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TELEVISION TRANSMITTER TESTING BY SIDEBAND ANALYSIS

THE COST OF THE TEST EQUIPMENT installed with the transmitter at a television station is a relatively high percentage of the total cost of the station. This expense is essential if the Broadcasting Authority concerned is to provide and maintain the high quality of transmissions expected of it and to obtain maximum return on the investment in the capital equipment.

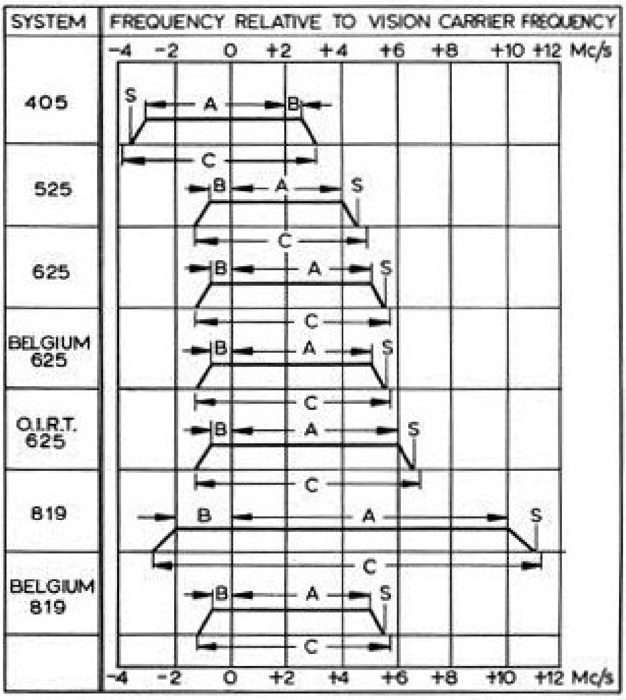
A Television Transmitter Sideband Analyser is a particularly indispensable piece of equipment, both during the commissioning of a station and for maintenance purposes thereafter. The final stages of a transmitter, including the modulator stages, must be carefully adjusted if the vision signals passed to them are to be radiated without changes which would be evident as poor quality on a good television receiver. The purpose of a TV Transmitter Sideband Analyser, therefore, is to enable these functions to be performed efficiently.

A few years ago the necessary tests had to be made by a painstakingly point-by-point method and repeated again and again—after making circuit adjustments—until the required sideband characteristic was obtained. This series of tests and adjustments could take several weeks and make the installation of a transmitting station a tiresome business.

By using a dynamic method, such as is employed in the TV Transmitter Sideband Analyser, the effect of adjustments can be seen instantaneously and transmitter circuits can be set up within a few hours. After commissioning, a check can be made before each transmission, if desired, in a matter of minutes.

In order to clarify the requirements of a sideband analyser, Fig. 1 is reproduced from the CCIR handbook. It shows the frequency bandwidths required for the various systems 405, 625 lines, etc. A sideband analyser makes it possible to display the response of the transmitter output circuits over the appropriate frequency band in the form of Fig. 1.

The basic instrument TF2360 (manufactured by Marconi Instruments Ltd), is suitable for use on Bands I and III. For Bands IV and V an additional unit is required—U.H.F Converter TM6936. The equipment can accommodate either 405-, 525- or 625-line systems.



Notes: (1) S indicates position of sound carrier. (2) C indicates limits of radio frequency channel. (3) A = nominal width of main sideband. (4) B = nominal width of vestigial sideband.

Fig. 1. Bandwidth requirements for the various systems used throughout the world.

oscilloscope is obtained from the same source as the modulating drive for the swept oscillator (Unit 1).

Unit 5, the Composite Signal Unit, provides facilities for combining mixed synchronizing and mixed blanking pulses with the video signal to give the composite television signal shown in Fig. 3. Although the standard level of the composite signal is 1 V d.a.p from sync. bottom to peak white, this may be varied over a wide range to cater for different tests. The video component may be varied in amplitude from 0·1 to 1 V d.a.p, picture level up to 0·8 V d.a.p, and sync. amplitude up to 0·5 V d.a.p, so that responses can be examined at any level from peak white to full black-to-white modulation.

