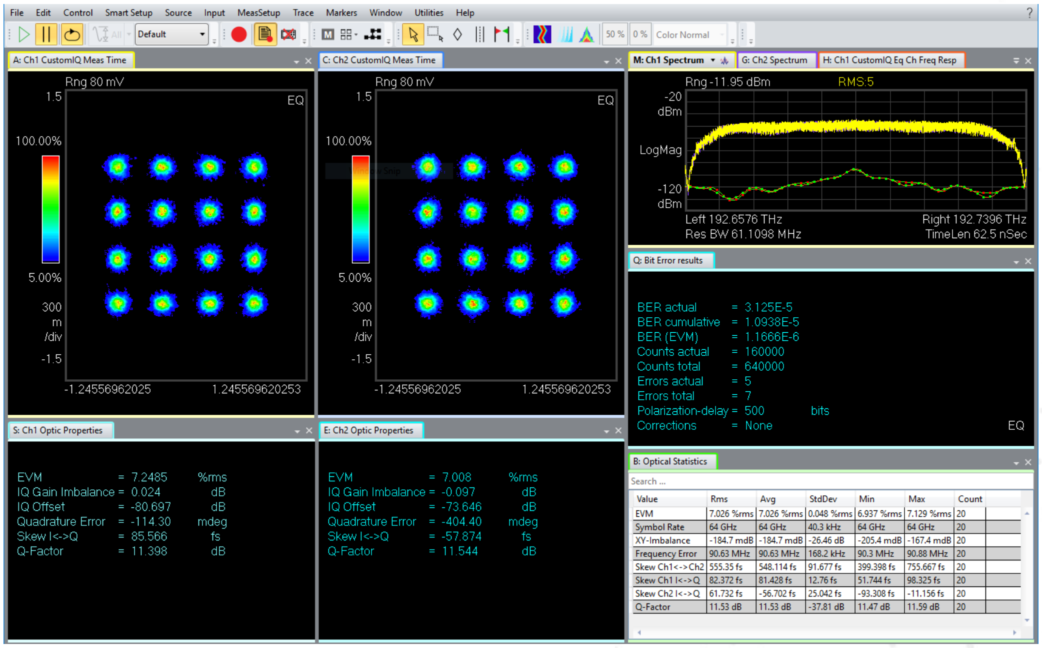
DATA SHEET

N4391SALC

Optical Modulation Analysis Software



Try before you buy

Download the Optical Modulation Analysis, 30 days free trail software to make measurements or to use our recorded demo signals.

Find more details here: www.keysight.com/find/N4391SALC

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Introduction

The analysis software from Keysight's Optical Modulation Analyzer portfolio can be used on your PC without any instrumentation. It offers all the analysis capabilities including its advanced signal processing algorithms for complex modulated optical signals. Use this software to process and analyze raw data stored as .sdf, .mat or .csv files from measurements with any Keysight Optical Modulation Analyzer. This capability allows you to work with the data as if you would work directly in front of the instrument. It is an excellent tool for developing your own signal processing algorithms and testing them off-line, together with your MATLAB compiler. In addition, this software is an effective tool for learning basic and advanced concepts of complex optical modulation, based on stored files.

Key features

- Post-process recordings with various analysis parameters without blocking hardware
- Hands-on learning about complex optical transmission
- Measure EVM for dual-polarization IQ signals including detailed impairment analysis
- Support of standard as well as user-defined constellation maps
- Standard-conform EVM measurement according to ITU G.698.2
- Smart way to setup the analysis software reduces setup time
- Modulation format transparent pre-processing algorithms including our patented polarization demultiplexing in Stokes space
- Interface for adding your own MATLAB-algorithm into the pre-processing chain
- Measurement tools such as laser linewidth, optical statistics table and 3D Poincaré polarization analysis
- Infiniium scope hardware connectivity

Optical Modulation Analysis Software

The analysis software from Keysight's Optical Modulation Analyzer portfolio can be used on your PC without any instrumentation. It offers all the analysis capabilities including its advanced signal processing algorithms for complex modulated optical signals

Vector Signal Analysis (VSA) Software

N4391SALC is an extension to the industry-standard Keysight Vector Signal Analysis (VSA) software for coherent optical dual polarization data streams. This analysis software is the work horse in RF and mobile engineering labs and offers all tools needed to analyze complex modulated (or vector modulated) optical signals. It provides a number of parameters that qualify the signal integrity of your measured signal. The most common one is the Error Vector Magnitude (EVM). In addition, the functionality can be extended with math and macro functions according to your needs.

