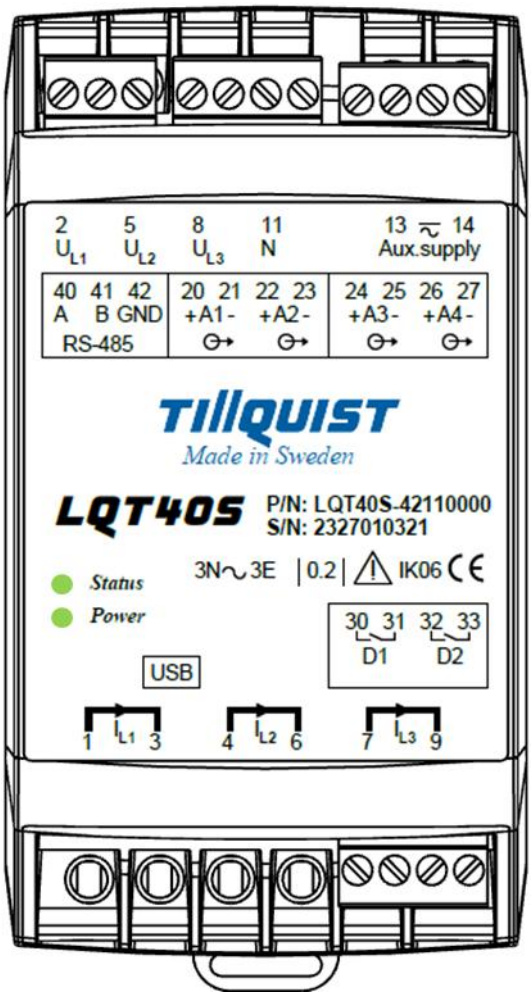
USER MANUAL LQT40S



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The LQT40S is a programmable multi-transducer designed for accurate and flexible measurement of AC current and voltage in modern power systems. With its True RMS measurement capability, it reliably monitors everything from basic single-phase installations to advanced 4-wire unbalanced loads.

In addition to general power monitoring, the LQT40S is particularly well-suited for applications requiring high-precision frequency measurement, such as turbine control and other demanding industrial processes where stability and accuracy are critical.

Equipped with 4 analog outputs, 2 digital outputs, and an RS-485 Modbus interface, the LQT40S offers seamless integration into control, protection, and monitoring environments. Its compact format and the free configuration software ConfigLQT ensure simple installation, programming, and customization via the integrated USB port.

This manual is intended for engineers, technicians, and system integrators. It provides guidance on installation, configuration, operation, and troubleshooting. Please read the safety instructions carefully before installation.

Important User Information

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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 Intended use

The transducer is intended to monitoring and measuring electrical quantities, 1 to 3-phases (alternating voltage and currents). The measured electrical quantities are then available via analog outputs and seriel interface.

1.3 Mounting

	The transducer shall be installed into a protecting cabinet on a 35 mm top hat rail (DIN rail) according IEC 60715. The enclosure shall not be accessible without tools.
	Ensure at least 5 mm free space is left around the device on the DIN rail to allow proper ventilation and safe operation.

1.4 Installation and maintenance

The installation, operation and maintenance shall only be made by qualified electrical engineering 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.

1.4.1 Safety notes

	Attention: Danger to life! Ensure that all leads are free of potential when connection them!
	The AUX supply must be protected by an external fuse or circuit breaker with a maximum rating of 10 A. In addition, an external disconnect device (circuit breaker or switch) shall be installed close to the equipment, easily accessible to the operator, and with its OFF position clearly marked.
	Voltage measurements (U_{L1}, U_{L2}, U_{L3}) inputs must have circuit breaker or fuses rated 10 Amps or less.
	No fuses should be used on the currents inputs (I_{L1}, I_{L2}, I_{L3}). The current measuring circuits from the current transformers must be short-circuited before disconnection.
	Digital outputs must have circuit breakers or fuses rated 100 mA or less.
	When UL certification is required, use a UL-listed current transformer with the correct transformation ratio to ensure compliance with UL standards. a) "Always open or disconnect circuit from power-distribution system (or service) of building before installing or servicing current transformers". b) "The current transformers may not be installed in equipment where they

