

# Keysight Oscilloscope-based NFC Test Solution

Keysight's low-cost near field communication (NFC) test solution consists of an InfiniiVision X-Series oscilloscope, Trueform waveform generator, programmable 3-in-1 NFC reference antenna (poller, listener, and resonant frequency coils), and PC-based NFC compliance test software that performs thorough analog testing of NFC-enabled devices.



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# Introduction

Testing Near Field Communication (NFC) devices is essential during the design validation phase, as well as during manufacturing test to ensure quality and reliability of data transmission. This is especially important when you consider that the transferred/exchanged data between NFC-enabled devices is often secured financial transactions.

Keysight’s oscilloscope-based NFC compliance test software provides thorough physical layer analog quality testing with fast throughput. This software package is based on Keysight’s award-winning Infiniium oscilloscope conformance test software to provide a low-cost NFC pre-compliance analog test solution that includes a broad range of the most critical tests to ensure quality and reliability.

The PC-based software controls a Keysight Trueform waveform generator to produce reference test signals based on various NFC technologies, and then measures the response captured by a Keysight InfiniiVision X-Series oscilloscope with NFC triggering and real-time sampling up to 5 GSa/s.

Measurement results are then compared against published NFC analog specifications for pass/fail conditions. This software also provides complete report generation with statistical and margin analysis capabilities as shown in Figure 1.

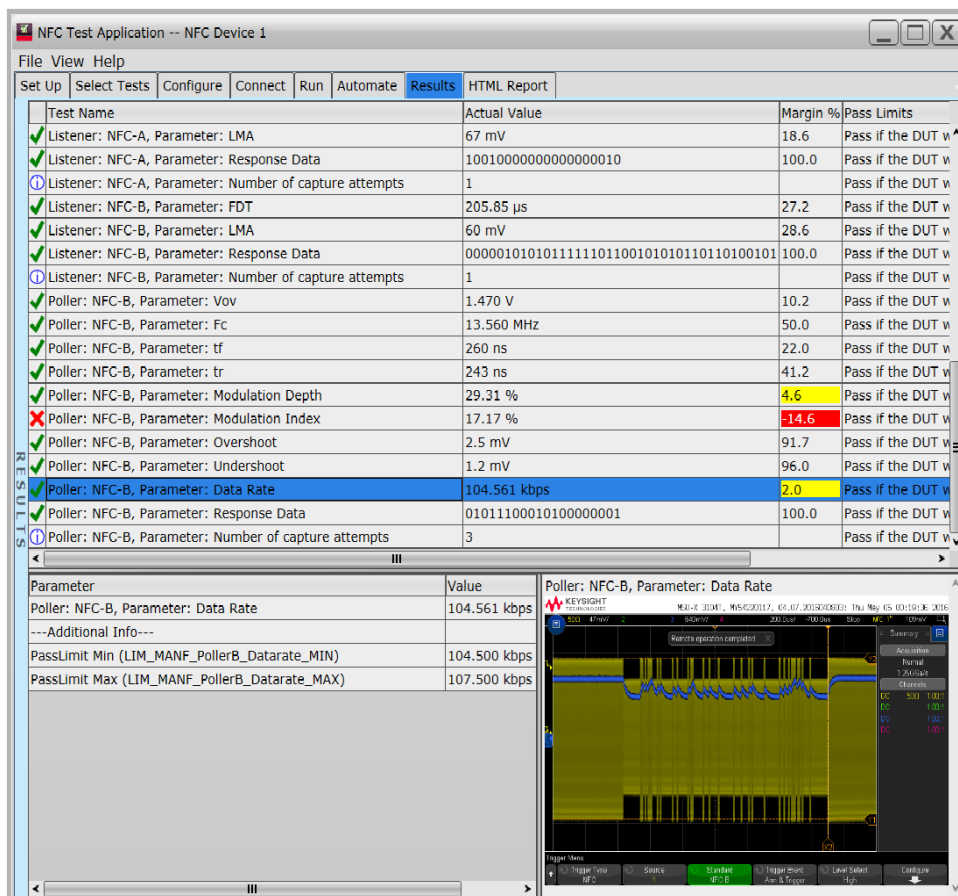


Figure 1. NFC Test results shows Poller parameter that fail to meet specification limits highlighted in red, as well as marginal test results highlighted in yellow.

