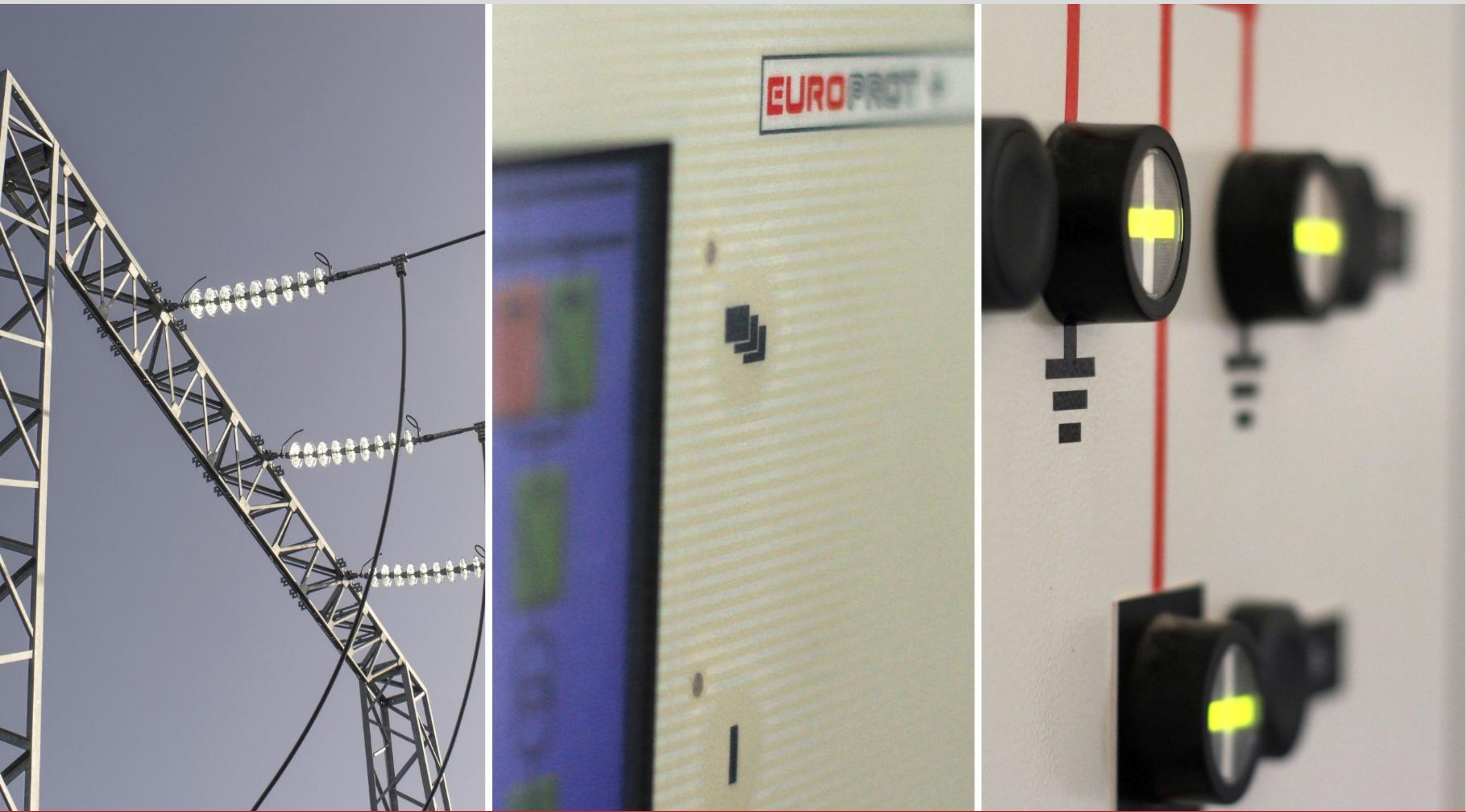

FUNCTION BLOCK DESCRIPTION

Directional three-phase overcurrent function block description

PROTECTA HUNGARY

DOCUMENT ID: PP-13-20321
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2025-03-13, BUDAPEST

PROTECTION, AUTOMATION AND CONTROL FOR POWER INDUSTRY

VERSION INFORMATION

VERSION	DATE	MODIFICATION	COMPILED BY
Preliminary	2009-11-24	Preliminary version, without technical information	Petri
	2010-06-18	Technical information added	Petri
	2010-10-05	Naming revision	Csipke
1.0	2010-11-11	First edition	Petri
1.1	2016-04-25	Timer parameter min. values changed, start current max raised to 3000%; minor formatting	Erdős
2.0	2022-07-13	Application both for solidly earthed and isolated (compensated) networks Overcurrent decision based on RMS values or on Fourier fundamental harmonics SOTF feature added Extension of parameter ranges Technical data updated Updated document design New chapters: overview, notes for testing	Petri, Erdős, Tóth F.
2.1	2022-08-17	• Range of the Time multiplier parameter updated • Some data in the table of Technical data updated	Seida
3.0	2025-01-17	Modifications for 2.10 system version • Algorithm structure updated, DirElement function included • Fundamental/RMS decision no longer controlled by parameter: configuration modification is needed • Updated parameters and functionblock screenshot • Additional chapter for the legacy 2.8 version	Erdős
3.1	2025-03-13	Minor correction	Ádám

CONTENTS

USED SYMBOLS

Additional information

Useful information for settings.

Important part for proper usage.

1 Application

The directional three-phase overcurrent protection function can be applied on solidly grounded, compensated or isolated networks, where the overcurrent protection must be supplemented with a directional decision.

The direction can be selected as forward or backward. The overcurrent decision can be set also without considering the decision.

The overcurrent decision can be based on current RMS values or on Fourier fundamental harmonic values. The selection is made either by parameter (2.8 firmware version variant) or configuration (2.10 firmware version variant)

The time overcurrent characteristic can be definite time or several types of standard IEC or ANSI characteristics.

1.1 Mode of operation

The inputs of the function are three-phase currents and voltages. For directional decision the Fourier basic harmonic components of the three phase currents and those of the three phase voltages are calculated. The Fourier fundamental components are used for overcurrent decision.

NOTE: if true RMS value is needed to be used instead of the Fourier fundamental component, the configuration (.epcs) file must be modified by Protecta personnel. In these cases, please contact Protecta Support.

The directional decision is similar to a distance protection function decision: Based on the measured voltages and currents, from among the six loops (L1L2, L2L3, L3L1, L1N, L2N, L3N) the block selects the one with the smallest calculated loop impedance. Based on the loop voltage and loop current of the selected loop the directional decision generates a signal of TRUE value if the voltage and the current is sufficient for directional decision, and the angle difference between the vectors is within the setting range. This decision enables the output start and trip signal of an overcurrent protection function block, based on the selected current. If the voltages of the selected loop are not sufficient for the directional decision, then healthy phase voltages (positive sequence), or pre-fault voltages stored in the memory are also applied.

The function generates a trip command if both the direction (if this choice is selected) and the current magnitude satisfy the requirements as set by parameters, and also the time delay defined by the selected characteristic has expired.

The operating characteristics meet the requirements of IEC 60255-151.

The function is influenced by input binary signals:

- The function can be blocked by “Blk” input
- The signal from the voltage transformer supervision circuit indicates that the voltage signals are not available. “VTS” input. If this input is active, then the directional operation is disabled.
- If the circuit breaker closes in case of close-up fault, then the voltage is not suitable for directional decision. To let the directional overcurrent function operate in case of this “switch-onto-fault” case, the binary input “SOTFCondition” is used. If this input is active, then the function operates without directional decision and with high speed.

NOTE: the input signals are assigned by the user, using the logic editor in the EuroCAP configuration software tool.

1.2 Structure of the three-phase directional overcurrent protection algorithm

Figure 1-1 shows the structure of the three-phase directional overcurrent protection (TOC67) algorithm.

