## Features

- **AMPS/Cell Band and PCS Band CDMA/GPS Operation**
- **Low-current Consumption**
- **Excellent Noise and IP3 Performance**
- **Adjustable Third Order intercept on LNA Stage**
- **Flexible IF Frequency Range from 80 MHz to 230 MHz**
- **Divide by 2 Prescaler**

## Benefits

- **Very Small 32-pin 5 mm x 5 mm Package**
- **Few External Components**
- **Fully ESD Protected**

## Applications

- **Quad-mode/Tri-band CDMA IS-95/98-based Mobile Phones with GPS Support**

Electrostatic sensitive device.
Observe precautions for handling.

## Description

The T0353 is a CDMA front-end receiver RFIC designed for Tri-band, quad-mode operation. The device supports AMPS, Cell CDMA, PCS CDMA, and A-GPS operation. The IF range is from 80 MHz to 230 MHz with external tuning. The low-noise amplifiers have an adjustable third order intercept point (IP3) to minimize inter-modulation and cross-modulation effects. The mixers are designed for differential IF outputs (single-ended or differential IF outputs for AMPS and GPS modes), and they feature excellent linearity and low-noise figure.

The T0353 also integrates a divide-by-2 frequency divider to allow the use of only one VCO module for both CDMA bands. However, it also has the option of connecting the LO directly to the cellular mixer LO input. This device is available in a 5 mm x 5 mm MLF package with 32 pins. The T0353 front-end receiver is capable of meeting all electrical requirements in accordance with the TIA/EIA 98-C wireless communication standard.

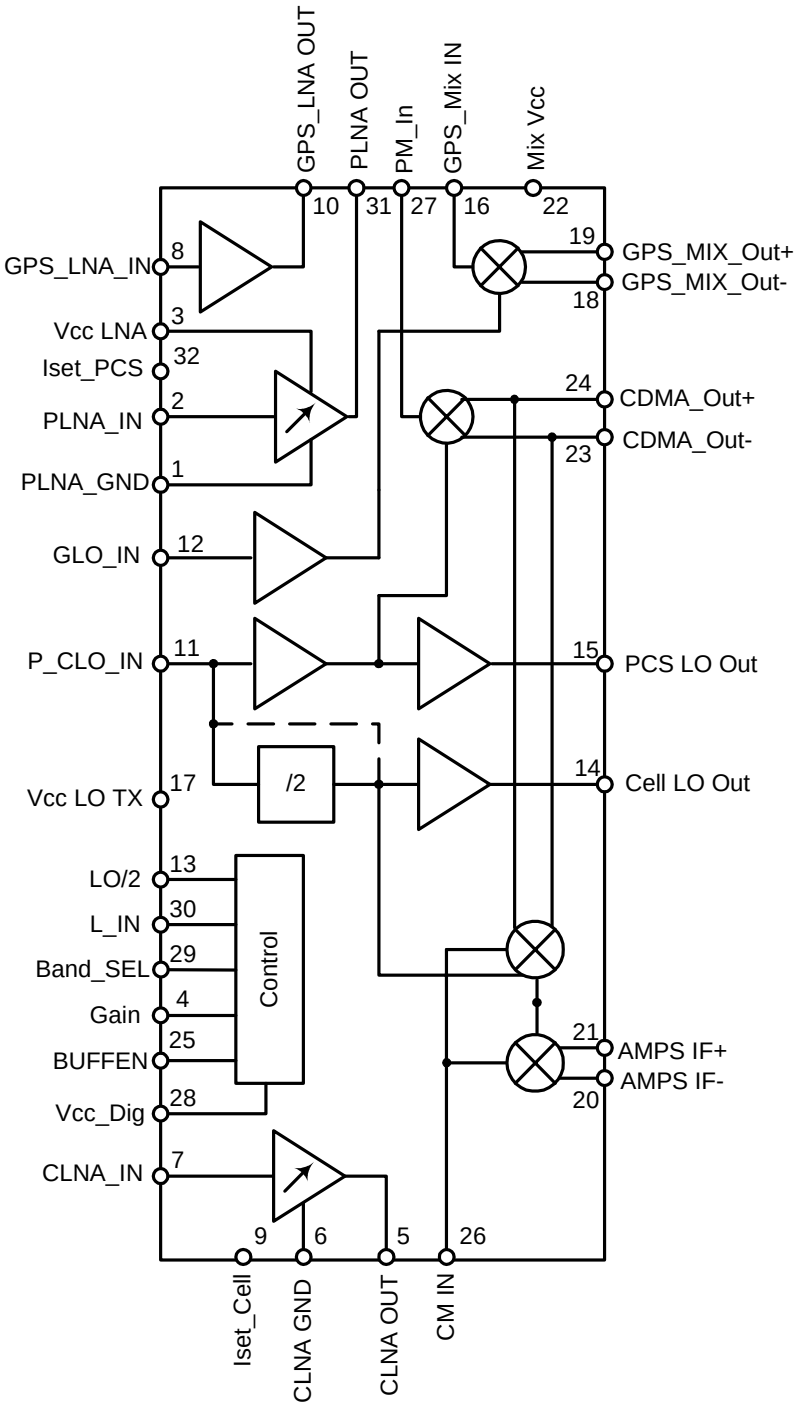
# 2.8 V Tri-band/ Quad-mode RF Receiver for CDMA/AMPS/ GPS

