

Technical Information



TV Test Transmitter R&S SFQ

R&S SFQ-B26: Coder for ISDB-T

- Characteristic: - meets ARIB STD-B31
- ISDB-T Mode: - Mode 1/2/3 (2K/4K/8K)
- Number of Layers: - max. 3 layers (A, B, C)
- Number of Segments: - 13 OFDM segments, setable number for each layer.
- Constellation: - DQPSK, QPSK, 16QAM, 64QAM
- Basic SFQ Features:
 - Wide frequency and level range
 - Several standards in one unit
 - Internal fading simulator, noise generator, BER measurement

ISDB-T:

Overview : The Japanese Association of Radio Industries and Business (ARIB) developed a transmission standard for digital terrestrial broadcasting. Unlike the transmission standards already in use in the other parts of the world, the television, radio and data services are to be covered by one standard. The Japanese broadcasting standard ISDB-T (Terrestrial Integrated Services Digital Broadcasting) was established, in which these services can be transmitted separately in a large number of combinations. The following capabilities should be particularly mentioned: SFN (single frequency network), the positive characteristics in mobile reception and narrowband reception where only a part of the transmitted data is evaluated (*Partial Reception*).

Characteristics of ISDB-T : For both ISDB-T and the other comparable standards, the MPEG-2 method was chosen as source coding of the digital signals to be transmitted. Hierarchical transmission allows adaptation to the different receive conditions. The signal in the transmission channel consists of 13 OFDM segments (Orthogonal Frequency Division Multiplex) whose parameters can be selected independently of each other. The MPEG-2 transport stream is channel-coded and then embedded in the OFDM segments for transmission. Pilot carriers predefine the OFDM frame structure.

Hierarchical Transmission: With ISDB-T, the transmission parameters of the OFDM carriers, the code rates of the *inner coder* and the length of *time interleaving* can be set separately for each layer. Hierarchical transmission with ISDB-T means, transmitting groups of OFDM segments. Up to three *layers*, i.e. segment groups, can be simultaneously transmitted in one channel. Narrowband reception with a special receiver (*Partial Reception*) is to be considered an independent hierarchical *layer*.

Partial Reception: If the influence range of *frequency interleaving* is limited to one OFDM segment, this segment can be considered independently of the other 12 segments. A narrowband receiver that only evaluates this OFDM segment thus receives a complete receive signal.

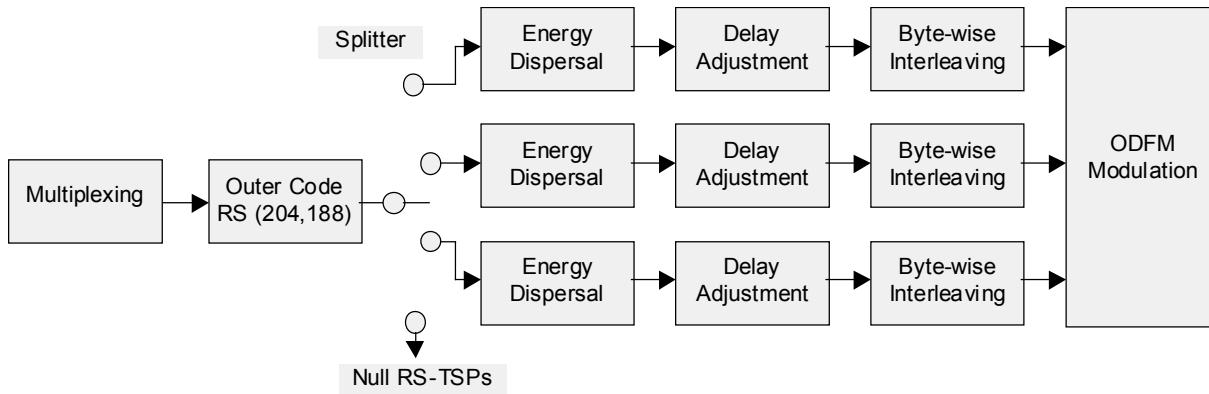
Transmission Parameters: The OFDM spectrum comprises 13 segments that have a bandwidth of approx. 429 kHz. A transmission bandwidth of approx. 5.6 MHz is thus obtained and the signal is suitable for transmission in a 6 MHz channel. Three transmission modes with four *guard intervals* each are available. The various combinations are represented in simplified form in the table below.

Mode	Mode 1	Mode 2	Mode 3
Number of segments	13		
Bandwidth	5.575 MHz	5.573 MHz	5.572 MHz
Carrier spacing	3.968 kHz	1.984 kHz	0.992 kHz
Number of carriers	1405	2809	5617
Carrier modulation	QPSK, 16QAM, 64QAM, DQPSK		
Symbols per frame	204		
Symbol duration	252 μ s	504 μ s	1008 μ s
Guard interval	1/4, 1/8, 1/16, 1/32		
IFFT length	2K	4K	8K



Inner code	Convolutional code (1/2, 2/3, 3/4, 5/6, 7/8)
Outer code	Reed Solomon RS (204,188)

Channel Coding: The block diagram below shows the functional design of channel coding with ISDB-T. Three identical paths are available, corresponding to the three hierarchical layers.



