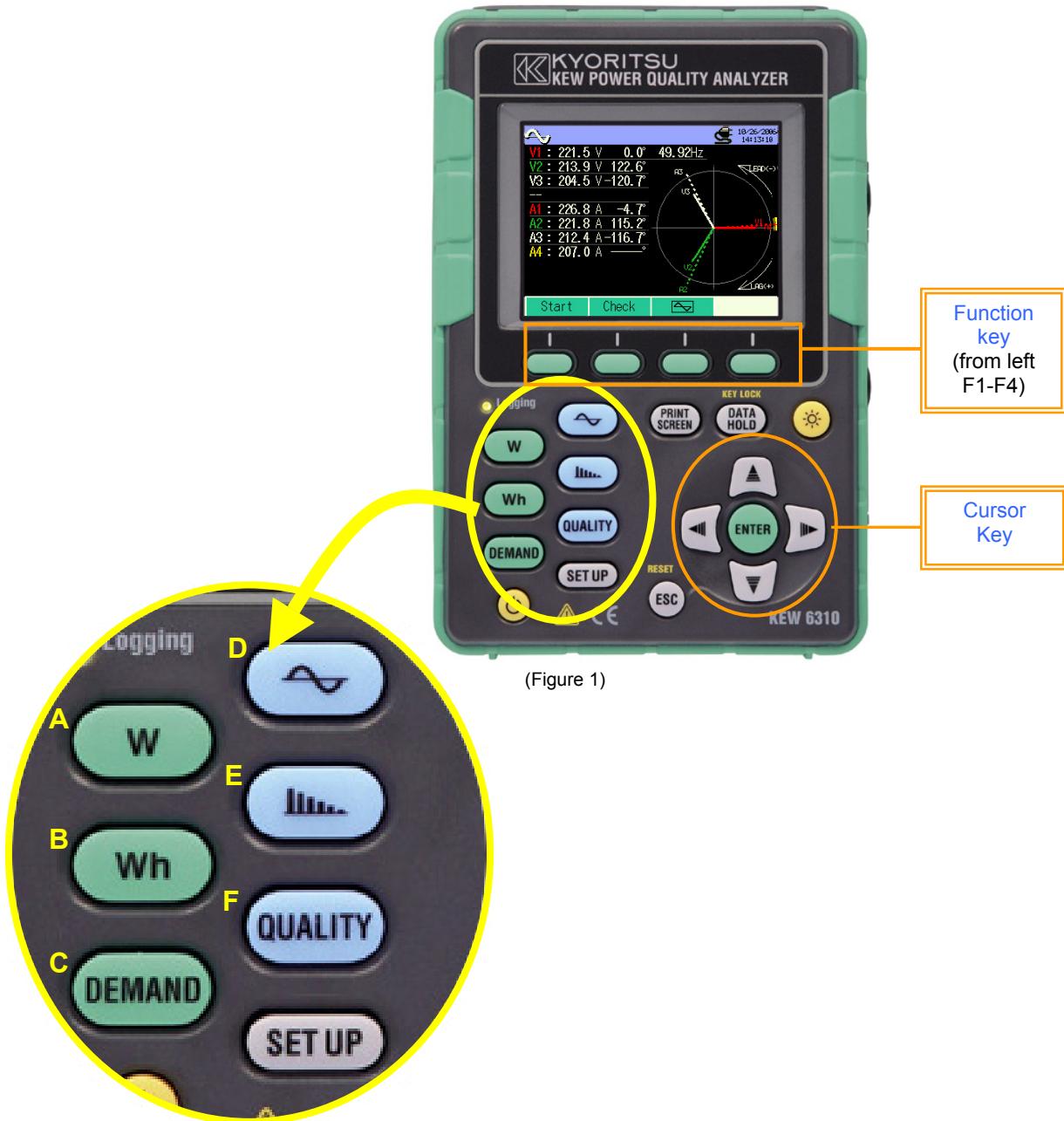


# KEW 6310 Modes

Power Quality Analyzer 6310 can monitor (1) Power Consumption (Energy) and (2) Power Quality. The monitoring of power consumption (energy) is similar to that of the KEW6300 and this can be operated by the green keys A/B/C in figure 1. Moreover the 6310 has power quality monitoring modes and these can be operated by the blue keys D/E/F in figure 1.



Each key/mode will be described in further detail;

**A W** Mode--Measures and saves all basic electrical instantaneous parameters.

<Display Screen> Renewal every 1 sec.

The upper row shows each channel's

V : Voltage  
A : Current  
P : Active power  
Q : Reactive power  
S : Apparent power  
PF : Power factor  
PA : Phase angle

The lower row shows total value of the 3 channels.

P : Active power  
Q : Reactive power  
S : Apparent power  
PF : Power factor  
PA : Phase angle  
f : Frequency  
An : Current flowing on the neutral line

Present Date & Time

2007/06/07  
16:15:32

System Switching \*  
System Switching can be done by operating left/right cursor, as there are several systems.

\* Four systems possible in case of Single-phase 2-wire (1P2W)

Two systems connectable in case of Single-phase 3-wire (1P3W) and Three-phase 3-wire (3P3W).

LOAD

1

Inst  
Avg  
Max  
Min

Interval  
30min.  
00:17

Start Zoom

Indicates the interval for measuring data.

Press F1 (START) Key to start survey.

Measurement starts when START Key is pressed or by presetting the time/date of commencement of the survey. In the latter case, the screen switches to a waiting mode, then starts measuring on the preset time.

When pressing START Key once, the setup screen (Basic Setting, Each Measurement Setting and Save Setting) is displayed to confirm setup, after which measurement starts.

If START Key is pressed more than 2 sec, measurement starts immediately, skipping setup confirmation.

Zoom Display

Press F3 (Zoom Display) to Zoom on of specified 4 parameters. Zoomed parameters can be customized.

Switching Display Item

Display can be toggled into Instantaneous value, Average value, Max value and Mini value by operating cursor keys (up/down).

2007/06/25  
16:24:38

V1 INST 227. 9 V  
V2 INST 228. 4 V  
V3 INST 223. 9 V  
f INST 49. 98 Hz

Start List

**B Wh** mode--Measures same paramtrs as in W and also Integrates power values  
 (Power energy<kWhr>) Power energy = Total power energy for the elapsed time.

**<Display Screen>**

Indicates elapsed Time (Integrated Time) from start of measurement.

Indicates Active power energy Apparent power energy Reactive power energy

Press F1 (START) Key to start survey.  
 <Refer to W Range START>

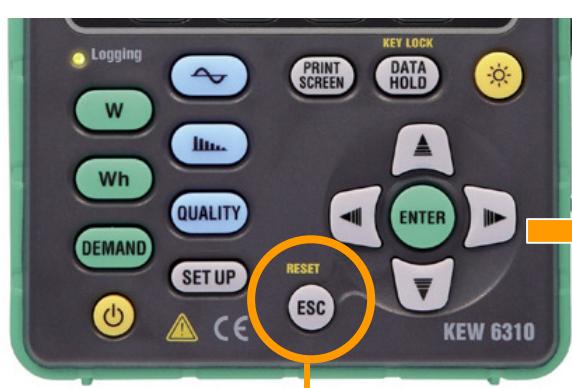
W Range Display  
 Can toggle to the W Mode Screen to confirm Instantaneous Value by pressing F2 Key.

Present Date and Time  
 System Switching  
 System toggling can be done by operating cursor left/right as there are several systems.

LOAD 1  
 $\Sigma$   
 1ch  
 2ch  
 3ch  
 Interval 30min.  
 Indicate the measurement interval

**<Caution>**  
 When Wh Key is pressed, the integration values displayed correspond to the values of the last survey. If START Key is pressed at this stage, power integration resumes from these values. Otherwise to reset the integration values to zero, **the ESC key must be pressed before the START Key is pressed.**

W	1ch	2ch	3ch	LOAD	2007/06/07 16:15:32
V : 229.4	220.0	227.4	V	1	
A : 455.3	445.5	427.9	A		
P : -51.19	3.98	-39.10	kW		
Q : 0.00	48.82	24.13	kvar		
S : 51.19	48.99	45.95	kVA		
PF: 1.000	0.081	0.851			
PA: -180.0	85.3	148.3	deg		
P : -86.31 kW	f : 49.92 Hz				
Q : 72.96 kvar	An: 1326.2 A				
S : 146.13 kVA	A: 412.8 A				
PF: 0.591	DC1: 3.957 V				Interval
PA: 126.2 deg	DC2: 3.695 V				30min.
					00:17
	Stop	W h	Zoom		