	exceed 75 percent of the wiring space of any cross-sectional area within the equipment". c) "Restrict installation of current transformer in an area where it would block ventilation openings". d) "Restrict installation of current transformer in an area of breaker arc venting". e) "Not suitable for Class 2 wiring methods" and "Not intended for connection to Class 2 equipment". f) "Secure current transformer and route conductors so that the conductors do not directly contact live terminals or bus". g) The word "WARNING" and the following or equivalent statement: "To reduce the risk of electric shock, always open or disconnect circuit from power-distribution system (or service) or building before installing or servicing current transformers".

1.5 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: -10…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.

If the equipment is used in a manner not specified by this instruction, the protection provided by the equipment may be impaired.

1.6 Safety

All inputs and outputs are galvanically isolated from each other.

Protection class:	II, protective insulation, voltage inputs via protective impedance.
Communication interfaces:	Only connect the communication interfaces of the device to circuits with extra-low voltage (max. 30VAC, 42.4V peak, 60VDC). Only connect the communication interfaces of the device to circuits which provide double or reinforced insulation to mains or other hazardous voltages.
Protection:	IP40 (housing), IP20 (terminals)

1.7 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.

1.8 Maintenance

The transducer requires no maintenance. Any repairs shall be performed by trained personnel authorized by the product's manufacturer only, or the equipment shall be returned to the supplier for repair.

Wipe the device using a clean, dry and soft cloth if necessary. Do not use solvents.

1.9 Symbols

Warning for life-threatening or hazardous for properties situations.

Caution, possibility of electric shock

Read the manual before use

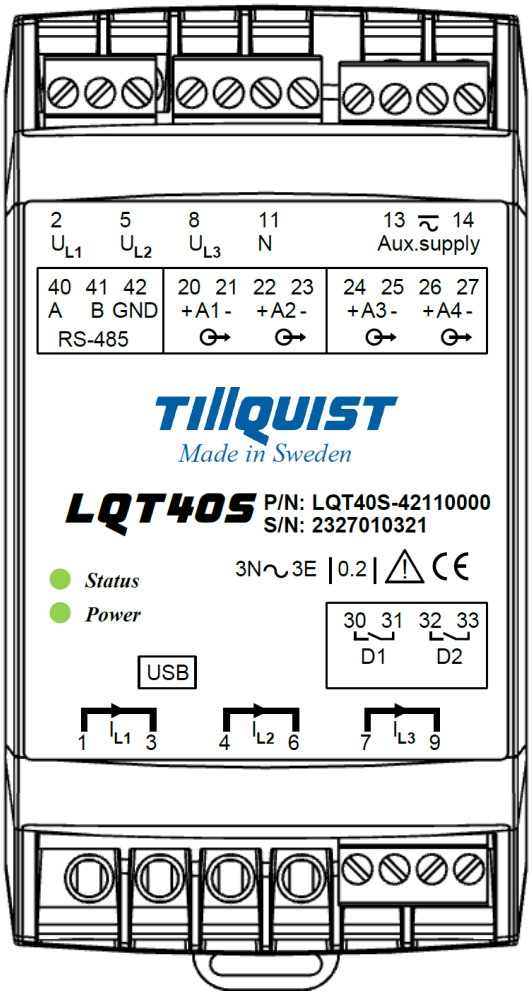
The device must be discarded in a professional way

CE conformity mark

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.

