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Chapter 4　Multiplexed Broadcast on the Ground System

４－４　Emergency Warning Broadcast　（Author：Seiichi Namba）

At present, the research and studies for transmitting promptly the prediction information of the earthquake such as Tokai earthquake and tsunami occurred after the earthquake are widely carried out. The broadcast is the most effective medium conveying urgently and correctly very important information like earthquake prediction and tsunami warning to related people completely. However, there was a problem that the information could not be conveyed to them in case power switches of receivers were not turned on at midnight, for example, in conventional broadcast. The emergency warning broadcasting system was developed and realized for solving this problem. The system is such as broadcasting system that the specified control signals are sent out from broadcasting station in preceding the emergency broadcast, dedicated receivers of the emergency warning broadcasting receive the control signals and make the receivers turned on automatically, then people can surely listen to the emergency broadcast.

Various proposals and development of such systems are done since 1960's and EBS (emergency broadcasting system) in the United State of America and the system of weather radio (NOAA) are carried out. In Japan the emergency warning broadcasting system started in operation on September 1, 1985 and the signals testing the receivers are broadcasted regularly. The first real broadcast were operate in broadcasting the tsunami warning at earthquake in Kyushu Area on March 18, 1987.

４－４－１　Composition of the emergency warning broadcasting system

The composition of the emergency warning broadcasting system is shown in Fig.4-33. The control signals (the start signals) which become start sign of the emergency broadcast are inserted to the broadcasting line after stopping the program in progress and are broadcasted through the relay line and broadcasting transmitter. At the receiver of the emergency warning broadcasting system, the tuner and detection circuit of the code signals are always operating in very little power and the power source of audio out-put circuit turns on after receiving the start signals and warning sound and

following announce of the emergency broadcast are heard. After the emergency broadcast are finished, the receiver gets back to former waiting state by end signals.

Because no one decides previously when the emergency warning broadcast is sent out and it broadcasts very important information, the following strict requirement have to be satisfied. Those are

① the receiver has very high reliability and low power consumption, because it has to always wait for continuously,
② no error operation occurs by program sounds and noises,
③ the receiver operates surely under various receiving conditions when the control signals come,
④ the receiver starts to operate promptly when the control signals come.

To satisfy these conditions, the signal system described in following clause 4-4-2 is adopted, the start signals are sent out more than 6 seconds and 15 seconds or more especially in medium wave and short wave radio broadcast and the unit codes are sent out repeatedly. Therefore, the receivers can surely operate even at the area in much noise because of low signal level and the fading occurring area because of interference between reflection waves from the ionosphere and the ground waves. And the test signals (using the end signals) for testing the receivers are sent out regularly for ascertaining the receivers are right state or not and lamp is lit when the test signals are received.

4－4－2　Signal system

The role of radio is important for easily letting people know the situation at emergency like disaster. Television is also a medium to inform viewers emergency. Then the control signals of the emergency warning broadcast are desirable to multiplex with sounds in consideration for common use in the radio and the television.

There are various methods as ways multiplexing the control signals with radio and television sounds and they are classified in Table 4-16. The table shows not only those of the emergency warning, but also automatic reception of the traffic information and news.

Code signal system that has the composition shown in Fig. 4-34 was adopted as the signal system of the emergency warning broadcast in Japan. The code signals are FSK (frequency shift keying) using two frequencies in middle band of sound. The signal system is designed for satisfying strict requirement as the emergency warning broadcasting system. The following are basic principle as the signals.

a. Frequency of the signals

Considering usage in both radio and television at the emergency warning broadcast and requirement for high reliability of transmission, the middle frequency band is most suitable for conveying sound because the band is under the best control among high, middle and low sound frequency bands. And as the middle frequency

sounds themselves are most easy to hear, signal sounds themselves can be used as warning sounds too. Moreover, the signals are determined in considering that the phase of the signal waveform is continuous (making the signal frequency integer times of code transmission rate), that influence by waveform distortion occurred during transmission is few (two frequencies have no harmonic relation each other) and that the signals give no sense of incongruity at hearing as warning sounds.

b. The tone signal system and code signal system

The tone signal system that identifies the control signals by signals of definite frequency has been used since past time because the system is simple in principle but this system makes error operation in case that the frequencies in broadcasting programs are same as the tone signals. Therefore it is necessary for the tone signals to be discriminated from program sounds by sending out the signals of definite frequency for enough long time that is not in the usual program sounds. For instance in the emergency broadcasting system, when two frequencies are received at same time more than 8 seconds, the signals are identified as the tone signals. And the system using tone signals is not appropriate for very close service that discriminates objective area of the emergency warning broadcast.

