Difference between Wide band and Narrow band Radio Module

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Valuable Radio Spectrum Resource

Radio spectrum is a limited resource. Arranging the transmission frequency efficiently becomes necessary, because interferences always happened if the transmissions occurred at the same time, in the same area, with the same frequency. That is the reason why most countries institute tight radio regulations for application of radio spectrum.

Expanding application of radio communication

Radio communication methods are classified into Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), and Code Division Multiple Access (CDMA). FDMA is the conventional communication method that is widely used for frequency band of under 1GHz. More and more kinds of high frequency radio module and one-chip radio IC can be easily found on the market, which makes the component selection for different application much easier.

Suitable Frequency under 1GHz for Mobile Communication

The frequency band over 1GHz such as Wireless LAN, C-band used for satellite broadcast, and KU-band is well suited to fixed communication. While the frequency band under 1GHz is well suited to mobile communication. As well known, high frequency radio wave has same characteristic as light, the frequency band over 1GHz has stronger straight directional transmission characteristic. Normally the frequency band of over 1GHz is used for fixed high-speed data communication, while under 1GHz is for low or medium-speed mobile communication.

Available frequency under 1GHz for license exempt application

In Europe, the 434MHz has been approved frequency band of ISM applications for decades, and 868MHz band has also been approved in recent years. More and more radio module and radio chip for these frequency bands have been provided by various manufactures. Among them, the ICs integrated with transceiver circuit and PLL synthesizer, and quadrature modulation/demodulation based direct conversion technologies are becoming more popular.

5mW-10mW limitation of transmission output power

Without radio license, the high-output power is not allowed to be transmitted. Although different country has different regulation, generally 10mW is the maximum power limit.
Within this limit, the requested transmission range is always related with product cost and the application, but the range will become the key point whether one-chip radio IC or discrete radio module is adopted.

100m line of sight is border line

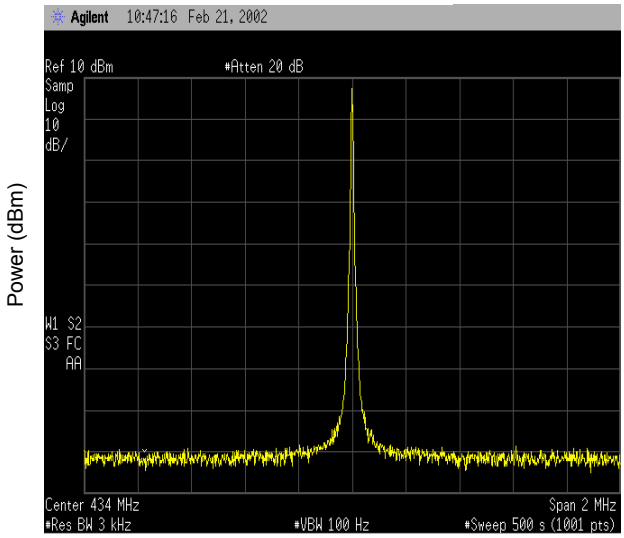
An efficient antenna of transmitter and receiver is an important factor of transmission range. But based on our test result, one-chip radio IC is recommended for the low cost application with range of less than 100 meters. Radio module is recommended for the applications that request a range of more than 100 meters.

Why the communication range is different

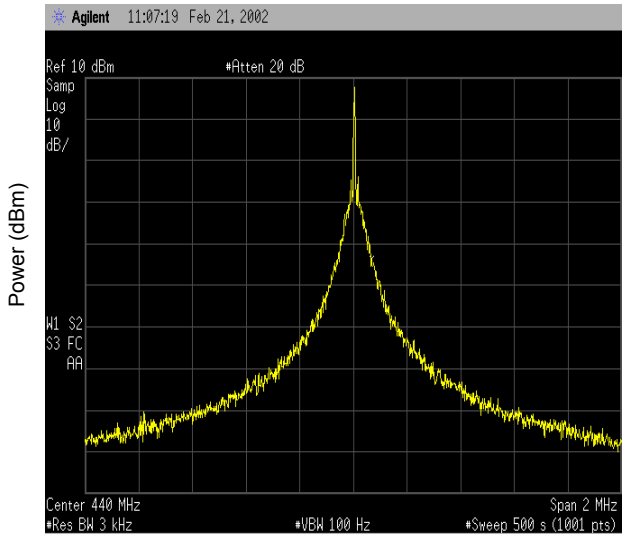
The transmission range of narrow band and wide band device are quite different. The receiver sensitivity of one chip radio IC is –100dBm, while some good radio module has sensitivity with –120dBm. The difference is 20dB. This 20dB difference of receiver sensitivity equals to the overall transmitter difference of 1/100. Converted to transmission power, the difference is just like 100 uW and 10mW. The reason of this

