

---

## PWM protocol two-wire differential wheel speed sensor

---

### FEATURES

- Two-wire current interface
- Detect speed and direction
- Detect magnetic or gear tooth
- PWM protocol
- AECQ100 Grade0
- South and North pole pre-induction possible
- Large air gap
- Single chip solution
- Wide supply voltage range: 4.5V to 24V
- Wide Operating temperature : -40°C to 150°C
- TS-2 package
- Enhanced PWM jitter stability
- Enhanced EMC performance with 2.2nF integrated capacitor

### DESCRIPTION

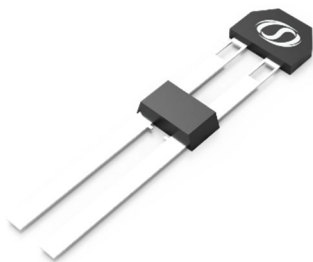
The SC9642TS-EC is an integrated, active magnetic field sensor for wheel speed applications based on Hall technology, Its basic function is to measure the speed and direction of a pole wheel or a ferromagnetic toothed wheel.

It has a two wire-current interface using the PWM protocol for communication, provides the speed and the direction information of wheel rotation.

Its unique circuit makes reliability meets AECQ100 standard and reaches Grade0 .

The package TS-2 is lead (Pb) free with 100% matte-tin lead frame plating.

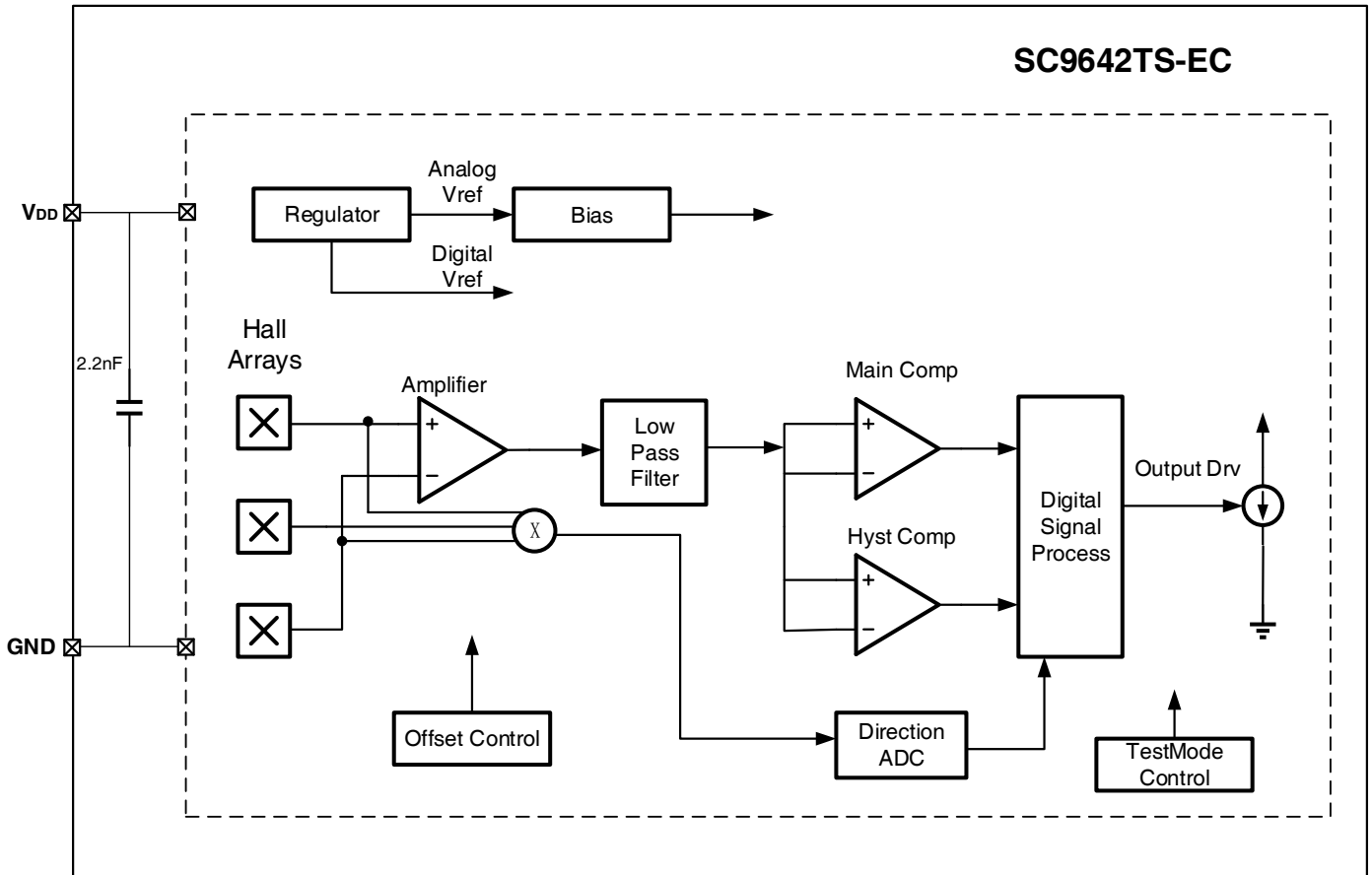
Sensor integrated a 2.2nF ceramic capacitor to enhance EMC performance.



