MMIC Design and Technology

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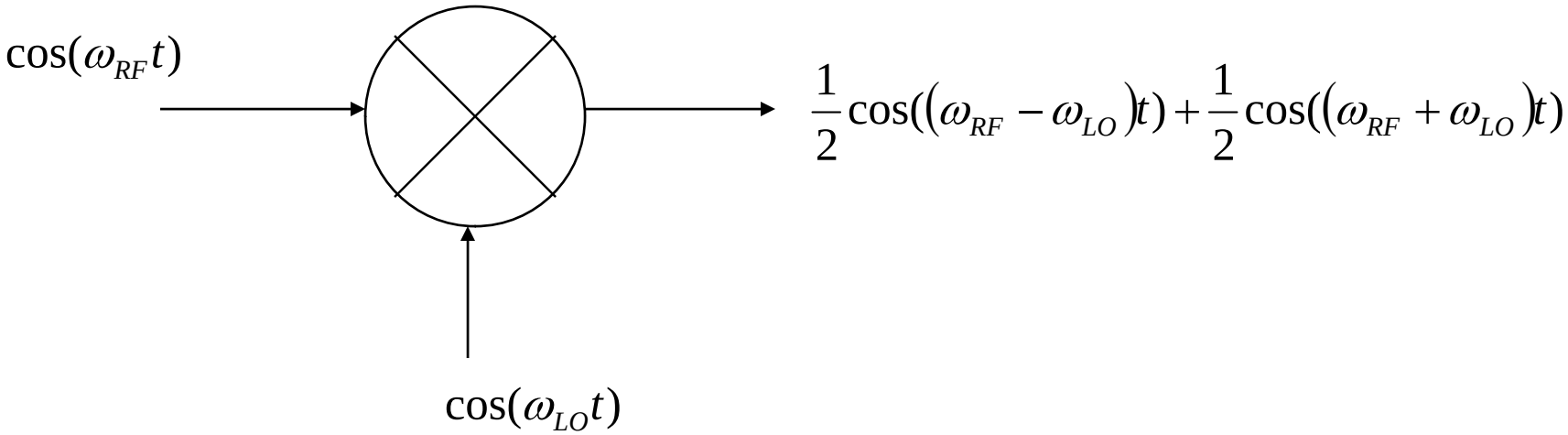
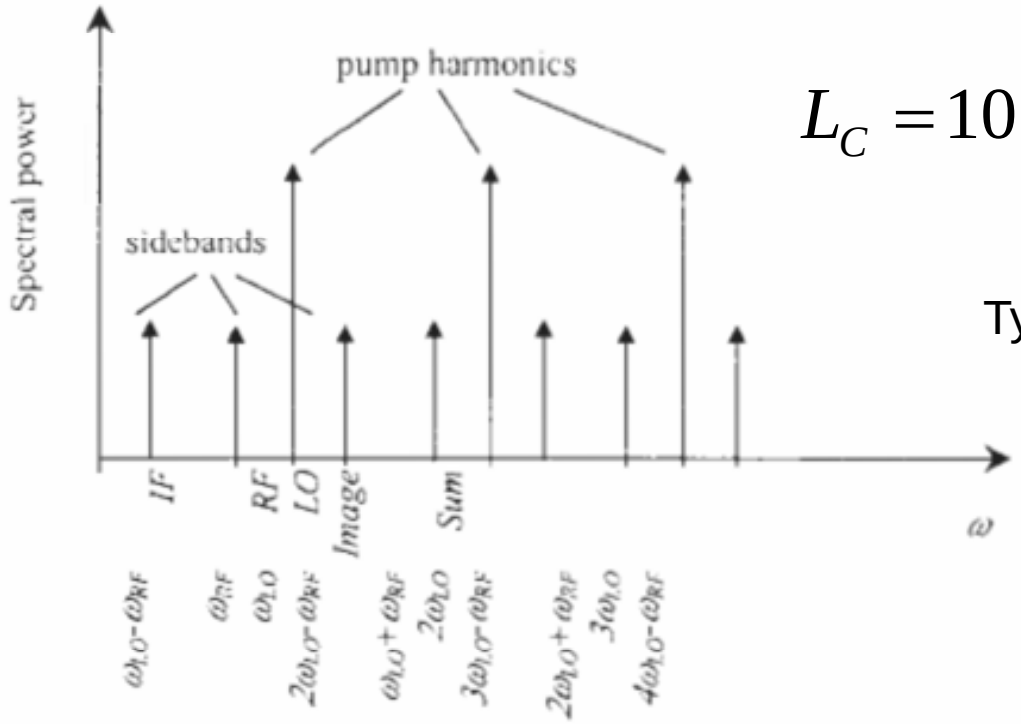
Frequency Translation

