

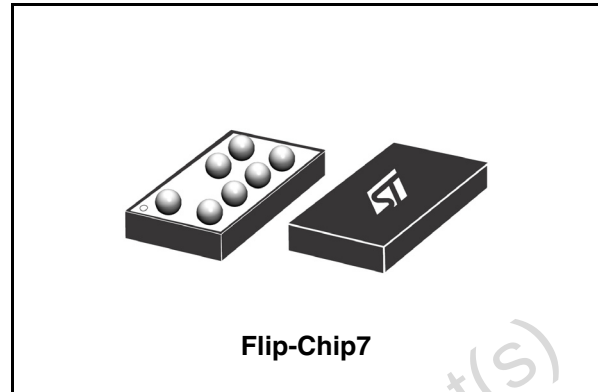


## STG4159

Low voltage  $0.3\Omega$  max single SPDT switch with break-before-make feature and 10kV contact ESD protection

### Features

- Wide operating voltage range:  
 $V_{CC}$  (OPR) = 1.65V to 4.8V
- Low power dissipation:  
 $I_{CC}$  = 0.2 $\mu$ A (max.) at  $T_A$  = 85°C
- Low "ON" resistance  $V_{IN}$  = 0V:
  - $R_{ON}$  = 0.40 $\Omega$  (max.  $T_A$  = 25°C) at  $V_{CC}$  = 2.25V
  - $R_{ON}$  = 0.35 $\Omega$  (max.  $T_A$  = 25°C) at  $V_{CC}$  = 3.0V
  - $R_{ON}$  = 0.30 $\Omega$  (max.  $T_A$  = 25°C) at  $V_{CC}$  = 4.3V
- Separate supply voltage for switch and control pin
- Latch-up performance exceeds 100mA per JESD 78, Class II
- ESD performance tested on common channel (D pin)
  - 10kV IEC-61000-4-2 ESD, contact discharge
  - 15kV IEC-61000-4-2 ESD, air discharge
- ESD performance test on all other pins
  - 10kV IEC-61000-4-2 ESD, contact discharge
  - 500V machine model (JE3D22 A115-A)
  - 1500V charged-device model (JE3D22 C101)



### Description

The STG4159 is a high-speed CMOS low voltage single analog SPDT (Single Pole Dual Throw) switch or 2:1 multiplexer/demultiplexer switch fabricated in silicon gate C<sup>2</sup>MOS technology. It is designed to operate from 1.65V to 4.58V, making this device ideal for portable applications. It offers low ON-resistance (0.45 $\Omega$ ) at  $V_{CC}$  = 4.3V. The SEL inputs are provided to control the switches.

The switch S1 is ON (connected to common Port D) when the SEL input is held high and OFF (high impedance state exists between the two ports) when SEL is held low; the switch S2 is ON (it is connected to common Port D) when the SEL input is held low and OFF (high impedance state exist between the two ports) when SEL is held high.

Additional key features are fast switching speed, break-before-make delay time and ultra low power consumption. All inputs and outputs are equipped with protection circuits against static discharge, giving them ESD immunity and transient excess voltage.

Table 1. Device summary

| Part number | Package    | Packaging     |
|-------------|------------|---------------|
| STG4159     | Flip-Chip7 | Tube          |
| STG4159BJR  | Flip-Chip7 | Tape and reel |

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Obsolete Product(s) - Obsolete Product(s)

# 1    Logic diagram

Figure 1.    Functional diagram

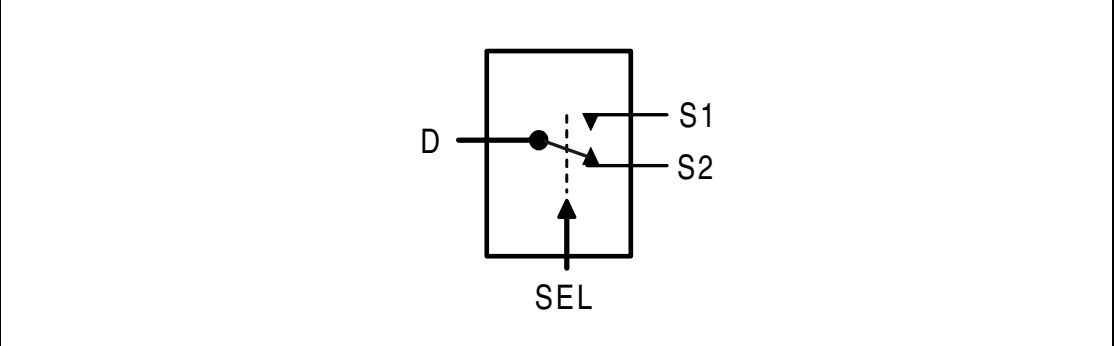


Figure 2.    Input equivalent circuit

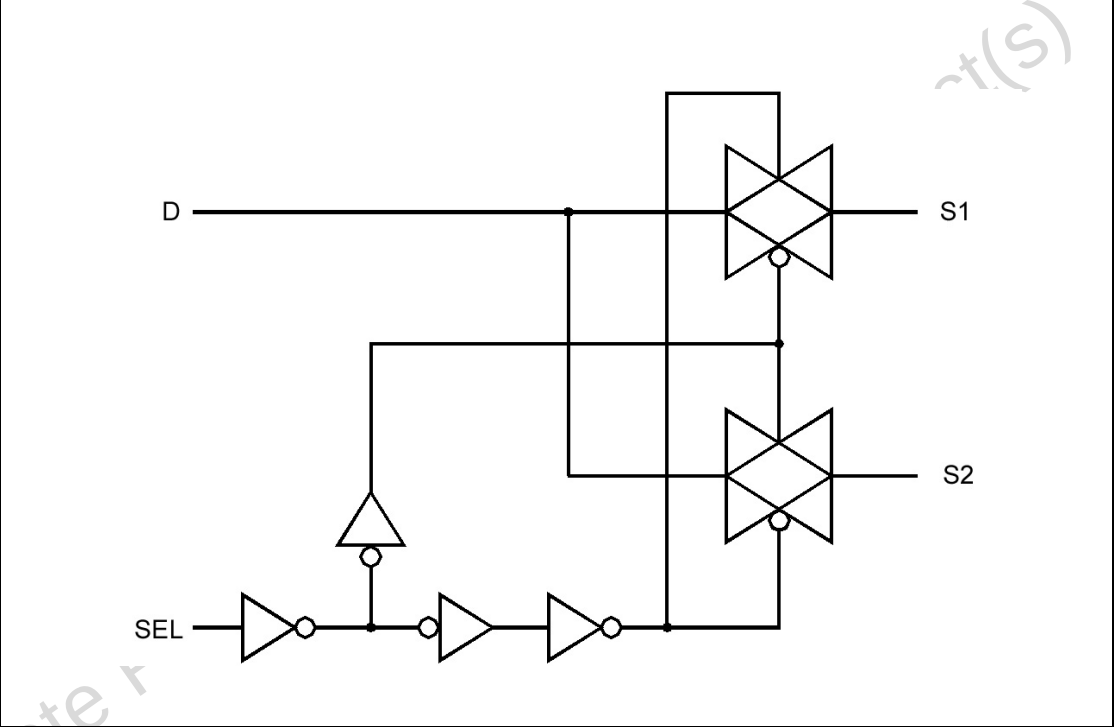
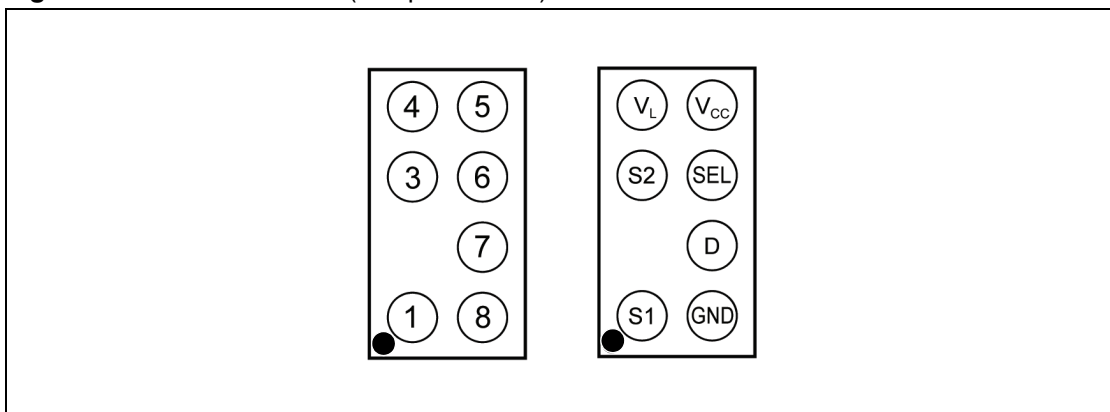


