PRELIMINARY

5.8 GHz One Antenna Reflective Transponder for Tag

GaAs Monolithic Microwave IC

Description

The CHR2244 is a MMIC transponder dedicated to short range communications at 5.8GHz. It includes all the RF functions for bi-directional transmission and CMOS compatible interfaces. Only one antenna is necessary.

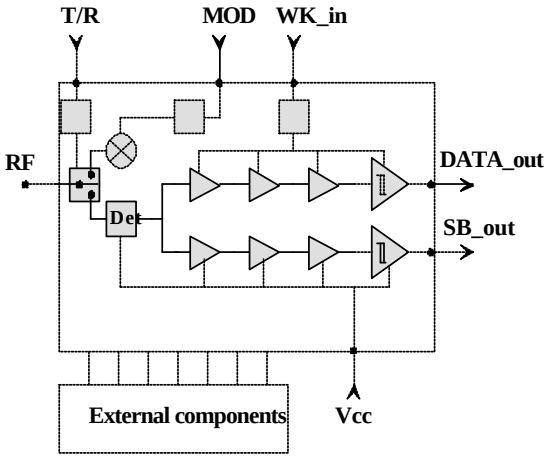
Three modes are implemented :

STANDBY : ultra low current AM detector, with a reduced bandwidth, providing a wake-up signal on SB_out output. This signal is a DC voltage. This output is active when and only when an AM modulated RF signal is applied to the RF input.

DOWNLINK : low current AM detector, with optimized IF bandwidth, providing the demodulated data at the CMOS compatible DATA_out output.

UPLINK : multiplier based on a passive reflective mixer.

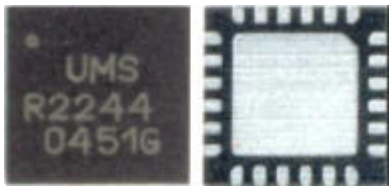
This circuit is manufactured on a MESFET process. It is supplied in plastic package (QFN-24).



Transponder block diagram

Main Features

- 5.8GHz ISM band operating frequency
- CMOS compatible
- Ultra low Standby current
- Integrated wake-up circuit
- High detection sensitivity for Downlink
- Reflective multiplier for Uplink
- Single bias voltage
- Low cost & high performances plastic package
- Lead-free, Matt Tin (Green) solder plating



Main Characteristics

Tamb = +25°C; Vcc = 3.1V

Symbol	Parameter	Min	Typ	Max	Unit
Vcc_sb_i	Standby DC current (Without RF input signal)		8	14	µA
RF_sb_p	Minimum power for Standby mode	-39	-43		dBm
RF_dl_p	Minimum power for Downlink mode	-39	-43		dBm
BW_dl	AM demodulation frequency (Downlink)	250		500	kHz
G_ul	Uplink multiplier gain (DSB)	-6.5	-4		dB
BW_ul	Uplink IF multiplier frequency band	0.1		10	MHz

ESD Protections : Electrostatic discharge sensitive device observe handling precautions !

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Electrical Characteristics (Full operating range)
Tamb = -30°C to +80°C

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Fop	Operating RF frequency range	(1)	5.725	5.8	5.875	GHz
BW_rf	RF bandwidth		50			MHz
RL_rf (*)	RF input return loss	50 Ω		12	7	dB
Vcc	Bias voltage		2.7	3.1	3.6	V
WK_in_imp (*)	WK_in port impedance		6		10	kΩ pF
T/R_imp (*)	T/R input port impedance		100		10	kΩ pF
T/R_t (*)	Transmit to Receive recovery time			150		µs
R/T_t (*)	Receive to Transmit recovery time			50		µs

(1) The centre frequency can be adjusted by a matching network located between the antenna and the RF component.
(*) Note : Min & Max values include technological spreads, supply & temperature range effect.

STANDBY mode : T/R='0' , MOD='0' , WK_in='0'

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
SB_out_load	Standby output port load impedance		1		10	MΩ pF
SB_out_v (*)	Standby output port DC voltage high level (1) low level		 Vcc-1 0		 Vcc 1	 V V
RF_sb_bw	Amplitude modulation frequency of RF for wake-up		250		500	kHz
RF_sb_p (*)	Amplitude modulated RF input power for wake-up	(2)	-38	-43		dBm
Vcc_sb_i (*)	Standby DC current	(3)		8	20	µA

(1) The SB_out voltage is high when the RF input signal is AM modulated.
(2) Total transmitted power of the modulated signal (modulation index = 0.5)
(3) Without RF input signal
(*) Note : Min & Max values include technological spreads, supply & temperature range effect.

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DOWNLINK mode : T/R='0' , MOD='0' , WK_in='Vcc'

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Data_out_load	Downlink output port load impedance		CMOS compatible			
Data_out_f	Amplitude demodulation frequency		250		500	kHz
Data_out_dc (*)	Data_out signal duty cycle		40	50	60	%
RF_dl_p (*)	Amplitude modulated RF input power	(1)	-38	-43		dBm
WK_in_i (*)	WK_in DC current			200	500	µA

(1) Total transmitted power of the modulated signal (modulation index = 0.5)
(*) Note : Min & Max values include technological spreads, supply & temperature range effect.

UPLINK mode : T/R='Vcc' , WK_in='Vcc'

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
MOD_imp (*)	Modulated signal input port impedance		100		10	kΩ pF
MOD_v	Modulated signal input port voltage	Square wave (1)		0/Vcc		
MOD_f	Uplink IF multiplier frequency		0.1		10	MHz
G_ul (*)	Uplink multiplier gain (DSB)		-7	-4		dB
WK_in_i (*)	WK_in DC current			200	500	µA

(1) The shape of the modulated signal can be optimized if better linearity is needed.
(*) Note : Min & Max values include technological spreads, supply & temperature range effect.

