

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

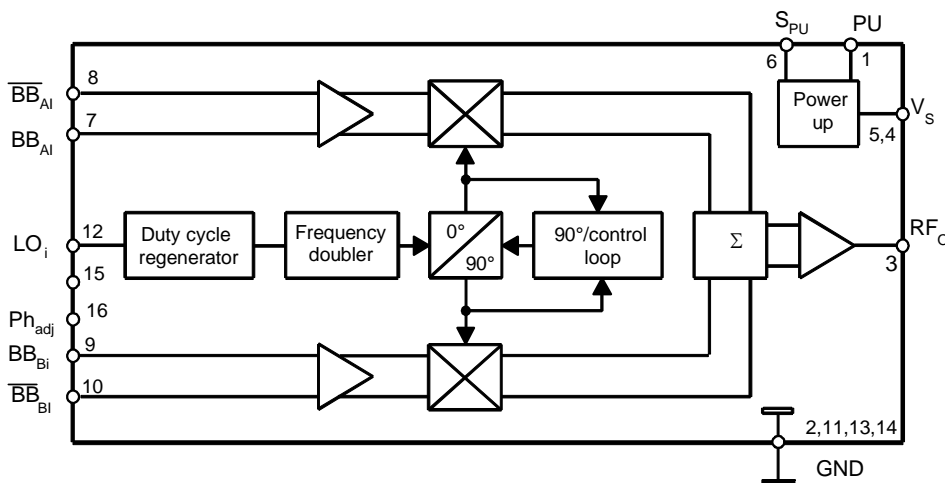
Electrostatic sensitive device.
Observe precautions for handling.



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



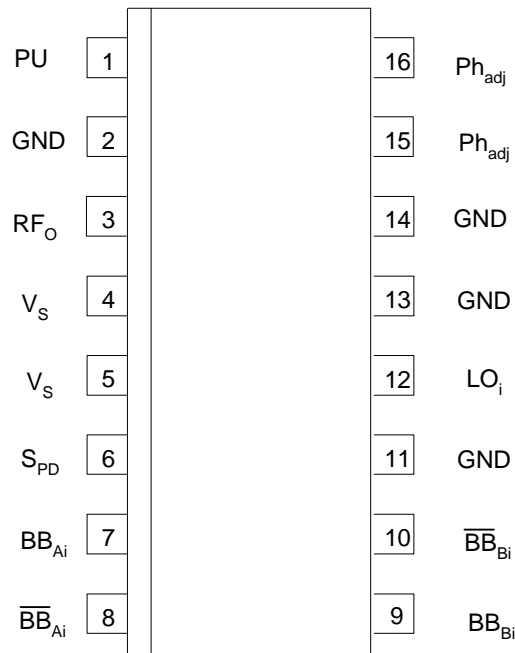
1000-MHz Quadrature Modulator

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 _O	RF output
4, 5	V _S	Supply voltage
6	S _{PU}	Settling time power-up
7	BB _{Ai}	Baseband input A
8	$\overline{\text{BB}}_{\text{Ai}}$	Baseband input A inverse
9	BB _{Bi}	Baseband input B
10	$\overline{\text{BB}}_{\text{Bi}}$	Baseband input B inverse
12	LO _i	LO input
15, 16	Ph _{adj}	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
2	Baseband Inputs								
2.1	Input-voltage range (differential)		7–8, 9–10	V_{BBi}		1000	1500	mV_{pp}	D
2.2	Input impedance (single ended)			Z_{BBi}		3.2		$\text{k}\Omega$	D
2.3	Input-frequency range ⁽⁵⁾			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
3	LO Input								
3.1	Frequency range		12	f_{LOi}	50		1000	MHz	D
3.2	Input level ⁽¹⁾			P_{LOi}	-12	-10	-5	dBm	D
3.3	Input impedance			Z_{iLO}		50		Ω	D

