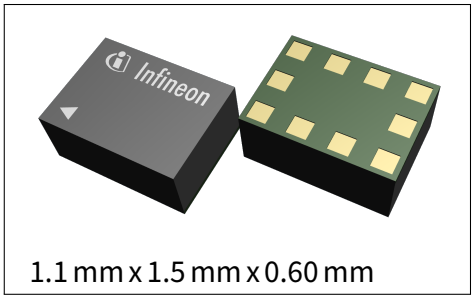
# BGSX22G6U10

## DPDT cross switch with GPIO control interface

### Features

- High linearity up to 39 dBm peak power
- Low current consumption
- Low insertion loss and high port to port isolation up to 7.125 GHz
- Fast switching speed to enable 5G-SRS applications
- General Purpose Input-Output (GPIO) Interface
- No decoupling capacitors required for typical applications
- Ultra low profile lead-less plastic package (MSL-1, 260 °C per IPC/JEDEC J-STD-20)
- RoHS and WEEE compliant package
- Small form factor 1.1mm x 1.5mm



1.1 mm x 1.5 mm x 0.60 mm

RoHS Halogen-Free Lead-Free Green

### Potential applications

- RF path routing/swapping for cellular mobile devices
- GSM, WCDMA, LTE and 5G applications

### Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

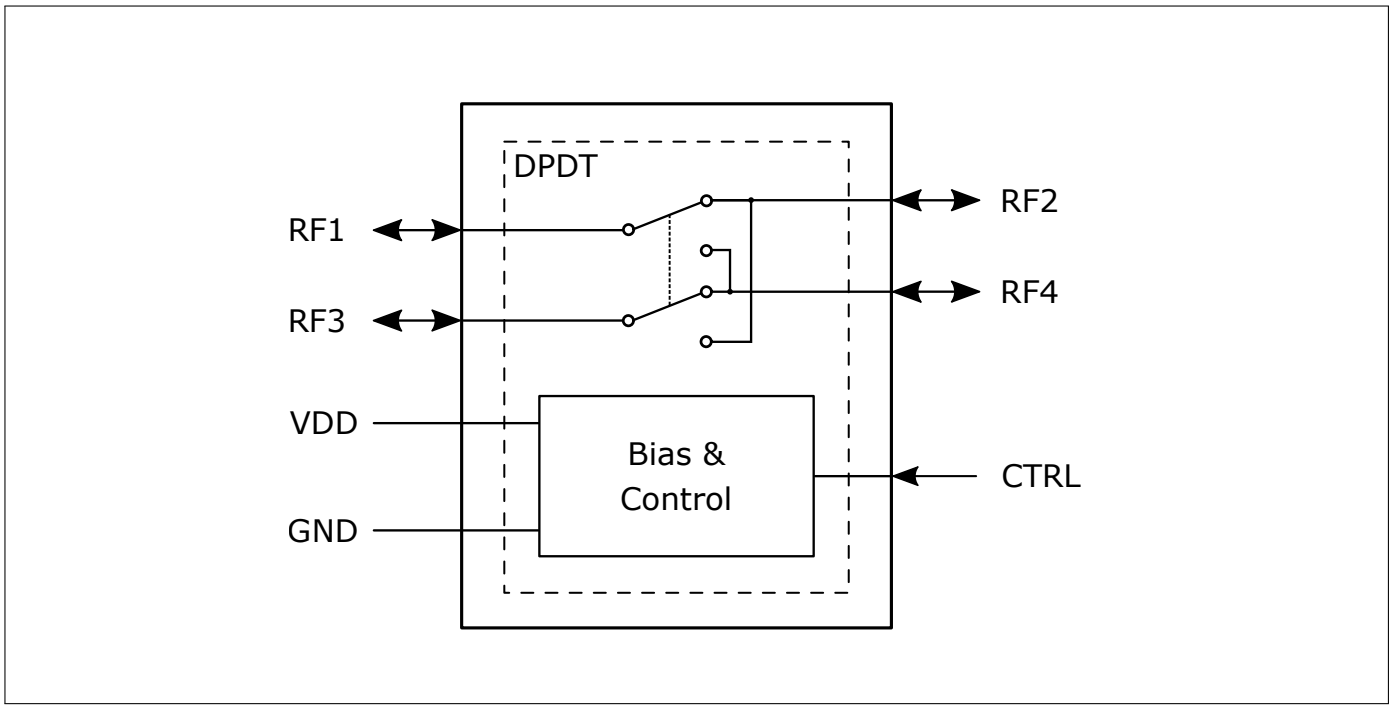
### Description

The BGSX22G6U10 RF CMOS switch is specifically designed for GSM, WCDMA, LTE and 5G applications. This DPDT offers low insertion loss even at high frequencies of up to 7.125 GHz, low harmonic generation along with high isolation between RF ports. In addition, the fast switching speed enables 5G-SRS applications.
The switch is controlled via a GPIO interface. The on-chip controller allows power-supply voltages from 1.6V to 3.6V.
The switch features direct-connect-to-battery functionality and DC-free RF ports. Unlike GaAs technology, external DC blocking capacitors at the RF Ports are only required if DC voltage is applied externally. The device has a very small size of only 1.1mm x 1.5mm and a thickness of 0.60mm.

**Table 1: Ordering information**

| Product type | Marking | Package |
|---|---|---|
| BGSX22G6U10 | X6 | PG-ULGA-10-1 |

## Block diagram



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# 1 Absolute maximum ratings

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

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{DD}$ | -0.3 | – | 3.9 | V | – |
| Abs-Max RF input power | $P_{RF,max}$ | – | – | 39 | dBm | Duty cycle 25 %, frequency 0.4–7.125 GHz, VSWR 1:1 |
| ESD robustness, CDM[1)] | $V_{ESD\_CDM}$ | -1 | – | +1 | kV | |
| ESD robustness, HBM[2)] | $V_{ESD\_HBM}$ | -2 | – | +2 | kV | |
| Maximum DC voltage on RF ports and RF ground | $V_{RFDC}$ | 0 | – | 0 | V | No DC voltages allowed on RF ports |
