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## 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.



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

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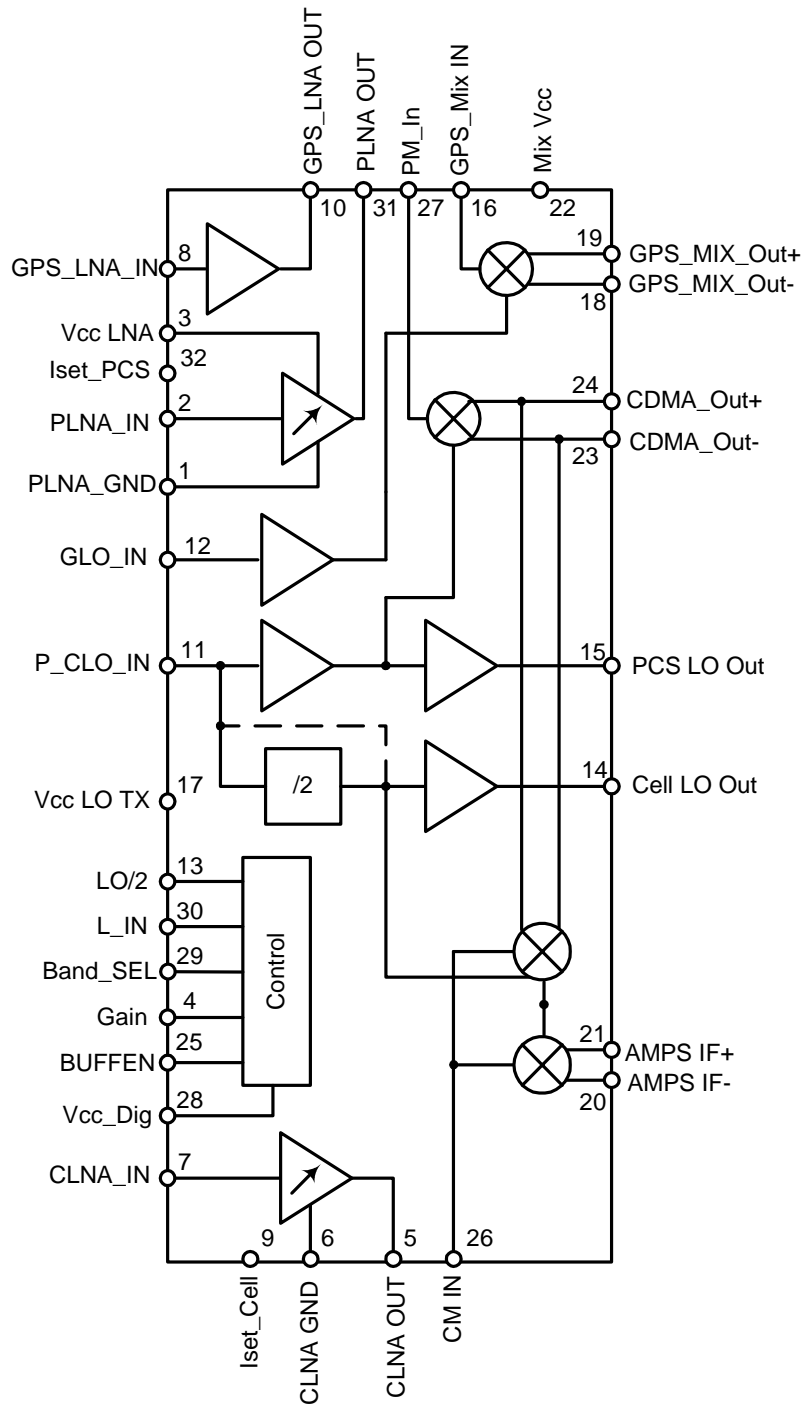
## T0353

## Preliminary (Summary)

Rev. 4559AS-CDMA-10/02

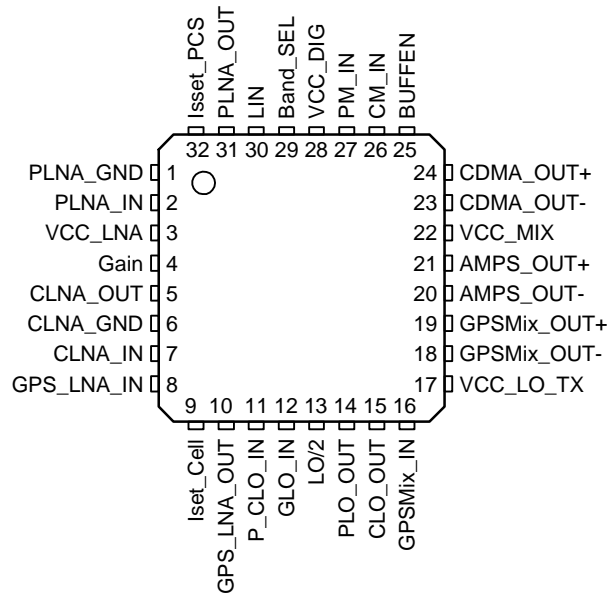


Figure 1. Block Diagram



## 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 $\Omega$ 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 $\Omega$ . 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 <sub>CC</sub> 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)

Mode	Condition	Logic Inputs <sup>(1)</sup>				
		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):  $V_{CC} = +2.75$  V,  $T_A = 25^\circ\text{C}$ .

