Radio frequency bandwidth and emission designators revisited

by Robert A. Gallinger

According to an old saying, there are two sure things in life: taxes and death. However, I believe there is also a third sure thing that each of us must cope with: change. People and things constantly change for better or worse and although many changes are slow and subtle, others are fast and dramatic. Change is certainly a sure part of our daily lives.

Today, as never before, each of us is continuously being bombarded with new technology and with it a vast new language to learn. Keeping up with technological innovations and a constantly expanding terminology is no small feat. Few, if any of us, could, for example, keep up with all of the technological advances taking place around us, let alone in our own career fields; but as professionals we must at least make the effort to keep up as much as possible.

It is not easy to accept change; we tend to become very secure in the way things are now. We get used to doing a thing in a specific way, to saying a thing in a certain way; we even get used to smiling, walking, studying, acting and reacting in a specific way. Then BANGO! Another change descends upon us and we feel that our whole lives are being threatened. We may become hostile or bitter and throw up our arms in frustration as each new change invades our rather secure, happy lives. In our dejected state, we may finally think about the other two sure things in life and come to realize that maybe change isn't so bad after all. And that brings me to a case in point.

A recent change will affect many people in the telecommunications career field, both military and civilian, here and abroad. It has to do with a recent World Administrative Radio Conference (WARC) ruling which will change the way in which radio frequency planners, users and managers will have to construct bandwidth and emission designators beginning in January 1982. At that time, the current bandwidth and emission designators we've all become so accustomed to over the years will no longer be authorized. Such designators as 3A3J, 16F3, 6A3, 6A9B and all of the others will be changed to new designators, using the new rules established by the WARC.

The National Telecommunications Information Administration (NTIA), the top radio spectrum management activity of the federal government, will implement the WARC changes through detailed revisions to their Manual of Regulations and Procedures for Federal Radio Frequency Management. This manual, incidentally, contains the rules and regulations governing the use of radio frequencies by various US government activities, including the military departments.

The Department of Defense will implement the NTIA rules and regulations by publication and/or revision of their military service regulations. The Army, for example, will update AR 105-24, Radio Frequency and Call Sign Assignments for US Army Communications-Electronics Activities, to incorporate the NTIA changes. This service regulation and others, together with numerous technical manuals, field manuals, Department of the Army pamphlets and similar documents dealing with radio frequency usage and management will all have to be changed to show the new bandwidth and emission designator symbols and the rules for their construction.

The new designators will improve upon the present method of standardizing emission designators nationally and internationally. "The revised method," according to the findings of the WARC, "is a result of about twenty years of effort on the part of the C.C.I.R. (The International Radio Consultative Committee) in collaboration with the I.F.R.B. (International Frequency Registration Board) to improve the present (emission designator) method which was adopted at the Administrative Radio Conference, Geneva, 1959 and which, even at the time of adoption, had proved to be inadequate to cater to the then existing needs of radio frequency spectrum management."

In other words, the WARC concluded as far back as 1959 that the present method of designating bandwidth and emission for radio transmissions needed to be improved upon. Now, with the rapid growth in the telecommunication industry — especially over the last ten years or so — and the significant increase in the potential for radio frequency interference between radio users and

systems, the need for a more standard emission designator system has become even more obvious.

The change for most of us will not be too difficult if the technical characteristics of the communications-electronics equipment we deal with are known and the rules for constructing the new emission designators are faithfully followed. The rules themselves are not especially complicated, but their use will require some concentration of effort, especially at first.

I learned some years ago that the best way to cope with changes, especially changes that might directly impact on my job and/or personal life was to learn all I could about the changes *before* reacting to them, if at all possible. I think this idea is particularly true for the emission designator changes now under review. Therefore, before going all out to convert current designators to the new ones required by WARC and NTIA, we might avoid aggravation by taking a moment to review terminology and some of the new rules.

New designators like the old ones will be constructed according to necessary bandwidth and emission classification. Necessary bandwidth, according to WARC, is as follows: "For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions." In other words, the necessary bandwidth is just wide enough to accomodate the desired signal at the speed and with the quality required. It's just wide enough to do the job and no wider.