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

- Notes:
- The required LO level is a function of the LO frequency.
 - In reference to an RF output level $\leq -1\text{ dBm}$ and I/Q input level of 400 mV_{pp} differential.
 - Sideband suppression is tested without connection at Pins 15 and 16. For higher requirements a potentiometer can be connected at these pins.
 - For $T_{amb} = -30^\circ\text{C}$ to $+85^\circ\text{C}$ and $V_S = 4.5$ to 5.5 V .
 - 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			VSWR_{LO}		1.4	2		D
3.5	Duty cycle range			DCR_{LO}	0.4		0.6		D
4	RF Output								
4.1	Output level		3	P_{RFo}	-5	-1	+2	dBm	B
4.2	LO suppression ⁽²⁾	$f_{\text{LO}} = 900\text{ MHz}$ $f_{\text{LO}} = 150\text{ MHz}$		LO_{RFo}	30 32	35 35		dB	B
4.3	Sideband suppression ^(2, 3)	$f_{\text{LO}} = 900\text{ MHz}$ $f_{\text{LO}} = 150\text{ MHz}$		SBS_{RFo}	35 30	40 35		dB	B
4.4	Phase error ⁽⁴⁾			P_e		<1		deg.	D
4.5	Amplitude error			A_e		< ±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_{FL}		-132 -144		dBm/Hz	D
4.7	VSWR			VSWR_{RF}		1.6	2		D
4.8	3rd-order baseband harmonic suppression			S_{BBH}	35	45		dB	D
4.9	RF harmonic suppression			S_{RFH}		35		dB	D
5	Power-up Mode								
5.1	Supply current	$V_{\text{PU}} \leq 0.5\text{ V}$, $V_{\text{PU}} = 1\text{ V}$	4, 5	I_{PU}		10	1	μA	D
5.2	Settling time	$C_{\text{SPU}} = 100\text{ pF}$, $C_{\text{LO}} = 100\text{ pF}$ $C_{\text{RFo}} = 1\text{ nF}$	6 to 3	t_{SPU}		10		μs	D
6	Switching Voltage								
6.1	Power-on		1	V_{PUon}	4			V	D
6.2	Power-up		1	V_{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 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) $T_{amb} = 25^\circ\text{C}$

