

# BGC100GN6

Switchable Wideband Directional Coupler IC

## Data Sheet

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Power Management & Multimarket

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## Revision History

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| Page | Subjects (major changes since last revision) |
|------|--|
| All  | Removed Confidential, NDA required           |
| 8    | Min. supply voltage                          |
|      |  |

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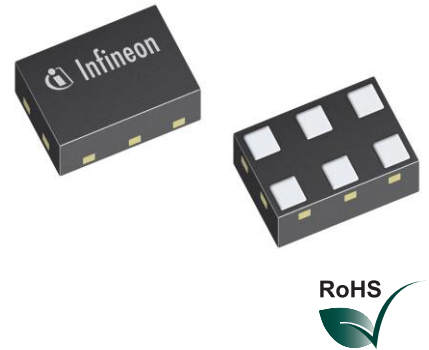
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## BGC100GN6 Switchable Wideband Directional Coupler IC

### 1 Features

- Fully integrated coupler in RF CMOS
- Bi-directional coupler
- Fitted for feedback receivers to accomplish closed loop power control and antenna tuning
- Wide frequency range: 0.6 to 2.7 GHz
- Designed for low insertion loss and high directivity
- Supports all cellular standards: GSM / WCDMA / HSPA+ / FDD-LTE / TD-LTE / TD-SCDMA / CDMA
- Integrated low-pass filter for 5GHz WiFi jammers suppression
- GPIO controlled
- Small form factor 1.1 mm x 0.7 mm
- RoHS and WEEE compliant package
- Product Validation: Qualified for industrial applications according to the relevant tests of JEDEC47/20/22



### 2 Product Description

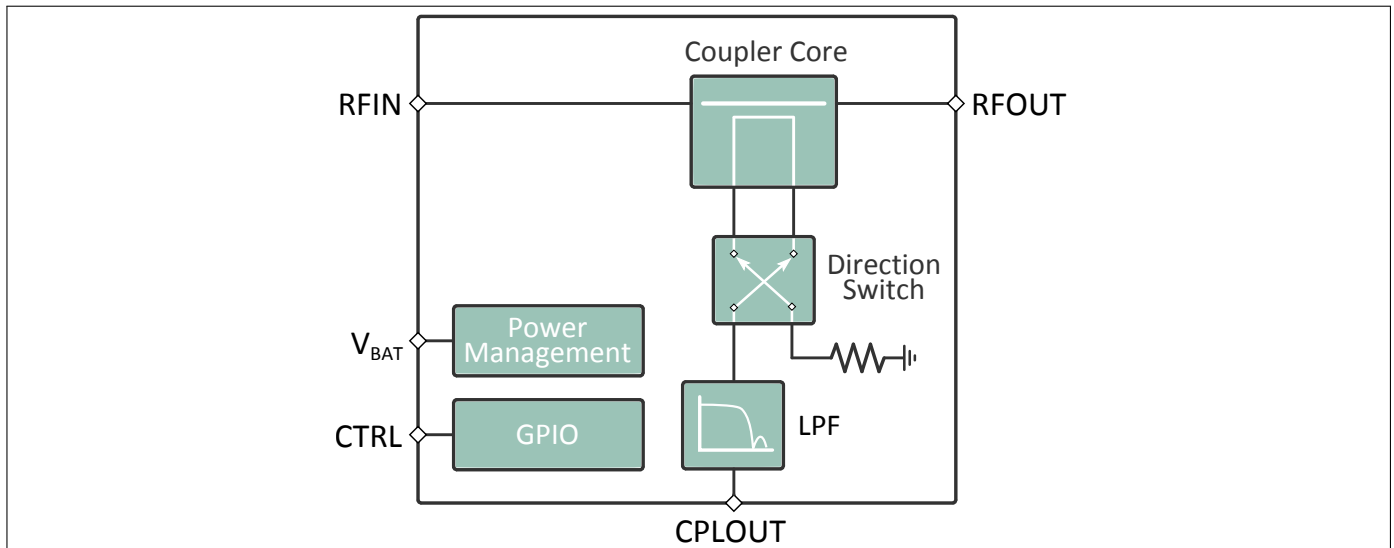
The BGC100GN6 bi-directional coupler IC is designed for 2G/3G/4G RF front end applications. The device contains a bi-directional coupler operating in one or multiple bands within 0.6 GHz to 2.7 GHz frequency range. The coupled output contains a low-pass filter for 5 GHz ISM blockers suppression. The coupler offers low insertion loss and high directivity.

