

EA-4000

Eye Analyzer



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Units of Measurement

Units of measurement in this publication conform to SI standards and practices.

Patents

The exhaustive list of patents is available at EXFO.com/patent.

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1 **Requirements to Run UI**

PC System Hardware Requirements

Minimum

- Process: 1.67 GHz CPU
- Video: NVIDIA GeForce GPU (for example: MX150)
- Memory: 2 GB RAM
- Storage: 500 MB of available hard disk space
- LAN: Gigabit Ethernet
- Resolution: 1366x768 display

Recommended

- Process: 2.0 GHz CPU
- Video: NVIDIA GeForce GTX series
- Memory: 4 GB RAM
- Storage: 1 GB of available hard disk space
- LAN: Gigabit Ethernet
- Resolution: 1920x1080 display

Requirements to Run UI

OS and .NET Framework Requirements

OS and .NET Framework Requirements

Supported Operating System

- Microsoft Windows 7 SP1 (x86 and x64)
- Microsoft Windows 10 (x86 and x64)

The GUI requires .NET Framework 4.6.1 to work. It is Microsoft official resource. The link is below.

<https://dotnet.microsoft.com/download/thank-you/net461>

or

<https://www.microsoft.com/en-us/download/details.aspx?id=49982>

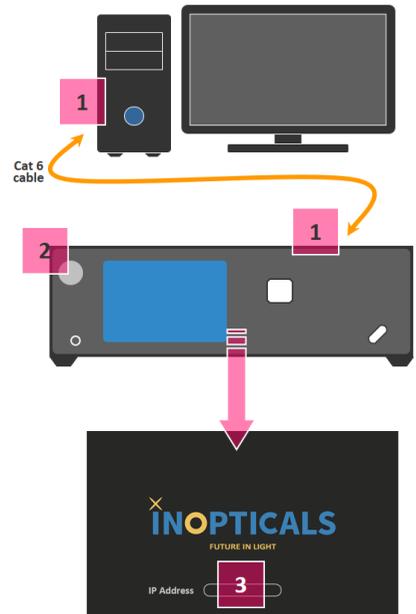
2 4 Steps to Measure Eye Diagram

Step 1: Hardware Configuration

To power on 1-CH EA (Eye Analyzer):

1. Connect a Cat 6 Ethernet cable¹ from the control PC to the RJ45 port on the rear of the chassis.
2. Push power button on the front panel.
3. Wait for initialization including checking receiver, detecting network, etc. Initialization is complete when the IP address appears.

Note: *If the IP address does not appear after 5 min, it means the unit is not connected to an Ethernet device yet. Please check the Ethernet cable and RJ45 port on the PC.*



1. A high-performance Ethernet cable is recommended, for example, Cat 6.

4 Steps to Measure Eye Diagram

Step 2: Link to Eye Analyzer

Step 2: Link to Eye Analyzer

To link to the EA:

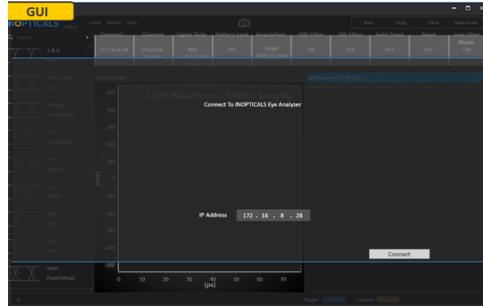
1. Input the IP address of the EA on the GUI page, for example: 172.16.8.20. (An example of IP of control PC = 172.16.1.10, and subnet mask = 255.255.0.0.)

Note: The IP address is shown on the chassis screen when initialization is completed.

2. Click **Connect** button to enter the main page.

There are 3 main setups to enable the eye diagram:

- A – Channel
- B – Symbol Rate
- C – Acquisition



Step 3: Main Setups



To set up the main windows:

1. Click **Channel** to select the input signal **Type**:

- **Electrical** (signal into RF differential ports)
- **850 nm** (multimode fiber)
- **1310 nm** or **1550 nm** (signal mode fiber)

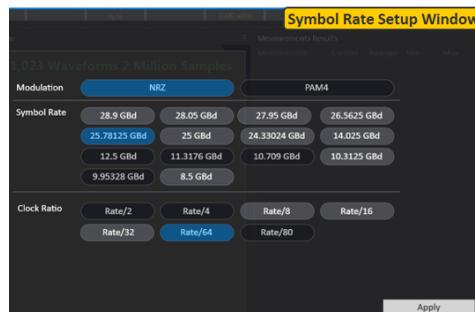


After type selection, the **Channel** number is automatically displayed to test.

Note: Ensure the fiber/cable connects to the correct channel port.

2. Click **Symbol Rate** to set the following items:

- **Modulation**
- **Symbol Rate**
- **Clock Ratio**



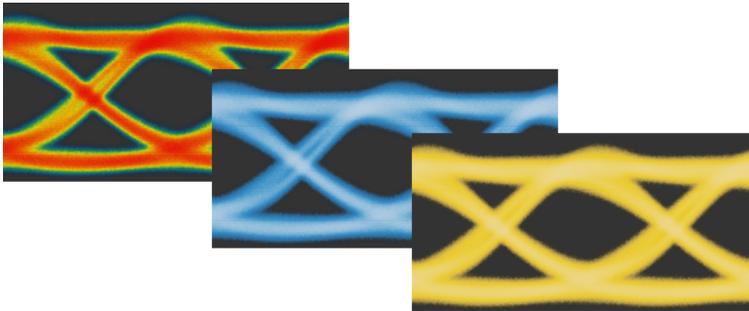
4 Steps to Measure Eye Diagram

Step 3: Main Setups

3. Click **Acquisition** to set the following items:

- **Type**

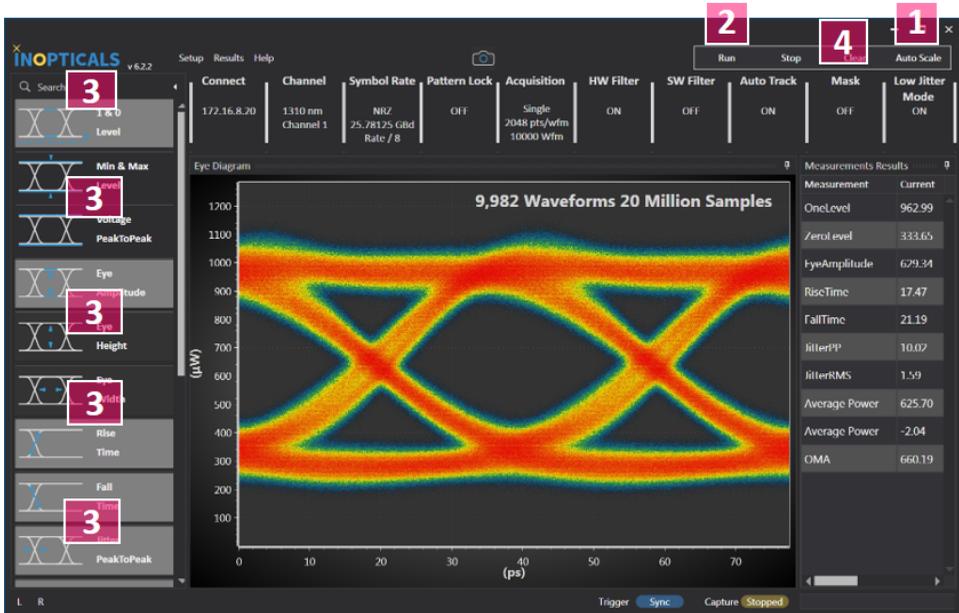
- **Oscilloscope** provides a fast update mode, good for real-time tuning.
- **Single** captures specified waveforms, once.
- **Repetitive** repeats to capture and clean specified waveforms.
- **Infinite** captures waveforms nonstop.
- **Waveforms** allows you to specify the number of waveforms to capture.
- **Color Scheme** displays the eye diagram in the following colors:
 - **Color Grade**
 - **Azure** (blue)
 - **Amber** (yellow)



