

Features

- 700 MHz to 2700 MHz Operating Frequency
- Very Low Noise Floor Performance
- Very Good Sideband and Carrier Suppression
- Supports Wideband Baseband Input
- Very High Linearity
- Very Low LO Leakage
- 50 Ω Impedance on RF and LO Port
- Low LO Drive Requirements
- No External IF Filter
- Supply Voltage 5 V
- Small SSOP16 Package

Applications

- Infrastructure Digital Communication Systems
- GSM/TDMA/CDMA2000/W-CDMA/UMTS/ISM Band Transceivers
- RF Radio Links
- Wireless Modem Access Points
- High Performance RF Instrumentation

Electrostatic sensitive device.
Observe precautions for handling.



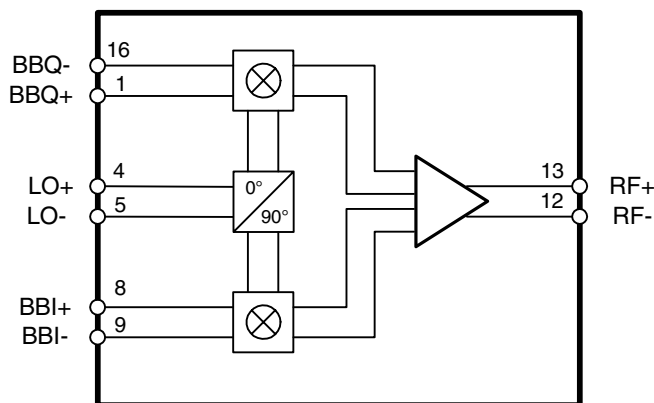
Description

The T0790 is a direct quadrature modulator using Atmel's Silicon-Germanium (SiGe) process.

This modulator features a frequency range of 700 to 2700 MHz with excellent carrier and sideband suppression and a very low noise floor. It operates from a single 5 V supply and provides -11 dBm of power while requiring only 0 dBm input to the integrated LO driver. An RF and an LO amplifier are also included.

The T0790 incorporates internal matching on each RF, IF and LO port to enhance ease of use and to reduce the external components required. The LO input can be driven differentially or single ended.

Figure 1. Block Diagram



700 MHz - 2700 MHz Direct Quadrature Modulator

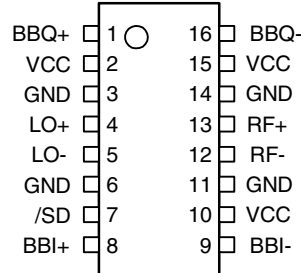
T0790

Preliminary



Pin Configuration

Figure 2. Pinning SSOP16



Pin Description

Pin	Symbol	Function
1	BBQ+	Baseband Q-axis positive input
2	VCC	Supply voltage
3	GND	Ground
4	LO_IN+	Positive local oscillator input, nominal DC voltage is 2.0 V internally biased; input should be AC-coupled
5	LO_IN-	Negartive local oscillator input, nominal DC voltage is 2.0 V internally biased; input should be AC-coupled
6	GND	Ground
7	/SD	Shutdown control
8	BBI+	Baseband I-axis positive input
9	BBI-	Baseband I-axis negative input
10	VCC	Supply voltage
11	GND	Ground
12	RF_IN-	Negative RF output; nominal DC voltage is 2.4 V internally biased; input should be AC-coupled
13	RF_IN+	Positive RF output; nominal DC voltage is 2.4 V internally biased; input should be AC-coupled
14	GND	Ground
15	VCC	Supply voltage
16	BBQ-	Baseband Q-axis negative input
–	Paddle	Device ground and heat sink, requires good thermal path; RF reference plane

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	Symbols	Value	Unit
Supply voltage, no RF applied	V_{CC}	5.5	V
LO input signals	LO_IN-, LO_IN+	+10.0	dBm
Input voltage	BBI+, BBI-, BBQ+, BBQ-	3	V
Operating case temperature	T_C	-40 to +85	°C
Storage temperature	T_{STG}	-55 to +150	°C

Thermal Resistance

Parameters	Symbols	Value	Unit
Junction ambient	R_{thJA}	35	K/W

Electrical Characteristics

Test conditions:

Unless otherwise noted, the following conditions apply to typical performance specification under static conditions:

