Integrated AMR for Cylinder Position Detection

DESCRIPTION

The TSHA6151 is produced with SIP (System in Package) technology which builds AMR sensor & ASIC in one IC. The TSHA6151 supports both 2-wire & 3-wire applications for cylinder position detection and offers two sensitivity level through different application circuit. The TSHA6151 is an AMR (Anisotropic Magneto Resistance) based magnetic sensor, when combined with a magnet, it becomes a non-contact switch with low power consumption, high sensitivity and high reliability device. A horizontal magnetic field parallel to the electrode of the package can be detected by an arbitrary polarity.

FEATURES

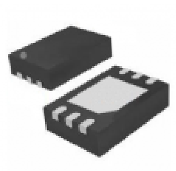
- Omni-polar
- Supply voltage range 2.7~30V
- Operating frequency ≥1kHz
- -30V Reversed Power Supply Protection
- Output Over-Current Protection
- Operating Temperature -40°C~105°C
- Sensitivity:
  - Level 1: B_{OP}=±13~±29Gs, B_{RP}=±10~±26Gs
  - Level 2: B_{OP}=±20~±40Gs, B_{RP}=±16~±36Gs
- Open-drain Output with Self-Adaptation of Pull-up or Pull-down Load
- RoHS compliant
- Halogen-Free according to IEC 61249-2-21

APPLICATION

- 2-wire & 3-wire cylinder position detection

Pb-Free RoHS COMPLIANT HALOGEN FREE

TDFN2x3-6L



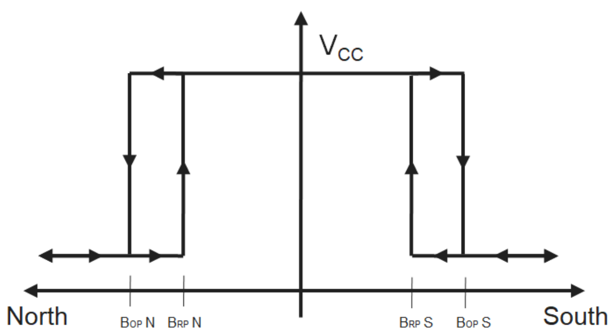
Pin Definition:

1. LED	6. OUT
2. LED	5. OUT
3. SEL	4. V_{CC}

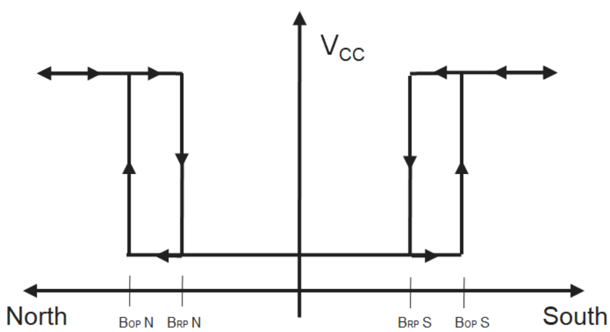
Exposed pad connected to Ground

Notes: MSL 1 (Moisture Sensitivity Level) per J-STD-020

DEFINITION OF SWITCHING FUNCTION



Pull-up load



Pull-down load

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise specified) (Note)

PARAMETER	SYMBOL	LIMIT	UNIT
Supply Voltage	V_{CC}	-30 ~ 36	V
Output Current	I_{OUT}	-500 ~ 500	mA
Output Voltage	V_{OUT}	-0.7 ~ 36	V
LED Output Voltage	V_{LED}	-30 ~ 36	V
SEL Output Voltage	V_{SEL}	-30 ~ 36	V
Magnetic Flux	B	3000	G_s
Operating Ambient Temperature	T_A	-40 to +105	°C
Storage Temperature Range	T_{STG}	-50 to +150	°C
ESD Rating (Human Body Mode)	HBM	±2	kV
ESD Rating (Charged Device Model)	CDM	±200	V

Note: Absolute maximum ratings are limited values to be applied individually, and beyond which the serviceability of the circuit may be impaired. Functional operability is not necessarily implied. Exposure to absolute maximum rating conditions for an extended period of time may affect device reliability. All voltages listed are referenced to GND.

