Tyco Electronics

Installation Guide

Tegra 710 and 810 Digital metering with RS485 Modbus™ o/p

Introduction

This manual provides operating and installation instructions for the Tegra 710 and 810 multifunction digital metering systems. Both Tegra metering systems combine a basic accuracy of 0.5% with fast response, optional RS485 or Relay output and an easy to read LCD display.

Tegra configurations and product codes

Description	Product Code
WITH RELAY O/P	TEGRA-710-200
WITH RS485 MODBUS™ O/P	TEGRA-710-010
WITH RELAY O/P	TEGRA-810-200
WITH RS485 MODBUS™ O/P	TEGRA-810-010

Warnings

In the interest of safety and functionality this product must be installed by qualified properly trained personnel abiding by local regulations. Voltages dangerous to human life are present at some of the terminal connection of this unit. Ensure that all supplies are de-energised before attempting any connection or disconnection. External installations must be sufficient to protect human life and equipment under fault conditions.

Caution

Follow the installation diagrams carefully. These products do not have internal fuses; therefore external fuses must be used for protection for safety under fault conditions. The current inputs of these products are designed for connection into systems via current transformers x/5A. Never open-circuit the secondary winding of a current transformer. Always ensure that the power is disconnected before separating the current connector from the Tegra. Operation outside specified limits may cause permanent damage or temporary disruption. Do not power or connect the instrument if any part is damaged.

Set up

The following sections give step by step procedures for configuring the Tegra using the display.
To access the set-up screens, press and hold the (▲) "up" and (▼) "down" keys at anytime when the product is switched on.
On completion of the last set up screen, the program exits Set-up mode and returns to the last selected display screen.
The following parameters can be programmed by the user in the order shown:

- Primary VT (Fixed secondary 230V)
- Primary CT (Fixed secondary 5A)
- RS485 serial port option (Port address, Baud rate, Parity)
- Zeroing of active energy meter
- Zeroing of reactive energy meter
- Rear lighting configuration setup

To change any parameters while the product is running you must first power down and repeat the setup access cycle as above.

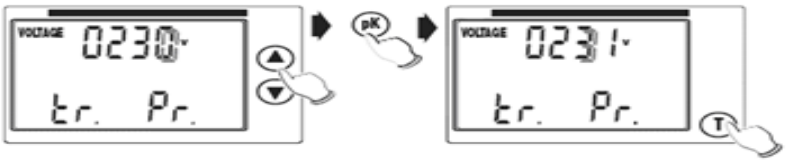
Setup Note 1

This procedure is used in the setup of the primary VT , CT and serial port address.
Press **"T"** to accept the currently displayed value and select the next set up screen.
Press the (▲) "up" and (▼) "down" keys to change the value of the flashing figure.
To move to the next figure press **"pK"** key.
To confirm the value and move to the next window press **"T".**

Primary VT setting

This product is set up for a fixed 230V secondary voltage for a single phase or 4 wire L-N system, when connected to a 3 wire L-L system with VT 's the primary voltage needs to be divide by √3 before entering, maximum primary input of 9999KV L-N can be displayed. The value displayed can be either Volts or Kilovolts by pushing the "**pK**" button after the far left figure is flashing and then pushing either the (▲) "up" and (▼) "down" keys to display the 'K' or pushing again to return to volts.

If there is no potential transformer (VT) associated with the Tegra, i.e. the voltage terminals are connected directly to the metered voltage, leave this value unchanged and skip this step.

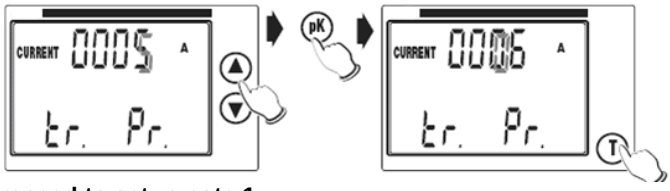


Proceed to setup note 1

Primary CT setting

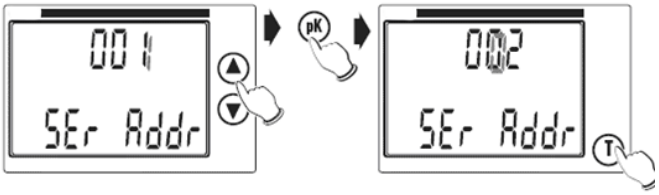
This parameter is the value of normal full scale current that will be displayed as line currents. This screen enables the user to display the line currents inclusive of ratios for X/5A CT.