## CONTENTS

|   |               |
|---|---------------|
| <b>FEATURES</b> .....                       | <b>- 1 -</b>  |
| <b>DESCRIPTION</b> .....                    | <b>- 1 -</b>  |
| <b>BLOCK DIAGRAM</b> .....                  | <b>- 3 -</b>  |
| <b>ORDERING INFORMATION</b> .....           | <b>- 3 -</b>  |
| <b>TERMINAL CONFIGURATION</b> .....         | <b>- 4 -</b>  |
| <b>ABSOLUTE MAXIMUM RATINGS</b> .....       | <b>- 5 -</b>  |
| <b>ESD PROTECTION</b> .....                 | <b>- 5 -</b>  |
| <b>ELECTRO MAGNETIC COMPATIBILITY</b> ..... | <b>- 6 -</b>  |
| <b>OPERATING CHARACTERISTICS</b> .....      | <b>- 7 -</b>  |
| <b>MAGNETIC FIELD</b> .....                 | <b>- 8 -</b>  |
| <b>PWM TIMING DEFINITION</b> .....          | <b>- 10 -</b> |
| <b>TYPICAL APPLICATION</b> .....            | <b>- 11 -</b> |
| <b>PACKAGE INFORMATION</b> .....            | <b>- 12 -</b> |
| <b>REVISION HISTORY</b> .....               | <b>- 13 -</b> |

## BLOCK DIAGRAM

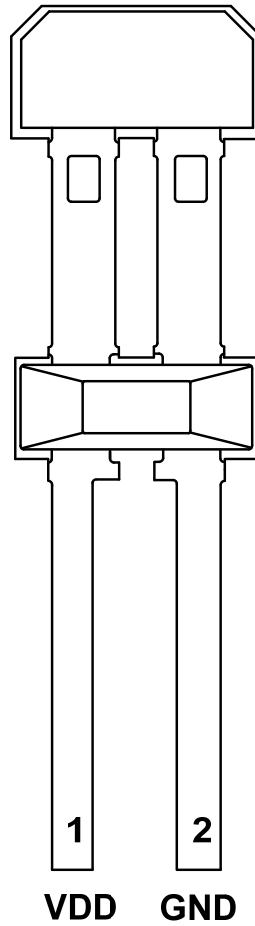


## ORDERING INFORMATION

| Part Number | Packing           | Mounting  | Ambient, T <sub>A</sub> | Marking |
|-------------|-------------------|-----------|-------------------------|---------|
| SC9642TS-EC | Bulk, 1500pcs/box | 2-pin SIP | -40°C to 150°C          | 9642    |

