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Interference due to data transmitted after the television field synchronising signal

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INTERFERENCE DUE TO DATA TRANSMITTED AFTER THE TELEVISION FIELD SYNCHRONISING SIGNAL

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Summary

This report describes work which has been carried out to investigate interference caused by data transmitted during the period immediately following the broad pulse sequence of the television field-synchronising waveform. It is known that data signals transmitted at this time will appear on field flyback lines and can sometimes cause interference. This report suggests a way of transmitting the data without causing interference, but concludes that a preferable long-term solution would be to modify the field-synchronising waveform in such a way as to provide extra line periods during which to transmit the data.*

**Throughout this report, the term 'data' will be understood as referring to any signal transmitted during the vertical interval whether it be a data signal, test signal, control signal, or identification signal.*

Issued under the authority of

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1. Introduction

There is an increasing demand for a greater proportion of the field blanking interval of the television waveform to be devoted to the transmission of data. With this in mind the EBU Synchronising Signal Sub-group[1]** was formed to study ways in which the standard field-synchronising signal (which at present occupies seven consecutive line periods) may be shortened without affecting the performance of television receivers designed to operate on the present standard waveform. Work already carried out[2] has investigated a number of alternative modifications to the field-synchronising waveform, designed to increase the number of line periods on which data could be transmitted. A summary of the conclusions resulting from this work will follow in Section 4. However, there are unused line periods in the existing waveform, particularly those occuring immediately after the broad pulses, which, it is felt, might be capable of carrying additional data signals. It is known that data or test signals transmitted during the field blanking interval may cause interference to the television picture if they occupy one of three regions which, for the purpose of this report, will be designated thus:

Region A
Lines immediately preceeding the broad-pulses (i.e. during the first equalising pulse sequence). In this case interference may be visible at the bottom of a picture which is slightly under-scanned or displaced upwards.

Region B
Lines immediately following the broad-pulses: in these circumstances interference may be visible on receivers whose flyback suppression is inadequate. It should be noted that the first 2½ lines of this region contain equalising pulses.

Region C
Lines near the end of the field-blanking interval. Under these conditions the pulses may be visible at the top of a picture which is slightly under-scanned or displaced downwards.

Regions A and B are separated by the broad-pulse sequence and Regions B and C are separated by those lines on which data signals are at present transmitted. The existing allocation of lines for data transmission is summarised in Table 1, and is illustrated relative to regions A, B and C in Fig. 1(a). It will be apparent that there is very little space between regions B and C that has not already been designated for other purposes, nevertheless, lines 13 (326) and 14 (327) are seen to be available for the transmission of data. In addition, since lines 17 (330) and 18 (331) are used only internationally, they also appear to be free for data transmission within the U.K.

The object of the work described in this report was to investigate the visibility on domestic television receivers of data transmitted during Region B.

2. Experimental work

Previous experimental work[3] has shown that data signals would have to be reduced by 15 dB to avoid interference if transmitted during the flyback period of receivers (region B). More recent work, using a somewhat simpler simulation of a data signal, has suggested that the level should be no greater than −18 dB. In these experiments, a pulse was produced to represent data which could be adjusted in level, width and location. The base of the pulse was fixed at black-level (0 V) and the tip was variable up to white-level (0·7V); the width was variable up to 50 μs and the pulse could be located on any line during the field blanking period. The pulse was normally used with a width of approximately 50 μs, since this corresponded to the duration at which it was most visible. The pulse was then added to the television waveform. Arrangements were made to modulate the resulting signal on to an appropriate u.h.f. carrier, and the modulated r.f. signal was distributed to a selection of receivers. These consisted of two colour receivers, and five different black-and-white receivers of recent design. The visibility of the pulse was found to depend to some extent on the settings of the contrast and brightness, so each receiver was adjusted to produce the brightest picture of which it was capable, consistent with good focus and e.h.t. stabilisation. This was the most interference-prone setting for the receivers.

