T2_L4A_8650C DAB / DAB+ / FM module specification

Features :

● ETSI EN 300 401 compliant receiver

● Ultra low-power DAB/FM baseband reception

● DAB/DAB+ sensitivity to -99dBm (typical)

● DAB Color Slide show support

● DMB video service support

● TPEG/TMC support for GPS applications

● Decodes audio services up to 256kbps without external RAM

● FM with RDS

　(RDS reception is subject to certain condition of power level and frequency deviation.)

● Combined antenna input for FM / Band3

● Support DAB L-band reception

● Serial control interface

● RoHS compliant

Approved by	Verified by	Made by	Date of modification:	Date of establishment
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Revision History

Rev.	Revise page	Revise Contents	Date	Ref. No.	Reviser
A		Initial document			
B	Page 14	Modify FM operation band	05/27/10'		Andy Liang
	Page 16	Modify FM performance	05/27/10'		Andy Liang
C	Page 16	Modify FM performance	06/11/10'		Andy Liang
D	Page 16	Modify FM performance	09/03/10'		Andy Liang
E	Page 16	Modify FM performance	08/01/11'		Andy Liang
F		Modify input DC range	09/08/11'		Andy Liang
G		Add TPEG/TMC support	09/13/11'		Andy Liang
H		Modify SPI interface	04/11/12'		Andy Liang
I	Page 11	Modify Serial port information	05/29/13'		C.A Hsieh
	Page 14	Modify HW reset information	05/29/13'		C.A Hsieh

Contents

1. General description

The T2_L4A_8650C module is a new generation of DAB/DAB+/DAB-Radio/FM radio modules to use the KSW8650 chipset. T2_L4A_8650C is designed to enable dual or tri-band DAB/DAB+/DMB-Radio/FM receivers of various types to be produced at lower cost. T2_L4A_8650C would operate in master mode stand alone or accepts commands by an external microcontroller and provide DMB-R, DMB-Video, color slide show, and TPEG or TMC bit stream to external host through SPI or UART. "T2_L4A_8650C" is pin-to-pin compatible with previous generation "T1_L4A_8290C".

T2_L4A_8650C includes all the interfaces necessary so that manufacturers need only add power supply, display, keypad, audio amplifier and speakers to provide a fully functional DAB/DAB+/DAB-Radio /FM radio.

2. Application

● Portable radio
● Clock radio
● Kitchen radio
● Boombox
● Hi-Fi radio
● Digital frame
● Car-radio
● Mini-CD system
● DVD player
● Multimedia System
● iPhone/iPod Docking System
● Personal Navigation Device

3. Introduction

3.1. Block Diagram

Figure 1 shows a block diagram of the T2_L4A_8650C. The main component is single chip, KSW8650 which provides baseband processor, RF processor, Flash memory and Audio DAC.