## TERMINAL CONFIGURATION

2 Terminal SIP  
Ts package  
(TOP View)



| Terminal |        | Type   | Description              |
|----------|--------|--------|--------------------------|
| Name     | Number |        |                          |
| VDD      | 1      | Power  | 4.5V ~ 24 V power supply |
| GND      | 2      | Ground | Ground                   |

## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range

| Parameter                     | Symbol    | Min. | Max. | Units       | Remarks   |
|-------------------------------|-----------|------|------|-------------|---|
| Power supply voltage          | $V_{DD}$  | -0.5 | 30   | V           |   |
| Reverse polarity current      | $I_{DDR}$ |      | 200  | mA          | $R_M > 75 \Omega$<br>included in $V_{DD}$ ,<br>$t < 4h$ |
| Operating ambient temperature | $T_A$     | -40  | 150  | $^{\circ}C$ |   |
| Junction temperature          | $T_J$     | -55  | 150  | $^{\circ}C$ | 5000h<br>$V_{DD} < 16.5V$                               |
| Junction temperature          | $T_J$     | -55  | 160  | $^{\circ}C$ | 2500h<br>$V_{DD} < 16.5V$                               |
| Junction temperature          | $T_J$     | -55  | 170  | $^{\circ}C$ | 500h<br>$V_{DD} < 16.5V$                                |
| Storage temperature           | $T_{STG}$ | -65  | 175  | $^{\circ}C$ |   |

Note: Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ESD PROTECTION

Human Body Model (HBM) tests according to: standard AEC-Q100-002 HBM

| Parameter      | Symbol    | Limit Values |      | Units |
|----------------|-----------|--------------|------|-------|
|                |           | Min.         | Max. |       |
| ESD-Protection | $V_{ESD}$ | -5           | 5    | kV    |

## ELECTRO MAGNETIC COMPATIBILITY

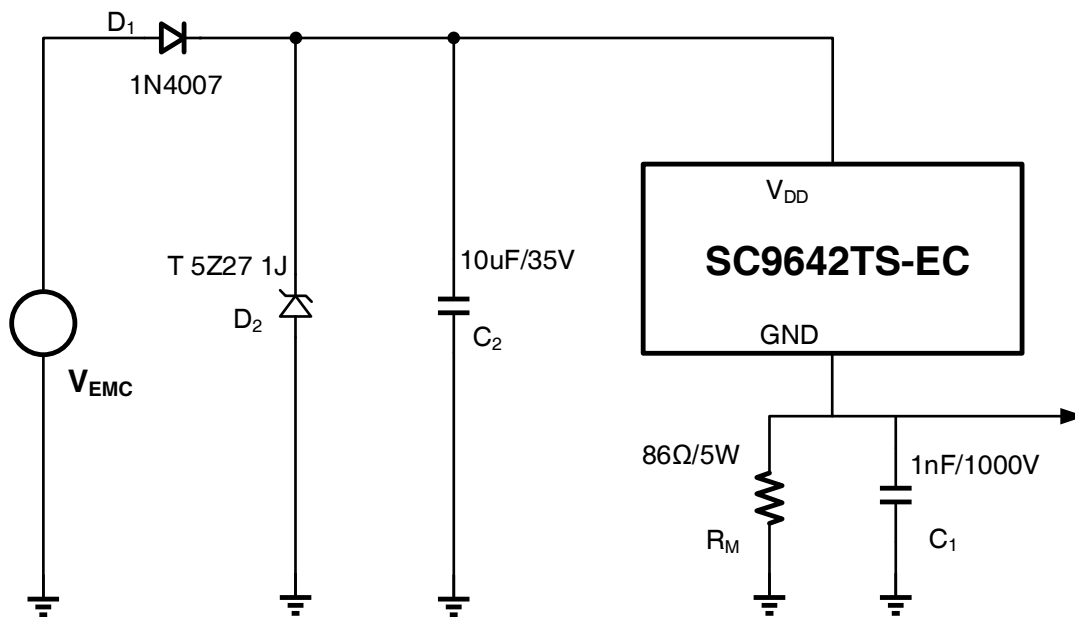
Ref. ISO 7637-2; see the test circuit for EMC tests;