difference is that it is difficult for one chip radio IC constituted by only semiconductor to narrow the receiver bandwidth, and IF (Intermediate Frequency) amplifier stage amplify the signal in wide band like Video amplifier. In addition, to make the transceiver VCO carrier purity of one chip radio IC up is more difficult than discrete components VCO.
Figure A shows the transmission spectrum of narrow band radio module in the frequency of 434 MHz with 2MHz span. Figure B shows the frequency spectrum of wide band one-chip radio IC. As you can see that one chip radio IC shows worse carrier purity, therefore the number of devices, which can operate at same time, is limited. The discrete receiver (radio module) has a SAW filter that blocks off unwanted radio wave of out of band at high frequency amplifier stage to avoid interference, a Crystal Monolithic Filter (CMF) with sharp selectivity for the first stage IF amplifier, and a ceramic filter at the second stage IF amplifier to make selectivity to 7.5kHz.

Figure A: Transmission spectrum
Narrow band radio



FigureB: Transmission spectrum
Wide band radio



Disadvantage of Narrow band communication

Since the receiver bandwidth is narrow, it is difficult for high-speed data communication. Generally, data speed is limited less than 9600bps, and the request for frequency stability is several PPM, which is about the same as TCXO. Of course, as a frequency standard, temperature compensation is necessary for crystal oscillation circuit. Narrow band Radio module is constituted of these discrete components, thus cost is higher and size is bigger than wideband one-chip radio IC. This is the disadvantage.

Advantage of Narrow band communication

The merit of narrow band communication is to realize stable long-range communication. In addition to, the carrier purity of transmission spectrum is very good, therefore it is available to manage an operation of many radio devices within same frequency bandwidth at same time. In other words, it leads the high efficiency of radio wave use within same frequency band. Figure C shows transmission spectrum of narrow band, and figure D shows receiver selectivity characteristic of narrow band, that are measured at 250kHz span. As shown in those figures, the noise level at 50kHz from fundamental carrier level is 80dB lower than the carrier, thus it is possible to make the other radio communication in the band. Narrow band communication is the optimal in the site where many radio-control equipments are used, such as a construction site or an industrial plant.

Figure C: Transmission spectrum
Condition: Input signal: PN9 9600bps
Narrow band transmitter: Input PN9, 9600bpsDev. +/- 2.4kHz

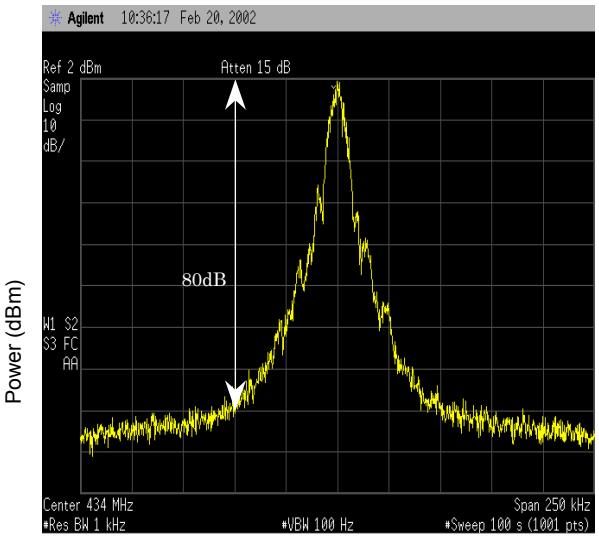
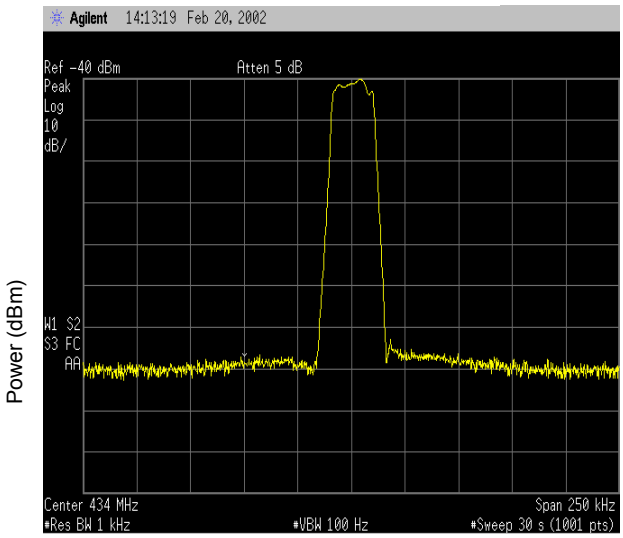


