

**Practical Principle and
Technical Standards
Addendum 1 to DAB+ Plan
(DAB+ Receiver Technical
Specifications)**

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Notice

This document is provided in good faith and is based on the Consultants' understanding of the NBTC's Radio Frequency Plan Project requirements. We would be pleased to discuss the contents of this document with you, particularly if NBTC's requirements have in any way changed.

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1. Summary

The Office of the National Broadcast and Telecommunications Commission, hereinafter referred to as “NBTC”, has the mandate to implement and promote the Thai Government’s policy objectives for the broadcast and telecommunications sector in Thailand, and to establish and monitor the regulatory frameworks and to provide guidance for the telecommunications and broadcast industry.

The NBTC has entrusted LS telcom Limited, hereinafter referred to as the “Consultant”, with the task to conduct this Radio Frequency Plan Project.

This Addendum 1 to the Practical Principle and Technical Standards to the DAB+ National and Local Planning report includes the Consultant’s recommendation in respect to a technical standard for digital sound broadcasting receivers for the implementation of the DAB+ system in Thailand.

2. Scope of the Document

NBTC has requested LS telcom to provide a recommendation for a DAB+ radio receiver technical specification for the introduction of the DAB+ services in Thailand. Understanding the strong integration of the international economy regarding consumer electronics and relating market mechanisms from a manufacturer's perspective, it is recommended that the DAB+ receiver technical specification for Thailand should align with an existing international or, at least, an ASEAN regional standard.

In addition to the United Kingdom, Germany and Australia a very few other countries in the world have officially launch a commercial operation of a DAB+ system. Therefore, to maximise receiver compatibility, portability between countries and economy of scale for manufacturers, all of which should result in lower equipment prices, the Consultant recommends that Thailand adopts the receiver specification as described in the international standard *IEC 62104 – Characteristics of DAB receivers, Second edition 2003-03*.

For easier reference, the Consultant has reproduced and inserted key sections of the IEC reference document. It is recommended that, should the NBTC decide to implement the recommended specification, the document issued by the IEC is considered the official version at all time.

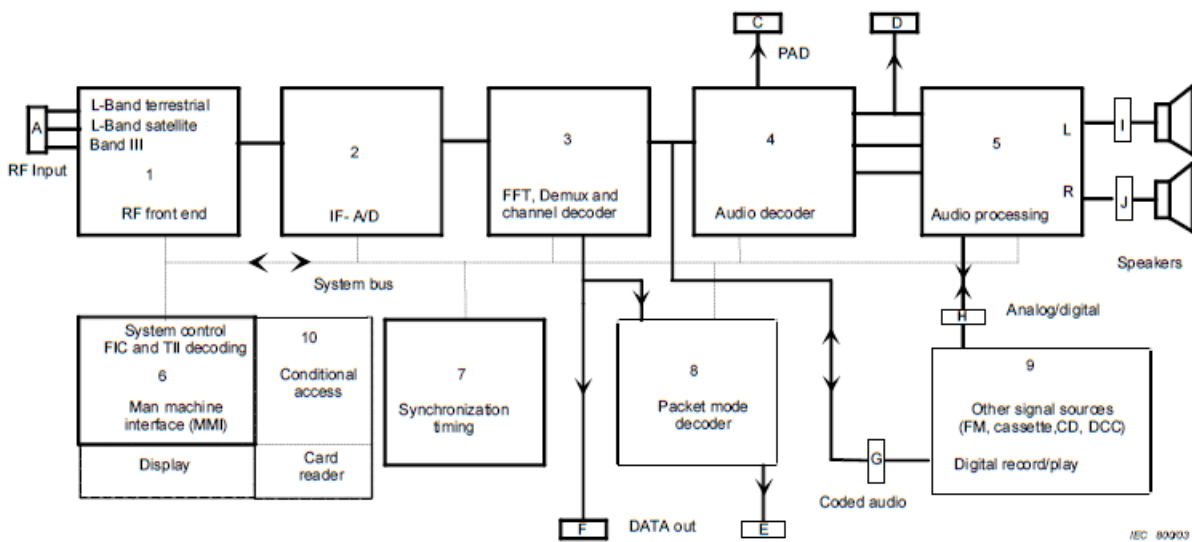
The Consultant's recommendation, which is based on an existing standard, represents the minimum receiver specification that should be implemented in order to commercialise DAB+ portable, fixed and in car receivers in Thailand.

