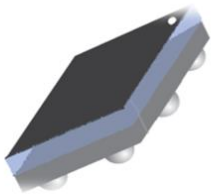
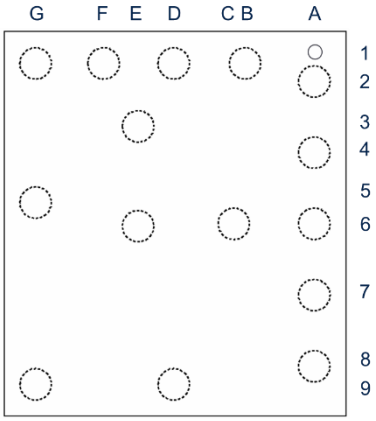
BALF-WL-00D3

50 Ω nominal input / conjugate match balun to module STM32WL in high & low power modes, 862-928 MHz with integrated harmonic filter



Chip Scale Package on Glass
15 bumps – 2.4 x 2.7 mm²

Pinout diagram
(top view – bumps down)



Features

• Module STM32WL Sub-GHz Wireless Microcontrollers
Impedance Matched Balun & Tx harmonics filter
• Optimized for Module STM32WL Sub-GHz Wireless
Microcontrollers in high & low power modes and dedicated to module package
• 50 Ω nominal input / conjugate match balun to
module STM32WL
• 50 Ω nominal impedance on antenna side Tx & Rx
• Deep Tx rejection harmonic filter
• Low insertion loss
• Small footprint
• Low profile ≤ 630 µm after reflow
• High RF performance
• RF BOM and area reduction
• ECOPACK®2 compliant component

Applications

• STM32WL Sub-GHz Wireless Microcontrollers

• LPWAN-compliant radio solution, enabling the following modulations: LoRa®, (G)FSK, (G)MSK, and BPSK

Description

STMicroelectronics BALFHB-WL-00D3 is an ultra-miniature balun. The BALFHB-WL-00D3 integrates matching network, balun and harmonics filter. Matching impedance has been customized for the STM32WL Sub GHz Wireless Microcontrollers.
It is using STMicroelectronics IPD technology on non-conductive Glass substrate which optimizes RF performances.

Product status
BALF-WL-00D3

1 Characteristics

Table 1. Absolute ratings (T_{amb} = 25 °C)

Symbol	Parameter	Value	Unit
P_{IN_HP}	Input power RF_{IN} High Power Tx Filter	27	dBm
P_{IN_LP}	Input power RF_{IN} Low Power Tx Filter	22	dBm
V_{ESD}	ESD ratings human body model (JESD22-A114-C), all I/O one at a time while others connected to GND	200	V
	ESD ratings machine model, all I/O	200	
T_{OP}	Operating temperature	-40 to +105	°C

Table 2. Impedances (T_{amb} = 25 °C)

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
Z_{RX}	Nominal differential Rx balun impedance	-	Matched to STM32WL	-	Ω
Z_{TX_HP}	Nominal HP Tx filter impedance	-	Matched to STM32WL	-	Ω
Z_{TX_LP}	Nominal LP Tx filter impedance	-	Matched to STM32WL	-	Ω
$Z_{RX\text{-}ANT}$	Nominal Rx balun antenna impedance	-	50	-	Ω
$Z_{TX\_HP\text{-}ANT}$	Nominal HP Tx filter antenna impedance	-	50	-	Ω
$Z_{TX\_LP\text{-}ANT}$	Nominal LP Tx filter antenna impedance	-	50	-	Ω

Table 3. Electrical characteristics and RF performance (T_{amb} = 25 °C)

