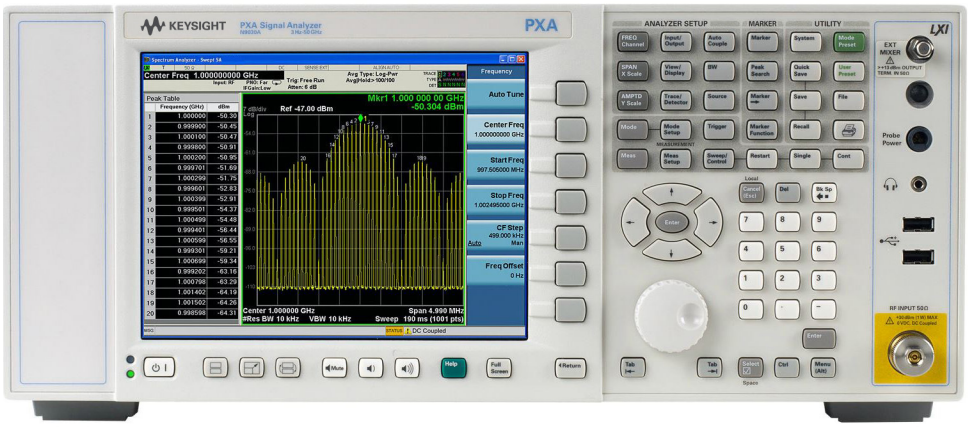
Keysight Technologies
Digital Cable TV
X-Series Measurement App, Traditional UI
N6152EM0D

Technical Overview



- Measure digital cable TV RF transmitter, modulator, tuner, or amplifier performance
- Easy-to-use, standard-based preset settings
- One-button tests with pass/fail limit per J.83/A (DVB-C), J.83/B (DOCSIS DS), and J.83/C (ISDB-C) standards
- Hardkey/softkey manual user interface or SCPI remote control
- Built-in, context-sensitive help
- Flexible licensing provides the option of using perpetual or time based licenses with one or multiple signal analyzers

KEYSIGHT TECHNOLOGIES

Digital Cable TV Measurement Application

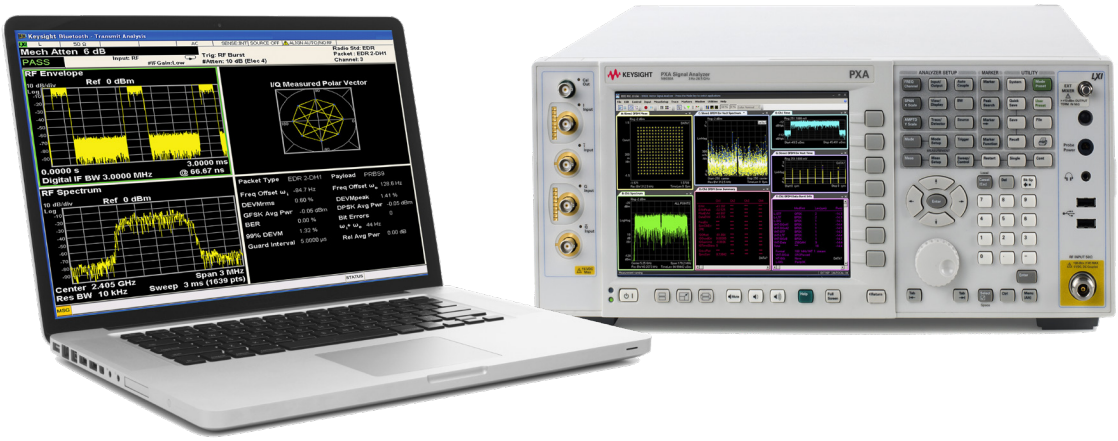
The Keysight Technologies, Inc. N6152EM0D provides one-button, standard-based power and modulation analysis capabilities to help your design, evaluation, and manufacturing of digital cable TV modulators, transmitters, amplifiers, and tuners. With the optional analog baseband IQ inputs in the PXA or MXA signal analyzer, it can also provide the flexibility of measuring signal quality and modulation accuracy with RF input or analog IQ input.

