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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: [info@chipsmall.com](mailto:info@chipsmall.com) Web: [www.chipsmall.com](http://www.chipsmall.com)

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## Features

- **Supply Voltage 5 V (Typically)**
- **Very Low Power Consumption: 150 mW (Typically) for -1 dBm Output Level**
- **Very Good Sideband Suppression by Means of Duty Cycle Regeneration of the LO Input Signal**
- **Phase Control Loop for Precise 90° Phase Shifting**
- **Power-down Mode**
- **Low LO Input Level: -10 dBm (Typically)**
- **50-Ω Single-ended LO and RF Port**
- **LO Frequency from 100 MHz to 1 GHz**
- **SO16 Package01/03**

## Benefits

- **No External Components Required for Phase Shifting**
- **Adjustment Free, Hence Saves Manufacturing Time**
- **Only Three External Components Necessary, this Results in Cost and Board Space Saving**

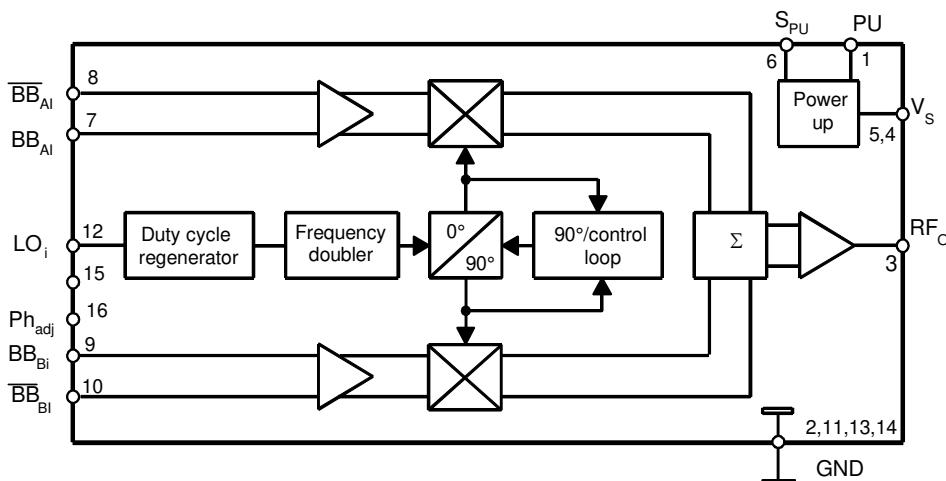
Electrostatic sensitive device.  
Observe precautions for handling.



## Description

The U2790B is a 1000-MHz quadrature modulator using Atmel's advanced UHF process. It features a frequency range from 100 MHz up to 1000 MHz, low current consumption, and single-ended RF and LO ports. Adjustment-free application makes the direct converter suitable for all digital radio systems up to 1000 MHz, e.g., GSM, ADC, JDC.

**Figure 1.** Block Diagram

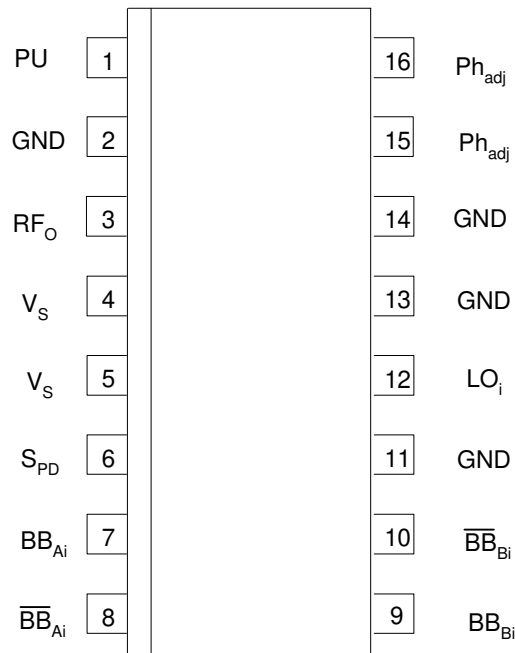


## 1000-MHz Quadrature Modulator

**U2790B**

## Pin Configuration

Figure 2. Pinning SO16



## Pin Description

Pin	Symbol	Function
1	PU	Power-up input
2, 11, 13, 14	GND	Ground
3	RF <sub>O</sub>	RF output
4, 5	V <sub>S</sub>	Supply voltage
6	S <sub>PU</sub>	Settling time power-up
7	BB <sub>Ai</sub>	Baseband input A
8	BB <sub>Ai</sub>	Baseband input A inverse
9	BB <sub>Bi</sub>	Baseband input B
10	BB <sub>Bi</sub>	Baseband input B inverse
12	LO <sub>i</sub>	LO input
15, 16	Ph <sub>adj</sub>	Phase adjustment (not necessary for regular applications)

## Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage	$V_S$	6	V
Input voltage	$V_i$	0 to $V_S$	V
Junction temperature	$T_j$	125	°C
Storage temperature range	$T_{Stg}$	-40 to +125	°C

## Operating Range

Parameters	Symbol	Value	Unit
Supply voltage range	$V_S$	4.5 to 5.5	V
Ambient temperature range	$T_{amb}$	-40 to +85	°C

## Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient SO16	$R_{thJA}$	110	K/W

## Electrical Characteristics

Test conditions (unless otherwise specified):  $V_S = 5\text{ V}$ ,  $T_{amb} = 25^\circ\text{C}$ , referred to test circuit, system impedance  $Z_O = 50\ \Omega$ ,  $f_{LO} = 900\text{ MHz}$ ,  $P_{LO} = -10\text{ dBm}$ ,  $V_{BBI} = 1\text{ V}_{pp}$  differential.

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
1.1	Supply voltage range		4, 5	$V_S$	4.5		5.5	V	A
1.2	Supply current		4, 5	$I_S$	24	30	37	mA	A
<b>2</b>	<b>Baseband Inputs</b>								
2.1	Input-voltage range (differential)		7–8, 9–10	$V_{BBI}$		1000	1500	$\text{mV}_{pp}$	D
2.2	Input impedance (single ended)			$Z_{BBI}$		3.2		$\text{k}\Omega$	D
2.3	Input-frequency range <sup>(5)</sup>			$f_{BBI}$	0		250	MHz	D
2.4	Internal bias voltage			$V_{BBb}$	2.35	2.5	2.65	V	A
2.5	Temperature coefficient			$TC_{BB}$		0.1	<1	$\text{mV}/^\circ\text{C}$	D
<b>3</b>	<b>LO Input</b>								
3.1	Frequency range		12	$f_{LOi}$	50		1000	MHz	D
3.2	Input level <sup>(1)</sup>			$P_{LOi}$	- 12	- 10	- 5	dBm	D
3.3	Input impedance			$Z_{iLO}$		50		$\Omega$	D

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

- Notes:
1. The required LO level is a function of the LO frequency.
  2. In reference to an RF output level  $\leq -1\text{ dBm}$  and I/Q input level of  $400\text{ mV}_{pp}$  differential.
  3. Sideband suppression is tested without connection at Pins 15 and 16. For higher requirements a potentiometer can be connected at these pins.
  4. For  $T_{amb} = -30^\circ\text{C}$  to  $+85^\circ\text{C}$  and  $V_S = 4.5$  to  $5.5\text{ V}$ .
  5. By low impedance signal source.



## Electrical Characteristics (Continued)

Test conditions (unless otherwise specified):  $V_S = 5\text{ V}$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ , referred to test circuit, system impedance  $Z_O = 50\ \Omega$ ,  $f_{\text{LO}} = 900\text{ MHz}$ ,  $P_{\text{LO}} = -10\text{ dBm}$ ,  $V_{\text{BBi}} = 1\text{ V}_{\text{pp}}$  differential.

