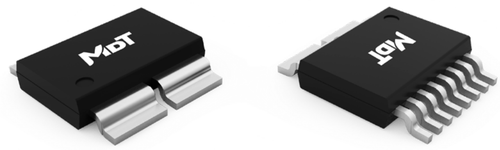
TMR7610-C

Current Sensor IC

Description

The TMR7610-C series current sensor IC operate on the principle of electromagnetic induction with high sensitivity, high signal-to-noise ratio tunneling magnetoresistance (TMR) sensors. With a temperature drift compensation circuit and galvanic isolation between the primary and secondary sides, it can accurately arbitrary current signal including direct current (DC), alternating current (AC), and pulses.



Features and Benefits

- 10-pin SOPW package
- High sensitivity
- Low noise
- High bandwidth, fast response
- Excellent temperature stability
- RoHS and REACH compliant

Applications

- Frequency converter current detection
- Power supply monitoring
- Motor drive
- Photovoltaic inverter
- Overload protection

Selection Guide

Part Number	Supply Voltage	Current Measurement Range	Offset Voltage	Sensitivity
TMR7610-050C3BFB	3.3 V	±50 A	1.65 V	26.4mV/A
TMR7610-075C3BFB	3.3 V	±75 A	1.65 V	17.6mV/A
TMR7610-100C3BFB	3.3 V	±100A	1.65 V	13.2 mV/A
TMR7610-150C3BFB	3.3 V	±150 A	1.65 V	8.8mV/A
TMR7610-200C3BFB	3.3 V	±200A	1.65 V	6.6mV/A
TMR7610-050C5BFB	5 V	±50 A	2.5 V	40 mV/A
TMR7610-075C5BFB	5 V	±75 A	2.5 V	26.67 mV/A
TMR7610-100C5BFB	5 V	±100 A	2.5 V	20 mV/A
TMR7610-150C5BFB	5 V	±150A	2.5 V	13.33 mV/A
TMR7610-200C5BFB	5 V	±200A	2.5 V	10 mV/A

Catalogue

1. Functional Block Diagram

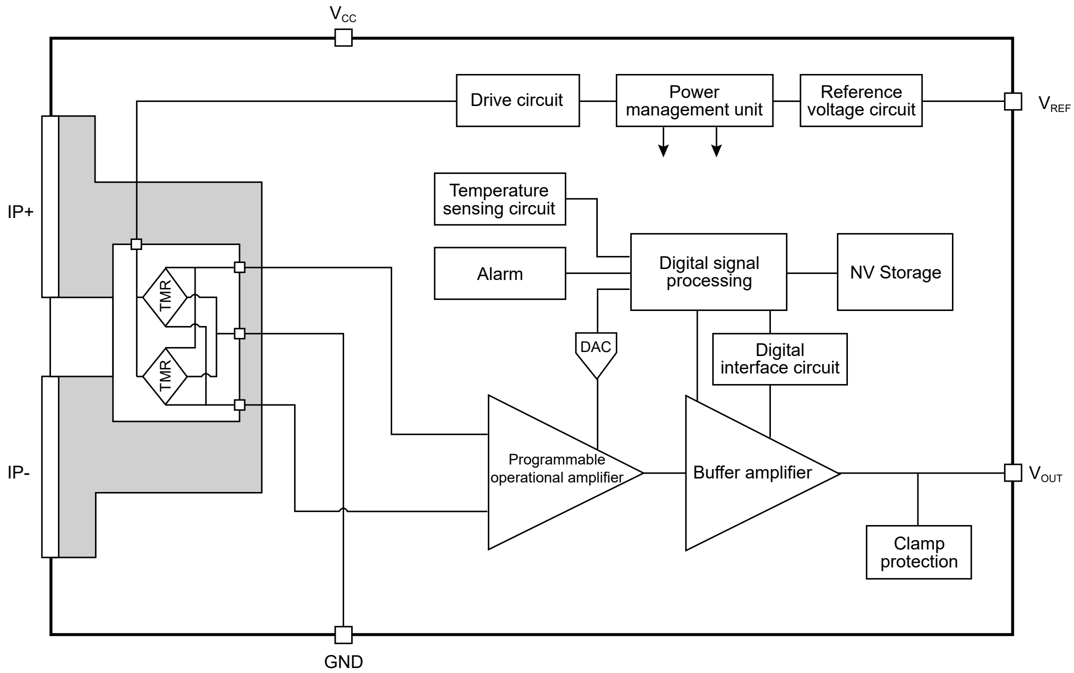


Figure 1. TMR7616-C functional block diagram

2. Absolute Maximum Rating

Parameter	Symbol	Min.	Max.	Unit
Supply voltage	V_{CC}	-	6	V
ESD (HBM)	V_{ESD}	-	4	kV
Operating temperature	T_A	-40	125	°C
Storage temperature	T_{STG}	-40	125	°C
Maximum junction temperature	$T_{J(MAX)}$	-	165	°C