ELECTRICAL SPECIFICATIONS (T_A= -40~105°C, V_{CC}= 2.7V~30V unless otherwise noted)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}	2.7	--	30	V
Supply Current	V_{CC}=24V; |B|<|B_{OP}|	I_{CC}	--	50	100	µA
Output Saturation Voltage (3-wire)	V_{CC}=24V; I_{OUT}=200mA |B|>|B_{OP}|; Pull-up Load	V_{SAT}	--	--	0.5	V
	V_{CC}=24V; I_{OUT}=-200mA |B|>|B_{OP}|; Pull-down Load		V_{CC}-0.5V;	--	--	
Output Over-current Protection Limit (2-wire or 3-wire)	|B|>|B_{OP}|; Pull-up Load	I_{OCP}	--	400	--	mA
	|B|>|B_{OP}|; Pull-down Load		--	-400	--	
Output Leakage Current (2-wire or 3-wire)	|B|<|B_{RP}|; V_{OUT}=24V; Pull-up Load	I_{OUT}	--	--	10	µA
	|B|<|B_{RP}|; V_{CC}=24V; V_{OUT}=0V; Pull-down Load		-10	--	--	
LED/SEL Pin Output Current	|B|>|B_{OP}|	I_{LED}	-1.0	-0.8	-0.6	mA
Switching Frequency	V_{CC}=24V	F_{SW}	1	--	--	kHz
Output Rise Time	V_{CC}=24V; C_L=1nf; Pull-down Load	T_R	--	--	10	µs
Output Fall Time	V_{CC}=24V; C_L=1nf; Pull-up Load	T_F	--	--	10	µs
Power on Time Refer to Figure.17	Including Pull-up/Pull-down Load Detection Time	T_{PO}	--	--	100	µs
Output Over-current Protection Delay Time		T_{OCPD}	--	--	0.2	ms
Output Over-current Protection Recovery Time		T_{OCPR}	--	--	200	ms
Over Temperature Protection Point	Junction Temperature	T_{OTPR}	--	140	--	°C
Over Temperature Recovery Point	Junction Temperature	T_{OTRC}	--	130	--	°C

ELECTRICAL SPECIFICATIONS (T_A= -40~105°C, V_{CC}= 2.7V~30V unless otherwise noted)

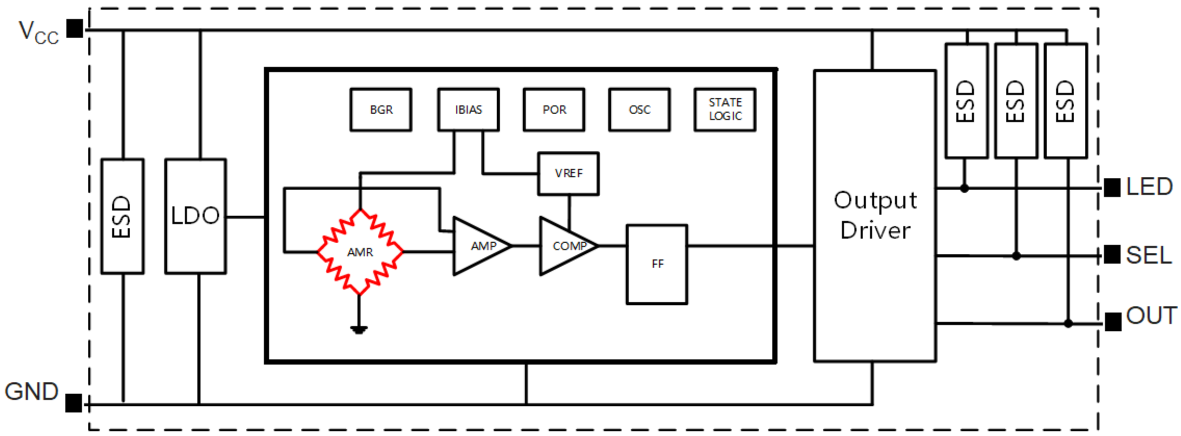
PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Sensitivity Level 1 (Default)	B_{OP}, T_A =25°C	Gs	±13	±21	±29	Gs
	B_{RP}, T_A =25°C		±10	±18	±26	
	B_{HYST}, T_A =25°C		1	3	5	
Sensitivity Level 2	B_{OP}, T_A =25°C		±20	±30	±40	
	B_{RP}, T_A =25°C		±16	±26	±36	
	B_{HYST}, T_A =25°C			4		

Note:
Magnetic operating/releasing point (B_{OP} & B_{RP}) is configurable in applications (refer to Typical Application Circuit). We provide two options of B_{OP} & B_{RP} with different application circuit