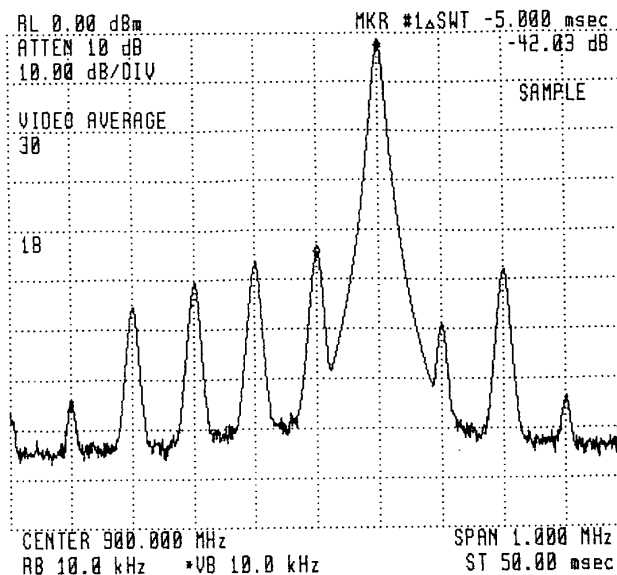
No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
3.4	Voltage standing wave ratio			$\text{VSWR}_{\text{LO}}$		1.4	2		D
3.5	Duty cycle range			$\text{DCR}_{\text{LO}}$	0.4		0.6		D
<b>4</b>	<b>RF Output</b>								
4.1	Output level		3	$P_{\text{RF0}}$	-5	-1	+2	dBm	B
4.2	LO suppression <sup>(2)</sup>	$f_{\text{LO}} = 900\text{ MHz}$ $f_{\text{LO}} = 150\text{ MHz}$		$\text{LO}_{\text{RF0}}$	30 32	35 35		dB	B
4.3	Sideband suppression <sup>(2, 3)</sup>	$f_{\text{LO}} = 900\text{ MHz}$ $f_{\text{LO}} = 150\text{ MHz}$		$\text{SBS}_{\text{RF0}}$	35 30	40 35		dB	B
4.4	Phase error <sup>(4)</sup>			$P_e$		<1		deg.	D
4.5	Amplitude error			$A_e$		< $\pm 0.25$		dB	D
4.6	Noise floor	$V_{\text{BBi}} = 2\text{ V}$ , $\overline{V_{\text{BBi}}} = 3\text{ V}$ $V_{\text{BBi}} = \overline{V_{\text{BBi}}} = 2.5\text{ V}$		$N_{\text{FL}}$		-132 -144		dBm/Hz	D
4.7	VSWR			$\text{VSWR}_{\text{RF}}$		1.6	2		D
4.8	3rd-order baseband harmonic suppression			$S_{\text{BBH}}$	35	45		dB	D
4.9	RF harmonic suppression			$S_{\text{RFH}}$		35		dB	D
<b>5</b>	<b>Power-up Mode</b>								
5.1	Supply current	$V_{\text{PU}} \leq 0.5\text{ V}$ , $V_{\text{PU}} = 1\text{ V}$	4, 5	$I_{\text{PU}}$		10	1	$\mu\text{A}$	D
5.2	Settling time	$C_{\text{SPU}} = 100\text{ pF}$ , $C_{\text{LO}} = 100\text{ pF}$ $C_{\text{RF0}} = 1\text{ nF}$	6 to 3	$t_{\text{SPU}}$		10		$\mu\text{s}$	D
<b>6</b>	<b>Switching Voltage</b>								
6.1	Power-on		1	$V_{\text{PUon}}$	4			V	D
6.2	Power-up		1	$V_{\text{PUdown}}$			1	V	D

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

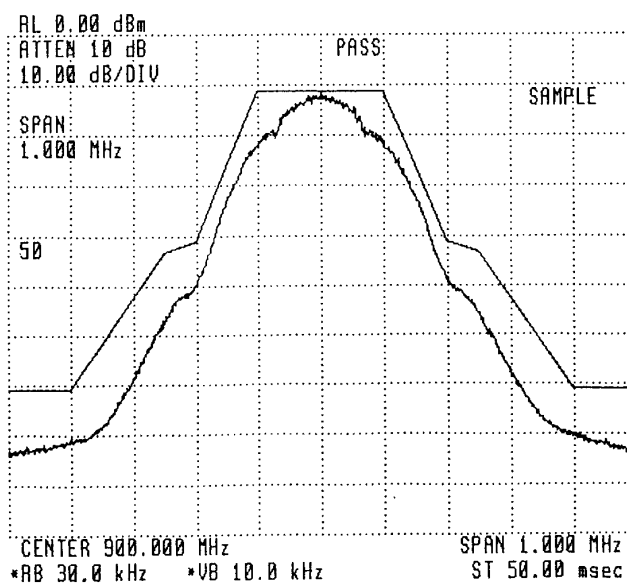
- Notes:
1. The required LO level is a function of the LO frequency.
  2. In reference to an RF output level  $\leq -1\text{ dBm}$  and I/Q input level of  $400\text{ mV}_{\text{pp}}$  differential.
  3. Sideband suppression is tested without connection at Pins 15 and 16. For higher requirements a potentiometer can be connected at these pins.
  4. For  $T_{\text{amb}} = -30^\circ\text{C}$  to  $+85^\circ\text{C}$  and  $V_S = 4.5$  to  $5.5\text{ V}$ .
  5. By low impedance signal source.

## Diagrams

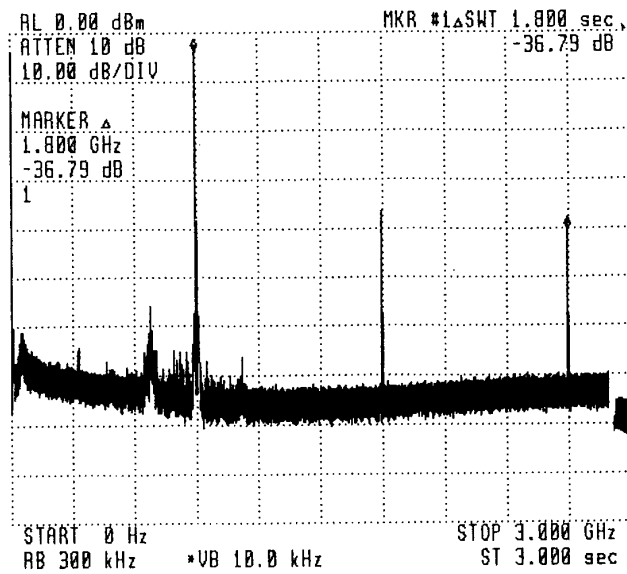
**Figure 3.** Typical Single Sideband Output Spectrum at  $V_S = 4.5\text{ V}$  and  $V_S = 5.5\text{ V}$ ,  $f_{LO} = 900\text{ MHz}$ ,  $P_{LO} = -10\text{ dBm}$ ,  $V_{BBI} = 1\text{ V}_{PP}$  (differential)  $T_{amb} = 25^\circ\text{C}$



