Application Note

DVB-T/H Test

MG3700A

Vector Signal Generator

Application Note
- DVB-T/H Test -

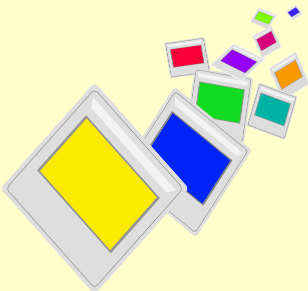
Anritsu

MG3700A

Vector Signal Generator

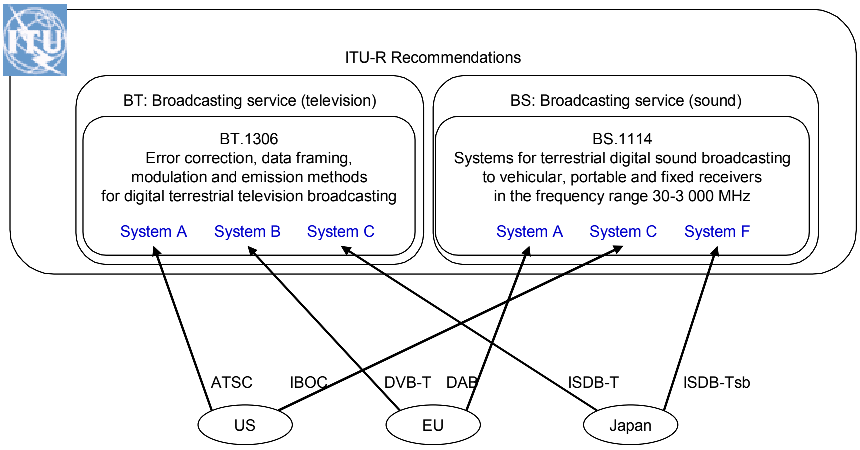
June 2007
(1.00)

Contents



World Digital Broadcast Standardization

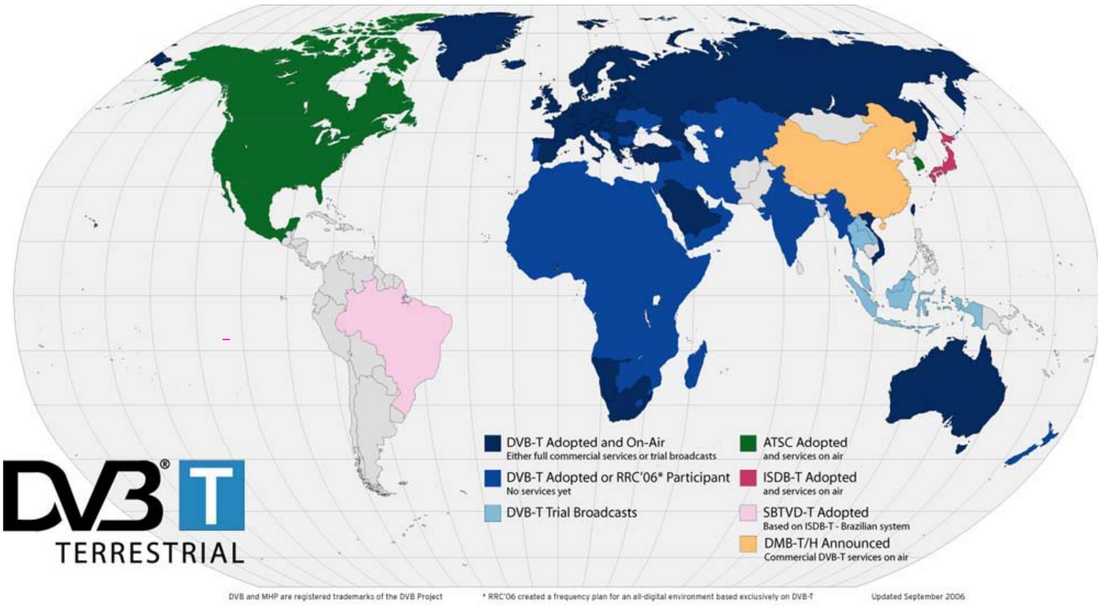
- The broadcasting standard specified in each region is submitted to ITU-R SG6, and is listed in ITU-R Recommendations.



Digital Terrestrial TV Broadcasting Specifications

	ATSC	DVB-T	ISDB-T
Adopted	US, Korea	EU, Australia	Japan, Brazil
Video encoding	MPEG-2 Video (Main profile)		
Voice encoding	AC-3	MPEG-2 BC Layer I, II	MPEG-2 AAC (LC profile)
Multiplexing	MPEG-2 Transport stream		
EPG	PSIP	DVB-SI	SI on ARIB STD-B10
Outer coding	Reed-Solomon (Length 208 Bytes, Dimension 188 Bytes)	Reed-Solomon (Length 204 Bytes, Dimension 188 Bytes)	
Inner coding	Trellis (2/3)	Convolutional (1/2, 2/3, 3/4, 5/6, 7/8)	
Modulation	8-VSB	COFDM QPSK, 16QAM, 64QAM, Non-uniform 16QAM, Non-uniform 64QAM	OFDM DQPSK, QPSK, 16QAM, 64QAM
Mode (representing FFT size/samples/points) (Number of carriers)	---	2K (1705), 8K (6817)	1 (1405), 2 (2809), 3 (5617)
Guard interval	---	1/4, 1/8, 1/16, 1/32	
Channel bandwidth	6 MHz (Available 7 and 8 MHz on standard)	7 MHz, 8 MHz (Available 5 and 6 MHz on standard)	6 MHz (Available 7 and 8 MHz on standard)

Worldwide Adoption



Source: DVB Project

Mobile TV Broadcasting Specifications

	DVB-H	ISDB-T (1Seg)	DMB
Adapted	EU	Japan	Korea
Frequency band	VHF/UHF-TV	UHF-TV	VHF-TV
Modulation	OFDM QPSK, 16QAM	OFDM QPSK, 16QAM	OFDM DQPSK
Channel bandwidth	8 MHz	428 kHz	1.5 MHz
Transmission capacity	11 Mbps	280 k to 624 kbps	0.8 M to 1.7 Mbps
Battery saving technology	Time slicing	Bandwidth reducing	Bandwidth reducing

Otherwise, MediaFLO from US

DVB Standardization

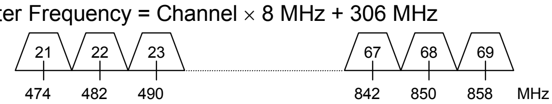
- DVB-S
  - » Digital satellite broadcasting
    - – QPSK, now *de facto* world satellite transmission standard
- DVB-T
  - » Digital terrestrial broadcasting
    - – Based on COFDM and QPSK, 16QAM and 64QAM
- DVB-C
  - » Digital cable TV broadcasting based on DVB-S
    - – Closely related to DVB-S, based on 64QAM
- DVB-H
  - » Digital handheld/mobile TV broadcasting
    - – Time slicing and MPE-FEC, based on DVB-T

http://www.dvb-h-online.org/

GLOBAL MOBILE TV DVB-H

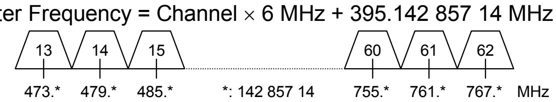
Channel Frequencies

- EU
  - » UHF Channel: 21 to 69
    - – Frequency: 470 M to 862 MHz
      - • Center Frequency = Channel × 8 MHz + 306 MHz

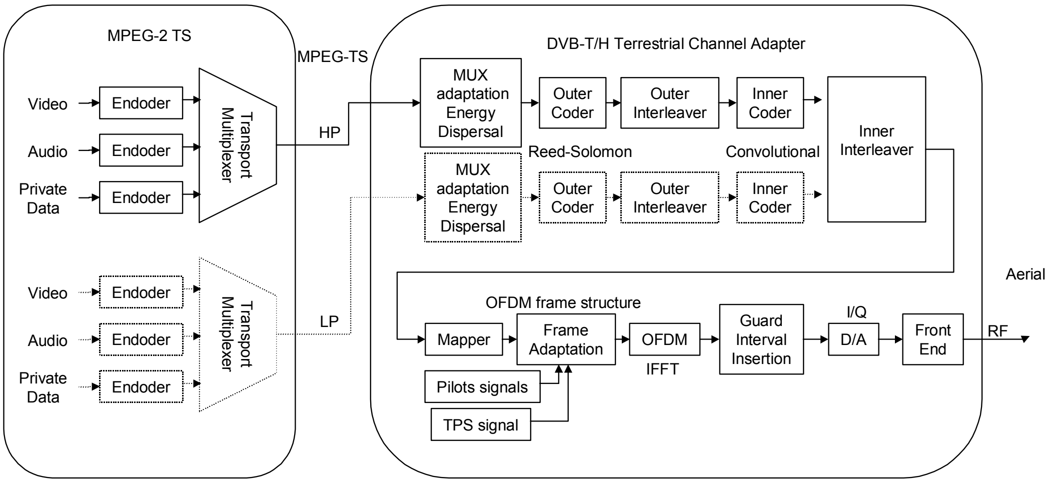


- Australia
  - » UHF Channel: 28 to 69
    - – Frequency: 526 M to 820 MHz
      - • Center Frequency = Channel × 7 MHz + 333.5 MHz

- Japan
  - » UHF Channel: 13 to 62
    - – Frequency: 470.142 857 14 M to 770.142 857 14 MHz
      - • Center Frequency = Channel × 6 MHz + 395.142 857 14 MHz



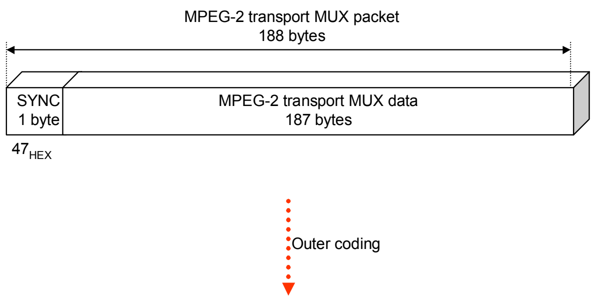
Functional Block Diagram



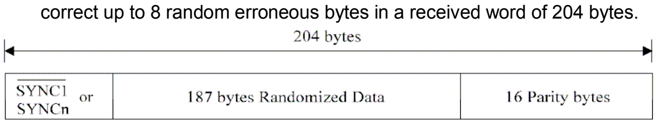
Reference: ETSI EN 300 744, ETSI EN 302 304

MPEG-2 Transport MUX Packet

- The input stream is organized in fixed length packets, following the MPEG-2 transport multiplexer. The total packet length of the MPEG-2 transport multiplex (MUX) packet is 188 bytes. This includes 1 sync-word byte (47_{HEX}).



  - The Reed-Solomon code has length 204 bytes, dimension 188 bytes and allows to correct up to 8 random erroneous bytes in a received word of 204 bytes.



c) Reed-Solomon RS(204,188,8) error protected packets

Hierarchical Modulation

Quoted from DVB DVB Project (White Papers)

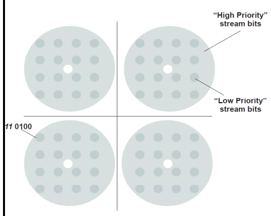
- What is Hierarchical Modulation?

  In hierarchical modulation, two separate data streams are modulated onto a single DVB-T stream. One stream, called the "High Priority" (HP) stream is embedded within a "Low Priority" (LP) stream. Receivers with "good" reception conditions can receive both streams, while those with poorer reception conditions may only receive the "High Priority" stream. Broadcasters can target two different types of DVB-T receiver with two completely different services. Typically, the LP stream is of higher bit rate, but lower robustness than the HP one. For example, a broadcast could choose to deliver HDTV in the LP stream.

Hierarchical Modulation

- How does it work?

  DVB-T is a multi-carrier system using about 2000 or about 8000 carriers, each of which carries QPSK, 16QAM or 64QAM. QAM is one of the means at our disposal to increase the amount of information per modulation symbol. Taking the example of 64QAM, the hierarchical system maps the data onto 64QAM in such a way that there is effectively a QPSK stream buried within the 64QAM stream. Further, the spacing between constellation states can be adjusted to protect the QPSK (HP) stream, at the expense of the 64QAM (LP) stream.



DVB-T Hierarchical 64QAM constellation with an embedded QPSK stream

  In layman's terms, good quality reception allows receivers to resolve the entire 64QAM constellation. In areas with poorer quality reception, or in the case of mobile or portable reception, receivers may only be able to resolve the lighter colored portions of the constellation, which corresponds to QPSK.

  Considering bits and bytes, in a 64QAM constellation you can code 6 bits per 64QAM symbol. In hierarchical modulation, the 2 most significant bits (MSB) would be used for the robust mobile service, while the remaining 6 bits would contain, for example, a HDTV service. The first two MSBs correspond to a QPSK service embedded in the 64QAM one.

  - ***11*** 0100 (bits "***11***" are sued to code the High Priority (HP) service)

Hierarchical Modulation

- Example system parameters

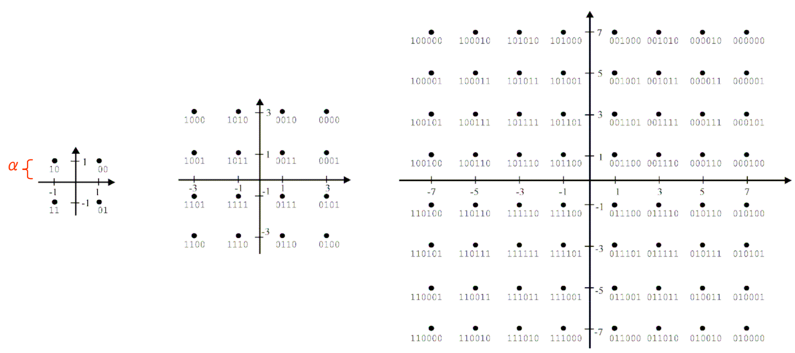
  A set of parameters, which might be appropriate for use in a North American 6 MHz channel for HD/SD simulcast, is as follows:

  - Modulation:
    - QPSK in regular 64QAM 6MHz DVB-T
    - Guard interval: 1/32
  - Code rates:
    - HD service: 3/4; SD service: 1/2
  - Video resolution:
    - HD: 720p; SD: 480i
  - Bit rate:
    - HD layer: 13.6Mbps; SD layer: 4.5Mbps
  - Gaussian noise performance:
    - HD layer: 19.6 dB; SD layer: 10 dB

Mapper

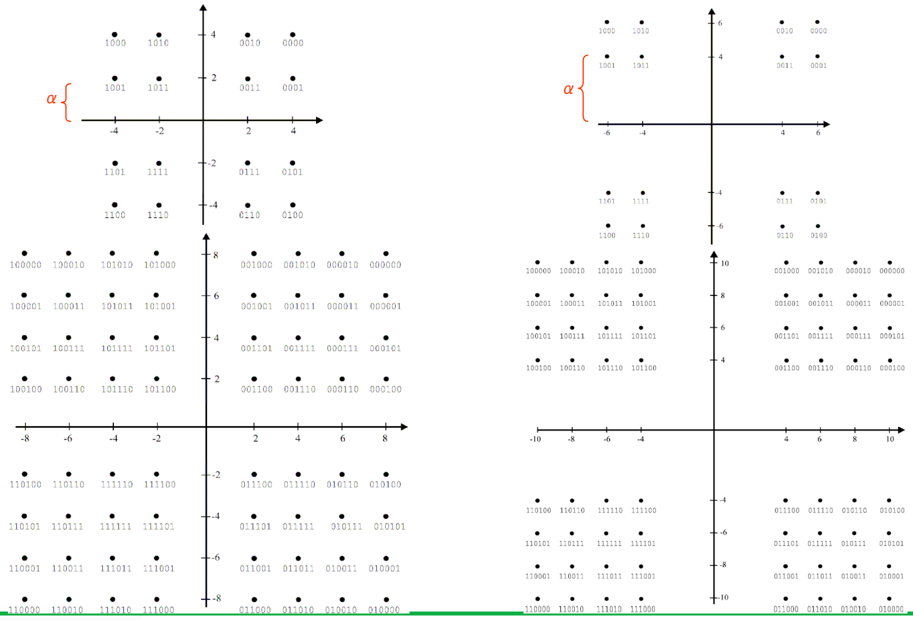
- All data carriers in one OFDM frame are modulated using either QPSK, 16QAM, 64QAM, non-uniform 16QAM or non-uniform 64QAM constellations.
- The exact proportions of the constellations depend on a parameter α, which can take the three values 1, 2 or 4, thereby giving rise to the three diagrams. α is the minimum distance separating two constellation points carrying different HP-bit values divided by the minimum distance separating any two constellation points.
- Non-hierarchical transmission uses the same uniform constellation as the case with α = 1.

