Low-Cost Test Solution for ASK/FSK Wireless Devices

Using Agilent Basic RF Instruments

Application Note

Agilent N9310A RF signal generator

Agilent N9320B RF spectrum analyzer

Overview

ASK/FSK modulation has been widely adopted in low power, low data rate RF communications because it ties low cost, high performance wireless connectivity with long battery life. Today, ASK/FSK modulation technology is embedded in a variety of products and systems, ranging from personal consumer electronics and automatic meter reading, to giant industrial devices.

Agilent Technologies

Challenges in Product Test

DID YOU KNOW FSK ENABLES...

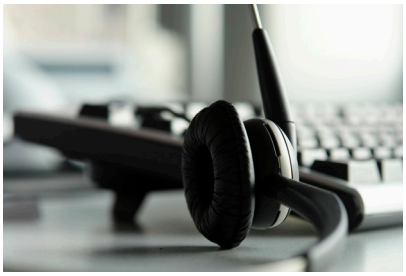
- Wireless medical telemetry (patient monitoring)
- Railway temperature monitoring
- Wireless peripherals: speakers, headphones, mice, and keyboards
- Auto vehicle access
- Tire pressure monitoring systems
- Garage door openers
- Crane control
- More...

Just because your customers are forcing you to deliver faster and work with tighter margins, does not mean they want you to compromise on quality. The performance of these ASK/FSK devices must be verified throughout development, new product introduction, and manufacturing phases, which may link to conformance test, certification test, QA test, design verification, production test, or troubleshooting.

Time-to-market and cost reduction are the perpetual goals for most of wireless device developers and manufacturers. Moving faster and reducing cost enables you to achieve better margins than your competition. Using an efficient and reliable testing solution helps you ramp up volume manufacturing and deliver products with proven quality. Choosing the proper testing equipments helps you save time and money, and yield better sales margins.

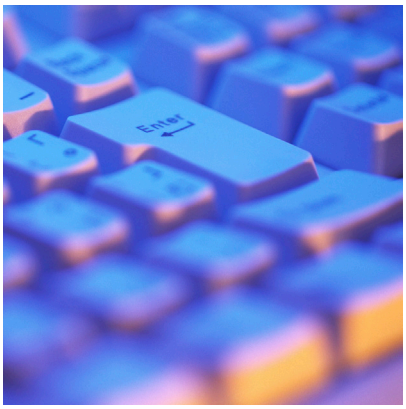
Wireless peripherals: speakers

Wireless peripherals: mouse



Wireless peripherals: headphones

Crane control



Wireless peripherals: keyboard

Agilent Low-Cost ASK/FSK Test Solution

To help you to get the most out of your limited budget, Agilent brings cost-reduction solutions to your test bench. Figure 1 illustrates the typical receiver test station, and Figure 2 shows the typical transmitter test station.

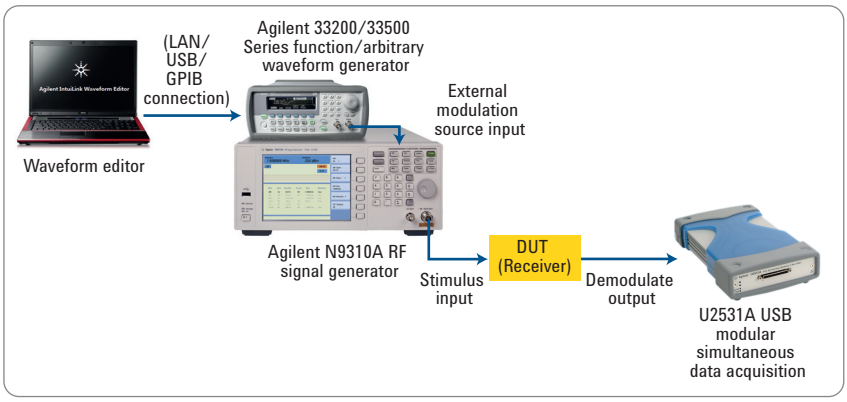


Figure 1. A typical system setup for measuring ASK/FSK receivers

The receiver test station characterizes the receiver's sensitivity by comparing its demodulated baseband signal with a reference baseband signal. Table 1 lists the Agilent instruments that are used in a receiver test station:

