

SET eXPerience 2021

Response to TV 3.0 Project CfP Phase-1 and 2 Physical Layer

DiBEG/Japan

Proposal of Physical Layer by DiBEG



1. General

We, DiBEG, or Digital Broadcasting Experts Group, of Japan, proposed Ph-1 and Ph-2 of the physical layer in response to the TV 3.0 CfP (Call for Proposal) issued by the SBTVD Forum. We describe the outline of our technical proposal of Ph-1 and Ph-2 for the physical layer.

2. Outline of Physical Layer

Our proposed Physical Layer is planning 4K or 8K services in the nextgeneration digital terrestrial TV broadcasting (DTTB) services in Japan (Advanced ISDB-T). The Advanced ISDB-T technology is applied to this physical layer in our proposal.

We offered the specifications of this Advanced ISDB-T in our proposal. This document describes the outline of the Advanced ISDB-T features.

Ph-1 Proposal of Physical Layer



We submitted the statement based on the CfP requirement. The following description is outline of the statement for Physical Layer.

PL1.1: Frequency Band

Basically the Advanced ISDB-T works in the UHF band from 470 to 698MHz. The supported frequency band is based on Japan's frequency allocation for terrestrial broadcasting. The frequency bands can be easily extended to other range.

PL1.2: Channel Bandwidth

Basically the Advanced ISDB-T supports 6MHz bandwidth. The Advanced ISDB-T is under development and can be extended to support other bandwidth in the future.

Ph-1 Proposal of Physical Layer



PL1.3: Co-channel PR (wanted: ISDB-T / unwanted: TV 3.0); ≤19dB Considering the RF signal of the Advanced ISDB-T is of an OFDM signal similar to that of ISDB-T, the impact of interference is expected to be similar the interference from ISDB-T. We tested with the required D/U to be less than 19dB in Japan.

PL1.4: Adjacent channel PR (wanted: ISDB-T / unwanted: TV 3.0); ≤ -36dB The 5.83MHz bandwidth of the Advanced ISDB-T is slightly larger than the 5.57MHz bandwidth of the current ISDB-T, and the impact to PR is very small.

It is almost the same as ISDB-T(wanted) to ISDB-T(unwanted) PR. We tested with the required D/U to be less than -36dB in Japan.

PL2.1: MIMO; 2x2

We had various test results on the Advanced ISDB-T including field tests of 2x2 MIMO transmission.

Ph-1 Proposal of Physical Layer



PL2.2: Multi RF channel transmission; Channel bonding Channel bonding function is included in the Advanced ISDB-T. It is considered to be implemented with the Advanced ISDB-T.

PL2.3: High-speed reception; 120km/h

It can be achieved technically by choosing appropriate parameters with the Advanced ISDB-T. We tested this at 3km/h and 70km/h by 16k FFT in Japan. Reception at 120km/h by 8k FFT will be achievable.

PL2.4: Spectrum efficiency; C/N 0dB in Rayleigh channel We tested the required C/N at 3km/h and 70km/h by 16k FFT in Japan. The required C/N shall be achieved at 120km/h by 8k FFT.

PL3.1: Wake-up capability

The Wake-up capability is included in Japan's next gen. DTTB requirements, it is considered to be implemented in the Advanced ISDB-T.

Ph-2 Proposal of Physical Layer



- 1. Specifications of the technical proposal DiBEG submitted the technical specification document on the Advanced ISDB-T. Also we conducted laboratory tests and submitted its test report.
- 2. Comment on the technical proposal DiBEG mentioned the detailed technical specification of the Advanced ISDB-T. It consists of basic structure, primary modulation, frame structure and OFDM modulation.

Laboratory tests were performed at a manufacture's factory in Japan. DiBEG conducted measurements of Gaussian noise, Rayleigh fading, ISDB-T interference, FM Radio interference and so on. We believe that the Advanced ISDB-T can satisfy most of the requirements.

Introduction of Advanced ISDB-T



The Advanced ISDB-T inherits the features of current ISDB-T such as OFDM, hierarchical transmission and partial reception. While inheriting the features of ISDB-T, the Advanced ISDB-T adopts new signal structures that expands transmission capacity with multiple levels of robustness.



FDM-based Transmission



Frequency

ISDB-T 13 s<mark>egm</mark>ents 5.57 MHz Advanced 35 segments **ISDB-T** 5.83 MHz 6 MHz

Transmission parameters



Standard	ISDB-T (Mode3)	Advanced ISDB-T			
Channel bandwidth	6 MHz	6 MHz			
Occupied bandwidth	5.57… MHz	5.57…MHz		5.83…MHz	
Number of segments	13	33 + adjustment ba	inds		35
Bandwidth of segment	429 kHz		167	kHz	
FFT size (N _{FFT})	8,192 (8k)	8,192 (8k)	16,384 ((16k)	32,768 (32k)
Number of carriers	5,617	7,561	15,12	21	30,241
Scattered Pilot ratio	1/12	1/3, 1/6, 1/12, 1/24, 1/48		/48	
Carrier modulation scheme	QPSK, 16QAM, 64QAM (UC)	QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM (UC, NUC)			6QAM, NUC)
Effective OFDM symbol length	1,008 ms	1,296 ms	ms 2,592 ms 5		5,184 ms
Guard interval ratio	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 800/N _{FFT}	1/4, 1/8, 800/N _{FFT} 1/4, 1/8, 1/16, 800/N _{FFT} 1/8		1/8, 1/16, 1/32, 800/N _{FFT}
GI duration (8kFFT, $GI = 1/8$)	126 ms		162	2 ms	
IFFT sampling frequency	512/63 = 8.12···· MHz	512/81 = 6.32···· MHz		z	
ΜΙΜΟ	No	2x2 (H,V Dual Polarization)		tion)	
Channel Bonding	No	Planed to be supported			ed
wake-up capability	Yes	Planed to be supported			ed
Supported RF band	470-710MHz	470-710MHz (Japan's DTTB Frequency allocation)		ency allocation)	

