

D9020AUTP Automotive Ethernet Triggering and Decode

10BASE-T1S and 100/1000BASE-T1 Protocol Trigger and Decode for Infiniium Oscilloscopes



Easily Debug and Test Designs That Include Automotive Ethernet Protocols

The Keysight D9020AUTP Automotive Ethernet protocol triggering and decode software provides you with an easy and accurate way to verify and debug your 10/100/1000BASE-T1 designs.

Automotive Ethernet enables faster data communication to meet the demands of today's vehicles and the connected vehicles of the future. Expertise with low-speed buses is less relevant than you may expect. Unlike with CAN or LIN, you can't glance at a few bits on the screen of an oscilloscope and quickly understand what's happening on the bus. Protocol decoding enables you to correlate a packet error back to the physical bus. Keysight's full suite of automotive Ethernet solutions automate testing and validation across Tx, Rx as well as channel testing for 10M to 10Gbps.

Automotive Ethernet is widely used today in automotive designs. In many designs, these connections and data links provide content-rich points for debugging and testing. The D9020AUTP Automotive Ethernet protocol triggering and decode software enables you to:

- Set up your scope to show Automotive Ethernet protocol decode in less than 30 seconds.
- Get access to a rich set of integrated protocol-level triggers.
- Save time and eliminate errors by viewing packets at the protocol level.
- Use time-correlated views to quickly troubleshoot protocol problems back to their timing or signal integrity root cause.

The D9020AUTP Automotive Ethernet protocol triggering and decode software includes a suite of configurable protocol-level trigger conditions specific to Automotive Ethernet. It enables you to save time and eliminate errors by viewing packets at the protocol level.

Decoding at the protocol layer enables you to map errors back to the physical bus, giving you more confidence in your design. The D9020AUTP software helps you debug quickly to get to the root cause and get back to testing the rest of your components.

The software is installed and runs on a Keysight Infiniium oscilloscope. There are a variety of license types and terms available. Please see the ordering instructions for more information.

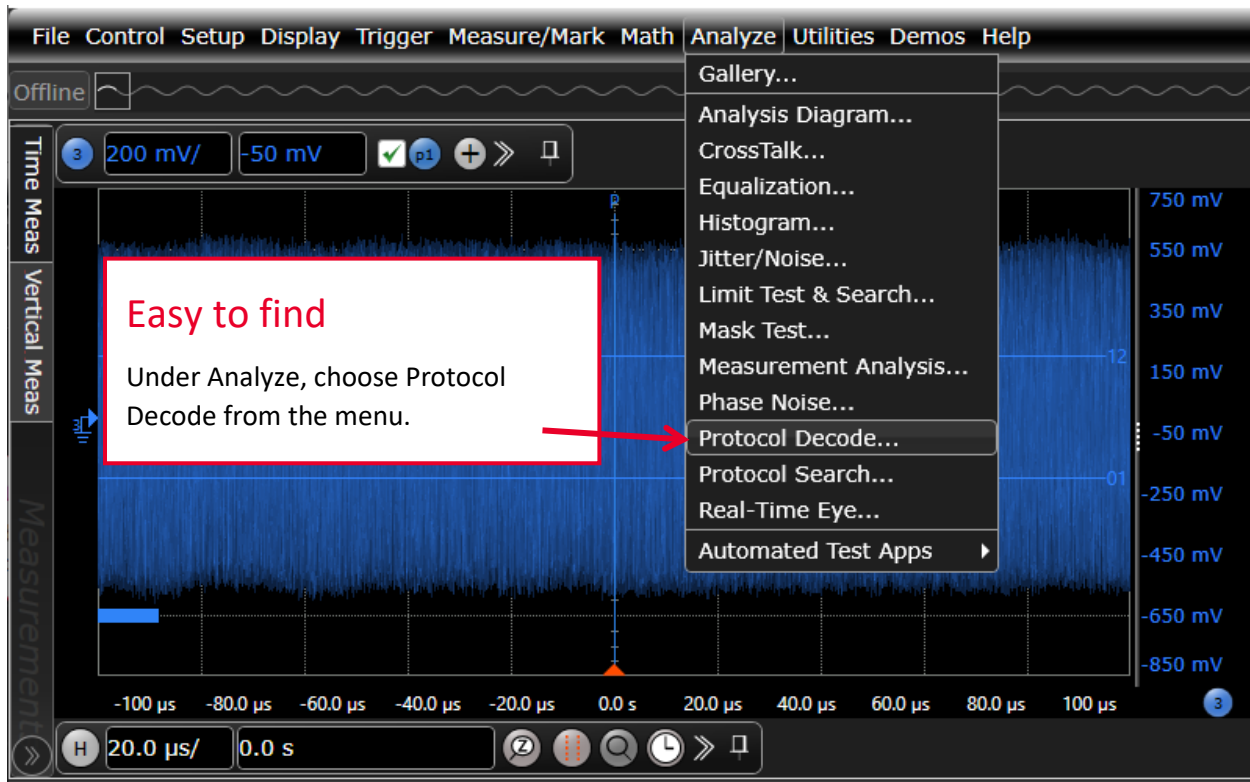
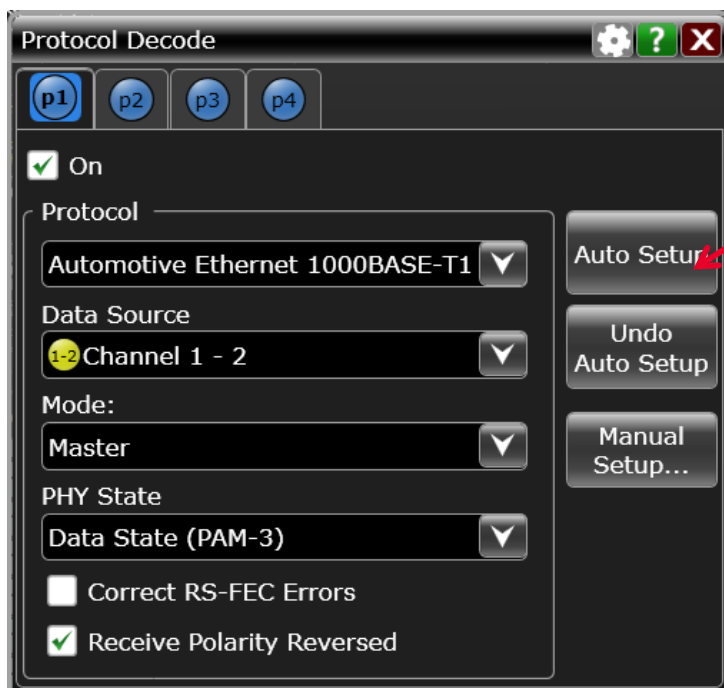