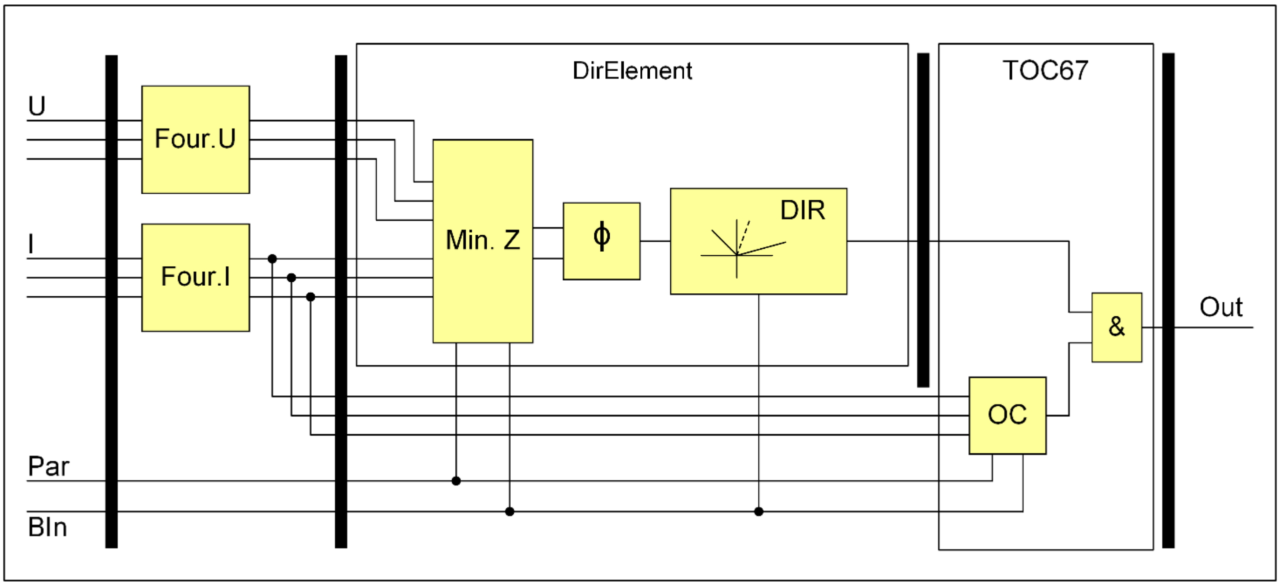


Figure 1-1 Structure of the three-phase directional overcurrent protection algorithm

The overall algorithm is the combination of two functions: the TOC67 functionblock itself and the DirElement function that handles the directionality calculations. The DirElement function has fault locator capability as well, for more information, see its description.

The **inputs** are

- the RMS value of the fundamental Fourier component of the three phase currents (IL1, IL2, IL3). NOTE: The Fourier calculation is not part of the directional overcurrent function, it is performed by an external function block.
- the RMS value of the fundamental Fourier component of the three phase voltages (UL1, UL2, UL3). NOTE: The Fourier calculation is not part of the directional overcurrent function, it is performed by an external function block.
- the RMS value of the fundamental Fourier component of the three phase-to-phase voltages (UL1L2, UL2L3, UL3L1). NOTE: The phase-to-phase voltage calculation is not part of the directional overcurrent function, it is performed by an external function block.
- parameters,
- binary status signals.

The function can be enabled or disabled by a parameter. The status signal of the VTS (voltage transformer supervision) function can also disable the directional operation.

The **outputs** are

- the binary output status signals (Start L1, Start L2, Start L3, General start, Trip).

The **software modules** of the three-phase directional overcurrent protection function are as follows:

MinZ

This module selects the faulty loop for directional decision. Using the pre-processing modules, from among the six loops (L1L2, L2L3, L3L1, L1N, L2N, L3N) this module selects the measuring loop with the smallest calculated loop impedance. The logic forwards the selected loop voltage and the loop current to the phase angle calculation module.

FI calculation (φ)

This module calculates the vector angle between the selected loop voltage and the loop current.

DIR

This module performs the directional decision.

OC

This is a non-directional three-phase overcurrent protection function.

The following description explains the details of the individual components.

1.2.1 Selection logic (MinZ)

Using calculated information of the pre-processing modules, in case of solidly grounded networks, from among the six loops (L1L2, L2L3, L3L1, L1N, L2N, L3N) this module selects the measuring loop with the smallest calculated loop impedance. The voltage must be above 5% of the rated voltage and the current must also be measurable (min. 8%). In compensated or isolated networks, the single phase-to-ground faults are supposed not to generate high fault currents. For these networks, the line-to-line loops (L1L2, L2L3, L3L1) are evaluated only.

Enumerated parameter for fault loop selection

Table 1-1 The enumerated parameter of the network type selection

PARAMETER NAME	TITLE	SELECTION RANGE	DEFAULT
Network neutral grounding selection			
TOC67_NetType_EPar_	Network type	Solidly Earthed, Isolated	Solidly earthed

NOTE: For compensated networks, select “Isolated” option.

The **input signals are** the RMS values of the fundamental Fourier components of the three-phase currents and three phase voltages and the three line-to-line voltages.

The **internal output status signal** for enabling the directional decision is true if both the three-phase voltages and the three-phase currents if they meet the minimum requirements above.

The RMS voltage and current values of the fundamental Fourier components of the selected loop are forwarded to angle calculation for further processing.

1.2.2 Calculation of the vector angle (FI calculation)

This module calculates the phase angle between the loop voltage and the loop current. The reference signal is the current according to Figure 1-2

The **input signals are** the fundamental Fourier components of the loop current and loop voltage.

The **internal output signal** is the calculated phase angle.

1.2.3 Directional decision (DIRST)

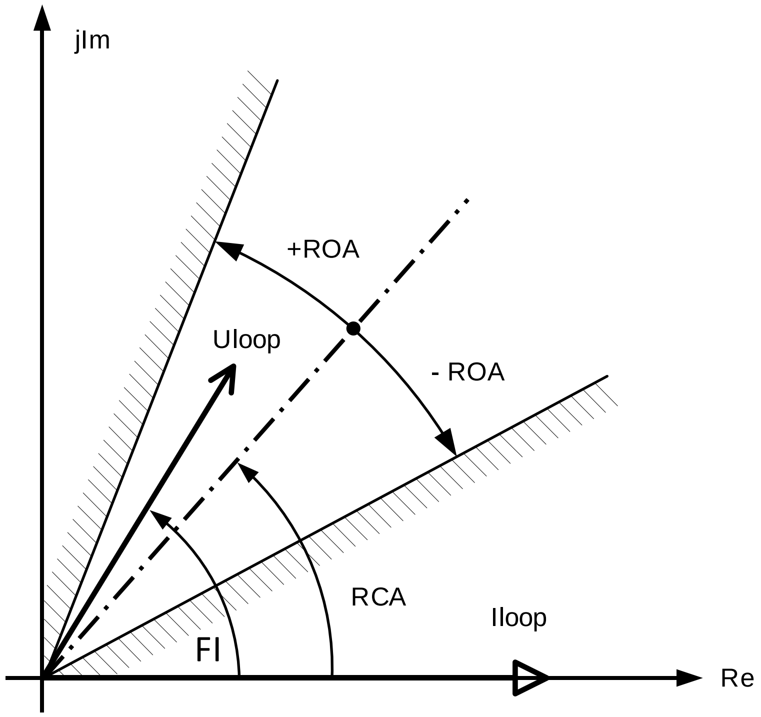


Figure 1-2 The directional decision

This module decides if the phase angle between the selected loop voltage and the current is within the limit range, defined by the preset parameters. The operation of this function is explained in Figure 1-2

The **input signals are**

- the enabling status signal from the pre-processing modules in AND relationship
- the calculated phase angle between the selected loop voltage and the selected current
- parameters.

The basic direction “Forward” or “Backward” (with the additional choice “NonDir”) is decided by the parameter “Direction”, NOTE: The direction is also influenced by the selected positive direction of the voltages and currents. These are set by the parameters of the VT4 and CT4 modules. The details are explained in the related documents.

