Networking Applications

INDUSTRIAL CONTROLLER AREA NETWORK (CAN) APPLICATIONS

SG2096/D, REV 0

OVERVIEW

The controller area network (CAN) is a serial, asynchronous, multimaster communication protocol for connecting electronic control modules in automotive and industrial applications.

CAN was designed for applications needing high-level data integrity and data rates of up to 1 Mbit/s.

Motorola has a complete line of products enabling industrial electronics designers to incorporate CAN into their applications.

KEY BENEFITS

- CAN products and tools are plentiful and reliable
- CAN is integrated in all levels of microcontrollers and DSPs
- CAN physical layers and system basis chips provide connectivity and increased integration

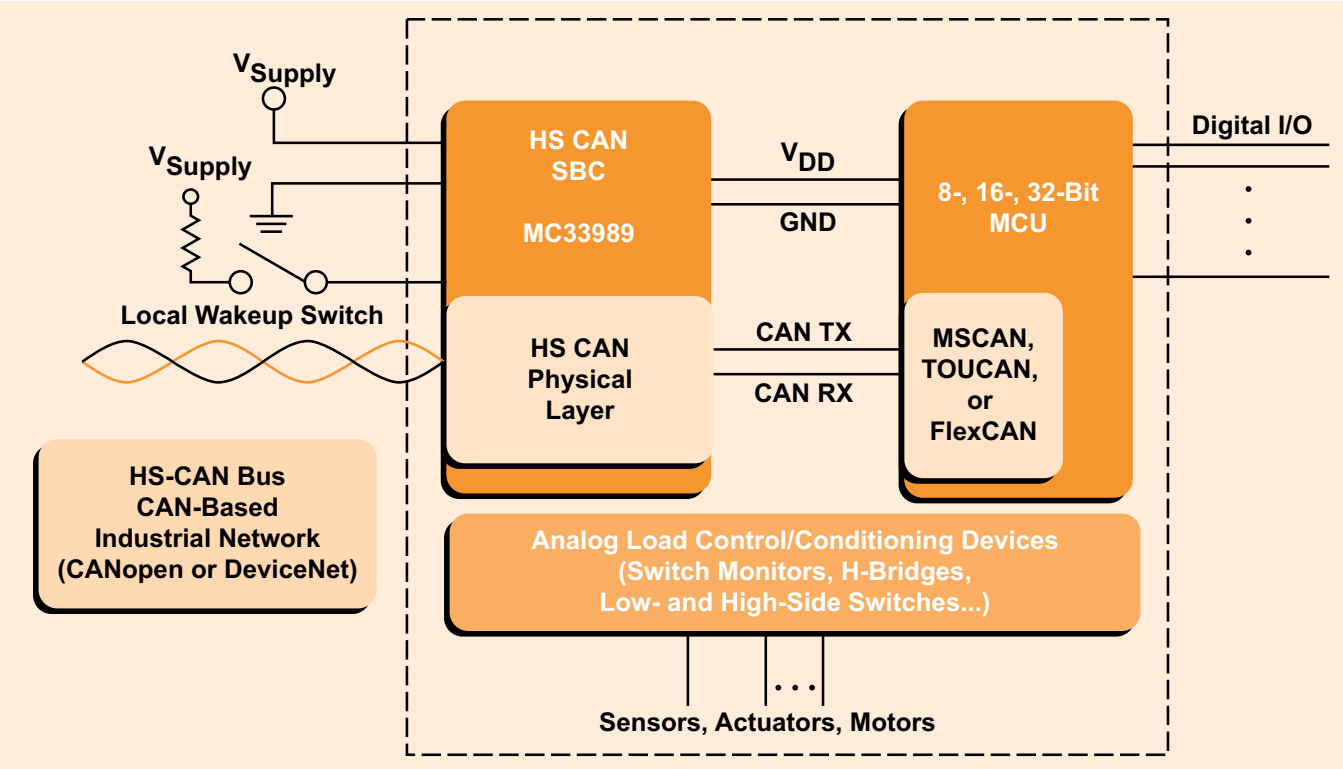

Figure 1. Representative Industrial CAN Slave Node

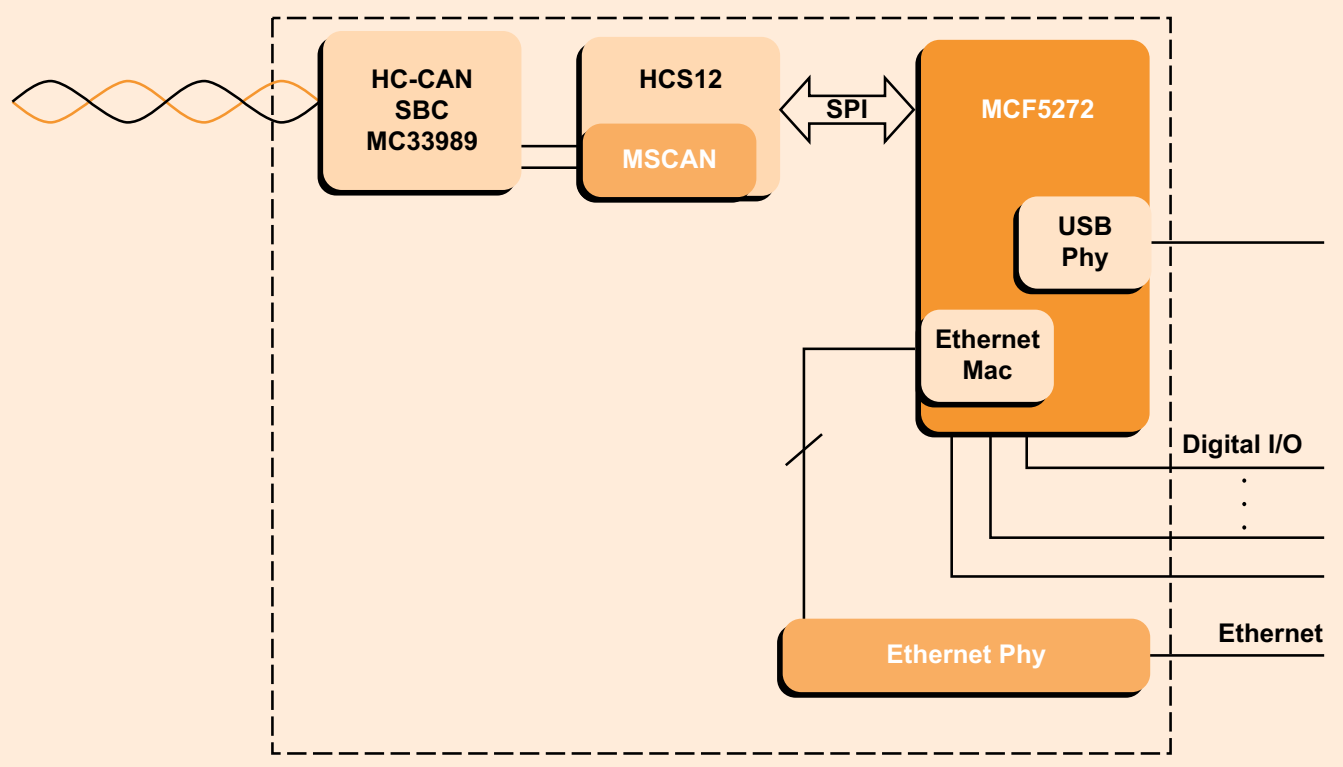

Figure 2. Representative Industrial CAN Master Node

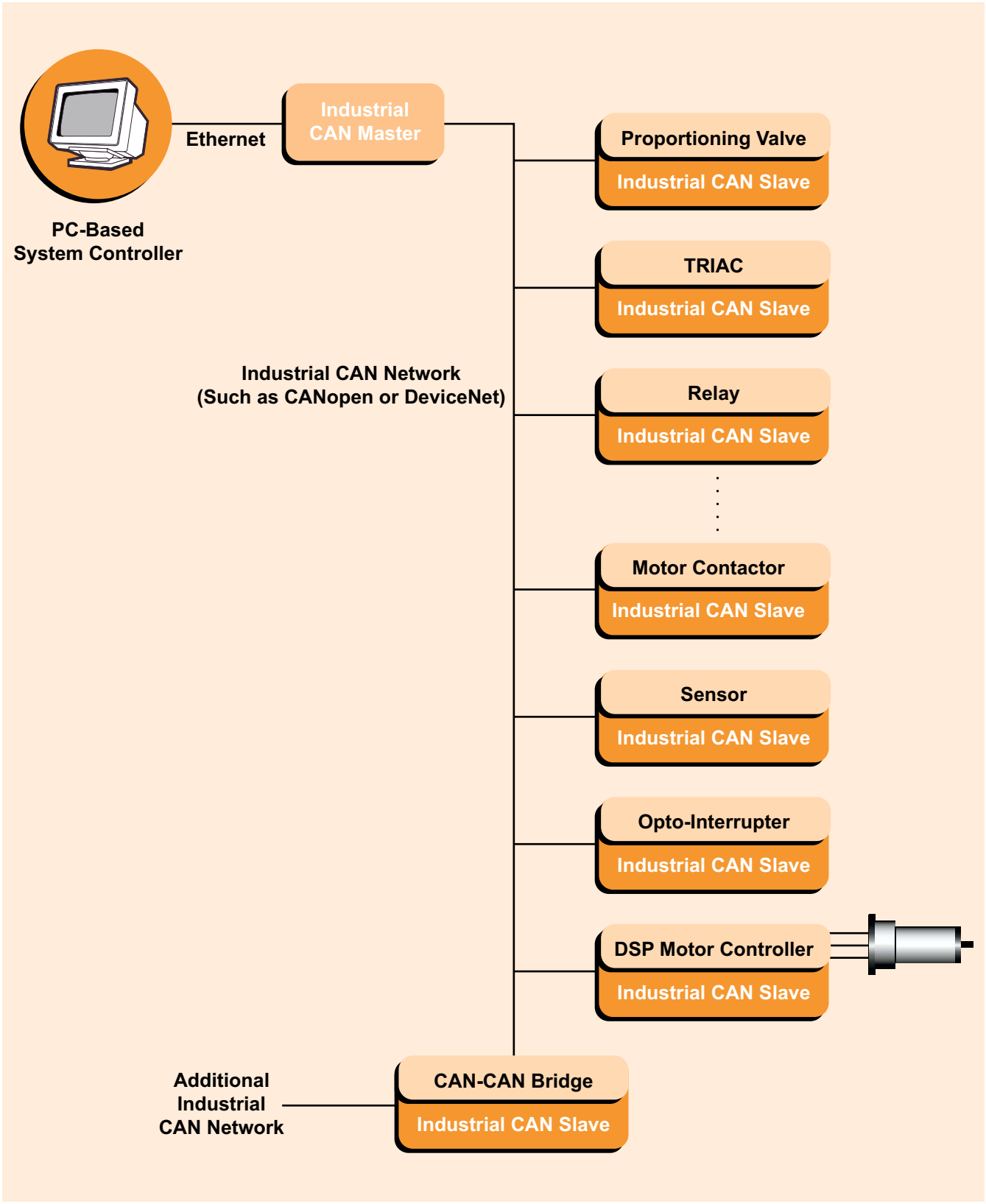

Figure 3. Representative Industrial CAN Network

MOTOROLA ORDERING INFORMATION