The IEC 62104 specification can be obtained from the IEC web site: www.iec.ch.

3. Minimum Technical Specifications for DAB+ Receivers

Unless otherwise specified by the Consultant, the information in section 3 has been extracted from the document IEC 62104 (second edition). The quotations from the IEC document that have been inserted into this report are represented in italic font for easier reference. The IEC 62104 document also specifies the testing methodologies for DAB+ receivers for type approval purposes.

The functional block diagram of a DAB receiver is defined by the IEC as per the following figure:



NOTE Blocks 8 and 10 are optional, block 9 is not part of the DAB receiver.

Figure 1: Functional block diagram of a DAB Receiver (c) IEC

3.1 Frequency Range

The Consultant recommends that receivers should be capable of receiving DAB and DAB+ Digital Radio broadcast signals in the frequency range of 174 MHz to 240 MHz. The centre frequencies of the transmitted signals should comply with the preferred Band III frequencies specified in the specification document ETSI TR 101 496.

The recommended frequency allocation is presented in the following table (the detailed table is available in Annex A of the IEC 62104 document):

Block	Centre Frequency
5A	174.928 MHz
5B	176.640 MHz
5C	178.352 MHz
5D	180.064 MHz
6A	181.936 MHz
6B	183.648 MHz
6C	185.360 MHz
6D	187.072 MHz
7A	188.928 MHz
7B	190.640 MHz
7C	192.352 MHz
7D	194.064 MHz
8A	195.936 MHz
8B	197.648 MHz
8C	199.360 MHz
8D	201.072 MHz
9A	202.928 MHz
9B	204.640 MHz
9C	206.352 MHz
9D	208.064 MHz
10A	209.936 MHz
10B	211.648 MHz
10C	213.360 MHz
10D	215.072 MHz
11A	216.928 MHz
11B	218.640 MHz
11C	220.352 MHz

Block	Centre Frequency
11D	222.064 MHz
12A	223.936 MHz
12B	225.648 MHz
12C	227.360 MHz
12D	229.072 MHz

Table 1: Frequency Allocation Table

3.2 Minimum Performance

The minimum performance levels and measuring methods are provided in section 7 of the IEC 62104 document. These specifications also include:

- General conditions: Power supply, Atmospheric conditions, BER measurement conditions, DAB signal
- Audio decoding
- RF demodulating: Sensitivity, Maximum input power, Selectivity, Performance in a Rayleigh channel, Acquisition time after synchronization loss

The above sections of the IEC 62104 document have been reproduced in the following sections.

3.2.1 BER Measurements Conditions

The bit-error ratio (BER) shall be measured at the receiver's convolutional decoder output, such as "F" in Figure 1. During the measurement, the receiver should remain synchronized. Unless otherwise noted, BER measurements shall be performed in the MSC (Main Service Channel), using an equal error protection (EEP) sub-channel with a code rate of $\frac{1}{2}$.

Any known digital pattern with a length of more than one symbol can be used as test sequence (audio stream, nulls, etc.).

The BER measurements conditions are used to determine the receiver sensitivity for a BER of 10^{-4} .

3.2.2 Sensitivity and Maximum Input Power for a Gaussian Channel

3.2.2.1 Method of measurement of sensitivity for a Gaussian Channel

The measurement set-up is given in Figure 2. The signal generator shall be connected to the RF input "A" of the receiver under test. The BER shall be measured at the output "F". The input power is reduced until the BER reaches the value 10^{-4} .

The sensitivity is the input power expressed in dB(mW) at which the BER reaches 10^{-4} .

