

## Tutorial for Lifetime Requirements and Physical Testing of Automotive Electronic Control Units (ECUs)

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## Purpose of this Presentation

- This presentation will explain typical requirements for automotive ECUs mainly used in engine compartment
- Physical requirements are very diverse and dependent on:
  - OEM test requirements
  - Electric/ Electronic Architectures
  - Use Cases
  - Specific location
  - Other specifications such as (ISO26262, DIN EN 60529, ...)
- This presentation is not a complete summary of all requirements



## Performance Characteristics

<b>Features</b>	<b>PC, LD_CV (Passenger-Car, Light-Duty Commercial vehicle)</b>
Service life	15 years
Hours of operation (active operation during service life)	8,000 h
Mileage	300,000 km
Days of operation per year	365 days
Cold starts	2/day =10950
All start-up procedures (averaged over service life)	6/day*

\* Not considered Start/Stop Systems



# Lifetime Requirements and Testing of ECUs

## Active Operation: Typical Temperature-Load Distribution (ambient)

T <sub>i,ECU</sub> = ECU inner air temperature	Typ. load (Passenger Car)	
	Vehicle body, bulkhead, extension close to the engine	
-40°C...10° C	6.0 %	480 h
10°C...45° C	20.0 %	1600 h
45°C...60° C	33.0 %	2640 h
60°C...70° C	18.0 %	1440 h
70°C...80° C	9.0 %	720 h
...85° C	3.0 %	240 h
...90° C	2.0 %	160 h
...95° C	1.7 %	136 h
...100° C	1.5 %	120 h
...105° C	1.4 %	112 h
...110° C	1.3 %	104 h
...115° C	1.2 %	96 h
...120° C	1.0 %	80 h
...125° C	0.9 %	72 h
<b>Total</b>	<b>100%</b>	<b>8000 h</b>

## ECU Tests

- High Temperature Endurance Test
  - 125° C ECU inner air temperature (= max. ambient temperature of components)
  - 2,000 h operation
  - operating state: active
  - ECUs will be tested autarkic with corresponding loads
  - Pass criteria: functional test within specified tolerances
  
- Damp Heat, constant
  - 85° C inner air temperature, 85 % rel. humidity
  - 1000h
  - operating state: 1h on, 1h off alternating
  - Pass criteria: functional test within specified tolerances
  - Following specification is used by some OEMs: IEC60068-2-30



## ECU Tests

- Temperature Cycles – Shock Test
  - -40° C to +125° C
  - 1650 cycles
  - 30 min. dwell time
  - 10 s transfer time
  - operating state: passive
  - Pass criteria: final functional test within specified tolerances



## ECU Tests

→ Vibrations, often combined with temperature changes (min to max)

Installation position	Stimulus	ISO16750-3: 2007	Acceleration	Bandwidth	t <sub>Test</sub>
Passenger compartment / car body / chassis	Noise	Test IV	$a_{\text{noise, eff}} = 27,8 \text{ m/s}^2$	10Hz...1000Hz	12h

→ Mechanical Shock

Parameter	Value
Reference	DIN EN 60068-2-29:1995
Use case	Passenger car
Pulse shape	Half sinusoidal
Acceleration	$500 \text{ m/s}^2 \sim 51 \text{ G}$
Duration	11ms
Number of shocks	10 per direction, 3 directions (a separate test sample has to be used per direction)
Operating state	active

## ECU Tests

### → Drop test

Parameter	Value
Reference	ISO16750-3:2007, DIN EN 60068-2-32:1995
Drop height	1m, free fall
Surface	Concrete
Number	2 falls per direction, maximum 2 falls per sample
Operating state	Passive (without plug)



# Examples Automotive Components

### Electronic Control Units:

- Chassis & Safety Control Unit
- Body Computer w/ integrated gateway
- Diesel Control Unit

