MT6631 Datasheet

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Document Revision History

Revision	Date	Author	Description
0.1A	2015-05-21	Yu-Li Hsueh Min Chen	First release for template consolidation.
0.2A	2016-04-21	Min Chen Yu-Li Hsueh	1. Updated Wi-Fi 5G RX performance. 2. Updated FM specification. 3. Updated whole-chip block diagram. 4. Updated GPS descriptions. 5. Updated chip top view.
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0.7A	2020-05-04	Yu-Li Hsueh ChienChih Chiu	Updated pin names.

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1 System Overview

1.1 Functional Block Diagram

MT6631 is a 4-in-1 connectivity chip which contains a 2.4 GHz Wi-Fi/Bluetooth transceiver front-end, a 5 GHz Wi-Fi transceiver front-end, a GPS receiver front-end and a complete FM receiver, along with Integrated Passive Device (IPD) in a QFN40 package. Simplified block diagram and how MT6631 is used are shown in Figure 1-1. An always-on low-dropout regulator (ALDO) provides supply voltage to top control logics in MT6631. The top control logics control each subsystem independently. Each subsystem also has dedicated LDOs. A thermal sensor and a low-speed ADC (analog-to-digital converter) are provided to monitor MT6631's temperature variation. MT6631 does not have its dedicated crystal oscillator. It uses either an external (might be temperature compensated) oscillator or clock source from companion chips in the platform.

For Wi-Fi and Bluetooth, MT6631 provides an advanced switching mechanism which allows fast switching between Wi-Fi and BT modes. Hardware sharing and reuse is maximized. The transceiver front-ends are on MT6631 while the ADC/DAC (Analog-to-Digital Converter/Digital-to-Analog Converter) is in the companion modem chip. The interface driver/receiver buffer is designed to drive PCB trace loading. The GPS IP in MT6631 is similar to Wi-Fi/Bluetooth such that the ADC/DAC is in the companion modem chip. In contrast, the FM system integrates the modem and ADC in MT6631, and no interface drivers/buffers are required. The IPD of MT6631 integrates 2.4G Wi-Fi/BT balun and its matching network, and a GPS matching network (see Figure 1-1).

Compared to its predecessor MT6625L, MT6631 exhibits several new features:

- FDD between Wi-Fi-5GHz and Bluetooth
- Configurable Wi-Fi 2.4 GHz PA for better efficiency in low-power applications
- Supports GPS + Glonass + Beidou/Galileo
- Supports external PA and LNA for 2.4 GHz and 5 GHz Wi-Fi

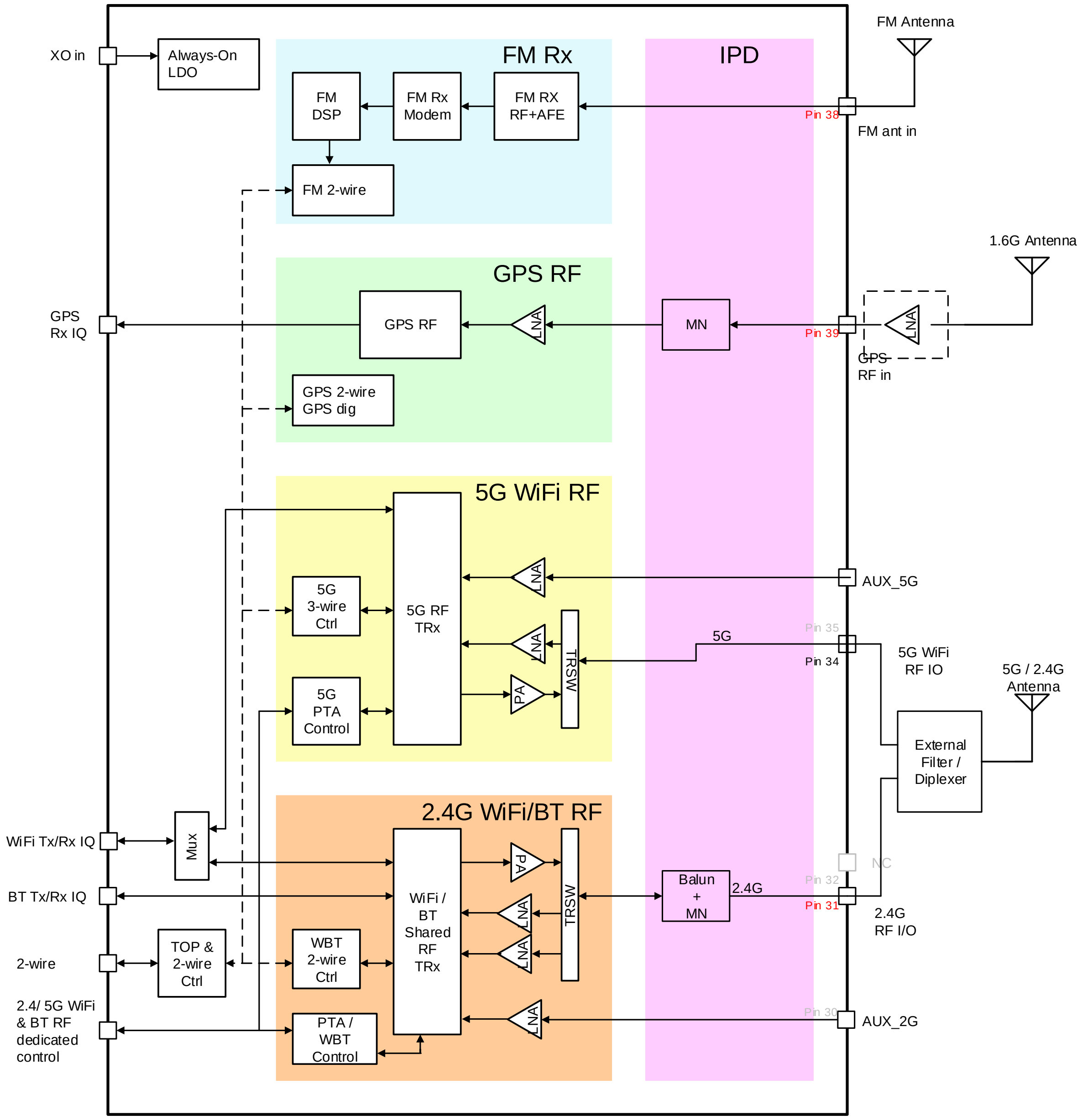


Figure 1-1. MT6631 block diagram

1.2 Features

- MT6631 is a 4-in-1 connectivity RF chip which contains front-ends of a 2.4 GHz Wi-Fi and Bluetooth transceiver, a 5 GHz Wi-Fi transceiver, a GPS receiver and an FM receiver. MT6631 supports integrated passive device to save footprint on PCB and cost due to Wi-Fi/Bluetooth/GPS external BoM (bill of materials) in a 40-pin QFN package.
- Supports GPS external LNA
- Option of IPD: MT6631 offers front-end components flexibility for various filtering/rejection requirements, multiple antenna configurations (e.g. 2-antenna and 3-antenna).

1.2.1 Wi-Fi/BT

- Simultaneous operation (FDD) of WiFi-5GHz and Bluetooth

WLAN

- Dual-band (2.4 GHz and 5 GHz) single stream 802.11 a/b/g/n/ac RF, 20/40/80 MHz bandwidth
- Supports worldwide Wi-Fi 5G channel including new band in US and China (5,925 MHz), and Bluetooth FDD operation
- Supports 802.11d/e/h/i/j/k/r/v/w with companion D-die
- Integrated 2.4 GHz PA with max. 20 dBm CCK output power, 5 GHz PA with max. 17 dBm OFDM 54 Mbps output power and 15 dBm VHT80 MCS9 output power
- Typical Rx sensitivity with companion chip modem: -76.5 dBm at both 11g 54 Mbps mode and 11a 54 Mbps mode, -62 dBm at 11ac VHT80 MCS9 mode
- Integrated power detector to support per packet Tx power control
- Built-in calibrations for PVT variation
- Fully integrated frequency synthesizers to support multiple crystal clock frequencies
- Configurable Wi-Fi 2.4 GHz PA for higher efficiency in low-power applications.
- Supports external PA and LNA for WiFi-2.4GHz and WiFi-5GHz.

Bluetooth

- Bluetooth specification v2.1+EDR, 3.0+HS and v4.1+HS compliant
- Integrated PA with 8 dBm (class 1) transmit power
- Typical Rx sensitivity with companion chip modem: GFSK -94 dBm, DQPSK -93 dBm, 8-DPSK -87.5 dBm
- Low-power scan function to reduce power consumption in scan modes

1.2.2

- 65~108 MHz with 50 kHz step
- Supports RDS/RBDS
- Digital stereo modulator/demodulator

- Digital audio interface (FM 2-wire bus)
- Fast seek time 30 ms/channel
- Stereo noise reduction
- Audio sensitivity 3 dBµVemf (SINAD = 26 dB)
- Audio SINAD ≥ 60 dB
- Anti-jamming
- Supports short antenna

1.2.3 GPS

- RF supports GPS, Galileo, Glonass, and Beidou.
- Simultaneous reception of GPS + Glonass + Beidou/Galileo for more accurate positioning
- Built-in calibrations for PVT variation
- Typical Rx tracking sensitivity of -163 dBm
- Supports external LNA
- Multi-mode filters for different GNSS receiver modes

1.2.4 IPD

WBT IPD

- Integrated matching network and balun
- Supports single, dual, and triple antenna operation
- Supports cellular co-existence with external filter

GPS IPD

- Integrated matching network and filtering notch for cellular co-existence
- Fully integrated in one IPD die
- Supports single and dual antenna operation

2 Pin Definition

2.1 I/O Definition

The I/O definitions used in Table 2-2 are listed below.