The coupler is controlled via a GPIO pin. No external power supply blocking or RF decoupling capacitors are required.

The BGC100GN6 is a fully integrated device deploying Infineon high volume RF-CMOS technology. The device has a very small size of only 1.1 x 0.7 mm<sup>2</sup> and a maximum height of 0.4 mm.

**Table 1: Ordering Information**

| Type      | Package  | Marking |
|-----------|----------|---------|
| BGC100GN6 | TSNP-6-2 | 2       |


**Figure 1:** BGC100GN6 Block diagram

### 3 Maximum Ratings

**Table 2: Maximum Ratings, Table I** at  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise specified

| Parameter                           | Symbol                | Values |      |      | Unit             | Note / Test Condition |
|-------------------------------------|-----------------------|--------|------|------|------------------|-----------------------|
|                                     |                       | Min.   | Typ. | Max. |                  |                       |
| Frequency range                     | f                     | 0.6    | –    | 2.7  | GHz              | 1)                    |
| Supply voltage                      | $V_{DD}$              | -0.5   | –    | 3.6  | V                | –                     |
| Storage temperature range           | $T_{STG}$             | -55    | –    | 150  | $^\circ\text{C}$ | –                     |
| Junction temperature                | $T_j$                 | –      | –    | 125  | $^\circ\text{C}$ | –                     |
| RF input power at RFIN, RFOUT ports | $P_{RF\_RFIN, RFOUT}$ | –      | –    | 36   | dBm              | 698–960 MHz           |
|                                     |                       | –      | –    | 33   | dBm              | 1400–2200 MHz         |
|                                     |                       | –      | –    | 30   | dBm              | 2300–2700 MHz         |
| ESD capability, CDM <sup>2)</sup>   | $V_{ESD\_CDM}$        | -1     | –    | +1   | kV               |                       |
| ESD capability, HBM <sup>3)</sup>   | $V_{ESD\_HBM}$        | -1     | –    | +1   | kV               |                       |

<sup>1)</sup> There is a DC connection between RFIN and RFOUT. The DC voltage at RF ports  $V_{RFDC}$  has to be 0V.

<sup>2)</sup> 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.

<sup>3)</sup> Human Body Model ANSI/ESDA/JEDEC JS-001 (R=1.5 k $\Omega$ , 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.

**Table 3: Maximum Ratings, Table II** at  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise specified

| Parameter                                     | Symbol     | Values |      |      | Unit | Note / Test Condition              |
|---|------------|--------|------|------|------|------------------------------------|
|   |            | Min.   | Typ. | Max. |      |                                    |
| Thermal resistance junction - soldering point | $R_{thJS}$ | –      | 58   | –    | K/W  | –                                  |
| Maximum DC-voltage on RF-Ports and RF-Ground  | $V_{RFDC}$ | 0      | –    | 0    | V    | No DC voltages allowed on RF-Ports |

## 4 Operation Ranges

**Table 4: Operation Ranges**

| Parameter                      | Symbol        | Values |      |                   | Unit         | Note / Test Condition |
|--------------------------------|---------------|--------|------|-------------------|--------------|-----------------------|
|                                |               | Min.   | Typ. | Max.              |              |                       |
| Supply voltage                 | $V_{DD}$      | 1.6    | –    | 3.4               | V            | –                     |
| Supply current <sup>1)</sup>   | $I_{DD}$      | –      | 60   | 200               | $\mu$ A      | –                     |
| GPIO control voltage high      | $V_{Ctrl\_H}$ | 1.35   | –    | $V_{DD}$<br>+ 0.3 | V            | Maximum 3.4V          |
| GPIO control voltage low       | $V_{Ctrl\_L}$ | -0.3   | –    | 0.43              | V            | –                     |
| GPIO control input capacitance | $C_{Ctrl}$    | –      | –    | 2                 | pF           | –                     |
| Ambient temperature            | $T_A$         | -40    | 25   | 85                | $^{\circ}$ C | –                     |