Informative References



No.	Document	Remarks
1	ARIB standard: "Transmission System for Digital Terrestrial Television Broadcasting," ARIB STD-B31 Version 2.2-E1 (Mar. 2014)	
2	M. Nakamura et al.: "A Study on the Transmission System for an Advanced ISDB-T," Proc. 14th IEEE Int. Symp. on BMSB, 4A-2 (Jun. 2019)	
3	N. Shirai et al.: "Laboratory Experiments and Large-scale Field Trials for Evaluating the Advanced ISDB-T," Proc. 14th IEEE Int. Symp. on BMSB, 4A-4 (Jun. 2019)	
4	T. Shitomi, et al.: "Fixed Reception Performance of FDM-based Transmission System for Advanced ISDB-T," SET INTERNATIONAL JOURNAL OF BROADCAST ENGINEERING, 6, 1, pp. 9-20 (Jan. 2021)	
5	ARIB standard: "MMT-Based Media Transport Scheme in Digital Broadcasting Systems," ARIB STD-B60 Version 1.13-E1 (Oct. 2018)	
6	Recommendation ITU-R BO.2098-0, "Transmission system for UHDTV satellite broadcasting", (Dec. 2016)	



Laboratory Test Report for Advanced ISDB-T Physical Layer

DiBEG/Japan



Comparison Table between SISO and MIMO

Comparison table between ISDB-T and Advanced ISDB-T system.

Standard	ISDB-T	SISO Advanced ISDB-T	MIMO Advanced ISDB-T
Video Coding	MPEG-2, MPEG-4	VVC*	VVC*
Speed (Bit rate)	16.0Mbps	Up to 54Mbps@16kFFT	Up to 108Mbps@16kFFT
Program	2K	2K, 4K and 8K	2K, 4K and 8K
Segment Number	13	35	35
Bandwidth	5.57MHz	5.83MHz	5.83MHz
Layer	Layer-A, B, C	Layer-A, B, C, LLch	Layer-A, B, C, LLch
FFT Size	1,024, 4096, 8,192	8,192, 16,384, 32,768	8,192, 16,384, 32,768
Guard Interval	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 1/16, 1/32, 1/256, 800/FFT size	1/4, 1/8, 1/16, 1/32, 1/256, 800/FFT size
Modulation	QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM 256, 1024, 4096QAM	QPSK, 16QAM, 64QAM 256, 1024, 4096QAM
Error Correction	RS + convolutional code	BCH + LDPC	BCH + LDPC

* VVC is under study and evaluation.

Proposed Parameters for TV 3.0



The following transmission parameters were applied to the laboratory tests in Japan. These parameters were used for 2K transmission for SISO and MIMO tests.

- Modulation
- Error correction
- FFT
- GI ratio
- Pilot
- Time Interleave
- Layer
- Program

- : QPSK
- Constellation : Uniform Constellation
 - : LDPC (3/16) + BCH
 - :16k
 - : 800/16384
 - : Dx=6, Dy=2
 - : |=3
 - : Layer-A, 35segments
 - : 2K (1080p), 3.4Mbps
- **35segments of Layer-A**



Evaluation of Call for Proposal Ph-2



The following measuring items are conducted in accordance with CfP.

- -1) RF Frequency Accuracy
- -2) Phase noise and Spectrum
- -3) RF/IF signal power
- -4) RF out of band emissions and linearity characterization
- -5) I/Q analysis Constellation and MER
- -6) C/N Carrier power vs AWGN by SISO and MIMO
- -7) C/N (Carrier power vs Rayleigh / AWGN) by SISO and MIMO
- -8) Receiver maximum and minimum level by SISO and MIMO
- -9) Co-channel Interference with own system by SISO and MIMO
- -10) Co-channel and adjacent channel interference to ISDB-T by SISO
- -11) Impulse noise by SISO
- -12) Single echo static multipath interference by SISO
- -13) Channel bonding by MIMO
- -14) Channel identification stability in frequency reuse-1 by MIMO
- -15) FM Radio (88 to 108 MHz) Interference by SISO

RF Frequency Accuracy



The RF frequency was measured under the MOD-H and MOD-V output conditions. U/C was applied to the Ch-10 and 33 measurements. The Advanced ISDB-T exciter was tuned to Ch-30 for measurements.



Results of RF Frequency Accuracy



Measuring table is mentioned as follows.

Channel	H/V	Measured Frequency	Deviation(ppm)	Remarks
10 (192-198MHz)	н	195.1428571MHz	0ppm	By U/C
ditto	V	195.1428571MHz	0ppm	ditto
33 (584-590MHz)	Н	587.1428571MHz	0ppm	ditto
ditto	V	587.1428571MHz	0ppm	ditto
30 (566-572MHz)	Н	569.1428570MHz	0.0002ppm	By Exciter
ditto	V	NA	NA	ditto

Phase noise and Spectrum



The RF frequency and spectrum were measured under the MOD-H and MOD-V output conditions. U/C was applied to the Ch-10 and 33 measurements. The Advanced ISDB-T exciter was tuned to Ch-30. The MOD output was reflected to CW. Please take care to adjust Sweep bandwidth, Resolution bandwidth and Sweep time.



Results of Phase noise and Spectrum



Measuring table is mentioned as follows.

Channel	H/V	Measured Frequency	Spectrum (Photo)	Remarks
10 (192-198MHz)	Н	Refer to 6.2.1	Refer to 6.2.2	By U/C
ditto	V	Refer to 6.2.3	Refer to 6.2.4	ditto
33 (584-590MHz)	Н	Refer to 6.2.5	Refer to 6.2.6	ditto
ditto	V	Refer to 6.2.7	Refer to 6.2.8	ditto
30 (566-572MHz)	Н	Refer to 6.2.9	Refer to 6.2.10	By Exciter
ditto	V	N/A	N/A	ditto

 * Regarding measurement of Phase Nosie, Anritsu Signal Analyzer was used and the integral values in the range of 10Hz to 1MHz were measured 5 times on average.

