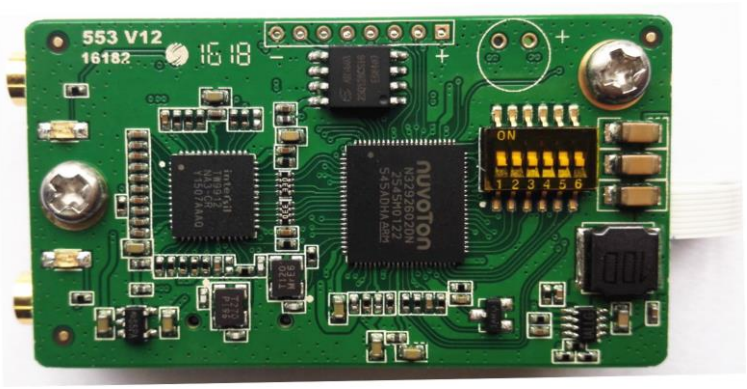
RAK553 Image Transmission Module

Specification V2.6



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Contents

1 Overview

1.1 Module overview

RAK553 supports IEEE802.111a/b/g/n wireless protocol and is an ultra-low power consumption intelligent image transmission module which support the CVBS input.It has small foot print and the easy using feature. The Module support the H.264 codec,the sound processor and is specially designed for accelerating video/audio streaming performance. To fast the evaluation, the user can get the demo Apps on Android, iPhone and other equipment to complete the play and display of audio and video. RAK553 integrates the high-speed serial port to use for transparent in interaction.

RAK553 integrates the WIFI Module ,which support IEEE 802.11a/b/g/n 2x2 MIMO.The module support the remote image transmission.

1.2 Application Field

- Air vehicle
- Smart toys
- Building Automation
- Logistics and freight management
- Family safety and automation
- Safety Inspection

1.3 Product Features

- Powerful WIFI
  - Support IEEE 802.11a/b/g/n protocol
  - TX Power ≤ 22dBm
  - Soft AP Mode
  - 2x2 300M PHY Rate
  - support Infra/Soft AP network type
  - support multiple security authentication mechanism: WEP64/WEP128/ TKIP/CCMP (AES) / WEP/WPA-PSK/WPA2-PSK
  - supporting many network protocol: TCP/UDP/ICMP/DHCP/DNS/HTTP

- Efficient video processing
  - support H.264/CIF/VGA/QVGA MJPG Stream
  - Continuous/Static JPEG/RTP Stream
  - Supports up to the 720p @ 25fps video resolution

- Pure Hardware engine
- Merged MJPG + MP3 Stream
- Separate MJPG + MP3 Stream
- Separate H.264 + PCMA Stream

- Input Interface
  - 1 UART for transparent and 1 high- speed UART
  - MIC Interface for audio
  - Video input Interface

- Module size

  55mm*30mm*16.3(±0.2)mm (DIP LED)

  55mm*30mm*13.1(±0.2)mm (Without LED)

1.4 Specifications

Parameters	Description
Video	VGA(640*480) 30FPS MJPEG /H.264Format Powerful hard-coding technique
Transmission distance	Work with RAK554(receiver):Effective distance: 1000m; Smooth video transmission: 500m. Only RAK553:Effective distance: 180m; Smooth video transmission: 100m.
Size	55mm*30mm*16.3(±0.2)mm (DIP LED) 55mm*30mm*13.1(±0.2)mm (Without LED)
Baud rate	115200bps (default) for transparent transmission, customers can modify it by command
Wireless parameters	Support IEEE 802.11a/b/g/n protocol,and Infra / Soft AP network; Support Soft AP connect.
power	Power supply:7.0V~~24V;Operation current :150mA(Typical Power Value: 12V); Wifi Peak current :300mA(Typical Power Value: 12V)
CPU	ARM926EJ-S
Operating system	Linux-2.6.35.5