Table 2-1. I/O definition

Pad attribute	
AI	Analog input (excluding pad circuitry)
AO	Analog output (excluding pad circuitry)
AIO	Analog bidirectional (excluding pad circuitry)
DIO	Bidirectional digital with CMOS input
DI	Digital input (CMOS)
DO	Digital output (CMOS)
Z	High-impedance (high-Z) output
NP	No internal pull
PU	Internal pull-high
PD	Internal pull-low
ADIO	Analog and digital I/O (excluding pad circuitry)

2.2 Pin Definition

Detailed pin descriptions of MT6631 are listed in Table 2-2.

Table 2-2. MT6631 pin definition

		Category	PAD type	Descriptions
1	AVDD28_FSOURCE	2.8V supply	AI	eFuse 2.8V supply voltage. Connected to ground in normal operation.
2	HRST_B	Digital control	DI	Hardware reset from companion modem
3	TOP_DATA	Digital control	DIO	2-wire clock and data connected to companion modem
4	TOP_CLK	Digital control	DI	
5	WB_PTA	Digital control	DI	PTA signal to Wi-Fi/BT
6	CEXT	Analog IO	AIO	External cap for MT6631 always-on LDO
7	NC	Analog IO	AO	Reserved
8	XO_IN	Analog IO	AI	Reference clock (26 MHz) input
9	GPS_ QN	Analog IQ	AO	GPS receiver IF IQ signals. Connected to companion modem.
10	GPS_ QP	Analog IQ	AO	
11	GPS_ IN	Analog IQ	AO	
12	GPS_ IP	Analog IQ	AO	
13	BT_QN	Analog IQ	AI	Bluetooth IF transmitter IQ signals. Connected to companion modem.
14	BT_QP	Analog IQ	AI	
15	BT_IN	Analog IQ	AI	
16	BT_IP	Analog IQ	AI	
17	WF_QN	Analog IQ	AO	Wi-Fi IF receiver IQ signals. Connected to companion modem.
18	WF_QP	Analog IQ	AO	
19	WF_IN	Analog IQ	AO	
20	WF_IP	Analog IQ	AO	
21	WF_CTRL2	Digital control	DIO	Wi-Fi dedicated high speed control bus.
22	WF_CTRL1	Digital control	DIO	
23	WF_CTRL0	Digital control	DIO	
24	BT_CLK	Digital control	DI	Bluetooth 2-wire clock and data signals. Connected to companion modem.
25	BT_DATA	Digital control	DIO	
26	AVDD18_WBT	1.8V supply	AI	1.8V supply of Wi-Fi and Bluetooth radio
27	AVDD18_WBT	1.8V supply	AI	1.8V supply of Wi-Fi and Bluetooth radio
28	WF_VDET_5G	Analog IO	AI	Feedback voltage from 5 GHz external PA
29	WF_VDET_2G	Analog IO	AI	Feedback voltage from 2.4 GHz external PA
30	WF_AUX_2G	RF IO	AI	Wi-Fi 2.4 GHz external LNA input
31	WB_RF_2G	RF IO	AIO	2.4 GHz Wi-Fi/BT RF IO
32	NC	RF IO	AIO	Reserved
33				
34	WF_RF_5G	RF IO	AIO	5G Wi-Fi RF IO
35	WF_AUX_5G	RF IO	AI	Wi-Fi 5 GHz external LNA input

		Category	PAD type	Descriptions
36	AVDD28	2.8V supply	AI	FM and eFuse 2.8V supply. If the external TCXO is used as reference source, AVDD28 will also serve as its supply voltage.
37	FM_LANT_N	RF IO	AI	FM differential RF input, negative terminal
38	FM_LANT_P	RF IO	AI	FM differential RF input, positive terminal
39	GPS_RFIN	RF IO	AI	GPS RF input, single-ended
40	AVDD18	1.8V supply	AI	1.8V supply to GPS IP; always on LDO for MT6631 top logic control

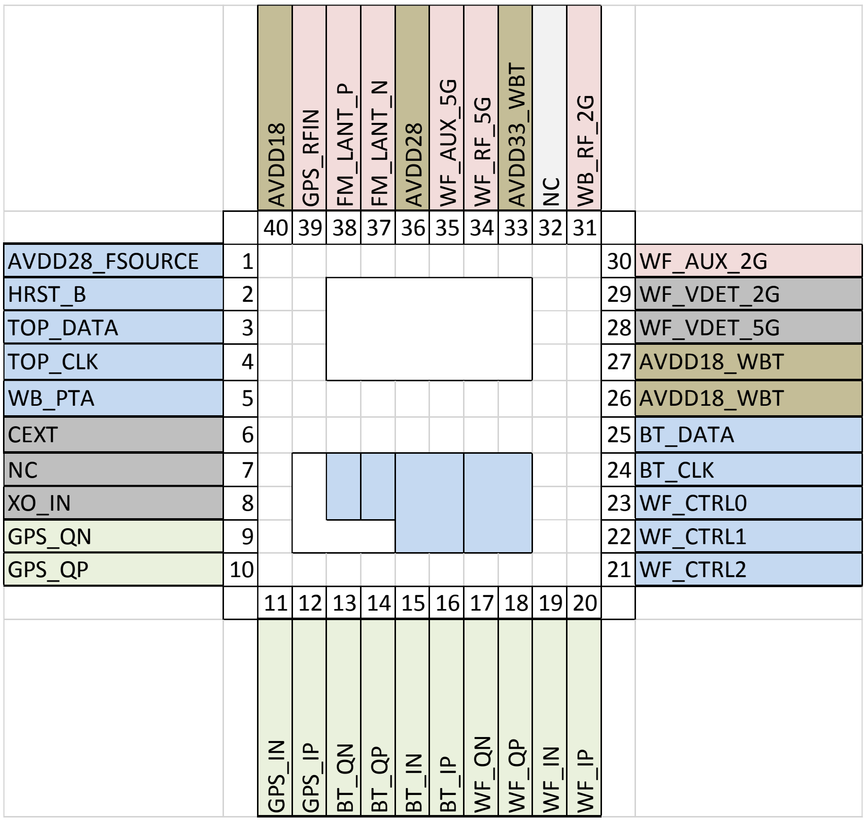


Figure 2-1. MT6631 pin definition

3 Electrical Characteristics

3.1 Absolute Maximum Ratings

Table 3-1. Absolute maximum ratings

Symbol	Parameter	Rating	Unit
AVDD33_WBT	Wi-Fi 3.3V supply for PA and Tx modulator	-0.3~3.96	V
AVDD28	FM 2.8V supply. If the external VCTCXO is used as reference source, AVDD28 will also serve as its supply voltage.	-0.3~3.36	V
AVDD18	1.8V supply to GPS IP; always on LDO for MT6631 top logic control	-0.3~2.16	V
AVDD18_WBT	1.8V supply of Wi-Fi and Bluetooth radio	-0.3~2.16	V
T_{STG}	Storage temperature	-60~+120	°C
T_A	Operating temperature	-40~+85	°C

3.2 Recommended Operating Range

Table 3-2. Recommended operating range

Symbol	Parameter	Min.	Typ.	Max.	Unit
AVDD33_WBT	Wi-Fi 3.3V supply for PA and Tx modulator	3.0	3.3	3.6	V
AVDD28	FM 2.8V supply. If the external VCTCXO is used as reference source, AVDD28 will also serve as its supply voltage.	2.5	2.8	3.1	V
AVDD18	1.8V supply to GPS IP; always on LDO for MT6631 top logic control.	1.62	1.8	1.98	V
AVDD18_WBT	1.8V supply of Wi-Fi and Bluetooth radio	1.62	1.8	1.98	V
T_j	Commercial junction operating temperature	0	25	115	°C
	Industry junction operating temperature	-20	25	125	°C
T_a	Operation temperature	-40	25	85	°C
T_{stg}	Storage temperature	-60	25	150	°C

3.3 Power Consumption and Supply Specifications

The following tables list the power supply requirements for AVDD18_WBT/AVDD18, AVDD28 and AVDD33_WBT.

Table 3-3. AVDD18 specifications

Test item	Min.	Typ.	Max.	Unit	Notes
Output voltage, VDD	1.62	1.8	1.98	V	
Output current	150			mA	
Output noise			550	nV/sqrt (Hz)	
PSRR	40			dB	< 1 MHz
Load transient	-200		200	mV	Transient slew rate 100 mA/us
Turn-on rising time	10		270	usec	10% -> 90% output voltage
Power-off settling time		2	4	ms	90% -> 10% output voltage

Table 3-4. AVDD28 specifications

Test item	Min.	Typ.	Max.	Unit	Notes
Output voltage	2.5	2.8	3.1	V	
Output current	30			mA	
PSRR	40			dB	< 1 MHz
Load transient	-150		150	mV	Transient slew rate 15 mA/us
Turn-on rising time	10		270	usec	10% -> 90% output voltage
Turn-on overshoot			10	%	

Table 3-5. AVDD33 specifications

Test Item	Min	Typ.	Max	Unit	Notes
Output voltage		3.3	3.6	V	
Output current (normal operation)	500			mA	
Output current (calibration mode)	900			mA	No need to meet noise and PSRR requirements in this mode
Output noise			550	nV/sqrt (Hz)	
PSRR	40			dB	< 1 MHz
Load transient	-200		200	mV	Transient slew rate 100 mA/us
Turn-on rising time	10		270	usec	10% -> 90% output voltage
Turn-					
Power-off settling time		2	4	ms	90% -> 10% output voltage

3.4 Power-on/off Sequence

MT6631 uses three supply voltages, AVDD18, AVDD28 and AVDD33. Specific power-on/off sequence must be followed as described below.

AVDD18

I/O and internal control logic use AVDD18, and this supply voltage needs to be powered on prior to AVDD28 and AVDD33 for functioning properly. The functionality of MT6631 will not be guaranteed if AVDD28 or AVDD33 power is supplied prior to this AVDD18 supply.

AVDD28 and AVDD33

There is no specific power-on/off timing relationship between AVDD28 (used by FM radio and external oscillator, if used) and AVDD33 (Wi-Fi).

3.5 Digital Logic Characteristics

MT6631 timing characteristics and interface protocols are shown here, including some general comments.