Figure 1. Easy to find protocol decode feature.



30-second trigger setup

Configure your oscilloscope to display protocol decode in under 30 seconds. Use *Auto Setup* to automatically configure sample rate, memory depth and threshold and trigger levels.

Figure 2. Easy to setup trigger for Automotive Ethernet

Automotive Ethernet Protocol Triggering and Searching

Get access to a rich set of integrated protocol-level triggers. The application includes a suite of configurable protocol-level trigger conditions specific to Automotive Ethernet. When protocol triggering is selected, the application enables special real-time triggering hardware/software inside the scope. Hardware-based triggering ensures that the scope never misses a trigger event when armed. It then inspects these protocol frames against specified protocol-level trigger conditions and triggers when the conditions are met. Hardware-based triggering for Automotive Ethernet is available on Infiniium MXR, EXR, and S-Series.

Trigger setup

Keysight's D9020AUTP Automotive Ethernet triggering supports the following trigger options:

Trigger	Description
Any Ethernet packet	Triggers on any ethernet packet
ARP	Triggers for ARP frames. the user can select following fields for further refining the search: <ul style="list-style-type: none">• Destination MAC• Source MAC• Hardware Type• Protocol Type• Hardware Length• Protocol Length• Operation• Sender MAC Address• Sender IP Address• Target MAC Address• Target IP Address• Payload
IPv4	Triggers on the following: <ul style="list-style-type: none">• Any IPv4 packet• IPV4 TCP• IPV4 UDP• IPV4 Packet The fields within the packets can also be set with a defined value for refined search
IPv4 ICMP	Triggers on different types of IPv4 ICMP (Internet Control Message protocol) types and their fields

Trigger	Description
IPv6	<p>Triggers on the following:</p> <ul style="list-style-type: none"> Any IPv6 packet IPv6 TCP IPv6 UDP IPv6 Packet <p>The fields within the packets can also be set with a defined value for refined search</p>
IPv6 ICMP	Triggers on different types of IPv6 ICMP (Internet Control Message protocol) types and their fields
IPv6 Extension Headers	Triggers on different types of IPv6 Extension Header types and their fields
802.1Q	<p>Triggers on 802.1Q frames. The user can select following fields for further refining the search:</p> <ul style="list-style-type: none"> Destination MAC Source MAC Priority Code Point (PCP) Drop Eligible Indicator (DEI) VLAN Identifier (VID) TPID Payload
802.ad	<p>Triggers on 802.ad frames. The user can select following fields for further refining the search:</p> <ul style="list-style-type: none"> Destination MAC Source MAC Priority Code Point (PCP Outer) Drop Eligible Indicator (DEI Outer) VLAN Identifier (VID Outer) TPID (Outer) Priority Code Point (PCP Inner) Drop Eligible Indicator (DEI Inner) VLAN Identifier (VID Inner) TPID (Inner) Payload
Ethernet packet	<p>Triggers on the following fields of an Ethernet packet</p> <ul style="list-style-type: none"> Destination MAC Source MAC Length/Type Payload
Symbol Sequence	Triggers when specified symbol sequence matches
Errors	<p>Triggers if following errors are detected:</p> <ul style="list-style-type: none"> Bad FCS CRC Bad IPv4 or TCP or ICMP or UDP Checksum Bad Ethernet Payload Length > 1500 bytes Any of the above errors



Figure 3. Example of trigger options

Manual setup

Choose to automate the trigger and decode setup or use the manual setup option. Manual setup enables you to set the Protocol decode and trigger thresholds, acquisition sample rate and depth, and clock recovery method.

