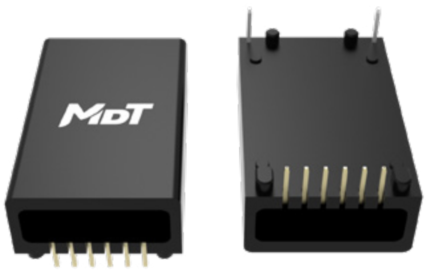
TMR8501

High-precision, Low-noise Linear Magnetic Sensor

Description

The TMR8501 is a compact and high-precision linear magnetic sensor, featuring low noise and fast response. This sensor is encased in a module-level package measuring 29mm × 18.5mm × 8.6mm. It boasts a measurement range of ±500 μT and supports either single or dual power supply options, with voltage ranges from ±3.3V to ±18V. Operating temperatures range from -40°C to 85°C. Utilizing advanced tunneling magnetoresistance (TMR) technology, the TMR8501 integrates a magnetic field feedback coil and a weak signal conditioning circuit. This configuration allows it to achieve a low noise level of 15 pT/√Hz at 1Hz, linearity of 0.05%, sensitivity temperature drift of 40 PPM, and sensitivity variation of 0.3% across a temperature range of -40°C to 75°C. With a bandwidth of 500 kHz, it enables high-resolution, real-time measurement of weak magnetic fields. The TMR8501 is ideally suited for applications such as environmental magnetic field monitoring, food safety testing, geophysical magnetic detection, traffic monitoring, and magnetic metal detection.



TMR8501

Features and Benefits

- Low-noise tunnel magnetoresistance technology
- Precision magnetic field feedback technology
- 15 pT/√Hz@1Hz low noise
- 40 PPM sensitivity temperature drift
- 0.05% linear response characteristics
- 500 kHz wide frequency response

Applications

- Environmental magnetic field monitoring
- Food safety testing
- Geophysical Magnetic Exploration
- Underground pipeline inspection
- Metal anomaly detection
- Traffic vehicle detection

Selection Guide

Part Number	Sensing Direction	Frequency Response (-3dB)	Magnetic Field Spectral Noise Density	Supply Voltage	Dimension
TMR8501	Single axis	DC to 500 kHz	10 to 20 pT/√Hz@1Hz	5 V to 36 V ±3.3 V to ±18 V	29mm × 18.5mm × 8.6mm

1. Features

1.1 Functional Block Diagram

The TMR8501 magnetoresistive sensor is primarily designed for detecting weak magnetic fields. The block diagram below explores its operating principle. The sensor IC measures the external magnetic field (H_{ext}) and outputs a voltage signal. This signal is amplified and passed through a feedback coil, which generates a feedback magnetic field (H_{fed}) to counteract H_{ext}. The feedback loop current (I_{fed}) is then measured via the sampling resistor (R_S), enabling the detection of the external magnetic field signal. When the feedback stabilizes, the loop operates in a state of deep negative feedback where the feedback magnetic field entirely cancels out H_{ext}. Consequently, the sensor's output voltage (V_{OUT}) varies linearly with changes in H_{ext}:

$$V_{OUT} = Sen \times H_{ext} + V_{offset}$$

Here, Sen represents the sensor's sensitivity, and V_{offset} is the zero offset voltage, which can be adjusted through the sensor's voltage-to-magnetic field relationship (V_H). The transfer characteristic curve is derived from empirical testing.

