Automation Systems Interconnect, Inc

Innovative Interconnect and Interface Solutions

AN004

Characteristics and usage guidelines for the ECOLEC Series 100 Meters

Introduction

The ECOLEC Series 100 meters are intended for use as Accuracy Class 2 direct connected electricity meters. They are small, electronic, rail mount units with a LED consumption rate / status indicator and a six plus one digit register for kilowatt-hours consumed. Their small size and extended performance characteristics make them ideally suited for application in a variety of diverse applications. This application note is intended to assist users of the meters to understand and apply the meters correctly.

Identification of parts

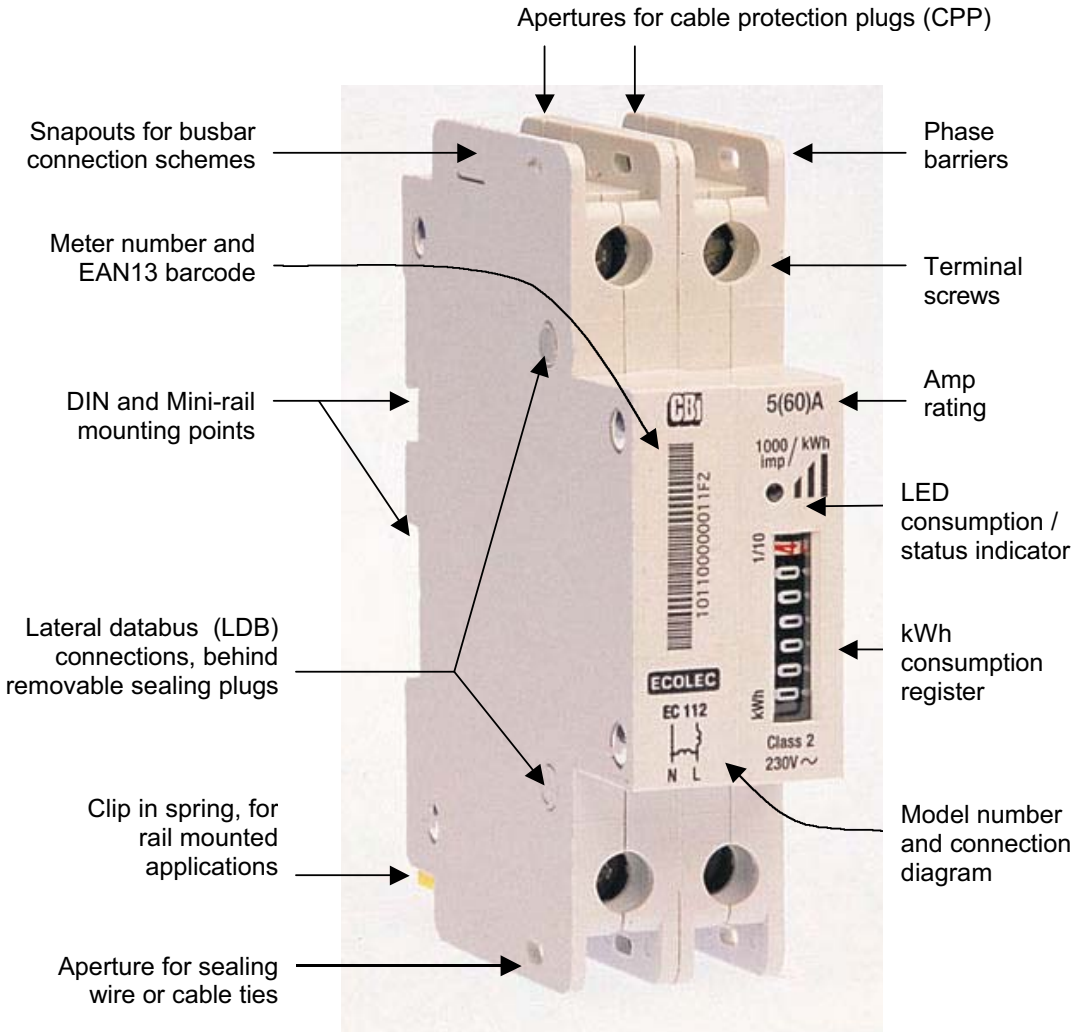

Diagram 1. Identification of key parts of an EC112 single-phase electricity meter

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Product application

- **Stand alone, manual meter reading**
  The meters are well suited to the replacement of conventional kWh meters, panel mounted meter installations and sub-metering / check metering applications.

