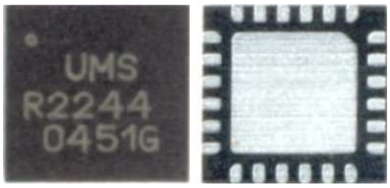
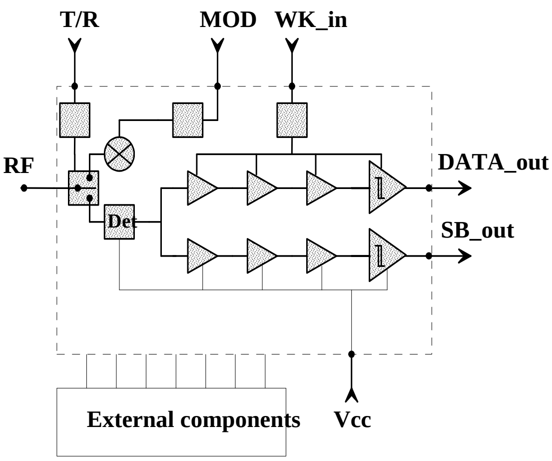
5.8 GHz One Antenna Reflective Transponder for Tag

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℃; 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 !

united monolithic semiconductors S.A.S.
Route Départementale 128 - B.P.46 - 91401 Orsay Cedex France
Tel. : +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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

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_v=0V , MOD_v=0V , WK_in_v=0V

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.

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09
united monolithic semiconductors

DOWNLINK mode : T/R_v=0V , MOD_v=0V , WK_in_v='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_v ='Vcc' , WK_in_v ='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)

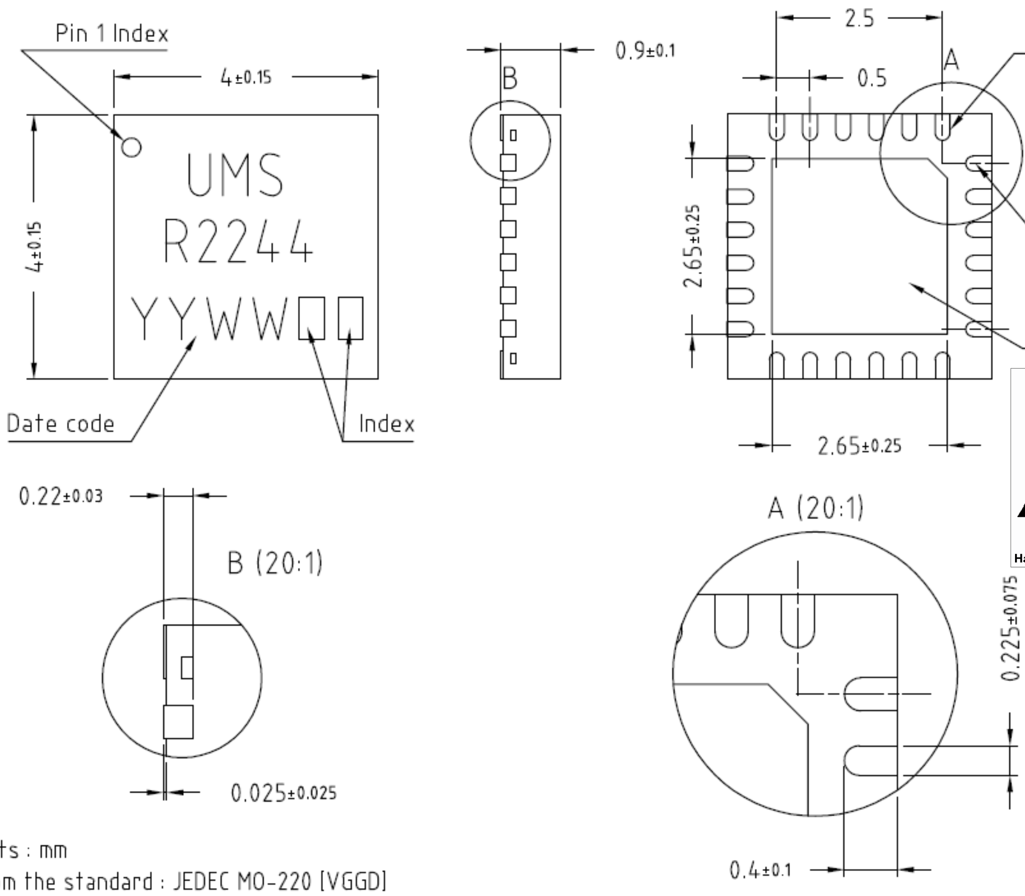
Tamb = -30℃ to +80℃

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	℃
Tstg	Storage temperature range	-55 to +125	℃