The NTIA manual indicates that the bandwidth may be expressed to a maximum of two decimal places. The emission designator itself will include the necessary bandwidth and emission classification in the following order:

Necessary bandwidth

BANDWIDTH	EXPRESSION
0.002 Hz	H002
0.1 Hz	H100
25.3 Hz	25H3
400 Hz	400H
3.4 kHz	3K4
6 kHz	6K
14.6 kHz	14K6
174.5 kHz	174K5
3 MHz	3M
12 MHz	12M
16.34 MHz	16M34
205.61 MHz	205M61
6.76 GHz	6G76
34.5 GHz	34G5
45 GHz	45G

Caution: To preclude the possibility of expressing the same values of bandwidth in more than one way, WARC does not permit the use of the figure 0 or one of the letters K, M or G in the first position. For example, 25.3 Hz might have been expressed as 0.0253 kHz or the 400 Hz may have been expressed as 0.4 kHz. This would mean that the 400 Hz, as an example, could then have been expressed K400 or 0K40, which is not authorized under the new rules.

Figure 1. Example of bandwidth expressions.

Type of modulation of the main carrier

Nature of signal(s) modulating the main carrier

Type of information to be transmitted

Details of the signal (optional)

Nature of multiplexing (optional)

The bandwidth must not exceed five numerals and one letter. The letter will occupy the position of the decimal point. It represents the unit of bandwidth. For example, H for Hertz, K for KiloHertz, M for MegaHertz and G for GigaHertz. A few other rules regarding necessary bandwidth follow:

Necessary bandwidth between .01 and 999.99 Hertz (Hz) shall be expressed in Hertz using the letter H in lieu of the decimal. For example, 20H is 20 Hertz (Hz) of bandwidth and 30H06 is 30.06 Hertz (Hz) of bandwidth.

Necessary bandwidth between 1.00 and 999.99 KiloHertz (kHz) shall be expressed in KiloHertz using the letter K in lieu of the decimal. For example, 16K is 16 KiloHertz (kHz) of bandwidth and 16K85 is 16.85 KiloHertz (kHz) of bandwidth.

Necessary bandwidth between 1.00 and 999.99 MegaHertz (MHz) shall be expressed in MegaHertz using the letter M in lieu of the decimal. For example, 20M is 20 MegaHertz (MHz) of bandwidth and 20M05 is 20.05 MegaHertz (MHz) of bandwidth.

Necessary bandwidth between 1.00 and 999.99 GigaHertz (GHz) shall be expressed in GigaHertz using the letter G in lieu of the decimal. For example, 15G is 15 GigaHertz (GHz) of bandwidth and 10G30 is 10.30 GigaHertz (GHz) of bandwidth.

Bandwidth expressions precede the emission symbols under the current system as well as in the new system. The emission symbols are grouped together in stringent order, using the emission symbols shown in other parts of this article. A maximum of five emission characters may follow a maximum number of six bandwidth characters discussed previously. This means, of course, that the bandwidth/emission designators taken together cannot exceed eleven characters: six bandwidth (650K04, for example) and three emission (PON), followed, if desired, by an additional two optional emission symbols (AN). Thus, an eleven

character designator might be expressed: 650K04PONAN. Normally, however, I would suspect that most Army designators will not exceed seven or so and that the use of the last two optional symbols will not be used extensively. Using some of the more current designators as examples will make it clear. The current 16F3 would equate to 16K0F3E under the new system and 3A3J would be 3K00J3E. Similarly, 6A3 would convert to 6K00A3E, 1.24F1 would convert to 1K24F1B and AO would change to HNON. None of these come even close to the maximum eleven character designator possible under the new rules.