Part Number	Product Highlights	Additional Information
HC08		
MC68HC908AZxx	1 MSCAN08 Module	www.motorola.com/semiconductors NOTE
HC12		
XC68HC912BCxx	1 MSCAN12 Module	www.motorola.com/semiconductors NOTE
MC68HC912Dxx(A)	2 MSCAN12 Modules	www.motorola.com/semiconductors NOTE
MC68HC912DG128A	2 MSCAN12 Modules	www.motorola.com/semiconductors NOTE
MC68HC912DT128A	3 MSCAN12 Modules	www.motorola.com/semiconductors NOTE
HCS12		
MC68HC9S12DPxx	5 MSCAN12 Modules (REV 2) 1 BDLC (J1850) Module	www.motorola.com/semiconductors NOTE
MC68HC9S12DTxx	3 MSCAN12 Modules (REV 2)	www.motorola.com/semiconductors NOTE
MC68HC9S12DJxx	2 MSCAN12 Modules (REV 2) 1 BDLC (J1850) Module	www.motorola.com/semiconductors NOTE
MC68HC9S12DGxx	2 MSCAN12 Modules (REV 2)	www.motorola.com/semiconductors NOTE
MC68HC9S12Dxx	1 MSCAN12 Module (REV 2)	www.motorola.com/semiconductors NOTE
MC68HC9S12Hxx	2 MSCAN12 Modules (REV 2)	www.motorola.com/semiconductors NOTE
MC68HC9S12Cxx	1 MSCAN12 Module (REV 2)	www.motorola.com/semiconductors NOTE
32-Bit Microcontrollers		
MPC555 6LFMZP40(R2)	2 TouCAN Modules	www.motorola.com/semiconductors NOTE
