| BOSCH | Technical Customer Information<br>Ambience Conditions and Mechanics<br>ACC Distance Control Radar 2nd Generation | 0 265 K60 059 |
|---|---|---|

| | |
|---|---|
| AE-DA/ELR<br>AE-DA/EFS<br>AE-DA/EPS | Customer : **General Information**<br><br>Vehicle type :<br>Order number :<br>Offer drawing :<br>System : **ACC 2 Radar-Sensor**<br><br>Remark : **For I N F O R M A T I O N only** |

| **Issue and Author:** | | **8** |
|---|---|---|
| Department: | Date: | Signature: |
| AE-DA/ELR4 | 26.11.03 | Gez. Beez |
| **Detailed description of modifications see page 2** | | |

| **Checked, Reviewed by:** | | |
|---|---|---|
| Department: | Date: | Signature: |
| AE-DA/ELR4 | 26.11.03 | Gez. Beez |
| | | |
| | | |

| **Agreements, Permission by:** | | |
|---|---|---|
| Department: | Date: | Signature: |
| AE-DA/ELR | | |
| AE-DA/EFS | | |
| AE-DA/EPS | | |

## Modifications

| No. | Date/<br>Reviser | Chapter | Description of modification |
|---|---|---|---|
| | 04.07.01 | - | Preliminary Edition |
| 1 | 08.08.01 | -<br>2 | Document Number<br>Mounting Conditions |
| 2 | 24.01.02 | | watermark<br>new department names<br>update of: drawings, outline dimensions, circuitry |
| 3 | 05.02.02<br>Bz | 3.1<br>4 | drawing of outline dimensions<br>update electrical data, circuits |
| 4 | 27.05.02<br>Bz | 1.3<br>2.1<br>2.2<br>3.1<br>4.2<br>4.3<br>5 | new chapter added for CAN communication specifications<br>temperature after painting increased<br>operating temperature range adapted<br>weight added<br>clearance updated for bracket needs<br>type of plug (MQS System from AMP) added<br>fusing for V Bat an load dump protection added<br>upper temperature adapted according chapter 2.1 |
| 5 | 12.08.02<br>Bz | 2.1<br>3.1 | Operating Temperature Range, max. temp. increased<br>Bracket Concept added |
| 6 | 24.01.03<br>Bz, Kl | | Cover Sheet updated<br>chap. 2.1: operating temperature range adapted<br>chap. 2.2: climate conditions updated<br>chap. 3: mounting conditions updated<br>(clearance, cone of the radar beam, offer drawing)<br>chap. 3.2: sensor adjustment directly from the front |
| 7 | 27.08.03<br>Ks<br>20.11.03<br>Pl<br>20.11.03<br>Hil | 3<br><br>5<br><br>3 | offer drawing, figures, cone, sensor mounting<br><br>information of the scraping of the DUT<br><br>Information for radome material |
| 8 | 12.01.04<br>Hil | 1.4 | FCC Part 15/RSS-210 wording for manual |

# Table of contents

# 1 External Reference Documents

## 1.1 Environmental Test Specifications

The environmental tests for the ACC SCU are proceeded according:

| |
|---|
| DIN IEC 68-x-x |
| DIN 50018 |
| DIN 50021 |
| DIN 40050, part 9 |
| Bosch N42 AP xxx |

## 1.2 Regulations

The ACC SCU meets the following statutory requirements and therefore obtains the type approvals from those countries mentioned in the requirements:

| |
|---|
| EN301091 V1.1.1 |
| Code of Federal Regulation Part 15 Title 47 (FCC)<br>RSS -210 Industry Canada |
| Japanese ARIB STD-48 |
| Radio-Communications(LIPD) Class Licence 2000 (Australia) |

Type approvals from other countries than these from the regulations above can be achieved but have to be charged separately.

## 1.3 Communications

The ACC SCU meets the following specifications for CAN communication (high speed CAN):

| |
|---|
| SAE J 22284 |
| ES-XS4T-12K259-Cx |
| others |
| |

## 1.4 Wording for User Manual

**The user manual shall contain the following statements:**

This device complies with Part 15 of the FCC Rules and with RSS-210 of Industry Canada.

Operation is subject to the following two conditions:

(1) this device my not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

**Warning:** Changes or modifications made to this equipment not expressly approved by ***ROBERT BOSCH GmbH*** may void the FCC authorization to operate this equipment.

# 2 Ambient Conditions

## 2.1 Temperature range

| | |
|---|---|
| Storage temperature | - 20..+ 50 °C max 5 years |
| Operating temperature range<br>(measured at ACC base plate) | - 40..+ 90 °C<br>(short time 100°C) |
| Temperature after painting | + 125 °C max. 1h, non powered |
| Temperature range for alignment<br>(measured at ACC base plate) | - 10..+ 100 °C |

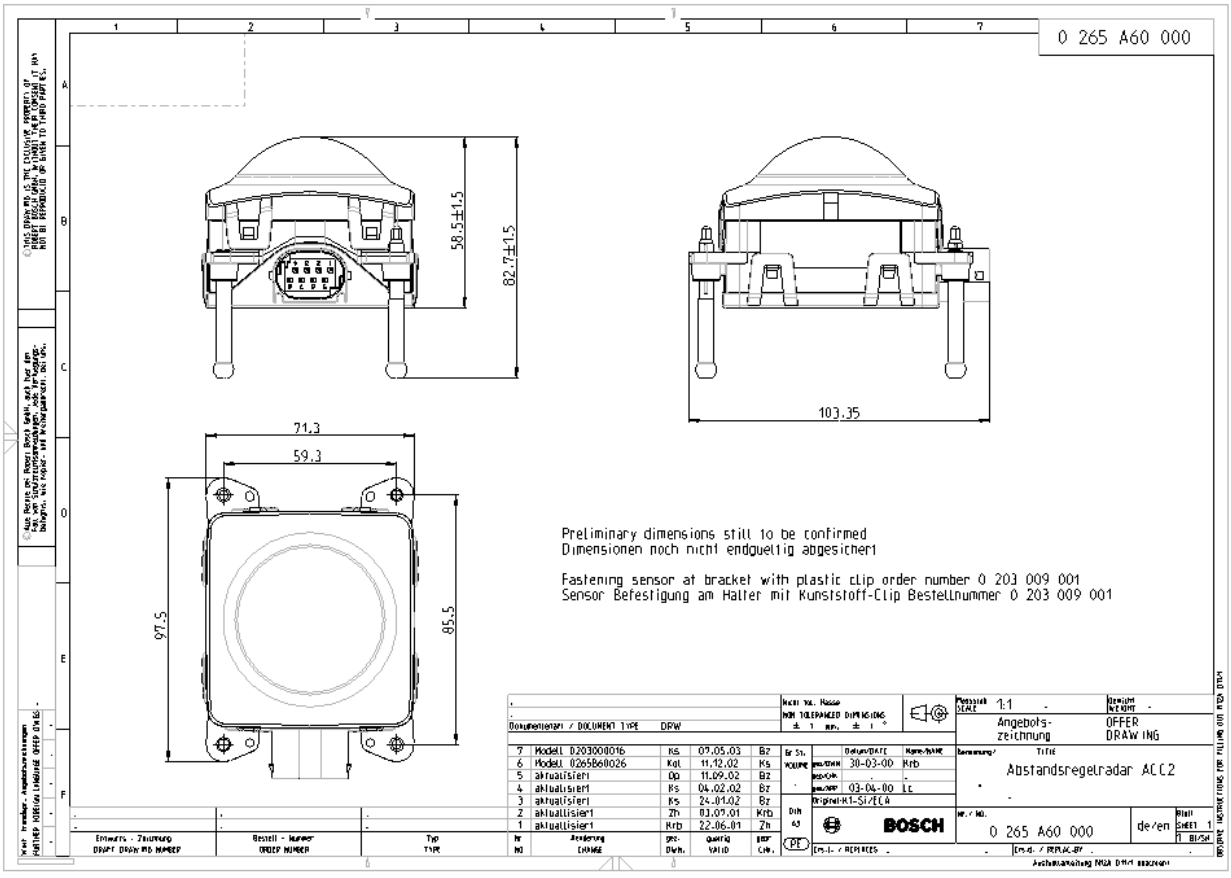
## 2.2 Mechanical and climate conditions

| | | |
|---|---|---|
| Mounting area | | Vehicle front area |
| Kind of protection | complete ACC-SCU | IP 54 K (DIN 40 050) |
| | frontal area (lens) | IP X4 K (DIN 40 050)<br>IP X6 K (DIN 40 050)<br>IP X9 K (DIN 40 050) |
| Stone impact | frontal area (lens) | Resistance to stone impact acording VDA 621-427 |
| Vibration | | Random vibration $a_{eff}$ = 27,8 m/s$^2$, 3x8 h<br>(according ISO/DIS 16750-3) |
| Weight without bracket | | < 300g |