ORDERING INFORMATION

ORDERING CODE	PACKAGE	PACKING
TSHA6151CQ M3G	TDFN2x3-6L	3,000pcs / 7" Reel

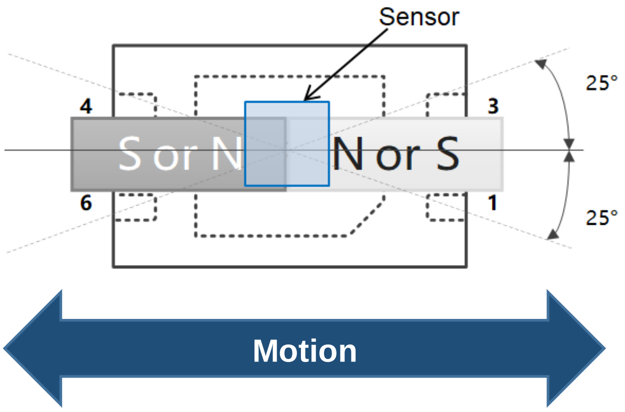
FUNCTION BLOCK



PIN DESCRIPTION

PIN NO.	NAME	FUNCTION
1	LED	LED driver output
2	LED	LED driver output
3	SEL	Magnetic Sensitivity Selection
4	V_{CC}	Supply voltage
5	OUT	Output
6	OUT	Output
Exposed Pad		Ground

DETECTION OF MAGNETIC FIELD



The device is sensitive to the magnetic field that is parallel to the package

FUNCTION DESCRIPTION

- B_{OP}: Operating Point, Magnetic flux density applied on the branded side of the package which turns the output driver ON (V_{OUT}=Low, pull-up load; V_{OUT}=High, pull-down load)
- B_{RP}: Releasing Point, Magnetic flux density applied on the branded side of the package which turns the output driver OFF (V_{OUT}=High, pull-up load; V_{OUT}=Low, pull-down load)
- B_{HYST}: Hysteresis Window, $|B_{OP} - B_{RP}|$

CHARACTERISTICS CURVES

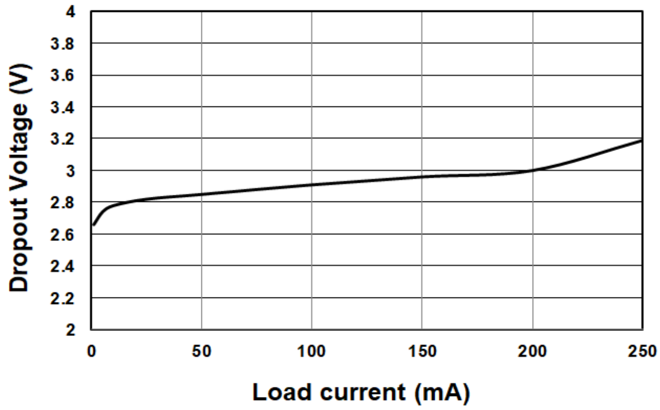


Figure 1. Voltage Drop vs. Loading Current
(2-wire application)

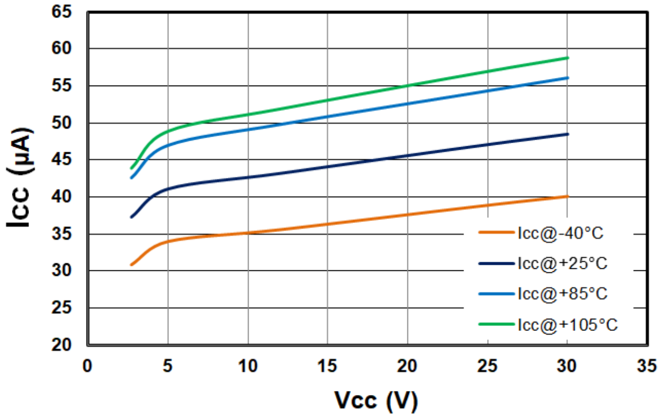


Figure 2. Supply Current vs. Temperature & V_{CC}
(2-wire & 3-wire application)

