Back to the future

This article is about a talented developer who uses the CAN relay module Keybox from Blink Marine to conduct a massive I/O extension in fully electric cars.

Before he discovered Blink Marine, Mr. Kidder’s project he was working on was a 1959 190SL Mercedes Benz that was converted to all electric. He needed a good way to control things like lights and contactors. Since the car is an antique, it was very, very, basic in terms of electrical connections. They just didn’t have much of anything powered back then, certainly not 500 A contactors or pre-charge resistors.

To accomplish his goal, Kidder used the Blink Marine Keybox to add control to systems that didn’t exist in the 1950’s. Keybox helped him to add things to the car that the car wasn’t designed for, like:

- LED turn signals with configurable blink duration and emergency (four way) flashing lights
- Control of a main contactor
- Control of the pre-charge resistor contactor

“I could have done some of the things I needed to do with my existing hardware, but I was running out of I/O on the ECU. The Keybox really helped by giving me a lot of extra outputs that I could easily control over CAN. As a bonus, the Keybox is also quite small and well-contained so it allowed me to pack a lot of outputs into a small space”, said Kidder. He also used the Powerkey PRO 2600 pad. This allowed him to add even more things that the car would never have had otherwise. He added cruise control to a 1959 car. The keys were also used for shifting (the car was originally a stick shift and he removed the

![Figure 1: The Mercedes Benz with Keybox from Blink Marine](Photo: Blink Marine)
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transmission), to trigger emergency four way lights, and to be able to manually force the cooling fans on. “The Blink Marine button faces are much nicer and more numerous than other company’s button faces, so we were able to find a set of self explanatory button faces that look really nice”, he added.

The Mercedes Benz kind of reminds of the cars in “steam punk” literature. But why did Kidder start working specifically on this type of car? What inspired him? According to him, his main business – where he works most of the time – involves making body and frame parts for antique Mercedes Benz and Porsche cars. So he is really familiar with Mercedes Benz’. “Some of the people here have restored more than 30 190SL cars. You could say we’re experts in 190SL restoration. Our close ties to antique Mercedes brought us to the attention of a customer who wanted to do a 190SL electric conversion and had purchased parts to do so. But he was having trouble getting the project done. We talked him into sending us the car and we finished it for him. It was the very first electric car we’d ever touched. The car worked, but the lead batteries were so heavy that they affected performance. So, we got the car back and switched to Lifepo4 batteries. That increased performance and the customer was happy for years. But then, over time electric car technology continued to improve. I had gotten the UQM inverter to work and the customer was looking for more power. The UQM fit the bill, and the batteries in the car were starting to suffer a bit anyway (a few bad cells) so we took the car back, switched to the UQM motor, removed the transmission, and added Blink Marine’s Keybox and Powerkey Pro. This final conversion really did take it in a steam punk direction. Now it is a 1959 car with custom body work, a very powerful motor, and LED push button controls on the dash. It’s a very interesting mix of antique and modern”, Collin explained.

GEVCU

The GEVCU (Generalized Electric Vehicle Control Unit) is an intermediary control device for electric cars which basically allows to transform various input signals like throttle pedal position or brake pressure to be transformed into control commands for electric motor controllers (aka inverters). The control commands are sent via CAN messages or digital / PWM signals to the motor controller to spin the electric motor. It consists of open source software and hardware. The hardware is based on Arduino Due technology but was hardened for use in automotive environments. The software is designed in a way that new motor controllers, input and output devices can be added to the existing solution and everybody is free to extend the existing solution.

Collin Kidder is also involved in the GEVCU project. He wrote most of it. It was originally conceived by Jack Rickard of EVT as a way to have a universal system that could bridge the gap between various OEM components installed in a custom car. The problem was that the Leaf DC/DC converter wasn’t meant to work in a car equipped with a UQM inverter, a Coda charger, and a Blink Marine keypad. It needed something in between all these systems; something that could provide each one the custom messages it needs to make everything work harmoniously in the custom vehicle. GEVCU was developed as the solution to that problem. Jack Rickard produced a design document and a few people got to work making it happen. Kidder is the main developer for the firmware, but other people wrote some of the code as well.

GEVCU has a set of eight outputs but they’re all low side drivers. This has worked fine for many people, but sometimes it’s nice to be able to switch high side as well. When going to high side there’s the question of “which voltage?” or “which signal?” It’s difficult to satisfy all possibilities. The Keybox from Blink Marine leaves the choice up to the user. Each output has two wires, and the end user decides what to connect. Kidder used this capability to do some high side and some low side switching with the Keybox. Also, he ended up with far more than eight necessary outputs, so he had to...
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Collin Kidder

- Skilled developer
- CAN protocol hacker
- Geek
- Gaming enthusiast

Active in embedded development, Collin has designed both the hardware and software for a biometric safe and a wireless vehicle access control project. He helped design hardware for a vehicle control system, and is currently leading a project to develop open source software for a vehicle control module.

overcome GEVCU’s limits anyway. The Keybox was a valuable addition both because he needed more outputs and because it is so configurable.

Most of the communications were custom messages on plain CAN. However, the Keybox and Powerkey use CANopen. Many hobbyist grade devices for DIY (Do It Yourself) electric cars just use plain CAN with custom message formats. This lack of standardization is partly why a VCU like GEVCU needs to exist - to translate and interpret messages in all of the custom formats so that all of the devices can work together. GEVCU does support the OBDII CAN standard (ISO 15765-4, PID codes). GEVCU uses an isolated transceiver: ISO 1050. This chip gives isolation between the CAN wiring and the board power and signal lines. Sometimes things get pretty electrically noisy in a car and an isolated transceiver seems to be the way to go. Everything in the car was 500 kbit/s. This allowed for fast communication without difficulties.

Since the car was from the 1950’s which was many decades before CAN even existed, Collin added many CAN connected devices to the car. GEVCU coordinates with them all. The HV battery charger is CAN controlled. There is a BMS monitoring the cells which allows GEVCU to make decisions about how to best control the battery charger. A CAB300 current sensor is also connected via CAN and is used by the BMS to measure state of charge for the pack. There is a 12-key Powerkey Pro on the dash which is CAN connected and is used for gear selection, cruise control, hazard lights, regen settings, and fan control. Additionally, a Blink Marine Keybox was used for most of the car’s 12-V switching needs. This controls such things as the LED turn signals, fans, pre-charging, main contactor control, and brake lights when doing heavy regen. The car uses a UQM Power Phase 100 motor and controller as well. GEVCU controls the inverter through CAN messaging. In the car one CAN network has GEVCU, the UQM inverter, and the OBDII plug on it. A second CAN network has everything else (with also the OBDII plug). In this way either network can be monitored from the OBDII plug for diagnostics.

What the future holds

Right now Collin is working on a somewhat secret car project he can’t really tell anything about. “I’ll be working on one or two more cars in the near future. I think all of them will use the same basic products now that I’ve got them all integrated. I continue to work on GEVCU improvements and reverse engineer other OEM electric vehicle components. I’m also working to make or find a reasonably priced Chademo station so that I can install more of them in the US. We’ve got a lot of Chademo stations in the US, but it’s a very big country and coverage is not good. For example, there are no stations within 200 km of where I live. This puts all existing chargers too far away. I’d like to fix that. Also, I have plans to help produce a system that makes it possible to add Chademo to electric vehicles that don’t have it. Some testing is already underway for that.”, he finished.

Applications

Author

Eliseo Boldrin
Blink Marine
eliseo.boldrin@gmail.com
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