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Siemens Industry Software B.V.

1218RF User's manual

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1 Overview

The 1218RF module is a wireless lossless audio interface based on the Texas Instruments CC8520 PurePath™ Wireless SoC. The module incorporates the crystal, the required RF matching, power supply filtering and filtering on the digital interface for FCC compliance. The module incorporates a CC2590 range extender with power amplifier for increased output power and LNA for improved receiver sensitivity.

The module has two antenna options:
- Single antenna
- Dual antenna with antenna diversity using an AS222-92 switch.

The module can be programmed to act both as master and as slave where the master dictates the audio sample rate and selects the rf channels, antenna diversity is only available on slave modules.

2 Operation

The 1218RF is a wireless lossless digital audio link based on the Texas Instruments CC8520 PurePath™ Wireless SoC.

It uses multiple techniques for excellent robustness and co-existence.

- Adaptive frequency hopping
- Forward error correction
- Buffering and retransmission
- Error concealment

It interfaces to audio ADCs, DACs and CODECs through an I2S digital audio interface.

The 1218RF module incorporates a CC2590 range extender with power amplifier that has a gain of 14dB, maximum output power equals +14 dBm (25 mW). Antenna diversity is available on slave modules to reduce effects of RF multipath fading. The 1218RF module is based on the Texas Instruments CC85XX-CC2590EM_Antenna_Diversity reference design.

All CC8520 SoC signals are available on 1218RF pins, allowing access to all features of the CC8520 SoC. A complete overview of the features can be found in the “CC85xx Family User’s Guide”.

3 Performance

The power supply on the 1218RF module is filtered but not regulated. To comply with FCC regulations the carrier must provide a regulated supply.

Recommended operating conditions

Parameter	Min	Max	Unit
Operating ambient temperature range, TA	-40	+85	°C
Operating supply voltage	2.4	3.6	V

RF characteristics, CC8520 + CC2590

Parameter	Test condition	MIN	TYP	MAX	Unit
RF frequency range		2400		2483.5	MHz
Data rate	Shaped 8FSK		5		Mbps
Output power	Maximum output power setting		11		dBm
Receiver sensitivity	5 Mbps		-87		dBm
Occupied bandwidth	99% energy bandwidth, 5 Mbps		3.8		MHz

Channel list

Channel	Center Frequency (MHz)	Channel	Center Frequency (MHz)
1	2406	10	2442
2	2410	11	2446
3	2414	12	2450
4	2418	13	2454
5	2422	14	2458
6	2426	15	2462
7	2430	16	2466
8	2434	17	2470
9	2438	18	2474

4 Approval and usage

The 1218RF module has been designed to meet FCC (US) and ETSI (Europe) regulations.

4.1 FCC compliance

This device complies with part 15 of the FCC rules

Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This in particular is applicable for the antenna which has been delivered with the system.

To comply with FCC RF exposure requirements for mobile transmitting devices, this transmitter should only be used or installed at locations where there is at least 20cm separation distance between the antenna and all persons.

4.2 FCC ID

The FCC ID for the 1218RF module is: 2AF88-1218RF.

4.3 FCC labeling requirements

The 1218RF modules are labelled with their own FCC ID; if this FCC ID is not visible from the outside of the finished product, the finished product must be labelled with the FCC ID.

Contains FCC ID: 2AF88-1218RF

5 Adaptive Frequency Hopping

The purpose of using frequency hopping in a radio system is to provide diversity that allows data throughput to be maintained even if interfering radio systems or the physical environment (multipath fading) renders some RF channels unusable. In the 2.4 GHz ISM band, the sheer amount of radio systems and the severity and dynamic nature of indoor fading phenomena in typical operating environments require the use of this kind of diversity if a minimum data throughput is to be assured (as audio streaming requires)

Frequency hopping systems can either implement a fixed sequence of channel hops or adapt its hopping sequence dynamically to the changing environment it operates in. In order to maximize its own chances of delivering audio data

in time and to co-exist amicably with other fixed-frequency or adaptive frequency hopping systems, PurePath Wireless uses an advanced adaptive frequency hopping (AFH) scheme that adapts to changing conditions within tens of milliseconds.

The PurePath Wireless RF Communication System divides the 2.4 GHz ISM band into 18 RF channels with 4 MHz bandwidth. The protocol master controls the adaptive frequency hopping scheme for the audio network, and maintains a table with an entry for each RF channel and an associated quality-of-service (QoS) estimate for each. Each time an RF channel is used the QoS estimate is updated based on what happens during the timeslot.

The frequency hopping algorithm separates the 18 RF channels into two sets:

- A set of 4 active channels
- A set of 14 trial channels

The active channel set contains the preferred RF channels that have proven that they provide sufficiently good quality-of-service. The trial channel set contains the remaining RF channels that are only evaluated occasionally in order to be able to maintain an accurate picture of their quality-of-service. If the QoS estimate of an RF channel in the active set goes beyond a minimum threshold this channel is swapped out with the RF channel in the trial channel set that has the best QoS estimate. Other factors play in when selecting a new RF channel to the active channel set, such as trying to maintain a certain minimum distance in frequency between the different active channels.

The frequency hopping algorithm, employs the following macro-sequence, when no swaps between the active and trial channel sets occur, it goes through a sequence of 70 frequency hops over the course of which every RF channel has been used.

This 70-hop macro-sequence consists of 14 repetitions of 5-hop micro-sequence during which:

- Each of the four active RF channels is used once
- One of the trial RF channels is used once (cycling through all trial channels over the course of a macro-sequence)

Four active channels are selected randomly at start-up seeded by a unique 32-bit device address, which is stored in the hardware by Texas Instruments during chip production.

