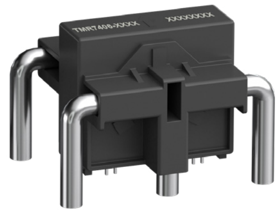
TMR7406-Q

Board Mount High Bandwidth Leakage Current Sensor

Description

TMR7406-Q series are (Type B) leakage current sensor base on TMR (Tunnel Magnetic Resistance) technology with galvanic isolation. It may be used for detecting three phase current unbalance. And it can also be for measuring DC, AC and arbitrary waveforms.

This current sensor has built-in self-check coil for its state. It's output voltage maintain in overload state when excess primary current is injected into the sensor without outputting any high impedance state (Primary current should not be overloaded beyond critical current).



Features and Benefits

- Tunnel magnetic resistance (TMR) technology
- High bandwidth (400kHz)
- Fast response time (1μs)
- No excitation current noise
- Stable overload state
- Low thermal drift
- Self check functionality
- Galvanic isolation
- RoHS & REACH compliant

Applications

- PV invertor
- battery energy storage system (BESS)
- EV Charger
- Three phase unbalance analysis
- Grounding error/Earth leackage detection

Applications

- IEC 60755
- EN 50178
- GB/T 17626, GB/T 2423
- VDE 0126-1-1
- UL 94-V0

Insulation and Environmental Characteristics

Parameters	Symbol	Typ.	Unit
Dielectric Strength	V_D	4	kV(50 Hz, 1 min)
Insulation Resistance	R_{IS}	1000	MΩ
Creepage Distance	d_{CP}	12	mm
Clearance	d_{CL}	12	mm
Ambient Operating Temperature	T_A	-40 to +105	°C
Ambient Storage Temperature	T_{STG}	-50 to +105	°C
Mass	m	130	g

Selection Guide

Part Number	Primary Nominal Current	Primary Current Measuring Range
TMR7406-300MQ	0.3 A	±0.5 A
TMR7406-600MQ	0.6 A	±1 A
TMR7406-0010Q	1 A	±1.7 A
TMR7406-0020Q	2 A	±3.5 A
TMR7406-0030Q	3 A	±5 A
TMR7406-0050Q	5 A	±8.5 A

Catalogue

1. Specifications

T_A = +25 °C, V_{CC} = 5 V, unless otherwise noted

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
General Electrical Data						
Primary Nominal Current	I_{PN}	TMR7406-300MQ	-	0.3	-	A
		TMR7406-600MQ	-	0.6	-	
		TMR7406-0010Q	-	1	-	
		TMR7406-0020Q	-	2	-	
		TMR7406-0030Q	-	3	-	
		TMR7406-0050Q	-	5	-	
Primary Current Measuring Range	I_{PM}	TMR7406-300MQ	-0.5	-	0.5	A
		TMR7406-600MQ	-1	-	1	
		TMR7406-0010Q	-1.7	-	1.7	
		TMR7406-0020Q	-3.5	-	3.5	
		TMR7406-0030Q	-5	-	5	
		TMR7406-0050Q	-8.5	-	8.5	
Sensitivity	S	I_P = 0 to ±I_{PN}, TMR7406-300MQ	-	4	-	mV/A
		TMR7406-600MQ	-	2	-	
		TMR7406-0010Q	-	1.2	-	
		TMR7406-0020Q	-	0.6	-	
		TMR7406-0030Q	-	0.4	-	
		TMR7406-0050Q	-	0.24	-	
Supply Voltage	V_{CC}	±5 %	4.75	5	5.25	V
Offset Voltage	V_{OFF}	I_P = 0	2.47	2.5	2.53	V
Output Voltage	V_{OUT}	I_P = 0 ~ ±I_{PM}	-	V_{OFF} + S × I_P	-	V
Reference Voltage	V_{REF}	-	2.49	2.5	2.51	V
Current Consumption	I_C	I_P = 0	6	8	12	mA
Load Resistance	R_L	V_{OUT} to 0V, I_P = 0 ~ ±I_{PM}	1	10	∞	kΩ
Load Capacitance	C_L	V_{OUT} to 0V, I_P = 0 ~ ±I_{PM}	-	1	10	nF
Number of Check Coil Turns	N_T	-	-	20	-	Turns
Check Coil input Current	I_{CHK}	-	0	-	25	mA
Check Coil Output Voltage	V_{CHK}	See Instructions 4 for details	-	V_{OFF} + S × 20I_{CHK}	-	V
Static Performance Data						
Accuracy	X_G	T_A = +25 °C, I_P = 0 to ±I_{PN}	±0.1	±0.6	±2	% I_{PN}
		T_A = -40 °C to +105 °C, I_P = 0 to ±I_{PN}	±0.1	±2	±4	
Linearity Error	ε_L	I_P = 0 to ±I_{PN}	0.1	0.3	1	% I_{PN}
Offset Error	V_{OE}	V_{OFF} - 2.5V or V_{OFF} - V_{REF}	-30	10	30	mV
Temperature coefficient of offset error	TCV_{OE}	T_A = -40 °C to +105 °C, I_P = 0 to ±I_{PN}	0.1	0.5	1	mV/°C
Hysteresis	V_{OH}	I_P = 0 to ±I_{PN}	-10	±4	10	mV
Dynamic Performance Data						
Response Time	t_R	di/dt > 5 A/μs, 10% to 90% of I_{PN}	0.1	1	3	μs
Bandwidth	BW	-3 dB	DC	400	600	kHz
Noise	V_N	DC to 100 kHz	5	20	-	mV_{PP}