# 3 Mounting conditions

## 3.1 Installation instructions for the ACC2 - SCU

The ACC SCU is installed in the frontal area of the vehicle. The sensor lens points in the vehicle driving direction, the connector either down to the road or up. The outline dimensions of the sensor are shown in the following drawing:



Ideally the sensor is to be integrated into the front-end without a cover in front of its lens.

If the sensor is to be installed behind a cover or a radome, special care must be taken in selecting the cover-material, cover shape (or design) and position of the cover relatively to the sensor. Water droplets and snow sticking onto the cover surface might cause additional attenuation that leads to a restricted performance or availability of ACC. For the uncovered build-in configuration the lens design of the ACC-SCU is chosen to minimise these effects. Water droplets can be blown off by the driving wind and sticking snow can be heated off by the integrated lens heating.

The following table lists the basic demands to the integration of the sensor into a front-end of the car:

| | |
|---|---|
| Installation height above ground (roadway) [1] | min. 300 mm<br>max. 1000 mm |
| Horizontal offset relative to the vehicle longitudinal axis [1] | max. 500 mm |
| Horizontal angle relative to the vehicle longitudinal axis [1] | 0° |
| Vertical tilt relative to the vehicle longitudinal axis [1]<br>(dependent on pitch when car is fully loaded or while braking) | Proposal: adjusting area at sensor ± 3° [2] |
| Clearance of parts (out of metal or even plastic) in front of the sensor can be described by a cone directly in front of the lens with the following angles<br>horizontal<br>vertical<br>The cone that represents the radar beam in shown in figure 1 | <br><br><br>± 14° [3]<br>± 7° [4] |
| Clearance to other vehicle parts:<br>(sensor-movement during adjustment: ± 3° vertical and horizontal and additional space for the bracket behind the SCU is considered)<br>in lateral direction<br>in front of the lens<br>behind the sensor (space for clip and bracket) | <br><br><br>each side 10 mm<br>15 mm<br>30 mm |
| Permissible attenuation caused by cover (bumper, radome) in front of the lens ; two-way (radar) loss | max . 1 dB |
| The constraints for the cover are:<br>- homogeneous material has to be favourized<br>- non perpendicular orientated relatively to sensor radar axis<br>- favoured materials : see following material list | Minimise material thickness due to dielectric loss |
| The material in front of the radar should not degrade the antenna parameters<br>• Beamwidth error<br>• Sidelobe change<br>• Peak boresight error | <br><br>• max. 1%<br>• max. 1 dB<br>• max. 0.1° |
| In case of radome heating the orientation of wire structures has to be checked<br>Wire diameter is limited to max. 0.25mm | linear 45°<br>from upper left to lower right as seen in |

| | |
|---|---|
| | driving direction |
| In case of shaped radome / bumper the radius of the material is limited | > 25 mm |
| In case of non-homogeneous material the air gap between the materials is limited | < 0.05mm |
| In case of painting carbon based primer is not allowed | |

[1] relative to the ACC SCU; central axis of the lens
[2] the full adjustment range is only available at 0° vertical tilt
[3] angle results from horizontal beam width (±8°) of the radar beam plus adjustment area (±3°) plus safety margin (±3°). Car tolerances wont be considered.
[4] angle results from vertical beam width (±3°) of the radar beam plus adjustment (±3°) area plus safety margin (±1°). Car tolerances wont be considered.

**Radome / Bumper Material list:**

| ***Material*** | | $\varepsilon_r$ | **tan $\delta$ x $10^{-4}$** |
|---|---|---|---|
| Polyethenimid | PEI | 3.05 | 150 |
| Polycarbonat | PC | 2.7 | 100 |
| Polyethylene | PE | 2.3 | 5 |
| Polypropylene | PP | 2.18 | 7 |
| Polytetrafluorethylene | PTFE | 2.07 | 5.5 |
| Polymethylenmetacrylat | PMMA | 2.62 | 26 |

Figure 1: Sketch of the area of clearance directly in front of the sensor (cone for representing the radar beam)

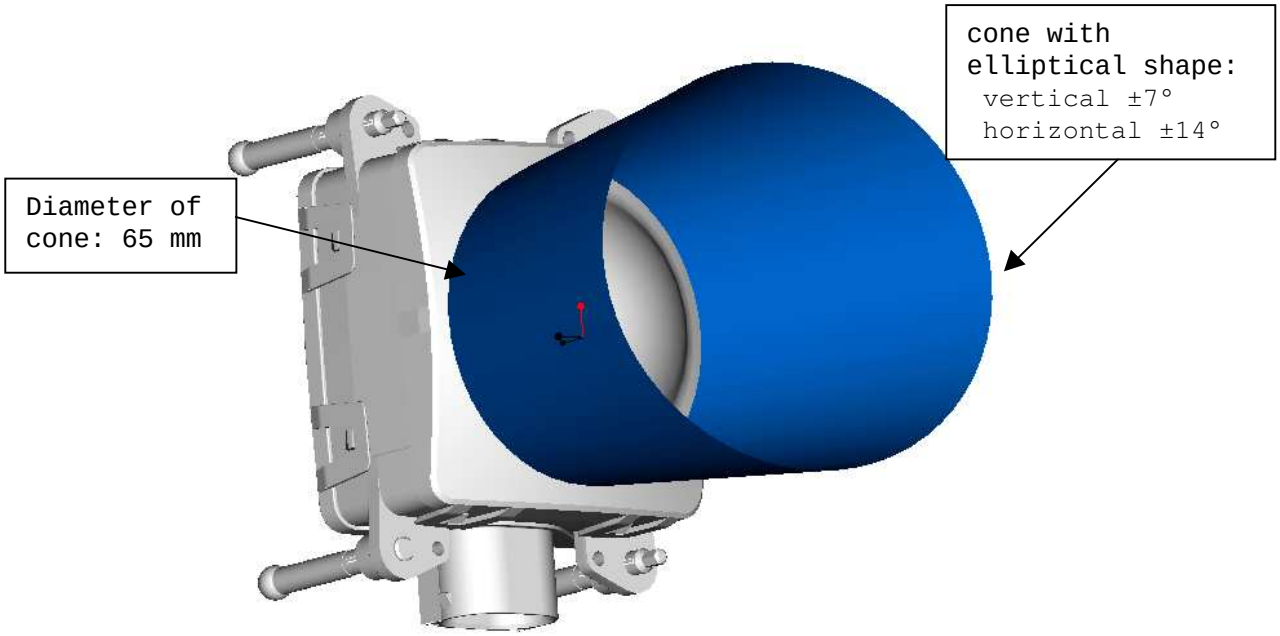
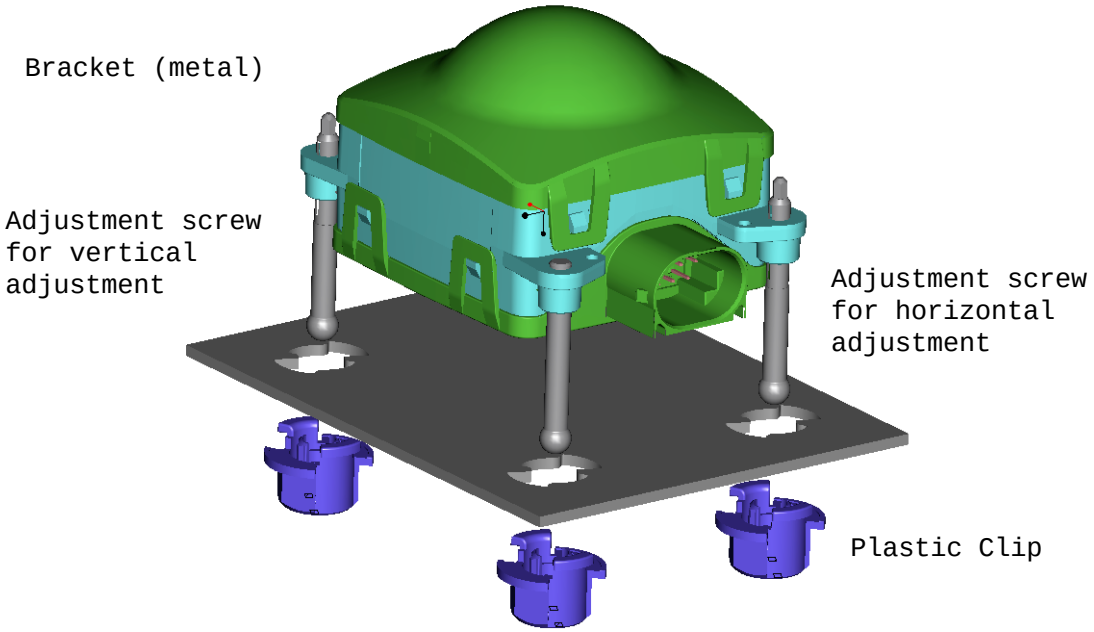



