



## CLT3-4BT6

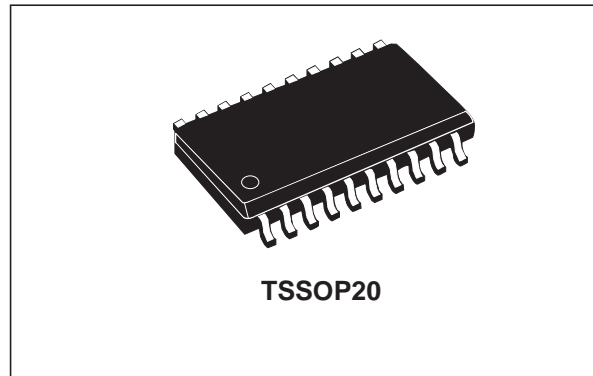
# CURRENT LIMITED OVER-VOLTAGE PROTECTED QUAD DIGITAL TERMINATION

### APPLICATIONS

- Industrial Automation
- Programmable Logic Controller
- Communication field bus nodes
- Peripheral Input / Output modules
- Machine tool interface

### FEATURES

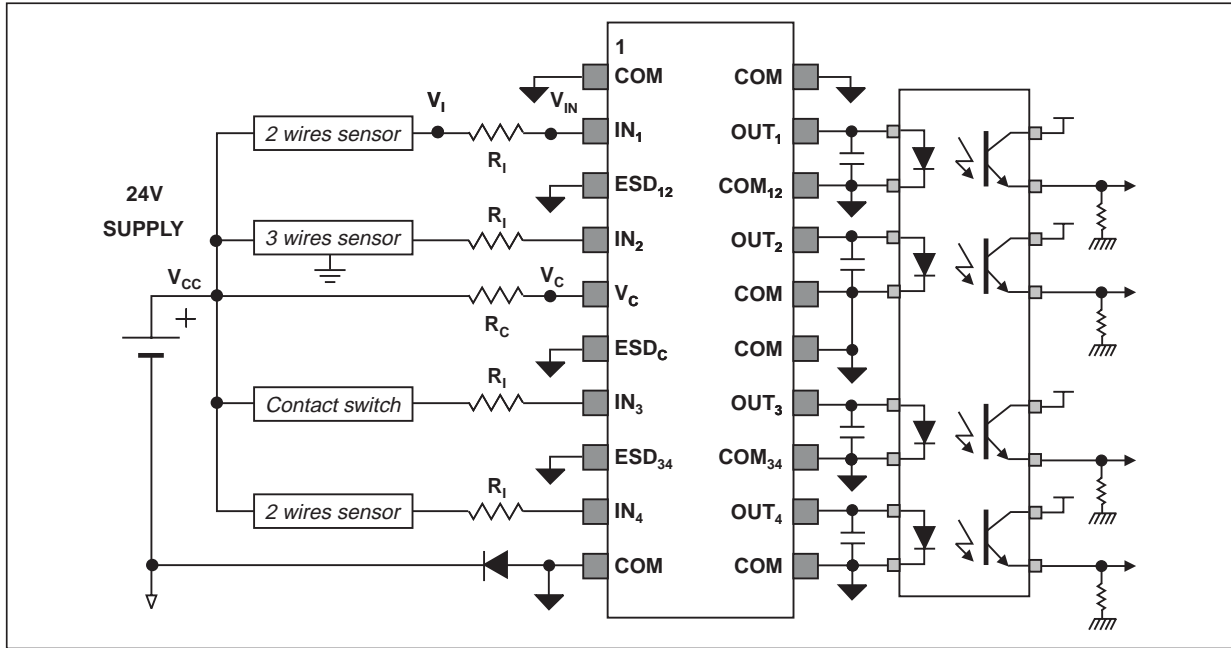
- 4 channels topology
- Wide range input DC Voltage:
  - $V_i = -0.3$  to 30V with  $R_i = 0$
  - $V_i = -30$  to 35V with  $R_i = 1.2k\Omega$
  - Low side configuration with common ground
- Current limiter:
  - $I_{GEN} = 3mA$
  - Input current limiter activation voltage  $< 5V$
  - Temperature compensated operation
- Opto-coupler drive:
  - No coupler activation below 1.5 mA input current
- Input protection ( $R_i = 1.2K\Omega$ ):
  - IEC61000-4-2 electrostatic discharge ESD, Class 3
    - In contact,  $\pm 6kV$ ; in air,  $\pm 8kV$
    - Level B: temporary disruption; no change of opto-coupler state
  - IEC61000-4-5 voltage surge, Class 3
    - $\pm 1000V$  with  $42\Omega$  serial resistor in differential mode
    - Level B: temporary disruption
  - IEC61000-4-4 transient burst immunity
    - $\pm 4kV$  peak voltage; 5kHz repetitive rate
    - Level A: fully functional
- Operating ambient temperature: - 25 to 85°C



