Theta 40 series of multi-transducers simultaneously measure several variables of an electric power system and process them to produce 2 or 3 or 4 analogue output signals. 2 or 4 digital outputs are available for signaling limits or power metering. For two of the limit outputs up to 3 measurands can be logically combined

Features

• For all heavy-current power system variables
• Upto 6 outputs (2A + 4D or 4A + 2D or 2A or 3A)
• Input voltage up to 693 V (phase-to-phase)
• Universal analogue outputs (programmable)
• High accuracy: U/I 0.2%, Frequency 0.15% and P 0.25% (under reference conditions)
• Universal digital outputs (meter transmitter, limits)
• AC/DC power supply/universal (24-80V AC/DC or 85-230V AC/DC)
• Windows software with password protection for programming, data analysis,
  power system status simulation, acquisition of meter data and making settings

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Theta 40 **for the measurement of electrical variables in heavy current power systems**

The Theta Series series of multi-transducers **simultaneously** measure several variables of an electric power system and process them to produce 2 or 3 or 4 analogue output signals. 2 or 4 digital outputs are available for signaling limits or power metering. For two of the limit outputs up to 3 measurands can be logically combined.

The multi - transducers are also equipped with an serial **RS 232** interface to which a PC with the corresponding software can be connected for programming or accessing & executing useful ancillary functions. The usual modes of connection, the types of measured variables, their ratings, the transfer characteristic for each output etc. are the main parameters that have to be programmed.

Ancillary functions include a power system check, provision for displaying the measured variable on a PC monitor, the simulation of the outputs for test purposes and a facility for printing nameplates.

Table 1

Measured variables	Output	Types
Current, voltage (rms), active/reactive/ apparent power cos, sin, power factor RMS value of the current with wire setting range (bimetal measuring function) Slave pointer function for the measurement of the RMS value IB Frequency Average value of the currents with sign of the active power (power system only)	2 analogue outputs	Theta M20
	3 analogue outputs	Theta M30
	2 analogue outputs and 4 digital outputs or	Theta M24
	4 analogue outputs and 2 digital outputs	Theta M42
	4 analogue outputs and bus RS 485 (MODBUS)	Theta M40 *
	Data bus (LON) M00	Theta M00 *
	Bus RS 485 (MODBUS)	Theta M01 *
	4 analog output with RS 485, optional display	Theta Trans *

* Refer dedicated data sheet for complete product details.

1 = Input transformer
2 = Multiplexer
3 = Latching stage
4 = A/D converter
5 = Microprocessor
6 = Electrical insulation
7 = D/A converter
8 = Output amplifier/latching stage
9 = Digital output (open-collector)
10 = Programming interface RS-232
11 = Power supply

Fig. 2. Block diagram.

Table 2

A, B, C, D = analogue outputs.
E, F, G, H = digital outputs.

Models	Analog Output	Digital Output	Communication type	Programming Port
Theta M42	4(A,B,C,D)	(E,F)	-	RS 232
Theta M24	2(A,B)	(E,F,G,H)	-	RS 232
Theta M20	2(A,B)	-	-	RS 232
Theta M30	3(A,B,C)	-	-	RS 232
Theta M00	-	-	LON Bus	RS 232
Theta M40	4(A,B,C,D)	-	RS 485	RS 232
Theta M01	-	-	RS 485	RS 232
ThetaTrans	4(A,B,C,D)	-	RS 485	RS 232

Table 3: Symbols and their meaning

| Symbols	Meaning
X	Measured variable
X0	Lower limit of the measured variable
X1	Break point of the measured variable
X2	Upper limit of the measured variable
Y	Output variable
Y0	Lower limit of the output variable
Y1	Break point of the output variable
Y2	Upper limit of the output variable
U	Input voltage
Ur	Rated value of the input voltage

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Table 3: Symbols and their meaning