X-Series measurement applications can help you:

- Gain more insight into device performance with intuitive display and graphs for your application. Select from our library of over 25 different measurement applications.
- Ensure that your design meets the latest standard. Updates are made to the X-Series measurement applications as standards evolve.
- Apply the same measurement science across multiple hardware platforms for consistent measurement results over your design cycle from R&D to production.
- Choose the license structure that meets your business needs. We provide a range of license types (node-locked, transportable, floating or USB portable) and license terms (perpetual or time-based).

Key parameter setup

- Radio standards: DVB-C (J.83/A), J.83/B, and J.83/C
- Symbol rate with standard default and settable by users
- Modulation: 16/32/64/128/256QAM for DVB-C and J.83/C and 64/256/1024QAM for J.83/B
- Adaptive equalizer with filter length and convergence settings
- Advanced settings: Meas interval, low SNR enhancement, out-of-band filter, and more.
- Input: RF or analog IQ (only available in the N9030A PXA or N9020A MXA) for signal quality and modulation accuracy measurements



Digital Cable TV Standards Overview

The digital cable TV measurement application includes three standards of digital video broadcasting over cable: DVB-C (J.83 Annex A), J.83 Annex B, and J.83 Annex C.

DVB-C (J.83 Annex A)

DVB-C is the DVB European consortium standard for the broadcast transmission of digital television over cable, mainly used in Europe and Asia with 8 MHz bandwidth.

J.83 Annex B (DOCSIS DS)

J.83/B, widely used in North America as digital television over cable and the same as the DOCSIS DS physical layer, has a greater difference in FEC coding and occupies a bandwidth of 6 MHz.

J.83 Annex C (ISDB-C)

J.83/C, mainly used in Japan as digital television over cable and also called ISDB-C, has identical structure as DVB-C, except for the channel bandwidth (6 MHz for J.83/C and 8 MHz for DVB-C) and roll-off factor of the baseband filter.

Table 1. Key parameters in digital cable TV standards

	J.83 Annex A (DVB-C)	**J.83 Annex B (DOSSIS DS)**	**J.83 Annex C (ISDB-C)**
Frequency	VHF, UHF	VHF, UHF	VHF, UHF
Bandwidth	8 MHz	6 MHz	6 MHz
Modulation	16QAM, 32QAM, 64QAM, 128QAM, 256QAM	64QAM, 256QAM, 1024QAM	16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Randomization	Polynomial for PRBS 1 + x14 + x15	Polynomial for PRBS 3-word polynomial for PRBS x3 + x + α3 over GF (128), where α7 +α3 +1 = 0	Polynomial for PRBS 1 + x14 + x15
FEC	RS (204,188) over GF (256)	RS (128,122) over GF (128) concatenated with convolutional coding	RS (204,188) over GF (256)
Trellis coding	No	Yes	No
Interleaving	Convolutional interleaving, depth: I = 12	Convolutional interleaving, depth: I = 128, 64, 32,16, 8 J = 1, 2, 3, 4, 5, 6, 7, 8, 16	Convolutional interleaving, depth: I = 12
Roll-off factor	0.15	0.18 for 64QAM, 0.12 for 256QAM, 1024QAM	0.13
Stream	MPEG-2 TS	Modified MPEG-2 TS, with the sync byte replaced by a parity checksum	MPEG-2 TS

RF Transmitter Tests

Standard-based RF transmitter tests

The RF transmitter test requirements for DVB-C is defined in the ETSI TR 101 290 standard. Table 2 shows the required base station RF transmitter tests along with the corresponding measurement applications.

Table 2. Required RF transmitter measurements and the corresponding measurements in N6152EM0D