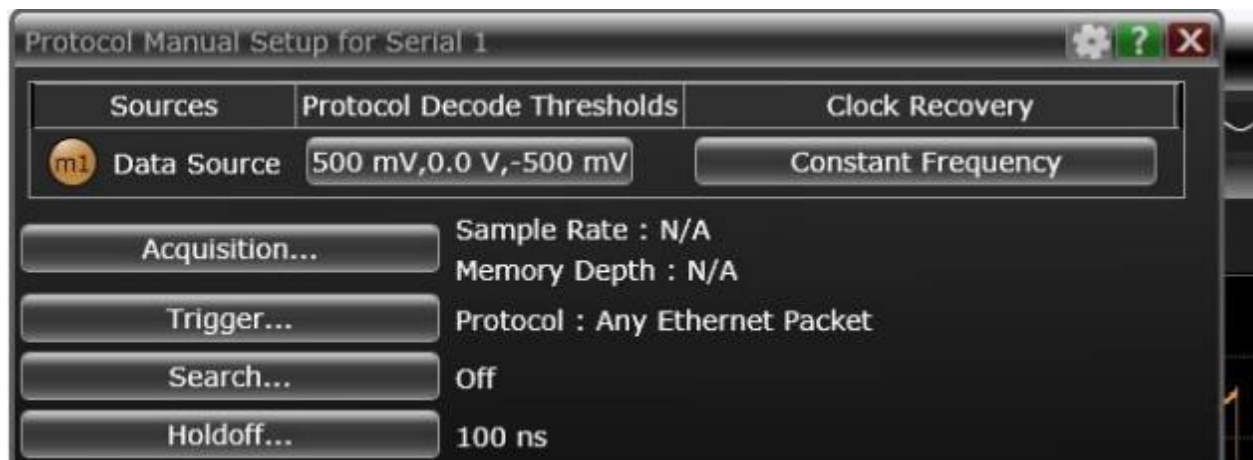


Figure 4. Example of protocol manual setup

Holdoff mode and time

The Holdoff Time control sets the amount of time that the oscilloscope waits before re-arming the trigger circuitry. With a fixed mode as an example, if you have a burst of pulses and want to trigger on the first pulse in the burst, you can set the holdoff time to be slightly longer than the burst width.

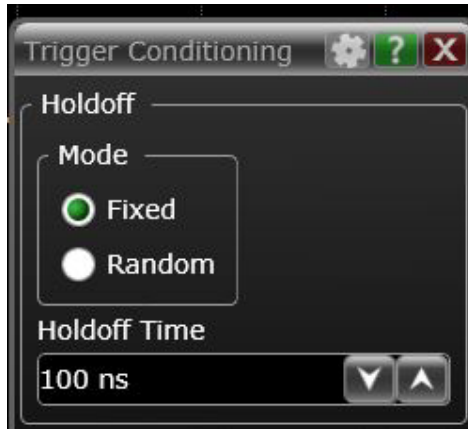


Figure 5. Example of Holdoff time setup

Trigger thresholds

Set specific thresholds for your system and the signals you are looking for.

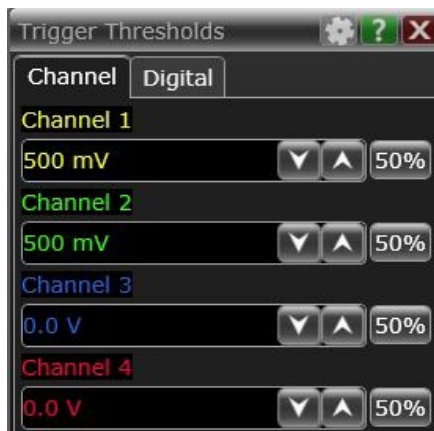


Figure 6. Example of trigger threshold setup

Post-acquisition searching

When data is being captured and decoded, you can search the decoded data for any Ethernet packet, selected packets, symbols, or errors. The software-based packet's "Trigger On Search" causes an automatic decode after each hardware trigger (acquisition). If the packet search specification is found in the captured data, the data is displayed; otherwise, the data is not displayed.

Then, another run (acquisition) is initiated, and the process repeats. If "Stop On Trigger" is also enabled, the first time the packet search specification is found, the oscilloscope stops capturing data and does not initiate another run.

The decoder also provides insight into FEC (forward error correction) status, indicating correctable FEC errors.

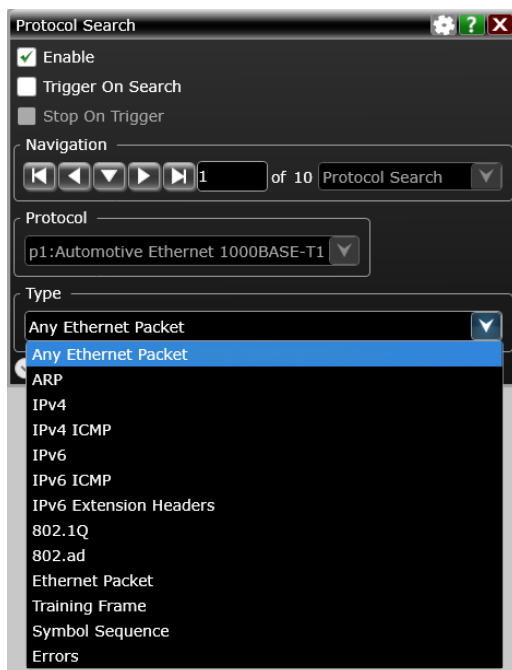


Figure 7. Protocol search dialog

Decode embedded in waveform area

Utilize the oscilloscope waveform area to display decode information. For Automotive Ethernet, minor ticks indicate clock transitions and major ticks show the beginning and end of each word in the serial packet.

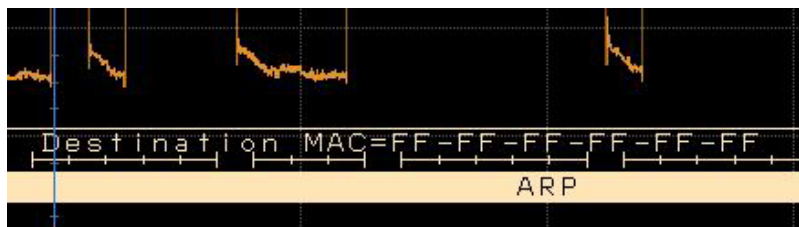


Figure 8. Protocol decode in waveform area.

Automotive Ethernet decode with precise time-correlation between waveforms and listings

The Keysight Automotive Ethernet protocol viewer includes a correlation between the waveforms and the selected packet. The selected packet, which appears as a highlighted blue row in the listing, is time-correlated with the blue line in the waveform display. Move the blue tracking marker in time through waveforms and the blue bar will automatically track in the packets window or scroll through the packet viewer and highlight a specific packet. The time-correlation tracking marker will move to the associated point in the waveform.

