RUAG

SAVOIR

space avionics open interface architecture

RS422 Communication Protocol Standardisation

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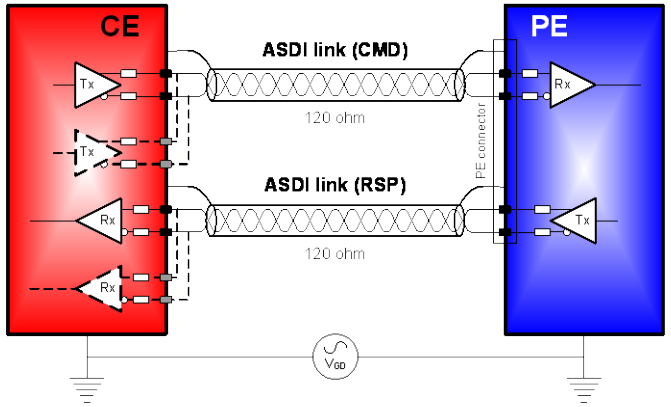
UART protocol study

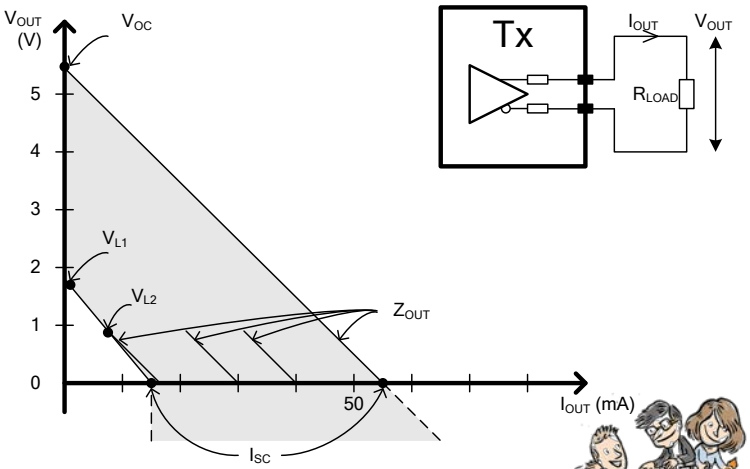
- Objective to define physical and data link layer requirements as input to an update of the ECSS-E-ST-50-14C standard
- Study performed by RUAG and TERMA
- Started Feb 2013, end May 2014
- Tasks performed:
  - Survey of existing protocols and collection of user requirements
  - Preparation of physical and data link layer requirements, including test bench definition
  - Test bench manufacturing and requirements verifications
- User needs survey performed and user requirements and draft physical and data link layer requirements distributed to the survey responders interested in following the work.

UART physical layer

- Based on ECSS-E-ST-50-14C terms and clause 8.8 physical layer:
  - Relaxed impedance matching and ground displacement voltage requirements (±1 V)
  - Drive current characteristics more detailed
  - Up to 16 m cable
  - Recommend to use a 9-pin connector at PE side
  - Optional cross-strapping at CE side to simplify sensor/actuator design



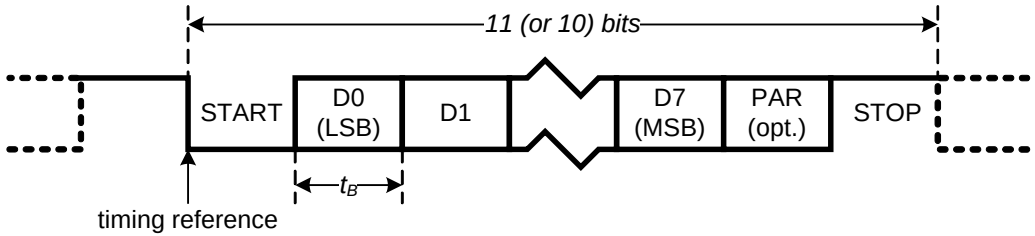
CE = Core Element
PE = Peripheral Element
ASDI = Asynchronous Serial Digital Interface