Absolute Maximum Ratings (1)

Tamb = -30°C to +80°C

Symbol	Parameter	Values	Unit
Vcc	Bias voltage	5	V
Wk_in_v	Wk_in input voltage	5	V
T/R_v	T/R input voltage	5	V
MOD_v	MOD input voltage	5	V
RF_sb_p RF_dl_p	Maximum Standby and Downlink RF input power (2)	+10	dBm
Top	Operating temperature range	-30 to +80	°C
Tstg	Storage temperature range	-55 to +125	°C

(1) Operation of this device above anyone of these parameters may cause permanent damage.
(2) Duration < 1s.

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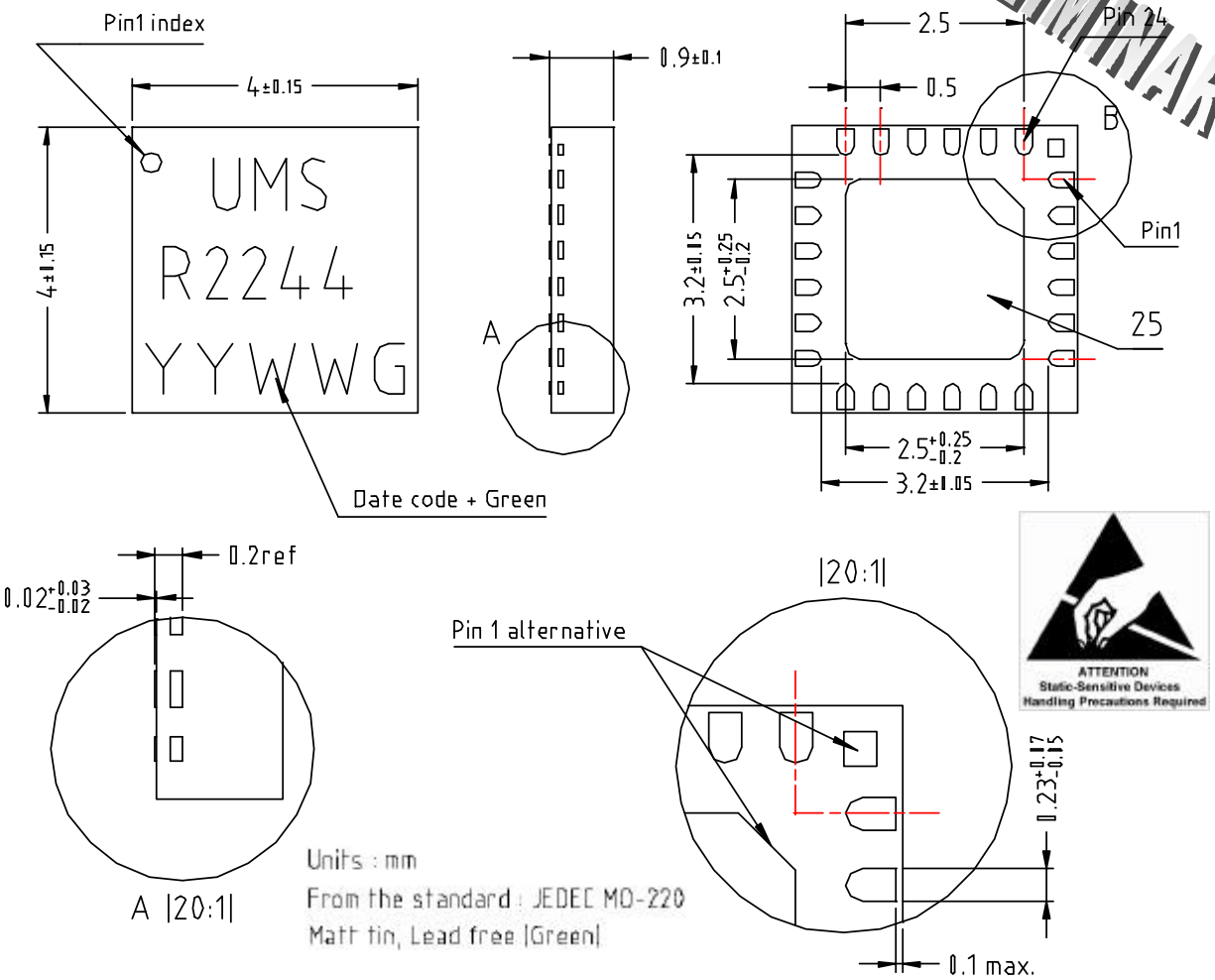
QFN-24 Package / Pad Allocation



Pin number	Pin name	**Description**
4, 5, 6, 8, 9, 10, 16, 18, 23, 24		Non Connected
1	**RF**	RF port
2	**TR**	Transmit / Receive input port
3	**MOD**	Modulation input port
7	**SENS**	Stand-by sensitivity adjust port
11	**Vcc**	Supply voltage
12	**Ga_SB**	Stand-by amplifiers Gain adjust port
13	**SB_out**	Stand-by output port
14	**C4**	External decoupling
15	**DATA_out**	Downlink output port
17	**WK_in**	Supply voltage input port for wake-up
19	**Ad**	Wake-up threshold adjust port
20	**Ga_WK**	Wake-up amplifiers Gain adjust port (optional)
21	**Cg**	External decoupling
22	**Fd**	External decoupling

