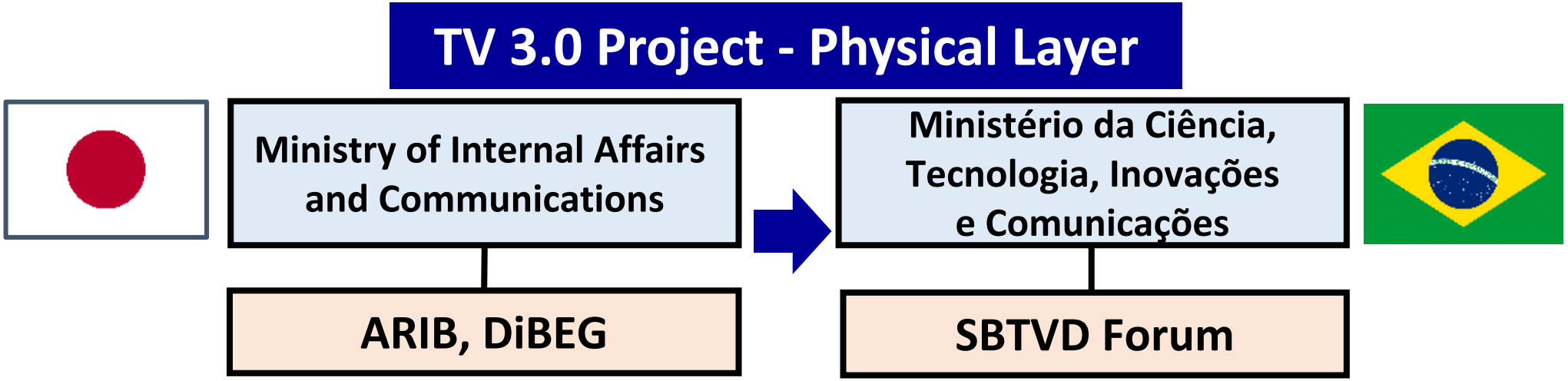
MIC Japan

Pilot Project on the MIMO Advanced ISDB-T Transmission Test and Evaluation for Brazil TV3.0

SET eXPerience 2021

1.1 Outline of the project

DiBEG in Japan, together with MIC, have conducted trial transmission of the "Physical Layer" of the CfP Ph-2 as a part of the Testing and Evaluation of the TV 3.0.



Proposed Technology "Advanced ISDB-T"

Objectives :

- **Preparation of MIMO Transmission Equipment of Advanced ISDB-T System**
- **Factory Test of MIMO Transmission System in Japan**
- **Technical Support of Laboratory Tests in SPO and Field Tests in Rio**
- **Technical Evaluation of Advanced ISDB-T System for CfP Ph-2**

1.2 Background and Purpose of the project

<Project Background>

SBTVD-F in Brazil announced the requirements for next-generation digital terrestrial broadcasting in 2020. Almost coincidentally Japan was conceptualizing the next-generation digital terrestrial broadcasting technologies called Advanced ISDB-T. DiBEG have decided to join the TV 3.0, together with MIC, based on the research and study results of the Advanced ISDB-T.

<Technical Proposal>

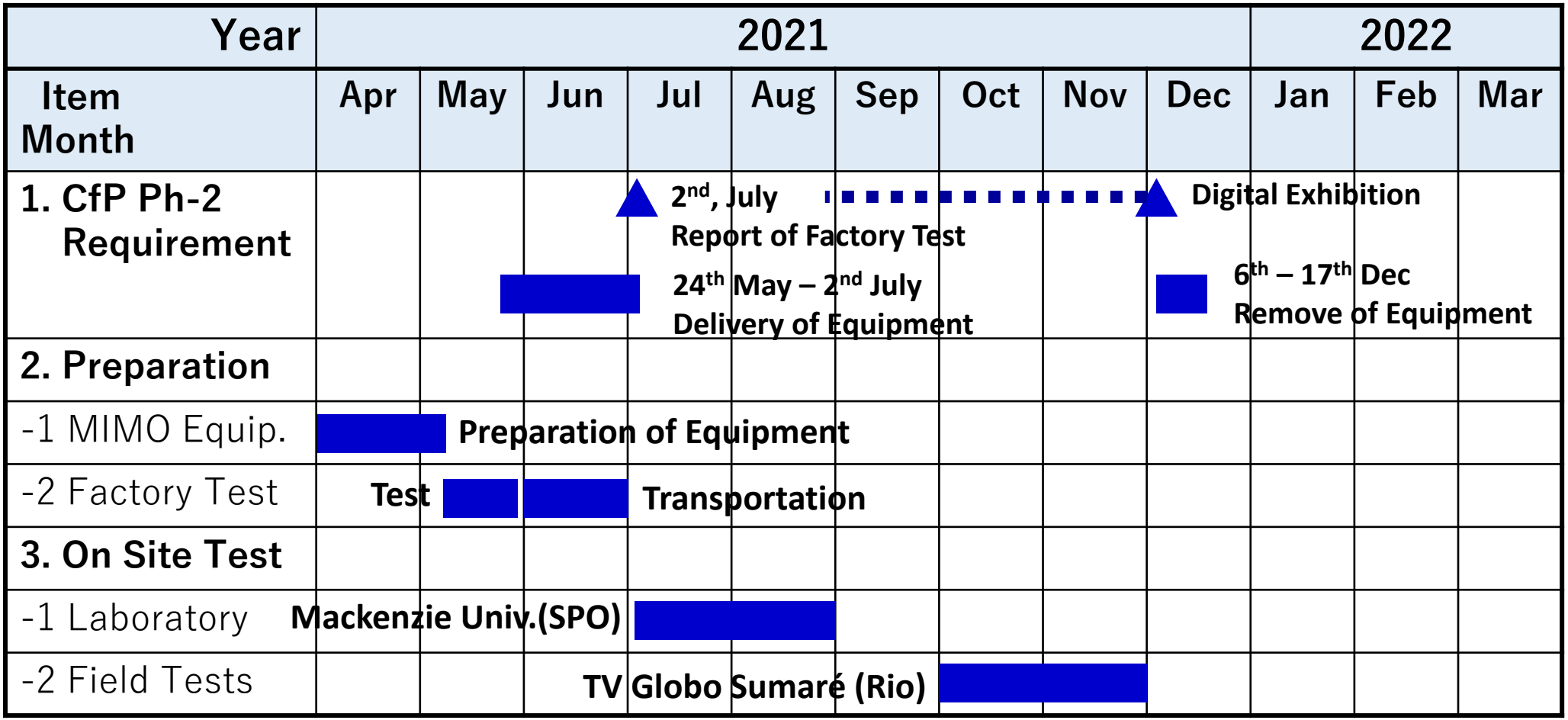
DiBEG had submitted the technical compliance statement on the whole layers of the CfP Ph-1; and also submitted technical proposal on the whole layers of the CfP Ph-2.

<Purpose of the Project>

In the physical layer, DiBEG had prepared a MIMO transmission system on the Advanced ISDB-T and installed a trial transmission system in Brazil. DiBEG will support the laboratory tests and the field tests in Brazil. By supporting these tests, DiBEG believe these activities would surely contribute to the standardization of the digital terrestrial broadcasting of Brazil.

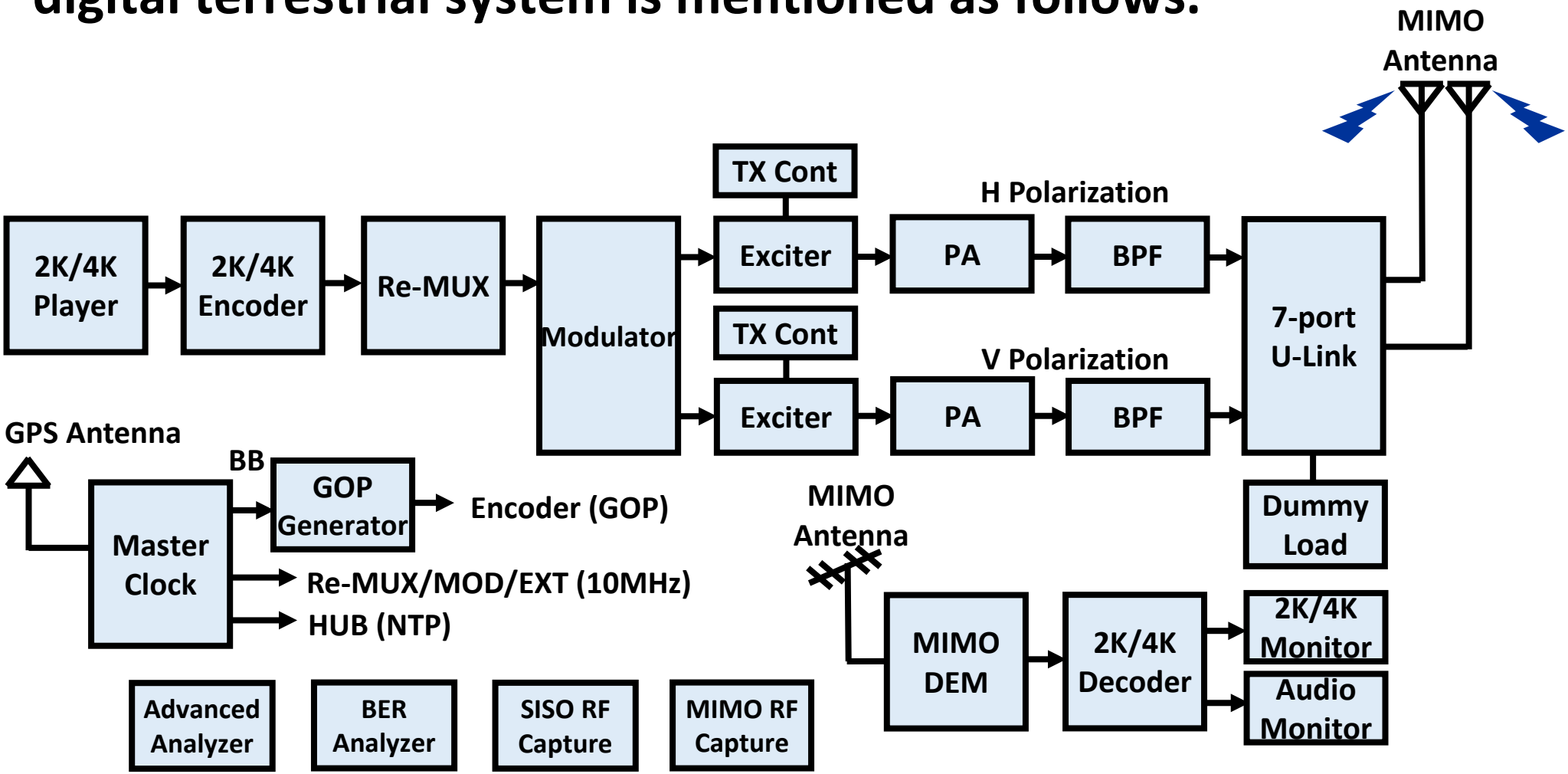
2. Implementation Schedule

DiBEG, jointly with MIC, support the delivery and installation of a trial MIMO Advanced ISDB-T transmission equipment and its testing in Sao Paulo and Rio de Janeiro.



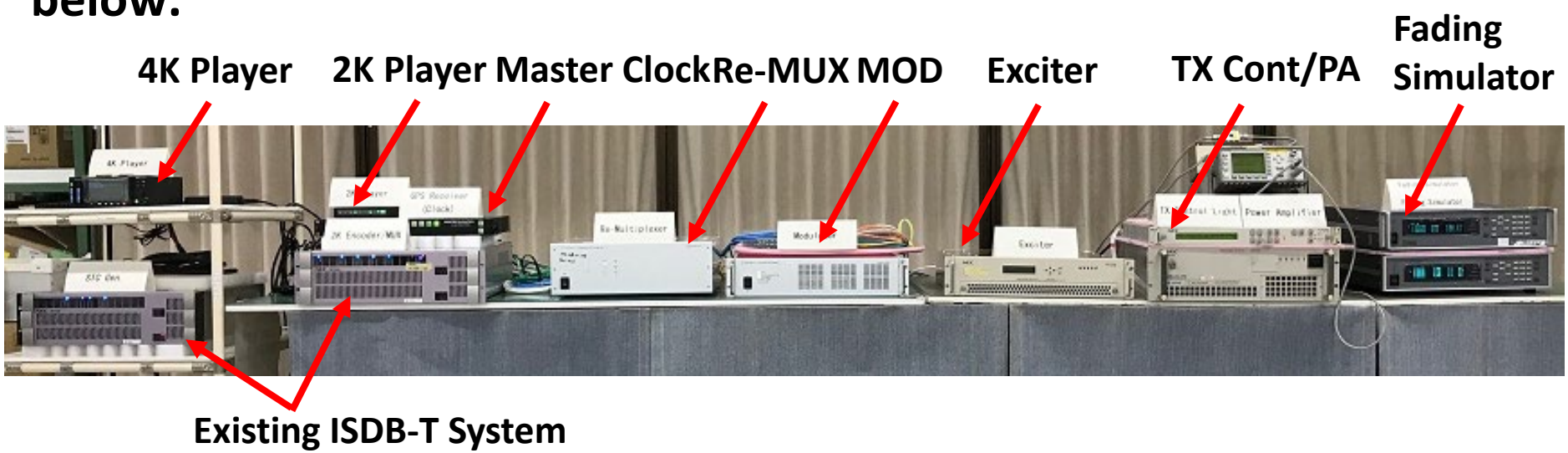
3.1 TX Diagram of MIMO Advanced ISDB-T System

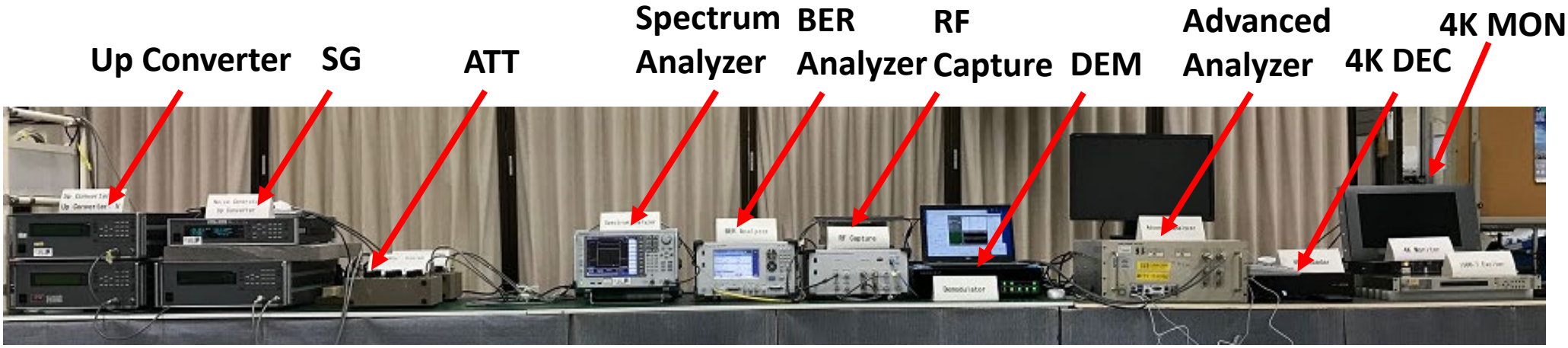
Transmission block diagram of the MIMO Advanced ISDB-T digital terrestrial system is mentioned as follows.



3.2 External View of MIMO Transmission Equipment

The MIMO Advanced ISDB-T transmission system had been tested in Japan before transportation to Brazil. The lineup of equipment is shown below.





