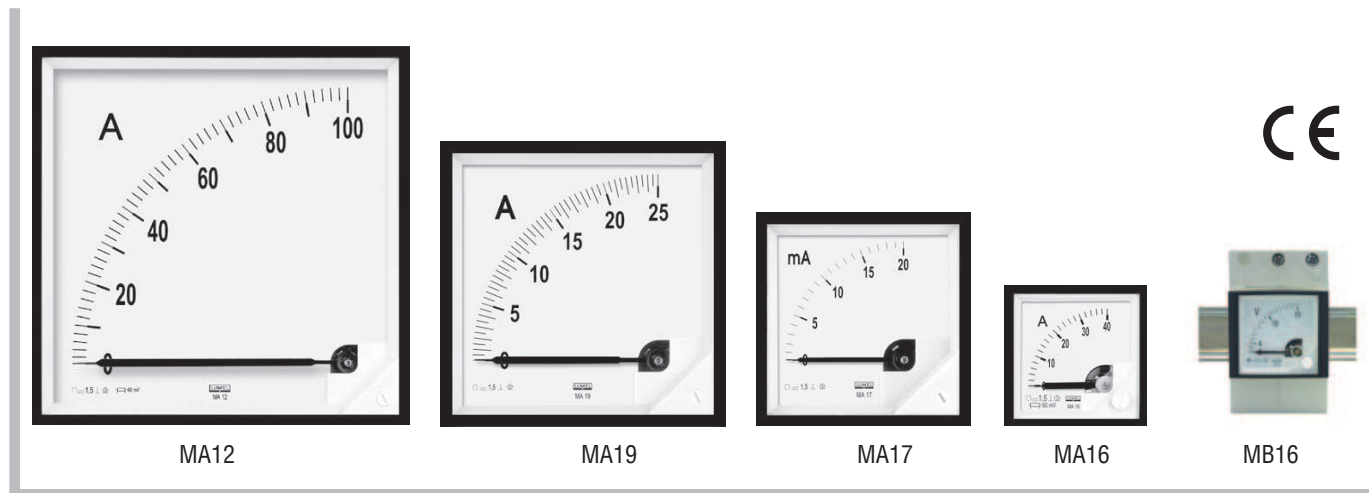


# MOVING-COIL METERS

## MA16, MB16, MA17, MA17P, MA19, MA19P, MA12, MA12P TYPES

### AMMETERS and VOLTMETERS



MA16, MB16, MA17, MA19 and MA12 moving-coil meters are intended for measuring d.c. voltage or d.c. current. These meters with built rectifiers can also be used for measuring a.c. voltages and a.c. currents. MA17P, MA19P, MA12P meters with built-in rectifiers are used for measurement of the rectified current or voltage arithmetical mean value and they are such calibrated that they indicate the RMS value at sinusoidal curve shape. The measurement of non-sinusoidal a.c. magnitudes results in additional errors.

MA16, MA17, MA17P, MA19, MA19P, MA12 and MA12P meters are designed for mounting into panels. MB16 meters are adapted for a fast assembly rail mounting (35 mm rail) in compliance with EN 60715 standard MA16, MA17 and MA19 meters are designed for interchangeable dials.

#### TECHNICAL DATA

<b>Accuracy class</b>	1.5
<b>Internal resistance, voltage drop, current or power consumption</b>	acc. tables 1, 2 and 3
<b>Adaptation of the meter measuring range to the range of interchangeable shunts or measuring transducers</b>	by changing of the dial: the dial is simply extracted with a suitable tool and replaced through the upper slot of the case <b>Note:</b> MA12 (144 x 144) meters are not provided for interchangeable dials

#### CATEGORIES OF METER CLIMATIC VERSIONS

If it is not written otherwise in the order, these meters are intended to use in moderate climatic conditions. Then, we do not place any symbol on the scale. On customers' request, meters can be adapted to use in conditions of a dry or wet tropical climat. Then, they are marked with the T III symbol.