3. Insulation Isolation Characteristics

Parameter	Symbol	Typ.	Unit
Dielectric strength	V_D	4.8	kV(50Hz, 1min)
Maximum working isolation voltage	V_{ISO}	1618	V_{PK}
		1144	V_{RMS}
Creepage distance	d_{CP}	8.2	mm
Electrical clearance	d_{CL}	8.2	mm
Relative Tracking Index	CTI	≥ 600	V

4. Electrical Specifications

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}	TMR7610-XXXC3BFB	3	3.3	3.6	V
		TMR7610-XXXC5BFB	4.5	5	5.5	
Offset voltage	V_{OFF}	I_P = 0, V_{CC} = 3.3 V, TMR7610-XXXC3BFB	-	1.65	-	V
		I_P = 0, V_{CC} = 5 V, TMR7610-XXXC5BFB	-	2.5	-	
Output voltage limit	V_{OL}	-	0.2	-	-	V
	V_{OH}	-	-	-	V_{CC} - 0.2	
Current consumption	I_C	V_{CC} = 3.3 V	-	-	6	mA
		V_{CC} = 5 V	-	-	6	
Power on time	t_{ON}	From when V_{CC} ≥ 2.5V to when V_{OUT} reaches stable output	-	200	-	µs
Primary conductor input resistance	R_{IN}	T_A = 25°C	-	0.27	-	mΩ
Load resistance	R_L	Between V_{OUT} and GND	1	10	-	kΩ
Load conductance	C_L	Between V_{OUT} and GND	-	-	10	nF
Output pull-up current	$I_{OUT(SOURCE)}$	V_{CC} = 3.3 V, V_{OUT} shorted to GND	-	43	-	mA
		V_{CC} = 5 V, V_{OUT} shorted to GND	-	45	-	
Output pull-down current	$I_{OUT(SINK)}$	V_{CC} = 3.3 V, V_{OUT} shorted to V_{CC}	-	43	-	mA
		V_{CC} = 5 V, V_{OUT} shorted to V_{CC}	-	45	-	
V_{REF} resistance	R_{LREF}	Between V_{REF} and GND	10	100	-	kΩ
V_{REF} conductance	C_{LREF}	Between V_{REF} and GND	-	1	10	nF
V_{REF} pull-up current	$I_{REF(SOURCE)}$	V_{CC} = 3.3 V, V_{REF} shorted to GND	-	3.7	-	mA
		V_{CC} = 5 V, V_{REF} shorted to GND	-	8.7	-	
V_{REF} pull-down current	$I_{REF(SINK)}$	V_{CC} = 3.3 V, V_{REF} shorted to V_{CC}	-	0.125	-	mA
		V_{CC} = 5 V, V_{REF} shorted to V_{CC}	-	0.135	-	
Power supply rejection ratio	PSRR	DC~1kHz, 100mV pk-pk ripple around V_{CC} = 5 V, I_P = 0	-	-40	-	dB
Common-mode magnetic field rejection ratio	CMFRR	Uniform external magnetic field	-	-40	-	dB
Rise time	t_{rise}	The time from 10% to 90% of the final V_{OUT}	-	0.58	-	µs
Delay	t_D	The time from 20% of the final I_P to 20% of the corresponding V_{OUT}	-	0.3	-	µs
Response time	t_R	The 90% time from the final I_P to the corresponding V_{OUT}	-	0.65	-	µs
Bandwidth	BW	I_P = 10 A, amplitude attenuates to -3dB	-	600	-	kHz

5. TMR7610-XXXC3BFB Specifications

T_A = 25 °C, V_{CC} = 3.3 V, R_L = 10 kΩ, unless otherwise noted

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Primary measured current	I_{PM}	TMR7610-050C3BFB	-50	-	50	A
		TMR7610-075C3BFB	-75	-	75	
		TMR7610-100C3BFB	-100	-	100	
		TMR7610-150C3BFB	-150	-	150	
		TMR7610-200C3BFB	-200	-	200	
Sensitivity	S	TMR7610-050C3BFB	-	26.4	-	mV/A
		TMR7610-075C3BFB	-	17.6	-	
		TMR7610-100C3BFB	-	13.2	-	
		TMR7610-150C3BFB	-	8.8	-	
		TMR7610-200C3BFB	-	6.6	-	
Accuracy	X_G	T_A = 25 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-	±1	-	$\%I_{PM(max)}$
		T_A = -40 °C to +25 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-2	-	2	
		T_A = 25 °C to +125 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-3	-	3	
Linearity error	ε_L	I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-	0.5	1	$\%I_{PM(max)}$
Sensitivity error	ε_S	T_A = 25 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-1	-	1	%
		T_A = -40 °C to +25 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-1.5	-	1.5	
		T_A = 25 °C to +125 °C, I_P = $I_{PM(min)}$ to $I_{PM(max)}$	-2	-	2	
Reference voltage	V_{REF}	T_A = 25 °C	1.645	-	1.655	V
		T_A = -40 °C to +125 °C	1.635	-	1.665	
Offset error	V_{OE}	T_A = 25 °C, I_P = 0, V_{OUT} - V_{REF}	-10	-	10	mV
		T_A = -40 °C to +25 °C, I_P = 0, V_{OUT} - V_{REF}	-12	-	12	
		T_A = 25 °C to +125 °C, I_P = 0, V_{OUT} - V_{REF}	-20	-	20	
Hysteresis	V_{OH}	I_P = $I_{PM(min)}$ or $I_{PM(max)}$ → 0	-10	-	10	mV
Noise	V_N	T_A = 25 °C, BW = 100 kHz	-	10	-	mV_{PP}