Keysight's NFC compliance test software guides you through the process of selecting and configuring tests, making oscilloscope connections, running tests, and evaluating the test results. This software:

- Allows you to select individual or multiple tests to run.
- Shows you how to make connections to the test equipment and device under test (DUT) based on a selected connection type.
- Automatically checks for proper test equipment configuration.
- Automatically sets up the equipment for each test.
- Provides detailed information for each test that has been run and lets you specify the thresholds at which marginal or critical warnings appear.
- Creates a printable HTML report of the tests that have been run.

The complete Keysight automated NFC test system for manufacturing test and/or pre-conformance design validation consists of the following four components as shown in Figure 1.

1. Keysight 3000T or 4000 X-Series InfiniiVision oscilloscope.
2. Keysight 33500 or 33600 Series Trueform arbitrary waveform generator.
3. Keysight N2116A/N2134A/N2135A 3-in-1 programmable NFC antenna (Poller, Listener, and Resonant Frequency test coils).
4. Keysight D3000NFCB or D4000NFCB NFC compliance test application software.

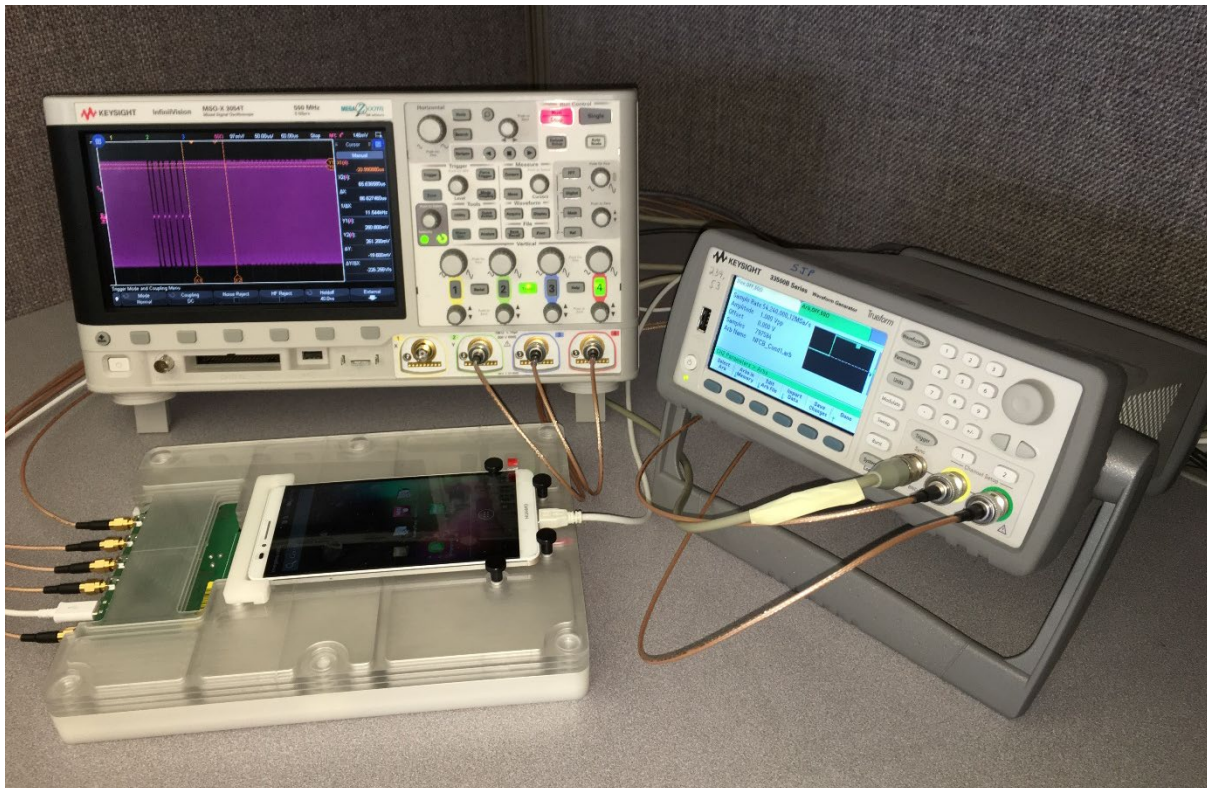


Figure 2. Keysight's oscilloscope-based NFC test system (antenna holding fixture not included).

## NFC Test Coverage

Keysight's NFC compliance test software provides higher-level functional pass/fail testing, as well as lower-level physical layer parametric analog testing. You can customize your specific test needs by selecting just the measurements required for your particular test environment. Table 1 shows the range of measurements that can be selected and performed.

Table 1. NFC automated test coverage

Test	NFC-A	NFC-B	NFC-F (212 kbps)	NFC-F (424 kbps)	NFC-V
<b>Listener mode tests</b>					
Overall Pass/Fail	✓	✓	✓	✓	✓
Frame delay time (FTD)	✓	✓	✓	✓	✓
Load modulation amplitude (LMA)	✓	✓	✓	✓	✓
Response data	✓	✓	✓	✓	✓
<b>Poller mode tests</b>					
Overall Pass/Fail	✓	✓	✓	✓	✓
t1	✓				✓
t2	✓				✓
t3	✓				✓
t4	✓				✓