Step 4: Eye Diagram

To display the eye diagram:

1. Click the **Auto Scale** button.
2. Click the **Run** button to show eye diagram.



3. Click the measurement icons to enable them.

4. Click **Mask** to set the following items to enable mask type:

- **Mask Select**
- **Hit Ratio**

5. Click **Apply**.



4 Steps to Measure Eye Diagram

Step 4: Eye Diagram

Mask List

EA Mask Title	Full Name	Reference
4WDM Rx	100G 4WDM Rx	4-Wavelength WDM MSA
ER4 TX	100GBASE-ER4 Tx	IEEE Std 802.3ba-2010
LR4 TX	100GBASE-LR4 Tx	IEEE Std 802.3ba-2010
SR4 TX	100GBASE-SR4 Tx	IEEE Std 802.3ba-2010
SR4 RX	100GBASE-SR4 Rx	IEEE Std 802.3ba-2010
CLR4	100G-CLR4	based on 100GBASE-LR4
CLR4 FEC	100G-CLR4 FEC	
CWDM4 TX	100G CWDM4 Tx	CWDM4 MSA
CWDM4 RX	100G CWDM4 Rx	CWDM4 MSA
PSM4 RX	100G PSM4 Rx	PSM4 MSA, Parallel Single Mode 4 lane
SWDM4 RX	100G SWDM4 Rx	100G SWDM4 MSA
32GFC MM	32GFC MM Tx	FIBRE CHANNEL Physical Interface-6
32GFC SM	32GFC SM Tx	FC-PI-6
EDR Cable In	InfiniBand EDR Cable In	InfiniBand Trade Association
EDR Cable Out	InfiniBand EDR Cable Out	IBTA
25G LR	25GBASE-LR Tx	IEEE Std 802.3cc-2017
OUT4	OTU4	ITU-T G.959.1

3 GUI Indication

Indication of Trigger/Capture/Camera

Screen Capture
Save GUI screen as PNG file

9,982 Waveforms 20 Million Samples
Number of total captured waveforms
Number of total sampling points

Slide the edge to tune the scale of eye diagram

Running Under capturing
Stopped Stopped capturing

Sync Clock Sync
LOL Loss of Lock
Provide clock signal into [Clock IN] port, and set correct symbol rate & clock ratio to get sync.

The screenshot shows the INOPTICALS v6.2.2 interface. At the top, a camera icon and 'Screen Capture' button are highlighted. Below it, a box indicates '9,982 Waveforms 20 Million Samples' in the eye diagram area. To the right, a callout explains that this represents the number of total captured waveforms and total sampling points. Below the eye diagram, a slider control is shown with three eye diagram icons, labeled 'Slide the edge to tune the scale of eye diagram'. At the bottom, two buttons are highlighted: 'Trigger Sync' and 'Capture (Stopped)'. A callout explains that 'Running' (green) means 'Under capturing' and 'Stopped' (yellow) means 'Stopped capturing'. Another callout explains that 'Sync' (green) means 'Clock Sync' and 'LOL' (yellow) means 'Loss of Lock', with a note to provide a clock signal to the [Clock IN] port and set the correct symbol rate and clock ratio.

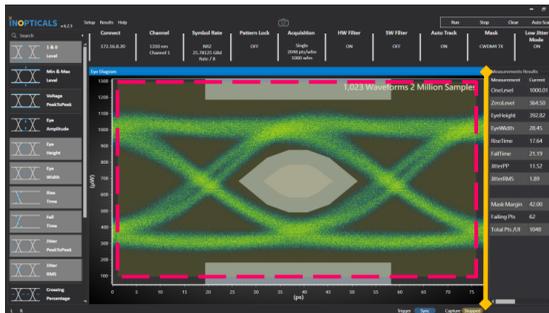
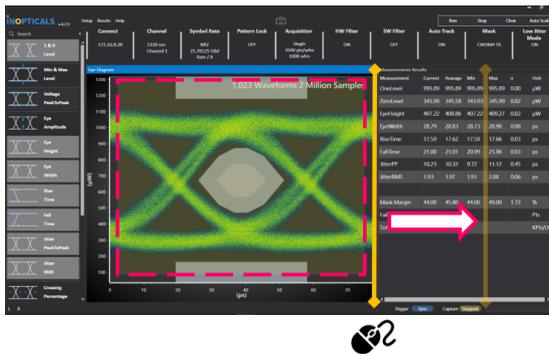
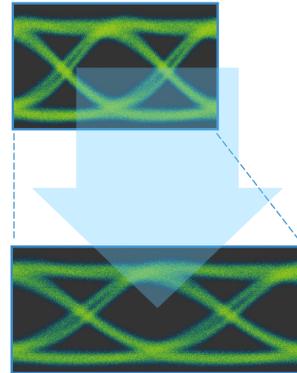
GUI Indication

Tune Eye Diagram Scale

Tune Eye Diagram Scale

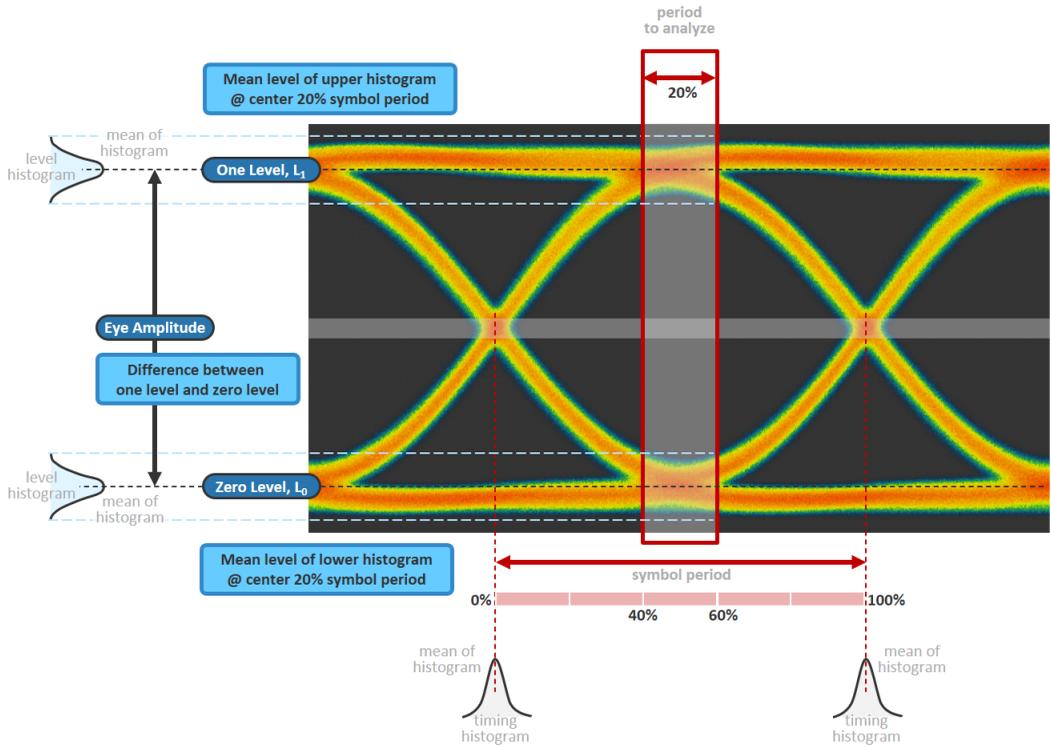
To tune the scale of the eye diagram:

1. Use the mouse button to drag the right edge of eye diagram.
2. Move mouse right or left.
3. Release mouse button to take effect.