4.1 Equipment Composition List

Equipment Composition List of the MIMO Advanced ISDB-T digital terrestrial system is shown below.

No.	Product	Q'ty	No.	Product	Q'ty
1.	2K/4K Player	1set	13.	MIMO Reception Antenna	1set
2.	2K/4K Encoder	1set	14.	4K Monitor	1set
3.	Advanced Re-Multiplexer	1set	15.	Audio Monitor	1set
4.	Advanced Modulator	1set	16.	Master Clock	1set
5.	Advanced Exciter	2sets	17.	GOP Generator	1set
6.	TX Controller	2sets	18.	L2 Switch	1set
7.	Power Amplifier	2sets	19.	Personal Computer	1set
8.	Band Pass Filter	2sets	20.	Advanced Analyzer	1set
9.	U-link Panel	1set	21.	BER Analyzer	1set
10.	Dummy Load	1set	22.	SISO RF Capture	1set
11.	Demodulator	1set	23.	MIMO RF Capture	1set
12.	2K/4K Decoder	1set	24.	Spectrum Analyzer	1set

4.2 Comparison Table

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

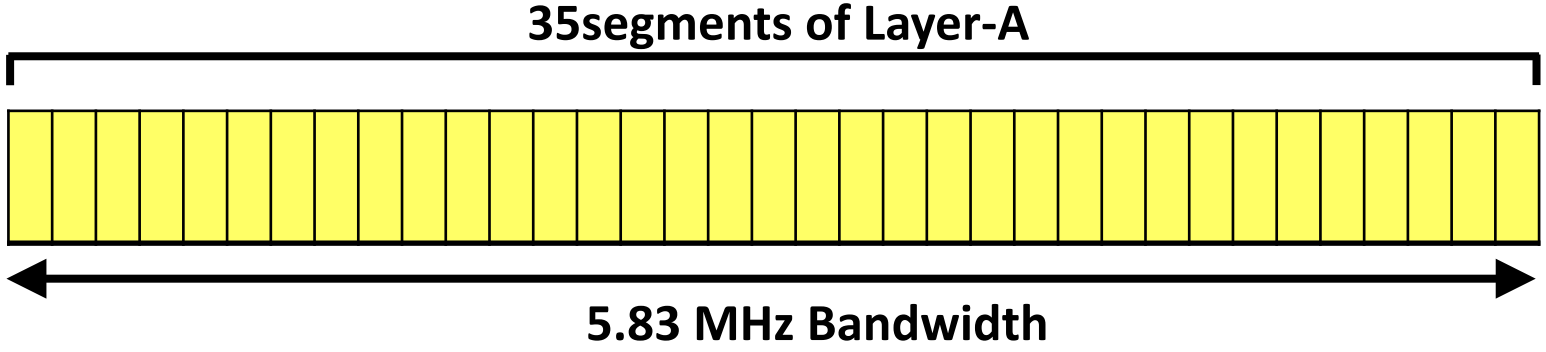
	ISDB-T	SISO Advanced ISDB-T	MIMO Advanced ISDB-T
Video Coding	MPEG-2, MPEG-4	VVC*	VVC*
Speed (Bit rate)	16.0Mbps	Up to 54Mbps@16kFFT	Up to 108Mbps@16kFFT
Program	2K	2K, 4K and 8K	2K, 4K and 8K
Segment Number	13	35	35
Bandwidth	5.57MHz	5.83MHz	5.83MHz
Layer	Layer-A, B, C	Layer-A, B, C, LLch	Layer-A, B, 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.

5.1 Proposed Parameter for TV3.0

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

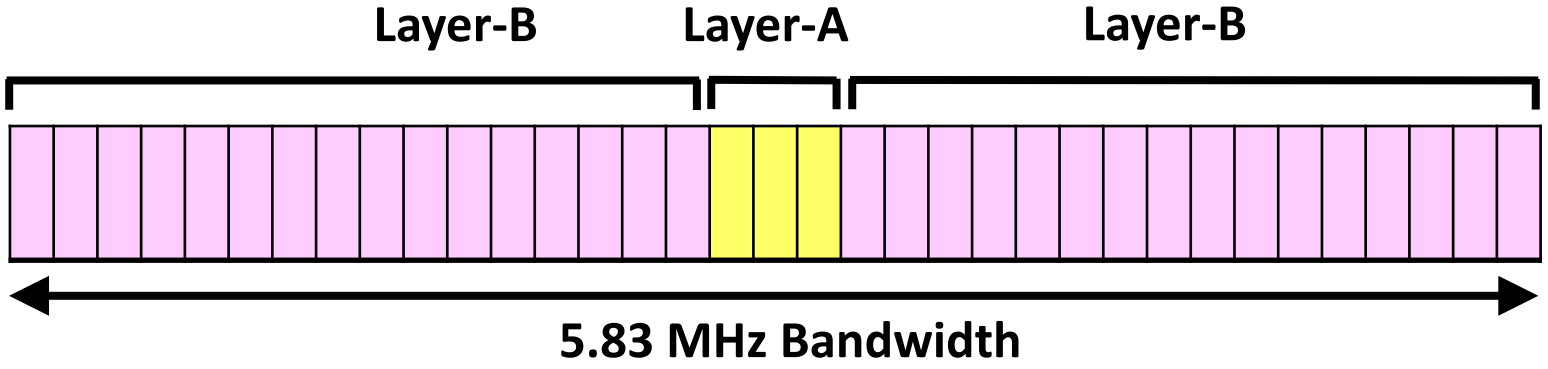
- Modulation : QPSK
- Constellation : Uniform Constellation
- Error correction : LDPC (3/16) + BCH
- FFT : 16k
- GI ratio : 800/16384
- Pilot : Dx=6, Dy=2
- Time Interleave : I=3
- Layer : Layer-A, 35segments
- Program : 2K (1080p), 3.4Mbps



5.2 Parameter for trial 4K transmission

The following transmission parameters were applied to the laboratory tests in Japan. These parameters were used for program content checking through 4K transmission.

- Modulation : 256QAM
- Constellation : Non-Uniform Constellation
- Error correction : LDPC (12/16) + BCH
- FFT : 16k
- GI ratio : 800/16384
- Pilot : Dx=6, Dy=4
- Time Interleave : I=2
- Layer : Layer-B, 32segments
- Program : 4K (2160p), 25Mbps



6.1 Laboratory Test Items for Call for Proposal Ph-2

The following items are measured in Japan in accordance with CfP procedure.

-1) RF Frequency Accuracy
-2) Phase noise and Spectrum
-3) RF/IF signal power
-4) RF out of band emissions & linearity characterization (Spectrum Mask)
-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

6.2 Evaluation of Laboratory Tests in Japan

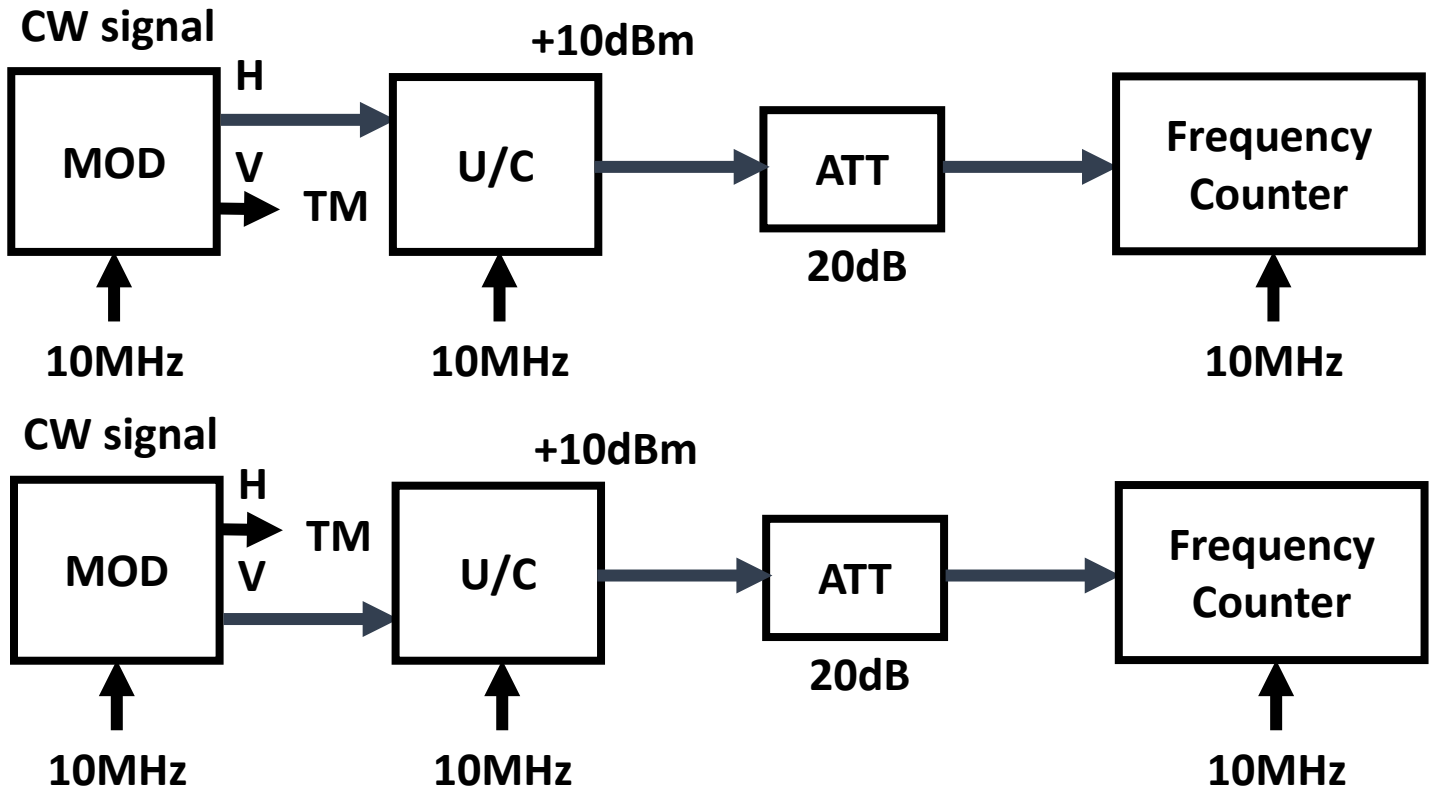
The Advanced ISDB-T satisfied most of the required specifications. The summary of the measuring results are shown below, with detailed measuring results in our laboratory tests;

<Summary of Measuring Results>

- **Transmission Frequencies applied: VHF and UHF bands.**
- **Frequency bandwidth applied: 6MHz bandwidth.**
- **Gaussian noise: measured and confirmed C/N≦0.**
- **Rayleigh Fading : measured at 3km/h and 70km/h with 16k FFT size. Advanced ISDB-T: applied 120km/h with 8k FFT size.**
- **Co-channel and adjacent channel interference to Advanced ISDB-T were measured. Advanced ISDB-T satisfied the required D/U.**
- **Tests on channel bonding, wake-up and extensibility will be conducted in the near future.**

7.-1) 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.



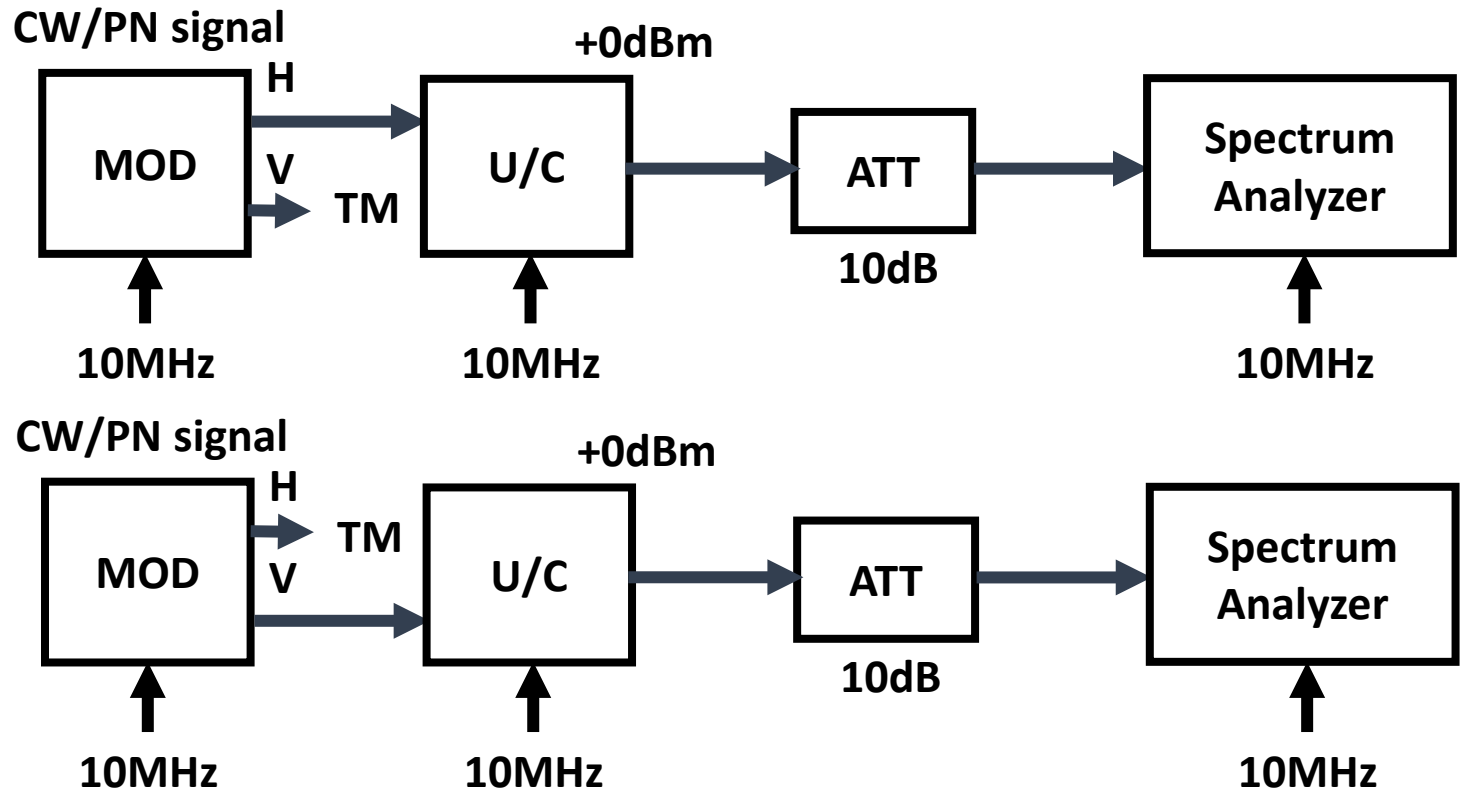
7.-1) RF Frequency Accuracy

Measuring table is mentioned as follows.

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

7.-2) 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.



7.-2) Phase noise and Spectrum

Measuring table is mentioned as follows.

Channel	H/V	Measured Frequency	Spectrum (Photo)	Remarks
10 (192-198MHz)	H	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)	H	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)	H	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.**

7.-2) Phase noise and Spectrum

Measuring photos are mentioned as follows.

