USER MANUAL LQT40S

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The LQT40S is a programmable multi transducer for power systems. All electrical quantities for AC current and voltage (True RMS) are covered by one single unit. It can measure single phase systems up to 4-wire unbalanced load systems. With its 4 analog and 2 digital outputs together with a serial interface RS 485, Modbus, LQT40S offers almost unlimited possibilities.

Our free transducer configuration software "ConfigLQT" is used to easily program the LQT40S via its USB-port.

Table of contents

1 Instructions

1.1 Purpose of this document

This document describes how to use the LQT40S multi transducer. The user manual is intended to be used by:

• installation personnel and commissioning engineers

• service and maintenance personnel

• planners

1.2 Mounting

The transducer can be mounted on a 35 mm DIN rail according EN50022, on a wall or device cabinet for suitable protection. The enclosure shall not be accessible without tools.

1.3 Installation

The installation shall be made by trained personnel and in accordance with applicable regulations. Before the installation, please check that the transducer is the correct type and complies with the installation needs.

	A marked external circuit breaker to turn off the power supply to the transducer must be installed near. The OFF-position shall be clearly marked.
	Attention: Danger to life! Ensure that all leads are free of potential when connection them!
	Voltage measurements inputs must have circuit breakers or fuses rated 5 Amps or less.
	The measuring circuits from the current transformers must be short-circuited before disconnection. No fuses are allowed on the current inputs.

1.4 Operation

The transducer is intended for operation at an altitude not exceeding 2000 m and in an environment that is not considered as wet location.

Operation temperature: -20…22…24…+55°C

Proper function is only guaranteed if the USB is not connected to the transducer and all the instructions in this manual are followed for safety reasons.

1.5 Safety

All inputs and outputs are galvanically isolated from each other.

Protection class:	II, protective insulation, voltage inputs via protective impedance.
Protection:	IP40 (housing), IP20 (terminals)

1.6 Warning!

Connection must comply with current regulations for systems with rated voltage up to 1000 V. Before switching on or off and if the housing is removed, all voltages to the equipment must be switched off and external currents circuit shorted before disconnected.

1.7 Maintenance

The transducer requires no maintenance. Any repairs shall be performed by trained personnel, or the equipment shall be returned to the supplier for repair.

1.8 Symbols


Double insulated device, protection class 2.


Warning for life-threatening or hazardous for properties situations.


Caution, possibility of electric shock


Read the manual before use


The device must be discarded in a professional way

CE conformity mark

1.9 FCC Part 15 information

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

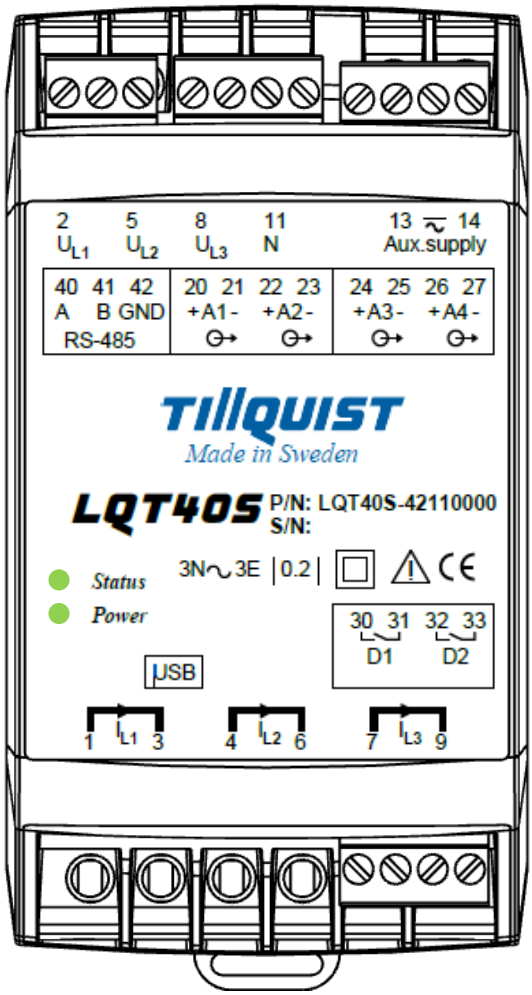
1.10 Disclaimer of liability

The content of this document has been reviewed to ensure correctness. Nevertheless it may contain errors or inconsistencies and we cannot guarantee completeness and correctness. This is especially true for different language versions of this document. This document is regularly reviewed and updated. Necessary corrections will be included in subsequent version and are available via our webpage http://www.tillquist.com.

