# DTA-2115B

## |All-Standard, All-Band Modulator

**PCI EXPRESS®**

# DATASHEET

**DekTec**

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# 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.
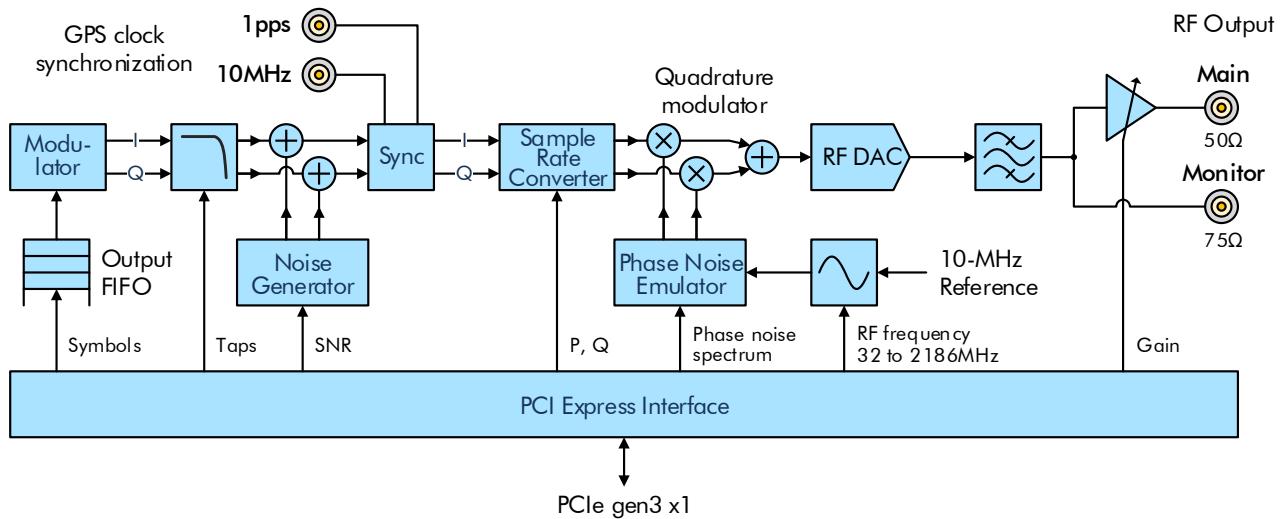


Functional block diagram of the DTA-2115B

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 evaluating 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 signals 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 DtInfo 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 the following 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;
- *T2Xpess*: 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 options are supported by the 8x 8-MHz firmware.

| Option | Order code | Supported by 8x 8MHz | Remark |
|---|---|---|---|
| ATSC | *Included*\* | 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 | Also enables DRM(+) |
| DTMB | DTC-374-DTMB | Yes | |
| DVB-C2 | DTC-379-C2 | Yes | |
| DVB-CID | *Included*\* | - | |
| DVB-S | *Included*\* | - | |
| DVB-S2 | *Included*\* | - | |
| DVB-S2X | DTC-383-S2X | - | |
| DVB-T | *Included*\* | Yes | |
| DVB-T2 full | DTC-378-T2 | Yes | |
| DVB-T2 single-PLP | *Included*\* | Yes | |
| GOLD | GOLD | Yes | Enables all current and future modulation options |
| GPS clock synchronization | *Included*\* | - | |
| 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 | *Included*\* | - | |
| QAM-A | *Included*\* | Yes | ITU J.83 Annex A, also known as DVB-C |
| QAM-B | *Included*\* | Yes | ITU J.83 Annex B |
| QAM-C | *Included*\* | 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 standards | -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 | Equalized | 48 | 50 | | dB |
| | Not equalized | 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 | Equalized | 45 | 48 | | dB |
| | Not equalized | 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 | |
| *StreamXpress* | 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 | |
| *StreamXpress* | 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 | |
|   *DabMux* | For multiplexing one or more audio and/or transport-stream files into an ETI(NI) stream |
|   *StreamXpress* | 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 | |
|   *DtPlay* | 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 L.3 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 L.3 baseband frames. The frames specify the transmission format and the user data.<br>Baseband frames can be created with a custom mode-adaptation application or through DekTec's L3Mux utility. The resulting L.3 file can be played using the StreamXpress player or using a custom application via the DekTec DTAPI. |
| FEATURES | |
| Input format | MPEG-2 transport stream |
| | L.3 baseband frames |
| Channel simulation | AWGN insertion with adjustable SNR |
| Number of channels | Maximum one channel |
| SOFTWARE SUPPORT | |
| *L3Mux* | Utility for creating L.3 baseband frame files |
| *StreamXpress* | For playing transport-stream files or L.3 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 L.3 baseband frames. The frames specify the transmission format and the user data.<br>Baseband frames can be created with a custom mode-adaptation application or through DekTec's L3Mux utility. The resulting L.3 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 |
| | L.3X baseband frames |
| Channel simulation | AWGN insertion with adjustable SNR |
| Number of channels | Maximum one channel |
| SOFTWARE SUPPORT | |
| *L3Mux* | Utility for creating L.3X baseband frame files |
| *StreamXpress* | For playing transport-stream files or L.3X 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 | |
| *StreamXpress* | For playing I/Q-sample files |
| DTAPI SDK | SDK for creating custom applications that play out I/Q samples |