4 Measurement Items

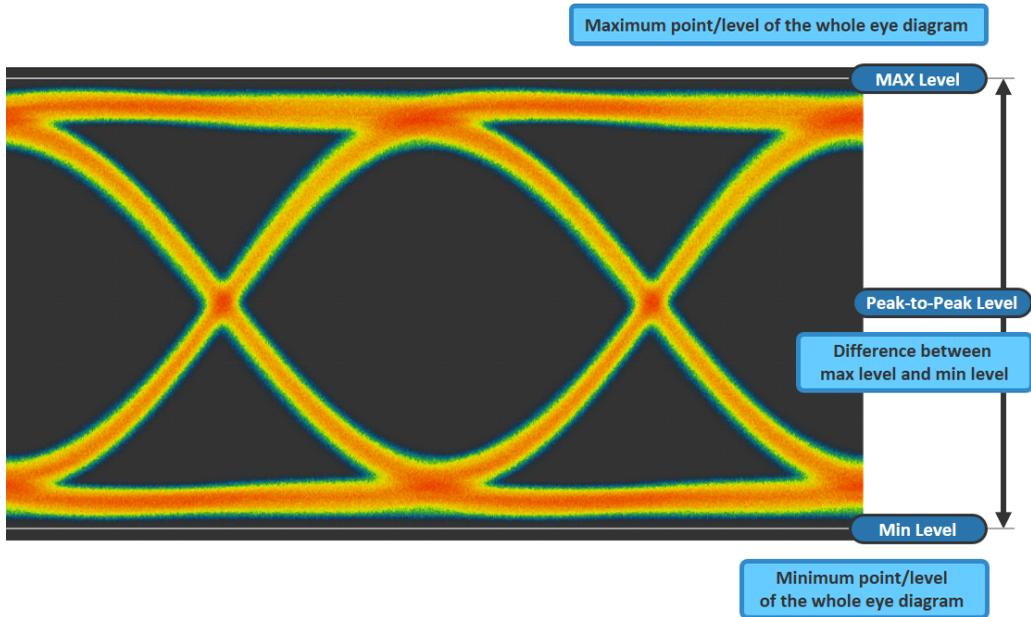
One and Zero Levels, and Eye Amplitude



Measurement Items

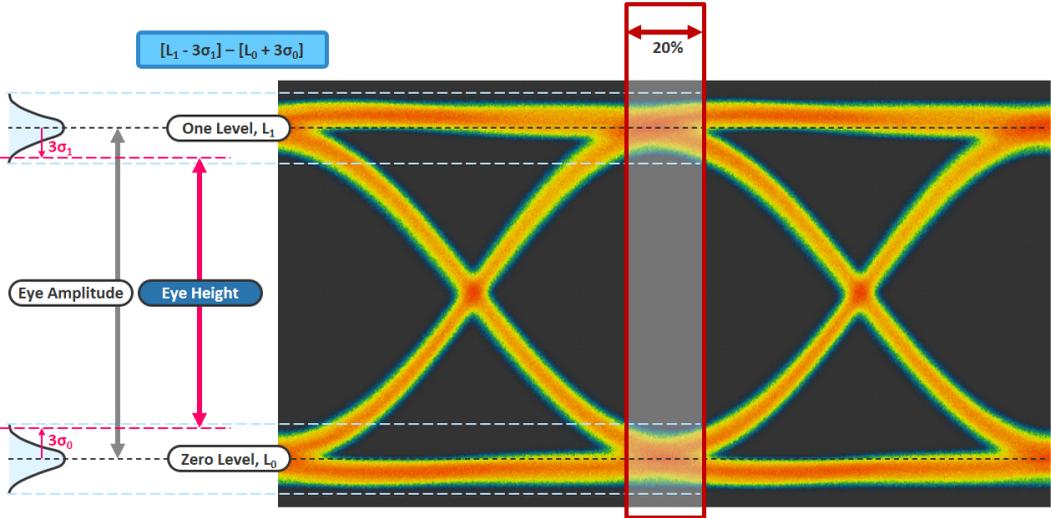
Max, Min, and Peak-to-Peak Levels

Max, Min, and Peak-to-Peak Levels

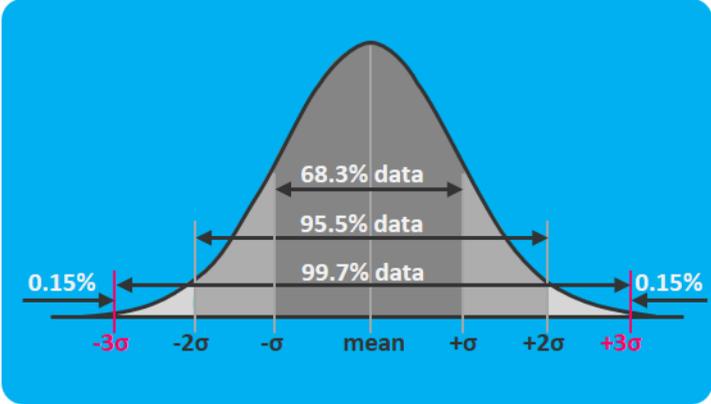


Eye Measurements

Eye Height



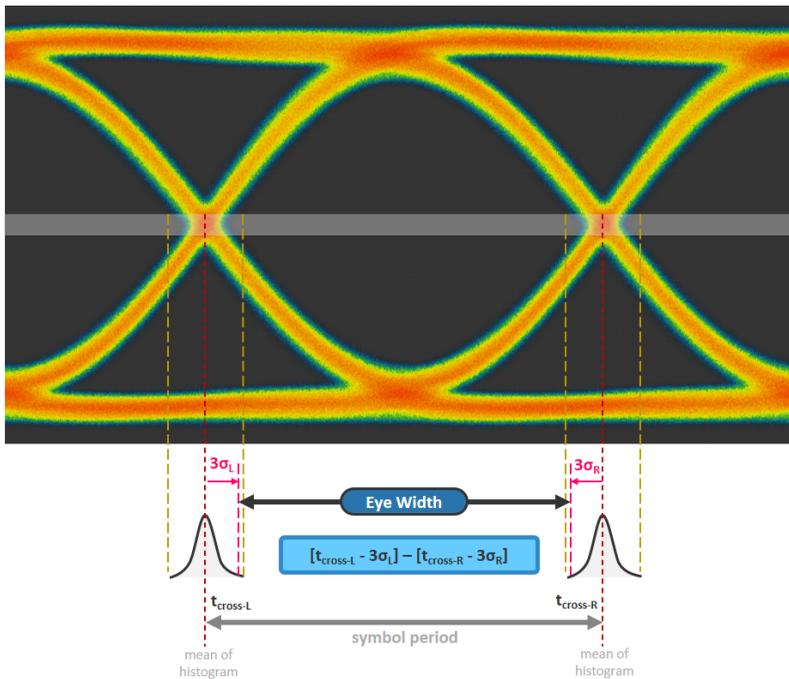
Normal Distribution and Standard Deviation