$V_{CC} = 5\text{ V}$, $T_{amb} = 25^\circ\text{C}$; baseband inputs: 1.9 V DC bias, 200 kHz frequency, 300 mV_{P-P} 600 mV_{P-P} differential drive, I/Q signals in quadrature, LO = 1960 MHz; $P_{LO} = -5\text{ dBm}$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
General Performance									
	Supply voltage		2, 10, 15	V_{CC}	4.75	5.0	5.25	V	A
	Supply current		2, 10, 15	I_{CC}		73	82	mA	A
LO Input									
	LO drive		4, 5	P_{LO}	-8	-5	-2	dBm	D
	LO frequency		4, 5	f_{LO}	700		2700	MHz	B
	LO return loss	Matched to 50 Ω	4, 5	RL_{LO}		16		dB	C
Baseband Inputs									
	Baseband input frequency range	-3 dB bandwidth, baseband inputs, terminated with 50 Ω	1, 8, 9, 16	f_{BB}	DC		500	MHz	D
	Baseband input resistance	Per pin	1, 8, 9, 16	R_{BB}		4.4		k Ω	D
	Baseband input capacitance	Per pin	1, 8, 9, 16	C_{BB}		4		pF	D
Miscellaneous									
	Shutdown attenuation		7	A_{SD}		60		dB	D
	Shutdown pin resistance	At 1 MHz	7	R_{SD}		11.9		k Ω	D
	Shutdown pin capacitance	At 1 MHz	7	C_{SD}		5.2		pF	D
	Shutdown input thresholds	Shutdown disabled (normal operation)	7	3.75		V_{CC}		V	D
		Shutdown enabled	7	0		1.5		V	D

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

RF Electrical Characteristics (700 to 1000 MHz)

Test conditions:

Unless otherwise noted, the following conditions apply to typical performance specification under static conditions:

$V_{CC} = 5\text{ V}$, $T_{amb} = 25^\circ\text{C}$; baseband inputs: 1.9 V DC bias, 200 kHz frequency, 300 mV_{P-P} 600 mV_{P-P} differential drive, I/Q signals in quadrature, LO = 900 MHz; $P_{LO} = -5\text{ dBm}$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
RF Output Port									
	RF frequency		12, 13	f_{RF}	700		1000	MHz	B
	Output power		12, 13	P_{RFout}	-13.0	-10.5	-9.0	dBm	A
	RF return loss	Matched to 50 Ω	12, 13	P_{LORL}		20		dB	D
	1-dB output compression point		12, 13	P_{1dB}	3	4		dBm	A
	LO-RF leakage		12, 13	P_{LORF}		-40	-34	dBm	D
	Sideband suppression		12, 13	A_{SB}	34	40		dB	D
	IM3 suppression	Two tone baseband input at 600 mV _{P-P} differential per tone	12, 13	A_{IM3}	58	62		dB	D
	Broadband noise floor		12, 13	P_{NOISE}		-154	-148	dBm/Hz	C
	Quadrature phase error		12, 13		-2	± 0.5	+2	$^\circ$	B
	I/Q amplitude balance		12, 13		-0.2	± 0.5	+0.2	dB	B

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

RF Electrical Characteristics (1700 to 2000 MHz)

Test conditions:

Unless otherwise noted, the following conditions apply to typical performance specification under static conditions:

$V_{CC} = 5\text{ V}$, $T_{amb} = 25^\circ\text{C}$; baseband inputs: 1.9 V DC bias, 200 kHz frequency, 300 mV_{P-P} 600 mV_{P-P} differential drive, I/Q signals in quadrature, LO = 1960 MHz; $P_{LO} = -5\text{ dBm}$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
RF Output Port									
	RF frequency		12, 13	f_{RF}	1700		2000	MHz	B
	Output power		12, 13	P_{RFout}	-15.0	-11.5	-10.0	dBm	A
	RF return loss	Matched to 50 Ω	12, 13	P_{LORL}		16		dB	D
	1-dB output compression point		12, 13	P_{1dB}	2	3		dBm	A
	LO-RF leakage		12, 13	P_{LORF}		-40	-32	dBm	D
	Sideband suppression		12, 13	A_{SB}	34	40		dB	D
	IM3 suppression	Two tone baseband input at 600 mV _{P-P} differential per tone	12, 13	A_{IM3}	58	62		dB	D

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

RF Electrical Characteristics (1700 to 2000 MHz) (Continued)

Test conditions:

Unless otherwise noted, the following conditions apply to typical performance specification under static conditions:

$V_{CC} = 5\text{ V}$, $T_{amb} = 25^\circ\text{C}$; baseband inputs: 1.9 V DC bias, 200 kHz frequency, 300 mV_{P-P} 600 mV_{P-P} differential drive, I/Q signals in quadrature, LO = 1960 MHz; $P_{LO} = -5\text{ dBm}$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
	Broadband noise floor		12, 13	P_{NOISE}		-155	-148	dBm/Hz	C
	Quadrature phase error		12, 13		-2	± 0.5	+2	°	B
	I/Q amplitude balance		12, 13		-0.2	± 0.5	+0.2	dB	B

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

RF Electrical Characteristics (2300 to 2700 MHz)

Test conditions:

Unless otherwise noted, the following conditions apply to typical performance specification under static conditions:

$V_{CC} = 5\text{ V}$, $T_{amb} = 25^\circ\text{C}$; baseband inputs: 1.9 V DC bias, 200 kHz frequency, 300 mV_{P-P} 600 mV_{P-P} differential drive, I/Q signals in quadrature, LO = 2600 MHz; $P_{LO} = -5\text{ dBm}$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
	RF Output Port								
	RF frequency		12, 13	f_{RF}	2300		2700	MHz	B
	Output power		12, 13	P_{RFout}	-18	-14.5	-13	dBm	A
	RF return loss	Matched to 50 Ω	12, 13	P_{LORL}		15		dB	D
	1-dB output compression point		12, 13	P_{1dB}		TBD		dBm	A
	LO-RF leakage		12, 13	P_{LORF}		-40	-32	dBm	D
	Sideband suppression		12, 13	A_{SB}	34	40		dB	D
	IM3 suppression	Two tone baseband input at 600 mV _{P-P} differential per tone	12, 13	A_{IM3}		TBD		dB	D
	Broadband noise floor		12, 13	P_{NOISE}		TBD		dBm/Hz	C
	Quadrature phase error		12, 13		-2	± 0.5	+2	°	B
	I/Q amplitude balance		12, 13		-0.2	± 0.5	+0.2	dB	B