6. TMR7610-XXXC5BFB Specifications

T_A = 25 °C, V_{CC} = 5 V, R_L = 10 kΩ, unless otherwise noted

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Primary measured current	I_{PM}	TMR7610-050C5BFB	-50	-	50	A
		TMR7610-075C5BFB	-75	-	75	
		TMR7610-100C5BFB	-100	-	100	
		TMR7610-150C5BFB	-150	-	150	
		TMR7610-200C5BFB	-200	-	200	
Sensitivity	S	TMR7610-050C5BFB	-	40	-	mV/A
		TMR7610-075C5BFB	-	26.67	-	
		TMR7610-100C5BFB	-	20	-	
		TMR7610-150C5BFB	-	13.33	-	
		TMR7610-200C5BFB	-	10	-	
Accuracy	X_G	T_A = 25 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-	±1	-	$\%I_{PM(max)}$
		T_A = -40 °C to +25 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-2	-	2	
		T_A = 25 °C to +125 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-3	-	3	
Linearity error	ε_L	$I_P = I_{PM(min)}$ to $I_{PM(max)}$	-	0.5	1	$\%I_{PM(max)}$
Sensitivity error	ε_S	T_A = 25 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-1	-	1	%
		T_A = -40 °C to +25 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-1.5	-	1.5	
		T_A = 25 °C to +125 °C, $I_P = I_{PM(min)}$ to $I_{PM(max)}$	-2	-	2	
Reference voltage	V_{REF}	T_A = 25 °C	2.495	-	2.505	V
		T_A = -40 °C to +125 °C	2.48	-	2.52	
Offset error	V_{OE}	T_A = 25 °C, I_P = 0, $V_{OUT} - V_{REF}$	-10	-	10	mV
		T_A = -40 °C to +25 °C, I_P = 0, $V_{OUT} - V_{REF}$	-15	-	15	
		T_A = 25 °C to +125 °C, I_P = 0, $V_{OUT} - V_{REF}$	-20	-	20	
Hysteresis	V_{OH}	$I_P = I_{PM(min)}$ or $I_{PM(max)} \rightarrow 0$	-10	-	10	mV
Noise	V_N	T_A = 25 °C, BW = 100 kHz	-	10	-	mV_{PP}

7. Typical Output Characteristics

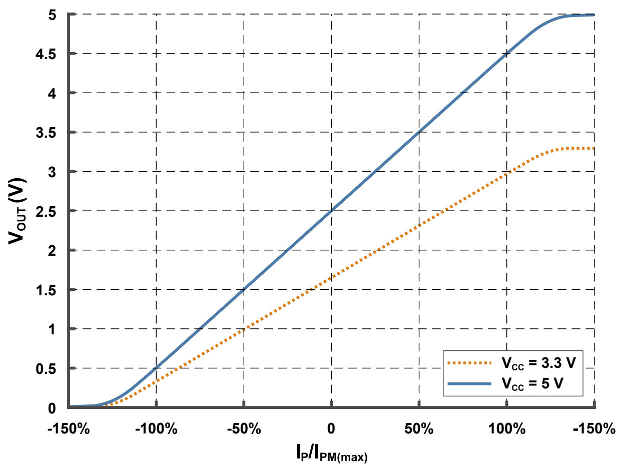


Figure 2. Output Voltage vs Primary Current

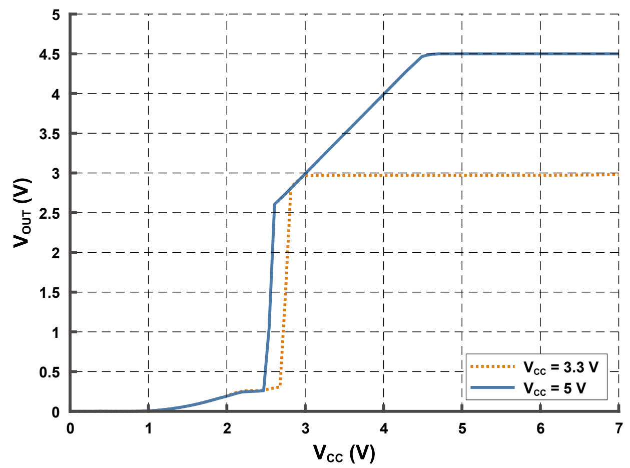


Figure 3. Output voltage vs supply voltage (@I_P = $I_{PM(Max)}$)