Symbols	Meaning
U 12	Phase-to-phase voltage L1 - L2
U 23	Phase-to-phase voltage L2 - L3
U 31	Phase-to-phase voltage L3 - L1
U1N	Phase-to-neutral voltage L1 - N
U2N	Phase-to-neutral voltage L2 - N
U3N	Phase-to-neutral voltage L3 - N
UM	Average value of the voltages (U1N + U2N + U3N) / 3
I	Input current
I1	AC current L1
I2	AC current L2
I3	AC current L3
Ir	Rated value of the input current
IM	Average value of the currents (I1+ I2 + I3) / 3
IMS	Average value of the currents and sign of the active power (P)
IB	RMS value of the current with wire setting range (bimetal measuring function)
IBT	Response time for IB
BS	Slave pointer function for the measurement of the RMS value IB
BST	Response time for BS
φ	Phase-shift between current and voltage
F	Frequency of the input variable
Fn	Rated frequency
P	Active power of the system P = P1 + P2 + P3
P1	Active power phase 1 (phase-to-neutral L1 - N)
P2	Active power phase 2 (phase-to-neutral L2 - N)
P3	Active power phase 3 (phase-to-neutral L3 - N)
Q	Reactive power of the system Q = Q1 + Q2 + Q3
Q1	Reactive power phase 1 (phase-to-neutral L1-N)
Q2	Reactive power phase 2 (phase-to-neutral L2-N)

Symbols	Meaning
Q3	Reactive power phase 3 (phase-to-neutral L3-N)
S	Apparent power of the system $S = \sqrt{I_1^2 + I_2^2 + I_3^2} \cdot \sqrt{U_1^2 + U_2^2 + U_3^2}$
S1	Apparent power phase 1 (phase-to-neutral L1-N)
S2	Apparent power phase 2 (phase-to-neutral L2-N)
S3	Apparent power phase 3 (phase-to-neutral L3-N)
Sr	Rated value of the apparent power of the system
PF	Active power factor cos φ =P/S
PF1	Active power factor phase1 P1/S1
PF2	Active power factor phase2 P2/S2
PF3	Active power factor phase3 P3/S3
QF	Reactive power factor sin j =Q/S
QF1	Reactive power factor phase1 Q1/S1
QF2	Reactive power factor phase2 Q2/S2
QF3	Reactive power factor phase3 Q3/S3
LF	Power factor of the system LF = sgnQ (1- PF)
LF1	Power factor phase 1 sgnQ1 (1 - PF1)
LF2	Power factor phase 2 sgnQ2 (1 - PF2)
LF3	Power factor phase 3 sgnQ3 (1 - PF3)
c	Factor for the intrinsic error
R	Output load
Rn	Rated burden
H	Power supply
Hn	Rated value of the power supply
CT	c.t. ratio
VT	v.t. ratio

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## Applicable standards and regulations

Table 4

DIN EN 60 688	Electrical measuring transducers for converting AC electrical variables into analogue and digital signals
IEC 1010 or EN 61 010	Safety regulations for electrical measuring, control and laboratory equipment
EN 60529	Protection types by case (code IP)
IEC 255-4 Part E5	High-frequency interference test (solid-state relays only)
IEC 1000-4-2,3,4,6	Electromagnetic compatibility for industrial process measurement & control equipment
VDI/VDE 3540, page2	Reliability of measuring and control equipment (classification of climates)
DIN 40 110	AC quantities
DIN 43 807	Terminal markings
IEC 68 /2-6	Basic environmental testing procedures, vibration, sinusoidal
IEC 1036	Solid state AC watt hour meters for active power (Classes 1 and 2)
DIN 43864	Current interface for the transmission of impulses between impulse encoder counter and tariff meter
UL 94	Tests for flammability of plastic materials for parts in devices and appliances

Vibration withstand

(tested according to DIN EN 60 068-2-6) Acceleration	± 2 g
Frequency range	10...150 10 Hz, rate of frequency sweep: 1 octave/minute
Number of cycles	10 in each of the three axes
Result	No faults occurred, no loss of accuracy and no problems with the snap fastener

Installation Data

Housing	Housing T24 See Section "Dimensioned drawings"
Housing material	Lexan 940 (polycarbonate) Flammability Class V-0 acc. to UL 94, self extinguishing, non dripping, free of halogen
Mounting	For snapping onto top-hat rail (35X15 mm or 35X7,5mm) acc. to EN 50022 or directly onto a wall or panel using the pull-out screw hole brackets
Orientation	Any
Weight Approx.	With supply transformer approx, 1.1kg With AC/DC power pack approx, 0.7kg