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
f_{RX}	Frequency range		862	895	928	MHz
f_{TX_HP}	Frequency range for the High Power Tx filter		862	915	928	MHz
f_{TX_LP}	Frequency range for the Low Power Tx filter		862	868	928	MHz
IL_{RX}	Rx balun Insertion Loss Differential Mode $\|S_{DS}\|$ without mismatch loss	f_{RX}		0.95	1.15	dB
IL_{TX_HP}	HP Tx filter Insertion Loss $\|S_{21}\|$ without mismatch loss	f_{TX_HP}		0.9	1.25	dB
IL_{TX_LP}	LP Tx filter Insertion Loss $\|S_{21}\|$ without mismatch loss	f_{TX_LP}		0.95	1.25	dB
$RL_{RX\text{-}ANT}$	Rx balun Input Return Loss Differential Mode $\|S_{DD}\|$ on Antenna	f_{RX}	14	17		dB
$RL_{TX\_HP\text{-}ANT}$	HP Tx filter Output Return Loss $\|S_{11}\|$ on Antenna	f_{TX_HP}	19	22		dB
$RL_{TX\_LP\text{-}ANT}$	LP Tx filter Output Return Loss $\|S_{11}\|$ on Antenna	f_{TX_LP}	14	17		dB
φ_{imb}	Rx balun Phase imbalance	f_{RX}	-4		4	°
A_{imb}	Rx balun Amplitude imbalance	f_{RX}	-3		3	dB
Att_{TX_HP}	HP Tx filter Harmonic rejection levels $\|S_{21}\|$	Attenuation at $2f_{TX\_HP}$	25	30		dB
		Attenuation at $3f_{TX\_HP}$	48	53		

		Attenuation at 4 $_{TX\_HP}$	45	52		
		Attenuation at 5f_{TX_HP}	51	53		
		Attenuation at 6f_{TX_HP}	40	50		
		Attenuation at 7f_{TX_HP}	40	43		
		Attenuation at 8f_{TX_HP}	51	60		
		Attenuation at 9f_{TX_HP}	63	70		
		Attenuation at 10f_{TX_HP}	40	76		
Att_{TX_LP}	LP Tx filter Harmonic rejection levels $\|S_{21}\|$	Attenuation at 2f_{TX_LP}	23	27		dB
		Attenuation at 3f_{TX_LP}	45	51		
		Attenuation at 4f_{TX_LP}	47	51		
		Attenuation at 5f_{TX_LP}	42	47		
		Attenuation at 6f_{TX_LP}	30	41		
		Attenuation at 7f_{TX_LP}	34	46		
		Attenuation at 8f_{TX_LP}	56	59		
		Attenuation at 9f_{TX_LP}	67	75		
		Attenuation at 10f_{TX_LP}	43	74		

1.1 RF measurements (Rx balun)

Figure 1. Insertion loss (dB)

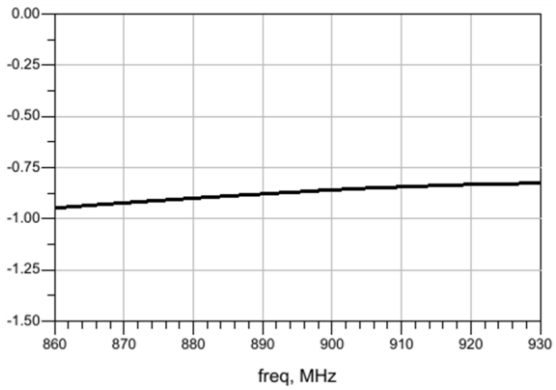


Figure 2. Return loss on antenna (dB)

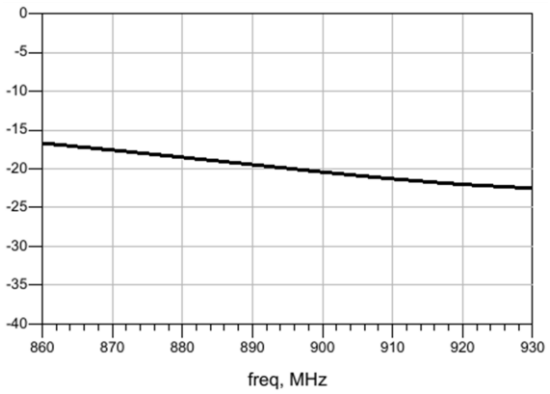


Figure 3. Amplitude imbalance (dB)

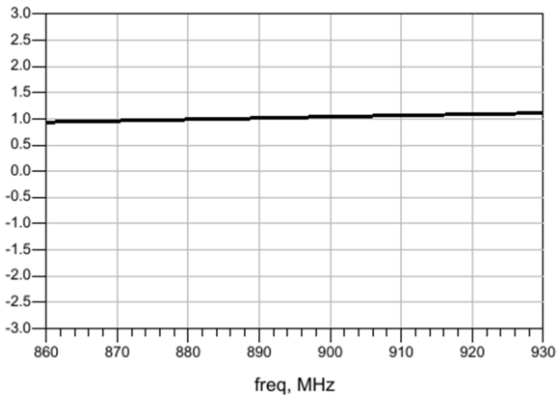
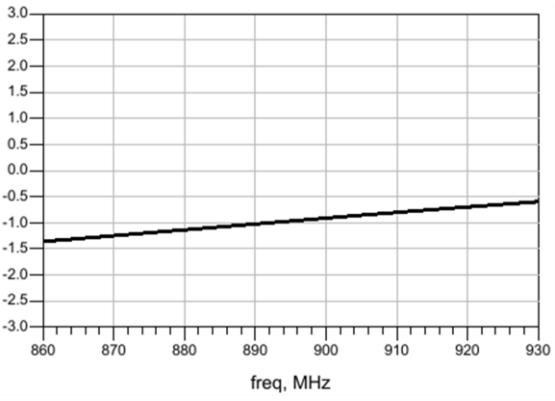