| GPIO control voltage levels | $V_{Ctrlx}$ | -0.7 | – | $V_{DD}$+0.7 (max. 3.9V) | V | – |
| Storage temperature range | $T_{STG}$ | -55 | – | 150 | °C | – |
| Junction temperature | $T_j$ | – | – | 125 | °C | – |

[1)] Field-Induced Charged-Device Model ANSI/ESDA/JEDEC JS-002. 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.
[2)] Human Body Model ANSI/ESDA/JEDEC JS-001 ($R$ = 1.5 kΩ, $C$ = 100 pF).

**Warning: Stresses above the max. values listed here may cause permanent damage to the device. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. Exposure to conditions at or below absolute maximum rating but above the specified maximum operation conditions may affect device reliability and life time. Functionality of the device might not be given under these conditions.**

# 2 Operation ranges

**Table 3: Operation ranges**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Max RF input power | $P_{RF,max}$ | – | – | 39 | dBm | Peak envelope power of a 5G NR signal[1], frequency 0.4-7.125 GHz, VSWR 1:1 |
| | | – | – | 37 | dBm | Pulsed RF input power, duty cycle of 25 % with $T_{period}$ = 4615 µs, through-path, frequency 0.4–7.125 GHz, VSWR 1:1 |
| Supply voltage | $V_{DD}$ | 1.6 | – | 3.6 | V | – |
| Control voltage Low | $V_{Ctrl,L}$ | -0.3 | – | 0.3 | V | – |
| Control voltage High | $V_{Ctrl,H}$ | 0.8 | – | $V_{DD}$ | V | – |
| Supply current | $I_{DD}$ | – | 25 | 35 | µA | $P_{RF}$ = 0 dBm |
| Control current | $I_{Ctrl}$ | – | 2 | 10 | nA | – |
| Ambient temperature | $T_A$ | -40 | 25 | 85 | °C | – |

[1] MCS 27 (256 QAM) OFDM, 60 kHz sub carrier spacing, 100 MHz bandwidth, RMS power is 9 dB below peak power.

# 3 RF characteristics

**Table 4: RF characteristics** at $T_A$ = 25 °C, $P_{RF}$ = 0 dBm, $V_{DD}$ = 1.8V, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Insertion loss**[1] | | | | | | |
| All RF ports | *IL* | – | 0.29 | 0.35 | dB | 400 to 960MHz |
| | | – | 0.34 | 0.42 | dB | 1710 to 2200MHz |
| | | – | 0.37 | 0.45 | dB | 2300 to 2690MHz |
| | | – | 0.44 | 0.56 | dB | 3300 to 4200MHz |
| | | – | 0.50 | 0.63 | dB | 4400 to 5000MHz |
| | | – | 0.55 | 0.72 | dB | 5150 to 5925MHz |
| | | – | 0.64 | 0.85 | dB | 5925 to 7125MHz |

[1] Measured on application board without any external matching components.

