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ATR4253C

Integrated Circuit Solution for Active Antennas

DATASHEET

Features

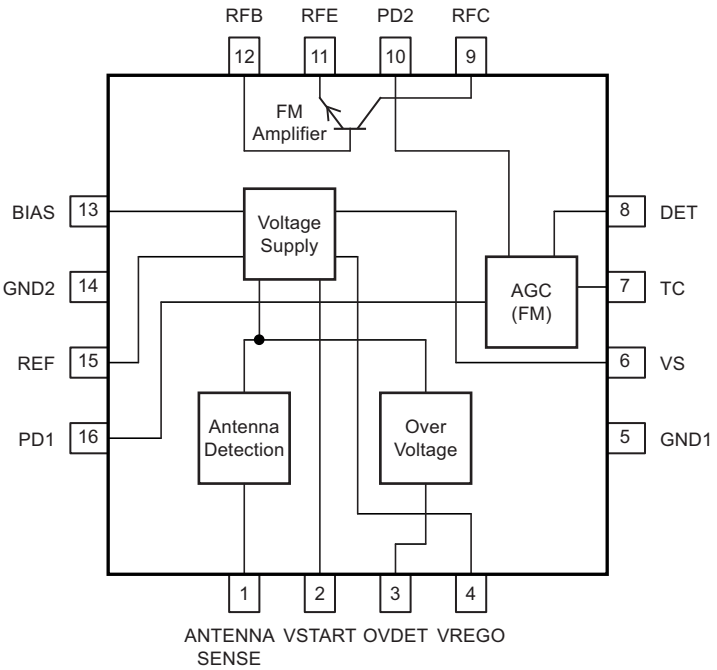
- Highly integrated - All-in-one active antenna IC
- Operating frequency range: 50MHz to 900MHz
- Main application 76MHz to 108MHz (broadcast FM worldwide)
- Integrated AGC
- Integrated driver for PIN diodes
- Integrated power supply regulator
- Integrated antenna sensor
- High dynamic range
- Excellent noise performance
- High intercept point 3rd order
- RF amplifier adjustable to various cable impedances
- Low noise output voltage
- Low power consumption

1. Description

The Atmel® ATR4253C is a highly integrated high-performance IC for active antenna amplification. The device has a built-in AGC, antenna detection, a power supply regulator and two driver stages for external PIN diodes.

The Atmel ATR4253C is based on BICMOS technology. The device is designed in particular for car applications and is suitable for active antennas located in several positions within the car such as bumpers, windscreen, mirrors or windows.

Figure 1-1. Block Diagram



2. Pin Configuration

Figure 2-1. Pinning QFN 3x3 / 16 Pins

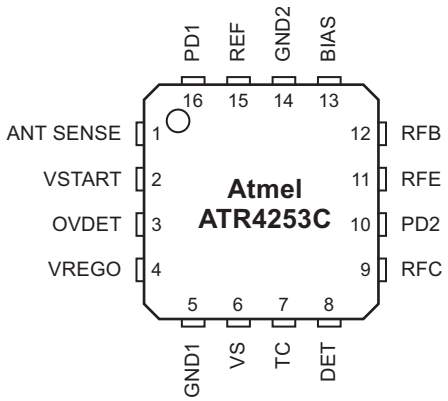


Table 2-1. Pin Description

Pin	Symbol	Function
1	ANT SENSE	Antenna sense input
2	VSTART	Comparator input of voltage detector
3	OVDET	Overvoltage detection input
4	VREGO	Voltage regulator output
5	GND1	Ground voltage regulator
6	VS	Supply voltage
7	TC	AGC time constant
8	DET	AGC level detector input
9	RFC	Amplifier collector (NPN)
10	PD2	2nd AGC output for pin diode
11	RFE	Amplifier emitter (NPN)
12	RFB	Amplifier base (NPN)
13	BIAS	Bias voltage (2.7V)
14	GND2	Ground FM
15	REF	Reference voltage (6V)
16	PD1	1st FM AGC output for pin diode
Paddle	GND	Ground paddle

3. Functional Description

The Atmel® ATR4253C is a highly integrated antenna amplifier with a broad range of features and functions. It compensates cable losses between the antenna and the car radio, which is usually placed far away from the antenna. The device can be used in the frequency range of 50MHz up to 900MHz (i.e., FM, DAB (+), DMB, DVB-T, ISDB-T, etc.) and has the flexibility to address different antenna types (e.g., glass, windscreen, roof antennas).