### Cable Harness:

- Harness for headlights
- Harness for Cockpit
- Harness for Body

Many Thanks for providing us these samples to:  
Helge Zinner (Continental)  
Stefan Buntz (Daimler)  
Michael Mehnert (Bosch)



# Chassis & Safety Control Unit (B-Sample)

## Hardware

- ▶ Dual Core CPU
- ▶ Communication Interfaces
  - ▶ 3x CAN
  - ▶ 1x FlexRay
- ▶ 3 x Gyros (X,Y,Z-Axis)
- ▶ 2 x Accelerometer
- ▶ Automotive Temperature Range -40°C – +85°C

## Features

- ▶ Focus on body control (ESP)
- ▶ Architecture based on fail safe CPU
- ▶ AUTOSAR stack implemented



# Engine Control Unit

- Solenoid valve injector and piezo injector control for Diesel Systems
  - Conform to actual exhaust gas legislativ regulations
  - Scalable SW product: from basic to high-end segment
  - Optional features availabe such as
    - Start-Stop,
    - Diesel Particle Filter (DPF),
    - Selective Catalytic Reduction (NOx reduction) (SCR)



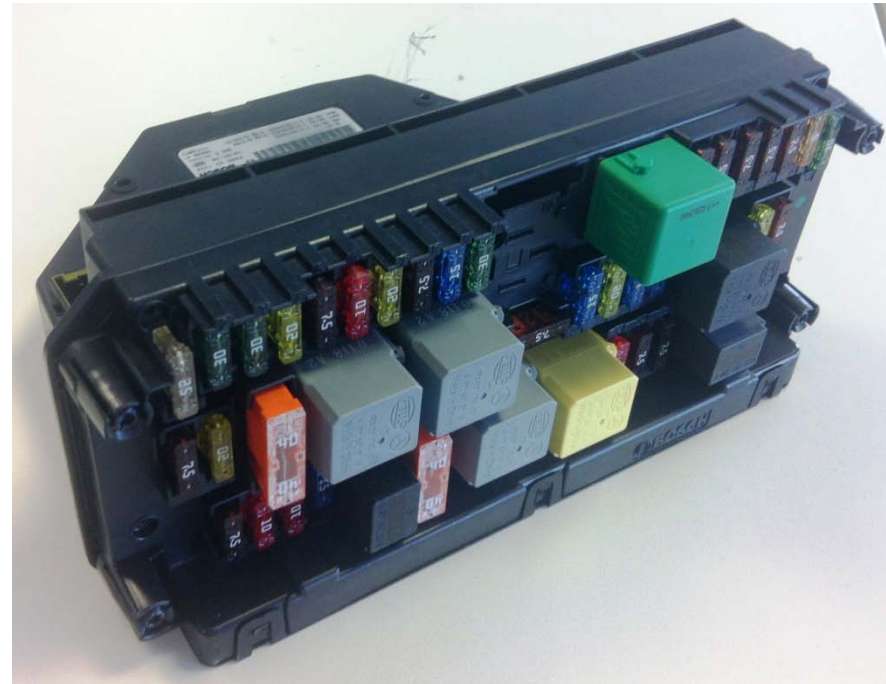
# Body Computer w/ Integrated Central Gateway

### Features:

- 2 CPUs
- Additional fail safe CPU
- 4 CANs
- 2 LINs
- Several I/Os up to 40 A
- Integrated fuses and relays