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25 slug	**GND**	Ground

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External Components

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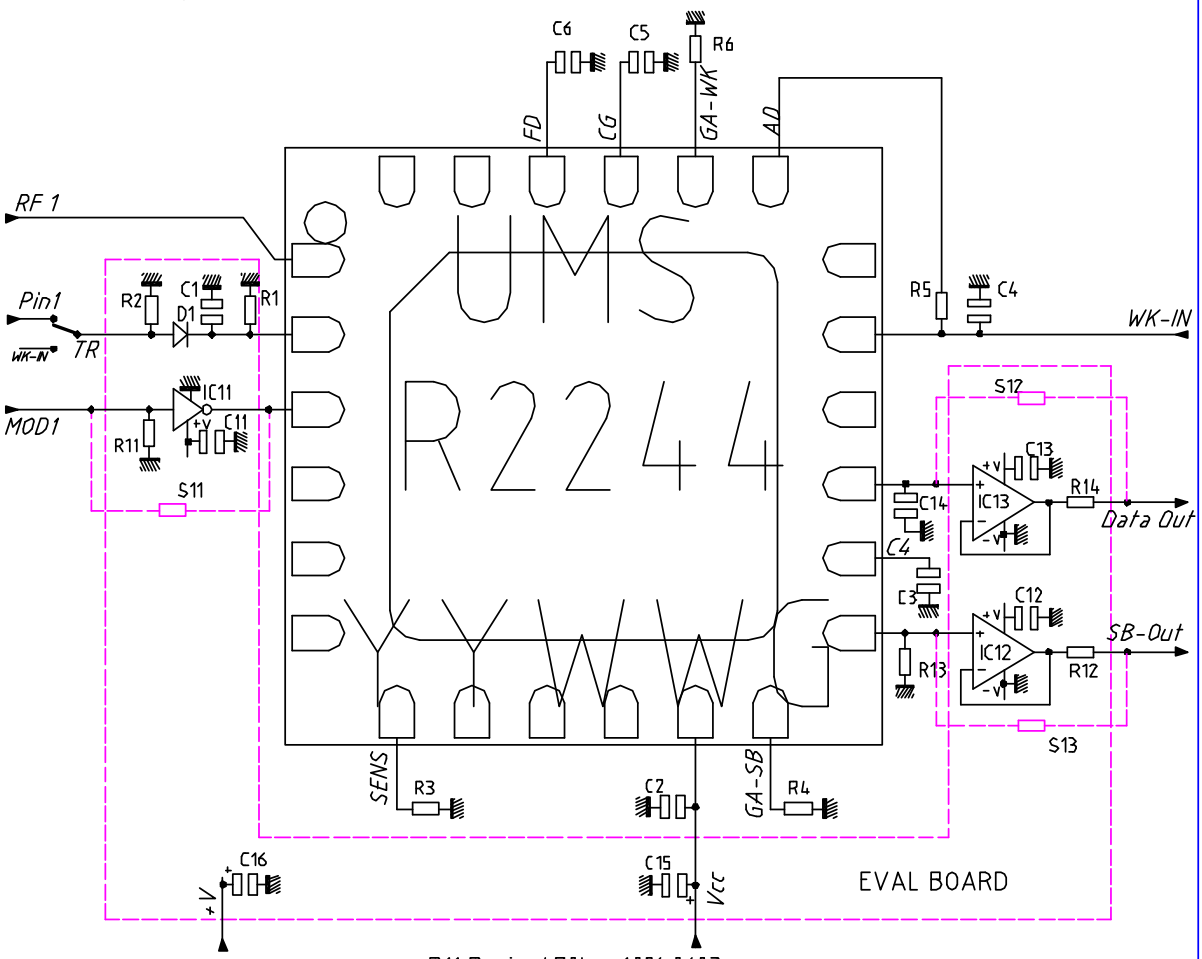
R1 Resis. 2.2kΩ ±10% 0603
R2 Resis. 10kΩ ±10% 0603
R3 Resis. 2.2MΩ ±10% 0603
R4 Resis. 680kΩ ±10% 0603
R5 Resis. 6.8MΩ ±10% 0805
R6 Resis. optional 0805

C1 Cond. 1nF 16V
C2 Cond. 100nF ±10% 0603
C3 Cond. 470pF ±10% 0603
C4 Cond. 100nF ±10% 0603
C5 Cond. 100nF ±10% 0603
C6 Cond. 100nF ±10% 0603

D1 |1N4148| SOT23



C11 Cond. 100nF ±10% 0603
C12 Cond. 100nF ±10% 0603
C13 Cond. 100nF ±10% 0603
C14 Cond. 33pF ±10% 0603
C15 Cond. 10µF 16V 595D_Boitier B "Sprague"
C16 Cond. 10µF 16V 595D_Boitier B "Sprague"

R11 Resis. 470kΩ ±10% 0603
R12 Resis. 51Ω ±10% 0603
R13 Resis. 470kΩ ±10% 0603
R14 Resis. 51Ω ±10% 0603

IC11 Trigger 74AHC1G14 SOT23-5L
IC12 Ampli MAX4230 SOT23-5L "MAXIM"
IC13 Ampli MAX4230 SOT23-5L "MAXIM"

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ELECTRICAL SCHEMATIC

IMPORTANT NOTICE :
All the components placed in the "EVAL BOARD" area are optional.
Other components make up the nominal environment where the specifications are guaranteed.