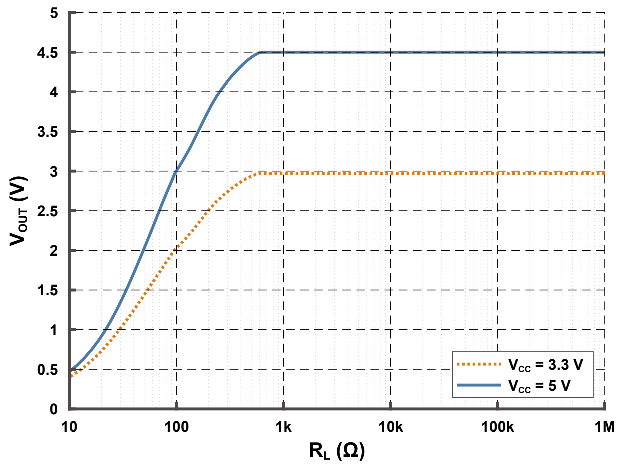


Figure 4. Output voltage vs load resistance (@I_P = $I_{PM(Max)}$)

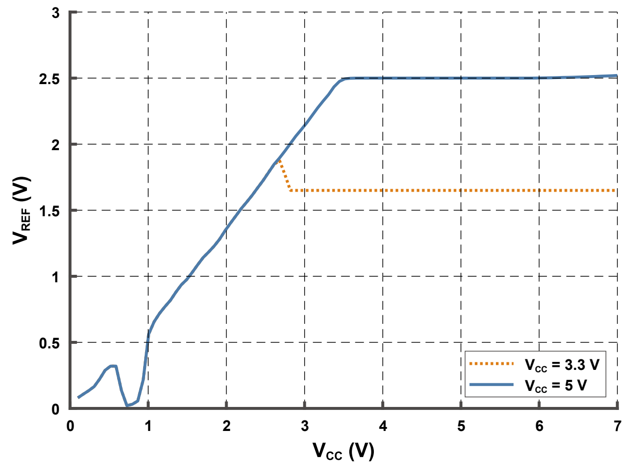


Figure 5. Reference voltage vs supply voltage (@I_P = $I_{PM(Max)}$)