Figure 1：Module Block Diagram
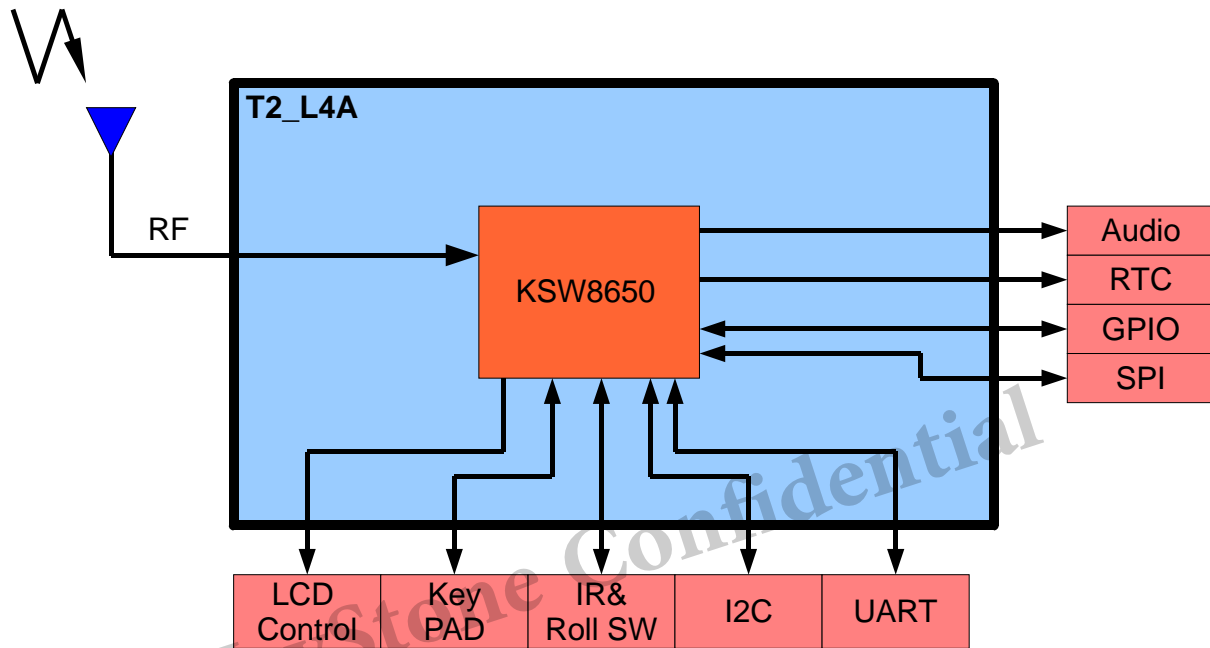
T2_L4A_8650C's dimension is 26 x 26 mm, and Hardware interface includes analogue stereo audio / LCD control / Keypad / GPIO / I^{2}C / SPI / UART.

3.2. Master & Slave mode Application

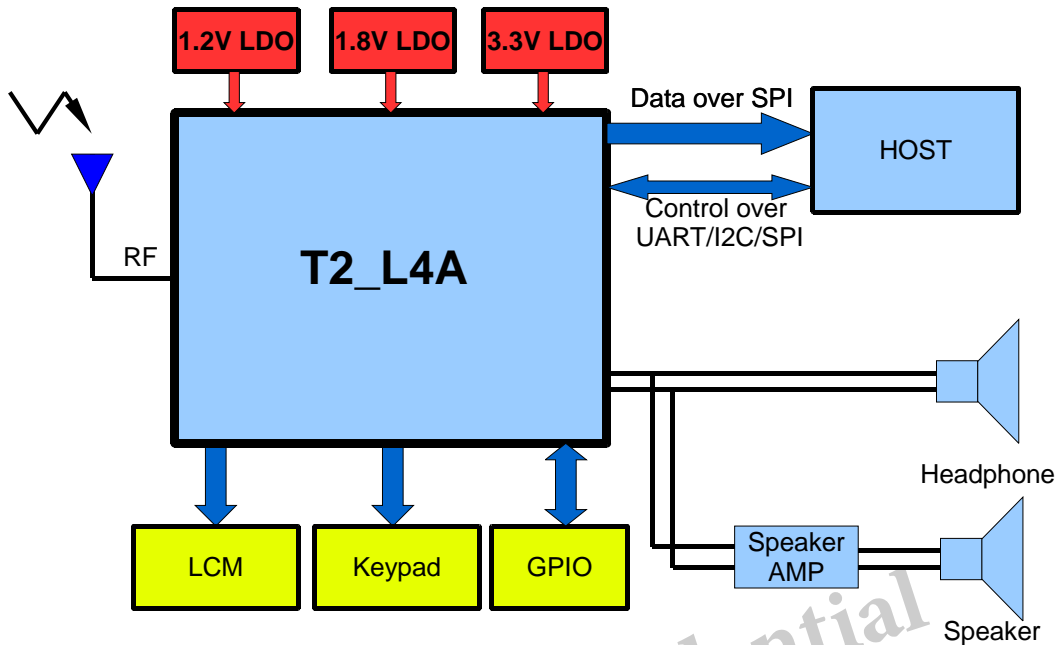Figure 2&3 show a master and slave mode application block diagram of the T2_L4A_8650C.