If the voltage of the loop is below 5% of the rated voltage, then the algorithm selects the appropriate polarizing method for directional decision. In sequence:

- If the loop voltage is below 5% of the rated voltage, then the **positive sequence component** is selected.
- If the positive sequence voltage is also not sufficient (in case of three-phase close-up fault) then the algorithm substitutes the small values with the voltages stored in the memory.

The SOTF condition is processed in this directional decision module. The binary input signal “SOTFCond” turns the directional decision to TRUE, and the function operates without additional time delay.

If the voltage transformer circuit cannot deliver measurable voltage, then no directional decision is possible. This state is indicated by the binary input signal “VTS”. This signal is assigned to the input of the function block by the user, using the logic editor function of the EuroCAP configuration software. The effect of this signal is decided by the Boolean parameter “NonDir when VTS”: if this parameter is logic TRUE (checked) then the evaluation for “Forward” or “Backward” turns automatically to “NonDir”, the output signal depend on the magnitude of the current only. If the “NonDir when VTS” Boolean parameter is not checked, then the TRUE state of the “VTS” binary input blocks the operation of the function block. The related parameter is shown in Table 1-2.

The **internal output signal** is the decision of the direction function. If the direction is OK, the output signal is TRUE, i.e. the phase angle between the three-phase voltage and the three-phase current is within the limit range, defined by the preset parameter OR non-directional operation is selected by the preset parameter TOC67_Dir_EPar_ (Direction=NonDir).

This block generates a TRUE internal status signal also for SOTF condition, and when no directional decision is required by parameter setting.

Table 1-2 The boolean parameter of the directional decision

PARAMETER NAME	TITLE	SELECTION RANGE	DEFAULT
Turn the function to non-directional mode or block the function if the “VTS” binary input gets active			
TOC67_NDirVTS _BPar_	NonDir when VTS	Checked, Not checked	Not checked

Table 1-3 The enumerated parameter of the directional decision

PARAMETER NAME	TITLE	SELECTION RANGE	DEFAULT
Directionality of the function			
TOC67_Dir_EPar_	Direction	NonDir, Forward, Backward	Forward

Table 1-4 The integer parameters of the directional decision

PARAMETER NAME	TITLE	UNIT	MIN	MAX	STEP	DEFAULT
Operating angle (See Figure 1-2)						
TOC67_**ROA**_IPar_	Operating Angle	deg	10	85	1	60
Characteristic angle (See Figure 1-2)						
TOC67_**RCA**_IPar_	Characteristic Angle	deg	-90	90	1	60

1.2.4 The overcurrent protection function (OC)

This module is equivalent to the TOC51 (three-phase (non-directional) overcurrent) function block described in a separate document. The additional input binary signal enables the operation if the directional decision module generates a logic TRUE value, indicating that the phase angle is in the range defined by the preset parameter or that non-directional decision is required.

1.2.4.1 Operating characteristics

Independent time characteristic

$$t(G) = t_{OP} \text{ when } G > G_S$$

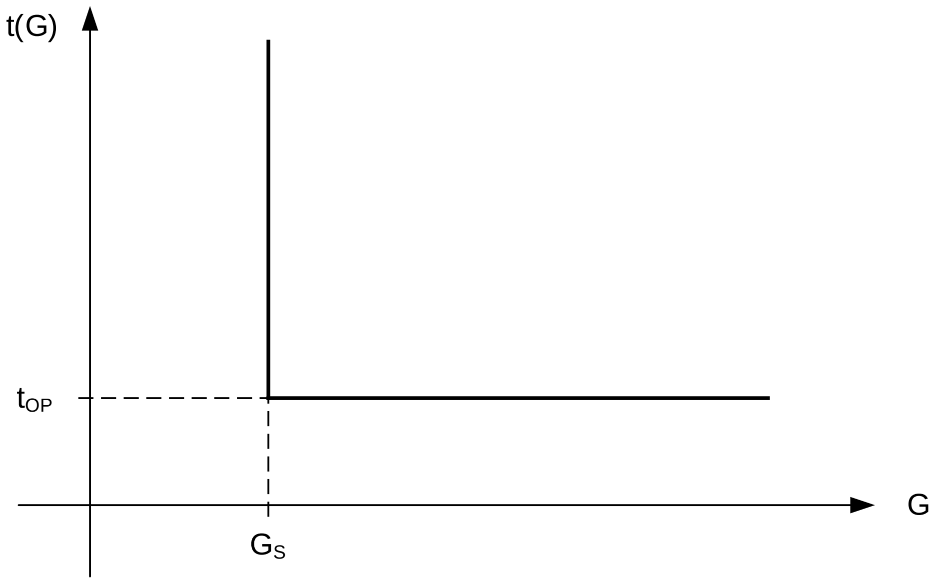


Figure 1-3 Overcurrent independent time characteristic

Where:

t_{OP} (seconds)	theoretical operating time if G> G_S, fix, according to the preset parameter,
G	measured value of the characteristic quantity, Fourier base harmonic of the phase currents,
G_S	preset value of the characteristic quantity ("Start current" parameter).

Standard dependent time characteristics

Operating characteristics:

$$t(G) = TMS\left[\frac{k}{\left(\frac{G}{G_S}\right)^{\alpha} - 1} + c\right] \text{ when } G > G_S$$

Where:

t(G)(seconds)	theoretical operate time with constant value of G,
k, c	constants characterizing the selected curve (in seconds),
α	constants characterizing the selected curve (no dimension),
G	measured value of the characteristic quantity, Fourier base harmonic of the phase currents (IL1Four, IL2Four, IL3Four),
G_S	preset value of the characteristic quantity (“Start current” parameter),
TMS	preset time multiplier (no dimension).

Table 1-5 The constants of the standard dependent time characteristics

	IEC REF	TITLE	kr	c	α
1	A	IEC Inv	0,14	0	0,02
2	B	IEC VeryInv	13,5	0	1
3	C	IEC ExtInv	80	0	2
4		IEC LongInv	120	0	1
5		ANSI Inv	0,0086	0,0185	0,02
6	D	ANSI ModInv	0,0515	0,1140	0,02
7	E	ANSI VeryInv	19,61	0,491	2
8	F	ANSI ExtInv	28,2	0,1217	2
9		ANSI LongInv	0,086	0,185	0,02
10		ANSI LongVeryInv	28,55	0,712	2
11		ANSI LongExtInv	64,07	0,250	2

The end of the effective range of the dependent time characteristics (G_D) is:

$$G_D = 20 * G_S$$

Above this value the theoretical operating time is definite:

$$t(G) = TMS\left[\frac{k}{\left(\frac{G_D}{G_S}\right)^{\alpha} - 1} + c\right] \text{ when } G > G_D = 20 * G_S$$

Additionally, a minimum time delay can be defined by parameter “Min Time Delay”. This delay is valid if it is longer than t(G), defined by the formula above.

The inverse characteristic is valid above G_T =1,1* G_S. Above this value the function is guaranteed to operate.

Resetting characteristics:

- For IEC type characteristics the resetting is after a fix time delay defined by “Reset delay”,
- for ANSI types however according to the formula below:

$$t_r(G) = TMS\left[\frac{k_r}{1-\left(\frac{G}{G_S}\right)^{\alpha}}\right] \text{ when } G < G_S$$

Where:

$t_r(G)$(seconds)	theoretical reset time with constant value of G,
k_r	constants characterizing the selected curve (in seconds),
α	constants characterizing the selected curve (no dimension),
G	measured value of the characteristic quantity, Fourier base harmonic of the phase currents,
G_S	preset value of the characteristic quantity (“Start current” parameter),
TMS	preset time multiplier (no dimension).

Table 1-6 The resetting constants of the standard dependent time characteristics

	IEC REF	TITLE	kr	α
1	A	IEC Inv	Resetting after fix time delay, according to preset parameter “Reset delay”	
2	B	IEC VeryInv		
3	C	IEC ExtInv		
4		IEC LongInv		
5		ANSI Inv	0,46	2
6	D	ANSI ModInv	4,85	2
7	E	ANSI VeryInv	21,6	2
8	F	ANSI ExtInv	29,1	2
9		ANSI LongInv	4,6	2
10		ANSI LongVeryInv	13,46	2
11		ANSI LongExtInv	30	2

Structure of the overcurrent protection algorithm

Fig.1-4 shows the structure of the overcurrent protection (OC) algorithm.