### Requirements:

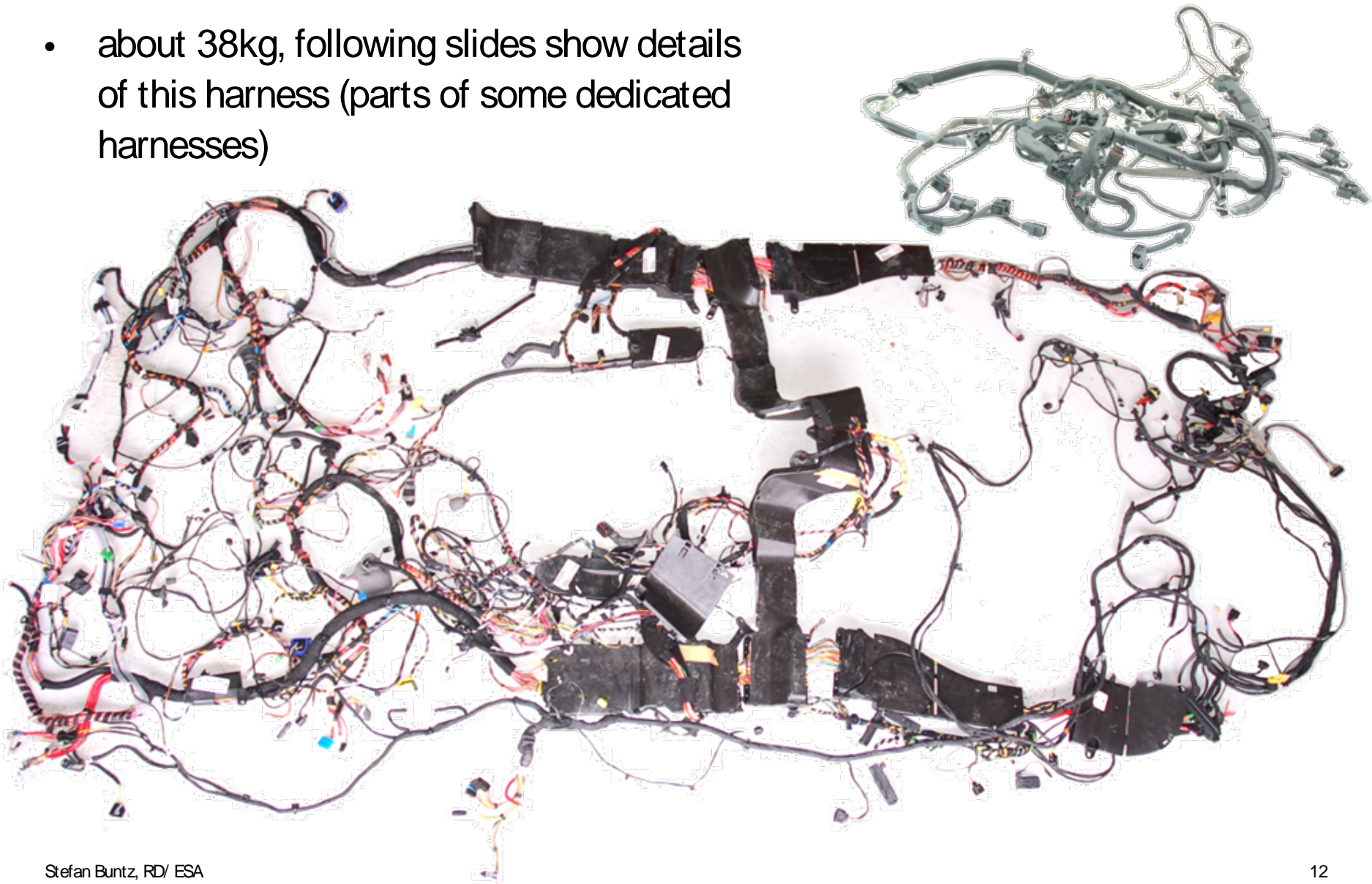
- Service Life: 15 years
- Sleep mode current consumption: 350 $\mu$ A (2 ECU in one, Daimler default per ECU 100 $\mu$ A)
- Normal mode (no function active) current consumption: 250mA
- Wake up time: 120ms





## Mercedes-Benz S-Class (2006) complete cable harness

- about 38kg, following slides show details of this harness (parts of some dedicated harnesses)



## engine harness (e.g. headlights)



## cockpit harness



## body harness (part)