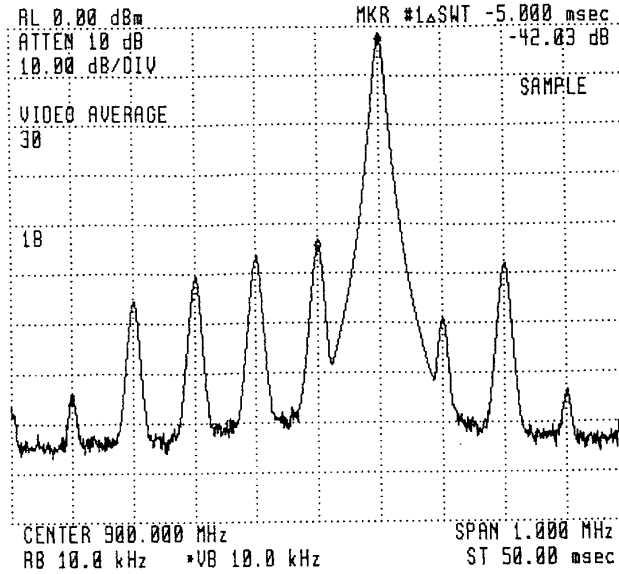


Figure 4. Typical GMSK Output Spectrum

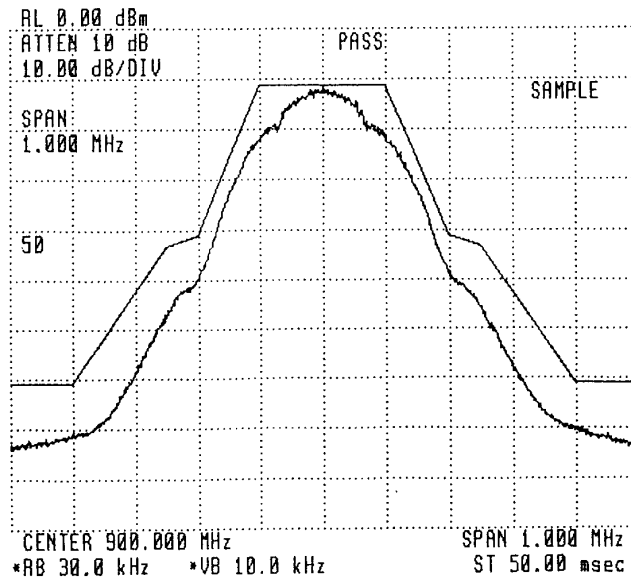


Figure 5. Demo Board Layout

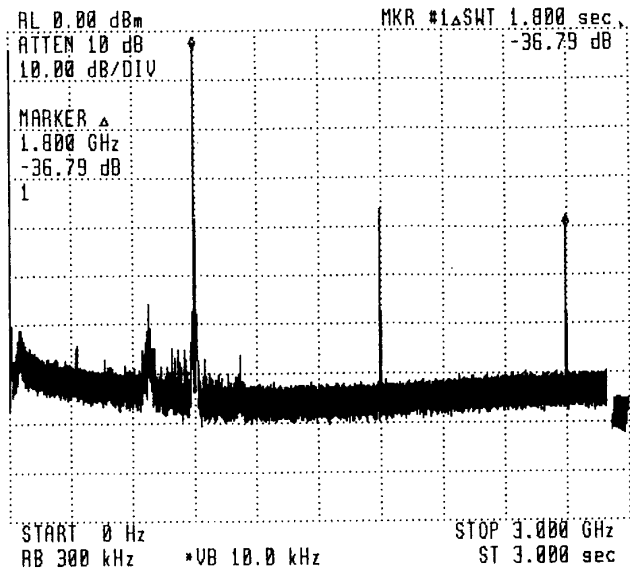


Figure 6. OIP3 versus T_{amb} , LO = 150 MHz, Level -20 dBm

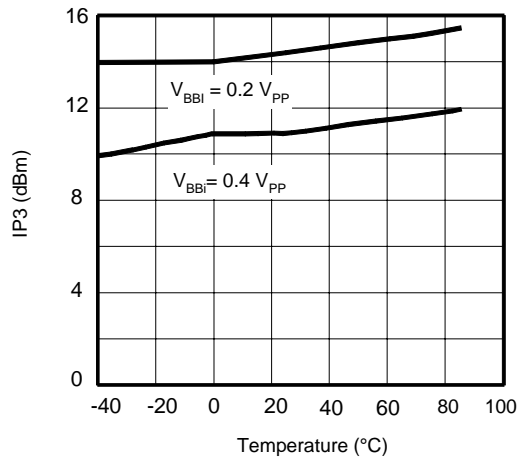


Figure 7. OIP3 versus T_{amb} , LO = 900 MHz, Level - 10 dBm

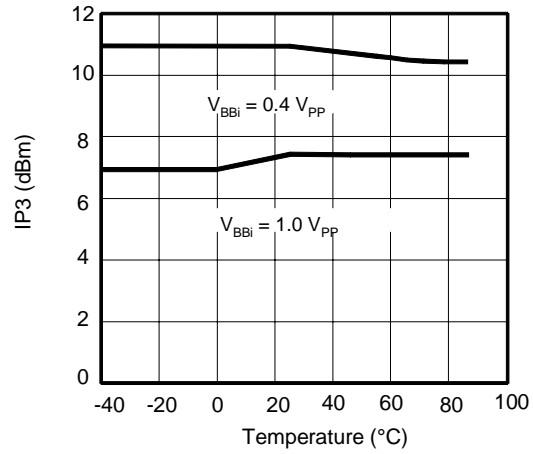