Figure 2: Sketch of the bracket concept for the SCU



## 3.2 Sensor bracket / adjustment

The ACC SCU has to be fixed with a vehicle-specific sensor bracket.
The bracket is used to attach the sensor to the vehicle. The points where the bracket is attached to the vehicle must be selected carefully to ensure a very stable mounting of the sensor relatively to the vehicle longitudinal axis.

The three clips are used to fix the sensor in the bracket. First each clip is locked by 90° rotation (clockwise). The sensor is fitted to the bracket by pressing the sensor with guiding the clip hole (see figure 2 above).

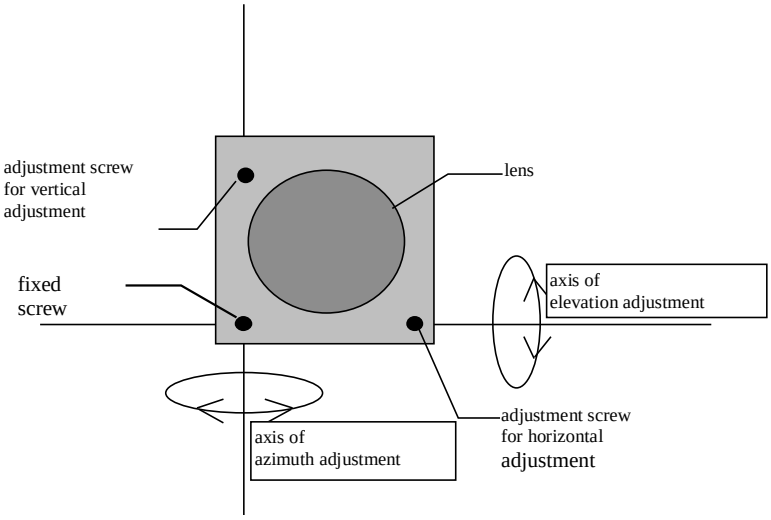
Please note that the bracket needs some space in the near surrounding of the sensor.
The overall dimensions of the sensor with bracket have to be discussed together with the customer.

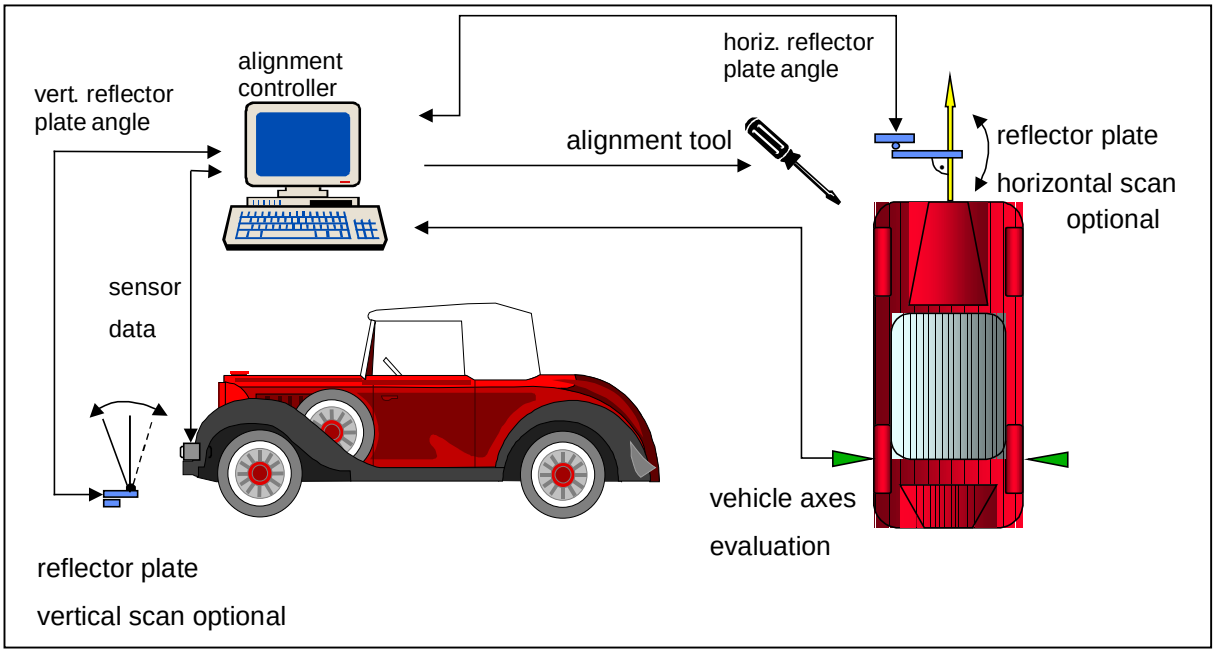
| | |
|---|---|
| Mounting conditions | min. 2 fixing points at the vehicle |
| | no relative movement between the fixing points at the vehicle |
| | long-term stability between the fixing points and relative to the vehicle longitudinal axis |
| max torque for clip (locking in the bracket) | < 2.5 Nm (max. 3.0 Nm allowed) |
| max pressing force (sensor to clip holes | < 170 N per screw |
| min dismantling force (sensor out of clips) | > 70 N per screw |

The sensor bracket also enables horizontal and vertical adjustment of the ACC SCU radar beam to the vehicle longitudinal axis → see figure below.
In our solution this is done with self-tapping adjustment screws in plastic mounts.
The adjustment is done after attaching the sensor to the vehicle, using an external adjustment fixture, like an optical mirror. No external high frequency measurement equipment is needed.

| | |
|---|---|
| Adjustment direction for screw driver | directly from the front |
| Adjustment range (proposal)<br>Horizontal angle [1]<br>vertical angle [1] | <br>$\pm 3°^{\pm 0,2°}$<br>$\pm 3°^{\pm 0,2°}$ |
| Permissible number of adjustments during vehicle life | 6 adjustment operations per adjustment screw over the adjustment range |
| Adjustment accuracy relative to the vehicle longitudinal axis | re-determined for each new type of vehicle |
| Speed of adjustment screw driver | Max. 120 revolutions/min. |

The following sketches illustrate in principle the horizontal and vertical adjustment of the sensor. The procedure is as easy as the alignment of the head lamps and can be done at the same test bench in the customers plant.

