همیان فن
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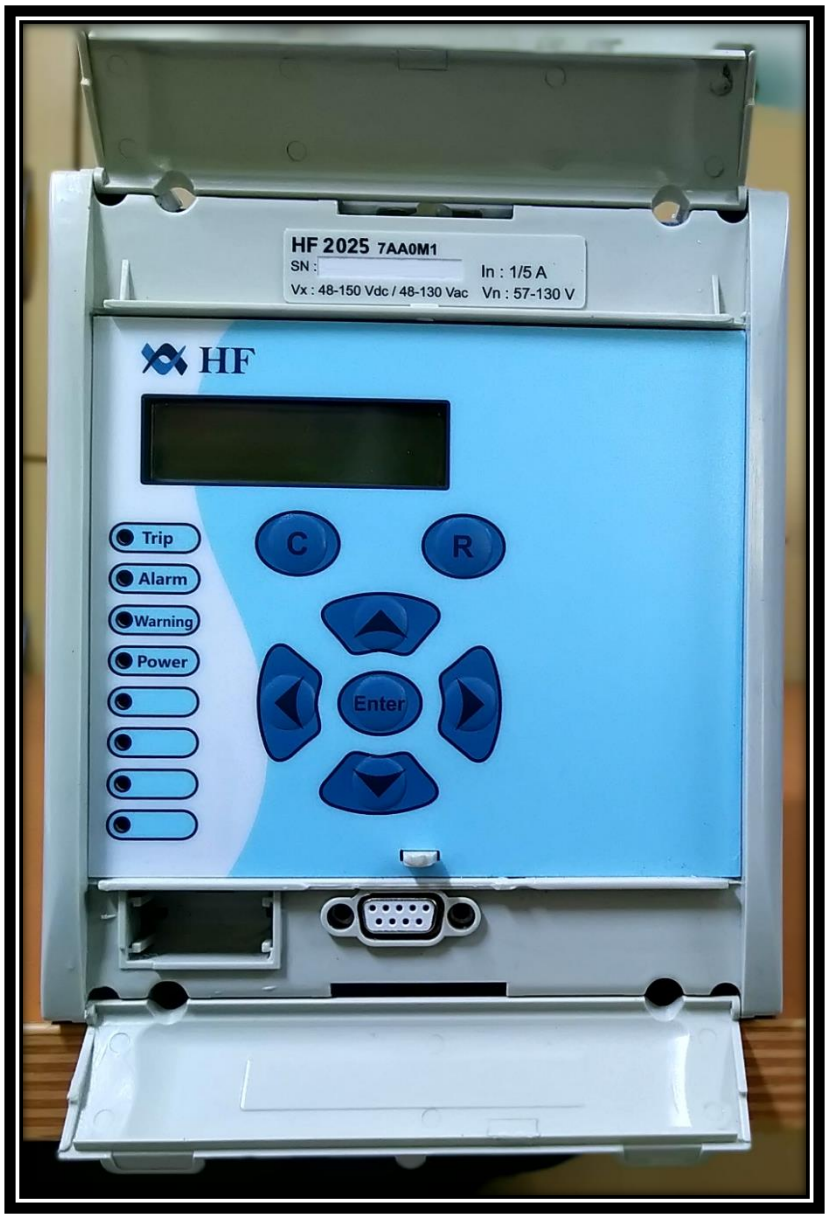
HF2025

Motor Protection Device

Technical Manual, Volume 1



Warning!

When electrical equipment is in operation dangerous voltage will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use or improper use may endanger personnel and equipment and cause personal injury or physical damage. Before working in the terminal strip area, the HF2025 must be isolated. Where stranded conductors are used, insulated crimped wire must be employed.

Any modifications to this HF2025 must be in accordance with the manual. If any other modification is made without the express permission of Hamian Fan Company, it will invalidate the warranty, and may render the product unsafe.

Proper and safe operation of this HF2025 depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing.

Contents

1 INTRODUCTION

1.1 Introduction

The HF2025 is a dedicated motor IED perfectly aligned for the protection, control, measurement and supervision of asynchronous motors in manufacturing and process industry. The HF2025 protection relay range is designed for motor protection applications. A complete set of protection functions is performed on the measurement of current, voltage and temperature. In addition to these basic functions, the relay carries out a large number of other functions that enable it to protect and run the motor more effectively.

1.2 Description of the HF2025 motor protection relay

The HF2025 relay uses digital techniques to fulfil the functions of protection, control and monitoring of motors.

The HF2025 relay is equipped with up to eight current inputs (2 times 4 earth and phase current inputs). The current inputs have dual ratings of 1 or 5 amperes (it is possible to combine an earth current rating of 1 A and a phase current rating of 5 A). HF2025 has 1 phase to phase voltage inputs. The voltage input's rating is either 57-130V or 220-480V (selected at time of order). These ranges make the relay suitable for connection to a VT secondary or direct connection to a system supply voltage of up to 440V.

It is possible to program the output relays to respond to any of the protection or control functions available. The different logic inputs can also be allocated to control functions.

Satisfactory operation of the HF2025 relay is guaranteed during brief interruptions of the auxiliary power supply lasting less than 50ms.

The front panel gives the operator access to the data of the HF2025 relay either via LEDs or via the display unit and the keypad. The various alarms are stored in the memory and made available to the operator on the backlit display device. These alarms can be read and acknowledged directly without a password. All the parameters and measurements are accessible without a password. The setting values can only be modified after entering the password stored in the memory.

The HF2025 relay records and measures a large number of data with high accuracy. It continuously measures the phase and earth currents and continuously measures the phase-phase voltage taking into account the true RMS values up to the 10th harmonic for a 50 Hz motor.

The HF2025 relay has on the rear connector a RS485 type link with a choice of MODBUS™ communication protocol. This enables the operator to read the data stored by the relay (measurements, alarms, parameters), or modify the different settings and allocations of outputs of each relay, or transmit remote controls.

It is also possible to reassemble or modify these data via the RS232 communication located on the front panel by using the SARA software.

The HF2025 relay can be connected directly via this link to a digital monitoring and control system (for example: SARA, SCADA). All the data available are then at the disposal of the supervisor and can be utilized either locally or remotely.

The HF2025 relay can be withdrawn while it is live. This means that its live parts can be withdrawn from the metal housing while the relay is supplied with power via the auxiliary source. When the relay is drawn out of its housing:

The current circuits from the phase and earth CTs are not interrupted thanks to the presence of internal short-circuiting devices located at the current inputs (metal housing part),

-no tripping order is generated,

-the watchdog relay drops out,

the RS485 link is not interrupted. However, communication is no longer possible for the relay which is drawn out.

1.3 HF2025 overview

HF2025 are fully numerical relays designed to perform electrical protection and control functions.

The following sections describe content and structure of the menu.

The five keys situated in the middle of the HF relay front panel are dedicated to set parameters.

With the keys it is possible to move in the direction indicated to the various levels of the menus. The key validates the settings modification.

The two keys READ and CLEAR are dedicated to acknowledging/clearing and displaying/reading of data. For example, if successive alarms are to be displayed, press on CLEAR key.

The alarms are presented in reverse order of their detection (the most recent alarm first, the oldest last). The user can either acknowledge and clear each alarm from the LCD by using READ key or go to the end of the ALARM menu and carry out a general acknowledgement.

1.4 Front view

The front panel is described in figure 1. Extra physical protection for the front panel can be provided by an optional transparent front cover. This allows read access only to the relay settings and data but does not affect the relay IP rating. When full access to the relay keypad is required, for editing the settings, the transparent cover can be unclipped and removed when the top and bottom covers are open.

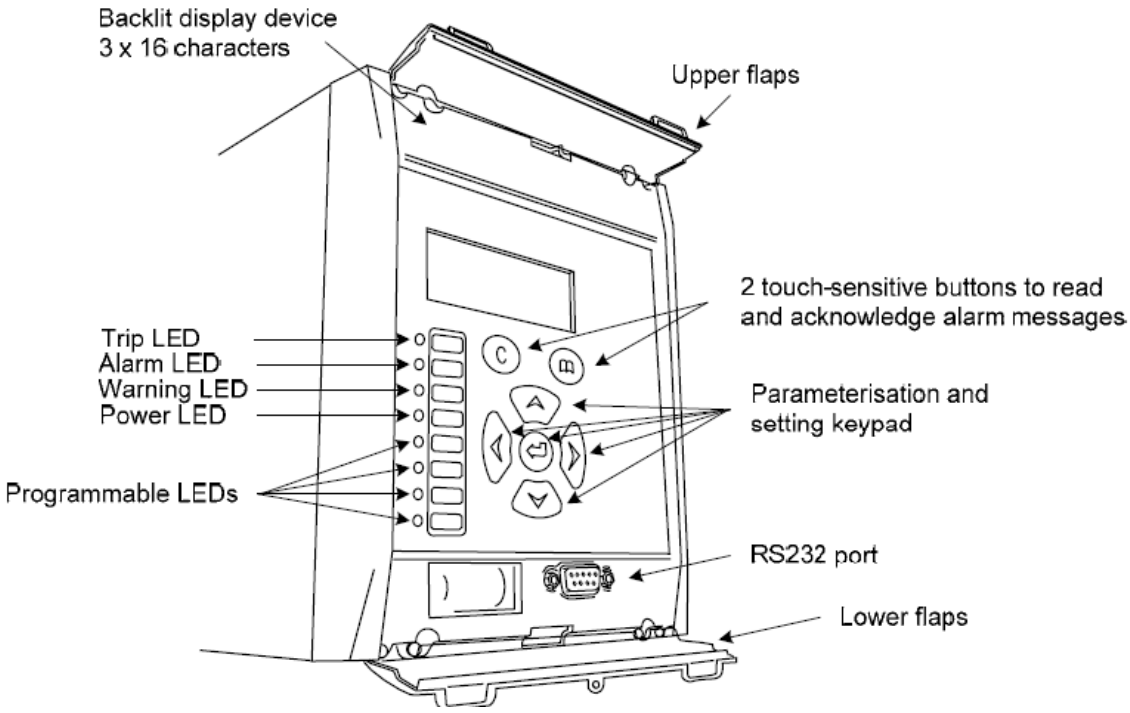


Figure 2 - front panel of the HF 2025 relay

The front panel of the relay includes the following, as indicated in figure1:

- 16 character by 2-line alphanumeric liquid crystal display (LCD)
- 7-Keypad comprising 4 arrow keys (an ENTER key, a CLEAR key,and a READ key)
- 8 LEDs: 4 fixed function LEDs and 4 programmable function LEDs on the left hand side of the front panel
- Under the top hinged cover:
  - The relay serial number and the relay voltage rating information (see figure 3 in this chapter)
- Under the bottom hinged cover:
  - A 9 pin female D-type front port for communication with a PC locally to the relay (up to 15m distance) via an RS232 serial data connection (SK1 port).

1.4.1 LCD display and keypad description

The front panel components are shown below. The front panel functionality is identical for the HF2025 relays.

1.4.1.1 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.

1.4.1.2 Keypad

The keypad has seven keys divided into two groups:

Two keys located just under the screen (keys CLEAR and READ).

Keys READ and CLEAR are used to read and acknowledge alarms. To display successive alarms, press READ 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 CLEAR or go to the end of the ALARM menu and acknowledge all the alarms at the same time.

When navigating through submenus, key CLEAR is also used to come back to the head line ofthe corresponding menu.

NOTE:

To acknowledge a relay latched refer to the corresponding submenu section.

Four main keys UP, DOWN, LEFT, RIGHT 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 LEFT key is used to validate a choice or a value (modification of settings).

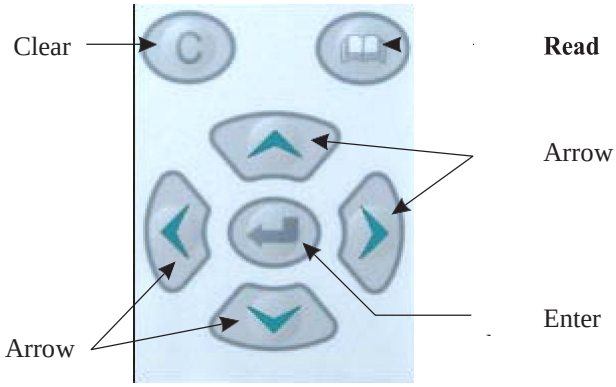


Figure 3 - HF2025 keypad

1.4.2 LEDs

The LED labels on the front panel are by default written in English, however the user has self-adhesive labels available with **HF** relays on which it is possible to write using a ball point pen.

The top four LEDs indicate the status of the relay (Trip condition, alarm LED, warning LED, auxiliary supply).

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):

Figure4 - LEDs

The fixed function LEDs are used to indicate the following conditions:

LEDs	**Color**	**Labels**	**Significance**
LED 1	Red	Trip	LED 1 indicates when a trip order has been issued bythe relay to the cut-off element (circuit breaker, contactor). This LED re-copies the trip order issued tothe trip output contact (RL1). Its normal state is unlit. It will light as soon as a trip order is issued. It goes out when the associated alarm is acknowledged (by pushing the CLEAR key).
LED 2	Yellow	Alarm	Upon detection of a fault or an alarm (CB state) by HF2025 relay, the LED will start flashing. After reading of the alarm(s) message(s) by pressing the READ key, the LED will change from flashing to constant illumination, and will extinguish when all the alarms are cleared (CLEAR Key). The alarms are either threshold crossings (instantaneous), or tripping orders (time delayed).
LED 3	Yellow	Warning	LED 3 is dedicated to the internal alarms of HF2025 relays. When a “non critical” internal alarm (typically communication Fault) is detected, the LED flashes continuously. When the fault is classified as “critical”, the LED is illuminated continuously. Theextinction of this LED is only possible by the disappearance of the cause that

			caused its function (repair of the module, disappearance of the fault).
LED 4	Green	Power	LED 4 indicates that HF2025 relays are working correctly.
LED 5 to LED 8	Red	Aux1 to Aux4	These LEDs can be programmed by the user on the basis of information on available thresholds (instantaneous and time-delayed). The user selects the information he wishes to see associated with an LED. Each LED illuminates when the associated informationis valid. The extinction of each LED is linked to the acknowledgement of the associated alarms.

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

1.4.3.1 Relay Identification

Prior to applying power, unclip the top cover and check that the model number of the relay listed on the front panel (top left) corresponds to the model ordered.

Under the top hinged cover there is an adhesive paper label that contains the relay model number, serial number, sensitive earth current range, rating information and the Cortex code for ordering etc.

1.4.3.2 Communication Port

Under the bottom hinged cover of the relay, a 9-pin female D-type socket, can be used to communicate with a local PC (up to 15m distance) via a RS232 serial data link cable (SK1 port).

The USB/RS232 cable provides an USB / RS 232 interface between the HF relay and the PC. This allows the user to be able to change the setting of the relay using a PC with its USB port.

It eases the use of the relay allowing the retrieval of records and disturbance files for example when the auxiliary supply has failed or is not available.

The associated driver (supplied with the relay) needs to be installed in the PC.

1.4.4 General features

The HF2025 rear panels comprise 3 connectors. The next figure represents the HF2025 rear plates with thermistor monitoring or relays with RTDs monitoring options (green connector).

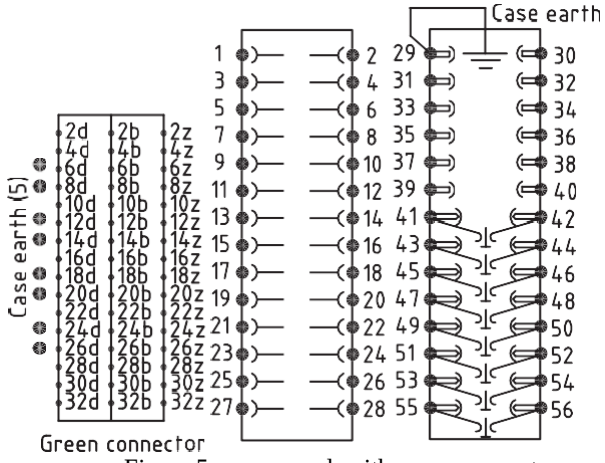


Figure 5 – rear panel, with green connector

The connection layout is detailed in the corresponding section.

1.5 Main functions

The following table shows the functions available with the models.

Protection functions	**HF2025**
[49] Thermal overload Replica	✓
[50/51] Phase overcurrent	✓
[50N/51N] Earth fault	✓
[46] Unbalance	✓
[27] Undervoltage	✓
[59] Overvoltage	✓
[48] Excess long start	✓
[51LR-50S] Blocked rotor	✓
[37] Loss of load	✓
[49/38] Thermal overload with RTD	✓
Control and monitoring	**HF2025**
[27] Anti backspin (ABS)	✓
Emergency start	✓
Min time between 2 starts	✓
General reset, start or stop motor local control (orders menu)	✓
Alarm inhibition facilities	✓
Boolean equations (AND, AND NOT, OR and OR NOT gates, 8 equations)	✓
Circuit Breaker Supervision and Monitoring	✓
Trip circuit supervision	✓
Setting groups	2
Measurements and records	**HF2025**
Measurements (True RMS + direct/derived Current/Voltage + MAX Value)	✓

Hardware	**HF2025**
Digital inputs	6
Output relays	6
Bus voltage control	1
RTD connections (optional)	6
1/5 dual rated AC current inputs (settable)	4
Re-acceleration. authorization	✓
Auto re-start	✓
Process menu	✓
Trip statistics	✓
Latching relays	✓
Communication protocols	**HF2025**
Modbus RTU	✓
RS485 rear communication port	✓
Events records	250
Disturbance records	5
Communications	**HF2025**
RS232 front communication port	✓
Faults records	250

HF2025 order information

HF2025 Motor Protection	HF2025	8	C	A	2	Z	1
Variant							
Motor Protection with Sensitive Earth fault with 8 RTD Monitoring		**8**					
Earth current input							
0.1 to 40 Ion			**A**				
0.01 to 8 Ion			**B**				
0.002 to 1 Ion			**C**				
Voltage input							
57 - 130 V				**A**			
220 - 480 V				**B**			
Optional features							
None					**0**		
3 thermistors monitoring (1 voltage input)					**1**		
8 RTD monitoring (1 voltage input)					**2**		
3 Voltage inputs					**3**		
3 Voltage inputs + IRIG-B / Second communication port / 5 digital inputs					**4**		
Auxiliary voltage	**Digital input voltage**						
48 - 150 Vdc / 48 - 130 Vac	24 - 250 Vdc / 24 - 240 Vac					**M**	
48 - 250 Vdc / 48 - 240 Vac	24 - 250 Vdc					**T**	
48 - 250 Vdc / 48 - 240 Vac	110 Vdc -30% / +20% (special application)					**V**	
48 - 250 Vdc / 48 - 240 Vac	220 Vdc -30% / +20% (special application)					**W**	
24 - 130 Vdc / 48 - 220 Vac	24 - 250 Vdc / 24 - 240 Vac					**Z**	
Communication interface							
MODBUS / MODBUS (RS485 /RS232)							**1**
KBUS / COURIER / MODBUS - not available							**2**
IEC60870-5-103 / MODBUS (if 2nd RS485 available)							**3**
DNP3 / MODBUS (if 2nd RS485 available)							**4**
IEC60870-5-103 / IEC60870-5-103 (if 2nd RS485 available)							**5**
Modbus TCP/IP / Modbus (if 2nd RS485 available)							**6**
IEC60870-5-103 Eth / Modbus (if 2nd RS485 available)		(with voltage V&W only)					**7**

2 TECHNICAL DATA

2.1 Protection functions

2.1.1 Too long start-up protection (Start-Up criteria)

Too long start-up protection (Start-Up criteria)	
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional
Current threshold I_{UTIL}	0.5 to 5 In by steps of 0.01 In
Time-delay tI_{start}	1 to 200 s by steps of 1 s
Thermal replica [ANSI 49]	
Thermal current threshold Iθ >	0,2 to 1,5 In by steps of 0,01
Negative sequence current recognition factor K_e	0 to 10 by steps of 1
Overload time-constant T_{e1}	1 to 180 min by steps of 1min
Start-up time-constant T_{e2}	1 to 360 min by steps of 1min
Cooling time-constant T_r	1 to 999 min by steps of 1min
Trip thermal threshold	Set to 100%
Thermal alarm threshold	20 to 100% by steps of 1%
Thermal trip & alarm thresholds hysteresis	97%
Start-up inhibition	20 to 100% by steps of 1%
Short-circuit protection [ANSI 50/51]	
Current threshold I>	0.1 to 25 In by steps of 0.05 In
Delay type:	DT, IDMT or RI
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s
Reset time t_{Reset}	0 to 600 s by steps of 0,01 s
Interlock with I>> & I>>> (IDMT)	Yes / No
Reverse Time Multiplier Setting (IDMT reset delay type)	0.025 to 1.5 by steps of 0.01
K multiplier (RI curve)	0.1 to 10 by steps of 0.001
Current threshold I>>	0.5 to 40 In by steps of 0,05 In

Delay type:	DT, IDMT or RI
Time delay tI>> (DMT)	0 to 150 s by steps of 0,01 s
Reverse Time Multiplier Setting (IDMT reset delay type)	0.025 to 1.5 by steps of 0.01
K multiplier (RI curve)	0.1 to 10 by steps of 0.001
Current Time delay tI>>>	0 to 150s by steps of 0,01 s
threshold I>>>	0.5 to 40 In by steps of 0.05 In
threshold I>>>	0.5 to 40 In by steps of 0.05 In
Time delay tI>>> (DMT)	0 to 150 s by steps of 0,01 s
Operating time	< 40 ms
Drop-off time	< 30 ms
Hysteresis	95 %
Earth fault protection [ANSI 50/51N]	
Current threshold Io>, Io>>	0,002 to 1 Ion by steps of 0,001 Ion
Time-delays tIo>, tIo>>	0 to 100 s by steps of 0,01 s
Operating time	< 40 ms
Drop-off time	< 30 ms
Hysteresis	95%
Unbalance protection [ANSI 46]	
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In
Time-delay tI2>	0 to 200 s by steps of 0,01 s
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In
IDMT time-delay	t = TMS x 1,2/(I2/In)
Time Multiplier setting TMS I2>>	0,2 to 2 by steps of 0,001
Hysteresis	95%
Undervoltage protection [ANSI 27]	
Voltage threshold V< Range A	5 to 130 V by steps of 0,1 V
Voltage threshold V< Range B	20 to 480 V by steps of 0,5 V
Time-delay tV<	0 to 600 s by steps of 0,01 s
V< inhibition during start-up	Yes/No
Hysteresis	105 %
Overvoltage protection [ANSI 59]	
Voltage threshold V> Range A	5 to 260 V by steps of 0,1 V
Voltage threshold V> Range B	20 to 960 V by steps of 0,5 V
Time-delay tV>	0 to 600 s by steps of 0,01 s
Hysteresis	95 %
Locked rotor protection [ANSI 51LR/50S]	
Current threshold I_{stall}	0.5 to 5 In by steps of 0.01 In
Time-delay tI_{stall}	0,1 to 60 s by steps of 0,1 s
Locked rotor at start-up detection	No/Input/Power Factor
Power factor	from 0.01 to 1 by steps of 0,01
Hysteresis	95%
Under current (Loss of load) protection [ANSI 37]	
Current threshold I<	0,1 to 1 In by steps of 0,01 In
Time-delay tI<	0,2 to 100 s by steps of 0,1 s
Inhibition time at start-up Tinhib	0,05 to 300 s by steps of 0,1 s
Hysteresis	105%

2.2 Automation functions

Limitation of the number of start-ups [ANSI 66]	
Reference period $T_{reference}$	10 to 120 min by steps of 5 min
Number of cold starts	1 to 5 by steps of 1
Number of hot starts	0 to 5 by steps of 1
Restart inhibition time $T_{Interdiction}$	1 to 120 min by steps of 1 min
Time between 2 start-ups	
Inhibition time $T_{betw\ 2\ start}$	1 to 120 min by steps of 1 min
Anti-backspin protection	
Restart prevention time tABS	1 to 7200 s by steps of 1 s
Re-acceleration authorization	
Voltage dip detection Range A	37 to 98 V by steps of 0.2 V
Voltage dip detection Range B	143 to 360 V by steps of 0.2 V
Voltage restoration detection Range A	45 to 117 V by steps of 0.2 V
Voltage restoration detection Range B	176 to 32 V by steps of 0.2 V
Voltage collapse duration T_{reacc}	0.1 to 5 s by steps of 0,01 s
Auto Re-Start delay $t_{reacc\ long}$	OFF to 60 s by steps of 1 s
Auto Re-Start restoration delay $t_{reacc\ shed}$	OFF to 99 min by steps of 1 min
Presence of bus voltage prior to start-up	
Voltage threshold Range A	5 to 130 V by steps of 0,1 V
Voltage threshold Range B	20 to 480 V by steps of 0,5 V
Hysteresis	105 %
CB failure	
Current threshold I< BF	10 to 100% In by steps of 10% In
Time-delay tBF	0,03 to 10 s by steps of 0,01 s
Trip circuit supervision	
Time-delay tSUP	0,1 to 10 s by steps of
Auxiliary timers	
Logic inputs with alarm on occurrence	tAux1 to tAux10
Timers tAux1 to tAux10	0 to 200 s by steps of 0,01s
Logic equation	
8 independents equations are available.	
Each one can used a maximum of 16 operands among all start and trip signalEach one can use NOT, OR, AND, OR NOT, AND NOT logical gates.	
t operates	0 to 600s in steps of 0.01s
t Reset	0 to 600s in steps of 0.01s
Latching of output relays	
Trip relay (RL1)	Configurable for each trip order
Auxiliary relays (RL2, RL3, RL4 and RL5)	Configurable for each auxiliary relay
CB control and monitoring	
Close command hold	0,2 to 5 s by steps of 0,05 s
Open command hold	0,2 to 5 s by steps of 0,05 s
Number of operations alarms	0 to 50 000 operations by steps of 1
Summated contact breaking duty	10^6 to 4 000.10^6 by steps of
Adjustment of the exponent «n»	1 or 2
Opening time alarm	0,05 to 1 s by steps of 0,05 s

2.3 Recording functions

Event recorder	
Capacity	250 events
Time-tag	to 1 millisecond
Triggers	Any protection alarm & threshold Self-test events
Fault recorder	
Capacity	25 records
Time-tag	to 1 millisecond
Triggers	Any trip order (RL1 operation)
Data	Fault record number Fault date & hour Active setting group Faulty phase(s) Fault type, protection threshold Fault current/ and earth current magnitudes Phase A-Phase C voltage magnitude
Oscillography	
Capacity	5 records
Duration of each record	3 s
Sampling rate	32 samples per frequency cycle
Pre-time setting	0,1 to 2,5 s by steps of 0,1 s
Post-time setting	0,1 to 2,5 s by steps of 0,1 s
Triggers	Any protection threshold overreach or any trip order (RL1 relay operation) logic input Remote command
Data	4 analogue current channels (3ph. + N) Logic input and output states Frequency value 1 analogue voltage channel

2.4 Communication

Type Port	**Relay position**	**Physical Link**	**Connectors**	**Data Rate**	**Protocol**
RS485	Rear port	Screened twister pair	Screws or snap-on	300 to 38400 baud (programmable)	ModBus RTU
RS232	Front port	Screened twister pair	Sub–D 9 pin female connector	300 to 38400 baud (programmable)	ModBus RTU

MODBUS™ communication	
Mode	RTU (standard)
Transmission mode	Synchronous
Interface	RS 485, 2 wires + shielding
Data rate	300 to 38 400 bauds (programmable)
Relay address	1 to 255
Parity	Settable
Date format	IEC format or Private format
Connection	Multi-point (32 connections)
Cable	Half-duplex (screened twisted wire pair)
Maximum cable length	1000 meters
Connector	Connector screws or snap-on
Insulation	2 kV RMS
Front communication	
Interface	RS232
Protocol	MODBUS™ RTU
Data rate	19200 bauds
Parity	Without
Stop bit	1
Data bits	8
Connector	Sub-D 9 pin female connector
Cable type	Screened twisted wire cable, no-crossed

2.5 Inputs and outputs

Analogue current inputs	
Phase currents In	1 and 5 Ampere
Earth current Ion	1 and 5 Ampere
Frequency Range	45 to 65 Hz
Frequency Nominal	50 Hz
Burdens Phase current inputs	< 0.3 VA @ In (5A) < 0,025 VA @ In (1A)
Burdens Earth current input	< 0.01 VA @ 0.1Ion (5A) < 0,004 VA @ 0,1 Ion (1A)
Thermal withstand of both phase and earth current inputs	100 In - 1 s 40 In - 2 s 4 In - continuous
Analogue voltage inputs	
Phase A - Phase C voltage input	57-130 Volt (range A) 220-480 Volt (range B)
Frequency Range	45 to 65 Hz
Frequency Nominal	50 Hz
Burden	< 0,1 VA @ Vn
Thermal withstand Range A	260 V – continuous 300 V - 10 s
Thermal withstand Range B	960 V – continuous 1300 V - 10 s

Logic inputs	
Type	Independent optical isolated
Number: Standard	6 (5 programmable, 1 fixed)
Burden	< 10 mA for each input
Recognition time	< 5 ms

Supply rating							
Ordering Code	**Relay Auxiliary Power Supply**		**Logic Inputs**				
	Nominal Volt. Range Vx	**Operating Volt. Range**	**Nominal Voltage Range**	**Minimal Polarization Voltage**	**Maximum Polarization Current**	**Holding Current After 2 ms**	**Maximum Continuous Withstand**
H	48 - 250 Vdc 48 - 240 Vac	43.2- 300 Vdc 43.2 - 288 Vac	48 - 220 Vdc 48 - 220 Vac	105 Vdc	3.0 mA @ 129 Vdc		145 Vdc
V	24 - 150 Vdc 24 - 150 Vac	21.6 - 180 Vdc 21.6 - 180 Vac	24 - 150 Vdc 48 - 220 Vac	77 Vdc	7.3 mA @ 110 Vdc		132 Vdc

Output relay	
Contact rating	
Contact relay	Dry contact Ag Ni
Make current	Max. 30A and carrry for 3s
Carry capacity	5A continuous
Rated Voltage	250Vac
Breaking characteristic	
Breaking capacity AC	1500 VA resistive 1500 VA inductive (P.F. = 0.5) 220 Vac, 5A (cos φ = 0.6)
Breaking capacity DC	135 Vdc, 0.3A (L/R = 30 ms) 250 Vdc, 50W resistive or 25W inductive (L/R = 40ms)
Operation time	<7ms
Durability	
Loaded contact	10000 operation minimum
Unloaded contact	100000 operation minimum

2.6 Accuracy

ACCURACY	
Protection thresholds	± 2 %
Time delays	± 2 % with a minimum of 40ms
Measurements Current	Typical ± 0,2 % @ In
Measurements Voltage	Typical ± 0,2 % @ Vn
Measurements Power	Typical ± 1 % @ Pn
Measurements Temperature	± 2 °C
Pass band for measurements of true RMS values	500Hz

2.7 CT & VT data

ACCURACY	
Phase CTs primary	1 to 3000 by steps of 1
Earth CT primary	1 to 3000 by steps of 1
Phase CTs secondary	1 or 5
Earth CT secondary	1 or 5
Recommended phase CTs	5P10 - 5VA (typical)
Recommended earth CT	Residual connection or core balanced CT (preferred in isolated neutral systems)
VT primary	1 to 20 000 V by steps of 1 V
VT secondary Range A	57 to 130 V by steps of 0,1 V
VT secondary Range B	220 to 480 V by steps of 1 V

2.8 Insulation withstand

Insulation withstand		
Dielectric withstand	IEC 60255-5: 2000	2 kVrms 1 minute to earth and between independent circuits
Dielectric withstand	IEEE C39.90: 1989	1.5kV rms AC for 1 minute, (reaffirmed 1994) across normally open contacts
Impulse voltage	IEC 60255-5: 2000	5 kVp Between all terminals & all terminals and case earth
Insulation resistance	IEC 60255-5: 2000	> 1000 MΩ at 500 Vdc

2.9 Electrical environment

Electrical environment		
High Frequency Disturbance	IEC 60255-22-1:1998	2.5 kV common mode, class 31 kV differential mode, class 3
Fast Transient	IEC 60255-22-4:2002	Class A 2 kV 5kHz terminal block comms. 4 kV 2.5kHz all circuits excluding comms.
	EN 61000-4-4:1995 Level 4	2 kV 5kHz all circuits excluding power supply4 kV 5kHz power supply
Electrostatic Discharge	EN 61000-4-2:1995 &IEC60255-22-2:1996	8 kV contact discharge, class 415kV air discharge, class 4
Surge Immunity	EN 61000-4-5:1995 & IEC 60255-22-5:2002	4kV common mode, level 4 2kV differential mode, level 4
Conducted Emissions	EN55022:1998 & IEC 60255-25:2000	0.15 - 0.5MHz, 79dBµV (quasi peak)66 dBµV (average) 0.5 - 30MHz, 73dBµV (quasi peak)60 dBµV (average)
Radiated Emissions	EN55022:1998 & IEC 60255-25:2000	30 - 230MHz, 40dBµV/m at 10m measurementdistance 230 - 1GHz, 47dBµV/m at 10m measurementdistance
Conducted Immunity	EN 61000-4-6:1996 & IEC 60255-22-6:2001	Level 3, 10V rms @ 1kHz 80% am, 150kHz to80MHz
Radiated Immunity	EN 61000-4-3:2002 & IEC 60255-22-3:2000	Level 3, 10V/m 80MHz to 1GHz @ 1kHz 80%am
Radiated Immunity from Digital Telephones	EN 61000-4-3:2002	Level 4, 30V/m 800MHz to 960MHz and1.4GHz to 2GHz @ 1kHz 80% am
	ANSI/ IEEE C37.90.2:2004	35V/m 80MHz to 1GHz @ 1kHz 80% am35V/m 80MHz to 1GHz @ 100% pulse modulated front face only
Magnetic Field Immunity	EN 61000-4-8:1994	Level 5, 100A/m applied continuously, 1000A/m for 3s
	EN 61000-4-9:1993	Level 5, 1000A/m
	EN 61000-4-10:1993	Level 5, 100A/m at 100kHz and 1MHz
ANSI Surge Withstand Capability	IEEE/ ANSI C37.90.1:2002	4kV fast transient and 2.5kV damped oscillatory applied common and transverse mode

2.10 Environment

Temperature	IEC 60255-6: 1988 IEC 60068-2: 2007	<u>Standard</u> Storage -25°C to +70°C Operation -25°C to + 55°C <u>Extended</u> Storage -25°C to +85°C Operation -40°C to + 85°C Note: Operation at -40°C and +85°Conly up to 96 hours. Storage at +85°C only up to 96hours.
Humidity	IEC 60068-2-78: 2001	56 days at 93% RH and 40 °C
Enclosure Protection	IEC 60-529: 2001	IP 52 Protection (front panel) againstdust and dripping water IP 50 Protection for the rear and sidesof the case against dust IP 10 Product safety protection for therear due to live connections on the terminal block
Sinusoidal Vibrations	IEC 60255-21-1:1998	Response and endurance, class 2
Shocks	IEC 60255-21-2:1998	Response and withstand, class 1 & 2
Bump	IEC 60255-21-2:1998	Response and withstand, class 1
Seismic	IEC 60255-21-3:1998	Class 2
Creep age Distances and Clearances	IEC 60255-27: 2005	Pollution degree 2, Overvoltage category III, Impulse test voltage 5 kV

2.11 Equivalence between RTD measurements and temperature

The next table presents typical equivalence between measured value and temperature for each RTD type.

Temperature (°C)	100 OHM Platinum (Ω)	100 OHM Nickel (Ω)	120 OHM Nickel (Ω)	10 OHM Copper (Ω)
-40	84.27	79.13	92.76	7.490
-30	88.22	84.15	99.41	7.876
-20	92.16	89.23	106.41	8.263
-10	96.09	94.58	113.0	8.649
0	100.0	100.0	120.0	9.035
10	103.9	105.6	127.2	9.421
20	107.8	111.2	134.5	9.807
30	111.7	117.1	142.1	10.19
40	115.5	123.0	149.8	10.58
50	119.4	129.1	157.7	10.97
60	123.2	135.3	165.9	11.35
70	127.1	141.7	174.3	11.74
80	130.9	148.3	182.8	12.12
90	134.7	154.9	191.6	12.51
100	138.5	161.8	200.6	12.90
110	142.3	168.8	209.9	13.28
120	146.1	176.0	219.3	13.67
130	149.8	183.3	228.9	14.06
140	153.6	190.9	238.8	14.44
150	157.3	198.7	249.0	14.83
160	161.0	206.6	259.3	15.22
170	164.8	214.8	269.9	15.61
180	168.5	223.2	280.8	16.00
190	172.2	231.6	291.9	16.38
200	175.8	240.0	303.5	16.78

3 USER GUIDE

3.1 The menu

The menu of the HF2025 relay is organized into main menus, some of which are subdivided into submenus.

The operator dialogue of the HF2025 relay is divided into 11 main menus (menucolumn):

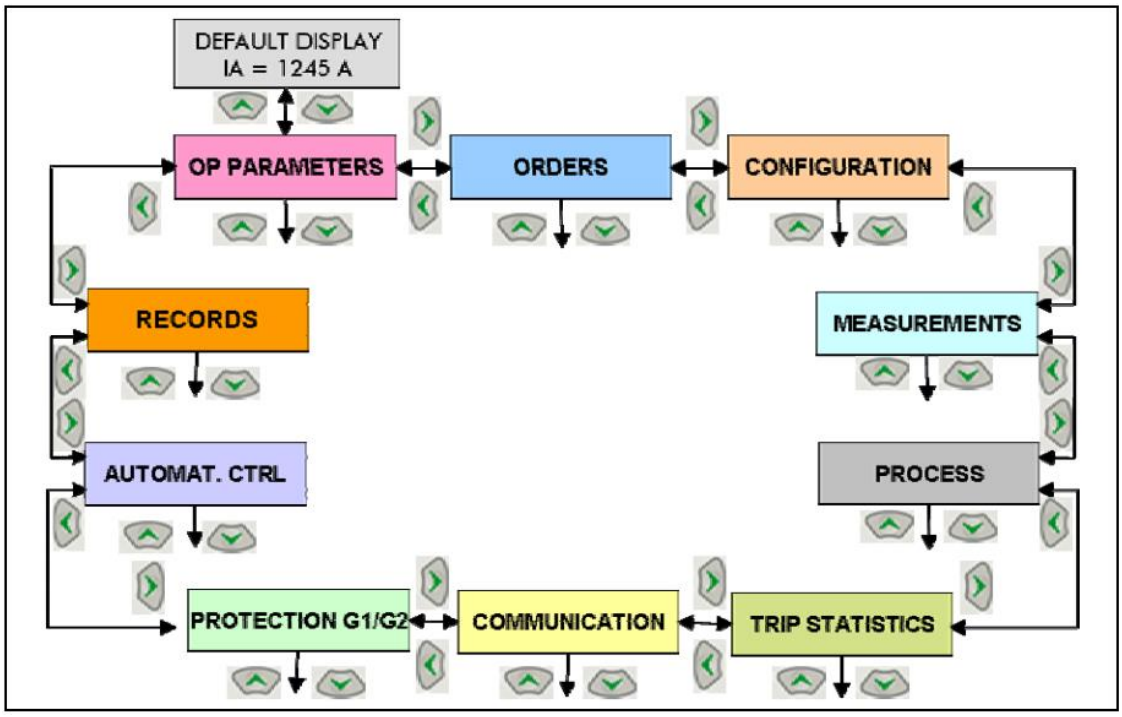


Figure 1 - organization of the menus of the HF2025 relay

Some of main menus are divided into submenus:

From the default display, access is gained to these different menus by using the DOWN key, then LEFT and RIGHT keys.

To return to the default display from any one of the menus, press the UP key.

3.1.1 Default display

By default, a value is continuously displayed, and the operator can select this value from alist in the 'CONFIGURATION/CONFIG. SELECT' menu ("Default display" cell).

As soon as an alarm is generated by the HF2025 relay, the relay indicates it by an alarm message: this display takes priority and replaces the default value (see the MOTOR ALARMS and HARDW ALARMS menus).

3.1.2 Access to the submenus

From a main menu, access to a submenu is gained to the different submenus via the UP and DOWN keys.

It is possible to read all the parameters and measurements without the password. The parameters can only be modified after entering the password.

3.1.3 Access to the setting parameters

Access to the setting parameters of the HF2025 relay is possible by:

- either locally: by using the keys or the RS232 port on the front panel,
- or remotely: via the RS485 port at the rear.

3.1.3.1 Protection by password

Modification of the relay parameters via the pushbuttons on the front panel is protected by password.

This protection applies to the relay configuration settings, particularly the selection of the different thresholds, time delays, communication parameters, allocation of the binary inputs, logic gates and output relays.

The password consists of four alphanumerical characters in capitals. On leaving the factory, the password is AAAA. The operator can define his own combination of characters. If the password is lost or forgotten, modification of the parameters stored in the memory of the relay is inhibited. All that is required then is to contact Hamian Fan Company, stating the serial number of the relay, to receive an emergency password specific to the relay concerned.