* The spectrum was measured with the setting of Span: 20MHz, RBW: 10kHz and VBW: 300Hz.

Results of Phase noise and Spectrum

Measuring photos are mentioned as follows.

6.2.2

6.2.1

6.2.5





587.1MH

10 Hz

1.161-

6.2.7

6.2.3

6.2.8

6.2.4



Amplitur

BW Marke

Trace



6.2.6



Results of Phase noise and Spectrum



 Inscription
 Subscription
 Subscription



RF/IF signal power



The IF and RF powers were measured under the MOD-H and MOD-V output conditions by the Power Meter. The IF was measured at output of MOD. The U/C was applied to the Ch-10 and 33 measurements. The Advanced ISDB-T exciter was tuned to Ch-30.





Results of RF/IF signal power

Measuring table is mentioned as follows.

Channel	H/V	Measured Power (dBm)	Remarks
IF (37.15MHz)	Н	-9.82dBm	
ditto	V	-9.56dBm	
10 (192-198MHz)	Н	-0.25dBm	By U/C
ditto	V	-0.42dBm	Ditto
33 (584-590MHz)	Н	-0.51dBm	Ditto
ditto	V	-0.52dBm	Ditto
30 (566-572MHz)	Н	6.03dBm *	By Exciter
ditto	V	N/A	Ditto

* Exciter output level is +6dBm.

RF out of band emissions and linearity characterization (Spectrum Mask)







Results of RF out of band emissions and linearity characterization (Spectrum Mask)

Measuring table is mentioned as follows.

Channel	H/V	Spectrum Mask (Photo)	Remarks
IF (34.15 - 40.15MHz)	Н	Refer to 6.4.1	By MOD
ditto	V	Refer to 6.4.2	Ditto
10 (192-198MHz)	Н	Refer to 6.4.3	By U/C
ditto	V	Refer to 6.4.4	Ditto
33 (584-590MHz)	Н	Refer to 6.4.5	Ditto
ditto	V	Refer to 6.4.6	Ditto
30 (566-572MHz)	Н	Refer to 6.4.7	By Exciter
ditto	V	N/A	Ditto

- * The breakpoint of the spectrum mask was applied to the specifications of domestic field tests in the metropolitan cities in Japan.
- * Regarding the Spectrum emission mask measurement function of the Signal Analyzer (MS series) of Anritsu, the above breakpoint was inserted for measurements





center frequency (MHz)	attenuation (dB)
-4.36	-50
-3.00	-27
-2.99	-20
-2.92	0
+2.92	0
+2.99	-20
+3.00	-27
+4.36	-50

Results of RF out of band emissions and linearity characterization (Spectrum Mask)

Measuring photos are mentioned as follows.

6.4.2

6.4.1









6.4.4



6.4.5

∕I MS2692A Spe	ctrum Analyzer						5/20/2021 10:42:35
							Spectrum Analyzer
				ARSI	ABS2	DEI	4
Reference	Level 0.00d	Bm			NOOL		Frequency
-10.0							4
							Span
			Ť.				4
			†				Amplitude
-60.0			t				
70.0			+				9
			+				BW
-80.0			-				
-90.0							9
-100.0							Marker
Center 587.143	MHz					Span 30.00MHz	
Spectrum Emis	sion Mask						L. L.
Desuit	Off	'set 1-6	Lo	wer	U	oper	Trace
Result	Start (MHz)	Stop (MHz)	Peak (dBm)	Freq (MHz)	Peak (dBm)	Freq (MHz)	Huce
	2.920 000	2.990 000	-34.34	584.222.857 584.144.987	-33.07	590.062.857	
Reference	3.000 000	4.360 000	-82.28	582,830 457	-82.62	591,482,457	Triggor/Oato
Reference	4.360 000	15.000 000	-81.70	582.623 257	-81.85	591.619 897	ringger/Gate
-0.54 dBm							-
							T (0
AWAvg 100.00%	B-	0 -	0-	B -	8	3-	Time/Sweep
Ref.Ext	Pre-Amp Off					ISDB-T	1 of 2

6.4.6

Reference Level 0.00dBmAB\$1AB\$2REL Frequen	r r cy
Reference Level 0.00dBm _ABS1_ABS2_REL Frequen	icy t
-10.0	
-20.0 Span	
-30.0	
-40.0	
-50.0	de
-60.0	
-700	. (
BW	
-90.0	ų
Marke	r
Center 587.143MHz Span 30.00MHz	
Spectrum Emission Mask	
Result Start (MHz) Stop (MHz) Pask (/Bm) Frag (MHz) Pask (/Bm) Frag (MHz)	
2.920.000 2.990.000 -34.14 584.222.857 -34.80 590.062.857	
FAIL 2.990 000 3.000 000 -74.12 584.150 107 -75.50 590.140 447	ų
Reference 3.000 000 4.360 000 -82.03 582.823 657 -82.87 591.498 777 Trigger/0	late
4.360 000 15.000 000 -74.39 574.292 137 -81.89 591.630 537	
3,000 000 12,500 000 111 111 111	
12.500.000 15.000.000 Time/Sw	eep
A WAyg 100.00% E- E- E-	
Ref.Ext Pre-Amp Off ISDB-T 1 of 2	-

6.4.7

6.4.3





Constellation and MER are measured under MOD H and MOD V output by Advanced Analyzer. U/C is applied to Ch-10 and 33.



I/Q analysis – Constellation and MER



Measuring table is mentioned as follows.

