Electrical measurement and control

M.7

Measurement Transformers and Shunts

M.7 - Measurement Transformers and Shunts

serie MC

Single-phase Efficient current transformers M7-7

serie MC-3

Three-phase Efficient current transformers M7-8

TC series

Narrow-profile current transformer. M7-9

TCH

Top-performance current transformer M7-12

TA

Large-scale current transformer M7-14

TP

Split-core current transformer M7-16

TA 210

High-accuracy wound primary current transformer M7-18

TM 45

Wound primary current transformer. M7-19

TW 25

Entrance bar current transformer. M7-20

TC 020 / TC 420

Narrow-profile current transformer with a built-in converter, with an output of 0...20 mA / 4...20 mA. M7-21

TP 420

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Measurement Transformers and Shunts

M.7

The concern to measure the installation's consumption or any electrical parameter during the energy management procedures has arisen with the need to transform high currents into small currents that can be measured by electronic units.

CIRCUTOR offers a solution with a vast range of transformers with different features that can cater for the main market needs.

Definition

CIRCUTOR's current transformers have the following features:

- 1. Insulation and separation of circuits and measurement devices from the voltage lines.

- 2. Prevention of alterations generated by the transmission of high currents.

- 3. Reduction of short-circuit currents to admissible values in measurement devices.

- 4. Obtaining currents that are proportional to those measured, so that they can be transmitted to the appropriate devices.

Selecting a transformer

1. Know the features of the work environment or operating conditions (indoor, outdoor, maximum operating temperature, etc.)

- 2. Know the features of the line where it will be installed:Cable or busbar dimensions

  - Measurement margin of the current being measured (maximum and minimum current)Overload (range and time).
  - Network voltage (low, medium or high voltage)
  - Short-circuit current

- Grid frequency3. Know the features of the associated instrument (accuracy, nominal current, consumption, etc.)

- 4. Know the distance between the transformer and instrument, as well as the section of the cable used for the connection.

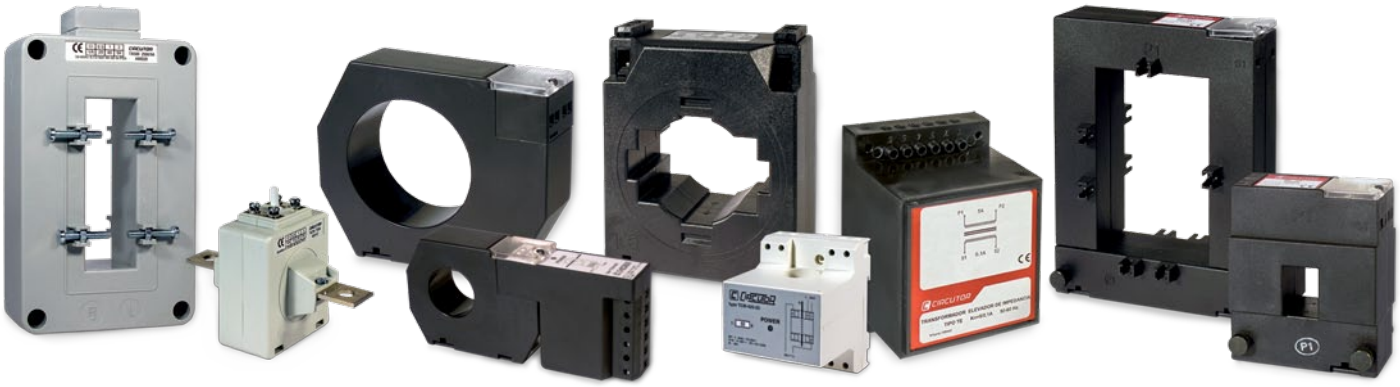
Transformer power

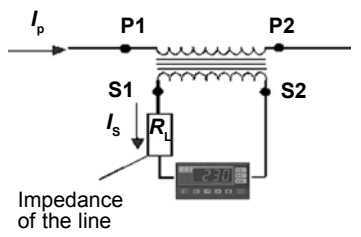
Power is a very important parameter that must be taken into account. In a transformer, the primary current must induce the necessary power in the secondary current in order to transmit it to the measurement unit. Induced power must be equal to or more than the line losses plus the power consumed by the measurement equipment, in order to ensure that it can operate correctly.

Line losses (P_L) are expressed as the power losses caused by heating during the transmission of current through the circuit cabling resistance (R_L) of the secondary transformer, i.e., the resistance of the cable between the transformer and the unit.

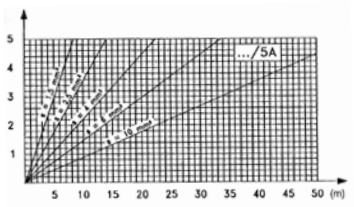
$$P_L = R_L \cdot I^2$$

Where: R_L is inversely proportional to the diameter's square and is proportional to the cabling length (one way+return).





Connection diagram



Length of the secondary line

Graph with the secondary line losses

Example: Power losses between a transformer and measurement equipment (line distance = 10 m).

- In a secondary transformer 5 A (.../5):
  - Cable length
    $L_{cable} = 2 \cdot l = 2 \cdot 10 = 20$ m (one way + return)
  - Cable section
    $s_{cable} = 1\ mm^2$
  - Resistance of the line
    $R_{line} = \rho \cdot L/s = 0.0172 \cdot 20/1 = 0.35\ \Omega$
    $\rho = 0.0172\ \Omega \cdot mm^2/m$
  - Line losses
    $P_{line} = R_{line} \cdot I^2 = 0.35 \cdot 5^2 =$ **8.62 V·A**
- In a secondary transformer 1 A (.../1):
  $P_{line} = 0.35 \cdot 1^2 =$ **0.35 V·A** (25 times greater)

Standard consumption of CIRCUTOR's equipment

Units	Standard consumption
Moving iron instruments	0.3...15 V·A
Moving coil instruments	0.5 V·A
Analogue watt-meters	0.2...2.5 V·A
Maximum demand indicators	2.5...5.0 V·A
Digital instruments	0.5...1.0 V·A
Energy meters	1.0...1.5 V·A
Recording instruments	2.0...5.0 V·A

Transformer accuracy

CIRCUTOR's transformers have been designed and manufactured in compliance with the IEC 44-1 Standard, which establishes the range between 25 and 100% of the nominal power, where the accuracy.

					Offset ± for % I_n							
	± % Error for % I_n				Minutes				Centiradians			
Type	5	20	100	120	5	20	100	120	5	20	100	120
0,1	0,40	0,20	0,10	0,10	15	8	5	5	0,45	0,24	0,15	0,15
0,2	0,75	0,35	0,20	0,20	30	15	10	10	0,90	0,45	0,30	0,30
0,5	1,50	0,75	0,50	0,50	90	45	30	30	2,70	1,35	0,90	0,90
1,0	3,00	1,50	1,00	1,00	180	90	60	60	5,40	2,70	1,80	1,80

						Offset ± for % I_n									
	± % Error for % I_n					Minutes					Centiradians				
Type	1	5	20	100	120	1	5	20	100	120	1	5	20	100	120
0.2 S	0,75	0,35	0,20	0,20	0,20	30	15	10	10	10	0,90	0,45	0,30	0,30	0,30
0.5 S	1,50	0,75	0,50	0,50	0,50	90	45	30	30	30	2,70	1,35	0,90	0,90	0,90

Accuracy class	± % Error for % I_n	
	50% I_n	120% I_n
3	3	3
5	5	5
No phase error		

Transformer saturation

A transformer will become saturated when its primary current or load are above the nominal values.

The linearity of the current transformation between the primary and secondary decreases, so that the error can be quite high. The saturation of the transformer is inversely proportional to the load. (See *Fig.1*)

In the case of current transformers, they are saturated by overloads in order to make sure that the equipment is not damaged from the secondary. The F_s parameter (Safety Factor) shows the number of primary current transmissions the transformer is capable of transferring to the measurement equipment before it is saturated.

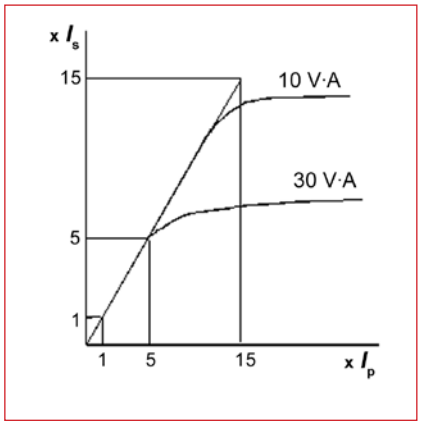


Fig.1, Graph I_p / I_s

Applications

Converting a high nominal current to a lower current so that it can be measured by the unit.

Here are some examples of applications that use **CIRCUTOR's** transformers:

- Applications with **TC** + **CVMk2** transformers:

The busbar or cable can be disconnected to insert the transformer.

- Applications with **TP** + **CVM Mini** transformers:

The busbar or cable can not be disconnected to insert the transformer.