$\Delta B_{PP} = 2\text{mT}$  (amplitude of sinus signal);  $V_{DD} = 13.5\text{V}$ ,  $f_B = 1\text{ kHz}$ ;  $T_A = 25^\circ\text{C}$ ;  $R_M \geq 75\ \Omega$ ;

| Parameter     | Symbol    | Level / Typ. | Status |
|---------------|-----------|--------------|--------|
| Test pulse 1  | $V_{EMC}$ | IV / -150V   | C      |
| Test pulse 2a |           | IV / 112V    | C      |
| Test pulse 3a |           | IV / -220V   | A      |
| Test pulse 3b |           | IV / 150V    | A      |
| Test pulse 5b |           | IV / 34V     | C      |

1. Test criteria for status A: No missing pulse no additional pulse on the IC output signal plus duty cycle and jitter are in specification limits.
2. Test criteria for status B: No missing pulse no additional pulse on the IC output signal.
3. Test criteria for status C: One or more parameter can be out of specification during the exposure but returns automatically to normal operation after exposure is removed.

**Test circuit for EMC test**



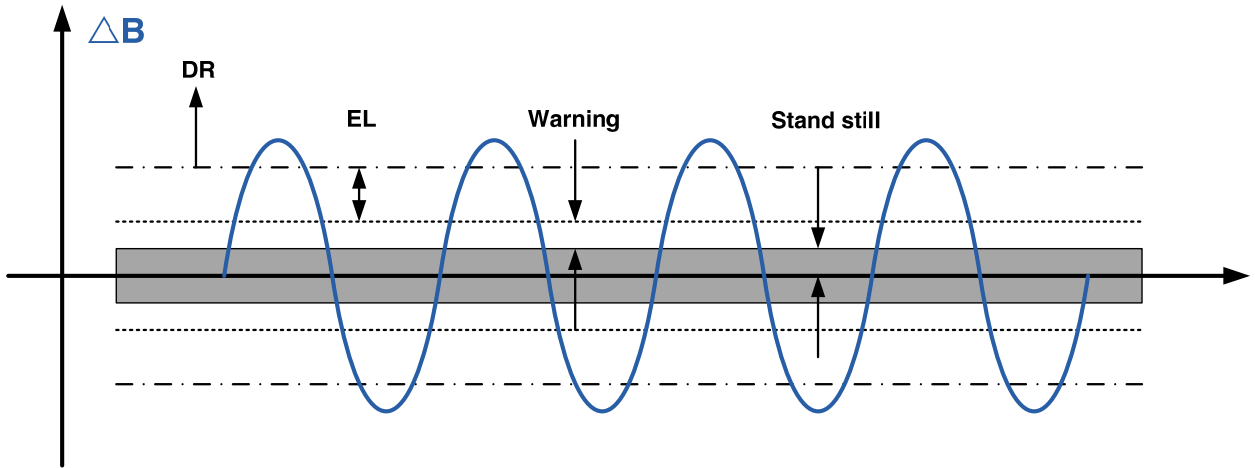
## OPERATING CHARACTERISTICS

 Valid through the full operating temperature range,  $V_{DD}=12V$ ,  $C_{BYPASS}=0.1\mu F$ ; unless otherwise specified.