Channel	H/V	Constellation	MER	Remarks
10 (192-198MHz)	Η	N/A	N/A	By U/C
ditto	V	N/A	N/A	Ditto
33 (584-590MHz)	Н	Refer to 6.5.1	38.3dB	Ditto
ditto	V	ditto	38.7dB	Ditto
30 (566-572MHz)	Н	Refer to 6.5.2	38.9dB	By U/C
ditto	V	ditto	38.3dB	Ditto

* Advanced Analyzer can't measure VHF band.

I/Q analysis – Constellation and MER



Measuring photos are mentioned as follows. 6.5.1 6.5.2

FILE(E) SET(S) TOOL(T) HELP(H)	FILE(E) SET(S) TOOL(I) HELP(H)
Analyze Received Offset MODE GI Carrier Mod 32 CH 1/7 MHz MODE 4 800/16384 A:QPSK B:256QAM C:4096QAM MEASUREMENT MODE FILE Analyze 32 CH 1/7 MHz MODE 4 800/16384 A:QPSK B:256QAM C:4096QAM MEASUREMENT MODE FILE	Analyze Received OffSet MODE GI Carrier Mod MEASUREMENT MODE FILE 29 CH 1/7 MHz MODE 4 800/16384 A:QPSK B:QPSK C:QPSK MASTER Normal Single Continuous FILE
SISO Prop.MMO Prop.SISO SETTING	MIMO SISO Prop.MIMO Prop.SISO STO-MIMO MISO SETTINIS
GPS RF1 R/2 No inter Satellite -53.0668m -53.0168m Satellite DATE RF -30.0068 5.6368 Lothude Lo 0.0068 0.0068 0.0068 Noise LB 0.0068 0.0068 0.0068 Variance LB 0.0068 0.0068 0.0068 Variance LB 0.0068 0.0068 0.0068 Freq. Response LA LA+LB ALL Messure Info. Wave Info. Wave Info. Wave Info. RF1 Constellation LA RF2 Constellation LA RF2 Constellation LA RF1 Constellation LB RF1 Constellation LB RF1	Image: door Image: door <thimage: door<="" th=""> <thimage: door<="" th=""></thimage:></thimage:>
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C/N - Carrier power vs. AWGN by SISO and MIMO

C/N \leq 0 was measured with AWGN (Gaussian noise) under the SISO condition. U/C is applied to the measurements at Ch-7, 13, 14, 30, 33 and 51. The RF input at DEM was set to -28, -53, -68 and -83dBm.



C/N - Carrier power vs. AWGN by SISO and MIMO

 $C/N \le 0$ was measured with AWGN (Gaussian noise) under the MIMO condition. U/C is applied to the Ch-7, 13, 14, 30, 33 and 51 measurements. The RF input at DEM was set to -28, -53, -68 and -83dBm.



Results of C/N - Carrier power vs. AWGN by SISO and MIMO



Measuring table of SISO and MIMO is mentioned as follows.

Ch.	RF IN Level(dBm)	SISO C/N	MIMO C/N	Remarks
Ch-14	-28	-1.0dB	-0.8dB / -0.8dB	By U/C
	-53	-1.1dB	-0.7dB / -0.7dB	Ditto
	-68	-1.1dB	-0.5dB / -0.8dB	Ditto
	-83	-1.2dB	-0.7dB / -0.7dB	Ditto
Ch-30	-28	-1.1dB	N/A	By U/C
	-53	-0.9dB	N/A	Ditto
	-68	-1.1dB	N/A	Ditto
	-83	-1.0dB	N/A	Ditto
Ch-51	-28	-1.0dB	-0.8dB / -0.9dB	By U/C
	-53	-1.1dB	-0.8dB / -0.9dB	Ditto
	-68	-1.1dB	-0.9dB / -0.8dB	Ditto
	-83	-1.1dB	-0.8dB / -0.9dB	Ditto

Results of C/N - Carrier power vs. AWGN by SISO and MIMO C/N is measured -28dBm input at DEM at Ch-51. This is the minimum C/N level.



C/N - Carrier power vs. Rayleigh and AWGN by SISO and MIMO

C/N \leq 0 was measured with Rayleigh noise under the SISO condition. U/C was applied to Ch-7, 13, 14, 33 and 51. Advanced Exciter is tuned to Ch-30. The RF input at DEM was set to -28, -53, -68 and -83dBm.



C/N - Carrier power vs. Rayleigh and AWGN by SISO and MIMO

C/N \leq 0 was measured with Rayleigh noise under the MIMO condition. U/C was applied to the Ch-7, 13, 14, 33 and 51 measurements. The RF input at DEM was set to -28, -53, -68 and -83dBm.



Result of C/N - Carrier power vs. Rayleigh and AWGN RF3A/B is applied 70km/h

Measuring table of SISO and MIMO is mentioned as follows.

Ch.	RF IN Level(dBm)	SISO C/N (RF1)	SISO C/N (RF3A)	MIMO C/N (RF2A/2B)	MIMO C/N (RF3A/3B)	Remarks
Ch-7	-28	-1.0dB	0.2dB	0dB / 0dB	0.3dB / 0.3dB	By U/C
	-83	-1.0dB	0.3dB	0.2dB / 0.1dB	0.4dB / 0.4dB	Ditto
Ch-13	-28	-0.9dB	0.2dB	0.1dB / 0.1dB	1.0dB / 1.1dB	By U/C
	-83	-0.9dB	0.2dB	0.4dB / 0.4dB	1.5dB / 1.3dB	Ditto
Ch-14	-28	-1.1dB	0.2dB	0dB / 0dB	1.7dB / 1.7db	By U/C
	-83	-0.9dB	0.2dB	0.1dB / 0.1dB	1.6dB / 1.6dB	Ditto
Ch-30	-28	-1.0dB	0.3dB	N/A	N/A	By Exciter
	-83	-1.1dB	0.3dB	N/A	N/A	Ditto
Ch-33	-28	-1.1dB	0.3dB	-0.1dB / 0dB	3.7dB / 3.7dB	By U/C
	-83	-1.0dB	0.2dB	0dB / 0dB	3.2dB / 3.2dB	Ditto
Ch-51	-28	-1.0dB	0.4dB	0.2dB / 0.2dB	12.7 / 12.6dB	By U/C
	-83	-0.8dB	0.4dB	0.1dB / 0.1dB	9.1dB / 8.5dB	Ditto