Figure 8. Output Power versus T_{amb}

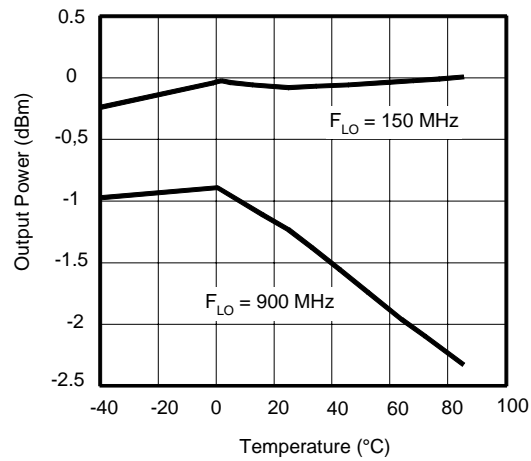


Figure 9. Supply Current versus T_{amb}

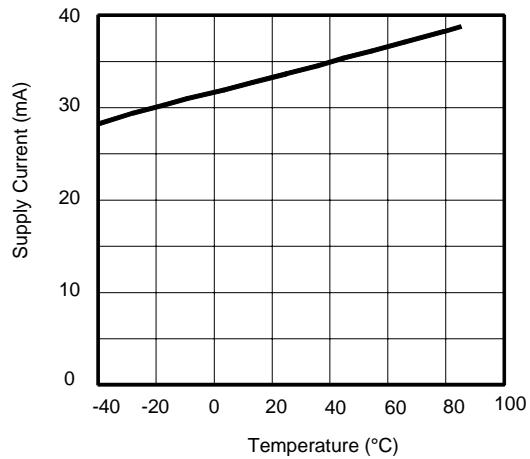


Figure 10. Typical S11 Frequency Response of the RF Output

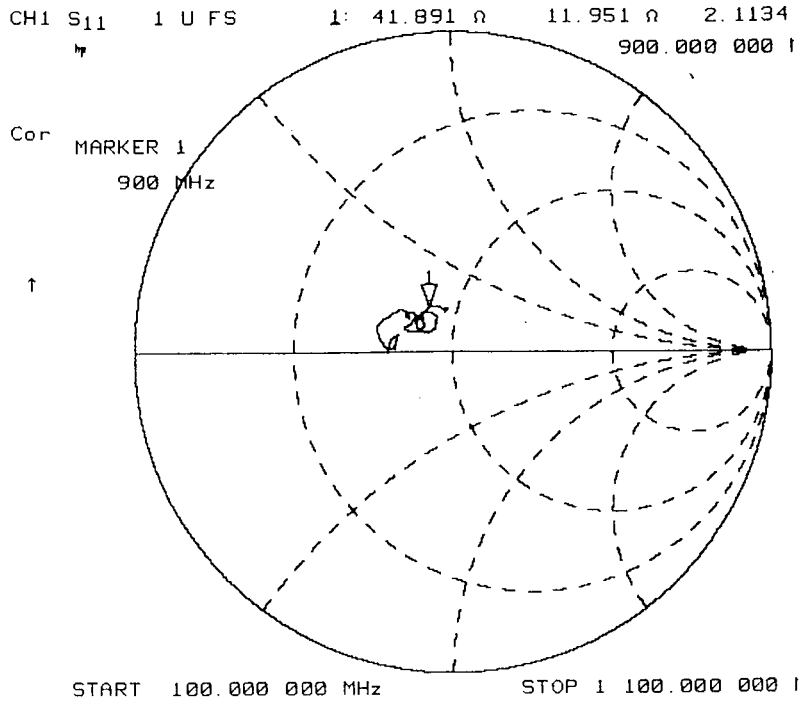


Figure 11. Typical VSWR Frequency Response of the RF Output

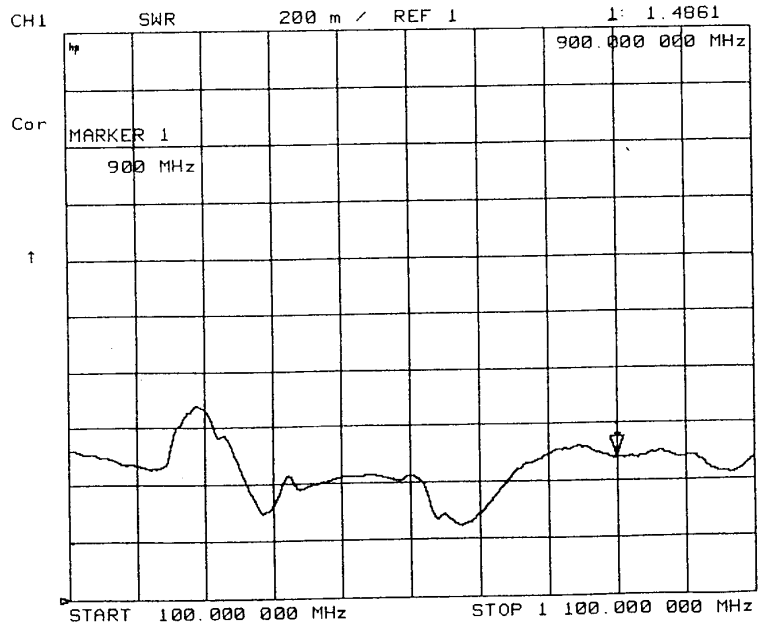