Note: For the VT and CT primaries, any value from 0001 to 9999 can bet set. If the value is set to 0000 then the instrument will force this to 0001.



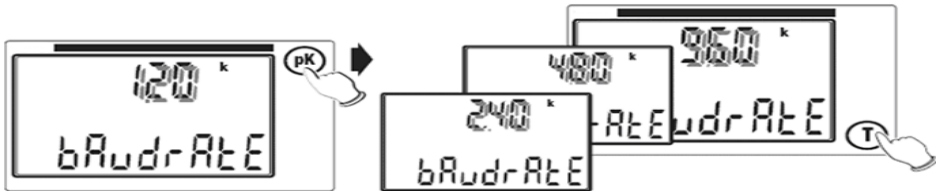
Proceed to setup note 1

RS485 Serial port configuration



Setting the serial port address: Proceed to setup note 1

Setting the serial port speed:

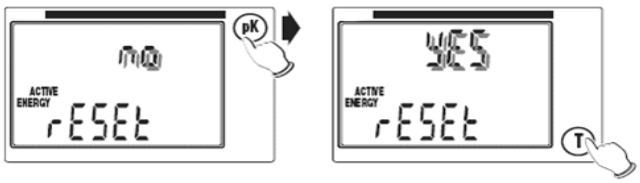


Press **'pK'** to select one of the 4 possible speeds (1200, 2400, 4800 or 9600 Baud)
To confirm the value set and move to the next window, press **"T"**.

Setting the parity bit

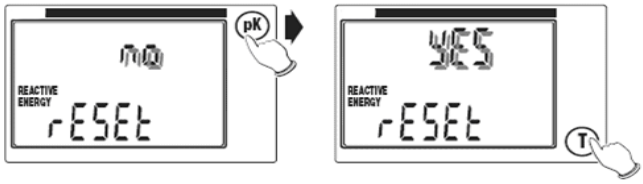
Press **'pK'** to select one of the 3 options, **NONE, ODD** or **EVEN** in that order.
To confirm the value set and move to the next window, press **"T".**

Zeroing the active energy meter



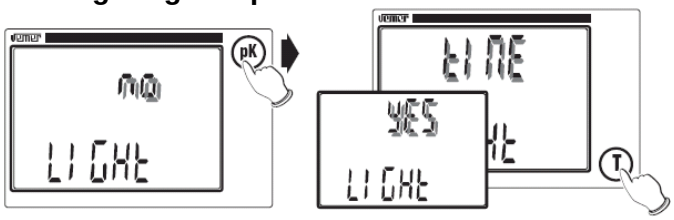
Press **"pK"** to select either **"Yes"** or **"No"** to reset active energy meter.
To confirm the option you require and move to the next window, press **"T"**

Zeroing the reactive energy meter



Press **"pK"** to select either **"Yes"** or **"No"** to reset reactive energy meter.
To confirm the option you require and move to the next window, press **"T"**.

Rear lighting setup



Press **"pK"** to select from one of the three options **"NO"** (rear light off), **"YES"** (on) or **"TIME"** (on for approximately 60 seconds after a key is pressed). To confirm the option set and to terminate the setting up procedure, press **"T".**

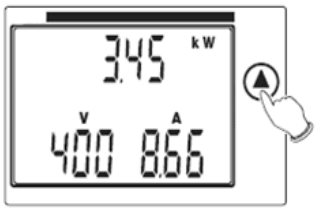
When **"T"** is pressed, all the symbols in the display will come on for approximately 3 seconds, followed by the display of the main page.

Note: If the power is cut off during the programming procedure, the instrument will memorise all the settings in place at the instant when this occurs.

Using the display screens

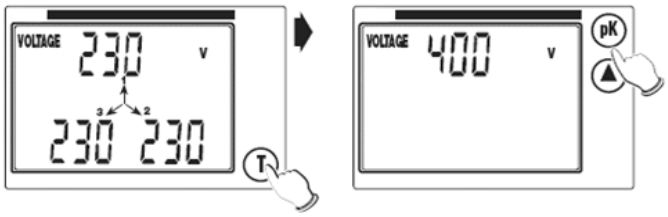
After 3 seconds of switch on or on completion of the setting up procedure the main page will now be operational.
If the (▲) "up" button is pressed screens 2 – 18 will be displayed in sequence if the (▼) "down" button is pressed then the trend is reversed. When the (▲) "up" button is pressed on the last screen it will return to the main screen.
If the voltage or the current is >999 the relevant measurement will flash to indicate that the unit is not set correctly (as prefix **K** or **M** is missing)