A separate automatic gain control (AGC) function is integrated in order to avoid overdriving the RF amplifier at large signal conditions.

The integrated PIN diode drivers help to reduce the external component cost and to minimize the board space.

The external component cost can be further reduced as the voltage regulation stage is also integrated. This stage provides overvoltage protection and current limitation. An external transistor is used as power driver for this stage.

3.1 RF Amplifier Stage

The RF amplifier is realized with a high-performance NPN transistor. This allows the use of an amplifier configuration which is optimized for the individual application requirements. For low-cost applications, the common emitter configuration enables good performance at reasonable BOM cost. For high-end applications, a common base configuration with transformer feedback provides high IP3 and low noise figures at reasonable current consumption. In both configurations, gain, input and output impedance can be adjusted by modifying the external components.

The bias voltage (BIAS) for the base of the NPN transistor is derived from an integrated voltage reference and has a PTAT (proportional to absolute temperature) behavior. The bias current of the RF amplifier is defined by an external resistor and is kept constant over temperature.

3.2 AGC

The IC is equipped with an AGC functionality to prevent overdriving the amplifier in case the amplifier is operated at strong antenna signals, e.g., near transmitters. It is possible to realize an additional antenna amplifier path with integrated AGC and external RF transistor. The bandwidth of the integrated AGC circuit is 900MHz.

The amplifier output (RFC) is connected to a capacitive voltage divider and the divided signal is applied to the AGC level detector at pin DET. This level detector input is optimized for low distortion. The rectified signal is compared against an internal reference. The divider ratio of the external voltage divider defines the AGC's threshold. If the threshold is reached, pin PD1 drives a positive current through one or two external pin diodes in shunt configuration. In case the limiting range of the shunt configuration is not sufficient an additional pin diode in serial configuration can be added and controlled via pin PD2. The current from PD2 through the serial pin diode is opposite to the current of PD1. This helps to limit the amplifier input signal and thus to prevent the FM amplifier from signal overdrive.

The drivers required for the external pin diode(s) are built-in into the Atmel ATR4253C IC, which reduces the BOM cost and the application size.

3.3 Supply Voltage Regulator

The driving voltage for an external power transistor is provided by an integrated regulator circuit.

An overvoltage protection circuit detects overvoltage condition and switches off the amplifier and AGC circuit in order to reduce current consumption and avoid thermal overload.

3.4 Antenna Sensor

The Atmel ATR4253C provides a built-in antenna sensor that detects if the antenna is properly connected to the amplifier module. If no antenna is detected, the amplifier and AGC circuit are switched off to signal this error via supply current reduction to the unit that provides and monitors the supply current for the antenna amplifier (e.g., the car radio).

4. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameters	Pin	Symbol	Min.	Max.	Unit
Supply voltage	6	V_S	–0.3	+12	V
Antenna sense current	1	ANT SENSE	–500	+500	µA
Comparator input current	2	VSTART	0	2	mA
Overvoltage detector	3	OVDET	–0.3	+3.3	V
Collector of FM amplifier	9	RFC	3	16	V
Power dissipation		P_{tot}		700	mW
Junction temperature		T_j		150	°C
Ambient temperature		T_{amb}	–40	+115	°C
Storage temperature		T_{stg}	–50	+150	°C
ESD HBM	All	V_{HBM}	–2	+2	kV

5. Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient, soldered on PCB, dependent on PCB layout	R_{thJA}	40	K/W

6. Operating Range

Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Normal operation	6	V_S	7.5	10	11	V
Supply voltage	Performance may be reduced, no malfunction	6	V_S	7		11	V
FM emitter current	Thermal condition	11	I_{RFE}			35	mA

7. Electrical Characteristics

See test circuit (Figure 8-2 on page 9), V_S = 10V, T_{amb} = 25°C, unless otherwise specified.

