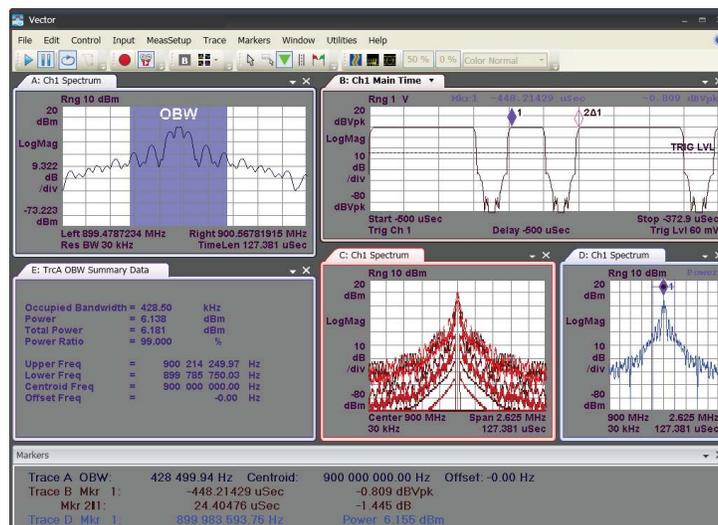


Keysight Technologies

89601B/BN-BHC RFID Modulation Analysis

89600B Vector Signal Analysis Software

Technical Overview



Key Features

- Compatible with RFID standards, including EPCglobal Class 1 Generation 2, and many NFC standards
- Analyze forward (interrogator) and return (tag) bursts
- Make important time-domain measurements
- Decode and analyze burst frame structure elements
- Advanced troubleshooting tools offer detailed look at signal behavior

RFID Modulation Analysis

Option BHC provides powerful measurements and displays designed to help you thoroughly understand your RFID signal. With detailed format-specific summary results, demodulation down to the bit level, versatile time and frequency analysis tools, and easy measurement setup tools, Option BHC offers insight into a wide range of RFID formats.

The RFID modulation formats covered by Option BHC are just some of over 70 signal standards and modulation types for which the 89600B vector signal analysis (VSA) software creates a window into what's happening inside your complex wireless devices. The 89600B tools provide views of virtually every facet of a problem, helping you see the "why?" behind signal problems. Whether you're working with emerging or established standards, Keysight's industry-leading 89600B VSA software helps you see through the complexity.

RFID overview

Radio Frequency Identification (RFID) is a wireless technology used for tracking placement or movement of objects as in, for example, inventory tracking. Applications vary from security access to buildings to tracking animals, automation of toll collections, and tracking goods in supply chain management.

Typically, inventory is tracked by attaching a passive "tag" device. In the EPCglobal Class 1 Generation 2 standard, for example, the tag must be extremely small and cheap, and typically cannot require any power source other than what can be received from RF transmissions. The "interrogator" or "reader" that talks to the RFID device typically alternates between a modulated signal (to communicate with the RFID device) and an unmodulated CW signal (to provide power so that the RFID device can respond). There are multiple incompatible standards for RFID, but over time they appear to be slowly converging. The EPCglobal Class 1 Generation 2 standard is an example of this. Near Field Communication (NFC), uses RFID technology as defined in ISO 18092, including some compatibility with ISO 14443 standards. NFC is expected to be implemented in mobile phones for bill payment, security ID card, or coupon ticket services.

Try before you buy!

Download the 89600B software and use it free for 14 days to make measurements with your analysis hardware, or use our recorded demo signals by selecting

