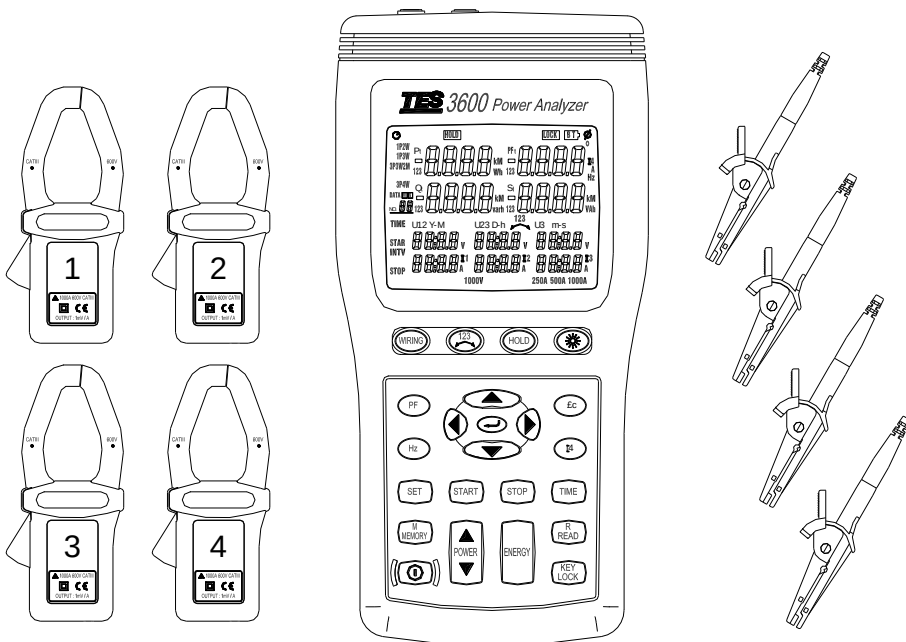




3P4W POWER ANALYZER

TES - 3600

INSTRUCTION MANUAL



TES ELECTRICAL ELECTRONIC CORP.

CONTENTS

Title	Page
I. SAFETY INFORMATION.....	1
II. INTRODUCTION FEATURE.....	4
III. SPECIFICATIONS.....	4
3-1 Environment Conditions	4
3-2 Safety Specifications.....	5
3-3 General Specification.....	5
3-4 Electrical Specification	7
IV. PARTS & CONTROLS.....	10
4-1 Description of Parts & Control keys	10
4-2 Description of Display	12
V. OPERATING INSTRUCTION	15
5-1 AC Current Adaptor	15
5-2 Single-Phase 2-Wire (1P2W) Power System Measurement	17
5-3 Single-Phase 3-Wire (1P3W) Power System Measurement	20
5-4 Three-Phase 3-Wire (3P3W) Power System Measurement	23
5-5 Three-Phase 4-Wire (3P4W) Power System Measurement	26
5-6 Only One Current I4 Measurement.....	29
5-7 Manual Data Memory and Read Function Operation	29
5-8 Auto Datalogging Function Operation	30
5-9 Phase Sequence Measurement	31
5-10 Voltage, Current Waveform and Harmonic Analyzer.....	31
5-11 Disable Auto Power Off Function	31
VI. MAINTENANCE	32
6-1 General Maintenance	32
6-2 Battery Replacement	32
VII. RS-232 INTERFACE, SOFTWARE INSTALLATION AND OPERATION....	33

I. SAFETY INFORMATION

This Instruction Manual provides information and warnings essential for operating this meter in a safe manner and for maintaining it in safe operating condition. Before using this meter, be sure to carefully read the following safety information.



DANGER

- During high voltage measurement, incorrect measurement procedures could result in injury or death, as well as damage to the meter. Please read this manual carefully and be sure that you understand its contents before using the meter.



DANGER

- Do not use the meter or test leads if they look damaged.
- Use extreme caution when working around bare conductors or bus bars, Accidental contact with the conductor could result in electric shock.
- To avoid damages to the meter, do not exceed the maximum limits of the input values shown in the specifications.
- Use the meter only as specified in this manual, otherwise, the protection provided by the meter may be impaired.

SAFETY SYMBOLS

- Caution refer to this manual before using the meter.



- This symbol is affixed to the meter where the operator should consult corresponding topics before using relevant functions of the meter.
- This mark indicates **explanation, which** is particularly important that the user **should** read before using the meter.



Dangerous voltages.



Meter is protected throughout by double insulation or reinforced insulation.
When servicing, use only specified replacement parts.



Comply with IEC61010-1, 2nd edition



DANGER : Indicates that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.



WARNING : Indicates that incorrect operation presents significant danger of accident resulting in death or serious injury to the user.



CAUTION : Indicates that incorrect operation presents possibility of injury to the user or damage to the meter.

NOTE : Denotes items of advice related to performance of the meter or to its correct operation.

NOTES ON USE

In order to ensure safe operation and to obtain maximum performance from the meter, observe the caution listed below.

☐ Installation



CAUTION

- The meter is designed for indoor use and can be safely used at temperatures ranging from 0°C to 40°C.
- Do not store or use the meter where it will be exposed to direct sunlight, high temperature, high humidity, or condensation, if exposed to such conditions, the meter may be damaged, the insulation may deteriorate, and the meter may no longer satisfy its specifications.
- The meter does not construct to be waterproof or dustproof, so do not use it in a very dusty environment or in one where will get wet.
- Do not use the unit where it may be exposed to corrosive or explosive gas. The meter may be damaged, or may occur explosion.

☐ Before use



WARNING

- To prevent electric shock, do not allow the meter to become wet and do not use the unit when your hands are wet.
- When working with live circuits, take all suitable precautions against accidents, including the use of electrical safety gear such as rubber gloves, rubber boots, and safety helmets.

❑ Connecting meter



WARNING

- To prevent electric shock, turn the power off before connecting the test leads and then take measurements.
- In order to prevent electrical shock and short – circuit accidents, shut off the power to the line to be measured before connecting the line to be measured to the voltage input terminals.



CAUTION

- The measurement input and synchronizing input are not isolated from each other. Connecting either one means that the other is exposed it is live, and there is a danger of electric shock. To avoid electrical shock, connect both terminals.



WARNING

To avoid electrical shock and / or meter damage, use caution when connecting test leads to live components. The jaws of alligator clips can create a short circuit between closely spaced live parts. Avoid making connections to feeder conductors or bus bars at elevated potentials. Whenever, please make connections to the output side of a circuit breaker as possible as you can, which can provide better short circuit protection.

- Follow all legal requirements.
- Follow all instructions in the manuals.
- Obey posted instructions.
- Never assume that a circuit is de-energized, check it first.
- Always set up the measurement first, then connect the test leads to the circuit.
- Remove all test leads that are not in use.
- Make connections to the meter first, before connecting leads to a live circuit.
- Connect the ground lead first, then the voltage leads and the current probe, Disconnect in reverse order.
- Route test leads carefully.

II.INTRODUCTION FEATURE

The symptoms of poor power quality include intermittent lock-ups and resets, corrupted data, premature equipment failure, over-heating of components for no apparent cause, etc. The ultimate cost is in downtime, decreased productivity and frustrated personnel.

Use power analyzer to power quality trouble shooting can help you keep your power system up and running, troubleshoot problems quickly, improve power efficient, manage energy costs, zero in on harmonics, optimize power system performance, improve power quality and analyze system data to design optimal upgrades.