- **Automated meter reading or load profiling**
  The meters have a multi-mode data output called SLMS (Single Line Messaging System). One mode outputs consumption pulses every 100 watt-hours and can be used for AMR (Automatic Meter Reading), while another outputs serial data containing instantaneous power readings and meter status information (use for load profiling and calibration). For more information on using the data output see *AN002 – Using the SLMS output of the ECOLEC Series 100 Meters.*

- **Application with currents in excess of 60 Amps**
  If currents in excess of 60 Amps are to be measured, then an external current transformer must be used. For more information on using external CT's see *AN003 – Using the ECOLEC Series 100 Meters as a CT operated meter.*

Safety features

The meters are Protection Class 2 meters (double insulated) and contain no external metal parts. The inherent safety of the meters has further been enhanced by;

- **Catering for high altitudes**
  Protection Class 2 meters require creepage and clearance distances sufficient for voltage impulses of up to 6kV (Protection Class 1 only requires 4kV). These distances are adequate for altitudes up to 2000m. The EC100 Series of meters has been designed to safely accommodate altitudes up to 3000m.

- **Sealing the terminals**
  The cable protection plugs (CPP) are removable plastic parts designed to protect the installation from unauthorized alteration. The CPP's clip into recesses at the terminal housing and directly prevent access to the terminal screws. Supply cables are first fed through a hole in the CPP and then tightened into the box terminals of the meter. The CPP is then slid towards the meter until it clips into place. They can then be sealed in place using either coded cable ties or sealing wire and lead seals.

- **Colour coding the CPP's**
  Table 1 gives the colour allocations of the CPP's fitted on different versions of the meters. The CPP's are colour coded to support proper installation and aid phase and neutral identification.

CPP Colour	EC100 AMR Modules	EC11x single phase meters	EC12x dual phase meters	EC13x three phase meters
Black	Mini-rail	Neutral	Neutral	Neutral
Red	-	Live	Live phases 1 & 2	Red phase
White	Din rail	-	-	White phase
Blue	-	-	-	Blue phase

Table 1. Colour assignments of the Cable Protection Plugs (CPP's)

Box terminal tightening

The box terminals close from the bottom of the square aperture, up towards the surface of the meter when tightened and must be fully opened prior to insertion of the conductors. This is important as it ensures that the cable is not inadvertently inserted beneath the box. If incorrectly inserted and then tightened, the terminal will not clamp the wire tightly, resulting in intermittent connections and/or dangerous heating of the terminal. This could lead to fires or lost neutral conditions.

Ensure that the terminals are tightened fully (with a good quality and well maintained screwdriver) when installing the meters, as high operational currents will generate excessive heat from marginal connections.

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Withstand capabilities

The robust design of the meters is intended to survive abnormal conditions likely to occur in rural pole-top reticulation systems. These are more severe than anticipated by the European IEC 61036 specification.

- **Lightning surges**
  A predominance of overhead reticulation could require higher than 6kV impulse voltage withstand. The ECOLEC Series 100 meters will withstand without degradation impulses of up to 10kV. Larger voltage impulses will flashover from the live path at the bottom of the meter directly to the metal rail mounting if this rail is connected to an earth potential. Earthing of the mounting rail will thus direct the impulse energy away from the meters measurement circuits, helping it to survive impulses greater than 10kV.

- **Fast transient bursts**
  Energisation of rural supply grids causes significant bursts of transients in common and differential modes. These disturbances exceed the IEC 61036 limits, and frequently cause corruption of electronic storage registers within a meter. The ECOLEC meters are immune to such transients as they have no electronic storage – the mechanical counter is the storage.

- **Insulation testing stresses**
  With sub metering applications, the SABS wiring code (SABS 1042) requires that the insulation properties of an installation be tested prior to connection of the main supply. These test are performed at 500V DC or 1000V DC. The ECOLEC meters will withstand such voltages for a period of at least one minute. The impedance of the meters internal power supply will however cause an erroneous reading to be registered on the insulation testing equipment.

- **Fault currents**
  Fault currents in excess of the IEC 61036 specified 1800 Amps (30 times Imax) rating, can arise in panel mounted sub-metering applications. Fault levels must be controlled and co-ordinated with properly specified circuit breakers. These meters will survive fault currents of up to 5kA for 10mS. 10kA is possible if the circuit is protected with one of Cbi's SH circuit breakers.

- **Overload currents**
  Although rated at 60 Amps maximum, the meter can withstand overload currents of up to 120 Amps for at least 48 hours. Currents above 90 Amps will be indicated by a red/green-flashing signal on the consumption LED. Sustained operation above 80 Amps is not recommended due to the terminal heating that can occur with the very short (bus bar) connections possible in distribution board applications.