Figure 4. Phase imbalance (°)



1.2 RF measurements (HP Tx filter)

Figure 5. Transmission wide band with harmonics attenuation (dB)

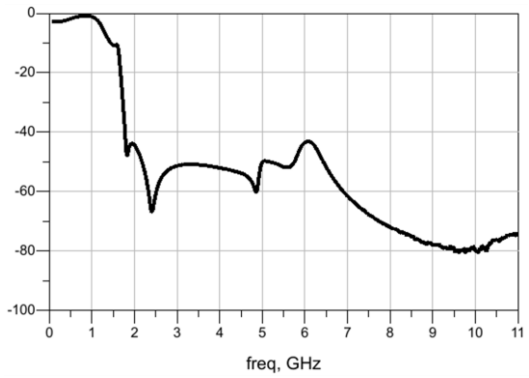


Figure 6. Insertion Loss (dB)

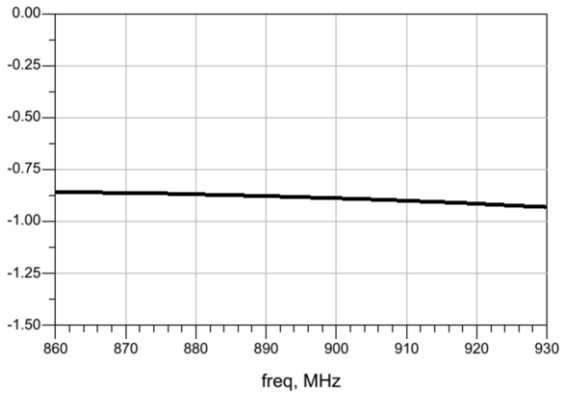
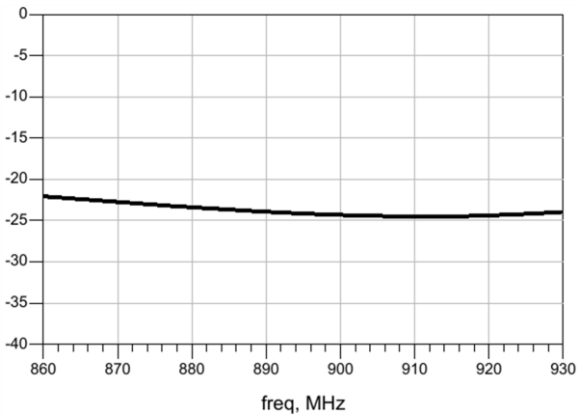


Figure 7. Return Loss on Antenna (dB)



1.3 RF measurements (LP Tx filter)

Figure 8. Transmission wide band with harmonics attenuation (dB)

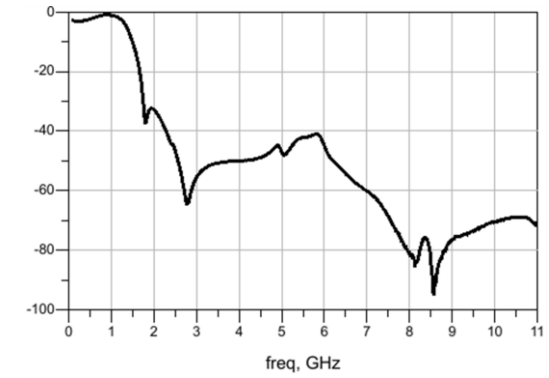


Figure 9. Insertion Loss (dB)