- 10 display Easy-to-view LCD screen, and is capable of showing many power quality parameters at the same time.
- 4 current probe including for measuring a neutral line current.
- Measures single-phase 2-wire, single-phase 3-wire, three-phase 3-wire and three-phase 4-wire systems.
- All True-RMS sensing , V, A, KW, KVAR, KVA, PF, θ , Hz, KWh, KVARh and KVAh measurements.
- Phase [sequence](#) indicator function.
- Backlight display function.
- Manual Data Memory and Read (99 sets).
- Data logging (504K byte memory, 12,000 sets per block, total 20,000 sets).
- RS-232 optical interface with three phase voltage / current waveform display and harmonic analysis.
- Easy-to-use key operation.
- Light weight and portable design.

III. SPECIFICATIONS

3-1 Environment Conditions:

- ① Altitude up to 2000 meters
- ② Indoor use only
- ③ Relatively humidity 80% max.
- ④ Operation ambient 0~40℃

3-2 Safety Specifications

Category Rating : 1000V Measurement Category III, Pollution Degree 2.

CE : IEC 61010-1 2nd Edition

CAT III : Measurement category in which measurements performed in the building installation.

Safety Characteristics :

Current Clamps, Model TES AC3600, to be used only with the Three-Phase Power Analyzer, Model TES-3600.

This manual contains information and warning that must be followed by the user to ensure safe operation and to keep the meter and its accessories in a safe condition.

Use of this meter and its accessories in a manner not specified by the manufacturer may impair the protection provided by the equipment.

Equipment operation, the responsible body shall be made aware that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the probe assembly may be impaired.

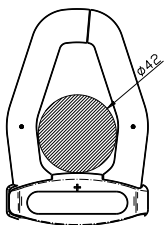
3-3 General Specification

- Maximum voltage between voltage input terminals and earth ground : 1000 Vrms
- Maximum rated working voltage for current input : 0.35 Vrms
- Maximum current for current probe : 1000 Arms
- Numerical 10 display : 10 display 4 digit LCD maximum reading 9999.
- Battery life : approx. 50 hours.
- Auto power off : approx. 30 minutes.
- Low battery indication : The **[BT]** is displayed when the battery voltage drops below the operating voltage.
- Backlight display time : Auto off approx. 30 seconds.
- Sampling rate : Approx. 1 time per 2 seconds (Digital display).
- Waveform and harmonic analyzer : 64 samples per period.
- Current probe jaw opening diameter : Cables ϕ 40mm.
- Operating temperature : 0°C to 40°C
- Operating humidity : Maximum relative humidity of 80% for temperatures up to 31°C decrease linearly to 50% relative humidity at 40°C (non-condensed).
- Temperature coefficient : $0.1 \times (\text{specified accuracy})/^{\circ}\text{C}$ (<18 or >28°C)

- Storage temperature and humidity : -10°C to 60°C
R.H. < 70% non-condensed.
- Dimensions : Meter $\rightarrow 235(\text{L}) \times 117(\text{W}) \times 54(\text{H})\text{mm}$.
Current probe $\rightarrow 193(\text{L}) \times 88(\text{W}) \times 40(\text{H})\text{mm}$.
- Weight : Meter including battery $\rightarrow$ approx. 730g
Current probe $\rightarrow$ approx. 333g
- Accessories :
 1. TES 3600 AC CURRENT ADAPTOR x 4pcs
Category Rating : CAT III 600V per IEC61010-1, Pollution Degree2.
CE : IEC 61010-1 2nd Edition and IEC61010-2-032
Input : AC 1000A maximum.
Output : 0.35mV/A
 2. Voltage test lead x 4pcs
Model no : TL 202I
Manufacturer : Hong Kai Co., Ltd.
Category Rating : CAT III, 1000V, AC 10A Max.
 3. Alligator clip x 4pcs
Model no : FC-A23
Manufacturer : Fu Chyi Enterprise CO., Ltd.
Category Rating : CAT III, 1000V, AC 10A Max.
 4. AC Adaptor (IN-OUT Isolated type, Input 120V AC 60Hz
Model : MW35-1200300
Input : 120V AC 60Hz 6.1W 
Output : 12V DC 300mA
Manufacturer : MAW WOEI Enterprise CO., Ltd.

AC Adaptor (IN-OUT Isolated type, Input 230V AC 50Hz
Model : MWD48-1200300GS
Input : 230V AC 50Hz 
Output : 12V DC 300mA
Manufacturer : MAW WOEI Enterprise CO., Ltd.
 5. Battery 1.5V “AA” $\times 8$
 6. Instruction manual $\times 1$
 7. PC software CD-R $\times 1$
 8. Carrying case $\times 1$
 9. Optical RS232 interface $\times 1$

3-4 Electrical Specification



Accuracy : $\pm$ (% of reading + number of digits) at 18°C to 28°C (64°F to 82°F) with relative humidity to 80%.

The current error is specified within the largest circle which can be drawn inside the jaw.

□ AC Voltage Trms measurement (V) :

Range	Resolution	Accuracy	Input impedance	Overload protection	Nominal power system frequency
999.9V	0.1V	$\pm(0.3\%rdg \pm 10dgt)$ ($>50V$)	2M Ω	1000Vrms	Only 50Hz or 60Hz

- Display item : RMS voltage value for each channel.

□ AC Current Trms Measurement (A) :

Range	Resolution	Accuracy (including current probe)	Current probe output	Overload protection	Nominal power system frequency
999.9A	0.1A	$\pm(0.5\%rdg \pm 15dgt)$ ($>3A$)	0.35mV/A	1000Arms	Only 50Hz or 60Hz

- Display item : RMS current value for each channel.

□ Active Power measurement P (KW) :

Range	Resolution	Accuracy
999.9KW	0.1KW	$\pm 1.0\%rdg \pm 20dgt$

- Display items : Active power of each channel and its sum of multiple channels.
- Polarity display : For influx (consumption) No symbol, For outflow (regenerative) “ - ”.

□ Apparent Power measurement S (KVA) :

Range	Resolution	Accuracy
999.9KVA	0.1KVA	$\pm 1.0\%rdg \pm 20dgt$

- Measurement method : Calculate from RMS voltage U and RMS current I.
- Display item : Apparent power of each channel and its sum of multiple channels.
- Polarity display : No polarity.

□ Reactive Power measurement Q (KVAR) :

Range	Resolution	Accuracy
999.9KVAR	0.1KVAR	$\pm 1.0\%rdg \pm 20dgt$

- Measurement method : Calculate from apparent power S and active power P,

$$Q = \sqrt{S^2 - P^2}.$$
- Display item : Reactive power of each channel and its sum of multiple channels.

- Polarity display : For phase lag (LAG : current is slower than voltage) :
No symbol.
For lead phase (LEAD : current is faster than voltage) : “-”

❑ Power Factor measurement (COS ϕ) :

Range	Resolution	Calculated Accuracy
0 ~ +1	0.001	±3dgt

- Measurement method : Calculate from apparent power S and active power P,
 $PF = \cos \phi = |P| / S$
- Display item : Power factor of each channel and its sum of multiple channels.

