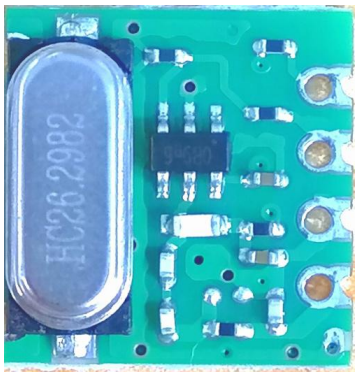
433MHz OOK Transmitter Module

KEY PRODUCT FEATURES

- Frequency Range:
  - 312 to 480 MHz (MDT110)
- OOK Modulation
- Symbol Rate: 0.5 to 40ksps
- Output Power: +13 dBm
- Supply Voltage: 2.0 to 3.6 V
- Current Consumption: 17.5 mA @ 433.92MHz
- Sleep Current:< 20 nA
- FCC / ETSI Compliant
- RoHS Compliant

APPLICATIONS

- Low-Cost Consumer Electronics Applications
- Home and Building Automation
- Remote Fan Controllers
- Infrared Transmitter Replacements
- Industrial Monitoring and Controls
- Remote Lighting Control
- Wireless Alarm and Security Systems
- Remote Keyless Entry (RKE)



GENERAL DESCRIPTION

The MDT110 devices are ultra low-cost, highly flexible, high performance, single-chip OOK transmitters module for various 433 MHz wireless applications. The MDT110 covers the frequency range from 312 to 480 MHz frequency range. With very low current consumption,the device modulates and transmits the data which is sent from the host MCU. The MDT110 uses a 1-pin crystal oscillator circuitwith the required crystal load capacitance integrated on-chip to minimize the number of external components.The MDT110 transmitter module together with the MDR2210/MDR2210H/MDR110 receiver module enables an ultra low cost RF link.

Abbreviations

Abbreviations used in this data sheet are described below

AN	Application Notes	**PA**	Power Amplifier
BOM	Bill of Materials	**PC**	Personal Computer
BSC	Basic Spacing between Centers	**PCB**	Printed Circuit Board
EEPROM	Electrically Erasable Programmable Read-Only Memory	**PN**	Phase Noise
		RCLK	Reference Clock
ESD	Electro-Static Discharge	**RF**	Radio Frequency
ESR	Equivalent Series Resistance	**RFPDK**	RF Product Development Kit
ETSI	European Telecommunications Standards Institute	**RoHS**	Restriction of Hazardous Substances
		Rx	Receiving, Receiver
FCC	Federal Communications Commission	**SOT**	Small-Outline Transistor
Max	Maximum	**SR**	Symbol Rate
MCU	Microcontroller Unit	**TWI**	Two-wire Interface
Min	Minimum	**Tx**	Transmission, Transmitter
MOQ	Minimum Order Quantity	**Typ**	Typical
NP0	Negative-Positive-Zero	**USB**	Universal Serial Bus
OBW	Occupied Bandwidth	**XO/XOSC**	Crystal Oscillator
OOK	On-Off Keying	**XTAL**	Crystal

433MHz OOK Transmitter Module

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433MHz OOK Transmitter Module

1.Electrical Characteristics

V_{DD} = 3.3 V, T_{OP} = 25 ℃, F_{RF} = 433.92 MHz, output power is +10 dBm terminated in a matched 50 Ω impedance, unless otherwise noted.

1.1.Recommended Operating Conditions

Table 1-1. Recommended Operation Conditions

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Voltage Supply	V_{DD}		2.0		3.6	V
Operation Temperature	T_{OP}	MDT110-ESR	-40		85	℃
Supply Voltage Slew Rate			1			mV/us

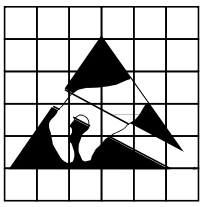
1.2.Absolute Maximum Ratings

Table 1-2. Absolute Maximum Ratings[1]

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		-0.3	3.6	V
Interface Voltage	V_{IN}		-0.3	V_{DD} +0.3	V
Junction Temperature	T_J		-40	125	℃
Storage Temperature	T_{STG}		-50	150	℃
Soldering Temperature	T_{SDR}	Lasts at least 30 seconds		255	℃
ESD Rating		Human Body Model (HBM)	-2	2	kV
Latch-up Current			-100	100	mA

Note:

[1]. Stresses above those listed as “absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.