6 Active Channel Selection / Listen-Before-Talk

In addition to AFH, listen-before-talk (LBT) is used by the master at the start of every timeslot to determine the energy in the current channel and these measurements are compared against a threshold and are used to detect a “bad” channel. In addition, at the end of every timeslot one will detect if one or more slave packets are missing.

- Two failing LBTs in a row for a given channel will mark the channel as bad / occupied.
- Three failing LBTs during the last five timeslots at a given channel will mark the channel as bad / occupied.
- If three timeslots in a row for a given channel has missing slave packets, the channel is marked as bad.

If any of the active channels are marked as bad they are replaced by the best channel that is furthest away from the remaining three good channels.

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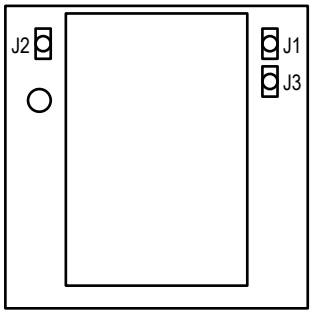
7 Mechanical

The 1218RF module measures 40 by 40 mm.



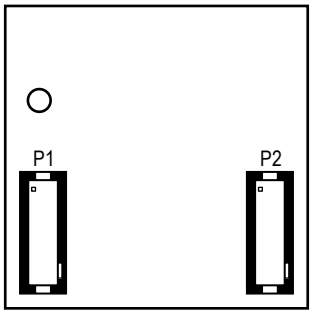
Two antenna options are available on the 1218RF module.

J1 and J2:	Dual antenna option with antenna diversity (slave only).
J3:	Single antenna option (master and slave).

Antennas are connected through U.FL connectors.

8 Mounting

The 1218RF module is mounted on the carrier using two 20-pin connectors and fixed using an M3 screw.



P1 and P2 are SAMTEC TFM-110-02-L-D-A-K.

9 Pinout

The pinout of the two 20-pin connectors is shown below.

P1			
GND	1	2	-
-	3	4	-
-	5	6	-
-	7	8	-
-	9	10	GIO1
SDA	11	12	GIO2_RESET
SCL	13	14	SPI_CSN
GIO12	15	16	SPI_CLK
GIO13	17	18	SPI_MOSI
GND	19	20	GIO0_SPI_MISO

P2			
-	1	2	GND
-	3	4	-
-	5	6	GIO9_AD2
P3V3	7	8	GIO8_AD1
P3V3	9	10	GIO7_AD0
GIO6_WCLK	11	12	-
GIO4_MCLK	13	14	-
RSTN	15	16	-
GIO5_BCLK	17	18	GIO3
-	19	20	-

10 Module types

Two 1218RF modules are available: One that acts a master and one that acts as a slave. The slave module supports antenna diversity.

10.1 Master module

The master module dictates the sample rate and decides which RF channels are used. The following connections are required on the master:

Pin	Signal	Direction	Function
P3V3	P3V3	Input	3.3V power supply
RSTN	RSTN	Input	Module reset
AD1	AD1	Output	I2S data
BCLK	BCLK	Output	I2S data clock
WCLK	WCLK	Output	I2S word clock
MCLK	MCLK	Output	I2S Master clock
GIO2	GIO2	Output	Audio device reset
SCK	SCK	Input	SPI clock
GIO1	GIO1	Input	SPI select
MISO	MISO	Output	SPI data (slave out)
MOSI	MOSI	Input	SPI data (slave in)
CSN	CSN	Input	Network pairing start

10.2 Slave module

The slave module derives its sample rate from the wireless interface. The following connections are required on the slave:

Pin	Signal	Direction	Function
	P3V3	Input	3.3V power supply
	RSTN	Input	Module reset
	AD1	Output	I2S data
	BCLK	Output	I2S data clock
	WCLK	Output	I2S word clock
	MCLK	Output	I2S Master clock
	GIO2	Output	Audio device reset
	SCK	Input	SPI clock
	GIO1	Input	SPI select
	MISO	Output	SPI data (slave out)
	MOSI	Input	SPI data (slave in)
	CSN	Input	Network pairing start

11 Programming

The 1218RF module can be configured and programmed using the “PurePath Wireless Configurator” from Texas Instruments. A manual is available from inside the configurator.

While configuring the modules using the “PurePath Wireless Configurator” take notice of the following:

11.1 Output power

Maximum output power of the 1218RF module is 25mW (without cables loss and antenna gain), well within the limits of FCC and ETSI. Make the following settings in the radio settings tab:

Range extender: CC2590 (HGM)

Target TX power (excl. CC259x): 5 dBm

11.2 Antenna diversity

In the radio settings tab of slave configurations antenna diversity can be enabled. Make sure to only program this configuration into a module that supports antenna diversity.

11.3 RF data rate

The 1218RF module was approved in 5Mbps mode which translates into 8FSK modulation. In order to use the FCC approval of the 1218RF module the RF data rate must be set to 5 Mbps.

12 Integration

The 1218RF module is not available for resale. The module was developed by Siemens Industry SoftWare (SISW) to ease integration of the purepath wireless protocol in several hardware platforms. SISW has integrated the 1218RF module as master in the “Pass By Noise conditioner” and as slave in a wireless microphone. Future implementations of the 1218RF module will be designed by SISW or must be approved by SISW.

13 Antenna

The following antennas have been approved for the 1218RF module.

Manufacturer	Model	Order code	Gain
Laird Technologies	WRR2400-RPSMA-B	MAF94028	1.3 dBi
Laird Technologies	WRR2400-RPSMA-G	MAF94026	1.3 dBi

Any compatible antenna with a gain of less than 2 dBi is allowed.

FCC requires the use of a non-standard antenna connector. The following connectors have been considered acceptable for meeting the requirement in Section 15.203: MMCX, MCX, and reverse polarity, SMA, BNC and TNC.