UST-611 — Two-Channel Servo-Valve Current Transducer

UST611-x-xx-x

Isolated Voltage-to-Current Servo-Valve Driver

Features & Benefits

- Two independent channels in one DIN-rail box
- Input ±10 V or ±5 V, normal or differential
- Output ±10 mA, ±20 mA, 4–20 mA or ±40 mA
- Six transfer curves set by factory links
- ±0.1 % FS accuracy after calibration
- Closed-loop current source
  - Coil current independent of coil heating
  - 50 µs rise time, no overshoot
  - Stable on inductive loads up to 1 H
- Galvanic isolation between channels and supply
- Safety functions
  - Coherence control with output relay
  - Fallback input with adjustable reference
  - PLC watchdog input
  - Status dry contact
- ±10 V current monitor output per channel
- Current-limited, short-circuit-proof output

Typical Applications

- Electro-hydraulic servo-valve drive (torque motor coil)
- Proportional valve and actuator control
- Hydraulic test benches and presses
- Steel, energy and process plant actuators
- PLC analog output to current-loop conversion

Product Ratings

V_{SUPPLY} = 18 – 36 V	2 channels
V_{IN} = ±10 V (diff.)	I_{OUT} up to ±40 mA
Accuracy ±0.1 % FS	Rise time 50 µs

Product Description

The UST-611 converts the ±10 V set-point of a PLC into a current in the coil of an electro-hydraulic servo-valve. The torque of the servo-valve motor, and therefore the spool position and the hydraulic flow, is proportional to the coil current: driving the coil in current makes the flow independent of the coil resistance, which rises by 20 % between 0 and 50 °C.

Each channel is a closed-loop current source built around a power amplifier and a high-side shunt, supplied by its own isolated converter. An output relay disconnects the coil when the measured current departs from the demand, when the PLC watchdog stops or on request of the fallback input, and reports the state on a dry contact.

Package Information

- DIN-rail box (EN 60715, 35 mm)
  - 108 × 45 × 80 mm
  - [4.25 × 1.77 × 3.15 in]
  - Weight: 450 g
- Front access, two plug-in terminal blocks (CH. 1, CH. 2), 16 points, 5.08 mm pitch
- Shield connection by faston tabs
- Operating temp: 0 to +50 °C

Preliminary visual

Typical Application

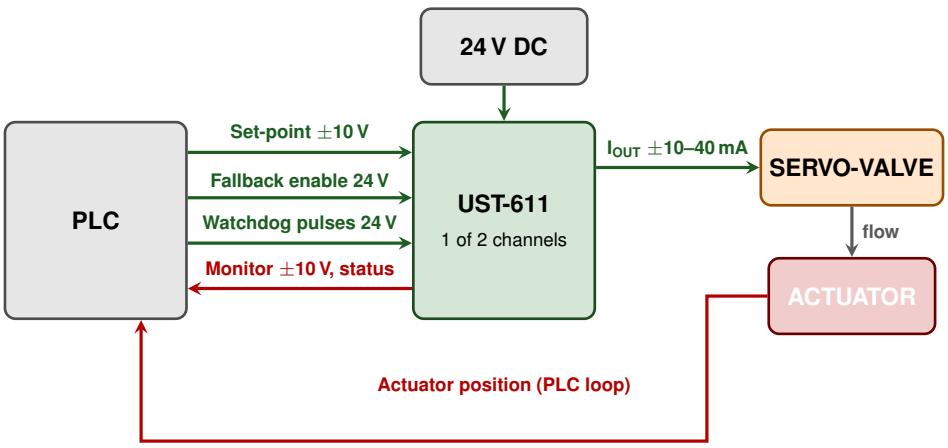

Figure 1 — Servo-valve drive: the PLC closes the position loop, the UST-611 closes the coil current loop and supervises the drive

Pin Configuration

Each channel has its own 16-point plug-in terminal block on the front panel: CH. 1 on the left, CH. 2 on the right, with the same pinout. Terminal 1 is at the top of each block, next to the ON indicator. Each channel is supplied through its own terminals 1–4.

