OPERATING MANUAL FOR

MULTI FUNCTION METER

(Model: MFM 9112 - 45mm Depth)

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MULTI FUNCTION METER

1. General Features

The Meter is designed with latest state of art technology. It offers high accuracy, reliability and also real value for money. This next generation micro controller based instruments monitors over 25 vital parameters and does not require any external Transducers. This instrument is most suitable for measuring all electrical parameters in 3 phase industrial applications. It replaces several meters like Voltmeters, Ammeters, Wattmeters, Frequency meter, kVA meter, pf meter and selector switches for the above in an electrical panel.

The measured informations are shown on a 2 row 16 character LCD display with backlit. Four keys are provided on the front panel of the meter to access these information easily and quickly. The front panel is provided with antiglare feature for improved readability.

The measurement parameters include 3 phase voltage, 3 phase current, kVA, kW, PF, Frequency, kWh or kVAh. All voltage, Current, Power and energy readings are true R.M.S including harmonics. The power and energy measurement is done for the full four quadrants. The energy reading is provided with reverse lock, showing only the imported energy consumed by the consumer. The meter computes and updates the parameters in every 2 seconds.

The meter is also provided with a optional RS 485 optically isolated communication port supporting MOD BUS RTU protocol. The port is very useful in networking the meters in multidrop communication and to collect datas in a centralised control room using any standard SCADA Software package like cimplicity, intellution, wonderware & citech etc.

(Note : For Every change of LT ⟷ HT or 1A ⟷ 5A or 3 Wire ⟷ 4 Wire the instrument should be switched OFF and then made ON.)

2. Installation

2.1. Mounting

The meter is housed in a compact ABS plastic enclosure of dimension 96(H) x 96(W) x 45(D)mm. The meter is suitable for panel mounting and has reliable mounting clamps to hold the meter to the panel.

The panel cut out for fixing the meter is a 92 x 92 mm. The depth behind the panel is 45 mm. Always provide extra space for the connectors and wiring. The panel cut out should be punched with proper tool and should be free from burrs. Insert the meter through panel cutout from front and fix the mounting clamps provided with the meter on each side. Tighten the fixing clamps with limit amount of force so as to hold the meter in position.

2.2. Wiring

2.2.1 Selection of PT & CT

The measurement of voltage and current is done using the PT voltage and CT current inputs. So the accuracy of measurement is determined by the accuracy and phase shift produced by the PT's and CT's so it is recommended to use PT's and CT's of instrument class 0.5 or better.

Also the PT's and CT's should have adequate VA rating to support the burden on the secondary side of them. The primary rating of the CT has to be selected such that the load variation lies between the dynamic range of the CT. (30% to 80% of the primary current).

2.2.2 Voltage signal connections

The Meter directly accepts voltages upto 415VAC R.M.S line to line (240VAC R.M.S line to neutral) with 10% over load capacity in case of LT meters and 110VAC R.M.S line to line (63.5 VAC R.M.S line to Neutral) with 10% over load capacity in case of HT meters. The primary of the PT is field programmable upto 330 kV.

There are four voltage input terminals marked as R, Y, B & N. The three phase input voltage should be connected to those terminals.

Meter voltage input burden : 0.25VA per phase

2.2.3 Current signal connections

The Meter current inputs can accept both 5A AC or 1A AC R.M.S (selectable) for connecting external CT's as. The CT Primary & Secondary value is field programmable. In both the cases, the current inputs has over load capability of 120%.

There are three pairs of terminals marked as IR (M,L) IY (M,L) and IB (M,L) for the connection of external CT's. For proper measurements, the polarity of the CT's must be connected properly. The CT wiring must be properly done by deenergising the CT secondary by shorting it through a shorting block. The primary current of CT is field programmable upto 10000A.