$$\cos(\omega_{RF}t)\cos(\omega_{LO}t) = \frac{1}{2}\cos((\omega_{RF} - \omega_{LO})t) + \frac{1}{2}\cos((\omega_{RF} + \omega_{LO})t)$$



Reality due to Nonlinearity

Conversion loss



$$L_C = 10\log\frac{RFinput}{IFoutput}\,dB$$

Typically 4 – 7 dB

Figure 7.2 Spectrum of frequencies of the form $\pm\omega_{RF} \pm n\,\omega_{LO}$

Mixer Design

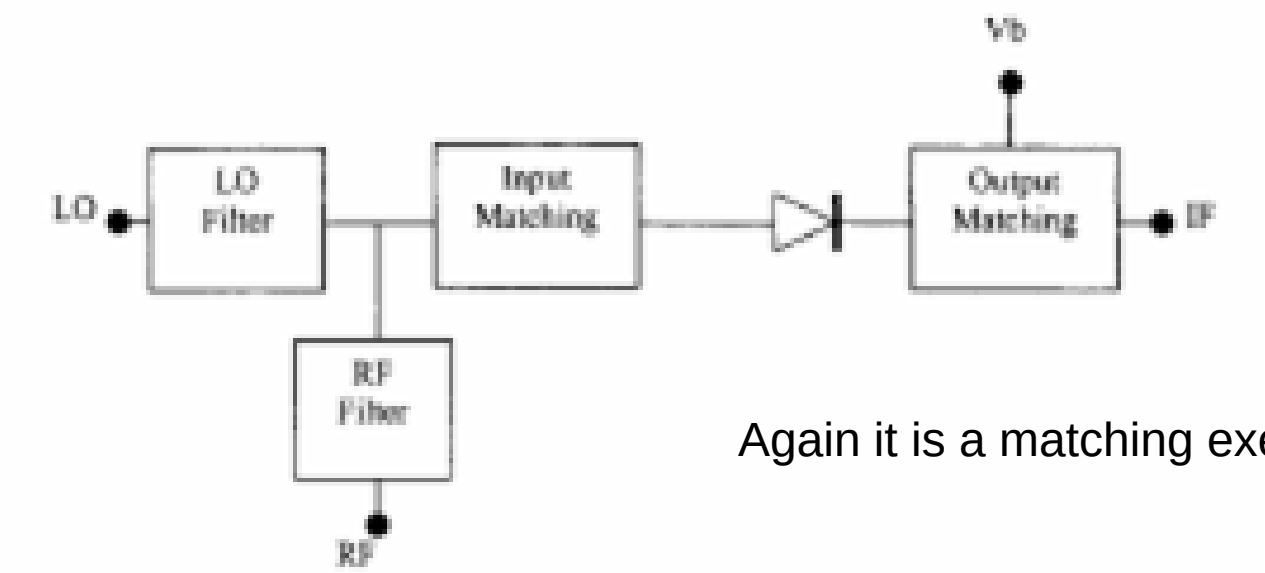


Figure 7.6 Single-ended diode mixer

Again it is a matching exercise!