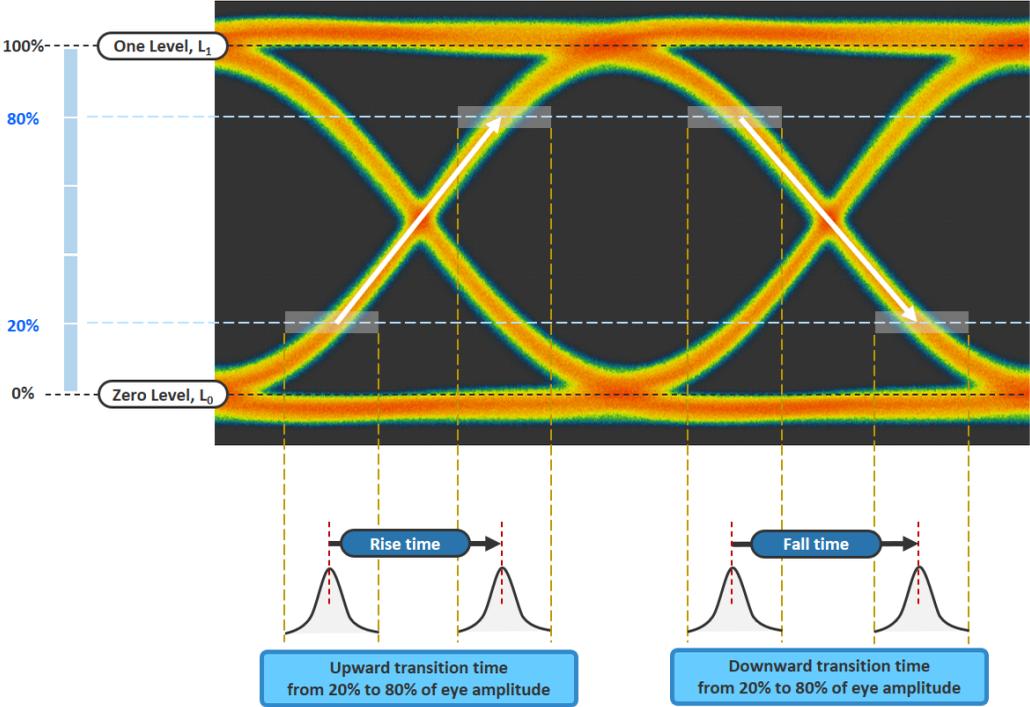
Measurement Items

Eye Measurements

Eye Width



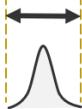
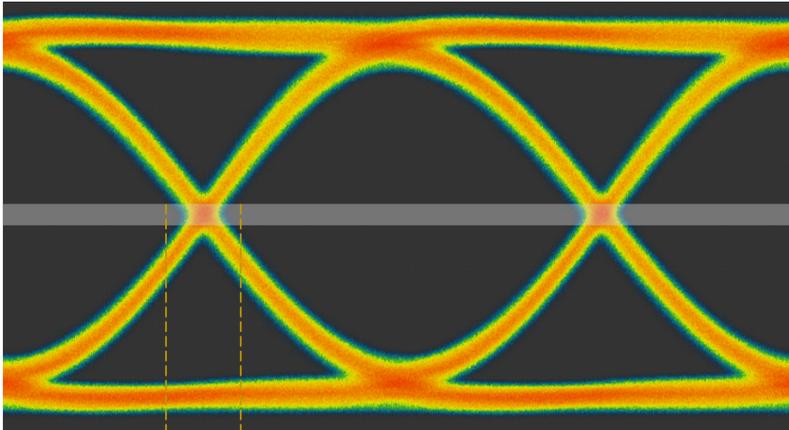
Rise and Fall Times



