REPORT 1060-1

ENERGY SAVING METHODS IN AMPLITUDE MODULATION BROADCASTING AND THEIR INFLUENCE ON RECEPTION QUALITY

(Question 44/10, Study Programmes 44A/10 and 44F/10)

(1986-1990)

1. Introduction

For high-power amplitude modulation transmitters used for LF, MF and HF broadcasting, reduction of power consumption has always been of major importance. Power consumption savings can be achieved by improving the efficiency of transmitters and/or by using other amplitude modulation techniques.

2. Improvement of transmitter efficiency

In the past, several transmitter systems have been developed with more efficient power amplification, e.g. the Doherty system, the Taylor principle (addition of third harmonics), etc. In modern transmitters, modulation amplifiers in switched mode have been introduced, e.g. pulse duration modulators (PDM) or pulse step modulators (PSM). Using such modulators, the overall efficiency of the transmitter has been improved by 10% or more compared with transmitters using conventional modulation techniques. However, such transmitters may radiate spurious signals caused by the switching frequencies and these spurious signals can cause interference in adjacent channels. Another disadvantage is that even small levels of over-modulation can lead to unacceptable amounts of distortion. However, both of these disadvantages can be reduced by appropriate control of the audio signal input and by the choice of a switching frequency that is a multiple of the channel spacing. Further measurements should be carried out to determine the full effects of radiated spurious signals from PDM or PSM transmitters on the adjacent-channel protection ratio, since this type of high-power transmitter will become increasingly available in the future.

3. Energy saving using other amplitude modulation techniques

It is already well established that the future use of SSB transmissions will achieve a considerable energy saving – in Table II of Report 1059 reductions in power consumption of up to 80% compared to equivalent DSB transmissions are indicated.

Two alternative amplitude modulation transmission systems employing carrier control proportional to the mean level of modulation have been proposed. Both can be introduced easily into modern transmitters. These are:

3.1 Dynamic amplitude modulation (DAM)

DAM was proposed in early 1939, and has been in operation successfully for several years in a number of European countries at MF and more recently in the Netherlands at HF. An overall reduction in power consumption of 50% for average programme material using moderate audio compression has been achieved. The level of energy saving depends upon the reduction of carrier power for zero modulation (**Fig.** 1). Additional dynamic compression occurs in the receiver due to the action of the automatic gain control (AGC).

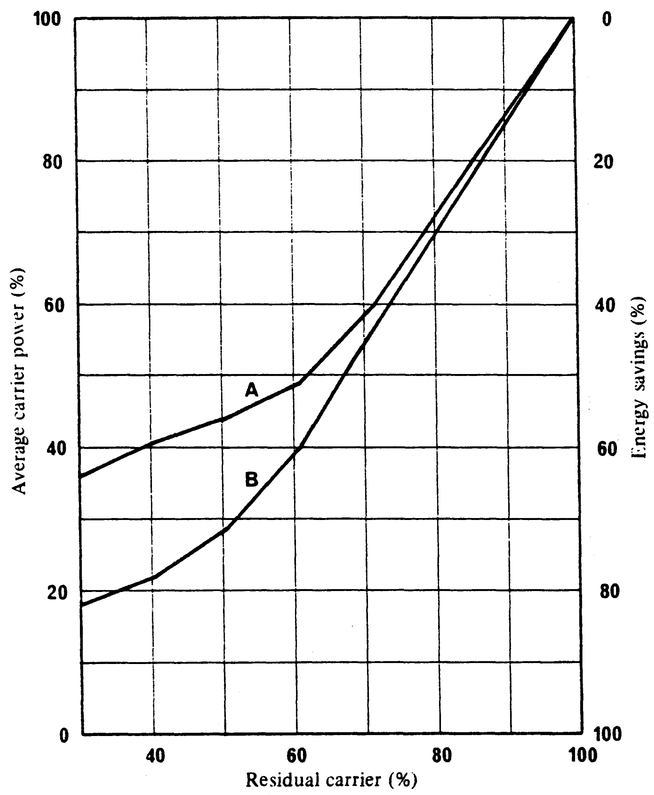

FIGURE 1 – *Relationship between carrier power, energy savings and residual carrier (knee-shaped characteristic with offset)*

Curves A: 9 dB compression gain
B: 0 dB compression gain

Rapid changes in the level of programme modulation can cause distortion. Moreover, programme pauses, during which the carrier level is reduced, result in an increase of noise and interference. However, these disadvantages can be reduced by the choice of an appropriate level of carrier control plus a limited reduction of the carrier during zero modulation (Fig. 2). Also the increase in noise and interference during programme pauses will be partially compensated by the increase in the mean programme level of the received DAM signal (i.e., depth of modulation). Based on theoretical investigations, a reduction of the wanted-to-interfering signal ratio of the order of 1 dB can be expected [CCIR, 1982-86]. The carrier regulation characteristic of some transmitters can be easily modified to take account of specific conditions of programme content and possible interference levels.