2 Connections

2.1 Connection diagram

Voltage input		
U_{L1}	2	
U_{L2}	5	
U_{L3}	8	
N	11	
Current input	In	Out
I_{L1}	1	3
I_{L2}	4	6
I_{L3}	7	9
Aux Power Supply		
	13	
	14	
Analog Output		
A1	20	+
	21	-
A2	22	+
	23	-
A3	24	+
	25	-
A4	26	+
	27	-
Digital Output		
D1	30, 31	
D2	32, 33	
Modbus RS485		
A	40	
B	41	
GND	42	



2.2 Electric connection

The plug-in terminals needs to be removed before accessing the input terminals.

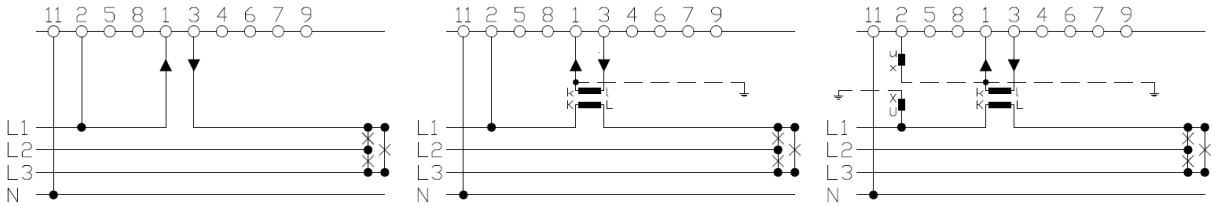
Inputs L1, L2, L3, N, I1, I2, I3, Aux.supply	
Wire section:	6.0 mm² / 10 AWG
Clamp opening size:	3.2 × 3.9 mm
Wire stripping:	max 9 mm
Recommended torque:	0.8 - 0.88 Nm / 7.2 - 7.9 in.lbs
Analog Outputs, Digital Outputs, RS 485 (plug-in terminals)	
Wire section:	2.5 mm² / 14 AWG
Clamp opening size:	2.8 × 3.1 mm
Wire stripping:	max 8 mm
Recommended torque:	0.5 - 0.55 Nm / 4.5 - 4.9 in.lbs

2.3 Connection diagrams – System connection

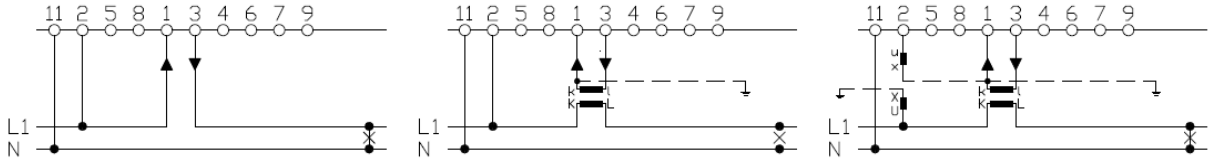
LQT40S system connection is programmable from single phase to 4-wire balanced or unbalanced connection.

Configurable System Connection											
System connection	**Application**	**I1**	**I2**	**I3**	**U1**	**U2**	**U3**	**N**	**U12**	**U23**	**U31**
-00	4wire, 3 phase symmetric load	X	-	-	X	-	-	X	-	-	-
-01	1-wire, 1 phase	X	-	-	X	-	-	X	-	-	-
-02	3-wire, 3 phase symmetric load	X	-	-	-	-	-	-	X	-	-
-03	3-wire, 3 phase symmetric load	X	-	-	-	-	-	-	-	X	-
-04	3-wire, 3 phase symmetric load	X	-	-	-	-	-	-	-	-	X
-05	3-wire, 3 phase symmetric load	X	-	-	X	X	X	-	X	X	X
-09	3-wire, 3 phase asymmetric load	X	-	X	X	X	X	-	X	X	X
-11	4-wire, 3 phase asymmetric load	X	X	X	X	X	X	X	X	X	X
-11	4-wire, 3 phase asymmetric load Open Delta	X	X	X	X	X	X	-	X	X	X