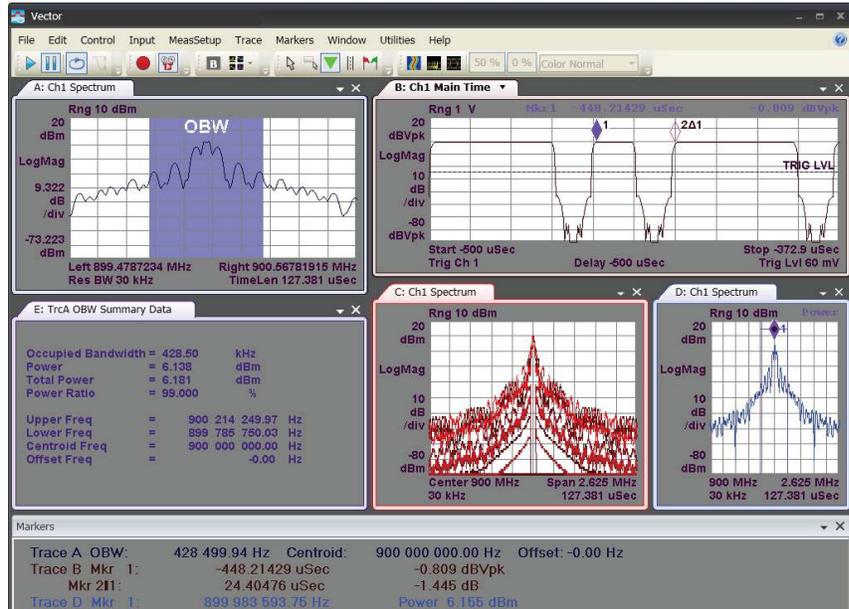
File > Recall > Recall Demo>RFID> on the software toolbar. Request your free trial license today:

[www.keysight.com/
find/89600B_trial](http://www.keysight.com/find/89600B_trial)

Analysis and Troubleshooting

Verify your signal performance using versatile time and frequency domain measurements

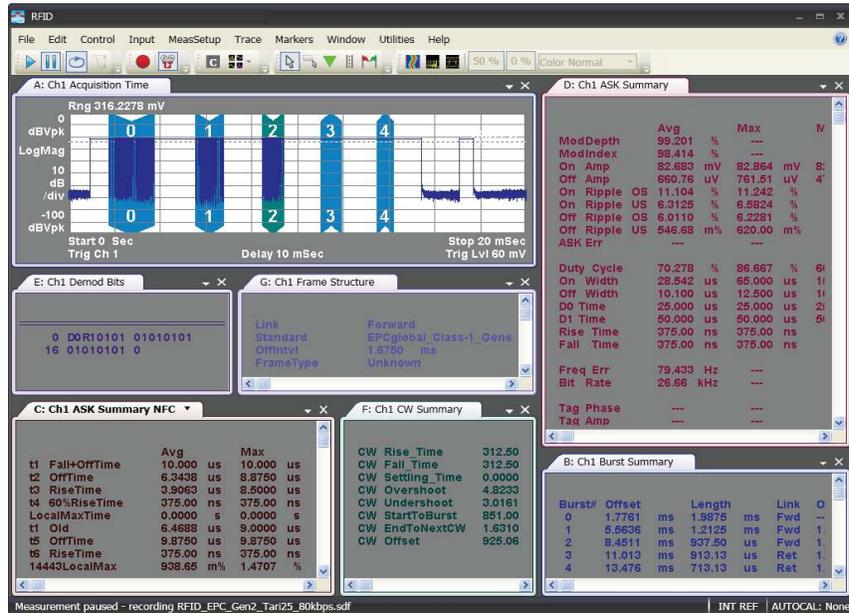
Start your characterization with a detailed understanding of your signal's time and frequency behavior. Option BHC offers simultaneous time, spectrum, occupied bandwidth, and statistical measurements, such as CCDF, plus innovative displays such as spectrogram, digital persistence, and cumulative history.



Examine your signal's time and frequency behavior. Up to 20 traces can be displayed, each with up to 20 markers. Size each display or undock the trace window to best fit your available workspace.

Examine your entire RFID signal with simultaneous burst and CW analysis

The 89600B software automatically identifies burst locations and displays them to you using "arrows" pointing downward for forward (interrogator) bursts and upward for return (tag) bursts. As you move from one burst to another, the analyzer determines the direction of the burst and automatically applies the modulation format and encoding parameters defined. Detailed CW and burst time, modulation, power and error parameters are available in multiple tables.



Option BHC provides a wide range of information, from burst structures and time parameters, to actual decoded bits. Additional features designed to make analyzing your signal easier include arrows on bursts to indicate direction (forward/reverse) and highlighting the current burst under analysis.

