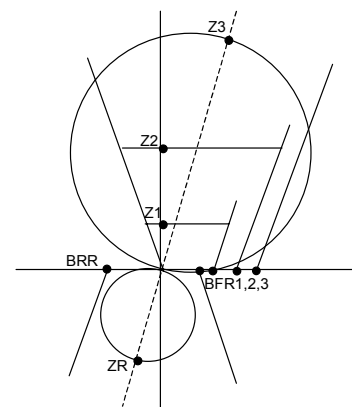
(b) Earth fault element
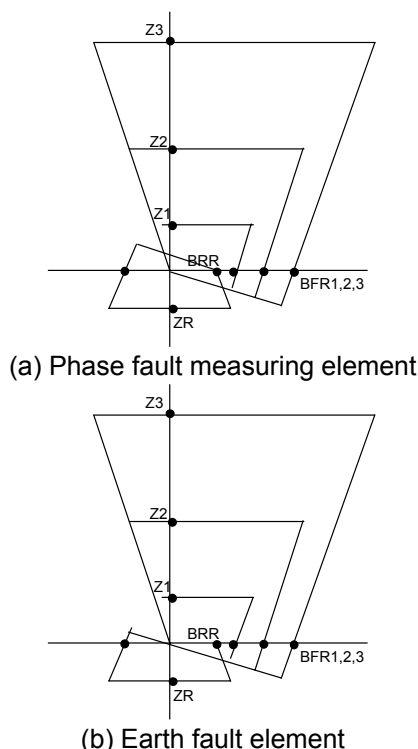
Figure 6 Mho-based characteristics

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(a) Phase fault measuring element

(b) Earth fault element

Figure 7 Quadrilateral Characteristics

■ **Directional Earth Fault Protection (Model 700)**

The GRL100 (model 700) provides directional earth fault protection. Both forward and reverse looking elements are available for inverse time or definite time operation. The system residual voltage is used as the polarizing signal. The residual voltage is obtained by direct measurement or derived internally from the three phase-to-neutral voltages.

The directional earth fault elements have a user selectable minimum voltage threshold.

DEF protection using telecommunication is provided with forward and reverse looking DEF element.
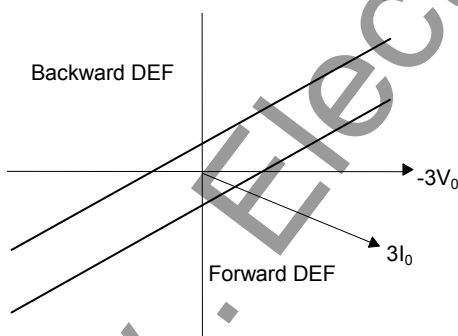
The characteristics are shown in Figure 8.

Figure 8 Directional Earth Fault Characteristics

■ **Broken Conductor Protection**

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

■ **Breaker Failure Protection (Models 200 through 700)**

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 back trip 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 back trip following a successful trip or re-trip action.

■ **Non-Directional Overcurrent Backup Protection**

GRL100 provides inverse time and definite time overcurrent protections for both phase faults and earth faults.

Inverse time overcurrent protection consists of an IDMT (inverse definite minimum time) element. IDMT 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 9.

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 is enabled by the instantaneous overcurrent element and pickup-delay timer.

Tripping by each element can be disabled by the scheme switches, and overcurrent backup protection can be blocked by a binary input signal.

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

■ **Overvoltage Protection (Model 700)**

GRL100 (Model 700) provides two-stage phase ovevoltage protection. The first stage threshold is set for inverse time or definite time operation, and the second threshold are for definite time operation.
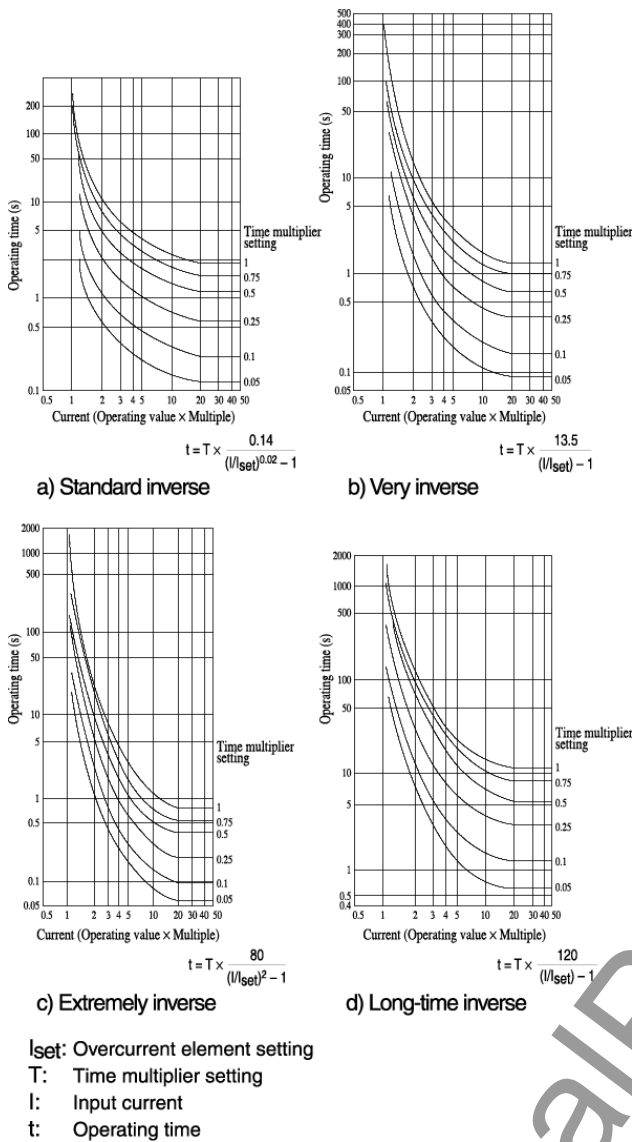
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$$t = T \times \frac{0.14}{(I/I_{set})^{0.02} - 1}$$

a) Standard inverse

$$t = T \times \frac{13.5}{(I/I_{set}) - 1}$$

b) Very inverse

$$t = T \times \frac{80}{(I/I_{set})^2 - 1}$$

c) Extremely inverse

$$t = T \times \frac{120}{(I/I_{set}) - 1}$$

d) Long-time inverse

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

Figure 9 IDMT operating time characteristics

■ 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 GRL100 issues a trip according to the 'cold' and 'hot' curves specified in IEC60255-8 (see Figure 10), 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.
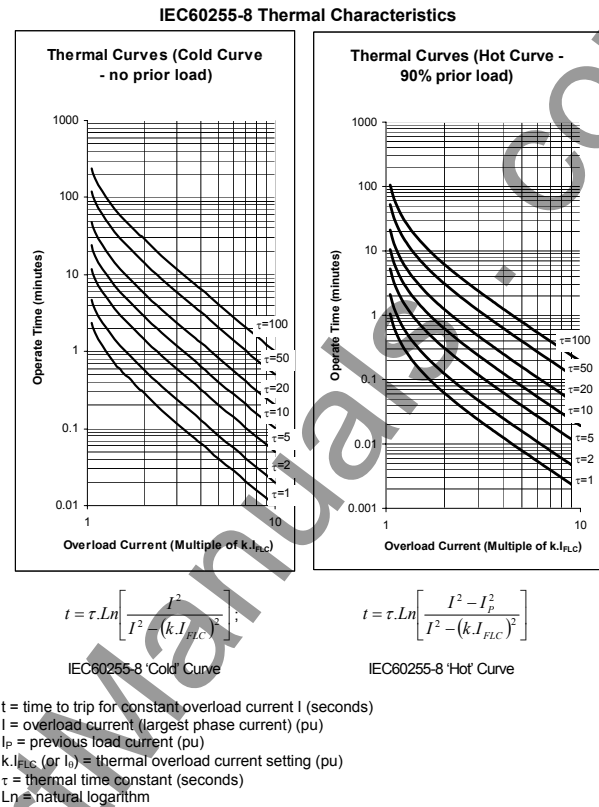
IEC60255-8 Thermal Characteristics

$$t = \tau . Ln\left[\frac{I^2}{I^2 - (k.I_{FLC})^2}\right]$$

IEC60255-8 'Cold' Curve

$$t = \tau . Ln\left[\frac{I^2 - I_P^2}{I^2 - (k.I_{FLC})^2}\right]$$

IEC60255-8 'Hot' Curve

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_θ) = thermal overload current setting (pu)
τ = thermal time constant (seconds)
Ln = natural logarithm

Figure 10 IEC60255-8 Thermal characteristics

■ Autoreclose (Models 200 through 700)

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. GRL100 provides two autoreclose schemes, single-shot autoreclose and multi-shot autoreclose.

■ Single-shot autoreclose

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

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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. The characteristics of the synchronism check element are shown in Figure 11.
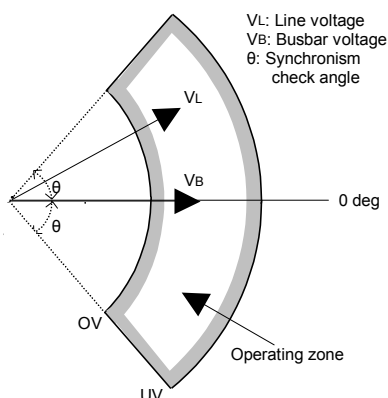

Figure 11 Synchronism check element

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 busbar system (Model 300, Model 500)

GRL100 performs two-breaker autoreclose in a one-and-a-half breaker configuration.

Single-shot autoreclose is only available in Models 300 and 500. Single-phase autoreclose, three-phase auto- reclose, single and three-phase autoreclose or multi- phase autoreclose can be applied to the two circuit breakers. The autoreclose scheme is different depending on the reclosing mode.

■ 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, GRL100 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

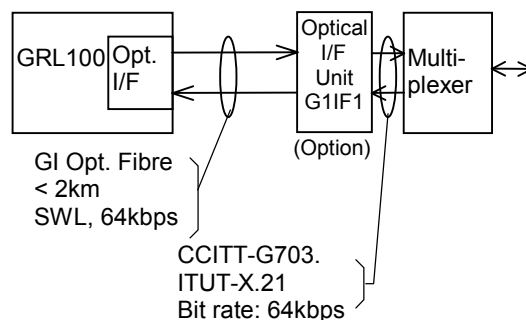## ■ Interfaces with Telecommunication Systems

Current data sampled at the local terminal is transmitted to the remote terminal(s) via the telecommunication system.

GRL100 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).
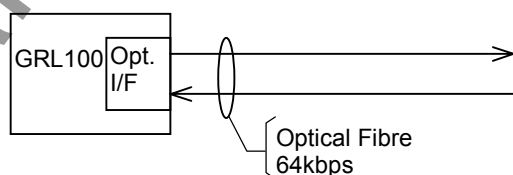
a) Optical interface

b) Optical interface using multiplexer
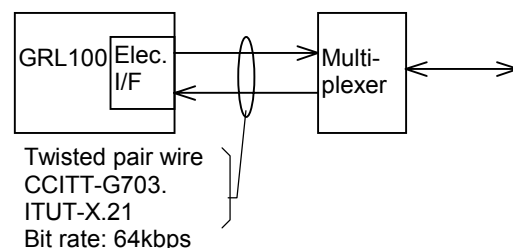
c) Electrical interface using multiplexer

Figure 12 Telecommunication system

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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.

- Local and remote terminal currents (phase, phase to phase, symmetrical components)
- Differential current and restraint current
- Voltages (phase, phase to phase, symmetrical components)
- Voltage phase differential between both terminals of the transmission line
- Active power and reactive power
- Frequency
- Data transmission delay time

Currents, voltages and differential current 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. 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 with operation of the current differential protection.

The fault locator measures the distance to fault on the protected line utilizing both the local and remote current & voltages. In principle, this method of measurement is free from the errors that are inherent with the standard impedance measuring method normally employed.

Fault location is indicated in km and % for the whole length of the protected line. The result of fault location calculation is stored as fault record data.

■ Disturbance Record

The relay can record 19 analog signals and 32 binary signals. The disturbance recorder is initiated by operation of the overcurrent element, undervoltage element or relay tripping.

In respect to analog data, the local phase current and voltage, remote phase current and the local and remote zero sequence current are recorded.

Pre-fault recording time is fixed at 300ms, post-fault recording time can be set from 100ms to 3s. 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 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, 4 line LCD with back light
- 8 Light Emitting Diodes (LED) including 4 that are configurable
- Operation keys
- RS232C port
- Monitoring jacks

Figure 13 shows the 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 message detected by the automatic supervision

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Figure 13 Relay front panel

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 LCD menu.

■ Local PC

The user can communicate with the GRL100 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 & Fault records
- Disturbance records
- Fault location

■ Relay Setting and Monitoring (RSM)

GRL100 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).

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

The RSM100 software is used to access to 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.
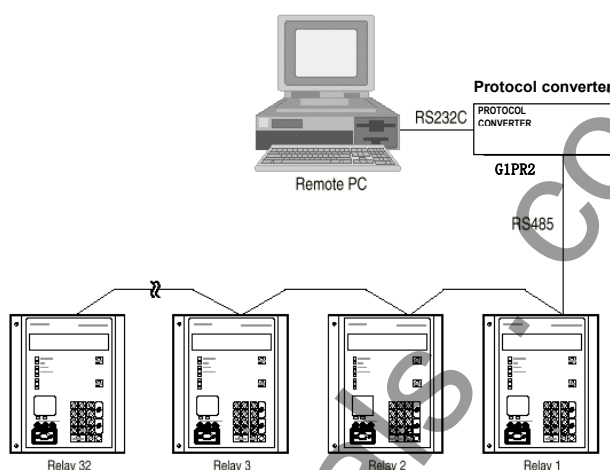

Figure 14 Relay setting and monitoring system

■ 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 the settings using the operation keys on the relay fascia or via a local or remote PC with the RSM100 software.

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

GRL100 is provided with 13 to 37 (non fault detector model), or 31 (with fault detector model) user configurable normally open output contacts used for indication and alarm. The number of outputs varies according to the relay model.