3.5.1 Timing Diagram Convention

Figure 3-1 shows the conventions used with timing diagram throughout this document.

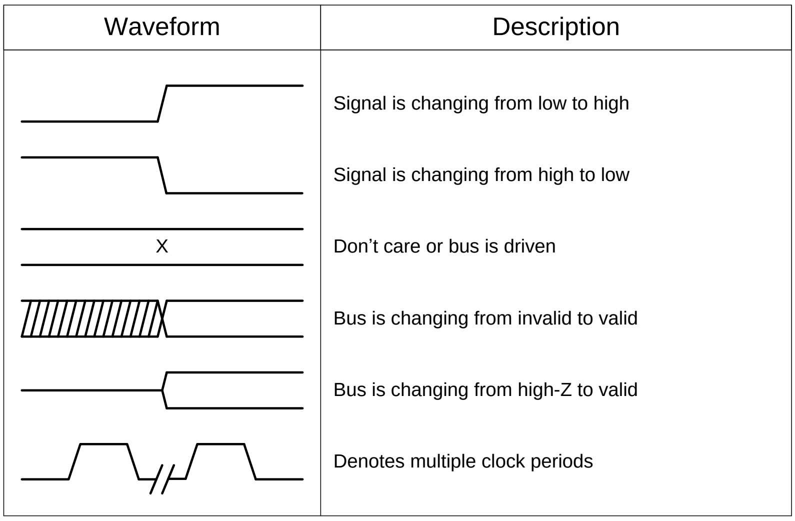
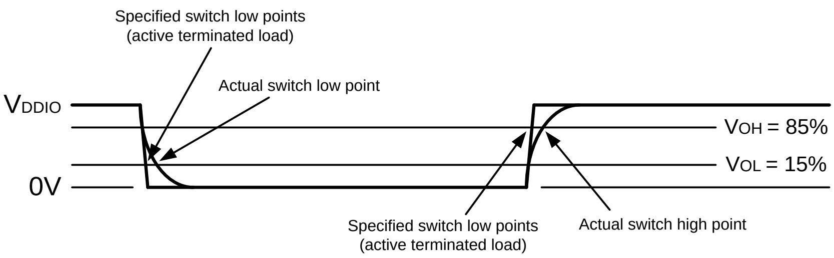


Figure 3-1. Timing diagram conventions

3.5.2 Rising/Falling Time Definition

Figure 3-2 is the rising and falling timing diagram. The actual signal timing curve is related to the external load conditions. See Table 3-6 for the operating conditions of digital logics.



diagram

Table 3-6. Operating conditions of digital logics

Parameter	Min.	Typ.	Max.	Unit	Notes
VDD, supply of core power	1.08	1.2	1.32	V	
VDDIO, supply of I/O power	1.62	1.8	1.98	V	
VIH, input logic high voltage	0.75*VDDIO		VDDIO + 0.3	V	
VIL, input logic low voltage	-0.3		0.25*VDDIO	V	
VOH (DC), DC output high voltage	0.85*VDDIO			V	VDD = min, I_{OH} = 1.5 mA
VOL (DC), DC output low voltage			0.15*VDDIO	V	VDD = min, I_{OL} = 1.5 mA

3.5.3 Protocols

There are three main interfaces for MT6631:

- 2-wire top control interface: Generally used for all systems (BT/Wi-Fi/FM/GPS)
- 3-wire bus: High-speed interface, for Wi-Fi
- 2-wire BT control interface: Dedicated used for BT control

3.5.3.1 2-Wire

The 2-wire bus of MT6631 is mainly used as below:

- Top control interface, the main interface to access Wi-Fi/BT/FM/GPS/eFuse command registers
- BT control interface, dedicated used for BT control

The bit number of SDATA depends on different operating conditions, as shown in Figure 3-3.

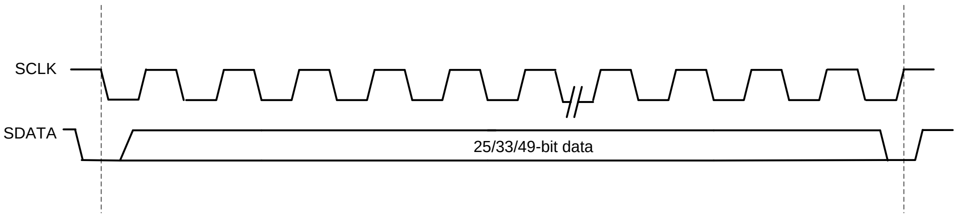


Figure 3-3. 2-wire SPI timing diagram

3.5.3.2 3-bit Bus

MT6631 has a dedicated 3-bit bus to control the Wi-Fi radio. The related control definitions depend on operating modes and conditions. The protocol is shown in Figure 3-4.

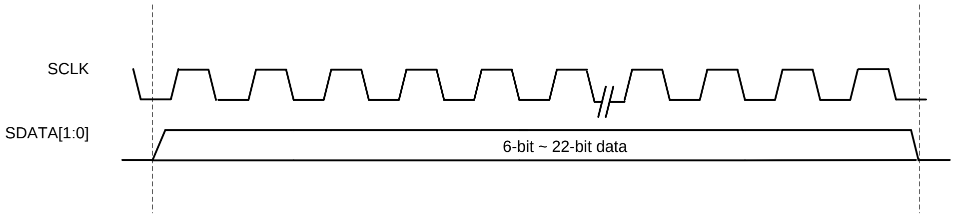


Figure 3-4. Wi-Fi 3-wire SPI access

3.6 MT6631 TOP Building Blocks

3.6.1 Reference Clock

The reference clock source needs to satisfy > 0.8 Vpp with rising/falling time of < 5 nsec and phase noise of < -149 dBc/Hz at 100 kHz offset frequency. The clock buffers draw 200 µA. The first stage buffer employs ac-coupled architecture to ensure proper amplification even with weak input clock whose swing is less than thresh voltage of transistors. There is a tie-low switch in the buffer to each block (i.e. WBT, GPS, FM, THADC and DIG) to guarantee well-defined voltage for input ports of blocks mentioned above.

3.6.2 Thermal ADC

A low-speed ADC converts the output of thermal sensor to 8-cycle-average or 16-cycle-average ADC code which represents the current chip temperature near the THADC. The temperature coverage range is between -40˚C and 120˚C. The chip top control may do corresponding adjustment (such as PA/Tx gain switching) based on such temperature information.

3.6.3 Always-on LDO

A low-power bandgap reference provides biasing currents for internal LDO as well as reference voltages for THADC's temperature sensing. An always-on LDO provides an internal 1.2V voltage to digital circuits from an external supply of 1.8V. In normal operation, the BG circuit generates the reference voltage for the LDO. In sleep mode, the BG+LDO consume small quiescent current of ~25 uA. The LDO output voltage and driving capability are programmable.

3.7 Wi-Fi/BT

MT6631 Wi-Fi/BT is a high performance and highly-integrated dual-band RF transceiver fully compliant with IEEE 802.11 a/ac/b/g/n and Bluetooth v2.1+EDR/v3.0+HS/v4.1 LE standards. A novel RF front-end topology is implemented to achieve maximum hardware sharing between 2.4 GHz/5 GHz Wi-Fi and Bluetooth with integrated TR-switches. MT6631 also features a self-calibration scheme to compensate the process and temperature variation to maintain high performance. The calibration is performed automatically right after the system boot-up.

3.7.1 Wi-Fi/BT Specifications

The WLAN/BT radio characteristics are described in this section. Unless otherwise specified, all specifications are measured at the RF port which is depicted in the following figure. Unlike most devices available today which requires matching network or filters between antenna port and RF ports (defined in Figure 3-5), due to the integration of integrated passive device (IPD), the RF port and antenna port of MT6631 can be directly connected by a 50 ohm trace.

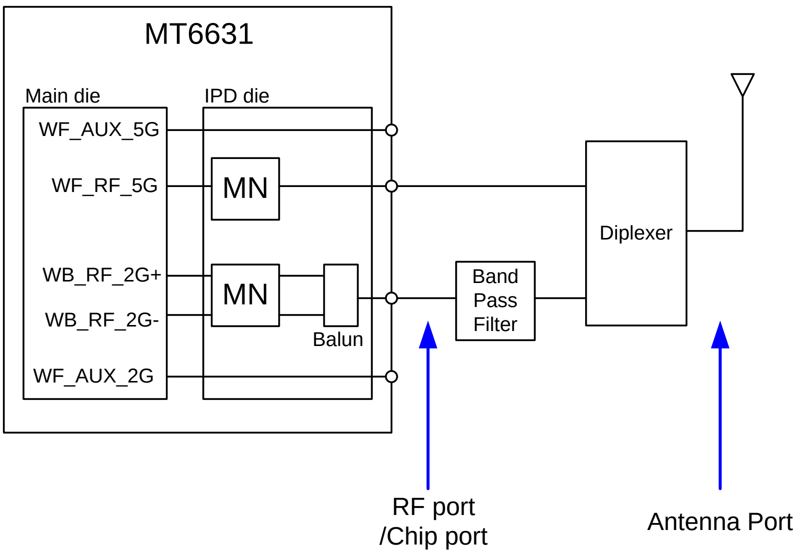


Figure 3-5. Wi-Fi/BT spec. measurement diagram

3.7.1.1 2.4 GHz Wi-Fi Receiver Specifications

Note:

(1) The specification

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-7. 2.4 GHz receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,412	-	2,484	MHz
Rx sensitivity	1 Mbps DSSS		-98		dBm
	2 Mbps DSSS		-94.5		dBm
	5.5 Mbps DSSS		-92		dBm
	11 Mbps DSSS		-89.5		dBm
Rx sensitivity	6 Mbps OFDM		-93.5		dBm
	9 Mbps OFDM		-91.5		dBm
	12 Mbps OFDM		-90.5		dBm
	18 Mbps OFDM		-88		dBm
	24 Mbps OFDM		-85		dBm
	36 Mbps OFDM		-81		dBm
	48 Mbps OFDM		-77.5		dBm
	54 Mbps OFDM		-76.5		dBm
Rx sensitivity BW = 20 MHz Green field 800 ns guard interval Non-STBC	MCS 0		-93		dBm
	MCS 1		-89.5		dBm
	MCS 2		-87.5		dBm
	MCS 3		-84.5		dBm
	MCS 4		-81.5		dBm
	MCS 5		-77		dBm
	MCS 6		-75.5		dBm
	MCS 7		-74		dBm
Rx sensitivity BW = 40 MHz Green field 800 ns guard interval Non-STBC	MCS 0		-90		dBm
	MCS 1		-86.5		dBm
	MCS 2		-84.5		dBm
	MCS 3		-81.5		dBm
	MCS 4		-78.5		dBm
	MCS 5		-74		dBm
	MCS 6		-72.5		dBm
	MCS 7		-70.5		dBm
Maximum receive level	11 Mbps DSSS			-5.5	dBm
	6 Mbps OFDM			-10.5	dBm
	54 Mbps OFDM			-10.5	dBm
	MCS0			-10.5	dBm
	MCS7			-10.5	dBm
Adjacent channel rejection (30 MHz offset)	1 Mbps DSSS			41.5	dB
Adjacent channel rejection (25 MHz offset)	11 Mbps DSSS			41.5	dB
Adjacent channel rejection (25 MHz offset)	6 Mbps OFDM			38.5	dB
	54 Mbps OFDM			26.5	dB
	MCS 0			34.5	dB

Parameter	Description	Min.	Typ.	Max.	Unit
Adjacent channel rejection (25 MHz offset), BW = 20 MHz	MCS 7			10.5	dB
Adjacent channel rejection (40 MHz offset), BW = 40 MHz	MCS 0			26.5	dB
	MCS 7			4.5	dB

3.7.1.2 2.4 GHz Wi-Fi Receiver Specifications (Aux Path)

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-8. 2.4 GHz aux receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,412	-	2,484	MHz
Rx sensitivity	1 Mbps DSSS		-100		dBm
	2 Mbps DSSS		-96.5		dBm
	5.5 Mbps DSSS		-94		dBm
	11 Mbps DSSS		-91.5		dBm
Rx sensitivity	6 Mbps OFDM		-95.5		dBm
	9 Mbps OFDM		-93.5		dBm
	12 Mbps OFDM		-92.5		dBm
	18 Mbps OFDM		-90		dBm
	24 Mbps OFDM		-87		dBm
	36 Mbps OFDM		-83		dBm
	48 Mbps OFDM		-79.5		dBm
	54 Mbps OFDM		-78.5		dBm
Rx sensitivity BW = 20 MHz Green field 800 ns guard interval Non-STBC	MCS 0		-94.5		dBm
	MCS 1		-91		dBm
	MCS 2		-89		dBm
	MCS 3		-86		dBm
	MCS 4		-83		dBm
	MCS 5		-78.5		dBm
	MCS 6		-77		dBm
	MCS 7		-75.5		dBm
Rx sensitivity BW = 40 MHz Green field 800 ns guard interval	MCS 0		-91.5		dBm
	MCS 1		-88		dBm
	MCS 2		-86		dBm
	MCS 3		-83		dBm

Parameter	Description	Min.	Typ.	Max.	Unit
Non-STBC	MCS 4		-80		dBm
	MCS 5		-75.5		dBm
	MCS 6		-74		dBm
	MCS 7		-72		dBm
Maximum receive level	11 Mbps DSSS			-5.5	dBm
	6 Mbps OFDM			-10.5	dBm
	54 Mbps OFDM			-10.5	dBm
	MCS0			-10.5	dBm
	MCS7			-10.5	dBm
Adjacent channel rejection (30 MHz offset)	1 Mbps DSSS			41.5	dB
Adjacent channel rejection (25 MHz offset)	11 Mbps DSSS			41.5	dB
Adjacent channel rejection (25 MHz offset)	6 Mbps OFDM			38.5	dB
	54 Mbps OFDM			26.5	dB
Adjacent channel rejection (25 MHz offset), BW = 20 MHz	MCS 0			34.5	dB
	MCS 7			10.5	dB
Adjacent channel rejection (40 MHz offset), BW = 40 MHz	MCS 0			26.5	dB
	MCS 7			4.5	dB

3.7.1.3 2.4 GHz Wi-Fi Transmitter Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-9. 2.4 GHz transmitter specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,412	-	2,484	MHz
Output power VBAT = 3.6V	802.11b, 1~11 Mbps DSSS		20		dBm
	802.11g, 6~54 Mbps OFDM		17.5		dBm
	802.11n, HT20 MCS0~4		18		dBm
	802.11n, HT20 MCS7		17		dBm
	802.11n, HT40 MCS7		16		dBm
EVM	802.11b, 1~11 Mbps DSSS @Pout = 18 dBm		25		%
	802.11g, 6~54 Mbps OFDM @Pout = 15.5 dBm		-31		dB
	802.11n, HT20 MCS0~7		-31		dB

Parameter	Description	Min.	Typ.	Max.	Unit
	@Pout = 15 dBm				
	802.11n, HT40 MCS0~7 @Pout = 14 dBm		-31		dB
Tx power accuracy	-40~85°C, 2~18 dBm			±1.5	dB
Transmitted power (Data rate = 1M, Pout = 20 dBm)	76~108 MHz			-146.5	dBm/Hz
	776~794 MHz			-145.5	dBm/Hz
	869~960 MHz			-146.5	dBm/Hz
	925~960 MHz			-146.5	dBm/Hz
	1,570~1,580 MHz			-146.5	dBm/Hz
	1,805~1,880 MHz			-145.5	dBm/Hz
	1,930~1,990 MHz			-143.5	dBm/Hz
	2,110~2,170 MHz			-136.5	dBm/Hz
Harmonic output power (Data rate = 1M, Pout = 20 dBm)	2nd harmonic			-21	dBm/MHz
	3rd harmonic			-28	dBm/MHz

3.7.1.4 5 GHz Wi-Fi Receiver Specifications (Main Path)

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip’s capability.

Table 3-10. 5 GHz receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		4,915	-	5,925	MHz
Rx sensitivity	6 Mbps OFDM		-93.5		dBm
	9 Mbps OFDM		-92		dBm
	12 Mbps OFDM		-91		dBm
	18 Mbps OFDM		-88.5		dBm
	24 Mbps OFDM		-85.5		dBm
	36 Mbps OFDM		-81.5		dBm
	48 Mbps OFDM		-78		dBm
	54 Mbps OFDM		-76.5		dBm
Rx sensitivity BW = 20 MHz Green field 800 ns guard interval Non-STBC (HT20/VHT20)	MCS 0		-93.5		dBm
	MCS 1		-90		dBm
	MCS 2		-88		dBm
	MCS 3		-85		dBm
	MCS 4		-82		dBm
	MCS 5		-77.5		dBm
	MCS 6		-76		dBm

Parameter	Description	Min.	Typ.	Max.	Unit
	MCS 7		-74.5		dBm
	MCS8		-70		dBm
Rx sensitivity BW = 40 MHz Green field 800 ns guard interval Non-STBC (HT40/VHT40)	MCS 0		-90.5		dBm
	MCS 1		-87		dBm
	MCS 2		-85		dBm
	MCS 3		-82		dBm
	MCS 4		-79		dBm
	MCS 5		-74.5		dBm
	MCS 6		-73		dBm
	MCS 7		-71		dBm
	MCS 8		-66.5		dBm
	MCS 9		-65		dBm
Rx sensitivity BW = 80 MHz Green field 800 ns guard interval Non-STBC (VHT80)	MCS 0		-87.5		dBm
	MCS 1		-84		dBm
	MCS 2		-81.5		dBm
	MCS 3		-78.5		dBm
	MCS 4		-75.5		dBm
	MCS 5		-70.5		dBm
	MCS 6		-69		dBm
	MCS 7		-68		dBm
	MCS 8		-63.5		dBm
	MCS 9		-62		dBm
Maximum receive level	6 Mbps OFDM		-11		dBm
	54 Mbps OFDM		-16		dBm
	MCS0		-16		dBm
	MCS9		-16		dBm
Adjacent channel rejection (25 MHz offset)	6 Mbps OFDM			24	dB
	54 Mbps OFDM			6	dB
Adjacent channel rejection (25 MHz offset), BW = 20 MHz	MCS 0			23	dB
	MCS 8			0	dB
Adjacent channel rejection (40 MHz offset), BW = 40 MHz	MCS 0			23	dB
	MCS 9			2	dB
Adjacent channel rejection (80 MHz offset), BW = 80 MHz	MCS 0			23	dB
	MCS 9			2	dB

3.7.1.5 5 GHz Wi-Fi Receiver Specifications (Aux Path)

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-11. 5 GHz aux receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		4,915	-	5,925	MHz
Rx sensitivity	6 Mbps OFDM		-95.5		dBm
	9 Mbps OFDM		-94		dBm
	12 Mbps OFDM		-93		dBm
	18 Mbps OFDM		-90.5		dBm
	24 Mbps OFDM		-87.5		dBm
	36 Mbps OFDM		-83.5		dBm
	48 Mbps OFDM		-80		dBm
	54 Mbps OFDM		-78.5		dBm
Rx sensitivity BW = 20 MHz Green field 800 ns guard interval Non-STBC (HT20/VHT20)	MCS 0		-95		dBm
	MCS 1		-91.5		dBm
	MCS 2		-89.5		dBm
	MCS 3		-86.5		dBm
	MCS 4		-83.5		dBm
	MCS 5		-79		dBm
	MCS 6		-77.5		dBm
	MCS 7		-76		dBm
	MCS 8		-71.5		dBm
Rx sensitivity BW = 40 MHz Green field 800 ns guard interval Non-STBC (HT40/VHT40)	MCS 0		-92		dBm
	MCS 1		-88.5		dBm
	MCS 2		-86.5		dBm
	MCS 3		-83.5		dBm
	MCS 4		-80.5		dBm
	MCS 5		-76		dBm
	MCS 6		-74.5		dBm
	MCS 7		-72.5		dBm
	MCS 8		-68		dBm
	MCS 9		-66.5		dBm
Rx sensitivity BW = 80 MHz Green field 800 ns guard interval Non-STBC (VHT80)	MCS 0		-89		dBm
	MCS 1		-85.5		dBm
	MCS 2		-83		dBm
	MCS 3		-80		dBm
	MCS 4		-77		dBm
	MCS 5		-72		dBm
	MCS 6		-70.5		dBm
	MCS 7		-69.5		dBm
	MCS 8		-65		dBm
	MCS 9		-63.5		dBm