ETSI TR101 290 v.1.2.1 paragraph number	Transmitter test	X-Series N6152EM0D measurement application
6.1	System availability	N/A
6.2	Link availability	N/A
6.3	BER before RS decoder	Modulation accuracy (BER view)
6.3.1	BER - out of - service	Modulation accuracy (BER view)
6.3.2	BER - in - service	Modulation accuracy (BER view)
6.4	Error events logging	N/A
6.5	Transmitter symbol clock jitter and accuracy	N/A
6.6	RF/IF signal power	Channel power measurement
6.7	Noise power	Spectrum analyzer mode
6.8	Bit error count after RS	Modulation accuracy (BER view)
6.9.1	I/Q analysis definition	N/A
6.9.2	Modulation error ratio	Modulation accuracy (result metrics view)
6.9.3	System target error	N/A
6.9.4	Carrier suppression	Modulation accuracy (result metrics view)
6.9.5	Amplitude imbalance	Modulation accuracy (result metrics view)
6.9.6	Quadrature error	Modulation accuracy (result metrics view)
6.9.7	Residual target error	N/A
6.9.8	Coherent interferer	N/A
6.9.9	Phase jitter	N/A
6.9.10	Signal-to-noise ratio (SNR)	Modulation accuracy (result metrics view)
6.10	Interference	Spectrum analyzer mode
7.1	Noise margin	Modulation accuracy (BER view)
7.2	Estimated noise margin	Modulation accuracy (BER view)
7.3	Signal quality margin test	Modulation accuracy (BER view)
7.4	Equivalent noise degradation (END)	Modulation accuracy (BER view)
7.5	BER vs. Eb/N0	Modulation accuracy (BER view)
7.6	Phase noise of RF carrier	Phase noise mode
7.7	Amplitude, phase, and impulse response of the channel	Modulation accuracy (channel frequency response)
7.8	Out - of - band emissions	Spectrum emission mask measurement

Measurement details

All of the RF transmitter measurements as defined by the digital cable TV standard, as well as a wide range of additional measurements and analysis tools, are available with a press of a button (Table 3). These measurements are fully remote controllable via the IEC/IEEE bus or LAN using SCPI commands.

Analog baseband measurements are available on the PXA or MXA signal analyzer equipped with BBIQ hardware supported baseband measurements include all of the modulation quality plus I/Q waveform measurements.

Table 3. One-button measurements provided by the N6152EM0D measurement application

Technology	**DVB-C (J.83 Annex A/C)**	**J.83 Annex B (DOCSIS DS)**
Measurements	**N6152EM0D**	**N6152EM0D**
Adjacent channel power	●	●
Spectrum emission mask	●	●
Power statistic CCDF	●	●
Modulation accuracy		
RMS EVM (%)	●	●
Peak EVM (%)	●	●
Position of peak EVM	●	●
RMS MER (dB)	●	●
Peak MER (dB)	●	●
Position of peak MER	●	●
RMS mag error (%)	●	●
Peak mag error (%)	●	●
Position of peak mag error	●	●
RMS phase error (deg)	●	●
Peak phase error (deg)	●	●
Position of peak phase error	●	●
IQ offset (dB)	●	●
Frequency error (Hz)	●	●
Clock error	●	●
Tx power (dBm)	●	●
Quadrature error (deg)	●	●
Amplitude imbalance (%)	●	●
EVM vs. symbols (%)	●	●
Mag error vs. symbols (dB)	●	●
Phase error vs. symbols (deg)	●	●
Amplitude vs. frequency (dB)	●	●
Phase vs. frequency (deg)	●	●
Group delay vs. frequency (ns)	●	●
Channel impulse response (dB)	●	●
BER results	●	●

