

CAN in Space Workshop

June 2019

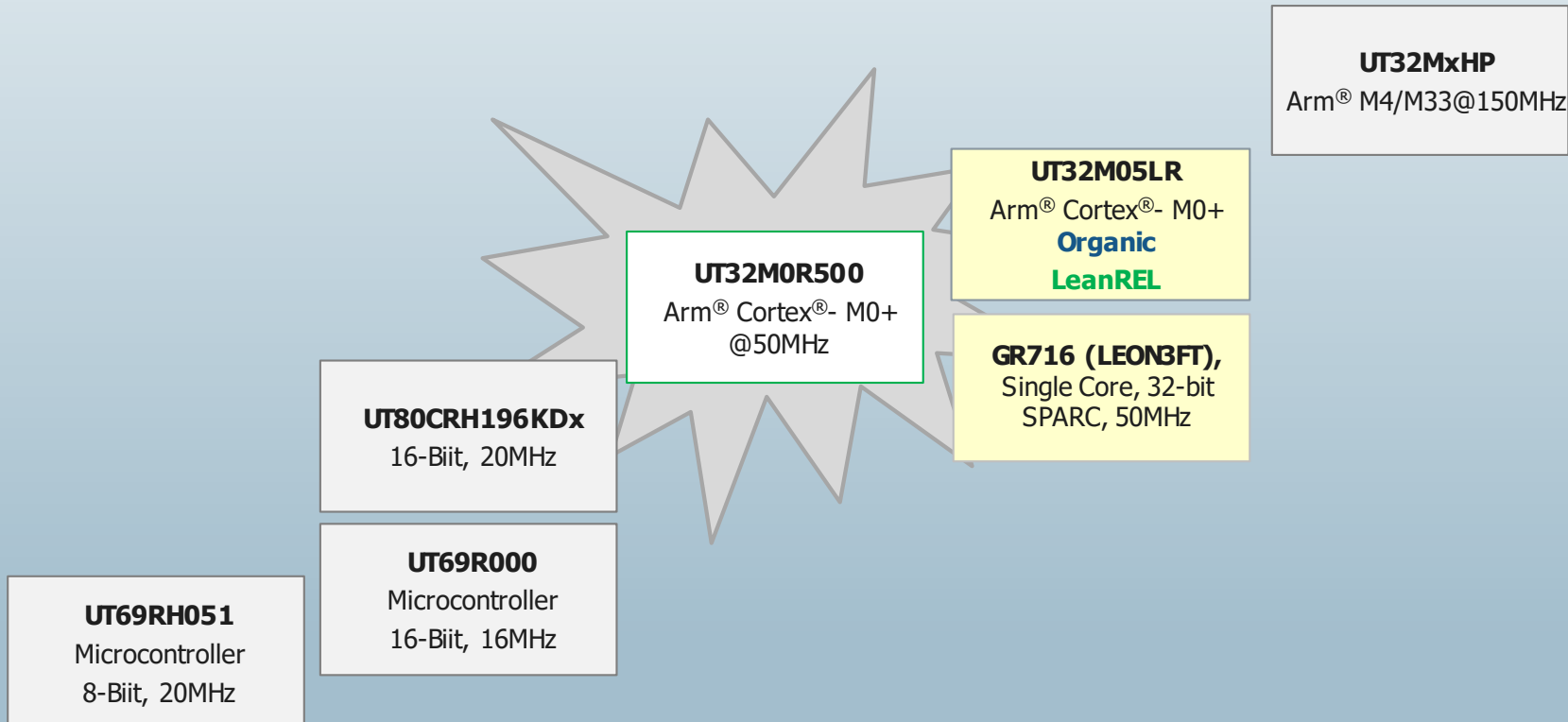
Presenter: Armand Dilworth
Semiconductor and Space Solutions

Agenda

- 
- *Microcontroller Heritage*
 - *UT32M0R500 Overview*
 - *Cobham CAN Eco System*
 - *Cobham CAN Architecture*

MCU Heritage

| Product Family | 2004~2008 | | | | 2018 | | | | 2019 | | | | 2020 | | | | 2021 | | | | 2022 | | | |
|----------------|-----------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |



UT32M0R500 Overview

Microcontroller Overview

Modern System on a Chip Designed for Space

**Processor
Core**

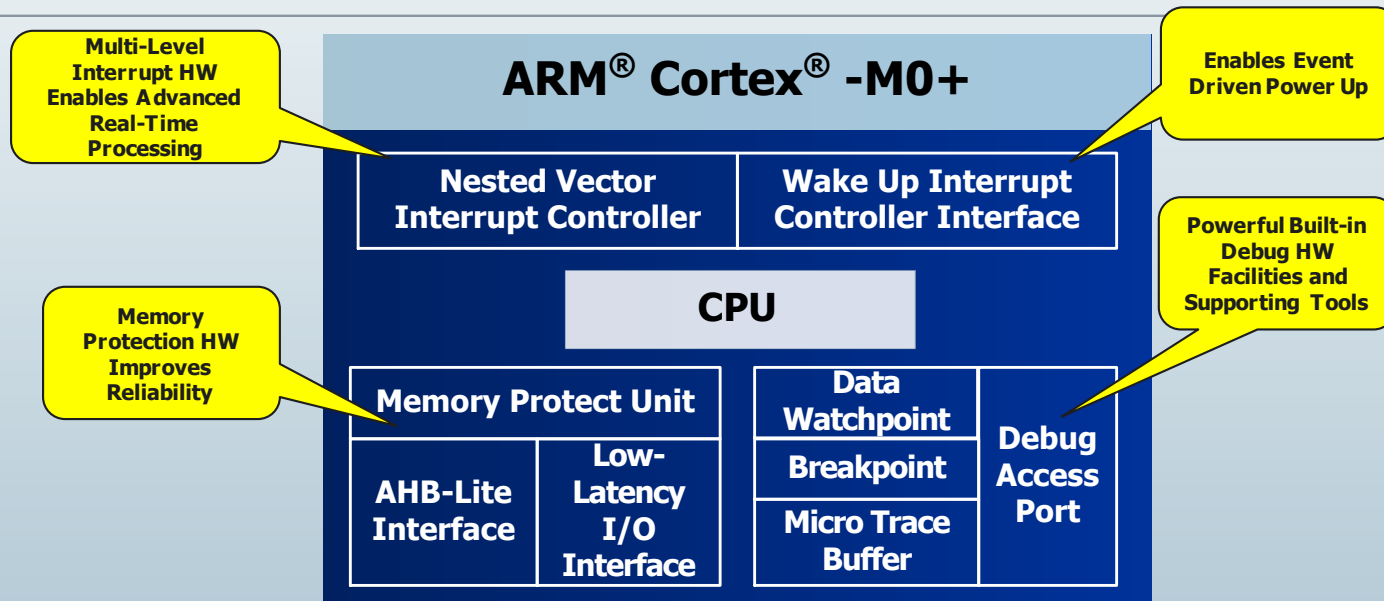
**Non Volatile
Memory**

**Analog
Peripherals**

**Digital and
Communication
Peripherals**

Processor Core

ARM® Cortex® M0+

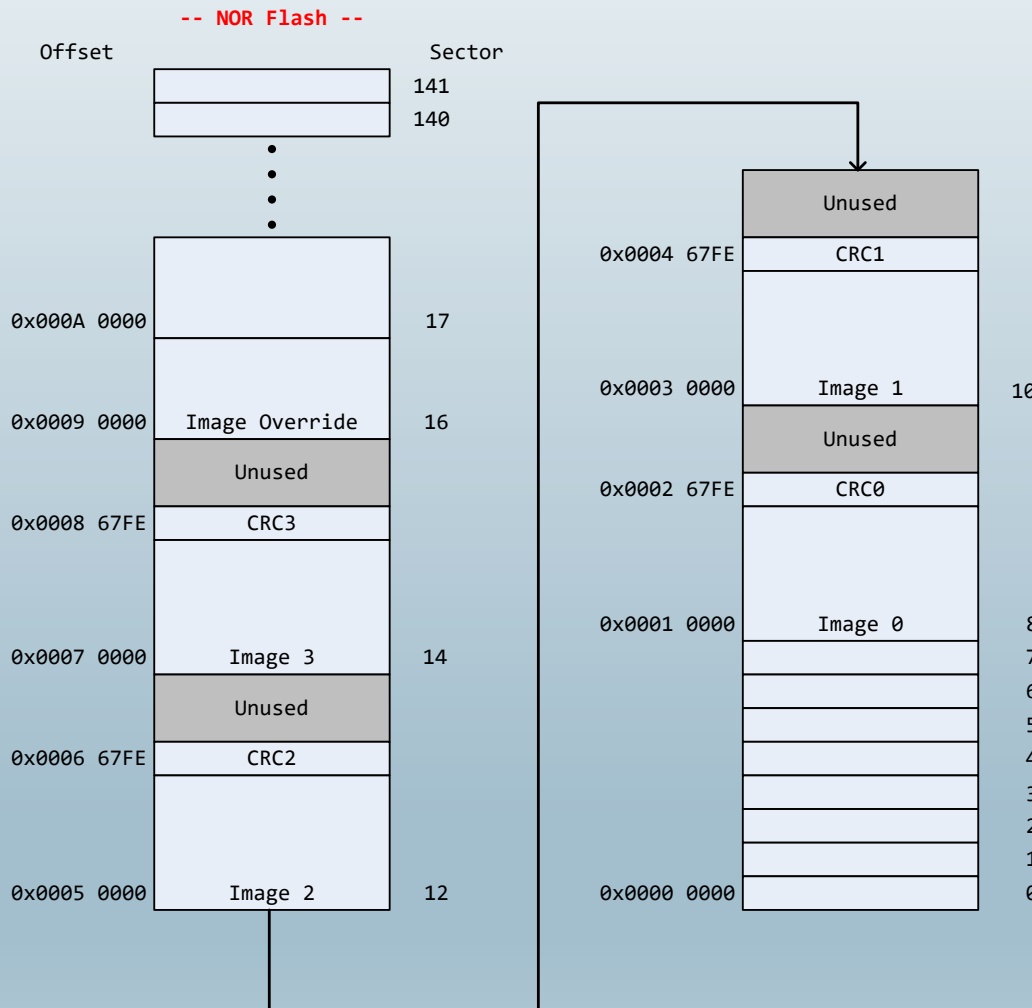


ARM's Leading Edge, Low Power Processor with Rich Development Environment

- Proven Processor Design Shipped in 100's of Millions of Units
- Compact Thumb-2 Instruction Set
- Broad Set of Development Tools with Support from Multiple Vendors: Keil Development Tools
- Debug HW is Integrated in M0+ Processor (Break points, watch points, trace buffer, stop/start)
- JTAG Debug Interface to External PC Tools which Access M0+ Debug HW

Non Volatile Memory

NOR Flash Memory Map