The availability of a composite signal containing blanked video and synchronizing pulses in their correct sequence and relative amplitudes enables dynamic measurements to be made on transmitters without the need for disconnecting black level clamping networks, thus giving a more realistic and accurate measurement.

The receiver (Unit 8, Fig. 2) has a frequency coverage of 40 to 100 Mc/s. It can therefore accommodate transmitter frequencies of 30 to 90 Mc/s covering Band I and 170 to 230 Mc/s covering Band III. (The difference between frequencies within these two bands and 130 Mc/s falls within the receiver range.)

The receiver i.f bandwidth is less than 40 kc/s so that the response of a transmitter may be examined close to the carrier without interference from the carrier.

BANDS IV AND V

These two bands cover the frequency range from 470 to 960 Mc/s except for a break between 585 and 610 Mc/s. The measurement is carried out in exactly the same way as for Bands I and III except that the transmitter output frequency is changed to a convenient frequency within Band I by introducing a wide-band converter TM6936 between the directional coupler and r.f mixer (Unit 6) of Fig. 2.

The converter/oscillator has a frequency range of approximately 400 to 900 Mc/s and will thus adequately cover the frequency range required.

It is worth while noting that a wide-band converter is used and not one in which the i.f frequency is fixed by the tuned circuits within the converter. This latter type of converter gives a better noise figure and larger output but at the expense of flatness of response and flexibility in operation.

If, for instance, two transmitters are situated at the same site, one on Bands I or III, the other on Bands IV or V, and one Sideband Analyser is available for tests on both equipments, it would be convenient to set the Sideband Analyser to the Bands I or III frequency, using this same frequency as the converter i.f when setting up the Bands IV or V transmitter. In this way, retuning of the main equipment is avoided; any i.f frequency within the receiver range can be used. This is possible if the converter is of the wide-band type but very precise adjustment of the converter to produce the fixed i.f frequency is necessary if a tuned type of converter is used. The main receiver must subsequently be tuned to this i.f frequency.

FACTORS WHICH MAY AFFECT MEASUREMENT ACCURACY

It can be stated that, in general, the flatness of sideband response required from a TV transmitter over the video band allocated to the particular system, is of the order of 1 dB. Therefore the test equipment used for setting-up purposes should be capable of a much better degree of accuracy than this, at any rate, not worse than 0·5 dB. This total tolerance has to be apportioned between the various factors which can affect setting-up accuracy.

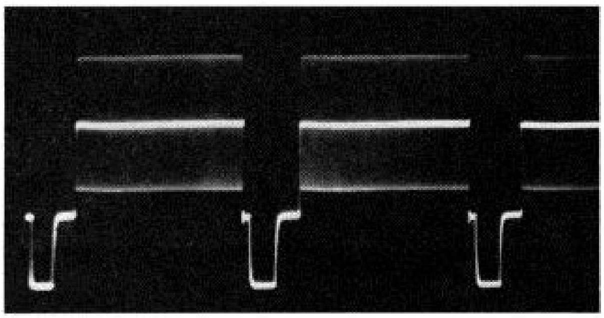


Fig. 3. Output from composite signal generator observed at line frequency on 405-line system. Standard picture level of 1 V d.a.p.

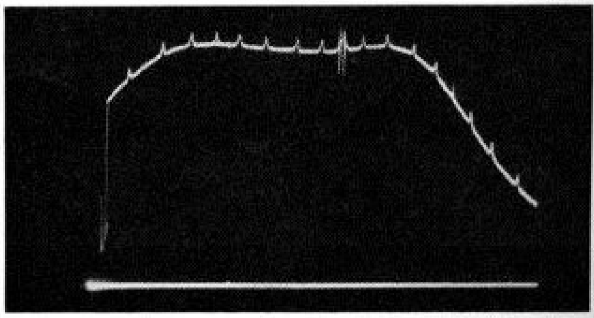


Fig. 4. Response of Band I transmitter simulator showing the frequency markers.