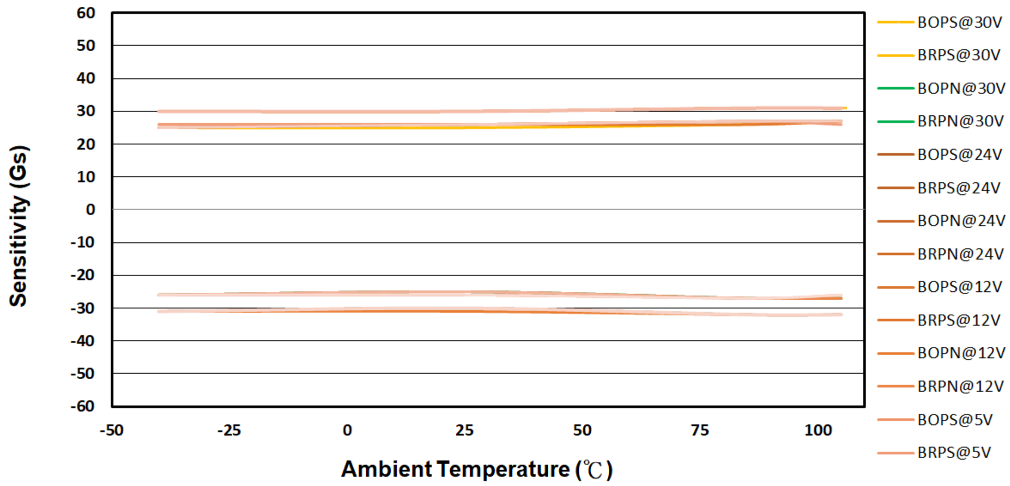


Figure 3. Magnetic Characteristics vs. Ambient Temperature & V_{CC} (B_{OP}& B_{RP})
(2-wire & 3-wire application)

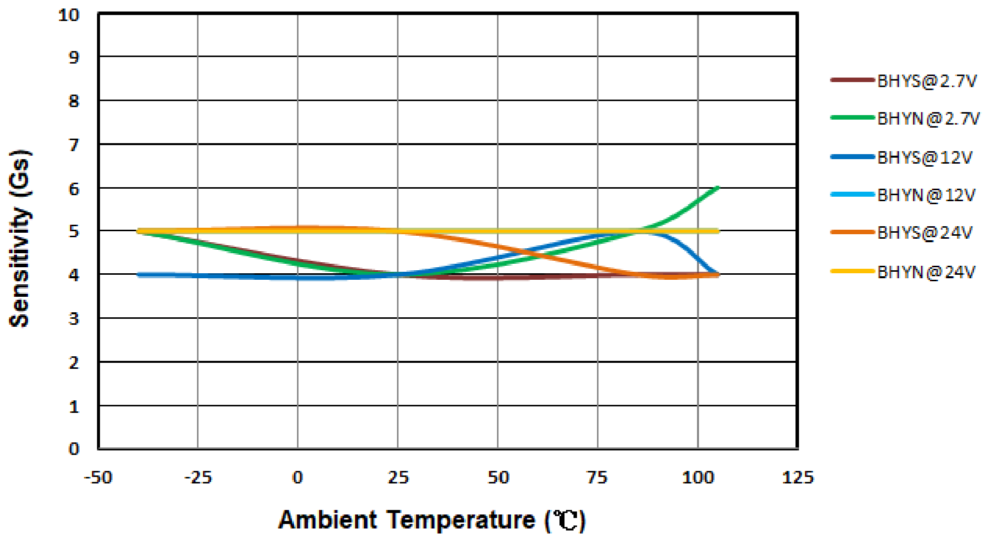
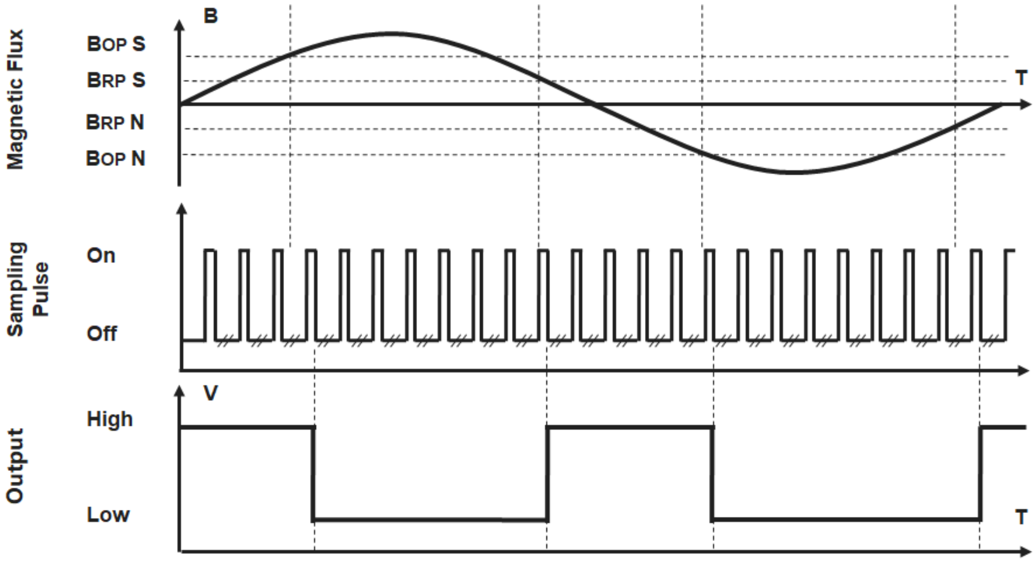