- Non-hierarchical, and hierarchical with α = 1



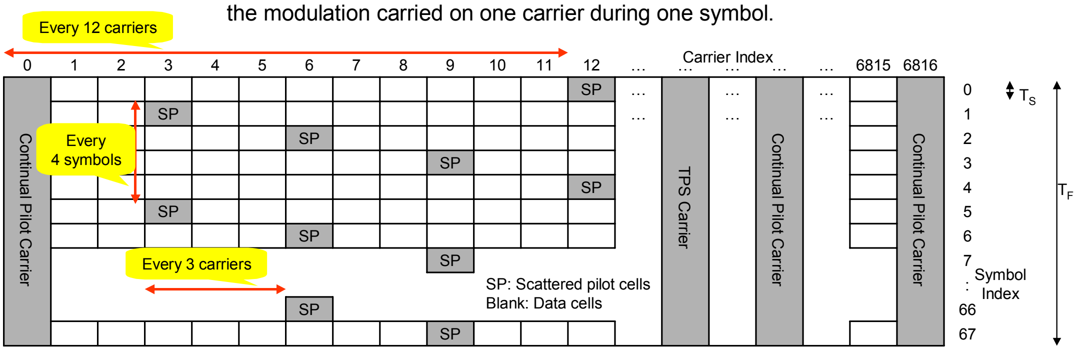
Mapper

- Non-uniform with α = 2
- Non-uniform with α = 4



OFDM Frame Structure

- Each frame has a duration of T_F, and consists of 68 OFDM symbols. Four frames constitute one super-frame. Each symbol is constituted by a set of K = 6817 carriers in the 8K mode and K = 1705 carriers in the 2K mode (and K = 3409 carriers in the 4K mode for DVB-H) and transmitted with a duration T_S. It is composed of two parts: a useful part with duration T_U and a guard interval with a duration Δ. The guard interval consists in a cyclic continuation of the useful part, T_U, and is inserted before it.
- The symbols in an OFDM frame are numbered from 0 to 67. All symbols contain data and reference information.
- Since the OFDM signal comprises many separately-modulated carriers, each symbol can in turn be considered to be divided into cells, each corresponding to the modulation carried on one carrier during one symbol.

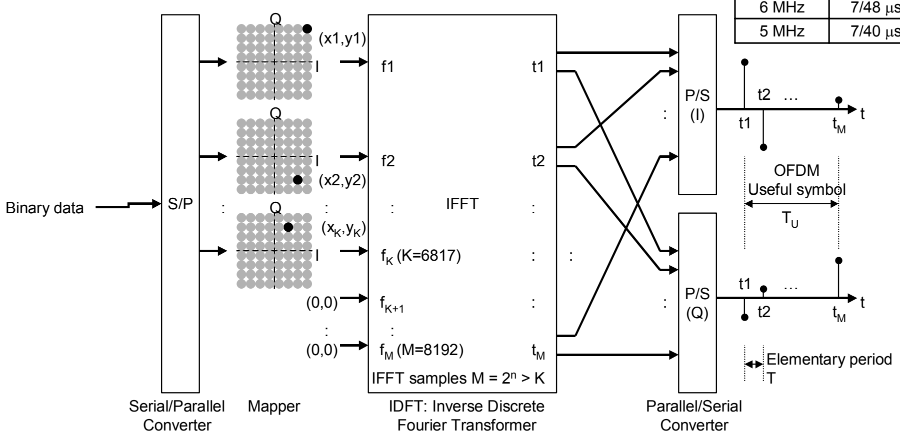


IFFT

IFFT: Inverse Fast Fourier Transform

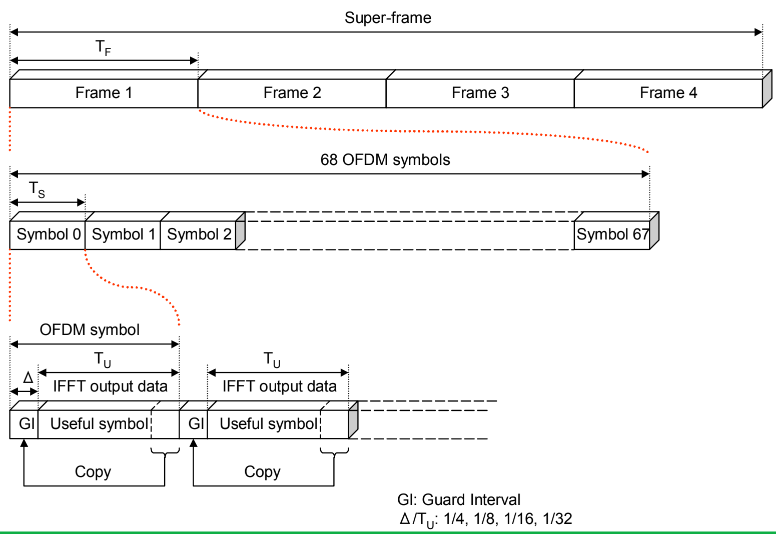
- Processing the amplitude phase data of each OFDM carrier using IFFT computes the amplitude discrete data of I and Q in one symbol period.

Channel bandwidth	Elementary period T	FFT sampling frequency (1/T)
8 MHz	7/64 µs	9.142 857 …MHz
7 MHz	7/56 µs	8 MHz
6 MHz	7/48 µs	6.857 143 …MHz
5 MHz	7/40 µs	5.714 286 …MHz



Guard Interval Insertion

- Interference between symbols by multipath fading can be avoided.



Number of MPEG-2 Packets per Super-frame

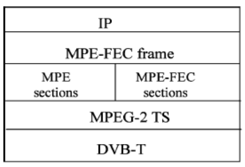
Code rate	QPSK			16-QAM			64-QAM		
	2K mode	**4K mode**	*8K mode*	*2K mode*	**4K mode**	*8K mode*	*2K mode*	**4K mode**	*8K mode*
1/2	*252*	**504**	*1 008*	*504*	**1 008**	*2 016*	*756*	**1 512**	*3 024*
2/3	*336*	**672**	*1 344*	*672*	**1 344**	*2 688*	*1 008*	**2 016**	*4 032*
3/4	*378*	**756**	*1 512*	*756*	**1 512**	*3 024*	*1 134*	**2 268**	*4 536*
5/6	*420*	**840**	*1 680*	*840*	**1 680**	*3 360*	*1 260*	**2 520**	*5 040*
7/8	*441*	**882**	*1 764*	*882*	**1 764**	*3 528*	*1 323*	**2 646**	*5 292*

Additional Features for DVB-H

DVB-H uses the DVB-T transmission system as the physical layer and adds extra error correction and time-slicing mechanisms on the link layer. DVB-H carries IP datagrams encapsulated using multi-protocol encapsulation.
A full DVB-H system is defined by combining elements in the physical and link layers as well as service information. DVB-H makes use of the following technology elements for the link layer and the physical layer.

- Link layer
  - Time-slicing to reduce average power consumption of terminal and enable smooth and seamless frequency handover
  - Forward error correction for multi-protocol encapsulated data (MPE-FEC) for improvement in the *C/N* and Doppler performance in mobile channels, also improving tolerance to impulse interference
- Physical layer

  DVB-T with following technical elements specifically targeting DVB-H use
  - DVB-H signalling in TPS-bits to enhance and speed up service discovery. A cell identifier is also carried on TPS-bits to support quicker signal scan and frequency handover on mobile receivers
  - 4K mode (3409 carriers) for trading off mobility and SFN cell size, allowing single-antenna reception in medium SFNs at very high speed, thus adding flexibility in the network design
  - Optional in-depth symbol interleaver for 2K and 4K modes for further improving robustness in mobile environment and impulse noise conditions
  - Transmission parameters to operate transmission system in 5 MHz channel bandwidth, even outside traditional broadcasting bands

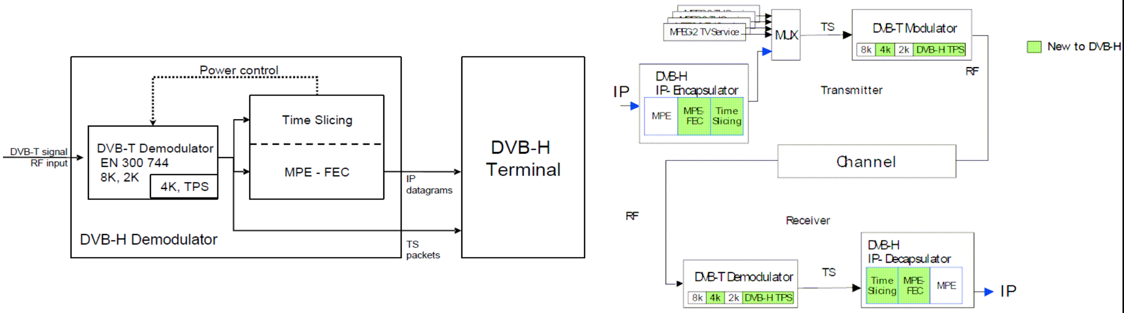


Protocol stack

Additional Features for DVB-H

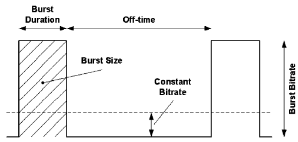
A DVB-H receiver includes a DVB-H demodulator and a DVB-H terminal. The DVB-H demodulator includes a DVB-T demodulator, a time-slicing module and a MPE-FEC module.

- The DVB-T demodulator recovers the MPEG-2 Transport Stream packets from the received DVB-T RF signal. It offers three transmission modes of 8K, 4K and 2K with the corresponding Transmitter Parameter Signalling (TPS).
- The time-slicing module, provided by DVB-H, aims to save receiver power consumption while enabling smooth and seamless frequency handhover.
- The MPE-FEC module, provided by DVB-H, offers transmission over the physical layer, a complementary FEC allowing the receiver to cope with particularly difficult receiving situations.



Time-slicing

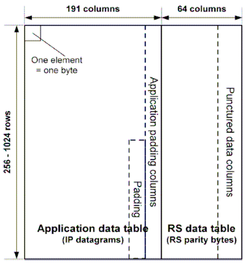
- The objective of time-slicing is to reduce the average power consumption of the terminal and enable smooth and seamless service handover.
  - Time-slicing consists of sending data in bursts using significantly higher instantaneous bit rate compared to the bit rate required if the data were transmitted using traditional streaming mechanisms.
  - To indicate to the receiver when to expect the next burst, the time (delta-t) to the beginning of the next burst is indicated within the burst. Between the bursts, data of the elementary stream is not transmitted, allowing other elementary streams to use the bandwidth otherwise allocated. Time-slicing enables a receiver to stay active only a fraction of the time, while receiving bursts of a requested service. Note that the transmitter is constantly on (i.e. the transmission of the transport stream is not interrupted).
  - Time-slicing also supports the possibility to use the receiver to monitor neighboring cells during the off-times (between bursts). By accomplishing the switching of the reception from one transport stream to another during an off period it is possible to accomplish a quasi-optimum handover decision as well as seamless service handover.
  - Time-slicing is always used in DVB-H.



Principle

MPE-FEC

- The objective of MPE-FEC is to improve the C/N- and Doppler performance in mobile channels and to improve tolerance to impulse interference.
  - This is accomplished through the introduction of an additional level of error correction at the MPE layer. By adding parity information calculated from the datagrams and sending this parity data in separate MPE-FEC sections, error-free datagrams can be output after MPE-FEC decoding despite a very bad reception condition. The use of MPE-FEC is optional.
  - With MPE-FEC a flexible amount of the transmission capacity is allocated to parity overhead. For a given set of transmission parameters providing 25 % of parity overhead, the MPE-FEC may require about the same C/N as a receiver with antenna diversity.
  - The MPE-FEC overhead can be fully compensated by choosing a slightly weaker transmission code rate, while still providing far better performance than DVB-T (without MPE-FEC) for the same throughput. This MPE-FEC scheme should allow high-speed single antenna DVB-T reception using 8K/16QAM or even 8K/64QAM signals. In addition MPE-FEC provides good immunity to impulse interference.



MPE-FEC frame

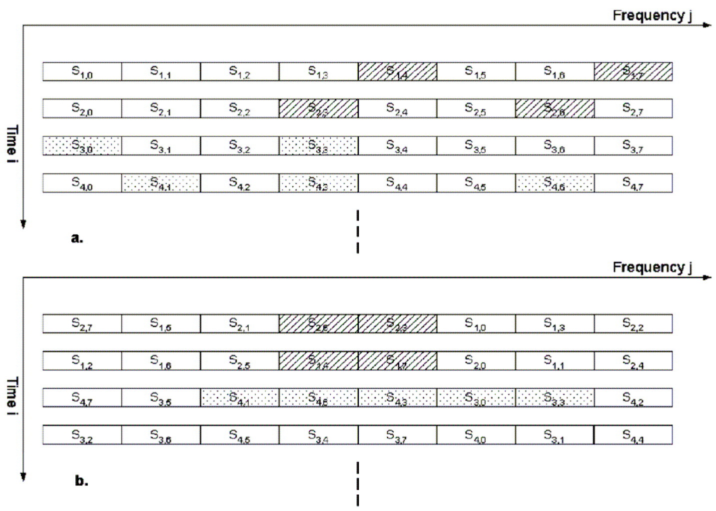
4K mode and In-depth Interleavers

- The objective of the 4K mode is to improve network planning flexibility by trading off mobility and SFN size.
  - To further improve robustness of the DVB-T 2K and 4K modes in a mobile environment and impulse noise reception conditions, an in-depth symbol interleaver is also standardized.
  - The additional 4K transmission mode is a scaled set of the parameters defined for the 2K and 8K transmission modes. It aims to offer an additional trade-off between Single Frequency Network (SFN) cell size and mobile reception performance, providing an additional degree of flexibility for network planning.
  - Terms of the trade-off can be expressed as follows:
    - The DVB-T 8K mode can be used both for single transmitter operation and for small, medium and large SFNs. It provides a Doppler tolerance allowing high speed reception.
    - The DVB-T 4K mode can be used both for single transmitter operation and for small and medium SFNs. It provides a Doppler tolerance allowing very high speed reception.
    - The DVB-T 2K mode is suitable for single transmitter operation and for small SFNs with limited transmitter distances. It provides a Doppler tolerance allowing extremely high speed reception.

