

**WORLDDAB AUTOMOTIVE RECEIVER
PERFORMANCE CALCULATOR (VERSION 1.0)**

Scope of Automotive Receiver Performance Calculator

Automotive Receiver Performance Calculator

- + provides awareness for large signal handling and receiver sensitivity
- + allows to understand standards and guideline for automotive receiver performance
- + allows to understand which parameters are relevant
- + allows to assess specific product designs
- + allows to understand why pairing of antenna and receiver is relevant

Automotive Receiver Reference Model

- + depicts subsystems and interfaces required for receiver performance
- + describes relevant parameters per subsystem
- + allows to learn how to be compliant for large and low signals

Considering

OEM Receiver Solutions / Aftermarket Full Integrated Solutions

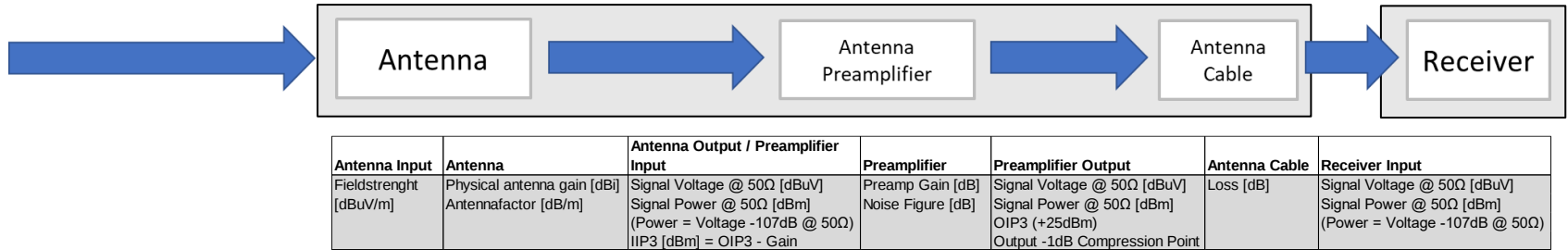
- + Higher physical antenna gain
- + Higher receiver sensitivity
- + Higher large signal capability
- + Higher maximum useful signal at input of receiver

Aftermarket Devices

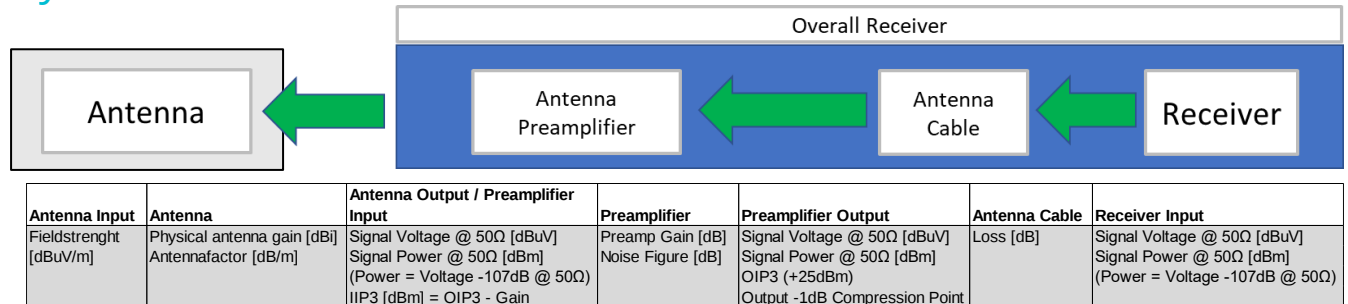
- + Lower physical antenna gain
- + Lower receiver sensitivity
- + Lower large signal capability
- + Lower maximum useful signal at input of receiver

Reference Models

Large Signal Handling



Receiver Sensitivity



Reference Models

Large Signal Handling

- + Signal is received by the antenna, preamplified and forwarded to the receiver
- + Critical elements are antenna, preamplifier and receiver
- + Critical aspects are physical antenna gain, preamplifier gain, large signal capability of preamplifier and receiver

Receiver Sensitivity

- + Receiver, cable and preamplifier are combined to the “overall receiver”
- + The noise figure of this overall receiver is calculated and relevant
- + With the physical antenna gain this overall receiver noise figure defines the receiver sensitivity
- + Critical aspects are physical antenna gain, preamplifier gain, noise figure of preamplifier and receiver