First the transport stream passes through the outer coder. The Reed-Solomon RS (204, 188) shortened code is applied to each transport stream packet. 16 parity bytes are added to the 188-byte packets so that 204-byte packets are obtained. With this Reed-Solomon code up to eight erroneous bytes can be detected in a transport stream packet and corrected.

The error-protected data stream passes through one splitter in which the transport stream packets are divided into up to three hierarchical layers. The control information necessary for this is generated in a data stream multiplexer.

The following module energy dispersal adds a pseudo random binary sequence (PRBS) to the data stream in order to obtain a quasi-random bit sequence that has a positive effect on the transmitted RF spectrum (lower VSWR).

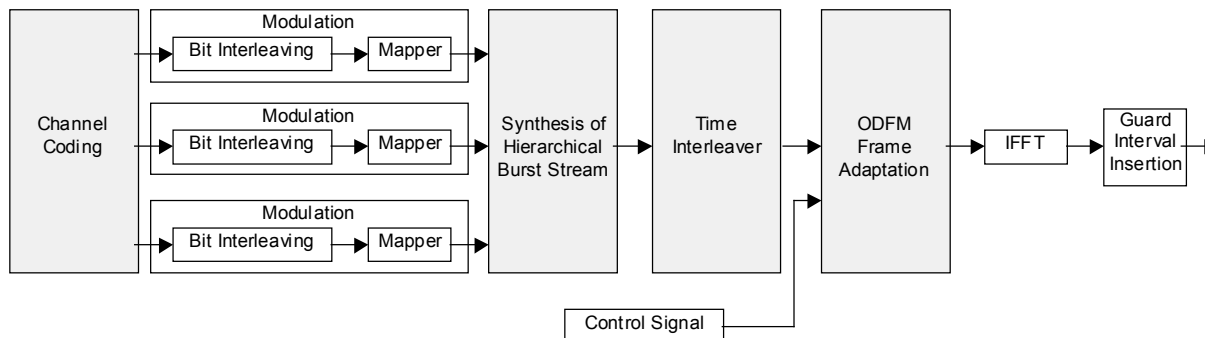
Depending on the transmission parameters modulation and code rate, a varying delay of the data stream in the three paths is obtained through the byte-wise interleaving in the transmitter and de-interleaving in the receiver. A delay adjustment is performed in the coder to minimize the expenditure in the receiver. In this module, the three data streams are delayed so that subsequent delay differences can be compensated for beforehand.

The following byte-wise interleaver separates bytes that were initially adjacent. Burst errors in the transmission channel interfere with the adjacent bytes, which, however, are again separated in the de-interleaver of the receiver. Thus, burst errors are sorted out as individual errors. Individual errors can be corrected by the Reed-Solomon decoder.

Finally, the convolutional coder adds further redundancy to the data stream to permit error correction in the receiver. The integrated puncturer removes bits from the redundant data stream. Puncturing slightly impairs the characteristics of the code. The code rates that can be set are 1/2, 2/3, 3/4, 5/6 and 7/8. The code rate can be selected according to the required transmission characteristics of the system.



Modulation: The block diagram below shows the functional design of the OFDM modulation block with ISDB-T.



Modulation is performed in the first block. Modulation includes bit interleaving with delay compensation and mapping to the modulation constellation diagram. The possible constellations with ISDB-T are DQPSK, QSPK, 16QAM and 64QAM. The constellation can be selected according to the required transmission characteristics of the system. Suitable bit interleaving and delay compensation are automatically selected. The synthesis of the hierarchical data stream is now performed. For this purpose, the complex mapped data from each of the three paths is added together to form a serial data stream.

Symbol-by-symbol time interleaving follows synthesis. This is an intra-segment time interleaver whose depth can be set separately for each layer. Delay compensation is also assigned to the time interleaver in order to compensate for different delays in the paths.

The following frequency interleaving scrambles the data in an OFDM symbol, i.e. in the frequency domain. First an inter-segment interleaver is applied between the OFDM segments that have the same modulation, followed by an intra-segment interleaver that rotates the data in a segment. The data pass through an intra-segment randomizer that shifts the data in a segment to quasi-random positions.

The next step is OFDM framing. Frames are formed from 204 OFDM symbols by adding pilot carriers. Depending on the mode and the selected modulation pilot carriers are inserted into the data stream at different positions. TMCC carriers (Transmission and Multiplexing Configuration Control) and AC carriers (Auxiliary Channel) are added.

The data handled in this way undergo inverse Fourier transform IFFT so that it is transferred from the frequency domain to the time domain as usual with OFDM modulation. The length of IFFT depends on the selected ISDB-T mode and can be 2K, 4K or 8K.

IFFT is followed by the insertion of the guard interval. This guard interval extends the OFDM symbols by a specific factor (1/4, 1/8, 1/16 or 1/32). This measure has a positive effect on the receiving characteristics with multipath propagation.