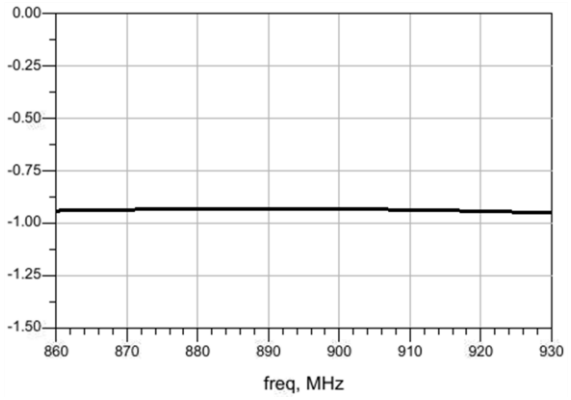
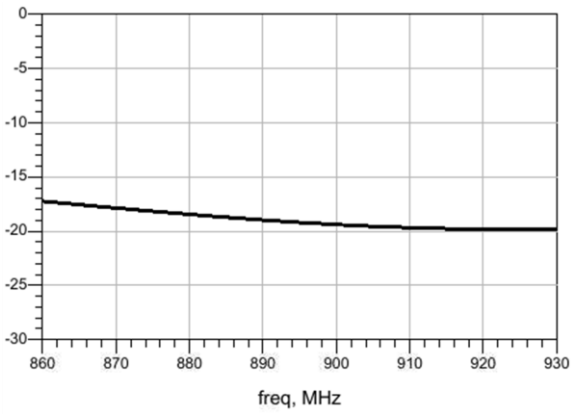


Figure 10. Return Loss on Antenna (dB)



2 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

2.1 CSPG 15 bumps package information

Figure 11. CSPG 15 bumps package outline (bottom view - bumps up) (in µm)

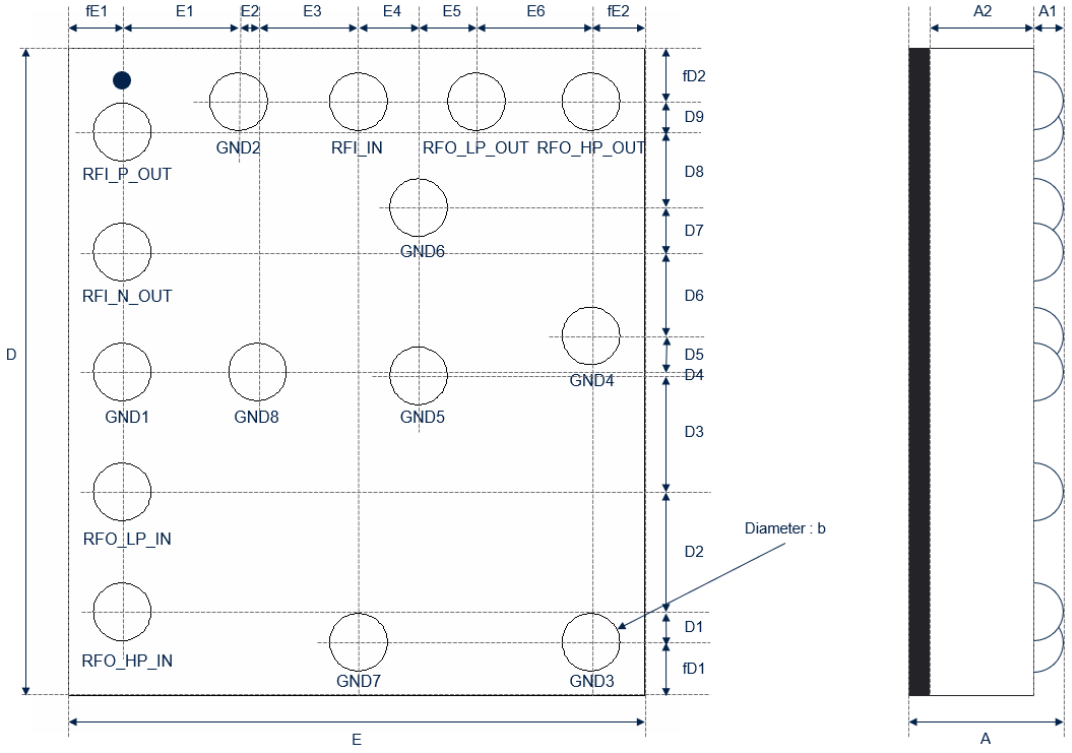


Table 4. CSPG 15 bumps dimensions (in µm)

Parameter	Min.	Typ.	Max.
A	580	630	680
A1	180	205	230
A2	380	400	420
b	230	255	280
D	2650	2700	2750
D1		127	
D2		500	
D3		484	
D4		16	
D5		150	

