

Nucleus CAN

A Technical Paper

Controller Area Network for Automotive and Automation Industry

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Intended Audience: Embedded software design engineers working in Industrial Automation, Industrial Controls or Transportation markets who are looking for technical background information on Accelerated Technology's CAN solution.

Summary of Contents: This technical paper provides an overview of Accelerated Technology's CAN solution. It surveys the origins and uses of Controller Area Network, and describes the implementation of the CAN standard available from Accelerated Technology. The architecture of the product is outlined, together with some of the features and benefits.

History of CAN

CAN is an advanced serial communication protocol originally developed in early 1980s for in-vehicle communication so that traditional electrical wiring in the vehicles, which was growing to be complex and bulky, may be minimized. Since then, it has found widespread acceptance in other areas like aerospace, medical instruments, control systems etc. as well.

Introduction

CAN efficiently supports distributed real-time control with a very high level of security. The attributes of a Controller Area Network (CAN) are:

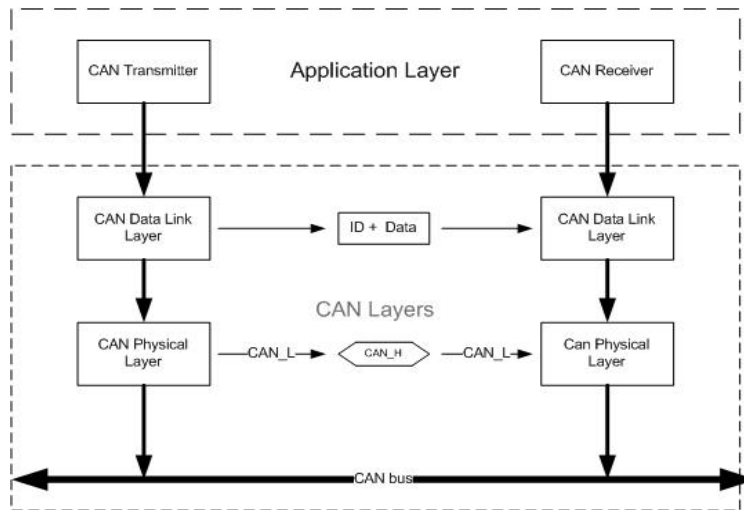
- ❑ The multi-master capabilities that allow building smart and redundant systems without the need of a valuable master.
- ❑ The broadcast messaging is the first piece of the guarantee for 100 percent data integrity as any device within the network uses the very same information.
- ❑ The sophisticated error detecting mechanism and the retransmission of faulty messages which is the second piece of the guarantee for 100 percent data integrity.

CAN protocol specified four types of message frames for the communication of the information among the devices. These include Data Frame, Remote Frame, Error Frame and Overload Frame. Each of these message frames has its own purpose specified in ISO 11898. The Data and RTR (Remote Transmission Request) frames are further distinguished based upon the length of the identifier field. The messages with 11-bit ID are known as standard ID messages while the ones with 29-bit are known as extended ID messages.

Nucleus CAN is the full-featured implementation of the CAN protocol. It is developed specifically for embedded applications in the automobile and automation industry. Nucleus CAN conforms to the ISO 11898 standard. It has been developed for the Nucleus PLUS RTOS as well as the Nucleus OSEK kernel and has been released on many embedded platforms.

How Nucleus CAN Works

At the application level, we are concerned only with CAN Data Frame and CAN Remote Frame, which are used for the communication of the application data. Nucleus CAN provides a data structure named **CAN_PACKET** that provides a convenient interface to the application for setting/getting all the attributes of a CAN frame. Messages are transmitted and received using a standard set of Nucleus CAN APIs, which take **CAN_PACKET** as the parameter. The following figure depicts the communication of CAN messages using Nucleus CAN.



Some of the salient features of Nucleus CAN include:

- ❑ *Loopback device Support:* This will help the user to rapidly build its application and debug it easily before final deployment or even before the availability of the hardware.
- ❑ *Hardware Driver:* Nucleus CAN integrates well with hardware driver for a CAN controller through a set of interface functions.
- ❑ *Multiple controller support:* Nucleus CAN is able to support more than one CAN hardware controller simultaneously and thus can be used to develop CAN gateways or routers.
- ❑ *Multiple ports supports:* Nucleus CAN provides an option to integrate up to four CAN hardware driver ports for different CAN controllers, where each of the hardware driver port may support varying number of similar CAN controller. This makes Nucleus CAN extremely scalable and able to operate on heterogeneous CAN controller simultaneously.
- ❑ *Optimizations for speed:* By enabling this option a user, requiring more speed for his application, may optimize Nucleus CAN for better speed response.
- ❑ *Optimizations for size:* Enabling this option would help the application, limited on memory resources, to better fit Nucleus CAN according to its needs.
- ❑ *Debugging support:* This option provides rigorous checking of application parameters to Nucleus CAN, and thus helps diminish the errors in the application.

- ❑ *All message ID support:* Being fully compliant with Bosch CAN specification 2.0B Nucleus CAN supports standard as well as extended CAN ID messages.

Scalability

Nucleus CAN provides a lot of configuration options to scale it according to the user's resources and needs. It provides optimizations for speed as well as size, incorporates a debugging feature whereby all the API parameters are rigorously checked and provides size-adjustable message I/O queues which may be used for count for a slow CAN controller and a fast application or vice versa.

Portability

Nucleus CAN is extremely portable. It can work on any target in loopback mode. Regardless of the underlying target, it provides the user with a uniform API. Currently, the hardware driver for Nucleus CAN exists on the following controllers:

- ❑ TouCAN
- ❑ MSCAN
- ❑ FlexCAN
- ❑ C167's CAN
- ❑ BF537's CAN

Nucleus CAN also provide a template and guide for porting hardware driver to a CAN controller.

Working with Nucleus Products

Nucleus CAN is the base for quite a few Nucleus products including Nucleus CANopen, Nucleus COM and Nucleus NM. These protocols/standard use Nucleus CAN at the data link layer and interface with it through a distinct interfacing layer. Thus Nucleus CAN may help the user to use various Nucleus products in its applications.

Requirements

Software Requirements

Nucleus CAN requires one of the following OSes:

- ❑ Nucleus PLUS 1.15 or higher
- ❑ Nucleus OSEK 2.0 or higher

Hardware Requirements

Nucleus CAN runs on any target in loopback mode. While using a hardware driver, it will need a CAN controller to be available on the target.

Memory Requirements

The actual memory requirements may vary a little bit depending upon the underlying OS and the configuration options chosen. Nucleus CAN may be adjusted as low as the following:

Operating System		ROM (Bytes)	RAM (Bytes)
Nucleus PLUS	Minimum Requirements	6 . 5k	324
	Maximum requirements	10 . 4k	324
Nucleus OSEK	Minimum Requirements	6k	436
	Maximum requirements	10k	436

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