#### Requirements concerning safety acc. EN 61010-1 standard:

*For MA16 and MB16 meters and meters with rectifiers:*

- maximal phase-earth working voltage 600 V
- installation category III
- pollution degree 2

*For MA17, MA19 and MA12 meters:*

- maximal phase-earth working voltage 600 V
- installation category III
- pollution degree 2

#### Protection Grade acc. to EN 60529

- in standard option:
  - IP 50 for MA16, MA17, MA17P, MA19, MA19P, MA12, MA12P meters
  - IP 54 (only for MA12 and MA12P meters)
  - IP 52 (only for MB16 meter)
- with IP 65 front protection grade (on request):
  - for MA16, MA17, MA17P, MA19, MA19P meters
- IP 20 terminal protection (with a terminal protective cover)

<b>Case material</b>	thermoplastic material
<b>Meter glass material</b>	glass
<b>Additional setting pointer</b>	On customers' request MA17 and MA19 meters can be equipped with an additional, setting red pointer fixed on the glass.

#### ACCESSORIES

We deliver with the meter:

- screw holders (for standard options)..... 2 pcs
- screw holders (for IP65 option) ..... 4 pcs
- terminal protection cover ..... 1 pc
- spring holders (only for MA16) ..... 2 pcs

**Note:** MB16 meters do not have terminal protective cover.

We can also deliver on request, interchangeable shunts of B2, B3, B4, B5 and B5 types.

## DC CURRENT AND DC VOLTAGE RANGES, INTERNAL RESISTANCE OR VOLTAGE DROP

Table 1

Frontal frame dimensions [mm]	48 x 48 <sup>1)</sup>		72 x 72		96 x 96		144 x 144	
Scale length [mm]	42		61		95		160	
Weight [kg]	0.15		0.2		0.25		0.4	
Type	MA16, MB16		MA17		MA19		MA12	
Internal resistance $\pm 20\%$ , voltage drop or current consumption								
Measuring range	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale
40 $\mu\text{A}$	5000 $\Omega$	5000 $\Omega$						
60 $\mu\text{A}$	5000 $\Omega$	2050 $\Omega$						
100 $\mu\text{A}$	2050 $\Omega$	945 $\Omega$	5 k $\Omega$	2.2 k $\Omega$	5 k $\Omega$	2.2 k $\Omega$	5.8 k $\Omega$	5.8 k $\Omega$
150 $\mu\text{A}$	945 $\Omega$	898 $\Omega$	5 k $\Omega$	2.2 k $\Omega$	5 k $\Omega$	2.2 k $\Omega$	5.9 k $\Omega$	2.6 k $\Omega$
250 $\mu\text{A}$	898 $\Omega$	312 $\Omega$	2.2 k $\Omega$	580 $\Omega$	2.2 k $\Omega$	580 $\Omega$	2.6 k $\Omega$	1.1 k $\Omega$