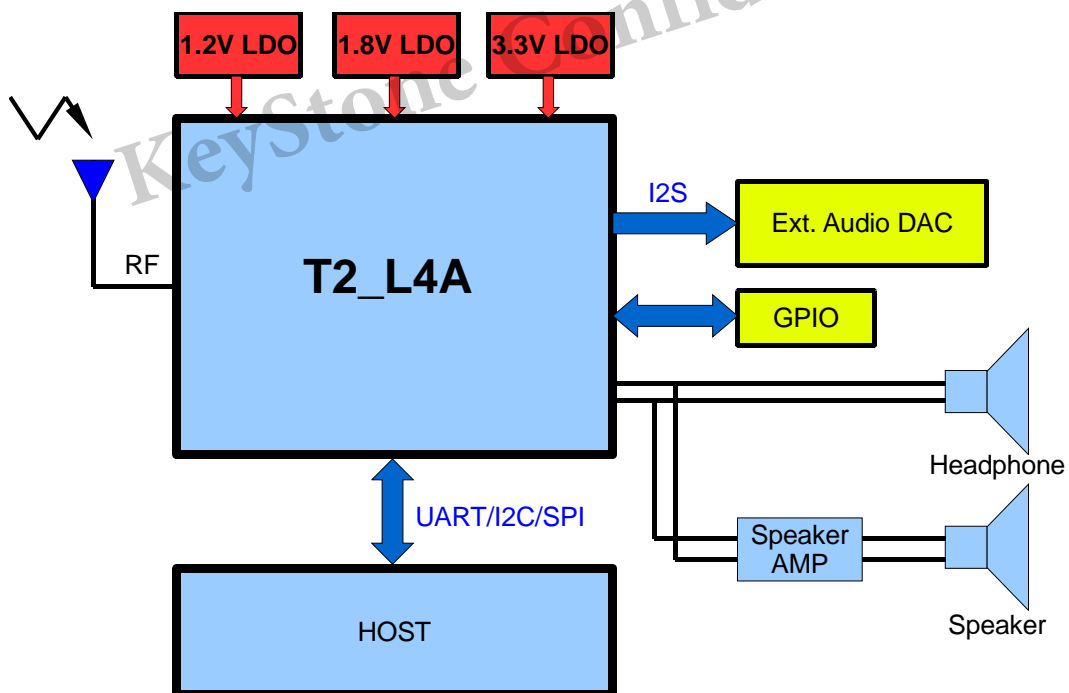**Figure 2：Block diagram of master mode application**

Figure 3：Block diagram of slave mode application

4. Software

◆ Software is configured to customer requirements and is pre-installed in the KSW8650. Software builds are available for the module to meet customer's application.

◆ DAB Slide Show Support

Slideshow adds synchronized visual content (slides) to radio broadcasts on DAB or DAB+. T2_L4A_8650C could support simple profile slide show for HOST to display on TFT screen.

- Image Format :

   PNG or JPEG format with 50kB in file size (51200 bytes).

   Resolution of 320 × 240 pixels at a color/ grey scale depth of 8 bits per pixel (¼-VGA).

◆ DMB video service profiles Support

T2_L4A_8650C could support DMB video service with provide DMB Video/Audio data stream for HOST to decode and display on the TFT screen.

- Video format :

   ITU-T Recommendation H.264 | MPEG-4 AVC.

   Simple profile, resolution up to 352x288 @30 frame/sec

- Audio format :

   Profile I---audio object: MPEG-4 ER-BSAC.

   Profile II ---MPEG-4 HE AAC V2

- Data transmitting interface: SPI with clock rate more than 1MHz

- Communication interface with HOST: UART / I2C / SPI

◆ TPEG/TMC Support

TPEG/TMC are encoded in raw data formats. The raw data formats of TPEG have been defined in ISO/TS 18234-1 to -6, in general, it will be defined by UML model. TMC data stream is defined by ETSI TS 102 368.