Table 2.    Truth table

| SEL | Switch S1          | Switch S2          |
|-----|--------------------|--------------------|
| H   | ON                 | OFF <sup>(1)</sup> |
| L   | OFF <sup>(1)</sup> | ON                 |

1. High Impedance

**Figure 3. Pin connection** (bump side view)**Table 3. Pin description**

| Flip-Chip | Symbol          | Name and function       |
|-----------|-----------------|-------------------------|
| 1, 3      | S1, S2          | Independent channels    |
| 7         | D               | Common channel          |
| 6         | SEL             | Control                 |
| 5         | V <sub>CC</sub> | Positive supply voltage |
| 4         | V <sub>L</sub>  | Logic supply voltage    |
| 8         | GND             | Ground (0V)             |

## 2 Maximum rating

Stressing the device above the rating listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 4. Absolute maximum ratings**

| Symbol                | Parameter                                                | Value                  | Unit       |
|-----------------------|----------------------------------------------------------|------------------------|------------|
| $V_{CC}$              | Supply voltage                                           | -0.5 to 5.5            | V          |
| $V_L$                 | Logic supply voltage                                     | -0.5 to 5.5            | V          |
| $V_I$                 | DC input voltage                                         | -0.5 to $V_{CC} + 0.5$ | V          |
| $V_{IC}$              | DC control input voltage                                 | -0.5 to $V_L + 0.5$    | V          |
| $V_O$                 | DC output voltage                                        | -0.5 to $V_{CC} + 0.5$ | V          |
| $I_{IKC}$             | DC input diode current on control pin ( $V_{SEL} < 0V$ ) | -50                    | mA         |
| $I_{IK}$              | DC input diode current ( $V_{SEL} < 0V$ )                | $\pm 50$               | mA         |
| $I_{OK}$              | DC output diode current                                  | $\pm 20$               | mA         |
| $I_O$                 | DC output current                                        | $\pm 300$              | mA         |
| $I_{OP}$              | DC output current peak (pulse at 1ms, 10% duty cycle)    | $\pm 500$              | mA         |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or ground current                            | $\pm 100$              | mA         |
| $P_D$                 | Power dissipation at $T_A = 70^\circ C$ <sup>(1)</sup>   | 500                    | mW         |
| $T_{stg}$             | Storage temperature                                      | -50 to 105             | $^\circ C$ |
| $T_L$                 | Lead temperature (10 sec)                                | 260                    | $^\circ C$ |

1. Derate above  $70^\circ C$  by 18.5mW/ $^\circ C$

**Table 5. Recommended operating conditions**

| Symbol   | Parameter                              | Value                   | Unit       |
|----------|----------------------------------------|-------------------------|------------|
| $V_{CC}$ | Supply voltage <sup>(1)</sup>          | 1.65 to 4.8             | V          |
| $V_L$    | Logic supply voltage <sup>(2)</sup>    | 1.65 to $V_{CC}$        | V          |
| $V_I$    | Input voltage                          | 0 to $V_{CC}$           | V          |
| $V_{IC}$ | Control input voltage                  | 0 to $V_L$              | V          |
| $V_O$    | Output voltage                         | 0 to $V_{CC}$           | V          |
| $T_{op}$ | Operating temperature                  | -40 to 85               | $^\circ C$ |
| dt/dv    | Input rise and fall time control input | $V_L = 1.65V$ to $2.7V$ | ns/V       |
|          |                                        | $V_L = 3.0V$ to $4.8V$  |            |

1. Truth Table guaranteed: 1.65V to 4.8V

2.  $V_L$  pin should not be left floating.