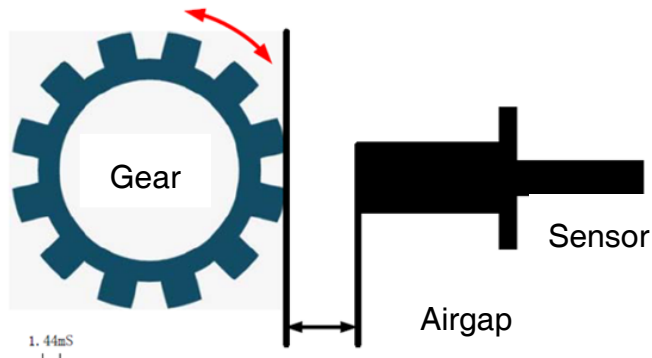
| Parameter                                      | Symbol                                | Test Condition                | Min.  | Typ. | Max.    | Unit      |
|--|---------------------------------------|-------------------------------|-------|------|---------|-----------|
| <b>Electrical Characteristics</b>              |                                       |                               |       |      |         |           |
| Supply Voltage                                 | $V_{DD}$                              |                               | 4.5   | 12.0 | 24.0    | V         |
| Anti-AC interference                           | $V_{AC}$                              | $f < 50 \text{ kHz}$          | --    | --   | 8       | Vpp       |
| Back magnetic strength range                   | $B_0$                                 |                               | -5000 | 0    | 5000    | Gs        |
| Pre-induction offset between outer probes      | $\Delta B_{start\_1/r}$               |                               | -200  | 0    | 200     | Gs        |
| Differential induction                         | $\Delta B$                            |                               | -1200 | --   | 1200    | Gs        |
| Supply Current                                 | $I_{LOW}$                             |                               | 5.9   | 7    | 8.4     | mA        |
| Supply Current                                 | $I_{HIGH}$                            |                               | 11.8  | 14   | 16.8    | mA        |
| Supply Current ratio                           | $I_{HIGH}/I_{LOW}$                    |                               | 1.9   | --   | --      |           |
| Output rise/fall slew rate                     | $t_r, t_f$                            | $R_m=75\text{ohm } T_A < 150$ | 8     | --   | 26      | mA/uS     |
| Current Ripple                                 | $I_x$                                 | $dI_x/dV_{DD}$                | --    | --   | 90      | $\mu A/V$ |
| Limit threshold                                | $\Delta B_{limit}$                    | 1Hz--2500Hz                   | --    | 7.7  | --      | Gs        |
| Airgap Warning threshold                       | $\Delta B_{warning}$                  | 1Hz--2500Hz                   | --    | 11.5 | --      | Gs        |
| Limit-warning threshold ratio                  | $\Delta B_{warning}/\Delta B_{limit}$ |                               | 1.3   | 2    | 2.7     |           |
| Assembly position threshold                    | $\Delta B_{EL}$                       | 1Hz--2500Hz                   | 52    | 72   | 96      | Gs        |
| Initial calibration time                       | $t_d$                                 |                               | --    | --   | 300     | $\mu S$   |
| Magnetic edges required for offset calibration | $n_{DZ-calibration}$                  |                               | --    | --   | 6       | pulse     |
| Operating Frequency                            | $f$                                   |                               | 1.0   | --   | 5000    | Hz        |
| Duty cycle                                     | DC                                    |                               | 40    | 50   | 60      | %         |
| jitter   | $S_{Jit-Close}$                       | $\Delta B > 20Gs$             | --    | --   | $\pm 3$ | %         |
|  | $S_{Jit-Far}$                         | $1Hz < f < 2500Hz$            | --    | --   | $\pm 6$ | %         |
|  | $S_{Jit-AC}$                          |                               | --    | --   | $\pm 3$ | %         |
| <b>Timing Characteristics</b>                  |                                       |                               |       |      |         |           |
| Pre- Low Time                                  | $t_{pre-low}$                         |                               | 38    | 45   | 52      | $\mu s$   |
| Warning Pulse Width                            | $t_{Warning}$                         |                               | 38    | 45   | 52      | $\mu s$   |
| DR-L Pulse Width                               | $t_{DR-L}$                            |                               | 76    | 90   | 104     | $\mu s$   |
| DR-R Pulse Width                               | $t_{DR-R}$                            |                               | 153   | 180  | 207     | $\mu s$   |
| DR-L & EL Pulse Width                          | $t_{DR-L\&EL}$                        |                               | 306   | 360  | 414     | $\mu s$   |
| DR-R & EL Pulse Width                          | $t_{DR-R\&EL}$                        |                               | 616   | 720  | 828     | $\mu s$   |
| Output of EL pluse maximum frequency           | $f_{ELmax}$                           |                               | --    | 117  | --      | Hz        |
| Stand Still Pulse Width                        | $t_{Stop}$                            |                               | 1.232 | 1.44 | 1.656   | mS        |

|                    |            |     |     |     |    |
|--------------------|------------|-----|-----|-----|----|
| Stand Still period | $T_{Stop}$ | 590 | 737 | 848 | mS |
|--------------------|------------|-----|-----|-----|----|

## MAGNETIC FIELD



Definition of differential magnetic flux density range



Mounting distance diagram



**Stand Still:** The installation distance is far or the gear does not rotate,  $\Delta B$  is less than 7GS, the chip output pulse width is 1.44ms, period is 737ms.

