



Numerical Voltage Protection Relay

HF9024 (DUA2.1)

Technical Guide and user manual



Technical Guide and
user manual

Contents
HF9024

NUMERICAL Voltage Relay

CONTENTS

Introduction

Handling, Installation and Case Dimensions

User Guide

Menu Content Tables

Technical Data and Curve Characteristics

Application Guide

CONTENTS

1. INTRODUCTION	2
2. HOW TO USE THIS MANUAL	3
3. INTRODUCTION TO THE HF9024	4
4. MAIN FUNCTIONS	5

1. INTRODUCTION

The Voltage relay type HF9024 is a numerical relay .

2. HOW TO USE THIS MANUAL

This manual provides a description of HF9024 functions and settings. The goal of this manual is to allow the user to become familiar with the application, installation, setting and commissioning of the relay.

This manual has the following format:

HF9024 *Introduction*

Contents of the manual and general introduction to the relay

HF9024 Handling, installation and case dimensions

Precautions to be taken when handling electronic equipment.

HF9024 User Guide of the relay as

A detailed description of the features

HF9024 Technical data and Comprehensive details

on nominal values, setting ranges,

Specifications.

HF9024 Commissioning and Maintenance Guide

Guide to commissioning, problem solving and maintenance of HF9024

HF9024 Connection diagrams for the relay

HF9024 Commissioning test records

HF9024 Hardware/Software version history

HF9024 Communication mapping data bases

3. INTRODUCTION TO THE *HF9024* RELAY

The HF9024 relay provide comprehensive Voltage fault protection for utilities networks, industrial plants and networks as well as for other applications where Voltage protection is required.

In addition to its protective functions, each relay offers control and recording features. They can be fully integrated to a control system so protection, control, data acquisition and recording of faults, events and disturbances can be made available.

The relay is equipped on the front panel with a liquid crystal display (LCD) with 2 x 16 back-lit alphanumerical characters, a tactile 7 button keypad (to access all settings, clear alarms and read measurements) and 11 LEDs that indicate the status of the relay.

In addition, the use of the RS485 communication port by using protocol mode bus makes it possible to read, reinitialize and change the settings of the relay, if required, from a local or remote PC computer loaded with software.

Its flexibility of use, reduced maintenance requirements and ease of integration allow the Relay to provide an adaptable solution for the problems of the protection electric networks.

4. MAIN FUNCTIONS

The following table shows the functions available for HF9024 relay.

PROTECTION FUNCTIONS OVERVIEW		HF9024
	Configuration depending on the number and type of voltage transformers	✓
	Phase-to-neutral or phase-to-phase voltage protection	✓
27	Phase under voltage (AND/OR logic)	✓
59	Phase over voltage (AND/OR logic)	✓
59N	Zero sequence over voltage	✓
47	Negative sequence over voltage	-
27D	Positive sequence under voltage	-
	Delta U / Delta T	✓
	Blocking logic	✓
	Balance voltage	-
	Digital inputs	2
	Output relays	6
	Remote communication (RS485 port)	✓
	Local communication (RS232 port)	✓
	Event recording	250
	Fault recording	25
	Disturbance recording	5
	Setting group	1
	Circuit Breaker Control	✓
	Output relay latching	✓

**HANDLING, INSTALLATION
AND CASE DIMENSIONS**

CONTENTS

1. GENERAL CONSIDERATIONS	2
1.1 Receipt of relays	2
1.2 Electrostatic discharge (ESD)	2
2. HANDLING OF ELECTRONIC EQUIPMENT	3
3. RELAY MOUNTING	4
4. UNPACKING	5
5. STORAGE	6
6. DIMENSIONS	7
7. Communication	8
7.1 RS232 Port	8
7.2 RS485 port	8
8. Earthing	8

1. GENERAL CONSIDERATIONS

1.1 Receipt of relay

Protective relay, although generally of robust construction, require careful treatment prior to installation on site. Upon receipt, relay should be examined immediately to ensure no damage has been sustained in transit. If damage has been sustained during transit a claim should be made to the transport contractor and HAMIANFAN should be promptly notified.

1.2 Electrostatic discharge (ESD)

The relay use components that is sensitive to electrostatic discharges. The electronic circuits are well protected by the metal case and the internal module should not be withdrawn unnecessarily. When handling the module outside its case, care should be taken to avoid contact with components and electrical connections. If removed from the case for storage, the module should be placed in an electrically conducting antistatic bag. There are no setting adjustments within the module and it is advised that it is not unnecessarily disassembled. Although the printed circuit boards are plugged together, the connectors are a manufacturing aid and not intended for frequent dismantling; in fact considerable effort may be required to separate them. Touching the printed circuit board should be avoided, since complementary metal oxide semiconductors (CMOS) are used, which can be damaged by static electricity discharged from the body.

2. HANDLING OF ELECTRONIC EQUIPMENT

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage, which often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits are completely safe from electrostatic discharge when housed in the case. Do not expose them to risk of damage by withdrawing modules unnecessarily.