Figure 4. Magnetic Characteristics vs. Ambient Temperature &V_{CC} (B_{HYST})
(2-wire & 3-wire application)

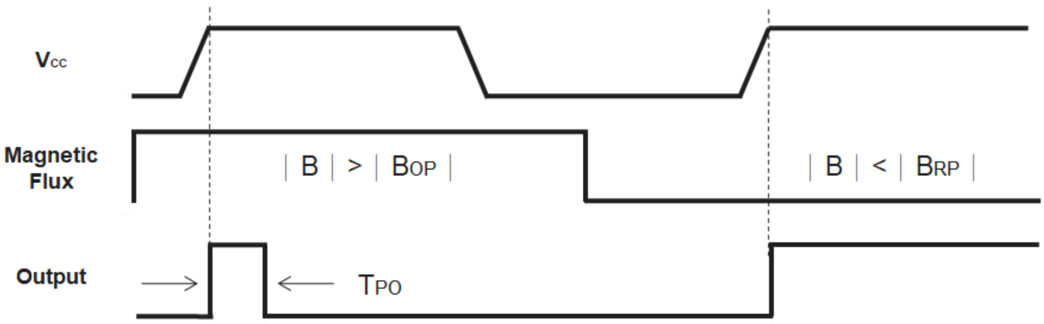
TYPICAL OUTPUT WAVEFORM



Digital Output vs. Magnetic Flux Density & Sampling Pulse (Pull-up load)

POWER ON OUTPUT WAVEFORM

V_{CC} rise time <1µs, T_{PO} is the time from the stable point of V_{CC} to the valid point of output



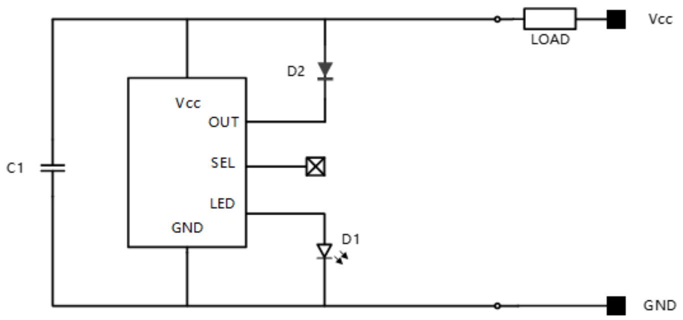
Power-On Output Waveform

TYPICAL APPLICATION CIRCUIT

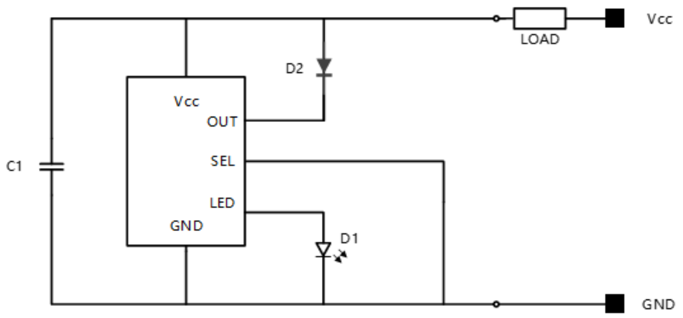
2-Wire Applications

For 2-wire applications, Level 1 sensitivity require SEL pin be floated, Level 2 sensitivity require SEL pin shorted to GND

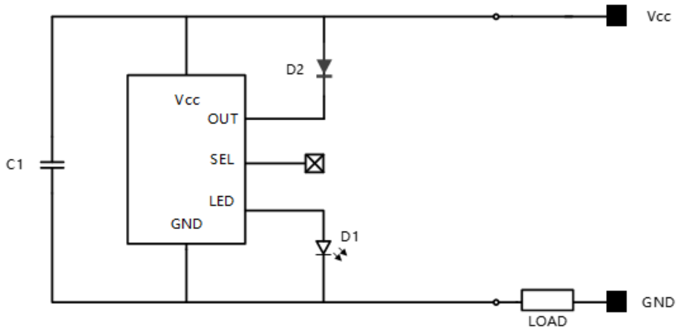
SYMBOL	RECOMMEND
D2	The voltage endurance capability of Schottky Diode should >30V
C1	0.1µF