Integration in the SFQ:

TV Test Transmitter R&S SFQ is a complete solution for testing digital TV links and receivers. The open-end software and modular hardware make the R&S SFQ future-proof. The standards für DVB-T, DVB-S/DVB-DSNG, turbocoding, DVB-C, J.83B, ATSC/8VSB and now ISDB-T are fully complied with. Thanks to its adaptability to future system changes , R&S SFQ is a useful and rewarding investment for your launch onto the digital TV market.

The new ISDB-T Coder R&S SFQ-B26 is fully integrated in this complete solution.

Concerning basic SFQ features see datasheet SFQ.

RF FREQUENCY	RF LEVEL	MODULATION	USED BANDWIDTH	C/N	FADING
485.142857 MHz	-30.0 dBm	ISDB-T MODE1	5.575 MHz	OFF	OFF
RF FREQUENCY	RF LEVEL	MODULATION	I/Q CODER <i>W/R CLK</i>	BANDWIDTH	SPECIAL
I/Q CODER	LAYER A / 13 SEG(S)	LAYER B / 0 SEG(S)	LAYER C / 0 SEG(S)		
INPUT SELECT ⇒	SPI	INPUT DATA RATE:		10.000 MBit/s	
USEFUL DATA RATE MAX	21.298475 MBit/s	0.000000 MBit/s		0.000000 MBit/s	
USEFUL DATA RATE MEASURE	0.000 MBit/s	0.000 MBit/s		0.000 MBit/s	
MODE ⇒	DATA	PRBS TS PACKET		PRBS TS PACKET	
CODE RATE ⇒	7/8	7/8		7/8	
TIME INTERLEAVING ⇒	8	8		8	
ISDB-T MODE ⇒	MODE1 (2K)				
GUARD INTERVAL ⇒	1/8				
BANDWIDTH ⇒	5.575397 MHz				
SPECIAL ⇒					
			F2=STATUS	F4=PRESET CODER	

Coder menu ISDB-T

Data Inputs:

ASI: Asynchronous Serial Interface. This input is available only with the option input interface (SFQ-B6). The data rate of the incoming data stream is converted to a defined data rate in the input interface (32.507936 Mbit/s). The new data stream thus obtained is transferred to the ISDB-T coder in which it is converted to a valid ISDB-T data stream.

SPI: Synchronous Parallel Interface. This input is available either with and without the option input interface (SFQ-B6). The option input interface does not modify the data stream. A valid data stream is only generated in the ISDB-T coder.

If the input ASI or SPI is selected data can be transmitted in maximally one layer. The table below shows the possible combinations. NULL/PRBS identifies test data, i.e. either NULL TS PACKET, PRBS TS PACKET, PRBS BEFORE CONV. or PRBS AFTER CONV.

Layer	Pattern 1	Pattern 2	Pattern 3	Pattern 4
A	NULL / PRBS	DATA	NULL / PRBS	NULL / PRBS
B	NULL / PRBS	NULL / PRBS	DATA	NULL / PRBS
C	NULL / PRBS	NULL / PRBS	NULL / PRBS	DATA



TS PARALLEL+AUX: The TS PARALLEL input and also the TS PARALLEL AUX input are used here. The actual data stream comes from a transport stream multiplexer and is already in line with the ISDB-T standard. The data rate is 32.507936 Mbit/s. The actual useful data are supplied via the TS PARALLEL input and the associated control information is fed to the TS PARALLEL AUX input. If the TS PARALLEL+AUX input is selected the mode can be set separately for each layer.



ISDB-T Coder

Characteristic

Inputs

Modes

Special Functions

Bandwidth

Carriers

Segments

ISDB-T Mode

Number of Layers

Number of Segments

Constellation

Code Rate

Guard Interval

Time Interleaving

AC Information

Symbol Clock Accuracy

Spectrum Mask

Output level (RF)

General data

Rated temperature rang

Operating temperature range

Storage temperature range

Order information

Order designation

TV TestTransmitter (0.3 MHz to 3300 MHz) for
ISDB-T

Option SFQ-B26

meets ARIB STD-B31

TS PARALLEL+AUX and SPI; with SFQ-B6: ASI
DATA, NULL TS PACKET, PRBS TS PACKET, PRBS
BEFORE/AFTER CONV. (PRBS: $2^{15}-1$, $2^{23}-1$ to ITU-T
Rec. O.151)

Scrambler, Reed Solomon, Byte Interleaver, Bit Inter-
leaver, Frequency Interleaver, Alert Broadcasting Flag
can be switched off.

5.57 MHz \pm 1 %

Data, SP, CP, TMCC and AC carriers can be switched
off. Also the modulation of these carriers can be swit-
ched off.

All carriers of one segment can be switched off.

Mode 1 (2K), Mode 2 (4K) and Mode 3 (8K)

max. 3 layers (A, B, C)

setable number of segments for each layer.

DQPSK, QPSK, 16QAM, 64QAM

1/2, 2/3, 3/4, 5/6, 7/8

1/4, 1/8, 1/16, 1/32, OFF

0, 1, 2, 4, 8, 16 (setable depth depending on ISDB-T
Mode)

PRBS, ALL1

see reference frequency of SFQ

according to ISDB-T specification.

+4dBm

5...+45°C

0...+50°C

-40...+70°C

R&S SFQ02

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Options

ISDB-T Coder

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