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

700 MHz to 1000 MHz: Typical Device Performance

Figure 3. SSB Power versus LO Frequency

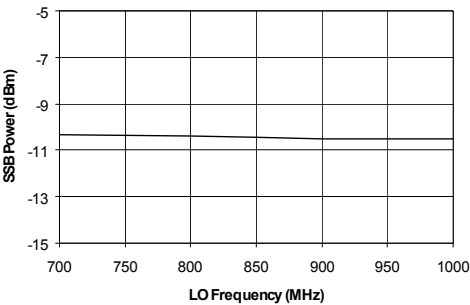


Figure 4. Output P1dB versus LO Frequency

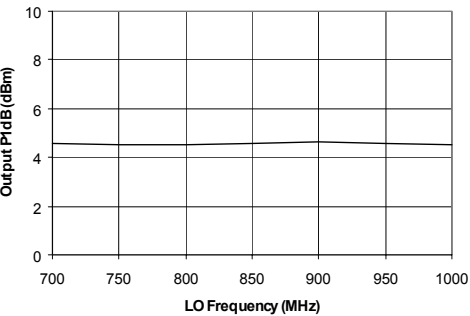


Figure 5. Carrier Feedthrough versus LO Frequency

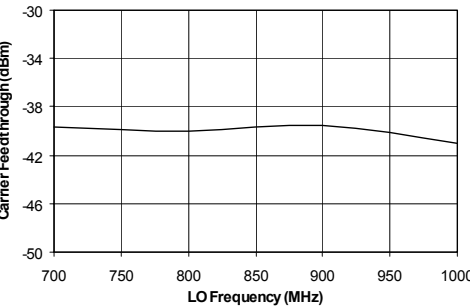


Figure 6. Sideband Suppression versus LO Frequency

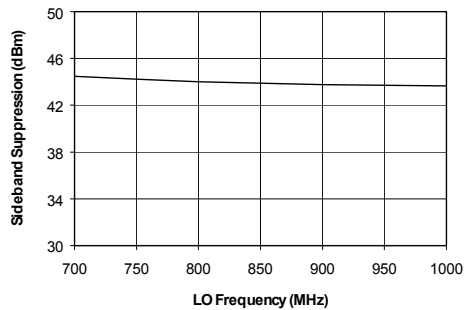


Figure 7. Intermodulation Distortion versus SSB Output Power

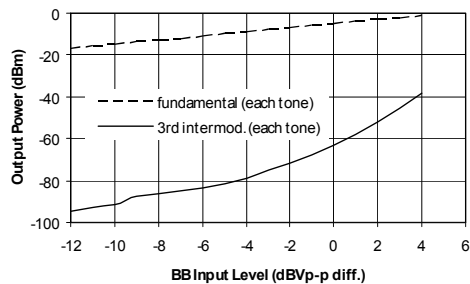
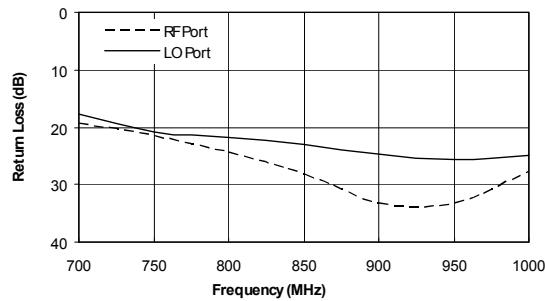


Figure 8. RF and LO Return Losses



1500 MHz to 2500 MHz: Typical Device Performance

All tests have been done on a testboard with LO and RF matching to 2600 MHz (see “Application Board Schematic” description on page 10). Test in a clima chamber required long cables, which added additional loss and affected the output power.