DTA-2115B – All-Standard All-Band Modulator
Data sheet

## 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 | |
| *IsdbsMux* | Utility for multiplexing one or more transport-stream files into an ISDB-S stream |
| *StreamXpress* | 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 | |
| *IsdbS3Mux* | Utility for multiplexing one or more transport-stream and single-TLV-stream files into a broadcast-TLV-stream pcap file. |
| *DtPlay* | 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 | |
| *StreamXpress* | 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 | |
| *StreamXpress* | 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 | |
| *StreamXpress* | 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 I/Q sample streams by multiple DTA-2115Bs. The advantage for the user is that no timestamps need to be inserted in the I/Q sample files.

The characteristics of the GPS clock synchronization 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.
$\omega_c$ : carrier frequency ($\omega_c = 2\pi f_c$, where $f_c$ is the frequency in Hz)
$\omega_m$ : 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 $A_0/A_1 \approx 20$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 playing out data samples with synthesized phase noise |

# 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.
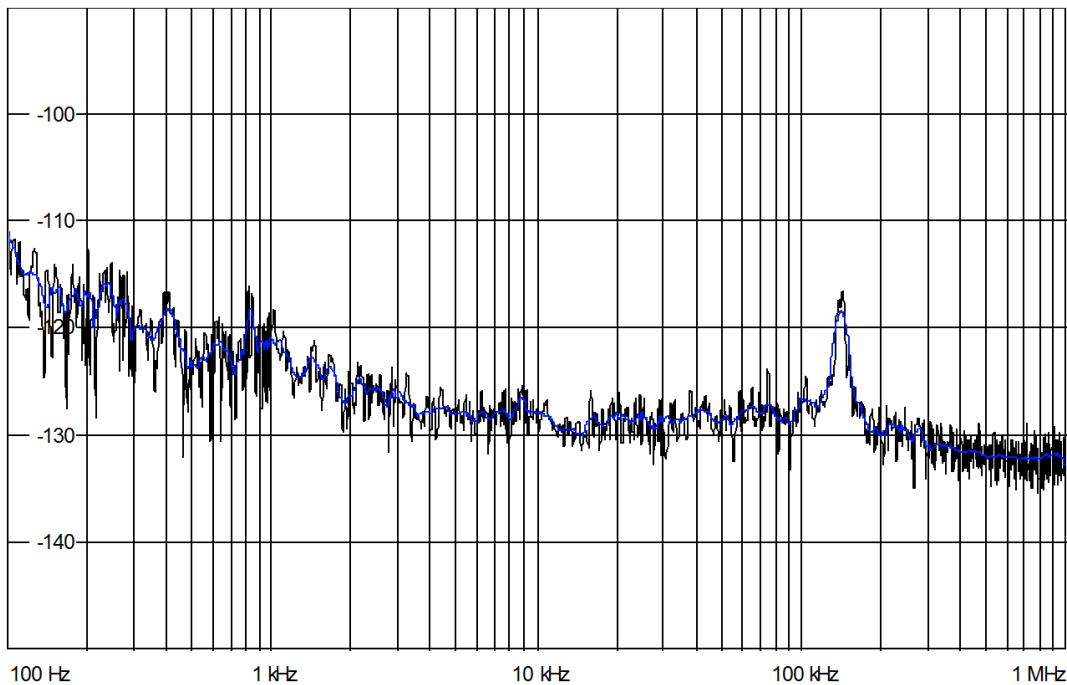


Figure 1. Phase noise @ 32MHz.
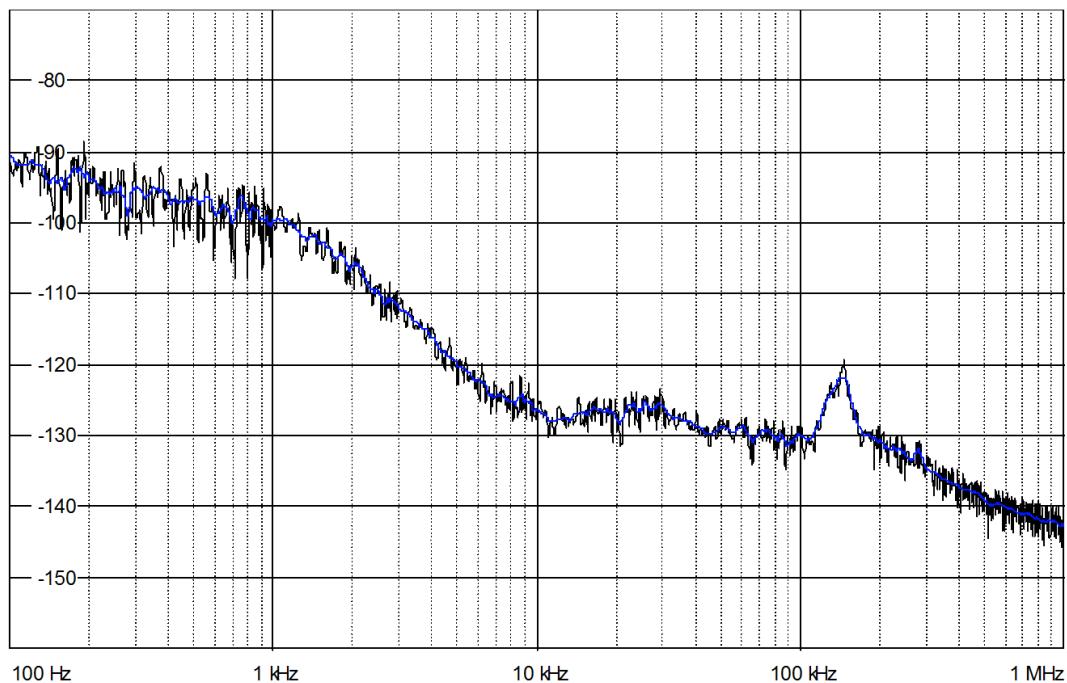


Figure 2. Phase noise @ 500MHz.
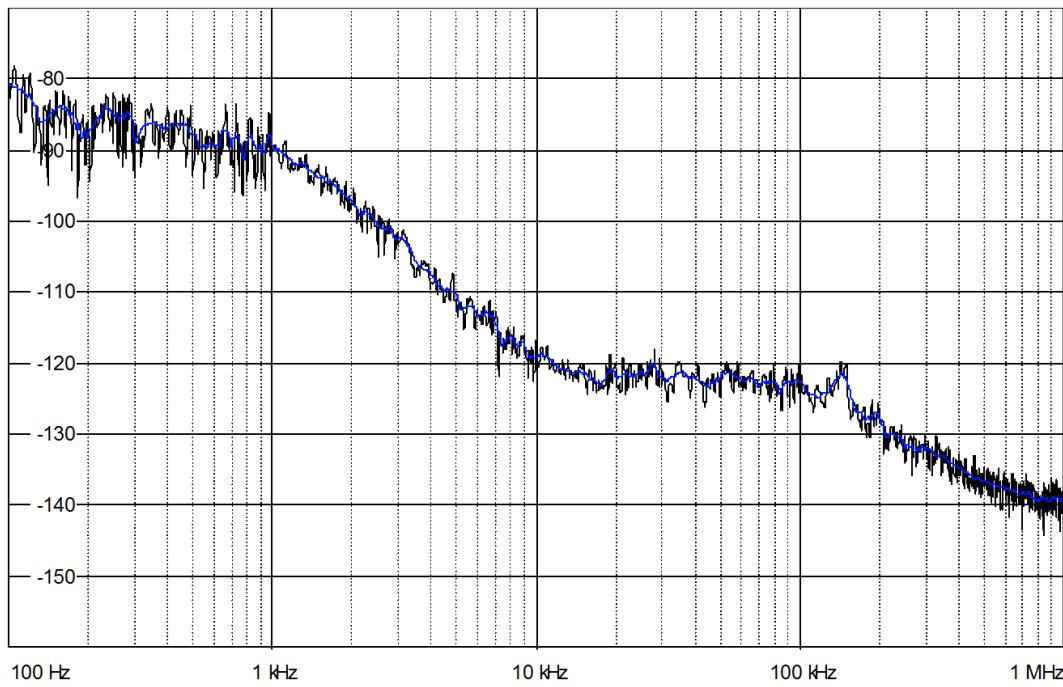
Figure 3. Phase noise @ 1500MHz.
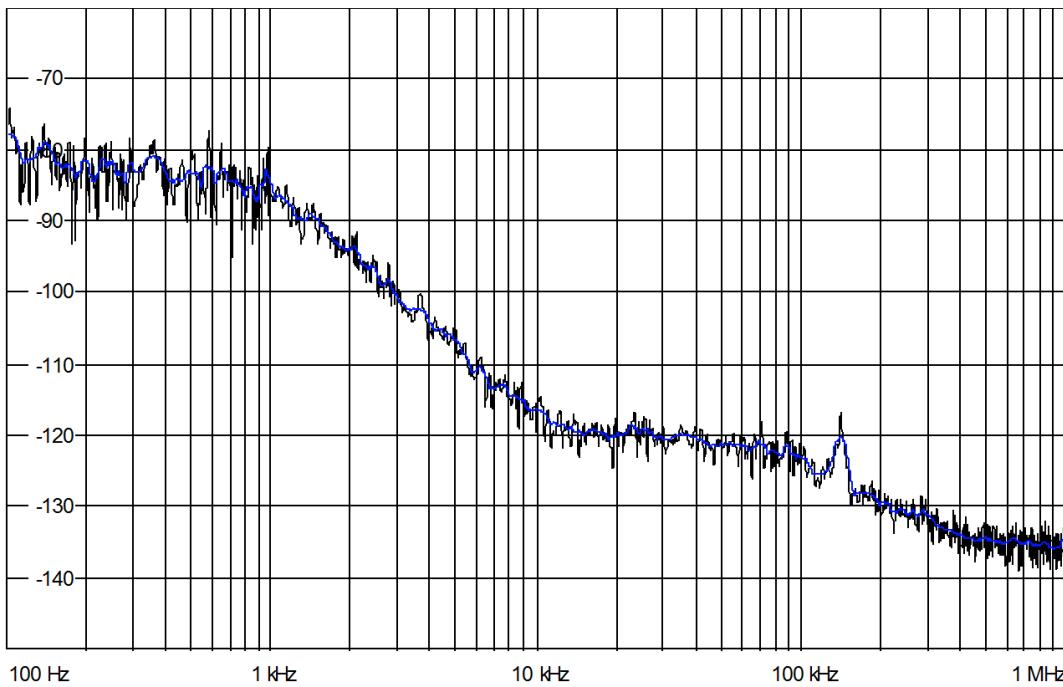


Figure 4. Phase noise @ 2186MHz.

## 6.2. Return Loss

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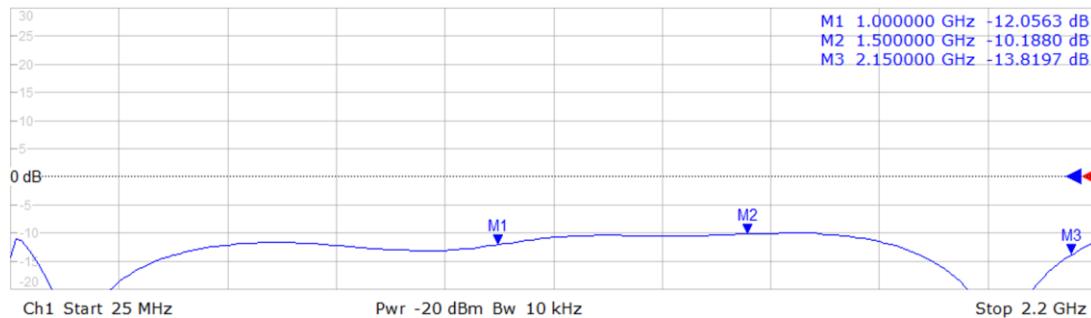