With a level corresponding to peak-white (0·7 V), the pulse was clearly visible as a flyback line across the picture on all the monochrome receivers tested as well as a black and white picture monitor which was also used,

**Since the completion of this work, the EBU Synchronising Signal Sub-Group has been disbanded. However, it is intended that this work should form the basis of a direct contribution to the CCIR although not on either of the colour receivers. As already stated, it was found that the level of the pulse had to be decreased by −18 dB before becoming invisible on the most sensitive receiver. Fig. 2 is a graphical representation of these results for the five black-and-white receivers in which the level (expressed as dB below 0·7 V) at which the pulse becomes invisible is plotted as a function of its position expressed by the line number. The variations in level over the range of pulse positions indicates that flyback suppression is not constant throughout field flyback. The graph also illustrates the distribution of flyback times amongst the receivers. (The limits of flyback are indicated by the points at which the curves end).

3. Discussion

The two main conclusions to be drawn from the work are:

(a) Field flyback times as long as 10 lines have been encountered and there could, of course, be television receivers with even longer flyback times.

(b) Those lines occurring during the field flyback period (Region B) can contain no data information at a level greater than −18 dB relative to 0·7 V.

In view of the restricted number of television receivers on which experiments were carried out, the figure of

Line Numbers		Authority	Arriving at Domestic Receiver or not
12,325	Noise measurement	BBC	No
13,326	No claim	—	
14,327	i) At Source Programme Identification (COSINE)	BBC	No
	ii) Distribution No claim	BBC	Yes
15,328	National data	IBA (No BBC Claim)	Unknown
16,329	National and International data line	CCIR	Yes
17,330 18,331	International I.T.S. (Figs. 1,2,3,4 of CCIR green book, Vol. 5, Part 2, pp.244 etc)	CCIR	No
19,332	National I.T.S. (Fig. 15, p.19 of Spec. on TV Standards for 625 lines System I, Jan. 1971)	BBC/IBA	Yes
20,333	National I.T.S. (Fig. 16, p.19 of Spec. on TV Standards for 625 lines System I, Jan 1971)	BBC/IBA	Yes
21,334	Internal reference signals (four lines of 100% colour bars)	BBC	No
22,335	International Noise measurement	CCIR (line 12 used by BBC)	No

TABLE 1

Table 1 - Established and proposed uses for television lines in the field-blanking interval of the 625/50 television waveform in the United Kingdom

−18 dB must be regarded as being very tentative, and it seems sensible to allow a safety margin and assume a level of about −20 dB. It can be shown that for NRZ* coding without parity checking, the signal-to-noise ratio at which the error rate is on the margin of acceptability is around 18 dB. Thus the transmission of data at −20 dB would require a conventional video signal-to-noise ratio of at least 38 dB. This might be achieved under good conditions but it is unlikely to be achieved under normal conditions.

An effective improvement in signal-to-noise ratio might be achieved by making use of the comparatively large time available during the field flyback period, Region B. Thus, if the information were spread over n lines instead of transmitting it all on one line, and the bandwidth were reduced by a factor of n, the dB improvement in signal-to-noise ratio would be given by $10 \log_{10} n$. This proposal would have the advantage of having a high resistance to to the effects of receiver mistuning because of the reduced bandwidth. A similar improvement in signal-to-noise ratio would be achieved by transmitting the information at the original bandwidth, repeating it on consecutive lines, and recovering it with one-line delays. As an example, if one line of data were transmitted over, say, 8 lines (by either of the two methods outlined above), an improvement in signal-to-noise ratio of 9 dB could be expected. This represents a realistic case, since this is the approximate duration of field flyback available for data transmission.