t5	✓				✓
Data rate	✓	✓	✓	✓	✓
Field strength (Vov)	✓	✓	✓	✓	✓
Carrier frequency (Fc)	✓	✓	✓	✓	✓
Modulation depth	✓	✓	✓	✓	✓
Modulation index	✓	✓	✓	✓	✓
Response data	✓	✓	✓	✓	✓
Overshoot	✓	✓	✓	✓	✓
Undershoot		✓	✓	✓	
Rise time (tr)		✓	✓	✓	
Fall time (tf)		✓	✓	✓	
<b>Resonant frequency test</b>					
Frequency at highest return loss	✓	✓	✓	✓	✓

## Design Validation and Debug

Keysight's InfiniiVision oscilloscope-based NFC test solution has several advantages over traditional NFC one-box testers. During the design phase of NFC-based products, an oscilloscope is a core test and debug instrument used by nearly all R&D hardware engineers. Although the NFC automated test software runs on an external PC, the software license resides in the scope. This is important because the license also enables special NFC hardware trigger modes in the scope. This means that you can use the scope in a standalone troubleshooting use-model to perform dynamic measurements with updated waveforms without running the automated compliance test software. The ability to trigger on NFC communication can be an invaluable R&D debug tool.

Before moving an NFC-based device into production, design verification based on published standards is important. Having an NFC test solution that can be quickly set up and provide automated test results in the R&D environment, and then transfer the same test methodology into the manufacturing test environment ensures consistency between all product development and manufacturing test phases.

And finally, when things go wrong on the production test floor, Keysight's NFC compliance test software can be used on the repair line as well. If a specific test fails on the production line, such as Listener NFC-A load modulation amplitude (LMA), just that test can be selected to run on the repair line. When the test is complete, the scope is configured for that particular debugging condition. This enables the repair technician to quickly begin manual troubleshooting with the scope without having to manually set up the scope for complex test conditions as shown in Figure 3.