Once the appropriate bandwidth expression is determined, the correct emission designator symbol may be extracted from the emission designator code list shown below. The code list provides the specific codes for each of the emission symbols to be used,

EMISSION DESIGNATOR CODE LIST

EMISSION DESIGNATOR SYMBOLS

FIRST SYMBOL — designates the type of modulation of the main carrier:

Symbol	Type of Emission
	UNMODULATED
N	Emission of an unmodulated carrier.
	AMPLITUDE-MODULATED
	Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated):
A	Double-sideband
H	Single-sideband, full carrier
R	Single-sideband, reduced or variable level carrier
J	Single-sideband, suppressed carrier
B	Independent sidebands
C	Vestigial sideband
	ANGLE-MODULATED
	Emission in which the main carrier is angle-modulated:
F	Frequency modulation
G	Phase modulation
	AMPLITUDE-MODULATED AND ANGLE-MODULATED
D	Emission in which the main carrier is amplitude-modulated and angle-modulated either simultaneously or in a preestablished sequence.
	PULSE
	Emission of pulses:[1]
P	Sequence of unmodulated pulses.
	A sequence of pulses:
K	Modulated in amplitude
L	Modulated in width/duration
M	Modulated in position/phase
Q	In which the carrier is angle-modulated during the period of the pulse
V	Which is a combination of the foregoing or is produced by other means
	COMBINATION
W	Cases not covered above, in which an emission consists of the main carrier modulated, either simultaneously or in a pre-established sequence, in a combination of two or more of the following modes: amplitude, angle, pulse.
	OTHER
X	Cases not otherwise covered.

SECOND SYMBOL - designates the nature of signal(s) modulating the main carrier:

Symbol	Type of Emission
0	No modulating signal.

1	A single channel containing quantized or digital information without the use of a modulating subcarrier.[2]
2	A single channel containing quantized or digital information with the use of a modulating subcarrier.
3	A single channel containing analogue information.
7	Two or more channels containing quantized or digital information.
8	Two or more channels containing analogue information
9	Composite system with one or more channels containing quantized or digital information, together with one or more channels containing analogue information.
X	Cases not otherwise covered.

THIRD SYMBOL - designates the type of information to be transmitted:[3]

Symbol	Type of Emission
N	No information transmitted.
A	Telegraphy - for aural reception.
B	Telegraphy - for automatic reception.
C	Facsimile.
D	Data transmission, telemetry, telecommand.
E	Telephony (including sound broadcasting).
F	Television (video).
W	Combination of the above.
X	Cases not otherwise covered.

OPTIONAL FOURTH SYMBOL - designates the details of signal(s):

Symbol	Type of Emission
A	Two-condition code with elements of differing numbers and/or durations.
B	Two-condition code with elements of the same number and duration without error-correction.
C	Two-condition code with elements of the same number and duration with error-correction.
D	Four-condition code in which each condition represents a signal element (of one or more bits).
E	Multi-condition code in which each condition represents a signal element (of one or more bits).
F	Multi-condition code in which each condition or combination of conditions represents a character.
G	Sound of broadcasting quality (monophonic).
H	Sound of broadcasting quality (sterophonic or quadraphonic).
J	Sound of commercial quality (excluding categories defined for symbols K and L below).
K	Sound of commercial quality with the use of frequency inversion or band-splitting.
L	Sound of commercial quality with separate frequency-modulated signals to control the level of demodulated signal.
M	Monochrome.
N	Colour.
W	Combination of the above.
X	Cases not otherwise covered.

OPTIONAL FIFTH SYMBOL - designates the nature of multiplexing:

Symbol	Type of Emission
N	None.
C	Code-division multiplex.[4]
F	Frequency-division multiplex.
T	Time-division multiplex.
W	Combination of frequency-division multiplex and time-division multiplex.
X	Other types of multiplexing.

1. Emissions, where the main carrier is directly modulated by a signal which has been coded into quantized form (e.g., pulse code modulation), shall be designated, as either an emission in which the main carrier is amplitude-modulated, or an emission in which the main carrier is angle-modulated.

2. This excludes time-division multiplex.

3. In this context the word "information" does not include information of a constant, unvarying nature such as provided by standard frequency emissions, continuous wave and pulse radars, etc.

