# BGSA13GN10

Single-Pole Triple Throw Antenna Tuning Switch

## Data Sheet

Revision 2.1 - 2016-06-06

Power Management & Multimarket

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# Revision History

| | |
|---|---|
| **Document No.:** BGSA13GN10.pdf | |
| **Revision History:** 2.0 | |
| **Previous Version:** 1.2 - 2015-08-04 | |
| **Page** | **Subjects (major changes since last revision)** |
| 6 | added on Table. 3 Absolute Maximum RF Voltage |
| 9 | deleted RF Operating Voltage on Table. 7 |
| 12 | Package Dimensions Drawing figure updated (Figure3) |

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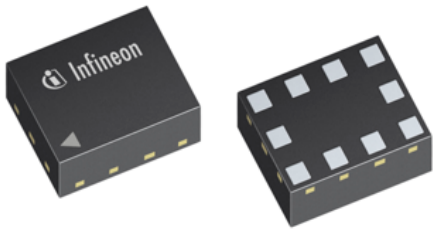
# BGSA13GN10 Single-Pole Triple Throw Antenna Tuning Switch

## 1 Features




- high-linearity SP3T for antenna aperture switching applications
- Ultra-Low $R_{ON}$ port featuring 0.8 Ω in ON state
- Ultra-Low $C_{OFF}$ port featuring 120 *fF* in OFF state
- High max RF voltage handling
- Low harmonic generation
- No power supply blocking required
- Battery supply: 1.8 to 3.6 V
- Control voltage: 1.35 to 3.3 V (control high)
- Suitable for EDGE / C2K / LTE / WCDMA Applications
- 0.1 to 5.0 GHz coverage
- Small form factor 1.1 mm x 1.5 mm
- 400 $\mu$m pad pitch
- RoHS and WEEE compliant package

## 2 Product Description

The BGSA13GN10 is a Single Pole Triple Throw (SP3T) RF antenna aperture switch optimized for low $C_{off}$ enabling applications up to 5.0 GHz. This single supply chip integrates on-chip CMOS logic driven by a simple, single-pin CMOS or TTL compatible control input signal. Unlike GaAs technology, the 0.1 dB compression point exceeds the switch maximum input power level, resulting in linear performance at all signal levels and external DC blocking capacitors at the RF ports are only required if DC voltage is applied externally. Due to its very high RF voltage ruggedness it is suited for switching any reactive devices such as inductors and capacitors in RF matching circuits without significant losses in quality factors.

**Table 1: Ordering Information**

| Type | Package | Marking/Type Code | Chip |
|---|---|---|---|
| BGSA13GN10 | TSNP10-1/-2 | A3 | BGSA13GN10 |