- Applications with **shunts** + **MK-DC**:

To measure electrical parameters in a DC installation.

SELECTING A MEASUREMENT TRANSFORMER

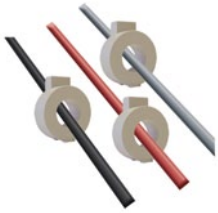
Product selection table

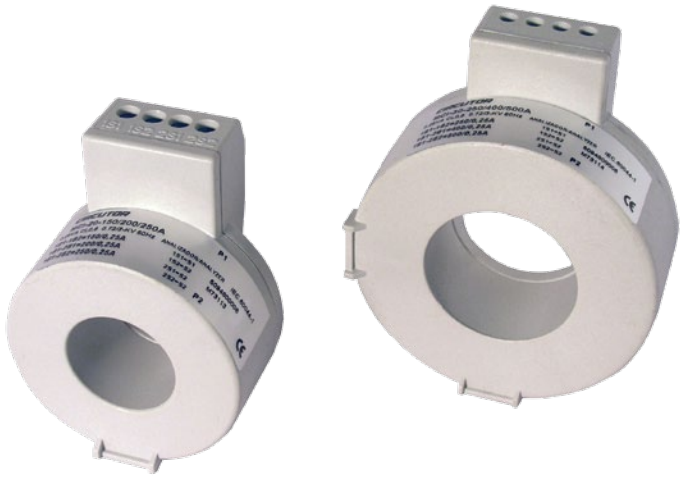
		Measurement	Wound primary	Bar entrance	Split core	With converter	Page
MC1		150 ... 1500 Aac		•			7
MC3		63 ... 250Aac		•			8
TC		40 ... 4000 Aac		•			9
TCH		100 ... 4000 Aac		•			12
TA		750 ... 5000 Aac		•			14
TP		100 ... 5000 Aac			•		17
TA 210		5 ... 400 Aac	•				18
TM 45		5 ... 50 Aac	•				19
TW 25		100 ... 300 Aac		•			21
TC 020		50 ... 1500 Aac		•		0...20 mA	21
TC 420		5 ... 1500 Aac		•		4...20 mA	21
TP 420		5 ... 4000 Aac			•	4...20 mA	23
TI 420		2.5 ... 1500 Aac		•		4...20 mA	26
TCB 420		2.5 ... 1500 Aac		•		4...20 mA	26
TCM 420		2.5 ... 300 Aac		•		4...20 mA	27
SHUNTS		1 ... 15000 Adc					28

Current transformers

serie MC-1

Single-phase Efficient current transformers





Description

- Transformer range from 150 to 1,500 A
- Secondary 250 mA
- Three ranges in the same transformer.
- Compatible with the MC product range from **CIRCUTOR**.

Aplication

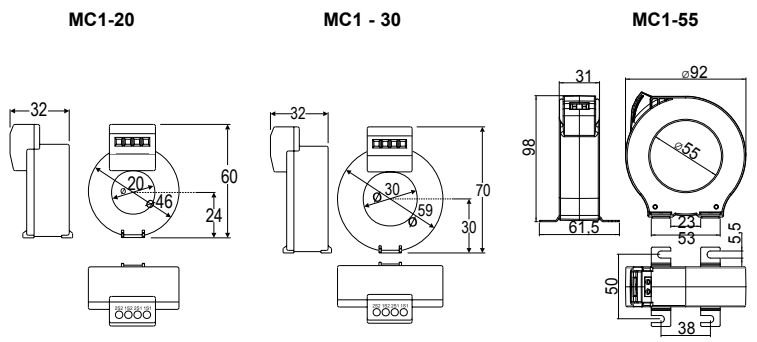
In installations that allow the power supply to be stopped to install transformers.

Very useful to install in places where the exact nominal current range is not known. Each transformer has 3 ratio ranges by changing a connection cable and the chosen ratio in the measuring device.

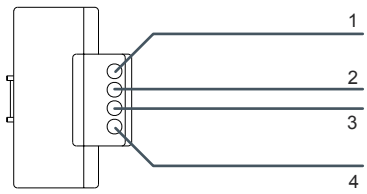
Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV_{ac}
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2,5 I_{th}
Highest current in the material	0,72 kV_{ac}
Thermal class	B (130 ºC)
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_S 5
Secondary sealable terminals	yes
Secondary terminals	IP 20
Fixing on DIN rail	**MC1-20 and MC1-30**
Standard	
IEC 60044-1	

Dimensions



Connection



	MC1-20	MC1-30	MC1-55
1	COM	COM	COM
2	150	250	500
3	200	400	1000
4	250	500	1500

References

MC1 single-phase Efficient Transformers

A máx.	Ranges	Class 0,5 Power	Measurement	Internal diameter	Type	Code
250	150/200/250	0,25 VA	1 phase	20 mm	**MC1-20-150/200/250**	**M73113**
500	250/400/500	0,25 VA	1 phase	30 mm	**MC1-30-250/400/500**	**M73114**
1500	500/1000/1500	0,25 VA	1 phase	55 mm	**MC1-55**-500/1000/1500	**M73115**

Current transformers

serie MC-3

Three-phase Efficient current transformers

Description

Current transformers specially designed to be installed above a switch

- Transformer range from 63 to 250 A
- Secondary 250 mA
- Compatible with the **MC** product range from **CIRCUTOR**.

Application

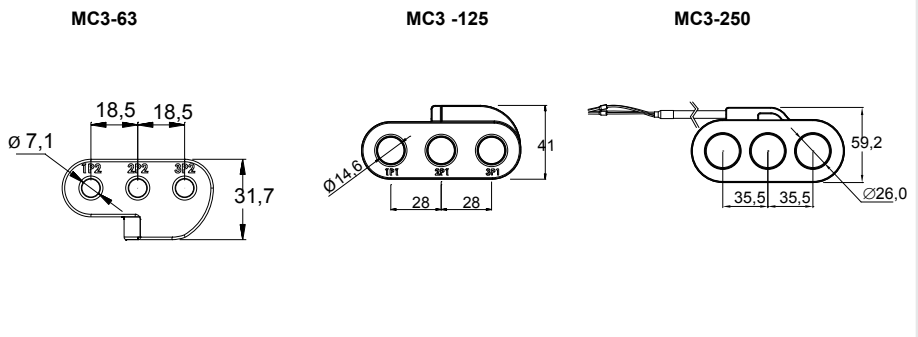
Installation in confined spaces, utilizing the space above the circuit breakers and earth leakage protection

In installations that allow the power supply to be shut down for the installation of transformers.

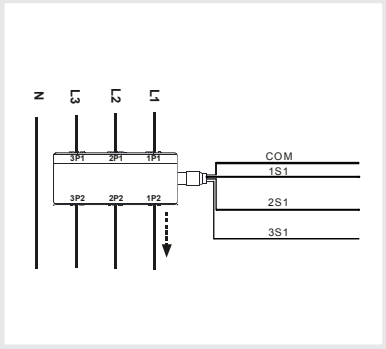
Features

Frequs	50 / 60 Hz
Isolation voltage	3 kVac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2,5 I_{th}
Highest current in the material	0,72 kVac
Clase	0,5
Thermal class	B (130 ºC)
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_S 5
Secondary sealable terminals	yes
Secondary terminals	IP 20
Standard	
IEC 60044-1	

Dimensions



Connections



References

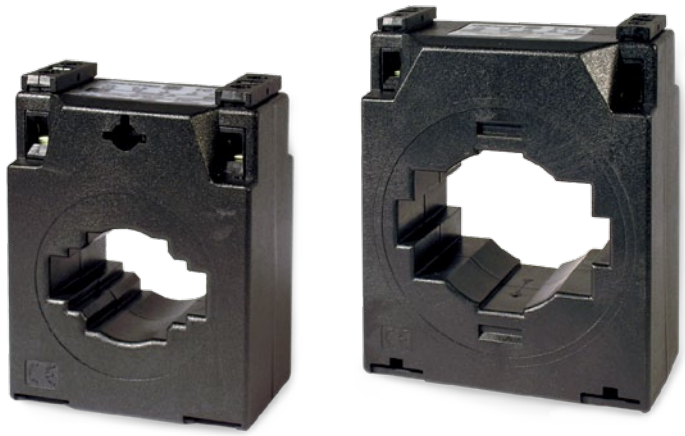
MC3 three-phase Efficient Transformers,

A max.	Class 0,5 Power	Measurement	Internal diameter	Type	Code
63	0,1 VA	3 phases	7,1 mm	**MC3-63**	**M73121**
125	0,1 VA	3 phases	14,6 mm	**MC3-125**	**M73122**
250	0,1 VA	3 phases	26 mm	**MC3-250**	**M73123**

Current transformers

TC series

Narrow-profile current transformer



Description

- Type: bar entrance
- Types: from 40 to 4000 A
- Internal diameter: from 20.3 to 63 mm, depending on the type
- Busbar dimensions: from 25 x 5 mm to 30 x 100 mm
- Transformer certificate sheet is attached
- DIN rail fixing accessory (Types **TC5** and **TC6**)
- Secondary coding types .../5 A (on demand .../1 A. TC12 not availabla)

Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

In installations where the electrical supply can be interrupted to install transformers.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	B (130 ºC)
Working temperature	-5 ... 40 ºC
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_S 5
Secondary sealable terminals	Yes
Secondary terminals	IP 20
Fixing on DIN rail	**TC5** and **TC6**
Standards	
IEC 44-1, BS2627	

Current transformers

TC series

Narrow-profile current transformer

References

Type	TC 4				TC 5				TC 5,2				TC 6,2				TC 6			
Busbar (mm)	30 x 10 20 x 10 25 x 5				25 x 5				20 x 12 25 x 10 30 x 10				30 x 10				40 x 10			
A \ V·A	Class			Code	Class			Code	Class			Code	Class			Code	Class			Code
	0,5	1	3		0,5	1	3		0,5	1	3		0,5	1	3		0,5	1	3	
40/5					-	-	1,5	**M70311**												
50/5	-	-	1	**M703D5**	-	-	3	**M70312**												
60/5	-	-	1,25	**M703D6**	-	1,25	3,5	**M70313**												
75/5	-	-	1,25	**M703D7**	-	2	3,5	**M70314**												
100/5	-	2	3	**M703D8**	1,5	2,5	3,75	**M70315**	-	1	1,5	**M70321**	1,75	3,75	7,5	**M70341**				
125/5	-	2,5	2,75	**M703D9**	1,75	3,5	5	**M70316**	-	1,5	2	**M70322**	3,75	7,5	10	**M70342**				
150/5	1,5	2,5	4	**M703DA**	2,5	3,5	5	**M70317**	1	2	2,5	**M70323**	5	7,5	10	**M70343**	1	5	7,5	**M70331**
200/5	2,5	5	6	**M703DB**	3,75	5	5	**M70318**	2,5	3	3,5	**M70324**	7,5	10	10	**M70344**	3,5	5	7,5	**M70332**
250/5					5	7,5	7,5	**M70319**	3,5	3,75	5	**M70325**	7,5	10	15	**M70345**	5	7,5	10	**M70333**
300/5									3,5	3,75	5	**M70326**	10	10	15	**M70346**	5	7,5	10	**M70334**
400/5									3,5	5	7,5	**M70327**	10	10	15	**M70347**	5	7,5	10	**M70335**
500/5									5	7,5	10	**M70328**	15	15	20	**M70348**	7,5	10	15	**M70336**
600/5									5	7,5	10	**M70329**	15	20	25	**M70349**	7,5	10	15	**M70337**
750/5																	10	15	20	**M70338**
800/5																	10	15	20	**M70339**

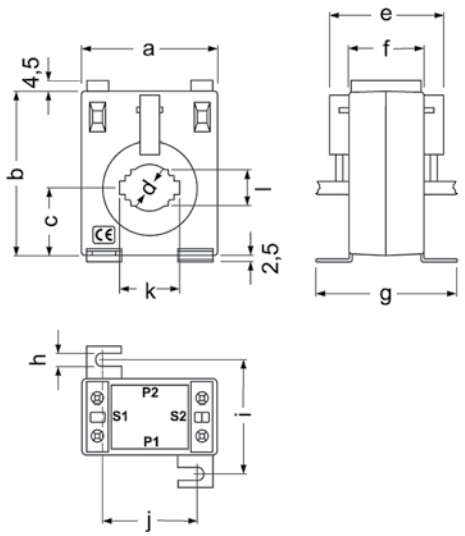
Type	TC 8				TC 8.3				TC 10				TC 12			
Busbar (mm)	60 x 12				40 x 10				50 x 50 60 x 30 80 x 30				3 x 100 x 10			
A \ V·A	Class			Code	Class			Code	Class			Code	Class			Code
	0,5	1	3		0,5	1	3		0,5	1	3		0,5	1	3	
100/5					5	5	5	**M703BA**								
150/5					5	7,5	10	**M703BC**								
200/5	1	2,5	5	**M7036C**	15	20	25	**M703B2**	1	2,5	5	**M7037F**				
250/5					10	15	20	**M703B1**								
300/5	2,5	5	7,5	**M7036B**	15	20	25	**M703B3**	2,5	5	7,5	**M7037D**				
400/5	5	7,5	10	**M70361**	15	20	25	**M703B4**								
500/5	7,5	10	15	**M70362**	15	20	25	**M703B5**	5	7,5	10	**M7037B**				
600/5	10	15	20	**M70363**	15	20	25	**M703B6**	7,5	10	15	**M7037C**				
750/5	15	20	25	**M70364**	20	25	30	**M703B7**								
800/5	15	20	30	**M70365**	25	30	35	**M703B8**	7,5	10	15	**M70372**	10	15	20	**M7038B**
1 000/5	15	20	30	**M70366**	25	30	35	**M703B9**	10	15	20	**M70373**	10	15	20	**M70381**
1 200/5	15	20	30	**M70367**					10	15	20	**M70374**	10	15	20	**M70382**
1 250/5				**M7036A**					10	15	20	**M7037E**	10	15	20	**M7038D**
1 500/5	15	20	30	**M70368**					15	20	25	**M70375**	15	20	30	**M70383**
1 600/5	15	20	30	**M70369**					15	20	25	**M70376**	15	20	30	**M70384**
2 000/5									15	20	25	**M70377**	15	20	30	**M70385**
2 500/5									15	20	30	**M70378**	20	30	40	**M70386**
3 000/5									15	20	30	**M70379**	30	40	60	**M70387**
3 200/5													30	40	60	**M7038C**
4 000/5													35	40	60	**M70388**

Current transformers

TC series

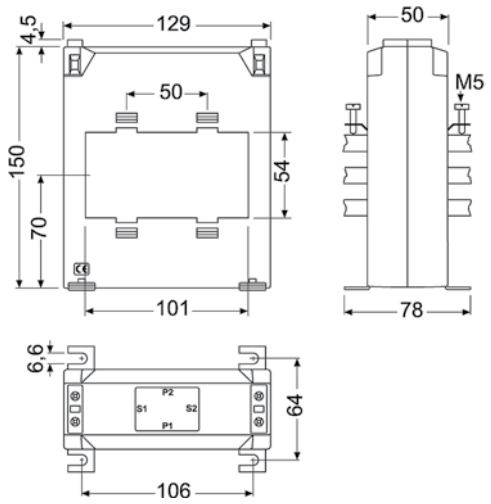
Narrow-profile current transformer

Dimensions



dimensions (mm)	TC 4	TC 5 TCH 5	TC 5.2 TCH 5.2	TC 6.2 TCH6.2	TC 6 TCH 6	TC 8 TCH 8	TC 10 TCH 10
a	50	58	58	64	64	84,5	108
b	70	70	70	80,5	80,5	102	130
c	29	29	29	34	34	46	61
d	21	20,3	22	26	28,5	44	63
e	43,5	45	45	60,5	66,5	69	---
f	30	32	32	44	44	50	50
g	56	59	59	71	71,2	78	78
h	5,5	5,6	5,6	5,6	5,6	6,6	6,6
i	45,5	48	48	60	60	64	64
j	31,6	39	39	46	46	62	86
k	30,5	25,6	30,6	20,6	40,6	60,6	80,6
l	30,5	15,6	15,6	30,6	25,2	30,6	50,8

TC 12 series



Current transformers

TCH

Top-performance current transformer

Description

- Narrow-profile
- Types: from 100 to 4000 A
- Internal diameter: from 26 to 63 mm, depending on the type
- Busbar dimensions: from 30 x 10 mm to 30 x 100 mm
- Transformer certificate sheet is attached

Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

In installations where the electrical supply can be interrupted to install transformers and a high accuracy is required.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	B 130 ºC
Working temperature	-5 ... 40 ºC
Type of encapsulation	VO self-extinguishing plastic
Safety factor	FS 5/10
Secondary sealable terminals	Yes

References

Type	TCH 6.2				TCH 6			
Busbar (mm)	30 x 10				40 x 10			
Dimensions (mm)								
 a b c	81 64 44				81 64 44			
V·A / A	Class 0.2S	Class 0,2	Class 0.5S	Code	Class 0.2S	Class 0,2	Class 0.5S	Code
100/5	1	1,5	2,5	[2] M70441				
150/5	2,5	3,5	3,5	[2] M70443	1	1,25	1,5	[2] M70431
200/5	3,5	5	5	[2] M70444	1,25	1,5	2	[2] M70432
250/5	5	5	5	[2] M70445	1,5	1,75	2,25	[2] M70433
300/5	5	5	5	[2] M70446	1,75	2	2,5	[2] M70434
400/5	7,5	7,5	7,5	[2] M70447	1	5	5	[2] M70435
500/5					5	7,5	7,5	[2] M70436
600/5					5	7,5	7,5	[2] M70437
750/5					7,5	10	10	[2] M70438
800/5					7,5	10	10	[2] M70439

