



Wireless Components

ASK Single Conversion Receiver

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Specification July 2004

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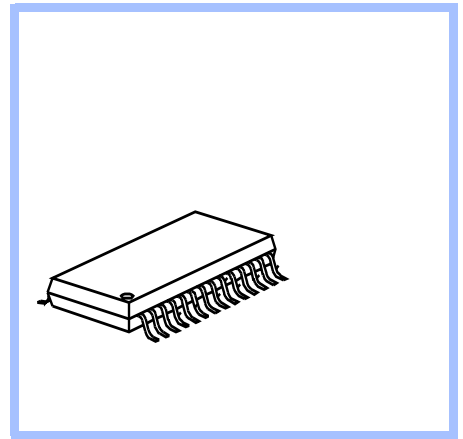
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Product Info

General Description

The IC is a very low power consumption single chip ASK Single Conversion Receiver for receive frequencies between 310 and 350MHz. The Receiver offers a high level of integration and needs only a few external components. The device contains a low noise amplifier (LNA), a double balanced mixer, a fully integrated VCO, a PLL synthesiser, a crystal oscillator, a limiter with RSSI generator, a data filter, a data comparator (slicer) and a peak detector. Additionally there is a power down feature to save battery life.

Package



Features

- Low supply current ($I_s = 4.6\text{mA typ.}$)
- Supply voltage range $5\text{V} \pm 10\%$
- Power down mode with very low supply current (50nA typ)
- Fully integrated VCO and PLL Synthesiser
- RF input sensitivity $< -110\text{dBm}$
- Selectable frequency ranges around 315 MHz and 345 MHz
- Selectable reference frequency
- Limiter with RSSI generation, operating at 10.7MHz
- 2nd order low pass data filter with external capacitors
- Data slicer with self-adjusting threshold

Application

- Keyless Entry Systems
- Remote Control Systems
- Fire Alarm Systems
- Low Bitrate Communication Systems

Ordering Information

Type	Ordering Code	Package
TDA 5201	Q67037-A1118	P-TSSOP-28-1
available on tape and reel		

1

Table of Contents

1 Table of Contents	i
2 Product Description	1
2.1 Overview	2
2.2 Application	2
2.3 Features	2
2.4 Package Outlines	3
3 Functional Description	1
3.1 Pin Configuration	2
3.2 Pin Definition and Function	3
3.3 Functional Block Diagram	9
3.4 Functional Blocks	10
3.4.1 Low Noise Amplifier (LNA)	10
3.4.2 Mixer	10
3.4.3 PLL Synthesizer	10
3.4.4 Crystal Oscillator	11
3.4.5 Limiter	11
3.4.6 Data Filter	11
3.4.7 Data Slicer	11
3.4.8 Peak Detector	12
3.4.9 Bandgap Reference Circuitry	12
4 Applications	1
4.1 Choice of LNA Threshold Voltage and Time Constant	2

4.2	Data Filter Design	4
4.3	Quartz Load Capacitance Calculation	5
4.4	Quartz Frequency Calculation	6
4.5	Data Slicer Threshold Generation	7
5	Reference	1
5.1	Electrical Data	2
5.1.1	Absolute Maximum Ratings	2
5.1.2	Operating Range	3
5.1.3	AC/DC Characteristics	4
5.2	Test Circuit	8
5.3	Test Board Layouts	9
5.4	Bill of Materials	11
5.5	Appendix - Noise Figure and Gain Circles	13

2 Product Description

Contents of this Chapter

2.1	Overview	2-2
2.2	Application	2-2
2.3	Features	2-2
2.4	Package Outlines	2-3

2.1 Overview

The IC is a very low power consumption single chip ASK Superheterodyne Receiver (SHR) for the frequency bands 315 and 345MHz. The SHR offers a high level of integration and needs only a few external components. The device contains a low noise amplifier (LNA), a double balanced mixer, a fully integrated VCO, a PLL synthesiser, a crystal oscillator, a limiter with RSSI generator, a data filter, a data comparator (slicer) and a peak detector. Additionally there is a power down feature to save battery life.

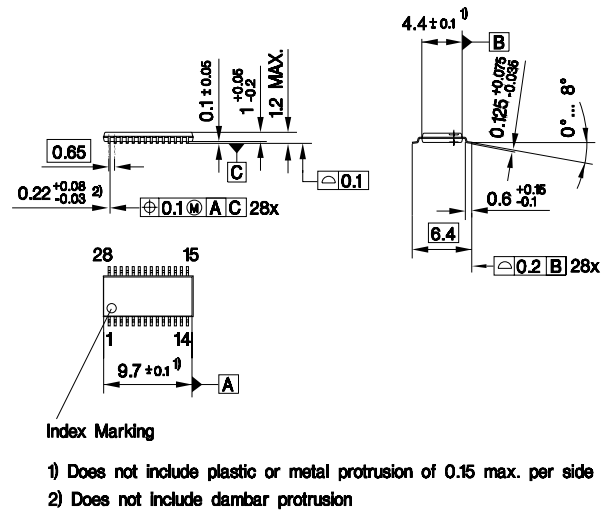
2.2 Application

- Keyless Entry Systems
- Remote Control Systems
- Fire Alarm Systems
- Low Bitrate Communication Systems

2.3 Features

- Low supply current ($I_s = 4.6\text{mA typ.}$)
- Supply voltage range $5\text{V} \pm 10\%$
- Power down mode with very low supply current (50nA typ.)
- Fully integrated VCO and PLL Synthesiser
- RF input sensitivity $< -110\text{dBm}$
- Selectable receive frequency bands 315 and 345MHz
- Selectable reference frequency
- Limiter with RSSI generation, operating at 10.7MHz
- 2nd order low pass data filter with external capacitors
- Data slicer with self-adjusting threshold

2.4 Package Outlines



P_TSSOP_28.EPS

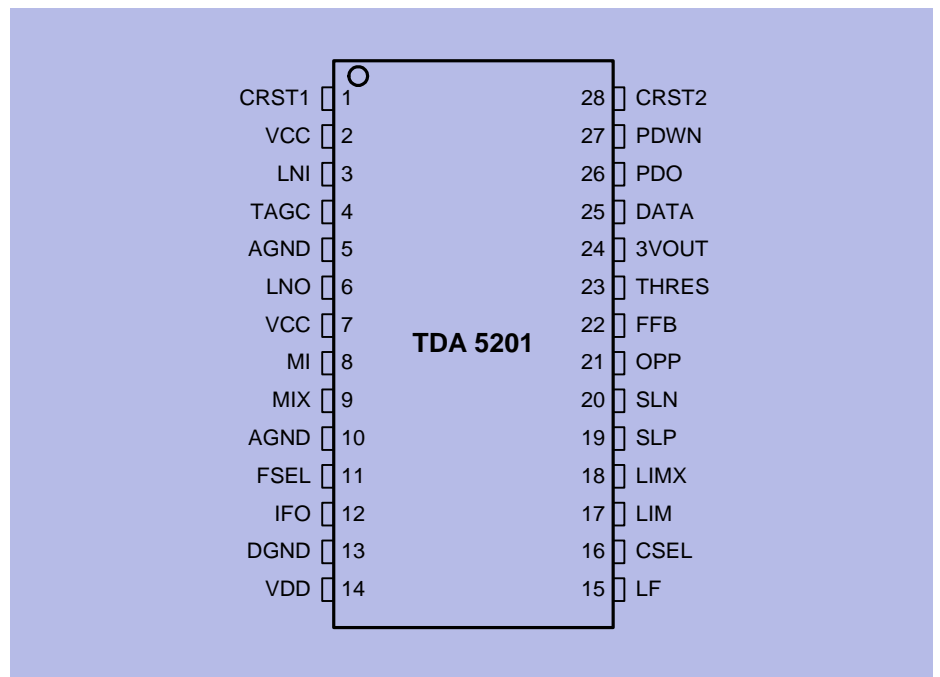
Figure 2-1 P-TSSOP-28-1 package outlines

3 Functional Description

Contents of this Chapter

3.1	Pin Configuration	3-2
3.2	Pin Definition and Function	3-3
3.3	Functional Block Diagram	3-9
3.4	Functional Blocks	3-10

