AN-1570
APPLICATION NOTE

One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

The ADF7030-1 in Meeting the Requirements of the ETSI Category 1 Social Alarm Devices

by Edwin Umali

INTRODUCTION

Social alarm devices have been defined by the European Telecommunication Standard Institute (ETSI) as a reliable radio communication system that allows a person in distress within a confined area to initiate a call for assistance. The target users of social alarms are the elderly and the disabled. In this application note, the operation and performance of the ADF7030-1 is presented in the context of the requirements of Category 1 social alarm devices. Optimization and trade-offs between sensitivity, blocking, and adjacent channel selectivity (ACP) are made to meet the Category 1 requirements without using an additional surface acoustic wave (SAW) filter.

The ADF7030-1 is a fully integrated, sub-GHz radio transceiver that achieves high performance at low power. This transceiver is designed to operate in the 169.4 MHz to 169.6 MHz, 426 MHz to 470 MHz, and 863 MHz to 960 MHz frequency bands. This transceiver is suitable for applications that require long range transmission, network robustness, and long battery life. This transceiver supports the IEEE 802.15.4g MR-FSK PHY requirements, as well as proprietary 2 frequency shift keying (FSK), 2 Gaussian frequency shift keying (GFSK), 4FSK, and 4GFSK modulation schemes in both packet and data streaming modes.

This highly configurable, low intermediate frequency (IF) receiver supports a large range of receiver channel bandwidths from 2.6 kHz to 738 kHz, which allows the ADF7030-1 to support ultranarrow-band, narrow-band, and wideband channel spacing. The transceiver is suitable for circuit applications under the European ETSI EN 300 220-1, the North American FCC, the Japanese ARIB, or other similar regional standards.

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REVISION HISTORY

9/2018—Revision 0: Initial Version

ETSI EN 300 220-3-1 SOCIAL ALARM STANDARD

An overview of the social alarm standard is provided in this section. The requirements and the associated reference limits are discussed. For complete information on the standard and the various measurement procedure, refer to the following documents:

- ETSI EN 300 220-3-1, Version 2.1.1: harmonized standard covering essential requirements for low duty cycle high reliability equipment, social alarm equipment operating on the designated frequencies of 869.200 MHz to 869.250 MHz.
- ETSI EN 300 220-1, Version 3.1.1: technical characteristics and methods of measurement.

The harmonized standard recognizes that the radio communication link alone does not determine the overall operation of a system, but that a functioning radio communication link is essential in creating a reliable system. The technical requirements in the standard have been defined to ensure robust performance of a radio communication link.

TRANSMITTER REQUIREMENTS

The following are the technical requirements when the equipment under test (EUT) is in transmit mode.

Operating Frequency and Operating Channel

The allocated frequency band is from 869.20 MHz to 869.25 MHz with an operating channel width (OCW) limit of 25 kHz. The channels are arranged in a raster formed by the OCW and the edges of the band. The operating frequency is the center of a channel.

Effective Radiated Power (ERP)

The effective radiated power is the power radiated in the direction of the maximum field strength. For EUT with a permanent antenna connector, ERP is the conducted output power taken as the power measured from that connector. The measured value is then adjusted to include the antenna gain. The maximum ERP is 10 mW or 10 dBm.

Duty Cycle

Duty cycle is the percentage of the cumulative duration of transmission within an observation time interval (typically set to 1 hour) in an observation bandwidth (the operational frequency band of 50 kHz). The limit is 0.1% over a 1 hour observation period.

Adjacent Channel Power (ACP)

The ACP is the power incidental to the proper operation of a transmitter falling into the neighboring channels. The adjacent channel is 25 kHz away from the operating frequency and the alternate adjacent channel is 50 kHz way from the operating frequency. Under normal test conditions and for an OCW greater than 20 kHz, the limit for the ACP is −37 dBm, and the limit for the alternate ACP is −10 dBm.

Transmitter Frequency Error

The transmitter frequency error is the difference between the measured unmodulated carrier and the nominal operating frequencies. Under normal testing conditions, the limit is ±10% of OCW, which is equal to 2.5 kHz.

