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Description

The TR5100 is a low power FM transceiver IC consisting of a receiver and a transmitter on a single chip. The receiver down converts an RF FM signal through an off-chip filter to IF frequency and then performs quadrature demodulation. IF filtering is performed by an off-chip filter. A speaker amplifier provides the capability of driving an off-chip class AB output stage which feeds audio signal to an external speaker. In addition, it allows the user to adjust speaker gain through a feedback function. A MUTE output is provided such that an RSSI current may be externally low-passed to provide a mute/disable function to the receiver audio in case of a weak received signal.

Receiving an audio input from a microphone, the transmitter amplifies and performs FM modulation onto a Colpitts oscillator output by way of a variable reactance circuit. The frequency of the signal is then up converted by an on-chip tripler to three times high as the RF output. The output is then sent to an antenna through an off-chip filter. A build-in feedback function in the microphone amplifier allows adjustment of its gain. In addition, an oscillation function is featured to enable paging of its transceiver mate by way of an external switch.

The frequency range of the TR5100 radio frequencies is from 15MHz to 150MH. It may be supported by simply choosing the appropriate external components. The transmitter and receiver oscillators require 2 crystals to clamp the TX and RX frequencies.

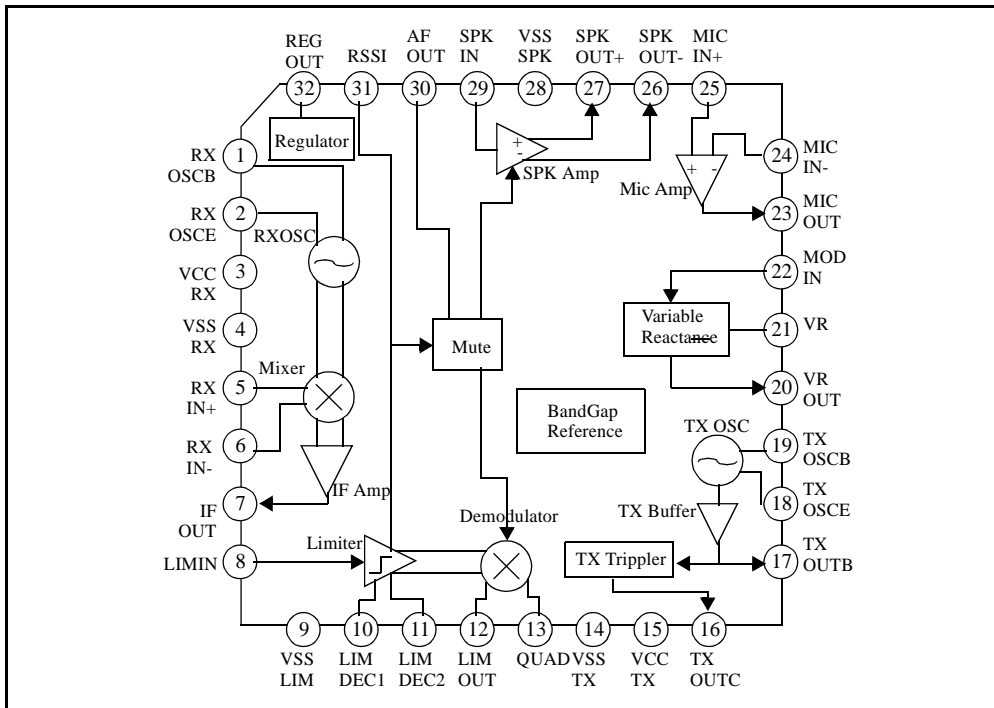
Features

- ◆ Fully integrated transceiver
- ◆ TX and RX operate in full duplex (FDD)
- ◆ Automotive temperature range
- ◆ TQFP 32L package (7mm x 7mm)