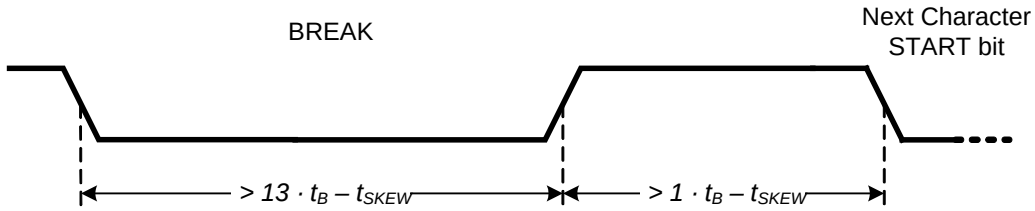


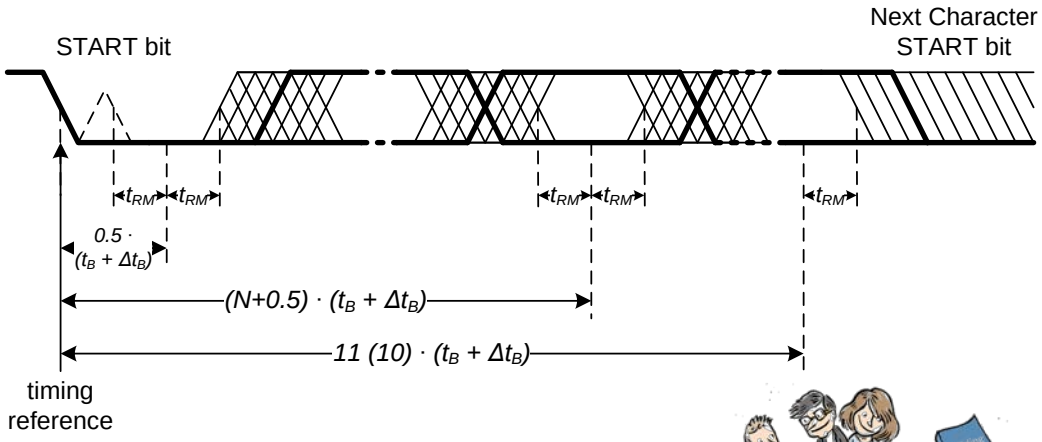
UART character layer
(part of data link layer)

- Characters and BREAK defined.
- Even parity recommended
- Baud rates of 19,2k, 115,2k and 460,8k recommended. 9,6k, 38,4k, 57,6k and 230,4k allowed

- Baud rate tolerances, start bit transients, skew, signal transition oscillations and receiver margins defined in detail

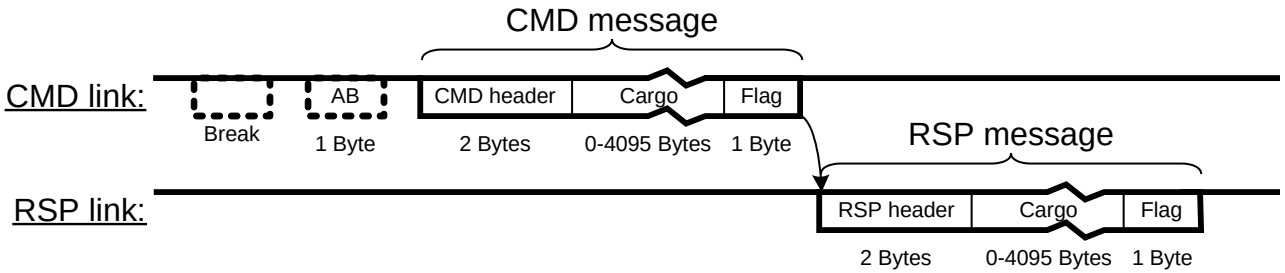


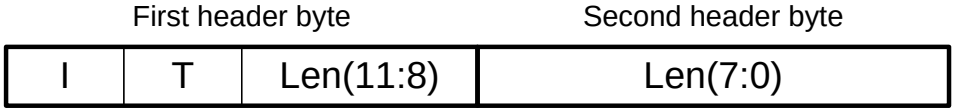




UART frame layer
(part of data link layer)