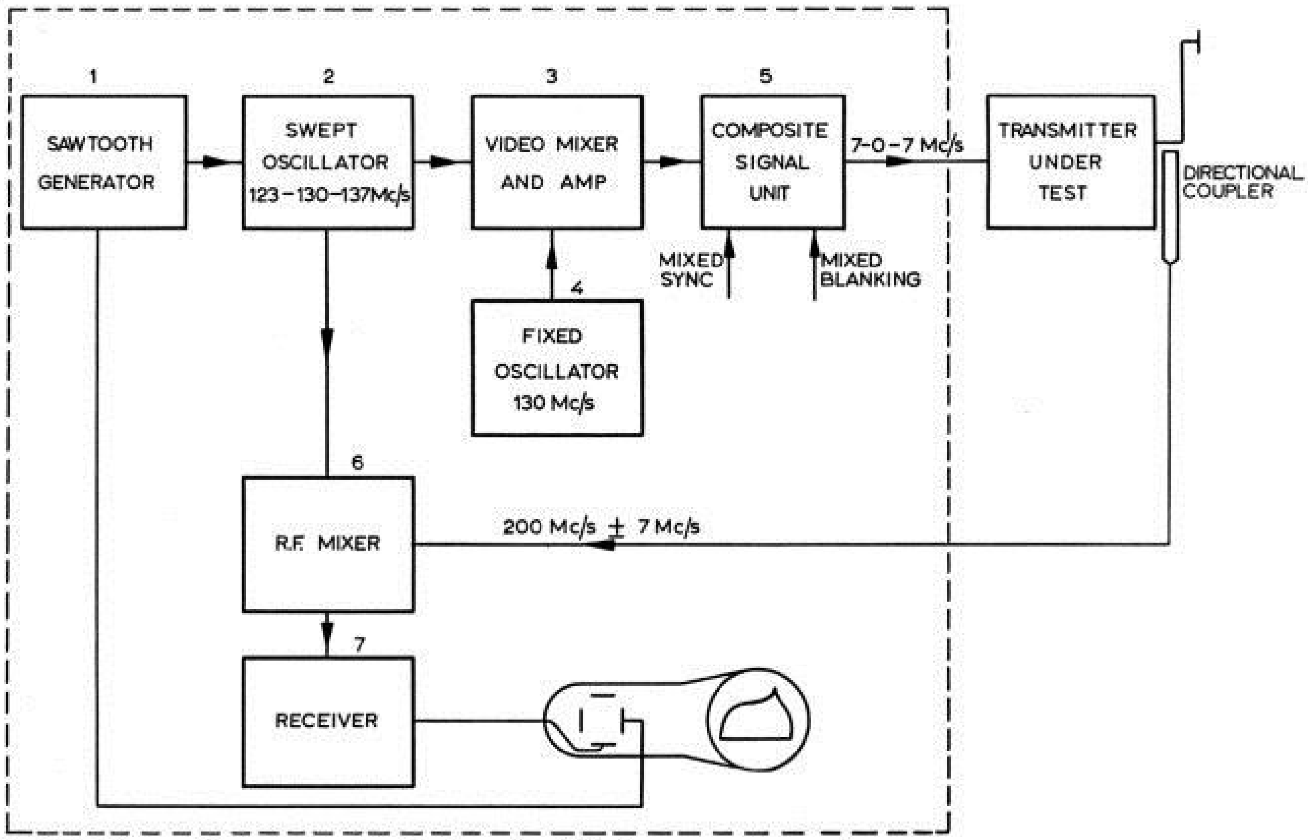


Fig. 2. Block diagram of the arrangement used for transmitter sideband response measurement.