Transmitter Transient Power

The transmitter transient power is the power falling into frequencies other than the operating channel that is produced as the transmitter is switched on and off. For a reference resolution bandwidth (RBW) of 1 kHz, the peak limits are 0 dBm for a frequency offset of ≤400 kHz and −27 dBm for a frequency offset of >400 kHz.

Transmitter Behavior Under Low Voltage Conditions

This requirement applies only to transmitters that are powered by battery. Transmitter behavior under low voltage conditions describes the ability of the EUT to maintain its operating frequency and not produce emissions that exceed any relevant limit when the battery voltage falls below the lower extreme voltage level. The accepted EUT behaviors when the voltage is low are as follows:

- Remain in the operating channel without exceeding any applicable limits.
- Reduce the ERP below the spurious emission limits without exceeding any applicable limits.
- Shut down.

RECEIVER CATEGORY 1 REQUIREMENTS

This section describes the Category 1 technical requirements when the EUT is in receive mode.

Blocking

Blocking is the capability of the EUT to receive a wanted modulated signal without exceeding a given degradation. This degradation is due to the presence of an unwanted input interference at any frequencies other than those of the spurious response or adjacent channels. The EUT must comply with the blocking requirement.

When performing blocking measurement, the power of the wanted modulated signal is first set to the receiver sensitivity level or to the reference level in Equation 1, whichever is higher. Sensitivity is the minimum received power level that produces the general performance criterion. Then, the power of the wanted signal level is increased by 3 dB. The power of the unwanted interference is increased until the general performance criterion is again reached. The power of the unwanted interference is recorded.

$$S_p = \log_{10} RB_{kHz} - 117 \text{ dBm} \quad (1)$$

where:
S_p is the reference sensitivity level.
RB_{kHz} is the receiver bandwidth declared by the manufacturer.

The general performance criterion is 0.1% bit error ratio (BER) without error correction, or an equivalent message success ratio given by Equation 2.

$$(1 - p)^n \quad (2)$$

where:
p is the probability of a single-bit error.
n is the number of bits in a message.

The minimum blocking levels at specific frequency offsets from the nominal operating frequency are provided in Table 1. The values in the table represent the minimum power level of the unwanted interference signal without exceeding the required performance.

Table 1. Blocking Level for Receive Category 1

Requirement	Limits (dBm)
±2 MHz from Operating Channel Edge	≥−20
±10 MHz from Operating Channel Edge	≥−20
±5% Center Frequency or 15 MHz	≥−20

In addition, the standard also requires repeating the blocking test with a 40 dB increased level for the wanted signal.

Adjacent Channel Selectivity

Adjacent channel selectivity is the capability of the receiver to operate as intended in the presence of an unwanted signal. The unwanted signal differs from the wanted signal by a frequency equal to the OCW. Adjacent channel selectivity is similar to blocking, aside from the frequency offset. When the power level of the wanted signal is set 3 dB above the sensitivity level or the reference level in Equation 2 (whichever is higher), the minimum adjacent channel selectivity is −50 dBm.

Adjacent Channel Saturation

Adjacent channel saturation is the capability of the receiver to operate as intended in the presence of a strong signal in the wanted channel, as well as a strong signal in the adjacent channel. The frequency of the signal in the adjacent channel differs from that in the wanted channel by an amount equal to the adjacent channel separation for which the equipment is declared. Adjacent channel saturation is similar to the adjacent channel selectivity, except that the power level of the wanted signal is 43 dB above the sensitivity level or the reference level in Equation 2 (whichever is higher). The minimum adjacent channel saturation is −20 dBm.

Spurious Response Rejection

Spurious response rejection is the capability of the receiver to detect a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted unmodulated signal at any other frequencies where a response can be obtained. Further information in locating these spurious frequencies can be found in the ETSI EN 300 220-1 document. Spurious response rejection is similar to blocking, except that the offset frequencies are the spurious frequencies. The minimum spurious response rejection is −44 dBm. The limit is relaxed by 25 dB if the offset of the spurious frequency is less than 0.1% of the operating frequency.

Behavior at High Wanted Signal Level

The behavior at high wanted signal level describes the capability of the receiver to operate as intended in the presence of a strong wanted signal in the operating channel. Behavior at high wanted signal level is similar to sensitivity, except that the power level is increased until either the wanted performance criterion is no longer met, or the specified test limit is reached. The limit is −10 dBm.

