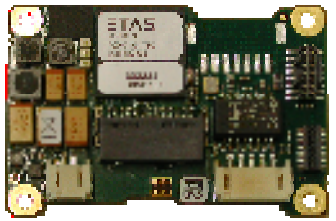
ETKS6.0

ETK for Renesas SH72xx microcontroller

Solution Proposal For ECU Integration



ETKS6.0 Solution Proposal For ECU Integration
Content

- **ETKS6.0 Product Overview**
  - **Supported Controllers, CPU- and Debug-Interface,**
  - **Emulation- and Measurement Memory, Features**
- Hardware Integration
  - Block Diagram, ECU Connection, Signal Conditioning, Power Connection
- Software Adaptations inside the ECU
  - Measurement, Triggering, Cold Start Measurement
  - Calibration, Page Switching
  - Bypass, Calculating Checksums, ECU Flashing, ECU Start Up
- External Files
  - Creating A2L File, ETK Configuration

ETKS6.0 Product Overview
Supported Controllers, CPU– and Debug-Interface

- Supported Controllers
  - Supports Renesas SH72512F(FCC), SH72513F(FCC), SH72544

- CPU-Interface
  - connected to the Renesas JTAG and AUD interface via flat cable adapter
  - **no need for Handshake- and Trigger Pins !**
  - 3.3V Interface

Debug-Interface

- Simultaneous Measurement, Calibration, Rapid Prototyping, and Debugging is possible using ETKS6.0 & Lauterbach or Renesas Debugger

ETKS6.0 Product Overview
Emulation- and Measurement Memory

Emulation Memory

- Using the microcontroller internal overlay RAM
  - SH72512FCC, SH72513FCC max. 8 x 64KByte (as working page, WP), standby powered
  - SH72512F, SH72513F, SH72544 measurement only

Measured Data Memory

- Within the internal RAM when using DISTAB13 hooks

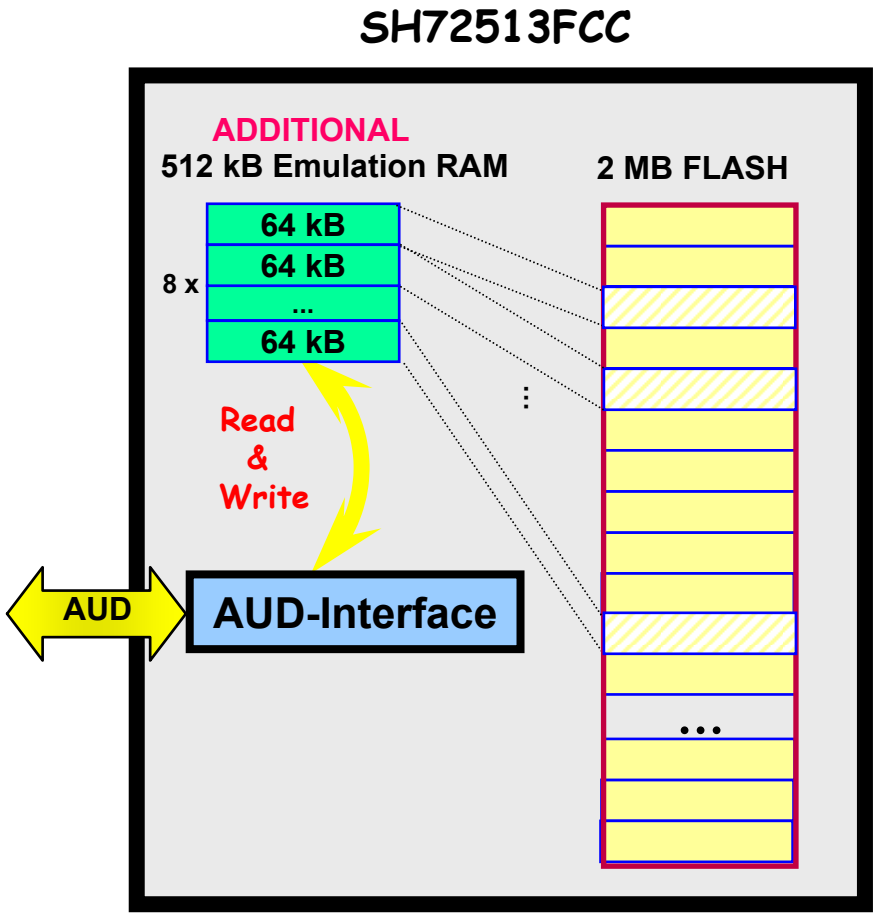
↳ Temperature rated for under the hood applications (-40°C to 110°C)

↳ Well understood calibration/measurement methodology (display table, ETK detection, working/reference page, cold start).

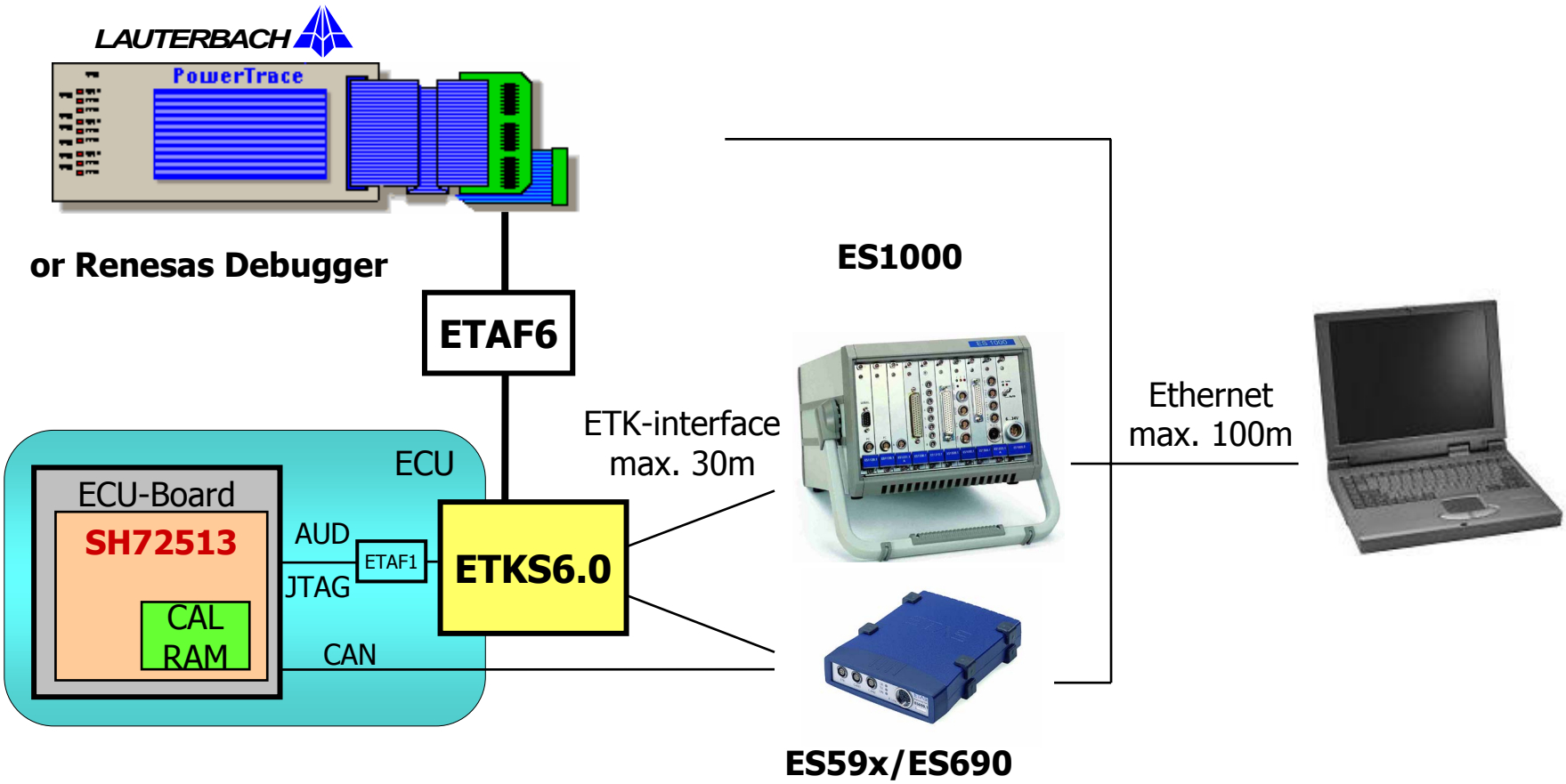
ETKS6.0 Product Overview

Measurement **and** Calibration with Evaluation Device possible

- The overlay mechanism SRAM / FLASH will be supported:
  - up to 8 parallel overlay segments
  - segment size: 64 kByte
  - stand-by supply possible
  - measurement possible



ETKS6.0 Product Overview
System overview



ETKS6.0 Product Overview
Features 1/5

- **Calibration**
  - using internal Overlay RAM on CPU as Calibration RAM
    - Reference Page = CPU internal Flash, Working Page = CPU internal RAM
  - Calibration RAM space limited by size and number of overlay blocks
  - ETK allows configurable location of RP and WP areas
  - location of overlay blocks managed by "Limited emulation RAM toolbox"
    - amount of calibration values may exceed size of CALRAM

ETKS6.0 Product Overview
Features 2/5

- **control of Page switching is selectable:**

  - **controlled by the ECU software ➔ Protocol Based Page Switching**

    generic mailbox protocol implemented by ETAS to make page switching possible

    ➔ ++ page switch synchronous with ECU tasks

    ➔ - - Mailbox Software required

  - **controlled by ETK ➔ Direct Register Access Page Switching**

    ➔ ++ no ECU effort

    ➔ - - page switch asynchronous *1

*1 **Microcontroller issue: first read access to overlay area after page switch may deliver corrupt data**

ETKS6.0 Product Overview
Features 3/5

- **Measurement**
  - Enable and Disable of measurement possible
  - Measurement variables selectable via INCA
  - 16/32 different measurement raster possible
  - Data acquisition via Distab13 Routine or TDM
    - **T**riggered **D**irect **M**easurement (measurement without DISTAB)
  - Power On - Cold Start Measurement
  - "Measurement Only" function

  - Requires reserved memory section of internal RAM

ETKS6.0 Product Overview
Features 4/5

- **Special functions**
  - ↳ hardware allows ETK full read/write access from µC memory !
  - ↳ ETK can generate ECU reset
  - ↳ ETK recognition and power fail detection from ECU
    Information exchange between ETK and CPU via AUD Register
  - ↳ ETK will supervise ECU voltage

  - ↳ only enabled AUD interface allows ETK access !