Example

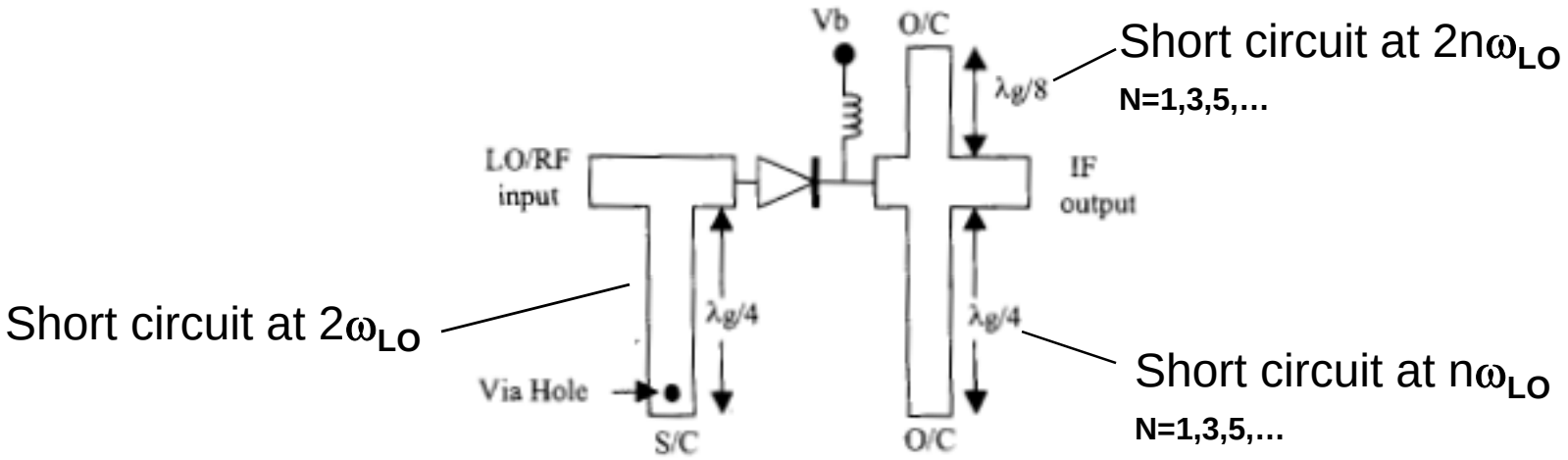


Figure 7.7 Microstrip implementation of a single-ended mixer

λ_g is wavelength in the guide at the LO frequency

Single frequency circuit to terminate LO harmonics reactively

FET Mixer

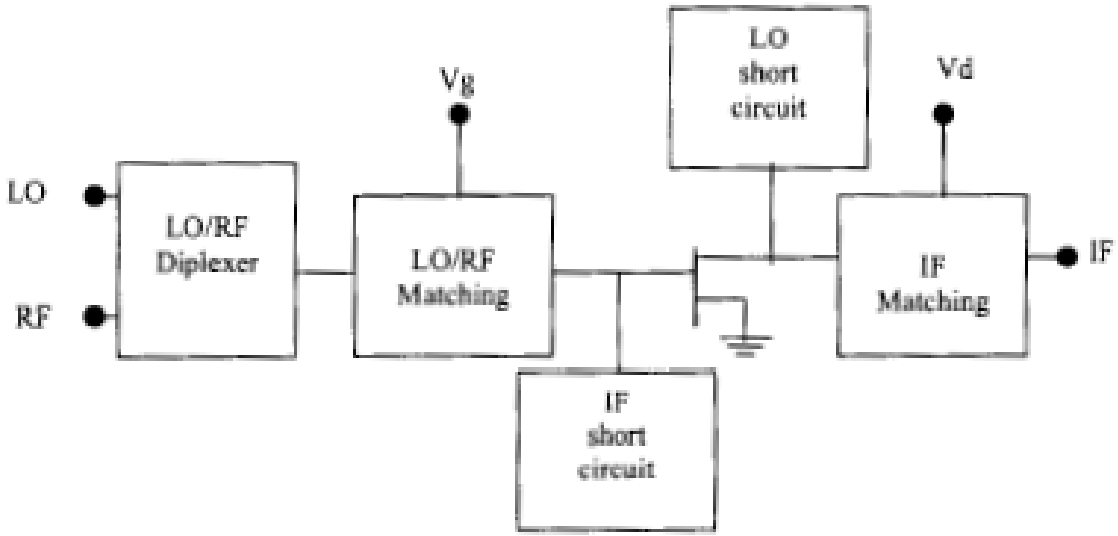


Figure 7.31 Single-gate single-ended FET mixer

Single Ended FET Implementation

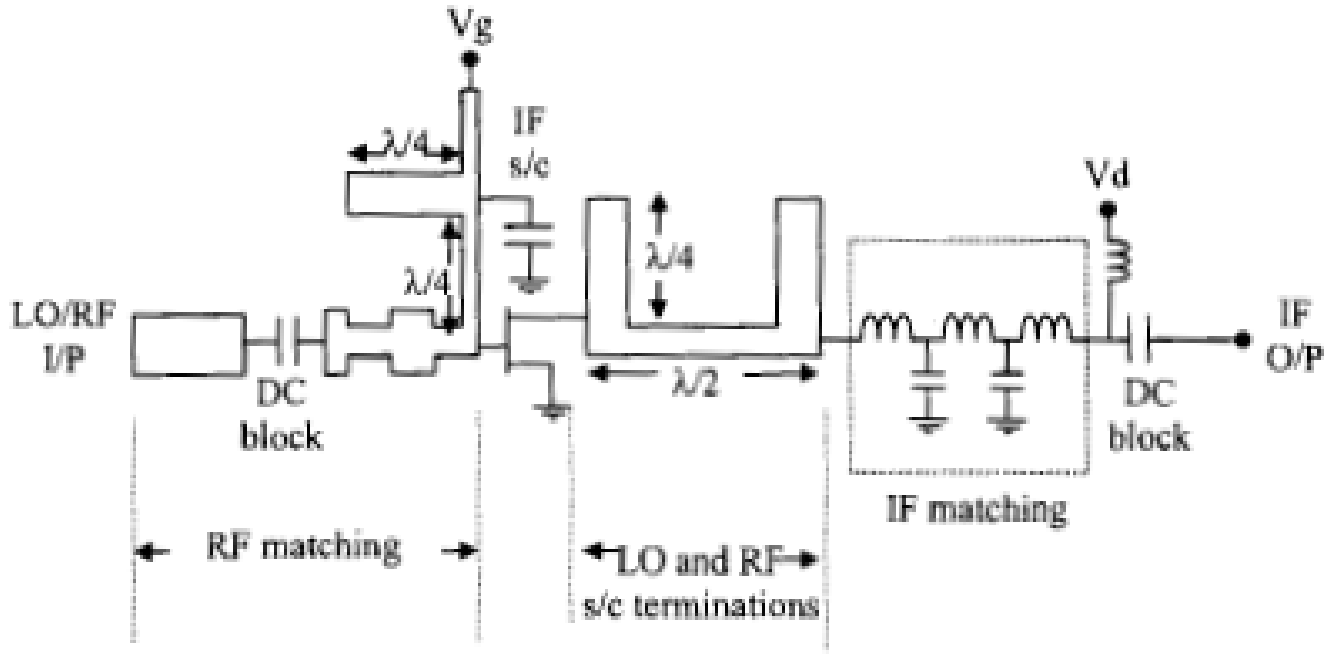


Figure 7.32 Schematic diagram of a typical FET single-ended mixer

