

DTA-2115B

| All-Standard, All-Band Modulator



PCI
EXPRESS®

DATASHEET

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Table of Contents

1. Introduction	3
1.1. General Description.....	3
1.2. Block Diagram	3
1.3. Firmware Selection	4
1.4. Software Support	4
1.5. Available Options.....	5
2. Specifications	6
2.1. RF Outputs	6
2.2. Frequency Reference Inputs	7
2.2.1. Selecting the external frequency reference input	7
2.3. RF and Modulation Parameters.....	8
2.3.1. 72-MHz VHF/UHF/L-Band modulator	8
2.3.2. 8-MHz VHF/UHF modulator	9
2.4. Miscellaneous Specifications.....	10
3. Modulation Standards	11
3.1. ATSC	11
3.2. ATSC 3.0	11
3.3. ATSC-MH.....	12
3.4. CMMB	12
3.5. DAB(+)/T-DMB	13
3.6. DRM(+)	13
3.7. DTMB (ADTB-T, DMB-T/H)	14
3.8. DVB-C2	15
3.9. DVB-CID	15
3.10. DVB-S.....	16
3.11. DVB-S2	17
3.12. DVB-S2X.....	18
3.13. DVB-T/H	19
3.14. DVB-T2	20
3.15. I/Q-samples.....	21
3.16. ISDB-S	22
3.17. ISDB-S3	22
3.18. ISDB-T/T _{SB}	23
3.19. ISDB-Tmm.....	24
3.20. QAM-A (DVB-C)	25
3.21. QAM-B	25
3.22. QAM-C (ISDB-C)	26
4. GPS Clock Synchronization	27
5. Phase noise emulation	28
6. Performance Measurements	29
6.1. Phase Noise	29
6.2. Return Loss.....	31
6.3. Adjacent Channel Power	32
6.4. Shoulder Attenuation	32
6.5. Second Harmonic Leakage	34

1. Introduction

1.1. General Description

The DTA-2115B is DekTec's highest-end modulator on a PCIe gen3 x1 card. It is a general-purpose modulator for generating virtually any cable, terrestrial and satellite modulation standard currently in use around the world, including multi-PLP DVB-T2 and DVB-S2X. Advanced features include ultra-low phase noise, GPS synchronization, phase noise emulation and special firmware for eight-channel modulation. The output frequency of the DTA-2115B is agile in the range from 32 to 2186MHz.

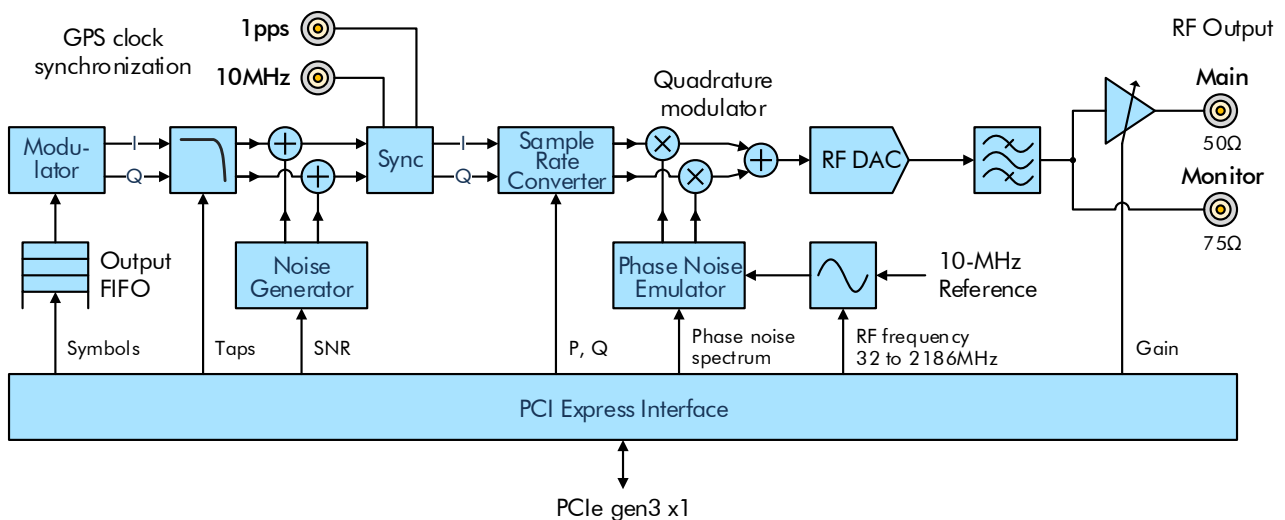
Dependent on the firmware, the DTA-2115B operates as a single 72-MHz modulator in VHF, UHF or L-band, or as eight independent 8-MHz modulators in the VHF/UHF band.

When operating as a single 72-MHz modulator, the DTA-2115B allows you to modulate one channel with a maximum bandwidth of 72MHz anywhere in the VHF/UHF band for terrestrial and cable standards, and anywhere in the L-Band for satellite standards.

When operating in eight-channel mode, the DTA-2115B allows you to modulate up to eight channels with a maximum bandwidth of 8MHz each. The channels can be located anywhere in the VHF/UHF band, but not in the L-band. In this mode, satellite standards (DVB-S/S2/S2X and ISDB-S) are not supported.

1.2. Block Diagram

The figure below shows a functional block diagram of the DTA-2115B.



Functional block diagram of the DTA-2115B

For each channel the modulation data from the PCIe bus is buffered in a transmit FIFO. An I/Q quadrature modulator converts this data into I/Q samples. Thereafter the I/Q samples pass a programmable channel filter.

The result of the channel filter is a modulated baseband signal in the digital domain. A noise generator with programmable noise level can be used to add simulated noise to the I- and Q-samples. This way, the Carrier to Noise (CNR) ratio of the modulated signal can be set by the user, e.g. for testing the implementation margin of a receiver.

The next digital processing steps are a Sample Rate Converter and a Quadrature Modulator. They output a digital RF-signal.

The sample rate and RF-frequency are synchronized to an accurate internal clock reference or an external clock reference, e.g. a 10MHz and 1pps GPS signals for Single Frequency Network operation.

Dependent on the firmware there are one or eight instances of the FIFO, Modulator Channel Filter Noise Generator, Sample Rate Converter and the Quadrature Modulator. They generate one or eight digital RF-signals.

These signal are combined and the high performance RF Digital-to-Analog Converter (RF-DAC) converts this signal in an analog RF-signal.

Finally, the output of the RF-DAC is filtered, amplified and – for the main output – attenuated with a 60-dB range.

1.3. Firmware Selection

The DTA-2115B includes two variants of the DTA-2115B firmware. Depending on the selected firmware, the DTA-2115B operates as a single 72-MHz VHF/UHF/L-Band modulator or as eight independent 8-MHz VHF/UHF modulators.

Changing the selected firmware can be achieved in two ways:

1. Using DekTec's DtlInfo utility for Windows and change the selected firmware in the GUI.
2. Using DekTec's SDK and call the library function to set the selected firmware. On Windows the selected firmware can be used after the library call, on Linux a reboot of the PC is necessary.

The firmware selection persists until you make a different selection for this card. It does not change after power-off or after installation in another system.

1.4. Software Support

The DTA-2115B comes with a free SDK that is available for both Windows and Linux. The SDK contains a device driver and the DTAPI library that provides uniform access to any DekTec hardware. The SDK enables you to write custom applications with direct RF output.