ETKS6.0 Product Overview
Features 5/5

- **Flashing**

The term ***Flashing*** has two meanings:

- Program the **ECU Flash** with new **code and data set**
  → Program code update, rarely done during calibration work

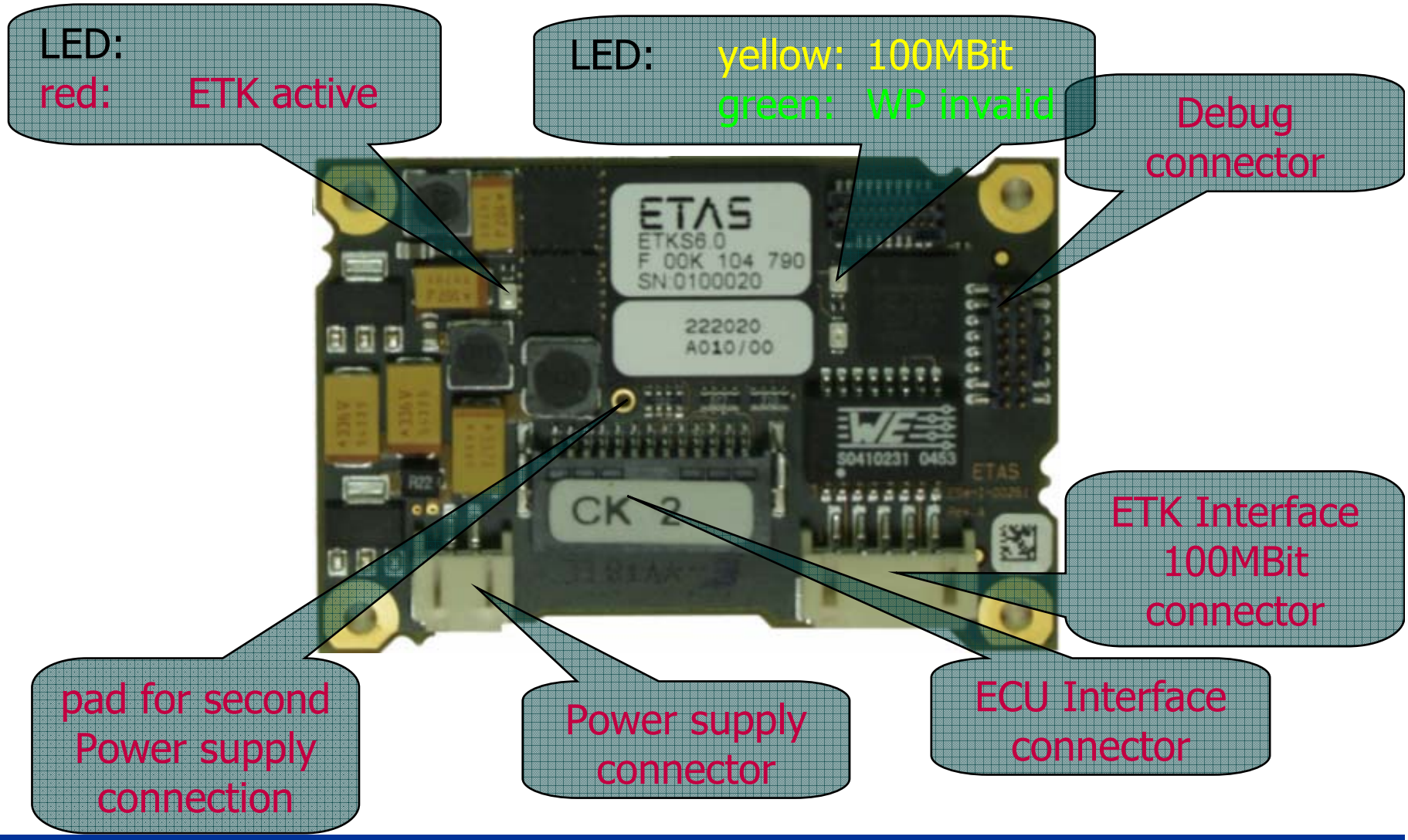
    → initial flashing done with third party tool

- Copy working page (WP) to persistent reference page (**RP**)
  → Data freeze, done frequently during calibration work

  ⇒ Data to be copied from overlay RAM into Flash,
    → **Flash driver running inside ECU, controlled by Prof**

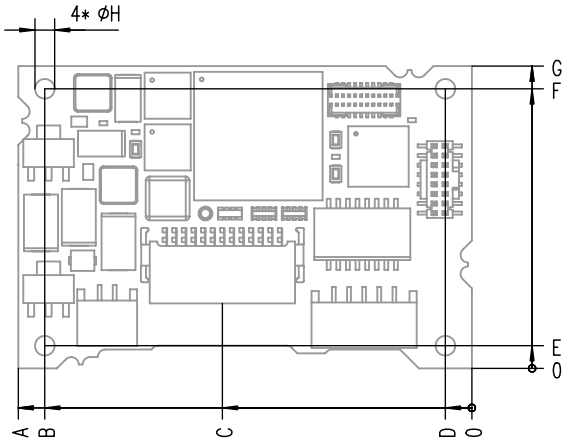
ETKS6.0 Product Overview

ETKS6.0 size and connectors (Hardware Axxx/yy)

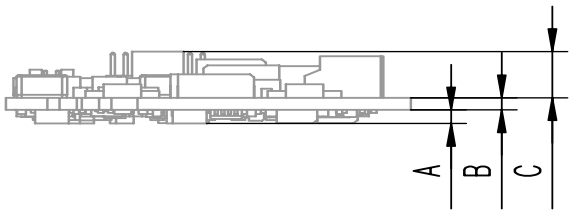


ETKS6.0 Product Overview

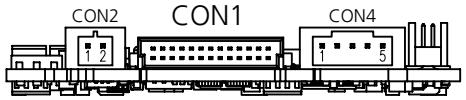
ETKS6.0 size and connectors (Hardware Axxx/yy)



DIM	Millimeters
A	**60.00**
B	56.50
C	33.00
D	3.50
E	3.00
F	37.00
G	**40.00**
H	2.60

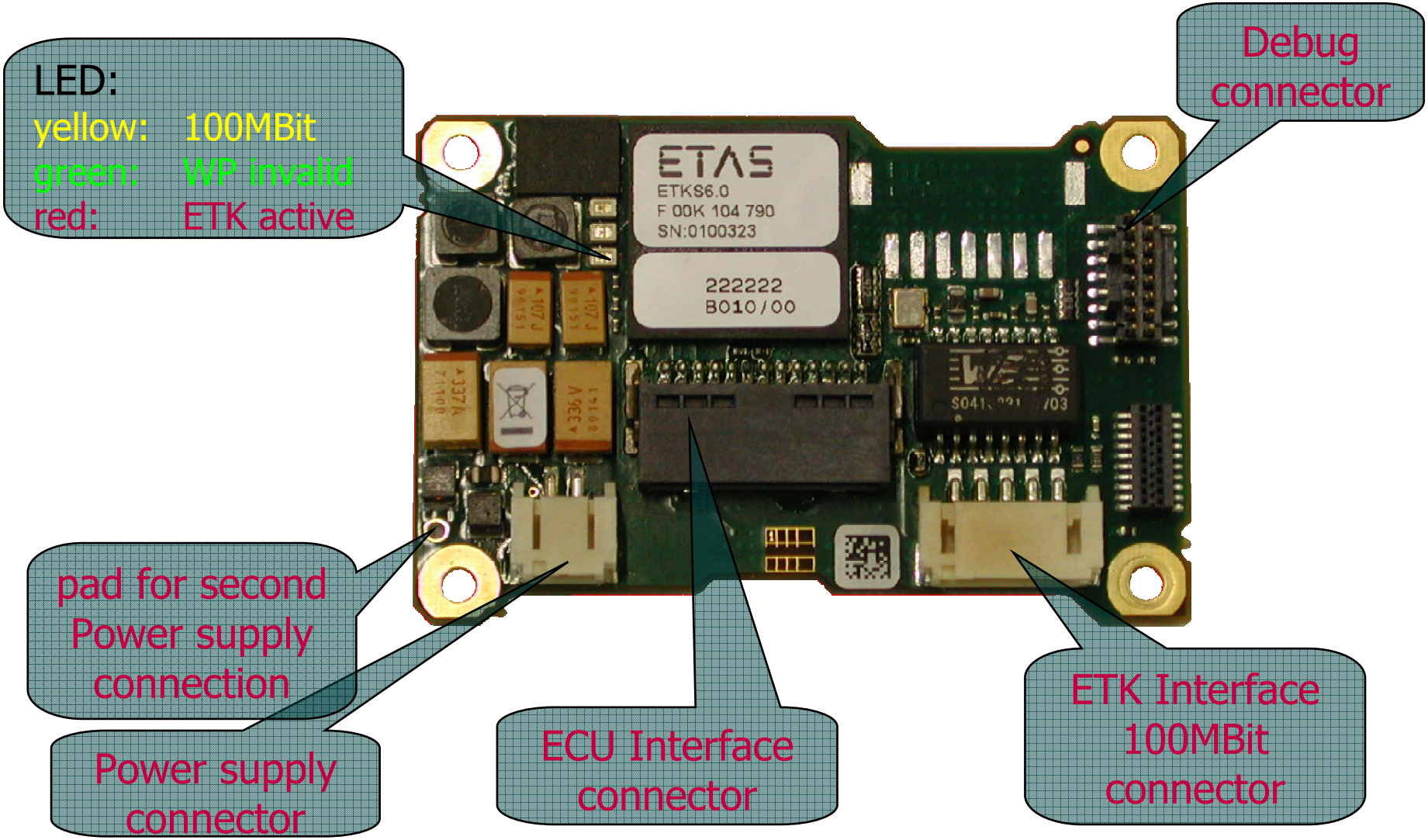


DIM	Millimeters
A	2.00
B	1.70
C	6.10



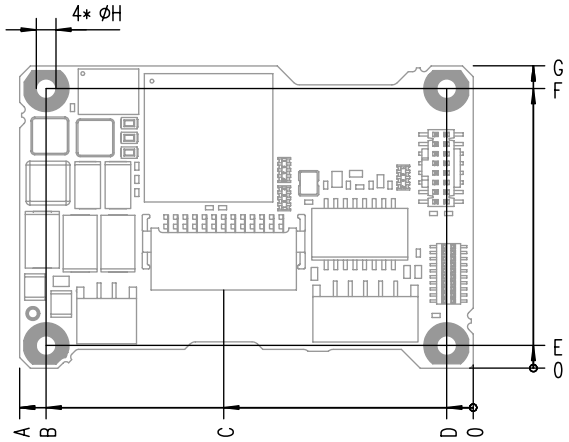
ETKS6.0 Product Overview

ETKS6.0 size and connectors (Hardware Bxxx/yy)



ETKS6.0 Product Overview

ETKS6.0 size and connectors (Hardware Bxxx/yy)



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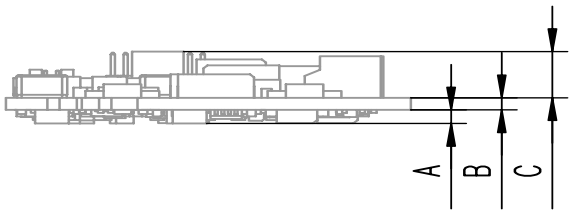

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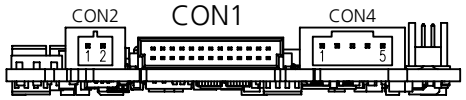

ETKS6.0 Product Overview
System Requirements

- Integrated with following software
  - INCA V5.4.1 SH72513FCC
  - INCA V6.1.0 SH72512(FCC), SH72513 and SH72544
  - ASCET-RP V5.6
  - INTECRIO 2.1
  - HSP V5.1

- Supported by following hardware
  - Compact Hardware: ES690, ES590, ES591, ES910.2 (INCA)
  - VME Hardware: ES1000.2/.3 with ES1232 (INCA/ASCET)