Consideration of High speed reception in Japan

C/N - Carrier power vs. Rayleigh

The tolerance against high-speed reception and bit rate depend on the FFT size. While the FFT size becomes larger, the symbol length becomes longer. Accordingly, higher bit rate can be achieved with large FFT size since the effective symbol length becomes longer when assuming the same guard interval length. On the other hand, by using a small FFT size, the tolerance against high-speed reception increases since the frequency interval between OFDM carriers becomes large. The laboratory tests were conducted by using 16k FFT size. This purpose was to increase the bit rate. By using 8k FFT, 120km/h high-speed reception can be achieved.

The tolerance of TMCC (Transmission and Multiplexing Configure Control) signal of the Advanced ISDB-T is mentioned in the following figure. As shown in the figure, the required C/N at 16k FFT deteriorates in the range over 120km/h. Since TMCC is the necessary signal to decode data, the data signal cannot be received in the range over 120km/h at 16k FFT. We understood this phenomenon in advance, but we decided to continue the test, putting the priority for higher bitrate.

Consideration of High speed reception in Japan C/N - Carrier power vs. Rayleigh

If the high-speed reception of 120km/h is prioritized than high bit rate, 8k FFT size must be selected rather than 16kFFT size. You can see from the figure that when 8k FFT size is applied, C/N of TMCC is not deteriorated even at 200km/h; therefore it will satisfy the requirement. The TV 3.0 Test Lab may conduct the tests with 8k FFT to confirm this.



Tolerance of TMCC for mobile reception (Simulation result) From the report of "Technical Test Project in Japan 2020"

Results of C/N - Carrier power vs. Rayleigh and AWGN



C/N is measured by -28dBm input at DEM on Ch-51. RF2A of MIMO is applied.