Use sophisticated advanced troubleshooting tools to uncover structure and coding errors

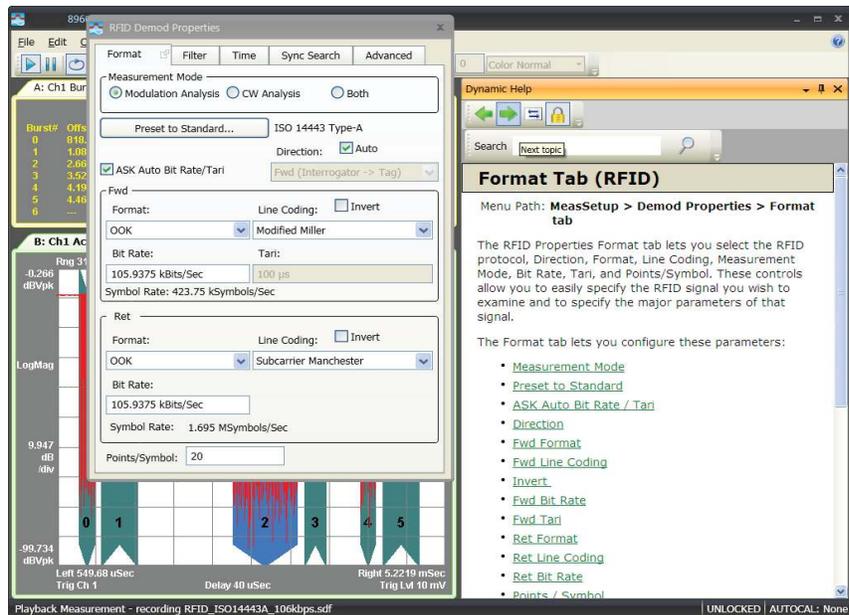
Both demodulated and raw demodulated bits detected prior to applying coding are available. Option BHC can synchronize on standard search words, such as a preamble, frame sync, or other. For greater flexibility, you can also search on a manually entered sync word.



The Frame Structure table decodes the burst header data. Depending on the burst, Option BHC can decode information useful for verifying that the setup matches the demodulation parameter setup. Different standards and formats dictate which parameters are available for decoding.

Analyze a wide range of standards, modulation formats, and line coding

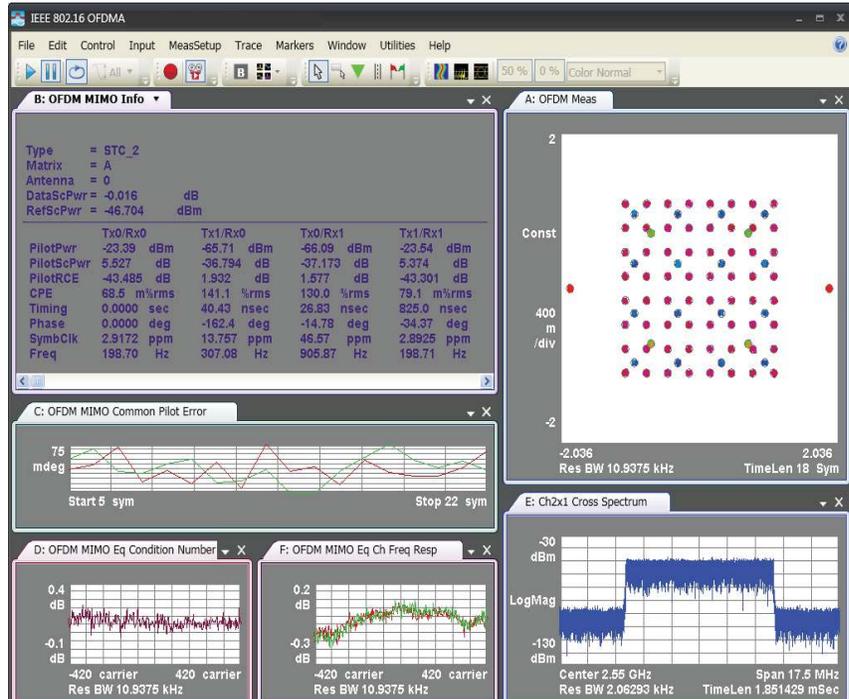
RFID standards vary widely and use many modulation formats and line coding. Option BHC is flexible enough to handle multiple standards, including EPCGen2, NFC formats 14443 Type A or B, and ISO 15693. Choose setup presets and adjust required parameters.