### 3 Electrical characteristics

Table 6. DC specifications

| Symbol            | Parameter                                           | Test conditions     |                    |                                                                              | Value                 |      |      |             |      | Unit |
|-------------------|-----------------------------------------------------|---------------------|--------------------|------------------------------------------------------------------------------|-----------------------|------|------|-------------|------|------|
|                   |                                                     | V <sub>CC</sub> (V) | V <sub>L</sub> (V) |                                                                              | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      |      |
|                   |                                                     |                     |                    |                                                                              | Min.                  | Typ. | Max. | Min.        | Max. |      |
| V <sub>IH</sub>   | High level input voltage                            | 1.65-4.3            | 1.65-1.95          |                                                                              | 1.25                  |      |      | 1.25        |      | V    |
|                   |                                                     |                     | 2.3-2.7            |                                                                              | 1.75                  |      |      | 1.75        |      |      |
|                   |                                                     |                     | 3.0-3.6            |                                                                              | 2.35                  |      |      | 2.35        |      |      |
|                   |                                                     |                     | 4.3                |                                                                              | 2.8                   |      |      | 2.8         |      |      |
| V <sub>IL</sub>   | Low level input voltage                             | 1.65-4.3            | 1.65-1.95          |                                                                              |                       |      | 0.6  |             | 0.6  | V    |
|                   |                                                     |                     | 2.3-2.7            |                                                                              |                       |      | 0.8  |             | 0.8  |      |
|                   |                                                     |                     | 3.0-3.6            |                                                                              |                       |      | 1.05 |             | 1.05 |      |
|                   |                                                     |                     | 4.3                |                                                                              |                       |      | 1.5  |             | 1.5  |      |
| R <sub>ON</sub>   | ON resistance                                       | 1.8                 | 1.65-4.3           | V <sub>S</sub> =0V to V <sub>CC</sub><br>I <sub>S</sub> =100mA               |                       | 0.49 | 0.65 |             | 0.85 | Ω    |
|                   |                                                     | 2.25                |                    |                                                                              |                       | 0.30 | 0.40 |             | 0.50 |      |
|                   |                                                     | 3                   |                    |                                                                              |                       | 0.25 | 0.35 |             | 0.45 |      |
|                   |                                                     | 3.7                 |                    |                                                                              |                       | 0.22 | 0.32 |             | 0.42 |      |
|                   |                                                     | 4.3                 |                    |                                                                              |                       | 0.21 | 0.30 |             | 0.40 |      |
| ΔR <sub>ON</sub>  | ON resistance match between channels <sup>(1)</sup> | 1.8                 | 1.65-4.3           | V <sub>S</sub> =0V to V <sub>CC</sub><br>I <sub>S</sub> =100mA               |                       | 5    |      |             |      | mΩ   |
|                   |                                                     | 2.25                |                    |                                                                              |                       | 3    |      |             |      |      |
|                   |                                                     | 3                   |                    |                                                                              |                       | 3    |      |             |      |      |
|                   |                                                     | 3.7                 |                    |                                                                              |                       | 3    |      |             |      |      |
|                   |                                                     | 4.3                 |                    |                                                                              |                       | 3    |      |             |      |      |
| R <sub>FLAT</sub> | ON resistance flatness <sup>(2)</sup>               | 1.8                 | 1.65 - 4.3         | V <sub>S</sub> =0V to V <sub>CC</sub><br>I <sub>S</sub> =100mA               |                       | 300  | 400  |             | 450  | mΩ   |
|                   |                                                     | 2.5                 |                    |                                                                              |                       | 130  | 170  |             | 230  |      |
|                   |                                                     | 3                   |                    |                                                                              |                       | 90   | 120  |             | 170  |      |
|                   |                                                     | 3.7                 |                    |                                                                              |                       | 90   | 120  |             | 170  |      |
|                   |                                                     | 4.3                 |                    |                                                                              |                       | 90   | 120  |             | 170  |      |
| I <sub>OFF</sub>  | Sn OFF state leakage current                        | 1.65-4.3            | 1.65 - 4.3         | V <sub>S</sub> =0 to V <sub>CC</sub><br>V <sub>D</sub> =0 to V <sub>CC</sub> | -20                   |      | 20   | -300        | 300  | nA   |
| I <sub>ON</sub>   | Sn ON state leakage current                         | 1.65-4.3            | 1.65 - 4.3         | V <sub>S</sub> =0 to V <sub>CC</sub><br>V <sub>D</sub> =Open                 | -20                   |      | 20   | -100        | 100  | nA   |
| I <sub>D</sub>    | D ON state leakage current                          | 1.65-4.3            | 1.65 - 4.3         | V <sub>S</sub> =Open<br>V <sub>D</sub> =0 to V <sub>CC</sub>                 | -20                   |      | 20   | -100        | 100  | nA   |

Table 6. DC specifications

| Symbol           | Parameter                | Test conditions     |                    |                                          | Value                 |      |      |             |      | Unit |
|------------------|--------------------------|---------------------|--------------------|------------------------------------------|-----------------------|------|------|-------------|------|------|
|                  |                          | V <sub>CC</sub> (V) | V <sub>L</sub> (V) |                                          | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      |      |
|                  |                          |                     |                    |                                          | Min.                  | Typ. | Max. | Min.        | Max. |      |
| I <sub>CC</sub>  | Quiescent supply current | 1.65-4.3            | 1.65 - 4.3         | V <sub>SEL</sub> =V <sub>CC</sub> or GND | -0.05                 |      | 0.05 | -0.2        | 0.2  | μA   |
| I <sub>SEL</sub> | SEL leakage current      | 1.65-4.3            | 1.65 - 4.3         | V <sub>SEL</sub> =4.3V or GND            | -0.1                  |      | 0.1  | -1          | 1    | μA   |

1.  $\Delta R_{ON} = R_{ON(Max)} - R_{ON(Min)}$

2. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

Table 7. AC electrical characteristics (C<sub>L</sub> = 35pF, R<sub>L</sub> = 50Ω, t<sub>r</sub> = t<sub>f</sub> ≤ 5ns)

| Symbol                                 | Parameter                    | Test conditions     |                    |                                                                                      | Value                 |      |      |             |      | Unit |
|----------------------------------------|------------------------------|---------------------|--------------------|--------------------------------------------------------------------------------------|-----------------------|------|------|-------------|------|------|
|                                        |                              | V <sub>CC</sub> (V) | V <sub>L</sub> (V) |                                                                                      | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      |      |
|                                        |                              |                     |                    |                                                                                      | Min.                  | Typ. | Max. | Min.        | Max. |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation delay            | 1.65-1.95           | 1.65-4.3           |                                                                                      |                       | 0.13 |      |             |      | ns   |
|                                        |                              | 2.3-2.7             |                    |                                                                                      |                       | 0.15 |      |             |      |      |
|                                        |                              | 3.0-3.3             |                    |                                                                                      |                       | 0.16 |      |             |      |      |
|                                        |                              | 3.6-4.3             |                    |                                                                                      |                       | 0.16 |      |             |      |      |
| t <sub>ON</sub>                        | TURN-ON time                 | 1.65-1.95           | 1.65-4.3           | V <sub>S</sub> = V <sub>CC</sub><br>R <sub>L</sub> = 50Ω<br>C <sub>L</sub> = 30pF    |                       | 95   | 123  |             | 160  | ns   |
|                                        |                              | 2.3-2.7             |                    |                                                                                      |                       | 48   | 62   |             | 80   |      |
|                                        |                              | 3-3.6               |                    |                                                                                      |                       | 33   | 43   |             | 56   |      |
|                                        |                              | 4.3                 |                    |                                                                                      |                       | 29   | 38   |             | 49   |      |
| t <sub>OFF</sub>                       | TURN-OFF time                | 1.65-1.95           | 1.65-4.3           | V <sub>S</sub> = V <sub>CC</sub><br>R <sub>L</sub> = 50Ω<br>C <sub>L</sub> = 30pF    |                       | 12   | 15   |             | 20   | ns   |
|                                        |                              | 2.3-2.7             |                    |                                                                                      |                       | 12   | 16   |             | 21   |      |
|                                        |                              | 3-3.6               |                    |                                                                                      |                       | 13   | 17   |             | 22   |      |
|                                        |                              | 4.3                 |                    |                                                                                      |                       | 13   | 17   |             | 22   |      |
| t <sub>D</sub>                         | Break-before-make time delay | 1.65-1.95           | 1.65-4.3           | C <sub>L</sub> = 35pF<br>R <sub>L</sub> = 50Ω<br>V <sub>S</sub> = V <sub>CC</sub> /2 | 10                    | 42   |      |             |      | ns   |
|                                        |                              | 2.3-2.7             |                    |                                                                                      | 10                    | 22   |      |             |      |      |
|                                        |                              | 3-3.6               |                    |                                                                                      | 5                     | 15   |      |             |      |      |
|                                        |                              | 4.3                 |                    |                                                                                      | 5                     | 12   |      |             |      |      |
| Q                                      | Charge injection             | 1.65-1.95           | 1.65-4.3           | C <sub>L</sub> = 1nF<br>V <sub>GEN</sub> = 0V                                        |                       | 83   |      |             |      | pC   |
|                                        |                              | 2.3-2.7             |                    |                                                                                      |                       | 98   |      |             |      |      |
|                                        |                              | 3.0-3.3             |                    |                                                                                      |                       | 114  |      |             |      |      |
|                                        |                              | 3.6-4.3             |                    |                                                                                      |                       | 140  |      |             |      |      |