Each module incorporates the highest practicable protection for its semiconductor devices.

However, if it becomes necessary to withdraw a module, the following precautions should be taken to preserve the high reliability and long life for which the equipment has been designed and manufactured.

1. Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.
2. Handle the module by its front plate, frame or edges of the printed circuit board. Avoid touching the electronic components, printed circuit track or connectors.
3. Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equal potential.
4. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.
5. Store or transport the module in a conductive bag. If you are making measurements on the internal electronic circuitry of an equipment in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between $500\text{k}\Omega$ – $10\text{M}\Omega$. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of static. Instrumentation which may be used for making measurements should be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC147. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the above-mentioned BS and IEC documents.

3. RELAY MOUNTING

The relay is dispatched either individually or as part of a panel/rack assembly. Modules should remain protected by their metal case during assembly into a panel or rack.

For individually mounted relays an outline diagram is supplied in following of this chapter showing the panel cut-outs and hole centers.

4. UNPACKING

Care must be taken when unpacking and installing the relay so that none of the parts is damaged or the settings altered. The relay must only be handled by skilled personnel. The installation should be clean, dry and reasonably free from dust and excessive vibration. The site should be well lit to facilitate inspection. The relay that has been removed from the case should not be left in a situation where that is exposed to dust or damp. This particularly applies to installation which is being carried out at the same time as construction work.

5. STORAGE

If relay is not to be installed immediately upon receipt they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained. The action of the de-humidifier crystals will be impaired if the bag has been exposed to ambient conditions and may be restored by gently heating the bag for about an hour, prior to replacing it in the carton.

Dust which collects on a carton may, on subsequent unpacking, find its way into the relay; in damp conditions the carton and packing may become impregnated with moisture and the de-humidifier will lose its efficiency.

Storage temperature: -25°C to $+70^{\circ}\text{C}$.

6. CASE DIMENSIONS

The relay is available in a 4U metal case for panel or flush mounting.