6.2.1

6.2.2

6.2.3

6.2.4

6.2.5

6.2.6

6.2.7

6.2.8

7.-2) Phase noise and Spectrum

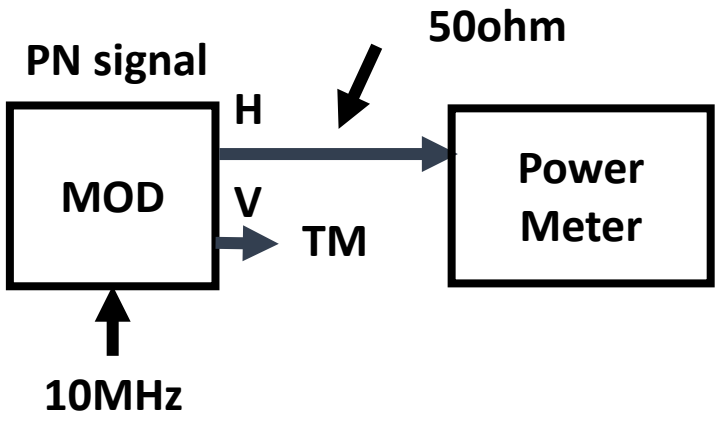
Measuring photos are mentioned as follows.

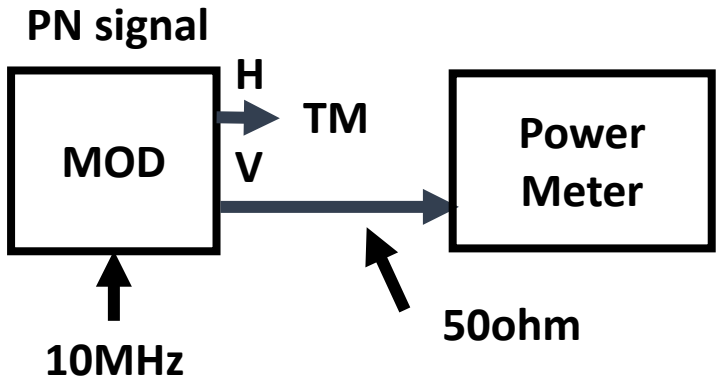
6.2.9

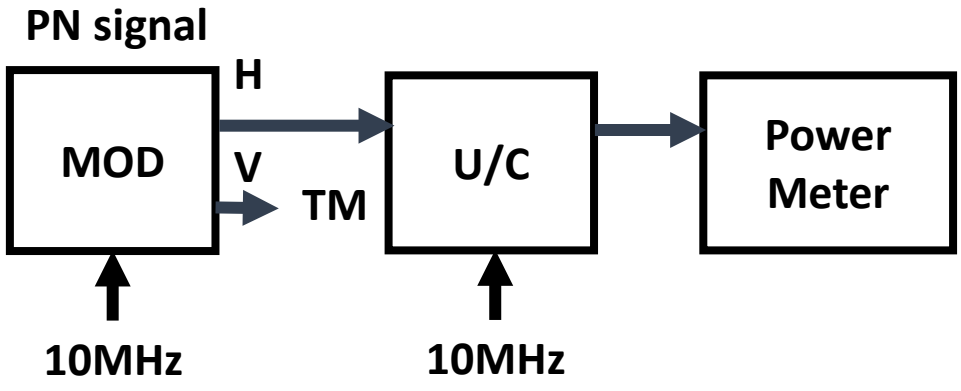
6.2.10

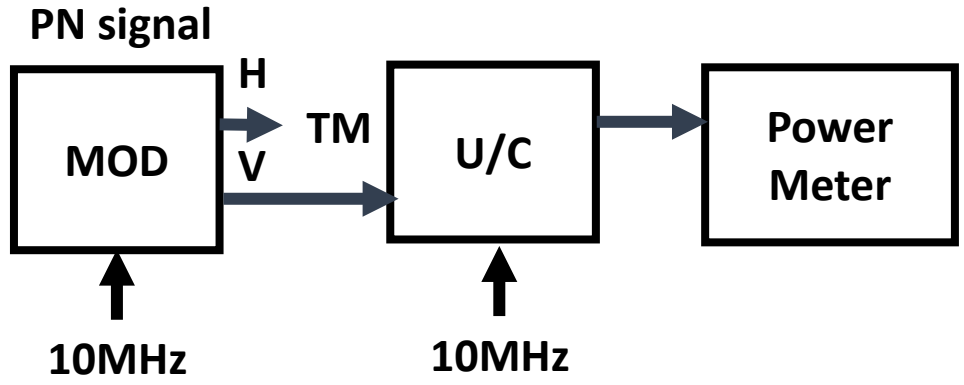
7.-3) RF/IF signal power

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.









7.-3) RF/IF signal power

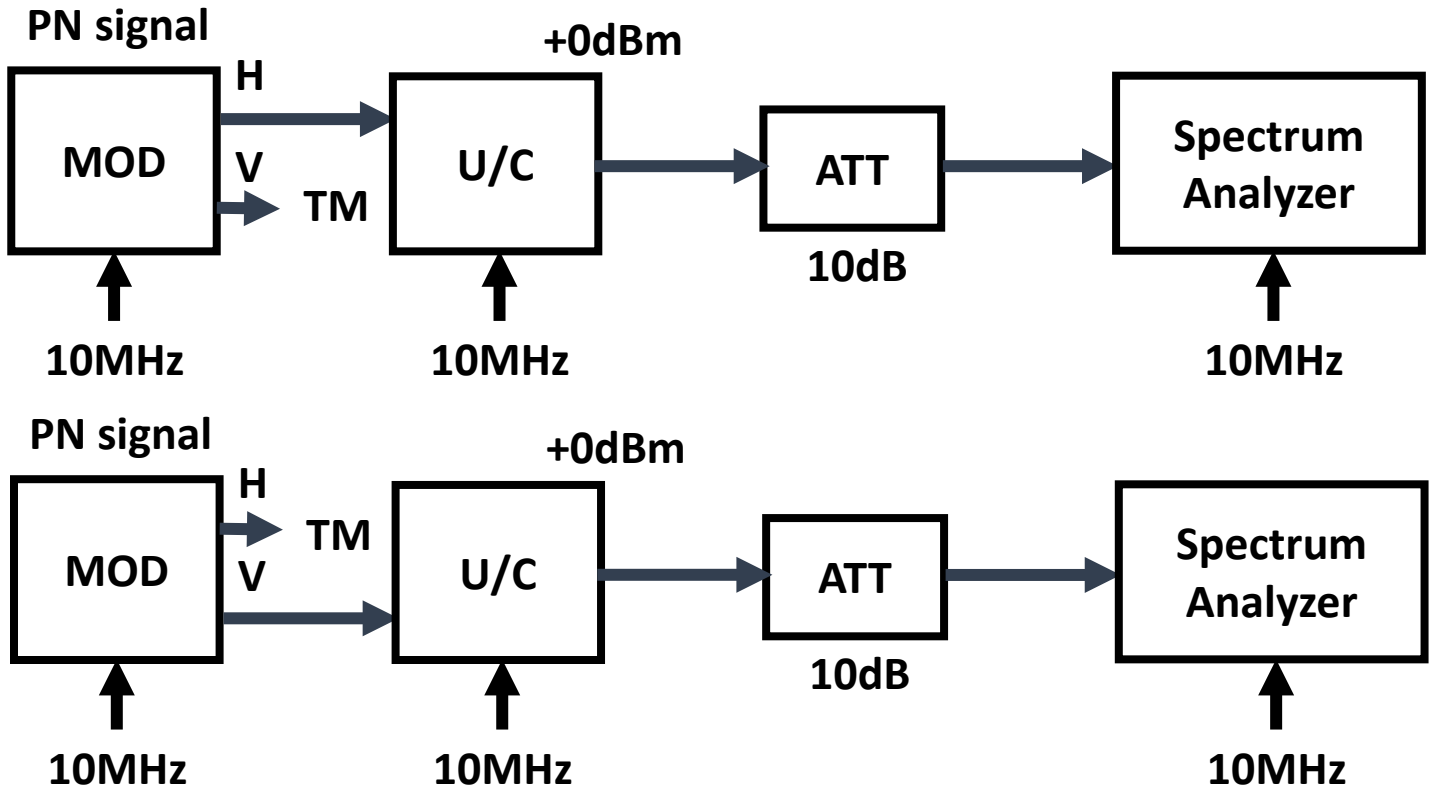
Measuring table is mentioned as follows.

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

*** Exciter output level is +6dBm.**

7.-4) RF out of band emissions and linearity characterization (Spectrum Mask)

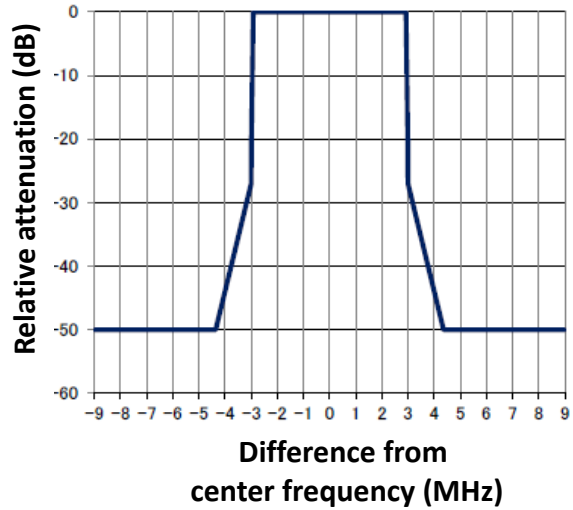
The spectrum was measured under the MOD-H and MOD-V output conditions. U/C was applied to the Ch-10 and 33 measurements.
The Advanced ISDB-T exciter was tuned to Ch-30.
Refer to ITU-R SM.1541-6 Annex.6.



7.-4) 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)	H	Refer to 6.4.1	By MOD
ditto	V	Refer to 6.4.2	Ditto
10 (192-198MHz)	H	Refer to 6.4.3	By U/C
ditto	V	Refer to 6.4.4	Ditto
33 (584-590MHz)	H	Refer to 6.4.5	Ditto
ditto	V	Refer to 6.4.6	Ditto
30 (566-572MHz)	H	Refer to 6.4.7	By Exciter
ditto	V	N/A	Ditto



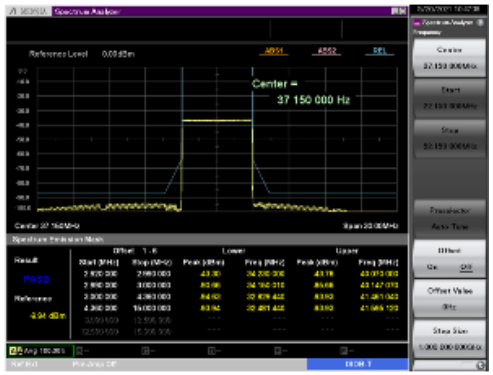
Difference from center frequency (MHz)	Relative attenuation (dB)
-4.36	-50
-3.00	-27
-2.99	-20
-2.92	0
+2.92	0
+2.99	-20
+3.00	-27
+4.36	-50

* 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

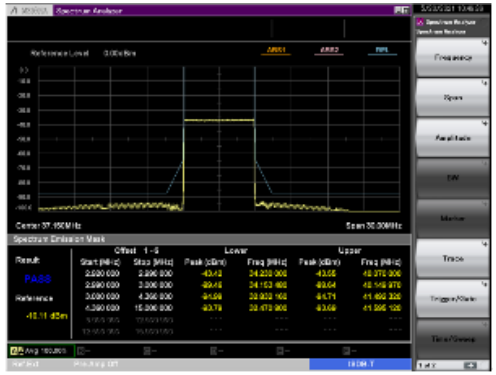
7.-4) RF out of band emissions and linearity characterization (Spectrum Mask)

Measuring photos are mentioned as follows.