Parameter	Description	Min.	Typ.	Max.	Unit
Maximum receive level	6 Mbps OFDM		-11		dBm
	54 Mbps OFDM		-16		dBm
	MCS0		-16		dBm
	MCS9		-16		dBm
Adjacent channel rejection (25 MHz offset)	6 Mbps OFDM			24	dB
	54 Mbps OFDM			6	dB
Adjacent channel rejection (25 MHz offset), BW = 20 MHz	MCS 0			23	dB
	MCS 8			0	dB
Adjacent channel rejection (40 MHz offset), BW = 40 MHz	MCS 0			23	dB
	MCS 9			2	dB
Adjacent channel rejection (80 MHz offset), BW = 80 MHz	MCS 0			23	dB
	MCS 9			2	dB

3.7.1.6 5 GHz Wi-Fi Transmitter Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-12. 5 GHz transmitter specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		4,900	-	5,950	MHz
Output power VBAT = 3.6V Spectral mask and EVM compliance	802.11a, 6~54 Mbps OFDM		17		dBm
	802.11n, HT20 MCS0~7		16		dBm
	802.11n, HT40 MCS0~7		16		dBm
	802.11ac, VHT20 MCS8		15.5		dBm
	802.11ac, VHT40 MCS9		15		dBm
	802.11ac, VHT80 MCS9		15		dBm
EVM	802.11g, 6~54 Mbps OFDM @Pout = 15 dBm		-31		dB
	802.11n, HT20 MCS0~7 @Pout = 14 dBm		-31		dB
	802.11n, HT40 MCS0~7 @Pout = 14 dBm		-31		dB
	802.11ac, VHT20 MCS8 @Pout = 13.5 dBm		-33		dB

Parameter	Description	Min.	Typ.	Max.	Unit
	802.11ac, VHT40 MCS9 @Pout = 13 dBm		-33		dB
	802.11ac, VHT80 MCS9 @Pout = 13 dBm		-33		dB
Tx power accuracy	-40~85°C, 2~18 dBm			±1.5	dB
Transmitted power (Data rate = 54M, Pout = 17 dBm)	76~108 MHz			-149	dBm/Hz
	776~794 MHz			-149	dBm/Hz
	869~960 MHz			-149	dBm/Hz
	925~960 MHz			-149	dBm/Hz
	1,570~1,580 MHz			-149	dBm/Hz
	1,805~1,880 MHz			-149	dBm/Hz
	1,930~1,990 MHz			-149	dBm/Hz
	2,110~2,170 MHz			-149	dBm/Hz
Harmonic output power (Data rate = 6M, Pout = 17 dBm)	2nd harmonic			-16	dBm/MHz
	3rd harmonic			-22	dBm/MHz

3.7.1.7 Bluetooth BDR Receiver Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-13. Basic data rate receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,402		2,480	MHz
Receiver sensitivity	BER < 0.1%		-94		dBm
Max. usable signal	BER < 0.1%	-20	-1.5		dBm
C/I co-channel	Co-channel selectivity (BER < 0.1%)	-	2.5	11	dB
C/I 1 MHz	Adjacent channel selectivity (BER < 0.1%)	-	-14.5	0	dB
C/I 2 MHz	2nd adjacent channel selectivity (BER < 0.1%)	-	-40.5	-30	dB
C/I ≥	rd				dB
C/I image channel	Image channel selectivity (BER < 0.1%)	-	-30.5	-9	dB
C/I image 1 MHz	1 MHz adjacent to image channel selectivity (BER < 0.1%)	-	-47.5	-20	dB

Parameter	Description	Min.	Typ.	Max.	Unit
Out-of-band blocking	30~2,000 MHz	-10			dBm
	2,001~2,339 MHz	-27			dBm
	2,501~3,000 MHz	-27			dBm
	3,001 MHz ~ 12.75 GHz	-10			dBm
Intermodulation	Max. interference level to maintain 0.1% BER	-39	-26.5		dBm

3.7.1.8 Bluetooth BDR Transmitter Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-14. Basic data rate transmitter specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,402	-	2,480	MHz
Output power	At max. power output level		8		dBm
Power control step		2	4	8	dB
ICFT	Initial carrier frequency drift	-75	5	75	kHz
Carrier frequency drift	One slot packet (DH1)	-	6	25	kHz
	Three slot packet (DH3)	-	6	40	kHz
	Five slot packet (DH5)	-	6	40	kHz
	Max. drift rate	-	180	400	Hz/us
Modulation characteristic	$\Delta f1_{avg}$	140	156	175	kHz
	$\Delta f2_{max}$ (for at least 99% of all $\Delta f2_{max}$)	115	150	-	kHz
	$\Delta f2_{avg}/\Delta f1_{avg}$	0.8	0.98	-	
20-dB bandwidth		-	922	1,000	kHz
In-band spurious emission	±2 MHz offset		-44.5	-20	dBm
	±3 MHz offset		-46.5	-40	dBm
	> ±3 MHz offset		-43.5	-40	dBm
Out-of-band spurious emission	30 MHz ~ 1 GHz			-36	dBm
	1~12.75 GHz			-30	dBm
	1.8~1.9 GHz			-47	dBm
	5.15~5.3 GHz			-47	dBm

3.7.1.9 Bluetooth EDR Receiver Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.
(3) System performance will depend on the companion modem chip's capability.

Table 3-15. Enhanced data rate receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,402	-	2,480	MHz
Receiver sensitivity	π/4 DQPSK (BER < 0.01%)	-	-93	-70	dBm
	8PSK (BER < 0.01%)	-	-87.5	-70	dBm
Max. usable signal	π/4 DQPSK (BER < 0.1%)	-20	-4.5	-	dBm
	8PSK (BER < 0.1%)	-20	-4.5	-	dBm
C/I co-channel	π/4 DQPSK (BER < 0.1%)	-	6.5	13	dB
	8PSK (BER < 0.1%)	-	12.5	21	dB
C/I 1 MHz	π/4 DQPSK (BER < 0.1%)	-	-13.5	0	dB
	8PSK (BER < 0.1%)	-	-8.5	5	dB
C/I 2 MHz	π/4 DQPSK (BER < 0.1%)	-	-37.5	-30	dB
	8PSK (BER < 0.1%)	-	-34.5	-25	dB
C/I ≥ 3 MHz	π/4 DQPSK (BER < 0.1%)	-	-45.5	-40	dB
	8PSK (BER < 0.1%)	-	-44.5	-33	dB
C/I image channel	π/4 DQPSK (BER < 0.1%)	-	-31.5	-7	dB
	8PSK (BER < 0.1%)	-	-26.5	0	dB
C/I image 1 MHz	π/4 DQPSK (BER < 0.1%)	-	-48.5	-20	dB
	8PSK (BER < 0.1%)	-	-42.5	-13	dB

3.7.1.10 Bluetooth EDR Transmitter Specifications

Note:
(1) The specification value is valid at room temperature (25°C).
(2) All specifications are measured at the RF port unless otherwise specified.
(3) System performance will depend on the companion modem chip's capability.

Table 3-16. Enhanced data rate transmitter specifications

Parameter	Description		Min.	Typ.	Max.	Unit
Frequency range			2,402		2,480	MHz
Output power	π/4 DQPSK			5.5		dBm
	8PSK			5.5		dBm
Relative transmit power	π/4 DQPSK		-4	-1.5	1	dB
	8PSK		-4	-1.5	1	dB
Frequency stability	ω_0	π/4 DQPSK	-10	3	10	kHz
		8PSK	-10	3	10	kHz
	ω_i	π/4 DQPSK	-75	3	75	kHz
		8PSK	-75	3	75	kHz

Parameter	Description		Min.	Typ.	Max.	Unit
	$\lvert\omega_0+\omega_i\rvert$	π/4 DQPSK	-75	4	75	kHz
		8PSK	-75	4	75	kHz
Modulation accuracy	RMS DEVM	π/4 DQPSK	-	4	20	%
		8PSK	-	4	13	%
	99% DEVM	π/4 DQPSK	-	8	30	%
		8PSK	-	8	20	%
	Peak DEVM	π/4 DQPSK	-	9	35	%
		8PSK	-	13	25	%
In-band spurious emission	±1 MHz offset	π/4 DQPSK		-30.5	-26	dB
		8PSK		-28.5	-26	dB
	±2 MHz offset	π/4 DQPSK		-26.5	-20	dBm
		8PSK		-26.5	-20	dBm
	±3 MHz offset	π/4 DQPSK		-40.5	-40	dBm
		8PSK		-40.5	-40	dBm

3.7.1.11 Bluetooth LE Receiver Specifications

Note:
(1) The specification value is valid at room temperature (25°C).
(2) All specifications are measured at the RF port unless otherwise specified.
(3) System performance will depend on the companion modem chip's capability.