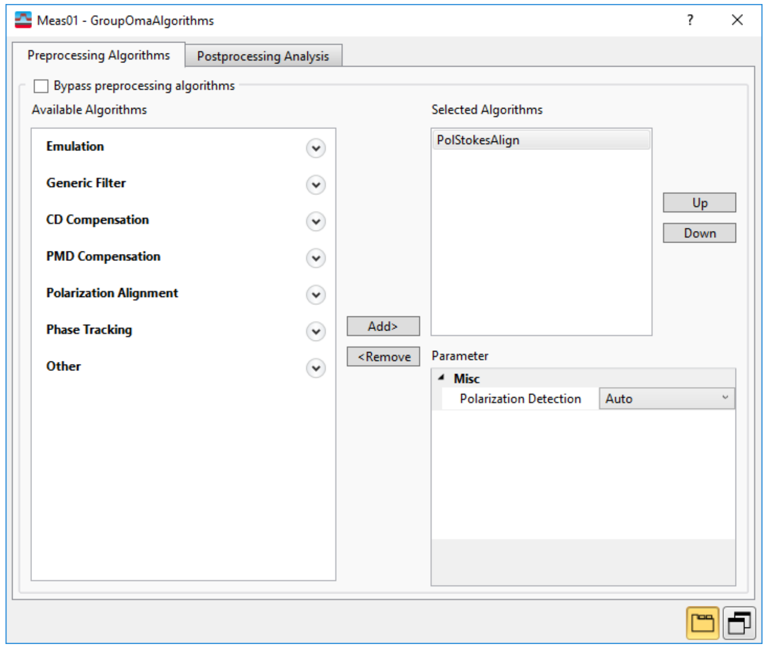
Required VSA Model for OMA	Description	Further Information
89601200C	Basic vector signal analysis	5992-4210EN
89601AYAC	Fixed Equalizer and Brick Wall	5992-4228EN

User-selectable algorithms

Choose from a comprehensive list of Keysight's algorithms. Freely change the order of selected algorithms and edit their respective parameters.

There are three ways to include your own custom algorithms:

- Write a custom algorithm in C# or VB .NET,
- Execute a MATLAB m-file using the MFileWrapper, or
- Execute a compiled MATLAB DLL

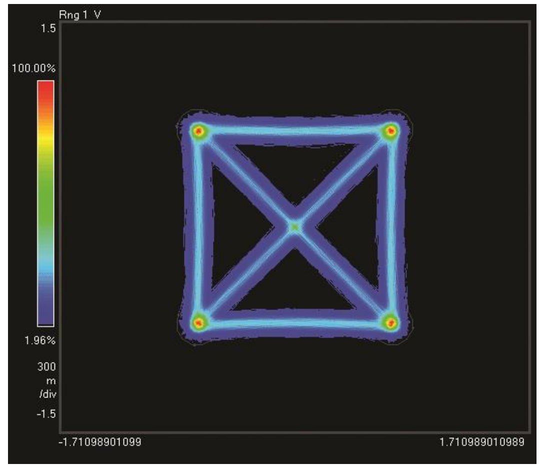


List of Algorithms	Options	Category
Emulation	CD and Noise	Preprocessing Algorithm
Generic Filter	Fixed Equalizer and Brick Wall	Preprocessing Algorithm
CD Compensation	4 variants	Preprocessing Algorithm
PMD Compensation	5 variants	Preprocessing Algorithm
Polarization Alignment	3 variants incl. Keysight's patented polarization alignment in Stokes space	Preprocessing Algorithm
Phase Tracking	Based on Kalman Filter	Preprocessing Algorithm
Other	AC coupling MFileWrapper RequestMorePoints	Preprocessing Algorithm
Estimate Symbol Rate	Update Symbol Rate	Postprocessing Analysis
EVM Percentile	Hit Ratio	Postprocessing Analysis
Interpolate IQ Meas.Time	Interpolation Factor	Postprocessing Analysis
Measure Skew		Postprocessing Analysis
Polarization Imbalance		Postprocessing Analysis
Polarization Stokes Analysis		Postprocessing Analysis
Show Enlarged	FontSize Choose up to 5 Measurement Results	Postprocessing Analysis
Show value Over Time	HistorySize MeasurementValue	Postprocessing Analysis