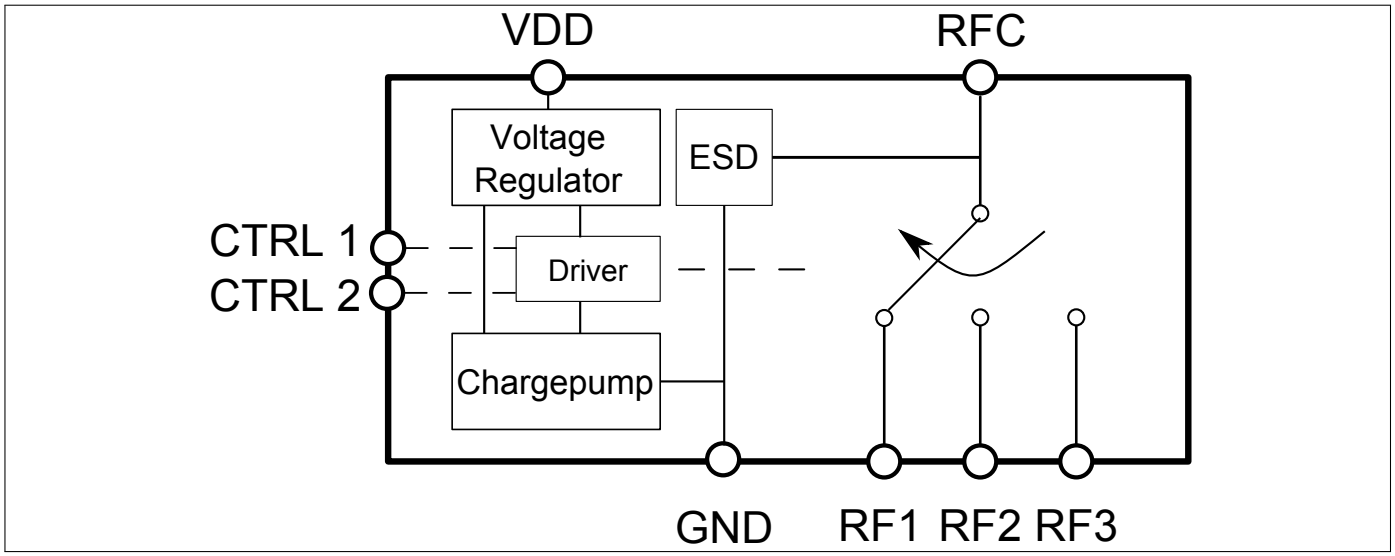



**Figure 1:** BGSA13GN10 block diagram

## 3 Maximum Ratings

**Table 2: Maximum Ratings, Table I** at $T_A$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Frequency Range | $f$ | 0.1 | – | – | GHz | [1] |
| Supply voltage [2] | $V_{DD}$ | -0.5 | – | 3.6 | V | – |
| Storage temperature range | $T_{STG}$ | -55 | – | 150 | °C | – |
| RF input power | $P_{RF\_TRx}$ | – | – | 39 | dBm | 25 % Duty Cycle |
| RF voltage[3] | $V_{RF\_max}$ | – | – | 48 | V | All switch throws operated in isolation mode. |
| ESD capability, CDM [4] | $V_{ESD_{CDM}}$ | -1.5 | – | +1.5 | *kV* | |
| ESD capability, HBM [5] | $V_{ESD_{HBM}}$ | -1 | – | +1 | *kV* | |
| ESD capability, system level (RFC port) [6] | $V_{ESD_{ANT}}$ | -8 | – | +8 | *kV* | RFC vs system GND, with 27 nH shunt inductor |
| Junction temperature | $T_j$ | – | – | 125 | °C | – |

[1] Switch has no highpass response. There is also a high ohmic DC to the RF path. The DC voltage at RF ports $V_{RFDC}$ has to be 0V.
[2] Note: Consider any ripple voltages on top of $V_{DD}$. A high RF ripple at the $V_{DD}$ can exceed the maximum ratings by $V_{DD} = V_{DC} + V_{Ripple}$.
[3] 1000h over 8 years lifetime-short pulse duration
[4] Field-Induced Charged-Device Model JESD22-C101. Simulates charging/discharging events that occur in production equipment and processes. Potential for CDM ESD events occurs whenever there is metal-to-metal contact in manufacturing.
[5] Human Body Model ANSI/ESDA/JEDEC JS-001-2012 ($R$ = 1.5 kΩ, $C$ = 100 pF).
[6] IEC 61000-4-2 ($R$ = 330 Ω, $C$ = 150 pF), contact discharge.

**Warning: Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.**

**Table 3: Maximum Ratings, Table II** at $T_A$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Maximum DC-voltage on RF-Ports and RF-Ground | $V_{RFDC}$ | 0 | – | 0 | V | No DC voltages allowed on RF-Ports |
| Control Voltage Levels | $V_{CTRL}$ | -0.7 | – | 3.3 | V | – |

# 4 Operation Ranges

**Table 4: Operation Ranges**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{DD}$ | 1.8 | 2.85 | 3.6 | V | – |
| Supply current[1)] | $I_{DD}$ | – | 80 | 150 | $\mu A$ | – |
| Control voltage low | $V_{Ctrl,low}$ | 0 | | 0.45 | V | – |
| Control voltage high | $V_{Ctrl,high}$ | 1.2 | 1.8 | 2.85 | V | $V_{Ctrl,high} \ll V_{DD}$ |
| Control current low | $I_{Ctrl,low}$ | -1 | 0 | 1 | $\mu A$ | – |
| Control current high | $I_{Ctrl,high}$ | -1 | 0 | 1 | $\mu A$ | $V_{Ctrl,high} \ll V_{DD}$ |
| Ambient temperature | $T_A$ | -30 | 25 | 85 | °C | – |
| RF switching time | $t_{sw}$ | 2 | 5 | 7 | $\mu s$ | tested in parametric verification |
| Startup time | $t_{sw}$ | | 20 | 30 | $\mu s$ | tested in parametric verification |

[1)] $T_A$ = -30 °C – +85 °C, $V_{DD}$ = 1.8 – 3.6 $V$

# 5 Logic Table

**Table 5: Logic Table**

| CTRL 1 | CTRL 2 | Mode |
|---|---|---|
| 0 | 0 | RF1 connected to RFC |
| 0 | 1 | RF2 connected to RFC |
| 1 | 0 | RF3 connected to RFC |
| 1 | 1 | Isolation Mode |

