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1.2	12.10.2010	Additions
1.3	07.12.2010	Modifications



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1 Introduction

1.1 Purpose

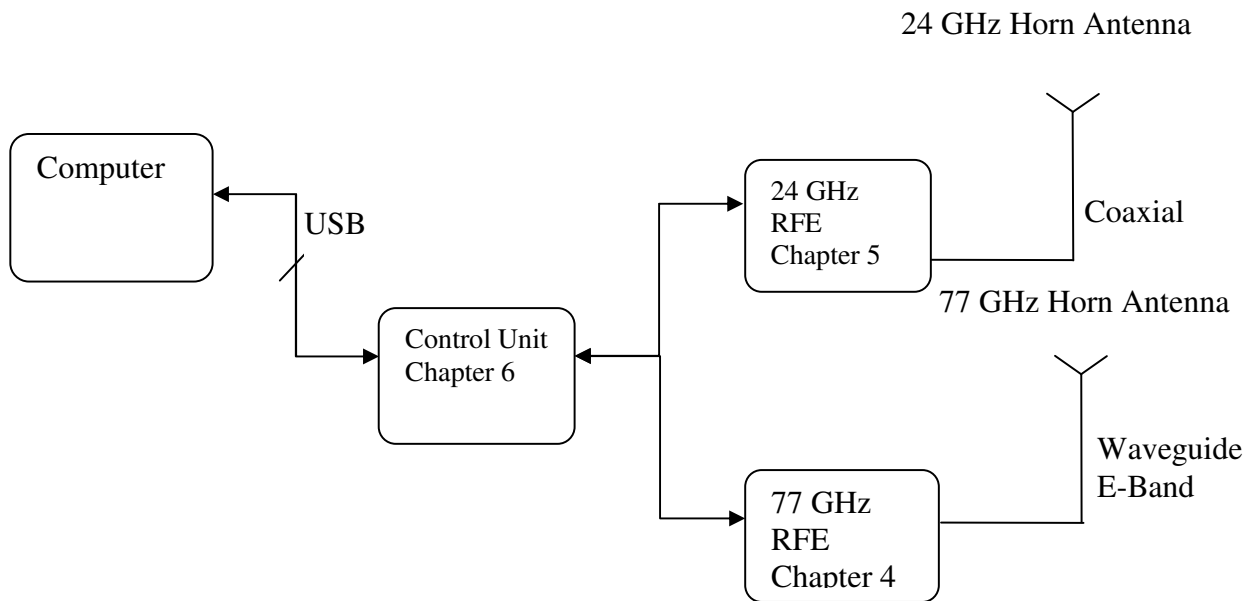
This document describes in detail the specifications of a compact, portable und non-automotive device, which shall be used as a Norm-Interferer working on the 24 and 77 GHz frequency ranges. These bands are of special interest since they are used for automotive radar applications, e.g. ACC, BSD, and LCS. Main focus of attention shall be put on

- Current modulation modes used by automotive radar sensors and other devices used for traffic monitoring, counting and classification, door openers and speed enforcement (police radar) working in the mentioned frequency range
- Full use of the available bandwidth
- Full use of the available EIRP and peak power
- Antenna polarisation used by automotive radar sensors

1.2 Scope

This document is for internal use of the MOSARIM project members.

2 Schematic Diagram



The Norm Interferer device consists of:

- a control unit, which supplies power and timing signals to the radar front end. It shall also provide an interface over a private USB to the end user,
- 24 GHz Radar Frontend,
- 77 GHz Radar Frontend

The present specifications are detailed in the following chapters

- Ch.3. The hardware constraints and maximum ratings valid for all the components of the Norm Interferer are listed here
- Ch.4. 77 GHz Frontend
- Ch.5. 24 GHz Frontend. In order to be able to cover the frequency band of interest (21.65 to 26.65 GHz) this module consists of 3 RFE:
 - + Section 5.1 RFE 21.65 – 23.65 GHz
 - + Section 5.2 RFE 24.05 – 24.25 GHz (ISM Band)
 - + Section 5.3 RFE 24.05 – 24.65 GHz
- Ch.6. Control Unit