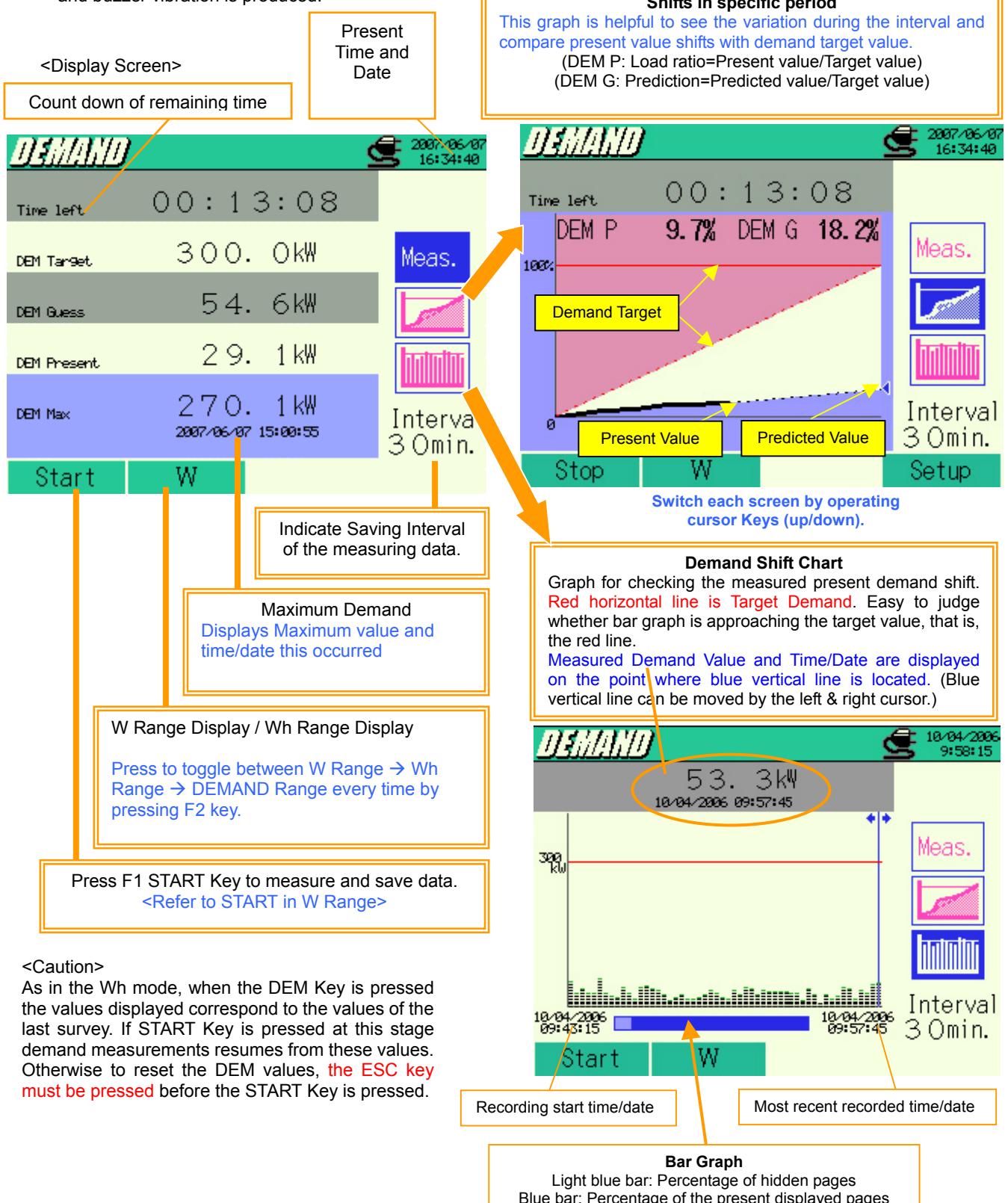
ESC(Escape) Key & RESET(Reset) Key

W	Elapsed Time	00000:00:00	LOAD	1	2007/06/07 16:32:04
Active	Wp+ : 0.00000 Wh				
	Wp- : 0.00000 Wh				
Apparent	Ws+ : 0.00000 VAh				
	Ws- : 0.00000 VAh				
Reactive	WQi+ : 0.00000 varh				
	WQc+ : 0.00000 varh				
	Start	W	Interval	30min.	

### C DEMAND Mode--DEMAND Target (Energy consumed during time interval.)

First the Demand target value (which must not be exceeded) is set.

The screen displays the Target value, Present value and Predicted (Guess) value. The Guess value is the projected value at the end of the interval, calculated by extrapolating the rate of increase of Present value. If the Predicted (Guess) demand value is greater than the Target value, then a warning Digital output signal and buzzer vibration is produced.

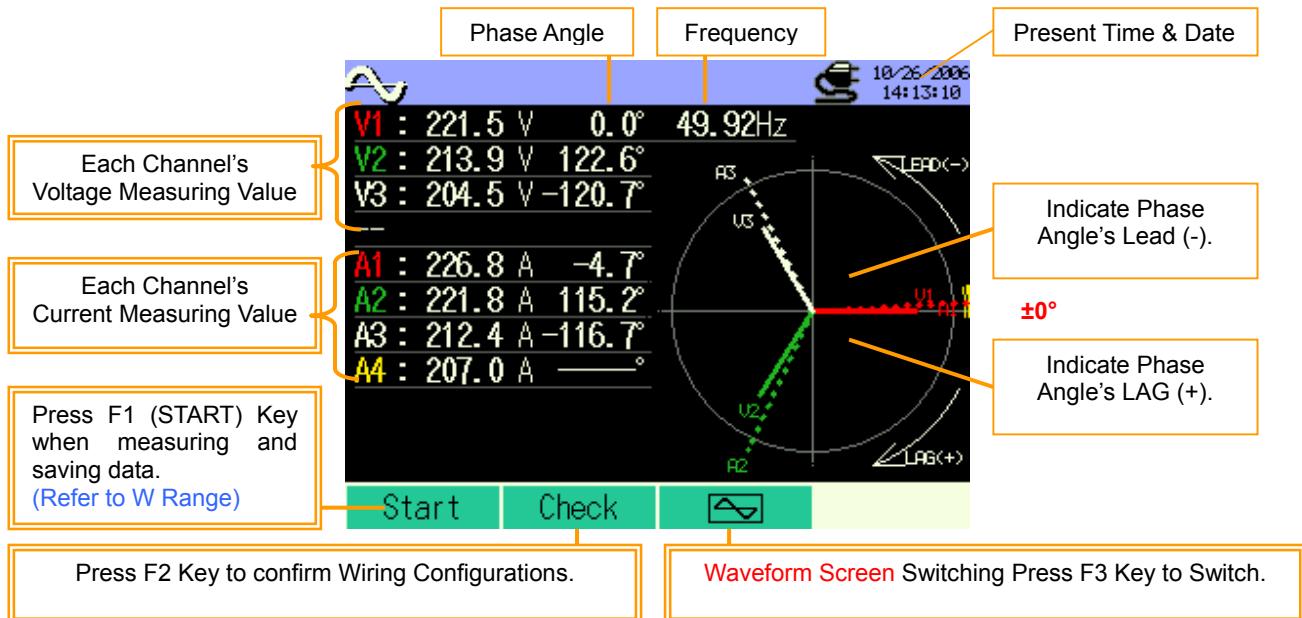


#### <Caution>

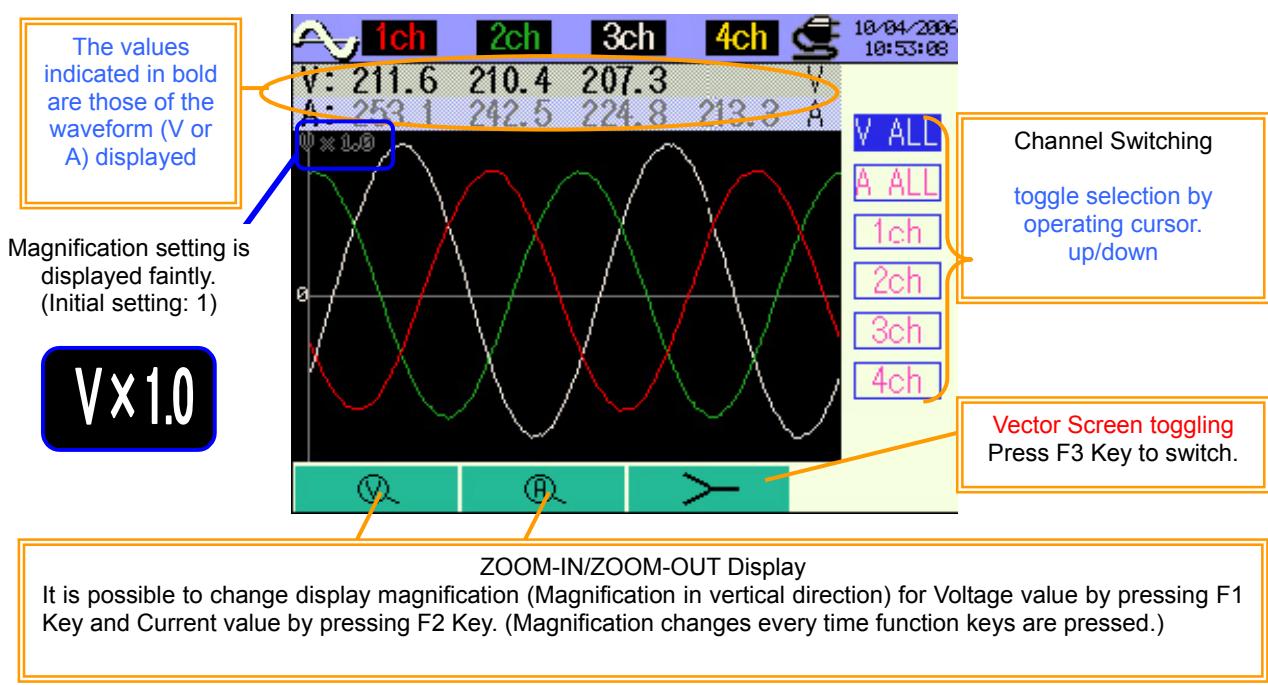
As in the Wh mode, when the DEM Key is pressed the values displayed correspond to the values of the last survey. If START Key is pressed at this stage demand measurements resumes from these values. Otherwise to reset the DEM values, the **ESC key must be pressed** before the START Key is pressed.