	/I MS2692λ Spectrum Analyzer		5/20/2021 19:07:58		/I MS2692A Spectrum Analyzer				5/20/2021 19:23.4
Main		RBW 30kHz CATT VBW 30kHz SWT	4dB Spectrum Analyzer 🛞	l Noise			RBW 30kHz VBW 30kHz	ATT 4dB SWT 34ms	Spectrum Analyzer Spectrum Analyzer
viaiii	Reference Level -30.00dBm	Positive 1001 po	Active Trace		Reference Level -30.00dBm		Positive	1001 points	Frequency
$H(\mathbf{C})$	-30.8		^	$H(\mathbf{N})$	-00.0				
	-40.8		Trace Type		-40.0				Span
	-50.1	5,049800000000000000000000000000000000000	Hinto 4		-50.0	(************************		
	-60.3		Average		-60.0				Amplitude
	-703		Storage Count		-70.0				
			100		-90.0				BW
	-101.0				-100.0				Marker
	-1100		~		-110.0				
	-120.0				-120.0				Trace
	-1300				-130.0				
	Center 695.14MHz Chappel Power	Span 10.000 0001	/i-iz		Center 695.14MHz Chappel Power		Span	10.000 000MHz	Trigger/Gate
	Channel Center 695.142.857 MHz	Absolute Power -95.72 dBm / Hz	Detection		Channel Center 695,142,857 MHz Channel With 5,830,000 MHz	Absolute Power	-95.92 dBm/H	Hz B20MUs	
	Channel Width 6.830 000 MHz	-28.07 GBm16.850MH2	Positive		AWAvg 100 / 100 E-	D-	-28.26 dBm/6	E-	Time/Sweep
	AWAvg 100 / 100 []- D-								
	Ref.Ext Pre-Amp On	ISOB-T	0		Ref.Ext Pre-Amp On			ISDB-T	1 el 2 📰
	AWAvg 100 ; too - - Ref Ext Pre-Amp On		5/20/2021 19:11 59		Ref.Ext Pre-Amp On MIS3/92A Spectrum Analyzer			ISDB-T	1 ef 2
Main	All Avg 100 r tog - - - Ref.Ext Pre-Amp On	RBW 30kHz DATT VBW 30kHz SWT 3	4dB Spectrum Analyzer Spectrum Analyzer	Noiso	Ref.Ext Pre-Amp On		RBW 30kHz VBW 30kHz	ISDB-T ATT 4dB SWT 34ms	1 of 2 5/20/2021 19 22: Spectrum Analyzer Spectrum Analyzer
Main	All Avg 100 r top B- Ref.Ext PrevAmp On NISS692A Spectrum Analyzer Reference Level 30.00dBm	RBW 30kHz MATT VBW 30kHz SWT 3 Positive 1001 pol	4dB Frequency	Noise	Ref.Ext Pre-Amp On		RBW 30kHz VBW 30kHz Positive	ISDB-T ATT 4dB SWT 34ms 1001 points	1 of 2 5/20/2021 19 22: Spectrum Analyzer Spectrum Analyzer Frequency
Main V(C)	All Avg 100 Ice Ice Ref.Ext PrevAmp On A 353/02A Spectrum Analyzer Reference Level -30.00dBm -300	RBW 30kHz C ATT VBW 30kHz SWT 3 Positive 1001 pol	SJ20/2021 18:11 59 ddB Spectrum Analyon Spectrum Analyon Frequency Spectrum Analyon Spectrum Spectrum Analyon Spectrum	Noise V(N)	RefEkt Pre-Amp On Attraction Spectrum Analyzer Reference Level -30.00dBm -100 -400		RBW 30kHz VBW 30kHz Positive	ISDB-T ATT 4dB SWT 34ms 1001 points	1 et 2 5/20/2021 19 22: Spectrue Analyze Spectrue Analyze Frequency
Main V(C)	All Avg 100 r top - - Ref.Ext Pre-Amp On - - A MS3692A Spectrum Analyzer -	RBW 30kHz DATT VBW 30kHz SWT 3 Positive 1001 pol	AdB Spectrum Analyzer Spectrum Analyzer Prequency Span	Noise V(N)	Ref.Ext Pre-Amp On Reference Level 30.00dBm -30.6 -40.6 -90.6 -40.6		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 5/20/2021 19 22 Spectrum Analyzer Spectrum Analyzer Frequency Span
Main V(C)	All Avg 100 r top B → Image: Control of the second s	RBW 30kHz IDATT VBW 30kHz SWT 3 Positive 1001 pol	S/20/2021 10.11.50 ddB Sectrum Analyon Sectrum Analyon Sectrum Analyon Sectrum Analyon Sectrum Analyon Span Span Span	Noise V(N)	RefExt Pre-Amp On Reference Level -30.00dBm -20.0 -43.0 -43.0 -43.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2
Main V(C)	All Avg 100 r too IS- Image: Contract of the sector of the	RBW 30kHz Part VBW 30kHz SWT SWT Positive 1001 pol	Sylov/2021 10 11 59 ddB Spectrum Analyon Spectrum Analyon Frequency Span Amplitude	Noise V(N)	RefEr Pre-Amp On ▲ MSS92A Spectrum Analyzer Reference Level -30.00dBm -10.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 C
Main V(C)	Ref Elixt Pre-Amp On ✓ 1353/02A Spectrum Analyzer Reference Level -30.00dBm -500	RBW 30kHz II ATT VBW 30kHz II ATT VBW 30kHz II ATT Positive 1001 pol	SJ20/2021 19:11 50 ddB dk Spectrum Analyon Spectrum Analyon Frequency Span Amplitude BW	Noise V(N)	Ref Ext Pre-Amp On ✓ MS36924 Spectrum Arealyzer Reference Level -30.00dBm -10.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 C
Main V(C)	All Avg 100 r top B → Image: Control of the second s	RBW 30kHz II ATT VBW 30kHz II ATT VBW 30kHz II ATT Positive 1001 pol	S/20/2021 10.11.50 Secture Analyor Secture Analyor Secture Analyor Span Amplitude BW BW	Noise V(N)	Ref Ext Pre-Amp On ✓ MS30/334 Spectrum Analyzer Reference Level -30.00dBm 0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 of 2 Control 1922. 5 /20/2021 1922. 5 Spectrum Analyse Frequency Span Amplitude EW
Main V(C)	All Avg 100 r too IS- Image: Contract of the sector of the	RBW 30kHz IDATT VBW 30kHz SWT S Positive 1001 pol	Sy20/2021 19 11 57 ddB Spectrum Analyor Spectrum Analyor Span Prequency Span W Amplitude BW W Marker	Noise V(N)	Ref Ext Pre-Amp On ✓ 3532624 Spectrum Analyzer Reference Level -30.00dBm -20.0		RBW 30kHz VBW 30kHz Positive	ISDBJ	1 et 2 C 5/20/2021 1922 Stracture Analyse Frequency Span Amplitude BW Marker
Main V(C)	All Areg 100 r too IS- Image: Contract of the sector of the	RBW 30kHz CATT VBW 30kHz CATT VBW 30kHz 100 ATT Positive 1001 pol	SJ20/2021 19.11 57 ddB Spectrum Analym Spectrum Analym Spectrum Analym Frequency Span Span W Amplitude BW W Marker W	Noise V(N)	Reference Level -30.00dBm -10.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 C
Main V(C)	All Areg 100 / 100 E Image: Contract of the second sec	RBW 30kHz II ATT VBW 30kHz II ATT SWT 3 Positive 1001 pol	SJ20/2021 19:11 50 Socitive Analyer Spectre Analyer Spectre Analyer Spectre Analyer Spectre Analyer Spectre Analyer Spectre S	Noise V(N)	Reference Level 30.00dBm 036 036 -036 036 -036 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -136 036 -138 036 -138 036 -138 036 -138 036 -138 036 -138 036 -138 036 -138 036 -138 036 -1109 036		RBW 30kHz VBW 30kHz Positive	ISDB-T	142 C
Main V(C)	All Avg 100 r too IS- Image: Contract of the second	RBW 30kHz ISBAT ISBAT VBW 30kHz SWT 2 Positive 1001 pol	Sylov/2021 19 11 59 ddB Spectrum Analyor Span Span Span W Span Span	Noise V(N)	Ref Ext Pre-Amp On ✓ 3530/34 Spectrum Analyzer Reference Level -30.00dBm -000		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 of 2 Constant of the second
Main V(C)	All Arg 100 r too IS- Image: Contract of the sector of the	RBW 30kHz ATT VBW 30kHz MATT VBW 30kHz MATT Positive 1001 pol	HZ Trigger/Gate	Noise V(N)	Reference Level -30.00dBm -10.0 -10.0		RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 C 5 /20/2021 1 922 Spectrum Analyse Reschum Analyse Prequency Span Amplitude EW Marker Trace Triggor/Gate
Main V(C)	Markar Image: Spectrum Analyzer Reference Level -30.00dBm -000	RBW 30kHz Part VBW 30kHz Part SWT SWT SWT Positive 1001 poi	Image: System State System 40B 5/20/2021 19:11.50 40B 5/20/2021 19:11.50 40B 5/20/2021 19:11.50 40B 5/20/2021 19:11.50 40B 9 8W 9 BW 9 11 12 12 13 14 15 16 17 17 18 17 18 17 18 17 17 17 18 17 18 17 17 18 18 19 17 17 18 18 19 19 10 10 10 10 10 10 11 12 12 13 14 14 15 16 17 18 18	Noise V(N)	Ref Ext Pre-Amp On ✓ MS39924 Spectrum Analyzer Reference Level -30.00dBm 0.6 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 -10.0 -0.0 <td>Absolute Power</td> <td>RBW 30kHz VBW 30kHz Positive</td> <td>ISDB-T</td> <td>1 et 2 C 5/20/2021 1922 C Spectrum Analyse Frequency Span Amplitude EW Murker Trace Trigger/Gate Time/Sweep</td>	Absolute Power	RBW 30kHz VBW 30kHz Positive	ISDB-T	1 et 2 C 5/20/2021 1922 C Spectrum Analyse Frequency Span Amplitude EW Murker Trace Trigger/Gate Time/Sweep
Main V(C)	All Arg 100 + top B → Breaking On Ref.Ext Preaking On All MS3692A Spectrum Analyzer Reference Level -30.00dBm -300	RBW 30kHz ATT VBW 30kHz DATT Positive 1001 pol Positive 1001 pol Positive 1001 pol Span 10 000 000M solute Power \$5.59 Span 10 000 000M solute Power \$5.59	Image: System of the system	Noise V(N)	Ref Ext Pre-Amp On ✓ M330/34 Spectrum Analyzer Reference Level -30.00dBm 0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -0.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0 -10.0 0.0	Absolute Power	RBW 30kHz VBW 30kHz Positive Positive Span	ISDB-T	1 of 2 1 1 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2