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
<b>All Modes</b>									
	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	$I_{CC\ LO/2} = \text{High} -$ $I_{CC\ LO/2} = \text{Low}$				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	$\mu\text{A}$	
	Logic-Low current				-5.0			$\mu\text{A}$	
	Power-down supply current	Band_SEL, Gain, LIN = Low					10	$\mu\text{A}$	

\*) 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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , all RF inputs and outputs with a return loss of 10 dB minimum

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*	
<b>General Performance</b>										
	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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $RF = 881.5\text{ MHz}$ ,  $LO = 2130\text{ MHz}$ ,  $IF = 183.6\text{ MHz}$ ,  $LO\text{ input} = -5.0\text{ dBm}$ ,  $RF\text{ input} = -35\text{ dBm}$  (High-gain mode),  $LO/2 = \text{Low}$ , 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*
<b>Combined LNA and Mixer Performance, CDMA Modulation</b>									
<b>High-Gain High-Linearity Mode (HGHL)</b>									
	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 <sub>CC</sub>		30		mA	
<b>High-Gain Low-Linearity Mode (HGLL Paging Mode)</b>									
	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 <sub>CC</sub>		23		mA	
<b>Low-Gain Mode (LG)</b>									
	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			I <sub>CC</sub>		28.5		mA	
<b>Combined LNA and Mixer Performance, AMPS Modulation</b>									
	Gain	Band_SEL = High; Gain = Low; LIN = Low		G		24		dB	
	Noise figure			NF		2.5		dB	
	Input IP3			IIP3		-10		dBm	
	Supply current			I <sub>CC</sub>		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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , 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*
<b>Combined LNA and Mixer Performance (CDMA Modulation)</b>									
<b>High-Gain High-Linearity Mode (HGHL)</b>									
	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	
<b>High-Gain Low-Linearity Mode (HGLL Paging mode)</b>									
	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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , 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*
<b>Combined LNA and Mixer Performance</b>									
	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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $RF = 881.5\text{ MHz}$ ,  $LO = 2130.82\text{ MHz}$ ,  $IF = 183.6\text{ MHz}$ ,  $LO\text{ input} = -5.0\text{ dBm}$ ,  $RF\text{ input} = -25\text{ dBm}$  (High-gain mode).

No.	Parameters	Test Conditions	Gain (dB)	NF (dB)	IIP3 (dBm)	Type*
<b>Cell Band, High-Gain High-Linearity Mode (HGHL); CDMA Modulation</b>						
	Cell LNA	Band_SEL = High; Gain = High; LIN = High	16	1.5	11.5	
	Cell mixer		12	7.0	11.5	
<b>Cell Band, High-Gain Low-Linearity Mode (HGLL); CDMA Modulation</b>						
	Cell LNA	Band_SEL = High; Gain = High; LIN = Low	15	1.6	8.5	
	Cell mixer		11.5	6.8	7.5	
<b>Cell Band, Low-Gain Mode (LG); CDMA Modulation</b>						
	Cell LNA	Band_SEL = High; Gain = Low; LIN = High	-2.2	4.0	24.0	
	Cell mixer		12	7.0	11.5	
<b>Cell Band, AMPS Modulation</b>						
	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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $RF = 1960\text{ MHz}$ ,  $LO = 2143.6\text{ MHz}$ ,  $IF = 183.6\text{ MHz}$ ,  $LO\text{ input} = -5.0\text{ dBm}$ ,  $RF\text{ input} = -25\text{ dBm}$  (High-gain mode).

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

## 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:  $V_{CC} = +2.75\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_F = 1575.42\text{ MHz}$ ,  $LO = 1391.82\text{ MHz}$ ,  $IF = 183.6\text{ MHz}$ ,  $LO\text{ input} = -5.0\text{ dBm}$ ,  $RF\text{ input} = -35\text{ dBm}$  (High-gain mode).

No.	Parameters	Test Conditions	Gain (dB)	NF (dB)	IIP3 (dBm)	Type*
<b>A-GPS Mode</b>						
	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

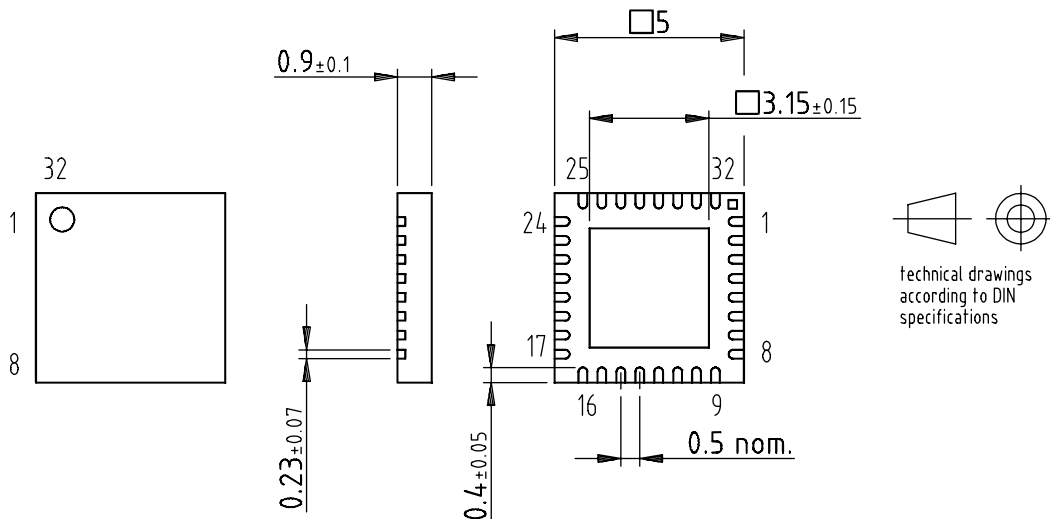
Extended Type Number	Package	Remarks
T0353	HP-VFQFP-N32	TBD

## 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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