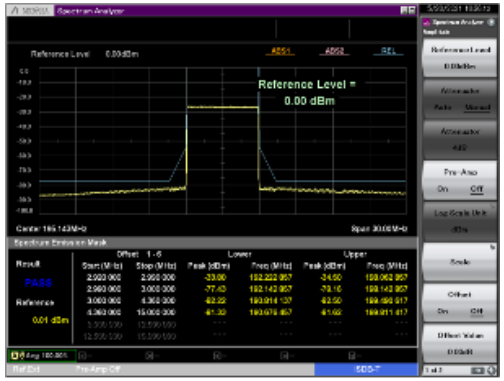
6.4.1



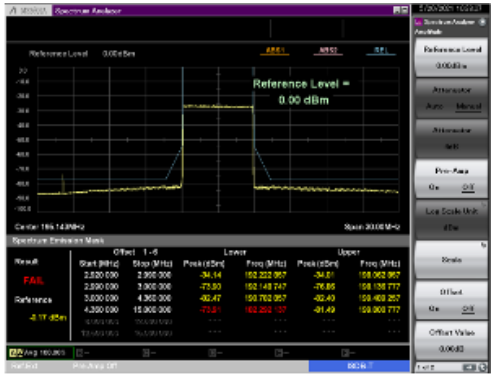
6.4.2



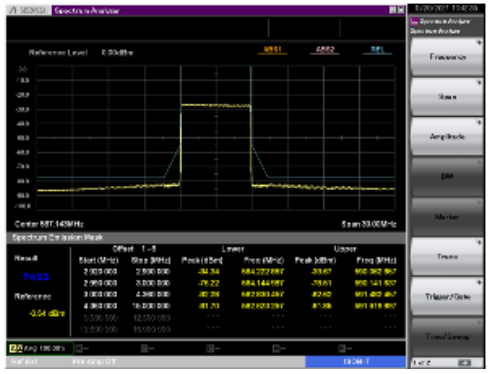
6.4.3



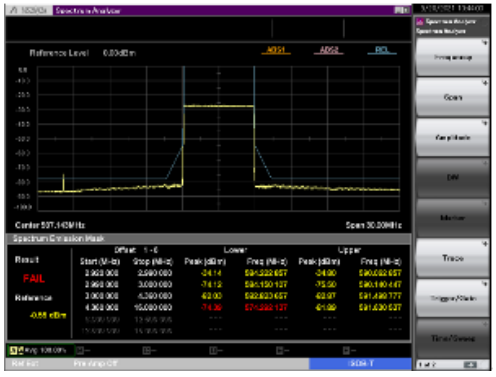
6.4.4



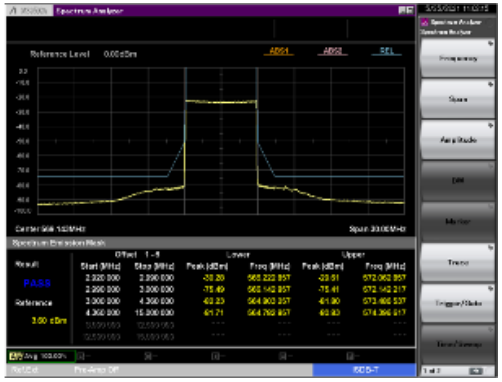
6.4.5



6.4.6

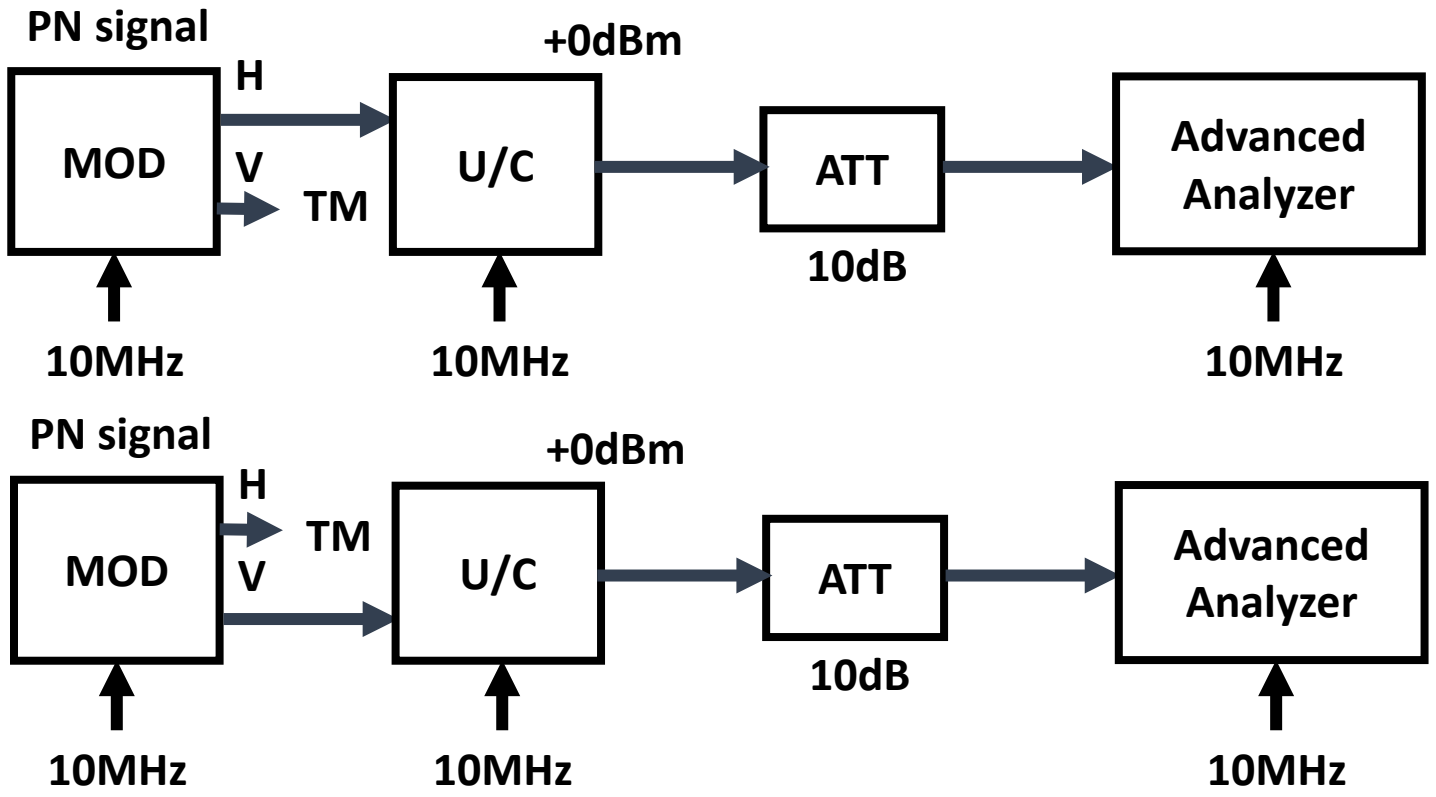


6.4.7



7.-5) I/Q analysis – Constellation and MER

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



7.-5) I/Q analysis – Constellation and MER

Measuring table is mentioned as follows.

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

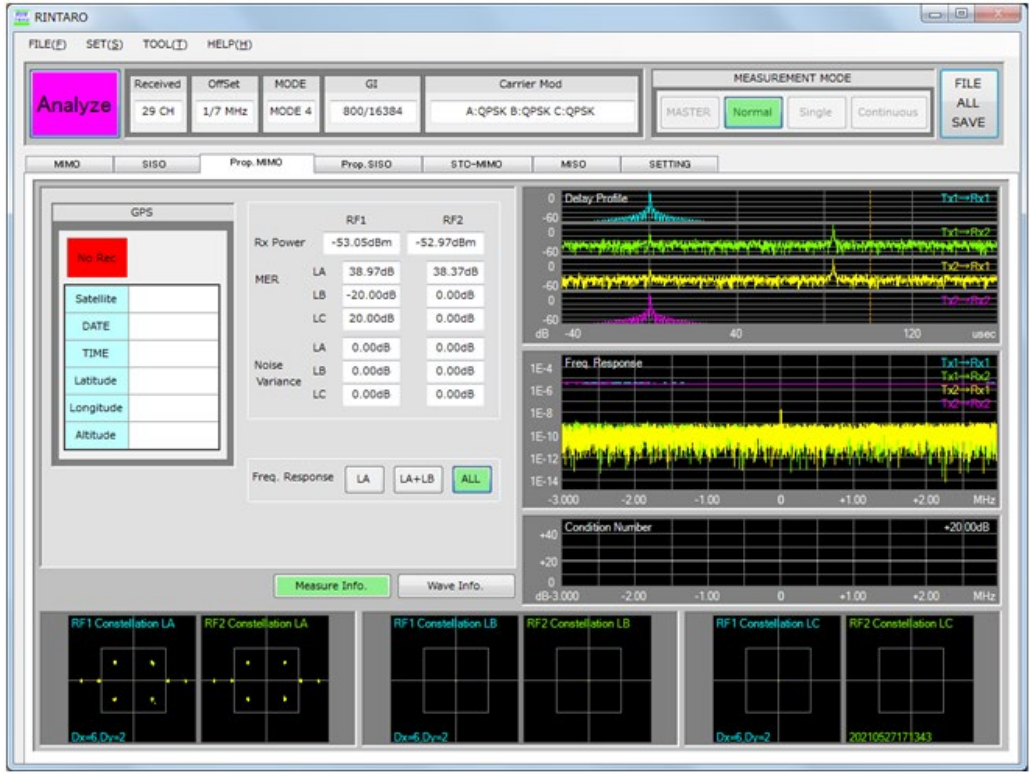
*** Advanced Analyzer can't measure VHF band.**

7.-5) I/Q analysis – Constellation and MER

Measuring photos are mentioned as follows.

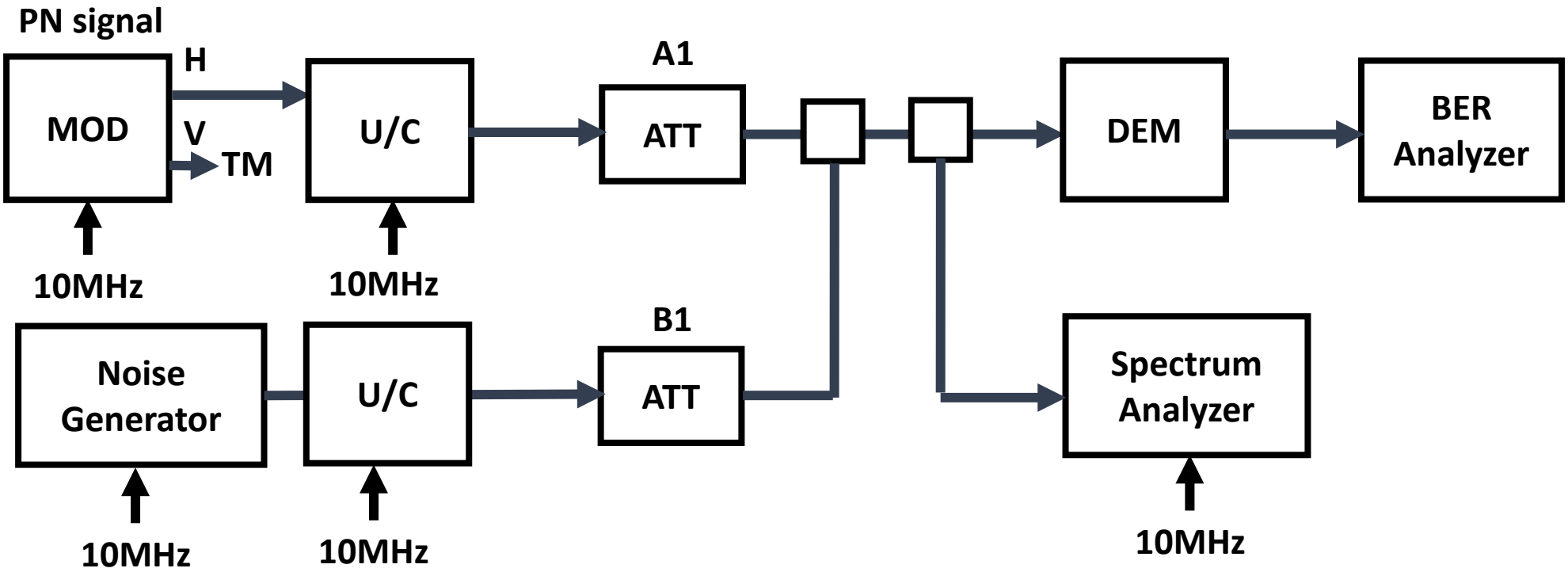
6.5.1

6.5.2



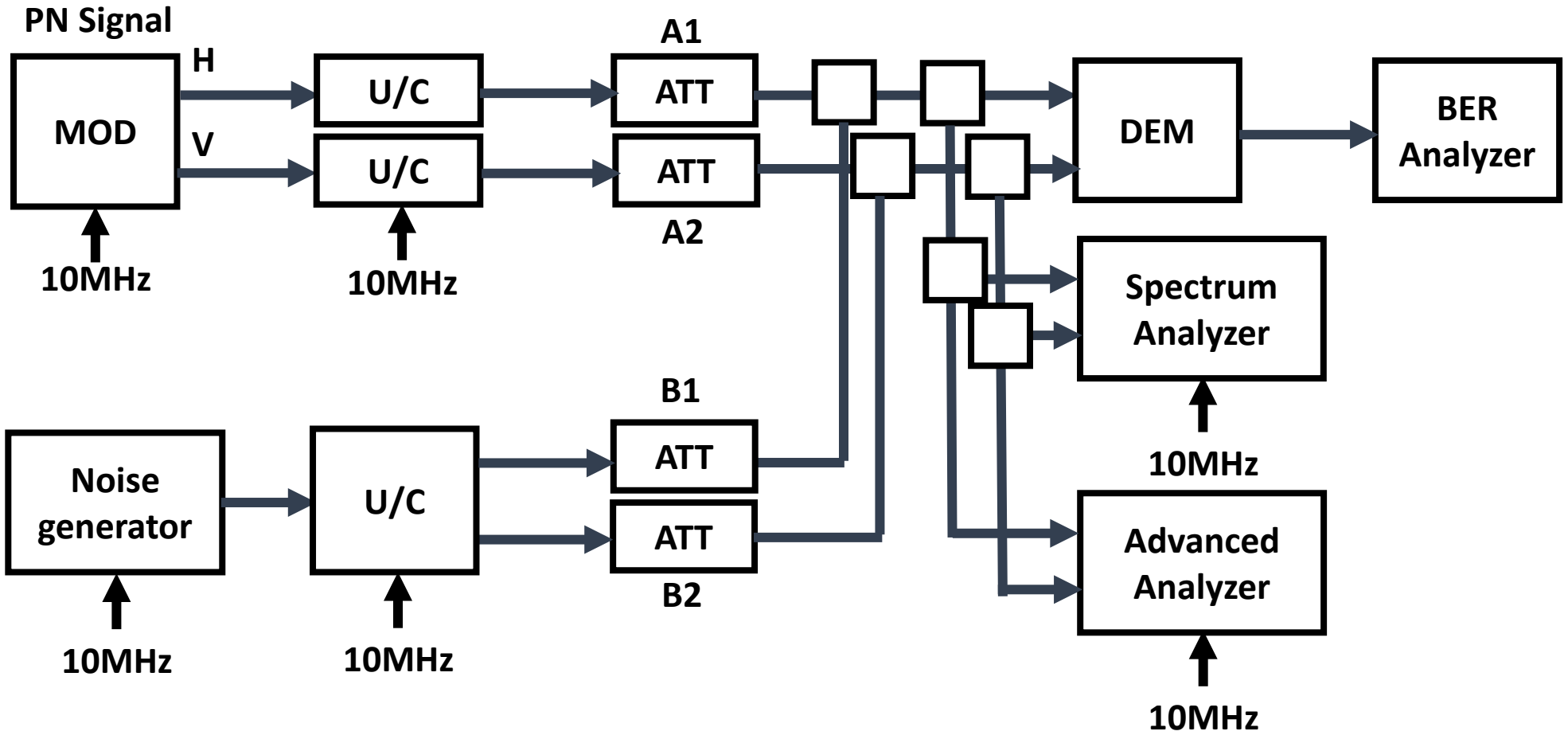
7.-6) C/N - Carrier power vs AWGN by SISO and MIMO

C/N≦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.



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

C/N≦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.



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

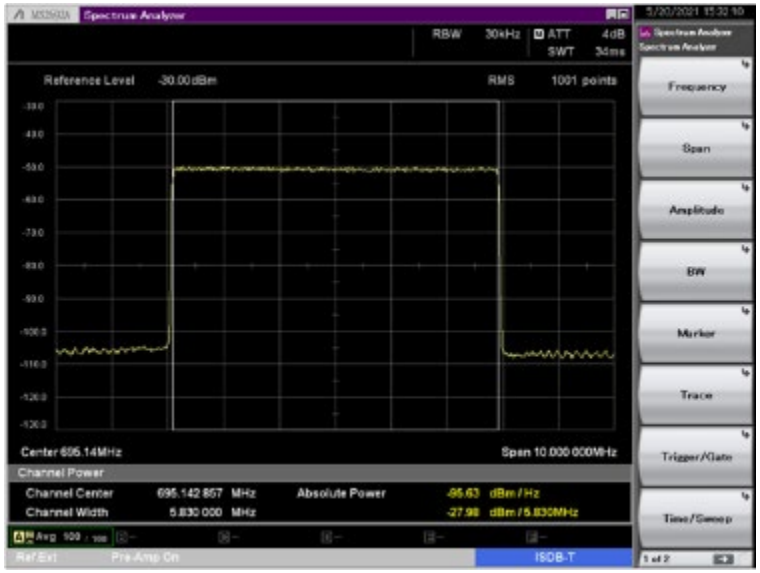
Measuring table of SISO and MIMO is mentioned as follows.

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

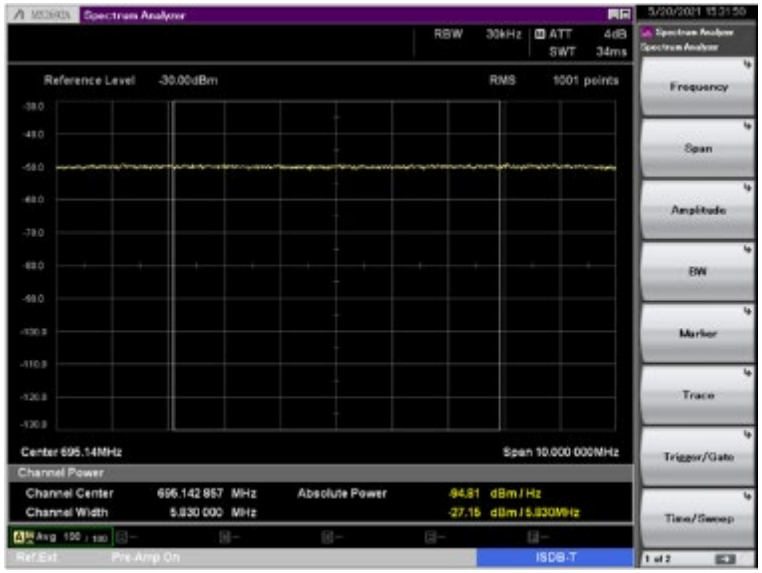
7.-6) C/N - Carrier power vs AWGN by SISO and MIMO

C/N is measured -28dBm input at DEM at Ch-51. This is minimum C/N level.