Weight: 1.8 Kg

Front panel 177 mm

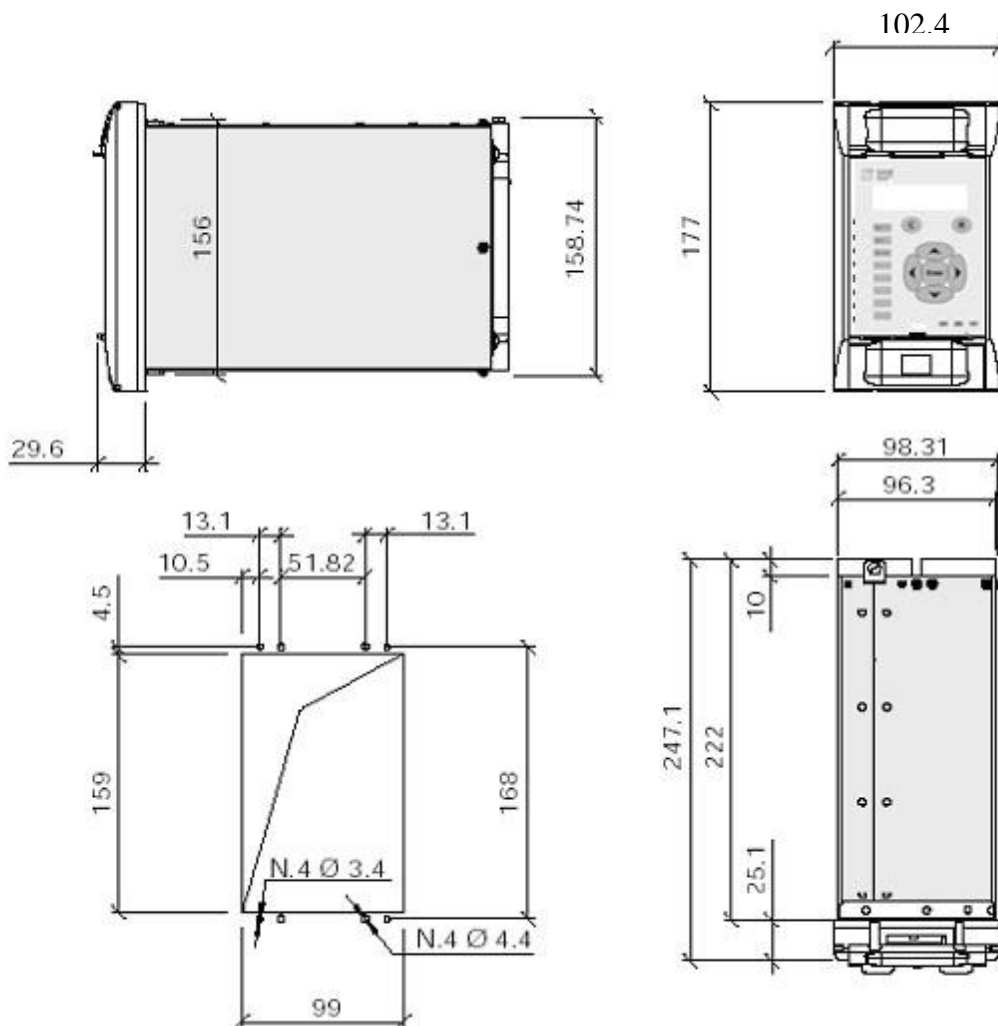
Front panel 103 mm

Front panel + case 252 mm

External size : Height case 152 mm

Width case 97 mm

Depth case 226 mm



All dimensions in mm

7. Communication

7.1 RS232 Port

In the bottom of the front panel, there is a RS232 port, The communication with a computer through the RS232 allows access to the relay all information and setting. It makes the access and changes of any information, setting and configuration.

You can see all events and records by this port on monitor of computer we will explain it by details in the next sections.

7.2 RS485 port

Connections to RS485 are made using annular terminals. It is recommended that a two core screened cable, is used with a maximum total length of 1000 m or a200nF total cable capacitance.

Typical specification:

- Each core: 16/0.2 mm copper conductor, PVC insulated.
- Nominal conductor area: 0.5 mm² per core
- Screen: Overall braid, PVC sheathed
- Linear capacitance between conductor and earth: 100pF/m

8. Earthing

Each equipment must be connected to a local earth terminal by the intermediary of a M4 earth terminal. We recommend a wire of minimal section of 2.5 mm², with annular terminals on the side of the equipment. Because of the limitations of the annular terminals, the possible maximum section is of 6mm² by wire. If a larger section is necessary, one can use cables connected in parallel, each one ending with an annular terminal separated on the side of the equipment. One can also use a metal bar.

NOTE: To prevent any electrolytic risk between copper conductor or brass conductor and the back plate of the equipment, it is necessary to take precautions to isolate them one from the other. This can be done in several ways, for example by inserting between the conductor and the case a plated nickel or insulated ring washer or by using a tin terminals.

User Guide

CONTENTS

1. PRESENTATION OF HF9024 RELAY	2
2. USER INTERFACE	3
2.1 LCD display and keypad description	4
2.1.1 LCD display	4
2.1.2 Keypad	4
2.2 LEDs	5
2.3 Description of the two areas under the top and bottom flaps	6
3. PASSWORD	7
3.1 Password protection	7
3.1.1 Password entry	7
3.1.2 Changing the password	7
3.1.3 Change of setting invalidation	8
4. DISPLAYS OF ALARM & WARNING MESSAGES	8
4.1 Electrical Network Alarms	8
4.2 Relay Hardware or Software Warning Messages	10

1. PRESENTATION OF HF9024 RELAY

This relay is fully numerical relays designed to perform electrical protection and control functions.

HF9024 relay is powered either from a DC or an AC auxiliary power supply.

Using the front panel, the user can easily navigate through the menu and access data, change settings, read measurements, etc.

Eleven LEDs situated in the front panel help the user to quickly know the status of the relay and the presence of alarms. Alarms that have been detected are stored and can be displayed on the back-lit LCD.

Any short time voltage interruption (<50ms) is filtered and regulated through the auxiliary power supply.

HF9024 relay have 3 phase inputs available for 1 and 5 Amps rated CTs. On each one of these relay.

HF9024 relay continuously measure phase and earth currents and take into account the true RMS current value up to 10th harmonic (at 50 Hz).

Output relays are freely configurable and can be activated by any of the control or protection functions available in the relay. Logic inputs can also be assigned to various control functions.

On their rear terminals HF9024 have a standard RS485 port available. When ordering, the user can choose between the following communication protocol: ModBus RTU.

Using RS485 communication channel, all stored information (measurements, alarms, and parameters) can be read and settings can be modified when the chosen protocol allows it.

HF9024 relay can be connected directly to a digital control system. All the available data can then be gathered by a substation control system and be processed either locally or remotely.

2. USER INTERFACE

HF9024 relay front panel allows the user to easily enter relay settings, display measured values and alarm and to clearly display the status of the relay.