3 Hardware constraints and maximum ratings

3.1 Power supply

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	DC Voltage [VDC]		12		+ / - 5%
	DC Voltage for the front ends[VDC]	4,5	5	5,5	+ / - 10%; internally generated by the Control Unit
	AC Voltage [VAC]		230		+ / - 5%

Table 1 Power supply requirements

3.2 Maximum temperature ratings and housing specifications

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Storage Temperature [°C]	0		70	
	Operating Temperature [°C]	0		50	
	IP Schutzklasse	IP40			

Table 2 Maximum Temperature Ratings

3.3 Mechanical specifications

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Weight		TBD		
	Dimensions		TBD		Based on 19" rack system

Table 3 Mechanical specification

3.4 Regulatory Specifications

Since the purpose of MOSARIM is to investigate the interference between devices, which comply with different versions of emission regulatory norms, the following norms [2], [3], [4], [5] are used merely as a reference. Nevertheless the EIRP emitted in the frequency band used by EESS and RA (23,6 to 24 GHz) must be under -74 dBm/MHz.

The Norm Interferer must comply with:

- RoHS Norm

The low voltage power supply complies with:

- ISO 16750-2
- ISO 7637

3.5 Trigger Capability

A trigger signal (TTL) allows the PC to trigger a "victim" (PC as master) or vice versa to be triggered by a "victim" (NI as slave). This means:

