LCDAS - Lane Change Decision Aid System

Model Name: SWA (Audi /Volkswagen/ Porsche)
Model Name: HC-2 (BMW)

System Function and Purpose

The LCDAS is an advanced driver assistant system, to warn the driver of the subject vehicle against potential collisions with vehicles to the side and/or to the rear of the subject vehicle, and moving in the same direction as the subject vehicle during lane change manoeuvres. The system therefore detects vehicles to the rear and sides of the subject vehicle.

When the subject vehicle driver indicates the desire to make a lane change, the system will evaluate the situation and warn the driver if a lane change is not recommended. LCDAS are not meant to encourage aggressive driving. The absence of a warning will not guarantee that the driver can safely make a lane change manoeuvre. The system will not take any automatic action to prevent possible collisions. Responsibility for the safe operation of the vehicle remains with the driver.

LCDAS System Architecture

The LCDAS consists of two radar sensor units which are mounted behind the rear bumper in the left and right rear corners of a car so that the rear and the sides of the car can be observed.
One of the units is the main control unit "master" and the other is the "slave".
The two units interchange data between each other via the sensor CAN-bus.
The master interchanges data with other electronic control units of the vehicle via the vehicle CAN-bus.
Both units incorporate a DSP-board and an RF unit (RFE).
Both DSP-boards incorporate a DSP to perfom the radar signal processing.
Only the DSP-board of the master incorporates a microprocessor which handles the communication to the vehicle CAN-bus.
An on-off-tipper to activate and de-activate the system is connected to the DSP-board of the master.
A respective status lamp which indicates whether the system is activated or de-activated is connected to the DSP-board of the master.
Audi has warning lamps for the left and the right side which are connected to the DSP-board of the slave.
BMW activates the warning lamps via FlexRay message. The lamps are not connected to the DSP Board.