MPC561 2LFMZP40(R2)	3 TouCAN Modules	www.motorola.com/semiconductors NOTE
MPC563 4LFMZP40(R2)	3 TouCAN Modules	www.motorola.com/semiconductors NOTE
MPC565 6LFMZP40(R2)	3 TouCAN Modules	www.motorola.com/semiconductors NOTE
MC68376	1 TouCAN Module	www.motorola.com/semiconductors NOTE
DSP Devices		
DSP56F803BU80	16-bit (DSP/MCU) with 1 MSCAN12 module	www.motorola.com/semiconductors NOTE
DSP56F805FV80	16-bit (DSP/MCU) with 1 MSCAN12 module	www.motorola.com/semiconductors NOTE
DSP56F807PY80	16-bit (DSP/MCU) with 1 MSCAN12 module	www.motorola.com/semiconductors NOTE
DSP56F807VF80	16-bit (DSP/MCU) with 1 MSCAN12 module	www.motorola.com/semiconductors NOTE
APD Devices		
MC33388	CAN low-speed fault tolerant physical interface	www.motorola.com/semiconductors NOTE
MC33389A MC33389C	System Basis Chip, Dual Vreg, LS CAN, Watchdog, 3 wakeup inputs	www.motorola.com/semiconductors NOTE
MC33889	System Basis Chip Lite with Low-Speed CAN, Dual Vreg, LS CAN, 2 wakeup inputs	www.motorola.com/semiconductors NOTE
MC33989	System Based Chip with High-Speed CAN, SBC dual Vreg, 2 wakeup inputs For use with ISO 11898, SAE J2284 CAN networks	www.motorola.com/semiconductors NOTE

NOTE: Search on the listed part number.

DESIGN CHALLENGES

Integration of High-Level Industrial CAN Networking Protocols

In industrial systems, factory automation, machine controls, and the like, it is not enough for a designer to simply decide to use CAN. Often, many systems, tools, and machines use additional higher-level messaging protocols on top of the CAN network such as CANopen or DeviceNET. These messaging protocols are devised to describe the nature of the behavior of different modules on the network used for input/output, sensor monitoring, motor controllers, and the like. They define what information passes from one node to another, when it is passed, and how often it is passed. These industrial messaging standards can be complicated and software driver code is often difficult to create. Many customers find it much easier to purchase this driver software and integrate this into their application, concentrating their software design on the application itself.