- **On-Chip** 64 Mb MCM Flash Non-volatile Memory – same die as UT8QNF8M8
- Dedicated memory address locations for four images, each 92KB.
- Power Up Memory on Demand
- 10% Duty Cycle to meet 50KRad (Si).

Mixed Signal Functions

- 16:1 Analog Mux, PGA, 12-b Analog-to-Digital Converter
- Precision Current Source – 1 mA Typical
- 2x Digital-to-Analog Converter (12-bit)
- 2x Analog Voltage Comparator
- On-chip Temperature Sensor
 - This is available as the “17th” input of the analog-digital conversion chain

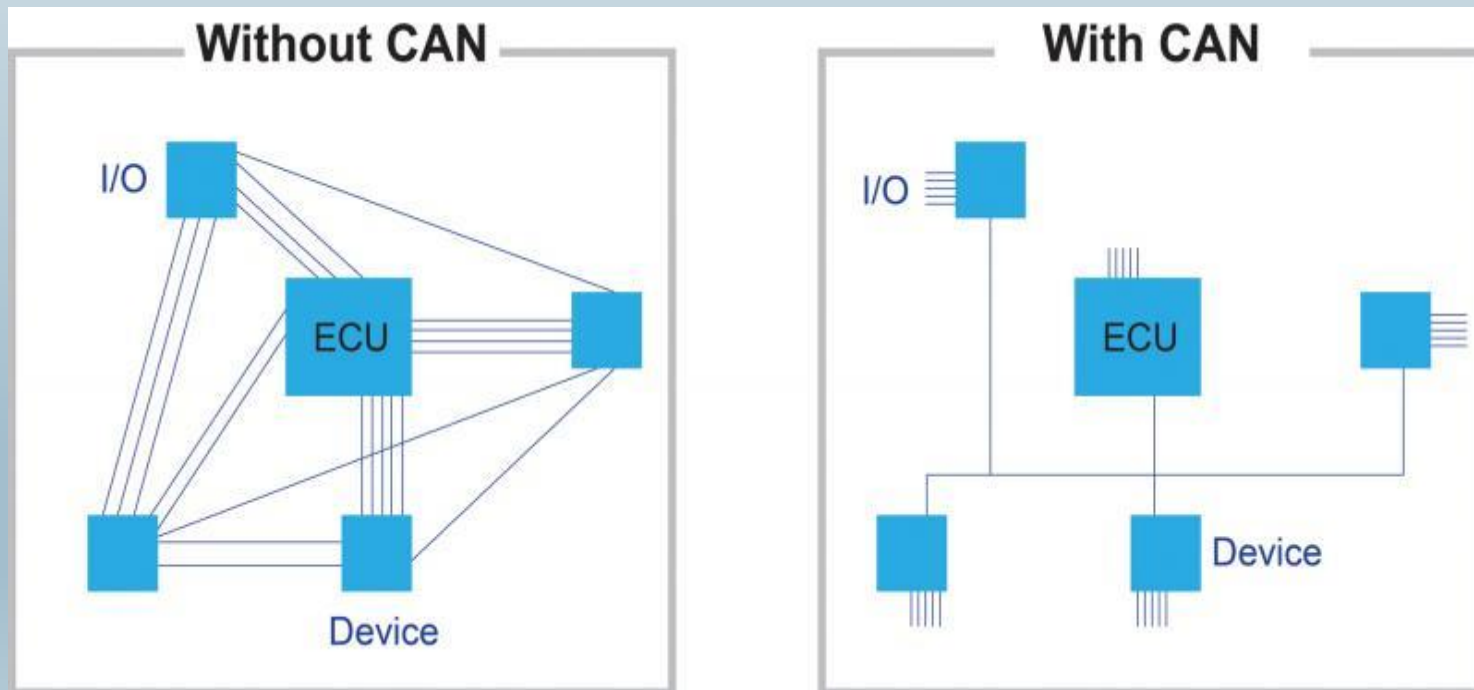
- 2x CAN 2.0B Controller
- 2x UART
- SPI
- 2x I2C Interface
- JTAG
- 8x Hardware Interrupt (4 dedicated pins/4 shared with GPIO)
- 48x GPIO (21 Dedicated)
- 4x General purpose timers
- 3x Pulse Width Modulator
- Watchdog Timer