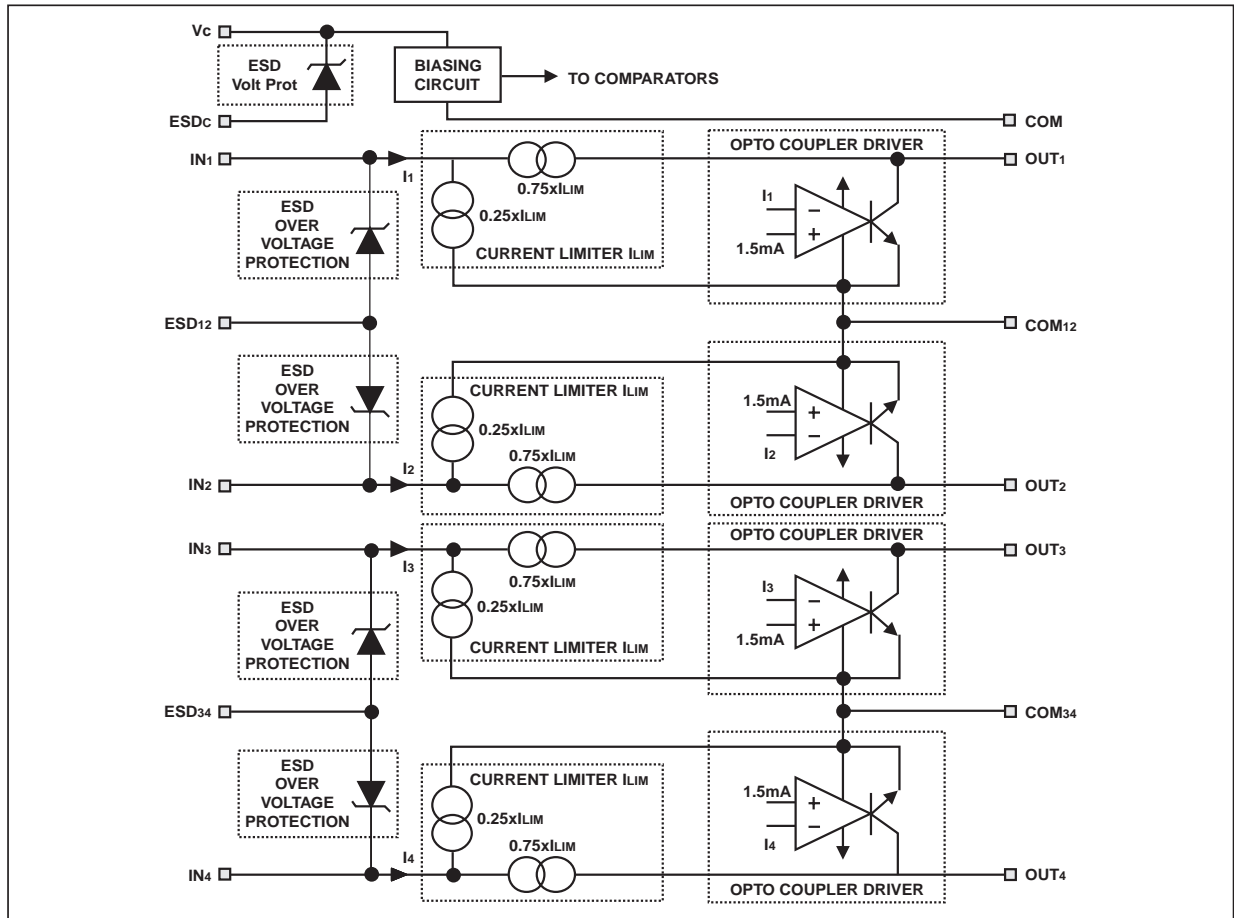
### BENEFITS

- Reduced overall dissipation
- Compact with high integration
- Enables input to meet type 1 characteristic of IEC61131-2 standard
- Compatible operation with 2 and 3 wires proximity sensor according EN60947-5-2 standard
- Insensitive to the on state sensor impedance
- Surface Mount Package for highly automated assembly
- Enhanced functional reliability

IEC61000-4 STANDARD ROBUST APPLICATION DIAGRAM



INPUT TERMINATION BLOCK DIAGRAM



## FUNCTIONAL DESCRIPTION

The CLTx-4 is a quadruple input digital termination device designed for 24 V DC automation applications. It achieves the front-end circuitry of a digital input module (I/O) in industrial automation, and drives an isolating opto-coupler.

Available in a four channels configuration, it offers a high-density termination by minimizing the external components count. It is housed in a TSSOP20 surface mount package to reduce the printed board size.

Made of an input voltage protection, a serial current limiting circuit and an opto-coupler driver, each channel circuit terminates the connection between the logic input and the associated high side sensor or switch.

The CLT3-4 is a 3 mA quad channel device compatible the type 1 characteristics of the IEC61131-2 standard.

Each input voltage clamping block protects the module input against electromagnetic interferences such as those described in the IEC61131-2 standard and IEC61000-4-2 (ESD), 4-4 (transient burst), 4-5 (voltage surge) standards. The supply input is also designed with such a protection structure.

The current limiting circuit connected between the input and the output pins is compensated all over the temperature range. Thanks to its low tolerance, the current limitation allows reducing drastically the dissipation of the input compared to a resistive input: the overall module requires less cooling capability and becomes smaller.

The output block of each termination channel controls the operation of an opto-coupler that is enabled by a Light Emitting Diode.

When the input current is less than 1.5 mA, this output circuit derivates the input current to maintain the opto-coupler off.

The original structure of the CLT limiter allows its activation threshold to be low and insensitive to the output voltage up to a maximum value of 2.0 V.

When the CLT input voltage  $V_{IN}$  is higher than 5 V, or the module input voltage  $V_i$  higher than 11 V with the use of a reverse diode and a serial resistor  $R_I = 1.2 \text{ k}\Omega$ , the output current that is a share of the input current (3/4) is higher than 1.5 mA. The whole termination channel including the opto-coupler is on.