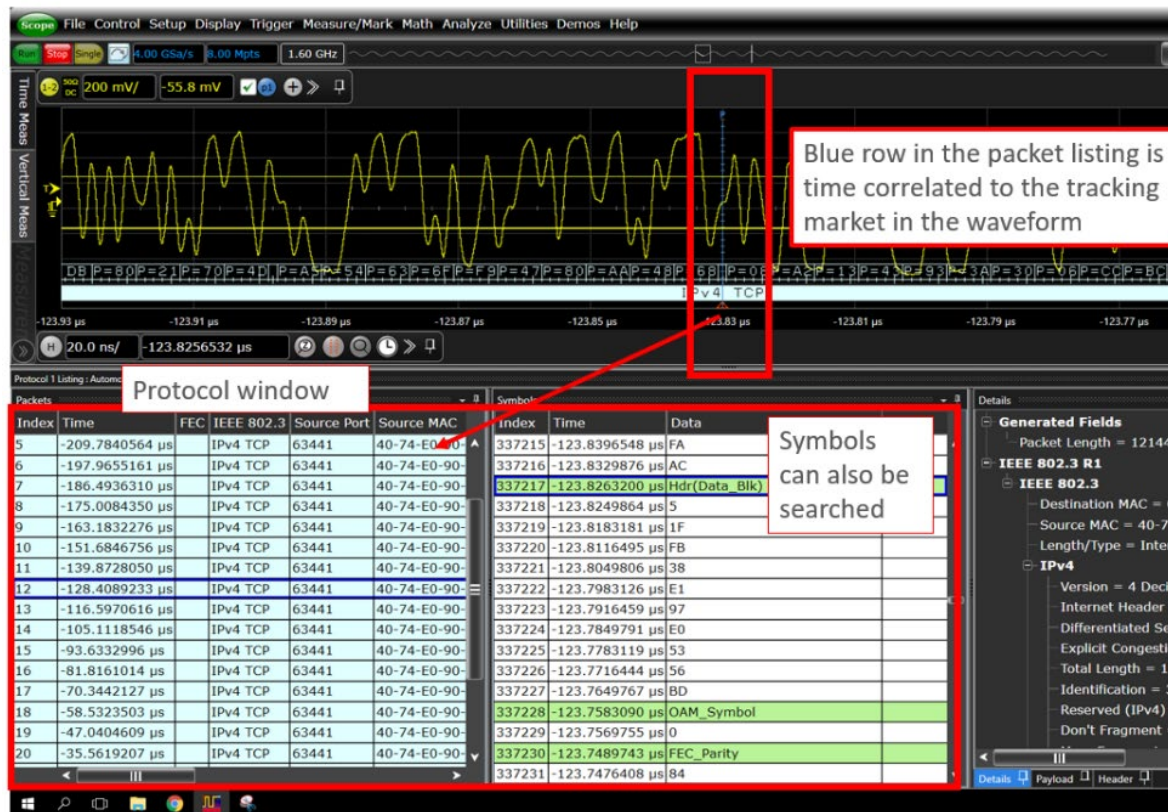


Figure 9. Protocol decode information with display waveform.

Protocol listing window

Quickly move between physical and Automotive Ethernet protocol layer information using the time correlated tracing marker. Display protocol content using embedded decode in the waveform area, or see protocol events in a compact listing format using the industry's first scope-based multi-tab protocol viewer. The entries in the Packets listing are color-coded with the waveform so you can easily see which sections of the protocol decode correspond to which packet. This is also convenient when you zoom out because you can easily match the color code even when you are not zoomed in enough to see the decode listings in the display. There can be up to five areas (or panes) within in the Protocol Listing window: packets, symbols, details, payload, and header.

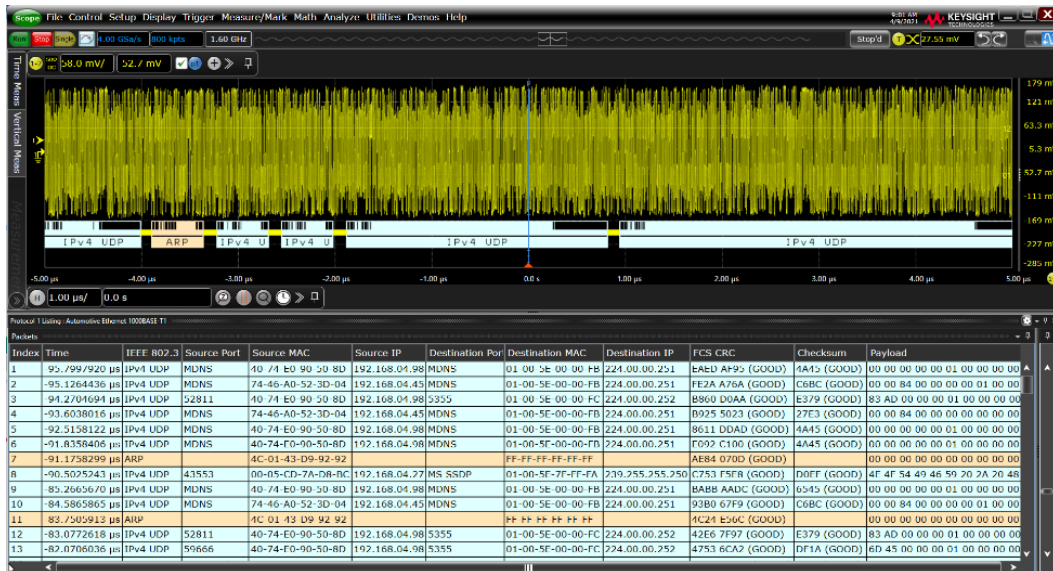


Figure 10. Protocol listing window with the time-correlated tracking marker and color-coded packet listing.

Display as many protocol packets as you want to see. The protocol viewer shows index number, time stamp, and data content for each serial packet. Listing content can be saved to a .csv or .txt file for off-line analysis or documentation. Use search capability to quickly navigate through an acquisition.