Meter Current input burden : 0.25VA per phase

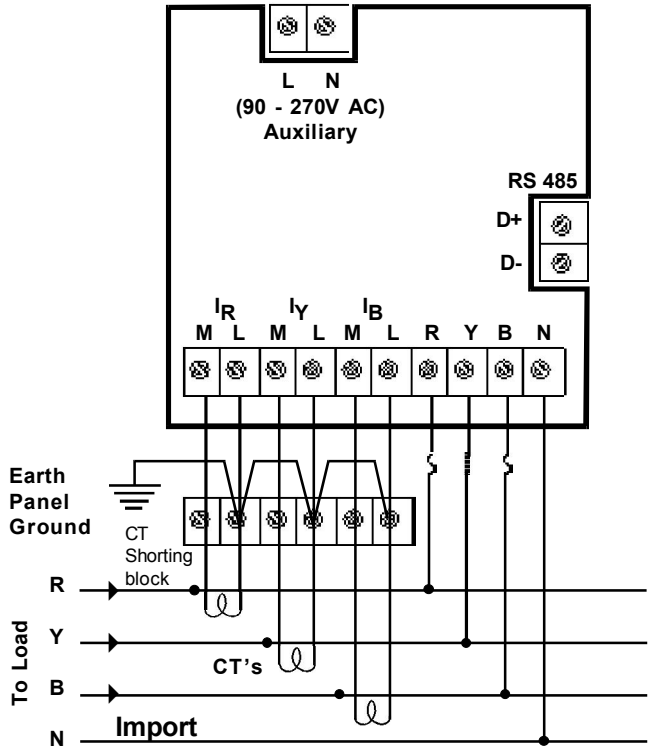
3. Wiring Diagram

3.1) Three phase four wire LT/HT systems (3 watt measurement)

Voltage Input : Direct 240V AC P-N (-20% to +10%)

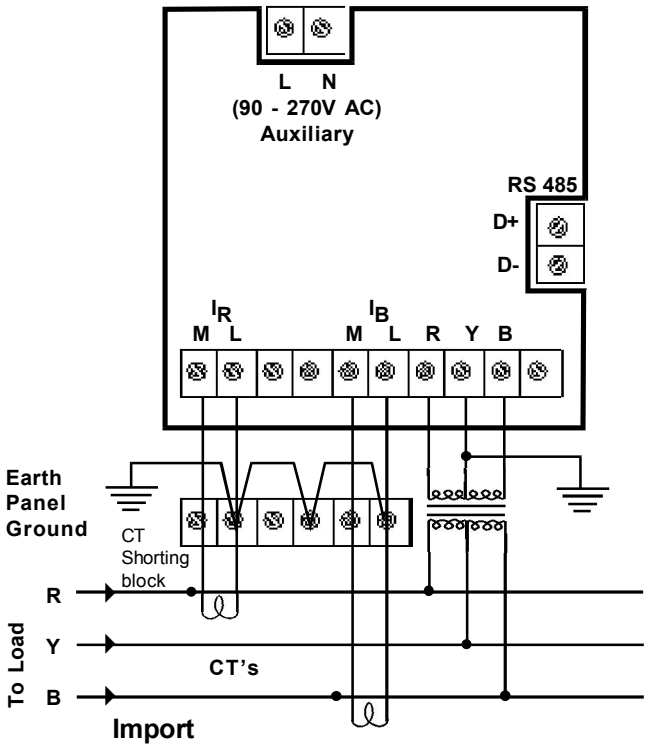
Current Input : 5/1A provide through 3 CT's

Voltage Input : 110V AC (L - L)(Through PT) - **HT Systems**



3.2) <u>Three phase three wire LT/HT systems (2 watt measurement)</u>

<u>Voltage Input</u> : 415V/110V AC (L - L)(Through PT)
<u>Current Input</u> : 5/1A provide through 2 CT's



3.4) Auxiliary power supply connections

The Meter derives auxiliary power from the voltage input terminals as standard. If the burden of the PT is not sufficient in the case of HT meters auxiliary power supply of 90 - 270 VAC can be provided seperately. But it has to be specified at the time of ordering.

In that case, seperate terminals will be provided for auxiliary supply. The auxiliary supply should be connected to proper specified voltage.

Burden on Auxiliary supply terminals : 4VA

3.5) Cross checking the wiring

Three phase voltage wiring and current wiring are to be properly done for correct measurements. Any wrong connections done either during installation or during rewiring can produce wrong measurement of electrical parameters. These incorrect wirings are difficult to detect since they produce wrong readings close to the expected readings.

