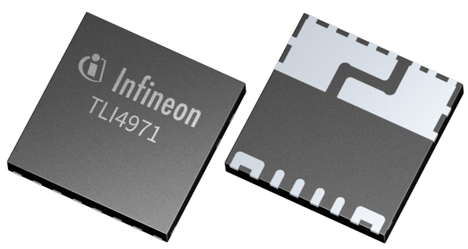
TLI4971 high precision coreless current sensor for industrial applications in 8x8mm SMD package

Features & Benefits

- Integrated current rail with typical 225µΩ insertion resistance enables ultra-low power loss
- Smallest form factor, 8x8mm SMD, for easy integration and board area saving
- Single supply voltage, 3.1V to 3.5V
- High accurate, scalable, DC & AC current sensing
- Full scale up to ±120A
- Bandwidth greater than 120kHz enables wide range of applications
- Low phase delay (< 48° at below 120kHz) for easy closed loop control
- Very low sensitivity error over temperature (< 2.5%)
- Excellent stability of offset over temperature and lifetime
- Integrated isolator provides high robustness to voltage slew rates up to 10V/ns
- Galvanic functional isolation up to 1150V peak V_{IORM}
- V_{ISO} 2500V RMS agency type-tested for 60 seconds per UL1577
- Partial discharge capability of at least 1200V
- Differential sensor principle ensures superior magnetic stray field suppression
- Two independent fast Over-Current Detection (OCD) pins with configurable thresholds enable protection mechanisms for power circuitry (typical 0.7µs)
- Ratiometric and non ratiometric analog output
- Fully calibrated



Coreless current sensor in PG-TISON-8 package

Description

TLI4971 is a high precision miniature coreless magnetic current sensor for AC and DC measurements with analog interface and two fast over-current detection outputs.

Infineon's well-established and robust monolithic Hall technology enables accurate and highly linear measurement of currents with a full scale up to ±120A. All negative effects (saturation, hysteresis) commonly known from open loop sensors using flux concentration techniques are avoided. The sensor is equipped with internal self-diagnostic feature.

Typical applications are electrical drives (up to 690V), current monitoring, chargers, photovoltaic inverters, general purpose inverters, overload and over-current detection.

The digitally assisted analog concept of TLI4971 offers superior stability over temperature and lifetime thanks to the proprietary digital stress and temperature compensation. The differential measurement principle allows great stray field suppression for operation in harsh environments.

The integrated primary conductor (current rail) with very low insertion resistance minimizes the power loss and enables miniaturization of sensing circuitry. A small 8mm x 8mm leadless package (QFN-like) allows for standard SMD assembly.

Two separate interface pins (OCD) provide a fast output signal in case a current exceeds a pre-set threshold.

The sensor is shipped as a fully calibrated product without requiring any customer end-of-line calibration.

Nevertheless, the high configurability enables individual customization for a wide variety of applications. All user-programmable parameters such as OCD thresholds, blanking times and output configuration modes are stored in an embedded EEPROM memory. Programming of the memory can be performed in the application through a Serial Inspection and Configuration Interface (SICI).

Order Information

Product Name	Product Type	Package	Ordering Number
TLI4971-A120T5-U-E0001	120A measurement range, UL certified device [1)2)]	PG-TISON-8	SP005272936
TLI4971-A120T5-E0001	120A measurement range [1)2)]	PG-TISON-8	SP005344532

1) Current sensor for industrial / consumer applications, qualified according to AEC Q100 grade 2
2) Semi-differential mode, non-ratiometric output sensitivity

Pin Configuration

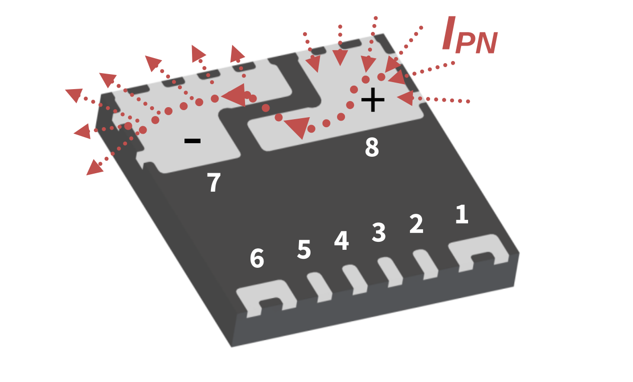


Figure 1 Pin layout PG-TISON-8-5

The current I_{PN} is measured as a positive value when it flows from pin 8 (+) to pin 7 (-) through the integrated current rail.

Pin configuration

Pin No.	Symbol	Function
1	VDD	Supply voltage
2	GND	Ground
3	VREF	Reference voltage input or output
4	AOUT	Analog signal output
5	OCD1	Over-current detection output 1 (open drain output)
6	OCD2	Over-current detection output 2 (open drain output)
7	IP-	Negative current terminal pin (current-out)
8	IP+	Positive current terminal pin (current-in)

Target Applications

The TLI4971 is suitable for AC as well as DC current measurement applications:

- Electrical drives
- Current monitoring
- Photovoltaic & general purpose inverters
- Overload and over-current detection
- Chargers
- etc.

Due to its implemented magnetic interference suppression, it is extremely robust when exposed to external magnetic fields. The device is suitable for fast over-current detection with a configurable threshold level. This allows the control unit to switch off and protect the affected system from damage, independently from the main measurement path.

General Description

The current flowing through the current rail on the primary side induces a magnetic field that is differentially measured by two Hall probes. The differential measurement principle of the magnetic field combined with the current rail design provides superior suppression of any ambient magnetic stray fields. A high performance amplifier combines the signal resulting from the differential field and the internal compensation information provided by the temperature and stress compensation unit. Finally the amplifier output signal is fed into a differential output amplifier which is able to drive the analog output of the sensor.

