



SOLUTION BRIEF

SA8700A C-V2X Test Solution

Develop C-V2X with Confidence as 5G Evolves

Fewer accidents and greater road safety are central to the vision for autonomous vehicles (AVs). That vision depends on technology that enables greater situational awareness: observing what's happening, predicting what's likely to happen, and automatically taking protective action.

Getting there requires dependable communication via wireless technology that provides superior range, predictable performance, low latency, and high-speed connectivity. Cellular vehicle-to-everything or C-V2X has emerged as the wireless link that can help enable higher levels of autonomous operation.



Challenges to successful development of C-V2X

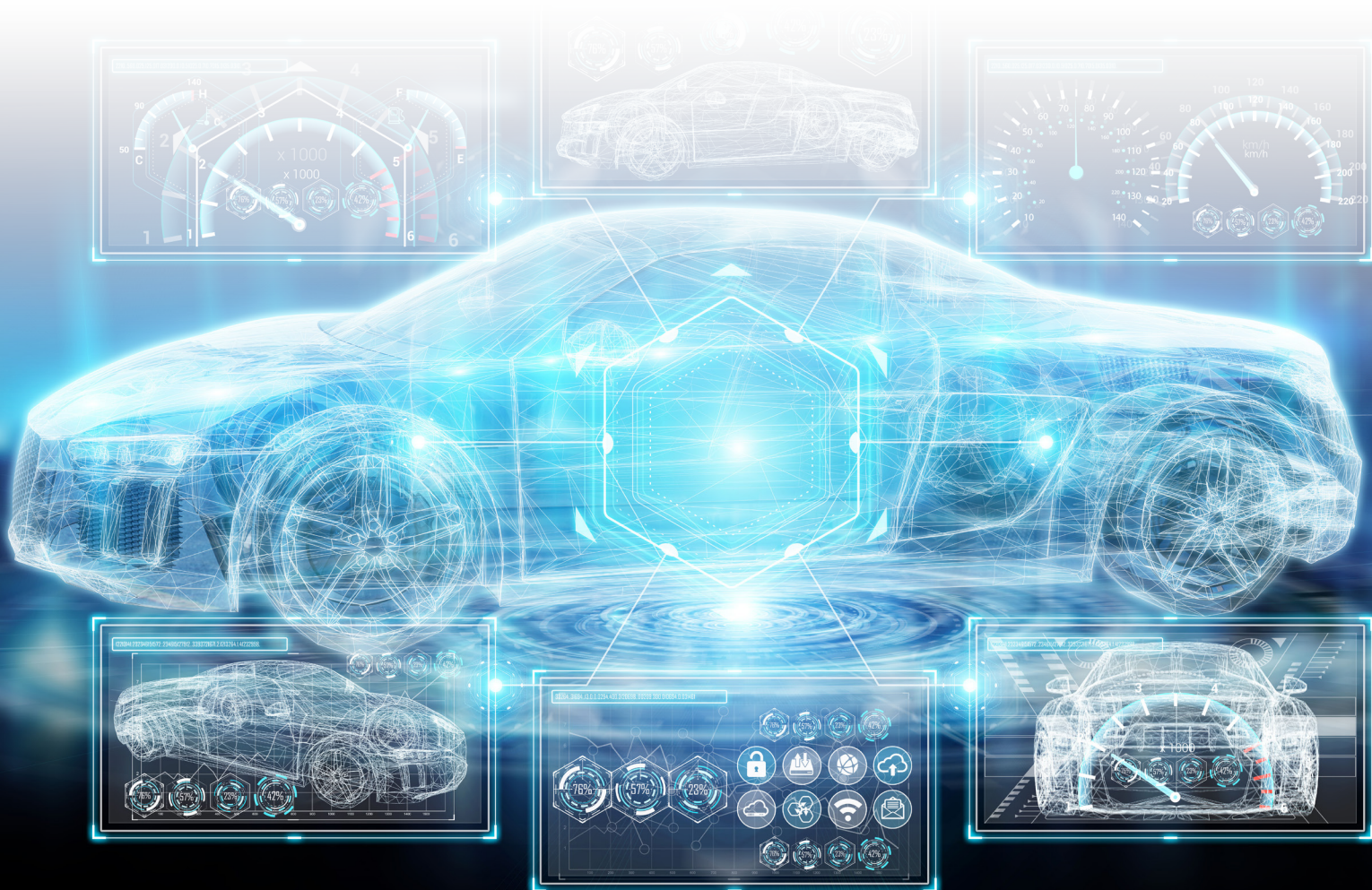
As 5G continues to evolve, the test requirements for C-V2X will be a moving target. The ability to thoroughly validate the performance of C-V2X designs depends on a test platform that can perform RF, protocol and application-layer testing while staying current with changing test scenarios.