Caution! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

433MHz OOK Transmitter Module

1.3.Transmitter Specifications

Table 1-3. Transmitter Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Frequency Range[1]	F_{RF}	MDT110	312		480	MHz
Output Power	$P_{OUT(Max)}$			+13		dBm
Current Consumption @ 433.92 MHz	$I_{DD433.92}$	+13 dBm, CW mode		17.5		mA
Current Consumption @ 868.35 MHz	$I_{DD868.35}$	+13 dBm, CW mode		19.5		mA
Sleep Current	I_{SLEEP}			20		nA
Symbol Rate	SR		0.5		40	ksps
Frequency Tune Time	t_{TUNE}			370		us
Phase Noise @ 433.92 MHz	$PN_{433.92}$	100 kHz offset from F_{RF}		-82		dBc/Hz
		200 kHz offset from F_{RF}		-83		dBc/Hz
		400 kHz offset from F_{RF}		-92		dBc/Hz
		600 kHz offset from F_{RF}		-97		dBc/Hz
		1.2 MHz offset from F_{RF}		-107		dBc/Hz
Phase Noise @ 868.35 MHz	$PN_{868.35}$	100 kHz offset from F_{RF}		-77		dBc/Hz
		200 kHz offset from F_{RF}		-78		dBc/Hz
		400 kHz offset from F_{RF}		-87		dBc/Hz
		600 kHz offset from F_{RF}		-93		dBc/Hz
		1.2 MHz offset from F_{RF}		-102		dBc/Hz
Harmonics Output for 433.92 MHz	$H2_{433.92}$	2 nd harm @ 867.84 MHz, +13 dBm P_{OUT}		< -45		dBm
	$H3_{433.92}$	3 rd harm @ 1301.76 MHz, +13 dBm P_{OUT}		< -45		dBm
Harmonics Output for 868.35 MHz	$H2_{868.35}$	2 nd harm @ 1736.7 MHz, +13 dBm P_{OUT}		< -45		dBm
	$H3_{868.35}$	3 rd harm @ 2605.05 MHz, +13 dBm P_{OUT}		< -45		dBm
OOK Extinction Ration				60		dB

Notes:

[1]. The frequency range is continuous over the specified range, and it is depend on crystal.

1.4.Crystal Oscillator

Table 1-4. Crystal Oscillator Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Crystal Frequency[1]	$F_{XTAL433.92}$	Frequency = 433.92MHz		26.2982		MHz
Crystal Tolerance[2]				± 20		ppm
Load Capacitance[3]	C_{LOAD}			15		pF
Crystal ESR	Rm				60	Ω
XTAL Startup Time[4]	t_{XTAL}			400		us

Notes:

[1]. The MDT110 can directly work with external reference clock input to XTAL pin (a coupling capacitor is required) with amplitude 0.3 to 0.7 Vpp.

[2]. This is the total tolerance including (1) initial tolerance, (2) crystal loading, (3) aging, and (4) temperature dependence. The acceptable crystal tolerance depends on RF frequency and channel spacing/bandwidth.

[3]. The required crystal load capacitance is integrated on-chip to minimize the number of external components.

[4]. This parameter is to a large degree crystal dependent.