<sup>1)</sup> $T_A = -40^{\circ}$ C -  $85^{\circ}$ C,  $V_{DD} = 1.6 - 3.4$  V

**Table 5: RF Input Power**

| Parameter                         | Symbol                | Values |      |      | Unit | Note / Test Condition        |
|-----------------------------------|-----------------------|--------|------|------|------|------------------------------|
|                                   |                       | Min.   | Typ. | Max. |      |                              |
| RFIN, RFOUT ports ( $50 \Omega$ ) | $P_{RF\_RFIN, RFOUT}$ | –      | –    | 35   | dBm  | 698–960 MHz                  |
|                                   |                       | –      | –    | 32   | dBm  | 1400–2200 MHz                |
|                                   |                       | –      | –    | 29   | dBm  | 2300–2700 MHz, <sup>1)</sup> |

<sup>1)</sup>Average LTE power



## 5 RF Characteristics

**Table 6: RF Characteristics** at  $T_A = -40\text{ }^{\circ}\text{C} - 85\text{ }^{\circ}\text{C}$ ,  $P_{IN} = 0\text{ dBm}$ , Supply Voltage  $V_{DD} = 1.6\text{ V} - 3.4\text{ V}$ , unless otherwise specified

| Parameter                       | Symbol              | Values |      |      | Unit | Note / Test Condition |
|---------------------------------|---------------------|--------|------|------|------|-----------------------|
|                                 |                     | Min.   | Typ. | Max. |      |                       |
| <b>Insertion Loss</b>           |                     |        |      |      |      |                       |
| RFIN to RFOUT Ports             | IL                  | –      | 0.07 | 0.1  | dB   | 698–960 MHz           |
|                                 |                     | –      | 0.14 | 0.2  | dB   | 1400–2200 MHz         |
|                                 |                     | –      | 0.2  | 0.3  | dB   | 2300–2700 MHz         |
| <b>Return Loss</b>              |                     |        |      |      |      |                       |
| RFIN and RFOUT Ports            | RL <sub>TX</sub>    | 22     | 25   | –    | dB   | 698–960 MHz           |
|                                 |                     | 21     | 24   | –    | dB   | 1400–2200 MHz         |
|                                 |                     | 20     | 21   | –    | dB   | 2300–2700 MHz         |
| CPLOUT Port                     | RL <sub>CPL</sub>   | 15     | 25   | –    | dB   | 698–960 MHz           |
|                                 |                     | 14     | 23   | –    | dB   | 1400–2200 MHz         |
|                                 |                     | 13     | 20   | –    | dB   | 2300–2700 MHz         |
| <b>Coupling Factor</b>          |                     |        |      |      |      |                       |
| RFIN and RFOUT to CPLOUT Port   | CPL <sub>LTE</sub>  | 26     | 28   | 30   | dB   | 698–960 MHz           |
|                                 |                     | 21     | 24   | 25   | dB   | 1400–2200 MHz         |
|                                 |                     | 21     | 23   | 24   | dB   | 2300–2700 MHz         |
| WiFi Coupling                   | CPL <sub>WiFi</sub> | 27     | 33   | –    | dB   | 4900–5900 MHz, CTRL=0 |
|                                 |                     | 26     | 29   | –    | dB   | 4900–5900 MHz, CTRL=1 |
| <b>Directivity</b>              |                     |        |      |      |      |                       |
| CPLOUT to RFOUT vs RFIN, CTRL=0 | DIR <sub>REV</sub>  | 22     | 28   | –    | dB   | 698–960 MHz           |
|                                 |                     | 22     | 30   | –    | dB   | 1400–2200 MHz         |
|                                 |                     | 22     | 25   | –    | dB   | 2300–2700 MHz         |
| CPLOUT to RFIN vs RFOUT, CTRL=1 | DIR <sub>FWD</sub>  | 19     | 23   | –    | dB   | 698–960 MHz           |
|                                 |                     | 20     | 23   | –    | dB   | 1400–2200 MHz         |
|                                 |                     | 20     | 22   | –    | dB   | 2300–2700 MHz         |