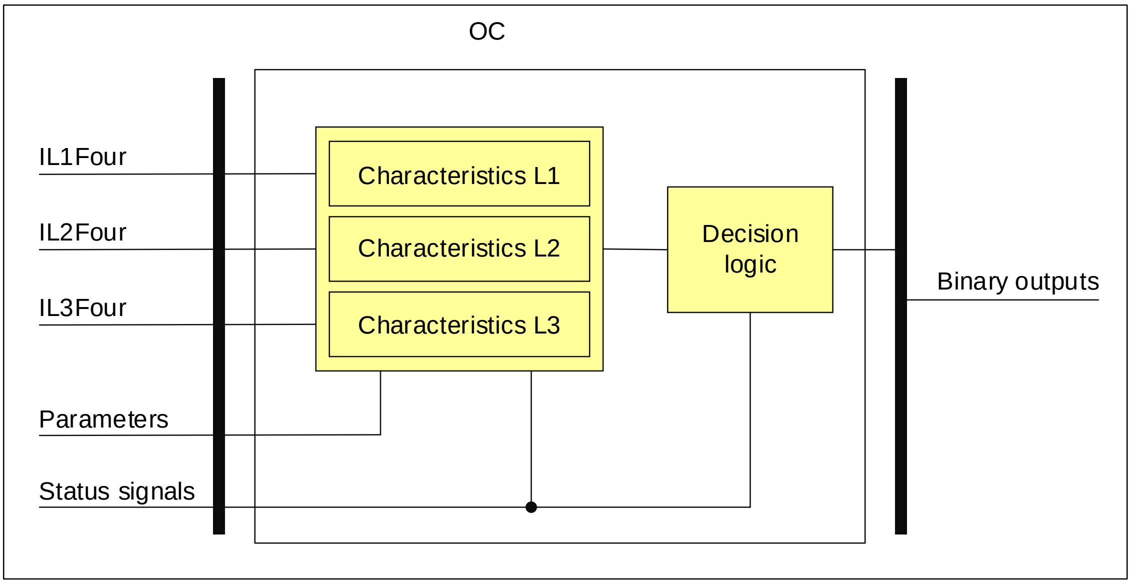


Figure 1-4 Structure of the overcurrent protection algorithm

The **inputs** are

- the RMS value of the fundamental Fourier component of three phase currents,
- parameters,
- status signals.

The **outputs** are

- the binary output status signals.

The **software modules** of the overcurrent protection function:

Characteristics

This module calculates the required time delay based on the Fourier components of the phase currents.

Decision logic

The decision logic module combines the status signals to generate the trip command of the function.

The following description explains the details of the individual components.

The definite time and the inverse type characteristics

This module calculates the required time delay based on the Fourier components of the phase currents. The formulas applied are described in Chapter 1.2.4.1.

The **inputs** are the RMS value of the fundamental Fourier component of the phase currents (IL1Four, IL2Four, IL3Four) and parameters.

The **outputs** are the status signals of the three phases individually. These indicate the started state and the generated trip command if the time delay determined by the characteristics expired.

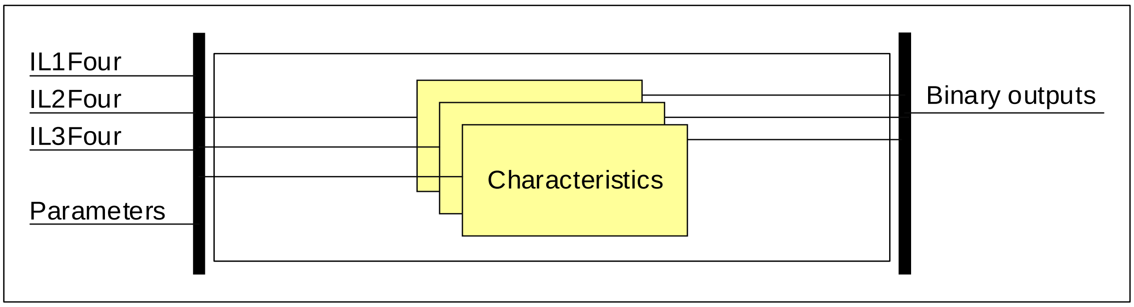


Figure 1-5 Schema of the characteristic calculation

The inverse type characteristics are also presented graphically on the following pages. These diagrams assume 100% setting value for the Start current parameter (GS), 1 for the Time multiplier (TMS) and 0 for the Min. time delay.