- Master/slave communication
- Delimited by header and end flag (FE_H)
- BREAK used as communication synchronisation





I = Instruction/information code

	CMD	RSP
00:	Command	Normal response
01:	Not used	Error response
10:	Reserved	Reserved
11:	Reserved	Reserved

T = Transaction ID, copied from CMD to RSP

Master/Slave protocol

- Note that the protocol is a Master/Slave protocol, and in the SAVOIR context it will be managed by the RTU

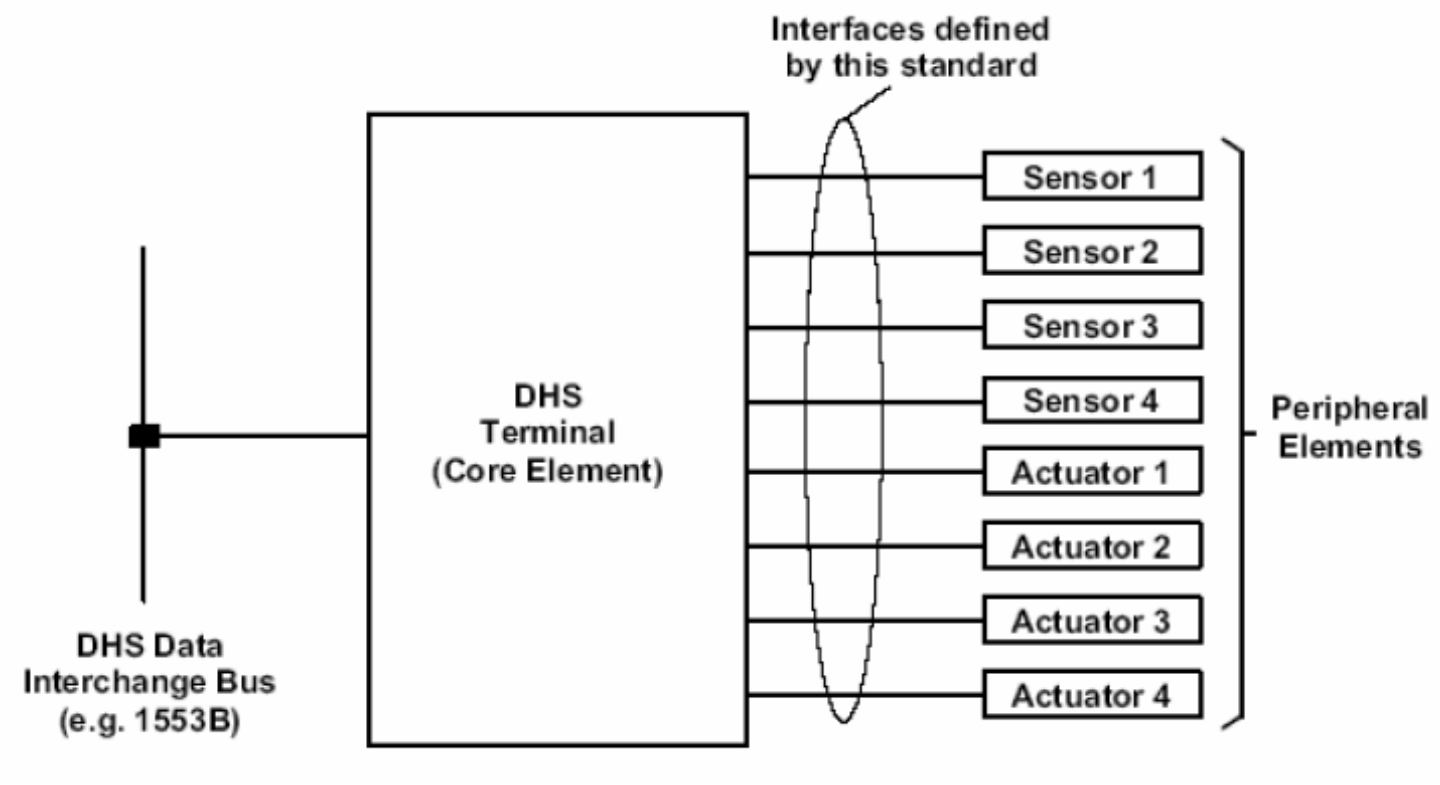


Figure 4-1 from ECSS-E-ST-50-14C

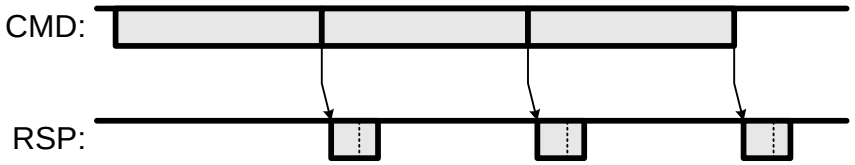
UART frame layer - upper layer interface

- The CE Frame Layer interface to upper layer includes the following:
  - Cargo of CMD messages for transmission
  - Transaction ID for transmission
  - Cargo of RSP messages received
  - Received Transaction ID
  - Frame Layer RSP error events