Protocol 1 Listing: Automotive Ethernet 1000BASE-T1

Index	Time	IEEE 802.3	Source Port	Source MAC
68	-12.9967206 µs	IPv4 UDP	MDNS	40-74-E0-90-50-8D
69	-12.3247454 µs	IPv4 UDP	MDNS	40-74-E0-90-50-8D
70	-11.6580820 µs	ARP		4C-01-43-D9-92-92
71	-10.6580997 µs	IPv4 UDP	43553	00-05-CD-7A-D8-BC
72	-5.7488201 µs	IPv4 UDP	MDNS	40-74-E0-90-50-8D
73	-5.0688212 µs	IPv4 UDP	MDNS	74-46-A0-52-3D-04
74	-3.8928288 µs	ARP		4C-01-43-D9-92-92
75	-3.2195112 µs	IPv4 UDP	52811	40-74-E0-90-50-8D
76	-2.5528557 µs	IPv4 UDP	59666	40-74-E0-90-50-8D
77	-1.8795296 µs	IPv4 UDP	BOOTP Client	80-DA-13-48-DF-B2
78	943.1157 ns	IPv4 UDP	BOOTP Client	00-04-20-E9-DD-01
79	5.4577402 µs	IPv4 UDP	MDNS	40-74-E0-90-50-8D
80	6.4710489 µs	IPv4 UDP	64839	40-74-E0-90-50-8D

Figure 11. Protocol viewer

Details

Generated Fields
Packet Length = 2768
IEEE 802.3 R1
IEEE 802.3
Destination MAC = FF-FF-FF-FF-FF-FF Hardware Address
Source MAC = 80-DA-13-48-DF-B2 Hardware Address
Length/Type = Internet Protocol version 4 (IPv4)
IPv4
Version = 4 Decimal
Internet Header Length = 5 Decimal
Differentiated Services = 4 Decimal
Explicit Congestion Notification = Non-ECT (Non ECN-Capable)
Total Length = 328 Decimal
Identification = 0000 Hex

Figure 12. Details tab breaks the packets into easy-to-read text fields.

Protocol 1 Listing: Automotive Ethernet 1000BASE-T1

Index	Time	IEEE 802.3	Source Port	Source MAC	Index	Time	Data	Payload
74	-3.8928288 µs	ARP		4C-01-43-D9-92-92	19468	17.9962409 µs	2C	0000: 4E 4F 54 49 46 59 20 2A NOTIFY.*
75	-3.2195112 µs	IPv4 UDP	52811	40-74-E0-90-50-8D	19469	18.0029079 µs	EC	0008: 20 48 54 54 50 2F 31 2E .HTTP/1.
76	-2.5528557 µs	IPv4 UDP	59666	40-74-E0-90-50-8D	19470	18.0095751 µs	Data_Blk_Hdr	0010: 31 0D 0A 48 4F 53 54 3A 1..HOST:
77	-1.8795296 µs	IPv4 UDP	BOOTP Client	80-DA-13-48-DF-B2	19471	18.0109085 µs	2C	0018: 20 32 33 39 2E 32 35 35 .239.255
78	943.1157 ns	IPv4 UDP	BOOTP Client	00-04-20-E9-DD-01	19472	18.0175747 µs	CC	0020: 2E 32 35 35 2E 32 35 30 .255.250
79	5.4577402 µs	IPv4 UDP	MDNS	40-74-E0-90-50-8D	19473	18.0242409 µs	34	0028: 3A 31 39 30 30 0D 0A 43 :1900..C
80	6.4710489 µs	IPv4 UDP	64839	40-74-E0-90-50-8D	19474	18.0309072 µs	B4	0030: 41 43 48 45 2D 43 4F 4E ACHE-CON
81	7.1510260 µs	IPv4 UDP	58018	40-74-E0-90-50-8D	19475	18.0375740 µs	8C	0038: 54 52 4F 4C 3A 20 6D 61 TROL:.ma
								0040: 78 2D 61 67 65 3D 31 38 x-age.18
								0048: 30 0D 0A 4C 4F 43 41 54 0..LOCAT
								0050: 49 4F 4E 3A 20 68 74 74 ION:.htt
								0058: 70 3A 2F 2F 31 39 32 2E p://192.

Figure 13. Payload tab shows data carried by the packet in byte-by-byte.

