Annex no. 5

Functional Description / User Manual

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LCA (Lane Change Assist) Gen. 1.7
SWA (Spurwechselassistent) Gen. 1.7

Model Names:
SWA SG1 / SWA SG2
(Audi / VW / Porsche / Hyundai**)**

MODULE-L/C/A RH / MODULE-L/C/A LH
(Mazda**)**

System Function and Purpose

The LCA system 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. LCA is 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.

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LCA System Architecture

The LCA system 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 = SWA SG1**" and the other is the "**slave = SWA SG2**".
For Mazda the units are the main control unit "**master = MODULE-L/C/A RH** " and the other is the "**slave = MODULE-L/C/A LH** ".
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 a Radar Frequency Unit (Radio Front End) to perform 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 unit.
In the car a respective status lamp which indicates whether the system is activated or de-activated is connected to the DSP-board of the master unit.
Warning lamps for the left and the right side are connected to the DSP-board of the slave unit.

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The RF units each consist of

- one 24-GHz-VCO,
- one transmit antenna,
- two 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 receiver signals are digitized by ADCs on the DSP-board.
The receiver antennas are microstrip patch antennas with a lower gain than the transmit antenna (1x8 or 2x8 elements).

Technical Data of LCA

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
Supply Voltage	+9 V … +15 V

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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
HC-2	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

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