**Table 5: RF Characteristics** at $T_A$ = −40 °C...85 °C, $P_{RF}$ = 0 dBm, $V_{DD}$ = 1.6V ... 3.6V, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Insertion loss**[1] | | | | | | |
| All RF ports | *IL* | – | 0.29 | 0.40 | dB | 400 to 960MHz |
| | | – | 0.34 | 0.48 | dB | 1710 to 2200MHz |
| | | – | 0.37 | 0.51 | dB | 2300 to 2690MHz |
| | | – | 0.44 | 0.63 | dB | 3300 to 4200MHz |
| | | – | 0.50 | 0.71 | dB | 4400 to 5000MHz |
| | | – | 0.55 | 0.80 | dB | 5150 to 5925MHz |
| | | – | 0.64 | 0.95 | dB | 5925 to 7125MHz |
| **Return loss**[1] | | | | | | |
| All RF ports | *RL* | 27 | 34 | – | dB | 400 to 960MHz |
| | | 22 | 33 | – | dB | 1710 to 2200MHz |
| | | 20 | 32 | – | dB | 2300 to 2690MHz |
| | | 17 | 28 | – | dB | 3300 to 4200MHz |
| | | 16 | 24 | – | dB | 4400 to 5000MHz |
| | | 14 | 22 | – | dB | 5150 to 5925MHz |
| | | 12 | 18 | – | dB | 5925 to 7125MHz |

[1] Measured on application board without any external matching components.

**Table 6: RF characteristics** at $T_A$ = −40 °C...85 °C, $P_{RF}$ = 0 dBm, $V_{DD}$ = 1.6V ... 3.6V, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Isolation**[1] | | | | | | |
| State 1 & State 2:<br>RF1 to RF3<br>RF2 to RF4 | *ISO* | 33 | 37 | – | dB | 400 to 960MHz |
| | | 26 | 29 | – | dB | 1710 to 2200MHz |
| | | 24 | 27 | – | dB | 2300 to 2690MHz |
| | | 21 | 24 | – | dB | 3300 to 4200MHz |
| | | 19 | 22 | – | dB | 4400 to 5000MHz |
| | | 18 | 21 | – | dB | 5150 to 5925MHz |
| | | 17 | 20 | – | dB | 5925 to 7125MHz |
| **Isolation**[1] | | | | | | |
| State 1:<br>RF1 to RF4, RF2 to RF3<br><br>State 2:<br>RF1 to RF2, RF3 to RF4 | *ISO* | 33 | 38 | – | dB | 400 to 960MHz |
| | | 26 | 30 | – | dB | 1710 to 2200MHz |
| | | 24 | 28 | – | dB | 2300 to 2690MHz |
| | | 21 | 25 | – | dB | 3300 to 4200MHz |
| | | 20 | 23 | – | dB | 4400 to 5000MHz |
| | | 19 | 22 | – | dB | 5150 to 5925MHz |
| | | 18 | 21 | – | dB | 5925 to 7125MHz |

[1] Measured on application board without any external matching components.

**Table 7: RF characteristics** at $T_A$ = −40 °C...85 °C, $V_{DD}$ = 1.6V ... 3.6V, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Harmonic generation**[1] at CW, VSWR 1:1 / 50 Ω | | | | | | |
| 2nd Harmonic | $P_{H2}$ | – | -84 | -78 | dBm | LTE LB, 663–915 MHz, $P_{RF}$ = 26 dBm |
| | | – | -80 | -76 | dBm | LTE MB, 1710–2020 MHz, $P_{RF}$ = 26 dBm |
| | | – | -78 | -73 | dBm | LTE HB, 2300–2690 MHz, $P_{RF}$ = 26 dBm |
| | | – | -75 | -67 | dBm | N77 NR, 3300–4200 MHz, $P_{RF}$ = 26 dBm |
| | | – | -72 | -67 | dBm | N79 NR, 4400–5000 MHz, $P_{RF}$ = 26 dBm |
| 3rd Harmonic | $P_{H3}$ | – | -86 | -80 | dBm | LTE LB, 663–915 MHz, $P_{RF}$ = 26 dBm |
| | | – | -86 | -76 | dBm | LTE MB, 1710–2020 MHz, $P_{RF}$ = 26 dBm |
| | | – | -86 | -76 | dBm | LTE HB, 2300–2690 MHz, $P_{RF}$ = 26 dBm |
| | | – | -86 | -72 | dBm | N77 NR, 3300–4200 MHz, $P_{RF}$ = 26 dBm |
| | | – | -86 | -77 | dBm | N79 NR, 4400–5000 MHz, $P_{RF}$ = 26 dBm |
| **Harmonic generation**[1] at 25 % duty cycle, VSWR 1:1 / 50 Ω | | | | | | |
| 2nd Harmonic | $P_{H2}$ | – | -66 | -60 | dBm | GSM LB, 824–915 MHz, $P_{RF}$ = 35 dBm |
| | | – | -67 | -62 | dBm | GSM HB, 1710–1910 MHz, $P_{RF}$ = 33 dBm |
| 3rd Harmonic | $P_{H3}$ | – | -60 | -55 | dBm | GSM LB, 824–915 MHz, $P_{RF}$ = 35 dBm |
| | | – | -66 | -60 | dBm | GSM HB, 1710–1910 MHz, $P_{RF}$ = 33 dBm |
| **Intermodulation distortion IMD2**[1] | | | | | | |
| IMD2 low & IMD2 high | *IMD2* | – | -120 | -104 | dBm | Test conditions, see Tab. 8 |
| IMD2 ULCA | | – | -98 | -92 | dBm | |
| IMD2 ENDC | | – | -100 | -92 | dBm | |
| **Intermodulation distortion IMD3**[1] | | | | | | |
| IMD3 mid & IMD3 high | *IMD3* | – | -125 | -115 | dBm | Test conditions, see Tab. 9 |
| IMD3 ULCA | | – | -95 | -90 | dBm | |
| IMD3 ENDC | | – | -110 | -100 | dBm | |