Safety

Protection Class	II
Protection	IP 40, housing IP 20 ,terminals
Overvoltage Category	III
Insulation Test	Input voltage: AC 400 V Input current: AC 400 V Output: DC 40 V Power supply: AC 400 V DC 230 V
Surge test	5 KV, 1.2/50ms, 0.5 Ws
Test voltages	50Hz, 1min. (DIN EN 61 010-1) 5550 V, Inputs versus all other circuits as well as outer surface 3250 V, Inputs circuits versus each other 3700 V, power supply versus outputs and SCI as well as outer surface 490V, outputs and SCI versus each other and versus

Terminals

Type	Screw terminals with wire guards
Max. wire gauge	≤ 4.0 mm² single wire or 2 X 2.5 mm² fine wire (use Taparia Screw driver-type 902) To use flat head lugs with total metal length (J) greater than or equal to 17mm.
Lugs	Lug (J)

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Technical data

Reference conditions

Ambient temperature	+ 23 ℃ ± 1 K
Pre-conditioning	30 min. acc. to DIN EN 60 688 Section 4.3, Table 2
Input variable	Rated useful range
Power supply	H =Hn + 1%
Active/reactive factor	cosj=1 resp. sin = 1
Frequency	50 ... 60 Hz, 16 2/3 Hz
Waveform	Sinusoidal, form factor 1.1107
Output load	DC current output: $R_n = \dfrac{7.5\ V}{Y2} \pm 1\%$ DC voltage output: $R_n = \dfrac{Y2}{1\ mA} \pm 1\%$
Miscellaneous	DIN EN 60 688

* Basic accuracy 0.5 c for applications with phase-shift

Duration of the measurement cycle	Approx. 0.25 to 0.5 s at 50 Hz, depending on measured variable & programming
Response time	1 ... 2 times the measurement cycle

Factor c (the highest value applies)

Linear characteristic	$c = \dfrac{1 - \dfrac{Y0}{Y2}}{1 - \dfrac{X0}{X2}}$ or c = 1
Bent characteristic X0 ≤ X ≤ X1	$c = \dfrac{Y1 - Y2}{X1 - X2} \cdot \dfrac{X2}{Y2}$ or c = 1
X1 ≤ X ≤ X2	$c = \dfrac{1 - \dfrac{Y1}{Y2}}{1 - \dfrac{X1}{X2}}$ or c = 1
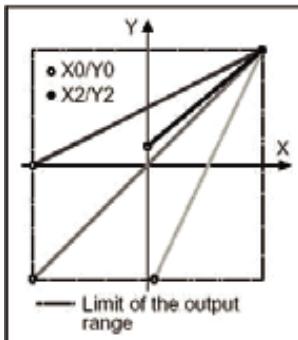
Fig. 3. Examples of settings with linear characteristic.
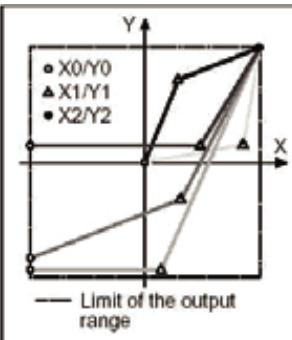
Fig. 4. Examples of settings with bent characteristic.

Power Supply

AC Voltage	100. 110. 230, 400, 500 or 693 V, + 10%, 45 to 65 Hz Power consumption approx 10 VA
AC / DC power pack (DC and 50...60 HZ)	

Input

Input variables	see Tables 10 and 15
Measuring ranges	see Tables 10 and 15
Wave form	Sinusoidal
Rated frequency	50...60 Hz, 16 2/3 Hz
Own consumption	Voltage circuit $\leq U^2$ / 400 kW Condition: external power supply Currenr circuit: 0.3 V A I / 5 A

Table 5 : Continuous thermal ratings of inputs

Current circuit	10 A 400 V single-phase AC system 693 V three-phase system
Voltage circuit	480V single-phase AC system 831V three-phase system

Table 6 : Short-time thermal rating of inputs

Input variable	Number of inputs	Duration of overload	Interval between two overloads
Current circuit	400 V single-phase AC system 693 V three-phase system		
100 A	5	3 s	5 min.
250 A	1	1 s	1 hour
Voltage circuit	1 A, 2 A, 5 A		
Single-phase AC system 600 V H intern : 1.5 Ur	10	10 s	10 s.
Three-phase system 1040 V H intern : 1.5 Ur	10	10 s	10 s.