The minimum requirement for DAB at VHF is: -81 dB(mW)

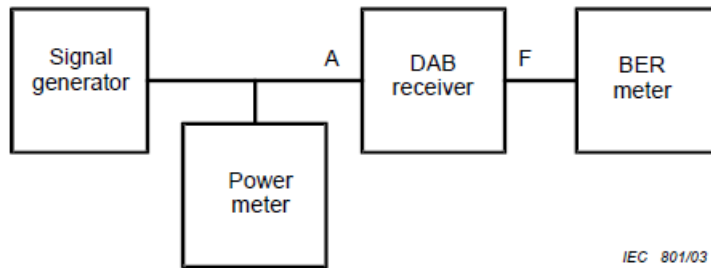


Figure 2: Block diagram for the measurement of the sensitivity and the maximum input power (c) IEC

3.2.2.2 Method of measurement of Maximum input power for a Gaussian Channel

The maximum input power is the maximum input level at which the DAB receiver will perform when the input power is increased until the BER reaches 10^{-4} or just before synchronization is lost.

The minimum requirements at VHF are the following:

- Mobile receiver: -10 dB(mW)
- Stationary receiver: -15 dB(mW)
- Portable receiver: -20 dB(mW)

3.2.3 Selectivity

Two types of measurements are considered to evaluate the sensitivity:

- adjacent channel selectivity (ACS); and
- far-off selectivity.

3.2.3.1 Method of measurement of Adjacent channel selectivity (A_{CS})

Both wanted and unwanted signal and interferer shall be DAB signals according to the specification ETSI ETS 300 401 and the spectrum shall be in accordance with Figure 3:

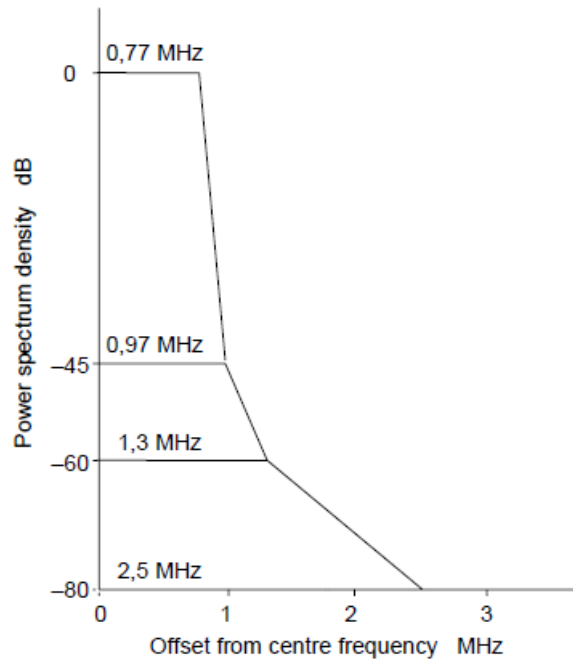
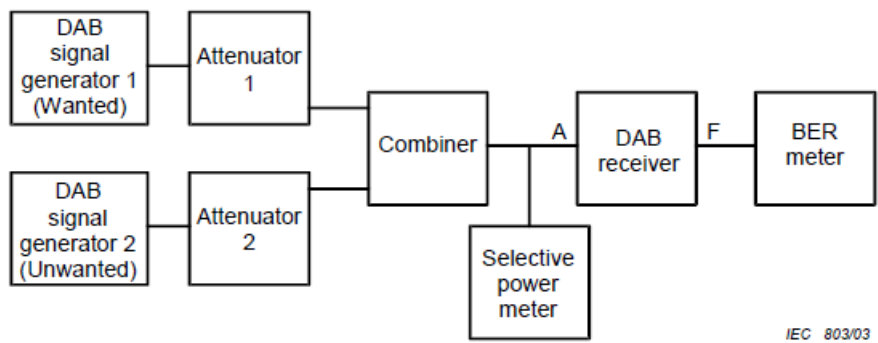