- TPEG Data transmitting interface: SPI with clock rate more than 1MHz

- TMC Data transmitting interface: UART

- Communication interface with HOST: UART

5. Mechanical Specification

5.1. T2_L4A_8650C mechanical drawing

TopView &SideView

unit : mm
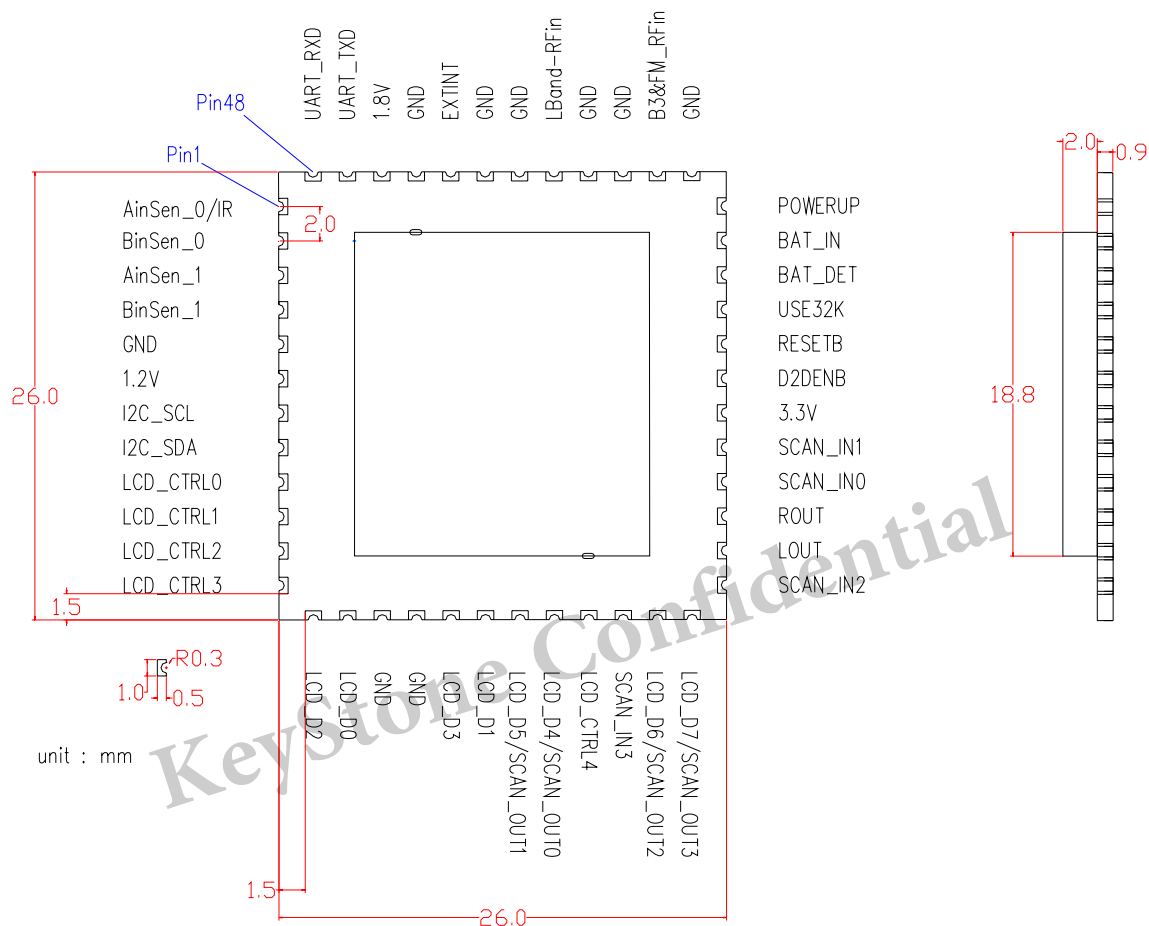
5.2. Module Pin Descriptions

Pin No.	Pin name	Pin Description	Note
1	AinSen_0/IR	Roll switch with Infrared receiver input	Roll_A0 and IR are pin sharing
2	BinSen_0	Roll switch	
3	AinSen_1	Roll switch	
4	BinSen_1	Roll switch	
5	GND	GND	
6	1.2V	+1.2V power supply	
7	I2C_SCL	I^{2}C clock	
8	I2C_SDA	I^{2}C data	
9	LCD_CTRL0	LCD control pins	Option : SPI_DI
10	LCD_CTRL1		Option : SPI_CSB
11	LCD_CTRL2		Option : SPI_CLK
12	LCD_CTRL3		Option : SPI_DO
13	LCD_D2	LCD data pins	
14	LCD_D0		
15	GND	GND	
16	GND	GND	
17	LCD_D3	LCD data pins	
18	LCD_D1	LCD data pins	
19	Scan_Key_O1/LCD_D5	LCD data pins and scan key output pin sharing	
20	Scan_Key_O0/LCD_D4		
21	LCD_CTRL4	GPIO	Option : S/PDIF
22	Scan_Key_I3	Scan Key input pin	Option: I2S_SBCLK
23	Scan_Key_O2/LCD_D6	LCD data pins and scan key output pin sharing	
24	Scan_Key_O3/LCD_D7		
25	Scan_Key_I2	Scan Key input pin	Option: I2S_SSCLK
26	LOUT	Stereo audio output	
27	ROUT	Stereo audio output	
28	Scan_Key_I0	Scan Key input pin	Option: I2S_SDATAO
29	Scan_Key_I1	Scan Key input pin	Option: I2S_SSYNC
30	3.3V	+3.3V power supply	
31	D2DENB	External LDO enable	Need pull-up to BAT_IN
32	RESETB	HW reset input pin	Low for reset

Pin No.	Pin name	Pin Description	Note
33	USE32K	XTAL selection	Low for normal operation
34	BAT_DET	Battery voltage detect input pin	
35	BAT_IN	Battery input pin for system and RTC	
36	POWERUP	Low for power up	
37	GND	GND	
38	B3&FM_RFin	RF input for B3 and FM	
39	GND	GND	
40	GND	GND	
41	LBand_RFin	RF input for L-band	
42	GND	GND	
43	GND	GND	
44	EXTINT	External interrupt input	
45	GND	GND	
46	1.8V	+1.8V power supply	