**Warning :** When the installation distance is at the critical position,  $\Delta B$  between 7GS to 12GS, the chip output pulse width is 45 $\mu$ S.

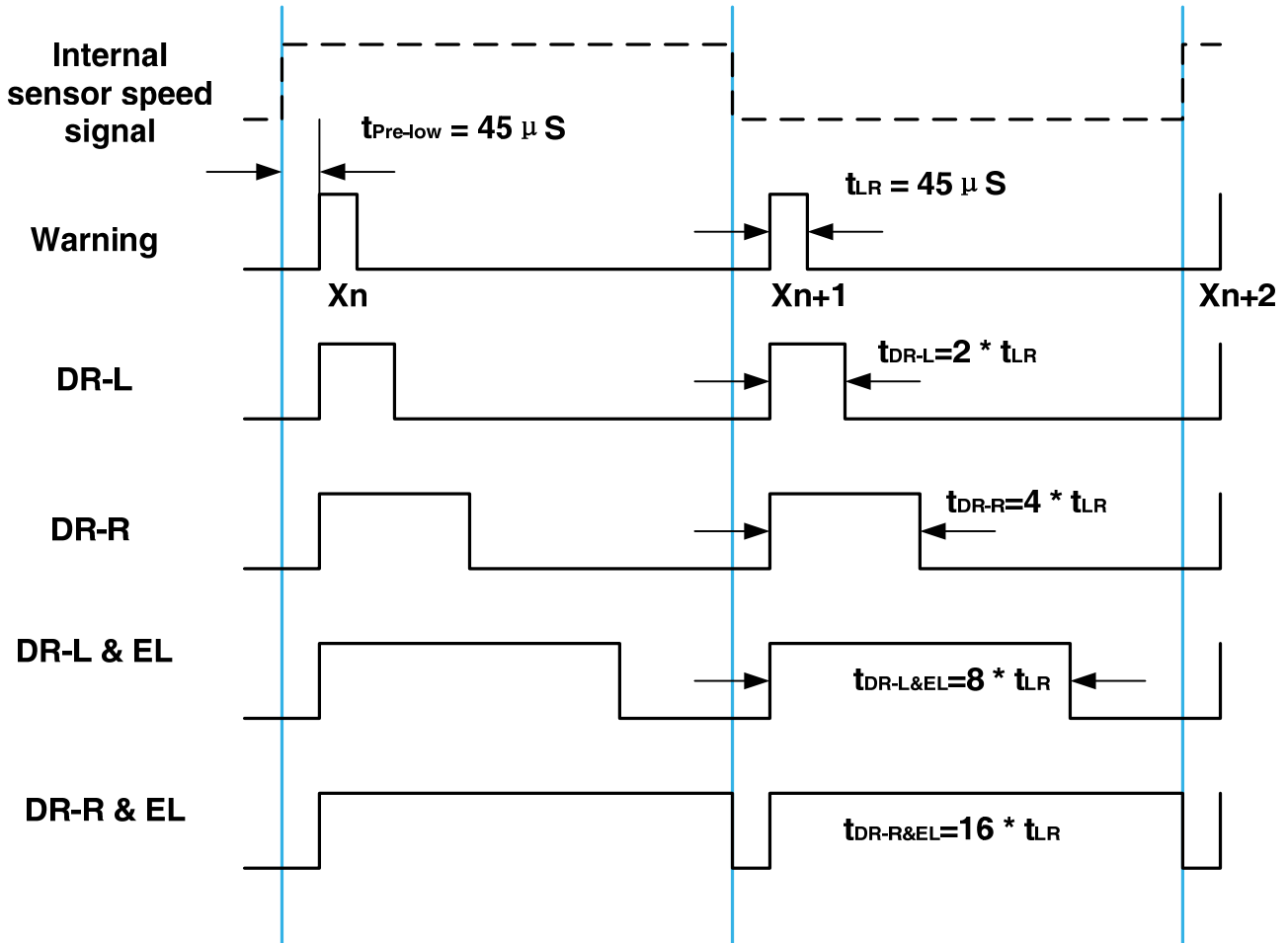
**EL:** When the installation distance is moderate,  $\Delta B$  between 12GS and 65GS, and the speed is slow,

