

# Arinc 825 specification for CAN in airborne applications

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CAN increasingly found its way into aerospace applications because of its cost effective and efficient networking capability for LRUs (line replaceable units) that may share data across a common media. The ability of CAN to transmit data, across a shared shielded twisted pair cable, has advantages in terms of weight savings at the aircraft integration level. Additionally, the CAN physical layer protocol specification provides error recovery and protection mechanisms making it attractive to aviation applications. Newer commercial air transport aircraft such as the Airbus A380 or the Boeing 787 already accommodate between 50 and 250 CAN networks for all sorts of functions including flight deck systems, engine control and flight control systems.

While CAN components and technology have served the automotive industry well over the years, there are certain aspects that need to be adapted to the airborne environment. Specifically the CAN protocol requires definitions to control the priority and separation of message delivery across the network suitable to meet the needs of aerospace applications. At the airplane level there is a need to standardize aspects of the protocol at the system level to ensure interoperability across system and network domains. These needs were met first by the CANaerospace standard, which was established in 1998 and is widely

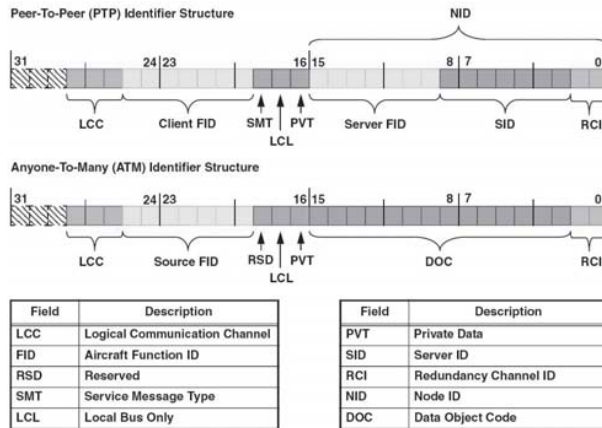


Fig. 1: Arinc 825 CAN-identifier structures

used within the general aviation world.

Commercial air transport aircraft are using a number of different networks favored by the various sub-systems vendors. Arising from significant problems trying to integrate systems based on differing CAN application layers, Airbus and Boeing teamed up and initiated the CAN Technical Working Group of the Airlines Electronic Engineering Committee to define the Arinc 825 standard. Both leading airframers identified CAN as an important baseline network for their future airplanes. The target of Arinc 825 is to en-

sure interoperability and to simplify interoperation of CAN sub-systems with other airborne networks for all classes of aircraft including the commercial air transport segment. The CAN Technical Working Group initially consisted of members from Airbus, Boeing, Rockwell Collins, GE Aerospace and Stock Flight Systems published the Arinc 825 specification in November 2007 with supplement 1 being released by December 2009. Arinc specifications may be obtained from [www.arinc.com](http://www.arinc.com).

Current commercial air transport aircraft system architectures have in-

corporated CAN as an ancillary sub-system to Arinc specification 664, part 7 (AFDX: avionics full duplex switched Ethernet), networking IMA (integrated modular avionics) architectures. For these aircraft, CAN has been used to link sensors, actuators and other types of avionics devices that typically require low to medium data transmission volumes during operation. In this role, CAN complements higher capacity networks that support systems controlling the flight deck information flow and presentation. In contrary, general aviation system architectures employ CAN as one of the major avionics networks or even as the avionics backbone network. In this role CAN may have to fulfill all requirements of a flight safety critical network. The Arinc 825 specification enhances CAN to create a network that embraces both philosophies. It may be used as a primary or ancillary avionics network and was designed to meet the following requirements:

- ◆ Easy connections of local CAN networks to other airplane networks ▶

Channel Number	Channel Acronym	Communication Type	Description	LCC Bits	Message Priority
0	EEC	ATM	Exception Event Channel	000	Highest
1			Reserved	001	↓
2	NOC	ATM	Normal Operation Channel	010	
3			Reserved	011	
4	NSC	PTP	Node Service Channel	100	
5	UDC	ATM/PTP	User-defined Channel	101	
6	TMC	PTP	Test and Maintenance Channel	110	
7	FMC	ATM/PTP	CAN Base Frame Migration Channel	111	