## ABSOLUTE RATINGS (limiting values)

Symbol	Pin	Parameter name & conditions	Value	Unit
$V_{CC}$	$V_C$	Supply steady state voltage, $R_C = 0 \text{ k}\Omega$	- 0.3 to 30	V
		Supply steady state voltage, $R_C = 4.7 \text{ k}\Omega$	- 0.3 to 35	V
$V_I^{(1)}$	IN	Input steady state voltage, $R_I = 0 \text{ k}\Omega$	- 0.3 to 30	V
		Input steady state voltage, $R_I = 1.2 \text{ k}\Omega$	- 0.3 to 32	V
		Input repetitive pulse voltage, $R_I = 1.2 \text{ k}\Omega$	- 0.3 to 35	V
		Input repetitive pulse voltage, $R_I = 1.2 \text{ k}\Omega$ , $R_C = 4.7 \text{ k}\Omega^{(2)}$	- 30 to 30	V
$I_{IN}$	IN	Input maximum forward current, $R_I = 1.2 \text{ k}\Omega$ , $R_C = 4.7 \text{ k}\Omega$	5	mA
		Input maximum reverse current, $R_I = 1.2 \text{ k}\Omega$ , $R_C = 4.7 \text{ k}\Omega^{(2)}$	20	mA
$V_{OM}$	OUT	Maximum output steady state voltage	2.5	V
$I_{OM}$	OUT	Output current	- 4 to 4	mA
$T_{AMB}$	All	Operating ambient temperature	- 25 to 85	°C
$T_J$		Operating and storage junction temperature	- 25 to 150	°C

**Note 1:**  $V_I = V_{IN} + R_I \times I_{IN}$ ;  $V_{IN}$  = voltage at the input pin itself

**Note 2:** according to test diagram on figure 8, this case covers especially the reverse polarity operation of one input.

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### ELECTROMAGNETIC COMPATIBILITY RATINGS

$R_I = 1.2k\Omega$ ,  $R_C = 4.7k\Omega$ , reverse diode connected as shown on figure 6 (unless otherwise specified)

Symbol	Node	Parameter name & conditions	Value	Unit
$V_{PP}$	IN	ESD protection, IEC61000-4-2, per input, in air	$\pm 8$	kV
		ESD protection, IEC61000-4-2, per input, in contact	$\pm 6$	kV
		ESD protection, IEC61000-4-2, per input, in air, $R_I = 0\Omega$	$\pm 3$	kV
		ESD protection, IEC61000-4-2, per input, in contact, $R_I = 0\Omega$	$\pm 3$	kV
$V_{PPB}$	$V_I$	Total Peak Pulse Voltage Burst, IEC61000-4-4 $C_{IN} = 100pF$ , $C_{OUT} = 22nF$ , $F = 5kHz$ (3)	$\pm 4$	kV
$V_{PP}$	$V_I$	Peak Pulse Voltage Surge, IEC61000-4-5, $R = 42\Omega$ , (4)	$\pm 1$	kV
$V_{PP}$	$V_{CC}$	Peak Pulse Voltage Surge, IEC61000-4-5, $R = 2\Omega$ (4)	$\pm 1$	kV

**Note 3:** test conditions of IEC standard applied to the application diagram page 2.

**Note 4:** see test circuit figure 6 or 7.

### THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	TSSOP20 thermal resistance junction to ambient Board copper surface = $2cm^2$ , copper thickness = $35\mu m$	90	$^{\circ}C/W$

### ELECTRICAL CHARACTERISTICS

( $T_J = 25^{\circ}C$ ,  $V_{CC} = 24V$  and COM pin voltage referred unless otherwise specified)

Symbol	Pin	Name	Conditions	Min.	Typ.	Max.	Unit
Current limitation							
$I_{LIM}$	IN	Input limiting current	$V_{OUT} = 0.9$ to $2.0V$ $V_{IN} = 5$ to $27V$ $T_{AMB} = -25$ to $85^{\circ}C$	2.1	3	3.7	mA
$V_{LOW}$	IN	Maximum off state voltage	$I_{IN} = 100\mu A$		1.5		V
$V_{TH}$	IN	Activation threshold	$I_{IN} = 2.1$ mA		3.4	5	V
Input & Supply Protection							
$V_{CL}$	IN	Clamping voltage	$I_{IN} = 7$ mA; $t_P = 1$ ms	31	38	-	V
Opto-coupler driver operation							
$I_{OFF}$	OUT	Off state output current	$V_I = 5V$ , (5)	-	10	40	$\mu A$
			$I_{IN} = 1.5$ mA, (6)	-	10	40	$\mu A$
$V_{OFF}$	OUT	Off state output voltage	$I_{IN} = 1.5$ mA		0.15	0.5	V
$I_{ON}$	OUT	On state output current	$V_{IN} = 5V$	1.5	2	-	mA
Supply & biasing circuit							
$V_C$	$V_C$	Supply voltage	$T_{AMB} = -25$ to $85^{\circ}C$	10			V
$I_C$	$V_C$	Supply current	$V_{IN} = V_C = 30V$		550	800	$\mu A$

**Note 5:** According to application diagram on page 2 with use of a  $R_I = 1.2k\Omega$  resistor, an opto-coupler ( $R_{LED}(0V) = 15k\Omega$ ,  $V_F = 1.2V$ ) and a reverse diode from COM to GND ( $V_F = 0.7V$ )