2. Typical Output Characteristics

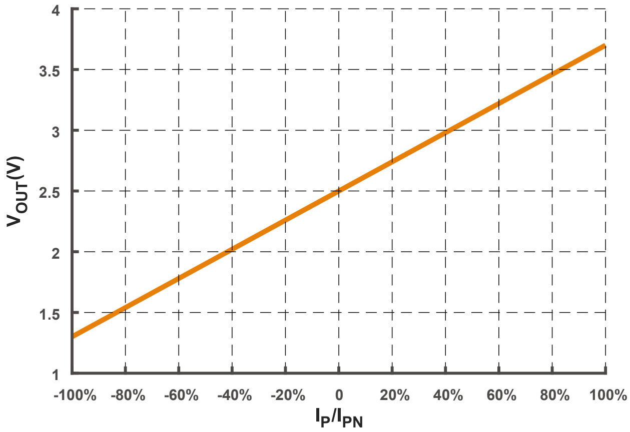


Figure 1. Output Voltage vs Primary Current

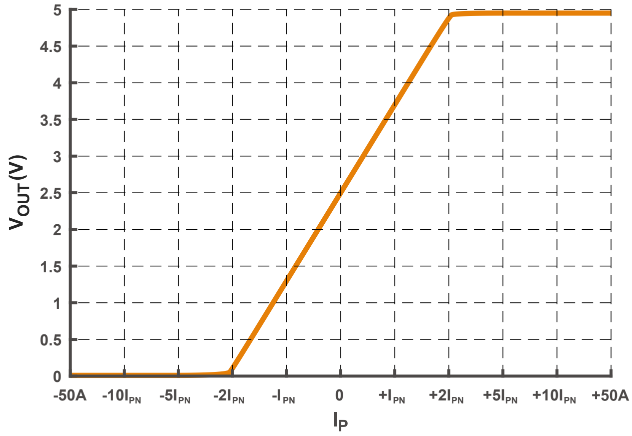


Figure 2. Output Voltage vs Primary Current Overload

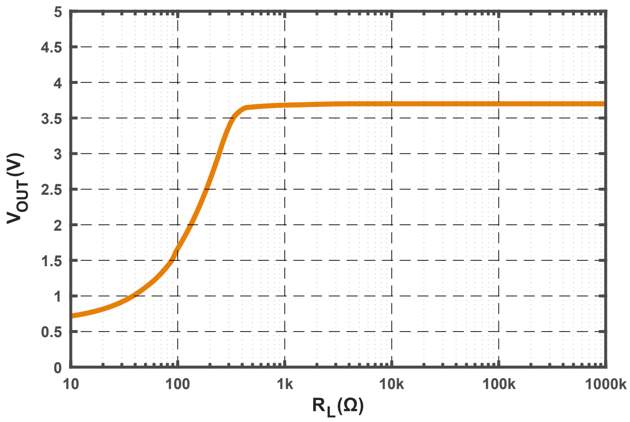


Figure 3. Output Voltage vs Load Resistance (@$I_P = I_{PN}$)

