



**ELECTRICITY MEASUREMENT,
COMPENSATION, POWER CONTROL
AND TRACKING SYSTEMS**

Contents

Meters _____	02-03
Singlephase Electronic Electricity Meters _____	04-06
Threephase Electronic Electricity Meters _____	07-11
Industrial Electronic Electricity Meters _____	12-16
Usobim _____	17-19
Wport2 Gsm-Gprs/NPort-ET Modem/Gateway_	20-21
E Port Ethernet Gateway _____	22
Optus USB Optic Reader _____	23
Electrical Measuring and Control Equipments _____	24
Reactive Power Compensation Relay _____	25-27
Thyristor Driver _____	28-35
Multimeter / Ampermeter / Voltmeter _____	36-39
Network Analyzer _____	40-41
Motor Protection Relays _____	42-43
Current Protection Relays _____	44-45
Voltage Protection Relays _____	46-47
Liquid Level Control Relays _____	48-49
Time Relays _____	50-55
Photocell Relays _____	56-57
Protection and Control Relays _____	58-59
Capacitors _____	60-63
Low Voltage Current Transformer _____	64-73
Shunt Reactor _____	74-79
Harmonic Filter _____	80-88

Meters

Makel has the broadest portfolio in the field of electronic electricity meters in Turkey. With its lowest return rates, high quality products, innovative unique rich features, superior customer service, Makel is the leader of the Turkish market in the field of electronic electricity meters.

Broad product portfolio

- ▶ Singlephase meters for residential and low consuming users,
- ▶ Threephase, direct and current transformer connected meters for medium-power commercial companies, offices, street lightings, big apartments and skyscrapers and such consumers
- ▶ Class 0.5 or class 1, direct connected or current transformer and/or voltage transformer connected active and reactive industrial meters for high consuming industries, hotels, Shopping malls, electricity production plants, Medium Voltage subscribers

100% test and verification

- ▶ All Makel products, from production to packaging are tested and verified 100% in 0.01 accuracy zero test system.

Compatibility to MID

All Makel meters conform European Union Measurement Instruments Directive (MID). Conformity of our meters are certified by notified bodies.

Wide LCD Screen with backlight

- ▶ Makel meters have large LCD screens. With backlight feature, even in dark environments our meters can easily be read from long distances.

Excess operating conditions

- ▶ Makel meters has protections over conformed standards. As an example, although surge tests defined as 4 kV in EN 50470-1 standards, Makel meters are applied to surge tests at 4.4 kV. Our meters are tested in 8 kV instead of 6 kV for isolation test. In regarding to EMI, Our meters are also tested under 30V/m EM field with current flowing through them. All our meters have IP54 protection class. Our meters also work between 40 and 60 Hz and operating voltage are far more than the ranges specified in standards.
- ▶ All makel meters can accurately measure between -40 and 85 degree Celsius. With this feature, they are unique in the market

Low time drift

- ▶ Makel meters are calibrated to compensate crystal frequency ppm error in production and continuously make temperature compensation while they are running.

Wide Load Profile

- ▶ Single Phase and Three phase meters have wide load profile records up to 2 years with 15 min sampling interval.
Industrial meters, depending on number of channels and directionality reaches up to one year load profile records capacity within 15 minutes interval.

Ready for AMI/AMR systems

- ▶ All meters equipped with RS485 interfaces which provide necessary communication interfaces for AMI/AMR applications. Using Makel Wport2, NPort-ET, Eport and Pport modems and gateways, meters can be easily integrated to MAKEL USOBIM AMR system.

General View

Rich content, ergonomic LCD screen with backlight

High temperature coefficient polycarbonate body and terminal

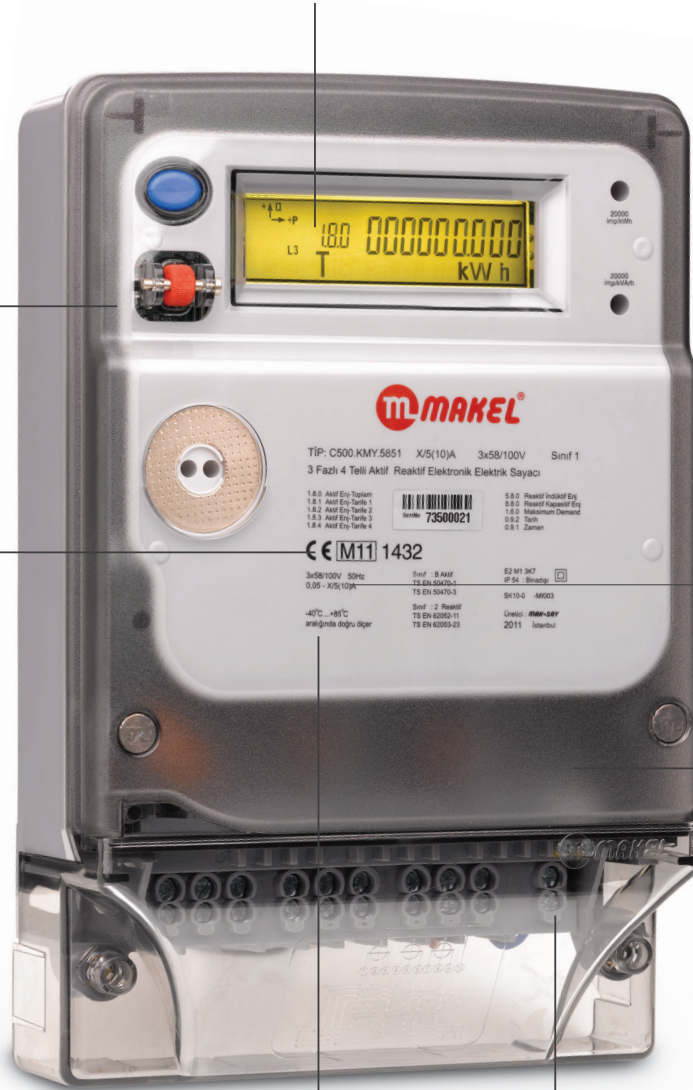
Compliant to EU MID directive

High-accuracy meters including class 0.5

Ten years battery life

Widest operating temperature range in its field (-40 °C ile +85 °C)

Improved high voltage protection over standards



Singlephase Electronic Electricity Meters



M560



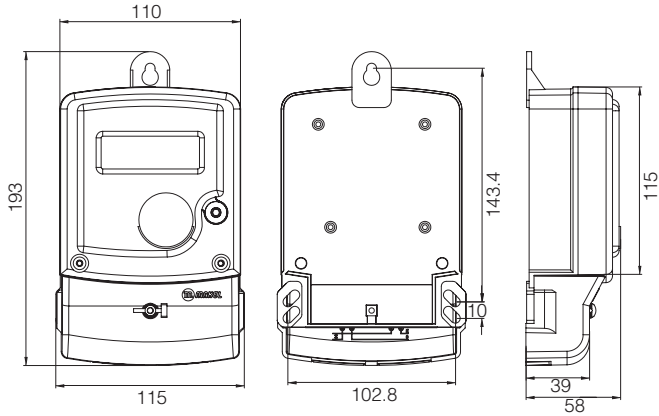
M600

You are one step ahead, with its backlighted wide screen, load profile capability, very low time drift by temperature and crystal calibration

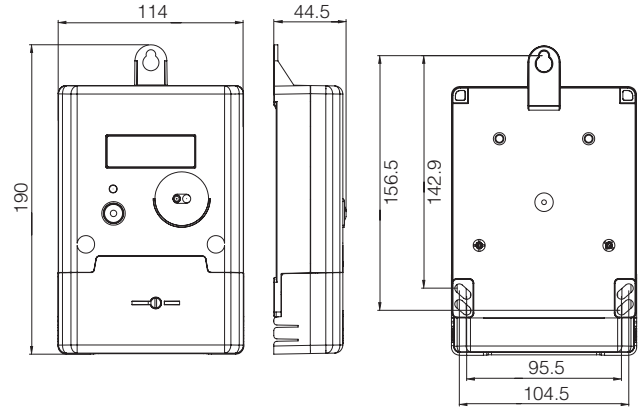
General Specifications

- ▶ Class B (1%) accuracy (EN 50470-1, EN 50470-3) when measuring active energy.
- ▶ Splits day into 8 time slices; measuring consumed energy in 4 different tariffs; weekdays, Saturday and Sunday can be programmed separately.
- ▶ Keeps information on permanent memory without the need for energy.
- ▶ Wide LCD screen showing consumed energy according to tariffs and error notices.
- ▶ Battery weakening, real time clock corruption, main cover and terminal cover intervention can be seen on LCD as flashing symbols and with their code numbers.
- ▶ 10 year lifetime lithium battery protects clock and the other information against power cut.
- ▶ Supports EN 62056-21 protocol on optic port and RS485 port for communication and programming needs.
- ▶ The information can also be read in power cut condition from LCD screen using button and via communication on optic port thanks to a secondary 10 year lifetime lithium battery.
- ▶ Keeps energy values of actual and previous 12 periods in memory.
- ▶ It has 1 hour / 30 days or optional 15 min / 2 years load profile
- ▶ Calculates demand in every 15 minutes.
- ▶ 150V-300V wide operating voltage range.
- ▶ The real time clock has 0,5sec/day precision. Temperature and crystal compensation is done to prevent real time clock's time drifts.
- ▶ Actual current and voltage can be seen on the screen.
- ▶ It is easy to read metering information even in the dark, thanks to the backlight of the LCD screen.
- ▶ An optional RS485 communication port is available for AMI/AMR applications.
- ▶ All single phase meters are MID compliant.
- ▶ Operating temperature range is between -40°C to 85°C.
- ▶ Optional Circuit Breaker Relay
- ▶ Communication icons indicates on the screen
- ▶ RS485 communication (optional)

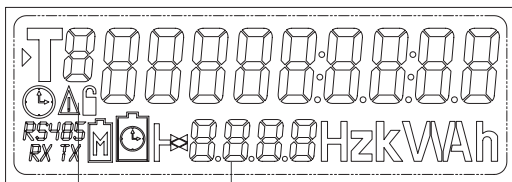
Outline Dimensions (M560)



Outline Dimensions (M600)



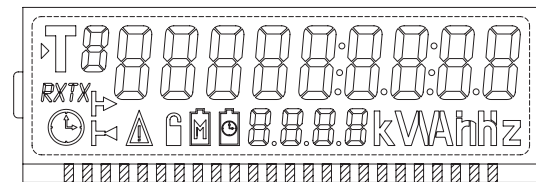
LCD Screen (M560)



Tariff codes
T, T1, T2, T3, T4

Obis codes

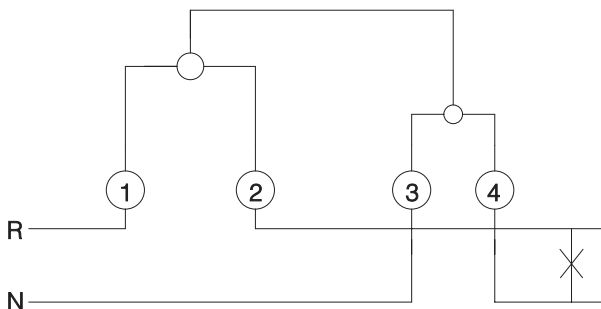
LCD Screen (M600)



Explanation of LCD Icons (M550 / M600)

	Battery low alarm
	Real time clock error alarm
	Terminal cover opened alarm
	Main cover opened alarm
	Current tariff indicator
	Maximum demand indicator

Wiring Diagram (M560/M600)

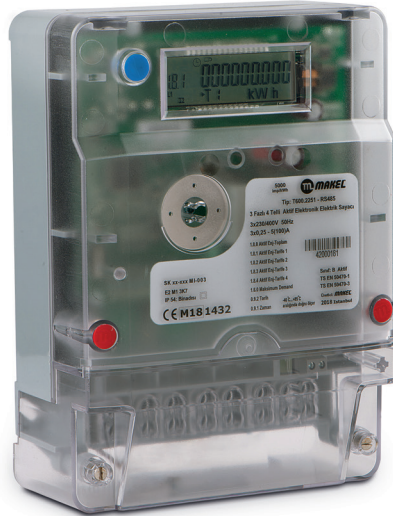


Technical Specifications

Specifications	Model No	
	M560.2251S M600.2251	M600.2251T M560.2251
Nominal Voltage	220 V or 230 V	220 V or 230 V
Operating Voltage Range	150 V~300 V	150 V~300 V
Nominal (Base) Current	5 A	5 A
Maximum Current	100 A	100 A
Minimum Current	250 mA	250 mA
Starting Current	20 mA	20 mA
Meter Constant	Active 3000, 3000, 5000 imp/kWh	5000, 3000 imp/kwh
	Reactive -	-
Accuracy (Class)	Active B (Class 1)	B (Class 1)
Directionality	One Way	Two-Way
Frequency	50 Hz ± 10%	50 Hz ± 10%
IP Protection Class	IP54	IP54
Protection Class	II	II
EMC Class	E2	E2
Mechanical Class	M1	M1
Humidity Ratio	<95%	<95%
Operating Temperature Range	-40°C~+85°C	-40°C~+85°C
Storage Temperature Range	-40°C~+85°C	-40°C~+85°C
Power Consumption in Voltage Circuit	< 2W 10 VA	< 2W 10 VA
Power Consumption in Current Circuit	< 4 VA	< 4 VA
Real Time Clock Battery (Lithium)	3,6 V 1,2 Ah	3, 6 V 1, 2 Ah
Meters Voltage Battery	Voltage 3 V	3 V
	Capacity 195 mAh	195 mAh
Battery Lifetime	10 Years /4 years shelf life	10 Years /4 years shelf life
Real Time Clock	Sensibility 0,5 sec./day	0,5 sec./day
	Temperature and Frequency Yes	Yes
	Calibration Yes	Yes
Communication	-/RS485 ops	- /RS485
Optical Communication	EN 62056- 21	EN 62056-21
Load Profile	Total Record Duration 30 days (optional 2 years)	30 days (optional 2 years)
	Channel Count 1	1
	Record Interval 1 hour	1 hour
Current Line Connection	Direct	Direct
LCD Display	Digit Count 9 (6+3) digit	9 (6+3) digit
	Lifetime 10 Year	10 Year
	Backlight Yes	Yes
	Menu Constant	Constant
	Current and Voltage Display Yes	Yes
	for each Phase Yes	Yes
Tariff	Count 4	4
Number of Time Slices	8	8
Log Record	Yes	Yes
Circuit Breaker	100 A optional	-



T510



T600 Smart Ready



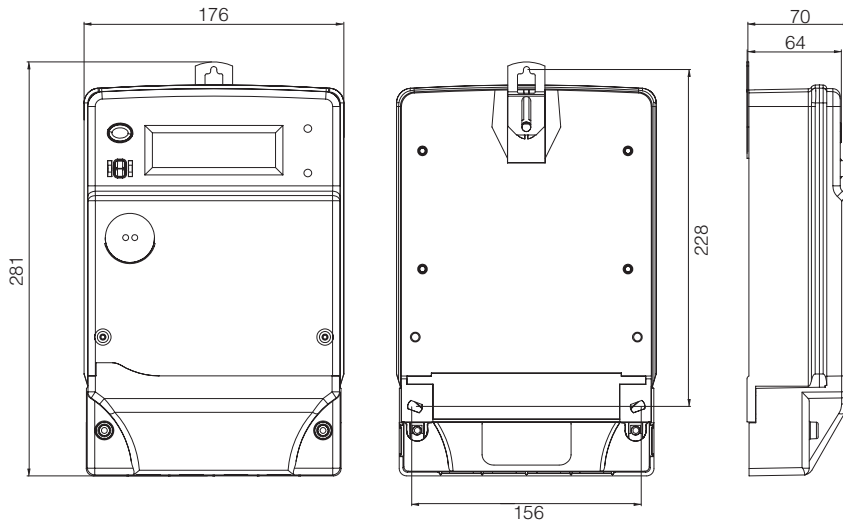
T600 Smart meter

General Specifications

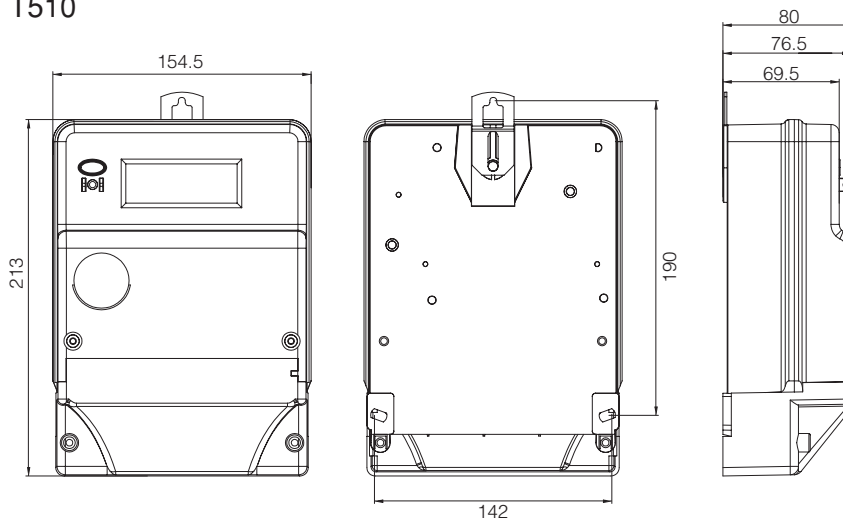
- ▶ Class B (1%) accuracy (TS EN 50470-1, TS EN 50470-3) when measuring active 3 phase energy.
- ▶ T600 series are smart ready meters which can be ordered with smart extension feature. It enables low initial investment in deployments of meters to be smart later with new technologies. Embedded communication modules for T600 are WPort2-IT, NPort-IT and Pport-G3-IT currently. LoRA and other technology solutions will be available in future.
- ▶ Splits day into 8 time slices; measuring consumed energy in 4 different tariffs; weekdays, Saturday and Sunday can be programmed separately.
- ▶ 10 year lifetime lithium battery protects time and date information against power cut.
- ▶ Keeps information on permanent memory for 100 years without the need for energy.
- ▶ LCD screen showing consumed energy according to tariffs and error notices.
- ▶ Battery weakening, real time clock corruption, absence of one of the phases, wrong phase sequence, reverse current direction main cover and terminal cover intervention can be seen on LCD as flashing symbols and with their code numbers.
- ▶ Supports TS EN 62056-21 protocol on optic port for communication and programming needs.
- ▶ An optional RS485 communication port is available for AMI/AMR applications.
- ▶ Daylight saving time (DST) configuration is supported.
- ▶ The information can also be read in power cut condition from LCD screen using button and via communication on optic port thanks to a secondary 10 year lifetime lithium battery.
- ▶ Keeps energy values of actual and previous 12 periods in memory.
- ▶ Maximum demand is calculated by its demand meter. Demand calculation period can be adjusted to 5, 10, 15, 30, 45 or 60 minutes.
- ▶ From 1 minute to 60 minute intermittently, up to 90 days long, 3 or 5 channels load profile.
- ▶ The meter has current transformers inside. These current transformers have lifetime accuracy guarantee and advantages like very low energy consumption and isolation from the mains
- ▶ Meters with X/5 current transformer models are available.
- ▶ Easy to read metering information even in the dark, thanks to the backlight of the LCD screen.
- ▶ All three phase meters are MID compliant.
- ▶ From 150V to 300V (3x220/380V) accurate metering.
- ▶ Operating temperature range is from -40°C to 85°C.
- ▶ Bidirectional models available.

Outline Dimensions

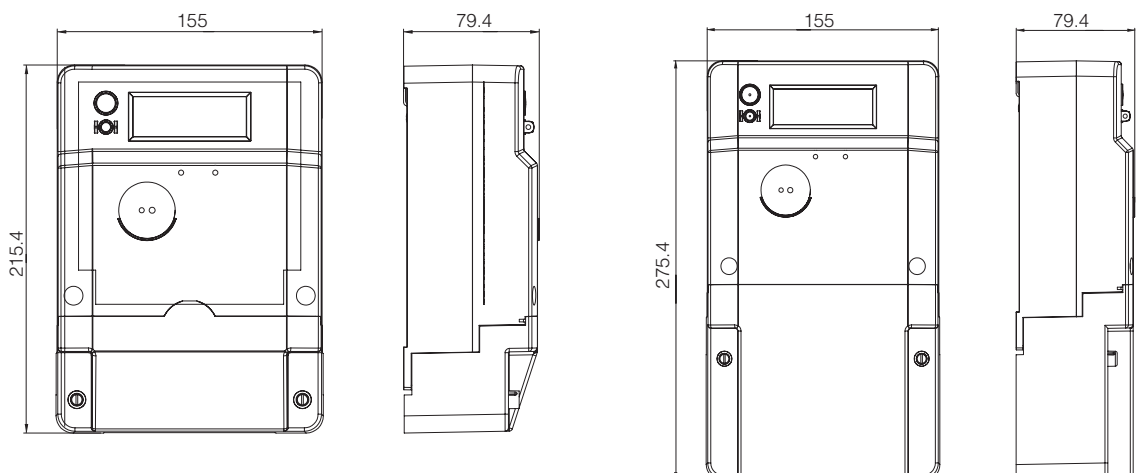
C520.K0Y / C520.K0T / C500.K0Y / C500.K0T



T510

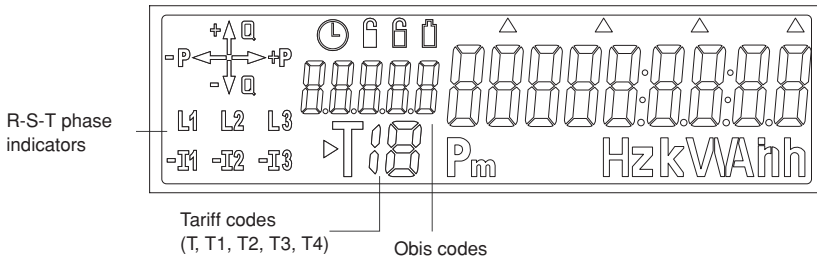


T600



LCD Screen

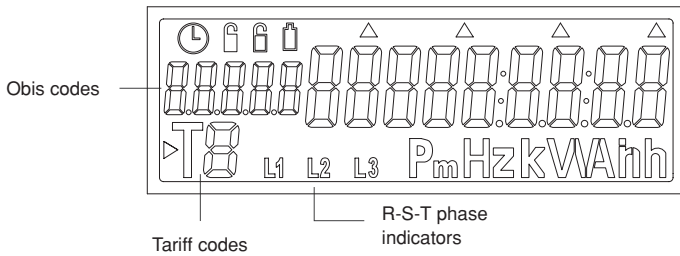
C500.KOY - C500. KOT



Coding Explanations

	Battery low alarm
	Real time clock error alarm
	Main cover opened alarm
	Terminal cover opened alarm
	Maximum demand indicator

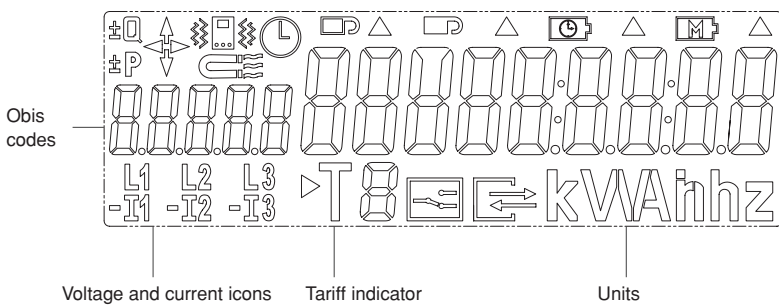
T510



Coding Explanations

	Battery low alarm
	Real time clock error alarm
	Main cover opened alarm
	Terminal cover opened alarm
	Maximum demand indicator

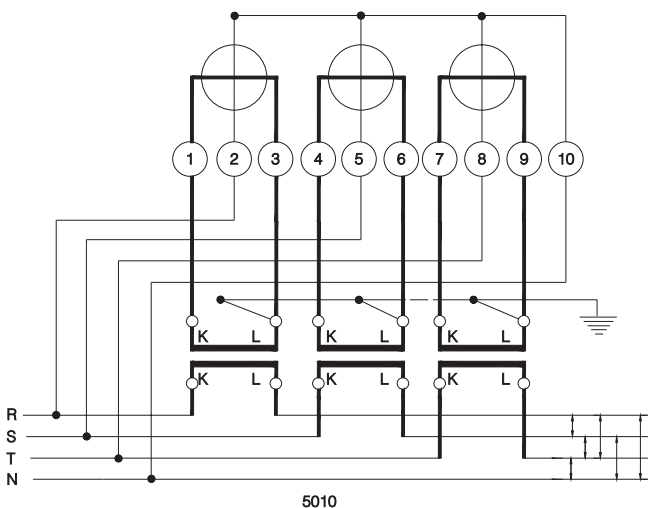
T600



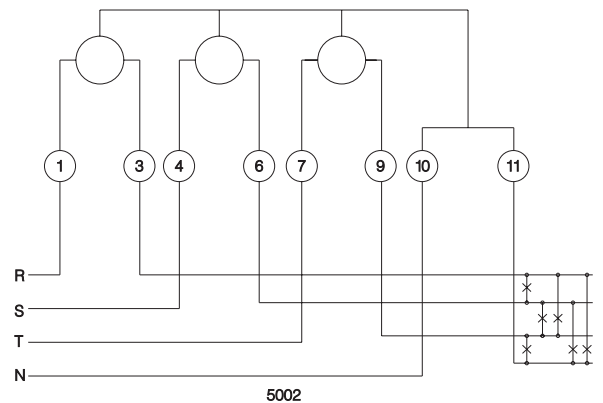
Coding Explanations

	Battery low alarm
	Real time clock error alarm
	Main cover opened alarm
	Terminal cover opened alarm
	It displays magnetic field detection

Current Transformer Connected Meters



Direct Connected Meters



Technical Specifications

Specifications		Model No		
		T510.2256 T600.2256	T510.2251 T600.2251	T510.2510
Nominal Voltage		3x220/380 V	3x220/380 V or 3x230/400V	3x220 / 380 V
Operating Voltage Range		150 V~300 V	150V~300V	150V~300V
Nominal (Base) Current		5 A	5A	X / 5 A
Maximum Current		60 A	100 A	10A
Minimum Current		250 mA	250 mA	50 mA
Starting Current		20 mA	20 mA / 20mA	10 mA
Meter Constant	Active	1000 imp/kWh	1000 imp/kWh	5000 imp/kWh
Accuracy (Class)	Active	B (Class 1)	B (Class 1)	B (Class 1)
Frequency		50 Hz ± 10%	50 Hz ± 20%	50 Hz ± 20%
IP Protection Class		IP54	IP54	IP54
Protection Class		II	II	II
EMC Class		E2	E2	E2
Mechanical Class		M1	M1	M1
Humidity Ratio		<95%	<95%	<95%
Operating Temperature Range		-40°C~+85°C	-40°C ~ +85°C	-40°C ~ +85°C
Storage Temperature Range		-40°C~+85°C	-40°C ~ +85°C	-40°C ~ +85°C
Power Consumption in Voltage Circuit		< 2W 10 VA	< 2W 10 VA	< 2W 10 VA
Power Consumption in Current Circuit		< 4 VA	< 4 VA	< 4 VA
Real Time Clock Battery (Lithium)		3,6 V/1.2 Ah	3,6 V/ 1.2 Ah	3,6 V/ 1.2 Ah
Battery Lifetime		10 Years /4 Years	10 Years /4 Years	10 Years /4 Years
Real Time Clock	Accuracy	TS EN 61038	TS EN 61038	TS EN 61038
	Temperature and Frequency Calibration	Yes	Yes	Yes
DST Application		Yes	Yes	Yes
Communication	EN 62056-21	RS485 ops	RS485 (opt)	RS485 (opt)
Optical Communication		EN 62056- 21	EN 62056-21	EN 62056-21
Load Profile	Total Record Duration	60/2 Years	60/2 Years	60/2 Years
	Channel Count	3	3	3
	Record Interval	15 min	15 min	15 min
Current Line Connection		Direct	Direct	Current Transformer
LCD Display	Digit Count	9 (6+3) digit	9 (6+3) digit	9 (6+3) digit
	Lifetime	10 Year	10 Year	10 Year
	Backlight	-	Optional	Optional
	Menu	Constant	Constant	Constant
	Quadrant Display			
	VDEW 2.0	-	-	-
	Current and Voltage Display	Yes		
	for each Phase	Yes	-/Yes	-/Yes
Tariff	Count	4	4	4
	Holidays	Optional	-	-
Number of Time Slices		8	8	8
Season Structure		Optional	Optional	Optional
Alarm Relay		Optional	Optional	-
Magnetic Field Sensor		Optional	Optional	Optional
Harmonic Analysis		-	-	-
Circuit Breaker		Optional	Optional	-

Technical Specifications

Specifications		Model No
		C520.K0Y.2251
		C520.K0T.2251
Nominal Voltage		3x230/400 V
Operating Voltage Range		150 V~300 V
Nominal (Base) Current		5 A
Maximum Current		100 A
Minimum Current		250 mA
Starting Current		20 mA
Meter Constant	Active	1000 imp/kWh
	Reactive	-
Accuracy (Class)	Active	B (Class1)
	Reactive	-
Frequency		50 Hz \pm 10%
Measure Direction		One Way
		Two-way
IP Protection Class		IP54
Protection Class		II
EMC Class		E2
Mechanical Class		M1
Humidity Ratio		<95%
Operating Temperature Range		-40°C ~ +85°C
Storage Temperature Range		-40°C ~ +85°C
Power Consumption in Voltage Circuit		< 2W 10 VA
Power Consumption in Current Circuit		< 4VA
Real Time Clock Battery (Lithium)		3.6 V/1.2 Ah
Battery Lifetime		10 Years /4 Years (Storage)
Real Time Clock	Accuracy	TS EN 61038
	Temperature and Frequency	Yes
	Calibration	Configurable
DST Application		RS 232 / RS 485
Communication	EN 62056-21	EN 62056-21
Load Profile	Total Record Duration	120 days
		100 days
	Channel Count	3
		4
	Record Interval	1,5,10,15,20,30,60 dk.
Current Line Connection		Direct
LCD Display	Digit Count	9 (6+3) digit
	Lifetime	10 Year
	Backlight	Optional
	Menu	Constant / Dynamically Configurable
	Quadrant Display	-
	Current and Voltage Display	Yes
	for each Phase	
	frequency, Cos ϕ	
Tariff	Count	4 (Optional 16)
	Holidays	- / Yes (Optional)
Number of Time Slices		8 / (Optional 32)
Season Structure		- / Yes (Optional)
Alarm Relay		- / Yes (Optional)
Magnetic Field Sensor		- / Yes (Optional)
Harmonic Analysis		Yes
Log Record		Yes
Generator Detection Input		- / Yes (Optional)



C520

Single or bidirectional, CT or Direct connected, class 0.5 or class 1 Industrial Meters for Industries, hotels, shopping malls, power plants, MV subscribers, etc.

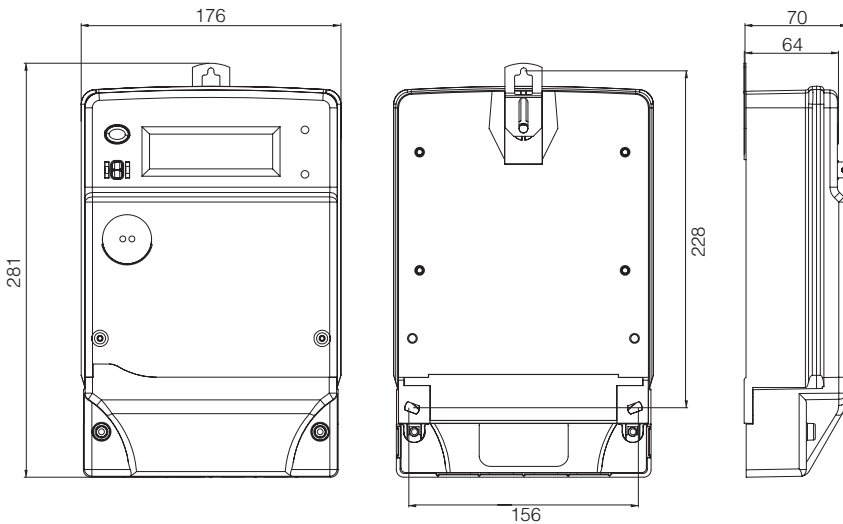
General Specifications

- ▶ Industrial (Combi) Electronic Electricity Metering Products, measures consumed active energy according to class B (%1) or class C (%0.5) (TS EN 50470-1, TS EN 50470-3) and reactive energy according to class 2 (TS EN 62053-23) in all 3 phases.
- ▶ Have ability to divide a week into 3 parts called “Week, Saturday,Sunday” and divide each part into 8 locals and calculate consumed energy in 4 different tariffs. (Some types have 16 tariffs, special tariff days and seasons).
- ▶ Date and time are prevented from electricity failures by lithium cell which has minimum 10 year battery life.
- ▶ Have a non-volatile memory that data remains over 100 years without energy.
- ▶ Have a wide lcd that displays consumed energy in each tariffs and fault notifications. (Some types of meters have dynamic menu.)
- ▶ Have the ability to display low battery, real time clock failure, power line failure, wrong ordered line, reversed current, main cover and terminal cover tampering.
- ▶ Have optical port interface that supports TS EN 62056-21 standard.
- ▶ Have RS485/RS232 ports to support AMI/AMR systems.
- ▶ Have the ability to make DST (Daylight saving time) automatically. It can be enabled/disabled dynamically by user.
- ▶ Have ability to read data from lcd by pressing button or communication interface on electricity breaks.
- ▶ Current and past 12 month period data are saved into non-volatile memory.
- ▶ Have the ability to measure maximum demands that can be programmed as 5, 10, 15, 30, 45, 60 minutes dynamically.
- ▶ Have 3 or 5 channels wide range load profile that supports up to 90 days with programmable period between 1-60 minutes.
- ▶ Current transformers, used as metering component, have guaranteed to save metering sensivity in all time.
- ▶ Additionally they have no power consumption and provide isolation from power line.
- ▶ Current “Voltage, current, frequency and $\cos\phi$ ” values of each phases are shown on lcd displays.