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

Package outline (1)

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09
united monolithic semiconductors



Units : mm
From the standard : JEDEC MO-220 [VGGD]
Matt tin, Lead free (Green)

Pin number	Pin name	**Description**
4, 5, 6, 8, 9, 10, 16, 18, 23, 24		Non Connected
1	**RF**	RF port
2	**T/R**	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
25 slug	**GND**	Ground

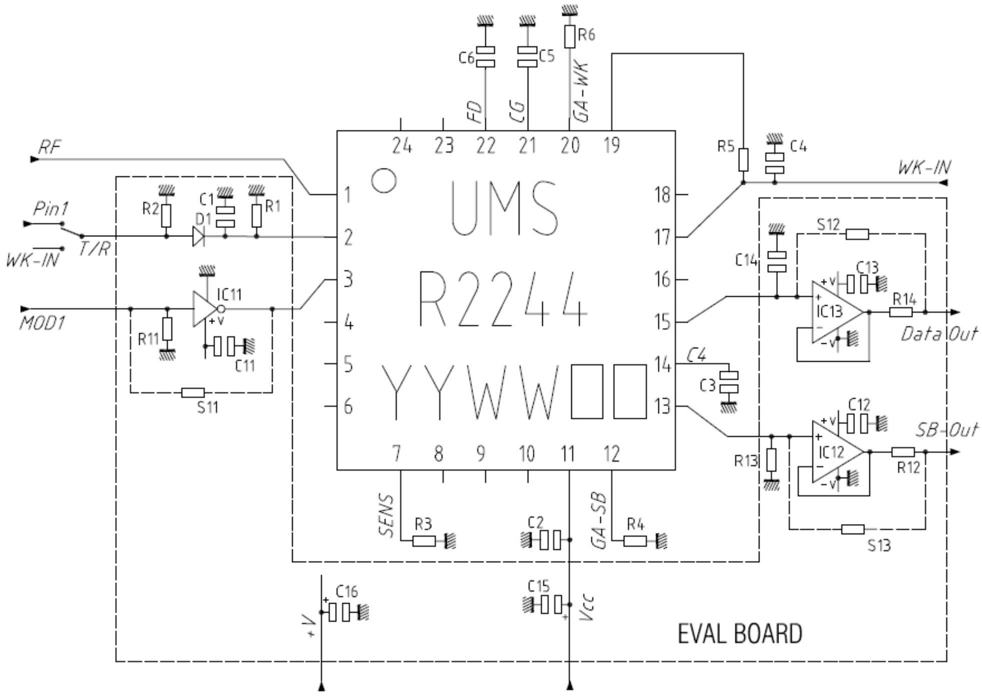
(1)The package outline drawing included to this data-sheet is given for indication. Refer to the application note AN0017 available at http://www.ums-gaas.com for exact package dimensions.

External Components

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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.