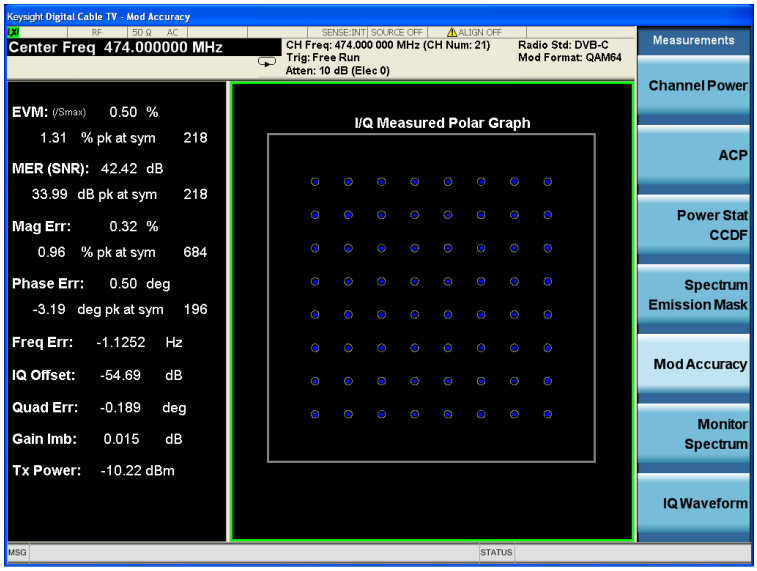


Figure 1. DVB-C constellation and MER results

Figure 2. DVB-C IQ quad view

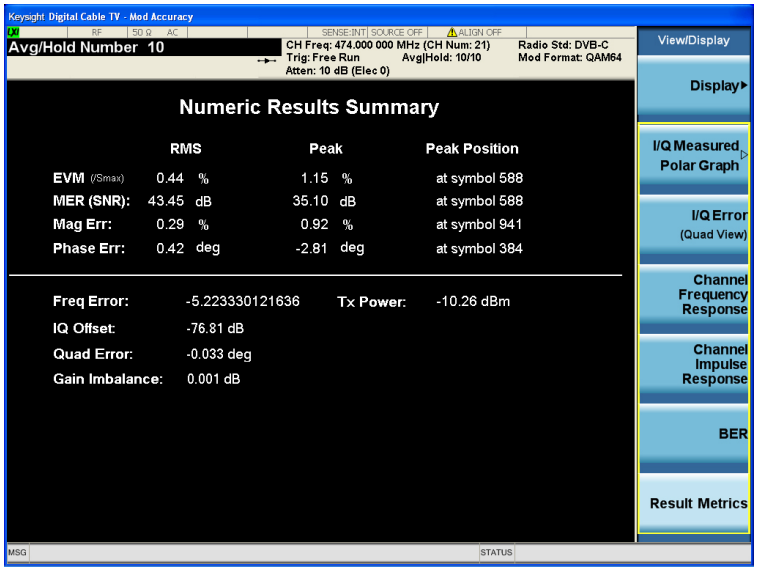


Figure 3. DVB-C result metrics view

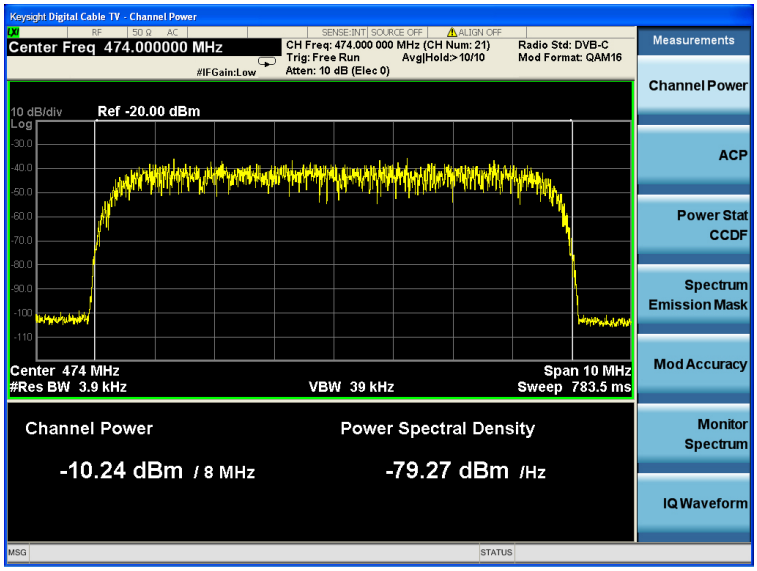


Figure 4. DVB-C channel power

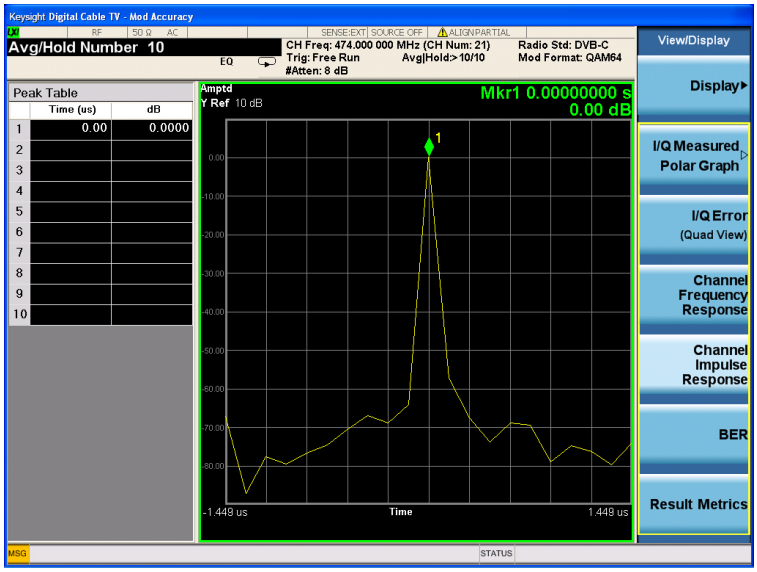


Figure 5. DVB-C channel impulse response view

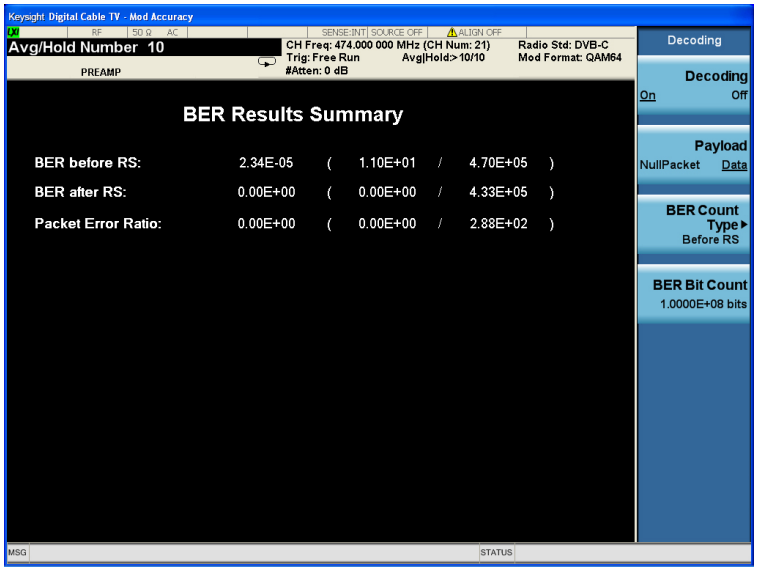


Figure 6. DVB-C BER view

Key Specifications

Definitions

- 95th percentile values indicate the breadth of the population (≈2σ) of performance tolerances expected to be met in 95% of cases with a 95% confidence.
- Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence.
- Nominal values are designated with the abbreviation "nom." These values indicate expected performance, or describe product performance that is useful in the application of the product.
- PXA specifications apply to analyzers with frequency options of 526 and lower. For analyzers with higher frequency options, specifications are not warranted but performance will nominally be close to that shown in this section.