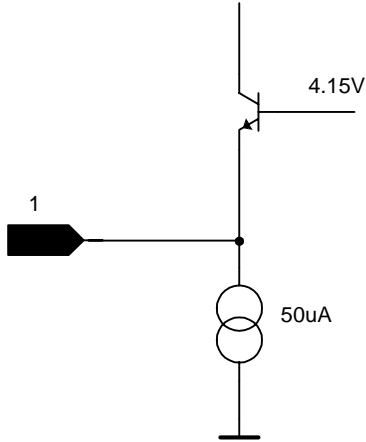
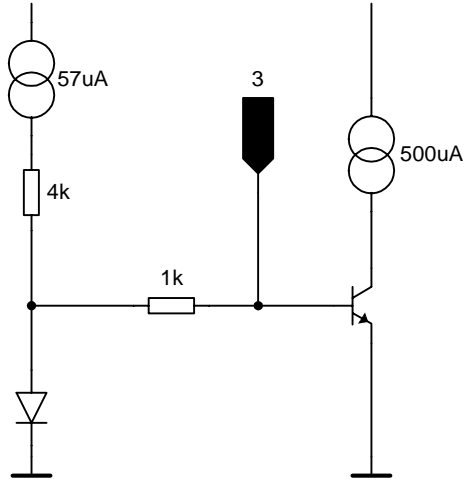
3.1 Pin Configuration



Pin_Configuration_5201_V1.4.wmf

Figure 3-1 IC Pin Configuration

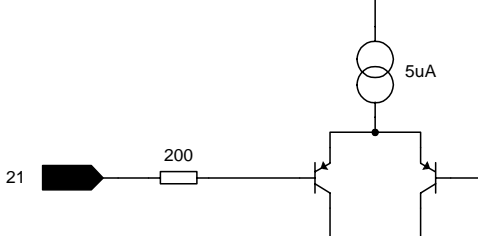
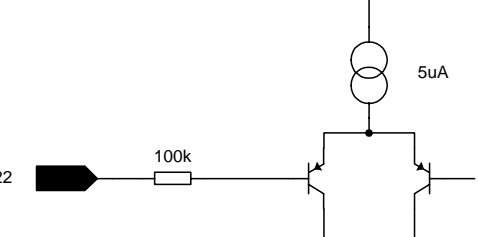
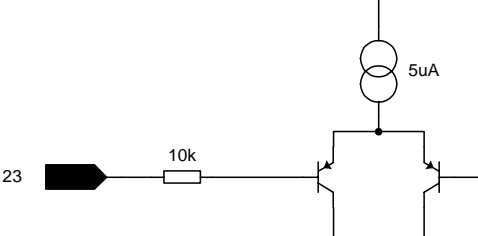

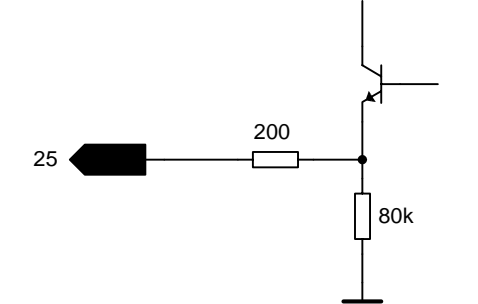
3.2 Pin Definition and Function

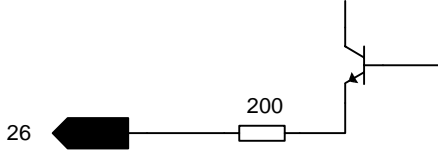
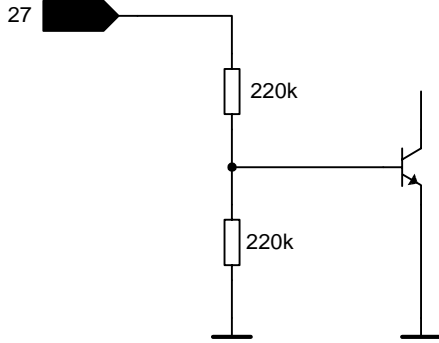
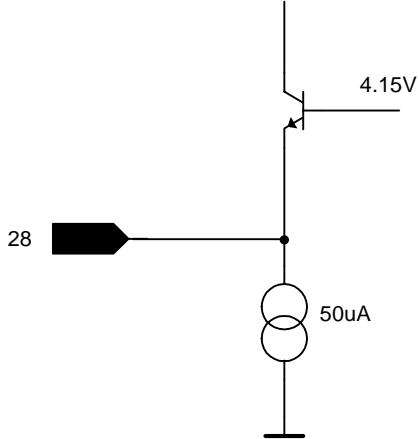
Table 3-1 Pin Definition and Function			
Pin No.	Symbol	Equivalent I/O-Schematic	Function
1	CRST1		External Crystal Connector 1
2	VCC		5V Supply
3	LNI		LNA Input

4	TAGC		AGC Time Constant Control
5	AGND		Analogue Ground Return
6	LNO		LNA Output
7	VCC		5V Supply
8	MI		Mixer Input
9	MIX		Complementary Mixer Input
10	AGND		Analogue Ground Return
11	FSEL		not applicable - has to be left open

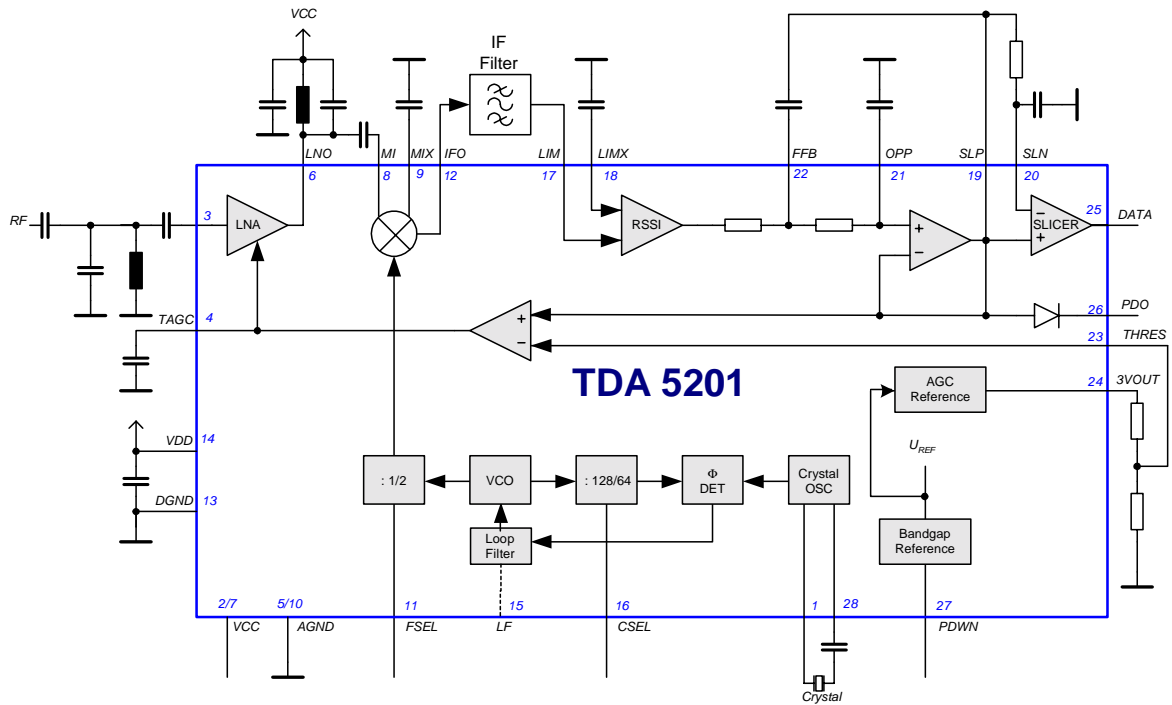
12	IFO		10.7 MHz IF Mixer Output
13	DGND		Digital Ground Return
14	VDD		5V Supply (PLL Counter Circuitry)
15	LF		PLL Filter Access Point
16	CSEL		5.xx or 10.xx MHz Quartz Selector