❑ Phase angle measurement (ϕ) :

Range	Resolution	Calculated Accuracy
+90° ~ 0° ~ -90°	0.1°	±3dgt

- Measurement method : Calculate from power factor COS ϕ , $\phi = \cos^{-1} PF$.
- Display item : Phase angle of each channel and its sum of multiple channels.
- Polarity display : For phase lag (LAG : current is slower than voltage) :
No symbol.
For phase lead (LEAD : current is faster than voltage) : “-”.

❑ Frequency measurement (Hz) :

Range	Resolution	Accuracy	Measurement source
60HZ	0.1Hz	±0.1%rdg±2dgt	Voltage U1 > 50V

- Measurable input range : > 50V

❑ Three Phase Sequence Detection :

Input voltage range	Normal phase indication	Reverse phase indication	Measurement source
3P > 50V	123 	123 	U1, U2 and U3

❑ Active Power Energy measurement (KWh) :

Range	Resolution	Active power accuracy	Timer interval	Timer Accuracy
3.999KWh	0.001KWh	±1.0%rdg±20dgt	1 sec	±50ppm (25°C, 77°F)
39.99KWh	0.01KWh			
399.9KWh	0.1KWh			
3.999MWh	0.001MWh			
39.99MWh	0.01MWh			
119.3MWh	0.1MWh			

- Measurement display : Display all active power consumption energy (sum of absolute values).

❑ Apparent Power Energy measurement (KVAh) :

Range	Resolution	Apparent power accuracy	Timer interval	Timer Accuracy
3.999KVAh	0.001KVAh	$\pm 1.0\% \text{rdg} \pm 20 \text{dgt}$	1 sec	$\pm 50 \text{ppm} (25^{\circ}\text{C}, 77^{\circ}\text{F})$
39.99KVAh	0.01KVAh			
399.9KVAh	0.1KVAh			
3.999MVAh	0.001MVAh			
39.99MVAh	0.01MVAh			
119.3MVAh	0.1MVAh			

- Measurement display : Display all apparent power energy (sum of absolute values).

☐ **Reactive Power Energy measurement (Kvarh) :**

Range	Resolution	Reactive power accuracy	Timer interval	Timer Accuracy
3.999Kvarh	0.001Kvarh	$\pm 1.0\% \text{rdg} \pm 20 \text{dgt}$	1 sec	$\pm 50 \text{ppm} (25^{\circ}\text{C}, 77^{\circ}\text{F})$
39.99Kvarh	0.01Kvarh			
399.9Kvarh	0.1Kvarh			
3.999Mvarh	0.001Mvarh			
39.99Mvarh	0.01Mvarh			
119.3Mvarh	0.1Mvarh			

- Measurement display : Display all reactive power consumption (sum of absolute values).

☐ **Harmonic measurement (use only PC on line analyzer)**

Order	Accuracy	Harmonic Source	No. of samples per period
1 ~ 31	$\pm 3\% \text{THD}$	U1, U2, U3 > 80V I1, I2, I3 > 50A	64

☐ **Waveform (use only PC on line displayed)**

Select phase A, B or C.

Select Voltage and current waveform output.

4-1 Description of Parts & Control keys



1. **Input for voltage terminals (U1, U2, U3, N).**
2. **Input for current probe jacks (I1, I2, I3, I4).**
3. **Plug for external AC adaptor power supply input.**
4. **Optical RS232 interface output.**
5. **LCD display.**
6. **WIRING key** : Select the type of electrical system under test, press WIRING key to select 1P2W (To measure signal-phase two-wire power lines), 1P3W (To measure signal-phase three-wire power lines), 3P3W2M (To measure three-phase three-wire power line without neutral, using the two power meter method, use this when measuring three-phase power with 2-current probe measurement only.) and 3P4W (To measure three-phase four-wire power lines with neutral) electrical system in cycles.
7.  **key** : Phase sequence detection function key. In a 3P4W mode, press and hold down this key, it will display phase detection results as follows :

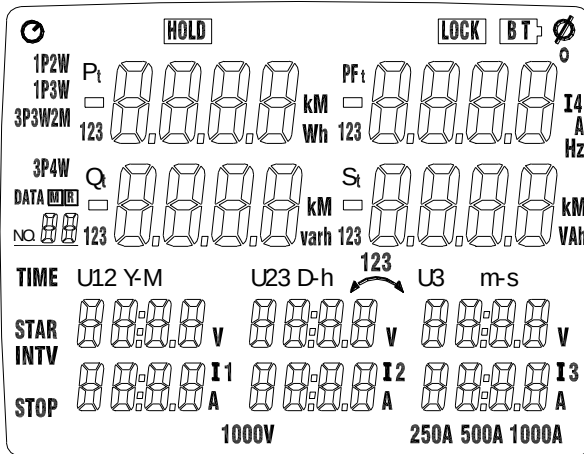
Normal phase 

Reverse phase 
8. **HOLD key** : Data hold function key, press HOLD key to hold data, the HOLD annunciator is displayed, press HOLD key again to exit Hold function.
 Press and hold down HOLD key then press  key turn on the meter, the “  ” mark disappear, exit auto power off function.
9.  **key** : Backlight function key, press  key to turn on and off of backlight. The backlight will switch off automatically after 30 seconds.
10. **PF key** : Display measured power factor value control key, the PF annunciator is displayed.
11. **Θ key** : Display measured phase angle value control key, the ϕ annunciator is displayed.
12. **Hz key** : Display measured frequency value control key, the Hz annunciator is displayed.
13. **I4 key** : Display measured I4 current probe value control key, the I4 annunciator is displayed.
14. **SET key** : Setting current date and time function key, press SET key to enter current time setting mode and interval time setting mode for auto datalogging use.
15. **TIME key** : Display current date and time control key, press and hold down

TIME key display current data and time.

16. ▲▼◀▶↵ Keys : Setting current date and time, or recall manual data memory to read memory data in cycles control keys.
17. **START key** : Start auto datalogging function.
18. **STOP key** : Stop auto datalogging function. Press START key to resume recording in current data sets.
19. **MEMORY key** : Manual data memory control key. Press MEMORY key each time to store one set current display reading into the memory, the M annunciator and the memory address number is displayed, total memory size is 99 sets.
20. **READ key** : Read manual memory data control key.
21. **▲POWER▼ Key** : Display measured power value control key, the Pt123, Qt123 and St123 annunciators will be displayed in cycles.
22. **ENERGY key** : Display total integrated power energy value control key, the three h annunciators will be displayed.
23. **KEY Lock key** : Lock all the functions key, except ⏻ and ☀ keys, the LOCK annunciator is displayed.
24. ⏻ key : Power on-off control key.

4-2 Description of Display



⏻ : Auto power off indication.

HOLD : Display hold mode.

LOCK : Set key lock mode.

[BT] : Low battery indication.

ϕ : Phase angle display.

$^{\circ}$: Phase angle unit.

1P2W : Measure signal-phase two-wire power line indication.

1P3W : Measure signal-phase three-wire power line indication.

3P3W2M : Measure three-phase three-wire power line indication.

3P4W : Measure three-phase four-wire power line indication.

P1 : Phase 1 active power measured display indication.

P2 : Phase 2 active power measured display indication.

P3 : Phase 3 active power measured display indication.

Pt : Total active power measured display indication and total active energy measured display indication.

KW : Active power unit.

KWh, MWh : Active energy unit.

PF1 : Phase 1 power factor measured display.

PF2 : Phase 2 power factor measured display.

PF3 : Phase 3 power factor measured display.

PFt : Total power factor measured display.