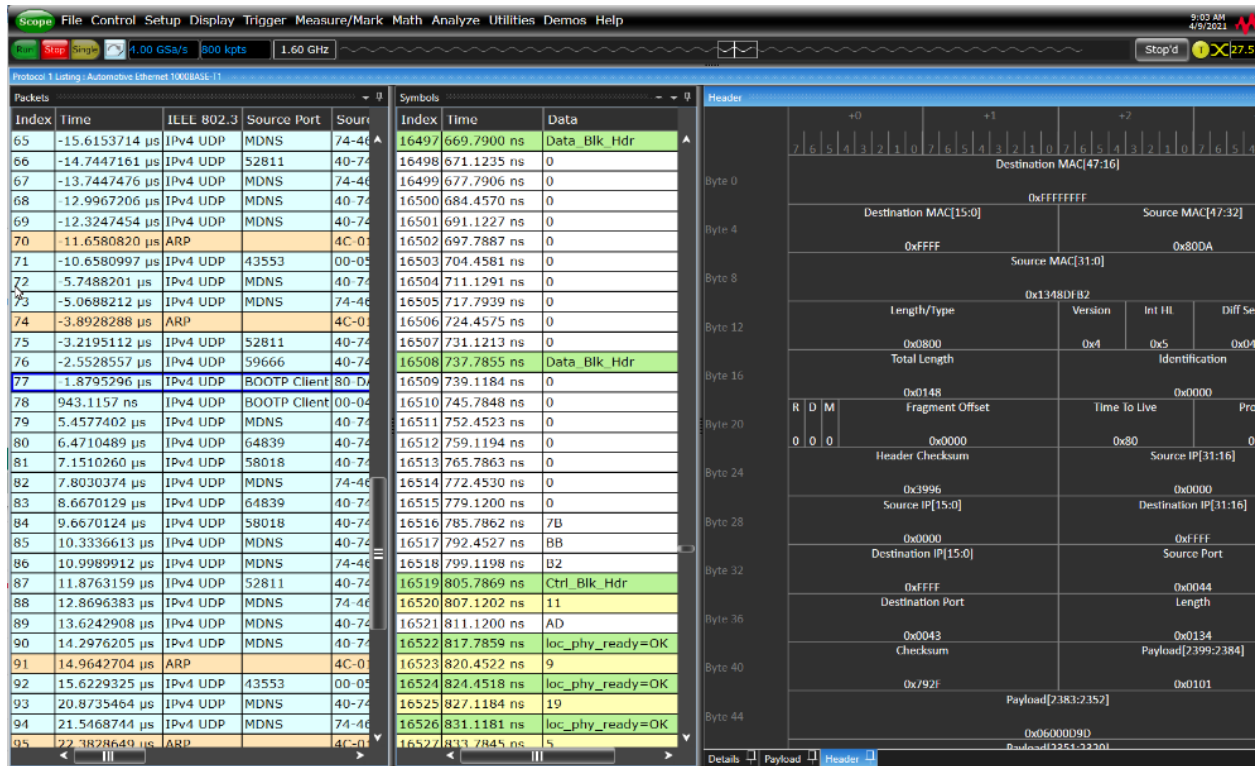


Figure 14. Header tab shows packets in a data book format. Hovering at any field reveals additional detail.

PAM-3 clock recovery

The Keysight D9020AUTP extends to the analysis of PAM-3 signals. A wizard walks you quickly through the steps required to set up measurements for a PAM encoded signal, select methods for clock recovery, and then the measurements you wish to have performed on your PAM signal. The software can accurately set the individual threshold levels of your PAM signal and render each individual eye. You can choose different, software-based clock methods that include first and second-order phase-locked loop or constant frequency clock recovery.

Other measurements supported include:

- Eye measurements including Eye center, eye width, eye height, eye skew, eye level
- Level measurements including Level mean, level RMS, level thickness, level skew
- Rise/fall times (for all edges at once),
- Noise measurements (levels can be specified, graphed)
- Jitter measurements (levels can be specified, graphed)
- BER (cumulative or per acquisition)
- SER (cumulative or per acquisition)
- PBR513Q (J4u, Jrms, EOJ)
- Clock recovery rate
- Pattern length

Deeper analysis with de-embedding and equalization

There are additional tools of optional Infiniium software that support more advanced analysis of signals, providing even more insight into your designs. Using the Infiniium signal processing interface tools for real-time oscilloscopes, you can (for example), cascade S-parameter models and/or equalizers to model your transmission line, or backplane, and receiver. The optional D91x0ASIA includes InfiniiSim and Serial Data Equalization Software, which adds powerful software equalization capability to accurate modelling of Feed-Forward (FFE), Decision Feedback (DFE), and Continuous-Time Linear Equalization (CTLE). The D91x0ASIA also includes Cross Talk Analysis.

Automotive Ethernet Specifications and Characteristics

Specifications and Characteristics

Trigger and decode channel source	Analog and digital channels (see support matrix)
Auto setup	Automatically configures scope settings for proper Automotive Ethernet decode and protocol triggering
Triggering	<ul style="list-style-type: none"> • MAC destination addresses • MAC source addresses • MAC length/type • ARP header • IPv4 header/payload • IPv6 header/payload • UDP header • TCP header/payload • Frame check sequence – FCS • Cyclic redundancy check - CRC • Errors • 802.1Q (VLAN) • 802.AD

Oscilloscope support matrix

Oscilloscope model:		Protocols: 10BASE-T1S / 100BASE-T1 / 1000BASE-T1		
		Decode	Hardware trigger	Software trigger on search
Analog channels	S-Series	No / Yes / Yes	No / Yes / Yes	No / Yes / Yes
	MXR, EXR- Series (ch. 1 - 4)	Yes / Yes / Yes	Yes / Yes / Yes	Yes / Yes / Yes
	MXR, EXR-Series (ch. 5 - 8)	Yes / Yes / Yes	Yes / Yes / No	Yes / Yes / Yes
	UXR-Series	Yes / Yes / Yes	No / No / No	Yes / Yes / Yes
	V, Q, Z, 9000A/H, 90000A-Series	No / Yes / Yes	No / No / No	No / Yes / Yes
Digital channels	S-Series	No / No / No	No / No / No	No / No / No
	MXR, EXR-Series	Yes / No / No	No / No / No	No / No / No

The Automotive Ethernet 100/1000BASE-T1 protocols generate a full duplex connection using a differential pair of wires for data transmission. If your wire pair signal is transmitting in opposite directions simultaneously, it cannot be decoded. To separate the signals, you can use the AE6941A Automotive Ethernet test fixture. The setup below shows how the test fixture is used in the test system.¹