Measurement Items

Peak-to-Peak and RMS Jitters

Peak-to-Peak and RMS Jitters



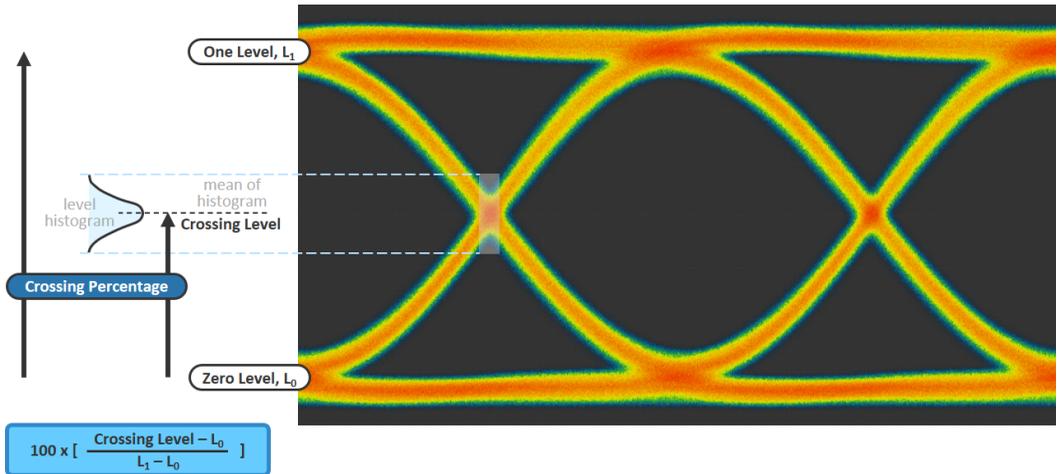
Peak-to-Peak Jitter, $Jitter_{pp}$

Full width of timing histogram
@ crossing point

RMS Jitter, $Jitter_{RMS}$

One standard deviation width
of timing histogram @ crossing point

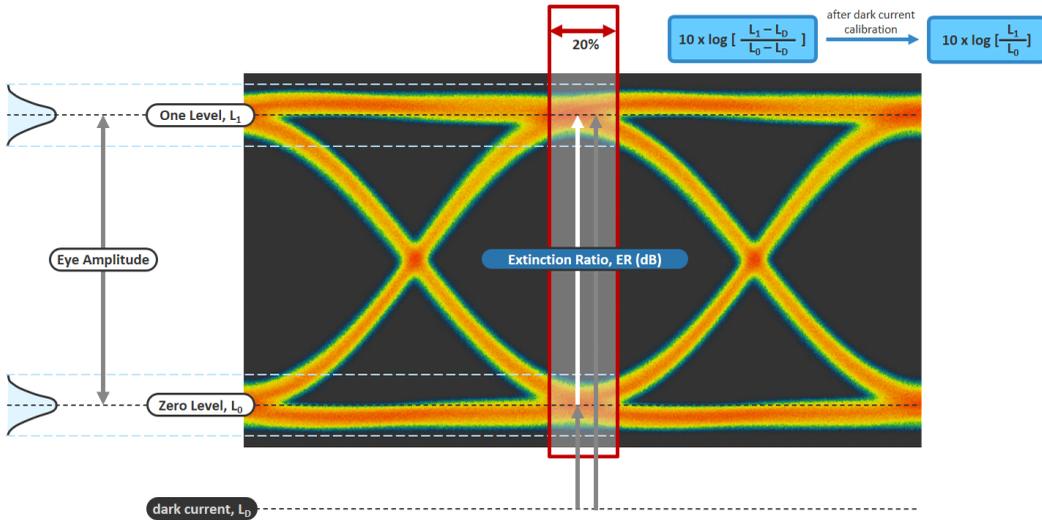
Crossing Percentage



Measurement Items

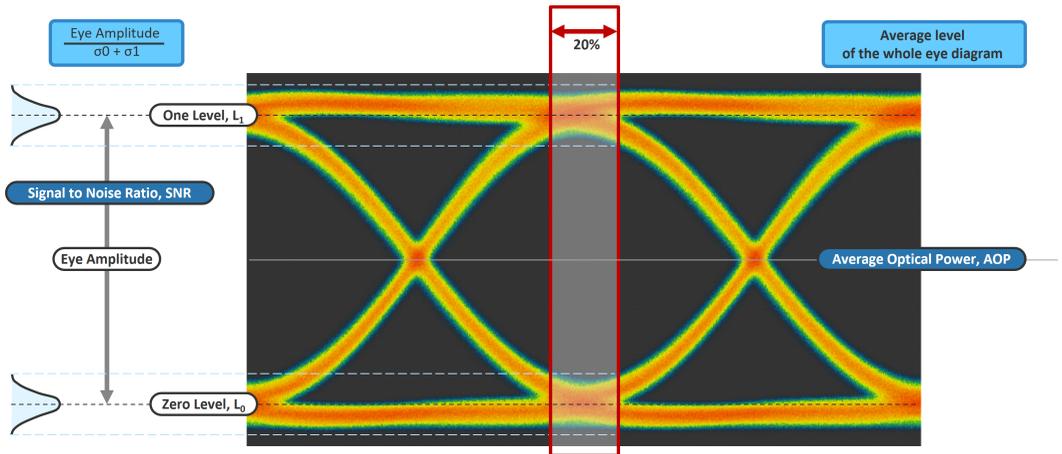
Extinction Ratio

Extinction Ratio

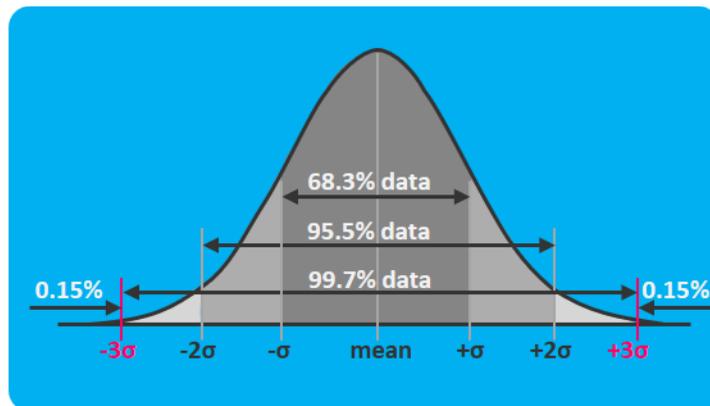


Note: Before ER measurement, perform dark current calibration.

Average Optical Power and Signal-to-Noise Ratio

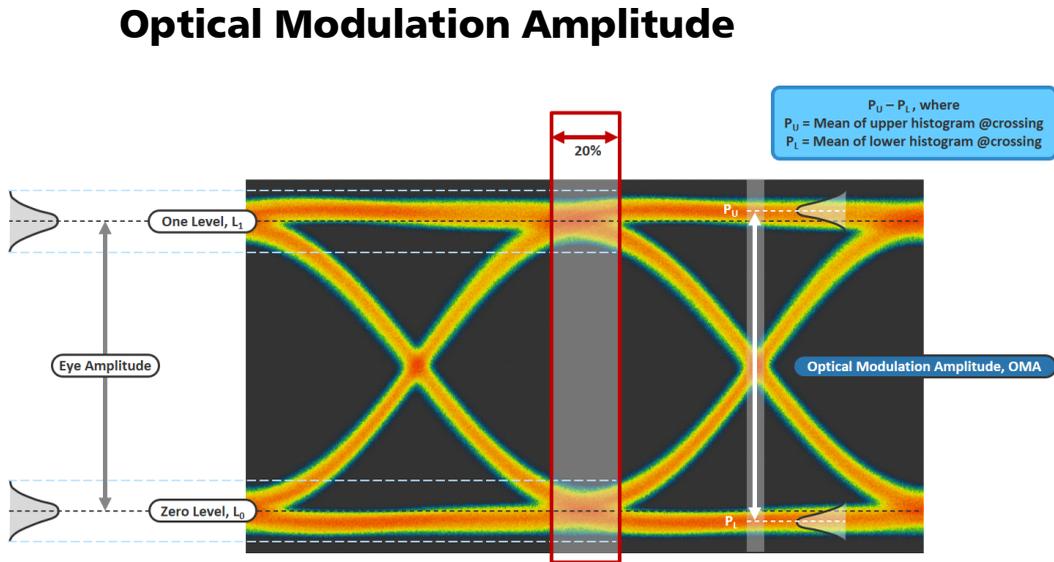


Normal Distribution and Standard Deviation

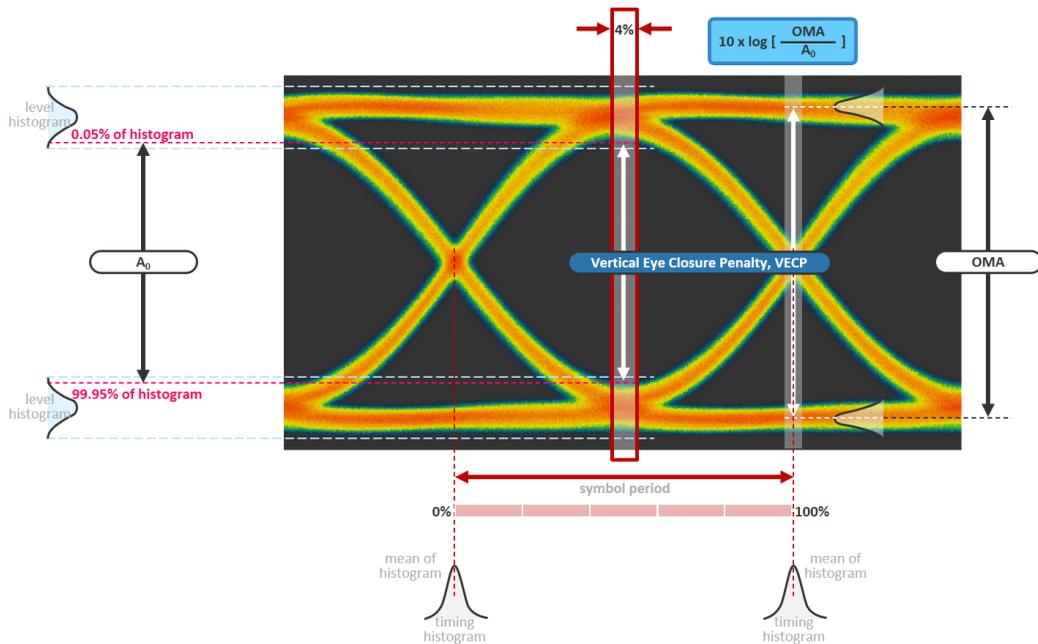


Measurement Items

Optical Modulation Amplitude



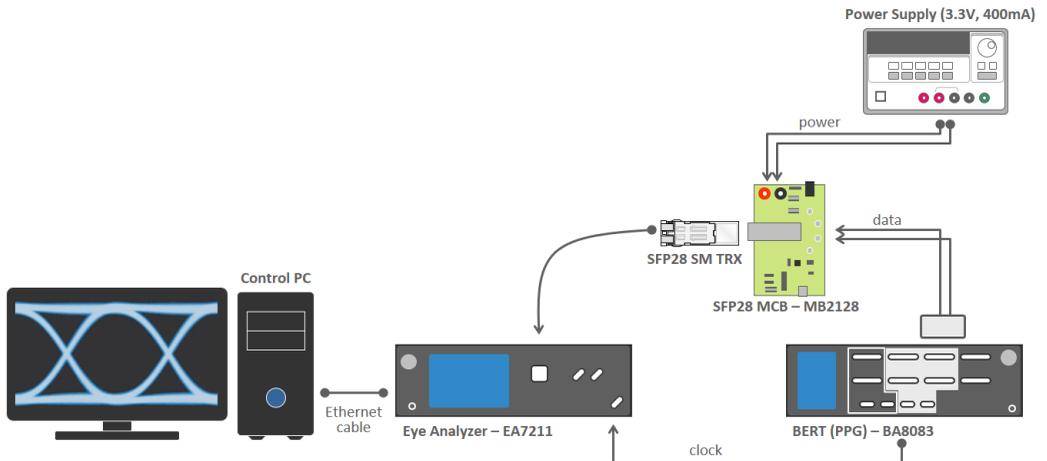
Vertical Eye Closure Penalty



A Example of Hardware Configuration for TRX Test

To measure the eye of the SFP28 SM transceiver:

1. Test its TX performance by preparing the following main hardware.
 - 28G O/E scope – EA7211
 - 8x56 G BERT – BA8083 (support 28 G)
 - SFP28 MCB – MB2128
 - Power Supply



2. Configure the main settings as follows.

- EA7211 – 28 G O/E Scope
 - Channel Type = 1310 nm
 - Modulation = NRZ
 - Symbol Rate = 25.78125 GBd
 - Clock Ratio = /8
 - Acquisition Type = Single

Example of Hardware Configuration for TRX Test

- Waveform Number = 1 K (1,000)
- Color Scheme = Color Grade
- Settings of BA8083 – BERT
 - Mode = Basic
 - Modulation = NRZ
 - Symbol Rate = 25.78125 GBd
 - Clock Ratio = /8
 - Test Pattern = PN31
 - Amplitude = 600 mV

Note: *The settings for Modulation, Symbol Rate, and Clock Ratio should be the same for both analyzers.*

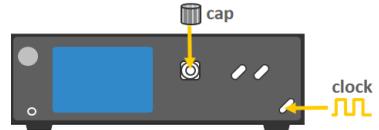
B Dark Current Compensation

Note: It is recommended to perform dark current compensation every 30 days.

To perform dark current compensation:

1. Provide clock signal into **Clock IN** port.

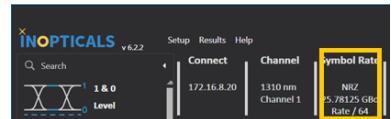
Note: When there is no clock signal, or the symbol rate or clock ratio are wrong, etc.; a pop-up message **Please make sure to have a valid clock input** is displayed.



2. Use a cap to cover optical port on the front panel.

Note: When the optical port is NOT covered well, a pop-up message **Please disconnect optical source** is displayed.

3. Click **Symbol Rate** area.



4. Provide the clock info by setting the correct **Symbol Rate** and **Clock Ratio**.



5. Click **Setup** on the menu bar to open the window of dark current compensation.

6. Select **Config Measurements** to show compensation window.



Dark Current Compensation

7. Click **Auto** to run compensation automatically. A pop-up message **Press OK to start compensating** is displayed.



8. Click **OK** to compensate dark current automatically. A pop-up message **Successfully Compensated** is displayed.
9. Click **OK** to update the value of dark current compensation.

C **Aligning EA with Referred Scope**

To make EA complied with some reference scope, there are 3 steps to compensate the difference between EA and the reference scope.



To align EA with the referred scope:

1. Perform **Loss Compensation**.

$$\text{Loss Compensation (dB)} = 10 \times \text{Log}_{10} \left[\frac{\text{Eye Amp}_{\text{ref}}}{\text{Eye Amp}_{\text{ea}}} \right]$$

where
 Eye Amp_{ref} = Eye amplitude (μW) measured by reference scope;
 Eye Amp_{ea} = Eye amplitude (μW) measured by Eye Analyzer

2. Perform **Dark Current Compensation**.

$$\text{Dark Current Compensation (}\mu\text{W)} = \text{Power}_{\text{avg,ref}} - \text{Power}_{\text{avg,ea}}$$

where
 Power_{avg,ref} = Average power (μW) measured by reference scope;
 Power_{avg,ea} = Average power (μW) measured by Eye Analyzer

3. Perform **ER (Extinction Ratio) Correction Factor**.

$$\text{ER Correct Factor (\%)} = \left[\frac{\text{ER}_{\text{ref}}}{\text{ER}_{\text{ea}}} - 1 \right] \times 100$$

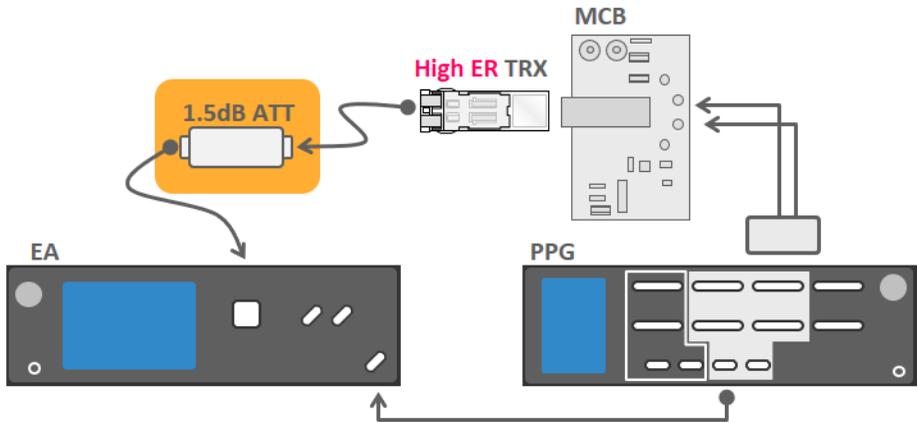
where
 ER_{ref} = Extinction ratio (dB) measured by reference scope;
 ER_{ea} = Extinction ratio (dB) measured by Eye Analyzer

D Testing High ER TRX

When the transceiver ER (Extinction Ratio) is ≥ 5 dB, you must perform one more step to keep an accurate measurement by insertion of a 1.5 dB attenuator.

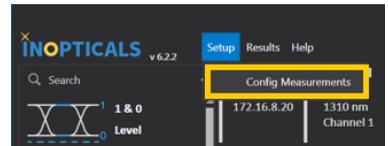
To test high ER DUT (device under test):

1. Insert 1.5 dB attenuator.



¹Legend

2. Compensate for the attenuation.
 - 2a. Click **Setup** on the menu bar.
 - 2b. Select **Config Measurements** to show compensation window.
 - 2c. Input 1.5 dB on **Loss Compensation**.
3. Start testing.



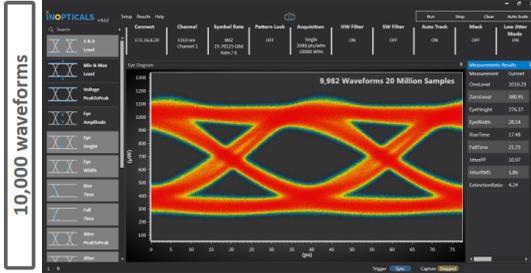
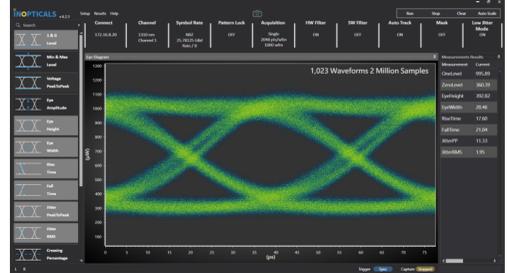
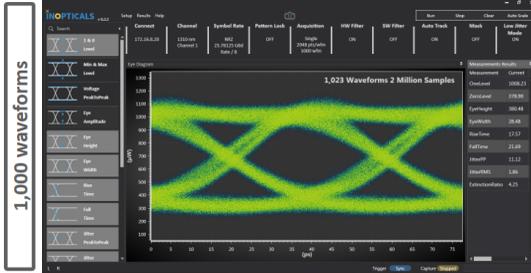
1. MCB: module compliance board; ATT: attenuator; EA: eye analyzer; PPG: pulse pattern generator

E Displaying Resolution Matters

A 1920 x1080 display provides more information and details. It is recommended to use full HD display.