C-V2X continues to take shape, in part because it is dependent on the evolution and deployment of fifth-generation (5G) wireless technology. As part of the 3rd Generation Partnership Project (3GPP) Release 14, C-V2X is focused on vehicle-to-infrastructure (V2I) communication. The goals of Rel14 C-V2X are to improve road safety, increase traffic efficiency, and support a growing range of traveler services.

Similarly, the vision for C-V2X based on 5G New Radio (NR) includes highly reliable communication with ultra-low latency, larger payloads, faster data rates and greater positioning accuracy. Leveraging these attributes, 5G NR C-V2X becomes a key enabler of increasingly autonomous vehicles.

Main features of Rel14 C-V2X	Main features of 5G NR based C-V2X
<ul style="list-style-type: none"> • Broadcasting of safety messages (e.g., Basic Safety Message) • Operation of V2V, V2I and V2P through the PC5 interface over ITS bands (e.g., ITS 5.9 GHz) • Notifications of hazardous locations, including signage applications 	<ul style="list-style-type: none"> • Broadcasting of safety messages (e.g., Basic Safety Message) • Groupcasting and unicasting • Platooning, advanced driving, extended sensing, and remote driving



Our Solutions: Keeping Pace with C-V2X

Currently, Keysight offers the only solution that is tracking along with the evolving C-V2X standard. The SA8700A test solution supports RF, protocol and application-layer testing, and the underlying platform will support future releases of 5G NR C-V2X. This protects your initial investment in the solution, and it will accelerate deployment of new technologies that enable advanced safety features.



Our C-V2X solution addresses protocol testing and functional testing of both key interfaces: Uu and PC5. The foundation is the proven Keysight UXM 5G wireless test set. We couple this with the C-V2X test application (C8732114A), a suite of Keysight X-Apps C-V2X RF measurements (C87320R1A), C-V2X waveform generation (C87320R2A), an Intelligent Transportation System (ITS) stack (CA8700A), and application-layer testing.

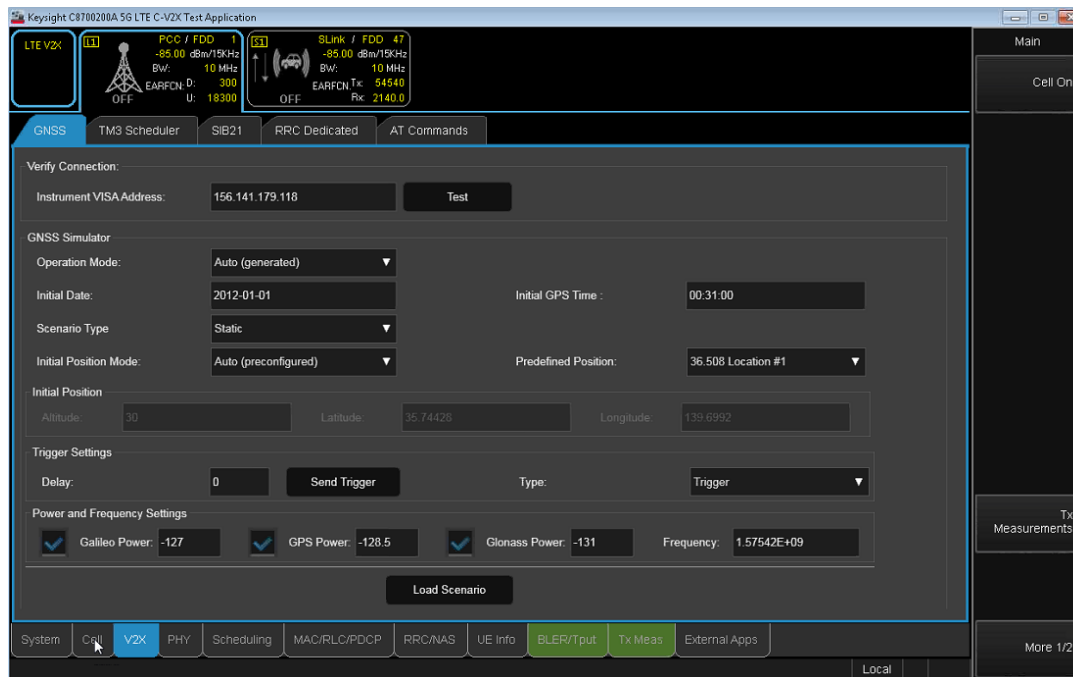
This powerful solution also provides RF measurements of the transmitters and receivers used in Uu and PC5 wireless links:

- **Transmitter characteristics:** power, error-vector magnitude (EVM), frequency accuracy, in-band emissions, adjacent channel leakage ratio (ACLR)
- **Receiver characteristics:** sensitivity, maximum input level, adjacent-channel selectivity

If you're already using another Keysight solution for 4G LTE or 5G testing, the C-V2X solution leverages the same X-Apps and the same measurement algorithms used in our signal analyzers and wireless test sets.