On the other side, the code signal system is able not to cause error operations by program sounds at even short time. For example, in case that operation of a receiver starts when a code of 64 bit length (1 second) which composed from a random arrangement signal of 1 and 0 signals at the rate of 64 times per second is received, probability that program sounds or noises added in code detector circuit of the receiver coincide with the specified code become $1/2^{64}$. As the comparison of the coincidence is occurred at the rate of 64 times per 1 second, average time interval of coincidence becomes $2^{64} \times (1/64) = 91$ billion year, that is the time length out of question. And as the code signal system can process digitally at the receiver, the simple, high reliable operation can be done by using IC circuits.

c. Modulation system

There are one wave ASK (amplitude shift keying) system at which 1 and 0 of the code signals correspond to large and small levels of a specified sound frequency signal respectively and two waves FSK (frequency shift keying) system at which 1 and 0 of the code correspond to two frequencies respectively. The former is simple in principle but judgment error occurs in case that reference levels are not kept exact on judging the code signals at the receivers. It is very difficult to keep highly reliable under conditions of strong and weak electrical waves in fading especially.

On the other side, two waves FSK system makes sure operation practicable as the code can be judged from difference of two frequencies. And two waves FSK becomes familiar to hear as the warning sound.

d. Transmission rate of the code

In case of sending a desired length of code, if transmission rate of code becomes

high, transmission time becomes short and it can eliminate non-operation by sending the same code signals repeatedly. But high speed makes bandwidth of control signals wide, and becomes disadvantageous for noises. At the point of hearing sense, in case selecting among the power of 2, two frequencies are heard separately under 32 b/s and they are apt to become harsh, mechanical and grating sounds over 128 b/s. About 64 b/s is the most appropriate to hear.

e. Kind of signals

The configurations of the signals for the emergency warning broadcasting system in Japan are shown in Fig. 4-34. And there are two kinds in the start signals, the category Ⅰ start signal and the category Ⅱ start signal. The former signal makes all receivers of the emergency warning broadcast operate and the latter is the signal (used for tsunami warning) that receiving people can previously select the operation state making the receiver turn on or not. And the area classification code is provided in the control signals for discriminating the relevant area and this code can protect unnecessary operation caused by the co-channel wave from remote broadcasting station at night. In addition of the prefecture code, the large legion code like Kanto Area and Kinki Area and the whole country code are prepared in the area classification code. For instance, the receiver set on Tokyo operates when either code of Tokyo, Kanto and whole country is sent out. Moreover, the preceding code is necessary code for discriminating between start signal and end signal (which is same pattern as the fixed code).

4－4－3 The receiver for emergency warning broadcast

The receiver for emergency warning broadcast has composition shown in Fig. 4-33. A unique method is used for the circuit detecting 16 bit unit code of the emergency warning signal. Fig. 4-35 shows an example of the circuit and the operation principle. (Here shorter pattern is shown than real pattern for explanation.)

At first, input signals are sent into the shift resister after being sampled by the fast clock having N times of code transmission rate (for example, 16 times). That means 1 bit of the input code is held in the shift resister with N samples (therefore 16 bits become 256 bits with 16 times sampling), and (Fig. 4-35 shows the pattern of 5 bits unit with N=4).

Next, 16 samples are taken out every N samples in the shift register and are compared at the coincidence circuit whether they coincides with the specified pattern previously set or not. After the right code is received, N coincidence pulses continuously come out from the output of incidence circuit during 1 bit time width ideally. Generally, as all N samples don't coincide under the influence of noises and wave distortion at the input signal, the judgment criterion K (K=2. 3 etc. at illustration example in Fig. 4-35) is set and it is judged that the specific code pattern (the emergency warning broadcasting signal) is received when more than K incidence pulses in N samples are detected for 1 bit duration.