Figure 3: Spectrum mask of the DAB signal for selectivity measurements (c) IEC

The difference between the centre frequencies of the DAB ensembles shall be 1.712 MHz, corresponding to a guard band of 176 kHz. The measurement set-up is described in Figure 4:



IEC 80303

Figure 4: Block diagram for selectivity measurements (c) IEC

The adjacent channel selectivity (A_{CS}) for VHF of a DAB receiver is expressed in dB. This value shall be calculated from the adjusted signal levels by equation:

$$A_{CS} = P_{unwanted} - P_{wanted} = P_{unwanted} + 70 \text{ [dB]}$$

The minimum requirement in VHF is: $A_{CS} \geq 30 \text{ dB}$

3.2.3.2 Method of measurement of rejection of unwanted signals (far-off selectivity)

An unwanted signal received together with the wanted signal at the input of the receiver may have a degrading effect on reception quality.

The measurement set-up is the same as shown in Figure 4 above. The wanted signal is a DAB signal according to the specification ETSI ETS 300 401. The attenuator 1 (in Figure 4) shall be adjusted so that the power level measured at the input "A" to the receiver becomes -70 dB(mW).

The unwanted signal is a standard FM modulated signal as defined in IEC 60315-4.

This measurement shall be carried out on the upper, lower and centre frequencies for VHF. The frequency of the unwanted signal should be ≥ 5 MHz from the centre frequency of the wanted DAB signal. The output power of the unwanted signal (measured at the DAB receiver input "A" is increased until the BER is 10^{-4} .

The relative level of the maximum permissible unwanted signal is given for both measurements by the equation:

$$R_r = P_{\text{unwanted}} - P_{\text{wanted}} = P_{\text{unwanted}} + 70 \text{ [dB]}$$

Where R_r is the rejection ratio.

The minimum requirement in VHF is 40 dB for any in-band or out-of-band interfering frequency with an offset ≥ 5 MHz from the centre of the wanted DAB signal.

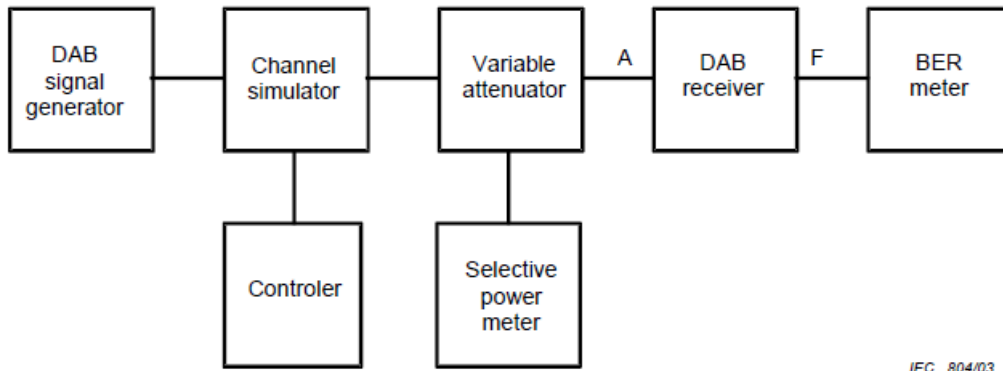
3.2.4 Sensitivity for a Rayleigh Channel

It is recognized that behaviour under mobile conditions is one of the strong features of the DAB system. The objective of this measurement is to provide a reference for the performance of a DAB in car receiver in a dynamically changing environment. Typically, such an environment is described by the Rayleigh channel model.

The effects described above model the propagation of electromagnetic waves in realistic terrain and under moving conditions. Included in these models is the Doppler-effect, as well as multi-path reception, plus fast and slow fading. Since many combinations of these effects are possible, there has been effort to standardize a set of conditions for measurement purposes. These so-called profiles were laid down in the COST 207 document on digital land mobile radio communications. Extracted from that document, certain relevant profiles have been selected. These are given in Annex B of the report.

Based on static conditions, it is possible to compare the behaviour of different receivers. However, since the channel is changing dynamically, it is difficult to test without long-term observation. Therefore, long-term evaluation is required, during which the BER may not drop below 10^{-4} .

