Introduction to CANaerospace

What is the Controller Area Network (CAN) ?

- Two-wire multi-transmitter serial data bus standard
- Designed by Bosch in 1983 as automotive network
- No central bus controller required
- Configurable data rate (83.3 kbit/s ... 1 Mbit/s)
- Maximum bus length at 1 Mbit/s: 40m (120 ft.)
- Data object oriented transmission based on message identifiers
- Broadcast transmission ensures network wide data consistency
- No overhead for bus arbitration
- Extremely low probability of undetected data corruption
- More than 500 million nodes installed to date
- Very low chip cost for controllers and transceivers (< $5 per node)
- Simple application programming (chip resident communication protocol)

The major characteristics of CAN

- Effective data rate max. 576 kBit/s (<= 40m bus length)
  -> adequate for most realtime control systems
- No overhead for bus arbitration, known response times even for high bus loads
  -> bus performance independant of number of participants
- Extremely low probability of undetected data corruption (~ $1*10^{-13}$ per transmission)
  -> suitable for safety critical applications
- Very low chip cost, easy and straightforward application programming
  -> even small systems can benefit from network technology

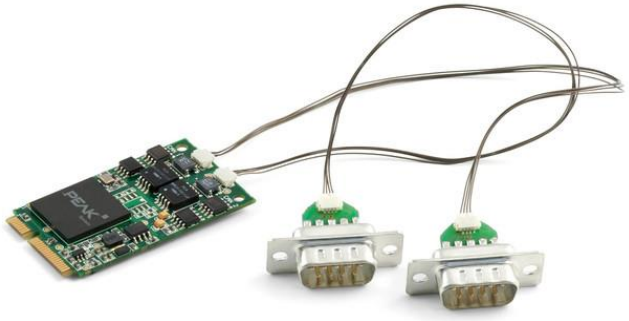
Due to these characteristics, CAN is used in several aircraft applications already and selected for many new aircraft:

- Grob Strato-2C High Altitude Research Aircraft: “throttle-by-wire” databus
- NH90 helicopter: Audio system intercommunication
- Airbus A340-600: Environmental control system databus, water&waste management
- Fairchild-Dornier 728JET: Primary/secondary flight control actuator databus, secondary power supply system intercommunication, smoke detection system databus
- A380: Environmental control system databus, cockpit cursor control device/MFD communication bus, electric power supply control databus, ...

CAN Hardware

CAN controllers and Microcontrollers with integrated CAN interfaces:

