Briefing Note 72

(CRA-ENG-BN072)

FM PI code assignment and DAB+ SId code alignment

Final Draft

16th November 2018

V0.99

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Contents

Abbreviations and Modal verbs

For the purposes of the present document, the following abbreviations apply:

AAC	Advance Audio Coding
ABC	Australian Broadcasting Corporation
ACMA	Australian Communications and Media Authority
AF	Alternative Frequency
BSA	Broadcast Services Act
CBAA	Community Broadcasting Association of Australia
CRA	Commercial Radio Australia
DAB	Digital Audio Broadcasting as per [2]
DAB+	DAB using AAC audio coding
EId	Ensemble Identifier
ECC	Extended Country Code
EEP	Equal Error Protection
FEC	Forward Error Correcting code
FM	Frequency Modulation
FQDN	Fully Qualified Domain Name
LA	Licence Area
LAP	Licence Area Plan
PI	Programme Identifier
RCZ	Remote Central Zone
RDS	Radio Data System
RFU	Reserved for Future Use
RNEZ	Remote North Eastern Zone
RWZ	Remote Western Zone
SBS	Special Broadcasting Service
SCId	Sub-Component Identifier
SFN	Single Frequency Network
SId	Service Identifier
SMX	Service MultipleXer
SP	Service Provider
SS-DAB	Small Scale-DAB
SubChId	Sub-Channel Identifier

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed except when used in direct citation.

1 Introduction

In Australia many FM services include RDS (Radio Data System) to deliver station names and dynamic text. RDS also contains a Program Identification code (PI code). Similarly, DAB+ services all have a mandatory Service Identifier code (SId code).

Prior to v0.6 of this document in 2016 the assignment of PI codes was undertaken by individual stations, or networks, without cross industry consultation or any overarching coordination. Conversely the SIds are formed in part through a set of internationally standardised codes, see ETSI document TS 101 756, DAB Registered Tables [1]. The result is that in Australia the FM PI codes are not aligned with the DAB+ SId codes in any way.

This misalignment can cause issues when receivers implement 'Implicit linking', see [5] for Service Linking methods and guidelines. Incorrect Implicit Linking occurs when a receiver, typically a car receiver, automatically associates FM and DAB services which have the same code for FM PI and DAB SId. Examples of this have been observed in Melbourne where ABC Radio National DAB+ SId and The Fox FM PI codes were both 3101 and similarly ABC News Radio DAB+ and 3MMM FM have the same code 3105. This situation was resolved by the ABC reassigning their FM PI codes.

Commercial radio stations in Australia do not support Service Linking, including implicit linking, hard linking or soft (broadcaster defined) linking. Car manufacturers and importers are advised to disable implicit linking functionality between DAB+ and FM however there are instances where the feature is reactivated by the user. Further discussion of Service Linking and the CRA members position can be found in [6] and [7].

The DTAC members considered the situation at a meeting on 12/08/2014 and advised that the preferred solution to this issue is:

- Not to allocate any FM PI codes which will clash with existing SId codes
- Discuss with the national and community broadcasters recommended practice for FM PI code allocation
- Investigate the establishment of a country wide database of FM PI codes

Subsequent cross industry meetings and discussion resulted in the scheme defined in v0.6 of this document being adopted by the Australian radio industry.

A review of the PI code assignment methods is provided in section 7: Annex A.

2 Australian FM PI code assignment

The Australian PI code assignment scheme provides the recommended PI codes but is not a mandatory scheme. There are many used PI codes which do not conform with preferred practice and these will often not be able to be changed. When new PI codes are assigned then the Australian radio industry supports the scheme defined in this document.

The Australian PI assignment scheme constructs the PI code based on a combination of the state number, as shown in [3] plus the final 3 digits of the transmitter frequency, e.g. for 2MMM in Sydney on 104.9MHz this would be 2 + 049 = 2049. This is defined as the base PI code for that FM frequency in that state.

In general the ACMA has assigned FM frequencies with odd values, i.e. 104.1, 104.3, 104.5 MHz etc, however there are a few cases where even frequencies are defined, e.g. 97.4 MHz for 3WRB Melbourne Western Suburbs.

The ACMA has assigned frequencies to FM services in such a way as to prevent any overlap of coverage areas. There are cases however where the same FM frequency is assigned within a state, for example in NSW 2MMM in Sydney, 2AAY in Albury and 2PNN in Muswellbrook all use 104.9 MHz, and in Victoria 3YFM in Warrnambool and 3SRR in Shepparton both use 95.3 MHz.