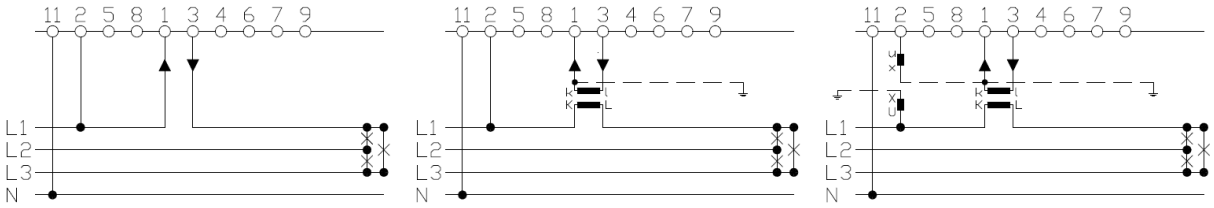
Inputs L1, L2, L3, N, I1, I2, I3, Aux.supply	
Wire section:	6.0 mm² / 10 AWG solid and stranded Copper ≥70 °C
Clamp opening size:	3.2 × 3.9 mm
Wire stripping:	max 9 mm
Recommended torque:	0.8 - 0.88 Nm / 7.2 - 7.9 in.lbs
Analog Outputs, Digital Outputs, RS 485 (plug-in terminals)	
Wire section:	2.5 mm² / 14 AWG solid and stranded Copper ≥70 °C
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

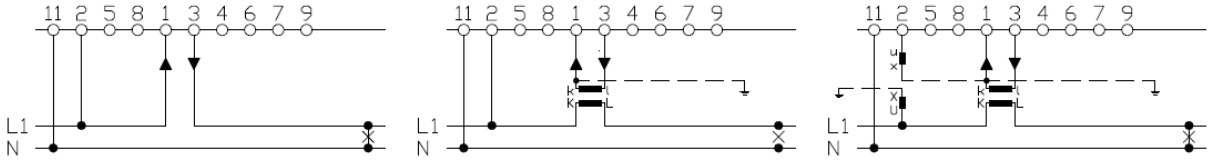
LQT40S system connection is programmable from single phase to 4-wire balanced or unbalanced connection.

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

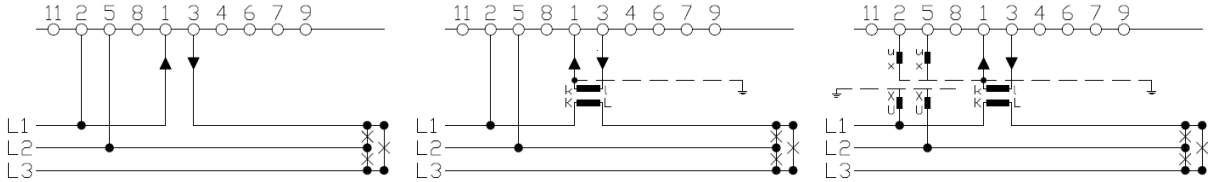
-00 1-phase 4-wire
1 element 3-phase symmetric load



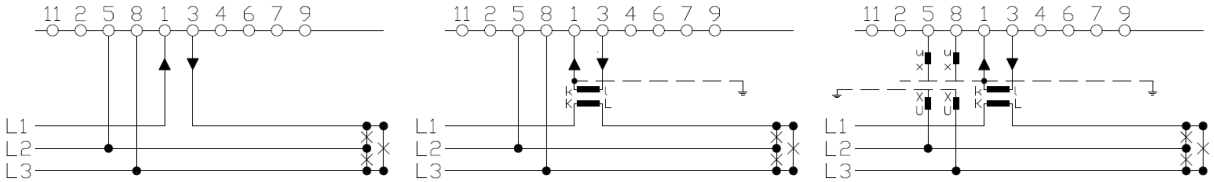
-01 1-phase 2-wire
1 element Single-phase AC



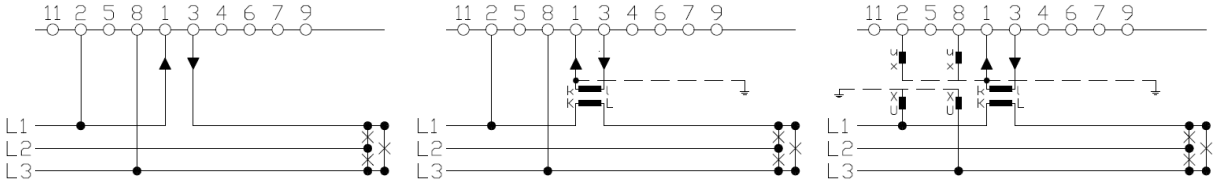
-02 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U12-I1



