EMB-TRX169PA

PRELIMINARY

Datasheet

Document information

Versions & Revisions

Revision	Date	Author	Comments
1.0	2013-11-08	F. Ducati	Preliminary version
1.1	2014-02-18	C. Biagi	Updated PA control logic section
1.2	2014-04-01	C. Biagi	Fixed typo in PA control logic section

References

Ref	Version	Date	Author	Title

Index

1 Description

EMB-TRX169PA is a radio transceiver for low power applications in the 169 MHz ISM band. It is based on Texas Instruments™ CC1120 transceiver. The RF section guarantees best-in-class performance in terms of covered area and power consumption, with an output power that can be increased up to +27 dBm.

The transceiver and the power amplifier sections have two different power supplies (VCC_RF and VCC_PA, respectively); this gives an additional flexibility for power management that allows to optimize the current consumption of the module.

The module is equipped with a **SAW filter on the transmission path** between the transceiver and the power amplifier in order to improve the performances in terms of spurious emissions.

In case the SAW filter is not required (e.g., because of the external antenna adopted) then the EMB-TRX169PA/B variant comes without it, to optimize BOM costs.

1.1 Specifications

- RF output power: up to +27 dBm;
- RF sensitivity: beyond -120 dBm;
- U.FL connector, RF PCB pads (GSG);
- Edge SMD connector

1.2 Applications

- Smart meter
- Smart grid concentrator
- Smart grid router/repeater or translator
- Proprietary solutions

1.3 Block diagram

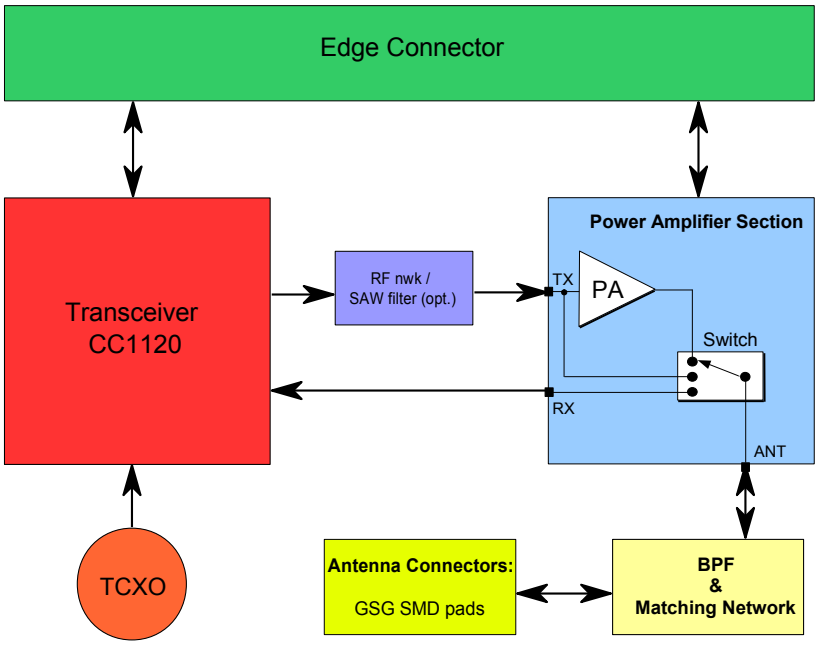


Image 1: Block diagram for the EMB-TRX169PA

1.4 Antenna

The **EMB-TRX169PA** offers two options for the antenna:

- External antenna connector (optional): 50 Ohm single ended U.FL connector;
- PCB pad (GSG) for printed or external antennas mounted on hosting board;

1.5 Development tools

A dedicated Evaluation Board (EVB) is available to test the **EMB-TRX169PA** module. For further information please contact Embit.

2 Size and Footprint

2.1 Size

The mechanical dimensions of the **EMB-TRX169PA** are 16,00 mm x 26,00 mm with a thickness lower than 4 mm.