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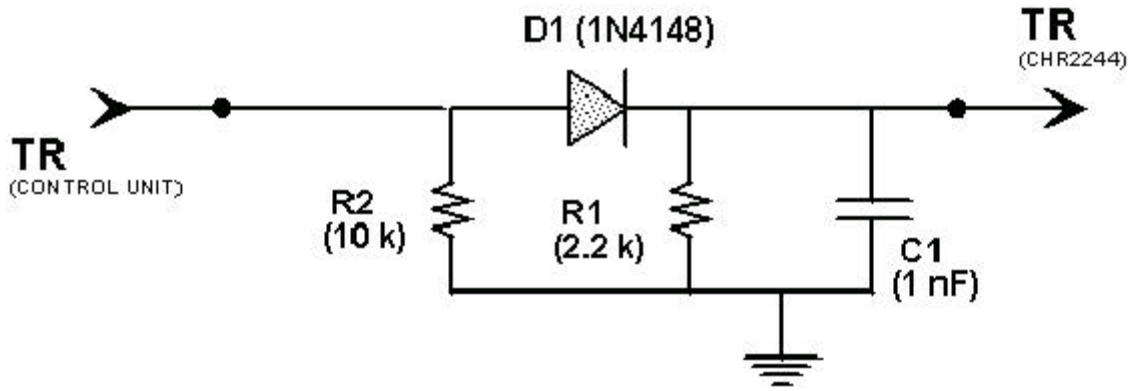
Design Recommendations

- All of the different inputs (TR, Mod) and outputs (SB_out, DATA_out) should be properly isolated (separated enough or with a ground path between them).
- As TR port is the most sensitive one, a specific circuit (see on diagram) can be used for high level of isolation.



- Device slug should be connected to RF ground plane through multiples vias (>=9).
- An external matching may be required to optimize RF performances on 50Ω impedance, versus substrate height. A RF ground plane height of 0.008" (0.203mm) under the component (evaluation board) provides the highest RF performances thanks to low RF ground inductance and low pin to pin coupling.

Adjustment abilities:

Pin number	Pin name	Component	Description
7	**SENS**	**R3**	**Standby sensitivity adjust port :** A value lower than 2.2MΩ decreases Standby chain sensitivity.
12	**Ga_SB**	**R4**	**Standby amplifiers Gain adjust port :** A value lower than 680kΩ increases Standby chain sensitivity.
19	**Ad**	**R5**	**Downlink threshold adjust port :** A value lower than 6.8MΩ decreases Downlink chain sensitivity.
20	**Ga_WK**	**R6**	**Downlink amplifiers Gain adjust port :** A value lower than 220 kΩ increases Downlink chain sensitivity.

IMPORTANT NOTICE :
All this adjustments may cause non linear response of the performances versus resistors values. The sensitivity is –1x(Minimum RF power for considered mode).

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Adjustment abilities characterization:

Typical performance, Tamb = +25°C, Vcc = 3.1V

- **STANDBY sensitivity:**

The maximum value of R3 resistor is 2.2MΩ. It could be used in order to reduce the Standby sensitivity. The R4 resistor should be used to set the Standby sensitivity higher or lower. The following table gives the typical relation between R3, R4 and the Standby sensitivity.

R3 (MW)	**R4 (kW)**	**Sensitivity (dB)**
>2.2	indifferently	Non guaranteed functionality
2.2	100	S + 1.5 dB
2.2	220	S + 1 dB
2.2	390	S + 0.5 dB
2.2 (*)	**680** (*)	**S** (*)
2.2	1200	S - 0.5 dB
2.2	3300	S - 1.5 dB
2.2	6800	S - 3 dB
2.2	No Resistor	S - 4 dB
1.5	No Resistor	S - 5 dB

(*) S is the sensitivity of a given chip in the recommended environment.
In the full operating range and the recommended environment, -|S| < -38 dBm in accordance with the electrical characteristics.

- **DOWNLINK sensitivity:**

R5 could be used in order to reduce the Downlink sensitivity or to set the compromise between sensitivity and unwanted data, when no RF signal, due to noise or parasitic coupling. The R6 resistor should be used to set the Downlink sensitivity higher or lower. The following table gives the typical relation between R5, R6 and the Downlink sensitivity.

R5 (MW)	**R6 (kW)**	**Sensitivity (dB)**
No Resistor	10	S + 2 dB
No Resistor	47	S + 1.5 dB
No Resistor	220	S + 1 dB
No Resistor	No Resistor	S + 0.5 dB
6.8 (*)	**No Resistor** (*)	**S** (*) (1)
4.7	No Resistor	S - 1 dB
3.3	No Resistor	S - 2 dB
2.2	No Resistor	S - 3 dB
1.5	No Resistor	S - 4 dB
1	No Resistor	S - 5 dB

(*) S is the sensitivity of a given chip in the recommended environment.
In the full operating range and the recommended environment, -|S| < -38 dBm in accordance with the electrical characteristics.

(1) A higher sensitivity than in recommended configuration may cause significant density of unwanted data when RF is not modulated.
These data are random because of the component noise floor proximity, or can be sensitive to an environment perturbation.