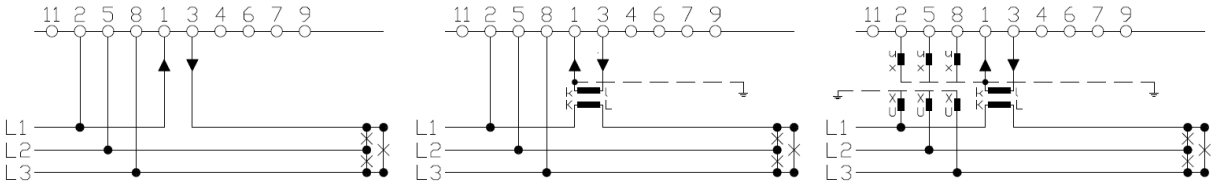
-03 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U23-I1



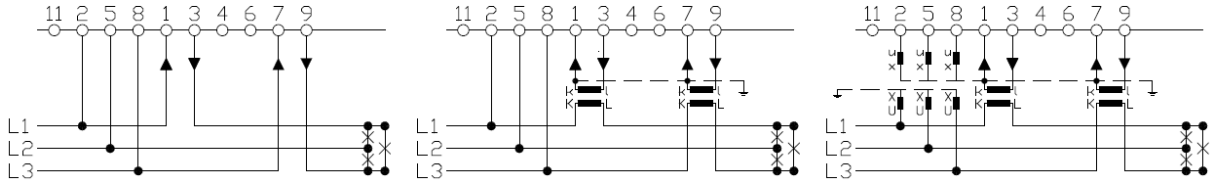
-04 1-phase 3-wire
1 element 3-phase symmetric load phase-shift U31-I1



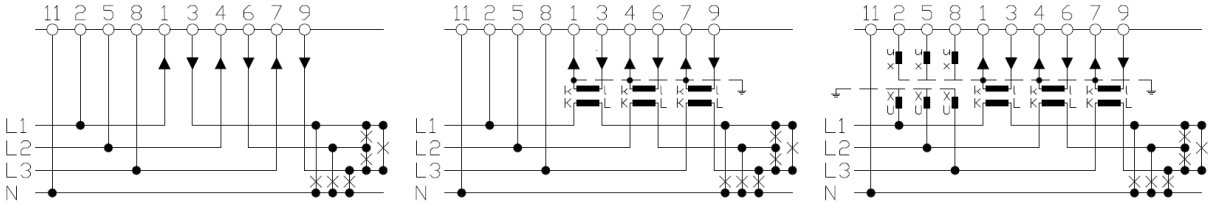
-05	3-phase 1 element	3-wire 3-phase symmetrical load



-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	U1*I1	L1
S2	Apparent power L2	U2*I2	L2
S3	Apparent power L3	U3*I3	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= cos(φ)	System
PF1	Active power factor	cos(φ1)=P1/S1=cos(PA1)	L1
PF2	Active power factor	cos(φ2)=P2/S2=cos(PA2)	L2
PF3	Active power factor	cos(φ3)=P3/S3=cos(PA3)	L3
QF	Reactive power factor	Q/S= sin(φ) =sin(PA)	System
QF1	Reactive power factor	sin(φ1)=Q1/S1=sin(PA1)	L1
QF2	Reactive power factor	sin(φ2)=Q2/S2=sin(PA2)	L2
QF3	Reactive power factor	sin(φ3)=Q3/S3=sin(PA3)	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	φ=arccos(P/S)/PI*180*sign(P)	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
F	Frequency		System