<p>17 18</p>	<p>LIM LIMX</p>		<p>Limiter Input Complementary Limiter Input</p>
<p>19</p>	<p>SLP</p>		<p>Data Slicer Positive Input</p>
<p>20</p>	<p>SLN</p>		<p>Data Slicer Negative Input</p>

21	OPP		OpAmp Noninverting Input
22	FFB		Data Filter Feedback Pin
23	THRES		AGC Threshold Input
24	3VOUT		3V Reference Output
25	DATA		Data Output

<p>26</p>	<p>PDO</p> 	<p>Peak Detector Output</p>
<p>27</p>	<p>PDWN</p> 	<p>Power Down Input</p>
<p>28</p>	<p>CRST2</p> 	<p>External Crystal Connector 2</p>

3.3 Functional Block Diagram



Function_5200.wmf

Figure 3-2 Main Block Diagram

3.4 Functional Blocks

3.4.1 Low Noise Amplifier (LNA)

The LNA is an on-chip cascode amplifier with a voltage gain of 15 to 20dB. The gain figure is determined by the external matching networks situated ahead of LNA and between the LNA output **LNO** (Pin 6) and the Mixer Inputs **MI** and **MIX** (Pins 8 and 9). The noise figure of the LNA is approximately 2dB, the current consumption is 500 μ A. The gain can be reduced by approximately 18dB. The switching point of this AGC action can be determined externally by applying a threshold voltage at the **THRES** pin (Pin 23). This voltage is compared internally with the received signal (RSSI) level generated by the limiter circuitry. In case that the RSSI level is higher than the threshold voltage the LNA gain is reduced and vice versa. The threshold voltage can be generated by attaching a voltage divider between the **3VOUT** pin (Pin 24) which provides a temperature stable 3V output generated from the internal bandgap voltage and the **THRES** pin as described in Section 4.1. The time constant of the AGC action can be determined by connecting a capacitor to the **TAGC** pin (Pin 4) and should be chosen along with the appropriate threshold voltage according to the intended operating case and interference scenario to be expected during operation. The optimum choice of AGC time constant and the threshold voltage is described in Section 4.1.

3.4.2 Mixer

The Double Balanced Mixer downconverts the input frequency (RF) in the range of 310-350MHz to the intermediate frequency (IF) at 10.7MHz with a voltage gain of approximately 21dB by utilising either high- or low-side injection of the local oscillator signal. In case the mixer is interfaced only single-ended, the unused mixer input has to be tied to ground via a capacitor. The mixer is followed by a low pass filter with a corner frequency of 20MHz in order to suppress RF signals to appear at the IF output (**IFO** pin). The IF output is internally consisting of an emitter follower that has a source impedance of approximately 330 Ω to facilitate interfacing the pin directly to a standard 10.7MHz ceramic filter without additional matching circuitry.

3.4.3 PLL Synthesizer

The Phase Locked Loop synthesizer consists of a VCO, an asynchronous divider chain, a phase detector with charge pump and a loop filter and is fully implemented on-chip. The VCO is including spiral inductors and varactor diodes. The **FSEL** pin (Pin11) has to be left open. The tuning range of the VCO was designed to guarantee over production spread and the specified temperature range a receive frequency range between 310 and 350MHz depending on whether high- or low-side injection of the local oscillator is used. The oscillator signal is fed both to the synthesiser divider chain and to a divider that is dividing

the signal by 2 before it is applied to the downconverting mixer. Local oscillator high side injection has to be used for receive frequencies between approximately 310 and 330 MHz, low side injection for receive frequencies between 330 and 350MHz - see also Section 4.4..

3.4.4 Crystal Oscillator

The on-chip crystal oscillator circuitry allows for utilisation of quartzes both in the 5 and 10MHz range as the overall division ratio of the PLL can be switched between 64 and 128 via the **CSEL** (Pin 16) pin according to the following table.

CSEL	Crystal Frequency
Open	5.xx MHz
Shorted to ground	10.xx MHz

The calculation of the value of the necessary quartz load capacitance is shown in Section 4.3, the quartz frequency calculation is explained in Section 4.4.

3.4.5 Limiter

The Limiter is an AC coupled multistage amplifier with a cumulative gain of approximately 80dB that has a bandpass-characteristic centred around 10.7MHz. It has an input impedance of 330 Ω to allow for easy interfacing to a 10.7MHz ceramic IF filter. The limiter circuit acts as a Receive Signal Strength Indicator (RSSI) generator which produces a DC voltage that is directly proportional to the input signal level as can be seen in Figure 4-2. This signal is used to demodulate the ASK receive signal in the subsequent baseband circuitry and to turn down the LNA gain by approximately 18dB in case the input signal strength is too strong as described in Section 3.4.1 and Section 4.1.

3.4.6 Data Filter

The data filter comprises an OP-Amp with a bandwidth of 100kHz used as a voltage follower and two 100k Ω on-chip resistors. Along with two external capacitors a 2nd order Sallen-Key low pass filter is formed. The selection of the capacitor values is described in Section 4.2.

3.4.7 Data Slicer

The data slicer is a fast comparator with a bandwidth of 100 kHz. This allows for a maximum receive data rate of approximately 120kbaud. The maximum achievable data rate also depends on the IF Filter bandwidth and the local oscillator tolerance values. Both inputs are accessible. The output delivers a digital data signal (CMOS-like levels) for the detector. The self-adjusting threshold on pin 20 is generated by RC-term or peak detector depending on the baseband coding scheme. The data slicer threshold generation alternatives are described in more detail in Section 4.5.

3.4.8 Peak Detector

The peak detector generates a DC voltage which is proportional to the peak value of the receive data signal. An external RC network is necessary. The output can be used as an indicator for the signal strength and also as a reference for the data slicer. The maximum output current is 500µA.

3.4.9 Bandgap Reference Circuitry

A Bandgap Reference Circuit provides a temperature stable reference voltage for the device. A power down mode is available to switch off all subcircuits which is controlled by the PWDN pin (Pin 27) as shown in the following table. The supply current drawn in this case is typically 50nA.

PWDN	Operating State
Open or tied to ground	Powerdown Mode
Tied to Vs	Receiver On

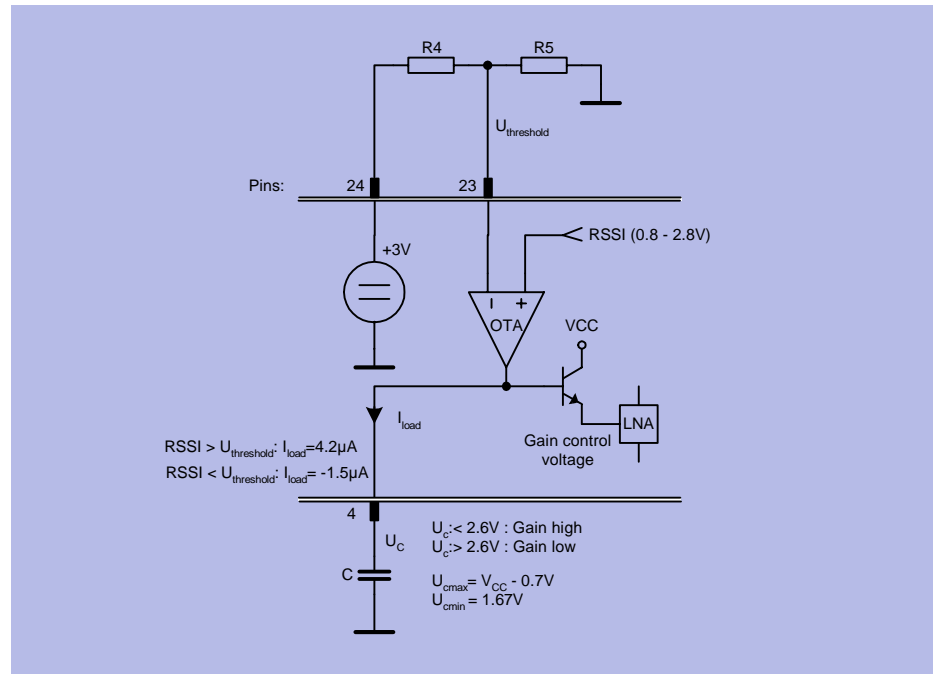
4 Applications

Contents of this Chapter

4.1	Choice of LNA Threshold Voltage and Time Constant	4-2
4.2	Data Filter Design	4-4
4.3	Quartz Load Capacitance Calculation	4-5
4.4	Quartz Frequency Calculation	4-6
4.5	Data Slicer Threshold Generation	4-7

4.1 Choice of LNA Threshold Voltage and Time Constant

In the following figure the internal circuitry of the LNA automatic gain control is shown.