D6		350	
D7		185	
D8		315	
D9		127	
E	2350	2400	2450
E1		485	
E2		79	
E3		421	
E4		250	
E5		242	
E6		477	
Fd1		223	
Fd2		223	
Fe1		223	
Fe2		223	

2.2 CSPG 15 bumps packing information

Figure 12. **Marking**

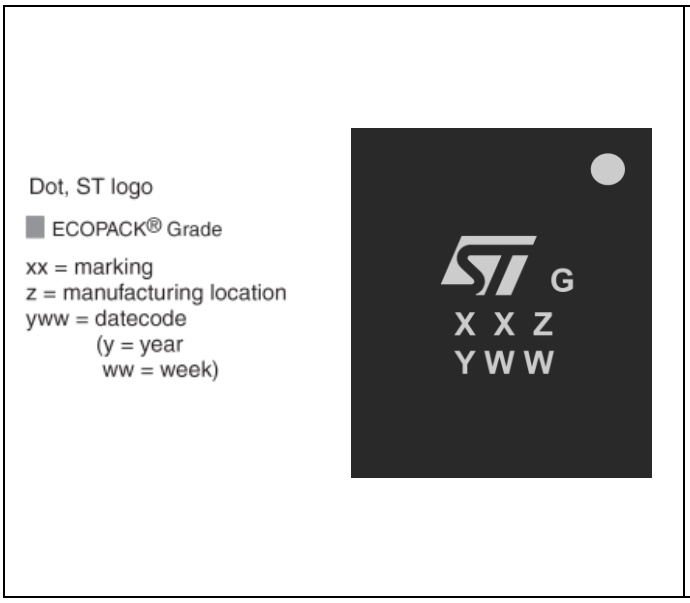


Figure 13. **Top view**

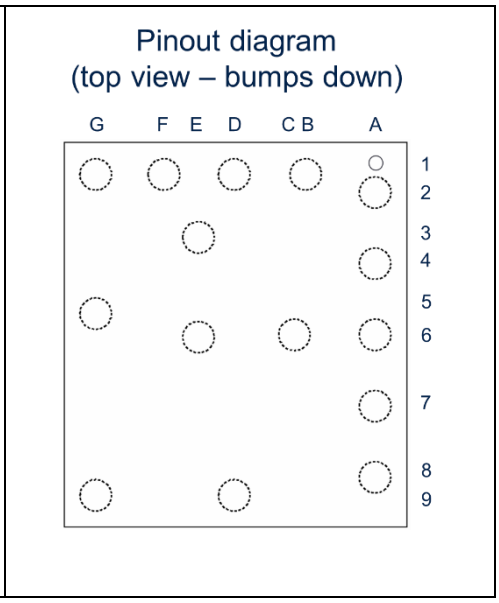
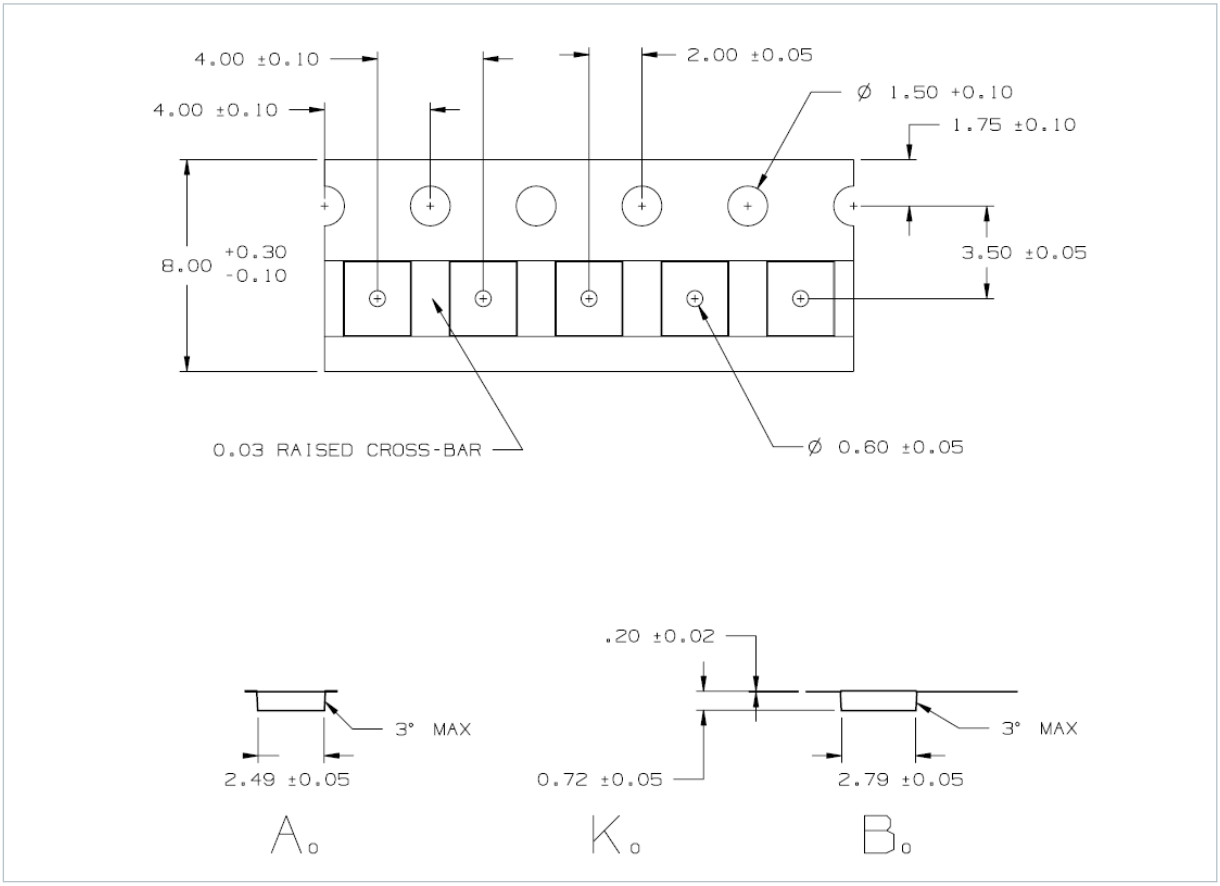