Figure 9. SSB Power versus LO Frequency

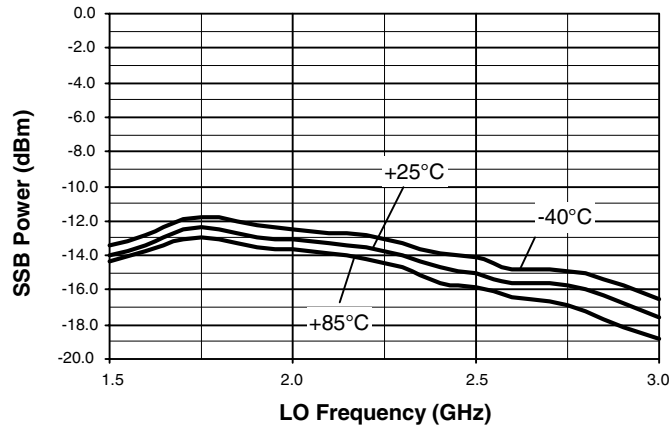


Figure 10. Carrier Feedthrough versus LO Frequency

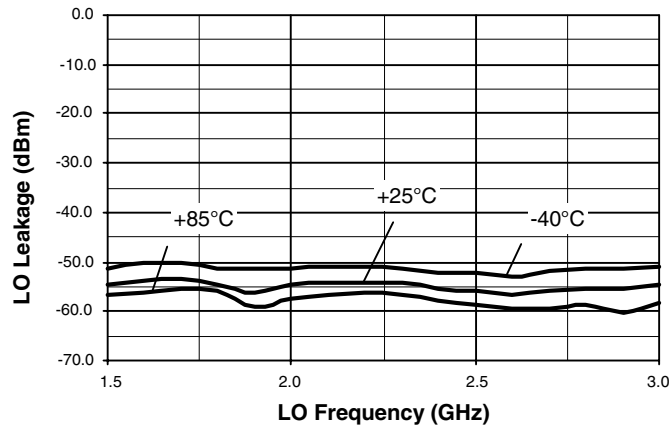


Figure 11. Sideband Suppression versus LO Frequency

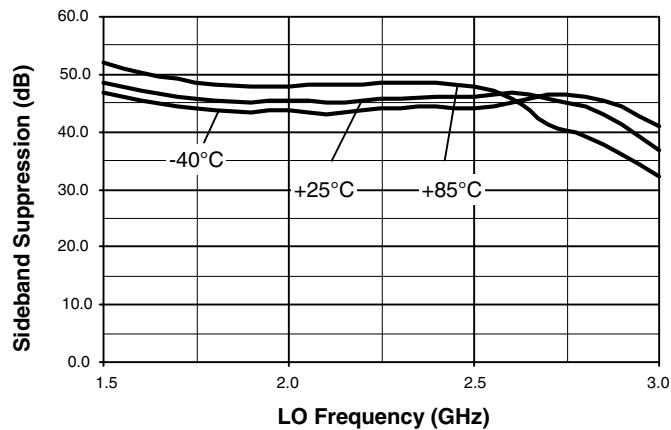


Figure 12. RF and LO Return Losses

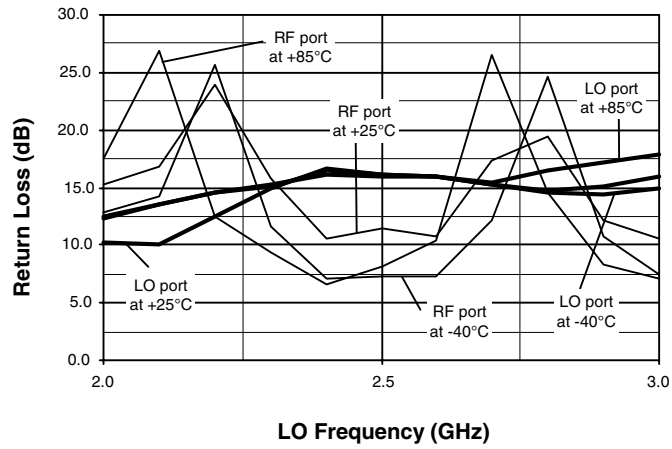


Figure 13. Phase Error versus LO Frequency

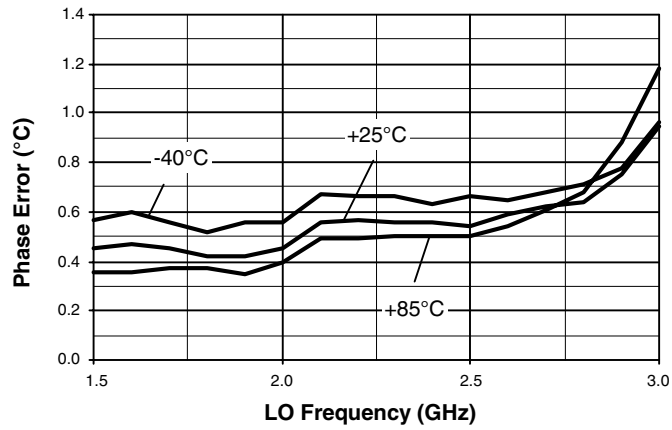


Figure 14. Amplitude Balance versus LO Frequency

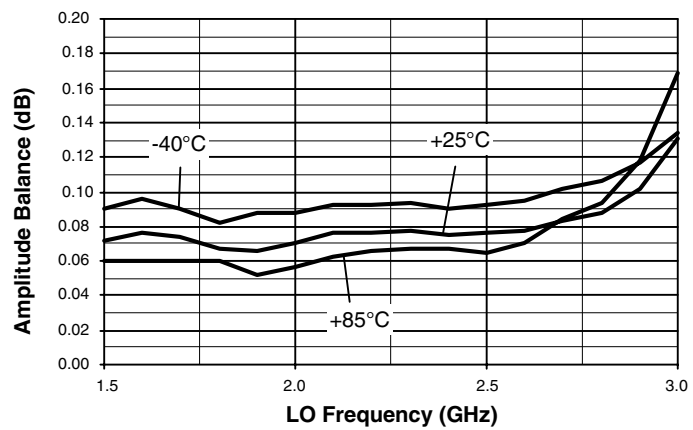
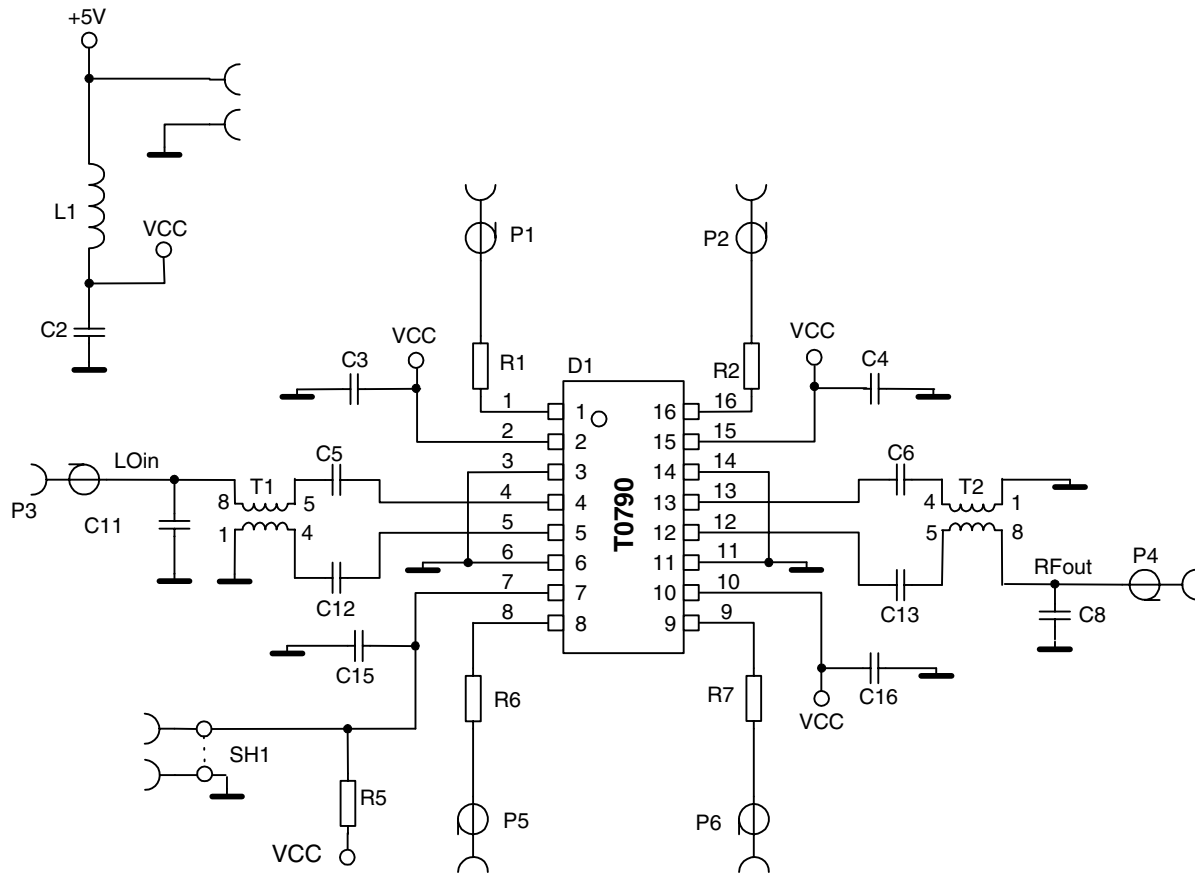