2.Pin Descriptions

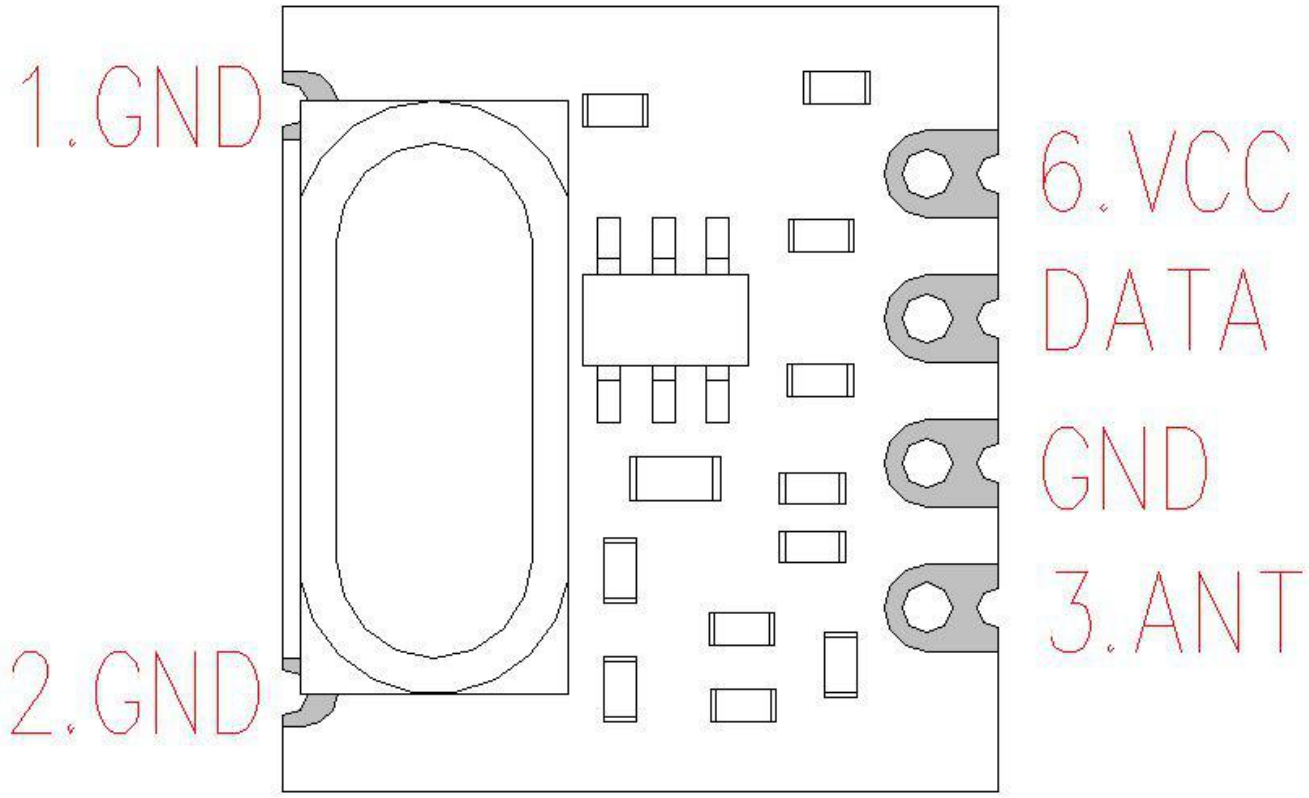


Figure 1. MDT110 Pin Assignments

Table 2-1.MDT110 Pin Descriptions

Pin Number	Name	I/O	Descriptions
1	GND	I	Ground
2	GND	I	Ground
3	ANT	O	Module Antenna terminal, Default terminal
4	GND	I	Ground
5	DATA	I	Data input to be transmitted
6	VCC	-	Module Power supply Positive