Programming connector on transducer

Interface	RS 232 C
DSUB socket	9-pin

CTS RTS DSR — GND DTR TXD RXD
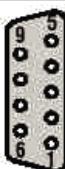
The interface is electrically insulated from all other circuits

Influencing quantities and permissible variations

Acc. to DIN IEC 688

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Technical data

Table 7

Analogue output		
Output Variable Y	Impressed DC Current	Impressed DC Voltage
Full scale Y2	See "Ordering Information"	
Limits of output signal for input overload and/ or	See "Ordering Information"	
R = 0	1.25 Y2	40 mA
R -> ∞	30 V	1.25 Y2
Rated useful range of output load	$0 \le \dfrac{7.5\,V}{Y2} \le \dfrac{15\,V}{Y2}$	$\dfrac{Y2}{2mA} \le \dfrac{Y2}{1mA} \le \infty$
AC component of output signal (peak-to-peak)	≤ 0.005 Y2	

The outputs A, B, C and D may be either short or open-circuited. They are electrically insulated from each other and from all other circuits (floating)

All the full - scale output values can be reduced subsequently using the programming software, but a supplementary error results. The hardware full-scale settings for the analogue outputs may also be changed subsequently. Conversion of a current to a voltage output or vice versa is also possible. This necessities changing resistors on the output board. The full-scale values of the current and voltage outputs are set by varying the effective value of two parallel resistors (better resolution). The values of the resistors are selected to achieve the minimum absolute error. Calibration with the programming software is always necessary following conversion of the outputs. Refer to the Operating Instructions.
Caution : The warranty is void if the device is tampered.

Digital outputs, pulse outputs, limit outputs	
The digital outputs conform to DIN43 864. The pulse width can be neither programmed nor is there a hardware setting.	
Type of contact	Open collector
Number of pulses	See "Ordering Information"
Pulse Duration	≥ 100 ms
Interval	≥ 100 ms
Power supply	8...40 V
Output current	ON 10...27mA OFF < 2mA
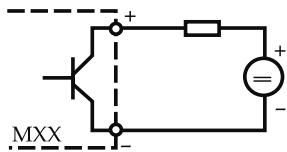
System response
Accuracy class

(the reference value is the fullscale value Y2)

Table 8

Measured variable	Condition	Accuracy class*
System Active, reactive and apparent power	0.5 ≤ X2/Sr ≤ 1.5 0.3 ≤ X2/Sr < 0.5	0.25 c 0.5 c
Phase Active, reactive and apparent power	0.167 ≤ X2/Sr ≤ 0.5 0.1 ≤ X2/Sr < 0.167	0.25 c 0.5 c
Power factor, active power and reactive power	0.5Sr ≤ S ≤ 1.5 Sr, (X2 - X0) = 2	0.25 c
	0.5Sr ≤ S ≤ 1.5 Sr, 1 ≤ (X2 - X0) < 2	0.5 c
	0.5Sr ≤ S ≤ 1.5 Sr, 0.5 ≤(X2 - X0) < 1	1.0 c
	0.1Sr ≤ S< 0.5 Sr, (X2 - X0) = 2	0.5 c
	0.1Sr ≤ S< 0.5Sr, 1≤ (X2 - X0) < 2	1.0 c
	0.1Sr ≤ S < 0.5Sr, 0.5 ≤ (X2 - X0) < 1	2.0 c
AC Voltage	0.1 Ur ≤ U ≤ 1.2 Ur	0.2 c
AC current/ current averages	0.1 Ir ≤ I ≤ 1.5 Ir	0.2 c
System frequency	0.1 Ur ≤ U ≤ 1.2 Ur resp. 0.1 Ir ≤ I ≤ 1.5 Ir	0.15+ 0.03 c (f_N =50...60 Hz) 0.15 + 0.1 c (f_N =16 2/3 Hz)
Pulse	acc. to IEC 1036 0.1 Ir ≤ I ≤ 1.5 Ir	1.0 c

Ambient conditions	
Climatic rating	Climate class 3 acc to VDI / VDE3540
Variations due to ambient temperature	± 0.1% / 10K
Nominal range of use	0...15...30...45°C (Usage group II)
Storage temperature	-40 to +85 °C
Relative humidity of annual mean	≤ 75%

Table 9: Rated voltages and tolerances	
Rated voltage U_N	Tolerance
24 ... 60 V DC/AC	DC -15 ... + 33% AC ± 10%
85 ... 230 V DC/AC	
Consumption:	≤ 9 W resp. ≤ 10VA

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Table 10: Theta 40, standard version

The two versions of the transducer below with the **basic** programming are available AC Aux. & AC/DCAux.