# 6 RF small signal parameter

**Table 6: RF small signal parameter**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Frequency range | f | 0.1 | – | 5.0 | GHz | – |
| RF1 Switch ON resistance | $R_{ON,RF1}$ | – | 0.8 | | Ω | RF1 to RFC |
| RF1 Switch OFF capacitance | $C_{OFF,RF1}$ | – | 300 | | fF | RF1 to RFC |
| RF2 Switch ON resistance | $R_{ON,RF2}$ | – | 1.4 | | Ω | RF2 to RFC |
| RF2 Switch OFF capacitance | $C_{OFF,RF2}$ | – | 160 | | fF | RF2 to RFC |
| RF3 Switch ON resistance | $R_{ON,RF3}$ | – | 1.6 | | Ω | RF3 to RFC |
| RF3 Switch OFF capacitance | $C_{OFF,RF3}$ | – | 120 | | fF | RF3 to RFC |
| Parasitic RF shunt capacitance | $C_{SH,PAR}$ | – | 42 | | fF | RFx to GND |
| Switch series inductance | $L_{SER}$ | – | 0.1 | | nH | |
| **RF1 Insertion Loss** [1,2,3] | | | | | | |
| 698 - 960 MHz | *IL* | 0.16 | 0.20 | 0.25 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| 1710 - 1980 MHz | | 0.23 | 0.29 | 0.38 | dB | |
| 1981 - 2169 MHz | | 0.29 | 0.27 | 0.39 | dB | |
| 2170 - 2690 MHz | | 0.32 | 0.36 | 0.47 | dB | |
| **RF2 Insertion Loss** [1,2,3] | | | | | | |
| 698 - 960 MHz | *IL* | 0.20 | 0.27 | 0.35 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| 1710 - 1980 MHz | | 0.29 | 0.39 | 0.49 | dB | |
| 1981 - 2169 MHz | | 0.36 | 0.45 | 0.55 | dB | |
| 2170 - 2690 MHz | | 0.44 | 0.53 | 0.64 | dB | |
| **RF3 Insertion Loss** [1,2,3] | | | | | | |
| 698 - 960 MHz | *IL* | 0.20 | 0.28 | 0.36 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| 1710 - 1980 MHz | | 0.37 | 0.44 | 0.53 | dB | |
| 1981 - 2169 MHz | | 0.39 | 0.46 | 0.57 | dB | |
| 2170 - 2690 MHz | | 0.49 | 0.63 | 0.75 | dB | |
| **RF1 Return Loss**[1,2,3] | | | | | | |
| All Ports @ 698 - 960 MHz | *RL* | 21 | 26 | 31 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| All Ports @ 1710 - 2690 MHz | | 17 | 20 | 25 | dB | |
| **RF2 Return Loss**[1,2,3] | | | | | | |
| All Ports @ 698 - 960 MHz | *RL* | 21 | 26 | 31 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| All Ports @ 1710 - 2690 MHz | | 18 | 20 | 27 | dB | |
| **RF3 Return Loss**[1,2,3] | | | | | | |
| All Ports @ 698 - 960 MHz | *RL* | 21 | 26 | 31 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| All Ports @ 1710 - 2690 MHz | | 15 | 17 | 25 | dB | |

[1] Valid for all RF power levels, no compression behavior
[2] Network analyser input power: $P_{IN} = -20\ dBm$
[3] On application board without any matching components

**Table 7: RF small signal parameter - Isolation**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Isolation RFx to RFC**[1,2,3] | | | | | | |
| 698 - 915 MHz | *ISO* | 23 | 26 | 30 | dB | $V_{DD}$ = 1.8 – 3.6 *V*, $T_A$ = -30 ... +85 °C, $Z_0$ = 50 Ω |
| 1710 - 1980 MHz | | 17 | 20 | 27 | dB | |
| 1981 - 2170 MHz | | 15 | 18 | 25 | dB | |
| 2171 - 2690 MHz | | 14 | 17 | 24 | dB | |

# 7 RF large signal parameter

**Table 8: RF large signal specifications**

**Harmonic Generation up to 12.75 GHz**(1,2,3)

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| All RF Ports - Second Order Harmonics | $P_{H2}$ | – | 105 | – | dBc | 25 dBm, 50Ω, $f_0$ = 786 MHz |
| All RF Ports - Third Order Harmonics | $P_{H3}$ | – | 115 | – | dBc | 25 dBm, 50Ω, $f_0$ = 786 MHz |
| All RF Ports - Second Order Harmonics | $P_{H2}$ | – | 93 | – | dBc | 36 dBm, 50Ω, $f_0$ = 824 MHz |
| All RF Ports - Third Order Harmonics | $P_{H3}$ | – | 94 | – | dBc | 33 dBm, 50Ω, $f_0$ = 824 MHz |
| All RF Ports | $P_{Hx}$ | 105 | – | – | dBc | 25 dBm, 50Ω |
| **Intermodulation Distortion IMD2** (1,2,3) | | | | | | |
| IIP2, low | IIP2,l | – | 110 | – | dBm | IIP2 conditions table 9 |
| IIP2, high | IIP2,h | – | 120 | – | dBm | |
| **Intermodulation Distortion IMD3** (1,2,3) | | | | | | |
| IIP3 | IIP3 | – | 75 | – | dBm | IIP3 conditions table 10 |
| **SV LTE Intermodulation** (1,2,3) | | | | | | |
| IIP3,SVLTE | IIP3,SV | – | 75 | – | dBm | SV-LTE conditions table 11 |