400 $\mu\text{A}$	312 $\Omega$	120 $\Omega$	1.6 k $\Omega$	225 $\Omega$	1.6 k $\Omega$	225 $\Omega$	1.1 k $\Omega$	300 $\Omega$
600 $\mu\text{A}$	120 $\Omega$	60 $\Omega$	583 $\Omega$	78.3 $\Omega$	583 $\Omega$	78.3 $\Omega$	783 $\Omega$	350 $\Omega$
1 mA	60 $\Omega$	66 $\Omega$	225 $\Omega$	21 $\Omega$	225 $\Omega$	21 $\Omega$	300 $\Omega$	140 $\Omega$
1.5 mA	33 $\Omega$	15.5 $\Omega$	76.7 $\Omega$	17.4 $\Omega$	76.7 $\Omega$	17.4 $\Omega$	140 $\Omega$	63.4 $\Omega$
2.5 mA	15.5 $\Omega$	4.8 $\Omega$	20.8 $\Omega$	9.2 $\Omega$	20.8 $\Omega$	9.2 $\Omega$	62 $\Omega$	16 $\Omega$
4 mA	8.8 $\Omega$	4.8 $\Omega$	16.5 $\Omega$	9.3 $\Omega$	16.5 $\Omega$	9.3 $\Omega$	20 $\Omega$	6.3 $\Omega$
5 mA	4.8 $\Omega$	4.8 $\Omega$	12.4 $\Omega$	3.0 $\Omega$	12.4 $\Omega$	3.0 $\Omega$	15 $\Omega$	6.0 $\Omega$
6 mA	5.0 $\Omega$	3.5 $\Omega$	9.2 $\Omega$	3.0 $\Omega$	9.2 $\Omega$	3.0 $\Omega$	25 $\Omega$	3.4 $\Omega$
10 mA	3.2 $\Omega$	3.2 $\Omega$	3.3 $\Omega$	2.2 $\Omega$	3.3 $\Omega$	2.2 $\Omega$	6.0 $\Omega$	2.0 $\Omega$
15 mA	3.2 $\Omega$	2.2 $\Omega$	2.7 $\Omega$	2.0 $\Omega$	2.7 $\Omega$	2.0 $\Omega$	3.0 $\Omega$	2.0 $\Omega$
20 mA	2.2 $\Omega$	2.4 $\Omega$	2.0 $\Omega$	1.4 $\Omega$	2.0 $\Omega$	1.4 $\Omega$	2.0 $\Omega$	1.5 $\Omega$
25 mA	60 mV		2.1 $\Omega$	1.4 $\Omega$	2.1 $\Omega$	1.4 $\Omega$	2.0 $\Omega$	1.4 $\Omega$
40 mA	60 mV		60 mV		60 mV		60 mV	
60 mA	60 mV		60 mV		60 mV		60 mV	
100 mA	60 mV		60 mV		60 mV		60 mV	
150 mA	60 mV		60 mV		60 mV		60 mV	
250 mA	60 mV		60 mV		60 mV		60 mV	
400 mA	60 mV		60 mV		60 mV		60 mV	
600 mA	60 mV		60 mV		60 mV		60 mV	
1 A	60 mV		60 mV		60 mV		60 mV	
1.5 A	60 mV		60 mV		60 mV		60 mV	
2.5 A	60 mV		60 mV		60 mV		60 mV	
4 A	60 mV		60 mV		60 mV		60 mV	
6 A	60 mV		60 mV		60 mV		60 mV	
10 A	60 mV		60 mV		60 mV		60 mV	
15 A	60 mV		60 mV		60 mV		60 mV	
20 A	60 mV		60 mV		60 mV		60 mV	
25 A	60 mV		60 mV		60 mV		60 mV	
4...20 mA	3.2 $\Omega$		2.7 $\Omega$		2.7 $\Omega$		3.0 $\Omega$	
For shunt connection								
... A/60 mV	10 mA		10 mA		10 mA		10 mA	
...A/150 mV	5 mA		5 mA		5 mA		5 mA	
60 mV	10 mA		10 mA		10 mA		10 mA	
100 mV	10 mA		10 mA		10 mA		10 mA	
150 mV	5 mA		5 mA		5 mA		5 mA	
250 mV	5 mA		2.5 mA		2.5 mA		5 mA	
400 mV	1000 $\Omega/V$		1.5 mA		1.5 mA		2.5 mA	
600 mV	1000 $\Omega/V$		1.5 mA		1.5 mA		1.5 mA	