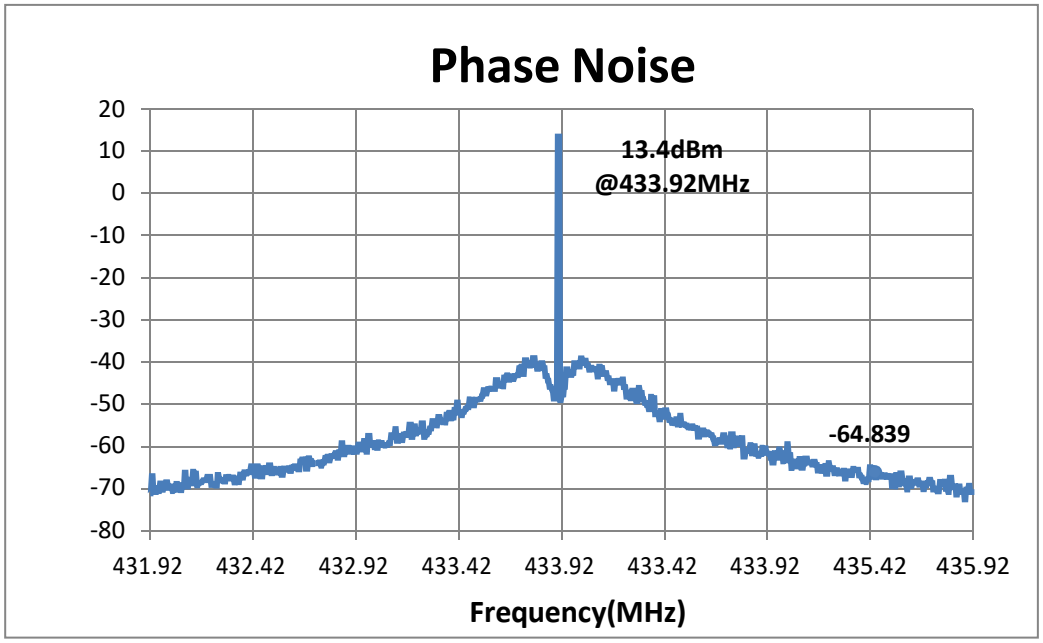


Figure 2. Phase Noise, F_{RF} = 433.92 MHz, P_{OUT} = +13 dBm, CW mode

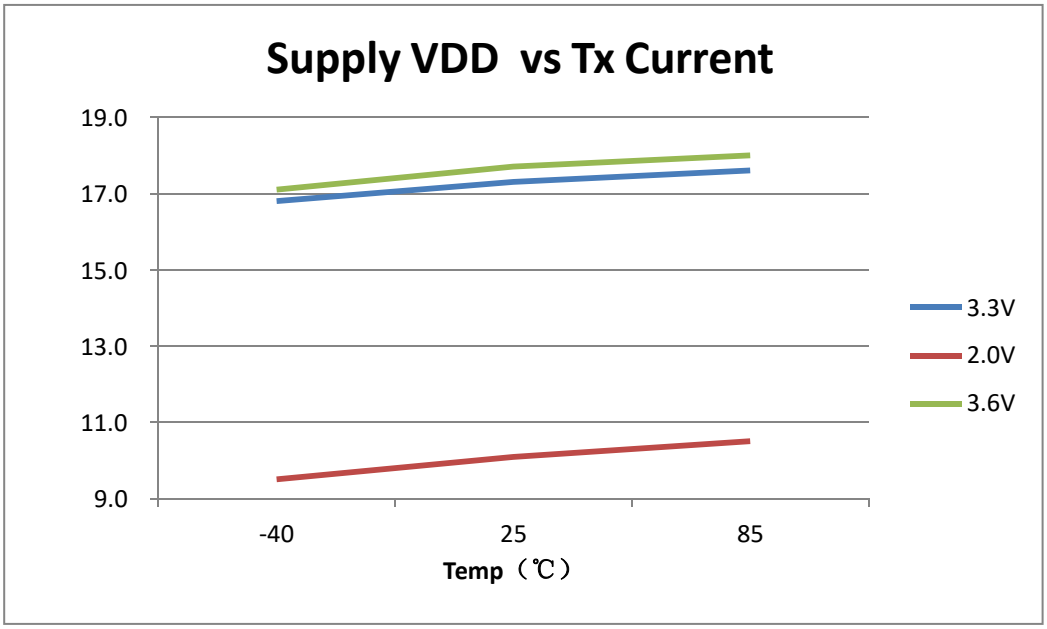


Figure 3. Tx Power – Rx Current – Supply VDD
F_{RF} = 433.92 MHz, P_{OUT} = +13 dBm, CW mode