- **Temperature extremes**
  Temperature extremes beyond the IEC specification are regularly encountered in pole top enclosures subjected to the harsh African sun. This meter is design to have very low self heating (less then 0.2 Watts) and has a limit range of operation of –25 to 70 degrees C.

- **Voltage extremes**
  Failure of supply connections may result in abnormal voltage conditions. The ECOLEC meters will continue to operate and will withstand such abnormal voltages without damage or degradation for a minimum of 48 hours at least. (A weekend)

	Under voltage condition due to loss of a phase connection	Over voltage condition due to loss of a neutral connection
230 volt meters	Operate down to 100 volts	Survive 48 hours at 600 volts
120 volt meters	Operate down to 60 volts	Survive 48 hours at 400 volts

Table 2. Withstand of abnormal voltage conditions

- **Tampering**
  As there are no user adjustable or serviceable parts in the ECOLEC meter, the meter is supplied in a completely enclosed, riveted enclosure. Access to the terminals is constrained by Cable Protection Plugs (CPP's) that prevent unauthorised connection alterations. Access to the Lateral Data Bus (LDB) terminals is likewise, blocked by sealing plugs.

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LED indications

The consumption/status indicator is a bi-colour LED, located on the face of the meter just above the counter. This indicator is used to show one of four conditions:

- **Consumption pulses**
  These are RED only pulses, which flash at a rate proportional to the load being measured (actual flash rate is 1000 pulses per kilowatt-hour). For a large load drawing high current the flash rate will be quick, while for a small load drawing little current, the rate will be slow. The change in flash rate will only occur after the present pulse is complete (which could take up to two minutes). This means that the user will not always see an instantaneous response in flash rate for a change from a low load to a high load.

- **Low load indication**
  When the meter is measuring very little (less than thirty watts) or no power, the LED Indicator will remain permanently GREEN. This is used to indicate to the user whether power to the meter is on or off when there is no load present.

- **Error conditions**
  If the meter detects an error, it will indicate it by repetitively toggling RED with GREEN. The pattern of the pulses (known as a dip code) can be interpreted to discover what the error is. Count the number of red pulses (dips) starting with the first normal pulse after a longer green pulse (2 seconds), and continue counting all of the red pulses up to the next long green pulse. Table 3 defines the dip codes.

Dip code	Error type	Error description
1	BIT error	Built-In-Test error. The diagnostic test performed every second revealed an error. Methods of accessing the diagnostic codes and their allocations are defined in AN002 – Using the SLMS output of the ECOLEC Series 100 Meters. Consumption accumulation is not guaranteed
8	Voltage over-range	The supply voltage has exceeded the meter's measuring capability. This is 360V for a 230V meter and 180V for a 120V meter. Consumption accumulation continues but the meter will under read due to clipping.
9	Current over-range	The load current has exceeded the meter's measuring capability. This occurs above 90 Amps. Consumption accumulation continues but the meter will under read due to clipping of the current waveform.

Table 3. Dip codes and descriptions

- **LED not indicating**
  Service personnel should not rely on the LED being off to indicate the absence of a supply voltage because the LED itself might have failed or an invalid supply voltage might be present. If the incoming supply voltage is lower than ±70% of the meters rated voltage, the LED will be switched off and will remain off until such time as the supply voltage exceeds ±75% of the meters rated voltage. This feature enables the meter to continue to measure correctly down to ±50% of its rated voltage by minimising the current drawn from its own power supply when the supply voltage is very low. The voltage thresholds, at which this occurs, are given in Table 4.

Meter configuration	Voltage at which LED is disabled	Voltage at which LED is re-enabled	Minimum operating voltage
230V / 50Hz	± 160V	± 170V	± 100V
220V / 60Hz	± 160V	± 170V	± 100V
120V / 60Hz	± 85V	± 90V	± 60V

Table 4. Voltage levels at which the LED is disabled

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Counter operation

The 7-digit electro-mechanical counter will increment for the following conditions:

- Every 100 watt-hours consumed during normal operation. The left most digit is incremented. It is a red colour to indicate that it represents $1/10^{th}$ of a kWh.
- If the meter has consumed more than 10 watt-hours of electricity since the last time the counter was incremented, and the supply to the meter is disconnected.

The second condition is a precautionary measure used to prevent tampering by individuals, who by some means are be able to disconnect and then reconnect the meter before 100 watt hours has been consumed.

The counter can be affected by severe mechanical vibration, which will cause the counter to increment at a rate exceeding the measured consumption. This can be often be negated by altering the orientation of the meter such that the plane of vibration does not influence the armature of the mechanical counter.