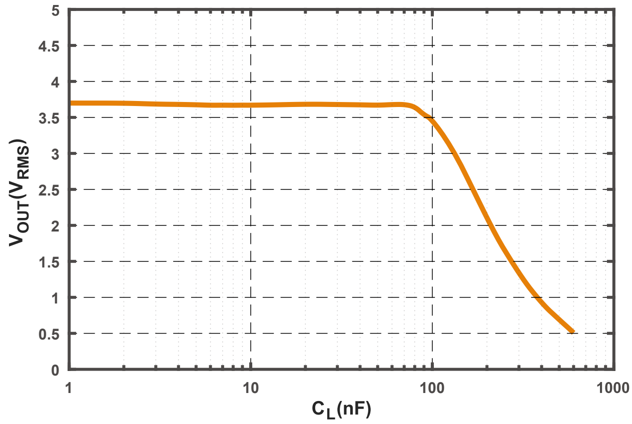


Figure 4. Output Voltage vs Load Capacitance (@$I_P = I_{PN}$)

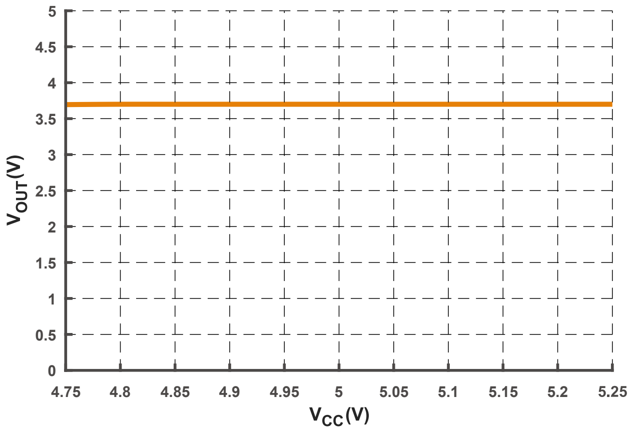


Figure 5. Output Voltage vs Supply Voltage (@$I_P = I_{PN}$)