Minimum Requirement of Display Resolution
1366x768

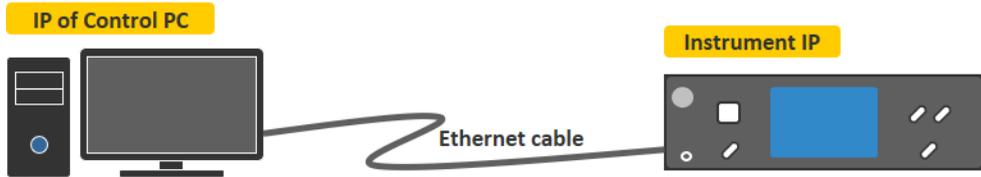
Recommended Requirement of Display Resolution
1920x1080



F Setup IP on Control PC

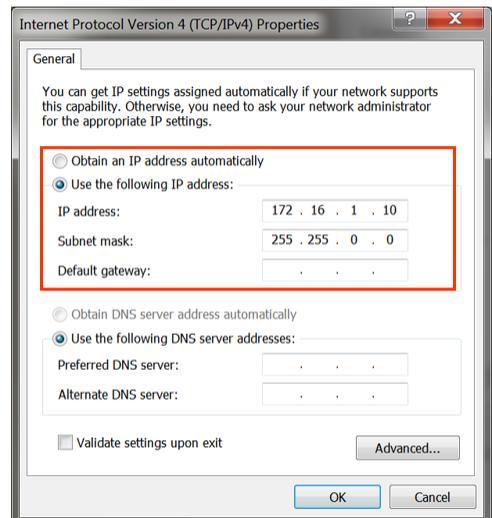
Quick Guide to Set IP Address

The IP address of the unit is 172.16.8.xxx (for example, 172.16.8.10). Therefore, set the IP Address of control PC as 172.16.yyy.zzz (for example, 172.16.1.10) and set the Subnet Mask as 255.255.0.0.



To set the IP address:

1. Open **TCP/IPv4 Properties** of the connected Ethernet device.
2. Select **Use the following IP address:**
3. Type **IP address as 172.16.1.10.**
4. Type **Subnet mask as 255.255.0.0.**



Setup IP on Control PC

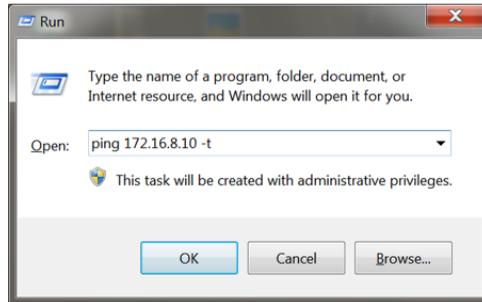
Pinging the Unit

Pinging the Unit

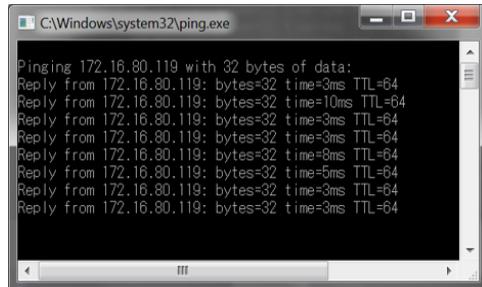
In order to check that the IP settings are correct, you can ping the unit. Getting a reply under 3 ms means the connection is correct. Otherwise, something is wrong.

To ping the unit:

1. On your keyboard, click  [Win] + [R] to open the Command Prompt.
2. Type the command **ping 172.16.8.10 -t**.
3. Click **OK**.



If well connected, this screen is displayed.



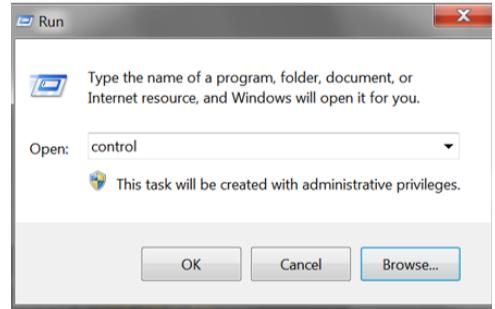
If disconnected, this screen is displayed.



Accessing the Control Panel in Windows

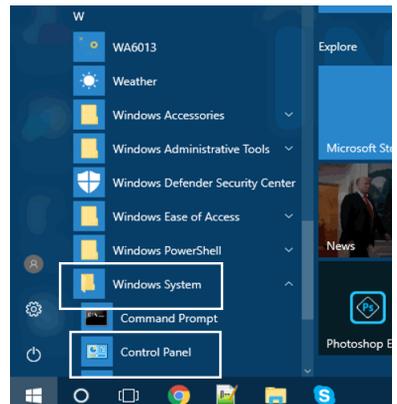
To open the control panel in Windows 7 and 10:

1. On your keyboard, click  [Win] + [R] to open the Command Prompt.
2. Type **control** in the **Open** field.
3. Click **OK**.



To open the control panel in Windows 10 only:

1. Expand the Start menu.
2. Select **Windows System** folder.
3. Select **Control Panel**.



Setup IP on Control PC

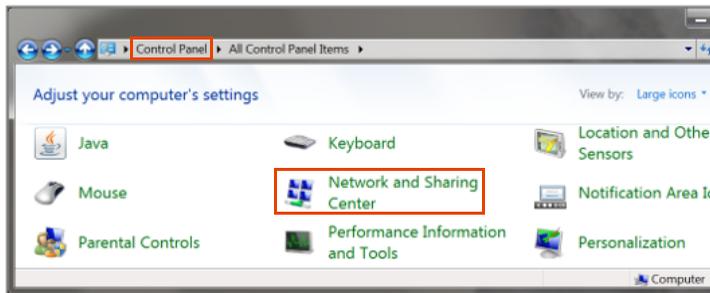
Setting the IP Address in Windows 7 and 10

Setting the IP Address in Windows 7 and 10

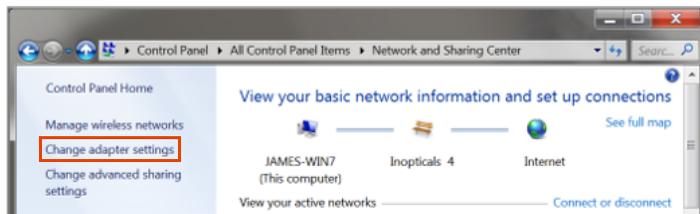
The procedure is the same for both Windows 7 and 10. Windows 7 screen shots are used as examples.

To set the IP address:

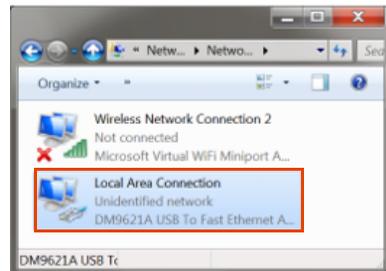
1. Open the **Control Panel** and enter **Network and Sharing Center**.



2. Click **Change adapter settings**.



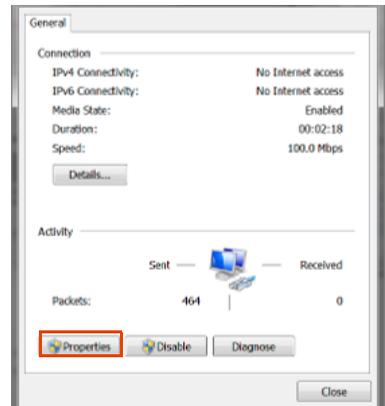
3. Select the Ethernet device already linked to the unit.