1) Main screen



The **system voltage, current** and **active power** are displayed

2) Phase voltage screen



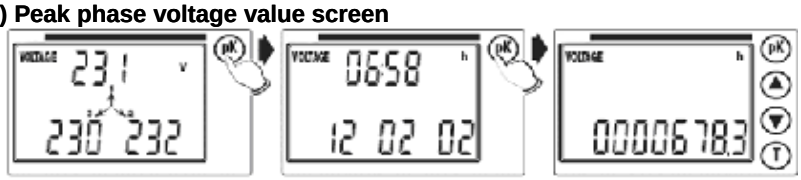
The **phase voltages** are displayed. If the three phase system has no neutral then the voltages shown refer to fictitious star delta centre. To check the system voltage, press the **"T"** key to display it on screen.

Setup note 2
This procedure is for using the display functions of peak phase voltage, current and active, apparent and reactive power.
If the **"pK"** is pressed repeatedly from one of the two phase voltage screen, then the following screens are displayed in order:

- The peak voltage values (the phase of system) with the **"V"** symbol unit flashing.
- The instant when the peak occurred (i.e. time and date).
- The number of hours lapsing between the start-up of the instrument and the occurrence of the peak (this is expressed in hours and tenths of an hour).

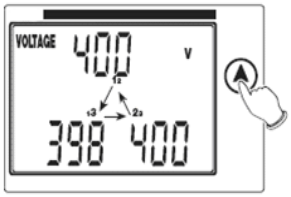
To zero the peak values simply press **"pK"** and **"T"** at the same time.
The (▲) "up" button can be pressed at anytime to move to the next screen.

3) Peak phase voltage value screen



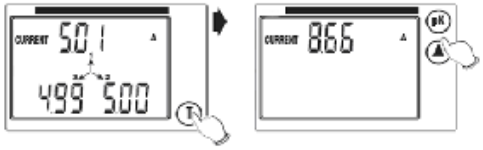
Proceed to setup note 2, section 2, page 3

4) Concatenating voltage screen



The **concatenating voltages** between the phases are displayed

5) Phase current screen

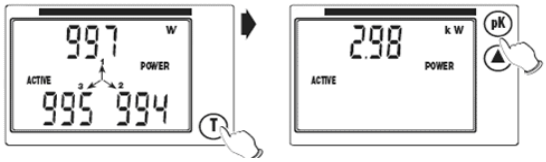


The phase currents are displayed.
To check the system current, press the **"T"** key to display it on screen

6) Peak phase current value screen

Proceed to setup note 2, section 2, page 3

7) Active phase power screen

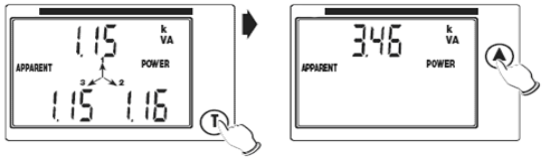


The active phase power is displayed.
To check the **active system power**, press the **"T"** key to display it on screen.

8) Active power peak value screen

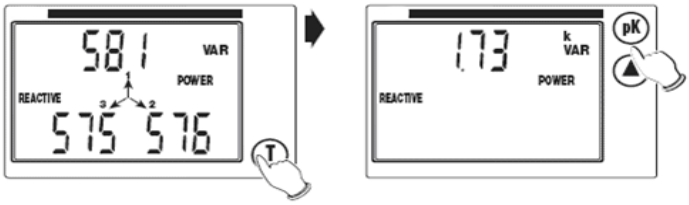
Proceed to setup note 2, section 2, page 3

9) Apparent phase power screen



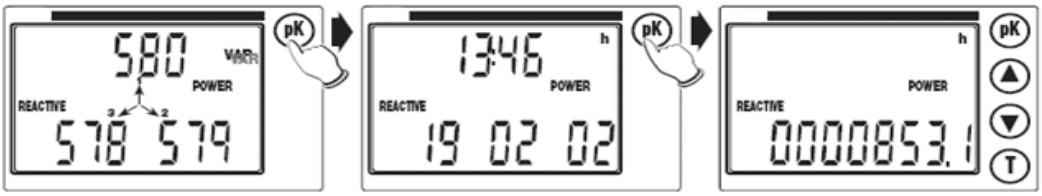
The **apparent phase powers** are displayed.
To check the **Apparent system power**, press the **"T"** key to display it on screen

10) Reactive phase power screen.