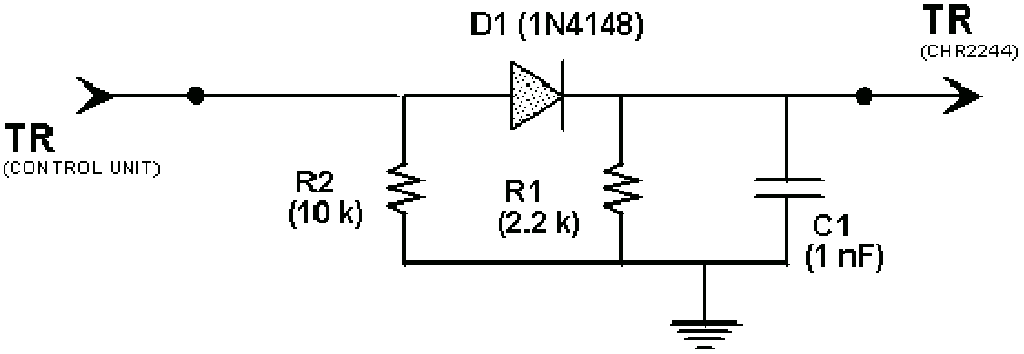
REP	DESIGNATION	MANUFACTURER
R1	Resistor 2.2kΩ ±10% CMS 0603	
R2	Resistor 10kΩ ±10% CMS 0603	
R3	Resistor 2.2MΩ ±10% CMS 0603	
R4	Resistor 680kΩ ±10% CMS 0603	
R5	Resistor 6.8MΩ ±10% CMS 0603	
R6	Resistor optional CMS 0805	
R11	Resistor 470kΩ ±10% CMS 0603	
R12	Resistor 51Ω ±10% CMS 0603	
R13	Resistor 470kΩ ±10% CMS 0603	
R14	Resistor 51Ω ±10% CMS 0603	
C1	Condensator 1nF ±10% 50V CMS 0603	
C2	Condensator 100nF ±10% 50V	
C3	Condensator 470pF ±10% 50V	
C4	Condensator 100nF ±10% 50V	
C5	Condensator 100nF ±10% 50V	
C6	Condensator 100nF ±10% 50V CMS 0603	
C11	Condensator 100nF ±10% 50V CMS 0603	
C12	Condensator 100nF ±10% 50V CMS 0603	
C13	Condensator 100nF ±10% 50V CMS 0603	
C14	Condensator 33pF ±10% 50V CMS 0603	
C15	Condensator 10µF ±10% 16V format 595D Case B	VISHAY
C16	Condensator 10µF ±10% 16V format 595D Case B	VISHAY
D1	Diode SOT 23 1N4148	
IC11	Trigger 74AHC1G14 SOT23-5L	
IC12	Ampli MAX4230 SOT23-5L	MAXIM
IC13	Ampli MAX4230 SOT23-5L	MAXIM
S11	Strap 0 Ω	
S12	Strap 0 Ω	
S13	Strap 0 Ω	

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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 T/R 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). Indeed, a decrease of the sensitivity means an increase of the minimum RF power for considered mode.

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09
united monolithic semiconductors

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 (MΩ)	**R4 (kΩ)**	**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 (MΩ)	**R6 (kΩ)**	**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.

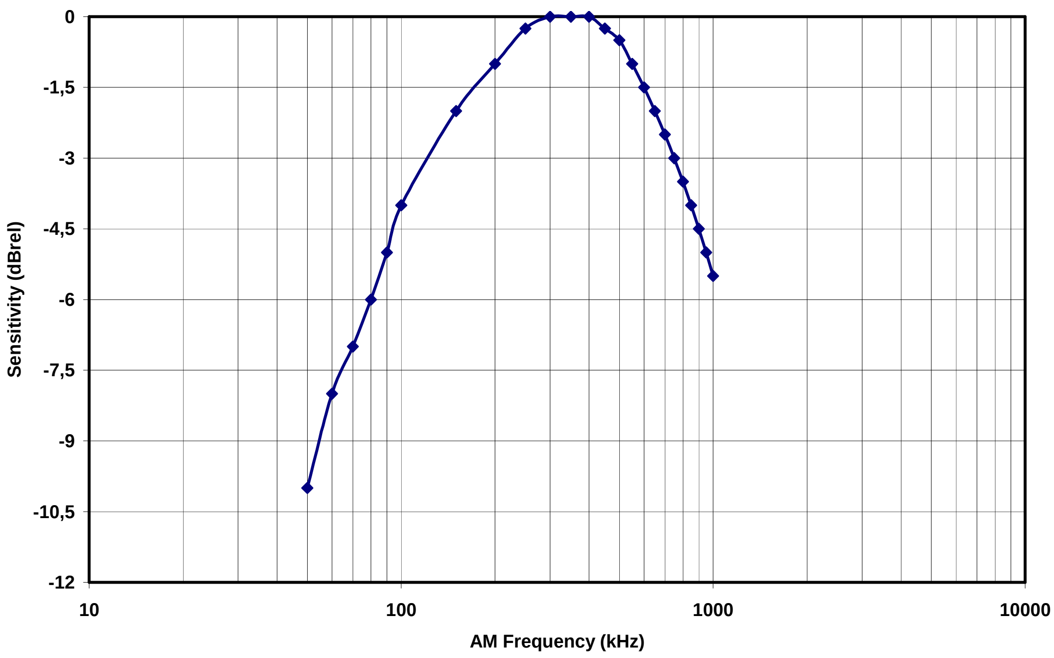
(1) A higher sensitivity than in recommended configuration may cause significant density of unwanted data when RF is not modulated.
These data are random because of the component noise floor proximity, or can be sensitive to an environment perturbation.

