Technical Note

Galvanic Isolation

October 2021

Introduction

This Technical Note describes recommended measures to reduce the risk of electrical injury and damage to the development equipment.

Tool requirements:
- ✓ Grounding wire
- ✓ USB galvanic isolation
- ✓ Isolation transformer

Embedded development and test means working with a live target system that is under the power. Connecting electronic hardware with a development equipment, a PC, and other hardware resources under development or test, poses some risk.

Some embedded designs, such as battery management systems in the automotive industry, feature high-voltage circuits. Such target systems can generate devastating transients that can propagate via BlueBox and USB connection to the development PC.

While these kinds of events occur very rarely due to the well-grounded hardware design of the iSYSTEM BlueBox, this document explains some guidelines, which can reduce the risk of electrical injury and damage to the development equipment without compromising signal integrity.

| Development PC | USB Isolator | Isolation Transformer | BlueBox | Embedded Target |
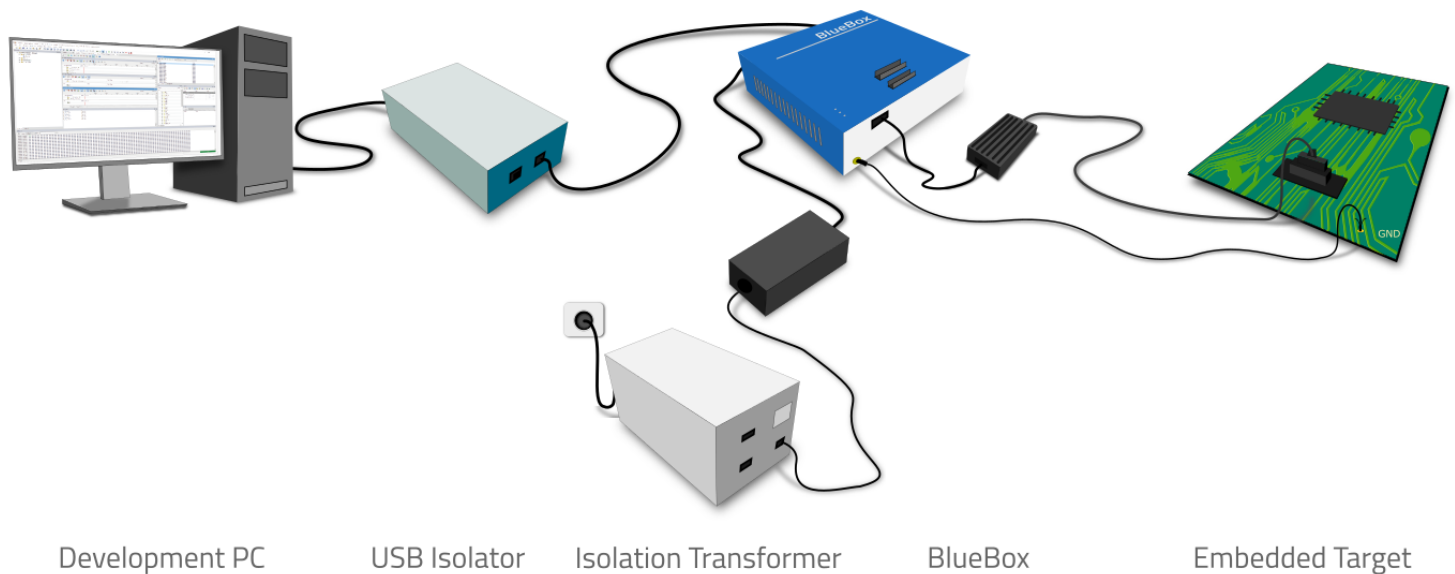
What is galvanic isolation?

Galvanic or electrical isolation is a separation of a circuit from other sources of electrical potential. Galvanic isolation means an electrical separation between the two circuits.

Why is galvanic isolation needed?

Galvanic isolation is needed where two or more electric circuits communicate with each other while their grounds may be at different potentials.
It is an effective method of protecting the development equipment by preventing:
- Unwanted current from flowing between the two units sharing a ground conductor
- Accidental current from reaching ground through a person's body

## Ground potentials in embedded development

A typical hardware setup consist of:
- Development PC
- BlueBox with DC Power Supply and Debug connection
- Embedded Target

To reduce the risks of damaging the hardware you need to isolate or balance the voltage difference between the development components.

Recommended solution

A recommended solution by iSYSTEM consist of:
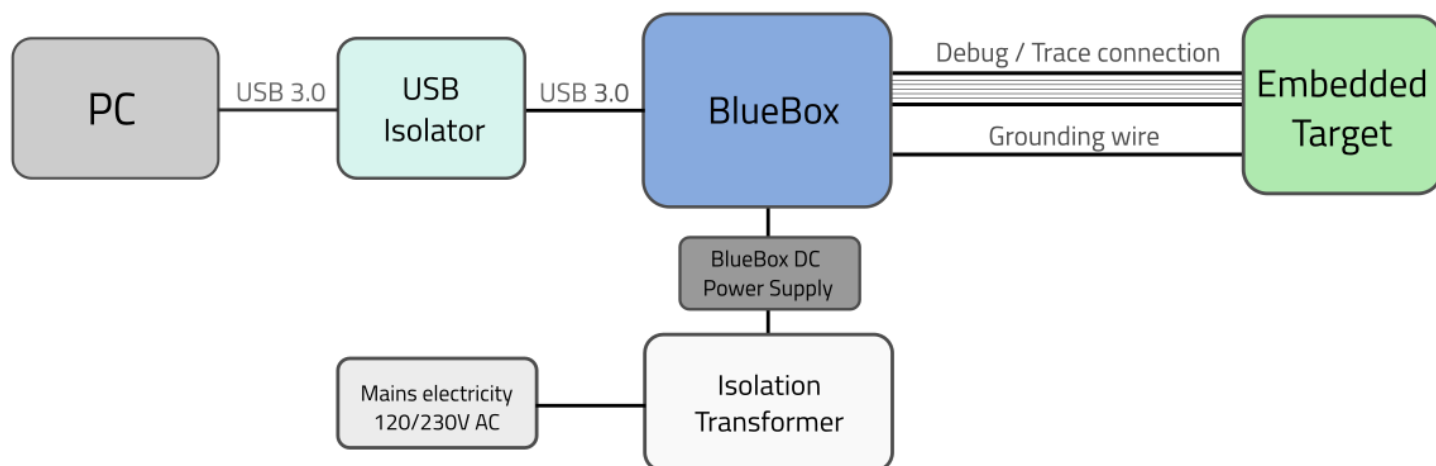
Ground potential difference between the embedded target circuit and the BlueBox debugger