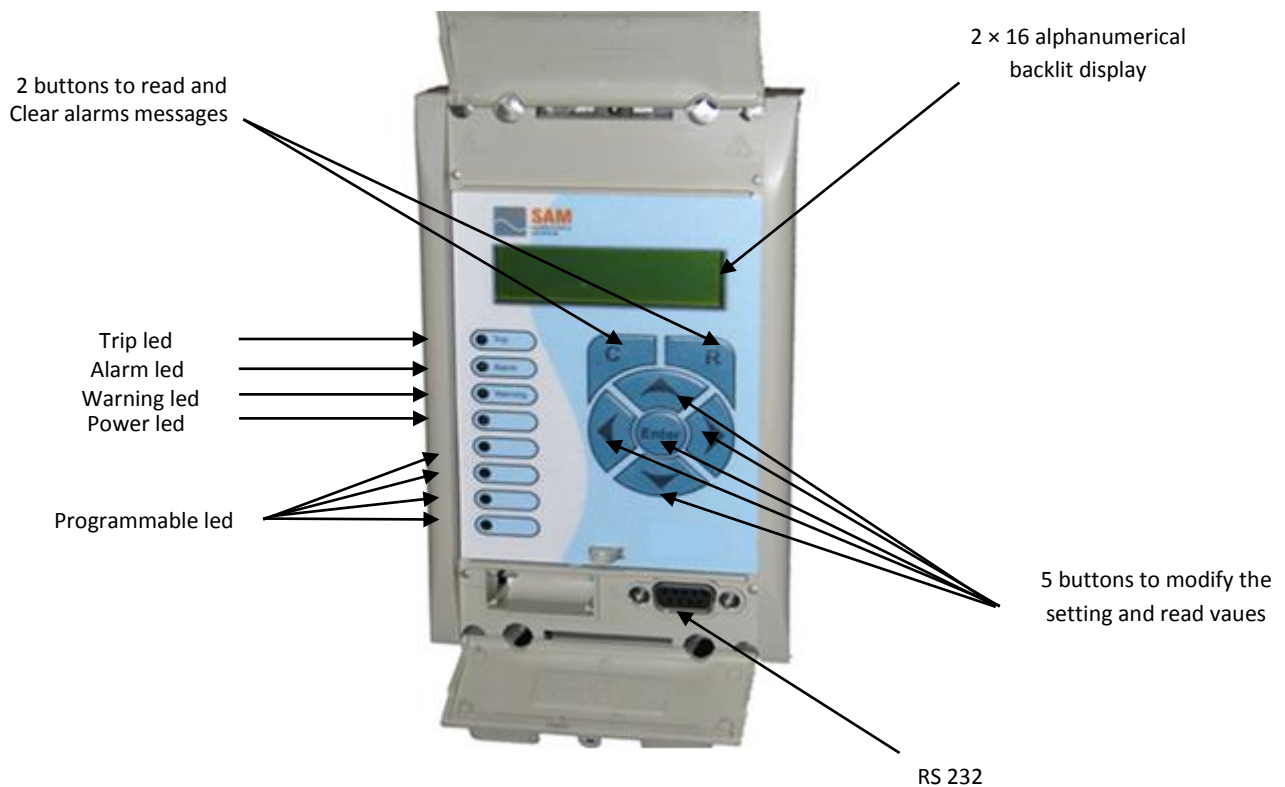


Figure 1: Front panel

The front panel of the relay has three separate sections:

1. The LCD display and the keypad
2. The LEDs
3. The two zones under the upper and lower flaps

2.1 LCD display and keypad description

2.1.1 LCD display

In the front panel, a liquid crystal display (LCD) displays settings, measured values and alarms. Data is accessed through a menu structure.

The LCD has two lines, with sixteen characters each. A back-light is activated when a key is pressed and will remain lit for five minutes after the last key press. This allows the user to be able to read the display in most lighting conditions.

2.1.2 Keypad

The keypad has seven keys divided into two groups:

- Two keys located just under the screen (keys and).

Keys and are used to read and acknowledge alarms. To display successive alarms, press key . Alarms are displayed in reverse order of their detection (the most recent alarm first, the oldest alarm last). To acknowledge the alarms, the user can either acknowledge each alarm using or go to the end of the ALARM menu and acknowledge all the alarms at the same time.

- Four main arrow keys located in the middle of the front panel.

They are used to navigate through the different menus and submenus and to do the setting of the relay.

The enter key is used to validate a choice or a value (modification of settings).

2.2 LEDs

The top four LEDs indicate the status of the relay (Trip condition, alarm LED, equipment failure, Power). The four lower LEDs are freely programmable by the user and can be assigned to display a threshold crossing for example (available for all models) or to show the status of the logic inputs .The description of each one of these eight LEDs located in the left side of the front view is given hereafter (numbered from the top to bottom from 1 to 8)

LED 1

Color: RED

Label: Trip

LED 1 indicates that the relay has issued a trip order to the cut-off element (circuit breaker, contactor). This LED recopies the trip order issued to the Trip logic output. As soon as a triggering order is issued, the LED lights up. It is cleared when the associated alarm is acknowledged either through the front panel, or by a remote command, a digital input, or by a new fault (configuration/Alarms menu).

LED 2

Color: YELLOW

Label: ALARM

LED 2 indicates that the relay has detected an alarm. This alarm can either be a threshold crossing (instantaneous), or a trip order (time delayed). As soon as an alarm is detected, the LED starts blinking. After all the alarms have been read, the LED lights up continuously. After acknowledgement of all the alarms, the LED is extinguished. The alarm LED can be reset by the front panel.

LED 3**Color: YELLOW****Label: Warning**

LED 3 indicates internal alarms of the relay. When the relay detects a « non-critical » internal alarm (typically a communication failure), the LED starts blinking continuously. When the relay detects a fault that is considered as « critical », the LED lights up continuously. Only the disappearance of the cause of the fault can clear this LED (repair of the module, clearance of the Fault).