2 Hardware Overview

2.1 Modules view

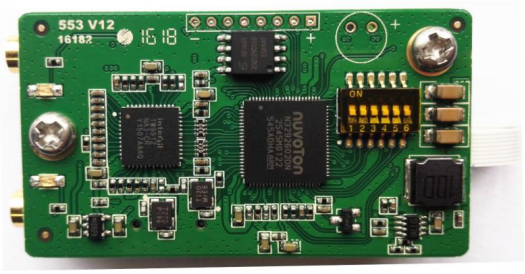


Figure 2-1 RAK553 module Top view

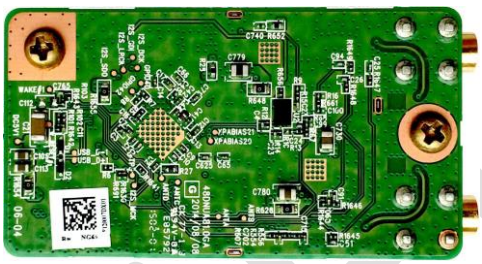


Figure 2-2 RAK553 module Bottom view

2.2 Module size

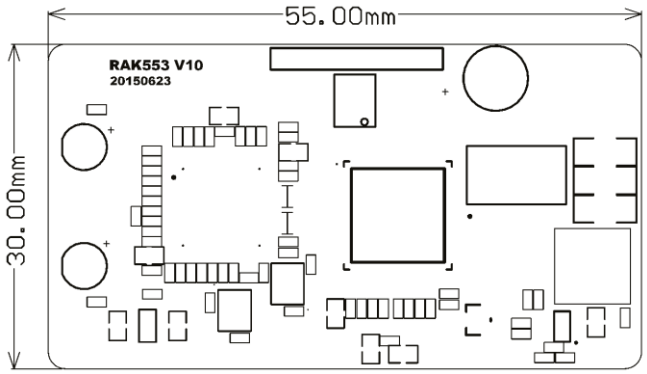
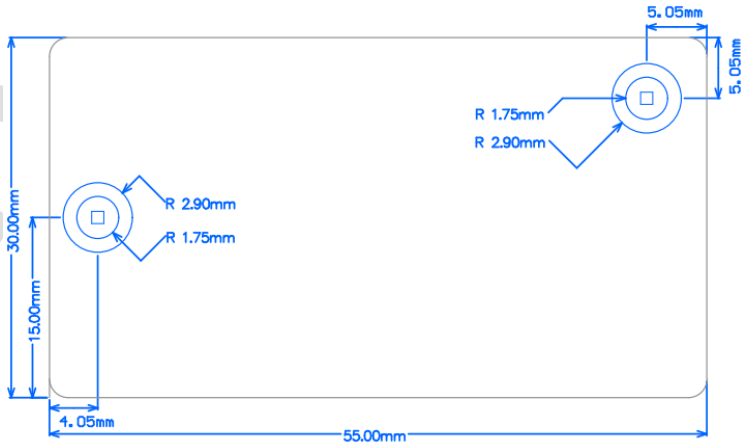


Figure 2-3 RAK553 Plane size

2.3 Location hole map



2.4 Pin definition

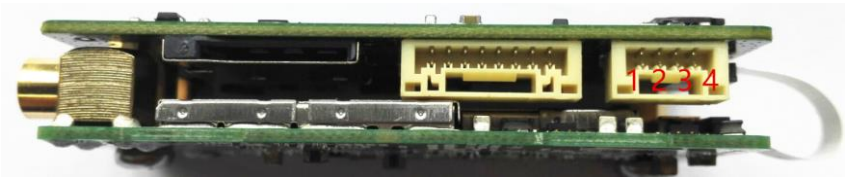


Figure 2-4 power supply

Pin	Name	Description	Remark
1	VDDIN	12V VCC	12V power input
2	VDDIN	12V VCC	12V power input
3	GND	GND	GND
4	GND	GND	GND