Table 5. **Pads description top view (pads down)**

Pad ref	Pad name	Description
A1	RFO_HP_OUT	Tx High Power filter output
A5	GND4	Ground #4
A9	GND3	Ground #3
B1	RFO_LP_OUT	Tx Low Power filter output
C3	GND6	Ground #6
C6	GND5	Ground #5
D1	RFI_IN	Single ended Rx balun input
D9	GND7	Ground #7
E6	GND8	Ground #8
F1	GND2	Ground #2
G2	RFI_P_OUT	Differential-P Rx balun output
G4	RFI_N_OUT	Differential-N Rx balun output
G6	GND1	Ground #1
G7	RFO_LP_IN	Tx Low Power filter input
G8	RFO_HP_IN	Tx High Power filter input

Figure 14. Tape and reel specifications



Note: More packing information is available in the application note:

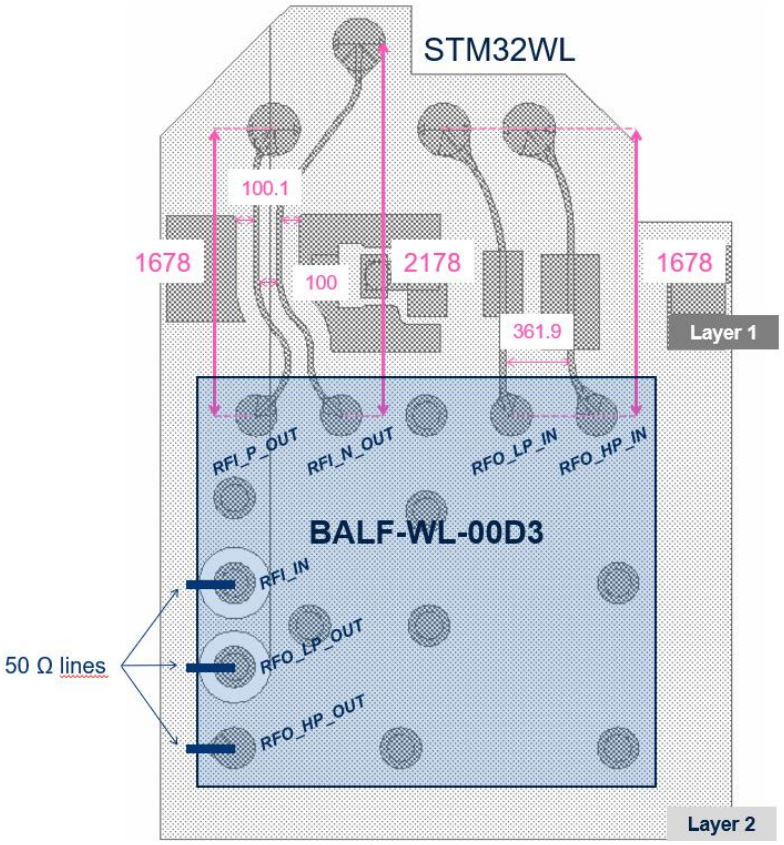
- *AN2348 Flip-Chip: "Package description and recommendations for use"*