- CAN provides simple two wire interface with external devices
- UT32M0R500 CAN controller based on Gaisler IP
 - Which is based on the Philips SJA1000 CAN Controller
 - SJA1000 can be used for supplemental documentation
- Two CAN peripherals included in the UT32M0R500
 - Independent of each other
- Compatible with CAN 2.0A (BasiCAN) and 2.0B (PeliCAN)
- Supports bit rate up to 1 Mbps
 - For exactly 1 Mbps will need to run with external clock at 48 MHz
- Support single and dual (PeliCAN only) filter modes
- Operationally tested with our CANFD Transceiver

Digital and Communication Peripherals

CAN Advantage

- Employing a CAN bus communications network in satellites enables much lower power consumption and reduces the amount of wiring and connectors vs. the conventional MIL-STD-1553 and RS-485 point-to-point interface solutions.
- Below shows the comparison between a conventional topology vs. the CAN two-wire broadcast topology. With CAN, several nodes are attached to a single bus. This significantly reduces system and cable costs.



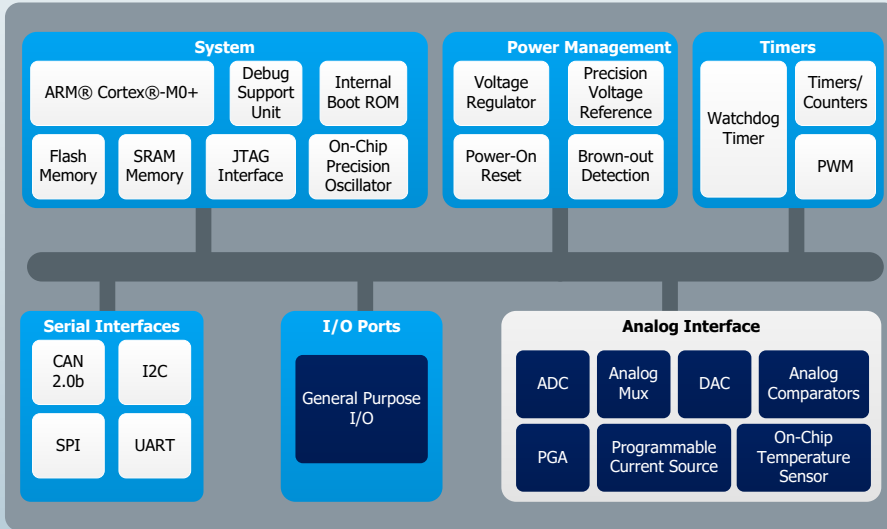
UT32M0R500

32-bit Arm® Cortex®-M0+ Microcontroller

COBHAM



| | |
|-----------|------------|
| Samples | Production |
| Available | Dec 2018 |