Figure D: Receiver selectivity

Narrow band receiver



Significant difference of the interference characteristic

Since there are repeater of armature radio station, GSM base station, and TETRA that is sending high power radio wave in Europe, it is important to reject interference when using low-power equipments. Also, it is considered that emission from other radio devices opening line at same band cause interference. Figure E shows the receiver interference characteristic of narrow band and figure F shows that of wide band. We measured the error level when jamming signal, which is 50kHz away from carrier, is applied to the receiver in communication. Even if jamming signal 50dB higher than receiver level is applied, error does not occur with narrow band receiver, but error occurs with wide band receiver by applying even 5dB high jamming signal.

Figure E: Interference against narrow band radio
(+50dB Jamming signal)
CH1 Transmitter input (1.0.1.0.1…repeated signal / 9600bps)
CH2 Receiver output

Carrier Frequency: 434MHz dev.+/-2.4kHz level –80dBm
Jamming Frequency: 434.05MHz 400Hz AM 80% level –30dBm

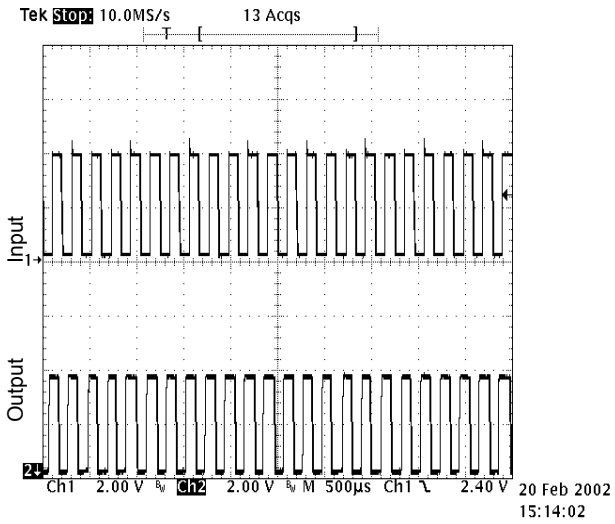
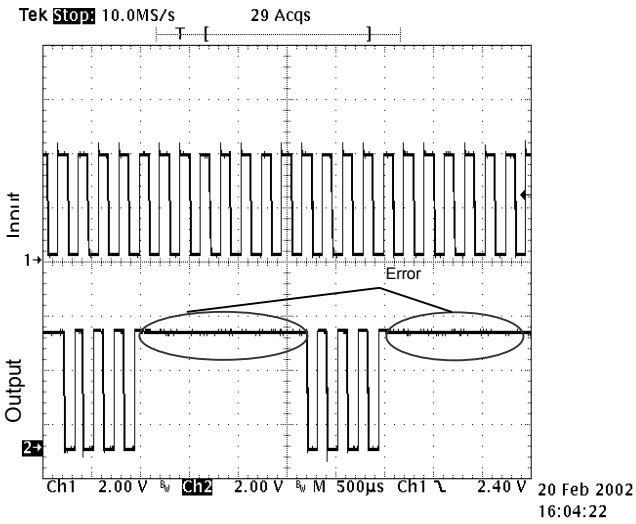


Figure F: Interference against wide band radio
(+5dB Jamming signal)
CH1 Transmitter input (1.0.1.0.1…repeated signal / 9600bps)
CH2 Receiver output

Carrier Frequency: 440MHz dev.+/-10kHz level –80dBm
Jamming Frequency: 440.05MHz 400Hz AM 80% level –75dBm



One-chip radio IC is recommended for the key-less entry system which functions lock/un-lock of a car door at close range, or radio part of barcode reader which has re-send function when data error occurs. Narrow band communication is mainly required for industrial use, such as the tele-control system of construction equipments required in real time communication, or industrial plant where stable communication is required in the concrete walls building.
Circuit Design, Inc. has products which find vacant channels and build a radio link automatically.

Circuit Design, Inc designs and manufactures CE-compliant FM low power radio data transmitter / receiver and transceiver modules for 433MHz, 868MHz and 2.4GHz band. If you need further information of our company and products, please visit http://www.circuitdesign.jp or contact our local distributors.

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