47	UART_TXD	UART TXD	Need pull up resistor
48	UART_RXD	UART RXD	Need pull up resistor

*T2_L4A_8650C is pin-to-pin compatible with T1_L4A_8290C.

5.3. Weight of module

2g

6. Hardware interface

6.1. RF Input

The T2_L4A_8650C has two RF inputs, one can support both Band 2(FM) and Band 3(DAB), the other can support L-Band(DAB)

6.2. Analogue audio output

Stereo audio outputs are provided by KSW8650's on-chip audio DAC with built-in headphone amplifiers. And can be directly connected to a 32ohm headphone without external headphone amplifiers to save cost and form-factor.

6.3. Serial port

Serial port pins (UART_RXD, UART_TXD) runs RS232 protocol, and can interface to external host or PC. Software control is required on this serial port. 10k resister pull-up is needed to add on UART path.

6.4. I^{2}C interface

I^{2}C interface can be used to communicate with I2C LCM, EPROM or other I2C devices. I2C need pull-up resisters on I2C_SCL and I2C_SDA.

6.5. Power and ground

3.3V is used for KSW8650's I/O, 1.8V power supply is for RF, and 1.2V power supply is for baseband processors. Noise and spurs associated with these power supplies should be kept as low as possible to ensure high receiving sensitivity performance.

GND is the lowest potential of the T2_L4A_8650C, and it should connect to true ground by a plane as close as possible.

6.6. LCM

T2_L4A_8650C module provides three series LCM control interfaces:

a) Character LCM Control Interface

T2_L4A_8650C module offers a wide range of character LCM control interfaces to fit for customer's applications. It provides three data-bus modes: 1-bit mode, 4-bit mode and 8-bit mode. The firmware now supports all these three data-bus modes and is able to control the standard 2x16 and 4x16 LCM with or without customized icons.

The following lists the LCM controllers that have been tested and qualified for used with T2_L4A_8650C.