• Dev Support

- Keil Development Tool Environment
- API Library w/ source code examples
- UT32M0R500-EVB Development Board



| | |
|--------------------------------|--|
| Part Number | UT32M0R500 |
| SMD# | 502-17212 |
| Processor | 32-bit Arm® Cortex®M0+ @ 50MHz |
| Memory | 64KB Flash (integrated) |
| Supply Voltage | +3.3V |
| Analog | <ul style="list-style-type: none"> • 12-bit ADC w/ PGA and Mux • Precision Current Source • Two DACs • Two Comparators • Timers • PWMs |
| Interfaces | <ul style="list-style-type: none"> • Two CAN 20B • 2x I2C, 2x SPI, 48x GPIO, 2x UART, JTAG, WDT |
| Process Technology | 130nm (LP) BMC |
| Typical Power | 300mW |
| Package | 143 pin CLGA, CPGA, CCPA options 145 x 145mm, 1mm pitch |
| Operational Environment | |
| Temp Range: | -55°C to 105°C |
| UID: | 50 kbit (1) |
| SE Immune: | ≤ 80 MeVcm²/mg @105°C |
| Qualifications | QML-Q, Q and LeanREL™ |

UT32M0R500

- 32-bit Arm® Cortex®-M0+ Microcontroller

- *Space VPX Chassis Management*
- *CAN Bus Controller*
- *Telemetry/System Health Monitoring*
- *Distributed Command and Control*
- *Data Acquisition Manager*
- *FPGA Scrubber*
- *FPGA Power Management*
- *RF Signal Chain Management*
- *Many others...*

*Over a Dozen Design WINS and Counting...
From SmallSats to Military Defense*



Product Matrix Overview



Arm® Microcontrollers

| Feature | UF32M0R500 | 100krad | FBGA |
|--------------------------------|--|--|--|
| Processor | 32-bit Arm® Cortex® M0+ Microcontroller @ 50MHz | 32-bit Arm® Cortex® M0+ Microcontroller @ 50MHz | 32-bit Arm® Cortex® M0+ Microcontroller @ 50MHz |
| Memory | 512KB dual port SRAM | 512KB dual port SRAM | 512KB dual port SRAM |
| | 64Mb Flash (integrated) | 64Mb Flash SNOIS (integrated) | 64Mb Flash SNOIS (integrated) |
| Analog | 12-bit ADC w/ PGA Mux Precision Current Source Two DACs Two Comparators Timers PWMs | 12-bit ADC w/ PGA Mux Precision Current Source Two DACs Two Comparators Timers PWMs | 12-bit ADC w/ PGA Mux Precision Current Source Two DACs Two Comparators Timers PWMs |
| Peripheral Interfaces | Two CAN2.0B 2 I2C, 2 SPI, 48 GPIO, 2 UART, JTAG, WDT | Two CAN2.0B 2 I2C, 2 SPI, 48 GPIO, 2 UART, JTAG, WDT | Two CAN2.0B 2 I2C, 2 SPI, 48 GPIO, 2 UART, JTAG, WDT |
| Power | <300mW | <300mW | 300mW |
| Supply Voltage | 3.3V | 3.3V | 3.3V |
| Package | 143-pin CGA, CBA, CCA 145 x 145mm, 1mm pitch | 143-pin CGA, CBA, CCA 145 x 145mm, 1mm pitch | 14-Plastic BGA 145 x 145mm, 1mm pitch |
| Operational Environment | | | |
| Temp Range: | -55°C to 105°C | -40°C to 105°C | -40°C to 105°C |
| TD: | 50 krad (Si) @ 10% power-on for NOR Flash | 100krad (S) | 50 krad (Si) @ 10% power-on for NOR Flash |
| SEL: | 80 MeVcm ² /mg @105°C | 80 MeVcm ² /mg @105°C | 80 MeVcm ² /mg @105°C |
| Qualifications | QML-Q, Q | QML-Q, Q, V | leanREL™ |

Cobham CAN Eco System

Single Core Microprocessors with CAN

Product Details: LEON Microprocessors

| Samples | Production |
|-----------|------------|
| Available | NDW |

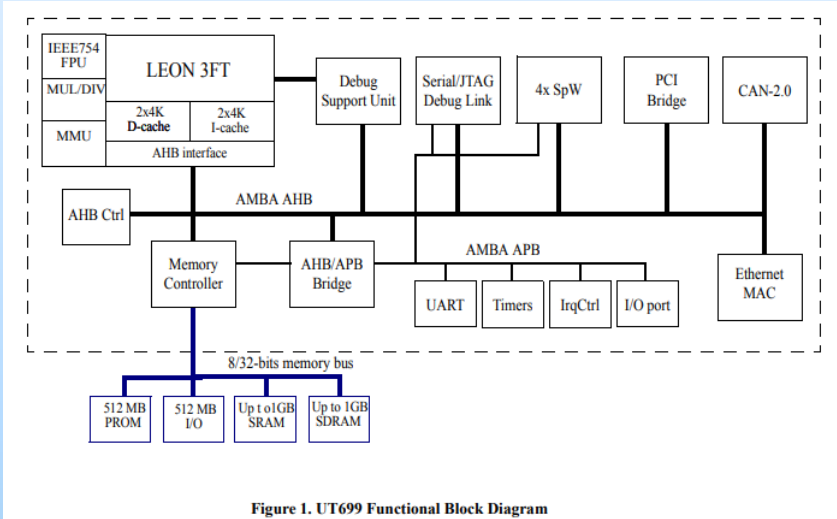


Figure 1. UT699 Functional Block Diagram

Target Applications

Ideal for processing solutions for markets such as spacecraft on-board computers and payload processing, nuclear power plant controls, critical transportation systems, high-altitude avionics, medical electronics and x-ray cargo scanning