Click on a menu or trace and use Dynamic Help to access information. Here you can learn more about the Format tab, where you can set many important parameters.

Save and recall signals for more effective troubleshooting

The 89600B VSA includes signal capture and playback capabilities. Use it to capture burst and transient signals for analysis. Use tools like overlap processing for detailed “slow motion” analysis and the spectrogram and cumulative history traces for evaluating your signal’s dynamic frequency and amplitude behavior over time. A player window provides detailed access to the recording, or you can use the stop/play buttons on the main toolbar.



Save a signal and analyze it later with all the Option BHC tools. The cumulative history display format (Trace C), highlights signal performance over long periods. Place a marker on any point, particularly a transient outlying point, to determine its density of occurrence.

Software Features

| Adjustable setup parameters | |
|--|--|
| Format parameters | |
| Standards supported (with presets) | EPCglobal Class-1 Generation-2 (ISO 18000-6 Type C); ISO 18000-4 Mode-1 ¹ ; ISO 18000-6 Type-A ¹ ; ISO 18000-6 Type-B ¹ ; ISO 18092 (106, 212, and 424 kbps, for passive and active targets); ISO 14443 Type A (106, 212, 424, 848 kbps); ISO 14443 Type B (106, 212, 424, 848 kbps); ISO 15693 (Low/High Rate) |
| Auto-direction | Automatically determine link direction; on/off |
| Direction | For both the forward link (interrogator -> tag) and return link (tag -> interrogator), independently set: |
| Modulation format | |
| Forward direction | DSB-ASK, SSB-ASK, PR-ASK, FSK-2, OOK |
| Return direction | DSB-ASK, FSK-2, OOK |
| Line coding | |
| Forward direction | None (NRZ), Manchester, FMO, PIE (ISO 18000-6 Type-A), PIE (EPC C1Gen2), Modified Miller, ISO 15693 1-out-of-4; ISO 15693 1-out-of-256 |
| Return direction | None (NRZ), Manchester, FMO, Miller, Miller-2, Miller-4, Miller-8, Modified Miller, Subcarrier Manchester, Subcarrier BPSK1, Subcarrier BPSK2, Subcarrier BPSK4, Subcarrier BPSK8; for ISO 15693: Single Subcarrier LR, Single Subcarrier HR, Dual Subcarrier LR, Dual Subcarrier HR |
| Invert | On/off; inverts the raw demod bits going into the line decoding |
| Bit rate | Manually set, or auto-detected; bps |
| Tari | Manually set, or auto-detected; used only for PIE line coding; forward direction only |
| Symbol rate | Rate (frequency) at which symbols occur; symbols/sec |
| ASK Auto Bit Rate/Tari | Adjusts the expected bit rate by analyzing input data; on/off |
| Points/symbol | Number of points to be used for MeasTime and RefTime traces; 10, 20 |
| Measurement modes | Modulation analysis (burst), CW analysis, or both |
| Filter parameters | |
| Measurement filters | None, root raised cosine |
| Reference filters | None, raised cosine, Gaussian |
| Alpha/BT | Alpha of root raised cosine, or raised cosine filter; or BT of Gaussian filter |
| Time parameters | |
| Acquisition length | Length over which demodulation will occur; secs |
| Burst search | On/off |
| Burst index | Specifies which burst is selected for demodulation when burst search on |
| Result length | Measurement interval; secs |
| Sync search length | Specifies the length of time over which to search for the sync pattern |
| Sync search offset | Specifies where to start the search for the sync pattern |
| Sync offset | Used to determine the start of the demodulated data, as an offset from the location of the sync pattern; only used when Sync search is on, and burst search is off |
| Result offset | Offset for measurement start point, secs |
| Synchronization search parameters | |
| Sync search | Used to measure a signal that has a certain symbol pattern; on/off |
| Type | Per standard preamble and/or delimiter values; or user-defined bit pattern encoded per specified line coding |