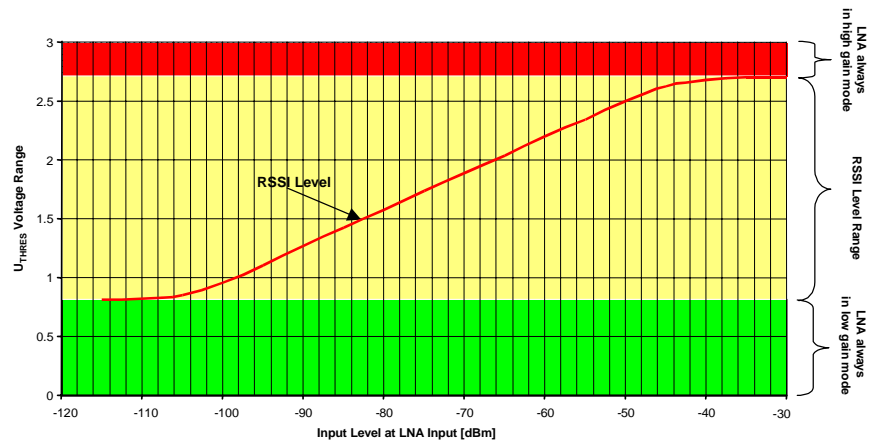


LNA_autom.wmf

Figure 4-1 LNA Automatic Gain Control Circuitry

The LNA automatic gain control circuitry consists of an operational transimpedance amplifier that is used to compare the received signal strength signal (RSSI) generated by the Limiter with an externally provided threshold voltage U_{thres} . As shown in the following figure the threshold voltage can have any value between approximately 0.8 and 2.8V to provide a switching point within the receive signal dynamic range.

This voltage U_{thres} is applied to the **THRES** pin (Pin 23). The threshold voltage can be generated by attaching a voltage divider between the **3VOUT** pin (Pin 24) which provides a temperature stable 3V output generated from the internal bandgap voltage and the **THRES** pin. If the RSSI level generated by the Limiter is higher than U_{thres} , the OTA generates a positive current I_{load} . This yields a voltage rise on the **TAGC** pin (Pin 4). Otherwise, the OTA generates a negative current. These currents do not have the same values in order to achieve a fast-attack and slow-release action of the AGC and are used to charge an external capacitor which finally generates the LNA gain control voltage.



RSSI-AGC.wmf

Figure 4-2 RSSI Level and Permissive AGC Threshold Levels

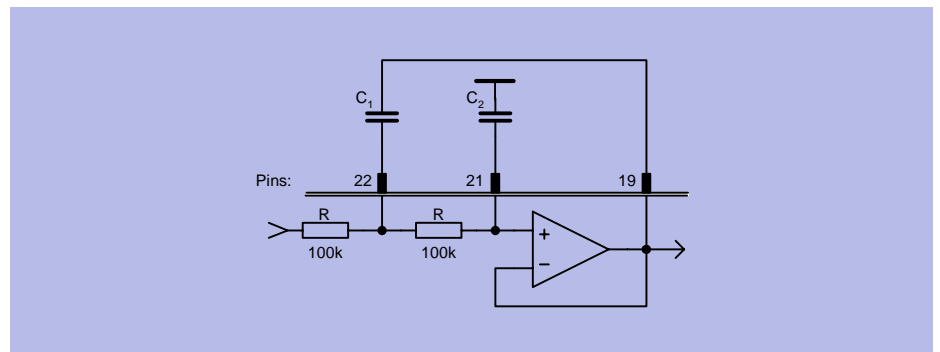
The switching point should be chosen according to the intended operating scenario. The determination of the optimum point is described in the accompanying Application Note, a threshold voltage level of 1.8V is apparently a viable choice. It should be noted that the output of the 3VOUT pin is capable of driving up to 50µA, but that the THRES pin input current is only in the region of 40nA. As the current drawn out of the 3VOUT pin is directly related to the receiver power consumption, the power divider resistors should have high impedance values. R4 can be chosen as 120kΩ, R5 as 180kΩ to yield an overall 3VOUT output current of 10µA.

Note: If the LNA gain shall be kept in either high or low gain mode this has to be accomplished by tying the **THRES** pin to a fixed voltage. In order to achieve high gain mode operation, a voltage higher than 2.8V shall be applied to the **THRES** pin, such as a short to the **3VOLT** pin. In order to achieve low gain mode operation a voltage lower than 0.7V shall be applied to the **THRES**, such as a short to ground.

As stated above the capacitor connected to the **TAGC** pin is generating the gain control voltage of the LNA due to the charging and discharging currents of the OTA and thus is also responsible for the AGC time constant. As the charging and discharging currents are not equal two different time constants will result. The time constant corresponding to the charging process of the capacitor shall be chosen according to the data rate. According to measurements performed at Infineon the capacitor value should be greater than 47nF.

4.2 Data Filter Design

Utilising the on-board voltage follower and the two 100kΩ on-chip resistors a 2nd order Sallen-Key low pass data filter can be constructed by adding 2 external capacitors between pins 19 (SLP) and 22 (FFB) and to pin 21 (OPP) as depicted in the following figure and described in the following formulas¹.



Filter_Design.wmf

Figure 4-3 Data Filter Design

$$C1 = \frac{2Q\sqrt{b}}{R2\pi f_{3dB}}$$

$$C2 = \frac{\sqrt{b}}{4QR\pi f_{3dB}}$$

with

$$Q = \frac{\sqrt{b}}{a}$$

the quality factor of the poles where

in case of a Bessel filter

$$a = 1.3617, b = 0.618$$

and thus

$$Q = 0.577$$

and in case of a Butterworth filter

$$a = 1.141, b = 1$$

and thus

$$Q = 0.71$$

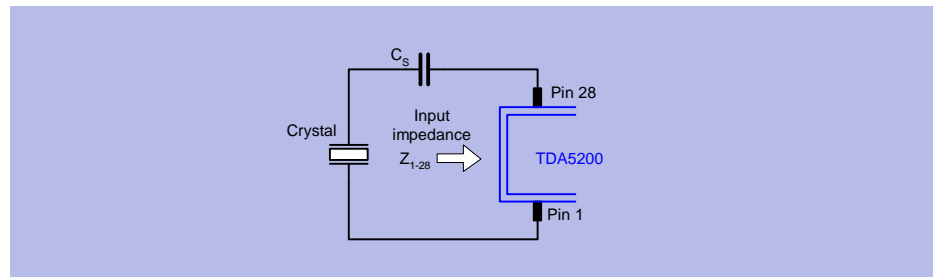
Example: Butterworth filter with $f_{3dB} = 5\text{kHz}$ and $R = 100\text{k}\Omega$:

$$C_1 = 450\text{pF}, C_2 = 225\text{pF}$$

1. taken from Tietze/Schenk: Halbleiterschaltungstechnik, Springer Berlin, 1999

4.3 Quartz Load Capacitance Calculation

The value of the capacitor necessary to achieve that the quartz oscillator is operating at the intended frequency is determined by the reactive part of the negative resistance of the oscillator circuit as shown in Section 5.1.3 and by the quartz specifications given by the quartz manufacturer.



Quartz_load.wmf

Figure 4-4 Determination of Series Capacitance Value for the Quartz Oscillator

Crystal specified with load capacitance

$$C_s = \frac{1}{\frac{1}{C_l} + 2\pi f X_L}$$

with C_l the load capacitance (refer to the quartz crystal specification).