4. This includes bandwidth expansion techniques.

CURRENT SYMBOL	NEW SYMBOL	CURRENT SYMBOL	NEW SYMBOL
A0	NON	A1	A1A
A2 (STC = RLB/RLM)	A2A	A2 (STC other than RLM/RLB)	A2D
A2A	R2B	A2B	B2B
A2H	H2B	A2J	J2B
A3	A3E	A3A	R3E
A3B	B8E	A3H	H3E
A3J	J3E	A4	A3C
A4A	R3C	A4J	J3C
A5	A3F	A5C	C3F
A6	A7B	A7	A7B
A7B	B7B	A7J	J7B
F0	NON	F1	F1B
F2 (STC = RLB/RLM)	F2A	F2 (STC other than RLB/RLM)	F2D
F3 (NTS = S363)	F1E	F3 (No S363 note)	F3E
F4	F3C	F5	F3F
F9 (with NTS: S583, S600, S605, S606, S607 or S616)	G7W	P0	P0N
P0E	P0N	P0G	M1DET
P1	P1B	P1D	K1A
P2	P2D	P2E	L2A
P2F	M2A	P3	K3E
P3D	K3E	P3F	M3E
P6	P7B		

NOTES: (1) STC refers to station class and NTS stands for notes. The appropriate station class and/or note to use may be found in the NTIA manual.

(2) The symbols RLB and RLM, contained in the NTIA manual, indicate: RLB - a radio beacon station in the aeronautical radio navigation service intended for the benefit of aircraft. RLM - marine radio beacon station in the maritime radio navigation service intended for the benefit of ships.

Figure 2. Table of emission symbol conversions.

including the two optional ones cited. Additionally, Figure 2 provides a conversion table for changing current emission symbols to the new symbols required by the WARC rulings. The conversion table and code list were developed by NTIA based on WARC rulings.

To construct the correct bandwidth/emission designator, first determine the bandwidth of the signal(s) and then ascertain the emission characteristics. Then it is a relatively simple matter to construct the new designator. Take the present 16F3 designator as an example. It reflects a bandwidth of 16 kHz and an emission symbol of F3, which under current rules equates to: F equals Frequency Modulation (FM) and the 3 designates a voice signal. Using the new rules and tables, the 16F3 would convert to 16J0F3E. This would equate to: 16 kHz of bandwidth with an emission of F3E which would break down into the following: F is Frequency Modulation (FM), 3 indicates a single channel containing analogue information and the E equates to telephony (including soundbroadcasting). Fourth and fifth optional symbols might have been added to the designator, if desired. The optional symbols could also have been derived from the tables previously mentioned.

In the final analysis, the new bandwidth and emission designators should provide radio frequency managers, planners and users at the national and international levels a better way to describe radio transmissions associated with various telecommunications equipment, operations and frequency management activities.

The radio frequency spectrum is a natural resource and as such is subject to problems similar to those normally associated with other natural resources such as fossil fuel. Both are in short supply and high demand and both require tight control to ensure that further technological advancements within our known environment can be accomodated.

With an improved capability to better identify bandwidths and emissions, frequency managers should be able to reduce the potential for radio interference while at the same time providing enhanced frequency management techniques to accomodate the newer and more complex telecommunications systems being developed (or to be developed) for use within an already congested communications-electronics environment. Time will tell.

Significant details of the new bandwidth and emission designator conversion rules may be summarized as follows:

Implementation within the Army will begin January 1982.

The new methods of constructing emissions will improve current standardization efforts at the national and international levels.

New bandwidth/emission designators will be constructed in accordance with the rules outlined by the WARC and as implemented by the NTIA and the military services.

DESIGNATOR	TYPE OF EMISSION
HNON	Continuous Wave (CW)
1K24F1B	1.24 kHz necessary bandwidth for a frequency modulated single channel of telegraphy.
16KF3EJN	16 kHz necessary bandwidth for commercial quality telephony.
650K04P0NAN	650.04 kHz necessary bandwidth for unmodulated pulse.
6M25C3F	6.25 kHz necessary bandwidth for television (vision and sound).

Figure 3. Examples of emission designators prepared by NTIA.

Attention to detail will pay off in the long run when converting the current emission designators to the new ones described in this article. With practice and time, use of the new designator rules should become second nature to us all.