[1] Terminating Port Impedance: $Z_0$ = 50 Ω
[2] Supply Voltage: $V_{DD}$ = 1.8 – 3.6 *V*
[3] On application board without any matching components

**Table 9: IIP2 conditions table**

| Band | In-Band Frequency [MHz] | Blocker Frequency 1 [MHz] | Blocker Power 1 [dBm] | Blocker Frequency 2 [MHz] | Blocker Power 2 [dBm] |
|---|---|---|---|---|---|
| Band 1 Low | 2140 | 1950 | 20 | 190 | -15 |
| Band 1 High | 2140 | 1950 | 20 | 4090 | -15 |
| Band 5 Low | 881.5 | 836.5 | 20 | 45 | -15 |
| Band 5 High | 881.5 | 836.5 | 20 | 1718 | -15 |

**Table 10: IIP3 conditions table**

| Band | In-Band Frequency [MHz] | Blocker Frequency 1 [MHz] | Blocker Power 1 [dBm] | Blocker Frequency 2 [MHz] | Blocker Power 2 [dBm] |
|---|---|---|---|---|---|
| Band 1 | 2140 | 1950 | 20 | 1760 | -15 |
| Band 5 | 881.5 | 836.5 | 20 | 791.5 | -15 |

**Table 11: SV-LTE conditions table**

| Band | In-Band Frequency [MHz] | Blocker Frequency 1 [MHz] | Blocker Power 1 [dBm] | Blocker Frequency 2 [MHz] | Blocker Power 2 [dBm] |
|---|---|---|---|---|---|
| Band 5 | 872 | 827 | 23 | 872 | 14 |
| Band 13 | 747 | 786 | 23 | 747 | 14 |
| Band 20 | 878 | 833 | 23 | 2544 | 14 |

# 8 Package Outline and Pin Configuration

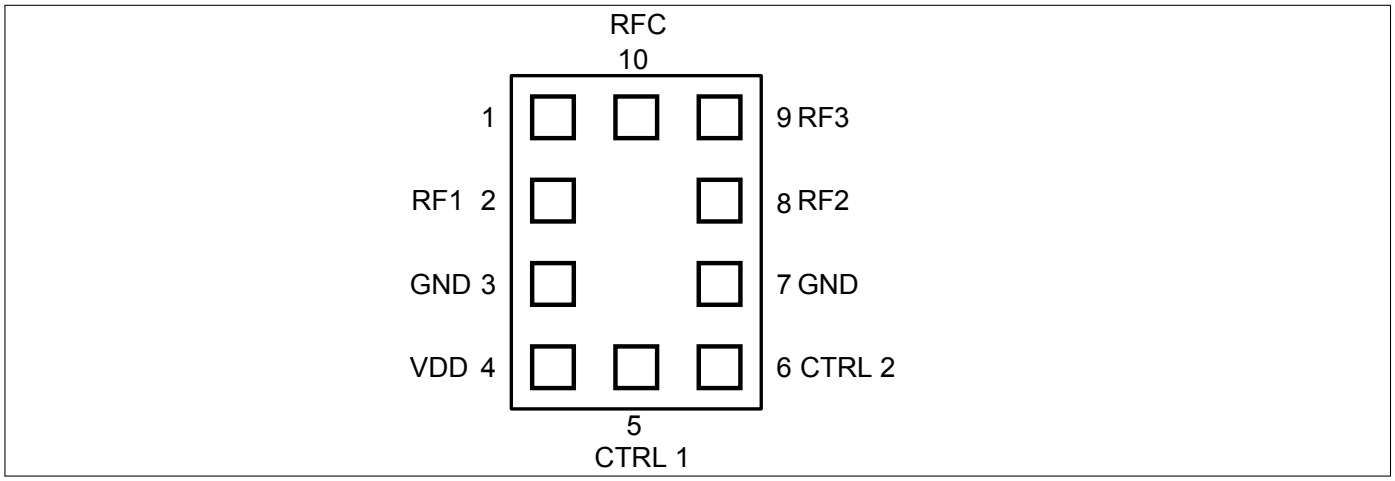



**Figure 2:** Pinout (top view)

**Table 12: Pin Description**

| Pin No. | Name | Pin Type | Buffer Type | Function |
|---|---|---|---|---|
| 1 | N.C. | N.C. | | Not connected |
| 2 | RF1 | I/O | | RF1 |
| 3 | GND | GND | | Ground |
| 4 | VDD | PWR | | Supply voltage |
| 6 | CTRL1 | I | | Control 1 Pin |
| 6 | CTRL2 | I | | Control 2 Pin |
| 7 | GND | GND | | Ground |
| 8 | RF2 | I/O | | RF2 |
| 9 | RF3 | I/O | | RF3 |
| 10 | RFC | I/O | | Common RF |

