Keysight Technologies
eCall/ERA-GLONASS Conformance Testing with Keysight E6950A

Application Note
eCall/ERA-GLONASS is an in-vehicle road safety system that triggers an emergency call to the nearest emergency center in the event of a serious road accident. The intention is to reduce fatalities, injuries or property loss by speeding up the response times from a rescue team. This application note describes the fundamentals of an eCall/ERA GLONASS system, common test challenges of the in-vehicle system (IVS) module and how to overcome these challenges with the Keysight Technologies, Inc. E6950A eCall conformance test solution. It will also explore the next generation eCall(NG-eCall) system and outline the differences from the current eCall service.
eCall/ERA-GLONASS Overview

The European Union has approved plans to install an emergency call feature, known as eCall in all vehicles within the EU after April 2018. Similarly, ERA-GLONASS, which is fully interoperable with the eCall system, is a Russian Federation initiative to provide quick emergency response to the accident site. Russia has made it mandatory for all new vehicle models to be equipped with ERA-GLONASS technology from Jan 2017 onwards. Both systems leverage the existing 2G or 3G cellular communication network and satellite positioning system to provide accident and vehicle information to a public safety answering point (PSAP). The figure below shows the basics of an eCall system.

![eCall System Illustration](image)

In a real environment, eCall comprises four elements: in-vehicle system (IVS) module, global network satellite system (GNSS), cellular network and PSAP. In the event of a car crash, eCall can be triggered either manually by passengers at the push of a button or automatically as soon as the car senses a severe impact in an accident, for example via in-car sensors such as those triggering the vehicle’s airbags.

The IVS module inside the car will automatically dial 112 to establish an emergency voice call that is routed to the nearest PSAP using the existing 2G or 3G public mobile wireless communications networks. The reason why 2G and 3G are being used is because of their wide coverage especially in rural areas.

An emergency message known as the minimum set of data (MSD) that contains the vehicle registration number, GPS location, a timestamp, direction of travel, number of passengers on board etc. will be sent to the PSAP once the call connection has been established between vehicle and PSAP. The accident site location information in the MSD is indicated by the GNSS positioning system.

ERA-GLONASS uses the same principles and protocols as eCall but provides further features like a redundant channel SMS or additional data services. As a backup method, in ERA-GLONASS, the SMS can be used to transmit the MSD. This reinforces the probability of the MSD reception. The SMS transmission can be requested by the PSAP, if the voice connection has been established successfully but the initial MSD reception fails. It also can be used by the IVS if the voice channel cannot be established successfully.
The primary aim of the eCall / ERA-GLONASS systems is to reduce the accident response time. This is believed that only 30% of death occurs within minutes of accident, but 70% of deaths occurs within 2 hours due to late arrival of emergency services. Therefore speeding up the emergency response time can save lives.

IVS module

The in-vehicle system (IVS) module is a hardware that installed inside a vehicle. A typical IVS module consists of an embedded computer, an in-band modem and a GPS receiver as shown in the figure below.

![Figure 2. Typical IVS module](image)

The embedded computer is the core element in an IVS. It continuously monitors the in-car sensors and at the same time controls the GNSS receiver and in-band modem via the respective interfaces. It constructs MSD data both from factory-entered data such as vehicle registration number, the type of fuel used, and instant information from various in-car sensors such as vehicle position, time stamp and the number of passengers. The GNSS receiver provides the constant tracking of the vehicle's location. In the event that the crash sensor is activated, the in-band modem will establish a voice connection using the public mobile wireless communication networks (2G or 3G) to enable MSD data transmission to the nearest PSAP. A microphone and speaker system is connected to the IVS via an audio interface to enable the driver or passenger to communicate with the PSAP operator.

GNSS (Global Navigation Satellite Systems)

Precise positioning is important in the eCall system. GNSS must deliver accurate location of accident victims. Hence the IVS module requires more reliable and accurate GNSS receiver characteristics.