Description / Basic programming		M 42	M 24	M20	M30	M40	M00	M01	Theta Trans
Mechanical design: Rated frequency:	Housing T24 for rail and wall mounting 50 Hz (60 Hz admissible without additional error, re-programming by user for 16 2/3Hz possible, but with additional error 1.25 c)				□ □ □ □				
Power supply:	**230 VAC** **85...230 V DC/AC**				□				
Power supply:	External connection (standard)	□	□	□	□	□	□	□	□
Full-scale output signal, output A:	Y2 = 20 mA	□	□	□	□	□	N. A.	N. A.	□
Full-scale output signal, output B:	Y2 = 20 mA	□	□	□	□	□	N. A.	N. A.	□
Full-scale output signal, output C:	Y2 = 20 mA	□	N. A.	N. A.	N. A.	□	N. A.	N. A.	□
Full-scale output signal, output D:	Y2 = 20 mA	□	N. A.	N. A.	N. A.	□	N. A.	N. A.	□
Test certificate:	None supplied	□	□	□	□	□	□	□	□
Programming:	Basic	□	□	□	□	□	□	□	□
Optional Display: See Table 15 : "Ordering information for MXX models" Theta Series		N. A.	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.	□
Basic programming Application	4-wire,3-phase system, asymmetric load(NPS)				□				
Input voltage	Design value Ur = 400 V				□				
Input current	Design value Ir = 5 A without specification of primary ratings				□				
Measured variable, output A Output signal, output A	P1; X0= 115.47 W; X2 = 115.47 W # DC current Y0 = - 20 mA; Y2 = 20 mA Linear characteristic Standard limits	□	□	□	□	□	N. A.	N. A.	□
Measured variable, output B Output signal, output B	P2; X0 = - 115.47; X2 = 115.47 W # DC current Y0 = - 20 mA; Y2 = 20 mA Linear characteristic Standard limits	□	□	□	□	□	N. A.	N. A.	□
Measured variable, output C Output signal, output C	P3; X0 = 115.47 W; X2 = 115.47 W # DC current Y0 = - 20 mA; Y2 = 20 mA Linear characteristic Standard limits	□	N. A.	N. A.	□	□	N. A.	N. A.	□
Measured variable, output D Output signal, output D	P; X0 = - 346.41; X2 = 346.41 W# DC current Y0 = - 20 mA; Y2 = 20 mA Linear characteristic Standard limits	□	N. A.	N. A.	N. A.	□	N. A.	N. A.	□
Output signal, output E	Limit P; XI = 311.77 W # Output ON if X>XI Min. pick-up delay	N. A.	□	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.
Output signal, output F	Limit Q; XI= 34.64 var # Output ON if X>XI Min. pick-up delay	N. A.	□	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.
Measured variable, output G	Limit P1; XI= 115.47 W # Output ON if X> XI Min. pick-up delay	□	□	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.
Measured variable, output H	Limit I1; XI = 2 A # Output ON if X> X1 Min. pick-up delay	□	□	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.

\# Other specifications on request contact to Factory

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Table 11

Function			Connection
Meas. input AC current	IL1		1 / 3
	IL2		4 / 6
	IL3		7 / 9
Meas. input AC Voltage	UL1		2
	UL2		5
	UL3		8
	N		11
Outputs Analogue	Digital		
A		+	15
		−	16
B		+	17
		−	18
C	E	+	19
		−	20
D		+	21
		−	22
	G	+	23
		−	24
	H	+	25
		−	26
Power Supply AC		~	13
		~	14
DC		+	13
		-	14