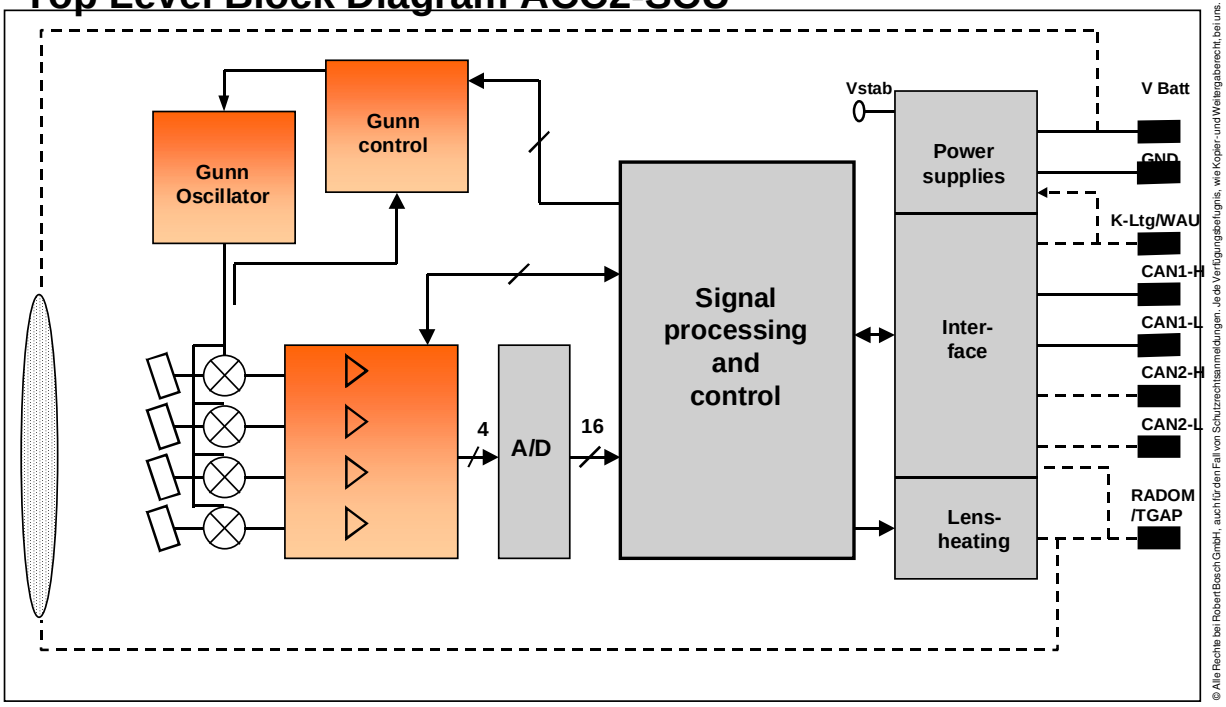


# 4 Electrical Data

## 4.1 Block diagram (Top level)

**ACC2 (Adaptive Cruise Control)**
**Top Level Block Diagram ACC2-SCU**

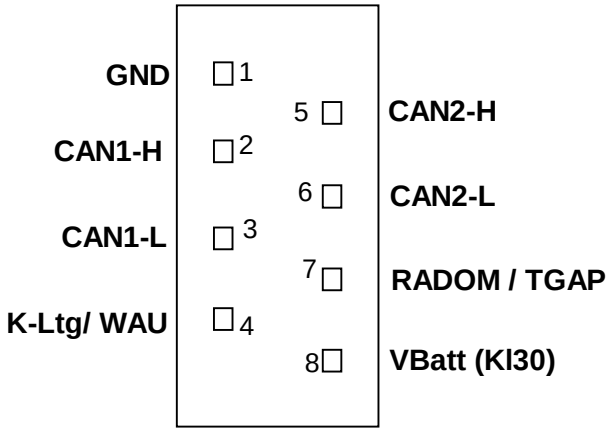



BOSCH

AE-DA/ELR 20204 0190

## 4.2 Pinning and Type of Connector

The following sketch shows the pinning of the ACC sensor. The number of pins are fixed to eight.




| Pin-No. | Designation | Description | Proposed wire size for connecting harness |
|---|---|---|---|
| 1 | GND | Sensor ground: connected to pin 31 | 0,75 $mm^2$ |
| 2 | CAN1-H | CAN1 High | 0,5 $mm^2$ |
| 3 | CAN1-L | CAN1 Low | 0,5 $mm^2$ |
| 4 | K-Ltg [1)] | Diagnosis interface | 0,5 $mm^2$ |
| 4 | WAU [1)] | Wake up signal | 0,5 $mm^2$ |
| 5 | CAN2-H | CAN2 High | 0,5 $mm^2$ |
| 6 | CAN2-L | CAN2 Low | 0,5 $mm^2$ |
| 7 | Radome [2)] | Output voltage for Radome heating | 0,75 $mm^2$ |
| 7 | TGAP [2)] | Analogue signal input (time gap) | 0,5 $mm^2$ |
| 8 | V Batt | Supply voltage for sensor | 0,75 $mm^2$ |

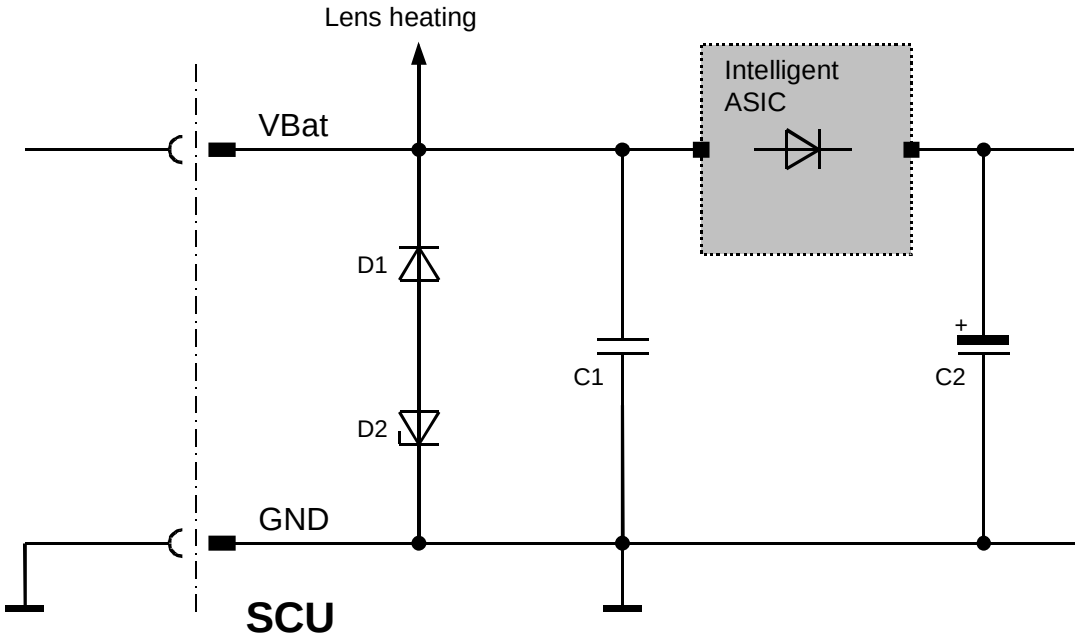
[1)]: Either K-line or WAU possible
[2)]: Either Radome or TGAP possible

The 2nd CAN bus can be used as a private CAN for future ACC functions.