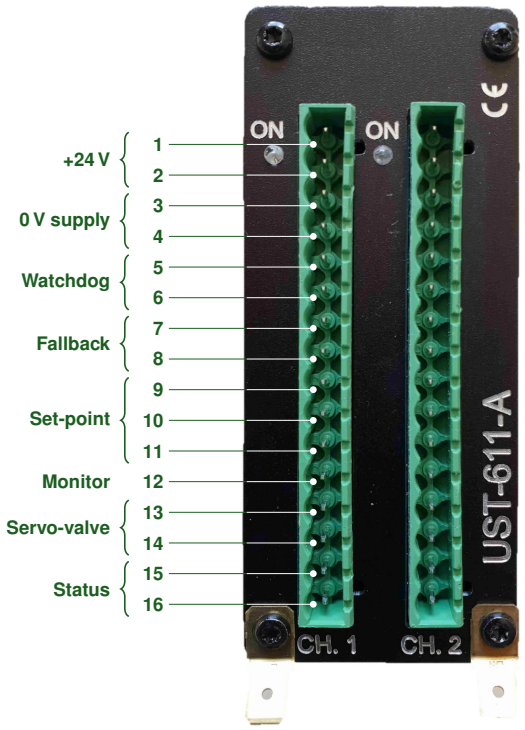

Figure 2 — Front panel and terminal numbering, CH. 1 shown (preliminary visual). CH. 2 has the same pinout. ON indicators at the top, shield faston tabs at the bottom.

Pin	Name	Function
1, 2	+24 V	Supply input, 18–36 V DC (internally jumped)
3, 4	0 V	Supply return (internally jumped), isolated from the channel
5	WD+	Watchdog input, 24 V pulses from a PLC output (version C)
6	WD−	Watchdog return, isolated
7	FB+	Fallback enable, 24 V PLC output: current present = set-point, no current = fallback reference (versions B, C)
8	FB−	Fallback return, isolated
9	E−	Set-point, inverting input (differential mode)
10	E+	Set-point, non-inverting input
11	0 V	Set-point reference in normal mode (channel ground)
12	MON	Current monitor, ±10 V at full scale, 10 Ω
13	IS	Servo-valve coil, current output
14	0 V	Coil and monitor return (channel ground)
15, 16	ST	Status dry contact, closed when the output relay is energised

Set-point wiring. Normal mode: signal on 10, reference on 11. Differential mode: 10 (E+) and 9 (E−), 11 unconnected or tied to the PLC ground through the cable shield. Terminals 9 and 11 are not an input pair.

Servo-valve wiring. Coil between 13 and 14, shielded twisted pair, shield on the faston tab. The monitor shares return 14 with the coil: use a separate wire to the PLC analog input.

Isolated inputs. Terminals 5–6 and 7–8 are optocoupler inputs driven by 24 V PLC outputs (6.7 mA at 24 V). They are isolated from the channel and from each other.

Grounds. The 0 V of the supply (3, 4) and the channel ground (11, 14) are isolated; CH. 1 and CH. 2 grounds are isolated from each other.

Front Panel Indicators

Indicator	Function (per channel)	Versions
ON LED	On: channel supply present	all
FALLBACK LED	On: PLC fallback enable present, set-point active; off: fallback reference applied	B, C
WATCHDOG LED	Flashes with the PLC pulses	C
OUTPUT LED	On: output relay energised, coil connected; off: fault, coil disconnected	all
RESET	Push button: re-energises the output relay after a fault	all

Absolute Maximum Ratings

The absolute maximum ratings below are stress ratings only. Operation at or beyond these maximum ratings can cause permanent damage to the device. Electrical specifications do not apply when operating beyond rated operating conditions.