Current transformers

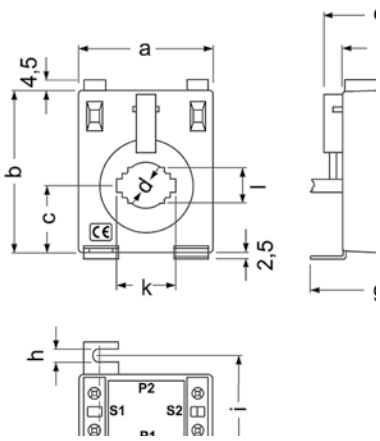
TCH series

Top-performance current transformer

References

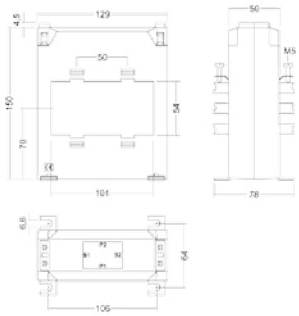
Type	TCH 8				TCH 10				TCH 12			
Busbar (mm)	60 x 12				50 x 50 60 x 30 80 x 30				3 x 100 x 10			
Dimensions (mm)												
 a b c	102 84,5 50				130 108 50				150 129 50			
V·A / A	Class 0.2S	Class 0,2	Class 0.5S	Code	Class 0.2S	Class 0,2	Class 0.5S	Code	Class 0.2S	Class 0,2	Class 0.5S	Code
600/5	5	10	10	[2] M70463								
750/5	7,5	10	10	[2] M70464								
800/5	7,5	10	10	[2] M70465								
1 000/5	10	15	15	[2] M70466	7,5	10	10	[2] M70473				
1 200/5	10	15	15	[2] M70467	10	10	10	[2] M70474	10	15	15	[2] M70483
1 250/5	10	15	15	[2] M7046A	10	10	10	[2] M7047C	10	15	15	[2] M7048C
1 500/5	10	15	15	[2] M70468	10	10	15	[2] M70475	10	15	15	[2] M70483
1 600/5	10	15	15	[2] M70469	10	10	15	[2] M70476	10	15	15	[2] M70484
2 000/5					10	10	15	[2] M70477	10	15	15	[2] M70485
2 500/5					10	10	15	[2] M70478	15	20	20	[2] M70486
3 000/5					10	10	15	[2] M70479	20	25	25	[2] M70487
4 000/5									25	30	30	[2] M70488

Dimensions



dimensions (mm)	TC 5 TCH 5	TC 5.2 TCH 5.2	TC 6.2 TCH6.2	TC 6 TCH 6	TC 8 TCH 8	TC 10 TCH 10
a	58	58	64	64	84,5	108
b	70	70	80,5	80,5	102	130
c	29	29	34	34	46	61
d	20,3	22	26	28,5	44	63
e	45	45	60,5	66,5	69	---
f	32	32	44	44	50	50
g	59	59	71	71,2	78	78
h	5,6	5,6	5,6	5,6	6,6	6,6
i	48	48	60	60	64	64
j	39	39	46	46	62	86
k	25,6	30,6	20,6	40,6	60,6	80,6
l	15,6	15,6	30,6	25,2	30,6	50,8

TCH 12 series



Current transformers

TA

Large-scale current transformer

Description

- Types: from 750 to 5000 A
- Busbar dimensions: from 20 x 100 mm to 60 x 125 mm
- Transformer certificate sheet is attached

Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

In installations where the electrical supply can be interrupted to install transformers.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	105 ºC
Type of encapsulation	VO self-extinguishing plastic
Safety factor	<5
Secondary sealable terminals	Yes
Standards	
IEC 44-1, UNE 21 088-1, UL 94, VDE 0414	

Current transformers

TA series

Large-scale current transformer

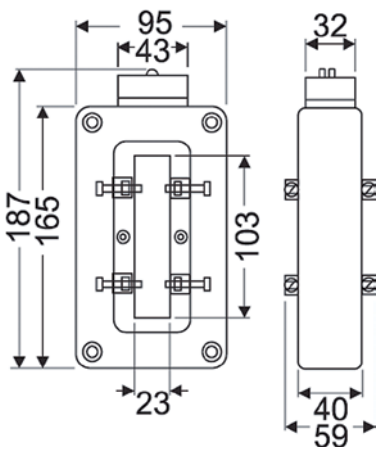
References



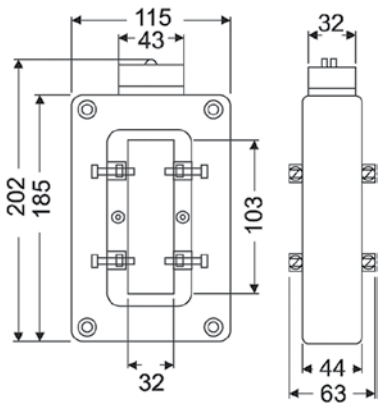
Type	TA 400				TA 500				TA 600			
Busbar (mm)	100 x 20 mm				100 x 30 mm				125 x 60 mm			
Dimensions (mm)												
 a b c	a 165 b 95 c 59				a 185 b 115 c 63				a 196 b 124 c 62			
V·A / A	Class 0,5	Class 1	Class 3	Code	Class 0,5	Class 1	Class 3	Code	Class 0,5	Class 1	Class 3	Code
750/5	15	20	30	[*] M70594								
800/5	15	20	30	[*] M70595								
1 000/5	15	20	30	[*] M70596					15	20	30	[*] M705B1
1 200/5	15	20	30	[*] M70597								
1 500/5	15	30	40	[*] M70598	15	30	40	[*] M705A4	15	20	30	[*] M705B3
2 000/5	20	40	50	[*] M70599	20	40	50	[*] M705A6	15	20	30	[*] M705B5
2 500/5					20	40	50	[*] M705A7	20	30	40	[*] M705B6
3 000/5					20	45	60	[*] M705A8	30	40	60	[*] M705B7
4 000/5					35	50	70	[*] M705A9	35	50	70	[*] M705B8
5 000/5									40	60	80	[*] M705B9

Dimensions

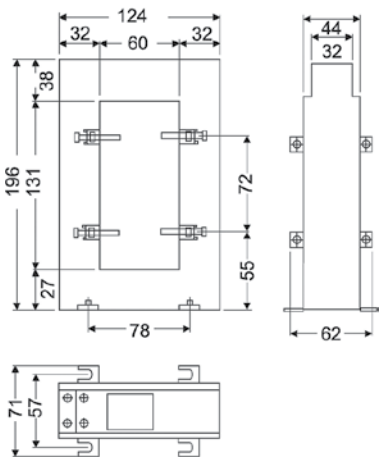
TA 400 series



TA 500 series



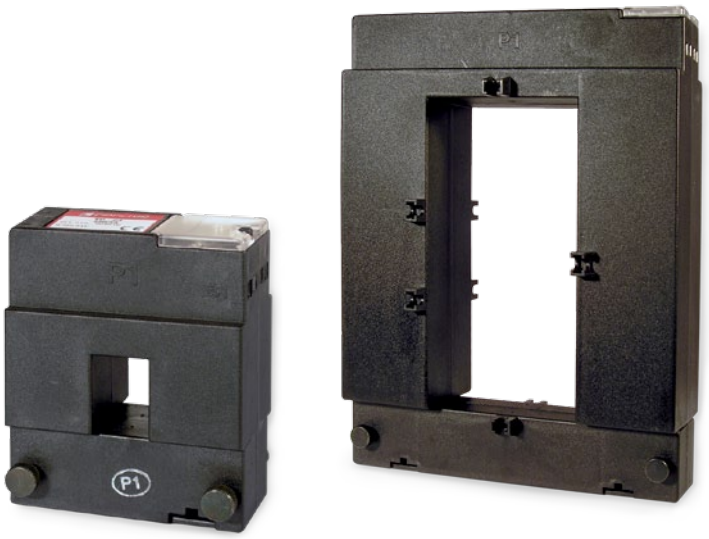
TA 600 series



Current transformers

TP

Split-core current transformer



Description

- The most important features of these transformers are that they are "disassemblable". In other words, the whole installation does not have to be disassembled.
- Types: from 100 to 5000 A
- Busbar dimensions: from 20 x 30 mm to 80 x 160 mm
- Transformer certificate sheet is attached

Application

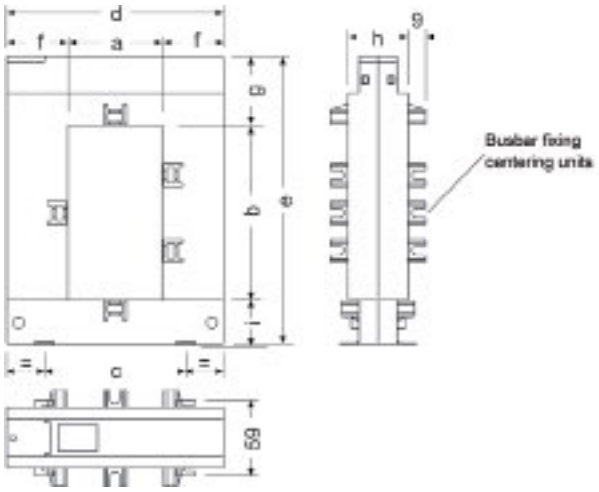
Converting a high nominal current to a lower current so that it can be measured by the unit.