Performance curves

The performance curves for the units are shown in the figures at the end of this document. At present there are three different configurations for the different supply voltage / frequency combinations:

- 230V / 50Hz - Figure 1
- 220V / 60Hz - Figure 2
- 120V / 60Hz - Figure 3

The graphs illustrate the performance for direct connected operation, and show the influence of current variations, voltage variations and frequency variations. The accuracy of the meter is well within the shaded areas of the graphs – these areas indicate the limits for required accuracy of a class 2 meter.

The meters will automatically detect and compensate for reverse fed installations. The counter will always increment correctly, regardless of the direction of current flow.

Model numbers

The ECOLEC Series 100 Meters are manufactured in single, dual and three phase versions. A single width module is also supplied for system integrators. All four of the above configurations are offered in a 230V mini-rail shell (black) with a 57mm escutcheon, as well as 230Vand 120V Din-rail shells (grey) with a 45mm escutcheon. The range of standard product model numbers is given in Table 5.

	AMR module	Single phase	Dual phase	Three phase	Shell colour
Mini-rail 230v / 50Hz	EC100	EC110	EC120	EC130	Black
Din-rail 120v / 60Hz	EC101	EC111	EC121	EC131	Grey
Din-rail 230v / 50Hz	EC102	EC112	EC122	EC132	Grey

Table 5. ECOLEC Series 100 Meter model numbers

Conclusion

The ECOLEC Series 100 meters provide exceptional accuracy in a small, convenient, rail mount enclosure. The meters are manufactured in standard MINI-rail and DIN-rail configuration for ease of use and installation, and can be used in a wide variety of applications.

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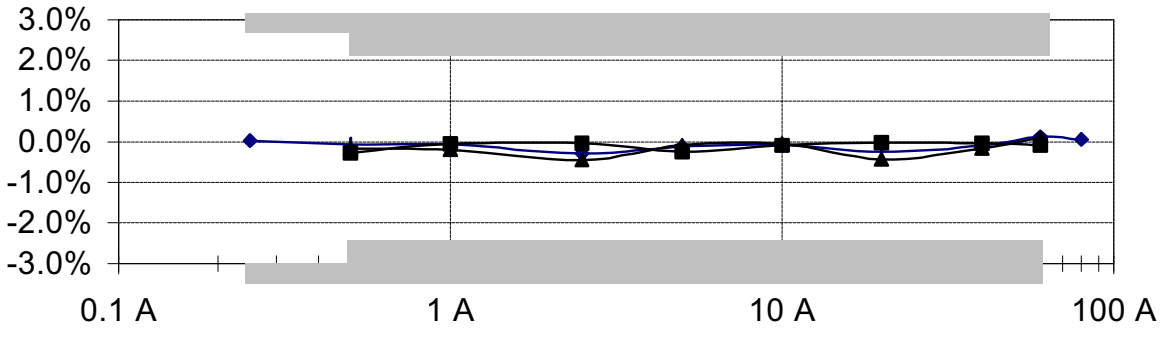
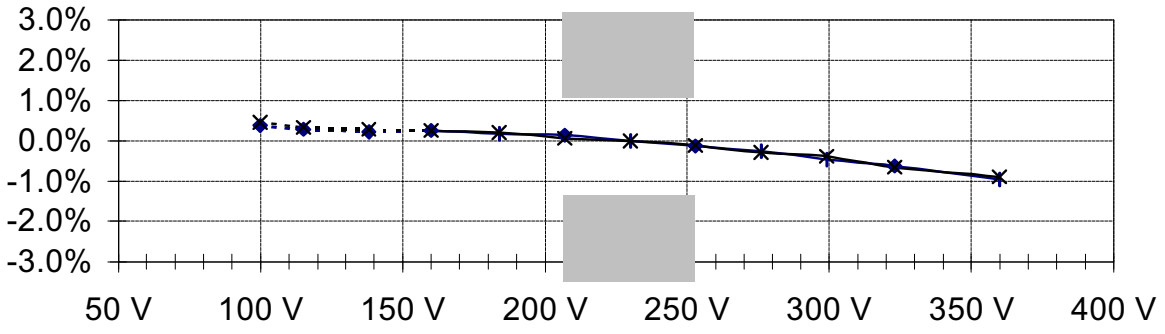


