

WHAT IS HARMONICS ?

Just as high blood pressure can create stress and serious problems in the human body, high levels of harmonic distortion can create stress which could result in problems for the utility's distribution system, the plant's distribution system, as well as the equipment serviced by that distribution system. This could result in the plant engineer's worst fear - shut down of important plant equipment, a single machine to an entire line or process.

Pollution of Power Systems due to injection of Harmonics by a variety of non-linear loads in the modern power has been an insurmountable problem in most industries.

These disturbing loads form a considerable part of the present day loads and are expected to grow at a faster rate due to need of better energy management and rapid industrial growth.

THEORY OF HARMONICS

A Harmonic can be defined as 'A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency'. Harmonics can be thought of therefore as voltages and/or currents present on an electrical system at some multiple of the fundamental frequency - 50Hz. Integral multiple means multiplying the fundamental frequency by a whole number such as 2,3,4 etc. Typical harmonics for a 50Hz system are the 5th (250 Hz) the 7th (350 Hz) and the 11th (550 Hz). Modern electronic power generally uses current rectifier for control and regulation. But these power supplies present non-linear loads to the AC Power lines. Thereby, besides the increased reactive power, harmonic currents become particularly high and these currents in flowing through the power line impedance cause harmonic voltages to occur on the power line. Additionally, transformers that demand high magnetizing currents, electric arc furnaces, gas discharge lamps etc. in their own way have undesirable effects on the power lines.

IMPORTANCE OF MEASURING HARMONICS WAVE CURRENT AND VOLATGE

When mentioning of Harmonic waves, everybody pays attention to harmonics wave voltage. The reason is very simple, because the easiest way of observing power quality is to observe it with an oscillator. The waveform observed with an oscillator is for voltage but very few people can see the current waveform. Thus, many assume that harmonic wave voltage is the trouble-maker causing a lot of problems. Therefore, it is imperative to know how much Harmonic wave is contained in the waveform of current or % value within the power system. Measuring current, however, is not easy because of the detection elements required in the circuit.

SOURCES OR CAUSES OF HARMONICS

- Electronic power converters, adjustable speed drives and thyristorised power supplies are by far the largest contributors to harmonic distortion in today's plant environment. An electronic power converter changes electrical energy from one form to another, typically by chopping up the power waveform and reassembling it in its own unique manner. This change is accomplished by using solid-state devices.
- Rapid use of energy conservation devices in both domestic sectors and industrial sectors such as electronics chokes for tube lights; electronics energy controllers for the motors and electronic fan regulators etc. also inject harmonics substantially.
- Large use of the shunt capacitors to improve power factor and stability has significant influence on harmonic level. Related to the supply system, converters and traction are the major causes of generation of harmonics.
- Use of solid state power converters for industrial furnaces for mini steel and non-ferrous metal plants, use of thyristors for locomotives, extensive use of single phase electronic loads in domestic sectors are causes of harmonic generation.

ADVERSE EFFECTS OF HARMONICS

Contamination of the power lines with harmonics result in unfavourable reactions at other consumers and installations e.g. reading errors in electronic instruments, false instruction to unmanned remote operated equipments, excessive line loss, thermal loading of motors, possible destruction of phase shift capacitors and transformers, malfunction of computers and other sensitive equipments. Other effects include:

- Poor efficiency & capacity utilization of transformers, generators, etc.
- High skin effect loss
- High I²R loss
- High failure rate in Motors, sophisticated electronics equipments like Computers, PLCs, Remote Monitoring Systems, Air-conditioning Systems, etc.

PLANNING & DESIGNING FOR HARMONIC SUPPRESSION

- Analyzing the spectra and knowing the size of systems planned, different solutions can be deduced and incorporated in the design that will lessen the disturbances or possibly eliminate them entirely.
- In providing a solution to power quality problems, cost plays a major role. It is thus necessary to find a cost effective solution to resolve Power Quality issues to minimise equipment downtime and loss of production by using handy and easy to use instruments for monitoring, measuring and recording all necessary values like TRUE-RMS Voltage, Current, Frequency, Apparent & Reactive Power, Energy, Power Factor, Phase Angle and above all Harmonic Analysis with Transients events.



Power & Harmonics Analyzer



Software

Preliminary Data



Are your equipment & electrical systems getting affected due to Harmonics ?

Does energy conservation in your electrical installation generate Harmonics ?

Are you ready to pay penalties for generating Harmonics ?

Are your neighbors generating Harmonics which are affecting your systems ?