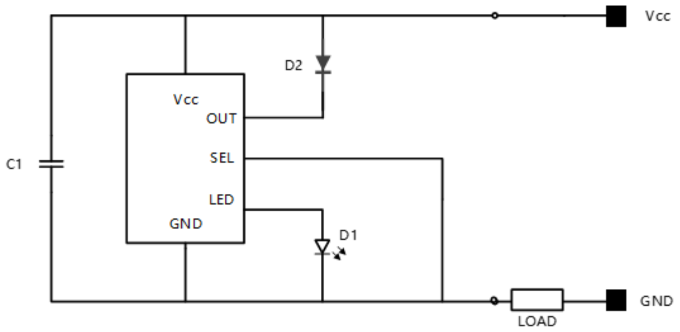
2-wire <u>Pull-up load</u> application circuit (Level 1)



2-wire <u>Pull-up load</u> application circuit (Level 2)



2-wire <u>Pull-down load</u> application circuit (Level 1)



2-wire <u>Pull-down load</u> application circuit (Level 2)

TYPICAL APPLICATION CIRCUIT

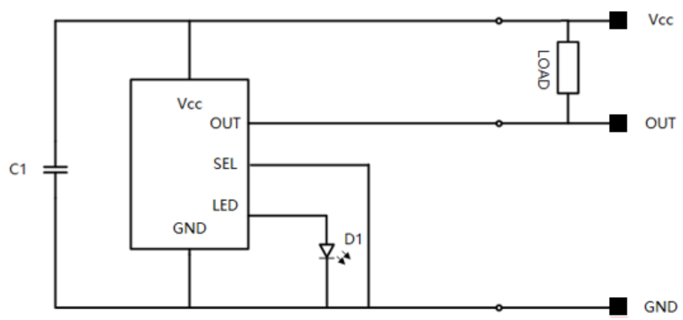
3-Wire Applications

For both pull-up and pull-down load in 3-wire applications, we recommend two kinds of connections, i.e. Type-I and Type-II

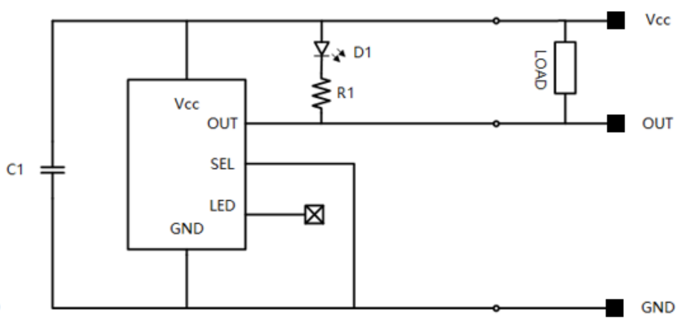
In Type-I connection, a constant current will be provided to D1.

In Type-II connection, user are allowed to tune the current of D1 by changing the value of R1

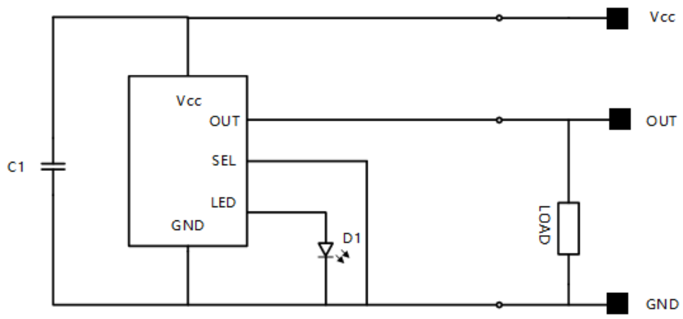
3-Wire also support the sensitivity selection through the SEL pin, Level 1 sensitivity require SEL pin be floated, Level 2 sensitivity require SEL pin shorted to GND