They have a split core and can be installed with no need to interrupt the installation's power supply.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	B (120 ºC)
Working temperature	-5 ... 40 ºC
Transformer ratio	Depending on the type (.../5 or .../1 A)
Type of encapsulation	Self-extinguishing VO plastic (UL 94VO)
Secondary sealable terminals	Yes
Standards	
IEC 44-1, UNE 21 088-1, UL 94, VDE 0414	

Dimensions



dimensions (mm)	TP-23	TP-58	TP-88	TP-812	TP-816
a	20	50	80	80	80
b	30	80	80	120	160
c	51	78	108	108	120
d	89	114	144	144	184
e	110	145	145	185	245
f	34	32	32	32	52
g	47	32	32	32	47
h	40	32	32	32	52
i	32	32	32	32	38

Note: All types have fixing centering units, except for **TP-23**

Current transformers

TP series

Split-core current transformer

References

Type	TP -23				TP -58				TP -88			
Busbar (mm)	20 x 30 mm				50 x 80 mm				80 x 80 mm			
Dimensions (mm)												
c b a / a b c	110 89 58				145 114 50				145 144 50			
V·A / A	Class			Code	Class			Code	Class			Code
	0,5	1	3		0,5	1	3		0,5	1	3	
100/5	-	-	1,5	[*] M70111								
150/5	-	-	2	[*] M70112								
200/5	-	1,5	2,5	[*] M70113								
250/5	-	2	4	[*] M70114	1	2	4	[*] M70121	1	2	4	[*] M70131
300/5	1,5	4	6	[*] M70115	1,5	3	6	[*] M70122	1,5	3	6	[*] M70132
400/5	2,5	6	10	[*] M70116	1,5	3	10	[*] M70123	1,5	3	10	[*] M70133
500/5					2,5	5	15	[*] M70124	2,5	5	15	[*] M70134
600/5					2,5	5	17,5	[*] M70125	2,5	5	17,5	[*] M70135
700/5					2,5	-	-	[c] M7012C				
750/5					3	6	18	[*] M70126	3	6	18	[*] M70136
800/5					3	7	18	[*] M70127	3	7	18	[*] M70137
1 000/5					5	10	20	[*] M70128	5	10	20	[*] M70138

Type	TP -812				TP -816			
Busbar (mm)	80 x 120 mm				80 x 160 mm			
Dimensions (mm)								
c b a / a b c	185 144 50				245 184 70			
V·A / A	Class			Code	Class			Code
	0,5	1	3		0,5	1	3	
500/5	-	4	12	[*] M70141				
600/5	-	5	14	[*] M70142				
750/5	2,5	6	17	[*] M70143				
800/5	3	7	18	[*] M70144				
1 000/5	5	9	20	[*] M70145	10	15	20	[*] M70151
1 200/5	6	11	24	[*] M70146				
1 250/5	7	15	28	[*] M70147	8	-	-	[c] M7015A
1 500/5	8	17	30	[*] M70148	15	20	25	[*] M70152
1 600/5	8	-	-	[c] M70149	8	-	-	[c] M7015B
2 000/5					15	20	25	[*] M70153
2 500/5					15	20	25	[*] M70154
3 000/5					20	25	30	[*] M70155
4 000/5					20	25	30	[*] M70156
5 000/5					20	25	30	[*] M70157

Current transformers

TA 210

High-accuracy wound primary current transformer

Description

- Types: from 5 to 400 A
- Wound primary

Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

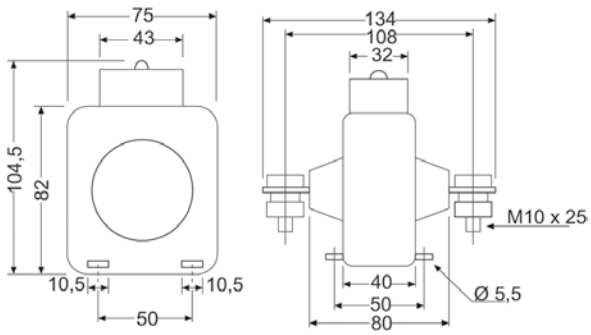
In installations where the nominal current is not too high or where the current requested from the secondary power transformer does not exceed 10 V·A.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	A 105 °C
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_s <5
Secondary sealable terminals	Yes
Standards	
IEC 44-1, UNE 21 088-1, UL 94, VDE 0414	

Dimensions

TA 210 series



References

Type	TA 210 (*1)			
	Wound Primary			
Dimensions (mm)				
a b c	104.5 75 134			
V·A / **A**	**Class**			**Code**
	0,5	**1**	**3**	
5/5	15	20	30	**[*] M70541**
10/5	15	20	30	**[*] M70542**
15/5	15	20	30	**[*] M70543**
20/5	15	20	30	**[*] M70544**
25/5	15	20	30	**[*] M70545**
30/5	15	20	30	**[*] M70546**
40/5	15	20	30	**[*] M70547**
50/5	15	20	30	**[*] M70548**
60/5	15	20	30	**[*] M70549**
75/5	15	20	30	**[*] M7054A**
100/5	15	20	30	**[*] M7054B**
125/5	15	20	30	**[*] M7054C**
150/5	15	20	30	**[*] M7054D**
200/5	15	20	30	**[*] M7054E**
250/5	15	20	30	**[*] M7054F**
300/5	15	20	30	**[*] M7054G**
400/5	15	20	30	**[*] M7054H**

(*1) Sealable terminal cover and anchoring base included

Current transformers

TM 45

Wound primary current transformer

Description

- Types: from 1 to 40 A
- Wound primary
- Assembly on DIN rail
- Transformer certificate sheet is attached

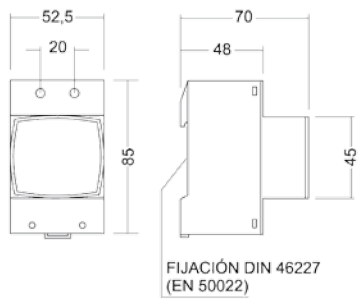
Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

In installations where the nominal current is not too high or a transformer has to be installed on the DIN rail.

Dimensions

TM 45 series



Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	A (105 ºC)
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_s <5
Secondary sealable terminals	Yes
Standards	
IEC 44-1, UNE 21 088-1, UL 94, VDE 0414	

References

Type	**TM 45**			
	Wound Primary			
Dimensions (mm)				
	**a** 85 **b** 52,5 **c** 70			
A \ **V·A**	**Class**			**Code**
	0,5	**1**	**3**	
5/5	2,5	5	7	**[*] M70601**
10/5	2,5	5	7	**[*] M70602**
15/5	2,5	5	7	**[*] M70603**
20/5	2,5	5	7	**[*] M70604**
25/5	2,5	5	7	**[*] M70605**
30/5	2,5	5	7	**[*] M70606**
40/5	2,5	5	7	**[*] M70607**
50/5	2,5	5	7	**[*] M70608**

Current transformers

TW 25

Entrance bar current transformer

Description

- Types: from 100 to 300 A
- Entrance bar
- Assembly for DIN rail

Application

Converting a high nominal current to a lower current so that it can be measured by the unit.

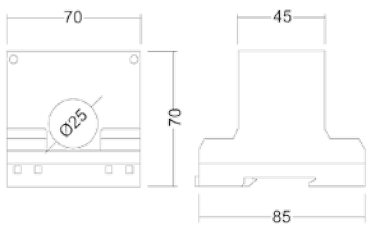
In installations where the nominal current is not too high or a transformer has to be installed on the DIN rail.