The base assignment scheme described above will cause stations with a common frequency within a state to then have the same PI code. To avoid this undesirable situation the following additional step in PI code assignment is used.

If the same frequency is used within a state then the service with the alphabetically lowest call sign shall be assigned the base PI code unless that PI code is already assigned. The next call sign in alphabetic order shall then be assigned the final digit of 0xA, unless that PI code is used. Assignment shall continue in this manner until the final digit is assigned the code of 0xF. This is referred to as the primary extended code range of 6 additional codes.

When the primary extended code range is exhausted then the second final digit assignment shall revert to the hex value 0xA and the final digit start at 0 rising to F. This is the first range of the 16 codes in the secondary extended code block which is available for each 'MegaHertz' frequency range[1].

If the first range of the secondary extended code block is insufficient then the second final digit continues to 0xB and the final digit again increases in the range 0x0 – F for the second range of the secondary extended code block.

This method continues with 6 ranges in the secondary extended code block being available for each 'MegaHertz' range, i.e. 6 x 16 = 96 codes.

Some examples the assignment of PI codes

FM frequency 104.9 MHz in NSW would proceed according to the following priority order list:

2049, 204A, 204B, 204C, 204D, 204E, 204F, 20A0 – 20AF, 20B0 – 20BF etc

FM frequency 93.5 MHz in VIC would proceed according to the following priority order list:

3935, 393A, 393B, 393C, 393D, 393E, 393F, 39A0 – 39AF etc

FM frequency 101.1 MHz in QLD would proceed according to the following priority order list:

4011, 401A, 401B, 401C, 401D, 401E, 401F, 40A0 – 40AF etc

[1] An example 'MegaHertz' range is 90.0 to 90.9 MHz

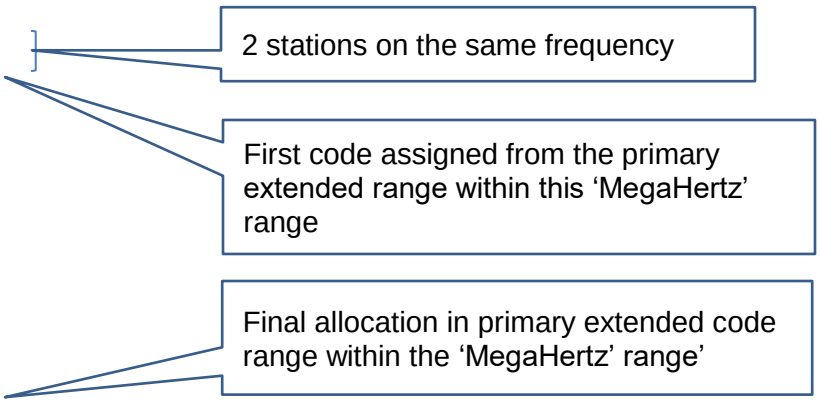
The scheme provides an additional 6 PI codes in the primary extended code range plus 96 PI codes for secondary extended code block for each 'MegaHertz' range in the FM frequency band. Currently the maximum use of a single FM frequency in any state is 8 for 101.9 MHz in NSW[2].

The following procedure is used for PI code allocation across all stations regardless of any currently used value:

1. Stations are first sorted by frequency
2. The station with the lower alphanumeric Call Sign for each frequency is allocated the first PI code in that range
3. If a valid code is already used that code shall be retained by the station and treated as already assigned
4. For each state
    a. The allocation begins with the lowest FM frequency of 88.0 where all stations on that frequency are assigned according to the scheme above, once all stations are assigned the next frequency is allocated moving in steps of 100kHz
    b. If a potential assignment is already used then the next value in the 'MegaHertz range' is assigned, this proceeds through all 100kHz steps within a MegaHertz range
5. If a station has no allocated Call Sign according to the ACMA FM stations listing then it is assigned the first available PI code after all stations with Call Signs have been allocated on an as requested basis
6. Once the list has been agreed then any new FM stations will have PI codes allocated on an as requested basis
7. If the transmitter is a retransmission site whether it is an on-channel repeater or a translator on a different frequency the PI code should be the same as the parent transmission which is either
    a. The code used for the FM transmission in that state's capital city, or
    b. for AM services the highest power FM site within the AM service's network of repeaters
        i. if there is more than one site on the highest power then the site with the lowest FM frequency shall be considered the primary site for PI allocation purposes