The plug itself is designed according the MQS System from AMP.
- The SCU plug is: AMP No.: C-114-19063-34 Kod A
- The harness wiring plug is: AMP No.: 153 42 29 (MQS System)

## 4.3 V Bat - Interface

The equivalent circuit diagram of the V Bat - interface is as follows:




Electrical specification:
$U_{nom}$ = 12 V (full operation from 10V to 16V)
$I_{max} \leq$ 1.5 A (without lens heating)
$I_{max} \leq$ 3.0 A (with lens heating at ambient temperature < 10°C)

V bat shall be fused externally by min. 10 A
V bat shall be protected externally against over voltage and load dump up to 40 V

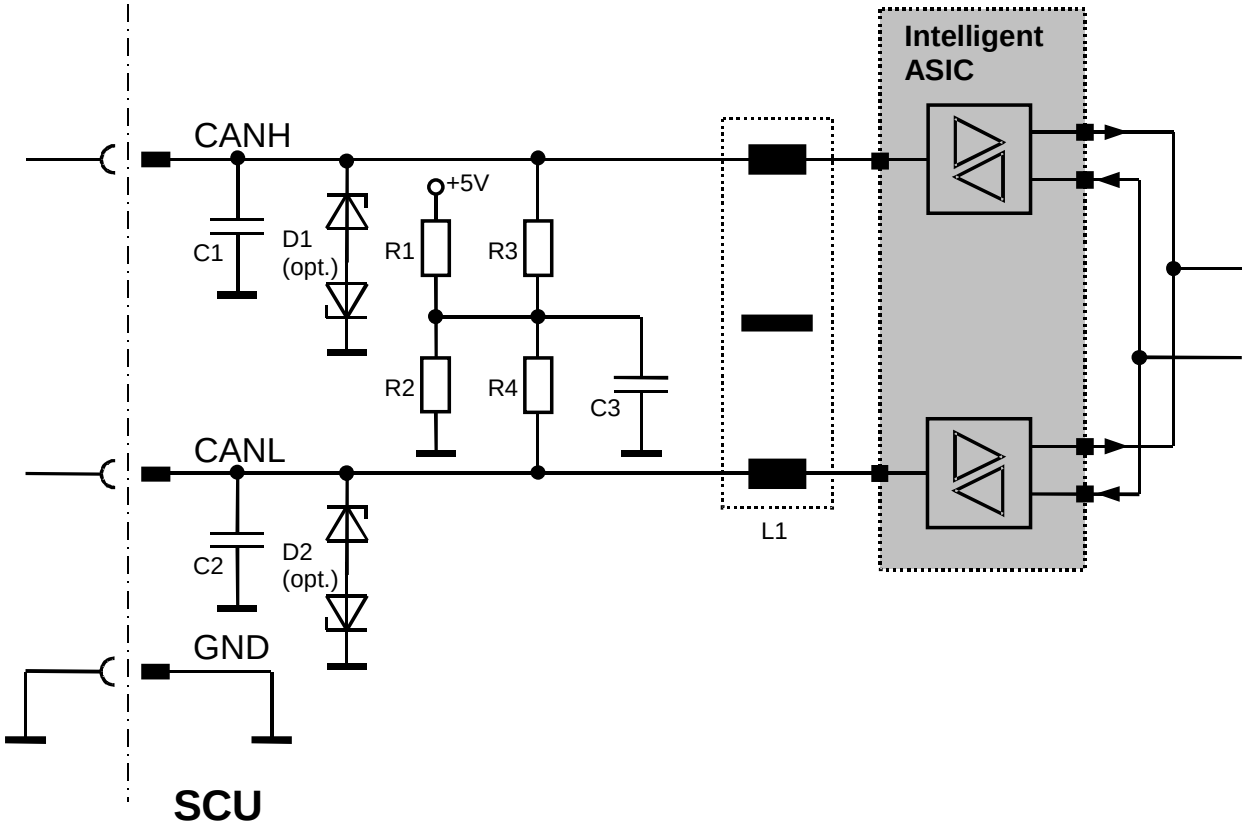
Quiescent Current:

| | |
|---|---|
| Sleep Mode: | $I_{max} \leq$ 50µA (without lens heating) |
| (wake up not activated) | $I_{max} \leq$ 100µA (with lens heating) |

Load capacitor: C1 + C2 < 300µF

## 4.4 CAN - Interfaces

The equivalent circuit diagram of the CAN - interface is as follows:




Optional population:
C1, C2 ≤ 100pF
C3< 10nF
R1,R2 < 1,5KΩ; R3, R4 = 61,9 bzw. 66,4 Ω
L: Choke 2 x 11µH (TDK, EPCOS)
D: Dual Common Cathode Zener for ESD Protection

The circuitry shows all possible options on the CAN.-interface.

If termination of the bus is not required the two 62 Ω-resistors($R_3$ and $R_4$) can be omitted or changed to higher value f.e. 1,3KΩ. The choke might be omitted if not required for EMC-reason.
The CAN bus is specified in „CAN Specification of the CAN physical layer for High-Speed-Application up to 1Mbit/s“, dated October 1989.

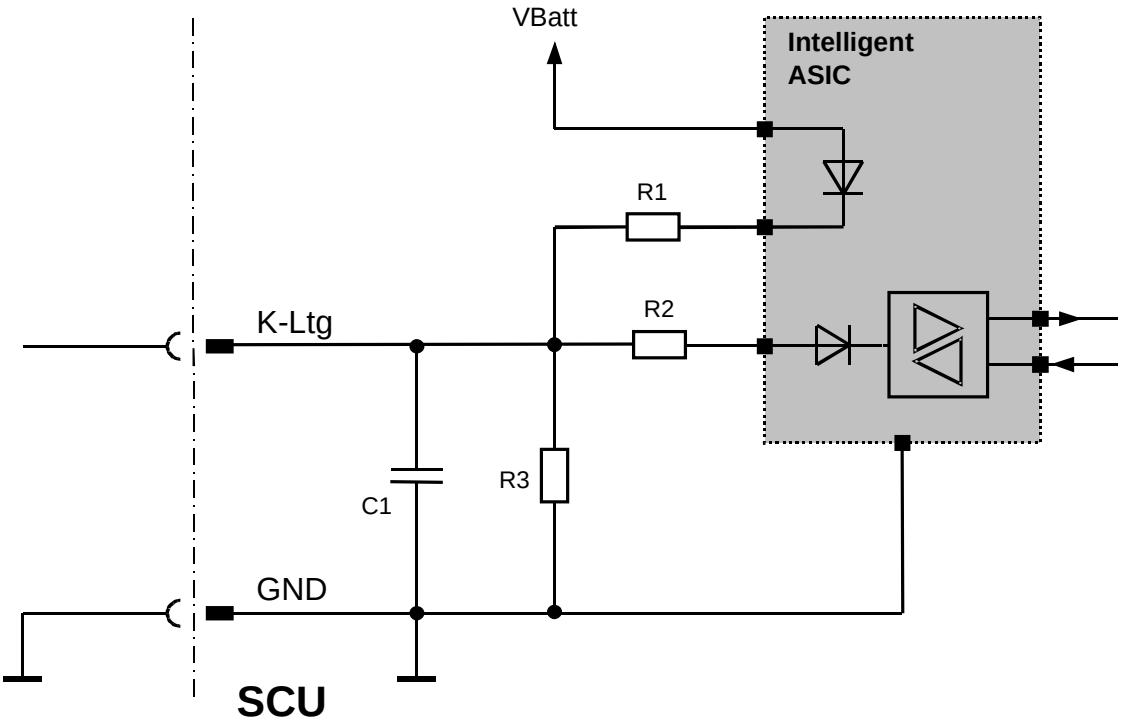
The following typical details are taken from this specification.
These details are valid for an ECU which is separated from the bus and loaded with a 60Ω resistor:

| **Recessive state:** | **(corresponding to logical 0)** |
|---|---|
| Output voltage: | $-0{,}5\ V \le U_{Signal1/Signal2} \le 0{,}05\ V$ |
| Input range: | $-1{,}0\ V \le U_{Signal1/Signal2} \le 0{,}5\ V$ |
| Input resistor: | $> 9\ k\Omega$ |

| **Dominant state:** | **(corresponding to logical 1)** |
|---|---|
| Output voltage: | $1{,}5\ V \le U_{Signal1/Signal2} \le 3{,}0\ V$ |
| Input range: | $0{,}9\ V \le U_{Signal1/Signal2} \le 5{,}0\ V$ |