**Note 6:** same as note 5 but  $R_I = 0\Omega$ .

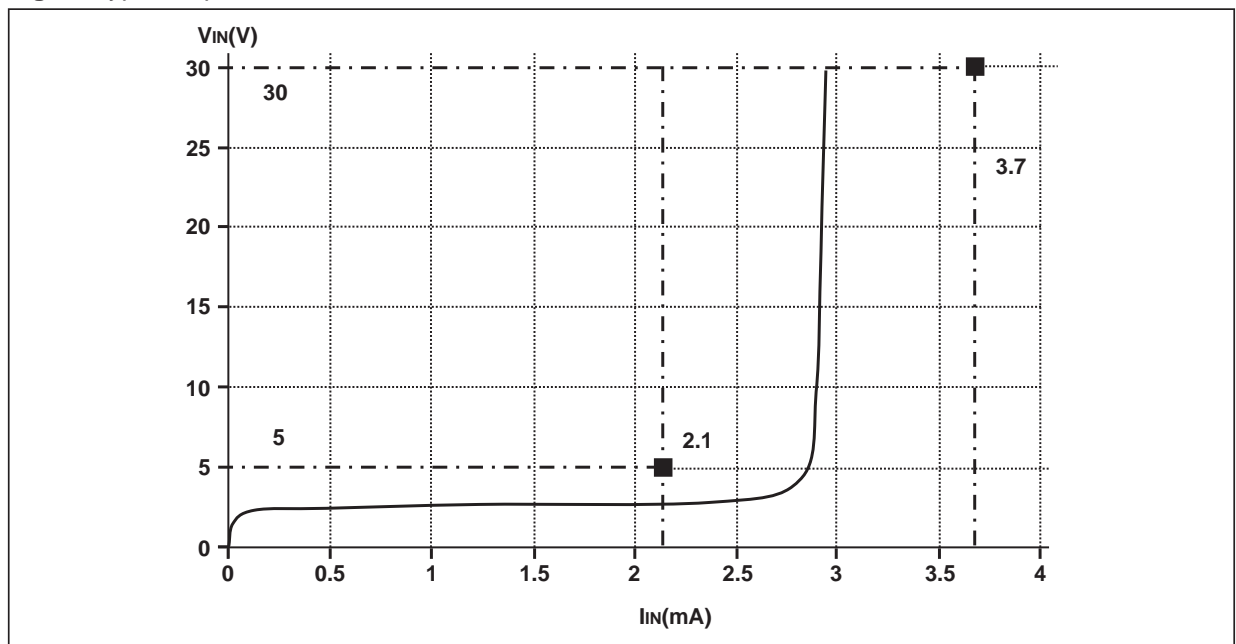
**SWITCHING ELECTRICAL CHARACTERISTICS**

( $T_J = 25^\circ\text{C}$ ,  $V_{CC} = 24\text{V}$  and COM pin voltage referred unless otherwise specified)

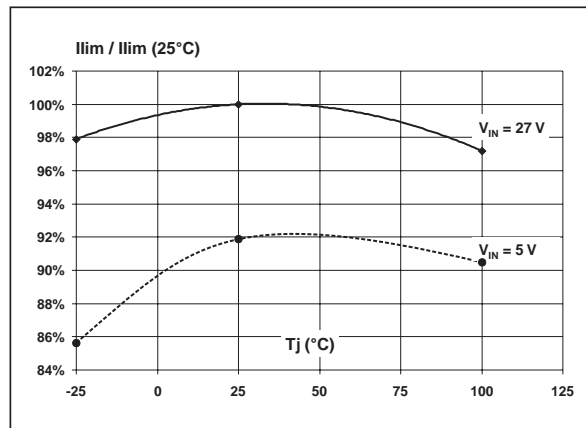
Symbol	Pin	Name	Conditions	Min.	Typ.	Max.	Unit
$F_{MAX}$	IN-OUT	Input to output running frequency			200		Hz
$t_{PLH}$	IN-OUT	Input activation propagation time	$C_{OUT} = 22\text{nF}$		6		$\mu\text{s}$
$t_{PHL}$	IN-OUT	Input de-activation propagation time	$C_{OUT} = 22\text{nF}$		10		$\mu\text{s}$

**INPUT CHARACTERISTICS OF CLT3-4**

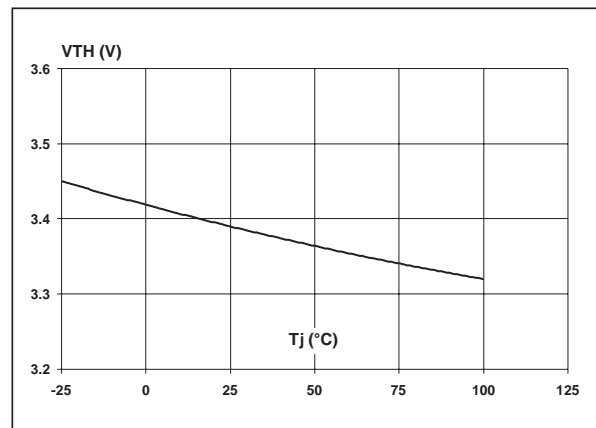
**Fig. 1:** Typical input characteristics of each CLT3-4 channel



**Fig. 2:** Typical current limiter variation versus junction temperature  $0.9\text{V} < V_{OUT} < 2\text{V}$



**Fig. 3:** Typical limiter threshold voltage variation versus junction temperature for  $I_{IN} = 2.1\text{mA}$



CLT3-4 INPUT / OUTPUT TRANSFER CHARACTERISTICS (respect to common pin COM)