Hypothetical example, in NSW

Frequency	Call sign	assigned PI code
88.1	2AA	2881
88.1	2BB	288A
88.3	2CC	2883
88.3	2DD	288B
88.4	2EE	2884
88.5	2FF	2885
88.5	2FG	288C
88.7	2GG	2887
88.9	2HH	2889
88.9	2JJ	288D
88.9	2JK	288E
88.9	2JL	288F



[2] See http://www.acma.gov.au/webwr/_assets/main/lib100059/stations_book_electronic_edition.pdf

88.9	2JM	28A0
89.1	2KA	2891
89.1	2KB	289A
89.1	2KC	289B
89.1	2KD	289C
89.1	2KE	289D
89.1	2KF	289E
89.1	2KG	289F
89.1	2KH	28A1
89.1	2KJ	28A2
89.3	2LA	2893

First code assignment from the secondary extended code block within the 'MegaHertz' frequency range

Next allocation from the secondary extended code block for this 'MegaHertz' range

There is no differentiation between commercial, national or community broadcasters.

This PI code allocation scheme uses codes in the following ranges: char 1: <1:8>, char 2 <8, 9, 0>, char 3 <0:F>, char 4 <0:F>.

3 Repeaters, wide area and national services

There are many services, particularly in regional Australia, which use repeaters. These retransmissions are used to provide coverage in areas where the main transmission signal does not reach, e.g. due to distance and terrain issues.

There are a number of repeater scenarios to consider:

1. The repeater is an FM off-air translator
    a. In this scenario the repeater simply receives the on-air signal from the parent FM transmitter and translates the signal to a new frequency. All signal content is preserved including the original parent site RDS and hence the PI code of the retransmission is the same as the parent.
    b. The repeater PI code must be the same as the parent transmission
2. The repeater is a link-fed translator
    a. In this scenario the repeater is too distant to use off-air pickup and needs to be fed by a link, either microwave, telco or satellite. The repeater transmission may be on the parent site frequency if distant enough to not cause unacceptable co-channel interference or on a different frequency. The RDS for this type of repeater can be independent of the parent site and as such is able to have independent AF settings if desired. Alternatively, particularly if the same frequency is used for the repeater it can/should have the same PI code.
    b. The repeater PI code shall be the same as the parent transmission[3]
3. The repeater is an AM off-air translator
    a. This scenario is very similar to the link-fed repeater as AMSS is not used to provide any AF information.

[3] There may be existing cases where the PI code has been set to be different with the addition of AF information

   b. The PI code used for all FM repeaters for the AM service shall be the same as defined in the procedure in section 2[4].
4. The repeater is a wide area repeater associated with state-wide or national coverage
   a. This is the case for a number of ABC and SBS services
   b. In the case that the original service is FM, e.g. Triple J
      i. The repeaters, i.e. all transmissions apart from the parent shall have the same PI code as the parent PI code
   c. In the case that the original service is AM, e.g. Radio National
      i. The FM repeaters shall have a common PI code based on the preferred FM transmission (highest power with lowest frequency as per section 2), or

If a common PI code is used across multiple repeater frequencies the receiver will be relying on the hard linking function in the receiver to search and select the alternative frequency when the current transmission quality fails.

Alternatively for non-off-air translators the AF signalling should be implemented to tell receivers what the preferred alternative transmissions are. Those transmissions should have the same PI code as the parent.

4 Receiver behaviour

A number of investigations have been conducted by CRA and broadcasters into the behaviour of receivers when PI codes are changed. It is generally accepted that static, home based receivers are not adversely affected by changes in PI code and that their preset mechanism is primarily, or totally, based on the station's frequency.

Conversely car receivers often make use of the PI code and some car receivers have built in hard-linking which uses the PI code as a reference when searching for other frequencies to replace the current station when quality degrades.

Discussions with Ford Motor Co. indicate that the Hard Linking feature is usually, but not always, enabled when the receiver's Alternative Frequency (AF) feature is enabled. Receivers generally do not have a specific hard linking feature switch.

DAB+ receivers use the SId, along with the Ensemble frequency and Ensemble Id (EId) to select services in the receiver's service database. This operation is essential due to the time multiplexed nature of DAB services. The receiver will cross reference the Ensemble frequency, EId and SId with the Service Information (SI) in the Fast Information Channel (FIC) to identify the sub-channel containing the desired service. Consequently if the SId of a service is changed the receiver will not be able to find the service, and if that SId has been reallocated to another service the receiver will 'tune to' that new service. Hence when SIds are changed the user will need to perform a rescan of the services on the receiver, e.g. an AutoTune function, to ensure correct operation. While this is not difficult and only takes a few minutes it is still an inconvenience to the listener and hence should be minimised.