- ▶ Have types that include “X/5 Current” and “voltage” transformers.
- ▶ With an lcd backlight, it's easy to read data from meters in dark places.
- ▶ Have types that support magnetic tamper detection.
- ▶ Have types that support WDEV 2.0 quadrant indication and harmonic analysis.
- ▶ %0.5 class products support bidirectional and high accuracy metering.
- ▶ Operates between 150V - 300V (3x220/380V) and 40V -75V (3x58/100V) voltages.
- ▶ Operates between temperatures -40 and 85 °C.
- ▶ Generator detection input is provided optionally.

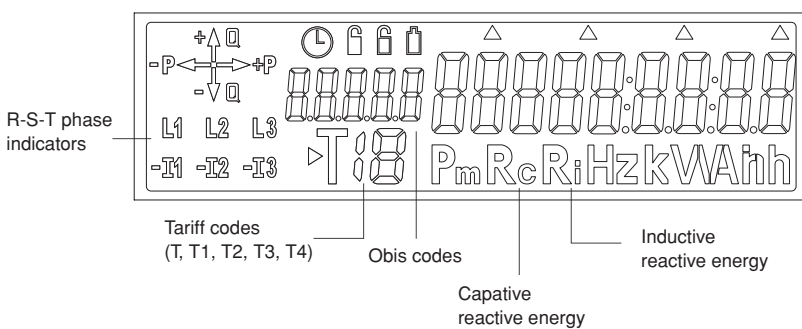
Outline Dimensions

C520 - C500 - C510



LCD Screen

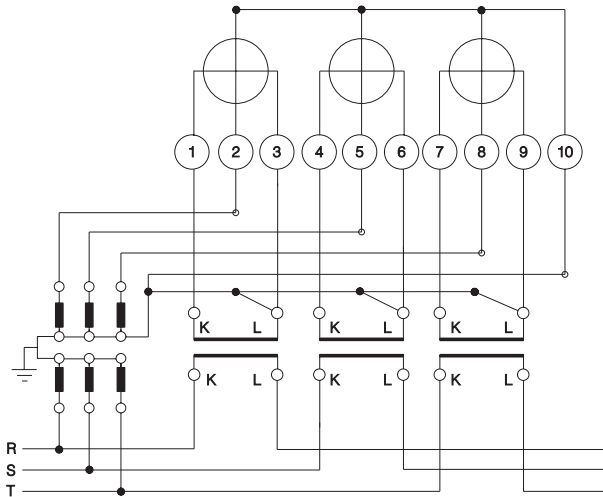
C520 - C500 - C510



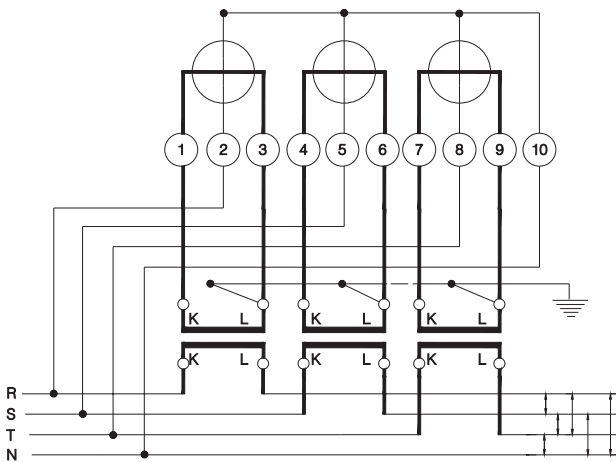
Coding Explanations

	Battery low alarm
	Real time clock error alarm
	Main cover opened alarm
	Terminal cover opened alarm
	Current tariff indicator
	Maximum demand indicator

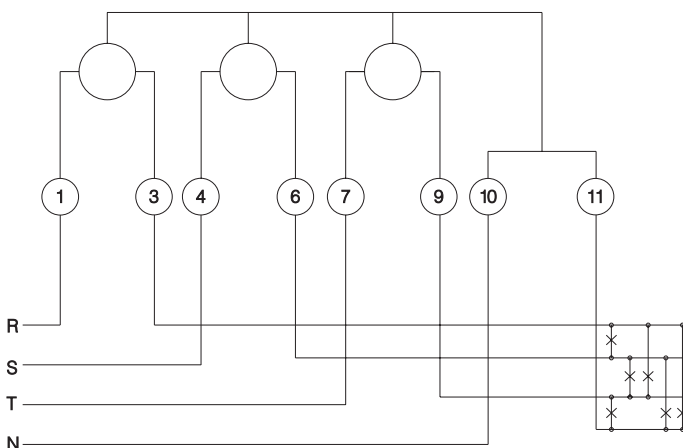
Current And Voltage Transformer Connected Meters



Current Transformer Connected Meters



Direct Connected Meters



Technical Specifications

Specifications		Model No	
		C520.KMY.2251 C520.KMT.2251	C520.AMY.2251 C520.AMT.2251
Nominal Voltage		3x230/400 V	3x230/400 V
Operating Voltage Range		150 V~300 V	150 V~300 V
Nominal (Base) Current		5 A	5 A
Maximum Current		100 A	100 A
Minimum Current		250 mA	150 mA
Starting Current		20 mA	20 mA
Meter Constant	Active	1000 imp/kWh	1000 imp/kWh
	Reactive	1000 imp/ kVArh	1000 imp/ kVArh
Accuracy (Class)	Active	B(Class1)	C(Class 0,5)
	Reactive	Class 2	Class 2
Frequency		50 Hz ± 10%	50 Hz ± 10%
Measure Direction		One Way	One Way
		Two-way	Two-way
IP Protection Class		IP54	IP54
Protection Class		II	II
EMC Class		E2	E2
Mechanical Class		M1	M1
Humidity Ratio		<95%	<95%
Operating Temperature Range		-40°C ~ +85°C	-40°C ~ +85°C
Storage Temperature Range		-40°C ~ +85°C	-40°C ~ +85°C
Power Consumption in Voltage Circuit		< 2W 10 VA	< 2W 10 VA
Power Consumption in Current Circuit		< 4VA	< 4VA
Real Time Clock Battery (Lithium)		3.6 V/1.2 Ah	3.6 V/1.2 Ah
Battery Lifetime		10 Years /4 Years (Storage)	10 Years /4 Years (Storage)
Real Time Clock	Accuracy	TS EN 61038	TS EN 61038
	Temperature and Frequency	Yes	Yes
	Calibration	Configurable	Configurable
DST Application		RS 232 / RS 485	RS 232 / RS 485
Communication		EN 62056-21	EN 62056-21
Load Profile	Total Record Duration	91 days	91 days
		91 days	91 days
	Channel Count	5	5
		8	8
Record Interval		1,5,10,15,20,30,60 dk.	1,5,10,15,20,30,60 dk.
Current Line Connection		Direct	Direct
LCD Display	Digit Count	9 (6+3) dijit	9 (6+3) dijit
	Lifetime	10 Year	10 Year
Backlight		Yes	Yes
Menu		Constant / Dynamically Configurable	Constant / Dynamically Configurable
Quadrant Display		vdew 2.1	vdew 2.2
Current and Voltage Display for each Phase		Yes	Yes
frequency, Cosφ			
Tariff	Count	4 (Optional 16)	4 (Optional 16)
	Holidays	- / Yes (Optional)	- / Yes (Optional)
Number of Time Slices		8 / (Optional 32)	8 / (Optional 32)
Season Structure		- / Yes (Optional)	- / Yes (Optional)
Alarm Relay		- / Yes (Optional)	- / Yes (Optional)
Magnetic Field Sensor		- / Yes (Optional)	- / Yes (Optional)
Harmonic Analysis		-	-
Log Record		-	-
Generator Detection Input		- / Yes (Optional)	- / Yes (Optional)

Technical Specifications

Specifications		Model No	
		C520.KMY.2556 C520.KMT.2556	C520.AMY.2556 C520.AMT.2556
Nominal Voltage		3x230/400 V	3x230/400 V
Operating Voltage Range		40 V~300 V	40 V~300 V
Nominal (Base) Current		X / 5 A	X / 5 A
Maximum Current		10 A	10 A
Minimum Current		50 mA	50 mA
Starting Current		10 mA	5 mA
Meter Constant	Active	20 000 imp/kWh	20 000 imp/kWh
	Reactive	20 000 imp/ kVARh	20 000 imp/ kVARh
Accuracy (Class)	Active	B (Class 1)	C (Class0,5)
	Reactive	Class 2	Class 2
Frequency		50 Hz ± 10%	50 Hz ± 10%
Measure Direction		One Way	One Way
		Two-way	Two-way
IP Protection Class		IP54	IP54
Protection Class		II	II
EMC Class		E2	E2
Mechanical Class		M1	M1
Humidity Ratio		<95%	<95%
Operating Temperature Range		-40°C ~ +85°C	-40°C ~ +85°C
Storage Temperature Range		-40°C ~ +85°C	-40°C ~ +85°C
Power Consumption in Voltage Circuit		< 2W 10 VA	< 2W 10 VA
Power Consumption in Current Circuit		< 4VA	< 4VA
Real Time Clock Battery (Lithium)		3.6 V/1.2 Ah	3.6 V/1.2 Ah
Battery Lifetime		10 Years /4 Years (Storage)	10 Years /4 Years (Storage)
Real Time Clock	Accuracy	TS EN 61038	TS EN 61038
	Temperature and Frequency Calibration	Yes	Yes
		Configurable	Configurable
DST Application		RS 232 / RS 485	RS 232 / RS 485
Communication		EN 62056-21	EN 62056-21
Load Profile	Total Record Duration	91 days	91 days
		91 days	91 days
		Channel Count	5
			8
		Record Interval	1,5,10,15,20,30,60 dk.
Current Line Connection		CT / CT and VT	CT / CT and VT
LCD Display	Digit Count	9 (6+3) dijit	9 (6+3) dijit
	Lifetime	10 Year	10 Year
		Backlight	Yes
		Menu	Constant / Dynamically Configurable
			Configurable
		Quadrant Display	vdew 2.3
			vdew 2.4
		Current and Voltage Display for each Phase	Yes
		frequency, Cos ^φ	
Tariff	Count	4 (Optional 16)	4 (Optional 16)
	Holidays	- / Yes (Optional)	- / Yes (Optional)
Number of Time Slices		8 / (Optional 32)	8 / (Optional 32)
Season Structure		- / Yes (Optional)	- / Yes (Optional)
Alarm Relay		- / Yes (Optional)	- / Yes (Optional)
Magnetic Field Sensor		- / Yes (Optional)	- / Yes (Optional)
Harmonic Analysis		-	-
Log Record		-	-
Generator Detection Input		- / Yes (Optional)	- / Yes (Optional)



MAKEL USOBIM, is a 100% web based OSOS(Automatic Meter Reading System) system that is designed for the AMI/AMR needs of the electricity distribution and industrial companies. Meters started to become a part of data communication system first by remote reading of the electricity meter data(AMR - Automatic Meter Reading) and this process is evolved to a Smart Grid: A distribution data management system enabling us to manage energy generation, usage and distribution.

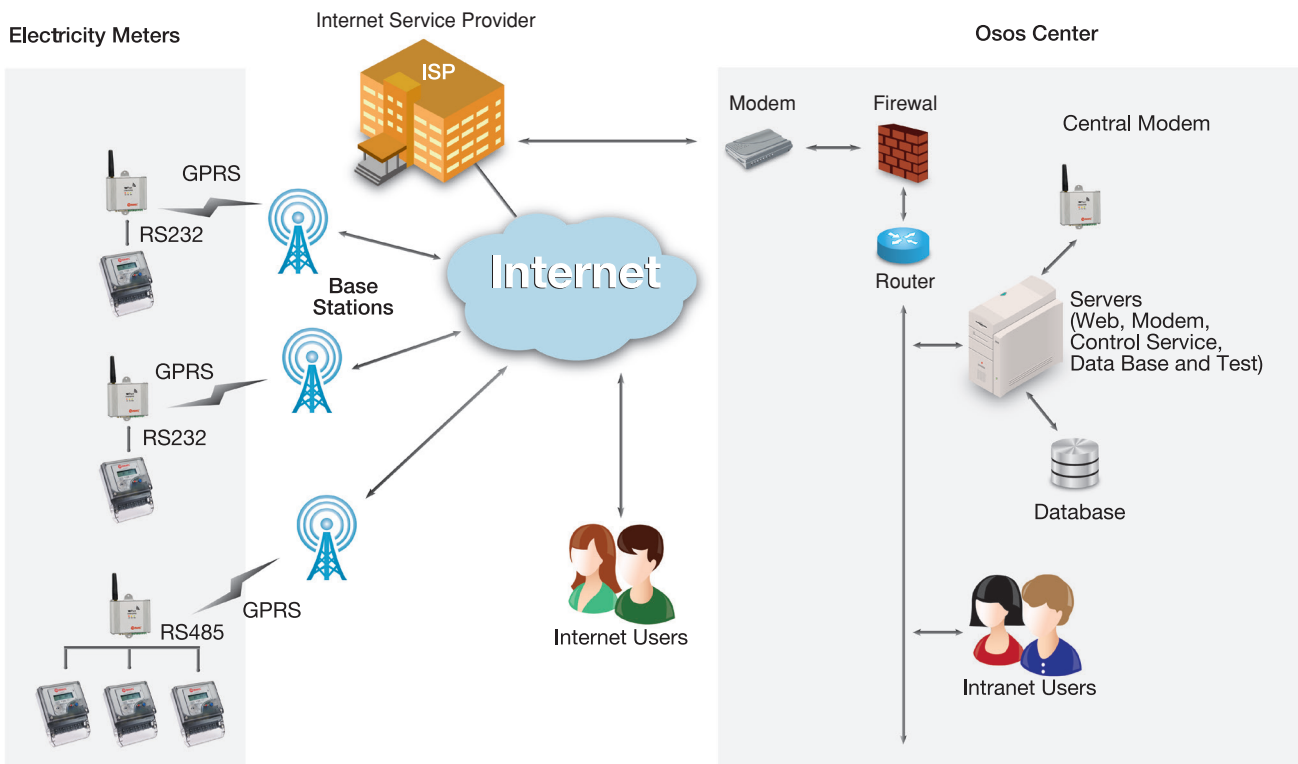
Remote meter reading systems enables us to use the electricity infrastructure efficiently, to make correct estimations for investments, correct grid analysis and planning, reduce tampering and losses, in time billing, real time multi pricing in a multi tariff system, distribution web automation, remote closing and opening, to reduce meter reading cost and to increase customer satisfaction. These features give distribution companies an ease in management and reduce costs. Makel automatic meter reading system, is designed to collect energy usage, state and notifications from customers into a central control station. Meters can also be controlled remotely by the help of the two-way communication. The system can be programmed to read metering data periodically or at the determined time. Also the central station can make immediate reading in cases of a new customer arrival, customer departure, customer objection, tamper or loss suspicion. Makel USOBIM system consists of 3 parts; communication software, application software and database.

Communications software which runs as background service in communication server at data center provides all necessary communication activities between meters and data center using TCP/IP protocols. Communications software and web interface uses database to communicate with each other. Application software is the backbone for web interface and services. It provides a web server for web users. Number of connected users is only limited by the capacity of the server and internet throughput. Database is based on SQL server and can hold millions of data for years safely and produces faster and sophisticated reports.

General Specifications

- ▶ GSM/GPRS technology and TCP/IP protocol gives us a wide range of coverage in a secure, fast and cost effective way.
- ▶ The system is independent of the underlying hardware infrastructure, with the help of the web based multi layer modular software architecture; it easy to add and remove a meter. You can start from 1 meter to a hundreds of thousands of meters.
- ▶ Provides data communication interfaces to exchange necessary data between external systems (Geographical information systems, subscriber information management systems, Billing systems, CRM, ERP software) using web services in xml language or in other formats. It also provides methods for processing of retrieved data for hand held terminals.
- ▶ Has a customer tracking aimed at periodic reading (hourly, daily, weekly, etc.), which can collect energy usage, state and notification information and also load profile data.
- ▶ Using universal standards the system is independent of mobile network operators.
- ▶ The analysis module working on top of the SQL database server can make flexible queries, analysis, create graphical views, and creates needed work commands.
- ▶ With the help of the flexible module in the multilayered software new meter communication protocols can be added easily (EN 62056-21, DLMS-COSEM, etc.). The system can read many different brands of meters
- ▶ The security is ensured by using an encrypted communication between the central station and the meter.
- ▶ Database security is ensured by the encrypted communication in the database access layer, authorization mechanism and firewall. Also the database is backed up periodically.
- ▶ With the easily usable GUI, error prone and efficient usage is ensured.
- ▶ Street lightening meters can be controlled automatically or manually by using the reed available in the Wport.
- ▶ Users can be informed through e-mail or SMS for cases like when the Reactive/Active energy ratio goes below or above the determined value, number of failed communication attempts.
- ▶ Different authentication levels enable to create users with different qualifications
- ▶ Virtual metering points can be constructed by using some of the metering points connected to the system.
- ▶ Using WPort2 modem, Partial (user specified or default packets with user defined or default contents) or complete readout data in meters can be read from data center.
- ▶ Up to 10 different packets with user specified contents can be defined in Makel USOBIM system.
- ▶ All reports created by the system can be exported to Excel, pdf, csv, text, rtf. Also the graphics can be saved in image formats. System can create OSF formats.
- ▶ System is designed to work 7/24.

Makel Usobim General Architecture



- ▶ OSOS center is the installed data center of AMR. Data management, collection and storage are coordinated in this center.
- ▶ Commands from OSOS data center passing through the routers and broadband modems reach to modems via ISPs and GSM/GPSR mobile internet infrastructure.
- ▶ Modems doing all necessary communications with meters or bypassing commands to meters, behave as a gateway between meters and OSOS data center. Communications are encrypted. If desired, modems can do all the necessary communications with meters in determined times to pick-up and store all required data in standalone fashion and when OSOS data center asks for data, they transfer all stored meter data to data center.
- ▶ Data obtained from meters are stored in a strong database in OSOS Center. So, one can easily and safely reach millions of data in a short time.
- ▶ When desired, internet and intranet users using a web browser which is available in their computers and by entering their user name and password can query all stored data, have desired reports or give new orders for new data reading action.



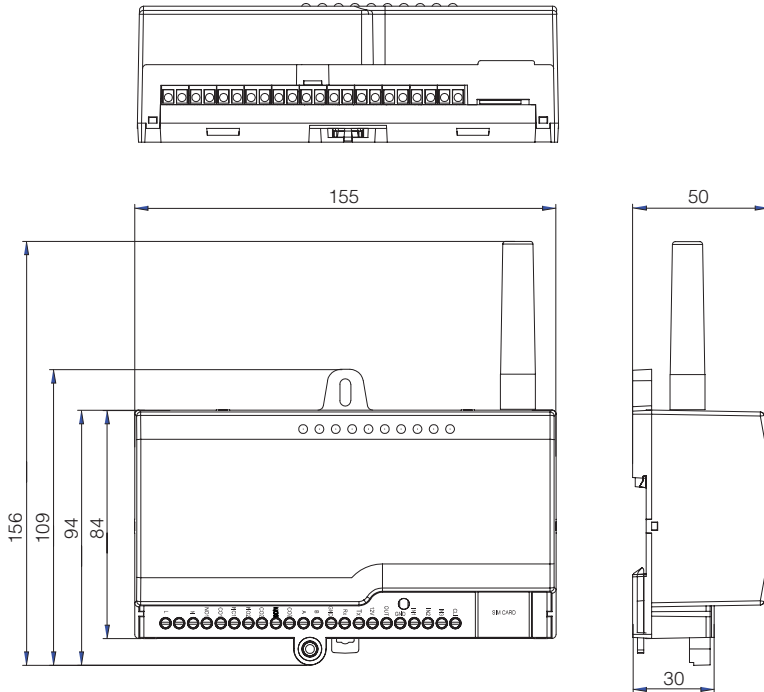
With its easy usage and installation, compact and high quality design, WPort2/NPort-ET is a data collection and supervision device intended to read and control of electronic electricity meters and such devices which build an AMI/AMR system.



General Specifications

- ▶ Support simultaneous multiple port TCP/UDP/IP protocols on GPRS/EDGE and NB-IoT
- ▶ Operator independent
- ▶ Provides secure communication with its powerful DES algorithm
- ▶ Supports software upgrade through air.
- ▶ RTC can also be updated using time data from 3G/4G Network.
- ▶ Supports IEC 62056-21 mod C and DLMS-COSEM protocols for meter communication with variable speeds.
- ▶ Modem device, store logs of remote remote or local software updates, parameter definitions, access attempts from unauthorised IP's other than defined IP, signal deficiencies, auxiliary information such as network errors and similar information along with date/time tags related to these events.
- ▶ Periodic and instant orders with variable contents can be defined According to these orders, WPort2/NPort-ET automatically communicates with meters and collects requested data and stores them in to its memory and realizes requested control operations.
- ▶ It is equipped with three digital inputs for instrument panel, opening cover or similar needs.
- ▶ It is equipped with 3 relay outputs for the activation of devices connected externally.
- ▶ Supports GSM/GPRS/EDGE, 900/1800/1900 Class B / LTE/CAT NB1/B20/B8 communication.
- ▶ External antenna can be connected in case of poor signal conditions.
- ▶ WPort2/NPort-ET has signal led's for indications such as connection status and communication activities.
- ▶ Sim card can be inserted and removed with its push/push type sim card connector without opening the device case.
- ▶ WPort2/NPort-ET has simultaneously working RS232 and RS485 communication interfaces. RS485 interface supports up to 31 meters connected simultaneously.
- ▶ All connections terminals are sealable
- ▶ Automatic reset feature provides a failsafe mechanism to recover from locks.
- ▶ 100% compatible to web based Makel Usobim AMI/AMR system.

Outline Dimensions



Technical Specifications

Model	WPort2	NPort-ET
Communication type	GSM/GPRS/EDGE	LTE CAT NB1
Frequency Band	900/1800 MHz	900 /1800 band
GPRS Class	Class 10	B20 / B8
TCP/IP Support	Yes	No / UDP
RS232 Communications	1 unit	1 unit
RS485 Communications	1 unit	1 unit
Digital inputs	3 unit	3 unit
CLI Input	1 unit	1 unit
Relay Capacity	1 unit 10A 250VAC, 2 unit 5A 250VAC	1 unit 10A 250VAC 2 unit 5A 250VAC
Digital output	1 unit	1 unit
Communication Type	RS232 ve RS485	RS232 ve RS485
Sim Card	1.8V/3V	1.8V/3V
External Antenna	SMA (50 Ohm)	SMA (50 Ohm)
RTC	Yes	Yes
Operating Temperature	-30°C / +75°C	-30°C / +75°C
Operating Voltage	50V - 300V	50V - 300V
Dimensions	155 x 110 x 50	155 x 110 x 50
Weight	250 gr	250 gr
Remote SW upgrade	Yes	Yes
Data Security	DES	DES

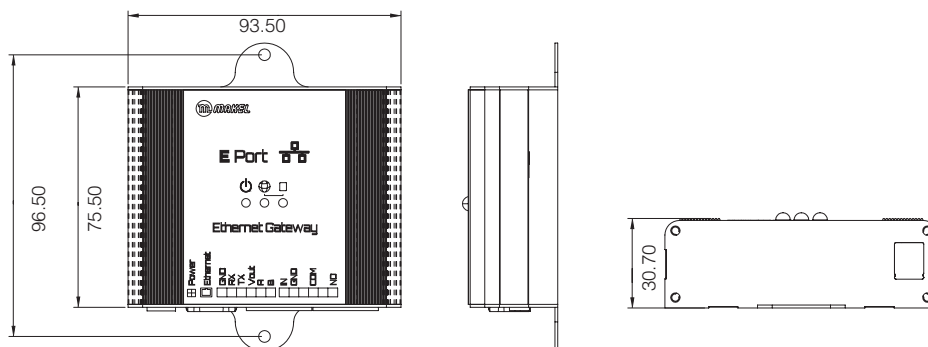


The EPort is a remote control and data collection device developed to enable remote reading of measurement values and control of the electrical meters on electronic and similar devices. Since communication is provided over the internet no extra costs are required. By connecting to the network via the RJ-45 Ethernet socket on the device remote reading is made possible by simply connecting with the RS232, RS485 or Optic Port to the meter.

General Specifications

- ▶ TCP/IP support
- ▶ 10BASE-T and 100BASE-TX Ethernet connection
- ▶ RS232 and RS485 ports can be used at the same time. The RS485 port supports up to 255 connections.
- ▶ It supports optic port connection to the meter
- ▶ Numerical alarm entry: compatible to dry contact or 0-24 V input.
- ▶ 220V/5 A capacity relay output.
- ▶ Compatible with IEC 62056-21 Mod C and DLMS meters.
- ▶ Supports all brands and models of meters.
- ▶ 100% Compatible with the Makel USOBIM (OSOS- automatic meter reading system).
- ▶ The MAC, IP, gateway, sub network mask and port numbers can be adjusted with the E Port configuration software.
- ▶ Has input/output with ESD protection

Outline Dimensions



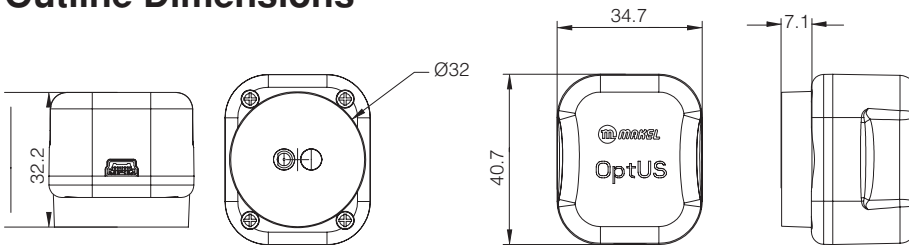
Technical Specifications

Model	
Communication Protocol	TCP/IP
Network connection	10BASE-T ve 100BASE-TX Ethernet
Network connection	RJ-45
RS232 port	1 item, 300-115200 bps
RS485 port	1 item, 300-115200 bps, max 255 device
Numerical input	1 item
Relay output	1 item, 250V/5A NO
Adaptor input	12V DC
Operation temperature	-40°C / +85°C
Dimensions	77 x 30.7 x 93.5 mm
Weight	180gr



Optus is a device that can use the computer's USB port to read the meter over the Optic Port.

Outline Dimensions



Technical Specifications

Mechanical Properties

Dimensions	40.5mm x 34.5mm x 32.5mm
Body Material	ABS
Weight	~150gr

Electrical Properties

Standard	IEC 62056-21
Cable Length	1.5m
Operation voltage	obtains power from the USB port
Electrical Interface	USB 2.0

Software

The driver needs to be loaded in order for Optus to be operated on this computer.
The address where the driver can be downloaded <http://www.makelamr.com/Setup/OptusSetup.exe>

Electrical Measuring and Control Equipments

Single Phase

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
M560.2251	152011029	1	24	5,40	380 x 405 x 255
M560.2251S	152011042	1	24	5,40	380 x 405 x 255
M600.2251	152011030	1	24	5,40	380 x 405 x 255
M600.2251T	152011036	1	24	5,40	380 x 405 x 255
M600.2251.RS485	152011031	1	24	5,40	380 x 405 x 255
M600.2251T.RS485	152011037	1	24	5,40	380 x 405 x 255

Three Phase

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
T510.2251	152013029	1	8	6,92	280 x 335 x 240
T510.2251.RS485	152013030	1	8	6,92	280 x 335 x 240
T510.2510	152013031	1	8	6,92	280 x 335 x 240
T510.2510.RS485	152013032	1	8	6,92	280 x 335 x 240
C500.K0T.2251	152013033	1	8	6,92	280 x 335 x 240
C500.K0Y.2251.RS485	152013023	1	8	6,92	280 x 335 x 240
C500.K0T.2251.RS485 J	152013056	1	8	6,92	280 x 335 x 240
T600.2251	152013097	1	8	6,92	280 x 335 x 240
T600.2251T	-	1	8	6,92	280 x 335 x 240
T600.2251.RS485	152013098	1	8	6,92	280 x 335 x 240
T600.2251T.RS485	-	1	8	6,92	280 x 335 x 240
C520.K0Y.2251.RS485	152013092	1	8	6,92	280 x 335 x 240
C520.K0T.2251.RS485	152013091	1	8	6,92	280 x 335 x 240

Industrial

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
C500.KMY.2251.RS232	152012023	1	8	7,36	330 x 380 x 283
C500.KMY.2251.RS485	152012025	1	8	7,36	330 x 380 x 283
C500.KMY.2256.RS232	152012026	1	8	7,36	330 x 380 x 283
C500.KMY.2256.RS485	152012024	1	8	7,36	330 x 380 x 283
C510.AMY.2256.RS485	152012036	1	8	7,36	330 x 380 x 283
C510.AMY.5851.RS485	152012035	1	8	7,36	330 x 380 x 283
C510.AMT.2256.RS485	152012032	1	8	7,36	330 x 380 x 283
C510.AMT.5851.RS485	152012034	1	8	7,36	330 x 380 x 283
C500.KMT.2251.RS485	152012043	1	8	7,36	330 x 380 x 283
C500.KMY.2556.RS485	152012041	1	8	7,36	330 x 380 x 283
C510.AMT.2256.RS485 J	152012048	1	8	7,36	330 x 380 x 283
C500.KMT.2251.RS485 J	152012047	1	8	7,36	330 x 380 x 283
C520.KMY.2556.RS485	152012096	1	8	7,36	330 x 380 x 283
C520.AMY.2556.RS485	152012093	1	8	7,36	330 x 380 x 283
C520.KMT.2556.RS485	152012083	1	8	7,36	330 x 380 x 283
C520.AMT.2556.RS485	152012084	1	8	7,36	330 x 380 x 283
C520.KMY.2251.RS485	152012085	1	8	7,36	330 x 380 x 283
C520.AMY.2251.RS485	152012086	1	8	7,36	330 x 380 x 283
C520.KMT.2251.RS485	152012087	1	8	7,36	330 x 380 x 283
C520.AMT.2251.RS485	152012088	1	8	7,36	330 x 380 x 283

Wport - E Port - Optus

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
WPort2 Gsm-Gprs Modem/Gateway	152040004	1	10	6,18	293 x 386 x 257
E Port Ethernet Gateway	152040002	1	10	6,18	293 x 386 x 257
Optus USB Optic Reader	152060001	1	-	-	-



Makel RG500 series Reactive Power Compensation Relay offers professional solutions for companies reactive power compensation needs, with its superior features such as wide current operating ranges starting from very low currents, ability and the ability to make inductive and capacitive compensation in 20 steps and other features

General Specifications

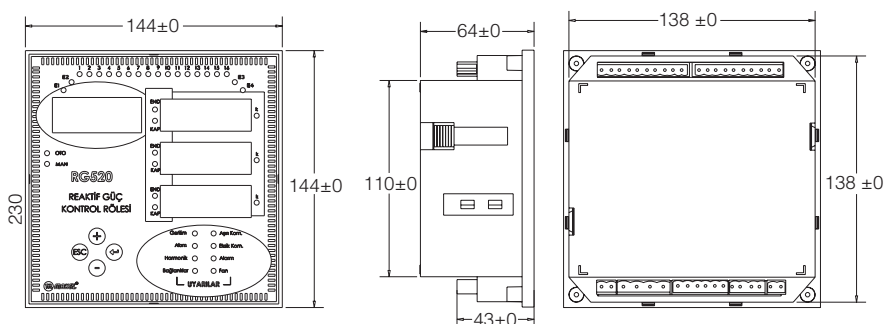
- ▶ It has 16 Capacitor ranges and 4 (2 alarm and fan choice) inductance ranges. These ranges can be established as mono phase, three phases or between phases connection. Due to the ability to compensate separately for each phase, especially in systems with unbalanced loads produces successful solutions.
- ▶ Two-way compensation can be made. This means that both capacitors and inductors can be used. With this feature places where have capacitive loads (air conditioning, SMPS, PC, Fluorescent and CFL-based lighting) such as banks, hotels, shopping centers, service sector companies, successful compensation can be done.
- ▶ Displays voltage, powers, $\cos\phi$, frequencies, total energies for all three phases and time and temperature.
- ▶ Harmonic measurement is available up to 21. harmonic and provides current and voltage harmonics protection.
- ▶ Overvoltage, undervoltage, overcurrent, ratio error, harmonic error, compensation error, and such as overtemperature error can be detected and alarm relay output for each one, or compensation control can be set.
- ▶ Keeps error log records. The times at which errors occur, and recovery time with the error types are recorded.
- ▶ Total active, inductive and capacitive energies are fixed and 3 phase x 3 channels load profile recording are optional. User replaceable 3 channels optional parts. For example; such as $\cos\phi$, currents, voltages. In addition, the period of recording is left to the user's needs.
- ▶ Using Fan output, a fan can be started and stopped between the desired temperatures Thus, temperature control for compensation panel doesn't need another temperature measurement system.
- ▶ Automatic test are available for the finding the reactive loads in ranges. In this way, the range powers are perceived automatically without the need to manually entering the capacitor or inductor powers. Additionally, daily control is available for the power values whether or not defective. User can disable or enable this control.
- ▶ If the current flow direction is false, it corrects reversed phase automatically in the Test mode. If phase sequence error is detected, system will continue compensation and will give corresponding error warning.
- ▶ Password protection is available also left to the user's request. When the password protection is active, all programming menu will be protected. Thus, the compensation settings and alarm operations will be protected from accidental accesses and system will run properly as set before.
- ▶ It supports modbus protocol on RS485 communication. A Special PC software are available for reading or manipulating relay settings remotely.
- ▶ Enables easy usage with four separate screen.
- ▶ With its improved compensation algorithm decreases the number of switching. Thus, life of the capacitors and contactors will be longer.
- ▶ Ranges ON, OFF and discharge time settings are adjustable.
- ▶ Very fast load changes can be successfully compensated with the thyristor drive model. For example, spot welder.