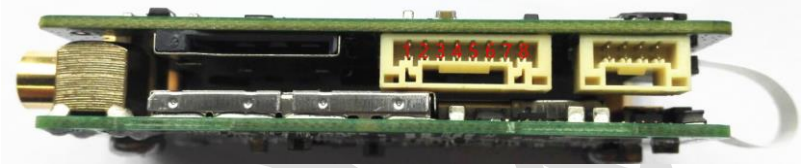


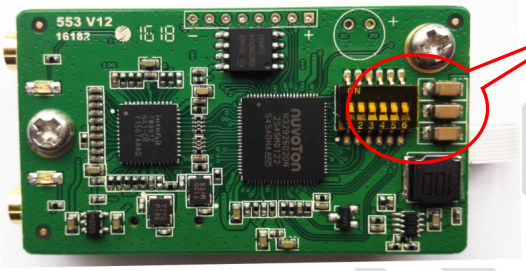
Figure 2-5 high-speed UART & Audio & video input interface

Pin	Name	Description	Remark
1	NC	Reserved	I/O
2	NC	Reserved	I/O
3	HUR_TXD	High-speed UART TXD	O
4	HUR_RXD	High-speed UART RXD	I
5	LINE_IN	LINE INPUT	I
6	AV_IN	PAL/NTSC Video Input	I
7	GND	GND	P
8	VCC12V	12V VCC	P

2.4 LED State

Note：LED will be changed by the demands of final customers.

2.5 Dip switch definition



There are 6 group Dial-up in the module . ON direction is showing low-level ,marked as 0.

When The Dial-up is on the opposite direcetion ,that is showing high-level,marked as 1 .

The dial-up flag order is 1-6,marked as sw1-6.

The function definition is followed ：

Sw6	Sw5	Band	Channel	Central Frequency
1	1	Band4	149	5745
1	0	Band1	48	5240
0	1	Band1	36	5180
0	0	Band4	165	5825

The default band is Band4. That is to say channel 149. If you are localing on china or Taiwan , you'd better set he channel to Band4 any channel .

Sw1 is using for WPS function . If you want to use this function , you need do the following steps.

1) Whatever the SW1 level , set SW1 into low-level more than 3 second .

2) Then Set SW2 into high-level .

3) The Wifi light will blink.that is showing you have step into the WPS mode.

3 RF Characteristic

Item	Key specifications
Chip	○ QCA AR9375
TX/RX	○ 2T2R
Frequency range	○ USA: 2.400 ~ 2.483GHz, 5.15 ~ 5.25GHz, 5.725 ~ 5.85GHz ○ Europe: 2.400 ~ 2.483GHz, 5.15 ~ 5.25GHz ○ Japan: 2.400 ~ 2.497GHz, 5.15 ~ 5.25GHz,
Modulation technique	○ 802.11 Legacy a/b/g DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM) DSSS (Direct Sequence Spread Spectrum) with DBPSK (Differential Binary Phase Shift Keying 1Mbps), DQPSK (Differential Quaternary Phase Shift Keying 2Mbps), and CCK (Complementary Code Keying 5.5&11Mbps), and OFDM (Orthogonal Frequency Division Multiplexing with BPSK for 6,9Mbps QPSK for 12,18Mbps 16QAM for 24,36Mbps 64QAM for 48,54Mbps) ○ 802.11n a/g
Host interface	○ USB 2.0
Channels support	○ 802.11n b/g US/Canada: 11 (1 ~ 11) Major European country: 13 (1 ~ 13) France: 4 (10 ~ 13) Japan: 11b: 14 (1~13 or 14th), 11g: 13 (1 ~ 13) ○ 802.11n a 1). US/Canada: channels (36,40,44,48,52, 149,153,157,161,165) 2). Europe: channel (36,40,44,48,52) 3). Japan: channels (36,40,44,48,52)
Operation voltage	○ 5V +/- 5%
Power consumption @25 ℃	802.11ng MCS8(40MHz) Avg: 350 (mA) 5V 802.11na MCS8(40MHz) Avg: 756

Output Power (Typical-for each chain; with ±2dB tolerance).