ETKS6.0 Product Overview
System Requirements

- **Products not supported**
  - Software
    - INCA 5.3 and Predecessors
    - ASCET_RP 5.4 and Predecessors
    - INTECRIO 1.0
  - Hardware
    - MAC2
    - ES1000.1 with ES1111 and ES1200 & ES1201
    - ES1000.2/3 with ES1120 and ES1200 & ES1201
    - ES1000.2/3 with ES1120 and ES1231
  - Firmware
    - HSP 4.1 and Predecessors
  - A2L Description Language
    - AML prior to v1.2

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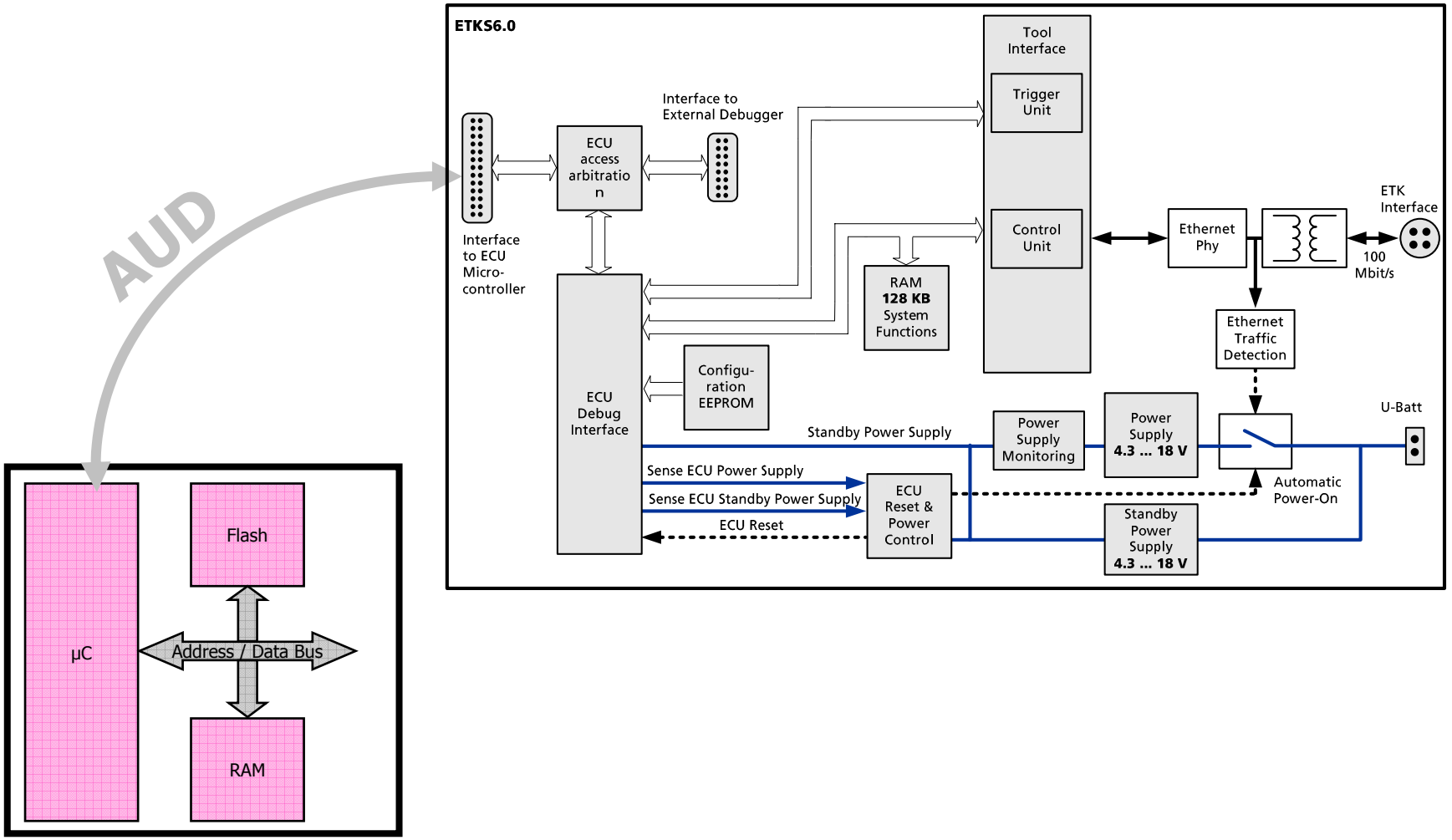
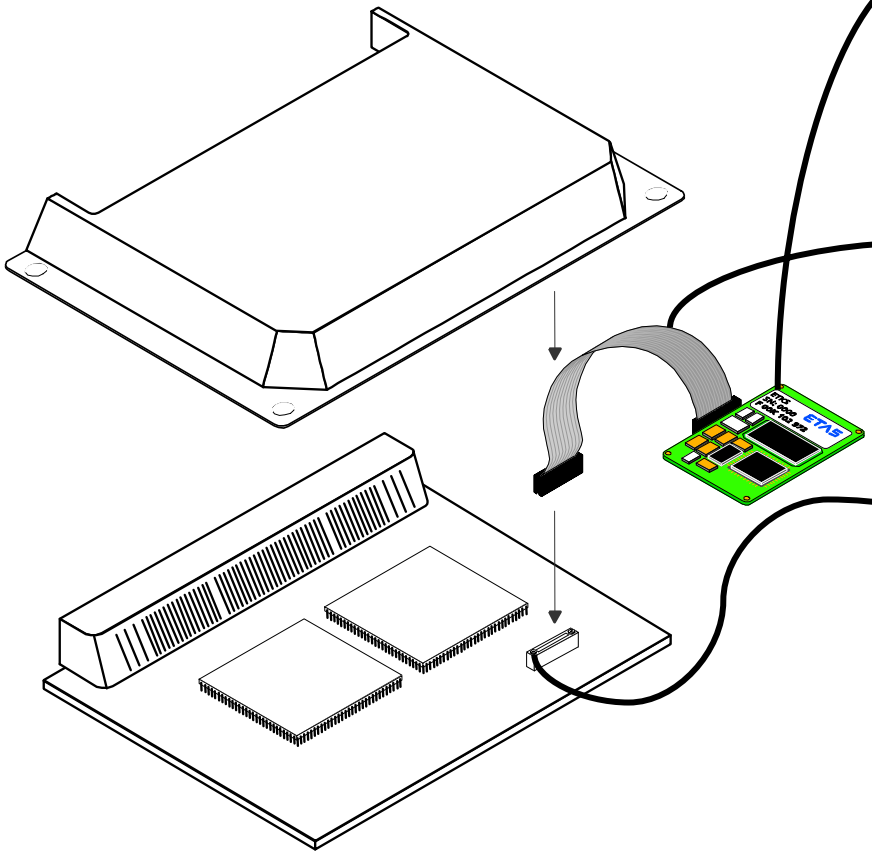
ETKS6.0 Hardware Integration
Block Diagram



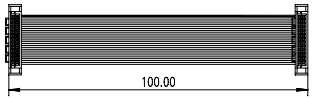
ETKS6.0 Hardware Integration

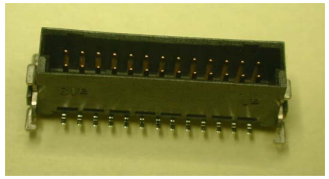
Hardware Overview



- **ETK:**
  ETKS6.0 – F 00K 104 790
  AUD ETK for the Renesas SH72xx

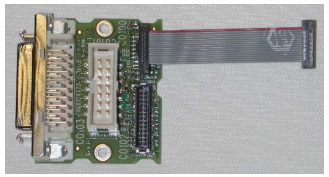
- **ETK - adapter:**
  ETAF1 – F00K 001 373
  Connects ETK to ECU





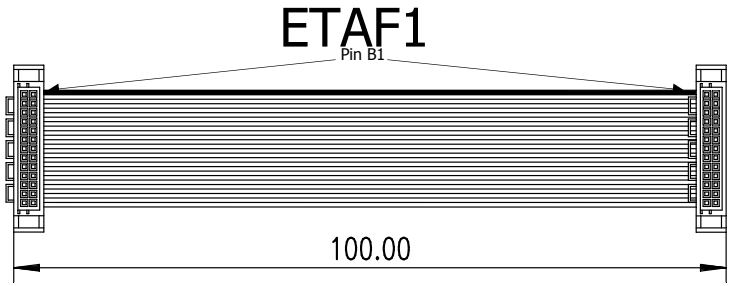
- **ECU connector:**
  ERNI connector "ERNI 064320"
  Fits to ETAF1 (ETK - adapter)

- **ETK-Debug - adapter:**
  ETAF6 – F00K 104 220
  Connects Debugger to ETK or ECU

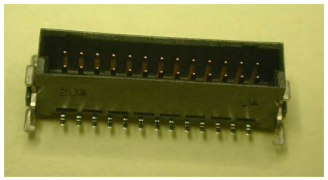


ETKS6.0 Hardware Integration
ECU Interface

- Flat ribbon cable to a 26-pin connector in the ECU



- JTAG signals
- AUD signals
- Reset signals
- VCC + ground signals



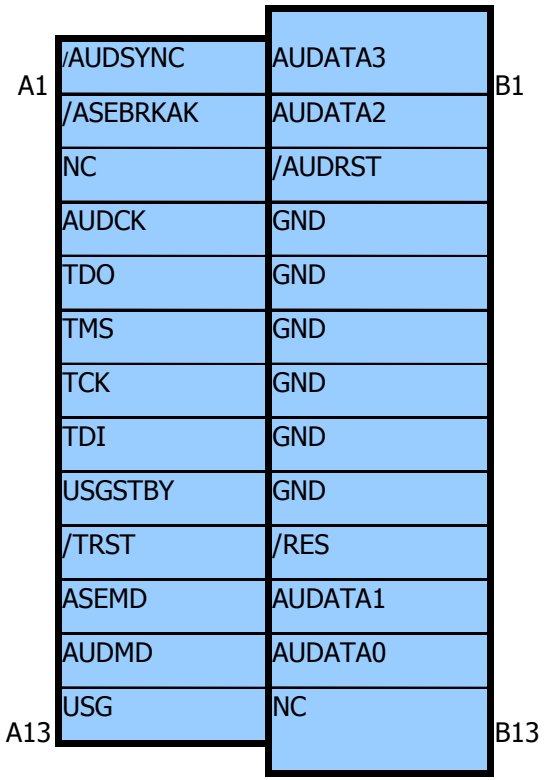
ERNI "064320"

A1	/AUDSYNC	AUDATA3	B1
	/ASEBRKAK	AUDATA2	
	NC	/AUDRST	
	AUDCK	GND	
	TDO	GND	
	TMS	GND	
	TCK	GND	
	TDI	GND	
	USGSTBY	GND	
	/TRST	/RES	
	ASEMD	AUDATA1	
	AUDMD	AUDATA0	
A13	USG	NC	B13

Bottom view to male connector

Signal	Direction	Load	Function
AUDATA[3..0]	INOUT	10pF	ETK
/AUDRST	OUT	12pF	ETK
/AUDSYNC	OUT	10pF	ETK
AUDMD	OUT	10pF	ETK
AUDCK	OUT	10pF	ETK
TCK	OUT	20pF	JTAG
TMS	OUT	20pF	JTAG
/TRST	OUT	20pF	JTAG
TDI	OUT	20pF	JTAG
TDO	IN	12pF	JTAG
ASEMD	OUT	10pF	ETK
/ASEBRKAK	IN	5pF	ETK
/RES	INOUT	39pF	ETK
USG	IN		ETK
USGSTBY	IN		ETK