The bandwidth portion of the designator will not exceed five numerals and one letter. The letter will occupy the position of the decimal and will represent the unit of bandwidth. For example, H for Hertz, K for KiloHertz, M for MegaHertz and G for GigaHertz. Fractional bandwidths will be expressed to a maximum of two decimal places following the letter. Example: 2K04F1B or 149M05F3E (see also Figure 3).

The emission portion of the designator which immediately follows the bandwidth data will be constructed to reflect, in the following order, the classification of the emission (see also Figure 4).

First symbol: Type of modulation

Second symbol: The nature of the signal(s)

Third symbol: The type of information to be transmitted

Fourth (Optional) symbol: Details of the signal(s)

Fifth (Optional) symbol: The nature of the multiplexing

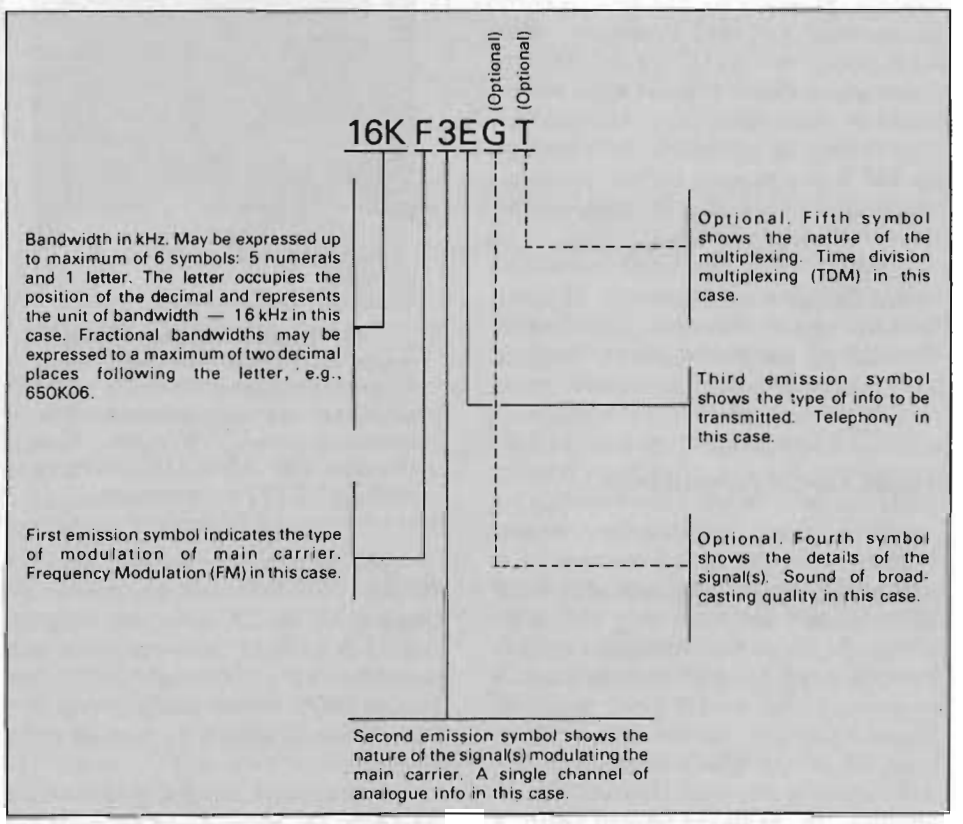

Figure 4. Construction of bandwidth and emission designators.

The combined bandwidth and emission data will not exceed eleven characters. The bandwidth shall not exceed six characters (five numerals and one letter) and the emission shall not exceed five characters of which three will be the basic symbols followed by two optional ones, if desired.

Many of the current emission symbols (e.g., AO) may be "Mass" changed directly to a new symbol (e.g., NON) by using the information found in Figure 2. Composite type emissions, such as A9, F9 and P9, however, will have to be "manually" changed once the specific classification of the emission is determined. For example, 6A9B may convert to 6K00B9W, using the emission codes provided by the WARC.

Army radio frequency applications must reflect new designators beginning January 1982. "Old" designators in current frequency records should be phased out by "Mass" and "Manual" change techniques by mid-1983.

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