Analysis Features

Optical I-Q diagram

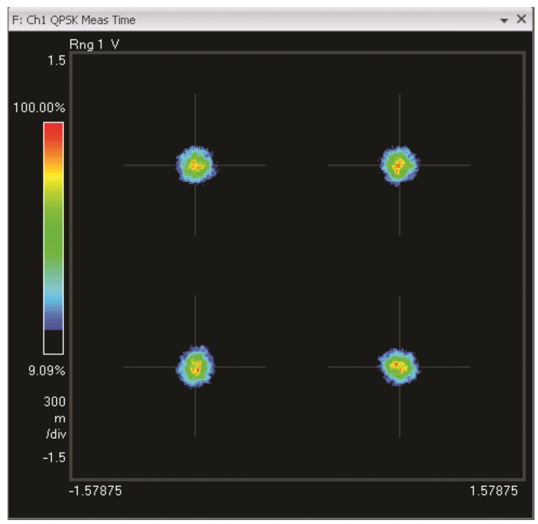
The I-Q diagram (also called a polar or vector diagram) displays demodulated data, traced as the in-phase signal (I) on the x-axis versus the quadrature signal (Q) on the y-axis. This tool gives deeper insight into the transition behavior of the signal



Optical constellation diagram

In a constellation diagram, information is shown in a two-dimensional polar diagram, displaying amplitude and phase of the signal. The constellation diagram shows the I-Q positions that correspond to the symbol clock times. These points are commonly referred to as detection decision-points and are called symbols. Constellation diagrams help identify such things as amplitude imbalance, quadrature error, or phase noise.

The constellation diagram gives fast insight into the quality of the transmitted signal as it is possible to see distortions or offsets in the constellation points. In addition, the offset and the distortion are quantified as parameters for easy comparison to other measurements



Symbol table/error summary

This result is one of the most powerful tools in the digit demodulation analysis. With just a few scalar parameters, you can get full insight in your transmitter quality and get an indication on the most likely error sources. Additionally, demodulated bits can be seen along with error statistics for all of the demodulated symbols. The following list describes the parameters briefly:

```
EVM       =  9.6577    %rms    26.092       % pk  at  sym    908
Mag Err   =  6.7412    %rms    -25.501      % pk  at  sym    908
Phase Err =  7.5304     deg    -38.213    deg pk  at  sym   1744
Freq Err  =  18.505     MHz
IQ Offset =  -30.783     dB    SNR (MER)  =  17.758           dB
Quad Err  =  -1.4532    deg    Gain  Imb  =  -0.059           dB

   0  11010100  11010101  00001010  01011100  01111010
  40  11100100  10011010  11111001  01101111  10011011
  80  00000110  01111100  11100000  01000101  10001111
 120  00001100  01011000  10100101  10010010  11111001
```

- EVM: The error vector magnitude (EVM) gives an indication of the overall transmitter signal quality. The rms values of the magnitude (Mag Err) and phase errors (Phase Err) are reported as well
- Freq Err: Offset between carrier laser and local oscillator
- IQ Offset: Indicates the transmitter modulator I and Q bias alignment
- Quad Err: Quadrature error to verify the 90-degree bias point alignment in the transmitter modulator
- SNR (MER): Signal-to-noise ratio based on the EVM measurement
- Gain Imb: Gain imbalance between I and Q signal path in the transmitter

Optical statistics

All measurement parameters can also be displayed in a statistics table which offers Rms, Avg, StdDev, Min, Max and Count