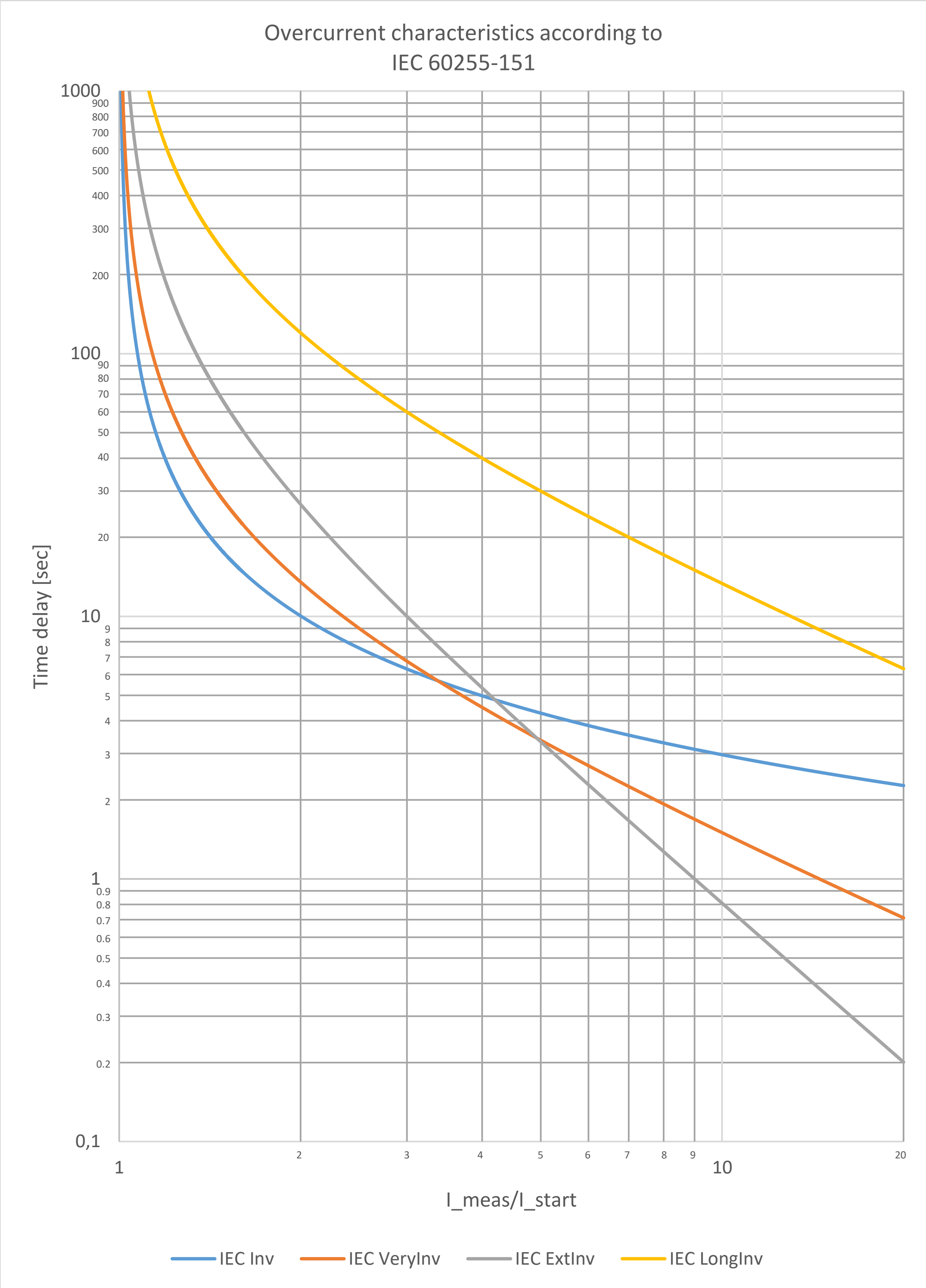


Figure 1-6 Overcurrent characteristics according to IEC 60255-151

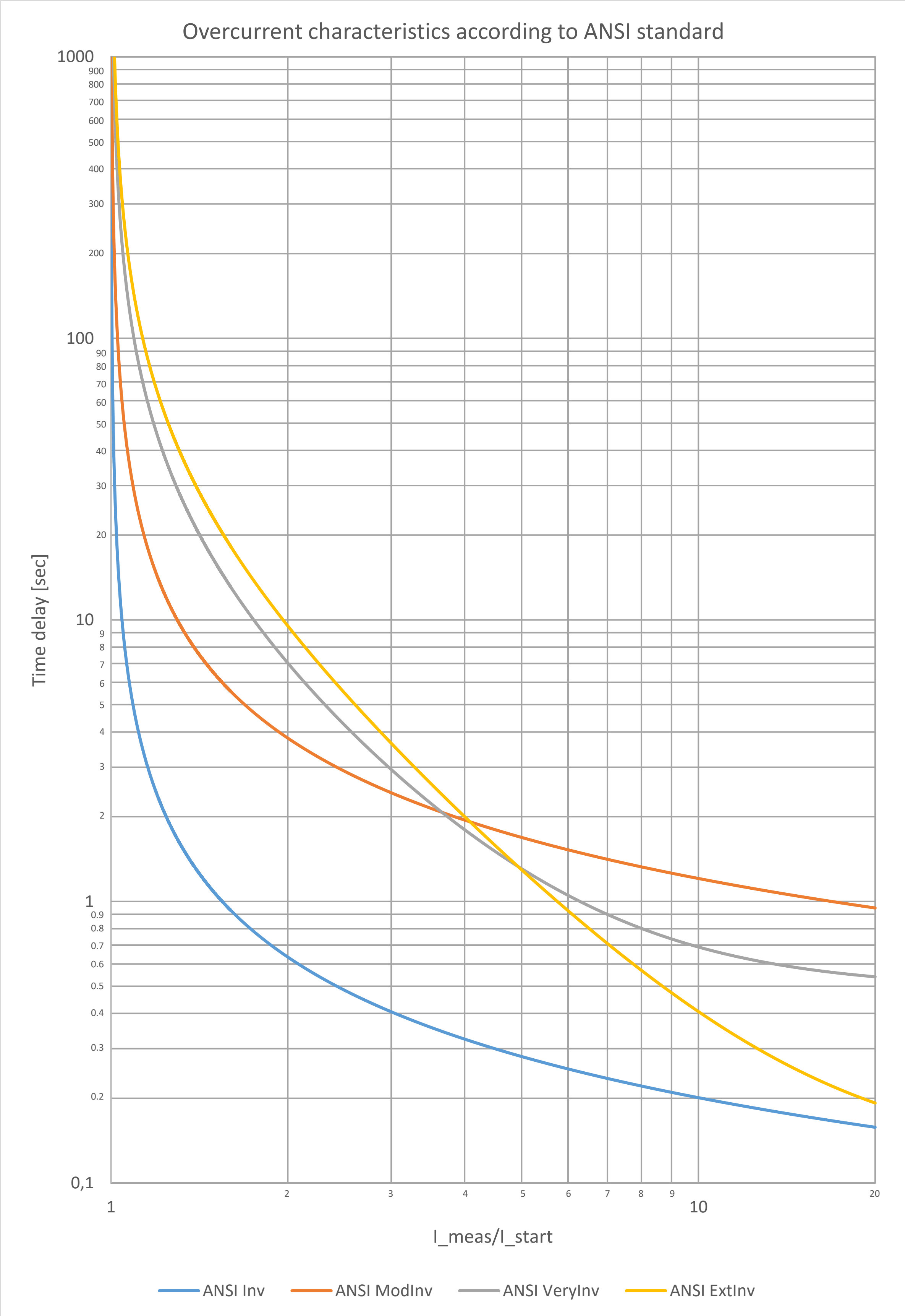


Figure 1-7 Overcurrent characteristics according to ANSI standard

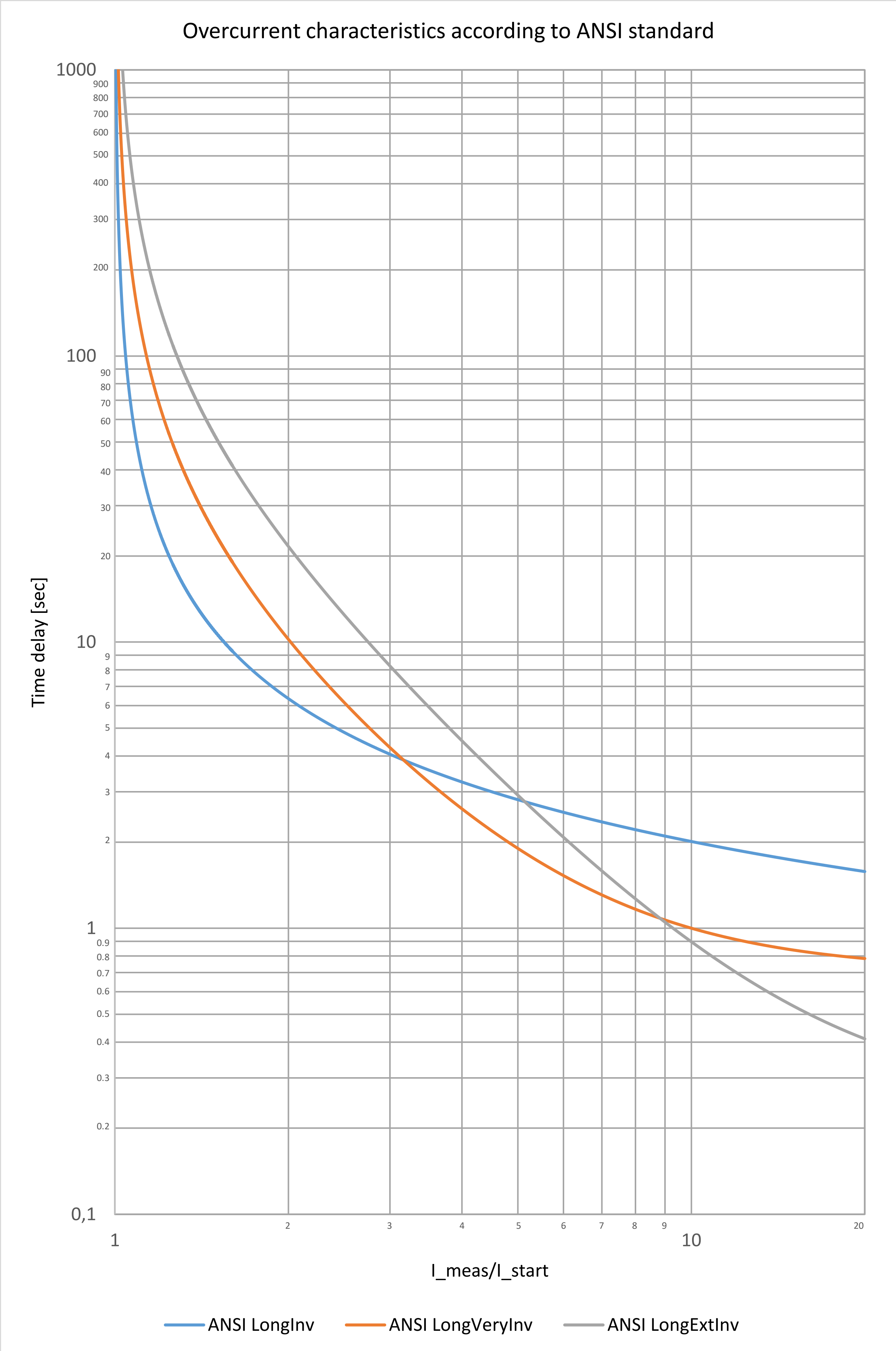


Figure 1-8 Overcurrent characteristics according to ANSI standard

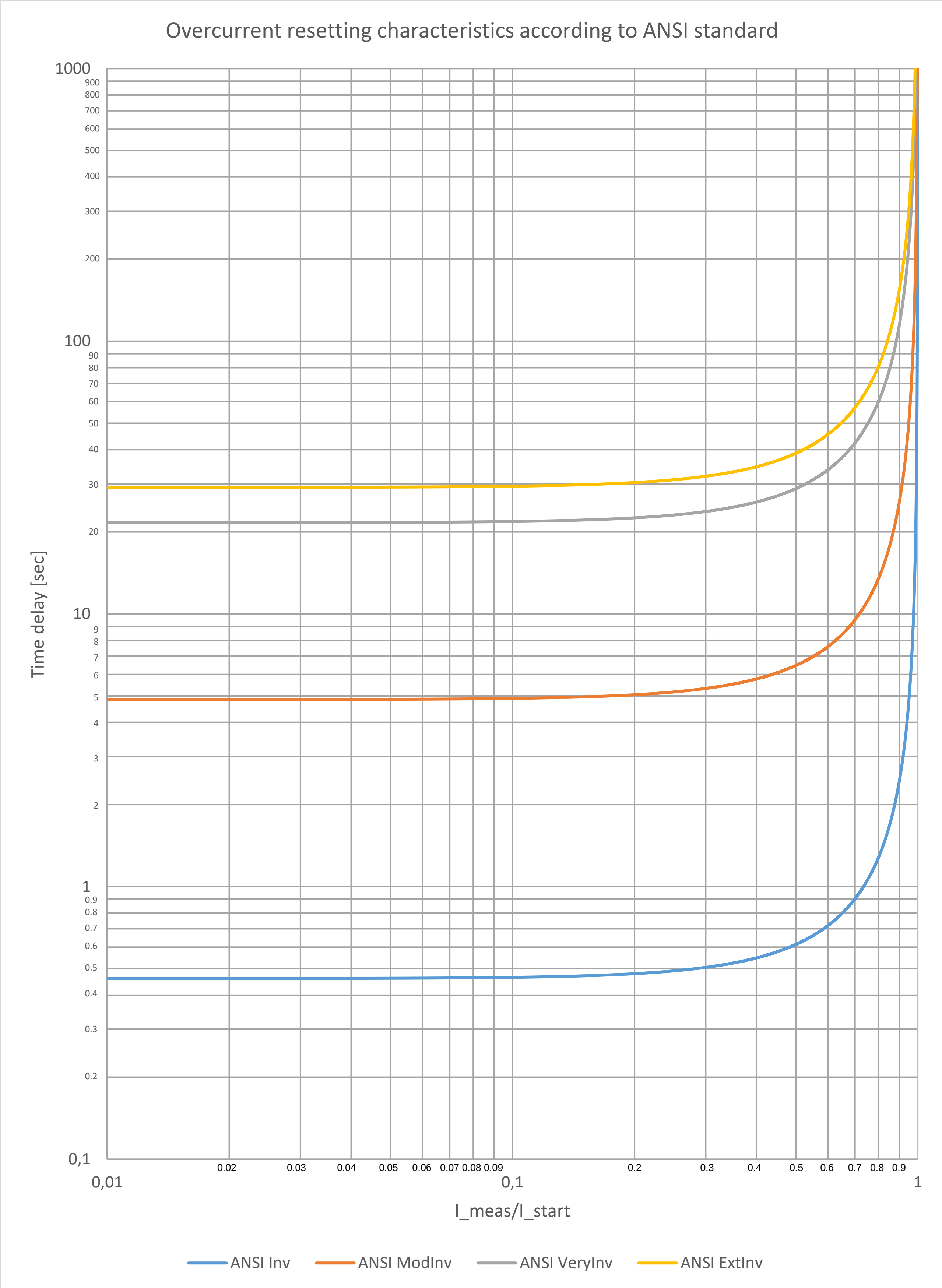


Figure 1-9 Overcurrent resetting characteristics according to ANSI standard

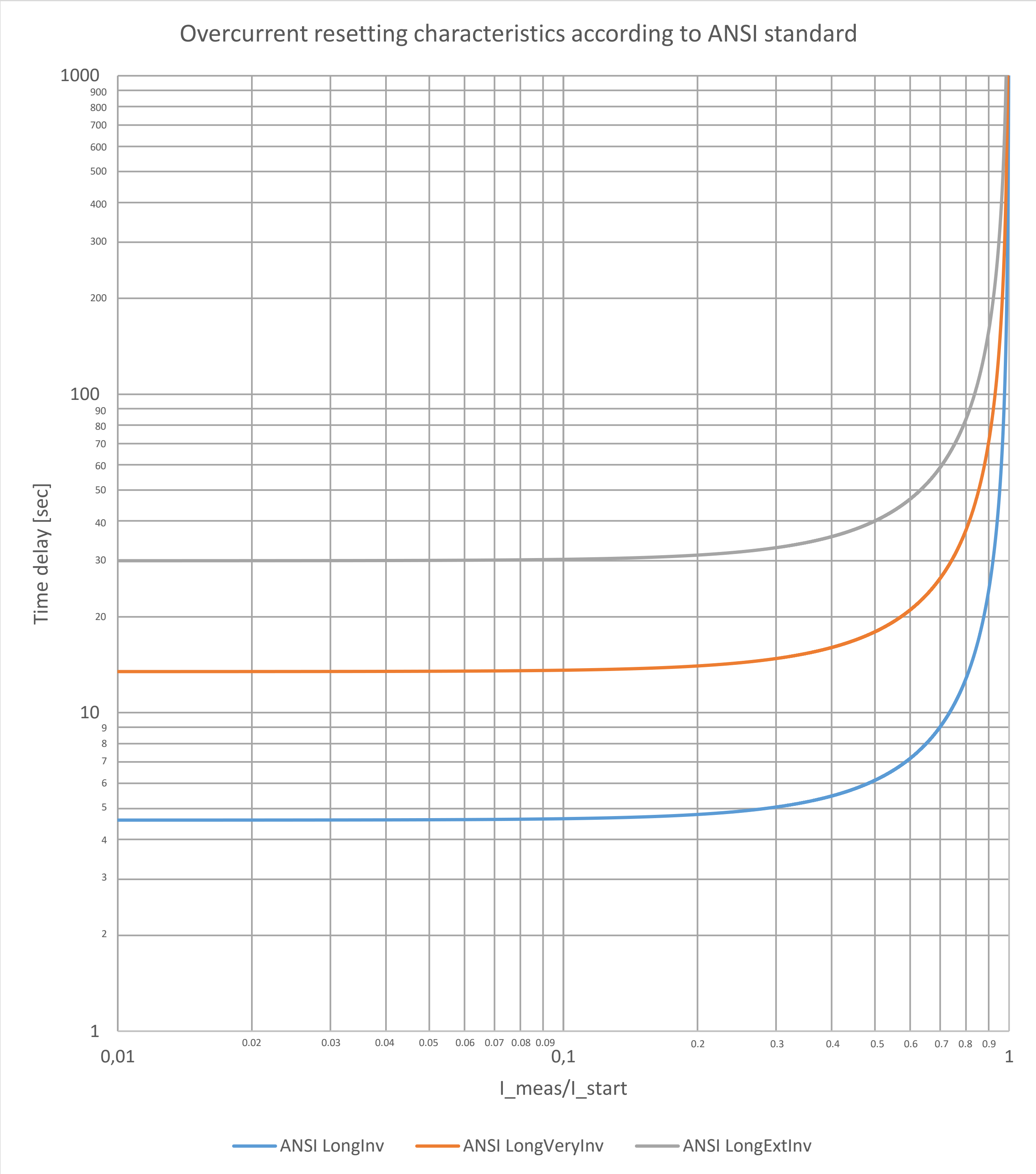


Figure 1-10 Overcurrent resetting characteristics according to ANSI standard

1.3 The previous (2.8 FW version) variant

In devices that have the firmware version **2.8.**13.2080 or lower, the algorithm works slightly differently:

- The DirElement function's calculations are integrated
- The type of the current input (true RMS or Fundamental value) can be selected by parameter. This is done by additional software modules in the algorithm, see the figure below.