If power supply is taken from the measured voltage internal connections are as follow:
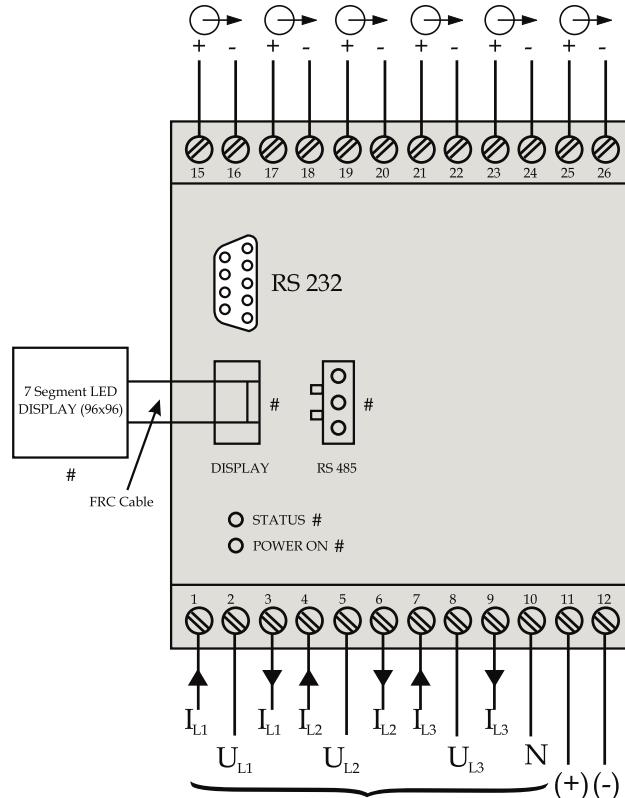
Table 12

Application (system)	Internal connection Terminal / System
Single phase AC current	2 / 11 (L1 - N)
4-wire 3-phase symmetric load	2 / 11 (L1 - N)
All other *	2 /5 (L1 - L2)

Table 13

	Modbus
M40	23, 24, 25, 26 (RS 485)
M00	15, 16 LON Bus
M01	23, 24, 25, 26 (RS 485)

applicable only for Theta Trans

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Table 14   Electrical Connections

| System / application	Terminals
Single-phase AC system	
3-wire 3-phase symmetric load I: L1	Connect the voltage according to the following table for current measurement in L2 or L3:
3-wire 3-phase symmetric load Phase-shift U: L1 - L2 I: L1	Connect the voltage according to the following table for current measurement in L2 or L3:
3-wire 3-phase symmetric load Phase-shift U: L3 - L1 I: L1	Connect the voltage according to the following table for current measurement in L2 or L3:

Current transf.	Terminals		2	5	8
L2	1	3	L2	L3	L1
L3	1	3	L3	L1	L2

Current transf.	Terminals		2	5
L2	1	3	L2	L3
L3	1	3	L3	L1

Current transf.	Terminals		8	2
L2	1	3	L1	L2
L3	1	3	L2	L3

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Table 14   Electrical Connections

System / application	Terminals
3-wire 3-phase symmetric load Phase-shift U: L2 - L3 I: L1	Connect the voltage according to the following table for current measurement in L2 or L3:

Current transf.	Terminals		5	8
L2	1	3	L3	L1
L3	1	3	L1	L2

System / application	Terminals
4-wire 3-phase symmetric load I: L1	Connect the voltage according to the following table for current measurement in L2 or L3:

Current transf.	Terminals		2	11
L2	1	3	L2	N
L3	1	3	L3	N

System / application	Terminals
3-wire 3-phase symmetric load	

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Table 14   Electrical Connections

System / application	Terminals
4-wire 3-phase asymmetric load	3 single-pole insulated voltage transformers in high-voltage system
4-wire 3-phase asymmetric load, Open Y connection	Low-voltage system 2 single-pole insulated voltage transformers in high-voltage system
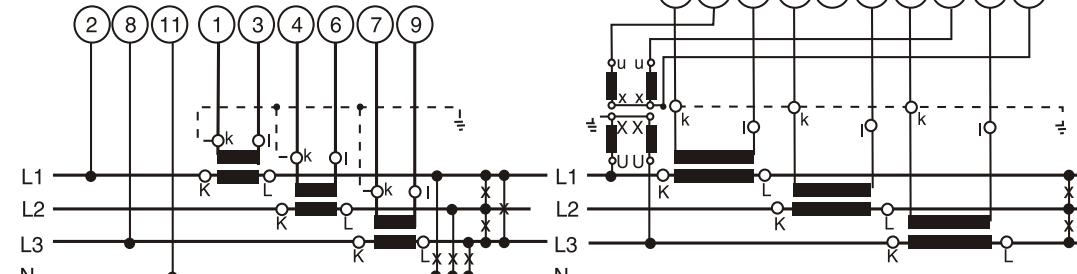
Relationship between PF, QF and LF