- 1 Master Analog Output, TTL level
- 1 Slave Analog Input, TTL level

4 77 GHz Radar Front End specifications

4.1 Tentative block diagram

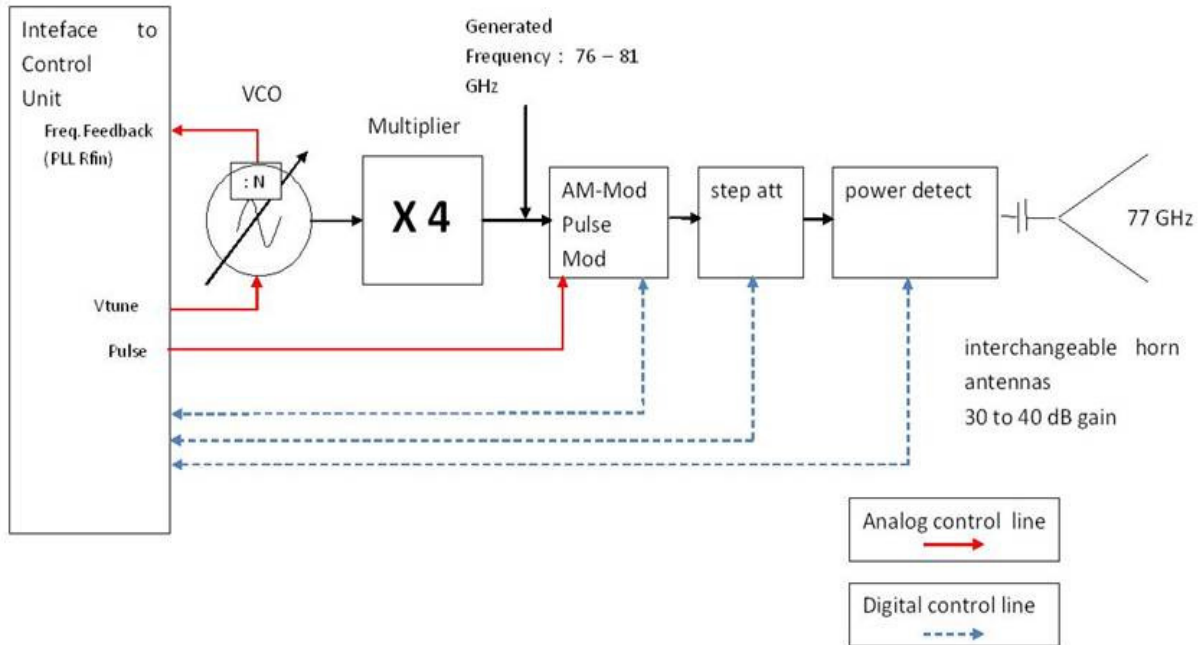


Figure 1 77 GHz RFE Block diagram

4.2 List of Parameters

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Frequency range [GHz]	76		81	
	Tune bandwidth [GHz]			1.5	
	Polarisation		Horizontal, Vertical, 45°, 135°		This will be achieved by means of mechanical adapters
	Interface to antenna				E Band waveguide
	Transmit Power at antenna connector [dBm]			0	+ / - 2dB
	Modulation modes		CW, FMCW, LFMSK, CSM (For a detailed description see chapter 6)		

Table 4 List of parameters of 77 GHz Radar front end

5 24 GHz Radar Front End specifications

5.1 RFE 21.65-23.6 GHz

5.1.1 Tentative block diagram

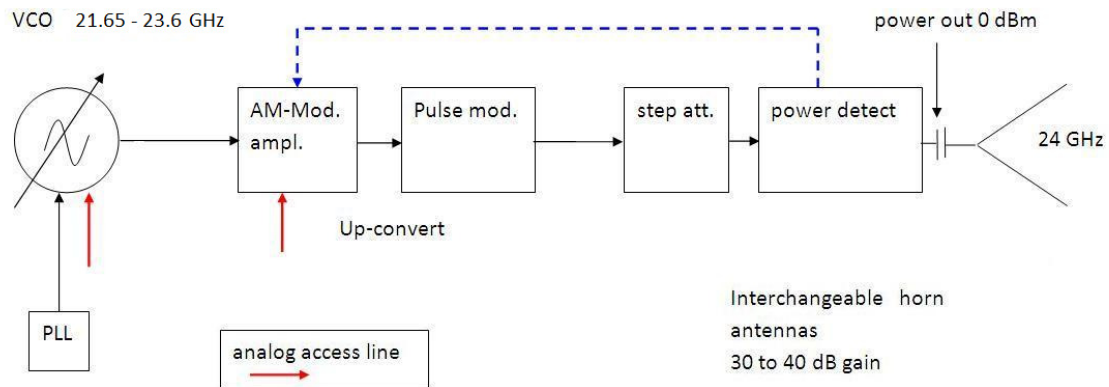


Figure 2 RFE 21.65-23.6 GHz Block diagram

5.1.2 List of parameters

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Frequency Range[GHz]	21.65		23.6	
	Tune bandwidth [GHz]			1	
	Polarisation		Horizontal, Vertical		This will be achieved by means of mechanical adapters
	Connector to antenna				SMA
	Transmit Power at antenna connector [dBm]			0	+ / - 2dB
	Modulation modes		CW,FMCW,LFMSK, pulsed FMCW, Pulse modulation(For a detailed description see chapter 6)		