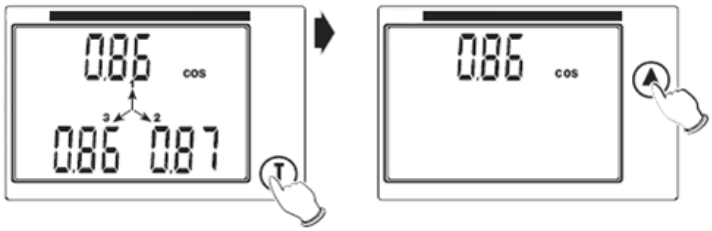
The **reactive phase powers** are displayed.
To check the **reactive system power**, press the **"T"** key to display it on screen.

11) Reactive power peak value screen



Proceed to setup note 2, section 2, page 3

12) Phase power factor screen

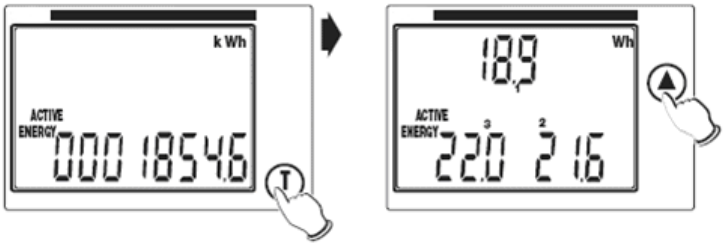


The phase power factors are displayed.
To check the **system power factor**, press the **"T"** key to display it on the screen.

13) Voltage-current phase shift screen

The voltage-current phase shifts are displayed in degrees (the letter **"C"** indicates a capacitive phase shift, and **"L"** indicates an inductive phase shift).

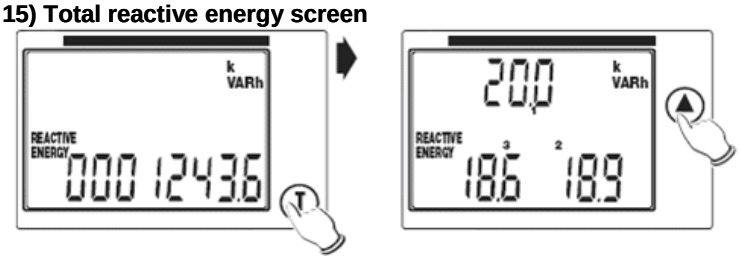
14) Total active energy screen



The **total active energy** is displayed.

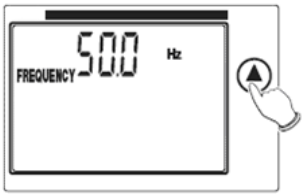
The **"T"** key is used to display the **partial active energy** of the single phases (These energy readings are zeroed each time the total active energy is increased).

15) Total reactive energy screen



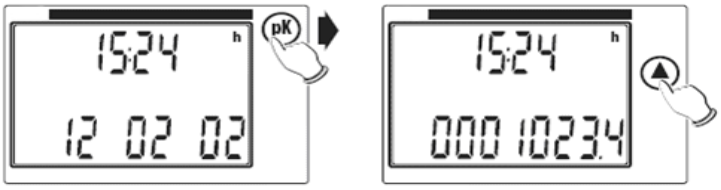
The **total reactive energy** is displayed. The "T" key is used to display **the partial reactive energy** readings for the single phases (These energy readings are zeroed each time the total active energy is increased).

16) Frequency



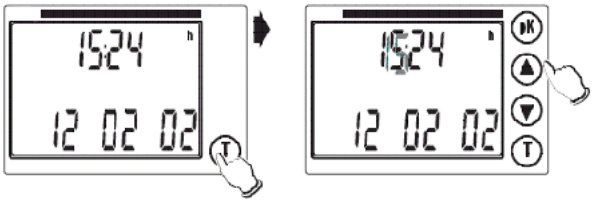
The frequency being displayed is measured from the voltage phase 1.

17) Time and date screen



The time and date are displayed in dd-mm-yy format.
The **"pK"** key is used to move from the display of the time and date lapsed since the instrument was switched on (expressed in hours and tenths of an hour). The (▲) "up" button can be pressed at anytime to move to the next screen.