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09
united monolithic semiconductors

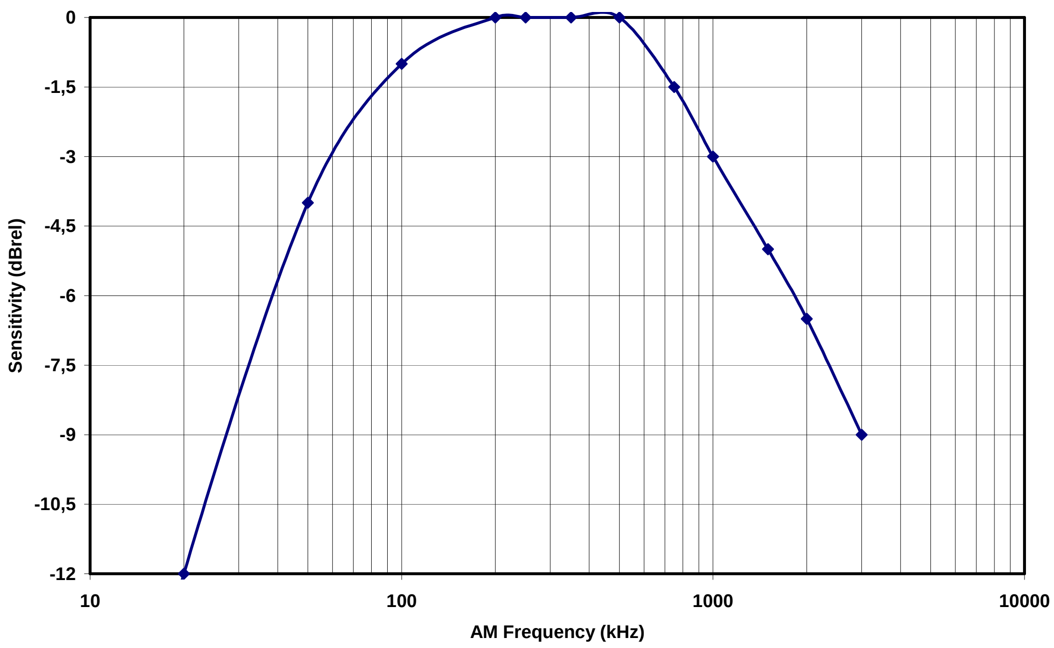
Frequency response characterization

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

- **STANDBY sensitivity versus AM frequency :**



- **DOWNLINK sensitivity versus AM frequency :**



Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

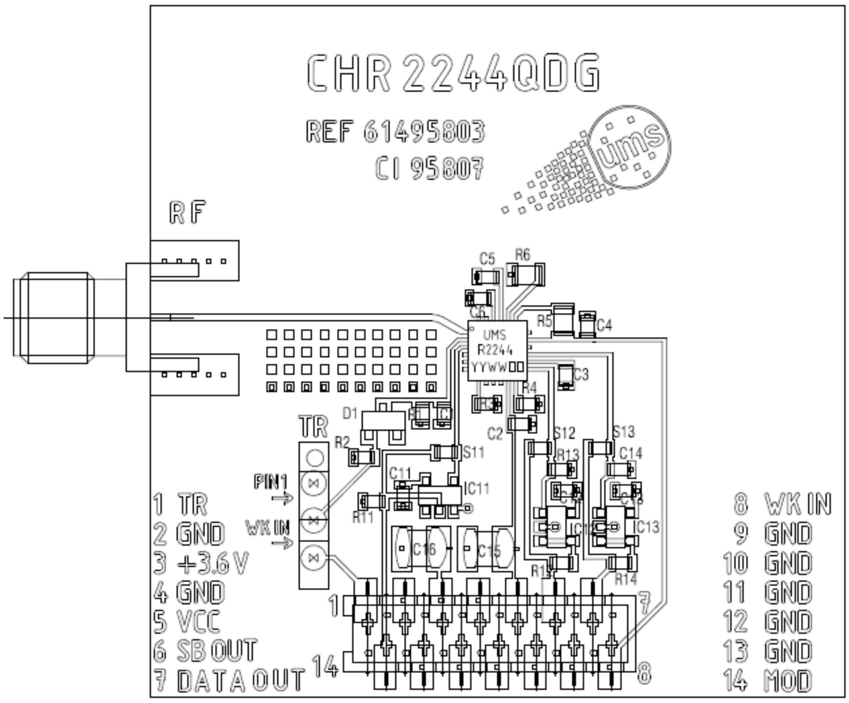
Evaluation board

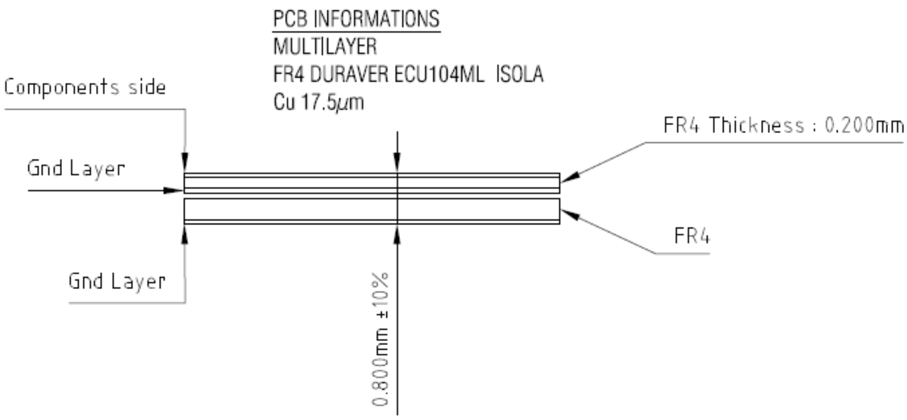
Important notice / design recommendations

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.





REP	DESIGNATION	MANUFACTURER
R1	Resistor 2.2kΩ ±10% CMS 0603	
R2	Resistor 10kΩ ±10% CMS 0603	
R3	Resistor 2.2MΩ ±10% CMS 0603	
R4	Resistor 680kΩ ±10% CMS 0603	
R5	Resistor 6.8MΩ ±10% CMS 0603	
R6	Resistor optional CMS 0805	