The block diagram of a basic set-up for channel simulation is shown in Figure 5:



IEC 804/03

Figure 5: Block diagram for measuring the performance in a Rayleigh channel (c) IEC

The DAB signal generator is set to one of the centre frequencies given in Table 2 and is modulated by a DAB encoder. A channel simulator is inserted between the DAB signal generator and the variable attenuator. This simulator must be programmed through its controller with parameters corresponding to the channel profiles mentioned in Annex B. An attenuator is foreseen at the output of the channel simulator. A bandpass filter may also be necessary to filter out spurious signals.

Measurements shall be made in different bands (frequencies) and modes combined with different channel simulation profiles: urban, rural and SFN (different for VHF-and L-band), according to the following:

- Measuring frequency in MHz (for VHF): 225,648 MHz
- DAB Transmission Mode: I
- Channel simulation profiles:
 - Urban at 25 km/h
 - Rural at 120 km/h
 - SFN (VHF) at 60 km/h

The measurement shall be performed in three steps:

- **Step 1:** The power level at the input of the DAB receiver shall be adjusted, using a selective power meter, in such a way that error-free reception is possible i.e. $BER \leq 10^{-4}$. All synchronization conditions shall be met, including FIC, phase-reference and null-symbol capturing.
- **Step 2:** The input power to the receiver is reduced by increasing the variable attenuation with 5 dB. During this process, care shall be taken that synchronization is not lost.
- **Step 3:** Read the BER meter and confirm that the reading stays better than the specified value 10^{-4} for a specified measuring time of 1 minute. If this is so, the receiver is qualified for this power level, and the procedure goes back to repeat the second and third steps, to measure the next lower power level. When the receiver fails to maintain the specified BER of 10^{-4} , the procedure stops.

The minimum requirement, as the lowest power level at which the receiver is still able to maintain a BER of 10^{-4} for each simulation profile (at VHF) is -75 dB(mW)

3.2.5 Acquisition time after synchronization loss

The time of audio mute between switching off the received ensemble and re-synchronizing to the same ensemble at an offset frequency is defined as the acquisition time after synchronization loss. Figure 6 below shows the block diagram of the measurement set-up:

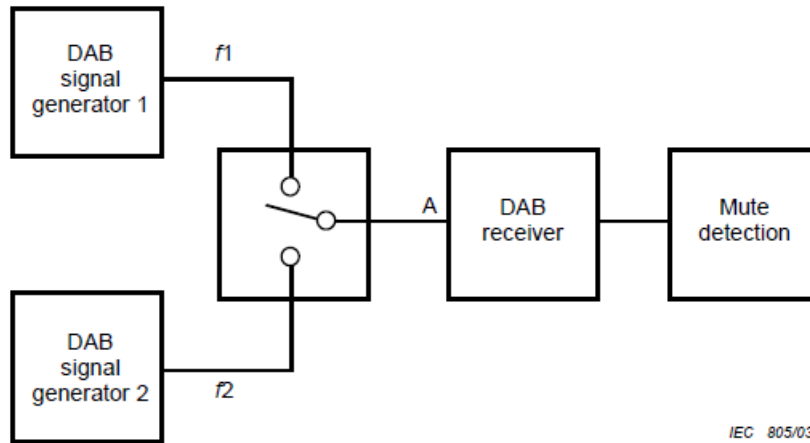


Figure 6: Block diagram for measuring acquisition time after synchronization loss (c) IEC

The DAB signal should be according to the specification ETSI EN 300 401.

The frequency f_2 of DAB signal generator 2 shall have an offset to frequency f_1 of DAB signal generator 1 of half a carrier spacing, according to the appropriate mode (500 Hz in the case of mode I for VHF).

First the signal of DAB signal generator 1 is supplied to the DAB receiver. After a switch-off time of at least 10 seconds the signal of DAB signal generator 2 is supplied to the DAB receiver and the time it takes for the DAB receiver to resynchronize is measured with the mute detection circuit.