**D**  Waveform Mode—It is possible to display the Instantaneous values of Voltage and Current in numerical form(as in W mode) together with Vector and Waveform charts. Vector Screen is the default screen when the WAVE mode Key is pressed.

**<Vector Screen>** Displays Voltage Vector in solid line and Current Vector in dotted line. The number of displayed vectors depends on the selected wiring configuration. In the case of a 3 Phase circuit, the angle between phase voltages should be 120 degrees. It is possible to view the phase angle between voltage and current.



**<Waveform Screen>** Displays voltage waveform in solid line and current waveform in dotted line. All the three voltage waveform can be displayed if the **V ALL** is selected. Likewise, the three current waveforms can be displayed if **A ALL** is selected. If 1ch is selected then the voltage/current waveforms of that channel are displayed.



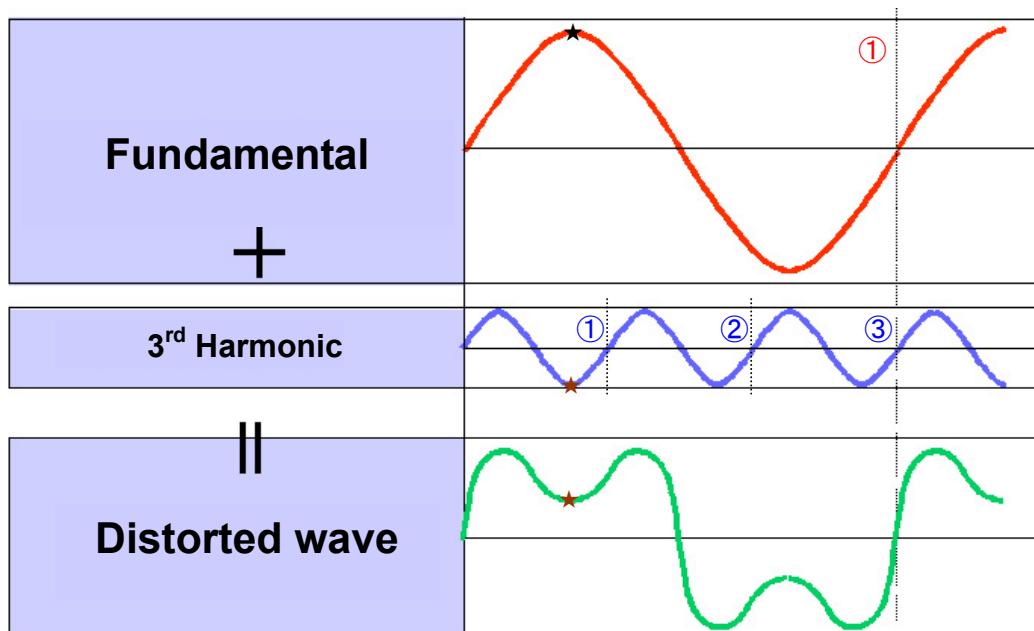
**E**  Harmonic Analysis Mode : The 6310 can analyse voltage and current harmonics on all voltage and current channels.

### What are Harmonics?

The electricity transmitted from the power company is an AC with a sinusoidal waveform of normally 50Hz or 60Hz. This frequency is called the fundamental frequency.

Non linear loads draw a current which is distorted. This results in the presence of multiple frequencies. Harmonic waveforms are AC waveforms having a frequency which is an integer multiple of the fundamental.

For example, the third harmonic means the fundamental waveform multiplied by 3 for 50Hz and the frequency would be 150Hz ( $= 50\text{Hz} \times 3$ ). This integer, in this case 3, is called the harmonic **order**.



(★)The distorted waveform is the sum of the fundamental and third harmonic

### Non linear Loads are the major source of harmonics

The advances in power electronics have increased the popularity of power electronic convertors. This is the most important type of non linear load in power systems. Convertors consist of

- Adjustable Speed Drives
- Switch mode power supplies (PC's, monitors, copiers)
- Battery chargers (UPS systems)
- High frequency, electronic ballasts (for fluorescent lighting)
- many other applications with rectifier/invertors (air conditioners with VRV)

A non linear load is effectively drawing current from the power source at the fundamental frequency, and generating current back at higher frequencies. This results in a distorted current waveform as shown above. Current harmonics disturb the supply voltage and this also results in a distorted voltage at the point of common coupling. Example: Consumer A and B are fed from the same line. The non linear loads of consumer A will distort the voltage of consumer B even if the latter has only linear loads.

### **Examples of Negative Effects of harmonics**

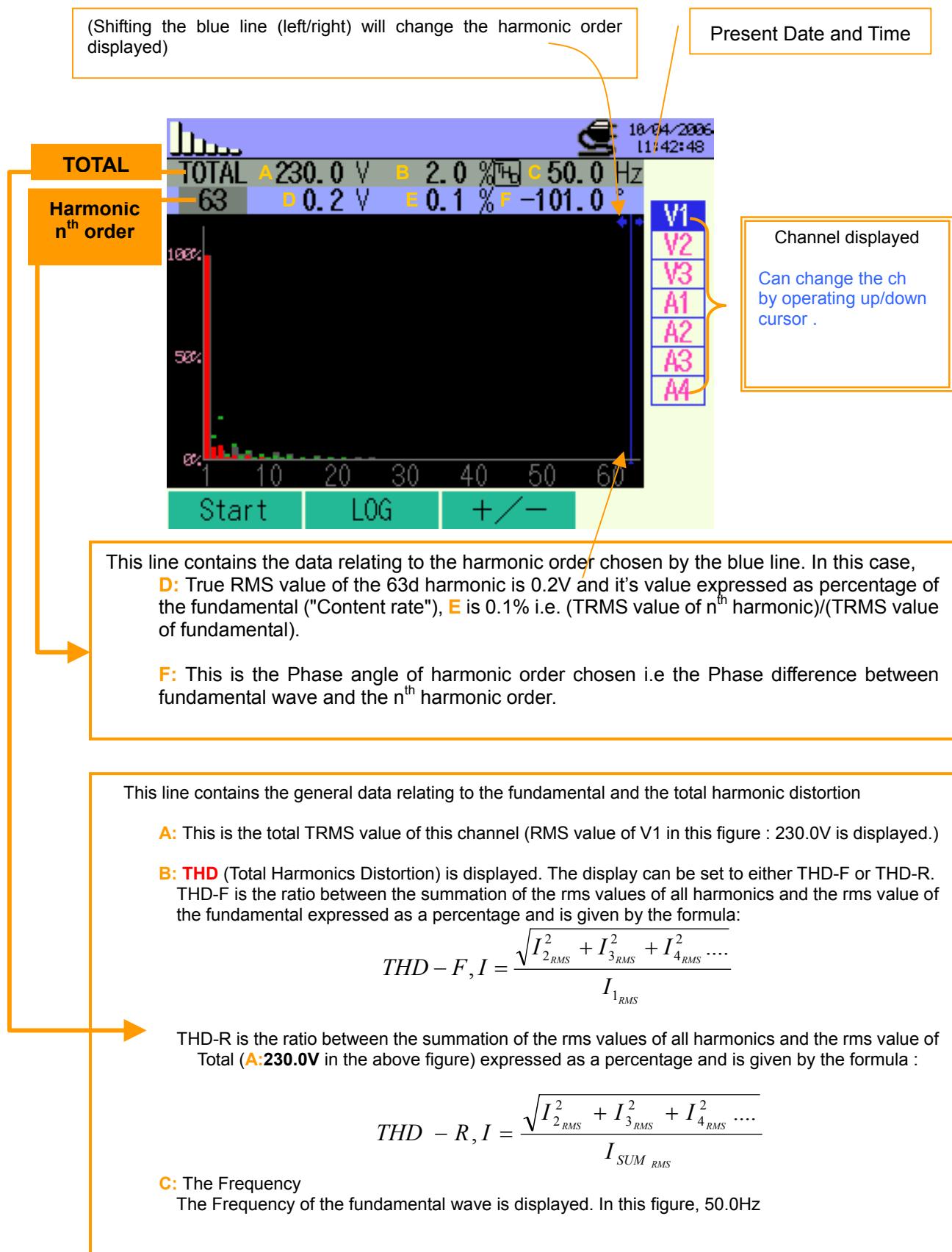
- Distorted voltage waveform affects appliances performance and ageing
- Overheating of transformer(additional copper losses due to increase in  $V_{rms}$  and  $I_{rms}$ )
- Also losses in the transmission system are increased for the same reason
- Circuit breakers can trip due to system resonance
- PLC's and control circuits malfunction due to distorted voltage, typically because of multiple zero crossing points
- Harmonic voltages cause harmonic fluxes, these have an affect on motors, namely additional heating, vibration and acoustic noise
- Failure of power factor correction banks due to resonant currents
- Overload of neutral conductor due to the summing up of harmonic currents of the 3<sup>rd</sup>, 9<sup>th</sup>, 15<sup>th</sup> order (triplet harmonics) which do not cancel out each other at the neutral point, even if the load on the 3 phases is balanced
- Harmonics produced by a consumer may “find” filters of other consumers, overload them and destroy them
- Interference with telecom equipment

Thus it is very important to know what harmonics are present in a system. This analysis can be easily done with the 6310.