Figure 12. Typical S11 Frequency Response of the LO Input

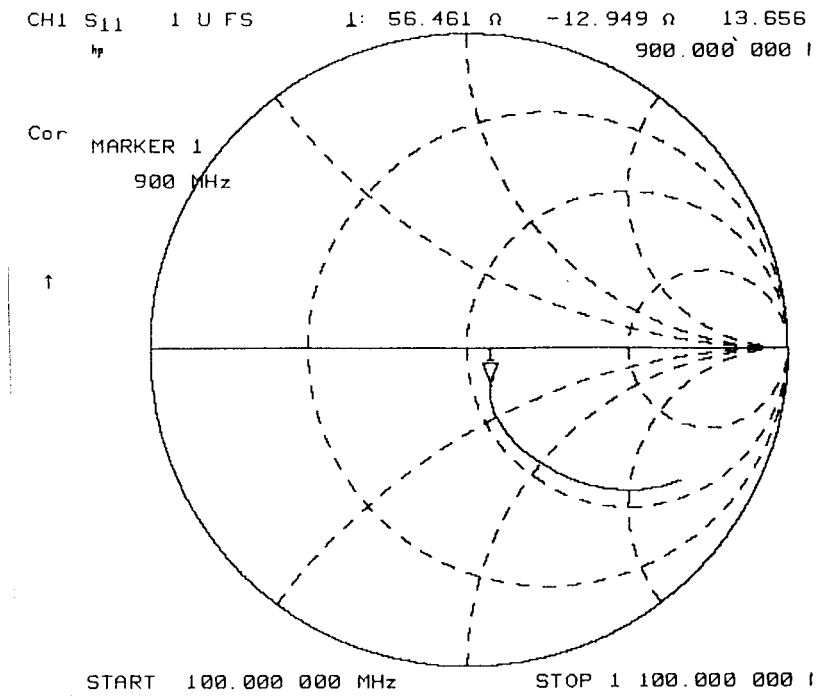


Figure 13. Typical VSWR Frequency Response of the LO input

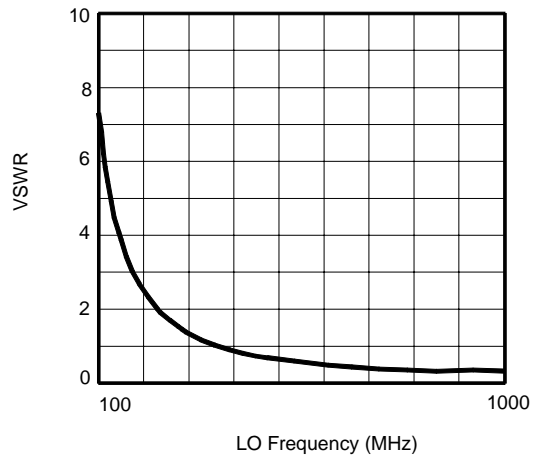


Figure 14. Typical Supply Current versus Temperature at $V_S = 5\text{ V}$

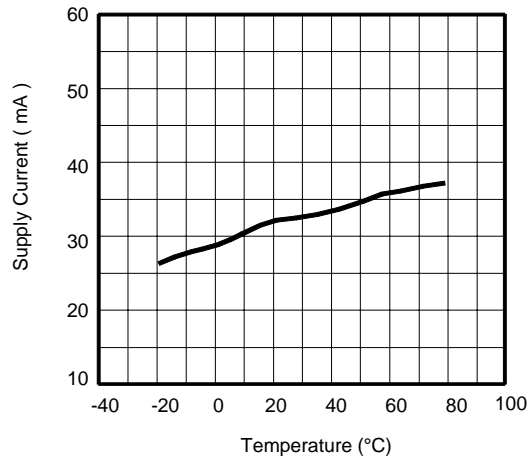


Figure 15. Typical Output Power versus LO-Frequency at $T_{amb} = 