The **EMB-TRX169PA** module has three 34 pin “edge” connector with a 1,27 mm pitch, plus 3 g*round-signal-ground* (GSG) pins for RF signal, for a total of 37 pins. Each pin is a metalized half hole 0,50 mm in diameter. The position of the connectors is shown in the following image:

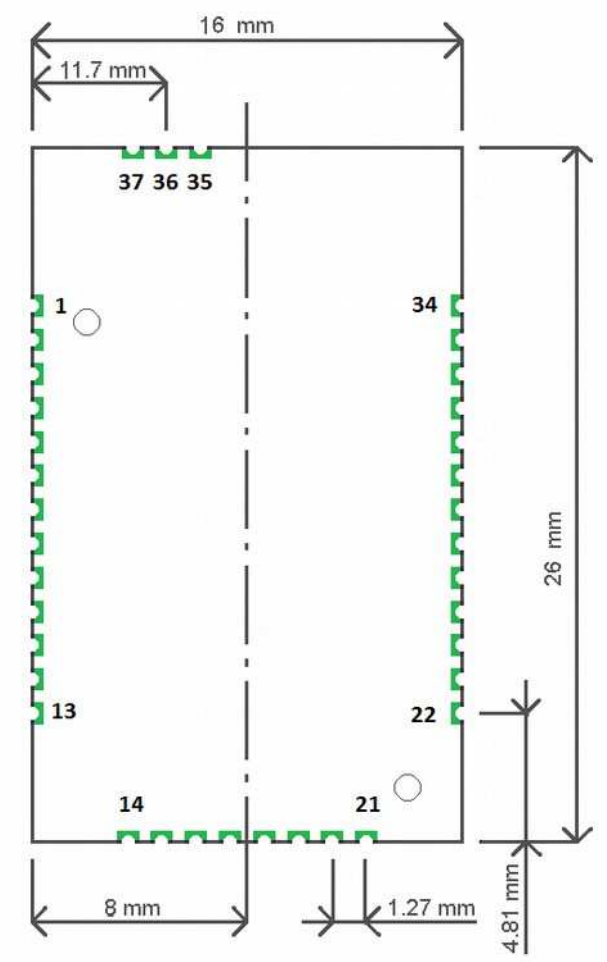


***Image 2**: Outline*

2.2 Suggested footprint

The EMB-WMB footprint consists in 37 SMD pads 1,00 x 0,80 mm in dimensions positioned as following:

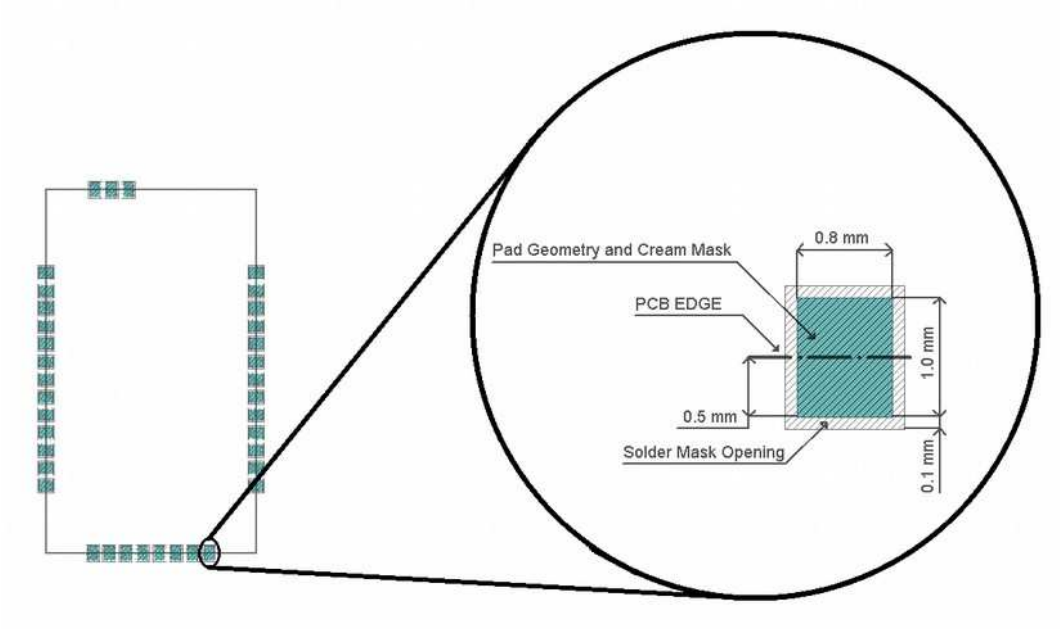


***Image 3**: Suggested Footprint*

2.3 Antenna connection

The Antenna output of the module is matched to 50 Ohm. By using a 50 Ohm antenna, no additional matching is required. Connection with antenna should be as short as possible, and must represent a characteristic impedance of 50 Ohm. A grounded coplanar waveguide is suggested to minimize the interaction with the external environment.