This power table bases on the maximum HW capability complying with IEEE spec regardless the regulatory limitation

- **802.11a**

Test Frequencies	6-24_Target	36_Target	48_Target	54_Target
5180	21	20	19	17
5320	21	20	19	17
5500	21	20	19	17
5600	21	20	19	17
5700	21	20	19	17
5825	21	20	19	17

- **802.11b**

Test Frequencies	1/2_Target	5.5_Target	11_Target
2412	16	16	16
2437	16	16	16
2472	16	16	16

- **802.11g**

Test Frequencies	6-24_Target	36_Target	48_Target	54_Target
2412	16	16	15	14
2437	16	16	15	14
2472	16	16	15	14

- **802.11n**

Freq. Range: HT20

Test Freq	MCS 0/8	MCS 1/9	MCS 2/10	MCS 3/11	MCS 4/12	MCS 5/13	MCS 6/14	MCS 7/15
5180	21	21	21	21	20	20	19	17
5240	21	21	21	21	20	20	19	17
5320	21	21	21	21	20	20	19	17
5500	21	21	21	21	20	20	19	17
5700	21	21	21	21	20	20	19	17
5745	21	21	21	21	20	20	19	17
5825	21	21	21	21	20	20	19	17

Freq. Range: HT40

Test Freq	MCS 0/8	MCS 1/9	MCS 2/10	MCS 3/11	MCS 4/12	MCS 5/13	MCS 6/14	MCS 7/15
5190	21	21	21	21	20	20	19	17
5230	21	21	21	21	20	20	19	17
5310	21	21	21	21	20	20	19	17
5510	21	21	21	21	20	20	19	17
5670	21	21	21	21	20	20	19	17
5755	21	21	21	21	20	20	19	17
5795	21	21	21	21	20	20	19	17

Freq. Range: HT20

Test Freq	MCS 0/8	MCS 1/9	MCS 2/10	MCS 3/11	MCS 4/12	MCS 5/13	MCS 6/14	MCS 7/15
2412	16	16	16	16	15	15	14	14
2437	16	16	16	16	15	15	14	14
2472	16	16	16	16	15	15	14	14

Freq. Range: HT40

Test Freq	MCS 0/8	MCS 1/9	MCS 2/10	MCS 3/11	MCS 4/12	MCS 5/13	MCS 6/14	MCS 7/15
2412	16	16	16	16	15	15	14	14
2437	16	16	16	16	15	15	14	14
2472	16	16	16	16	15	15	14	14

EVM

The transmit modulation accuracy is measured using error vector magnitude (EVM). EVM is the magnitude of the phase difference as a function of time between an ideal reference signal and the measured transmitted signal.

- **802.11a**

Modulation	Code Rate	Relative constellation error (dB) IEEE Spec (1Tx dB)	Relative constellation error (dB) Typical (1Tx dB)
BPSK	1/2	-5	-25
BPSK	3/4	-8	-25
QPSK	1/2	-10	-25
QPSK	3/4	-13	-25
16-QAM	1/2	-16	-25
16-QAM	3/4	-19	-28
64-QAM	2/3	-22	-30
64-QAM	3/4	-25	-31

- **802.11b**

Modulation	Code Rate	Relative constellation error (dB) IEEE Spec (1Tx dB)	Relative constellation error (dB) Typical (1Tx dB)
DBPSK		-10	-28
DQPSK		-10	-28
CCK		-10	-28

- **802.11g**

Modulation	Code Rate	Relative constellation error (dB) IEEE Spec (1Tx dB)	Relative constellation error (dB) Typical (1Tx dB)
BPSK	1/2	-5	-28
BPSK	3/4	-8	-28
QPSK	1/2	-10	-28
QPSK	3/4	-13	-28
16-QAM	1/2	-16	-28
16-QAM	3/4	-19	-29
64-QAM	2/3	-22	-29
64-QAM	3/4	-25	-29