R11	Resistor 470kΩ ±10% CMS 0603	
R12	Resistor 51Ω ±10% CMS 0603	
R13	Resistor 470kΩ ±10% CMS 0603	
R14	Resistor 51Ω ±10% CMS 0603	
C1	Condensator 1nF ±10% 50V CMS 0603	
C2	Condensator 100nF ±10% 50V	
C3	Condensator 470pF ±10% 50V	
C4	Condensator 100nF ±10% 50V	
C5	Condensator 100nF ±10% 50V	
C6	Condensator 100nF ±10% 50V CMS 0603	
C11	Condensator 100nF ±10% 50V CMS 0603	
C12	Condensator 100nF ±10% 50V CMS 0603	
C13	Condensator 100nF ±10% 50V CMS 0603	
C14	Condensator 33pF ±10% 50V CMS 0603	
C15	Condensator 10µF ±10% 16V format 595D Case B	VISHAY
C16	Condensator 10µF ±10% 16V format 595D Case B	VISHAY
D1	Diode SOT 23 1N4148	
IC11	Trigger 74AHC1G14 SOT23-5L	
IC12	Ampli MAX4230 SOT23-5L	MAXIM
IC13	Ampli MAX4230 SOT23-5L	MAXIM
S11	Strap 0 Ω	
S12	Strap 0 Ω	
S13	Strap 0 Ω	