25^\circ\text{C}$, $V_{BBI} = 230\text{ mV}_{PP}$ (differential)

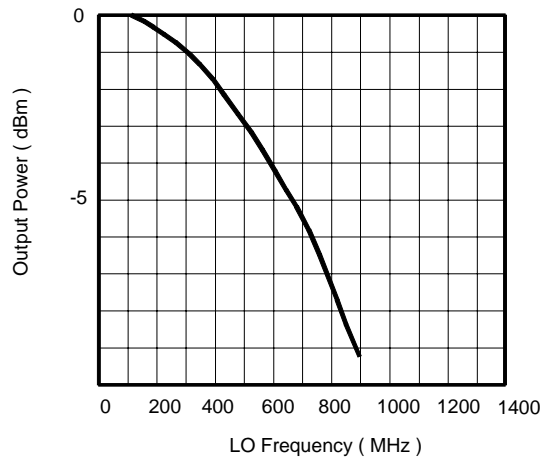


Figure 16. Typical required V_{BBI} Input Signal (differential) versus LO Frequency for $P_O = 0\text{ dBm}$ and $P_O = -2\text{ dBm}$

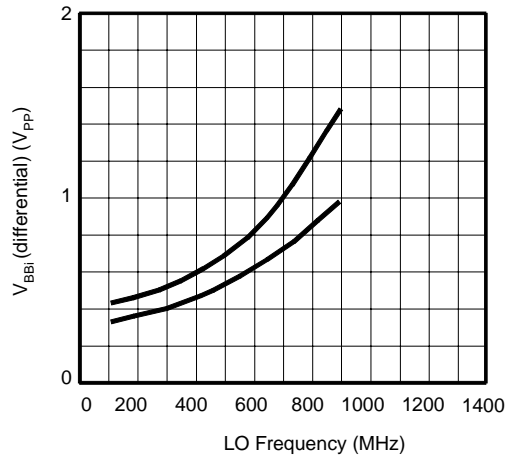


Figure 17. Typical useful LO Power Range versus LO Frequency at $T_{amb} = 25^{\circ}\text{C}$