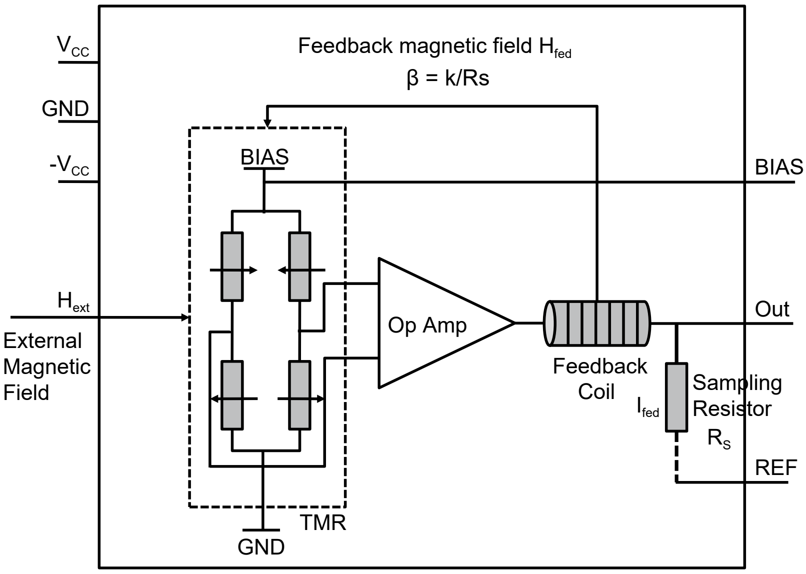


Figure 1. TMR8501 functional block diagram

1.2 Pin Definition

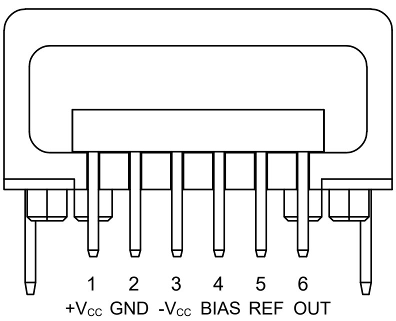


Figure 2. Pin definition

Pin	Name	Function	Reference Connection	
			Single Supply Connection	Dual Supply Connection
1	$+V_{CC}$	Positive supply	Positive supply	Positive supply
2	GND	Ground	Ground	Ground
3	$-V_{CC}$	Negative supply	Ground	Negative supply
4	BIAS	Internal bias voltage	REF	NC
5	REF	Output reference	Bias or external	Ground or external
6	OUT	Output	Output	Output

2. Specifications

V_{CC} = ±5 V， T_A = 25 °C

Specification	Symbol	Condition	Min.	Typ.	Max.	Unit
Measuring range	FS	V_{CC} = ±15 V	-	±200	±500	μT
Sensitivity	Sen	-200 μT to 200 μT	19.50	20.00	20.50	mV/μT
Sensitivity temperature coefficient	TCS	-40°C to 75°C	-	40	-	PPM/°C
Vertical field sensitivity	YSen	Hy = -200 μT to 200 μT	-	0.04	-	mV/μT
Vertical field sensitivity cross coefficient [1]	YCS	Hy = -200 μT to 200 μT	-	0.25	-	%/Sen
Zero magnetic field offset [2]	H_{offset}	H = 0	-	-	5	μT
Zero offset temperature coefficient [2]	TCH	-40 °C to 75 °C, H = 0	-	20	-	nT/°C
Nonlinearity	δ_L	±200 μT	-	0.05	0.1	%
Hysteresis	Hys	±200 μT	-	0.5	1	μT
Voltage noise density	V_N	H = 0, at 1Hz	-	400	600	nV/√Hz@1Hz
Magnetic field noise density	B_N	H = 0, at 1Hz	10	15	20	pT/√Hz@1Hz
Thermal magnetic field noise density	B_{NW}	H = 0, f = 1kHz	-	1.0	-	pT/√Hz
Magnetic field noise peak-to-peak	B_{NPP}	0.1 Hz to 10 Hz	-	0.3	0.4	nTpp
Output voltage range	V_{OUT}	-	$-V_{CC}+0.5$	-	$V_{CC}-0.5$	V
Maximum output current	I_{OUT}	-	-	-	30	mA
Frequency characteristics	FR	-3 dB	-	500	-	kHz
Single supply voltage	V_{CC}	-	5	12	36	V
Dual power supply voltage		-	±3.3	±5	±18	V
Static power	P_W	H = 0, ±5 V	-	10	-	mW
$+V_{CC}$ static operating current	I_{Q+}	H = 0	-	3	-	mA
$-V_{CC}$ static operating current	I_{Q-}	H = 0	-	3	-	mA
Operating temperature	T_A	-	-40	-	85	°C
storage temperature	T_S	-	-40	-	85	°C

Note:

1. Refers to the output change of an external magnetic field in the direction perpendicular to the sensitivity of the chip surface, and the cross-influence coefficient of the output in the relative sensitivity direction.
2. Users can compensate for zero offset and zero temperature drift as needed.

