

# GateKeeper – Bridging Dissimilar Automotive Buses

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**Abstract — This paper presents the design and use of a gateway module, GateKeeper, for automotive applications. GateKeeper translates messages between various speed CAN buses, running from 83.3Kbps to 500Kbps, and a J1850 bus operating at 10.4Kbps.**

**The hardware portion of the paper describes the processor selection and overall electrical design. The software development environment is discussed along with message translation methods. A description of the use of the J2190 protocol to enable and disable each individual CAN and J1850 message is also provided. An example application of GateKeeper is presented.**

## Introduction

Most current US vehicles use the Society of Automotive Engineers (SAE) J1850 bus standard for message communication between electronic control modules in a vehicle. A CAN/J1850 gateway module has been designed to help development engineers build and test new CAN-based electronic modules and systems in current production legacy J1850 vehicles. Such vehicles are equipped with both new CAN modules and older J1850 modules.

Imagine placing a CAN-based engine and transmission controller in a vehicle containing a J1850-based instrument cluster, shift indicator display, HVAC controller, audio system, and other electronic modules. How do you display transmission gear position, vehicle speed, or engine RPM? How do you show engine

temperature or oil pressure? These parameters are usually transmitted via the vehicle bus. However, dissimilar buses, such as CAN and J1850, do not communicate with each other. Thus, there is a need for a gateway to translate messages. That was the challenge that led to the development of GateKeeper.

Figure 1 shows a typical system configuration of the gateway module and various electronic control units (ECUs). The CAN-C and CAN-B buses have data rates up to 1Mbps and 125Kbps respectively. The data rate for the Variable Pulse Width Modulation (VPWM) version of the SAE J1850 standard is 10.4Kbps. A RS-232 link allows the firmware embedded in the gateway to be updated and acts as a possible port for monitoring or logging bus traffic with a PC or a PDA.