[1] Measured on application board without any external matching components.

**Table 8: IMD2 testcases**[1]

| Band | Symbol | In-Band Frequency (MHz) | Blocker Frequency 1 (MHz) | Blocker Power 1 (dBm) | Blocker Frequency 2 (MHz) | Blocker Power 2 (dBm) |
|---|---|---|---|---|---|---|
| Band 1 | $B1_{IMD2,high}$ | 2140 | 1950 | 20 | 4090 | -15 |
| | $B1_{IMD2,low}$ | 2140 | 1950 | 20 | 190 | -15 |
| Band 5 | $B5_{IMD2,high}$ | 881.5 | 836.5 | 20 | 1718 | -15 |
| | $B5_{IMD2,low}$ | 881.5 | 836.5 | 20 | 45 | -15 |
| Band 7 | $B7_{IMD2,high}$ | 2655 | 2535 | 20 | 5190 | -15 |
| | $B7_{IMD2,low}$ | 2655 | 2535 | 20 | 120 | -15 |
| Band 3 + Band 5 ULCA | $B3B5_{IMD2,ULCA}$ | 881.5 | 836.5 | 23 | 1718 | 10 |
| Band 3 + N77 ENDC | $B3N77_{IMD2,ENDC}$ | 1842.5 | 1747.5 | 23 | 3590 | 10 |

[1] Both blockers applied to same RF path.

**Table 9: IMD3 testcases**[1)]

| Band | Symbol | In-Band Frequency (MHz) | Blocker Frequency 1 (MHz) | Blocker Power 1 (dBm) | Blocker Frequency 2 (MHz) | Blocker Power 2 (dBm) |
|---|---|---|---|---|---|---|
| Band 1 | $B1_{IMD3,high}$ | 2140 | 1950 | 20 | 6040 | -15 |
| | $B1_{IMD3,mid}$ | 2140 | 1950 | 20 | 1760 | -15 |
| Band 5 | $B5_{IMD3,high}$ | 881.5 | 836.5 | 20 | 2554.5 | -15 |
| | $B5_{IMD3,mid}$ | 881.5 | 836.5 | 20 | 791.5 | -15 |
| Band 7 | $B7_{IMD3,high}$ | 2655 | 2535 | 20 | 7725 | -15 |
| | $B7_{IMD3,mid}$ | 2655 | 2535 | 20 | 2415 | -15 |
| Band 1 + Band 3 ULCA | $B1B3_{IMD3,ULCA}$ | 2140 | 1950 | 23 | 1760 | 10 |
| Band 5 + N78 ENDC | $B5N78_{IMD3,ENDC}$ | 2122 | 3780 | 26 | 829 | 10 |

[1)] Both blockers applied to same RF path.