When the frequency is below 117Hz, the forward rotation (VDD $\rightarrow$ GND) ,output pulse width is 360 $\mu$ S ,which is DR-L&EL, and the reverse rotation (GND $\rightarrow$ VDD) output pulse width is 720 $\mu$ S , which is DR-R&EL.

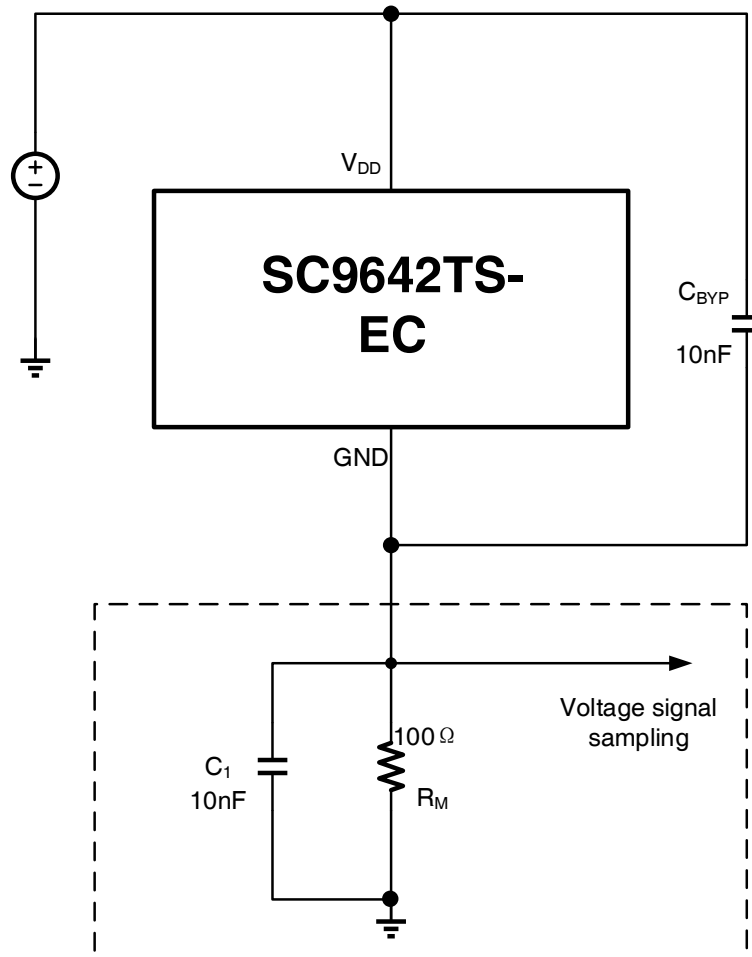
When the frequency is beyond 117HZ, the forward rotation (VDD $\rightarrow$ GND) ,output pulse width is 90 $\mu$ S, which is DR-L&EL, and the reverse rotation (GND $\rightarrow$ VDD) output pulse width is 180 $\mu$ S, which is DR-R&EL.

**DR:** When the installation distance is relatively close,  $\Delta B$  is greater than 65GS, regardless of frequency, forward rotation (VDD $\rightarrow$ GND) output pulse width is 90 $\mu$ S ,which is DR-L, reverse (GND $\rightarrow$ VDD) output pulse width is 180 $\mu$ S, which is DR-R.