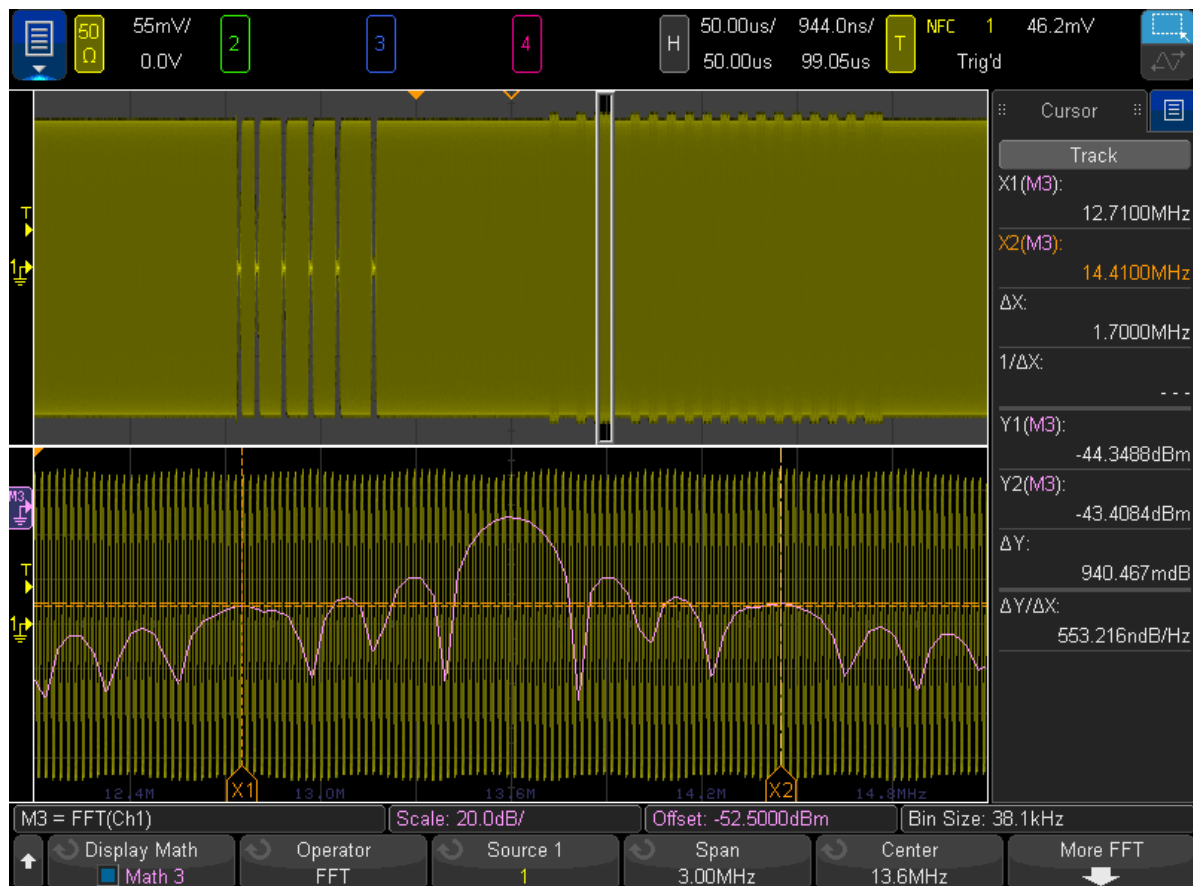


Figure 3. Testing load modulation amplitude (LMA) from an NFC-A tag's weak response (-44 dBm < 2 mVp) based on FFT sideband measurements while monitoring live/updated waveforms with

## Keysight 3-in-1 Programmable NFC Reference Antenna

Another key element of Keysight's test system is the 3-in-1 programmable NFC antenna. This multi-coil size-3 equivalent antenna is available with three different fixed spacings (coil to DUT test plane):

- 5 mm (N2116A)
- 10 mm (N2134A)
- 15 mm (N2135A)

With this programmable reference antenna, testing can quickly progress from Listener mode to Poller mode to Resonant Frequency test mode without having to manually or robotically move the DUT from one antenna type to the next. But note that Keysight's NFC compliance test software is also compatible with non-programmable standard NFC Forum reference antennas.