The device driver implements low-level operations that require direct access to the DTA-2115B hardware, such as initiation and coordination of DMA transfers, the handling of interrupts and reading and writing of Vital Product Data (VPD).

DekTec provides a number of standard (chargeable) applications for the DTA-2115B:

- **StreamXpress**: Play out a transport-stream file and modulate;
- **MuxXpert**: Real-time multiplexing with modulated output;
- **C2Xpress**: DVB-C2 signal generator software;
- **T2Xpress**: DVB-T2 signal generator software;
- **TmmXpress**: ISDB-Tmm signal generator software.

1.5. Available Options

The table below lists the options that are available for the DTA-2115B. The table also list which of these options are supported by the eight 8-MHz VHF/UHF modulators.

Option	Order code	Supported by 8x 8MHz	Remark
ATSC	<i>Included*</i>	Yes	
ATSC 3.0	DTC-386-ATSC3	Yes	
ATSC-MH	DTC-377-MH	Yes	
Channel simulation	DTC-305-CM	Yes	AWGN and multipath emulation
CMMB	DTC-375-CMMB	Yes	
DAB	DTC-376-DAB	Yes	Enables also DRM(+)
DTMB	DTC-374-DTMB	Yes	
DVB-C2	DTC-379-C2	Yes	
DVB-CID	<i>Included*</i>	-	
DVB-S	<i>Included*</i>	-	
DVB-S2	<i>Included*</i>	-	
DVB-S2X	DTC-383-S2X	-	
DVB-T	<i>Included*</i>	Yes	
DVB-T2 full	DTC-378-T2	Yes	
DVB-T2 single-PLP	<i>Included*</i>	Yes	
GOLD	GOLD	Yes	Enables all current and future modulation options
GPS clock synchronization	<i>Included*</i>	-	
8x 8-MHz modulators	DTC-385-HW8CH	Yes	Enables the usage of eight 8-MHz VHF/UHF modulators
I/Q samples	DTC-371-IQ	Yes	
ISDB-S	DTC-373-IS	-	
ISDB-S3	DTC-387-IS3	-	
ISDB-T	DTC-370-ISDB	Yes	
ISDB-Tmm	DTC-382-TMM	-	
Phase noise emulation	<i>Included*</i>	-	
QAM-A	<i>Included*</i>	Yes	ITU J.83 Annex A, also known as DVB-C
QAM-B	<i>Included*</i>	Yes	ITU J.83 Annex B
QAM-C	<i>Included*</i>	Yes	ITU J.83 Annex C

* "*Included*" means that the option is included in the base product and that no special license is required.

2. Specifications

2.1. RF Outputs

The modulated signal is available on two output connectors:

- On a 50- Ω main output with programmable RF level;
- On a 75- Ω monitor output with fixed RF level.

The characteristics of the outputs are specified in the table below.

	Qualification	Min	Typ	Max	Unit
MAIN OUTPUT					
Connector type		SMA, female			
Impedance		50			Ω
Level (programmable)	DVB-S(2), ISDB-S, QAM	-60		0	dBm
	DVB-S2 32APSK, DVB-S2X, ISDB-S3	-61		-1	dBm
	ATSC 3.0	-64.5		-4.5	dBm
	Other OFDM-based stand-ards	-63		-3	dBm
Level, step size		0.1			dB
Level, accuracy	32 to 1000MHz		0.3	±2	dB
	1000 to 2186MHz		0.5	±3	dB
Return loss	32 to 1000MHz		-12		dB
	1000 to 2186MHz		-10		dB
MONITOR OUTPUT					
Connector type		F-type, female			
Impedance		75			Ω
Level (fixed)		-50	-45	-40	dBm
Return loss	32 to 1000MHz		-12		dB
	1000 to 2186MHz		-10		dB

2.2. Frequency Reference Inputs

The frequency reference inputs can be used to lock the DTA-2115B modulator to an external GPS source. Applications include SFN operation and experiments or operation of transmit diversity systems (MIMO, MISO).

	Qualification	Min	Typ	Max	Unit
1PPS					
Connector type			BNC, female		
Impedance			High impedance		
Standard	Schmitt trigger		Low Voltage CMOS (LVC)		
Vin	High level	1.6			V
	Low level			0.5	V
10MHz					
Connector type			BNC, female		
Impedance			50		Ω
Amplitude		10		1000	mVpp

2.2.1. Selecting the external frequency reference input

The DTA-2115B must be manually set to use the external frequency reference input. This can be done in two ways:

- Using DekTec's DtInfo utility for Windows the DTA-2115B can be configured to use the external frequency reference input, by navigating to Change>Advanced and selecting "External" for the "RF clock source" property.
- Using the DTAPI the DTA-2115B can be configured to use the external frequency reference input by using the I/O capability RFCLKSEL. See the DTAPI Core Classes documentation for more details.

The external clock can be presented at any time at the DTA-2115B frequency reference input. Presenting no signal at the frequency reference input, when external clock mode is enabled, will result in a very instable output signal.

2.3. RF and Modulation Parameters

This section specifies the characteristics of the modulated signal.

2.3.1. 72-MHz VHF/UHF/L-Band modulator

The characteristics of the modulated signal if operating as a signal single 72-MHz VHF/UHF/L-Band modulator are specified in the table below.

	Qualification	Min	Typ	Max	Unit
RF FREQUENCY					
Range	Min/max frequency*	32		2186	MHz
Initial accuracy	25°C	-0.5		+0.5	ppm
Aging in first year				1	ppm
Stability	0 to 40°C ambient	-0.5		+0.5	ppm
Step size				0.1	Hz
Phase noise	2186MHz, 10kHz offset			-116	dBc
MODULATION					
Bandwidth				72	MHz
MER	Equalised	48	50		dB
	Unequalised	38	42		dB
SIGNAL PURITY					
Spectral purity	32 to 1000MHz	50			dB
	1000 to 2186MHz	45			dB
Adjacent channel power				-60	dB
Shoulder attenuation				-50	dB
CHANNEL SIMULATOR					
SNR, range	DVB-S, DVB-S2, ISDB-S, ISDB-S3	3		30	dB
	DVB-S2X	-10		30	dB
	All other standards	-10		100	dB
SNR, step size			0.1		dB
SNR, accuracy		±1			dB

* These are the minimum and maximum frequencies of the generated spectrum. The carrier frequency range is less, depending on the modulation bandwidth.

2.3.2. 8-MHz VHF/UHF modulator

The characteristics of the modulated signal if operating as eight 8-MHz VHF/UHF modulators are specified in the table below.