■ Configurable Binary Inputs

GRL100 is provided with 18 to 31 user configurable binary inputs.

The number of inputs varies according to the relay model.

The binary input circuits are provided with a logic level inversion function.

■ PLC Function

GRL100 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.

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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
- Differential current
- Analog-to-digital converter
- Watch Dog Timer
- Binary output circuits
- DC power supply circuits
- CPU
- Telecommunication circuit
- Synchronisation control circuit
- Relay address monitoring

■ 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.
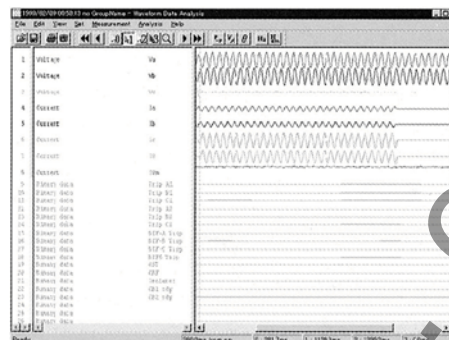
Waveform data analysis
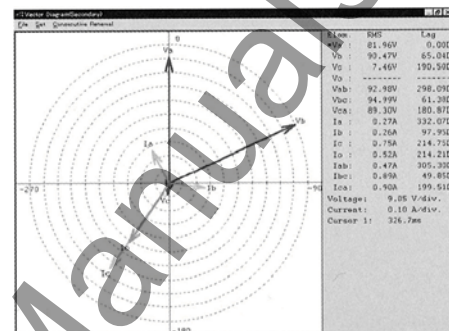
Vector diagram

PC DISPLAY

Fault record

Metering

TOSHIBA CORPORATION

GRL100

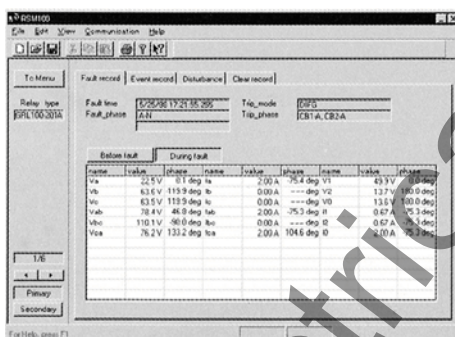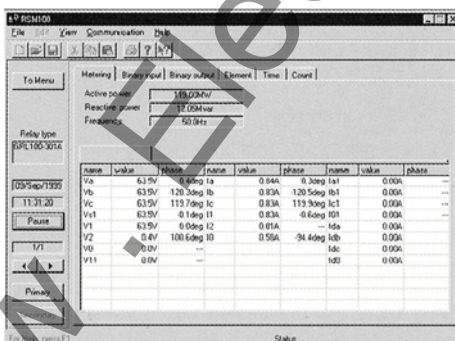| Ratings	
AC current I_n:	1A or 5A
AC voltage	100V, 110V, 115V, 120V
Frequency:	50Hz or 60Hz
DC power supply:	110Vdc/125Vdc (Operative range: 88 - 150Vdc) 220Vdc/250Vdc (Operative range: 176 - 300Vdc) 48Vdc/54Vdc/60Vdc (Operative range: 38.4 - 72Vdc)
AC ripple on DC supply IEC60255-11	maximum 12%
DC supply interruption IEC60255-11	
Permissive duration of DC supply voltage interruption to maintain normal operation:	up to 50ms at 110V
Restart time:	less than 10s
Binary input circuit DC voltage:	110/125Vdc 220/250Vdc 48/54/60Vdc
Overload Ratings	
AC current input	4 times rated continuous 100 times rated for 1s
AC voltage input	2 times rated continuous
Burden	
AC current input	0.2VA per phase (at rated 5A) 0.4 VA at zero-sequence circuit (at rated 5A) 0.1VA per phase (at rated 1A) 0.3 VA at zero-sequence circuit (at rated 1A)
AC voltage input	0.1VA (at rated voltage)
DC power supply:	less than16W (quiescent) less than 25W (operation)
Binary input circuit:	≤ 0.5W per input at 110Vdc
Phase-segregated Current Differential Protection	
DIFI1 (Small current region)	0.10 to 2.00A in 0.01A steps (1A relay) 0.50 to 10.00A in 0.01A steps (5A relay)
DIFI2 (Large current region)	0.6 to 24.0A in 0.1A steps (1A relay) 3.0 to 120.0A in 0.1A steps (5A relay)
Operating time	less than 1 cycle at 300% of DIFI1
Resetting time	less than 110ms (for tripping output) less than 40ms (for signal output)
Zero-sequence Current Differential Protection for high-resistance earth	
DIFGI	0.05 to 1.00A in 0.01A steps (1A relay) 0.25 to 5.00A in 0.01A steps (5A relay)
Timer	0.00 to 10.00s in 0.01s steps
Operating time	less than 45ms
Resetting time	less than 100ms
Charging Current Compensation	
DIFIC	0.00 to 1.00A in 0.01A steps (1A relay) 0.00 to 5.00A in 0.01A steps (5A relay)
Differential Current Supervision	
DIFSV	0.05 to 2.00A in 0.01A steps (1A relay) 0.25 to 10.00A in 0.01A steps (5A relay)
Timer	0 to 60s in 1s steps

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Telecommunication Interface for current differential protection	
Bit rate	64kbs
Transmission format	IEC60870-5-1
Electrical interface (Telecomm. equipment link)	
Applicable standard	CCITT-G703-1.2.1 CCITT-G703-1.2.2 or 1.2.3 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

Phase Fault Distance Measuring Element	
Z1S, Z2S	0.10 to 250.00Ω in 0.01Ω steps (1A relay) 0.01 to 50.00Ω in 0.01Ω steps (5A relay)
Z3S and Z4S	0.1 to 250.0Ω in 0.1Ω steps (1A relay) 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) 1.5Ω fixed (5A relay)
Blinder (BFRS1/2/3 BRRS)	0.1 to 250.0Ω in 0.1Ω steps (1A relay) 0.01 to 50.00 in 0.01Ω steps (5A relay)
BRLS: Linked with BRRS	
Characteristic angle (BFRS1/2/3, BRRS)	75° fixed
Characteristic angle (BFLS)	90° to 135°

Earth Fault Distance Measuring Element	
Z1G, Z2G	0.10 to 250.00Ω in 0.01Ω steps (1A relay) 0.01 to 50.00Ω in 0.01Ω steps (5A relay)
Z3G and Z4G	0.1 to 500.0Ω in 0.1Ω steps (1A relay) 0.01 to 100.00 in 0.01Ω steps (5A relay)
Characteristic angle	45° to 90° in 1° steps
Blinder (BFRG1/2/3, BRRG)	0.5 to 100.0Ω in 0.1Ω steps (1A relay) 0.10 to 20.00Ω in 0.01Ω steps (5A relay)
BRLG: Linked with BRRG	
Characteristic angle (BFRG1/2/3, BRRG)	75° fixed
Characteristic angle (BFLG)	90° to 135°

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Directional Earth Fault Protection	
E/F 1st Overcurrent threshold:	OFF, 0.02 – 5.00A in 0.01A steps (1A rating)
	OFF, 0.1 – 25.0A in 0.1A steps (5A rating)
Delay type:	DTL, IEC NI, IEC VI, IEC EI,
IDMTL Time Multiplier Setting TMS:	0.010 – 1.500 in 0.001 steps
DTL delay:	0.00 – 300.00s in 0.01s steps
E/F 2nd threshold:	OFF, 0.02 – 5.00A in 0.01A steps (1A rating)
	OFF, 0.1 – 25.0A in 0.1A steps (5A rating)
DTL delay:	0.00 – 300.00s in 0.01s steps
E/F Characteristic angle:	0° to +95° in 1° steps
E/F directional voltage threshold:	0.5 – 100.0V in 0.1V steps

Inverse Time Overcurrent Protection	
OCI (for phase fault protection)	0.10 to 5.00A in 0.01A steps (1A relay)
	0.5 to 25.0A in 0.1A steps (5A relay)
OCI time multiplier	0.05 to 1.00 in 0.01 steps
OCI characteristic	Standard / Very / Extremely / Long-time inverse
Reset time delay	0.0 to 10.0s in 0.1s steps
EFI (for earth fault protection)	0.10 to 1.00A in 0.01A steps (1A relay)
	0.5 to 5.0A in 0.1A steps (5A relay)
EFI time multiplier	0.05 to 1.00 in 0.01 steps
EFI characteristic	Standard / Very / Extremely / Long-time inverse
Reset time delay	0.0 to 10.0s in 0.1s steps

Definite Time Overcurrent Protection	
OC (for phase fault protection)	0.1 to 20.0A in 0.1A steps (1A relay)
	0.5 to 100.0A in 0.1A steps (5A relay)
OC time delay	0.00 to 10.00s in 0.01s steps
EFI (for earth fault protection)	0.10 to 1.00A in 0.01A steps (1A relay)
	0.5 to 5.0A in 0.1A steps (5A relay)
EF time delay	0.00 to 10.00s in 0.01s steps

Overvoltage Protection	
1st, 2nd Overvoltage thresholds:	OFF, 10.0 – 150.0V in 0.1V steps
Delay type (1st threshold only):	DTL, IDMTL
IDMTL Time Multiplier Setting TMS:	0.05 - 100.00 in 0.01 steps
DTL delay:	Inst, 0.01 - 300.00s in 0.01s steps

Thermal overload Protection	
Thermal setting (THM = k.I_{FLC})	OFF, 0.40 – 2.00A in 0.01A steps (1A rating)
	OFF, 2.0 – 10.0A in 0.1A steps (5A rating)
Time constant (τ)	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)
	0.0 – 5.0A in 0.1A steps (5A rating)

Stub Protection	
Stub	ON / OFF

Breaker Failure (BF) Protection	
Overcurrent element	0.1 to 2.0A in 0.1A steps (1A relay)
	0.5 to 10.0A in 0.1A steps (5A relay)
Reset	less than 80% of operating value
BF timer for retry-trip of failed circuit breaker	50 to 500ms in 1ms steps
BF timer for adjacent circuit breaker tripping	50 to 500ms in 1ms steps
Operating time of overcurrent element	less than 20ms at 50Hz or 17ms at 60Hz
Resetting time of overcurrent element	less than 15ms at 50Hz or 13ms at 60Hz

TOSHIBA CORPORATION

GRL100

Accuracy	
Current differential protection: pick-up	$\pm5\%$ ($\pm7\%$ at I $<$ 0.3$\times$In)
Inverse time overcurrent characteristics	$\pm5\%$ or 30ms(1.5 to 30 times setting)
Definite time overcurrent protection: pick-up	$\pm5\%$
Overcurrent element for BF: pick-up	$\pm5\%$
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 system	
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	60 to 150V in 1V steps
OV element	10 to 100V in 1V steps
Busbar or line dead check	10 to 100V in 1V steps
Busbar or line live check	10 to 100V 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
Fault Detector	
Multi-step overcurrent element	L1: 0.10A, L2: 0.16A, L3: 0.26A, L4: 0.41A, L5: 0.66A, L6: 1.05A, L7: 1.68A (1A relay)
	L1: 0.50A, L2: 0.80A, L3: 1.28A, L4: 2.05A L5: 3.28A, L6: 5.24A, L7: 8.39A (5A relay)
Current change detection element	0.1 times rated current
Earth fault overcurrent element	0.1 times rated current
Undervoltage element for earth fault	46V
Undervoltage element for phase fault	80V
Undervoltage change detection element	0.07 times voltage before fault
Fault Locator	
Line resistance and reactance settings	0.0 to 999.9Ω in 0.1Ω steps (1A relay) 0.00 to 199.99Ω in 0.01Ω steps (5A relay)
Line length	0.0 to 399.9km in 0.1km steps
Accuracy	
Two terminal	±1km (up to 100km) or $\pm1\%$ (up to 399.9km at DIFI=0.5In setting and Id=2In
Three terminal	±2km (up to 100km) or $\pm2\%$ (up to 399.9km at DIFI=0.25In setting and Id=2In
Minimum measuring cycles	2 cycles

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Disturbance Record Initiation	
Overcurrent element	0.1 to 50.0A in 0.1A steps (1A relay)
	0.5 to 250.0A in 0.1A steps (5A relay)
Undervoltage element	0 to 132V in 1V steps (for phase fault)
	0 to 76V in 1V steps (for earth fault)
Pre-fault time	0.3s (fixed)
Post-fault time	0.1 to 3.0 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-sub miniature 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
	Typical 138Vdc(min.125Vdc) for 220V/250Vdc rating
	Typical 31Vdc(min.28Vdc) for 48V/54V/60Vdc rating
	Typical 15Vdc(min.14Vdc) for 24Vdc rating

Contact Ratings	
Trip contacts	
Make and carry	5A continuously,
	30A, 290Vdc for 0.5s (L/R=10ms)
Break	0.15A, 290Vdc (L/R=40ms)
Auxiliary contacts	
Make and carry	4A continuously,
	10A, 220Vdc for 0.5s (L/R$\geq$5ms)
Break	0.1A, 220Vdc (L/R=40ms)
Durability	
Make and carry	10,000 operations minimum
Break	100,000 operations minimum

Mechanical design	
Weight	11kg (Type-A), 14kg (Type-B)
Case colour	Munsell No. 10YR8/0.5
Installation	Flush mounting or rack mounting

CT Requirement

The CT knee point voltage Vk is required as follows:

$$Vk \geq If \times (X/R \times (1-\exp(-t/T))+1) \times (Rct + Rl + Pr / In^2) / N$$

If: Max Primary Fault Current(A)	X/R: System X/R Ratio	
T: Time Constant (sec)	t: : Operating time	
Rct: CT Secondary Resistance(Ω)	Rl : CT Lead loop Resistance(Ω)	Pr: Relay Burden(VA)
In: CT Secondary Current Rating(A)	N: Ct ratio	

TOSHIBA CORPORATION

GRL100

ENVIRONMENTAL PERFORMANCE

Test	Standards	Details
Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. 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 Endurance - Class 1
Shock and Bump	IEC60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC60255-21-3	Class 1
Electrical Environment		
Dielectric Withstand	IEC60255-5	2kVrms for 1 minute between all terminals and earth. 2kVrms for 1 minute between independent circuits. 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. 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: HV ports: 2kV/1kV (peak) PSU and I/O ports: 2kV/1kV (peak) 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. 150V 50Hz for 10s applied to ports in differential mode. Not applicable to AC inputs.
Conducted and Radiated Emissions	IEC60255-25, EN55022 Class A, IEC61000-6-4 / EN61000-6-4	Conducted emissions: 0.15 to 0.50MHz: <79dB (peak) or <66dB (mean) 0.50 to 30MHz: <73dB (peak) or <60dB (mean) Radiated emissions (at 30m): 30 to 230MHz: <30dB 230 to 1000MHz: <37dB
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.