18) Setting the time and date



When **"T"** is pressed from one of the time display pages, the time and date can now be set.
Press the "up" (▲) or "down" (▼) button to select the required value of the flashing number.
Press **"pK"** to move to the next number. The **"T"** key can be pressed at any time to return to the time display page, with the memorisation of the modifications entered.

Note: up to the entry of the first setting, the time and date will flash. The time and date will also flash in the peak value screens.

Serial Communications Modbus™ Guide

This document contains all the specifications necessary to implement the Modbus™ communication protocol in a master device that has to be integrated with a number of line supervisor slave devices. It contains the specific features of the slave units, such as the data format that can be transmitted on the bus and the Modbus™ sub-system implemented. The reference document for all the aspects of Modbus™, as well as the only official specification of the protocol in question, is to be found on the web site **www.modbus.org** . The data communication system based on the Modbus™ protocol makes it possible to connect up to 247 instruments to a common RS485 line. The communication takes place in half duplex, and only the master (PC/PLC) is able to initiate the question and answer type dialogue with the slaves (address 0) without obtaining any reply.

Characteristics of the Modbus™ protocol

- Type of Modbus™ coding : RTU (Remote Terminal Unit)
- Transmission speed (Baud rate) : 9600, 4800, 2400, 1200 bps (selected by the user)
- Byte format transmitted : 1 start bit, 8 data bits, parity bit : none, odd, even (as selected), 1 stop bit.

The default configuration on leaving the factory for the communication parameters (Which can be selected from the keyboard only) is: baud rate = 9600 bps, parity bit = none , address = 1.

Message structure

The message is structured in various fields (start, address, function, data, CRC check, end), made up of 1 or more characters each. The characters permitted for each field are the hexadecimals 0…9, A…F. The entire message has to be sent with no interruptions, and if there is a pause lasting more than a transmission time of 1.5 characters the receiver has to recognise the incomplete message condition and assume that the following byte is the start of a new message. The start and end of the message can be recognised by a silent interval of at least 3.5 characters. The message can be summed up as follows

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1 +T2 +T3 +T4	8 BITS	8 BITS	n X 8 BITS	16 BITS	T1 + T2 +T3 +T4

Error check calculated procedure

The Cyclical Redundancy Check (CRC) field is made up of two bytes and contains a 16 bit binary value. This value is calculated by the transmitter device, which inserts the CRC in the message. The receiver device recalculates the CRC during the reception of the message and compares the value calculated with that which is received in the message. If the two values do not coincide, an error condition is generated

Modbus™ functions implemented

Read holding register (3)
Read input register (4)
Force multiple coil (15) *
Preset multiple register (16) *

* Slave Address 0 is used for the broadcast address, which all slave devices recognize.

Read holding register (3):

Is the function used for the reading of the registers used to memorise the programmable parameters of the instrument. The registers are programmed by means of the 'preset multiple register' (16) function.

The two bytes to indicate the register are obtained by removing the indicative and subtracting one from the register number. For example:
30003 -> 0003 -> (0003-1) = 0002

List of holding registers (in hexadecimal format):

30001 KTA (primary ammeter transformer)
30002 KTV (primary voltmeter transformer)
30003 calendar: month – day (if the real time clock function is available)
30004 calendar: year – hours (if the real time clock function is available)
30005 calendar: minutes – seconds (if the real time clock function is available)

Read input register (4):

Is the function used for the reading of the registers in which the measurements are memorised. It is possible to obtain more than 10 registers and up to 66 registers for each request.
The measurements available are:

V = system voltage
I = system current
P = active system power
Q = reactive system power
A = apparent system power
PF = system power factor
Ea = total active energy
Er = total reactive energy
f = frequency (phase 1)
V12, V23, V31 = concatenated voltage
Vn = phase voltage (n = 1, 2, 3)
In = phase current (n = 1, 2, 3)
Pn = active phase power (n = 1, 2, 3)
An = apparent phase power (n = 1, 2, 3)
Qn = reactive phase power (n = 1, 2, 3)
PFn = phase power factor (n = 1, 2, 3)
□n = phase shift between voltage and corresponding current (n = 1, 2, 3)

Vmax = maximum system voltage value
Imax = maximum system current value
Pmax = maximum system active power value
Qmax = maximum system reactive power value
TVmax = instant of maximum system voltage value
TImax = instant of maximum system current value
TPmax = instant of maximum system active power value
TQmax = instant of maximum system reactive power value
Vnmax = phase voltage value corresponding to the instant of TVmax (n = 1, 2, 3)
Inmax = phase current value corresponding to the instant of TImax (n = 1, 2, 3)
Pnmax = active phase power value corresponding to the instant of TPmax (n = 1, 2, 3)
Qnmax = reactive phase power value corresponding to the instant of TQmax (n = 1, 2, 3)