Table 5 List of parameters for the RFE 21.65-23.6 GHz radar front end

5.2 RFE 24.05-24.25 GHz (ISM)

5.2.1 Tentative block diagram

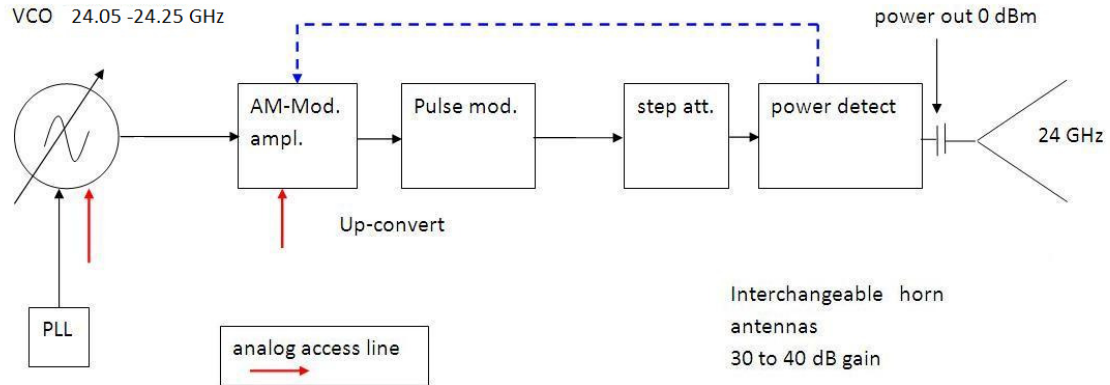


Figure 3 RFE 24.05-24.25 GHz Block diagram

5.2.1 List of parameters

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Frequency Range[GHz]	24.05		24.25	
	Tune bandwidth [MHz]			200	
	Polarisation		Horizontal, Vertical		This will be achieved by means of mechanical adapters
	Connector to antenna				SMA
	Transmit Power at antenna connector [dBm]			0	+ / - 2dB
	Modulation modes		CW,FMCW,LFMSK, pulsed FMCW, Pulse modulation(For a detailed description see chapter 6)		

Table 6 List of parameters for the RFE 24.05-26.65 GHz radar front end

5.3 RFE 24.05-26.65 GHz

5.3.1 Tentative block diagram

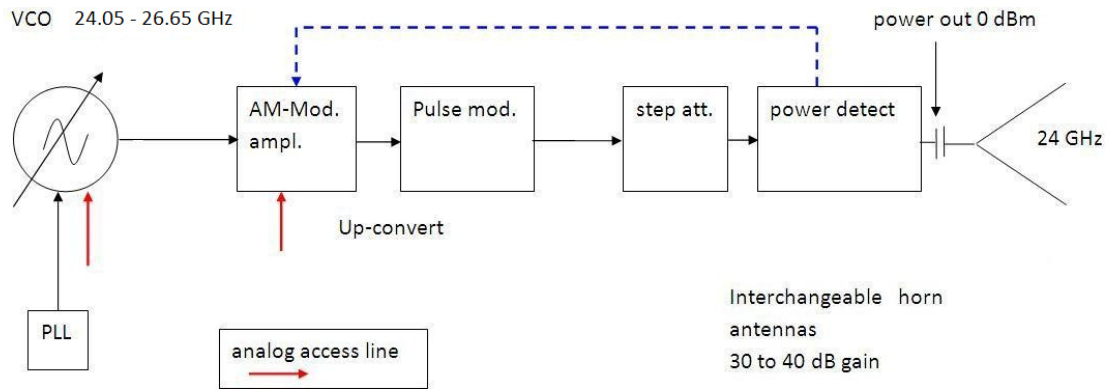


Figure 4 RFE 24.05-26.65 GHz Block diagram

5.3.2 List of parameters

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Frequency Range[GHz]	24.05		26.65	
	Tune bandwidth [GHz]			1	
	Polarisation		Horizontal, Vertical		This will be achieved by means of mechanical adapters
	Connector to antenna				SMA
	Transmit Power at antenna connector [dBm]			0	+ / - 2dB
	Modulation modes		CW,FMCW,LFMSK, pulsed FMCW, Pulse modulation(For a detailed description see chapter 6)		

Table 7 List of parameters for the RFE 24,05-26,65 GHz radar front end

6 Control Unit

This component must generate the power supply and control signals for the 77 and 24 GHz radar front ends.

It must implement at least the current modulations schemes described in the following sections 6.1 and 6.2. Additionally a free programable mode must be provided (see section 6.3). All these modes must be configurable over the private USB of the Control Unit.

