Si8901
Ring Demodulator/
Balanced Mixer

Siliconix

FEATURES

- High Third-Order Intercept Point
- <6% Device Matching Error

Contact factory for Application Note AN 85-2.

BENEFITS

- Low Harmonic Distortion
- Wide Dynamic Range
- Reduced System Component Count

APPLICATIONS

- HF Mixer/Demodulator
- HF Modulator/Up-converter

DESCRIPTION

The Si8901 Ring Demodulator/Balanced Mixer offers significant improvement for HF mixer applications where the third-order harmonic distortion has been a problem. When used as a commutation HF double-balanced mixer, the Si8901 provides a high-fidelity IF output with typical conversion loss of 8 dB. Signal frequencies may be as high as 150 MHz. Available in an 8-pin TO-99 package, this device is specified over –55 to 125°C operating temperature range.
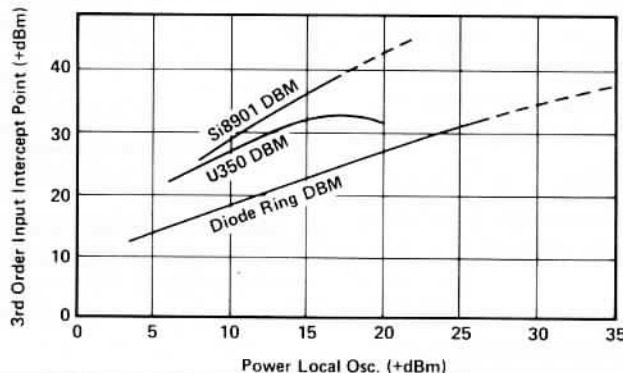
FUNCTIONAL BLOCK DIAGRAM
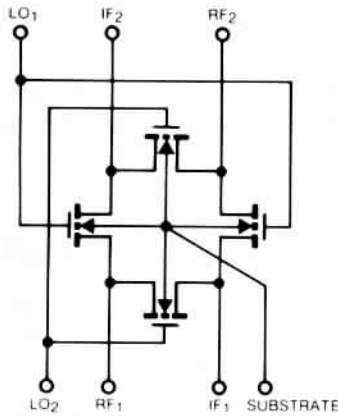
PIN CONFIGURATION
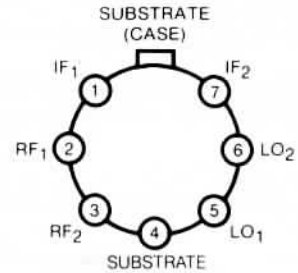
TOP VIEW

Order Numbers:
Si8901A (TO-78)
Si8901Y (SO 14)
See Section 6

PERFORMANCE COMPARISON

ABSOLUTE MAXIMUM RATINGS

V_{DS} Drain to Source .... 15 V
V_{DB} Drain to Substrate .... 22.5 V
V_{SB} Source to Substrate .... 22.5 V
V_{GS} Gate to Source .... –22.5 V to 30 V
V_{GB} Gate to Substrate .... –0.3 V to 30 V
V_{GD} Gate to Drain .... –22.5 V to 30 V

I_D Drain Current .... 50 mA
Operating Temperature .... –55 to 125°C
Storage Temperature .... –65 to 150°C
Power Dissipation (Package) .... 640 mW*

* Derate 5 mW/C above 25°C

ELECTRICAL CHARACTERISTICS[1]

$T_A = 25°C$

	PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE NOTED:	LIMITS MIN[2]	LIMITS TYP[3]	LIMITS MAX	UNIT
STATIC	Drain-Source Breakdown Voltage	BVDS	$V_{GS} = V_{SB} = -5$ V, $I_S = 10$ nA	15	25		V
	Source-Drain Breakdown Voltage	BVSD	$V_{GD} = V_{DB} = -5$ V, $I_D = 10$ nA	15			
	Drain-Substrate Breakdown Voltage	BVDB	Source Open, $V_{GB} = 0$V, $I_D = 10$ nA	22.5			
	Source-Substrate Breakdown Voltage	BVSB	Drain Open, $V_{GB} = 0$V, $I_D = 10$ uA	22.5			
	Threshold Voltage	V_{TH}	$V_{DS} = V_{GS} = V_{TH}$, $I_S = 1$ uA, $V_{SB} = 0$ V	0.1	1	2.0	
	Gate Leakage Current	I_{GBS}	$V_{DB} = V_{SB} = 0$ V, $V_{GB} = 30$ V			2	uA
	Drain-Source "ON" Resistance	r_{DS} (on)	$I_D = 10$ mA, $V_{SB} = 0$ V, $V_{GS} = 5$ V		50	75	Ω
			$I_D = 10$ mA, $V_{SB} = 0$ V, $V_{GS} = 10$ V		30		
			$I_D = 10$ mA, $V_{SB} = 0$ V, $V_{GS} = 15$ V		23		
			$I_D = 10$ mA, $V_{SB} = 0$ V, $V_{GS} = 20$ V		19		
	Resistance Matching	r_{DS} (on)	$I_D = 10$ mA, $V_{SB} = 0$ V, $V_{GS} = 5$ V		3₁	7	
DYNAMIC	LO₁-LO₂ Capacitance	C_{gg}	$V_{DS} = 0$ V, $V_{BS} = -5.5$ V, $V_{GS} = 4$ V		4.4		pF
	Conversion Loss	L_C	See Figure 1, $P_{LO} = +17$ dBm		8		dB
	Third Order Intercept	IMD_3			+35		
	Maximum Operating Frequency	f_{max}			200		MHz