3.Typical Application Schematics

3.1.Low-Cost Application Schematic

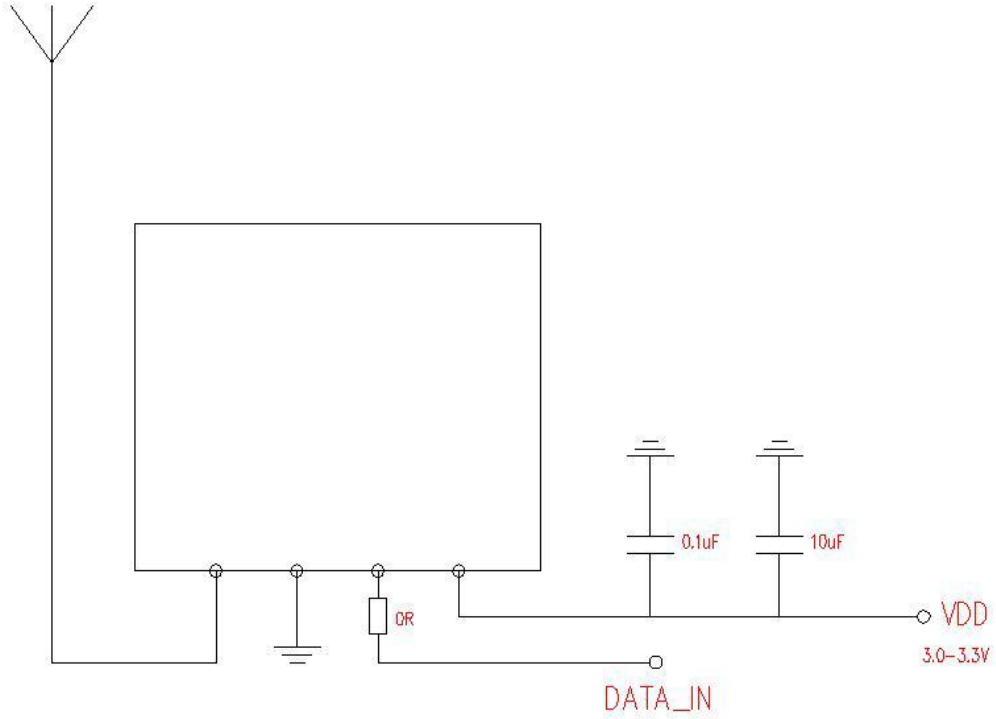


Figure 4. Application Schematic

4.Functional Descriptions

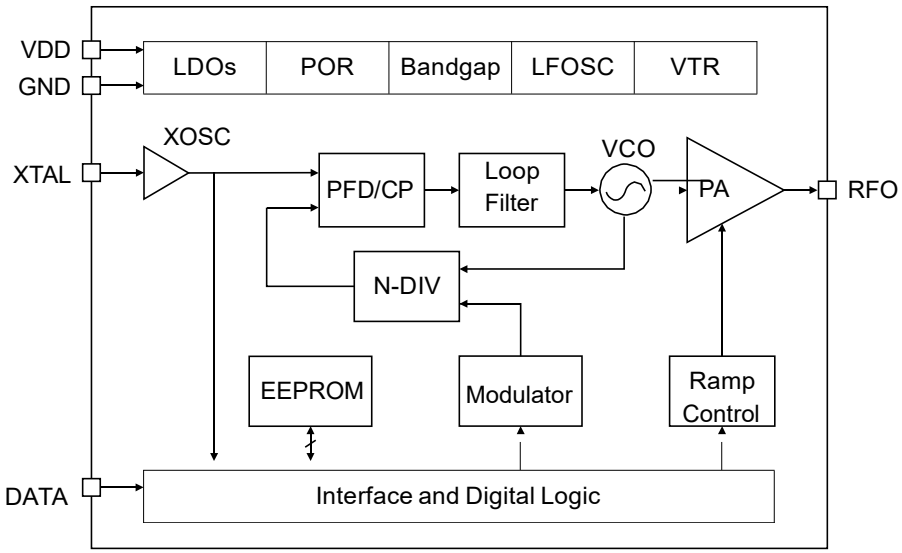


Figure 5. MDT110 Functional Block Diagram

4.1.Overview

The MDT110 is an ultra low-cost, highly flexible, high performance, single-chip OOK transmitter module for various 433 MHz wireless applications.The MDT110 covers the frequency range from 312 to 480 MHz frequency range. They are part of the CMOSTEK NextGenRF™ family, which includes a complete line of transmitters, receivers and transceivers. The chip is optimized for the low cost system, low power consumption, battery powered application with its highly integrated and low power design.

The functional block diagram of the MDT110 is shown in the figure above. The MDT110 is based on direct synthesis of the RF frequency, and the frequency is generated by a low-noise integer-N frequency synthesizer. It uses a 1-pin crystal oscillator circuit with the required crystal load capacitance integrated on-chip to minimize the number of external components. Every analog block is calibrated on each Power-on Reset (POR) to the highly accurate reference voltage internally. The calibration can help the chip to finely work under different temperatures and supply voltages. The MDT110 uses the DATA pin for the host MCU to send in the data. The input data will be modulated and sent out by a highly efficient PA which output power is +13 dBm. RF Frequency, The MDT110 operates from 2.0 to 3.6 V so that it can finely workwith most batteries to their useful power limits. Working under 3.3 V supply voltage when transmitting signal at +13 dBm power, it only consumes 17.5 mA at 433.92 MHz（CW Mode）.

4.2.Modulation, Frequency and Symbol Rate

The MDT110 supports OOK modulation with the symbol rate up to 40 ksps. The MDT110 covers the frequency range from 312 to 480 MHz, including the license free ISM frequency band around 315 MHz, 433.92 MHz.

Table 4-1. Modulation, Frequency and Symbol Rate

Parameter	Value	Unit
Modulation	OOK	-
Frequency(MDT110)	312 to 480	MHz
Symbol Rate	0.5 to 40	ksps

4.3.Power Amplifier

A highly efficient single-ended Power Amplifier (PA) is integrated in the MDT110 to transmit the modulated signal out. Depending on the application, the user can design a matching network for the PA to exhibit optimum efficiency at the desired output power for a wide range of antennas, such as loop or monopole antenna.

4.4.Crystal Oscillator and RCLK

The MDT110 uses a 1-pin crystal oscillator circuitwith the required crystal load capacitance integrated on-chip. Figure shows the configuration of the XTAL circuitry and the crystal model. The recommended specification for the crystal is about 26 MHz with ±20 ppm, ESR (Rm) <60 Ω, load capacitance C_{LOAD} about 15 pF.To save the external load capacitors, a set of variable load capacitors C_L is built inside the MDT110 to support the oscillation of the crystal.

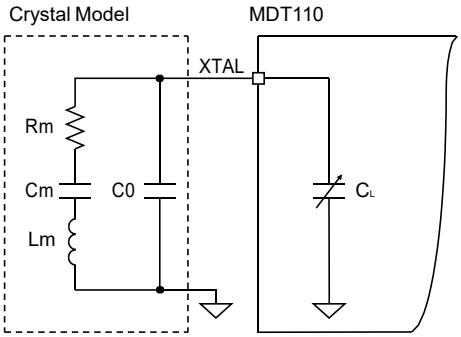


Figure 6. XTAL Circuitry and Crystal Model

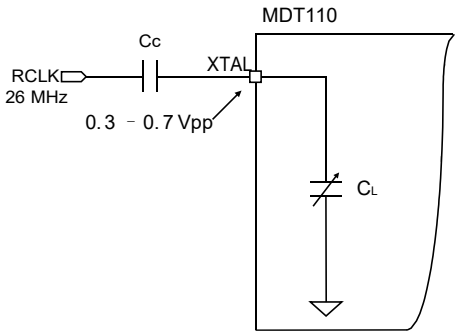


Figure 7. RCLK Circuitry

If a about 26 MHz RCLK (reference clock) is available in the system, the user can directly use it to drive the MDT110 by feeding the clock into the chip via the XTAL pin. This further saves the system cost due to the removal of the crystal. Acoupling capacitor is required if the RCLK is used. The recommended amplitude of the RCLK is 0.3 to 0.7 Vpp on the XTAL pin. Also, the user should set the internal load capacitor C_L to its minimum value. See Figure for the RCLK circuitry.