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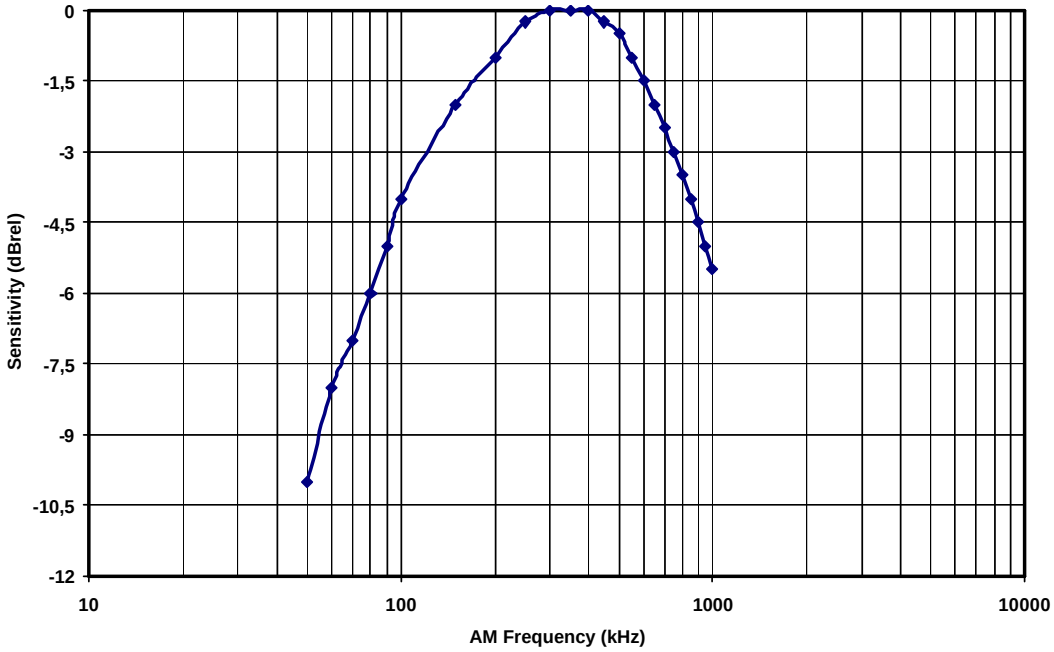
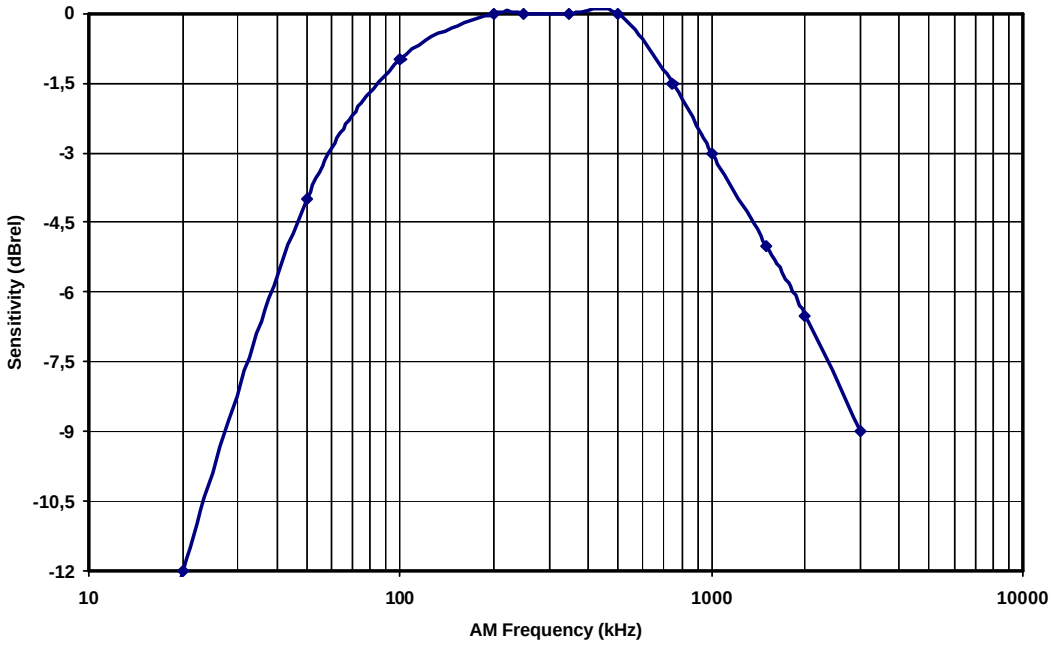
Frequency response characterization:

Typical performance, Tamb = +25°C, Vcc = 3.1V, Recommended environment.

- **STANDBY sensitivity versus AM frequency :**



- **DOWNLINK sensitivity versus AM frequency :**



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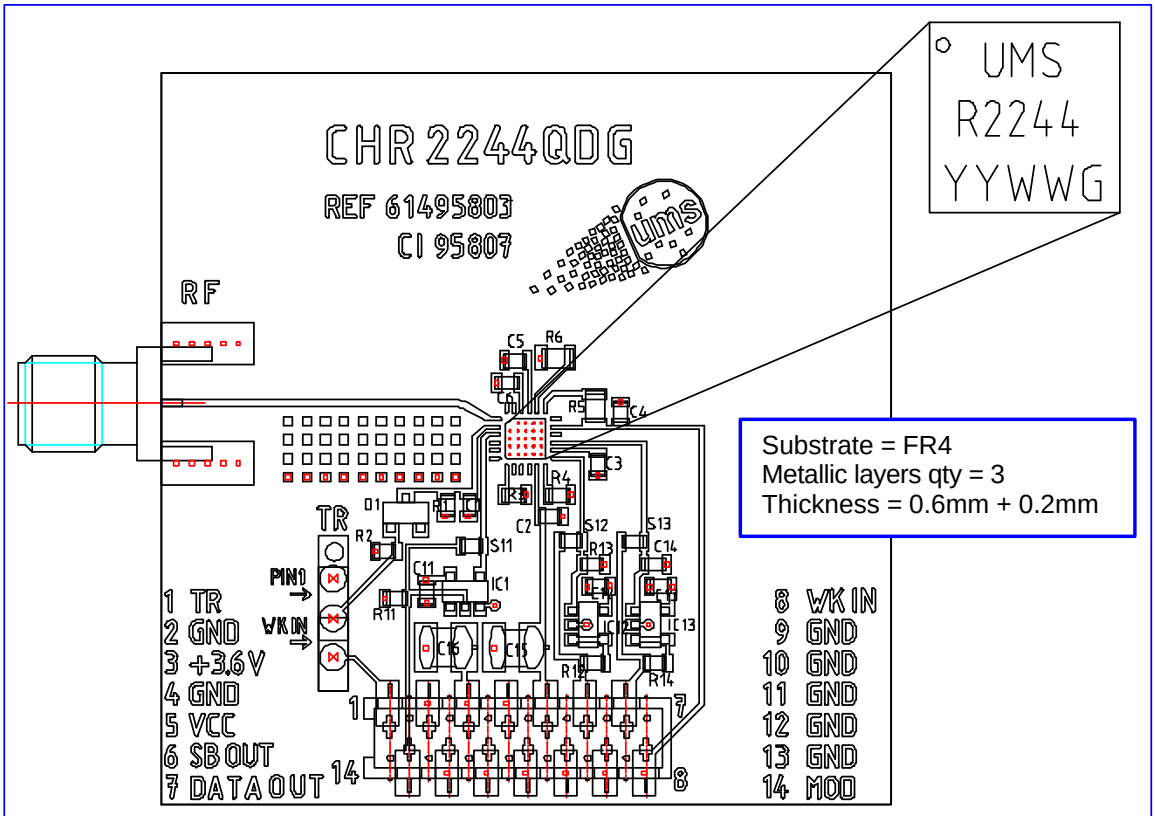
Evaluation board