I4 : Current probe 4 current measured display.

Hz : Frequency unit.

DATA No.xx : Last manual datalogged memory address number indication (01~99).

[M] : Manual datalogged indication, **[M]** displays one time store one sets data into the memory.

DATA [R] No.xx : Recall manual datalogged address number indication, the memory data displayed for read.

DATA [M] xx : Auto datalogging indication, **[M]** disappears one time store one sets data into the memory .

01 ~ 10 : Maximum 10 memory blocks can be use, only 12,000 sets data can be stored in one block.

Maximum 20,000 sets data can be stored.

FF : Memory full indication, if exceed 10 memory blocks or exceed 20,000 stored data.

Q1 : Phase 1 reactive power measured display indication.

Q2 : Phase 2 reactive power measured display indication.

Q3 : Phase 3 reactive power measured display indication.

Qt : Total reactive power measured display indication and total reactive energy measured display indication.

Kvar : Reactive power unit.

Kvarh, Mvarh : Reactive energy unit.

S1 : Phase 1 apparent power measured display indication.

S2 : Phase 2 apparent power measured display indication.

S3 : Phase 3 apparent power measured display indication.

St : Total apparent power measured display indication and total apparent energy measured display indication.

KVA : Apparent power unit.

KVAh : Apparent energy unit.

MVAh : Apparent energy unit.

TIME : Current data and time indication.

Y-M D-h m-s : Date and time displayed.

INTV : Auto datalogging interval time setting indication.

START : Energy calculating start time indication.

STOP : Energy calculating stop time indication.

U1, V, A : 1P2W phase U1 voltage and current probe I1 measured display indication.

U1, V, A, U2, V, A : 1P3W phase U1, U2 voltage and current probe I1, I2 measured display indication.

U12, V, I1, A, U23, V, I2, A : 3P3W2M phase U12, U23 voltage and current probe I1, I2 measured display indication.

U1, V, A, U2, V, A, U3, V, A : 3P4W phase U1, U2, U3 voltage and current probe I1, I2, I3 measured display indication.

V : Voltage unit.

A : Current unit.

1000V : Voltage range indication.

250A, 500A, 1000A : Current range indication (Autoranging)

V. OPERATING INSTRUCTION



CAUTION

- If possible, before connecting the meter to the electrical equipment to be tested, take off the electrical equipment's power.



DANGER

- Voltage input connectors U1 to U3 are common for input connector N, each input connectors are not insulated.
- Do not connect the unnecessary number of cords.



WARNING

- Always set up the measurement first, then connect the test leads to the circuit.
- Make connections to the instrument first, before connecting leads to a live circuit.
- Connect the ground lead first, then the voltage leads and the current probe, Disconnect in reverse order.
- Remove all test leads that are not in use.

※ **U1 must be connected to voltage source during the measurement of U2, U3, I1, I2 and I3, because U1 is the main signal source of the whole meter measuring system. Otherwise you could not have any measurement from U2, U3, I1, I2 and I3.**

5-1 AC Current Adaptor

Safety Information



Read First: Safety Information

To ensure safe operation and service of the current clamp, follow these instructions:

- Read the operating instructions before use and follow all safety instructions.
- Use the Current Clamp only as specified in the operating instructions, otherwise the clamp's safety features may not protect you.
- Adhere to local and national safety codes. Individual protective equipment must be used to prevent shock and arc blast injury where hazardous live conductors are exposed.
- Do not hold the Current Clamp anywhere beyond the tactile barrier, see Figure 1.

- Before each use, inspect the Current Clamp. Look for cracks or missing portions of the clamp housing or output cable insulation. Also look for loose or weakened components. Pay particular attention to the insulation surrounding the jaws.
- Never use the clamp on a circuit with voltages higher than 600V CAT III.
- Use extreme caution when working around bare conductor or bus bars. Contact with the conductor could result in electric shock.
- Use caution when working with voltages above 60V or 30V ac. Such voltages pose a shock hazard.



Warning

To avoid possible electric shock or personal injury:

- Before each use, inspect the Current Clamp. Look for cracks or missing portions of the clamp housing and output cable insulating cover and for loose or weakened components. Pay particular attention to the insulation surrounding the clamp jaws.
- Do not use a damaged Current Clamp. If a clamp is damaged, tape it shut to prevent unintended operation.

Measurement Considerations

- Center the conductor inside the Current Clamp jaw.
- Make sure the clamp is perpendicular to the conductor.
- For optimal reading, make sure the conductor is positioned between the alignment marks on the jaws of the Current Clamp.

Observe the following guidelines when making measurements :

- Avoid taking measurements close to other current carrying conductors.

Operation

To use the AC Current Adaptor, refer to “Measurement Considerations” and Figure 1.

1. Connect the clamp cable to the instrument.
2. The arrow on the top of the clamp must face towards the load of the circuit.
3. Connect the current clamp jaws around the conductor to be measured.



Warning

To avoid shock or personal injury, keep fingers behind the tactile barrier, see Figure 1.

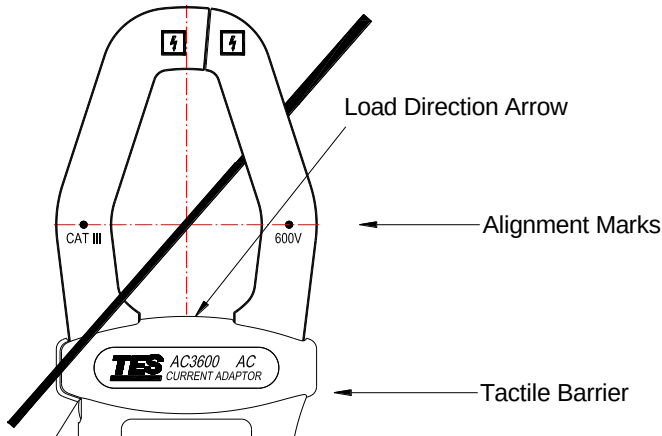


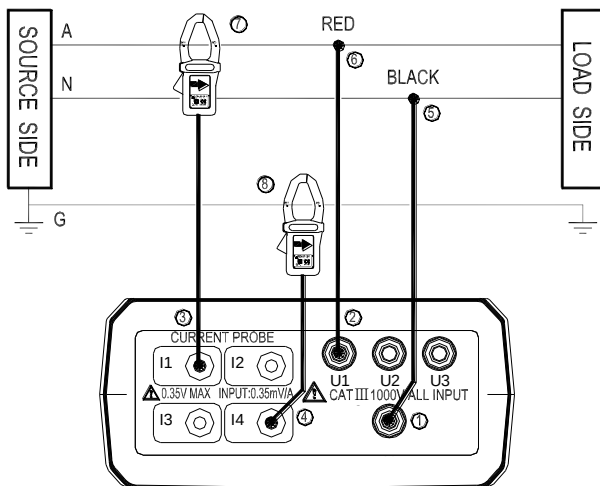
Figure 1

5-2 Single-Phase 2-Wire (1P2W) Power System Measurement

Application :

Receptacle branch circuit	Lighting loads
● Troubleshooting electrical distribution system.	● Measuring current harmonic (use PC).
● Measuring line rms voltage.	● Measuring power on single phase loads.
● Measuring line rms current.	
● Measuring frequency.	
● Measuring voltage harmonics (use PC).	
● Measuring current harmonics (use PC).	
● Measuring voltage waveform (use PC).	
● Measuring current waveform (use PC)	
● Measuring the load on a transformer.	
● Recording the load on a transformer.	