# T0353

# Preliminary (Summary)

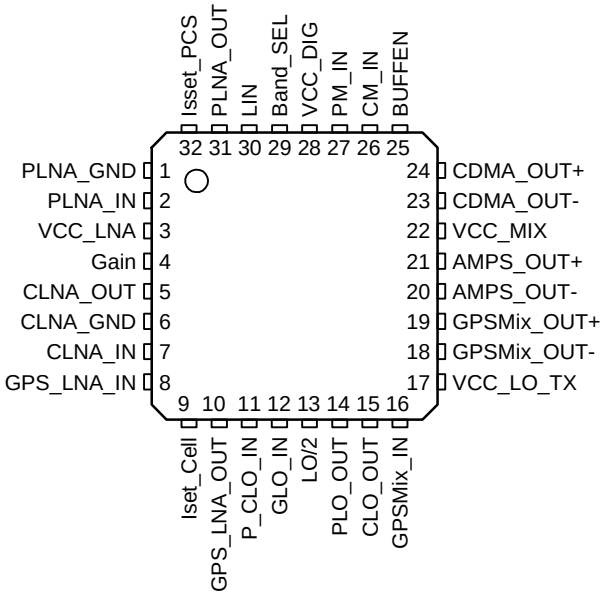
Rev. 4559AS–CDMA–10/02

**Figure 1.** Block Diagram



## Pin Configuration

**Figure 2.** Pinning




## Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1 | PLNA_GND | PCS LNA emitter-ground. The LNA emitter ground should be grounded immediately to the ground-plane to reduce stray inductance and capacitance that may affect performance. |
| 2 | PLNA_IN | PCS LNA input. Requires a DC blocking capacitor and an L-C (shunt C/series L) matching network for optimum gain, intercept and noise performance. |
| 3 | Vcc_LNA | Power supply pin for PCS and Cell LNAs. Bypass with a capacitor as close to the pin as possible. |
| 4 | Gain | Gain select logic input for cellular band. Logic high selects High Gain. |
| 5 | CLNA_OUT | Cell LNA output. Requires a pull-up inductor to $V_{CC}$ and a series DC blocking capacitor, which can be used as part of the output matching network. |
| 6 | CLNA_GND | Cell LNA emitter-ground. The LNA emitter ground should be grounded immediately to the ground-plane to reduce stray inductance and capacitance that may affect performance. |
| 7 | CLNA_IN | Cell LNA input. Requires a DC blocking capacitor and an L-C (shunt C/series L) matching network for optimum gain, intercept and noise performance. |
| 8 | GPS_LNA_IN | GPS LNA input. Requires a DC blocking capacitor and an L-C (shunt C/series L) matching network for optimum gain, intercept and noise performance. |
| 9 | Iset_CELL | Bias resistor for Cell LNA. For typical bias use a 390 Ω resistor to ground which sets the bias current for HGHL mode. |
| 10 | GPS_LNA_OUT | GPS LNA output. |
| 11 | P_CLO_IN | PCS and Cell band LO input. |
| 12 | GLO_IN | GPS LO input. |
| 13 | LO / 2 | LO divider-select input. Low disables divider. High selects divider in cellular and AMPS modes. |
| 14 | PLO_OUT | PCS LO buffer output. Internally matched to 100 Ω. Does not require a blocking capacitor. |