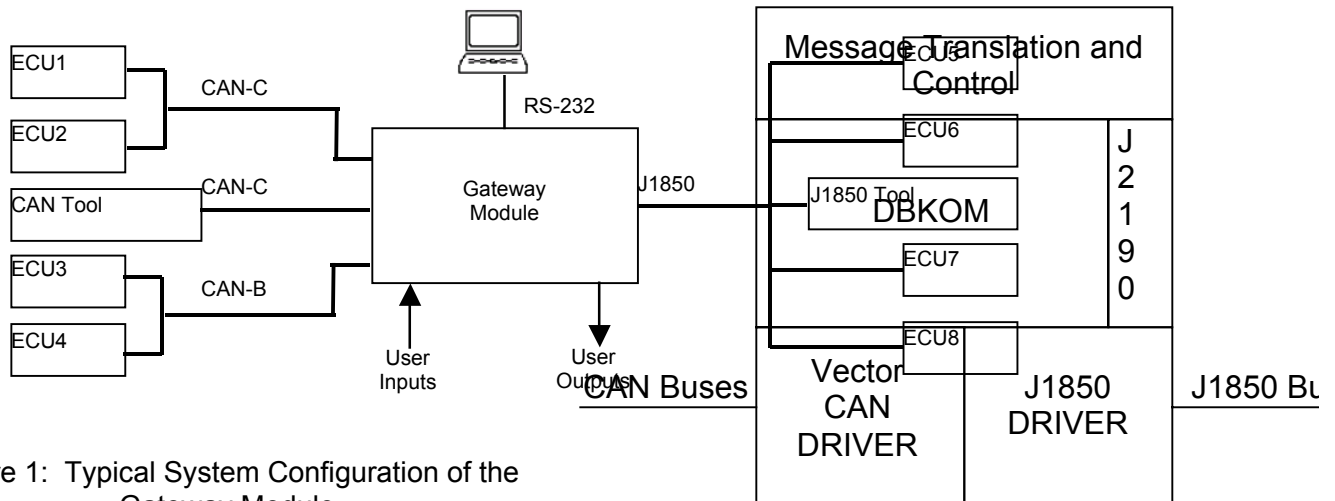
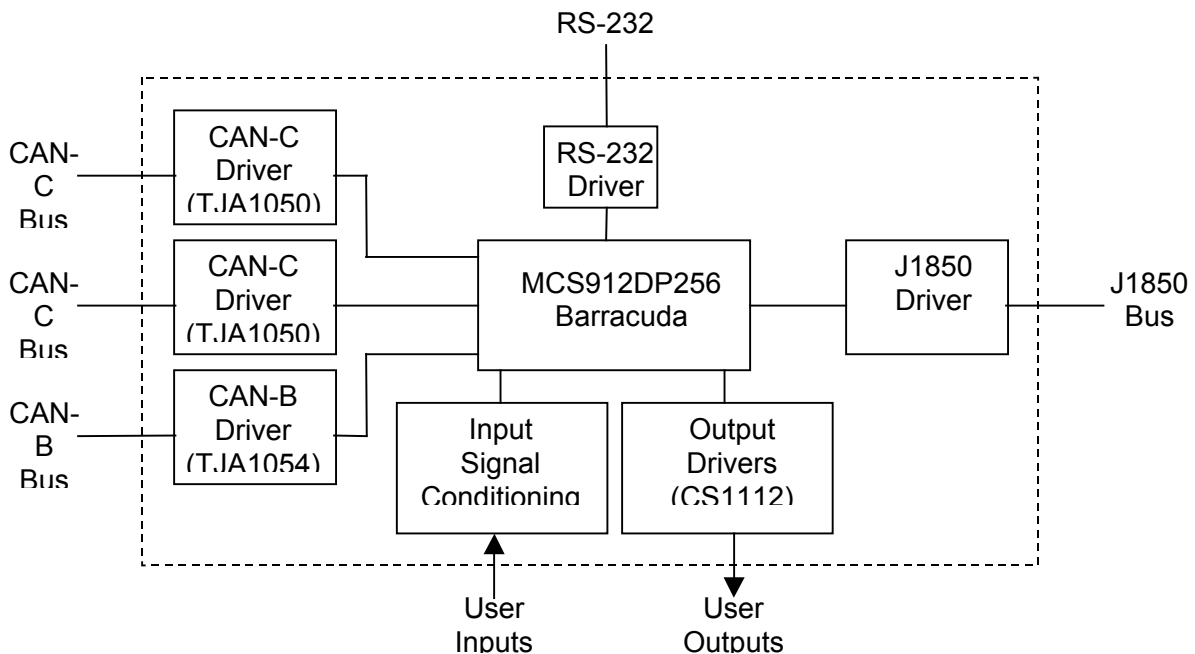


Figure 1: Typical System Configuration of the Gateway Module

### Hardware Design

The gateway must communicate between a single J1850 bus and up to three CAN buses. Motorola's MCS912DP256 microcontroller was selected because of its multiple bus support, flash memory, EEPROM (Electrically Erasable Programmable Read-Only Memory), and automotive temperature range (-40 to + 85 °C).

256K bytes of flash memory, 12K bytes of RAM, 4K bytes of EEPROM, two serial communication interfaces, a J1850 port, and five embedded CAN ports. The high level of integration simplified the hardware design, which Figure 2 illustrates in terms of its functional blocks. The CAN-C buses utilize a Philips TJA1050 driver and the CAN-B bus uses the TJA1054 driver with fault tolerance features. The J1850 bus uses a customized integrated driver/receiver.



The processor uses the 16-bit STAR 12 CPU,

Figure 2: Gateway Module Function Block Diagram

A CS1112 DMOS quad power output driver is used to drive user status indicator lamps.

Thermal chamber testing has validated the gateway’s operation over the full temperature range.

### 3. Software Development

The majority of the effort in developing the gateway was spent in the software area. The software structure shown in Figure 3 was developed using an iSystem emulator.