Reactive Power Compensation Relay

Technical Specifications

RG520	
Operating Voltage (Un)	220V AC
Operating Measuring Range	3mA – 6A
Operating Voltage Range	(0,68 – 1,36)xUn (150-300V)
Operating Current Range	0,015 – 6A
Operating Frequency	50Hz
Operating Temperature Range	-30 to +85 degree
Number of Ranges	16 capacitors, 2+2 inductors (+2 alarm and fan out change)
Range Powers	Mono phase, three phase and between phases able to connecting Capacitors or Inductors,automatic steps power sense
Power Consumption	<4VA
Relay Contact capacity	5A
Screen	1 line 4 digits alpha numeric and 3 line 4 digits 7 segment led display
Wire Diameter	2,5 mm
Safety Class	IP20 and IP40
Connection Type	Terminal connection
Displayed Parameters	Cos ϕ , Current, Voltage, frequency, Total active, inductive, capacitive energies Apparent power, active power, reactive power Harmonic measuring (include 21. harmonic)
Measuring Accuracy	Temperature measuring, real time calendar and hour Voltage, current and Cos ϕ = 1% Active, reactive and apparent power = 1% Temperature between 25 to 85 degree = +/- 5 degree
Setting Limits	Target Cos ϕ = 0.8 inductive to 0.8 capacitive Current transformer ratio = 5/5 to 5000/5 Voltage transformer ratio = 220 /220 Step On, Off and discharge times = 1to 180 second
RS 485 Communication ModBus	Address range = 1 to 247 Baud rate = 1200, 2400, 4800, 9600, 19200 and 38400 bps
Load Profile	Record period = 1, 5, 10, 15, 30, 60 minute Record type = Energies and 3 phase x 3 channel change Max record time = 19 hours to 48 days
Error Log Records	Max record number = 192 number
Alarm Functions	Low and over voltage Over current, over temperature Harmonic protection Poor or over compensation Rate error
Fan Function	On board temperature control relay
Password Protection	Exist

Outline Dimensions



Model No.	Code No.	Max. Number of Ranges	Measurement devices with RS485 VL1, VL2, VL3 IL1, IL2, IL3, Hz P1, P2, P3, Q1, Q2, Q3, S1, S2, S3 Cosφ ₁ , Cosφ ₂ , Cosφ ₃ ΣkWh ΣkVARh(ind) ΣkVARh(kap) ΣkVAh %ind ve %kap Load Profile Error Record	3 Phase	V (Voltage)	I (Current)	Cosφ	Single Phase Capacitor	Three-Phase Capacitor	Support for Balanced and Unbalanced Loads	Active Power (W)	Reactive Power (Yes)	Apparent Power (VA)	kWh	kVARh	% THD-I	% THD-V	1-21. Harmonics (for current and voltage)	Shunt Reactor	Thyristor Control	Generator Detection	RS-485 Modbus	Temperature Measurement and Fan Output Relay	Alarm Functions	Real Time-clock	Equal Aging	Load Profile	Error Record	Password Protection	Led Display	144x144
RG 520EC	152033007	20		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RG 520E	152033008	20		-	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RG 518C	152033009	16		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RG 518	152033010	16		-	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RG 520T*	152033014	16		-	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RG 520TC*	152033013	16		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	

Reactive Power Compensation Relay

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
RG 520EC	152033007	1	6	10,26	285 x 475 x 275
RG 520E	152033008	1	6	10,26	285 x 475 x 275
RG 518C	152033009	1	6	10,26	285 x 475 x 275
RG 518	152033010	1	6	10,26	285 x 475 x 275
RG 520T*	152033014	1	6	10,26	285 x 475 x 275
RG 520TC*	152033013	1	6	10,26	285 x 475 x 275

(*) The thyristor outputs of the RG520T, RG520TC models will be used with one of the RG TR xx drivers appropriately

Thyristor Driver



Makel microprocessor controlled capacitive load drivers, dynamic power factor control Capacitive up to 80 kVAR in applications designed to switch loads.

The modules trigger signals can activate control of capacitors after within 10ms. The microprocessor based architecture and algorithm ensures that the modules enter the circuit at the time of zero transition, so that no damage is caused to the capacitors. Modules can be up to 480V, star or delta connected, symmetrical or asymmetrical, capacitive, resistive or inductive loads at the time of zero crossing. The triggering of the modules can easily be done by reactive power control relays or PLCs.

The benefits of microprocessor controlled capacitive load drivers compared to conventional mechanical contactors are: longer life, very high speed and number of switches, ensuring no current and voltage transients during switching and keeping the life of the capacitor used long.

The capacitive load drivers with microprocessor control continuously control the operating voltage, operating condition and temperature and record the fault detections and inform the user with four LEDs and dry contact output on the front panel. Makel microprocessor controlled capacitive load drivers operate without problems in harmonic filter reactors or without reactors. The external thermal connection terminals protect the harmonic filter reactor used in the compensation system against overheating. Makel microprocessor controlled capacitive load drivers do not require maintenance and are quiet.

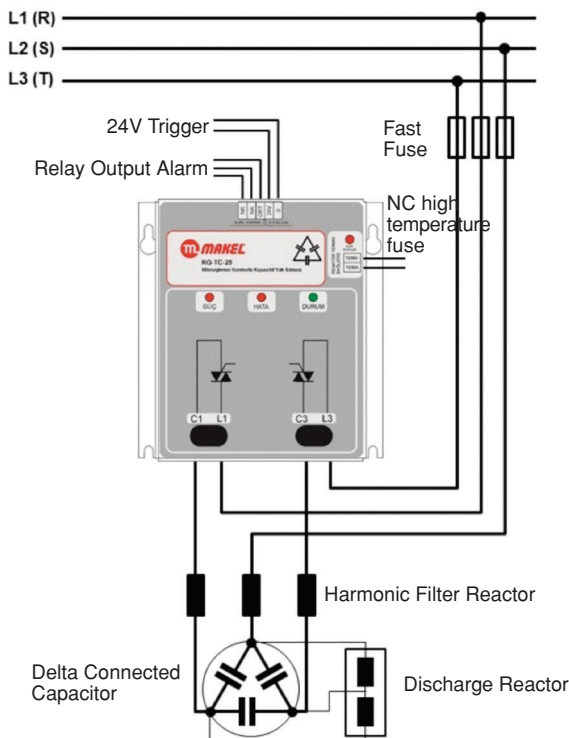
Fields of Application

Capacitive microprocessor controlled capacitive load drivers are used in all dynamic reactive power compensation systems that require fast response times. Facilities such as welding machines, elevators, cranes, arc and induction hobs, wind turbines, and other facilities with rapidly varying fluctuating loads are examples of petrol stations, commercial buildings, public institutions and other businesses.

Technical Specifications

Parameter	Unit	RG-TC-12	RG-TC-25	RG-TC-50	RG-TC-80
Nominal voltage	V	400±%14	400±%14	400±%14	400±%14
Maximum Cutting Voltage	V	1600	1600	1600	1600
Maximum Working Voltage	A	20	40	80	115
Maximum di/dt	A/μs	50	100	140	140
Conductor Thickness	mm ²	16	16	35	35
Semi-Conductor Item	-	2	2	2	2
Load Characteristic	-	R/L/C	R/L/C	R/L/C	R/L/C
External Supply Voltage	V	-	-	230±%10	230±%10
Fan Power	VA	-	-	32	32
External supply Conductor Thickness	mm ²	-	-	2.5	2.5
Fan Switch on Temperature	°C	-	-	50	50
Trigger Voltage/Current	V/mA	24/10	24/10	24/10	24/10
Trigger Conductor Thickness	mm ²	2.5	2.5	2.5	2.5
Power Loss	W	40	84	155	278
Thermal Protection Temperature Level	°C	90±5	90±5	90±5	90±5
Overvoltage Protection	-	C	C	C	C
IP Class	-	20	20	20	20
Ambient Temperature					
Operation (Nominal)	°C	-20~45	-20~45	-20~45	-20~45
Working (75% load)	°C	-20~60	-20~60	-20~60	-20~60
Storage	°C	-40~100	-40~100	-40~100	-40~100
Relative Humidity	%	5~95	5~95	5~95	5~95
Dimensions: Width x Length x Depth	mm	144x150x117.5	144x150x117.5	161x229x197.5	161x229x197.5
Weight	kg	2.2	2.2	5.9	5.9

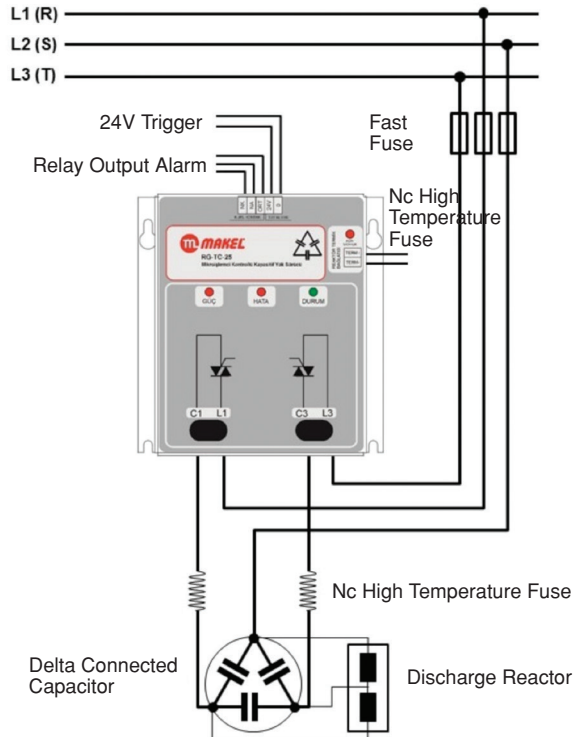
Wiring Diagrams



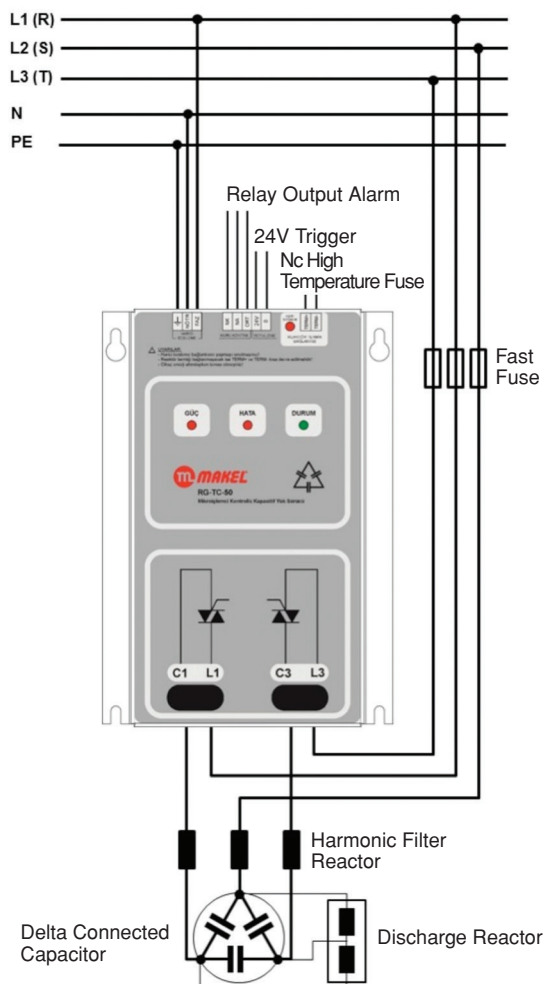
Recommended electrical connection diagram of RG-TC-12 and RG-TC-25 modules with harmonic filter reactor and discharge reactor. The structure of RG-TC-12 and RG-TC-25 modules, terminals and connection diagrams are equivalent.

Thyristor Driver

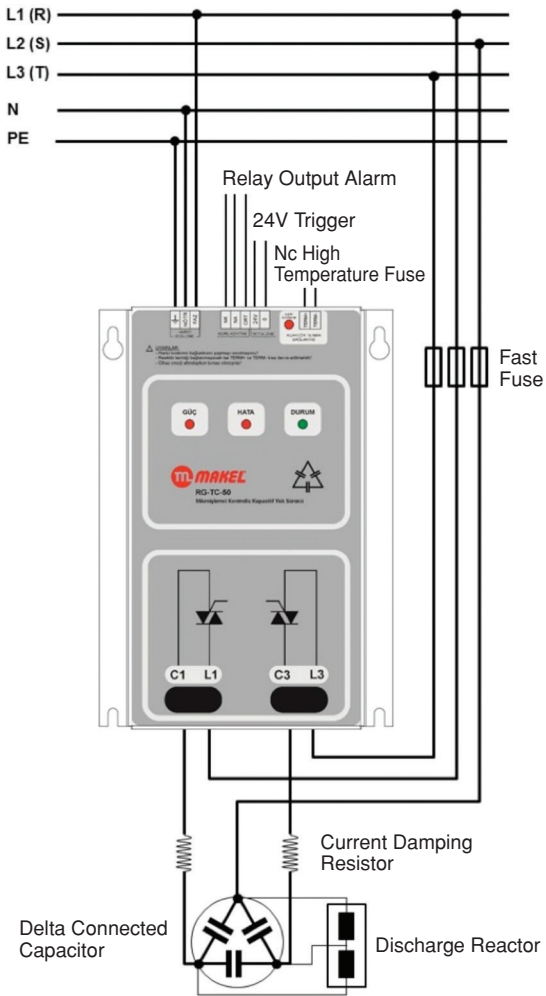
Wiring Diagrams



Recommended electrical connection diagram of RG-TC-12 and RG-TC-25 modules with harmonic filter reactor and discharge reactor. The structure of RG-TC-12 and RG-TC-25 modules, terminals and connection diagrams are equivalent.



Recommended electrical connection diagram of RG-TC-50 and RG-TC-80 modules with harmonic filter reactor and discharge reactor. The structure of the RG-TC-50 and RG-TC-80 modules, terminals and connection diagrams are equivalent.

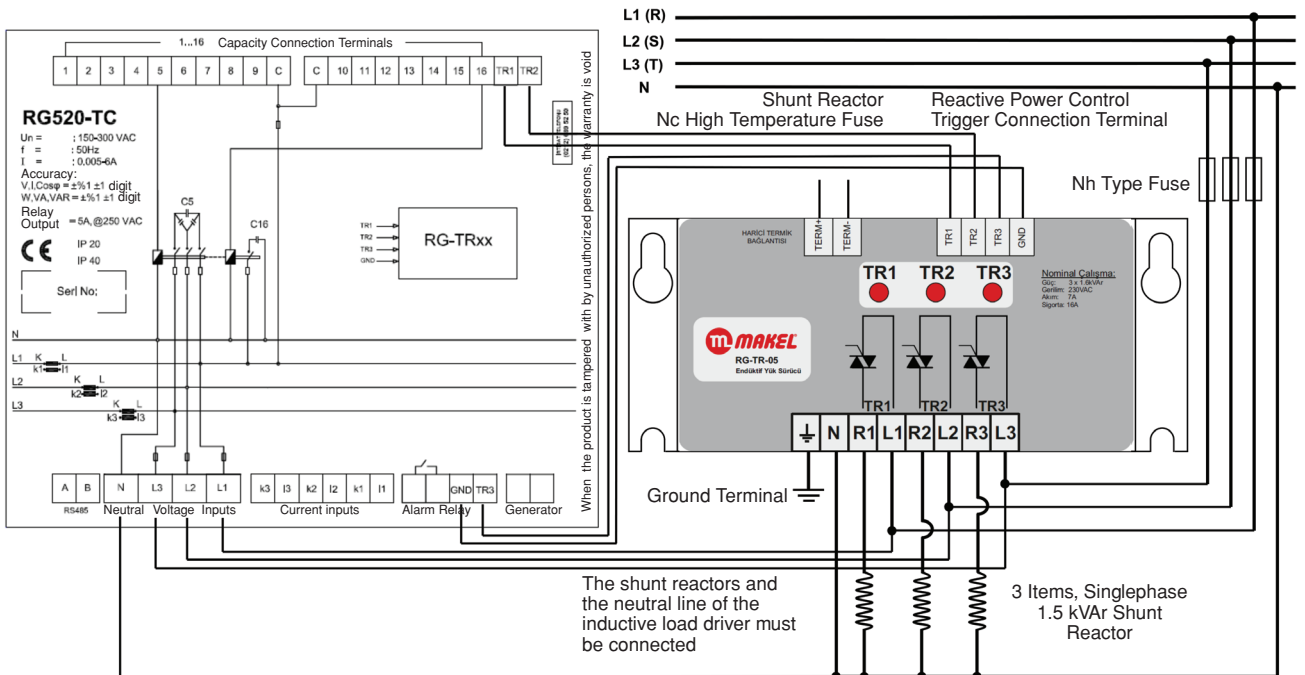
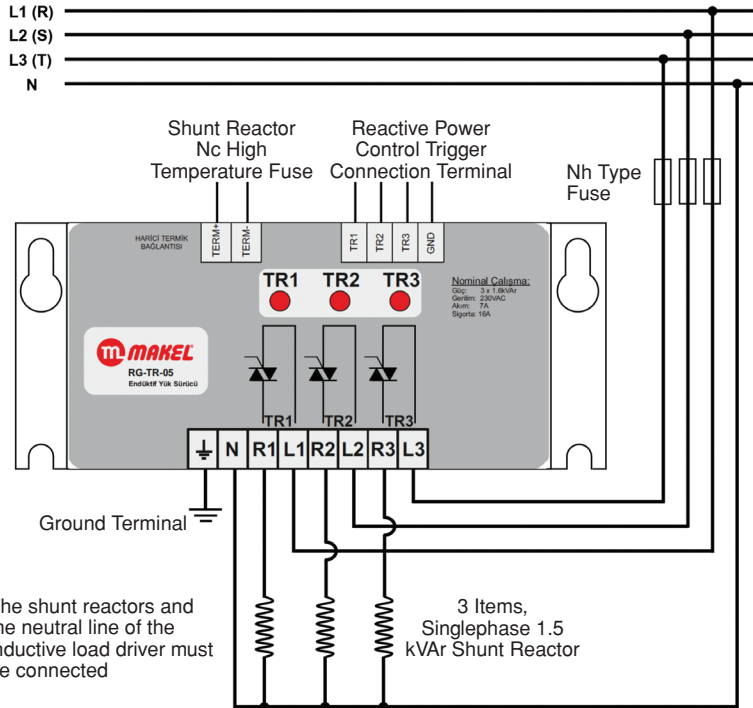


Recommended electrical connection diagram of RG-TC-50 and RG-TC-80 modules with harmonic filter reactor and discharge reactor. The structure of the RG-TC-50 and RG-TC-80 modules, terminals and connection diagrams are equivalent.

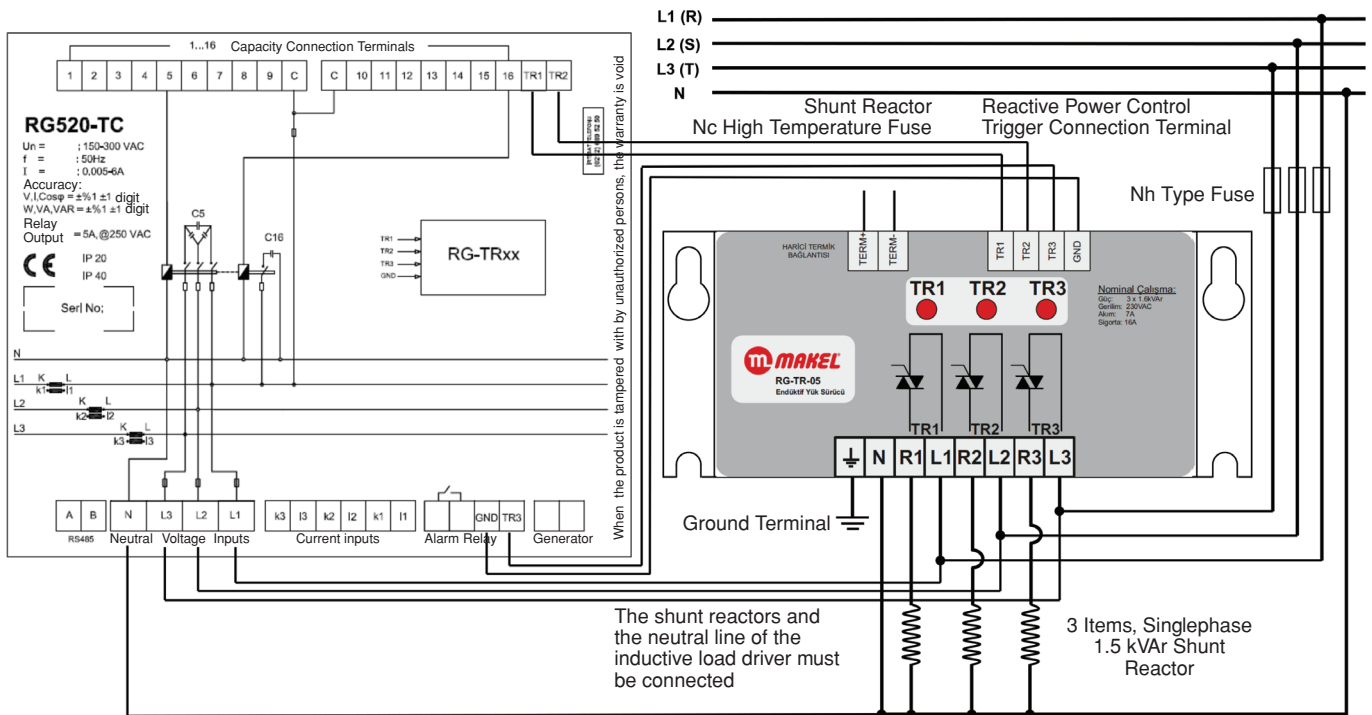
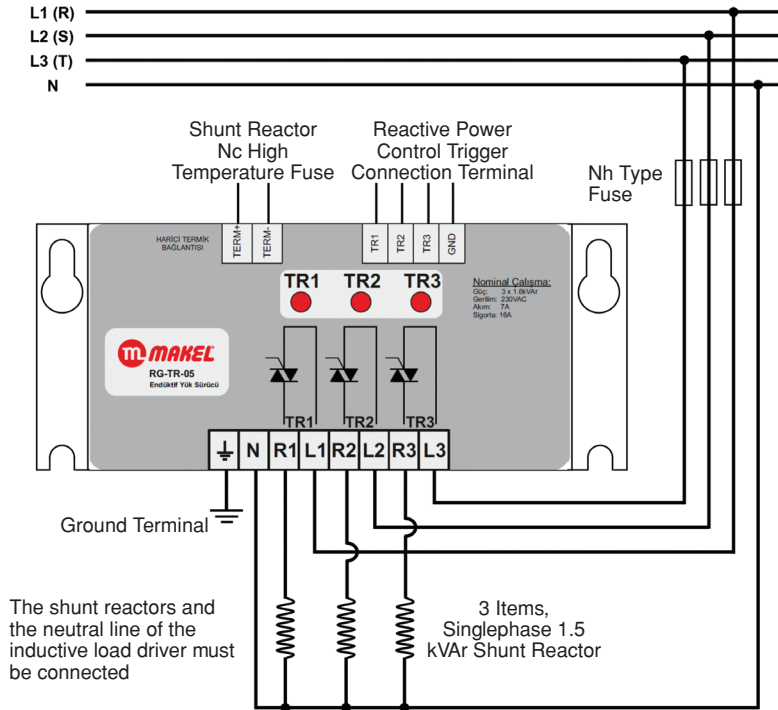
Thyristor Driver

Wiring Diagrams

RG-TR-05-Diagram



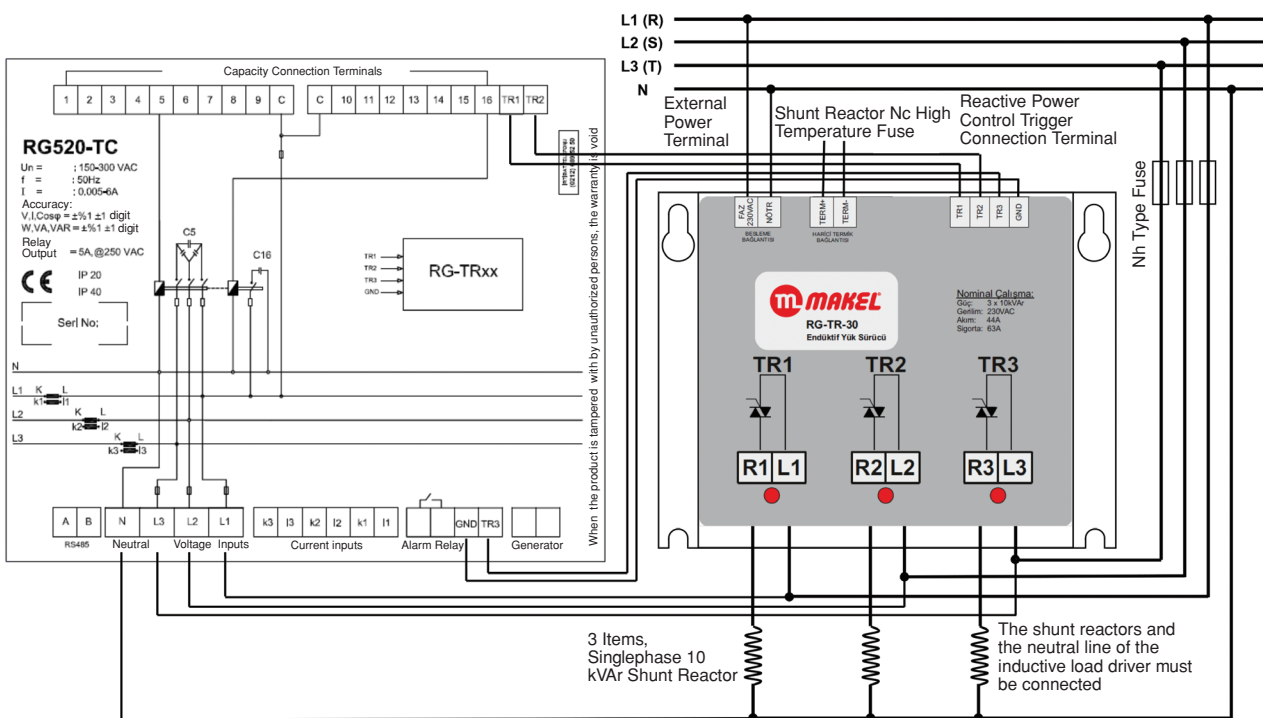
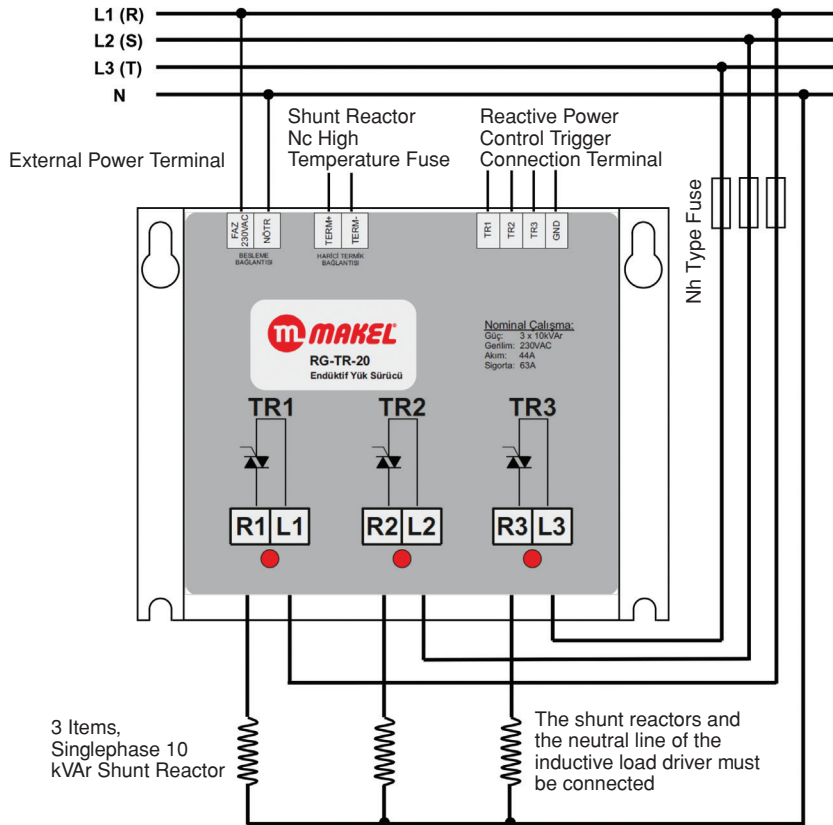
RG-TR-20-Diagram



Thyristor Driver

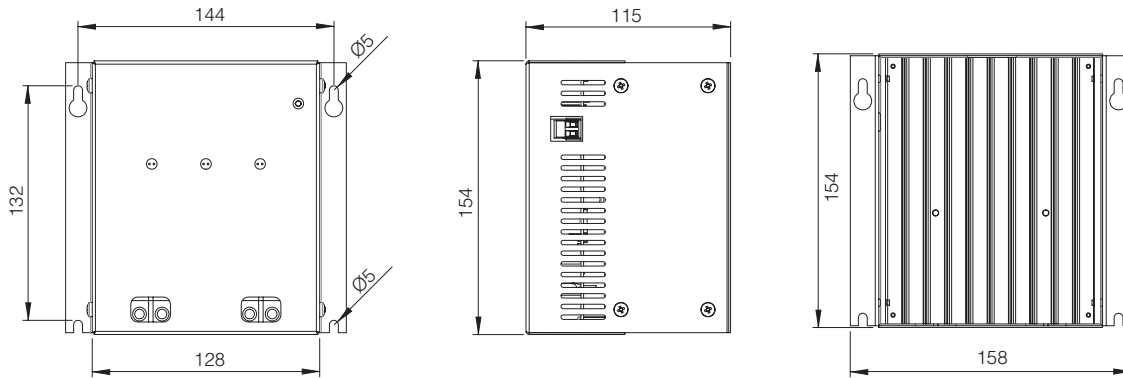
Wiring Diagrams

RG-TR-30-Diagram

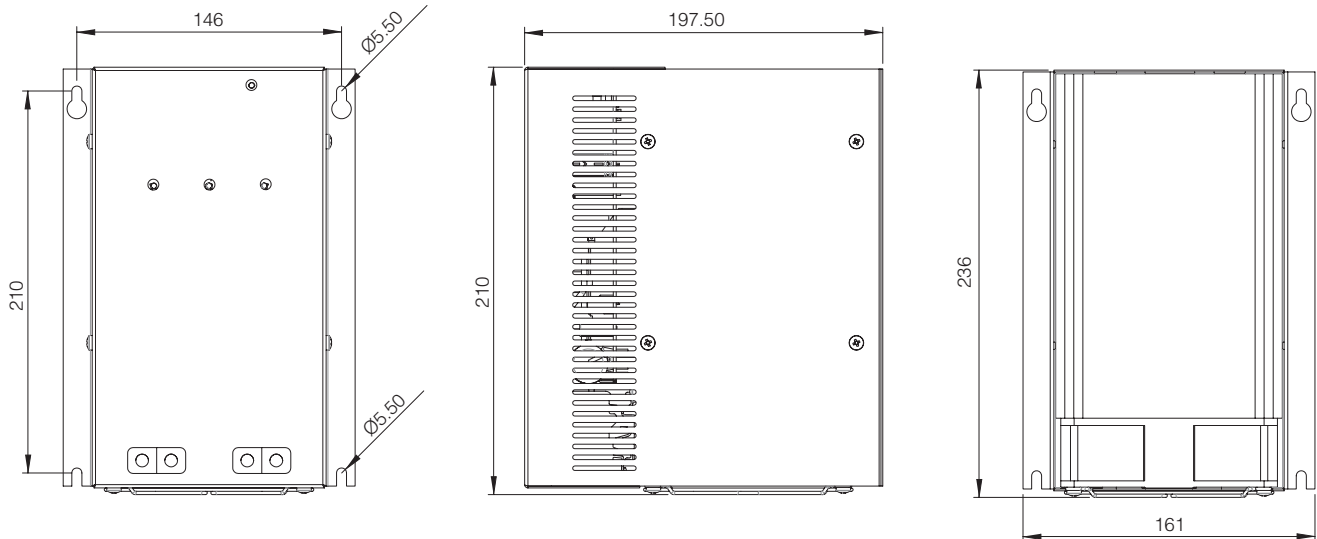


Technical Drawings

RG-TC-12-25



RG-TC-50-80



Thyristor Driver

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Monopase connection	Threepases connection	Max Power kVAr	Over Temperature Protection	Error Notifications (Relay Output)	Trigger Speed (ms)
RG TR -05	150021127	1	1	1,2	130 x 85 x 105	■	-	1.6	■	-	20
RG TR -10	152033015	1	1	1,7	130 x 125 x 105	■	-	3.3	■	-	20
RG TR -20	150021128	1	1	2,8	130 x 145 x 155	■	-	6.6	■	-	20
RG TR -30	150021129	1	1	2,9	130 x 145 x 156	■	-	10	■	-	20
RG TC-12	150021123	1	1	2,2	144 x 150 x 117	-	■	12.5	■	■	10
RG TC-25	150021124	1	1	2,2	144 x 150 x 117	-	■	25	■	■	10
RG TC-50	150021125	1	1	5,9	161 x 229 x 197	-	■	50	■	■	10
RG TC-80	150021126	1	1	5,9	161 x 229 x 197	-	■	80	■	■	10

Multimeter / Ampermeter / Voltmeter

Multimeter



Multimeter M3T



Multimeter M6T



Voltmeter V3T

Industries can keep their energy supply healthy, by monitoring and supervising their power system with the help of Makel Panelmeter solutions. Makel panelmeter products with reactive power control relay offer complete product portfolio to its customers.