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

Application Information

General Transmission system

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

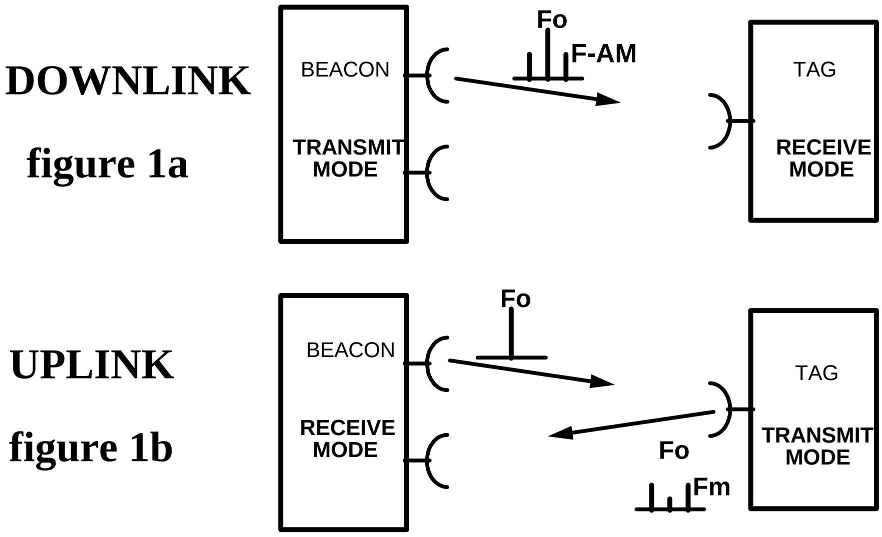


Figure 1: Transmission system operating principle

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.

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09
united monolithic semiconductors

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** (figures 2a; 2B and 2c) 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.

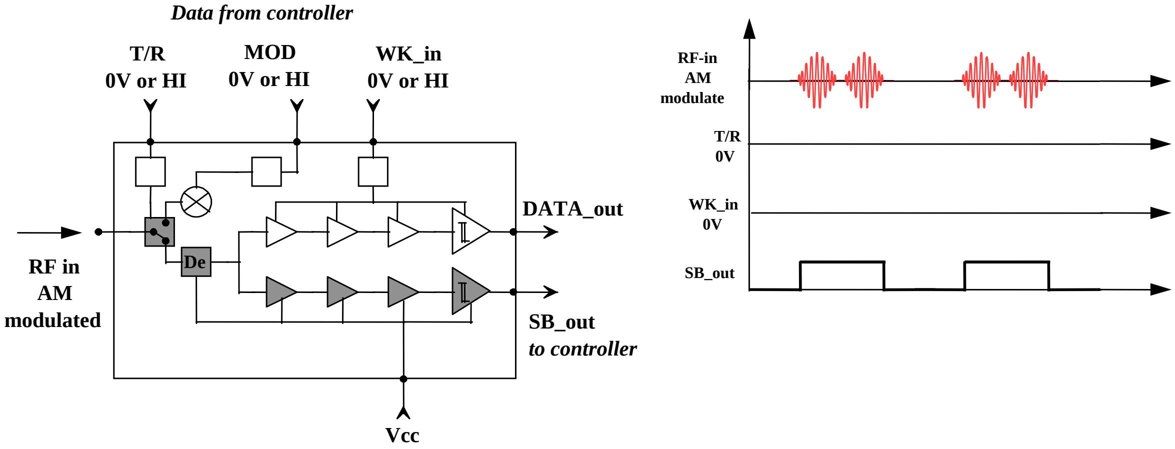


Figure 2a: Standby mode

The received AM modulated RF spectrum is the following (figure 2b), 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.