Receiver maximum and minimum level by MIMO

Max. and Min. reception levels were measured under the MIMO condition with a BER Analyzer. U/C was applied to the Ch-7, 13, 14, 33 and 51 measurements. The Advanced ISDB-T exciter was tuned to Ch-30.



Results of Receiver maximum and minimum level by MIMO

Measuring table of SISO and MIMO is mentioned as follows.

Ch.	SISO Max Level	SISO Min Level	MIMO Max Level H / V	MIMO Min Level H / V	Remarks
Ch-7					By U/C
Ch-13	>-14dBm	<-95dBm	>-14dBm / >-14dBm	<-95dBm / <-95dBm	Ditto
Ch-14					Ditto
Ch-33					Ditto
Ch-51	>-16dBm	<-95dBm	>-16dBm />-16dBm	<-95dBm / <-95dBm	Ditto
Ch-30	>-16dBm	<-95dBm	>-16dBm />-16dBm	<-95dBm / <-95dBm	Ditto

* Maximum Level:

Signal reception was available, if ATT is removed.

Therefore the above maximum level was measured without ATT.

* Minimum Level:

ATT is inserted and the minimum level was measured at -95dBm with ATT.

Co-channel Interference with own system by MIMO

The co-channel interference was measured under the MIMO condition with a BER analyzer and the Advanced ISDB-T analyzer. U/C was applied to the Ch-10 and 33 measurements. The Advanced ISDB-T exciter was tuned to Ch-30. The RF input at DEM was set to -53dBm.



Results of Co-channel Interference with own system by MIMO



SISO

Ch.	D/U (dB) Synchronization	D/U (dB) Un-synchronization	Remarks
Ch-10	N/A	1.3dB	By U/C
Ch-33	N/A	0.6dB	ditto
Ch-30	N/A	1.2dB	ditto

MIMO

Ch.	D/U (dB) Synchronization	D/U (dB) Un-synchronization	Remarks
Ch-10	N/A	1.6dB / 1.7dB	By U/C
Ch-33	N/A	0.9dB / 1.1dB	ditto
Ch-30	N/A	0.7dB / 0.9dB	ditto

Co-channel and adjacent channel interference to ISDB-T by SISO

The co-channel and adjacent channel interference was measured under the SISO condition with an ISDB-T STB. The U/C was applied to the Ch-28 to 32 measurements. The Advanced ISDB-T exciter was set to Ch-30.



Results of Co-channel and adjacent channel interference to ISDB-T by SISO



Measuring table of VHF and UHF of SISO is mentioned as follows.

Pro	otection Ratio D/U (dB)	Remarks
Desired Channel	Interference Channel	Receiver D/U (dB)	
VHF	Ch-8	N/A	
ISDB-T: Ch-10	Ch-9	N/A	
	Ch-10	N/A	
	Ch-11	N/A	
	Ch-12	N/A	
UHF	Ch-28	<-38dB*	Refer to 6.10.1
ISDB-T: Ch-30	Ch-29	-35.6dB	
	Ch-30	17.6dB	Refer to 6.10.2 to 4
	Ch-31	-30.9dB	
	Ch-32	<-38dB*	

* Signal reception is available, if ATT of A2 side (MOD side) is removed. Then data of Ch-28 and Ch-32 is reference D/U data in this case.

Results of Co-channel and adjacent channel interference to ISDB-T by SISO Measuring photos are mentioned as follows.

Span

BW

Marker

Trace

ISDB-



6.10.1 RBW 100kHz | 🖾 ATT 14dB -12.000 000 00 MHz 37.92 dB SWT 15ms **Ch-28** Reference Level -10.00dBm RMS 1001 points Frequency Amplitude Center 569.14MHz Span 50.000 000MHz Trigger/Gate Channel Center 569.142.857 MHz Absolute Powe -120.45 dBm / Hz 5.570 000 MHz Channel Width -52.99 dBm / 5.570MH Time/Sweep

6.10.3 **Ch-30 ISDB-T** side

AWAyg 100 / 100



6.10.2 **Ch-30** Minimum reception

> 6.10.4 **Ch-30 SISO** side

A MS2692A Spectrum	Analyzer						_ 🗆	5/25/2021 14	59/20
				RBW	30kHz	🖾 ATT	4dB	Spectrum Anal	lyzor -
						SWT	34ms	- Spectrum Analyza	-
Reference Level	-20.00dBm				RMS	1001	points	Peak Sea	rch
-20.0									
-30.0					\square			Maanur	
-40.0								Weasur	
-50.0									
-60.0									
-70.0					Ц				
-90.0	week an international states of the second states o	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	and the second product of the second s	n e Marada Marada					
-80.0									
-90.0	r				Ν				
-100.0									
-110.0					Gener	*****	stratered		
-120.0									
Center 569.14MHz					Span	10.000 0	00MHz		
Channel Power									
Channel Center	569.142 857 N	IHz Absolu	te Power	-120.39	dBm / H	Z SZOMUN			
	0.070 000 W			-02.00	abilito	or own2		Accesso	ry
Ref Evt Pro-	Amp Off	0		-		ISDB.T		0.40	
rtenext rie-	Amp.on					1000-1		2 01 2	22



Single echo static multipath interference by SISO



Transmission performance of SISO against multipath was measured. U/C was applied to the Ch-10 measurements. The Advanced ISDB-T exciter was tuned to Ch-30. The RF input at DEM was set to -53dBm.