	Qualification	Min	Typ	Max	Unit
RF FREQUENCY					
Range	Min/max frequency	32		999	MHz
Initial accuracy	25°C	-0.5		+0.5	ppm
Aging in first year				1	ppm
Stability	0 to 40°C ambient	-0.5		+0.5	ppm
Step size				1	Hz
Phase noise	999MHz, 10kHz offset			-120	dBc
MODULATION					
Bandwidth				8	MHz
MER	Equalised	45	48		dB
	Unequalised	35	40		dB
SIGNAL PURITY					
Spectral purity	32 to 1000MHz	47			dB
Adjacent channel power				-57	dB
Shoulder attenuation				-47	dB
CHANNEL SIMULATOR					
SNR, range	All supported standards	-10		100	dB
SNR, step size			0.1		dB
SNR, accuracy		±1			dB

2.4. Miscellaneous Specifications

	Qualification	Min	Typ	Max	Unit
POWER					
Supply rails used		3.3, +12			V
Power consumption		13.5		23.5	W
	Card is idle	14.4			W
	Modulating one channel	18.1			W
	Modulating eight channels	22.2			W
PCI EXPRESS BUS					
Label		PCIe3 x1			
Profile		Standard profile			
MECHANICAL					
Dimensions	W x H x D	162.65 x 106.65 x 16.20			mm
Weight		325			g
ENVIRONMENTAL					
Operating temperature		0		+45	°C
COMPLIANCY					
In compliant PC					
CE – Emission		EN 55022:2011			
		EN 61000-3-2:2006/A1:2009			
		EN 61000-3-3:2006/A2:2010			
CE – Immunity		EN 55024:2010			
FCC – Class		B			
Safety		UL 1419, IEC60065			

3. Modulation Standards

This section provides features, specifications and software support per modulation standard.

3.1. ATSC

Parameter / Feature	Value / Comment
STANDARD	ATSC A/53E
MODULATION PARAMETERS	
Mode	8VSB, 16VSB
Roll-off	0.115, programmable
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
StreamXpress	Application for playing transport-stream files and modulating in ATSC
DTAPI SDK	SDK for creating custom applications that generate ATSC directly

3.2. ATSC 3.0

Parameter / Feature	Value / Comment
STANDARD	ATSC 3.0
MODULATION PARAMETERS	
Channel raster bandwidth	6MHz, 7MHz, 8MHz
Bootstrap minor version	0 to 7
EAS wakeup	0 to 3
PARP reduction	None, ACE only, TR only, both ACE and TR
LLS present flag	On, off
Number of PLPs	Up to 64
PLP payload	PRBS, IP-capture file, live IP-input
Other ATSC 3.0-parameters	All ATSC 3.0 defined parameters
FEATURES	
Input format	PRBS IP-capture file Live IP-input
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
SOFTWARE SUPPORT	
Atsc3Xpress	For playing and modulating single-PLP and multi-PLP ATSC 3.0 streams with full control over the entire ATSC 3.0 parameter set
DTAPI SDK	SDK for creating custom applications that generate ATSC 3.0 directly

3.3. ATSC-MH

Parameter / Feature	Value / Comment
STANDARD	ATSC A/153
MODULATION PARAMETERS	
Mode	8VSB
Roll-off	0.115, programmable
FEATURES	
Input format	ATSC M/H transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	Applications for playing transport-stream files and modulating in ATSC-MH
DTAPI SDK	SDK for creating custom applications that generate ATSC-MH directly

3.4. CMMB

Parameter / Feature	Value / Comment
STANDARD	GY/T 220.1/2-2006
MODULATION PARAMETERS	
Bandwidth	2MHz, 8MHz
Identification	Transmitter Identification and Area Identification are freely settable
FEATURES	
Input format	CMMB-PMS stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	For playing and modulating CMMB-PMS files
DTAPI SDK	For creating custom applications that generate CMMB directly

3.5. DAB(+)/T-DMB

Parameter / Feature	Value / Comment
STANDARD	EN 300 401, TS 102 563 and TS 102 427
MODULATION PARAMETERS	
Modes	I, II, III, IV
FEATURES	
Input format	ETI(NI) stream according to EN 300 799
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>DabMux</i>	For multiplexing one or more audio and/or transport-stream files into an ETI(NI) stream
<i>StreamXpress</i>	For playing transport-stream files and modulating in DAB(+) or T-DMB
DTAPI SDK	For creating custom applications that generate DAB(+) or T-DMB directly

3.6. DRM(+)

Parameter / Feature	Value / Comment
STANDARD	ETSI ES 201 980
MODULATION PARAMETERS	
Robustness modes	A, B, C, D, E
FEATURES	
Input format	Application Framing (AF) packets according ETSI TS 102 821 section 6
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>DtPlay</i>	Application for playing DCP-files according ETSI TS 102 821 Annex B.3
DTAPI SDK	SDK for creating custom applications that generate DRM(+) directly

3.7. DTMB (ADTB-T, DMB-T/H)

Parameter / Feature	Value / Comment
STANDARD	GB 20600-2006
MODULATION PARAMETERS	
Bandwidth	5, 6, 7, 8 MHz
Constellation	4QAM-NR, 4QAM, 16QAM, 32QAM, 64QAM
Code rate	0.4, 0.6, 0.8
Guard interval	PN420, PN595, PN945
Interleaving	Mode1 (B=54,M=240), mode2 (B=54,M=720)
Frame numbering	On, off
Pilots	On, off
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
StreamXpress	For playing transport-stream files and modulating in DTMB
DTAPI SDK	For creating custom applications that generate DTMB directly

3.8. DVB-C2

Parameter / Feature	Value / Comment
STANDARD	EN 302 769
MODULATION PARAMETERS	
Channel raster bandwidth	6MHz, 8MHz
C2-system bandwidth	Up to 32MHz completely filled; up to 64MHz partly filled
Number of PLPs	Up to 255
PLP bundling	Fully supported
Number of data slices	Up to 255
PAPR reduction	None, TR
Other DVB-C2-parameters	All DVB-C2 defined parameters
FEATURES	
Input format	MPEG-2 transport stream GSE packets
Special simulation features	ACM and L1-update simulation
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	One 32MHz completely filled; up to 64MHz partly filled or up to eight 8MHz channels
SOFTWARE SUPPORT	
C2Xpress	For playing and modulating single-PLP and multi-PLP DVB-C2 streams with full control over the entire DVB-C2 parameter set
DTAPI SDK	SDK for creating custom applications that generate DVB-C2 directly; The DTAPI supports “Multi-PLP Extensions” to easily create multi-PLP applications.

3.9. DVB-CID

Parameter / Feature	Value / Comment
STANDARD	ETSI TS 103 129 v1.1.2
MODULATION PARAMETERS	
Constellation	BPSK
Roll off	0.35
FEATURES	
Input format	DVB-CID Global Unique Identifier
SOFTWARE SUPPORT	
StreamXpress	For playing transport-stream files or L3 baseband frame files, and modulating in DVB-S2/S2X, including DVB-CID
DTAPI SDK	SDK for creating custom applications that generate DVB-S2/S2X, including DVB-CID directly

3.10. DVB-S

Parameter / Feature	Value / Comment
STANDARD	EN 300 421
MODULATION PARAMETERS	
Symbol rate	0.088MBd to 85MBd
Constellation	QPSK
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
Roll off	0.35, programmable
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
StreamXpress	For playing transport-stream files and modulating in DVB-S
DTAPI SDK	SDK for creating custom applications that generate DVB-S directly

3.11. DVB-S2

Parameter / Feature	Value / Comment
STANDARD	EN 302 307-1
MODULATION PARAMETERS	
Symbol rate	0.088MBd to 85MBd
Constellation	QPSK, 8PSK, 16APSK, 32APSK
Constellation amplitude	E=1, R=1 (for 16APSK, 32APSK)
Code rate	All DVB-S2 defined code rates
FEC-frame size	Normal, short
Pilots	On, off
Roll-off	0.20, 0.25, 0.35, programmable
CCM	Default modulation mode
VCM, ACM, multiple streams, generic streams, null-packet deletion	Supported through L3 baseband frames. The frames specify the transmission format and the user data. Baseband frames can be created with a custom mode-adaptation application or through DekTec's L3Mux utility. The resulting L3 file can be played using the StreamXpress player or using a custom application via the DekTec DTAPI.
FEATURES	
Input format	MPEG-2 transport stream L3 baseband frames
Channel simulation	AWGN insertion with adjustable SNR
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
L3Mux	Utility for creating L3 baseband frame files
StreamXpress	For playing transport-stream files or L3 baseband frame files, and modulating in DVB-S2
DTAPI SDK	SDK for creating custom applications that generate DVB-S2 directly