TOSHIBA CORPORATION

GRL100

Optical Interface Unit G1IF1 (Option)

Ratings		

Power supply:		110Vdc/125Vdc
		  (Operative range: 88 - 150Vdc of 110Vdc rated voltage
		220Vdc/250Vdc
		  (Operative range: 170 - 300Vdc of 220Vdc rated voltage
		48Vdc (Operative range: 38.4 - 72Vdc)

Burden:		less than 8W
Interface		
Communication interface:		CCITT-G703-1.2.1 CCITT-G703-1.2.2 or 1.2.3 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. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP40 (excluding terminal parts)

GPS Receiver Unit HHGP1 (Option)

Ratings		
Power supply:		48Vdc (Operative range: 38.4 - 72Vdc)
Burden:		less than 8W
Receiving Function		
Number of receiving satellites:		Eight satellites received in parallel
Receive signals:		L1 C/A code
Receive frequency:		1575.42 MHz
Time transfer accuracy		Within±2μs with respect to UTC（When the receiver is tracking GPS Satellites.
Data Backup		
Data life:		more than 16 hours
Communication Interface		
Connection:		ST connector
Cable type:		GI multimode optical fibre (62.5/125μm or 50/125μm)
Wavelength:		820nm
Cable Length:		0 to 1km (3dB/km)
GPS Antenna Interface		
Preamp power supply for Antenna:		Min 4.5V(at 20mA), Min 4.0V(at 40mA)
Connection:		BNC connector
Cable type:		50 ohm coaxial cable
GPS Antenna		
NF:		Max 3dB
Gain:		10 to 35dB(Antenna + Amp + Cable)
Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP40 (excluding terminal parts)

TOSHIBA CORPORATION

GRL100

Protocol Converter G1PR2 (Option)

Ratings	

Power supply:	110Vdc/100Vac
	  (Operative range: 88 - 150Vdc of 110Vdc rated voltage,
	                          80 - 120Vac of 100Vac rated voltage)
	220Vdc/200Vdc
	  (Operative range: 170 - 300Vdc of 220Vdc rated voltage,
	                          200 - 240Vac of 200Vac rated voltage.)
	48Vdc (Operative range: 38.4 - 72Vdc)

Burden:	less than 20W
Interface	
Interface:	RS485 or Optical interface
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
Contact Ratings	
Auxiliary contacts	
Make and carry	4A continuously, 10A, 220Vdc for 0.5s (L/R$\geqq$5ms)
Break	0.1A, 220Vdc (L/R=40ms)
Durability	
Make and carry	10,000 operations minimum
Break	100,000 operations minimum

Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP20

TOSHIBA CORPORATION

GRL100

1. Line Differential Protection Relay
a. Two-terminal application

GRL100 – ☐ B– ☐☐ – ☐☐
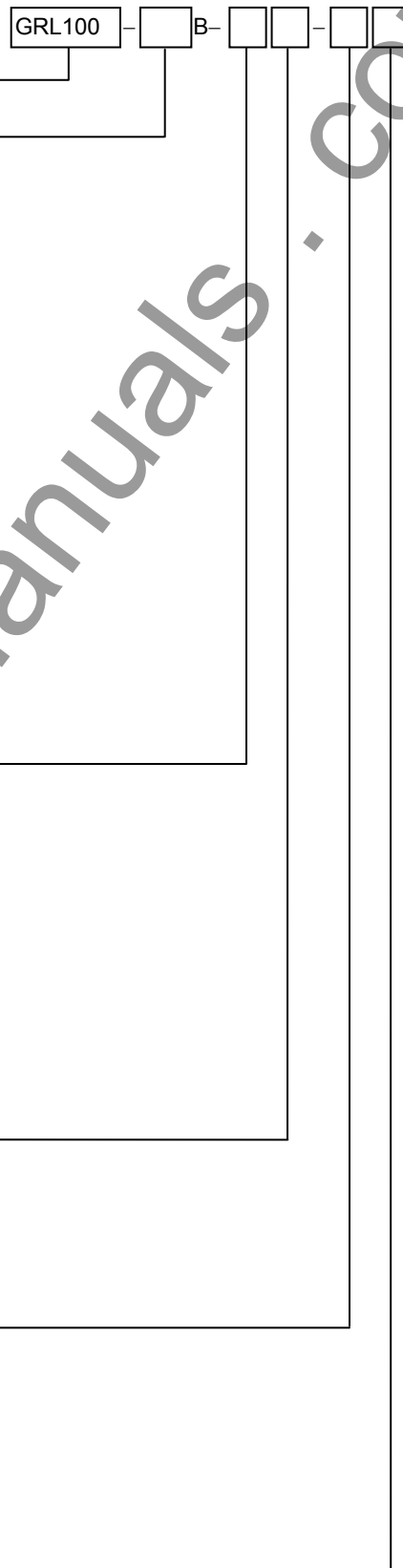
Relay Type:	
Line differential protection relay	GRL100
Relay Model:	
-Model100: No autoreclose	
18 BIs, 13 BOs, 6 trip BOs	101
18 BIs, 23 BOs, 6 trip BOs	102
-Model200: With autoreclose for single breaker scheme	
25 BIs, 19 BOs, 6 trip BOs	201
31 BIs, 37 BOs, 6 trip BOs	202
22 BIs (12-independent), 19 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	
25 BIs, 19 BOs, 6 trip BOs	301
31 BIs, 37 BOs, 6 trip BOs	302
-Model400: With autoreclose for single breaker scheme and redundant fault detector scheme	
28 BIs, 31 BOs, 6 trip BOs	401
-Model500: With autoreclose for one and a half breaker scheme and redundant fault detector scheme	
28 BIs, 31 BOs, 6 trip BOs	501
28 BIs, 31 BOs, 6 trip BOs	503
-Model700: With autoreclose and backup distance protection scheme	
25 BIs, 19 BOs, 6 trip BOs	701
31 BIs, 37 BOs, 6 trip BOs	702
Note: Model 503 has countermeasure for through-fault current.	
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
Note: Additional 24Vdc rating option is available	
Differential relay communication interface:	
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:	
RS485	1
Fibre optic	2
Dual RS485	3
Dual fibre optic	4
RS485 + Fibre optic	9
Note:	
Fibre optic is available for model 206, 302, 401, 501 and 503	
10BASE-T option is available for specific configuration	
Miscellaneous	
None	0
GPS optical Input (for model 204, 206, 302, 401, 501, 503)	1

Note: Please inform us which is ordered panel surface 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

Terminal A   Terminal B

GRL100 ← Communication route → GRL100

TOSHIBA CORPORATION

GRL100

–☐☐B–☐☐☐–☐☐

b. Dual channel or Three-terminal application

Relay Type:	
Line differential protection relay	GRL100
Relay Model:	
-Model100: No autoreclose	
18 BIs, 13 BOs, 6 trip BOs	111
18 BIs, 23 BOs, 6 trip BOs	112
-Model200: With autoreclose for single breaker scheme	
25 BIs, 19 BOs, 6 trip BOs	211
31 BIs, 37 BOs, 6 trip BOs	212
22 BIs (12-independent), 19 BOs, 3 trip BOs	214
28 BIs (12-independent), 37 BOs, 3 trip BOs	216
-Model300: With autoreclose for one and a half breaker scheme	
25 BIs, 19 BOs, 6 trip BOs	311
31 BIs, 37 BOs, 6 trip BOs	312
-Model400: With autoreclose for single breaker scheme and redundant fault	
detector scheme	
28 BIs, 31 BOs, 6 trip BOs	411
-Model500: With autoreclose for one and a half breaker scheme and	
redundant fault detector scheme	
28 BIs, 31 BOs, 6 trip BOs	511
28 BIs, 31 BOs, 6 trip BOs	513
-Model700: With autoreclose and backup distance protection scheme	
25 BIs, 19 BOs, 6 trip BOs	711
31 BIs, 37 BOs, 6 trip BOs	712
Note: Model 513 has countermeasure for through-fault current.	
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
Note: Additional 24Vdc rating option is available	
Differential relay communication interface:	
Electrical interface (CCITT-G703-1.2.1) ×2	1
Electrical interface (CCITT-G703-1.2.2 or 1.2.3) ×2	2
Optical interface(Short wavelength light: GI: 2km class) ×2	3
Optical interface(Long wavelength light: SM: 30km class) ×2	5
Optical interface(Long wavelength light: SM: 80km class) ×2	7
Electrical interface (RS530, X.21) ×2	9
Optical I/F (2km class) + Optical I/F (30km class)	G
Optical I/F (2km class) + Optical I/F (80km class)	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 216, 312, 411, 511 and 513	
10BASE-T option is available for specific configuration	
Miscellaneous	
None	0
GPS optical Input (for model 216, 312, 411, 511 and 513)	1

Note: Please inform us which is ordered panel surface 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

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GRL100
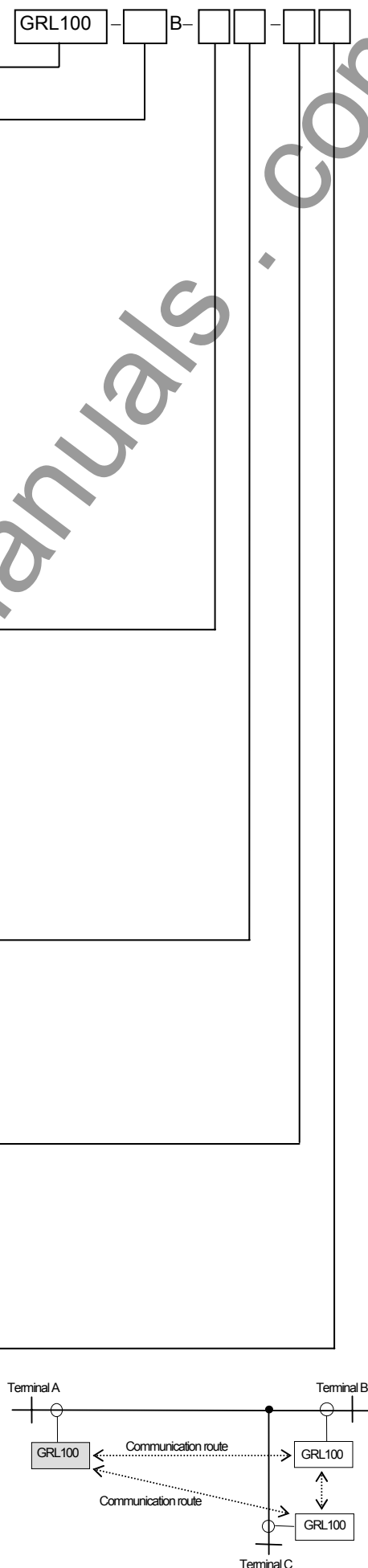
2. Optical Interface Unit (Option)

```
G1IF1 – ☐ – ☐
```

Type:	
Communication interface box	G1IF1
Model:	
For X.21	01
For CCITT-G703-1.2.1	02
For CCITT-G703-1.2.2 or 1.2.3	03
Auxiliary power supply:	
DC 48V / 54V / 60V	01
DC 110V / 125V	02
DC 220V / 250V	03
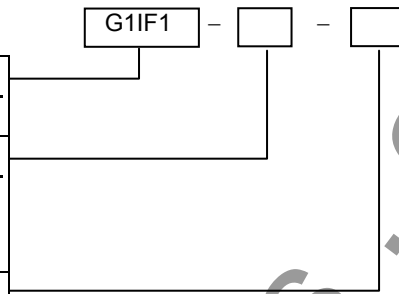
3. GPS Receiver (Option)

```
HHGP1 – 0101
```

Type:	
GPS receiver	HHGP1
DC power supply rating:	
DC 48V	
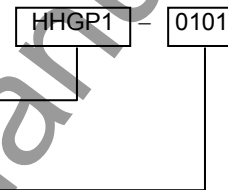
4. Protocol Converter (Option)

```
G1PR2 – ☐ A – ☐ – ☐
```

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:	
DC 110V / AC 100V	10
DC 220V / AC 200V	50
DC 48V	A0
External time synchronisation:	
None.	00
IRIG-B port	10

GRL100

RELAY OUTLINE

Figure 13 Relay case Type-A outline (for Model 101, 111, 102, 112, 201, 211, 204, 214, 301, 311, 701, 711)

Figure 14 Relay case Type-B outline (for Model 202, 212, 206, 216, 302, 312, 401, 411, 501, 511, 503, 513, 702, 712)