Receiver test solution	Purpose
Agilent N9310A RF signal generator	Rx characterization
Agilent 33220/33500 Series with: Option 001 – 10 MHz external time base	Flexible waveform generation
Intuilink waveform editor or 33503A BenchLink Waveform Builder Pro software	For PC development of waveform
Agilent U2531A USB data acquisition module	Simultaneous data acquisition

Table 1. Equipment for ASK/FSK receiver test.

The transmitter test station characterizes the transmitter's power, channel power measurement, and occupied bandwidth measurement at several frequency points. It also tests additional items depending on specific test requirements. In most cases, a spectrum analyzer is used in such frequency-selective power measurements. Given these requirements, the Agilent N9320B RF spectrum analyzer is an ideal choice for consumer electronic manufacturing.

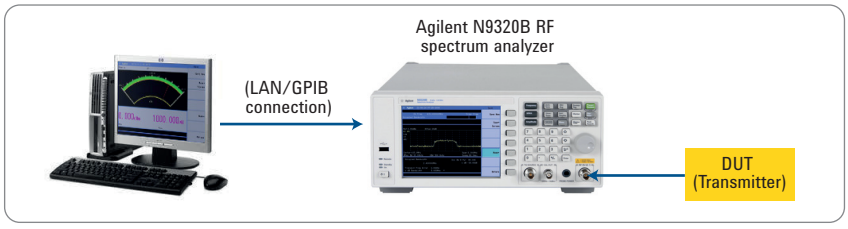


Figure 2. A typical system setup for measuring ASK/FSK transmitters

Wireless medical telemetry (patient monitoring)

Railway temperature monitoring

Tire pressure monitoring systems

Garage door openers

Demonstration Preparation

In the following pages you will learn how to:

- Generate an FSK signal using the N9310A RF signal generator and 33220A function/arbitrary waveform generator
- Measure the FSK signal on the N9320B RF spectrum analyzer

Before continuing, please make sure you have downloaded and installed the following PC software from Agilent's Web site (**www.agilent.com**):

- Agilent IntuiLink Waveform Editor or 33503A BenchLink Waveform Builder Pro software
- Agilent IO Libraries Suite (**www.agilent.com/find/iolib**)

Demonstration Setup

When characterizing a wireless receiver, you need a signal generator to output stimulus signals. An Agilent N9310A signal generator and a 33200/33500 Series arbitrary function generator, as well as PC-based waveform editor software, combine to create a low-cost receiver test station for ASK/FSK wireless devices. Spectrum analyzers, such as the N9320B, are frequently used to characterize wireless transmitters' RF performance.

- The waveform editor software provides a standard waveform library and flexible modes for creating custom shapes for the 33200/33500A Series arbitrary waveform generators, without requiring hours of programming
- The 33220A generates FSK baseband signals with the waveform library information and outputs the external modulation source for the N9310A RF signal generator
- The N9310A outputs FSK-modulated RF signals for the DUT's receiver
- The N9320B receives the FSK signal and displays the signal from the DUT's transmitter

Referring to Figure 3, to set up the instruments:

- Connect the 33220A to your PC via a LAN/USB/GPIB interface
- Connect the output of the 33220A to the external modulation input connector of the N9310A RF signal generator with a BNC cable
- Connect the output of the N9310A to the N9320B spectrum analyzer with an RF cable (N-N type, male)