Fig. 4: Current transfer characteristic

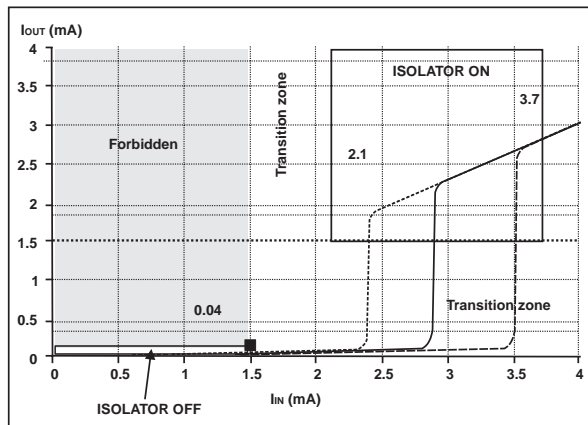
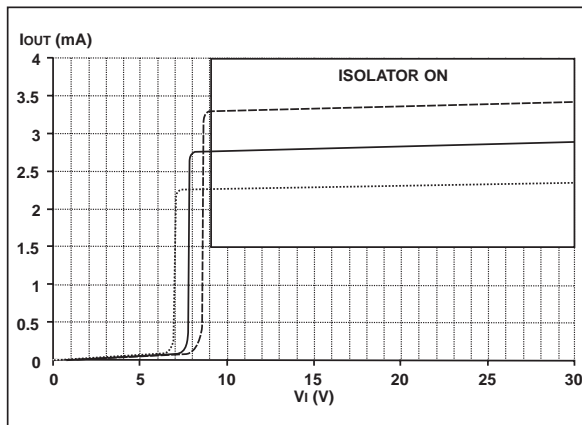


Fig. 5: Transconductance characteristic



APPLICATION DESCRIPTION

The CLT device is used between the connector and the opto-coupler of an I/O module. To secure the coupler off state and the non-conduction of its diode, the maximum CLT output current is 40µA with  $R_{opto} = 15k\Omega$ . When the CLT input voltage  $V_{IN}$  is higher than 5 V, a minimum CLT output current of 1.5 mA will secure the opto-coupler on state.

The CLT limiter is insensitive to the output voltage up to 2.0V. Therefore, its output is able to drive any state of the art opto-coupler. Some additional device can be added in series with the opto-coupler if the output voltage remains within its functional limits.

A stand-alone sensor is normally connected on the CLT input. For a good off state control, its quiescent current has to be less than 1.5 mA (EN60947-5-2 standard compatible) keeping then the opto-coupler off thanks to the CLT device ( $I_{OUT} < 40\mu A$ ). And its maximum ON state voltage  $V_{S-ON}$  will be lower than 8 V (EN60947-5-2 standard compatible) corresponding to the difference between the minimum supply voltage ( $V_{CC MIN} = 19.2V$ ) and the maximum current limitation activation voltage  $V_{CC MIN} = V_{S-ON} + V_I$ ;  $V_I = V_{IN} + R_I \times I_{IN MAX} + V_D$  ( $V_I = 11 V$  when  $V_{IN} = 5 V$ ,  $R_I = 1.2 k\Omega$ ,  $I_{IN} < 3.7 mA$ ,  $V_D = 1V$ ).

SURGE VOLTAGE TEST CIRCUIT

The input and supply pins are designed to withstand electromagnetic interferences. As shown on the device block diagram, each channel input is protected by a clamping diode that is connected to the common pin COM. Combined with a serial input resistance  $R_I = 1.2 k\Omega$ , this clamping diode implements an effective protection against transient voltage burst ( $\pm 4 kV$ , IEC61000-4-4) and voltage surge ( $\pm 1 kV$ , IEC61000-4-5).

This combination allows the surge voltage to be applied from each input to other inputs, the ground and the supply contacts in differential or common modes (see figure 6).

Thanks to its high resistance  $R_C = 4.7 k\Omega$  and the conventional power supply protection that uses a clamping diode such as the SM15T39C Transil™, the supply pin  $V_C$  withstands IEC61000-4-5 with +/- 1000 V surge voltage (see figure 7).

Finally, an external output capacitor may be placed in parallel with the opto-coupler diode to filter the transient disturbances injected in the inputs of the module and secure the immunity of the opto-coupler itself.

Fig. 6: Input pin IN voltage surge test circuit.

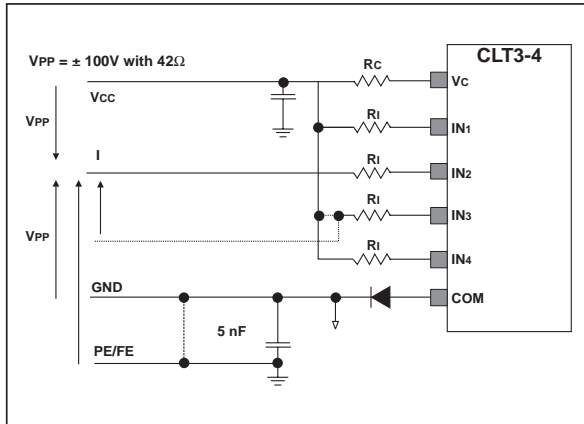
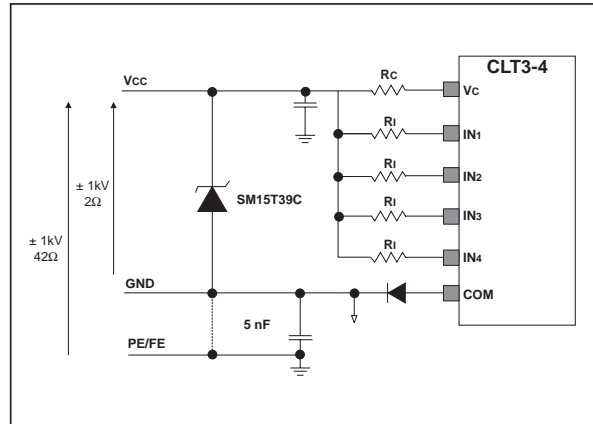


Fig. 7: Supply pin Vc voltage surge test circuit.