Depending on the selected programming option, the analog output signal can be provided either as:
- Single-ended
- Fully-differential
- Semi-differential

In single-ended mode, the pin VREF is used as a reference voltage input. The analog output signal is provided on pin AOUT. In fully-differential mode, both AOUT (positive polarity) and VREF (negative polarity) are used as signal outputs whereas VDD is used as reference voltage input. Compared to the single-ended mode, the fully-differential mode enables doubling of the output voltage swing.
In semi-differential mode a chip-internal reference voltage is used and provided on VREF (output). The current sensing information is provided in a single-ended way on AOUT.

For fast over-current detection, the raw analog signal provided by the Hall probes is fed into comparators with programmable switching thresholds.
A user-programmable deglitch filter is implemented to enable the suppression of fast switching transients.
The open-drain outputs of the OCD pins are active “low” and they can be directly combined into a wired-AND configuration on board level to have a general over-current detection signal.

All user-programmable parameters such as OCD thresholds, deglitching filter settings and output configuration mode are stored in an embedded EEPROM memory.
Programming of the memory can be performed in the application through a Serial Inspection and Configuration Interface (SICI). The interface is descripded in detail in the programming guide which can be found on the Infineon webside. Please contact your local Infineon sales office for further documentation.

Standard Product Configuration

- The pre-configured full scale range is set to ±120A with a sensitivity of 10mV/A.
- The pre-configured output mode is set to semi-differential mode.
- The quiescent voltage is set to 1.65V.
- The OCD threshold of channel 1 is set to the factor 1.68 of the full scale range.
- The OCD threshold of channel 2 is set to the factor 0.82 of the full scale range.
- The pre-defined setting of the OCD deglitching filter time is set to 0s.
- The sensor is pre-configured to work in the non-ratiometric mode.
- The sensitivity and the derived measurement range (full scale) can be reprogrammed by user according to the sensitivity ranges listed in Table 4.
- The sensor can be reprogrammed into single-ended operating mode or fully-differential mode by user without any recalibration of the device.
- The OCD thresholds and filter settings can be reprogrammed by the user according to the values listed in Table 6 and Table 7.
- For semi-differential uni-directional mode or ratiometric output sensitivity, please contact your local Infineon sales office.

Block Diagram

The current flowing through the current rail on the primary side induces a magnetic field, that is measured by two Hall probes differentially. The differential measurement principle provides superior suppression of any ambient magnetic stray fields. A high performance amplifier combines the signal resulting from the differential field and the compensation information, provided by the temperature and stress compensation unit. Finally the amplifier output signal is fed into a differential output amplifier, which is able to drive the analog output of the sensor.

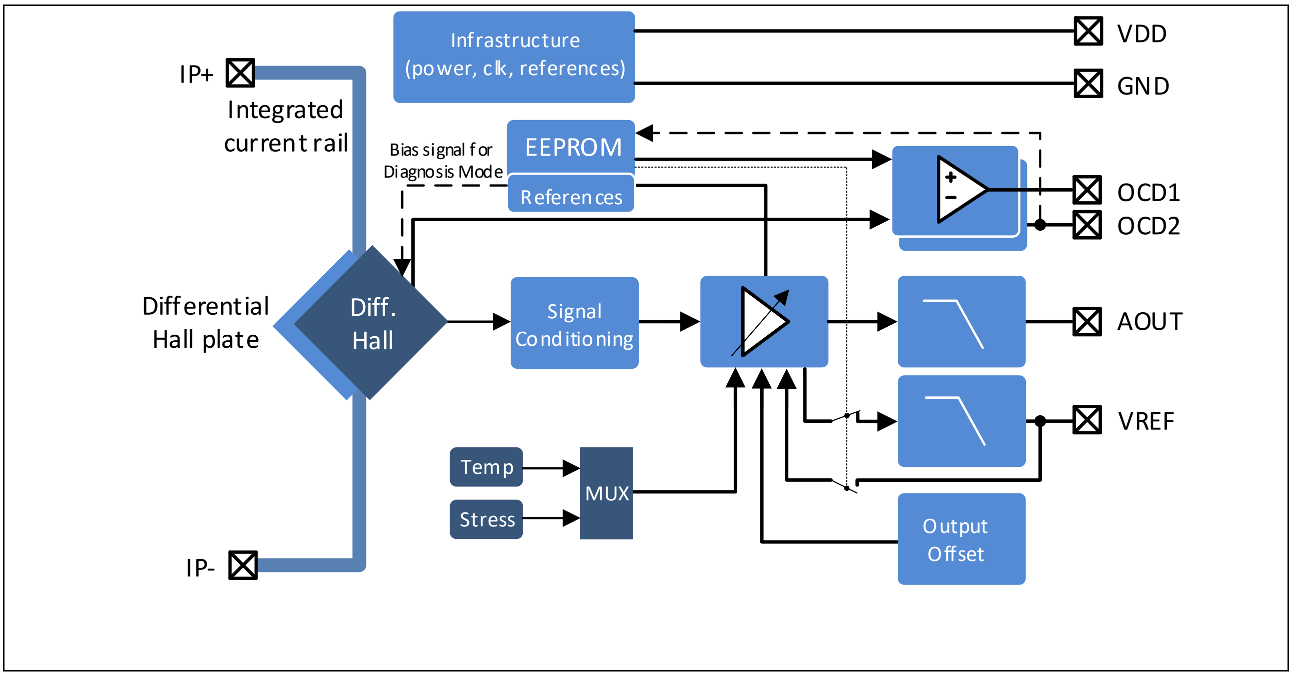


Figure 2 Block Diagram

Absolute Maximum Ratings

Table 1 Absolute Maximum Ratings
General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C … +105°C