## 4.5 Optional Diagnosis Interface (K-Line)

The equivalent circuit diagram of the diagnosis interface is as follows:

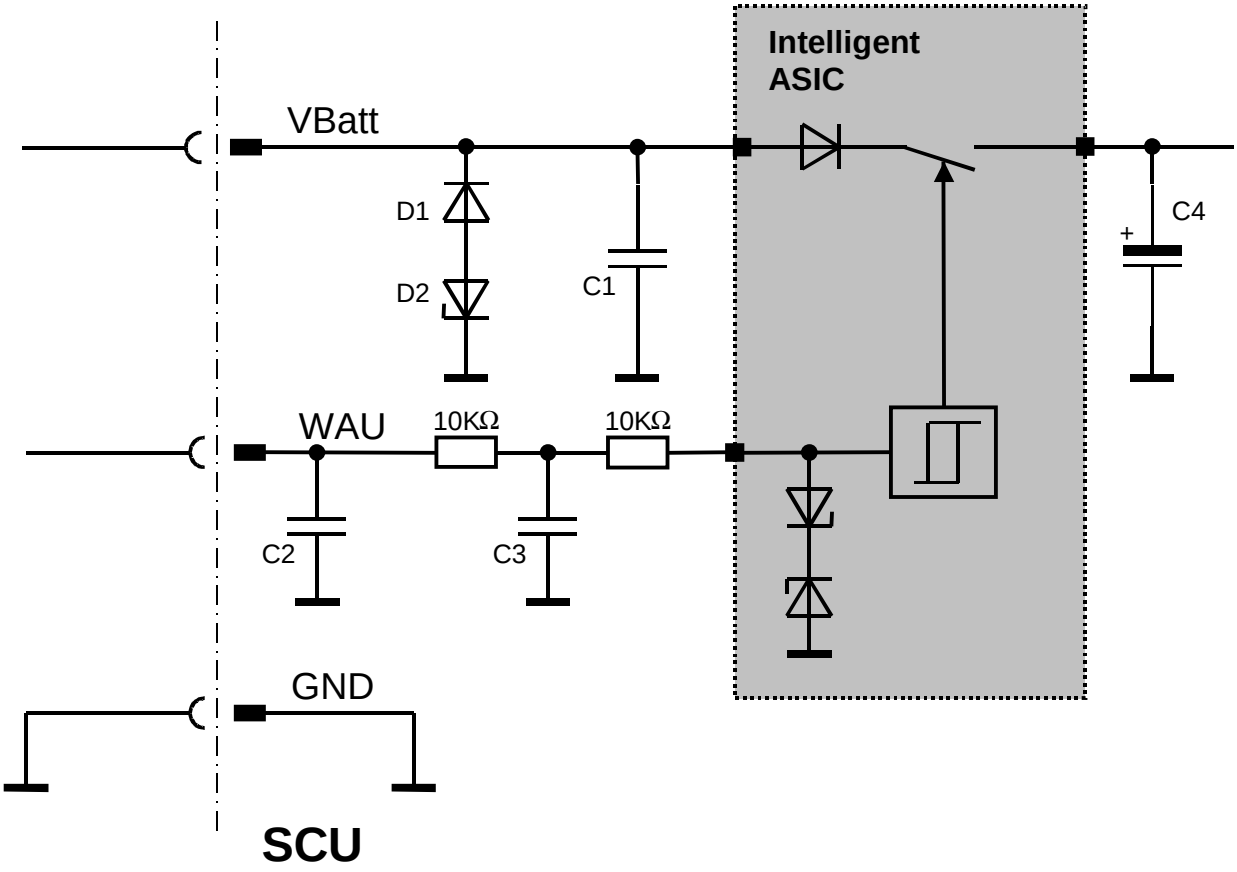



Electrical specification:
R1 ≤ 110 kΩ
R3 ≤ **TBC**
Either R1 or R3 to be inserted
R2 ≤ 80 Ω
C1 ≤ 500 pF

| | Transmit | Receive |
|---|---|---|
| logical „1“ | ≥ 0.8 × V Bat | ≥ 0.7 × V Bat |
| logical „0“ | ≤ 0.2 × V Bat | ≤ 0.3 × V Bat |

## 4.6 Optional Wake Up Line (WAU)

The equivalent circuit diagram of the wake-up interface is as follows:



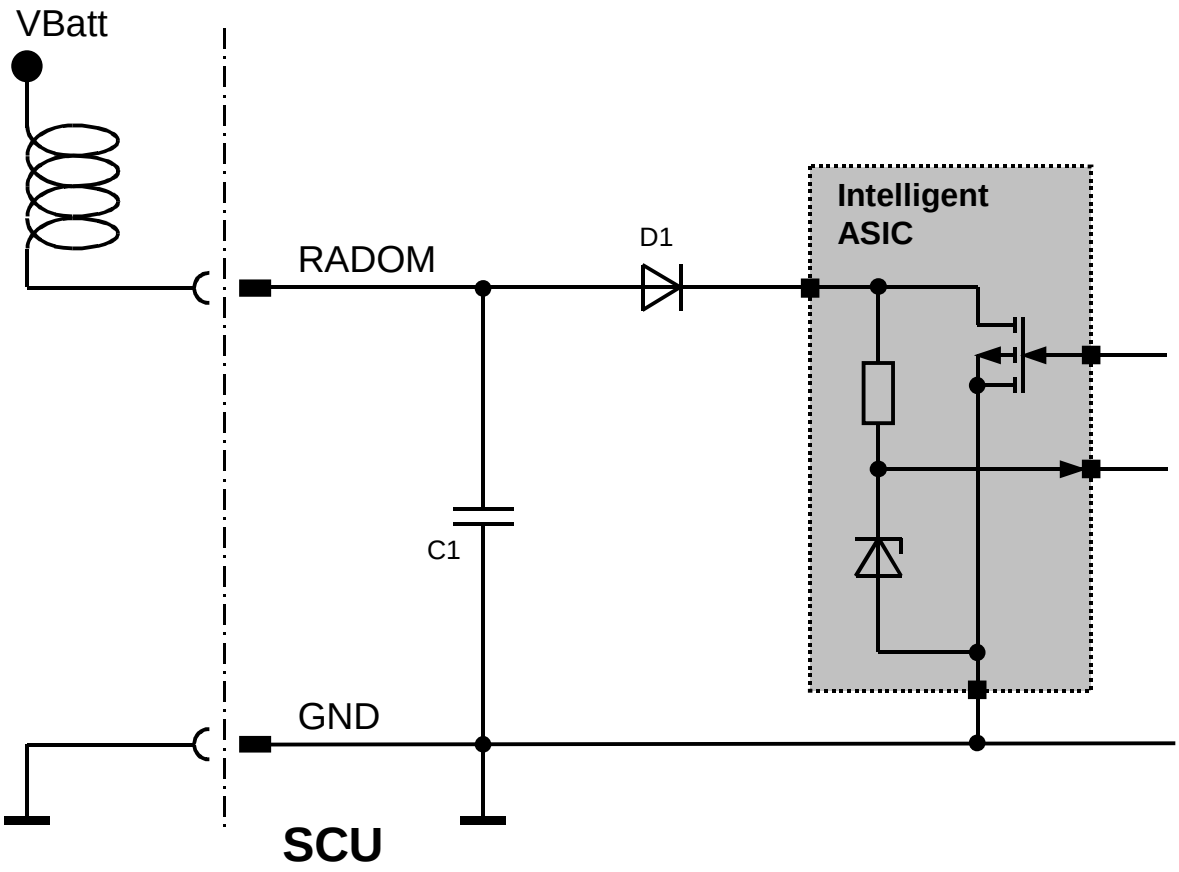

Wake-up voltages:

$U_{WAU\text{-}On} \geq 4.0$ V
$U_{WAU\text{-}Off} \leq 2.0$ V

C2 + C3 ≤ 200 nF

## 4.7 Optional Radome Heating Line (RADOM)

The equivalent circuit diagram of the RADOM - interface is as follows:




Electrical specification:
$U_{nom}$ = 12 V
$I_{max} \leq$ 3 A at $U_{nom}$

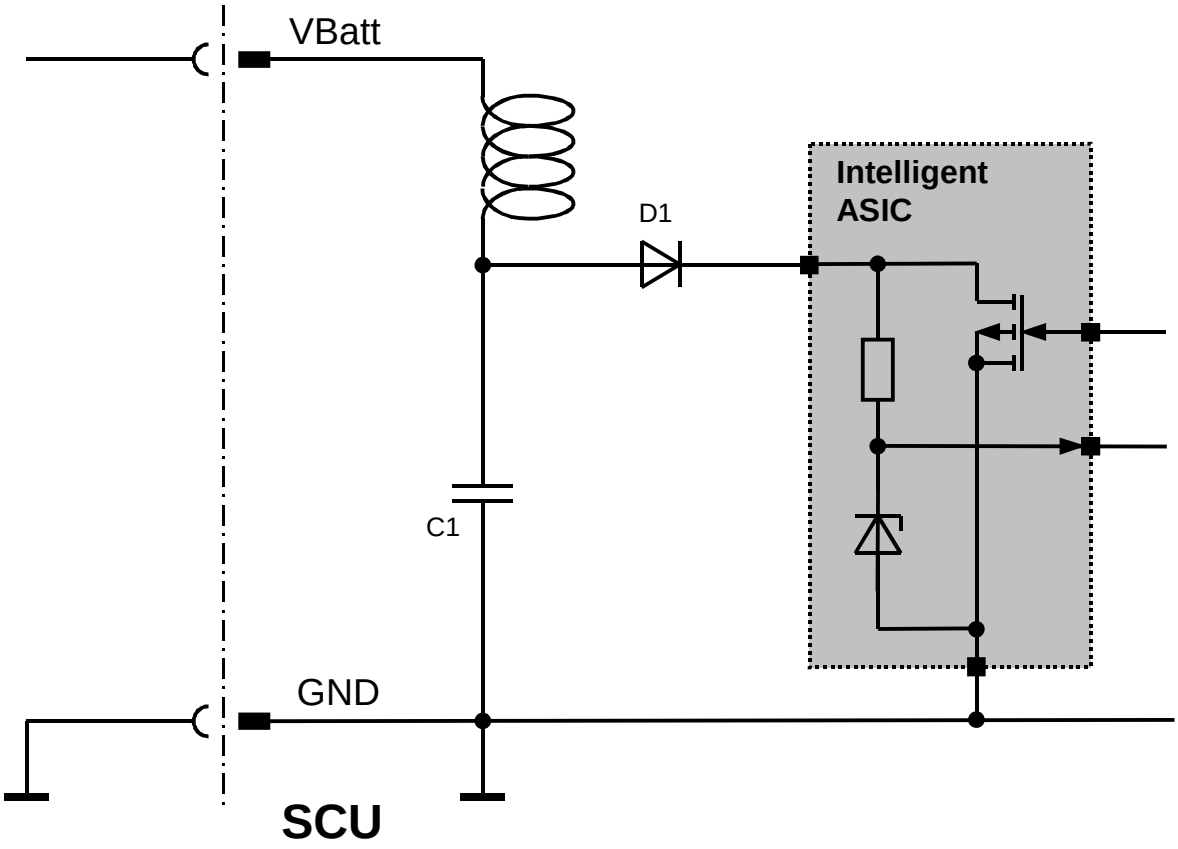
Quiescent current:
Sleep mode: $I_{max} \leq$ 10µA (T<25°C)
(wake up not activated) $I_{max} \leq$ 50µA (T<125°C)

Active mode: $I_{max} \leq$ 200µA
(wake up activated)

Load capacitor: $C_1 \leq$ 22 nF

## 4.8 Optional Lens Heating Line

The equivalent circuit diagram of the lens heating is as follows:




Electrical specification:
$U_{nom}$ = 12 V
$I_{typ}$ ≤ 1.2 A at $U_{nom}$
$I_{max}$ ≤ 1.5 A at $U_{nom}$

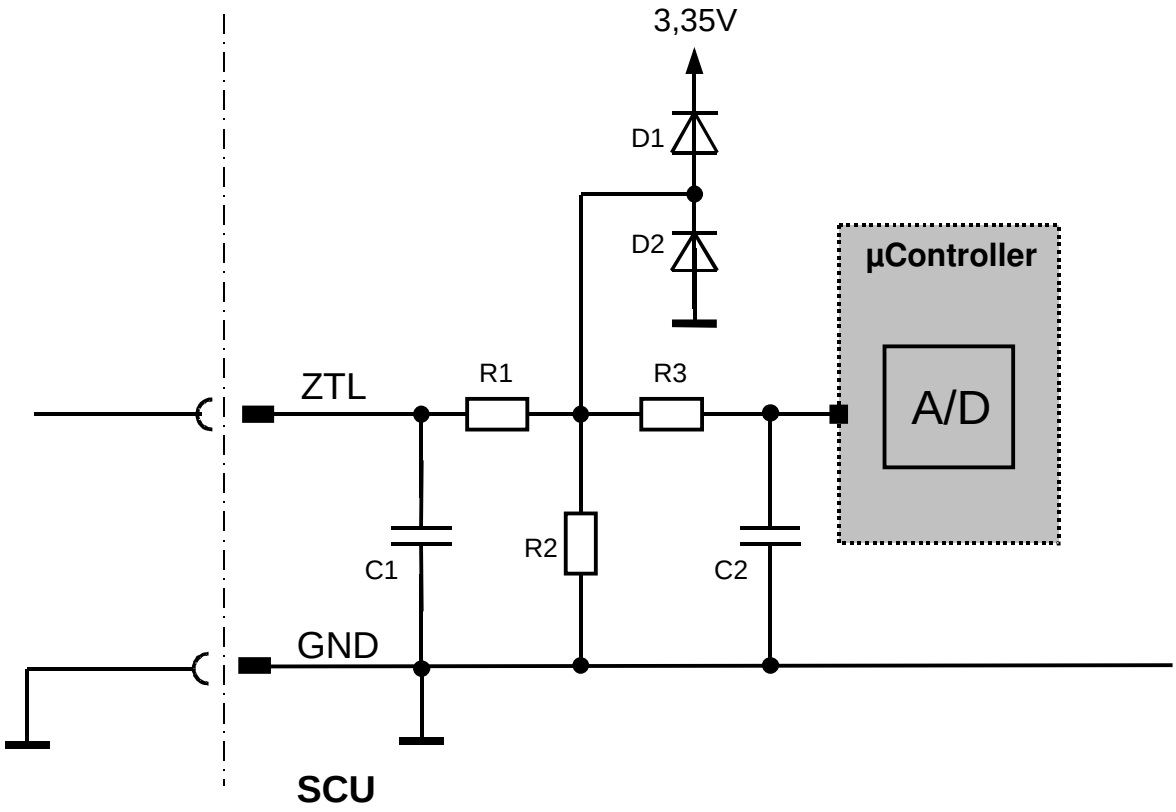
Quiescent current:
Sleep mode: Imax ≤ 10µA (T<25°C)
(wake up not activated) Imax ≤ 50µA (T<125°C)

Active mode: Imax ≤ 200µA
(wake up activated)

Load capacitor: $C_1$ ≤ 22 nF

## 4.9 Optional Time Gap Input (TGAP)

The equivalent circuit diagram of the TGAP - interface is as follows:




Logic levels to be discussed and defined between the customer and Bosch.