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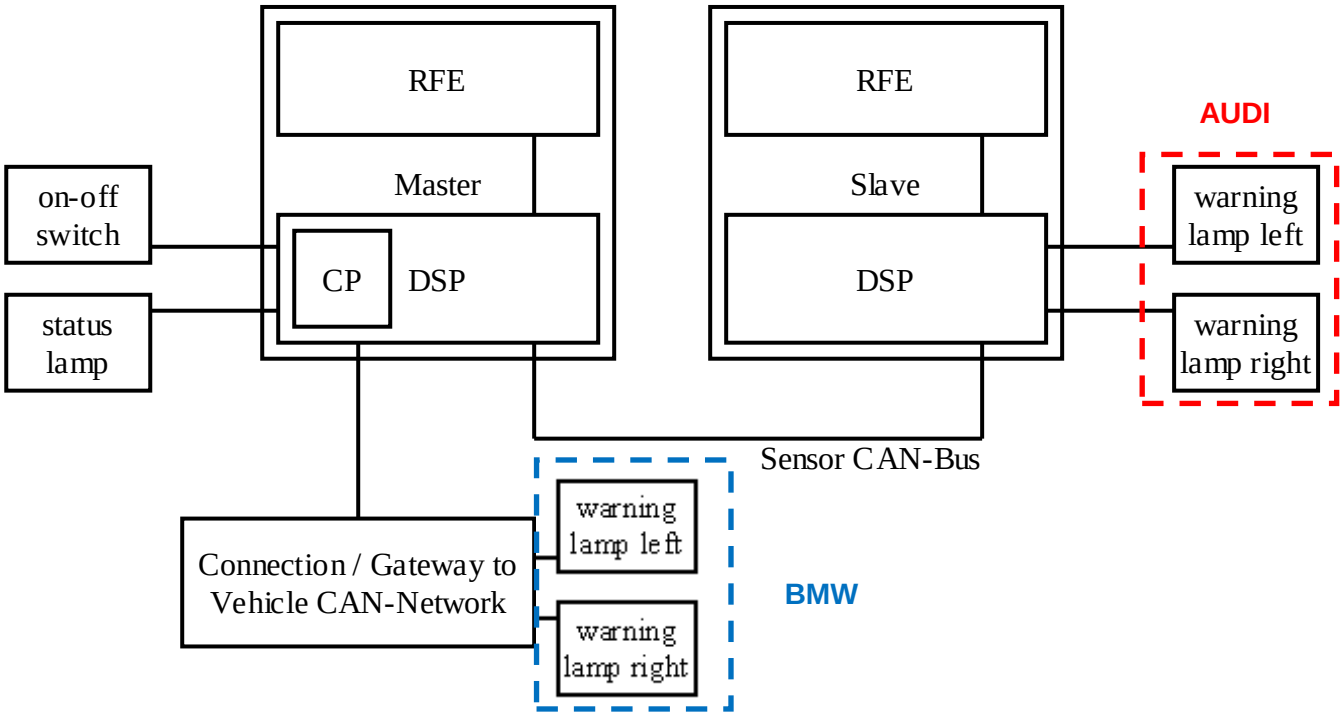
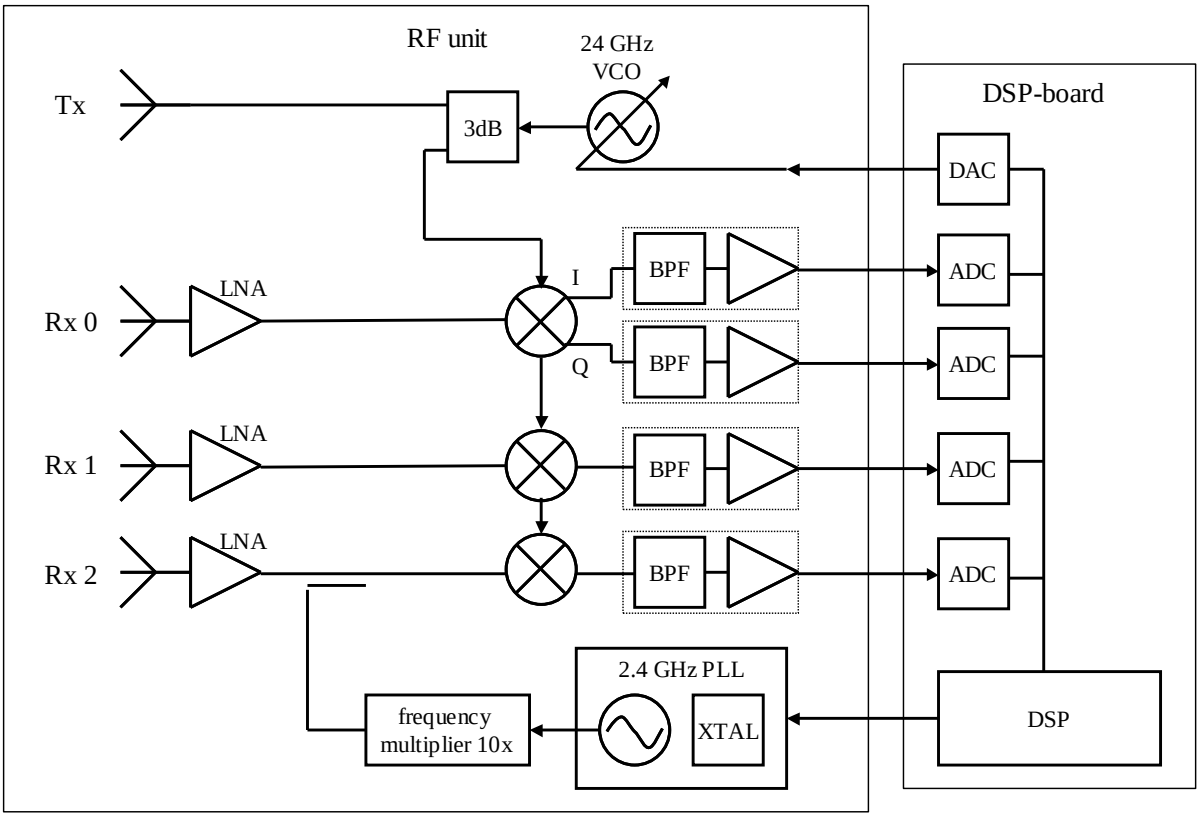


block diagram of LCDAS system architecture



block diagram shows RF unit and DSP board parts for master and slave

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The RF units each consist of