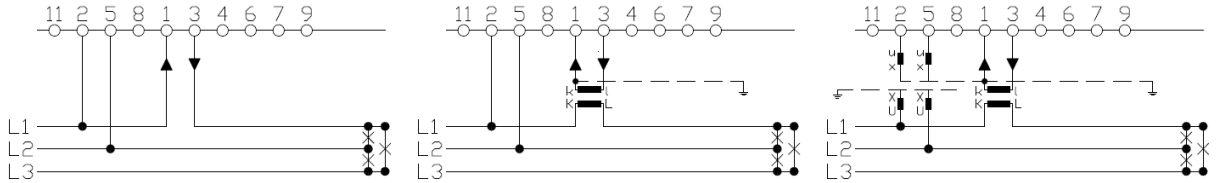
-00 1-phase 4-wire
1 element 3-phase symmetric load



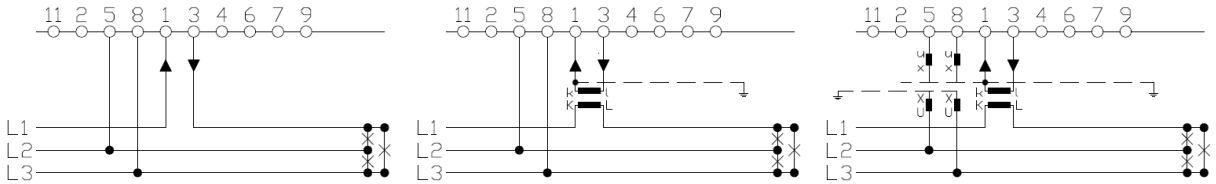
-01 1-phase 2-wire
1 element Single-phase AC



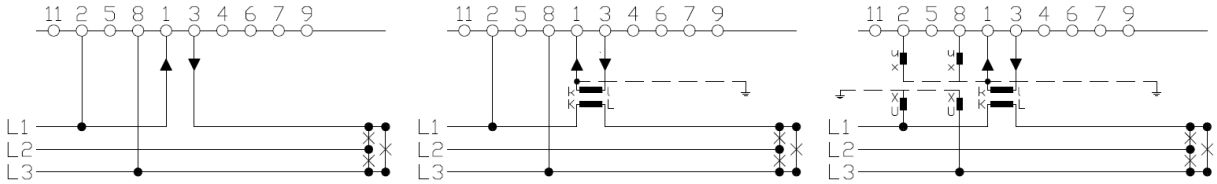
-02 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U12-I1



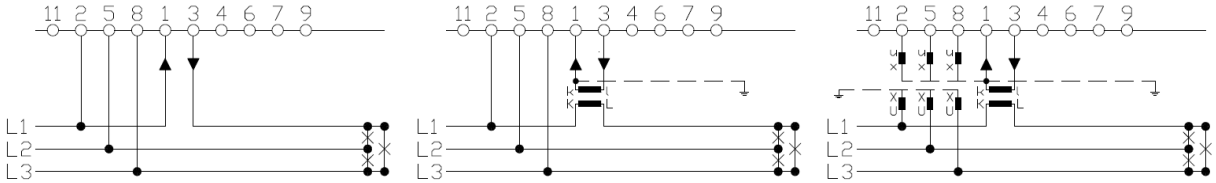
-03 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U23-I1