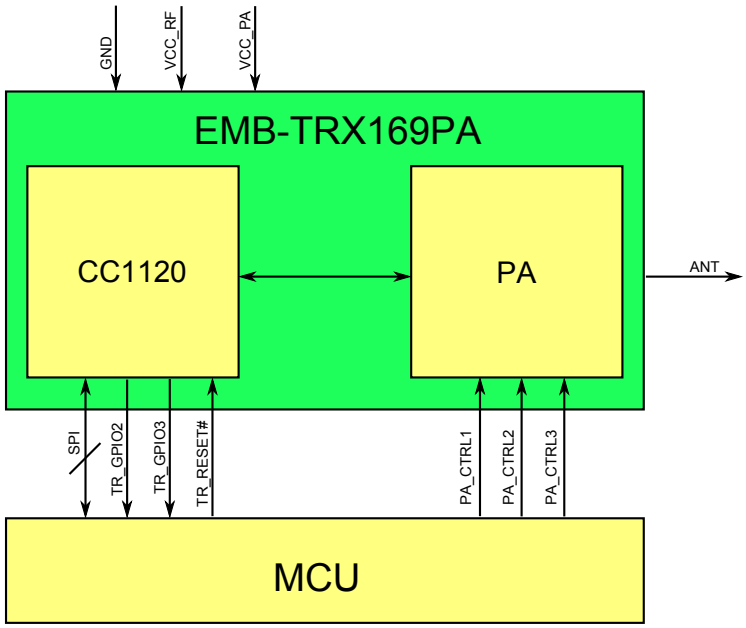
2.4 Notes

- The area underneath the module must be kept free of components (both top and bottom layers) and must be covered with solder resist.
- The PCB top layer underneath the module must be free of nets, power planes and vias. The bottom layer shall provide a ground plane.
- The power supply of the module must be as clean as possible; it must be decoupled placing a ceramic capacitor as near as possible at the Vcc pins, additional filtering made by a ferrite bead is recommended.
- Noisy electronic components (such as switching power supply) must be placed as far as possible and adequately decoupled.
- The ground pins of the module shall be connected to a solid ground plane.

Note: Taking no account this recommendations may affect the radio performances.

3 Connections

3.1 Typical Application Circuit



Note:

- The MCU input connected to TR_GPIO2 and/or TR_GPIO3 should be IRQ capable.
- The TR_RESET# is the reset input pin of CC1120. Refer to the datasheet of CC1120 for further information.

3.2 Module Pinout

Pin #	Pin Name	Type	Description
1	GND	GND	GND
2	GND	GND	GND
3	GND	GND	GND
4	GND	GND	GND
5	VCC_PA	Power Input	Power Amplifier Supply Voltage
6	GND	GND	GND
7	VCC_PA	Power Input	Power Amplifier Supply Voltage
8	VCC_PA	Power Input	Power Amplifier Supply Voltage
9	VCC_PA	Power Input	Power Amplifier Supply Voltage

Pin #	Pin Name	Type	Description
10	GND	GND	GND
11	VCC_PA	Power Input	Power Amplifier Supply Voltage
12	VCC_PA	Power Input	Power Amplifier Supply Voltage
13	GND	GND	GND
14	PA_CTRL1	Digital Input	Power Amplifier chip select
15	PA_CTRL2	Digital Input	Power Amplifier TX/RX select
16	PA_CTRL3	Digital Input	Power Amplifier bypass mode
17	TR_RESET#	Digital Input	Transceiver Reset
18	TR_GPIO3	Digital Input/Output	Transceiver GPIO3
19	TR_GPIO2	Digital Input/Output	Transceiver GPIO2
20	TR_SI	SPI	Transceiver Serial Input
21	TR_SCLK	SPI	Transceiver Serial Clock
22	TR_SO	SPI	Transceiver Serial Output
23	TR_CS#	SPI	Transceiver Chip Select
24	VCC_RF	Power Input	Transceiver Supply Voltage
25	GND	GND	GND
26	VCC_RF	Power Input	Transceiver Supply Voltage
27	VCC_RF	Power Input	Transceiver Supply Voltage
28	VCC_RF	Power Input	Transceiver Supply Voltage
29	GND	GND	GND
30	VCC_RF	Power Input	Transceiver Supply Voltage
31	GND	GND	GND
32	GND	GND	GND
33	GND	GND	GND
34	GND	GND	GND
35	GND	GND	GND
36	RF	RF Output	RF Power Amplifier Output
37	GND	GND	GND

3.3 PA Switch Control Logic

In the following table is reported how to set the PA's operating mode:

Mode	PA_CTRL1	PA_CTRL2	PA_CTRL3
Sleep	L	x	x
Transmit in bypass mode	H	H	L
Receive	H	L	x
Transmit	H	H	H

Note:

- The PA power-on time and switching time is less than 5 µs.