The top application layer, Message Translation and Control, translates messages between the J1850 and CAN buses. The DBKOM module controls timing of all the messages. The end user uses the J2190 protocol to enable or disable individual CAN and J1850 messages at run time. Vector CAN drivers are used to transmit and receive CAN messages. A customized J1850 driver handles J1850 messages.

Figure 3: Gateway Module Software Structure

Modular software was used in the development of GateKeeper. Additional software development is required to accommodate message translation for new applications because messages do not always translate one-for-one between CAN and J1850. Various message translation examples follow:

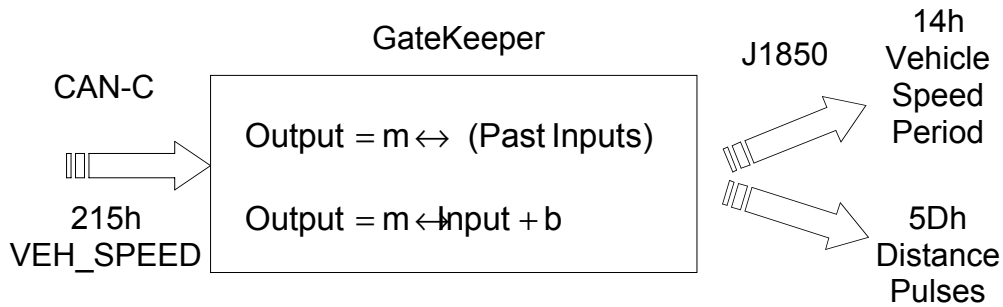
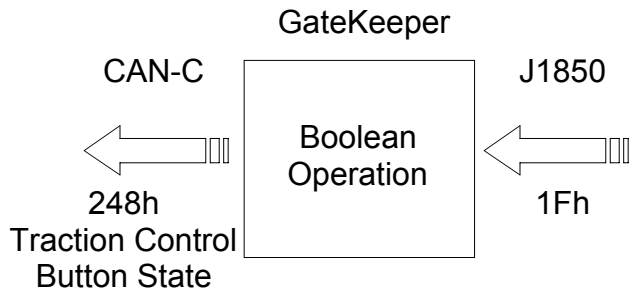


Figure 4: Multiple J1850 Messages are Updated Based on a Single CAN Message.<sup>1</sup> (Translation Functions are Applied).

<sup>1</sup> Both “m” and “b” are parameters defined by application translation requirements.

Figure 5: CAN Message is Updated Based on a Received J1850 Message.



(Boolean Operations are Applied).

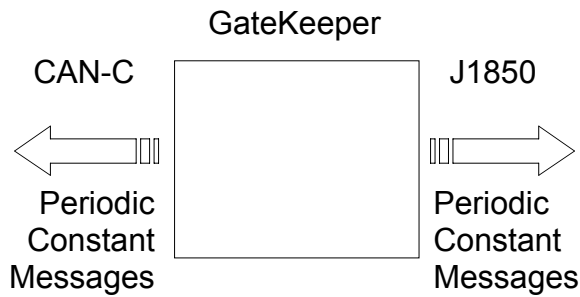


Figure 6: GateKeeper Sends Periodic and Constant Messages onto Both J1850 and CAN Buses.

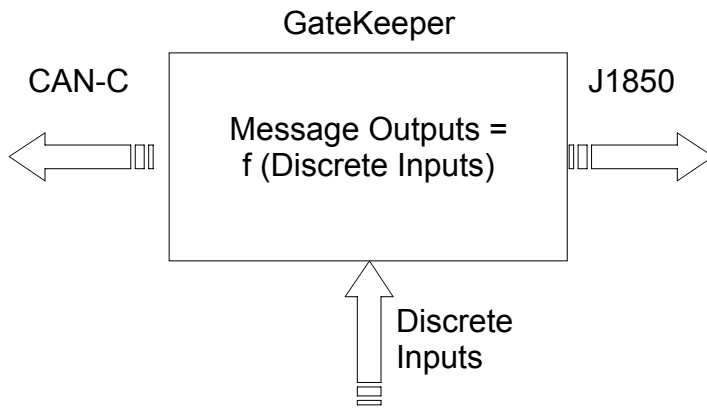


Figure 7: CAN and J1850 Messages are Created Based on Discrete Inputs.