3.12. DVB-S2X

Parameter / Feature	Value / Comment
STANDARD	EN 302 307-2
MODULATION PARAMETERS	
Symbol rate	0.088MBd to 85MBd
Constellation	QPSK, 8PSK(-L), 16/32/64/128/256APSK(-L)
Constellation VL-SNR	QPSK, BPSK(-S)
Code rate	All DVB-S2X defined code rates
FEC-frame size	Normal, medium, short
Pilots	On, off
Roll-off	0.05, 0.10, 0.15, 0.20, 0.25, 0.35, programmable
CCM	Default modulation mode
VCM, ACM, multiple streams, generic streams, null-packet deletion	Supported through L3 baseband frames. The frames specify the transmission format and the user data. Baseband frames can be created with a custom mode-adaptation application or through DekTec's L3Mux utility. The resulting L3 file can be played using the StreamXpress player or using a custom application via the DekTec DTAPI.
Channel bonding	Not supported
FEATURES	
Input format	MPEG-2 transport stream L3X baseband frames
Channel simulation	AWGN insertion with adjustable SNR
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
L3Mux	Utility for creating L3X baseband frame files
StreamXpress	For playing transport-stream files or L3X baseband frame files, and modulating in DVB-S2X
DTAPI SDK	SDK for creating custom applications that generate DVB-S2X directly

3.13. DVB-T/H

Parameter / Feature	Value / Comment
STANDARD	EN 302 769-2
MODULATION PARAMETERS	
Bandwidth	5, 6, 7, 8 MHz
Constellation	QPSK, 16QAM, 64QAM
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
FFT mode	2k, 4k, 8k
Interleaving	Native, in-depth
Guard interval	1/32, 1/16, 1/8, 1/4
TPS format	DVB-T, DVB-H
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
StreamXpress	For playing transport-stream files and modulating in DVB-T
DTAPI SDK	SDK for creating custom applications that generate DVB-T directly

3.14. DVB-T2

Parameter / Feature	Value / Comment
STANDARD	EN 302 755 v1.1.1, v1.2.1, v1.3.1
MODULATION PARAMETERS	
Bandwidth	1.7, 5, 6, 7, 8, 10 MHz
T2 version	1.1.1, 1.2.1, 1.3.1
T2 profile	Base, lite, base+lite
Number of PLPs	Single-PLP: 1 Multi-PLP: up to 255
PLP payload	Transport stream (TS), Generic Stream Encapsulation (GSE)
PAPR reduction	None, ACE, TR, ACE+TR
Transmitter signature	Through auxiliary-streams or FEFs
Other DVB-T2-parameters	All DVB-T2 defined parameters
FEATURES	
Input format	MPEG-2 transport stream GSE packets T2 Modulator Interface (T2-MI)
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation MISO simulator, generating both MISO transmitter signals
Number of channels	One 10MHz channel or up to eight 8MHz channels
SOFTWARE SUPPORT	
T2Xpress	For playing and modulating single-PLP and multi-PLP DVB-T2 streams with full control over the entire DVB-T2 parameter set
StreamXpress	Application for playing transport streams or T2-MI files and modulating in DVB-T2
DTAPI SDK	SDK for creating custom applications that generate DVB-T2 directly; The DTAPI supports "Multi-PLP Extensions" to easily create multi-PLP applications.

3.15. I/Q-samples

Parameter / Feature	Value / Comment
STANDARD	DekTec proprietary
MODULATION PARAMETERS	
Sample rate	0.088Msps to 85Msps
Roll off	None, 0.05, 0.10, 0.15, 0.20, 0.25, 0.35, programmable
FEATURES	
Input format	I/Q samples as pairs of 16-bit signed integers in I, Q order
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	One 85Msps channel or up to eight 9.375Msps channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	For playing I/Q-sample files
DTAPI SDK	SDK for creating custom applications that play out I/Q samples

3.16. ISDB-S

Parameter / Feature	Value / Comment
STANDARD	ARIB STD-B20
MODULATION PARAMETERS	
Symbol rate	0.088MBd to 85MBd
Number of layers	1 when using transport stream input Up to 4 when using ISDB-S streams input
Modulation and code rate	BPSK 1/2, QPSK 1/2, QPSK 2/3, QPSK 3/4, QPSK 5/6, QPSK 7/8, 8PSK 2/3
Roll off	0.35, programmable
FEATURES	
Input format	ISDB-S stream: Transport streams with TMCC encoded in SYNC bytes
Channel simulation	AWGN insertion with adjustable SNR
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
<i>IsdbsMux</i>	Utility for multiplexing one or more transport-stream files into an ISDB-S stream
<i>StreamXpress</i>	Application for playing transport-stream files and modulating in ISDB-S
DTAPI SDK	SDK for creating custom applications that generate ISDB-S directly

3.17. ISDB-S3

Parameter / Feature	Value / Comment
STANDARD	ARIB STD-B44
MODULATION PARAMETERS	
Symbol rate	0.088MBd to 85MBd (default 33.7561MBd)
Modulation	BPSK, QPSK, 8PSK, 16APSK, 32APSK
Code rate	1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 7/9, 4/5, 5/6, 7/8, 9/10
Roll off	0.03
FEATURES	
Input format	Broadcast-TLV-stream packets: UDP-packets with TMCC information (5810 byte payload)
Channel simulation	AWGN insertion with adjustable SNR
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
<i>IsdbS3Mux</i>	Utility for multiplexing one or more transport-stream and single-TLV-stream files into a broadcast-TLV-stream pcap-file.
<i>DtPlay</i>	Application for playing broadcast-TLV-stream pcap-files and modulating in ISDB-S3
DTAPI SDK	SDK for creating custom applications that generate ISDB-S3 directly

3.18. ISDB-T/T_{SB}

Parameter / Feature	Value / Comment
STANDARD	ARIB STD-B31 and ARIB STD-B29
MODULATION PARAMETERS	
Bandwidth	5, 6, 7, 8 MHz
Number of segments	ISDB-T: 13 ISDB-T _{SB} : 1, 3
Constellation	DQPSK, QPSK, 16QAM, 64QAM
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
FFT mode	Mode 1 (2k), mode 2 (4k), mode 3 (8k)
Guard interval	1/4, 1/8, 1/16, 1/32
Interleaving	0, 1, 2, 4, 8, 16
IIP PID	Selectable
Partial reception	On, off
Emergency broadcasting	On, off
FEATURES	
Input format	MPEG-2 transport stream 204-byte transport stream with TMCC encoded in the last 16 bytes of the 204-byte transport packets
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
StreamXpress	Application for playing transport-stream files and modulating in ISDB-T. For ISDB-T, StreamXpress includes a hierarchical multiplexer.
DTAPI SDK	SDK for creating custom applications that generate ISDB-T directly. Includes a hierarchical multiplexer API.