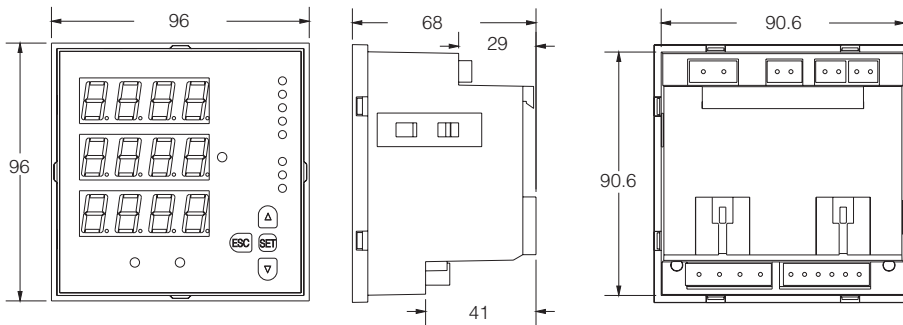
Panelmeter product portfolio includes 3-phase measuring M6T, M3T Multimeters, V3T Voltmeters and 1-phase measuring A1M Ammeter, V1M Voltmeter products. A1M and V1M have single display group, M3T and V3T have 3 display group and M6T has 6 display group.

General Specifications

- ▶ Voltmeters are three phase devices and can measure line-neutral voltages, line-line voltages and phase frequencies.
- ▶ Multimeters are multifunctional devices which can measure many electrical parameters of the system. Multimeters can measure phase currents, line-neutral voltages, line-line voltages and phase frequencies. They can also calculate the neutral current and $\cos\phi$ values.
- ▶ Panelmeter models can generate alarms via relays if the system parameters like currents and voltages go out of the boundary limits which user configures or if there is a phase sequence error.
- ▶ Panelmeters have 3 or 6 group of 4 digit seven segment displays. User can see 3 phase data at the same time.
- ▶ Maximum values of currents, line-neutral voltages, line-line voltages, demands of currents and minimum values of currents, line-neutral voltages, line-line voltages are recorded in its flash memory and can be displayed.
- ▶ The metering menu of the multimeter can be changed automatically in period of from 1 to 15 seconds.
- ▶ Maximum demand period can be adjusted.
- ▶ Current and voltage transformer ratio can be configured.
- ▶ To prevent unauthorized person to change the configuration, it is possible to activate password control.
- ▶ Current starting delay can be set for motor applications.
- ▶ Instant tripping property can be activated separately for current, voltage and frequency values.
- ▶ Latch property of relays of the panelmeter can be activated and the default position of the relays can be reversed.
- ▶ Modbus RTU protocol is supported over RS485 line. So the measured values and configuration values can be read and configuration values can also be changed.

Model No.	Code No.	Panel type I1, I2, I3	Voltage Phase-neutral VL1N, VL2N, VL3N	Voltage phase-phase VL12, VL23, VL13	Cosφ	Hz	I Neutral	V, Hz, Overflow and Underflow Protection	IV, Hz, Overflow and Underflow Protection	Demand ((Current))	Phase Sequence protection	Contact (Single relay)	(Current)	RS-485 Modbus	...X/5A (Voltage transformer range)	Voltage Transformer Rate	96X96	Panel Type	Rail Type	3 Display 4 Digit	6 Display 4 Digit	Password Protection
V3T - 21	152050003	-	•	•	-	•	-	-	-	-	•	-	-	-	-	•	•	•	•	-	-	•
M3T - 22	152050001	•	•	•	•	•	-	-	-	•	•	-	-	-	-	•	•	•	•	-	-	•
M6T - 22C	152050004	•	•	•	•	•	-	-	-	•	•	-	-	-	-	•	•	•	•	-	-	•
M3T - 22C	152050002	•	•	•	•	•	-	-	-	•	•	-	-	-	-	•	•	•	•	-	-	•
M3T - 21	152050006	•	•	•	-	•	•	-	-	•	•	-	-	-	-	•	•	•	•	-	-	•
M3T - 20	152050005	•	•	•	-	•	•	-	-	•	•	-	-	-	-	•	•	•	•	-	-	•

Outline Dimensions



Technical Specifications

Specifications	V3T - 21	M3T - 22	M6T - 22C
Operating voltage	24V-300V AC/DC	24V-300V AC/DC	24V-300V AC/DC
Operating frequency	50/60Hz	50/60Hz	50/60Hz
Temperature range	-10 C° / +70 C°	-10 C° / +70 C°	-10 C° / +70 C°
Supply power consumption	< 6 VA	< 6 VA	< 6 VA
Class	%1 ±1 digit	%1 ±1 digit	%1 ±1 digit
Outputs relay	1 piece NO 5A 250V	2 piece NO 5A 250V	2 piece NO 5A 250V
Safety class	IP20	IP20	IP20
Cable thickness for terminal connection	2,5mm ²	2,5mm ²	2,5mm ²
Weight	< 300g	< 300g	< 300g

Specifications	M3T - 22C	M3T - 21	M3T - 20
Operating voltage	24V-300V AC/DC	24V-300V AC/DC	24V-300V AC/DC
Operating frequency	50/60Hz	50/60Hz	50/60Hz
Temperature range	-10 C° / +70 C°	-10 C° / +70 C°	-10 C° / +70 C°
Supply power consumption	< 6 VA	< 6 VA	< 6 VA
Class	%1 ±1 digit	%1 ±1 digit	%1 ±1 digit
Outputs relay	2 piece NO 5A 250V	1 piece NO 5A 250V	-
Safety class	IP20	IP20	IP20
Cable thickness for terminal connection	2,5mm ²	2,5mm ²	2,5mm ²
Weight	< 300g	< 300g	< 300g

Multimeter / Ampermeter / Voltmeter

Ampermeter



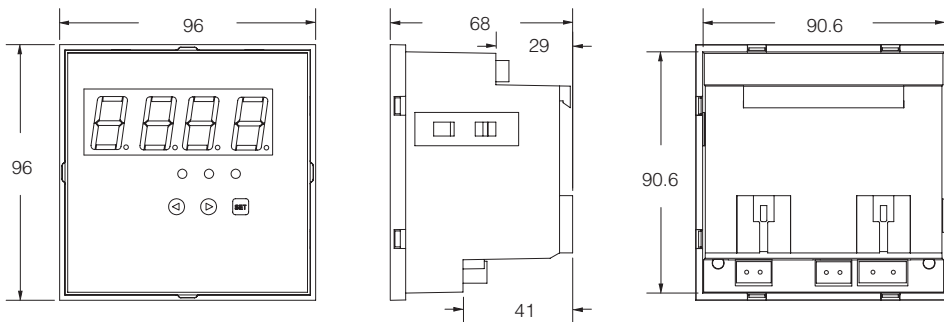
Ampermeter A1M

Model No	Code No.	Single-phase Current	Demand	Max Demand	Contact Output (single relay)	Over/Low Protection	...X/5A (Current transformer ratio)	96X96	Panel Type	Rail Type	1 Display 4 Digit	150-300V AC/DC Feeding
A1M - 10	152070017	■	■	■	■	■	■	■	■	■	■	■
A1M - 11	152070018	■	■	■	■	■	■	■	■	■	■	■
A1M - 10T *	152070030	■	■	■	■	■	■	■	■	■	■	■

*AT-20 is supplied with current transformer.

Outline Dimensions

Ampermeter A1M



Voltmeter

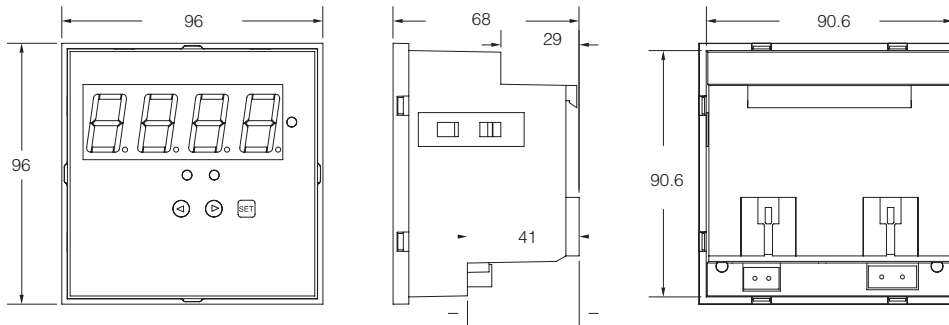


Voltmeter V1M

Model No	Code No.	Single-phase Voltage	Max Voltage	Min. Voltage	Contact Output (single relay)	Over/Low Protection	Voltage Transformer Ratio	96X96	Panel Type	Rail Type	1 Display 4 Digit	150-300V AC/DC Feeding
V1M-10	152070019	■	■	■	■	■	■	■	■	■	■	■
V1M-11	152070027	■	■	■	■	■	■	■	■	■	■	■

Outline Dimensions

Voltmeter V1M



Technical Specifications

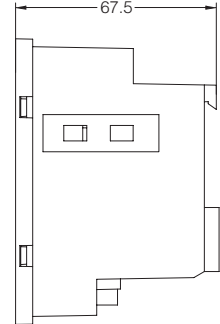
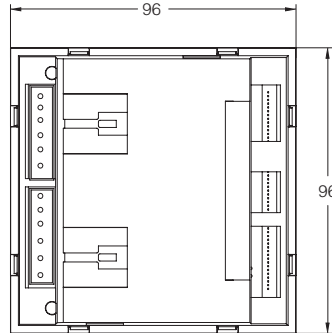
Specifications	A1M-10 / A1M-10T	A1M-11	V1M-10	V1M-11
Operating voltage	150-300V AC/DC	150-300V AC/DC	150-300V AC/DC	150-300V AC/DC
Operating frequency	50/60Hz	50/60Hz	50/60Hz	50/60Hz
Temperature range	-20 C° / +70 C°	-20 C° / +70 C°	-20 C° / +70 C°	-20 C° / +70 C°
Supply power consumption	4VA (max)	4VA (max)	4VA (max)	4VA (max)
Class	%1 ±1 digit	%1 ±1 digit	%1 ±1 digit	%1 ±1 digit
Outputs relay	-	1 Pcs NO 5A 250V	-	1 Pcs NO 5A 250 V
Safety class	IP20	IP20	IP20	IP20
Cable thickness for terminal connection	2,5mm ²	2,5mm ²	2,5mm ²	2,5mm ²
Weight	220g / 275g	235g	225g	240g

Multimeter / Ampermeter / Voltmeter

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
V3T - 21	152050003	1	12	3,71	250 x 235 x 220
M3T - 22	152050001	1	12	4,14	250 x 235 x 220
M6T - 22C	152050004	1	12	4,17	250 x 235 x 220
M3T - 22C	152050002	1	12	4,17	250 x 235 x 220
M3T - 21	152050006	1	12	4,04	250 x 235 x 220
M3T - 20	152050005	1	12	3,88	250 x 235 x 220
A1M - 10	152070017	1	12	2,96	250 x 235 x 220
A1M - 11	152070018	1	12	3,12	250 x 235 x 220
A1M - 10 T	152070030	1	12	3,60	250 x 235 x 220
V1M - 10	152070019	1	12	3,02	250 x 235 x 220
V1M - 11	152070027	1	12	3,18	250 x 235 x 220

Network Analyzer

Outline Dimensions



MEA 11C is a network analyzer that displays and records measurements of all specified network parameters. It has one, two or three phase measurement capability. Can be used in two, three or four-wire networks.

Thanks to the structure of 96 x 96 mm format, it is suitable for all analogue displays. The 3.6-inch LCD display makes it possible to read measured parameters from a distance. In poorly lit environments, the MEA 11C also has a background illumination to create the optimal reading area.

MEA 11C uses the MODBUS protocol as the communication protocol.

General Specifications

- ▶ The measurement information of parameters can be read from display
- ▶ 3 wire + neutral systems can be measured.
- ▶ It supports modbus protocol on RS485 communication. A Special PC software are available for downloading specified parameters.
- ▶ The turn rate of current transformer and the turn rate of voltage transformer can be changed.
- ▶ The specified parameters can be recorded in static area with timestamp. the recorded parameters can be downloaded to PC using special software.
- ▶ The electricity in wires can be seen from the symbols on the LCD instantly.
- ▶ The device is protected with password for authorized used.

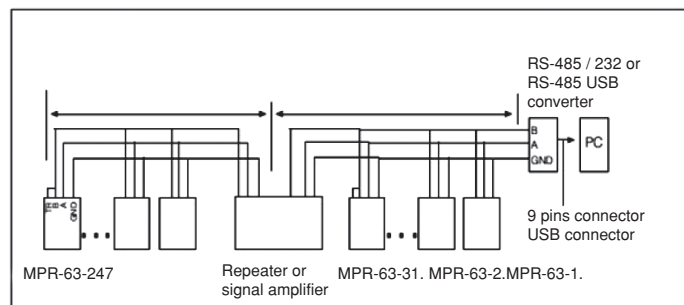
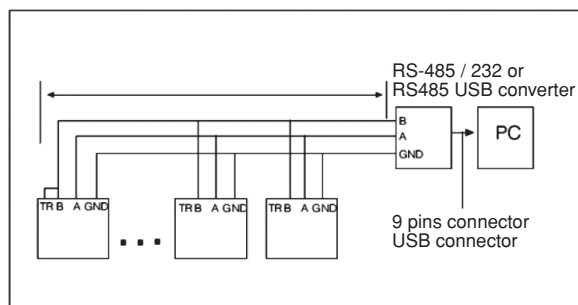
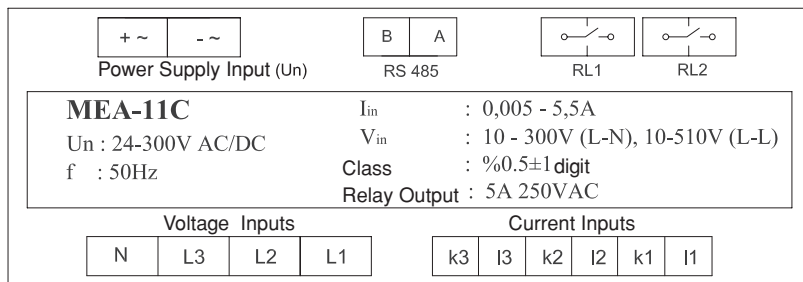
Technical Specifications

Operating voltage	24V-300V AC/DC
Operating frequency	50/60Hz
Temperature range	-10°C / +70°C
Supply power consumption	<6 VA
Class	%1 ±2 digit
Outputs relay	2 adet NO 5A 250V
Safety class	IP20
Cable thickness for terminal connection	2,5mm ²
Weight	<300g

Security Precautions

- ▶ Use appropriate personal protective equipment. carefully follow safe electrical operation practices.
- ▶ Installation of this device must only be carried out by a qualified electrician. Safety measures must be read before installation.
- ▶ Before starting work on the device, disconnect all power to the network analyzer and the equipment it is installed into.
- ▶ Before starting work on the device, disconnect all power to the network analyzer and the equipment it is installed into.
- ▶ Never remove the front panel when the device is connected to the network.
- ▶ Never work alone when setting up, operating and servicing the energy analyzer.
- ▶ Clean the energy analyzer with dry cloth only.
- ▶ Do not touch the electricity wire during dismantling or installation of the energy analyzer.
- ▶ The faultless use of the network analyzer depends on proper transport, installation and operation. Failure to observe the basic installation rules may result in death, injury and equipment damage.
- ▶ Separate all input and output cables for the network analyzer before exposing the equipment containing the network analyzer to the high voltage test. Otherwise, high voltage tests may damage the electronic components of the network analyzer.
- ▶ The network analyzer must be installed in a suitable electric panel.

Wiring Diagrams



Network Analyzer

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
MEA 11C Network Analyzer	152070044	1	12	5,00	246 x 232 x 215

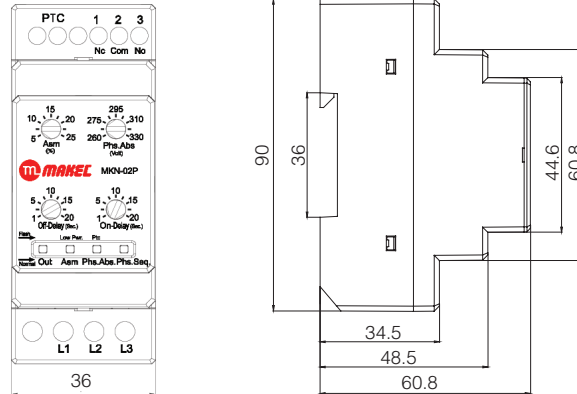
Panel type I1, I2, I3, Σ
Voltage Phase-neutral VL1N, VL2N, VL3N
Voltage phase-phase VL12, VL2v3, VL13
PF (Power Factor) PF1, PF2, PF3, ΣPF
Cosφ1, Cosφ2, Cosφ3
kW, kVA, kVA, ΣP, ΣQ, ΣS, Demand (Max., Min., Anlk)
% THD1
% THD V
Frequency Hz
Average Voltage (Phase-Natural, Phase - Phase)
Energy (kWh, kVAh)
Voltage Harmonic Separately (Until 32th Harmonic)
Current Harmonic Separately (Until 32th Harmonic)
Load Profile (25 Different Parameter Recording)
Real Time and Date
Neutral
V, Hz, Overflow and Underflow Protection
IV, Hz, Overflow and Underflow Protection
Protect Phase Order
Error Records
Shortchange (2 Relay)
Alarm Function
15 Real-Time Alarm Controls For Each Shortchange.
RS-485 Modbus
...:X/5A (Current Transformer Turn Rate)
Voltage Transformer Rate
96X96
Panel Type
Rail Type
LCD (Graphic Display + Custom Design Display) Password Protection

Motor Protection Relays



MKN - 02P

Outline Dimensions



Motor Protection Relays

During the operation of three phase motors if voltage imbalance or voltage outage occurs the motor overheats. This situation can cause damage in the motors. Motor protection relays are designed to cut off the motor's power supply in such situations to prevent any kind of malfunction. Also by doing phase checks it makes sure that motor connections run smoothly.

Control Functions

During Phase Control: Makes sure whether or not the phase connection order is done correctly as L1, L2, L3.

If the connection order is different the relay (out) cannot be made to draw and the motor will not be operated. In this case the "Phs. Seq." on the device will be lit up.

Ptc Control (in MKx02P models): This control is done in order for the motor winding temperature to be measured. If the winding temperature reaches dangerous levels the relay will release without delay and the motor will be stopped. When Ptc error occurs or the Ptc connection is left idle the "Phs.Seq." led flashes.

Insufficient Supply Control: When the 3 phase voltages fall below the margin to the point that the device cannot be supplied with power the relay will release without delay and the motor will be stopped. During this time the "Asm" led flashes.

Absence of Phase Control: When at least one of the 3 phase voltages falls below the set Phs. Abs. setting the relay will release without delay and the motor will be stopped. During this time the "Phs.Abs" led flashes.

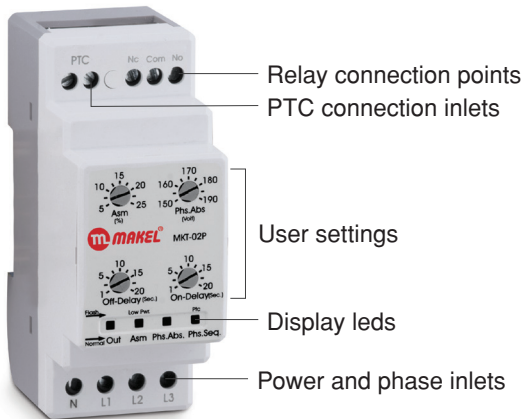
Operating the Device

The necessary connections are made by studying the connection chart. Care must be taken to avoid Phase order and Ptc error (in Ptc models). If Ptc is not to be used the Ptc ends must be made into short circuits. When the system is operated if there is no error the out relay draws and the "out" led lights up. If there is an error the out relay will not extract and the relevant error light will go on.

Asymmetry Error During Normal Operation: If the voltage imbalance is higher than the asymmetry setting in the system a period that is as long as the Off-Delay setting will be waited. If the problem continues after this period the drawn relay is released and the motor is stopped the "Asm" led lights up, the "Out" led turns off, if the error is not continuing the relay remains drawn.

Moving to Normal Operation While an Asymmetry Error is Ongoing: If the voltage imbalance is lower than the asymmetry setting in the system, a period that is as long as the On-Delay setting will be waited out. If there is no asymmetry error at the end of the period the released relay is drawn and the motor is operated, the "Asm" led turns off, the "Out" led turns on, if the error continues the relay remains released.

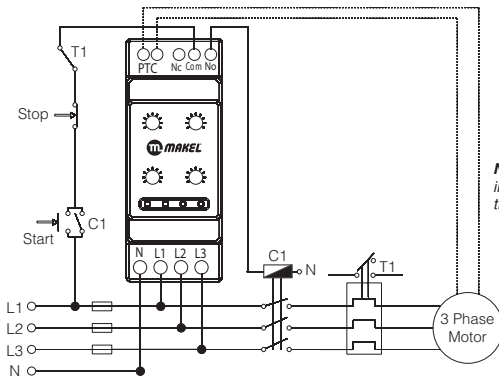
Note: In the event that a single phase is cut off while the motor is operating, the cut off phase's voltage cannot be zero because the other phase voltages pass over the motor windings and appear in the entry of the cut off phase. Therefore make the asymmetry setting lower.



Meanings of the display leds	Out	Asm.	Phs. Abs	Phs. Seq
No problem, normal operation, exit relay active	x			
Asm. error occurred (period being counted)	x	x		
Asymmetry error		x		
Phase order error (Phs. Seq)				x
Ptc error (Ptc)				Flash
Insufficient supply (Low Pwr.)		Flash		
Absence of phase error (Phs. Abs)			x	

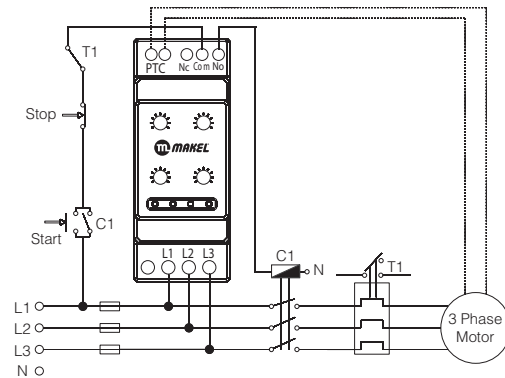
Wiring Diagrams

MKT-01, MKT-02P



Note: The only difference in the MKT-01 model is that there is no PTC connection.

MKN-02P



Technical Specifications

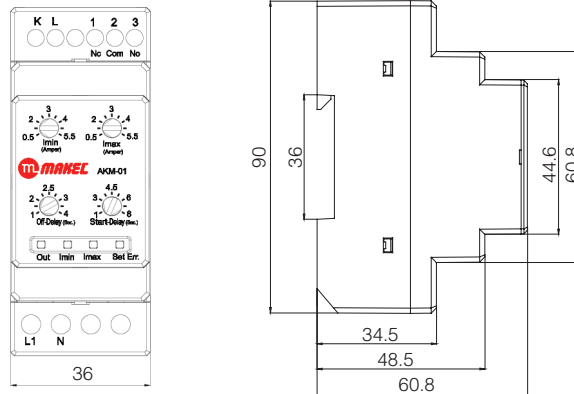
Specifications	MKT-01 / MKT-01L / MKT-02P	MKN-02P	MKT-01S
Operation Voltage (Un)	230 V AC	400 V AC	230 V AC
Operation Voltage Interval (U)	150-300V AC	260-520 V AC	65-300V AC
Insufficient Supply Interval	100-120 V AC	175-210 V AC	58-60 V AC
Operation Frequency	50 Hz	50 Hz	50 Hz
Power Consumption (Max)	2.5 VA	2.5 VA	2.5 VA
Measurement Method	TrueRMS	TrueRMS	TrueRMS
Asymmetry	%15 Sabit / %40 Sabit / %5...%25	%5...%25	%15 constant
Phs. Abs. (Absence of Phase)	170 V Fix / 150...190 V adj.	260...330 V adj.	65 constant
Phase Sequence Control	Yes / None / Yes	Yes	Yes
Hysteresis	20% of asymmetry value	20% of asymmetry value	20% of asymmetry value
Off-Delay (Release Delay)	1sec / Set at 1...20 sec	Set at 1...20 sec	1sec
On-Delay (Draw Delay)	1sec	Set at 1...20 sec	1sec
Ptc Operation Interval	None / Opening: more than 1600 ohm Closing: less than 1400 ohm	Opening: more than 1600 ohm Closing: less than 1400 ohm	None
Setting Accuracy	None / + or - %5	+ or - %5	None
Exit Relay	5 A 250 V AC	5 A 250 V AC	5 A 250 V AC
Operation Temperature	Between -20°C...50°C	Between -20°C...50°C	Between -20°C...50°C
Relative Humidity	Less than 90% (Without condensation)	Less than 90% (Without condensation)	Less than 90% (Without condensation)
Cable Sections	2.5 mm ² multi vessel cable	2.5 mm ² multi vessel cable	2.5 mm ² multi vessel cable
Assembly Types	Rail type	Rail type	Rail type
Protection Class	IP20 (Terminals), IP40 (Front Panel)	IP20 (Terminals), IP40 (Front Panel)	IP20 (Terminals), IP40 (Front Panel)
Dimensions	36x90x61	36x90x61	36x90x61
Weight	125gr	125gr	125gr
Insulation	400 V insulation voltage 4 KV source impact	400 V insulation voltage 4 KV source impact	400 V insulation voltage 4 KV source impact

Current Protection Relays



AKM-01

Outline Dimensions



Current Protection Relays

Current protection relays monitor the current in every phase of motors and similar devices and make sure that the devices operate in the desired power intervals. When the devices draw currents at intervals other than what is set the system's power is cut off to prevent the device from malfunctioning.

Current protection relays are designed to protect the systems they are attached to from excessive and low currents. It is possible to enter the operation current interval. The relays can also be used as only "excessive current protection" and "low current protection". The first start currents in motors are high, therefore they have a start delay to prevent incorrect excessive currents that may occur.

Operation of Device

The necessary connections are made according to the connection chart. I_{max} and I_{min} current margin values cannot be set close to each other or I_{max} cannot be smaller than I_{min} . If they are set as such an error will occur and the "Set.Err." led will light up. This must be checked. When the system is operated if there is no error the out relay will draw and the "Out" led will light up. If there is an error the relay-out will not draw and the relevant led will light up.

Normal Operation and Excessive or Low Current Error: When the system is first started up the period of time that the Star-delay has been set at is waited out. The current levels measured during the wait period are not evaluated. Thus the start-up current of the motor being high will not cause a problem. After the Start-Delay period is finished the system will go back to working normally.

If the system's current value goes above the excessive current level or falls below the low current level, a PERIOD AS LONG AS THE Off-Delay period is waited out. If the error is ongoing after the waiting period the drawn relay is released, the system it is attached to is stopped and the "Imax" or "Imin" led lights up. If the error is not continuing the relay will continue to be drawn.

Important Explanation

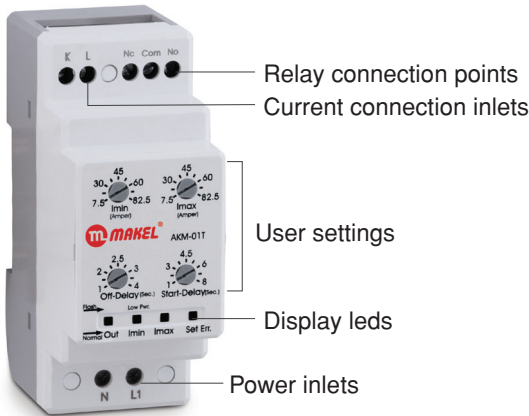
- The excessive current margin and low current margin can be set close to each other
- If the excessive current margin is set lower than the low current margin there will be an error, the current protection device will not work and the "Set.Err." led will light up.

To use as "**excessive current protection**" set I_{min} current margin to min. ampere,

To use as "**low current protection**" set I_{max} current margin to max. ampere.

Off-Delay: As soon as an excessive or low current error is detected the Off-Delay waiting period must be waited out.

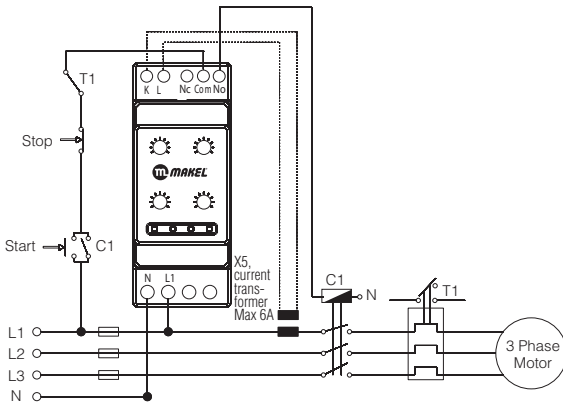
Start Delay: At the first point that the system operates the Start-Delay period must be waited out. The current levels that are measured at this time are not taken into account and no excessive load error occurs.



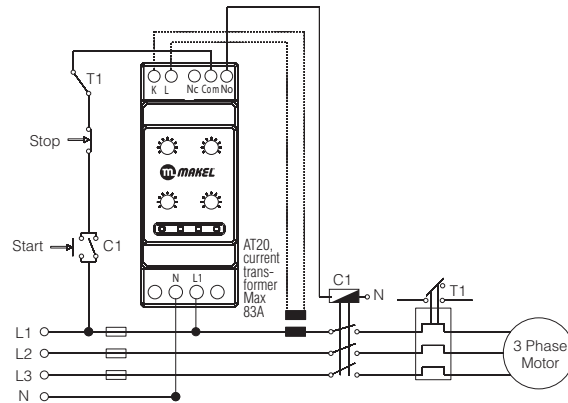
Meaning of the display leds	Out	Imin	Imax	Set.Err.
No problem, normal operation, axit relay active	x			
Excessive error occurred (period being counted)	x		x	
Over current error			x	
Low current occurred (period being counted)	x	x		
Low current error		x		
Outside the boundary of the Imax and Imin settings				x

Wiring Diagrams

AKM-01



AKM-01T



Technical Specifications

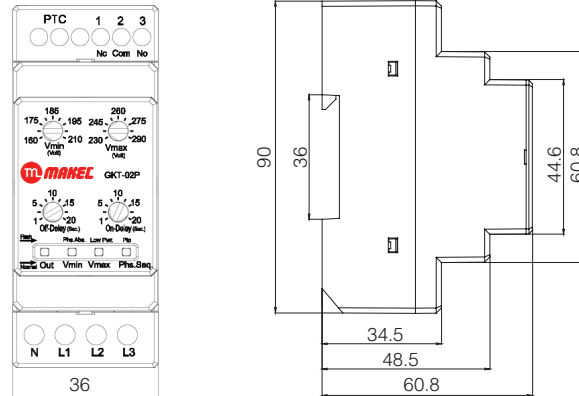
Specifications	AKM-01	AKM-01T
Operation Voltage (Un)	230 V AC	230 V AC
Operating Voltage Interval (U)	150-300 V AC	150-300V AC
Operation Frequency	50 Hz	50 Hz
Power Consumption (Max)	2.5 VA	2.5 VA
Measurement Method	TrueRMS	TrueRMS
I _{max} (Over Current Setting)	0,5...5,5 A	7,5...82,5 A
I _{min} (Low Current Limit Setting)	0,5...5,5 A	7,5...82,5 A
Hysteresis	200 mA	3 A
Off-Delay (Release Delay)	Set at 1...4 sec	Set at 1...4 sec
Start-Delay (Start-up Delay)	Set at 1...8 sec	Set at 1...8 sec
Setting Accuracy	+ or -%5	+ or -%5
Exit Relay	5 A 250 V AC	5A 250 V AC
Operation Temperature	Between -20°C...50°C	Between -20°C...50°C
Relative Humidity	Less than 90% (Without condensation)	%90'dan küçük (Yoğunlaşma olmadan)
Cable Sections	2.5 mm ² multi vessel cable	2.5 mm ² multi vessel cable
Assembly Types	Rail type	Rail type
Protection Class	IP20 (Terminals), IP40 (Front Panel)	IP20 (Terminals), IP40 (Front Panel)
Dimensions	36x90x61	36x90x61
Weight	125gr	125gr
Insulation	400 V insulation voltage, 4 KV source impact	400 V insulation voltage, 4 KV source impact

Voltage Protection Relays



GKT-02P

Outline Dimensions



Voltage Protection Relays

Used to protect triphase motors and similar devices from phase interruptions, voltage imbalances, incorrect connections and overheating. In any error situation the system's power is cut off to prevent the device from malfunctioning.

The voltage protection relay has been designed to protect the systems they are connected to from excessive voltage, low voltage and overheating. Also in 3 phase models they control the phase order to make sure that the motor connections work properly.

Control Functions

During Phase Control (in GKx02P models): Makes sure whether or not the phase connection order is done correctly as L1, L2, L3. If the connection order is different the relay (out) cannot be made to draw and the motor will not be operated. In this case the "Phs. Seq." on the device will be lit up.

Ptc Control (in GKx02P models): This control is done in order for the motor winding temperature to be measured. If the winding temperature reaches dangerous levels the relay will release without delay and the motor will be stopped. When Ptc error occurs or the Ptc connection is left idle and the "Phs. Seq." led flashes.

Insufficient Supply Control (in GKx02P models): When the 3 phase voltages fall below the margin to the point that the device cannot be supplied with power, the relay will release without delay and the motor will be stopped. During this time the "Vmax" led flashes.

Absence of Phase Control (in GKx02P models): When at least one of the 3 phase voltages is cut off the relay releases without delay and the motor is stopped. During this time the "Vmin" led flashes.