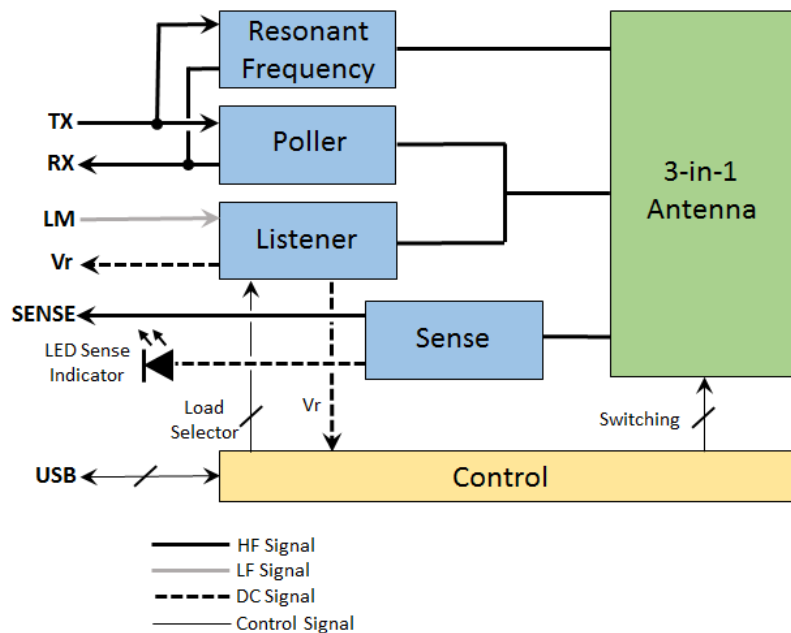


Figure 4. Block diagram of Keysight's 3-in-1 programmable NFC reference antenna.



Figure 5. Keysight's N2116A 3-in-1 programmable NFC reference antenna.

## Technical Performance Characteristics

Table 2. DSOX3014T Oscilloscope (receiver)

Parameter	Measurement input channel <sup>1</sup>	Value
Input impedance	Resonant frequency (channel-1)	50-Ω
	Listener sense (channel-2)	50-Ω
	Poller receive (channel-4)	50-Ω
	Poller Vov (channel-3)	1-MΩ, 14 pF
Max input voltage	Listener sense, Poller receive	8 Vpp
	Poller Vov	40 V
Δ voltage accuracy	Listener sense, Poller receive	± 3% of full-scale at 13.56 MHz
Absolute voltage accuracy	Poller Vov	± 2% of full-scale ± 0.1 div ± 2 mV ± 1% of offset setting
Vertical resolution	All channels	8 bits (0.4%)
Frequency range	All channels	DC to 100 MHz <sup>2</sup>
Max sample rate	All channels	5 GSa/s
Timebase accuracy	All channels	± 1.6 ppm + aging factor <sup>3</sup> (< ± 45 Hz at 13.56 MHz after 5 years)
Spurious (non-harmonic)	Listener sense, Poller receive	< -60 dBc typical (10 to 20 MHz)
Input return loss	Listener sense, Poller receive	> 35 dB

1. Default settings. Channel assignments can be user-modified.
2. -3 dB bandwidth specification for the 100-MHz bandwidth DSOX3014T model. Maximum frequency higher for higher bandwidth 3000T and 4000A X-Series oscilloscope models.
3. Aging factor - 1st year: ± 0.5 ppm, 2nd year: ± 0.7 ppm, 5 years: ± 1.5 ppm, 10 years: ± 2.0 ppm.