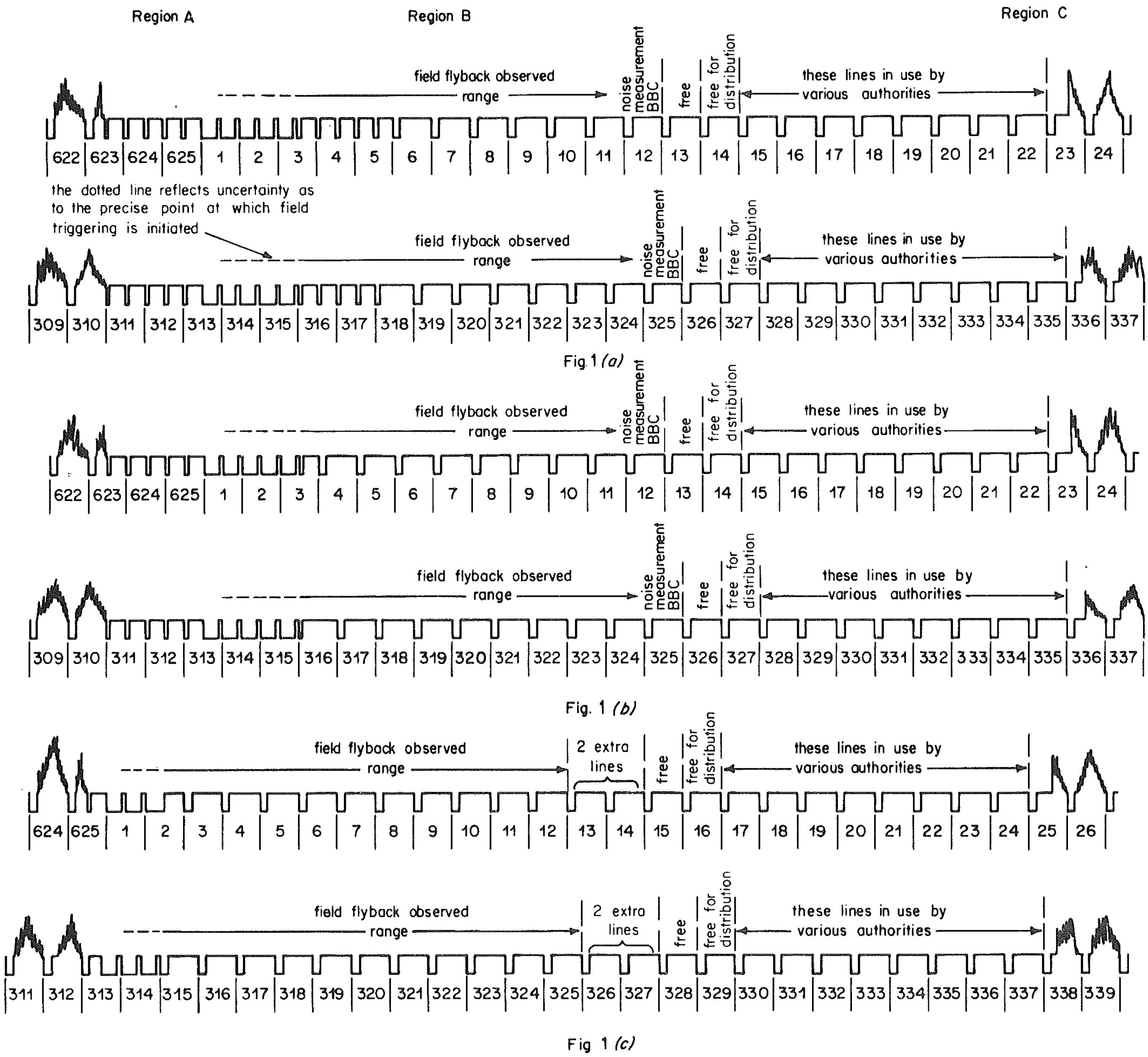

Fig. 1 - *(a) Allocation of lines during field-blanking for System I*
(b) Allocation of lines during field-blanking for proposed new field synchronising signal (First Proposal)
(c) Allocation of lines during field-blanking for proposed new field synchronising signal (Second Proposal)

*NRZ Non-return-to-zero

Thus, a signal-to-noise ratio of 29 dB would be required, and this is more likely to be achieved in practice. The average bit-rate attainable under these conditions would be approximately 13 kbs^{-1} for simple NRZ coding[3], but would be less for other methods of coding such as bi-phase and delay modulation. Greater average bit-rates could be obtained at the expense of signal-to-noise ratio.

Methods of these kinds are thought to be the only way of using lines in Region B. The presence of equalising pulses on the first 2½ lines of this region is inconvenient but does not change the amount of data which potentially could be transmitted.

4. Proposed modified field synchronising signal

It is at this stage logical to consider how this work may be linked to previous work[2] in which two proposals for the simplification of the field synchronising waveforms were made. These two proposals are summarised below.

4.1. A First Proposal

It has been shown that it would now be possible to remove four of the five equalising pulses which follow the broad-pulse sequence without impairing the performance of domestic television receivers. This modification to the waveform which could be introduced at once without detriment to the received picture is illustrated in Fig. 1(b) in which it can be seen that line numbers 4 and 5 in one field and line numbers 316 and 317 in the other field become free of equalising pulses. This would enable Region B to be used in the way already discussed but without the inconvenience presented by the five post-sync equalising pulses. This advantage would clearly be very slight.