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	A (105 ºC)
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_s <5
Secondary sealable terminals	Yes
Standards	
IEC 44-1, UNE 21 088-1, UL 94, VDE 0414	

Dimensions

TW 25 / TW 25M



References

Type	**TW 25 / TW 25M**			
inner Ø (mm)	Bar entrance 25			
Dimensions (mm)				
c b a **a** **b** **c**	85 70 70			
V·A / **A**	**Class**			**Code**
	0,5	1	3	
100/5	-	1,5	3	**[*] M70611**
125/5	-	2	4	**[*] M70612**
150/5	-	3	5	**[*] M70613**
200/5	3	5	8	**[*] M70614**
250/5	4	9	11	**[*] M70615**
300/5	6	11	13	**[*] M70616**
100 / 125 / 150 / 200 / 250 / 300	Identical to **TW 25**			**[*] M70621**

Current transformers with converter

TC 020 / TC 420

Narrow-profile current transformer with a built-in converter, with an output of 0...20 mA / 4...20 mA

Description

TC 020 Series

- Self-powered: does not need an auxiliary power supply.
- Primary current: from 50 to 1500 A ac, depending on the type
- Secondary current: 0..20 mA
- Internal diameter: from 28 to 44 mm, depending on the type
- Busbar dimensions: from 40 x 10 mm to 60 x 12 mm

TC 420 series

- Needs an output power supply of 7.5...36 V dc
- Primary current: from 5 to 1500 A ac, depending on the type
- Secondary current: 4..20 mA
- Internal diameter: from 20 to 44 mm, depending on the type
- Busbar dimensions: from 25 x 5 mm to 60 x 12 mm

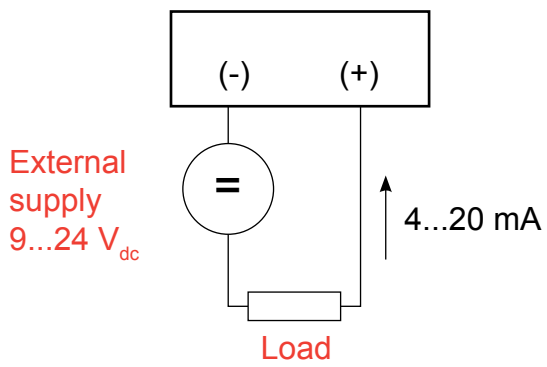
Application

Used in power lines to obtain a current proportional to the primary current rated at 0..20 mA / 4...20 mA in the secondary

Features

Frequency	50 / 60 Hz
Isolation voltage	3 kV ac
Thermal short-circuit current, I_{th}	60 I_n
Dynamic current, I_{dyn}	2.5 I_{th}
Highest current in the material	0.72 kV ac
Thermal class	B (130 ºC)
Type of encapsulation	VO self-extinguishing plastic
Safety factor	F_s <5
Secondary sealable terminals	Yes
Standards	
IEC 44-1, B5 2627	

Connection



Current transformers with converter

TC 020 / TC 420 series

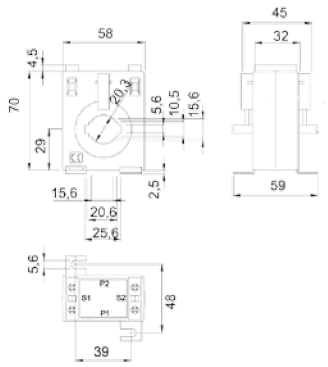
Narrow-profile current transformer with a built-in converter, with an output of 0...20 mA / 4...20 mA

References

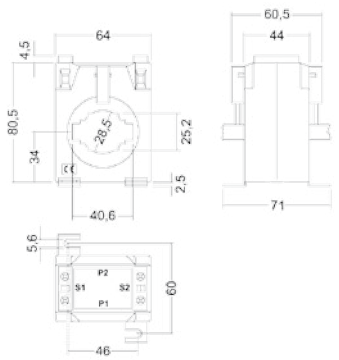
Type	TC 420			TC 020	
	TC 5,420	TC 6,420	TC 8,420	TC 6 020A	TC 8,020A
inner Ø (mm)	20	28	44	28	44
Busbar (mm)	25 x 5	40 x 10	60 x 12	40 x 10	60 x 12
Dimensions (mm)					
 a b c	70 58 32	80,5 64 44	102 84,5 50	80,5 64 44	102 84,5 50
A	Output 4...20 mA, external power supply 7.5...36 Vdc			Output 0...20 mA	
	Code			Code	
5	[1] M72112				
10	[1] M72113				
20	[1] M72114				
50		[1] M72131		[1] M72031	
100		[1] M72132		[1] M72032	
200		[1] M72134		[1] M72034	
300		[1] M72136		[1] M72036	
500			[1] M72151		[1] M72051
1 000			[1] M72152		[1] M72052
1 500			[1] M72153		[1] M72053
For greater currents, use: transformer + converter					

Dimensions

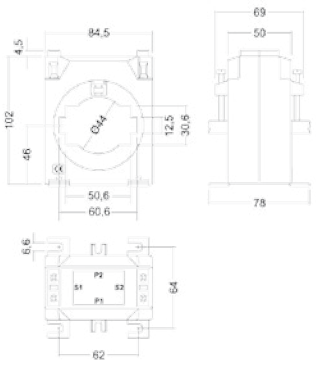
TC 5,420 series



TC 6 020 A / TC 6 420 A series



TC 8,020 A / TC 8,420 A series



Current transformers with converter

TP 420

Split-core current transformer with built-in converter

Description

- Needs a power supply output of 10 to 28 Vdc
- Primary current: from 5 to 4000 A ac, depending on the type
- Secondary current 4...20 mA
- Internal diameter from 20 to 80 mm, depending on the type
- Busbar dimensions from 20 x 30 mm to 80 x 160 mm, depending on the type

Application

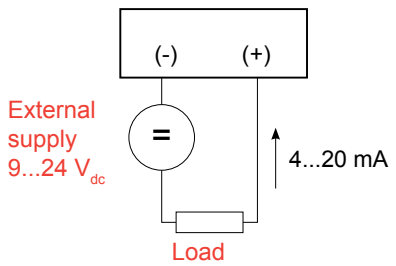
Used in power lines to obtain a current proportional to the primary current rated at 4...20 mA in the secondary

Recommended in scenarios where the process signal must be proportional to the current of an automated system or PLC and the installation's power supply can not be interrupted to install a closed entrance bar transformer.

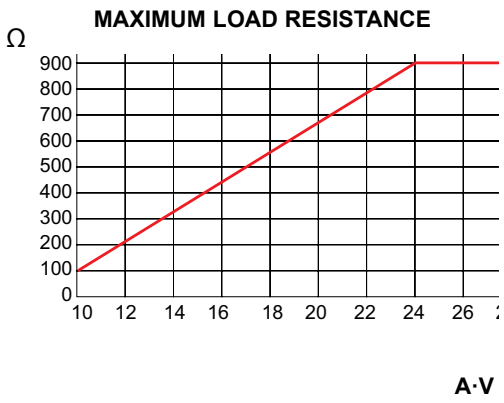
Features

Measurement circuit	
Frequency	50 / 60 Hz (linear)
Secondary current	4...20 mA dc
Accuracy class	±1.5% reading (between 5... 110 % I_n)
Overloads (at room temperature)	1.5 I_n permanent
Highest current in the material	0.72 kV ac
Operating temperature	-10°...+50 °C
Standards	
IEC 44-1, UNE 21 088-1, IEC 664, VDE 0110, VDE 0414, UL 94, IEC 1010-1, EN 61010-1	

Connection



Graph



Current transformers with converter

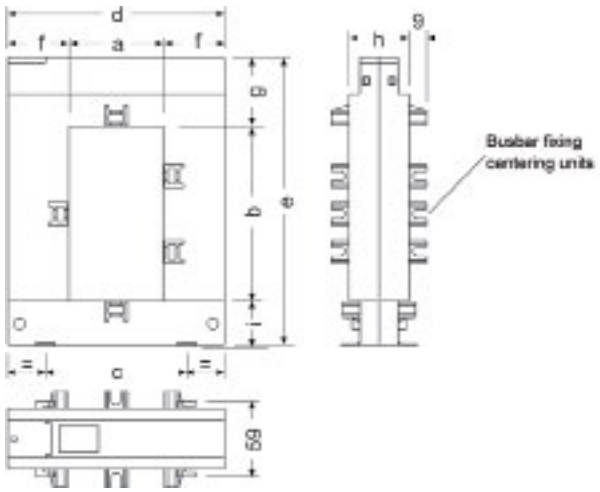
TP 420 series

Split-core current transformer with built-in converter

References

Type	TP-420 23	TP-420 58	TP-420 88	TP-420 812	TP -420 816
inner Ø (mm) Busbar	20 x 30	50 x 80	80 x 80	80 x 120	80 x 160
Dimensions (mm)					
 a b c	110 89 58	145 114 50	145 144 50	185 144 50	245 184 70
A	**10...28 V dc power supply output 4...20 mA**				
	Code	**Code**	**Code**	**Code**	**Code**
5	**[*] M70211**				
10	**[*] M70212**				
20	**[*] M70213**				
50	**[*] M70214**				
100	**[*] M70215**	**[*] M70221**	**[*] M70231**		
200	**[*] M70216**				
250	**[*] M70217**	**[*] M70222**	**[*] M70232**	**[2] M70241**	
500	**[*] M70218**	**[*] M70223**	**[2] M70233**	**[2] M70242**	**[2] M70251**
750		**[*] M70224**	**[2] M70234**	**[2] M70243**	**[2] M70252**
1 000			**[2] M70235**	**[2] M70244**	**[2] M70253**
1 500			**[2] M70236**	**[2] M70245**	**[2] M70254**
2 000					**[2] M70255**
3 000					**[2] M70256**
4 000					**[2] M70257**
For greater currents, use: transformer + converter					

Dimensions



dimensions (mm)	TP-23	TP-58	TP-88	TP-812	TP-816
a	20	50	80	80	80
b	30	80	80	120	160
c	51	78	108	108	120
d	89	114	144	144	184
e	110	145	145	185	245
f	34	32	32	32	52
g	47	32	32	32	47
h	40	32	32	32	52
i	32	32	32	32	38