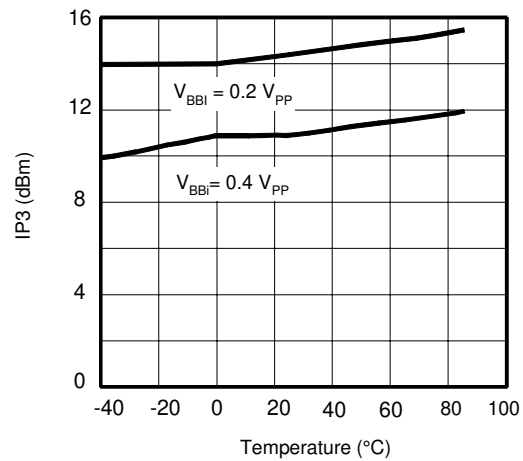
**Figure 4.** Typical GMSK Output Spectrum



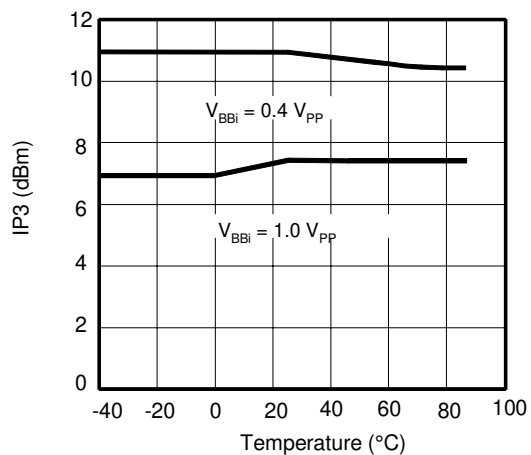
**Figure 5.** Demo Board Layout



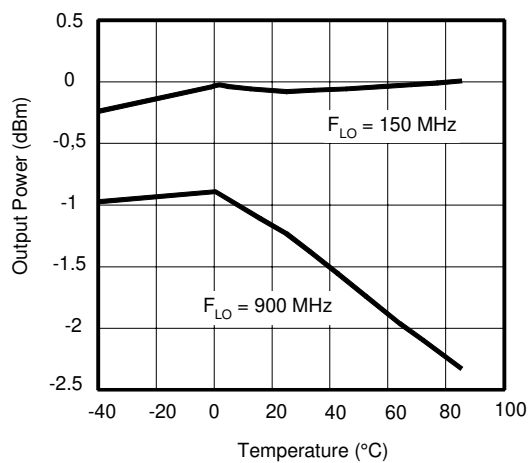
**Figure 6.** OIP3 versus  $T_{amb}$ , LO = 150 MHz, Level -20 dBm



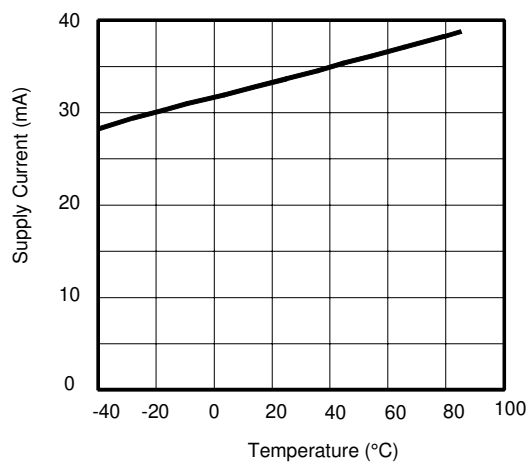
**Figure 7.** OIP3 versus  $T_{amb}$ , LO = 900 MHz, Level - 10 dBm