Examples:

5.1 MHz:	$C_L = 12 \text{ pF}$	$X_L = 580 \ \Omega$	$C_S = 9.8 \text{ pF}$
10.18 MHz:	$C_L = 12 \text{ pF}$	$X_L = 870 \ \Omega$	$C_S = 7.2 \text{ pF}$

These values may be obtained by putting two capacitors in series to the quartz, such as 18pF and 22pF in the 5.1MHz case and 18pF and 12pF in the 10.2MHz case.

But please note that the calculated value of C_S includes the parasitic capacitors also.

4.4 Quartz Frequency Calculation

As described in Section 3.4.3 the operating range of the on-chip VCO is wide enough to guarantee a receive frequency range between 310 and 350MHz. The VCO signal is divided by 2 before applied to the mixer . This local oscillator signal can be used to downconvert the RF signals both with high- or low-side injection at the mixer. High-side injection of the local oscillator has to be used for receive frequencies between 310 and 330 MHz. In this case the local oscillator frequency is calculated by adding the IF frequency (10.7 MHz) to the RF frequency.

Low-side injection has to be used for receive frequencies between 330 and 350 MHz. The local oscillator frequency is calculated by subtracting the IF frequency (10.7 MHz) from the RF frequency then. The overall division ratios in the PLL are 64 or 32 depending on whether the CSEL-pin is left open or tied to ground.

Therefore the quartz frequency may be calculated by using the following formula:

$$f_{QU} = \frac{f_{RF} - 10.7}{r}$$

with

f_{RF}	receive frequency
f_{LO}	local oscillator (PLL) frequency ($f_{RF} \pm 10.7$)
f_{QU}	quartz oscillator frequency
r	ratio of local oscillator (PLL) frequency and quartz frequency as shown in the subsequent table.

Table 4-1 PLL Division Ratio Dependence on States of CSEL

CSEL	Ratio r = (f_{LO}/f_{QU})
open	64
GND	32

Example:

Addition of 10.7 is used in case of operation the device at 315 MHz, subtraction in case of operation at 345 MHz for instance. This yields the following frequencies:

CSEL tied to GND:

$$f_{QU} = (315\text{ MHz} + 10.7\text{ MHz}) / 32 = 10.1781\text{ MHz}$$

$$f_{QU} = (345\text{ MHz} - 10.7\text{ MHz}) / 32 = 10.4469\text{ MHz}$$

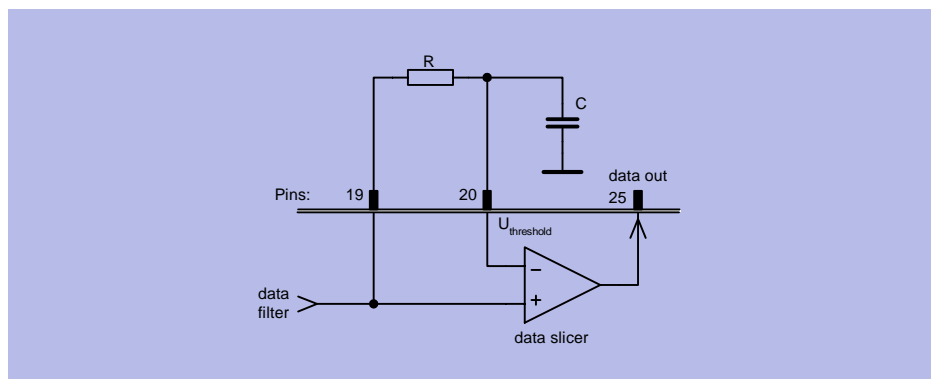
CSEL open:

$$f_{QU} = (315 \text{ MHz} + 10.7 \text{ MHz}) / 64 = 5.0891 \text{ MHz}$$

$$f_{QU} = (345 \text{ MHz} - 10.7 \text{ MHz}) / 64 = 5.2234 \text{ MHz}$$

4.5 Data Slicer Threshold Generation

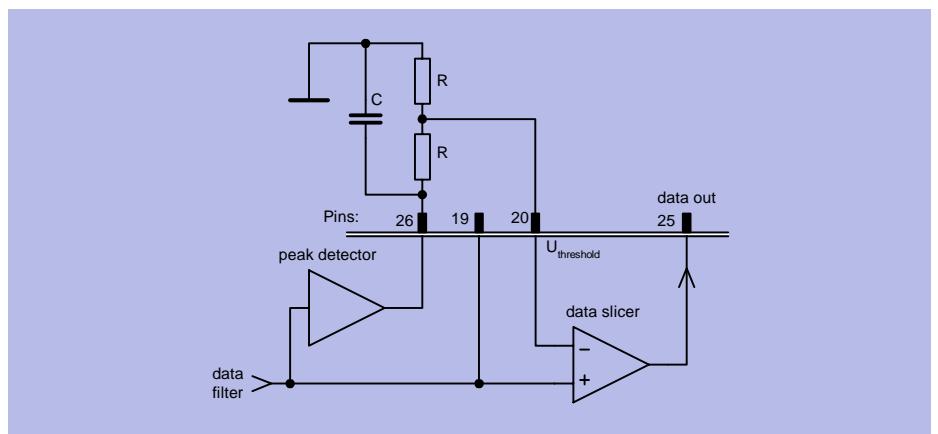
The threshold of the data slicer especially for a coding scheme without DC-content, can be generated in two ways, depending on the signal coding scheme used. In case of a signal coding scheme without DC content such as Manchester coding the threshold can be generated using an external R-C integrator as shown in Figure 4-5. The time constant T_A of the R-C integrator has to be significantly larger than the longest period of no signal change T_L within the data sequence. In order to keep distortion low, the minimum value for R is 20kΩ.



Data_slice1.wmf

Figure 4-5 Data Slicer Threshold Generation with External R-C Integrator

Another possibility for threshold generation is to use the peak detector in connection with two resistors and one capacitor as shown in the following figure. The component values are depending on the coding scheme and the protocol used.



Data_slice2.wmf

Figure 4-6 Data Slicer Threshold Generation Utilising the Peak Detector

5 Reference

Contents of this Chapter

5.1	Electrical Data	5-2
5.2	Test Circuit	5-8
5.3	Test Board Layouts	5-9
5.4	Bill of Materials	5-11
5.5	Appendix - Noise Figure and Gain Circles	5-13

5.1 Electrical Data

5.1.1 Absolute Maximum Ratings



WARNING

The maximum ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

Table 5-1 Absolute Maximum Ratings, Ambient temperature $T_{AMB} = -40^{\circ}\text{C} \dots +85^{\circ}\text{C}$

#	Parameter	Symbol	Limit Values		Unit	Remarks
			min	max		
1	Supply Voltage	V_s	-0.3	5.5	V	
2	Junction Temperature	T_j	-40	+125	$^{\circ}\text{C}$	
3	Storage Temperature	T_s	-40	+150	$^{\circ}\text{C}$	
4	Thermal Resistance	R_{thJA}		114	K/W	
5	ESD integrity, all pins	V_{ESD}	-1	+1	kV	HBM according to MIL STD 883D, method 3015.7

5.1.2 Operating Range

Within the operating range the IC operates as explained in the circuit description. The AC/DC characteristic limits are not guaranteed.

Supply voltage: VCC = 4.5V .. 5.5V

Table 5-2 Operating Range, Ambient temperature T _{AMB} = -40°C ... + 85°C								
#	Parameter	Symbol	Limit Values		Unit	Test Conditions/Notes	L	Item
			min	max				
1	Supply Current	I _S		5.2	mA	f _{RF} = 315MHz		
2	Receiver Input Level	RF _{in}	-110	-13	dBm	@ source impedance 50Ω, BER 2E-3, average power level, Manchester encoded datarate 4kBit, 280kHz IF Bandwidth	■	
3	LNI Input Frequency	f _{RF}	310	350	MHz			
4	MI/X Input Frequency	f _{MI}	310	350	MHz			
5	3dB IF Frequency Range	f _{IF -3dB}	5	23	MHz			
6	Powerdown Mode On	PWDN _{ON}	0	0.8	V			
7	Powerdown Mode Off	PWDN _{OFF}	2	V _S	V			
8	Gain Control Voltage, LNA high gain state	V _{THRES}	2.8	V _S	V			
9	Gain Control Voltage, LNA low gain state	V _{THRES}	0	0.7V	V			

■ Not part of the production test - either verified by design or measured in an Infineon Evalboard as described in Section 5.2.