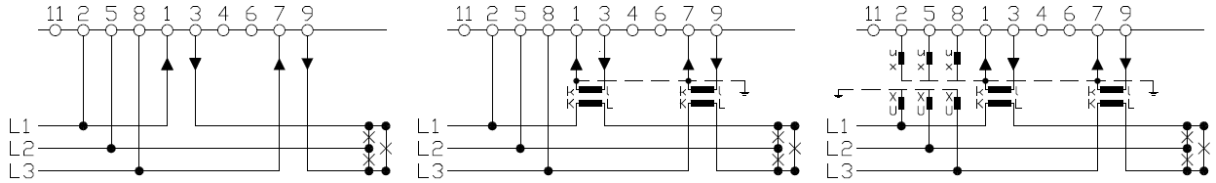
-04 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U31-I1



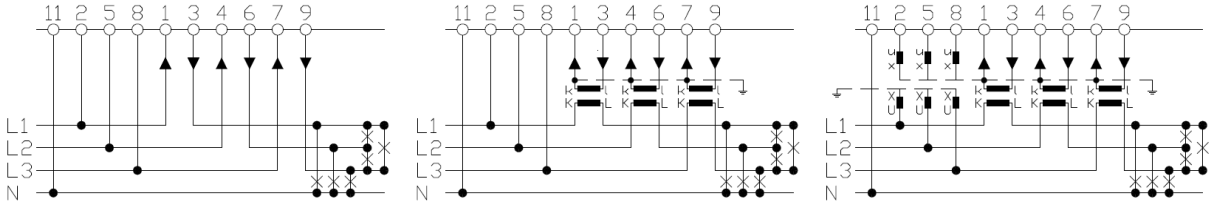
-05	3-phase 1 element	3-wire 3-phase symmetrical load



-09	3-phase 2 elements	3-wire 3-phase asymmetrical load



-11	3-phase 3 elements	4-wire 3-phase asymmetrical load



3 Measuring

3.1 Measured quantities

Prefix	Quantity	Calculation	System / Phase
I	Input current	(I1+I2+I3)/3	System
I1	Phase current L1		L1
I2	Phase current L2		L2
I3	Phase current L3		L3
U	Input voltage	(U1+U2+U3)/3	System
U1	L1 Phase voltage		L1
U2	L2 Phase voltage		L2
U3	L3 Phase voltage		L3
P	Active power	P1+P2+P3	System
P1	Active power L1		L1
P2	Active power L2		L2
P3	Active power L3		L3
Q	Reactive power	Q1+Q2+Q3	System
Q1	Reactive power L1		L1
Q2	Reactive power L2		L2
Q3	Reactive power L3		L3
S	Apparent power	S1+S2+S3	System
S1	Apparent power L1		L1
S2	Apparent power L2		L2
S3	Apparent power L3		L3
U12	Main voltageL1-L2		L1 - L2
U23	Main voltage L2-L3		L2 - L3
U31	Main voltage L3-L1		L3 - L1
PF	Active power factor	P/S	System
PF1	Active power factor	COS(φ1)=P1/S1	L1
PF2	Active power factor	COS(φ2)=P2/S2	L2
PF3	Active power factor	COS(φ3)=P3/S3	L3
QF	Reactive power factor	Q/S	System
QF1	Reactive power factor	SIN(φ1)=Q1/S1	L1
QF2	Reactive power factor	SIN(φ2)=Q2/S2	L2
QF3	Reactive power factor	SIN(φ3)=Q3/S3	L3
LF	LF factor	sign(Q)*(1-|PF|)	System
LF1	LF factor	sign(Q1)*(1-|PF1|)	L1
LF2	LF factor	sign(Q2)*(1-|PF2|)	L2
LF3	LF factor	sign(Q3)*(1-|PF3|)	L3
PA	Phase angel	PA=(PA1+PA2+PA3)/3	System
PA1	Phase angel	φ1=ARCCOS(P1/S1)/PI*180*sign(P1)	L1
PA2	Phase angel	φ2=ARCCOS(P2/S2)/PI*180*sign(P2)	L2
PA3	Phase angel	φ3=ARCCOS(P3/S3)/PI*180*sign(P3)	L3
IS	Input current with sign	(IS1+IS2+IS3)/3	System
IS1	Phase current with sign	I1*sign(P1)	L1
IS2	Phase current with sign	I2*sign(P2)	L2
IS3	Phase current with sign	I3*sign(P3)	L3
P_I1_U12	Active power, System connection-02		System
P_I1_U23	Active power, System connection -03		System
P_I1_U31	Active power, System connection -04		System
Q_I1_U12	Reactive power, System connection -02		System
Q_I1_U23	Active power, System connection -03		System
Q_I1_U31	Active power, System connection -04		System
F	Frequency		System