Note: Data subject to change

For a complete list of specifications refer to the appropriate Specifications Guide.

PXA: **www.keysight.com/find/pxa_specifications**
MXA: **www.keysight.com/find/mxa_specifications**
EXA: **www.keysight.com/find/exa_specifications**
CXA: **www.keysight.com/find/cxa_specifications**

Description	PXA (N9030A)	MXA (N9020A)	EXA (N9010A)	CXA (N9000A)
Channel power				
8 MHz integration BW	–50 dBm (nom)	–50 dBm (nom)	–50 dBm (nom)	–50 dBm (nom)
Absolute power accuracy 20 to 30 °C	± 0.61 (± 0.19 dB 95%)	± 0.82 (± 0.23 dB 95%)	± 0.94 (± 0.27 dB 95%)	± 1.33 (± 0.61 dB 95%)
Measurement floor	–85.7 dBm (typ)	–82.7 dBm (typ)	–78.7 dBm (typ)	–75.7 dBm (typ)
Power statistics CCDF				
Minimum power at RF Input	–50 dBm (nom)	–50 dBm (nom)	–50 dBm (nom)	–50 dBm (nom)
Histogram resolution	0.01 dB	0.01 dB	0.01 dB	0.01 dB
Adjacent channel power				
Minimum power at RF input; 0 to 55 °C	–36 dBm (nom)	–36 dBm (nom)	–36 dBm (nom)	–36 dBm (nom)
ACPR accuracy	8.0 MHz noise bandwidth, method = IBW			
Offset frequency 8 MHz	± 0.21 dB	± 0.46 dB	± 0.98 dB	± 1.43 dB