**Figure 8.** Output Power versus  $T_{amb}$

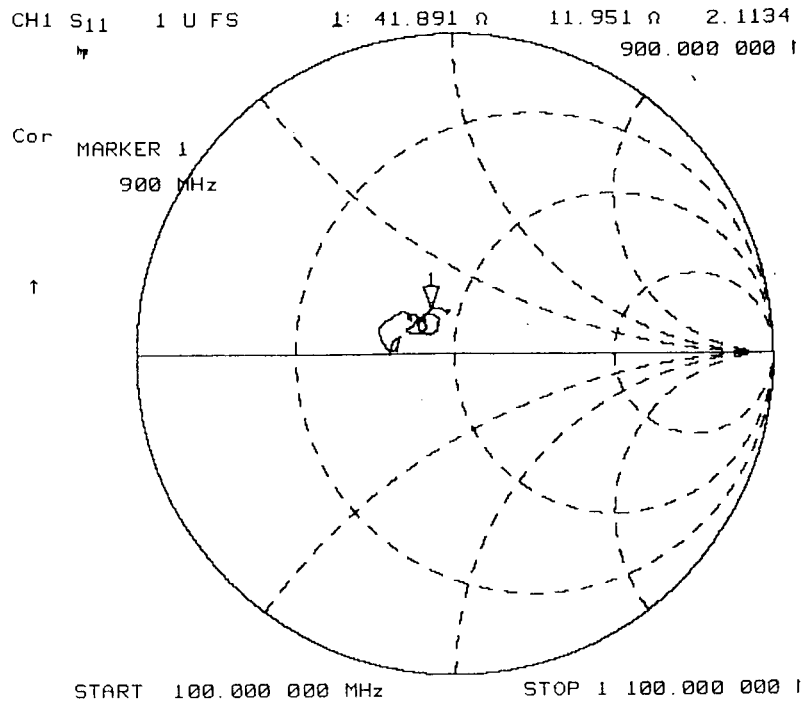


**Figure 9.** Supply Current versus  $T_{amb}$

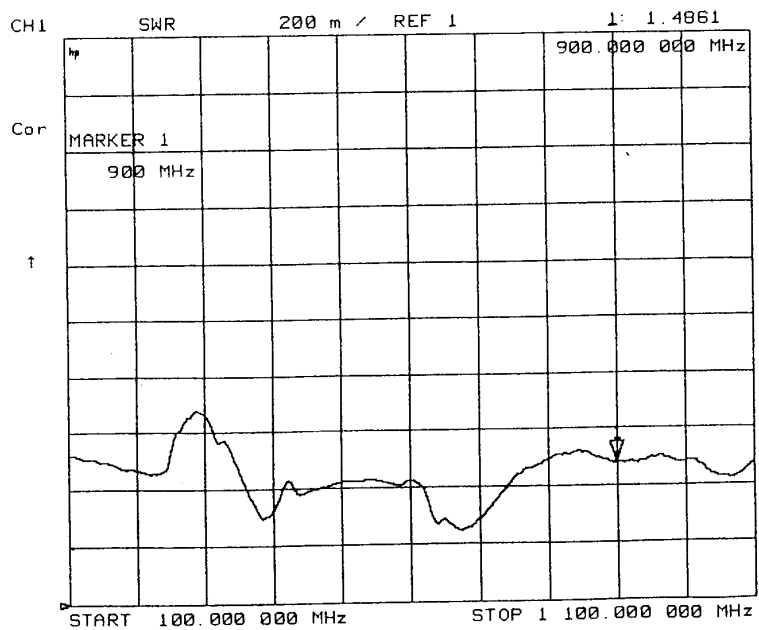




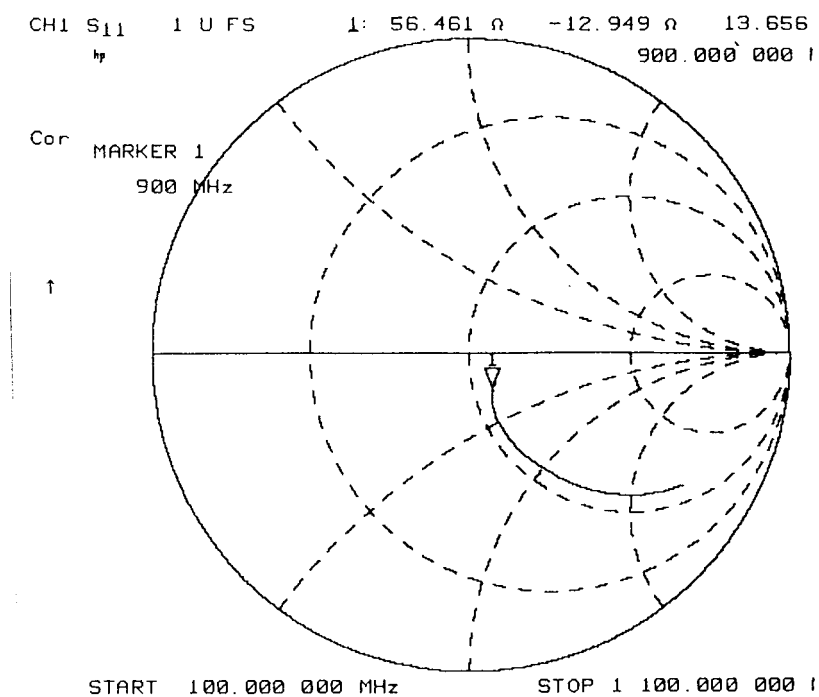
**Figure 10.** Typical S11 Frequency Response of the RF Output