3.2 Meassuring system

3.2.1 Phase-Locked loop - PLL

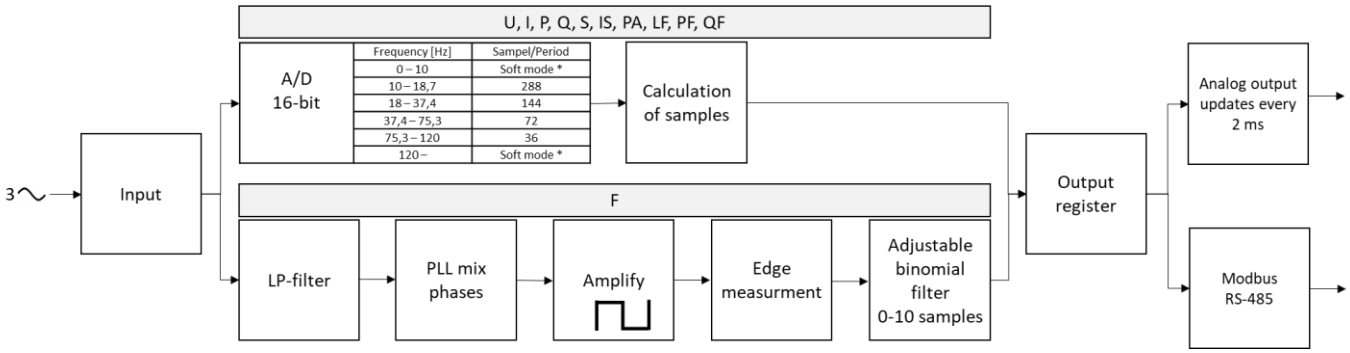
The measuring system use a phase-locked loop (PLL) between 10-120 Hz. All quantities are being measured. The number of samples per period is deppending of the frequency.

3.2.2 Soft mode

A fixed sample rate of 1800 samples/second (soft mode) is used when the frequency is lower than 10 Hz or higher than 120 Hz. Measured quantities in soft mode are voltage (U), current (I) and frequency (F).

3.2.3 Block diagram

Schematic block diagram of measure process.