MECO has an easy and affordable solution to locate, measure & record presence of Harmonics.

MECO Power and Harmonics Analyser Model PHA-5850 can Analyze, Measure, Monitor & Data Log values of power quality & consumption (energy). It comes with a user friendly application software that increases the utility & performance of this instrument. The analyzer is ideal for an any Engineer / Inspector for carrying out Periodic Visits, Vigilance checks, Surveys and Energy Audits for checking at Industrial and Consumers end.

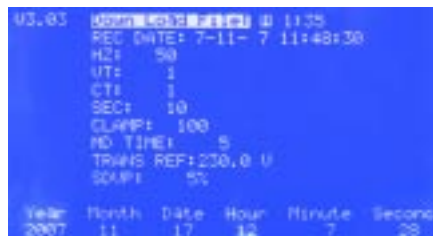
Features:

- Analysis of 3P4W, 3P3W, 1P2W, 1P3W Systems
- Programmable CT (1 to 600) and PT (1 to 3000) Ratios
- Capture 28 Transient Events With Programmable Threshold (%) DIP, SWELL & OUTAGE
- Calculated Voltage & Current of Neutral with respect to ground
- True RMS value, Active Power, Apparent & Reactive Power (KVA, KVAR)
- Power Factor, Phase Angle (Φ) & Energy (WH, KWH, KVARH, PF)
- Built in timer & Calander for Data Logging
- Facility to retrieve Power Data & Harmonics on Meter Screen
- 512K Memory with Programmable Interval (2 to 3000 seconds, 17000 records for 3P4W System)
- Optical Isolated RS-232C~USB Interface
- Software for easy download of Recorded Data & Transient events



Display Screens

Setup Page



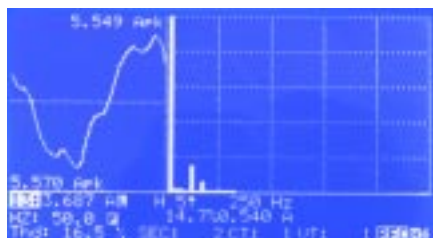
Graphic Phasor Diagram with 3 ϕ System



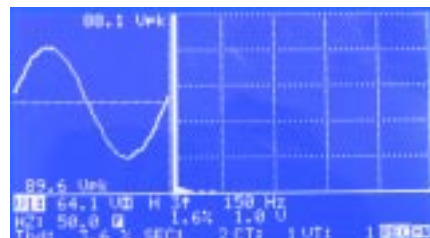
Display of 35 Parameters in One Screen



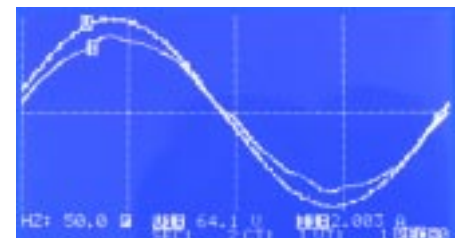
50th Harmonics of Voltage & Current



Waveform with Peak Values



Waveform of Voltage & Current





Power & Harmonics Analyzer

AC Watt For **5850A** : (50 or 60 Hz, PF 0.5 to 1, CT = 1, Voltage > 20VAC, A > 40mA (1A range), A > 0.4A (10A range), A > 4A (100A range) and continuous waveform. For **5850B** : (50 or 60 Hz, PF 0.5 to 1, CT = 1, Voltage > 20VAC, A > 4A (100A range), A > 40A (1000A range) and continuous waveform.

Model PHA-5850A (100A) / PHA-5850B (1000A)

Range 5850A (100A)	Range 5850B (1000A)	Resolution	Accuracy of Readings
5.0 – 999.9 W	5.0 – 999.9 W	0.1W	±1% ± 0.8W
1.000 – 9.999 KW	1.000 – 9.999 KW	0.001 KW	±1% ± 8W
10.00 – 99.99 KW	10.00 – 99.99 KW	0.01 KW	±1% ± 80W
100.0 – 999.9 KW	100.0 – 999.9 KW	0.1 KW	±1% ± 0.8KW
1000 – 9999 KW	1000 – 9999 KW	1 KW	±1% ± 8KW

AC Watt For **5850C** : (50 or 60 Hz, PF 0.5 to 1 CT = 1, Voltage > 5VAC, A > 5AAC for A range, and continuous waveform. Conductor is located at the center of flexible loop. Position sensitivity is 2% of range. External field effect of < 40A/m & 200mm from the coupling is 1% of range. Temperature coefficient is 0.02% of reading / °C)