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
1.1	Supply current	AGC OFF	VS	Is		12		mA	B
		AGC ON, includes 7mA pin diode current	VS	Is		19		mA	B
		Antenna sense error detected	VS	Is	15	20	25	mA	A
		Over voltage	VS	Is		10	14.9	mA	A
		T_{amb} = –40 to +115°C; AGC ON; includes 7mA pin diode current and 31mA RF current	VS, RFC	Is, I_{RFC}		50	70	mA	C
1.2	Bias voltage output		BIAS	V_{BIAS}	2.5	2.8	3.1	V	A
1.3	Output current of bias voltage		BIAS	I_{BIAS}	0		3	mA	B
1.5	Bias voltage output	1kΩ output resistor	REF	V_{REF}	5.7	6	6.3	V	A
2	RF Amplifier								
2.1	Emitter voltage	T = 25°C	RFE		2.0	2.1	2.2	V	A
2.2	Emitter voltage	T = –40°C to +115°C	RFE		1.9	2.1	2.3	V	C
2.3	Supply current(1)	Common base	RFC	I_{RFC}		31		mA	B
2.4	Supply current(2)	Common emitter	RFC	I_{RFC}		35		mA	A
2.5	Maximum output voltage	V_s = 10V	RFC		12			V_{pp}	C
2.6	Input resistance	f = 100MHz	RF IN	R_{FMIN}		50		Ω	C
2.7	Output resistance	f = 100MHz	RF OUT	R_{FMOUT}		50		Ω	C
2.8	Power gain	f = 100MHz	RF IN, RF OUT	G		5.2		dB	C
2.9	OIP3 at FMOUT	Common base	RF OUT			146		dBµV	C
2.10	NF	Common base	RF OUT			1.6		dB	C
2.11	Power gain	f = 100MHz, common emitter	RF OUT	G		13.5		dB	B
2.12	OIP3 at FMOUT	Common emitter	RF OUT			140		dBµV	B
2.13	NF	Common emitter	RF OUT			3.5		dB	C
2.14	Maximum operating frequency	3dB corner, common emitter	RF OUT		450			MHz	C
3	AGC								
3.1	AGC input voltage threshold	FM range: f = 100MHz Extended: f = 900MHz	DET	$V_{th1,100}$ $V_{thl,900}$	83 81	85 85	87 89	dBµV dBµV	B C
3.2	Saturation voltage	10mA	PD1,2			VS – 2.0		V	B
3.3	Leakage current		PD1,2				1	µA	B
3.4	Maximum pin diode current	AGC active, 115°C	PD1		12	19		mA	D
3.5	Maximum pin diode current	AGC not active	PD2		12			mA	A

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

Notes: 1. Current defined by R11= 68Ω
2. Current defined by R11= 56Ω

7. Electrical Characteristics (Continued)

See test circuit (Figure 8-2 on page 9), V_S = 10V, T_{amb} = 25°C, unless otherwise specified.

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
3.6	Input resistance		DET	R_{DET}	17		25	kΩ	C
3.7	Input capacitance	f = 100MHz	DET	C_{DET}	1.5		2.0	pF	C
3.8	IP3 Pin 8 FM	100MHz + 105MHz, VDET = 120dBµV	DET			150		dBµV	C
3.9	Transconductance	dI_{FMTC} / dV_{FMDET}	TC DET	dI_{TC} / dV_{DET}	0.35	0.5	0.8	mA/V (rms)	B
4	Voltage Regulator / Monitor								
4.1	Output voltage of regulator	Battery voltage V_B = 14V	VS		9.5	10	10.5	V	A
4.2	Ripple rejection of regulator	100Hz, $V_B > V_S$ + 1V	VB, RF OUT		40	50		dB	C
4.3	Threshold for over-voltage detection		OVDET		1.6		1.8	V	A
4.4	Hysteresis of overvoltage detection		OVDET			5		%	C
5	Antenna Sensor								
5.1	Antenna monitor range	R_{SENSE} = 22kΩ, antenna detected	ANT SENS		0 to 3		6 to 16	V	C