Table 3. Oscilloscope NFC Triggering<sup>1</sup>

	Trigger on:	...Arm & Trigger
NFC-A	<ul style="list-style-type: none"> <li>– SENS_REQ</li> <li>– ALL_REQ</li> <li>– Either (SENS_REQ or ALL_REQ)</li> <li>– SDD_REQ</li> <li>– Arm &amp; Trigger...</li> </ul>	Arm on: <ul style="list-style-type: none"> <li>– SENS_REQ</li> <li>– ALL_REQ</li> <li>– Either (SENS_REQ or ALL_REQ)</li> </ul> Trigger on: <ul style="list-style-type: none"> <li>– SDD_REQ or Time-out<sup>2</sup></li> </ul>
NFC-B	<ul style="list-style-type: none"> <li>– SENSB_REQ</li> <li>– ALLB_REQ</li> <li>– Either (SENSB_REQ or ALLB_REQ)</li> <li>– ATTRIB</li> <li>– Arm &amp; Trigger...</li> </ul>	Arm on: <ul style="list-style-type: none"> <li>– SENSB_REQ</li> <li>– ALLB_REQ</li> <li>– Either (SENB_REQ or ALLB_REQ)</li> </ul> Trigger on: <ul style="list-style-type: none"> <li>– ATTRIB or Time-out<sup>2</sup></li> </ul>
NFC-F <sup>3</sup>	<ul style="list-style-type: none"> <li>– SENSF_REQ</li> <li>– ATR_REQ</li> <li>– Preamble</li> <li>– Arm &amp; Trigger...</li> </ul>	Arm on: <ul style="list-style-type: none"> <li>– SENSF_REQ</li> </ul> Trigger on: <ul style="list-style-type: none"> <li>– ATR_REQ or Time-out<sup>2</sup></li> </ul>

1. NFC triggering capabilities are available in the oscilloscope when licensed with the D3000NFCB/D4000NFCB/M9240NFCB/P9240NFCC option. Running the automated NFC compliance test software is not required to support these triggering conditions.
2. When using the "Arm & Trigger" selection, after qualifying on the "arm" condition, the scope will trigger on the specified "trigger on" condition or the user-entered time-out setting, whichever occurs first.
3. Both NFC-F (212 kbps) and NFC-F (424 kbps) supported.

Table 4. 33512B Trueform arbitrary waveform generator (transmitter)

Parameter	Output channel	Value
Output impedance	Load modulation (channel-1)	50-Ω
	RF carrier (channel-2)	50-Ω
Output voltage range	RF carrier, Load modulation	1 mVpp to 10 Vpp (re: 50-Ω)
Output power	RF carrier	> 23.9 dBm
Output voltage accuracy	RF carrier, Load modulation	± 3.5% of setting ± 1 mVpp at 13.56 MHz
Output voltage resolution	Load modulation	16 bits (160 μV at 10 Vpp)
	RF carrier	4 digits (1 mV or 0.01 dBm at 10 Vpp)
Frequency range	RF carrier (channel-2)	1 μHz to 20 MHz <sup>1</sup>
Frequency accuracy	RF carrier, Load modulation	± 2 ppm of setting ± 15 pHz (< 27 Hz at 13.56 MHz)
Frequency resolution	RF carrier	1 μHz
Spurious	RF carrier	Standard: < -75 dBc, increasing +20 dBc/decade above 2MHz
		Option OCX: < -75 dBc, increasing +20 dBc/decade above 10 MHz

1. Maximum frequency based on the 20 MHz 33512B. Higher frequency ranges available on higher frequency 33500 and 33600 models.