ETKS6.0 Hardware Integration
ETK Interface Connector on ECU



Bottom view to male connector

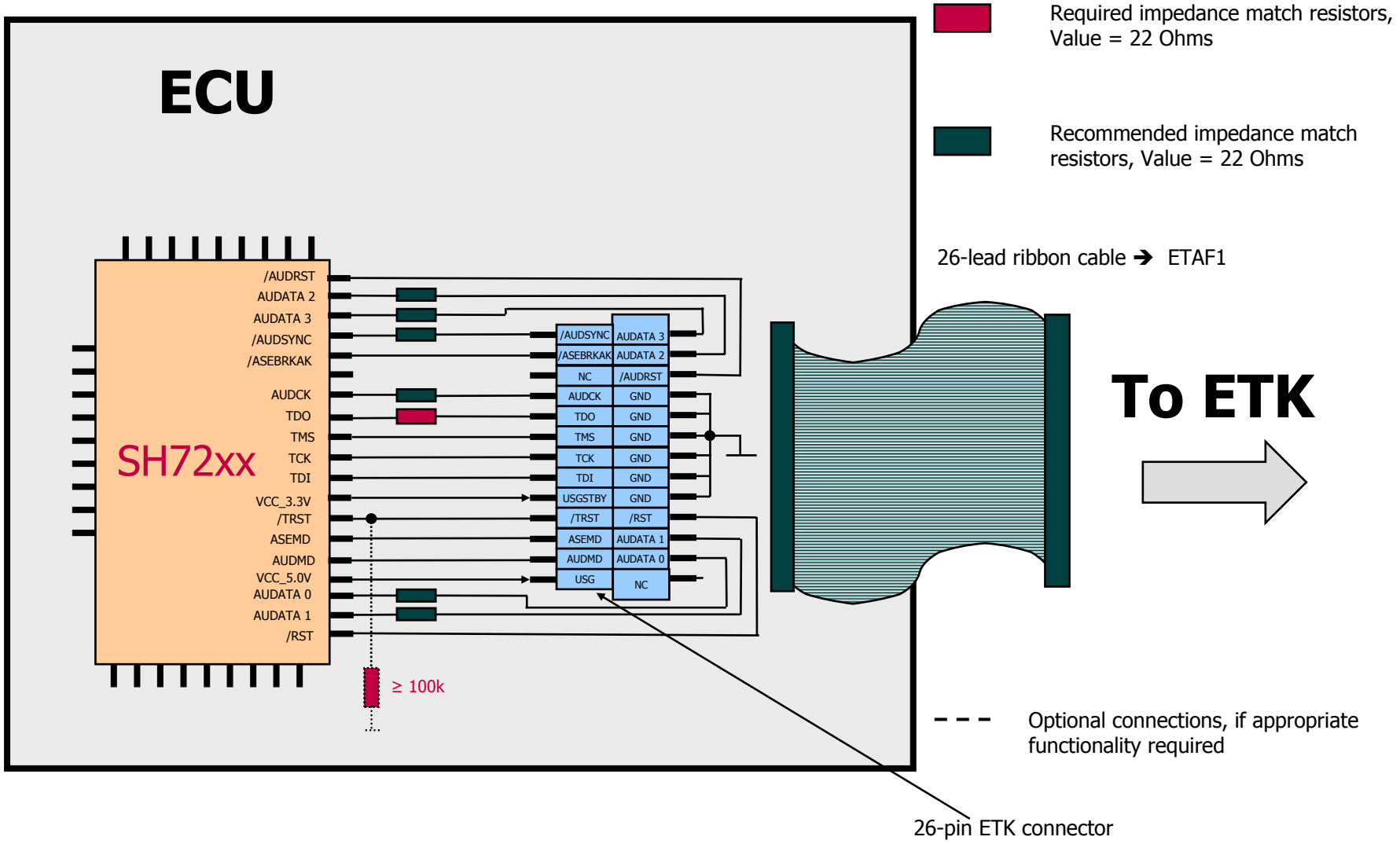
ECU connector type:
ERNI 064320

- **/AUDSYNC, /ASEBRKAK, /AUDRST,AUDDATA[3..0], AUDCK**: Microcontroller Pins, used by ETK
- **TDO, TMS, TCK, TDI, /TRST**:

  Microcontroller Pins, path through ETK, used by Debugger
- **/RES:** Power on Reset
- **USGSTBY (Comparator Input)**: ECU Standby RAM supervised by ETK to detect data consistency
- **USG (Comparator Input)**: Supply of microcontroller JTAG pins supervised by ETK to detect CPU is powered

  NC: Customer specific; not used for ETK; if not required, do not connect

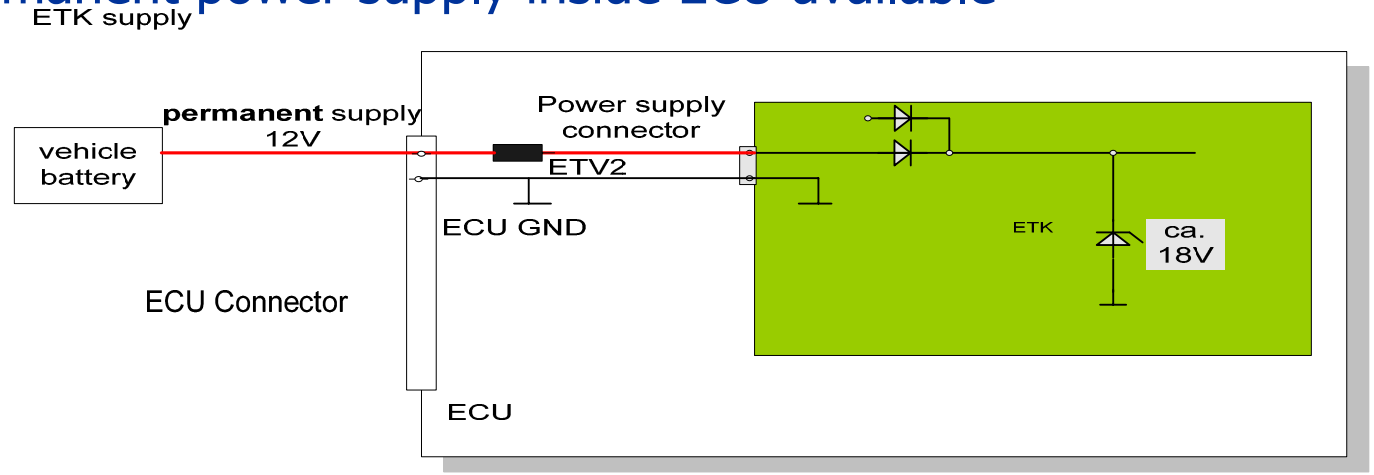
ETKS6.0 Hardware Integration
ETK-Interface on ECU



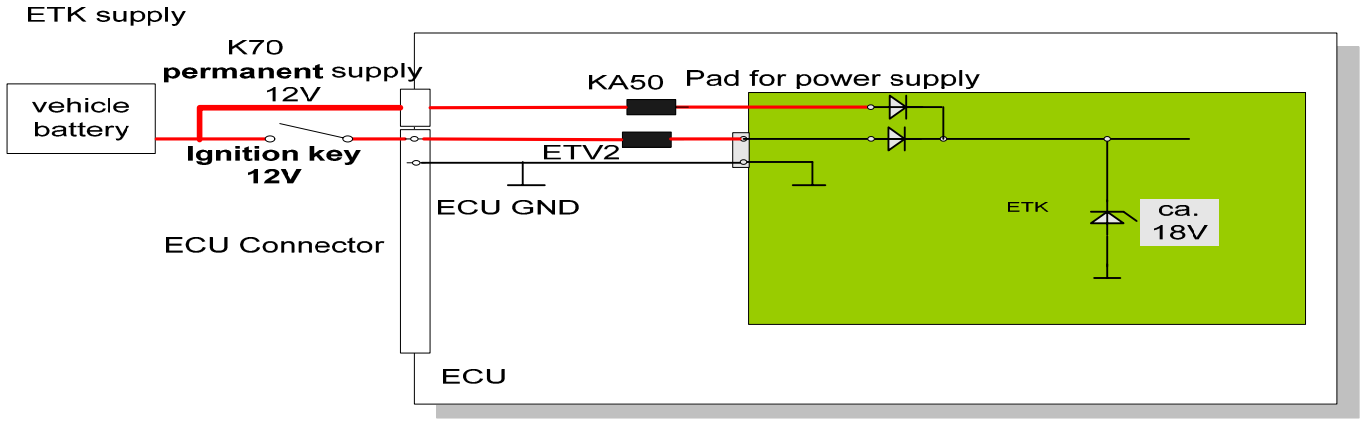
ETKS6.0 Hardware Integration

ETK need a permanent power supply !

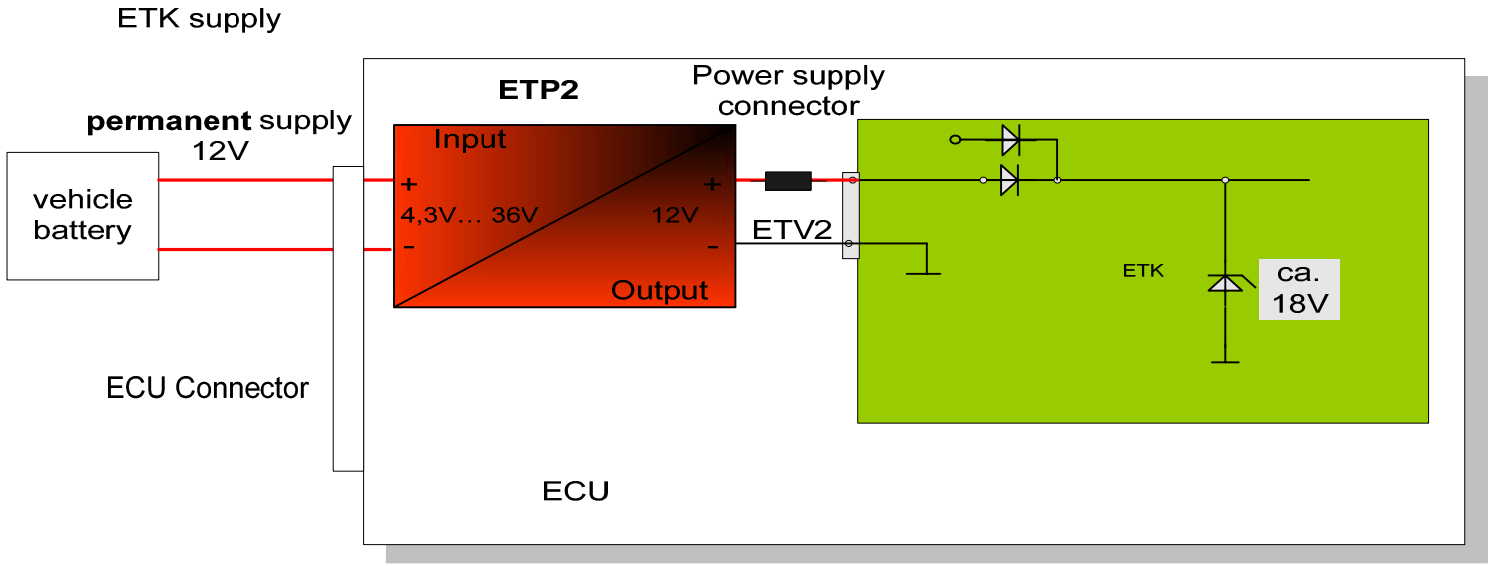
a) permanent power supply inside ECU available



b) permanent power supply inside ECU not available



ETKS6.0 Hardware Integration
isolated power supply ETP2 inside ECU



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ETKS6.0 Software adaptations inside the ECU
Overview