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test Condition
Supply voltage	V_{DD}	-0.3	3.3	3.6	V	
Primary nominal rated current LF[1)]	I_{PNRLF}	-70	-	70	A	Peak, frequency < 10Hz. Tested on Infinenon reference PCB (see related application note: AppNote TLI4971 PCB)
Primary nominal rated current HF[2)]	I_{PNRHF}	-70	-	70	A	RMS, frequency ≥ 10Hz. Tested on Infinenon reference PCB (see related application note: AppNote TLI4971 PCB)
Primary current	I_{PNS}	-250	-	250	A	Single peak for 10µs, 10 assertions per lifetime
Voltage on interface pins VREF, OCD1, AOUT	V_{IO}	-0.3	-	V_{DD} + 0.3	V	
Voltage on Interface pin OCD2	V_{IO_OCD2}	-0.3	-	21	V	
ESD voltage[3)]	V_{ESD_HBM}	-2	-	2	kV	
ESD voltage[4)]	V_{ESD_SYS}	-16	-	16	kV	In the application circuit
Voltage slew-rate on current rail	ΔV/dt	-	-	10	V/ns	
Maximum junction temperature	T_{j_max}	-	-	130	°C	
Storage temperature	T_{A_STORE}	-40	-	130	°C	
Life time	LT	15	-	-	Years	Considering continuous operation with T_S = 70°C and I = 30 A RMS

1) Tested with primary nominal rated current of 70A peak on Infineon reference PCB at Low Frequency (LF). Thermal equilibrium reached after 2 min.
2) Tested with primary nominal rated current of 70A rms on Infineon reference PCB at High Frequency (HF). Thermal equilibrium reached after 2 min.
3) Human Body Model (HBM), according to standard AEC-Q 100-002
4) According to standard IEC 61000−4−2 electrostatic discharge immunity test

Stress above the limit values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings. Exceeding only one of these values may cause irreversible damage to the integrated circuit.

Product Characteristics

Table 2 Operating Ranges
General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C … +105°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note / Test Condition
Supply voltage	V_{DD}	3.1	3.3	3.5	V	
Ambient temperature at soldering point	T_S	-40	-	105	°C	Measured at soldering point
Capacitance on analog output pin	C_O	4.7	6.8	8	nF	W/o decoupling resistor, including parasitic cap on the board
Capacitor on VDD	C_{VDD}	-	220	-	nF	
Reference input voltage	V_{REF}	-	1.65	-	V	Default value is semi-differential mode. Other values available by EEPROM: 1.2V, 1.5V, 1.8V
Reference input voltage variation	V_{REF_var}	-10	-	10	%	
EEPROM programming voltage	V_{IO_PRG}	20.5	-	20.7	V	

Table 3 Operating Parameters
General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C … +105°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note / Test Condition
Current consumption	I_{DD}	-	15	25	mA	I(AOUT) = 0mA
Primary path resistance	R_{PN}	-	225	-	µΩ	25°C, when soldered on PCB with 140µm copper thickness
Power-on delay time	t_{POR}	-	-	1.5	ms	From V_{DD} rising above V_{DD}(min) to full operation. Output with lower accuracy is available within 0.5 ms. 0A primary input current.
Voltage on interface pin OCD1	V_{IO_OCD1}	-0.3	-	3.5	V	
Voltage on interface pin OCD2	V_{IO_OCD2}	-0.3	-	3.5	V	In functional mode
Voltage on analog output AOUT	V_{AOUT}	-0.3	-	V_{DD} + 0.3	V	
Supply undervoltage lockout threshold	U_{VLOH_R}	-	-	3	V	V_{DD} at rising edge
Supply undervoltage lockout threshold	U_{VLOH_F}	2.5	-	-	V	V_{DD} at falling edge
Supply overvoltage lockout threshold	O_{VLOH}	3.55	-	-	V	V_{DD} at rising edge
OCD undervoltage detection limit	$V_{DD,OCD}$	1.8	-	-	V	For V_{DD}<$V_{DD,OCD}$ undervoltage may not be performed.
Undervoltage/overvoltage lockout delay	t_{UVLOe}	1	2.4	3	µs	Enabled to disabled
Thermal resistance[1)]	R_{THJS}	-	-	0.6	K/W	Current rail to soldering point, on Infineon reference PCB (see related application note AppNote TLI4971 PCB)

1) Not tested in production. Proven by design and characterization.

Functional Output Description

The analog output signal depends on the selected output mode:

- Single-ended
- Fully-differential
- Semi-differential

Single-Ended Output Mode

In single-ended mode VREF is used as an input pin to provide the analog reference voltage, V_{REF}. The voltage on AOUT, V_{AOUT}, is proportional to the measured current I_{PN} at the current rail:

$$V_{AOUT}(I_{PN}) = V_{OQ} + S \cdot I_{PN}$$

The quiescent voltage V_{OQ} is the value of V_{AOUT} when I_{PN}=0. V_{OQ} tracks the voltage on VREF

$$V_{OQ}(V_{REF}) = V_{REF}$$

The reference voltage can be set to different values which allow either bidirectional or uniderictional current sensing. The possible values of V_{REFNOM} are indicated in Table 2.

The sensitivity is by default non ratiometric to $V_{REF.}$ If ratiometricity is activated the sensitivity becomes as follows:

$$S(V_{REF}) = S(V_{REFNOM}) \cdot \frac{V_{REF}}{V_{REFNOM}}$$

Fully-Differential Output Mode

In fully-differential output mode, both VREF and AOUT are analog outputs to achieve double voltage swing: AOUT is the non-inverting output, while VREF is the inverting output:

$$V_{AOUT}(I_{PN}) = V_{QAOUT} + S \cdot I_{PN}$$
$$V_{REF}(I_{PN}) = V_{QREF} - S \cdot I_{PN}$$

The quiescent voltage is derived from the supply pins VDD and GND and has the same value on both AOUT and VREF:

$$V_{QAOUT}(V_{DD}) = V_{QREF}(V_{DD}) = \frac{V_{DD}}{2}$$

The sensitivity in the fully-differential mode can be generally expressed as:

$$S(V_{DD})_{diff} = S(3.3V)_{diff} \cdot \frac{V_{DD}}{3.3V}$$

In this mode, the quiescent voltages and the sensitivity are both ratiometric with respect to V_{DD} if ratiometricity is enabled.

Semi-Differential Output Mode

In semi-differential output mode, the sensor is using a chip-internal reference voltage to generate the quiescent voltage that is available on pin VREF (used as output).

The analog measurement result is available as single-ended output signal on AOUT. The dependence of sensitivity and output offset on reference voltage is the same as described in single-ended output mode.