**Table 1 (continuation)**

Type	MA16, MB16		MA17		MA19		MA12	
Internal resistance $\pm 20\%$ , voltage drop or current consumption								
Measuring range	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale	zero on the side of the scale	zero in the middle of the scale
1 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
1.5 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
2.5 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
4 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
6 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
10 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
15 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
25 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
40 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
60 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
100 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
150 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
250 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
300 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
400 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
500 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
600 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
800 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
1000 V	1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
To co-operate with an external resistor D2								
1500 V	–		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	
2500 V	–		1000 $\Omega/V$		1000 $\Omega/V$		1000 $\Omega/V$	

\*) Concerns MA16 meters: frontal dimensions, see fig.1

**DC MEASURING RANGES WITH EXTERNAL SHUNTS**
**Table 2**

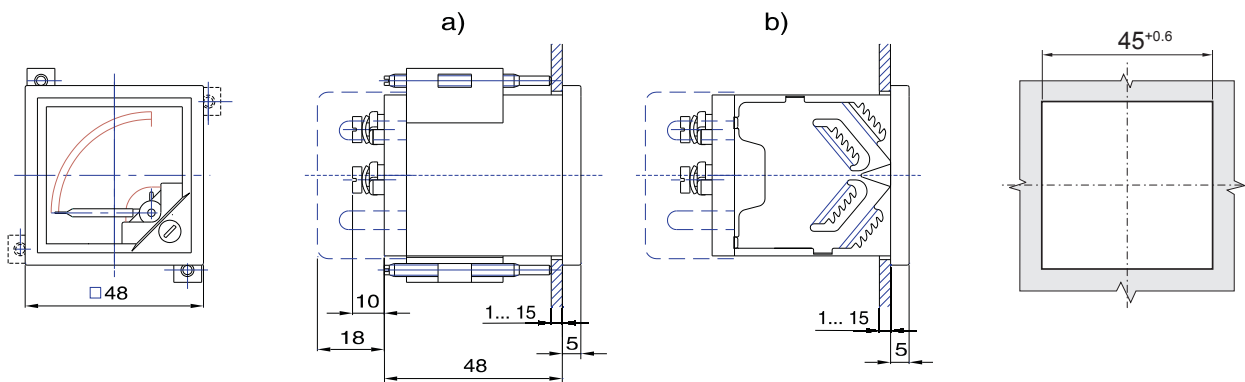
1 A 1.5 A 2.5 A 4 A 6 A 10 A 15 A 25 A 40 A 60 A 100 A 150 A 250 A 400 A 600 A 1 kA 1.5 kA 2.5 kA 4 kA 6 kA 10 kA 15 kA	<ol style="list-style-type: none"> <li>Measuring movement current considered when calibrating shunts: B2 - 60 mV – 10 mA B3 - 150 mV – 5 mA</li> <li>Resistance of conductors linking the meter with the shunt: 0.035 <math>\Omega</math></li> <li>After agreeing with the producer it is possible to offer shunts with following standardized voltage drops: 50 mV, 75 mV, 100 mV</li> <li>Further particulars on shunts are contained in the catalogue: Interchangeable shunts</li> </ol>
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**AC MEASURING RANGES**

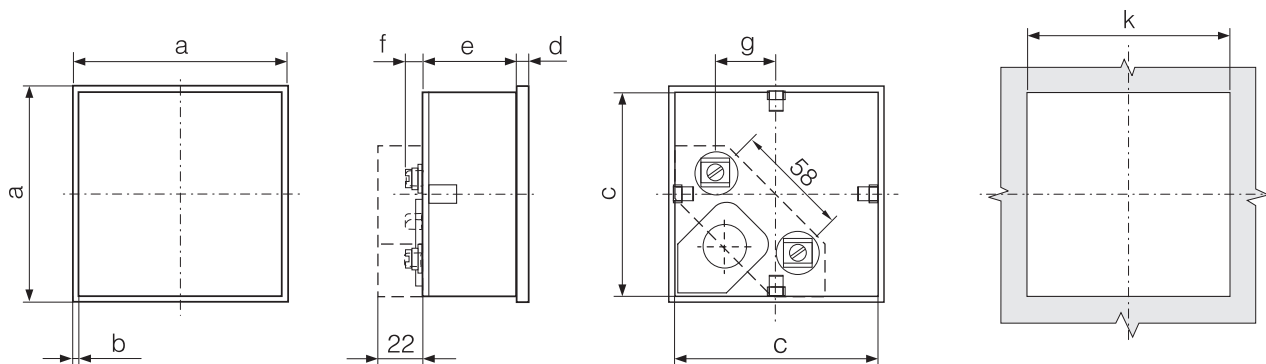
Table 3

Frontal frame dimensions [mm]	72 x 72	96 x 96	144 x 144	Notes
Scale length [mm]	61	95	160	
Weight [kg]	0.2	0.25	0.4	
Type	MA17P	MA19P	MA12P	
Measuring range	Drop voltage or power consumption (self-consumption)			
400 $\mu$ A	1.7 V	1.7 V	1.6 V	Rated operational range for frequency <u>30...1000...10 000 Hz</u>
600 $\mu$ A				
1 mA				
1.5 mA				
2.5 mA				
4 mA				
6 mA				
10 mA				
15 mA				
25 mA				
40 mA				
60 mA				
100 mA				
150 mA				
250 mA				
400 mA				
500 mA				
2.5 mA				
600 mA				
1 A				
1 A	5 mW	5 mW	–	Rated operational range for frequency <u>49...50...51 Hz</u>
1.5 A				
2.5 A				
4 A				
5 A				
6 A				
60 mV				
100 mV				
150 mV				
250 mV				
400 mV				
600 mV				
1 V				
1.5 V				
2.5 V	1000 $\Omega/V$	1000 $\Omega/V$	1000 $\Omega/V$	Rated operational range for frequency <u>30...1000...10 000 Hz</u>
4 V				
6 V				
10 V				
15 V				
25 V				
40 V				
60 V				
100 V				
150 V				
250 V				
400 V				
500 V				
600 V				