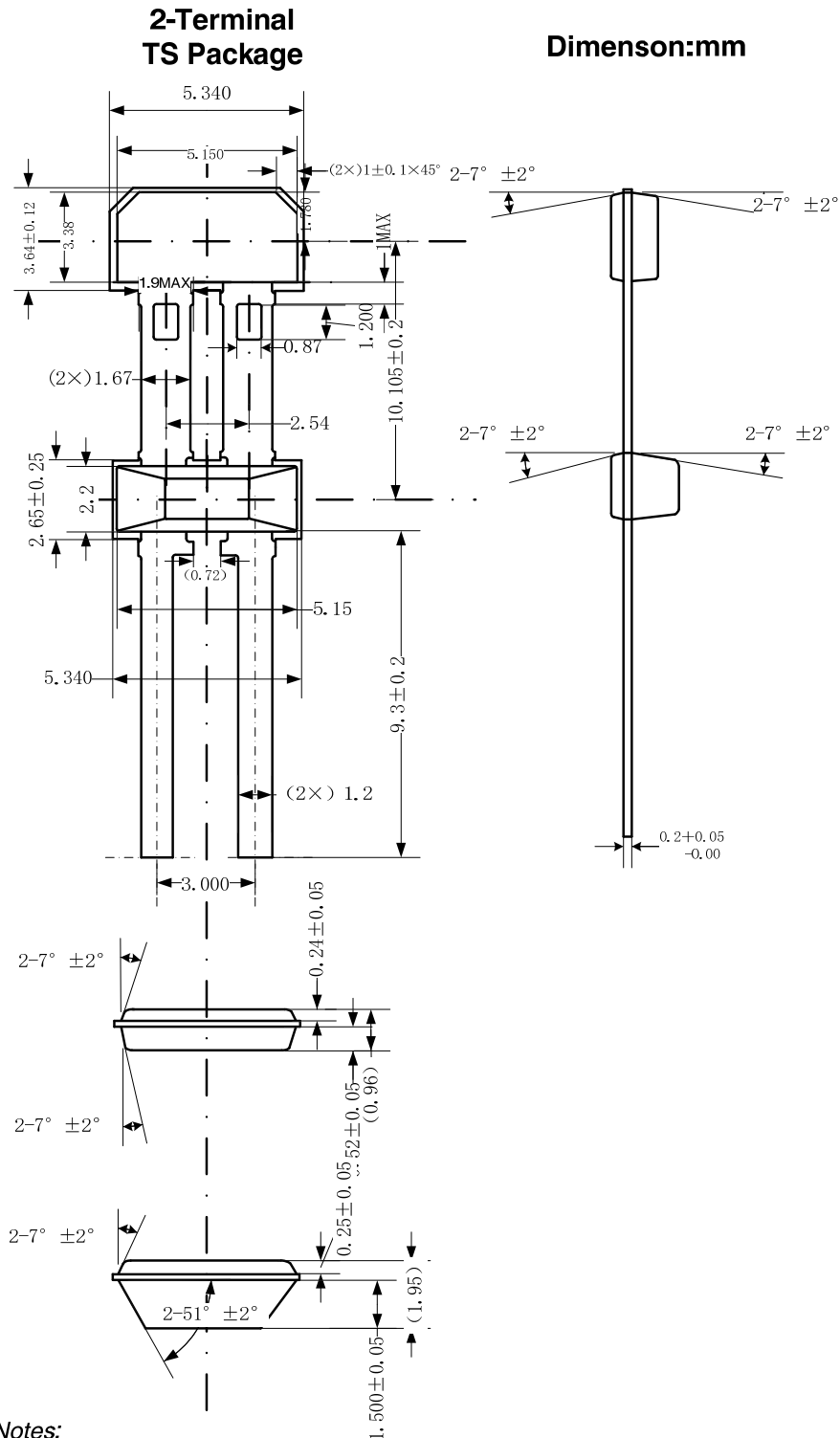
## PWM TIMING DEFINITION



## TYPICAL APPLICATION



## PACKAGE INFORMATION



**Notes:**

1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## REVISION HISTORY

| Revision | Date       | Description        |
|----------|------------|--------------------|
| RevA/1.0 | 2022-11-22 | The Final revision |