**Table 7: Switching Time** at  $T_A = -40\text{ }^{\circ}\text{C} - 85\text{ }^{\circ}\text{C}$ ,  $P_{IN} = 0\text{ dBm}$ , Supply Voltage  $V_{DD} = 1.6\text{ V} - 3.4\text{ V}$ , unless otherwise specified

| Parameter                 | Symbol       | Values |      |      | Unit          | Note / Test Condition                                     |
|---------------------------|--------------|--------|------|------|---------------|---|
|                           |              | Min.   | Typ. | Max. |               |   |
| <b>Switching Time</b>     |              |        |      |      |               |   |
| GPIO to RF switching time | $t_{on/off}$ | –      | 2    | 5    | $\mu\text{s}$ | 50 % of GPIO voltage flank to 90 % of target RF amplitude |
| Power up settling time    | $t_{PUP}$    | –      | 10   | 25   | $\mu\text{s}$ | After power down mode                                     |

## 6 RF Large Signal Parameter

**Table 8: RF Large Signal Specifications** at  $T_A = -40\text{ }^{\circ}\text{C} - 85\text{ }^{\circ}\text{C}$ , Supply Voltage  $V_{DD} = 1.6\text{ V} - 3.4\text{ V}$ , unless otherwise specified

| Parameter                                      | Symbol           | Values |      |      | Unit | Note / Test Condition   |
|--|------------------|--------|------|------|------|---|
|  |                  | Min.   | Typ. | Max. |      |   |
| <b>Nonlinearity</b>                            |                  |        |      |      |      |   |
| Second Harmonic, RFIN, RFOUT Ports             | $P_{H2.824.24}$  | -      | -87  | -    | dBm  | $P_{in}=24\text{ dBm}$ , $50\ \Omega$ , 824 MHz   |
| Third Harmonic, RFIN, RFOUT Ports              | $P_{H3.824.24}$  | -      | -92  | -    | dBm  | $P_{in}=24\text{ dBm}$ , $50\ \Omega$ , 824 MHz   |
| Second Harmonic, RFIN, RFOUT Ports             | $P_{H2.824.33}$  | -      | -72  | -    | dBm  | $P_{in}=33\text{ dBm}$ , $50\ \Omega$ , 824 MHz   |
| Third Harmonic, RFIN, RFOUT Ports              | $P_{H3.824.33}$  | -      | -62  | -    | dBm  | $P_{in}=33\text{ dBm}$ , $50\ \Omega$ , 824 MHz   |
| Second Harmonic, RFIN, RFOUT Ports             | $P_{H2.1800.30}$ | -      | -78  | -    | dBm  | $P_{in}=30\text{ dBm}$ , $50\ \Omega$ , 1800 MHz  |
| Third Harmonic, RFIN, RFOUT Ports              | $P_{H3.1800.30}$ | -      | -73  | -    | dBm  | $P_{in}=30\text{ dBm}$ , $50\ \Omega$ , 1800 MHz  |
| IMD2, B39+B41, $F_2-F_1$ , RFIN, RFOUT Ports   | $IMD_2$          | -      | -77  | -    | dBm  | $P_1=P_2=24\text{ dBm}$ , $F_1=1.9\text{ GHz}$ , $F_2=2.6\text{ GHz}$ , $F_{IMD2}=700\text{ MHz}$   |
| IMD3, B39+B41, $2F_2-F_1$ , RFIN, RFOUT Ports  | $IMD_3$          | -      | -75  | -    | dBm  | $P_1=P_2=24\text{ dBm}$ , $F_1=1.9\text{ GHz}$ , $F_2=2.6\text{ GHz}$ , $F_{IMD3}=3.3\text{ GHz}$   |
| IMD4, B39+B41, $2F_2-2F_1$ , RFIN, RFOUT Ports | $IMD_{4.1}$      | -      | -100 | -    | dBm  | $P_1=P_2=24\text{ dBm}$ , $F_1=1.9\text{ GHz}$ , $F_2=2.6\text{ GHz}$ , $F_{IMD4.1}=1.4\text{ GHz}$ |
| IMD4, B39+B41, $3F_2-F_1$ , RFIN, RFOUT Ports  | $IMD_{4.2}$      | -      | -98  | -    | dBm  | $P_1=P_2=24\text{ dBm}$ , $F_1=1.9\text{ GHz}$ , $F_2=2.6\text{ GHz}$ , $F_{IMD4.2}=5.9\text{ GHz}$ |