### METER EXTERNAL DIMENSIONS

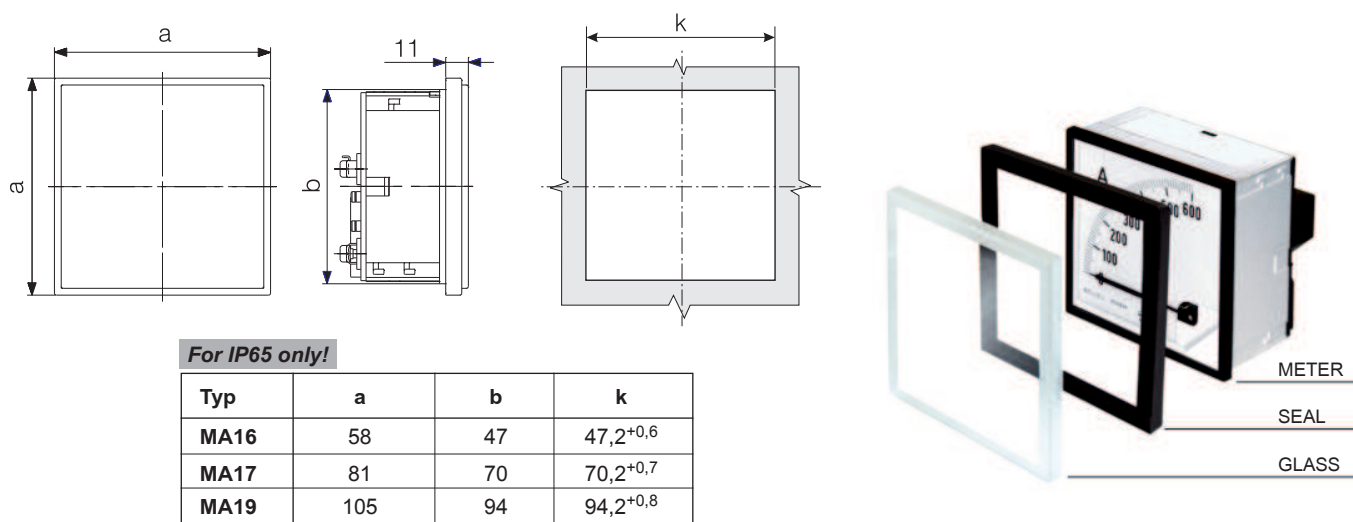


**Fig. 1. External dimensions of MA16 meters**  
 a) with screw holders  
 b) with spring holders



Typ	a	b	c	d	e	f	g	k
mm								
MA17	72	4	68 <sup>-0,3</sup>	5	45	10... 20	20,5	68 <sup>+0,7</sup>
MA19	96	4	92 <sup>-0,3</sup>	5	45	10... 20	32,5	92 <sup>+0,8</sup>
MA12	144	4,5	137,3 <sup>-0,5</sup>	6	48	10... 20	55,5	138 <sup>+1,0</sup>

**Fig. 2. External dimensions of MA17, MA19 and MA12 meters**



**For IP65 only!**

Typ	a	b	k
MA16	58	47	47,2 <sup>+0,6</sup>
MA17	81	70	70,2 <sup>+0,7</sup>
MA19	105	94	94,2 <sup>+0,8</sup>

**Fig. 3. External dimensions of meters with IP 65 protection grade**

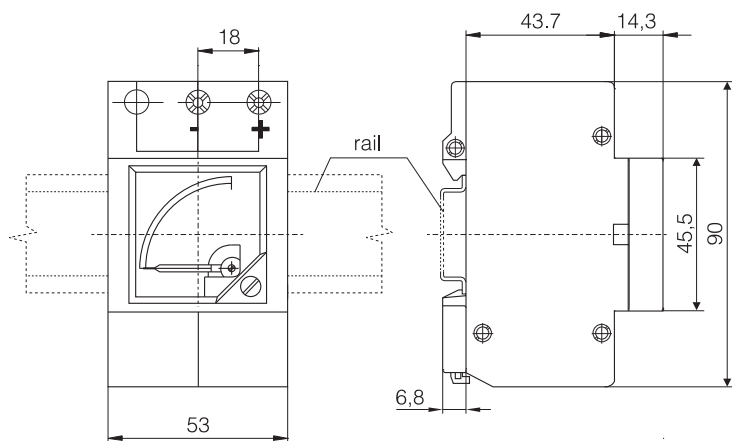


Fig. 4. External dimensions of MB16 meters

### FASTENING ON PANELS

#### MA16 meters

The meters are adapted to be mounted from the front of panels and then they are equipped with two spring holders, which can be fixed on arbitrary opposite case sides (Fig. 1b) or to be mounted from the rear of panels and then they are equipped with two screw holders which can be fixed on arbitrary, opposite case corners (Fig. 1a).