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

Notes: 1. Current defined by R11= 68Ω
2. Current defined by R11= 56Ω

8. Application Circuits

Figure 8-1. Common Emitter Configuration

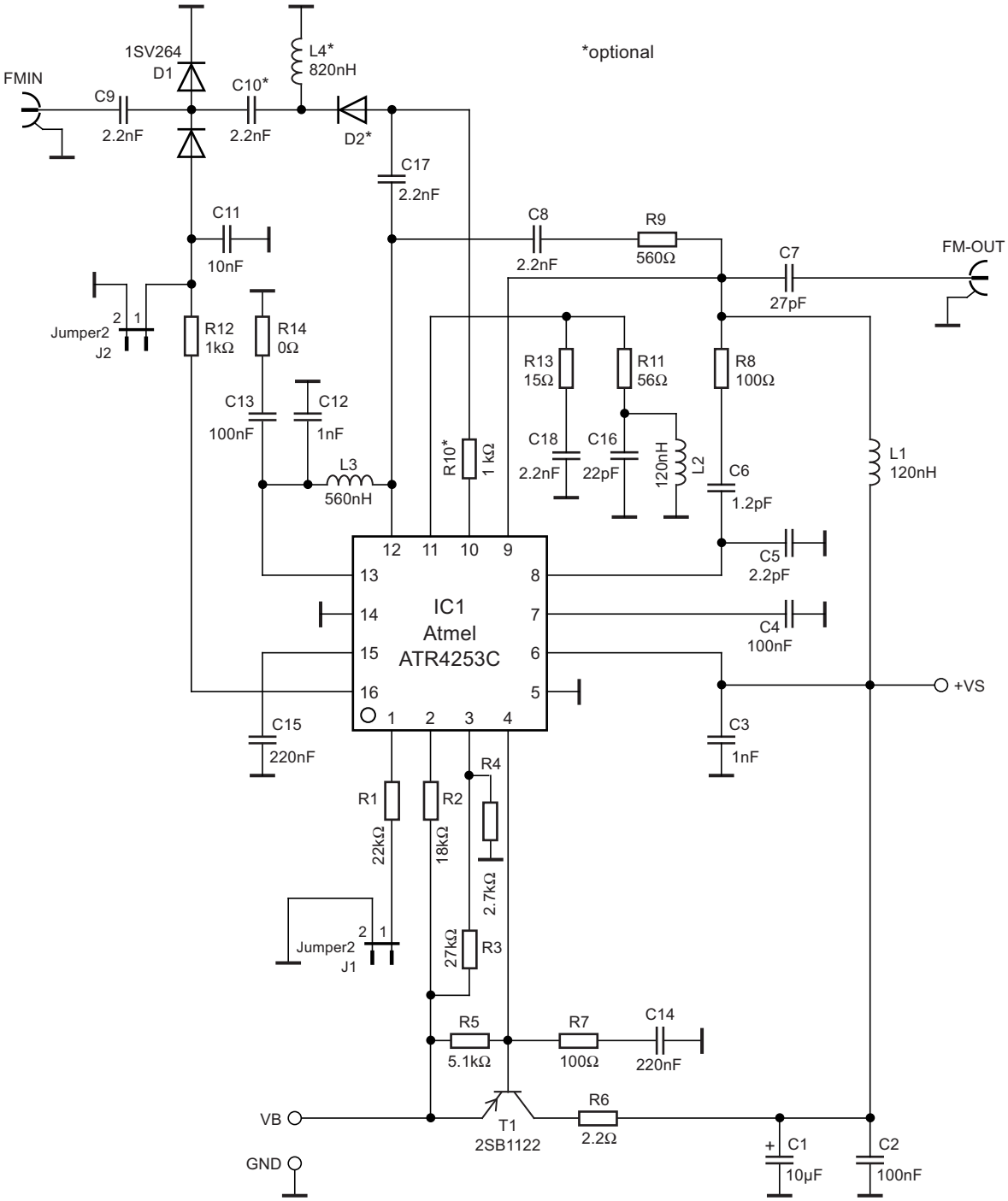


Figure 8-2. Common Base Configuration

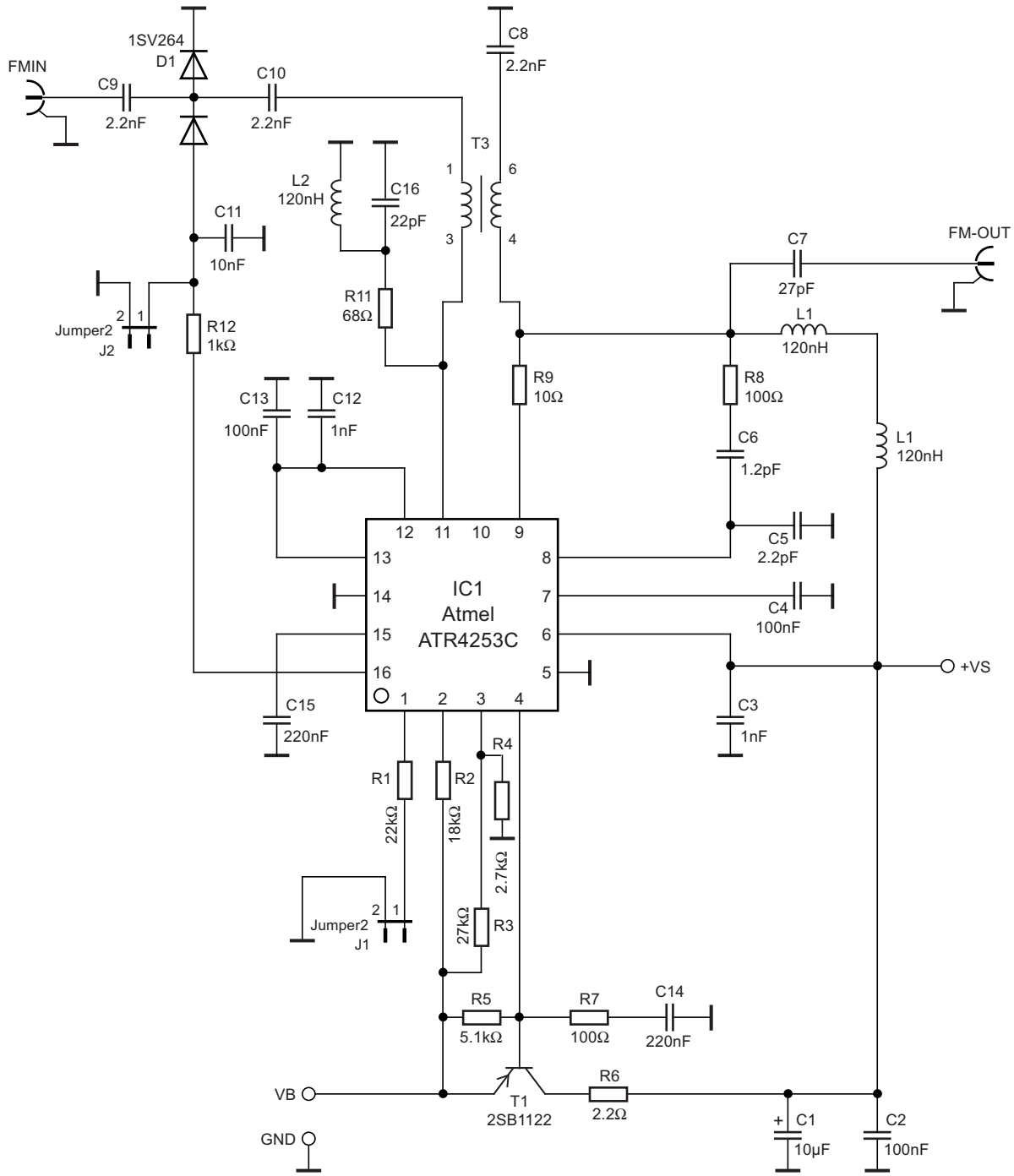
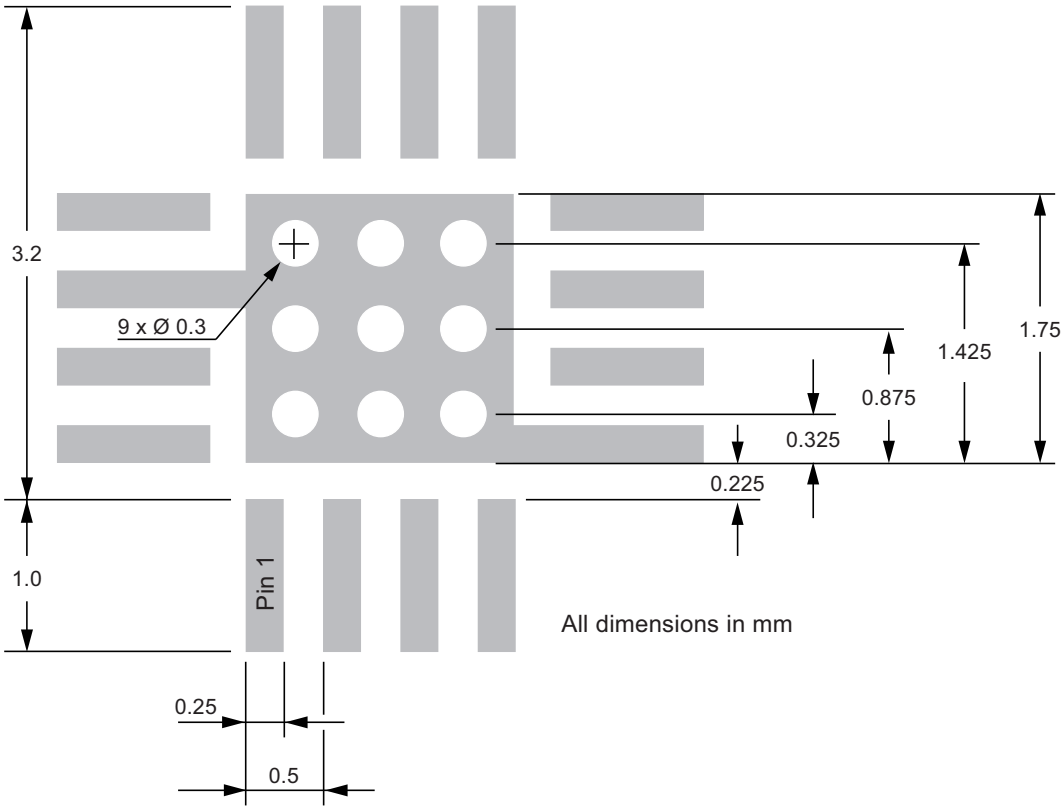