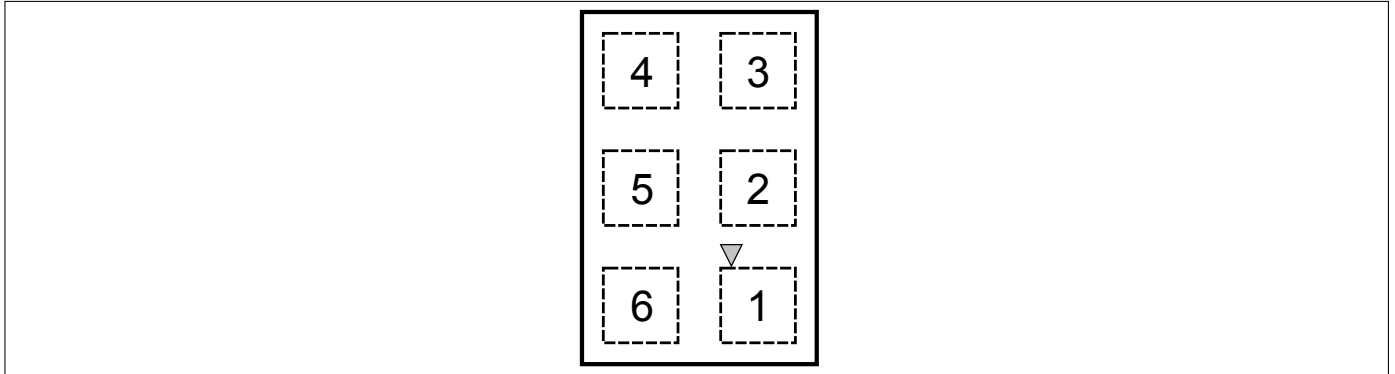
## 7 Truth Table

**Table 9: Modes of Operation (Truth Table)**

| State | Mode  | CTRL |
|-------|---|------|
| 1     | RF signal propagating from RFOUT to RFIN is coupled into CPLOUT | 0    |
| 2     | RF signal propagating from RFIN to RFOUT is coupled into CPLOUT | 1    |