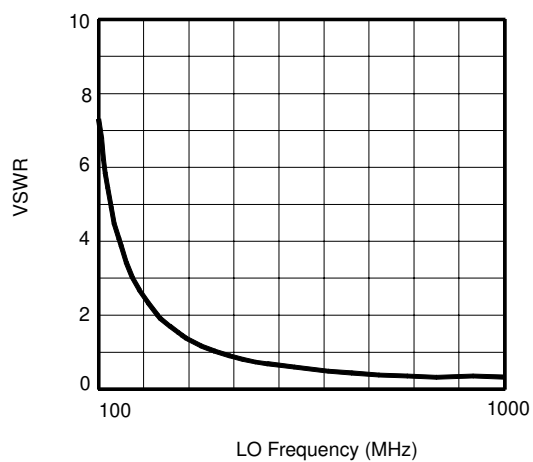
**Figure 11.** Typical VSWR Frequency Response of the RF Output



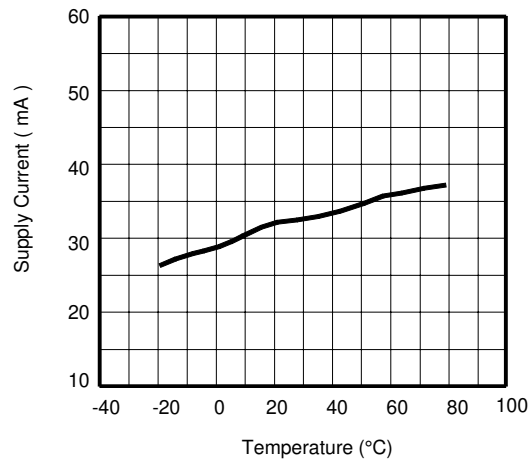
**Figure 12.** Typical S11 Frequency Response of the LO Input



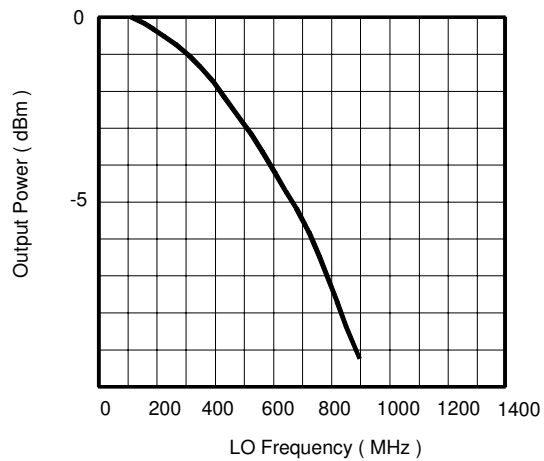
**Figure 13.** Typical VSWR Frequency Response of the LO input



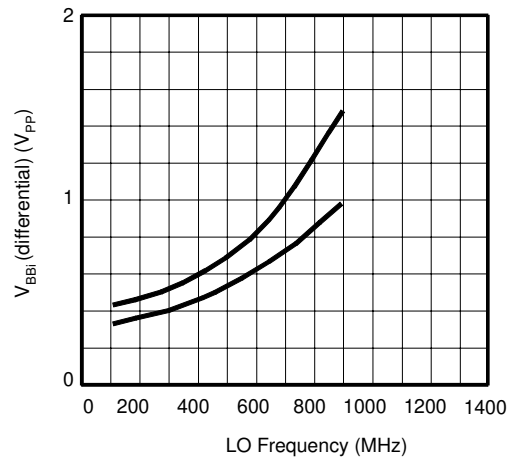
**Figure 14.** Typical Supply Current versus Temperature at  $V_S = 5\text{ V}$



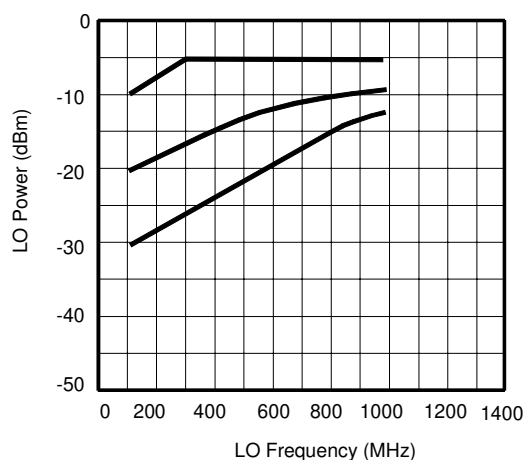
**Figure 15.** Typical Output Power versus LO-Frequency at  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $V_{\text{BBI}} = 230\text{ mV}_{\text{PP}}$  (differential)