3.19. ISDB-Tmm

Parameter / Feature	Value / Comment
STANDARD	ARIB STD-B46
MODULATION PARAMETERS	
Channel raster bandwidth	6, 7, 8 MHz
Total bandwidth	Up to 14.5 MHz
Number of segments	Up to 33, with any combination of 13-, 3- and 1-segment signals
Constellation	DQPSK, QPSK, 16QAM, 64QAM
Code rate	1/2, 2/3, 3/4, 5/6, 7/8
FFT mode	Mode 1 (2k), mode 2 (4k), mode 3 (8k)
Guard interval	1/4, 1/8, 1/16, 1/32
Interleaving	0, 1, 2, 4, 8, 16
IIP PID	Selectable
Partial reception	On, off
Emergency broadcasting	On, off
FEATURES	
Input format	MPEG-2 transport stream 204-byte transport stream with TMCC encoded in the last 16 bytes of the 204-byte transport packets
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
TmmXpress	Application for playing and modulating an ISDB-Tmm signal with full control over the ISDB-Tmm/ T_{SB}/T parameters.
DTAPI SDK	SDK for creating custom applications that generate ISDB-Tmm directly.

3.20. QAM-A (DVB-C)

Parameter / Feature	Value / Comment
STANDARD	ITU-T J.83 Annex A and EN 300 429
MODULATION PARAMETERS	
Constellation	16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Roll off	0.15, programmable
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	Application for playing transport-stream files and modulating in DVB-C
DTAPI SDK	SDK for creating custom applications that generate DVB-C directly

3.21. QAM-B

Parameter / Feature	Value / Comment
STANDARD	ITU-T J.83 Annex B
MODULATION PARAMETERS	
Constellation	16QAM, 256QAM
Roll-off	0.18 (64QAM), 0.12 (256QAM), programmable
Interleaving	All ITU-T J.83.B defined interleaving modes
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	Application for playing transport-stream files and modulating in QAM-B
DTAPI SDK	SDK for creating custom applications that generate QAM-B directly

3.22. QAM-C (ISDB-C)

Parameter / Feature	Value / Comment
STANDARD	ITU-T J.83 Annex C
MODULATION PARAMETERS	
Constellation	16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Roll off	0.13, programmable
FEATURES	
Input format	MPEG-2 transport stream
Channel simulation	AWGN insertion with adjustable SNR, multipath fading, Rayleigh channels and Doppler simulation
Number of channels	Up to eight channels
SOFTWARE SUPPORT	
<i>StreamXpress</i>	Application for playing transport-stream files and modulating in QAM-C
DTAPI SDK	SDK for creating custom applications that generate QAM-C directly

4. GPS Clock Synchronization

The DTA-2115B supports 10MHz and 1pps inputs for locking its time base to an external GPS reference source.

The applications foreseen for GPS clock synchronization are:

- Operating the DTA-2115B in a Single Frequency Network (SFN).
- Using multiple synchronized DTA-2115Bs to operate or experiment with MIMO or MISO configurations that use multiple transmitter antennas.
- Synchronizing multiplexer and modulator by locking both to the GPS clock. This way, the modulator does not need to re-multiplex the transport stream or lock to the transport rate generated by the multiplexer.

Time synchronization can be achieved in two ways:

1. Using GPS timestamps embedded in the transport-stream data. This technique is used for real-time transmission of for example DVB-T and DVB-T2. For each mega frame (DVB-T) or T2 frame (DVB-T2), the time of transmission of the first OFDM symbol is embedded in the transport stream.
2. By starting transmission at an explicit GPS time. In this case no timestamps are required. This technique is useful for synchronized transmission of pre-computed IQ sample streams by multiple DTA-2115Bs. The advantage for the user is that no timestamps have to be inserted in the IQ sample files.

The characteristics of the GPS clock synchronisation are specified in the table below.

Parameter / Feature	Value / Comment
GPS CLOCK SYNCHRONIZATION	
Clock reference inputs	10MHz and 1pps
Synchronization method	DVB-T MIP according ETSI TS 101 191 DVB-T2 timestamps according ETSI TS 102 773 Starting transmission at an explicit GPS-time, relative to 1pps specified in units of 1ns
Time offset	-0.5s to +0.5s in steps of 1ns
Monitoring	10MHz- and 1pps-signals Synchronization status
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
DTAPI SDK	SDK for creating custom applications that control the GPS-time synchronization

5. Phase noise emulation

The inherent phase noise of the DTA-2115B is ultra-low. Using the phase noise emulation option you can generate fully customized phase noise, which results in a well-defined phase noise in the output signal desired for receiver design and verification.

The phase noise is injected as samples of the phase modulating signal.

Consider a single constant RF carrier, phase modulated by a sine.

ω_c : carrier frequency ($\omega_c = 2\pi f_c$, where f_c is the frequency in Hz)

ω_m : modulation frequency

Approximation of the resulting signal:

$$y(t) \approx A_0 \cos(\omega_c t) + A_1 [\cos([\omega_c + \omega_m]t) - \cos([\omega_c - \omega_m]t)]$$

Where $A_0/A_1 \approx 20\text{dB}$ if a full-range sine is applied as a phase modulating signal.

The characteristics of the phase noise emulation are specified in the table below.

Parameter / Feature	Value / Comment
STANDARD	DekTec proprietary
MODULATION PARAMETERS	
Sample rate	0.1Msps to 20Msps
FEATURES	
Input format	Phase modulation data samples in 16-bit signed integers
Number of channels	Maximum one channel
SOFTWARE SUPPORT	
DTAPI	SDK for creating custom applications that play out phase modulation data samples

6. Performance Measurements

6.1. Phase Noise

The figures below show the phase noise of a CW signal generated by the DTA-2115B, measured at different RF frequencies: 32, 500, 1500 and 2186MHz.

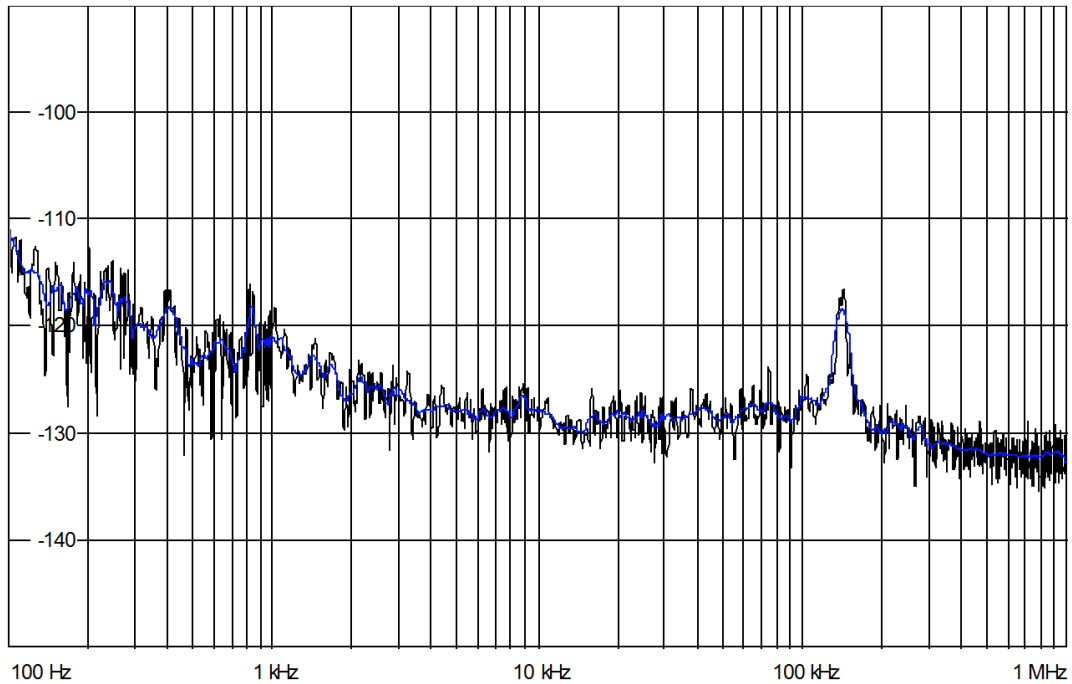


Figure 1. Phase noise @ 32MHz.