4K mode and In-depth Interleavers

- For 2K and 4K modes the in-depth interleavers increase the flexibility of the symbol interleaving, by decoupling the choice of the inner interleaver from the transmission mode used. This flexibility allows a 2K or 4K signal to take benefit of the memory of the 8K symbol interleaver to effectively quadruple (for 2K) or double (for 4K) the symbol interleaver depth to improve reception in fading channels. This provides also an extra level of protection against short noise impulses caused by, e.g. ignition interference and interference from various electrical appliances.
- 4K and in-depth interleavers affect the physical layer, however their implementations do not imply large increase in equipment (i.e. logic gates and memory) over DVB-T for either transmitters or receivers. A typical mobile demodulator already incorporates enough RAM and logic for the management of 8K signals.

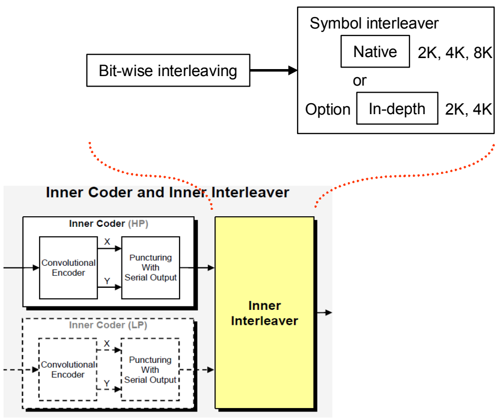
Conceptual Principle of In-depth Interleaver



- 4k mode with 8k interleaving, conceptual drawing with 8 carriers
- (a) The symbol order before in-depth interleaving and after deinterleaving
- (b) The symbol order after interleaving in the channel
- The shaded areas in (b) demonstrate how the influence of frequency-concentrated (oblique lines) and time-concentrated (dots) interference in the channel is randomly distributed after deinterleaving (a).

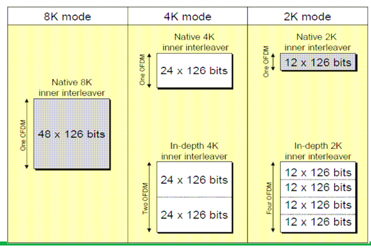
Inner Interleaver

- The inner interleaving consists of bit-wise interleaving followed by symbol interleaving.
  - Both the bit-wise interleaving and the symbol interleaving processes are block-based motion.



Inner Interleaver

- This option enlarge the depth of the inner interleaving to four consecutive OFDM symbols (2K), or two consecutive OFDM symbols (4K).
  - Bit interleaving is performed only on the useful data. The block size is the same for each interleaver, but the interleaving sequence is different in each case. The bit interleaving block size is 126 bits. The block interleaving process is therefore repeated exactly twelve times per OFDM symbol of useful data in the 2K mode, forty-eight times per OFDM symbol in the 8K mode, twenty-four times per OFDM symbol in the 4K mode.
  - When the in-depth interleaving is applied in the 2K or 4K modes, either hierarchical or non-hierarchical, the block interleaving process is repeated forty-eight times, thus providing the symbol interleaver with the blocks of useful data needed to produce four consecutive "2K OFDM symbols" and two consecutive "4K OFDM symbols".



DVB Measurement Guidelines

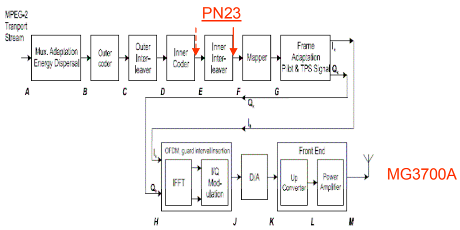
- The ETSI TR 101 290 provides measurement guidelines for DVB-S, DVB-C, DVB-T and related TV system, and gives recommendations for measurement techniques.
  - » The clause 9 lists useful measurements in a DVB-T OFDM environment.

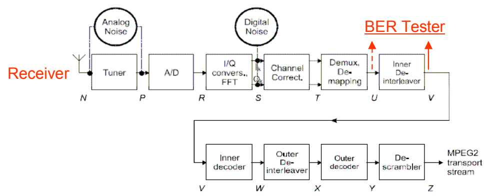
Measurement parameter	Transmitter	Network	Receiver
1) RF frequency measurements			
1.1) RF frequency accuracy (Precision)	X		
1.2) RF channel width (Sampling Frequency Accuracy)	X		
1.3) Symbol Length measurement at RF (Guard Interval verification)	X		
2) Selectivity			X
3) AFC capture range			X
4) Phase noise of local oscillators (LO)	X		X
5) RF/IF signal power	X	X	X
6) Noise power			X
7) RF and IF spectrum	X		
8) Receiver sensitivity/ dynamic range for a Gaussian channel			X
9) Equivalent Noise Degradation (END)	X		X
9a) Equivalent Noise Floor (ENF)	X		
10) Linearity characterization (shoulder attenuation)	X		
11) Power efficiency	X		
12) Coherent interferer	X	X	
13) BER vs. C/N ratio by variation of transmitter power	X	X	
14) BER vs. C/N ratio by variation of Gaussian noise power		X	X
15) BER before Viterbi (inner) decoder	X	X	X
16) BER before RS (outer) decoder	X	X	X
17) BER after RS (outer) decoder	X	X	
18) I/Q analysis			
18.1) N/A			
18.2) Modulation Error Ratio	X	X	X
18.3) System Target Error	X		X
18.4) Carrier Suppression	X		X
18.5) Amplitude Imbalance	X		X
18.6) Quadrature Error	X		X
18.7) Phase Jitter	X		X
19) Overall signal delay	X	X	
20) SFN synchronization			
20.1) MIP_timing_error	X		
20.2) MIP_structure_error	X		
20.3) MIP_presence_error	X		
20.4) MIP_pointer_error	X		
20.5) MIP_periodicity_error	X		
20.6) MIP_ts_rate_error	X		
21) System Error Performance	X	X	X

one by one…

9.14 BER vs. C/N Ratio by Variation of Gaussian Noise Power

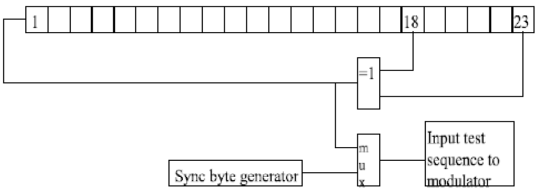
- Purpose
  - To evaluate BER performance of receiver as Carrier to Noise (C/N) ratio is varied by changing added Gaussian noise power.
    - This measurement can be used to compare the performance of a receiver with theory or with other receivers. For example to evaluate the influence of receiver noise floor.
- Method
  - A 2^{23}-1 Pseudo-Random Binary Sequence (PRBS) is injected at interface F (or E). Various C/N ratios are established at the input of the receiver under test by addition of Gaussian noise and the BER of the received PRBS is measured at point V (or U) using a BER test set.
    - For the measurement of carrier and noise power, the system bandwidth is defined as n × $f_{SPACING}$ where n is the number of active carriers i.e. 6817 or 1705 carriers and $f_{SPACING}$ is the frequency spacing of the OFDM carriers.
    - The bandwidth in an 8 MHz channel is approx. 7.61 MHz, in a 7 MHz channel system it is 6.66 MHz and 5.71 MHz in a 6 MHz channel.





PRBS based on standard

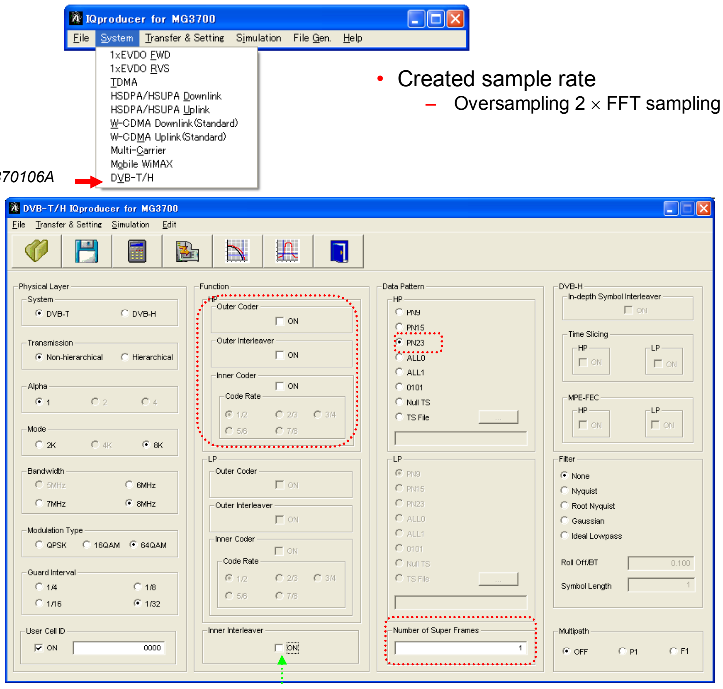
- Annex F.2
  - The number of bits in a super-frame is depending on the actual DVB-T mode. The maximum number of Reed-Solomon/MPEG-2 packets in a super-frame is 5 292. This corresponds to 7 959 168 input bits that is shorter than a maximum length sequence of length 2^{23}-1 = 8 388 607. The input test sequence to the modulator can therefore be generated by a shift register of length 23 with suitable feedback. The generator polynomial should be $1 + x^{18} + x^{23}$. The PRBS data on every 188 byte is replaced by the sync byte content, 47 HEX. This means that during the sync bytes the PRBS generator should continue, but the source for the output is the sync byte generator instead of the PRBS generator. The input test sequence starts with a sync byte as the first eight bits, and the initialization word in the PRBS generator is "all ones". The PRBS generator is reset at the beginning of each super-frame. The test sequence at the beginning of each super-frame starts with:
    - 0100 0111 0000 0000 0011 1110 0000 0000 0000 1111 1111 1100
    - 47 00 3E 00 0F FC $_{HEX}$



DVB-T/H IQproducer Setup

- Created sample rate
  - Oversampling 2 × FFT sampling frequency

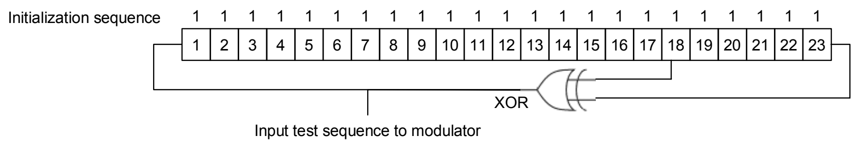
License option MX370106A



☑ Check-mark in the case of E before inner interleaver

PN23

- The input test sequence to the modulator can be generated by a shift register of length 23 with suitable feedback. The generator polynomial is $1 + x^{18} + x^{23}$. The input test sequence starts with the initialization word in the PRBS generator is "all ones". The PRBS generator is reset at the beginning of each super-frame. If any of checkmark in Function field is not ON, the sync byte isn't generated. The test sequence at the beginning of each super-frame starts with:
  - 0000 0000 0000 0000 0011 1110 0000 0000 0000 1111 1111 1100
  - 00 00 3E 00 0F FC $_{HEX}$

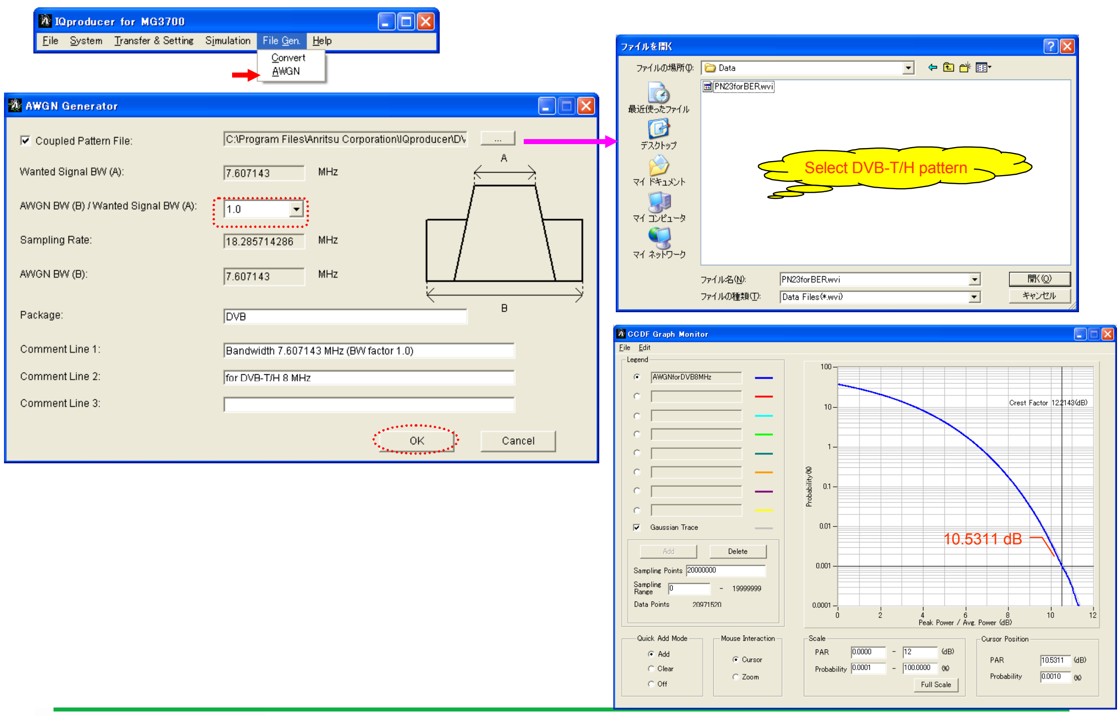


Number of bits per super-frame

	QPSK			16QAM			64QAM		
Code rate	2K mode	4K mode	8K mode	2K mode	4K mode	8K mode	2K mode	4K mode	8K mode
1/2	411,264	822,528	1,645,056	822,528	1,645,056	3,290,112	1,233,792	2,467,584	4,935,168
2/3	548,352	1,096,704	2,193,408	1,096,704	2,193,408	4,386,816	1,645,056	3,290,112	6,580,224
3/4	616,896	1,233,792	2,467,584	1,233,792	2,467,584	4,935,168	1,850,688	3,701,376	7,402,752
5/6	685,440	1,370,880	2,741,760	1,370,880	2,741,760	5,483,520	2,056,320	4,112,640	8,225,280
7/8	719,712	1,439,424	2,878,848	1,439,424	2,878,848	5,757,696	2,159,136	4,318,272	8,636,544

by 204 bytes/RS-packets

AWGN IQproducer Setup



Connection Setup

MG3700A
DVB-T/H Signal Generator
+ AWGN Generator
BER Tester (Option 31)