The quiescent voltage is programmable at 3 different values, V_{OQbid_1} and V_{OQbid_2} for bidirectional current and V_{OQuni} for unidirectional current (see Table 4).

Total error distribution

Figure 3 shows the total output error at 0h (E_{TOTT}) and over lifetime (E_{TOTL}) over the full scale range for sensitivity range S1 (10mV/A).

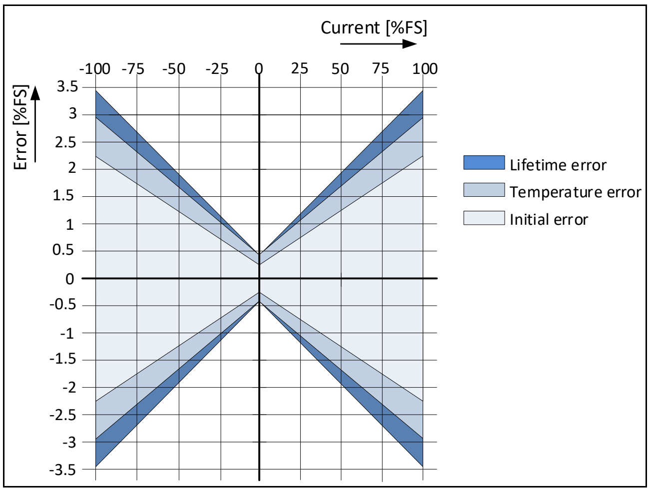


Figure 3 Distribution of max. total error in S1 range

Table 4 Analog Output Characteristics

General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C ... +105°C

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test conditions
Quiescent output voltage (bidirectional option 1)[1)2)]	V_{OQbid_1}	-	$V_{DD}/2$	-	V	I_{PN} = 0A; fully-differential or semi-differential (bidirectional) modes, standard setting
Quiescent output voltage (bidirectional option 2)[2)]	V_{OQbid_2}	-	1.5	-	V	I_{PN} = 0A; semi-differential (bidirectional) mode; for this option the ratiometricity offset is disabled
Quiescent output voltage (unidirectional mode)[2)]	V_{OQuni}	-	$V_{DD}/5.5$	-	V	I_{PN} = 0A; semi-differential (unidirectional) mode
Sensitivity, range1[1)2)3)]	S1	-	10	-	mV/A	±120A FS (Full Scale)
Sensitivity, range2[2)3)]	S2	-	12	-	mV/A	±100A FS
Sensitivity, range3[2)3)]	S3	-	16	-	mV/A	±75A FS
Sensitivity, range4[2)3)]	S4	-	24	-	mV/A	±50A FS
Sensitivity, range5[2)3)]	S5	-	32	-	mV/A	±37.5A FS
Sensitivity, range6[2)3)]	S6	-	48	-	mV/A	±25A FS
Sensitivity ratiometry factor	K_S	-	1	-	-	
Quiescent ratiometry factor	K_{OQ}	-	1	-	-	
Analog output drive capability	I_O	-2	-	2	mA	DC current
Analog output saturation voltage	V_{SAT}	-	150	300	mV	V_{DD}-V_{AOUT}; Output current = 2mA
Transfer function cutoff frequency	BW	120	240	-	kHz	-3dB criterion, C_O = 6.8nF
Output phase delay[4)]	ϕ_{delay}	-	-	48	°	f_{signal} = 120kHz
Output Noise density[5)6)]	I_{NOISE}	-	350	-	µA/√Hz	Referenced to Input current, typical value is at 25°C. Higher noise is present at higher temperatures.
External Homogenous magnetic field suppression[4)]	B_{SR}	34	40	-	dB	Frequency up to 150kHz. Up to 20mT homogeneous field applied

1) Pre-configured setting, for other pre-configured versions please contact your local sales.
2) Can be programmed by user.
3) Values refer to semi-differential mode or single-ended mode, with VREF =1.65 V.
In fully-differential mode the sensitivity value is doubled.
4) Not tested in production. Proven by design, characterization and qualification.
5) Typical value in fully-differential mode, sensitivity range S6
6) $Noise\ Density = \frac{Output\ Noise\ [V_{RMS}]}{\sqrt{\frac{\pi}{2} * BW[Hz]}} * \frac{1}{Sensitivity\left[\frac{V}{A}\right]}$

Table 4 Analog Output Characteristics (cont'd)
General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C … +105°C

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test conditions
Sensitivity error	E_{SENS}	-2	-	2	%	@ T_S = 25°C, at 0h
Sensitivity error over temperature	E_{SENST}	-2.5	-	2.5	%	At 0h
Sensitivity error over temperature and lifetime[4)]	E_{SENSL}	-3	-	3	%	
Output offset	E_{OFF}	-300	-	300	mA	@ T_S = 25°C, at 0h
Output offset over temperature and lifetime[4)]	E_{OFF_L}	-500	-	500	mA	
Total error	E_{TOT}	-2.25	-	2.25	%	Percentage of FS, sensitivity S1; includes sensitivity, offset and linearity error @ T_S=25°C at 0h
Total error over temperature	E_{TOTT}	-2.95	-	2.95	%	Percentage of FS, sensitivity S1; includes sensitivity, offset and linearity error at 0h
Total error over temperature and lifetime[4)]	E_{TOTL}	-3.45	-	3.45	%	Percentage of FS, sensitivity S1; includes sensitivity, offset and linearity error

4) Not tested in production. Proven by design, characterization and qualification.

Fast Over-Current Detection (OCD)

The Over-Current Detection (OCD) function allows fast detection of over-current events. The raw analog output of the Hall probes is fed directly into comparators with programmable switching thresholds. A user programmable deglitch filter is implemented to enable the suppression of fast switching transients. The two different open-drain OCD pins are active low and can be directly combined into a wired-AND configuration on board level to have a general over-current detection signal. TLI4971 supports two independent programmable OCD outputs, suited for different application needs.
The OCD pins are providing a very fast response, thanks to independence from the main signal path. They can be used as a trap functionality to quickly shut down the current source as well as for precise detection of soft overload conditions.