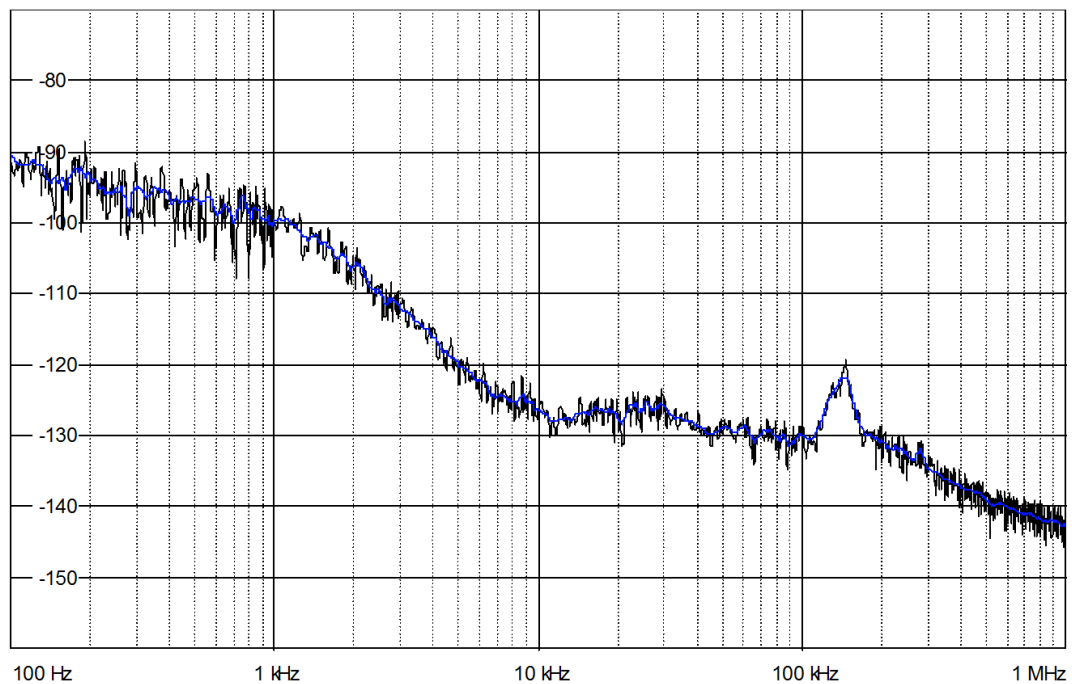


Figure 2. Phase noise @ 500MHz.

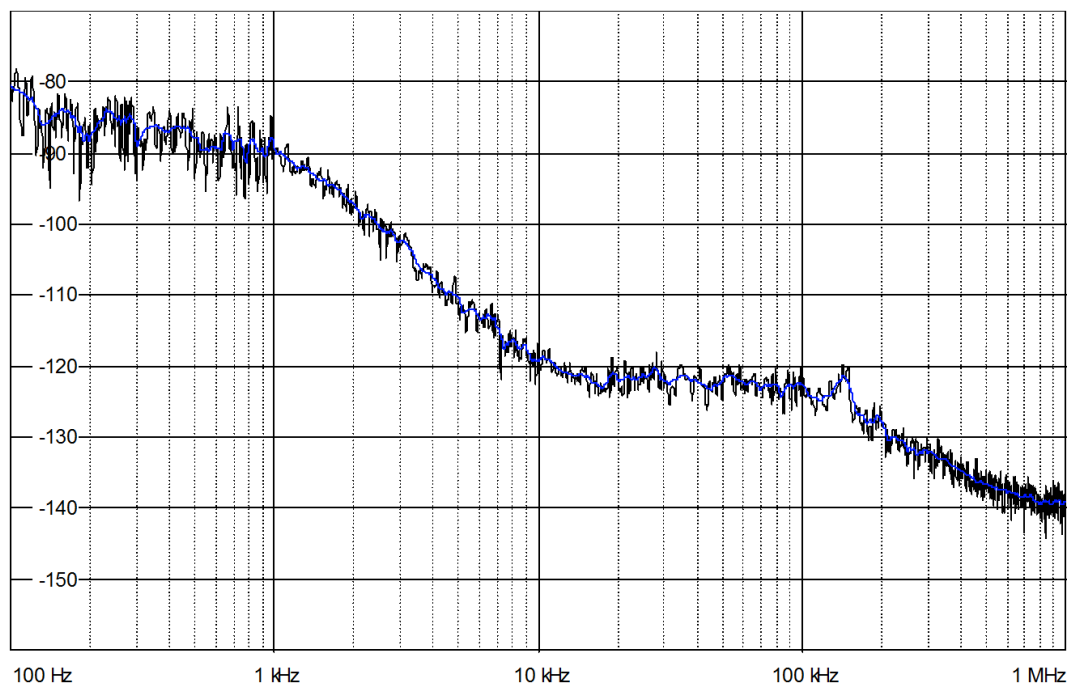


Figure 3. Phase noise @ 1500MHz.

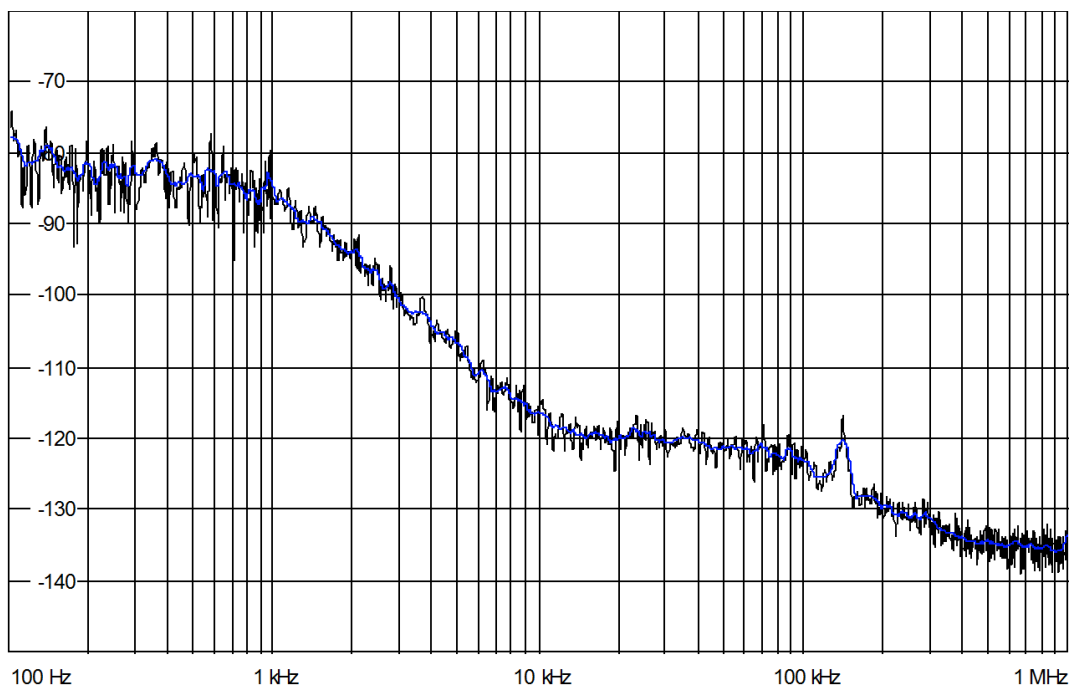


Figure 4. Phase noise @ 2186MHz.