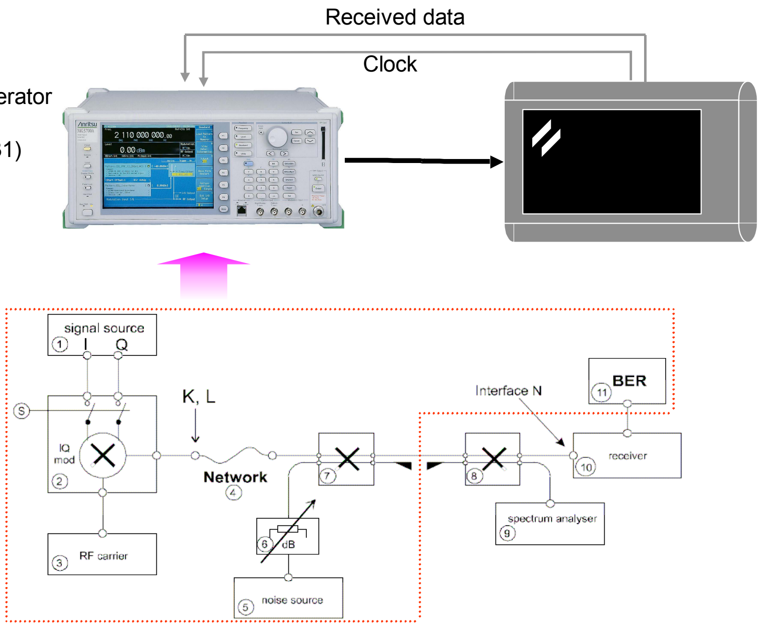
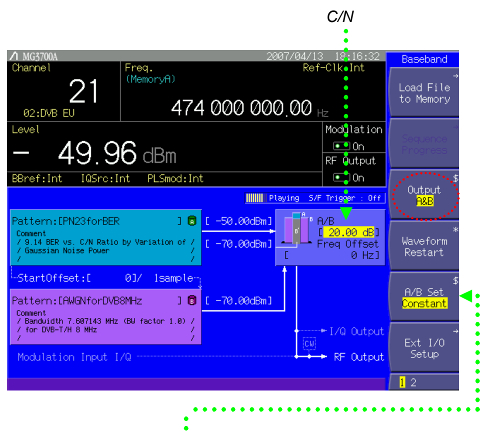


Figure E-22: BER vs. C/N by variation of Gaussian noise power

DVB-T/H Signal + AWGN Setup Example

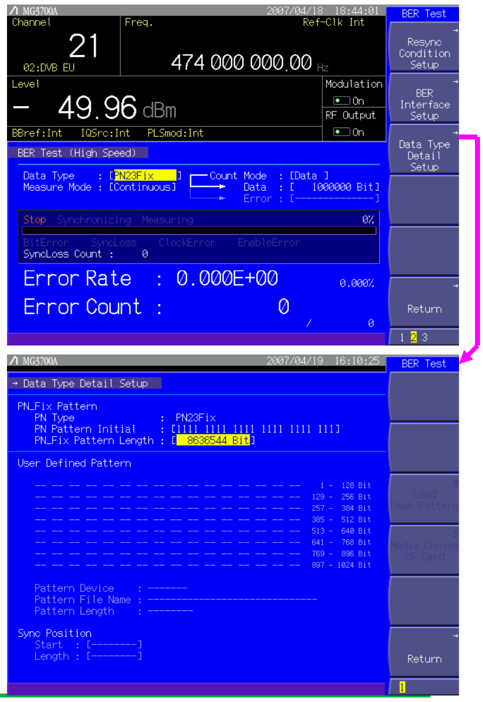
- DVB-T/H Signal
  +
- AWGN



A/B Set	A level	B level	RF level
A	Variable	Static	Coupled
B	Static	Variable	Coupled
Constant	Variable	Variable	Static

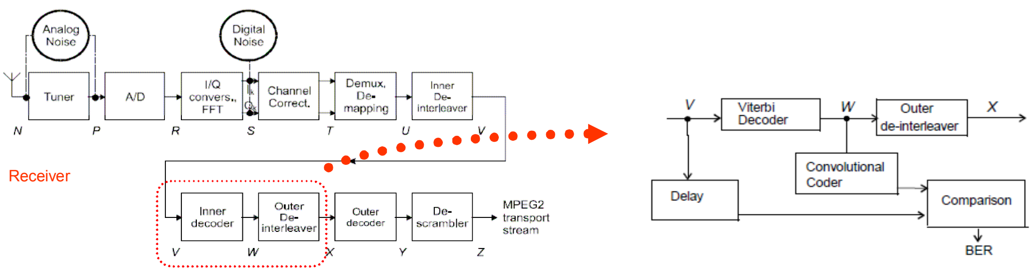
BER Tester Setup Example

- MG3700A-031/131
  High-speed BER Test Function
  - » Data Type
    - – PN23 fixed pattern
      - • PN23 initialized at any length
  - » PN23 Fixed Pattern Length
    - – Number of bits per super-frame

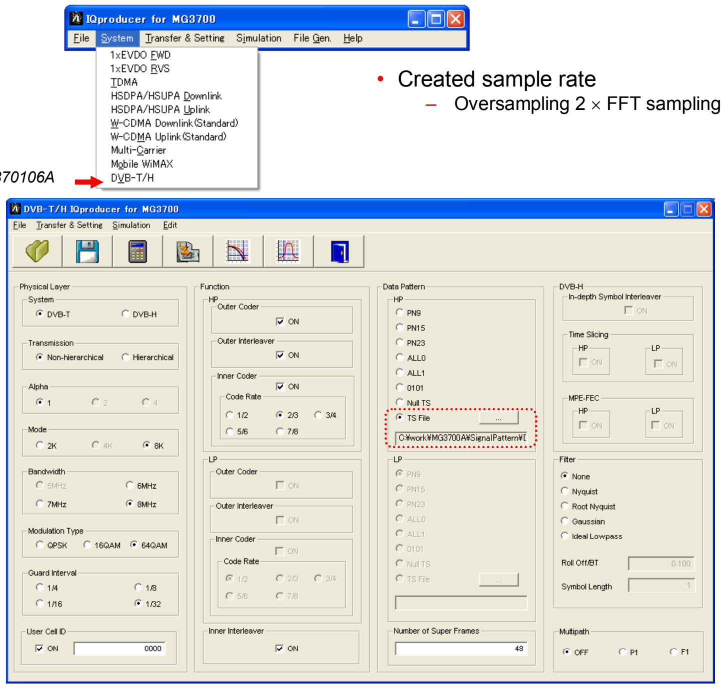


9.15 BER before Viterbi (Inner) Decoder

- Purpose
  - • This measurement gives an in-service indication of the un-coded performance of the transmitter, channel and receiver.
- Method
  - • The signal after Viterbi decoding in the test receiver is coded again using the same convolutional coding scheme as in the transmitter in order to produce an estimate of the originally coded data stream. This data stream is compared at bit-level with the signal before the Viterbi decoder.
    - – The measurement should be based on at least several hundred bit errors.



DVB-T/H IQproducer Setup

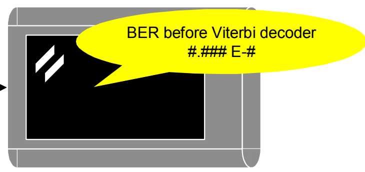


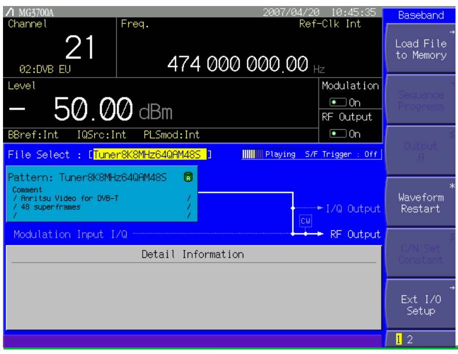
License option MX370106A

- Created sample rate
  - Oversampling 2 × FFT sampling frequency

Connection Setup

MG3700A
DVB-T/H Signal Generator

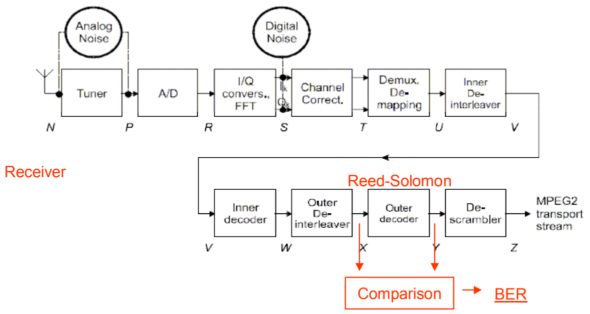




- Receiver
  - Reports internal BER before Viterbi (inner) decoder for received data by FTM (Factory Test Mode)

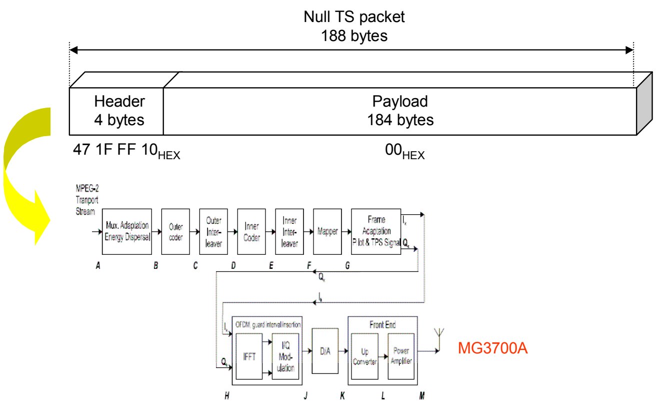
9.16 BER before RS (Outer) Decoder

- Two alternative methods are available;
  - » 9.16.1 Out of Service
  - » 9.16.2 In Service
- Method
  - The number of erroneous bits within a TS packet is estimated by comparing the bit pattern of this TS packet before and after RS decoding. If the measured BER exceeds 10^{-3}, the measurement should be regarded as unreliable due to the limits of the RS decoding algorithm. Any TS packet that the RS decoder cannot correct should cause the calculation to restart.

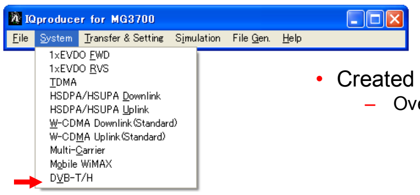


9.16.1 Out of Service

- The basic principle of this measurement is to generate a known, fixed, repeating sequence of bits, essentially of a Pseudo-Random nature, within the channel encoder. To do this, the data input to the sync-inversion/randomization function is a continuous repetition of one fixed TS packet. This sequence is defined as the null TS packet with all data bytes set to 0x00. In other words, the fixed packet is defined as the four byte sequence of 0x47, 0x1F, 0xFF, 0x10, followed by 184 zero bytes (0x00).
  - – Ideally, this would be available as an encoding system option.

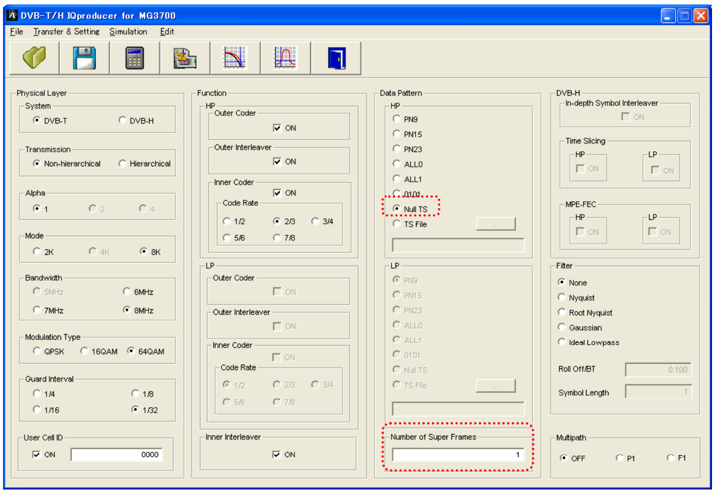


DVB-T/H IQproducer Setup



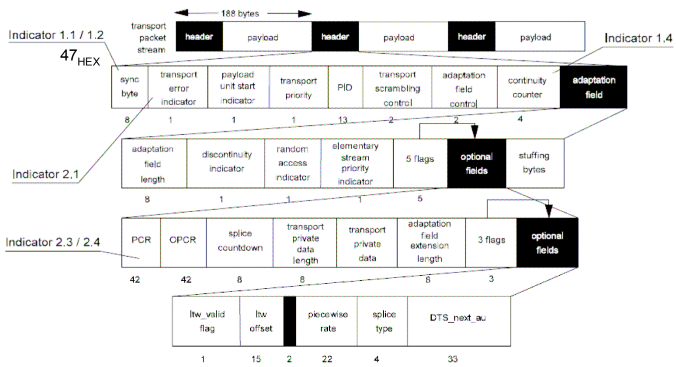
License option MX370106A

- Created sample rate
  - Oversampling 2 × FFT sampling frequency

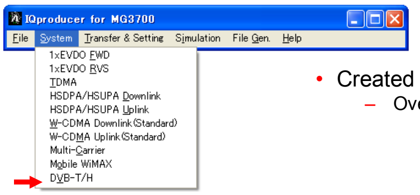


9.16.2 In Service

- The basic assumption of this measurement method is that the RS check bytes are computed for each link in the transmission chain. Under normal operation, the RS decoder will correct all errors and produce an error-free TS packet. If there are severe error-bursts, the RS decoding algorithm may be overloaded and unable to correct the packet. In this case, the transport_error_indicator bit shall be set, no other bits in the packet shall be changed, and the 16 RS check bytes shall be recalculated accordingly before re-transmission to another link.