| Part Number | UT699 | UT699E | UT700 |
|--------------------------------|--|--|---|
| SMD# | 552-08288 | 552-13237 | 552-13238 |
| Processor | LEON3FT | LEON3FT | LEON3FT |
| | 32-bit SPARC V8 | | |
| Clock Frequency | 66MHz | 100MHz | 166MHz |
| DMIPS/Core | 2 | 140 | 230 |
| Cache ID | 8/8 | 16/16 | 16/16 |
| MMU | Yes | | |
| SpaceWire | 2 x DMA 2 x DMA/RMAP | 4 x DMA/RMAP | 4 x DMA/RMAP |
| Interfaces | <ul style="list-style-type: none"> Two CAN One PCI | <ul style="list-style-type: none"> Two CAN One PCI | <ul style="list-style-type: none"> SPI Two CAN One PCI 1553 |
| Process Technology | 250nm | 130nm | 130nm |
| Package | 352-lead P 484 GA, CA | 484 GA, CA | 484 GA, CA |
| Operational Environment | | | |
| Temp Range: | -55C to 105C | | |
| TD: | 100 kad(Si) | | |
| SEL: | ≤108 MeVcm ² /mg | ≤110 MeVcm ² /mg | ≤110 MeVcm ² /mg |
| Qualifications | QML-Q, V | | |

CAN Transceivers

Multiple Modes

| Samples | Production |
|---------|------------|
| | Shipping |

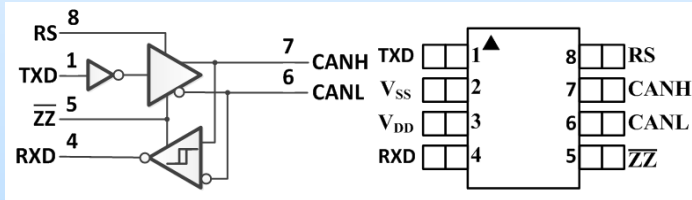


Figure 1: Sleep Mode

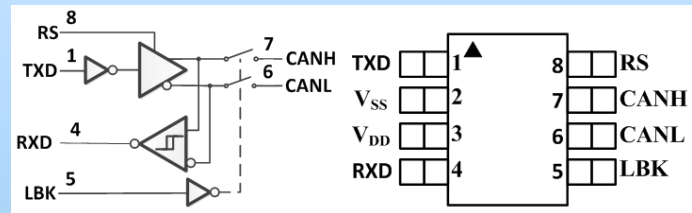


Figure 2: Diagnostic Loopback

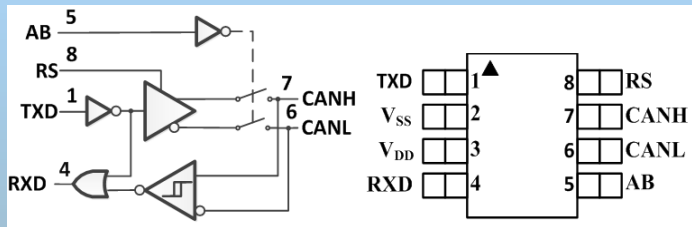


Figure 3: Auto-baud Loopback

Die sales are supported

LeanREL will be supported

| Part Number | UT64CAN3330 | UT64CAN3331 | UT64CAN3332 |
|--------------------------------|---|-------------|-------------|
| SMD# | 962-15232 | 962-15232 | 962-15232 |
| Supply Voltage | +3.3V | +3.3V | +3.3V |
| Digital I/O | +3V (5V Tolerant) | | |
| Baud Rate | 1Kbps to 8Mbps | | |
| Package | 8lead IP | | |
| Operational Environment | | | |
| Temp Range: | 55°C to +125°C | | |
| TD: | 10 kad(Si) | | |
| SEL: | IET <= 141 M ² V-cm ² /mg | | |
| Qualifications | QML-Q, V | | |

Target Applications

- Avionic/Aerospace sensor monitoring
- Avionic/Aerospace system telemetry
- Avionic/Aerospace command and control
- Utility Plane Communication
- Smart Sensor Communication
- ARINC825 Applications
- Time Triggered (TTP/C and TTP/A) Applications