Parameter	Comments	Min	Max	Unit
Supply Voltage (1, 2 to 3, 4)	Reverse-polarity protected	−36	36	V
Set-point Input, differential (10 to 9)		−15	15	V
Set-point Input, common mode (9, 10 to 11)	Limited by terminal creepage	−200	200	V
Watchdog and Fallback Inputs (5–6, 7–8)		−5	32	V
Status Contact (15–16)	Resistive load		30 V_{DC} / 1	V / A
Output (13 to 14)	Short circuit to 14, permanent	Protected		
Monitor Output (12 to 14)	Short circuit to 14, permanent	Protected		
Operating Temperature Range	Ambient	0	+50	°C
Storage Temperature		−40	+85	°C

Part Ordering Information

Version	Description	Fallback	Watchdog	Coherence
UST611-A	Transducer only	—	—	•
UST611-B	Transducer with fallback input	•	—	•
UST611-C	Transducer with fallback and PLC watchdog	•	•	•

*Order code: **UST611-v-rr-c**, with v = version (A, B, C), rr = output range (10, 20, 40 for ±10, ±20, ±40 mA) and c = transfer curve (1 to 6, Figure 7). Example: UST611-B-20-5 = ±10 V → ±20 mA with fallback. The configuration and the calibration are made in factory and apply to both channels unless specified per channel. On request: fault polarity forcing (a defined current is injected in the coil when the relay drops, the resistor value is set by the coil resistance) and non-standard transfer curves.*

Safety, Reliability and Isolation

Parameter	Comments	Min	Typ	Max	Unit
Isolation, supply to channel	Isolated DC/DC per channel (1500 V_{DC} rated)	1000			V_{DC}
Isolation, channel to channel		1000			V_{DC}
Isolation, PLC inputs to channel	Optocouplers (5000 V_{RMS} rated)	1000			V_{DC}
Isolation, status contact	Relay contact to coil (1500 V_{AC} rated)	1000			V_{DC}

Transfer Curves

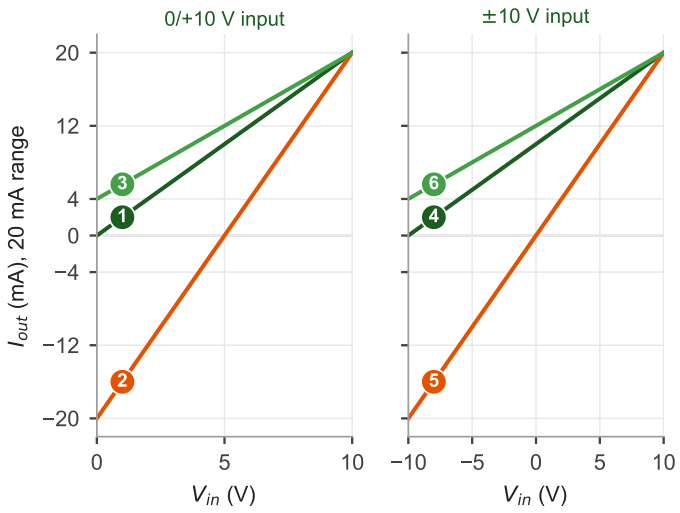

Figure 7 — Transfer curves, 20 mA range

Curve	Transfer (20 mA range)
1	0/+10 V → 0/20 mA
2	0/+10 V → ±20 mA
3	0/+10 V → 4–20 mA
4	±10 V → 0–20 mA
5	±10 V → ±20 mA
6	±10 V → 4–20 mA

The current scales by 0.5 on the 10 mA range and by 2 on the 40 mA range. Reversing E+ and E− mirrors the curve about the vertical axis. The monitor output gives ±10 V for the full-scale current of the range.