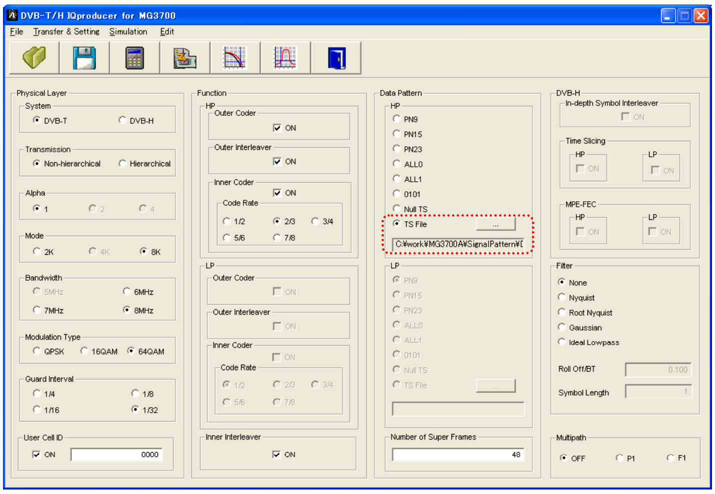


DVB-T/H IQproducer Setup



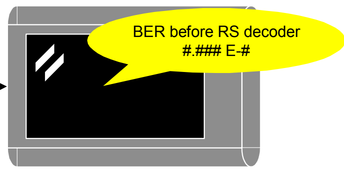
License option MX370106A

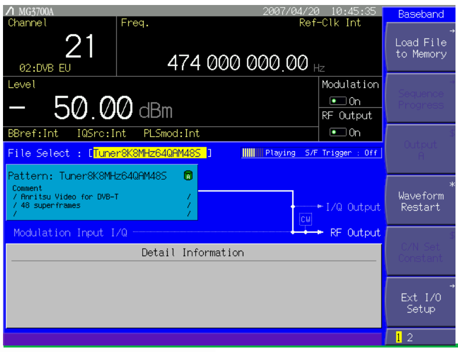
- Created sample rate
  - Oversampling 2 × FFT sampling frequency



Connection Setup

MG3700A
DVB-T/H Signal Generator





- Receiver
  - Reports internal BER before before RS (Outer) decoder for received data by FTM (Factory Test Mode)

Annex K Channel Models

- Annex K provides some information on terrestrial channel profiles that can be used for off-line computer simulations and realtime simulations based on dedicated equipment.
  - » K.1
    Theoretical channel profiles for simulations without Doppler shift
    The performance of the DVB-T system has been simulated during development of the standard EN 300 744 with two channel models.
    - 2 channel models
      - 20 paths
      - Fixed reception F_1
      - Portable reception P_1
        - Rayleigh fading

Annex K Channel Models

- » K.2
  Profiles for realtime simulations without Doppler shift
  The profiles were used in laboratory tests in a research project with satisfactory results.
  - 6 paths
- » K.3
  Profiles for realtime simulation with Doppler shift (mobile channel simulation)
  Three channel profiles were selected to reproduce the DVB-T service delivery situation in a mobile environment. Two of them reproduce the characteristics of the terrestrial channel propagation with a single transmitter, the third one reproduces the situation from SFN operation of the DVB-T network.
  - 3 channel models
    - Typical Urban reception (TU6)
      - 6 paths with wide dispersion in delay and relatively strong power
      - Used for GSM and DAB tests
    - Typical Rural Area reception (RA6)
      - 6 paths with relatively short delay and small power
      - Used for GSM and DAB tests
    - 0 dB Echo profile
      - 2 paths with same power, delayed by half Guard Interval value and presenting pure Doppler characteristic.

Mobile and Portable DVB-T/H Test

- The IEC 62002 Mobile and portable DVB-T/H radio access interface (MBRAI) consists of two parts:
  - » Part 1:
    - – Interface specification
      - Radio access specification for mobile, portable and handheld portable devices capable of receiving DVB-T/H services
  - » Part 2:
    - – Interface conformance testing
      - Conformance testing rules and guidelines for equipment built to meet mobile and portable DVB-T/H radio access interface specification (Part 1)

Terminal Categories

a Integrated car terminals

– This category covers DVB-T terminals installed in a car where the antenna is integral with the car.

b Portable digital TV sets

– This category covers terminals, which are intended for receiving normal MPEG-2 based digital TV services indoors and outdoors with terminal attached antennas. This category is divided into two subcategories.

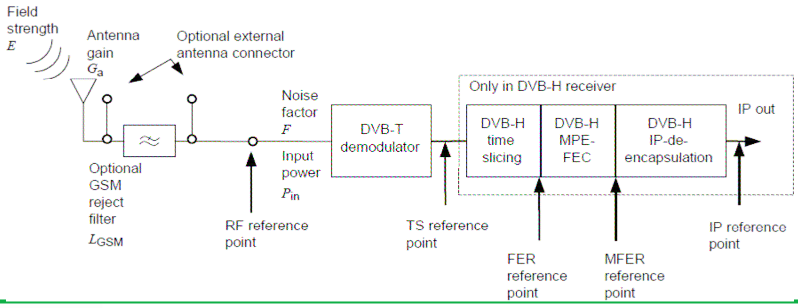
1. The receiver screen size is typically greater than 25 cm and the receiver may be battery- or mains-powered. Typically, the terminal is stationary during the reception. An example of the antenna construction may be an adjustable telescope or wideband design, either active or passive, attached to the receiver.
2. Pocketable digital TV-receiver. The terminal is battery operated and can be moved during use. Usually the antenna is integral with the terminal.

c Hand-held portable convergence terminals

– This category covers small battery powered hand held convergence terminals with built in cellular radio like GSM, GPRS or UMTS. The terminals have the functionality of a mobile phone and can receive IP-based services using DVB-H over DVB-T physical layer. The DVB-T antenna and the cellular antenna are both integral with the terminal.

Receiver Performance

- The receiver performance is defined according to the reference model.
- All the receiver performance figures are specified at the reference point, which is the receiver input.
- For a DVB-H receiver, the manufacturer provides the specified test mode in which the following parameters can be monitored.
  - » TS-*BER* after Viterbi decoder
  - » TS-*PER*
  - » MPE-FEC *FER* (MFER)



Degradation Criteria

- Four different degradation criteria (a) to (d)
  - » (a) (b): Non-mobile cases
  - » (c): Mobile reception
  - » (d): DVB-H reception

a Reference *BER*
- – Defined as *BER* = 2×10^{-4} after Viterbi decoding

b PFP: Picture failure point
- – Defined as *C/N* or *C/I* value, where visible picture errors start to appear on screen

c SFP: Subjective failure point in mobile reception
- – SFP corresponds to ESR_5 (erroneous second ratio 5 %) criterion, which allows one erroneous second within the 20 s observation period.
- – SFP corresponds also fairly well to a *PER* = 10^{-4} after RS decoder at demodulator TS output.
  - – The observation period for the *PER* measurement should be at least 800 k TS packets, corresponding to about 2 minutes using 16QAM, *CR* = 1/2, *GI* = 1/4.

d DVB-H error criterion
- – 5 % MPE-FEC frame error rate (MFER)
  - – At least 100 frames analyzed for sufficient accuracy

$$MFER[\%] = \frac{\text{Number of erroneous frames}}{\text{Total number of frames}} \times 100$$

Conformance Measurements

Clause	Conditions	DVB-T/H Wanted Signal Generator	DVB-T Interference Signal Generator	Analog Interference Signal Generator	AWGN Generator	Impulsive Noise Generator	Channel simulator	Others
5 *C/N* performance	Gaussian	MG3700A			*			
	Portable	MG3700A			*			
	Mobile	MG3700A			MG3700A		One	Z-164A 1 GHz Combiner
6 Receiver minimum and maximum input signal levels		MG3700A						
7 Immunity to analogue and/or digital signals in other channels	S1	MG3700A		One				Z-164A 1 GHz Combiner
	S2	MG3700A	*					
	L1	MG3700A	*	One				Z-164A 1 GHz Combiner
	L2	MG3700A		Two				MP659A 1 GHz Combiner
	L3	MG3700A	MG3700A *					Z-164A 1 GHz Combiner
8 Immunity to co-channel interference from analogue TV signals		MG3700A		One				Z-164A 1 GHz Combiner
9 Guard interval utilization: echoes within guard interval		MG3700A			MG3700A		One	Z-164A 1 GHz Combiner
10 Guard interval utilization: echoes outside guard interval		MG3700A			MG3700A		One	Z-164A 1 GHz Combiner
11 Tolerance to impulse interference		MG3700A				One		Z-164A 1 GHz Combiner

Measurement Conditions

Clause	Conditions	Terminal category a car terminals	Terminal category b1 portable TVs	Terminal category b2 pocketable TVs	Terminal category c hand-held convergence terminals
5 *C/N* performance		Ch 45			
	Gaussian	All modulations, 2k/4k/8k			
	Portable	All modulations, 2k/4k/8k			
	Mobile	QPSK 1/2 , 16QAM 1/2 and 2/3 *GI* 1/4	-	-	QPSK 1/2 , 16QAM 1/2 and 2/3 *GI* 1/4
6 Receiver minimum and maximum input signal levels	Minimum and maximum input levels	Ch 21, 45, 64 (UHF), Ch 8, 12 (VHF)			
		QPSK 1/2			
7 Immunity to analogue and/or digital signals in other channels	S1	$N \pm 1$: Ch 45 (UHF), Ch 8 (VHF) with 64QAM 2/3 additionally Ch 21, 64 (UHF), Ch 5, 12 (VHF). $N \pm 2$: Ch 45 (UHF), Ch 8 (VHF)			
		16QAM 3/4 , 16QAM 2/3, 16QAM 1/2 , 64QAM 3/4 , 64QAM 2/3 GI1/8			
	S2	Ch 45 (UHF), Ch 8 (VHF)			
		64QAM 2/3, *GI* 1/8			
	L1-L3	Ch 21,45,64 (UHF) Ch 8 (VHF)			
		16QAM 2/3, *GI* 1/8			
8 Immunity to co-channel interference from analogue TV signals		Ch 45 (UHF)			
		All modulations, *GI* 1/8			
9 Guard interval utilization: echoes within guard interval		Ch 45 (UHF)			
		8k, 64QAM 2/3, *GI* 1/8 8k, 16QAM 1/2, *GI* 1/8			
10 Guard interval utilization: echoes outside the guard interval		Ch 45 (UHF)			
		8k, 64QAM 2/3, *GI* 1/8 8k, 16QAM 1/2, *GI* 1/8 8k, 16QAM 2/3, *GI* 1/8			
11 Tolerance to impulse interference		Ch 45 (UHF)			
		8k, 64QAM 2/3, *GI* 1/8 8k, 16QAM 1/2, *GI* 1/8 8k, 16QAM 2/3, *GI* 1/8			

5 C/N Performance

Test purpose

- To verify *C/N* performance of receiver in different channel conditions
  - » Gaussian channel conditions
    - Ideal channel conditions
      - – Wanted DVB-T/H signal + AWGN
  - » Portable channel conditions
    - Stationary multipath channel without direct path
      - – Wanted DVB-T/H signal through Rayleigh Fading Channel (P_1) + AWGN
  - » Mobile channel conditions
    - Moving in a car
      - – Wanted DVB-T/H signal through Typical Urban Channel (TU6) + AWGN

C/N (dB) in Gaussian channel

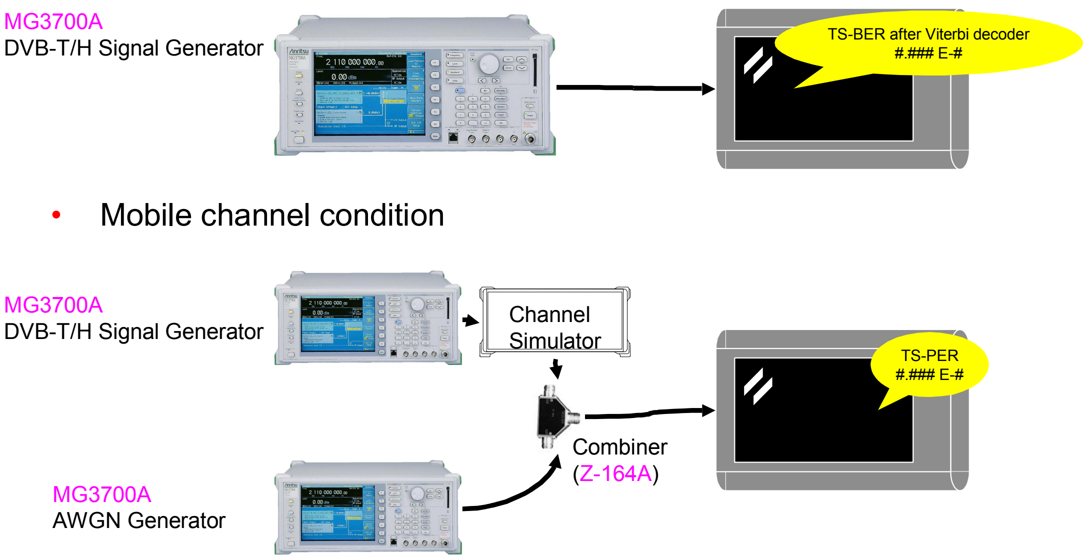
2×10^{-4}

Modulation	Code rate	*C/N* (dB) Ref *BER*	*C/N* (dB) PFP
QPSK	1/2	5,6	4,3
QPSK	2/3	7,4	6,1
QPSK	3/4	8,4	7,1
16-QAM	1/2	11,3	10,0
16-QAM	2/3	13,7	12,4
16-QAM	3/4	15,1	13,8
64-QAM	1/2	17,0	15,7
64-QAM	2/3	19,2	17,9
64-QAM	3/4	20,8	19,5

5 Connection Setup

- Gaussian or Portable channel condition

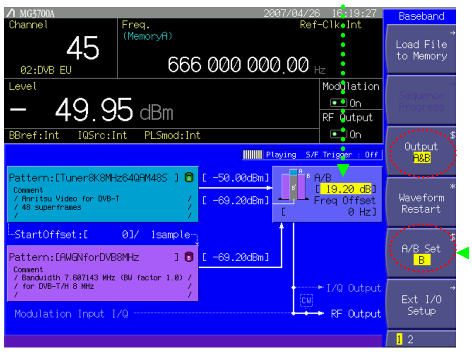
- Mobile channel condition



5 DVB-T/H Signal + AWGN Setup Example

- DVB-T/H Signal
  -50 dBm
  +
- AWGN

C/N



– Gaussian channel

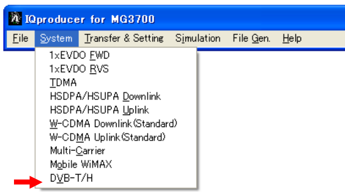
Modulation	Code rate	C/N (dB) Ref *BER*	C/N (dB) PFP
QPSK	1/2	5,6	4,3
QPSK	2/3	7,4	6,1
QPSK	3/4	8,4	7,1
16-QAM	1/2	11,3	10,0
16-QAM	2/3	13,7	12,4
16-QAM	3/4	15,1	13,8
64-QAM	1/2	17,0	15,7
64-QAM	2/3	19,2	17,9
64-QAM	3/4	20,8	19,5

– Portable channel

Modulation	Code rate	C/N (dB) Ref *BER*	C/N (dB) PFP
QPSK	1/2	7,9	6,6
QPSK	2/3	10,9	9,6
QPSK	3/4	13,2	11,9
16-QAM	2/1	13,8	12,5
16-QAM	2/3	16,8	15,5
16-QAM	3/4	19,4	18,1
64-QAM	1/2	18,7	17,4
64-QAM	2/3	22,1	20,9
64-QAM	3/4	24,8	23,5