Table 5. N2116A/N2134A/N2135A 3-in-1 Programmable NFC Reference Antenna

Parameter	Value
Resonant frequency	13.56 MHz
Poller coil size	Poller 3 equivalent
Listener coil size	Listener 3 equivalent
Listener loads (configurable)	82, 330, 820, 5000- $\Omega$
Standards supported	NFC Forum Types A, B, F
Poller/Listener test spacing	
– N2116A	5 mm
– N2134A	10 mm
– N2135A	15 mm
I/O ports	
Tx – RF input port for Poll mode and Resonant Frequency	Connector type: SMA
– Impedance	50- $\Omega$
– Input power range	-1.85 to +24.25 dBm
– Frequency range	10 to 20 MHz
Rx – RF output port for Poll mode and Resonant Frequency	Connector type: SMA
– Impedance	50- $\Omega$
– Output voltage range	10 mV to 1 V
LM (load modulation) for Listen mode	Connector type: SMA
– Impedance	> 10 M $\Omega$
– Input voltage range	0 to 5 V
Sense – RF output for Listen mode	Connector type: SMA
VR – VDC output for Listen mode	Connector type: SMA
– Range	0 to 10 VDC
Communication and power	Connector type: MicroUSB

Table 6. N2116A/N2134A/N2135A 3-in-1 Antenna General Characteristics

Parameter	Value
N2116A Dimensions <sup>1</sup> (5 mm fixed spacing <sup>2</sup> )	116 mm x 18 mm x 162 mm (W x H x D)
N2134A Dimensions <sup>1</sup> (10 mm fixed spacing <sup>2</sup> )	116 mm x 23 mm x 162 mm (W x H x D)
N2135A Dimensions <sup>1</sup> (15 mm fixed spacing <sup>2</sup> )	116 mm x 28 mm x 162 mm (W x H x D)
Supply voltage range	5 V (microUSB loaded)
Supply frequency range	DC
Operating temperature	10 to 45 °C
Storage temperature	-20 to +60 °C
Humidity	20 to 80%
EMC	IEC 61326-1:2012
	EN 61326-1:2013

1. Refer to the D3000NFCB/D4000NFCB User's Guide for mechanical drawings with exact dimensions.
2. Refers to the vertical spacing between the poller/listener antenna coils and the DUT test plane surface.

## Recommended Configuration

### Step 1. Select oscilloscope

All 4-channel InfiniiVision 3000T and 4000 X-Series oscilloscopes (DSO or MSO models) are compatible with performing NFC compliance testing. The minimum recommended and lowest-priced model that meets specifications is the 100-MHz bandwidth DSOX3014T oscilloscope.

Automated NFC compliance testing can be performed via LAN (Ethernet) or USB. All Keysight InfiniiVision X-Series oscilloscopes come standard with USB interfaces. The LAN interface is standard on all 4000 X-Series oscilloscopes. However, if using a 3000T X-Series oscilloscope in your NFC test system, and if you wish to use a LAN interface, you also will need to order the optional LAN interface module for this scope (DSOXLAN).

In addition to the above listed minimum system requirements, it is recommended that your 3000T or 4000A X-Series oscilloscope be running on firmware version 7.20 or greater.

### Step 2. Select software

If your automated NFC test system includes one of Keysight's InfiniiVision 3000T X-Series oscilloscopes, then order the D3000NFCB software license. If your automated NFC test system includes one of Keysight's InfiniiVision 4000 X-Series oscilloscopes, then order the D4000NFCB software license. The NFC compliance test application software version 1.05 onwards requires 64-bit Windows 7 or Windows 10 operating system with MATLAB Runtime version 9.1 installed.

The NFC compliance test software can be downloaded from Keysight's D3000NFCB or D4000NFCB product website at no charge. However, running the software requires that the license be installed in the oscilloscope.

### Step 3. Select waveform generator

All 2-channel Trueform 33500 and 33600 waveform generators are compatible with performing automated NFC testing. The minimum recommended and lowest-priced model that meets specifications is the 20-MHz 33512B with Option MEM. If ordering one of the 2-channel 33600 models, Option MEM is not required.

### Step 4. Select reference antenna

For fastest throughput, Keysight recommends ordering the N2116A 3-in-1 programmable NFC antenna (size-3 equivalent). This antenna provides a fixed 5 mm spacing between the device-under-test and the poller/listener coils. NFC Forum analog specifications are based on 5 mm spacing. Also available is the N2134A with 10 mm spacing and the N2135A with 15 mm spacing if testing at a greater distance is preferred. The N2116A-001 option is a kit that provides all three spacing versions.