- ● Sitronix ST7032 (2x16 Characters)
- ● Sitronix ST7070 (4x16 Characters)
- ● Samsung KS0066 (2x16 Characters)
- ● SunPlus SPLC780C (2x16 Characters)

b) Serial Control Interface

T2_L4A_8650C also supports I2C and SPI Character LCM such as Sitronix ST7032i (I2C), Philips PCF2116 (I2C) and Samsung KS0074 (SPI).

c) Parallel Control Interface

There are two popular parallel control interfaces used especially in the graphic LCM: Motorola 6800-series and Intel 8080-series parallel interface. The following lists the LCM controllers that have been tested and qualified for used with T2_L4A_8650C.

● Sitronix ST7565R (65 x 132 Dot Matrix LCD Controller)
● Solomon Systech SSD1303 (OLED driver/controller IC)
● Novatek NT7501
● PTC PT6866 (OLED driver/controller IC)

LCD interface contains 8 data pins (LCD_D[0:7]) and 4 control pins (LCD_CTRL[0:3]) to drive typical 2x16 LCD display or OLED display.

LCD_CTRL3 is configured to control the backlight of the LCD panel.

LCD_D[0:3] can be configured as GPIO if 8-bit data mode is not needed.

In order to prevent the LCD interface interference, a serial resistor under 2kohm should be placed on each LCD output lines as close to module as possible.

6.7. Keyboard

SCAN_IN[0:3] and SCAN_OUT[0:3] forms a 4x4 key matrix consist of 16 key pads. A key is detected when it shorts (pressed) the intersection of any SCAN_IN and SCAN_OUT lines. In order to prevent scan key interference, a serial resister 3.3Kohm with shunt 560pF capacitor should be placed on each scan key output pins as close to module as possible.

6.8. GPIO

Every digital pin of the T2_L4A_8650C has a main function plus a GPIO function. If an application does not use the main function of a pin, then it can be reconfigured to input, output or bi-directional function through software configuration.

All GPIO pins are input mode as reset default value, and FW can configure each GPIO to its main function.

6.9. Roll switch

Two sets of Roll Switch inputs are provided. Roll Switch used 2-pin phase-encoder to determine the direction and counts of rotation.

6.10. IR receiver

T2_L4A_8650C provide one IR receiver sharing pin with AinSen_0 since the IR is not functional together with roll switch.

6.11. SPI interface

LCD_D[0:3] can be configured as SPI interface if LCD_D[0:3] are not used.
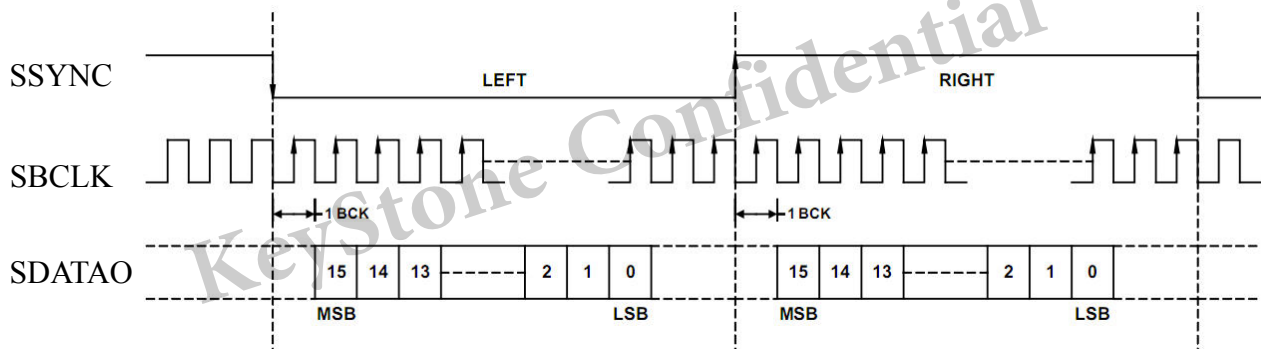
SPI interface is the default data transmitting path for Host to decode DMB video stream.

T2_L4A_8650C supports both master and slave SPI application.

6.12. I2S interface

L4A support I2S output for optional and two formats are supported: 32-bit I2S format and 32-bit Right justified format.