The Meter has a built in program to identify the reverse sequences in PT as well as CT wiring. A seperate diagnostic display page is provided to view the PT, CT Connections. IT can be selected by pressing the Shift Key repeatedly.

If the PT & CT wiring are done correctly. The diagnostic page as shows as

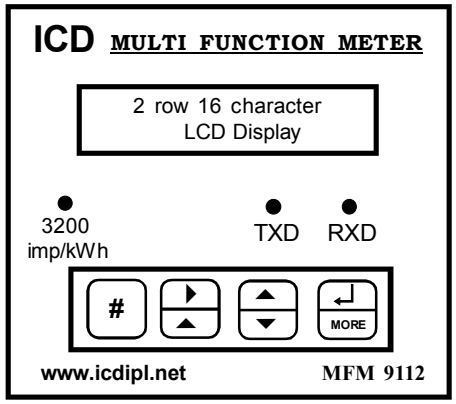
PT SEQ : RYB
CT REVR : NIL

Otherwise the phase in which voltage connections or current connections are wrongly connected is displayed.

While checking the wiring through the diagnostic page, make sure the load current is 10% above the full scale current and also the load is in import mode.

4. Front Panel Features

Multi Function Meter



The LCD Display is a 2 row 16 character Alpha numeric display with backlit. The LCD Display is used to display voltage, current, kVA, kW, PF, Freq., kWh/kVAh, Run Hour, THD (if applicable) & program mode settings. The LCD backlit is switched off when no key is pressed for 3 minutes to save power and to enhance the life of LCD. The LCD backlit is switched ON, when any key is pressed.

The TxD and RxD LED's are provided to Indicate the activity in the communication port. The RxD LED flashes, whenever the data is received through communication port and the TxD LED flashes when data is transmitted from the meter. These LED's are not provided in the meters without communication port. Calibration pulse output is provided through 3mm RED LED in front panel. Meter constant is 3200 impulse/kWh.

The front panel is also provided with 4 keys. The key descriptions are given below.The keys are used to select the respective parameters in the normal operating mode and to configure various items in the program mode.

4.1 Key Description :

Keys	Program mode	Normal operating mode
	Index key *(To select Menus)*	SCRL/HLD *(To switch between Scroll/Hold mode)*
	Shift Key *(To move between characters & to select parameters)*	To increment Display pages
	Increment Key *(To increment the selected digit & to select parameters)*	To decrement Display pages
	Enter Key *(To store the modifications & datas)*	More Key *(To view further sub pages)*

4.2 Changing the configuration Items

In program mode, after selecting the configuration item through Index key, It can be altered by using shift, Increment & Enter key.

The shift (▶) key is used to select the digit one by one. The selected digit is shown by flashing that digit.

The Increment (▲) key is used to increment the selected digit. The increment key Increments the digit from 0 to 9 and then wraps down to zero once again. Shift and Increment keys are also used for selecting the required parameter.

Once the required values are set in the configuration items press the Enter ↵ key to store it in memory. If the change is accepted the display Indicates 'E' otherwise an error message is displayed as 'Error'.

Once the configuration Items are programmed hold in the ▶ & ▲ keys together for 3 seconds to return back to normal operating mode.

5. Programming Instructions

All meters are to be programmed properly to work in a particular Installation. The various items that are to be programmed are shown in the table below.

Configuration Item	In Meter
New pass word	*In All meters*
Primary Voltage	*In All meters*
Secondary Voltage	*In All meters*
Primary Current	*In All meters*
Secondary Current	*In All meters*
Wiring Type	*In All meters*
Modbus Address	*Meters with Communication Interface only*
kWh/KVAh & Run Hour reset	*All meters*

The Meters are provided with password facility to prevent alteration of configuration items by unauthorised persons. The configuration Items of the meter may be changed by following the sequence given below.

With power applied to the meter hold in the ▶ & ▲ keys (shift and Incr) together for 3 seconds. The display Indicates enter password

PROG PASS WORD
/ / / /

The password set in the menu, “new password” has to be entered by using Shift, Incr and enter keys (Refer changing the configuration items for using Shift, Incr and Enter keys). After valid password is entered the meter enters into program mode by showing it in display.