- Start up after reset
  - ETK recognition
  - Start up protocol
  - Cold start handshake
  - Power fail detection
- Calibration
  - Page switch
  - Start on working page
- Measurement
  - Display table
  - Trigger
- Bypass
- ECU flashing

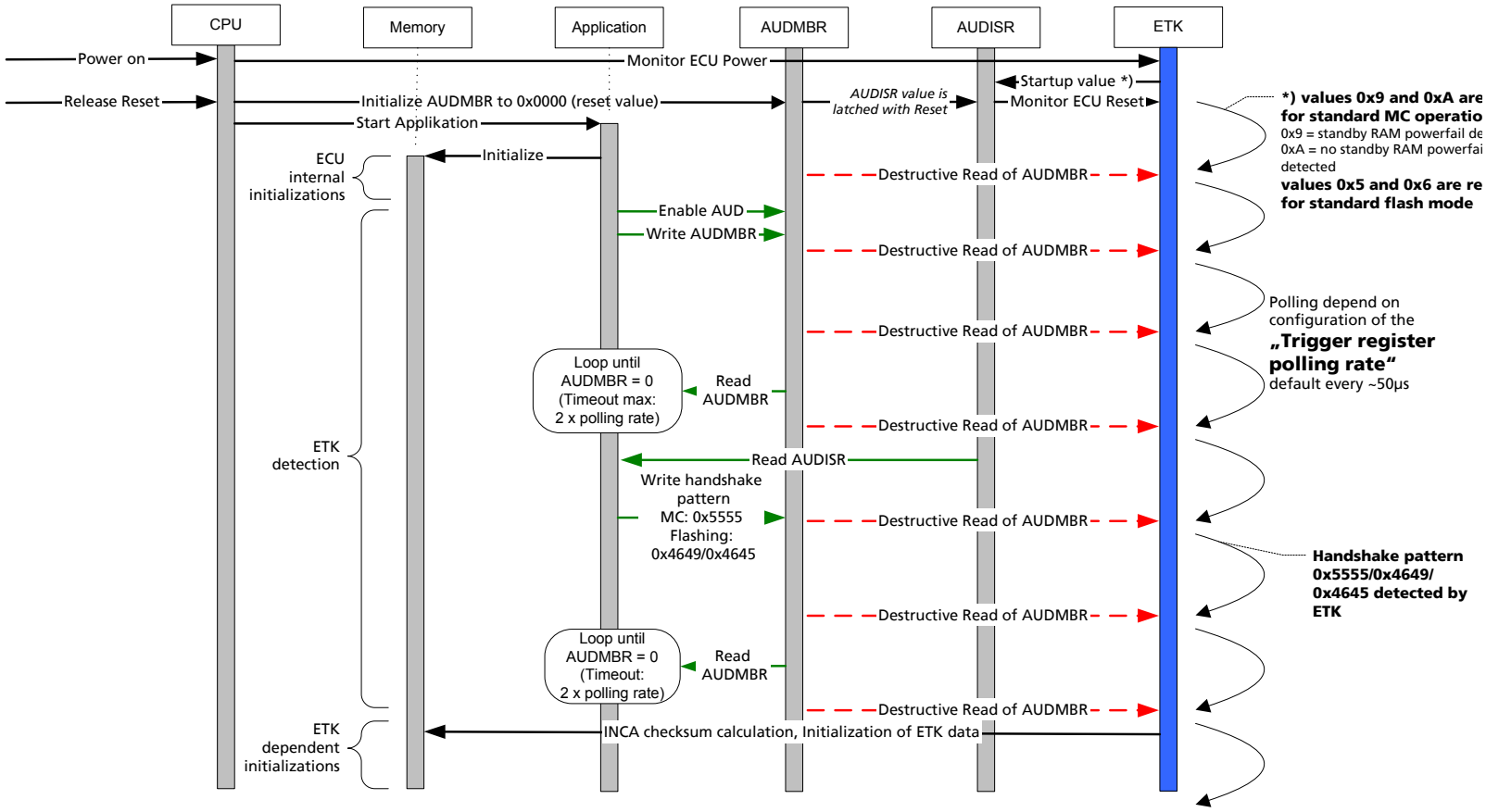
ETKS6.0 Software adaptations inside the ECU
Start-up after reset

- ECU start-up after Reset:
  - ETK detection
  - Initialize ECU e.g. Register initialising,
    deactivation of any access to overlay memory (e.g. SERAP,...)
  - detection of ECU power fail
  - detection of end of ECU initialisation

  ➔ precondition:
    - **AUD interface enabled**
    - **ECU effort required**

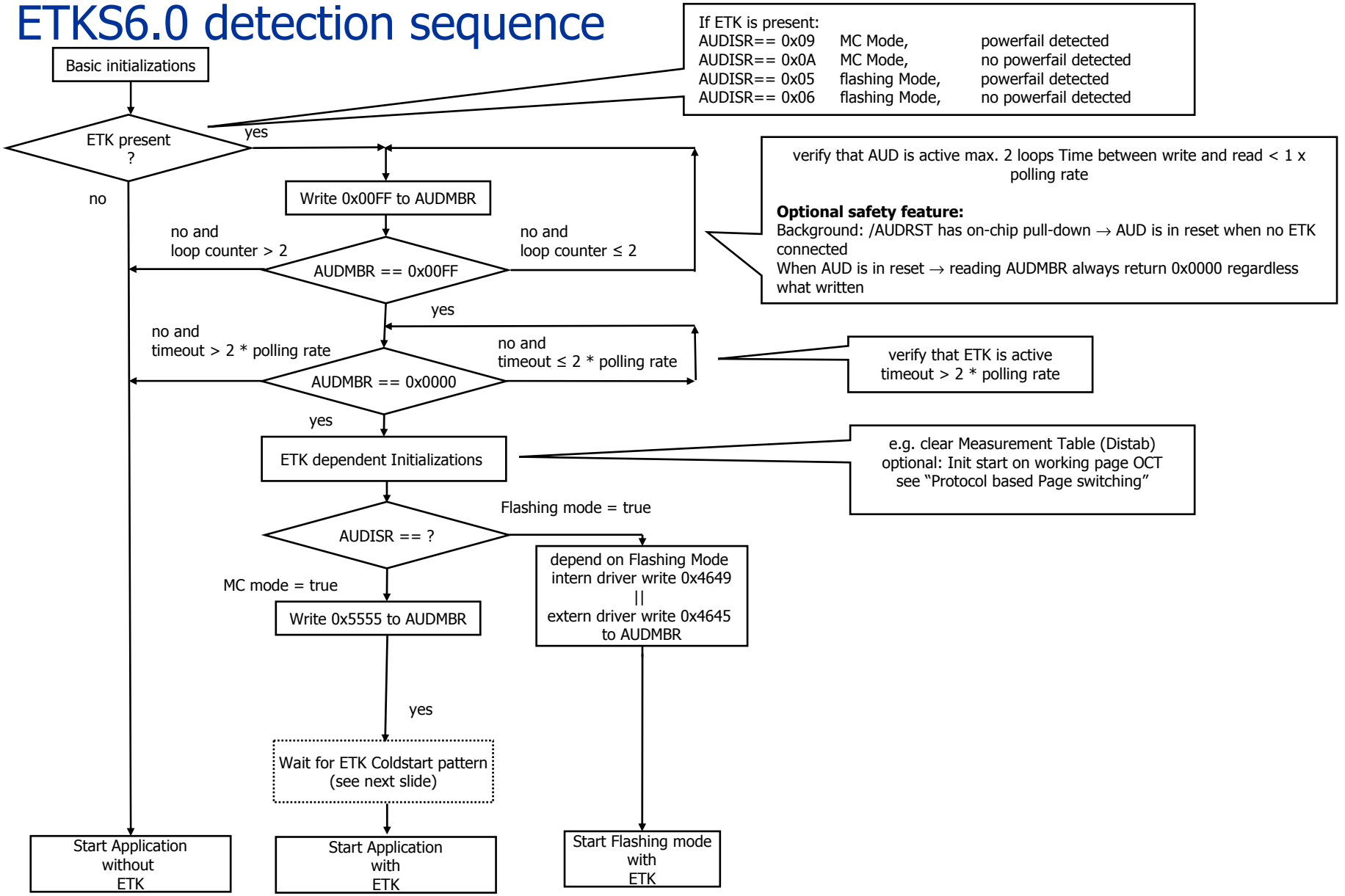
ETKS6.0 detection sequence

Startup handshake with ETKS6

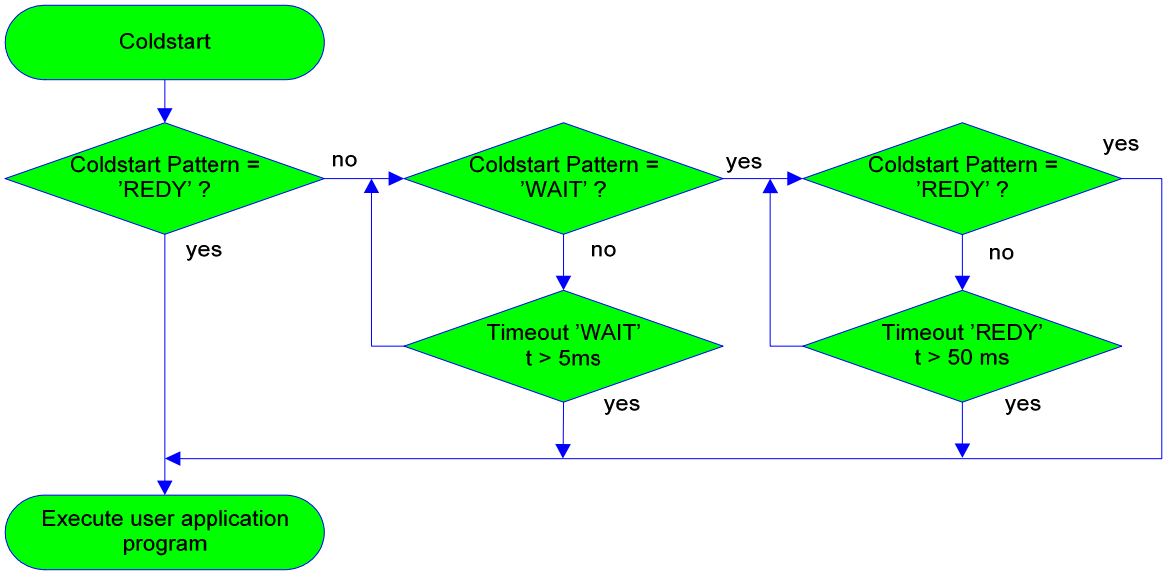


ETKS6:
ETAS/PMC/EPM-22 Mai
26.10.2006

ETKS6.0 detection sequence



ETKS6.0 detection sequence
Communication Protocol for Cold start Measurement



The coldstart pattern is used to synchronize the measurement system with the ECU software.
The address of the Coldstart pattern is defined in the A2L File

WAIT: System will do coldstart measurement and start to prepare the measurement table.
REDY: The Displaytable is valid and INCA is ready.