Figure 5. Return loss measurement of the main output.
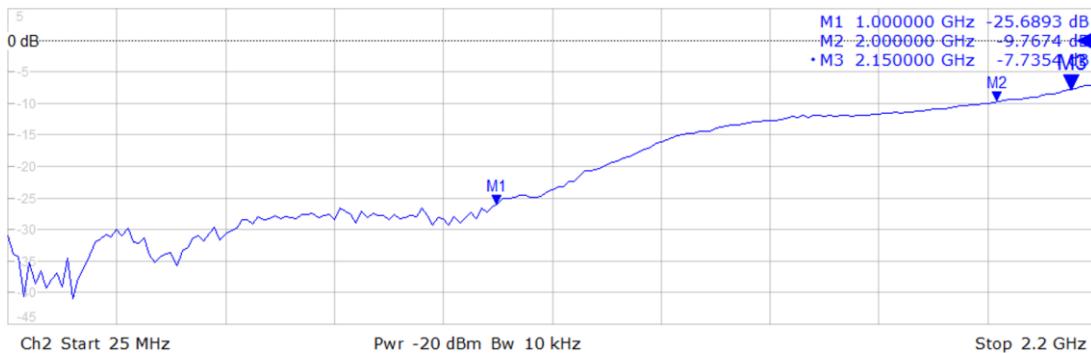


Figure 6. Return loss measurement of the monitor output.
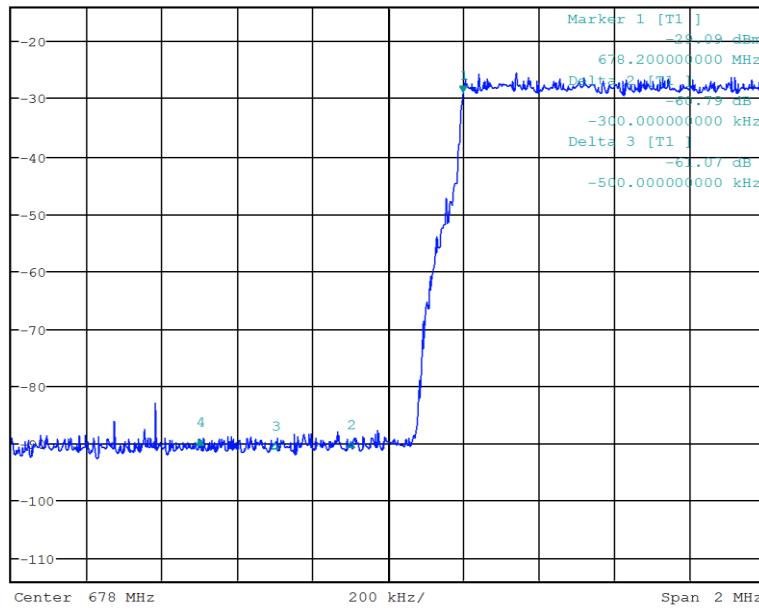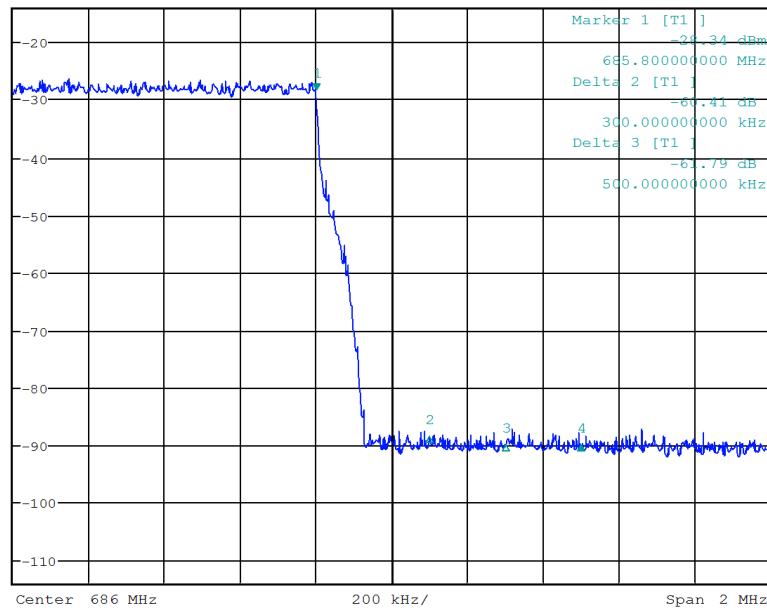
Figure 9. Right shoulder attenuation.