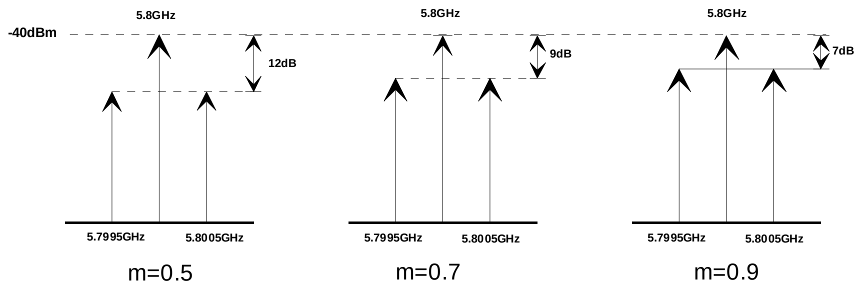


Figure 2b: AM modulated RF spectrum

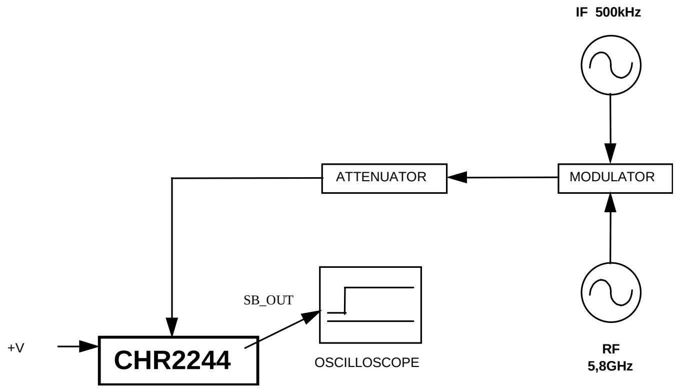


Figure 2c: Standby test bench diagram

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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.