5.Working States and Transmission Control Interface

5.1.Working States

The MDT110 has 4 different working states: SLEEP, XO-STARTUP, TUNE and TRANSMIT.

5.1.1.SLEEP

When the MDT110 is in the SLEEP state, all the internal blocks are turned off and the current consumption is minimized to 20 nA typically.

5.1.2.XO-STARTUP

After detecting a valid control signal on DATA pin, the MDT110 goes into the XO-STARTUP state, and the internal XO starts to work. The valid control signal can be a rising edge on the DATA pin, which can be configured on the RFPDK. The host MCU has to wait for the t_{XTAL} to allow the XO to get stable. The $t_{XTAL}$is to a large degree crystal dependent. A typical value of t_{XTAL} is provided in Table .

5.1.3.TUNE

The frequency synthesizer will tune the MDT110 to the desired frequency in the time t_{TUNE}. The PA can be turned on to transmit the incoming data only after the TUNE state is done, before that the incoming data will not be transmitted. See Figure 3 for the details.

5.1.4.TRANSMIT

The MDT110 starts to modulate and transmit the data coming from the DATA pin. The transmission can be ended by: driving the DATA pin low for t_{STOP} time, where the t_{STOP} is fixed for 20 ms.

Table 5-1. Timing in Different Working States

Parameter	Symbol	Min	Typ	Max	Unit
XTAL Startup Time [1]	t_{XTAL}		400		us
Time to Tune to Desired Frequency	t_{TUNE}		370		us
Hold Time After Rising Edge	t_{HOLD}	10			ns
Time to Stop The Transmission	t_{STOP}		20		ms
Notes: [1]. This parameter is to a large degree crystal dependent.					

5.2.Transmission Control Interface

The MDT110 uses the DATA pin for the host MCU to send in data for modulation and transmission. The DATA pin is used as pin for data transmission, as well as controlling the transmission. The transmission can be started by detecting rising on the DATA pin, and stopped by driving the DATA pin low for t_{STOP} as shown in the table above.

As shown in the Figure 310, once the MDT110 detects a rising edge on the DATA pin, it goes into the XO-STARTUP state. The user has to pull the DATA pin high for at least 10 ns (t_{HOLD}) after detecting the rising edge, as well as wait for the sum of t_{XTAL} and t_{TUNE} before sending any useful information (data to be transmitted) into the chip on the DATA pin. The logic state of the DATA pin is “Don’tCare” from the end of t_{HOLD} till the end oft_{TUNE}.In the TRANSMIT state, PA sends out the input data after they are modulated. The user has to pull the DATA pin low for t_{STOP} in order to end the transmission.