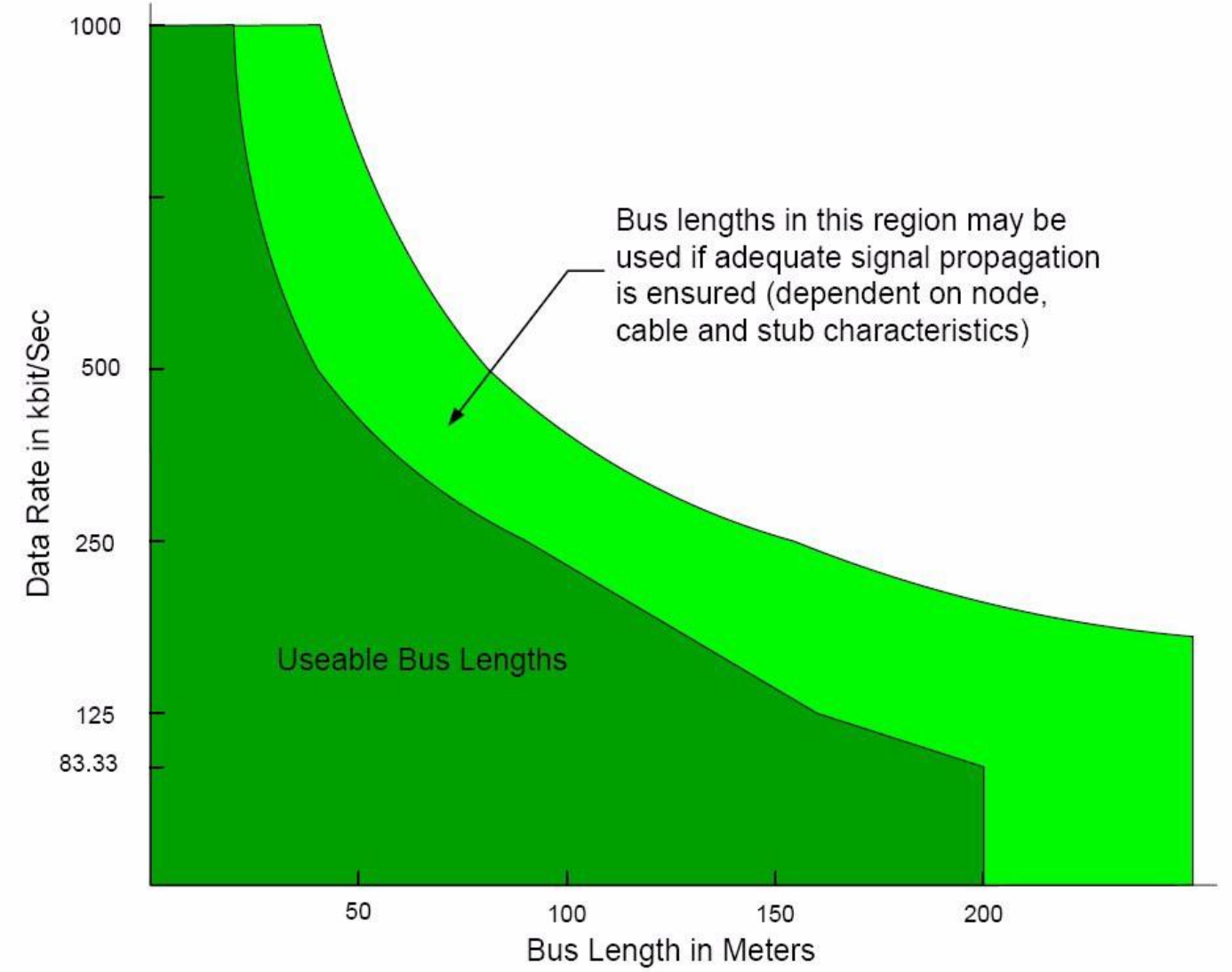
- Motorola
- Intel
- Philips
- Infineon
- Toshiba
- NEC
- Texas Instruments, ...



CAN boards for various bus systems:

- VME
- PCI/PMC
- ISA/EISA
- Sbus
- PC104/PC104+
- IP, M-modules, PC-MIP, ...

CAN Data Rate vs. Bus Length vs. Node Number



CAN Data Rate (Kbit/s)	Number of CAN Nodes (Typical Maximum)
1000	30
500	35
250	40
125	50
83.333	60

Typical Relationship between Maximum Number of CAN Nodes and Data Rate

Introduction to CANaerospace

CANaerospace is an extremely lightweight protocol/data format definition which was designed for the highly reliable communication of microcomputer-based systems in airborne applications via Controller Area Network (CAN).The purpose of this definition is to create a standard for applications requiring an efficient data flow monitoring and easy time-frame synchronisation within redundant systems. The definition is kept widely open to allow implementation of user-defined message types and protocols.

Based on experience in flight control and guidance systems, Stock Flight Systems created the CANaerospace interface definition back in 1997. CANaerospace is an open standard and may be used by anybody free of any charge. CANaerospace has also been standardized by the US National Air and Space Administration (NASA) as “AGATE data bus” in 2001 (document AGATE-WP01-001-DBSTD, Langley Research Center).