Important notice / design recommendations:

Device slug should be connected to RF ground plane through multiples vias (>=9).

An external matching may be required to optimize RF performances on 50Ω impedance, versus substrate height.

A RF ground plane height of 0.008" (0.203mm) under the component (evaluation board) provides the highest RF performances thanks to low RF ground inductance and low pin to pin coupling.



C11 Cond. 100nF ±10% 0603
C12 Cond. 100nF ±10% 0603
C13 Cond. 100nF ±10% 0603
C14 Cond. 33pF ±10% 0603
C15 Cond. 10µF 16V 595D_Boitier B "Sprague"
C16 Cond. 10µF 16V 595D_Boitier B "Sprague"
C1 Cond. 1nF ±10% 0603
C2 Cond. 100nF ±10% 0603
C3 Cond. 470pF ±10% 0603
C4 Cond. 100nF ±10% 0603
C5 Cond. 100nF ±10% 0603
C6 Cond. 100nF ±10% 0603

Circuit 95807 pl..61.495.807
Connecteur PSF-S01-0.8MM "GigaLane"
Connecteur C_8-188275-4

R11 Resis. 470kΩ ±10% 0603
R12 Resis. 51Ω ±10% 0603
R13 Resis. 470kΩ ±10% 0603
R14 Resis. 51Ω ±10% 0603
R1 Resis. 2.2kΩ ±10% 0603
R2 Resis. 10kΩ ±10% 0603
R3 Resis. 2.2MΩ ±10% 0603
R4 Resis. 680kΩ ±10% 0603
R5 Resis. 6.8MΩ ±10% 0805
R6 Resis. optional 0805

IC11 Trigger 74AHC1G14 SOT23-5L
IC12 Ampli MAX4230 SOT23-5L "MAXIM"
IC13 Ampli MAX4230 SOT23-5L "MAXIM"
D1 BAV99(1N4148) SOT23

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ASSEMBLY

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Application Information

General Transmission system

The transmission system is described as follows, the tag doesn't generate any frequency :

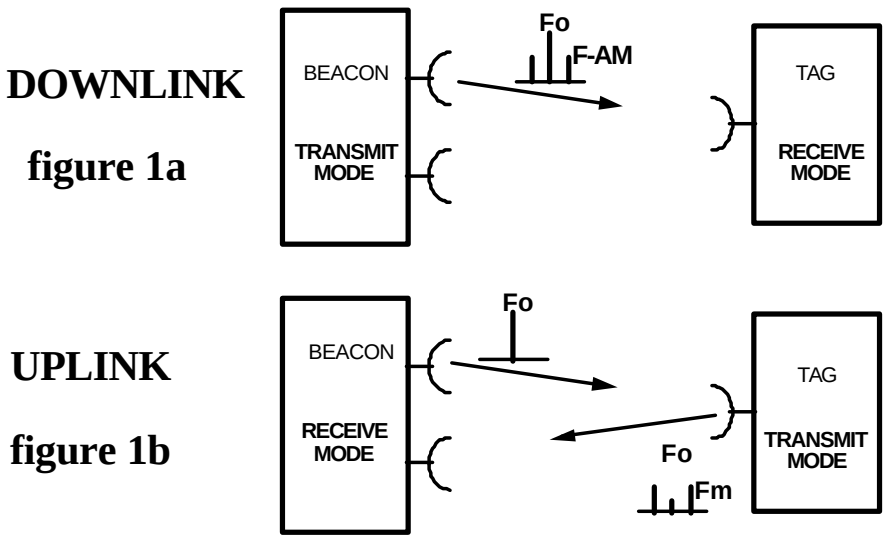

Figure 1 : Transmission system operating principle

Two modes of communication are implemented :

From beacon to tag (figure 1a) : the beacon is in transmit mode while the tag is in the receive mode. The beacon sends an Amplitude Modulated (AM) RF signal to the tag. In figure 1a, F-AM is the amplitude modulation frequency and F0 is the carrier.

From tag to beacon (figure 1b) : the beacon is in receive mode while the tag is in transmit mode. The beacon sends a continuous wave (CW) RF signal to the tag, this signal is then mixed (at tag level) with the MOD input signal (Fm) thanks to a reflective mixer. The reflected signal is sent back to the beacon and is demodulated thanks to an homodyne receiver.

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Tag operating modes

Within this transmission system, The CHR2244 operates in three basic modes depending on the WK_in and T/R input signal levels. They are described hereafter :

1 - The **STANDBY MODE** (figure 2) is a very low power consumption state. In this mode an Amplitude Modulated RF signal is necessary to produce a DC voltage at the SB_out output which may be used to wake-up the CHR2244 by applying Vcc to the WK_in input.