LED 4:**Color: GREEN****Label: Power**

LED 4 indicates that the relay is powered by an auxiliary source at the nominal range.

LED 5 to 8:**Color: RED**

These LEDs are user programmable and can be set to display information about instantaneous and time-delayed thresholds as well as the status of the logic inputs. Under the CONFIGURATION/LED menu of the relay, the user can select the information he wishes to associate with each LED. He can affect more than one function to one LED. The LED will then light up when at least one of the associated information is valid (OR gate). The LED is cleared when all the associated alarms are acknowledged.

2.3 Description of the two areas under the top and bottom flaps

2.3.1 Relay Identification

Under the upper flap, a label identifies the relay according to its model number (order number) and its serial number. This information defines the product in a way that is unique. In all your requests, please make reference to these two numbers.

Under the model and serial number, you will find information about the level of voltage of the auxiliary supply and the nominal earth current value.

There is RS232 port available under the lower flap in the relay. This RS232 port can be used to plug a laptop loaded with setting software.

To withdraw more easily the active part of the relay (i-e the chassis) from its case, open the two flaps, then with a 3mm screwdriver, turn the extractor located under the upper flap, and pulls it out of its case pulling the flaps towards you.

3. PASSWORD

3.1 Password Protection

An unlock key (up down) is required, when you want to press any key. After 5 minutes that you don't press any key, you must unlock the keys for navigation through menus.

A password is required for relay settings, especially when changing the various thresholds, time delays, and communication parameters, allocation of inputs and outputs relays.

The password consists of four capital characters. When leaving factory, the password is set to AAAA. The user can define his own combination of four characters. Should the password be lost or forgotten, the modification of the stored parameters is blocked. It is then necessary to contact the manufacturer or his representative and a standby password specific to the relay may be obtained.

3.2 Password entry

The input of the password is requested as soon as a modification of a parameter is made for any one of the six/eight menus and the submenus. The user enters each one of the 4 characters and then validates the entire password with enter keypad. After 5 seconds, the display returns to the point of the preceding menu. If no key is pressed inside of 5 minutes, the password is deactivated. A new password request is associated with any subsequent parameter modification

3.3 Changing the password

To change an active password, go to the OP PARAMETERS menu and then to the Password submenu. Enter the current password and validate it. Then press enter keypad and enter the new password character by character and validate the new password using enter keypad.

The message NEW PASSWORD OK is displayed to indicate that the new password has been accepted.

4. DISPLAYS of ALARM

Alarm messages are displayed directly on the front panel LCD. They have priority over the default display presenting measured current values. As soon as the relay detects an alarm condition (crossing of a threshold for example), the associated message is displayed on the front panel LCD and the LED Alarm (LED 2) lights up.

Alarm messages generated by the electrical power network.

4.1 Electrical Network Alarms

Any crossing of a threshold (instantaneous or time delay) generates an "electrical network alarm". The involved threshold is indicated. Regarding the phase thresholds, the phase designation is also displayed.

If several alarms are triggered, they are all stored in their order of appearance and presented on the LCD in reverse order of their detection (the most recent alarm first, the oldest alarm last). Each alarm message is numbered and the total number of alarm messages is displayed.

The user can read all the alarm messages pressing.

The user acknowledges and clears the alarm messages from the LCD pressing.

The user can acknowledge each alarm message one by one or all by going to the end of the list to acknowledge, and clear, all the alarm messages pressing.

The control of the ALARM LED (LED 2) is directly assigned to the status of the alarm

If all the messages have been ACKNOWLEDGED, and cleared, if the cause that generated the alarm disappears, the ALARM LED (LED 2) is extinguished.

the different electrical system alarms are listed below:

```
le>      1st stage earth fault threshold
le>>    2nd stage earth fault threshold
le>>>   3rd stage earth fault threshold
tle>    1st stage earth fault time-out
tle>>   2nd stage earth fault time-out
tle>>>  3rd stage earth fault time-out
```

5. MENU





The menu of HF1021relay is divided into main menus and submenus.

5.1 Default display

By default, the LCD displays the current value measured. As soon as an alarm is detected by the relay, that information is considered as more important and the alarm message is then displayed instead of the default value.

The user can configure the information he wants to display by default going under the CONFIGURATION/Display menu.


5.2 Access To The Menu

Navigation through the different menus is done pressing the arrow keys , , , 

The organization of the menus is shown in figure as follows.

There is need of an unlock key when reading parameters and measured values.


Modification of a parameter requires entering a password.