Dual Gate or 2 FET

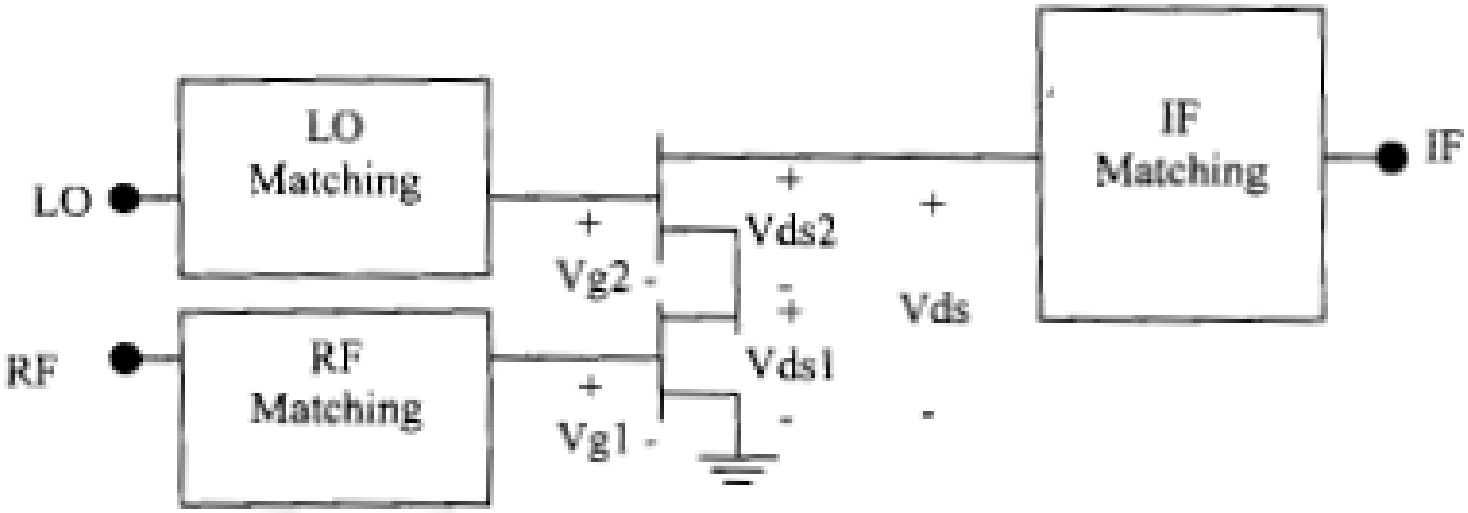


Figure 7.33 Dual-gate single-ended FET mixer

Balanced FET Mixer

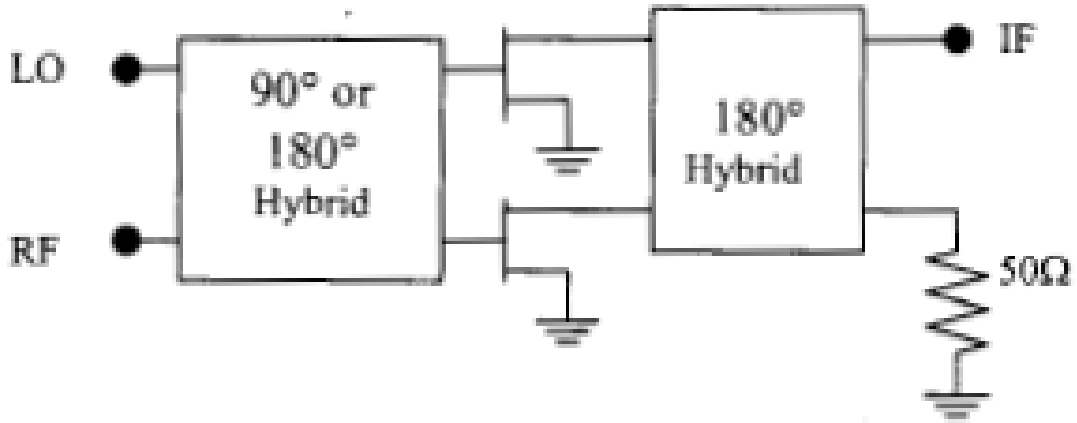


Figure 7.34 Single-balanced FET mixer using hybrid couplers

Dual Gate Balanced Mixer

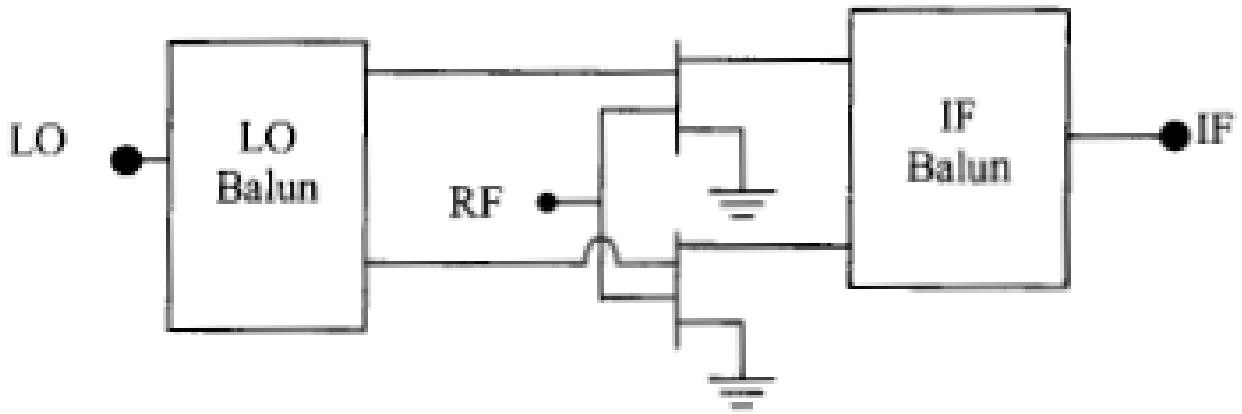


Figure 7.35 Dual-gate single-balanced FET mixer

Double Balanced Mixer

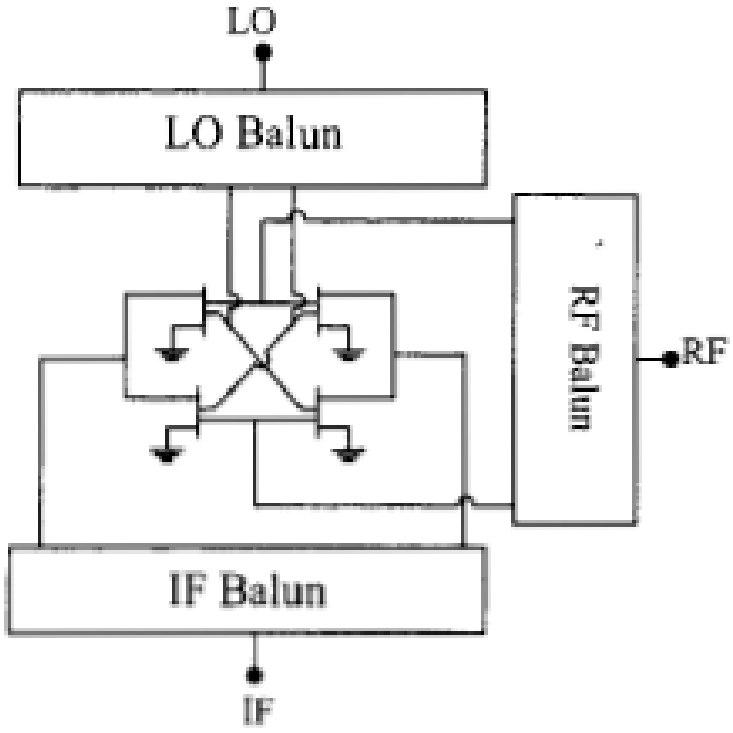