3.1.3.2 Entering the password/modification of the parameters

To modify a parameter, first press the key to go into updating mode (or parameterization mode).

The operator is asked to enter the password as soon as a parameter is modified in any of the menus or sub-menus. So when the operator presses the key, to make an adjustment, and the password is not active, the following display appears on the screen:

ENTER PASSWORD **A A A A**

The password consists of the letters between A and Z. The password is entered letter by letter by using the UP and DOWN keys to move forwards and backwards in the alphabet.

After each letter, press the ENTER key to enter the next letter.

At the end of the input press the E N T E R key to confirm the password. If the password is correctthe message PASSWORD OK appears on the screen.

After 2 seconds, the display returns to the previous point in the menu. Press the ENTER key again. A cursor appears on the first field of the data to be updated:

Example modification of the current threshold I >> ([50/51] Phase OC submenu)

I>> THRESHOLD = **1.0 In**

A flashing cursor indicates that the operator can change the value in the cell. To scroll through the possible values for a cell, use the UP and DOWN keys.

After each value, press the ENTER key to enter the next digit.

At the end of the input, press the ENTER key to confirm the modification.

If no action is taken on the keypad for 5 minutes, the password is deactivated and the letter P disappears. Any subsequent modification of parameters will give rise to a further request for the password.

NOTE:

- The parameterization mode only allows modification of the relay configuration via the interface through which it was activated: if forexample the password was entered by the keys on the front panel,only modifications carried out using these keys will be accepted.
- When the parameterization mode is activated by entering the password via the front panel (pushbuttons), as long as this mode ofparameterization remains active, it is no longer possible to modify the relay parameters via the RS485 or RS232 communication ports. The parameters of the HF2025 relay can only be modified by using the pushbuttons. Once the parameterization mode is deactivated (no action on any pushbutton for 5 minutes), itis then possible to modify the parameters of the HF2025 relay by using one of the communication ports.
- Pressing the CLEAR key during modification makes it possible to returnto the value before modification.
- To modify the active password, gain access to the ‘OP. PARAMETERS’ menu then to the PASSWORD point in the menu.

3.1.4 ‘OP. PARAMETERS’ menu

The ‘OP. PARAMETERS’ menu indicates the following information:

- this relay with the software version,
- Frequency of the electrical power system, active phase sequence and active settinggroup,
- The state of all the logic inputs and of all programmable output relays.

In this menu, the operator can also:

- modify the password,

- give the relay/motor feeder a reference (4 characters, letters or numbers),
- indicate the rated frequency of the motor (50 Hz),
- Modify the date and time.

3.1.5 'ORDERS' menu

'ORDERS' menu makes it possible to clear all the registers of the relay locally, and to start or stop a motor.

This menu is divided into 3 orders: 'GENERAL RESET', 'START MOTOR' and 'STOP MOTOR'.

Before sending an order, a 'CONFIRMATION' cell is displayed.

3.1.5.1 'GENERAL RESET' order

'GENERAL RESET' order makes it possible to clear locally:

- LEDs,
- Alarms,
- Counters,
- Disturbance records,
- Fault records,
- Starting records,
- Event records,
- Measured values,
- CB monitoring records,
- Latched trip output (RL1) or latched output relays (under no fault condition).

3.1.5.2 'START MOTOR' and 'STOP MOTOR' orders

'START MOTOR' and 'STOP MOTOR' orders make it possible to start and stop motors. A 'CONFIRMATION' cell is displayed before sending an order.

3.1.6 'CONFIGURATION' menu

'CONFIGURATION' menu makes it possible to configure the HF2025 relay.This menu is divided into 8 submenus:

- 'CONFIG. SELECT', to configure the relay and its accessories,
- 'CT/VT RATIO' setting,
- 'LED 5' to 'LED 8' settings,
- 'ALARM CONFIG', allowing inhibition of an or several alarm,
- 'INPUT CONFIG.', for opto isolated inputs configuration.

3.1.6.1 'CONFIG. SELECT' submenu

- Setting group

The HF2025 relay has two setting groups corresponding to two protection groups(menus 'PROTECTION G1' and 'PROTECTION G2'). The operator can thus carry out 2 settings for each parameter: one for setting group 1 and the other for setting group 2.

Management of the active setting group can be performed either on a transition or depending on a level. This selection is done by selecting in the ’SET GRP CHANGE INPUT‘ cell:

- either ‘EDGE’,
- or ‘LEVEL’.

1. If ‘EDGE’ is selected, the setting group switch can be controlled by:
   - a local command:
     - via a logic input which must have been previously configured by the operator
     - via the keys on the front panel
     - via the RS232 port on the front panel
   - a remote command via the RS485 port at the rear:

     NOTE:

     – The default configuration group is PROTECTION G1.

     – The list of access methods above is given in the order of priority: for example, the configuration changeover order given by a logic input takes priority over the one given by the keys on the front panel.

2. If ‘LEVEL’ is selected, the active setting group depends on the state of the logic input configured as "SET GROUP":
   - Logic input in low state: ‘PROTECTION G1’ group active
   - Logic input in high state: ‘PROTECTION G2’ group active

   NOTE:

   If no logic input is configured as ’SET GROUP‘, ‘PROTECTION G1’ is the default active group.
   - Selection of a default value to be display

The operator can select the measured value permanently displayed on the LCD screen as current, voltage or thermal overload (see section “configuration menu”).

- ’Phase rotation’

  ‘Phase rotation’ is suitable for application such as mines conveyor where the use of bidirectional motors is part of the process. The direction of motor is changed by changing the phase sequence in the switchgear.

  ‘PHASE ROTATION’ cell makes it possible to change the phase sequence via INPUT or MENU. It is possible:
  - to select ‘PHASE SEQUENCE” within A B C (default value) or A C B through MENU,
  - to assign any digital input (except if some of them are dedicated to protection) to phase rotation. In this case, input energized means A C B, otherwise, it means default ABC.

Standard A B C: The calculations of positive (I1, V1) and negative (I2, V2) phase sequence voltage and current is as follows:

$$\overline{X}_1 = \frac{1}{3}[\overline{X}_a + \alpha\overline{X}_b + \alpha^2\overline{X}_c]$$

$$\overline{X}_2 = \frac{1}{3}[\overline{X}_a + \alpha^2\overline{X}_b + \alpha\ \overline{X}_c]$$

where $\alpha = 1\angle 120^\circ$

Reverse A B C: The calculations of positive (I1, V1) and negative (I2, V2) phase sequencevoltage and current is as follows:

$$\overline{X}_1 = \frac{1}{3}[\overline{X}_a + \alpha^2\overline{X}_b + \alpha\ \overline{X}_c]$$

$$\overline{X}_2 = \frac{1}{3}[\overline{X}_a + \alpha\ \overline{X}_b + \alpha^2\overline{X}_c]$$

where $\alpha = 1\angle 120^\circ$

- Motor start-up/motor halted detection criteria

  The HF2025 relay offers the choice of start detection criteria as follows:

  - Closure of the contactor/circuit breaker: criterion listed as 52A,
  - Closure of the contactor/circuit breaker and overshoot of the starting current threshold IUTIL (START CRITERIA submenu). These two events must appear within an interval of time of approximately 90 ms for the detection of a start to be accepted. This criterion is known as 52A + I.

  This facility makes it possible to adapt the configuration of the HF2025 relay to the type of starting used: direct on-line or soft start.

  The relay will consider the motor stopped upon drop-off of logic input L1 (logic state 0).

NOTE: The HF2025 relay detects the information "contactor/circuit breaker position" via logic input L1 (inputs section). The connection of this logic input to the status of the breaking device is obligatory.

When an analogue output is configured to indicate the active or reactive power, a cell is displayed. It is used to set the maximum rating of the analogue output.

Equivalence between analogue output signal and remote measurement is given in section corresponding HF2025.

3.1.6.2 ‘CT/VT RATIO’ submenu

In the ‘CT/VT RATIO’ submenu, the operator sets the primary and secondary ratings of the Line and Earth CTs, and of the phase-phase VT.

NOTE:

Where the earth current input is connected to a CT summation of the 3 phase current circuits (residual connection, no core balanced CT), the primary and secondary values of "Earth CT" must be set to the same values of those of the "Line CTs".

3.1.6.3 The ‘LED 5’, ‘LED 6’, ‘LED 7’ and ‘LED 8’ submenus

Four identical sub-menus – ‘LED 5’, ‘LED 6’, ‘LED 7’ and ‘LED 8’ are used to configure the 4 programmable LEDs of the HF2025 relay.

The user can assign one or several indications to each of these LEDs. These data can originate inside the relay (protection, automatic control, or internal logic state function) or outside the relay (logic input).

One LED is lit if at least one of the pieces of information associated with it is valid (logic OR). It is extinguished:

  - either after acknowledgement of the of associated data item or items
  - or on the disappearance of the data item or items which gave rise to it.

- The "EMERG. RESTART" information is activated:
  - either following reception of an emergency start command via the logic input programmed on "EMERG. RESTART". It stays lit up as long as the associated logic input is excited,
  - or following an emergency start remote order sent via the communication network. It will be extinguished when the "SUCCESSFUL START" information appears.
- The "FORBIDDEN START" information is active if at least one of the 4 pieces of data blocking signals is active:
  - either thermal blocking start "theta FORBID.START",
  - or blocking due to limitation of the number of starts "START NB LIMIT ",
  - or blocking due to a minimum time between 2 starts "T betw 2 start",
  - or blocking due to a minimum time between a stop and a start Anti backspin "ABS".
- The motor shut down information "MOTOR STOPPED" is activated when logic input L1 (terminals 22-24) is not excited. It remains active until logic input L1 is excited.
- The motor running information "MOTOR RUNNING" is activated when logic input L1 (terminals 22-24) is excited. It remains active until logic input L1 is de-energized.
- The successful start information "SUCCESSFUL START" is activated after a motor start phase if at the end of the time delay t Istart the following criteria are respected:
  - the locked rotor at start information "LOCKED ROTOR" is not present
  - the excessively long start information "EXCES LONG START" is not present. This information stays active until the motor shuts down (de-energization of logic input L1).

The protection functions that can be assigned to the LEDs (5 to 8) for the HF2025 are detailed in the corresponding section.

3.1.6.4 The ‘ALARM CONFIG’. Submenu

The ‘ALARM CONFIG.’ allows to avoid to generate alarms for instantaneous and temporizedevents (alarm inhibition). In this case, alarm LED does not light, and no message are displayed.

The HF2025 can inhibit tAux1 to tAux10 alarms, i< alarm and results of Boolean equations.

3.1.6.5 ‘INPUT CONFIG.’ sub-menu

- This allows the user to set the logical state of each logic input:
  - If 1 is selected: the logic input is active when energized, and inactive when de-energized.
  - if 0 is selected: the logic input is inactive when energized, and active when de-energized.

By default the logic inputs are active when they are energized and inactive when de-energized (logic inputs set to 1).

Explanations on the relay algorithms, connection diagrams and commissioning procedures in this manual are given for logic inputs set to 1. It is therefore recommended not to modify this setting of the logic inputs. Logic input L1 is reserved for motor start up detection and this information in turn is used by several protection functions. Therefore, it is necessary to hardwire auxiliary contact of the motor switching device to logic input 1 of the relay.

3.1.7 ‘MEASUREMENTS1’ and ‘MEASUREMENT2’ menus

- The measurements of the phase currents and the earth current are expressed as true root-mean-square values. For a 50 Hz motor, the harmonics are taken into account up to the 10th order; for a 50 Hz motor the harmonics are taken into account up to the 8th order.
- The measurements of the phase-phase voltage VAC is expressed as true root-mean-square values.
- The measurement of the symmetrical components is taken from the fundamental component of the current. The positive and negative sequence components of the current are calculated on the basis of the three phase currents, and the zero phase sequence component is calculated from the earth current input. The following formulae are used to calculate the symmetrical components:

$$\overrightarrow{I_{positive}} = \frac{1}{3}[\overrightarrow{I_A} + \alpha \overrightarrow{I_B} + \alpha^2 \overrightarrow{I_C}]$$

$$\overrightarrow{I_{negative}} = \frac{1}{3}[\overrightarrow{I_A} + \alpha^2 \overrightarrow{I_B} + \alpha \overrightarrow{I_C}]$$

$$\overrightarrow{I_0} = \frac{1}{3}[\overrightarrow{I_{earth}}]$$

- The phase current maxi meter retains the greatest current value of one of the three phases outside the motor starting phase. This variable is expressed as a true RMS value.
- The I2/I1 value is the ratio of the symmetrical components "negative-sequence current" over "positive-sequence current'.
- The active, reactive and apparent powers are derived assuming that the voltage system is balanced.
- The active and reactive energy counters represent the energies absorbed by the motor. When these counters reach respectively 20GWh and 20GVARh, they are automatically reset.

- These counters can be reset by pressing the READ key (without password). The energy calculation is updated every second.

- The power factor is the ratio of the active power over the apparent power.

3.1.8 'PROCESS' menu

A set of measurements relating to operation displayed in the PROCESS menu makes itpossible to monitor the utilization and state of the motor.

- "%I FULL LOAD" is the percentage ratio of the equivalent thermal current Ieq absorbed by the motor over the thermal current threshold Itheta> (sub-menu [49] THERMAL OVERLOAD).

- The value of the motor thermal state can be reset by the user:
  - either by pressing the READ key after entering the password
  - or through a logic input set to "theta RESET"
  - or through a command received on the RS485 communications port
- The estimate of the time before a thermal trip "T before TH TRIP" is given under the following conditions:
  - the thermal alarm threshold theta ALARM is reached
  - the equivalent thermal current Ieq is greater than the thermal current threshold Itheta>
  - considering the constant motor overload rate Ieq/Itheta>

When the above conditions are not respected, the HF2025 relay displays the value "9999".

- The number of authorized starts of the motor "PERMIT START NB" takes into account all the criteria for limiting or blocking start, that is, the functions: "limitation of the number of starts", "minimum time between 2 starts", "minimum time between a stop and a start" and "thermal criterion for blocking a start". When there is no limit to the number of authorized starts, the relay displays the value "9999".

- The indication of the time before a further start is authorized "T before START" is given when an inhibition on starting is in progress. This indication takes into account all the criteria for limiting or blocking start, that is, the functions: "limitation of the number of starts", "minimum time between 2 starts", "minimum time between a stop and a start" and "thermal criterion for blocking a start".

- The counter for the number of starts of the motor is incremented at each start. In contrast, authorization for the motor to re-accelerate does not increment this counter.

- The counter for the number of motor operation hours is the accumulated sum of hours during which the motor is running.

3.1.9 'TRIP STATISTICS' menu

In the 'TRIP STATISTICS' menu the following are displayed:

- the total number of tripping operations,
- the number of tripping operations per type of fault.

Tripping can have two possible causes:

- tripping on a fault: when the HF2025 relay detects a fault (exceeding a threshold), it generates a tripping order.

- deliberate tripping. The operator can order tripping from three access points:
  - a logic input, (EXT1 and EXT2 functions),
  - the RS232 port on the front panel,
  - the communications network.

NOTE:

– The tripping orders stored in the memory of the HF2025 protection relay for the statistics are only those transmitted to the tripping relay (logic output RL1). This relay is one of the logic outputs of the HF2025. It is configured in the TRIP OUTPUT RLY submenu.

– Motor shutdowns for which the command was not relayed via the output relay RL1 of the HF2025 are not taken into account in the TRIP STATISTICS menu.

3.1.10 'COMMUNICATION' menu

The HF2025 relay can communicate under the MODBUS™ via RS2323 front port or RS485 rear port (general features). This protocol are based on the master-slave principle. The HF2025 relay can therefore be integrated, as a slave, in a digital monitoring and control system. In this system, the supervisor (master), for example a PC, can:

- read and modify the setting values,
- remote the measurements, alarm data, changes of state (changes of state of inputs/outputs, changes of setting group), values relating to fault recordings, disturbance recording and the form of the starting current and voltage,
- issue remote orders such as commands to open or close the circuit breaker/contactor (motor On/Off), to block start, to trig disturbance recording or to acknowledge the relay remotely.

3.1.11 ‘PROTECTION G1’ and ‘PROTECTION G2’ menus

The menus ‘PROTECTION G1’ and ‘PROTECTION G2’ are identical and enable the operator to program 2 different configuration groups (‘CONFIGURATION’ menu).

Each of these 2 menus is divided into 11 submenus corresponding to the different protection functions:

- ‘START CRITERIA’, to define start-up threshold and time delay of the motor,
- ‘[49] THERMAL OVERLOAD’, to protect the motor against thermal overload,
- ‘[50/51] PHASE OC’, three phase overcurrent protection,
- ‘[50N/51N] EARTH FAULT’
- ‘[46] UNBALANCE’, to protect the motor against unbalance condition, broken conductor and phase inversions,
- ‘[27] UNDERVOLTAGE’,
- ‘[59] OVERVOLTAGE’,
- ‘[48] EXCES. LONG START’, to protect the motor against excessive start-up overcurrent,
- ‘[51LR/50S] BLOCK ROTOR’, to detect stalling while the motor is running,
- ’[37] LOSS OF LOAD’,
- ’[49/38] RTD

The operator can bring each of the 10 protections functions (except “START CRITERIA”) into service or take them out of service in the submenus of the menu PROTECTION G1 or PROTECTION G2.

The setting parameters of the functions taken out of service do not appear on the LCD unit and are not accessible via the communication

If the threshold or thresholds of these functions are reached, a time delay with a duration preset by the operator is started. When this time delay expires, if the fault is still present, an instantaneously signal is generated and can be used to energize one of the output relays.

All the algorithms of the protection functions, except the thermal replica, are based on the fundamental component of the current.

The thermal replica is based on the model working with the true rms values of the line current and the negative-sequence component of the current.

State of the protection functions (active/inactive) according to the operation mode of the motor

The HF2025 protection functions are automatically* activated or deactivated by the relay itself according to the motor's operation mode (motor halted, start-up sequence, re-acceleration phase or normal running condition). The table below indicates under which conditions these protection functions are active or inactive.

ProtectiveFunctions	Motor Halted	Start-up Sequence	Motor Running	Re-acceleration Phase
Thermal overload	Activated (Tr)**	Activated (Te2)**	Activated (Te1)**	Activated (Te2)**
Phase OC	Activated	Activated	Activated	Activated
Earth fault	Activated	Activated	Activated	Activated
Unbalance	Activated	Activated	Activated	Activated
Excessive long start	Deactivated	Activated	Deactivated	Activated
Stalled rotor whilstrunning	Deactivated	Deactivated	Activated	Deactivated
Locked rotor at start	Deactivated	Activated	Deactivated	Deactivated
Undervoltage	Deactivated	Activated****	Activated	Activated
Overvoltage	Activated	Activated	Activated	Activated
Loss of load	Deactivated	Activated***	Activated***	Activated***

These protection functions are activated by the relay only if they have previously been commissioned by the user.

** The time constant used in the thermal model depends on the value of the motor load current and on the motor's operating mode. The time constant indicated in brackets isthe one used by the relay.

*** The "loss of load" function is activated upon expiry of the Tinhib timer. This timer is user settable, it is initiated by the relay when a motor start is detected.

**** The user can inhibit this function during the starting sequence.

3.1.11.1 ‘START CRITERIA’ submenu

Although this submenu is not a protection entity, it contains two threshold settings that are used by other protection entities. This submenu contains two thresholds I_{util} and tI_{start}. I_{util} defines a start-up current threshold and tI_{start} defines start-up time delay threshold of the motor. Protection functions [49] THERMAL OVERLOAD and [48] EXCES. LONG START use both of these settings while [51LR-50S] BLOCK ROTOR uses tI_{start} setting for their operation. Detailed description of their use can be found in sections 4.11.2.1, 4.11.8 and

3.1.11.2 Respectively.

‘[49] THERMAL OVERLOAD’ submenu: Protection against thermal overload conditions

The HF2025 relay produces a thermal image of the motor from the line current and the negative component of the current consumed by the motor, in such a way as to take into account the thermal effects created in the stator and in the rotor. The currents' harmoniccomponents

contribute to the motor's heating. For this reason, the thermal replica uses the line current I_{RMS} expressed in true rms value. The negative component currents consumed in the stator generate in the rotor large amplitude currents which create a substantialtemperature rise in the rotor winding. The composition carried out by the HF2025 results in an equivalent thermal current I_{eq}, the image of the temperature rise caused by the current in the motor.

The current I_{eq} is calculated according to the following formula:

$$I_{eq} = (I_{RMS}^2 + Ke \times I_{negative}^2)^{0.5}$$

Starting from this equivalent thermal current, the thermal state of the motor θ is calculated every cycle (every 20 ms for a 50Hz system) by the HF2025 relay according to the following formula:

$$\theta_{i+1} = (\frac{I_{eq}}{I\theta>})^2(1+\exp(\frac{-t}{T})) + \theta_i \exp(\frac{-t}{T})$$

In which:

- K_e is the negative sequence current recognition factor (settable).
- Iθ> is the thermal overload current threshold.
- θ_i is the value of the thermal state calculated above (1 cycle before, i.e. 20ms in a 50Hz system).
- t is the iteration cycle time (20 ms for a 50 Hz system).
- T is the time constant of the motor. As a function of the operating conditions of the motor, the relay uses one of the following 3 thermal time constants:
  - the heating time constant Te1, used when the equivalent thermal current I_{eq} is comprised between 0 and 2 Iθ>, i.e. when the motor is running at (under/full/over load condition);
  - the start-up time constant Te2, used when the equivalent thermal current I_{eq} is greater than 2 Iθ>, i.e. when the motor is in the start-up stage or in a locked rotor condition;
  - the cooling time constant Tr which is applied when the motor is shut down (logic input L1 in the zero logic state - terminals 22-24). In this case, the motor no longer consumes current and the value of the thermal state θ therefore decreases as time passes according to the formula:

$$\theta_{i+1} = \theta_i \exp(\frac{-t}{T})$$

The steady state thermal capacity used up in percent of the full thermal capacity is calculated according to the following formula:

$$\%\text{ of thermal capacity used} = (\frac{I_{eq}}{I\theta>})^2 * 100\,\%$$

A thermal overload signal “THERM.OV” is generated when the value of the thermal state θ reaches 100 %.

NOTE:

- On interruption of the auxiliary power supply to the HF2025 relay, the value of the thermal state θ is stored in the non-volatile memory. On re-energization of the relay, the value of the thermal state θ is reset to its value before the interruption if it was lower than 90%. In the opposite case (greater than 90%), it is reset to 90%, to avoid premature tripping of the relay HF2025 when the auxiliary voltage returns.
- The thermal state θ of the motor is displayed in the PROCESSmenu.
- The thermal state value θ can be reset (see the PROCESS menu in this section).
- Examples of the thermal overload curve are shown in the corresponding chapter HF2025.

- Function inhibiting thermal tripping during a start: theta INHIBIT

This function permits inhibition of the thermal tripping information THERM. OV. during the starting phase. It may be necessary to use this function for some motors with temperature rise characteristics in a starting phase very different from those in a locked rotor condition.

If the user brings this function into service, this inhibition is activated as soon as the starting time delay tI_{start} begins (cf. submenu START CRITERIA). The timer tI_{start} begins after the issue of successful start. Successful start is issued as soon as 52a signal is set and the current exceeds I_{util} threshold. On expiry of tI_{start} (end of the time allowed for starting), this inhibition is deactivated.

When this function is activated, that is during the motor starting phase, the value of the thermal state θ calculated cannot exceed 90 %. This means that thermal tripping cannot take place under any circumstances as long as tI_{start} is timing. At the end of the time allowed for starting, the value of the thermal state is authorized to exceed 90 %.

NOTE:

- This function has no influence on the thermal alarm signal “theta ALARM” and thermal base blocking start function “thetaFORBID. START”.
- When this function is brought into service, the motor is stillthermally protected by monitoring of the starting time.

- Thermal alarm function: theta ALARM

The purpose of this function is to produce an alarm signal indicating that the thermal state θ of the motor has exceeded an adjustable threshold: ALARM. Corrective action can thus be taken before thermal tripping occurs.

Once the threshold theta ALARM is exceeded, the HF2025 relay calculates and displays, in the PROCESS menu, an estimate of the time remaining before a thermal trip THERM. OV. Occurs. This estimate is given for a constant overload rate.

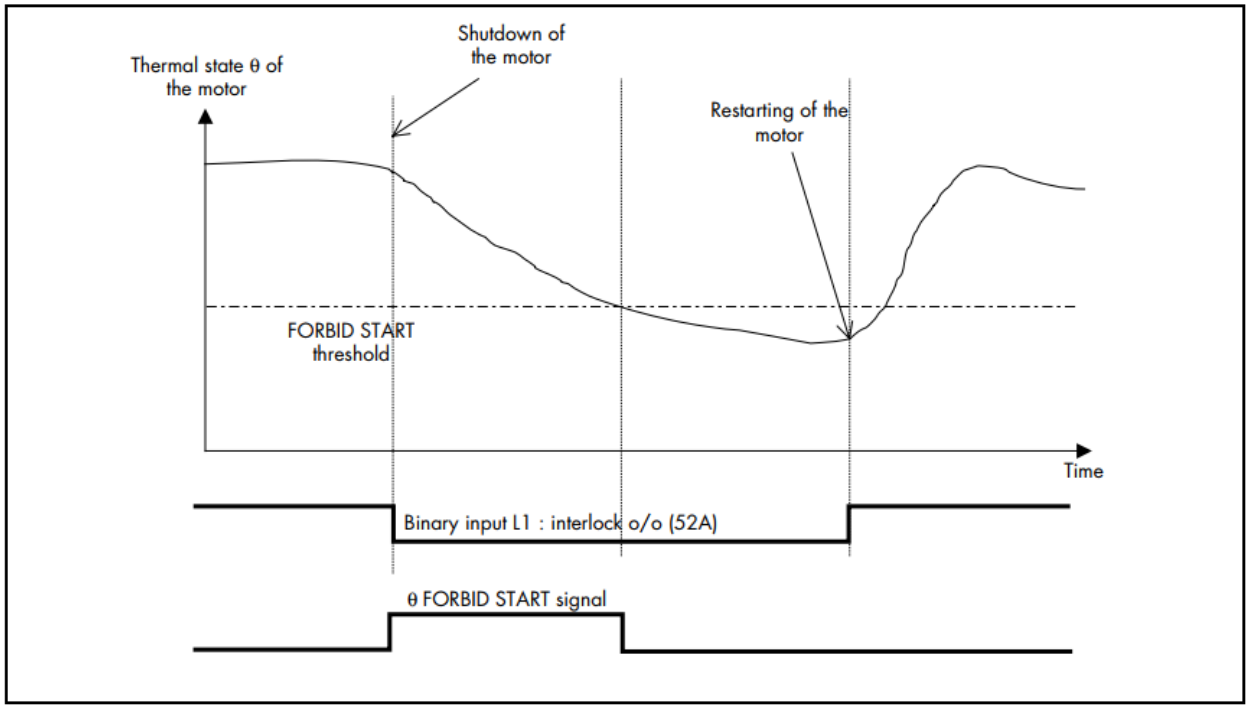
- Thermal base blocking start function: theta FORBID. START

This function makes it possible to block a start on a hot motor, or not, as a function of its thermal state. When this function has been adjusted in service by the user, a further start is inhibited for the motor as long as its thermal state θ is higher than an adjustable threshold theta FORBID START. It is then necessary to wait until the motor cools down. When the value of the thermal state θ falls below the threshold theta FORBID START, the starting of the motor is authorized.

The blocking start theta FORBID START information is activated if both of the following conditions are met:

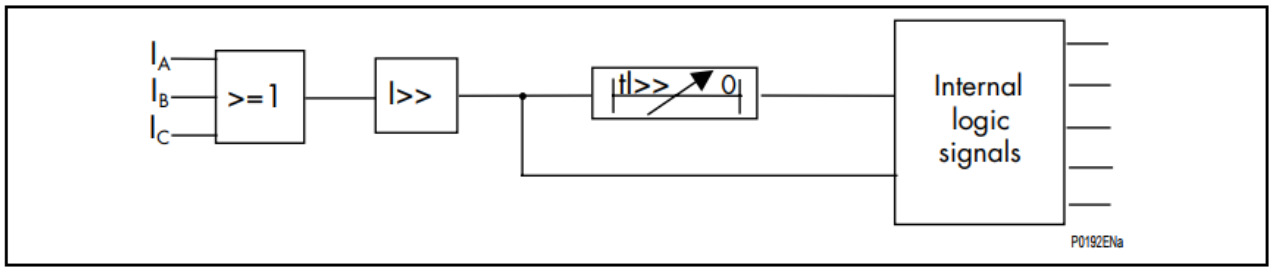
- Motor shut down: logic input L1 in the zero state (terminals 22-24).
- Thermal state value θ higher than the threshold theta FORBID START.

The following diagram illustrates the operation of the thermal base blocking start criterion:



3.1.11.3 The [50/51] non directional three phase overcurrent protection submenu

The non-directional phase overcurrent protection has three thresholds: I>=, I>>= and I>>>=. The first and the second thresholds can be set as definite delay time or inverse delay time using the IEC, IEEE/ANSI and RI curves where their parameters are shown in the Technical Data section of this Technical Guide. The third threshold can be set as definite delay time only. The following diagram depicts the functionality for the second stage as an example. All other stages functionality are similar.



NOTE:

- The time delay can be set to instantaneous.
- When the operator has adjusted the [50/51] PHASE OC function inservice, this function is always active whatever the mode of operation of the motor (motor running, shut down, starting phase, locked rotor condition).
- In the event of saturation of the phase CTs, the HF2025 will detect a short-circuit under the following conditions:
- Fault current lower than 200 times the limit current value forsaturation of the CTs.
- No remnant flux in the CTs at the time of establishing the fault.
- No direct current component at the time of establishing the fault.

3.1.11.4 '[50N/51N] EARTH FAULT' submenu

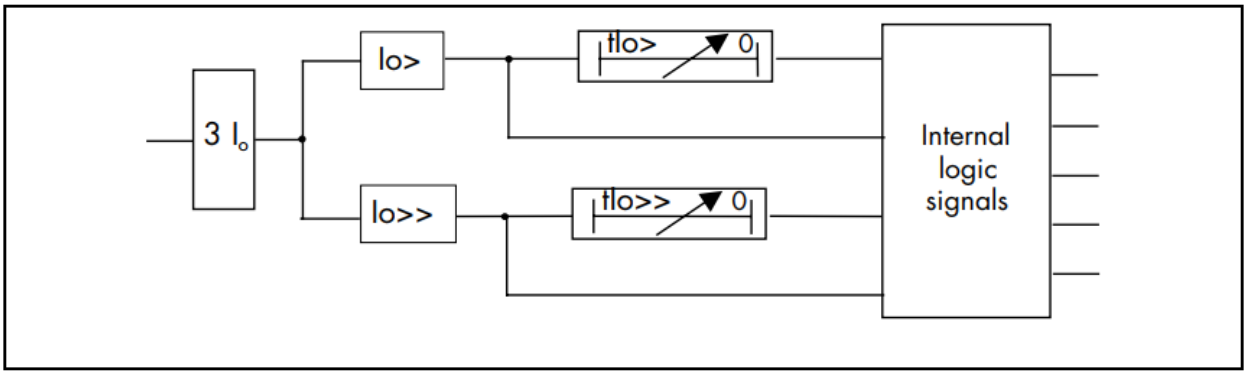
The [50N/51N] EARTH FAULT function which protects the motor against faults between one or more phases and earth uses a definite time zero phase sequence overcurrent protection.

Earth faults create a zero phase sequence current measured either by 3 phase CTs in a residual connection, or directly by a core balanced CT surrounding the 3 conductors.

Two independent earth current thresholds (Io > and Io >>) with their associated time delays (tIo > and tIo >>) enable the operator to configure for example an alarm threshold and a tripping threshold.

The settings of the thresholds are expressed as a function of the residual current (3 times the zero phase sequence component).

For each earth current threshold, time-delayed information and instantaneous information is available. The following diagram depicts the functionality of [50N/51N] EARTH FAULT protection function.



3.1.11.5 '[46] UNBALANCE' submenu

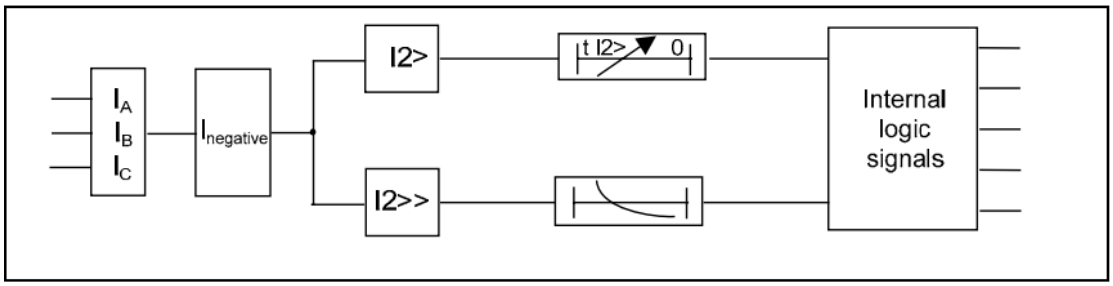
The '[46] UNBALANCE' function, which protects the motor against unbalance conditions, broken conductor and phase inversions, is based on the measurement of the negative sequence component of the current.

Two negative sequence overcurrent thresholds are available:

- I2>, is associated with a definite time delay,
- I2>>, is associated with an inverse time characteristic.

The user can use the threshold I2> to detect the inversion or loss of a phase, or to give an unbalance alarm.

The threshold I2>> has an inverse time characteristic which enables it to allow slight instantaneous unbalances to pass whilst more substantial unbalances will be detected more quickly. This inverse time characteristic permits selective clearance of external two-phase faults which appear on the system. This operating characteristic is in compliance with the withstand limits of the motors and is shown in the corresponding chapter.

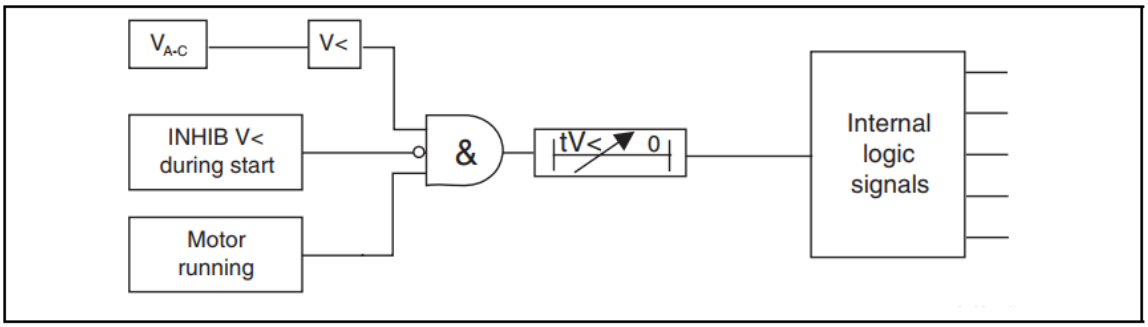


3.1.11.6 '[27] UNDERVOLTAGE' submenu: Undervoltage protection

This function, which makes it possible to detect a voltage drop, uses a phase-phase undervoltage protection with a definite time characteristic.

This function is deactivated when the motor is stopped (logic input L1 state = 0) and can alsobe deactivated during the motor start-up stage ("INHIB V<" set to "YES" by the user).

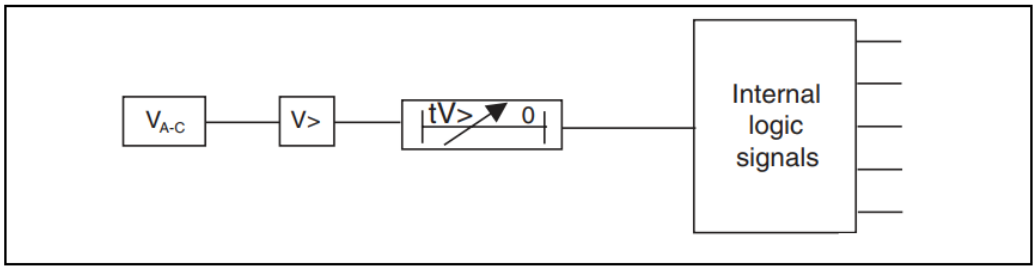
If the measured voltage (voltage between phases A and C) remains below the "V<" thresholdfor a time greater than or equal to "tV<", a voltage drop signal "tV<" is issued by the HF2025 relay.



3.1.11.7 The [59] OVERVOLTAGE sub-menu: Overvoltage protection

This function, which makes it possible to detect a voltage increase, uses a phase-phase overvoltage protection with a definite time characteristic.

If the measured voltage (voltage between phases A and C) remains above the "V>" threshold for a time greater than or equal to "tV>", an overvoltage signal "tV>" is issued by the HF2025 relay.

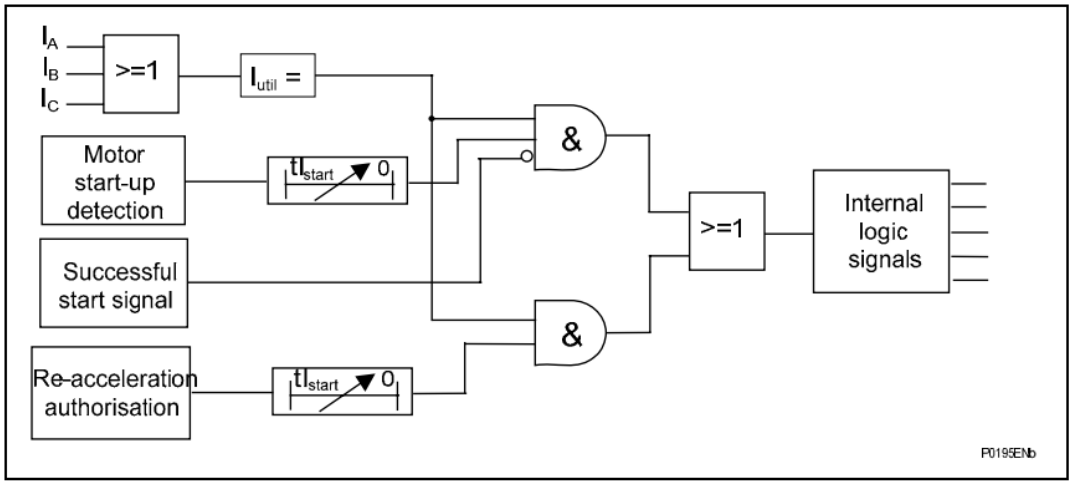


3.1.11.8 '[48] EXCES LONG START' submenu: Protection against excessively long starts

The '[48] EXCES. LONG START' function protects the motor against excessive start-up overcurrent. To this effect, it uses a start-up current threshold I_{util} and a start-up time-delay tI_{start}. These thresholds are set within the 'START CRITERIA' submenu. Both current threshold and the time delay can be adjusted to allow the starting current to pass. It is recommended to set I_{util} threshold to 2 times rated current of the motor and to set tI_{start} threshold to starting time of the motor which can be found in the motor data sheet provided by the manufacturer.

This function is activated (time delay tI_{start} initiated) as soon as the HF2025 relay detects a start (the criterion for detection of a start is selected in the CONFIGURATION menu). It is deactivated on expiry of the starting current time delay tI_{start}.

If, on expiry of the time delay tI_{start}, the current drawn by the motor has not fallen below the threshold I_{util}=, a prolonged start signal "EXCESS LONG START t I_{start}" will be generated.



Information indicating a "successful start" is generated on expiry of the time delay tI_{start} if notripping order has been given.

NOTE:

- During normal operation of the motor, the excessively long start function "EXCES LONG START" can be reactivated during a flying restart of the motor (re-acceleration of the motor following a voltage dip), that is when re-acceleration is authorized (AUTOMAT. CTRL menu).