Keysight's automated NFC test solution is also compatible with individual NFC Forum poller and/or listener reference antennas of any standard size. However, the resonant frequency test is not available when using these non-programmable reference antennas.

## Related Literature

Table 7. Related Literature

Publication title	Publication number
InfiniiVision 3000T X-Series Oscilloscopes - Data Sheet	5992-0140EN
InfiniiVision 4000 X-Series Oscilloscopes - Data Sheet	5991-1103EN
33500B Series Trueform Waveform Generators - Data Sheet	5991-0692EN
33600A Series Trueform Waveform Generators - Data Sheet	5991-3272EN
NFC Device Turn-on and Debug – Application note	5992-2066EN
NFC Sideband Measurements – Application note	5992-2067EN
Decoding NFC-F – Application note	5992-2337EN

## Ordering Information

Table 8. Oscilloscope-based NFC test solution model numbers

Product number	Description
DSOX3014T <sup>1</sup>	100-MHz bandwidth, 4-channel InfiniiVision 3000T X-Series oscilloscope.
D3000NFCB <sup>2</sup>	NFC automated test software and NFC triggering license for 3000T X-Series oscilloscopes
DSOXLAN	LAN module (not required if using USB connectivity) for 3000T X-Series oscilloscope.
DSOX4024A <sup>1</sup>	200-MHz bandwidth, 4-channel InfiniiVision 4000 X-Series oscilloscope. LAN is standard.
D4000NFCB <sup>2</sup>	NFC automated test software and NFC triggering license for 4000 X-Series oscilloscopes.
33512B <sup>1</sup>	20-MHz, 2-channel Trueform waveform generator.
33512B-MEM	16 M memory option for 33500.
N2116A <sup>3</sup>	3-in-1 programmable NFC antenna with 5 mm fixed spacing <sup>4</sup> .
N2116A-001	3-in-1 programmable NFC antenna kit (not required) that supports 5-, 10-, and 15-mm spacing <sup>4</sup> . Must also order N2116A.
N2134A <sup>3</sup>	3-in-1 programmable NFC antenna with 10 mm fixed spacing <sup>4</sup> .
N2135A <sup>3</sup>	3-in-1 programmable NFC antenna with 15 mm fixed spacing <sup>4</sup> .

1. Only the lowest priced 4-channel oscilloscopes (3000T and 4000A X-Series) and 2-channel waveform generator models are listed in this table. All other higher bandwidth InfiniiVision 3000T and 4000A X-Series oscilloscope models with 4 channels, as well as higher frequency Trueform waveform generators (33500 and 33600 Series) with 2 channels, are compatible. For ordering information on higher performance oscilloscope and waveform generator models, refer to the appropriate data sheets listed in the Related Literature section of this document.
2. Automated NFC compliance test application software version 1.05 onwards requires 64-bit Windows 7 or Windows 10 operating system with MATLAB Runtime version 9.1 installed.
3. Keysight 3-in-1 programmable NFC antennas come standard with all required SMA and BNC cabling.
4. Spacings refers to the vertical distance between the poller/listener coils and the DUT test plane surface.

Table 9. Related products

Product number	Description
M9240NFCB <sup>1</sup>	NFC triggering license for M9240A Series modular oscilloscopes.
P9240NFCC <sup>1</sup>	NFC triggering license for P9240A Streamline Series USB oscilloscopes.

1. NFC automated compliance test software is not compatible with the M9240A Series modular oscilloscopes nor the P9240A Streamline Series USB oscilloscopes. These licensed options enable NFC-A, NFC-B, and NFC-F triggering only in these modular and USB-based oscilloscopes.

To configure your product and request a quote:

<http://www.keysight.com/find/software>

Contact your Keysight representative or authorized partner for more information or to place an order:

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

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