Influence of current variations @ Un=230v, f=50Hz, t=23deg

AMPS	0.05 A	0.1 A	0.25 A	0.5 A	1 A	2.5 A	5 A	10 A	20 A	40 A	60 A	80 A	100 A
Resist [1]	-5.80%	-2.13%	0.02%	-0.07%	-0.07%	-0.30%	-0.12%	-0.08%	-0.25%	-0.11%	0.12%	0.06%	-5.97%
Ind [.5]	15.5%	5.63%	-0.07%	-0.27%	-0.05%	-0.04%	-0.24%	-0.08%	-0.03%	-0.04%	-0.09%	0.45%	8.15%
Cap [.8]	-16.5%	-5.55%	-0.03%	-0.17%	-0.19%	-0.45%	-0.08%	-0.05%	-0.43%	-0.17%	0.11%	0.27%	-13.2%
% Ib	1%	2%	5%	10%	20%	50%	100%	200%	400%	800%	1200%	1600%	2000%

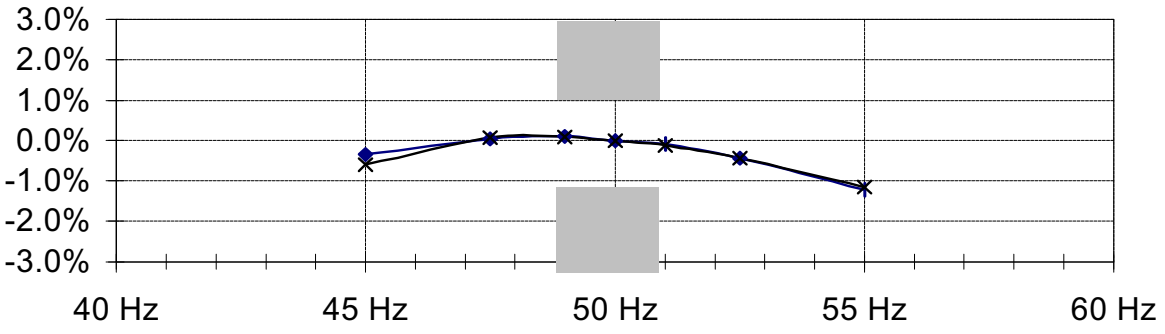
Current circuit burden: 0.19 VA — Over current withstand: 120A for 48 hours, 180A for 1minute, 5kA for 10mS



ADDITIONAL influence of voltage variations @ Ib=5A, f=50Hz, t=23deg

VOLTS	100 V	115 V	138 V	160 V	184 V	207 V	230 V	253 V	276 V	299 V	323 V	360 V	400 V
Resist [1]	0.39%	0.29%	0.22%	0.25%	0.17%	0.14%	0.00%	-0.12%	-0.26%	-0.46%	-0.63%	-0.95%	-2.57%
Ind [.5]	0.47%	0.34%	0.29%	0.25%	0.20%	0.06%	0.00%	-0.11%	-0.29%	-0.39%	-0.65%	-0.90%	-2.51%
%Un	43%	50%	60%	70%	80%	90%	100%	110%	120%	130%	140%	156%	175%

Voltage circuit burden: 0.24 W and 3.70 VA — Over voltage withstand: 600V for 48 hrs, 1kV for 1 min, 10kV for 1.2/50uS



ADDITIONAL influence of frequency variations @Un=230v, Ib=5A, t=23deg

HERTZ	40.0 Hz	42.5 Hz	45.0 Hz	47.5 Hz	49.0 Hz	50.0 Hz	51.0 Hz	52.5 Hz	55.0 Hz	57.5 Hz	60.0 Hz	62.5 Hz	65.0 Hz
Resist [1]	-4.14%	-0.96%	-0.35%	0.04%	0.10%	0.00%	-0.09%	-0.43%	-1.22%	-2.20%	-3.08%	-5.43%	-5.13%
Ind [.5]	-4.23%	-1.48%	-0.59%	0.07%	0.08%	0.00%	-0.12%	-0.44%	-1.15%	-1.99%	-3.27%	-4.01%	-4.34%
%freq	80%	85%	90%	95%	98%	100%	102%	105%	110%	115%	120%	125%	130%