Figure 8-3. Recommended Footprint



9. Internal Circuitry

Table 9-1. Equivalent Pin Circuits (ESD Protection Circuits not Shown)

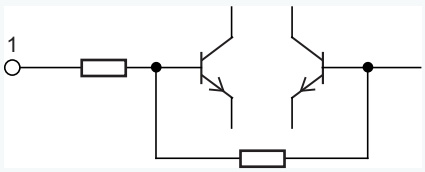
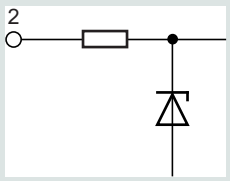
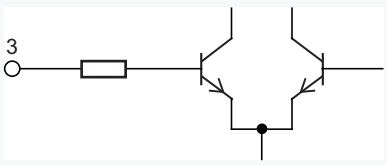
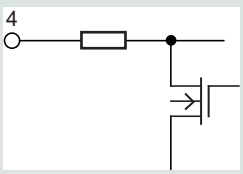
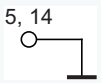
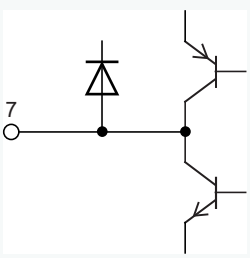
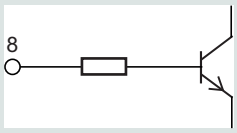
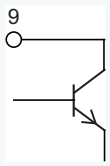
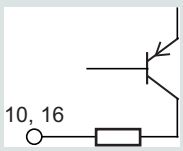
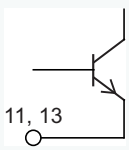
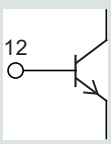
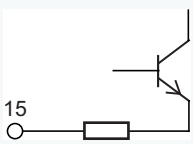
Pin	Symbol	Function
1	ANT SENSE	
2	VSTART	
3	OVDET	
4	VREGO	
5, 14	GND1, GND2	
6	VS	
7	TC	