3.2 Meassuring system

3.2.1 Phase-Locked loop - PLL

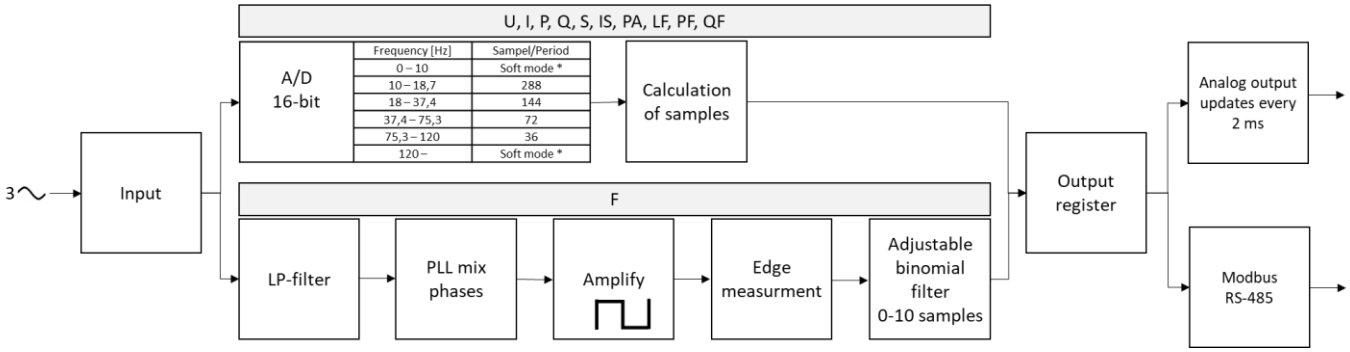
The measuring system use a phase-locked loop (PLL) between 10-120 Hz. All quantities are being measured. The number of samples per period is deppending of the frequency.

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 measurement filter

The voltage inputs, including the neutral line, first pass through a low-pass filter (1-pole, cutoff at 3.4 kHz) to remove high-frequency noise.

Next, the signals are buffered and passed through DC-blocking filters (1-pole, cutoff at 0.033 Hz) to remove any offset. These signals are then sampled by the ADC with reference to the neutral.

An analog multiplexer selects two of the buffered signals (see table). The difference between these signals is filtered and amplified, and then converted into a square wave with the same frequency. This square wave is sent to the microcontroller for frequency detection.

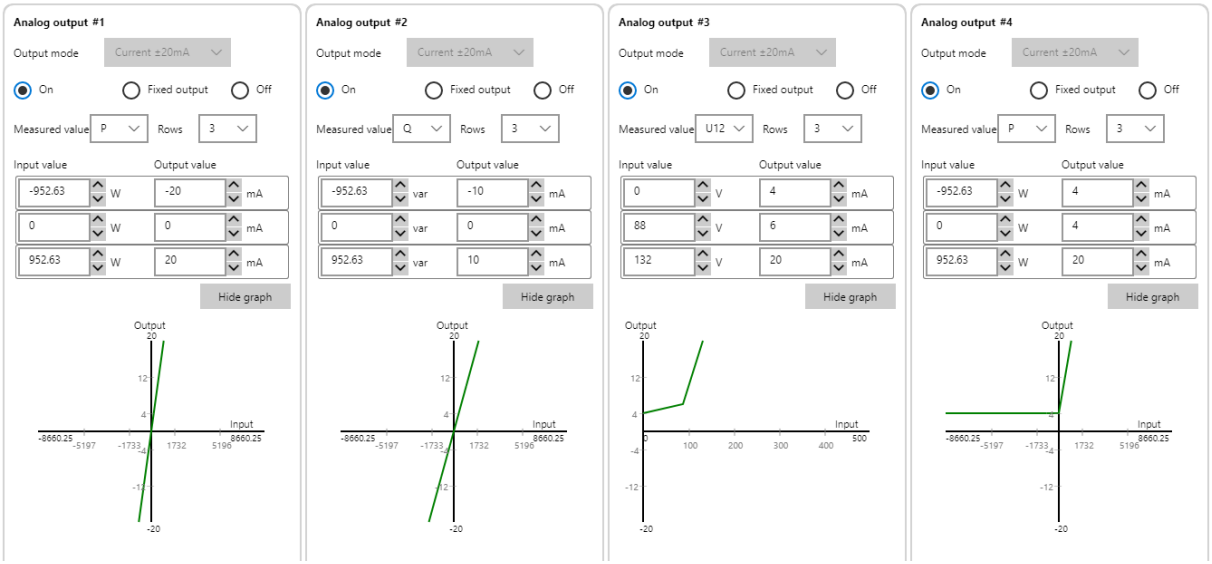
A binomial filter is also available and can be set from 0 to 10 to further smooth the data.