* *Soft mode = 1800 samples / second*

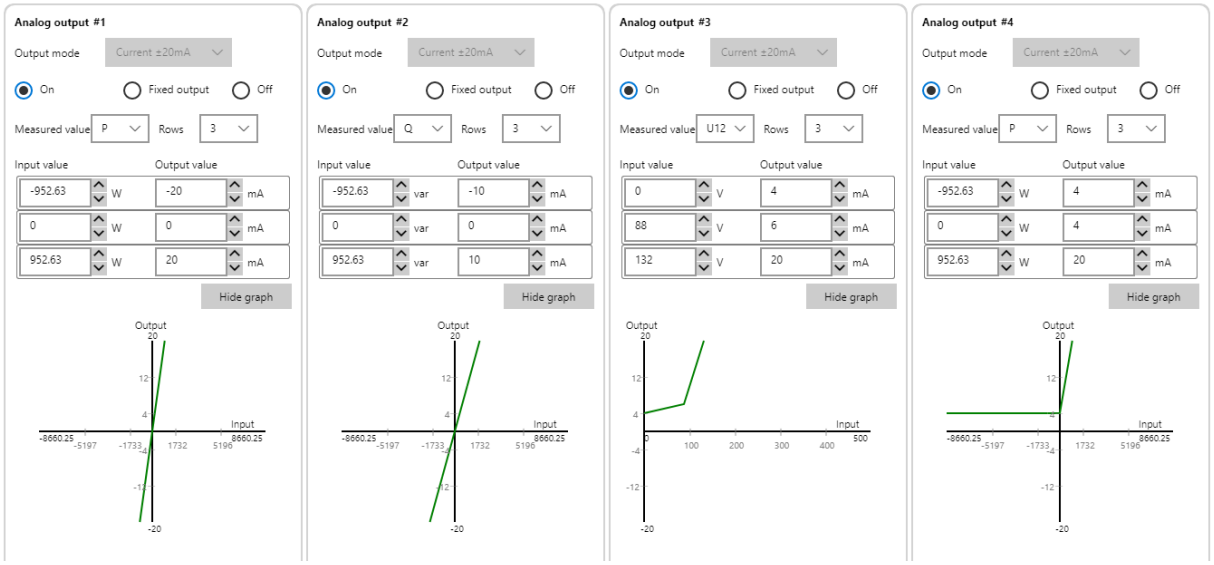
3.2.4 Frequency filter

The frequency measurement is low-pass filtered with a binomial filter. This setting determines the length of the filter in periods of the measured frequency. A shorter length gives a more responsive measurement. A longer length gives a slower, more stable measurement.
Frequency filter is adjustable between 0 – 10.

4 Outputs

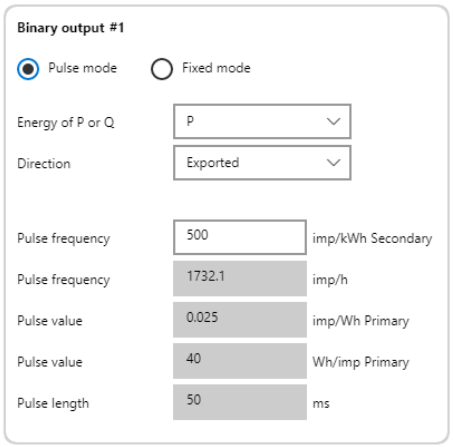
4.1 Analog output

The analog outputs can be assigned any measured quantity, see table *"3.1 Measured quantities"*. The output is available with three different ranges, ±20 mA, ±5 mA or ±10V. The resolution of the output is 16 bits. 2 to 5 characteristic point can be programmed for each channel. It is possible to set a fixed value for the output. Fixed output is useful when testing an installation. Off position is the same as 0 mA or V.



4.2 Digital outputs

Digital output is used to pulse energy, P (active power) or Q (reactive power) as export or import.



4.3 Modbus RS485

4.3.1 Interface Modbus RTU

Protocol:	Modbus RTU
Physics:	RS-485, max 1200 m (4000 ft)
Baud rate:	2400, 4800, 9600, 19200, 38400 Baud
Number of participants:	max 32

For additional information about Modbus: www.modbus.org

4.3.2 Modbus mapping

Different Modbus protocol profiles are available, depending of needs and the update frequency of data.

Modbus protocol profile Mapping 001

The output registry for the measured quantities is updated every 100 ms with profile mapping 001.