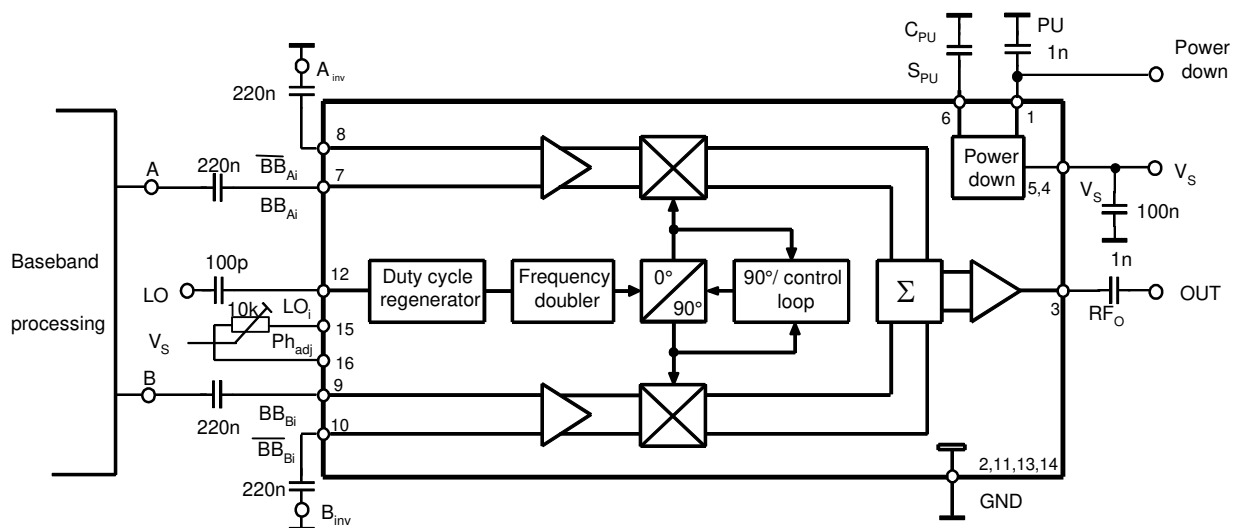
**Figure 16.** Typical required  $V_{\text{BBI}}$  Input Signal (differential) versus LO Frequency for  $P_O = 0\text{ dBm}$  and  $P_O = -2\text{ dBm}$



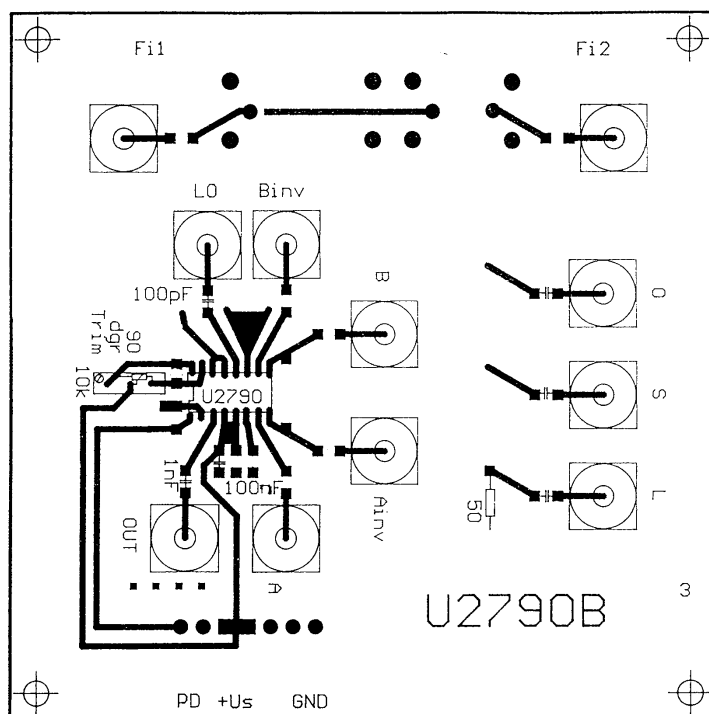
**Figure 17.** Typical useful LO Power Range versus LO Frequency at  $T_{amb} = 25^{\circ}\text{C}$



**Figure 18.** Application Circuit



**Figure 19.** Demo Board Layout



## Application Notes

### Noise Floor and Settling Time

In order to reduce noise on the power-up control input and improve the wide-off noise floor of the 900-MHz RF output signal, capacitor  $C_{PU}$  should be connected from Pin 6 to ground in the shortest possible way.

The settling time has to be considered for the system under design. For GSM applications, a value of  $C_{PU} = 1$  nF defines a settling time,  $t_{sPU}$ , equal or less than 3 ms. This capacitance does not have any influence on the noise floor within the relevant GSM mask. For mobile applications the mask requirements can be achieved very easily without  $C_{PU}$ .