#### MA17, MA19 and MA12 meters

In their basic execution these meters are adapted to be mounted from the rear of panels by means of two screw holders which can be fixed on arbitrary opposite case corners (Fig. 5).

#### Execution of meters with IP 65

The meter is fixed in the panel by means of 4 screw holders.

After agreeing with the manufacturer, MA17 and MA19 meters can be delivered with a snap fastened frontal frame and then these meters can be mounted from the front of panels by means of two spring holders fixed on arbitrary opposite case sides.

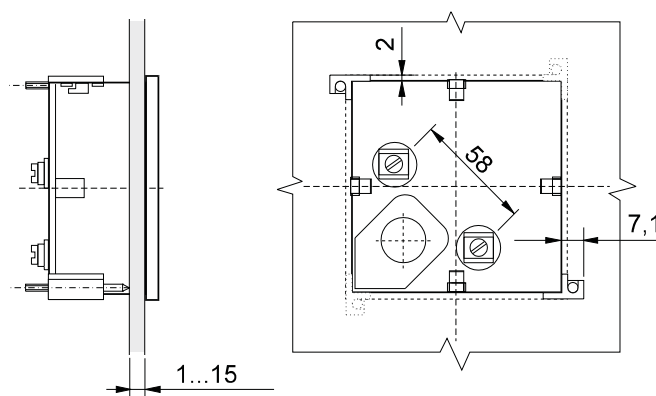


Fig. 5. Fixing of meters in the panel

### CODING OF THE WORKING POSITION

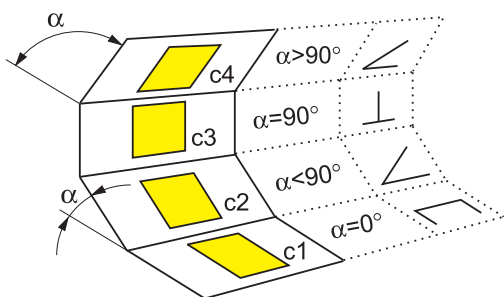


Table 4

Code	Working position
O	c3, $\alpha = 90^\circ$
A	c1, $\alpha = 0^\circ$
B	c2, $\alpha = 15^\circ$
C	c2, $\alpha = 30^\circ$
D	c2, $\alpha = 45^\circ$
E	c2, $\alpha = 60^\circ$
F	c2, $\alpha = 75^\circ$
H	c4, $\alpha = 105^\circ$
I	c4, $\alpha = 120^\circ$

Table 5  
(only for MA16)

Code	Working position
A	c3, $\alpha = 90^\circ$
B	c1, $\alpha = 0^\circ$
C	c2, $\alpha = 15^\circ$
D	c2, $\alpha = 30^\circ$
E	c2, $\alpha = 45^\circ$
F	c2, $\alpha = 60^\circ$
G	c2, $\alpha = 75^\circ$
H	c4, $\alpha = 105^\circ$
I	c4, $\alpha = 120^\circ$

### ORDERING PROCEDURE

In the order one must specify: name and type of meter, measuring range, shunt data if the meter is foreseen to co-operate with an interchangeable shunt, working position, kind of climat (only for tropical versions), kind of holders and eventual additional requirements. One must order interchangeable shunts or D2 series resistors. When ordering meters for measuring a.c. current or a.c. voltage, one must add to the meter name „rectifier” - (rectifier meter)

#### Example of order:

MA16 ammeter, 40 A, c2 30, TIII, screw holders, 0...40 A range IP54, B2/60 mV- 40 A shunt, IP65.

- MA16** – moving-coil meter (48 x 48 mm),
- 40 A** – 40 A range,
- c2 30** – working position 30° with relation to horizontal position (table 5),
- TIII** – design and materials adapted to specific tropical klimat,
- Screw holders** – type of holders (screw or spring-holders),
- 0...40 A** – measuring range on the dial,
- B2/60 mV/ 40 A** – to co-operate with a 40 A shunt of B2 type
- IP 54** – protection grade of the casting front