6.1 77 GHz Modulation Modes

CW

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	CW Frequency[GHz]	76		81	
	Step[MHz]	0,4882			
	Number of steps	1		3072	

Table 8 - 77 GHz CW tuning parameters

FMCW

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Center frequency[GHz]	76		81	In steps as the CW Modulation
	Frequency deviation[MHz]			1.5	
	Ramp duration time[msec]	1		40	

Table 9 -77 GHz FMCW tuning parameters

FSK/LFMSK

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Start Frequency[GHz]	76		81	
	Number of steps	1		2048	
	Time between steps[usec]	10		1000000	
	Frequency step[MHz]	-1500		1500	

Table 10 - 77 GHz FSK/FMSK

CSM (Chirp sequence modulation)

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Start frequency[GHz]	76		81	In steps as the CW Modulation
	Frequency slope[MHz/usec]	100/125		750/16	
	Freq. Repitition time[usec]	16	0	16000	
	Ramp Duration[usec]	16	0	125	

Table 11 -77 GHz CSM Tuning Parameters

Pulse / Doppler

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Center frequency[GHz]	76		81	Tune as a CW frequency
	Pulse width[nsec]	25		25	
	Pulse width steps[nsec]	0	0	0	
	Pulse repitition interval[usec]	2,5	2,5	2,5	

Table 12- 77 GHz Pulse / Doppler Tuning Parameters

6.2 24 GHz Modulation Modes

CW modulation

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	CW Frequency[GHz]	21.65		26.65	23.6 to 24 GHz is not available.
	Step[MHz]	0,4882			
	Number of steps	1		2048	

Table 13- 24 GHz CW Tuning Parameters

FMCW modulation

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Center frequency[GHz]	21.65		26.65	Tune as a CW frequency. 23.6 to 24 GHz is not available.
	Frequency Deviation[GHz]			1	For the ISM RFE just 200 MHz
	Ramp duration time[msec]	1		40	

Table 14- 24 GHz FMCW Tuning Parameters

FSK/LFMSK

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Start frequency[GHz]	24.05		26.65	Tune as a CW frequency . 23.6 to 24 GHz is not available.
	Number of steps	1		2048	
	Time between steps [usec]	10		1000000	
	Frequency step[MHz]	-1000		1000	

Table 15- 24 GHz FSK/FMSK Tuning Parameters

Pulse / Doppler

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Center frequency[GHz]	24.05		26.65	Tune as a CW frequency. 23.6 to 24 GHz is not available
	Pulse width[nsec]	0.8		40	
	Pulse width steps[nsec]	0.8	1		
	Pulse repetition interval[nsec]	200		2000	

Table 16- 24 GHz Pulse / Doppler Tuning Parameters

CSM (Chirp sequence modulation)

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Start frequency[GHz]	21.65		26.65	In steps as the CW Modulation 23.6 to 24 GHz is not available
	Chirp Slope[GHz/s]	10		800	
	Freq. Repetition time[usec]	250	0	20000	
	Ramp Duration[usec]	250	0	20000	

Table 17 -24 GHz CSM Tuning Parameters

6.3 User Mode

In this mode the PLL of the RFE (see Figures 1,2,3,4,) will be arbitrarily set according to a table of 2048 frequencies. The start frequency, the end frequency, the number of frequencies to be set and the time step between frequencies is configurable (see Table 18).

The table must be loaded over the USB interface of the control unit.

Free Configurable Mode

Nr.	Parameter [unit]	Min.	Typical	Max.	Notes
	Number of steps	1		2048	
	Time between steps [usec]	10		1000000	
	Frequency step[MHz]	-1000		1000	

Table 18- Free Configurable Mode

7 Terminology, Abbreviations and Definitions

Table of abbreviations used in this document

Abbreviation	Denotation
ACC	Automatic Cruise Control
BSD	Blind Spot Detection
CSM	Chirp sequence mode
CW	Continous wave
FCC	Federal Communications Commission
FSK	Frequency shift keying
FMCW	Frequency modulated continuous wave
FMSK	Frequency modulation shift keying
HW	Hardware
IF	Intermediate frequency
ISM band	"Industrial Scientific Medical" band (24,05-24,25 GHz)
RFE	Radar Front End
SW	Software
TBD	To be defined
VGA	Variable gain amplifier
VCO	Voltage Control Oscillator

Table 19 Abbreviations

8 References

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