The two bytes to indicate the register are obtained by removing the indicative and subtracting one from the register number. For example: 30009 -> 0009 -> (0009-1) = 0008

List of register inputs: each pair of registers contains the value of an electrical dimension measured,
List of register inputs: each pair of registers contains the value of an electrical dimension measured, expressed in IEEE floating point format. The two energy meters are expressed by means of an internal number in 32 bits

Address	No. of words	Dimension	Unit
30001	2	V	[V]
30003	2	I	[A]
30005	2	P	[W]
30007	2	A	[VA]
30009	2	Q	[var]
30011	2	PF	---
30013	2	f	[Hz]
30015	2	V12	[V]
30017	2	V23	[V]
30019	2	V31	[V]
30021	2	V1	[V]
30023	2	V2	[V]
30025	2	V3	[V]
30027	2	I1	[A]
30029	2	I2	[A]
30031	2	I3	[A]
30033	2	P1	[A]

Address	No. of words	Dimension	Unit
30035	2	P2	[W]
30037	2	P3	[W]
30039	2	A1	[VA]
30041	2	A2	[VA]
30043	2	A3	[VA]
30045	2	Q1	[var]
30047	2	Q2	[var]
30049	2	Q3	[var]
30051	2	PF1	---
30053	2	PF2	---
30055	2	PF3	---
30057	2	□1	°
30059	2	□2	°
30061	2	□3	°
30063	2	Ea	[kW/10]
30065	2	Er	[kvar/10]

Apart from the input register at address 0067, there are also the peak values memorised and their times. The time format is identical to that of the holding register 40003 40004 40005.

Address	No. of words	Dimension	Unit
30067	2	Vmax	[V]
30069	2	Imax	[A]
30071	2	Pmax	[W]
30073	2	Qmax	[var]
30075	2	TVmax	(*)
30078	2	TImax	(*)
30081	2	TPmax	(*)
30084	2	TQmax	(*)
30087	2	V1max	[V]
30089	2	V2max	[V]

Address	No. of words	Dimension	Unit
30091	2	V3 max	[V]
30093	2	I1 max	[A]
30095	2	I2 max	[A]
30097	2	I3 max	[A]
30099	2	P1 max	[W]
30101	2	P2 max	[W]
30103	2	P3 max	[W]
30105	2	Q1 max	[var]
30107	2	Q2 max	[var]
30109	2	Q3 max	[var]

(*) The times are expressed in the month-day-year-hour-minutes-seconds format (1 byte for each field).

All the measurements contained in the input registers (with the exception of the times and energy meters) are expressed in standard floating point numerical format IEEE-754, which encodes a floating point number of 32 bits, made up of: 1 sign bit, 8 exponent bits and 23 mantissa bits, arranged as follows:

Sign	Exponent	Mantissa
1 bit	**8 bits**	**23 bits**

The value is encoded as:

$$-1^{s} * (1+m) * 2^{(e-127)}$$

s: sign bit. If the value is negative, this is equal to 1, if positive it is equal to 0.
e: exponent encoded at 8 bits, calculated with an offset of +127.
m: mantissa encoded at 23 bits, calculated by subtracting 1, in such a way as to obtain numbers always between 1 and 1.999999881 (2-(2^{-23}))which can be encoded in negative powers of 2.

Force multiple coil (15)
This function is used to carry out commands on the instrument. The commands are regarded as output coils.

List of outputs:
0001 reset energy meters
0002 reset peak values
0003 disable keyboard
0004 enable keyboard

Preset multiple register (16)
Function used to programme a number of holding registers.

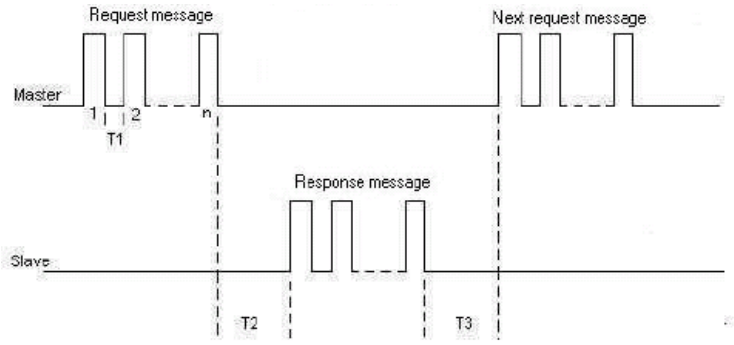
Communication errors detected

"No response". Data format error, CRC error, etc (it is therefore not possible to be certain that the message is correctly addressed).