In the emergency warning broadcasting system the code signals coming independently can be caught and received immediately and correctly without preparing the signal for bit synchronization and the extracting circuit as the unique receiving circuit above described is adopted. Namely, the system which detects the code pattern after establishing at first bit synchronization is not adopted but the system which detects it by using independent clock timing at the receiver is adopted. As the result, This system attains extremely high reliable system which does not take long time for sure start of operation and has no state that does not receive the control signals because of being not able to get bit synchronization under bad receiving condition. At this time, the receiver needs stable clock timing and crystal for a clock and watch can be utilized for it. The value that is divided from the crystal frequency for clock and watch is selected as the code transmission rate for this purpose.

By using such receiving method, the emergency warning broadcasting system has extremely strong feature for random noise and the code control signals can be received even at the conditions being not able to listen the sound program at all. It has been ascertained that the code control signals are received without trouble at all broadcasting media such as the medium and short wave radio, FM radio and TV (sound) on the possible condition of broadcast service including special propagation area.

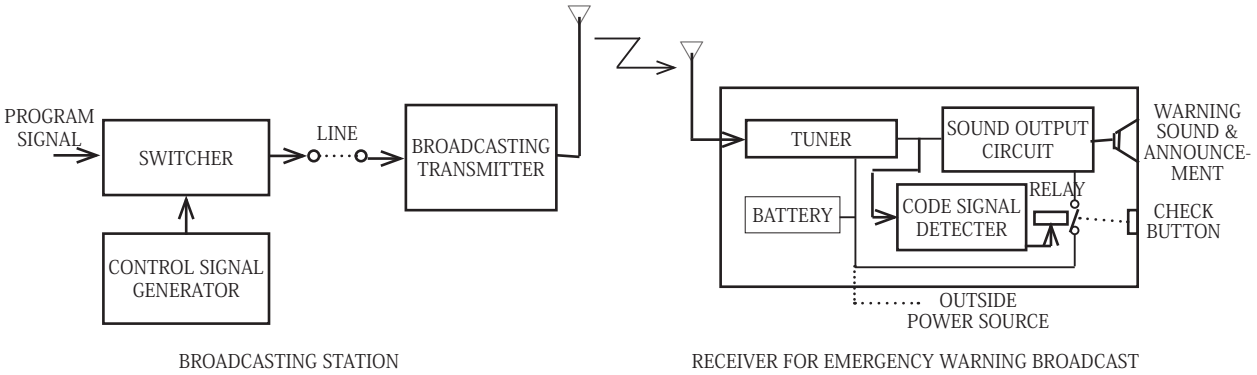

Fig. 4-33 Emergency warning broadcasting system

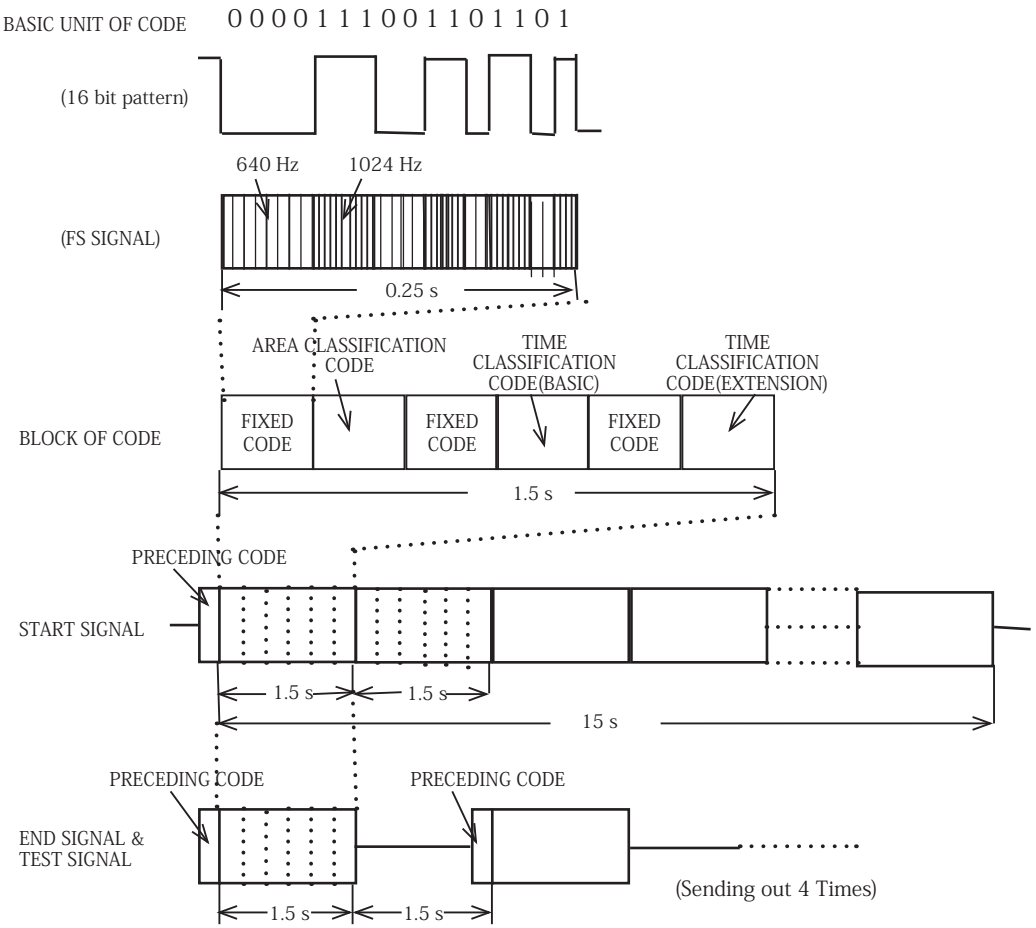

Fig. 4-34 Composition of emergency warning signals

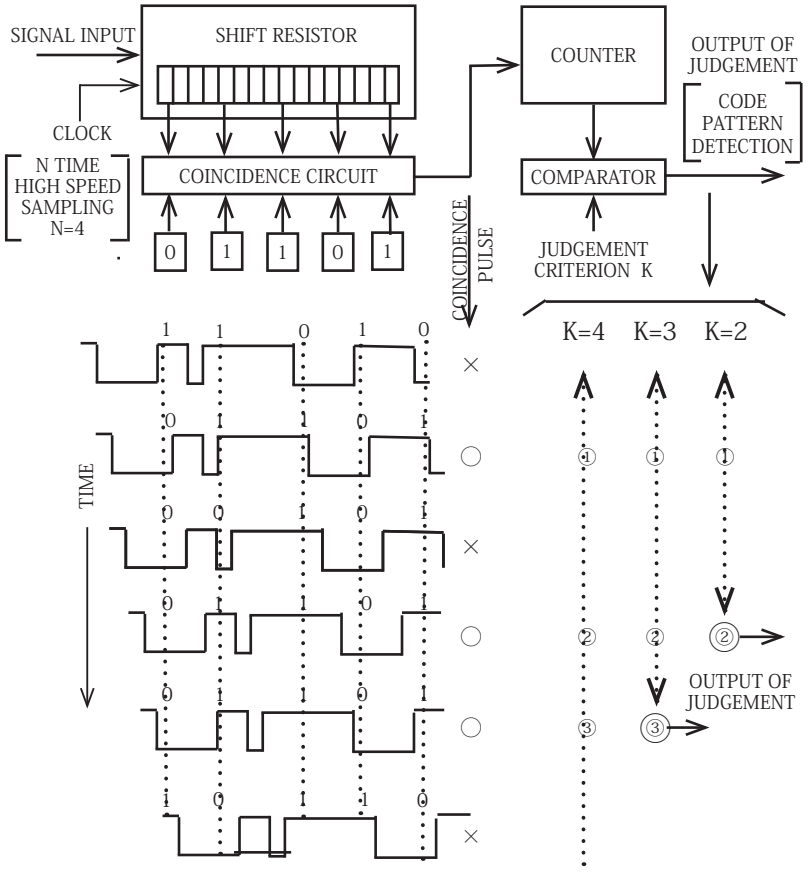

Fig. 4-35 Conposiyion of code pattern coincidennce circuit and principle of working (Example of 5 bit pattern and N=4)