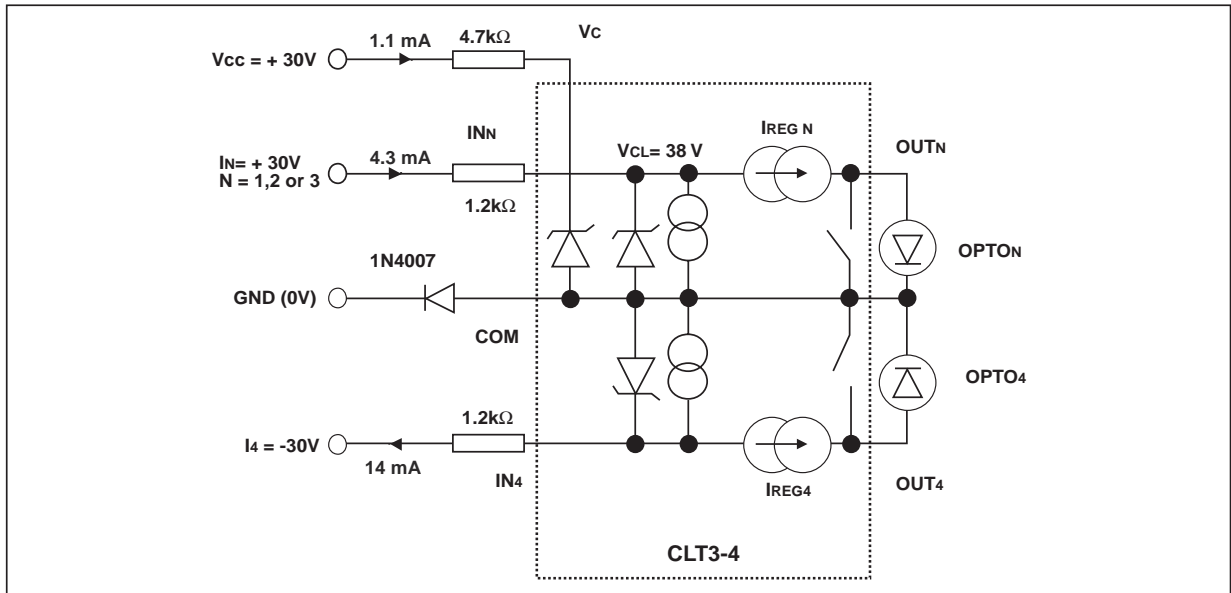
**INPUT REVERSE POLARITY ROBUSTNESS**

Each input of the CLT device may be biased to a reverse polarity. This case corresponds to a connection mistake or a reverse biasing that is generated by the demagnetization of a monitored inductive solenoid.

The involved input withstands the high reverse current up to 20 mA; its opto-coupler is OFF and protected by the conducting input diode. The other inputs remain operational, and some extra dissipation is generated in their clamping protections.

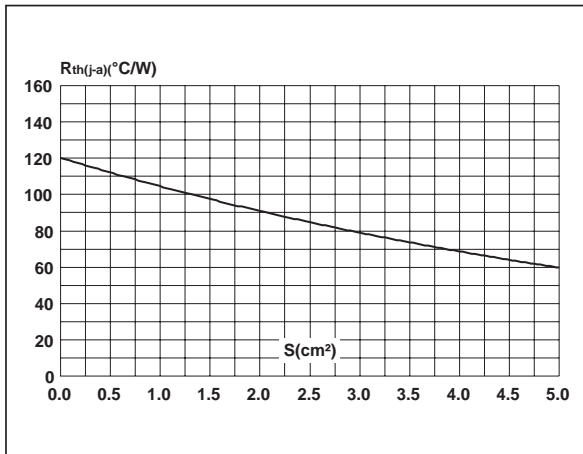
Considering the supply operation, a reverse blocking diode can be connected between the module ground and the common pin COM to protect the CLT device against any spurious reverse supply connection. Then, the whole module supply voltage rating is extended to ± 30V.

Fig. 8: Current sharing in the CLT device when IN4 is biased at - 30V and the others at + 30V