A/B Set	A level	B level	RF level
A	Variable	Static	Coupled
B	Static	Variable	Coupled
Constant	Variable	Variable	Static

5 DVB-T/H IQproducer Setup



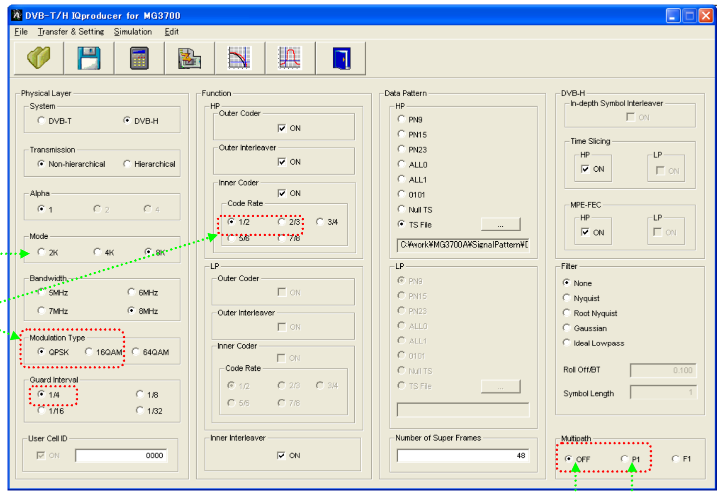
License option MX370106A

Clause	Conditions	Terminal category a car terminals	Terminal category b1 portable TVs	Terminal category b2 pocketable TVs	Terminal category c hand-held convergence terminals
5 C/N performance		Ch 45			
	Gaussian	All modulations, 2k/4k/8k			
	Portable	All modulations, 2k/4k/8k			
	Mobile	QPSK 1/2 , 16QAM 1/2 and 2/3 *GI* 1/4	-	-	QPSK 1/2 , 16QAM 1/2 and 2/3 *GI* 1/4

In mobile channels:

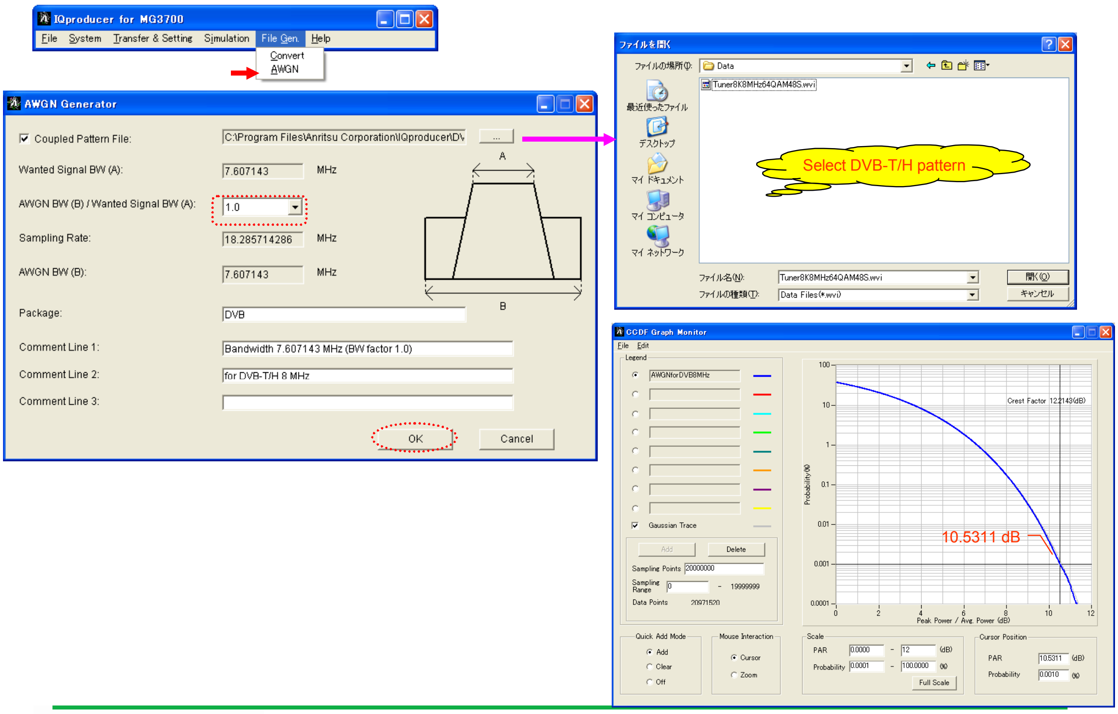
Highest available one

QPSK, 16QAM: 1/2
16QAM: 2/3



Gaussian or Mobile channel condition   Portable channel condition

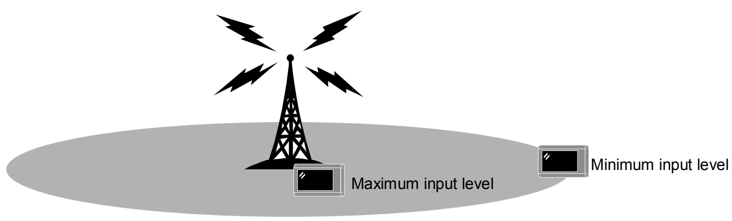
5 AWGN IQproducer Setup



6 Receiver Minimum and Maximum Input Signal Levels

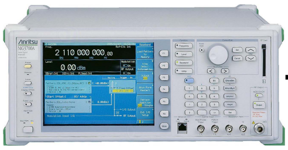
Test purpose

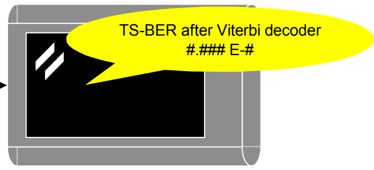
- To verify that receiver can operate with sufficiently large dynamic range of the input signals
  - Receivers unable to fulfill the minimum and maximum input levels performance decrease the service coverage area. These receivers cannot operate close to or far from transmission stations.



6 Connection Setup

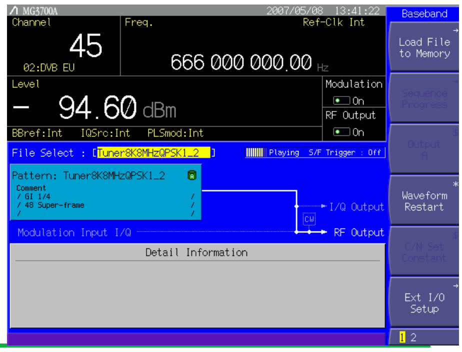
MG3700A
DVB-T/H Signal Generator



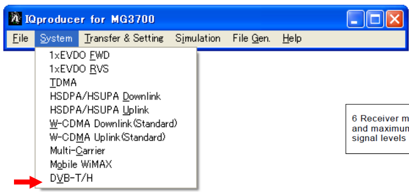


- DVB-T/H Signal
  - Minimum input level
    - -94.6 dBm (8 MHz channel)
    - -95.1 dBm (7 MHz channel)
    - -95.8 dBm (6 MHz channel)

    If GSM reject filter is included,
    - -93.6 dBm (8 MHz channel)
    - -94.1 dBm (7 MHz channel)
    - -94.8 dBm (6 MHz channel)
  - Maximum input level
    - -18 dBm (Terminal category a)
    - -28 dBm (Terminal category b,c)



6 DVB-T/H IQproducer Setup

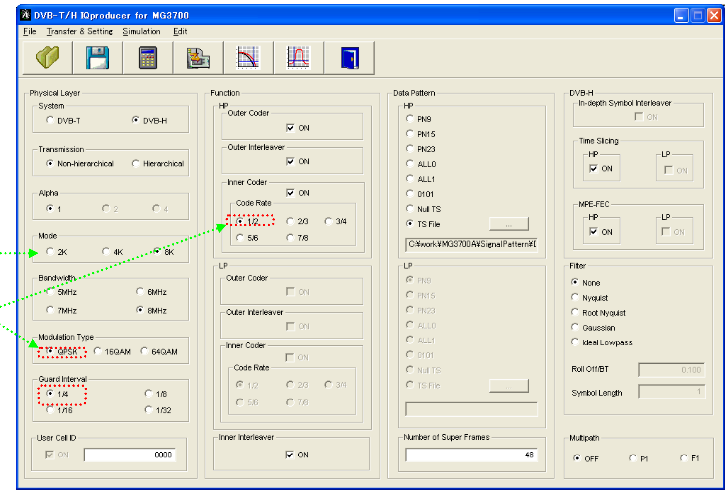


License option MX370106A

6 Receiver minimum and maximum input signal levels	Minimum and maximum input levels	Ch 21, 45, 64 (UHF), Ch 8, 12 (VHF)
		QPSK 1/2

Any one

QPSK 1/2

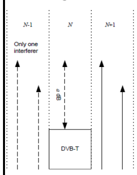


7 Immunity to Analogue and/or Digital Signals in Other Channels

Test purpose

- To verify that the set reference *BER* criterion or PFP criterion does not exceed when strong interfering signals are near the desired channel
  - Receivers not capable of operating when strong interfering signals are near the desired channel decrease service coverage area.

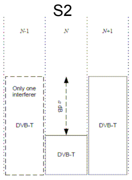
S1



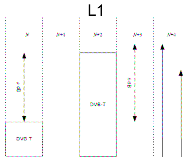
» Receiver selectivity testing
  - Pattern S1
    - One adjacent analogue interferer on *N* ± 1 or *N* ± m or image
  - Pattern S2
    - One adjacent DVB-T interferer on *N* ± 1 or *N* ± m or image

» Receiver linearity testing
  - Pattern L1
    - *N* + 2 DVB-T and *N* + 4 analogue interferer
  - Pattern L2
    - *N* + 2 and *N* + 4 analogue interferer
  - Pattern L3
    - *N* + 2 and *N* + 4 DVB-T interferer

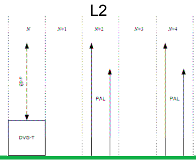
S2



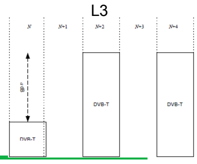
L1



L2



L3

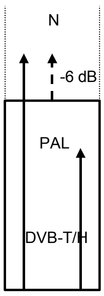


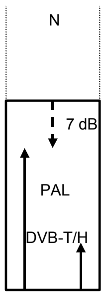
8 Immunity to Co-channel Interference from Analogue TV Signals

Test purpose

- To verify that the set reference *BER* criterion (failure criterion a) or PFP criterion (failure criterion b) does not exceed when co-channel interfering signals are present

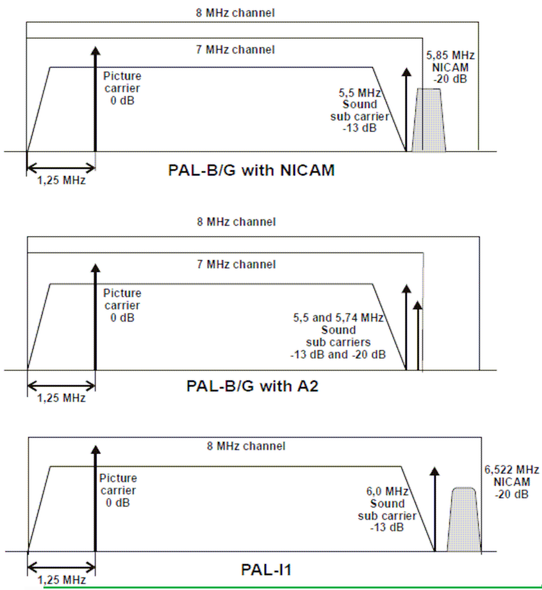
Mode	PAL I1	PAL B/G	SECAM	*BER*
2k/8k 16QAM *CR* = 1/2 *GI* = 1/8	–6 dB	–6 dB	–5 dB	<2 x 10⁻⁴
2k/8k 16QAM *CR* = 2/3 *GI* = 1/8	–1 dB	–1 dB	0 dB	
2k/8k 16QAM *CR* = 3/4 *GI* = 1/8	0 dB	2 dB	3 dB	
2k/8k 64QAM *CR* = 2/3 *GI* = 1/8	4 dB	4 dB	5 dB	
2k/8k 64QAM *CR* = 3/4 *GI* = 1/8	7 dB	7 dB	8 dB	



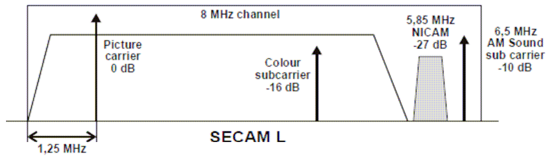


7,8 Analogue Interfering Signals

- PAL B/G/I1 interfering signals



- Standard SECAM signal with NICAM sound (1.25 MHz vestigial sideband bandwidth)



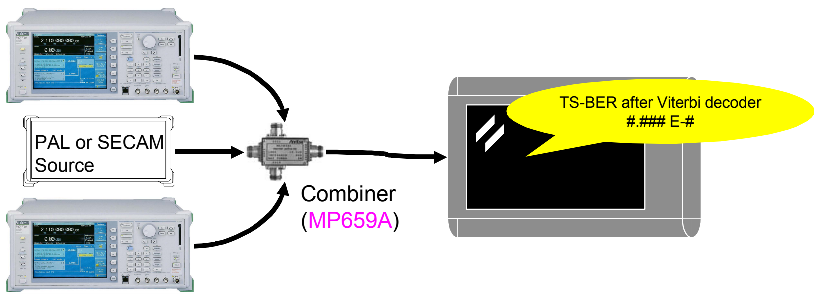
Anritsu

7,8 Connection Setup

MG3700A
DVB-T/H Signal Generator (Wanted DVB-T/H channel + DVB-T interferer)

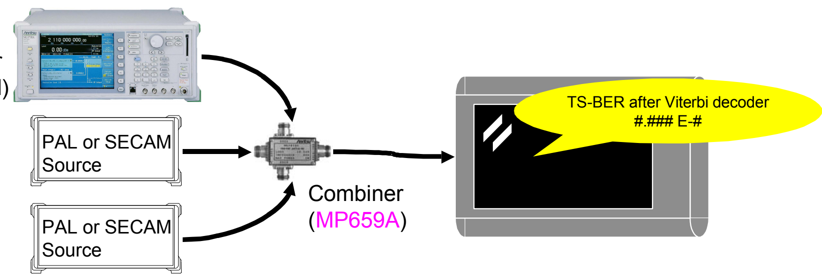
Analog interferer for L1 and clause 8

MG3700A
DVB-T/H Signal Generator (DVB-T interferer for L3)



MG3700A
DVB-T/H Signal Generator (Wanted DVB-T/H channel)