Electrical Specifications

Specifications apply at V_{SUPPLY} = 24 V, T_{AMB} = 25 °C, 20 mA range, curve 5, unless otherwise noted. ***Boldface*** *specifications apply over 0 to +50 °C. Typical values are design values from analysis and simulation.*

Attribute	Conditions / Notes	Min	Typ	Max	Unit
Power Input					
Supply Voltage	Continuous operation	**18**	24	**36**	V
Supply Current	Both channels at 40 mA		172	**250**	mA
Supply Current	Both channels at 0 mA		105		mA
Protection	Reverse polarity, 1 A fuse per channel				
Set-point Input					
Input Range	Normal or differential mode	−10		10	V
Input Range, ±5 V version	Gain ×2 link	−5		5	V
Input Resistance	Common mode	250			kΩ
Input Resistance	Differential mode	1			MΩ
Common-Mode Voltage	Terminals 9, 10 to 11	−200		200	V
Common-Mode Rejection	DC	80			dB
Current Output					
Output Range	Ordering option	±10 / ±20 / 4–20 / ±40			mA
Load Resistance	±10 mA range	0		1000	Ω
Load Resistance	±20 mA and 4–20 mA ranges	0		500	Ω
Load Resistance	±40 mA range	0		250	Ω
Load Inductance	Stable, see Figure 4	0		1	H
Compliance Voltage	Terminal 13 to 14	±**12**	±12.7		V
Accuracy	After calibration, 25 °C	−0.1		+0.1	% FS
Gain Temperature Coefficient	3σ / worst case		77	**160**	ppm FS/K
Zero Temperature Coefficient	Worst case			**12**	ppm FS/K
Reference Drift, Offset Curves	Curves 2, 3, 4, 6 (curve 6 shown)			**60**	ppm FS/K
Recalibration Interval	Long-term drift of resistors		2		years
Current Limit	Output shorted	32	47	62	mA
Dynamic Response					
Rise Time 10–90 %	0 to full scale, max. resistive load		47		µs
Response Time to 90 %	All ranges, max. resistive load		55	**100**	µs
Settling Time to 1 %	Max. resistive load		100		µs
Overshoot	Resistive load		0		%
Overshoot	500 Ω + 0.1 H		8		%
Bandwidth (−3 dB)	Small signal		8		kHz
Monitor Output					
Scale	Full-scale current		±10		V
Output Resistance			10		Ω
Load	Error −0.5 % at 2 kΩ	2			kΩ
Fallback and Watchdog Inputs (isolated)					
Input Voltage	PLC output		24	**30**	V
ON Threshold		**14.9**	16.8	**19.0**	V
Input Current	At 24 V / 30 V		6.7 / 11.6		mA
Fallback Reference	Adjustable, trimmer	−FS		+FS	
Watchdog Pulse Frequency	Square wave, 50 % duty	4		100	Hz
Watchdog Time-out	Pulses stopped (output low)	**0.32**	0.64	**1.4**	s
Watchdog Time-out	Output stuck high		0.4		s
Coherence Control and Output Relay					
Trip Threshold	|demand − measure|	**10.8**	13.6	**16.5**	% FS
Reaction Time	Open coil to relay released		8	20	ms
Step Immunity	Full-scale step into 1 H		No trip		
Power-up Hold	Relay held while the loop starts	**1.4**	2.6	**4.1**	s
Reset	Push button or supply off				
Status Contact Rating	Resistive, 30 V_{DC} / 125 V_{AC}			1 / 0.3	A

Typical Performance Characteristics

Curves from the ngspice models of the design justification (datasheet-validated behavioural models), 20 mA range and curve 5 unless otherwise noted.