## Pin Description (Continued)

| Pin | Symbol | Function |
|---|---|---|
| 15 | CLO_OUT | Cellular LO buffer output. Internally matched to 100 Ω. Does not require a blocking capacitor. |
| 16 | GPSMix_IN | GPS mixer input. |
| 17 | Vcc_LO_Tx | Supply voltage for LO buffers. |
| 18 | GPSMix_OUT- | Negative GPS IF output. |
| 19 | GPSMix_OUT+ | Positive GPS IF output. |
| 20 | AMPS_OUT- | Negative AMPS IF output. |
| 21 | AMPS_OUT+ | Positive AMPS IF output. |
| 22 | Vcc_Mix | Supply voltage for all mixers. |
| 23 | CDMA_OUT- | Negative CDMA IF output. |
| 24 | CDMA_OUT+ | Positive CDMA IF output. |
| 25 | BUFFEN | LO output buffer enable. Set BUFFEN pin HIGH to power up the LO buffer output corresponding to the selected band. |
| 26 | CM_IN | Cell RF input to Cell CDMA mixer and Cell AMPS mixer. |
| 27 | PM_IN | PCS mixer RF input. |
| 28 | Vcc_DIG | Supply voltage for logic control circuits. |
| 29 | Band_SEL | Logic input for band select. Logic LOW selects PCS or GPS. Logic HIGH selects cellular (AMPS). |
| 30 | LIN | Logic input for high or low linearity. Logic HIGH selects High linearity. |
| 31 | PLNA_OUT | PCS LNA output. Requires a pull-up inductor to $V_{CC}$ and a series blocking capacitor, which can be used as part of the output matching network. |
| 32 | Iset_PCS | Bias resistor for PCS LNA. For typical bias use a 560 Ω resistor to ground which sets the bias current for HGHL mode. |
| – | Paddle | Device ground and heat sink, requires good thermal path; RF reference plane. |

## Operation

The various operating modes are controlled by the logic inputs Band_SEL, Gain, LIN, LO/2 and BUFFEN. Table 1 shows the pin settings for the various operating modes.

**Table 1.** Mode Programming Truth Table (Continued)

| | | Logic Inputs [1] | | | | |
|---|---|---|---|---|---|---|
| **Mode** | **Condition** | **Band SEL** | **Gain** | **LIN** | **LO/2** | **BUFFEN** |
| Shut down | All circuits off | Low | Low | Low | X | X |
| PCS mode | High-gain, high-linearity | Low | High | High | X | X |
| | High-gain, low-linearity | Low | High | Low | X | X |
| | Activate PCS LO output buffer | Low | X | X | X | High |
| Cellular mode | High-gain, high-linearity | High | High | High | X | X |
| | High-gain, low-linearity | High | High | Low | X | X |
| | Low-gain | High | Low | High | X | X |
| | AMPS mode | High | Low | Low | X | X |
| | LO/2 On | High | X | X | High | X |
| | Activate Cell LO output buffer | High | X | X | X | High |
| GPS mode | | Low | Low | High | X | X |

Note: 1. The symbol X (“do not care”) means a logic input does not affect an operating mode.