Existing Solutions

EMS Standard SBC Products

- Command/Control mission applications
- 3U cPCI compact form factor
- Low flight weight – 1.4 lbs
- Low power < 5W (Typical)
- Extensive OS/App software ecosystem
- Proven QML component flight heritage
- CAN Interface via cPCI Backplane



Gen 6 LEON 3FT Single Board Computer (SBC)

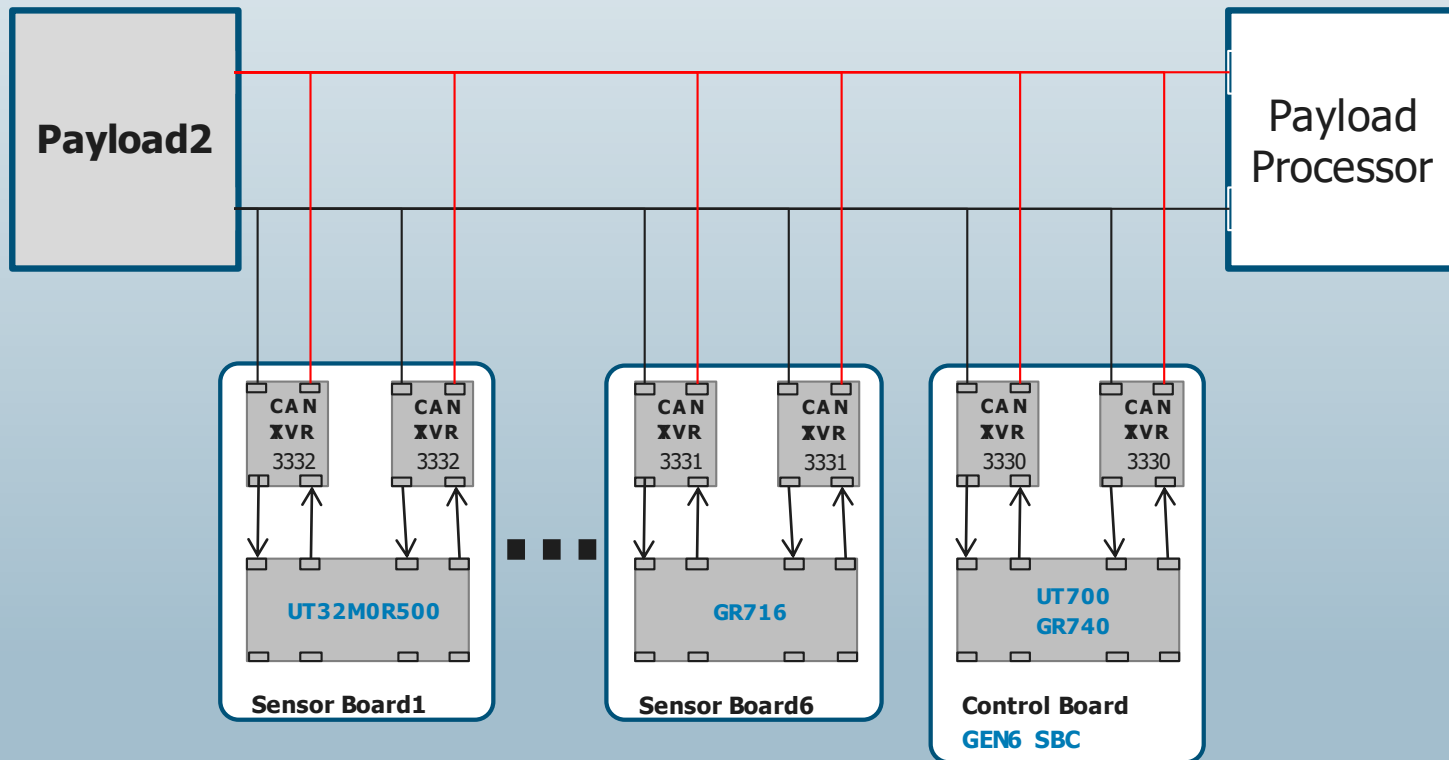
cobham.com/HiRel

| LEON | Main Clock (MHz) | AMBA Clock (MHz) | Memory Access (MHz)/ wait states (W-S) | Estimated DMIPS | SpW Clk (MHz) | Typical Power Consumption (W) | Maximum Power (W) |
|---------------|------------------|------------------|---|-----------------|---------------|----------------------------------|----------------------|
| DS4350272-x00 | UT699E | 33 | 33 / 0 W-S | 44.2 | 33 | 3.0 | 5.1 |
| DS4350272-x01 | UT699E | 66 | 66 / 3 W-S | 70.4 | 132 | 3.5 | 6.6 |
| DS4350272-x02 | UT700 | 33 | 33 / 0 W-S | 44.2 | 33 | 3.0 | 5.1 |
| DS4350272-x03 | UT700 | 66 | 66 / 3 W-S | 70.4 | 132 | 3.5 | 6.6 |
| DS4350272-x04 | UT700 | 132 | 66 / 3 W-S | 94.9 | 132 | 4.2 | 7.3 |