SPURIOUS EMISSIONS

Spurious emissions are unwanted emissions in the spurious domain radiated by the equipment or its antenna. In transmit mode, the spurious domain covers all frequencies except those that fall within the operating channel, the adjacent channel, and the alternate adjacent channel. In receive mode, the spurious domain is all frequencies. All EUTs must comply with the emission limits found in Table 2 under normal test conditions.

Table 2. Spurious Domain Emission Limits

State	47 MHz to 74 MHz, 87.5 MHz to 118 MHz, 174 MHz to 230 MHz, 470 MHz to 790 MHz	Other Frequencies Below 1000 MHz	Frequencies Above 1000 MHz
Transmit Mode	−54 dBm	−36 dBm	−30 dBm
Receive Mode and All Other Modes	−57 dBm	−57 dBm	−47 dBm

CONFIGURATION OF THE ADF7030-1

Among the technical requirements of the social alarm standard, receiver blocking (−20 dBm for Category 1 devices) at a frequency offset of ±2 MHz is the most difficult to satisfy. A typical solution is to add a SAW filter before the receive input pins of a transceiver. However, if properly configured, the ADF7030-1 can meet the blocking requirements without the need for a SAW filter.

Optimizing the configuration of the ADF7030-1 for Category 1 social alarms is mainly a trade-off between blocking and sensitivity. Based on Equation 1, an increase in the receiver bandwidth results in an increase in the reference sensitivity level, which is also the power level of the wanted signal in a blocking test. For the same receiver performance criterion, a higher wanted signal results in a higher unwanted interfering signal. The ADF7030-1 can therefore meet the −20 dBm blocking requirement by employing a wider receiver bandwidth.

To lessen the effect of a wider receiver bandwidth, the ADF7030-1 is configured to operate with a narrower phase-locked loop (PLL) filter bandwidth. In addition, the gain of the programmable analog filter is reduced to avoid saturating the analog-to-digital converter (ADC).

A summary of the required register changes is provided in Table 3 to Table 5. Modify the PLL_CP and PLL_LF registers to decrease the PLL filter bandwidth. To lower the gain of the analog filter before the ADC, modify the AFERX_FILT_STG1 register. The register values that have been provided are applicable for data rates of 9.6 kbps and lower.

PLL CHARGE PUMP REGISTER

Address: 0x40004020, Reset: 0x00000070, Name: PLL_CP

Table 3. Bit Description for PLL_CP

Bits	Bit Name	Description	Access	Reset	Required Changes
[31:23]	RESERVED	Reserved	R	0x0	Not applicable
[22:18]	PLL_CP_ICP_CODE	PLL charge pump code	R/W	0x0	Set to 7
[17:0]	RESERVED	Reserved	R	0x70	Not applicable

PLL LOOP FILTER REGISTER

Address: 0x40004024, Reset: 0x00001C11, Name: PLL_LF

Table 4. Bit Description for PLL_LF

Bits	Bit Name	Description	Access	Reset	Required Changes
[31:16]	RESERVED	Reserved	R	0x0	Not applicable
[15:10]	PLL_LF_C2_CODE	PLL filter capacitor code	R/W	0x7	Set to 7
9	PLL_LF_R3_CODE	PLL filter resistor Code 3	R/W	0x0	Set to 0
[8:7]	PLL_LF_R2_CODE	PLL filter resistor Code 2	R/W	0x0	Set to 0
[6:0]	PLL_LF_R1_CODE	PLL filter resistor Code 1	R/W	0x11	Set to 20

ANALOG FILTER RECEIVER STAGE 1 REGISTER

Address: 0x40004058, Reset: 0x00000000, Name: AFERX_FILT_STG1

Table 5. Bit Description for AFERX_FILT_STG1

Bits	Bit Name	Description	Access	Reset	Required Changes
[31:21]	RESERVED	Reserved	R	0x0	Not applicable
[20:16]	AFERX_FILT_STG1_R2	Filter resistor code	R/W	0x0	Set to 7
[15:10]	RESERVED	Reserved	R	0x0	Not applicable
[9:0]	AFERX_FILT_STG1_CAP	Filter capacitor code	R/W	0x0	Set to 387

PERFORMANCE DATA

The performance of the ADF7030-1 under the social alarm requirement was obtained using three EV-ADF70301-868BZ daughter boards. The daughter boards are used together with an ADuCM3029 EZ-KIT. The five use cases are summarized in Table 6. For the packet configuration, each packet consists of 8 bytes of preamble, 2 bytes of sync word, 14 bytes of fixed payload, and 2 bytes of cyclic redundancy check (CRC). The operating frequency (f_C) used for all tests is 869.2125 MHz.