PROGRAM MODE

Special Note :

If the user enters the ‘Enter pass word’ for the first time, or if the user fails to remember the password entered in ‘New pass word’, the default password ***0386*** *can be entered.*

The configuration Items can be selected by pressing the Index (#) key. Top row in displays are used to differentiate the various configuration items. The displays for various configuration item are given below,

NEW PASS WORD 0 0 0 0	Password to prevent unauthorised persons entry (Range : 0000 - 9999; for all meters)
Press # Key	
PRIMARY VOLT 0 1 1 0 0 0	Primary Voltage setting -(Range :415 V AC for LT, (0 - 330000)V AC for HT)
Press # Key	
SECONDARY VOLT 1 1 0V	Secondary Voltage setting -415V for LT & 110V for HT meters
Press # Key	
PRIMARY CURRENT 0 1 0 0	Primary current setting (0000 - 9999)A AC
Press # Key	
SECONDRY CURRENT 5 A	Secondary current setting (1/ 5)A AC
Press # Key	
WIRING TYPE 4 W I R E	Wiring Type can be changed either for 3 wire or 4 wire systems
Press # Key	
DEVICE ADDRESS 0 0 1	Modbus address (for meters with communication interface only ; 001 - 127)

BAUD RATE
9 6 0 0

For Modbus communication
(9600 or 19200 can be selected)

Press # Key

PARITY
N O N E

For Modbus communication
(None, even & odd-can be selected when shift key or increment key pressed)

Press # Key

STOP BIT
O N E

For Modbus communication
(One & two can be selected when shift key or increment key pressed)

Press # Key

FAVOURITE PAGE
ENERGY

Start-up page can be selected (Energy, voltage, current & power can be selcted when shift key or increment key pressed)

Press # Key

LCD POWER SAVE
ENABLED

LCD Power save Enabled/Disabled is selected using Shift or Increment key and pressing Enter key. *(If it is Enabled, then backlit is automatically switched off when there is no any key press for 3 minutes. Pressing any key will make backlit ON. If LCD power save is Disabled, then backlit is switched on permanently)*

Press # Key

ENERGY SELECTION
KVAh/KWh

User can change the Energy

Press # Key

ENERGY CLEAR OK

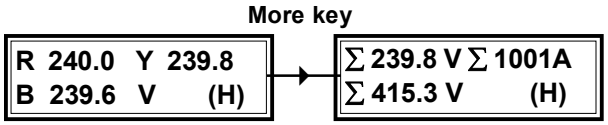
kWh Energy Reset. *(pressing Enter key resets energy & Run Hour and displays* "DONE" *in Bottom Row)*

Again pressing Index (#) key repeats the same process in cyclic manner. Press ▶ & ▲ keys (Shift & Increment) together for few seconds to quit program mode & return to RUN mode.

6. RUN Mode display pages

When power is applied to the meter the starting message consisting of Manufacturer's name,model number,version number and meter type is displayed and the run mode is selected automatically. In Run mode the power parameters are shown in different pages. These pages are accessed using the "Page UP & DOWN" keys provided on the front panel. The display pages, can also be made to scroll automatically 5 seconds once by selecting scroll mode by pressing scroll/hold key. The Scroll or Scroll/Hold key toggles between Scroll & Hold mode. The available display pages are given below.

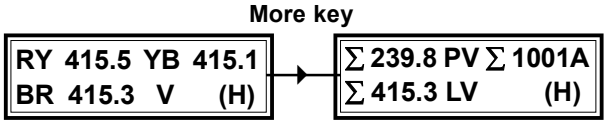
Page 1 :



a) Phase to Neutral Voltages of all 3 phases

b) Average Phase Voltage, Line Voltage & Current

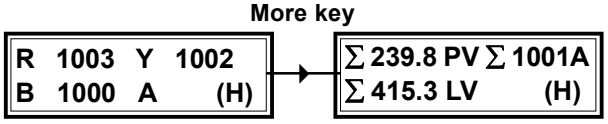
Page 2 :