Large Signal Handling – Use of Calculator

Input signal to be set manually

Design parameters to be set manually

Overload indication acc. EN62104

Calculator for Large Signal Handling

SRG SSR rmo, 11. November 2021

Reference Model	Antenna Input	Antenna	Antenna Output / Preamplifier Input	Preamplifier	Preamplifier Output	Antenna Cable	Receiver Input
	Fieldstrength [dBuV/m]	Physical antenna gain [dBi] Antennafactor [dB/m]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] (Power = Voltage -107dB @ 50Ω) IIP3 = OIP3 - Gain	Preamp Gain [dB] Noise Figure [dB]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] OIP3 (+25dBm) Output -1dB Compression Point	Loss [dB]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] (Power = Voltage -107dB @ 50Ω)
OEM	According EN62104 - quarter wave roof top antenna - compliant with large signal handling - lower end of defined preamplifier gain						
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		12		-2	
Antennafactor [dB/m]		18.9					
Total Fieldstrength [dBuV/m]	130						
Signal [dBuV]			111.1		123.1		121.1
Signalpower [dBm]			4.1		16.1		14.1
Max. signal power [dBm]					15		10
OIP3 [dBm]					25		
Legend							
bold marked	input signal						
bold and italic marked	system parameters to be chosen						

Large Signal Handling – Calculation Examples for OEM solutions

Overload of preamplifier and receiver

OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		12		-2	
Antennafactor [dB/m]		18.9					
Total Fieldstrength [dBuV/m]	130						
Signal [dBuV]			111.1		123.1		121.1
Signalpower [dBm]			4.1		16.1		14.1
Max. signal power [dBm]					15		10
OIP3 [dBm]					25		

Overload of receiver

OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		12		-2	
Antennafactor [dB/m]		18.9					
Total Fieldstrength [dBuV/m]	126						
Signal [dBuV]			107.1		119.1		117.1
Signalpower [dBm]			0.1		12.1		10.1
Max. signal power [dBm]					15		10
OIP3 [dBm]					25		

Highest acceptable signal before overload (large signal handling just a bit too low)

OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		12		-2	
Antennafactor [dB/m]		18.9					
Total Fieldstrength [dBuV/m]	125						
Signal [dBuV]			106.1		118.1		116.1
Signalpower [dBm]			-0.9		11.1		9.1
Max. signal power [dBm]					15		10
OIP3 [dBm]					25		

Large Signal Handling – Examples for OEM solutions

Slightly revised design: no overload of preamplifier and receiver / large signal handling ok



OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		11		-2	
Antennafactor [dB/m]		18.9					
Total Fieldstrength [dBuV/m]	126						
Signal [dBuV]			107.1		118.1		116.1
Signalpower [dBm]			0.1		11.1		9.1
Max. signal power [dBm]					15		10
OIP3 [dBm]					25		

Design to be double-checked for receiver sensitivity on slide 11

Application of Calculator for Large Signal Handling

Input

- + Physical antenna gain, preamplifier gain, cable loss and receiver are defined
- + Fieldstrength of wanted signal to be set manually in fields C19 and C26 (sum of all available DAB signals within the VHF band III)
- + Light red marked input fieldstrength indicate when large signal handling is weak

Results

- + Red marked fields (G17/I17; G28/I28) indicate when fieldstrength is too high
- + Large signal capability of design and overload of subsystems
- + Verification if a design that fulfils receiver sensitivity is compliant with large signal handling too
- + Awareness about relevant dynamic range of receiver and its influencing parameters

Receiver Sensitivity – Use of Calculator

Input signal to be set manually

Design parameters to be set manually

Signal too low for specific design

DAB+ Receiver Performance Reference Model for OEM- and Aftermarket Receivers according IEC EN62104 Version 1.0

Receiver Performance and Sensitivity

SRG SSR rmo, 11. November 2021

Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
	Fieldstrength [dBuV/m]	Physical antenna gain [dBi] Antennafactor [dB/m]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] (Power = Voltage -107dB @ 50Ω) IIP3 = OIP3 - Gain	Preamp Gain [dB] Noise Figure [dB]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] OIP3 +25dB	Loss [dB]	Signal Voltage @ 50Ω [dBuV] Signal Power @ 50Ω [dBm] Power = Voltage -107dB @ 50Ω