Measurements shall be made five times.

The minimum requirement: <3 000 ms for a switch-off time >10 s.

3.3 DAB and DAB+ Channel Decoding

The IEC 62104 document only specifies the minimum requirements for DAB decoding (MPEG Layer I and Layer II). In order to decode DAB+ audio signals, the receivers must be able to decode a DAB+ audio service contained in a sub-channel of a size up to and including 144 Capacity Units (e.g. 96 kbps@EEP1A). DAB+ audio services are defined in the ETSI TS 102 563 document.

3.4 Analogue Radio Services

The DAB+ receiver, other than the DAB+ adaptor, must be able to receive FM analogue radio services currently on air in Thailand. The Thai FM transmission standard recommended by the Consultant is described in ETSI 300 384 document. For more information please refer to the Milestone IIA Report which, among others, is covering the FM plan and the relating technical receiver specification.

3.5 Functional Specifications

The following functional specifications are not defined as mandatory in the IEC 62104 document. Nevertheless, the Consultant recommends that these specifications are supported by DAB+ receivers sold in Thailand. Those minimum functional specifications are extracted from the document "Minimum Specifications for DAB and DAB+ Personal and Domestic Digital Radio Receivers. DRAP-TEG-002, Department for Culture, Media and Sport, United Kingdom", here after referred to as DRAP-TEG-002.

3.5.1 Retuning

Retuning function of the receivers should support the requirement defined in the document DRAP-TEG-002:

"A receiver which has a stored list of service labels must provide the user with the option of scanning the whole Band III band to update its stored service list when required.

This feature must either be initiated by the press of a single button on the device or, if it is a feature in a menu structure, it must be in the top level of the menu, or one level down.

This rescan / retune feature must be able to cope with the following changes:

1. *Service moves to a different multiplex*
2. *New multiplex launches*
3. *Multiplex changes its frequency*
4. *New Service appears*
5. *Service changes name*
6. *Service disappears*
7. *Multiple Instances of the same programme content with the same Service ID on different frequencies and with varying signal levels"*

In respect to the DAB+ Ensembles configuration the Consultant wants to highlight the following aspect, specific to the situation in Thailand:

DAB+ Ensembles might change their configuration from time to time. Therefore, it is preferred that the receiver should update its stored database of available programmes by constantly checking the FIC (Fast Information Channel) of the ensemble to which it is currently tuned.

3.5.2 Text Display

In respect to the text display capability, please refer to the following quotation from the document DRAP-TEG-002:

“The receiver must have a means of displaying text to the user.

The text display shall display the audio service name (the Component Label). The text display must be able to display the following graphic symbols, correctly mapped, visually well-formed and clear:

ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789

Lower case characters may be mapped to upper case equivalents and therefore show only:

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789

Note: It is likely that Broadcasters will also use the following characters: £ % & ! . " () , ”

For displays wishing to display the full range of Dynamic Label text, including these symbols, this is specified in ETSI EN 300 401

For any of these characters which cannot be shown correctly, the graphical symbol shown should be a “space” or “□” or, in any case, a similar distinctly non alpha / numeric character.

Receivers shall receive labels from ensembles and audio services, and display long form labels in preference to short form labels.

The receiver shall display the Component Label, in preference to the Service Label, as it is possible to have two audio channels sharing the same Service Label. If a Component Label is not broadcast, the Service Label shall be used.

The text display must display the Component label in either its short form (8 characters long) or its long form (16 characters long). It is not permissible for the receiver to truncate the label to any other length.