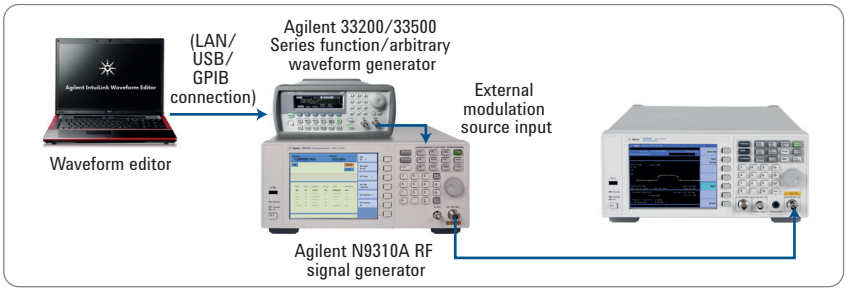


Figure 3. Equipment configuration for FSK signal generation and measurement

For this demonstration we are going to create an FSK signal with the following properties:

- The carrier frequency is 433.92 MHz and its amplitude is -20 dBm
- The FSK symbol rate is 4 ksps, peak deviation is 50 kHz
- The baseband waveform pattern is 1110000110

Getting Started

Note: In the following demonstration steps, the [ ] refers to the hardkey, and the { } refers to the softkey on the front panel of the N9310A/N9320B.

Step 1. Set up the waveform editor software

1. Run the Agilent IntuiLink Waveform Editor software or 33503A BenchLink Waveform Builder Pro software on the PC. (In this demonstration, we use Freehand Draw mode to create the waveform. You may use other methods to create your waveform using the Help menu.)

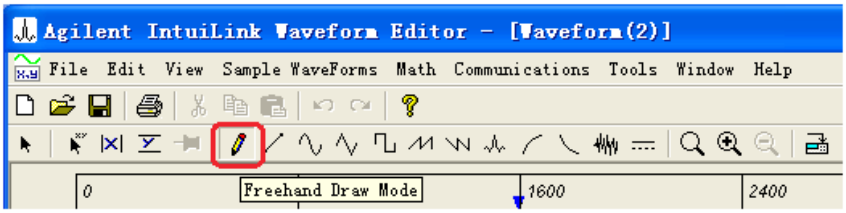


Figure 4. Choose the Freehand Draw mode

2. Draw the baseband pattern: 1110000110.

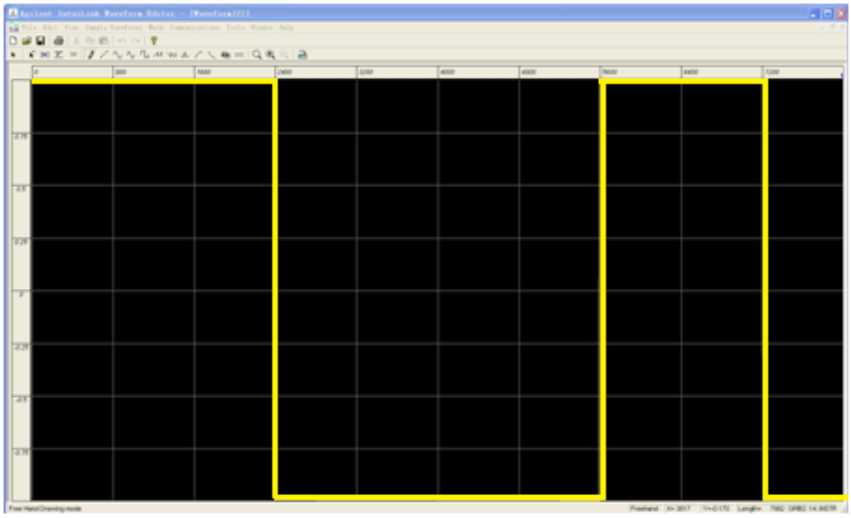


Figure 5. Draw the baseband pattern 1110000110

3. Transfer the waveform to the 33200/33500 arbitrary function generator:

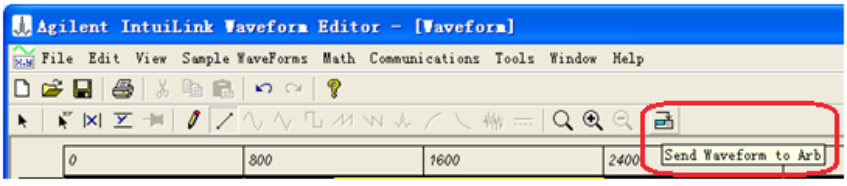


Figure 6. Click "Send waveform to Arb"

3.1 The software opens a dialog window, “Searching Busses”, indicating it is searching for the instruments that are connected to the PC.