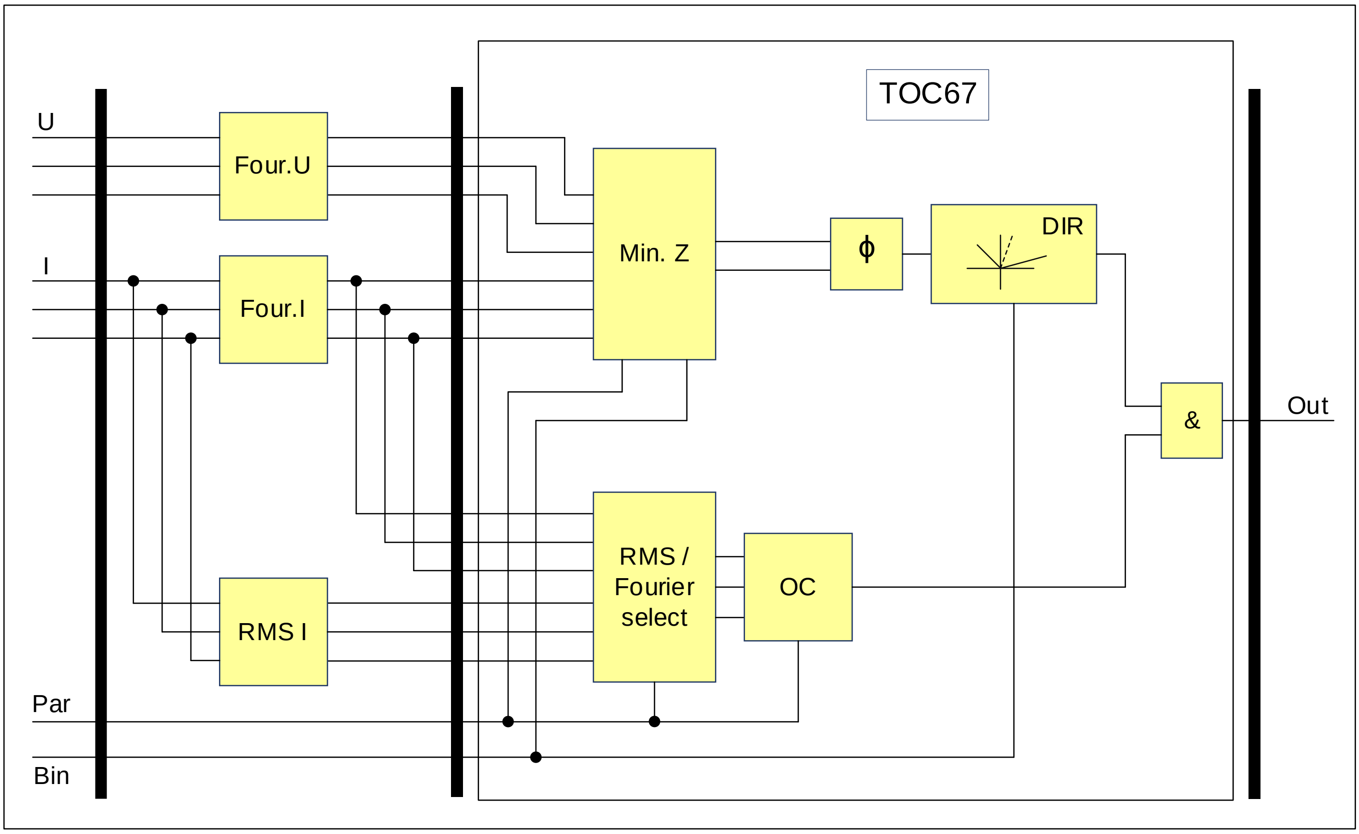


Figure 1-11 Structure of the three-phase directional overcurrent protection algorithm on 2.8 system

There is one additional **input**:

- the RMS value of the three phase currents (IL1, IL2, IL3). NOTE: The RMS calculation is not part of the directional overcurrent function, it is performed by an external function block.

The function can be enabled or disabled by a parameter. The status signal of the VTS (voltage transformer supervision) function can also disable the directional operation.

There are no additional **outputs**. In that regard, the two versions are the same.

There is one additional **software module**:

RMS/Fourier select

This module selects RMS or Fourier values as inputs for overcurrent module.

1.3.1 RMS or Fourier selection (RMS/Fourier select)

This module selects RMS or Fourier values as inputs for overcurrent module.

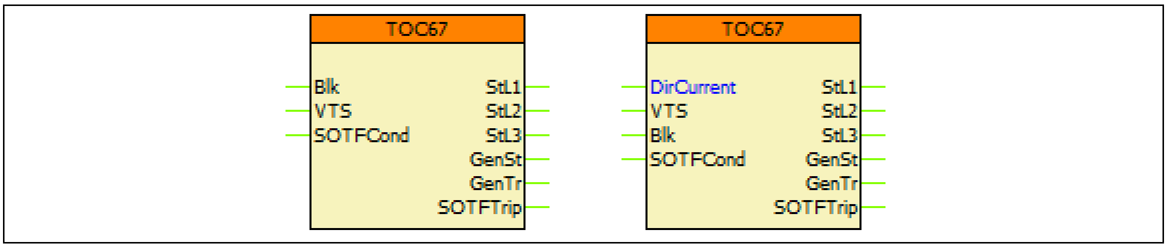
Table 1-7 The enumerated parameter of the input type selection

PARAMETER NAME	TITLE	SELECTION RANGE	DEFAULT
RMS or Fourier selection			
TOC67_InputType_EPar_	Input Type	Fundamental, RMS	Fundamental

NOTE: the RMS/Fourier selection can be made in the new (2.10) version as well, but that requires modification of the configuration (.epcs) file itself. In this regard, please contact Protecta Support.

2 3ph Dir Overcurrent function overview

The function block of the three-phase directional overcurrent protection function is shown in Figure 2-1. This block shows all binary input and output status signals that are applicable in the graphic equation editor. The legacy 2.8 version is on the left, while the new one is on the right.



2-1. Figure The function block of the directional three-phase overcurrent function

2.1 Settings

2.1.1 Parameters

The available parameters are listed below in order of their appearance in the *parameters* menu.
If the setting range of a parameter should be extended, contact Protecta Support.

Table 2-1 The available parameters of the directional three-phase overcurrent function

TITLE	DIM.	RANGE	STEP	DEFAULT	EXPLANATION
Operation	-	Off, Definite Time, IEC Inv, IEC VeryInv, IEC ExtInv, IEC LongInv, ANSI Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv	-	Off	Enabling the function by choosing the characteristics.
Direction	-	Non-directional, Forward, Backward	-	Non-directional	*Non-directional* makes the function operate as a basic TOC51 function.
Non-Directional – VT Fail	-	FALSE, TRUE	-	FALSE	When checked, the VT failure signal does not block the function but switches it to non-directional mode instead.
Operating Angle	deg	10 – 85	1	60	Relay Operating Angle. The angle at which the characteristic is extended in both directions from the Characteristic angle (e.g. a setting of 60 degrees will result in 120 degrees wide characteristics).
Characteristic Angle	deg	-90 – 90	1	60	The angle from which the Operating angle parameter defines the characteristics.
Start Current	%	10 – 3000	1	50	Starting current of the function
Time Multiplier	-	0.05 – 15.00	0.01	1.00	Time multiplier of the inverse characteristics
Min Time Delay	msec	30 – 60000	1	100	Minimal time delay for the inverse characteristics
Definite Time Delay	msec	30 – 60000	1	100	Time delay in case of definite time characteristic is selected
Reset Time	msec	60 – 60000	1	100	Reset time delay for the IEC inverse characteristics

2.2 Function I/O

This section describes briefly the analogue and digital inputs and outputs of the function block.