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19-inch rack mount

Attachment kit EP 101

4− φ 4.4

190.5

265.9

37.7

465.1

483.0
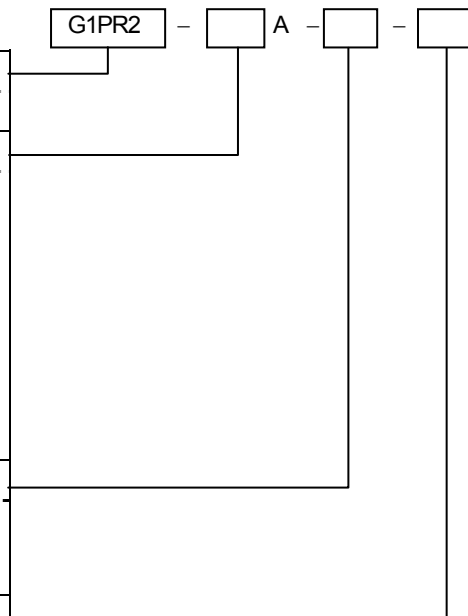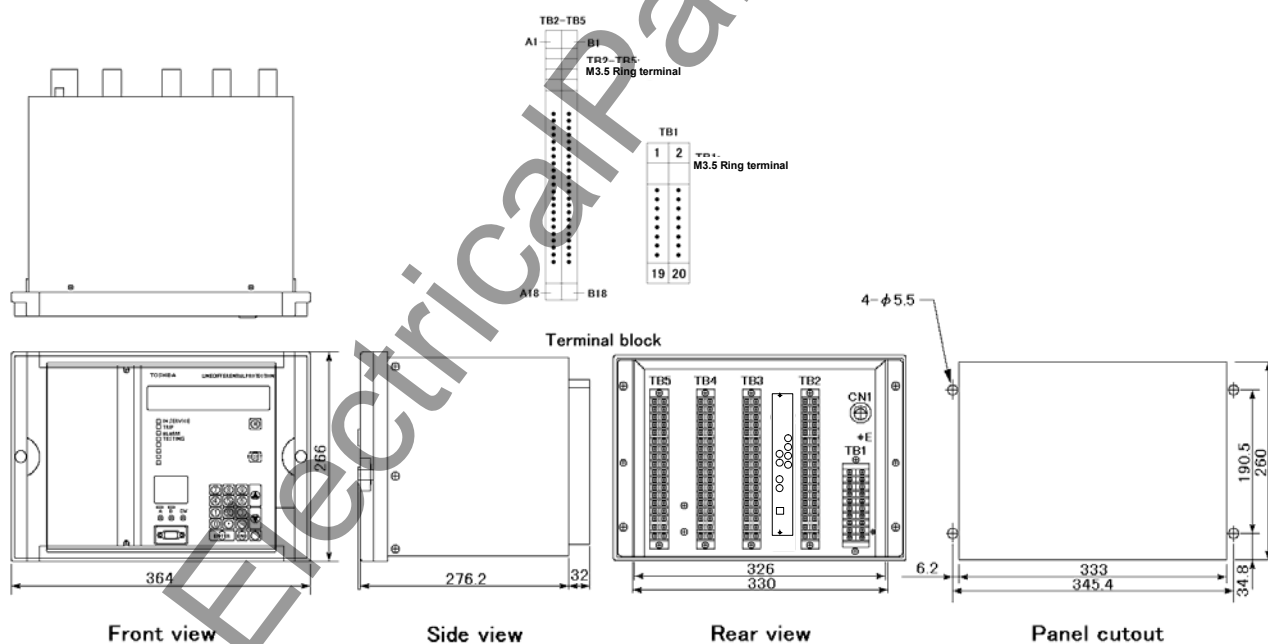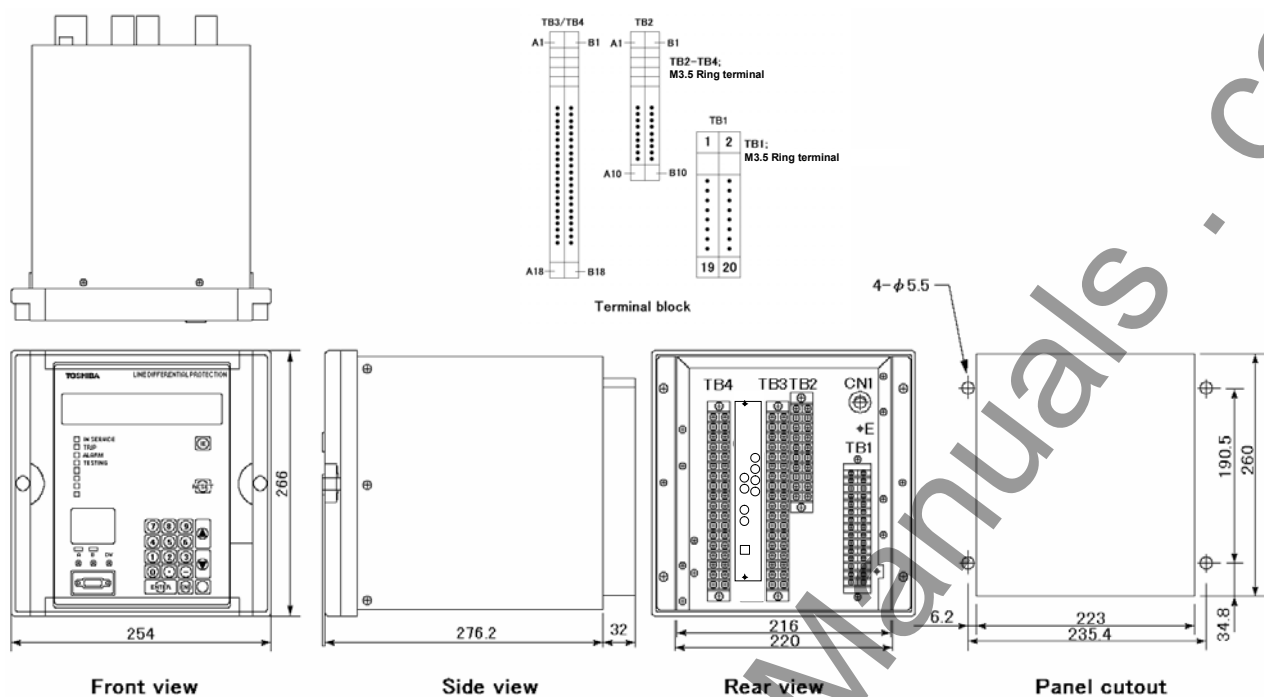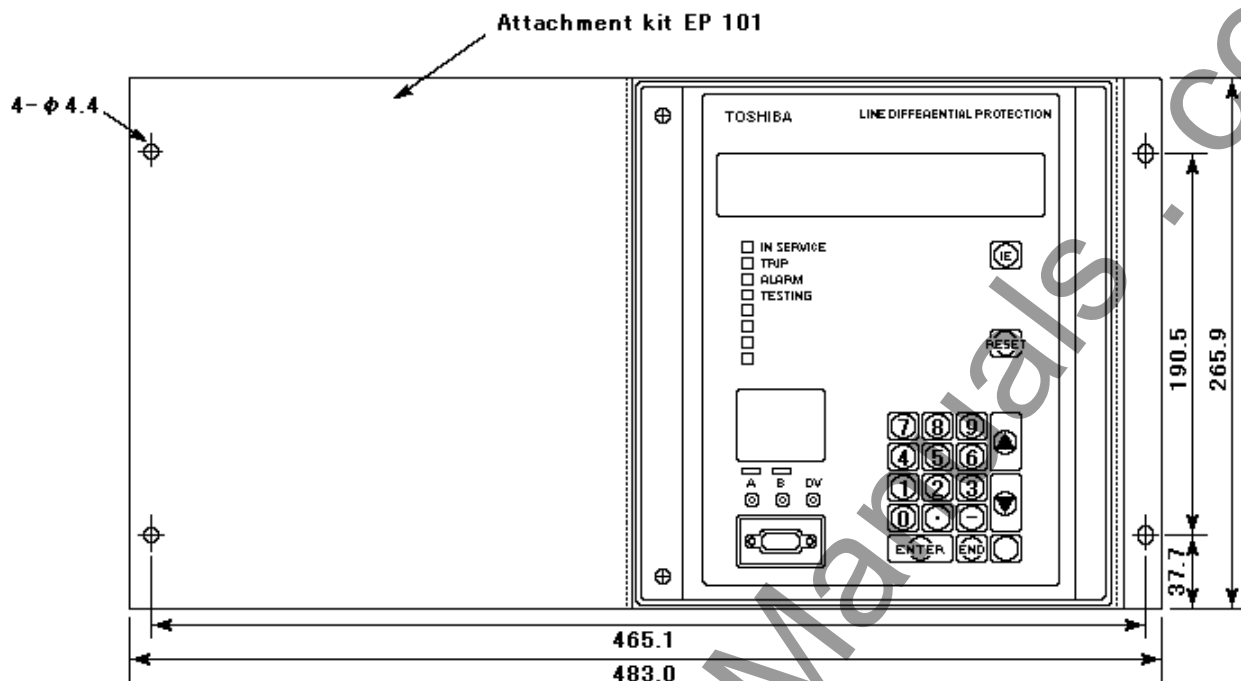
Figure 15 Relay case Type-A outline (for Model 101, 111, 102, 112, 201, 211, 204, 214, 301, 311, 701, 711)

Attachment kit EP 102

4− φ 4.4

190.5

265.9

37.7

465.1

483.0
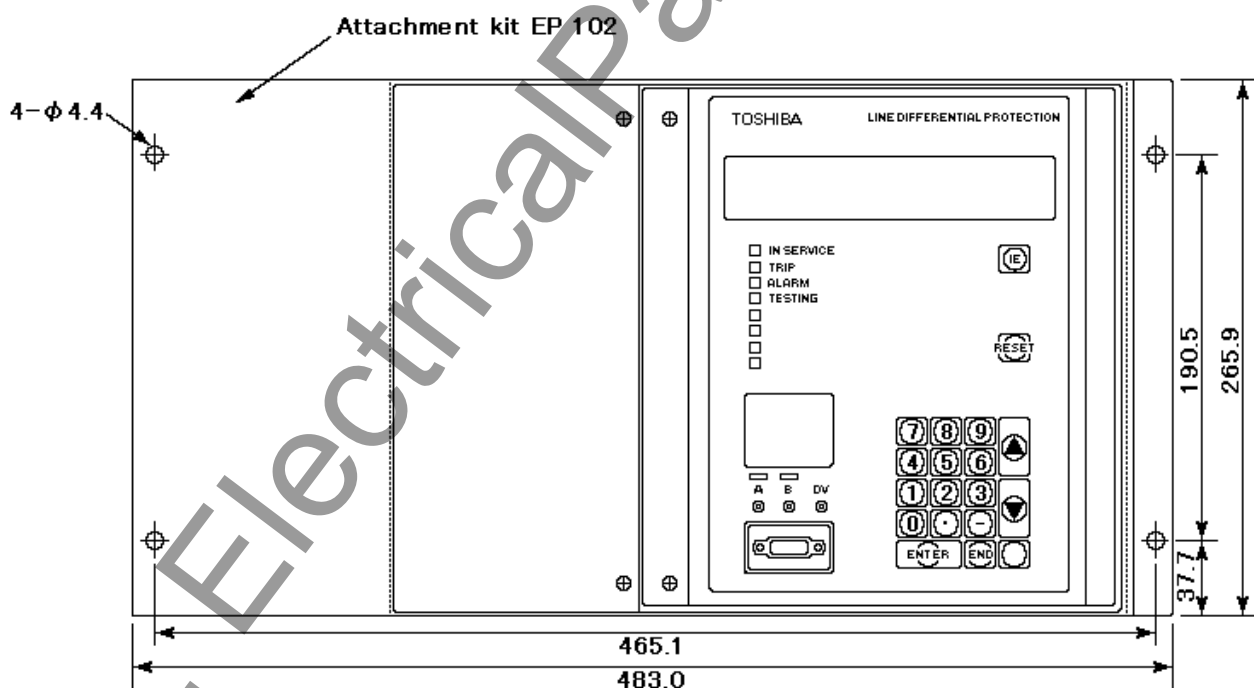
Figure 16 Relay case Type-B outline (for Model 202, 212, 206, 216, 302, 312, 401, 411, 501, 511, 503, 513, 702, 712)

Outline of Optical interface unit

2- Φ5

TB1

TOSHIBA

130   195

Power
TX from COM
TX from RELAY
CLK from COM

2-5x9

168
180

156

RX   TX   CLK   SPARE

66
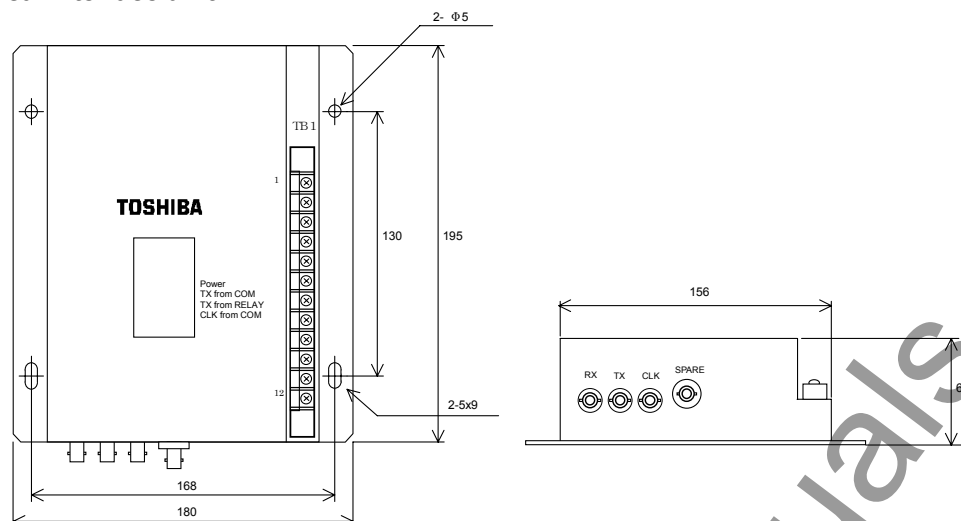
Figure 17 Outline of optical interface unit G1IF1

Outline of GPS Receiver

162.5

70.0

290.0
308.0

Figure 18 Outline of GPS receiver HHGP1

Outline of Protocol Converter

88-150Vdc/80-120Vac

POWER
OFF ON

RS232C

P FG N

IRIG-B

OPT1   OPT2   OPT3   OPT4   OPT5   OPT6   OPT7   OPT8
RX TX   RX TX   RX TX   RX TX   RX TX   RX TX   RX TX   RX TX

1 2 3   1 2 3   1 2 3   1 2 3   1 2 3   1 2 3   1 2 3   1 2 3   1 2 3

TB1   RS485-1 RS485-2 RS485-3 RS485-4 RS485-5 RS485-6 RS485-7   RS485-8 SG FG   TB2

(Note) IRIG-B: Option

356
339.3
316

TOSHIBA

TX
1 2 3 4 5 6 7 8
2 3 4 5 6 7 8

RX

○ POWER
○ ALARM
○ IRIG-B

PROTOCOL CONVERTER
Type   G1PR2
Model   180A-10-**
Power   110Vdc/100Vac
Made in Japan