Should an error be made in entering a parameter, press  to cancel

5.3 Menu Contents Description

The menu of HF1021relay is divided into 8 main sections:

- ⇒ OP PARAMETERS
- ⇒ CONFIGURATION
- ⇒ MEASUREMENTS
- ⇒ COMMUNICATION
- ⇒ PROTECTION
- ⇒ AUTOMATIC CTRL
- ⇒ RECORDS

To access these menus from the default display press 

To return to the default display from this menu or sub-menu press 

Ratings

Voltage

Nominal voltage
57 – 130V_{ph - ph eff}

Operating range
0.5 to 200V_{ph - ph eff}

Duration

Thermal withstand
Continuous
10 seconds

(V_n = 57V ... 130V)
260V_{ph - ph eff}
300V_{ph - ph eff}

Auxiliary Voltage

Nominal ranges 48... 150 Vdc

Frequency

Nominal value 50Hz
Operating range 40 – 60 Hz
Nominal value 60Hz
Operating range 50 – 70 Hz

Logic inputs

All the logic inputs are optically-isolated and independent :HF9024 relay has 2 logic inputs.

Energization of the logic inputs is realised with a DC or AC auxiliary voltage.

Auxiliary voltage: 48-150VDC/32-100VAC

Logic input recognition time = 5 ms

Output Relay Contacts

The output contacts of HF9024 RELAY are AgCdO dry contacts.

Make and carry :	30A for 3s
Carry :	5A continuous
Break :	DC : 50W resistive DC : 25W inductive (L/R = 40ms) AC : 1250VA AC : 1250 VA inductive (cos φ = 0.5)
Maxima :	5A and 300V
Loaded contact :	10 000 operation minimum
Unloaded contact :	100 000 operation minimum
Operation time	< 7 ms

BURDENS

Voltage circuits

REFERENCE VOLTAGE (VN)

VN = 57 – 200V <0,25 VA

VN = 220 – 480V <0,36 VA

Auxiliary supply

Nominal* : 3W

* Nominal is with 50% of the optos energised and one relay per card energised

Optically-isolated inputs

Reference voltage

Current (per logic input)

PROTECTION SETTING RANGES

UNDERVOLTAGE (ANSI CODE 27)

Threshold settings (secondary values)

> Nominal voltage range : 57 – 130V

V<= Voltage Set 0.5...130.0V

V<<= Voltage Set 0.5...130.0V

V<<<= Voltage Set 0.5...130.0V

Time delay settings

Each voltage element is associated to an independent time delay.

Each measuring element time delay can be blocked by the operation of a user defined logic (optical isolated) input (see “Blocking logic1” or “Blocking logic2” functions).

Element	Time delay type
1st stage	Definite Time (DT) or IDMT
2nd stage	DT
3rd stage	DT

Inverse Time Delay Characteristic

The inverse characteristic is defined by the following formula :

$$t = \left(\frac{TMS}{\left| \frac{V}{V_s} - 1 \right|} \right)$$

where :

t = operating time in seconds
TMS = time Multiplier Setting
V = applied input voltage
Vs = relay setting voltage

NOTE : this equation is only valid for $\frac{V}{V_s}$ ratio < than 0.95

TMS	0.5...100.0	(by step: 0.5)
TRESET (only DT)	40ms	

Hysteresis

Hysteresis 1.02... 1.05%

NOTE : this range is a percentage value of the pickup value of the undervoltage elements

OVERVOLTAGE (ANSI CODE 59)

Threshold settings (secondary values)

> Nominal voltage range : 57 – 130V

V>= Voltage Set 0.5...200.0V

V>>= Voltage Set 0.5...260.0V

V>>>= Voltage Set 0.5...260.0V

Time delay settings

Each voltage element is associated to an independent time delay.

Each measuring element time delay can be blocked by the operation of a user defined logic (optical isolated) input (see “Blocking logic1” or “Blocking logic2” functions).

Element	Time delay type
1st stage	Definite Time (DT) or IDMT
2nd stage	DT
3rd stage	DT

Inverse Time Delay Characteristic

The inverse characteristic is defined by the following formula :

$$t = \left(\frac{TMS}{\left| \frac{V}{V_s} - 1 \right|} \right)$$

where :

t	= operating time in seconds
TMS	= time Multiplier Setting
V	= applied input voltage
Vs	= relay setting voltage

NOTE : this equation is only valid for $\frac{V}{V_s}$ ratio > than 1.1

TMS 0.5...100.0 (by step: 0.5)

TRESET (only DT) 0.00... 100.00s

When the V> is associated with IDMT curve, the recommended maximum setting value should be less or equal to max. setting range divided by 20.

Definite time delay characteristics

tV> 0.00... 599.00s

tV>> 0.00... 599.00s

tV>>> 0.00... 599.00s

Hysteresis

Hysteresis 95%...100%

NOTE : this range is a percentage value of the pickup value of the overvoltage elements

Time delay settings

Each voltage element is associated to an independent time delay.

Each measuring element time delay can be blocked by the operation of a user defined logic (optical isolated) input (see “Blocking logic1” or “Blocking logic2” functions).