A : Line, N : Neutral, G : Ground,  Face the arrow toward the load.



1P2W Wiring Connection Diagram

1. Press  key to turn on the meter.
2. Press WIRING key to select the 1P2W electrical system under test, the 1P2W annunciator will be displayed.
3. Connect the voltage test leads and current probe to the meter.
 - ① Connect the black voltage test lead to the “N” terminal.
 - ② Connect the red voltage test lead to the “U1” terminal.
 - ③ Connect the I1 current probe output plug to the “I1” jack.
 - ④ If you want to measure ground leakage current, connect the I4 current probe output plug to the “I4” jack.
4. Connect the voltage test leads and current probe to the electrical equipment to be tested.



CAUTION

- If possible, before connecting the voltage test leads and current probe to the electrical equipment to be tested, take off the electrical equipment's power.

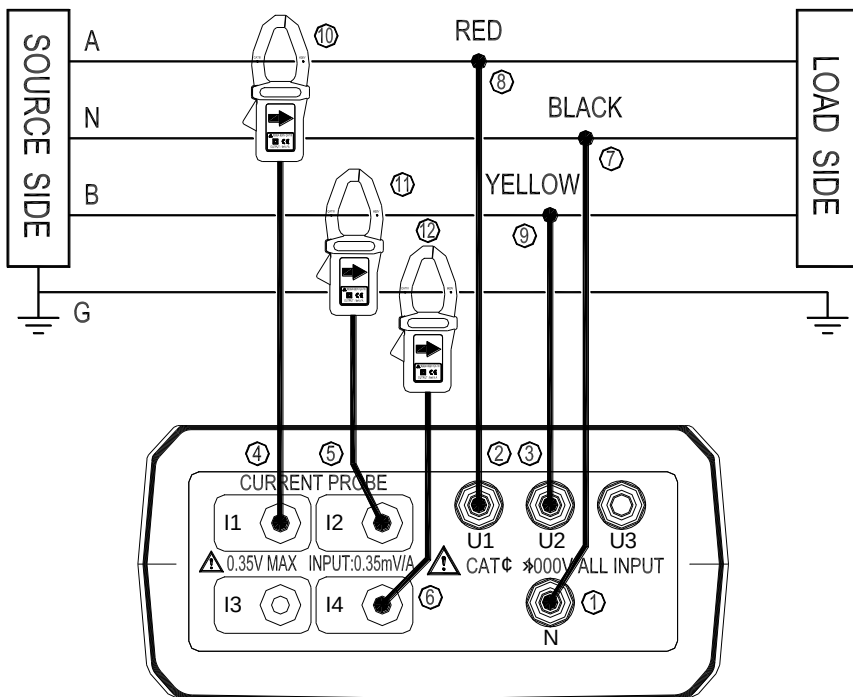
- ⑤ Connect the black voltage test alligator to the Neutral Line “N”.
- ⑥ Connect the red voltage test alligator to the Line “A”.
- ⑦ Press I1 current probe trigger to open the jaw and fully enclose the Line “A”.
- ⑧ If you want to measure ground leakage current, press I4 current probe the trigger to open the jaw and fully enclose the Ground Line “G”.

※ U1 must be connected to voltage source during the measurement of U2, U3, I1, I2 and I3, because U1 is the main signal source of the whole meter measuring system. Otherwise you could not have any measurement from U2, U3, I1, I2 and I3.

5-3 Single-Phase 3-Wire (1P3W) Power System Measurement

Application : Same as 1P2W power system measurement.

A, B : Line, N : Neutral, G : Ground,  Face the arrow toward the load.



1P3W Wiring Connection Diagram

1. Press  key to turn on the meter.
2. Press WIRING key to select the 1P3W electrical system under test, the 1P3W annunciator will be displayed.
3. Connect the voltage test leads and current probe to the meter.
 - ① Connect the black voltage test lead to the “N” terminal.
 - ② Connect the red voltage test lead to the “U1” terminal.

- ③ Connect the yellow voltage test lead to the “U2” terminal.
 - ④ Connect the I1 current probe output plug to the “I1” jack.
 - ⑤ Connect the I2 current probe output plug to the “I2” jack.
 - ⑥ If you want to measure ground leakage current, connect the I4 current probe output plug to the “I4” jack.
4. Connect the voltage test leads and current probe to the electrical equipment to be tested.



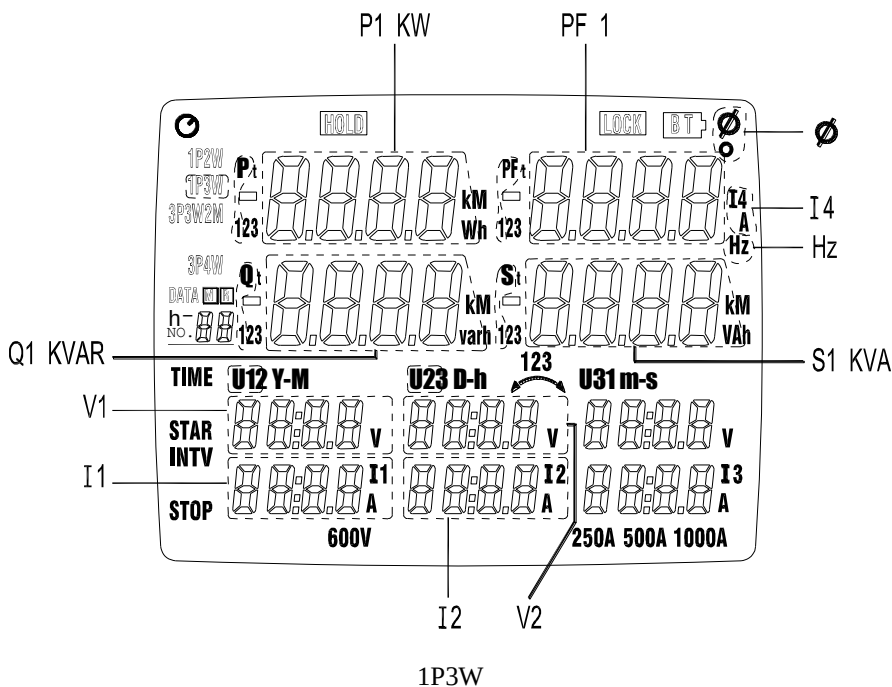
CAUTION

- If possible, before connecting the voltage test leads and current probe to the electrical equipment to be tested, take off the electrical equipment's power.

- ⑦ Connect the black voltage test alligator to the neutral line “N”.
 - ⑧ Connect the red voltage test alligator to the line “A”.
 - ⑨ Connect the yellow voltage test alligator to the line “B”.
 - ⑩ Press I1 current probe trigger to open the jaw and fully enclose the Line “A”.
 - ⑪ Press I2 current probe trigger to open the jaw and fully enclose the Line “B”.
 - ⑫ If you want to measure ground leakage current, press I4 current probe trigger to open the jaw and fully enclose the ground line “G”.
5. Press ▲ POWER ▼ key to select (P1, Q1, S1, PF1), (P2, Q2, S2, PF2) and (Pt, Qt, St, Pft) measured values.
6. Frequency (Hz), Phase Angle (Θ), Ground Leakage Current (I4) and Power Factor (pF) measurement :
- ① Hz : Press “Hz” key, PF1 will show “Hz”. Press “PF” key to exit.
 - ② Θ : Press “ Θ ” key, PF1 will show “ ϕ ”. Press “PF” key to exit.
 - ③ I4 : Press “I4” key, PF1 will show “I4”. Press “PF” key to exit.
 - ④ pF : Press “PF” key.