6.2. Return Loss

The figures below show the return loss measured at the main- and monitor outputs of the DTA-2115B.

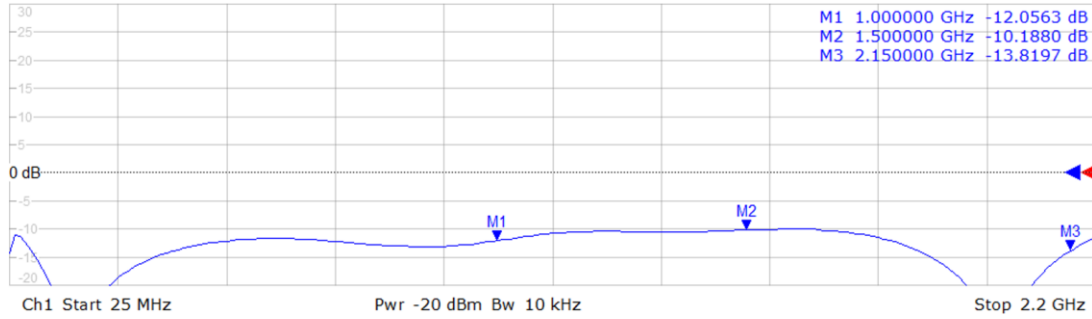


Figure 5. Return loss measurement of the main output.

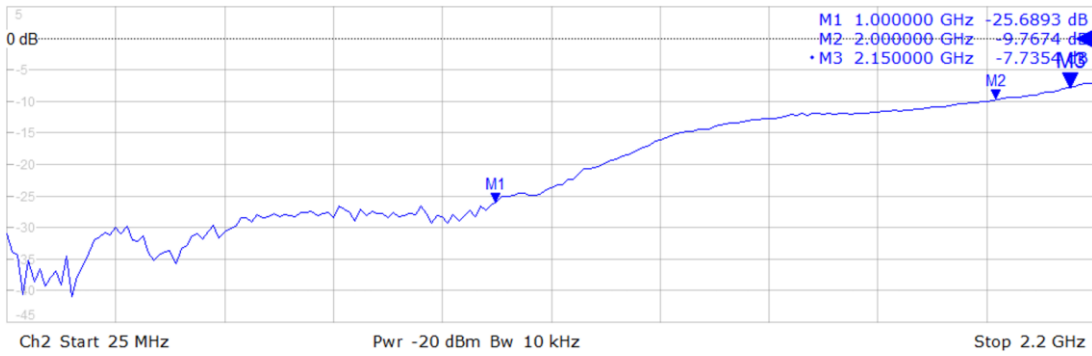


Figure 6. Return loss measurement of the monitor output.

6.3. Adjacent Channel Power

The graph below shows the power level of adjacent channels (ACP) at different RF frequencies when generating a DVB-C 256QAM signal at 0dBm.

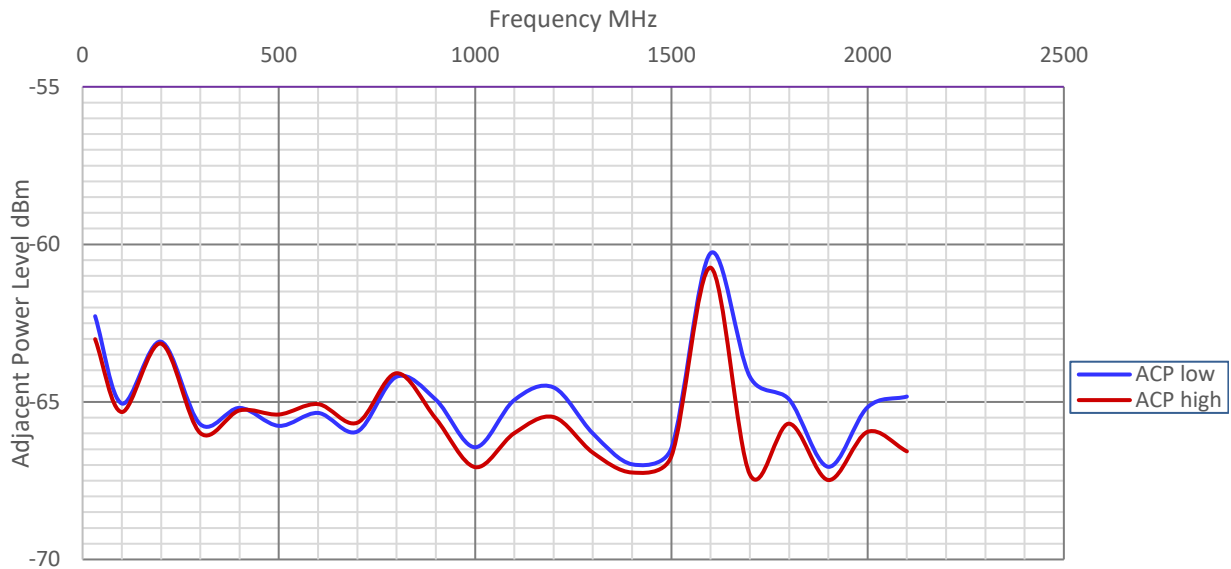


Figure 7. Power of lower and upper adjacent channel.

6.4. Shoulder Attenuation

The figures below show the shoulder attenuation, measured according to ETSI TR 101 290, using a DVB-T 8MHz signal at 682MHz centre frequency.

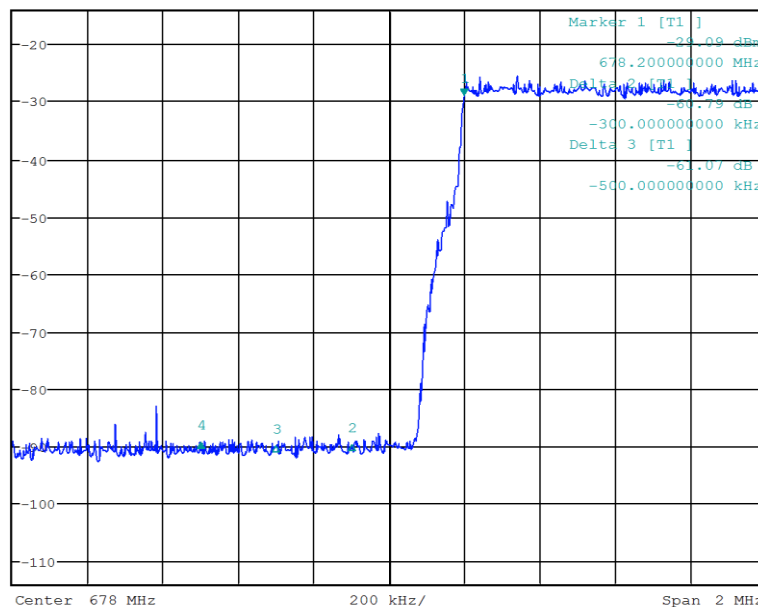


Figure 8. Left shoulder attenuation.