Figure 7.37 Double-balanced FET mixer using dual-gate FETs

Balun

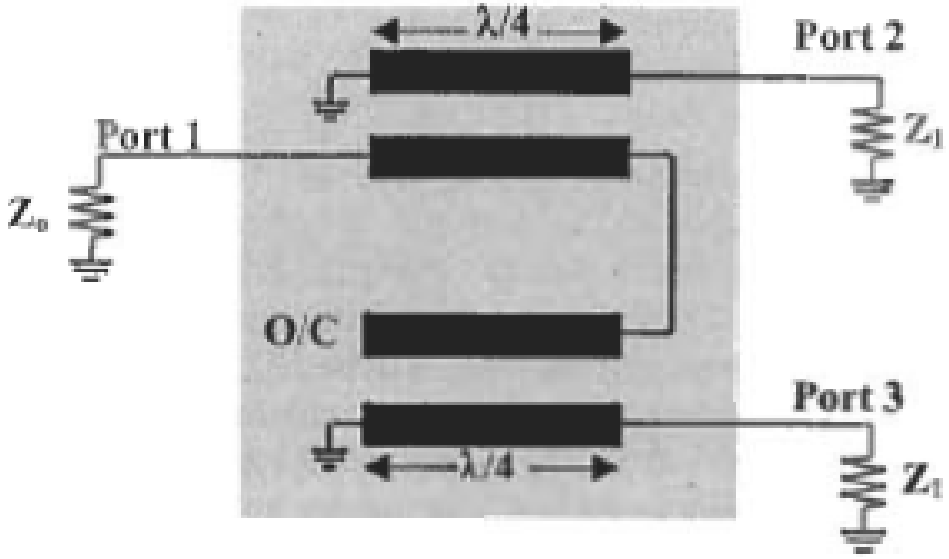


Figure 7.20 Schematic diagram of planar Marchand balun

Resistive FET Mixer

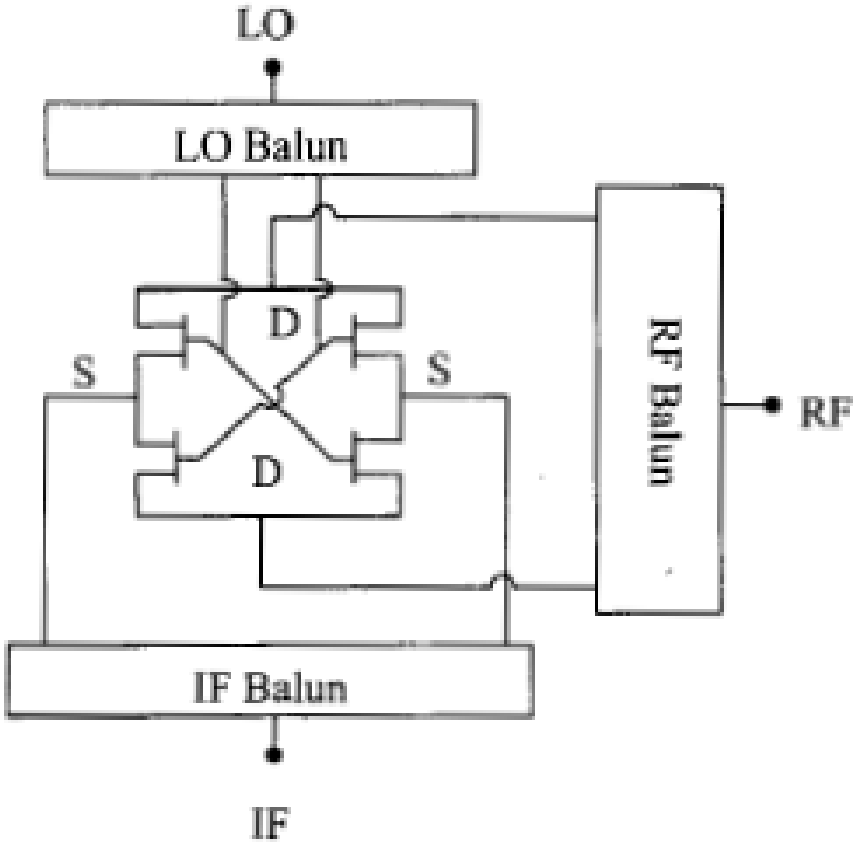


Figure 7.45 Double-balanced resistive FET mixer

Double Balanced FET Mixer

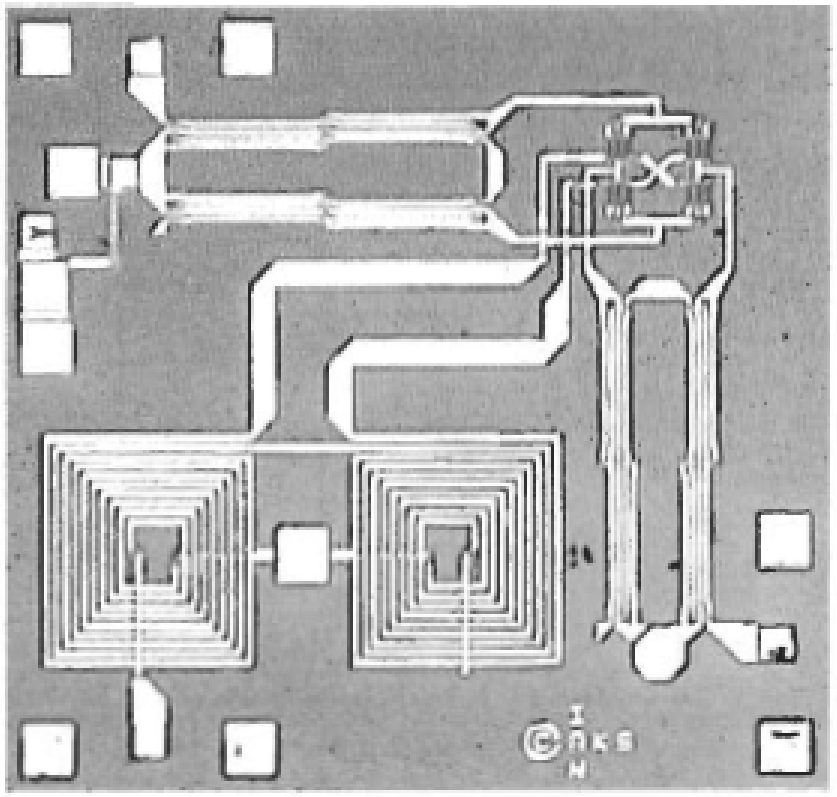


Figure 7.46 A millimetre-wave double-balanced resistive mixer (3 × 3.2 mm²)