Figure 1. Performance curves for 230V 50Hz configuration

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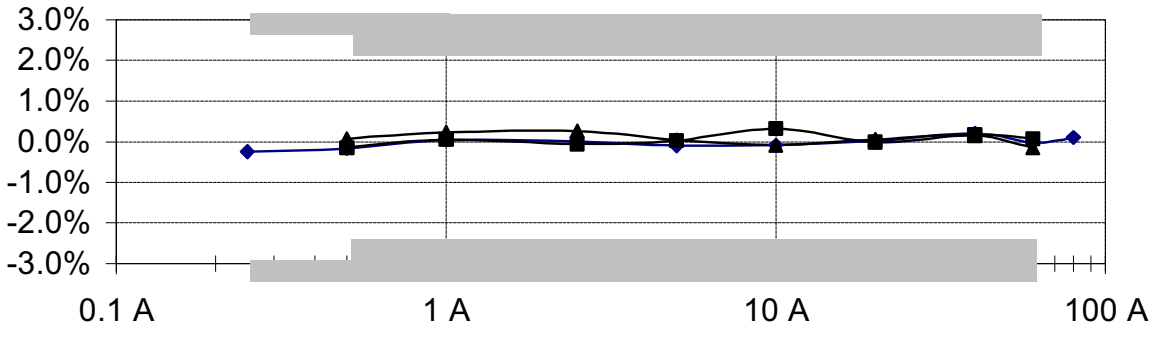
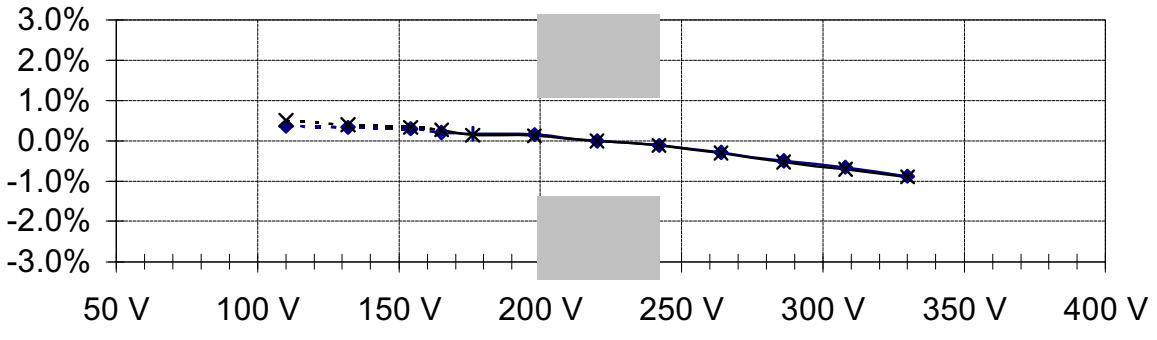


Influence of current variations @ Un=220v, f=60Hz, t=23deg

AMPS	0.05 A	0.1 A	0.25 A	0.5 A	1 A	2.5 A	5 A	10 A	20 A	40 A	60 A	80 A	100 A
Resist [1]	-5.42%	-1.89%	-0.25%	-0.16%	0.04%	0.01%	-0.11%	-0.09%	0.03%	0.19%	-0.02%	0.11%	-3.88%
Ind [.5]	11.6%	3.88%	-0.23%	-0.15%	0.05%	-0.06%	0.02%	0.33%	0.00%	0.16%	0.07%	0.77%	-1.42%
Cap [.8]	-13.3%	-4.20%	0.10%	0.07%	0.23%	0.26%	0.04%	-0.09%	0.06%	0.15%	-0.15%	0.44%	-5.04%
% Ib	1%	2%	5%	10%	20%	50%	100%	200%	400%	800%	1200%	1600%	2000%

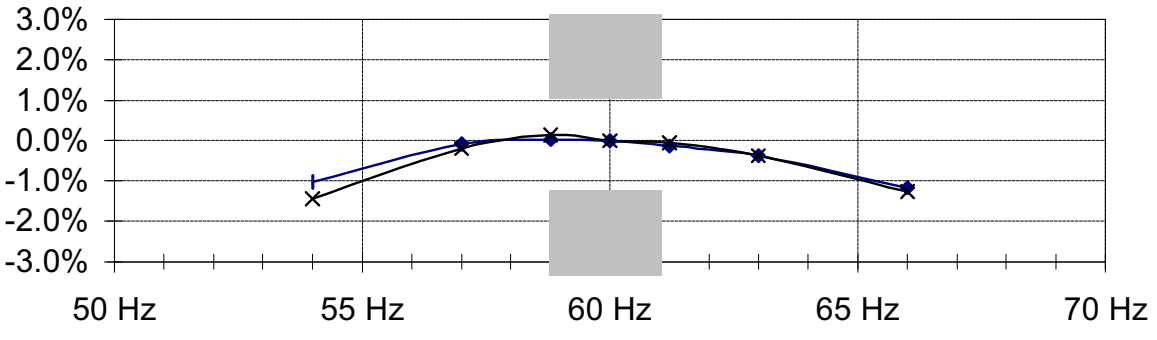
Current circuit burden: 0.19 VA — Over current withstand: 120A for 48 hours, 180A for 1minute, 5kA for 10mS