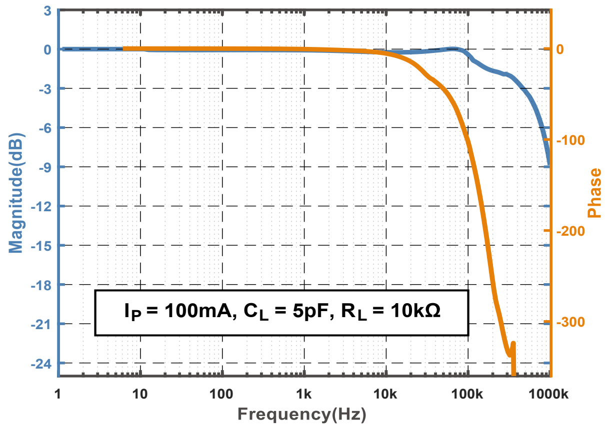


Figure 6. Bode Plot

3. Typical Temperature Characteristics

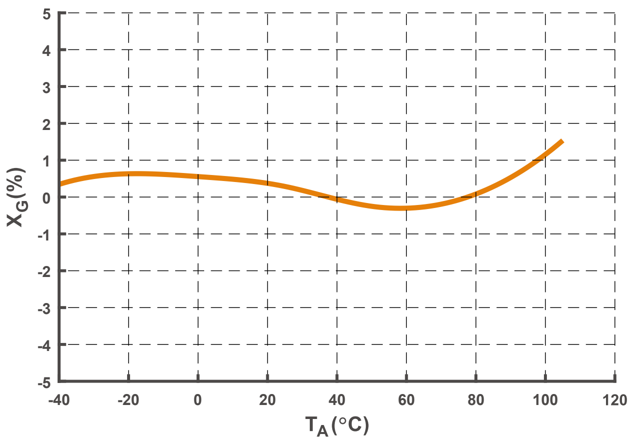


Figure 7. Accuracy

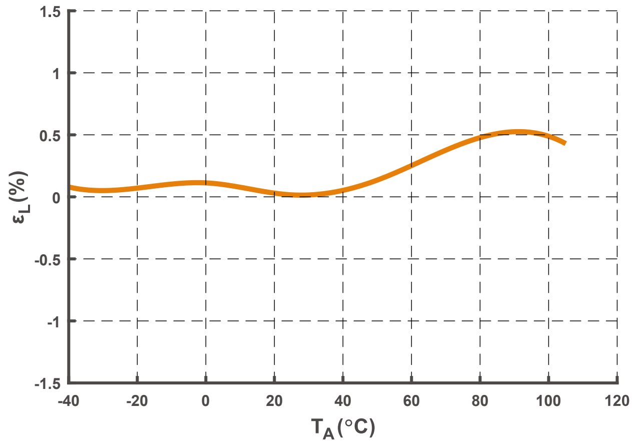


Figure 8. Linearity Error

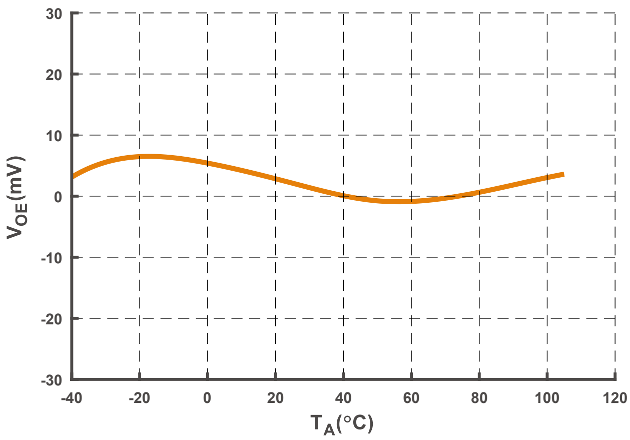


Figure 9. Offset Error

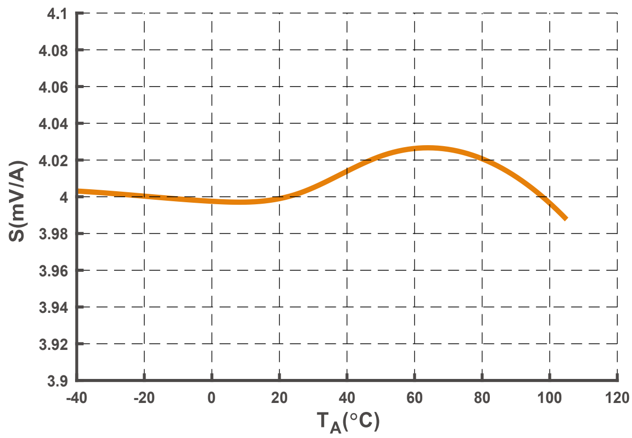


Figure 10. Sensitivity (@I_{PN} = 0.3 A)

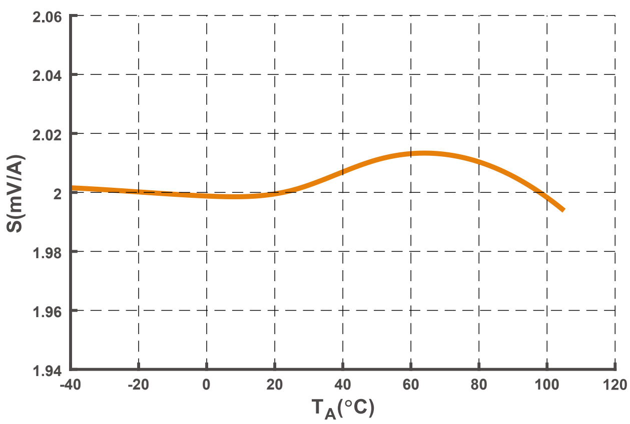


Figure 11. Sensitivity (@I_{PN} = 0.6 A)

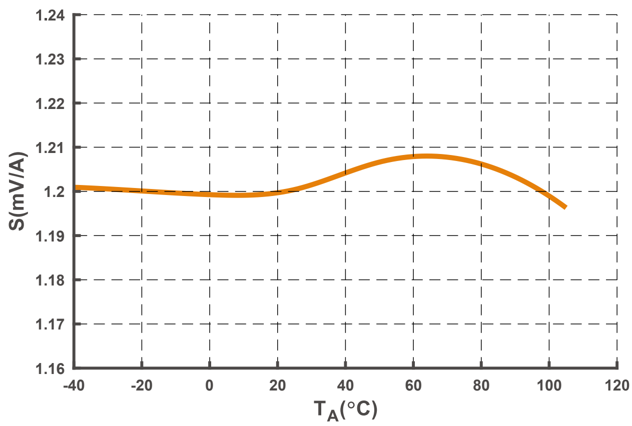


Figure 12. Sensitivity (@I_{PN} = 1.0 A)