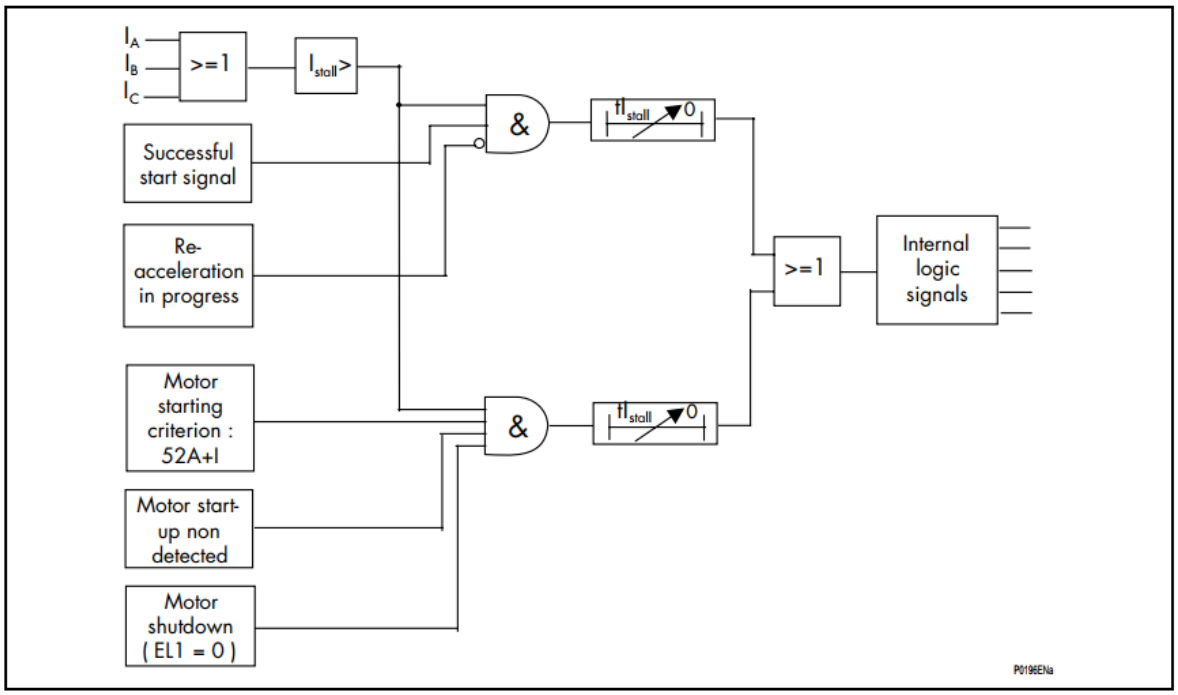
3.1.11.9 '[51LR/50S] BLOCK ROTOR' submenu

- Rotor stalled whilst the motor running

This function, which makes it possible to detect stalling while the motor is running, is activated immediately after the starting period, that is on expiry of the starting time delay tI_{start} (submenu 4.11.1 'START CRITERIA').

Two parameters can be set: the stalled rotor current threshold I_{stall} with its associated time delay tI_{stall}, the stalled rotor time.

The HF2025 relay detects the overcurrent caused by stalling and generates information that the rotor has stalled while the motor is running if the phase current exceeds the threshold I_{stall} for a length of time greater than tI_{stall}



NOTE:

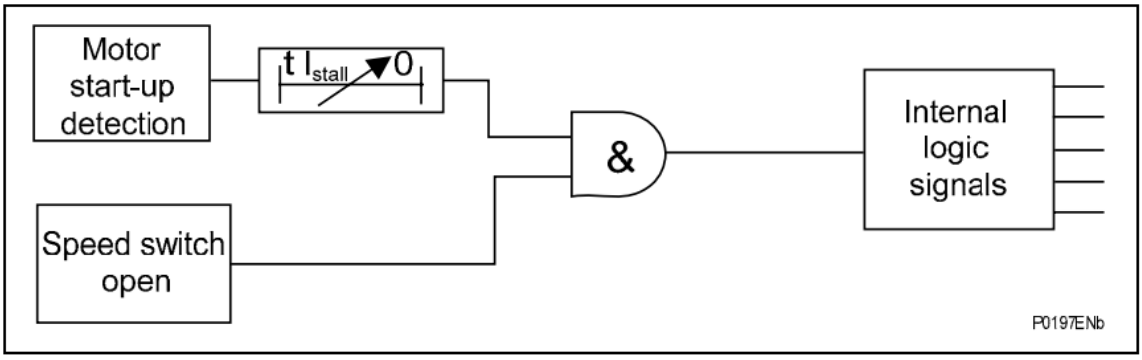
- During authorization of re-acceleration (AUTOMAT. CTRL menu), this function is deactivated during the time delay allowed for starting tI_{start} (START CRITERIA).
- On starting the motor, when the start detection criterion selected is "closure of the contactor/circuit breaker and exceeding of the starting current threshold I_{util} i.e. (52 a + I)", if the relay sees only one of these events, (closure of the breaking device or the appearance of a current greater than I_{util}), then the function ofmonitoring a stalled rotor whilst the motor is running is activated.

- Locked rotor at start (with speed switch)

This function, which makes it possible to detect that the motor is locked at the start, is activated only during the starting phase, that is during the course of the starting time delay tI_{start}.

It uses a motor speed indication received via a logic input of the HF2025 relay set on SPEED SW and the tI_{stall} time-delay: locked rotor time (a speed switch device must be connected to this logic input:" the INPUTS submenu: programmable inputs").

On detection of a start, the "locked rotor at start" function is activated: the time delay tI_{stall} begins. At the end of this time delay, the logic input set on SPEED SW must be in logic state 1 to indicate that the motor speed is not zero. The opposite case (zero speed) means that the rotor is locked, so the HF2025 relay generates a locked rotor at start order LOCKED ROTOR.



NOTE:

- The speed switch device sends information to the HF2025 relayindicating, by the closing of a contact, that the rotor is rotating.
- The time delay tI_{stall} is common to the protection functions for "rotorstalled while motor is running" and "rotor locked at start".
- If the motor is not fitted with a speed switch device, this functioncannot be used and must therefore be deactivated.

- Locked rotor at start (Power factor setting)

The HF2025 relay in the following conditions:

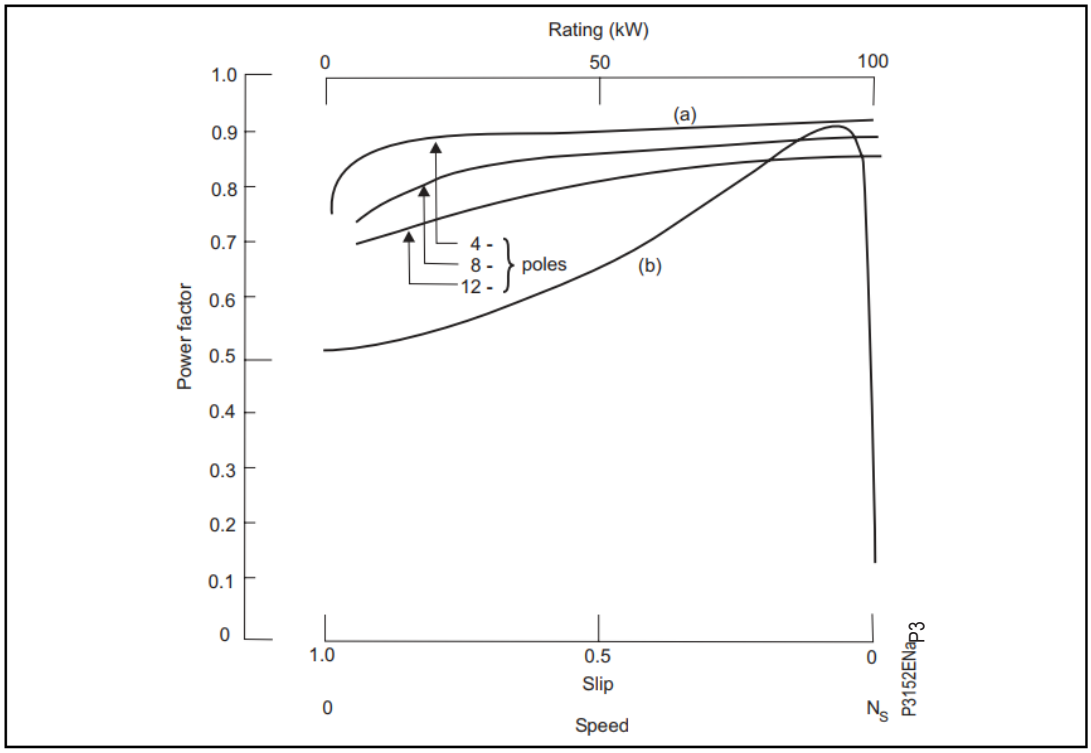
- Motor where startup time is less than locked rotor withstand time,
- Reduced voltage start type motor,
- Motors where startup time is greater than the locked rotor withstand time (i.e. for the high inertia type motors).

Motors for which the real start-up time is shorter than their locked rotor withstand time can beprotected against locked rotor condition at start-up without the help of a speed switch. For such cases, the use of [t_{Istart}] time setting shorter than the motor locked rotor withstand time allows to provide efficient protection against both too long start-up sequence and locked rotor at start-up conditions.

To address the second and third cases, the use of Power Factor involves usage of voltage inputs and the same can also avoid the usage of speed switch as we can always set therelay based on the relation between slip and Power Factor.

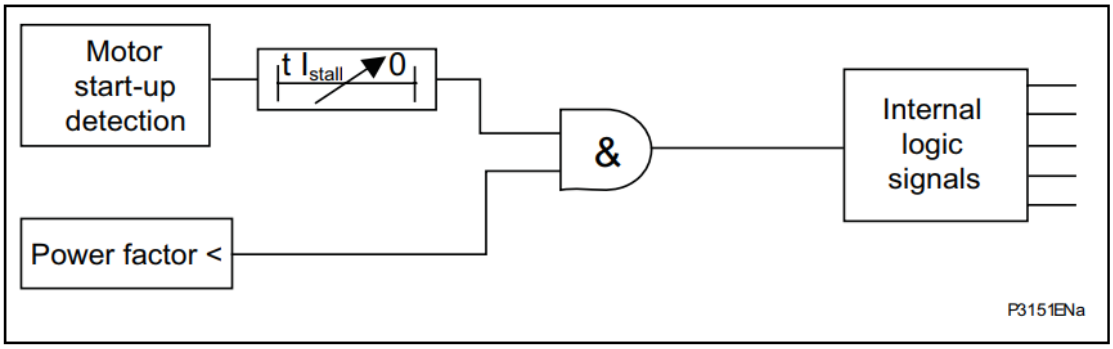
The Power Factor of the motors of a given rating decreases with increase in the number of poles. The slip of the motor similarly increases as we reach the locked rotor condition i.e. for a locked rotor situation slip is 1.

The below curve (b) shows the Power Factor for such a motor which is 0.5 at slip = 1. Hencedepending on the motor's slip VS Power Factor characteristics we can set the relay. We need only a Power Factor setting in the relay to differentiate normal operating condition anda locked rotor condition.



Three values are available for "LOCKED ROTOR AT START" setting: No, Input or Power Factor (Settable form 0 to 1 by steps of 0.1)

If the power factor is below the setting, it will operate as the speed switch open.



3.1.11.10 '[37] LOSS OF LOAD' submenu: Protection against undercurrent/loss of load conditions

The '[37] LOSS OF LOAD' function which makes it possible to detect a loss of load (for example the draining of a pump or breakage of a conveyor belt), uses definite time undercurrent protection. The user sets the following parameters:

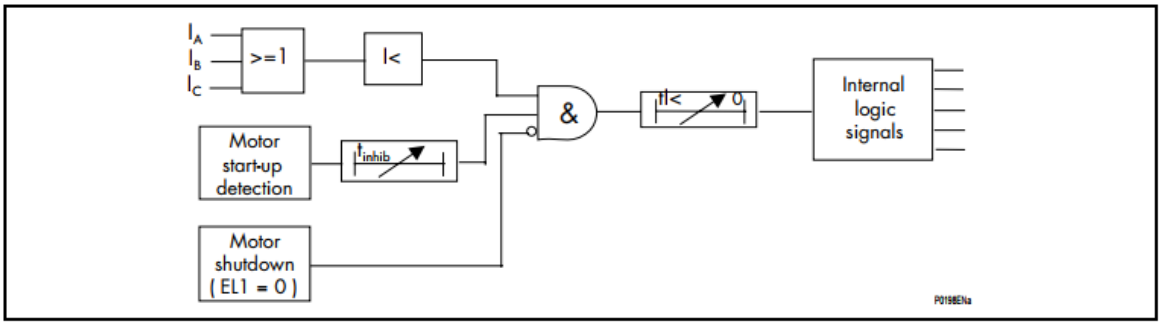
- undercurrent threshold I <
- time delay tI < associated with the undercurrent threshold
- the inhibit start time delay T_{inhib}

This function is deactivated when the motor is shut down (logic input L1 in the 0 state) and also during the inhibit time delay T_{inhib}.

When the HF2025 relay detects that the motor is starting, this function is activated at the end of the inhibit time delay T_{inhib}.

The time delay T_{inhib} is useful for motors with no-load starting which take on load gradually at the end of starting.

When the motor is running (and after expiry of the inhibit time delay T_{inhib}), if the value of one of the phase currents consumed by the motor is lower than the threshold I< for a period greater than or equal to tI <, the HF2025 relay will generate a loss of load signal " t I< ".



3.1.12 'AUTOMAT. CTRL' menu

- The AUTOMAT. CTRL menu comprises the following 14 sub-menus:
- '[66] START NUMBER' to limit number of starts,
- 'MIN TIME BETW 2 START' to set a minimum time before two start of a motor,
- 'REACCEL AUTHORIZ', to set re-acceleration/load shedding authorization
- 'INPUTS', to set opto-isolated inputs,
- 'LOGIC EQUATION', to customize the HF2025 relay,
- 'AUX OUTPUT RLY', to assign data to an auxiliary output relay,
- 'LATCH AUX RLY',
- 'TRIP OUTPUT RLY', to configure the trip output relay,
- 'LATCH TRIP ORDER', to select functions maintaining output relays energized
- 'CB FAIL', to detect if a circuit-breaker has not opened
- 'ABS' (Anti-BackSpin), to set minimum time between stop and start,
- 'BUS VOLTAGE CTRL', to validate voltage presence before a start,
- 'CB SUPERVISION'.

3.1.12.1 '[66] START NUMBER' submenu: Limitation of the number of starts per period

The [66] START NUMBER function allows the number of motor start-ups over a given periodto be limited. In effect, starting the motor too frequently can be too constraining for the motor(over-heating), for its starting system (starting impedance, electrolytic bath) or can in somecases reveal an anomaly in the process operation,

The [66] START NUMBER function uses the following adjustable parameters.

- a monitoring period $T_{reference}$
- a number of hot starts limit HOT START NB
- a number of cold starts limit COLD START NB
- a start inhibit time delay $T_{interdiction}$.

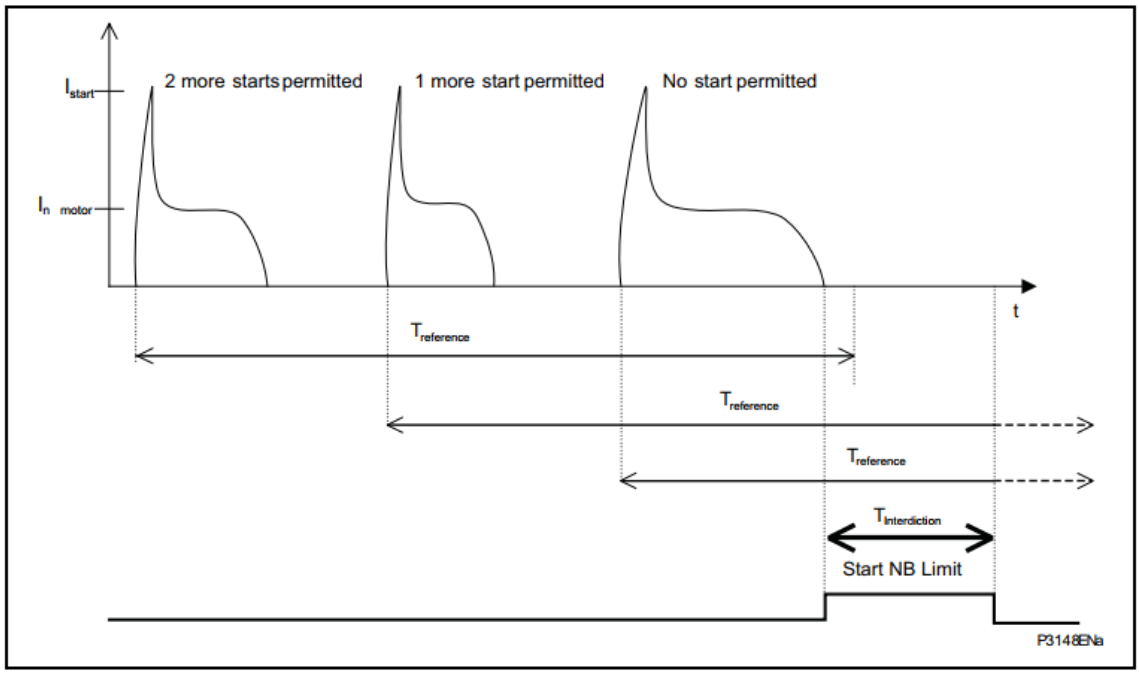
Each time a motor start is detected, the $T_{reference}$ time delay is initiated and the number of starts registered by the counter corresponding to the temperature of the motor (hot or cold) is incremented by one. At the end of this time delay, the counter in question will be decremented by one.

Each time the motor is stopped (change of state of logic input L1: from state 1 to state 0) relay HF2025 establishes whether either of the two counters (cold and hot) has been reached. If so, start inhibit signal START NB LIMIT will be generated for a length of time equal to $T_{interdiction}$. At the end of $T_{interdiction}$, this signal drops out, and it is possible to start the motor again.

Examples: Taking as an example cold starts where the limit of the number of cold starts has been set at 3 for a period of $T_{reference}$.

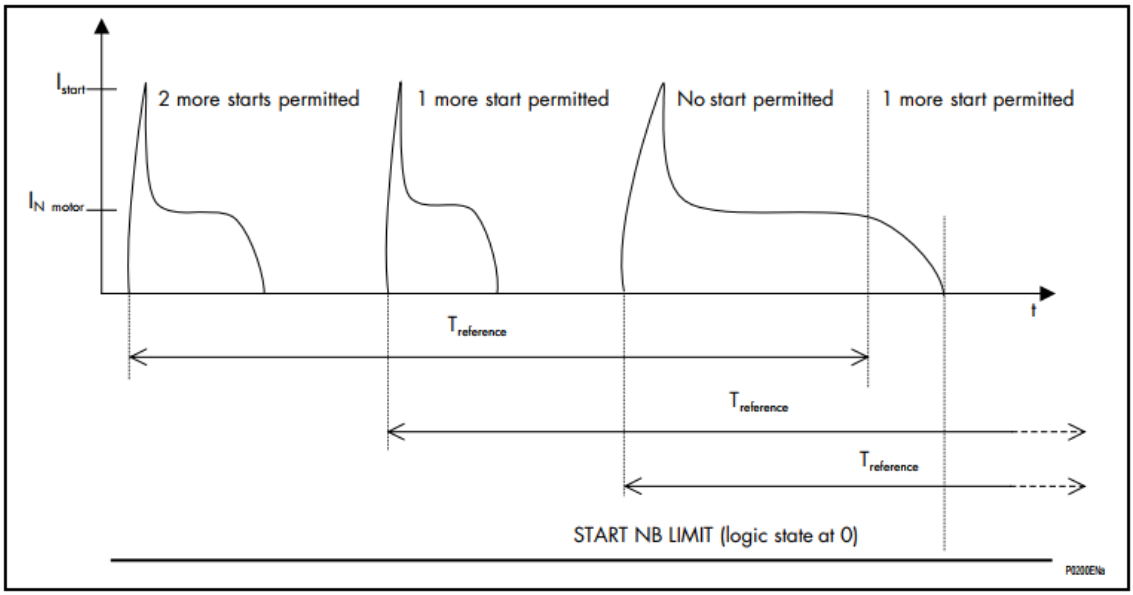
Case n°1:

The number of cold starts limit has been reached and the motor is stopped before the end of the $T_{reference}$ period: the $T_{interdiction}$ time delay is therefore initiated when the motor stops. A new start up is permitted at the end of the $T_{interdiction}$ time delay.



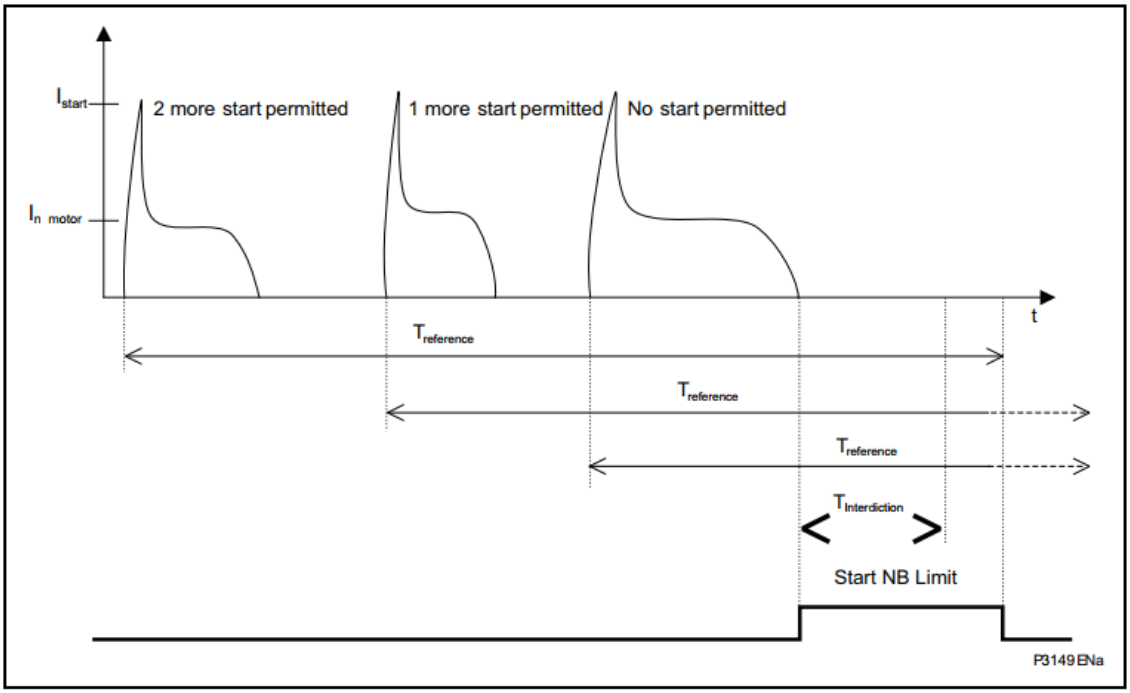
Case n°2:

The number of cold starts limit is reached but the motor is not stopped until after the end ofthe $T_{reference}$ period: therefore the $T_{interdiction}$ time delay is not initiated. There is no start inhibit.



Case n°3:

Particular cases where at the end of the $T_{interdiction}$ time delay, the number of starts counter is reached and the $T_{interdiction}$ time delay period is completed while $T_{reference}$ timer is still running: any new start up is inhibited until the end of the $T_{reference}$ period (the START NB LIMIT signal is extended).



NOTE:

- A start is considered cold if the value of the motor's thermal state is less than or equal to 50% when a motor start phase is detected.
- A start is considered warm if the value of the motor's thermal state is more than 50% when a motor start phase is detected.

- In cases where at the end of the $T_{interdiction}$ time delay period, one of the counters is has been reached, the START NB LIMIT startinhibit signal will not drop out until the counter in question is decremented (example case No.3).
- The number of authorized starts and the waiting time before a new start is authorized are available in the PROCESS menu (see The PROCESS menu).
- If the number of cold starts and the number of hot starts have not reached their settings while the time between two consecutive starts is greater than the fixed threshold, then the number of permitted start will be frozen to 1.

3.1.12.2 ‘MIN TIME BETW 2 START’ submenu: Minimum time between two starts

Excessive motor heating caused by two consecutive starts can be avoided by means of the ‘MIN TIME BETW 2 START’ function.

It is based on the use of an adjustable time delay: minimum time between 2 starts “T betw 2 start”.

This time delay is initiated on detection of a motor start up by the HF2025 relay. When the motor stops and if the “Tbetw 2 start” time delay has not reached, start inhibit signal “Tbetw 2 start” is generated until the end of the “Tbetw 2 start” time delay.

3.1.12.3 ‘REACCEL AUTHORIZ’ submenu: Re-acceleration/load shedding authorization

In cases when the supply voltage falls below a settable under voltage threshold, the durationof the fall in voltage can be classified as short, medium, or long (corresponding to “reacc”, “reac-long” and “reac-shed” respectively of HF2025 relay designations), based on settable time thresholds.

- Short falls are intended to cover situations when it is appropriate to authorize re-acceleration of the rotor and not to issue a trip order on voltage restoration detectedvia a settable over voltage threshold.
- Medium falls (interruptions actually) are for when it is appropriate to restart the motor with any staged startup sequence the starter type might provide.
- Long falls are intended to cover cases when restoration is from back-up power, and there must be substantial intervals between starting different motors to maintain stability, and/or only critical motors can be started.

A short fall in voltage from the electrical network causes a reduction in rotor speed. If the motor was running at the time a short fall occurred, a forced re-acceleration will occur as soon as the relay detects healthy supply voltage. A forced re-acceleration bypasses any pre-staged start-up sequence the starter type might otherwise provide.

When the voltage is restored, the rotor starts on a re-acceleration phase in order to regain itsnominal speed. This re-acceleration manifests itself as an intake of current of approximately the same value as that of the locked rotor current, its duration being relative to the magnitude of the fall in voltage and the duration of the fall in voltage.

The HF2025 relay can detect and measure the duration of a voltage drop. By comparing how long this voltage reduction lasts with an adjustable short time delay T_{reacc}, therelay will authorize or prevent the motor’s re-acceleration.

The HF2025 relay can detect a fall in voltage via an external voltage based protection device the output signal of which is subsequently fed to any one of the 5 programmable inputs and assigned to “V Dip” for re-acceleration.

This relay can either detect a fall in voltage via an external voltage based protection device the output signal of which is subsequently fed to any one of the 5 programmable inputs Assigned to “V Dip” for re-acceleration or HF2025 relay can be configured via “Detect Volt Dip”setting to monitor the voltage by the relay itself.

The user adjusts a time delay T_{reacc}. This time delay corresponds to the maximum duration of a voltage sag for which the motor re-acceleration is to be authorized.

If HF2025 relay is configured via “Detect Volt Dip” setting to monitor the voltage by the relayitself then the following applies:

A settable undervoltage threshold "Detection V DIP" makes it possible to detecta voltage drop.

A settable overvoltage threshold "Restoration V DIP" makes it possible to detect a restoration of the voltage.

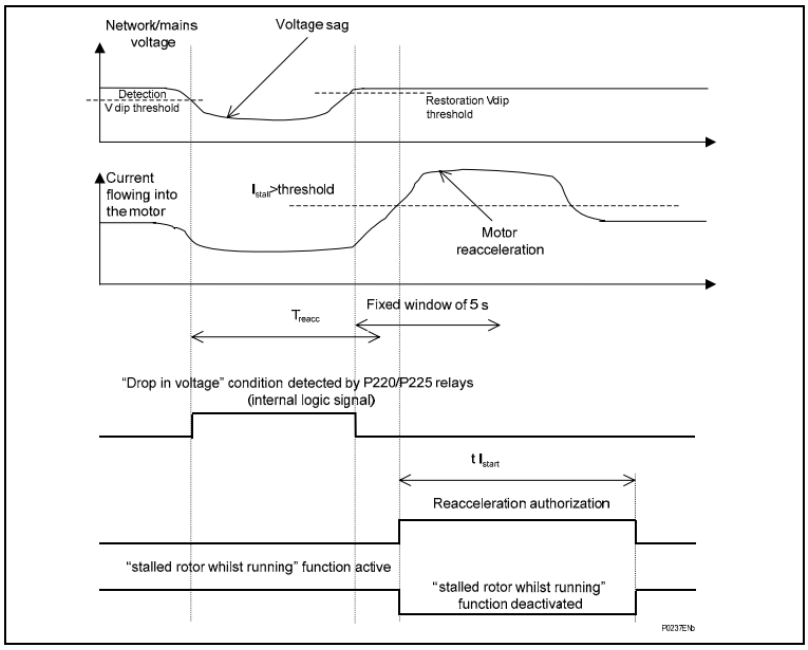
Upon detection of a voltage drop, the HF2025 relay initiates a time-delay, T_{reacc}.Three circumstances are possible:

- Before the end of the time-delay T_{reacc} (duration of the voltage sag shorter than T_{reacc}), the voltage is restored (voltage greater than "Restoration V Dip") and within 5 seconds after this restoration, the current absorbed by the motor exceeds the I_{stall} threshold (function [51LR/50S] BLOCK ROTOR), then:
  - the HF2025 goes into monitoring of a start-up sequence (initiation of the tI_{start} time delay, START CRITERIA menu, and it deactivates the “stalled rotor whilst running” function.
  - at the end of the tI_{start} delay allowed for a start, the relay HF2025 reactivatesthe “stalled rotor whilst running” function.
- Before the end of the T_{reacc} time-delay (duration of the voltage sag shorter than T_{reacc}), the voltage is restored (voltage greater than "Restoration V Dip"), but the current absorbed by the motor does not exceed the I_{stall} threshold within 5 seconds after this restoration, then:
  - the HF2025 relay operation does not change.
- At the end of the T_{reacc} time-delay, the voltage drop is still present (duration of the voltage sag greater than T_{reacc}), then:
  - a VOLTAGE DIP signal is issued by the HF2025relay. Assigning this signal tothe trip output relay (RL1) allows to stop the motor if required.

Examples

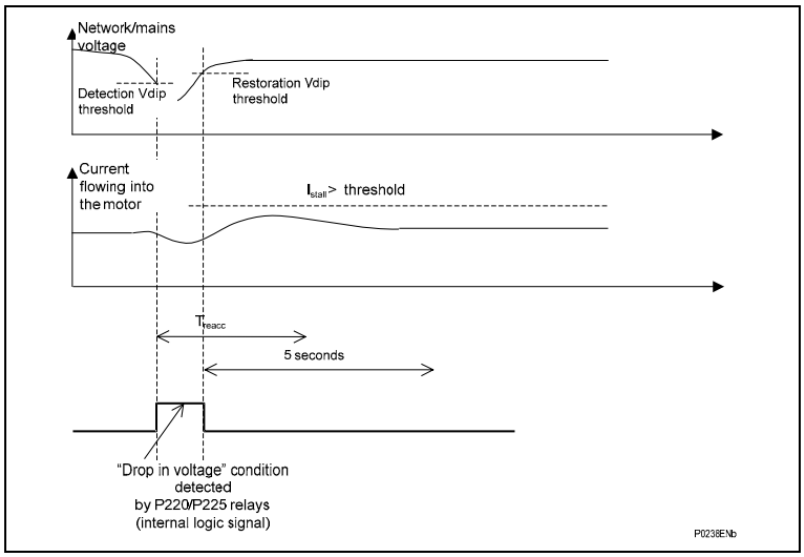
Case 1:

The duration of the voltage drop is less than the T_{reacc} time delay, when the mains voltage isrestored, re-acceleration of the motor is authorized.



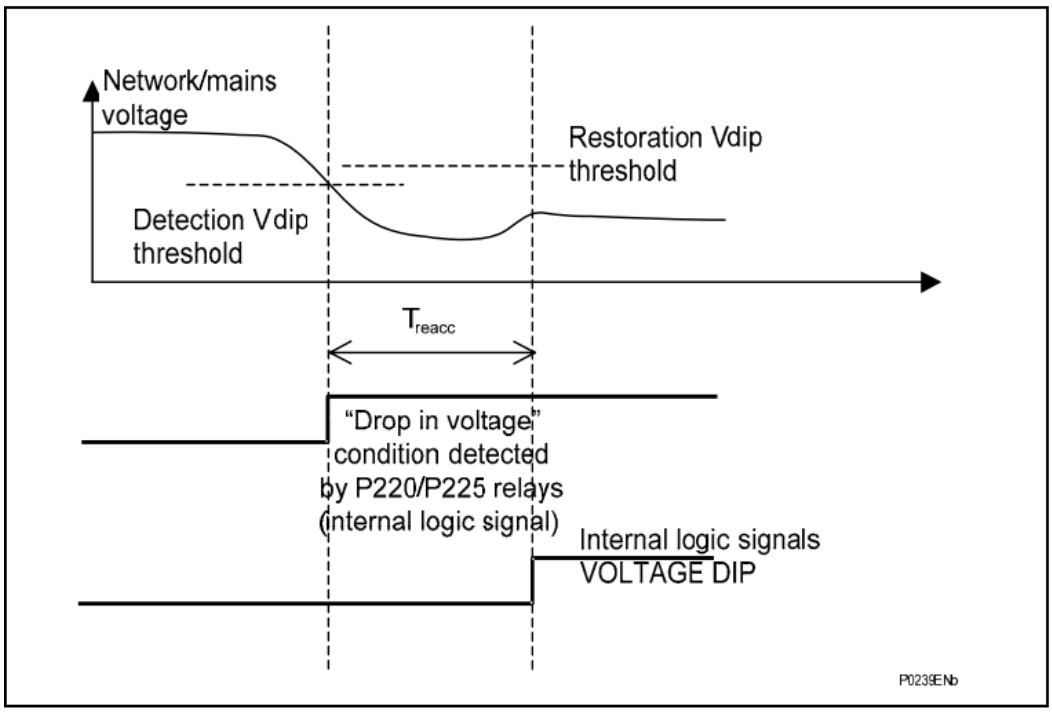
Case 2:

The duration of the voltage sag is shorter than the T_{reacc} time-delay, but the motor does not reaccelerate within 5 seconds after the voltage has returned. The HF2025 operation does not change.



Case 3:

The duration of the voltage sag is greater than the T_{reacc} timer. A VOLTAGE DIP signal is issued by the HF2025 relay at the end of T_{reacc}. It can be used to stop the motor.



- The 'AUTO RE-START' submenu: Re-start/load restoration

When motor supply monitoring is included, as in HF2025, the Auto-Restart feature is available to carry out automatic re-starting of the motor upon restoration of supply for cases when duration of the voltage fall is medium or long.

The AUTO RE-START element provides for controlling the timing of controlled starts following interruptions.

The re-start is carried out after a medium set time delay $T_{reac\text{-}long}$ or after an extended long time delay $T_{reac\text{-}shed}$. $T_{reac\text{-}long}$ threshold setting can be used for when it is appropriate to restart the motor with any staged startup sequence the starter type might provide. $T_{reac\text{-}shed}$ threshold setting can be used for to cover cases when restoration is from backup power, andthere must be substantial intervals between starting different motors to maintain stability, and/or only critical motors can be started. The Auto re-start feature, if enabled (AUTO RE-START FUNCT set to YES), becomes active after the relay has issued a trip signal due to a voltage sag condition with a duration longer than T_{reacc} threshold as described by example case no. 3 in last section.

If $T_{reac\text{-}long}$ is set to a value other than Zero (off) and after a trip order has been issued (due to the supply voltage not being restored within the time interval of T_{reac}), the HF2025 relay initiates $T_{reac\text{-}long}$ time-delay.

If the supply is restored within $T_{reac\text{-}long}$ time-delay interval, a close order is issued by therelay and a normal start is allowed to initiate. A programmable LED and an output contact can be assigned to this close order while this event is recorded. If the supply is not restored within $T_{reac\text{-}long}$ time-delay interval, AUTO RE-START will be de-activated.

It is possible extend the delay to start different motors and to arrange a load restoration sequence in cases where the system is week or when restoration is from backup power In this case $T_{reac\text{-}shed}$ time-delay can be adjusted to perform a sequence start. If $T_{reac\text{-}shed}$ is set to a value

other than Zero (off) while$T_{reac\text{-}long}$ time-delay has been set to Zero (off) re-start willbe extended by $T_{reac\text{-}shed}$ time delay.

3.1.12.4 Binary inputs

The HF2025 has 6 logic inputs (and 5 optional additional inputs), 5 (or 10) of which are programmable.

3.1.12.5 “Fixed” input

One of the logic inputs is predefined for a fixed usage, it is:

Logic input L1 (terminals 22 - 24) and is linked to the position of the fuse-contactor or circuit breaker (52a). This input should be linked to the 52a interlock of the cut off device (52a). This interlock is open when the cut off device is open and is closed when the cut off device isclosed. The connection of this logic input is compulsory.

3.1.12.6 The INPUTS submenu: Programmable inputs

The user can program five of the logic inputs. These are logic inputs L2 (terminals 26-28), L3 (terminals 13-15), L4 (terminals 17-19), L5 (terminals 21-23) and L6 (terminals 25-27). The user with HF2025 relays with optional “IRIG-B / Sec. comm port / 5 DI” relays can additionally program L7 to L11 digital inputs (terminals 61, 62, 63, 66 and 65, with common “input on terminal 62) The user chooses the allocation of these logic inputs in the INPUTS menu, that is to say to what use the relay HF2025 will put these external logic data:

3.1.12.7 Emergency Start

An emergency start may be necessary for safety reasons. When the logic input having been assigned to the “EMERG START” function is powered on (logic state at 1), the HF2025 relay reacts as follows:

- The thermal state value θ is limited at 90% so that no thermal trip order “THERM. OV.”can occur during the motor start up phase (see Function inhibiting thermal tripping during a start: theta *INHIBIT*). At the end of the tI_{start} time delay allocated to the start up, the thermal condition value θ will be allowed to exceed 90%.
- The thermal base blocking start signal “theta FORBID. START” is suppressed.
- The blocking start “START NB LIMIT” signal from the “limitation of number of starts”function is suppressed.
- The “T betw 2 start” blocking start signal from the “minimum time between 2 starts”function is suppressed.
- The “ABS” blocking start signal from the “minimum time between a stop and a start” function is suppressed.
- The “AUTO RE-START” is suppressed while the scheme is still timing out.

The motor can therefore be restarted and no thermal tripping can take place during the startup phase.

NOTE:

- The logic input “EMERG ST” must be kept powered during thewhole of the motor start-up phase.
- The relay HF2025 can also receive a remote emergency start command via the communication network.
- An emergency start up instruction “EMERG ST” does not orderthe closure of the cut off device (motor start up) but makes the motor start up possible.

- Setting group switch/active setting group

If “PICK UP” has been selected in the ‘INPUT CONFIG.’ sub-menu:

Upon receipt of a pick-up (minimum duration 15ms) of the logic input set to "SET GROUP", the HF2025 relay switches between setting groups.

The change from one configuration to another can also be achieved via the operator menuor the communication network (see Configuration Group).

- If “LEVEL” has been selected in ‘CONFIG. SELECT.’ Submenu:

Setting group G1 is active when the logic input set to "SET GROUP" is de-energized (low state).

Setting group G2 is active when the logic input set to "SET GROUP" is energized (high state).

A parameter setting group change is not possible if one of the following protection functionsis in progress (that is if the threshold of these functions is exceeded):

- ‘[50/51] PHASE OVERCURRENT’ function,
- ‘[50N/51N] EARTH FAULT’ function,
- ‘[46] UNBALANCE’ function,
- ‘[27] UNDERVOLTAGE’ function,
- ‘[59] OVERVOLTAGE’ function,
- ‘[48] EXCES LONG START’ function,
- ‘[50S/51LR] BLOCK ROTOR’ function,
- ‘[37] LOSS OF LOAD’ function,
- ‘[49/38] RTD’ probe function,
- ‘[49] THERMAL OVERLOAD’ function.

- Speed switch device

A logic input set on “SPEED SW” can be connected to a speed sensor usually known as a “speed switch”.

The speed switch should be open when the rotor is not turning and should close as soon asit detects rotor rotation. The connection of this logic input to a “speed switch device” is necessary in order to be able to use the “locked rotor at start” protection function.

NOTE:

When no logic input is set to "SPEED SW", the "Locked rotor at start-up" function cannot be used, it must therefore be deactivated.

- Trigging of the disturbance recording

  By assigning the command “DIST TRIG” to a programmable logic input, the operator will be able to initiate the disturbance recordings (RECORD menu) from this input. The energizing (rising edge) of this programmed logic input on “DIST TRIG” will trigger a disturbance recording.

- External acknowledgement

  By dedicating a logic input to the external acknowledgement command “EXT RESET”, the operator can acknowledge the alarms and unlatch the output relays if the latter were kept energized, by energizing this logic input.

- Auxiliary inputs and Auxiliary timers

  The “tAux1” to “tAux10” assignments allow relay HF2025 to acquire external binary data. A time delay (tAux1 to tAux10) is linked to each assignment.

  Auxiliary timers tAux1 to tAux10 are available associated to Aux1 to Aux10. When these inputs are energized, the associated timers start and, after the set time, the output relays close. The time delays are independently settable.

  The internal “Aux1” or “Aux2” signal to the relay is in logic state 1 if the associated logic inputis energized for a time longer or equal to tAux1 or tAux2 time delay. When the logic input is no longer energized the logic state of the internal “Aux1” or “Aux2” signal drops back to 0.

  When the tAux1 or tAux2 timers expire, the following happen:

  – an alarm message is sent
  – the Alarm LED is lit
  – an event is recorded

  The “Aux3” to “Aux10” assignments operate similarly to “Aux1” and “Aux2”, but when the associated timers expire:

  – there is no alarm message,
  – the "Alarm" led is not lit,
  – an event is recorded.

  NOTE:

  auxiliary timers are settable up to 200 s.

- Thermal state reset

  When a logic input is assigned to the "theta RESET" signal, the user can reset the thermal state value θ (refer to section 4.11.2), by energizing this logic input.

- Trip circuit supervision

  One or two logic inputs can be set to "TRIP CIRC" so as to be used to supervise the trip circuit (refer to section 4.12.11.1).

- Re-acceleration authorization

When INPUT is selected in Detection Volt Dip, any one of the programmable logic inputs can be set to “V Dip” so as to be used to initiate the timer used in re-acceleration authorization control function.

- The Boolean ‘LOGIC EQUATION’ submenu

The HF2025 relays integrate complete logic equations to allow customization of the product based on customer application.