ADDITIONAL influence of voltage variations @ Ib=5A, f=60Hz, t=23deg

VOLTS	110 V	132 V	154 V	165 V	176 V	198 V	220 V	242 V	264 V	286 V	308 V	330 V	360 V
Resist [1]	0.37%	0.33%	0.30%	0.21%	0.17%	0.16%	0.00%	-0.11%	-0.28%	-0.49%	-0.65%	-0.87%	-1.20%
Ind [.5]	0.51%	0.40%	0.33%	0.27%	0.15%	0.12%	0.00%	-0.11%	-0.30%	-0.53%	-0.70%	-0.89%	-1.21%
%Un	50%	60%	70%	75%	80%	90%	100%	110%	120%	130%	140%	150%	164%

Voltage circuit burden: 0.24 W and 3.70 VA — Over voltage withstand: 600V for 48 hrs, 1kV for 1 min, 10kV for 1.2/50uS



ADDITIONAL influence of frequency variations @Un=220v, Ib=5A, t=23deg

HERTZ	45.0 Hz	48.0 Hz	51.0 Hz	54.0 Hz	57.0 Hz	58.8 Hz	60.0 Hz	61.2 Hz	63.0 Hz	66.0 Hz	69.0 Hz	72.0 Hz	75.0 Hz
Resist [1]	-8.86%	-5.58%	-2.18%	-1.02%	-0.08%	0.03%	0.00%	-0.14%	-0.37%	-1.17%	-2.35%	-3.23%	-5.54%
Ind [.5]	-10.5%	-6.13%	-2.65%	-1.44%	-0.20%	0.13%	0.00%	-0.05%	-0.38%	-1.27%	-2.44%	-3.72%	-4.46%
%freq	75%	80%	85%	90%	95%	98%	100%	102%	105%	110%	115%	120%	125%

Figure 2. Performance curves for 220V 60Hz configuration

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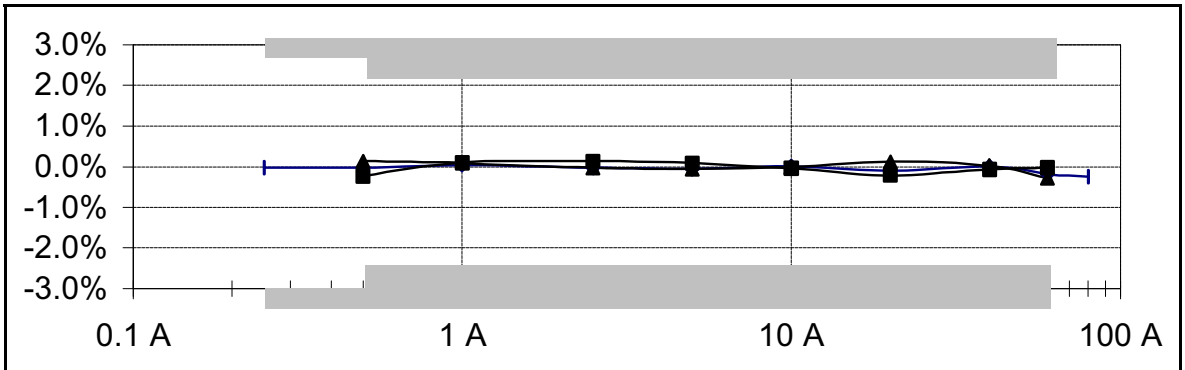
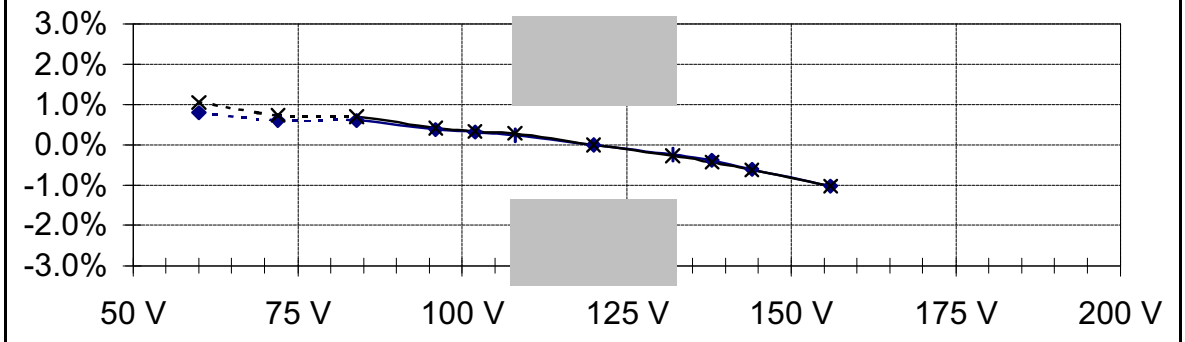