Fig. 2: Arinc 825 logical communication channel assignment

- ◆ Minimal cost of implementation and cost of change over time
- ◆ Maximum interoperability and interchangeability of CAN connected LRUs
- ◆ Configuration flexibility: Easy addition, deletion, and modification of network nodes, without undue impact to other LRUs
- ◆ Simplified system and network boundary crossing for both parametric and block data transfers
- ◆ Integrated error detection and error signaling
- ◆ Support for system level functions such as on-board data load and air-plane health management

### Technical background

To ensure interoperability and reliable communication, Arinc 825 specifies the electrical characteristics, network transceiver requirements and bit-rates with the corresponding tol-

bits not only for the data object identification and transmission prioritization inherent to CAN but also for the purpose of creating a standardized application layer. CAN communication using 11-bit identifiers may co-exist on an Arinc 825 system if it is free of potential deadlock scenarios caused by single source network masters. While this use is not encouraged for interoperability reasons, it permits the use of already existing equipment in certain applications.

The communication mechanisms of Arinc 825 are derived from the corresponding CANaerospace mechanisms. Just as CAN-aerospace, Arinc 825 defines additional ISO/OSI-layer 3, 4 and 6 functions to support logical communication channels, one-to-many/peer-to-peer communication and station addressing. To accomplish this, the 29-bit CAN-identifier is given a special structure for Arinc 825. Logical commu-

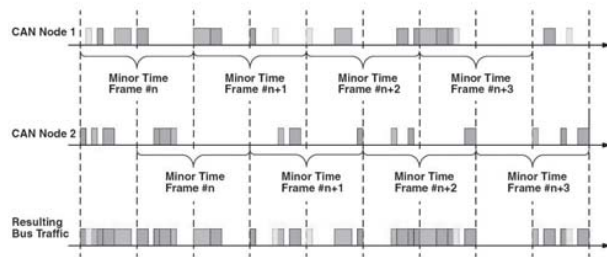


Fig. 3: Arinc 825 bandwidth management

erances. The bit-timing calculation (accuracy, sample point definition) and robustness to electromagnetic interference are given special emphasis. Also addressed within Arinc 825 are CAN connector and wiring considerations. The bit-rates supported by Arinc 825 are 1000 kbit/s, 500 kbit/s, 250 kbit/s, 125 kbit/s and 83,333 kbit/s.

Arinc 825 uses extended CAN-frames (29-bit CAN-identifiers), which provide an adequate number of bits to divide the identifier into several sub-fields. These sub-fields are a key issue in employing the identifier

communication channels (LCCs) provide these independent layers of communication.

To maximize interoperability in airborne systems, Arinc 825 includes:

- ◆ Data endian definition (big endian exclusively)
- ◆ Data type definition (boolean, integer, floating-point, etc.)
- ◆ Aeronautical axis system and sign convention (ISO 1151, EN 9300)
- ◆ Physical unit definitions (m, kg, etc.)
- ◆ Aircraft function definition (flight state, air data, etc.)

The aircraft function definitions used to identify source

CAN | CANopen | J1939

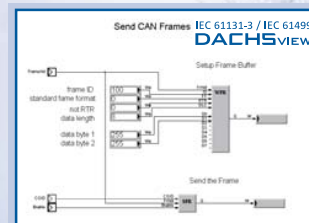
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and destination of messages are derived from the ATA (Air Transport Association) aircraft system chapters. This helps system engineers to assign the proper functions for their systems based on definitions well known in aeronautics since decades.

Arinc 825 adopted the CANaerospace bandwidth management concept. This concept provides a straightforward means of computing the busload based on the number of messages in a network segment and adjusting their transmission rates. Bandwidth management minimizes peak load scenarios and jitter caused by the CAN arbitration. Applying this concept, it can be demonstrated that Arinc 825 networks behave predictably and are able to fulfill the requirements for flight safety critical systems. Arinc 825 may be used for systems classified up to DAL (design assurance level) A if the effect of the loss of one network does not present a hazard exceeding the classification "major".