OEM	According EN62104 - quarter wave roof top antenna compliant receiver sensitivity						
Gain [dBi / dB]		-2.9		12		-2	
Antennafactor [dB/m]		18.9					
Fieldstrength wanted signal [dBuV/m]	22						
Signal [dBuV]			3.10		15.1		13.1
Signalpower [dBm]			-103.90		-91.9		-93.9
OIP3 [dBm]					25		
Minimum signalpower Gauss [dBm]			-103.46				-97
Minimum signalpower Rayleigh [dBm]			-97.46				-91
Noise Figure [dB] (@ referencepoint)			2.67	1.5		2	7.3
C/N Rayleigh							12

Legend

bold marked

input signal

bold and italic marked

system parameters to be chosen by OEM/supplier

Receiver Sensitivity – Calculation Examples for OEM solutions

Excellent receiver sensitivity compliant with guideline (design from slide 8)

OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-2.9		11		-2	
Antennafactor [dB/m]		18.9					
Fieldstrength wanted signal[dBuV/m]	23						
Signal [dBuV]			4.10		15.1		13.1
Signalpower [dBm]			-102.90		-91.9		-93.9
OIP3 [dBm]					25		
Minimum signalpower Gauss [dBm]			-103.20				-97
Minimum signalpower Rayleigh [dBm]			-97.20				-91
Noise Figure [dB] (@ referencepoint)			2.93	1.5		2	7.3
C/N Rayleigh							12

Noncompliant receiver sensitivity due to low physical antenna gain

OEM Receiver / Aftermarket Receiver full intergrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-12.9		11		-2	
Antennafactor [dB/m]		28.9					
Fieldstrength wanted signal[dBuV/m]	33						
Signal [dBuV]			4.10		15.1		13.1
Signalpower [dBm]			-102.90		-91.9		-93.9
OIP3 [dBm]					25		
Minimum signalpower Gauss [dBm]			-103.20				-97
Minimum signalpower Rayleigh [dBm]			-97.20				-91
Noise Figure [dB] (@ referencepoint)			2.93	1.5		2	7.3
C/N Rayleigh							12

Receiver Sensitivity – Calculation Examples for OEM solutions

Low physical antenna gain cannot be compensated even with higher preamplification gain.
Standard compliant input signal is not sufficient

OEM Receiver / Aftermarket Receiver full integrated solution							
Criteria / Parameter	Antenna Input	Antenna	Antenna Output	Preamplifier	Preamplifier Output	Cable	Receiver Input
Gain [dBi / dB]		-12.9		30		-2	
Antennafactor [dB/m]		28.9					
Fieldstrength wanted signal[dBuV/m]	30						
Signal [dBuV]			1.10		31.1		29.1
Signalpower [dBm]			-105.90		-75.9		-77.9
OIP3 [dBm]					25		
Minimum signalpower Gauss [dBm]			-104.61				-97
Minimum signalpower Rayleigh [dBm]			-98.61				-91
Noise Figure [dB] (@ referencepoint)			1.52	1.5		2	7.3
C/N Rayleigh							12

Too low physical antenna gain cannot be compensated by preamplifier gain. This is applicable for aftermarket antennas for windows as well.

Application of Calculator for Receiver Sensitivity

Input

- + Physical antenna gain, preamplifier gain, cable loss and receiver are defined
- + Fieldstrength of wanted signal to be set manually in fields C19 and C26 (sum of all available DAB signals within the VHF band III)
- + Light red marked input fieldstrength indicate when large signal handling is weak

Results

- + Red marked fields (G17/I17; G28/I28) indicate when fieldstrength is too high
- + Large signal capability of design and overload of subsystems
- + Verification if a design that fulfils receiver sensitivity is compliant with large signal handling too
- + Awareness about relevant dynamic range of receiver and its influencing parameters

Relevant Standards and Guidelines

- + ETSI TS 103 461 V1.1.1, Digital Audio Broadcasting (DAB); Domestic and in-vehicle digital radio receivers; Minimum requirements and Test specifications for technologies and products; 2017-08
- + IEC EN62104, Characteristics of DAB receivers
- + ETSI EN 303 354 V1.1.1, Amplifiers and active antennas for TV broadcast reception in domestic premises; Harmonised standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; 2016-06
- + EBU tech 3391 Guidelines for DAB network planning, Geneva 2018
- + EBU Fact Sheet, Planning Parameters for DAB in VHF Band III, Geneva 2019
- + ETSI EN 300 401 V2.1.1 – Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers, January 2017