**Table 8. Analog switch characteristics** ( $C_L = 5\text{pF}$ ,  $R_L = 50\Omega$ ,  $T_A = 25^\circ\text{C}$ )

| Symbol           | Parameter                                 | Test conditions     |                    |                                                                                                                          | Value                 |      |      |             |      | Unit |
|------------------|-------------------------------------------|---------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------|------|------|-------------|------|------|
|                  |                                           | V <sub>CC</sub> (V) | V <sub>L</sub> (V) |                                                                                                                          | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      |      |
|                  |                                           |                     |                    |                                                                                                                          | Min.                  | Typ. | Max. | Min.        | Max. |      |
| OIRR             | Off Isolation<br>(1)                      | 1.65-4.3            | 4.3                | V <sub>S</sub> = 1V <sub>RMS</sub><br>f = 100kHz                                                                         |                       | -69  |      |             |      | dB   |
| Xtalk            | Crosstalk                                 | 1.65-4.3            | 4.3                | V <sub>S</sub> = 1V <sub>RMS</sub><br>f = 100kHz                                                                         |                       | -69  |      |             |      | dB   |
| THD              | Total harmonic distortion                 | 2.3-4.3             | 4.3                | R <sub>L</sub> = 600Ω<br>C <sub>L</sub> = 50pF<br>V <sub>S</sub> = V <sub>CC</sub> V <sub>PP</sub><br>f = 600Hz to 20kHz |                       | 0.01 |      |             |      | %    |
| BW               | -3dB Bandwidth<br>(switch ON)             | 1.65-4.3            | 4.3                | R <sub>L</sub> = 50Ω                                                                                                     |                       | 28   |      |             |      | MHz  |
| C <sub>SEL</sub> | Control pin input capacitance             | 1.8-4.3             | 1.8-4.3            | V <sub>L</sub> = V <sub>CC</sub>                                                                                         |                       | 30   |      |             |      | pF   |
| C <sub>Sn</sub>  | Sn port capacitance                       | 1.8-4.3             | 1.8-4.3            | V <sub>L</sub> = V <sub>CC</sub>                                                                                         |                       | 94   |      |             |      |      |
| C <sub>D</sub>   | D port capacitance when switch is enabled | 1.8-4.3             | 1.8-4.3            | V <sub>L</sub> = V <sub>CC</sub>                                                                                         |                       | 227  |      |             |      |      |