57.1 115

φ7.1

10.3

Note: IRIG-B (Option)

200

108.3

Fi

gure 19 Outline of protocol converter G1PR2

25

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EXTERNAL CONNECTION DIAGRAM

Figure 20 Typical external connection of Model 101, 111

Figure 21 Typical external connection of Model 102, 112

Figure 22 Typical external connection of Model 201, 211

BUS

BUS VT

CT

CB

VT

TB1 -1
2
3
4
5
6
7
8

11
12
13
14

15
16
20

BUS VT

TB2- A2
B01 A1
B02 B1
B03 B2

A3
B04 B3
A4
B05 B4
A5
B06 B5
A6
B07 B6
A7
B08 B7
A8
B09 B8
A9
B010 B9
A10
B011 B10
A11
B012 B11 (HIGH SPEED RELAY)
A13
B013 B13 (HIGH SPEED RELAY)
A12
FAIL B12 RELAY FAILURE

IO#4

TB3- A2
B01 A1
B02 B1
B03 B2
A3
B04 B3
A4
B05 B4
A5
B06 B5
A6
B07 B6
A7
B08 B7
A8
B09 B8
A9
B010 B9
A10
B011 B10
A11
B012 B11
A12
B013 B12
A13
B014 B13

TB5-A1
B01 B1
A2
B02 B2
A3
B03 B3
A4