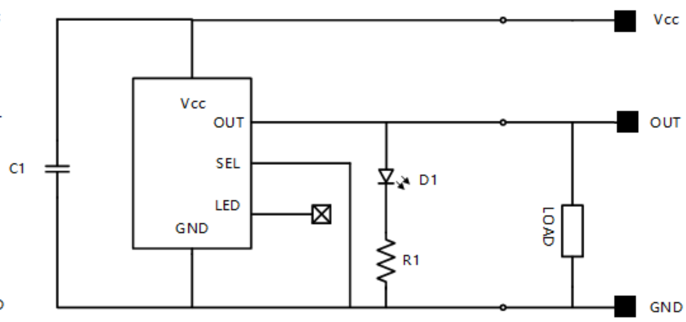
Type I 3-wire Pull-up load application circuit (Sensitivity Level 2)



Type II 3-wire Pull-up load application circuit (Sensitivity Level 2)



Type I 3-wire Pull-down load application circuit (Sensitivity Level 2)

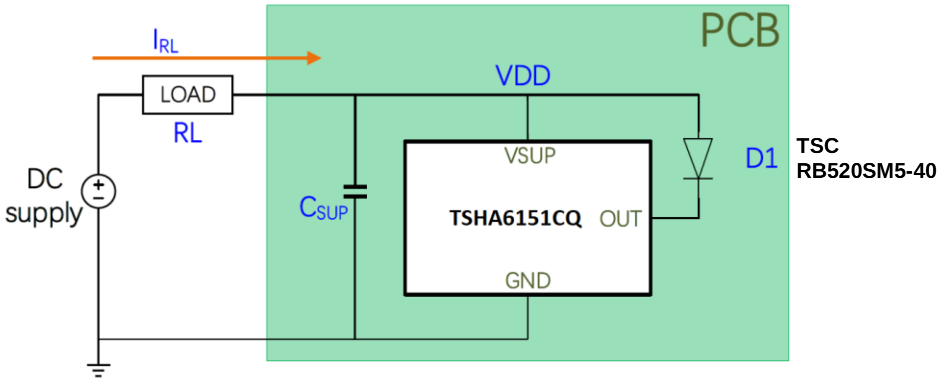


Type II 3-wire Pull-down load application circuit (Sensitivity Level 2)

APPLICATOIN INFORMATION

2-wire cylinder application circuit

The 2-wire cylinder application circuit employing the TSHA6151CQ is demonstrated in following recommend circuit include a decoupling capacitor C_{SUP} and a Schottky diode D1. In 2-wire application, the PCB is connected to a load element with the load resistance R_L and load current I_{RL}



Recommended 2-wire cylinder application circuit

In addition, we recommend the customers to read through the following important notes:

- TSHA6151CQ has internal over-temperature protection mechanism to prevent it from over-heating and thermal damage. The following equation can be used to estimate the IC's temperature rise:

  $$T_J = T_A + R_{\theta JA} \cdot P_{IC} \qquad \text{............ (1)}$$

  Where T_J is IC's internal junction temperature, T_A the environment temperature, $R_{\theta JA}$ the thermal resistance. If T_J exceeds 130°C, the IC will enter over-temperature protection mode where the output driver is turned off momentarily.

- Thermal resistance $R_{\theta JA}$ depends strongly on the PCB layout. $R_{\theta JA}$ should be minimized to reduce the IC's internal temperature rise and prevent it from entering over-temperature mode. The next section provides some design guidelines for PCB layout. It is estimated that $R_{\theta JA}$ =430°C/W can be achieved for the layout presented in the following section.

RECOMMEND PCB Layout guidelines

1. To better heat dissipation, apply mass copper clad on the PCB back side. Also apply copper clad on the front side if the PCB area allows.
2. The routing line of V_{CC}, OUT and GND pad should be greater than 10mil because they are large current pads. If PCB area allows, increase these lines width to 20mil or even use copper clads to route these lines.
3. The SEL and LED are small current pads, so PCB trace connected to those 2 signals can have the minimum width.
4. At least 2 vias are required on the GND copper clad. More vias help to conduct the heat more efficiently.
5. Add teardrops around PCB pads to increase reliability and to avoid high voltage tips.
6. If possible, apply 2-ounce copper on the PCB for better heat dissipation.