Model PHA-5850C (3000A)

Range (0 to 3000A)	Resolution	Accuracy of Readings	
		> 20V and > 30A	< 20V or < 30A
10.0 – 999.9 W	0.1W	± 1% of range	± 2% of range
1.000 – 9.999 KW	0.001 KW	± 1% of range	± 2% of range
10.00 – 99.99 KW	0.01 KW	± 1% of range	± 2% of range
100.0 – 999.9 KW	0.1 KW	± 1% of range	± 2% of range
1000 – 9999 KW	1 KW	± 1% of range	± 2% of range

AC Current (50 or 60 Hz, Auto Range, True RMS, Crest Factor < 4, CT=1)

Range 5850A (100A) Overload Protection AC 200A	Range 5850B (1000A) Overload Protection AC 2000A	Range 5850C (3000A) Overload Protection AC 3000A	Resolution	Accuracy of Readings
0.04 – 1A	-	-	0.001A	±0.5% ± 0.05A
0.4 – 10A	-	-	0.01A	±0.5% ± 0.05A
4 – 100 A	-	-	0.1 A	±1.0% ± 0.5A
-	10.00 A	-	0.001A/0.01A	-
-	4A – 100.0A	-	0.01A/0.1A	±0.5% ± 0.5A
-	40 – 1000.0 A	-	0.1A/1A	±0.5% ± 5A
-	-	0– 300.0 A	0.1 A	±1% of range
-	-	300.0 – 3000 A	0.1 A/1A	±1% of range

AC Voltage (50 or 60 Hz, Auto Range, True RMS, Crest Factor < 4, Input Impedance 10 MΩ, VT (PT) = 1, Overload Protection 800VAC)

Range	Resolution	Accuracy of Readings
20.0 V – 500.0 V (Phase to Neutral)	0.1 V	±0.5% ± 5dgts
20.0 V – 600.0 V (Phase to Phase)		±0.5% ± 5dgts

Harmonics of AC Voltage in Percentage (1 to 99th order, minimum voltage at the 50 or 60 Hz > 80VAC. If the voltage is 0 at 50 or 60 Hz, all the percentage (%) display is 0)

Range	Resolution	Accuracy
1 – 20 th	0.1%	±2%
21 – 49 th		±4% of rdg ±2.0%
50 – 99 th		±6% of rdg ±2.0%

Harmonics of AC Voltage in Magnitude (1 to 99th order, minimum voltage at the 50 or 60 Hz > 80VAC, VT=1)

Range	Resolution	Accuracy
1 – 20 th	0.1V	±2% ± 0.5V
21 – 49 th		±4% of rdg ±0.5V
50 – 99 th		±6% of rdg ±0.5V



Power & Harmonics Analyzer

Harmonics of AC Current in Percentage (1 to 99th order, Minimum current at the 50Hz or 60Hz Model 5850A > 10% of the range, Model 5850B > 20A and Model 5850C > 30A. If the current is 0 at 50 or 60 Hz, all the percentage (%) display is 0)

Range 5850A (100A)	Range 5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
1 – 10 th	-	-	0.1%	±0.2% of rdg ± 1%
11 – 20 th	-	-		± 2% of rdg ± 1%
21 – 50 th (A range)	-	-		± 5% of rdg ± 1%
21 – 50 th (mA range)	-	-		± 10% of rdg ± 1%
51 – 99 th	-	-		± 35% of rdg ± 1%
-	1 – 20 th	-		± 2%
-	21 – 49 th	-		± 4% of rdg ± 2.0%
-	50 – 99 th	-		± 6% of rdg ± 2.0%
-	-	1 – 20 th		± 2%
-	-	21 – 50 th		± 6%
-	-	51 – 99 th	± 10%	

Harmonics of AC Current in Magnitude (1 to 99th order, Minimum current at the 50Hz or 60Hz Model 5850A > 10% of the range, Model 5850B > 20A, CT = 1)