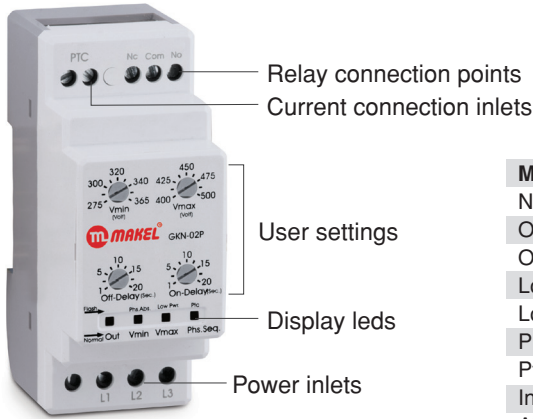
Operating the Device

The necessary connections are made by studying the connection chart. Care must be taken to avoid Phase order and Ptc error (in Ptc models). If Ptc is not to be used the Ptc ends must be made into short circuits. When the system is operated if there is no error the out relay draws and the "out" led lights up. If there is an error the out relay will not draw and the relevant error light will go on.

Excessive and/or Low Voltage Occurring During Normal Operation: If any of the system's phase voltages rise above the excessive voltage margin and/or fall below the low voltage margin period that is as long as the Off-Delay setting will be waited. If the problem continues after this period the drawn relay is released, the system it is connected to is stopped and the "Vmin" and/or "Vmax" led lights up and the "Out" led turns off. If the problem continues the relay stay drawn.

Moving to Normal Operation While there is an Excessive and/or Low Voltage Error: If the system's 3 phase voltages are lower than the set Vmax voltage and lower than the set Vmin voltage, a period that is as long as the On-Delay setting will be waited. If there is no error at the end of the period the released relay is drawn and the system is operated. The "Vmax" and "Vmin" led turns off, the "Out" led turns on, if the error is continuing the relay remains released.

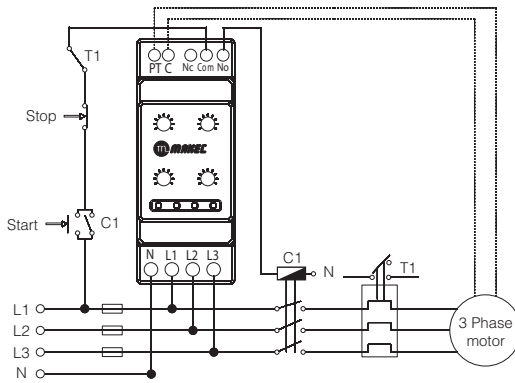
Note: In the event that a single phase is cut off while the motor is operating, the cut off phase's voltage cannot be zero because the other phase voltages pass over the motor windings and appear in the entry of the cut off phase. Therefore make the Vmin setting higher.



Meaning of the display leds	Out	Vmin	Vmax	Phs. Seq.
No problem, normal operation, exit relay active	x			
Overvoltage error occurred (period being counted)	x		x	
Overvoltage error			x	
Low voltage error occurred (period being counted)	x	x		
Low voltage error		x		
Phase order error (Phs. Seq)				x
Ptc error (Ptc)				Flash
Insufficient supply (Low Pwr.)			Flash	
Absence of phase error (Phs. Abs)		Flash		

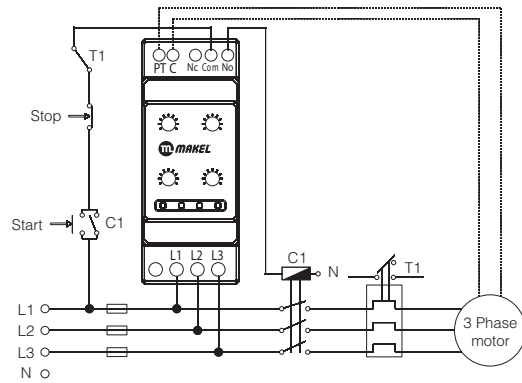
Wiring Diagrams

GMK-01 / GKT-02P



Note: The only difference in the GKM 01 model is that there are no PTC connection and L2, L3.

GKN-02P



Technical Specifications

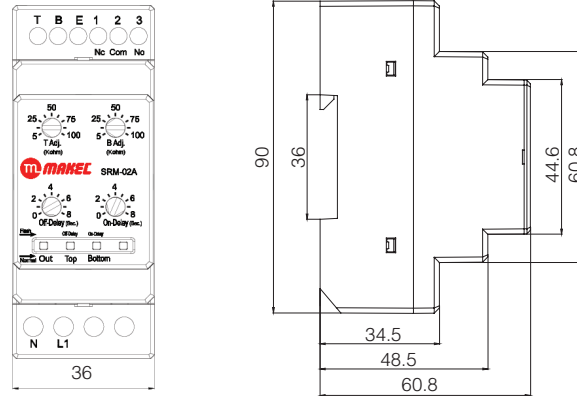
Specifications	GKM-01/03 - GKT-02P/03P/ 02PL	GKN-02P	GKT-01S
Operation Voltage (Un)	230 V AC	400 V AC	230 V AC
Operation Voltage Interval (U)	150-300 V AC Gxx-01/02, 80-300V AC Gxx-03	260-520 V AC	65-300 V AC
Insufficient Supply Interval	100-120 AC Gxx-01/02, 70-80V AC Gxx-03	175-210 V AC	58-60V AC
Operation Frequency	50 Hz	50 Hz	50 Hz
Power Consumption (Max)	2.5VA	2.5 VA	2.5 VA
Measurement Method	TrueRMS	TrueRMS	TrueRMS
Vmax (Over Voltage Setting)	230...290 V AC	400..500 V AC	230...290 V AC
Vmin (Low Voltage Setting)	160...210 V AC Gxx-01/02, 90...200V Gxx-03	275...365 V AC	Yok
Phase Sequence Control	Yok / Var / Yok	Var	Var
Hysteresis	%5 of Vmax Vmin value	%5 of Vmax Vmin value	%5 of Vmax Vmin value
Off-Delay (Release Delay)	Set at 1 ... 20 sec.	Set at 1 ... 20 sec.	1sec. constant
On-Delay (Draw Delay)			
Ptc Operation Interval	None/Opening: more than 1600 ohm Closing: less than 1400 ohm	Opening: more than 1600 ohm Closing: less than 1400 ohm	None None
Setting Accuracy	+ veya -%5	+ veya -%5	+ veya -%5
Exit Relay	5A 250 V AC	5A 250 V AC	5A 250 V AC
Operation Temperature	-20°C...50°C arası	-20°C...50°C arası	-20°C...50°C arası
Relative Humidity	%90'dan küçük (Yoğunlaşma olmadan)	%90'dan küçük (Yoğunlaşma olmadan)	%90'dan küçük (Yoğunlaşma olmadan)
Cable Sections	2.5mm ² çok damarlı kablo	2.5mm ² çok damarlı kablo	2.5mm ² çok damarlı kablo
Assembly Types	Ray tipi	Ray tipi	Ray tipi
Protection Class	IP20 (Terminaller), IP40 (Ön Panel)	IP20 (Terminaller), IP40 (Ön Panel)	IP20 (Terminaller), IP40 (Ön Panel)
Dimensions	36x90x61	36x90x61	36x90x61
Weight	125gr	125gr	125gr
Insulation	400V Yalıtım Gerilimi, 4KV Source darbe	400V Yalıtım Gerilimi, 4KV Source darbe	400V Yalıtım Gerilimi, 4KV Source darbe

Liquid Level Control Relays



SRM-02A

Outline Dimensions



Liquid Level Relays

When liquids with certain conductivity are emptied from storage tanks or while the tanks are being filled these relays prevent the tanks from overflowing and the motors working unnecessarily.

The liquid level relay has 3 electrodes. It is used for emptying liquid reservoirs or water wells. The liquid needs to be conductive in order for the electrodes to be detected. The relay may not be used for flammable or explosive liquids.

Operation of the Device

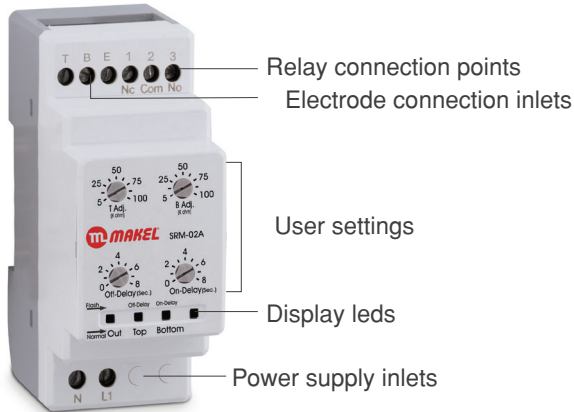
The necessary connections are made according to the connection chart. If the liquid reservoir surface is conductive the E connection terminal may be connected to the reservoir surface. If the reservoir is conductive an electrode must be also be connected to the E terminal.

Attention must be paid to the order of the electrodes in the reservoir or well. The E electrode must be placed in the bottom, the T electrode determining the motor operation point must be placed at the very top and the B electrode determining the stopping point of the motor must be placed in between.

The liquid must be conductive. The relay may not be used with flammable or explosive liquids. If the electrodes are not being detected in the SRM-02A model you can change the perception level and enable it to be detected with the Adj. setting.

Operation When the Relay is Passive: When the T and E electrodes are outside of the liquid the "Top" and "Bottom" leds lights up. During this process the out relay is in passive state. The leds of the electrodes that enter the liquid will turn off. When both of the electrodes enter the liquid the On-Delay wait period is counted down. During this period the "Bottom" led will flash. At the end of the period the relay becomes active and the "Out" led goes on.

Operation When the Relay is Active: When the T and E electrodes are inside the liquid the "Top" and "Bottom" leds are off. During this process the out relay is in active state. The leds of the electrodes that come out of the liquid will turn on. When both of the electrodes come out of the liquid the Off-Delay wait period is counted down. During this period the "Top" led will flash. At the end of the period the relay becomes passive and the "Out" led goes off.

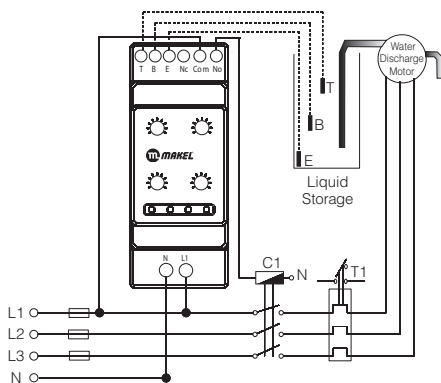


Meanings of the display leds	Out	Top	Bottom
Top and bottom electrodes are outside of the liquid		x	x
Top electrode is outside of the liquid, bottom is inside		x	
Exit active, top and bottom electrodes in liquid	x		
Exit active, top electrode outside liquid	x	x	
The period that exit relay is to be Off is counting down	x	Flash	x
The period that exit relay is to be On is counting down			Flash

Note: There are no T Adj., B Adj., Off-Delay and On-Delay settings on the SRM-01 model.

Wiring Diagrams

SRM-01 / SRM-02A



Technical Specifications

Specifications	SRM-01	SRM-02A
Operation Voltage (Un)	230 V AC	230 V AC
Operation Voltage Interval (U)	150-300 V AC	150-300 V AC
Operation Frequency	50 Hz	50 Hz
Power Consumption (Max)	2.5 VA	2.5 VA
T- adj. (Top electrode sensitivity setting)	Fixed between 0-50 kohm	Set between 0-100 kohm
B- adj. (Top electrode sensitivity setting)	Fixed between 0-50 kohm	Set between 0-100 kohm
Off-Delay (Release period)	1 sec fixed	Set at 1-8 sec
On-Delay (Draw period)	1 sec fixed	Set at 1-8 sec
Setting Accuracy	+ or -5%	+ or -5%
Exit Relay	5 A 250 V AC	5 A 250 V AC
Operation Temperature	Between -20°C...50°C	Between -20°C...50°C
Relative Humidity	Less than 90% (Without condensation)	Less than 90% (Without condensation)
Cable Sections	2.5 mm ² multi vessel cable	2.5 mm ² multi vessel cable
Assembly Types	Rail type	Rail type
Protection Class	IP20 (Terminals), IP40 (Front Panel)	IP20 (Terminals), IP40 (Front Panel)
Dimensions	36x90x61	36x90x61
Weight	125gr	125gr
Insulation	400 V insulation voltage 4 KV source impact	400 V insulation voltage 4 KV source impact

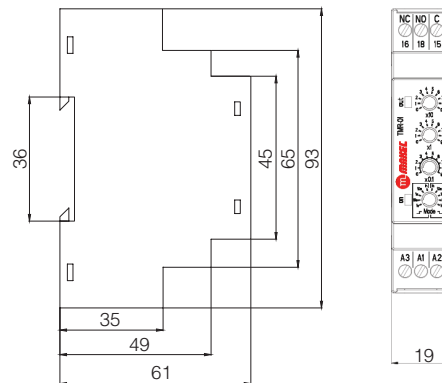
Time Relays

Time Relay TMR-01



TMR-01

Outline Dimensions



Used especially for process control in industrial automation. They activate or inactivate systems with set delays or start or stop events with a delay.

Draw Delayed Relays: draw contact at the end of the T period after voltage is applied to the time relay.

Release Delayed Relays: draw contact when voltage is applied to the time relay and release contact at the end of the t period.

Note: In order for time settings which have been made when the time relay is with power to be valid, the time relay power supply needs to be provided again.

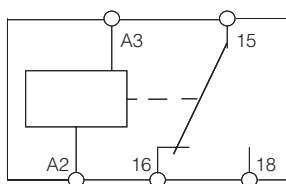
General Specifications

Time Relays are used in industry for their following feature.

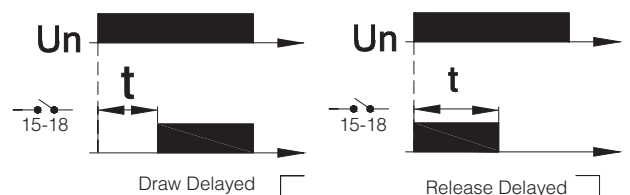
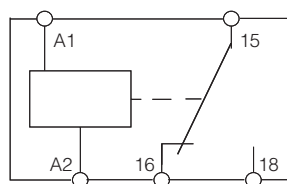
- ▶ General purpose use
- ▶ Easily adjustable time interval
- ▶ Easy attachment to rail
- ▶ Narrow and small size

Wiring Diagrams

24 V AC / DC \pm %10



220 / 230 V AC \pm %20



Safety Warnings

- ▶ The assembly and electrical connections must be done by technical personnel according to the instructions.
- ▶ While the device is being assembled there should be no power on the connection cables.
- ▶ The device should be mounted inside of the panel.
- ▶ Check the cable connections before operating the device.
- ▶ Do not open the device.
- ▶ Do not operate the device in dirty, wet or vibrating conditions.
- ▶ Use a dry cloth to clean the device, never use a solvent or chemical substance.

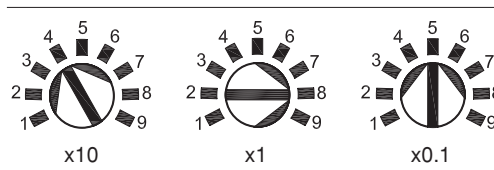
Time Setting

X10 trimpot value show the tens digit of the desired time, x1 shows the ones digit and x0.1 show the one tenths digit of the desired time.

Example: x10 = 4, x1 = 8, x0.1 = 5 and

Mode= if 1s has been set the contact outlets will change position after 48.5 seconds.

x10	x1	x0.1	Mode	Set Time
4	8	5	1s	48,5 sec
4	8	5	10s	485 sec
4	8	5	1m	48,5 min
4	8	5	10m	485 min
4	8	5	1h	48,5 hour



Technical Specifications

Specifications	TMR-01
Time Interval	0.5sec – 99.9 hours
Accuracy	<1%
Power Supply	220/230 Vac ± 20% 24 Vac / dc ± 10%
Power Consumption *	Active Power 0.9 W (220 Vac 50 Hz) Visible Power 8 VA
Sudden Impact Voltage Resistance * Surge (IEC 61000-4-5)	2 kV
Quick Temporary Sudden Impact Voltage * Resistance Burst (IEC 61000-4-4)	4.4 kV
Electromagnetic RF Fields Resistance * (IEC 61000-4-3)	10 V/m
Assembly Form	Th Rail assembly (EN 60715)
Protection Class	IP20 (EN 60529),
Ambient Temperature	-5°C + 50°C (Operation) -25°C + 75°C (Storage)
Contact Current /Power	1 C/O, 8A, 2000 VA

* Applies to 220/230 Vac (A1-A2) supply line

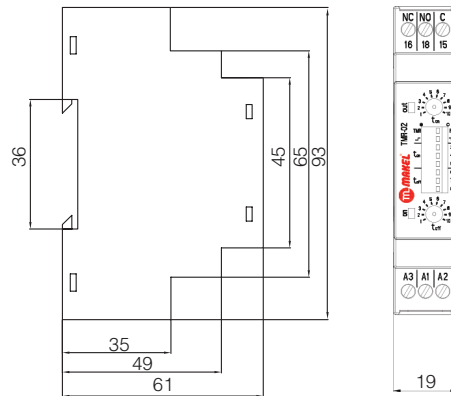
Time Relays

Time Relay TMR-02



TMR-02

Outline Dimensions



Draw Delayed Relays: draw contact at the end of the T period after voltage is applied to the time relay.

Release Delayed Relays: draw contact when voltage is applied to the time relay and release contact at the end of the t period.

Note: In order for time settings which have been made when the time relay is with power to be valid, the time relay power supply needs to be provided again.

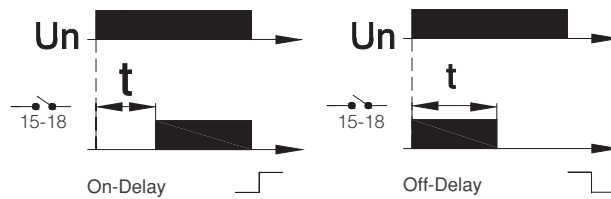
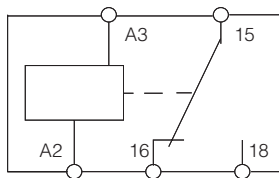
General Specifications

Time Relays are used in industry for their following feature.

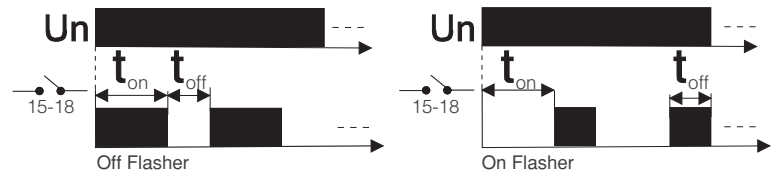
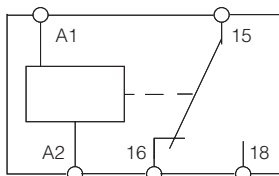
- ▶ General purpose use
- ▶ Easily adjustable time interval
- ▶ Easy attachment to rail
- ▶ Narrow and small size

Wiring Diagrams

24 VAC/DC $\pm 10\%$



220 / 230 V AC $\pm 20\%$

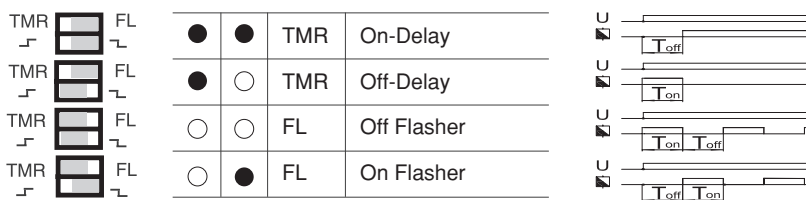


Safety Warnings

- ▶ The assembly and electrical connections must be done by technical personnel according to the instructions.
- ▶ While the device is being assembled there should be no power on the connection cables.
- ▶ The device should be mounted inside of the panel.
- ▶ Check the cable connections before operating the device.
- ▶ Do not open the device.
- ▶ Do not operate the device in dirty, wet or vibrating conditions.
- ▶ Use a dry cloth to clean the device, never use a solvent or chemical substance.

Time Setting

TM-02 timer operated as On-Delay (ER), Off Delay(EM), On Flash mode or Off Flasher mode according to user needs. Adjustable time range of TMR-02 is between 0.5 second- 30 hours.



TMR-02					
5	4	3	T on Time Setting		
8	7	6	T off Time Setting		
			Time Range	Adjustable Time Range	
○	○	○	5 sec	0,5-5 sec	
○	○	●	10 sec	1-10 sec	
○	●	○	30 sec	3-30 sec	
○	●	●	60 sec	6-60 sec	
●	○	○	10 min	1-10 min	
●	○	●	60 min	6-60 min	
●	●	○	10 hour	1-10 hour	
●	●	●	30 hour	3-30 hour	

T on time is setting by 3,4,5 switches and ton trimmer,

T off time is setting are by 6,7,8 switches and toff trimmer.

T on and/or T off time settings are calculated according to the following formulas

a: Selected time range (by switches)

x: Position of timer

t: Desired time

$$x = \frac{10 \cdot t}{a} \quad \text{and} \quad t = \frac{x \cdot a}{10}$$

Technical Specifications

Specifications	TMR-02	Specifications	TMR-02
Time Interval	0,5sec – 30 hours	Electromagnetic RF Fields Resistance *	10 V/m
Accuracy	<1%	(IEC 61000-4-3)	
Power Supply	220/230 Vac ± 20% 24 Vac / dc ± 10%	Assembly Form	Th Rail assembly (EN 60715)
Power Consumption *	Active Power 0.9 W Visible Power 8 VA	Protection Class	IP20 (EN 60529),
Sudden Impact Voltage Resistance *	2 kV	Ambient Temperature	-5°C + 50°C (Operation) -25°C + 75°C (Storage)
Surge (IEC 61000-4-5)		Contact Current /Power	1 C/O, 8A, 2000 VA
Quick Temporary Sudden Impact Voltage *	4.4 kV		
Resistance Burst (IEC 61000-4-4)			

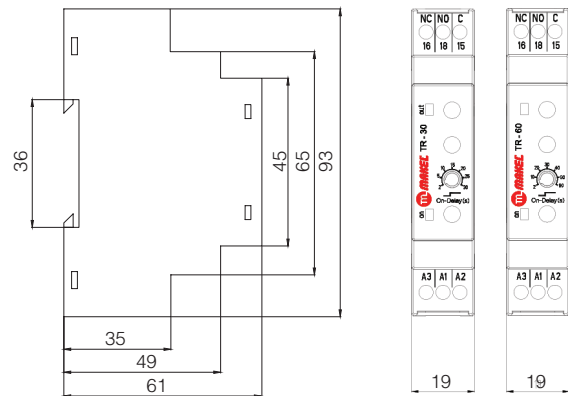
* Applies to 220/230 Vac (A1-A2) supply line

Time Relays

Time Relay TMR-30 / TMR-60



Outline Dimensions



Draw Delayed Relays: draw contact at the end of the T period after voltage is applied to the time relay.

Note: In order for time settings which have been made when the time relay is with power to be valid, the time relay power supply needs to be provided again.

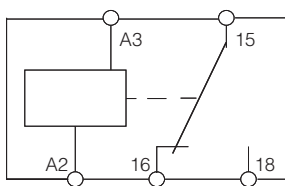
General Specifications

Time Relays are used in industry for their following feature.

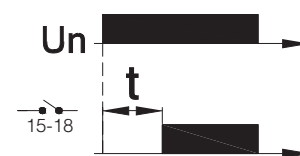
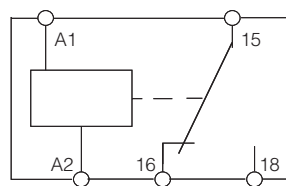
- ▶ General purpose use
- ▶ Easily adjustable time interval
- ▶ Easy attachment to rail
- ▶ Narrow and small size

Wiring Diagrams

24 V AC / DC \pm %10



220 / 230 V AC \pm %20



Safety Warnings

- ▶ The assembly and electrical connections must be done by technical personnel according to the instructions.
- ▶ While the device is being assembled there should be no power on the connection cables.
- ▶ The device should be mounted inside of the panel.
- ▶ Check the cable connections before operating the device.
- ▶ Do not open the device.
- ▶ Do not operate the device in dirty, wet or vibrating conditions.
- ▶ Use a dry cloth to clean the device, never use a solvent or chemical substance.

Technical Specifications

Specifications	TMR-30	TMR-60
Time Interval	2-30 sec	2-60 sec
Accuracy	<1%	<1%
Power Supply	220/230 Vac ± 20% 24 Vac / dc ± 10%	220/230 Vac ± 20% 24 Vac / dc ± 10%
Power Consumption * (220 Vac 50 Hz)	Active Power 0.9 W Visible Power 8 VA	Active Power 0.9 W Visible Power 8 VA
Sudden Impact Voltage Resistance * Surge (IEC 61000-4-5)	2 kV	2 kV
Quick Temporary Sudden Impact Voltage * Resistance * Burst (IEC 61000-4-4)	4.4 kV	4.4 kV
Electromagnetic RF Fields Resistance * (IEC 61000-4-3)	10 V/m	10 V/m
Assembly Form	TH Rail assembly (EN 60715)	TH Rail assembly (EN 60715)
Protection Class	IP20 (EN 60529)	IP20 (EN 60529)
Ambient Temperature	-5°C + 50°C (Operation) -25°C + 75°C (Storage)	-5°C + 50°C (Operation) -25°C + 75°C (Storage)
Contact Current /Power	1 C/O, 8A, 2000 VA	1 C/O, 8A, 2000 VA

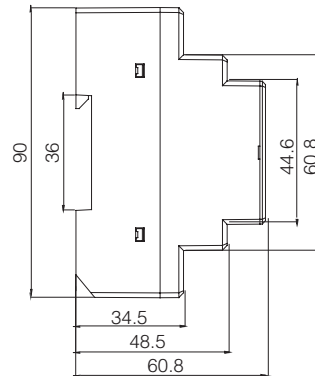
* Applies to 220/230 Vac (A1-A2) supply line.

Photocell Relays



FRM-01

Outline Dimensions



Photocell Relays

These relays turn lights on and off according to the level of daylight and the sleep mode keeps the lights on for a set period to provide energy efficiency.

Photocell relays have a sensor that can detect light intensity and a relay-out that operates according to the light intensity. The device controls the lighting systems that are connected to this outlet. Thus lighting can be turned on automatically when dark and turned off when light.

Operation of the Device

The necessary connections are made according to the connection chart. The sensor optic connected to the photocell relay must be attached so that the lighting system is not exposed to direct light. Also it is recommended that the optic be attached to areas which are less likely to get dirty.

If the Sleep Mode is not desired in FRM-02S this setting must be brought to Off. When the lux adjustment is being set it should be on 0 Lux for moderate darkness and 1 Lux for the darkest.

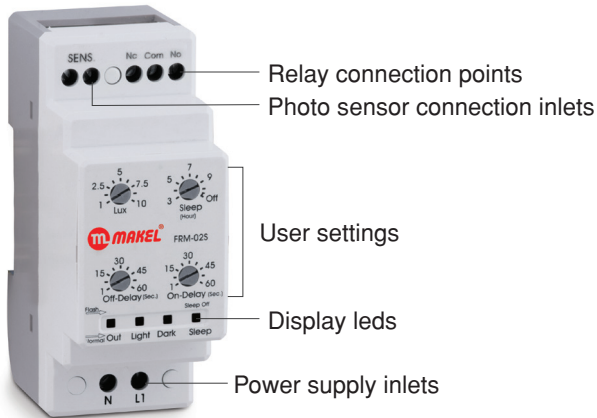
Normal Operation: If the ambient light intensity is lower than the set Lux level it means it has gotten dark and the "Dark" led will light up. The On-Delay period will be waited out. (30 sec is fixed on FRM-01). If at the end of the period the setting is dark the "Out" led goes on and the relay-out becomes active.

If the ambient light intensity is higher than the set Lux level it means it has gotten light and the "Light" led will light up. The Off-Delay period will be waited out. (30 sec is fixed on FRM-01). If at the end of the period the setting is light the "Out" led goes off and the relay-out becomes passive.

Operation in Sleep Mode (In the FRM-02S model): After it has gotten dark the relay-out becomes active for as long as the number of hours in the sleep setting. After this period is over the "Sleep" led goes on, the "Out" led goes off and the relay-out becomes passive. Thus the lighting will have operated for as long as the set Sleep time and energy efficiency will have been achieved for the time remaining until morning.

After the intensity of the light increases 1 minute goes by. If it is still light when the period is up the "Sleep" led goes off and the normal operation mode starts.

If you do not want the photocell relay to work in Sleep mode set it to "Off". In this situation the "Sleep" led will flash to inform that the Sleep mode has been cancelled.

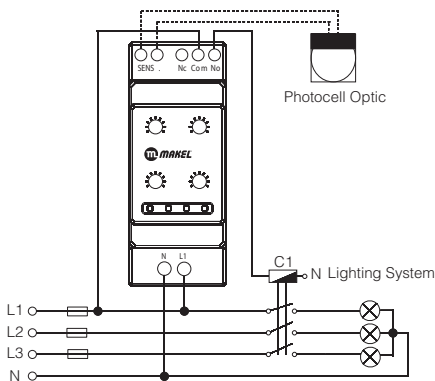


Meanings of the display leds	Out	Light	Dark	Sleep
Operate in daylight (Light)		X		
Dark Has Set (On Delay period countdown)			X	
Operate in dark (Dark)	X		X	
Light Has Set (Off Delay period countdown)	X	X		
Operation in sleep mode (Sleep)			X	X
Exit Sleep Mode (Period countdown)		X		X
Sleep Mode off (Sleep off)				Flash

Note: There are no Sleep leds and Off-Delay and On-Delay settings on the FRM-01 model.

Wiring Diagrams

FRM-01 / FRM-02S



Technical Specifications

Specifications	FRM-01	FRM-02S
Operation Voltage (Un)	230 V AC	230 V AC
Operation Voltage Interval (U)	150-300 V AC	150-300 V AC
Operation Frequency	50 Hz	50 Hz
Power Consumption (Max)	2.5 VA	2.5 VA
Lux adjustment	1...10	1...10
Sleep Adjustment	None	3-10 hours Set/Sleep off
Off-Delay (Release delay)	30 sec fixed	1...60 sec Set
On-Delay (Draw delay)	30 sec fixed	1...60 sec Set
Setting Accuracy	+ or -5%	+ or -5%
Exit Relay	5 A 250 V AC	5 A 250 V AC
Operation Temperature	Between -20°C...50°C	Between -20°C...50°C
Relative Humidity	Less than 90% (Without condensation)	Less than 90% (Without condensation)
Cable Sections	2.5 mm ² multi vessel cable	2.5 mm ² multi vessel cable
Assembly Types	Rail type	Rail type
Protection Class	IP20 (Terminals), IP40 (Front Panel)	IP20 (Terminals), IP40 (Front Panel)
Dimensions	36x90x61	36x90x61
Weight	125gr	125gr
Insulation	400 V insulation voltage 4 KV source impact	400 V insulation voltage 4 KV source impact

Protection and Control Relays

Motor Protection Relays

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Absence of Phase	Phase Order	Ptc	Fixed Asymmetry	Set Asymmetry	Without Neutral	Draw Delay	Open Delay	Insufficient Power Supply Warning	Pole Type 2P	Pole Type 1P
MKT - 01	152070001	1	12	1,40	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-
MKT - 02P	152070002	1	12	1,40	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-
MKN - 02P	152070003	1	12	1,40	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-
MKT - 01S	152070028	1	12	1,40	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-
MKT - 01L	152070048	1	12	1,40	253 x 138 x 103	■	-	-	■	-	-	-	-	■	■	-
MKT-11	152070051	1	22	-	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-
MKT-12	152070052	1	22	-	253 x 138 x 103	■	■	-	■	-	-	-	-	■	■	-

Current Protection Relays

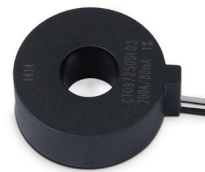
Product Name	Code No.	Technical Specifications	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Low Current Warning	Excessive Current Warning	Singlephase	External Current Transformer	Relay Delay	Start Delay
AKM-01	152070007	1-10.000/5 A veya 0.5-5 A Poles	1	12	1,75	253 x 138 x 103	■	■	-	-	■	■
AKM-01T	152070008	7,5-82,5 A (AT-20 included Current Transformer)	1	12	2,10	265 x 138 x 112	■	■	■	■	■	■

Low Voltage Current Transformer

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
AT-20	152070025	1	50	2,90	185 x 230 x 45

Technical Specifications

Current Rating	200 A / 80 mA
Wrap Interval	1 / 2500
Frequency	50/60 Hz
Accuracy	Class 1 (%1)
RL	3.3 Ohm
Operation Temperature	-10°C...65°C
Hole Diameter	12.8 mm
Out Diameter	37 mm



AT-20

Voltage Protection Relays

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Absence of Phase	Phase Order	Ptc	Low Voltage Warning	Over Voltage Warning	Singlephase	Three-phase	Neutral	Draw Delay	Open Delay	Insufficient Power Supply Warning	150 V Operation	90 V Operation	Pole Type 2P	Pole Type 1P
GKM-01	152070004	1	12	1,40	253 x 138 x 103	■	-	-	■	■	-	-	-	■	■	■	■	-	■	■
GKT-02P	152070005	1	12	1,40	253 x 138 x 103	■	■	-	■	■	-	-	-	■	■	■	■	-	■	■
GKN-02P	152070006	1	12	1,40	253 x 138 x 103	■	■	-	■	■	-	-	-	■	■	■	■	-	■	■
GKT-01S	152070029	1	12	1,40	253 x 138 x 103	-	■	-	■	■	-	-	-	■	■	■	■	-	■	■
GKM-03	152070045	1	12	1,40	253 x 138 x 103	■	-	-	■	■	-	-	-	■	■	■	■	-	■	■
GKT-03P	152070046	1	12	1,40	253 x 138 x 103	■	■	-	■	■	-	-	-	■	■	■	■	-	■	■
GKT-03PL	152070047	1	12	1,40	253 x 138 x 103	■	-	-	■	■	-	-	-	■	■	■	■	-	■	■
GKM-11	152070049	1	22	-	253 x 138 x 103	■	-	-	■	■	-	-	-	■	■	■	■	-	■	■
GKT-12	152070050	1	22	-	253 x 138 x 103	■	■	-	■	■	-	-	-	■	■	■	■	-	■	■

Liquid Level Protection Relays

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Fixed Sensitivity	Set Sensitivity	Singlephase	Fixed Draw Delay	Fixed Open Delay	Set Draw Delay	Set Open Delay	1 C/O Kontakt	Small Size Electrode	Large Size Electrode
SRM-01	152070013	1	12	1,40	253 x 138 x 103	■	-	■	■	■	-	-	■	-	-
SRM-02A	152070026	1	12	1,40	253 x 138 x 103	-	■	-	-	-	■	■	-	-	-
SRE-01 (Small Electrode)	152070015	1	12	0,38	-	-	-	-	-	-	-	-	■	-	-

Time Relays

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Draw Delayed (ER)	Release Delayed (ER)	Control Entry Release Delayed (R)	Drawn Control Entry (R)	Triggered in Release Delayed in Release (TS)	Triggered in Release Delayed in Draw (TA)	Symmetric Flasher (EF)	Trigger Entry	Open Flasher	Closed Flasher	Down Meter	Right-Left	Delayed Fall	24V AC/DC	220/230V AC	12-240C AC/DC	24-240C AC/DC	
TMR-30 (2-30sn)	152070009	1	22	-	253 x 138 x 103	■	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-
TMR-60 (2-60sn)	152070010	1	22	-	253 x 138 x 103	■	-	-	-	-	-	-	-	-	-	-	-	-	■	-	-	-	-
TMR-01 (0,1sn-99,9 h.)	152070011	1	22	-	253 x 138 x 103	■	■	-	-	-	-	-	-	-	-	-	-	-	■	■	-	-	-
TMR-02 (0,5sn-30 h.)	152070012	1	22	-	253 x 138 x 103	■	■	-	-	-	-	-	-	■	■	-	-	-	■	■	-	-	-

Photocell Relays

Product Name	Code No.	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)	Light Intensity Setting	Sleep Economy Mode	Singlephase	Fixed Draw Delay	Fixed Open Delay	Set Draw Delay	Set Open Delay
FRM-01*	152070014	1	10	1,45	330 x 180 x 98	■	-	■	■	■	-	-
FRM-02S*	152070016	1	10	1,45	330 x 180 x 98	■	■	■	-	-	■	■
FRG-01 (Lens)	152070024	1	15	0,48	-	-	-	-	-	-	-	-

*Optical lens is included.