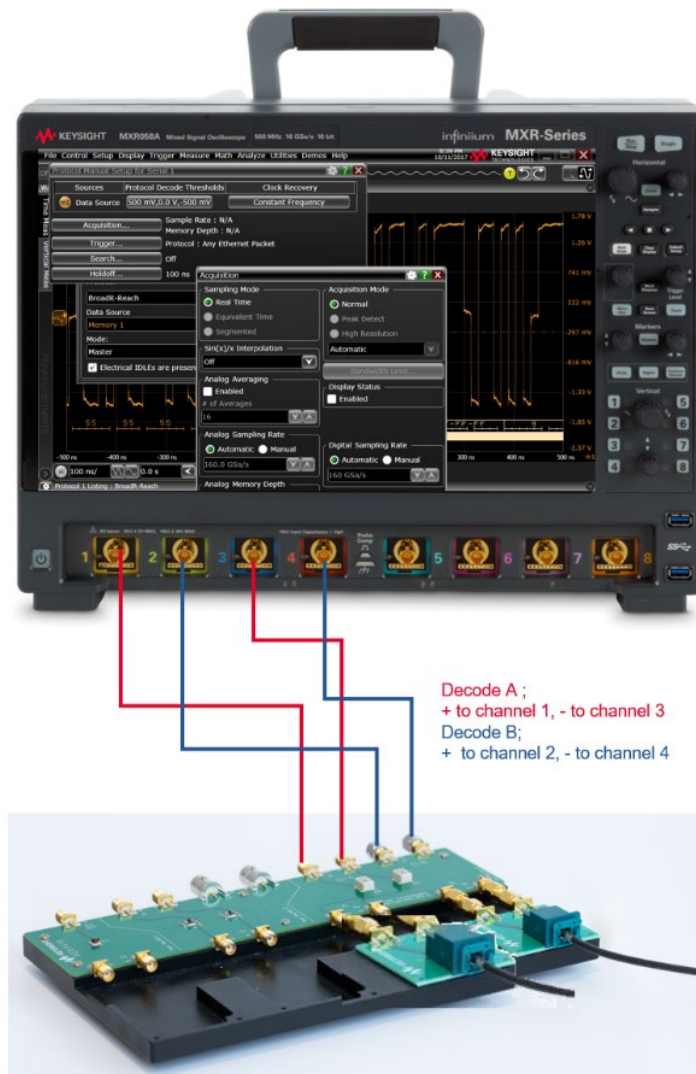


Figure 15. The AE6941A Automotive Ethernet test fixture and the set-up

The D9020AUTP supports only half-duplex point-to-point and multidrop mode of 10Base-T1S. The software does not support full duplex point-to-point mode and it does not support 10base-T1L. To connect the 10base-T1S differential signals using a probe, we recommend using the Keysight DP0010A/11A/12A/13A or N2792A/N2818A differential probe.

1. The AE6941A works for 100BASE-T1 and limited 1000BASE-T1 cases. For recommendations for other 1000BASE-T1 devices please see the recommended accessories section.

Ordering Information

Optional and recommended software

Model number	Description	
AE6910T/AE6920T	Automotive Ethernet Tx compliance	Optional, offers transmit compliance 10M-5G (AE6910T), 10M-10G (AE6920T)
D90x0ASIA†	Advanced Signal Integrity Software (EQ, InfiniiSimAdv, Crosstalk)	Optional, provides equalization capability, includes Equalization, InfiniiSim, and Crosstalk/Power Integrity packages
D90xxPAMA	Pulse Amplitude Modulation PAM-N Analysis Software	Optional, offers PAM-n analysis for high-speed auto ethernet compliance

† D90x0ASIA includes InfiniiSim Serial Data Equalization Software, which adds powerful software equalization capability. You can leverage CTLE and FFE/LFE which will allow you to simulate more than one element to de-embed or embed.

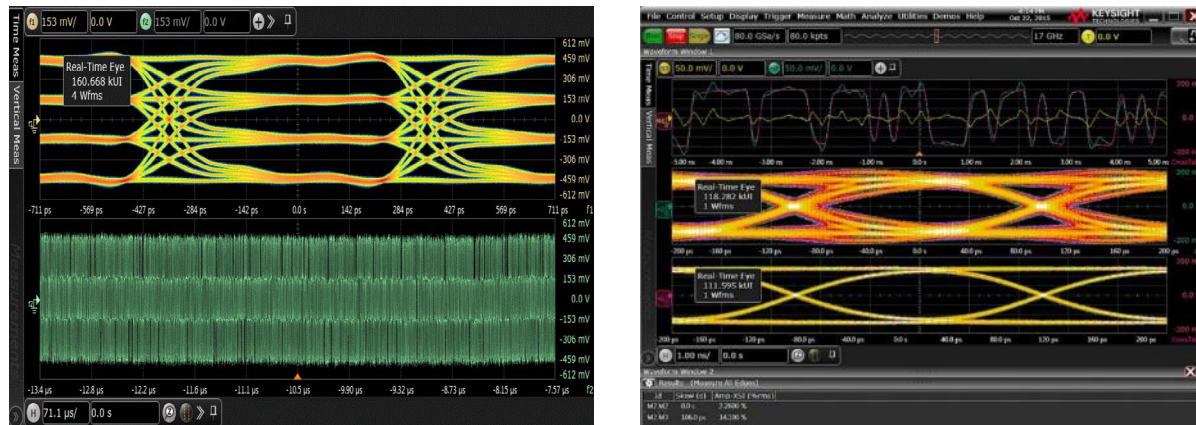


Figure 16. Optional software that adds additional insight includes automotive Ethernet compliance: AE6910T/AE6920T, D90x0ASIA, and D91xxPAMA.

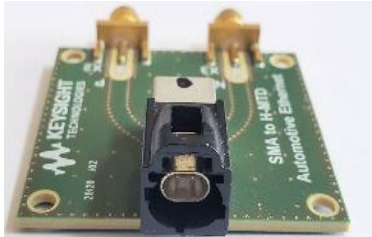
Recommended accessories

The recommended configuration is to use SMA cables, adapters with the fixture boards from Keysight.