Main H(C)

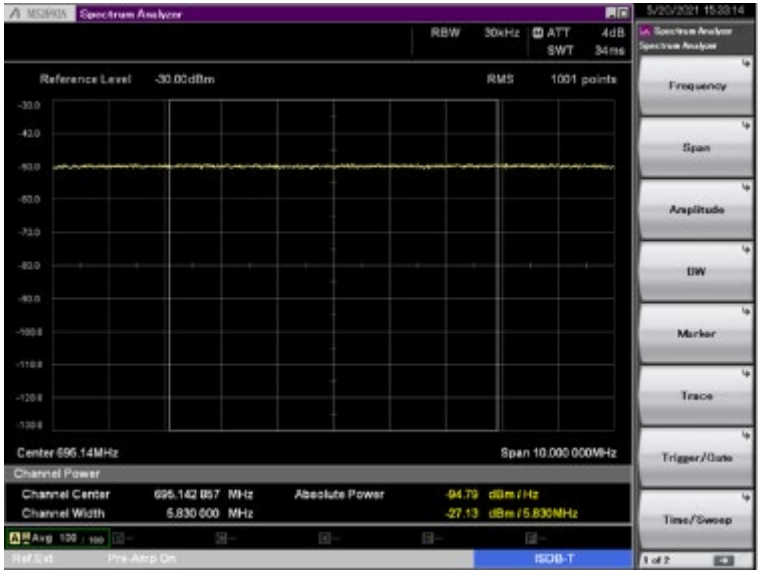


Noise H(N)



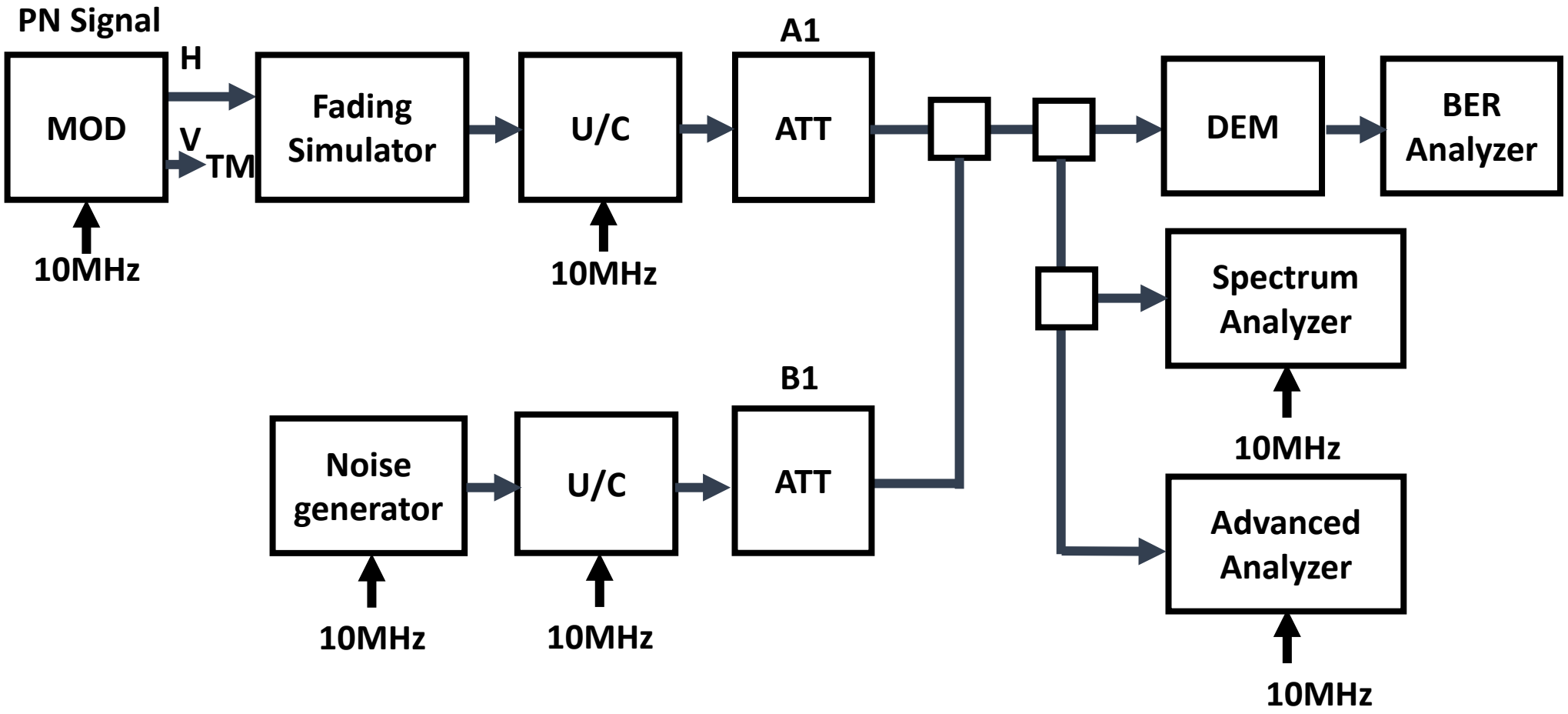
Main V(C)

Noise V(N)



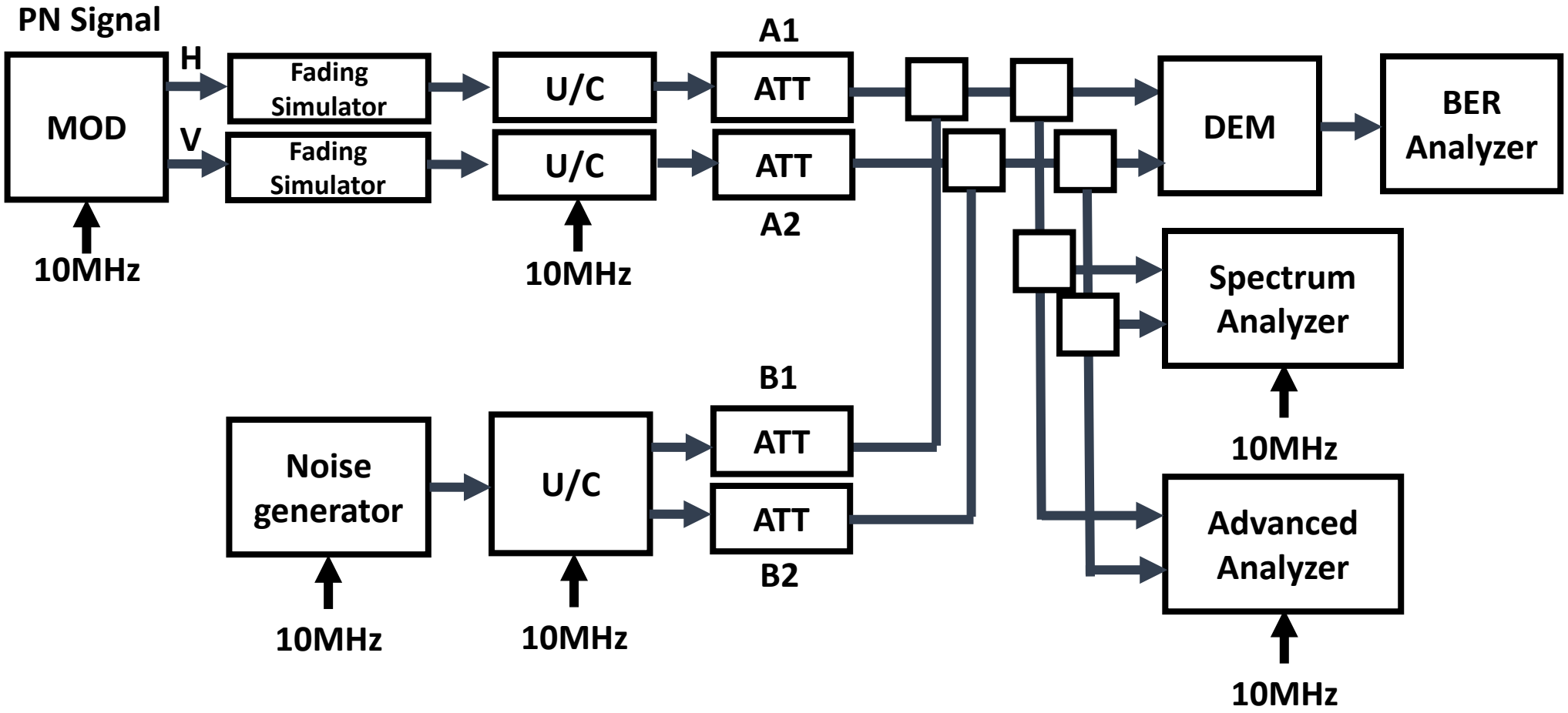
7.-7) C/N - Carrier power vs Rayleigh and AWGN by SISO and MIMO

C/N≦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.



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

C/N≦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.



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

1) Fading Simulator of 4410A (Eiden) was utilized in Japan.

2) We measured at 70km/h for FR3A/B. Each phase (Hz) was calculated as follows.

3) For SISO measurements, we applied RF1 and RF3A (70km/h).

4) For MIMO measurements, we applied RF2A/B and RF 3A/B (70km/h).

Ch.	Ch-7	Ch-10	Ch-13	Ch-14	Ch-30	Ch-33	Ch-51
UHF Frequency	177.142857 Hz	195.142857	213.142857	473.142857	569.142857	587.142857	695.142857
λ	1.69354839 m	1.53733529	1.4075067	0.63405797	0.52710843	0.51094891	0.43156597
speed=3km/h	0.5 Hz	0.6	0.6	1.4	1.6	1.7	2
speed=120km/h	19.7 Hz	21.7	23.7	52.6	63.3	65.3	77.3
speed=70km/h	11.5 HZ	12.7	13.9	30.7	36.9	38.1	45.1

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

5) Channel Ensemble used for the test

Table 1: Channel Ensemble RF1 – Single path Rayleigh

Reference	Channel Model Designation	Fading Simulator Set Up							Remarks
RF1	Single Path Rayleigh	Speed of 3 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.							
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**	
		Profile	Doppler	N/A	N/A	N/A	N/A	N/A	
		Path Loss (dB)	0	N/A	N/A	N/A	N/A	N/A	
		Delay (µs)	0	N/A	N/A	N/A	N/A	N/A	
		Phase (Hz)	TBC	N/A	N/A	N/A	N/A	N/A	

Table 2: Channel Ensemble RF2A – Outdoor to Indoor or Pedestrian A

Reference	Channel Model Designation	Fading Simulator Set Up							Remarks
RF2A	Outdoor to Indoor or Pedestrian A	Speed of 3 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.							ITU-R M.1225
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**	
		Profile	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	
		Path Loss (dB)	0.0	-9.7	-19.2	-22.8	N/A	N/A	
		Delay (µs)	0.00	0.11	0.19	0.41	N/A	N/A	
		Phase (Hz)	TBC	TBC	TBC	TBC	N/A	N/A	

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

6) Channel Ensemble used for the test

Table 3: Channel Ensemble RF2B – Outdoor to Indoor or Pedestrian B

Reference	Channel Model Designation	Fading Simulator Set Up						Remarks
RF2B	Outdoor to Indoor or Pedestrian B	Speed of 3 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.						ITU-R M.1225
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**
		Profile	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
		Path Loss (dB)	0.0	-0.9	-4.9	-8.0	-7.8	-23.9
		Delay (µs)	0.00	0.20	0.80	1.20	2.30	3.70
		Phase (Hz)	TBC	TBC	TBC	TBC	TBC	TBC

Table 4: Channel Ensemble RF 3A – Vehicular A

Reference	Channel Model Designation	Fading Simulator Set Up						Remarks
RF3A	Vehicular A	Speed of 120 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.						ITU-R M.1225
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**
		Profile	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
		Path Loss (dB)	0.0	-1.0	-9.0	-10.0	-15.0	-20.0
		Delay (µs)	0.00	0.31	0.71	1.09	1.73	2.51
		Phase (Hz)	TBC	TBC	TBC	TBC	TBC	TBC

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

7) Channel Ensemble used for the test

Table 5: Channel Ensemble RF 3B – Vehicular B

Reference	Channel Model Designation	Fading Simulator Set Up							Remarks
RF3B	Vehicular B	Speed of 120 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.							ITU-R M.1225
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**	
		Profile	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	
		Path Loss (dB)	-2.5	0.0	-12.8	-10.0	-25.2	-16.0	
		Delay (µs)	0.0	0.3	8.9	12.9	17.1	20.0	
		Phase (Hz)	TBC	TBC	TBC	TBC	TBC	TBC	

Table 6: Channel Ensemble RF4 – Modified Typical Urban 6

Reference	Channel Model Designation	Fading Simulator Set Up							Remarks
RF4	Modified Typical Urban 6	Speed of 120 Km/h at RF - Doppler in Hz depending on the RF frequency - round up value in Hz for first decimal.							COST 207
			Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**	
		Profile	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	
		Path Loss (dB)	- 3.0	0.0	- 2.0	- 6.0	- 8.0	-10.0	
		Delay (µs)	0.0	0.2	0.5	1.6	2.3	5.0	
		Phase (Hz)	TBC	TBC	TBC	TBC	TBC	TBC	

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

Measuring table of SISO and MIMO is mentioned as follows.

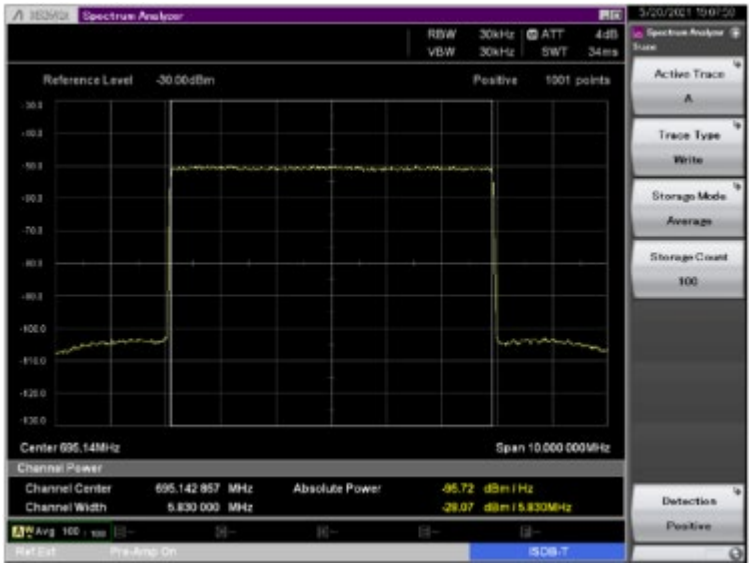
RF3A/B is applied 70km/h

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

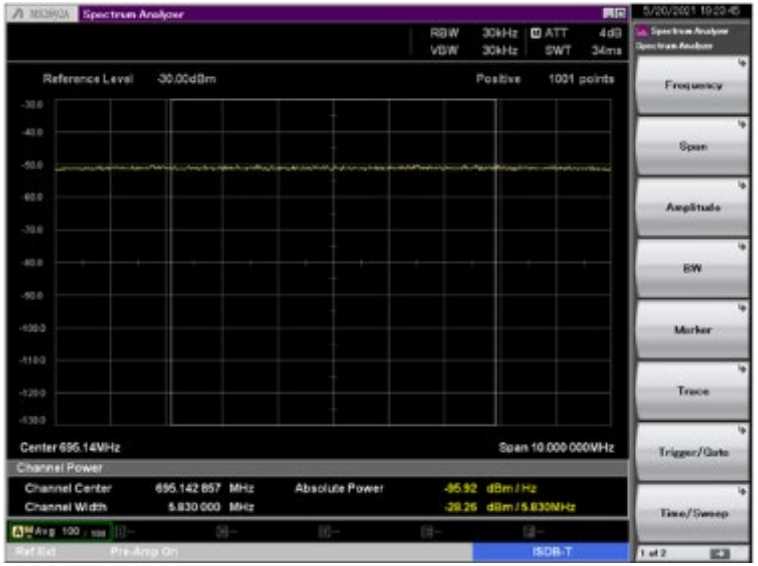
7.-7) C/N - Carrier power vs Rayleigh and AWGN by SISO and MIMO