## 8 Application Information

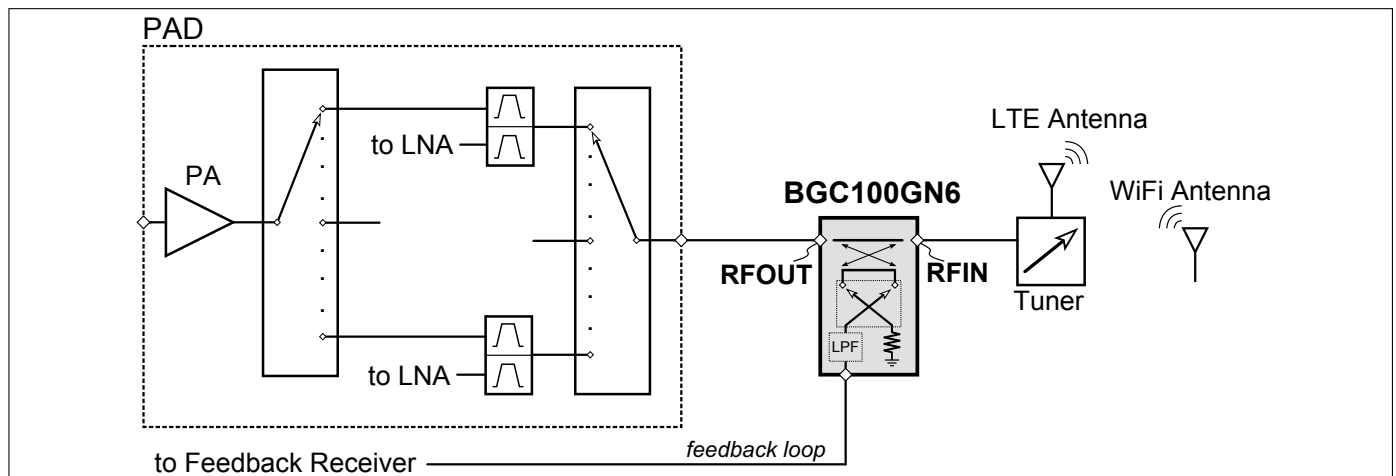
### Pin Configuration and Function



**Figure 2:** BGC100GN6 Pin Configuration (top view)

**Table 10: Pin Definition and Function**

| Pin No. | Name            | Function              |
|---------|-----------------|-----------------------|
| 1       | RFOUT           | Main Path Output Port |
| 2       | V <sub>DD</sub> | Supply Voltage        |
| 3       | CTRL            | Control Pin           |
| 4       | CPLOUT          | Coupled Output        |
| 5       | GND             | Ground                |
| 6       | RFIN            | Main Path Input Port  |

**RF Front-End Example**


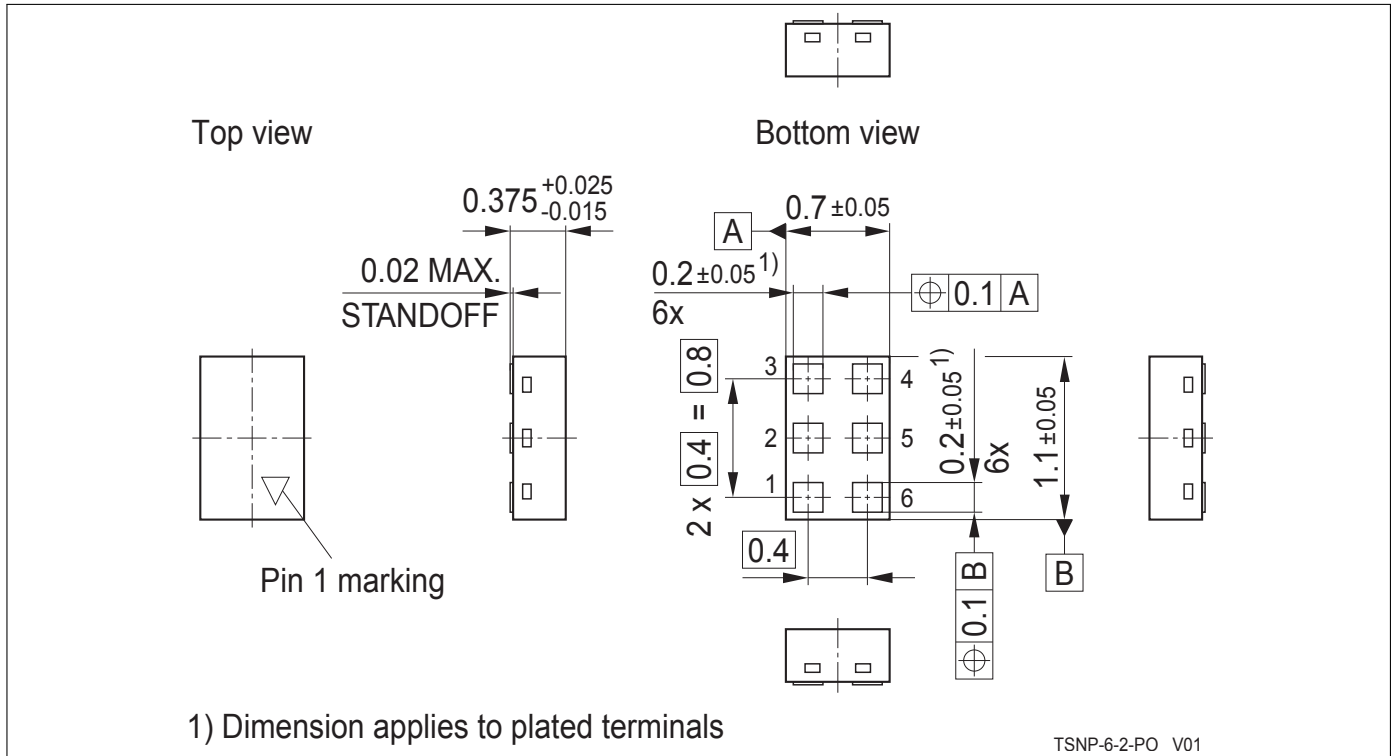
**Figure 3:** RF front-end block diagram with BGC100GN6 switchable coupler IC