*Receivers shall receive the Dynamic Label Service from up to 48 bytes of the X-PAD of the currently received service and display it to the user legibly. Receivers should treat the special characters 0x0A and 0x0B as specified and apply such formatting as is possible on the display. The Receiver shall act upon the Command to remove the label from the display by **immediately** removing the label, even if it has only been partially displayed.”*

In respect to the text display of DAB+ receivers the Consultant wants to highlight the following aspects specific to the situation in Thailand:

The text display of DAB+ receiver should also support optionally the ISO/IEC 8859-11 Latin/Thai alphabet character set. The corresponding codes are reproduced in the Figure 7 table below:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0000	0001	0002	0003	0004	0005	0006	0007	0008	0009	000A	000B	000C	000D	000E	000F
1	0010	0011	0012	0013	0014	0015	0016	0017	0018	0019	001A	001B	001C	001D	001E	001F
2		!	"	#	\$	%	&	'	()	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{		}	~	
8																
9																
A		ก	ข	ฃ	ค	ค	ฅ	ง	จ	ฉ	ช	ช	ฌ	ญ	ฎ	ฏ
B	ฐ	ฑ	ฒ	ณ	ด	ต	ถ	ท	ธ	น	บ	ป	ผ	ฝ	พ	ฟ
C	ภ	ม	ย	ร	ฤ	ล	ฬ	ว	ศ	ษ	ส	ห	ฬ	อ	ฮ	ฯ
D	๕	๖	๗	๘	๙	๐	๑	๒	๓	๔	๕	๖	๗	๘	๙	๐
E	๑	๒	๓	๔	๕	๖	๗	๘	๙	๐	๑	๒	๓	๔	๕	๖
F	๐	๑	๒	๓	๔	๕	๖	๗	๘	๙	๐	๑	๒	๓	๔	๕

Figure 7: Latin/Thai ISO/IEC 8859-11 Character Set

Please Note: In the case of any discrepancy between the values in Figure 7 and the ISO/IEC 8859-11 specifications, the ISO/IEC 8859-11 specifications must be considered as the source document.

3.6 EMC Specifications

The Consultant recommends that the DAB+ receivers should be compliant with the Electro Magnetic Compatibility (EMC) standard for radio equipment and services as specified in the document EN 301 489-1 Part 1: Common technical requirements.

4. Conclusions and Recommendations

As noted before, this document has been created based on the documents:

- International Standard IEC 62104 – Characteristics of DAB receivers, Second edition 2003-03.
- DRAP-TEG-002 Minimum Specifications for DAB and DAB+ Personal and Domestic Digital Radio Receivers, Department for Culture, Media and Sport, United Kingdom.

The original above listed documents might evolve over time and may include new findings as new receiver technology becomes available. Therefore, should the NBTC decide to adopt these technical specifications, the Consultant recommends that a notification should be sent to the Government of United Kingdom and to the International Electrotechnical Commission (IEC) requesting that any revision to the parent documents should be notified to the Thai Government and the NBTC respectively to harmonise the specification.

In conclusions, the Consultant recommends the following:

- | |
|--|
| <ul style="list-style-type: none">• The NBTC should consider the IEC 62104 as the <u>only</u> document used for the purpose of DAB+ receiver specifications, in order to facilitate the introduction of receivers in Thailand• The NBTC should consider this document has providing “optional” features to the basic DAB+ receiver specification IEC 62104. |
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5. References

This document is based on the following reference:

- IEC 62104, “Characteristics of DAB receivers – Second Edition”, International Electrotechnical Commission, Switzerland.
- DRAP-TEG-002 Minimum Specifications for DAB and DAB+ Personal and Domestic Digital Radio Receivers, Department for Culture, Media and Sport, United Kingdom.

The following documents describe the international specifications that are considered as the basis of the DAB and DAB+ technology:

- ETSI EN 300 401 Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to Mobile, Portable and Fixed receivers.
- ETSI TS 101 756 Digital Audio Broadcasting (DAB); Registered Tables.
- ETSI TS 102 563 Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio.
- ETSI TR 101 496 Digital Audio Broadcasting (DAB); Guidelines and rules form implementation and operation; (Parts 1 and 2).
- ETSI 300 384 Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters
- BS EN 62104:2007 Characteristics of DAB Receivers
- ETSI TS 103 176 Digital Audio Broadcasting (DAB); Rules of implementation; Service information features

ETSI standards are available and can be retrieved free of charge from the ETSI website www.etsi.org.