OCD pins external connection

The OCD pins can be connected to a logic input pin of the microcontroller and/or the pre-driver to quickly react to over-current events. They are designed as open-drain outputs to easily setup a wired-AND configuration and allow monitoring of several current sensors outputs via only one microcontroller pin.

OCD thresholds

The symmetric threshold level of the OCD outputs is adjustable and triggers an over-current event in case of a positive or negative over-current. The possible threshold levels are listed in Table 6 and Table 7. The instruction for the settings is documented in the TLI4971 programming guide.

OCD outputs timing behavior

Both output pins feature a deglitch filter to avoid false triggers by noise spikes on the current rail. Deglitch filter settings can be programmed according to application needs. Available options are listed in Table 6 and Table 7.

Figure 4 shows the OCD output pin typical behavior during an over-current event.

Over-current Pulse 1: duration exceeds the over-current response time t_{D_OCDx} + response time jitter Δt_{D_OCDx} + deglitch filter time $t_{deglitch}$. The OCD output voltage is set low until the current value drops below the OCD threshold.

Over-current Pulse 2: duration does not exceed the over-current response time t_{D_OCDx} and therefore no OCD event is generated.

Over-current Pulse 3: duration exceeds the response time t_{D_OCDx} + response time jitter Δt_{D_OCDx}, but does not exceed the glitch filter time $t_{deglitch}$ and no OCD event is generated.

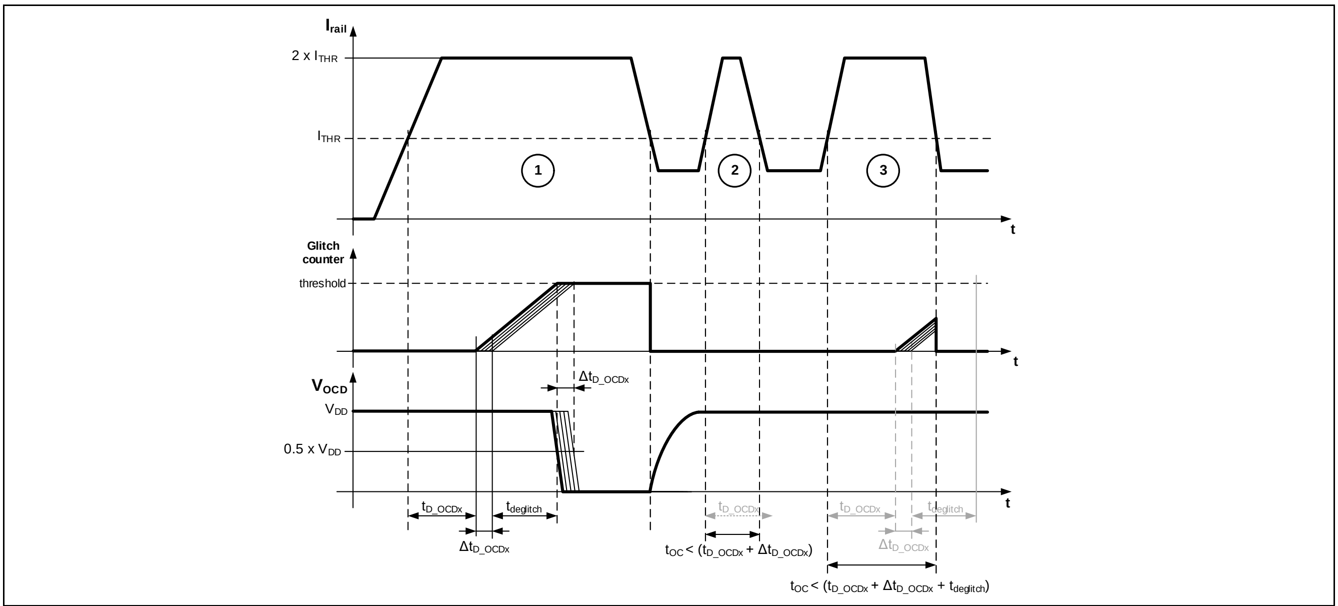


Figure 4 Fast over-current detection output timing

Fast Over-Current Detection (OCD) Output Parameters

Table 5 Common OCD Parameters
General conditions (unless otherwise specified): V_{DD} = 3.3V; T_S = -40°C … +105°C, C_L=1nF.

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test Conditions
Threshold level tolerance[1]	I_{THT}	-10	-	10	%	
Response time jitter[1]	Δt_{D_OCD}	-	-	0.25	µs	At 3σ, I_{rail}=2x$I_{THRx.x}$, input rise time 0.1µs
Deglitch filter basic time	t_{OCDgl}	400	500	600	ns	
Detection minimum time	t_{OCD_low}	3	-	-	µs	Valid for both OCDs
Load capacitance	C_L	-	-	1	nF	
Open-drain current	I_{OD_ON}	-	-	1	mA	DC current
Pull-up resistor	R_{PU}	4.7	-	10	kΩ	To V_{DD}

1) Not tested in production. Proven by design, characterization and qualification

Table 6 OCD1 Parameters

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test Conditions
Threshold level - Level1[1)2)]	$I_{THR1.1}$	-	1.25	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level2[1)2)]	$I_{THR1.2}$	-	1.39	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level3[1)2)]	$I_{THR1.3}$	-	1.54	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level4[1)2)3)]	$I_{THR1.4}$	-	1.68	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level5[1)2)]	$I_{THR1.5}$	-	1.82	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level6[1)2)]	$I_{THR1.6}$	-	1.96	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level7[1)2)]	$I_{THR1.7}$	-	2.11	-	x I_{FS}	Factor with respect to I_{FS}
Threshold level - Level8[1)2)]	$I_{THR1.8}$	-	2.25	-	x I_{FS}	Factor with respect to I_{FS}
Response time[4)]	t_{D_OCD1}	-	0.7	1	µs	I_{PN} = 2*$I_{THR1.x}$
Fall time[5)]	t_{f_OCD1}	-	100	150	ns	
Deglitch filter setting[2)6)]	$OCD1_{gl\_mul}$	0	-	7	-	$t_{deglitch}$ = $OCD1_{gl\_mul}$*t_{OCDgl} pre-configured setting = 0

1) Symmetric threshold level for positive and negative currents.
2) Can be programmed by user.
3) Pre-configured threshold level
4) Falling edge level of OCD1-pin < 0.5 x V_{DD}.
5) Not tested in production. Proven by design, characterization and qualification.
6) The specified deglitching timing is valid when input current step overtakes the threshold of at least 10%.