In general, it is the odd numbered harmonic orders (3<sup>rd</sup>, 5<sup>th</sup> up to the 15<sup>th</sup>) that are under scrutiny as they are the cause for major concern. Nonetheless the distorted waveform is the result of the various harmonic orders.

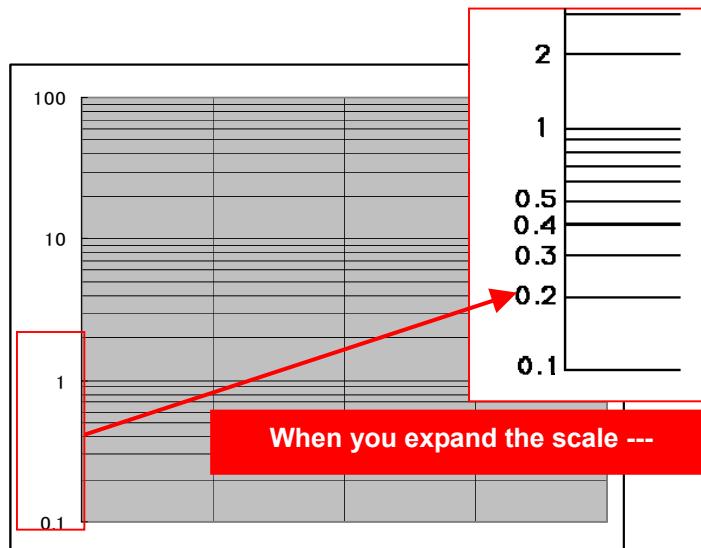
The frequency spectrum on the harmonic analysis screen mode can display up to the 63rd harmonic. The value of each harmonic order (% and TRMS voltage or current) can be checked at a glance as follows.

<Display> Pressing the  Key, will display the harmonics frequency spectrum.

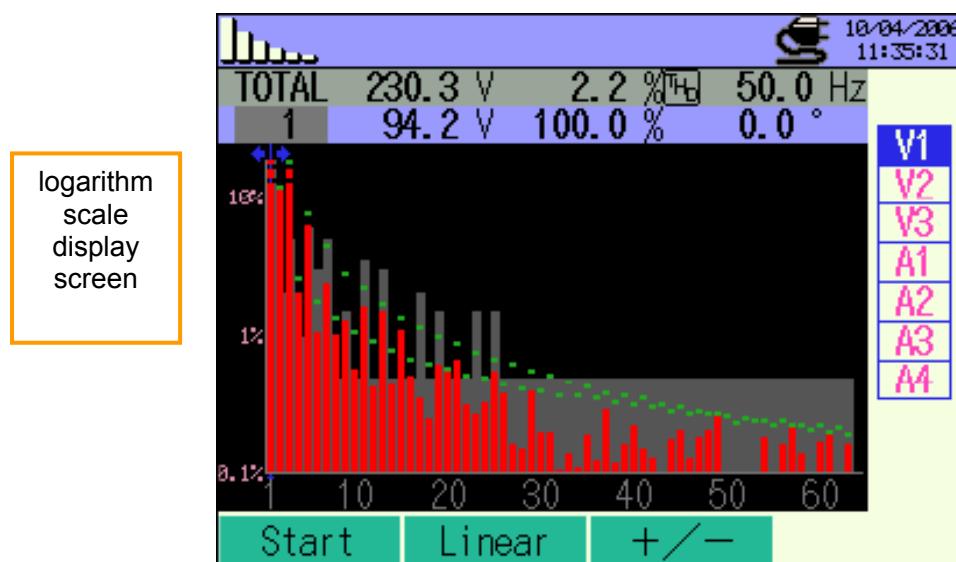


The harmonics frequency spectrum shown in the previous page has a linear scale. This is the **linear display** mode and is very convenient to read values of THD greater than 1% but not values less than 1 %. In the above example there was a 0.1% 63<sup>rd</sup> harmonic content. However this was not visible on the display as 0.1% would be too small to display on a full scale of 100%.

Since most harmonic content values are less than 1%, these can only be analysed using a logarithmic scale. This **logarithm display** is obtained by pressing the F2 key.

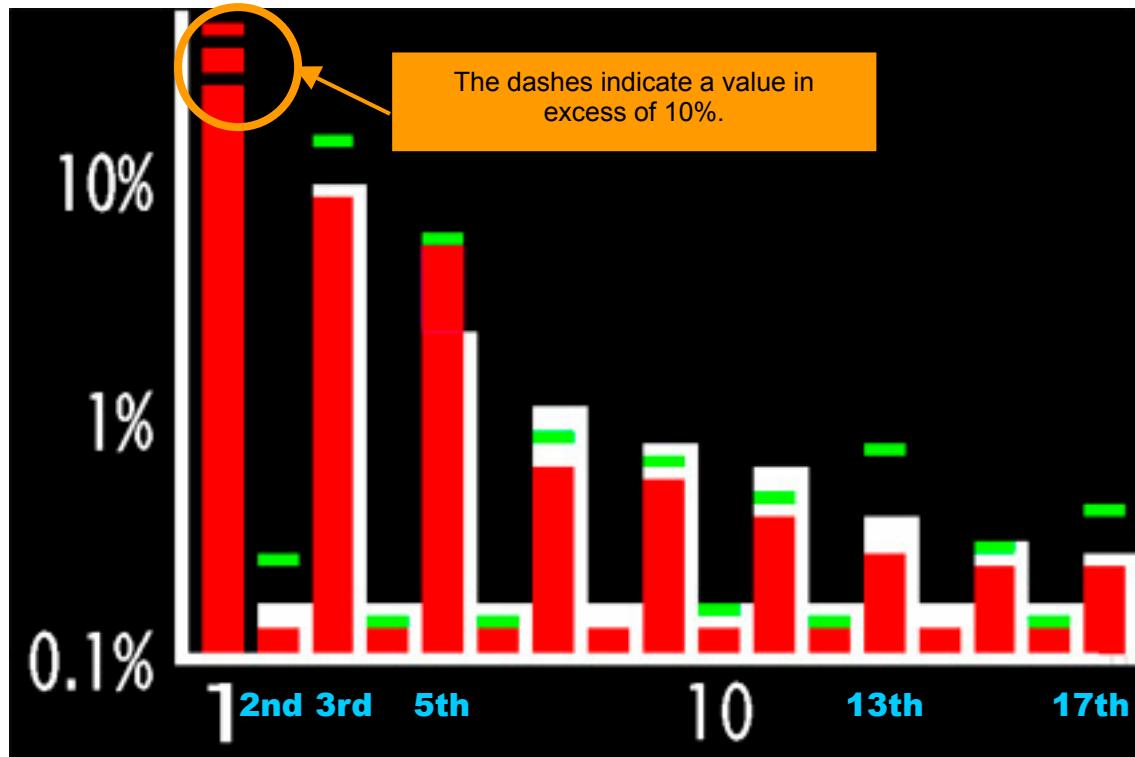


The below screen is the display of the logarithm of 6310.



From the above display it can easily be observed that there is a 63rd harmonic component (bar chart where the rightest edge is red) and that there is no 62nd harmonic component.