Figure 15. Application Schematic



Bill of Materials (700 MHz to 1000 MHz Evaluation Board)

Component	Reference	Vendor	Part Number/ Remark	Value ⁽¹⁾	Size/Package
Direc Quadrature Modulator	D1	Atmel	T0790		SSOP16
Inductor	L1	Würth Elektronik®	74476401	1 µH	1210
Resistor	R1, R2, R6, R7			180 Ω	0402
Resistor	R5			1 kΩ	0402
Capacitor	C3, C16			33 pF	0402
Capacitor	C4, C15			1 nF	0402
Electrolytic capacitor	C2			10 µF	Size A
Capacitor	C5, C6, C12, C13			10 pF	0402
Capacitor	C8, C11			n.c.	0402
RF transformer 700 MHz to 1300 MHz	T1, T2	Panasonic®	EHF-FD1618		3216
RF connector	P8, P9, P10, P11, P12, P13	Johnson Components™	142-0711-841		SMA

Note: 1. May vary due to printed board layout and material.

Bill of Materials (1700 MHz to 2500 MHz Evaluation Board)

Component	Reference	Vendor	Part Number/ Remark	Value ⁽¹⁾	Size/Package
Direc Quadrature Modulator	D1	Atmel	T0790		SSOP16
Inductor	L1	Würth Elektronik	74476401	1 μ H	1210
Resistor	R1, R2, R6, R7			180 Ω	0402
Resistor	R5			1 k Ω	0402
Capacitor	C3,C16			6.8 pF	0402
Capacitor	C4,C15			1 nF	0402
Electrolytic capacitor	C2			10 μ F	Size A
Capacitor	C5, C6, C12, C13			2.7 pF	0402
Capacitor	C8, C11			n.c.	0402
RF transformer 1200 MHz to 2200 MHz	T1, T2	Panasonic	EHF-FD1619		3216
RF connector	P8, P9, P10, P11, P12, P13	Johnson Components	142-0711-841		SMA

Note: 1. May vary due to printed board layout and material.

Bill of Materials (2500 MHz to 2700 MHz Evaluation Board)

Component	Reference	Vendor	Part Number/ Remark	Value ⁽¹⁾	Size/Package
Direc Quadrature Modulator	D1	Atmel	T0790		SSOP16
Inductor	L1	Würth Elektronik	74476401	1 μ H	1210
Resistor	R1, R2, R6, R7			180 Ω	0402
Resistor	R5			1 k Ω	0402
Capacitor	C3,C16			6.8 pF	0402
Capacitor	C4,C15			1 nF	0402
Electrolytic capacitor	C2			10 μ F	Size A
Capacitor	C5, C12			1.5 pF	0402
Capacitor	C6, C13			1.8 pF	0402
Capacitor	C8, C11			n.c.	0402
RF transformer 1200 MHz to 2200 MHz	T1, T2	Panasonic	EHF-FD1619		3216
RF connector	P8, P9, P10, P11, P12, P13	Johnson Components	142-0711-841		SMA

Note: 1. May vary due to printed board layout and material.