1. Beta implementation only.

| Advanced parameters | |
|--------------------------------------|---|
| IQ normalize | Valid only for non-ASK formats; on/off |
| Mirror frequency spectrum | Determines whether to do a frequency inversion before synchronizing and demodulating a signal |
| Clock adjust | Allows user-adjustment of symbol timing used when demodulating; symbols |
| Thresholds | Used for setting levels used when calculating CW or ASK errors; CW lower/upper/settling; ASK lower/upper, if applicable |
| Measurement results | |
| Channel 1 trace results | |
| Raw main time | Time data acquired by the hardware, including any extra acquisition to allow for filter settling |
| Acquisition time | Block of data acquired and searched for bursts |
| Spectrum | Averaged frequency spectrum of time trace |
| Instantaneous spectrum | Frequency spectrum of time trace |
| Time | Time record block of data |
| Correction | Frequency domain correction applied to raw measured time data |
| Raw demod bits | Raw demod bit stream obtained |
| Burst summary table | Table of values for all detected bursts in the acquisition time, including burst index, offset length link direction, off interval |
| CW summary table | Summary of time-domain characteristics of the interrogator CW power-up and power-down |
| CW rise time | Time for the CW to transition between CW lower and upper threshold values during power up; secs |
| CW overshoot | Overshoot of CW signal during power-up; % of steady-state CW level |
| CW undershoot | Undershoot of CW signal during power-up; % of steady-state CW level |
| CW settling time | Time from the end of the CW rise time until the CW has settled to within the CW settling threshold of the steady state CW level; secs |
| CW fall time | Time it takes the CW to transition between the CW upper threshold and the CW lower threshold during power-down; secs |
| CW start to burst | Time between the end of the CW burst and the start of the next CW burst |
| End to next CW | Time between the start of CW and the start of the first burst |
| Channel 1 demod trace results | Trace results available for ASK, OOK, FSK; dependent on burst selected for analysis |
| Demod bits | Decoded raw demod bit stream using selected line-coding method |
| Hex bits | Hexadecimal display of demodulated bits; follows Symbol Table Bit Order for MSB- or LSB-first |
| Meas time with CW | Signal trace that is filtered, resampled, and frequency-, phase-compensated |
| Meas time | Same as Meas Time with interrogator CW power removed |
| Magnitude error | Amplitude difference between the I/Q reference signal and the I/Q measured signal measured at the symbol times |
| Ref time | Reference of signal which is shaped using the reference filter |
| Error time | Error trace calculated as [Meas Time] – [Ref Time] |

| Channel 1 demod trace results | Trace results available for ASK, OOK, FSK; dependent on burst selected for analysis |
|--------------------------------------|---|
| Summary table | For non-FSK formats |
| Modulation depth | Calculated from Meas time with CW |
| Modulation index | Calculated from Meas time with CW |
| On amplitude | Calculated from Meas time with CW; average, max, min calculated for a single scan |
| Off amplitude | Calculated from Meas time with CW; average, max, min calculated for a single scan |
| On ripple overshoot | Calculated from Meas time; avg, max calculated for a single scan |
| On ripple undershoot | Calculated from Meas time; avg, max calculated for a single scan |
| Off ripple overshoot | Calculated from Meas time; avg, max calculated for a single scan |
| Off ripple undershoot | Calculated from Meas time; avg, max calculated for a single scan |
| ASK error | Calculated from Error time; rms avg, max calculated for a single scan |
| Duty cycle | Calculated from Meas time; avg, max, min calculated for a single scan |
| On width | Calculated from Meas time; avg, max, min calculated for a single scan |
| Off width | Calculated from Meas time; avg, max, min calculated for a single scan |
| D0 time | Calculated from Meas time when PIE encoding selected |
| D1 time | Calculated from Meas time when PIE encoding selected |
| Rise time | Calculated from Meas time; avg, max calculated for a single scan |
| Fall time | Calculated from Meas time; avg, max calculated for a single scan |
| Frequency error | Avg frequency offset between the center of the signal and the center frequency of the front end instrument |
| Bit rate | Calculated from Meas time, when auto bit rate enabled or PIE line coding selected |
| Tag phase | Phase of tag relative to CW; avg, max, min values |
| Tag amplitude | Amplitude of tag relative to CW; avg, max, min values |
| FSK summary table | For FSK formats only |
| FSK error | Calculated from FSK error time; rms avg, max calculated for a single scan |
| Magnitude error | Carrier magnitude drift from a constant reference line; rms avg, max |
| Deviation | Frequency deviation of the FSK signal |
| Frequency error | Average carrier offset of FSK signal |
| NFC summary | Summary table specific to NFC formats |
| t1 Fall Time + Off Time | Avg, max, min values |
| t2 Off Time | Avg, max, min values |
| t3 Rise Time | 5 to 90 % rise time; avg, max, min values |
| t4 60 % Rise Time | 5 to 60 % rise time; avg, max, min values |
| t1 Old | Avg, max, min fall off time using a previous definition |
| t5 Off Time | Avg, max, min values for t5 (ISO 14443 Type A standard) |
| t6 Rise Time | Avg, max, min values for t6 (ISO 14443 Type A standard) |
| 14443B EGT | Extra guard time separation between transmitted characters (ISO 14443 Type B standard); etu |
| 14443B SOF On Width | Length of the logic "1" start of frame field (ISO 14443 Type B standard) |
| 14443B SOF Off Width | Length of logic "0" part of start of frame field (ISO 14443 Type B standard) |
| 14443B EOF Off Width | Length of logic "0" part of the end of frame field (ISO 14443 Type standard) |
| 14443 Local Max | Avg, max, min values of the local peaks during the Local Maximum search period (ISO 14443 signals using ASK only) |