Typical Temperature Characteristics

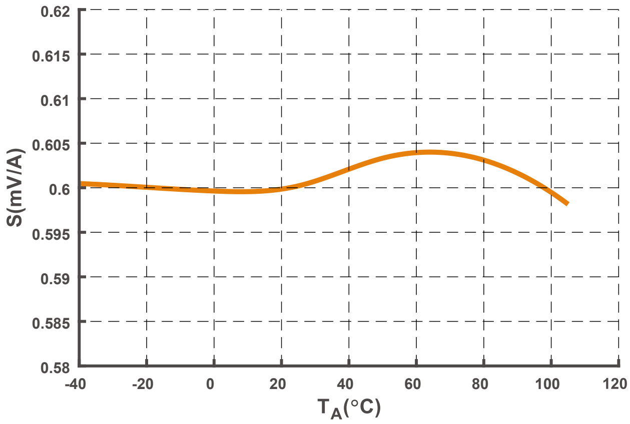


Figure 13. Sensitivity (@I_{PN} = 2.0 A)

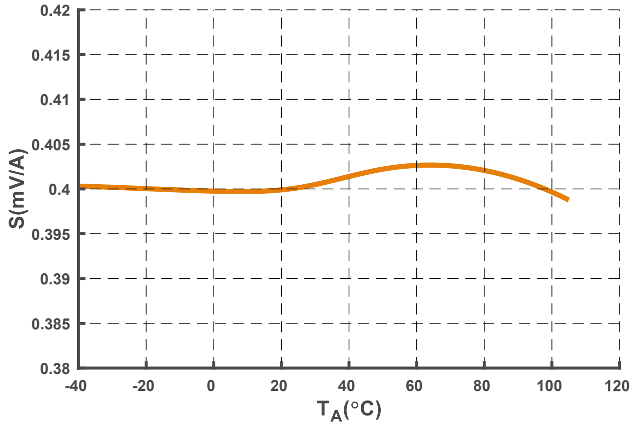


Figure 14. Sensitivity (@I_{PN} = 3.0 A)

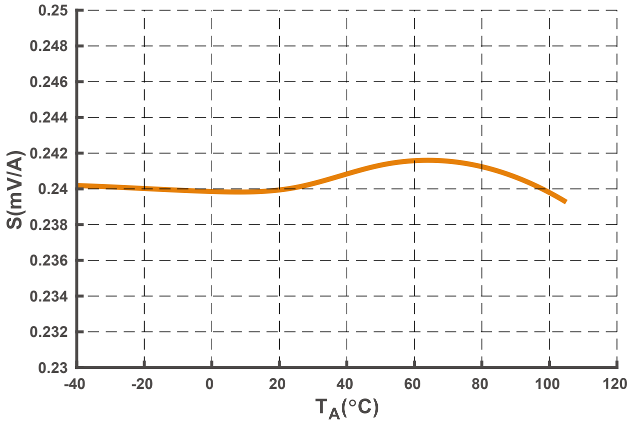


Figure 15. Sensitivity (@I_{PN} = 5.0 A)

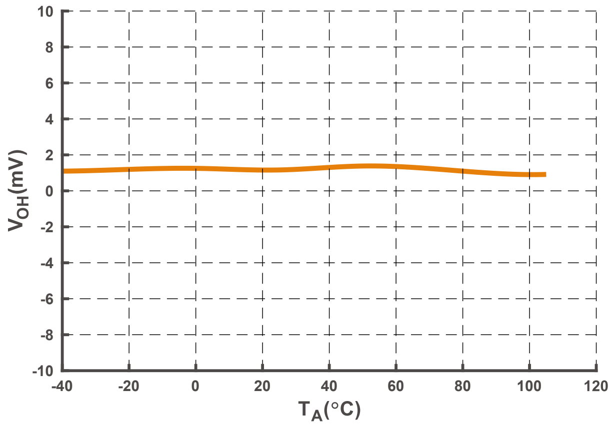


Figure 16. Hysteresis

4. Parameters Definition and Formula

1) Output Current

$$V_{OUT} = V_{OFF} + S \times I_P$$

V_{OFF} stands for offset voltage, S stands for sensitivity, I_P stands for primary current, V_{OUT} stands for current sensor output voltage at given primary current.

2) Accuracy

$$X_G = \underset{I_P \in [-I_{PN}, I_{PN}]}{MAX} \left(\frac{(\overline{V_{OUT}} - V_{REF}) - (S \times I_P)}{S \times I_{PN}} \times 100\% \right)$$

I_{PN} stands for nominal primary current, $\overline{V_{OUT}}$ stands for mean value for output voltage, V_{REF} stands for reference voltage.