Figure 16. Demo Test Board (Fully Assembled PCB)

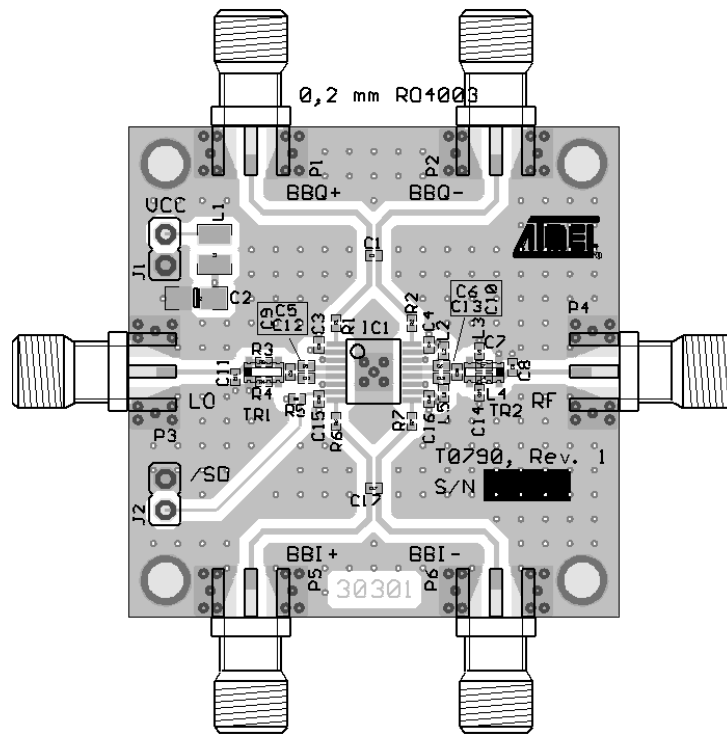
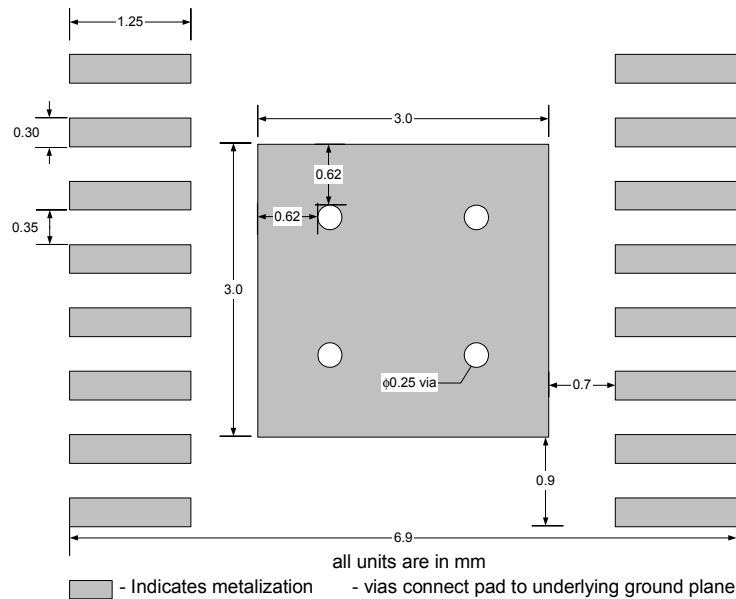