Table 7 OCD2 Parameters

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test Conditions
Threshold level - level1[1)2)]	$I_{THR2.1}$	-	0.5	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level2[1)2)]	$I_{THR2.2}$	-	0.61	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level3[1)2)]	$I_{THR2.3}$	-	0.71	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level4[1)2)3)]	$I_{THR2.4}$	-	0.82	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level5[1)2)]	$I_{THR2.5}$	-	0.93	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level6[1)2)]	$I_{THR2.6}$	-	1.04	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level7[1)2)]	$I_{THR2.7}$	-	1.14	-	x I_{FSR}	Factor with respect to I_{FS}
Threshold level - level8[1)2)]	$I_{THR2.8}$	-	1.25	-	x I_{FSR}	Factor with respect to I_{FS}
Response time[4)]	t_{D_OCD2}	-	0.7	1.2	µs	I_{PN} = 2 x $I_{THR2.x}$
Fall time[5)]	t_{f_OCD2}	-	200	300	ns	
Deglitch filter setting[2)6)]	$OCD2_{gl\_mul}$	0	-	15	-	$t_{deglitch}$ = $OCD2_{gl\_mul}$ x t_{OCDgl} pre-configured setting = 0

1) Symmetric threshold level for positive and negative currents.
2) Can be programmed by user.
3) Pre-configured threshold level.
4) Falling edge level of OCD2-pin < 0.5 x V_{DD}.
5) Not tested in production. Proven by design, characterization and qualification.
6) The specified deglitching timing is valid when input current step overtakes the threshold of at least 10%.

Undervoltage / Overvoltage detection

TLI4971 is able to detect undervoltage or overvoltage condition of its own power supply (V_{DD}). When an undervoltage ($V_{DD}<U_{VLOH}$) or overvoltage ($V_{DD}>O_{VLOH}$) condition is detected both OCD pins are pulled down in order to signal such a condition to the user.
The undervoltage detection on OCD pins is performed only if $V_{DD} > V_{DD,OCD}$.
Both OCD pins are pulled down at start up. When V_{DD} exceeds the undervoltage threshold U_{VLOH_R} and the power on delay time t_{POR} has been reached, the sensor indicates the correct functionality and high accuracy by releasing the OCD pins.

Isolation Characteristics

TLI4971 conforms functional isolation.

Table 8 Isolation Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Note / Test Conditions
Maximum rated working voltage (sine wave)1)2)3)	V_{IOWM}	-	-	690	V	RMS, @ 4000m altitude
Maximum rated working voltage (sine wave)1)2)3)	V_{IOWMP}	-	-	975	V	Peak, @ 4000m altitude
Maximum repetitive isolation voltage2)3)	V_{IORM}	-	-	1150	V	Max DC voltage, spike, @ 4000m altitude
Apparent charge voltage capability (method B)2)3)	V_{PDtest}	1500	-	-	V	Partial discharge < 5pC peak @ 0m altitude
Isolation test voltage3)4)	V_{ISO}	2500	-	-	V	RMS, 60s
Isolation production test voltage	V_{ISOP}	3000	-	-	V	RMS, in production, 1.2s, UL certified version
	V_{ISOP}	2470	-	-	V	RMS, in production, 600ms, Non-UL certified version
Isolation pulse test voltage3)	V_{pulse}	4500	-	-	V	Peak, rise time = 1.2µs, fall time = 50µs
Minimum external creepage distance	CPG	4	-	-	mm	
Minimum external clearance distance	CLR	4	-	-	mm	
Minimum comparative tracking index	CTI	Material group II	-	-	-	
Isolation resistance3)	R_{IO}	10	-	-	GΩ	U_{IO} = 500V DC, 1min

1) The given value is considered an example based on pollution degree 2.
2) After stress test according to qualification plan.
3) Not subject to production test - verified by design and characterization.
4) Agency type tested for 60 seconds by UL according to UL 1577 standard.