ETKS6.0 Software adaptations inside the ECU
Calibration: Overview

- **Calibration:**
  - Overlay memory of µC must be available for calibration

Reference Page:

➔ µC – Flash is used as Reference Page

Working Page:

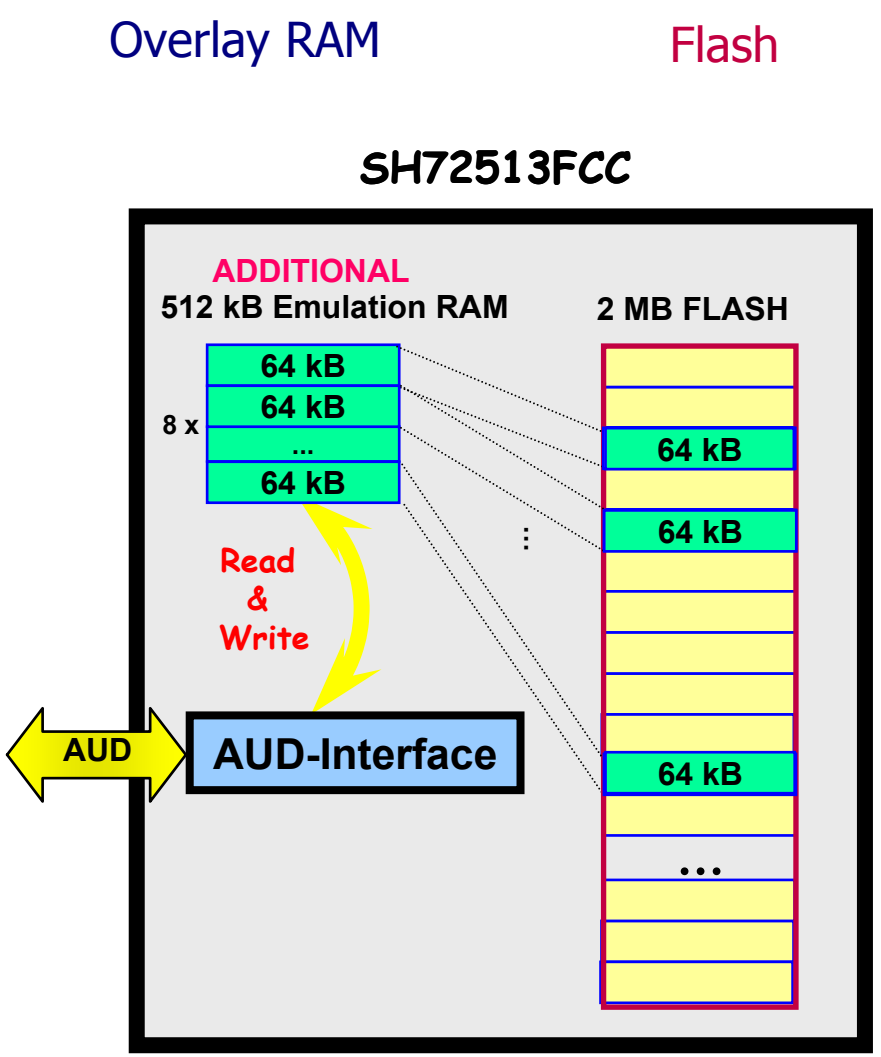
➔overlay or calibration memory is used as Working Page

Memory Map:

➔ Memory map managed completely by ETK and INCA

ETKS6.0 Software adaptations inside the ECU
Calibration: Memory concept

- Reference Page = µC internal Flash
- Working Page = internal Overlay RAM regions of the µC
  - 8 regions
- Page Switching by enable/disable the internal overlay mechanism



ETKS6.0 Software adaptations inside the ECU
Calibration: Page switching

- Page Switching
- Limited Emulation Ram Toolbox
- The feature „Start On Working Page“
- Protocol Based Page Switching with “Start On X Page” option
  - Overlay Configuration Table
  - Mailbox procedure

ETKS6_CalibrationPageHandling_V05

ETKS6.0 Software adaptations inside the ECU
Calibration: Verify that RP and WP is valid

➔ Checksum calculation of the calibration memory

- direct access to memory by ETK

➔ **no ECU effort required**

ETKS6.0 Software adaptations inside the ECU

Bypass

- Bypass: **ECU effort required**
  - Trigger generation
    - Trigger generated by write into Trigger Register

      up to 16 raster by direct triggering, up to 32 raster by indirect triggering
  - Data acquisition
    - DISTAB13 approach (for data consistency & performance)
    - Display table is located in RAM, power-up check necessary
  - ETAS proposal
    - FCC-Device : DISTAB13 approach
  - Bypass implementation
    - identical to other ETKs

ETKS6.0 Software adaptations inside the ECU
Measurement

- Measurement: **ECU effort required**
  - Trigger generation
    - Trigger generated by write into Trigger Register

      up to 16 raster by direct triggering, up to 32 raster by indirect triggering
  - Data acquisition
    - DISTAB13 approach (for data consistency & performance) **or**
    - **T**riggered **D**irect **M**easurement (measurement without DISTAB)

      (refer to the attached document)
    - Display table is located in RAM, power-up check necessary
  - ETAS proposal
    - DISTAB13 approach

Trigger Concept of serial ETKs.ppt

ETKS6.0 Software adaptations inside the ECU
Measurement with Display table DISTAB13

- examples with 6 Measurement Rasters

Raster	Signals		Datarate
0,714 msec	40 x 2 Byte	20 x 4 Byte	224 kByte/sec
1,000 msec	40 x 2 Byte	20 x 4 Byte	160 kByte/sec
2,140 msec	40 x 2 Byte	20 x 4 Byte	75 kByte/sec
4,000 msec	40 x 2 Byte	20 x 4 Byte	40 kByte/sec
8,000 msec	40 x 2 Byte	80 x 4 Byte	50 kByte/sec
128,000 msec	40 x 2 Byte	200 x 4 Byte	7 kByte/sec
			556 kByte/sec

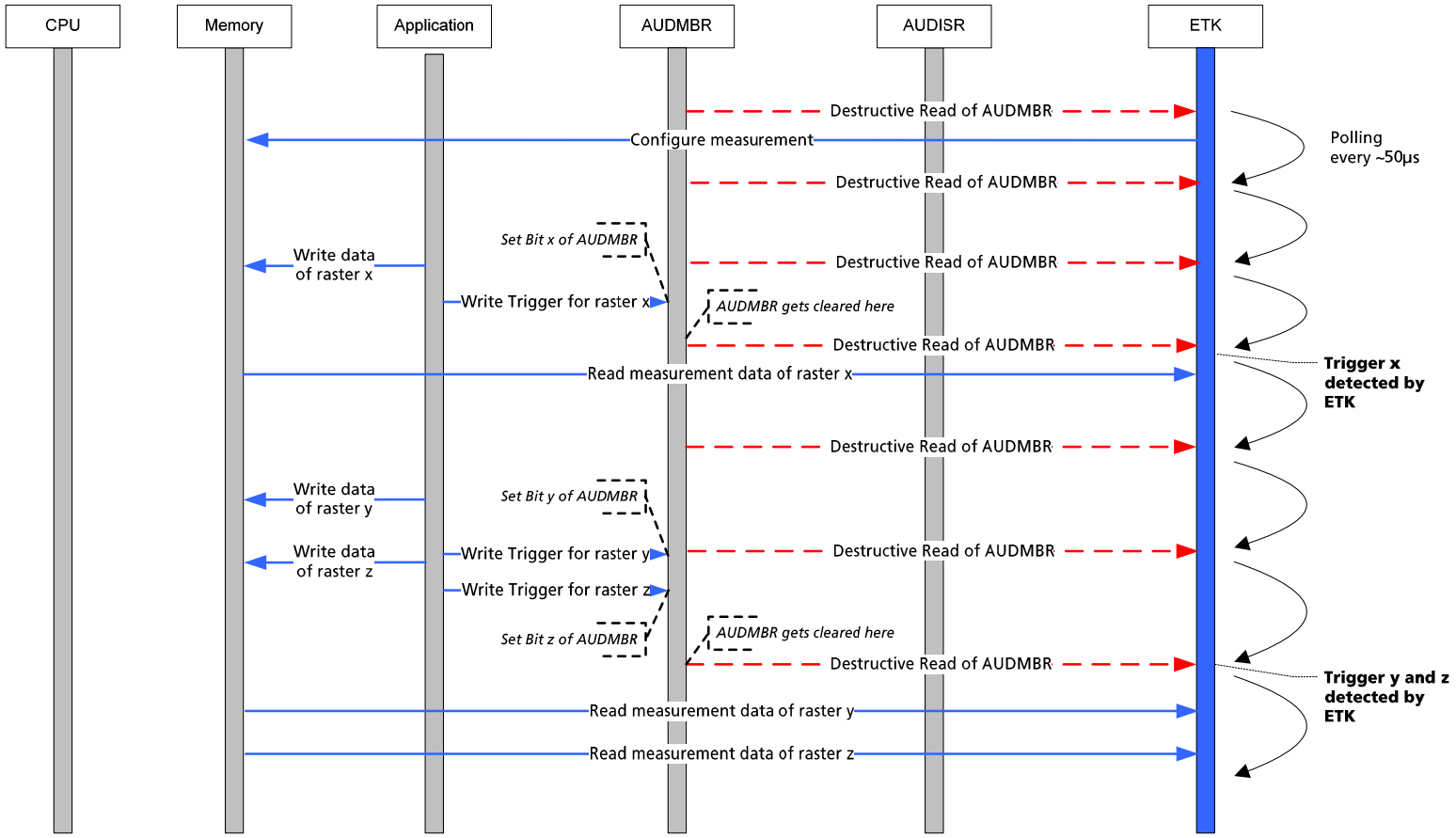
ETKS6.0 Software adaptations inside the ECU
Measurement with Triggered Direct Measurement TDM

- examples with 6 Measurement Rasters

Raster	Signals		Datarate
0,714 msec	20 x 2 Byte	20 x 4 Byte	169 kByte/sec
1,000 msec	20 x 2 Byte	20 x 4 Byte	120 kByte/sec
2,140 msec	20 x 2 Byte	20 x 4 Byte	57 kByte/sec
4,000 msec	20 x 2 Byte	30 x 4 Byte	40 kByte/sec
8,000 msec	40 x 2 Byte	30 x 4 Byte	25 kByte/sec
128,000 msec	140 x 2 Byte	180 x 4 Byte	8 kByte/sec
			419 kByte/sec

ETKS6.0 trigger generation

Trigger with ETKS6



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ETAS/PMC/EPM-22 Mai
8/1/2006
Startup and Trigger for
ETKS6 V04.vsd