# 5 Environmental tests

The tests described below will be carried out with the complete ACC-SCU including the 76,5 GHz transceiver-module, the connected wiring harness plug and the mounted sensor bracket (according to the offer drawing). The “bracket only” tests will be carried out with an ACC-SCU- weight dummy, these tests are always passive tests. Qualification tests are intended to anticipate artificial ageing to simulate long term behaviour of the devices under test. Unless otherwise stated, the tolerances in the temperatures are ± 2 °C and all laboratory tests are performed under the following conditions:

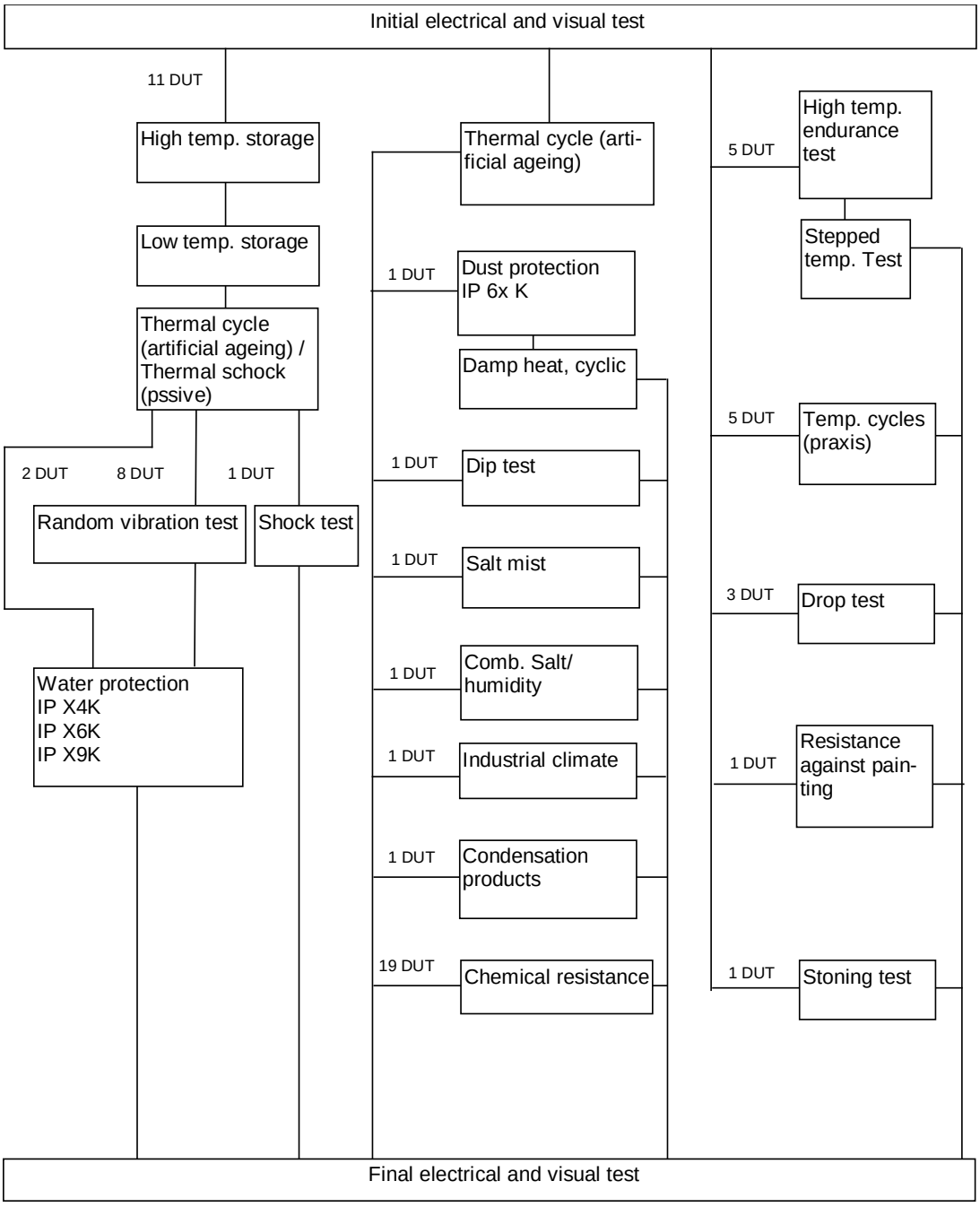
- upper temperature ($T_{max}$) + 85 °C ± 2 °C
- lower temperature ($T_{min}$) - 40 °C ± 2 °C
- room temperature + 23 °C ± 5 °C.
- relative humidity 45 to 75 %
- test power 14 V ± 0,2 V
- operation mode active / non powered (valid for ACC-SCU)

Test criteria:

- Electrical function test completed without failures (if test values outside the tolerance, a separate evaluation is necessary).
- No electrical or mechanical error function during the tests.
- No functionally related mechanical damages after the tests and no functionally related foreign substances in the device under test after the kind-of-protection-tests.

After the tests the devices will be scraped not earlier than 1 year and not last than 2 years after SOP.

The ACC2 sensor with its bracket will be approved according the following test sequence:




Customer specific tests in addition to this test sequence have to be discussed and fixed in detail together with Bosch and might be charged separately.

# 6 EMC

## 6.1 Vehicle Tests

This EMC tests plan describes the general requirements to electronic equipment in the car. Additional tests or changed parameters may be necessary because of specific SCU requirements. The electronic design of the device, the location and wiring of the SCU in the car may cause the necessity of additional tests.

All tests are to be carried out within an certified EMC test laboratory at an air humidity between 45% ± 15% and a room temperature of 23°C ± 5°C unless otherwise stated.

In general vehicle tests are in customer's responsibility. Test vehicles, which are identical to production vehicles, become available only at a very late date, so we must refer to the bench tests described below for internal release of the project. Nevertheless it is necessary to test the performance of the system in the vehicle.

If the SCU passes the bench tests, but fails the vehicle tests, then further investigations are necessary. To find an acceptable solution the responsible sensor development department will work together with the customer. The final release can only be made in a vehicle test.

The ACC2 sensor will be approved according the following EMC test sequence:

- Radiation Immunity according ISO 11541-2 (12.1995)
- Radiated Emission according CISPR 25 Section 2 (11.1995)
- Disturbance by other in-vehicle components

Further customer specific tests in addition to this test sequence have to be discussed and fixed in detail together with Bosch and might be charged separately.

## 6.2 Bench Tests

The bench test plan for the ACC SCU is defined as follows:

- Conducted Immunity
  ESD according ISO TR 10605 (10.1994) and IEC 801-2 (04.1991)
  electrical transient conduction along supply lines according ISO 7637-1 (06.1990)
  electrical transient transmission by capacitive and inductive coupling according ISO 7637-3 (07.1995)
  immunity to abnormal supply voltage
  over-voltage
  sinusoidal ripple
  micro cut off (drop outs)
  supply voltage ramps
  short circuit to supply voltage
- Conducted Emission
  transient emission test according ISO 7637-1 (06.1990), CISPR 25 chapter 3 clause 11.2.1 (11.1995)
- Radiation Immunity
  strip line test according ISO 11452-5 (12.1995)
  BCI test method according ISO 11452-4 (12.1995)
  absorber lined chamber according ISO 11452-2 (12.1995)
  mobile phone simulation test according ISO 1145-2 (12.1995)
- Radiation Emission
  antenna measurement according CISPR 25 chapter 13
  Strip line test according ISO 11452-5

Further customer specific tests in addition to this test sequence have to be discussed and fixed in detail together with Bosch and might be charged separately.