a) Phase to Phase Voltages of all 3 phases

b) Average Phase Voltage, Line Voltage & Current

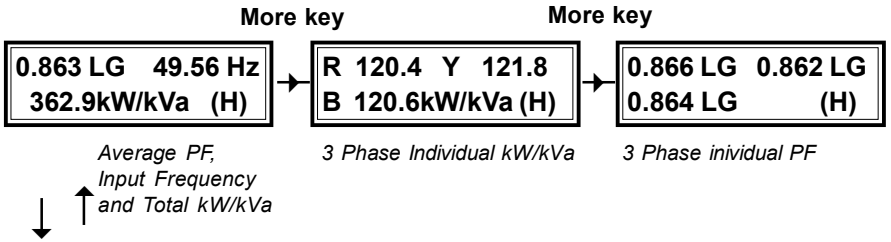
Page 3 :



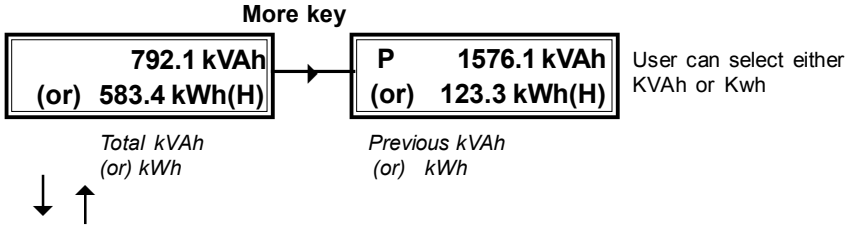
a) 3 Phase current

b) Average Phase Voltage, Line Voltage & Current

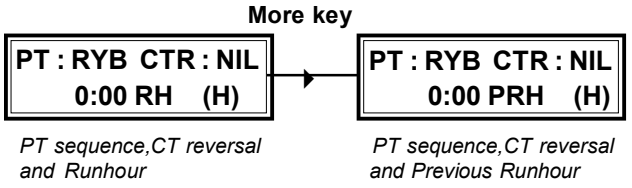
Page 4 :



Page 5 :



Page 6 :



0:00 CRH
0:00 PRH (H)

The above pages are given for 3 phase 4 wire LT meters. For HT meters, the resolution and units will change as given in technical specifications. The display pages sequence and parameters can be altered based on user requirement (to be mention while ordering).

7. Communication Port Details

The Meter is provided with a optically Isolated RS 485 communication Port, which is an optional Feature and has to be specified at the time of ordering. The communication protocol used is MODBUS - RTU or MODBUS-ASCII (to be specified while ordering). Using the communication Port, the meters can be connected in multi drop network and data can be collected in a centralised control room using any standard SCADA Software.

The communication between the PC and the instrument would be in Master slave mode. P.C acts as a master and sends a command message (query) containing the slave Id, function code and address of the information required. The command is received by all the slaves. The slave whose address is matching with that of the command address would respond with the requested data.

The communication settings are,

Protocol	:	MODBUS RTU
Baud rate	:	9600/19200
Data bit	:	8
Data Type	:	UINT
Stop bit	:	1 or 2
Parity	:	None/even/odd
Starting Address	:	40001
Communicating mode	:	Half Duplex

The above configuration are to be done in any standard scada package for collecting the data.

The instrument is provided with screwable 2 pin phoenix connector for connecting the communication cable at the rear side.

The address of the parameters are as follows.

Sl.No	Parameter	Address	Resolution	
			LT	HT
1	R - Voltage	40001	0.1	0.01
2	Y - Voltage	40002	0.1	0.01
3	B - Voltage	40003	0.1	0.01
4	RY Voltage	40004	0.1	0.01
5	YB Voltage	40005	0.1	0.01
6	BR Voltage	40006	0.1	0.01
7	R Current	40007	0.1	0.1
8	Y Current	40008	0.1	0.1
9	B Current	40009	0.1	0.1
10	Σ kVA	40010	0.1	1
11	Σ kW	40011	0.1	1
12	Nil	40012	0.1	1
13	Σ PF	40013	0.001	0.001
14	Frequency	40014	0.01	0.01
15	kWH MSB	40015	0.1	1
16	kWH LSB	40016	0.1	1
17	Meter Type / Runhour MSB	40017		
18	Runhour LSB	40018		
19	Import / Export	40019		