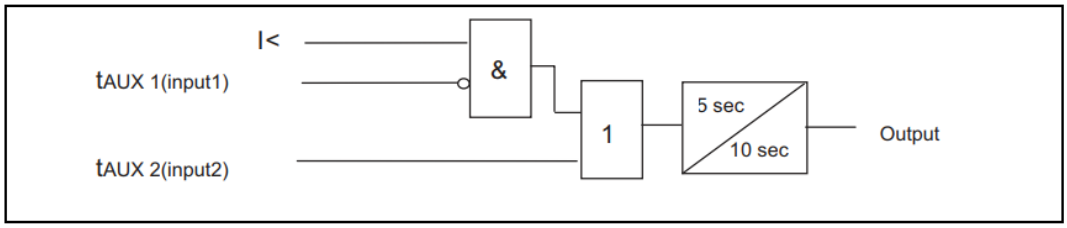
Up to 8 independent Boolean equations can be used. Each equation offers the possibility to use AND, OR, AND NOT, OR NOT & NOT logical gates. Up to 16 parameters can be used for each equation. Every result of equation can be time delayed and assigned to any output relays, trip, trip latching and/or HMI LEDs.

Every equation has a rising temporization from 0 s to 600 s with a step of 0.01 s.

Every equation has a falling temporization from 0 s to 600 s with a step of 0.01 s.

Every equation temporized result is assignable to trip, trip latching, outputs and LEDs.

An example of a logic implementation using Equation A is shown below:



3.1.12.2 ‘AUX OUTPUT RLY’ submenu: Auxiliary programmable output relays

In the ‘AUX OUTPUT RLY’ menu, the user assigns the HF2025 internal and external data to the auxiliary output relays (relays RL2, RL3, RL4 or RL5). These are changeover type relays (1 common, 1 normally open contact, 1 normally close contact).One relay is switched on when at least one of the data items linked to it is valid (OR logic). Itdrops back once all its associated data has disappeared.

- Data assignable to the auxiliary output relays can be:
  - of the internal type
  - logic state of a protection function (instantaneous, time delayed signals)
  - logic state of an automatism or state function (blocking start, successful start)
  - the result of an “AND” logic equation
- of the external type
  - signal received via logic inputs (“tAux1 to tAux10, Inputs 1 to 10”)
  - signal received via the communication network (remote control by the supervisor)

The protection functions that can be assigned to the output relays (2 to 5) for the HF2025 is detailed in the section HF2025/EN HI – Menu of the HMI.

- ‘TRIP OUTPUT RLY’ submenu: Configuration of the trip output relay

Data which is going to control the relay RL1 (terminals 2-4-6) can be assigned using the ‘TRIP OUTPUT RLY’ sub-menu. This changeover type relay is used to give a tripping order to the cut-off device.

The relay RL1 (tripping relay) has the same electrical and mechanical characteristics as the other output relays.

Reminder: A certain number of the HF2025 functions are based on the operation of relay RL1, i.e.

- The Trip Cause Statistics
- The Latching of the Trip Output Relay
- The CB fail function
- The trip circuit supervision function
- The Surveillance of the cut-off device
- The record of fault values
- The triggering of disturbance record
- The display of data relating to the cut-off device

3.1.12.3. ‘LATCH TRIP ORDER’ submenu: Latching of the trip output relay

In this menu, the user selects which functions are to maintain the output relays energized when an order is generated by these functions.

Therefore, when one of the functions set as latching issues a trip signal via output relay RL1,the relay remains energized after the end of the trip signal. It will be necessary to attend and acknowledge the HF2025 in order to switch off the output relay RL1.

NOTE:

- Latching of the output relays is optional for each of these functions. The user can choose whether to assign these functions to the “trip output relay latching facility”
- There are 3 possible ways to acknowledge the HF2025, andthus switch off the output relay RL1 in the event of latching:

press the Clear pushbutton

- send an acknowledge order to the configured logic input on “EXT RESET”
- send an acknowledge remote order via the communication network (order given by a supervisor)
- On loss of auxiliary power, the output relay drops back. On return of auxiliary power, the output relay is re-energized, independently of the fault status (whether the fault is still present or cleared)

- ‘CB FAIL’ sub-menu: Breaker failure protection

The breaker failure function is used to quickly detect if a circuit-breaker has not opened (phase fault currents still present) after a trip signal.

This function is based on a "I<BF" current threshold and on a "tBF" time-delay; these two settings can be configured by the user.

If this function is commissioned by the user, it is activated every time relay RL1 issues a trip command.

The "tBF" time-delay is initiated upon energiztion of output relay RL1. Then, for each phase, the HF relay detects the first crossing of the current out of the zone created by "I<BF". Upon detecting this crossing, the HF relay initiates another time-delay with a fixed value equivalent to 20 samples.

The relay sampling value is 32 samples/cycle. Therefore, the duration of the fixed time-delay is 12.5ms at 50Hz and 10.4ms at 60Hz As long as this 12.5ms timer is running, the relay checks whether the current leaves the current zone again. Where the current is notsuppressed by the circuit breaker pole, it will come out of the zone after a half cycle, i.e. 16 samples (10ms at 50Hz).

The relay restarts the 20 sample timer each time it detects that the current comes out of the preset current zone "I<BF".

For each 20 sample window the relay checks that when the current leaves the zone it does so in the opposite direction to the previous crossing:

- If there is no opposed current crossing, then the relay decides that the circuit breakerpole is open.
- If there is a current crossing opposed to the previous crossing, then the relay decidesthat the circuit breaker pole is still close.

At the end of the tBF time-delay, the relay checks the state of each breaker pole (according to the principle described above). If one or several poles are not open, the HF relay issues an alarm message: "CB FAIL".

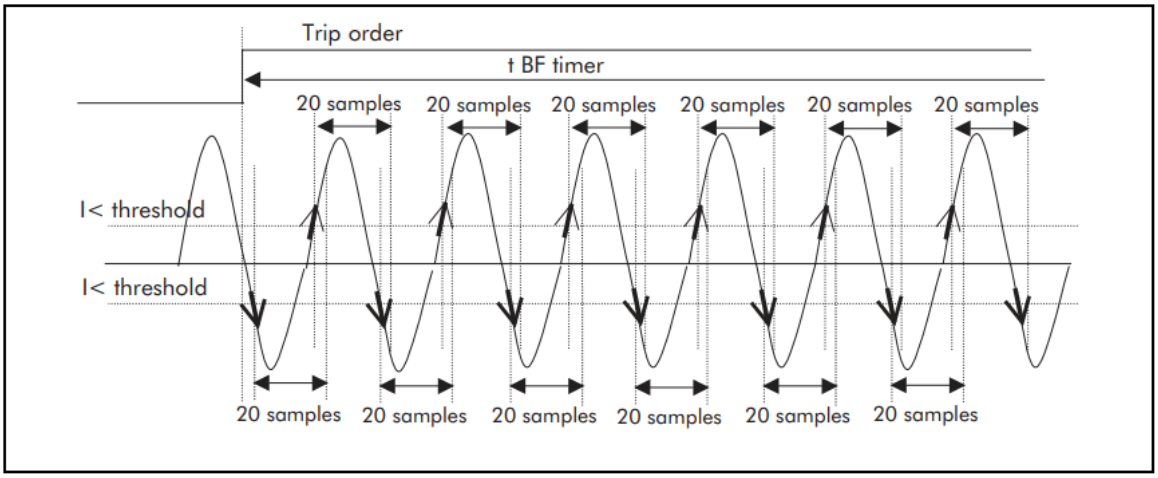


Figure 4 - circuit breaker failure detection principle

Case 1:

The figure below shows a correct opening of the circuit-breaker before the tBF time-delayexpires. In this case, no alarm is issued.

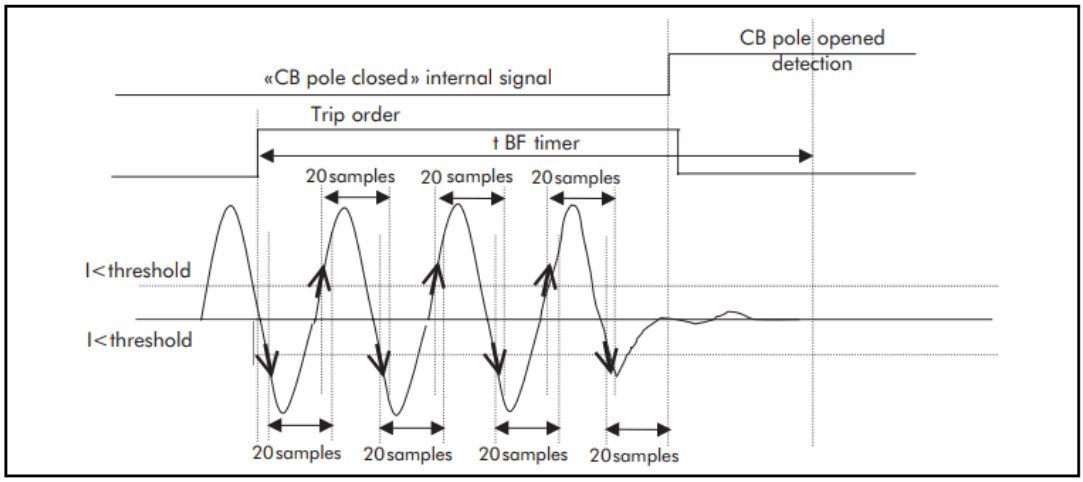


Figure 5 - opening of the breaker pole before tBF drop off

Case 2:

In the figure below the circuit-breaker does not open before the end of the tBF time-delay. In this case the relay issues a CB FAIL indication.

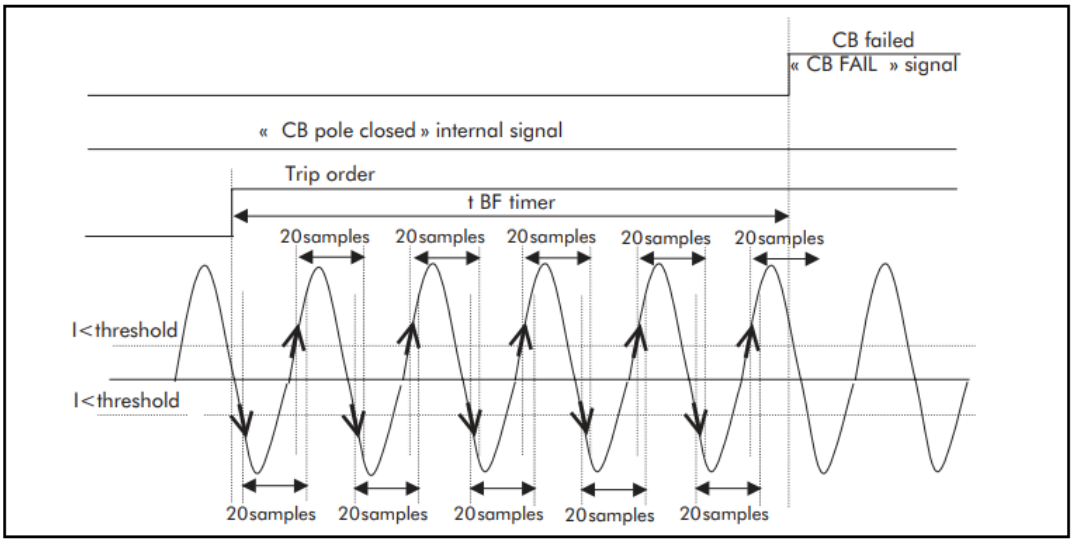


Figure 6 - the breaker pole does not open before the end of tBF

Case 3:

The figure below shows a correct circuit-breaker opening. After fault clearance, the phase current does not decrease immediately. This is often due to the phase CT de-magnetization.

In this case, were the breaker failure detection based solely on an undercurrent threshold, there would be an erroneous breaker failure diagnostic.

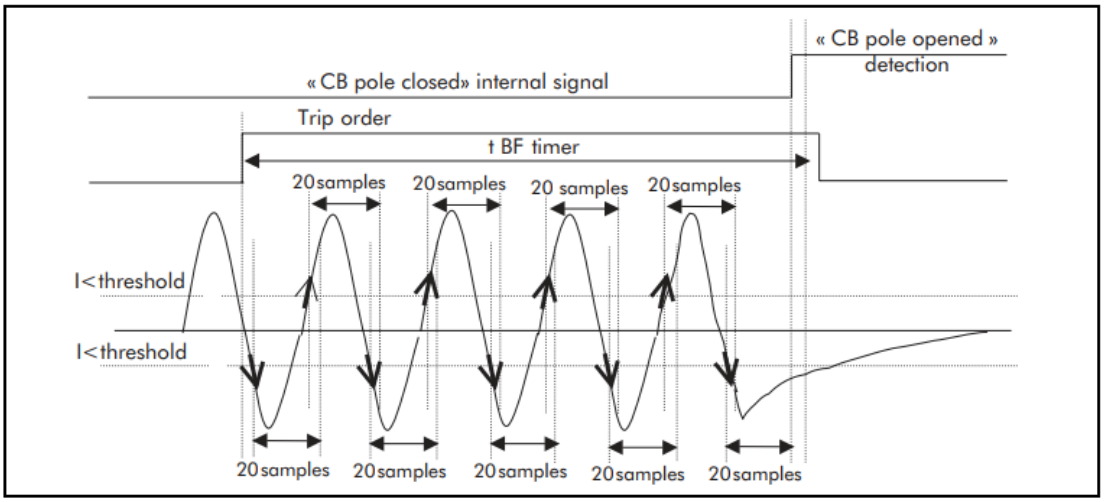


Figure 7 - phase CT de-magnetization

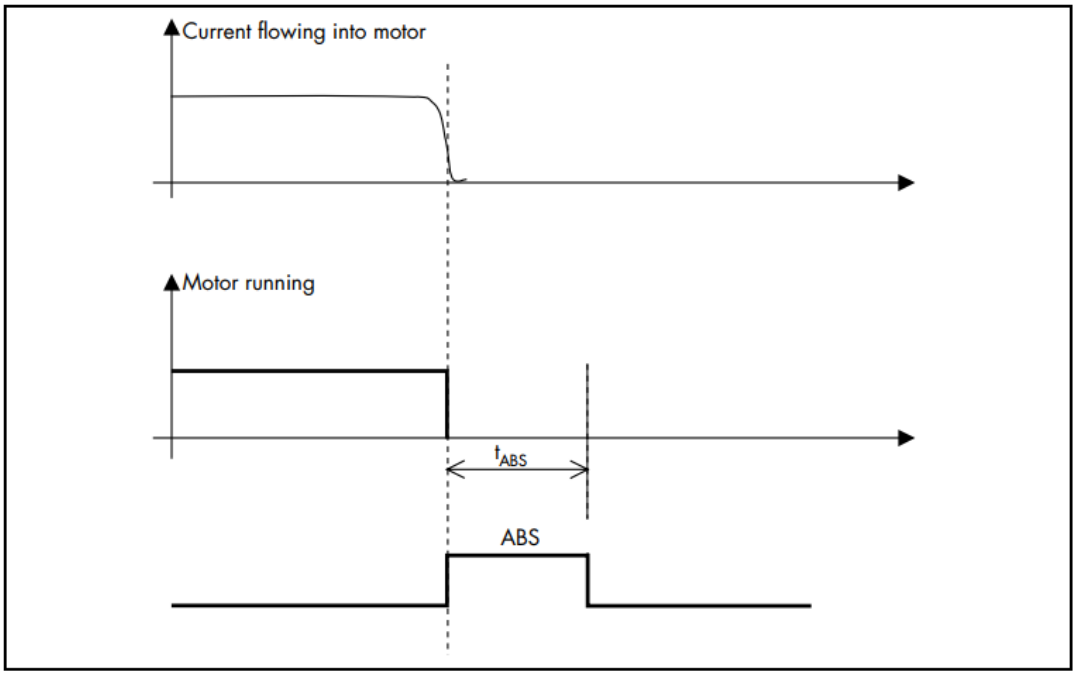
3.1.12.9 The ABS (Anti-BackSpin) sub-menu: Minimum time between a stop and a start

Anti-backspin protection is typically used on pump-motors which are installed down hole upto kilometers underground. Although stop valves are often used in this kind of application to prevent reversal of flow when the pump stops, however the reversal of flow may happen due to faulty or non-existent stop valves, causing the pump impeller to rotate the motor in the reverse direction. Starting the motor while it is back-spinning may result in motor damage. Anti-backspin protection function ensures that the motor can only be started when the motor has fully stopped.

The ABS (anti-backspin) function imposes a waiting time between a stop and a re-start of themotor. This waiting time allows the rotor coming to a halt before the motor is re-started.

It is based on the use of an adjustable time delay: tABS.

This time-delay is initiated when a motor stop is detected. As long as this timer is running, an ABS indication remains issued. This ABS indication disappears at the end of the tABS time-delay.



3.1.12.10 ‘BUS VOLTAGE CTRL’ sub-menu : Validation of voltage presence before a start

This function makes it possible to check that the system voltage level is sufficient to allow asatisfactory motor start sequence.

It is only valid when the relay "sees" the motor as stopped.

With the motor stopped, the HF2025 relay issues a "BUS VOLTAGE" indication if the measuredvoltage (between phases A and C) is below a settable threshold, "V BUS".

The pick-up and drop-off of the "BUS VOLTAGE” indication are instantaneous.

3.1.12.11. ‘CB SUPERVISION’ submenu: Circuit-breaker supervision

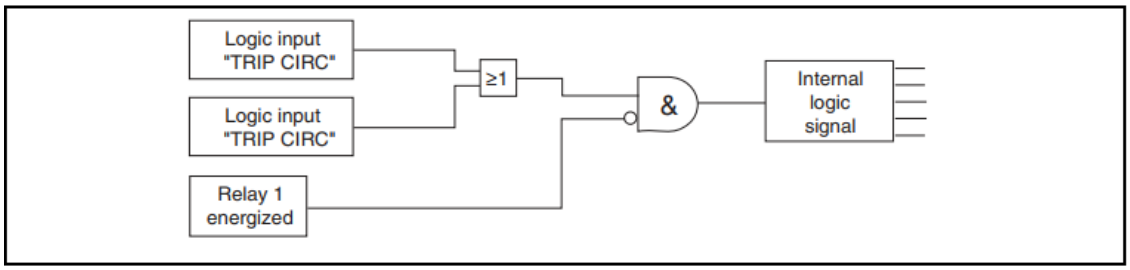
- Trip circuit supervision

The ‘TRIP CIRCUIT SUPERV’ function supervises the trip circuit wiring continuity.

One or two logic inputs must have been assigned to "TRIP CIRC" (refer to section 4.12.4.2.8), then connected to the trip coil power circuit.

When the ‘TRIP CIRCUIT SUPERV’ function is set on YES, the HF relay continuously checks the trip circuit whatever the position of the circuit breaker poles, open or closed. This function is inhibited when the protection relay sends a tripping order to the circuit-breaker, via its RL1 output relay.

If, during a time equal to tSUP, the state of the logic input(s) assigned to "TRIP CIRC" is 0, the HF relay issues a ‘TRIP CIRC. FAIL’ alarm.



- Circuit-breaker supervision

The HF2025 relay monitors the operation of the cut-off device (fuse-contactor or circuit breaker). Three criteria are monitored and for each of these an adjustable alarm threshold is available to the user. These thresholds are based on:

- Monitoring of the time of opening of the cut-off device. This is the time from the moment when the HF2025 sends an order to the output relay RL1 to the moment when the HF2025 relay receives the data on the logic input RL1 (terminals 22-24) indicating that the cut-off device is open.
- Monitoring of the number of opening orders. This is the number of tripping orders which have been issued to relay RL1.
- Monitoring of the sum of broken amp to the power of "n" broken by the switching device (exponent: n =1 or 2). The current value taken into account is that of the current when output relay RL1 receives the trip command.

When one of the thresholds described above is exceeded, an alarm message is available on the display and logic data can be assigned by the user on one or several of the auxiliary output relays (relays RL2, RL3, RL4 or RL5).

So as to adapt the HF2025 to any type of cut-off device, the user can also configure 2 time delays:

One maintenance of tripping order TRIP T time delay: For each tripping order sent on the relay RL1, the latter is kept switched on for a time TRIP T (if the “trip output relay latching” facility has not been set on).

One maintenance of tripping order CLOSE T time delay: a tripping order (closure of the cut-off device) given by the communication network (remote control CLOSE ORDER) is maintained on the auxiliary output relay for a time equal to CLOSE T. This is the output relay to which the CLOSE ORDER, order has been allocated (AUX OUTPUT RLY menu).

NOTE:

- For the summation of the amps to exponent “n” cut, the exponent “n” can be adjusted to the value 1 or the value 2.
- In all cases, the orders sent on the output relay RL1 (tripping order) are maintained for at least 100 ms.

3.1.12.11 ‘LATCH AUX OUTPUT RLY’ submenu: Latching of the output relays

In this menu the user programs each auxiliary output relays (relays RL2, RL3, RL4 or RL5) to have a latching operation or a self-reset operation.

When a relay set as latching receives an energization signal, it remains energized even after the signal has been removed. It will then become necessary to acknowledge the HF2025 in order to switch off this output relay.

NOTE:

- There are 3 possible ways to acknowledge the HF2025, and thus switch off one output relay in the event of it being latched:
- press the READ button
- send an acknowledge order to the configured logic input on “EXT RESET”
- send an acknowledge remote order via the communication network (order given by a supervisor)
- On loss of auxiliary power, the output relay drops back. On return of auxiliary power, the output relay is re-energized, independently of the fault status (whether the fault is still present or cleared)

3.1.13 ‘RECORD’ menu

The ‘RECORD’ menu comprises 3 sub menus:

- ‘FAULT RECORD’
- ‘DISTURB RECORD’
- ‘CB MONITORING’

3.1.13.1 ‘FAULT RECORD’ submenu

A collection of data on each of the 25 last faults registered is displayed in the ‘FAULT RECORD’ sub menu.

For each recording, the relays memorizes

- the fault number,
- the time of the fault,
- the date of the fault,
- setting group (group G1 or G2) active at the time of the fault,
- the faulty phase,
- the function which detected the fault,
- magnitude of fault current or voltage (in fundamental value),
- the phase A, B and C currents (in true rms values),
- the earth current (in true rms value),
- the phase A - phase C voltage (in true rms value)
- either through the Human Machine Interface (display front face),
- either using the remote communication network (RS485 rear port(s)),
- or using the SARA support software (RS232 front port).

Fault number 25 is the last fault registered. Fault number 1 is the oldest.

NOTE:

- These data are not erasable. They are managed in a circular list(first in first out): when this is full, the oldest fault is erased.
- Faults are signaled by one or several alarm messages.

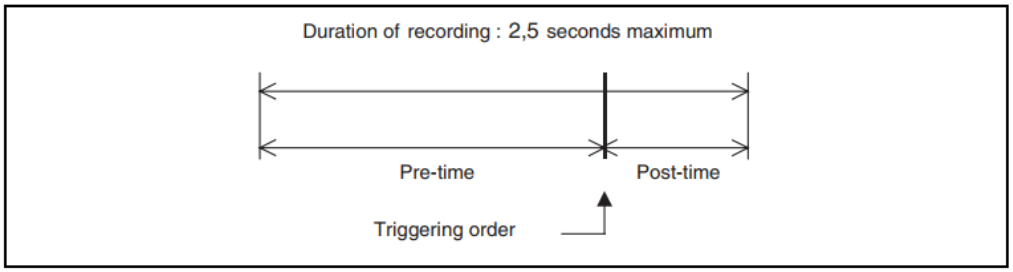
3.1.13.2 ‘DISTURBANCE RECORD’ submenu

The HF2025 relay offers the possibility of saving 5 disturbance records. The data is acquired at a frequency of 32 samples per electrical cycle, i.e. 1600Hz in a 50Hz system or 1920 Hz in 60Hz system, and allows for a very true reconstruction of the analogue signals.

For each recording, the relays memorizes:

- the 3 phase currents
- the earth current
- the phase-phase voltage VAC
- the frequency
- the state of the 6 logic inputs
- the state of all the output relays (including the watchdog relay)
- the date and the time

The total duration of a recording is defined by the configuration of the pre-time and post-time. The pre-time defines the duration of the recording before the disturbance recording triggering order. The post time defines the duration of the recording after the disturbance recording triggering order. In all cases, the total duration of a recording cannot exceed 2.5 seconds.



The triggering of a disturbance recording can be generated:

- when a logic entry programmed on “DIST TRIG” is excited (Trigging of the disturbance recording)
- on receipt of a remote control from a supervisor on the communications network,
- on receipt of a remote control from SARA support software,
- when one of the following occurs (exclusive choice):
- instantaneous over-stepping of one of the following current thresholds: I>>, Io>, Io>>, V< or V> (instantaneous short-circuit, instantaneous earth fault 1st and 2nd stages, instantaneous under- and overvoltage data respectively)
- or when output relay RL1 is excited (relay dedicated to the tripping of the cut-off device). The excitement of this relay can be due to the detection of an electrical fault or to a voluntary opening order (opening remote control on the communication network, external order relayed by one of the logic inputs)

The disturbance recordings can be retrieved:

- either using the remote communication network (RS485 rear port(s))
- or using the SARA support software (RS232 front port)

NOTE:

- If the configuration of the pre-time and post-time corresponds to total recording duration of more than 2.5 seconds then the post-time duration is automatically reduced so that the total recording duration is 2.5 seconds.
- Disturbance recordings are not erasable. They are managed in a circular list: when this is full, the oldest recording is erased.
- When the disturbance recordings are extracted from relay HF2025 using the SARA software, they are stored in the COMTRADE format.

3.1.13.3 CB MONITORING' submenu display of the values related to the cut-off device

In this menu the operator with access to data relating to the cut-off device:

- Summation of the amps exponent "n" switched by the cut-off device for each phase
- Total number of operations of relay RL1
- Opening time of the cut-off device.

NOTE:

- These data are those calculated by the relay HF2025 whilst in the CB SUPERVISION menu the operator with access to the adjustment of the parameters to generate alarm data when a threshold is exceeded.
- The way in which relay HF2025 calculates its data is explained in the section CB SUPERVISION.

3.1.14 Alarm messages

The management of the alarms is carried out directly on the front face screen. The display of alarm messages takes priority over that of the value by default (selected in CONFIG. SELECT submenu), so that as soon as an alarm is detected the message is displayed onthe HF2025 relay LCD screen.

The alarm messages are classified into 2 categories:

- Motor alarm message
- Relay hardware or software fault, or RTD/thermistor failure message

The display of a HARDWARE ALARM message takes priority over the display of a MOTOR ALARM message.

NOTE:

Upon loss of auxiliary power supply, the alarm messages disappear. They are restored upon return of the power supply. The MOTOR ALARM messages.

3.1.14.1 'ALARM' menu

Data considered as motor alarm are displayed in the MOTOR ALARMS menu.

If several alarms appear, they are written to memory in the order of their detection. They aredisplayed in reverse chronological order (the most recent alarm first, the oldest last). Each message is numbered and the total number of messages is indicated.

- Example

This message indicates an earth fault (time delayed threshold tIo>>). This alarm is the 2ndout of total of 7.

t I0>> 2/7

The operator can read all of the alarm messages using the c key, without any necessity tokey in the password.

The operator can acknowledge the alarms using the ② key. Keying in the password is not necessary. The operator can acknowledge each message one at a time, or acknowledge all the messages by going to the end of the list and acknowledging all the messages by pressing the ② key.

NOTE:

If an alarm has not been acknowledged, it will not be possible to viewthe default display programmed by the operator.

3.1.14.2 The HARDWARE ALARM messages

The safety and availability of the HF2025 relay can be improved by a cyclic auto-test procedure of both hardware and software. Each time the HF2025 relay is switched on, auto-diagnostic tests are initiated: these tests deal with the output relays(engaging/triggering tests), the microprocessor, the memories (EEPROM checksum calculation, RAM tests) and the acquisition circuit of each analogue input.

The hardware faults are split into 2 groups:

- Minor faults: these are faults classified as non-serious (communication fault, analogue output fault, RTD or thermistor failure and internal clock)
- Major faults: these are serious faults (RAM fault, EEPROM data fault, EEPROMcalibration fault, analogue signal acquisition fault, watchdog fault)

Any major fault recorded is immediately the subject of an alarm and provokes the activation of the WATCHDOG relay (relay WD, terminals 35-36-37), as well as the switching off of the other output relays.

The acknowledged alarms are all written to memory in the order of their appearance. The display of the alarms is ensured in reverse chronological order (the most recent alarm first, the least recent last). Each message is numbered and the total number of messages is indicated in the top left hand corner of the display.

The operator can read all of the alarm messages using the c key, without any necessity tokey in the password.

The acknowledgement of the relay hardware alarm messages is IMPOSSIBLE. Only the disappearance of the cause of the alarm will provoke their acknowledgement.

The display of a hardware fault (equipment fault) takes priority over the other alarms (non-equipment fault).

NOTE:

In the case of major hardware alarm and when the trip output relayRL1 has been configured latched, this relay drops out too.

3.2 Auxiliary functions

3.2.1 Event records

The HF 2025 relay records 250 state changes in non-volatile memory and dates with a 1ms accuracy. For each state change (event) the relay gives the date, time and label.

This applies to any change of state of the logic inputs/outputs, the alteration of one orseveral setting parameters, alarm or triggering data. Please refer to Chapter HF2025/EN CT/B44 for more information.

The recordings of the consignment of states can be downloaded:

- either using the remote communication network (RS485 rear port(s))
- or using the SARA support software (RS232 front port)

NOTE:

These consignments are not erasable. They are managed in a circular list: when this is full, the change of state of the oldest is erased

3.3 Recording of the form of the starting current and voltage

The HF 2025 relay records the current waveform and voltage waveform of the latest start. In order to do this, it records every 5 cycles (every 100 ms if the frequency is at 50 Hz) the maximum value of one of the three line currents, and the value of the line-line voltage V_{A-C}. The values recorded are expressed in True RMS values.

The recording is initiated following detection by the relay of a motor start up, it stops at the end of the tl_{start} time delay allocated to the start up.

The file containing the recording of the form of the starting current/voltage can be repatriatedon a PC:

- either using the remote communication network (RS485 rear port)
- or using the SARA software (RS232 front port). The data will bestored in COMTRADE format.

NOTE:

The maximum duration of a recording is limited to 200 seconds

3.3.1 Standard remote control via the RS485 communications port

In the AUX OUTPUT RLY sub-menu, it is possible to assign the ORDER1 information to oneor several output relays.

A communications command (via the RS485 port) issues the ORDER1 information, which is latched during a fixed 200ms period.

3.3.2 Block start via the RS485 communications port

In the AUX OUTPUT RLY sub-menu, it is possible to assign the ORDER2 information to oneor several output relays.

A communication command (via the RS485 port) issues the ORDER2 information which is latched until another communication command (via the RS485 port) makes the first one drop off.

Inserting an output relay, to which the ORDER2 information has been assigned, into the startcoil circuit allows a supervisor to remotely block/authorize a motor re-start.

4 INSTALLATION GUIDE

4.1 General

4.1.1 Receipt of the relays

Protection relays are generally robust. However it is appropriate to treat them with care before installing them on site. As soon as they arrive, the relays should be examined immediately, looking for any deterioration which could have occurred during transport. If there is any deterioration, make a claim against the forwarding company and inform Hamian Fan Company Electric as soon as possible.

Relays not intended for immediate installation must be stored in their protective polyethylenepackaging.

4.1.2 Electrostatic discharge (ESD)

Relays use components sensitive to electrostatic discharges. The electronic circuits are wellprotected by the metal housing. Consequently, the internal module must not be taken out pointlessly. When handling the module outside its housing, be very careful to avoid any contact with electrical connections and components. If it is removed from its housing for storage, the module must be placed in electrically conductive antistatic packaging.

No configuration setting is possible in the module. We therefore advise you not to dismantle it pointlessly. The printed circuit boards are interconnected. They are not designed for disconnection by the user. Avoid touching the printed circuit boards. They are made with complementary metal-oxide semiconductors (CMOS) and the static electricity discharged by the human body has an adverse effect on them.

4.2 Handling electronic equipment

The usual movements of a person easily generate electrostatic energy which may reach several thousand volts. The discharging of this voltage into devices comprising semiconductors, when handling electronic circuits, can cause severe deterioration. Such damage is not necessarily visible immediately. Nevertheless, it reduces the reliability of the circuit.

Electronic circuits are completely protected against any electrostatic discharge when inside their housing. Do not expose them to any risk by needlessly taking the modules out of their housings.

Each module has the best possible protection for its devices consisting of semiconductors. However, should it be necessary to withdraw the module from its housing, please take the following precautions to preserve the great reliability and long service life for which the equipment was designed and manufactured.

Before taking the module out of its housing, touch the housing to balance yourelectrostatic potential.

When handling the module, hold it by its front plate, or by its frame or by the edges of the printed circuit board. Do not touch the electronic components, the printed circuit conductors and the connectors.

Before passing the module to another person, shake hands with him or her forexample to balance your electrostatic potential.

Place the module on an antistatic surface or an electrically conductive surface with the same potential as yourself.

To store or transport the module, place it in conductive packaging.

If you carry out any measurements on the internal electronic circuits of a device in service, earth yourself to exposed conductive parts by linking yourself to the housing by a conductive strap attached to your wrist. The resistance to earth of the conductive strap which you attach to your wrist and to the housing must be between 500 k□ and 10 M□. If you do not have a device of this type, you must remain permanently in contact with the housing to prevent any static energy accumulating. The instruments used to take the measurements must be earthed to the housing insofar as this is possible.

For further information on the procedures for safe working with all the electronic equipment, please consult standards BS5783 and IEC 147-OF. In a special handling area we strongly advise you to undertake a detailed analysis of the electronic circuits and working conditions according to the BS and IEC standards mentioned above.

4.3 Installing the relays

The relays are supplied individually. The modules must still be protected in their metal housings during installation. The design of the relays makes it possible to reach the mounting holes easily without taking off the cover. For individually mounted relays, a positioning diagram is normally supplied to indicate the center of the holes and the layout of the cubicle.

4.4 Unpacking

When unpacking and installing relays, take great care to avoid damaging the parts and changing the settings. Relays must be handled only by people who are experts in this field. As far as possible, the installation must remain clean, dry, free from dust and free from excessive vibration. The site must be well lit to facilitate inspection. Relays removed from their housings

must not be exposed to dust or humidity. To this end, it is necessary to take great care when installing relays whilst construction work is taking place on the same site.

4.5 Storage

If relays are not to be installed immediately upon receipt they should be stored in a placefree from dust and moisture in their original packaging. If dehumidifying crystals are placed in the relay packaging, it is advisable not to remove them. The effect of the dehumidifying crystals is reduced if the packaging is exposed to ambient conditions. To restore their original effectiveness, you need only to heat the crystals slightly for around an hour, before replacing them in their delivery carton.

As soon as the packaging is opened, the dust which has accumulated on the carton risks settling on the relays. In the presence of moisture, the carton and the packaging can become humidified to the point where the effectiveness of the dehumidifying crystals is reduced.

The temperature for storage should remain between - 25 □C and + 70 □C.

Warning!

Sustained exposure to high humidity during storage may cause damage toelectronics and reduce the lifetime of the equipment.

Therefore, once the HF products have been unpacked, we recommend that they are energized within the three following months.

Where electrical equipment is being installed, sufficient time should be allowed for acclimatization to the ambient temperature of the environment, before energization.

4.6 Safety instructions

Warning!

For your safety, please read these instructions beforecarrying out any work on the HF 2025 relay.

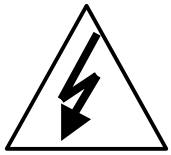
4.6.1 Health and safety

The safety instructions described in this document are intended to guarantee correct installation and use of the HF 2025 relay and to avoid any damage. All persons directly or indirectly concerned with the use of these devices must be familiar with these safety instructions.

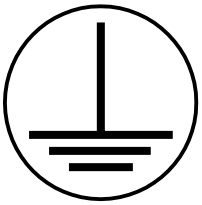
4.6.2 The meaning of the symbols

The meaning of the symbols which may be used on the equipment or in the product documentation is as indicated below:

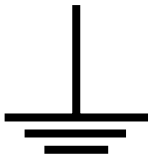
Important: refer to the product documentation



Important: risk of electrocution



Protective/safety earth *



Functional earth *

Note:

This symbol can also be used for a protective/safety earth on a terminal strip or in a subassembly, for example for the electrical power supply.

*NOTE:

The term "earth" used in the product documentation is the directequivalent of the term "exposed conductive parts" which is also used.

4.7 Installation, commissioning and maintenance

4.7.1 Connection of the HF2025 relay

Warning!

The personnel in charge of the installation, commissioning and maintenance of a HF2025 relay must apply adequate procedures to guarantee safety when using the equipment. Before

installation, commissioning or maintenance on the equipment, consult the relevant chapters in the technical documentation of the relay.

The terminal blocks of the relays may have a dangerously high voltage during installation, commissioning or maintenance, if electrical isolation is not carried out.

Access to the connectors at the rear of the relays can present risks of electrocution and thermal shock.

Before you consider energization, the HF2025 relay must be connected to earth via the terminal provided for this purpose.

Unless otherwise indicated in the technical data chapter of the product documentation, the minimum size recommended for the earth wire is 2.5 mm^2.

Before energizing your HF2025 relay, please check the following points:

- Rated voltage and polarity of the auxiliary power supply
- Current value of the current transformer circuit and integrity of the connections
- Integrity of the earth connection.

4.7.2 Operating conditions of the HF2025 relay

The operation of the HF2025 relay must comply with the electrical and environmental requirements described in this document.

4.7.3 Current transformer circuits

Never open the auxiliary circuit of a live current transformer. The high voltage produced maycause serious physical injury and damage the insulation of the equipment.

4.7.4 Dielectric withstand test

Following an insulation test, the capacitors may still be charged with a potentially dangerous voltage. At the end of each part of the test, the voltage must be progressively brought down to zero to discharge the capacitors before disconnecting the test wiring.

4.7.5 Removal and destruction of the HF2025 relay

4.7.5.1 Removal

Warning!

The auxiliary power supply circuit of the relay can include capacitors for the power supply or for earthing. To avoid any risk of electrocution or thermal shock, it is appropriate to isolate the relay completely (the two direct current poles) from any power supply, then to discharge the capacitors in complete safety via the external terminals, before taking the device out of service.

4.7.5.2 Destruction

It is recommended that the relay should not be incinerated nor thrown into a river. HF relays and their components should be disposed of and recycled strictly in compliance with regulations on safety and the environment. Before destruction, remove the batteries, taking the necessary precautions to avoid any risk of electrocution.

4.7.6 Technical specifications

Insulation level:	IEC 1010-1: 1990/A2: 1995 class I EN 61010-1: 1993/A2: 1995class I	This device must be connected to earth to guarantee the safety of the user.
Environment**:**	IEC 1010-1: 1990/A2: 1995 pollution level 2 EN 61010-1: 1993/A2: 1995 pollution level 2	Conformity is established by reference to the generic safety standards.
Product **safety:**	73/23/EEC	Conformity with the European Commission directive relating to lowvoltages.
	EN 61010-1: 1993/A2: 1995	Conformity is established by
CE	EN 60905: 1992/A3: 1995	Reference to the generic safety standards.

4.8 Connections

4.8.1 Connection of power and signal circuits

Warning!

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety guide sfty/4lm/e11 or later issue, or the safetyand technical data sections of the technical manual and also the ratings on the equipment rating label.

Warning!

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety guide sfty/4lm/e11 or later issue, or the safetyand technical data sections of the technical manual and also the ratings on the equipment rating label.

To ensure the safe isolation of adjacent terminals and to maintain UL/CSA Listing, equipment wire terminations shall be made using UL/CSA Listed wire and suitable insulated pressure/crimp terminals or terminal kits only.

All wires shall have a minimum temperature rating 75°C and for power circuits be terminated in insulated pressure/crimp terminals. The exception is for low voltage signal circuits, the wire for these connections may be directly inserted into the screw clamp connector, or be terminated in a suitable crimp/pressure pin terminal, before insertion. Wires shall have the following minimum cross-sections:

- Current Transformers (CTs) 2.5 mm² or12 AW

- Auxiliary (supply input), Vx: 1.5 mm² or 16 AW
- Communication Port
- Low voltage signal circuits
- Protective Earth/Ground
- Other Input/Output Circuits 1.0 mm² or 18 AW

The individual equipment is delivered with sufficient M4 screws and washers to connect the relay via insulated crimp/pressure ring terminals. The maximum number of insulated crimp/pressure ring terminations, per terminal block terminal shall be two.

There are 3 types of suitable insulated crimp/pressure terminals (see below) according to the cross sectional area of the wire and the type of terminal. Each reference corresponds to a sachet of 100 terminals.

*Push-on terminal 4.8 x 0.8 (wire size 0.25 - 1.65mm²/ 22AWG - 16AWG)  *See Note below
M4 90˚ Ring Tongue terminal (wire size 0.25 - 1.65mm²/22AWG - 16AWG) 
M4 90˚ Ring Tongue terminal (wire size 1.04 - 2.63mm²/16AWG - 14AWG)Automation Products reference: ZB9124 900 

NOTE:

Pressure/crimp push-on or ring terminals may be used for communication circuit connections. Only pressure/crimp ring terminals shall be used for connections to other circuits.