Table 6. Configurations in the 869.2125 MHz Social Alarm Operating Frequency

Configuration Name (kbps)	Modulation	Data Rate (kbps)	Frequency Deviation (kHz)	Intermediate Frequency (kHz)	Receiver Bandwidth (kHz)	Maximum Frequency Error (ppm)	Reference Sensitivity Level (dBm)
2.4	2GFSK	2.4	1.2	81.25	20.0	+17	−104.0
4.8	2GFSK	4.8	2.4	81.25	16.4	+8	−104.9
6.4	2GFSK	6.4	3.2	81.25	17.6	+6	−104.5
7.2	2GFSK	7.2	3.6	81.25	16.4	+3	−104.9
9.6	2GFSK	9.6	4.8	81.25	18.7	+1	−104.3

TRANSMITTER DATA

Table 7. Transmitter Data

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Occupied Bandwidth (OBW)					Contains 99% of the total integrated power, limit: 25 kHz
Configuration 2.4 kbps	4.0	kHz	21.0	kHz	
Configuration 4.8 kbps	7.8	KHz	17.2	kHz	
Configuration 6.4 kbps	10.6	kHz	14.4	kHz	
Configuration 7.2 kbps	11.8	kHz	13.2	kHz	
Configuration 9.6 kbps	15.8	kHz	9.2	kHz	
Adjacent Channel Power (ACP)					EUT is set to maximum ERP, power is integrated over 0.7 of OCW, limit is −37 dBm for adjacent channel, limit is −40 dBm for alternate adjacent channel, spectrum analyzer setting RBW = 100 Hz, spectrum analyzer setting video bandwidth (VBW) = 300 Hz, detector mode: room mean square (RMS), trace mode: maximum hold
Configuration 2.4 kbps					
Adjacent Channel (±25 kHz)	−58.8	dBm	+21.8	dB	
Alternate Channel (±50 kHz)	−57.2	dBm	+17.2	dB	
Configuration 4.8 kbps					
Adjacent Channel (±25 kHz)	−58.9	dBm	+21.9	dB	
Alternate Channel (±50 kHz)	−57.3	dBm	+17.3	dB	
Configuration 6.4 kbps					
Adjacent Channel (±25 kHz)	−58.8	dBm	+21.8	dB	
Alternate Channel (±50 kHz)	−57.2	dBm	+17.2	dB	
Configuration 7.2 kbps					
Adjacent Channel (±25 kHz)	−58.3	dBm	+21.3	dB	
Alternate Channel (±50 kHz)	−57.3	dBm	+17.3	dB	
Configuration 9.6 kbps					
Adjacent Channel (±25 kHz)	−47.9	dBm	+10.9	dB	
Alternate Channel (±50 kHz)	−57.3	dBm	+17.3	dB	
Transmitter Frequency Error	0.3	kHz	2.2	kHz	Transmits an unmodulated carrier test signal, limit: 10% OCW or 2.5 kHz