System Connection	**Frequency reference**	
00, 01	U1	(UL1 – UN)
03	U32	(UL3 – UL2)
02, 05, 09, 11	U12	(UL1 – UL2)
04	U31	(UL1 – UL3)

4 Outputs

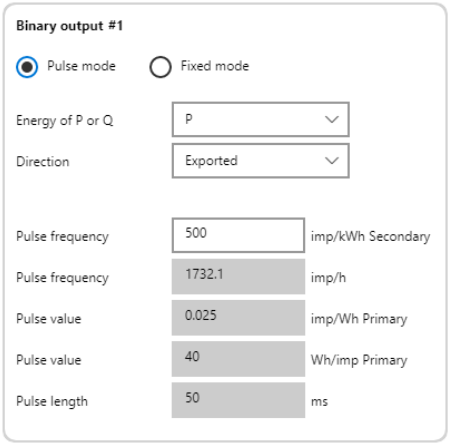
4.1 Analog output

The analog outputs can be assigned to any measured quantity (see Table 3.1, “Measured Quantities”). Each output is available in three selectable ranges: ±20 mA, ±5 mA, or ±10 V, with a resolution of 16 bits. For each channel, 2 to 5 characteristic points can be programmed. It is also possible to set a fixed output value, which is useful for testing installations. The “Off” position corresponds to 0 mA or 0 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 on application requirements, update frequency, and selection of primary or secondary values.

Modbus protocol profile Mapping 001

Profile mapping 001 updates the output register every 100 ms.

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= arccos(P/S)/PI*180*sign(P)
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

Profile mapping 002 updates the output register every 25 ms.

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 available for download from the Tillquist website (www.tillquist.com). The software connects to the transducer, enabling users to modify adjustable parameters and monitor live readings.

ConfigLQT also supports offline configuration, allowing parameter settings to be prepared in advance. Configurations can be saved to a file and later loaded into a transducer.

Key Features of ConfigLQT

With ConfigLQT, users can:

- Monitor live readings of measured values
- Adjust output functionality
- Save parameter settings to a file
- Load parameter settings from a file
- Generate and print a settings report
- Upgrade the transducer firmware

5.2 USB configuration interface

The USB interface is intended for configuration and commissioning of the transducer. It is not designed for measurement processing during normal operation.

5.3 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_{L-L} TRMS 50/60 Hz or 16⅔ Hz CAT III 1–300 V_{L-N} TRMS 50/60 Hz or 16⅔ Hz CAT III
	Configurable measuring range	0–520 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	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 VAC 50/60 Hz ±10 %
	Burden	max 7.1 W / 20 VA
Output	Analog outputs	4 or 2
	Programmable range	±20 mA, ±5 mA, ±10 V settings within the range depending on version
	Resolution	16 bits
	External resistance load	Current output: max 750 Ω (15 V) Voltage output: min 750 Ω
	Response time	<50 ms T90
	Ripple	≤0.2%
	Digital Outputs	2 (Metering pulse and pilot duty)
		max 110 VAC/VDC 75 mA SELV / Limited Power Source (LPS)
	Communication	Modbus RS485 (RTU)
General Data	Accuracy class	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
	Measurement category	Cat. III
	Overvoltage category	Cat. III
	Pollution degree	2
	Dimension (W x H x D)	70 x 132 x 101 mm
	Weight	330 gr
	Protection	IP40 (enclousing), IK06
	Flammability class	UL94 V-0
	Standards	IEC 60688:2021 Transducers SS-EN 61010-1 Safety IEC 61010-2-030 EN 61000-6-2 / -6-4 / -6-5

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