Note: All types have fixing centering units, except for TP-23

Current transformers with converter

TI 420

Large-scale current transformer with built-in converter

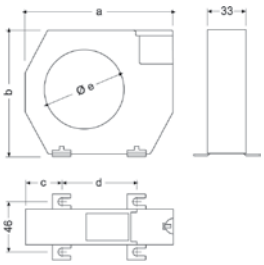
Description

- Needs an output power supply of 10...28 V dc
- Primary current: from 2.5 to 1500 A ac, depending on the type
- Secondary current: 4..20 mA
- Internal diameter: from 35 to 105 mm, depending on the type
- Busbar dimensions: from 35 to 105 mm, depending on the type

Application

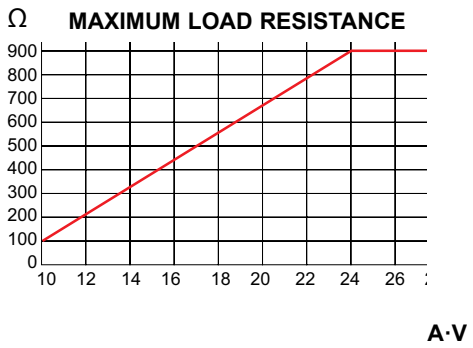
Used in power lines to obtain a current proportional to the primary current rated at 4...20 mA in the secondary

Dimensions

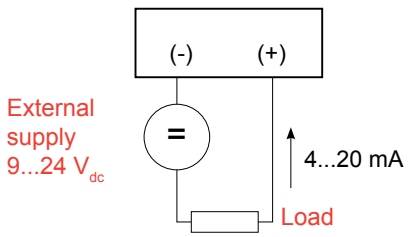


Dimensions (mm)			
	TI-420-35	TI-420-70	TI-420-105
a	100	130	170
b	79	110	146
c	26	32	38
d	48,5	66	94
e	35	70	105

Graph



Connection



Features

Measurement circuit	
Frequency	50 / 60 Hz (linear)
Secondary intensity	4...20 mA dc
Accuracy class	±1.5% reading (between 5... 110 % I_n)
Overloads (at room temperature)	1.5 I_n permanent
Highest current in the material	0.72 kV AC
Operating temperature	-10°...+50 °C
Standards	
IEC 44-1, UNE 21 088-1, IEC 664, VDE0110, VDE0414, UL 94, IEC 1010-1, EN 61010-1	

References

Type	TI-420 35	TI-420 70	TI-420 105
inner Ø (mm) Busbar	35	70	105
Dimensions (mm)			
c b a / a b c	79 100 33	110 130 33	146 170 33
A	**10...28 V dc**	**power supply output 4...20 mA**	
	Code	**Code**	**Code**
2,5	[1] M70811		
5	[1] M70812		
10	[1] M70813		
20	[1] M70814		
50	[1] M70815		
100	[1] M70816	[1] M70821	
250	[1] M70817	[1] M70822	[1] M70831
500		[1] M70823	[1] M70832
750		[1] M70824	[1] M70833
1 000			[1] M70834
1 500			[1] M70835
For greater currents, use: transformer + converter			

Current transformers with converter

TCB 420

Large-scale current transformer
with built-in converter

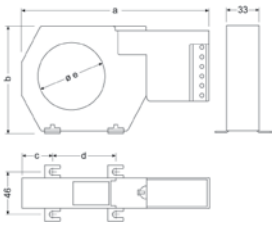
Description

- Built-in internal output power supply
- Needs an auxiliary power supply of 230 V ac
- Primary current: from 2.5 to 1500 A ac, depending on the type
- Secondary current: 4..20 mA
- Internal diameter / Busbar dimensions: from 35 to 105 mm

Application

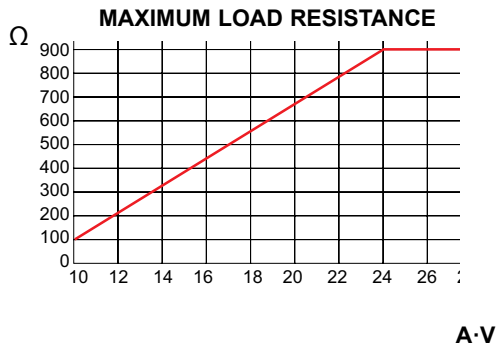
Used in power lines to obtain a current proportional to the primary current rated at 4...20 mA in the secondary

Dimensions



	TCB-420 35	TCB-420 70	TCB-420 105
a	166	196	236
b	79	110	146
c	26	32	38
d	48,5	66	94
e	35	70	105

Graph



Features

Frequency	50 / 60 Hz
Highest current in the material	0.72 kV ac
Overloads (at room temperature)	1.5 I_n permanent
Class	
Accuracy class	±1.5% I_n
Operating temperature	-10°...+50 °C
Standards	
IEC 44-1, UNE 21 088-1, IEC 664, VDE0110, VDE0414, UL 94, IEC 1010-1, EN 61010-1	

References

Type	TCB-420 35	TCB-420 70	TCB-420 105
inner Ø (mm) Busbar	35	70	105
Dimensions (mm)			
 a b c	79 166 33	110 196 33	146 236
A	**internal power supply output 4...20 mA (230 V ac auxiliary power supply)**		
	Code	**Code**	**Code**
2,5	[*] M71011		
5	[*] M71012		
10	[*] M71013		
20	[*] M71014		
50	[*] M71015		
100	[*] M71016	[1] M71021	
250	[*] M71017	[*] M71022	[1] M71031
500		[*] M71023	[*] M71032
750		[*] M71024	[1] M71033
1 000			[1] M71034
1 500			[*] M71035
For higher currents, use: transformer + converter			

Current transformers with converter

TCM 420

Current transformer for DIN rails with built-in converter

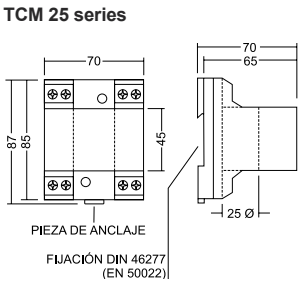
Description

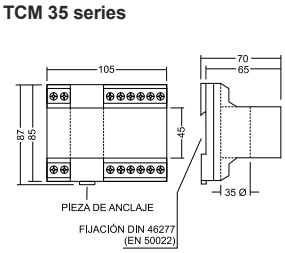
- Built-in internal output power supply
- Needs an auxiliary power supply of 230 V ac
- Primary current: from 2.5 to 300 A ac, depending on the type
- Secondary current: 4..20 mA
- Internal diameter: from 25 to 35 mm, depending on the type
- Busbar dimensions: from 25 to 35 mm, depending on the type

Application

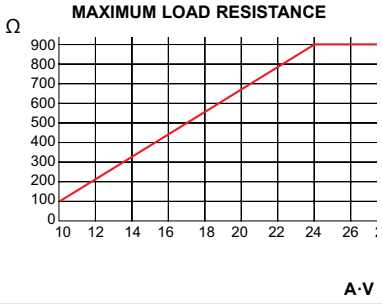
Used in power lines to obtain a current proportional to the primary current rated at 4...20 mA in the secondary

Dimensions





Graph



Features

Frequency	50 / 60 Hz
Highest current in the material	0.72 kV ac
Overloads (at room temperature)	1.5 I_n permanent
Accuracy class	±1.5% I_n
Operating temperature	-10°...+50 °C
Standards	
IEC 44-1, UNE 21 088-1, IEC 664, VDE0110, VDE0414, UL 94, IEC 1010-1, EN 61010-1	

References

Type	TCM -420 25 (*)	TCM -420 35 (*)
inner Ø (mm) Busbar	25	35
Dimensions (mm)		
c b a — a / b / c	87 / 70 / 70	87 / 105 / 70
A	internal power supply output 4...20 mA (230 V ac auxiliary power supply)	
	Code	Code
2,5	[*] M71041	
5	[*] M71042	
10	[*] M71043	
20	[*] M71044	
50	[*] M71045	
100	[*] M71046	[2] M71054
200	[*] M71047	[*] M71055
300		[2] M71056
For greater currents, use: transformer + converter		

Shunts

SH

Shunt to measure DC in high amperages

Description

- Shunt for the measurement of DC, from 1 A dc to 15 000 A dc, depending on the type
- Accuracy class: 0.5
- All types are supplied with 1.5 m long cables, with a section of 1.5 m²
- The standard output voltage is .../60 mV, but there are other types of outputs on demand, see coding table.