  - Command communication synchronisation (BREAK)
  - Command AB Sequence (including BREAK)
  - Command AB Character only
- The PE Frame Layer interface to upper layer includes the following:
  - Cargo of CMD messages received
  - Cargo of RSP messages for transmission
  - Frame Layer CMD error events

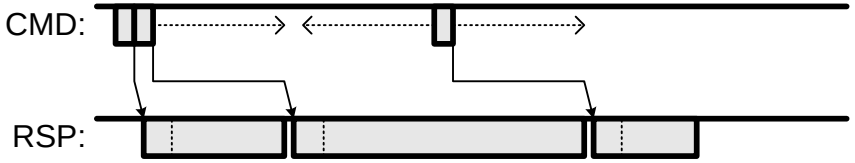
UART frame layer options

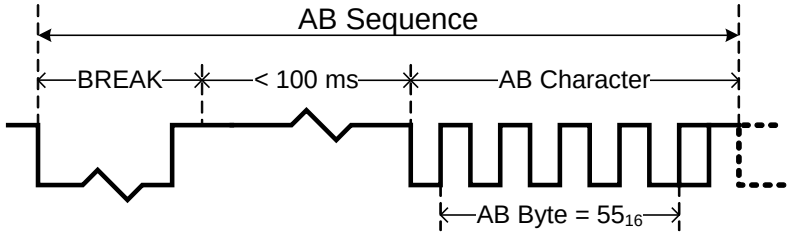
- Pipe-lining allows full bandwidth utilisation with relaxed timing constraints for instance when loading or dumping PE memory
- Future protocol extensions using the reserved I-field values 10_B and 11_B are e.g.:
  - Addressing multiple PEs on a single RS-485 link
  - Adding data field headers
- Auto-baud function using BREAK + 55_H character allows for simple oscillators in the PE

Load memory:



Dump memory:

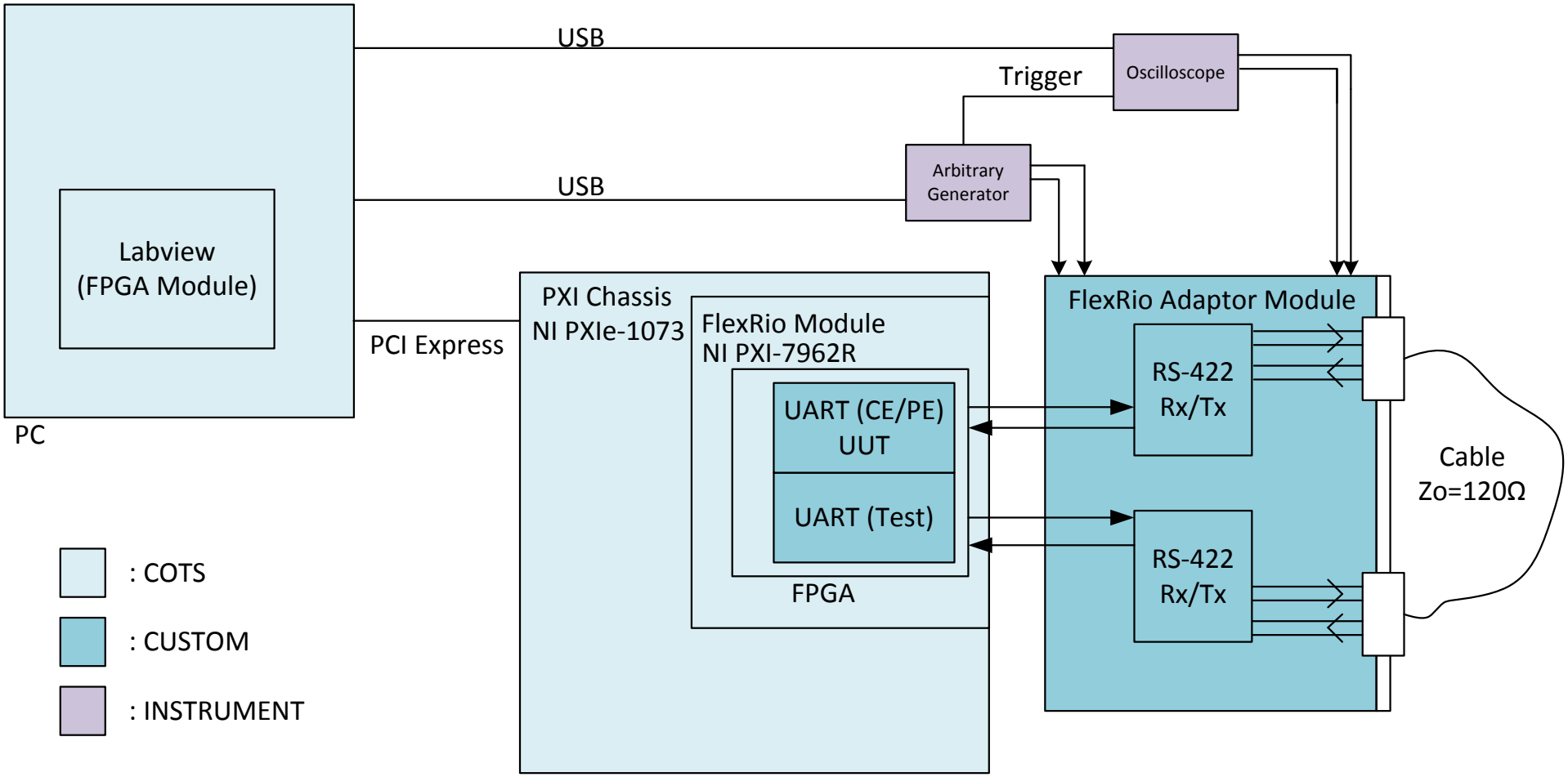




Verification

- Performed by analysis and test
- By analysis:
  - Failure propagation
  - Interface Timing margins
    - Baud rate, BREAK, Autobaud, bit jitter, FPGA utilisation
- By test:
  - Tx electrical characteristics (voltages, currents, rise/fall time)
  - Rx electrical characteristics (voltages, currents)
  - Tx bit skew at different baud rates (9600 – 460800)
  - Rx bit skew tolerance at different baud rates
  - Autobaud timing skew
  - Character and Frame layer protocols incl. error injection

Test bench



Test bench

Contact

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