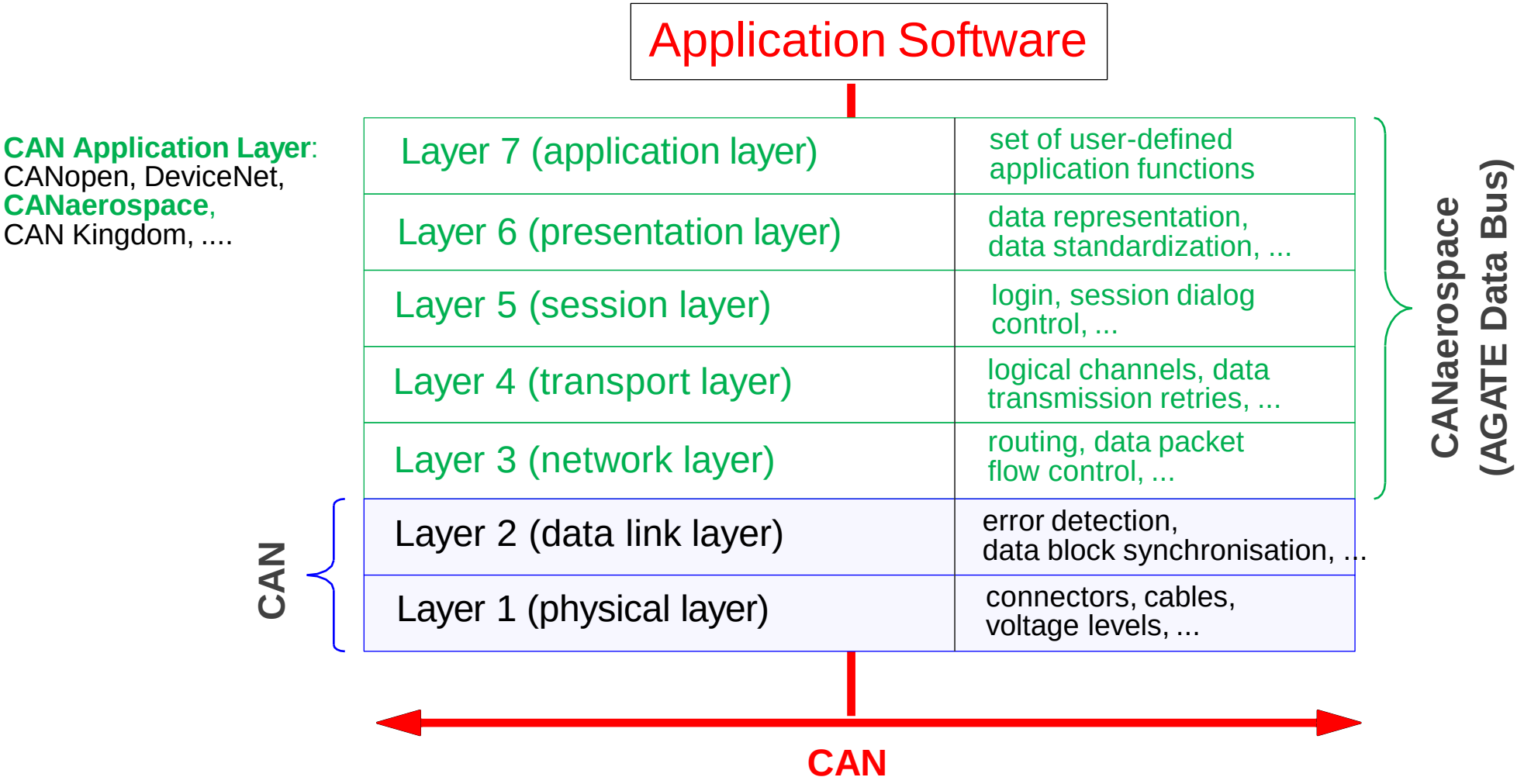
CANaerospace is used and supported by some major European aerospace companies (EADS, Eurocopter, Aero Vodochody, Rotax-Bombardier, Kayser-Threde, ...). For some flight critical systems of the Ae270 IBIS aircraft, it has been certified by the US Federal Aviation Administration (FAA).

CANaerospace is also the leading interface standard for flight simulator cockpits, driving flight simulation systems all over the world.