| Channel 1 demod trace results | Trace results available for ASK, OOK, FSK; dependent on burst selected for analysis |
|--------------------------------------|---|
| 14443B TR0 | Time between PCD end of EOF and PICC start of subcarrier (ISO 14443B signals only) |
| 14443B TR1 | Time between PICC start of subcarrier and start of SOF (ISO 14443B signals only) |
| 14443B TR2 | Time between PICC start of EOF and PCD start of SOF (ISO 14443B signals only) |
| 14443B FsToOff | Time between PICC end of EOF and end of subcarrier (ISO 14443B signals only) |
| Frame structure table | EPC Class 1 Gen 2 signals only. Additional table entries may also be present depending on frame type. |
| Link | Defines the direction of the burst: forward or reverse |
| Standard | Displays the standard being used for the measurement |
| Off interval | Interval between bursts preceding the numbered burst |
| Frame type | Type of frame. Additional information specific to the frame type is also displayed |
| Preamble type | Shows the preamble type: Preamble or FrameSync |
| Command | Multi-bit command code corresponding to frame type |

Ordering Information

Software licensing and configuration

Choose from two license types:

- **PC/instrument license (89601B):** Order this if the license will reside on a PC/instrument. The license can be transferred to another PC/instrument at any time.
- **Floating license (89601BN):** Order this if the license will reside on a server to be accessed by multiple users, one at a time.

| Model-Option | | Description | Notes |
|-----------------------|------------------|------------------------------|---------------------------------------|
| PC/Instrument license | Floating license | | |
| 89601B | 89601BN | 89600B VSA software | Required |
| 89601B-BHC | 89601BN-BHC | RFID modulation analysis | Required for RFID modulation analysis |
| 89601B-200 | 89601BN-200 | Basic vector signal analysis | Required |
| 89601B-300 | 89601BN-300 | Hardware connectivity | Required |

For complete ordering instructions, see the 89600B Vector Signal Analysis Software, Configuration Guide, literature number 5990-6386EN.

Hardware configuration

The 89600B software supports over 30 instrument platforms, including spectrum analyzers, oscilloscopes, logic analyzers, and modular instrument systems. For a complete list, visit

www.keysight.com/find/89600B_hardware

Keep your 89600B VSA up-to-date

With rapidly evolving standards and continuous advancements in signal analysis, the 89601BU/BN software update and subscription service offers you the advantage of immediate access to the latest features and enhancements available for the 89600B VSA software.

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You can upgrade!

All 89600B options can be added after your initial purchase and are license-key enabled. For more information please refer to

www.keysight.com/find/89600B_upgrades

Additional Resources

Literature

89600B Vector Signal Analysis Software, Brochure, literature number 5990-6553EN

89600B Vector Signal Analysis Software, Configuration Guide, literature number 5990-6386EN

89601B/BN -200 Basic VSA and -300 Hardware Connectivity, Technical Overview, 5990-6405EN

89600 Series VSA Software Option BHC: RFID modulation analysis, Self-Guided Demonstration Guide, literature number 5989-6239EN

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