Interpreting the the harmonics frequency spectrum :



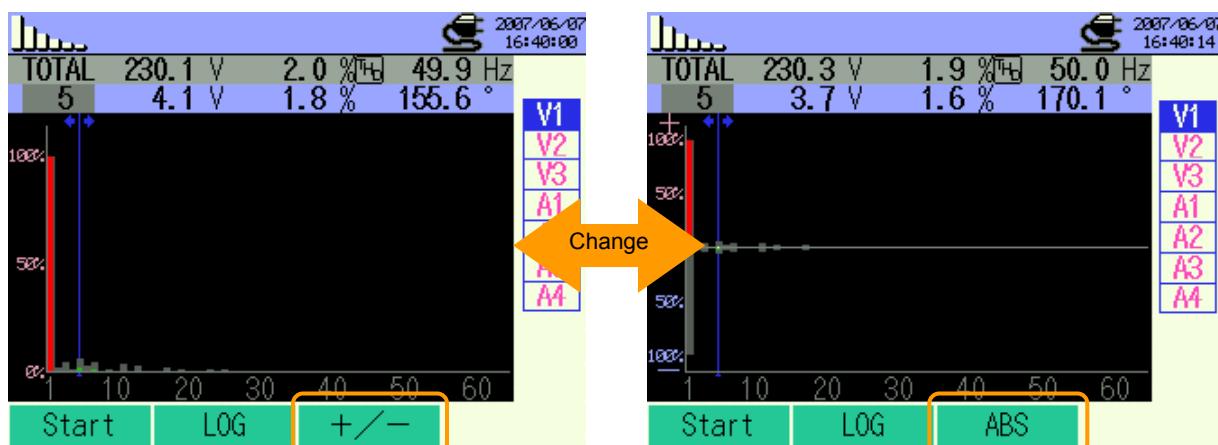
**Red bar graph:** The present value is displayed.

**White bar graph:** The extent of an allowed value \* is displayed.

**Green mark:** When the MAX holding is turned on during setting up, the maximum value reached since start of measurement is displayed.

\* An allowed value is a predetermined value (default values accoring to IEC50160, but these can be customised) which a harmonic order value should not exceed. In the example above, the current value of 5th harmonic exceeds the allowed value. Also the max values recorded for the 2<sup>nd</sup> and 3<sup>rd</sup> harmonic have exceeded the allowed value .

Pressing the F3 key will toggle the display between an absolute scale and the +/- scale.



There are two types of harmonics; one is absorbed from the power source and the other which is generated from the load side (i.e. the appliance connected to the power source). For instance, if the load is an air conditioner with a built-in inverter and with an energy saving feature, harmonics are generated by the air conditioner into the power source. Current normally flows from the power source to the load side, but in the case of harmonics, it is the current that flows from the load (air conditioner) into the power source. Thus the +/- value of a harmonic indicates whether a harmonic is generated by the power source (+) inflow) or generated by the load (-) outflow).

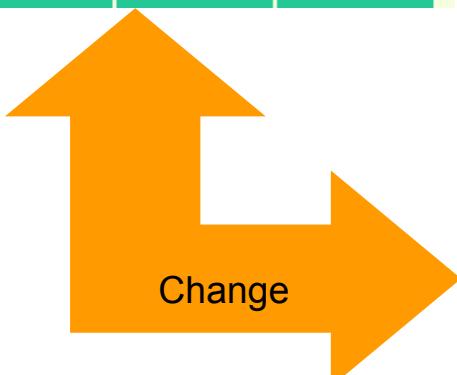
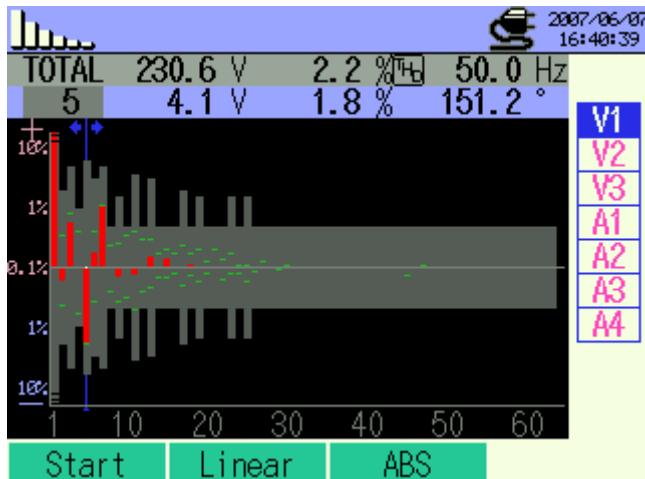
Harmonics behave in a complex manner and alternate continuously between +/-.

Example: An appliance built in inverter (load side) generates (outflow) a harmonic wave current into the power source. This in turn causes distortion in the distribution voltage (inflow), resulting in the negative effects explained before.

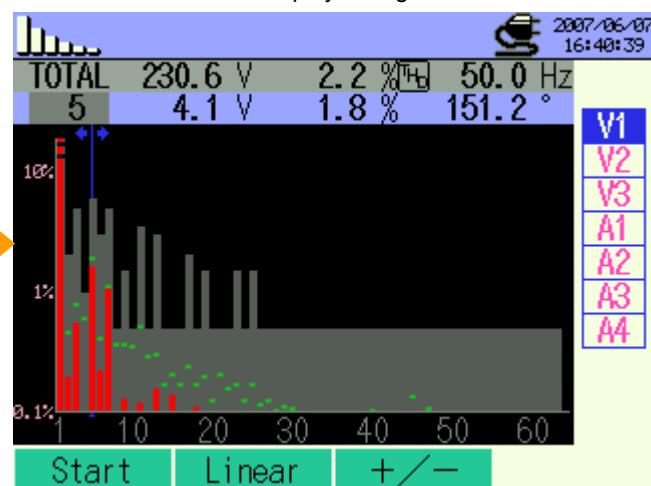
This +/- indication is very useful for users to know from which side the harmonics are generated, the power source (inflow) or the load (outflow).

Nonetheless, it is easier to compute harmonic analysis from the absolute graph.

<+/- Display in Logarithmic> Screen



<Absolute Value Display in Logarithmic> Screen



## F **QUALITY** -- "Power Quality" range

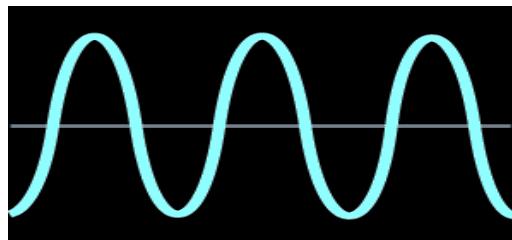
### What is "Power Quality"?

There are four factors that determine Power Quality in an AC circuit. These are

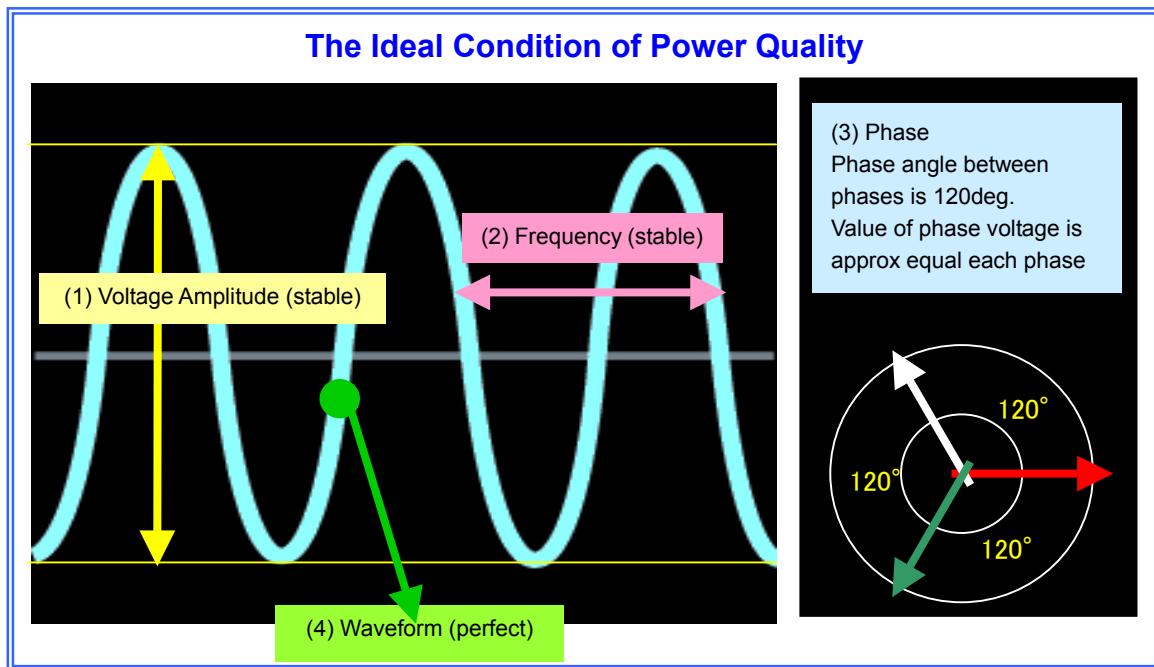
- 1) Voltage amplitude
- 2) Frequency
- 3) Phase
- 4) Waveform

Ideally the above 4 factors should meet National standards and the voltage waveform should be a perfect sine wave as shown in figure 1, without any distortions whatsoever.