System integration

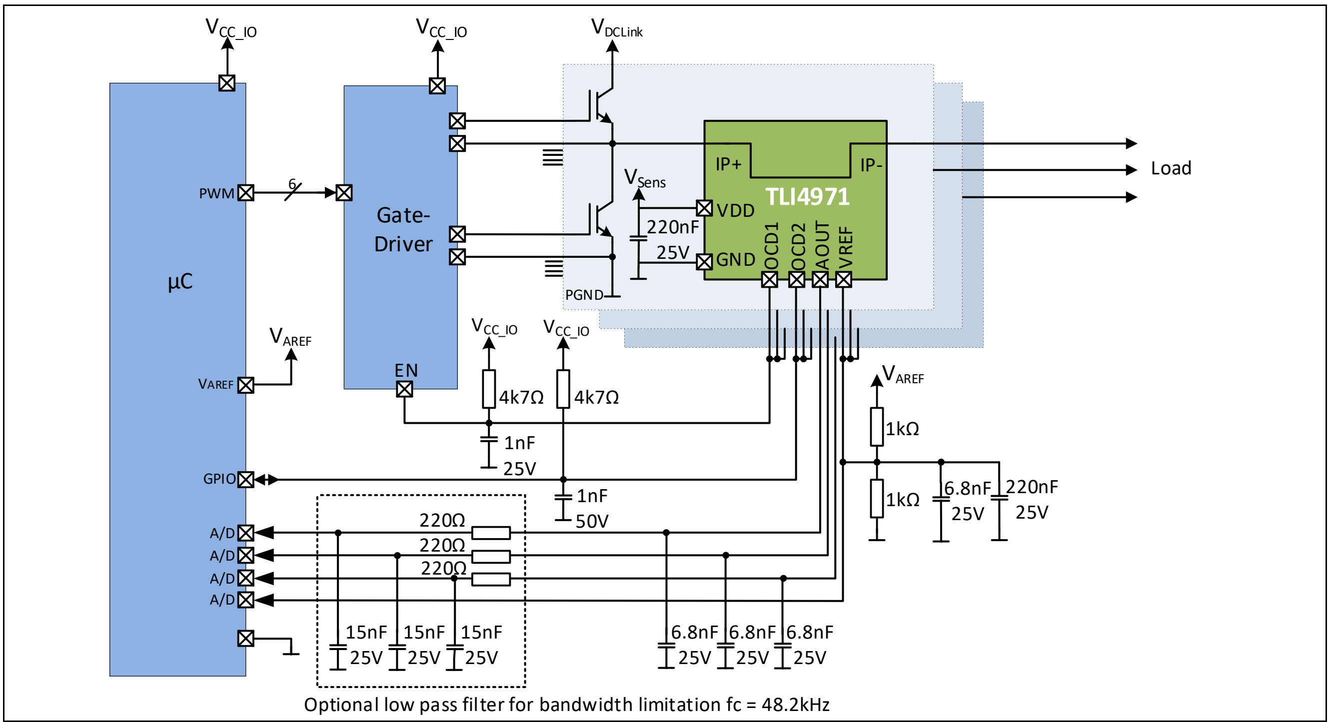


Figure 5 Application circuit for three phase system in single-ended configuration

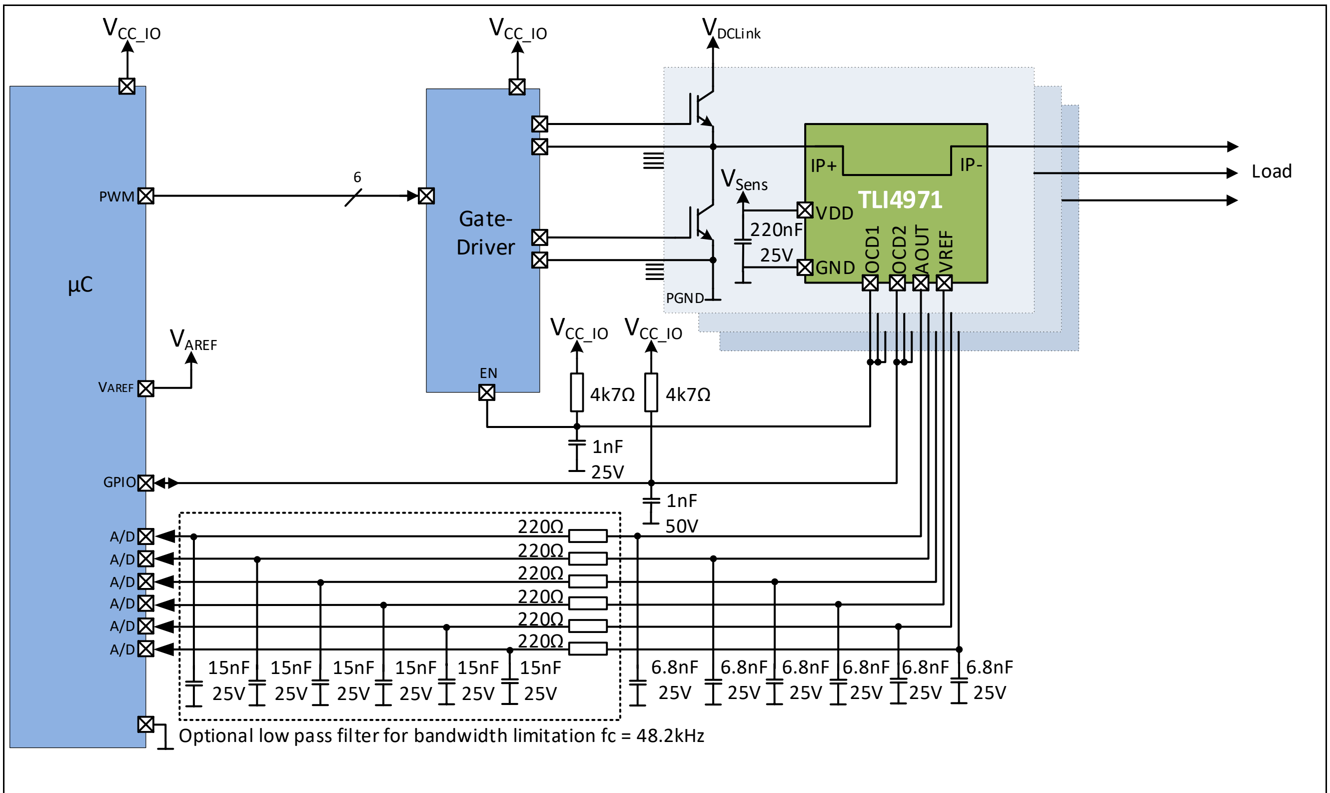


Figure 6 Application circuit for three phase system in differential configuration