8. Power-on Characteristics

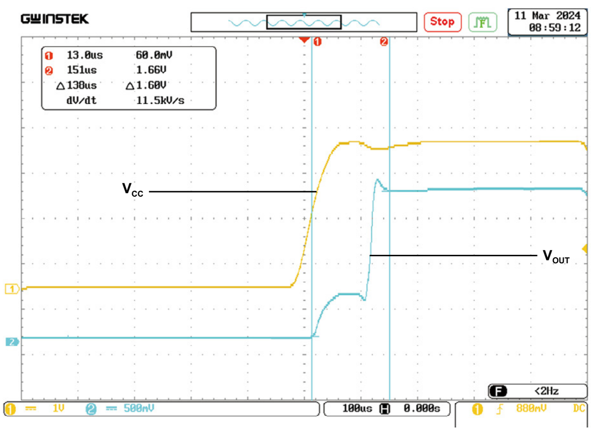


Figure 6. TMR7610-xxxC3BFB power-on start-up characteristics

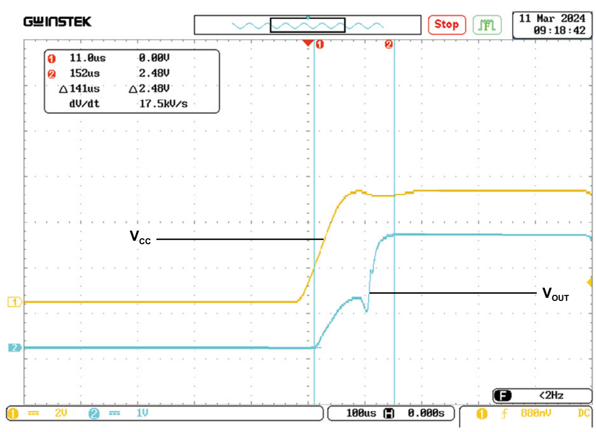


Figure 7. TMR7610-xxxC5BFB power-on start-up characteristics

9. Frequency Response Characteristics

Characteristics below tested with TMR7610-050C5BFB

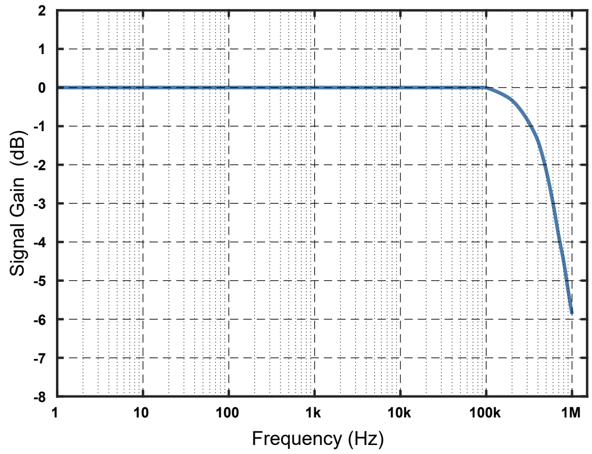


Figure 8. TMR7610-C bode plot

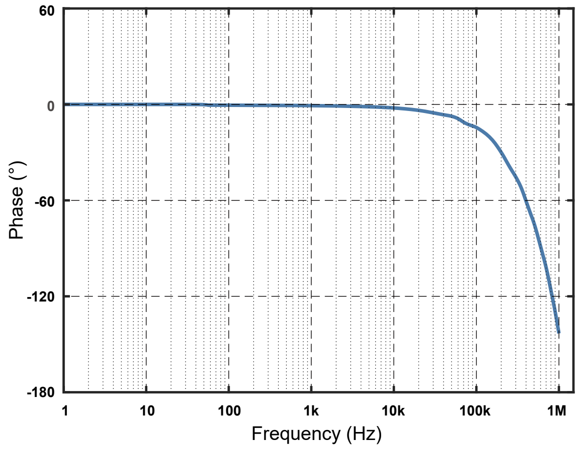


Figure 9. TMR7610-C phase frequency plot

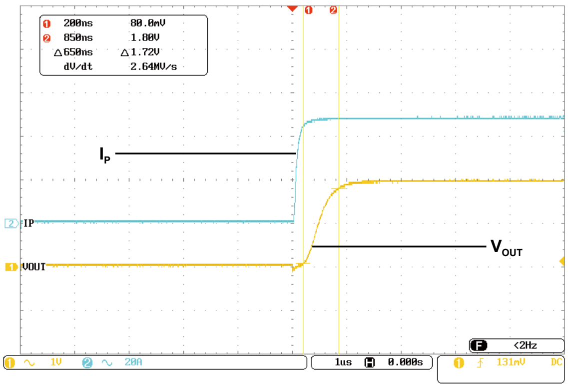


Figure 10. TMR7610-C response time

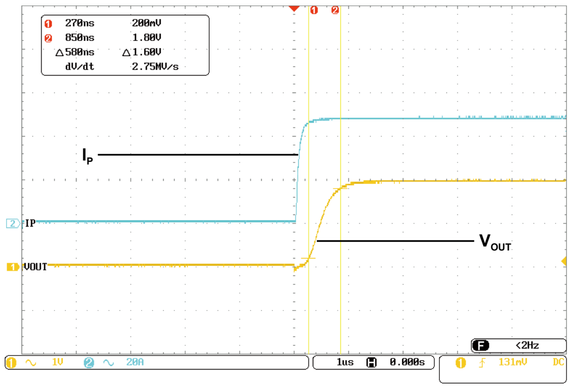


Figure 11. TMR7610-C rise time

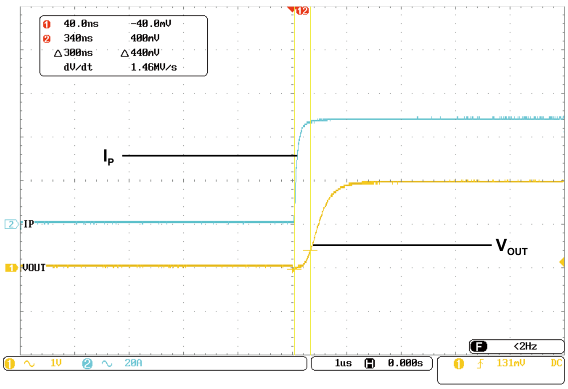


Figure 12. TMR7610-C propagation delay

10. Parameters Definition and Formula

1) Accuracy

$$X_G = \underset{I_p \in [I_{PM(min)}, I_{PM(max)}]}{MAX}\left(\frac{V_{OUT} - (I_P \times S + V_{REF})}{I_{PM(max)} \times S} \times 100\%\right)$$

I_P stands for primary current, $I_{PM(max)}$ and $I_{PM(min)}$ stand for maximum and minimum within current measurement range, V_{OUT} stands for output voltage at given primary current I_P, S stands for sensitivity, V_{REF} stands for reference voltage.