Element	Time delay type
1st stage	Definite Time (DT) or IDMT
2nd stage	DT

Inverse Time Delay Characteristic

The inverse characteristic is defined by the following formula :

$$t = \left(\frac{TMS}{\left| \frac{V_1}{V_s} - 1 \right|} \right)$$

where :

t	= operating time in seconds
TMS	= time Multiplier Setting
V1	= applied input voltage
Vs	= relay setting voltage

TMS	0,5... 100.0	(by step: 0.5)
tRESET (only DT)	0.00... 100.00s	

Definite time delay characteristics

tV1<	0.00... 599.00s
tV1<<	0.00... 599.00s

Hysteresis

Hysteresis fixed	105%
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COMMUNICATIONS

FRONT PORT (RS232)

Front port Communication Parameters
(Fixed)Protocol Modbus RTU
Address To be specified in the

« COMMUNICATIONS » menu of the relay

Messages format IEC60870FT1.2
Baud rate 19200 bits/s
Parity Without
Stop bits 1
Data bits 8

REAR PORT (RS485)

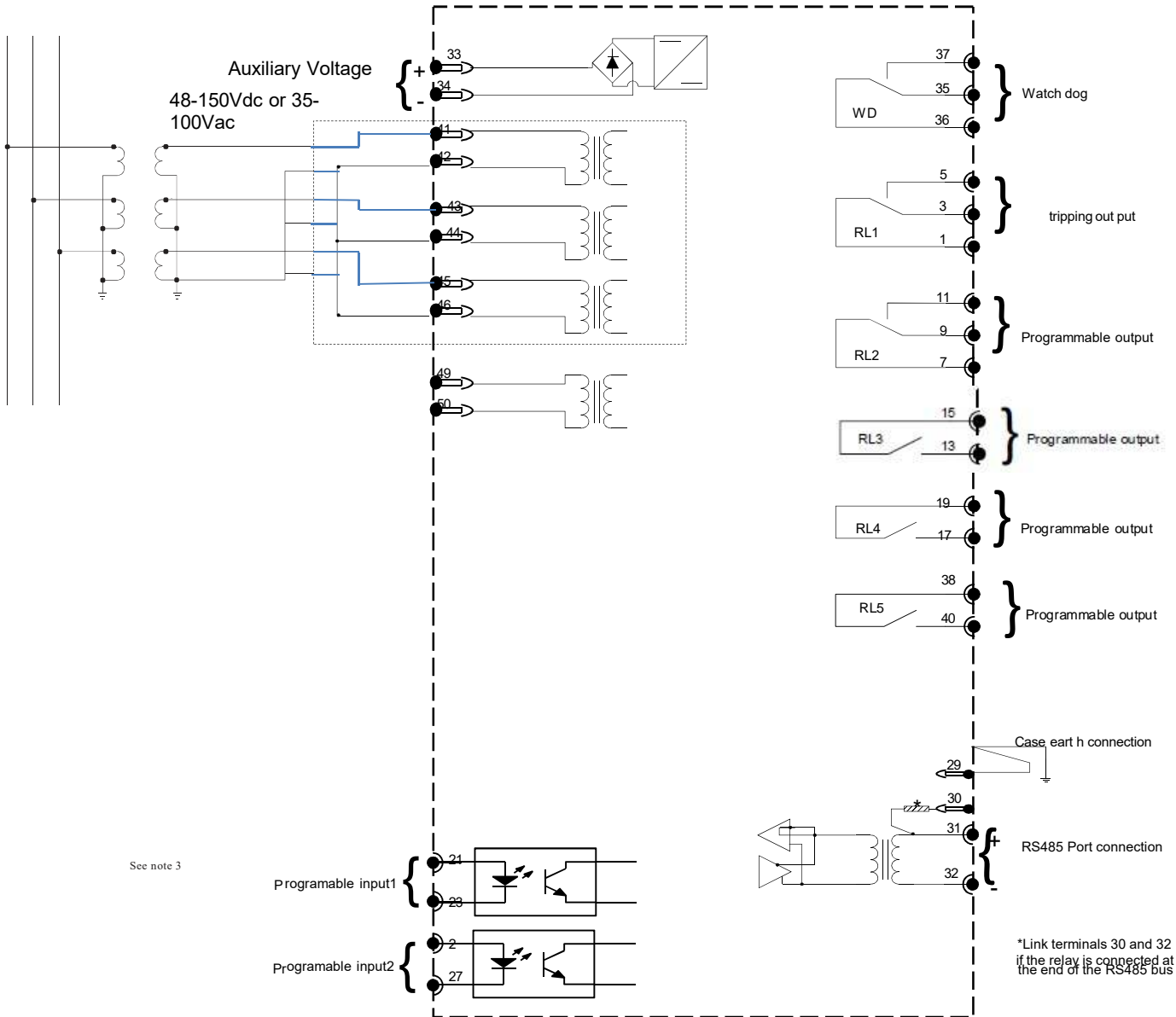
Rear port settings	Setting options	Setting available for:
Remote address	0 - 255 (step = 1)	Modbus RTU
Baud rate	9 600 or 19 200 bits/s	IEC
Baud rate	300, 600, 1200, 2400, 4800, 9600, 19 200 or 38 400 bits/s	Modbus
Baud rate	64000 bits/s	Kbus
Parity	“Even”, “Odd” or “Without”	Modbus RTU
Stop bits	0 or 1 or 2	Modbus RTU

VT RATIOS


The primary and secondary rating can be independently set for each set of VT inputs, for example the residual VT ratio can be different to that used for the phase voltages.