CANaerospace at a Glance

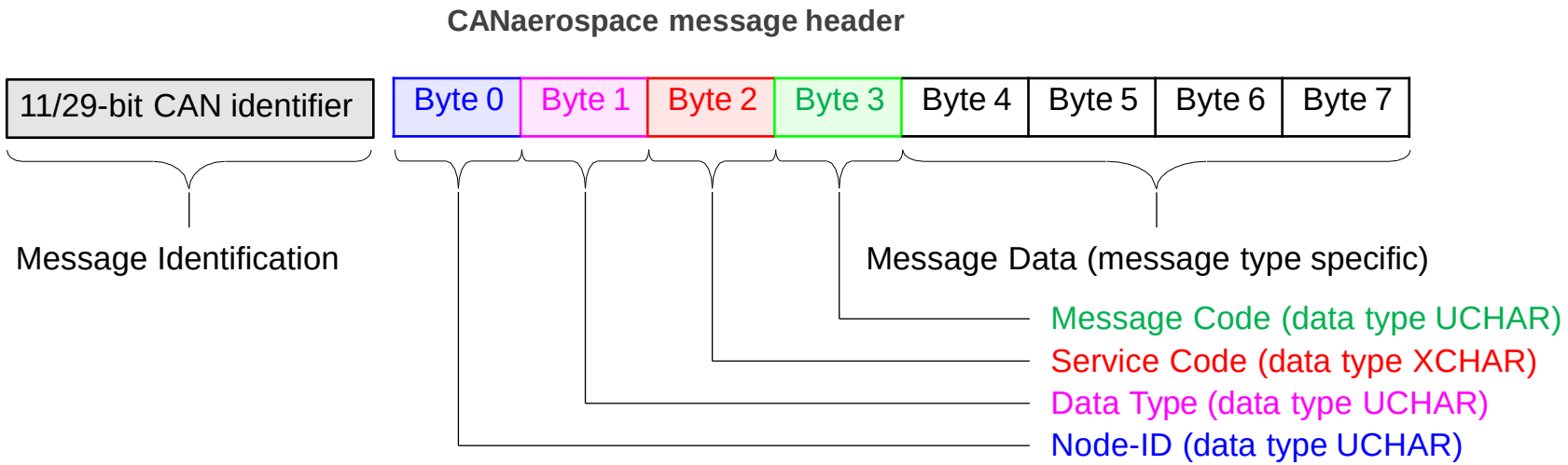
- **Democratic network:** No master/slave relationships for normal operation
- **Self-identifying message format:** Information about data type and transmitting station
- **Message numbering:** Support for coherent data processing in redundant systems
- **Message status code:** Continous integrity monitoring support
- **Emergency event signalling mechanism:** Information about CBIT detected failures
- **Node service mechanism:** Addressing of specific stations for integrity monitoring, data download, time synchronisation, ...
- **Identifier assignment:** Proposed default identifier distribution (similar to ARINC429)
- **Ease of implementation:** Reduction of work required for certification
- **Openness to extensions:** Minimum of fixed definitions to provide flexibility
- **Free availability:** No cost for use, free source code, free specification and tutorials

CANaerospace as Link between CAN and Application Software



CANaerospace Basic Message Format

- Node-ID (Byte 0): Some system architectures employ backup units which become active if the main unit fails. The Node-ID allows to immediately identify this situation and react accordingly (i.e. mode change within redundancy management).
- Data Type (Byte 1): CANaerospace supports multiple data types for every message. Backup units (or units from different vendors) may use different data types while performing identical functions. Specifying the data type with each message allows automatic system configuration, even during runtime.
- Service Code (Byte 2): For Normal Operation Data, this byte should continously reflect the status of the data (or the transmitting unit) to support data integrity monitoring within receiving units. With this information, the validity of data is known at any given time.
- Message Code (Byte 3): Message numbering allows to detect if messages are missing and if the transmitting unit is operating properly. Also, it can be used to compare the "age" of messages from redundant sources.