**Table 13: Mechanical Data**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| X-Dimension | *X* | 1.1 $\pm$ 0.05 | *mm* |
| Y-Dimension | *Y* | 1.5 $\pm$ 0.05 | *mm* |
| Size | *Size* | 1.65 | $mm^2$ |
| Height | *H* | 0.375 | *mm* |

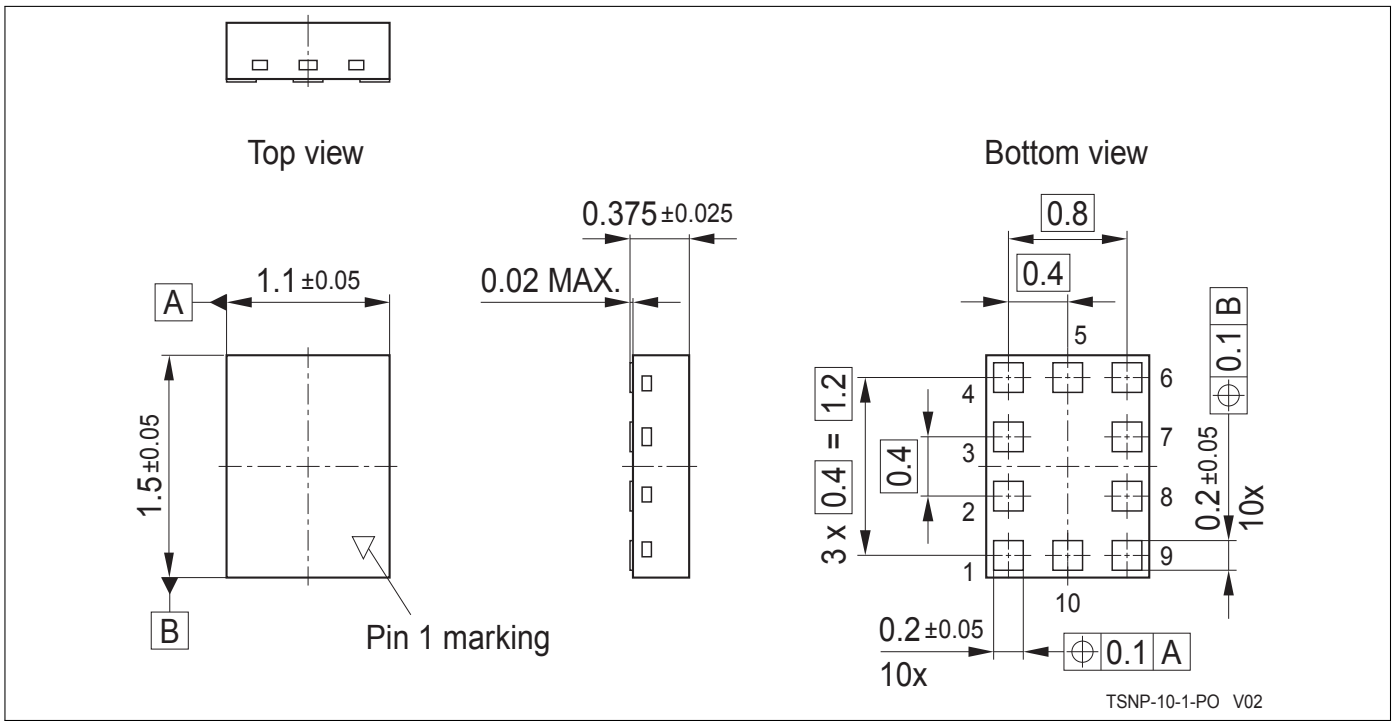



**Figure 3:** Package Dimensions Drawing (TSNP-10-1)

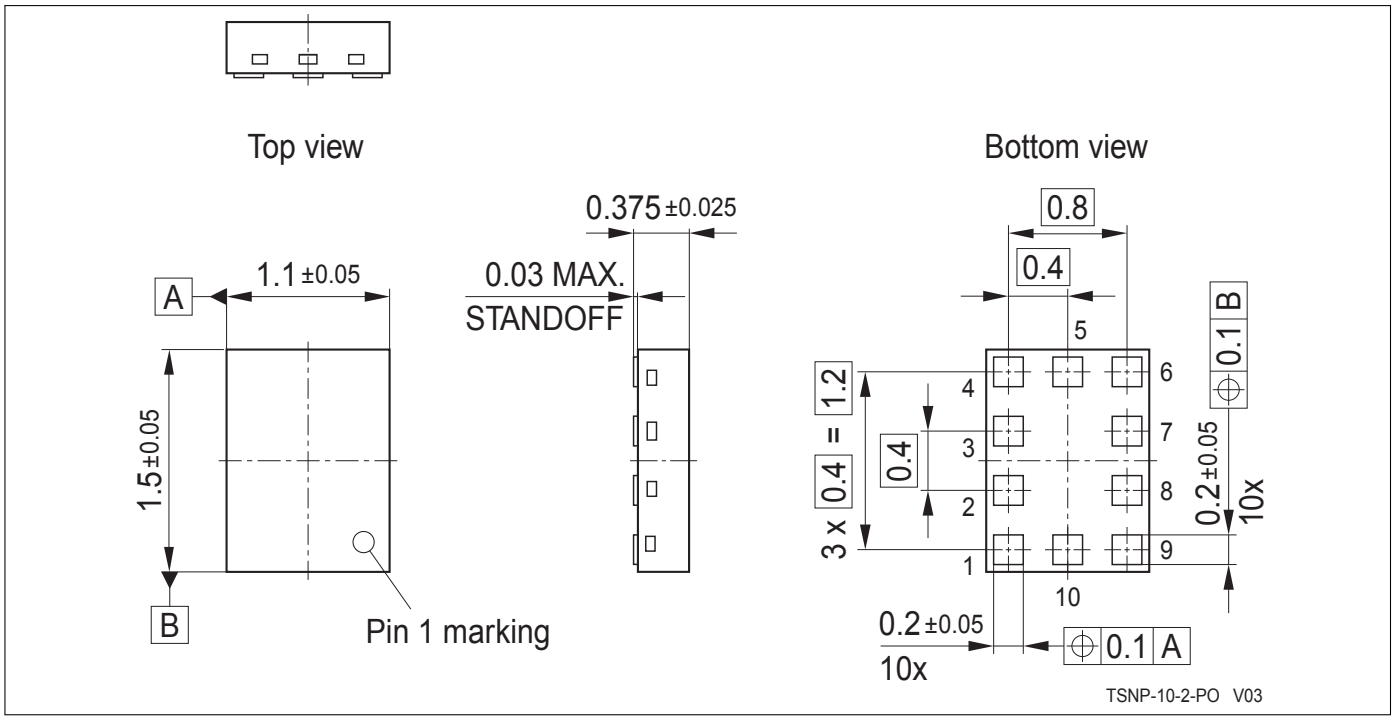



**Figure 4:** Package Dimensions Drawing (TSNP-10-2)

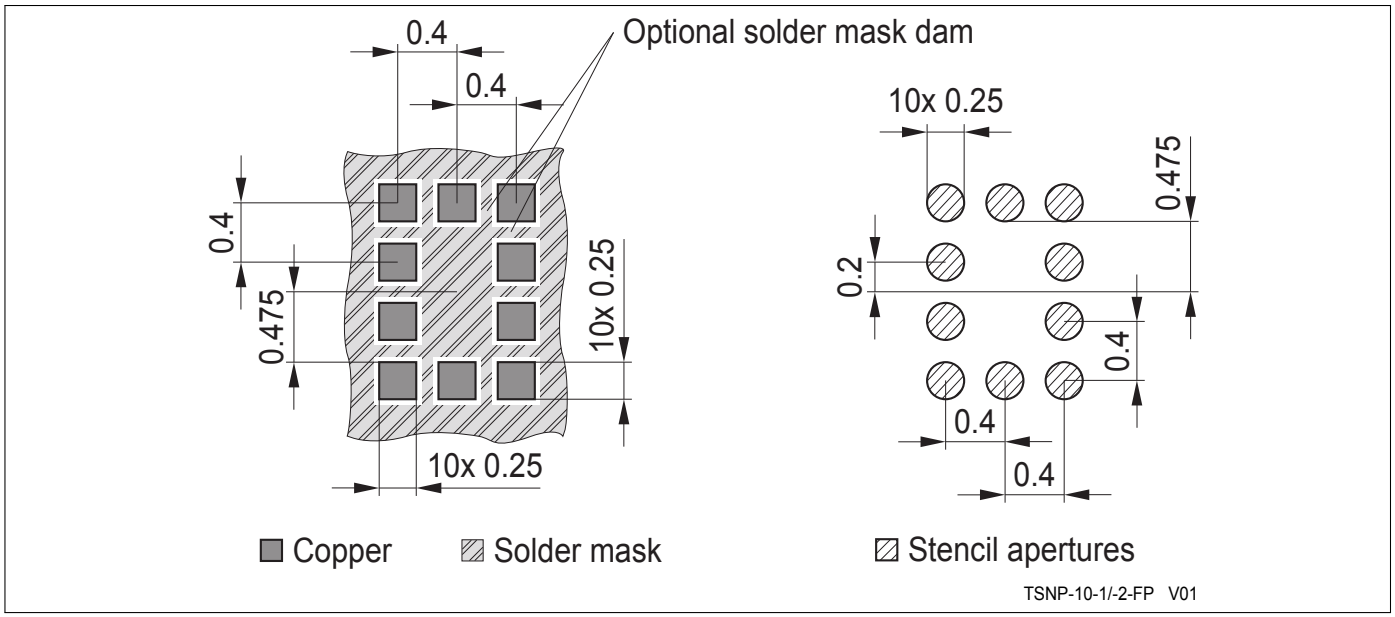



**Figure 5:** Land pattern and stencil mask (TSNP-10-1/-2)

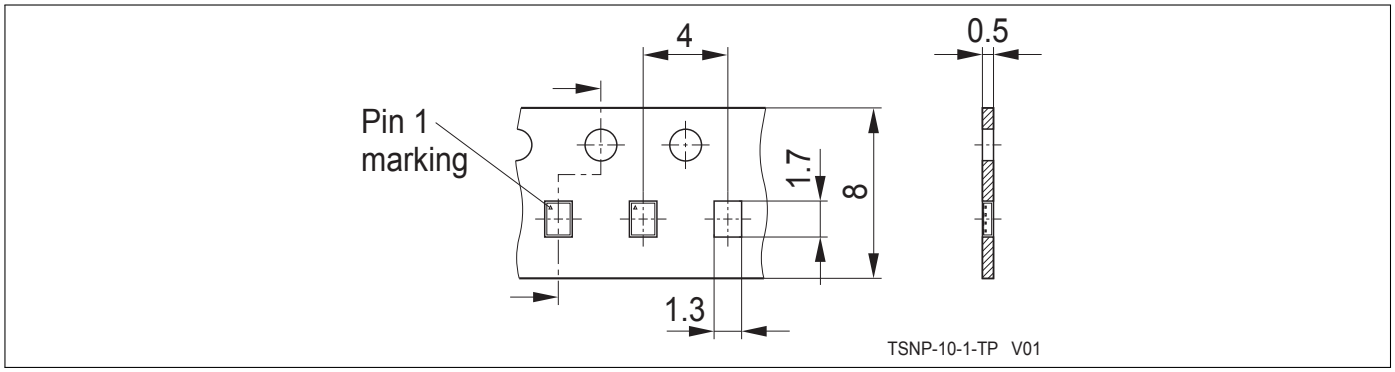