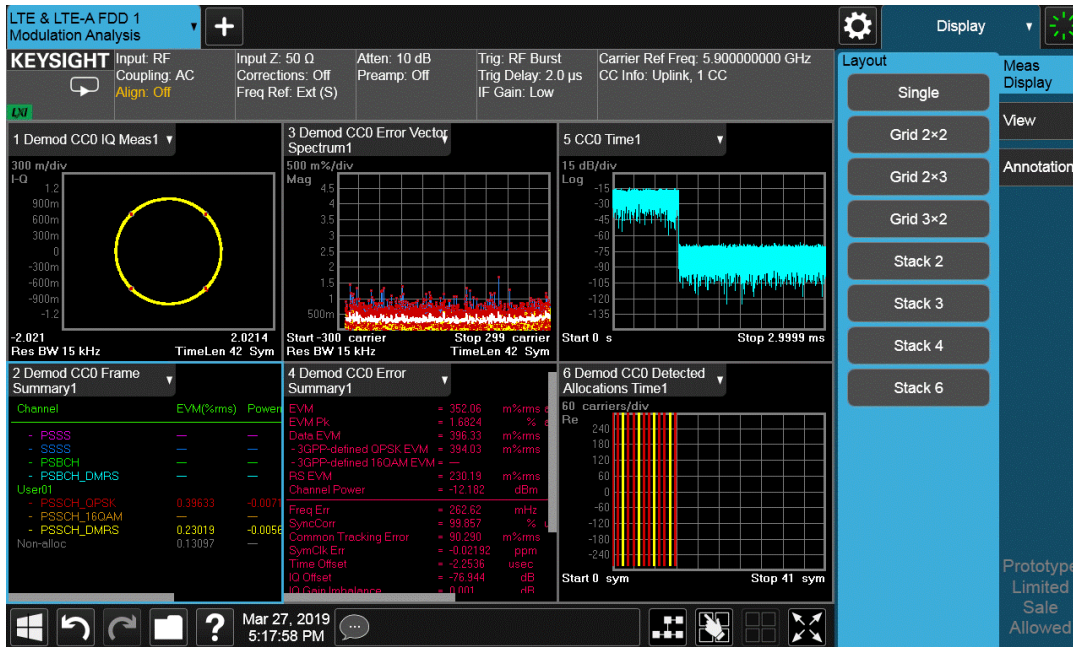
Required UXM 5G Software Options

Product Number	Description
C8732114A	C-V2X Rel 14 – PC5 signaling
C87320R1A	C-V2X RF measurements
C87320R2A	C-V2X waveform generation
C8730115A	LTE Rel 15 – core signaling
C8700200A	Test application framework



C8732114A C-V2X Test Application features

- Basic Sidelink (SL) data Tx and Rx
- SL Sync Tx
- SL MAC throughput measurements
- X-Apps integration for generic measurements
- LTE RRC signaling for V2X (SIB21, TM3 RRCReconfiguration)
- TM3 basic scheduler
- GNSS simulation (via MXG)
- Test Mode E via AT commands
- ITS stacks ready (separate app)



C87320R1A C-V2X RF measurements

- Modulation analysis
- PSSCH with DMRS
- PSCCH with DMRS
- PBSS and SSSS
- PSBCH with DMRS
- EVM, frequency error, I/Q offset
- EVM vs. Time
- Channel power
- On/Off time mask

C87320R2A C-V2X waveform generation

- Fully coded PSSCH, PSCCH, PSBCH, PSSS, SSSS
- Multi-UE scheduling
- MIB-SL-V2X auto generation
- SCI auto generation
- FRC wizard