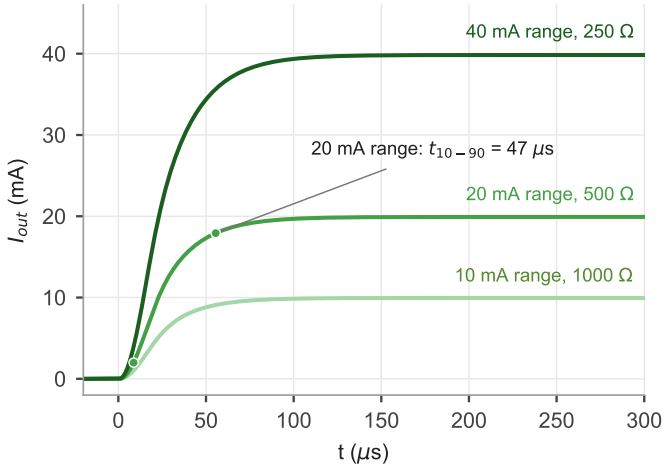

Figure 3 — Step response, 0 to full scale, maximum resistive load

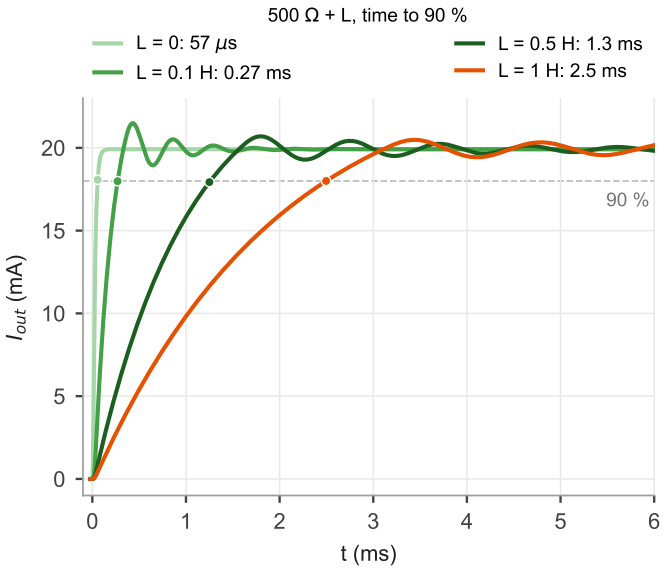

Figure 4 — Step 0 to 20 mA into a servo-valve coil, 500 Ω + L

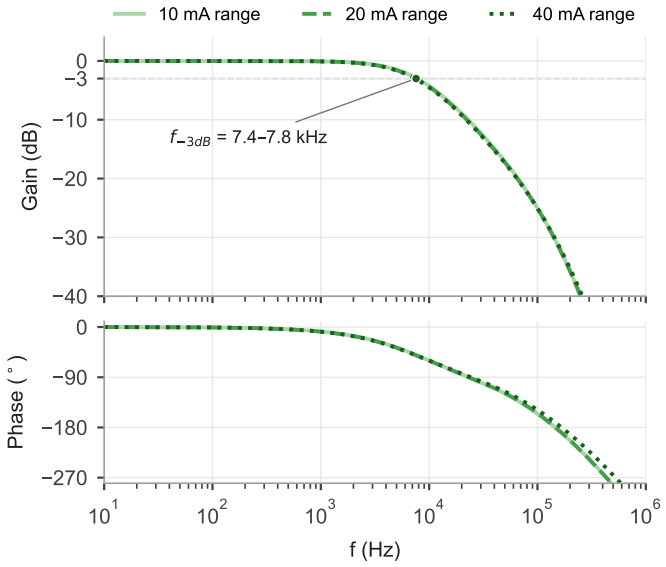

Figure 5 — Small-signal frequency response

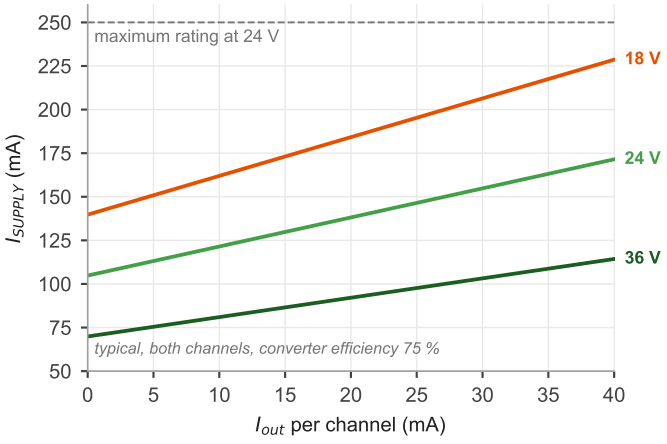

Figure 6 — Supply current, both channels loaded (calculated, converter efficiency 75 %)