5.1.3 AC/DC Characteristics

AC/DC characteristics involve the spread of values guaranteed within the specified voltage and ambient temperature range. Typical characteristics are the median of the production. The device performance parameters marked with ■ are not part of the production test, but verified by design or measured on an Infineon evaluation board as described in Section 5.2.

Table 5-3 AC/DC Characteristics with T_A 25 °C, $V_{VCC} = 4.5 \dots 5.5$ V

#	Parameter	Symbol	Limit Values			Unit	Test Conditions / Notes	L	Item
			min	typ	max				
Supply									
Supply Current									
1	Supply current, standby mode	$I_{S\ PDWN}$		50	70	nA	Pin 27 (PDWN) open or tied to 0 V		
2	Supply current	I_S		4.6	5	mA			
LNA									
Signal Input LNI (PIN 3), $V_{THRES} > 2.8V$, high gain mode									
1	Average Power Level at BER = 2E-3 (Sensitivity)	RF_{in}		-112		dBm	Manchester encoded datarate 4kBit, 280kHz IF Bandwidth	■	
2	Input impedance, $f_{RF} = 315$ MHz	$S_{11\ LNA}$	0.895 / -25.5 deg					■	
3	Input level @ 1dB C.P. $f_{RF}=315$ MHz	$P1dB_{LNA}$		-14		dBm		■	
4	Input 3 rd order intercept point $f_{RF} = 315$ MHz	$IIP3_{LNA}$		-10		dBm	$f_{in} = 315 \& 317$ MHz	■	
5	LO signal feedthrough at antenna port	LO_{LNI}		-119		dBm		■	
Signal Output LNO (PIN 6), $V_{THRES} > 2.8V$, high gain mode									
1	Gain $f_{RF} = 315$ MHz	$S_{21\ LNA}$	1.577 / 150.3 deg					■	
2	Output impedance, $f_{RF} = 315$ MHz	$S_{22\ LNA}$	0.897 / -10.3 deg					■	
3	Voltage Gain Antenna to MI $f_{RF} = 315$ MHz	G_{AntMI}		21		dB			
4	Noise Figure	NF_{LNA}		2		dB	excluding matching network loss - see Appendix	■	
Signal Input LNI, $V_{THRES} = GND$, low gain mode									
1	Input impedance, $f_{RF} = 315$ MHz	$S_{11\ LNA}$	0.918 / -25.2 deg					■	
2	Input level @ 1dB C. P. $f_{RF} = 315$ MHz	$P1dB_{LNA}$		-7		dBm	matched input	■	

Table 5-3 AC/DC Characteristics with $T_A = 25\text{ }^\circ\text{C}$, $V_{VCC} = 4.5 \dots 5.5\text{ V}$ (continued)

	Parameter	Symbol	Limit Values			Unit	Test Conditions/ Notes	L	Item
			min	typ	max				
Signal Input LNI, $V_{THRES} = \text{GND}$, low gain mode									
3	Input 3 rd order intercept point $f_{RF} = 315\text{ MHz}$	IIP3 _{LNA}		-13		dBm	$f_{in} = 315 \text{ \& } 317\text{ MHz}$	■	
Signal Output LNO, $V_{THRES} = \text{GND}$, low gain mode									
1	Gain $f_{RF} = 315\text{ MHz}$	S_{21} LNA	0.007 / 153.7 deg					■	
2	Output impedance, $f_{RF} = 315\text{ MHz}$	S_{22} LNA	0.907 / -10.5 deg					■	
3	Voltage Gain Antenna to MI $f_{RF} = 315\text{ MHz}$	G_{AntMI}		2		dB			
Signal 3VOUT (PIN 24)									
1	Output voltage	$V_{3\text{VOUT}}$		3		V			
2	Current out	$I_{3\text{VOUT}}$			50	μA			
Signal THRES (PIN 23)									
1	Input Voltage range	V_{THRES}	0		$V_S - 1\text{V}$	V	see chapter 4.1		
2	LNA low gain mode	V_{THRES}	0			V			
3	LNA high gain mode	V_{THRES}	2.8	3	$V_S - 1$	V	or shorted to Pin 24		
4	Current in	I_{THRES_in}		5		nA		■	
Signal TAGC (PIN 4)									
1	Current out, LNA low gain state	I_{TAGC_out}		4.2		μA	$RSSI > V_{THRES}$		
2	Current in, LNA high gain state	I_{TAGC_in}		1.5		μA	$RSSI < V_{THRES}$		
MIXER									
Signal Input MI/MIX (PINS 8/9)									
1	Input impedance, $f_{RF} = 315\text{ MHz}$	S_{11} MIX	0.954 / -10.9 deg					■	
2	Input 3 rd order intercept point	IIP3 _{MIX}		-25		dBm		■	
Signal Output IFO (PIN 12)									
1	Output impedance	Z_{IFO}		330		Ω			
2	Conversion Voltage Gain $f_{RF} = 869\text{ MHz}$	G_{MIX}		+21		dB			
3	Noise Figure, SSB (~DSB NF+3dB)	NF _{MIX}		13		dB		■	
4	RF to IF isolation	$A_{\text{RF-IF}}$		46		dB		■	

Table 5-3 AC/DC Characteristics with T_A 25 °C, V_{VCC} = 4.5 ... 5.5 V (continued)

	Parameter	Symbol	Limit Values			Unit	Test Conditions/ Notes	L	Item
			min	typ	max				
LIMITER									
Signal Input LIM/X (PINS 17/18)									
1	Input Impedance	Z _{LIM}	264	330	396	Ω		■	
2	RSSI dynamic range	DR _{RSSI}	60		80	dB			
3	RSSI linearity	LIN _{RSSI}		±1		dB		■	
4	Operating frequency (3dB points)	f _{LIM}	5	10.7	23	MHz		■	
DATA FILTER									
1	Useable bandwidth	BW _{BB} FILT			100	kHz		■	
2	RSSI Level at Data Filter Output SLP	RSSI _{low}		1.1		V	LNA in high gain RF _{IN} ~-103dBm		
3	RSSI Level at Data Filter Output SLP	RSSI _{high}		2.65		V	LNA in high gain. RF _{IN} ~-30dBm		
SLICER									
Signal Output DATA (PIN 25)									
1	Useable bandwidth	BW _{BB} SLIC			100	kHz		■	
2	Capacitive loading of output	C _{max} SLIC			20	pF			
3	LOW output voltage	V _{SLIC_L}		0		V			
4	HIGH output voltage	V _{SLIC_H}	V _S -1.3	V _S -1	V _S -0.7	V	Output current =200μA		
5	Output current	I _{SLIC_out}			200	μA			
PEAK DETECTOR									
Signal Output PDO (PIN 26)									
1	LOW output voltage	V _{SLIC_L}		0		V			
2	HIGH output voltage	V _{SLIC_H}			V _S -1	V			
3	Load current	I _{load}	-500			μA	Static load current must not exceed -500μA		
4	Leakage current	I _{leakage}		700		nA			

Table 5-3 AC/DC Characteristics with T_A 25 °C, $V_{VCC} = 4.5 \dots 5.5$ V (continued)

	Parameter	Symbol	Limit Values			Unit	Test Conditions/ Notes	L	Item
			min	typ	max				

CRYSTAL OSCILLATOR

Signals CRSTL1, CRISTL 2, (PINS 1/28)

1	Operating frequency	f_{CRSTL}	5		11	MHz	fundamental mode, series resonance		
2	Input Impedance @ ~5MHz	Z_{1-28}		-760 +j580		Ω		■	
3	Input Impedance @ ~10MHz	Z_{1-28}		-600 +j870		Ω		■	
4	Serial Capacity @ ~5MHz	$C_{S5=C1}$		9.3		pF			
5	Serial Capacity @ ~10MHz	$C_{S10=C1}$		6.4		pF			

PLL

Signal LF (PIN 15)

1	Tuning voltage relative to V_S	V_{TUNE}	0.4	1.6	2.4	V			
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POWER DOWN MODE