- **802.11ng**

Modulation	Code Rate	Relative constellation error (dB) IEEE Spec (1Tx dB)	Relative constellation error (dB) Typical (1Tx dB)
HT20			
(MCS0) BPSK	1/2	-5	-25
(MCS1) QPSK	1/2	-10	-26
(MCS2) QPSK	3/4	-13	-26
(MCS3) 16-QAM	1/2	-16	-26
(MCS4) 16-QAM	3/4	-19	-29
(MCS5) 64-QAM	2/3	-22	-30
(MCS6) 64-QAM	3/4	-25	-30
(MCS7) 64-QAM	5/6	-27	-31
(MCS8) BPSK	1/2	-5	-25
(MCS9) QPSK	1/2	-10	-26
(MCS10) QPSK	3/4	-13	-26

	(MCS11)	16-QAM	1/2	-16	-26
	(MCS12)	16-QAM	3/4	-19	-29
	(MCS13)	64-QAM	2/3	-22	-30
	(MCS14)	64-QAM	3/4	-25	-30
	(MCS15)	64-QAM	5/6	-27	-31
	HT40				
	(MCS0)	BPSK	1/2	-5	-26
	(MCS1)	QPSK	1/2	-10	-27
	(MCS2)	QPSK	3/4	-13	-27
	(MCS3)	16-QAM	1/2	-16	-27
	(MCS4)	16-QAM	3/4	-19	-29
	(MCS5)	64-QAM	2/3	-22	-30
	(MCS6)	64-QAM	3/4	-25	-30
	(MCS7)	64-QAM	5/6	-27	-31
	(MCS8)	BPSK	1/2	-5	-26
	(MCS9)	QPSK	1/2	-10	-27
	(MCS10)	QPSK	3/4	-13	-27
	(MCS11)	16-QAM	1/2	-16	-27
	(MCS12)	16-QAM	3/4	-19	-29
	(MCS13)	64-QAM	2/3	-22	-30
	(MCS14)	64-QAM	3/4	-25	-30
	(MCS15)	64-QAM	5/6	-27	-31
	○ 802.11na				
EVM	Modulation		Code Rate	Relative constellation error (dB) IEEE Spec (1Tx dB)	Relative constellation error (dB) Typical (1Tx dB)
	HT20				
	(MCS0)	BPSK	1/2	-5	-25
	(MCS1)	QPSK	1/2	-10	-26
	(MCS2)	QPSK	3/4	-13	-26
	(MCS3)	16-QAM	1/2	-16	-26
	(MCS4)	16-QAM	3/4	-19	-29
	(MCS5)	64-QAM	2/3	-22	-30
	(MCS6)	64-QAM	3/4	-25	-30
	(MCS7)	64-QAM	5/6	-27	-31
	(MCS8)	BPSK	1/2	-5	-25
	(MCS9)	QPSK	1/2	-10	-26
	(MCS10)	QPSK	3/4	-13	-26
	(MCS11)	16-QAM	1/2	-16	-26
	(MCS12)	16-QAM	3/4	-19	-29
	(MCS13)	64-QAM	2/3	-22	-30
	(MCS14)	64-QAM	3/4	-25	-30
	(MCS15)	64-QAM	5/6	-27	-31
	HT40				
	(MCS0)	BPSK	1/2	-5	-26
	(MCS1)	QPSK	1/2	-10	-27
	(MCS2)	QPSK	3/4	-13	-27
	(MCS3)	16-QAM	1/2	-16	-27
	(MCS4)	16-QAM	3/4	-19	-29
	(MCS5)	64-QAM	2/3	-22	-30
	(MCS6)	64-QAM	3/4	-25	-30
	(MCS7)	64-QAM	5/6	-27	-31
	(MCS8)	BPSK	1/2	-5	-26
	(MCS9)	QPSK	1/2	-10	-27
	(MCS10)	QPSK	3/4	-13	-27