CANaerospace Identifier Range Definitions

Emergency Event Data	0 - 127	128 data objects
High Priority Node Service Data	128 - 199	72 data objects (36 com. channels)
High Priority User-Defined Data	200 - 299	100 data objects
Normal Operation Data	300 - 1799	1500 data objects
Low Priority User-Defined Data	1800 - 1899	100 data objects
Debug Service Data	1900 - 1999	100 data objects
Low Priority Node Service Data	2000 - 2031	32 data objects (16 com. channels)

CANaerospace Logical Communication Channels and Message Types

Highest Priority

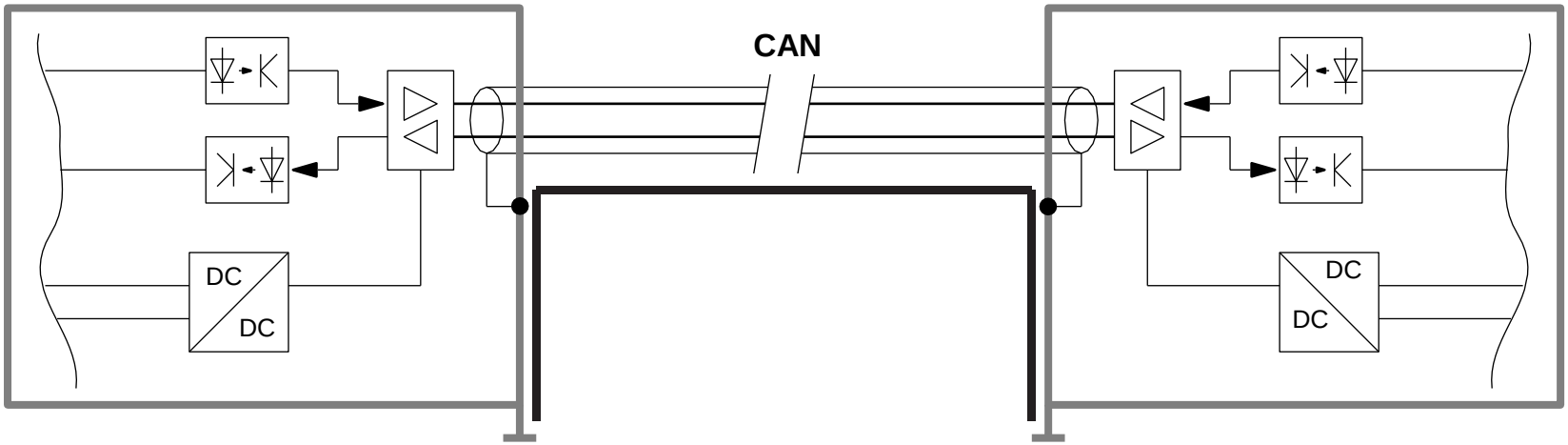
Lowest Priority

Logical Communication Channel Acronym	Logical Communication Channel Message Type	CAN Identifier Range	Description and Communication Type (ATM/PTP)
EED	Emergency Event Data	0 - 127 (128 Identifiers)	ATM messages transmitted asyn- chronously whenever a situation re- quiring immediate action occurs
NSH	Node Service Data (High Priority)	128 - 199 (72 Identifiers)	PTP messages transmitted asyn- chronously or cyclic with defined transmission intervals for operational commands (36 PTP channels)
UDH	User-Defined Data (High Priority)	200 - 299 (100 Identifiers)	ATM messages with user-defined message/data format and transmissi- on intervals
NOD	Normal Operation Data	300 - 1799 (1500 Identifiers)	ATM messages transmitted asyn- chronously or cyclic with defined transmission intervals for operational and status data
UDL	User-Defined Data (Low Priority)	1800 - 1899 (100 Identifiers)	ATM messages with user-defined message/data format and transmissi- on intervals
DSD	Debug Service Data	1900 - 1999 (100 Identifiers)	User-defined messages, transmitted asynchronously or cyclic for node specific debug communication ac- tions
NSL	Node Service Data (Low Priority)	2000 - 2031 (32 Identifiers)	PTP messages transmitted asyn- chronously or cyclic for test & mainte- nance actions (16 PTP channels)