## Absolute Maximum Ratings

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltages, no RF applied | $V_{CC}$ | -0.5 to +4.0 | V |
| Logic control voltages | $V_{CTRL}$ | -0.5 to +4.0 | V |
| Supply current | $I_{CC}$ | 50.0 | mA |
| RF and LO input signals | $P_{LO}$ ; $C_{LO;}$ CLNA_IN; PLNA_IN; GPSLNA_IN; | +5.0 | dBm |
| Storage temperature | $T_{STG}$ | -55 to +150 | °C |
| Operating case temperature | $T_C$ | -40 to +100 | °C |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Junction ambient | $R_{thJA}$ | TBD | K/W |

## DC Supply Characteristics

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions (no RF applied): Vcc = +2.75 V, $T_A$ = 25°C.

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| | **All Modes** | | | | | | | | |
| | Supply voltage | | | | 2.7 | 2.75 | 3.3 | V | |
| | Control voltage High | | | | 1.7 | | | V | |
| | Control voltage Low | | | | | | 0.5 | V | |
| | LO divider supply current | I_CC LO/2 = High - I_CC LO/2 = Low | | | | 1.7 | | mA | |
| | Cell LO Tx buffer current | BUFFEN = High | | | | 6.0 | | mA | |
| | PCS LO Tx buffer current | BUFFEN = High | | | | 8.5 | | mA | |
| | Logic-High current | | | | | | 100 | µA | |
| | Logic-Low current | | | | -5.0 | | | µA | |
| | Power-down supply current | Band_SEL, Gain, LIN = Low | | | | | 10 | µA | |

*) Type means: A =100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## AC Electrical Characteristics

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, all RF inputs and outputs with a return loss of 10 dB minimum

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| | **General Performance** | | | | | | | | |
| | Operating frequency range | Cellular band | | | 869 | 881.5 | 894 | MHz | |
| | | PCS band | | | 1930 | 1960 | 1990 | MHz | |
| | | A-GPS Band | | | | 1575.42 | | MHz | |
| | LO frequency range | Cellular band (LO/2 is Low): IF = 184 MHz | | | 685 | | 710 | MHz | |
| | | | | | 1053 | | 1078 | MHz | |
| | | Cellular band (LO/2 is High): IF = 184 MHz | | | 1370 | | 1420 | MHz | |
| | | | | | 2106 | | 2156 | MHz | |
| | | PCS band: IF = 184 MHz | | | 1746 | | 1806 | MHz | |
| | | | | | 2114 | | 2174 | MHz | |
| | | GPS band: IF = 183.6 MHz | | | | 1759.02 | | MHz | |
| | | | | | | 1391.82 | | MHz | |
| | IF frequency range | Cellular, PCS and GPS bands | | | 80 | 183.6 | 230 | MHz | |
| | LO input power level | Cellular, PCS and GPS bands | | | -10 | -5 | 0 | dBm | |
| | LO Tx buffer output power level | Cellularband, not matched at dedicated frequency | | | -8 | -5.5 | | dBm | |
| | | | | | -8 | -3 | | dBm | |

*) Type means: A =100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Cascade RF Electrical Characteristics (Cellular Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 881.5 MHz, LO = 2130 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -35 dBm (High-gain mode), LO/2 = Low, In case of activated LO/2 divider the current consumption increases by 2 mA. In a cascaded configuration Gain and IP3 values are also influenced by the SAW filter. No correction has been made for filter loss (1.6 dB) and interstage board trace losses.