Capacitors



Power from 1.0 kVAr to 30 kVAr
230V / 400V / 440V / 525V voltage options
Capacitors (ECP Series) are used in low voltage applications such as compensation systems, motor compensation and filter compensation

Electrical and Mechanical Properties

- ▶ Three phase applications up to 50 kVAr power
- ▶ 135,000 hours life
- ▶ High inrush current (up to 200 x IR)
- ▶ 1.0 50 kVAr
- ▶ 230V ... 525 VAC voltage range
- ▶ Easy connection, installation and assembly
- ▶ Low weight, convenient size
- ▶ Maintenance-free
- ▶ Faston clamps at 1.0 and 2.5 kVAr
- ▶ Screw terminals at 2.5 kV power

General Specifications

- ▶ Cylindrical aluminum design
- ▶ Closed-loop metallized polypropylene film
- ▶ Resin impregnated
- ▶ Three phase, delta connection
- ▶ External discharge resistor
- ▶ Self-repairing
- ▶ Overpressure safety
- ▶ Environment friendly; Do not have PCB

Fields of Application

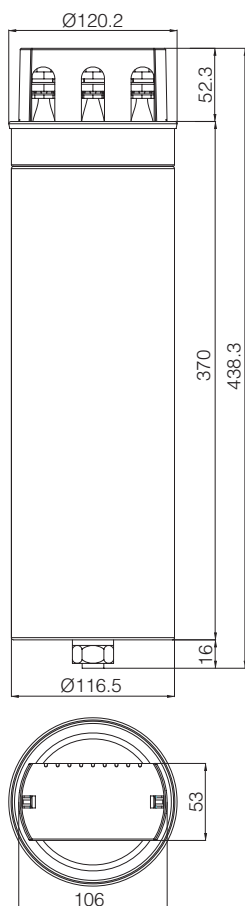
They are used in low voltage applications such as compensation systems, motor compensation and filtered compensation.

Technical Specifications

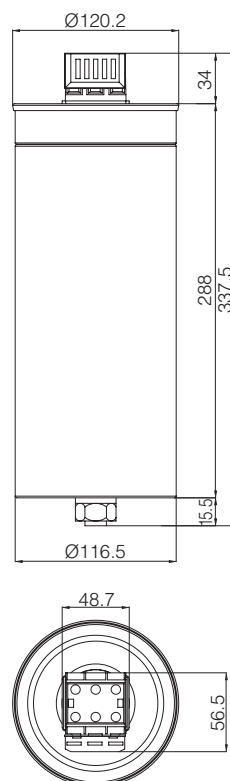
Specifications		
Inrush current	IS	up to 200 x IR
Frequency	f	50 Hz
Capacitance tolerance	%	-5% / + 10%
Overcurrent	I _{max}	up to 1.3 x IR (including all effects of harmonics, extrinsic stress and capacitance)
Losses: -Dielectric	W / kVAr	<0.2 W / kVAr-
-Total		<0.45 W / kVAr (without discharge resistor)
Overvoltage	V _{max}	VR + 10% (up to 8 hours per day) / VR + 15% (up to 30 minutes per day) VR + 20% (up to 5 minutes per day) / VR + 30% (up to 1 minute per day)
Test voltage, terminal / terminal	V	2.15 x VR AC, 2 seconds
Test voltage, terminal / housing	V	3000 V AC, 10 seconds
Design life	hour	Up to 135,000 hours
Number of on / off operations		per year according to IEC 60831-1 + 2 max. 5000 opening and closing operation
Ambient Temperature	° C	max. temperature 55 ° C min. temperature -25 ° C
Cooling		Natural or fan cooled
Humidity	%	max. 95%
Altitude	m	Max. 2000m high
Standard		IEC 60831-1 + 2
Discharge resistor		within 3 minutes 75V

Technical Drawings

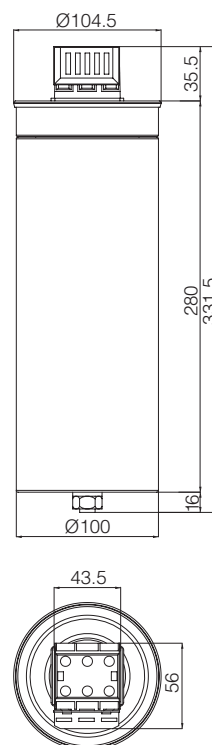
Tube Capacitor 14
(40-50 kVAr)



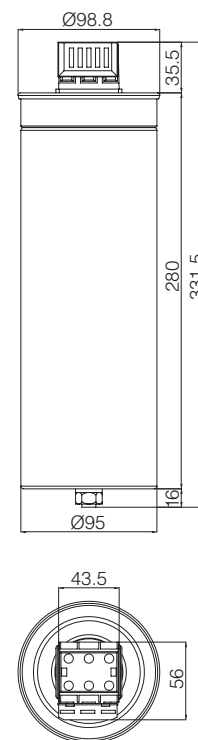
Tube Capacitor 13
(30 kVAr)



Tube Capacitor 12
(25 kVAr)



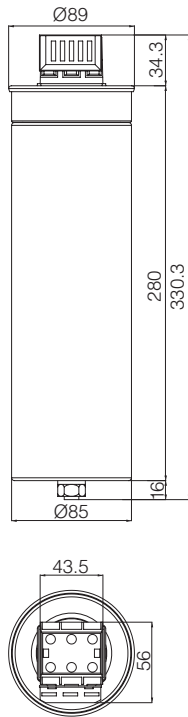
Tube Capacitor 11
(20 kVAr)



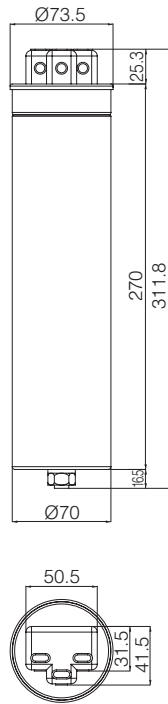
Capacitors

Technical Drawings

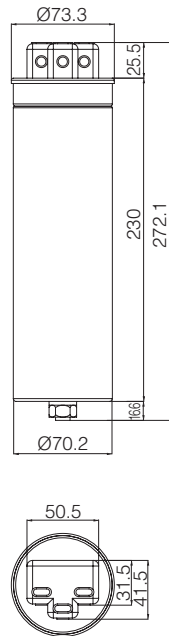
Tube Capacitor 10
(15 kVAr)



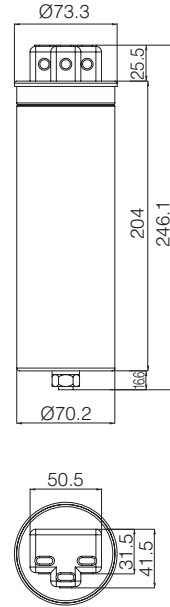
Tube Capacitor 9
(12,5 kVAr)



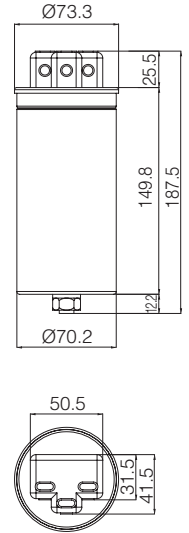
Tube Capacitor 8
(10 kVAr)



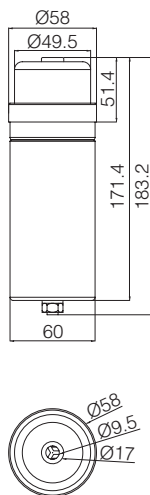
Tube Capacitor 7
(7,5 kVAr)



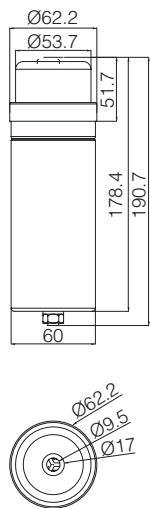
Tube Capacitor 6
(5 kVAr)



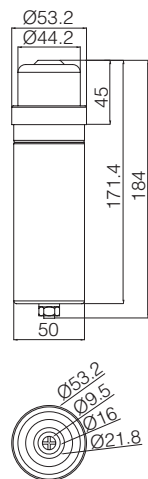
Tube Capacitor 5
(2,5 kVAr)



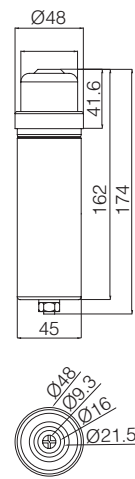
Tube Capacitor 4
(1,38 kVAr)



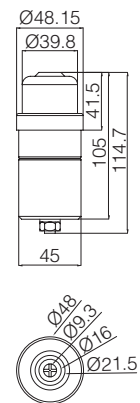
Tube Capacitor 3
(0,83 kVAr)



Tube Capacitor 2
(0,55-1-1,5 kVAr)



Tube Capacitor 1
(0,26 kVAr)



Capacitor

Code No.	Nominal Power (kVAr)	Nominal Voltage(V AC)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
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Three Phase Tube Capacitor

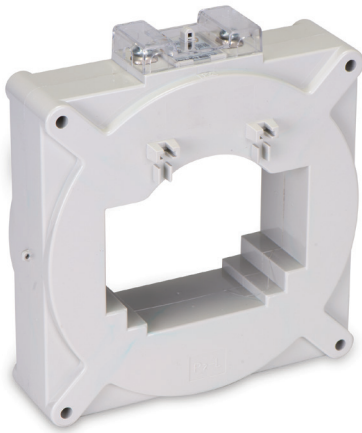
76066007	400-1 kVAr	400V AC	-	20	4,94	228 x 418 x 108
76066008	400-1,5 kVAr	400V AC	-	20	5,28	228 x 418 x 108
76066009	400-2,5 kVAr	400V AC	-	20	8,30	286 x 478 x 151
76066010	400-5 kVAr	400V AC	-	6	4,44	228 x 418 x 108
76066011	400-7,5 kVAr	400V AC	-	6	5,90	273 x 478 x 123
76066012	400-10 kVAr	400V AC	1	6	6,71	268 x 323 x 183
76066013	400-12,5 kVAr	400V AC	1	6	7,76	300 x 385 x 205
76066014	400-15 kVAr	400V AC	1	6	11,28	300 x 385 x 205
76066015	400-20 kVAr	400V AC	1	6	13,88	348 x 378 x 213
76066016	400-25 kVAr	400V AC	1	6	15,34	348 x 378 x 213
76066017	400-30 kVAr	400V AC	1	4	13,40	268 x 383 x 283
76066018	400-40 kVAr	400V AC	1	4	17,70	290 x 480 x 280
76066019	400-50 kVAr	400V AC	1	4	17,70	290 x 480 x 280
76066020	450-1 kVAr	450V AC	-	20	4,96	228 x 418 x 108
76066021	450-1,5 kVAr	450V AC	-	20	5,26	228 x 418 x 108
76066022	450-2,5 kVAr	450V AC	-	20	8,16	286 x 478 x 151
76066023	450-5 kVAr	450V AC	-	6	4,46	228 x 418 x 108
76066024	450-7,5 kVAr	450V AC	-	6	5,90	273 x 478 x 123
76066025	450-10 kVAr	450V AC	1	6	6,71	268 x 323 x 183
76066026	450-12,5 kVAr	450V AC	1	6	7,74	300 x 385 x 205
76066027	450-15 kVAr	450V AC	1	6	11,58	300 x 385 x 205
76066028	450-20 kVAr	450V AC	1	6	14,06	348 x 378 x 213
76066029	450-25 kVAr	450V AC	1	6	15,30	348 x 378 x 213
76066030	450-30 kVAr	450V AC	1	4	13,41	268 x 383 x 283
76066031	450-40 kVAr	450V AC	1	4	17,62	290 x 480 x 280
76066032	450-50 kVAr	450V AC	1	4	17,68	290 x 480 x 280
76066033	525-10 kVAr	525V AC	1	6	6,69	268 x 323 x 183
76066034	525-12,5 kVAr	525V AC	1	6	7,70	300 x 385 x 205
76066035	525-15 kVAr	525V AC	1	6	11,50	300 x 385 x 205
76066036	525-20 kVAr	525V AC	1	6	13,88	348 x 378 x 213
76066037	525-25 kVAr	525V AC	1	6	15,20	348 x 378 x 213
76066038	525-30 kVAr	525V AC	1	4	13,46	268 x 383 x 283
76066039	525-40 kVAr	525V AC	1	4	17,52	290 x 480 x 280
76066040	525-50 kVAr	525V AC	1	4	17,52	290 x 480 x 280
76066041	550-2,5 kVAr	550V AC	-	10	4,22	298 x 473 x 82
76066042	550-5 kVAr	550V AC	-	12	8,78	245 x 447 x 184
76066043	550-7,5 kVAr	550V AC	-	6	5,90	273 x 478 x 123

Mono Phase Tube Capacitor

Code No.	Nominal power (kVAr)	Nominal Voltage(V AC)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
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76066000	230-0,26 kVAr	230	-	49	7,52	278 x 650 x 172
76066001	400-1,67 kVAr (230-0,55)	230	-	25	6,32	288 x 443 x 143
76066002	400-2,5 kVAr (230-0,83)	230	-	24	7,10	288 x 443 x 143
76066003	400-4,17 kVAr (230-1,38)	230	-	25	11,24	353 x 528 x 153
76066004	400-8,33 kVAr (230-2,76)	230	-	20	10,78	306 x 543 x 148
76066005	230-5 kVAr	230	-	6	6,19	273 x 478 x 123
76066006	230-10 kVAr	230	1	6	10,73	300 x 385 x 205

Low Voltage Current Transformer



Low voltage current transformer is a measurement transformer with the phase difference between primary current and secondary current around 0 degree when connected suitably and secondary current of which is proportional to primary current practically under normal conditions.

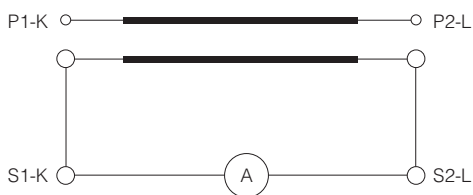
Primary Winding is the winding in which current passes by transforming. Primary tips are marked as P1-K, P2-L.

Secondary Winding is the winding that supports current circuits of current transformer, measuring instruments, counters, relays and similar devices. Secondary tips are marked as S1-K, S2-L.

Secondary windings are wrapped with more spheres with thin wire, Primary windings are wrapped with few spheres from thick wire. Measurement Transformers do not contain primary winding, instead, primary winding is created by passing busbar or cable through nucleus of transformer.

Connection and installation should be conducted by competent technical teams and engineers.

Since internal resistances of elements connected to secondary of Current Transformers are very small, transformer works in short circuit status. Therefore, secondary of current transformers should be left unloaded. When secondary of a transformer, primary of which is connected to network, is left unloaded, magnetic current in reverse direction of primary winding flow of secondary circuit is eliminated. This situation creates high voltages in proportion with winding count in secondary and results in deterioration of isolation of windings, besides, loss of iron in nucleus increases due to high magnetic current and nucleus is heated excessively. While current passes from primary, if it is necessary to change device or connections in secondary or to open secondary due to maintenance, windings should be short circuited with a switch or a conductor. Or, dangerous situations may arise for workers.



Fields of Application

In general, they are used in compensation panels, generators, compressor panels.

Technical Specifications

Load Emerging From Copper Cables Loss Of Power (Va.) in Cables with Secondary Current 5A				
Cable (CU)	2,5 mm ²	4,0 mm ²	6,0 mm ²	10,0 mm ²
1m	0,36	0,22	0,15	0,09
2m	0,71	0,45	0,31	0,18
3m	1,07	0,57	0,45	0,27
4m	1,43	0,89	0,61	0,36
5m	1,78	1,12	0,74	0,44
6m	2,14	1,34	0,89	0,54
7m	2,51	1,59	1,04	0,63
8m	2,85	1,79	1,19	0,71
9m	3,21	2,01	1,34	0,81
10m	3,57	2,24	1,49	0,89

Specifications		
Highest Network Voltage		720 V
Test Voltage for One Minute		3 kV
Usage Location Internal	Internal	Indoor
Continuous Operation Current		1,2 x In
Safety Coefficient		5
Rated Primary Current	From 100A	2500A
Rated Secondary Current		5 A
Working Frequency		50-60 Hz.
Operational Temperature	-5 °C	45°C
Thermal Rated Current		I _{th} = 60 x I _n
Dynamic Rated Current		I _{dyn} = 2,5 I _{th}

Power Values of Devices Connected to Current Transformers	
Devices	Power VA
Ammeters	0,7...1,5
Wattmeters	0,2...5,0
Cos.φ Meters	2,0...6,0
Meter Active, R.active	0,4...1,0
Reactive Power Control Relay	0,5...1,0
Overcurrent Relay	0,2...6,0
Reverse Current Relay	2
Secondary Thermal Relay	7,2...9,0
Standard	TS EN 61869-2 / IEC 61869-2
Protection Class	IP20

Primary Wound Type

MAK B	
Primary Rated Current	5-150 A
Secondary Rated Current	5-1 A
Rated Output Power	5-10-15 VA
Class	0,5-1

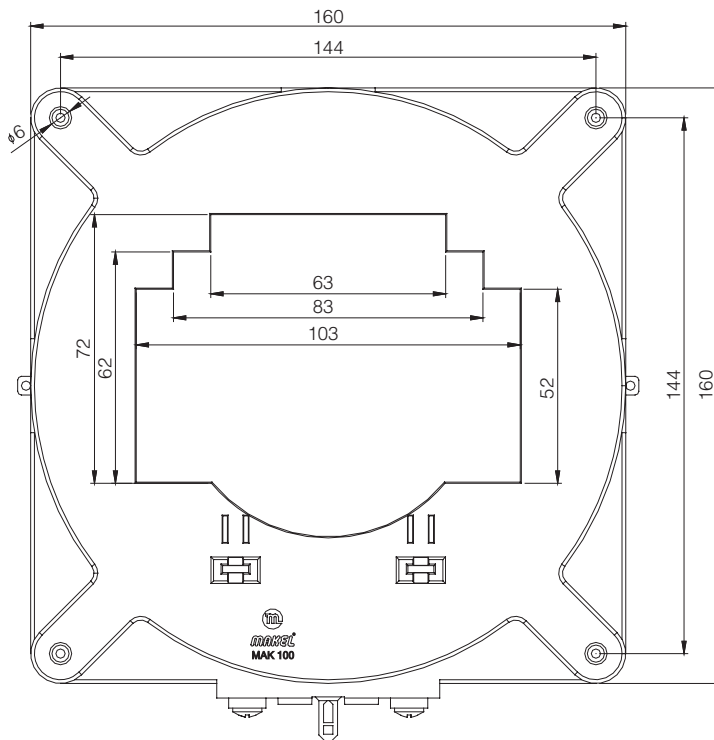
Busbar Primary Type

	MAK 30	MAK 40	MAK 60	MAK 100
Primary Rated Current	200-300	400-600	750-1250	1500-500
Secondary Rated Current	5,1-10	5,1-10	5,1-10	5,1-10
Rated Output Power	5-10-15	5-10-15	10-15-30	15-30
Class	0,5-1	0,5-1	0,5-1	0,5-1

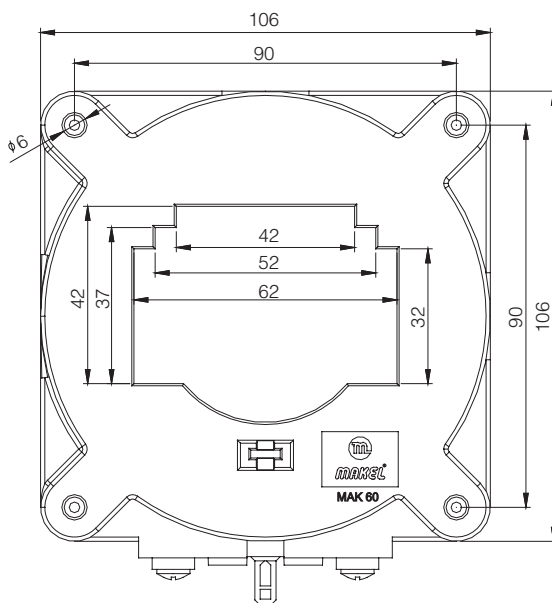
Low Voltage Current Transformer

Technical Drawings

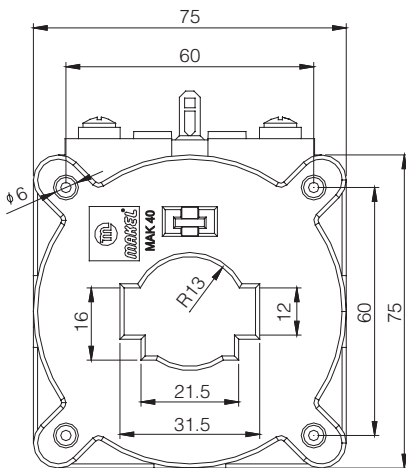
MAK 100



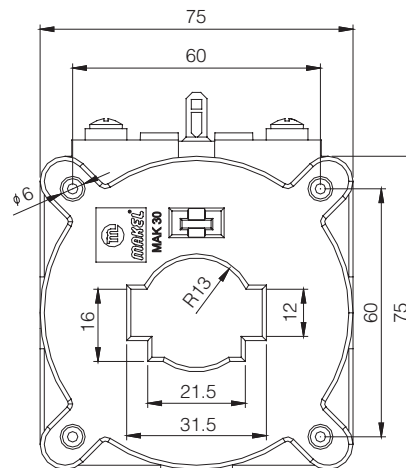
MAK 60



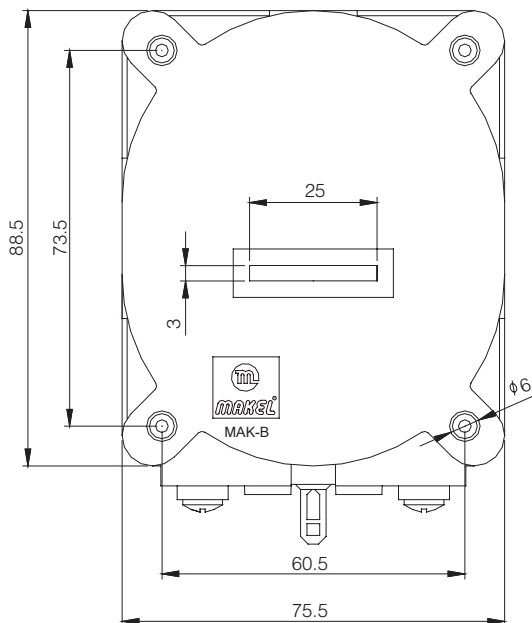
MAK 40



MAK 30

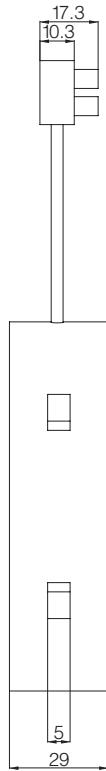
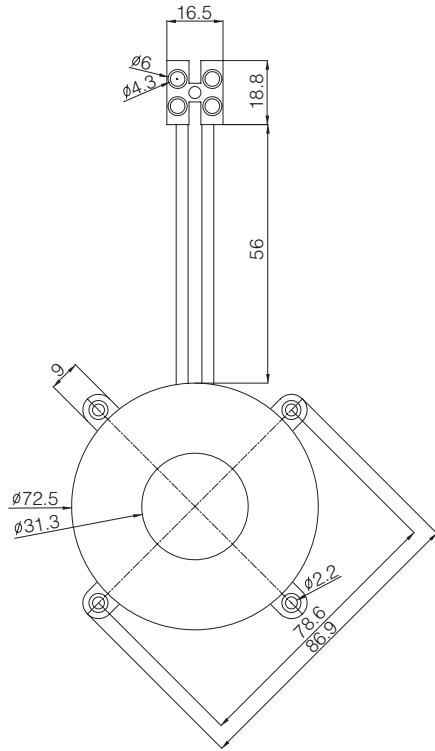


MAK B

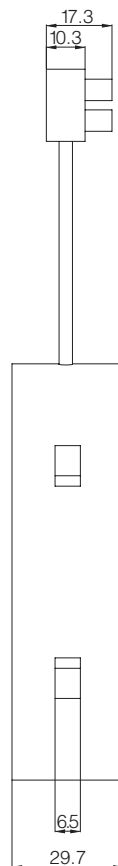
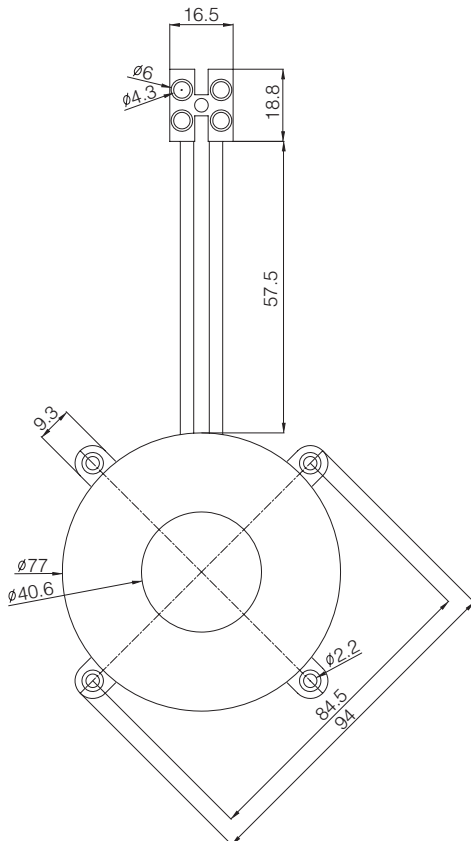
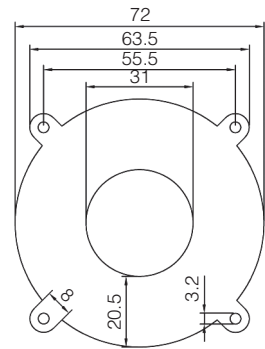


Round Transformer

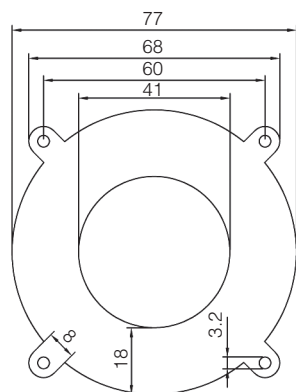
Technical Drawings

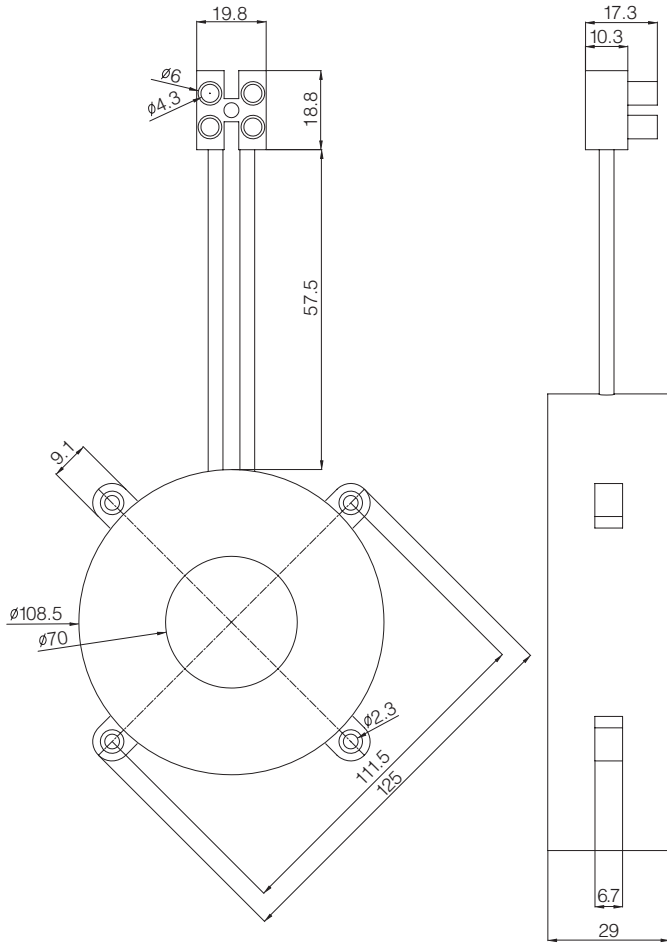


MST - 30

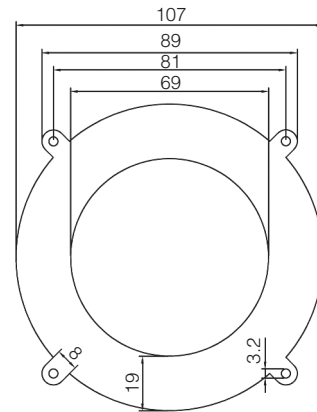


MST - 40



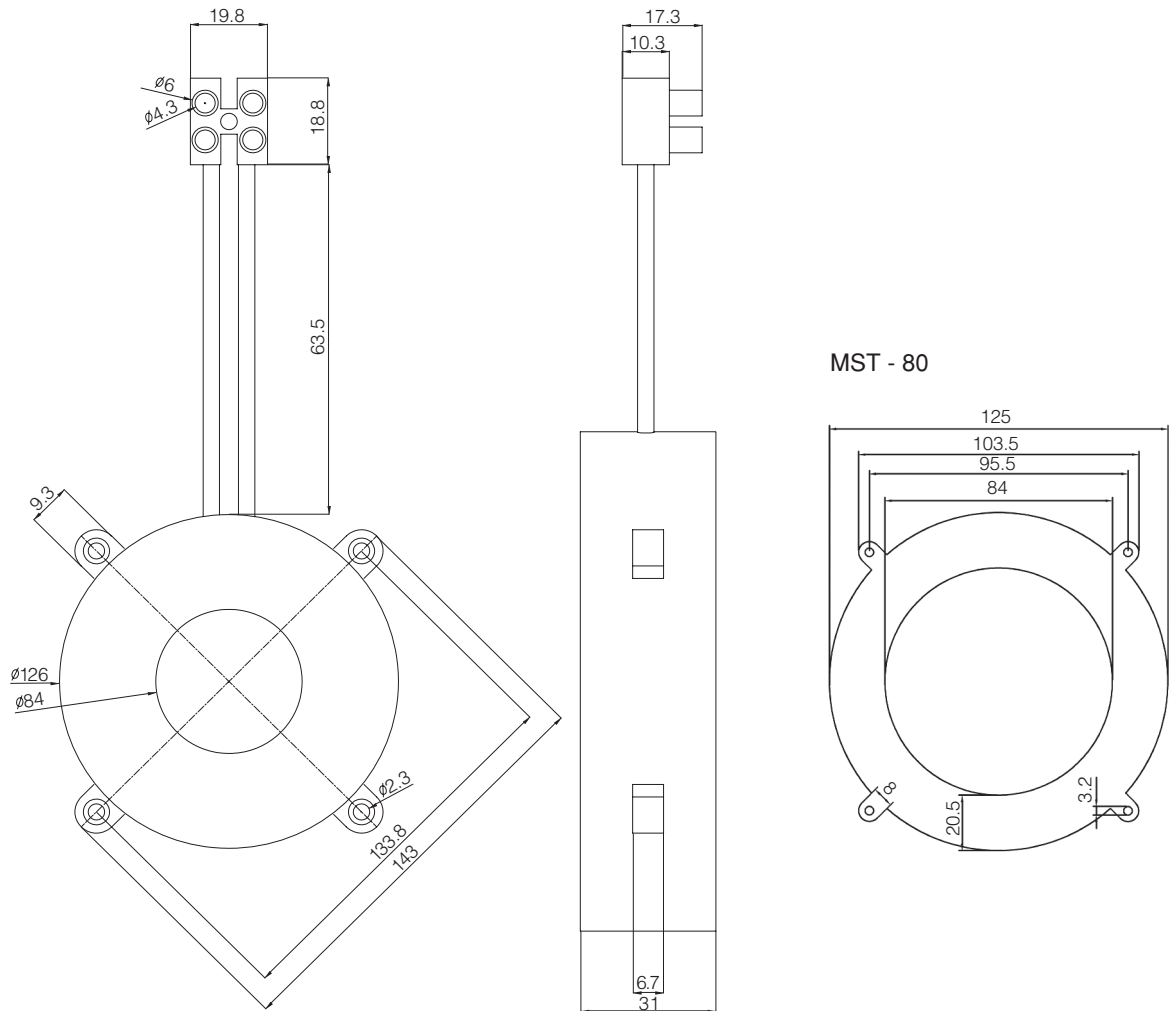


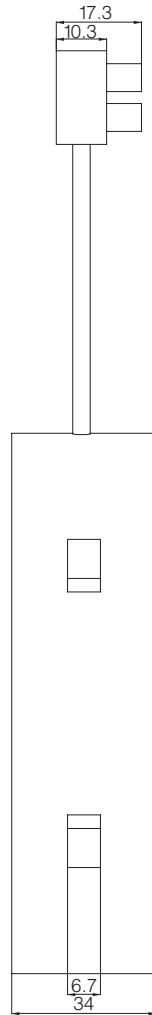
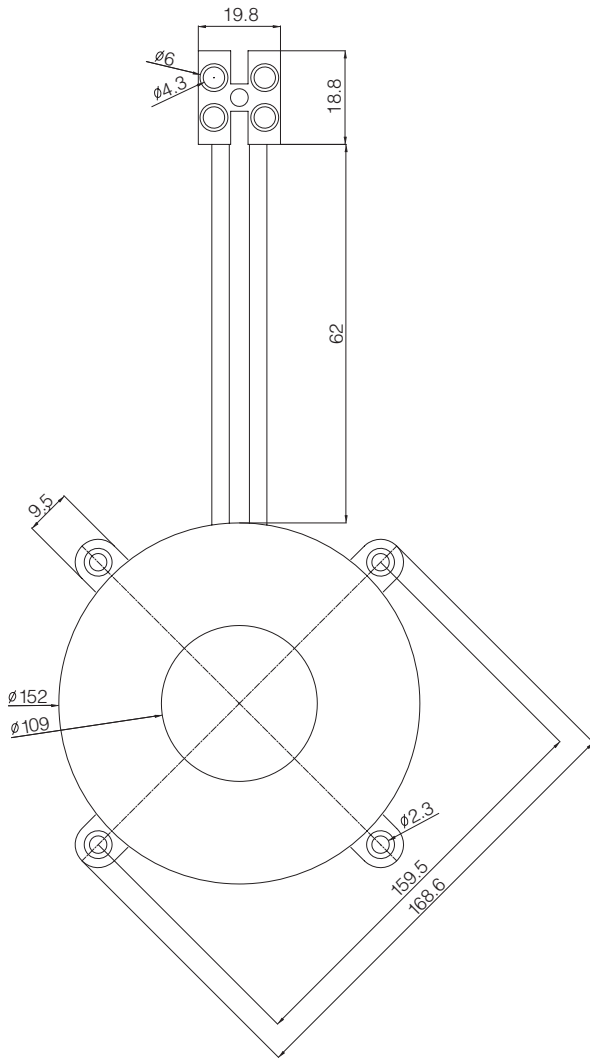
MST - 60