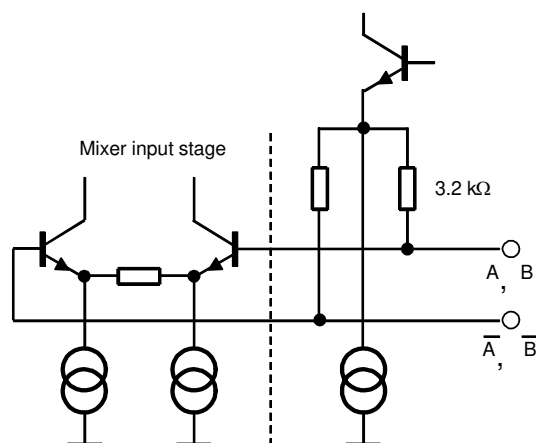
A significant improvement of the wide-off noise floor is obtainable with  $C_{PU}$  greater than 100 nF. Such values are recommended for applications where the settling time is not critical such as in base stations. Coupling capacitors for  $LO_i$  and  $RF_O$  also have a certain impact on the settling time. The values used for the measurements are  $C_{LO_i} = 100$  pF and  $C_{RF_O} = 1$  nF.

### Baseband Coupling

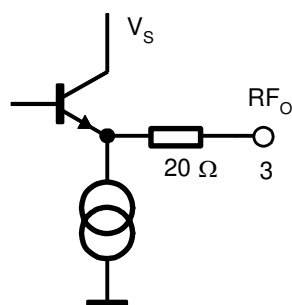
The U2790B-FP (SO16) has an integrated biasing network which allows AC coupling of the baseband signal at a low count of external components. The bias voltage is  $2.5 \text{ V} \pm 0.15 \text{ V}$ .

Figure 19 shows the baseband input circuitry with a resistance of  $3.2 \text{ k}\Omega$  for each asymmetric input. The internal DC offset between A and A, and B and B is typically  $< \pm 1 \text{ mV}$  with a maximum of  $\pm 3 \text{ mV}$ . DC coupling is also possible with an external DC voltage of  $2.5 \pm 0.15 \text{ V}$ .

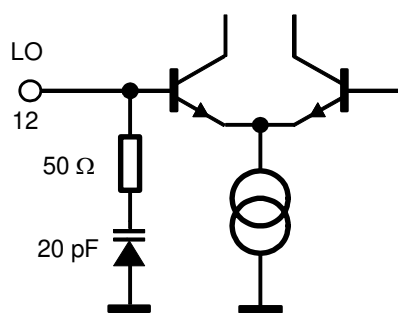
**Figure 20.** Baseband Input Circuitry



**RF Output Circuitry LO Input Circuitry**



**Figure 21.** LO Input Circuitry



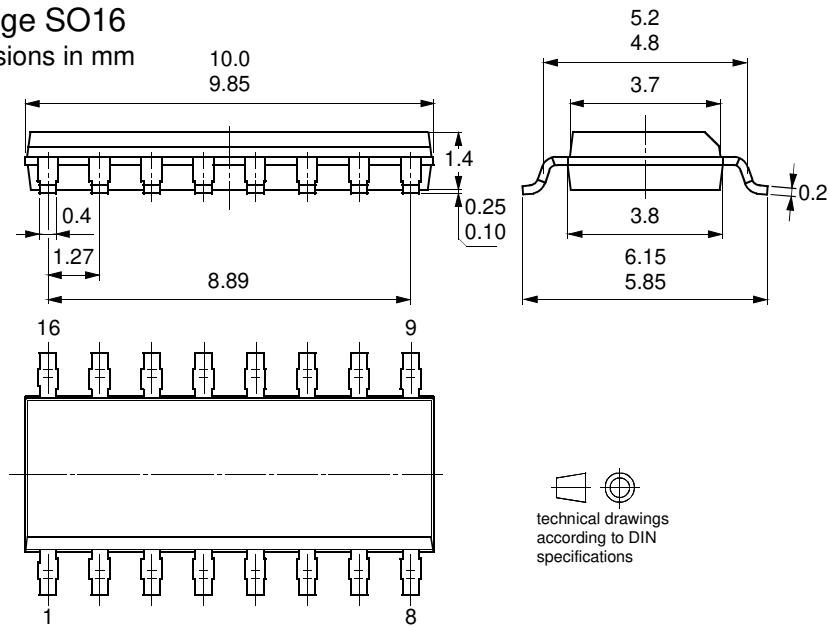


## Ordering Information

Extended Type Number	Package	Remarks
U2790B-MFP	SO16	Tube
U2790B-MFPG3	SO16	Taped and reeled

## Package Information

Package SO16  
Dimensions in mm





## **Atmel Headquarters**

### **Corporate Headquarters**

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 487-2600

### **Europe**

Atmel Sarl  
Route des Arsenaux 41  
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### **Asia**

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### **e-mail**

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### **Web Site**

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