Results of Single echo static multipath interference by SISO

Measuring table of Ch-10 and Ch-30 is mentioned as follows.

No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)	No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)	No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)
1	2,000	2.5	2.6	13	650	2.1	2.1	25	150	0	0
2	1,800	2.5	2.6	14	648	1.8	1.9	26	100	0	0
3	1,600	2.5	2.6	15	600	1.8	1.8	27	70	0	0
4	1,500	2.5	2.6	16	500	1.8	1.8	28	65	0	0
5	1,400	2.5	2.6	17	400	1.8	1.8	29	63	0	0
6	1,300	2.5	2.6	18	350	1.8	1.8	30	60	0	0
7	1,200	2.5	2.6	19	340	1.8	1.8	31	40	0	0
8	1,100	2.5	2.6	20	330	1.8	1.8	32	20	0	0
9	1,000	2.5	2.6	21	325	1.8	1.8	33	0	0	0
10	900	2.5	2.6	22	324	0	0	34	-20	0	0
11	800	2.5	2.6	23	300	0	0	35	-40	0	0
12	700	2.5	2.6	24	200	0	0	36	-60	0	0

Results of Single echo static multipath interference by SISO

Measuring table of Ch-10 and Ch-30 is mentioned as follows.

No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)	No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)	No.	Delay (us)	Ch-10 ATT(dB)	Ch-30 ATT(dB)
37	-63	0	0	49	-400	1.8	1.8	61	-1,400	2.5	2.5
38	-65	0	0	50	-500	1.8	1.8	62	-1,500	2.5	2.5
39	-70	0	0	51	-600	1.8	1.8	63	-1,600	2.5	2.5
40	-100	0	0	52	-648	1.8	1.8	64	-1,800	2.5	2.5
41	-150	0	0	53	-650	2.0	2.0	65	-2,000	2.5	2.5
42	-200	0	0	54	-700	2.5	2.5				
43	-300	0	0	55	-800	2.5	2.5				
44	-324	0	0	56	-900	2.5	2.5				
45	-325	1.8	1.8	57	-1,000	2.5	2.5				
46	-330	1.8	1.8	58	-1,100	2.5	2.5				
47	-340	1.8	1.8	59	-1,200	2.5	2.5				
48	-350	1.8	1.8	60	-1,300	2.5	2.5				

Channel bonding by MIMO



Channel bonding test was conducted with two sets of MIMO configuration. One signal was transmitted in Ch-10 and the other one was transmitted in Ch-33. The RF input at DEM was set to -53dBm. Channel bonding function will be applied to the Advanced ISDB-T in the near future.



Consideration of Channel Bonding in Japan



BICM : Bit Interleaved Coded Modulation

Since channel bonding function is included in the requirements of Japan's next generation DTTB, it is considered in the Technical Test Project in Japan 2020. Currently, two different modes of channel bonding schemes are considered in the Advanced ISDB-T. In 2021, the channel bonding function of "Dividing before BICM" at left side is planned to be verified by hardware at the Technical Test Project.



Considered Channel bonding scheme for the Advanced ISDB-T From the report of "Technical Test Project in Japan 2020" Channel identification stability in frequency reuse-1 by MIMO



The channel identification stability was tested with one MIMO and one RF capture configuration. Both MIMO systems were transmitted in Ch-10 or Ch-30. The RF input at DEM was set to -53dBm. The channel identification function will be applied to the Advanced ISDB-T in the near future.



Consideration of Frequency Reuse-1 in Japan



The current prototype Advanced ISDB-T receiver of the Demodulator is basically designed for Japan's next generation DTTB, which will be improved by the Frequency reuse-1.

Since the Advanced ISDB-T can achieve under 0dB required C/N, by designing the receiver algorithm for the Frequency reuse-1 from the very beginning of the receiver development, it will be able to achieve the requirements.

FM Radio (88 to 108 MHz) Interference by SISO DiBLEG

This test was conducted under the SISO condition. The power level of U/C was set at -80, -70, -60, -50, -40, -30 and -20 dBm. The QEF level of DEM was measured. U/C was applied to the Ch-7, 13, 15, 33 and 50 measurements. The Advanced ISDB-T exciter was tuned to Ch-30.



Results of FM Radio Interference by SISO



Measuring table of Ch-13, Ch-50 and Ch-30 is mentioned as follows.

TV Level (dBm)	Ch-7	Ch-13	Ch-15	Ch-33	Ch-50	Ch-30
			QEF Leve	l (dBm)		
-20		>-1dBm			>-1dBm	>-1dBm
-30						
-40						
-50		>-1dBm			>-1dBm	
-60						
-70						
-80		-20dBm			>-1dBm	>-1dBm

* TV Level

: Input Level into Demodulator from SISO Modulator

* QEF Level : FM wave Level (Max -1dBm)

* Input FM freq.: 88, 98 and 108MHz

* Comment

- : Above measuring date is same among 88, 98 and 108MHz.
 - : Low reception level at VHF frequency is affected from FM wave level.



Muito obrigado!

ARIB / DiBEG extend technical cooperation to Brazil adopting Next Generation Broadcasting Standard!

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