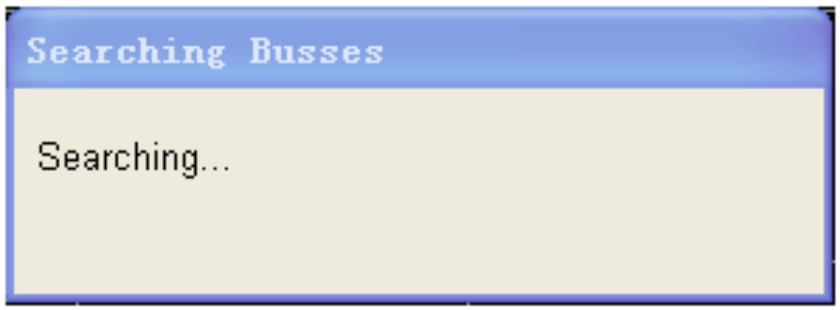


Figure 7. Searching busses dialog

3.2 When the search is completed, a “Connection Dialog” window appears:

- Select the correct instrument address from the “Select Address(es)” area on the left
- The “Identified Instruments on My Computer” area on the right displays the selected instrument information
- Click “Connect”

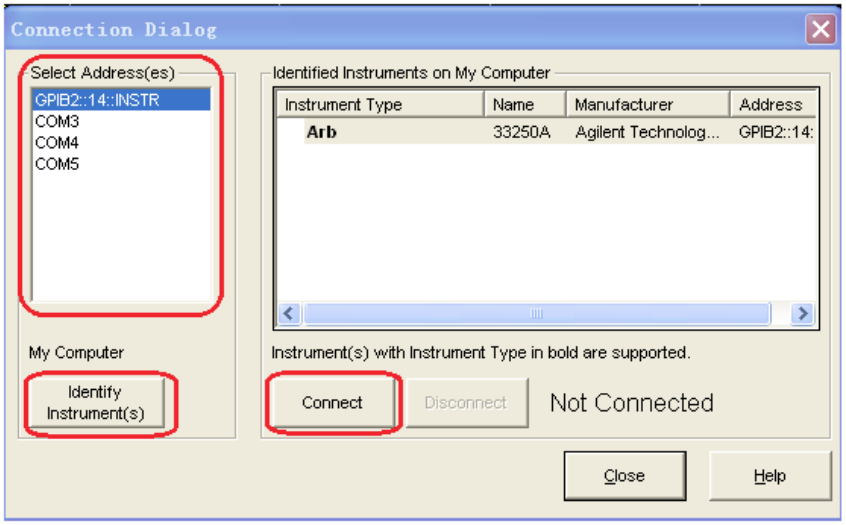


Figure 8. Choose the instrument address and press “Connect”

3.3 After the connection is established, a “Send Arbitrary Waveform” dialog window opens for editing the baseband waveform parameters:

- Frequency (kHz) = 1/[(1/symbol rate) × symbol length] = 1/[(¼) × 10] = 0.4 kHz
- Amplitude (Vp-p) = 50 kHz = N9310A’s offset × (external modulation source amplitude (Vp-p) /1 Vp-p), therefore, the amplitude (Vp-p) can be set as 1 Vp-p
- Click “Send” to transfer the waveform to the arbitrary/function generator