B04 B4
A5
B05 B5
A6
B06 B6
A7
B07 B7
A8
B08 B8
A9
B09 B9
A10
B010 B10

IO#3

[Default setting] (+)
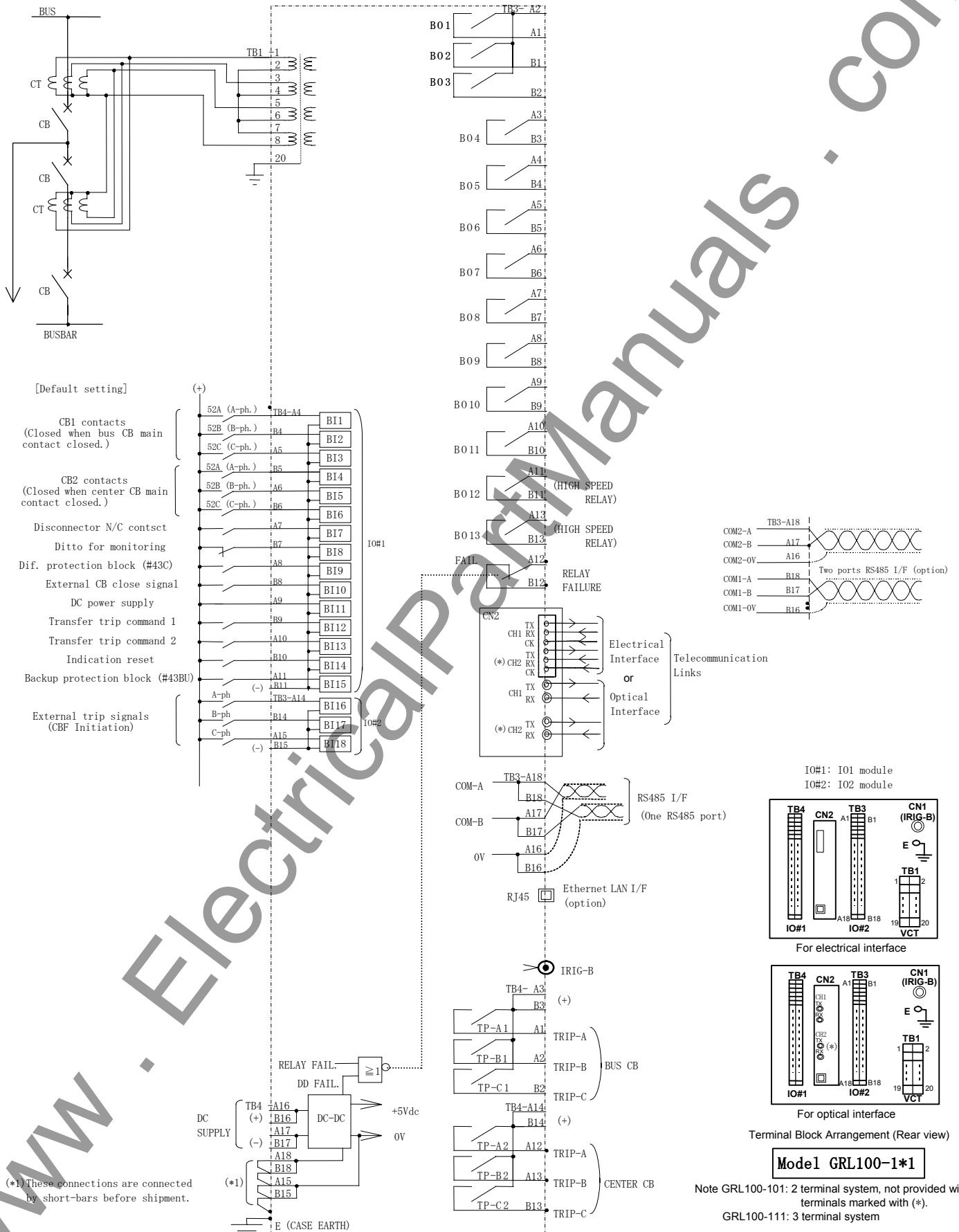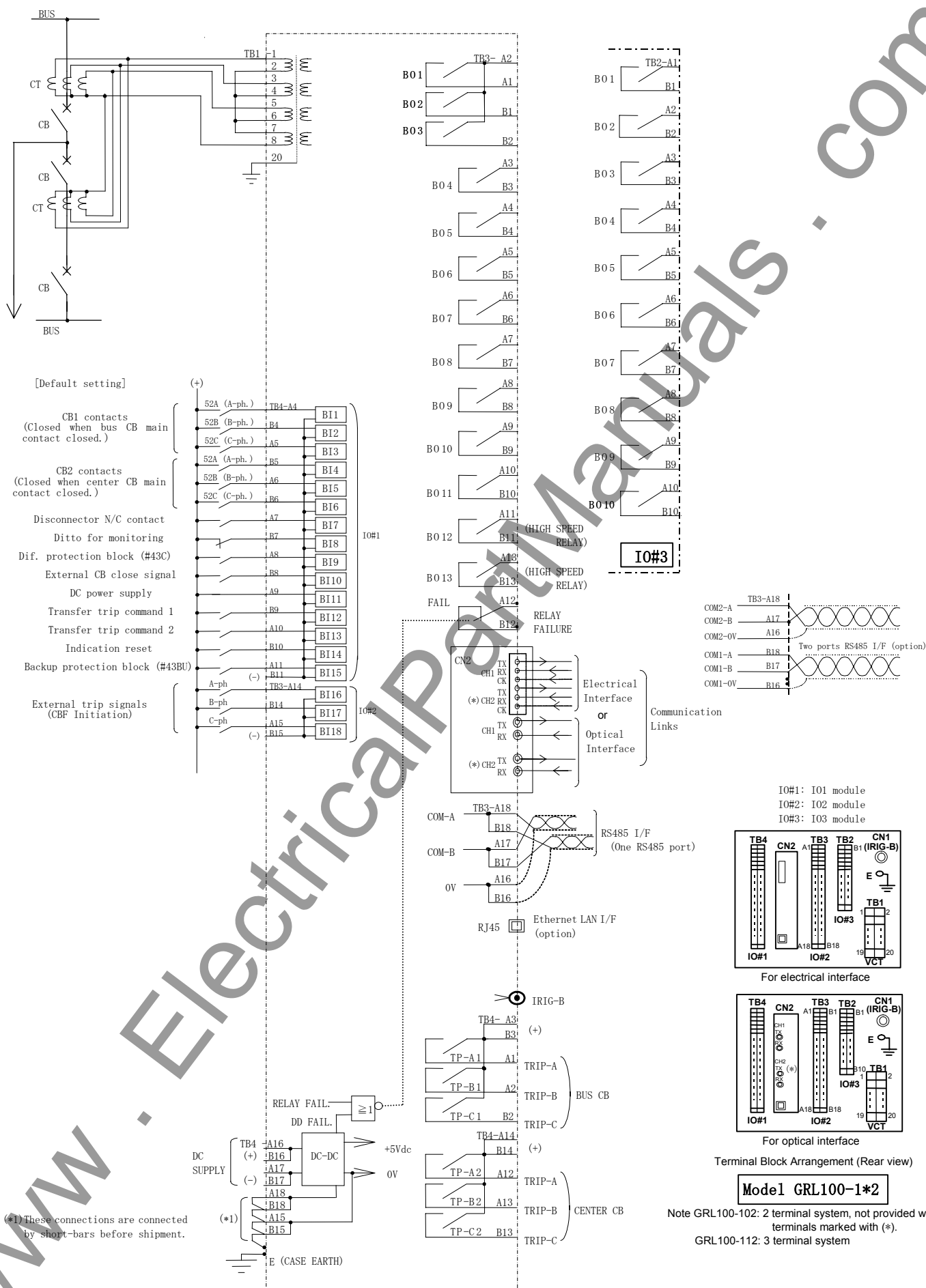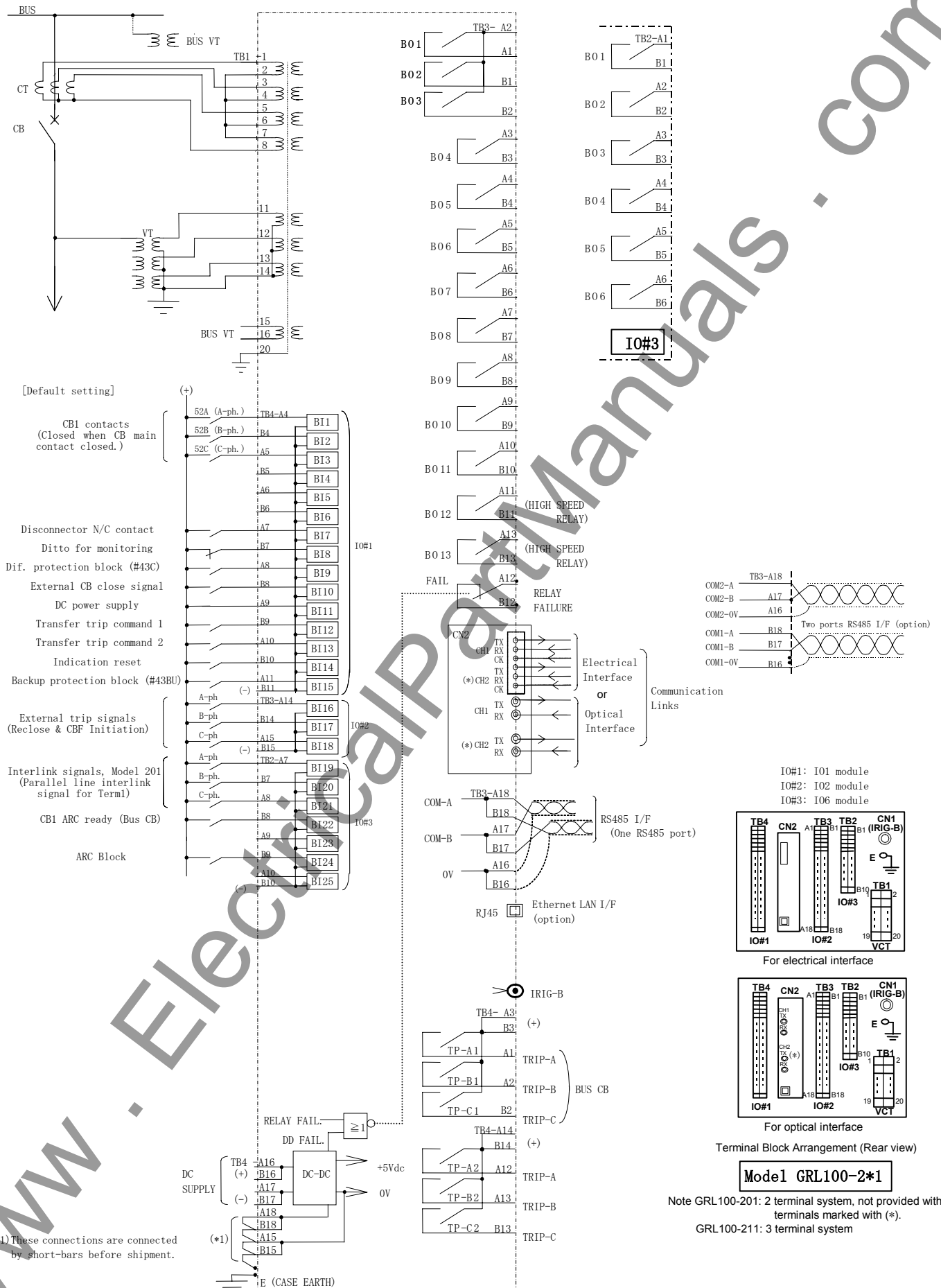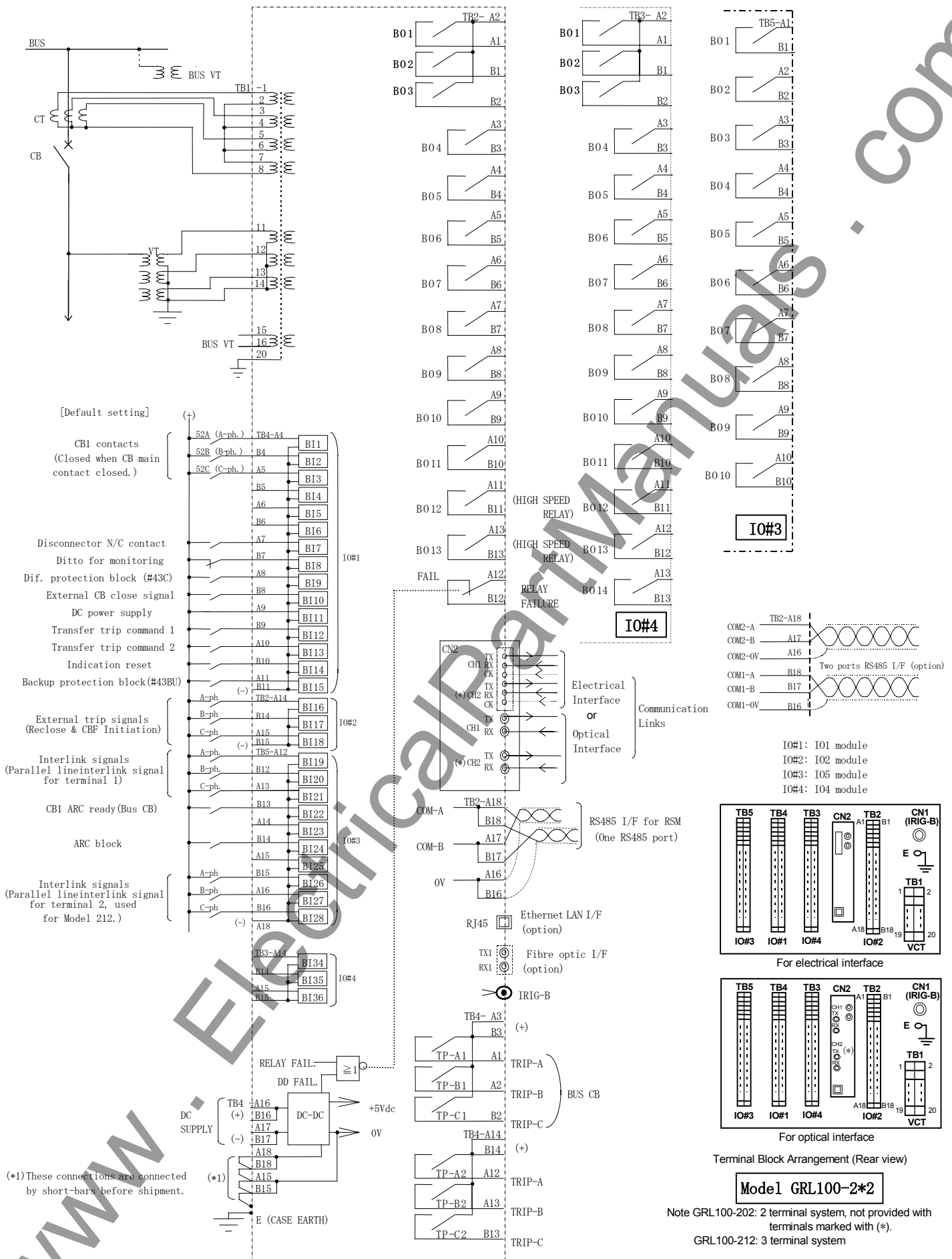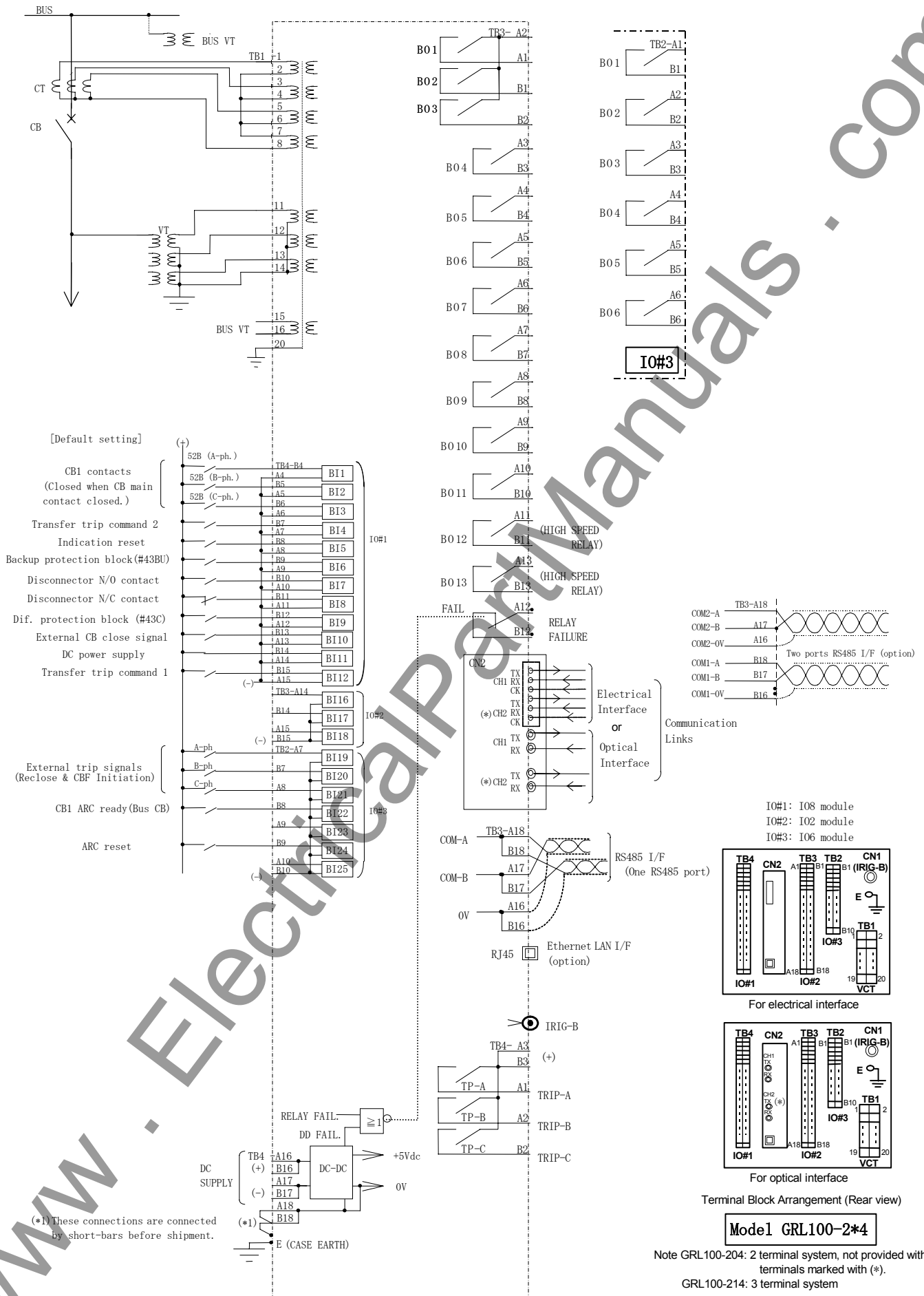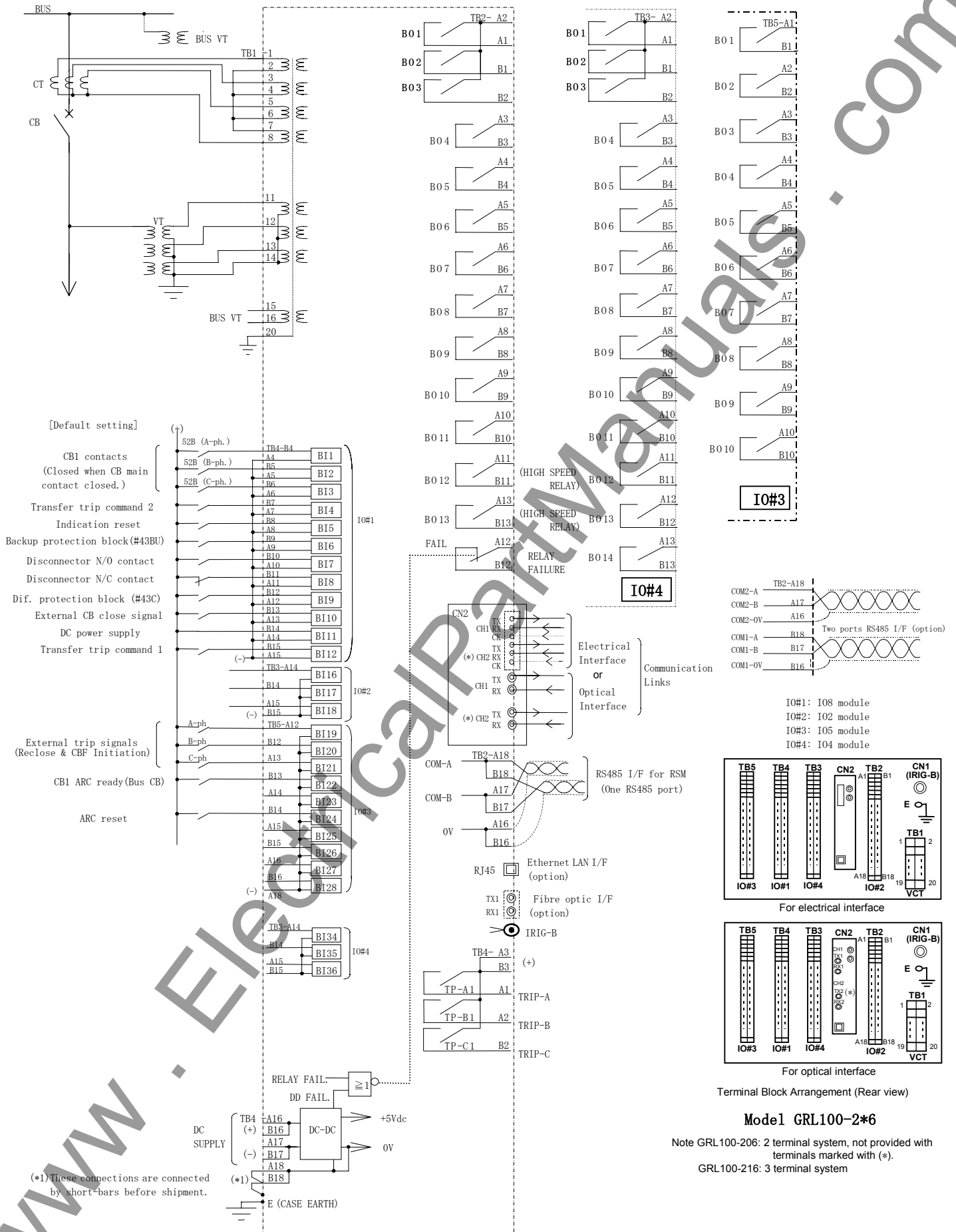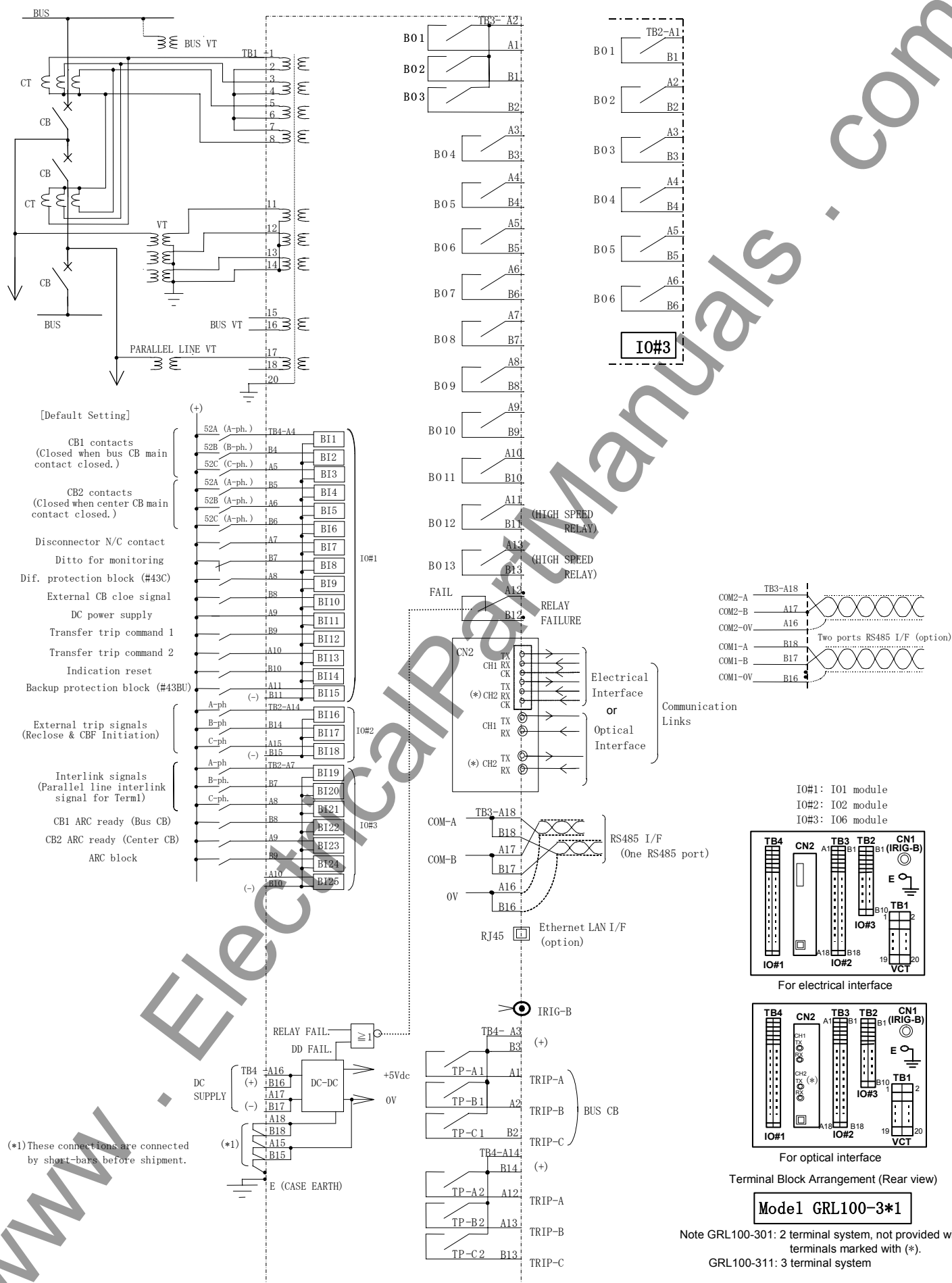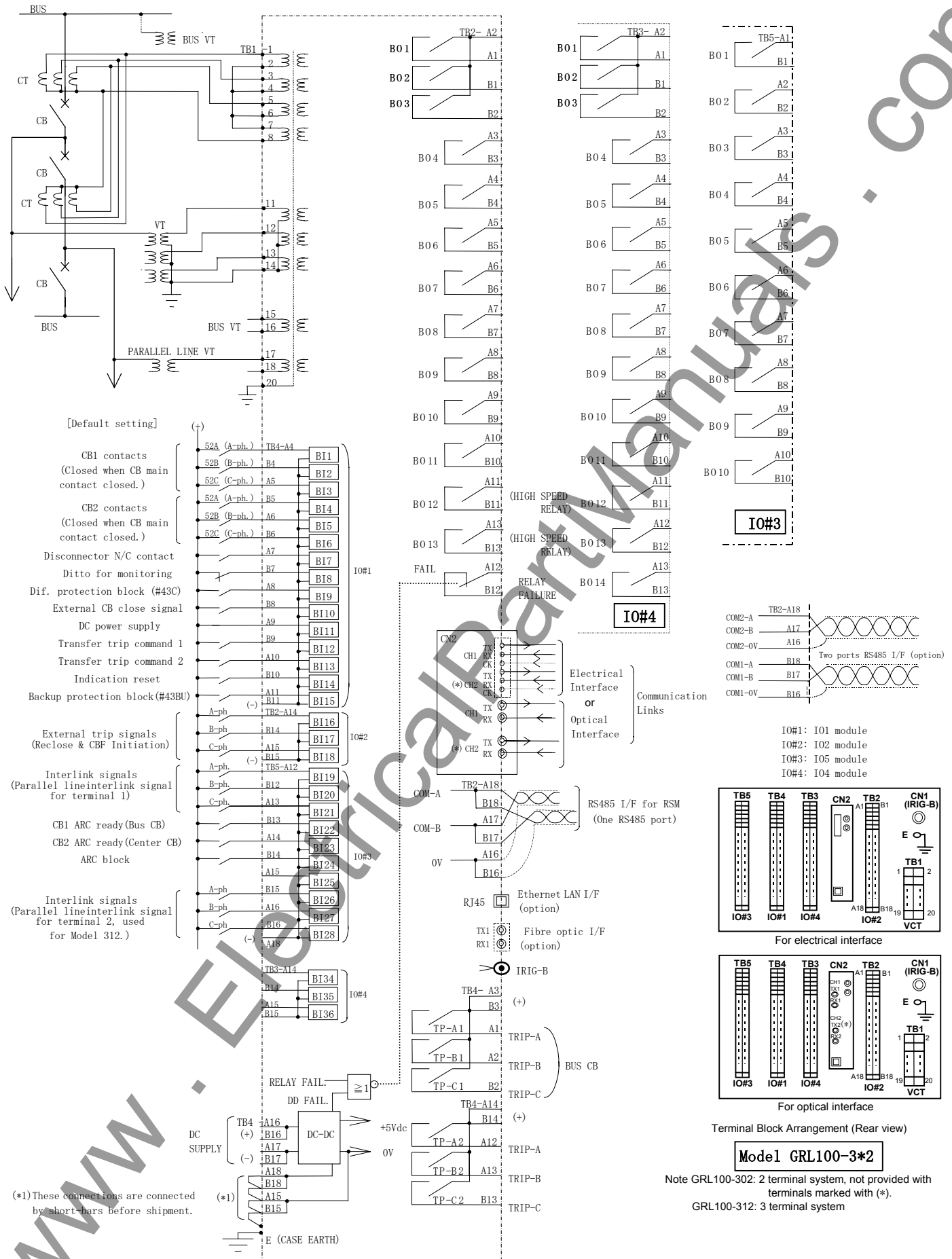
CB1 contacts (Closed when CB main contact closed.)
52A (A-ph.) TB4-A4 BI1
52B (B-ph.) B4 BI2
52C (C-ph.) A5 BI3
B5 BI4
A6 BI5
B6 BI6
Disconnector N/C contact A7 BI7
Ditto for monitoring B7 BI8
Dif. protection block (#43C) A8 BI9
External CB close signal B8 BI10
DC power supply A9 BI11
Transfer trip command 1 B9 BI12
Transfer trip command 2 A10 BI13
Indication reset B10 BI14
Backup protection block(#43BU) A11 BI15 (-) B11