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Transmitter Transient Power					EUT is set to maximum ERP, limit: 0 dBm for frequency offset ≤400 kHz, limit: −27 dBm for frequency offset >400 kHz, spectrum analyzer setting VBW/RBW = 10, RBW filter: Gaussian, detector mode: RMS, trace mode: maximum hold, sweep time = 500 ms, sweep points = 501, measurement mode: continuous sweep
Configuration 2.4 kbps					
±15.5 kHz	−25.6	dBm	+25.6	dB	
±25 kHz	−25.0	dBm	+25.0	dB	
±412.5 kHz	−34.2	dBm	+7.2	dB	
±1212.5 kHz	−38.9	dBm	+11.9	dB	
Configuration 4.8 kbps					
±15.5 kHz	−25.2	dBm	+25.2	dB	
±25 kHz	−24.6	dBm	+24.6	dB	
±412.5 kHz	−34.2	dBm	+7.2	dB	
±1212.5 kHz	−38.9	dBm	+11.9	dB	
Configuration 6.4 kbps					
±15.5 kHz	−25.0	dBm	+25.0	dB	
±25 kHz	−24.6	dBm	+24.6	dB	
±412.5 kHz	−34.2	dBm	+7.2	dB	
±1212.5 kHz	−38.9	dBm	+11.9	dB	
Configuration 7.2 kbps					
±15.5 kHz	−24.0	dBm	+24.0	dB	
±25 kHz	−24.0	dBm	+24.0	dB	
±412.5 kHz	−34.2	dBm	+7.2	dB	
±1212.5 kHz	−38.9	dBm	+11.9	dB	
Configuration 9.6 kbps					
±15.5 kHz	−23.3	dBm	+23.3	dB	
±25 kHz	−23.7	dBm	+23.7	dB	
±412.5 kHz	−34.2	dBm	+7.2	dB	
±1212.5 kHz	−38.9	dBm	+11.9	dB	

RECEIVER DATA

Table 8. Receiver Data

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Sensitivity, PER-Based					At PER = 10%, limit is the reference sensitivity level in Table 6, automatic frequency control (AFC) enabled
Configuration 2.4 kbps	−120.5	dBm	+16.5	dB	
Configuration 4.8 kbps	−118.6	dBm	+13.7	dB	
Configuration 6.4 kbps	−117.7	dBm	+13.2	dB	
Configuration 7.2 kbps	−117.3	dBm	+12.4	dB	
Configuration 9.6 kbps	−116.1	dBm	+11.8	dB	
Sensitivity, BER-Based					At BER = 0.1%, limit is the reference sensitivity level in Table 6, AFC disabled
Configuration 2.4 kbps	−120.8	dBm	+16.8	dB	
Configuration 4.8 kbps	−118.6	dBm	+13.7	dB	
Configuration 6.4 kbps	−117.8	dBm	+13.3	dB	
Configuration 7.2 kbps	−117.4	dBm	+12.5	dB	
Configuration 9.6 kbps	−116.3	dBm	+12.0	dB	

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Blocking, PER-Based					Desired signal 3 dB above the input reference sensitivity level, channel width (CW) interferer power level increased until PER = 10%, limit is −20 dBm, AFC enabled, image calibrated, reference sensitivity level given in Table 6
Configuration 2.4 kbps					
±2 MHz	−17.0	dBm	+3.0	dB	
±10 MHz	−12.5	dBm	+7.5	dB	
5% of f_C	0.9	dBm	20.9	dB	
Configuration 4.8 kbps					
±2 MHz	−18.0	dBm	+2.0	dB	
±10 MHz	−14.1	dBm	+5.9	dB	
5% of f_C	−2.2	dBm	+17.8	dB	
Configuration 4.8 kbps					
±2 MHz	−18.4	dBm	+1.6	dB	
±10 MHz	−14.4	dBm	+5.6	dB	
5% of f_C	−2.6	dBm	+17.4	dB	
Configuration 7.2 kbps					
±2 MHz	−18.9	dBm	+1.1	dB	
±10 MHz	−15.0	dBm	+5.0	dB	
5% of f_C	−3.4	dBm	+16.6	dB	
Configuration 9.6 kbps					
±2 MHz	−19.6	dBm	+0.4	dB	
±10 MHz	−15.3	dBm	+4.7	dB	
5% of f_C	−4.1	dBm	+15.9	dB	
Blocking, BER-Based					Desired signal 3 dB above the input reference sensitivity level, CW interferer power level increased until BER = 0.1%, limit is −20 dBm, AFC disabled, reference sensitivity level given in Table 6
Configuration 2.4 kbps					
±2 MHz	−16.8	dBm	+3.2	dB	
±10 MHz	−11.8	dBm	+8.2	dB	
5% of f_C	2.0	dBm	22.0	dB	
Configuration 4.8 kbps					
±2 MHz	−17.9	dBm	+2.1	dB	
±10 MHz	−13.9	dBm	+6.1	dB	
5% of f_C	−1.7	dBm	+18.3	dB	
Configuration 4.8 kbps					
±2 MHz	−18.2	dBm	+1.8	dB	
±10 MHz	−14.1	dBm	+5.9	dB	
5% of f_C	−2.1	dBm	+17.9	dB	
Configuration 7.2 kbps					
±2 MHz	−18.7	dBm	+1.3	dB	
±10 MHz	−14.7	dBm	+5.3	dB	
5% of f_C	−3.1	dBm	+16.9	dB	
Configuration 9.6 kbps					
±2 MHz	−19.3	dBm	+0.7	dB	
±10 MHz	−15.0	dBm	+5.0	dB	
5% of f_C	−3.6	dBm	+16.4	dB	