Because of the limitations of the ring terminals, the maximum wire cross-section which can be used for the connector blocks (for current inputs and signals) is 6mm² by using non-insulated ring terminals. When only pre-insulated terminals can be used, the maximum wire cross-section is reduced to 2,63 mm²/14AWG per ring terminal. If a more significant wire cross-section is necessary, two wires can be connected in parallel, each one terminatedby a separate ring terminal.

Except for the RS485 port all the terminal blocks used for connections, can withstand a maximum working voltage of 300V.

4.8.2 Communication port RS485

Connections to RS485 are made using ring terminals. It is recommended that a two core screened cable, is used with a maximum total length of 1000 m or a 200nF total cable capacitance.

Typical UL/CSA Listed Cable Specification:

- Each core: 16/0.2 mm Copper conductor, PVC insulated
- Minimum conductor cross sectional area per core: 0.25 mm² per core/22AWG
- Screen: Overall braid, PVC sheathed
- Linear capacitance between conductor and Earth/Ground: 100pF/m

4.8.3 RS232 port

Short term connections to the RS232 port, located behind the bottom access cover, can be made using a screened multi-core communication cable up to 15m long, or a total capacitance of 2500pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug.

4.8.4 Protective conductor (earth/ground)

The equipment must be connected to the protective conductor via the M4 protective conductor (earth/ground) terminal (PCT) of the terminal block numbered 1 to 28, marked with the earth/ground symbol. We recommend a wire of minimal cross section 2,5 mm²/12AWG. Because of the limitations of the ring terminals, the maximum possible wire cross section is 6mm². If a larger section is necessary, one can use cables connected in parallel, each one terminated with a ring terminal. Alternatively a suitably sized metal strip may be used.

NOTE:

To prevent any electrolytic risk between copper conductor or brass conductors and the back plate of the equipment, it is necessary totake precautions to isolate them one from the other. This can be donein several ways, for example by inserting between the conductor and the case a plated nickel washer or by using tinned terminations.

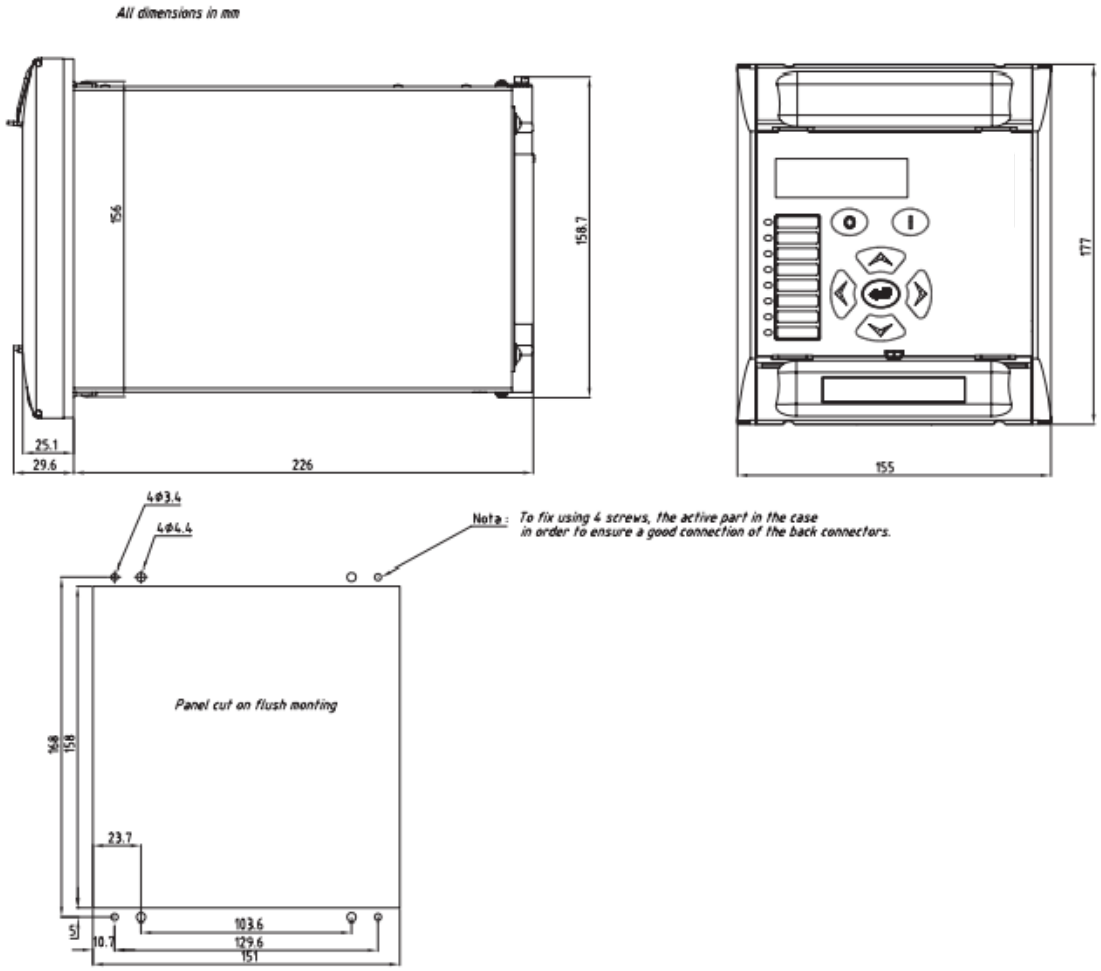
4.9 Case dimensions

HF2025 relays are available in a 4U metal case for panel or flush mounting.

Weight: about 3.7 Kg

External size:	Height	Case	156 mm
		Front panel	177 mm
	Width	Case	148,1 mm
		Front panel	155 mm

Depth	Case (flush part)	226 mm
	Case + Front panel	256 mm



5 SETTING

5.1 'OP. PARAMETERS' menu

OP. PARAMETERS	Press the UP and DOWN keys to move around in the OP PARAMETERS menu.
PASSWORD = *** * * ***	Modification of the password: key in the old password and confirm it. Then press the key, key in the newpassword and confirm the whole input with the key.The message NEW PASSWORD OK is displayed to indicate that the password has changed.
LANGUAGE = **ENGLISH**	Indicates the language used in the display.
DESCRIPTION = **HF2025**	Displays the model of HF relay.
REFERENCE = **XXXX**	Displays your reference code. It contains letters between A and Z. To enter it, press the key for each letter and use the UP and DOWN to move forwards and backwards in the alphabet. After each letter, press the key to enter the next letter. At the end of the input, press the ENTER key to confirm your reference code.
SOFTWARE VERSION =	Displays the software version code.

FREQUENCY = **50 Hz**	Acquisition of the reference frequency of the electrical power system. There is a choice of: 50 Hz or 60 Hz.
ACTIVE PHASE **SEQUE = A B C**	Displays the active phase sequence
ACTIVE SETTING = **GROUP 1**	Displays the active setting group number: 1: PROTECTION Group 1 active 2: PROTECTION Group 2 active
INPUTS 6 5 4 3 2 1 **ST = 0 0 0 0 0 0**	Displays the state of the 6 binary inputs (or 11 binary inputs with option "5 digital inputs"). The binary inputs are numbered from 1 to 6 starting from the right. The state of each binary input is displayed immediately below: – state 0: input inactive – state 1: input active (state of 11 binary inputs is displayed with option
OUTPUTS 5 4 3 2 1 **ST = 0 0 0 0 0**	Displays the state of the output relays. The output relays are numbered from 1 to 5 starting from the right. The status of each output relay is displayed immediately below: – state 0: output inactive – state 1: output active
DATE **14/09/00**	Selection and display of the date.
TIME **16:35:30**	Selection and display of the time.

5.2 'ORDERS' menu

This menu gives the possibility:

- to send start and stop orders to the motors from the front panel,
- to clear LEDs, alarms and records.

ORDERS	Press the UP and DOWN keys to enter in the ORDERS menu.
General Reset **No**	"General reset" clears LEDs, alarms, counters, disturbance records, fault records, starting records, eventrecords, measurements values (maximum and average phase currents, energies, thermal status…), CB monitoring records ("S A 2 n" and "CB OPERATION NB" values). The reset order does not reset the latched trip outputrelay RL1 or the latched output relays. To change the setting, enter the password (if necessary).In the "confirmation?" cell, select Yes to apply the reset.
Start Motor **No**	Sends manually a start command from the local control panel to the motor. Setting range: No, Yes. (The "confirmation?" cell will be displayed after setting change).
Stop Motor **No**	Sends manually a stop command from the local control panel to the motor Setting range: No, Yes (the "confirmation ?" cell will be displayed after setting change)

5.3 'CONFIGURATION' MENU

5.3.1 'CONFIG. SELECT' submenu

CONFIGURATION	Press the UP and DOWN keys to enter the CONFIGURATION menu then press the L E F T and RIGHT keys togo into submenus.
CONFIG. SELECT	To move about in the CONFIG. SELECT submenu, use the UP and DOWN keys.

SET GRP CHANGE INPUT = LEVEL	Selection and display of the way to switch over from one setting group to another. The active setting group can be performed either on a transition (edge) or depending on a level. If "LEVEL" is set, the active group depends on the "SET GROUP" parameter (assigned to a logic input): "SET GROUP" low: "PROTECTION G1" is active, "SET GROUP" high: "PROTECTION G2" is active, Otherwise ("EDGE" set), any local or remote control (RS 232, RS 485 ports, or logic input configured) sets the protection group. Choice of: EDGE or LEVEL
SETTING GROUP **1**	Selection and display of the configuration group. Thiscell appears only if the above EDGE mode has been selected. Choice of: group 1 or group 2 1: PROTECTION G1 2: PROTECTION G2
DEFAULT DISPLAY **IA RMS**	Selection and display of a default value. Choice of :IA RMS, IB RMS, IC RMS, IN RMS, THERM ST, % I LOAD, TbefSTART, TbefTRIP, VAC RMS, POWER FACT, WATTs or VARs.
PHASE ROTATION **Menu**	Selection of the phase rotation detection.

When “menu” is set, the “PHASE SEQUENCE” cell is displayed and the user can select phase rotation sequence using this cell.

When the detection of the change phase sequence is provided by a digital input wired to the relay, the “Input” selection makes possible to detect phase rotation sequence using a digital input (assigned to this function using “Automat. Ctrl, Phase rotat.” Menu)

Choice of: “Menu” or “Input”

PHASE SEQUENCE **A B C**	This cell is displayed when “PHASE ROTATION” settingis set to “Input”. It allows phase rotation selection between either A-B-C or A-C-B

START DETECTION **52 A + I**	Selection and display of the start detection criterion. Choice of: 52A or 52A + I

ANALOG. OUTPUT **0 - 20 mA**	Selection and display of the analog output type: 0-20 mA or 4-20 mA (optional).

5.3.2 ‘CT/VT RATIO’ submenu

CONFIGURATION	Press the UP and DOWN keys to enter the CONFIGURATION menu then press the L E F T and RIGHT keysto go into configuration submenus.
CT/VT RATIO	To move about in the CT/VT RATIO submenu, press the UP and Down keys.
LINE CT PRIM = *** * * ***	Selection and display of the primary rating of the phase CT. The value is entered on 4 figures: from 1 to 3000 insteps of 1.
LINE CT SEC = *****	Selection and display of the secondary rating of the phase CT. The value is to be selected between either 1or 5.
E/GND CT PRIM = *** * * ***	Selection and display of the primary rating of the earth CT. The value is entered on 4 figures: from 1 to 3000 insteps of 1.
E/GND CT SEC = *****	Selection and display of the secondary rating of the earthCT. The value is to be selected between either 1 or 5.

LINE VT PRIM = *** * * * ***

HF2025 only. Selection and display of the primary VT rating. The value is entered on 5 digits: from 1 to 20000 in steps of 1.

LINE VT SEC = *** * ***

Selection and display of the secondary VT rating. The value is entered on 3 digits.
Two ranges: 57 - 130 Volt or 220 - 480 Volt.

5.3.3 'LED' submenus

CONFIGURATION

Press the UP and DOWN keys to enter the CONFIGURATION menu then press the LEFT and RIGHT keys to go into submenus.

LED 5

To reach the LED configuration submenu press DOWN for Led 5. Press RIGHT to reach Led 6, again to reach Led 7 and again to reach Led 8.

THERM OVERLOAD? **YES**

To link LED 5 with the «thermal overload» function so that it lights up if the thermal overload function operates, press , select YES by using the UP and DOWN keys, then press again to confirm.

Setting Choice: Yes or No. The default value is No (except "THERM OVERLOAD?"=Yes)

- SARA setting:

A double click on LED 5 (6, 7 or 8) displays LEDs submenus. Each submenu contains several lines parameter settings. In the value column, the first value (function) is displayed. If several values (or functions) are selected, an arrow ("-->") is added to the first value selected.

- HF2025 Front panel setting:

Press DOWN to access the LED 5 CONFIGURATION submenu, then RIGHT twice (press RIGHT to access to others LEDs CONFIGURATION submenus).

Select "Yes" to assign a LED to a function.

NOTES: Each parameter can be assigned to one or more LEDs.One or more parameters (OR logic) can light each LED.

The next table indicates the functions that can be assigned to the LEDs (5 to 8) for each HF relay model:

Function	"YES" links the LED to…
THERM OVERLOAD?	The LED will indicate the thermal overloadfunction operating
θALARM?	Thermal overload alarm threshold $\theta_{ALARM.}$
tI>?	Time delayed 1st phase overcurrent threshold tI>(protection against Phase OC)
tI>>?	Time delayed 2nd phase overcurrent thresholdtI>> (protection against Phase OC)
tI>>>?	Time delayed 3rd phase overcurrent thresholdtI>>> (protection against Phase OC)
tI0>?	Time delayed 1st earth overcurrent threshold tI0>
tI0>>?	Time delayed 2nd earth overcurrent thresholdtI0>>

Function	"YES" links the LED to…
tI2>?	Time delayed 1st negative phase sequence overcurrent threshold tI2> (protection against unbalances)
tI2>>?	Time delayed 2nd negative phase sequence overcurrent threshold tI2>> (protection against unbalances)
tI<?	Time delayed undercurrent threshold tI< (protection against undercurrent/loss of load)
EXCES LONG START?	Time delayed threshold tIstart (protection against excessive long starts)
tIstall?	Time delayed threshold tIstall (protection against rotor stalling when the motor is running)
LOCKED ROTOR?	Function «rotor locked on starting»
EMERG RESTART?	«emergency restart» information
FORBIDDEN START?	«forbidden start» information
t RTD 1,2,3 ALARM?	Time delayed thresholds tRTD1 ALARM, tRTD2 ALARM and tRTD3 ALARM (temperature protection: optional).
t RTD 1,2,3 TRIP?	Time delayed thresholds tRTD1 TRIP, tRTD2 TRIP, and tRTD3 TRIP (temperature protection: optional)
t RTD 4,5,6 ALARM?	Time delayed thresholds tRTD4 ALARM, tRTD5 ALARM and tRTD6 ALARM (temperature protection: optional)
t RTD 4,5,6 TRIP?	Time delayed thresholds tRTD4 TRIP, tRTD5 TRIP, and tRTD6 TRIP (temperature protection: optional)
tAux 1? … tAux 10?	Copy of Aux1 to Aux 10 logic inputs delayed by Aux1 to Aux6 timers (logic inputs and auxiliary timers are set with "automat ctrl/inputs" menu)
MOTOR STOPPED?	Indication with the information «motor stopped».
MOTOR RUNNING?	Indication with the information «motor running».
SUCCESSFUL START?	Information «successful start».

tV< ?	Time delayed undervoltage threshold tV< (undervoltage protection)
VOLTAGE DIP?	Load shedding information further to a voltage dip (cf. re-acceleration authorization).
tV> ?	Time delayed overvoltage threshold tV< (overvoltage protection)
BUS VOLTAGE?	BUS VOLTAGE information (Bus voltage too low to enable start).
AUTO RESTART?	Auto Restart

5.3.4 'ALARM CONFIG.' submenu

CONFIGURATION	Press the UP and DOWN keys to enter the CONFIGURATION menu then press the DOWN and RIGHT keys to go into submenus.
ALARM CONFIG.	To move about in the ALARM CONFIG. menu, press the UP and DOWN keys.
Inh. Alarm tAux1 **No**	Inhibit Alarm tAux1 Yes: the "tAux1" will not raise an alarm: Alarm LED stays OFF, no message will be displayed on the HMI. No: the "tAux1" will raise an alarm. Setting choice, Yes or No. The default value is No (except "Inh Alarm Ctrl Trip"=Yes), In the inh Alarm sub-menus, when the event is noted as a time delayed threshold, the alarm is inhibited by the time delayed threshold and the corresponding instantaneous threshold (for instance, if "Inh Alarm tAux1"= yes, "Aux1" will not raise an alarm. Note, If one of this function is set to Yes, the alarm will be inhibited if this one is NOT affected to RL1. Refer to the following table for trip list.

Trip	Label description
Inh Alarm tAux1 **Inh Alarm tAux10**	Inhibition of Aux1 (to Aux 10) delayed by tAux1 (to tAux 10) timer alarm
Inh Alarm I<	Inhibition of Instantaneous undercurrent threshold I< alarm (protection against undercurrent/loss of load)
Inh Alarm tEqu.A **Inh Alarm tEqu.H**	Inhibition of logical output of boolean equation A to equation H alarms.

5.3.5 INPUT CONFIG.' Submenu

The inversion of the logic input in this menu inverts its allocated function status in the logic inputs allocation (AUTOMAT CTRL/INPUTS menu). For example: if the state of logic input number 2 is 1, then tAux1 = 0 when logic input is 1 and tAux1 = 1 when logic input is 0.

CONFIGURATION	Press the UP and DOWN keys to enter the CONFIGURATION menu then press the RIGHT and DOWN keys to go into submenus.
INPUT CONFIG.	Heading of input configuration menu. To move about in the INPUT CONFIG. Menu, press the UP and DOWN keys

INPUT 6 5 4 3 2 1 **PICK-UP 1 1 1 1 1 1**	To configurate the active/inactive state of each binary input, press the key, use the UP and DOWN keys, then confirm your choice pressing the key. 0: inactive state when a control voltage is applied on. 1: active state when a control voltage is applied on. (the number of inputs depends on the relay option)
CONTROL VOLT = **DC**	Configuration of the control voltage type necessary to power on the binary inputs. Choice: DC: Direct current voltage Vdc AC: Alternative current voltage Vac

5.3.6 'MEASUREMENTS 1' & 'MEASUREMENTS 2' SUBMENUS

MEASUREMENTS 1	Heading of the Measurements 1 menu. To gain access to the MEASUREMENTS 1 menu from the default display, press DOWN then RIGHT key until the menu is reached. Press the UP and DOWN keys to move about in the MEASUREMENTS 1 menu.
IA RMS = **0.00 A**	Display of the current of phase A (true RMS value) taking into account the phase CT ratio (CT/VT RATIO submenu).
IB RMS = **0.00 A**	Display of the current of phase B (true RMS value) taking into account the phase CT ratio (CT/VT RATIO submenu).
IC RMS = **0.00 A**	Display of the current of phase C (true RMS value) taking into account the phase CT ratio (CT/VT RATIO submenu).
IN RMS = **0.00 A**	Display of the earth current (true RMS value) taking into account the earth CT ratio (CT/VT RATIO submenu).
VA RMS = **0.00 V**	Display of the voltage of phase A (true RMS value) taking into account the phase VT ratio (CT/VT RATIO submenu).
VB RMS = **0.00 V**	Display of the voltage of phase B (true RMS value) taking into account the phase VT ratio (CT/VT RATIO submenu).
VC RMS = **0.00 V**	Display of the voltage of phase C (true RMS value) taking into account the phase VT ratio (CT/VT RATIO submenu).
V1 POSITIVE= **0.00 A**	Display of the positive sequence voltage.

V2 NEGATIVE = 0.00 A	Display of the negative sequence voltage.
V0 ZERO = 0.00 A	Display of the zero-sequence voltage.
VAB RMS = 0.00 V	(Optional). Display of the phase A - phase B voltage (true RMS value) taking into account the VT phase ratio (CT/VT RATIO submenu).
VBC RMS = 0.00 V	(Optional). Display of the phase B - phase C voltage (true RMS value) taking into account the VT phase ratio (CT/VT RATIO submenu).
VCA RMS = 0.00 V	Display of the phase A - phase C voltage (true RMS value) taking into account the VT phase ratio (CT/VT RATIO submenu).
I1 POSITIVE= 0.00 A	Display of the positive sequence current.
I2 NEGATIVE = 0.00 A	Display of the negative sequence current.
I0 ZERO = 0.00 A	Display of the zero sequence current.
FREQUENCY = 0.0 Hz	Display of the frequency of the power system supplying the motor, calculated from the voltage or the phase current signals.

5.4 'PROCESS' menu

PROCESS	Heading of the process menu. To gain access to the PROCESS menu from the default display, press DOWN then until the menu is reached. Press the UP and DOWN keys to move about in the PROCESS menu.
% I FLC 0 %	Display of the current flowing into the motor as a percentage of the thermal current threshold Iθ>.

THERMAL STATE = **CLR? =[C] 0 %**	Display of the thermal state of the motor (tripping at 100%). For the test phases of the HF2025 relay, you can reset the thermal state to zero by pressing the READ key.
T before TH TRIP *** * * ***	Display of the time before thermal tripping occurs, once the thermal alarm threshold θ ALARM is exceeded.
PERMIT START NB *** * * ***	Display of the number of starts permitted.
T before START **0 s**	Display of the time to wait before a new start is permitted.
Last Start I= **0.0 A**	Display of the current of the last start.
Last Start Time **0 s**	Display of the duration of the last start.
MOTOR START NB **CLR = [C] 0**	Display of the number of starts of the motor. To reset to zero, press READ key.
EMERG RESTART **NB CLR = [C]**	Display of the number of emergency starts. To reset to zero, press READ key.
MOT RUN. HOURS **CLR = [C] 0 h**	Display of the number of running hours of the motor. To reset to zero, press the READ key.

5.5 'TRIP STATISTICS' menu

TRIP STATISTICS	Heading of the trip statistics menu. To gain access to the TRIP STATISTICS menu from the default display, press DOWN then RIGHT until the menu is reached. Press the UP and DOWN keys to move about in the TRIP STATISTICS menu.
STATISTICS **CLR = [C] NO**	To reset all the tripping statistics to zero, press READ key.
TOTAL TRIP NB **0**	Display of the total number of tripping operations (with and without fault).

OPERATOR TRIP NB **0**	Display of the number of deliberate tripping operations (without fault).
THERM TRIP **NB = 0**	Display of the number of tripping operations caused by a thermal overload.
t I >> TRIP **NB = 0**	Display of the number of tripping operations caused by a short-circuit.
t IO>, t IO>> TRIP **NB = 0**	Display of the number of tripping operations caused by an Earth fault.
t I2 >, t I2 >> TRIP **NB = 0**	Display of the number of tripping operations caused by an unbalance.
tV< TRIP **NB = 0**	Display of the number of tripping operations caused by an undervoltage.
tV> TRIP **NB = 0**	Display of the number of tripping operations caused by an overvoltage.
VOLTAGE DIP TRIP **NB = 0**	Display of the number of tripping operations caused by a load shedding further to a voltage dip.
t Istart TRIP **NB = 0**	Display of the number of tripping operations caused by an excessively long start.
t Istall TRIP **NB = 0**	Display of the number of tripping operations caused by a stalled rotor while the motor is running.
LOCKED ROT TRIP **NB = 0**	Display of the number of tripping operations caused by a locked rotor when starting.
t I < TRIP **NB = 0**	Display of the number of tripping operations caused by the protection against undercurrents/loss of load.
Thermist 1 TRIP **NB = 0**	Display of the number of tripping operations caused by the temperature protection function by thermistor 1 (optional) ditto for thermistor 2 and thermistor 3 (optional).
EQUATION A TRIP **NB = 0**	Display of the number of tripping operations caused by the validation of equation A, ditto for equations B to H.

5.6 ‘COMMUNICATION’ menu

The COMMUNICATION menu depends on the type of communications protocoland on theconnection type (optional second rear port configuration)

To gain access to the COMMUNICATION menu from the default display, press DOWN then RIGHT until the menu is reached.

COMMUNICATION	Heading of COMMUNICATION menu.
COMM1 ? **No**	Select Yes in order to use the first communication port. Setting choice: Yes or No
COMM2 ? **No**	HF2025 optional configuration only. Select Yes in order to use the second communication port. Setting choice: Yes or No

Warning!

A Modbus network can only comprise **31 relay addresses + 1 relay master** on the same Modbus sub-lan.

5.7 COMM1’ and ‘COMM2’ submenus

The following menu is displayed when “COMM1” or “COMM2” = Yes is selected. The firstpart of the following presentation is identical for the two communication options.

COMM1 (or 2) ? **Yes**	
Baud Rate **19200 bd**	This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting. Select from: 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 bd.
Parity **Without**	Choose the parity in the Modbus data frame. Select parity: Even, Odd or Without
Stop Bits **1**	Choose the number of stop bits. Select 1 or 2 using UP. Press ENTER to validate your choice.
Relay Address **1**	This cell sets the unique address for the relay such that only one relay is accessed by master station software. Select from 1 to 255.

5.8 ‘PROTECTION G1’ AND G2 MENUS

The protection menus are designated as PROTECTION G1 and PROTECTION G2 menus. By opening the PROTECTION menu, the user can program the parameters of various protection functions and settings (thresholds, time delay, and logic) associated with each of the phase or earth protection functions.

5.8.1 ‘START CRITERIA’ submenu

The start criteria menu contains setting relating starting characteristics of the motor (start detection and time for start-up)

PROTECTION G1	Heading of the PROTECTION G1menu. To gain access to the ROTECTION G1 menu from the default display, press DOWN then RIGHT until the menu is reached. Press the UP and DOWN keys to enter the PROTECTION G1 menu.
START CRITERIA	This menu header contains two important setting thresholds that are used by several protection functions and should be set before the relay is commissioned. These thresholds relate to starting characteristic of the motor under control/protection.
Iutil = **1 In**	This threshold should be set to a typical value of twice the rated current of the motor. It is used by the relay to detect successful start of the motor. The range is from 0.5 In to 5.0 In in steps of 0.01 In.
t Istart = **1 s**	This threshold should be set according to the motor data sheet if available or a typical value pertaining to the motor being protected. This threshold defines the time it takes for the motor to start up. The range is from 1 s to 200 s in steps of 1 s.

5.8.2 [49] ‘THERMAL OVERLOAD’ submenu

PROTECTION G1	Heading of the PROTECTION G1menu. To gain access to the ROTECTION G1 menu from the default display, press DOWN then RIGHT until the menu is reached. Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[49] THERMAL OVERLOAD	To move about in the [49] THERMAL OVERLOAD submenu, press the UP and DOWN keys. To enter the other submenus, press RIGHT the LEFT and keys.
THERMAL OVERLOAD? **FUNCT? YES**	To switch on the «thermal overload» function: press the ENTER key, select YES using the UP and DOWN keys. To

	confirm the selection, press the ENTER key.
therm INHIBIT? **YES**	To switch on the «thermal inhibition on starting» function: press the key, select YES using the UP and DOWN keys. To confirm the selection, press the ENTER key.
I flc > = **0.2 In**	Setting of the thermal overload current threshold Iθ>: from 0,2 In to 1,5 In in steps of 0,01 In.
Ke = **3**	Setting of the value of the negative sequence contribution factor Ke in the thermal image: from 0 to 10 in steps of 1.
Te1 = **1 mn**	Setting of the value of the overload time constant Te1: from 1 to 180 min in steps of 1 min.
Te2 = **1 mn**	Setting of the starting time constant value Te2: from 1 to 360 min in steps of 1 min.
Tr = **1 mn**	Setting of the value of the cooling time constant Tr: from 1 to 999 min in steps of 1 min.
RTD1 INFLUENCE? **YES**	To switch on the «influence of a RTD temperature» function (optional): press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
therm ALARM? **YES**	To switch on the «thermal alarm» function: press the key, select YES by using the UP and DOWN keys. To confirm the choice, press the key. YES choice will display the “Therm alarm” setting.
therm ALARM = **20 %**	Setting of the thermal alarm threshold value θ_{ALARM}: from 20% to 100% in steps of 1%.
therm FORBID START? **YES**	To switch on the «thermal inhibition of start» function: press the key, select YES by using the UP and DOWN keys. To confirm the choice, press the key. YES choice will display the “Therm FORBID STA” setting.
therm FORBID START? **20 %**	Setting of the threshold value for thermal inhibition of start $\theta_{FORBID\ START}$: from 20% to 100% in steps of 1%.

5.8.3 '[50/51] PHASE OVERCURRENT' submenu

5.8.3.1DFirst stage overcurrent threshold (I>) protection

PROTECTION G1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[50/51] PHASE OVERCURRENT	To move about in the [50/51] PHASE OVERCURRENT submenu, press the UP and DOWN keys. To enter the others submenus, press the RIGHT and LEFT keys.
I> FUNCTION? YES	To switch on the first stage «phase overcurrent» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I > 1.0 In	Setting of the first stage of phase overcurrent current threshold value I>: from 0.10 to 25.00 In in steps of 0.05 In.
Delay Type IDMT	Setting of the first stage phase OC delay type. Selection of DMT (definite minimum time), IDMT (inverse time delay curve) or RI (electromechanical inverse time curve).

If Delay type = DMT

tI > 150.00 s	Sets the time delay associated with I>. The setting range is from 0.040 to 150.0s (step 10ms).
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s by steps of 0.01 s.

If Delay type = IDMT:

Idmt SI (IEC)	Setting of the first stage phase OC tripping characteristic: Reset Delay Type (when IDMT has been selected as delay type). Selection of IEC (STI, SI, VI, EI, LTI and RC), CO2 (SEI), ANSI (MI, VI, EI) and CO8 (LTI).
INTERLOCK I>> I>>> NO	Setting to interlink first stage with second and third stage characteristics.
TMS 0.025	Time multiplier setting to adjust the operating time of the IEC IDMT characteristic. From 0.025 to 1.5 in steps of 0.001.
Reset Delay Type DMT	if "idmt" = IEEE/ANSI or COx curve is selected only. Selects the reset delay time type. Select between DMT (Definitive Time) and IDMT (Inverse Time).

Rtms **0.025**	If "idmt" = IDMT is selected. Sets the Reverse Time Multiplier Setting (RTMS) value associated with the IDMT reset time choice from 0.025 to 1.5 (step 0.001)
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s in steps of 0.01.

If Delay type = RI:

K **0.1**	Time multiplier setting to adjust the operating time for the RI curve. From 0.100 to 10.00 in steps of 0.001.
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s in steps of 0.01.

5.8.3.2 Second stage overcurrent threshold (I>>) protection

I>> FUNCTION? **YES**	To switch on the second stage «phase OC» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I >> **1.0 In**	Setting of the second stage phase OC current threshold value I>>: from 0.5 to 40.0 In in steps of 0.05 In.
Delay Type IDMT	Setting of the second stage phase OC delay type. Selection of DMT (definite minimum time), IDMT (inverse time delay curve) or RI (electromechanical inverse time curve).

If Delay type = DMT

tI >> **150.00 s**	Sets the time delay associated with I>>. The setting range is from 0.040 to 150.0s (step 10ms).
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s in steps of 0.01.

If Delay type = IDMT:

Idmt **SI (IEC)**	Setting of the first stage phase OC tripping characteristic: Reset Delay Type (when IDMT has been selected as delay type). Selection of IEC (STI, SI, VI, EI, LTI and RC), CO2 (SEI), ANSI (MI, VI, EI) and CO8 (LTI).
TMS **0.025**	Time multiplier setting to adjust the operating time of the IEC IDMT characteristic. From 0.025 to 1.5 in steps of 0.001.
Reset Delay Type **DMT**	if "idmt" = IEEE/ANSI or COx curve is selected only. Selects the reset delay time type. Select between DMT (Definitive Time) and IDMT (Inverse Time).

Rtms **0.025**	If “idmt” = IDMT is selected. Sets the Reverse Time Multiplier Setting (RTMS) value associated with the IDMT reset time choice from 0.025 to 1.5 (step 0.001)
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s in steps of 0.01.

If Delay type = RI:

K **0.1**	Time multiplier setting to adjust the operating time for the RI curve. From 0.100 to 10.00 in steps of 0.001.
t Reset 0 s	Reset/release time setting for definite time reset characteristic. From 0.00 s to 600.0 s in steps of 0.01.

5.8.3.3 Third stage overcurrent threshold (I>>>) protection

I>>> FUNCTION? **YES**	To switch on the third stage «phase overcurrent» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I >>> = **1.0 In**	Setting of the DMT third stage of phase overcurrent current threshold value I>>>: from 0.50 to 40.00 In in steps of 0.05 In.
t I >>> = **0.01 s**	Setting of the time delay tI>>> associated with the I>>> threshold: from 0.00 to 150.00 s in steps of 0,01 s.

5.8.4 '[50N/51N] EARTH FAULT' submenu

5.8.4.1 First stage earth overcurrent threshold (I0>) protection

PROTECTION G1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[50N/51N] EARTH FAULT	To move about in the [50N/51N] EARTH FAULT submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
I0> FUNCTION? **YES**	To switch on the «Earth fault» function (Io> threshold): press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I0> = **0.002 Ien**	Setting of the first earth fault current threshold value Io>: from 0,002 to 1 Ien in steps of 0,001 Ien.
t I0> = **0 s**	Setting of the tIo> time delay associated with the Io> threshold: from 0 to 100 s in steps of 0,01 s.

5.8.4.2 Second stage earth overcurrent threshold (I0>>) protection

I0>> FUNCTION? **YES**	To switch on the «Earth fault» function (Io>> threshold): press the ENTER key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I0>> = **0.002 Ion**	Setting of the second earth fault current threshold value Io>>: from 0,002 to 1 Ien in steps of 0,001 Ien.
t I0>> = **0 s**	Setting of the tIo>> time delay associated with the Io>> threshold: from 0 ms to 100 s in steps of 0,01 s.
PROTECTION G1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.

5.8.5 '[46] UNBALANCE' submenu

5.8.5.1 First stage unbalance threshold (I2>) protection

[46] UNBALANCE	To move about in the [46] UNBALANCE submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
I2> FUNCTION? **YES**	To switch on the «unbalance» function (I2> threshold): press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I2 > = **0.01 In**	Setting of the first unbalance current threshold value I2>: from 0,04 to 0,8 In in steps of 0,001 In.

t I2 > = **0 s**	Setting of the tI2> time delay associated with the I2> threshold: from 0 ms to 200 s in steps of 0,01 s.

5.8.5.2 Second stage unbalance threshold (I2>>) protection

I2>> FUNCTION? **YES**	To switch on the «unbalance» function (I2>> threshold): press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
TMS I2>> = **1**	Setting of the TMS time multiplier value of the curve associated with the I2>> threshold: from 0,2 to 2 in steps of 0,001.
I2 >> = **0.01 In**	Setting of the second unbalance current threshold value I2>>: from 0,04 to 0,8 In in steps of 0,001 In.

5.8.6 '[27] UNDERVOLTAGE' submenu

PROTECTION G1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[27] UNDERVOLTAGE	To move about in the [27] UNDERVOLTAGE submenu, press the UP and DOWN keys. To enter the other submenus, press the and keys.
V< FUNCTION? **YES**	To switch on the «undervoltage» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
V< = **5 V**	Setting of the undervoltage threshold value V<: from 5 to 130 Volt or 20 to 480 Volt.
t V<= **0 s**	Setting of the tV< time delay associated with the V< threshold: from 0 to 600 s in steps of 0,01 s.
INHIB V<? **YES**	Inhibition of the [27] UNDERVOLTAGE function during the motor start sequence.

5.8.7 '[59] OVERVOLTAGE' submenu

PROTECTION G1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[59] OVERVOLTAGE	To move about in the [59] OVERVOLTAGE submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
V> FUNCTION? **YES**	To switch on the «overvoltage» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.

V> = 5 V	Setting of the overvoltage threshold value V>: from 5 to 260 Volt or from 20 to 960 Volt.
t V>= 0 s	Setting of the tV> time delay associated with the V> threshold: from 0 to 600 s in steps of 0,01 s.

5.8.8 '[48] EXCES LONG START' submenu

PROTECTION G 1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[48] EXCES LONG START	To move about in the [48] EXCES LONG START submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
EXCES LONG START FUNCT? YES	To switch on the «excessively long start» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the ENTER key.

5.8.9 '[51LR/50S] BLOCK ROTOR' submenu

PROTECTION G 1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[51LR-50S] BLOCK ROTOR	To move about in the [51LR/50S] BLOCK ROTOR submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
BLOCKED ROTOR FUNCTION? YES	To switch on the «blocked rotor» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
t Istall = 0,1 s	Setting of the blocked rotor tIstall time delay associated with the Istall current threshold: from 0,1 to 60 s in steps of 0,1 s.
STALLED ROTOR? YES	To switch on the «stalled rotor with motor running» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
Istall DETECTION = 1.0 In	Setting of the stalled rotor detection current threshold Istall: from 0.50 to 5.00 In in steps of 0.01 In.
LOCKED ROTOR AT START? YES	To switch on the «locked rotor at start» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key. Setting choice: NO, PF (Power Factor) or Input

Power Factor **0.5**	Sets the Power factor for “locked rotor at start”. If the power factor is below this setting, the motor will operate as “speed switch” open. From 0.01 to 1 by steps of 0,01 s

5.8.10 ‘[37] LOSS OF LOAD’ submenu

PROTECTION G 1	Press the UP and DOWN keys to enter the PROTECTION G1 menu.
[37] LOSS OF LOAD	To move about in the [37] LOSS OF LOAD submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
I< FUNCTION? **YES**	To switch on the «undercurrent» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
I < = **0.1 In**	Setting of the undercurrent threshold value I<: from 0,1 to 1 In in steps of 0,01 In.
t I < = **0.2 s**	Setting of the tI< time delay associated with the I< threshold: from 0,2 to 100 s in steps of 0,1 s.
T inhib = **0.05 s**	Setting of the inhibition time of the «undercurrent/loss of load» function on starting Tinhib: from 0.05 s to 300 s in steps of 0.01 s.

5.9 ‘AUTOMAT. CTRL’ MENU

5.9.1 ‘[66] START NUMBER’ submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
[66] START NUMBER	To move about in the [66] START NUMBER submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
START NB LIMIT FUNCT? YES	To switch on the «number of starts limitation» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
Treference = **10 mn**	Setting of the Treference reference time during which the starts are counted: from 10 to 120 min in steps of 5 min.
HOT START NB = **0**	Setting of the threshold of the number of hot starts: from 0 to 5 in steps of 1.

COLD START NB = 1	Setting of the threshold of the number of cold starts: from 1 to 5 in steps of 1.
Tinterdiction = 1 mn	Setting of the time delay during which starting is forbidden Tforbiden: from 1 to 120 min in steps of 1 min.

5.9.2 'MIN TIME BETW 2 START' submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
MIN TIME BETW 2 START	To move about in the MIN TIME BETW 2 START submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
TIME BETW START FUNCT? YES	To switch on the «minimum time between two starts» function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
Tbetw 2 start = 1 mn	Setting of the minimum time between two starts Tbetw 2 start : from 1 to 120 min in steps of 1 min.

5.9.3 'REACCEL AUTHORIZ' submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
REACCEL AUTHORIZ	To move about in the RE-ACCEL AUTHORIZ submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
Detect Volt Dip VOLTAGE	To select source of detection of voltage sag. Choice of INPUT or VOLTAGE available.
REACCEL AUTHORIZ FUNCT? YES	To switch on the «re-acceleration authorization» function, press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the LEFT and RIGHT keys .
Detection V DIP = 72 V	Setting of the voltage dip detection threshold: from 37.0 to 98.0 Volt or from 143.0 to 360.0 Volt in steps of 0.1 Volt.
Restoration V DIP = 99 V	Setting of the voltage restoration detection threshold: from 45.0 to 117.0 Volt or from 176.0 to 432.0 Volt in steps of

	0.1 Volt.
VOLT. DIP DURAT **Treacc = 0.2 s**	Setting of the Treacc time delay (maximum voltage dip duration to authorize a re-acceleration): from 0.1 s to 5 s in steps of 0.01 s.
AUTO RE-START FUNCT? **YES**	To switch on the «Auto Re-start» function, press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key.
Treac-long = **2 s**	To set a medium time interval during which if the voltage is restored a close order is issued: from 0.0 s to 60.0 s in steps of 0.1 s. If set to 0 s, meaning OFF, then «Auto Re-start» function will be de-activated.
Treac-shed = **OFF**	To set a long time interval to be used for load restoration sequencing: from 0.0 s to 5940 s in steps of 0.1 s. If set to 0 s (meaning and displayed OFF), then «Auto Re-start» function will be de-activated.