IO#1

External trip signals (Reclose & CBF Initiation)
A-ph TB2-A14 BI16
B-ph B14 BI17 IO#2
C-ph A15 BI18 (-) B15

Interlink signals (Parallel lineinterlink signal for terminal 1)
A-ph TB5-A12 BI19
B-ph B12 BI20
C-ph A13 BI21
CB1 ARC ready(Bus CB) B13 BI22
A14 BI23
ARC block B14 BI24
A15 BI25

Interlink signals (Parallel lineinterlink signal for terminal 2, used for Model 212.)
A-ph B15 BI26
B-ph A16 BI27
C-ph B16 BI28 (-) A18

IO#3

TB3-A14 BI34
B14 BI35 IO#4
A15 BI36
B15

RELAY FAIL.
DD FAIL. ≧1

DC SUPPLY TB4 A16 (+)
B16 DC-DC +5Vdc
A17 (-)
B17 0V

(*1) A18
B18
(*1) A15
B15

E (CASE EARTH)

(*1)These connections are connected by short-bars before shipment.

CN2
CH1 TX RX CK
(*) CH2 TX RX CK
CH1 TX RX
(*) CH2 TX RX

Electrical Interface or Optical Interface } Communication Links

COM-A TB2-A18
B18
COM-B A17
B17
0V A16
B16

RS485 I/F for RSM (One RS485 port)

RJ45 Ethernet LAN I/F (option)

TX1 Fibre optic I/F (option)
RX1

IRIG-B

TB4- A3
B3 (+)
TP-A1 A1 TRIP-A
TP-B1 A2 TRIP-B } BUS CB
TP-C1 B2 TRIP-C

TB4-A14
B14 (+)
TP-A2 A12 TRIP-A
TP-B2 A13 TRIP-B
TP-C2 B13 TRIP-C

COM2-A TB2-A18
COM2-B A17
COM2-0V A16
COM1-A B18
COM1-B B17
COM1-0V B16

Two ports RS485 I/F (option)

IO#1: I01 module
IO#2: I02 module
IO#3: I05 module
IO#4: I04 module

TB5 TB4 TB3 CN2 TB2 CN1 (IRIG-B)
A1 B1
E
TB1
1 2
A18 B18 19
IO#3 IO#1 IO#4 IO#2 VCT 20

For electrical interface

TB5 TB4 TB3 CN2 TB2 CN1 (IRIG-B)
CH1 TX RX
CH2 TX (*) RX
A1 B1
E
TB1
1 2
A18 B18 19
IO#3 IO#1 IO#4 IO#2 VCT 20

For optical interface

Terminal Block Arrangement (Rear view)

Model GRL100-2*2

Note GRL100-202: 2 terminal system, not provided with terminals marked with (*).
GRL100-212: 3 terminal system

Figure 23 Typical external connection of Model 202, 212

29

Figure 24 Typical external connection of Model 204, 214

IO#1: IO8 module
IO#2: IO2 module
IO#3: IO6 module

For electrical interface

For optical interface

Terminal Block Arrangement (Rear view)

Model GRL100-2*4

Note GRL100-204: 2 terminal system, not provided with terminals marked with (*).
GRL100-214: 3 terminal system

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Figure 25 Typical external connection of Model 206, 216

Figure 26 Typical external connection of Model 301, 311

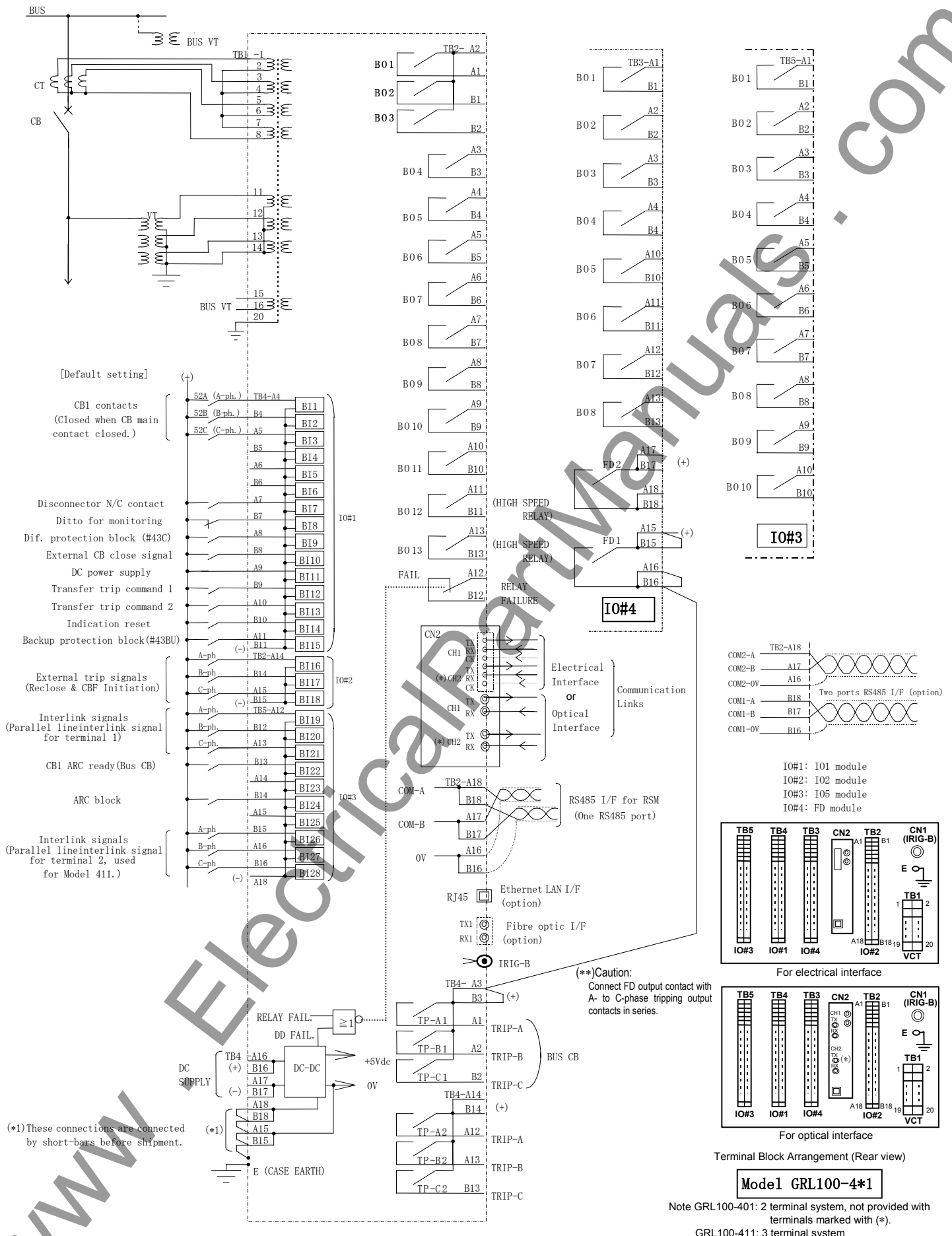**Figure 27 Typical external connection of Model 302, 312**