- one 24-GHz-VCO,
- one transmit antenna,
- three receivers (each consisting of antenna, LNA, mixer, BPF and base-band amplifier) and
- one 2.4-GHz-PLL oscillator with a 10x-frequency multiplier.

The transmit signal is generated by the 24-GHz-VCO.
The 24-GHz-VCO is frequency modulated by a DAC on the DSP-board.
The DSP-board is able to switch off the transmitter.
The tenth harmonic of 2.4-GHz-PLL is generated and used to align the modulation of the 24-GHz-VCO and to keep it within the frequency band limits.
The transmit antenna pattern is a microstrip patch antenna array with 5x8 elements.
It is designed to illuminate the rear and the side of the vehicle and is thus a medium gain antenna.
The three receivers down-convert the receive signals directly to zero-IF by using the 24-GHz-VCO signal.
The base-band receive signals are digitized by ADCs on the DSP-board.
The receive antennas are microstrip patch antennas with a lower gain than the transmit antenna (1x8 or 2x8 elements).

Technical Data

Hella part number of master and slave	6PZ 009 014-xx 6PZ 010 287-xx 6PZ 010 316-xx 6PZ 010 664-xx
Supply Voltage	+9 V … +15 V
Supply Current	appr. 0.5 A (of master and slave without lamps connected)
Frequency Band 1	24075 MHz ... 24175 MHz
Frequency Band 2	24150 MHz … 24250 MHz
Modulation	FMCW
Modulation Bandwidth	< 100 MHz
EIRP	< +20 dBmW
Antenna Type	microstrip patch array
Antenna gain	16 dBi
Operating Temperature Range	-40°C …+70°C
Storage Temperature Range	-40°C …+90°C

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Abbreviations

ADC	analog-to-digital converter
BPF	band pass filter
CAN	controller area network
CP	communication processor
DAC	digital-to-analog converter
DSP	digital signal processor
EIRP	equivalent isotropically radiated power
FMCW	frequency modulated continuous wave
IF	intermediate frequency
LCDAS	Lane Change Decision Aid System
LNA	low noise amplifier
PLL	phase-locked-loop
RF	radio frequency
Rx	Receive
SWA	Spurwechselassistent - german term for LCDAS
Tx	Transmit
VCO	voltage controlled oscillator
XTAL	crystal oscillator

LCDAS 1.5 (LCDAS, Generation 1.5)

Several types for different vehicle manufacturers and vehicle models belong to the LCDAS 1.5. All types are similar in electric characteristics.

Difference between LCDAS Gen. 1.5 for

a) SWA: Audi, VW , Porsche and for

b) HC-2: BMW

1. The vehicle network connection at VW, Audi, Porsche is realized with CAN. The BMW types use FLEX RAY connection. Thereby a different communication controller and network driver in the master control unit is used. Accordingly the printed circuit board (PCB) layout in this area is different.

2. At the same layout for BMW additional filters are equipped in the radar front end because of the higher requirements for the elimination of emissions at 2,4 GHz.

3. Reffering to the last two sentences on site 1:
   Audi:
   The warning lamps for the left and the right side are connected to the DSP-board of the slave.
   BMW:
   Activation of the warning lamps via FlexRay message. The lamps are not connected to the DSP Board.

The differences have no influence to the radar emission (frequency range and power). The frequency range of the system (24,075 – 24,175 GHz and 24,150 – 24,250 GHz) is unchanged.