3 PCB assembly recommendations

3.1 Land pattern

Figure 15. PCB land pattern recommendation

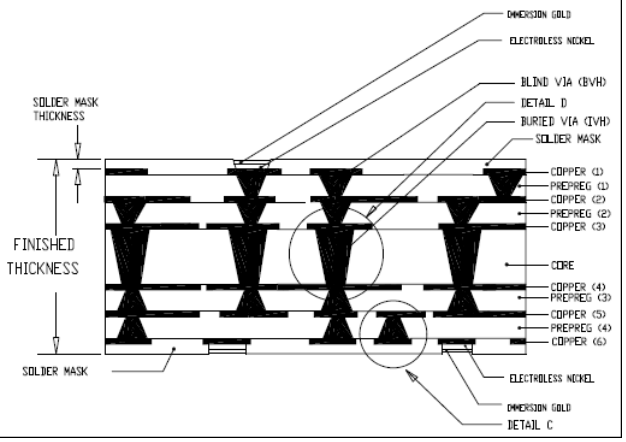
Layout example using module STM32WL / 4 layers PCB: layer 1 (blue) / ground plane in layer 2 (black)



Transmission Line between BALF-WL-00D3 and Antenna is dimensioned to 50 ohms characteristics impedance.
Transmission Line between STM32 and BALF-WL-00D3 RFI_P_OUT and RFI_N_OUT pins are a differential line dimensioned to 64 omhs characteristic impedance.
Transmission Line between STM32 and BALF-WL-00D3 RFO_LP_IN pin is dimensioned to 25 ohms characteristics impedance including the transmission line itself and the print of the CMS component.
Transmission Line between STM32 and BALF-WL-00D3 RFO_HP_IN pin is dimensioned to 21 ohms characteristics impedance including the transmission line itself and the print of the CMS component.
These transmission line characteristics impedance have to be followed as close as possible.
Moreover, lines physical dimensions will have to be tuned according to specific PCB stack up if different from the one presented in datasheet to keep expected characteristic impedance values.

Figure 16. PCB stack-up recommendation

DESCRIPTION		MATERIAL	THICKNESS	FIGURE
FINISHED THICKNESS			248+/-40	
METAL FINISH	BUMP PAD	ENIG		
	BALL PAD	ENIG		
	OTHERS	ENIG		
NICLEL PLATING		Electroless NI	3~8	
GOLD PLATING		Inversion Au	0.03~0.12	
SOLDER MASK		PSR4000 AUS308	18+/-10 (ON CU)	
PREPREG(C1X2X(3X4)		GEA-770G	25+/-10	
CORE		MCL-E-770G(R)	40+/-10	
COPPER THICKNESS (C1X2X(3X4X(5X6)		12+/-6		
COPPER THICKNESS IN IVH		FILLED		
COPPER THICKNESS IN BVH		FILLED		
IVH BARREL COPPER		10 MIN.		
DIMPLE DEPTH		10 MAX.		



3.2 Stencil opening design

Figure 17. Footprint - 3 mils stencil -non solder mask defined

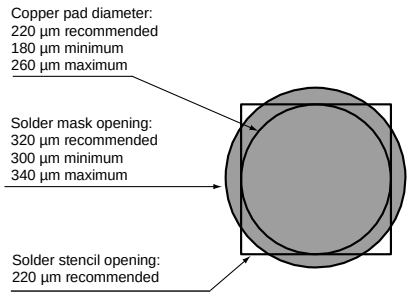
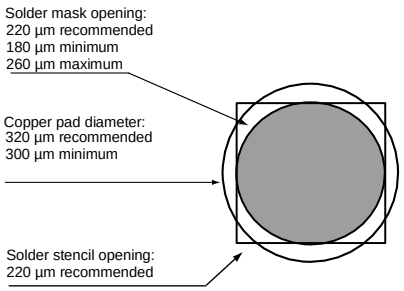


Figure 18. Footprint - 3 mils stencil - solder mask defined



3.3 Solder paste

1. Halide-free flux qualification ROL0 according to ANSI/J-STD-004.
2. “No clean” solder paste is recommended.
3. Offers a high tack force to resist component movement during high speed.
4. Use solder paste with fine particles: powder particle size 20-38 µm.