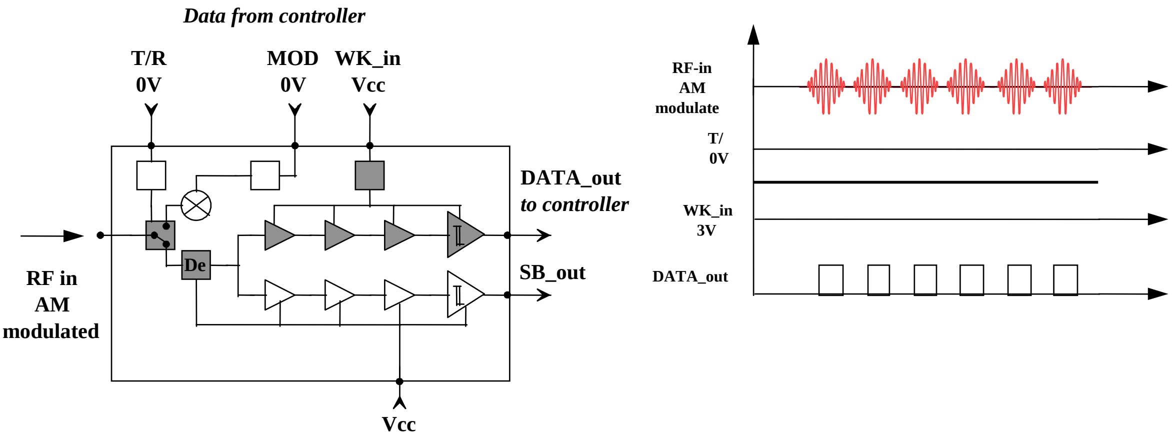


Figure 3a: Downlink mode

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

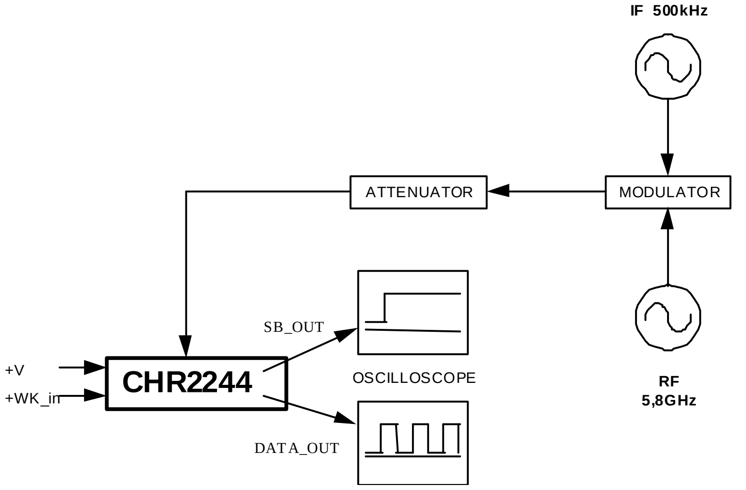


Figure 3b: Downlink test bench diagram

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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) .

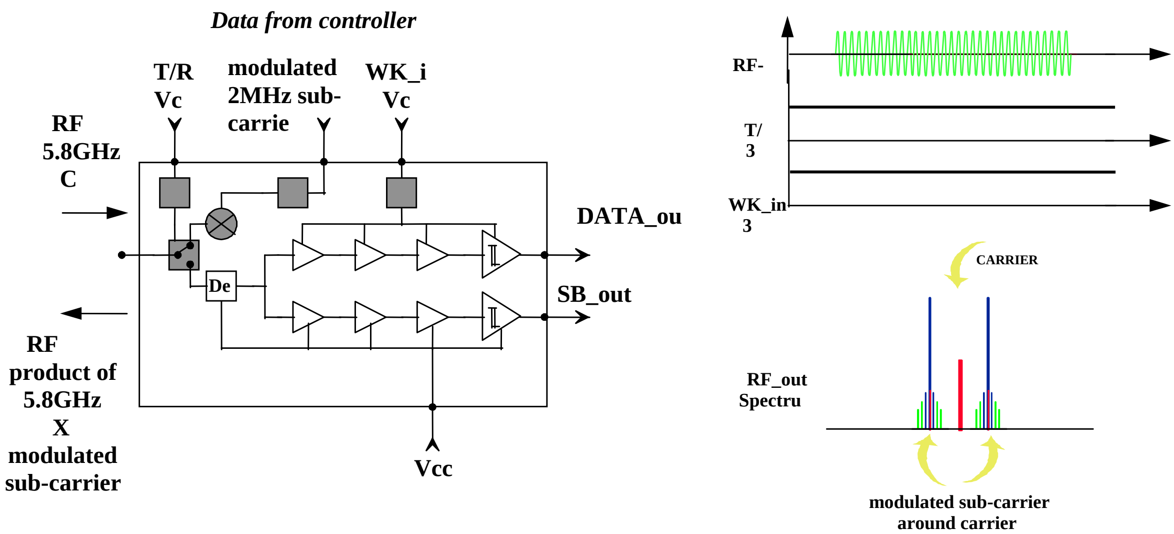


Figure 4a: Uplink mode

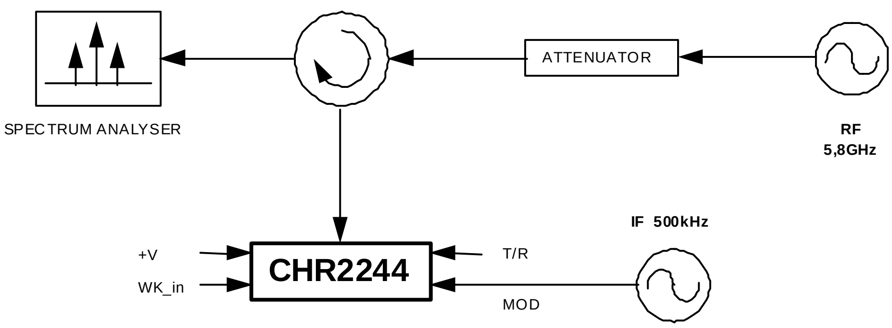


Figure 4b: Uplink test bench diagram

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09

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

Ordering Information

QFN 4x4 RoHS compliant package : CHR2244-QDG/XY

Stick: XY = 20 Tape & reel: XY = 21

Route Départementale 128 , B.P.46 - 91401 ORSAY Cedex - FRANCE
Tel.: +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09