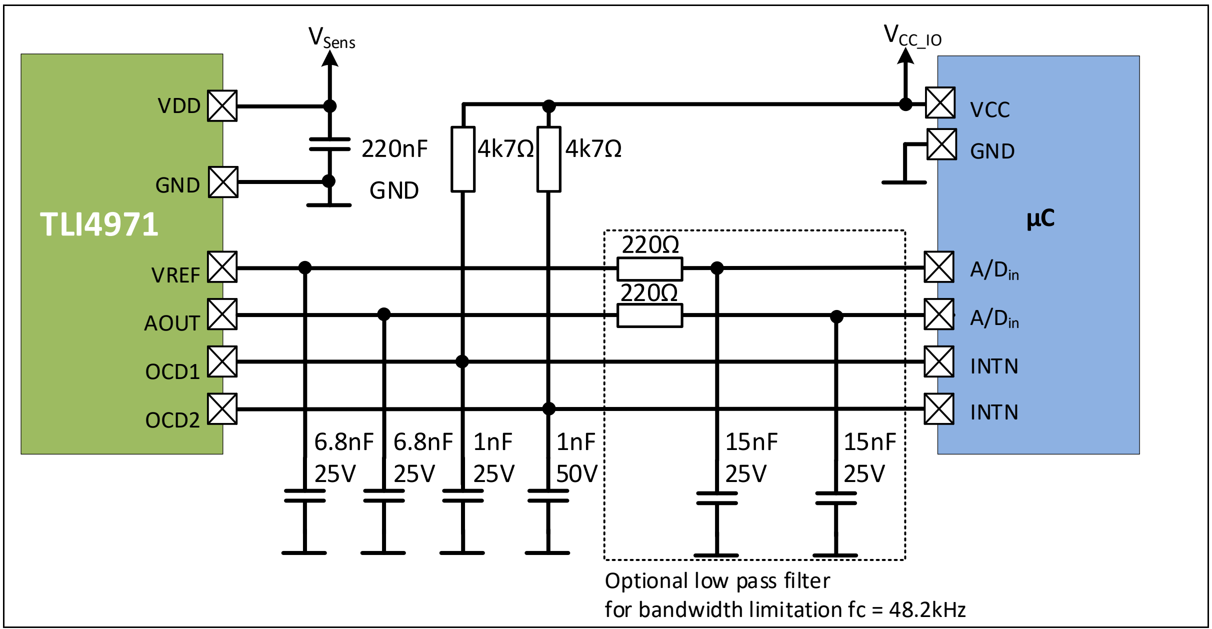


Figure 7 Application circuit with external components

For bandwidth limitation an external filter is recommended as shown in the above application circuits.

Package

The TLI4971 is packaged in a RoHS compliant, halogen-free leadless package (QFN-like).

PG-TISON-8 Package Outline

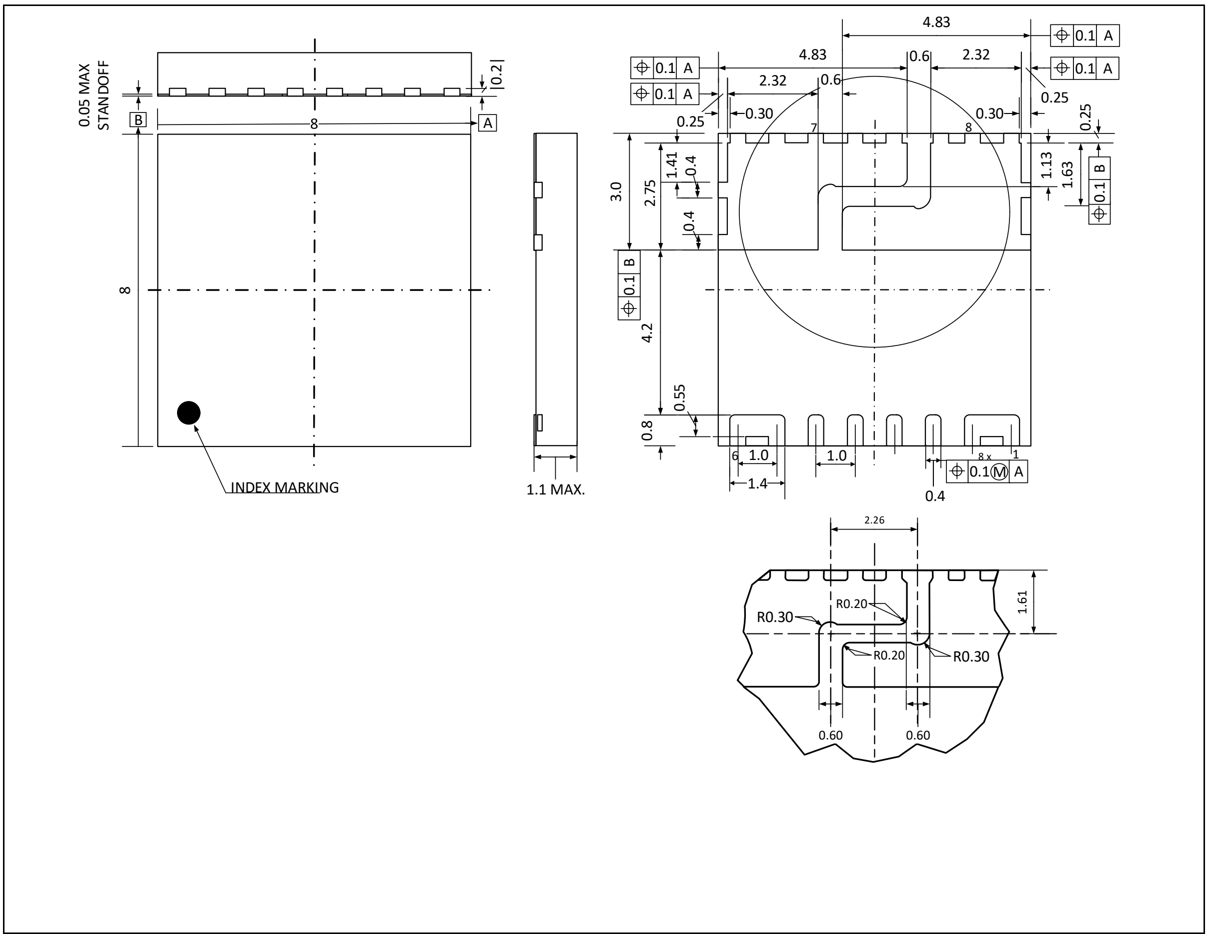


Figure 8 PG-TISON-8 package dimensions

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Revision History

Major changes since the last revision

Date	Description of change
10-02-2020	Initial version
09-03-2020	Pre-configured OCD threshold levels changed / Page3, Table 6 and Table 7
	Standard Product Configuration updated on Page 3 / OCD settings according to Table 6 and Table 7
	Updated Table 8, isolation characteristics
	Updated application circuits
	Editorial changes
	Revision update 1.1

Edition 09-03-2020

Published by

Infineon Technologies AG

81726 München, Germany

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Document reference