I2S format:

Right justified format:
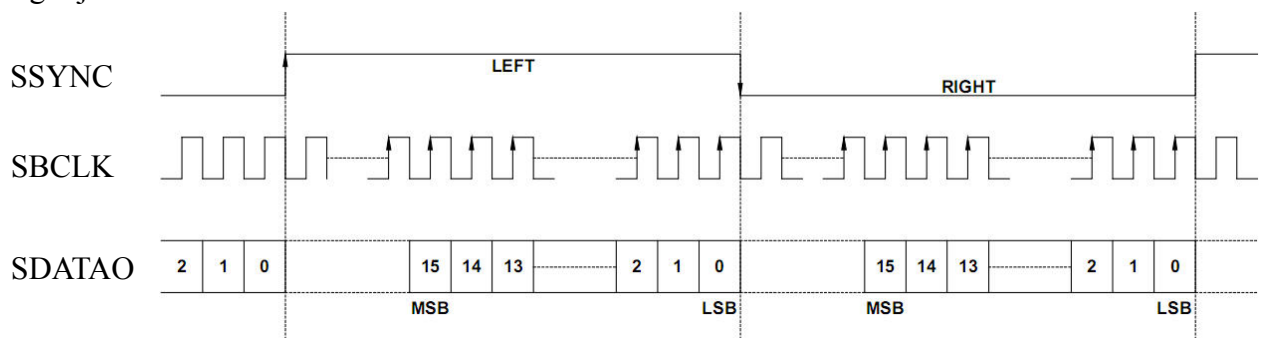
6.13. H/W reset

The external H/W reset control is required. Either controlled by external MCU in slave mode or just simple 100k ohm resister pull up with 0.1uF capacitor to ground as power on reset are recommended. Before power off DAB module at slave mode. Reset signal should be active before power down 100ms.
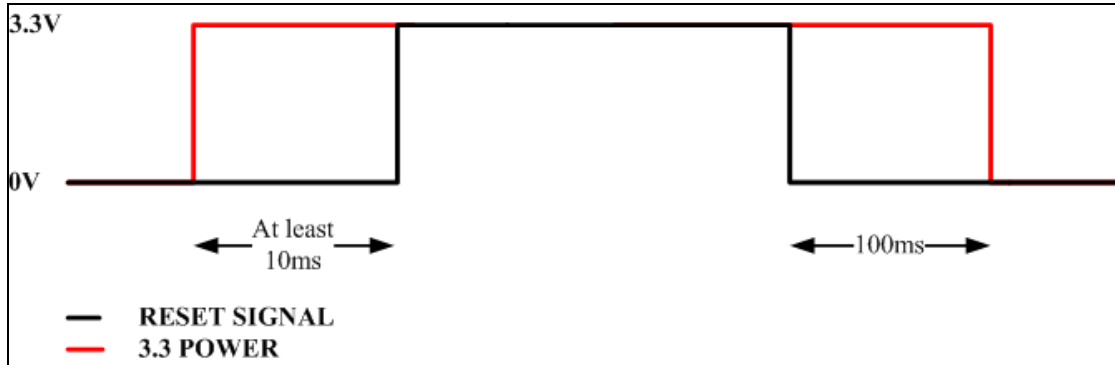
Fig 4 Power On/Off reset timing

7. Technical Specification

No.	Item	Conditions
7-1	**RF/IF Description** (1) Input frequency range	FM：87.5~108MHz Band-3：174~240MHz L-Band：1452MHz~1492MHz
	(2) Antenna impedance	50Ω
	(3) IF frequency	FM：108kHz DAB：1MHz
7-2	**Signal format**	FM：BS5942-2 / BS 60315-4 DAB：ETSI EN 300 401, All Modes (I, II, III, and IV) support.
7-3	**Analogue audio output**	Stereo audio output
7-4	**Power supply voltage** Pin46 Pin6 Pin30	+1.8V±10% +1.2V±10% +3.3V±10%
7-5 7-5-1	**Environmental specification** **Temperature** Operating Storage	0 ~ +70 º C -20 ~ +70 º C
7-5-2	**Humidity** Operating Storage	Less than 80% RH(at 40 º C) Less than 95% RH(at 40 º C)

8. Standard Test Conditions

Test for electrical specifications shall be performed at following condition unless otherwise specified.