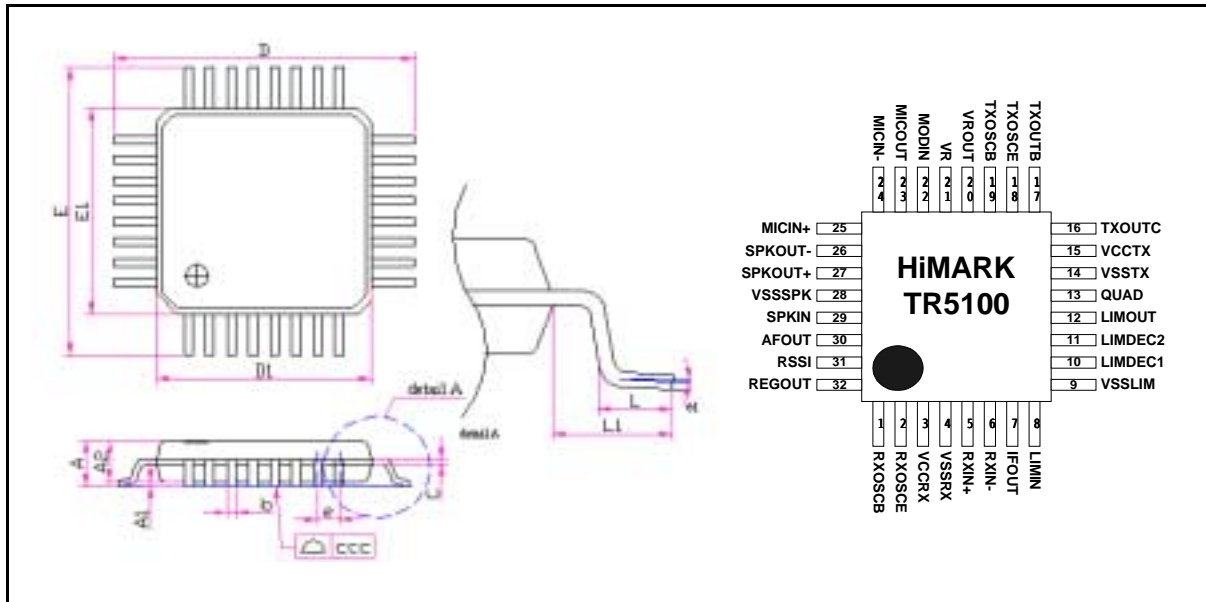
Applications

- ◆ One/Two Way Walkie Talkie
- ◆ Hands-free
- ◆ Elder/Baby Monitor

Block Diagram



Package and Pin Assignment: 32L, TQFP



Symbols	Dimensions in mm			Dimensions in inch		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	1.20	---	---	0.047
A1	0.05	---	0.15	0.002	---	0.006
A2	0.95	1.00	1.05	0.037	0.039	0.041
b	0.3	0.37	0.45	0.011	0.015	0.018
C	0.09	---	0.20	0.003	---	0.008
D1	6.90	7.00	7.10	0.271	0.275	0.279
D	8.80	9.00	9.20	0.346	0.354	0.362
E1	6.90	7.00	7.10	0.271	0.275	0.279
E	8.80	9.00	9.20	0.346	0.354	0.362
e	---	0.80(typ.)	---	---	0.03(typ.)	---
L	0.45	0.60	0.75	0.018	0.024	0.029
L1	---	1.00(ref.)	---	---	0.039(ref.)	---
θ1	0°	3.5°	7°	0°	3.5°	8°
ccc	---	---	0.10	---	---	0.004

Pin Descriptions

Number	Name	I/O	Description
1	RXOSCB	I/O	Receiver Oscillator tank connection B
2	RXOSCE	I/O	Receiver Oscillator tank connection E
3	VCCR _X	POWER	Positive voltage supply of RX
4	VSSR _X	GND	Receiver VSS
5	RFIN+	I	Mixer input A (requires external ac decoupling capacitor)
6	RFIN-	I	Mixer input B (requires external ac decoupling capacitor)
7	IFOUT	O	IF amplifier output
8	LIMIN	I	Limiter input
9	VSSLIM	GND	Limiter VSS
10	LIMDEC1	I/O	Limiter feedback A
11	LIMDEC2	I/O	Limiter feedback B
12	LIMOUT	O	Limiter output
13	QUAD	I/O	Demodulator tank connection
14	VSST _X	GND	Transmitter VSS
15	VCCT _X	POWER	Positive voltage supply of TX
16	TXOUTC	O	Transmitter output - C
17	TXOUTB	O	Transmitter output - B
18	TXOSCE	I/O	Transmitter Oscillator tank connection E
19	TXOSCB	I/O	Transmitter Oscillator tank connection B
20	VR _{OUT}	O	Variable Reactant output
21	VR	I/O	Variable Reactant I/O pin
22	MODIN	I	Transmitter modulator I/P pin
23	MIC _{OUT}	O	Microphone amp output
24	MICIN-	I	Microphone input -
25	MICIN+	I	Microphone input +
26	SPK _{OUT} -	O	Speaker output -
27	SPK _{OUT} +	O	Speaker output +
28	VSSSPK	GND	Speaker VSS
29	SPKIN	I	Speaker-amp input
30	AF _{OUT}	O	Demodulator output
31	RSSI	O	RSSI output
32	REG _{OUT}	O	Regulator output

Absolute Maximum Ratings

$V_{SS} = 0V$

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	$V_{SS} - 0.5$ to $V_{SS} + 6.0$	V
Operating temperature range	T_{OPR}	-10 to 60	°C
Storage temperature range	T_{STG}	-40 to 125	°C
Soldering temperature range	T_{SLD}	255	°C
Soldering time range	t_{SLD}	10	s

Recommended Operating Conditions

$V_{SS} = 0V$

Parameter	Symbol	Value			Unit
		min.	typ.	max.	
Supply voltage range	V_{CC}	2.7	3.0	3.3	V
Receive RF carrier range	F_{RX}	15		150	MHz
Transmit RF carrier range	F_{TX}	15		150	MHz
Receive IF range	F_{IF}		455		KHz
Transmit modulation deviation	F_{DEV}		3	5	KHz
Operating temperature	T_A	-10	25	60	°C