1. OFF-isolation =  $20 \log_{10} (V_D/V_S)$ ,  $V_D$  = output,  $V_S$  = input to off switch

4 Test circuits

Figure 4. ON-Resistance

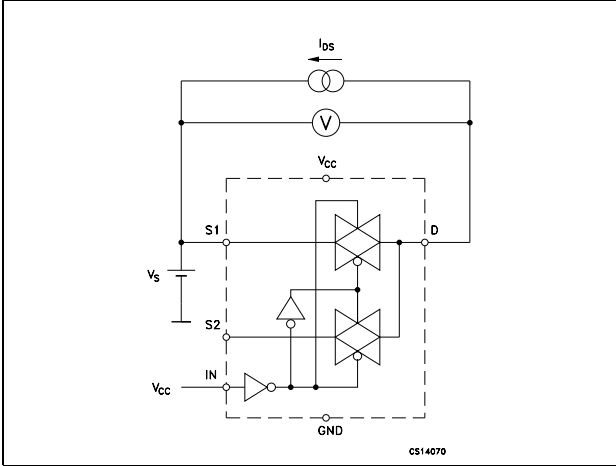


Figure 5. Bandwidth

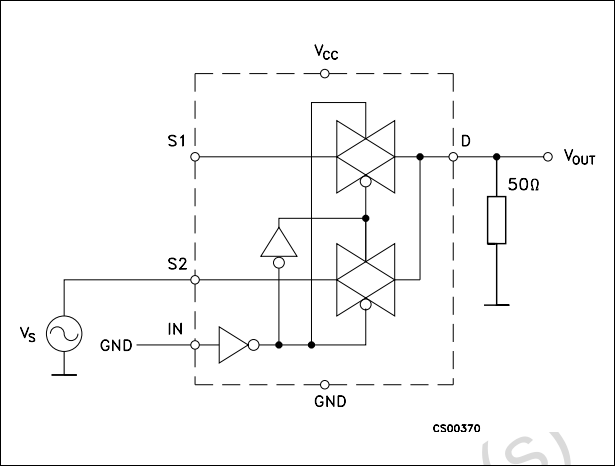


Figure 6. OFF Leakage

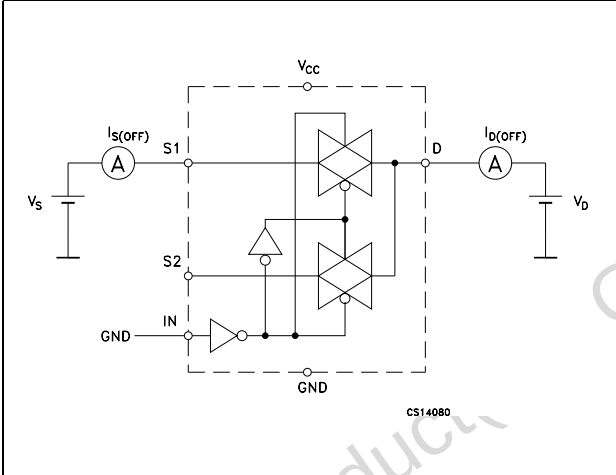


Figure 7. Channel to channel crosstalk

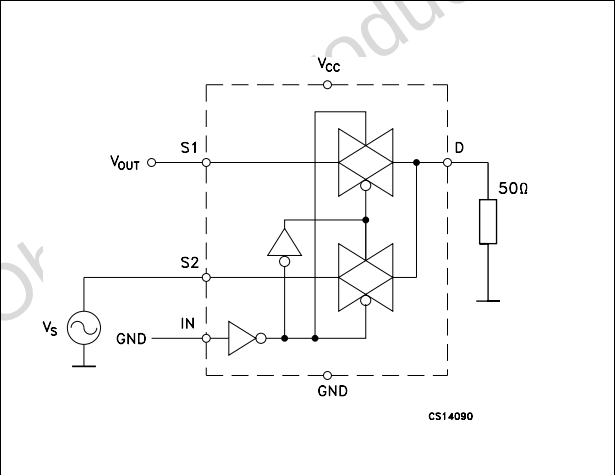


Figure 8. OFF Isolation

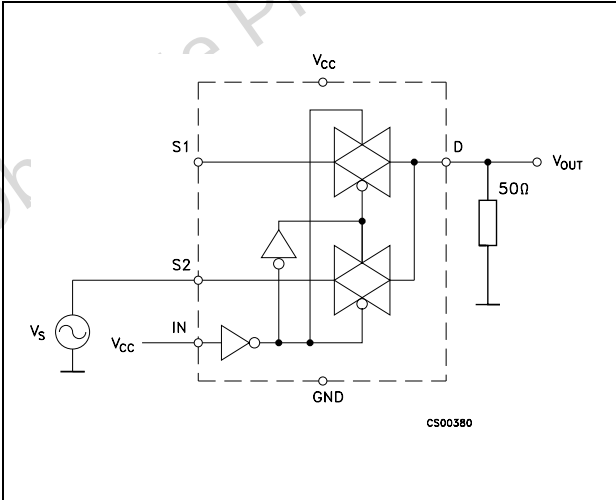
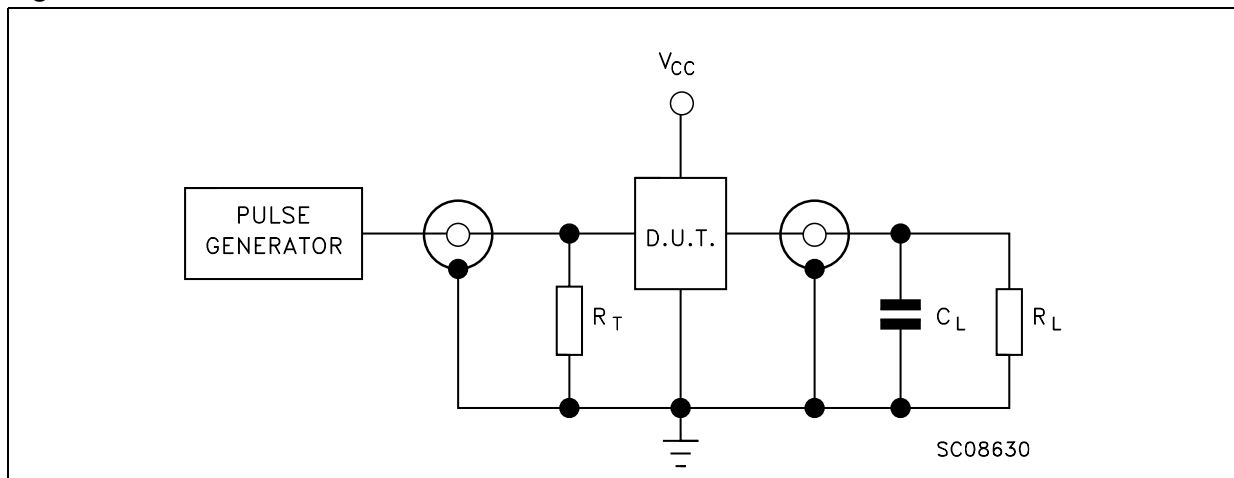


Figure 9. Test circuit

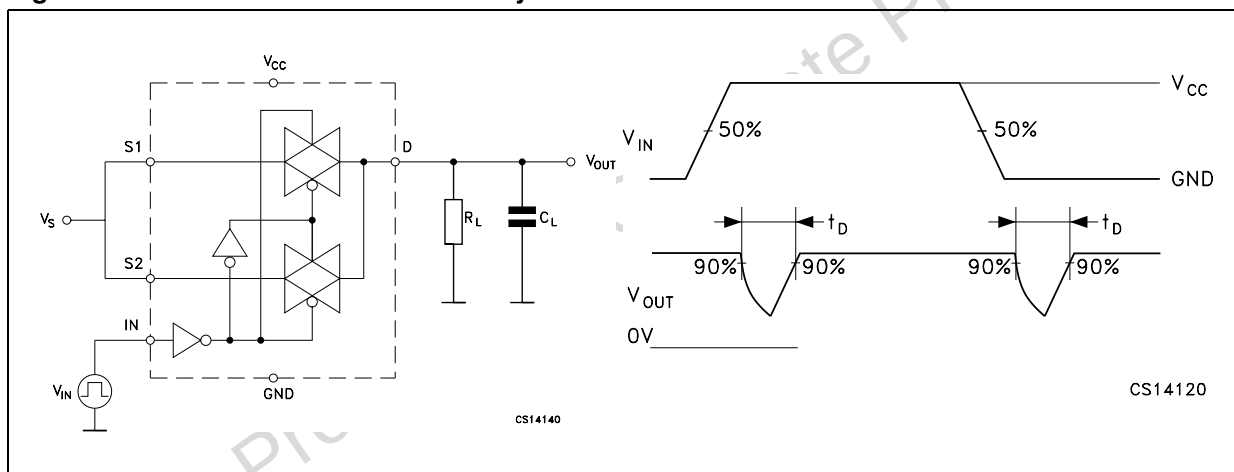


Note: 1  $C_L = 5/35\text{pF}$  or equivalent: (includes jig capacitance)