Application

Used in DC electrical lines to obtain a voltage signal that is proportional to the current through the shunt

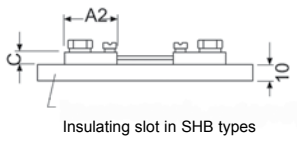
Features

Voltage drop		.../60 mV or.../150 mV
Accuracy class		0.5 from 0 to 120% I_n
Overloads	Permanent	1.2 I_n
	During 5 s	10 I_n, when 10 A ≤ I_n ≤ 500 A 5 I_n, when 600 A ≤ I_n ≤ 2 000 A 2 I_n, when 2 500 A ≤ I_n
Operating temperature		-25...+60 ºC
Build features		Manganin rods Brass terminals
Standards		
DIN 43703, IEC 51, VDE 410, BS 89		

Dimensions

Voltage drop mV(1)	Scope A(1)	Fig.	a1	a2	b1	b2	b3	c1	c2	e	h	Weight (kg)	N.o current joints	Current joints: DIN 933 Hexagonal screw	Current joints: DIN 125 Washer	Current joints: DIN 934 Nut	Voltage joints
60	1-1 , 5-2, 5-4-6-10-15-25	1	90	28	20	-	-	8	-	78	-	0,15	2 x 1	M5 x 12	5,3	-	Two M5 Screws x 8 DIN 84 and Two 5.3 DIN 433 washers
	30-40-60-100-150		100	33	20	-	-	8	-	80	-	0,13	2 x 1	M8 x 16	8,4	-	
	250	2	145	55	30	15	-	10	10	105	30	0,54	2 x 1	M12 x 40	13	M12	
	400-600				40	20						0,78	2 x 1	M16 x 45	17	M16	
	1000 - 1200		165	65	60	30	-	10	10	115	30	1,49	2 x 1	M20 x 50	21	M20	
	1500				90	21	48					1,95	2 x 2	M16 x 45	17	M16	
	2500				120	30	60	10	10	115	30	3	2 x 2	M20 x 50	21	M20	
150	1-1 , 5-2 , 5-4-6-10-15-25	1	90	25	20	-	-	8	-	78	-	0,18	2 x 1	M5 x 12	5,3	-	
	40-60-100-150		225	33	25	-	-	8	-	205	-	1,14	2 x 1	M8 x 16	8,4	-	
	250	2	270	55	30	15	-	10	10	230	50	0,80	2 x 1	M12 x 40	13	M12	
	400-600				40	20						1,38	2 x 1	M16 x 45	17	M16	
	1000		290	65	70	35	-	10	10	240	60	2,55	2 x 1	M20 x 50	21	M20	

(1) All shunts are supplied with connection cables that are 1.5m long and have a section of 1.5 mm² .



Insulating slot in SHB types

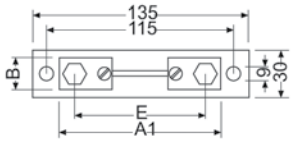


fig 1: from 1 to 150 A

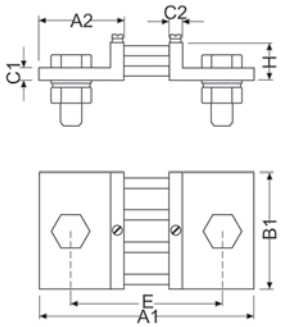


fig 2: from 200 to 1200 A

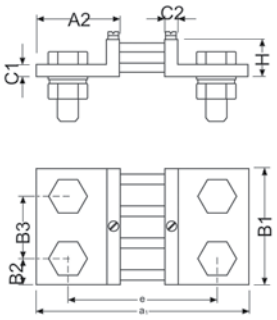


fig 3: from 1500 to 2500 A

Shunts

SH series

Shunt to measure DC in high amperages

References



Ratio	Type	Code	Type	Code	Type	Code
	SH		SHB		SHP	
1 A / 60 mV	-		SHB 1	M71221	-	
1.5 A / 60 mV	-		SHB 1.5	M71222	-	
2.5 A / 60 mV	-		SHB 2.5	M71223	-	
4 A / 60 mV	-		SHB 4	M71224	-	
5 A / 60 mV	-		SHB 5	M71225	-	
6 A / 60 mV	-		SHB 6	M71226	-	
10 A / 60 mV	-		SHB 10	M71227	-	
15 A / 60 mV	-		SHB 15	M71228	-	
25 A / 60 mV	-		SHB 25	M71229	-	
30 A / 60 mV	SH 30	M71231	SHB 30	M7122A	SHP 30	M71211
40 A / 60 mV	SH 40	M71232	SHB 40	M7122B	SHP 40	M71212
50 A / 60 mV	SH 50	M71233	SHB 50	M7122C	SHP 50	M71213
60 A / 60 mV	SH 60	M71234	SHB 60	M7122D	SHP 60	M71214
75 A / 60 mV	-		-		SHP 75	M71215
80 A / 60 mV	SH 80	M71235	SHB 80	M7122E	-	
100 A / 60 mV	SH 100	M71236	SHB 100	M7122F	SHP 100	M71216
150 A / 60 mV	SH 150	M71237				
200 A / 60 mV	SH 200	M71238				
250 A / 60 mV	SH 250	M71239				
300 A / 60 mV	SH 300	M7123A				
400 A / 60 mV	SH 400	M7123B				
500 A / 60 mV	SH 500	M7123C				
600 A / 60 mV	SH 600	M7123D				
750 A / 60 mV	SH 750	M7123E				
800 A / 60 mV	SH 800	M7123F				
1 000 A / 60 mV	SH 1 000	M7123G				
1 200 A / 60 mV	SH 1 200	M7123H				
1 500 A / 60 mV	SH 1 500	M7123J				
2 000 A / 60 mV	SH 2 000	M7123K				
2 500 A / 60 mV	SH 2 500	M7123L				
3 000 A / 60 mV	SH 3 000	M7123M				
4 000 A / 60 mV	SH 4 000	M7123N				
5 000 A / 60 mV	SH 5 000	M7123P				
6 000 A / 60 mV	SH 6 000	M7123Q				
7 500 A / 60 mV	SH 7 500	M7123R				
8 000 A / 60 mV	SH 8 000	M7123S				
10 000 A / 60 mV	SH 10 000	M7123T				
12 500 A / 60 mV	SH 12 500	M7123U				
15 000 A / 60 mV	SH 15 000	M7123V				
18 000 A / 60 mV	SH 18 000	M7123Z				
20 000 A / 60 mV	SH 20 000	M7123O				

Coding table

Shunts	M	7	X	X	X	X	0	0	X
	Code						Internal Code		↑
	Input			Standard .../60 mV					0
				.../50 mV					1
				.../100 mV					2
				.../150 mV					3
				.../200 mV					4
				.../300 mV					5
				.../400 mV					6

Voltage transformers

VT

Voltage transformers

Description

- Accuracy class 1
- Power 25 V·A

Application

Used in AC electricity lines to obtain a lower voltage in the secondary than in the primary, so that it can be measured by electronic equipment

References

V	Type	Code
230 / 110 V	**VT2311**	**M72311**
380 / 230 V	**VT3823**	**M72352**
400 / 110 V	**VT4011**	**M72321**
400 / 230 V	**VT4023**	**M72322**
440 / 110 V	**VT4411**	**M72331**
440 / 230 V	**VT4423**	**M72332**
480 / 110 V	**VT4811**	**M72341**
480 / 230 V	**VT4823**	**M72342**
700 / 230 V	**VT7023**	**M72382**

Transformers used to increase the impedance

TE series

Transformer used to increase the impedance

Description

- Accuracy class 1
- Power 15 V·A

Application

For applications where the measurement unit can not be installed near the measurement transformer and, as a consequence, the distance between both is longer. The problem lies in the fact that increasing the distance increases the number of losses caused by the overheating of the cable and in some cases the unit might not take readings accurately. With this unit at the transformer's output and another unit at the input of the measurement device we can increase the distance between both without so many power losses.

References

Current ratio	Type	Code
5 / 0.1 A	**TE - 5 / 0.1**	**M70911**

Current adding transformers

TSR Series

Current adding transformers, fixed on a DIN rail

Description

- Accuracy class 0.5
- Power 15 V·A
- The transformers added must have the same ratio
- No input must be without a connection
- Transformer certificate sheet is attached

Application

Used to add the current to various AC electrical lines to obtain a common output current that is proportional to the sum of all currents. The current of various lines can be measured in a single unit.

References

N.º of inputs	Type	Code
2 x 5 A	**TSR-2**	**M70701**
3 x 5 A	**TSR-3**	**M70702**
4 x 5 A	**TSR-4**	**M70703**
5 x 5 A	**TSR-5**	**M70704**

Relation between products and accessories

		PA-TC/WG	TET TP-58	TET TP-88/812	TET TP-816	PS-24
						
	Terminal cover	Accessory used to install the transformer on a DIN rail	Protector for **TP** transformers (outdoors)			Power supply unit
	M79951	**P19921**	**M79972**	**M79973**	**M79974**	**M60415**
TA		-	●	-	-	-	-
TC		●	●	-	-	-	-
TCH		-	-	●	●	●	-
TP		●	●	-	-	-	-
TC 020		●	●	-	-	-	-
TC 420		●	●	-	-	-	●
TI 420		-	-	-	-	-	●
TP 420		-	-	●	●	●	●