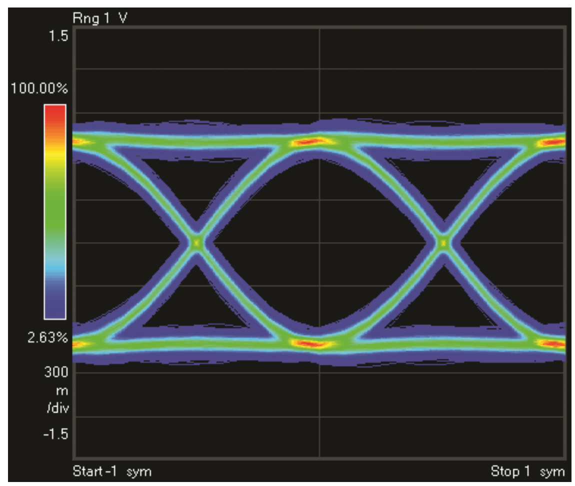
D: Optical Statistics

Value	Rms	Avg	StdDev	Min	Max	Count
EVM	9.709 %rms	9.709 %rms	0.043 %rms	9.627 %rms	9.753 %rms	8
Symbol Rate	64 GHz	64 GHz	658.6 kHz	64 GHz	64 GHz	8
XY-Imbalance	39.57 mdB	39.49 mdB	-21.73 dB	1.333 mdB	69.67 mdB	8
Frequency Error	11.5 MHz	11.5 MHz	95.74 kHz	11.33 MHz	11.61 MHz	8
Skew Ch1<->Ch2	7686.916 fs	7686.804 fs	44.455 fs	7638.171 fs	7763.249 fs	8
Skew Ch1 I<->Q	24.979 fs	22.696 fs	11.154 fs	3.458 fs	39.643 fs	8
Skew Ch2 I<->Q	15.792 fs	13.161 fs	9.331 fs	0.532 fs	23.282 fs	8
Q-Factor	10.13 dB	10.13 dB	-42.89 dB	10.11 dB	10.17 dB	8

Eye-diagram of I or Q signal

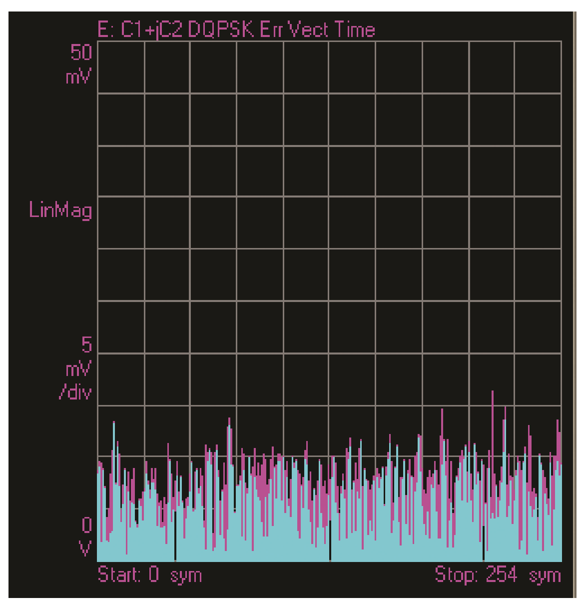
An eye-diagram is simply the display of the I (real) or Q (imaginary) signal versus time, as triggered by the symbol clock.

The display can be configured so that the eye-diagram of the real (I) and imaginary (Q) part of the signal are visible at the same time. Eye-diagrams are well-known analysis tools in the optical ON/OFF keying modulation analysis. Here, this analysis capability is extended to include the imaginary part. This tool allows comparison of I and Q eye openings, illustrating possible imbalances very quickly.



Error vector magnitude

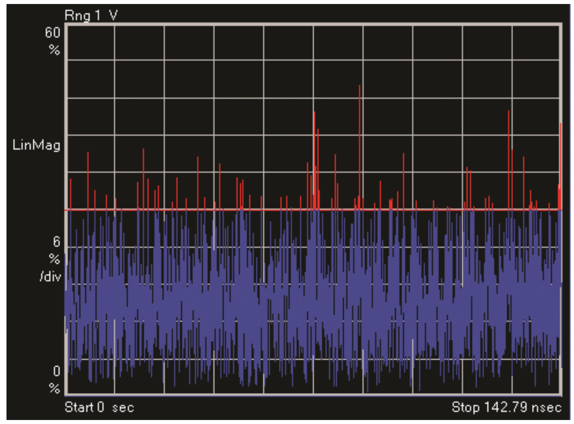
The error vector time trace shows computed error vector between measured I-Q points and the reference I-Q points. The data can be displayed as error vector magnitude, error vector phase, the I component only or the Q component only.
This tool gives a quick visual indication of how the signal matches the ideal signal.