Table 3-17. Bluetooth LE receiver specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,402		2,480	MHz
Receiver sensitivity (*)	PER < 30.8%		-97	-70	dBm
Max. usable signal	PER < 30.8%	-10	-5.5		dBm
C/I co-channel	Co-channel selectivity (PER < 30.8%)		2.5	21	dB
C/I 1 MHz	Adjacent channel selectivity (PER < 30.8%)		-13.5	15	dB
C/I 2 MHz	2nd adjacent channel selectivity (PER < 30.8%)		-31.5	-17	dB
C/I ≥ 3 MHz	3rd adjacent channel selectivity (PER < 30.8%)		-34.5	-27	dB
C/I image channel	Image channel selectivity (PER < 30.8%)		-26.5	-9	dB
C/I image 1 MHz	1 MHz adjacent to image channel selectivity (PER < 30.8%)		-36.5	-15	dB
Out-of-band blocking	30~2,000 MHz			-30	dBm
	2,001~2,339 MHz			-35	dBm
	2,501~3,000 MHz			-35	dBm

Parameter	Description	Min.	Typ.	Max.	Unit
	3,001 MHz ~ 12.75 GHz			-30	dBm

3.7.1.12 Bluetooth LE Transmitter Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-18. Bluetooth LE transmitter specifications

Parameter	Description	Min.	Typ.	Max.	Unit
Frequency range		2,402	-	2,480	MHz
Output power(*)	Power output level	-20	1.5	6	dBm
Carrier frequency offset and drift	Frequency offset	-150	-2	150	kHz
	Frequency drift	-50	2	50	kHz
	Max. drift rate	-20	3	20	Hz/us
Modulation characteristics	$\Delta f1_{avg}$	225	251	275	kHz
	$\Delta f2_{max}$ (for at least 99% of all $\Delta f2_{max}$)	185	215		kHz
	$\Delta f2_{avg}/\Delta f1_{avg}$	0.8	0.88		
In-band spurious emission	±2 M offset		-48.5	-20	dBm
	> ±3 MHz offset		-52.5	-30	dBm

(*): Depends upon companion chip control setting

3.7.2 2.4 GHz Wi-Fi/BT Tx

The circuits in the Tx path of MT6631 are shared between Wi-Fi and Bluetooth to achieve minimum area. The data are digitally modulated in the baseband processor from the companion chip, then up-converted to 2.4 GHz RF channels through the DA converter, filter, IQ up-converter and power amplifier. The power amplifier is capable of transmitting 20dBm CCK power and 8dBm BDR power for Bluetooth class 1 operation.

3.7.3 2.4 GHz Wi-Fi/BT Rx

For Bluetooth, MT6631 uses a low IF receiver architecture. An image-rejecting mixer down-converts the RF signal to the IF with the LO from the synthesizer, which supports different clock frequencies. The mixer output is then converted to digital signal, down emodulation. A fast AGC enables the effective discovery of device within the dynamic range of the receiver.

For Wi-Fi, direct down-conversion receiver architecture is used, which includes a high linearity and low noise figure LNA, and a quadrature passive mixer and a bandwidth-programmable low-pass filter with DC offset cancellation embedded.

3.7.4 2.4 GHz Wi-Fi/BT Sx

A fractional-N frequency synthesizer is implemented to support both Wi-Fi and Bluetooth LO signal. The frequency synthesizer is capable of supporting various crystal clock frequencies. VCO operates at 2.5 times of RF frequency to avoid any coupling with RF front-end circuitry. An LO generation is employed to divide the VCO signal by 2.5 and generate I/Q quadrature signals.

3.7.5 5 GHz Wi-Fi Tx

The 5G transmitter utilizes the most cost efficient direct up architecture and integrates a high performance PA with on-chip balun. The data are digitally modulated in the baseband processor from the companion baseband chip, then up-converted to 5 GHz RF channels through the DA converter, low-pass filter, IQ up-converter and power amplifier. The power amplifier is capable of transmitting 17 dBm OFDM power.

3.7.6 5 GHz Wi-Fi Rx

Direct down-conversion receiver architecture is also used in 5G Wi-Fi Rx, which consists of a high linearity, low noise figure single-ended LNA with on-chip integrated T/R switch, a quadrature passive mixer and a bandwidth-programmable low-pass filter with DC offset cancellation embedded.

3.7.7 5 GHz Wi-Fi Sx

A-band Sx is an independent RF-PLL for a-band Wi-Fi RF use. It adopts 8/5xLO architecture while VCO frequency is RF frequency*8/5 to avoid xX pulling. Thus, it is composed of PLL, offset LO mixer and a repeater. Its integrated PN from 100 kHz to 10 MHz is less than 0.45 degree to ensure good Tx low-power EVM. It supports multi-frequency XTAL frequency from 19.2 MHz to 52 MHz. Typical application is 26 MHz reference clock input. In MT6631 application, typical Sx supply voltage is 1.8V, and internal cap-less LDO regulates this 1.8V into 1.35V for core circuit operation. Sx output frequency is 2xLO frequency (~11 GHz), and after IQ DIV2 of Tx and Rx, it generates I/Q quadrature phase to TRX mixer.

3.8 FM

3.8.1 FM Radio Description

FM radio subsystem integrates complete receiver supporting 65~108 MHz bands with 50 kHz tuning step. MT6631 performs fast channel seek/scan algorithm to validate 206 carrier frequencies (87.5~108 MHz) in six seconds. In addition to receiving FM audio broadcasting, the digital RDS/RBDS data system is supported as well. The integrated FM receiver utilizes state-of-the-art digital demodulation/modulation technique to achieve excellent performance.

In order to achieve high SINAD, good sensitivity and excellent noise suppression, the FM receiver adopts adaptive demodulation scheme to optimize the Rx system performance in all ranges of signal quality by referring to the Channel Quality Index (CQI). When receiving poor signals, MT6631 not only enhances the ACI rejection capability but also soft-mutes annoying noise to provide good perception quality.

The FM radio subsystem supports long antenna, which is usually in the earphone on the mobile device and short antenna, which is usually a FPC short antenna or shared antenna with GSM.

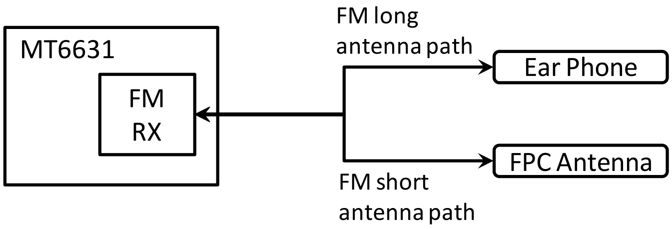


Figure 3-6. Long/short antenna application scenario

3.8.1.1 FM Specifications

Unless otherwise stated, all receiver characteristics are applicable to both long and short antenna ports when operated under the recommended operating conditions. Typical specifications are for channel 98 MHz, default register settings and under recommended operating conditions. The min./max. specifications are for extreme operating voltage and temperature conditions, unless otherwise stated.

Note:
(1) The specification value is valid at room temperature (25°C).
(2) All specifications are measured at the RF port unless otherwise specified.
(3) System performance will depend on the companion modem chip’s capability.

Table 3-19. FM specifications

Description	Condition	Min.	Typ.	Max.	Unit
Input frequency range		65		108	MHz
Sensitivity (long antenna)[1,3]	SINAD = 26 dB, unmatched		3		dBμVemf
	SINAD = 26 dB, matched		2		dBμVemf
RDS sensitivity (long antenna)	Δf = 2 kHz, BLER < 5%, unmatched		18		dBμVemf
RDS sensitivity (short antenna)	Δf = 2 kHz, BLER < 5%, unmatched		19		dBμVemf
LNA input resistance[4]	Antenna port		2.4k		Ohm
LNA input capacitance[4]	Antenna port		8		pF
AM suppression[1,4]	m = 0.3	50	60		dB
Adjacent channel selectivity[1,4]	±200 kHz	49	53		dB
Alternate channel selectivity[1,4]	±400 kHz	62	66		dB
Spurious response rejection[4]	In-band		55		dB
Maximum input level				130	dBμVemf
Audio mono SINAD[1,3,4]		56	60		dB
Audio stereo SINAD[2,3,4]		51	55		dB
Audio stereo separation[4]	Δf = 75 kHz		45		dB
Audio output load resistance	Single-ended at AFR/AFL outputs		10k		Ohm
Audio output load capacitance	Single-ended at AFR/AFL outputs		12.5		pF
Audio output voltage[1,4]	At AFR/AFL outputs		80		mVrms
Audio output THD[1,4]			0.05	0.1	%
Audio output frequency range	3 dB corner frequency	30		15k	Hz
[1] Δf = 22.5 kHz, fm = 1 kHz, mono, L = R					
[2] Δf = 22.5 kHz, fm = 1 kHz, 50s de-emphasis, stereo					
[3] A-weighting, BW = 300 Hz ~ 15 kHz					
[4] Vin = 60 dBμVemf					
[5] Reference clock accuracy assumes ideal FM source. If the input FM source has less frequency error, it is recommended to use a reference clock of accuracy within ±100 ppm so as not to affect the quality of channel scan.					

Description	Performance	
	Typ.	Unit

3.9 GPS

3.9.1 GPS Radio Description

The GPS RF consists of a low-IF receiver and a fractional-N frequency synthesizer. All RF/analog blocks operate under a 1.3V supply voltage. The radio architecture allows for configurations of GPS-only, Galileo-only, GPS/Galileo, GPS/Glonass, Galileo/Glonass, GPS/Beidou, Galileo/Beidou, GPS/Glonass/Beidou, and GPS/Glonass/Galileo modes, which are set by LO and baseband filter configurations.

Simultaneous reception of multiple satellite signals, i.e. GPS, Galileo, Glonass, and Beidou, allows a shorter time to first lock and higher location accuracy. Since different satellite signals are uncorrelated and are buried well below the noise floor, they can be amplified and down-converted by the same RF/analog chain as an image of one another and separated in the digital domain by the corresponding correlator and signal processor. In the case of GPS-only reception, LO (fLO_GPS) is set to 1,571.328 MHz resulting in an IF frequency of 4.092 MHz, with the baseband filter configured as complex BPF. On the other hand, for simultaneous GPS/Glonass reception, LO (fLO_GG) is set to 1,588.608 MHz. As a result, the GPS signal becomes the image of the Glonass satellite signal with an IF frequency of 13.1 MHz, and the baseband filter in this case is configured as real LPF. The Glonass signal is separated from the GPS image signal in digital baseband. Similarly, with LO (fLO_GB) set to 1,568.256 MHz, the resulting IF frequency is about 7.1 MHz for simultaneous GPS/Beidou reception. Finally for the GPS/Glonass/Beidou mode, LO (fLO_G3B) is set to 1,582.464 MHz which will cause the IF frequency to fall on -7 MHz, 19.2 MHz and -21.36 MHz respectively. Only one synthesizer is required to support this architecture.