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

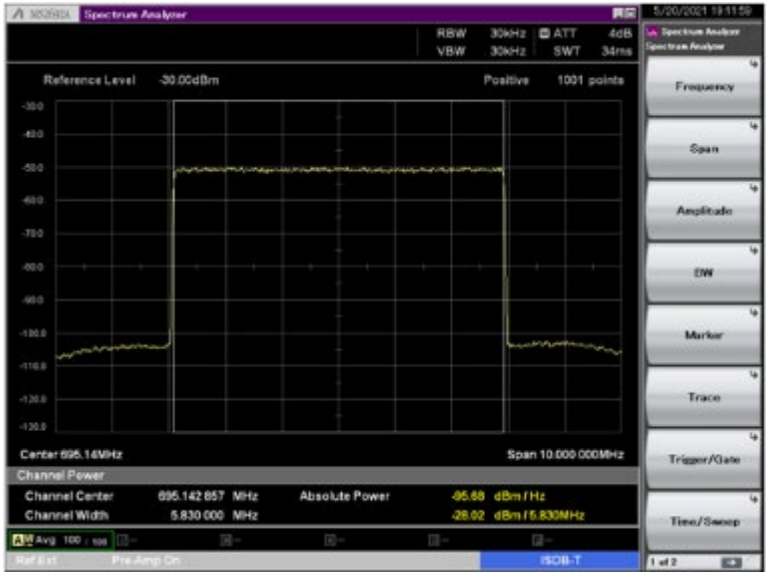
Main H(C)



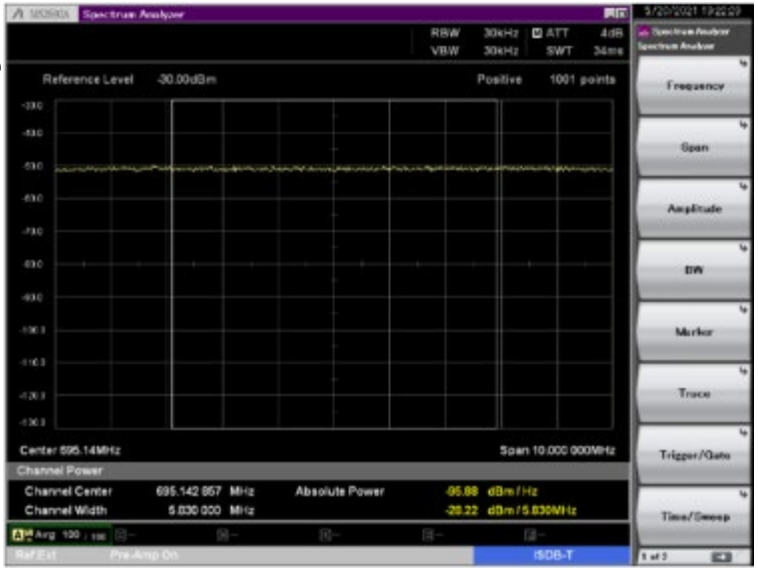
Noise H(N)



Main V(C)

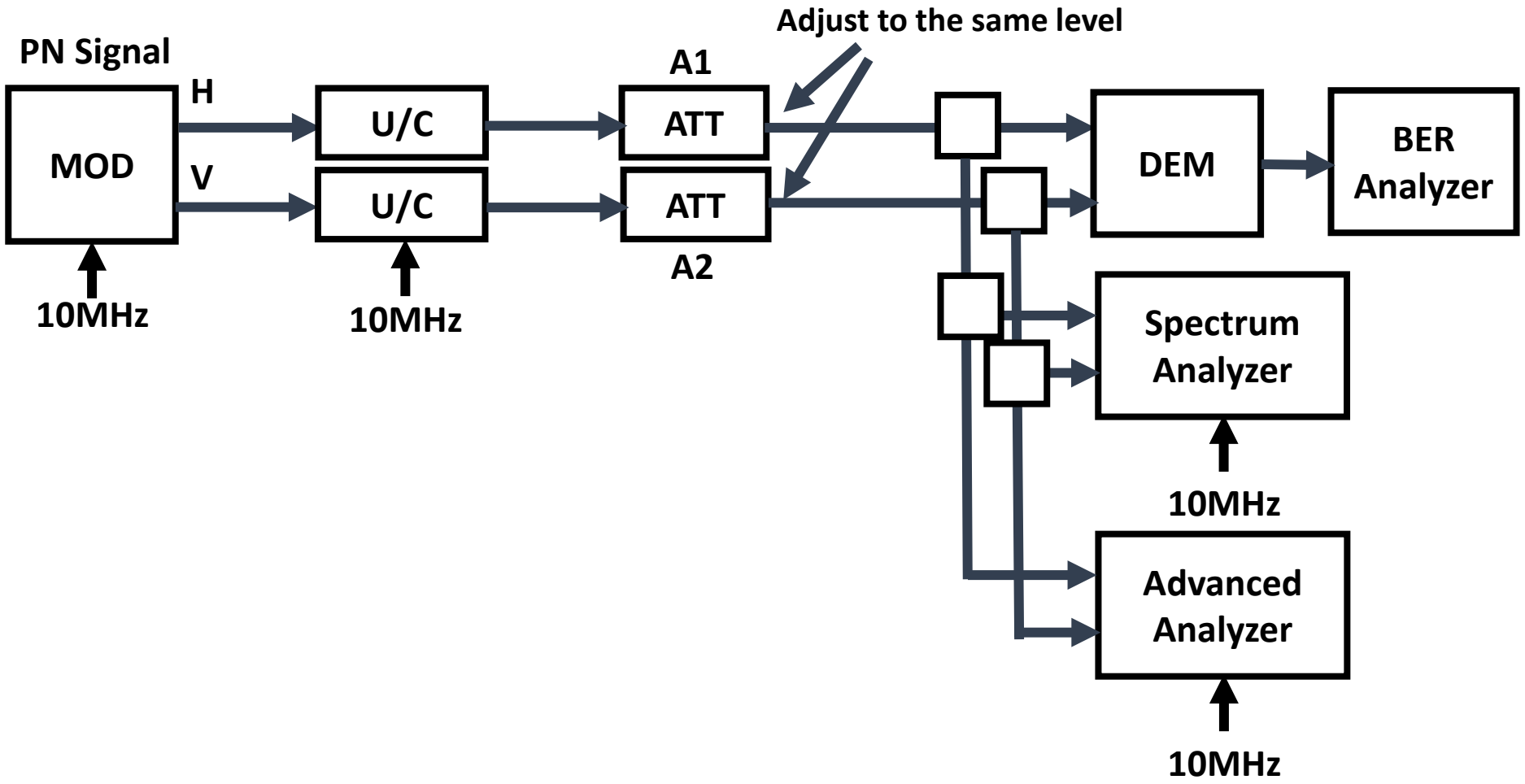


Noise V(N)



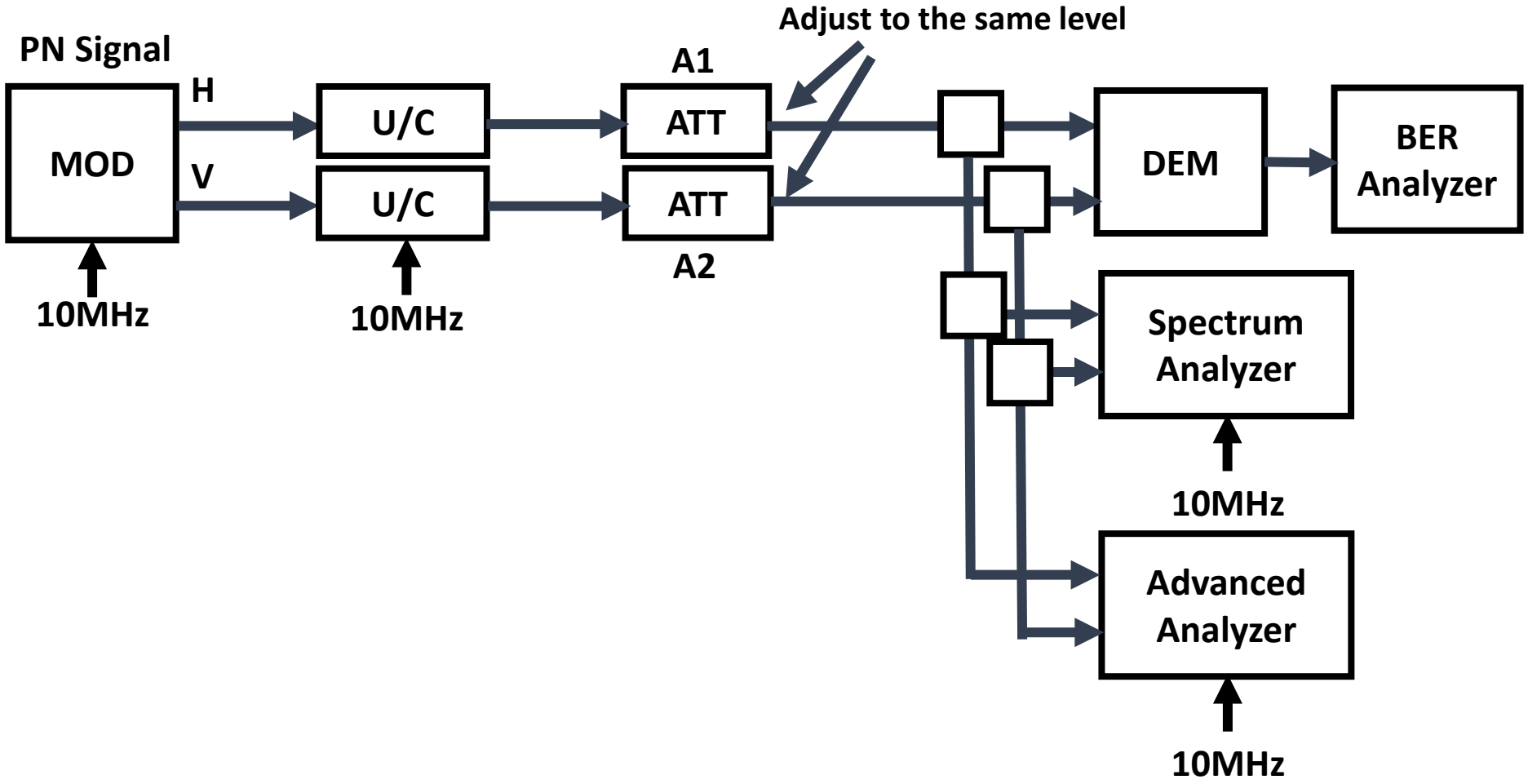
7.-8) Receiver maximum and minimum level by SISO

Max. and Min. reception levels were measured under the SISO condition by 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.



7.-8) 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.



7.-8) Receiver maximum and minimum level by SISO and MIMO

Measuring table of SISO and MIMO is mentioned as follows.

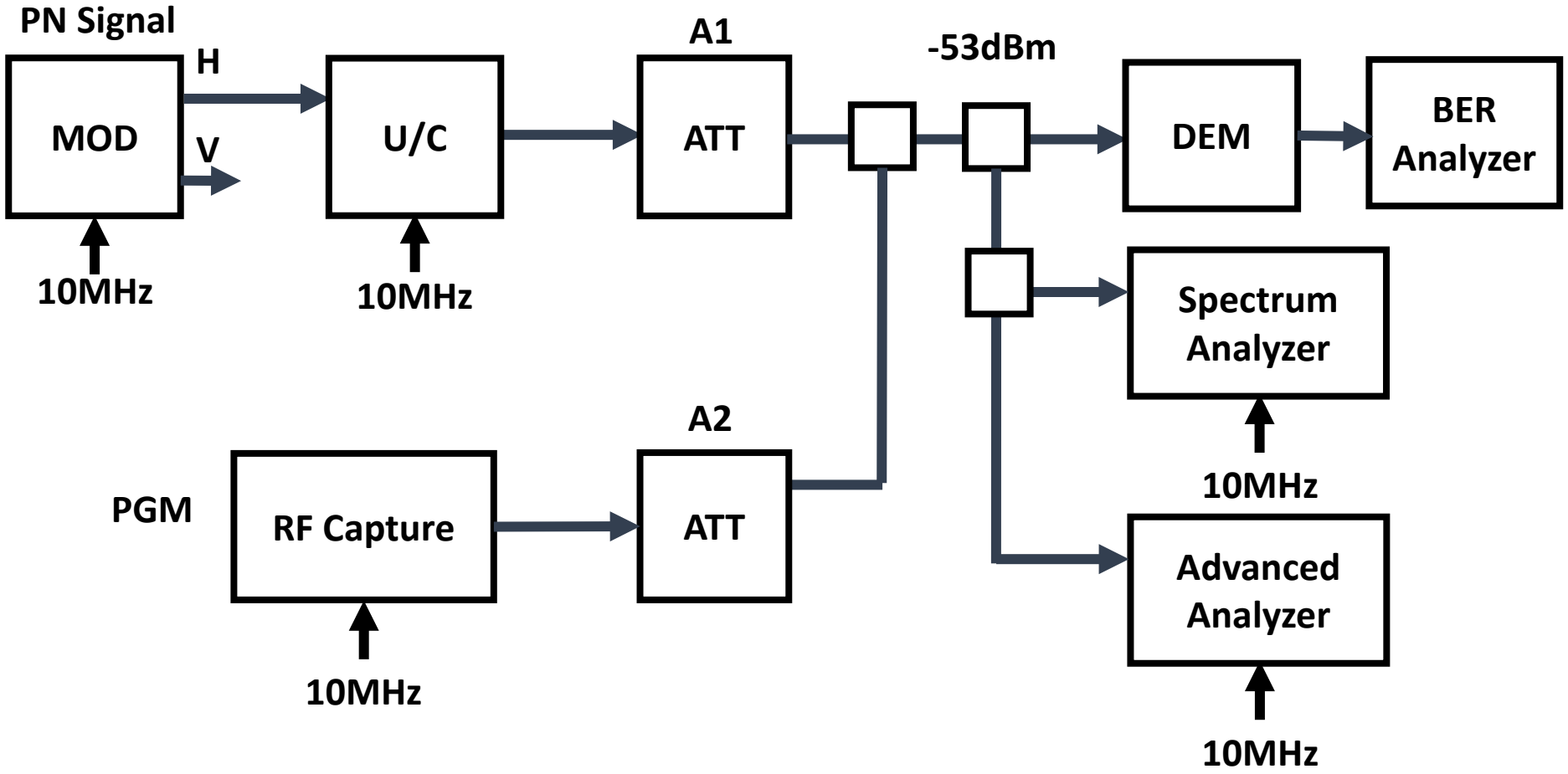
Ch.	SISO Max Level	SISO Min Level	MIMO Max Level H / V	MIMO Min Level H / V	Remarks
Ch-7					By U/C
Ch-13	>-14dBm	<-95dBm	>-14dBm / >-14dBm	<-95dBm / <-95dBm	Ditto
Ch-14					Ditto
Ch-33					Ditto
Ch-51	>-16dBm	<-95dBm	>-16dBm />-16dBm	<-95dBm / <-95dBm	Ditto
Ch-30	>-16dBm	<-95dBm	>-16dBm />-16dBm	<-95dBm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