7. Energy measurement :

- ① Press “ENERGY” key, the “Pt”, “Qt”, “St” and “PFt” or “ ϕ t” annunciator and energy integrate start time are displayed. The energy integrate value and the current time will be continuous accumulate.
 - a). KW displays KWh
 - b). KVAR displays KVARh
 - c). KVA displays KVAh
- ② Press “ STOP ” key to stop energy accumulated and the **HOLD** annunciator is displayed.
- ③ Press $\downarrow$ key to exit the energy measurement.



※ U1 must be connected to voltage source during the measurement of U2, U3, I1, I2 and I3, because U1 is the main signal source of the whole meter measuring system. Otherwise you could not have any measurement from U2, U3, I1, I2 and I3.

5-4 Three-Phase 3-Wire (3P3W) Power System Measurement

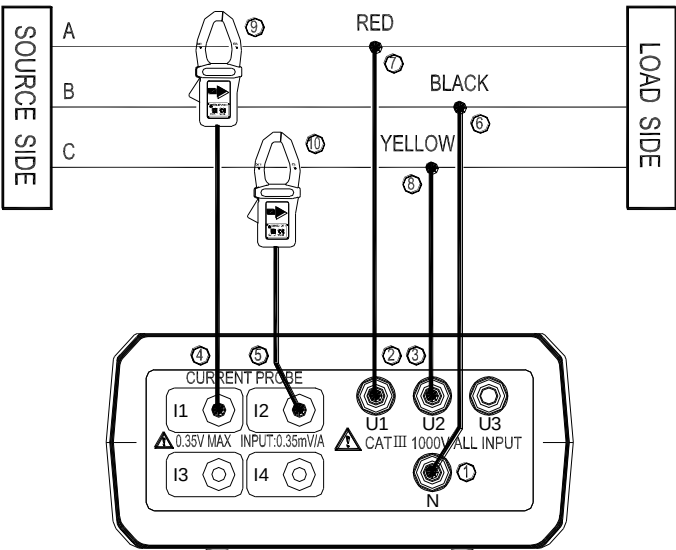
Application :

Induction motors without adjustable speed drive.	Induction motors with adjustable speed drive.
● Checking voltage unbalance.	● Checking current on phases.
● Checking current and current unbalance.	● Measuring frequency of motor current.
● Measuring power in 3-phase balanced and unbalanced system.	
● Measuring power factor of 3-phase motors.	
● Measuring voltage harmonics (use PC).	

Unbalance factor :

When the load of the specified phase becomes too heavy due to fluctuations in loads connected to each power line phases, or when operating on uneven device, the voltage and current waveforms become distorted, causing voltage drops, they can cause voltage unbalance, reverse phase to neutral voltage, and harmonics may cause accidents such as uneven motor rotation, circuit breaker trips, and over load heating in the transformer.

A, B, C : Line, G : Ground, ➡ Face the arrow toward the load.



3P3W Wiring Connection Diagram

1. Press **①** key to turn on the meter.
2. Press WIRING key to select the 3P3W2M electrical system under test, the 3P3W2M annunciator will be displayed.
3. Connect the voltage test leads and current probe to the meter.
 - ① Connect the black voltage test lead to the “N” terminal.
 - ② Connect the red voltage test lead to the “U1” terminal.
 - ③ Connect the yellow voltage test lead to the “U2” terminal.
 - ④ Connect the I1 current probe output plug to the “I1” jack.
 - ⑤ Connect the I2 current probe output plug to the “I2” jack.
4. Connect the voltage test leads and current probe to the electrical equipment to be tested.



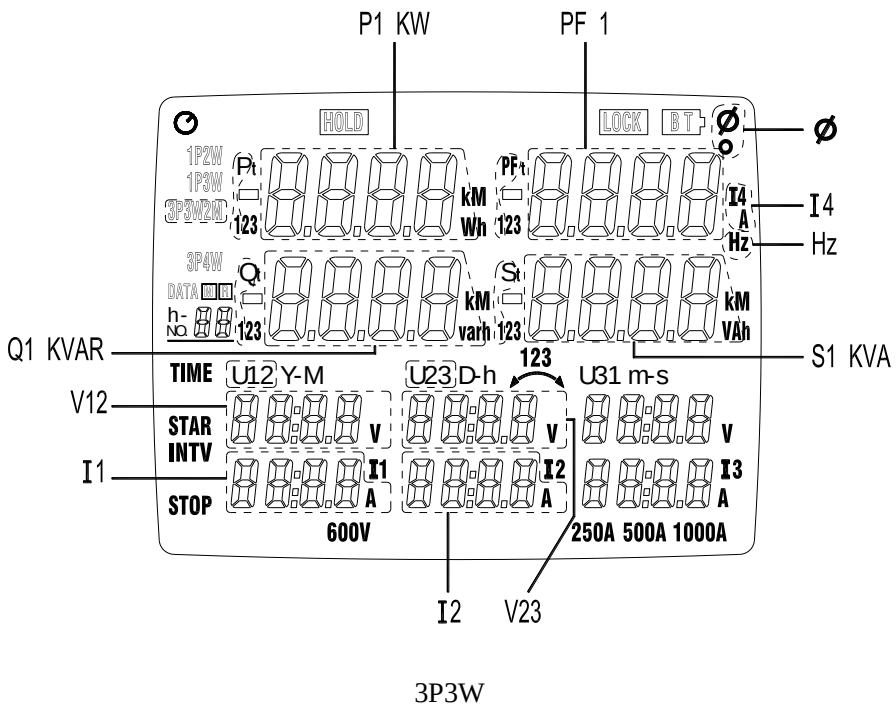
CAUTION

- If possible, before connecting the voltage test leads and current probe to the electrical equipment to be tested, take off the electrical equipment's power.

- ⑥ Connect the black voltage test alligator to the line “B”.
 - ⑦ Connect the red voltage test alligator to the line “A”.
 - ⑧ Connect the yellow voltage test alligator to the line “C”.
 - ⑨ Press I1 current probe trigger to open the jaw and fully enclose the Line “A”.
 - ⑩ Press I2 current probe trigger to open the jaw and fully enclose the Line “C”.
5. Press **▲ POWER ▼** key to select (P1, Q1, S1, PF1), (P2, Q2, S2, PF2) and (Pt, Qt, St, PFt) measured values.
 6. Frequency (Hz), Phase Angle (Θ) and Power Factor (pF) measurement:
 - ① Hz : Press “Hz” key, PF1 will show “Hz”. Press “PF” key to exit.
 - ② Θ : Press “ Θ ” key, PF1 will show “ ϕ ”. Press “PF” key to exit.
 - ③ pF : Press “PF” key.