3.9.1.1 GPS Mode Definition

GPS-only mode or Galileo-only mode

The receiver sets LO to 1,571.42 MHz and IF filter to complex BPF with center frequency of 4 MHz and bandwidth of 2 MHz.

GPS/Galileo mode

The receiver sets LO to 1,571.42 MHz and IF filter to complex BPF with center frequency of 4 MHz and bandwidth of 4 MHz.

GPS/Glonass mode or Galileo/Glonass mode

The receiver sets LO to 1,588.608 MHz and IF filter to LPF with bandwidth of 15 MHz.

GPS/Beidou mode or Galileo/Beidou mode

idth of 9 MHz. The receiver set

GPS/Glonass/Beidou mode or GPS/Glonass/Galileo mode

The receiver sets LO to 1,582.464 MHz and IF filter to LPF with bandwidth of 24 MHz.

3.9.1.2 GPS Specifications

Note:

(1) The specification value is valid at room temperature (25°C).

(2) All specifications are measured at the RF port unless otherwise specified.

(3) System performance will depend on the companion modem chip's capability.

Table 3-20. GPS RF specifications

GPS-only mode or Galileo-only mode or GPS/Galileo mode:

Parameter	Condition	Min.	Typ.	Max.	Unit
RF input frequency			1,575.42		MHz
LO frequency	LO frequency is 4.092 MHz lower than RF		1,571.42		MHz
LO leakage	Measured at balun matching network input at LNA high gain		-70		dBm
Input return loss	Single-ended input and external matched to 50 source using balun matching network for all gain	-10			dB
Gain (Av) (Note 1)	High current mode with max. PGA gain	80	78	76	dB
	Low current mode with max. PGA gain			58	
PGA gain range			24		dB
PGA gain step			2		dB
Gain compression	Blocker -25 dBm CW at 1,710 MHz, relative to uncompressed gain, max. PGA gain		1	2	dB
NF	High current mode with max. PGA gain		3		dB
ΔNF at gain = 62 dB	Relative to NF at max. gain		0.5	1	dB
ΔNF at gain = 52 dB	Relative to NF at max. gain		2	3	dB
NF under compression	Blocker -25 dBm CW at 1,710 MHz, max. gain		9	12	dB
Input IP3, inband	Max. gain, 5M/10M offset@-60 dBm	-33	-28		dBm
Input IP3, outband	Max. gain, ~2,000M/2,400M@-40 dBm	-13	-8		dBm
Input IP2, outband	Max. gain, ~800M/2,400M@-40 dBm	+32	+37		dBm
Input P1 dB, inband	PGA gain = 0 dB, offset 500k	-56	-53		
Frequency response, relative to 4.092 MHz, (GPS/Galileo)	At offset ±3 MHz		-12/-6		
	At offset ±10 MHz		-40/-34		
	At offset ±20 MHz		-60/-54		
	At offset ±100 MHz		-100/-94		
Gain ripple, GPS	4.092 ±1 MHz		1.0	1.5	dB

Parameter	Condition	Min.	Typ.	Max.	Unit
Gain ripple, Galileo	4.092 ±2 MHz		2.0	3.0	dB
Delay ripple, GPS	4.092 ±1 MHz		60	110	Ns
Delay ripple, Galileo	4.092 ±2 MHz		40	70	Ns
Image rejection	All mode		35		dB
DC offset			±50	±100	mV
Rx Current	High current mode		7.2		mA

GPS/Glonass mode 0r Galileo/Glonass mode:

Parameter	Condition	Min.	Typ.	Max.	Unit
RF input frequency	GPS/Glonass		1,575.42/ 1,601.71		MHz
LO frequency			1,588.608		MHz
LO leakage	Measured at balun matching network input at LNA high gain		-70		dBm
Input return loss	Differential input and external matched to 50 source using balun matching network for all gain	-10			dB
Gain (Av) (integrated average over Fc ±4M)	High current mode with max. PGA gain	80	76	70	dB
	Low current mode with max. PGA gain			52	
PGA gain range			24		dB
PGA gain step			2		dB
Gain compression	Blocker -25 dBm CW at 1,710 MHz, relative to uncompressed gain, max. PGA gain		1	2	dB
NF (integrated average over Fc ±4M)	High current mode with max. PGA gain		3		dB
ΔNF at gain = 56 dB	Relative to NF at max. gain		0.5	1	dB
ΔNF at gain = 46 dB	Relative to NF at max. gain		2	3	dB
NF under compression	Blocker -25 dBm CW at 1,710 MHz, max. gain		7	10	dB
Input IP3, inband	Max. gain, +10M/+20M offset@-70 dBm	-50	-45		dBm
Input IP3, outband	Max. gain, ~2,000M/2,400M@-40 dBm	-15	-10		dBm
Input IP2, outband	Max. gain, ~800M/2,400M@-40 dBm	+30	+35		dBm
Input P1 dB, inband	PGA gain = 0 dB, offset 500k	-58	-55		dBm
Frequency response (relative to 13.14M)	At 0~23 MHz		3	4	dB
	At 33 MHz		-25	-22	
	At 53 MHz		-43	-40	
	At 120 MHz		-66	-63	
	At 180 MHz		-85	-82	

Parameter	Condition	Min.	Typ.	Max.	Unit
LPF 3 dB bandwidth	(recom. 4th order Butterworth BW = 15M)		TBD		MHz
Gain ripple	13 ±1 MHz		0.5	1.0	dB
	13 ±4 MHz		2.0	3.0	
Delay ripple	13 ±4 MHz		10	14	Ns
Image rejection	All gain mode		35		dB
DC offset			±50	±100	mV
Rx current	High current mode		8.1		mA

GPS/Beidou mode:

Parameter	Condition	Min.	Typ.	Max.	Unit
RF input frequency	GPS/Beidou		1,575.42/ 1,561		MHz
LO frequency			1,568.2		MHz
LO leakage	Measured at balun matching network input at LNA high gain		-70		dBm
Input return loss	Differential input and external matched to 50 source using balun matching network for all gain	-10			dB
Gain (Av) (integrated average over Fc ±4M)	High current mode with max. PGA gain	80	76	70	dB
	Low current mode with max. PGA gain			52	
PGA gain range			24		dB
PGA gain step			2		dB
Gain compression	Blocker -25 dBm CW at 1,710 MHz, relative to uncompressed gain, max. PGA gain		1	2	dB
NF (integrated average over Fc ±2M)	High current mode with max. PGA gain		3		dB
ΔNF at gain = 56 dB	Relative to NF at max. gain		0.5	1	dB
ΔNF at gain = 46 dB	Relative to NF at max. gain		2	3	dB
NF under compression	Blocker -25 dBm CW at 1,710 MHz, max. gain		7	10	dB
Input IP3, inband	Max. gain, +10M/+20M offset@-70 dBm	-50	-45		dBm
Input IP3, outband	Max. gain, ~2,000M/2,400M@-40 dBm	-15	-10		dBm
Input IP2, outband	Max. gain, ~800M/2,400M@-40 dBm	+30	+35		dBm
Input P1 dB, inband	PGA gain = 0 dB, offset 500k	-58	-55		dBm
Frequency response (relative to 7.16M)	At 0~5 MHz		3	4	dB
	At 33 MHz		-43	-40	
	At 53 MHz		-60	-57	
	At 120 MHz		-83	-80	

Parameter	Condition	Min.	Typ.	Max.	Unit
	At 180 MHz		-100	-97	
LPF 3 dB bandwidth	(recom. 4th order Butterworth BW = 9M)		TBD		MHz
Gain ripple	7.2 ±1 MHz		0.5	1.0	dB
	7.2 ±2 MHz		1.0	2.0	
Delay ripple	7.2 ±2 MHz		40	70	Ns
Image rejection	All gain mode		35		dB
DC offset			±50	±100	mV
Rx current	High current mode		8.1		mA

GPS/Glonass/Beidou mode or GPS/Glonass/Galileo mode:

Parameter	Condition	Min.	Typ.	Max.	Unit
RF input frequency	GPS/Galileo/Glonass/Beidou		1,575.42/ 1,601.71/ 1,561		MHz
LO frequency	LO frequency is 4.092 MHz lower than RF		1,582.464		MHz
LO leakage	Measured at balun matching network input at LNA high gain		-70		dBm
Input return loss	Differential input and external matched to 50 source using balun matching network for all gain	-10			dB
Gain (Av) (integrated average over Fc ±4M)	High current mode with max. PGA gain	80	76	70	dB
	Low current mode with max. PGA gain			52	
PGA gain range			24		dB
PGA gain step			2		dB
Gain compression	Blocker -25 dBm CW at 1,710 MHz, relative to uncompressed gain, max. PGA gain		1	2	dB
NF (integrated average over Fc ±2M)	High current mode with max. PGA gain		3		dB
ΔNF at gain = 56 dB	Relative to NF at max. gain		0.5	1	dB
ΔNF at gain = 46 dB	Relative to NF at max. gain		2	3	dB
NF under compression	Blocker -25 dBm CW at 1,710 MHz, max. gain		7	10	dB
Input IP3, inband	Max. gain, +10M/+20M offset@-70 dBm	-50	-45		dBm
Input	Max. gain, ~2,000M/2,400M@-40				dBm
Input IP2, outband	Max. gain, ~800M/2,400M@-40 dBm	+30	+35		dBm
Input P1 dB, inband	PGA gain = 0 dB, offset 500k	-58	-55		dBm
Frequency response (relative to 7.16M)	At 0~5 MHz		3	4	dB