According to a study - *In depth evaluation of the effects of an automatic emergency call system on road fatalities* - 53% of the callers could not pinpoint the accident site accurately, and in some 56% of the accidents this resulted in the need for additional information. In exceptional cases this may lead into sending the rescue units to wrong locations. All these potential delays can be avoided with the eCall system.
Requirements for GNSS receiver testing

It is possible to test a GNSS receiver by using an antenna and trying to receive off-the-air signals. While this approach is realistic, it can only provide limited information because the signals presented to the receiver are highly variable and non-repeatable. There may not be adequate satellites signals available at a particular location and time. In addition, testing under specific conditions, such as in particular locations or at high velocities, can become expensive and impractical.

A record-and-playback system can also be used to provide simulated GNSS signals to test the receiver. While this system provides a very repeatable test signal, it is not possible to modify the recorded signals, make adjustments to individual satellite signals, or add impairments in real-time while the signals are playing back.

To address these issues, a GNSS signal simulator may be used. A GNSS signal simulator produces an output signal that models the signal that would be received by the GNSS receiver: a mix of signals from many different satellites at different time delays, Doppler shifts, and power levels. A real-time GNSS simulator allows modifications to the signal while it is being generated. Another advantage is that a GNSS simulator can simulate satellites that are not yet present in the real world, allowing earlier testing of systems like Galileo and Beidou before the satellites are fully deployed.

MSD

Minimum Set of Data, often abbreviated as MSD forming the data component of an eCall sent from a vehicle to a Public Safety Answering Point (PSAP) or other designated emergency call centers. The MSD has a minimum size of 140 bytes and the European Committee has standardized the MSD format, which include the following information:

- Message identifier – MSD format version
- Activation – whether the eCall is generated manually or automatically
- Call type – whether the eCall is real or testing
- Vehicle type – passenger car, lorry, truck, bus and etc
- Vehicle ID – Vehicle registration number
- Vehicle propulsion storage type – gasoline, diesel, gas, etc
- Time stamp – timestamp of incident event
- Vehicle location – Latitude and longitude of the accident location
- Confidence in position – this bit is to be set to Low confidence in position if the position is not within the limits of +/-150 m with 95% confidence
- Direction – In which direction the vehicle is traveling
- Recent vehicle location n – This is an optional information regarding the vehicle’s position in (n-1) and (n-2)
- Number of passengers – This is an optional information, it is either based on the seatbelt sensor or seat pressure sensors.
- Optional additional data – This is an optional information. In some cases, optional data may be available in the MSD.

PSAP

A public-safety answering point (PSAP), sometimes called public-safety access point, is one of the key elements in In-Vehicle Emergency call services. PSAPs must be able to handle an eCall that automatically provides the location, time, vehicle information and severity of the incident. PSAP staff should also be trained to handle eCall from both national and foreign registered vehicles.
Third party supported eCall

Third party supported (TSP) eCall is a paid service whereas normal eCall is a public service. When the TPS eCall service provider (TPSP) receives an eCall, related data from the IVS is relayed to the PSAP. TPS eCall and TPSP PSAP interface are defined in CEN Standard EN16102, the intelligent transport systems ecall operating requirements for third party support.

Many car manufacturers already provide an emergency service option for their customers, typically for breakdown situations (B-Call), general service provision, directions, message forwarding and of course emergency calls in the event of an accident.

Figure 3. TPS eCall concept from CEN TC278 WG15

Next generation eCall

Current eCall deployments are based on ETSI and CEN standards, which are using circuit switched 112 eCall. Today’s 2G/3G networks are mature and provide best coverage; 4G network deployments are increasing but still lack coverage in certain regions. However circuit switched emergency services infrastructure will eventually be replaced by IMS eCall. The IETF has produced NG eCall drafts and ETSI addresses the issue of how eCall can be achieved using IMS emergency call in ETSI TR 103 140.

Below is a migration scenario for current eCall and IMS eCall; however it will vary between countries and depend on individual country strategies.