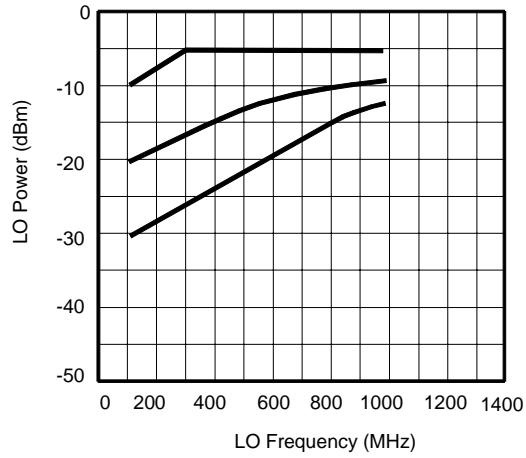


Figure 18. Application Circuit

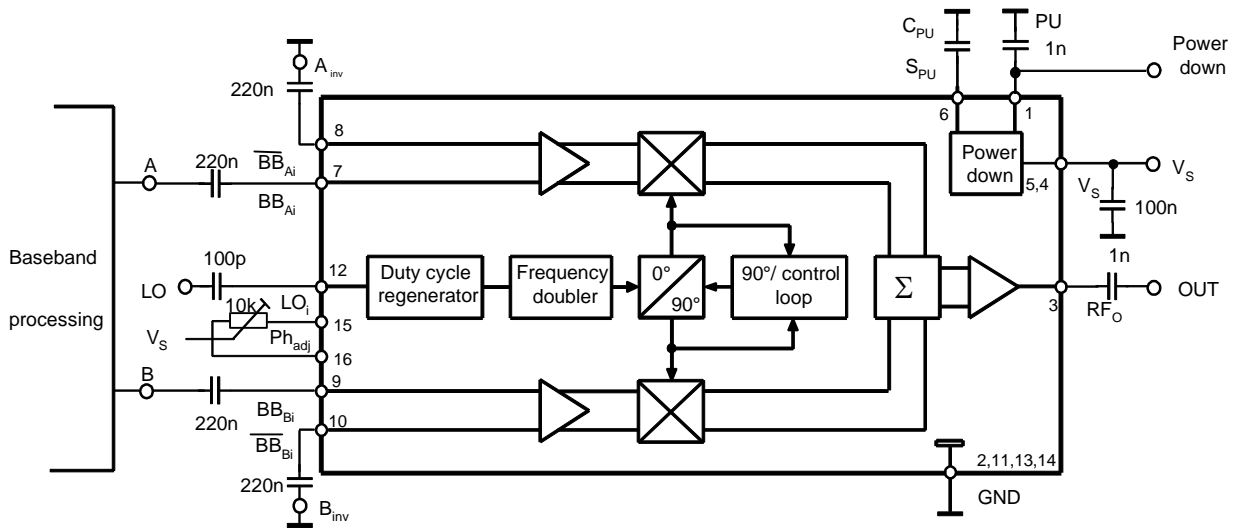
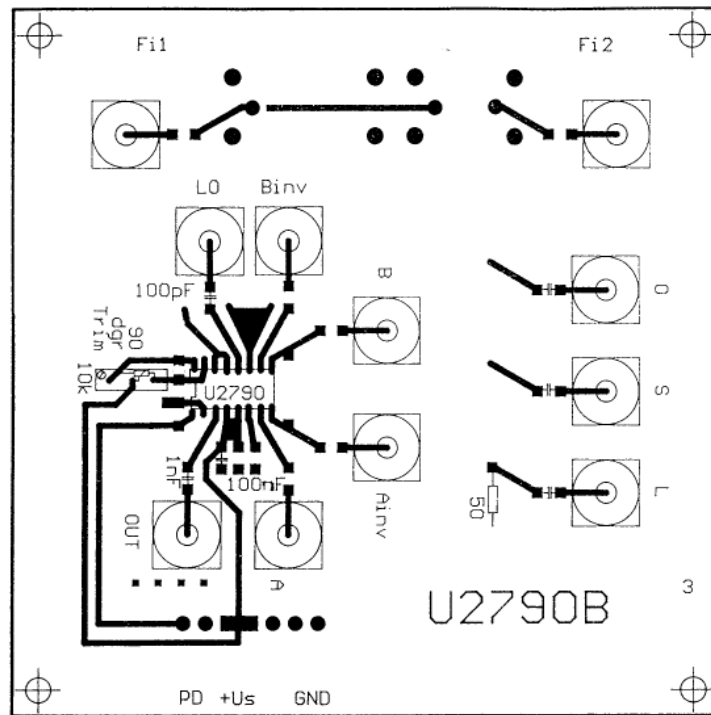


Figure 19. Demo Board Layout



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 $C_{PU} = 1 \text{ nF}$ 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} .