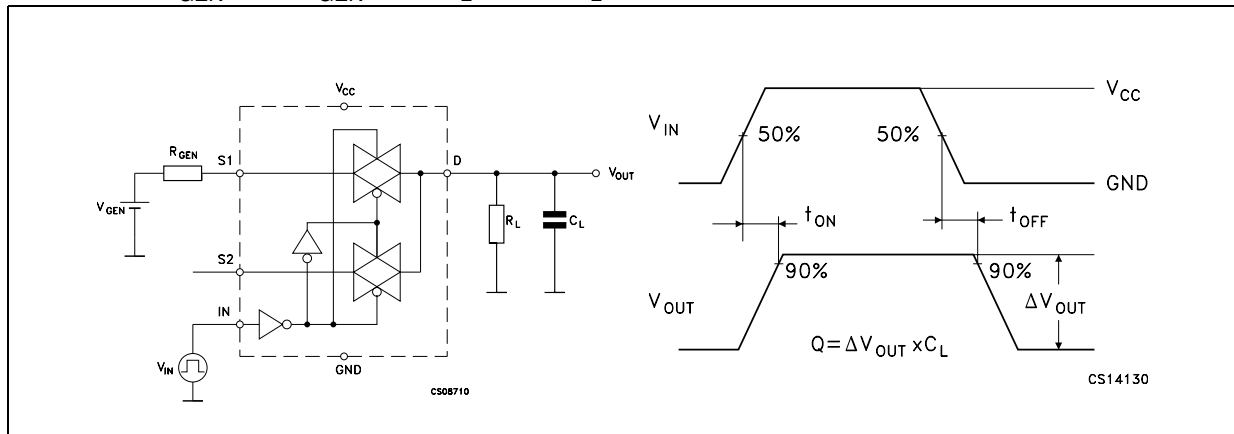
2  $R_L = 50\Omega$  or equivalent

3  $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

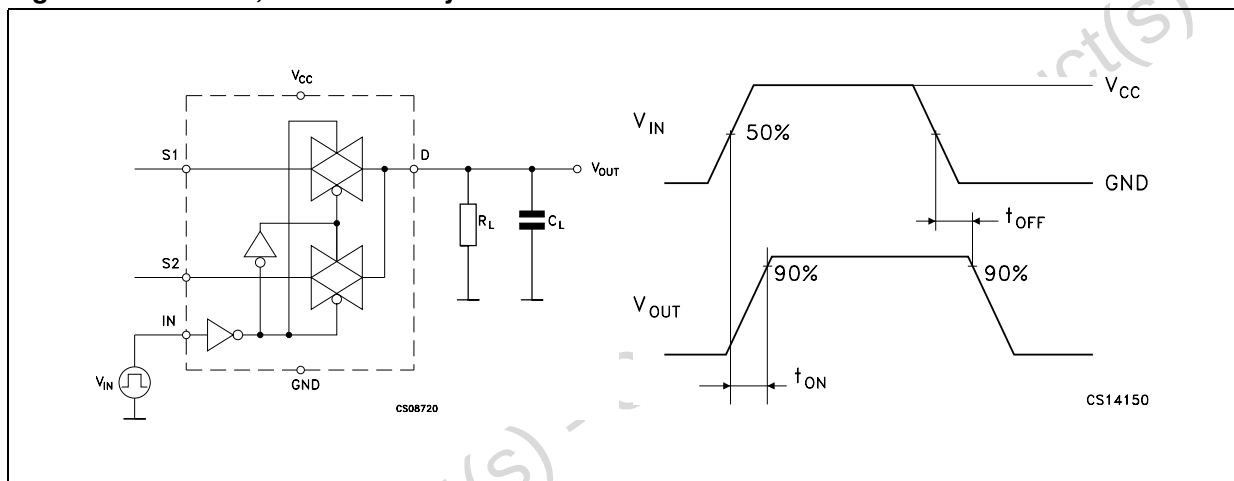
Figure 10. Break-before-make time delay



**Figure 11. Switching time and charge injection**  
 ( $V_{GEN} = 0V$ ,  $R_{GEN} = 0\Omega$ ,  $R_L = 1M\Omega$ ,  $C_L = 100pF$ )



**Figure 12. Turn ON, turn OFF delay time**



## 5 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

Obsolete Product(s) - Obsolete Product(s)

Table 9. Flip-Chip7 mechanical data

| Dim. | Data book (mm) |       |       | Drawing (mm) |       |       |
|------|----------------|-------|-------|--------------|-------|-------|
|      | Min            | Typ   | Max   | Min          | Typ   | Max   |
| A    | 0.585          | 0.65  | 0.715 | 0.60         | 0.65  | 0.70  |
| A1   | 0.21           | 0.25  | 0.29  | 0.22         | 0.25  | 0.28  |
| A2   |                | 0.4   |       | 0.38         | 0.4   | 0.42  |
| b    | 0.265          | 0.315 | 0.365 | 0.290        | 0.315 | 0.340 |
| D    | 1.018          | 1.068 | 1.118 | 1.053        | 1.068 | 1.083 |
| D1   |                | 0.5   |       | 0.49         | 0.5   | 0.51  |
| E    | 2.018          | 2.068 | 2.118 | 2.053        | 2.068 | 2.083 |
| E1   |                | 1.5   |       | 1.49         | 1.5   | 1.51  |
| e    | 0.45           | 0.5   | 0.55  | 0.46         | 0.5   | 0.54  |
| f    |                | 0.284 |       | 0.272        | 0.284 | 0.292 |
| ccc  |                | 0.08  |       |              | 0.08  |       |

Note: 1 The terminal Pin 1 on the bumps side is identified by a distinguishing feature (for instance by a circular "clear area" - typically 0.1mm diameter - ) The terminal Pin 1 on the backside of the product is identified by a distinguishing feature (for instance by a circular "dot" - typically 0.5mm diameter - ).