3) Sensitivity

$$S = \frac{V_{OUT(@\,I_{PN})} - V_{OUT(@\,-I_{PN})}}{2 \times I_{PN}}$$

$V_{OUT(@I_{PN})}$ and $V_{OUT(@-I_{PN})}$ stand for the voltage output at I_{PN} and $-I_{PN}$ respectively.

4) Linearity

$$\varepsilon_L = \underset{I_P \in [-I_{PN}, I_{PN}]}{MAX} \left(\frac{(\overline{V_{OUT}} - V_{REF}) - (\overline{V}_{OE} + \overline{S} \times I_P)}{S \times I_{PN}} \times 100\% \right)$$

$\overline{S}$ and $\overline{V}_{OE}$ stand for the average values of the sensitivity and offset error.

5) Hysteresis

$$V_{OH} = MAX\ \Delta H$$

ΔH is the maximum residual voltage between full scale positive and negative nominal current.

6) Offset Error

Single-ended: $V_{OE} = V_{OFF} - 2.5$

Difference: $V_{OE} = V_{OFF} - V_{REF}$

5. Application Information

5.1 Electrical Connection

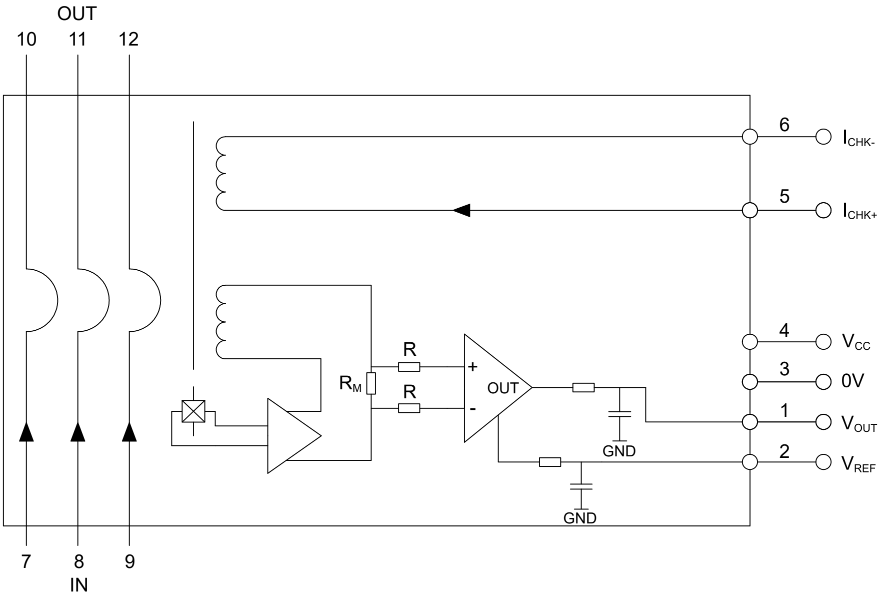


Figure 17. Electrical Connection

Number	Symbol	Description
1	V_{OUT}	Output voltage
2	V_{REF}	Reference voltage
3	0V	Power supply ground
4	V_{CC}	5V
5	I_{CHK+}	Current input
6	I_{CHK-}	Current output
7, 8, 9	IN	Primary current input
10, 11, 12	OUT	Primary current output