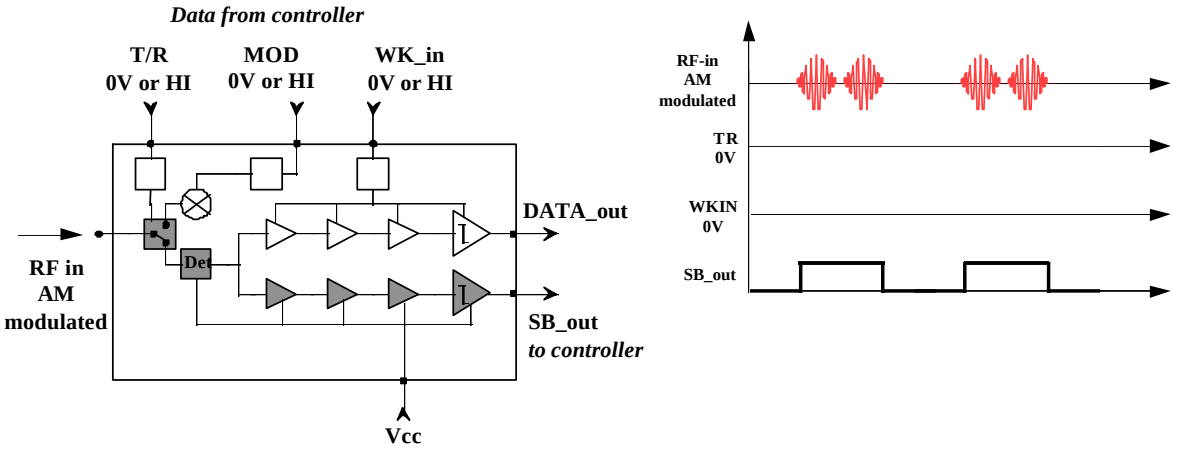

Figure 2a : Standby mode

The received AM modulated RF spectrum is the following, versus the modulation index (m). This plot is done for the minimum AM modulated RF input power (-40 dBm) and only for an ideal spectrum with only 2 rows (5.7995 and 5.8005 GHz) i.e. the 5.8 GHz carrier AM modulated with a 500 kHz signal.

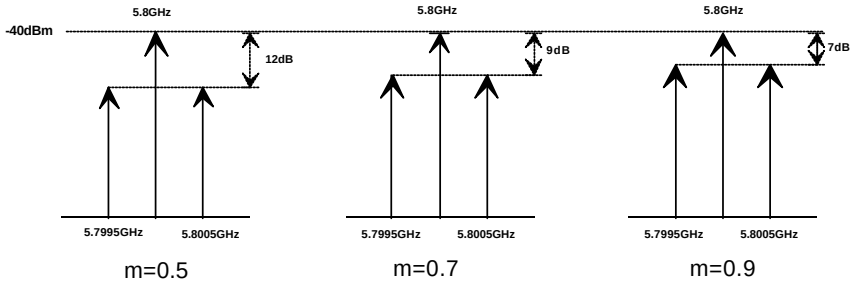

Figure 2b : AM modulated RF spectrum

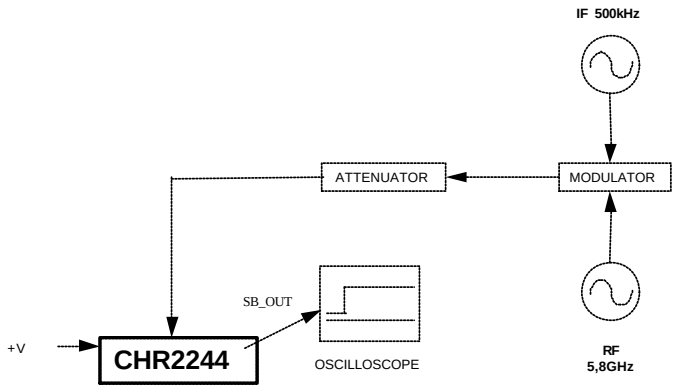

Figure 2c : Standby test bench diagram

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2 - When the WK_in is set to Vcc (TR remaining at 0V), the CHR2244 switches to the **DOWNLINK MODE** (figure 3a), allowing an optimized bandwidth for the demodulation. The received data is demodulated and accessible at the DATA_out output.

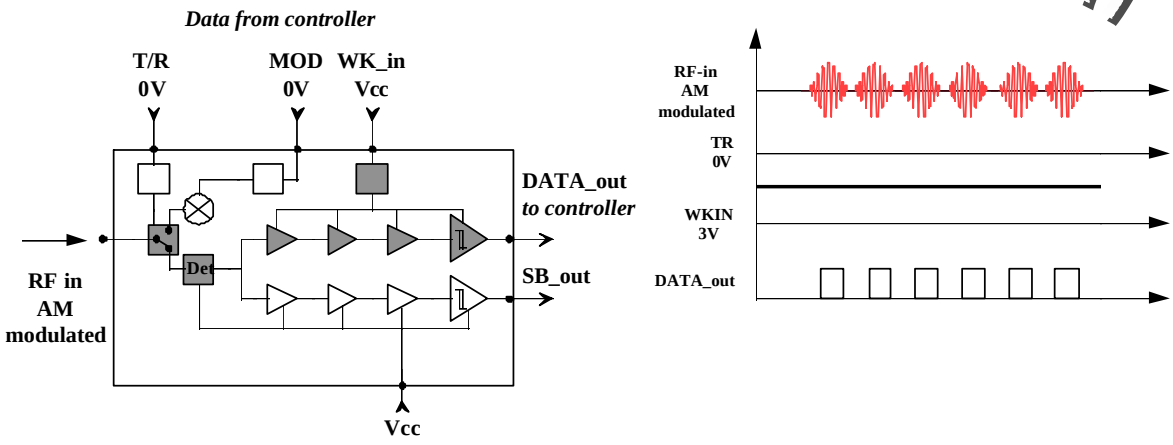

Figure 3a : Downlink mode

The received AM modulated RF spectrum is as in standby mode.