BGC100GN6 switchable coupler IC is optimized for RF front-end applications, where it is a part of power control and antenna tuning loops. The BGC100GN6 IC exhibits 3 to 6 dB higher directivity and 3 to 5 dB higher WiFi jammer suppression when it is configured to operate in reverse mode, i.e. when incident RF signal is propagating from RFOUT towards RFIN pins of the IC and reflected signal is propagating from RFIN towards RFOUT pins of the IC. Figure 3 demonstrates an example of BGC100GN6 IC connected in reverse mode in a generic RF front-end of cellular handheld device. The RFOUT pin is coupled to the PA/antenna switch module, while RFIN pin is coupled to antenna side. The benefits of such configuration (as opposed to configuration where RFOUT and RFIN pins are swept in the main RF path) for the application are:

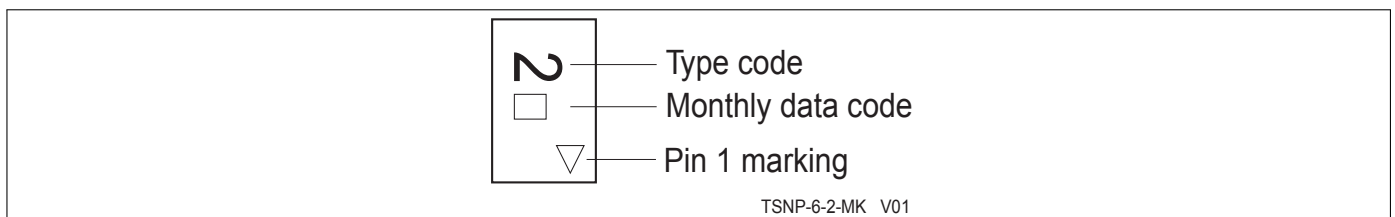
- higher accuracy of power control loop due to lower peak-to-peak forward coupled power variation over the angle for a given antenna VSWR;
- 30...35 dB WiFi signal suppression parasitically coupled into LTE antenna. Such suppression prevents feedback receiver from downconverting the WiFi blockers at frequencies which are the integer multiples of target LTE signal.

Please check the truth table for GPIO control pin to ensure that forward and reverse directions are correctly configured.