Description	PXA (N9030A)	MXA (N9020A)	EXA (N9010A)	CXA (N9000A)
Spectrum emission mask	**6.9 MHz Integration BW, RBW = 3.9 kHz**			
4.2 MHz offset				
Dynamic range, relative	97.8 (102.7 typ)	92.1 (98.5 dB typ)	86.9 dB (94.0 dB typ)	84.5 dB (91.7 dB typ)
Sensitivity, absolute	–114.5 (–118.5 dBm typ)	–110.5 (–115.5 dBm typ)	–105.5 (–111.5 dBm typ)	–102.5 (–108.5 dBm typ)
Accuracy				
Relative	± 0.10 dB	± 0.18 dB	± 0.18 dB	± 0.27 dB
Absolute, 20 – 30 °C	± 0.62 (± 0.20 dB 95%)	± 0.88 dB (± 0.23 dB 95%)	± 1.05 dB (± 0.31 dB 95%)	± 1.53 dB (± 0.64 dB 95%)
10.0 MHz offset				
Dynamic range, relative	101.9 (106.8 dB typ)	96.1 (101.8 dB typ)	90.8 (97.1 dB typ)	88.7 (96.3 dB typ)
Sensitivity, absolute	–114.5 (–118.5 dBm typ)	–110.5 (–115.5 dBm typ)	–105.5 (–111.5 dBm typ)	–102.5 (–108.5 dBm typ)
Accuracy				
Relative	± 0.12 dB	± 0.22 dB	± 0.22 dB	± 0.37 dB
Absolute	± 0.62 (± 0.20 dB 95%)	± 0.88 (± 0.23 dB 95%)	± 1.05 dB (± 0.31 dB 95%)	± 1.53 dB (± 0.64 dB 95%)
Modulation accuracy	DVB-C 64QAM EVM, symbol rate = 6.9 MHz, ML[1] = –20 dBm, 20 to 30 °C			
EVM (Smax)				
Operating range	0 to 5%	0 to 5%	0 to 5%	0 to 5% (nom)
Floor	0.51% (adaptive EQ Off)	0.57% (adaptive EQ Off)	0.63% (adaptive EQ Off)	0.63% (adaptive EQ Off) (nom)
MER				
Operating range	≥ 22 dB	≥ 22 dB	≥ 22 dB	≥ 22 dB (nom)
Floor	43 dB (adaptive EQ Off)	42 dB (adaptive EQ Off)	41 dB (adaptive EQ Off)	41 dB (adaptive EQ Off) (nom)
Frequency error[2]				
Range	–150 kHz to 150 kHz	–150 kHz to 150 kHz	–150 kHz to 150 kHz	–150 kHz to 150 kHz
Accuracy	± 10 Hz + tfa[3]	± 10 Hz + tfa[3]	± 10 Hz + tfa[3]	± 10 Hz + tfa[3]
Quad error				
Range	–5 deg to 5 deg	–5 deg to 5 deg	–5 deg to 5 deg	–5 deg to 5 deg (nom)
Gain Imbalance				
Range	–1 to +1 dB	–1 to +1 dB	–1 to +1 dB	–1 to +1 dB (nom)
BER before RS	For DVB-C (J.83 Annex A/C) and J.83/B (DOCSIS DS)			
Range	0 to 1.0 x 10^{-1}	0 to 1.0 x 10^{-1}	0 to 1.0 x 10^{-1}	0 to 1.0 x 10^{-1} (nom)
BER after RS	For DVB-C (J.83 Annex A/C) and J.83/B (DOCSIS DS)			
Range	0 to 1.0 x 10^{-3}	0 to 1.0 x 10^{-3}	0 to 1.0 x 10^{-3}	0 to 1.0 x 10^{-3} (nom)
Packet error ratio	For DVB-C(J.83 Annex A/C) and J.83/B (DOCSIS DS)			
Range	0 to 1.0	0 to 1.0	0 to 1.0	0 to 1.0 (nom)
Clock error	Increasing symbol length to more than 5000 can significantly improve the clock error accuracy			

1. ML (mixer level) is RF input power minus attenuation
2. The accuracy specification applies at the EVM = 1%s
3. tfa = transmitter frequency × frequency reference accuracy

Ordering Information

Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Time-based:** License is time limited to a defined period, such as 12-months.
- **Node-locked:** Allows you to use the license on one specified instrument/computer.
- **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- **Floating:** Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- **Software support subscription:** Allows the license holder access to Keysight technical support and all software upgrades

You Can Upgrade!

All of our X-Series application options are license-key upgradeable.