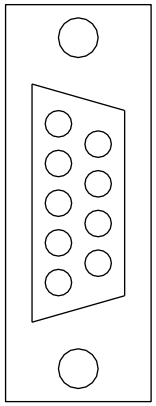
CANaerospace Default Identifier Distribution (examples)

CAN Identifier	System Parameter Name	Data Type	Units	Notes
317 ($13D)	Calibrated Airspeed	FLOAT SHORT2	m/s	
321 ($141)	Heading Angle	FLOAT SHORT2	deg	+/- 180°
401 ($191)	Roll Control Position	FLOAT SHORT2	%	Right: + Left: -
500-503 ($1F4-$1F7)	Engine #n N1 (1 < n < = 4) ECS Channel A	FLOAT SHORT2	1/min	N1 for Jet; RPM for piston engines
1008 ($42E)	Active NAV System Track Error Angle (TKE)	FLOAT SHORT2	deg	Service code field contains waypoint #
1070 ($42E)	Radio Height	FLOAT SHORT2	m	
1205 ($4B5)	Lateral Center of Gravity	FLOAT SHORT2	% MAC	

CANaerospace proposal for the physical interface

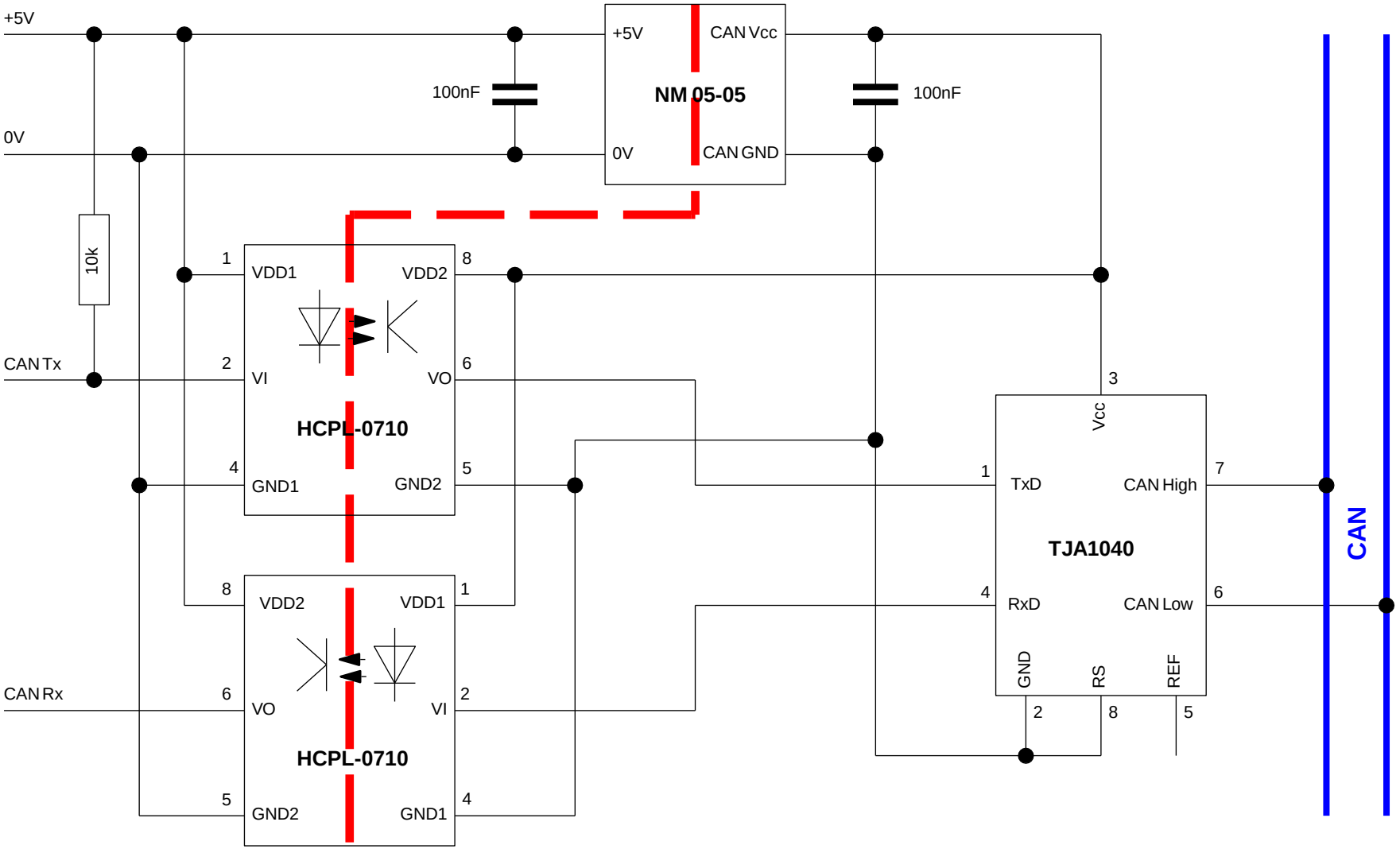


Power +28VDC	**1**	6	RS-232 RxD (maintenance/service)
CAN Low	**2**	**7**	**CAN High**
unused	3	8	unused
RS-232 TxD (maintenance/service)	4	9	RS-232 Gnd (maintenance/service)
Power Gnd	**5**		

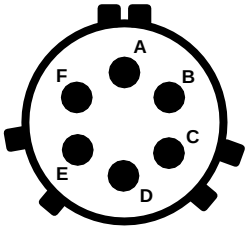


MIL-24308/8 CANaerospace connector

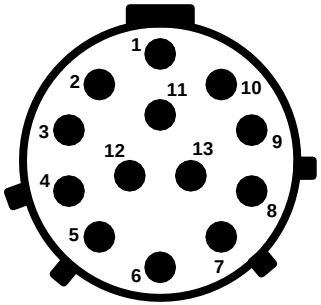
CANaerospace proposal for the physical interface (contd.)



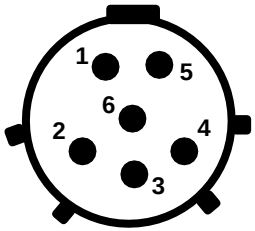
CANaerospace proposal for MIL-C-26482 and MIL-C-38999 connectors