a) Σ PF Calculation : If P.F < 1000 PF is in Lag (P.F = PF)
If P.F > 1000 PF is in Lead P.F = (PF-1000)

b) Σ kWh Calculation : Σ kWh = (kWh MSB * 65536) + kWH LSB

c) Meter Type / Runhour MSB : 256

d) Q = Meter Type : 03 = LT Meter ; 05 = HT Meter

e) R : Runhour MSB

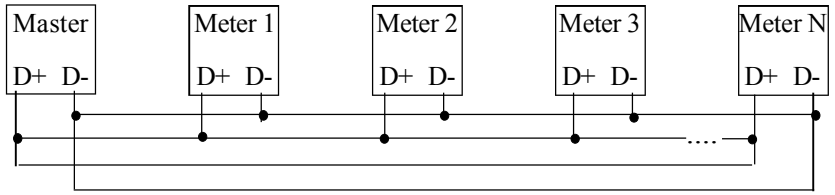
d) Total Runhour : (Runhour MSB * 65536) + Runhour LSB

Note : kWh or kVah are shown in the same address which ever is selected in program mode

7.1 Communication connection diagram

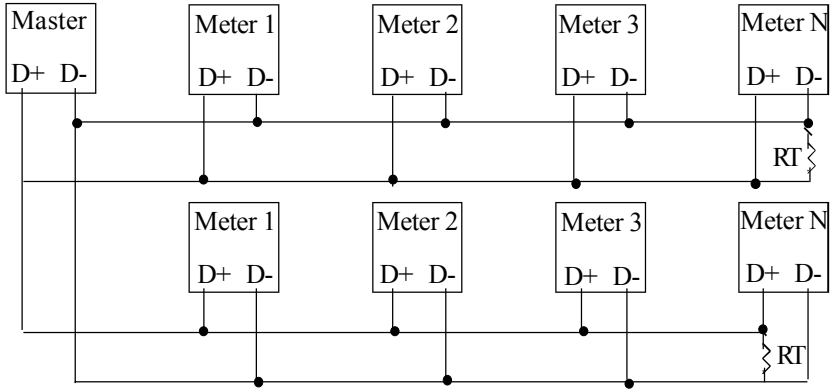
When connecting the meters in multidrop communication network, the following methods are to be adopted for trouble free communication.

1. **Loop Topology**



In this method, the communication continous to work even if there is a breakage in any one of the Loop. Termination resistors are not required.

2. **Straight line Topology**



In this method termination resistor RT (60 -100 Ω) of value equal to characteristic Impedance of the cable used may be required to avoid reflection loses.

It is recommended to use proper & suitable communication cable for trouble free communication.

8. Technical specification (class 0.5 & Class 1)

Type	: ICD make **MULTI FUNCTION METER**
Application	: LT / HT Application (Field programmable)
Model	: **MFM 9112**
Voltage Input	: **LT :** 415 AC RMS (-20% to +10%)
(Line to Line)	**HT :** 110V AC RMS (30VAC to 140VAC)
Current Input	: 5A / 1A AC R.M.S. (Field programmable)
Over Load Capacity	: 10A Max continuous, 50A max for 3 seconds
Working Load Range	: 0.5% to120% of load current
Frequency	: 40.00 to 60.00Hz
Measurement Method	: 3 Watt Meter or
	2 Watt Meter (Field programmable)
Accuracy	: **Class 0.5** as per **IS 14697** (or)
	Class 1 as per **IS 13779 (ordering Option)**
Display	: 2 row 16 character LCD Display with Backlit
Character Size	: 4.35(H) x 2.95(W) mm
LCD Power Save	: Provided, when no key is operated for 3 minutes the LCD backlit is switched OFF to save power and to enchance the life of LCD.The backlit is switched ON, when any key is pressed.
Programmable Parameter	: PT primary & secondary Voltage , CT Primary & secondary current, Modbus ID, Energy & Runhour Reset facility with password protection
Parameter storage	: In non-volatile EERAM
Phase Reverse Indication	: Provided by showing minus sign in Instant kW
Energy Registering during Reverse	: Not done
Display page selection	: By set of keys provided in front panel.
Calibration pulse O/P	: Provided thru' IR LED in front panel
Meter Constant	: 3200imp/kWh

Burden on Voltage I/P : 0.25VA per phase
Burden on Current I/P : 0.25 V A per phase
Burden on Auxiliary I/P : 4 V A
THD Accuracy : ± 2%OFS for % values (for loads > 20%)
Auxiliary Supply : 90 - 270 VAC(Derived from Voltage input terminals. External110V /240V AC RMS available as ordering option.)