Figure 4. Generic migration scenario from ETSI TR 103 140 v.1.1.1

As technology advances, in-vehicle eCall systems also continue to evolve. In this context, we need to understand how each system differs from one another and consider interoperability test and co-existence among different standards, system architecture and specification.
Keysight E6950A eCall Conformance Test Solution

The Keysight E6950A eCall Conformance Test Solution performs end-to-end functional and standard-compliant conformance testing of eCall/ERA-GLONASS modules, with optional audio performance analysis. The test solution simulates a PSAP and uses a Keysight wireless test set and RF signal generator to emulate a cellular network and provide GNSS coordinates. The Keysight E6950A eCall test solution includes the following items:

- 1 x E7515A UXM or E5515C/E (89600 wireless test set)
- 1 x E6951A Public Safety Answering Point (PSAP) software
- 1 x N5172B or N5182B vector signal generator
- 1 x N7609B Signal Studio for GNSS
- 1 x U8903B performance audio analyzer (optional)

The eCall test setup emulates the elements of a real environment as shown below:
E7515A UXM Wireless Test Set

E7515A UXM Wireless Test Set emulates a cellular network in the real environment. The UXM takes care of today’s complex network scenarios and eliminates the complexity of test setup by providing integrated base station and channel emulation along with flexible control, measurement capability and diagnostic ability. In the eCall case, it emulates a 2G (GSM or CDMA) or a 3G (UMTS) network.

E5515C/E (8960) Wireless Test Set

Alternately the user can use E5515C/E (8960) wireless test set as the network emulator to replace E7515A UXM, thus offering many existing E5515C users a cost-competitive option to re-purpose existing equipment.
N5172B EXG Vector Signal Generator or N5182B MXG X-Series Vector Signal Generator

EXG or MXG is used as a GNSS positioning emulator as in the real environment. It provides the location coordinates to the IVS module to construct the MSD. Two modes of operation are supported:

- **Real Time** operation based on scenario files (.ags). A preconfigured scenario file may be used, or you can select the Custom option to enter parameters for creating a custom scenario.
- **Basic** single or multi-satellite waveform playback. A waveform file (.wfm) may be downloaded directly to the ARB memory to simulate the GNSS signal.

E6951A PSAP software

The heart of this eCall test solution is the eCall software, E6951A PSAP emulator. E6950A PSAP emulator can be installed either on an external PC or internally on the E7515A wireless test set. The software executes the following tasks:

- Controls E7515A UXM or E5515C (8960) to emulate a cellular network.
- Controls signal generator EXG/MXG to provide GNSS coordinates required by the IVS to compile the MSD.
- Simulates a PSAP to respond to the IVS under test and decode MSD data.

Verifies that the IVS modem is able to trigger an emergency call, send raw MSD data and establish a voice connection with the PSAP.

User can refer to E6951A PSAP User’s Guide for details of the software operation.
U8903B Audio Analyzer

The U8903B Audio Analyzer setup enables the developer to analyze the audio quality of the voice connection between IVS and PSAP.

Keysight Test Automation Platform and eCall/ERA-GLONASS test case plugin

The Keysight KS8400A Test Automation Platform (TAP) Developer’s System 2017 provides powerful, flexible and extensible test sequence and test plan creation with additional capabilities that optimize your test software development and overall performance. Keysight TAP is a modern Microsoft .NET-based application that can be used stand-alone or in combination with higher-level test executive software environments. Leveraging C# and the power of Microsoft Visual Studio, TAP is not just another programming language. It’s a platform upon which you can build your test solutions, maximizing your team’s productivity by using your existing software development tools and infrastructure.
eCall/ERA-GLONASS test case plugin

Keysight also provides automated test cases for eCall and ERA-GLONASS. KS8205A eCall/ERA-GLONASS Test Cases controls UXM, MXG instrument, PSAP software and IVS module. All eCall test cases are referenced by ETSI TS 103 412 V1.1.1 (2016-04) Pan-European eCall end to end and in-band modem conformance testing specification and for ERA-GLONASS conformance test cases. All the procedures are according to GOST R 55530.
Instrument Setup and Communications Path

The test solution is capable of supporting current and legacy wireless test sets, such as the Keysight E7515A and E5515C. There are three test setup options that the user can pick, depending on the instrument availability.