Further studies would be useful to determine the consequences on reception quality and effective coverage area for transmissions using DAM, and to determine any change in protection ratio for conventional amplitude modulation transmissions experiencing interference from a DAM transmission.

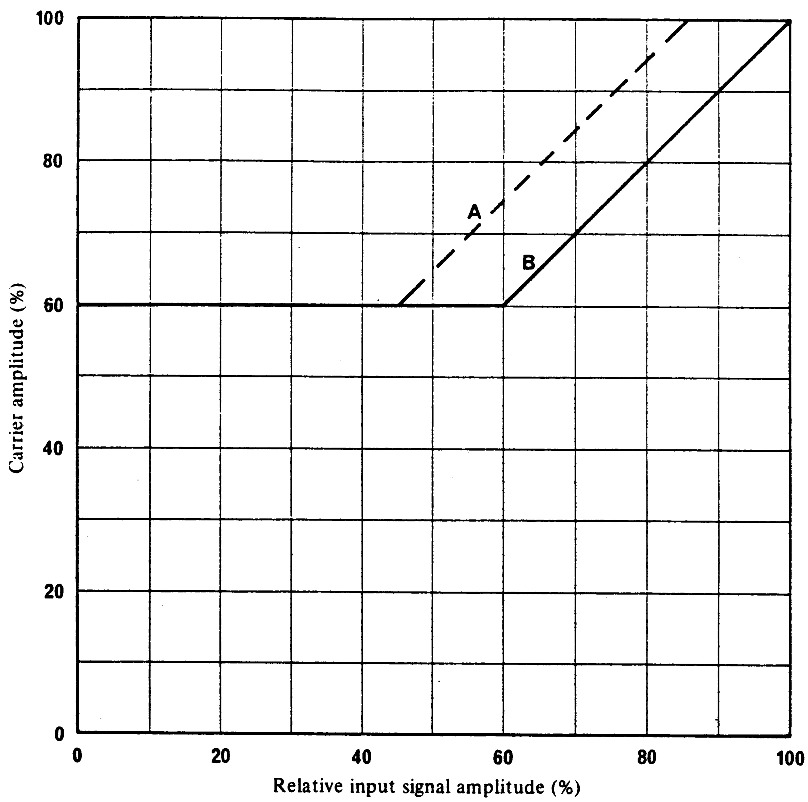

FIGURE 2 – *Carrier control characteristics for a transmitter using DAM technique*

A: knee-shaped characteristic with offset

B: knee-shaped characteristic

3.2 AM companding system*

This method has been developed in the UK, [Lawrence et al., 1986 ; Williams, 1986] and differs from DAM in that the compression is increased approximately linearly from zero in the unmodulated condition to a maximum value at 100% modulation, whilst maintaining the appropriate depth of modulation. This is seen as having the following advantages:

- receiver AGC operation compensates for the applied compression ;
- the reduction of peak voltages and powers allow further savings due to redesign of the transmitter output; reduced peak demand may allow lower electricity charge rates ;
- maintenance of normal power levels during periods when the programme content is most susceptible to interference, i.e. under conditions of low modulation.

* The United States of America points out that the term "companding" is used extensively in North America in a different system.

The results of the various laboratory tests and field trials conducted in the UK have indicated that the application of Amplitude Modulation Companding (AMC) with a maximum compression of 3 dB causes negligible loss in reception quality, even in fringe areas. Tests involving interfering signals were conducted with the interfering programme the same as the wanted programme and the interfering transmitter synchronised with the wanted transmitter, and with the interfering programme different from the wanted programme. Co-channel and adjacent-channel protection ratios were not significantly affected by changing from conventional AM to AMC.

A number of UK MF transmitters have been using AMC since November 1987.

REFERENCES

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