5.9.4 'INPUTS' submenu

Each relay model has a fixed number of opto-isolated logic inputs:

Model	**HF2025**
Logic Input	6

With the submenu Inputs, it is possible to assign a label or an automation function to eachlogic input (see the following table):

Label designation	**Label description**
Unlatch	Unlocks latched output relays
EMERG. START	«emergency restart» information
SET GROUP	Change of setting group (default setting group 1) when the changing group parameter ('CONFIGURATION / config select / Set grp change') is set to level.
SPEED SW	motor speed indication (speed switch)
DIST TRIG	Disturbance recorder trigger command
EXT. RESET	external acknowledgement command
tAux 1 to tAux 10	Assigning external information to inputs Aux1 to Aux10
Therm RESET	Reset of the thermal state
TRIP CIRC	Trip circuit supervision function
V DIP	undervoltage threshold Detection (voltage drop…)
Synchro.	Assign a Time synchronisation input
Phase Rotat.	Phase rotation signal input
52a	Position of the circuit breaker (open)

5.9.4.1 Setting of submenu Inputs

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
Inputs	Heading of inputs submenu To move about in the INPUTS submenu, press UP and DOWN keys.
Input 1 =	Heading of input 1 submenu. Press LEFT or RIGHT key to select other input or auxiliary timers menu, and 2 or 8 to scroll through functions.
Input 1 LABEL **No**	Assigning a label or automation function (see previous table) to logic Input 1. Setting choice: Yes or No Press UP and DOWN keys to scroll through the possible allocations, and ENTER to assign or de-assign a function to the input.

5.9.4.2 Setting auxiliary timers

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
Inputs	Heading of inputs submenu To move about in the INPUTS submenu, press the UP and DOWN keys.
Aux timers	Heading of auxiliary timers submenu. Press or key to select other input or auxiliary timers menu, and 2 or 8 to scroll through functions.
t Aux 1 **0 ms**	Displays setting value of timer assigned to logic input Aux1 from 0 ms to 200 s, in steps of 10 ms.
…	As above for auxiliary timers 2 to 6 (general case) or auxiliary timers 2 to 11 (“IRIG-B/2nd communication port / 5 additional digital inputs” option)

5.9.5 ’LOGIC EQUATION’ submenu

5.9.5.1 Parameters

With the Logic Equations submenu, it is possible to form complex Boolean functions using NOT, AND and OR operators (indicated from highest to lowest priority). Up to 16 operands can be used in any single equation. The following logic signals are available for mapping to an equation:

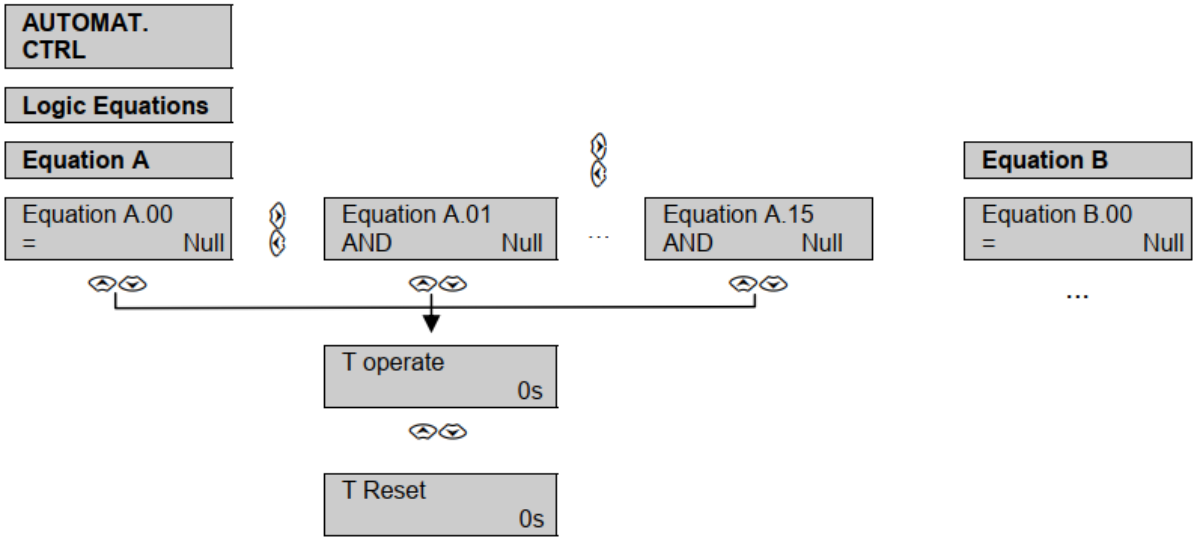
Function	Information
Null	The condition is null (low level)
Not Null	The condition is not null (high level
TH.OVER	Thermal overload.
TH.ALARM	Thermal alarm threshold θALARM.
FOR.START	«forbidden start» information
I>	Instantaneous 1st phase overcurrent threshold I> (protection against Phase OC)
tI>	Time delayed 1st phase overcurrent threshold tI> (protection against Phase OC)
I>>	Instantaneous 2nd phase overcurrent threshold I>> (protection against Phase OC)
tI>>	time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
I>>>	Instantaneous 2nd phase overcurrent threshold I>> (protection against Phase OC)
tI>>>	Time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
I0>	Instantaneous 1st earth overcurrent threshold tI0>
tI0>	Time delayed 1st earth overcurrent threshold tI0>
I0>	Instantaneous 2nd earth overcurrent threshold I0>>
tI0>>	Time delayed 2nd earth overcurrent threshold tI0>>
tI2>	Time delayed 1st negative phase sequence overcurrent threshold tI2> (protection against unbalances)
tI2>>	Time delayed 2nd negative phase sequence overcurrent threshold tI2>> (protection against unbalances)
EX.START	Time delayed threshold tIstart (protection against excessive long starts)
t Istall	Time delayed threshold tIstall (protection against rotor stalling when the motor is running)
LO.ROTOR	Function «rotor locked on starting»
tI<	Time delayed undercurrent threshold tI< (protection against undercurrent/loss of load)
CB FAIL	Detection of a Circuit Breaker failure (CB not open at the end of tBF timer)
T.C.FAIL	TRIP CIRCUIT FAIL information (open trip circuit).
Function	**Information**
tAux 1… tAux 10	Copy of Aux1 to Aux 10 logic inputs delayed by Auxiliary 1 (Aux1) to Aux6 timers
SUC.STAR	Information «successful start».
tV<	Time delayed undervoltage threshold tV< (undervoltage protection)

VOL DIP	Load shedding information further to a voltage dip (cf. re-acceleration authorization).
tV>	Time delayed overvoltage threshold tV< (overvoltage protection)
BUS VOLT	BUS VOLTAGE information (Bus voltage too low to enable start).
A.RESTAR	Auto Restart
EQU.A **… EQU.H**	Results of equations A to H.
INPUT 1 **… INPUT 6**	Copy of the status of logic inputs (“automat ctrl/inputs” menu)

5.9.5.2 Interface

The Logic equation has the following structure:

- “Equation A.00” to “Equation A.15” views are accessible using UP and DOWN keys,
- Pressing DOWN key will open “T Operate” menu.



In order to modify an “Equation A.xx” menu:

- Press DOWN key to access to the menu (if necessary, enter password).

Equation A.00 **Boolean** **Logic**

press LEFT or Right key to access to Boolean operator or Logic signal

AUTOMAT. CTRL

LOGIC EQUATIONS

EQUATION A	Heading of Equation A submenu.

The following submenu is identical from A.01 to A.15.

EQUATION A.00 **= Null**	Boolean function (left lower part of the LED panel): selects the Boolean function associated to the logic signal. Presence or not presence of the corresponding logic signal can selected and combined to the previous equation with an OR or AND condition. Setting choices: - for A.00: "=", "= Not" - for A.01 to A.15: "OR", "OR NOT", "AND" or "AND NOT", Note: AND operator has priority to OR operator (refer to the following note)
EQUATION A.00 **= Null**	Logic signal (right lower part): Is used to select the logic signal corresponding to the Boolean equation. Refer to the previous table to see the text corresponding to each signal. Setting Choice: Null and logic signals.
T OPERATE **0s**	The time of operation setting is used to set the minimum time of truth of the selected conditions before validating the truth of the logic operation. Setting choice: from 0 to 600s, step 10ms
T RESET **0s**	The reset time sets a minimum time before the logic operation is not true when at least one condition is not true. Setting choice: from 0 to 600s, step 10ms

Example of Equation A settings:

Equation A.00 "= not" "tAux 1" + Equation A.01 "and not" "tAux 2"means not tAux 1 and not tAux 2.

Note:

AND operator has priority on OR operator:

- "A or B and C" means "A or (B and C)".
- To obtain "A and (B or C)", select "A and B or A and C".

5.9.6 'AUX OUTPUT RLY' submenu

This submenu makes it possible to assign various alarm and trip thresholds (instantaneous and/or time delay) to a logic output. Excepted from this option are the Watchdog (RL0) and the Tripping (RL1) outputs (refer to Trip Commands submenu).

AUTOMAT. CTRL

Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.

AUX OUTPUT RLY

To move about in the AUX OUTPUT RLY, press the UP and DOWN keys.
To enter the other submenus, press the UP and DOWN keys.

Function 5 4 3 2 **0 0 0 0**

To allocate the «function» (see next table) to one (or more) of the outputs n° 2 to 5: press the ENTER key, allocate the value 1 under the letter by pressing the UP and DOWN keys to increase or decrease, then confirm the selection using the key.

The following functions can be assigned to output relays using this submenu.

Function	Information
THERM OV	Thermal overload.
θ ALARM	Allocation of thermal alarm threshold θ ALARM.
θ FORBID START	Allocation of the thermal block start signal: θ FORBID START.
I>	Allocation of instantaneous 1st phase overcurrent threshold I> (protection against Phase OC)
tI>	Allocation of time delayed 1st phase overcurrent threshold tI> (protection against Phase OC)
I>>	Allocation of instantaneous 2nd phase overcurrent threshold I>> (protection against Phase OC)
tI>>	Allocation of time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)

Function	Information
I>>>	Allocation of instantaneous 2nd phase overcurrent threshold I>> (protection against Phase OC)
tI>>>	Allocation of time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
I0>	Allocation of instantaneous 1st earth overcurrent threshold tI0>
tI0>	Allocation of time delayed 1st earth overcurrent threshold tI0>
I0>	Allocation of instantaneous 2nd earth overcurrent threshold I0>>
tI0>>	Allocation of time delayed 2nd earth overcurrent threshold tI0>>
tI2>	Allocation of time delayed 1st negative phase sequence overcurrent threshold tI2> (protection against unbalances)

tI2>>	Allocation of time delayed 2nd negative phase sequence overcurrent threshold tI2>> (protection against unbalances)
EXCES LG START	Time delayed threshold tIstart (protection against excessive long starts)
t Istall	Allocation of the tIstall time-delayed threshold (stalling of the rotor when the motor is running).
LOCKED ROTOR	Allocation of function «rotor locked on starting»
tI<	Allocation of time delayed undercurrent threshold tI< (protection against undercurrent/loss of load)
START NB LIMIT	Allocation of the function «limitation of the number of starts».
T betw 2 start	Allocation of the Tbetw 2 start time delay (minimum time between 2 starts function).
CB FAIL	Allocation of the «circuit breaker failure» function.
T.C.FAIL	Allocation of the «trip circuit wiring supervision» function.
tAux 1… tAux 10	Copy of Aux1 to Aux 10 logic inputs delayed by Auxiliary 1 (Aux1) to Aux6 timers
ABS	Anti Back spin protection signal
tV<	Time delayed undervoltage threshold tV< (undervoltage protection)
VOLTAGE DIP	Allocation of the load-shedding information VOLTAGE DIP (re-acceleration function).
tV>	Time delayed overvoltage threshold tV< (overvoltage protection)
BUS VOLTAGE	BUS VOLTAGE information (Bus voltage too low to enable start).
AUTO RE- START	Auto Restart
Function	**Information**
CLOSE ORDER	Allocation of the closing command (order given by a supervisor via the RS485).
TRIP ORDER	Allocation of the tripping command (order given by a supervisor via the RS485).
ORDER 1	Allocation of the ORDER 1 command (any order given by a supervisor via the RS485).
ORDER 2	Allocation of the ORDER 2 command (any order given by a supervisor via the RS485).
SUCCESS START	Allocation of «successful start» Information
tEQU.A… tEQU.H	Results of the logic equations A to H.
CB OPEN TIME	Allocation of the circuit breaker opening time threshold

CB OPER NB	Allocation of the threshold of the number of operations performed by the circuit breaker
S A n	Allocation of the threshold of the sum of amperes to the power of n interrupted by the circuit breaker.
CB Fail	Allocation of the «circuit breaker failure» function.
TRIP CIRC Fail	Allocation of the «trip circuit wiring supervision» function
GROUP 2 ACTIV	Allocation of the information «configuration group 2 active» (PROTECTION G2 active).
INPUT 1… INPUT 6	Copy of the status of logic inputs (“automat ctrl/inputs” menu)

5.9.7 ‘LATCH AUX OUTPUT RLY’ submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
LATCH AUX RLY	To move about in the LATCH AUX RLY submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
LATCH RL2? **YES**	Latching of the RL2 auxiliary output relay: press the key, select «YES» by using the UP and DOWN keys, then confirm the selection using the key.
LATCH RL3? **YES**	Latching of the RL3 auxiliary output relay.
LATCH RL4? **YES**	Latching of the RL4 auxiliary output relay.
LATCH RL5? **YES**	Latching of the RL5 auxiliary output relay.

5.9.8 ‘TRIP OUTPUT RLY’ submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
TRIP OUTPUT RLY	To move about in the TRIP OUTPUT RLY submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.

Function? YES	Allocation of a function (see next table). To allocate the “Function” to the tripping relay (RL1 relay): press the key, select YES by using the UP and DOWN keys, then confirm the selection by using the ENTER key.

The following functions can be assigned to trip output relays using this submenu.

Function	Information
tI>	Allocation of time delayed 1st phase overcurrent threshold tI> (protection against Phase OC)
tI>>	Allocation of time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
tI>>>	Allocation of time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
tI0> ?	Allocation of time delayed 1st earth overcurrent threshold tI0>
tI0>> ?	Allocation of time delayed 2nd earth overcurrent threshold tI0>>
tI2> ?	Allocation of time delayed 1st negative phase sequence overcurrent threshold tI2> (protection against unbalances)
tI2< ?	Allocation of time delayed 1st undercurrent threshold tI< (protection against unbalances)
THERMAL OVERLOAD	Thermal overload information (protection against thermal overloads)
EXCES LG START	Time delayed threshold tIstart (protection against excessive long starts)
t Istall	Allocation of the tIstall time-delayed threshold (stalling of the rotor when the motor is running).
LOCKED ROTOR	Allocation of function «rotor locked on starting»
EQU.A **… EQU.H**	Results of the logic equations A to H.
tV<	Time delayed undervoltage threshold tV< (undervoltage protection)
Function	**Information**
VOLTAGE DIP	Allocation of the load-shedding information VOLTAGE DIP (re-acceleration function).
tV>	Time delayed overvoltage threshold tV< (overvoltage protection)

5.9.9 ‘LATCH TRIP ORDER’ submenu

With this submenu the user can program trip functions so that the resulting output signal willremain latched after the cause for exceeding the threshold has disappeared.

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the

	AUTOMAT. CTRL menu.
LATCH TRIP ORDER	To move about in the LATCH TRIP ORDER submenu, press the UP and DOWN keys. To enter the other submenus, press the UP and DOWN keys.
LATCH tFunction? **YES**	Latching on exceeding the function.

The following functions can be assigned to trip output relays using this submenu.

Function	Information
tI>	Latching on exceeding the time delayed 1st phase overcurrent threshold tI> (protection against Phase OC)
tI>>	Latching on exceeding the time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
tI>>>	Latching on exceeding the time delayed 2nd phase overcurrent threshold tI>> (protection against Phase OC)
tI0> ?	Latching on exceeding the time delayed 1st earth overcurrent threshold tI0>
tI0>> ?	Latching on exceeding the time delayed 2nd earth overcurrent threshold tI0>>
tI2> ?	Latching on exceeding the time delayed 1st negative phase sequence overcurrent threshold tI2> (protection against unbalances)
tI2< ?	Latching on exceeding the time delayed 1st undercurrent threshold tI< (protection against unbalances)
THERMAL OVERLOAD	Latching on Thermal overload tripping (protection against thermal overloads)
EXCES LG START	Latching on exceeding the time delayed threshold tIstart (protection against excessive long starts)
t Istall	Latching on exceeding the tIstall time-delayed threshold (stalling of the rotor when the motor is running).
LOCKED ROTOR	Latching on «rotor locked on starting» information (rotor stalled at start)
EQU.A **… EQU.H**	Latching on validation of equations A to H.
tV<	Latching on exceeding the time delayed undervoltage threshold tV< (undervoltage protection)
VOLTAGE DIP	Latching on VOLTAGE DIP load-shedding information (re-acceleration function).
tV>	Latching on exceeding the t V> time-delayed threshold (overvoltage).

5.9.10 'CB FAIL' submenu

With the CB Fail submenu, circuit breaker failure can be detected and associated parameters can be set.

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
CB FAIL	To move about in the CB FAIL submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
CB FAIL FUNCT? **YES**	To switch on the CB FAIL function: press the ENTER key, select YES by using the UP and DOWN keys. To confirm the selection, press the key again.
I< BF = **20%**	Setting of the I< BF current threshold value: from 10% to 100% In in steps of 1% In.
t BF **0.1 s**	Setting of the tBF time delay: from 0.03 s to 10.00 s in steps of 0.01 s.

5.9.11 'ABS', Anti Back Spin submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
ABS	To move about in the Anti Back Spin submenu, press the UP AND DOWN and keys. To enter the other submenus, press the RIGHT and LEFT keys.
ABS FUNCTION? **YES**	To switch on the ABS function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key again.
t ABS = **1s**	Setting of the t ABS time delay (anti backspin/minimum time between a stop and a restart): from 1s to 7200s in steps of 1s.

5.9.12 'BUS VOLTAGE CTRL' submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.

BUS VOLTAGE CTRL	To move about in the BUS VOLTAGE CTRL submenu, press the UP and DOWN keys. To enter the other submenus, press the RIGHT and LEFT keys.
BUS VOLTAGE CTRL FUNCT? **YES**	To switch on the BUS VOLTAGE CTRL function: press the key, select YES by using the UP and DOWN keys. To confirm the selection, press the key again.
V BUS = **5.0 V**	Setting of the V BUS threshold value (presence of bus voltage before a start): from 5 to 130 Volt or from 20 to 480 Volt.

5.9.13 'CB SUPERVISION' submenu

AUTOMAT. CTRL	Press the UP and DOWN keys to enter the AUTOMAT. CTRL menu.
CB SUPERVISION	To move about in the CB SUPERVISION submenu, press the UP and DOWN keys. To enter the other submenus, press the RIGHT and LEFT keys.
TRIP CIRCUIT SUPERV? **YES**	To switch on the TRIP CIRCUIT SUPERV function (trip circuit supervision): press the ENTER key, select YES by using the UP and DOWN keys. To confirm the selection, press the ENTER key again.
t SUP = **0.1 s**	Setting of the tSUP time delay: from 100ms to 10s in steps of 10ms.
CB OPENING TIME? **YES**	Switching on the circuit breaker opening time function: select YES.
CB OPENING TIME = **0.05 s**	Setting of the circuit breaker opening time threshold: from 50ms to 1s in steps of 10ms.
CB OPERATION NB? **YES**	Switching on the CB operation number function: select YES.
CB OPERATION NB = **0**	Setting of the threshold of the CB operation number: from 0 to 50000 in steps of 1.
S A n? **YES**	Switching on the threshold of the sum of amperes to the power n interrupted by the circuit breaker: select YES.

S A n = **0 MA^n**	Setting of the threshold of the sum of mega amperes to the power n interrupted: from 0 to 4000 MA^n in steps of 1 MA^n.
n = **1**	Setting of the exponent n: 1 or 2
TRIP T = **0.2 s**	Setting of TRIP T: from 0.2 to 5s in steps of 0.01 s.
CLOSE T = **0.2 s**	Setting of CLOSE T: from 0.2 to 5s in steps of 0.01 s.

5.10 'RECORD' MENU

5.10.1 'FAULT RECORD' submenu

RECORD	Press the UP and DOWN keys to enter the RECORD menu.
FAULT RECORD	To move about in the FAULT RECORD submenu, press the UP and DOWN keys. To enter the DISTURB RECORD and CB MONITORING submenus, press the LEFT and RIGHT keys.
RECORD NUMBER **5**	Displays the fault number. To display the information on one of the last 25 faults, press the key, select the number (1 to 25) by using the UP and DOWN keys, then press the key to confirm the selection.
FAULT TIME **16 : 39 : 23 : 82**	Displays the time of the fault occurrence.
FAULT DATE **04/05/10**	Displays the date of the fault occurrence.
ACTIVE SET GROUP. **1**	Displays the active configuration group (1 or 2) at the time of the fault.
PHASE IN FAULT **PHASE B**	Displays the faulty phase (or phases): phase A, phase B or phase C.
FAULT DETECTED BY I>>	Displays the origin of the fault: here it is exceeding the instantaneous threshold I>>.

MAGNITUDE **1.917 kA**	Displays the fault magnitude.
IA MAGNITUDE **1.917 kA**	Displays the value of the current of phase A (IA) at the time of the fault (true RMS value).
IB MAGNITUDE **1.997 kA**	Displays the value of the current of phase B (IB) at the time of the fault (true RMS value).
IC MAGNITUDE **1.931 kA**	Displays the value of the current of phase C (IC) at the time of the fault (true RMS value).
IN MAGNITUDE **0.03 A**	Displays the value of the earth current IN at the time of the fault (true RMS value).
V AC MAGNITUDE **5126 V**	HF2025 only. Displays the phase A - phase C voltage value at the time of the fault (true RMS value).

5.10.2 'DISTURB RECORD' submenu

RECORD	Press the UP and DOWN keys to enter the RECORD menu.
DISTURB RECORD	To move about in the DISTURB RECORD submenu, press the UP and DOWN keys. To enter the FAULT RECORD and CB MONITORING submenus, press the and keys.
PRE-TIME = **0.1 s**	Setting of the «pre-time» time delay: from 0,1 to 2,5 s in steps of 0,1 s.
POST-TIME = **0.1 s**	Setting of the «post time» time delay: from 0,1 to 2,5 s in steps of 0,1 s.
DISTUR REC TRIG= **ON INST.**	Selection of the criterion for trigging the disturbance recording: - on exceeding certain instantaneous thresholds (I>>, Io>, Io>>, V< or V>): ON INST. - on tripping of the n°1 relay (trip output relay): ON TRIP.

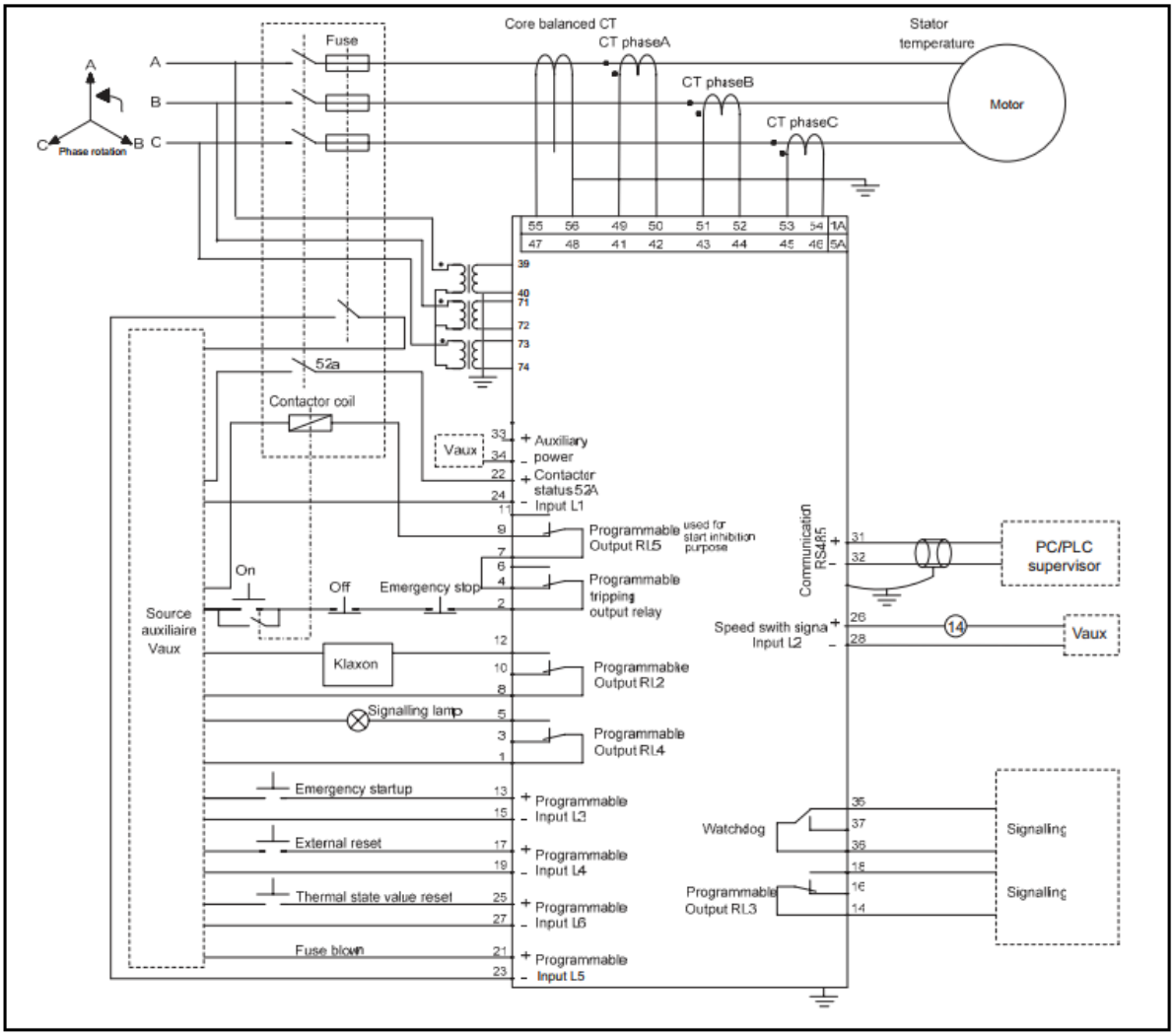
5.10.3 'CB MONITORING' submenu

RECORD	Press the UP and DOWN keys to enter the

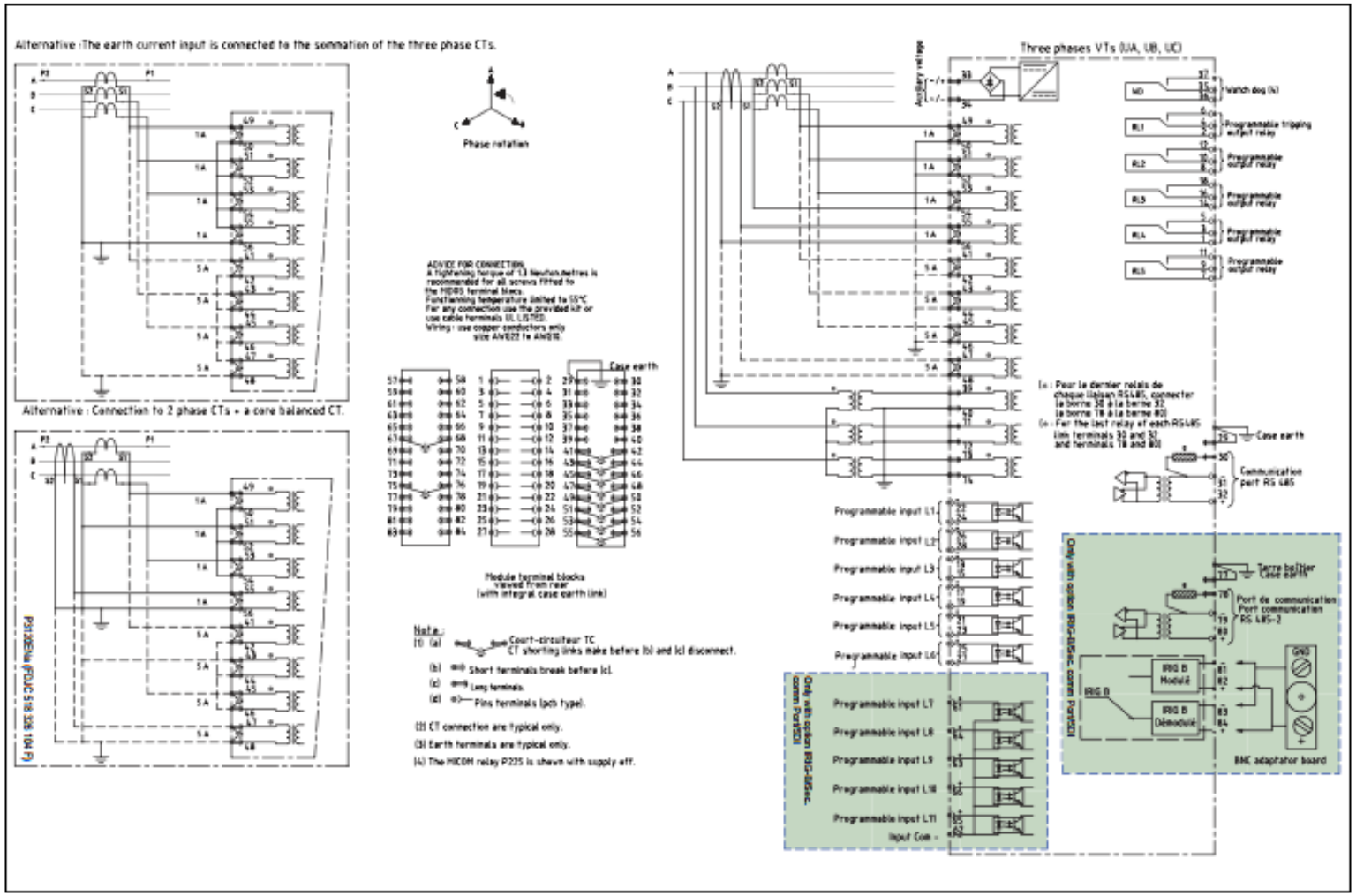
	RECORD menu.
CB MONITORING	To move about in the CB MONITORING submenu, press the UP and DOWN keys. To enter the other submenus, press the LEFT and RIGHT keys.
S A n CLR? = [C]	To reset to zero the sum of the amperes to the power of n interrupted: press the READ key.
S A 2 IA = **E06**	Displays the sum of the square amperes interrupted by the circuit breaker for the current of phase IA. E06 means 106.
S A 2 IB = **E06**	Displays the sum of the square amperes interrupted by the circuit breaker for the current of phase IB. E06 means 106.
S A 2 IC = **E06**	Displays the sum of the square amperes interrupted by the circuit breaker for the current of phase IC. E06 means 106.
CB OPERATION NB = CLR? =[C] **0**	Displays the number of operations performed by the circuit breaker. To reset to zero: press the READ key.
CB OPEN TIME = **100 ms**	Displays the opening time of the circuit breaker.

6 CONNECTION DIAGRAMS

HF2025 with 3-voltage inputs option:



HF2025 with 3 voltage inputs options:



6.1 Connection

The rear face of the HF2025 relay comprises at least 2 connectors. The relay mayhave:

- an optional green third connector dedicated to the connection of:
  - temperature RTD sensors or 10 temperature RTD or 3thermistors for HF2025,
  - 2 analogue outputs,
  - 2 voltage inputs (HF2025 with “3 voltage inputs” option)

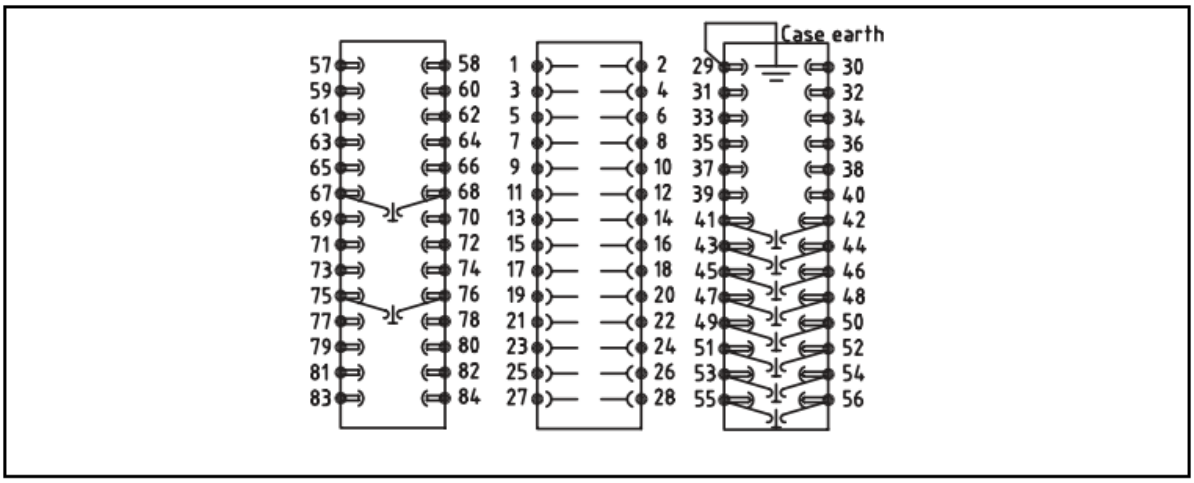
The terminals of HF2025 are represented with power supply off.

NO = Normally Open, NC = Normally ClosedWD = Watchdog)

NOTE:

See section Installation Guide for cable characteristics.

- 3 voltage inputs option.



	57	58		RL4 (common)	1	2	RL1 (common)	Case earth	29	30	RS485 (resistance)
	59	60		RL4 (NC)	3	4	RL1 (NC)	RS485(–)	31	32	RS485(+)
Input L7[1] (+)	61	62	Input COMM L7-L11[1] (–)	RL4 (NO)	5	6	RL1 (NO)	Auxiliary Supply (+)	33	34	Auxiliary Supply (–)
Input L9[1] (+)	63	64	Input L8[1] (+)	RL5 (common)	7	8	RL2 (common)	WD (NO)	35	36	Common WD
Input L11[1] (+)	65	66	Input L10[1] (+)	RL5 (NC)	9	10	RL2 (NC)	WD (NC)	37	38	--
--	67	68	--	RL5 (NO)	11	12	RL2 (NO)	Voltage input VA	39	40	Voltage input VA
--	69	70	--	Input L3(+)	13	14	RL3 (common)	IA (input ph.A/5A)	41	42	Common IA (ph.A/5A)
Voltage input VB[2]	71	72	Voltage input VB[2]	Input L3(–)	15	16	RL3 (NC)	IB (input ph.B/5A)	43	44	Common IA (ph.B/5A)
Voltage input VC[2]	73	74	Voltage input VC[2]	Input L4(+)	17	18	RL3 (NO)	IC (input ph.C/5A)	45	46	Common IA (ph.C/5A)
--	75	76	--	Input L4(–)	19	20	--	E/F input (5A)	47	48	Common E/F (5A)
Case earth[1]	77	78	RS485-2[1] (resistance)	Input L5(+)	21	22	Input L1(+)	IA (input ph.A/1A)	49	50	Common IA (ph.A/1A)
RS485-2[1] (–)	79	80	RS485-2[1] (+)	Input L5(–)	23	24	Input L1(–)	IB (input ph.B/1A)	51	52	Common IA (ph.B/1A)
IRIG-B mod – terminal	81	82	IRIG-B mod + terminal	Input L6(+)	25	26	Input L2(+)	IC (input ph.C/1A)	53	54	Common IA (ph.C/1A)
IRIG-B dem – terminal	83	84	IRIG-B dem + terminal	Input L6(–)	27	28	Input L2(–)	E/F input (1A)	55	56	Common E/F (1A)

6.1.1 Earth connection

The case shall be earthed according to the local standards.

6.1.2 Auxiliary power

The universal auxiliary power for the HF2025 relays can be either Direct (range 24-150 Vac – 50Hz and 24 - 150 Vdc) or Alternating (48 - 240 Vac - 50Hz and 48-250 Vdc). The range of voltage is specified on the relay indicator plate under the top flap of the front face. The power should be connected to terminals 33 and 34 only.

A minimum 1.5mm² wire size is recommended.

6.1.3 Current inputs

The HF2025 relays have 2x4 analogue inputs for phase and earth currents. The nominal value of current of these measuring inputs is either 1 Amp or 5 Amp (according to the wiring diagram). The operator can, for the same relay, mix the 1 and 5 Amp inputs (phase and earth).

A minimum 2.5mm² wire size is recommended.

6.1.4 Voltage measurement input

The HF2025 relay has:

- one voltage input for phases A and C,
- or three voltage inputs for U_{AB}, U_{BC} and U_{CA}.

The nominal value of these inputs is either comprised between 57 and 250 Volts, or between220 and 480 Volts.

A minimum 1mm² wire size is recommended.

6.1.5 Binary inputs

The HF2025 relays have:

- six opto-insulated logic inputs of which five are programmable,
- or eleven opto-insulated logic inputs of which ten are programmable.

Each input has its own polarity and it shall be powered with either a dc voltage or an ac voltage between the range of 24 to 250 volts (please, refer to section HF2025/EN TD - Technical Data - of this guide for more information).

The control and signalling functions to which the programmable logic inputs are assignedcan be selected by means of the AUTOMAT. CTRL menu.

A minimum 1mm² wire size is recommended.

NOTE:

A 52a contact (CB auxiliary contact: open when CB is opened)shall be wired to the binary input n°1 (terminals 22-24).

6.1.6 Output relays

Six output relays are available on the HF2025 relays. Five relays are programmable,the last relay being assigned to the signalling of an equipment fault (WATCH DOG). All these relays are of the changeover type (1 common, 1 normally opened, 1 normally closed).

The protection and control functions to which these relays are assigned can be selected via the AUTOMAT. CTRL menu.

6.1.7 Front port connection (RS232)

The front communication port is provided by a 9-pin female D-type connector located underthe bottom hinged cover. It provides:

- Connection to a PC using the USB/RS232 HF E2 cable to power and set the relay,

- RS232 serial data communication (asynchronous RS232 connection according the IEC60870 requirements) and is intended for use with a PC locally to the relay (up to 15mdistance).

The relay is a Data Communication Equipment (DCE) device. Thus the pin connections ofthe relay's 9-pin front port are as follows:

Pin no. 2 Tx Transmit data

Pin no. 3 Rx Receive data

Pin no. 5 0V Zero volts common

The relay should be connected to the serial port of a PC, usually called COM1 or COM2.PCs are normally Data Terminal Equipment (DTE) devices which have a serial port pin connection as below (if in doubt check your PC manual):

Pin no. 2 Rx Receive data

Pin no. 3 Tx Transmit data

Pin no. 5 0V Zero volts common

For successful data communication, the Tx pin on the relay must be connected to the Rx pin on the PC, and the Rx pin on the relay must be connected to the Tx pin on the PC. Therefore, providing that the PC is a DTE with pin connections as given above, a 'straight through' serial connector is required, i.e. one that connects pin 2 to pin 2, pin 3 to pin 3, and pin 5 to pin 5.

The cable between the HF relay and the PC is a standard RS232 shielded cable (male connector on the HF relay side, usually female connector on PC side).

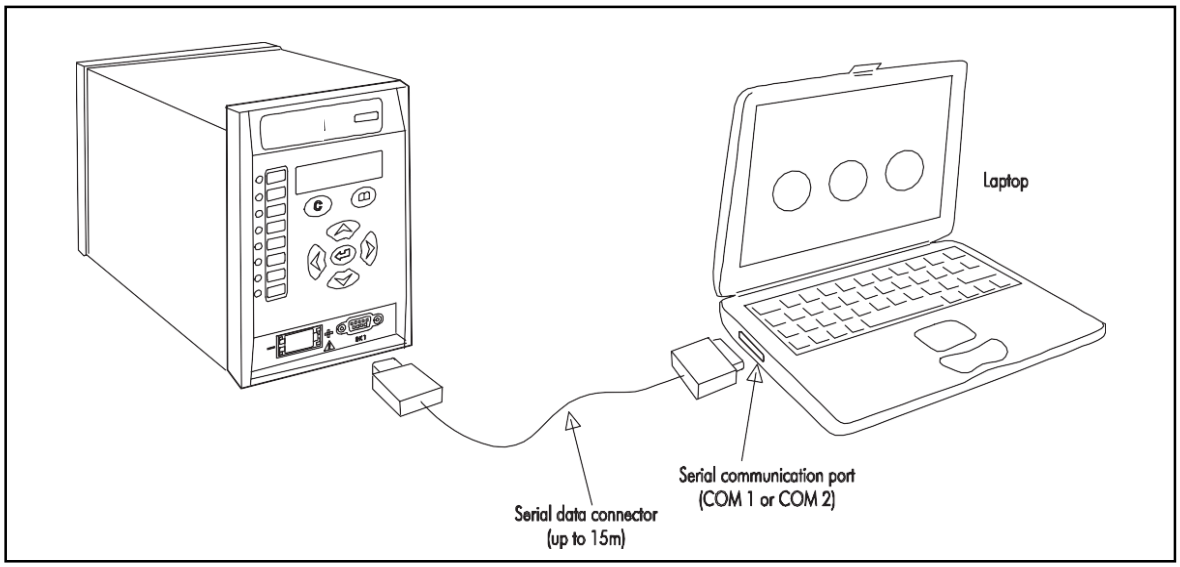
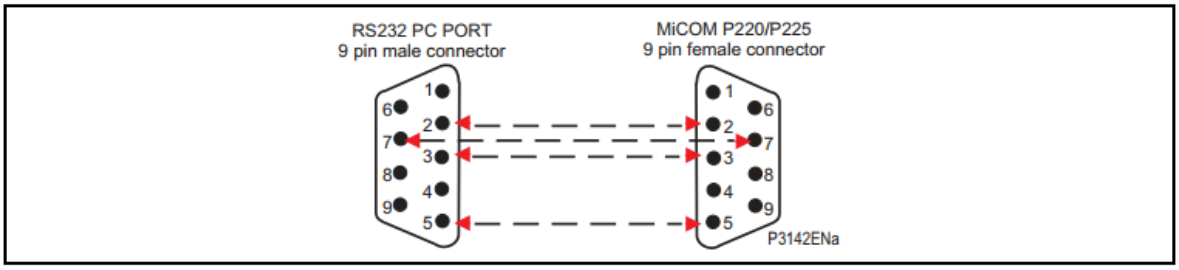


Figure 2 - pc<->front port connection

For a local connection between a PC and the relay, a serial cable with metallic shield shouldbe used.