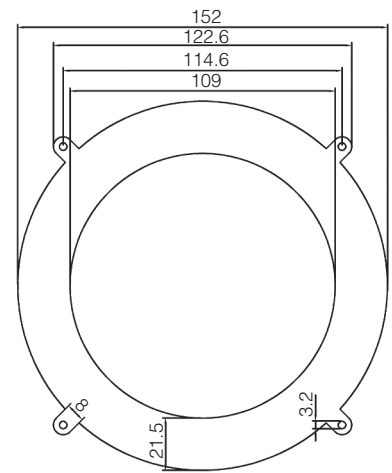
Round Transformer

Technical Drawings





MST - 100



Low Voltage Current Transformer

Low Voltage Current Transformer

Product Name	Code No.	Class	Maximum Bara Dimension (mm)	Nominal Power (VA)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
MAK 30								
30/5	75063031	1,00	Ø30	5VA	1	60	28,28	365 x 490 x 220
40/5	75063032	1,00	Ø30	5VA	1	60	28,64	365 x 490 x 220
50/5	75063033	1,00	Ø30	5VA	1	60	28,70	365 x 490 x 220
60/5	75063034	1,00	Ø30	5VA	1	60	28,76	365 x 490 x 220
75/5	75063035	1,00	Ø30	5VA	1	60	28,76	365 x 490 x 220
100/5	75063036	1,00	Ø30	5VA	1	60	29,36	365 x 490 x 220
125/5	75063037	0,5	Ø30	5VA	1	60	29,48	365 x 490 x 220
150/5	75063038	0,5	Ø30	5VA	1	60	29,60	365 x 490 x 220
200/5	75063039	0,5	Ø30	10VA	1	60	30,08	365 x 490 x 220
250/5	75063040	0,5	Ø30	10VA	1	60	25,76	365 x 490 x 220
300/5	75063041	0,5	Ø30	10VA	1	60	22,94	365 x 490 x 220
MAK 40								
400/5	75063042	0,5	Ø40	5VA	1	60	20,84	365 x 490 x 220
400/5	75063043	0,5	Ø40	10VA	1	60	20,66	365 x 490 x 220
500/5	75063044	0,5	Ø40	5VA	1	60	21,74	365 x 490 x 220
500/5	75063045	0,5	Ø40	10VA	1	60	21,86	365 x 490 x 220
600/5	75063046	0,5	Ø40	5VA	1	60	22,04	365 x 490 x 220
600/5	75063047	0,5	Ø40	10VA	1	60	22,10	365 x 490 x 220
MAK 60								
750/5	75063048	0,5	Ø60	10VA	1	36	17,61	315 x 495 x 280
750/5	75063049	0,5	Ø60	15VA	1	36	17,68	315 x 495 x 280
800/5	75063050	0,5	Ø60	10VA	1	36	18,10	315 x 495 x 280
800/5	75063051	0,5	Ø60	15VA	1	36	18,10	315 x 495 x 280
1000/5	75063052	0,5	Ø60	10VA	1	36	18,73	315 x 495 x 280
1000/5	75063053	0,5	Ø60	15VA	1	36	18,69	315 x 495 x 280
1250/5	75063054	0,5	Ø60	10VA	1	36	19,45	315 x 495 x 280
1250/5	75063055	0,5	Ø60	15VA	1	36	19,38	315 x 495 x 280
MAK 100								
1500/5	75063056	0,5	Ø100	10VA	1	18	14,88	505 x 455 x 195
1500/5	75063057	0,5	Ø100	15VA	1	18	14,81	505 x 455 x 195
1600/5	75063058	0,5	Ø100	10VA	1	18	15,06	505 x 455 x 195
1600/5	75063059	0,5	Ø100	15VA	1	18	15,10	505 x 455 x 195
2000/5	75063060	0,5	Ø100	15VA	1	18	15,87	505 x 455 x 195
2000/5	75063061	0,5	Ø100	30VA	1	18	15,94	505 x 455 x 195
2500/5	75063062	0,5	Ø100	15VA	1	18	16,97	505 x 455 x 195
2500/5	75063063	0,5	Ø100	30VA	1	18	17,02	505 x 455 x 195
3000/5	75063064	0,5	Ø100	15VA	1	18	17,74	505 x 455 x 195
3000/5	75063065	0,5	Ø100	30VA	1	18	18,23	505 x 455 x 195

Sealed Low Voltage Current Transformer

Product Name	Code No.	Class	Maximum Bara Dimension (mm)	Nominal Power (VA)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
MAK 30								
100	75064009	1	Ø30	5VA	1	60	-	365 x 490 x 220
150	75064010	0,5	Ø30	5VA	1	60	-	365 x 490 x 220
200	75064011	0,5	Ø30	10VA	1	60	-	365 x 490 x 220
250	75064012	0,5	Ø30	10VA	1	60	-	365 x 490 x 220
300	75064013	0,5	Ø30	10VA	1	60	-	365 x 490 x 220
MAK 40								
400	75064014	0,5	Ø40	10VA	1	60	-	365 x 490 x 220
500	75064015	0,5	Ø40	10VA	1	60	-	365 x 490 x 220
600	75064016	0,5	Ø40	10VA	1	60	-	365 x 490 x 220
MAK 60								
750	75064017	0,5	Ø60	15VA	1	36	-	315 x 495 x 280
800	75064018	0,5	Ø60	15VA	1	36	-	315 x 495 x 280
1000	75064019	0,5	Ø60	15VA	1	36	-	315 x 495 x 280
1250	75064020	0,5	Ø60	15VA	1	36	-	315 x 495 x 280
MAK 100								
1500	75064021	0,5	Ø100	15VA	1	18	-	505 x 455 x 195
1600	75064022	0,5	Ø100	15VA	1	18	-	505 x 455 x 195
2000	75064023	0,5	Ø100	15VA	1	18	-	505 x 455 x 195
2500	75064024	0,5	Ø100	15VA	1	18	-	505 x 455 x 195
3000	75064025	0,5	Ø100	30VA	1	18	-	505 x 455 x 195

Barred Low Voltage Current Transformer

Product Name	Code No.	Class	Maximum Bara		Nominal Power (VA)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
			Dimension (mm)						
MAK B									
5/5	75063000	0.5	Barred		5VA	1	36	21,62	420 x 395 x 345
5/5	75063001	0.5	Barred		10VA	1	36	21,51	420 x 395 x 345
5/5	75063002	0.5	Barred		15VA	1	36	21,62	420 x 395 x 345
10/5	75063003	0.5	Barred		5VA	1	36	19,17	420 x 395 x 345
10/5	75063004	0.5	Barred		10VA	1	36	19,17	420 x 395 x 345
10/5	75063005	0.5	Barred		15VA	1	36	19,10	420 x 395 x 345
15/5	75063006	0.5	Barred		5VA	1	36	18,34	420 x 395 x 345
15/5	75063007	0.5	Barred		10VA	1	36	18,34	420 x 395 x 345
15/5	75063008	0.5	Barred		15VA	1	36	18,34	420 x 395 x 345
20/5	75063009	0.5	Barred		10VA	1	36	18,74	420 x 395 x 345
20/5	75063010	0.5	Barred		15VA	1	36	18,74	420 x 395 x 345
25/5	75063011	0.5	Barred		10VA	1	36	18,23	420 x 395 x 345
25/5	75063012	0.5	Barred		15VA	1	36	18,23	420 x 395 x 345
30/5	75063013	0.5	Barred		10VA	1	36	21,74	420 x 395 x 345
30/5	75063014	0.5	Barred		15VA	1	36	21,40	420 x 395 x 345
40/5	75063015	0.5	Barred		10VA	1	36	21,11	420 x 395 x 345
40/5	75063016	0.5	Barred		15VA	1	36	20,97	420 x 395 x 345
50/5	75063017	0.5	Barred		10VA	1	36	21,26	420 x 395 x 345
50/5	75063018	0.5	Barred		15VA	1	36	20,90	420 x 395 x 345
60/5	75063019	0.5	Barred		10VA	1	36	22,19	420 x 395 x 345
60/5	75063020	0.5	Barred		15VA	1	36	22,12	420 x 395 x 345
75/5	75063021	0.5	Barred		10VA	1	36	21,62	420 x 395 x 345
75/5	75063022	0.5	Barred		15VA	1	36	21,40	420 x 395 x 345
80/5	75063023	0.5	Barred		10VA	1	36	21,76	420 x 395 x 345
80/5	75063024	0.5	Barred		15VA	1	36	21,47	420 x 395 x 345
100/5	75063025	0.5	Barred		10VA	1	36	21,62	420 x 395 x 345
100/5	75063026	0.5	Barred		15VA	1	36	21,76	420 x 395 x 345
125/5	75063027	0.5	Barred		10VA	1	36	20,90	420 x 395 x 345
125/5	75063028	0.5	Barred		15VA	1	36	20,90	420 x 395 x 345
150/5	75063029	0.5	Barred		10VA	1	36	21,47	420 x 395 x 345
150/5	75063030	0.5	Barred		15VA	1	36	21,33	420 x 395 x 345

Barrel Sealed Low Voltage Current Transformer

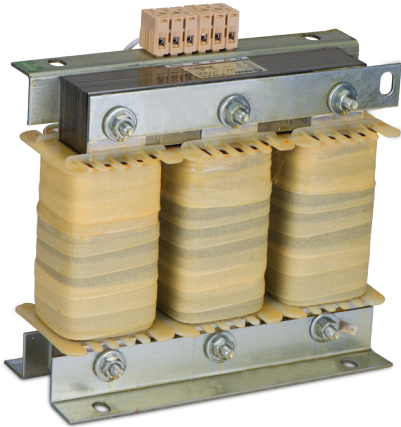
Product Name	Code No.	Class	Maximum Bara		Nominal Power (VA)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
			Dimension (mm)						
MAK B									
30/5	75064000	0.5	Barred		10VA	1	36	-	420 x 395 x 345
40/5	75064001	0.5	Barred		10VA	1	36	-	420 x 395 x 345
50/5	75064002	0.5	Barred		10VA	1	36	-	420 x 395 x 345
60/5	75064003	0.5	Barred		10VA	1	36	-	420 x 395 x 345
75/5	75064004	0.5	Barred		10VA	1	36	-	420 x 395 x 345
80/5	75064005	0.5	Barred		10VA	1	36	-	420 x 395 x 345
100/5	75064006	0.5	Barred		10VA	1	36	-	420 x 395 x 345
125/5	75064007	0.5	Barred		10VA	1	36	-	420 x 395 x 345
150/5	75064008	0.5	Barred		10VA	1	36	-	420 x 395 x 345

Round Transformer

Product Name	Code No.	Class	Operating frequency	Nominal Power (VA)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
MST 50/5	75065000	1	50 Hz	5 VA	5	140	44,82	570 x 350 x 215
MST 75/5	75065001	1	50 Hz	5 VA	5	140	46,10	570 x 350 x 215
MST 100/5	75065002	1	50 Hz	5 VA	5	140	46,10	570 x 350 x 215
MST 125/5	75065003	1	50 Hz	5 VA	5	140	39,24	570 x 350 x 215
MST 150/5	75065004	1	50 Hz	5 VA	5	140	39,24	570 x 350 x 215
MST 200/5	75065005	1	50 Hz	5 VA	5	140	39,80	570 x 350 x 215
MST 250/5	75065006	1	50 Hz	5 VA	5	140	39,80	570 x 350 x 215
MST 300/5	75065007	1	50 Hz	5 VA	5	140	42,46	570 x 350 x 215
MST 400/5	75065008	1	50 Hz	5 VA	5	140	37,28	570 x 350 x 215
MST 500/5	75065009	1	50 Hz	5 VA	5	140	38,82	570 x 350 x 215
MST 600/5	75065010	1	50 Hz	5 VA	5	140	40,08	570 x 350 x 215
MST 750/5	75065011	1	50 Hz	5 VA	5	80	31,39	670 x 390 x 375
MST 800/5	75065012	1	50 Hz	5 VA	5	80	31,79	670 x 390 x 375
MST 1000/5	75065013	1	50 Hz	5 VA	5	80	33,63	670 x 390 x 375
MST 1250/5	75065014	1	50 Hz	5 VA	5	80	35,39	670 x 390 x 375
MST 1500/5	75065015	1	50 Hz	5 VA	5	30	15,36	670 x 390 x 375
MST 1600/5	75065016	1	50 Hz	5 VA	5	30	15,48	670 x 390 x 375
MST 2000/5	75065017	1	50 Hz	5 VA	5	30	18,66	535 x 395 x 205
MST 2500/5	75065018	1	50 Hz	5 VA	5	30	20,55	535 x 395 x 205

Shunt Reactor

Shunt reactors are connected in parallel with the system and act as inductive loads. These reactors, which can be produced as monophasic and triphasic, can attract the desired inductive current from the network

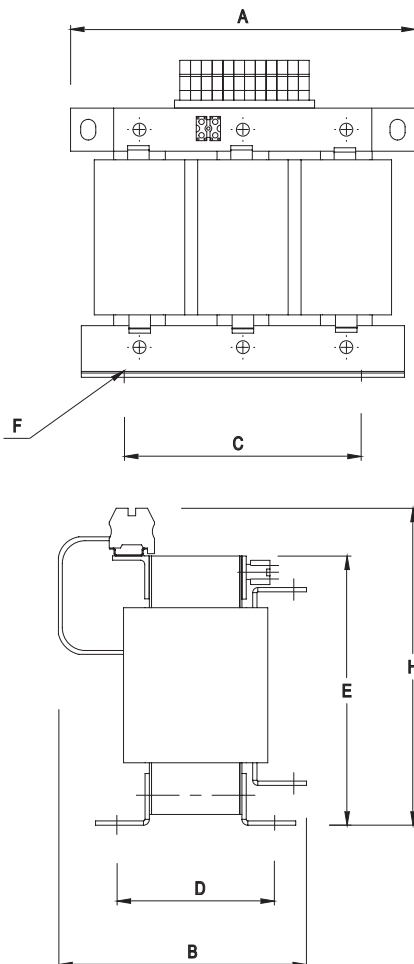


Reactors can be added to automatic compensation systems to compensate for excessive capacitive power.

The most common applications of shunt reactors are those using long energy transmission and distribution cables. To transmit energy to systems such as radio base stations and radio and TV transmitters, especially in rural areas kilometers long cable must be used. (The cables also have certain capacity values according to their type and characteristics.) In these installations where the load level is low, the system becomes overcompensated due to the capacitive effect of the long cable.

In this case, a continuous capacitive reactive penalty payment is encountered. Also, due to overcompensation, an increase in the mains voltage may occur and sensitive devices may be damaged.

Technical Dimensions (mm)



Mono Phase Shunt Reactors

Model No	A	B	C	D	H
MAK ERS1 230/0,1	84	76	64	64	64
MAK ERS1 230/0,25	84	76	64	64	64
MAK ERS1 230/0,5	96	102	84	87	84
MAK ERS1 230/1	150	113	122	89	122
MAK ERS1 230/1,5	150	129	122	104	122
MAK ERS1 230/1,75	150	153	122	128	122
MAK ERS1 230/2,5	192	166	130	148	130

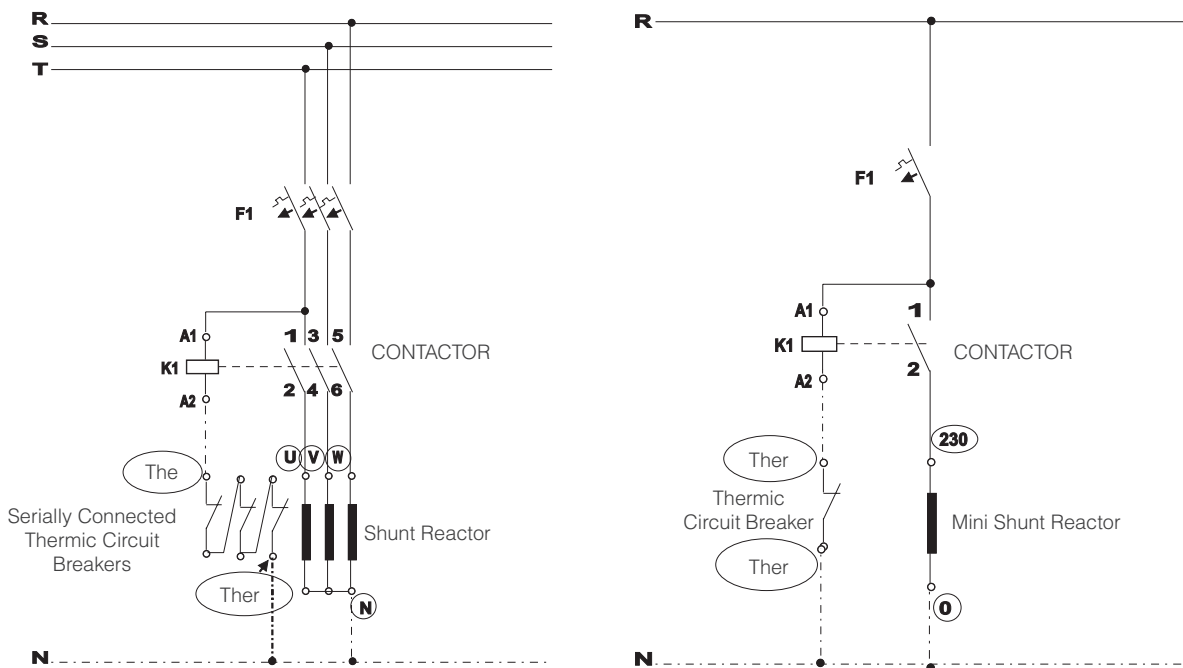
Three Phase Shunt Reactors

Model No	A	B	C	D	H
MAK ERS3 400/1	180	130	135	84	190
MAK ERS3 400/1,5	180	135	132	94	190
MAK ERS3 400/2	240	150	185	80	240
MAK ERS3 400/2,5	240	120	185	78	240
MAK ERS3 400/3	240	140	185	98	240
MAK ERS3 400/5	300	165	224	120	285
MAK ERS3 400/7,5	300	167	224	130	285
MAK ERS3 400/10	360	195	265	116	300
MAK ERS3 400/12,5	360	210	265	135	300
MAK ERS3 400/15	360	210	265	130	300
MAK ERS3 400/20	420	240	315	175	412
MAK ERS3 400/25	420	255	320	190	420
MAK ERS3 400/30	480	320	400	193	470
MAK ERS3 400/40	480	330	400	220	470
MAK ERS3 400/50	540	340	400	170	530

General Specifications

- ▶ Single or three-phase, high permeability iron core, air spacing design
- ▶ Electrolytic copper and aluminum wound
- ▶ Current and power required for the design and production
- ▶ Thermal protection against overheating on each leg
- ▶ According to the current terminals, lugs or busbar connection
- ▶ Protection from moisture and ensuring silent work with varnish in vacuum
- ▶ Compliance with EN 61558-1 and EN 61558-2-20 standards, TSE approved and CE marked
- ▶ Production under ISO 9001 quality management system

Wiring Diagrams



Common Applications

- ▶ Base stations, transmitter systems and other consumers in rural areas, fed on long transmission lines,
- ▶ The campus covers a large area such as a farm and uses long cables,
- ▶ Inductive load testing systems.

Shunt Reactor

Technical Specifications

Specifications	MAK-ERS1 230/0.3	MAK-ERS1 230/0.5	MAK-ERS1 230/1	MAK-ERS1 230/1.5
Inductance (mH)	562±5%	338±5%	168±5%	112±5%
Nominal Current (A)	1.30	2.17	4.35	6.50
Thermal Current (A)	1.43	2.39	4.79	7.15
Saturation Peak Current (A [^])	2	3.3	6.6	10
Nominal Voltage (V)	230	230	230	230
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	7501.3±10%@22C°	3559.5±10%@22C°	1312.5±10%@22C°	611±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	0.3	0.5	1	1.5
Capacitor Type:	0	0	0	0
Winding Losses (W)	17.03	21.45	34.3	34.6
Core Losses (W)	6.52	5.91	20.79	33.69
Total Losses (W)	23.55	27.36	55.09	68.29
Overtemperature protection	132C°	132C°	132C°	132C°
Winding Material	Copper Round Wire	Aluminium Flat Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Terminal Block	Terminal Block	Terminal Block	Terminal Block
Width (mm)	112	128	160	200
Depth (mm)	57.4	70.7	81.6	91.5
Height (mm)	115	125	145	170
Weight (kg)	2	3	5.4	9

Specifications	MAK-ERS1 230/2	MAK-ERS1 230/2.5	MAK-ERS1 230/5	MAK-ERS1 230/0.1
Inductance (mH)	562±5%	338±5%	168±5%	112±5%
Nominal Current (A)	1.30	2.17	4.35	6.50
Thermal Current (A)	1.43	2.39	4.79	7.15
Saturation Peak Current (A [^])	2	3.3	6.6	10
Nominal Voltage (V)	230	230	230	230
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	7501.3±10%@22C°	3559.5±10%@22C°	1312.5±10%@22C°	611±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	0.3	0.5	1	1.5
Capacitor Type:	0	0	0	0
Winding Losses (W)	17.03	21.45	34.3	34.6
Core Losses (W)	6.52	5.91	20.79	33.69
Total Losses (W)	23.55	27.36	55.09	68.29
Overtemperature protection	132C°	132C°	132C°	132C°
Winding Material	Copper Round Wire	Aluminium Flat Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Terminal Block	Terminal Block	Terminal Block	Terminal Block
Width (mm)	112	128	160	200
Depth (mm)	57.4	70.7	81.6	91.5
Height (mm)	115	125	145	170
Weight (kg)	2	3	5.4	9

Specifications	MAK-ERS1 230/0.25	MAK-ERS1 230/7.5	MAK-ERS1 230/10	MAK-ERS3 400/40
Inductance (mH)	672±5%	22.5±5%	16.8±5%	12.6±5%
Nominal Current (A)	1.09	32.60	43.50	58.00
Thermal Current (A)	1.2	35.86	47.85	63.8
Saturation Peak Current (A [^])	1.6	51	68	83
Nominal Voltage (V)	230	230	230	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	11590.7±10%@22C°	96.5±10%@22C°	70.9±10%@22C°	23±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	0.3	7.5	10	40.2
Capacitor Type:	0	0	0	0
Winding Losses (W)	18.58	145.56	190.75	328.43
Core Losses (W)	5.69	65.76	76.34	192.7
Total Losses (W)	24.27	211.32	267.09	521.13
Overtemperature protection	132C°	132C°	132C°	
Winding Material	Copper Round Wire	Aluminium Flat Wire	Aluminium Flat Wire	Aluminium Flat Wire
Connection Type	Terminal Block	DIN Rail Block	DIN Rail Block	Bar
Width (mm)	112	300	360	480
Depth (mm)	57.4	142	123	311
Height (mm)	115	320	370	405
Weight (kg)	1.9	26.3	27.3	119.4

Specifications	MAK-ERS3 400/0.5	MAK-ERS3 400/1	MAK-ERS3 400/1.5	MAK-ERS3 400/2
Inductance (mH)	672±5%	22.5±5%	16.8±5%	12.6±5%
Nominal Current (A)	1.09	32.60	43.50	58.00
Thermal Current (A)	1.2	35.86	47.85	63.8
Saturation Peak Current (A [^])	1.6	51	68	83
Nominal Voltage (V)	230	230	230	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	11590.7±10%@22C°	96.5±10%@22C°	70.9±10%@22C°	23±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	0.3	7.5	10	40.2
Capacitor Type:	0	0	0	0
Winding Losses (W)	18.58	145.56	190.75	328.43
Core Losses (W)	5.69	65.76	76.34	192.7
Total Losses (W)	24.27	211.32	267.09	521.13
Overtemperature protection	132C°	132C°	132C°	
Winding Material	Copper Round Wire	Aluminium Flat Wire	Aluminium Flat Wire	Aluminium Flat Wire
Connection Type	Terminal Block	DIN Rail Block	DIN Rail Block	Bar
Width (mm)	112	300	360	480
Depth (mm)	57.4	142	123	311
Height (mm)	115	320	370	405
Weight (kg)	1.9	26.3	27.3	119.4

Shunt Reactor

Technical Specifications

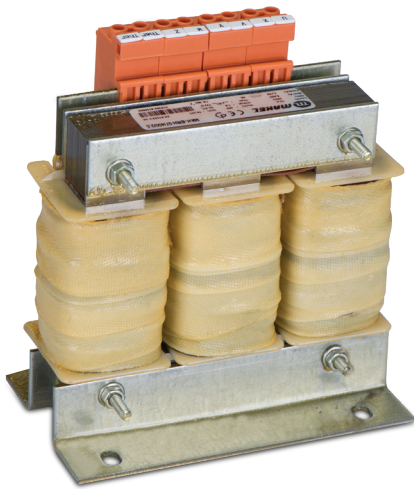
Specifications	MAK-ERS3 400/2.5	MAK-ERS3 400/3	MAK-ERS3 400/5	MAK-ERS3 400/7.5
Inductance (mH)	203±5%	170±5%	102±5%	68±5%
Nominal Current (A)	3.62	4.33	7.21	10.80
Thermal Current (A)	3.98	4.76	7.93	11.88
Saturation Peak Current (A [^])	5.2	6.21	12.2	16
Nominal Voltage (V)	400	400	400	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	1437.4±10%@22C°	859.4±10%@22C°	702±10%@22C°	334.3±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	2.5	3	5	7.5
Capacitor Type:	0	0	0	0
Winding Losses (W)	79.64	68	148.47	163.4
Core Losses (W)	78.57	89.9	33.08	54.33
Total Losses (W)	158.21	157.9	181.55	217.73
Overtemperature protection	132C°		132C°	
Winding Material	Aluminium Round Wire	Aluminium Round Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Terminal Block	Terminal Block	Terminal Block	Terminal Block
Width (mm)	240	240	300	300
Depth (mm)	80.8	90.8	102	120
Height (mm)	245	245	295	295
Weight (kg)	11.8	15	23.3	30.8

Specifications	MAK-ERS3 400/10	MAK-ERS3 400/12.5	MAK-ERS3 400/15	MAK-ERS3 400/20
Inductance (mH)	51±5%	40±5%	33.8±5%	25.5±5%
Nominal Current (A)	14.40	18.10	21.70	29.00
Thermal Current (A)	15.84	19.91	23.87	31.9
Saturation Peak Current (A [^])	21	27	32	41
Nominal Voltage (V)	400	400	400	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	203.1±10%@22C°	140.5±10%@22C°	99.4±10%@22C°	66.1±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	10	12.5	15	20.1
Capacitor Type:	0	0	0	0
Winding Losses (W)	181.27	188.44	200.01	233.58
Core Losses (W)	65	85.1	93.26	144.19
Total Losses (W)	246.27	273.54	293.27	377.77
Overtemperature protection	132C°	132C°		132C°
Winding Material	Aluminium Round Wire	Aluminium Flat Wire	Aluminium Flat Wire	Aluminium Round Wire
Connection Type	DIN Rail Block	Bar	Bar	Bar
Width (mm)	300	360	360	420
Depth (mm)	140	266	269	288.5
Height (mm)	320	305	305	355
Weight (kg)	39.9	49.2	53.9	76.4

Specifications	MAK-ERS3 400/25kVAr	MAK-ERS3 400/30	MAK-ERS3 400/50
Inductance (mH)	20±5%	17±5%	10±5%
Nominal Current (A)	36.20	43.30	72.50
Thermal Current (A)	39.82	47.63	79.75
Saturation Peak Current (A [^])	55	61.2	105
Nominal Voltage (V)	400	400	400
Frequency (Hz)	50	50	50
Winding Resistance (mΩ)	46.2±10%@22C°	43.7±10%@22C°	20.7±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	25.1	30	50.2
Capacitor Type:	0	0	0
Winding Losses (W)	264.39	355.35	468.77
Core Losses (W)	161.41	144.49	234.91
Total Losses (W)	425.8	499.84	703.68
Overtemperature protection	132C°	132C°	132C°
Winding Material	Aluminium Flat Wire	Aluminium Flat Wire	Aluminium Flat Wire
Connection Type	Bar	Bar	Bar
Width (mm)	420	420	540
Depth (mm)	295.5	277.9	333.5
Height (mm)	355	355	455
Weight (kg)	88.3	92.9	167.3

Product Name	Code No.	Class	Operating Voltage (V)	Power (kVAr)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
MAK-ERS1	77000016	230V	230/0.1	1P	1	-	1,20	137 x 117 x 129
MAK-ERS1	77000017	230V	230/0.25	1P	1	-	1,90	137 x 117 x 129
MAK-ERS1	77000101	230V	230/0.3	1P	1	-	2,00	137 x 117 x 129
MAK-ERS1	77000018	230V	230/0.5	1P	1	-	3,10	137 x 117 x 129
MAK-ERS1	77000019	230V	230/1	1P	1	-	5,40	172 x 172 x 180
MAK-ERS1	77000020	230V	230/1.5	1P	1	-	9,22	172 x 172 x 180
MAK-ERS1	77000021	230V	230/2.5	1P	1	-	12,50	172 x 172 x 180
MAK-ERS1	77000022	230V	230/5	1P	-	-	17,10	128 x 71 x 125
MAK-ERS1	77000102	230V	230/7.5	1P	-	-	26,30	300 x 142 x 320
MAK-ERS1	77000103	230V	230/10	1P	-	-	27,30	360 x 123 x 370
MAK-ERS3	77000000	400V	400/0.5	3P	1	-	4,28	172 x 172 x 180
MAK-ERS3	77000001	400V	400/1	3P	-	1	7,04	215 x 190 x 265
MAK-ERS3	77000002	400V	400/1.5	3P	-	-	9,54	172 x 172 x 180
MAK-ERS3	77000003	400V	400/2	3P	-	1	11,40	170 x 285 x 310
MAK-ERS3	77000004	400V	400/2.5	3P	-	1	12,18	170 x 285 x 310
MAK-ERS3	77000005	400V	400/3	3P	-	1	15,00	170 x 285 x 310
MAK-ERS3	77000006	400V	400/5	3P	-	1	21,82	245 x 335 x 355
MAK-ERS3	77000007	400V	400/7.5	3P	-	1	30,80	245 x 335 x 355
MAK-ERS3	77000008	400V	400/10	3P	-	-	38,62	300 x 140 x 320
MAK-ERS3	77000009	400V	400/12.5	3P	-	-	49,20	360 x 266 x 305
MAK-ERS3	77000010	400V	400/15	3P	-	-	53,90	360 x 269 x 305
MAK-ERS3	77000011	400V	400/20	3P	-	-	76,40	420 x 288 x 355
MAK-ERS3	77000012	400V	400/25	3P	-	-	88,30	420 x 295 x 355
MAK-ERS3	77000013	400V	400/30	3P	-	-	92,90	420 x 278 x 355
MAK-ERS3	77000014	400V	400/40	3P	-	-	119,40	480 x 311 x 405
MAK-ERS3	77000015	400V	400/50	3P	-	-	167,30	540 x 333 x 455

Harmonic Filter



Harmonic Filter Reactors, Capacitors in Filter Compensation Systems By using harmonic filter reactors in compensation systems, the following problems encountered in harmonic systems are solved

- ▶ Overcurrent pulling at the moment when the capacitors are switched on
- ▶ The excessive increase of currents due to harmonic resonance condition and overloading of capacitors
- ▶ Condenser breakdown in a short time
- ▶ Loads of lines due to overcurrents, warming on wires
- ▶ Opening the protective elements as untimely
- ▶ Harmonics cause excessive distortion of mains voltage, therefore problems experienced in sensitive devices
- ▶ Developments in communication systems
- ▶ Unexplained problems and failures in electronic cards, devices and computers

Selection of Suitable Harmonic Filter Reactor

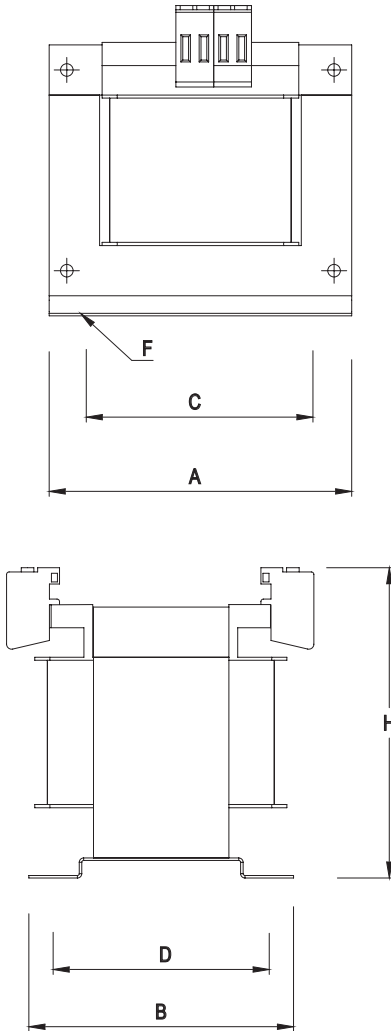
The choice of harmonic filter reactors and power capacitors is of great importance in filter-based compensation systems. The following points are important during the selection of the capacitor and the reactor in order to obtain the expected performance from the installed filter compensation system.