**Figure 6:** Tape drawing (TSNP-10-1)

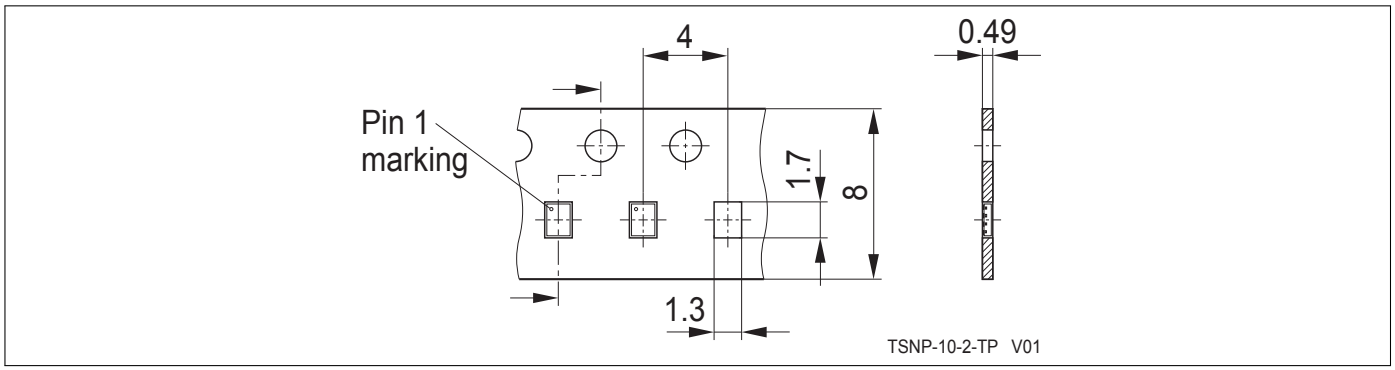



**Figure 7:** Tape drawing (TSNP-10-2)

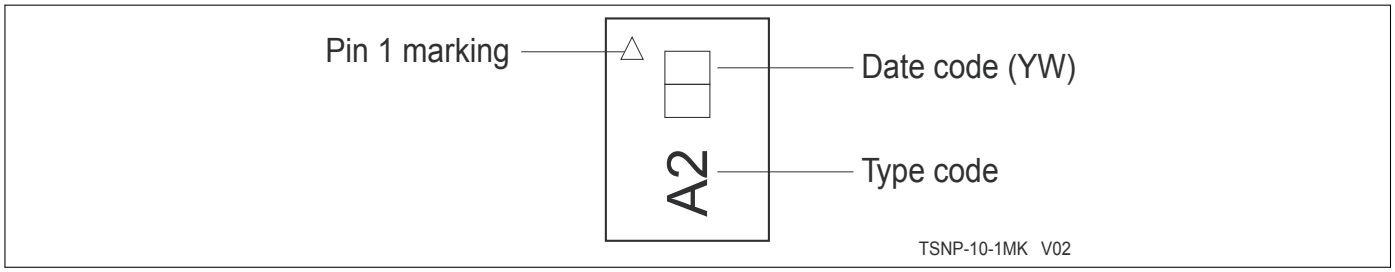



**Figure 8:** Package marking (TSNP-10-1): Date code digits Y and W are found in Table 13/14

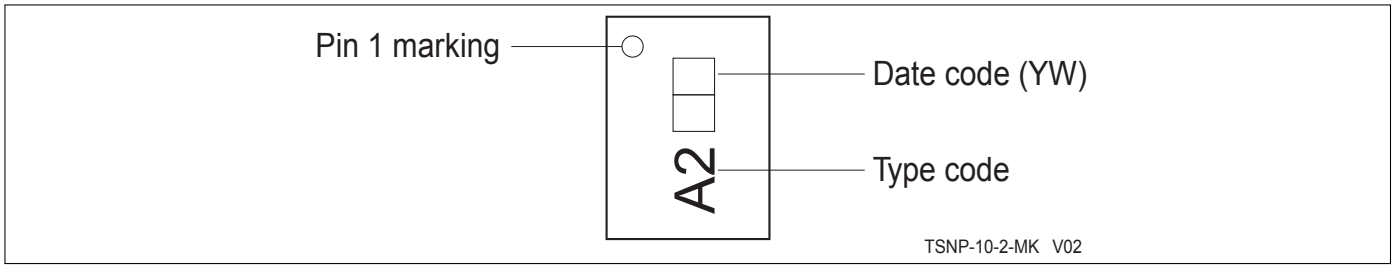



**Figure 9:** Package marking (TSNP-10-2): Date code digits Y and W are found in Table 13/14

**Table 14: Year date code marking - digit "Y"**

| Year | "Y" | Year | "Y" | Year | "Y" |