2.2.1 Analogue inputs

The function uses the Fourier values of the three-phase currents and of the calculated impedance loops. This is defined in the configuration.

Graphic Analogue inputs *(only from firmware version 2.10.2.3010 and up)*

The sources of the analogue inputs are defined by the user, applying the graphic equation editor (*Logic Editor*). Parts written in **bold** are seen on the left side of the function block in the Logic editor.

The function uses the following analogue signals as inputs:

Table 2-2 Analogue input signal of the directional three-phase overcurrent function

ANALOGUE INPUT SIGNAL	SIGNAL TITLE	EXPLANATION
TOC67FL_**DirCurrent**_AnIn_	3phase directional current	Directional current signal created by the DirElement function

The applied analogue connectors must be identical to the analogue input type (i.e. voltage to voltage input etc.), Invalid connections are not allowed.

2.2.2 Analogue outputs (measurements)

The function block has no analogue output signals.

2.2.3 Binary input signals (graphed output statuses)

The conditions of the inputs are defined by the user, applying the graphic equation editor (logic editor). The part written in **bold** is seen on the function block in the logic editor.

Table 2-3 The binary input signals of the directional three-phase overcurrent function

BINARY INPUT SIGNALS	EXPLANATION
TOC67_**VTS**_GrO_	Usually connected to the voltage transformer supervision function or other VT failure signal, this input either blocks the function or makes it operate without directional decision, depending on the *Non-Directional - VT Fail* parameter
TOC67_**Blk**_GrO_	Output status of a graphic equation to disable the function
TOC67_**SOTFCond**_GrO_	In case of switching on fault, this status makes the function to operate without directional decision and delay with high speed.

2.2.4 Binary output signals (graphed input statuses)

The binary output status signals of the directional three-phase overcurrent protection function, parts written in **bold** are seen on the function block in the logic editor.

Table 2-4 The binary output signals of the directional three-phase overcurrent function

BINARY OUTPUT SIGNALS	SIGNAL TITLE	EXPLANATION
TOC67_**StL1**_GrI_	Start L1	Starting of the function in phase L1
TOC67_**StL2**_GrI_	Start L2	Starting of the function in phase L2
TOC67_**StL3**_GrI_	Start L3	Starting of the function in phase L3
TOC67_**GenSt**_GrI_	General Start	General start of the function
TOC67_**GenTr**_GrI_	General Trip	General trip command of the function
TOC67_**SOTFTrip**_GrI_	SOTF Trip	Trip during active SOTF condition

2.2.5 On-line data

Visible values on the on-line data page:

Table 2-5 On-line data of the directional three-phase overcurrent protection function

SIGNAL TITLE	DIMENSION	EXPLANATION
Direction	-	Direction of the measured current (unknown, forward, backward) when the function starts
Start L1	-	Starting of the function in phase L1
Start L2	-	Starting of the function in phase L2
Start L3	-	Starting of the function in phase L3
General Start	-	General start of the function
General Trip	-	General trip command of the function
SOTF Trip	-	Trip during active SOTF condition
Directional current input assignment	-	*Status of the graphical analogue input (if exists) (Complete if OK, Missing if not connected)*

2.2.6 Events

The following events are generated in the event list, as well as sent to SCADA according to the configuration.

Table 2-6 Events of the three-phase overcurrent protection function

EVENT	VALUE	EXPLANATION	IEC61850 DATA ATTRIBUTES
Start	off, on	General start of the directional three-phase overcurrent protection function	F3PTOC2STStr
Start L1	off, on	Start of the directional three-phase overcurrent protection function in measuring element L1	F3PTOC2STStr$phsA
Start L2	off, on	Start of the directional three-phase overcurrent protection function in measuring element L2	F3PTOC2STStr$phsB
Start L3	off, on	Start of the directional three-phase overcurrent protection function in measuring element L3	F3PTOC2STStr$phsC
Trip	off, on	General trip command of the directional three-phase overcurrent protection function	F3PTOC2STOp
Direction		Direction of the measured current (unknown, forward, backward) when the function starts	F3PTOC2STStr$dirGeneral

2.3 Technical data

Table 2-7 Technical data of the function

FUNCTION	VALUE	ACCURACY
Operating accuracy		<2 %
Operate time accuracy	If Time multiplier is >0.1	±5 % or ±35 ms, whichever is greater
Accuracy in minimum time range		±35 ms
Reset ratio	0,95	
Reset time Dependent time char. Definite time char.	Approx. 50 ms	<2% or ±35ms, whichever is greater
Transient overreach	2 %	
Pickup time with non-directional setting Pickup time with directional setting	25-30 ms <100 ms	
Memory storage time span 50 Hz 60 Hz	80 ms 70 ms	±15 ms ±15 ms
Angular accuracy I ≤ 0.1 In 0.1 In < I ≤ 0.4 In 0.4 In < I		< ±10° < ±5° < ±2°
Angular reset	10°	

2.3.1 Notes for testing

There is an XRIO setting file available for the function (downloadable from the Protecta website). With that, only the parameters of the corresponding VT and CT modules and the 3ph Dir Overcurrent function should be entered along with the test current, when the characteristics are to be tested. By using this file, testing the operation characteristic will not need any further setting.

Normally in the EuroProt+ devices, the trip contacts are assigned to the Trip Logic function block, and not to the protection function blocks. Because of this, the testing personnel must make sure that the Trip Logic is switched on ('Operation' parameter is set to other than 'Off') before starting the testing, otherwise there will be no physical trip on the relay.

Note that the time delay parameter incorporates the algorithm time as well, so the time delay *does **not** mean the time difference between the appearance of the start and trip signals* of the function. In other words: it is not the delay between the detection of the fault and the trip that follows it. This should be taken into consideration when checking the disturbance records.

Instead, the time delay parameter defines the elapsed time from the appearance of the faulty state to the trip. Because of this, while testing, the delay measurement should start *from the moment of the fault injection* until the trip signal.

The reset time of the IDMT characteristics can be tested only indirectly by injecting the same fault currents again after a successful trip: if the time elapsed between the two injections is less than the reset time, the second injection will result in a quicker operation than the first.

The *angle reference of the setting is the current*, not the voltage, see Figure 1-2.

The 10° angular reset also means that if the prefault currents' angle is already in the characteristic, then the generated fault currents will still be considered as inside faults if their angle is less than 10° away from the borders.

Directionality (polarization) is based on the following measurements (numbers based on priority):

1. Voltage of the faulty phase (if present)
2. If the voltage is missing (e.g. 1ph fault), then the angle between the positive sequence current and positive sequence voltage is considered (only the angles, not the magnitudes)
3. If all voltages drop to 0, then the memory is used

Additional notes for Graphic Analogue inputs *(from firmware version 2.10.2.3010 and up):*

Starting from the firmware version **2.10.2.3010**, the majority of the function blocks can be updated to be equipped with graphic analogue inputs which **allow the user to assign the functions' analogue inputs by applying the graphic equation editor**.

The analogue connections of these functions can be checked by examining the source that is connected to their inputs (just like examining the source of a logic signal).

These functions must be placed in the Logic Editor and their graphic analogue inputs must be connected to make them operate. If a connection is intact, the online status of the corresponding analogue input will show "Complete". If it is missing, the status will be "Missing" and the function will not operate.

Note that these graphical inputs do not exist in the earlier firmware/function versions! Checking and modifying the analogue assignments in these cases are done by using the EuroCAP Software Configuration menu.