3. Mechanical and interface parameters

Name	Parameter	Unit
Dimensions (length × width × height)	29 × 18.5 × 8.6	mm
Weight	8.5	g
Electrical Interface	6 × Φ0.8, hole center distance 2.0	mm
Install the positioning interface	2 × Φ2.4, hole center distance 14.4 2 × Φ1.3, hole center distance 10.0	mm
Sensitive axis direction	Sensor long axis direction	-

4. Characteristic Curves

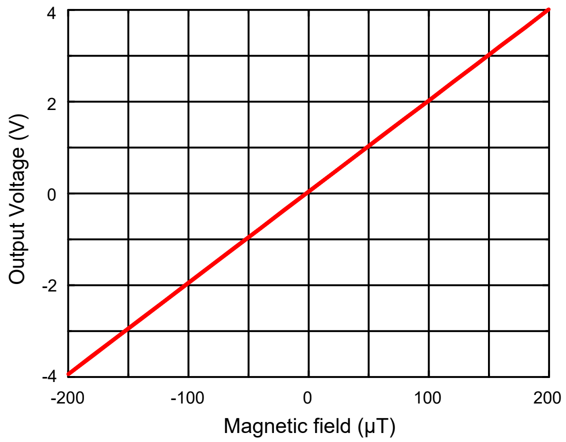


Figure.3 Typical VH transfer curve

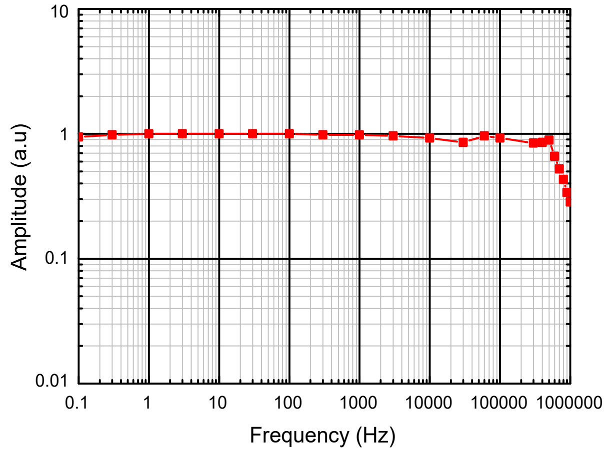


Figure 4. Typical frequency response characteristics

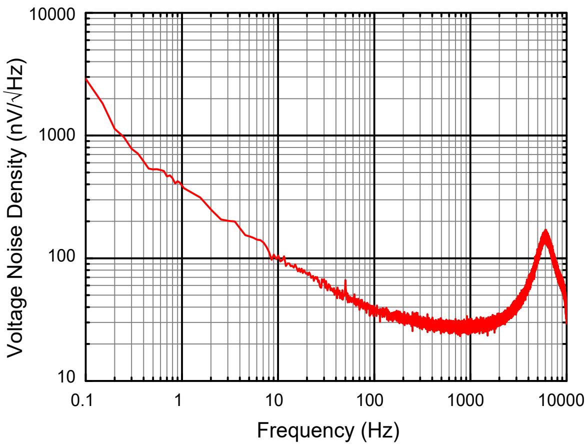


Figure.5 Typical voltage noise spectral density

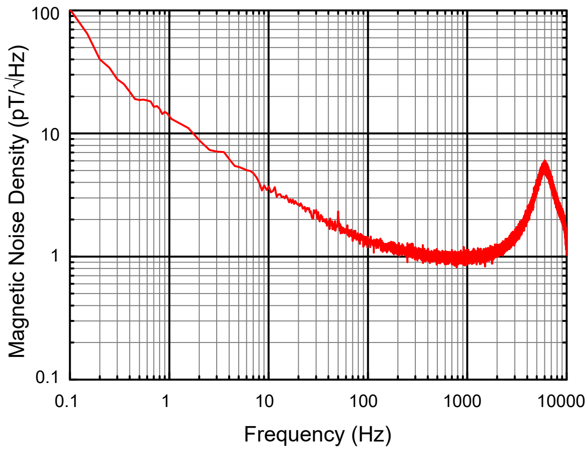
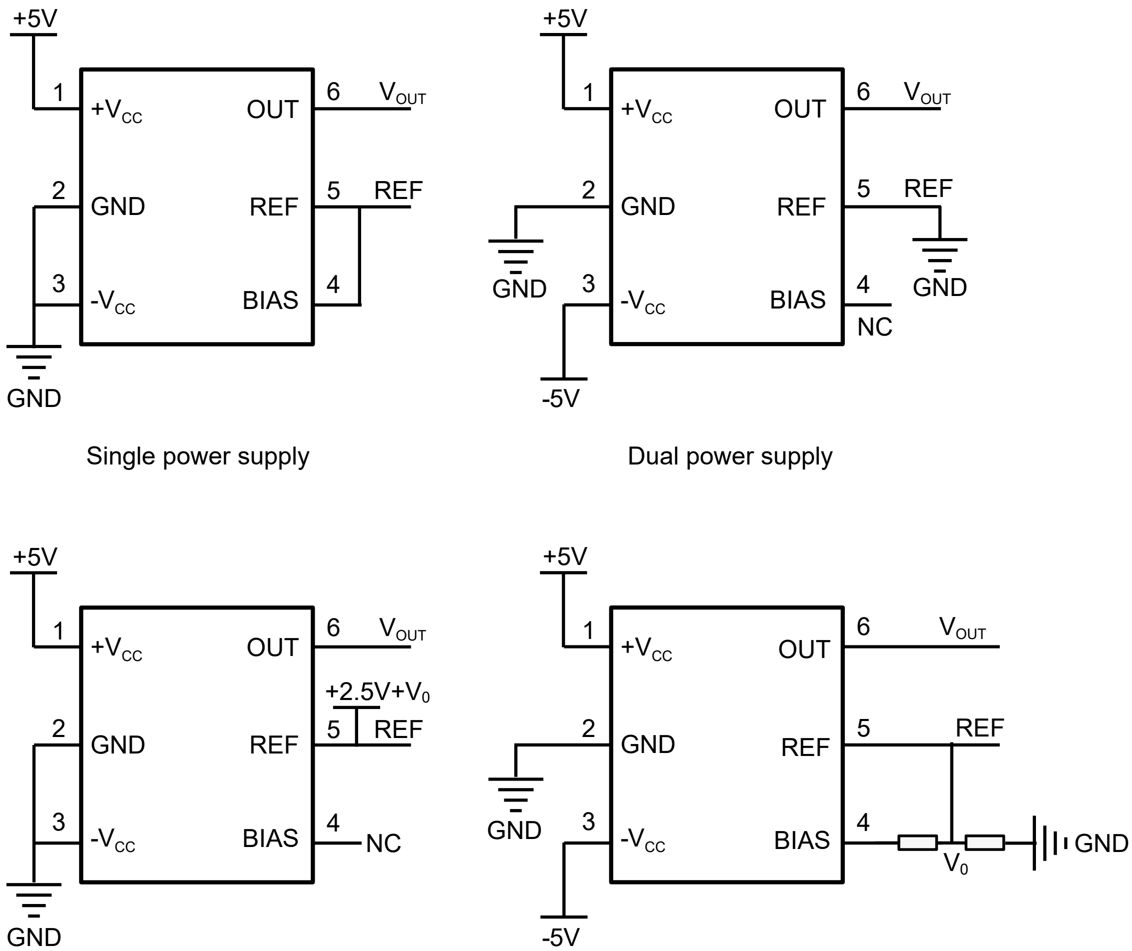


Figure 6. Typical magnetic field noise spectral density curve

5. Application Guide

TMR8501 can be operated with either a single or dual power supply setup, featuring an integrated power bypass capacitor that eliminates the need for additional power supply processing. This design effectively suppresses power ripple interference, ensuring stable and reliable operation. To mitigate installation errors, the package includes a specially designed mounting positioning hole. In practice, the sensor simply requires external positive and negative power supplies to function. It incorporates an internal precision magnetic field feedback coil and a signal conditioning circuit for stable performance and ease of use.

To enhance zero-point accuracy, users can utilize the reference point REF (Pin 5). By connecting an externally constructed reference voltage, this setup compensates for zero offset and temperature drift. Depending on the application, the compensation reference point can be adjusted using resistor voltage division, external network voltage division, or microcontroller-controlled DAC to modify the analog output voltage of the reference point. In specific scenarios, the output of the first sensor (V_{OUT}) can be linked to the output reference point of the second sensor REF (Pin 5), facilitating differential output between the two sensors. This connection helps better counteract the common-mode magnetic interference from external environments. For more details, please refer to the typical application reference circuit provided.