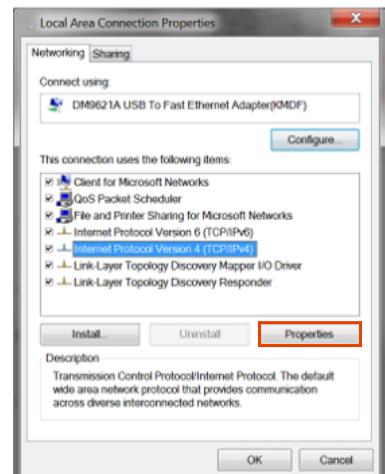
Setup IP on Control PC

Setting the IP Address in Windows 7 and 10

4. Click **Properties**.



5. Select **IPv4** and click **Properties**.



Setup IP on Control PC

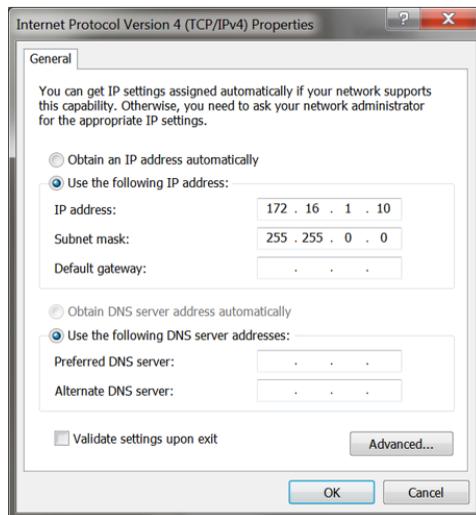
Setting the IP Address in Windows 7 and 10

6. Setup IP address by selecting **Use the following IP address:**

IP address = 172.16.1.10

Subnet mask = 255.255.0.0

7. Click **OK**.

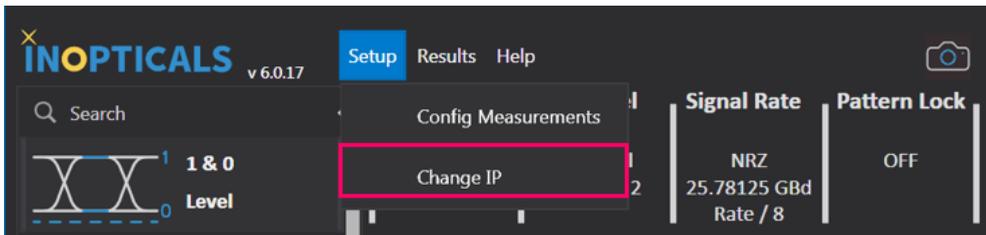


Changing the IP Address

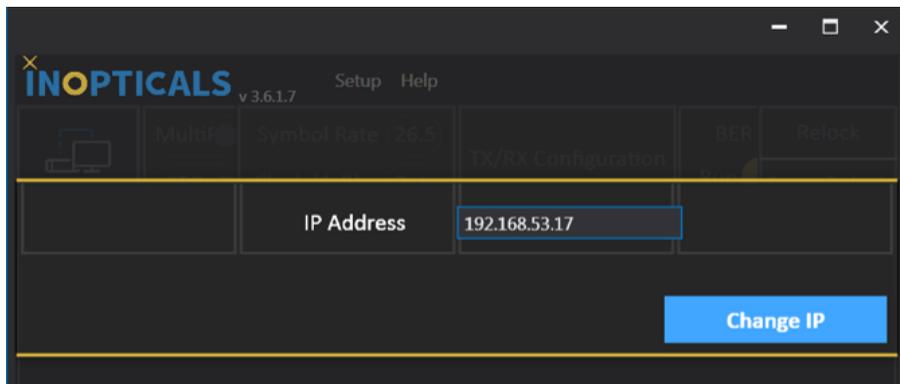
The tool for changing the unit's IP address is already integrated in the GUI.

To change the IP address of the unit:

1. Connect the unit.
2. Click **Change IP** in the **Setup** menu.



3. Input the desired **IP Address**.
4. Click the **Change IP** button.

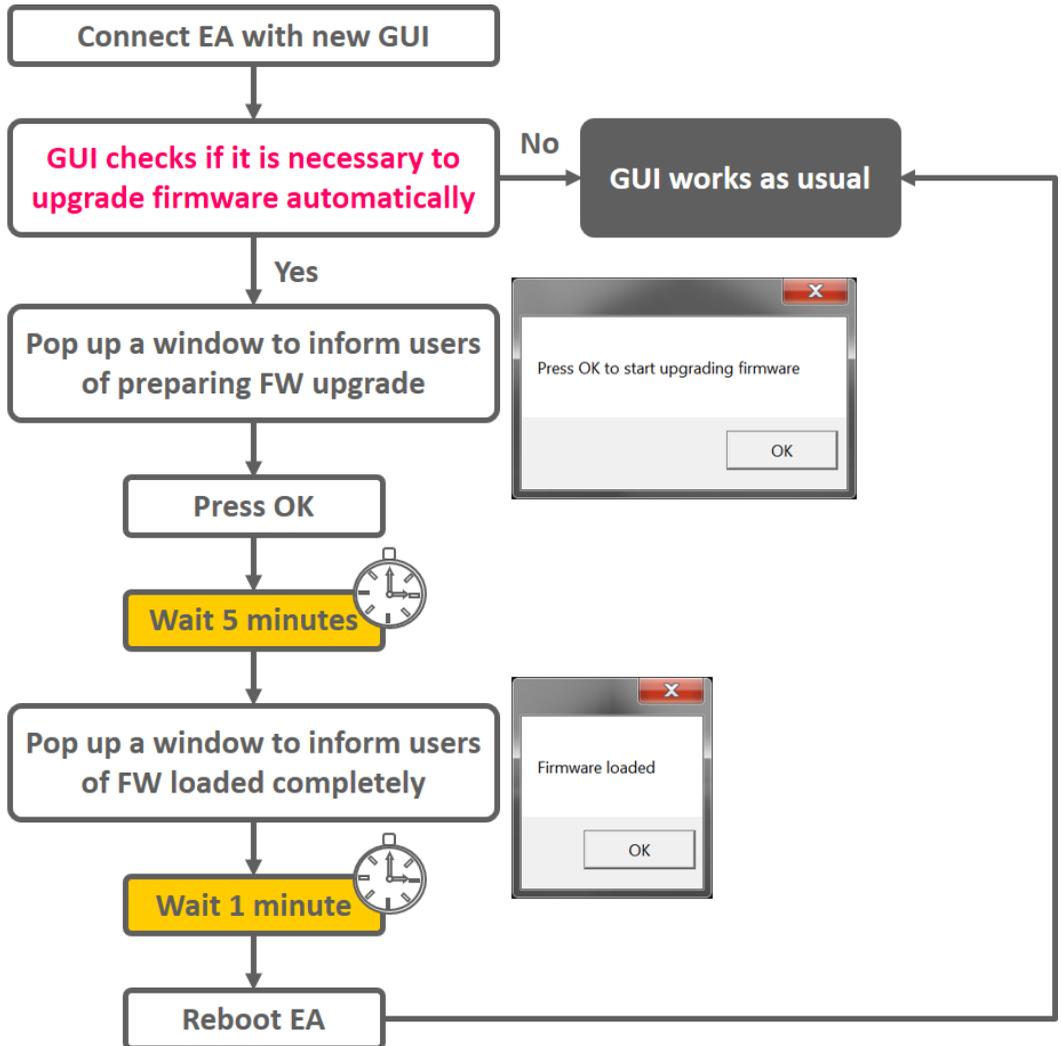


5. Wait 10 seconds and reboot the unit (IP is already changed).

To confirm if the IP was changed, ping the unit. If a reply is received, the address was changed successfully.

G Firmware Upgrade

You can download the latest GUI to upgrade and run the EA (Eye Analyzer) with new functions. The automatic upgrade process is displayed as follows.



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