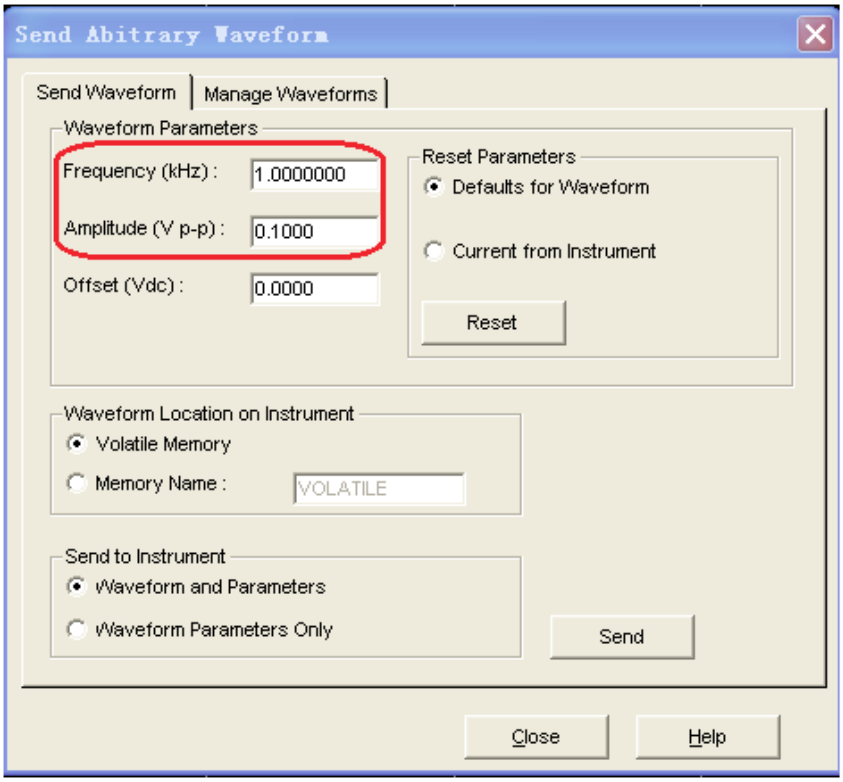


Figure 9. Waveform parameter setup

DID YOU KNOW...

When you test the ASK/FSK transmitters in the spectrum analyzer mode, you usually have to apply the maximum hold method to get the FSK deviation with marker and marker delta. This test procedure can be time consuming at the test station and it also consumes the DUT's battery.

As an alternative method, using the N9320B with Option DMA improves test efficiency in ASK/FSK transmitter characterization:

- Greatly reduces the test time per DUT since the N9320B directly demodulates on the carrier. No maximum hold is required with a trace. Synchronizing the N9320B with the DUT by setting up a triggering scheme further enhances the test station's efficiency
- Intuitively shows the modulation metrics, including carrier power, FSK deviation, FSK error, magnitude error, and carrier frequency offset
- Displays four types of demodulation view maps: waveform, symbol, FSK error, and eye diagram

Step 2. Set up the N9310A RF signal generator for FSK modulation

1. Press [Frequency] > [433.92] > {MHz} to set the carrier frequency at 433.92 MHz
2. Press [Amplitude] > [-20] > {dBm} to set the amplitude at -20 dBm
3. Press [FM] > {FM Deviation} > [25] > {kHz} to set the FM deviation at 25 kHz
4. Press {FM Source} > {EXT} to enable the external modulation source
5. Press {FM On} to turn on the FM modulation
6. Press [RF On/Off] to turn on the RF output

Step 3. Set up the N9320B RF spectrum analyzer to view and verify the FSK signal

1. View the FSK signal in spectrum analyzer mode:
   - Press [Frequency] > [433.92] > {MHz} to set the center frequency to 433.92 MHz
   - Press [SPAN] > [200] > {kHz} to set the span at 200 kHz
   - Press [View/Trace] > {Max Hold} to maximum hold the trace
   - Press [Peak Search] to put a marker at the highest level of signal (the carrier center frequency)
   - Press [Marker] > {Delta} > {Delta}; [Peak Search] > {Next Peak} to set the marker frequency offset