Parameter displayed : (Class 1)

Parameter	Range	Resolution	Accuracy
R, Y, B Voltage	50 - 280 V AC	0.1 V (LT)	±1%+2Least digit
	25 - 80 V AC	0.01kV (HT)	±1%+2Least digit
RY, YB, BR Voltage	90 - 485 V AC	0.1 V (LT)	±1%+2Least digit
	40 - 140 V AC	0.01kV (HT)	±1%+2Least digit
Current	0 - 100 A AC	0.1 A (LT & HT)	±1%+2Least digit
	> 100 A - primary current (CT) set	1 A (LT & HT)	
kVA/KW (LT) 3 Phase & total	0 -1000 KVA/KW	0.1kV A/KW	±1%+2Least digit
	>1000 kVA/KW / kVAr	1 kVA /KW	±1%+2Least digit
kVA/KW (HT) 3 Phase & total	0-10000kVA/KW	1kV A/KW	±1%+2Least digit
	>10000 kVA/KW	0.01 MVA/MW	±1%+2Least digit
3Phase Power factor&Avg	0.0Lg - Unity - 0.0Ld	0.001 (LT & HT)	±1%+2Least digit
Frequency	40.00 - 60.00 Hz	0.01Hz(LT & HT)	±0.2%+2Least digi
kWh (or) kVah	9999999.9 kWh (or) kVah	0.1 (LT/HT)	Class 1 as per IS 13997 (±1%)
Run Hour	9999.59 Hours Max.	1 Minute	± 3 sec/day

Parameter displayed : (Class 0.5)

Parameter	Range	Resolution	Accuracy
R, Y, B Voltage	50 - 280 V AC	0.1 V (LT)	±0.5%+2Least digit
	25 - 80 V AC	0.01kV (HT)	±0.5%+2Least digit
RY, YB, BR Voltage	90 - 485 V AC	0.1 V (LT)	±0.5%+2Least digit
	40 - 140 V AC	0.01kV (HT)	±0.5%+2Least digit
Current	0 - 100 A AC	0.1 A (LT & HT)	±0.5%+2Least digit
	> 100 A - primary current (CT) set	1 A (LT & HT)	
kVA/KW (LT) 3 Phase & total	0 -1000 KVA/KW	0.1kV A/KW	±0.5%+2Least digit
	>1000 kVA/KW	1 kVA /KW	±0.5%+2Least digit
kVA/KW (HT) 3 Phase & total	0-10000kVA/KW	1kV A/KW	±0.5%+2Least digit
	>10000 kVA/KW	0.01 MVA/MW	±0.5%+2Least digit
3Phase Power factor&Avg	0.0Lg - Unity - 0.0Ld	0.001 (LT & HT)	±0.5%+2Least digit
Frequency	40.00 - 60.00 Hz	0.01Hz(LT & HT)	±0.2%+2Least digi
kWh (or) kVah	9999999.9 kWh (or) kVah	0.1 (LT/HT)	Class 0.5 as per IS 14697 (±0.5%)
Run Hour	9999.59 Hours Max.	1 Minute	± 3 sec/day

PC Interface (Optional) : An optically isolated RS 485 O/P is available with MODBUS-RTU (MODBUS ASCII, RJ45 are provided as ordering option)

Isolation : 2 kV Isolation for 1 minute between communication and other circuits.

Operating Temperature : 10ºC to 55ºC

Box Dimension : 96(W) x 96(H) x 45(D) mm (Cutout : 92x92mm)

Mounting : Panel

Enclosure / Weight : ABS Plastic case / 325g (Approximately)