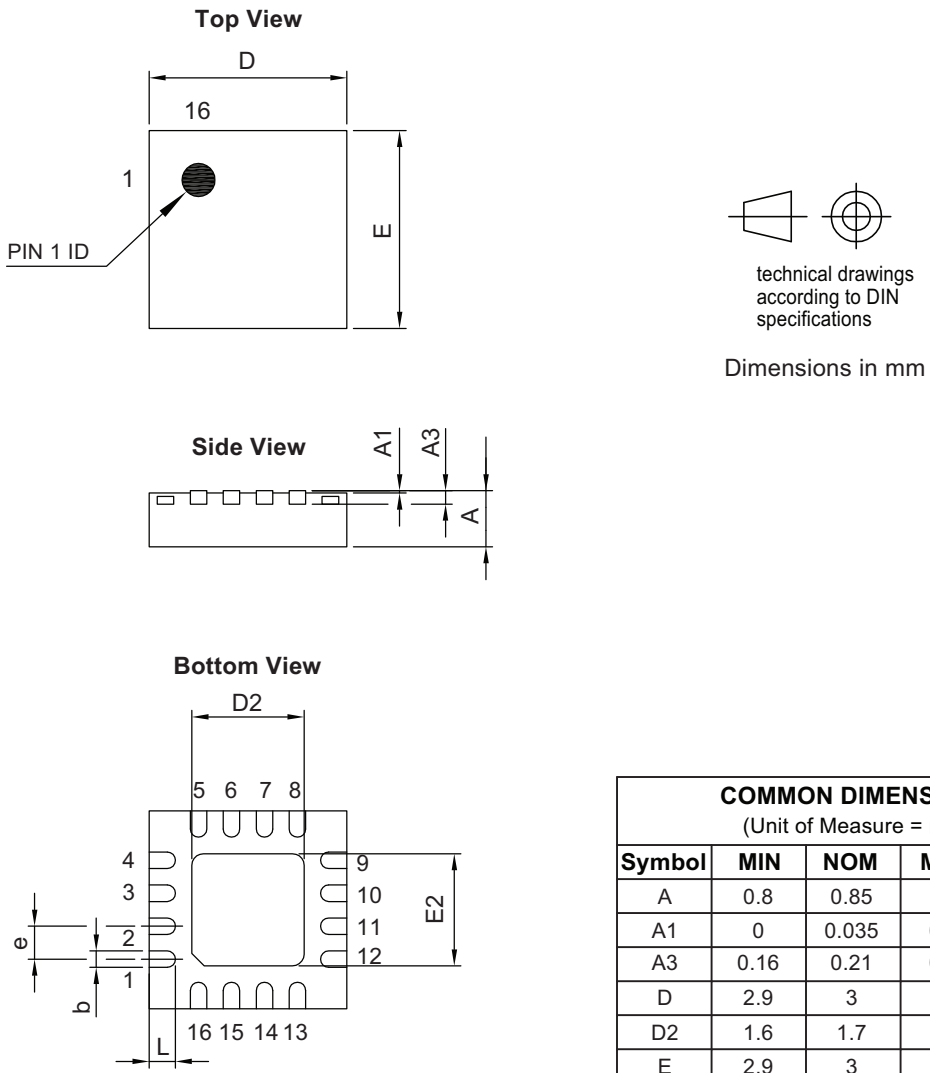
Table 9-1. Equivalent Pin Circuits (ESD Protection Circuits not Shown) (Continued)

Pin	Symbol	Function
8	DET	
9	RFC	
10, 16	PD1, PD2	
11, 13	RFE, BIAS	
12	RFB	
15	REF	

10. Ordering Information

Extended Type Number	Package	Remarks	MOQ
ATR4253C-PVQW-1	VQFN 3x3 / 16L	Taped and reeled	8000 pieces

11. Package Information



COMMON DIMENSIONS (Unit of Measure = mm)				
Symbol	**MIN**	**NOM**	**MAX**	**NOTE**
A	0.8	0.85	0.9	
A1	0	0.035	0.05	
A3	0.16	0.21	0.26	
D	2.9	3	3.1	
D2	1.6	1.7	1.8	
E	2.9	3	3.1	
E2	1.6	1.7	1.8	
L	0.35	0.4	0.45	
b	0.2	0.25	0.3	
e		0.5		

05/20/14

	TITLE	GPC	DRAWING NO.	REV.
Atmel **Package Drawing Contact:** packagedrawings@atmel.com	**Package: QFN_3x3_16L** Exposed pad 1.7x1.7		6.543-5186.01-4	1

12. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
9265C-AUDR-11/14	• Section 10 “Ordering Information” on page 13 updated • Section 11 “Package Information” on page 13 updated
9265B-AUDR-08/14	• Put datasheet in the latest template

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