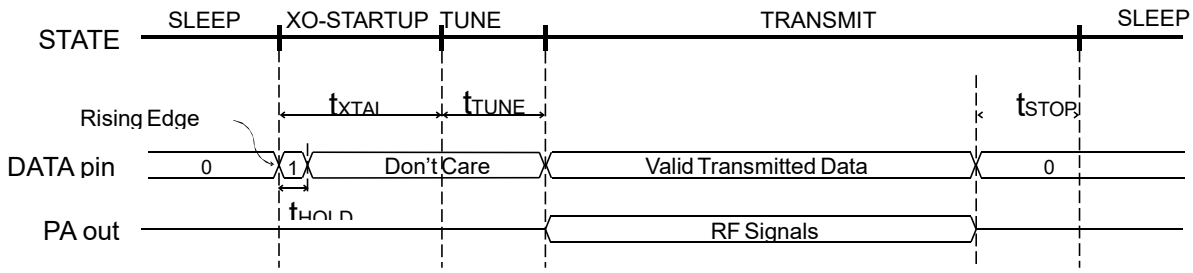
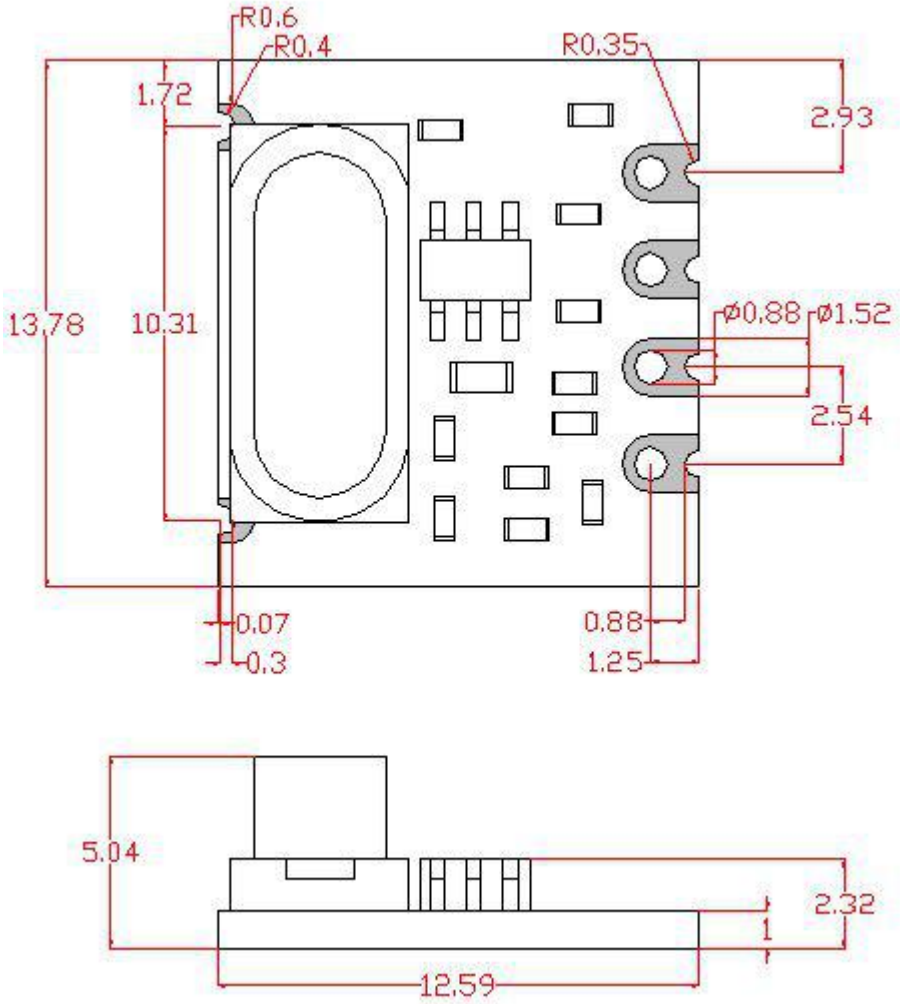