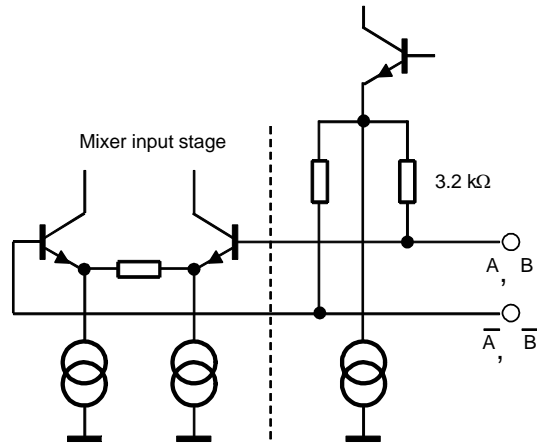
A significant improvement of the wide-off noise floor is obtainable with C_{PU} greater than 100 nF. Such values are recommended for applications where the settling time is not critical such as in base stations. Coupling capacitors for LO_i and RF_O also have a certain impact on the settling time. The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

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 k Ω 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

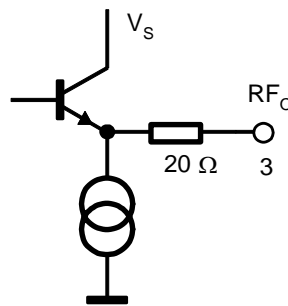
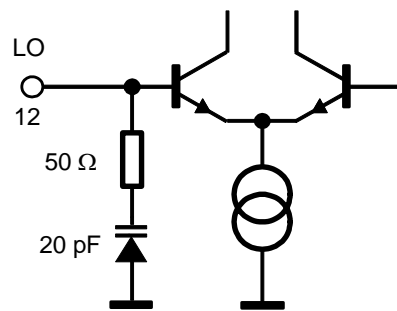


Figure 21. LO Input Circuitry

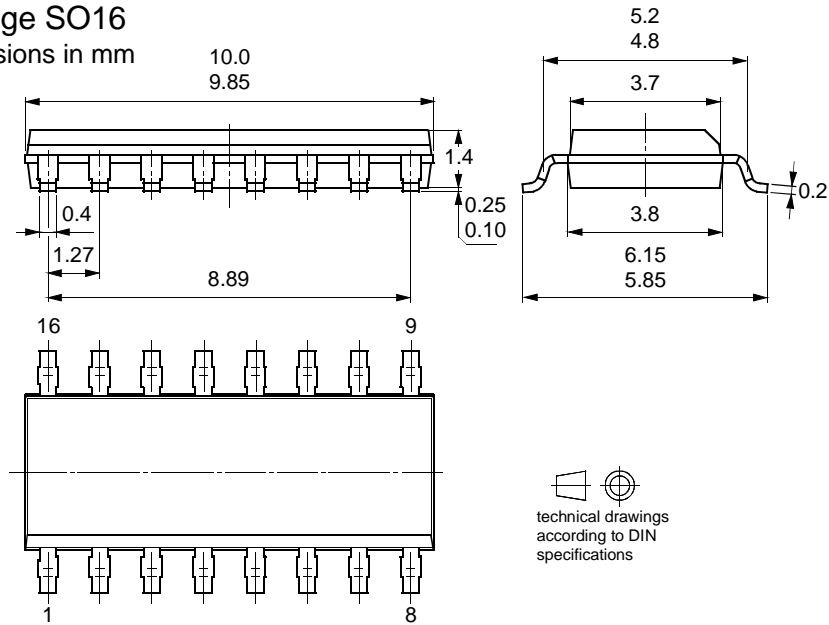


Ordering Information

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

Package Information

Package SO16
Dimensions in mm





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