### Waveform of AC power supply

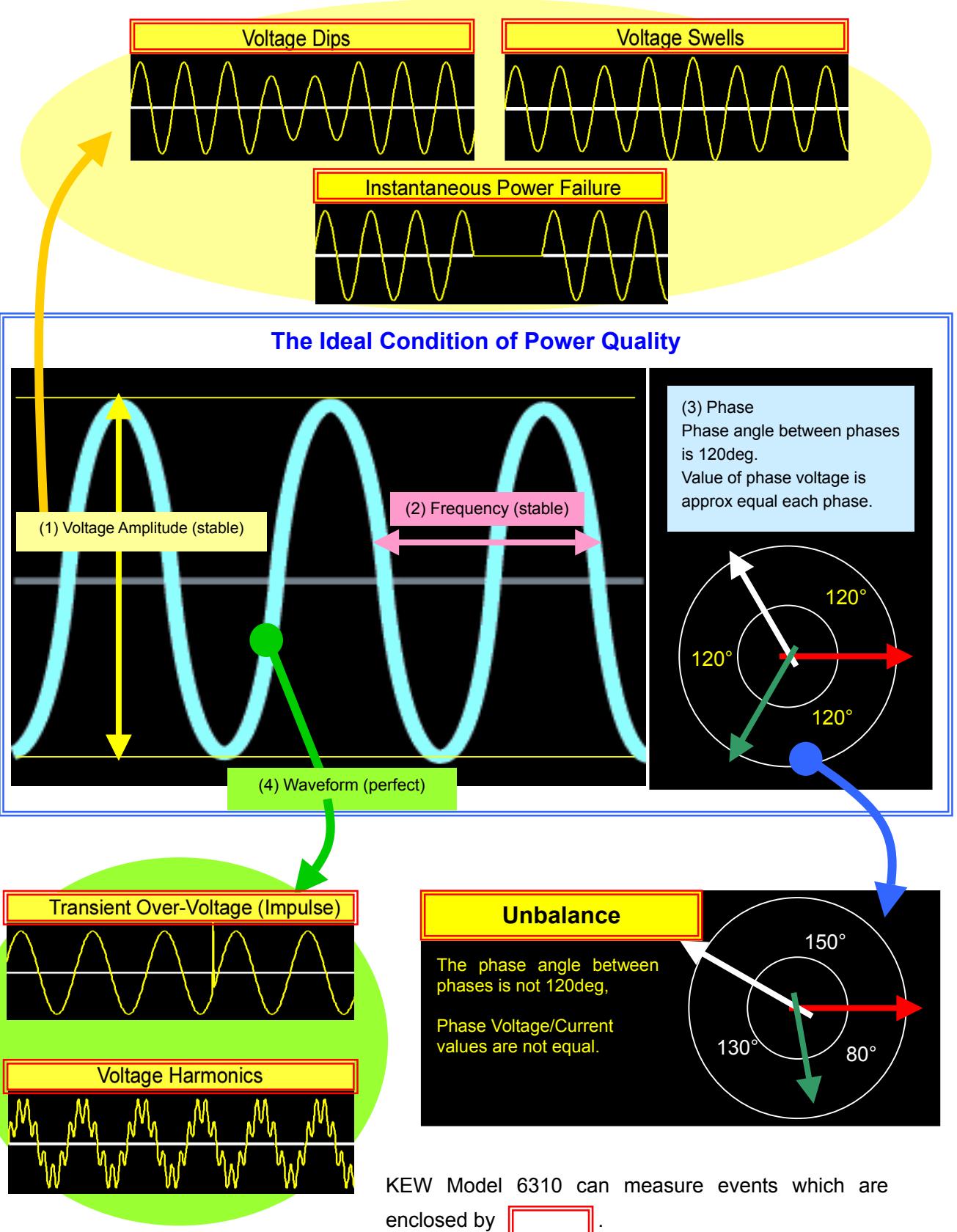


Electrical/Electronic appliances are designed assuming an ideal and stable voltage waveform. Thus, any deviation from National standards of the 4 parameters listed above will imply a deterioration of the Power Quality. This will cause damage in appliances, such as overheating in motors, premature ageing, computer interference, flickering lights or at worst complete loss of the appliance.



(Figure 1)

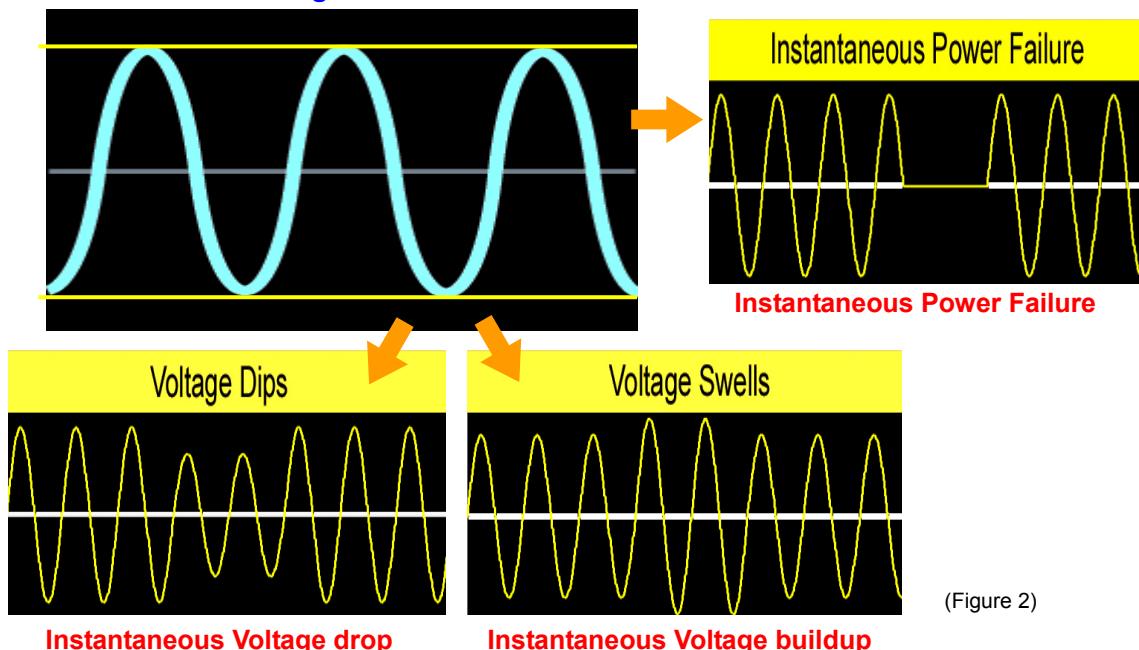
The following are some examples with harmful effects on Power Quality.



The following are explanations of the different scenarios mentioned.

### 1) Voltage fluctuation ("Instantaneous Power Failure", "Dips" and "Swell")

**Waveform of voltage should be stable**



(Figure 2)

The Model 6310 can measure "Instantaneous Power Failure", "Dips" and "Swell".

**"Instantaneous Power Failure"** is when the power supply source from the power company is lost for short/long periods, namely through the operation of a breaker following a fault, or generation problems, or due to lightning storms affecting the distribution network.

An "Interruption" implies loss of supply for more than 1 (one) second.

On the other hand, an "Instantaneous Power Failure" implies a loss of power supply, for a very short time, less than 1 (one) second. Normally this momentary loss cannot be conceived due to its brief duration, but it can easily cause interruption or re-set of production machines and personal computers.

Nowadays, UPS – Uninterruptible Power Supplies are very popular, especially for large-scale computer systems to protect the system from "Instantaneous Power Failures".

However not every computer facility has a UPS.

#### "DIP" / "SWELL"

"DIP" /SAG means a short-term decrease in voltage. (0.07 sec. ~ 2.00 sec.)

"SWELL" means a short-term increase in voltage. (0.07 sec. ~ 2.00 sec.)