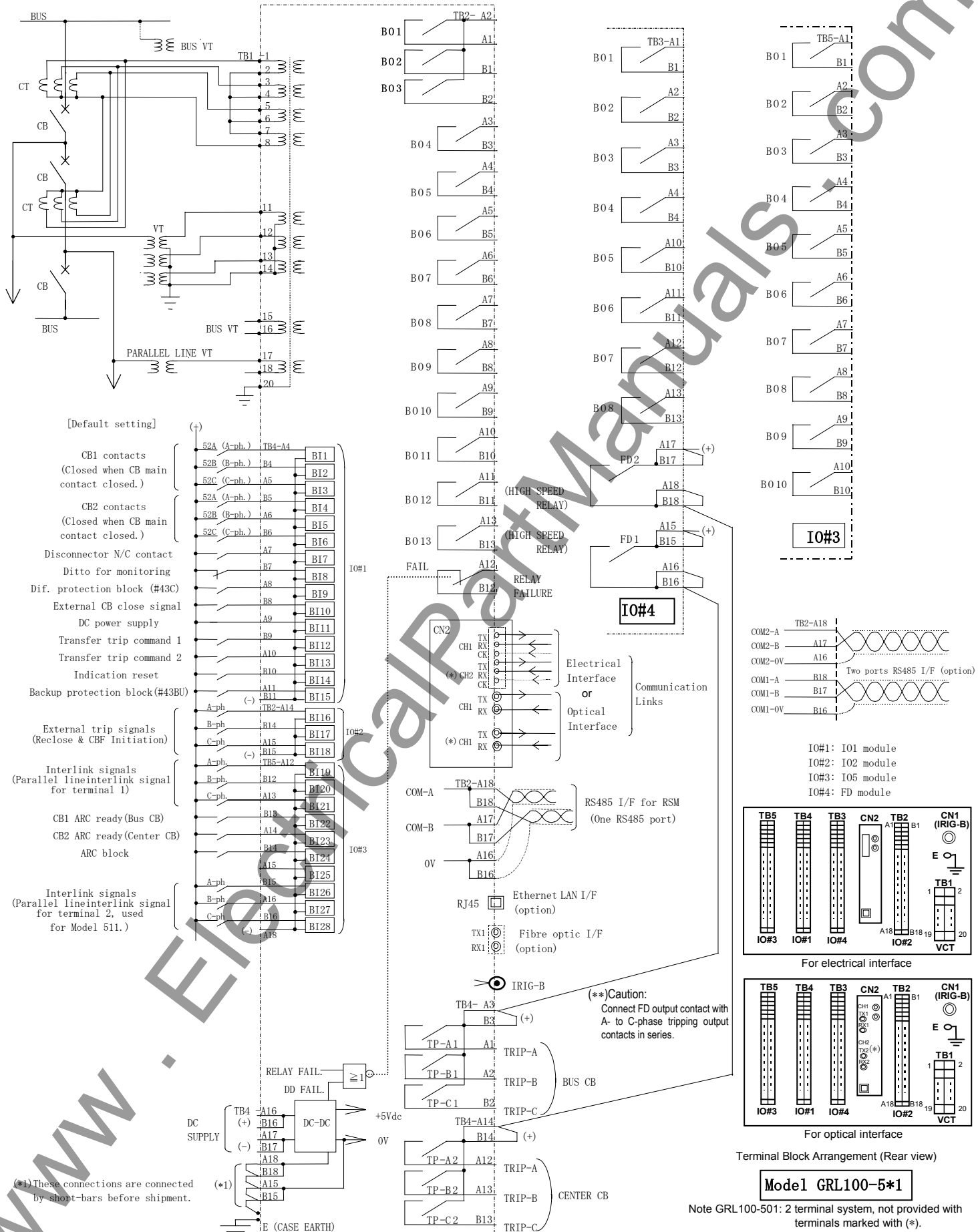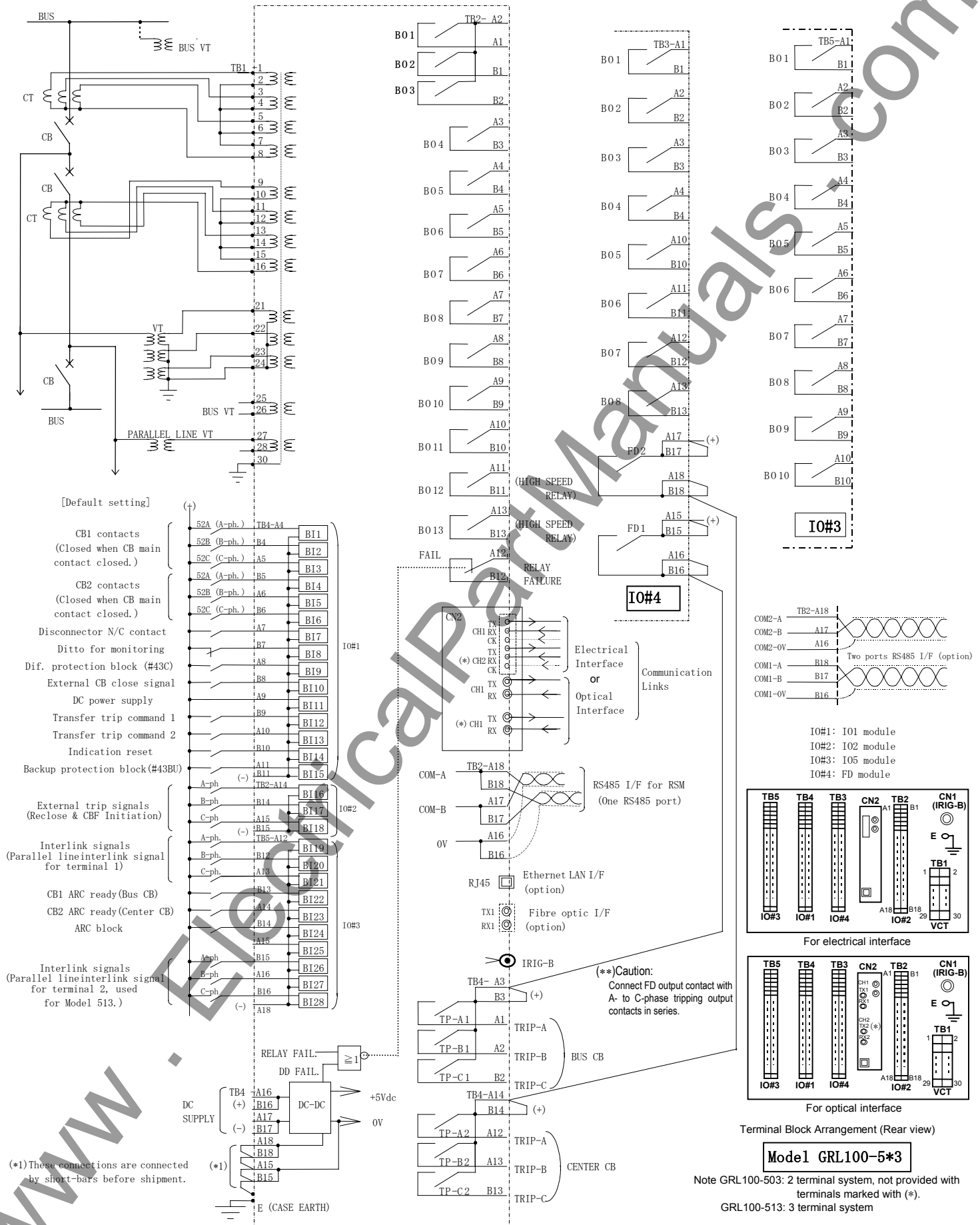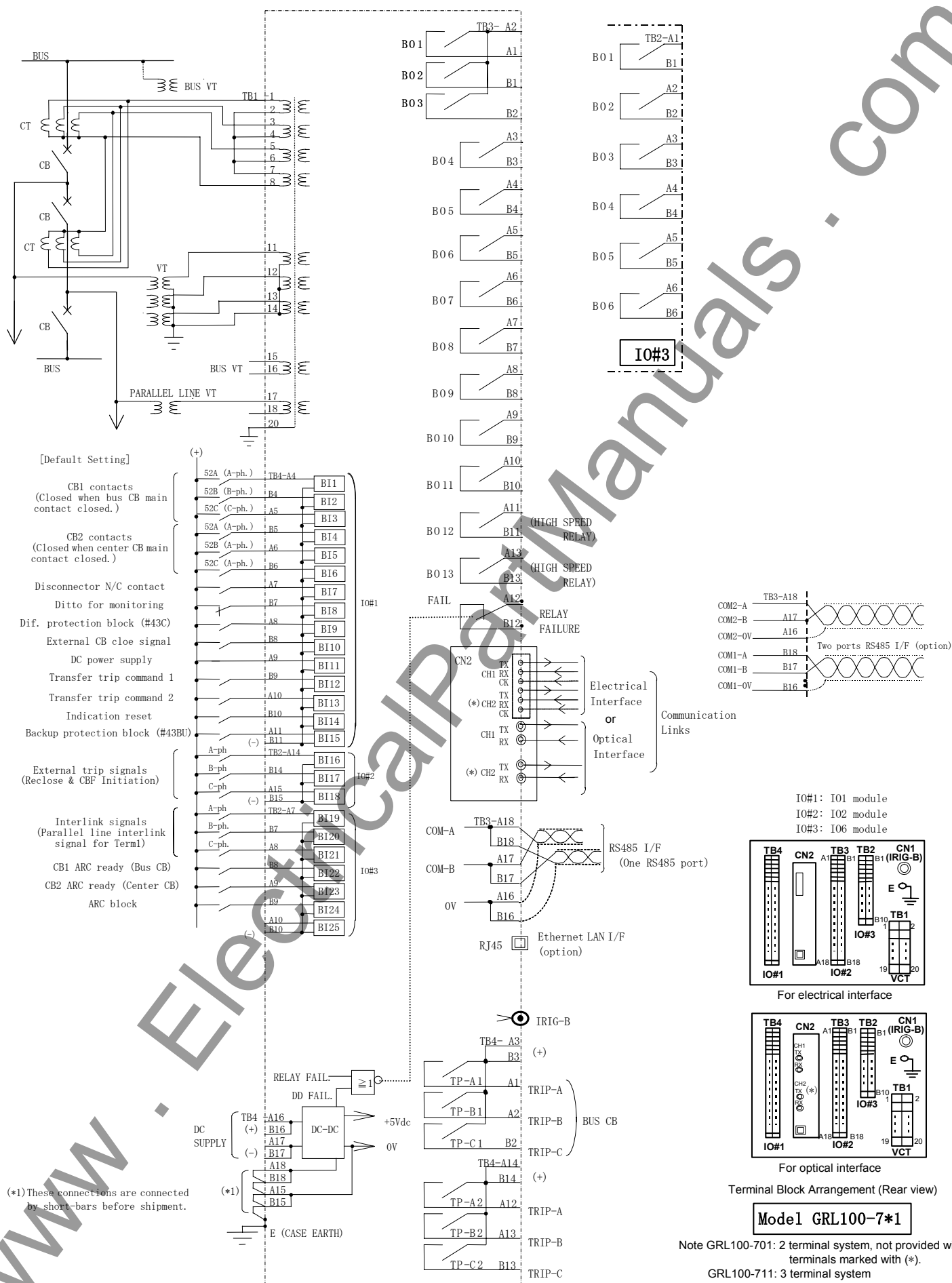**Figure 28 Typical external connection of Model 401, 411**

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Figure 29 Typical external connection of Model 501, 511

Model GRL100-5∗1

Note GRL100-501: 2 terminal system, not provided with
terminals marked with (∗).
GRL100-511: 3 terminal system

IO#1: IO1 module
IO#2: IO2 module
IO#3: IO5 module
IO#4: FD module

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Figure 30 Typical external connection of Model 503, 513

Figure 31 Typical external connection of Model 701, 711

Note GRL100-701: 2 terminal system, not provided with terminals marked with (∗).
GRL100-711: 3 terminal system
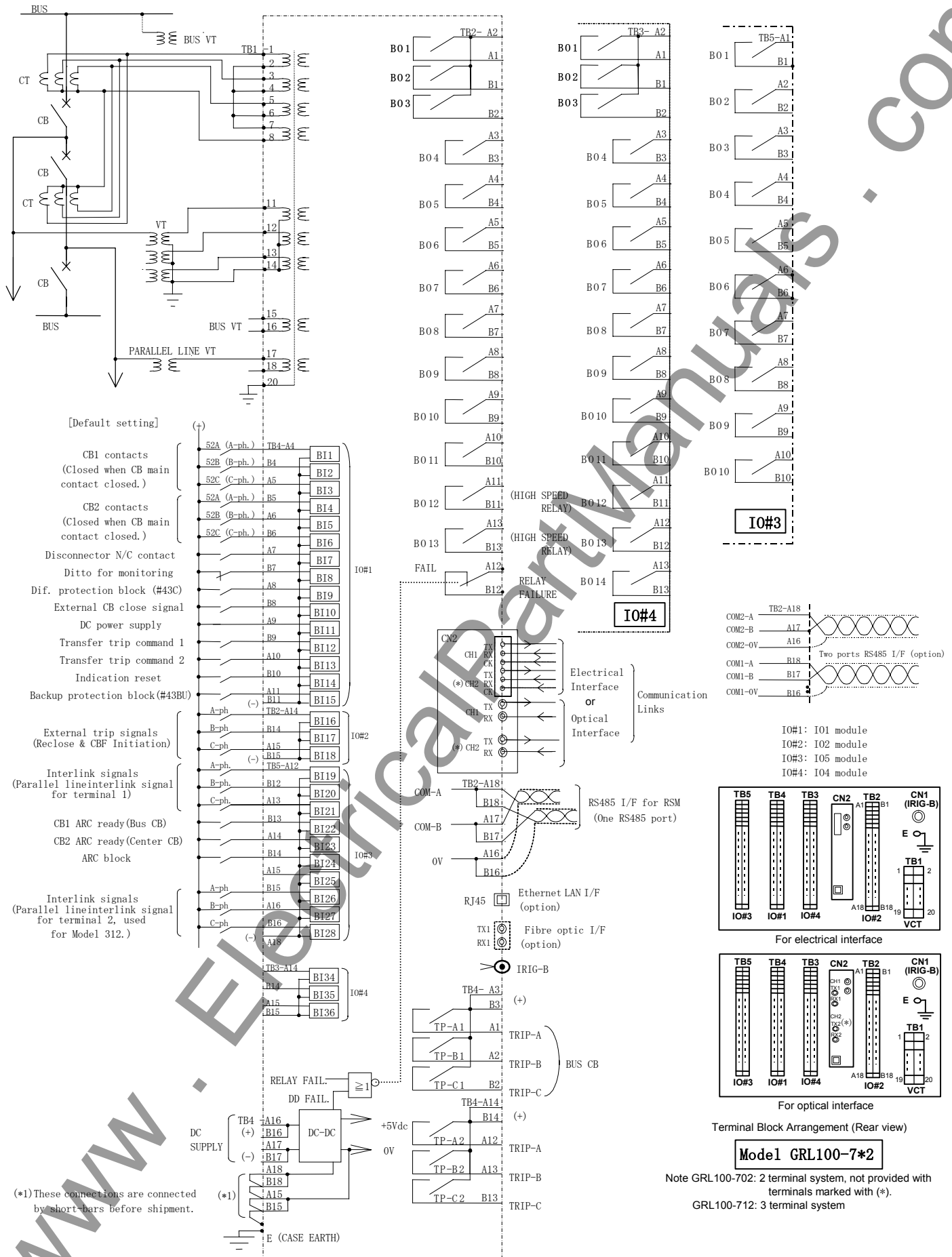
Model GRL100-7∗1

37

Figure 32 Typical external connection of Model 702, 712

GRL100

Numerical Relay

LINE DIFFERENTIAL PROTECTION

TOSHIBA

TOSHIBA CORPORATION

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http://www.toshiba.co.jp/f-ene/tands/english/protect/f_pc_top.htm

The data given in this catalog are subject to change without notice.   6640-1   0508T1