|---|---|---|---|---|---|
| 2000 | 0 | 2010 | 0 | 2020 | 0 |
| 2001 | 1 | 2011 | 1 | 2021 | 1 |
| 2002 | 2 | 2012 | 2 | 2022 | 2 |
| 2003 | 3 | 2013 | 3 | 2023 | 3 |
| 2004 | 4 | 2014 | 4 | 2024 | 4 |
| 2005 | 5 | 2015 | 5 | 2025 | 5 |
| 2006 | 6 | 2016 | 6 | 2026 | 6 |
| 2007 | 7 | 2017 | 7 | 2027 | 7 |
| 2008 | 8 | 2018 | 8 | 2028 | 8 |
| 2009 | 9 | 2019 | 9 | 2029 | 9 |

**Table 15: Week date code marking - digit "W"**

| Week | "W" | Week | "W" | Week | "W" | Week | "W" | Week | "W" |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 12 | N | 23 | 4 | 34 | h | 45 | v |
| 2 | B | 13 | P | 24 | 5 | 35 | j | 46 | x |
| 3 | C | 14 | Q | 25 | 6 | 36 | k | 47 | y |
| 4 | D | 15 | R | 26 | 7 | 37 | l | 48 | z |
| 5 | E | 16 | S | 27 | a | 38 | n | 49 | 8 |
| 6 | F | 17 | T | 28 | b | 39 | p | 50 | 9 |
| 7 | G | 18 | U | 29 | c | 40 | q | 51 | 2 |
| 8 | H | 19 | V | 30 | d | 41 | r | 52 | 3 |
| 9 | J | 20 | W | 31 | e | 42 | s | | |
| 10 | K | 21 | Y | 32 | f | 43 | t | | |
| 11 | L | 22 | Z | 33 | g | 44 | u | | |

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