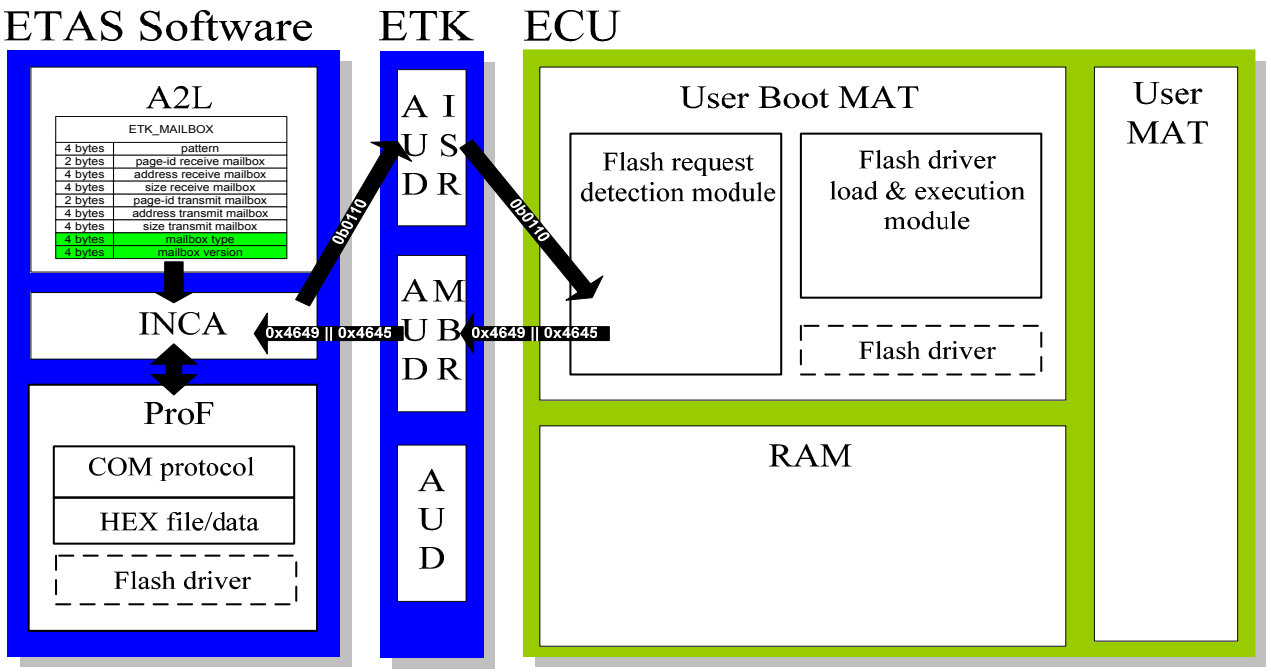
ETKS6.0 trigger generation

- Initialization
  - At the end of initialization, software writes 0x5555 to AUDMBR register → ECU software
  - ETK detects 0x5555 pattern and enables trigger generation → ETK
- Application running
  - For generating triggers, software sets appropriate Bit of AUDMBR register (No Read-Modify-Write sequence !!!), each Bit of AUDMBR corresponds to a specific raster → ECU software
  - ETK polls AUDMBR register for detecting triggers and starts acquisition of appropriate data → ETK

ETKS6.0 Software adaptations inside the ECU
ECU flashing

- **Boot Code or Flash Software is running inside ECU:**
  - **communication via AUD - Register and ETK - Mailbox**
  - A ProF-control-flow is required for running the flash procedure "ProF" within INCA

  ➔ECU effort required, brain death flashing not supported



Description of the ECU-backed Flashing:

Standard-Flashing_V11

ETKS6.0 Solution Proposal For ECU Integration
Content

- **ETKS6.0 Product Overview**
  - **Supported Controllers, CPU- and Debug-Interface,**
  - **Emulation- and Measurement Memory, Features**
- Hardware Integration
  - Block Diagram, ECU Connection, Signal Conditioning, Power Connection
- Software Adaptations inside the ECU
  - Measurement, Triggering, Cold Start Measurement,
  - Calibration, Page Switching,
  - Bypass, Calculating Checksums, ECU Flashing, ECU Start Up
- External Files
  - Creating A2L File, ETK Configuration

ETKS6.0 External A2L - File
content

the A2L – File contains:

- memory layout
- Limited EMU RAM toolbox configuration
- Communication e.g. Protocol speed (100MBit only), Byte order,…
- ETK configuration ➔ ETK_CFG Parameter
- Address of Distab Address- and Output table
- Specification of Trigger Raster timing

optional:

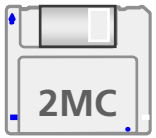
- definition of pattern for Coldstart
- Mailbox parameter for Protocol based page switching
- Mailbox parameter for Flashing
- …

ETKS6.0 Project Configuration
Memory Layout

- specify Memory Segment

➔ Code Area
➔ Data Area
➔ Variables Area

ASAM-2MC File




```
/begin MEMORY_SEGMENT code
  ""
  CODE FLASH INTERN 0x00000000 0x68000 -1 -1 -1 -1 -1
/end MEMORY_SEGMENT

/begin MEMORY_SEGMENT data_ETK
  ""
  DATA FLASH INTERN 0x00068000 0x90000 -1 -1 -1 -1 -1
/end MEMORY_SEGMENT


/begin MEMORY_SEGMENT IRAM
  ""
  VARIABLES RAM INTERN 0xFFF80000 0x20000 -1 -1 -1 -1 -1
/end MEMORY_SEGMENT
```

ETKS6.0 Project Configuration
Application Memory handling in Inca (1/4)

- Full Emulation

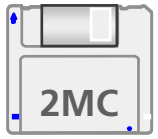
  = all Calibration Variables covered by overlay RAM at the same time

- Partial Emulation

  = only a part of Calibration Variables can be covered at a time

➔ Limited Emulation RAM toolbox of Inca is always required

ASAM-2MC File




```
/begin CALIBRATION_METHOD  "FixedSizeMoveableEmuRAM"  /* Method name */
        1                       /* Method version */

        /begin CALIBRATION_HANDLE
                0                       /* EmuRAM page identifier *1 */
                0x00600000              /* Original RAM Address has to be defined in the memory segment
                0x10000                 /* Page size */
        /end CALIBRATION_HANDLE

        /begin CALIBRATION_HANDLE
                1                       /* EmuRAM page identifier */
                 0x00610000             /* Original RAM Address has to be defined in the memory segment
                 0x10000                /* Page size  */
       /end CALIBRATION_HANDLE

/end CALIBRATION_METHOD
```

*1 The relation between EmuRAM page identifier and Original RAM Address is fixed:

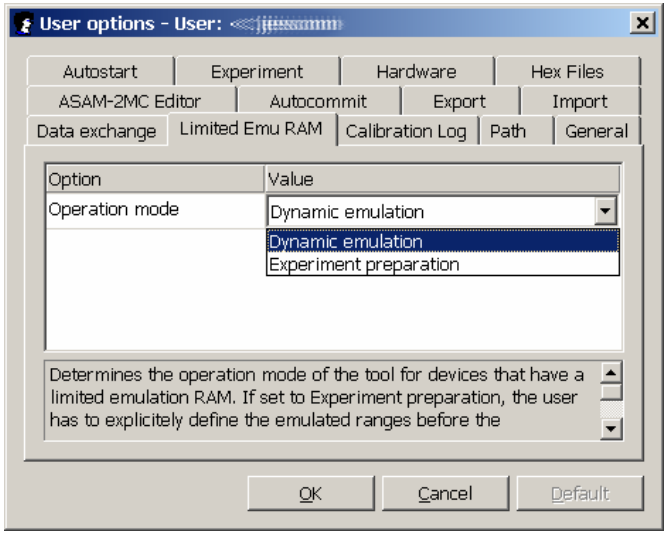
0: 0x00600000; 1: 0x00610000; 2: 0x00620000; …

ETKS6.0 Project Configuration
Application Memory handling in Inca (2/4)

There are two different methods to work with Limited Emulation RAM:

1. Experiment Preparation
2. Dynamic Emulation

Link to User Guide



In both methods Limited Emulation RAM toolbox will:

1. try to emulate all Calibration Variables defined in the Project (A2L file) to reach "Full Emulation"
2. ignore Calibration Variables, intended for special use, like:
   - Read-only calibration variables
   - calibration variables outside the DATA region specified in the A2L file
   - adaptive characteristics

ETKS6.0 Project Configuration
Application Memory handling in Inca (3/4)

Method: Experiment preparation

- The Limited Emulation Toolbox will configure the CALRAM when:
  - the experiment is opened in INCA.
  - the user requests it in the menu: Variables -> Limited Emulation RAM

Steps to configure the CALRAM:

1. Full Emulation possible ?
   ⇨ toolbox configures the memory silent to cover all calibration variables

2. Calibration variables stored in the Experiment ?
   these variables can be covered at the same time ?
   ⇨ toolbox configures the memory silent to cover these calibration variables

3. Ask the user for a selection of Calibration Variables (Partial Emulation)
   ⇨ Variable Pre-selection dialog is displayed and selection is configured

ETKS6.0 Project Configuration
Application Memory handling in Inca (4/4)

Method: Dynamic emulation

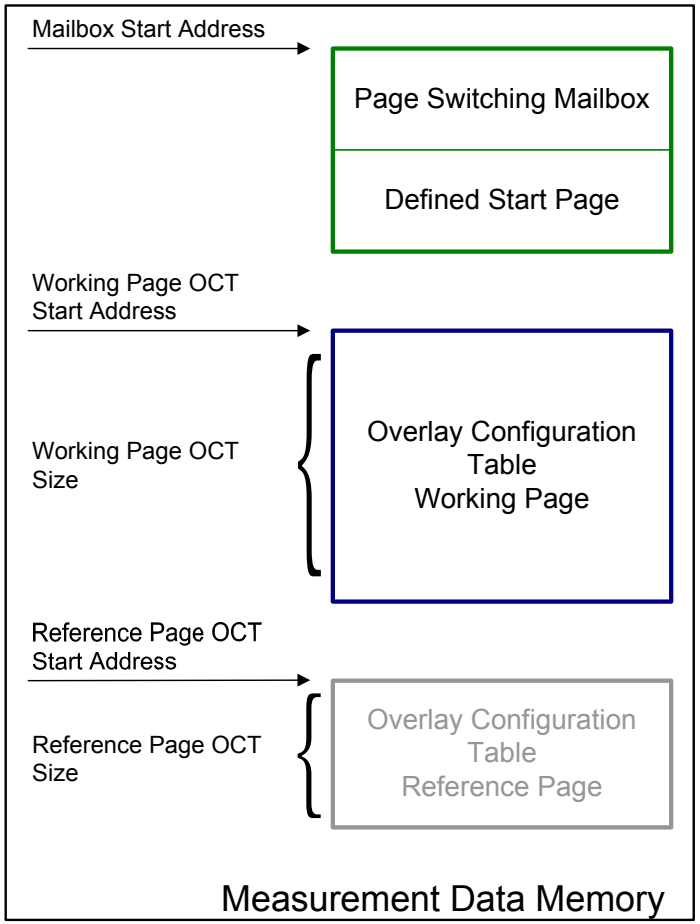
When the experiment is opened in INCA the Limited Emulation Toolbox will:

- Check if Full Emulation is possible?
  a) Possible:
  ⇨ toolbox configures the memory silent to cover all calibration variables
  b) Impossible:
  ⇨ toolbox configures the memory silent to cover all calibration variables which are different between WP and RP
    ⇨ if not possible INCA will request to FLASH the WP data
  ⇨ mark all Calibration Variables as writeable, even not covered by CALRAM yet

During Calibration:

⇨ after the modification of a calibration value the toolbox will adapt the CALRAM to cover this calibration variable and write the changed value