Range 5850A (100A)	Range 5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
1 – 10 th	-	-	0.1mA / 0.1A	±0.2% of rdg ± 7dpts
11 – 20 th	-	-		± 2% of rdg ± 7dpts
21 – 50 th (A range)	-	-		± 5% of rdg ± 7dpts
21 – 50 th (mA range)	-	-		± 10% of rdg ± 7dpts
51 – 99 th	-	-		± 35% of rdg ± 7dpts
-	1 – 20 th	-	0.1A	± 2% of rdg ± 0.4A
-	21 – 49 th	-		± 4% of rdg ± 0.4A
-	50 – 99 th	-		± 6% of rdg ± 0.4A
-	-	1 – 20 th (< 300A)	0.1%	± 2% of rdg ± 4A
-	-	21 – 50 th (< 300A)		± 4% of rdg ± 4A
-	-	51 – 99 th (< 300A)		± 6% of rdg ± 4A
-	-	1–20 th (300 - 3000A)		± 2% of rdg ± 40A
-	-	21 – 50 th (300 - 3000A)		± 4% of rdg ± 40A
-	-	51 – 99 th (300 - 3000A)	± 6% of rdg ± 40A	

Power Factor (PF)

Range 5850A (100A)	Range 5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
0.00 – 1.00	-	-	0.01	± 0.04
-	0.00 – 1.00	-	0.01	± 0.04
-	-	0.000 – 1.000	0.001	> 20V & > 30A ± 0.04 < 20V & < 30A ± 0.1

Phase Angle (Φ)

Range 5850A (100A)	Range 5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
-180° to 180°	-180° to 180°	-	0.1°	± 1°
-	-	-180° to 180°		± 2° (V > 20V, A > 30A)
-	-	0° to 360°		

Peak Value of AC Voltage (peak value > 20V) or AC Current (peak value : Model 5850A > 10% of the range, Model 5850B > 20A and Model 5850C > 30A), VT = 1

Range	Sampling Time	Accuracy of Reading
50 Hz	19 μs	± 5% ± 30 digits
60 Hz	16 μs	± 5% ± 30 digits

Crest Factor (C.F.) of ACV (peak value > 20V) or AC A (peak value: Model 5850A > 10% of the range, Model 5850B > 20A and Model 5850C > 30A) VT = 1

Range	Resolution	Accuracy of Readings
1.00 – 99.99	0.01	± 5% ± 30 digits

Frequency in AUTO Mode (ACV RMS value > 10V or AC A RMS value > 30A)

Range 5850A (100A)	Range5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
45 – 65 Hz	-	-	0.1Hz	± 0.1Hz
-	45 – 65 Hz	-		± 0.1Hz
-	-	45 – 65 Hz		± 0.2Hz

Total Harmonic Distortion (THD-F with respect to the fundamental frequency, min. value at the 50 or 60 Hz is voltage > 80VAC and Current in Model PHA-5850A > 10% of the Range, Model PHA-5850B > 20A and Model PHA-5850C > 30A. Calculation is done over 1 to 50th Harmonics. If the voltage or current is 0 at 50 or 60 Hz, all the percentage (%) display is 0)

Range 5850A (100A)	Range5850B (1000A)	Range 5850C (3000A)	Resolution	Accuracy
0.0 – 20.0 %	---	---	0.1%	± 1%
20.0 – 100%	---	---		± 3% of rdg ± 5%
100 – 999.9%	---	---		± 10% of rdg ± 10%
---	0.0 – 20.0 %	---		± 2%
---	20.0 – 100%	---		± 6% of rdg ± 1%
---	100 – 999.9%	---		± 10% of rdg ± 1%
---	---	0.0 – 20.0 %		± 2%
---	---	20.0 – 100%		± 6% of rdg ± 5%
---	---	100 – 999.9%		± 10% of rdg ± 10%

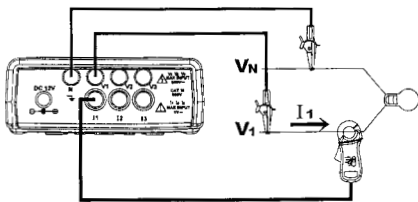
Key Description

	Exit Key		Harmonic in Magnitued Key		Setup Page		Recording On / Off
	Transient Detection Key		Select Voltage / Current Harmonics		Up Key		Phase Diagram / Angle
	Screen Hold & Read key		Select Voltage / Current Range		Down Key		Voltage / Current Waveform
	Power Page		Voltage Waveform		Left Key		Selection of System
	Backlight On / Off		Power On or Off		Right Key		