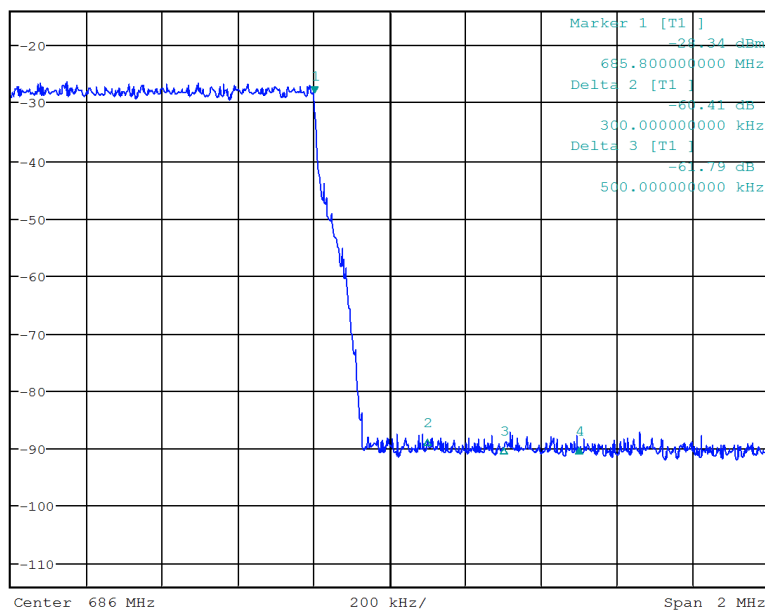


Figure 9. Right shoulder attenuation.

6.5. Second Harmonic Leakage

An undesirable side effect of digital-to-analog conversion on the DTA-2115B is that small “second-harmonic” signals are generated. The table below shows the frequency of the second-harmonic signals as a function of the carrier frequency f_c . Dependent on the band, one or two spurious signals are generated.

Band	Frequency	Second harmonic #1	Second harmonic #2
Band I	32 to 1000MHz	$2 * f_c$	
Band II	1000 to 1400MHz	$2 * f_c - 1600\text{MHz}$	$3200\text{MHz} - 2 * f_c$
Band III	1400 to 2186MHz	$2 * f_c - 2400\text{MHz}$	$4800\text{MHz} - 2 * f_c$

The measurement of the level of the second-harmonic signals is shown in the graph below.

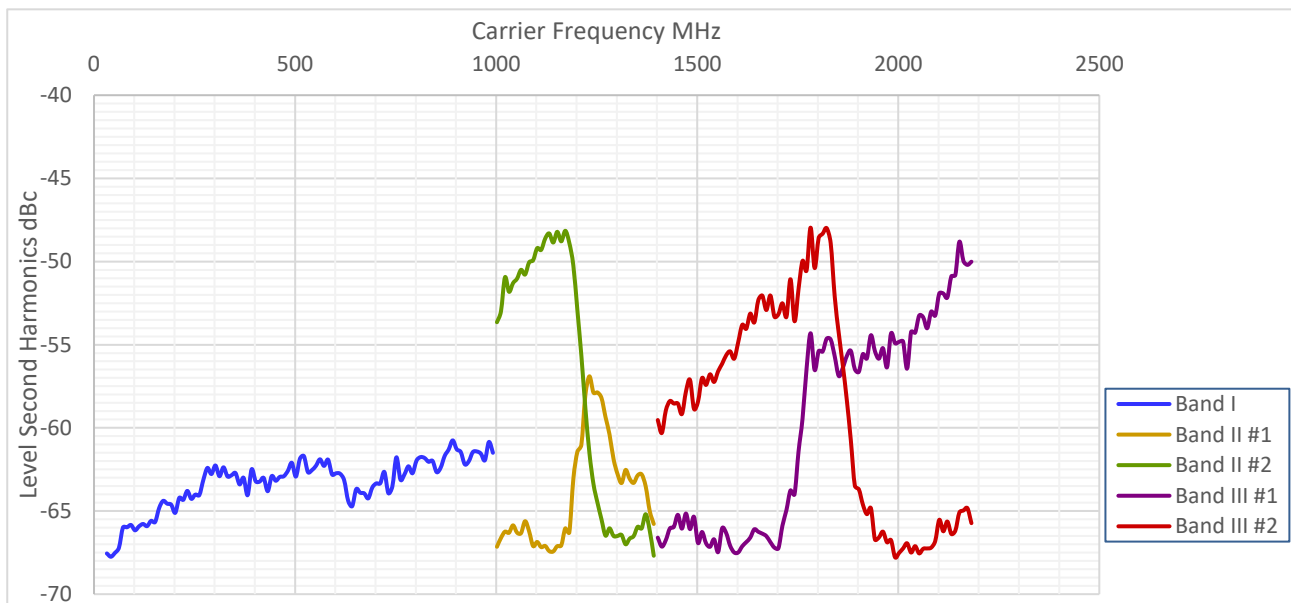


Figure 10. Level of the second-harmonic spurious signal.

An example of the level of the main and second-harmonic signal is shown in the graph below. A main signal at 1830MHz gives a second-harmonic signal at 1260MHz ($= 2*1830\text{MHz} - 2400\text{MHz}$) and another at 1140MHz ($= 4800\text{MHz} - 2*1830\text{MHz}$).

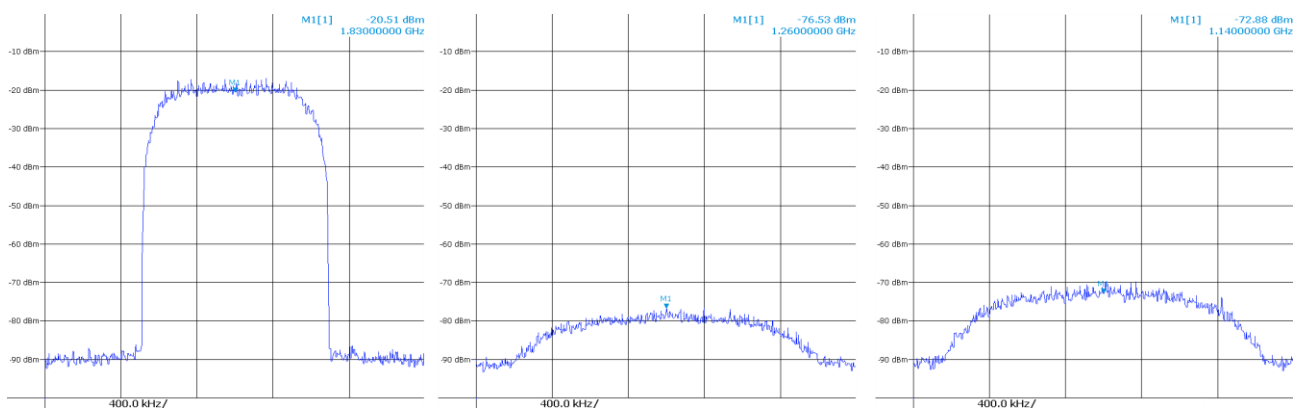


Figure 11. Level of the main signal at 1830MHz and the second-harmonics at 1260MHz and 1140MHz.