Following are the PCB design for your reference:

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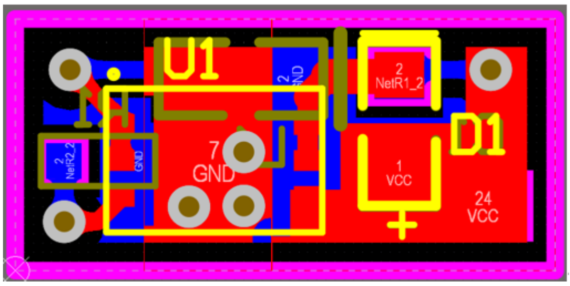
<tr><td>
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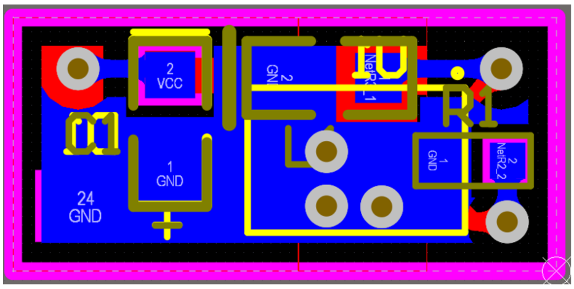
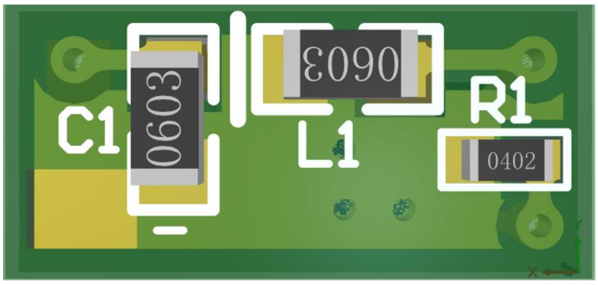
<tr><th colspan="2">Back side</th></tr>
<tr><td>
</td><td>
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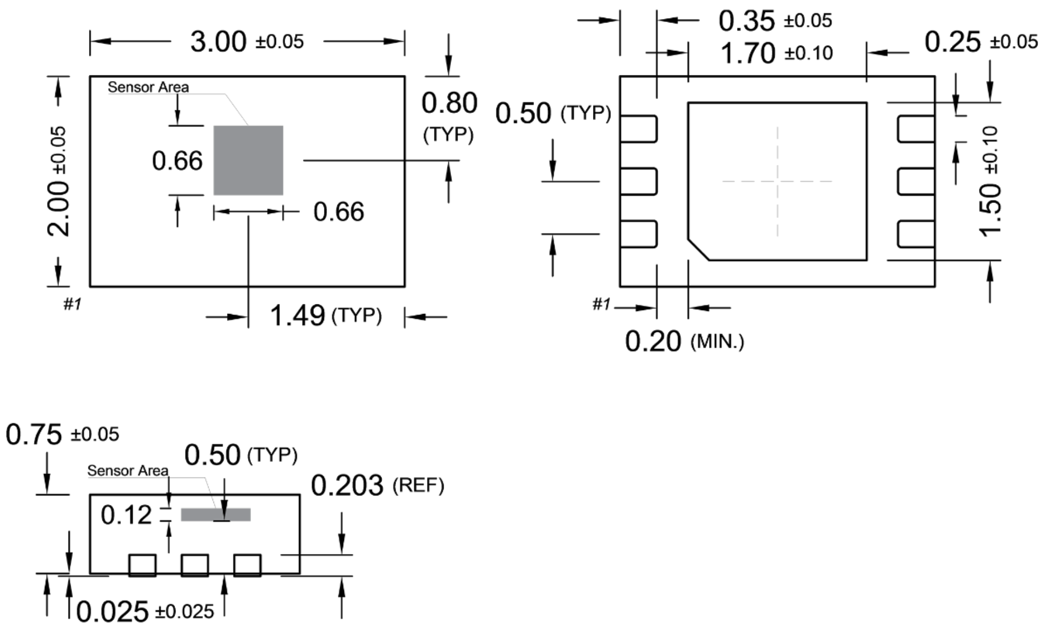
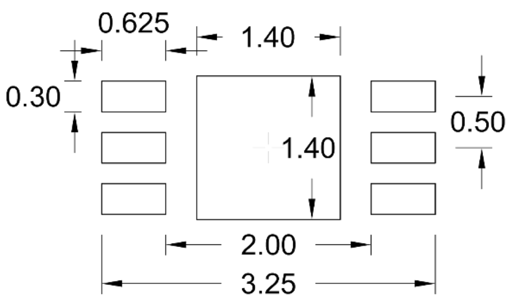
PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

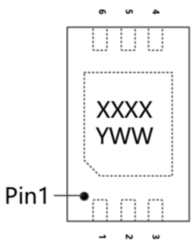
TDFN2x3-6L



SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



XXXX	=	6151 (Device Code)
Y	=	Year Code (0~9)
WW	=	Week Code (01~52)

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