Signal PDWN (PIN 27)

1	Powerdown Mode On	$PWDN_{ON}$	2.8		V_S	V			
2	Powerdown Mode Off	$PWDN_{Off}$	0		0.8	V			
3	Input bias current PDWN	I_{PDWN}		19		μA			
4	Start-up Time until valid IF signal is detected	T_{SU}		1		mS	Depends on the used crystal		

PLL DIVIDER

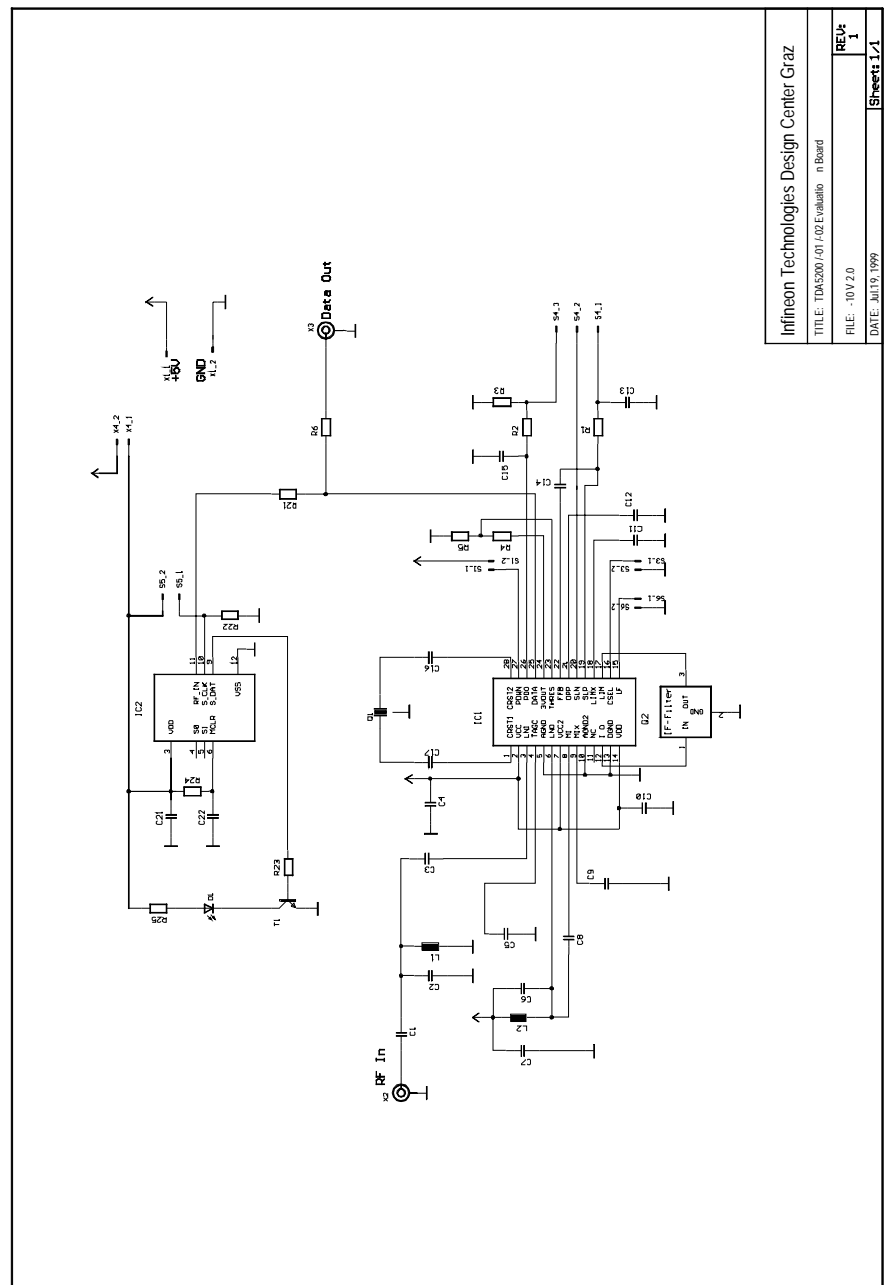
Signal CSEL (PIN 16)

1	f_{CRSTL} range 5.xxMHz	V_{CSEL}	1.4		4	V	or open		
2	f_{CRSTL} range 10.xxMHz	V_{CSEL}	0		0.2	V			
3	Input bias current CSEL	I_{CSEL}		5		μA	CSEL tied to GND		

■ Not part of the production test - either verified by design or measured in an Infineon Evalboard as described in Section 5.2.

5.2 Test Circuit

The device performance parameters marked with ■ in Section 5.1.3 were either verified by design or measured on an Infineon evaluation board. This evaluation board can be obtained together with evaluation boards of the accompanying transmitter device TDA5101 in an evaluation kit that may be ordered on the INFINEON RKE Webpage www.infineon.com/rke



Infineon Technologies Design Center Graz	
TITLE: TDA5200/01/02 Evaluation Board	REV: 1
FILE: -10V20	DATE: Jul'9, 1999
	Sheet 1/1

Test_circuit.wmf

Figure 5-1 Schematic of the Evaluation Board

5.3 Test Board Layouts

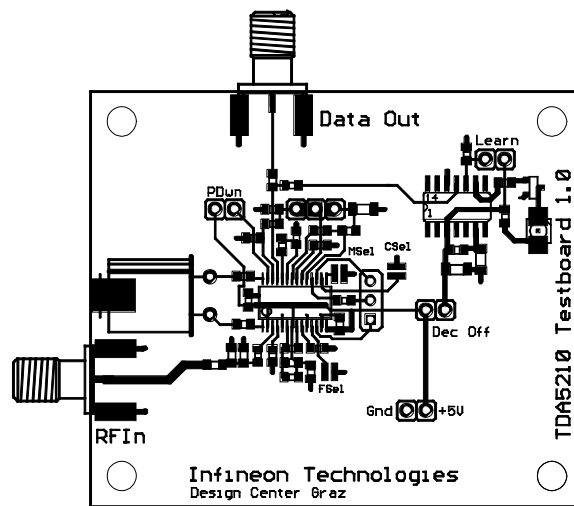


Figure 5-2 Top Side of the Evaluation Board

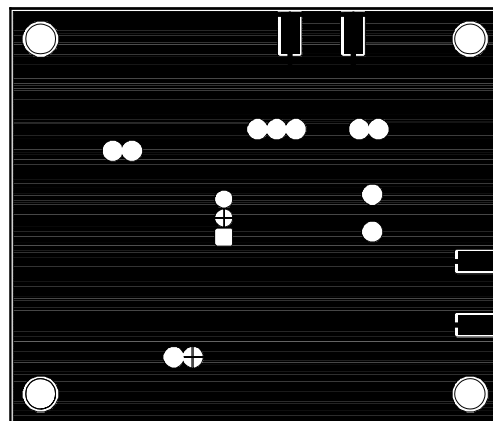


Figure 5-3 Bottom Side of the Evaluation Board

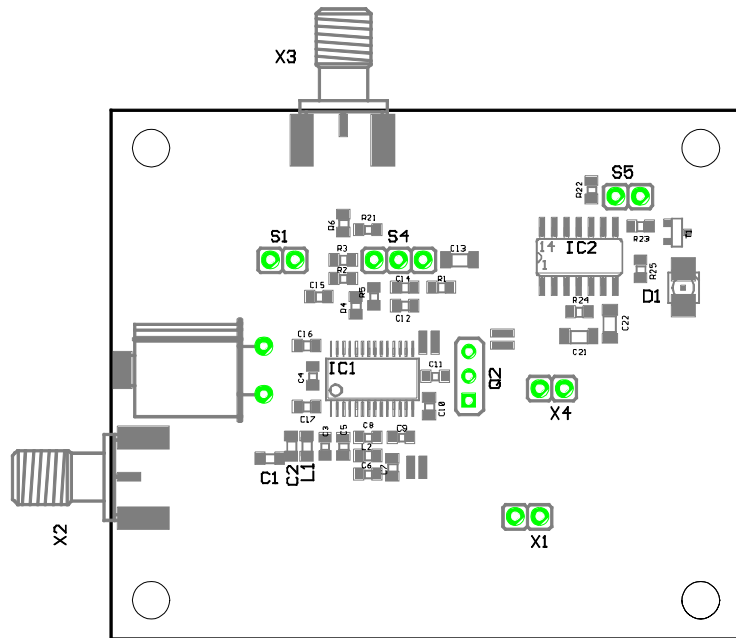


Figure 5-4 Component Placement on the Evaluation Board

5.4 Bill of Materials

The following components are necessary for evaluation of the TDA5201 at 315MHz without use of a Microchip HCS515 decoder.