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| | **Combined LNA and Mixer Performance, CDMA Modulation** | | | | | | | | |
| | **High-Gain High-Linearity Mode (HGHL)** | | | | | | | | |
| | Gain | Band_SEL = High; Gain = High; LIN = High | | G | | 26 | | dB | |
| | Noise figure | | | NF | | 2.1 | | dB | |
| | Input IP3 | | | IIP3 | | -3.9 | | dBm | |
| | Supply current | | | $I_{CC}$ | | 30 | | mA | |
| | **High-Gain Low-Linearity Mode (HGLL Paging Mode)** | | | | | | | | |
| | Gain | Band_SEL = High; Gain = High; LIN = Low | | G | | 25 | | dB | |
| | Noise figure | | | NF | | 2.1 | | dB | |
| | Input IP3 | | | IIP3 | | -7.2 | | dBm | |
| | Supply current | | | $I_{CC}$ | | 23 | | mA | |
| | **Low-Gain Mode (LG)** | | | | | | | | |
| | Gain | Band_SEL = High; Gain = Low; LIN = Low | | G | | 8.5 | | dB | |
| | Noise figure | | | NF | | 12.0 | | dB | |
| | Input IP3 | | | IIP3 | | 14 | | dBm | |
| | Supply current | | | Icc | | 28.5 | | mA | |
| | **Combined LNA and Mixer Performance, AMPS Modulation** | | | | | | | | |
| | Gain | Band_SEL = High; Gain = Low; LIN = Low | | G | | 24 | | dB | |
| | Noise figure | | | NF | | 2.5 | | dB | |
| | Input IP3 | | | IIP3 | | -10 | | dBm | |
| | Supply current | | | Icc | | 23 | | mA | |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Cascade RF Electrical Characteristics (PCS Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 1960 MHz, LO = 2143.6 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -30 dBm (High-gain mode). In a cascaded configuration Gain and IP3 values are also influenced by the SAW filter. No correction has been made for filter loss (2.4 dB) and interstage board trace losses.

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| | **Combined LNA and Mixer Performance (CDMA Modulation)** | | | | | | | | |
| | **High-Gain High-Linearity Mode (HGHL)** | | | | | | | | |
| | Gain | Band_SEL = Low; Gain = High; LIN = High | | G | | 26 | | dB | |
| | Noise figure | | | NF | | 2.4 | | dB | |
| | Input IP3 | | | IIP3 | | -3.9 | | dBm | |
| | Supply current | | | Icc | | 30 | | mA | |
| | **High-Gain Low-Linearity Mode (HGLL Paging mode)** | | | | | | | | |
| | Gain | Band_SEL = Low; Gain = High; LIN = Low | | G | | 25 | | dB | |
| | Noise figure | | | NF | | 2.5 | | dB | |
| | Input IP3 | | | IIP3 | | -6.7 | | dBm | |
| | Supply current | | | Icc | | 24 | | mA | |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Cascade RF Electrical Characteristics (GPS Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 1960 MHz, LO = 2143.6 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -30 dBm (High-gain mode). In a cascaded configuration Gain and IP3 values are also influenced by the SAW filter. No correction has been made for filter loss (1.7 dB) and interstage board trace losses.

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| | **Combined LNA and Mixer Performance** | | | | | | | | |
| | Gain | Band_SEL = Low; Gain = Low; LIN = High | | G | | 33 | | dB | |
| | Noise figure | | | NF | | 1.8 | | dB | |
| | Input IP3 | | | IIP3 | | -15 | | dBm | |
| | Supply current | | | Icc | | 23.5 | | mA | |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Typical Electrical Characteristics LNA and Mixer Separately (Cellular Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 881.5 MHz, LO = 2130.82 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -25 dBm (High-gain mode).

| No. | Parameters | Test Conditions | Gain (dB) | NF (dB) | IIP3 (dBm) | Type* |
|---|---|---|---|---|---|---|
| | **Cell Band, High-Gain High-Linearity Mode (HGHL); CDMA Modulation** | | | | | |
| | Cell LNA | Band_SEL = High; Gain = High; LIN = High | 16 | 1.5 | 11.5 | |
| | Cell mixer | | 12 | 7.0 | 11.5 | |
| | **Cell Band, High-Gain Low-Linearity Mode (HGLL); CDMA Modulation** | | | | | |
| | Cell LNA | Band_SEL = High; Gain = High; LIN = Low | 15 | 1.6 | 8.5 | |
| | Cell mixer | | 11.5 | 6.8 | 7.5 | |
| | **Cell Band, Low-Gain Mode (LG); CDMA Modulation** | | | | | |
| | Cell LNA | Band_SEL = High; Gain = Low; LIN = High | -2.2 | 4.0 | 24.0 | |
| | Cell mixer | | 12 | 7.0 | 11.5 | |
| | **Cell Band, AMPS Modulation** | | | | | |
| | Cell LNA | Band_SEL = High; Gain = Low; LIN = Low | 15 | 1.6 | 8.5 | |
| | Cell mixer | | 10 | 9.0 | 4 | |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Typical Electrical Characteristics LNA and Mixer Separately (PCS Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 1960 MHz, LO = 2143.6 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -25 dBm (High-gain mode).