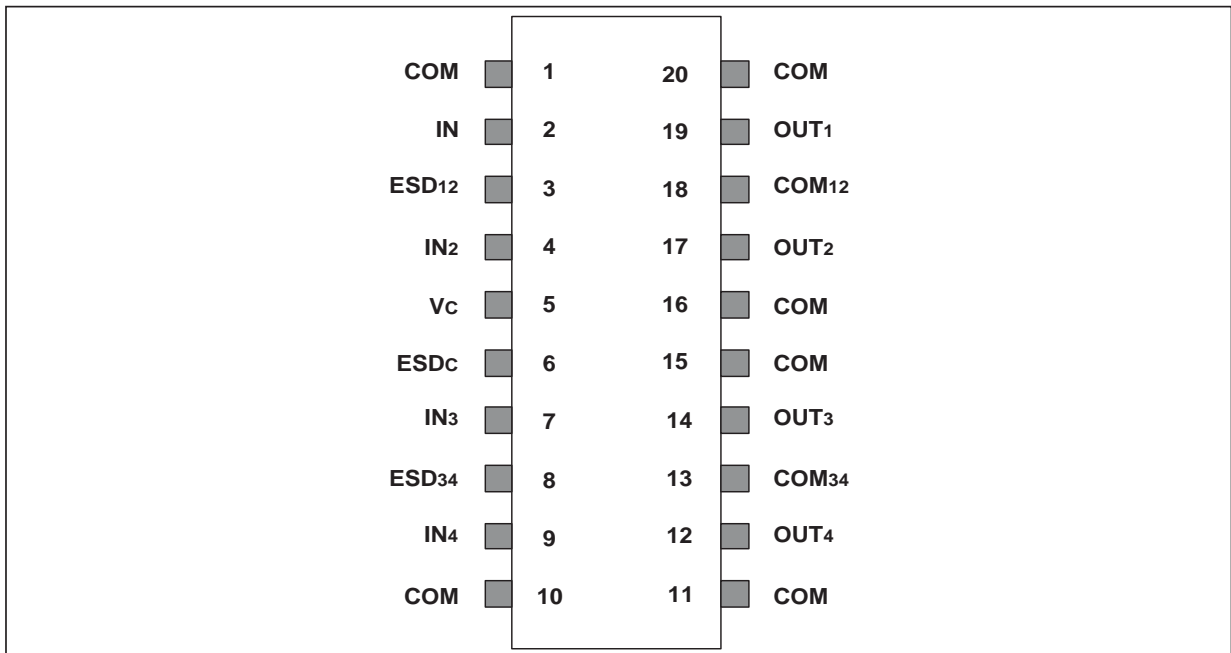


## CLT3-4BT6

**Fig. 9:** Typical junction to ambient thermal resistance versus copper surface under common pad (FR4 epoxy; copper thickness is 35 $\mu$ m).



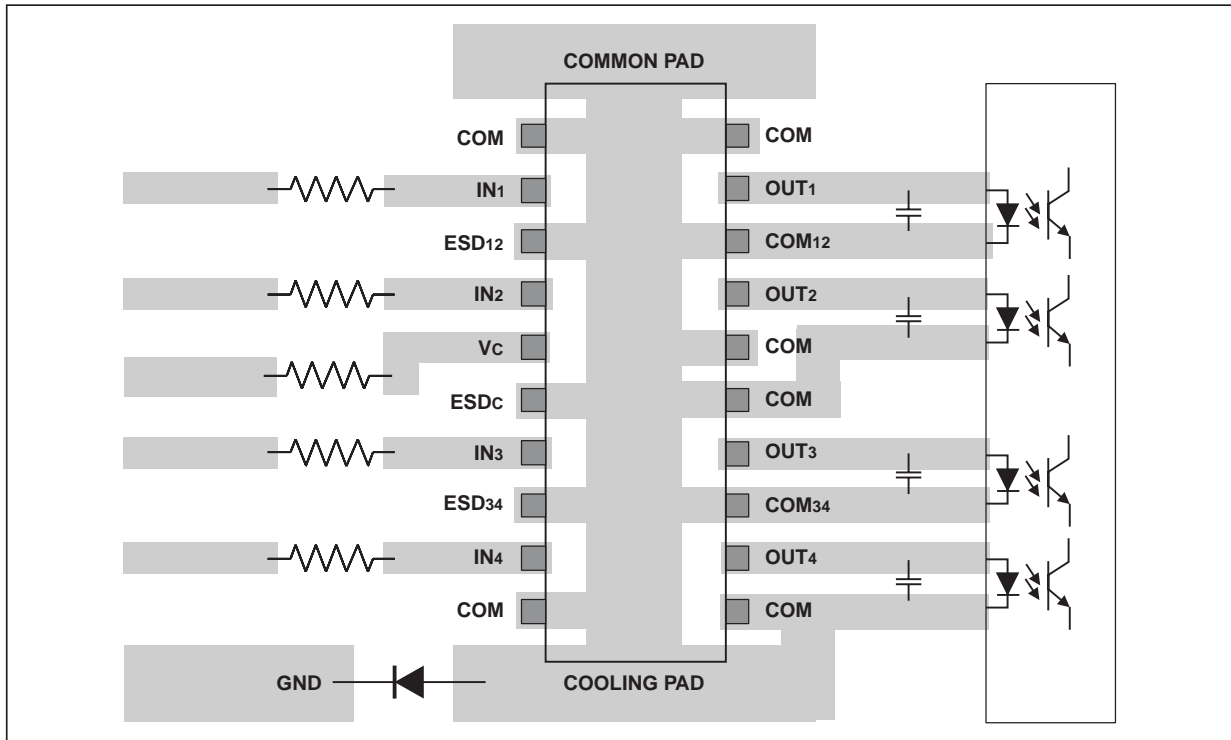
## PIN-OUT CONNECTION



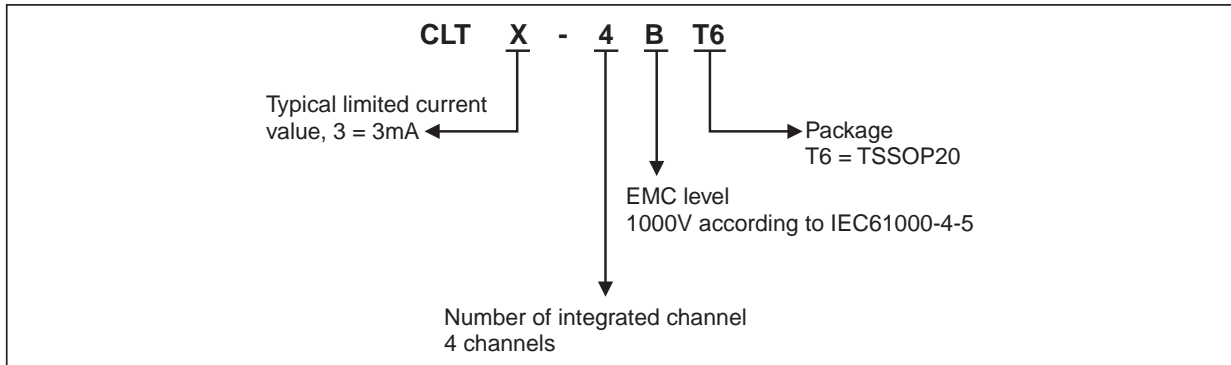
The pins ESD, COM<sub>I,J</sub>, COM (pins # 1, 3, 6, 8, 10, 11, 13, 15, 16, 18, 20) must be connected together externally. This common pad COM is enlarged to reduce the thermal resistance and improve the device cooling. The COM and IN pins are designed to minimize the EMI effects on the circuit.