5.2 Typical Application Circuit

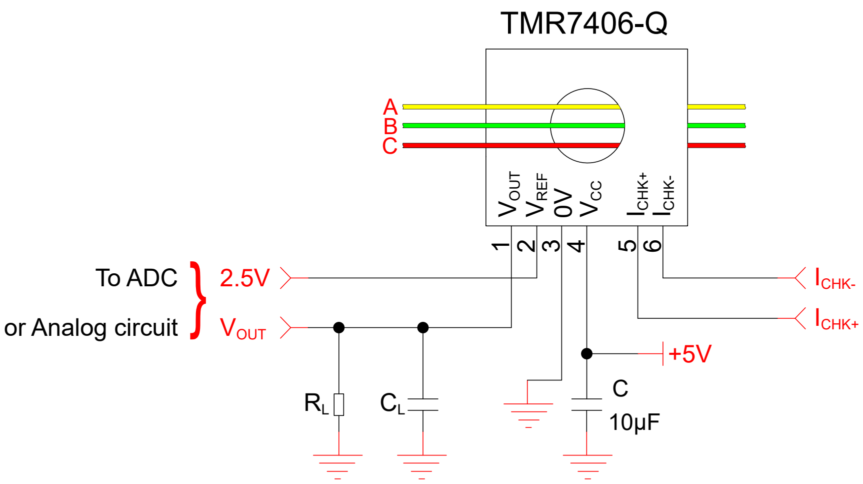


Figure 18. Application Circuit Diagram

Symbol	Description
C	Power filter capacitance, C ≥ 1μF, Recommended C = 10μF
R_L	Load resistance, R_L ≥ 1kΩ, Recommended R_L = 10kΩ
C_L	Load capacitance, C_L ≤ 10nF, Recommended C_L = 1nF

5.3 Recommended PCB Layout

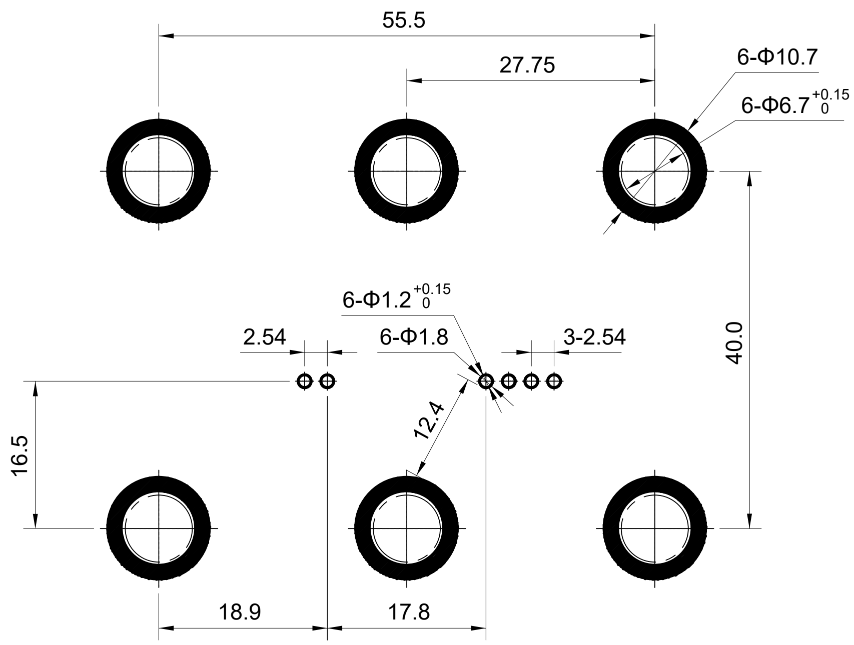


Figure 19. 7406-Q Pin Layout Diagram

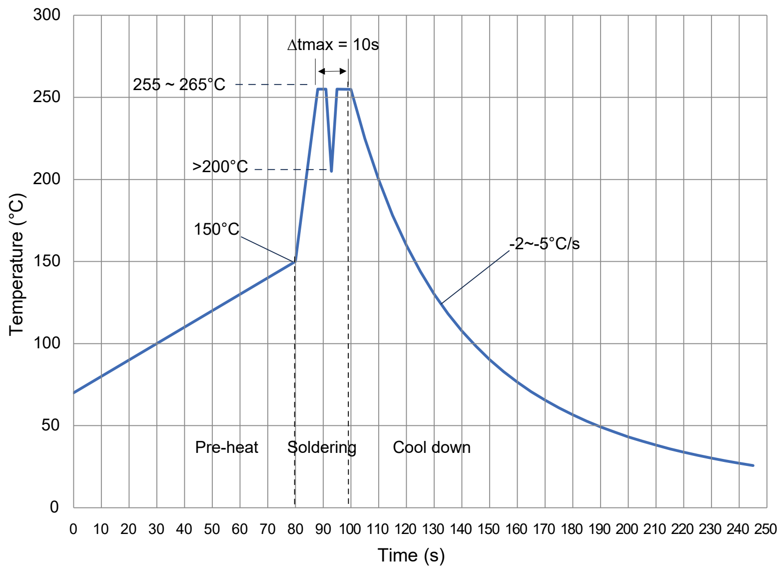
5.4 Remarks

1. This type of current sensor contain highly magnet-sensitive component and magnetic-concentrator elements, making it highly sensitive to magnetic fields. It should avoid being installed in place with strong magnetic interference to ensure it's safe and normal operation for its service life.