2) Sensitivity

$$S = \frac{V_{OUT(@I_{PM(max)})} - V_{OUT(@I_{PM(min)})}}{2 \times I_{PM(max)}}$$

$V_{OUT(@I_{PM(max)})}$ and $V_{OUT(@I_{PM(min)})}$ stand for the voltage output at $I_{PM(max)}$、$I_{PM(min)}$ respectively.

3) Linearity

$$\varepsilon_L = \underset{I_p \in [I_{PM(min)}, I_{PM(max)}]}{MAX}\left(\frac{\left|V_{OUT} - (I_{PM(max)} \times \overline{S} + \overline{V_{REF}})\right|}{I_{PM(max)} \times S} \times 100\%\right)$$

$\overline{S}$ and $\overline{V_{REF}}$ stand for the average values of the sensitivity and offset voltage.

4) Zero Offset Voltage

$$V_{OE} = V_{OUT(@I_P = 0)} - V_{REF}$$

5) Hysteresis

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

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

11. Dimensions

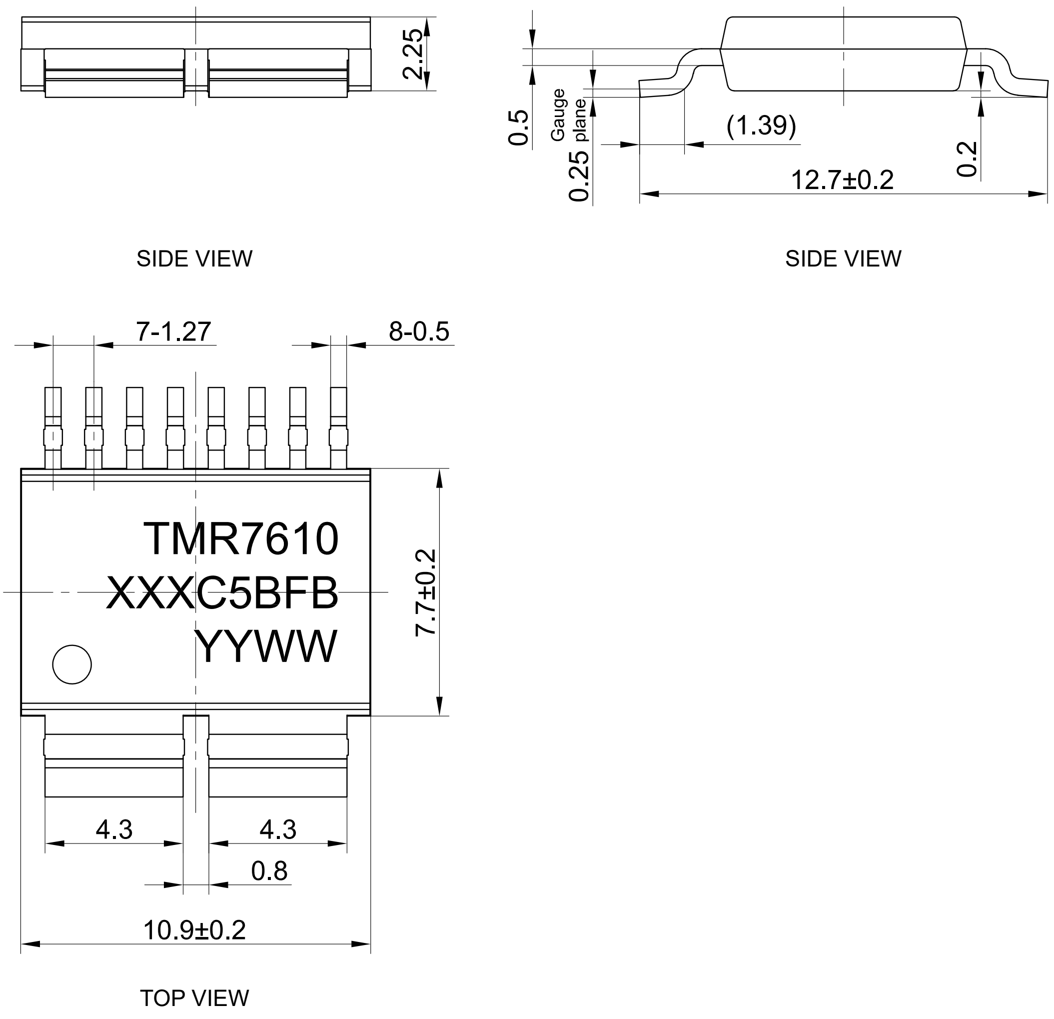


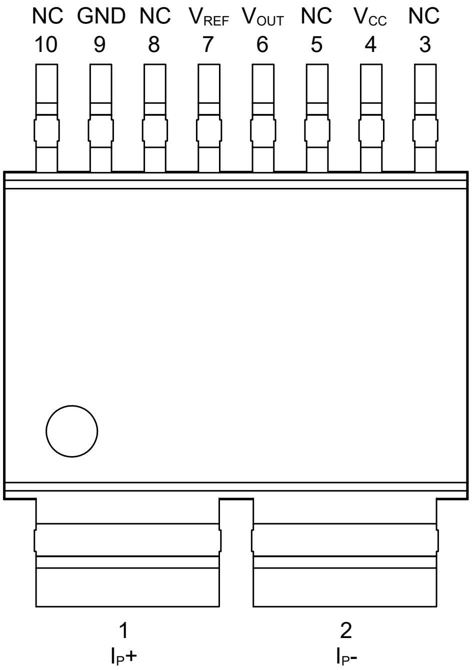
Figure 13. SOPW10 dimensions (unit: mm)

Marking Description:

TMR7610 XXX C 5 B F B YYWW

- TMR7610 → Product number (10: SOPW10 package)
- XXX → Current measurement range
  - 050: 50A
  - 075: 75A
  - 100: 100A
  - 150: 150A
  - 200: 200A
- C → Current sensor series
- 5 → 5: Supply voltage 5V; 3: Supply voltage 3.3V
- B → Bidirectional current
- F → Bidirectional fixed zero at 2.5 V or 1.65 V
- B → Operating temperature -40°C to 125°C
- YYWW → Production date in YYWW

12. Pin Definition and Wiring Diagram



No.	Pin	Description
1	I_P+	Current in, positive direction
2	I_P-	Current out, negative direction
3	NC	Not connected
4	V_{CC}	Voltage supply
5	NC	Not connected
6	V_{OUT}	Output voltage
7	V_{REF}	Reference voltage
8	NC	Not connected
9	GND	Ground
10	NC	Not connected

Figure 14. Pin definition

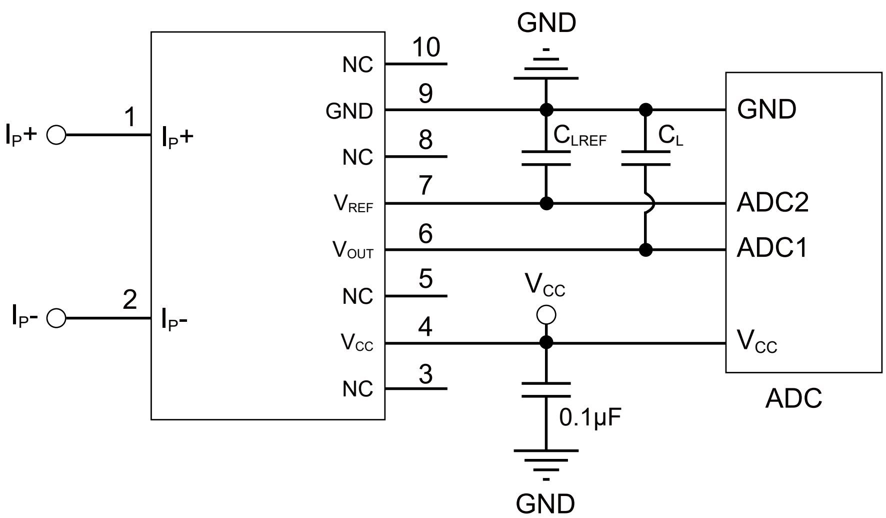


Figure 15. Wiring diagram

13. Recommended PCB Layout

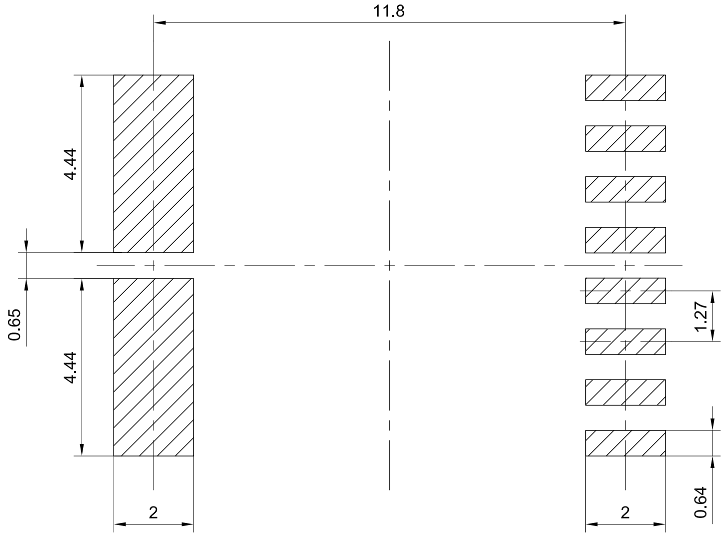
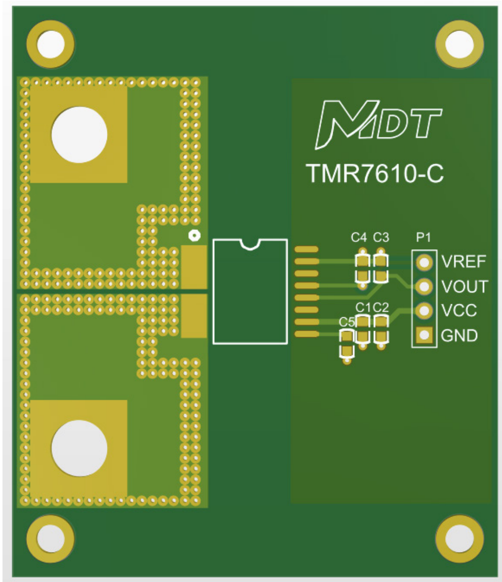