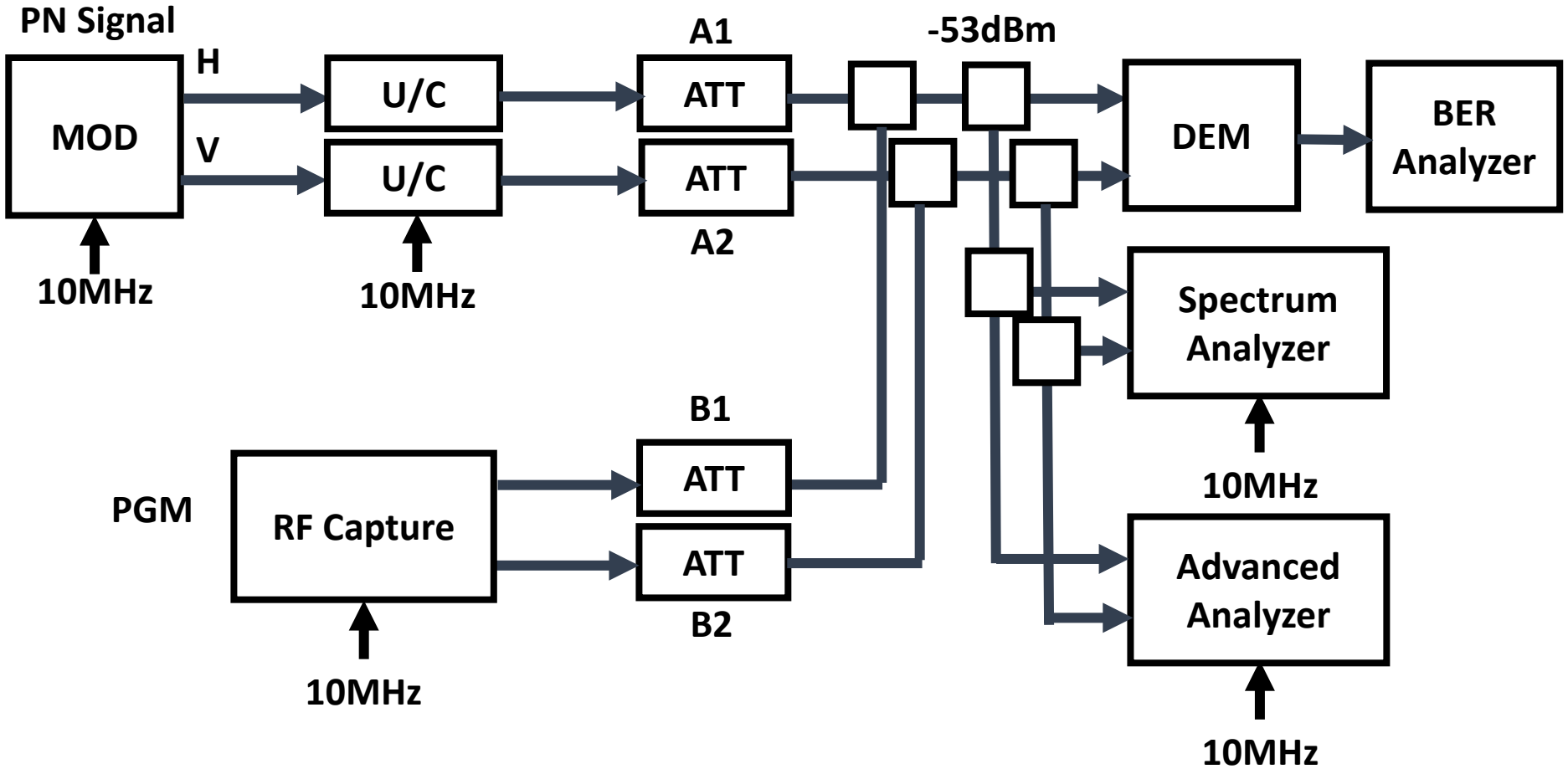
7.-9) Co-channel Interference with own system by SISO

The co-channel interference was measured under the SISO 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.



7.-9) 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.



7.-9) Co-channel Interference with own system by SISO and MIMO

SISO

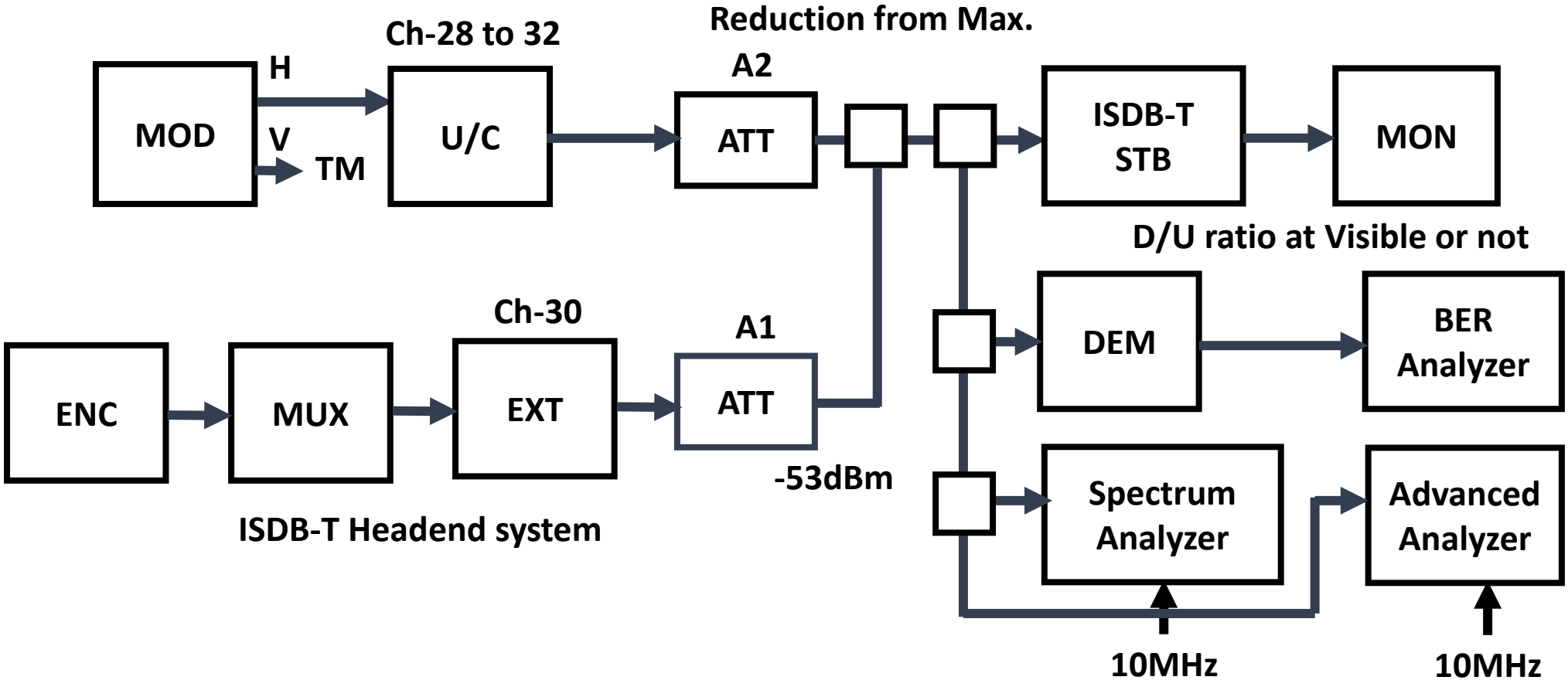
Ch.	D/U (dB) Synchronization	D/U (dB) Un-synchronization	Remarks
Ch-10	N/A	1.3dB	By U/C
Ch-33	N/A	0.6dB	ditto
Ch-30	N/A	1.2dB	ditto

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

7.-10) 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.



7.-10) Co-channel and adjacent channel interference to ISDB-T by SISO

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

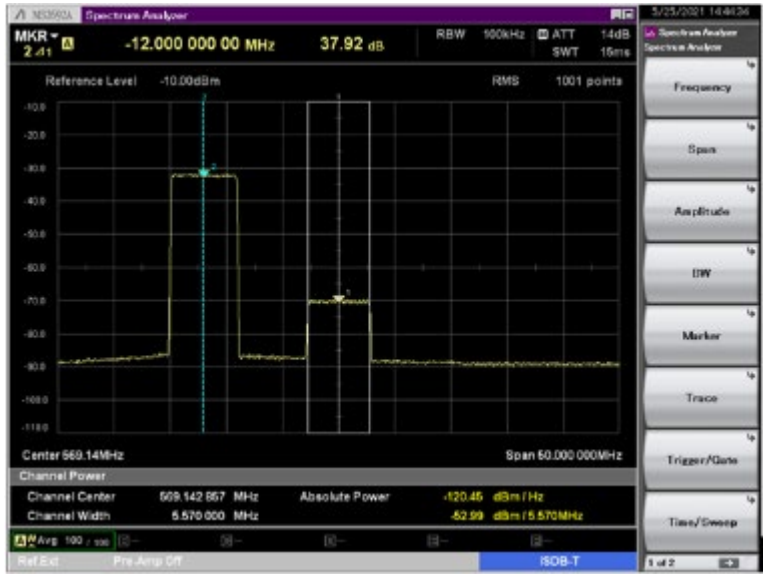
Protection Ratio D/U (dB)			Remarks
Desired Channel	Interference Channel	Receiver D/U (dB)	
VHF ISDB-T: Ch-10	Ch-8	N/A	
	Ch-9	N/A	
	Ch-10	N/A	
	Ch-11	N/A	
	Ch-12	N/A	
UHF ISDB-T: Ch-30	Ch-28	<-38dB*	Refer to 6.10.1
	Ch-29	-35.6dB	
	Ch-30	17,6dB	Refer to 6.10.2 to 4
	Ch-31	-30.9dB	
	Ch-32	<-38dB*	

*** 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.

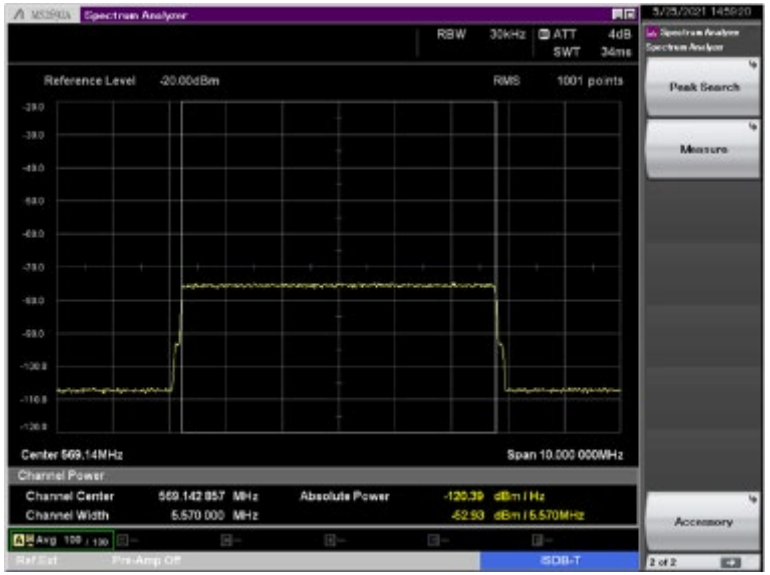
7.-10) Co-channel and adjacent channel interference to ISDB-T by SISO

Measuring photos are mentioned as follows.