- ▶ The resonance frequency of the filter compensation system is selected according to the harmonics in the system
- ▶ Since the terminal voltages of the condensers will be higher than the mains voltage with the use of the reactors, the nominal voltage of the capacitors to be used is determined according to the selected resonance frequency
- ▶ High-voltage capacitors and harmonic filter reactors, which use compensation power in filter-based compensation systems, are different from the sum of capacitor and reactor due to their reasons.
- ▶ For this reason, the compensation power of the filtered system should be calculated. Otherwise, an incomplete compensation state may be encountered.
- ▶ To participate in the calculation of the additional temperature increases due to the reactors in the filter compensation panels to be installed and taking necessary measures in the panel.

Harmonics	$U_3 = 0,5\% U_R$
	$U_5 = 5,0\% U_R$
	$U_7 = 5,0\% U_R$
	$U_{11} = 3,5\% U_R$
	$U_{13} = 3,0\% U_R$

$$\text{Nominal Current } I_{rms} = \sqrt{(I_1^2 + I_3^2 \dots I_{13}^2)}$$

Technical Dimensios (mm)



$p=7\%$ 189Hz 400V/50Hz

Model No	A	B	C	D	E	F	H
ERH 7/400/2,5	105	50	75	42	-	5x10	120
ERH 7/400/6,25	150	100	110	70	-	5x10	160
ERH 7/400/10	180	115	135	78	-	5x10	195
ERH 7/400/12,5	180	140	135	94	-	5x10	190
ERH 7/400/20	225	117	176	74	-	5x10	260
ERH 7/400/25	240	155	185	100	210	10x15	-
ERH 7/400/40	220	140	200	100	247	10x15	-
ERH 7/400/50	253	180	200	120	247	10x15	-
ERH 7/400/75	300	185	224	124	310	10x15	-
ERH 7/400/100	360	210	267	136	310	10x15	-

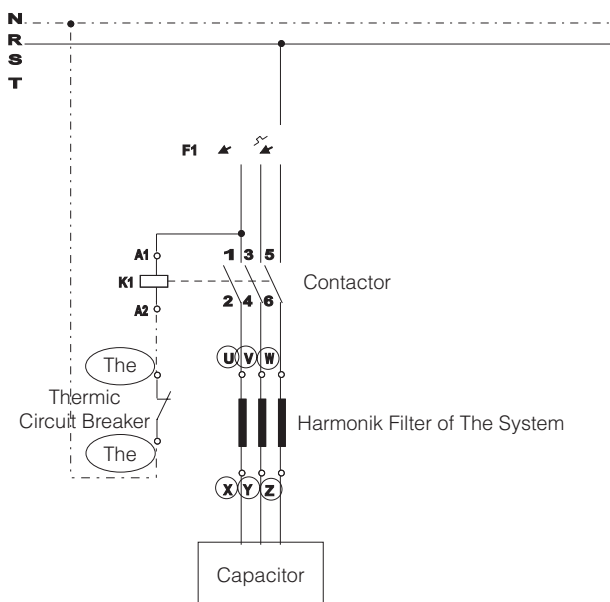
$p=5,67\%$ 210Hz 400V/50Hz

Model No	A	B	C	D	E	F	H
ERH 5,67/400/2,5	120	60	95	52	-	5x10	120
ERH 5,67/400/6,25	180	94	135	74	-	5x10	150
ERH 5,67/400/10	180	105	135	85	-	5x10	181
ERH 5,67/400/12,5	180	115	135	94	-	5x10	181
ERH 5,67/400/20	200	105	185	80	-	10x15	252
ERH 5,67/400/25	200	125	185	100	-	10x15	252
ERH 5,67/400/40	220	150	200	110	247	10x15	-
ERH 5,67/400/50	250	154	224	119	252	10x15	-
ERH 5,67/400/75	300	148	224	114	310	10x15	-
ERH 5,67/400/100	360	166	264	134	310	10x15	-

$p=14\%$ 134Hz 400V/50Hz

Model No	A	B	C	D	E	F	H
ERH 14/400/2,5	150	90	110	70	-	5x10	151
ERH 14/400/6,25	180	105	135	85	-	5x10	181
ERH 14/400/10	180	115	135	94	-	5x10	181
ERH 14/400/12,5	228	120	175	78	-	10x15	220
ERH 14/400/20	200	125	185	100	-	10x15	252
ERH 14/400/25	265	155	200	110	220	10x15	-
ERH 14/400/40	300	200	224	116	250	10x15	-
ERH 14/400/50	300	220	224	135	255	10x15	-
ERH 14/400/75	360	166	264	138	310	10x15	-
ERH 14/400/100	360	193	264	174	310	10x15	-

Wiring Diagrams



Harmonic Filter

Technical Specifications

Specifications	MAK-ERH 5.67/400/100K	MAK-ERH 5.67/400/2.5	MAK-ERH 5.67/400/5K	MAK-ERH 5.67/400/10K
Inductance (mH)	0.31±5%	12.3±5%	6.12±5%	3.06±5%
Nominal Current (A)	167.67	4.18	8.39	16.79
Thermal Current (A)	184.44	4.6	9.23	18.47
Saturation Peak Current (A [^])	351	9.24	18.5	37
Nominal Voltage (V)	400	400	400	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	1.5±10% _{@22C°}	634.7±10% _{@22C°}	231.7±10% _{@22C°}	70.3±10% _{@22C°}
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	5.67	5.67	5.67	5.67
Capacitor Type:	0	0	0	0
Winding Losses (W)	218.63	45.98	66.65	82.01
Core Losses (W)	212.35	15.4	10.43	21.55
Total Losses (W)	430.98	61.38	77.08	103.56
Overtemperature protection		132C°	132C°	132C°
Winding Material	Aluminium Foil	Aluminium Round Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Lug	Terminal Block	Terminal Block	Terminal Block
Width (mm)	360	120	150	180
Depth (mm)	149	51	51.5	61.5
Height (mm)	305	145	170	195
Weight (kg)	42.8	2.1	2.9	5.1

Specifications	MAK-ERH 5.67/400/12.5	MAK-ERH 5.67/400/20K	MAK-ERH 5.67/400/25K	MAK-ERH 5.67/400/30K	MAK-ERH 5.67/400/40K
Inductance (mH)	2.33±5%	1.53±5%	1.22±5%	1.02±5%	0.765±5%
Nominal Current (A)	22.09	33.63	42.02	50.41	67.15
Thermal Current (A)	24.3	36.99	46.22	55.45	73.87
Saturation Peak Current (A [^])	46.2	74.2	84.7	115	140
Nominal Voltage (V)	400	400	400	400	400
Frequency (Hz)	50	50	50	50	50
Winding Resistance (mΩ)	30.7±10% _{@22C°}	15±10% _{@22C°}	11.4±10% _{@22C°}	11.7±10% _{@22C°}	6.9±10% _{@22C°}
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	5.67	5.67	5.67	5.67	5.67
Capacitor Type:	0	0	0	0	0
Winding Losses (W)	61.35	80.84	93.22	132.45	140.81
Core Losses (W)	25.33	39.09	53.27	53.47	72.3
Total Losses (W)	86.68	119.93	146.49	185.92	213.11
Overtemperature protection	132C°	132C°	132C°	132C°	132C°
Winding Material	Aluminium Flat Wire	Aluminium Foil	Aluminium Foil	Aluminium Foil	Aluminium Foil
Connection Type	DIN Rail Block	Bar	Bar	Bar	Bar
Width (mm)	180	240	240	240	240
Depth (mm)	81.3	185.8	195.8	205.8	237
Height (mm)	220	205	205	205	205
Weight (kg)	8.3	12.2	14.3	16.9	18.7

Specifications	MAK-ERH 5.67/400/50K	MAK-ERH 5.67/400/75K	MAK-ERH 7/400/0.5	MAK-ERH 7/400/0.83K	MAK.ERH-E50 7/400/1
Inductance (mH)	0.58±5%	0.41±5%	76.7±5%	43.2±5%	38.4±5%
Nominal Current (A)	88.35	125.74	0.81	1.43	1.60
Thermal Current (A)	97.18	138.32	0.89	1.57	1.76
Saturation Peak Current (A [^])	185	308	1.75	3	3.5
Nominal Voltage (V)	400	400	400	400	400
Frequency (Hz)	50	50	50	50	50
Winding Resistance (mΩ)	3.9±10%@22C°	2±10%@22C°	8786.3±10%@22C°	2112±10%@22C°	2613.7±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	5.67	5.67	7	7	7.27
Capacitor Type:	0	0	0	0	0
Winding Losses (W)	140.81	158.41	21.67	15.84	25.46
Core Losses (W)	97.42	162.16	2.84	6.17	4.91
Total Losses (W)	238.23	320.57	24.51	22.01	30.37
Overtemperature protection	132C°	132C°	132C°	132C°	132C°
Winding Material	Aluminium Foil	Aluminium Foil	Copper Round Wire	Copper Round Wire	Copper Round Wire
Connection Type	Bar	Bar	Terminal Block	Terminal Block	Terminal Block
Width (mm)	264	360	120	120	120
Depth (mm)	219	254	41	67	41
Height (mm)	242.6	305	145	145	145
Weight (kg)	25.9	42.7	1.4	1.5	1.5

Specifications	MAK-ERH 7/400/1.5K	MAK-ERH 7/400/1.25K	MAK-ERH 7/400/2.5K	MAK-ERH 7/400/5K
Inductance (mH)	25.6±5%	30.7±5%	15.3±5%	7.66±5%
Nominal Current (A)	2.29	2.05	3.80	7.60
Thermal Current (A)	2.52	2.25	4.18	8.36
Saturation Peak Current (A [^])	4.41	4.4	8	14.7
Nominal Voltage (V)	400	400	400	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	1507.3±10%@22C°	1776.2±10%@22C°	555.9±10%@22C°	176.6±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	7	7	7	7
Capacitor Type:	0	0	0	0
Winding Losses (W)	31.13	29.2	32.29	40.91
Core Losses (W)	6.52	6.35	10.57	27.93
Total Losses (W)	37.65	35.55	42.86	68.84
Overtemperature protection	132C°	132C°	132C°	132C°
Winding Material	Copper Round Wire	Copper Round Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Terminal Block	Terminal Block	Terminal Block	Terminal Block
Width (mm)	120	120	120	150
Depth (mm)	41	41	85	51.5
Height (mm)	145	145	145	170
Weight (kg)	1.5	1.5	1.6	3.1

Harmonic Filter

Technical Specifications

Specifications	MAK-ERH 7/400/6.25K	MAK-ERH 7/400/10K	MAK-ERH 7/400/12.5K	MAK-ERH 7/400/15K
Inductance (mH)	6.13±5%	3.83±5%	3.07±5%	2.55±5%
Nominal Current (A)	9.51	15.21	19.11	22.91
Thermal Current (A)	10.46	16.73	21.02	25.2
Saturation Peak Current (A [^])	18.4	28	36.8	42
Nominal Voltage (V)	400	400	400	400
Frequency (Hz)	50	50	50	50
Winding Resistance (mΩ)	156.7±10%@22C°	72±10%@22C°	46.7±10%@22C°	36.7±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	7	7	7	7
Capacitor Type:	0	0	0	0
Winding Losses (W)	56.65	68.1	70.5	82.14
Core Losses (W)	38.89	12.95	14.92	21.55
Total Losses (W)	95.54	81.05	85.42	103.69
Overtemperature protection	132C°	132C°	132C°	132C°
Winding Material	Aluminium Round Wire	Aluminium Round Wire	Aluminium Round Wire	Aluminium Foil
Connection Type	Terminal Block	Terminal Block	DIN Rail Block	Bar
Width (mm)	180	180	180	180
Depth (mm)	61.5	105	71.4	195
Height (mm)	195	190	220	155
Weight (kg)	4.8	5.1	6.9	9.2

Specifications	MAK-ERH 7/400/20K	MAK-ERH 7/400/25K	MAK-ERH 7/400/30K	MAK-ERH 7/400/40K	MAK-ERH 7/400/50K
Inductance (mH)	1.92±5%	1.53±5%	1.3±5%	0.95±5%	0.767±5%
Nominal Current (A)	30.63	38.13	45.72	60.94	76.26
Thermal Current (A)	33.7	41.94	50.3	67.04	83.89
Saturation Peak Current (A [^])	58.8	74	85	117	147
Nominal Voltage (V)	400	400	400	400	400
Frequency (Hz)	50	50	50	50	50
Winding Resistance (mΩ)	19.6±10%@22C°	15.3±10%@22C°	16.7±10%@22C°	7.9±10%@22C°	6.3±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	7	7	7.11	7	7
Capacitor Type:	0	0	0	0	Not-Present
Winding Losses (W)	76.15	97.87	159.97	128.51	163.39
Core Losses (W)	25.8	27.35	30.61	44.19	58.42
Total Losses (W)	101.95	125.22	190.58	172.7	221.81
Overtemperature protection	132C°	132C°	132C°	132C°	132C°
Winding Material	Aluminium Foil	Aluminium Foil	Aluminium Foil	Aluminium Foil	Aluminium Foil
Connection Type	Bar	Bar	Bar	Bar	Bar
Width (mm)	240	240	240	240	264
Depth (mm)	185.8	185.8	211.8	231.8	230
Height (mm)	205	205	205	205	242.6
Weight (kg)	11.7	12.2	12.7	17.6	21.2

Specifications	MAK-ERH 7/400/75K	MAK-ERH 7/400/80K	MAK-ERH 7/400/100K	MAK-ERH 14/400/2.5	MAK-ERH 14/400/5K
Inductance (mH)	0.51±5%	0.48±5%	0.383±5%	33.1±5%	16.6±5%
Nominal Current (A)	114.11	121.51	153.10	3.83	7.26
Thermal Current (A)	125.52	133.67	168.41	4.21	7.99
Saturation Peak Current (A [^])	221	235	294	6.5	12.2
Nominal Voltage (V)	400	400	400	400	400
Frequency (Hz)	50	50	50	50	50
Winding Resistance (mΩ)	3.4±10%@22C°	2.4±10%@22C°	2±10%@22C°	788.7±10%@22C°	263.1±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	7	7	7	14	14
Capacitor Type:	0	0	0	0	0
Winding Losses (W)	207.69	169.87	223.54	47.18	55.92
Core Losses (W)	81.53	87.07	130.27	4.34	18.96
Total Losses (W)	289.22	256.94	353.81	51.52	74.88
Overtemperature protection	132C°	132C°	132C°	132C°	132C°
Winding Material	Aluminium Foil	Aluminium Foil	Aluminium Foil	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Bar	Bar	Bar	Terminal Block	Terminal Block
Width (mm)	300	300	360	150	150
Depth (mm)	241	246	195	51.5	66.5
Height (mm)	255	255	310	170	170
Weight (kg)	27.9	31.3	42	2.9	4.6

Specifications	MAK-ERH 14/400/10K	MAK-ERH 14/400/20K	MAK-ERH 14/400/30K	MAK-ERH 14/400/40K	MAK-ERH 14/400/60K
İndüktans (mH)	8.3±5%	4.14±5%	2.76±5%	2.07±5%	1.38±5%
Nominal Akım (A)	14.49	29.08	43.57	58.06	87.13
Termal Akım (A)	15.94	31.99	47.93	63.87	95.85
Dayanım Akımı (A [^])	24.4	53.2	73.2	97.5	133
Nominal Voltaj (V)	400	400	400	400	400
Frekans (Hz)	50	50	50	50	50
Sargı Direnci (mΩ)	119.9±10%@22C°	54.8±10%@22C°	15.7±10%@22C°	9.5±10%@22C°	5.9±10%@22C°
Yalıtım Sınıfı	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/F
İlgili Standart	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtre Kapasitesi p(%)	14	14	14	14	14
Kapasitör Tipi	0	0	0	0	0
Sargı Kayıpları (W)	103.95	196.78	136.77	145.46	199.63
Sac Kayıpları (W)	11.67	38.13	35.06	46.65	68.57
Toplam Kayıplar (W)	115.62	234.91	171.83	192.11	268.2
Yüksek Sıcaklık Koruması	132C°	132C°	132C°	132C°	132C°
Sargı Malzemesi	Alüminyum Yuvarlak Tel	Alüminyum Yassı Tel	Alüminyum Folyo	Alüminyum Folyo	Alüminyum Folyo
Bağlantı Tipi	Terminal Blok	DIN Ray	Bar	Bar	Bar
Genişlik-En (mm)	180	240	264	300	300
Derinlik (mm)	81.3	116.8	219	220	273
Yükseklik-Boy (mm)	195	270	242.6	255	255
Ağırlık (kg)	8.1	14.6	25.9	29.9	41.1

Harmonic Filter

Technical Specifications

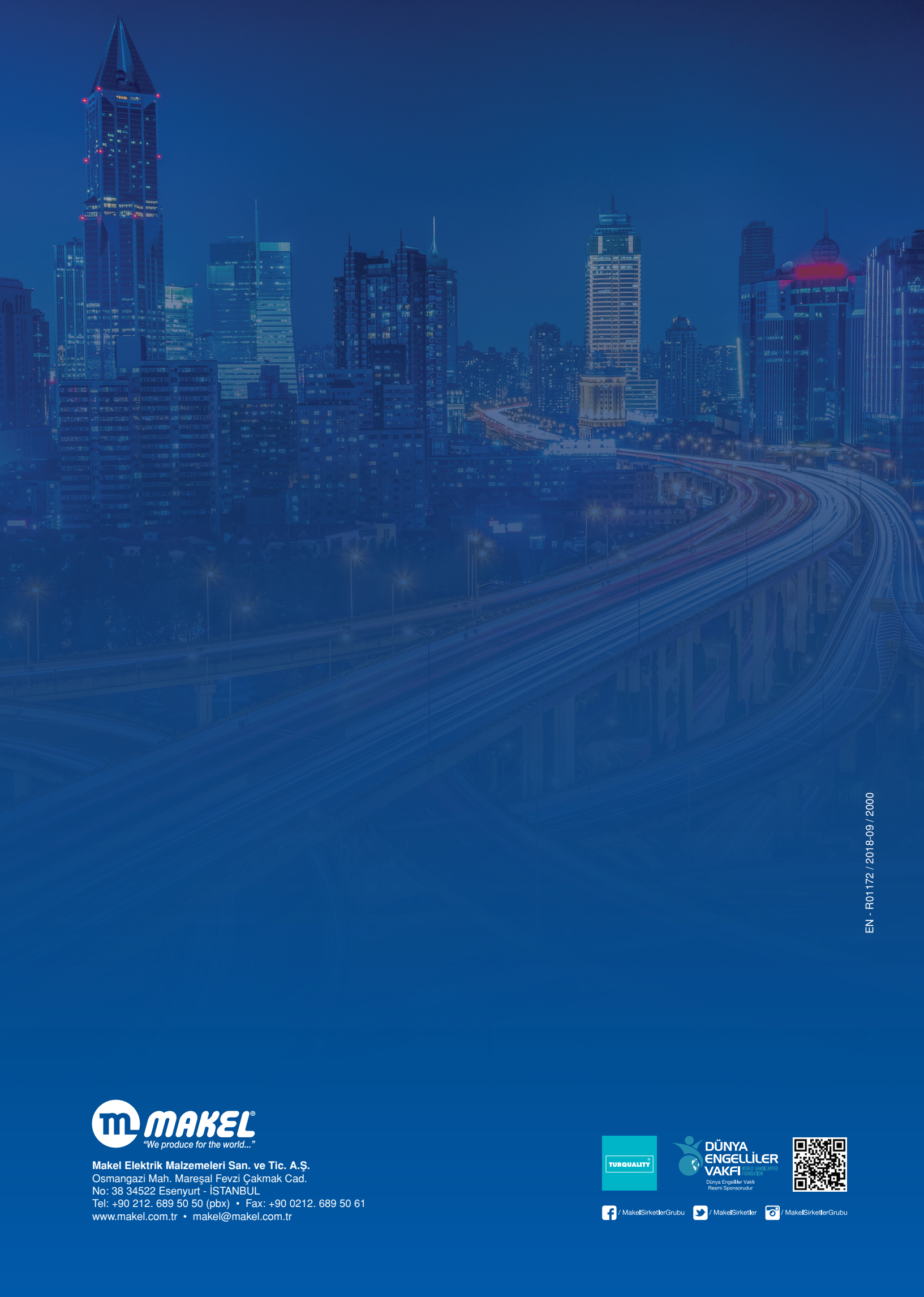
Specifications	MAK-ERH 14/400/12.5K	MAK-ERH 14/400/25K	MAK-ERH 14/400/50K
Inductance (mH)	6.63±5%	3.3±5%	1.66±5%
Nominal Current (A)	18.11	36.32	72.65
Thermal Current (A)	19.92	39.96	79.91
Saturation Peak Current (A [^])	30.5	61	122
Nominal Voltage (V)	400	400	400
Frequency (Hz)	50	50	50
Winding Resistance (mΩ)	62.8±10%@22C°	21.7±10%@22C°	9.2±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F
Varnish Type	Vacuum Impregnated Varnish	Vacuum Impregnated Varnish	Vacuum Impregnated Varnish
Isolation Level	3000VAC/1 min	3000VAC/1 min	3000VAC/1 min
Harmonic Loading	Acc. En 61000-2-2 THDU<%6	Acc. En 61000-2-2 THDU<%6	Acc. En 61000-2-2 THDU<%6
Relevant Standard	EN 61558-2-20; EN 60076-6	EN 61558-2-20; EN 60076-6	EN 61558-2-20; EN 60076-6
Filtering Factor p(%)	14	14	14
Capacitor Type	0	0	0
Winding Losses (W)	83.06	125.16	220.93
Core Losses (W)	13.7	26.94	56.45
Total Losses (W)	96.76	152.1	277.38
Overtemperature protection	132°C on Middle Coil	132°C on Middle Coil	132°C on Middle Coil
Winding Material	Aluminium Round Wire	Aluminium Foil	Aluminium Foil
Connection Type	Terminal Block	Bar	Bar
Width (mm)	180	240	300
Depth (mm)	90	237	251
Height (mm)	195	205	255
Weight (kg)	9.7	19.4	31.8

Specifications	MAK-ERH 14/400/100K	MAK-ERH1 7/230/000.50	MAK-ERH1 7/230/1	MAK-ERH1 7/230/1.5	MAK-ERH1 7/230/2.5
Inductance (mH)	0.829±5%	25.1±5%	12.6±5%	8.43±5%	5.1±5%
Nominal Current (A)	144.90	2.44	4.84	7.27	12.18
Thermal Current (A)	159.39	2.68	5.33	7.99	13.4
Saturation Peak Current (A [^])	242	5.1	10.1	15.2	25.4
Nominal Voltage (V)	400	230	230	230	230
Frequency (Hz)	50	50	50	50	50
Winding Resistance (mΩ)	3.2±10%@22C°	1143.3±10%@22C°	529.5±10%@22C°	236±10%@22C°	139.6±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F	ta 40C°/F	ta 40C°/B	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	14	7	7	7	7
Capacitor Type:	0	0	0	0	0
Winding Losses (W)	320.4	8.97	16.78	16.6	28.16
Core Losses (W)	105.22	3.17	4.98	7.82	13.34
Total Losses (W)	425.62	12.14	21.76	24.42	41.5
Overtemperature protection	132C°	132C°	132C°	132C°	132C°
Winding Material	Aluminium Foil	Copper Round Wire	Aluminium Round Wire	Aluminium Round Wire	Aluminium Round Wire
Connection Type	Bar	Terminal Block	Terminal Block	Terminal Block	Terminal Block
Width (mm)	360	88	112	112	128
Depth (mm)	284	34.1	43.4	65.8	87.4
Height (mm)	305	100	115	115	125
Weight (kg)	61.2	0.6	1.7	2.9	2.5

Specifications	MAK-ERH1 7/230/5	MAK-ERH 7/230/10
Inductance (mH)	2.5±5%	1.27±5%
Nominal Current (A)	24.26	48.42
Thermal Current (A)	26.68	53.26
Saturation Peak Current (A [^])	51	101
Nominal Voltage (V)	230	230
Frequency (Hz)	50	50
Winding Resistance (mΩ)	35.3±10%@22C°	10.4±10%@22C°
Isolation Class	ta 40C°/F	ta 40C°/F
Relevant Standard	EN 61558-2-20	EN 61558-2-20
Filtering Factor p(%)	7	7
Capacitor Type:	0	0
Winding Losses (W)	29.25	35.88
Core Losses (W)	22.22	29.66
Total Losses (W)	51.47	65.54
Overtemperature protection	132C°	132C°
Winding Material	Aluminium Flat Wire	Aluminium Flat Wire
Connection Type	Lug	Lug
Width (mm)	160	200
Depth (mm)	81.6	74.7
Height (mm)	105	130
Weight (kg)	7.2	6.9

Harmonic Filter

Code No.	Product Name	p	Resonance Frequency (Hz)	Operating Voltage (Hz)	Piece in Box	Piece in Package	Gross Weight (kg)	Size of Package (mm)
77000023	14/400/2.5	p=%14	134Hz	400V/50Hz	1	-	2,3	137 x 152 x 162
77000092	14/400/5	p=%14	134Hz	400V/50Hz	1	-	4,6	172 x 172 x 180
77000024	14/400/6.5	p=%14	134Hz	400V/50Hz	-	1	7	215 x 190 x 265
77000025	14/400/10	p=%14	134Hz	400V/50Hz	-	1	8,1	215 x 190 x 265
77000026	14/400/12.5	p=%14	134Hz	400V/50Hz	-	1	9,7	170 x 285 x 310
77000027	14/400/20	p=%14	134Hz	400V/50Hz	-	1	14,6	230 x 280 x 305
77000028	14/400/25	p=%14	134Hz	400V/50Hz	-	1	19,4	230 x 280 x 305
77000093	14/400/30	p=%14	134Hz	400V/50Hz	-	1	18	230 x 280 x 305
77000029	14/400/40	p=%14	134Hz	400V/50Hz	-	1	29,9	200 x 285 x 310
77000030	14/400/50	p=%14	134Hz	400V/50Hz	-	1	31,8	200 x 285 x 310
77000094	14/400/60	p=%14	134Hz	400V/50Hz	-	1	41,1	200 x 285 x 310
77000031	14/400/75	p=%14	134Hz	400V/50Hz	-	1	48,5	245 x 335 x 355
77000032	14/400/100	p=%14	134Hz	400V/50Hz	-	1	61,2	245 x 335 x 355
77000104	7/400/0,5	p=%7	189Hz	400V/50Hz	1	-	1,4	137 x 152 x 162
77000033	7/400/0.83	p=%7	189Hz	400V/50Hz	1	-	1,5	137 x 152 x 162
77000105	7/400/1,0	p=%7	189Hz	400V/50Hz	1	-	1,5	137 x 152 x 162
77000034	7/400/1.25	p=%7	189Hz	400V/50Hz	1	-	1,5	137 x 152 x 162
77000035	7/400/1.5	p=%7	189Hz	400V/50Hz	1	-	1,5	137 x 152 x 162
77000036	7/400/2.5	p=%7	189Hz	400V/50Hz	1	-	1,84	137 x 152 x 162
77000037	7/400/5	p=%7	189Hz	400V/50Hz	1	-	3,1	172 x 172 x 180
77000038	7/400/6.25	p=%7	189Hz	400V/50Hz	-	1	5,14	215 x 190 x 265
77000039	7/400/10	p=%7	189Hz	400V/50Hz	-	1	5,2	215 x 190 x 265
77000040	7/400/12.5	p=%7	189Hz	400V/50Hz	-	1	7,28	215 x 190 x 265
77000089	7/400/15	p=%7	189Hz	400V/50Hz	-	1	9,2	215 x 190 x 265
77000041	7/400/20	p=%7	189Hz	400V/50Hz	-	1	11,3	170 x 285 x 310
77000042	7/400/25	p=%7	189Hz	400V/50Hz	-	1	12,92	170 x 285 x 310
77000090	7/400/30	p=%7	189Hz	400V/50Hz	-	1	12,7	170 x 285 x 310
77000043	7/400/40	p=%7	189Hz	400V/50Hz	-	1	17,6	170 x 285 x 310
77000044	7/400/50	p=%7	189Hz	400V/50Hz	-	1	21,2	170 x 285 x 310
77000045	7/400/75	p=%7	189Hz	400V/50Hz	-	1	27,9	230 x 280 x 305
77000091	7/400/80	p=%7	189Hz	400V/50Hz	-	1	31,3	230 x 280 x 305
77000046	7/400/100	p=%7	189Hz	400V/50Hz	-	1	41,46	200 x 285 x 310
77000047	5.67/400/2.5	p=%5,67	210Hz	400V/50Hz	1	-	2,1	137 x 152 x 162
77000086	5.67/400/5	p=%5,67	210Hz	400V/50Hz	1	-	2,9	172 x 172 x 180
77000048	5.67/400/6.25	p=%5,67	210Hz	400V/50Hz	-	1	3,4	215 x 190 x 265
77000049	5.67/400/10	p=%5,67	210Hz	400V/50Hz	-	1	5,1	215 x 190 x 265
77000050	5.67/400/12.5	p=%5,67	210Hz	400V/50Hz	-	1	8,3	215 x 190 x 265
77000051	5.67/400/20	p=%5,67	210Hz	400V/50Hz	-	1	12,2	170 x 285 x 310
77000052	5.67/400/25	p=%5,67	210Hz	400V/50Hz	-	1	14,3	170 x 285 x 310
77000087	5.67/400/30	p=%5,67	210Hz	400V/50Hz	-	1	16,9	170 x 285 x 310
77000053	5.67/400/40	p=%5,67	210Hz	400V/50Hz	-	1	18,7	230 x 280 x 305
77000054	5.67/400/50	p=%5,67	210Hz	400V/50Hz	-	1	25,9	230 x 280 x 305
77000088	5.67/400/60	p=%5,67	210Hz	400V/50Hz	-	1	33,2	230 x 280 x 305
77000055	5.67/400/75	p=%5,67	210Hz	400V/50Hz	-	1	43,6	200 x 285 x 310
77000056	5.67/400/100	p=%5,67	210Hz	400V/50Hz	-	1	42,8	200 x 285 x 310
77000106	7/230/0,5 1P	p=%7	-	230V	1	-	0,6	137 x 117 x 129
77000095	7/230/1.0 1P	p=%7	-	230V	1	-	1,2	137 x 117 x 129
77000096	7/230/1.5 1P	p=%7	-	230V	1	-	2,9	137 x 117 x 129
77000097	7/230/2.5 1P	p=%7	-	230V	1	-	2,5	137 x 117 x 129
77000098	7/230/5.0 1P	p=%7	-	230V	1	-	7,2	137 x 117 x 129
77000099	7/230/7.5 1P	p=%7	-	230V	1	-	5	172 x 172 x 180
77000100	7/230/10.0 1P	p=%7	-	230V	1	-	6,9	172 x 172 x 180



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