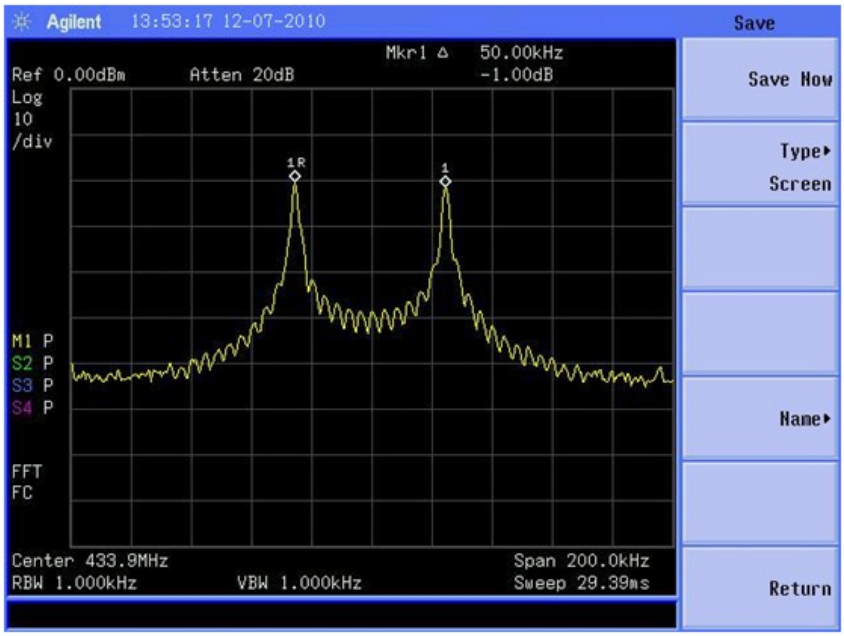


Figure 10. View an FSK signal in spectrum analyzer mode

You may also make use of the FSK demodulation capability of the N9320B spectrum analyzer to view the demodulation metrics directly (Option DMA needs to be enabled on your N9320B).

2. Verify the FSK signal in FSK demodulation mode:
   - Press [Mode] on the N9320B front panel and rotate the knob to select the FSK modulation analysis mode, and press [Enter]
   - Press {Carrier Freq} > [433.92] > {MHz} to set the center frequency at 433.92 MHz
   - Press {Symbol Rate} > [4] > {ksps} to set the symbol rate at 4 ksps
   - Press {Filter Setup} > {Ref Filter} > {Off} to turn off the filters. (In this demonstration, the measurement filter and reference filter are turned off)
   - All the operations are accessible through manual operation or remote control with SCPI commands