ETKS6.0 Project Configuration
Protocol Based Page Switching



Overlay Configuration Table

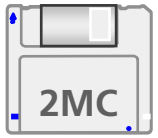
- describes registers to be written to switch page (address, value)
- Inca writes table, when configuration has changed
- ECU software writes registers by processing this table

Page Switching Mailbox

- Communication channel between Inca and ECU software
- Inca writes request („WPRQ", „RPRQ")
- ECU software processes request and write acknowledge

ETKS6.0 Project Configuration
Protocol Based Page Switching

ASAM-2MC File

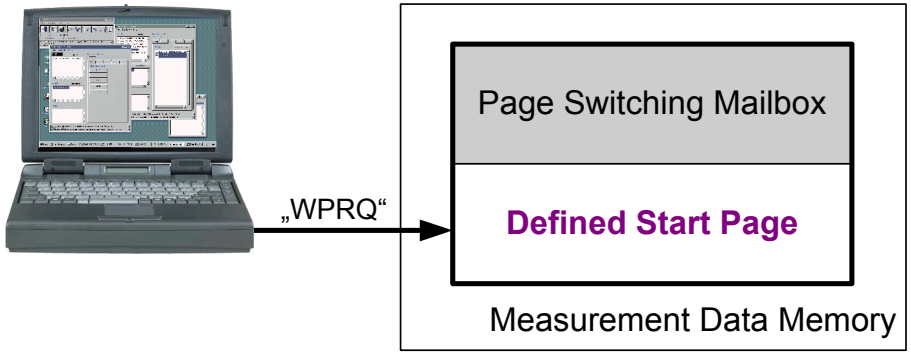


AML1.7 or newer

```
PAGE_SWITCH_METHOD
      1                                  /* version                                  */
      MAILBOX
       1                                 /* Version of mailbox                       */
       500                               /* max time the ECU needs to set up page in ms */
                                         /* max allowed time 500 ms !                */
       0xfff90000                        /* Start address of table                   */
       AUTOSTART_BEHAVIOR
       ALWAYS_WP
       OCT_WORKINGPAGE
       0x21                              /* Version of table                         */
       0xfff90964                        /* Start address of table                   */
       52                                /* max Length of table in byte              */
```

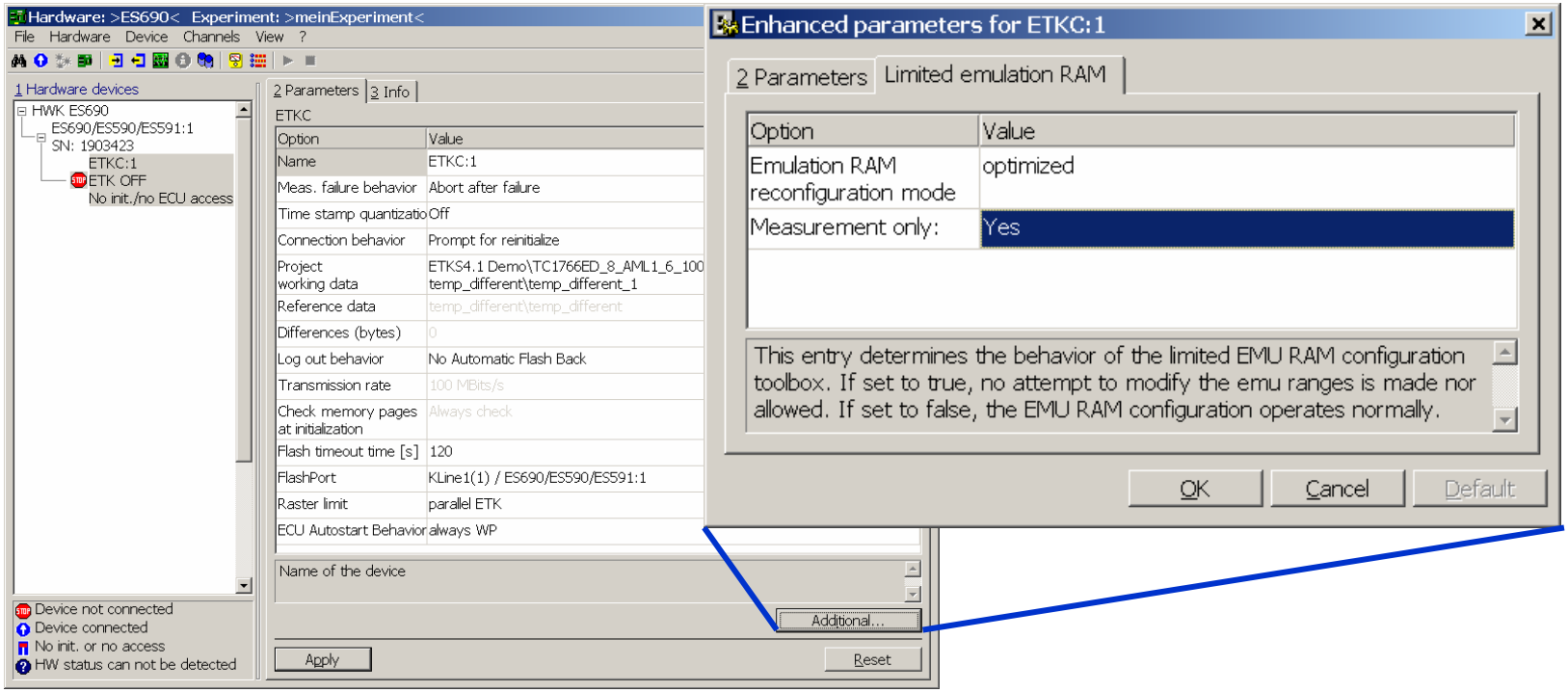
Autostart Behaviour:

- Always Working Page
- Always Reference Page
- Last active page

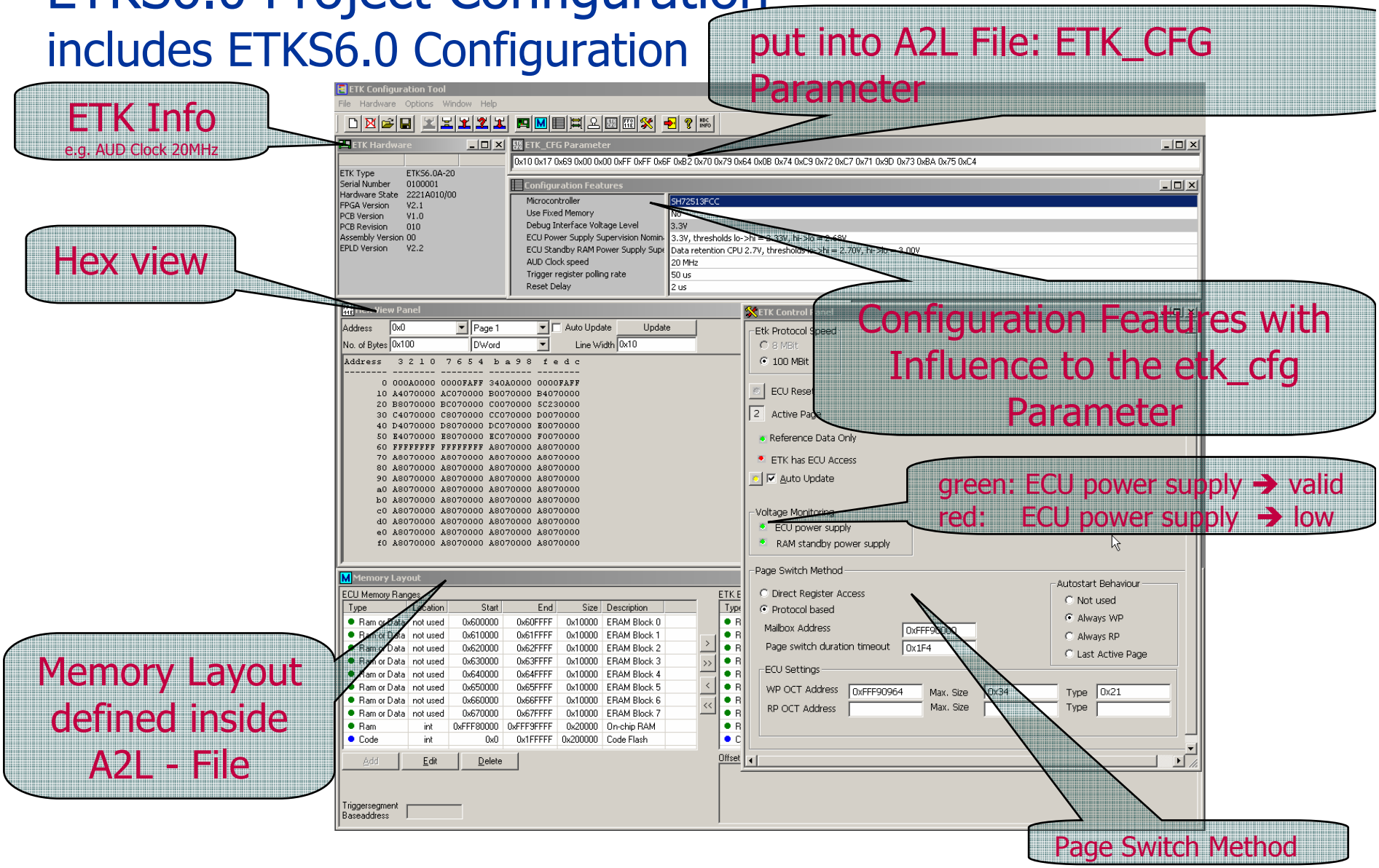


ETKS6.0 Project Configuration
Advanced feature: Measurement Only Mode

- Requirement:
  - program (code) version in ECU is different than the version in Inca; but A2L description in Inca is correct
  - User wants to measure but not to calibrate



ETKS6.0 Project Configuration
includes ETKS6.0 Configuration



ETKS6.0 Solution Proposal For ECU Integration
External Files

- **Reference Documents**

↳ Trigger Concept of serial ETKs


Trigger Concept of serial ETKs.ppt

↳ Calibration Page Handling


ETKS6_CalibrationP
ıgeHandling_V04.pp

↳ Standard Flashing


Standard-Flashing_
V11

ETKS6.0 Solution Proposal For ECU Integration

Implementation Order (Protocol based page switching and Distab) 1/2

- Verify hardware:
  - verify that ECU power supply is valid
  - verify that standby voltage is valid !
    - ➔Without standby voltage it is not possible to switch to WP
  - verify that CPU AUD is enabled
  - ➔while reset inactive, it is possible to view ECU memory via ETK Configuration Tool

- ETK HW Detection
  - ECU handshake via AUD - Register
  - ➔ETK is now detected

ETKS6.0 Solution Proposal For ECU Integration

Implementation Order (Protocol based page switching and Distab) 2/2

- Page switch via direct register access
  - no entry of PAGE_SWITCH_METHOD in A2L File
  - ➔It is now possible to use INCA direct register access switching

- Data Acquisition
  - Add display table functionality
  - ➔Measure variables in INCA

- Implement WP/RP Mailbox
  - Implement actual page switch using **Protocol Based Page Switching**
  - entry of PAGE_SWITCH_METHOD in A2L File
  - ➔It is now possible to use INCA with Protocol Based Page Switching

ETKS6.0 Solution Proposal For ECU Integration

Change Information

Revision	Description	Page	Date
V08	- Support additional Microcontroller with INCA 6.1: SH72512F(FCC), SH72513F(FCC), SH72544 - Redesign of the board	 3, 4, 16 14,15	07.11.2007