	(MCS11)	16-QAM	1/2	-16	-27
	(MCS12)	16-QAM	3/4	-19	-29
	(MCS13)	64-QAM	2/3	-22	-30
	(MCS14)	64-QAM	3/4	-25	-30
	(MCS15)	64-QAM	5/6	-27	-31

Sensitivity (1RX with +4/-2dB tolerance, dBm)

- 802.11a

Modulation	Code Rate	IEEE Spec (1Rx dBm)	Typical (1Rx dBm)
BPSK	1/2	-82	-88
BPSK	3/4	-81	-86
QPSK	1/2	-79	-85
QPSK	3/4	-77	-83
16-QAM	1/2	-74	-79
16-QAM	3/4	-70	-77
64-QAM	2/3	-66	-73
64-QAM	3/4	-65	-70

- 802.11b

Modulation	IEEE Spec (1Rx dBm)	Typical (1Rx dBm)
DBPSK	not specified	-93
DQPSK	not specified	-91
CCK	not specified	-87

- 802.11g

Modulation	Code Rate	IEEE Spec (1Rx dBm)	Typical (1Rx dBm)
BPSK	1/2	-82	-93
BPSK	3/4	-81	-91
QPSK	1/2	-79	-89
QPSK	3/4	-77	-86
16-QAM	1/2	-74	-83
16-QAM	3/4	-70	-80
64-QAM	2/3	-66	-75
64-QAM	3/4	-65	-70

- 802.11ng

Modulation	Code Rate	IEEE Spec (1Rx dBm)	Typical (1Rx dBm)
HT20			
(MCS0) BPSK	1/2	-82	-90
(MCS1) QPSK	1/2	-79	-87
(MCS2) QPSK	3/4	-77	-86
(MCS3) 16-QAM	1/2	-74	-84
(MCS4) 16-QAM	3/4	-70	-80
(MCS5) 64-QAM	2/3	-66	-77
(MCS6) 64-QAM	3/4	-65	-72
(MCS7) 64-QAM	5/6	-64	-67
HT40			
(MCS0) BPSK	1/2	-79	-88
(MCS1) QPSK	1/2	-76	-86
(MCS2) QPSK	3/4	-74	-84
(MCS3) 16-QAM	1/2	-71	-80
(MCS4) 16-QAM	3/4	-67	-78
(MCS5) 64-QAM	2/3	-63	-73
(MCS6) 64-QAM	3/4	-62	-70
(MCS7) 64-QAM	5/6	-61	-64

	○ 802.11na HT20 Modulation Code Rate IEEE Spec (1Rx dBm) (MCS0) BPSK 1/2 -82 -89 (MCS1) QPSK 1/2 -79 -87 (MCS2) QPSK 3/4 -77 -84 (MCS3) 16-QAM 1/2 -74 -80 (MCS4) 16-QAM 3/4 -70 -77 (MCS5) 64-QAM 2/3 -66 -72
Sensitivity (1RX with +4/-2dB tolerance, dBm)	(MCS6) 64-QAM 3/4 -65 -71 (MCS7) 64-QAM 5/6 -64 -67 HT40 (MCS0) BPSK 1/2 -79 -84 (MCS1) QPSK 1/2 -76 -81 (MCS2) QPSK 3/4 -74 -79 (MCS3) 16-QAM 1/2 -71 -76 (MCS4) 16-QAM 3/4 -67 -72 (MCS5) 64-QAM 2/3 -63 -70 (MCS6) 64-QAM 3/4 -62 -67 (MCS7) 64-QAM 5/6 -61 -64
Transmit spectrum mask	For transmitted spectral mask for 11a shall be less than –40dBr for fc–30MHz<f<fc+30MHz. For transmitted spectral mask for 11b shall be less than –50dBr for fc–22MHz<f<fc+22MHz. For transmitted spectral mask for 11g shall be less than –40dBr for fc–30MHz<f<fc+30MHz. For transmitted spectral mask for 11n 20MHz shall be less than –45dBr for fc–30MHz<f<fc+30MHz. For transmitted spectral mask for 11n 40MHz shall be less than –45dBr for fc–60MHz<f<fc+60MHz.
Transmit spectrum flatness	For 802.11a/g the average energy of the constellations in each of spectral lines –16..-1 and +1..+16 will deviate no more than +/- 2dB from their average energy. For 802.11n 40MHz mode, the average energy of the constellations in each of spectral lines –42..-2 and +2..+42 will deviate no more than +/- 2dB from their average energy. The transmitted spectral flatness should be with in +2/- 4dB.
Transmit center frequency tolerance	The transmitted center frequency tolerance shall be ±20 ppm maximum.
Receiver maximum input level	Modulation Code Rate IEEE Spec (1Rx dBm) >-30 802.11b Modulation IEEE Spec (1Rx dBm) DBPSK >-10 DQPSK >-10 CCK >-10 802.11g Modulation Code Rate IEEE Spec (1Rx dBm) >-20