3.4 CC1120 Power Settings

The RF output power can be set using PA_CTRLx pins and the register “PA_CFG2” of the CC1120 transceiver.

The relation between the register value and the output power is shown in the table below:

CC1120 – PA_CFG2 Register Setting (HEX)	RF Power [dBm] (± 2 dBm)
0x43 (min)	+0
0x7F (max)	+27

Note: the output power is affected by the supply voltage. The values are valid at VCC_PA=3.3V and T=25°C.

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

	Value	Unit
Transceiver Power Supply Voltage (VCC_RF)	+3,9	Vdc
PA and LDO Power Supply Voltage (VCC_PA)	+3,8	Vdc
Voltage on any pin	VCC_RF+0,3 (Max 3,6)	Vdc
RF input power	+10	dBm
Storage Temp. Range	-45 ~ +125	ºC

4.2 Operating Conditions

Parameter	Min	Typ	Max	Unit
Transceiver Power Supply Voltage (VCC_RF)	2,375	3,3	3,6	Vdc
PA Power Supply Voltage (VCC_PA)	2,6	3,3	3,6	Vdc
Operating Temperature Range	-40	+25	+85	ºC
RF output power [±1]	TBD		+27	dBm
Logic Input Low Voltage	0		0,2xVCC_RF	Vdc
Logic Input High Voltage	0,8xVCC_RF		VCC_RF	Vdc
Logic Output Low Voltage	0		0,18xVCC_RF	Vdc
Logic Output High Voltage	0,82xVCC_RF		VCC_RF	Vdc

* On the PA version the supply voltage affects the maximum power achievable.

4.3 Power Consumption

Temperature +25°C					
Mode	Effective Supply Voltage	Transceiver CC1120 Power Setting [± 2dBm]	Max RF Signal Output Power [±6%]*	Value	Unit
Transmit	3,3V 3,0V 2,7V 3,3V	+10 dBm +10 dBm +10 dBm +15 dBm	+26,6 dBm +25,9 dBm +25,0 dBm -6 dBm [PA in bypass mode]	385 [±7%] 330 [±7%] 310 [±7%] ~62	mA
Receive	From 2,7V to 3,3V			~27	mA

* Values measured at the antenna connector (conducted measure).

4.4 RF Characteristics

EMB-TRX169PA RF Characteristics (VCC_PA=VCC_RF=3.3V, 25°C):

Parameter	Min	Typ.	Max	Unit	Note
RF Frequency range	169,400		169,475	MHz	
Frequency tolerance			±3,5	ppm	Excluding ageing typ. ±1 ppm / year
RF Data Rate	0		200	kbps	
Programmable Output Power Range*	0		+27	dBm	CC1120 power setting from -11 to +10 dBm ~0,5dB ± 2dB** PA = ON
	-32		-6		CC1120 power setting from -11 to +15 dBm ~0,5dB ± 1dB** step gain PA = Bypass Mode
Receiver Bandwidth	8		200	kHz	
Receiver Sensitivity 2.4 kbps GFSK		 -120		 dBm	
RF Input saturation		+10		dBm	
Blocking ± 2 MHz ± 10 MHz		 83 89		 dB dB	TA = +25°C, VCC_RF = 3,3V ± 5%, 12,5 kHz channel separation, DEV = 4 kHz, CHF = 10kHz, 2-GFSK, 2400 bps

* Values measured at the antenna connector (conducted measure).