NOTES:

1. Refer to PROCESS OPTION FLOWCHART for additional information
2. The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum, is used in this data sheet.
3. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

APPLICATION HINTS

Schematic of the basic commutation-type HF double-balanced mixer using resonant-gate excitation. Recommended reading is AN85-2 "A Commutation Double-Balanced MOSFET Mixer of High Dynamic Range."
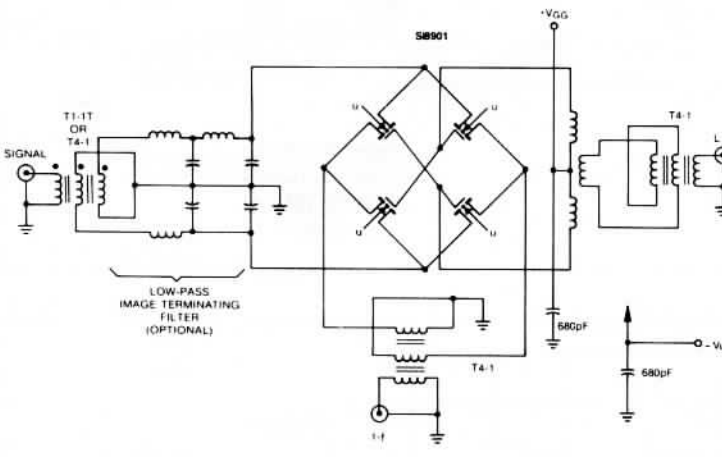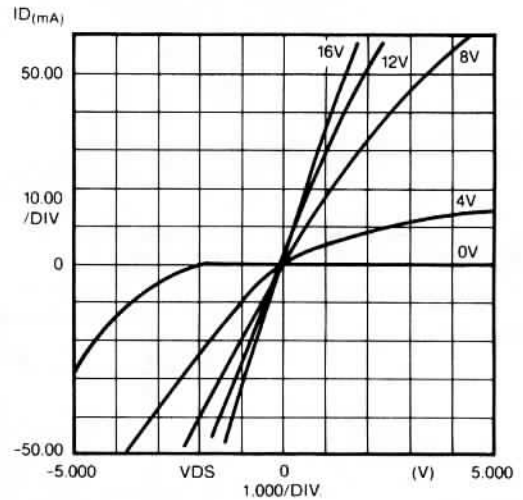

Figure 1

First and Third Quadrant I-E Characteristics Showing Effect of Gate Voltage Leading to Large-Signal Overload Distortion.

Figure 2

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THE Si8901 AND HIGH-FREQUENCY MIXERS

A Synopsis:

Given a monolithic quad small-signal DMOS FET, our objective was to apply this product to a high-frequency (0.5 to 150 MHz) balanced mixer circuit and see what performance features would result. Since the FET has an inherent square-law transfer characteristic, low-distortion in mixing was expected; also, a high figure-of-merit was expected because the subject quad FET had both low ON-resistance and low inter-lead capacitance; finally, the required local oscillator power was predictably low because the FET is a voltage-controlled device. What is proffered is a new commutation mixer circuit which achieves mixing and frequency conversion by the switching action of a quad FET ring.

Using the Si8901 in circuitry described herein will produce a high-dynamic-range high-frequency mixer with outstanding intermodulation performance and overload characteristics. The recommended circuit is capable of two-tone 3rd-order input intercepts exceeding +36 dBm with less than 50 milliwatts of local-oscillator drive. This intercept point says that two signals of −20 dBm will have 3rd-order intermodulation products greater than −110 dB below the intermediate-frequency output signal!

The application note presents the theory and operation of commutation balanced mixers. It compares switching mixers to passive diode ring and active FET mixers; it examines frequency-selective filtering; and finally, novel/practical circuitry to achieve the required local oscillator driving voltage is presented. Since the Si8901 is uniquely suited to build a double-balanced mixer, the product data sheet and application note have been combined in this one document.

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