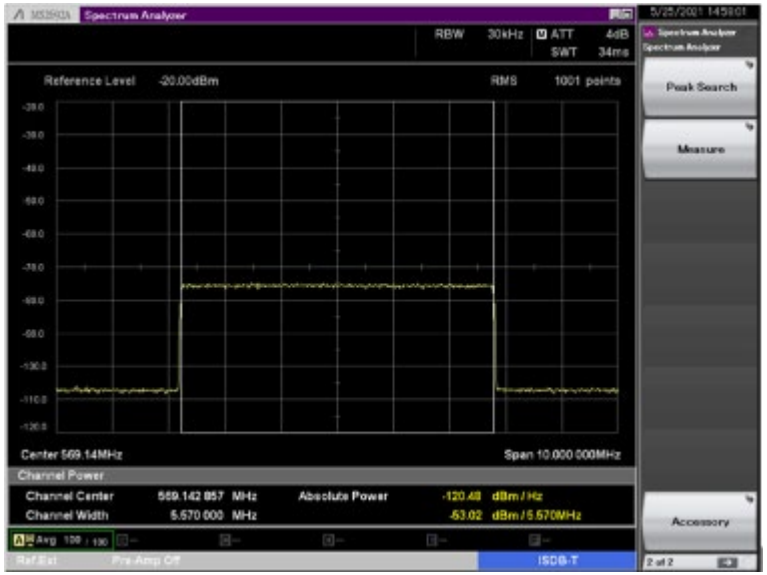
6.10.1 Ch-28



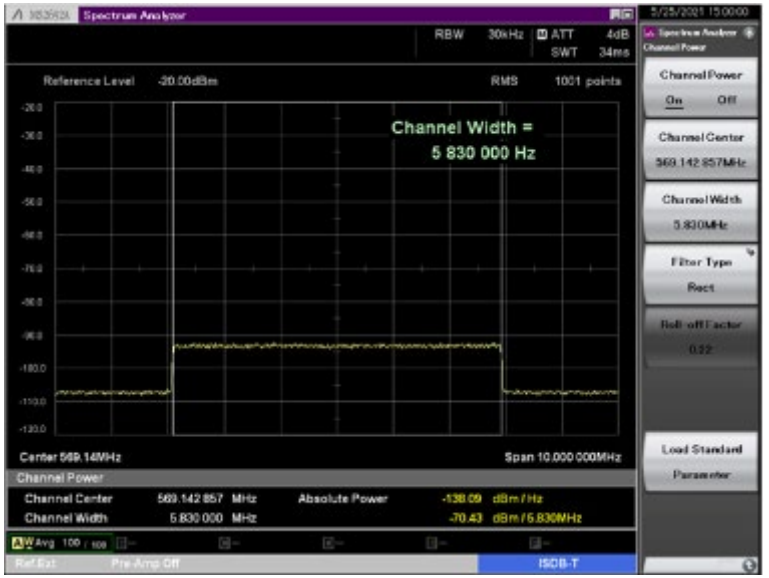
6.10.2 Ch-30 Minimum reception



6.10.3 Ch-30 ISDB-T side

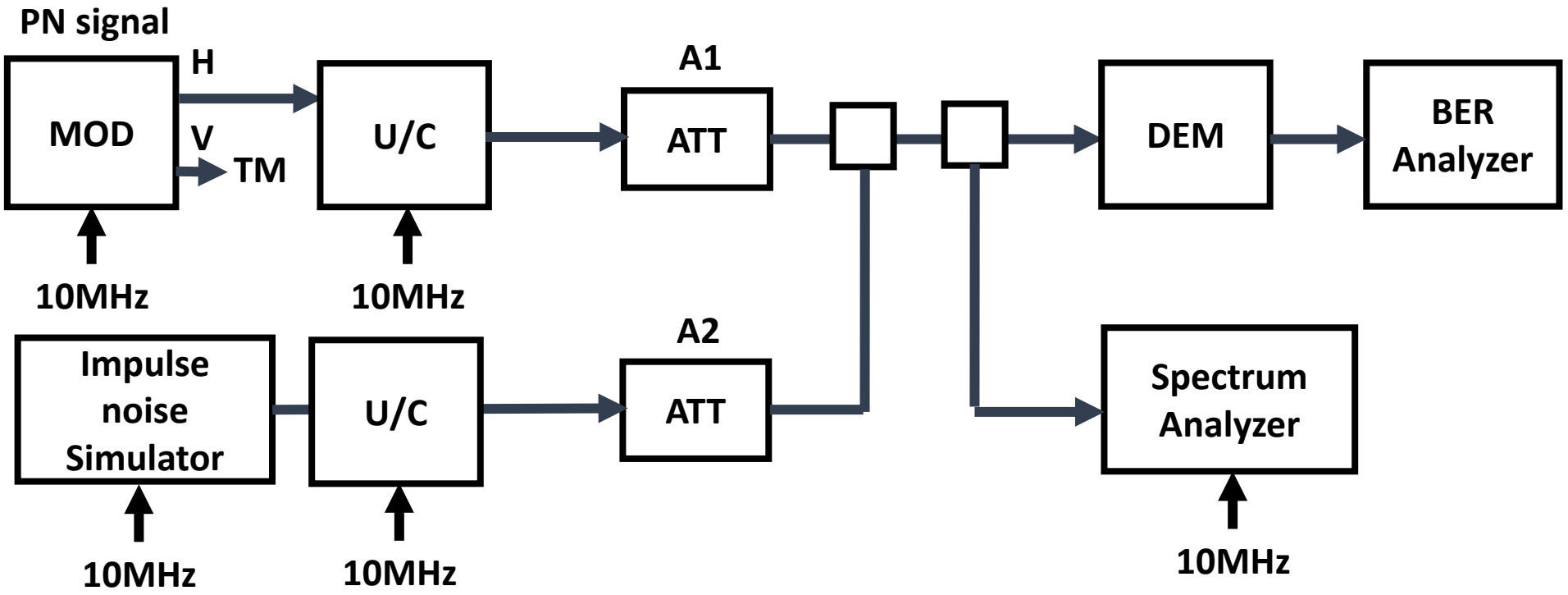


6.10.4 Ch-30 SISO side



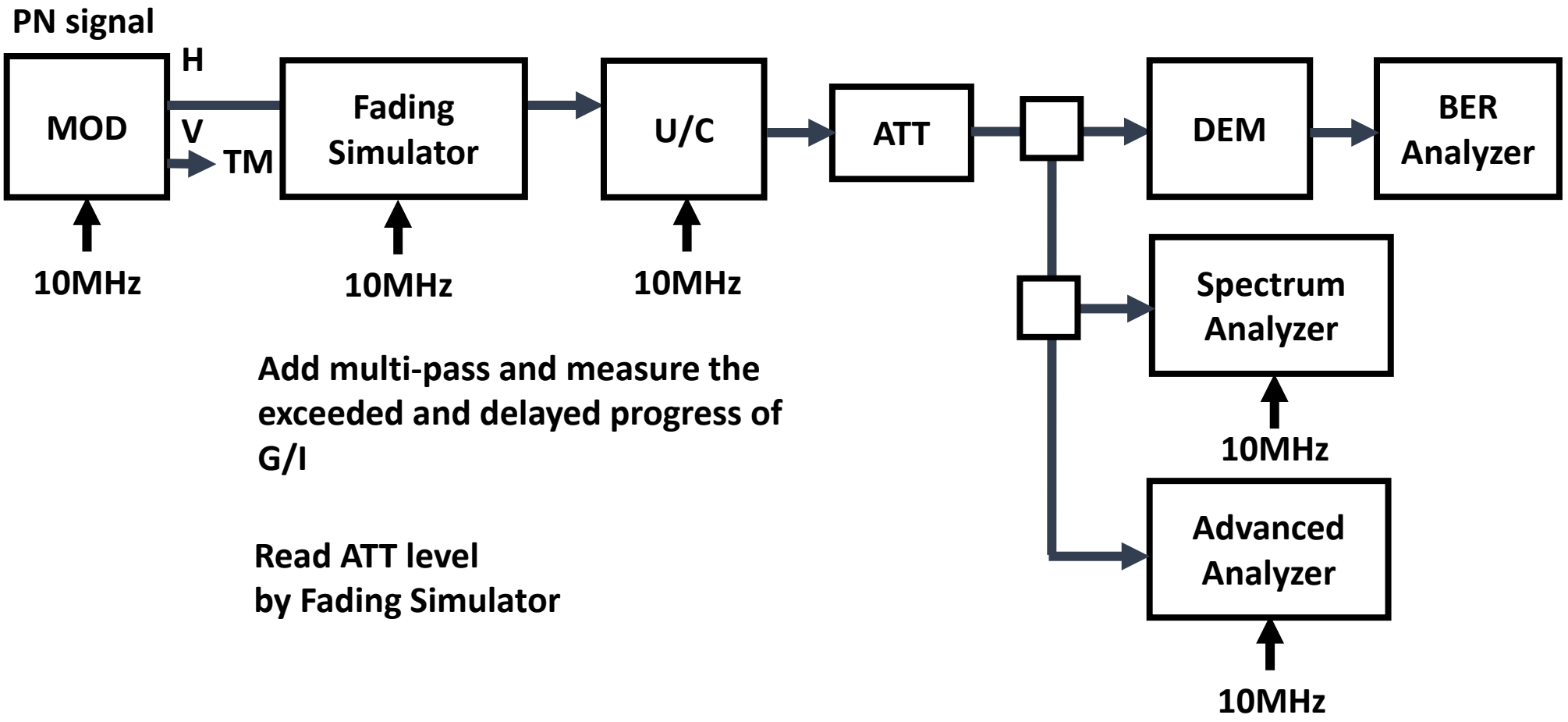
7.-11) Impulse noise by SISO

Required C/N for SISO was measured under impulse noise condition.
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. Impulse noise will be measured in Brazil.



7.-12) 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.



7.-12) 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

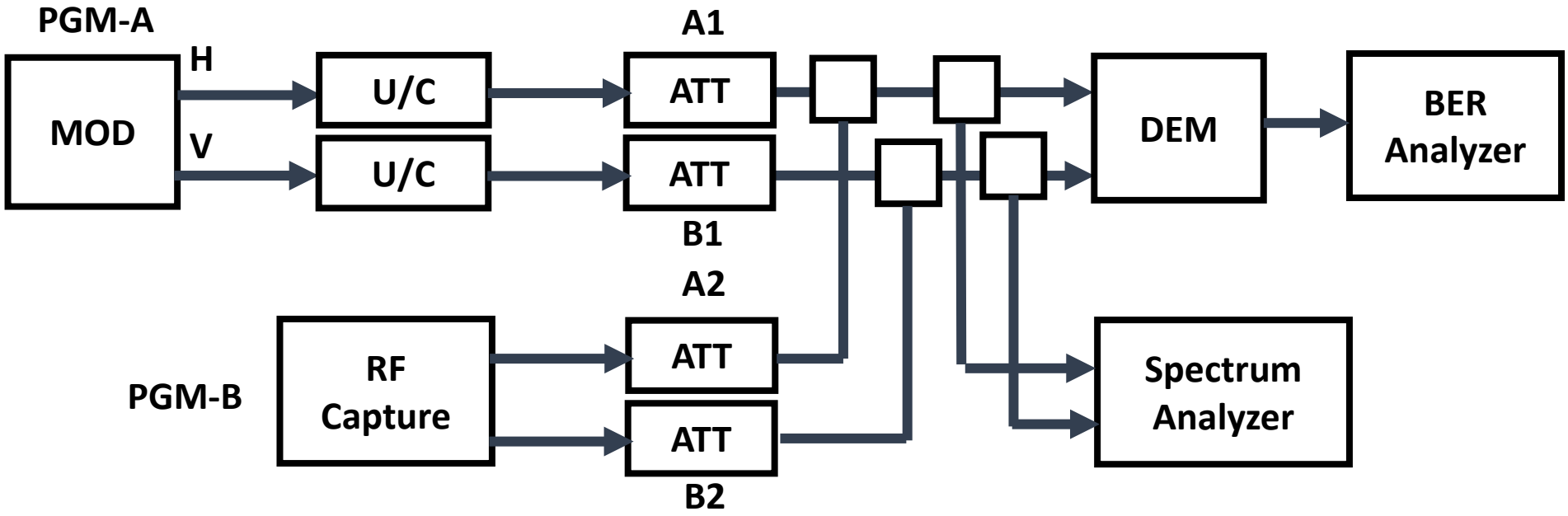
7.-12) Single echo static multipath interference by SISO

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				

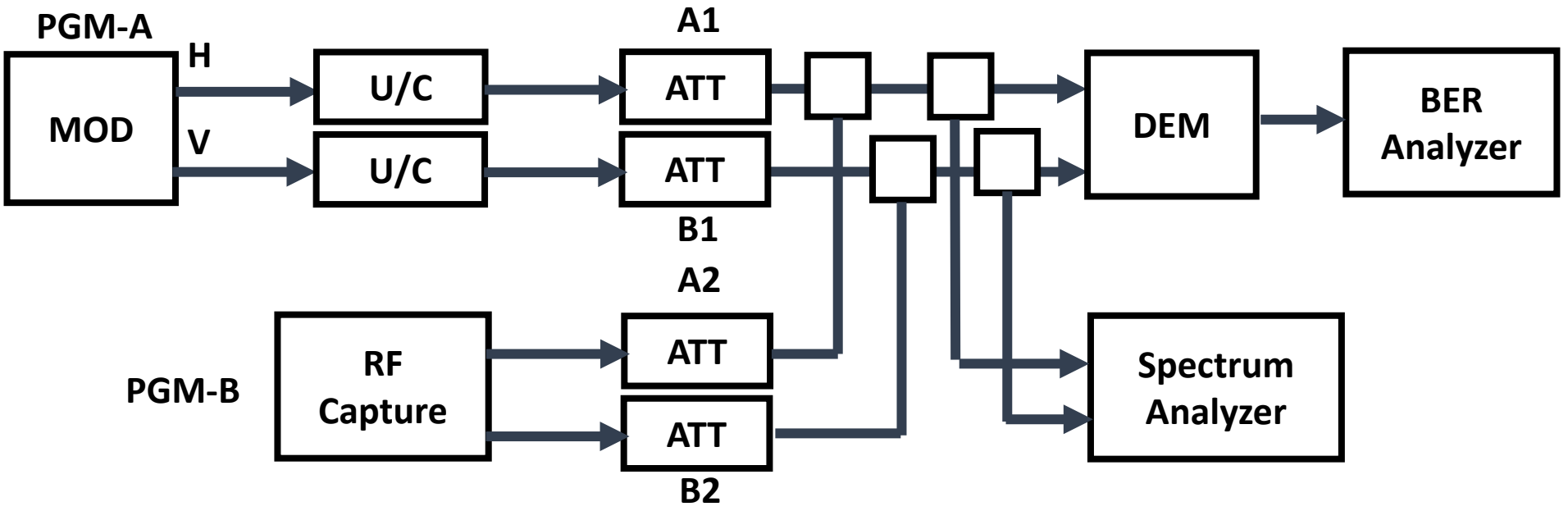
7.-13) Channel bonding by MIMO

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.



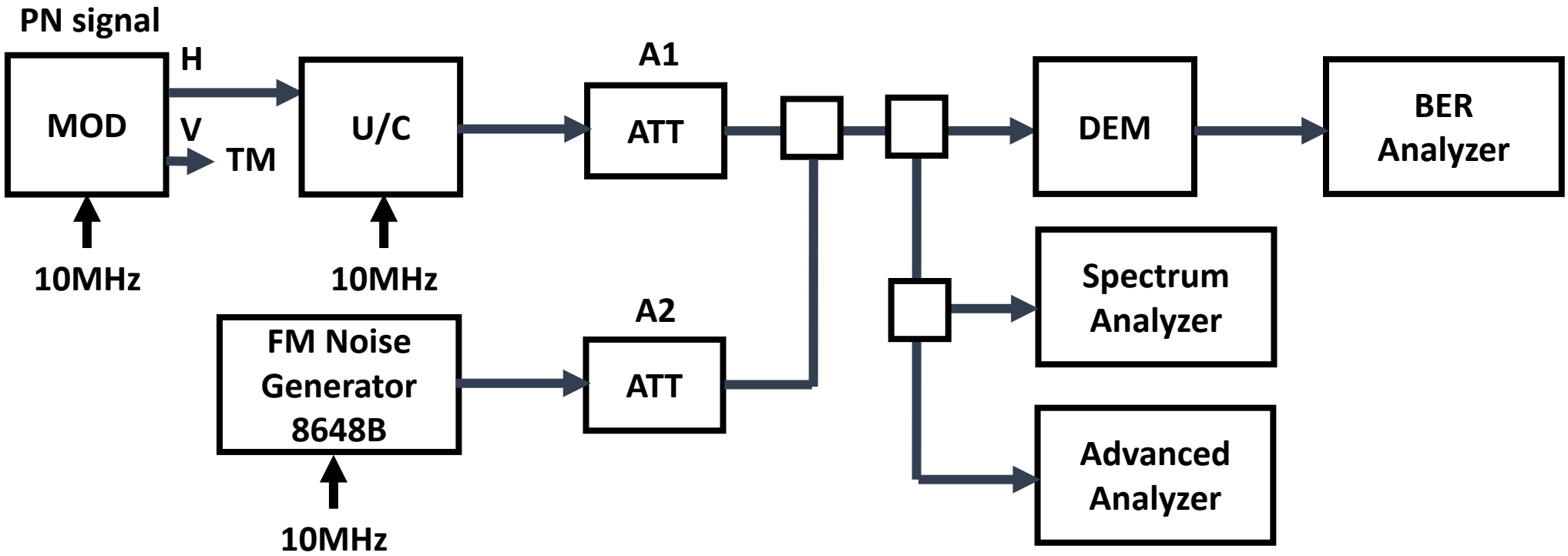
7.-14) Channel identification stability in frequency reuse-1 by MIMO

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.



7.-15) FM Radio (88 to 108 MHz) Interference by SISO

This test was conducted in 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.



7.-15) FM Radio (88 to 108 MHz) Interference by SISO

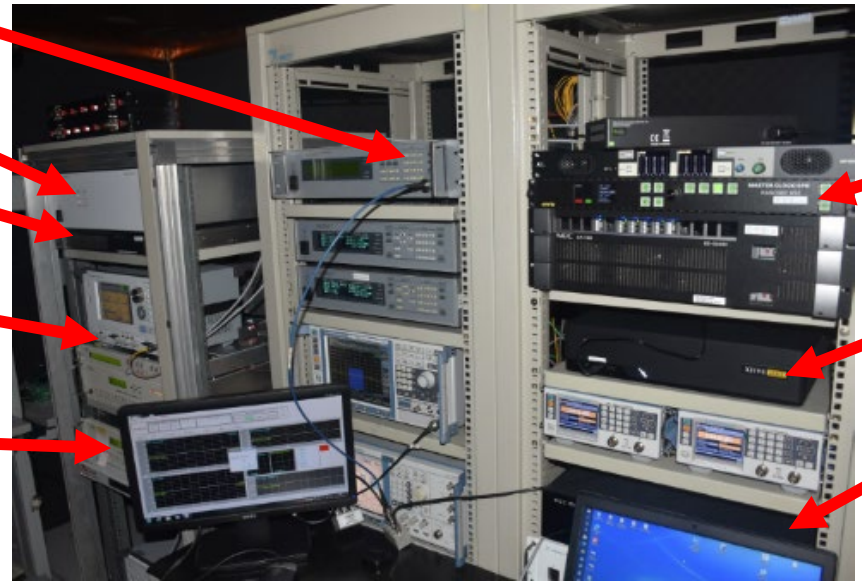
Measuring table of Ch-13, Ch-50 and Ch-30 is mentioned as follows.

TV Level (dBm)	Ch-7	Ch-13	Ch-15	Ch-33	Ch-50	Ch-30
	QEF Level (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.

8. Evaluation of Physical Layer

We continue to support the laboratory tests in Sao Paulo and the field tests in Rio de Janeiro from July to December in 2021. The following picture shows the laboratory tests at Mackenzie University. The SISO and MIMO Advanced ISDB-T systems were constructed in Mackenzie University, and the IF and RF measurements were conducted. We will also prepare measuring equipment for the CfP Ph-2.



Muito Obrigado!

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