7. Energy measurement:

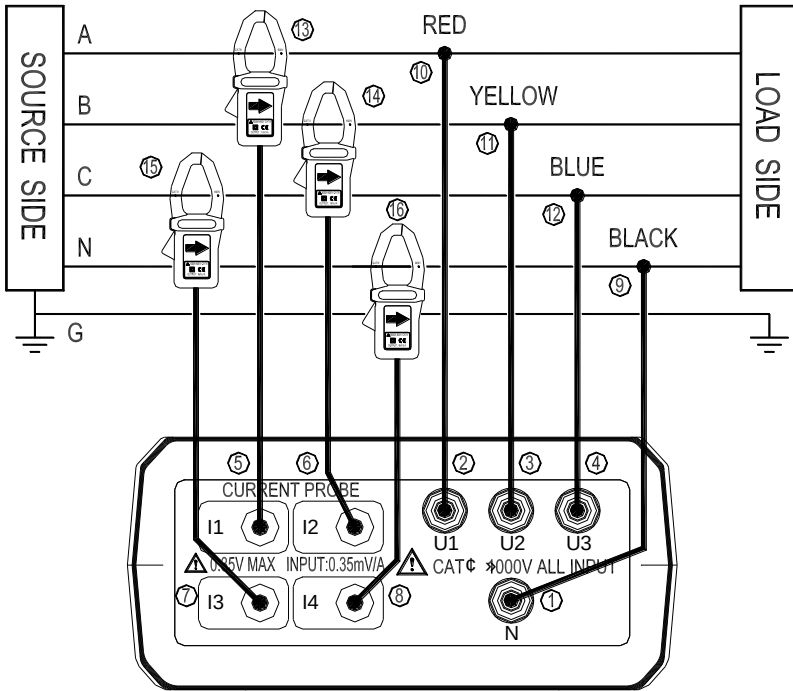
- ① Press “ENERGY” key, the “Pt”, “Qt”, “St” and “PFt” or “ ϕt ” annunciator and energy integrate start time are displayed. The energy integrate value and the current time will be continuous accumulate.
 - a). KW displays KWh
 - b). KVAR displays KVARh
 - c). KVA displays KVAh
- ② Press “STOP” key to stop energy accumulated and the **HOLD** annunciator is displayed.
- ③ Press $\downarrow$ key to exit the energy measurement.



5-5 Three-Phase 4-Wire (3P4W) Power System Measurement

Application : Same as 3P3W power system measurement.

A, B, C : Line, N : Neutral, G : Ground,  Face the arrow toward the load.



3P4W Wiring Connection Diagram

1. Press  key to turn on the meter.
2. Press WIRING key to select the 3P4W electrical system under test, the 3P4W annunciator will be displayed.
3. Connect the voltage test leads and current probe to the meter.
 - ① Connect the black voltage test lead to the “N” terminal.
 - ② Connect the red voltage test lead to the “U1” terminal.
 - ③ Connect the yellow voltage test lead to the “U2” terminal.
 - ④ Connect the blue voltage test lead to the “U3” terminal.
 - ⑤ Connect the I1 current probe output plug to the “I1” jack.
 - ⑥ Connect the I2 current probe output plug to the “I2” jack.
 - ⑦ Connect the I3 current probe output plug to the “I3” jack.
 - ⑧ Connect the I4 current probe output plug to the “I4” jack.

4. Connect the voltage test leads and current probe to the electrical equipment to be tested.



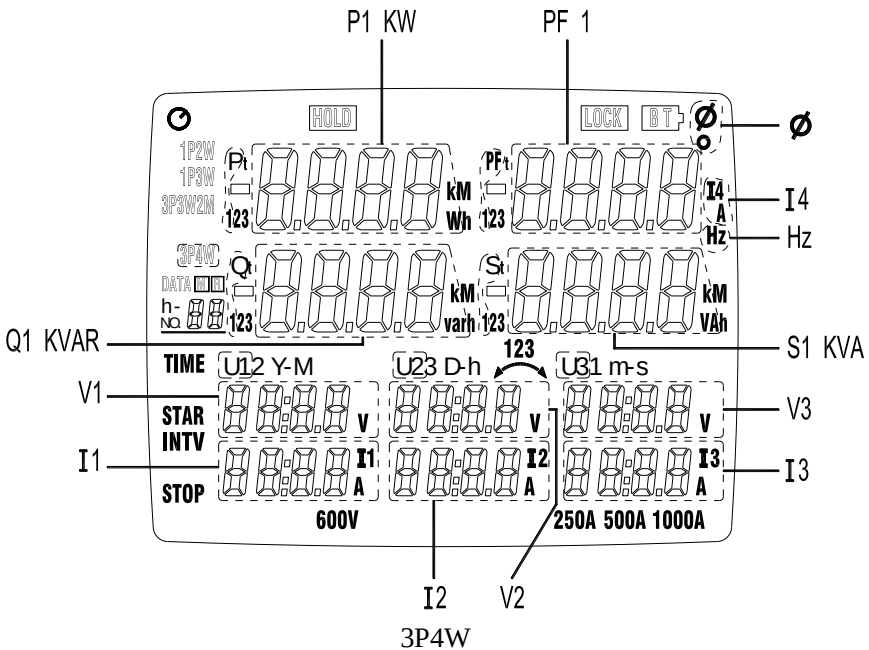
CAUTION

- If possible, before connecting the voltage test leads and current probe to the electrical equipment to be tested, take off the electrical equipment's power.

- ⑨ Connect the black voltage test alligator to the neutral line “N”.
- ⑩ Connect the red voltage test alligator to the line “A”.
- ⑪ Connect the yellow voltage test alligator to the line “B”.
- ⑫ Connect the blue voltage test alligator to the line “C”.
- ⑬ Press I1 current probe trigger to open the jaw and fully enclose the Line “A”.
- ⑭ Press I2 current probe trigger to open the jaw and fully enclose the Line “B”.
- ⑮ Press I3 current probe trigger to open the jaw and fully enclose the Line “C”.
- ⑯ Press I4 current probe trigger to open the jaw and fully enclose neutral line “N”.
5. Press ▲ POWER ▼ key to select (P1, Q1, S1, PF1), (P2, Q2, S2, PF2), (P3, Q3, S3, PF3) and (Pt, Qt, St, PFt) measured values.
6. Frequency (Hz), Phase Angle (Θ), Neutral Line Current (I4) and Power Factor (pF) measurement :
- ① Hz : Press “Hz” key, PF1 will show “Hz”. Press “PF” key to exit.
- ② Θ : Press “ Θ ” key, PF1 will show “ ϕ ”. Press “PF” key to exit.
- ③ I4 : Press “I4” key, PF1 will show “I4”. Press “PF” key to exit.
- ④ pF : Press “PF” key.