**Table 10: Switching time** at $T_A$ = −40 °C...85 °C, $P_{IN}$ = 0 dBm, $V_{DD}$ = 1.6V ... 3.6V, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **Switching time**[1)] | | | | | | |
| Switching time | $t_{ST}$ | – | 1.3 | 1.8 | µs | Time between RF states in active mode $V_{Ctrl,H}$ Min. or $V_{Ctrl,L}$ Max. level to 90% RF-signal |
| RF rise time | $t_{RT}$ | – | 0.65 | 0.9 | µs | Time between 10% to 90% RF Signal |
| Power up settling time | $t_{PUP}$ | – | 10 | 25 | µs | Time from $V_{DD}$ Min. power level to 90% RF-signal |

[1)] Measured on application board without any external matching components.

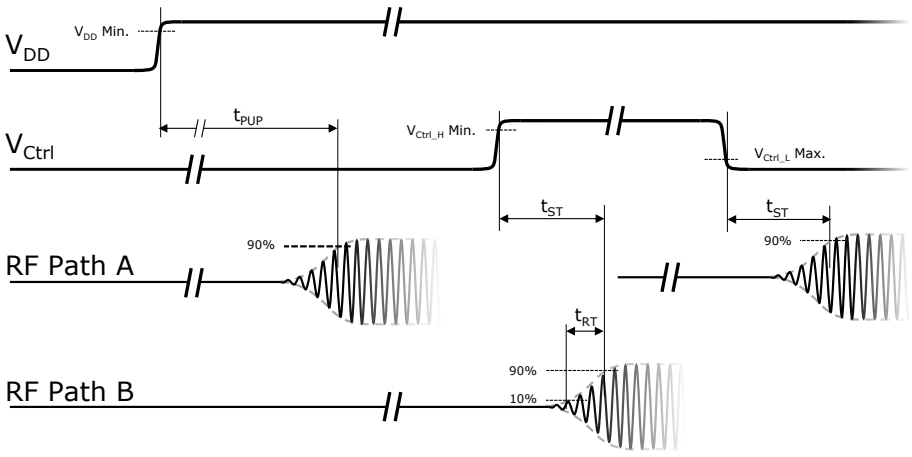


**Figure 1:** CTRL to RF time

# 4 Modes of operation

**Table 11: Modes of operation (truth table)**

| | | Control input |
|---|---|---|
| **State** | **Mode** | **CTRL** |
| 1 | RF1 - RF2 | 0 |
| | RF3 - RF4 | |
| 2 | RF1 - RF4 | 1 |
| | RF3 - RF2 | |

# 5 Application Information

## Pin Configuration and Function

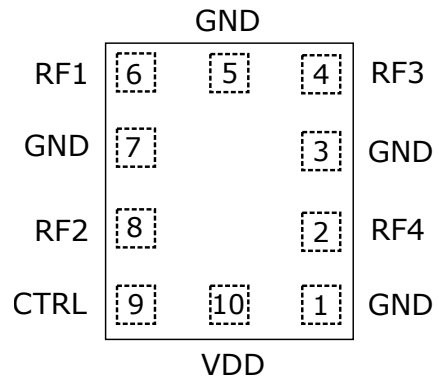


**Figure 2:** BGSX22G6U10 Pin Configuration (top view)

**Table 12: Pin Definition and Function**

| Pin No. | Name | Function |
|---|---|---|
| 1 | GND | DC ground |
| 2 | RF4 | RF port 4 |
| 3 | GND | RF ground |
| 4 | RF3 | RF port 3 |
| 5 | GND | RF ground |
| 6 | RF1 | RF port 1 |
| 7 | GND | RF ground |
| 8 | RF2 | RF port 2 |
| 9 | CTRL | GPIO control pin |
| 10 | VDD | Power supply |

# 6 Package information

**Table 13: Mechanical data**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| X-Dimension | *X* | 1.1 ± 0.05 | mm |
| Y-Dimension | *Y* | 1.5 ± 0.05 | mm |
| Size | *Size* | 1.65 | $mm^2$ |
| Height | *H* | 0.60 ± 0.05 | mm |