Influence of current variations @ Un=120v, f=60Hz, t=23deg

AMPS	0.05 A	0.1 A	0.25 A	0.5 A	1 A	2.5 A	5 A	10 A	20 A	40 A	60 A	80 A	100 A
Resist [1]	-2.37%	-0.75%	-0.02%	-0.03%	0.04%	-0.02%	-0.05%	0.01%	-0.10%	0.01%	-0.18%	-0.24%	-4.03%
Ind [.5]	9.60%	2.86%	-0.38%	-0.23%	0.10%	0.13%	0.09%	-0.04%	-0.22%	-0.07%	-0.02%	0.65%	-0.63%
Cap [.8]	-8.19%	-2.40%	0.21%	0.14%	0.08%	-0.02%	-0.06%	0.00%	0.12%	0.02%	-0.27%	-0.19%	-5.67%
% Ib	1%	2%	5%	10%	20%	50%	100%	200%	400%	800%	1200%	1600%	2000%

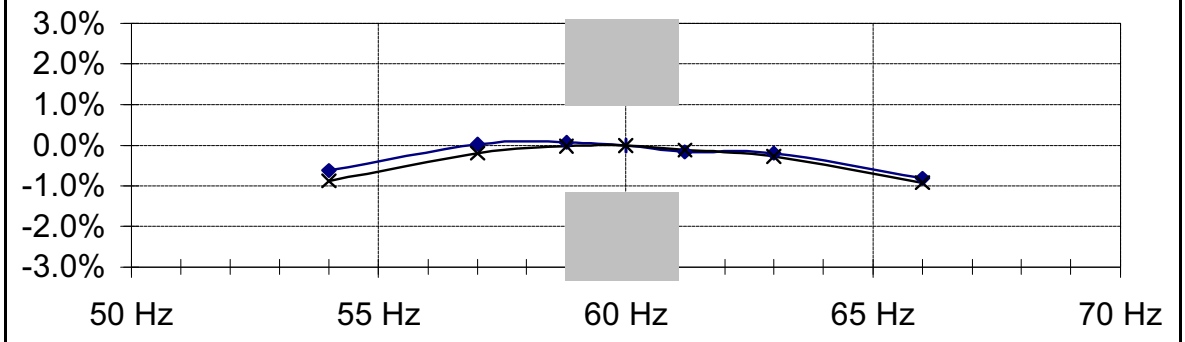
Current circuit burden: 0.05 VA — Over current withstand: 120A for 48 hours, 180A for 1minute, 5kA for 10mS



ADDITIONAL influence of voltage variations @ Ib=5A, f=60Hz, t=23deg

VOLTS	60 V	72 V	84 V	96 V	102 V	108 V	120 V	132 V	138 V	144 V	156 V	168 V	180 V
Resist [1]	0.79%	0.60%	0.60%	0.39%	0.32%	0.24%	0.00%	-0.24%	-0.39%	-0.60%	-1.02%	-1.58%	-2.29%
Ind [.5]	1.06%	0.74%	0.71%	0.41%	0.34%	0.28%	0.00%	-0.27%	-0.43%	-0.62%	-1.02%	-1.58%	-2.34%
%Un	50%	60%	70%	80%	85%	90%	100%	110%	115%	120%	130%	140%	150%

Voltage circuit burden: 0.22 W and 1.80 VA — Over voltage withstand: 400V for 48 hrs, 1kV for 1 min, 10kV for 1.2/50uS



ADDITIONAL influence of frequency variations @Un=120v, Ib=5A, t=23deg

HERTZ	45.0 Hz	48.0 Hz	51.0 Hz	54.0 Hz	57.0 Hz	58.8 Hz	60.0 Hz	61.2 Hz	63.0 Hz	66.0 Hz	69.0 Hz	72.0 Hz	75.0 Hz
Resist [1]	-8.31%	-3.20%	-2.15%	-0.62%	0.02%	0.07%	0.00%	-0.16%	-0.19%	-0.82%	-1.98%	-2.85%	-5.32%
Ind [.5]	-13.2%	-7.70%	-2.95%	-0.88%	-0.19%	-0.02%	0.00%	-0.12%	-0.27%	-0.93%	-2.45%	-3.68%	-4.98%
%freq	75%	80%	85%	90%	95%	98%	100%	102%	105%	110%	115%	120%	125%

Figure 3. Performance curves for 120V 60Hz configuration

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