adr	format	parameter			explanation	
0	binary32	F	Hz	Frequency	system	
2	binary32	I	A	Input current	system	I = (I1+I2+I3)/3
4	binary32	I1	A	Phase current	L1	
6	binary32	I2	A	Phase current	L2	
8	binary32	I3	A	Phase current	L3	
10	binary32	U	V	Input voltage	system	U = (U1+U2+U3)/3
12	binary32	U1	V	Phase voltage	L1-N	
14	binary32	U2	V	Phase voltage	L2-N	
16	binary32	U3	V	Phase voltage	L3-N	
18	binary32	U12	V	Main voltage	L1-L2	
20	binary32	U23	V	Main voltage	L2-L3	
22	binary32	U31	V	Main voltage	L3-L1	
24	binary32	P	W	Active power	system	P = P1+P2+P3
26	binary32	P1	W	Active power	L1	
28	binary32	P2	W	Active power	L2	
30	binary32	P3	W	Active power	L3	
32	binary32	Q	var	Reactive power	system	Q = Q1+Q2+Q3
34	binary32	Q1	var	Reactive power	L1	
36	binary32	Q2	var	Reactive power	L2	
38	binary32	Q3	var	Reactive power	L3	
40	binary32	S	VA	Apparent power	system	S = S1+S2+S3
42	binary32	S1	VA	Apparent power	L1	S1 = U1*I1
44	binary32	S2	VA	Apparent power	L2	S1 = U1*I2
46	binary32	S3	VA	Apparent power	L3	S1 = U1*I3
48	binary32	LF	-	LF factor	system	LF = sign(Q)*(1-|PF|)
50	binary32	LF1	-	LF factor	L1	LF1 = sign(Q1)*(1-|PF1|)
52	binary32	LF2	-	LF factor	L2	LF2 = sign(Q2)*(1-|PF2|)
54	binary32	LF3	-	LF factor	L3	LF3 = sign(Q3)*(1-|PF3|)
56	binary32	PF	-	Active power factor	system	PF = P/S = COS(ϕ) = COS(PA)
58	binary32	PF1	-	Active power factor	L1	PF1 = P1/S1 = COS(ϕ1) = COS(PA1)
60	binary32	PF2	-	Active power factor	L2	PF2 = P2/S2 = COS(ϕ2) = COS(PA2)
62	binary32	PF3	-	Active power factor	L3	PF3 = P3/S3 = COS(ϕ3) = COS(PA3)
64	binary32	QF	-	Reactive power factor	system	QF = Q/S = SIN(ϕ) = SIN(PA)
66	binary32	QF1	-	Reactive power factor	L1	QF1 = Q1/S1 = SIN(ϕ1) = SIN(PA1)
68	binary32	QF2	-	Reactive power factor	L2	QF2 = Q2/S2 = SIN(ϕ2) = SIN(PA2)
70	binary32	QF3	-	Reactive power factor	L3	QF3 = Q3/S3 = SIN(ϕ3) = SIN(PA3)
72	binary32	PA	°el	Phase angle ϕ	system	PA=(PA1+PA2+PA3)/3
74	binary32	PA1	°el	Phase angle ϕ1	L1	PA1 = ARCCOS(P1/S1)/PI*180*sign(P1)
76	binary32	PA2	°el	Phase angle ϕ2	L2	PA1 = ARCCOS(P2/S2)/PI*180*sign(P2)
78	binary32	PA3	°el	Phase angle ϕ3	L3	PA1 = ARCCOS(P3/S3)/PI*180*sign(P3)
80	binary32	IS	A	Input current with sign	system	IS = (IS1+IS2+IS3)/3
82	binary32	IS1	A	Phase current with sign	L1	IS1 = I1*sign(P1)
84	binary32	IS2	A	Phase current with sign	L2	IS2 = I2*sign(P2)
86	binary32	IS3	A	Phase current with sign	L3	IS3 = I3*sign(P3)
120	binary32	CTR	A/A	primary to secondary current transformer ratio (i.e. 600A/1A)		
122	binary32	PTR	V/V	primary to secondary potential (voltage) transformer ratio (i.e. 220kV/110V)		

Modbus protocol profile Mapping 002

The output registry for the measured quantities is updated every 25 ms with profile mapping 002.

adr	format	parameter			explanation	
0	binary32	F	Hz	Frequency	system	
2	binary32	I	A	Input current	system	I = (I1+I2+I3)/3
4	binary32	I1	A	Phase current	L1	
6	binary32	I2	A	Phase current	L2	
8	binary32	I3	A	Phase current	L3	
10	binary32	U	V	Input voltage	system	U = (U1+U2+U3)/3
12	binary32	U1	V	Phase voltage	L1-N	
14	binary32	U2	V	Phase voltage	L2-N	
16	binary32	U3	V	Phase voltage	L3-N	
18	binary32	U12	V	Main voltage	L1-L2	
20	binary32	U23	V	Main voltage	L2-L3	
22	binary32	U31	V	Main voltage	L3-L1	
24	binary32	P	W	Active power	system	P = P1+P2+P3
26	binary32	Q	var	Reactive power	system	Q = Q1+Q2+Q3

Modbus function code 04: Read Input Registers

The data format used is IEEE 754 single-precision binary floating-point format: binary32
Parameters are represented as two consecutive Modbus registers.
The value of a parameter is represented in SI unit as secondary values on transducer input.
To calculate primary values, use the primary to secondary transformer ratio of parameter CTR, PTR
The CTR and PTR parameter can be configured by the user by editing primary to secondary current- and voltage-ratio in ConfigLQT.