"Exception response". The possible error codes are:
01 – illegal function
02 – illegal data address
03 – illegal data value

Serial communication times

The communication protocol has no restrictions with regard to the response time of a slave device interrogated by a master (time T2), or with regard to time T3, that is, the time lapsing between the end of a response and the start of a new interrogation by the master.



However, these parameters take on particular importance in the setting up of a network made up of a large number of instruments. If T2 and T3 are not restricted by determined maximum values, the time needed by the master (PC) to interrogate the entire rate may be excessive. It is also necessary to set the minimum values to avoid problems of conflict between different devices. The following have been set and checked at experimental level:

Time	Description	Min and max values
T1	Inter-character timeout	Max=1.5ms (as9600 bps)
T2	Slave (ADR) response time	Min = 10ms Max = 30ms
T3	Minimum time between two requests messages from the Master	Min = 30ms (note 1) Typ = 10s (note 2)

The values set out in the table have been set as design restrictions and checked at experimental
(Note 1) Serial communication allowed. Some functions (for example display refresh and precision) are not performed as well as in normal operation.
(Note 2) Typical value. All functions are well performed.

Technical Specification

Inputs

Nominal rated input voltage	50 – 500V ac L-N (30-300V L-L) 50/60Hz
Nominal input voltage burden	< 2 VA
Nominal rated input current	0.25 – 6A a.c. rms
Nominal input current burden	< 2 VA

System CT primary values 1-9999 A (secondary 5 A)
System VT primary values 1-9999 V (secondary 230 V)

Auxiliary

Standard supply voltage	195.5V - 253V AC 50/60Hz
Supply burden	< 4 VA

Measuring ranges

Values of measured quantities for which accuracy is defined.

Voltage	30 – 550V (minimum voltage 10V)
Current	0.25 - 6A (minimum current 20 mA)
Frequency	47 – 63Hz
Power Factor	0.2 IND – 0.2 CAP
Power	100 MW per phase
Energy	100 MWh

Accuracy

Voltage	0.5 % ± 1 digit
Current	0.5 % ± 1 digit
Frequency	± 0.1Hz
Power factor	± 3 digit
Active power (W)	1% ± 1 digit
Reactive power (var)	1 % ± 1 digit
Apparent power (VA)	1 % ± 1 digit
Active energy (Wh)	class 2
Reactive energy (varh)	class 3

Reference conditions of influence quantities

Influence quantities are variables which affect measurement errors to a minor degree. Accuracy is verified under nominal value (within specified tolerance) of these conditions.

Ambient temperature	20°C
Input frequency	50 or 60Hz
Input waveform	Sinusoidal
Auxiliary supply voltage	230V
Auxiliary supply frequency	50 or 60 Hz
Magnetic field of external origin	Terrestrial flux.

Standards

EMC Emissions	EN 61000-6-3
EMC Immunity	EN 61000-6-2
Safety	EN 61010-1

Insulation

CT primary to voltage circuits	Principal (EN61010-1)
Relay “contact” to voltage circuits	Reinforced (EN 61010-1)
RS485 to voltage circuits	Reinforced (EN 61010-1)
Analogue to voltage circuits	NA
Auxiliary supply to voltage circuits	Principal (EN 61010-1)

Environmental

Operating temperature	0 to +50°C *
Storage temperature	-20 to +60°C *
Relative humidity	10 - 90 % not condensing
Warm up time	1 minute
Shock	0.5 J

* Maximum operating and storage temperatures are in the context of typical daily and seasonal variation. This product is not designed for permanent operation or long term storage at maximum specified temperatures.