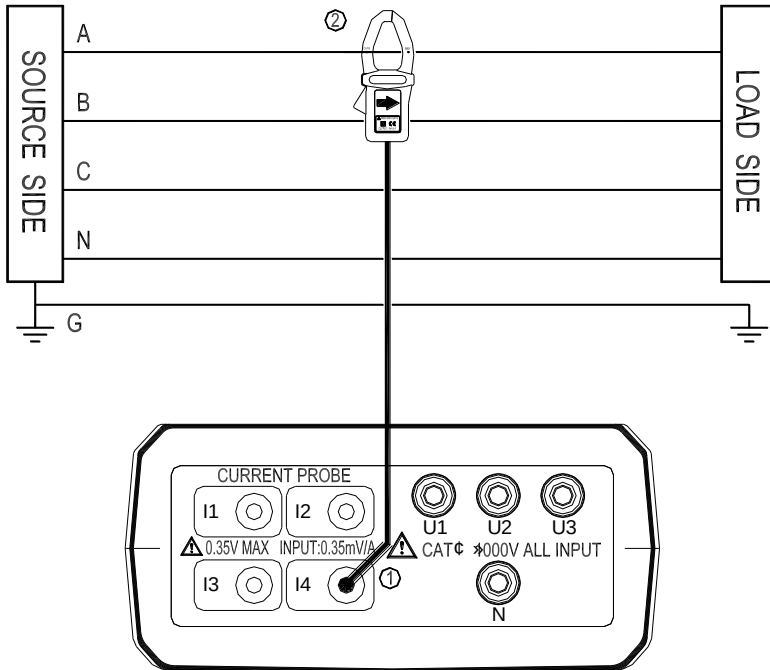
7. Energy measurement:

- ① Press “ENERGY” key, the “Pt”, “Qt”, “St” and “Pft” or “ ϕ t” annunciator and energy integrate start time are displayed. The energy integrate value and the current time will be continuous accumulate.
 - a). KW displays KWh
 - b). KVAR displays KVARh
 - c). KVA displays KVAh
- ② Press “ STOP ” key to stop energy accumulated and the HOLD annunciator is displayed.
- ③ Press $\downarrow$ key to exit the energy measurement.



5-6 Only One Current I4 Measurement

Application : Measurement any wire current independent of voltage, the same as clamp meter application.



1. Press ① key to turn on the meter.
2. Press “I4” key.
3. Connect the I4 current probe output plug to the “I4” jack.
4. Press I4 current probe trigger to open the jaw and fully enclose desired measured wire.
5. Read the I4 value, if the measured current value greater than 250A, the display will show the “OL” symbol.

5-7 Manual Data Memory and Read Function Operation

1. Clear memory data :

- ① Press ① key to turn off the meter.
- ② Press and hold down the MEMORY key then press ① key again to turn on the meter, the “CLr” annunciator is displayed and all manual memories data is cleared.

2. Store Manual data to memory :

- ① Press MEMORY key one time store one sets displayed data to memory, the **[M]** annunciator display one time and the stored memory address will be displayed.
- ② Maximum store memory capacity size is 99 sets.

3. Read the manual stored data :

- ① Press READ key to enter the read mode, the **[R]** annunciator is displayed.
- ② Press **▲ ▼** key to read the memories data, the memories data address will be displayed.
- ③ Press “**↵**” key to exit the read mode.

5-8 Auto Datalogging Function Operation

1. Clear memory data :

Please refer to software manual (CD-ROM), use PC to clear memories data, the meter can not clear memories data free from lost memories data.

2. Store Auto datalogging data to memory :

■ **Setting the current time and Auto datalogging interval time.**

- ① Press SET key to enter current time setting mode.
- ② Press **▲ ▼ ◀ ▶** keys to set actual current YEAR-month, DAY-hour, minute-second.
- ③ Press **↵** key to enter auto datalogging interval time setting, the “INTV” annunciator is displayed.
- ④ Press **▲ ▼** keys cycle select the interval time, you can select 5 seconds, 30 seconds, 1 minute or 2 minutes.
- ⑤ Press **↵** key to exit TIME setting mode.

■ **Enter Auto datalogging mode.**

- ① Press START key to start Auto data logging, the DATA **[M]××** will be displayed, the **[M]** annunciator, according to the interval time disappear one time store one sets data into the memory.
- ② Press STOP key to stop data record, press START key will resume data record, but maximum can be divide to 10 memory blocks, only 12,000 sets data can be stored in one block, the current block number will be displayed, total maximum record capacity size is 20,000 sets data.
- ③ When maximum block or maximum capacity is full, the “FF” annunciator will be displayed, the data record is auto stopped.

■ **Download data to PC**

Please refer to the software manual (CD-ROM) to download the data.

5-9 Phase **Sequence** Measurement

1. Press ① key to turn on the meter.
2. Press WIRING key to select 3P4W mode.
3. Connect the voltage test leads to the meter.
 - ① Connect the red voltage test lead to the “U1” terminal.
 - ② Connect the yellow voltage test lead to the “U2” terminal.
 - ③ Connect the blue voltage test lead to the “U3” terminal.
4. Connect the voltage test leads to the electrical equipment to be tested.



CAUTION

- If possible, before connecting the voltage test leads and current probe to the electrical equipment to be tested, take off the electrical equipment's power.

- ① Connect the red voltage test alligator to the power line “A” phase.
 - ② Connect the yellow voltage test alligator to the power line “B” phase.
 - ③ Connect the blue voltage test alligator to the power line “C” phase.
5. U1, U2 and U3 measured voltage must be greater than 30V, then press and hold down “¹²³” key. If connection wires is normal phase, the “¹²³” annunciator is displayed. If connection wires is reverse phase, the “¹²³” annunciator is displayed. Release the “¹²³” key to exit this measurement.

5-10 Voltage, Current Waveform and Harmonic Analyzer

Application :

May device power sources now use semiconductor control devices and harmonics occur because of distorted voltage or current wave forms.

When harmonic components become too large, they can cause serious accidents, such as transformer supplying seeming average loads are overheating, neutral conductors in balanced circuit are overheating from exceeing loads, circuit breakers are tripping for no apparent reason, overheating the motor or burning out the reactor connected to the phase advance capacitor.

Please refer to software manual (CD-ROM) for waveform and harmonic measurement.

5-11 Disable Auto Power Off Function

The meter will automatically enter sleep mode approx. 30 minutes to save power consumption.

1. Disable auto power off procedure :

- ① Press  key to turn off the meter.
- ② Press and hold down HOLD key, then press  key to turn on the meter, the auto power function will be disabled, and the auto power off symbol “  ” will be disappear.

2. Auto power off mode is enabled each time you turn on the meter and is automatically disabled as the follow modes.

- ① ENERGY function is active.
- ② Auto datalogging function is active.
- ③ PC linked.

VI. MAINTENANCE

6-1 General Maintenance

1. Repairs or services es that are not covered in this manual should only be performed by qualified personnel.
2. Clean the meter and accessories with a damp cloth and a mild soap. Do not use abrasives, solvent, or alcohol. These may damage the text.
3. Additional to this it is recommended to open the jaws of the Current Clamp and to wipe the magnetic pole pieces with a lightly oiled cloth. This in order to avoid rust or corrosion to form on the magnetic poles.

6-2 Battery Replacement



WARNING

- To AVOID electrical shock, remove the test leads and current probe before replacing the batteries.

1. As battery power is not sufficient, LCD will display  annunciator, replace new battery is required.
2. Disconnect all test leads and current probe from any power electrical source, press  key to turn off the meter, and remove the test leads from the jacks.
3. The battery cover is secured to the bottom case by two screws. Using a screw drive to remove the two screws from the bottom case.
4. Remove battery cover, take out the batteries and replace with new batteries. (Please note battery polarity)

VII. RS-232 INTERFACE, SOFTWARE INSTALLATION AND OPERATION

For the detailed instruction, please refer to the content of attached CD disk, which has the complete instruction of RS-232 interface, software operation and relevant information.



TES ELECTRICAL ELECTRONIC CORP.

7F, No. 31, Lane 513, Rui Guang Road, Neihu Dist. Taipei.
Taiwan, R. O. C.

Tel : (02) 2799-3660

Fax : 886-2-2799-5099

E-Mail : tes@ms9.hinet.net

<http://www.tes.com.tw>