No.	Item	Conditions	
8-1	**Ambient Condition**		
	Temperature	25 º C	
8-2	**Power Supply**		
	+1.2V (Pin 6)	1.2 V DC , ripple $\leqq$ 10mVpp	
	+1.8V (Pin 46)	1.8 V DC , ripple $\leqq$ 10mVpp	
8-3	+3.3V (Pin 30)	3.3 V DC , ripple $\leqq$ 10mVpp	
	Current Consumption (mA)	Typ.	Max.
	DAB Mode*		
	+1.2V (RMS)	48	75
	+1.8V (RMS)	45	68
	+3.3V (RMS)	15	20
	FM Mode		
	+1.2V (RMS)	56	62
	+1.8V (RMS)	64	70
	+3.3V (RMS)	15	20

* : Data marked as is still preliminary, need to be confirmed.

9. Absolute Maximum Ratings

No	Item	Max.	Unit
9-1	VDD12 Power Supply	1.5	
9-2	VDD18 Power Supply	2.1	
9-3	VDD33 Power Supply	3.9	V
9-4	RF IO Pad Input Voltage	-0.3 to VDD18+0.3	
9-5	Digital & Analog IO Pad Input Voltage	-0.3 to VDD33+0.3	

10. DC Operating Condition

No	Item	Specification			Unit
		Min.	Typ.	Max.	
10-1	+1.2 Power Supply	-0.3	+1.2	+1.35	
10-2	+1.8 Power Supply	-0.3	+1.8	+2.0	V
10-3	+3.3 Power Supply	-0.3	+3.3	+3.6	

11. Electrical Specifications

11.1. DAB Band-3 Performance

No	Item	Specification				Condition
		Min.	Typ.	Max.	Unit	
11-1-1	Sensitivity		-99		dBm	
11-1-2	RF input large signal		-7		dBm	
11-1-3	Far off selectivity		55		dB	N ± 5MHz
11-1-4	Adjacent channel		30		dB	N±1
11-1-5	Audio output impedance	16	32		Ω	
11-1-6	Audio output voltage		2.0V	2.6V	V_{pp}	
11-1-7	THD		0.026		%	@32ohm load
11-1-8	SNR	81	81		dB	@32ohm load
11-1-9	Stereo separation	53	53		dB	@32ohm load
11-1-10	Audio 3dB cutoff frequency				Hz	@32ohm load
	Low		42			
	Higher		20000			

11.2. FM Performance

No	Item	Specification				Condition
		Min.	Typ.	Max.	Unit	
11-2-1	Sensitivity @(S+N)/N=26dB		-108		dBm	
11-2-2	RF input large signal		-7		dBm	
11-2-3	Far off selectivity		45		dB	
11-2-4	Adjacent channel		36		dB	
11-2-5	Audio output impedance	16	32		Ω	
11-2-6	Audio output voltage		440		mV_{pp}	*
11-2-7	THD		0.22		%	*
11-2-8	SNR		52		dB	*
11-2-9	Stereo separation		26		dB	@32ohm load
11-2-10	Audio 3dB cutoff frequency				Hz	@32ohm load
	Low		30			*
	High		12500			Audio 3dB BW

* L=R , ΔF=22.5KHz,F_{mod}=1KHz,de-emphasis=75us, @32ohm ohm load

12. Compliance standards

12.1. Electromagnetic compatibility (EMC)

T2_L4A_8650C module is tested to comply with the following standard:

BS EN 55022:1998

BS EN 55013:2001

The electromagnetic compatibility of a particular product is highly dependent on the usage environment and how the module is installed within final product. Care should be taken to integrate the module with due regard to the effects of conducted and radiated signals.

12.2. Electrostatic discharge (ESD) protection

T2_L4A_8650C module is an ESD-sensitive device and is tested to IEC 61000-4-2 standard. Special precautions should be taken during manufacturing and testing process.