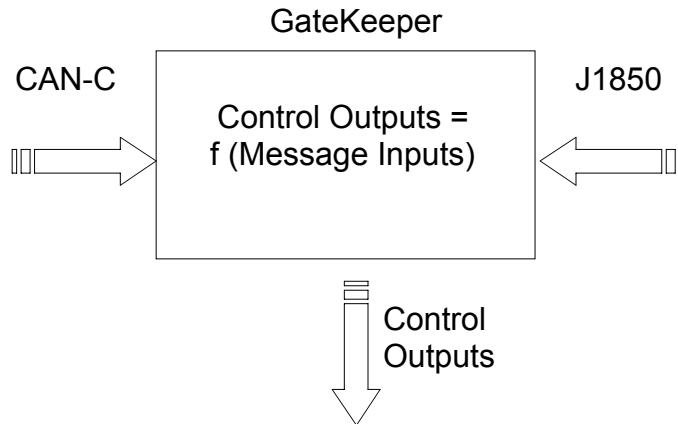


Figure 8: Control Outputs are Driven by CAN or J1850 Messages.

An On/Off message control pattern, stored in the memory of the microcontroller, enables or disables each CAN and J1850 message. The user configures these control patterns via the J1850 bus link using the SAE J2190 protocol. The process is described below.

A diagnostic request is sent to the gateway module to change the message control pattern. It consists of 7 bytes, which are detailed below:

Byte1	\$24	Diagnostic request
Byte2	\$2B	Gateway module ID
Byte3	\$A0	Write the data byte (Byte6 of this message) at the 16-bit memory address (Byte4 and Byte5)
Byte4	\$xx	Memory address Bit 15 – Bit 8
Byte5	\$yy	Memory address Bit 7 – Bit 0
Byte6	\$dd	Data byte (either \$00 to disable a message or \$01 to enable a message)
Byte7	CRC	Cyclic Redundancy Check

Each memory address represents a message ID ranging from \$000 to \$7FF. This applies to all three CAN ports and the J1850 port. The

content of a memory address, \$00 or \$01, determines if its corresponding message is enabled or disabled.

All diagnostic requests respond with a diagnostic response message.

A description of the positive diagnostic response to CAN/J1850 message control follows:

Byte1	\$26	Diagnostic response
Byte2	\$2B	Gateway module ID
Byte3	\$E0	Response for Write Data Byte at 16-bit memory address
Byte4	\$dd	Echo of data byte, \$00 or \$01
Byte5	\$00	Data Write successful and complete
Byte6	\$00	Filler
Byte7	CRC	Cyclic Redundancy Check

### Applications

The flexibility of the hardware and software design has resulted in many successful applications of GateKeeper. The original design target was for validation of a new CAN-

based engine and transmission controller using a current production vehicle.

The ability to enable and disable messages allowed one version of the software to handle either six or eight cylinder engines. GateKeeper has also been used for a CAN-based Continuously Variable Transmission (CVT), a new CAN-B based HVAC control module, a Next Generation Transmission module tester, and a Telematics system tester. GateKeeper could also be used with current J1850 logging and analysis tools to translate CAN data to J1850 data, thus extending the life of older tools.

### Summary

The shift from older J1850 bus standards to the new higher speed CAN bus represents a major redesign task for automotive electronic module designers. GateKeeper is playing an important role in assisting designers in this process by allowing them to conduct early testing and validation of new modules and systems. The flexible design is allowing GateKeeper to be applied to a wide range of applications.

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