4.2. A Second Proposal

An alternative proposal which would release two additional line-periods is illustrated in Fig. 1(c). In this proposal, all the equalising pulses are removed and replaced by only one pre-sync equalising pulse on alternate fields. The number of broad pulses is also reduced to three and this has the advantage that the beginning of the broad-pulse sequence is advanced by two lines and thus increases by two the number of lines clear of Regions A, B and C. The removal of two of the broad pulses results in the appearance of a further line in Region B. This proposal has been thoroughly investigated[2] and is not suitable for introduction at present because of interlace problems in some receivers. However, it is attractive, and with the co-operation of receiver manufacturers, it may be possible to plan for its introduction at some later date. Future receivers could be made compatible with both the existing and proposed waveforms; after, say, ten-to-fifteen years, the number of television receivers affected would become negligible and the new waveform could be introduced, providing two more free lines in the field blanking period, and one more in Region B.

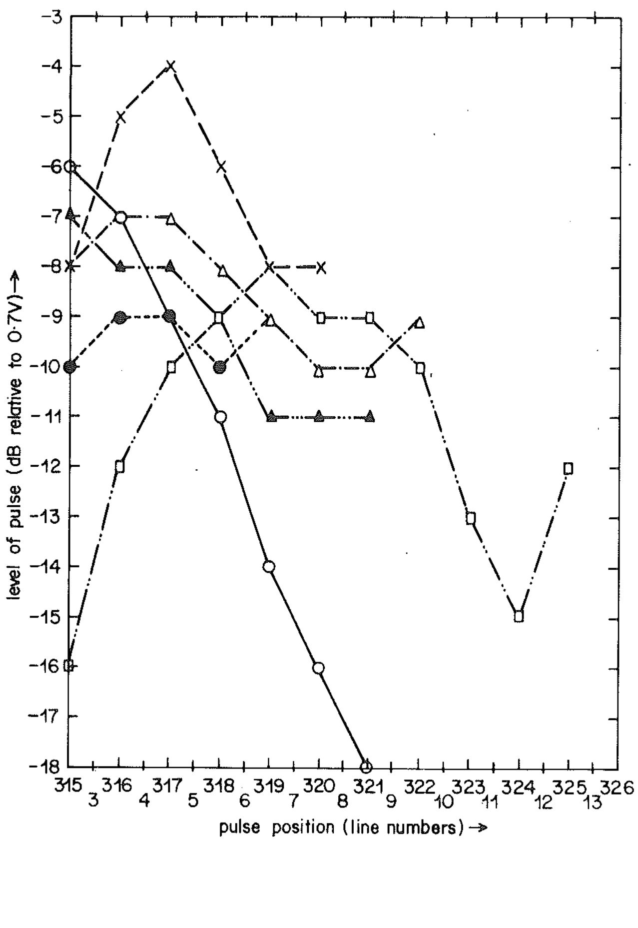

Fig. 2 - Level of data pulse which is just invisible, as a function of a pulse position

5. Conclusions

Unfortunately, in this type of test, it is never possible to obtain receivers which are fully representative of all types at present in use in the country, and consequently the possibility that durations of field flyback in excess of ten lines may be found on some receivers cannot be ruled out. In that event, lines 13 (326) and 14 (327) might be in Region B and the only lines which could conceivably be used for the transmission of data would be 17 (330) and 18 (331), but this would be restricted to the country of origin, since these lines at present carry the international insertion test signals. Alternatively, further data-carrying capacity might be achieved by exploiting the possibility of sending low-level data during Region B, as discussed in Section 3. In the longer term the situation could be eased by the introduction of the modified waveform described in Section 4.2. and illustrated in Fig. 1 (c). This would release two extra lines for the transmission of data. However, this could only be done with the co-operation of manufacturers, and after a ten-to-fifteen year period.

It is now proposed to carry out broadcast tests to determine the suitability of lines 13 (326) and 14 (327) for the transmission of data. This work will form the subject of a further report.

6. References

1. Report on the first meeting of the Synchronising Signal Sub-group of the EBU Technical Working Party Com.T.(M) P. 5–E.

2. An investigation into an EBU proposal for a simplified television field synchronising signal. BBC Research Department Report in course of preparation.

3. The Transmission of Data Signals with Television. BBC Research Department Technical Memorandum No. EL-1034, December 1971.

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