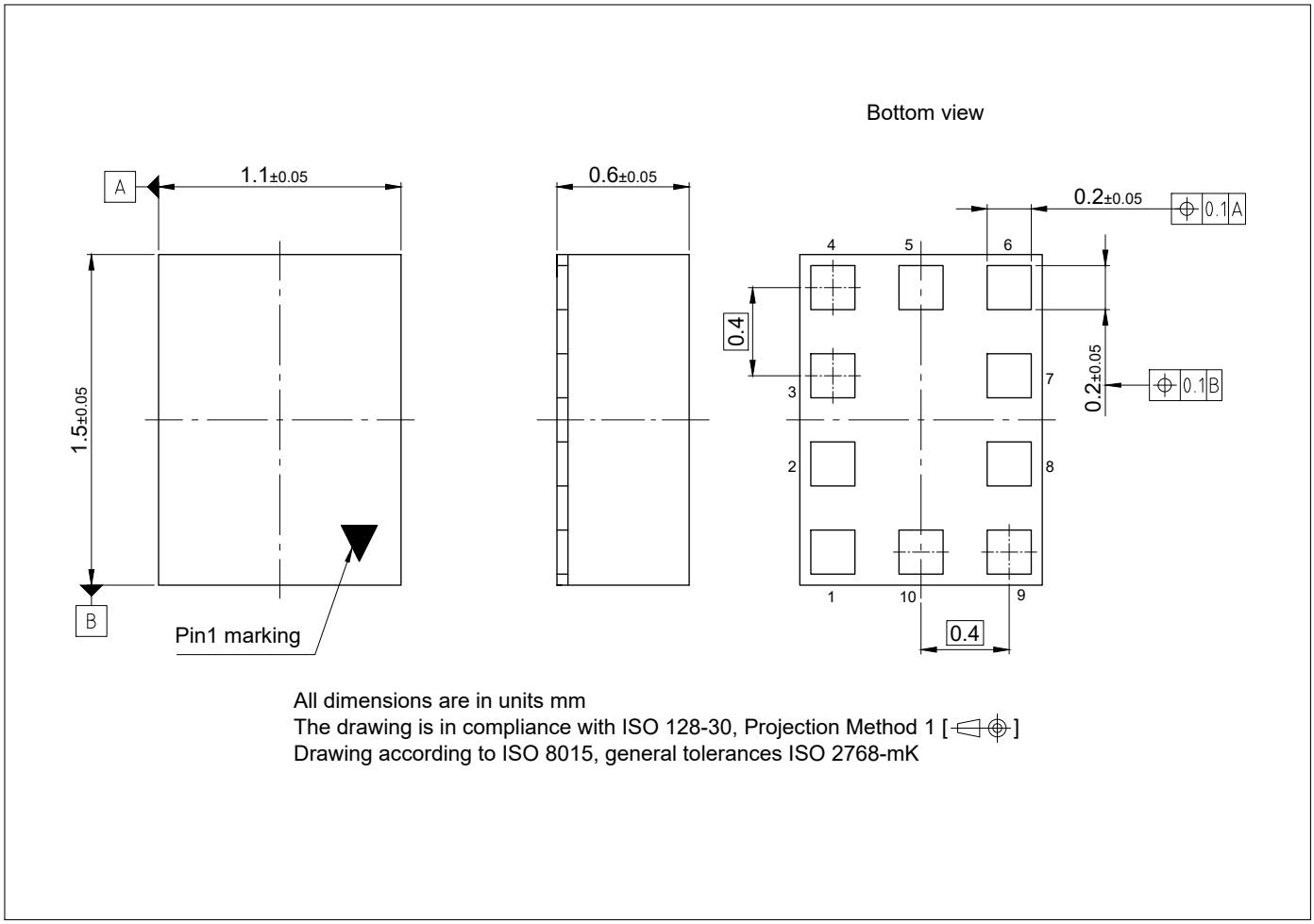


**Figure 3:** Package outline (top, side and bottom views)

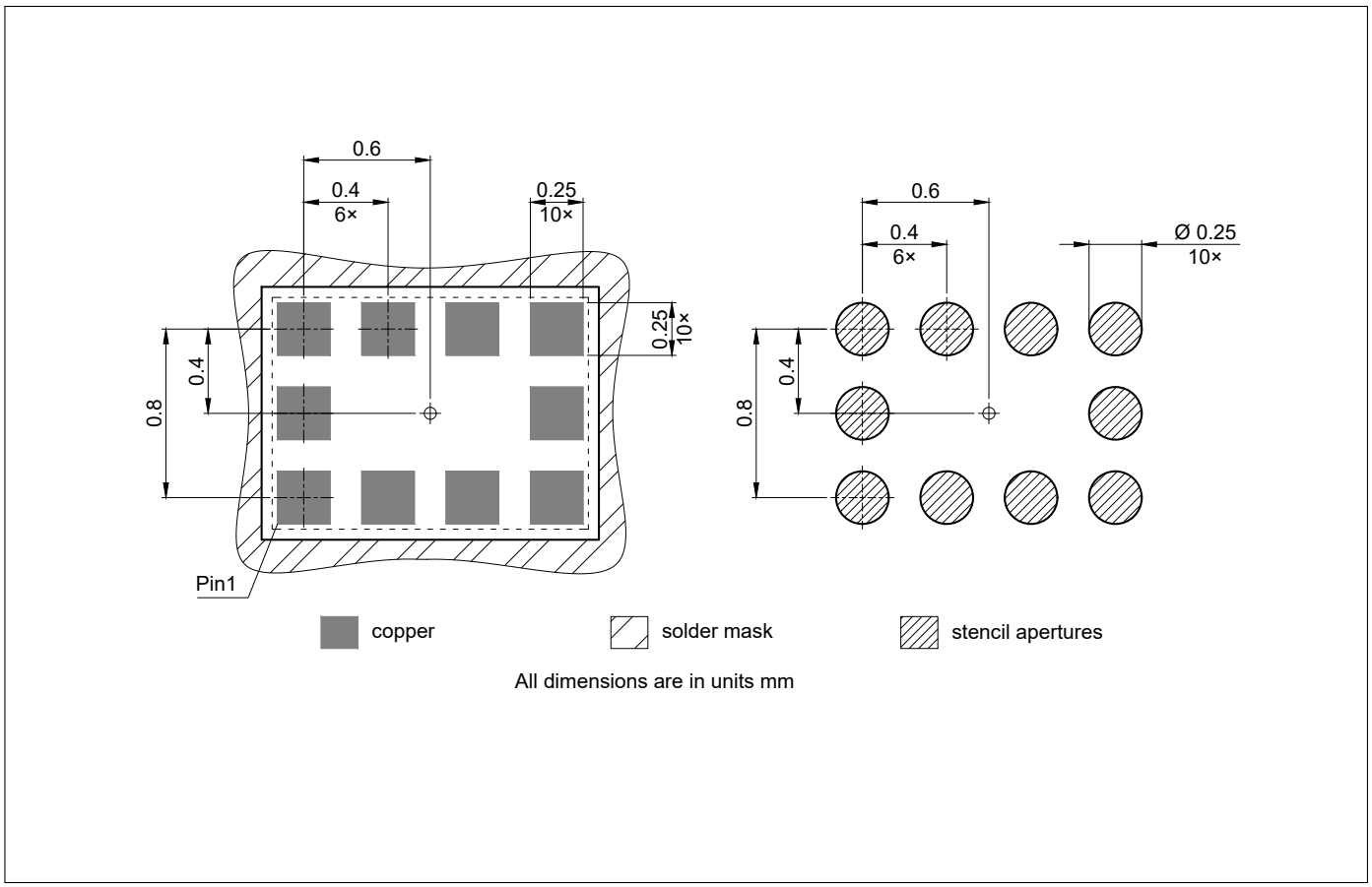


**Figure 4:** Footprint recommendation

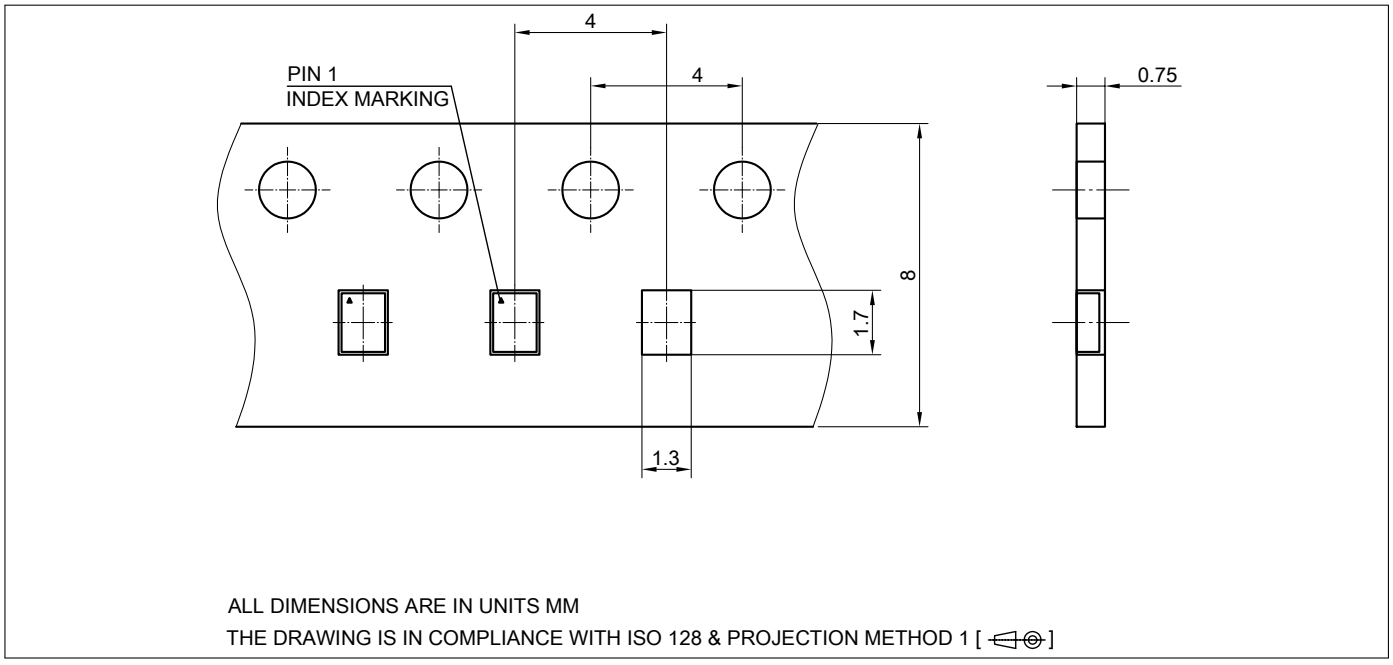


**Figure 5:** Carrier tape

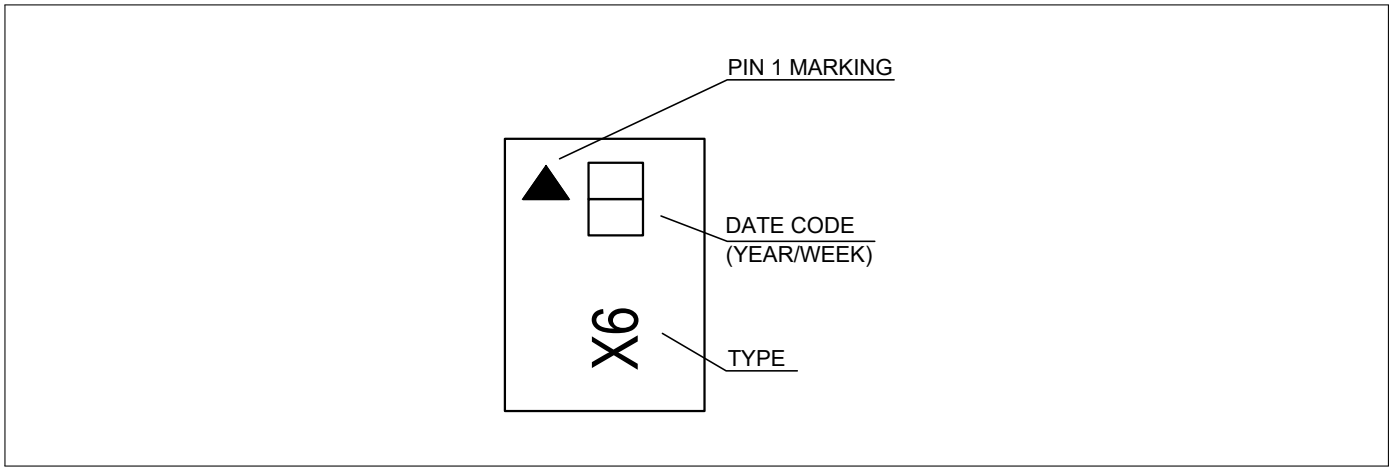


**Figure 6:** Marking specification (top view): date code digits Y and W defined in tables 14 and 15

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

| Year | "Y" | Year | "Y" |
|---|---|---|---|
| 2020 | 0 | 2030 | 0 |
| 2021 | 1 | 2031 | 1 |
| 2022 | 2 | 2032 | 2 |
| 2023 | 3 | 2033 | 3 |
| 2024 | 4 | 2034 | 4 |
| 2025 | 5 | 2035 | 5 |
| 2026 | 6 | 2036 | 6 |
| 2027 | 7 | 2037 | 7 |
| 2028 | 8 | 2038 | 8 |
| 2029 | 9 | 2039 | 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 | 53 | M |
| 10 | K | 21 | Y | 32 | f | 43 | t | | |
| 11 | L | 22 | Z | 33 | g | 44 | u | | |

| Revision History | |
|---|---|
| **Page or Item** | **Subjects (major changes since previous revision)** |
| **Revision 2.1, 2023-10-17** | |
| 3 | Control voltage high limits changed in Table 3 |

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**Edition 2023-10-17**
**Published by**
**Infineon Technologies AG**
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