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Blocking Saturation, PER-Based					Desired signal 43 dB above the input reference sensitivity level, CW interferer power level increased until PER = 10%, limit is −20 dBm, AFC enabled, reference sensitivity level given in Table 6
Configuration 2.4 kbps					
±2 MHz	5.9	dBm	25.9	dB	
±10 MHz	10.0	dBm	30.0	dB	
5% of f_C	10.0	dBm	30.0	dB	
Configuration 4.8 kbps					
±2 MHz	2.2	dBm	22.2	dB	
±10 MHz	10.0	dBm	30.0	dB	
5% of f_C	10.0	dBm	30.0	dB	
Configuration 4.8 kbps					
±2 MHz	1.2	dBm	21.2	dB	
±10 MHz	10.0	dBm	30.0	dB	
5% of f_C	10.0	dBm	30.0	dB	
Configuration 7.2 kbps					
±2 MHz	0.5	dBm	20.5	dB	
±10 MHz	10.0	dBm	30.0	dB	
5% of f_C	10.0	dBm	30.0	dB	
Configuration 9.6 kbps					
±2 MHz	0.4	dBm	20.4	dB	
±10 MHz	10.0	dBm	30.0	dB	
5% of f_C	10.0	dBm	30.0	dB	
Adjacent Channel Selectivity, PER-Based					Desired signal 3 dB above the input reference sensitivity level, CW interferer power level increased until PER = 10%, limit is −50 dBm, AFC enabled, reference sensitivity level given in Table 6
Configuration 2.4 kbps					
−25 kHz	−41.5	dBm	+8.5	dB	
+25 kHz	−40.7	dBm	+9.3	dB	
Configuration 4.8 kbps					
−25 kHz	−43.2	dBm	+6.8	dB	
+25 kHz	−43.4	dBm	+6.6	dB	
Configuration 6.4 kbps					
−25 kHz	−44.0	dBm	+6.0	dB	
+25 kHz	−43.9	dBm	+6.1	dB	
Configuration 7.2 kbps					
−25 kHz	−44.8	dBm	+5.2	dB	
+25 kHz	−44.6	dBm	+5.4	dB	
Configuration 9.6 kbps					
−25 kHz	−45.5	dBm	+4.5	dB	
+25 kHz	−45.2	dBm	+4.8	dB	