## 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 | $2 * f_C - 1600$MHz | $3200$MHz $- 2 * f_C$ |
| Band III | 1400 to 2186MHz | $2 * f_C - 2400$MHz | $4800$MHz $- 2 * f_C$ |

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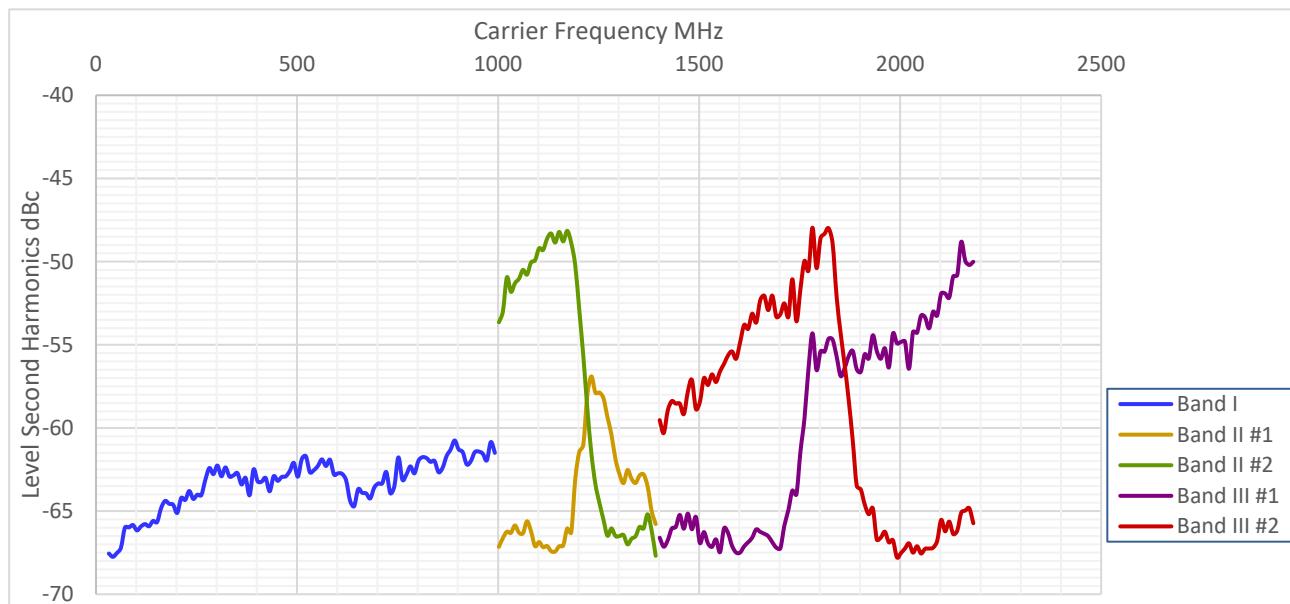


Figure 10. Level of the second-harmonic spurious signal.

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*1830MHz - 2400MHz) and another at 1140MHz (= 4800MHz - 2*1830MHz).
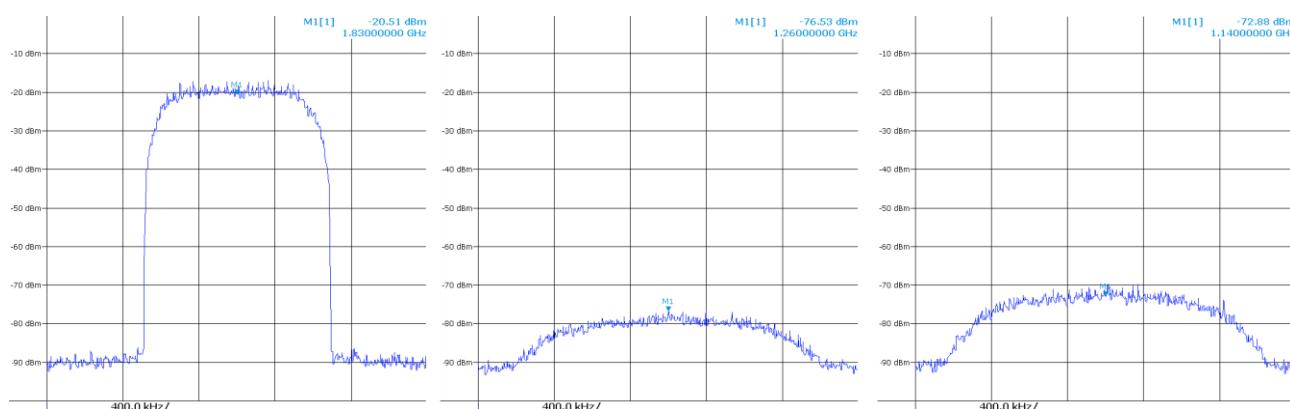


Figure 11. Level of the main signal at 1830MHz and the second harmonics at 1260MHz and 1140MHz.