| No. | Parameters | Test Conditions | Gain (dB) | NF (dB) | IIP3 (dBm) | Type* |
|---|---|---|---|---|---|---|
| | **PCS Band, High-Gain High-Linearity Mode (HGHL); CDMA Modulation** | | | | | |
| | PCS LNA | Band_SEL = Low; Gain = High; LIN = High | 15 | 1.6 | 9.0 | |
| | PCS mixer | | 13 | 6.7 | 10.5 | |
| | **PCS Band, High-Gain Low-Linearity Mode (HGLL); CDMA Modulation** | | | | | |
| | PCS LNA | Band_SEL = Low; Gain = High; LIN = Low | 15 | 1.6 | 6.5 | |
| | PCS mixer | | 13 | 6.0 | 5.5 | |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design paramete

## Typical Electrical Characteristics LNA and Mixer Separately (GPS Band)

Test conditions: Unless otherwise noted, the following conditions apply to typical performance specification under static conditions: $V_{CC}$ = +2.75 V, $T_A$ = 25°C, RF = 1575.42 MHz, LO = 1391.82 MHz, IF = 183.6 MHz, LO input = -5.0 dBm, RF input = -35 dBm (High-gain mode).

| No. | Parameters | Test Conditions | Gain (dB) | NF (dB) | IIP3 (dBm) | Type* |
|---|---|---|---|---|---|---|
| | **A-GPS Mode** | | | | | |
| | Cell LNA | Band_SEL = Low; Gain = Low; LIN = Low | 19.5 | 1.5 | -4.0 | |
| | Cell mixer | | 16 | 7.9 | -1 | |

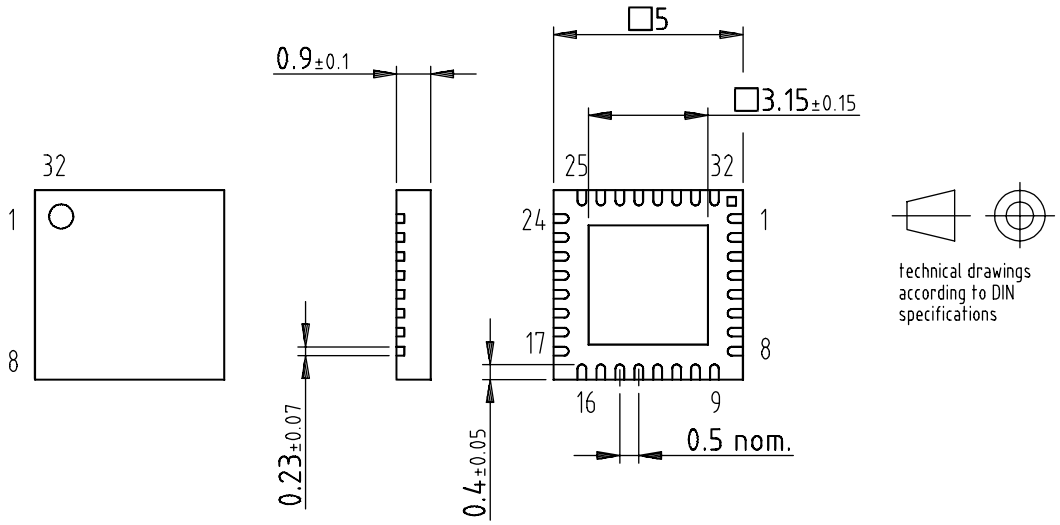
*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| T0353 | HP-VFQFP-N32 | TBD |

## Package Information

Package: HP-VFQFP-N32
(acc. JEDEC OUTLINE No. MO-220)
Dimensions in mm




Drawing-No.: 6.543-5087.01-4
Issue: 1; 26.02.02

Note: GND solder mask opening is not centered on the package.

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