Parameter	Average	Unit	Margin	Unit	Test Conditions/Comments
Adjacent Channel Saturation, PER-Based					Desired signal 3 dB above the input reference sensitivity level, CW interferer power level increased until PER = 10%, limit is −20 dBm, AFC enabled, reference sensitivity level given in Table 6
Configuration 2.4 kbps					
−25 kHz	−9.4	dBm	+10.6	dB	
+25 kHz	−2.3	dBm	+17.7	dB	
Configuration 4.8 kbps					
−25 kHz	−11.2	dBm	+8.8	dB	
+25 kHz	−5.6	dBm	+14.4	dB	
Configuration 6.4 kbps					
−25 kHz	−11.0	dBm	+9.0	dB	
+25 kHz	−6.8	dBm	+13.2	dB	
Configuration 7.2 kbps					
−25 kHz	−11.2	dBm	+8.8	dB	
+25 kHz	−7.2	dBm	+12.8	dB	
Configuration 9.6 kbps					
−25 kHz	−11.4	dBm	+8.6	dB	
+25 kHz	−8.2	dBm	+11.8	dB	
Spurious Response Rejection, PER-Based					Desired signal 3 dB above the input reference sensitivity level, CW interferer power level increased until PER = 10%, limit is −69 dBm (relaxed by 25 dB), AFC enabled, image calibrated
Configuration 2.4 kbps					
Adjacent Channel (−162.5 kHz)	−56.9	dBm	+12.1	dB	
Configuration 4.8 kbps					
Adjacent Channel (−162.5 kHz)	−59.0	dBm	+10.0	dB	
Configuration 6.4 kbps					
Adjacent Channel (−162.5 kHz)	−59.0	dBm	+10.0	dB	
Configuration 7.2 kbps					
Adjacent Channel (−162.5 kHz)	−58.7	dBm	+10.3	dB	
Configuration 9.6 kbps					
Adjacent Channel (−162.5 kHz)	−58.6	dBm	+10.4	dB	
Behavior at High Wanted Signal, PER-Based					At PER = 10%, limit is −10 dBm, AFC enabled
Configuration 2.4 kbps	10.0	dBm	20.0	dB	
Configuration 4.8 kbps	10.0	dBm	20.0	dB	
Configuration 6.4 kbps	10.0	dBm	20.0	dB	
Configuration 7.2 kbps	10.0	dBm	20.0	dB	
Configuration 9.6 kbps	10.0	dBm	20.0	dB	

SPURIOUS EMISSIONS DATA

For transmit mode, the EUT is set to the maximum ERP and transmits an unmodulated carrier test signal. The limit can be found in Table 2. Spectrum analyzer RBW settings can be found in the ETSI EN 300 220-1 document.

Table 9. Spurious Emissions Data

Parameter	Average	Unit	Margin	Unit
Transmit Mode				
9 kHz to 150 kHz	−84.5	dBm	+48.5	dB
150 kHz to 30 MHz	−83.6	dBm	+47.6	dB
30 MHz to 47 MHz	−74.2	dBm	+38.2	dB
47 MHz to 74 MHz	−72.2	dBm	+18.2	dB
74 MHz to 87.5 MHz	−76.4	dBm	+40.4	dB
87.5 MHz to 118 MHz	−70.4	dBm	+16.4	dB
118 MHz to 174 MHz	−71.7	dBm	+35.7	dB
174 MHz to 230 MHz	−72.6	dBm	+18.6	dB
230 MHz to 470 MHz	−74.2	dBm	+38.2	dB
470 MHz to 790 MHz	−69.4	dBm	+15.4	dB
790 MHz to f_C − 0.5 MHz	−51.0	dBm	+15.0	dB
f_C − 0.5 MHz to f_C − 0.1 MHz	−47.1	dBm	+11.1	dB
f_C − 0.1 MHz to f_C − 0.0625 MHz	−56.5	dBm	+20.5	dB
f_C + 0.0625 MHz to f_C + 0.1 MHz	−56.7	dBm	+20.7	dB
f_C + 0.1 MHz to f_C + 0.5 MHz	−47.0	dBm	+11.0	dB
f_C + 0.5 MHz to 1000 MHz	−52.8	dBm	+16.8	dB
1 GHz to 1.5 GHz	−59.4	dBm	+29.4	dB
1.5 GHz to 4 GHz	−48.0	dBm	+18.0	dB
Receive Mode				
9 kHz to 150 kHz	−85.7	dBm	+28.7	dB
150 kHz to 30 MHz	−84.3	dBm	+27.3	dB
30 MHz to f_C − 0.5 MHz	−76.7	dBm	+19.7	dB
f_C − 0.5 MHz to f_C − 0.1 MHz	−84.6	dBm	+27.6	dB
f_C − 0.1 MHz to f_C + 0.1 MHz	−94.4	dBm	+37.4	dB
f_C + 0.1 MHz to f_C + 0.5 MHz	−84.7	dBm	+27.7	dB
f_C + 0.5 MHz to 1000 MHz	−73.6	dBm	+16.6	dB
1 GHz to 1.5 GHz	−62.9	dBm	+15.9	dB
1.5 GHz to 4 GHz	−65.1	dBm	+18.1	dB