TSSOP20 PRINTED BOARD EXAMPLE



ORDERING INFORMATION



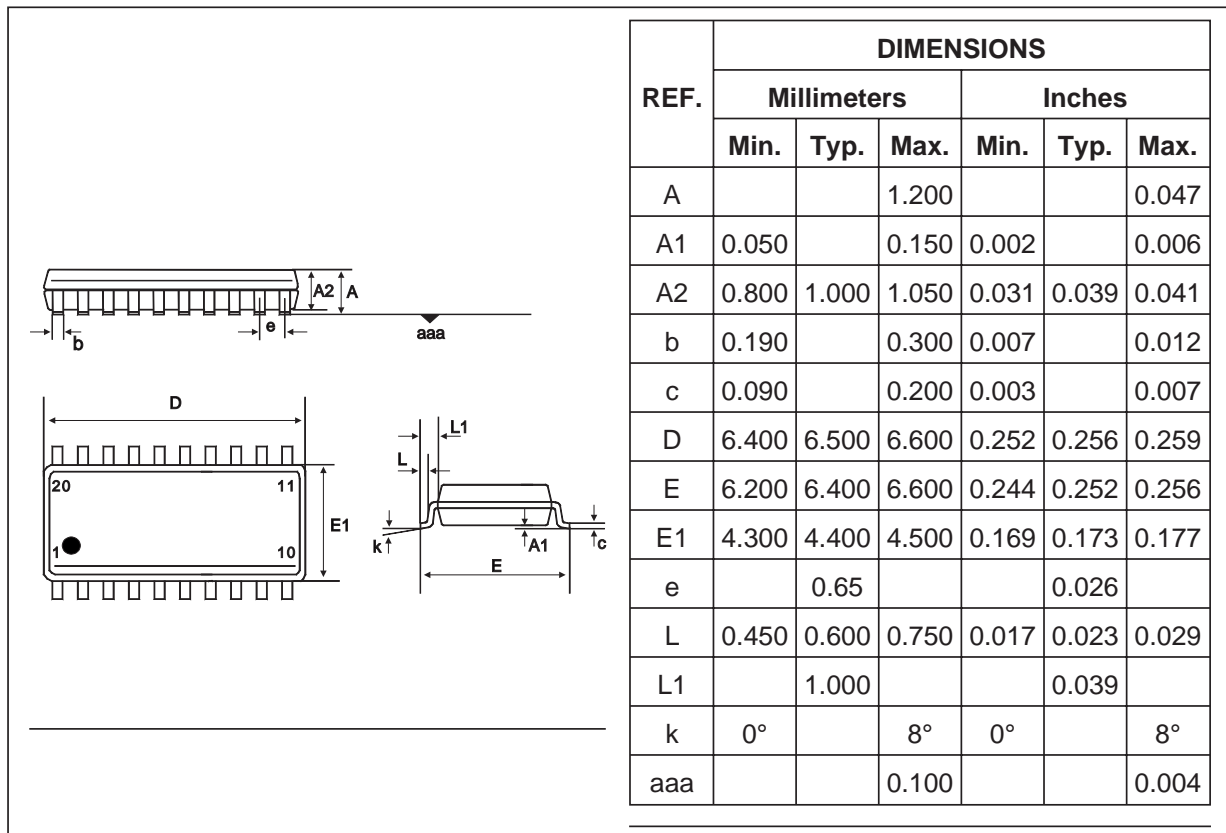
OTHER INFORMATION

Ordering code	Marking	Package	Weight	Base qty	Delivery mode
CLT3-4BT6	CLT3-4B	TSSOP20	0.074 g	74	Tube
CLT3-4BT6-TR	CLT3-4B	TSSOP20	0.074 g	2500	Tape & reel

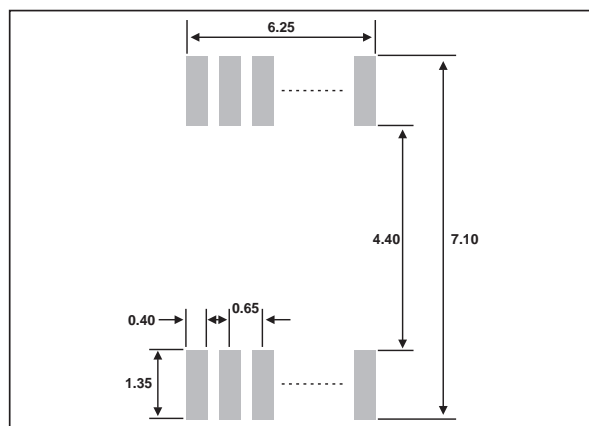
- Epoxy moulding resin meets UL 94,V0

# CLT3-4BT6

## PACKAGE MECHANICAL DATA TSSOP20



### TSSOP20 FOOTPRINT (in millimeters)



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