On an inductive load the rise time is set by the compliance voltage: the current slope is $(12.7\,\text{V} - R_L\,I)/L$, i.e. 0.27 ms to 90 % for 0.1 H and 2.5 ms for 1 H at 20 mA. The loop remains stable over the full range of inductance; the output relay does not trip during these steps.

Safety Functions

Output relay. The coil is connected through a relay contact. When the relay drops, the coil is disconnected and the servo-valve returns to its mechanical null; with the polarity-forcing option, a defined current drives the actuator to a safe end position instead. Because the contact interrupts the coil current, a fault stays latched until the RESET push button is pressed or the supply is switched off. At power-up the relay is held for 1.4 to 4.1 s while the current loop starts. The second relay contact is the status output (terminals 15–16).

Coherence control. The demand and the measured current are compared continuously. A difference above 10.8 to 16.5 % of full scale, filtered over 47 ms, drops the relay: open coil, short circuit or current limitation are detected within about 8 ms. The filter makes the control immune to the transient error of a full-scale step into a 1 H coil.

Fallback input (versions B, C). The PLC keeps a 24 V current on terminals 7–8 to validate the set-point. When this current disappears (PLC stop, wire break), the input set-point is replaced by the fallback reference, adjustable over the full output range. The channel keeps driving the coil in closed loop.

Watchdog input (version C). The PLC sends a 24 V square wave (4 to 100 Hz) on terminals 5–6. If the pulses stop, with the PLC output low or stuck high, the relay drops within 0.32 to 1.4 s.

Mechanical Specifications

Parameter	Value
Dimensions (H × W × D)	108 × 45 × 80 mm
Mounting	35 mm DIN rail
Mass	450 g
Terminal blocks	Plug-in, 5.08 mm, 16 pts per channel
Wire section	0.2 to 2.5 mm^2
Settings access	Factory, calibrated

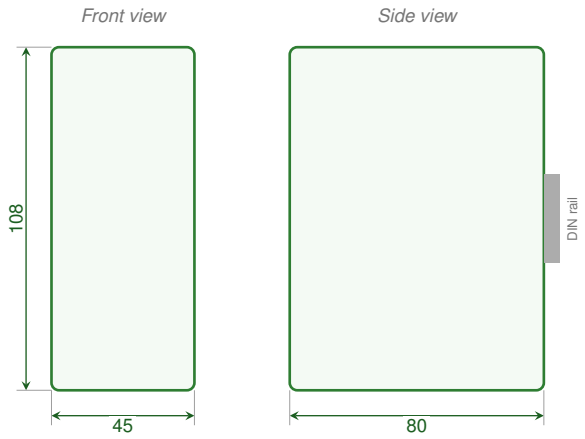

Figure 8 — Outline, dimensions in mm

Application note — Choosing the output range for a servo-valve

Select the range from the rated current of the servo-valve coil, then check that the coil voltage at full scale, $R_{coil,\,hot} \times I_{FS}$, stays below 10 V with the coil resistance at its maximum temperature (copper: +0.4 %/K). The remaining 2 V of compliance set the slew rate of the current on the coil inductance. Coils wired in series, parallel or push-pull are driven as a single load between terminals 13 and 14; a push-pull coil needs the bipolar ranges (±10, ±20 or ±40 mA). Contact POWCOMA for coils outside these limits.