Figure 8. Transmission Enabled by DATA Pin Rising Edge

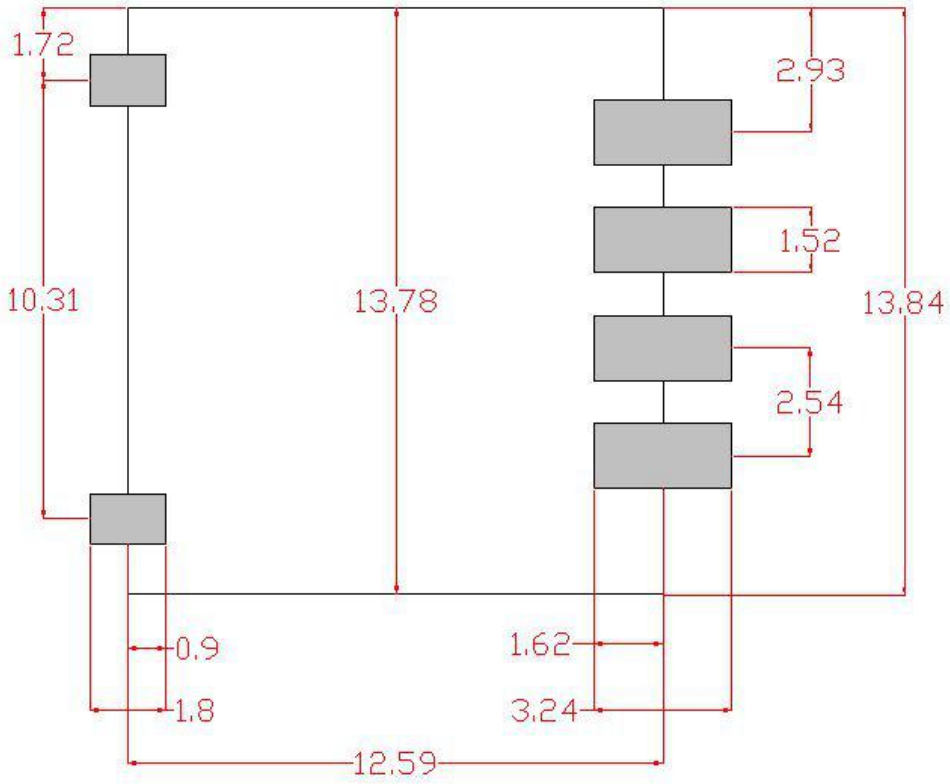
6. Module Package Outline Drawing

Unit: mm



7.Recommended PCB Land Pattern

Unit: mm



8.Tray packaging

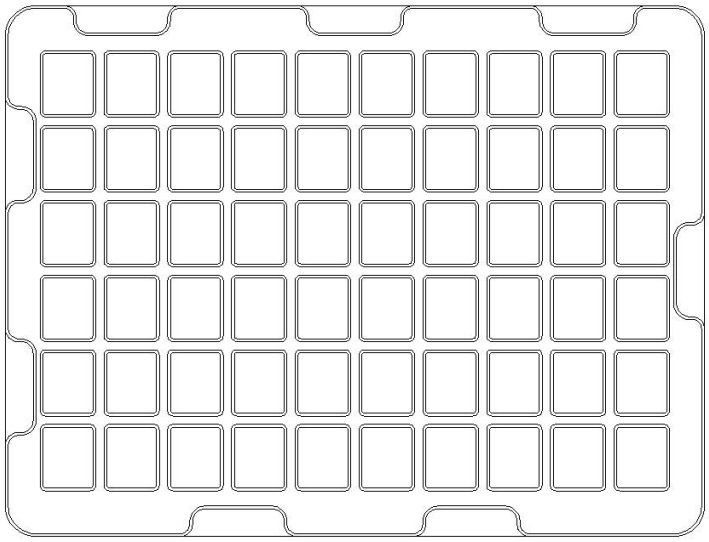
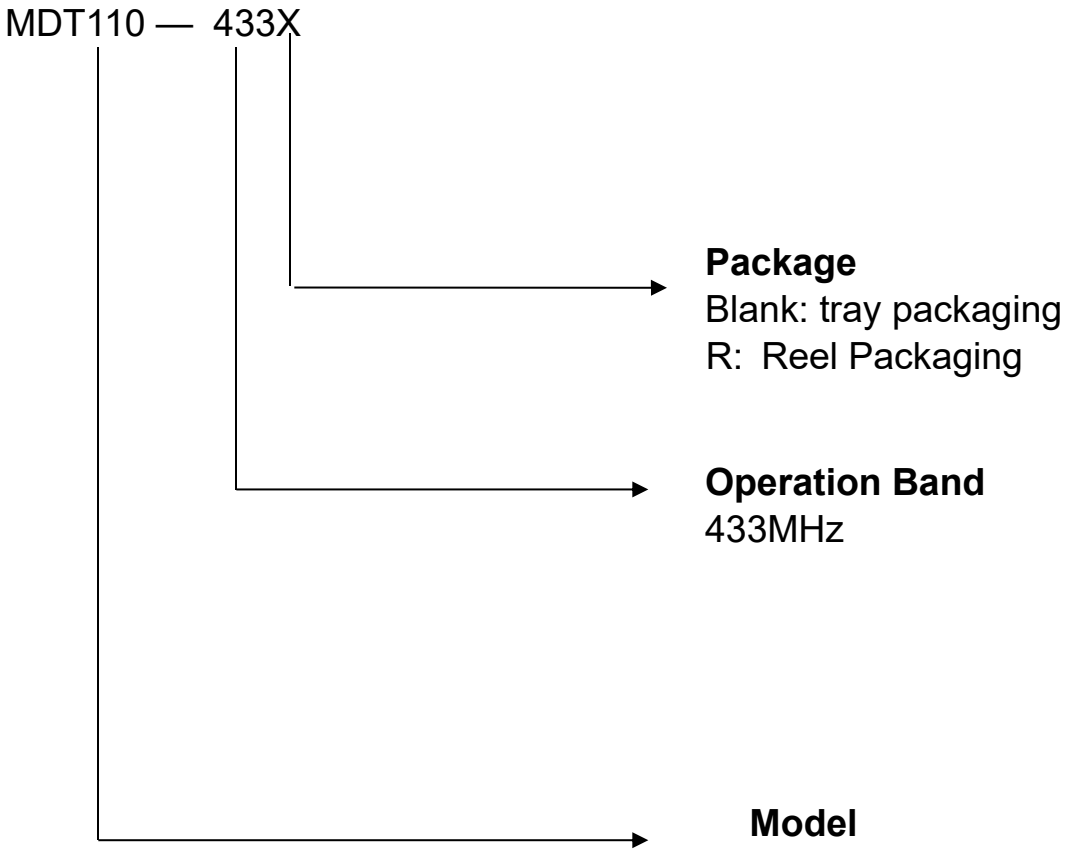


Figure 9. Package Outline Drawing

Note:

tray packaging, 60pcs/tray.

9.Ordering Information



10.Revision History

Table 10-1. Revision History

Revision	Date	Updated History
Rev1.0	January, 2017	The first final release

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