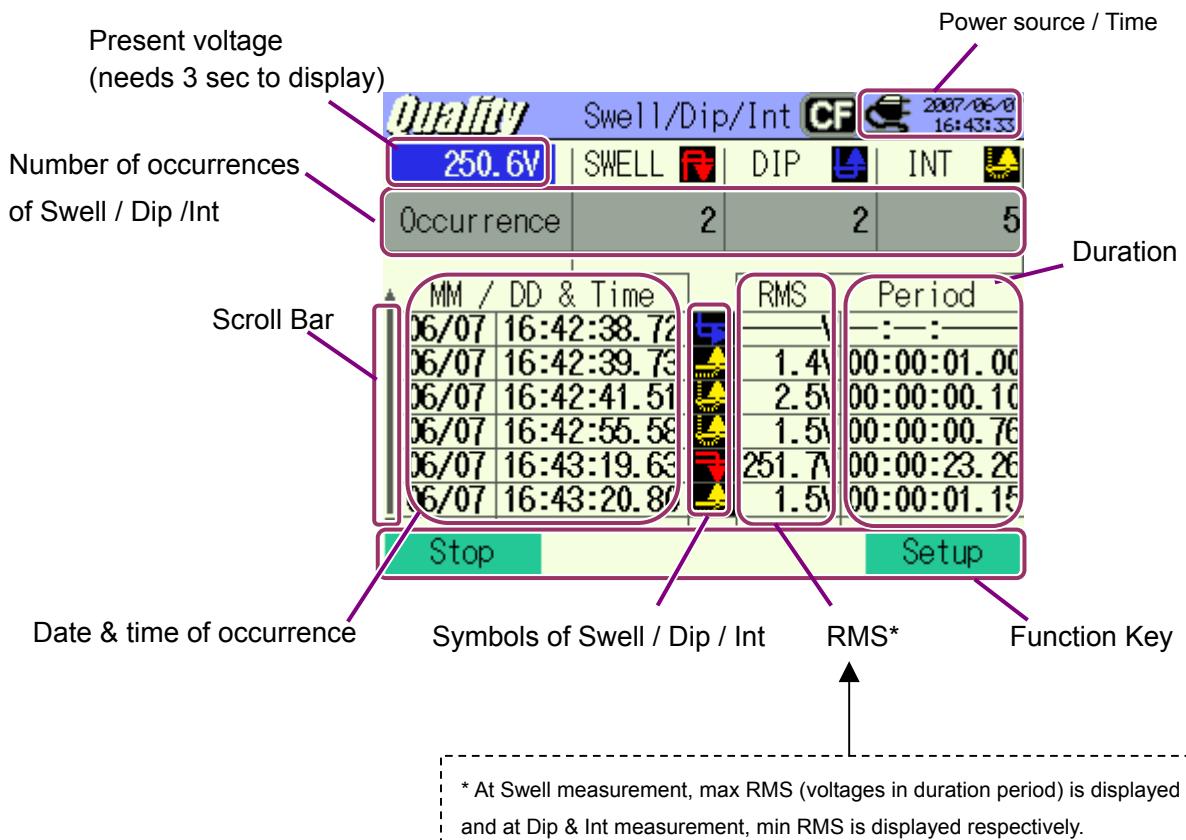
Refer to figures 2.

The threshold value of “DIP” and “SWELL” is plus/minus 10% of standard voltage value. That is, if the short-term increase in voltage is over 110% of standards, a “SWELL” occurs, and if the short-term decrease in voltage is below 90% of the reference voltage, a “DIP” occurs. The new Model, Power Quality Analyzer 6310 is set up along with these dip/swell threshold values as default. However the value can be varied according to user’s preference.

“DIPS” are usually caused by failures in the distribution network and due to large inrush currents originated by equipment start-up such as in air conditioning equipment, copy machine, etc.

“SWELLS” are usually caused by customer equipment operation, such as the switching off air conditioning equipment, or switching on of a large capacitor bank, etc....

The 6310 can display “DIP”, “SWELL” and “Instantaneous Power Failures” on the screen simultaneously by pressing the quality key to view list display, then press the cursor keys and select the required parameters, and then press the enter key to display.



Symbols displayed on the LCD			
	Start to End	Start	End
Swell			
Dip			
Int			

The 6310 will record 402 data pts on the occurrence of a swell (or a dip, or an int), 201pts on the start of the swell and 201 on the end of the swell. Refer to the figure below. Each set of 201 data pts includes 100pts before start/end point, 1pt at threshold value, 100pts after the start/end point.

If the duration of the swell is very short, then all the event (start to end) is recorded.

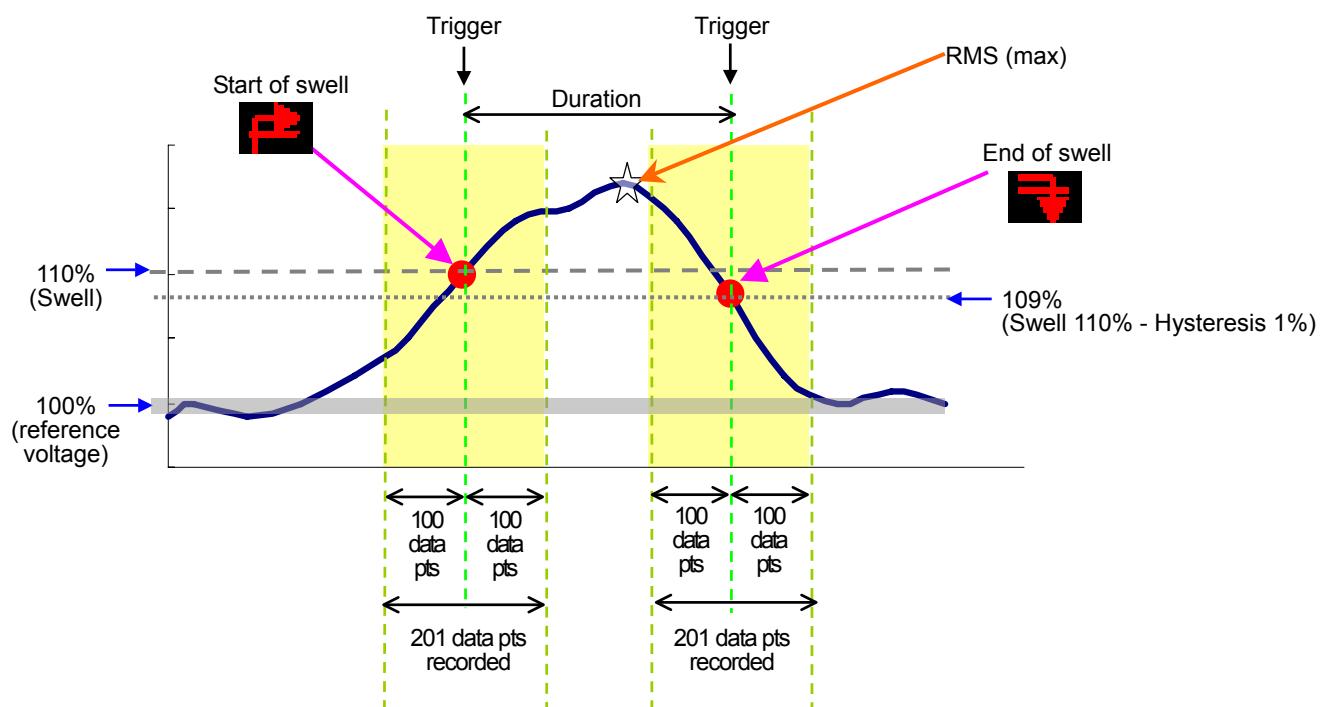
Thus when downloading the data to a pc, 2 types of graph can be obtained depending on the swell duration, namely:

- A) A continuous Graph showing Swell START to Swell END
- B) A graph showing 201 data pts at Swell start and 201data pts at Swell end, without the data in between.

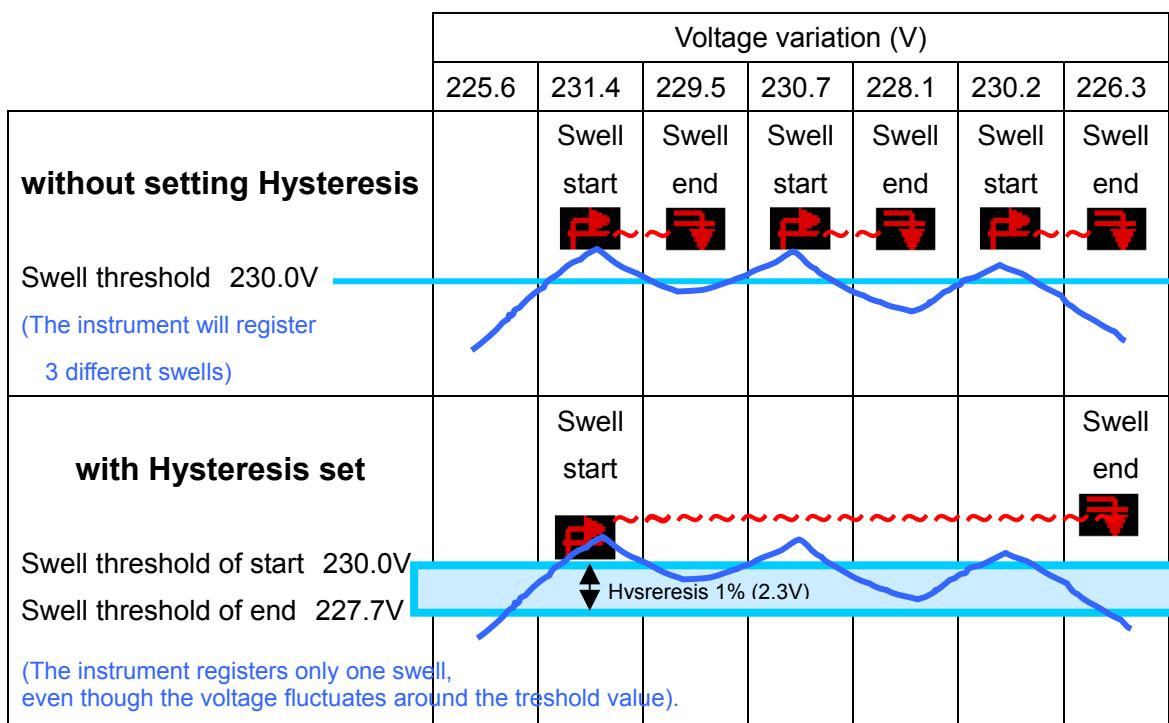
### Example of Trigger point

Setting item	e.g.
Reference voltage	230V
Swell	110%
Dip	90%
Int	10%
Hysteresis	1%
Trigger point	Past: 100, Next: 100