UP GRADE

Digital Cable TV measurement application (N6152EM0D)

Model	Software License Type	Support Contract	Support Subscription (12-month) [1,2]
N6152EM0D-1FP	Node-locked perpetual	R-Y5C-001-A[2]	R-Y6C-001-L[2]
N6152EM0D-1FL	Node-locked 12-month	R-Y4C-001-L[1]	Included
N6152EM0D-1TP	Transportable perpetual	R-Y5C-004-D[2]	R-Y6C-004-L[2]
N6152EM0D-1TL	Transportable 12-month	R-Y4C-004-L[1]	Included
N6152EM0D-1NP	Floating perpetual	R-Y5C-002-B[2]	R-Y6C-002-L[2]
N6152EM0D-1NL	Floating 12-month	R-Y4C-002-L[1]	Included
N6152EM0D-1UP	USB portable perpetual	R-Y5C-005-E[2]	R-Y6C-005-L[2]
N6152EM0D-1UL	USB portable 12-month	R-Y4C-005-L[1]	Included

One month software support subscription extensions [3]

Model	Description
R-Y6C-501[3]	1-month of software support subscription for node-locked license
R-Y6C-502[3]	1-month of software support subscription for floating license
R-Y6C-504[3]	1-month of software support subscription for transportable license
R-Y6C-505[3]	1-month of software support subscription for USB portable license

1. All time-based X-Series measurement application licenses includes a 12-month support contract which also includes the 12-month software support subscription as same duration.
2. Support contract must bundle software support subscription for all perpetual licenses in the first year. All software upgrades and Keysight support are provided for software licenses with valid support subscription.
3. After the first year, software support subscription may be extended with annual or monthly software support subscription extension.

Try Before You Buy!

Evaluate a full-featured version of our X-Series measurement application with our ***FREE*** trial. Redeem one 30-day trial license of each measurement application online at: www.keysight.com/find/X-Series_apps_trial

Hardware Configurations

To learn more about compatible platforms and required configurations, please visit: **www.keysight.com/find/X-Series_apps_platform**

Software Models & Options

To learn more about X-Series measurement application licensing, model numbers and options, please visit: **www.keysight.com/find/X-Series_apps_model**

Hardware Configuration

For optimizing the Digital Cable TV measurement application, Keysight recommends a minimum level of instrument hardware functionality at each instrument performance point. Supported instruments include:

Benchtop:

- PXA N9030A
- EXA N9010A
- MXA N9020A
- CXA N9000A

N90x0A X-Series signal analyzer

Capability	Instrument Option	Benefit
Analysis bandwidth	10 or 25 MHz as default or higher	**Required**: Wider analysis bandwidth options such as 25/40/85/160 MHz can be selected depending on the specified signal analyzer model
Precision frequency reference	-PFR	**Recommended**: For enhanced frequency accuracy and repeatability for lower measurement uncertainty
Electronic attenuator	-EA3	**Recommended**: Fast and reliable attenuation changes ideal for manufacturing without the wear associated with mechanical attenuators up to 3.6 GHz in 1 dB steps
Pre-amplifier	3.6 GHz (-P03) or higher	**Recommended**: For maximizing the measurement sensitivity
Fine resolution step attenuator	-FSA	**Recommended**: Useful for maximizing useable dynamic range to see signals
Analog baseband I/Q inputs	-BBA on PXA and MXA only	**Optional**: To extend measurements at baseband if required by device under test

Related Literature

Description	Publication number
N6152A & W6152A Digital Cable TV Measurement Application, Self-Guided Demonstration	5990-6792EN
N6152A & W6152A Digital Cable TV Measurement Application, Measurement Guide	N6152-90002
N6152A & W6152A Digital Cable TV Measurement Application, User's and Programmer's Reference	N6152-90001

Web

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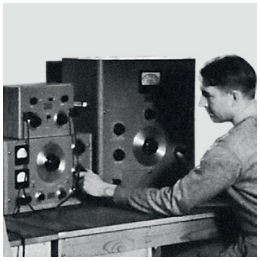

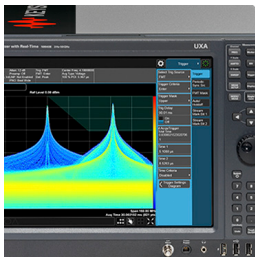

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