Figure 13. Package dimensions

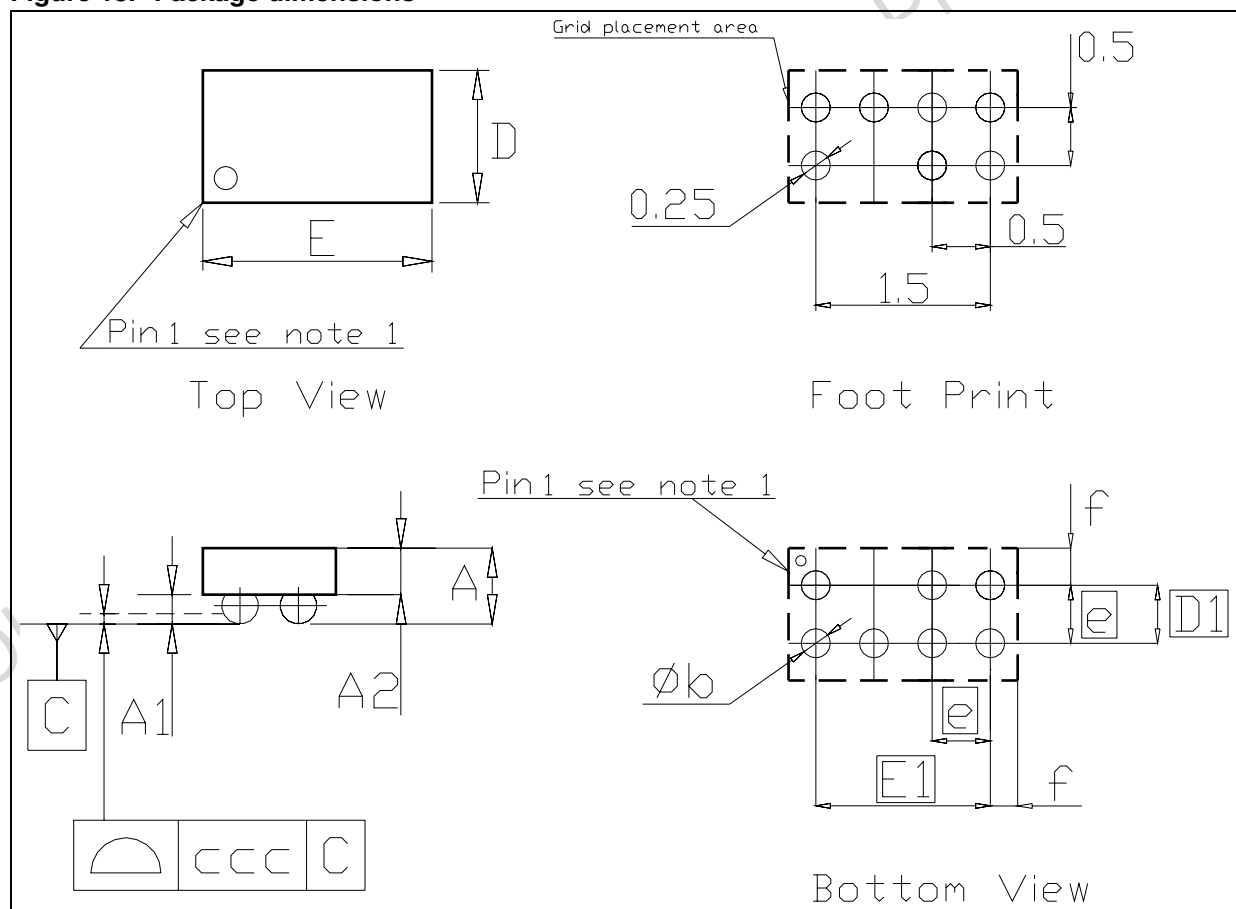


Figure 14. Foot print recommendations

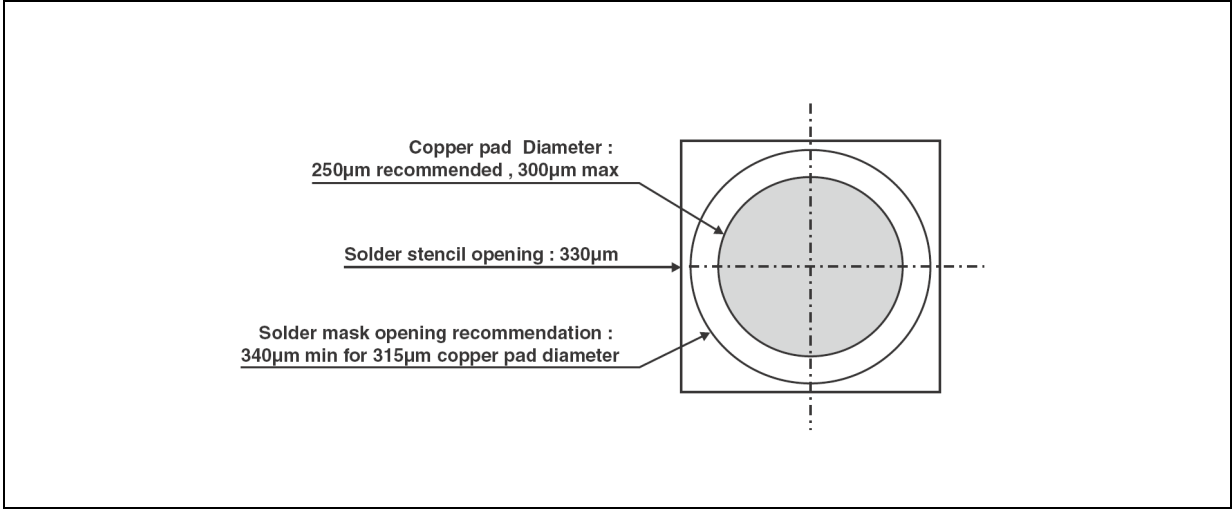


Figure 15. Marking

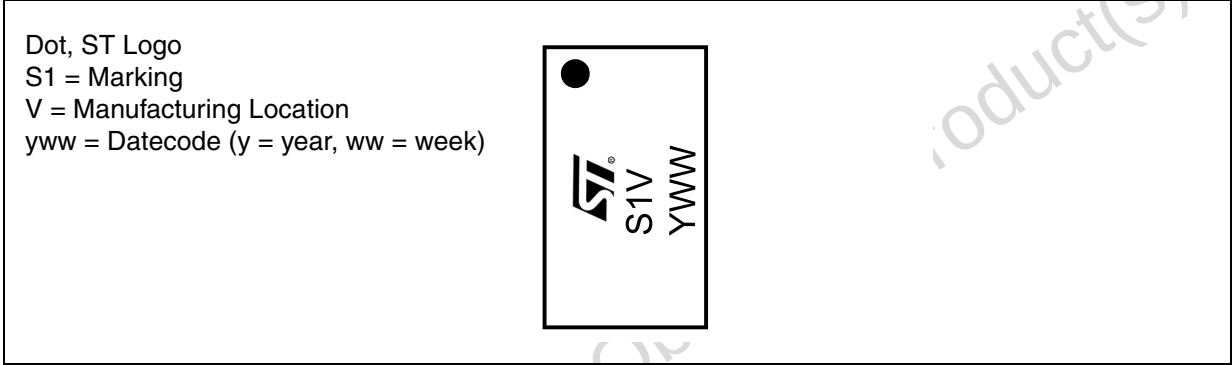


Figure 16. Flip-Chip7 tape specification

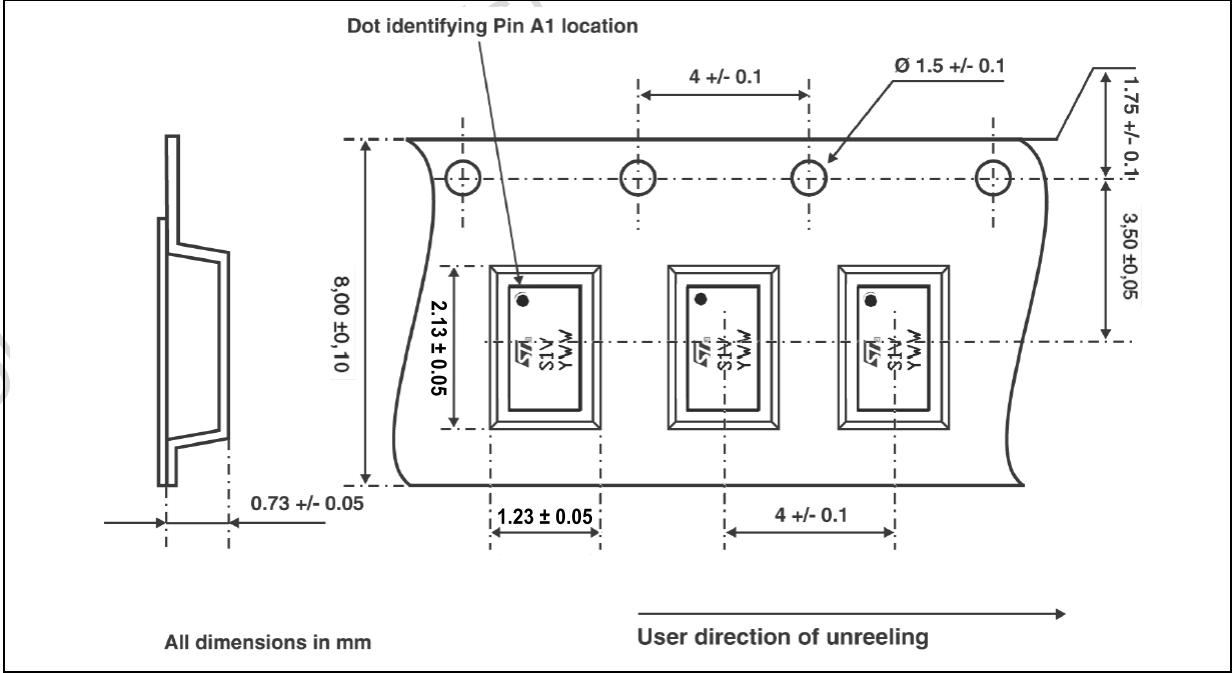


Figure 17. Flip-Chip7 reel information

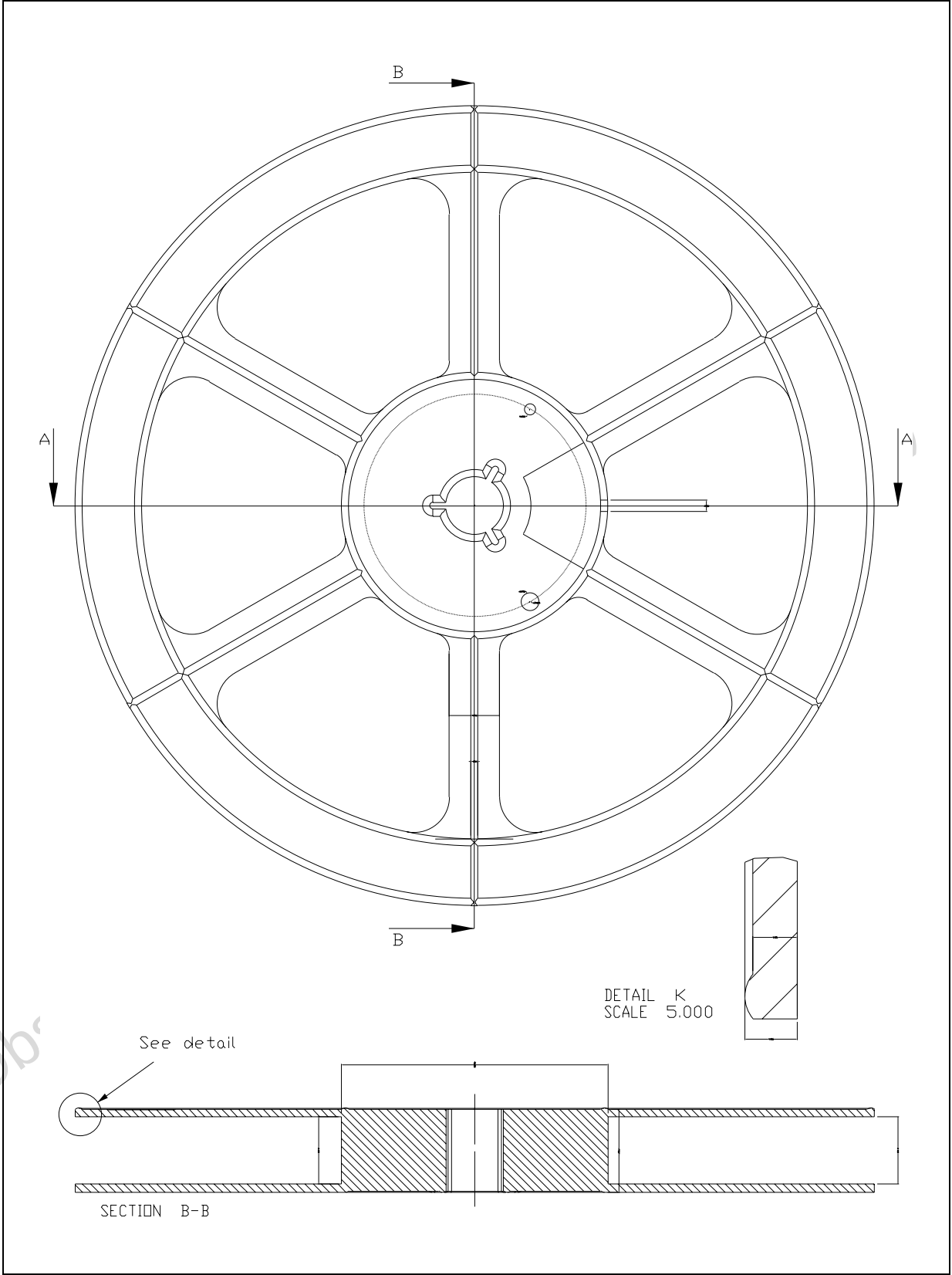
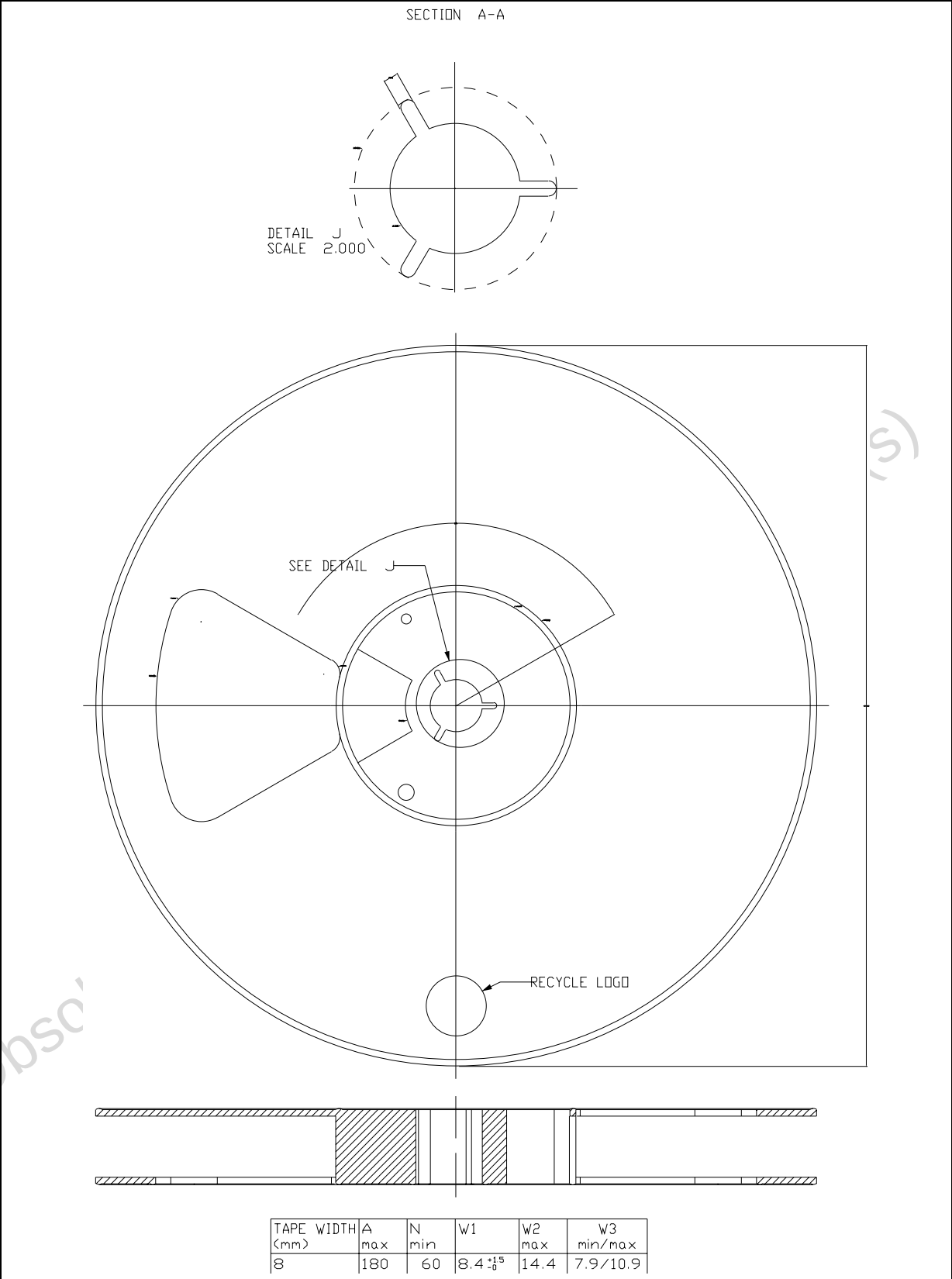


Figure 18. Flip-Chip7 reel information



## 6 Revision history

Table 10. Revision history

| Date        | Revision | Changes                                              |
|-------------|----------|------------------------------------------------------|
| 05-May-2006 | 1        | First release                                        |
| 22-Nov-2006 | 2        | Schematic <a href="#">Figure 1 on page 3</a> updated |
| 17-Apr-2007 | 3        | Typo in cover page description                       |

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