CA8732114A C-V2X test application

Required UXM 5G Software Options

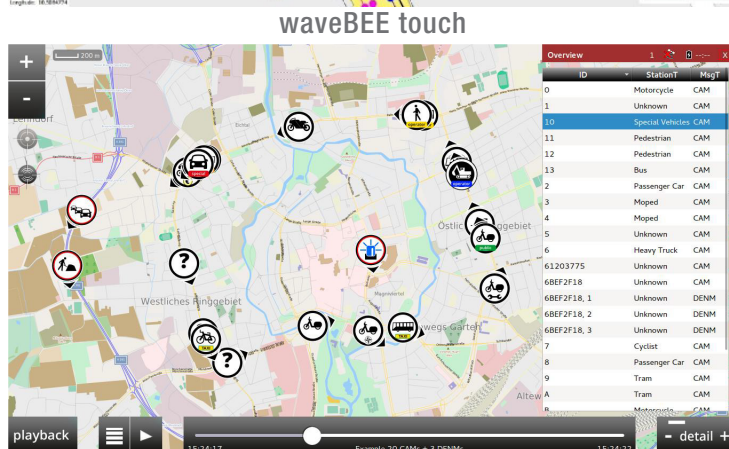
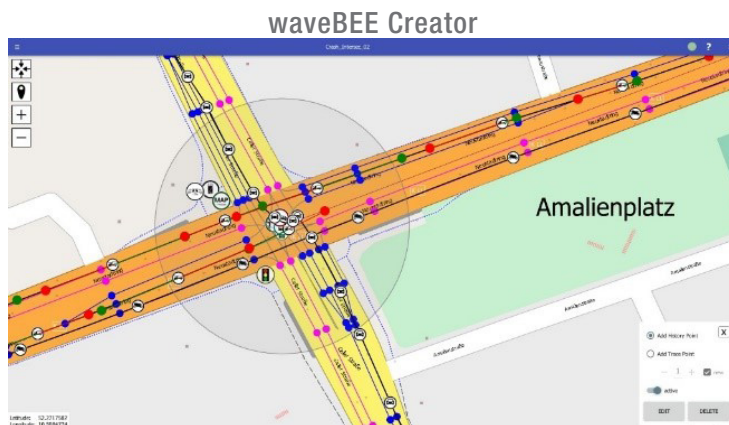
Product Number	Description
E7515B-506	Frequency range 300 MHz to 6 GHz
E7515B-PA1	Protocol processor A
E7515B-PB1	Protocol processor B
E7515B-PC1	Protocol processor C
E7515B-PD1	Protocol processor D
E7515B-R81	RF up-down converter (8 out/4 in)
E7515B-SA1	Signal processing module A
E7515B-SB1	Signal processing module B
E7515B + R-C7A-002-L	Standard Hardware Support Plan - 1 year
PS-S20-UXM	On-site Start-up Assistance Support
C88899A-011	Accessories for C-V2X

Required Signal Generator Hardware and Software Options

Product Number	Description
N5182B	MXG X-Series RF Vector Signal Generator
N5182B-503	Frequency range, 9 kHz to 3 GHz
N5182B-656	ARB baseband generator (80 MHz RF bandwidth, 32 MSa)
N5182B-660	Upgrade baseband generator with real-time capability
N5182B-009	Internal solid-state memory
N5182B-1EQ	Low specified power (less than -110 dBm)
N5182B-403	Calibrated AWGN, fixed perpetual license
N5182B-UNX	Low phase noise
N7609EMBC	Signal Studio for Global Navigation Satellite Systems (GNSS)

CA8700A ITS Functional Test Application

- ITS common components: Connect UXM5G with Nordsys* software components
- ITS stack for Europe, US and China
- waveBEE Creator: Create Scenario
 - All types of V2X messages (traffic and infrastructure)
 - Multiple entities (cars, traffic lights, etc.) and events in a single scenario
 - Easy integration of DUT into scenario
 - Pre-defined set of day-1 scenarios included
 - Seamless scenario execution
- waveBEE touch: Scenario Analysis
 - Real-time visual scenario view
 - Human-readable message information (path history, lane information, signal phases, vehicle dimensions, etc.)
 - Record and replay function for in-depth analysis
 - Detailed message dissection of raw and interpreted values
 - Customizable filters for multi-level message analysis



* Keysight and Nordsys have signed a license agreement that enables Keysight's test solutions to include central software components from Nordsys for testing V2X systems. waveBEE® products are used daily by automotive manufacturers, engineering companies, public research institutes and are the systems of choice in recent European ITS corridor projects.

Accelerates deployment of V2X technologies

The most effective C-V2X test solution is always up to date with the latest evolution of the requirements. Keysight's solution offers your team a comprehensive and holistic approach to testing—RF, protocol and application-layer. Five key capabilities enhance your ability to meet stringent goals for quality, performance and safety:

- Intuitive user interface to simplify C-V2X measurements (protocol and RF)
- Global Navigation Satellite System (GNSS) emulator (Keysight N5182B MXG X-Series RF vector signal generator)
- 5G measurement platform (UXM 5G wireless test set)
- Roadmap to 5G NR V2X
- Foundation for C-V2X conformance testing

Keysight is also ready to help your team climb the learning curve and master these standards. We have a series of RF, 5G and C-V2X webcasts available online, and our application experts are available to present face-to-face seminars.

Related Web Pages

Measurement guides, user's guides, and programming guides can be found on the following web pages under the Document Libraries tab:

LTE-V2X X-app

www.keysight.com/find/N9080EM4E

V2X Waveform Signal Creation and Offline Playback

www.keysight.com/find/N7626C

Signal Studio for Global Navigation Satellite Systems (GNSS)

www.keysight.com/find/N7609C

C-V2X solution web pages

www.keysight.com/find/cv2x

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