Connect the BlueBox hardware and the embedded target circuit with a grounding wire. By connecting the grounding wire, you even out the ground potential between the two components.

If the grounding wire is not connected, the ground potential difference between the BlueBox hardware and the embedded target circuit can exceed well over 1000V even before any of the devices are powered up. This voltage difference is then discharged over the BlueBox hardware and the embedded target circuit, leading to a possible destruction of electronic components within the BlueBox hardware, the embedded target circuit or both.

A grounding wire is enclosed in every BlueBox package.

Why you shouldn't put a galvanic isolator between the embedded target circuit and the BlueBox

BlueBox connects to the target microcontroller via a fast debug interface. Debug adapters or Active Probes through which the BlueBox connects to the embedded target circuit are designed to exploit the full potential of the debug interface. For instance, Infineon Aurix DAP debug interface operates at up to 160 MHz clock.

A galvanic isolator represents an obstruction for these high-speed signals. Putting one between the two components, slows down the communication speed significantly, can be even by factor of 100. For example, it can slow down to the point that trace operation is not possible.

Fast communication speed   *Slowed down communication speed*
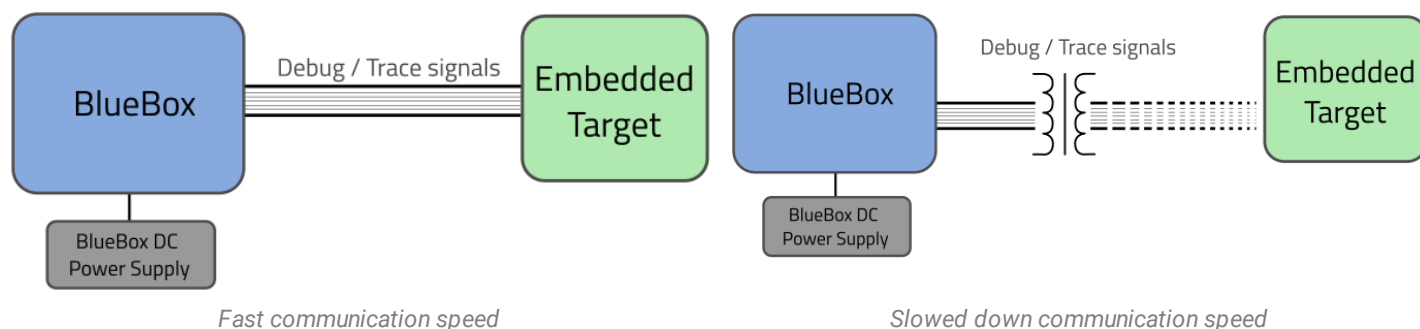
Ground potential difference between the BlueBox and development PC

USB connection

To protect the development equipment from large transients originating from the embedded target circuit, connect an USB isolator between PC USB port and the BlueBox and separate BlueBox power supply from mains electricity by using isolation transformer.

Ethernet connection

As the Ethernet interface has galvanic isolation inside the BlueBox already, no dedicated isolator is required externally. Make sure to use unshielded Ethernet cable when connecting the BlueBox to PC. Such cable is enclosed in every BlueBox package.

If the cable is shielded, ground from the BlueBox would get connected with computer network ground and galvanic isolation inside the BlueBox would lose its purpose.

Similarly to USB connection you still need to separate BlueBox power supply from mains electricity by using an isolation transformer.

Does a USB isolator decrease the overall system performance?	Required Technical specifications for isolation transformer
BlueBox performance is not affected when using a quality high-speed USB 3.0 isolator. *iSYSTEM has tested and recommends using ALLDAQ USB 3.0 SuperSpeed Isolator*.* **iSYSTEM does not produce nor market USB galvanic isolators.*	✓ *Transformer ratio: 1:1* ✓ *Power rating: min 100 VA* ✓ *Input voltage: same as BlueBox / Target system power supply* **iSYSTEM does not produce nor market isolation transformers.*

Conclusion

Implementing presented solution will ensure smooth debugging experience and will significantly reduce the possibility of personal injury and electrical damage to your development equipment.

More resources

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iSYSTEM – Provider of tool solutions for embedded software development and test. Specialized in the automotive industry, and any other sector where its customers place value on functional safety or the highest level of software

BlueBox – High-speed connection to the embedded microcontroller platforms that are based on a variety of processor architectures, enabling flash programming, on-chip debug and trace.

winIDEA IDE – Integrated Software Development Environment delivers the visual insights required to debug the embedded application, performs timing analysis measures code coverage, and visualizes RTOS task states.