In Application Reprogramming, Network Downloads

Once a factory or machine is built, it can be difficult, expensive, or impossible to physically access certain modules which are in the network. For this reason, it is extremely desirable to be able to re-program the devices through the network itself. This only requires access to the network at some point, rather than direct physical access to each module. In application programming allows module software to be upgraded, fixing bugs, adding new features, or updating calibration data. This provides an extremely effective way to extend the life of a module, but requires a microcontroller which is easy to reprogram at a distance.

Diagnostics, Load Control, and Load Handling

In a factory automation or industrial control environment, there are generally a large number of sensors and actuators of all types. Controlling these devices intelligently and accurately is the key to controlling the system. The more control a designer has over each component in the system, the more control he or she has over the system as a whole. Motors, for example, might need to be controlled very accurately and very quickly to keep an assembly line working at top speed. If a motor can be turned at maximum efficiency, this could represent a significant cost savings to the company running the system. These levels of motor control often also depend on accurate and detailed sensor feedback to determine the speed of the motor or perhaps the placement of materials on the manufacturing line.

Different CAN Networks Have Physical Layer Requirements

CAN, like all major networking protocols, requires a physical layer device in order to communicate. This physical layer comes from the ISO/OSI seven layer stack model, and is responsible for current and voltage control for the bus, dealing with current and voltage transients, and signalling bus (line) faults and possibly correcting them.

The Bosch CAN specification does not dictate physical layer specifications for anyone implementing a CAN network. This is both a blessing and a curse to the designer. Over the course of the last decade, two major physical layer designs have come to the fore and become the basic physical layer designs used in most CAN applications. They both communicate using a differential voltage on a pair of wires and are commonly referred to as a high-speed and a low-speed physical layer. The low-speed architecture has the ability to change to a single-wire operating (referenced off ground) when one of the two wires is faulted through a short or open. Although both architectures use a voltage difference on a pair of wires, the termination methods for each are different and incompatible in production systems.

Since there are no requirements on physical layer in the CAN specification, other standards organizations have developed standards to help designers create compatible CAN devices. The International Standards Organization (ISO) creates standards to ensure inter operability of components at the physical layer and recommended design practices. ISO standards are generally the standards followed for industrial applications.

CAN Physical Layer Type	ISO Standards (Europe) www.iso.org
Low-speed fault tolerant CAN	ISO 11519-2 Road vehicles -- Low-speed serial data communication -- Part 2: Low-speed controller area network (CAN) ISO 11898-3 is likely soon to replace 11519-2
High-speed CAN	ISO 11898 Road vehicles -- Interchange of digital information -- Controller area network (CAN) for high-speed communication

Table 1. Common Industrial CAN Physical Layer Standards

MOTOROLA SOLUTION

Integration of High-Level Industrial CAN Networking Protocols

Motorola offers a complete development tools environment for creating embedded applications in C. This environment allows application designers to create embedded applications and easily integrate existing C-based software drivers to support industrial CAN networks such as DeviceNet or CANopen.

In Application Reprogramming

With a large portfolio of FLASH memory based MCUs with CAN networking capability, Motorola has an excellent selection of devices which are perfectly suited to creating nodes which can be upgraded through the network. In addition to having the FLASH memory, there are additional features which make in-application reprogramming even easier. Motorola FLASH MCUs operate from -40 to 125 degrees Celsius, and can be reprogrammed quickly and easily without any additional power supplies. One voltage supply will power up the MCU and provide programming voltage for the FLASH array, eliminating any need for additional circuitry for managing a separate programming voltage supply.