Single power supply with

Dual power supply with

Figure 7. Typical application reference circuit

6. Dimensions

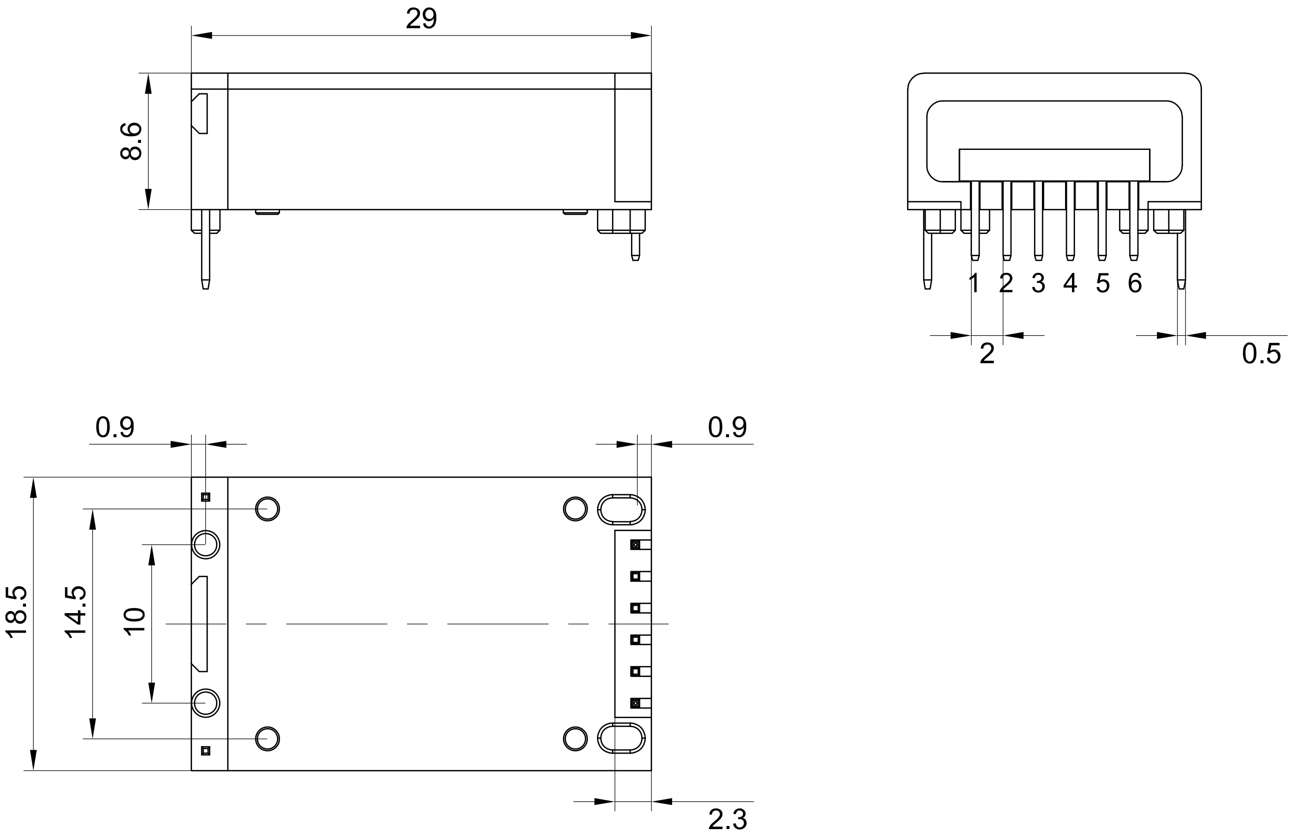


Figure 8. Dimensions (unit: mm)

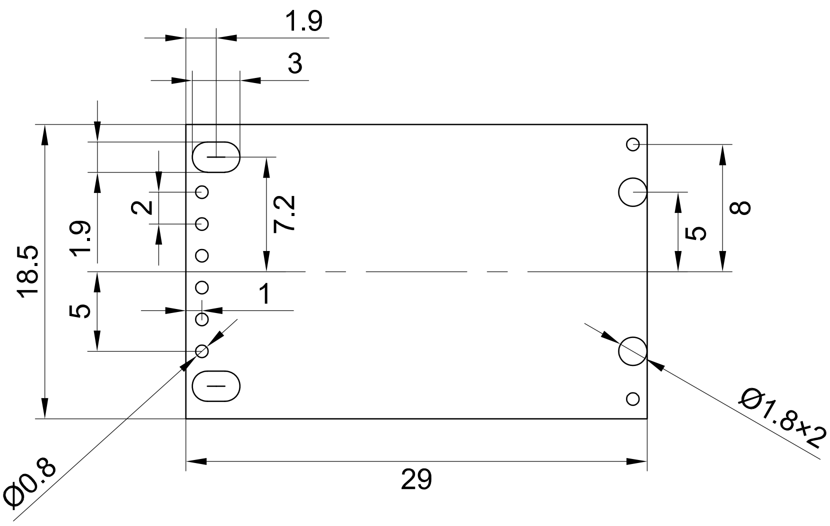


Figure 9. PCB board opening dimensions (unit: mm)

Absolute maximum ratings are the extreme limits the device will withstand without damage to the MDT product. However, the electrical and mechanical characteristics are not guaranteed as the maximum limits (above recommended operating conditions) are approached. MDT disclaims any and all warranties and liabilities of the MDT product will operate at absolute maximum ratings.

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