Cobham CAN Architecture

CAN Based Control Architecture

Cobham Solutions

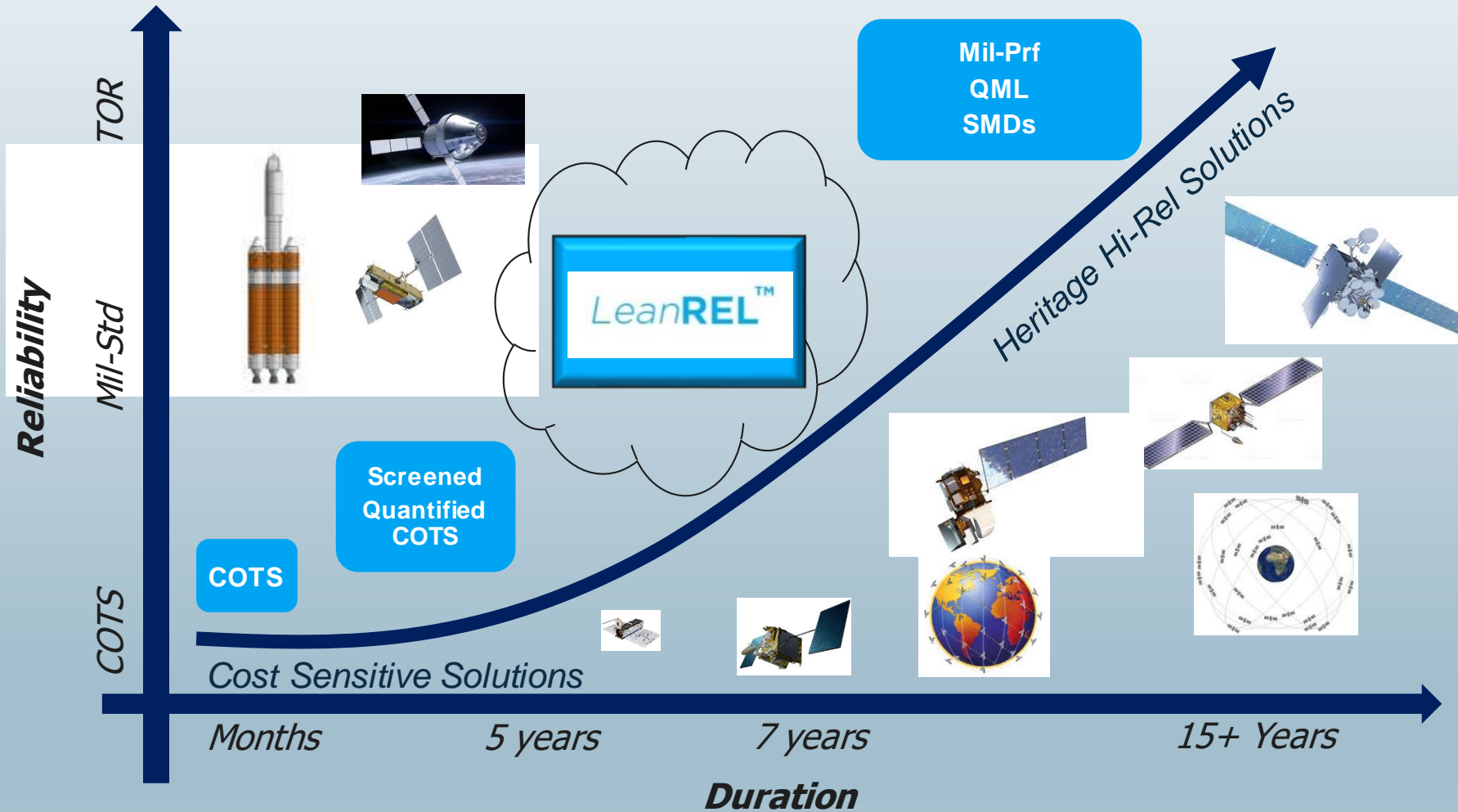


Questions



Satellite Mission Operation Domains

Cobham LeanREL™ Products Fill the Gap



LeanREL™ products provide optimized balance for reliability, performance and cost