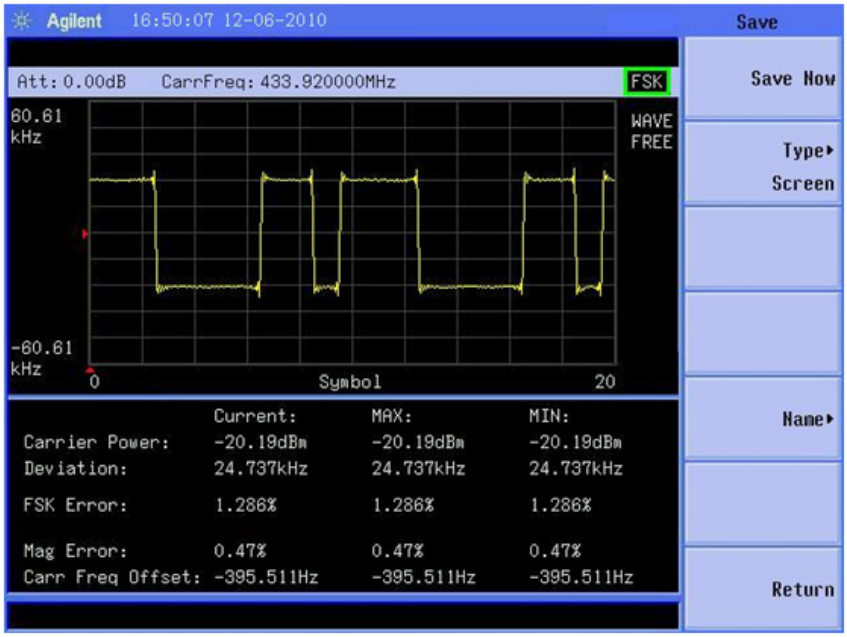


Figure 11. FSK demodulation – waveform view

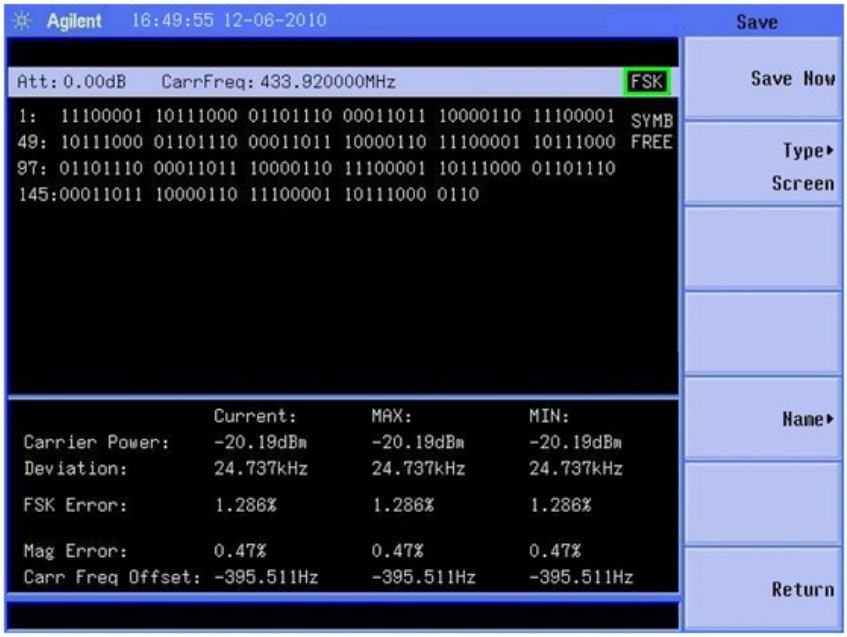


Figure 12. FSK demodulation – symbol view

About Agilent Basic RF Instruments

N9320B RF spectrum analyzer

Regardless of whether your application is electronics' manufacturing, bench repair, RF education, or R&D projects, you need a spectrum analyzer that is equipped with the essential functionality and one that delivers the required performance at an affordable price. The N9320B is designed to be the right answer for you.

- Frequency range: 9 kHz to 3 GHz
- Reference stability: < ±1ppm/year
- Displayed average noise level: -148 dBm (with optional preamp on)
- Resolution bandwidth: 10 Hz to 1 MHz
- Sweep speed: minimum 10 ms sweep speed in none-zero span
- Amplitude accuracy: typical ±0.5 dB
- Connectivity: LAN, USB, GPIB
- Modulation analysis: AM/FM, ASK/FSK demodulation metrics

For more information about the N9320B, including options, upgrade kits, and the product configuration guide (literature number 5990-8120EN) visit **www.agilent.com/find/n9320b**

N9310A RF signal generator

The N9310A is ideal for manufacturing test of electronics in modern consumer products like cordless phones, digital radios, modules, and general wireless devices. It comes with all the capability and reliability you need—at a price you've always wanted.

- Frequency range: 9 kHz to 3 GHz
- Reference stability: < ±1ppm/year
- Output amplitude range: -127 to +13 dBm
- Amplitude accuracy: < ±1 dB
- Switch time: < 10 ms
- Analog modulation: AM, FM, ΦM, pulse modulation
- Connectivity: USB

For more information about the N9310A, including options, upgrade kits, and the product configuration guide (literature number 5990-8117EN) visit **www.agilent.com/find/n9310a**

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Revised: June 8, 2011

Product specifications and descriptions in this document subject to change without notice.

Published in USA, October 25, 2011
5990-8818EN

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