Transmitter & Receiver Characteristics

($V_{CC} = 2.7$ to $3.3V$, $V_{SS} = 0V$, $T_A = -10$ to $60^\circ C$, $F_{IF} = 455KHz$, unless otherwise noted)

Parameter	Symbol	Condition	Value			Unit
			min.	typ.	max.	
Receiver Sensitivity		$F_{MOD} = 1 KHz$, $F_{DEV} = 3 KHz$, SINAD = 12 dB At filter antenna port		-100		dBm
Transmitter Output Power	P_{TX}	At IC Pin 16		-20		dBm

Electrical Characteristics

($V_{CC} = 2.7$ to $3.3V$, $V_{SS} = 0V$, $T_A = -10$ to $60^\circ C$, $F_{IF} = 455KHz$, unless otherwise noted)

Parameter	Symbol	Condition	Value			Unit
			min.	typ.	max.	
RX & TX						
RX Operating Current	$I_{CC,RX}$	MUTE ON			12	mA
TX Operating Current	$I_{CC,TX}$	Tripler Output power > -20 dBm			10	mA
IF Filter Port Impedance		At F_{IF}		1.5		K Ω
Speaker Amplifier						
(Unless otherwise specified, all parameter must be satisfied with both 6 and 16 Ω speaker load and gain adjust pot set to max gain)						
Gain	G_{SPK}	Open Loop		40		dB
3dB Passband	$f_{SA,L}$ $f_{SA,H}$			0.3 3.0		KHz KHz
Total Harmonic Distortion	THD	Delivered to 32 Ω load			10	%
Maximum Output Voltage Swing	V_{SWING}	Delivered to 32 Ω load $V_{CC} = 3.0 V$ $V_{CC} = 2.5 V$		1.0 0.5		V_{P-P}
Mic-Amplifier						
Voltage Gain	G_{MIC}	Open Loop		30		dB
3dB Passband	$f_{MA,L}$ $f_{MA,H}$			0.3 3.0		KHz KHz

Functional Description

◆ Mixer

The mixer features a double-balanced configuration and incorporates an AC-coupled input. It is designed to work up to 150MHz. It can be used in differential or single ended mode by connecting the input pin "RFIN-" to ground through an 1uF capacitor.

◆ TX & RX Oscillators

Both are Colpitts oscillators. The on-chip transistor operates with a crystal and LC resonant elements up to 150MHz. Series resonant and overtone crystal are used to achieve excellent local oscillator stability. Using an overtone crystal to enhance operation, the internal transistor bias is increased by adding an external resistor from "RXOSCE" to ground. Typically, -10dBm of local oscillator drive is needed to adequately drive the mixer. (please refer to the application circuit)

◆ IF amplifier

The IF amplifier is a differential-input, single-ended output emitter-coupled pair. It is used to provide additional gain for reducing the influence of noise from the succeeding limiter amplifier on the total receive noise figure. The output of the IF amplifier is buffered and has an impedance is 1.5K Ω . When using 455KHz ceramic filter with source and load impedance of 1.5K Ω , no external matching is needed.

◆ RSSI

The received signal strength indicator (RSSI) output is a current proportional to the log of the received signal amplitude. The RSSI current output is derived by summing currents from limiting amplifier stages. The RSSI output current creates a voltage across an external resistor at pin 31.

◆ Limiter

The limiting amplifier consists of several dc-coupled amplifier stages. The fixed internal input impedance is 1.5K Ω . The total gain of the limiting amplifier section is approximately 75dB.

◆ Demodulator

Following the limiting amplifier, is the demodulator. The demodulator is a double-balanced four-quadrant multiplier with an external 10pF quadrature capacitor between "LIM-OUT" & "QUAD". The external capacitor value may be increased to increase the IF signal at the external parallel RLC resonant circuit which provides the 90 degree phase shift and drives the quadrature detector. A single pin "QUAD" is for the external LC parallel resonant network connecting to the quadrature detector.

◆ Mute

The mute circuit is controlled by the RSSI voltage which detects received signal strength. If the incoming signal is weak, then the mute circuit would disable the demodulator and speaker amp output.

◆ Speaker Amp

After demodulation, audio signal can be obtained from the pin “AFOUT”. That signal swing however is very small, and an operational amplifier must be added to increase the signal swing. The Speaker Amp gain can be adjusted by applying external resistive feedback. A class AB output buffer have to be added at the output of the Speaker Amp “SPKOUT+” & “SPKOUT-” to decrease distortion of the audio signal.

◆ Bandgap Reference

A bandgap reference provides precise biasing of the entire chip over temperature.

◆ Mic-Amp

The Mic-Amp is used to increase the swing of input audio signal which could be limited by two diodes in $1.4V_{pp}$. The Mic-Amp gain can also be adjusted by applying external resistive feedback.

◆ Variable Reactance

A varactor is featured in this block to allow modulation of the TX oscillator.

◆ Tripler

FM modulation is imparted to the TX oscillator at the fundamental frequency (f_o). The modulated signal (f_o) is then multiplied to the higher transmit frequency ($3f_o$) by this tripler circuit.

Application Circuits