Figure 16. PCB Layout (Unit: mm)

14. Junction Temperature vs Primary Current

The relationship between the junction temperature and the primary current of the TMR7610-C series sensor IC was measured under the following experimental demo board conditions.



Demo Board Specifications	
Layers	2
Primary side trace copper single-layer area	450 mm^2
Single-layer copper thickness	4Oz

Figure 17. Demo board layout

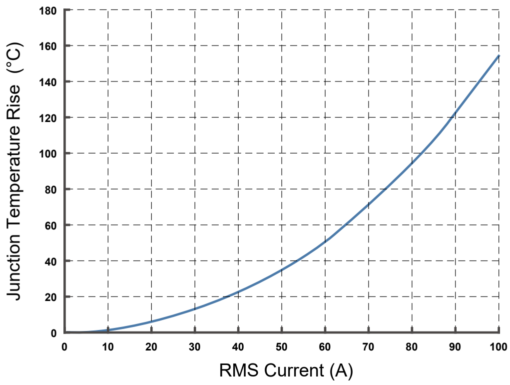


Figure 18. Junction temperature vs RMS current

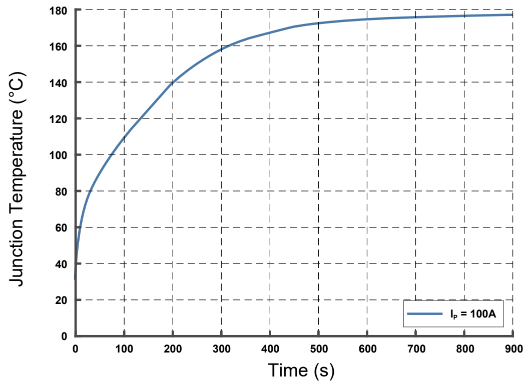


Figure 19. Junction temperature at 50A primary current at room temperature

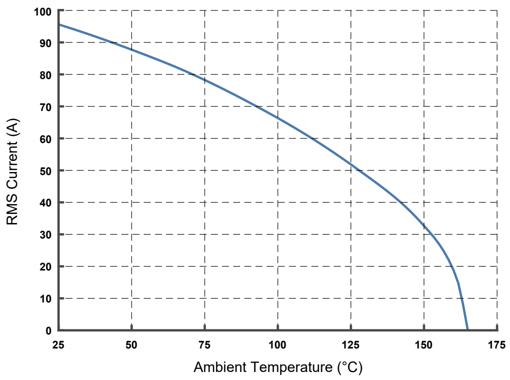


Figure 20. RMS current vs ambient temperature

The primary source of temperature rise in the TMR7610-C is Joule heating within the primary conductor path. This heat dissipates through the encapsulation, lead frame, PCB, and surrounding air of TMR7610-C resulted in temperature rise of its junction temperature. Figure 18 illustrates the relationship between continuous RMS current and the resulting temperature rise at room temperature. Under natural convection at ambient temperature, the TMR7610-C typically reaches thermal equilibrium within approximately 10 minutes of continuous current loading, as demonstrated in Figure 19. For example, applying a continuous 100A RMS DC current at 26°C causes the chip temperature to approach 165°C in about 350 seconds.

The maximum permissible continuous RMS current versus ambient operating temperature is shown in Figure 20. This current derates from 96A at 25°C ambient to approximately 54A at 125°C ambient, based on a maximum junction temperature limit of 165°C. Transient surge or pulse currents exceeding these continuous RMS ratings are permissible, provided the junction temperature does not surpass 165°C.

15. Application Instructions

1. Improper wiring may damage sensor.
2. Supply voltage V_{CC} must match specification. Low supply voltage will cause in accurate output. High supply voltage may result in permanent damage to the current sensor.
3. A RC filter may be added between the V_{OUT} and GND to adjust output frequency characteristics.
4. Contact MDT to request custom sensor specifications including voltage supply, current measurement range, and pin definition.

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Recycling

The product(s) in this document need to be handed over to a qualified solid waste management services company for recycling in accordance with relevant regulations on waste classification after the end of the product(s) life.

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