Error vector limit test

The error vector concept is a very powerful way to qualify the overall performance of a complex modulated signal. Testing against a limit with pass/fail indication covers all typical error sources that could occur during transmitter manufacturing, alignment or along a link.

While deploying a new link operating with complex modulated signals, the pass-fail test is an easy-to-use and powerful tool to test the physical layer signal quality against a defined limit. Having a physical layer signal in the desired quality is a prerequisite for well performing higher layer protocols.



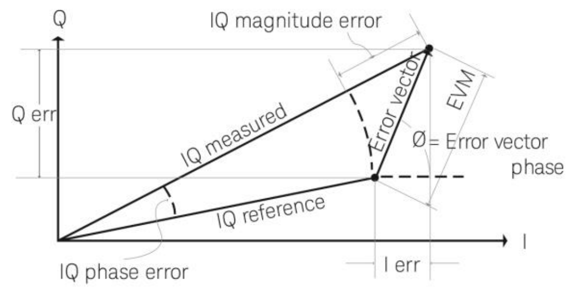
Bit/Symbol/Error Analysis

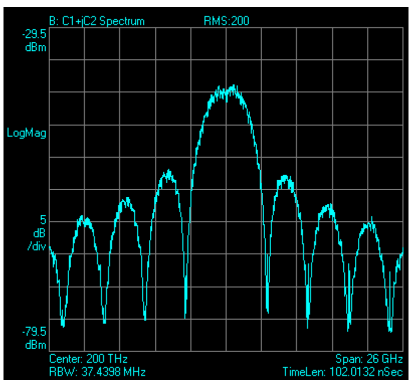
Beside the wide variety of physical parameters that can be analyzed, the optical modulation analyzer also offers the bit and symbol error analysis. Being able to detect the transmitted symbols and bits, enables comparison of the measured data against the real transmitted data.

With PRBS of any polynomial up to 2^31 and the option for user defined patterns, the optical modulation analyzer software is able to actually count the symbol errors and measure the bit error ratio during a burst.

Having these analysis tools, it is now very easy to identify the error causing element, — transmitter, link or receiver — if a classic electrical point to point BER test fails

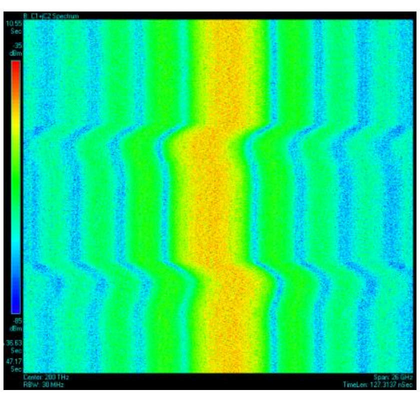
In addition, this feature offers the option to perform a stress test on a receiver, by exactly knowing the quality of the receiver input signal and being able to compare to the overall BER of the system.





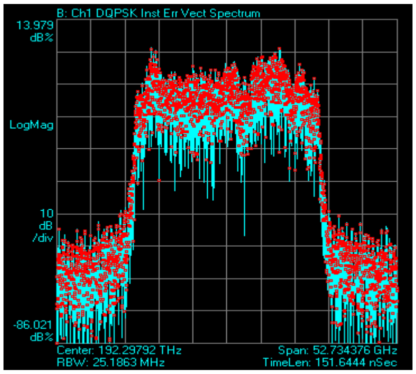
Narrow-band, high-resolution spectrum

The narrow-band high resolution spectrum displays the Fourier-transformed spectrum of the time-domain signal. The center-frequency corresponds to the local oscillator frequency, as entered in the user interface.