Test Setup #1

In this configuration, the E6951A PSAP Emulator is run externally. This requires a LAN connection to the E7515A UXM call box. With the E7515A UXM, the audio signal is transferred via the LAN connection. The E7515A UXM does not provide analog audio in/out. If required, this connection can be made using an USB audio module. The IVS serial control is an optional mechanism to communicate with the IVS module to initiate an emergency call. The E6951A PSAP Emulator will monitor the connected call box (E7515A UXM or E5515C/E) for incoming calls, independent of how that call is established.

Test Setup #2

If the E5515C/eCall box is used, an audio connection from the PC sound card to the audio in/out BNC ports is required. An USB audio module can also be optionally used with the E5515C/E audio path to avoid audio level calibration issues e.g. variability with PC sound cards input/output levels.
Test Setup #3

The E6951A PSAP Emulator can also run on the E7515A UXM PC (Windows 7). In this case, there is still a need for an external LAN connection for communication to the signal generator, and an optional USB connection to control the IVS.

Audio Quality Testing (optional).

It is also possible to perform audio quality testing of the eCall using the Keysight U8903B Audio Analyzer. This requires an analog audio path connection between the E7515A UXM or the E5515C/eCall box. The E5515C/eCall box can be connected directly to the U8903B using the existing analog audio in/out ports.
Related Literature

<table>
<thead>
<tr>
<th>Title</th>
<th>Literature number</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNSS Technologies and Receiver Testing, Application Note</td>
<td>5991-2288EN</td>
</tr>
<tr>
<td>Keysight E6950A eCall Conformance Test Solution, Configuration Guide</td>
<td>5992-1726EN</td>
</tr>
</tbody>
</table>

References

CEN EN 16062 eCall High Level Application Protocol
CEN EN 16072 eCall Pan European Operating Requirements
In-depth evaluation of the effects of an automatic emergency call system on road fatalities, European Conference of Transport Research Institutes (ECTRI) 2009
EENA Next Generation 112 – Long Term Definition, EENA NG112 Document
Next Generation eCall, EENA Technical Document
ETSI TR 103 140 V1.1.1 (2014-04), eCall for VoIP
Evolving Since 1939

Our unique combination of hardware, software, services, and people can help you reach your next breakthrough. We are unlocking the future of technology. From Hewlett-Packard to Agilent to Keysight.

myKeysight
www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

www.keysight.com/find/EMT_product_registration
Register your products to get up-to-date product information and find warranty information.

Keysight Services
www.keysight.com/find/service
Keysight Services can help from acquisition to renewal across your instrument’s lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.

Keysight Assurance Plans
www.keysight.com/find/AssurancePlans
Up to ten years of protection and no budgetary surprises to ensure your instruments are operating to specification, so you can rely on accurate measurements.

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight’s measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/ecall

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

Americas
Canada (877) 894 4414
Brazil 55 11 3351 7010
Mexico 001 800 254 2440
United States (800) 829 4444

Asia Pacific
Australia 1 800 629 485
China 800 810 0189
Hong Kong 800 938 693
India 1 800 11 2826
Japan 0120 (421) 345
Korea 080 769 0800
Malaysia 1 800 888 848
Singapore 1 800 375 8100
Taiwan 0800 047 866
Other AP Countries (65) 6375 8100

Europe & Middle East
Austria 0800 0011 22
Belgium 0800 58580
Finland 0800 523252
France 0805 9003 33
Germany 0800 6270999
Ireland 1800 832700
Israel 1 809 343051
Italy 800 599100
Luxembourg +32 800 58580
Netherlands 0800 0233 200
Russia 8800 5009286
Spain 800 0001 54
Sweden 0200 82255
Switzerland 0800 805363
Opt. 1 (DE)
Opt. 2 (FR)
Opt. 3 (IT)
United Kingdom 0800 0260 637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-9-7-17)

DEKRA Certified
ISO 9001:2015
Quality Management System

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2015
Quality Management System

This information is subject to change without notice.
© Keysight Technologies, 2017
Published in USA, December 1, 2017
5992-2262EN
www.keysight.com