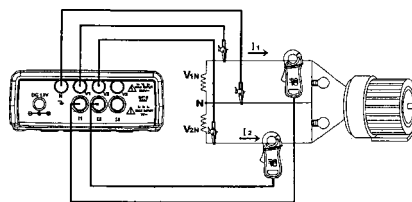
Panel Description

Applications

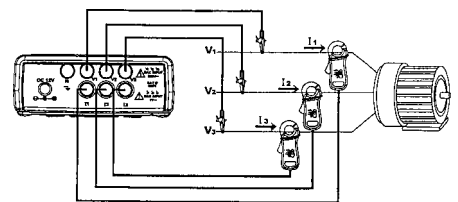
Single Phase (1P2W) System



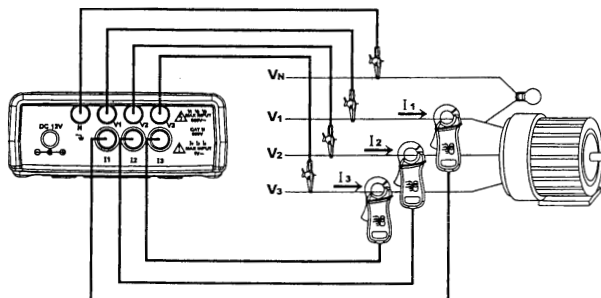
Single Phase Three Wire (1P3W) System



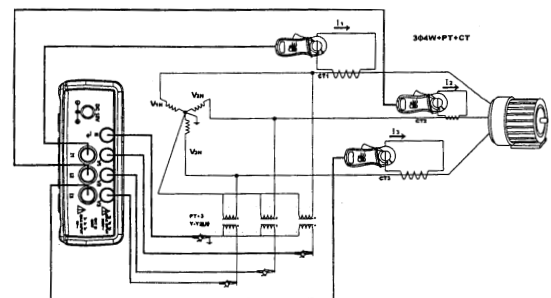
Three Phase Three Wire (3P3W) System



Three Phase Four Wire (3P4W) System



Measurement of System with CT or PT





Display of 35 Parameters on Meter Screen

V12: 234.7V	V1: 128.3V	I1: 21.55A
V23: 213.6V	V2: 131.4V	I2: 21.28A
V31: 204.0V	V3: 117.3V	I3: 19.96A
P1: 2.75KW	S1: 2.76KVA	Q1: 0.23KVAR
P2: 2.78KW	S2: 2.79KVA	Q2: 0.23KVAR
P3: 2.32KW	S3: 2.34KVA	Q3: 0.30KVAR
PΣ: 7.85KW	SΣ: 7.88KVA	QΣ: 0.76KVAR
PFΣ: 0.99	PF1: 0.99	PF2: 0.99
PFH: 0.99	1Φ: -1.4°	Φ2: -1.6°
Φ3: -0.9°		
Sh: 0.16KVAH	Wh: 0.15KWH	Qh: 0.01KVARH
Hz: 50.0	AD: 5.14KW	MD: W-15
34W:	SEC: 1	CT: 60
		PT: 1
		CT

Power Parameters on PC



- Model : PHA 5850A = PHA 5850 + CT set A
- Model : PHA 5850B = PHA 5850 + CT set B
- Model : PHA 5850C = PHA 5850 + CT set C

Power & Harmonics Analyzer

General Specification (Indoor Use)

Battery Type	1.5V SUM-3 x 8
External DC Input	Power supply adapter 12 Volts. DC
Display	Dot Matrix LCD (240x128) with backlight
LCD Update Rate	1 time / second
Power Consumption	140mA (approx.)
No. Of Samples	1024 samples / period
Data Logging Files	85
Max. File Capacity	17474 records (3P4W, 3P3W) 26210 records (1P3W) 52420 records (1P2W) 4096 records (50 Harmonics / record)
Sampling Time	2 to 3000 seconds for data logging
Low battery Indication	
Overload Indication	OL
Operating Temperature	-10°C to 50°C
Operating Humidity	less than 85% relative
Storage Temperature	-20°C to 60°C
Storage Humidity	less than 75% relative
Dimension	257(L) x 155(W) x 57(H) mm
Weight	1160g (Batteries included)

Accessories

- Voltage Test Leads x 3 meter long x 4
- Alligator Clips (Voltage) x 4 (R.Y.B.N.)
- Carrying Bag x 1
- Batteries 1.5V DC x 8
- External DC Adaptor x 1
- Software CD x 1
- Users Manual x 1
- Software Manual x 1
- RS232 ~ USB Cable x 1
- Current Clamps x 3 (Any One Range as per Model selected)



Model : CT set A
3 pcs (R,Y,B,) Clamp - On CTs
Range : 1 / 10 / 100A

OR

Model : CT set B
3 pcs (R,Y,B,) Clamp - On CTs
Range : 10 / 100 / 1000A

OR

Model : CT set C
3 pcs Flexible CTs Range : 300 / 3000A