Description		Keysight Model Number(s)	Comments
Signal Separation Fixture		AE6941A Automotive Ethernet test fixture	Required for 100BASE-T1
Order either SMA cables or adapters	Adapter fixtures	AE6942A SMA to Molex/Mini-50 adapter	Choose one adapter type Qty 4
		AE6943A SMA to MATEnet adapter	
		AE6960A SMA to H-MTD adapter	
	SMA cables	AE6900T-104 (8121-3118)	Qty 4
	SMA to BNC	AE6900T-102 (54855-67604)	Qty 4



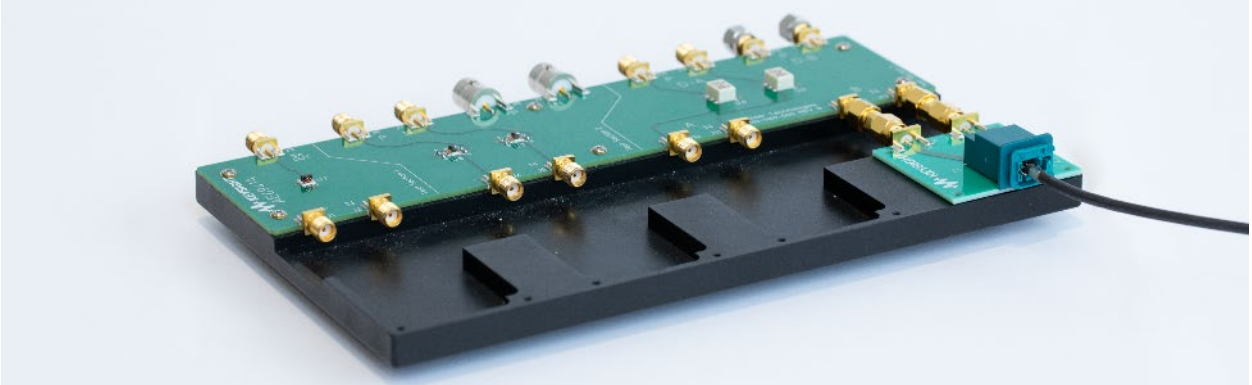
AE6942A SMA to Molex/Mini-50



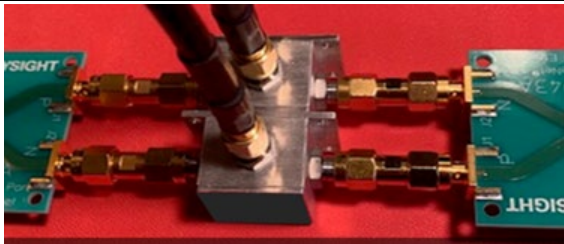
AE6960A SMA to H-MTD.



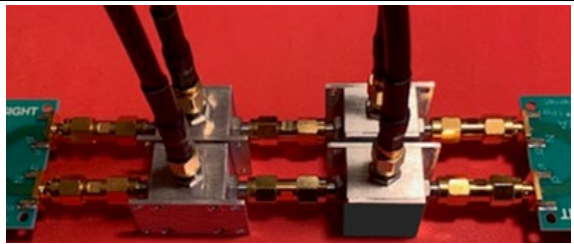
AE6943A SMA to MATEnet



The AE6941A works as a signal separation solution for 100BASE-T1 and limited 1000BASE-T1 cases.



Directional coupler



Dual Directional coupler

For 1000BASE-T1 cases that require enhanced performance of directional coupler, Keysight recommends the MiniCircuits ZEDC-10-2B directional coupler.

Recommended hardware

The protocol triggering and decode software is compatible with Keysight Infiniium-Series oscilloscopes with operating software as listed in the table below. For oscilloscopes with earlier revisions, free upgrade software is available here: www.keysight.com/find/scope-apps-sw

Standard	Data rate	Minimum bandwidth	Minimum channels	Firmware revision	Oscilloscope models
802.3cg	10 Mb/s	500 MHz	2	11.52	Infiniium EXR and MXR-Series
802.3bw	100 Mb/s	1 GHz		11.15 for EXR/MXR	Infiniium, EXR, MXR, S, and V-Series
802.3bp	1000 Mb/s	2 GHz		6.70 for S and V-Series	

Flexible software licenses

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term and license type.

License terms

Perpetual – Perpetual licenses can be used indefinitely.

Subscription – Subscription licenses can be used through the term of the license only (6, 12, 24, or 36 months).

License types

Node-locked – License can be used on one specified instrument/computer.

Transportable – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).

USB Portable – License can be used on one instrument/computer at a time but may be transferred to another using a certified USB dongle (available for additional purchase with Keysight part number E8900-D10).

Floating (single site) – Networked instruments/computers can access a license from a server one at a time. Multiple licenses can be purchased for concurrent usage.

KeysightCare Software Support Subscriptions

Perpetual licenses are sold with a 12 (default) and up to 60-month software support subscription with a user-selected start and end date. Support subscriptions can be renewed for a fee after that.

Subscription licenses include a software support subscription through the term of the license, from 3 to 36 months, with a user-selected start date.

Selecting your license

Step 1. Choose your software product (e.g., D9020ASIA)

Step 2. Choose your license term: perpetual or subscription.

Step 3. Choose your license type: node-locked, transportable, USB portable, or floating.

Step 4: Depending on the license term, choose your support subscription duration.

Example

If you selected:	Your quote will look like this:	
D9020ASIA Node-locked	Part Number D9020ASIA	Description Advanced Signal Integrity Software (EQ, InfiniiSimAdv, Crosstalk) Node-locked perpetual license
Perpetual license	SW1000-LIC-01 SW1000-SUP-01	Node-locked KeysightCare software support subscription with user-selected start and end dates
D9020ASIA Transportable Subscription 6- month license	Part Number D9020ASIA SW1000-SUB-01	Description Advanced Signal Integrity Software (EQ, InfiniiSimAdv, Crosstalk) 6-months, transportable subscription license

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

To learn more about Keysight Automotive Ethernet solutions:

www.keysight.com/find/automotive-ethernet



Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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