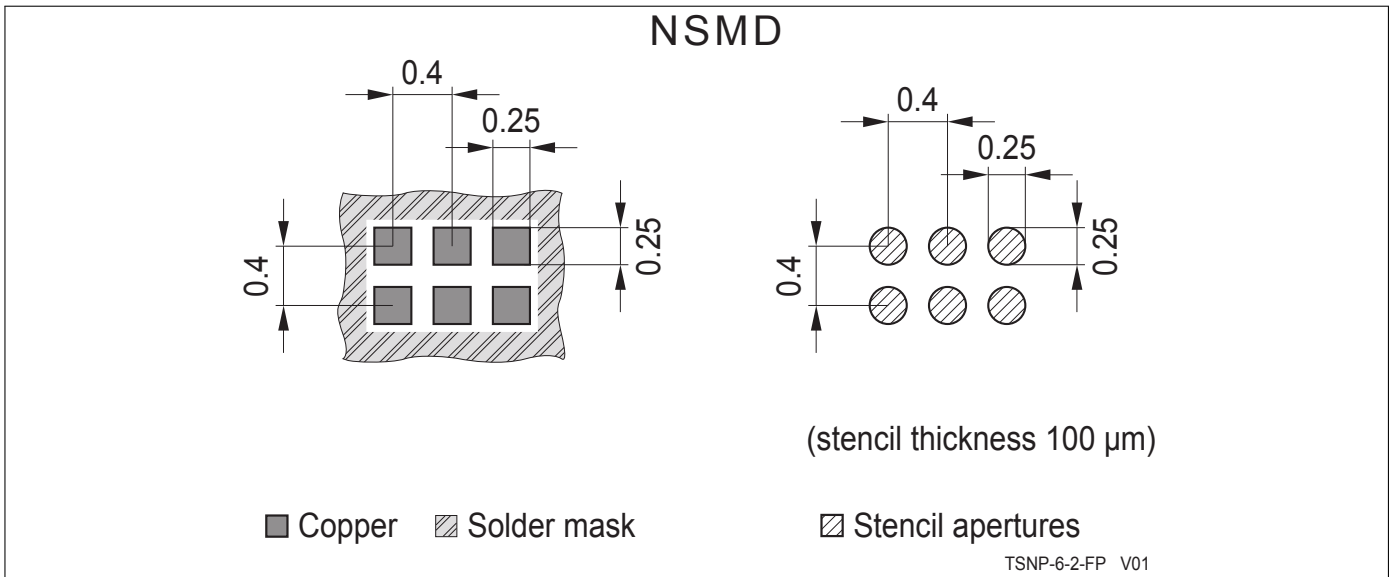
## 9 Package Information



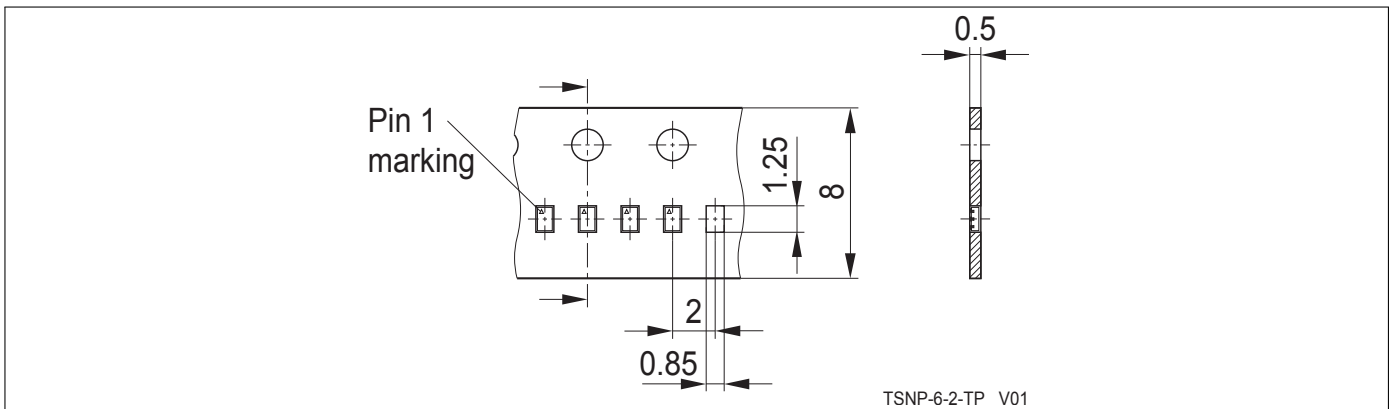
**Figure 4:** TSNP-6-2 Package Outline (top, side and bottom views)



**Figure 5:** Marking Specification (top view)



**Figure 6:** Footprint Recommendation



**Figure 7:** TSNP-6-2 Carrier Tape

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