5 Commissioning

5.1 Programming of the transducer

”ConfigLQT” is a free configuration software, it is availible for download from Tillquist homepage, www.tillquist.com. The software connects to the transducer and make it possible to change the configuration of adjustable parameters and to visualize live readings.

ConfigLQT supports offline configuration of adjustable parameters.

Save and load configuration file.

Functionality of ConfigLQT

ConfigLQT allows the user to:

- See online readings of measured values
- Adjust the functionality of the outputs
- Save parameter settings to a file
- Load parameter settings from a file
- Print settings report
- Upgrade firmware

5.2 LED functionality

LQT40S have two LEDs at front, *Power* and *Status*.

State	Power	Status
Start-up	Flashing - On 1 sec / Off 0.5 sec	Flashing - On 1 sec / Off 0.5 sec
Normal operation	On	Off
Modbus active	On	Flashing - On 200 ms / Off 200 ms
Error	Flashing - On 100 ms / Off 100 ms	Off

6 Technical Data

	Technical Data	Details
Input	Voltage range (Un)	100 – 400 V (L-L) main voltage (nominal)
	Measuring range	1 – 520 V TRMS L-L 50/60 Hz or 1 - 520 V TRMS L-L 16⅔ Hz
	Configurable measuring range	0 - 500 V L-L / 0 - 300 V L-N
	Frequency	50/60 Hz (10…40….70…120 Hz) 16⅔ Hz (10…15….18…120 Hz)
	Overload voltage	1.5 x Un – continuously, 2 x Un – 10 s
	Consumption	U x 1 mA / phase
	Current (In)	1 – 5 A
	Measuring range	5 mA – 10 A TRMS
	Configurable measuring range	0 – 10 A
	Overload current	2 x In continuously, 10 x In 15 s, 40 x In 1 s
	Consumption	<0.05 VA / phase
	Auxiliary power supply	24 – 230 VDC / 90 – 230 V AC ±10 %
	Burden	max 7.1 W / 15 VA
Output	Analog outputs	4 or 2
	Programmable range	±20mA, ±5 mA, ±10V (settings within the range)*
	Resolution	16 bits
	External resistance load	Current output: max 750 Ω (15 V) Voltage output: min 750 Ω
	Response time	<100 msec
	Ripple	≤0.2%
	Digital Outputs	2 (Energy pulse output)
		max 100 VAC/VDC 0.1 A
	Communication	Modbus RS485 (RTU)
General Data	Accuracy	0.2 (Ref. temp. 23 °C)
	Galvanic isolation	Supply, in- and output are galvanically isolated
	Connection terminals / Torque	Input and Auxiliary power supply: 6 mm^2 / 0.8 Nm Output: 2.5 mm^2 / 0.5 Nm
	Humidity	95 % non-condensing
	USB	USB Micro-B, port for configuration
	Temperature	-10…+55 °C (operation) -40…+70 °C (storage) Temperature coefficient < 0.1 % / 10 °C
	Test voltage	4 kV AC /1 min
	Inputs	overvoltage cat. III
	Pollution degree	2
	Dimension (W x H x D)	70 x 132 x 101 mm
	Weight	330 gr
	Protection	IP40 (housing), IP20 (terminals)
	Standards	IEC 60688:2021 Transducers SS-EN 61010-1 Safety EN 61000-6-2 / -6-4 / -6-5

**Depending on the version*

7 Ordering Codes

	LQT40S-	X	2	1	X	X	XXX
Number of Analog Outputs							
4		4					
2		2					
Number of Digital Outputs							
2			2				
Serial communication							
RS485 - Modbus				1			
Range of Analog Outputs							
± 20mA					1		
± 5mA					2		
± 10V					3		
Frequency							
50/60 Hz						0	
16⅔ Hz						1	
Other Requirements							
Standard configuration							000
Customer configuration (to provide ERF)							001