Parameter	Condition	Min.	Typ.	Max.	Unit
	At 33 MHz		-43	-40	
	At 53 MHz		-60	-57	
	At 120 MHz		-83	-80	
	At 180 MHz		-100	-97	
LPF 3 dB bandwidth	(recom. 5th order Butterworth BW = 24M)		TBD		MHz
Gain ripple	19.2 ±2 MHz		1.5	2	dB
	19.2 ±4 MHz		2	3	dB
Delay ripple	19.2 ±4 MHz		10	14	Ns
Image rejection	All gain mode		35		dB
DC offset			±50	±100	mV
Rx current	High current mode		10.3		mA

3.9.1.3 GPS Block Diagram

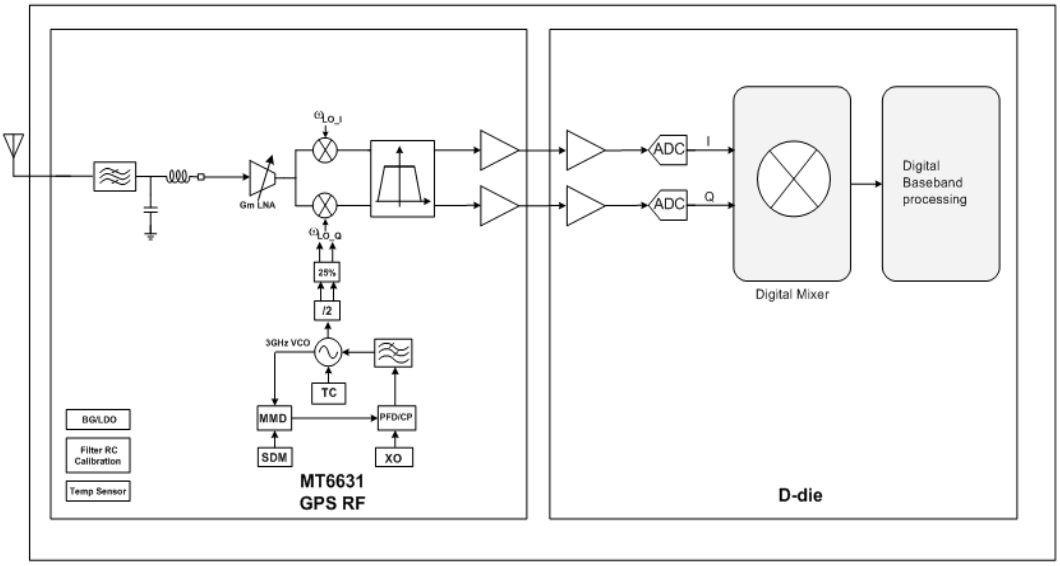


Figure 3-7. GPS block diagram

3.10 IPD

3.10.1 IPD Block Diagram for MT6631

- Integrated ISM balun-filter
- GPS MN provides filtering for co-existence.
- IPD configuration supports single, dual and triple antenna.

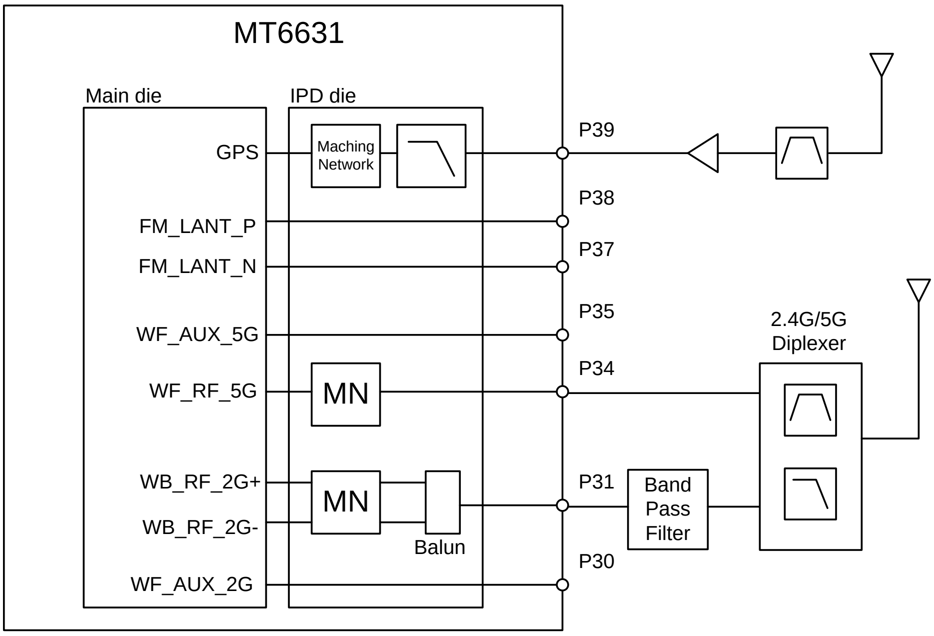
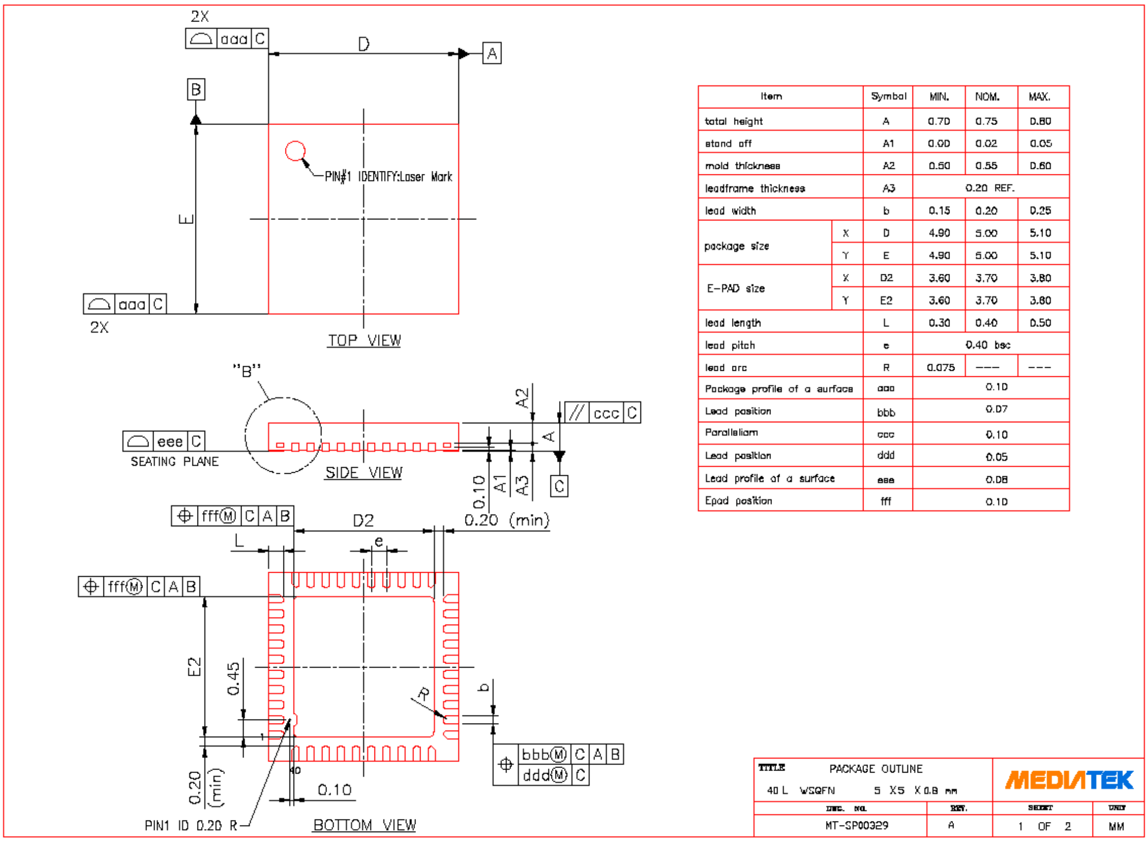


Figure 3-8. IPD block diagram for MT6631

4 Mechanical Information

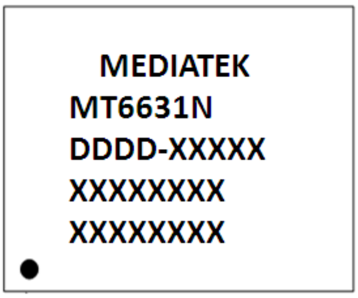
4.1 Device Physical Dimension/Part Number

MT6631 uses QFN40 package. The physical dimension is shown in Figure 4-1. MT6631 top view and part number information are shown in Figure 4-2.



Item		Symbol	MIN.	NOM.	MAX.
total height		A	0.70	0.75	0.80
stand off		A1	0.00	0.02	0.05
mold thickness		A2	0.50	0.55	0.60
leadframe thickness		A3	0.20 REF.		
lead width		b	0.15	0.20	0.25
package size	X	D	4.90	5.00	5.10
	Y	E	4.90	5.00	5.10
E-PAD size	X	D2	3.60	3.70	3.80
	Y	E2	3.60	3.70	3.80
lead length		L	0.30	0.40	0.50
lead pitch		e	0.40 bsc		
lead arc		R	0.075	---	---
Package profile of a surface		aaa	0.10		
Lead position		bbb	0.07		
Parallelism		ccc	0.10		
Lead position		ddd	0.05		
Lead profile of a surface		eee	0.08		
Epad position		fff	0.10		

Figure 4-1. Physical dimension of MT6631



MT6631N : Part number
DDDD : Date Code
XXXXXXX : Lot number

Figure 4-2. Top view of MT6631

4.2 Ordering Information

Order No.	Marking	Temperature range	Package
MT6631N/A	MT6631N	-40~85°C	QFN40

ESD CAUTION

MT6631 is ESD (electrostatic discharge) sensitive device and may be damaged with ESD or spike voltage. Although MT6631 is with built-in ESD protection circuitry, please handle with care to avoid the permanent malfunction or the performance degradation.

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