Figure 17. Recommended Package Footprint



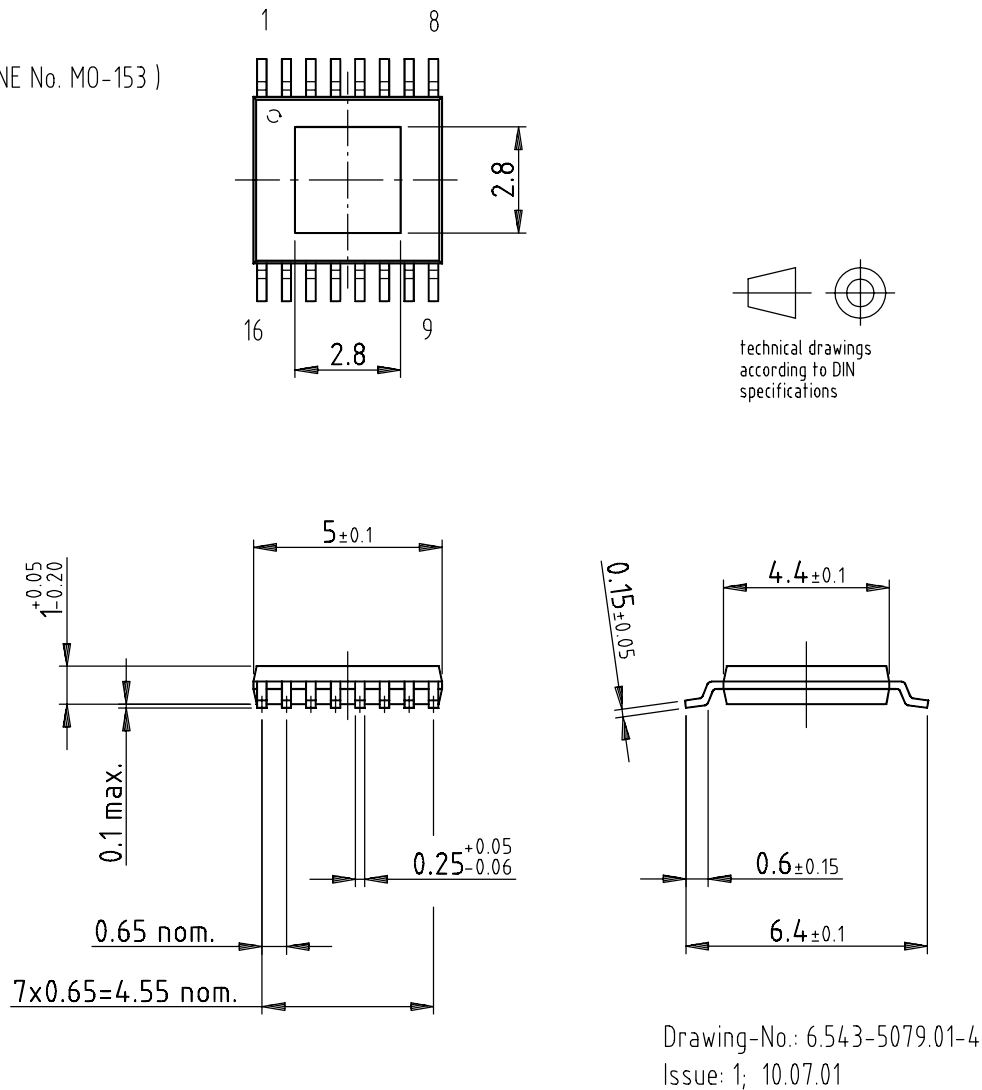
Note: Only ground signal traces are allowed directly under the package.
 Heatslug must be soldered to GND.
 Plugging of the ground vias under the heat slug is also recommended to avoid soldering problems.

Ordering Information

Extended Type Number	Package	Remarks
T0790-6C	SSOP16	–

Package Information

Package: SSOP16
(acc. JEDEC SMALL OUTLINE No. MO-153)
Dimensions in mm





Atmel Corporation

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

Regional Headquarters

Europe

Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Switzerland
Tel: (41) 26-426-5555
Fax: (41) 26-426-5500

Asia

Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimshatsui
East Kowloon
Hong Kong
Tel: (852) 2721-9778
Fax: (852) 2722-1369

Japan

9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
Tel: (81) 3-3523-3551
Fax: (81) 3-3523-7581

Atmel Operations

Memory

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

Microcontrollers

2325 Orchard Parkway
San Jose, CA 95131, USA
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
Tel: (33) 2-40-18-18-18
Fax: (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards

Zone Industrielle
13106 Rousset Cedex, France
Tel: (33) 4-42-53-60-00
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
Tel: (44) 1355-803-000
Fax: (44) 1355-242-743

RF/Automotive

Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
Tel: (49) 71-31-67-0
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906, USA
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
Tel: (33) 4-76-58-30-00
Fax: (33) 4-76-58-34-80

Literature Requests

www.atmel.com/literature

Disclaimer: Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

© Atmel Corporation 2003. All rights reserved. Atmel® and combinations thereof are the registered trademarks of Atmel Corporation or its subsidiaries, Würth Elektronik® is a registered trademark of Adolf Würth GmbH & Co. KG, Panasonic® is a registered trademark of Matsushita Electric Industrial Co., Ltd., Johnson Components™ is a trademark of Emerson Electric Co.

Other terms and product names may be the trademarks of others.



Printed on recycled paper.