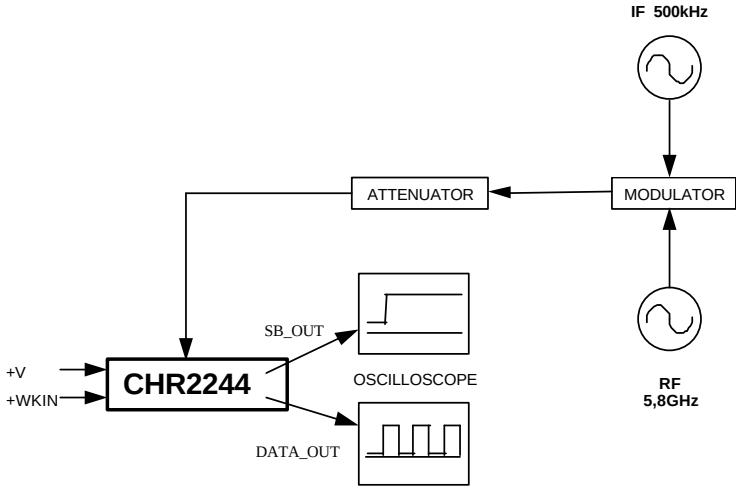

Figure 3b : Downlink test bench diagram

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3 - In the **UPLINK MODE** (figure 4a), the received CW carrier (F0) is multiplied with the modulation signal (Fm) coming from MOD input. In fact, if ETSI CEN TC278 recommendation is applied, the modulation is around the sub-carrier Fm. The resulting reflected signal is a transposition of Fm around the carrier F0 (F0 ± Fm) .

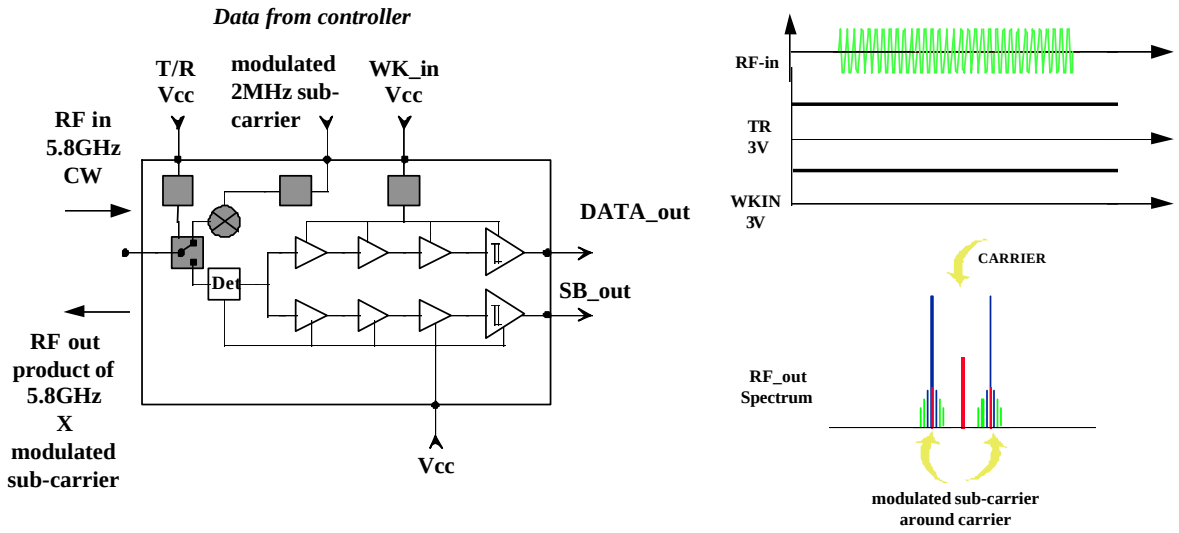

Figure 4a : Uplink mode

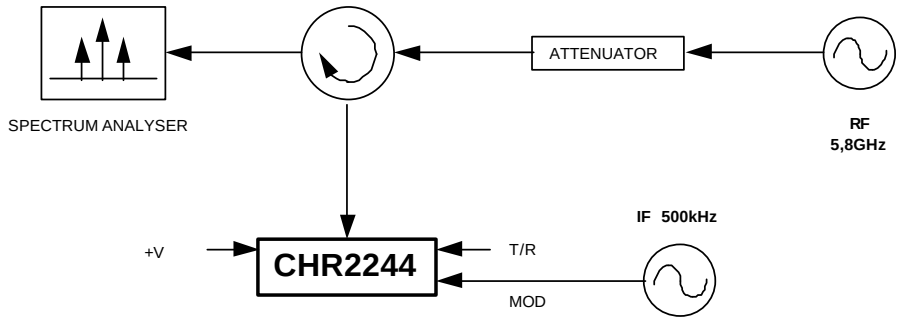

Figure 4b : Uplink test bench diagram

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4 - I/O configuration summary

	T/R	WK_in	RF_in	SB_out	DATA_out	MOD
Standby	0V or High impedance	0V or High impedance	AM signal	>Vcc-1V		
			CW or no signal	<1V		
Downlink	0V	Vcc			CMOS	
Uplink	Vcc	Vcc	**Input** : CW **Output** : Fm around the carrier			Modulation signal (Fm)

AM : Amplitude Modulated
CW : Continuous Wave

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