Table 5-4 Bill of Materials

Ref	Value	Specification
R1	100kΩ	0805, ± 5%
R2	100kΩ	0805, ± 5%
R3	820kΩ	0805, ± 5%
R4	120kΩ	0805, ± 5%
R5	180kΩ	0805, ± 5%
R6	10kΩ	0805, ± 5%
L1	15nH	Toko, PTL2012-F15N0G
L2	12pF	0805, COG, ± 2%
C1	3.3 pF	0805, COG, ± 0.1pF
C2	10pF	0805, COG, ± 0.1pF
C3	6.8pF	0805, COG, ± 0.1pF
C4	100pF	0805, COG, ± 5%
C5	47nF	1206, X7R, ± 10%
C6	15nH	Toko, PTL2012-F15N0G
C7	100pF	0805, COG, ± 5%
C8	33pF	0805, COG, ± 5%
C9	100pF	0805, COG, ± 5%
C10	10nF	0805, X7R, ± 10%
C11	10nF	0805, X7R, ± 10%
C12	220pF	0805, COG, ± 5%
C13	47nF	0805, X7R, ± 10%
C14	470pF	0805, COG, ± 5%
C15	47nF	0805, X7R, ± 10%
C16	18pF	0805, COG, ± 0.1pF
C17	12pF	0805, COG, ± 2%
Q2	(315 + 10.7MHz)/32	HC49/U, fundamental mode, C _L = 12pF, e.g. 434.2 MHz: Jauch Q 10.17813-S11-1323-12-10/20
F1	SFE10.7MA5-A	Murata
X2, X3	142-0701-801	Johnson
X1, X4, S1, S5		2-pole pin connector
S4		3-pole pin connector, or not equipped
IC1	TDA 5201	Infineon

The following components are necessary in addition to the above mentioned ones for evaluation of the TDA5201 in conjunction with a Microchip HCS515 decoder.

Table 5-5 Bill of Materials Addendum		
Ref	Value	Specification
R21	22kΩ	0805, ± 5%
R22	100kΩ	0805, ± 5%
R23	22kΩ	0805, ± 5%
R24	820kΩ	0805, ± 5%
R25	560kΩ	0805, ± 5%
C21	100nF	1206, X7R, ± 10%
C22	100nF	1206, X7R, ± 10%
IC2	HCS515	Microchip
T1	BC 847B	Infineon
D1	LS T670-JL	Infineon

5.5 Appendix - Noise Figure and Gain Circles

The following gain and noise figure circles were measured utilizing Microlab Stub Stretchers and a HP8514 network analyser. Maximum gain is shown at point 1 at 18.5 dB, minimum noise figure is 1.9dB at point 2, step size of circles is 0.5dB.

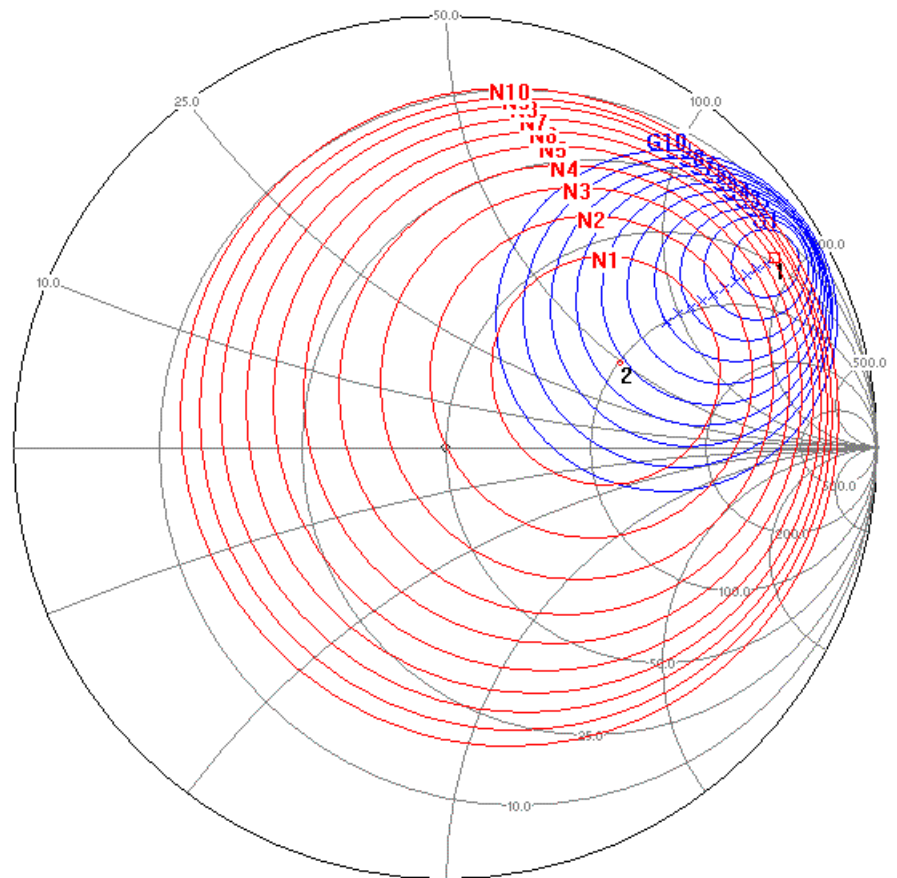


Figure 5-5 Gain and Noise Circles of the TDA5201 at 315 MHz.

List of Figures

Figure 2-1	P-TSSOP-28-1 package outlines	3
Figure 3-1	IC Pin Configuration	2
Figure 3-2	Main Block Diagram	9
Figure 4-1	LNA Automatic Gain Control Circuitry	2
Figure 4-2	RSSI Level and Permissive AGC Threshold Levels	3
Figure 4-3	Data Filter Design	4
Figure 4-4	Determination of Series Capacitance Value for the Quartz Oscillator	5
Figure 4-5	Data Slicer Threshold Generation with External R-C Integrator	7
Figure 4-6	Data Slicer Threshold Generation Utilising the Peak Detector	7
Figure 5-1	Schematic of the Evaluation Board	8
Figure 5-2	Top Side of the Evaluation Board	9
Figure 5-3	Bottom Side of the Evaluation Board	9
Figure 5-4	Component Placement on the Evaluation Board	10
Figure 5-5	Gain and Noise Circles of the TDA5201 at 315 MHz.	13

List of Tables

Table 3-1	Pin Definition and Function	3
Table 3-3	PDWN Pin Operating States	12
Table 5-1	Absolute Maximum Ratings, Ambient temperature $T_{AMB}=-40^{\circ}\text{C} \dots + 85^{\circ}\text{C}$	2
Table 5-2	Operating Range, Ambient temperature $T_{AMB}=-40^{\circ}\text{C} \dots + 85^{\circ}\text{C}$	3
Table 5-3	AC/DC Characteristics with $T_A 25^{\circ}\text{C}$, $V_{VCC} = 4.5 \dots 5.5 \text{ V}$	4
	AC/DC Characteristics with $T_A 25^{\circ}\text{C}$, $V_{VCC} = 4.5 \dots 5.5 \text{ V}$ (continued)	5
	AC/DC Characteristics with $T_A 25^{\circ}\text{C}$, $V_{VCC} = 4.5 \dots 5.5 \text{ V}$ (continued)	6
	AC/DC Characteristics with $T_A 25^{\circ}\text{C}$, $V_{VCC} = 4.5 \dots 5.5 \text{ V}$ (continued)	7
Table 5-4	Bill of Materials	11
Table 5-5	Bill of Materials Addendum	12