The wiring of the RS232 cable must be as shown in the following drawing.



A USB/RS232 cable can also be used to communicate to the relay

Once the physical connection is established, the relay and PC settings must be checked in order to start the communication.

The default communication settings of the RS232 port are as follows:

Protocol	MODBUS
Rate	19 200 bits/s
Address	Must be set in the "Communication" menu, "Address" line
Message format	11 bit - 1 bit start, 8 bits data, 1 bit even, 1 bit stop

6.1.8 RS485 rear ports

6.1.8.1 Description

The standard configuration of HF2025 relays is fitted with one RS485 rear port. The second one is optional. The rear RS485 interfaces are isolated and are suitable for permanent connection whichever protocol is selected. The advantage of this type of connection is that up to 31 relays can be ‘daisy chained’ together using a simple twisted pair electrical connection.

6.1.8.2 Connection

The first communication connection (port RS485) is assigned on terminals 31 - 32 according to the HF2025 relay wiring diagram.

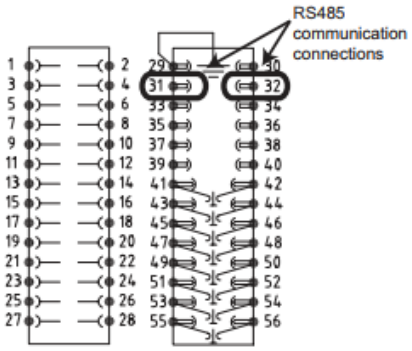


Figure 3 - RS485 connection

The total communication cable from the master unit to the farthest slave device is a spur, and no branches may be made from this spur. The maximum cable length is 1000m and the maximum number of devices per spur is 31. Polarity is necessary for the 2 twisted wires.

The transmission wires should be terminated using a 150 □ resistor at both extreme ends of the cable. To this effect, link terminals 30 and 32, if the relay is connected at the end of the RS485 bus, as indicated in figure 3. If a second RS485 communication port is used, a 150□ □resistor is connected on terminals 78 and 79.

Terminals 29 and 77 of each HF relay shall be connected to the RS485 cable shielding, as mentioned figure 3.

For only one HF relay connected to the RS485 bus, link terminal 29 to the case earth as indicated in figures 2 and 3.

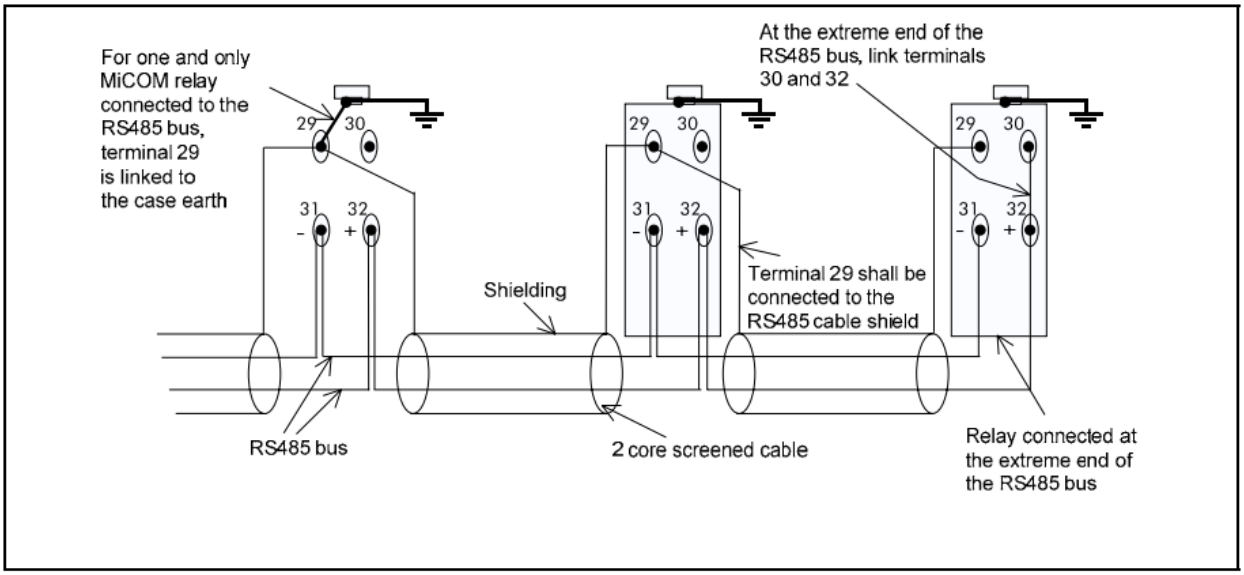


Figure 4 - RS485 first connection

6.1.8.3 RS485 cable

It is recommended that a 2 core screened cable is used with a maximum total length of 1000 m or 200 nF total cable capacitance (see technical specifications: section “Low voltagesignal circuits, Installation section)

7 COMMISSIONING AND MAINTENANCE

7.1 Introduction

The HF2025 relays are fully numerical in design and employ a high degree of self-checking. Any fault affecting a hardware or software component is instantly detected and signalled as a device fault.

Warning!

Before carrying out any work on the equipment, the user should be familiar with the contents of the "handling andsafety" section.

7.2 Requirements prior to commissioning

Before commissioning the relay, the safety section of the manualmust be read.

When commissioning this relay for the first time, 1/4 hour should be allowed to become familiar with the menu (“menu of the HMI” section).

With a laptop computer and SARA setting software, the user can configure the HF2025 relay and save this setting. The saved file can subsequently be downloaded via the rs232 front port or via the rs485 link on the rear of these relays.

7.2.1 Injection test boxes

For reasons of convenience (weight, spatial requirement, transportation), a single-phase injection test set is more suitable for the tests and is able to perform all the tests relating to the HF2025 relay.

Thus, the following descriptions indicate how to conduct the tests with a single-phaseinjection test set.

However, for certain tests, the three-phase wiring diagrams are easier to understand and, in this case, the description is also given in three-phase format.

Single-phase injection test set

1 current (0 to 50 A), timer (precision 1 ms).

Three-phase injection test set

3 currents (0 to 50 A), timer (precision 1 ms).

6.2.1.1 Additional test equipment

2 multimeters (precision 1%),

1 clip-on ammeter to measure the currents exceeding 10 A (precision 2%),

Test plugs and wires to carry out injections to the CTs secondary (dimensions according to the currents injected).

6.2.1.2 Communication

For all tests, the records can be made by using either the RS485 rear port or the RS232 front port of the relay.

6.2.1.3 Commissioning test records

Commissioning test records are available in Chapter HF2025/EN RS/B44.

The presentation of the Commissioning test records follows the sequence of the tests of this chapter.

The contents of these Commissioning test records enable you to log:

- The name of the relay, station and circuit/plant
- The characteristics of the HF2025 relay
- The various settings
- The results of the tests

7.3 Product verification tests

7.3.1 Allocation of terminals

It is necessary to consult the appropriate wiring diagram of the HF2025 whilst observing the various polarities and ground/earth connection.

7.3.2 Electrostatic discharge (ESD)

Before any handling of the module (active part of the relay), please refer to the recommendations in chapter HF2025/EN SS/B44.

Visual inspection

Carefully examine the relay to see if there has been any possible deterioration following installation.

Check the serial number under the upper flap of the front panel. Also inspect the stated nominal values and the model number.

Check if the external wiring corresponds to the appropriate relay diagram or the assembly diagram.

When the relay is withdrawn from its case, use a continuity tester to check if the current short-circuits (phases and earth CTs) between the terminals indicated on the wiring diagram are closed.

7.3.3 Earthing

Check if the earth connection of the case situated above the rear terminal block is used to connect the relay to a local earth bar. With several relays present, make sure that the copper earth bar is properly installed for solidly connecting the earthing terminals of each case.

7.3.4 Current transformers (CTs)

Warning!

Never open circuit the secondary circuit of a current transformer since the high voltage produced may be lethal and could damage insulation.

6.3.4.1 Use of a core balance CT for earth faults

If a core balance CT is used to detect earth faults, prior to any test, the user must check the following points:

MV cable screens and core balance CT,

No current flow through the MV cables.

6.3.4.2 Cable shields and core balance CT

When mounting a core balance CT around electric cables, check the connection to the earth of the cable shields. It is vital that the earth cable of the shield moves in the opposite direction through the core balance CT. This cancels the currents carried by the cable shieldsthrough the core balance CT.

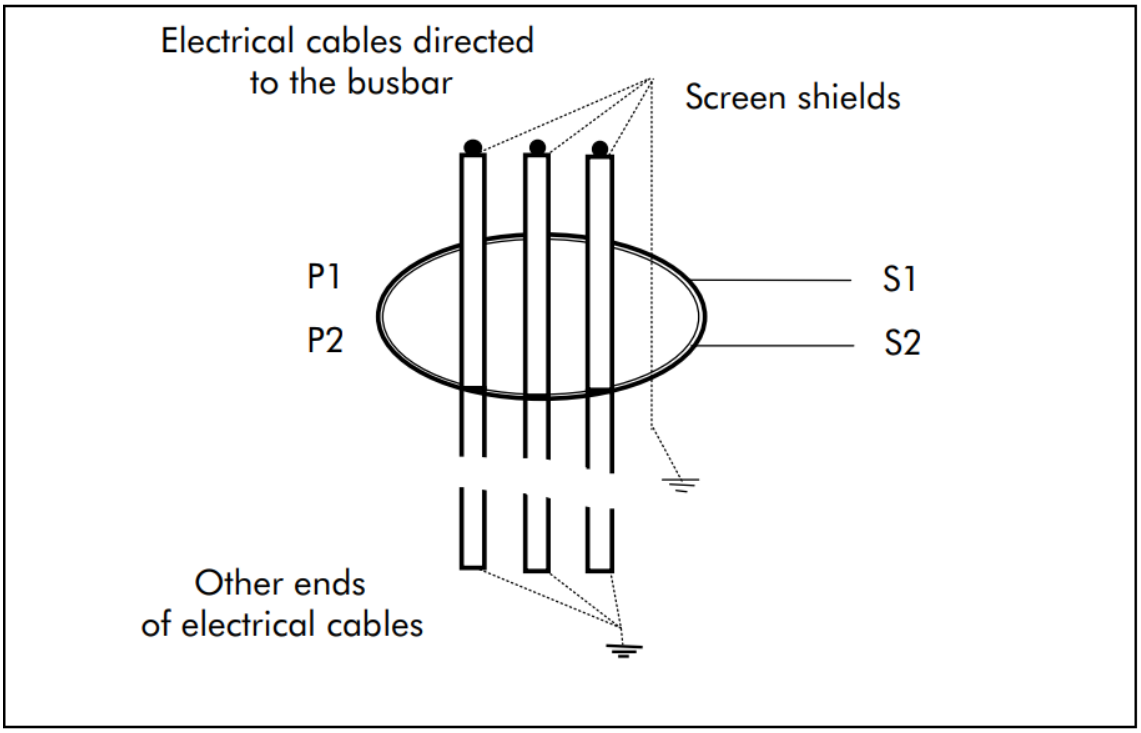


Figure 1 - screen shields and core balance CT

6.3.4.3 Phase CTs orientation

It is necessary to check the orientation of the phase CTs by using the following quickest method (flick test):

Have available a centre point analogue ammeter. Temporarily short-circuit the battery by checking the diagram polarities (+ on P1 and – on P2). A positive current pulse traverses the milliammeter and the needle shall turn in a positive direction .

Proceed this test for each phase CT.

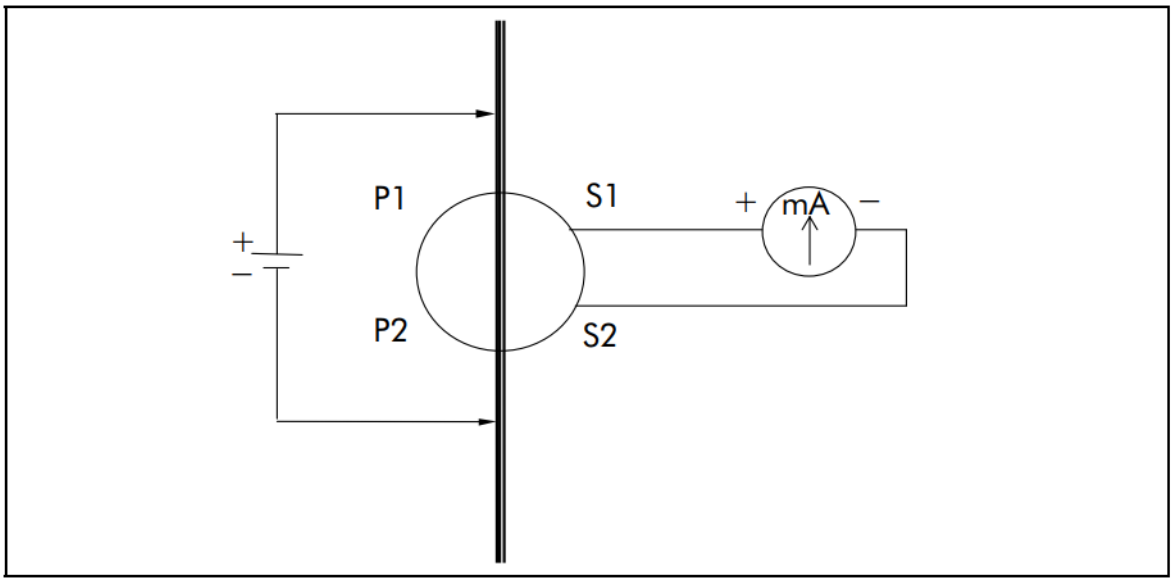


Figure 2 - phase CT orientation test

NOTE:

De-magnetize the CT after the test. Inject a current starting from zero and slowly cross the CT nominal value and then decrease slowly to zero.

7.4 Exchanging the relay

The case and the rear terminal blocks have been designed to facilitate removal of the relay without having to disconnect the scheme wiring.

Warning!

Before carrying out any work on the equipment, the usershould be familiar with the contents of the "handling and safety" section.

The method is to replace the withdrawable part, but it may be necessary to replace the complete relay (with the case):

7.4.1 Remove the withdrawable part

To remove the withdrawable part, lift the upper flap on the front panel to reveal a slot in the centre towards the top. Using a screwdriver (approx. 3 mm cross-section) insert it in the hole in the middle of the slot then move the screwdriver from right to left. This moves a cam which has the effect of moving the withdrawable part of the HF relay a few centimetres.

Lift the lower flap on the front panel. Proceed as above. The withdrawable part can now be easily removed from the case.

NOTE:

- HF2025 relays have integral current transformer shorting switches which will close when the withdraw able part is removed.
- In case of fuse-contactor controlled by a voltage loss coil, do not remove the withdraw able part if the contactor is closed. In fact, removing the withdraw able part will break the power circuit for thevoltage loss coil, causing the opening of the contactor.

7.4.2 Exchanging the relay and the case

Warning!

Before working at the rear of the relay, isolate allvoltage and current supplies to the relay.

Disconnect the relay earth connection from the rear ofthe case.

Note: the use of a magnetic-bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost.

Warning!

Withdraw the relay from the panel, rack, etc. Carefullyas it will be heavy owing to the internal transformers.

To reinstall the repaired or replacement relay, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position andthe case earth is replaced.

7.5 List of the motor alarm messages

MOTOR ALARMS — Heading of the MOTOR ALARMS messages, default display incase of motor alarm. To display the alarms messages, press the READ key.

The next alarms can be displayed (alphabetical order)

Alarm	Description
ANTI BACK SPIN	Block start due to Anti backspin function: minimum timebetween a motor stoppage and a re-start (self resettable alarm).
AUTO RE-START	Auto Re-start sequence in progress (self-resettable)
BUS VOLTAGE	Busbar voltage too low to enable a start. (self resettable alarm).
CB FAIL.	Circuit breaker failure.
CB OPENING TIME	Circuit breaker opening time has reached (or it has exceeded)the “CB OPENING TIME” threshold.
CB OPERATION NB	Circuit breaker operation number has reached (or it has exceeded) the “CB OPERATION NB” threshold.
CLEAR ALL ALARMS.	To clear all the alarms, press the READ key.
EQUATION A	And logic equation A active …and so on for the AND logicequations B, C and D
LATCH AUX OUTPUTRLY	One or several output relays are latched energized.
LOCKED ROTOR	Operation of the “locked rotor at start” function.
LONG START tIstart	Operation of the “excessive start time” function: time delayedelement tI_{start}

MECHAN JAM tIstall (whilst running)	Operation of the "stalled rotor while running" function: timedelayed element tIstall
RE-ACCELER AUTHOR (re-acceleration in progress)	Authorized motor reacceleration sequence in progress(self-resettable)
SA2n (Ampers cut by CB)	The sum of amperes has reached (or it has exceeded) the"SAn" threshold.
start failed(Treac-shed time out and no re-start)	Auto Re-start sequence progress failed (self-resettable)
start in progress(Treac-shed no time out)	Auto Re-start load restoration sequence in progress (self-resettable)
START NB LIMIT	Block start based on the "limitation of starts number" functionactive (self resettable)
T between 2 start	Block start based on the "minimum time between 2 starts"function active. (self-resettable).
t I >> PHASE …	Operation of the "phase OC" function: time delayed elementtI>>. Display of the faulty phase.
t I >> PHASE	Operation of the "phase OC" function: time delayed elementtI>>. Display of the faulty phase.

Alarm	Description
t I >>> PHASE …	Operation of the "phase OC" function: time delayed element tI>>>. Display of the faulty phase.
t I >PHASE	Operation of the "phase OC" function: time delayed element tI>. Display of the faulty phase.
t I< PHAS E	Operation of the "loss of load" function: time delayed element tI<. Display the faulty phase.

t I0>	Operation of the “earth fault” function: time delayed element tIo>
t I0>>	Operation of the “earth fault” function: time delayed element tIo>>
t I2>	Operation of the “unbalance” function: time delayed elementtI2>
t I2>>	Operation of the “unbalance” function: time delayed elementtI2>>
t RTD 1 ALAR	Operation of the RTD1 temperature alarm element: timedelayed element tRTD1 ALARM (self-resettable)
t RTD 1 TRIP	Operation of the RTD1 temperature trip element: time delayedelement tRTD1 TRIP, and so on for RTD2, RTD3, RTD4, RTD5, RTD6.
t V<	Undervoltage default: tV< time delayed threshold.
t V>	Overvoltage default: tV> time delayed threshold.
tAux1… tAux10	Operation of the auxiliary timer tAux 1.to tAux 10
TH OVERLOAD (thermaloverload)	Operation of the «thermal overload» function
TRIP CIRC.FAIL	Open trip circuit wiring.
VOLTAGE DIP	Load shedding further to a voltage dip.
θ ALARM (thermal alarm)	«Thermal alarm» element active: < ALARM (self-resettable).
θ FORBIDDEN START	«Block start based on thermal criterion» active (self resettable).

8 ATTACHMENT

8.1 IDMT characteristic curves

8.1.1 General

Although the curves tend towards infinite when the current approaches Is (general threshold), the minimum guaranteed value of the operating current for all the curves with the inverse time characteristic is 1.1Is (with a tolerance of ± 0.05Is).

8.1.1.1 Inverse time curves:

The first and second stage thresholds for phase overcurrent can be selected with an inverse definite minimum time (IDMT) characteristic. The time delay is calculated with a mathematical formula.

In all, there are eleven IDMT characteristics available.

The mathematical formula applicable to the first ten curves is:

$$t = T \times \left(\frac{K}{(I / I_s)^{\alpha} - 1} + L \right)$$

Where:

t Operation time

K Factor (see the next table)

I Value of measured current

Is Value of the programmed threshold (pick-up value)

α Factor (see the next table)

L ANSI/IEEE constant (zero for IEC and RECT curves)

T Time multiplier setting from 0.025 to 1.5

Type of Curve	Standard	K Factor	α Factor	L Factor
Standard inverse	IEC	0.14	0.02	0
Very inverse	IEC	13.5	1	0
Extremely inverse	IEC	80	2	0
Long time Inverse	IEC	120	1	0
Short time inverse	C02	0.02394	0.02	0.01694
Moderately Inverse	ANSI/IEEE	0.0515	0.02	0.114
Long time inverse	C08	5.95	2	0.18
Very inverse	ANSI/IEEE	19.61	2	0.491
Extremely inverse	ANSI/IEEE	28.2	2	0.1217
Rectifier protection	Rect	45900	5.6	0

The RI curves has the following definition:

$$t = K \times \left(\frac{1}{0.339 - \frac{0.236}{(I / I_s)}} \right)$$

K setting is from 0.10 to 10 in steps of 0.05. The equation is valid for 1.1 < I/Is < 20.

8.1.1.2 Reset timer

The first and second stage thresholds for phase overcurrent protection is provided with a timer hold facility "t Reset".

It may be set to a definite time value or to an inverse definite minimum time characteristic (IEEE/ANSI curves only). This may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays that have inherent reset time delays.

A possible situation where the reset timer may be used is to reduce fault clearance times where intermittent faults occur.

An example may occur in a cable with plastic insulation. In this application it is possible that the fault energy melts the cable insulation, which then reseals after clearance, thereby eliminating the cause for the fault. This process repeats itself to give a succession of fault current pulses, each

of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is set to minimum the HF2025 relay will be repeatedly reset and will not be able to trip until the fault becomes permanent. By using the reset timer hold function the relay will integrate the fault current pulses, thereby reducing fault clearance time.

The mathematical formula applicable to the five curves is:

$$t = T \times \left(\frac{K}{1-(I / I_s)^{\alpha}} \right)$$

Where:

t Reset time

K Factor (see the next table)

I Value of the measured current

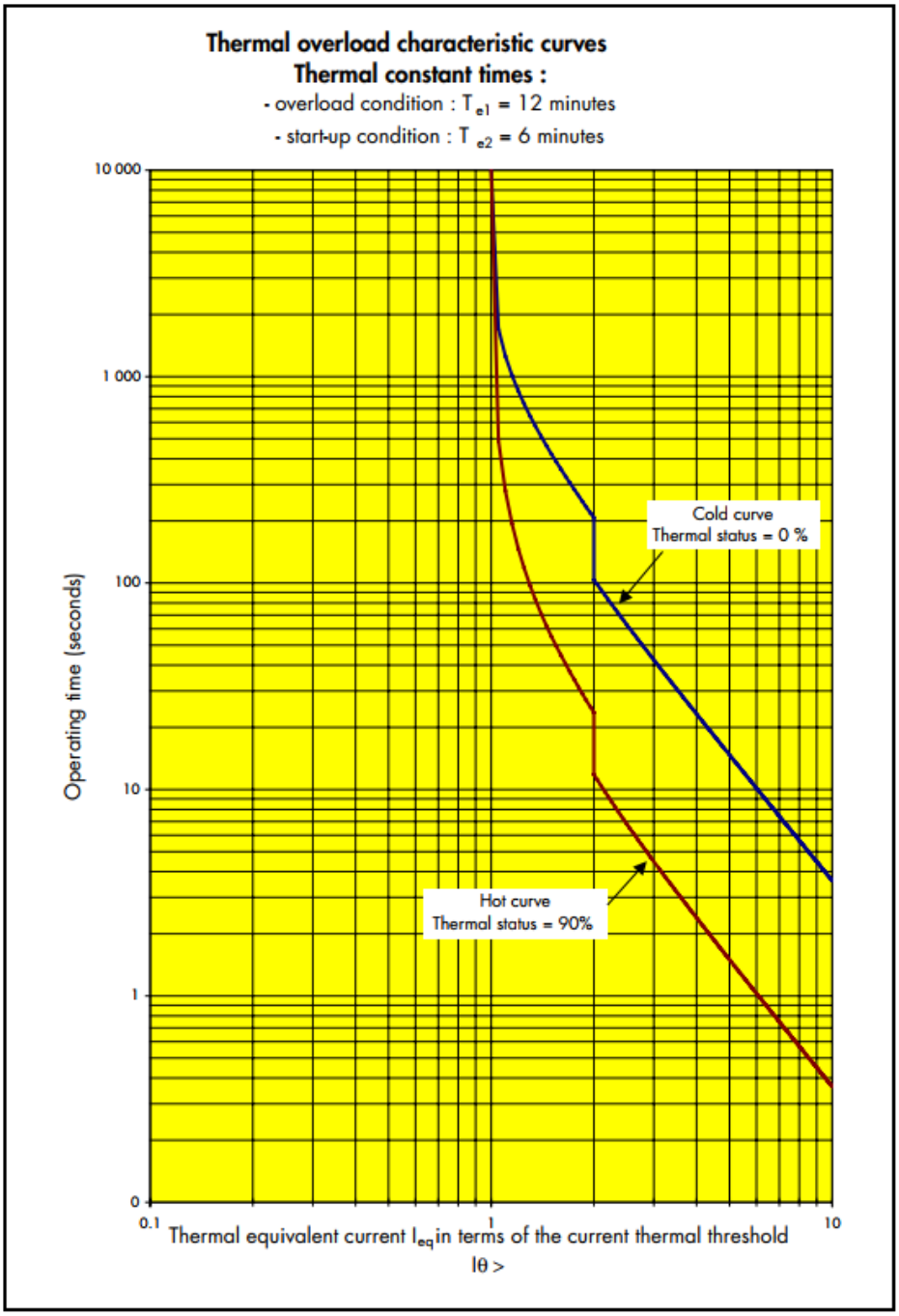
Is Value of the programmed threshold (pick-up value)

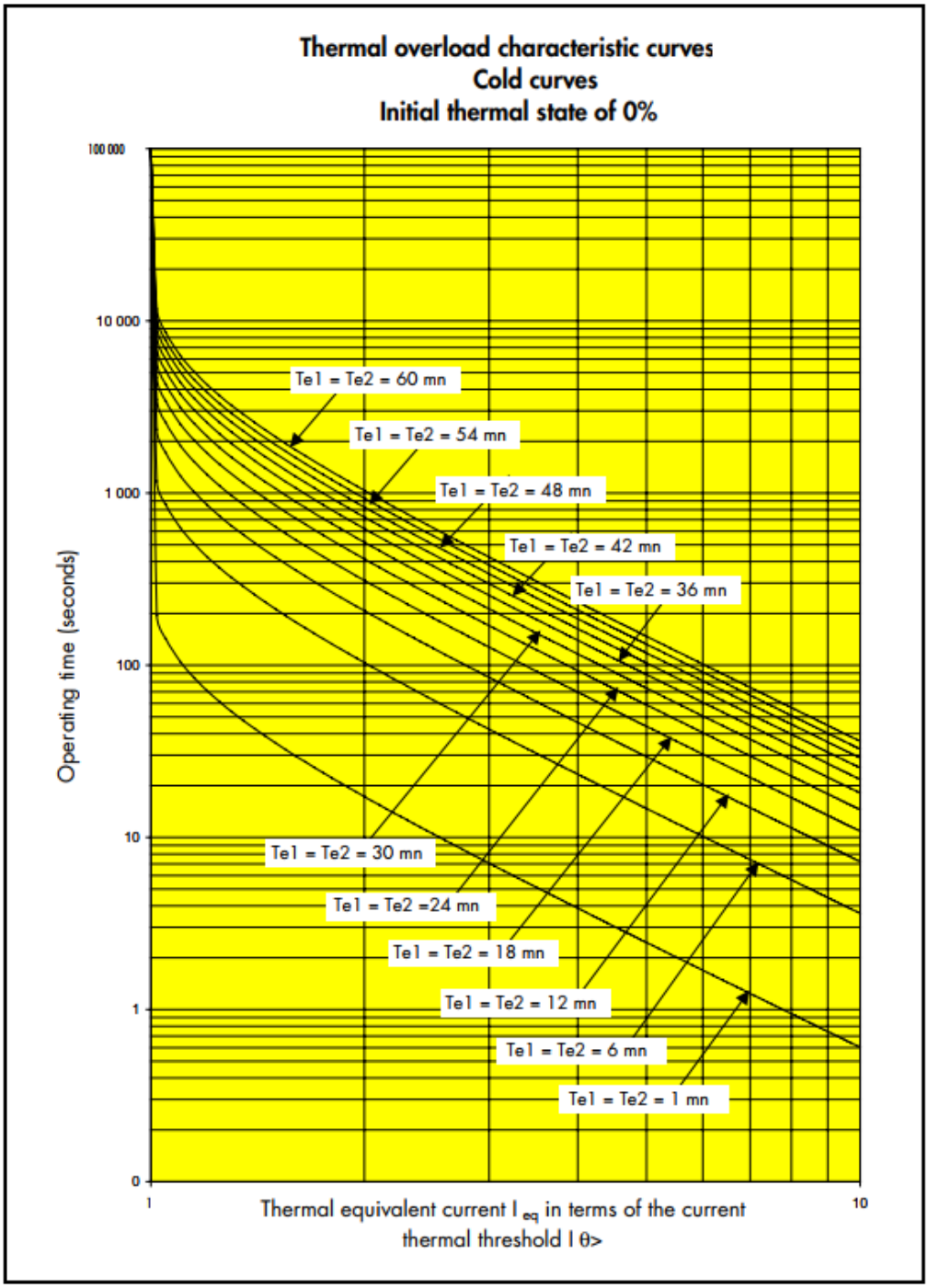
α Factor (see the next table)

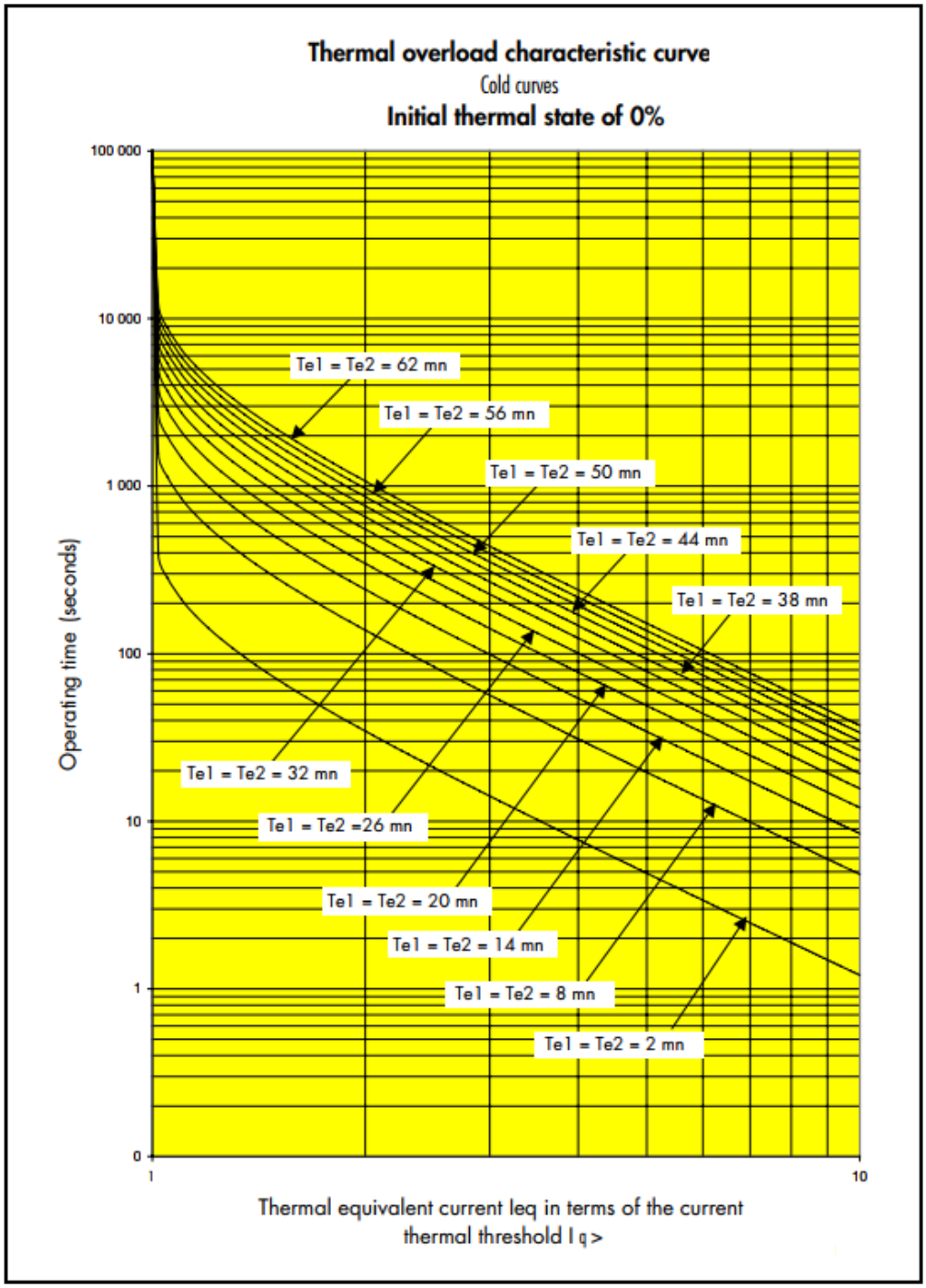
T Reset time multiplier (RTMS) setting between 0.025 and 1.5.

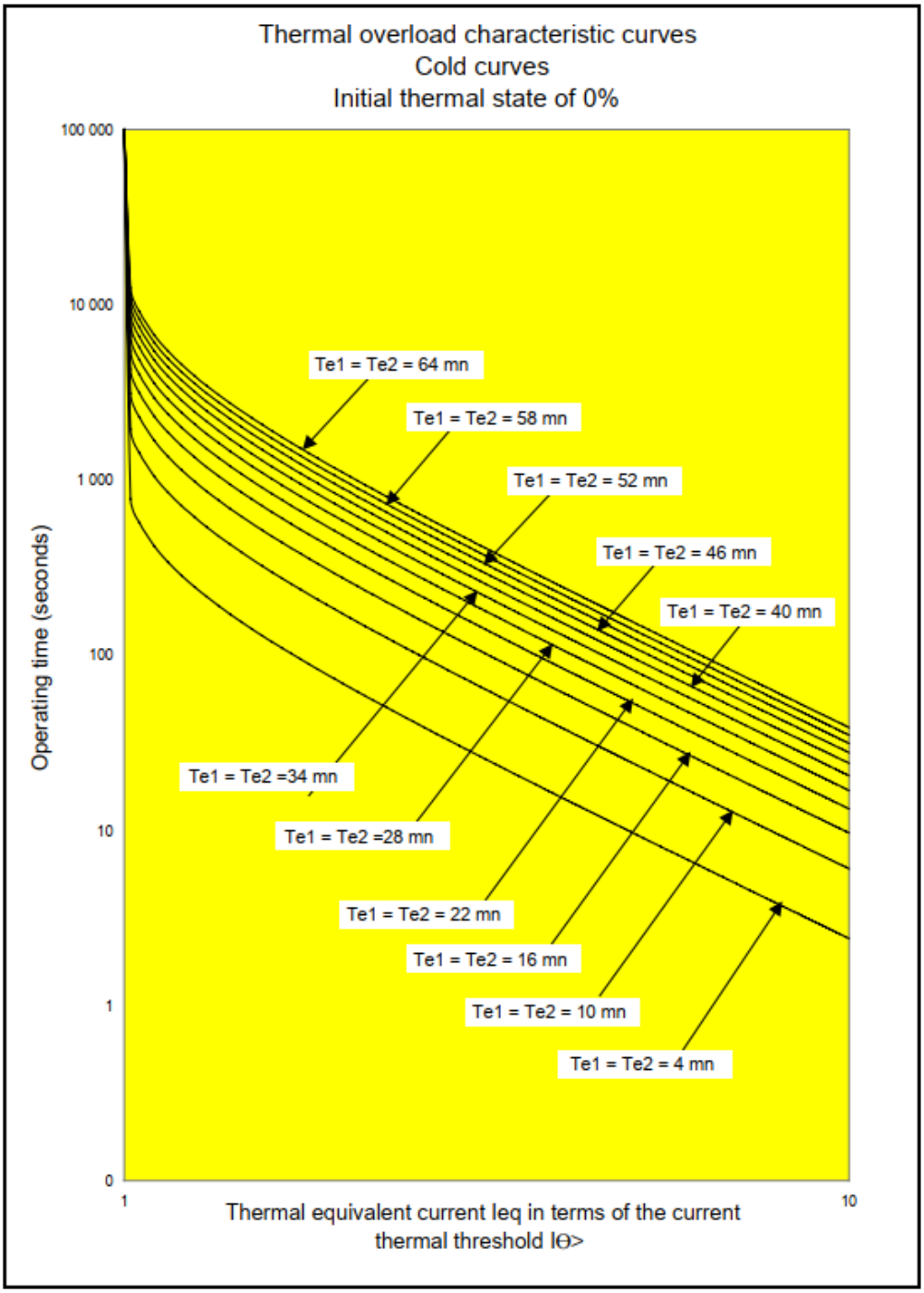
Type of Curve	**Standard**	**K Factor**	**α Factor**
Short time inverse	C02	2.261	2
Moderately inverse	ANSI/IEEE	4.850	2
Long time inverse	C08	5.950	2
Very inverse	ANSI/IEEE	21.600	2
Extremely Inverse	ANSI/IEEE	29.100	2

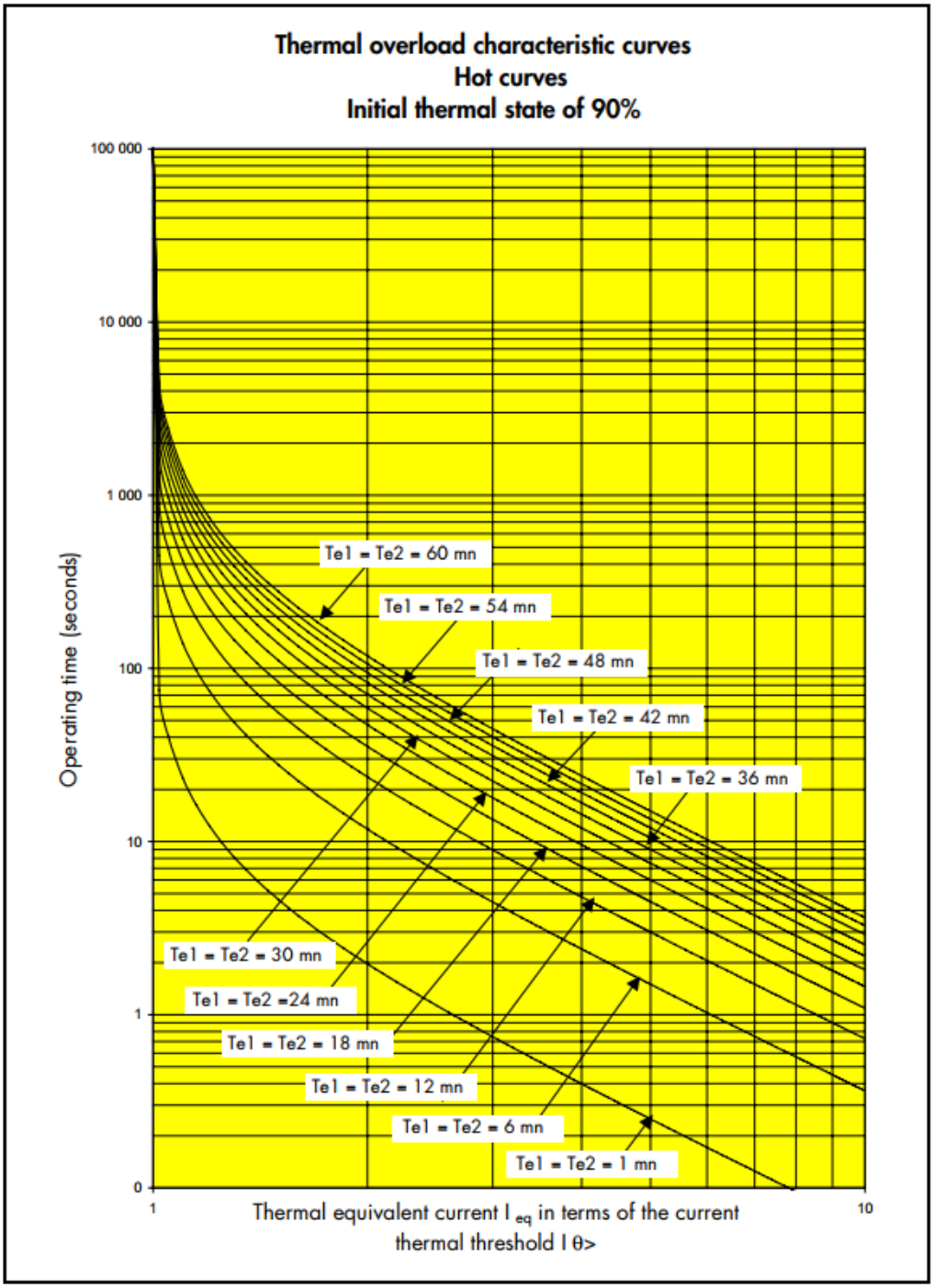
8.2 Thermal overload characteristic curves