Analog interferers for L2



Anritsu

7 Wanted DVB-T/H Signal + DVB-T Interferer Setup Example

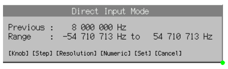
- DVB-T/H Signal

-35 dBm	(S2: $N \pm 1$)
-25 dBm	(L1,L3: Terminal category a)
-35 dBm	(L1,L3: Terminal category b,c)

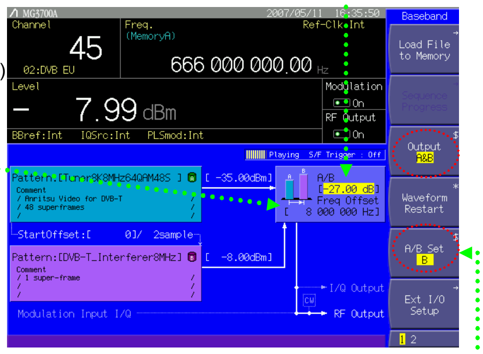
\+

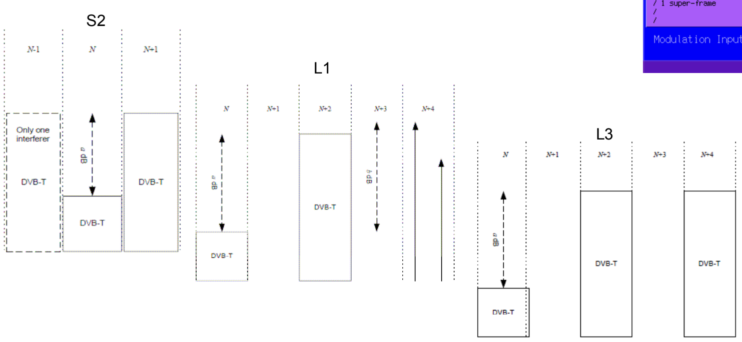
- DVB-T Interferer

a dB	
27 dB	(S2: $N \pm 1$)
40 dB	(L1,L3)



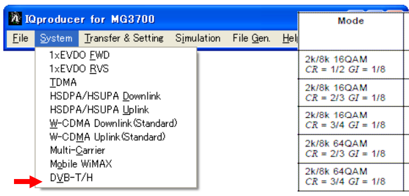
-a dB





A/B Set	A level	B level	RF level
A	Variable	Static	Coupled
B	Static	Variable	Coupled
Constant	Variable	Variable	Static

7 DVB-T/H IQproducer Setup Pattern S1



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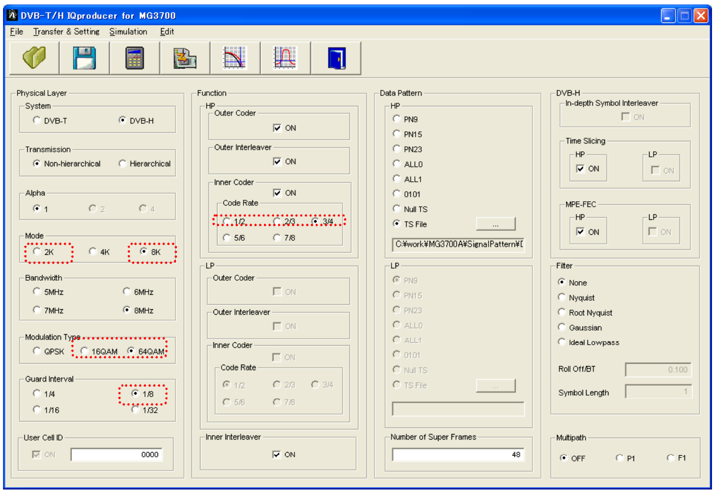
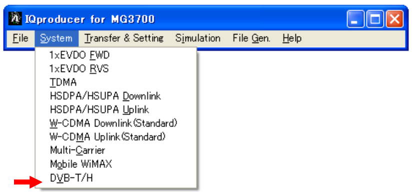
Mode	$N \pm 1$ PALG or I1	$N \pm 1$ PALB	N-1 SECAM L	N + 1 SECAM L	$N \pm m$ ($m \neq 1$) SECAM L	$N \pm m$ ($m \neq 1$) PAL B/G/I1	BER
2k/8k 16QAM CR = 1/2 GI = 1/8	38 dB	36 dB	30 dB	36 dB	48 dB	48 dB	<2 x 10^{-4}
2k/8k 16QAM CR = 2/3 GI = 1/8	38 dB	36 dB	30 dB	36 dB	48 dB	48 dB	
2k/8k 16QAM CR = 3/4 GI = 1/8	37 dB	35 dB	29 dB	35 dB	48 dB	48 dB	
2k/8k 64QAM CR = 2/3 GI = 1/8	35 dB	33 dB	30 dB	33 dB	45 dB	46 dB	
2k/8k 64QAM CR = 3/4 GI = 1/8	35 dB	33 dB	30 dB	33 dB	42 dB	43 dB	

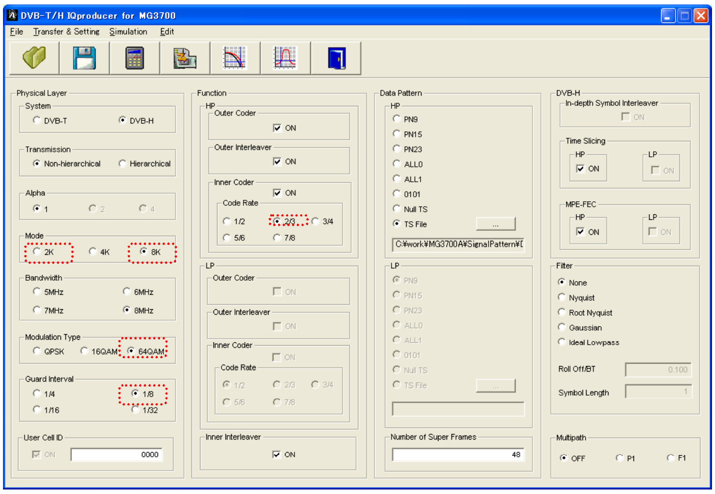


7 DVB-T/H IQproducer Setup Pattern S2

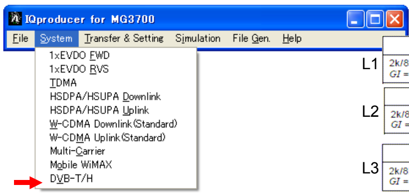


License option MX370106A

Mode	$N\pm1$	$N\pm m$ ($m\neq1$) except $N+9$	$N+9$	BER
2k/8k 64QAM CR = 2/3 GI = 1/8	27 dB	40 dB	31 dB	<2 x 10^{-4}



7 DVB-T/H IQproducer Setup Pattern L1 to 3



License option MX370106A

L1

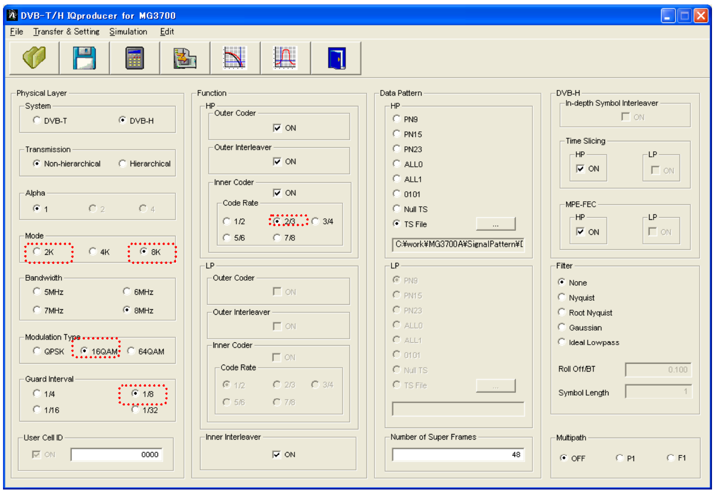
Mode	a [$N+2$]	b [$N+4$]	BER
2k/8k 16QAM CR = 2/3 GI = 1/8l	40 dB	45 dB	<2 x 10^{-4}

L2

Mode	a [$N+2$ and $N+4$]	BER
2k/8k 16QAM CR = 2/3 GI = 1/8	45 dB	<2 x 10^{-4}

L3

Mode	a [$N+2$ and $N+4$]	BER
2k/8k 16QAM CR = 2/3 GI = 1/8	40 dB	<2 x 10^{-4}



7 DVB-T/H IQproducer Setup DVB-T Interferer

- No DVB-T interferer definition

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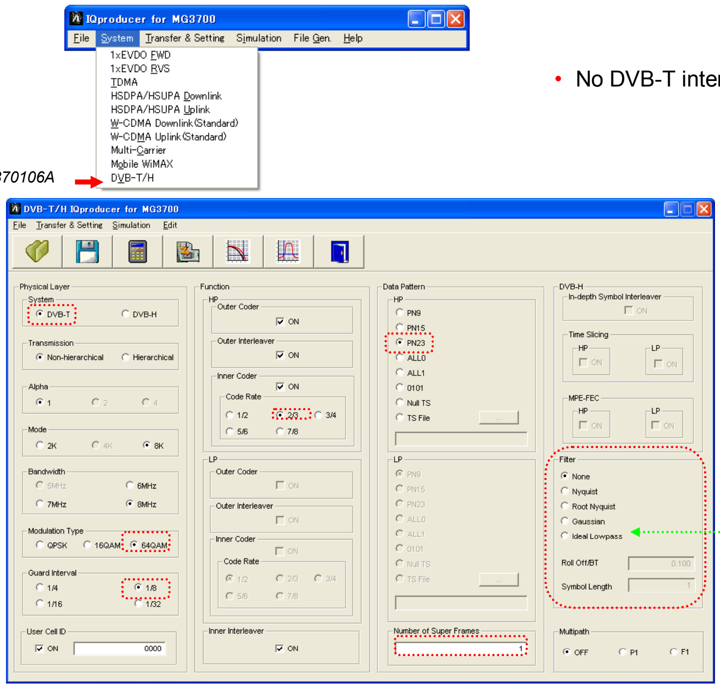
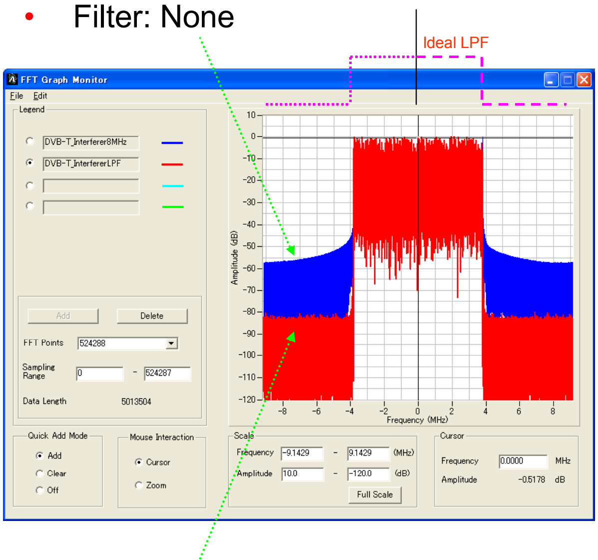
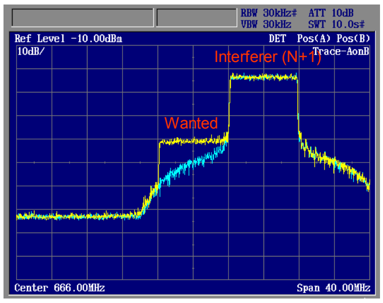


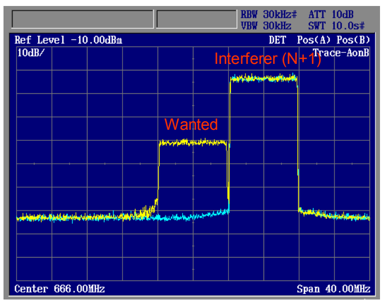
Bandlimiting filter

7 Effect of Spectrum on Bandlimiting Filter

- Filter: None

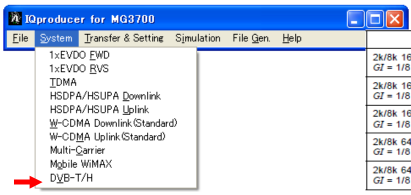






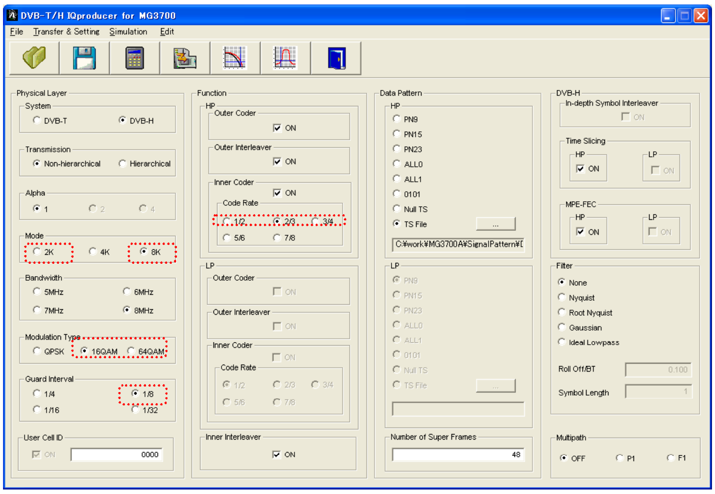
- Filter: Ideal Lowpass

8 DVB-T/H IQproducer Setup



License option MX370106A

Mode	PAL I1	PAL B/G	SECAM	*BER*
2k/8k 16QAM *CR* = 1/2 *GI* = 1/8	–6 dB	–6 dB	–5 dB	<2 x 10^{-4}
2k/8k 16QAM *CR* = 2/3 *GI* = 1/8	–1 dB	–1 dB	0 dB	
2k/8k 16QAM *CR* = 3/4 *GI* = 1/8	0 dB	2 dB	3 dB	
2k/8k 64QAM *CR* = 2/3 *GI* = 1/8	4 dB	4 dB	5 dB	
2k/8k 64QAM *CR* = 3/4 *GI* = 1/8	7 dB	7 dB	8 dB	



9 Guard Interval Utilization: Echoes within Guard Interval

Test purpose

- To verify that the set reference *BER* criterion or PFP criterion does not exceed when echoes inside guard interval are present

Mode	*C/N* (dB)	*BER*
8k, 16-QAM, *CR* = 1/2, *GI* = 1/8	16,3	<2 x 10^{-4}
8k, 64-QAM, *CR* = 2/3, *GI* = 1/8	26,2	

3 paths

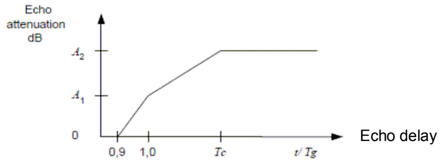
Path number	Attenuation (dB)	Delay	Doppler
0	0	0	None
1	0	*Tg* x 0,9	None
2	–1	*Tg* x 0,9	Pure 0,2 Hz
The test is repeated by setting the following echo pattern (pre echo).			
Path number	Attenuation (dB)	Delay	Doppler
0	0	0	None
1	0	*Tg* x 0,9	None
2	–1	0	Pure 0,2 Hz

Tg: Guard interval duration

10 Guard Interval Utilization: Echoes Outside Guard Interval

Test purpose

- To verify that the set reference *BER* criterion or PFP criterion does not exceed when echoes outside guard interval are present
  - When receiving a signal consisting of the main path and one echo with a delay longer than $t = 0.9 \times Tg$, the receiver shall provide reference BER when the level of the echo, compared to the main signal, is lower than the mask shown in the figure.