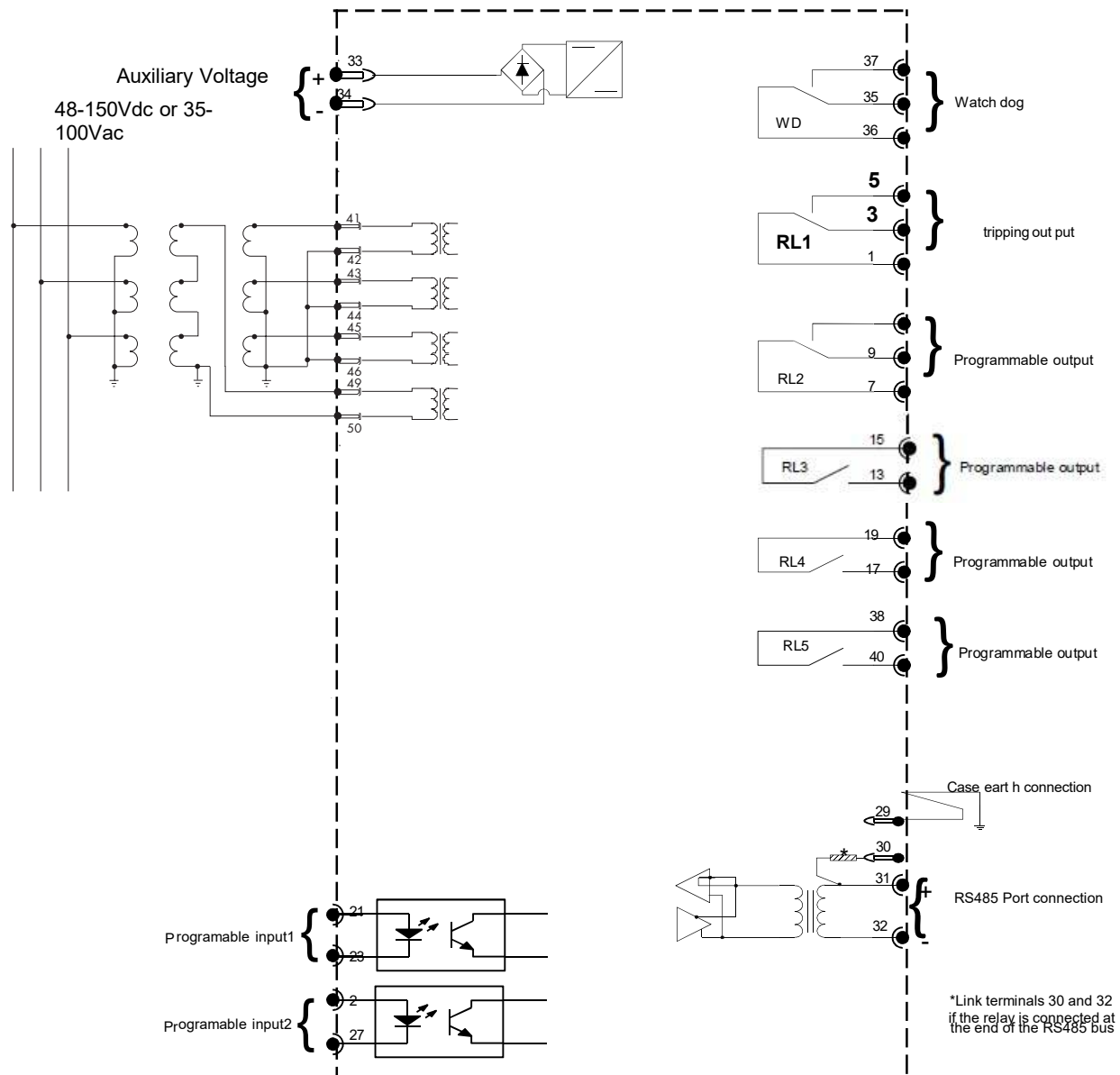
Voltage ranges	Primary	Secondary
57 – 130V	0,1 – 100kV step = 0.01kV	57 – 130V step = 0.1V
220 – 480V	220 – 480V step = 10V	220 – 480V step = 10V **


**** By customer order**



See note 3

	Date: 99/10/27	Page 1/1	Drawn By:
	Revision: V 002		Checked By:
	HF9024 (DUA2.1)		Approved By: Araghi



	Date: 99/10/27	Page 1/1	Drawn By:
	Revision: V 002		Checked By:
	HF9024 (DUA2.1)		Approved By: Araghi