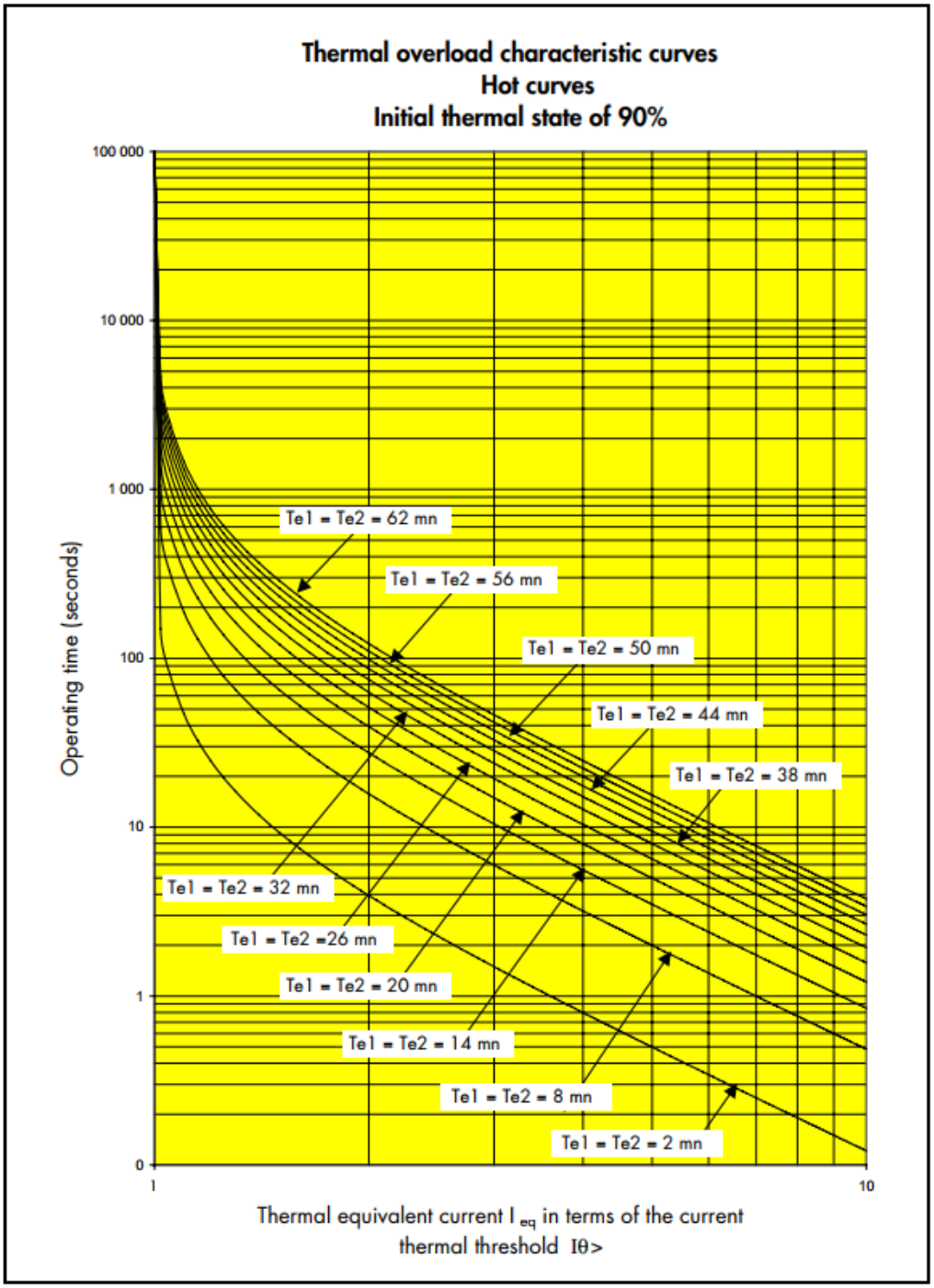


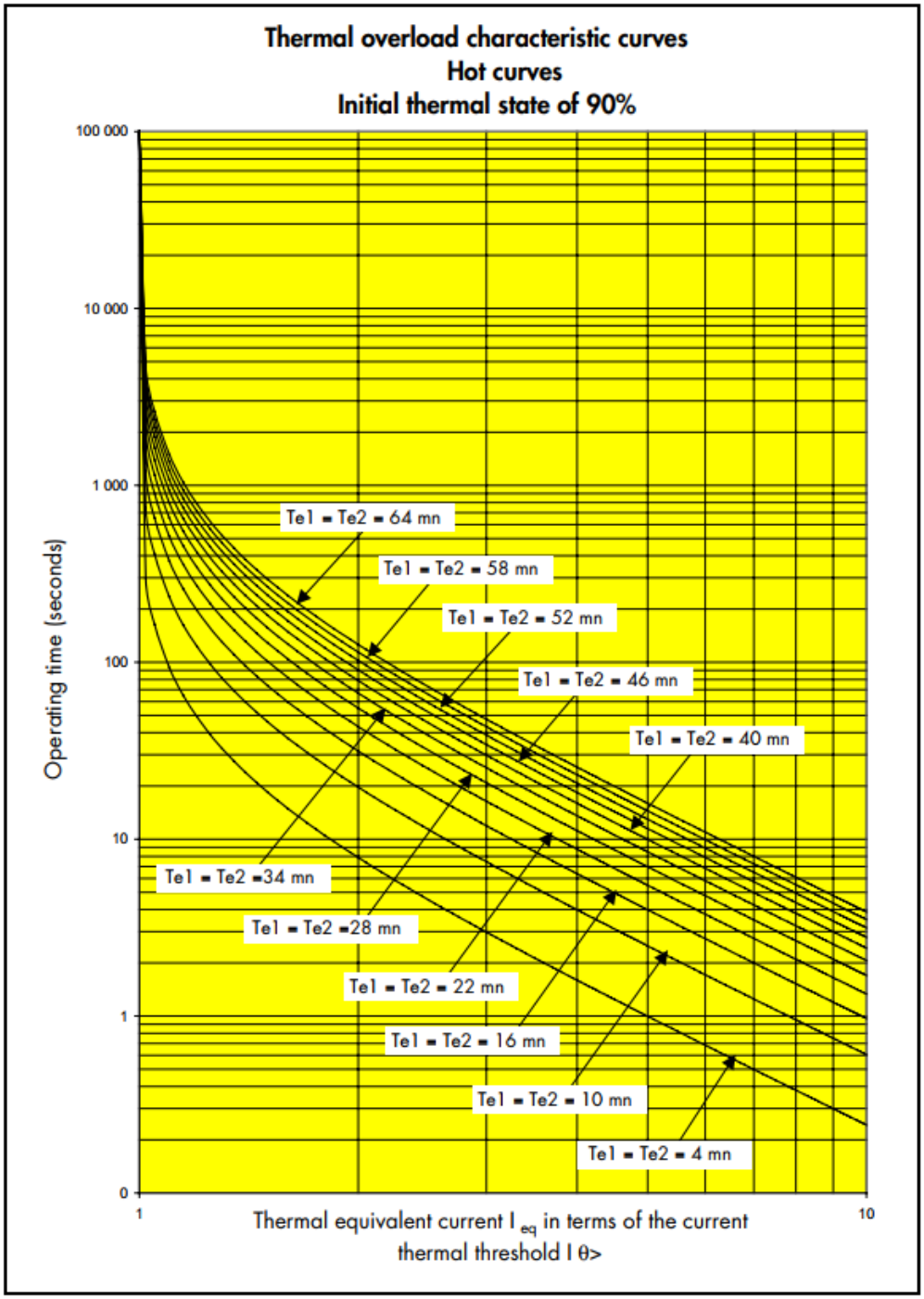

Thermal overload characteristic curves
Cold curves
Initial thermal state of 0%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 60 mn
Te1 = Te2 = 54 mn
Te1 = Te2 = 48 mn
Te1 = Te2 = 42 mn
Te1 = Te2 = 36 mn
Te1 = Te2 = 30 mn
Te1 = Te2 =24 mn
Te1 = Te2 = 18 mn
Te1 = Te2 = 12 mn
Te1 = Te2 = 6 mn
Te1 = Te2 = 1 mn
1
10
Thermal equivalent current I eq in terms of the current thermal threshold I θ>

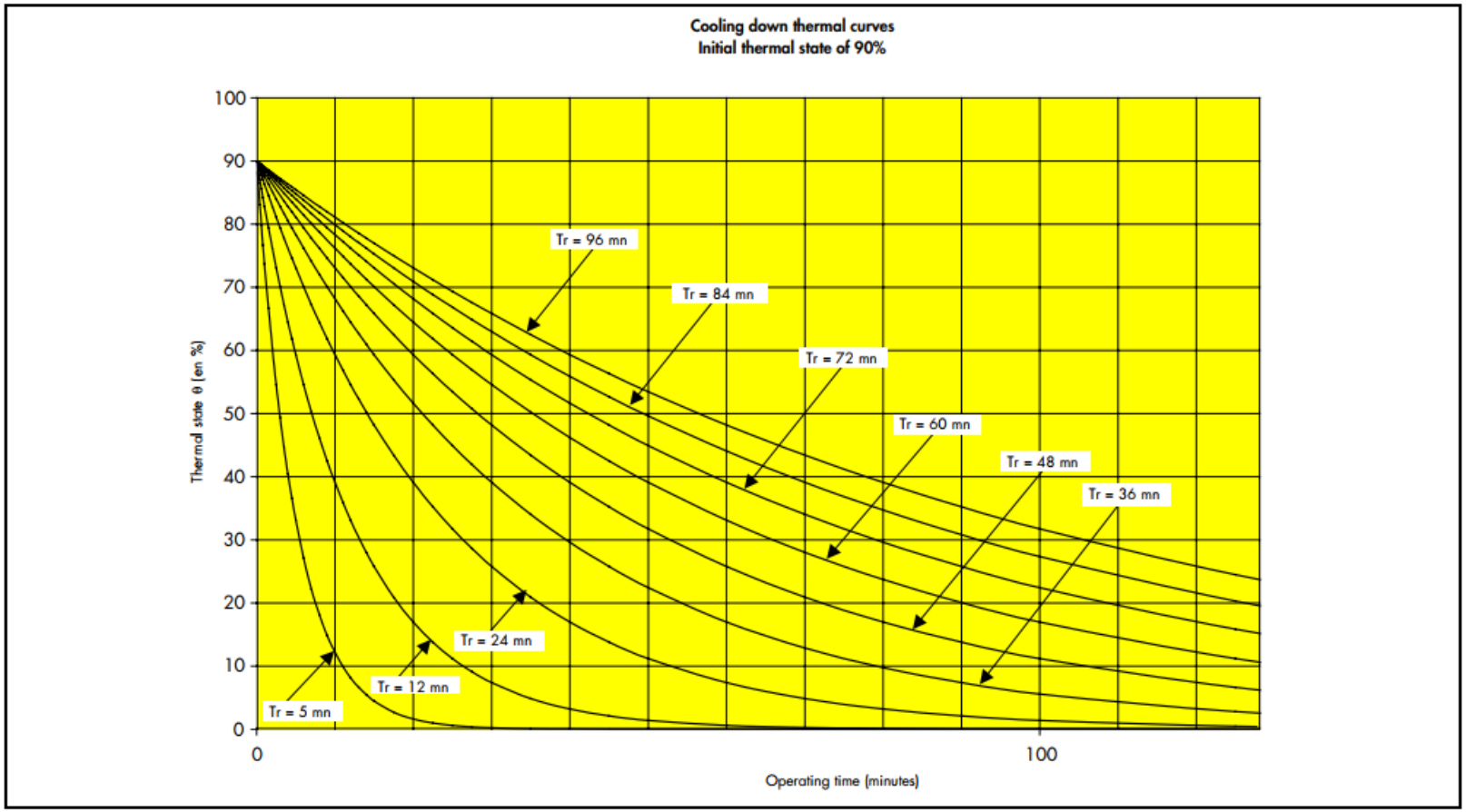

Thermal overload characteristic curve
Cold curves
Initial thermal state of 0%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 62 mn
Te1 = Te2 = 56 mn
Te1 = Te2 = 50 mn
Te1 = Te2 = 44 mn
Te1 = Te2 = 38 mn
Te1 = Te2 = 32 mn
Te1 = Te2 =26 mn
Te1 = Te2 = 20 mn
Te1 = Te2 = 14 mn
Te1 = Te2 = 8 mn
Te1 = Te2 = 2 mn
1
10
Thermal equivalent current Ieq in terms of the current thermal threshold I q >

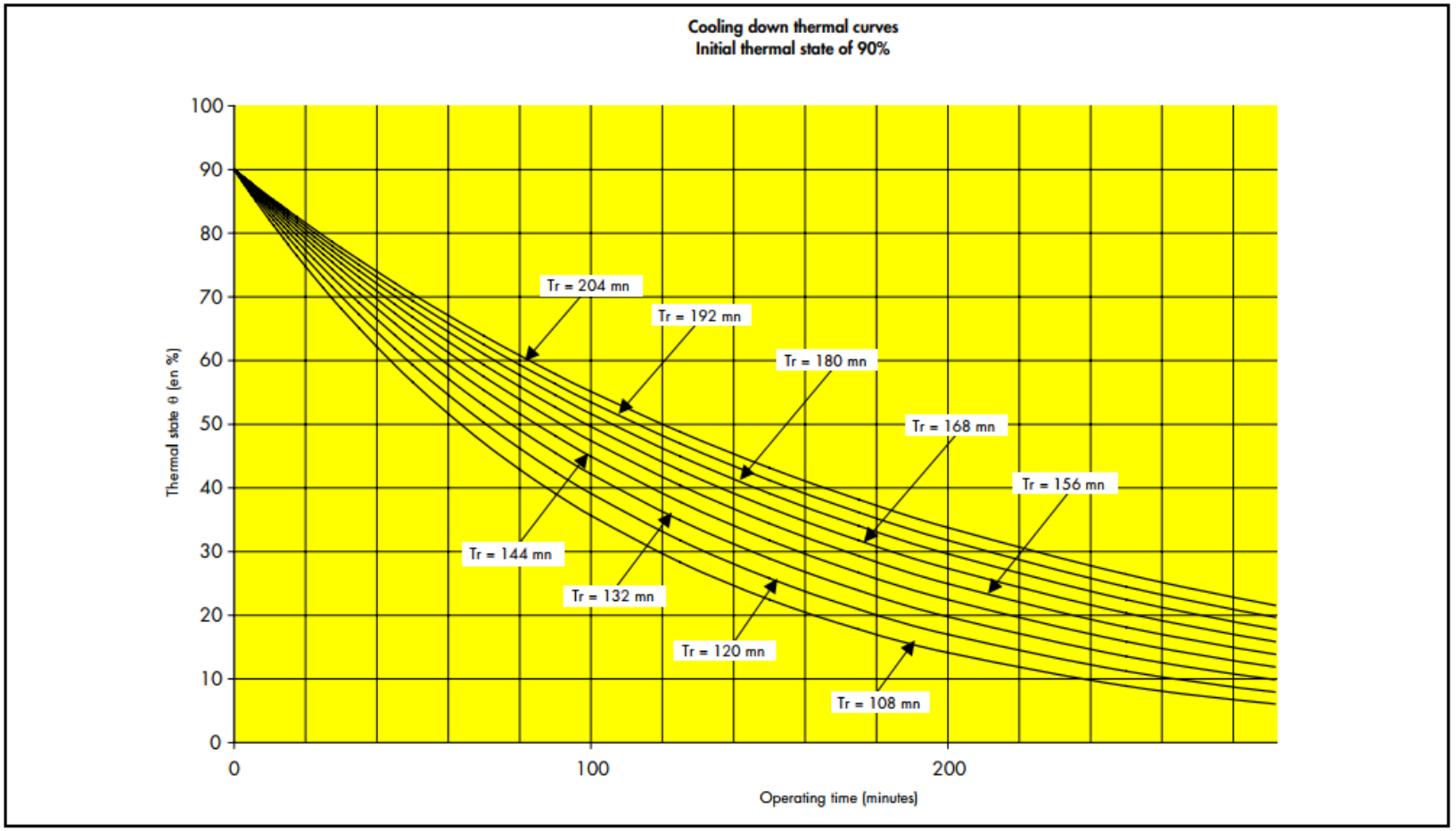

Thermal overload characteristic curves
Cold curves
Initial thermal state of 0%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 64 mn
Te1 = Te2 = 58 mn
Te1 = Te2 = 52 mn
Te1 = Te2 = 46 mn
Te1 = Te2 = 40 mn
Te1 = Te2 =34 mn
Te1 = Te2 =28 mn
Te1 = Te2 = 22 mn
Te1 = Te2 = 16 mn
Te1 = Te2 = 10 mn
Te1 = Te2 = 4 mn
1
10
Thermal equivalent current Ieq in terms of the current thermal threshold Iθ>

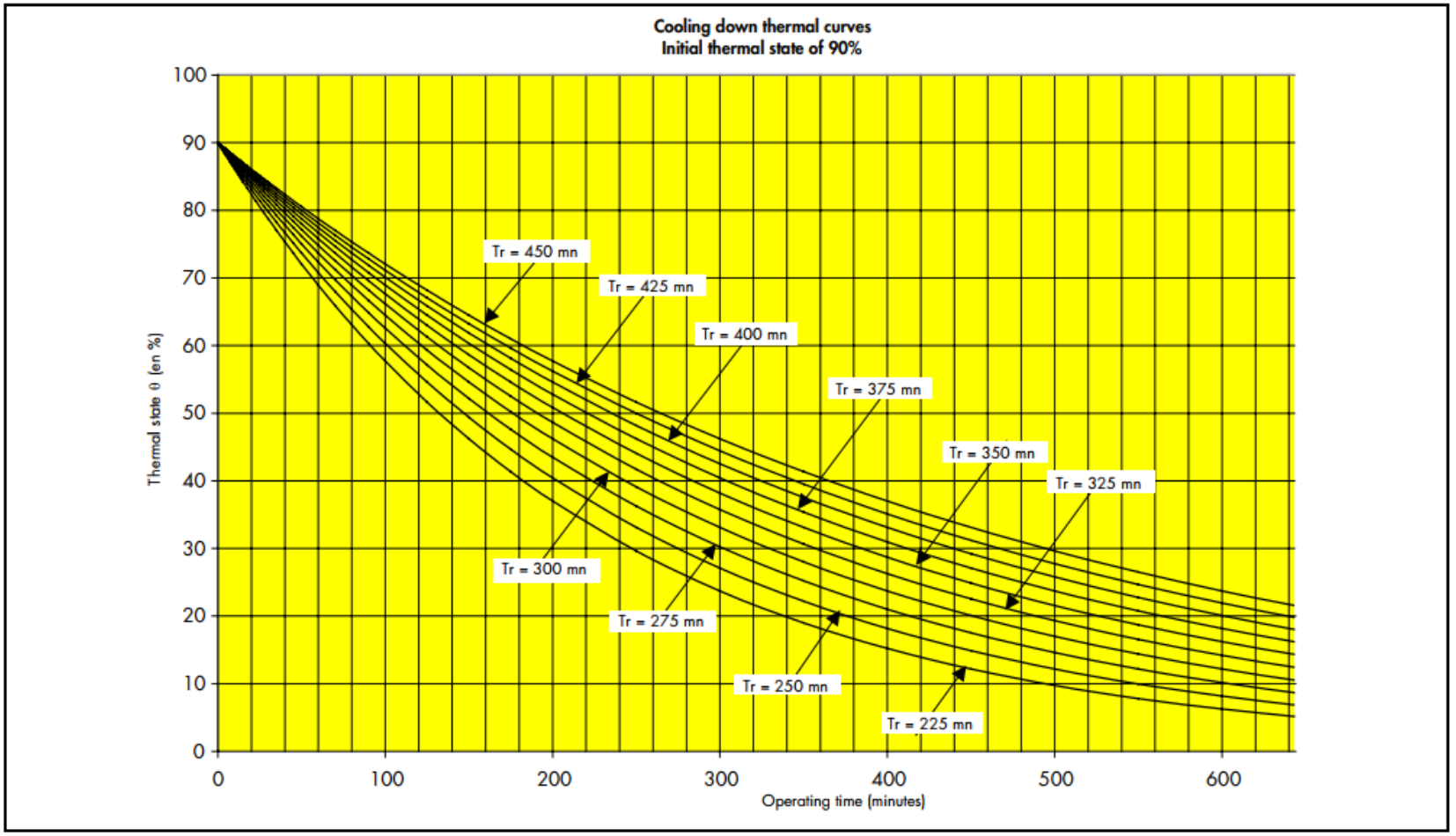

Thermal overload characteristic curves
Hot curves
Initial thermal state of 90%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 60 mn
Te1 = Te2 = 54 mn
Te1 = Te2 = 48 mn
Te1 = Te2 = 42 mn
Te1 = Te2 = 36 mn
Te1 = Te2 = 30 mn
Te1 = Te2 =24 mn
Te1 = Te2 = 18 mn
Te1 = Te2 = 12 mn
Te1 = Te2 = 6 mn
Te1 = Te2 = 1 mn
1
10
Thermal equivalent current I eq in terms of the current thermal threshold I θ>

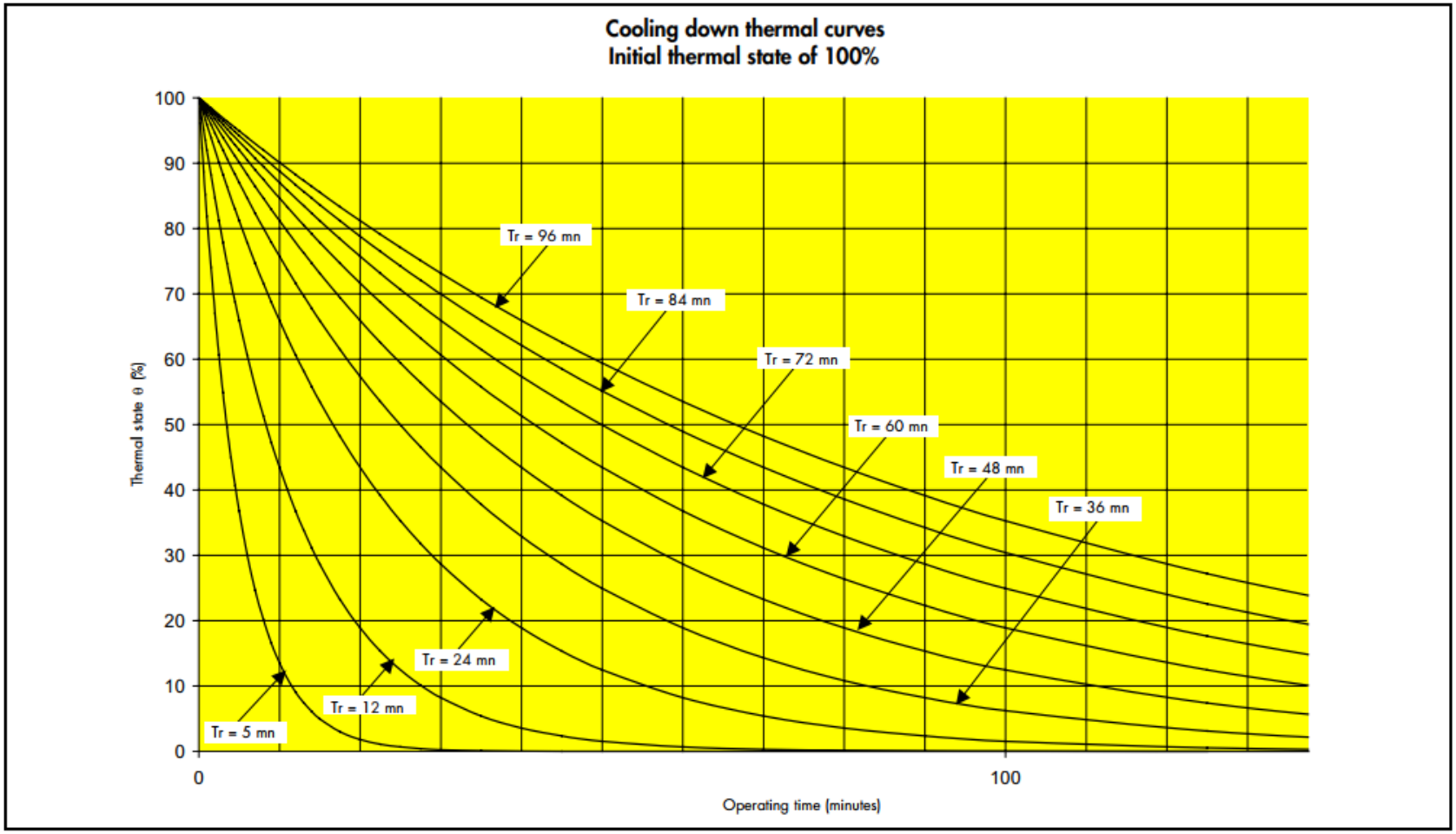

Thermal overload characteristic curves
Hot curves
Initial thermal state of 90%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 62 mn
Te1 = Te2 = 56 mn
Te1 = Te2 = 50 mn
Te1 = Te2 = 44 mn
Te1 = Te2 = 38 mn
Te1 = Te2 = 32 mn
Te1 = Te2 =26 mn
Te1 = Te2 = 20 mn
Te1 = Te2 = 14 mn
Te1 = Te2 = 8 mn
Te1 = Te2 = 2 mn
1
10
Thermal equivalent current I eq in terms of the current thermal threshold Iθ>

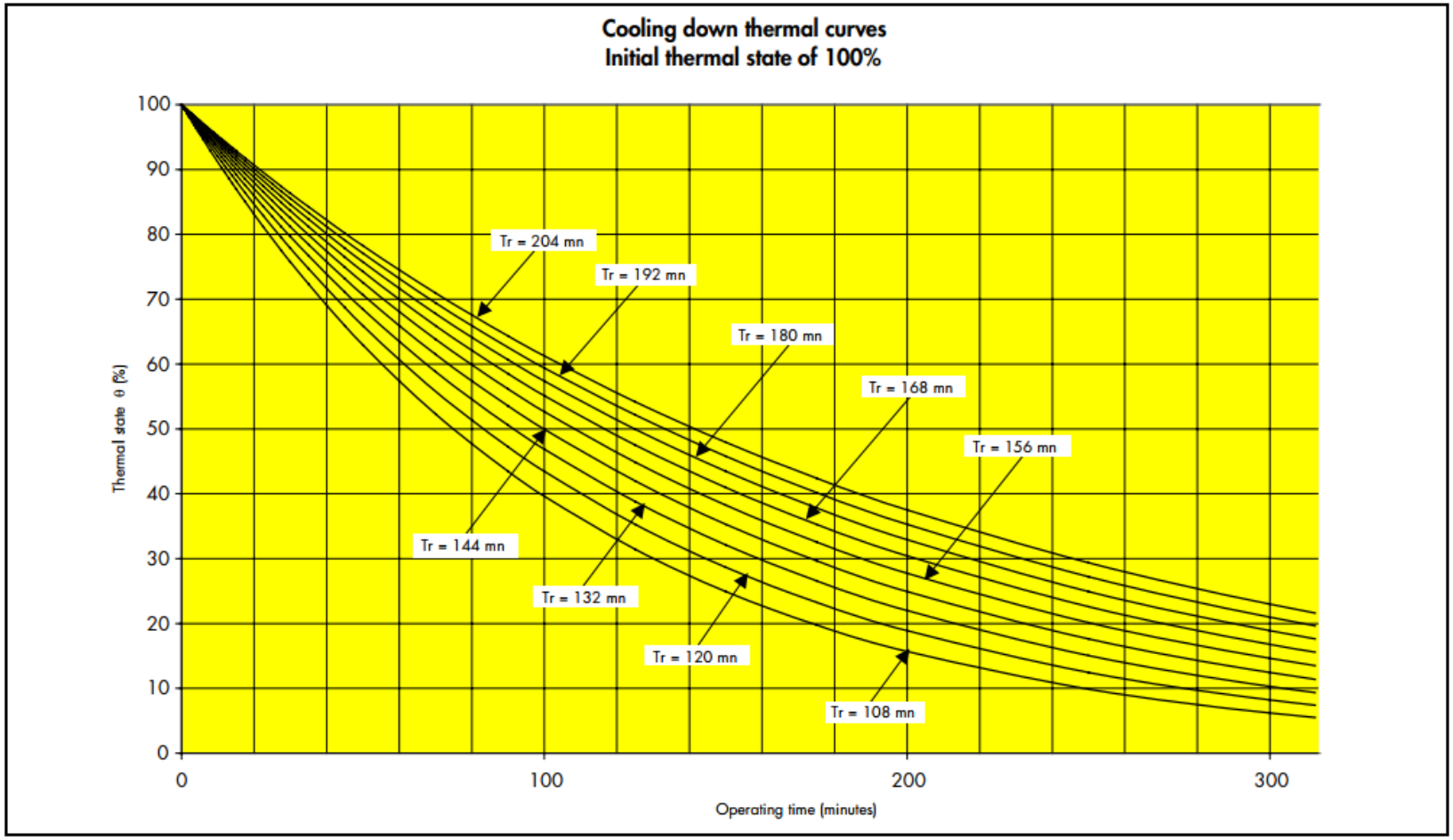

Thermal overload characteristic curves
Hot curves
Initial thermal state of 90%
100 000
10 000
1 000
100
10
1
0
Operating time (seconds)
Te1 = Te2 = 64 mn
Te1 = Te2 = 58 mn
Te1 = Te2 = 52 mn
Te1 = Te2 = 46 mn
Te1 = Te2 = 40 mn
Te1 = Te2 =34 mn
Te1 = Te2 =28 mn
Te1 = Te2 = 22 mn
Te1 = Te2 = 16 mn
Te1 = Te2 = 10 mn
Te1 = Te2 = 4 mn
1
10
Thermal equivalent current I eq in terms of the current thermal threshold I θ>

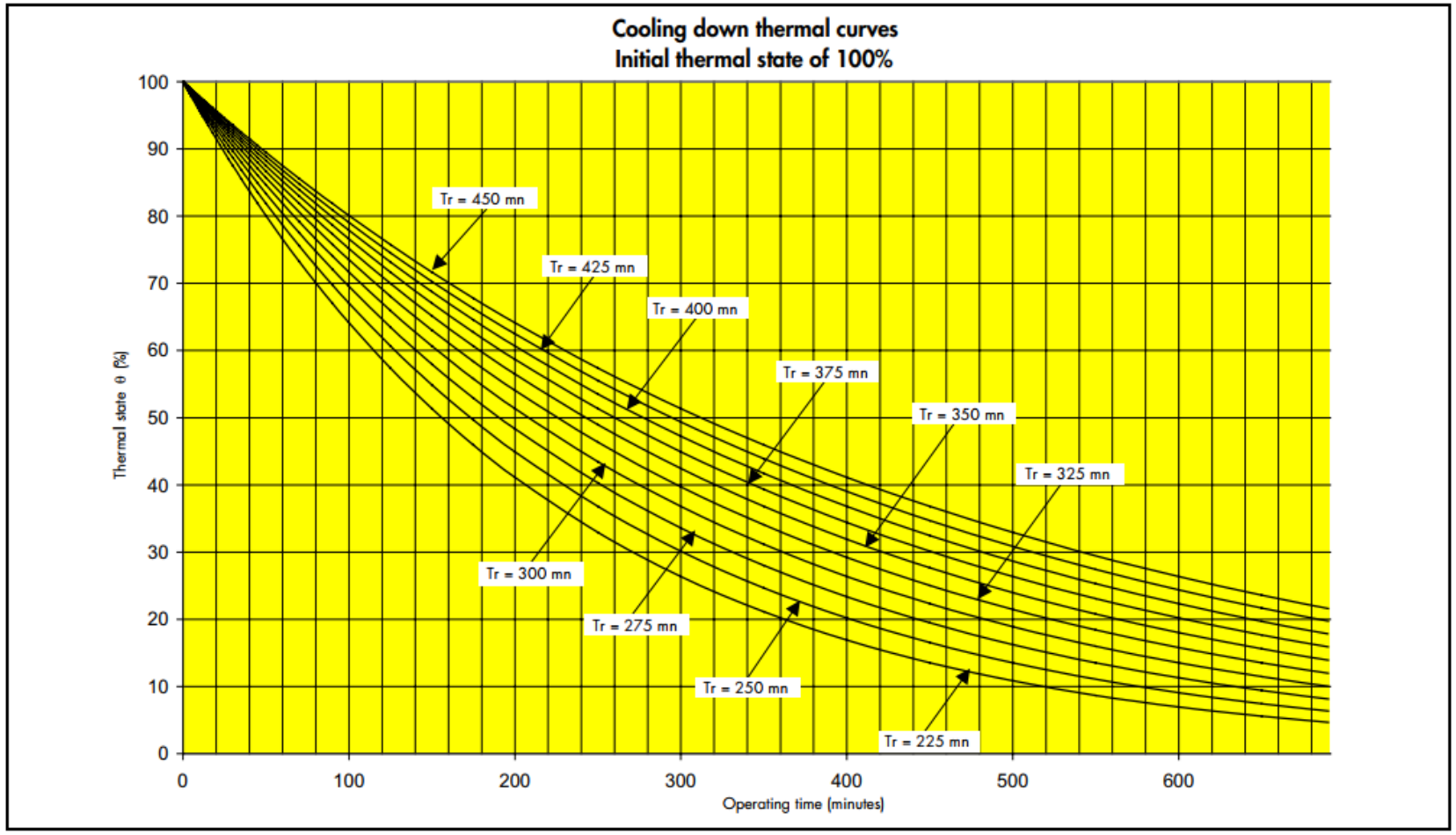

Cooling down thermal curves
Initial thermal state of 90%
Thermal state θ (en %)
100
90
80
70
60
50
40
30
20
10
0
0
100
Operating time (minutes)
Tr = 96 mn
Tr = 84 mn
Tr = 72 mn
Tr = 60 mn
Tr = 48 mn
Tr = 36 mn
Tr = 24 mn
Tr = 12 mn
Tr = 5 mn

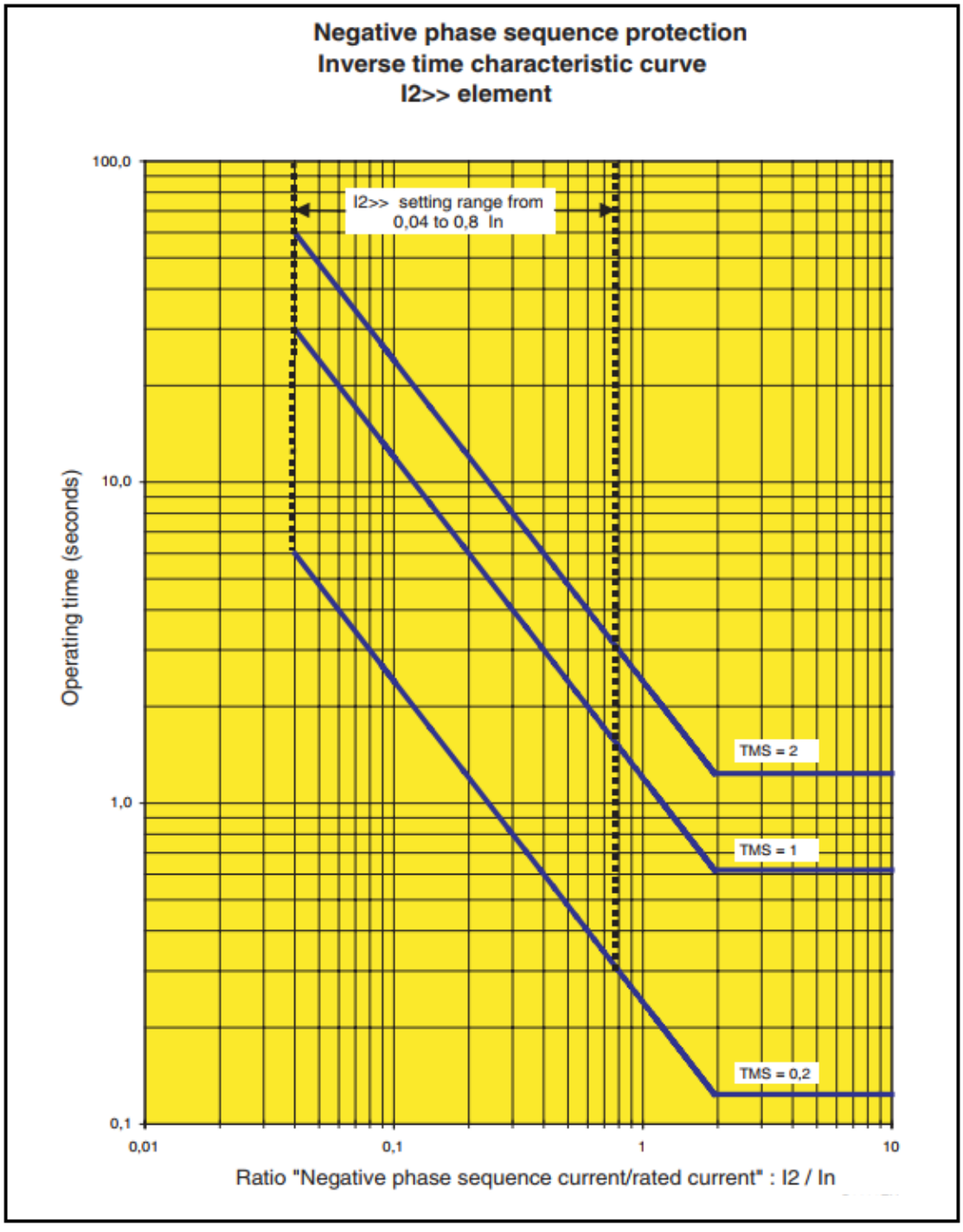

Cooling down thermal curves
Initial thermal state of 90%
Thermal state θ (en %)
Operating time (minutes)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
Tr = 204 mn
Tr = 192 mn
Tr = 180 mn
Tr = 168 mn
Tr = 156 mn
Tr = 144 mn
Tr = 132 mn
Tr = 120 mn
Tr = 108 mn


Cooling down thermal curves
Initial thermal state of 90%
Thermal state θ (en %)
Operating time (minutes)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
Tr = 450 mn
Tr = 425 mn
Tr = 400 mn
Tr = 375 mn
Tr = 350 mn
Tr = 325 mn
Tr = 300 mn
Tr = 275 mn
Tr = 250 mn
Tr = 225 mn


Cooling down thermal curves
Initial thermal state of 100%
Thermal state θ (%)
100
90
80
70
60
50
40
30
20
10
0
0
100
Operating time (minutes)
Tr = 96 mn
Tr = 84 mn
Tr = 72 mn
Tr = 60 mn
Tr = 48 mn
Tr = 36 mn
Tr = 24 mn
Tr = 12 mn
Tr = 5 mn


Cooling down thermal curves
Initial thermal state of 100%
Thermal state θ (%)
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
Operating time (minutes)
Tr = 204 mn
Tr = 192 mn
Tr = 180 mn
Tr = 168 mn
Tr = 156 mn
Tr = 144 mn
Tr = 132 mn
Tr = 120 mn
Tr = 108 mn


Cooling down thermal curves
Initial thermal state of 100%
Thermal state θ (%)
Operating time (minutes)
Tr = 450 mn
Tr = 425 mn
Tr = 400 mn
Tr = 375 mn
Tr = 350 mn
Tr = 325 mn
Tr = 300 mn
Tr = 275 mn
Tr = 250 mn
Tr = 225 mn
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600


Negative phase sequence protection
Inverse time characteristic curve
I2>> element
I2>> setting range from
0,04 to 0,8 In
100,0
10,0
1,0
0,1
Operating time (seconds)
TMS = 2
TMS = 1
TMS = 0,2
0,01
0,1
1
10
Ratio "Negative phase sequence current/rated current" : I2 / In