Spectrogram

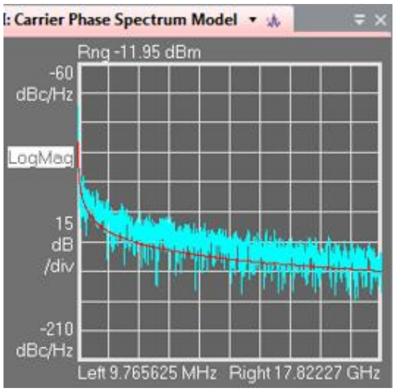
A spectrogram display provides another method of looking at trace data. In a spectrogram display, amplitude values are encoded into color. For the Spectrum Analyzer application, each horizontal line in the spectrogram represents single acquisition record. By observing the evolution of the spectrum over time, it is possible to detect sporadic events that normally would not be visible as they occur only during one or two screen updates.
In addition, it is possible to so detect long-term drifts of a transmitter laser or even detect periodic structures in the spectrogram of a laser spectrum.



Error vector spectrum

The EVM spectrum measurement is calculated by taking the FFT of the EVM versus time trace. Any periodic components in the error trace will show up as a single line in the in the error vector spectrum. Using this tool to analyze the detected signal offers the possibility to detect spurs that are overlaid by the normal spectrum.

Therefore, spurs that are not visible in the normal signal spectrum can be detected. This helps to create best signal quality of a transmitter or to detect hard to find problems in a transmission system.



Laser line-width measurement

In optical coherent transmission systems operating with advanced optical modulation formats, the performance of the transmitter signal and therefore the available system penalty depends strongly on the stability of the transmitter laser. Using our *Kalman Filter Phase Tracking* algorithm, the phase error can be evaluated over time and via Fourier transformation, the phase error spectrum can be obtained. By fitting a model to the phase error spectrum, the laser linewidth is estimated.

Standard-conform EVM measurement

Interoperability is a very new topic for coherent optical transceivers. The ITU developed a method for measuring EVM on DP-(D)QPSK signals and provides pass/fail limits for the different application codes in their recommendation G.698.2. The key parts in this specification are a defined block length for all processing steps, a 7-tap T-spaced equalizer and digital noise loading. N4391SALC offers EVM evaluation according to this and potential future standards in parallel to the flexible and versatile analysis features mentioned above.

Supported Infiniium Oscilloscopes

Model	Bandwidth	Sample Rate	Channels
UXR0404A(P)	40 GHz	256 GSa/s	4
UXR0504A	50 GHz	256 GSa/s	4
UXR0594A(P)	59 GHz	256 GSa/s	4
UXR0704A(P)	70 GHz	256 GSa/s	4
UXR0804A	80 GHz	256 GSa/s	4
UXR1004A	100 GHz	256 GSa/s	4
UXR1104A	110 GHz	256 GSa/s	4
DSxZ334A	33 GHz	80 GSa/s	4
DSxZ504A	33 GHz | 50 GHz	80 GSa/s | 160 GSa/s	4 | 2
DSxZ594A	33 GHz | 59 GHz	80 GSa/s | 160 GSa/s	4 | 2
DSxZ634A	33 GHz | 63 GHz	80 GSa/s | 160 GSa/s	4 | 2

Ordering information

Software licensing and configuration

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

Optical Modulation Analysis Software (N4391SALC)

Software License Type	Software License	Support subscriptions
Node-locked perpetual	R-B5C-001-A	R-B6C-001-z[2]
Node-locked time-based	R-B4C-001-z[1]	Included
Transportable perpetual	R-B5C-004-D	R- B6C-004-z[2]
Transportable time-based	R-B4C-004-z[1]	Included
Floating perpetual (single-site)	R-B5C-002-B	R- B6C-002-z [2]
Floating time-based (single-site)	R-B4C-002-z[1]	Included
Floating perpetual (regional)	R-B5C-006-F	R- B6C-006-z[2]
Floating time-based (regional)	R-B4C-006-z[1]	Included
Floating perpetual (worldwide)	R-B5C-010-J	R- B6C-010-z[2]
Floating time-based (worldwide)	R-B4C-010-z[1]	Included
USB-portable perpetual	R-B5C-005-E	R- B6C-005-z[2]
USB-portable time-based	R-B4C-005-z[1]	Included

1. z means different time-based license duration. F for six months, L for 12 months, X for 24 months, and Y for 36 months. All time-based licenses have included the support subscription as the time-base duration.
2. z means different support subscription duration. L for 12 months (as default), X for 24 months, Y for 36 months, and Z for 60 months. Support subscription must be purchased for all perpetual licenses with 12 months as the default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription.

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