3.4 Placement

1. Manual positioning is not recommended.
2. It is recommended to use the lead recognition capabilities of the placement system, not the outline centering
3. Standard tolerance of ±0.05 mm is recommended.
4. 1.0 N placement force is recommended. Too much placement force can lead to squeezed out solder paste and cause solder joints to short. Too low placement force can lead to insufficient contact between package and solder paste that could cause open solder joints or badly centered packages.
5. To improve the package placement accuracy, a bottom side optical control should be performed with a high resolution tool.
6. For assembly, a perfect supporting of the PCB (all the more on flexible PCB) is recommended during solder

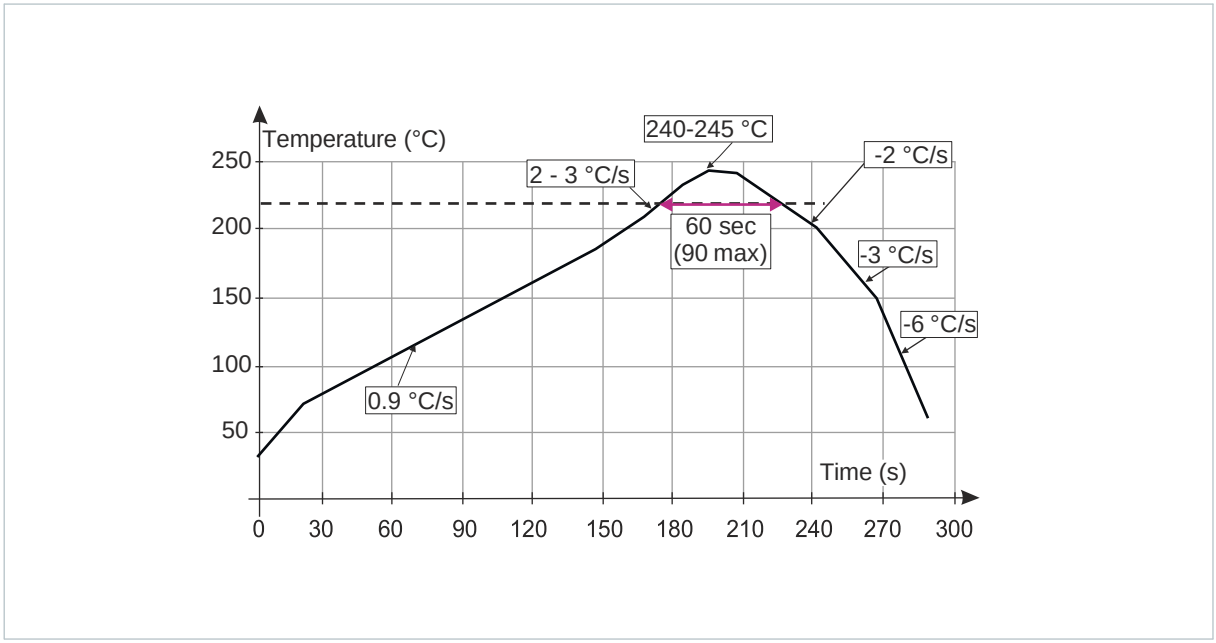
paste printing, pick and place and reflow soldering by using optimized tools.

3.5 PCB design preference

1. To control the solder paste amount, the closed via is recommended instead of open vias.
2. The position of tracks and open vias in the solder area should be well balanced. A symmetrical layout is recommended, to avoid any tilt phenomena caused by asymmetrical solder paste due to solder flow away.

3.6 Reflow profile

Figure 19. ST ECOPACK® recommended soldering reflow profile for PCB mounting



Note: Minimize air convection currents in the reflow oven to avoid component movement.

4 Ordering information

Table 7. **Ordering information**

Order code	Marking	Package	Weight	Base qty.	Delivery mode
BALF-WL-00D3		CSPG		5000	Tape and reel

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
19-Oct-2022	0.B	Initial release.