Enclosure

Sealing	IP 40 (54 front side installed)
Mounting	DIN rail 4 modules, panel mounting version 72mm DIN-rail mounting, plastic moulded case. ABS + polycarbonate alloy UL94-V0
Weight	0.25 kg DIN-rail and panel mounting (Overall)

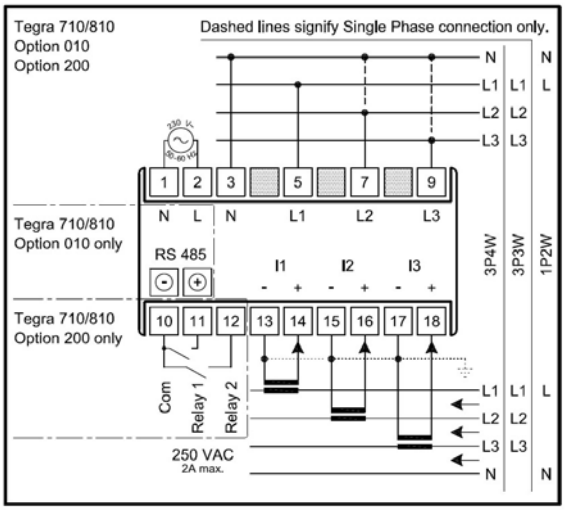
Serial Communications Option

Baud rate	max 9600 bps (programmable)
Parity	None, Odd or Even
Protocol	Modbus™ RTU (RS485)

Active Energy or Reactive Energy Pulsed Output Option

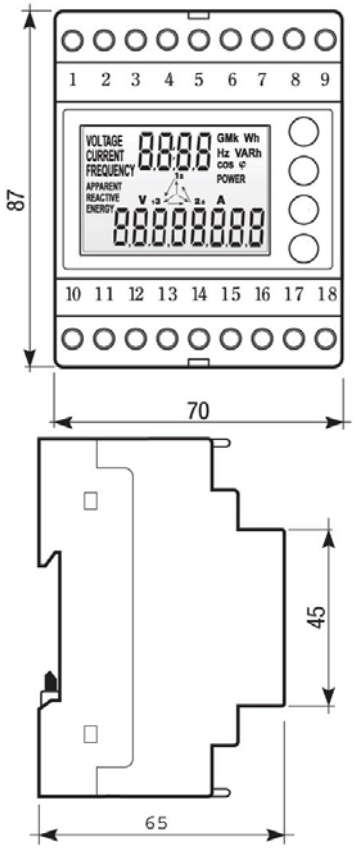
Default pulse rate	1 pulse each "20 x primary CT" Wh or varh for VT primary till 230 V 1 pulse each "40 x primary CT" Wh or varh for VT primary from 230 V to 580 V
Pulsed Output	Relay (free contact)
Pulsed Duration	100 ms

Connection diagram

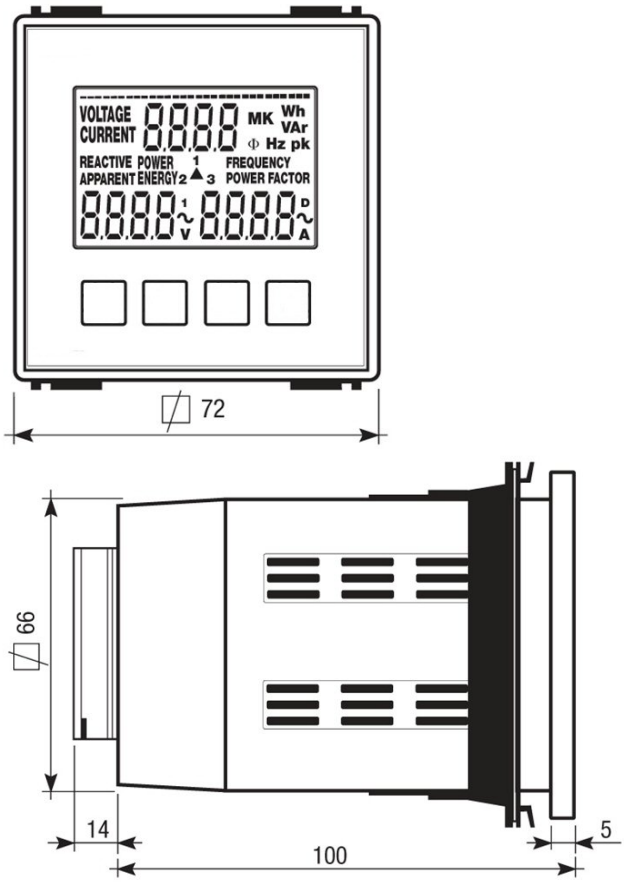


Dimensions

Tegra 710



Tegra 810



Tyco Electronics UK Limited, Energy Division
Freebournes Road, Witham, Essex, CM8 3AH, UK
Phone: +44 (0)870 870 7500
Fax: +44 (0)870 240 5287
www.crompton-instruments.com

Tyco Electronics