» Inflection point $t = 1.0 \times Tg$

Modulation	Code rate	A_1 at t = 1,0 x Tg [dB]
16-QAM	1/2	1
16-QAM	2/3	2
64-QAM	2/3	3

» Corner point $Tc = 1.3 \times Tg$ ($GI = 1/8$)

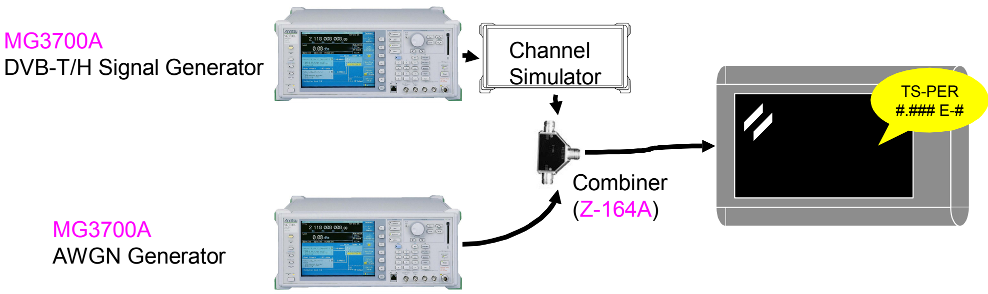
– $A_2 = C/N_{\text{Mode}} + \Delta$

Modulation	Code rate	C/N (dB) Ref *BER*	C/N (dB) PFP
QPSK	1/2	5,6	4,3
QPSK	2/3	7,4	6,1
QPSK	3/4	8,4	7,1
16-QAM	1/2	11,3	10,0
16-QAM	2/3	13,7	12,4
16-QAM	3/4	15,1	13,8
64-QAM	1/2	17,0	15,7
64-QAM	2/3	19,2	17,9
64-QAM	3/4	20,8	19,5

Modulation	Δ [dB]
16QAM	3
64QAM	4

9,10 Connection Setup

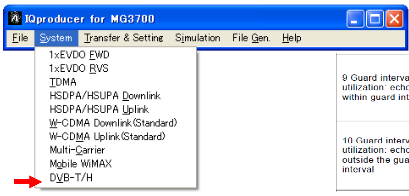
- Conformance measurement



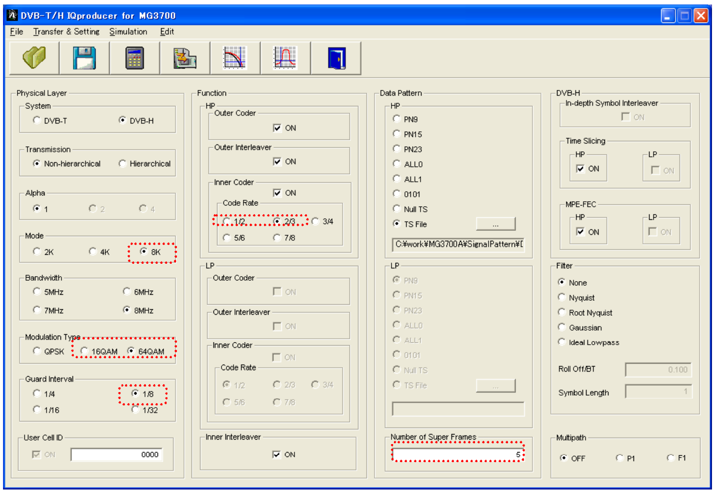
- No conformance measurement without channel simulator

9,10 DVB-T/H IQproducer Setup

License option MX370106A



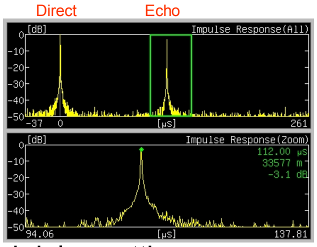
9 Guard interval utilization: echoes within guard interval		Ch 45 (UHF)
		8k, 64QAM 2/3, *GI* 1/8 8k, 16QAM 1/2, *GI* 1/8
10 Guard interval utilization: echoes outside the guard interval		Ch 45 (UHF)
		8k, 64QAM 2/3, *GI* 1/8 8k, 16QAM 1/2, *GI* 1/8 8k, 16QAM 2/3, *GI* 1/8



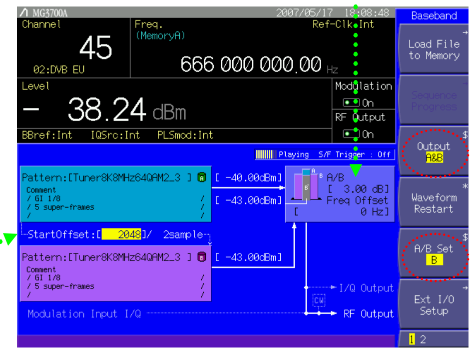
No Conformance Measurement without Channel Simulator

- The MG3700A generates a direct path signal from baseband memory A and an echo path signal from baseband memory B.
- Considering the echo delay setting because of 1/2 FFT sample resolution:

Direct Echo

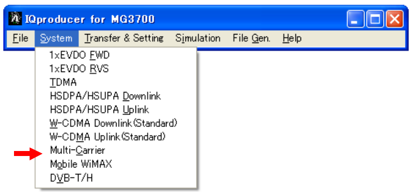


A_1 dB

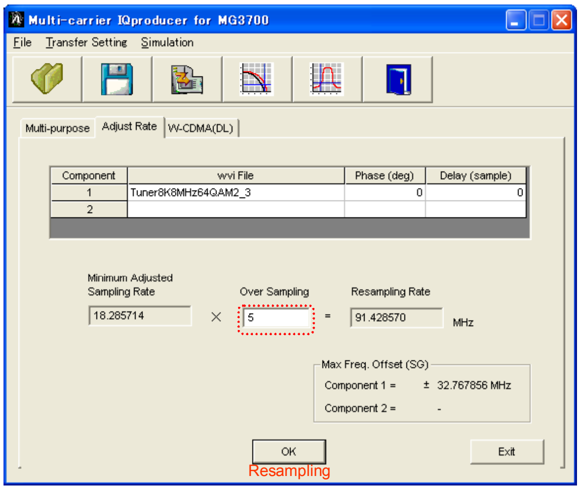


  » Required delay setting
    - 0.9 × *Tg* = 921.6 samples
    - 1.0 × *Tg* = 1024 samples
    - 1.3 × *Tg* = 1331.2 samples
      - *Tg* = Usuful symbol × GI = 112 μs
        (FFT samples) = FFT size M × 1/8 = 1024 samples
- Therefore, use oversampling of more 5.
  - 1/10 FFT sample resolution for delay setting

Multi-carrier IQproducer Setup for Resampling



License option MX370104A

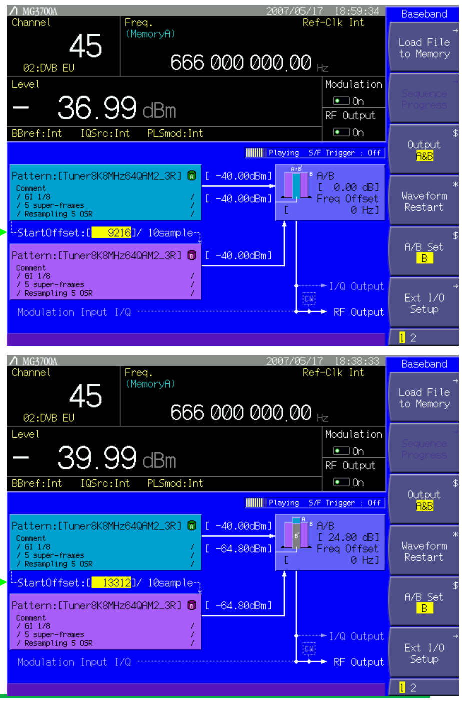


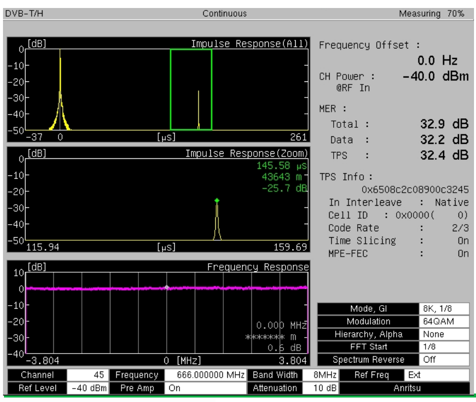
Direct Path + Echo Path Setup Example

- Direct Path Signal
  -40 dBm
  +
- Echo Path Signal

0.9 × *Tg*

1.3 × *Tg*





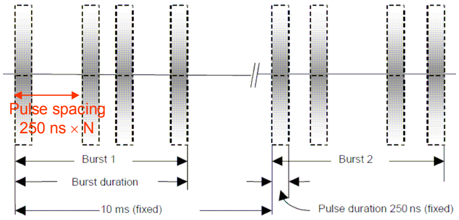
11 Tolerance to Impulse Interference

Test purpose

- To verify that the set PFP criterion does not exceed when different kinds of impulsive noise patterns are present
  - Impulse interference is different from other forms of interference, because it is generated in short bursts. Sources include car ignition systems and domestic appliances such as switches and electric motors. In portable and mobile environment, the impulse interference reaches the receiver directly through the antenna. The damage is potentially serious because a single impulse burst can destroy a complete symbol's worth of data.
    - The higher the test number, the greater the difficulty in designing effective countermeasures.
    - DVB-H receivers with MPE-FEC or receivers using the in-depth interleavers with 4k or 2k are expected to have resistance to impulse interference compared to DVB-T receivers.

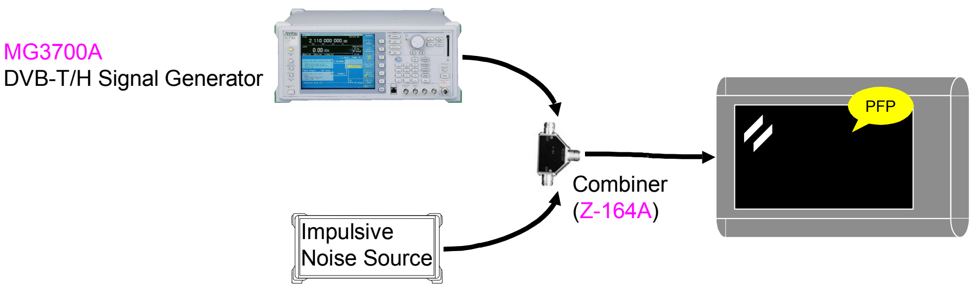
Test No	Pulses per burst	Effective burst duration µs	Min. pulse spacing µs	Max. pulse spacing µs	Range of actual burst durations µs	16-QAM *CR* = 1/2	16-QAM *CR* = 2/3	64-QAM *CR* = 2/3
1	1	0,25	N/A	N/A	*0,25*	X		
2	2	0,50	1,5	45	*1,75 – 45,25*		X	
3	4	1,00	15	35	*45,25 – 105,25*		X	
4	12	3,00	10	15	*110,25 – 165,25*			X
5	20	5,00	1	2	*19,25 – 38,25*			X
6	40	10,00	0,5	1	*19,75 – 39,25*			X

Pulse duration × Pulses per burst

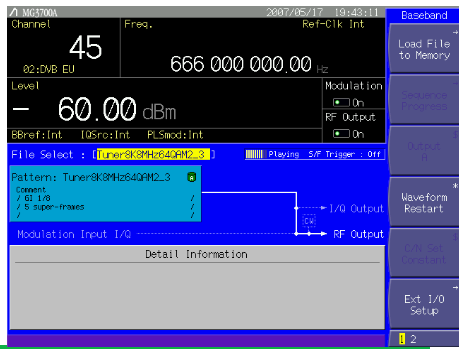


NOTE The number of pulses per burst is defined, but the spacing between pulses is allowed to vary randomly between the given maximum and minimum values.

11 Connection Setup

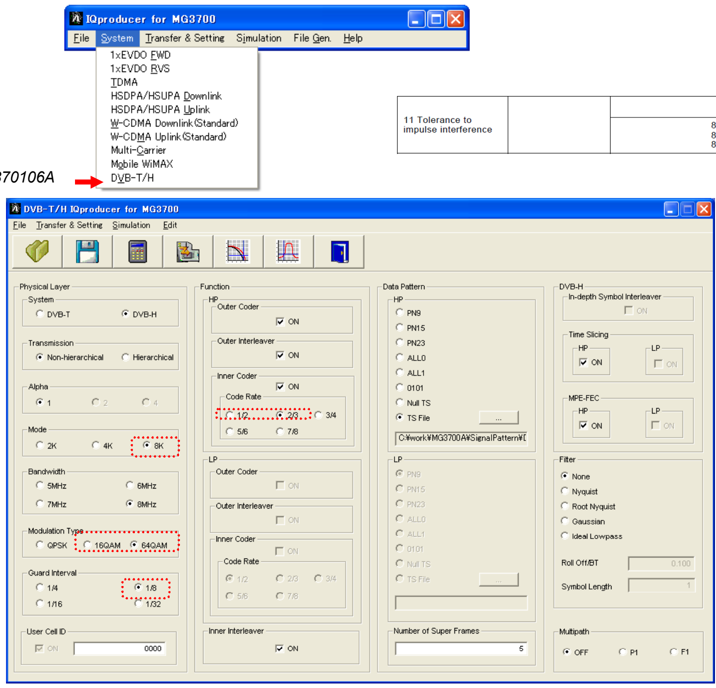


- DVB-T/H Signal
  -60 dBm



11 DVB-T/H IQproducer Setup

License option MX370106A



11 Tolerance to impulse interference		Ch 45 (UHF)
		8k, 64QAM 2/3, GI 1/8 8k, 16QAM 1/2, GI 1/8 8k, 16QAM 2/3, GI 1/8

Additional Information

- The DVB-T/H analyzer screenshots were taken using the MS8911B.
  - MS8911B Digital Broadcast Field Analyzer (100 kHz to 7.1 GHz)
    - The Digital Broadcast Field Analyzer features a high performance spectrum analyzer in a compact battery-operated unit. The MS8911B is very useful for area surveys and field maintenance of digital broadcasting equipment.
  - MS8911B-050 DVB-T/H Analysis Software (30 MHz to 990 MHz)
    - The MS8911B-050 DVB-T/H Analysis Software is the measurement software for analyzing DVB-T and DVB-H. It is very useful for area surveys, installation and maintenance of terrestrial digital broadcasting equipment.

Specifications are subject to change without notice.

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