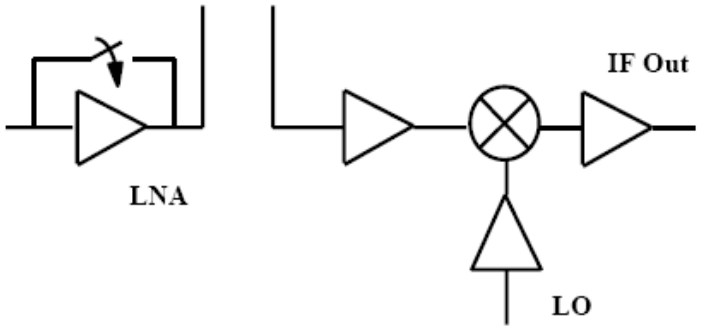
TriQuint SEMICONDUCTOR

GaAs MMIC CMH192

Datasheet

- High-Linearity, PCS LNA/Mixer IC for use in US and Korean band CDMA Mobile Phones
- Integrated bypass switch for LNA
- GaAs PHEMT Process
- Leadless 3.5 x 3.5 mm. SMT package
- LO Input power range: -7.0 to 0 dBm
- Operating voltage range: 2.7 to 4 V
- Total current consumption: 22 mA
- Adjustable Mixer Gain and IP3

ESD: **E**lectro**s**tatic **d**ischarge sensitive device
Observe handling Precautions!



TriQuint SEMICONDUCTOR

GaAs MMIC CMH192

MIXER - Electrical Characteristics of Mixer section

Test conditions: T_a = 25°C; V_{DD}= 2.7V, P_{LO} = -7 dBm,PRF=-22 dBm, f_{RF} = 1960 MHz, $f_{LO} = f_{RF} - f_{IF}$, f_{IF} = 210MHz, LOW=GND, HIGH=Vdd

Mode – High Linearity	**min**	**typ**	**max**	**Unit**
Operating Current		15		mA
Conversion Gain		15.0		dB
Noise Figure		3.5		dB
3rd Order Input Intercept Point		5.5		dBm
RF Input return loss		10		dB
LO Input return loss		10		dB
IF Output Impedance (1)		350 - j*515		Ω
Mode – Reduced Current	**min**	**typ**	**max**	**Unit**
Operating Current		12		mA
Conversion Gain		14.5		dB
Noise Figure		3.8		dB
3rd Order Input Intercept Point		4		dBm
RF Input return loss		10		dB
LO Input return loss		10		dB
IF Output Impedance (1)		350 - j*515		Ω

1) IF Output externally tuned to desired impedance