	◴ **802.11na** **Modulation Code Rate IEEE Spec (1Rx dBm)** **>-30** ◴ **802.11ng** **Modulation Code Rate IEEE Spec (1Rx dBm)** **>-20**
Transfer data rate	◴ **802.11a: 6, 9, 12, 18, 24, 36, 48, 54Mbps** ◴ **802.11b: 1, 2, 5.5, 11Mbps** ◴ **802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps** ◴ **802.11n: @800GI(400GI)** z **20MHz BW** **1 Nss: 65(72.2) Mbps maximal** **2 Nss: 130(144.444) Mbps maximal** z **40MHz BW** **1 Nss: 135(150) Mbps maximal** **2 Nss: 270(300) Mbps maximal**

4 Electrical Characteristics

4.1 Absolute maximum

The table below gives the absolute maximum value, exceed the maximum range may make the module device damaged. In order to avoid the modules and devices damaged please operate under specified conditions.

Table 4-1: parameter and range

parameters	Symbol	value	uint
The external power supply voltage	VDDIN	7~~24	V
IO maximum input voltage	$3V3V_{in}IOMax$	3.6	V
IO minimum input voltage	$3V3V_{in}IOMin$	-0.3	V
Storage temperature	T_{store}	-40~+125	℃
Operation temperature	T_{oper}	-20~+65	℃

4.2 Recommended operating parameters

Figure 4-2 Power supply range

parameters	Symbol	minimum	Typical values	maximum	unit
Power supply	VDD	7.0	12.0	24.0	V

5 Order Information

Table 5-1: Product Models

PART NO.	Description	Volume/tray	MPQ
RAK553	Image transmission,plug and play.	12PCS/tray	60PCS

6 Sales and Technical Support

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7 Revision&History

Revision	Update	Date
V0.1	Update picture and format.	2014-07-08
V0.2	Update the contact way,Update the document format.	2014-08-22
V0.3	Updated pictures and transmit distance,modify product feature,add order info and sales services.	2014-10-22
V0.4	Update the new module picture, size and pin definitions.	2015-04-07
V0.5	Adding UART transparent transmission-related information.	2015-04-17
V0.6	Update the power supply.	2015-05-17
V0.7	Update the new module and hardware physical map marked. Update the power supply parameters.	2015-07-13
V2.0	Add the LED light instruction. And release the document.	2015-08-31
V2.1	Add the Dial-up definition. 1，Add the channel selection. 2，Add the WPS function .	2015-10-11
V2.2	Modify the PIN definition of 8PIN eGH from PWM to NC.	2015-11-11
V2.3	Add the location hole position	2016-02-29
V2.4	Delete some error description for audio and video resolution.	2016-08-25
V2.5	1，Update sales and Technical Support. 2，update module picture.	2016-11-10
V2.6	Fixed the channel list for the switcher .	2017-03-03