MS3476L1006SN



D38999/26FB35SN



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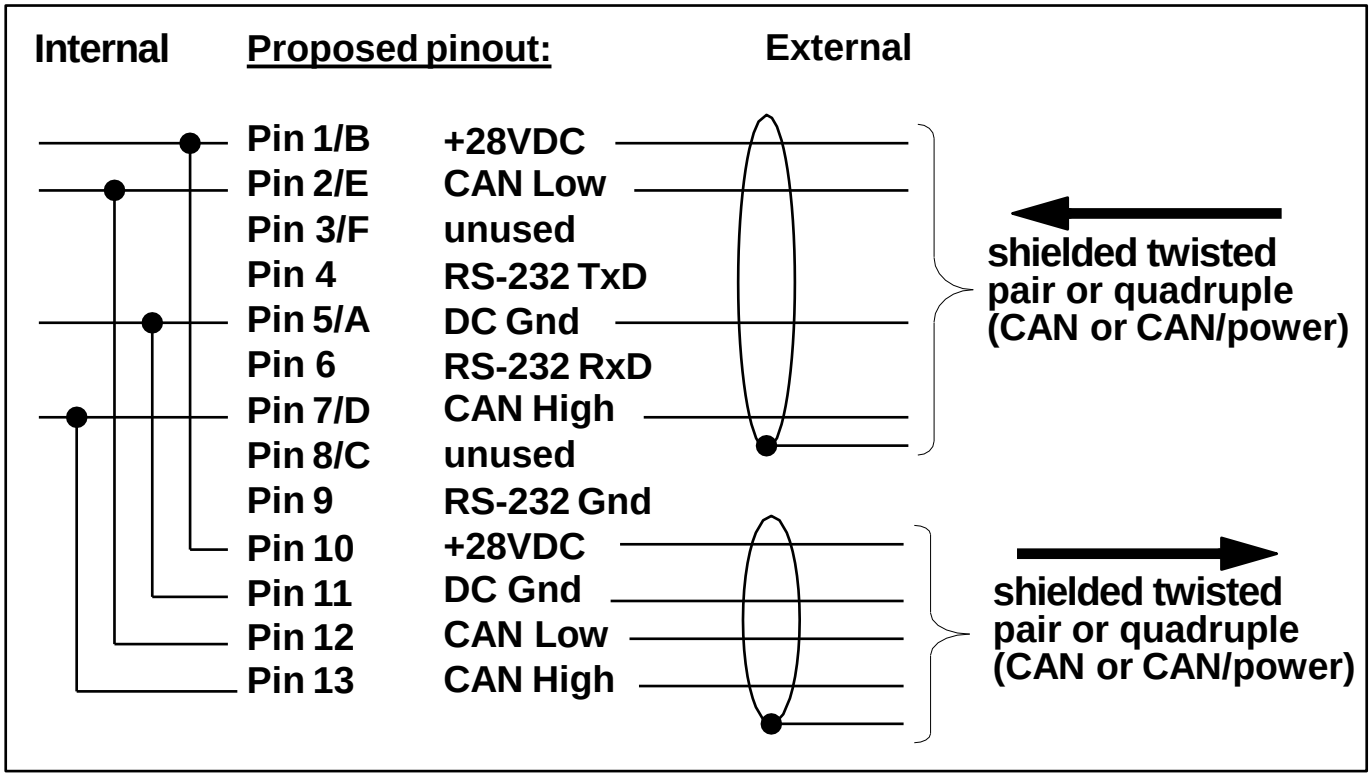

Example for suitable CANaerospace cables

U.I. Lapp GmbH	PRODUCT INFORMATION	LAPP GROUP
	UNITRONIC® BUS CAN	07.11.2014

LAPP KABEL STUTTGART UNITRONIC® BUS CAN

CANopen cULus RoHS

- Automation
- Halogen-free
- Industrial machinery and plant engineering
- Power chain
- UV-resistant

Info
CAN = Controller Area Network

Application range
Fixed installation

Product Make-up
0.22 + 0.34 + 0.5: bare stranded conductor, 7-wire
0.75: bare stranded conductor, fine-wire
Colour-coded in accordance with DIN 47100
Copper braid
PVC sheath
Colour: violet (RAL 4001)

Norm references / Approvals
Standardised internationally in ISO 11898
UL/CSA type CMX (UL 444)

Product features
Maximum bit rate: 1 Mbit/s for 40 m
segment length
Larger conductor cross-section is necessary with increasing length. Refer to the table below (reference values from ISO 11898).
ISO 11898 makes recommendations for the segment length, cable cross section and bit rate
Flame-retardant according IEC 60332-1-2

Product Management	Document: LAPP_PRO275EN.pdf	1 / 3

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System components in 24-48 hours

Advantages of chainflex bus cable - CAN bus:

chainflex CAN bus are cables for energy chains. The CAN bus cables are tested in e-chains® with many million cycles. The selection includes PVC CAN Bus cables, PUR CAN Bus cables and TPE CAN Bus cables. The chainflex® CAN Bus cables have various certifications and compliances, such as UL, CSA, NFPA-79-2012, EAC and CTP. The CAN bus cables can be used for high speeds and accelerations. chainflex® bus cables are also available as Profibus cable, Interbus cable, Device Net cable, CC Link cable, Ethernet cable, Cat5 cable, Cat6A cable, GigE cable, Profinet cable, FireWire cable, USB cable, ASI Bus cable and DVI cable.

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