[4] There may be cases where a network of FM repeaters for an AM service have already been assigned different PI codes, along with AF information.

5 Central database

CRA provides a central database of FM PI codes based on the ACMA Radio and Television Broadcasting Stations document which lists all FM frequencies licenced in Australia. The database may be viewed by the public on the website codes.dra.com.au

When a broadcaster wishes to add RDS or change their PI code they should undertake the following procedure:

1. Review current PI code assignments and recommended PI codes for the new PI code on the website
2. Email CRA at info@commercialradio.com.au with a request for a PI code assignment providing:
    a. Operating frequency
    b. Transmission location(s)
    c. Transmission power(s)
3. CRA will respond with a preferred PI code value
    a. The assigned value will then be entered into the PI code database

6 References

All standards references refer to the latest version of the specified document unless an actual version reference is provided.

[1] ETSI TS 101 756, Digital Audio Broadcasting (DAB); Registered Tables
[2] ETSI EN 300 401 v2.1.1 (2017-01), Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers
[3] IEC62106, Radio Data System, 2009
[4] RBDS. USA Radio Broadcast Data System, National Radio Systems Committee, NRSC-4-B, April 2011
[5] ETSI TS 103 176, DAB Rules of implementation; Service information features
[6] CRA-ENG-BN075, DAB EId and SId code allocation
[7] CRA-ENG-BN077, DAB+ Service Linking

7 Annex A: Review of PI code assignment methods

There are currently two different ways to allocate the PI codes as defined in the European RDS [3] and USA RBDS [4] standards. These methods include the use of a Country Id, a localisation code and the stations call sign to define the PI code.

The European standard for the Radio Data System [3] defines PI code construction in Appendix D of that document. While the Country Ids initially defined focus on ITU region 1 which includes Europe, North Africa and the Middle East, Country Ids for the Rest of the World, including Australia, are defined in Appendix N as shown below. These codes are based on the state number / postcode scheme.

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N.3 Allocations of symbols for countries in ITU Region 3

COUNTRY/AREA	ISO CODE	SYMBOL FOR PI	ECC
Afghanistan	AF	A	F0
Australia	AU		
Australia Capital Territory		1	F0
New South Wales		2	F0
Victoria		3	F0
Queensland		4	F0
South Australia		5	F0
Western Australia		6	F0
Tasmania		7	F0
Northern Territory		8	F0
Bangladesh	BD	3	F1
Bahrain	BH	E	F0

Table 7-1: Extract of PI Country Id/symbol from Appendix N of [3]

The PI code consists of 4 ‘nibbles’, each being a single hexadecimal character. The first nibble, bits 12-15, are the Country Id.

The second nibble is the localisation code. As most commercial radio is considered to be local, as defined by Licence Area Plans (LAPs), the 2nd nibble will be 0.

The final 2 nibbles are assigned from a specific register providing 255 options (0x00 is not used).

So using 2MMM as an example, the PI code will be 0x20?? with the last 2 nibbles being assigned from a register, e.g. 0x2023

We note that there are no regional area definitions in Australia where the characters 0x4 to 0xF could be assigned to the 2nd nibble.

Consequently there is a high probability that PI codes will not be unique in each state area, particularly in NSW, VIC and QLD where there many FM transmissions. Reviewing the allocation of frequencies however

shows that there is little opportunity for PI clashes in most cases with the exception of some travel scenarios. For example 104.9MHz is used in NSW in Sydney (2MMM) and Albury (2AAY) and the national station 2PNN in Muswellbrook. There is potential that vehicles travelling between these areas will encounter the different services but only after traversing other areas where the frequency is not used.

The RBDS system used in the USA is based on the original European system with some changes to the PI code allocation method and PTY codes. The variations are defined in [4].

Document history		
V0.1	2nd July 2014	First draft Dr Les Sabel
V0.2	25th August 2014	Updated after feedback from DTAC and further research
V0.3	3d September 2014	Updated after feedback from DTAC, added section on repeaters and national / wide area services, receiver behaviour and added Country Id 9 for national FM services
V0.4	20th March 2015	Updated PI code allocation method to minimise reuse of same code within a state after feedback from Ray Baker.
V0.5	25th September 2015	Updated the PI allocation method to overcome cases where there are multiple users of the same frequency within a state, updated Sid range to avoid PI code clashes
V0.6	19 September 2016	Minor updates, typos and layout adjustments
V1.0	16th November 2018	Formatting update, release for open publication

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