### < Swell >



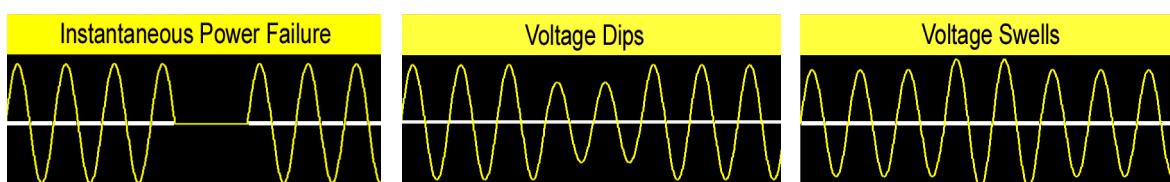
"Hysteresis" is the upper/lower tolerance of the threshold value of each event. This will facilitate the recording of an event and avoid confusion arising from the recording of multiple events in the same swell as can be seen from the figure below.



### "TRANSIENT OVERVOLTAGE"

A Transient overvoltage, also called "Spike" or "Impulse" is caused by the secondary effects by lightning or by electrical switching events.

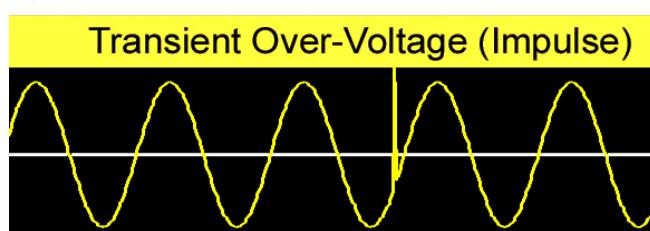
It is a very short duration and sudden momentary change in voltage when compared with "Instantaneous Power Failure", "DIP" and "SWELL". "Instantaneous Power Failure", "DIP" and "SWELL" are events that occur with duration of at least a half of cycle (in case of 50 Hz, this is 0.01 sec. = 10m sec.)



On the other hand, Transient overvoltage is a phenomenon that occurs with a duration starting from several nano seconds to several microseconds.

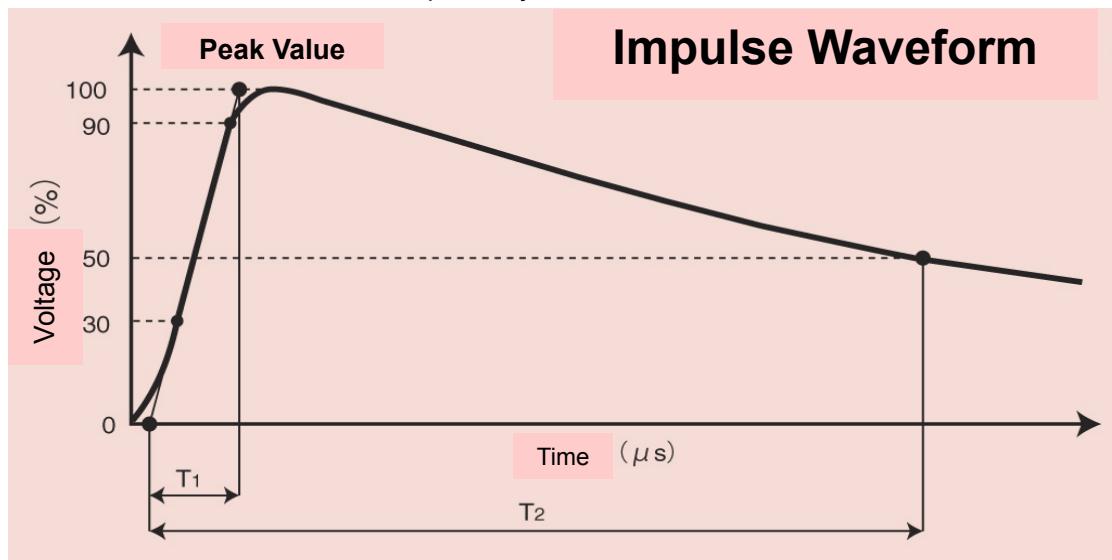
(1nano sec.=1n sec.=0.000000001 sec., 1micro sec.=1μ sec.=0.000001 sec.)

Thus, only part of a cycle is affected as shown below.



The 6310 will check the transient overvoltages every 100 micro secs. to cover the duration of the event.

In case of a Transient overvoltage caused by lightning, (also called lightning impulse), the time from the start to peak is very short, typically several nano secs. The 6310 cannot catch this event perfectly. However in the case of a Transient overvoltage which is caused by electrical switching events, such as contact error of magnet relays, tripping of breakers, etc., the time from the start to peak is typically from several 10xmicro sec to several milli sec., then the 6310 can measure the event perfectly.



Although the duration of such an event is very short, there is a possibility that data storage of computer systems and electric/electronic machines are damaged due to the high voltage.

The 6310 can display the transient occurrence list.

100 data pts before and after the event are recorded (201 data pts in total).

Power source / Time

Quality Transient 2006/10/1  
8:41:28

353.3Vpeak	Occurrence	132
MM / DD & Time		V peak
2006/10/12	08:10:10.325	687.1V
2006/10/12	08:10:22.220	686.9V
2006/10/12	08:10:33.843	530.7V
2006/10/12	08:10:34.000	528.7V
2006/10/12	08:10:44.213	530.2V
2006/10/12	08:10:45.233	544.8V

Start

Time & date of occurrence

V peak

Function Key

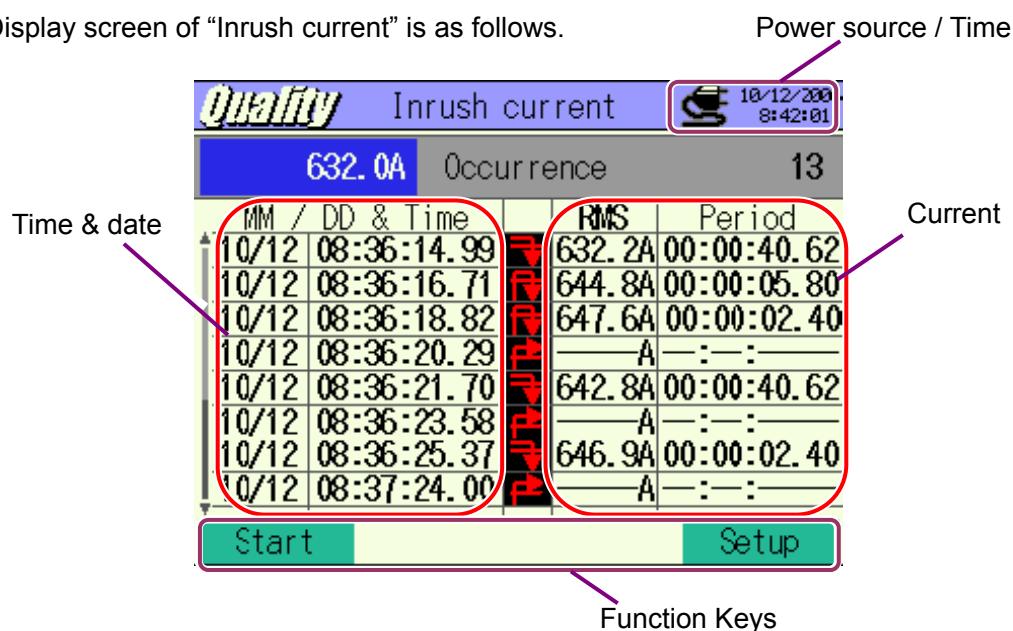
**"Inrush current"**, - (Input surge current) is the peak instantaneous input current normally caused by the start up of some electrical devices.

Some electrical loads, upon switching on, reach their load currents instantly, whilst others draw a start up current, which may be up to 5 times the normal load current. Then after a few cycles the start up current falls to a stable load current value. Some examples of the latter are:

- A motor draws a peak current upon start up until it builds up the rated speed. In fact large motors are usually protected by soft starters to limit these effects.
- The incandescent light bulb. Upon switching ON, the filament resistance is low as it is still cold, resulting in a higher current. Gradually the filament becomes warmer and its resistance higher, resulting in a lower and stable current flow.
- Apparatus with large capacitor filters draw inrush current until their charge is build up.

Inrush current can adversely affect electrical components such as rectifier circuits and cause the tripping of circuit breakers, welding fuses, welding contacts and power switches. Also it affects the voltage.

Display screen of "Inrush current" is as follows.



Symbols displayed on the LCD		
Start to End	Start	End