Arinc 825 uses a communication profile database

for the description of integrated networks. A communication profile is created for each LRU in a human-readable file format based on XML 1.0. The combination of all LRU communication profiles for a given network describes the entire network traffic and provides a valuable means for specification and verification of Arinc 825 networks. An analysis of the communication profile database allows detecting potential network problems at an early stage. Arinc 825 test tools must be able to read the communi-



Fig. 4: The Airbus A350 will be the first airplane to use Arinc 825

cation profile database and interpret network data accordingly.

Commercial air transport aircraft IMA system architectures use multiple networks with different characteristics, which have

to exchange data with each other using gateways. Typically, bandwidth and communication principles of the involved networks differ widely. To support the design of gateways between CAN and other networks, Arinc 825 specifies a gateway model and provides substantial information about protocol conversion, bandwidth management, data buffering and fault isolation.

The specification contains a large design guidelines section that helps system engineers and CAN

LRU designers to implement Arinc 825 properly and in a certifiable manner. This section is intended to document industry experience that led to the decisions in the specification. The guidelines are general network

design criteria to be considered when designing an Arinc 825 network; they are not requirements but rather the recommendations to avoid potential design traps a network designer may encounter.

## Outlook

The consistency and integrity of the Arinc 825 specification was continuously verified during the standardization process using a reference hardware/software system (see also [www.arinc825.com](http://www.arinc825.com)). The Airlines Electronic Engineering Committee decided that all other Arinc specifications using CAN (i.e. the Arinc 826 data load and Arinc 812 galley insert communication standards) shall be based on Arinc 825. Airbus Technical Design Directives already specify Arinc 825 for many systems of the new A350. CANaerospace continues to coexist with Arinc 825 as the "11-bit identifier alternative" and will provide enhanced Arinc 825 compatibility as of revision 1.8.

[www.arinc.com](http://www.arinc.com)  
[www.arinc825.com](http://www.arinc825.com)

The KE/KW servo converters from the German company AMK come optionally with sinusoidal current for supply and regeneration. Unfortunately, the country-specific power networks differ greatly: Voltages, impedances, and interference signals differ depending upon the external conditions. This calls for

The 8201N pressure sensor by Burster is suitable for liquid and gaseous media. The CANopen connectable sensor measures statically or dynamically pressure in the ranges from 0 bar to 5 bar or 0 bar to 1000 bar. The accuracy is specified as < 0,25 %. The devices are immune to shock loads and vibrations

## Servo regenerates power

systems that demonstrate a corresponding robustness towards the different networks.

The development engineers at AMK paid tribute to this trend and developed a supply module with sinusoidal supply and regeneration. The module generates

a robust DC link with harmonic supply current, which is particularly insusceptible to power network interferences. In addition to reducing interfering emissions, the regeneration of regenerative energy into the supply also results in significant savings of energy.

Furthermore, the voltage increase in the DC link allows for a higher speed and output of the drives. The servos use the CANopen-based ACC (Amkasyn CAN Bus Communication) network, which is not in all respects compliant to CiA 301 and CiA 402. (hz)

[www.amk-antriebe.de](http://www.amk-antriebe.de)

## Pressure transducer with CANopen

as they are constructed without moving parts. They have a small dead volume. Measuring element and transducer housing are made of one piece of stainless steel. This guarantees absolute impermeability and insensitivity against aggressive media. The measuring ele-

ment of the precision pressure transducer consists in a diaphragm. On its reverse side a strain gauge rosette is applied, which is an assembly of four active resistance strain gages arranged in a bridge circuit. The pressure measurement is effected against atmosphere

that means the space behind the diaphragm is connected to the surrounding air pressure via a small outlet in the housing. The surrounding atmosphere has to be clean and dry. The medium to be measured is led via the pressure port onto the diaphragm. (hz)

[www.burster.de](http://www.burster.de)