** Output Power Steps value depend from the adopted look-up table accuracy.

4.5 Considerations

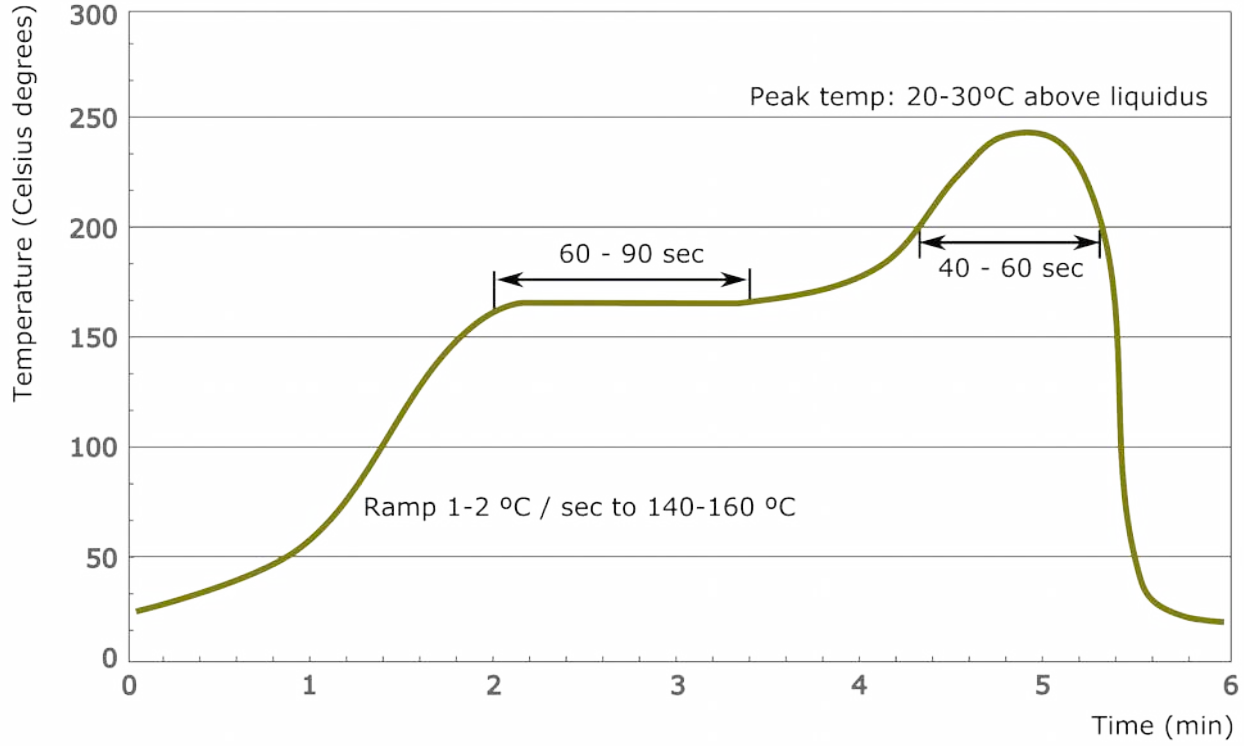
The previous tables shows the voltage-supply dependence with the absorbed current and RF signal output power. The reported voltage parameter is the “effective supply voltage” that indicates the value measured directly on the power pin of the module.

The maximum output power that can be set, in order to meet ETSI constraints, will depend on the antenna and its work environment.

The granularity of the configurable output power steps is directly affected by the transfer function of the Power Amplifier and by the Insertion-loss variability of the SAW-FILTER. For these reasons, is important to realize a look-up table in order to minimize the influence of the variable parameters described above, “absorbing” the non-linear characteristics that are typical/common to each device.

5 Soldering

Temperature profile for reflow soldering:



Pb-Free Soldering Paste: it is suggested to used soldering pastes that don't need later clean for residuals.

Cleaning: it's not suggested to clean the module. Solder paste residuals underneath the module cannot be removed.

- Water cleaning: the cleaning process using water can involve water entering underneath the module between the two PCBs creating short circuits.
- Alcohol cleaning: the cleaning process with alcohol can damage the module.
- Untrasound cleaning: the cleaning process with ultrasound can damage the module.

It is suggested to use no clean solder paste to avoid any need for cleaning.

Cycles: it is suggested to do only one soldering cycle.

In case of reflow soldering, a drying bake should be done in order to prevent a popcorn effect. Re-baking should be done following IPC standards. Any unused modules that has been open for more than 168 hours or not stored at <10% RH should be baked before any subsequent reflow.

6 Ordering Information

6.1 Types

Module variations:

Part No.	Description
EMB-TRX169PA/S	EMB-TRX169PA with SAW filter
EMB-TRX169PA/B	EMB-TRX169PA without SAW filter

Related products:

Part No.	Description
EMB-TRX169PA-EVK	EMB- TRX169PA Evaluation Kit

7 Disclaimer

The user must read carefully all the documentation available before using the product. In particular, care must be taken in order to comply with the regulations (i.e. power limits, duty cycle limits, etc.).

7.1 Handling precautions

This product is an ESD sensitive device. Handling precautions should be carefully observed.

7.2 Limitations

Every operation involving a modification on the internal components of the module will void the warranty.

7.3 Disclaimer of liability

The information provided in this and other documents associated to the product might contain technical inaccuracies as well as typing errors. Regulations might also vary in time. Updates to these documents are performed periodically and the information provided in these manuals might change without notice. The user is required to ensure that the documentation is updated and the information contained is valid. Embit reserves the right to change any of the technical/functional specifications as well as to discontinue manufacture or support of any of its products without any written announcement.

7.4 Trademarks

Embit is a registered trademark owned by Embit s.r.l.

All other trademarks, registered trademarks and product names are the sole property of their respective owners.