2. When the primary current (I_P) follows in the direction indicated by the arrow on the product, it is defined as positive, at which V_{OUT} > 2.5V; otherwise, it is negative, and V_{OUT} < 2.5V.

3. Please use the sensor according to the pinout on the datasheet, incorrect wiring may result in permanent damage of the sensor.

4. The recommended peak wave soldering temperature is 260 ºC with a maximum continuous duration of 10 seconds.



5. It is recommended to perform a self-check of the sensor before use, with the following steps:

a) Ensure that the sensor is properly powered, and I_P the primary current is set to no current or 0A. Verify that V_{OE} the offset error meets the spec in the datasheet.

b) Apply the I_{CHK} self-check current (Recommended current: 2mA ≤ I_{CHK} ≤25mA) to the sensor's self-check coil, make sure that the current direction follows from I_{CHK+} towards I_{CHK-}. With self-check current being applied, the differential output of the sensor should be: $V_{OUT} - V_{REF} = V_{OE} + 20 \times I_{CHK} \times S$.

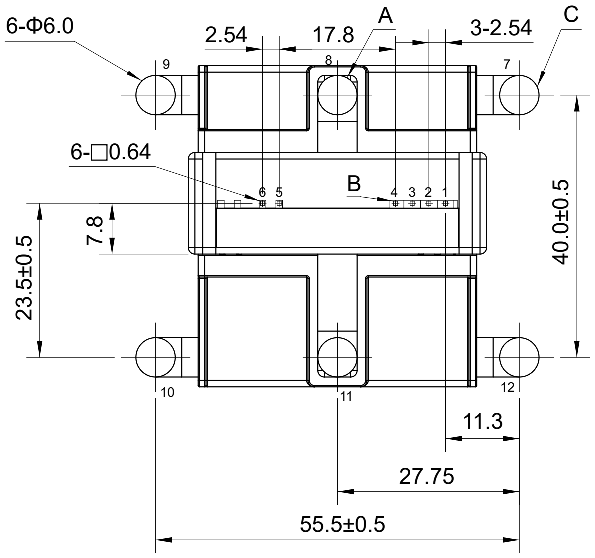
c) Reset the self-check current, ie. Set I_{CHK} = 0A. Then differential output of the sensor should be: $V_{OUT} - V_{REF} = V_{OE}$

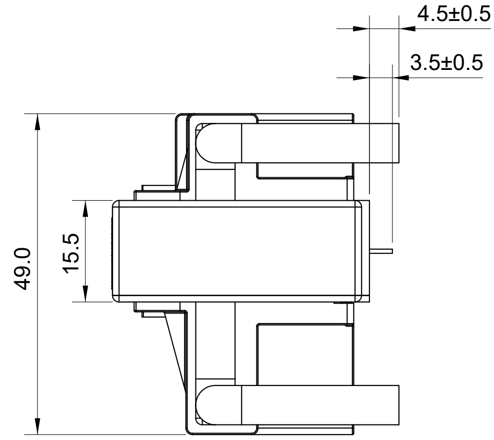
d) Once all previous steps are completed the current sensor shall be use as intended. Otherwise the sensor's status might be abnormal.

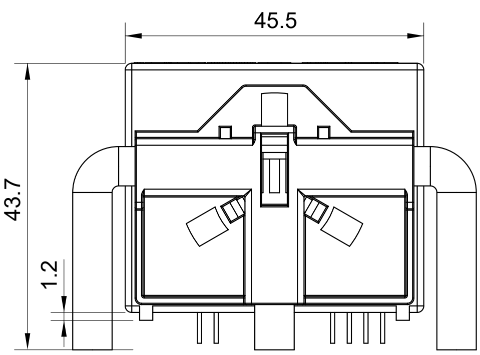
e) During normal operation, the self-check coil should not be open. After the self-check is completed, it is recommended to connect both ends of the sensor's self-check coil (I_{CHK+} and I_{CHK-} to GND or 0V).

6. Sensors are customizable upon request.

6. Dimensions







Sensor end

	d_{CL}	d_{CP}
A-B	15.3mm	17.4mm
A-C	13.1mm	15.1mm

Client PCB end

	d_{CL}	d_{CP}
A-B	12.2mm	12.2mm
A-C	16.3mm	16.3mm

Figure 20. Dimension (unit: mm, tolerances for unmarked scales ±0.5 mm)

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