Diagnostics, Load Control, and Load Handling

Motorola SMARTMOS (SMOS) products bring an unparalleled level of control and diagnostic capabilities for connecting to motors, lamps, sensors, and other types of industrial loads. Protection features which are difficult, expensive, or impossible to implement in discrete components are available in products such as H-bridge drivers for motors, for example. SMOS H-bridge drivers are fully protected against conditions of over current, over voltage, over temperature, and low voltage, automatically shutting off outputs to prevent damage. Additionally, monitoring features such as current recopy allow the monitoring of current through the low-side of the bridge to determine how much current is going to the motor. This can be used to indicate motor stall conditions or other application-specific diagnostics. Die temperature and supply voltage can also be measured and monitored, allowing previously unattainable diagnostics capabilities. SMOS also offers load control capabilities by controlling the amount of current delivered to a load by setting current limits and driving the outputs with controllable pulse-width modulation. Another essential component to many motor control applications which is provided for in SMOS is inputs for Hall Effect sensors, used to measure motor speeds.

Other SMOS products allow monitoring of high voltage switches, allowing an MCU with 5V input/output requirements to interface to higher voltage switches. The devices provide pulse wetting current to clean the switch contacts and allow an MCU to interface to 12 switches at one time, while only using 4 pins of the MCU for communication with the device.

Motorola SMOS CAN Physical Layer Products to Meet Industrial Customer Needs

To address the need for multiple types of CAN physical layers, Motorola offers a range of CAN physical layer devices designed to meet or exceed the performance standards set out by ISO.

But a simple physical layer device is not always enough. Modules in the system might need to run from a regulated power supply, for example. Sometimes a local switch or sensor might need to be able to wake up the module from sleep state to active running state very quickly. That switch or sensor might be running at higher than digital logic voltage levels. This is where the Motorola System Basis Chip (SBC) brings power and value to the industrial design table. SBCs combine the CAN physical layers needed for CAN connectivity with voltage regulation, independent watchdog timer, and local wake-up circuitry to allow greater flexibility with fewer components. Since these circuits can be made with the same semiconductor processes, it makes sense to combine these functions into one package and reduce the number of components needed in the final design. This reduces assembly costs, increases reliability, and increases design flexibility.

DEVELOPMENT TOOLS

Tool Type	Product Name	Vendor	Description
Software drivers	MSCAN low-level software drivers	Metrowerks	Low-level driver software for MSCAN08, MSCAN12, and MSCAN for HCS12
Configuration tool	MSCAN filter generation tool	Metrowerks	Calculates optimal hardware filter settings for MSCAN architecture for customer application
Hardware Development Tools	EVBs and other development tools for respective MCUs	Metrowerks	www.metrowerks.com

THIRD PARTY SUPPORT

Vendor	Description	Contact Information
Vector CANtech	CAN network analysis and development tool.	www.vector-cantech.com/
Dearborn Group Technology	CAN development and analysis tools	www.dgtech.com/
Hitex Development Tools	Toolbox for CAN Applications	www.hitex.de/
IXXAT, Inc.	CAN development and analysis tools, DeviceNet and CANopen drivers	www.ixxat.com
NSI	CAN, VAN, KWP20002	www.nsi.fr/
National Instruments	CAN test and Measurement Tools	www.ni.com
PHYTEC	32-bit PowerPC Power with dual TouCAN in credit card sized package, providing rapid development with MPC555 in a cost-effective, high-performance single board computer	www.phytec.com

RELATED INFORMATION

For inquiries about Motorola products, please contact the Technical Information Center at 800-521-6247, or visit us online at www.motorola.com/semiconductors.

Document Number	Description
AN1798/D	CAN Bit Timing Requirements
AN2010/D	Using The Motorola msCAN Filter Configuration Tool
AN2011/D	The MSCAN on the MCS912DP256 vs. HC12 family
APDPAK/D	Analog ICs Integrated Solutions Pitch Pack
AN1776/D	Stereo Audio transmission with TouCAN
AN1828/D	Flash Programming via CAN
AN2255/D	MSCAN Low Power Applications
EB376/D	A comparison of the MC9S12DP256 (mask set 0K36N) versus the HC12
SG1002/D	Analog Product Selector Guide
SG1006/D	Microcontrollers Product Selector Guide

See also the CAN in Automation (CiA) - international users' and manufacturers' group web site at www.can-cia.org.

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Tokyo 106-8573, Japan
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June2002