Fig.5.
Active Power PF
Reactive Power QF
Power factor LF

Output

Dimensional Drawing

5.905"
150mm

6.181"
157mm

3.445"
87.5mm

4.882" / 124mm
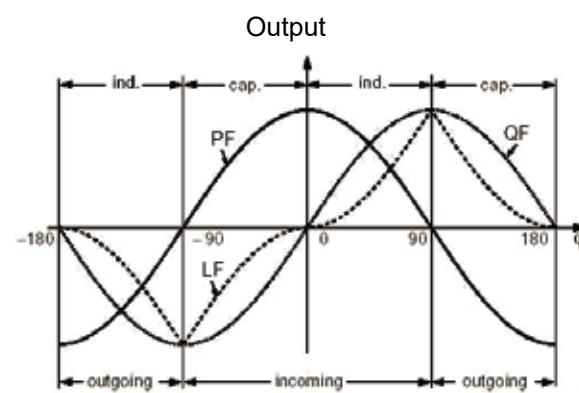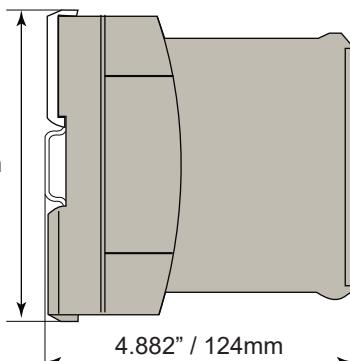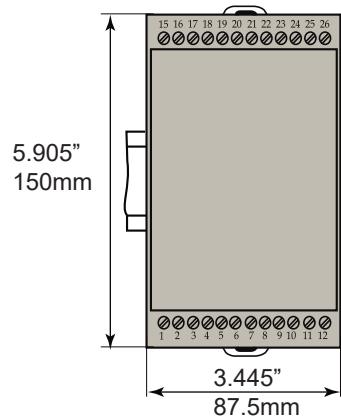
Theta Series in housing T24 clipped onto a top-hat rail
(35 X 15 mm or 35 X 7.5 mm, acc. to EN 50 022).

0.798"
19mm

0.256"
6.5mm

0.177"
4.5mm

5.905"
150mm

6.496"
165mm

7.126"
181mm

0.472"
12mm

4.858" / 123.4mm

3.445" / 87.5mm
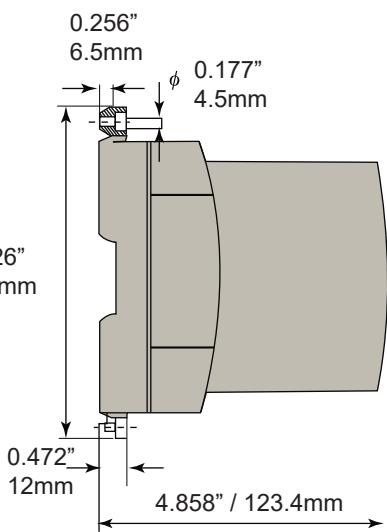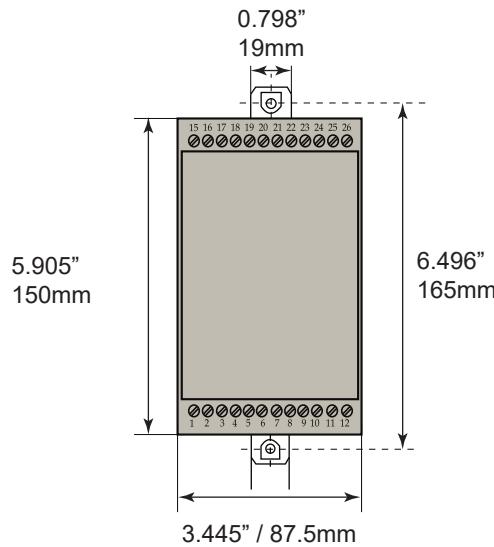
Theta Series in housing T24, screw hole mounting
brackets pulled out.

Ordering Information

Product Code	TT40-		X	X	00000000000
Compensation	M42	1			
	M24	2			
	M20	3			
	M40 RS485	4			
	M30	5			
	M01 RS485	6			
	M00 LONBUS	7			
Power Supply	24-60U			F	
	85-230U			J	