MODE OF OPERATION

Stated briefly, the mode of operation is that of generating a sweeping video signal of approximately 7–0–7 Mc/s which is used to modulate the transmitter under test. A sample of the modulated r.f output is then suitably processed—in a manner to be described—amplified in a narrow band receiver and the detected response displayed on an oscilloscope.

Fig. 2 shows a block diagram of the arrangement. For the purposes of the explanation it is assumed that the transmitter is operating at a frequency of 200 Mc/s.

The swept video signal is produced by mixing the outputs from two oscillators, one fixed in frequency at 130 Mc/s (Unit 4) and the other sweeping at either half mains frequency or half field frequency symmetrically about 130 Mc/s with a maximum excursion of at least 123 to 137 Mc/s (Unit 2). The difference frequency produced gives a video signal which sweeps from 7 Mc/s to zero and back to 7 Mc/s. Sweep width is variable up to this maximum value and the frequency response is flat to within ±0·1 dB.

After amplification the video signal is used to modulate the transmitter. At any instant one of the two sidebands produced is changing in frequency at the same rate and in the same direction as the frequency of the swept oscillator (Unit 2). When the swept oscillator frequency is 123 Mc/s, for instance, the video modulating signal is 7 Mc/s and the two sidebands 193 Mc/s and 207 Mc/s. The difference frequency between one of the sidebands (193 Mc/s) and the swept oscillator (123 Mc/s) is 70 Mc/s. This same difference frequency occurs throughout the sweep between one of the sidebands and the swept oscillator and, of course, is equal to the difference between the transmitter carrier frequency and the centre swept oscillator frequency, i.e. in this case 200−130=70 Mc/s. The sideband amplitude at any frequency will be proportional to the response of the transmitter circuits at the particular frequency.

Consequently, if a sample of the final output from the transmitter is fed to a mixer (Unit 6) together with the swept oscillator frequency, and the mixer connected to a receiver tuned to the difference frequency, a detected display of the transmitter sideband response will be shown on an oscilloscope connected to the receiver output socket. The time-base for the

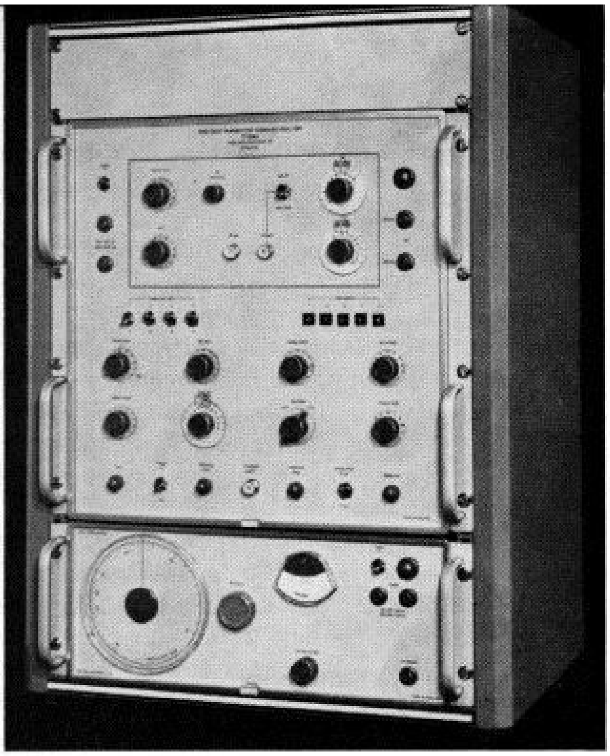


Fig. 5. The Marconi Instruments Television Transmitter Sideband Analyser TF2360, shown here with U.H.F Converter TM6936.

Assuming that the transmitter modulation equipment has a satisfactory amplitude/frequency response, the first essential for accurate measurement of transmitter sideband response is that the video output from the composite signal unit (Unit 5)—the signal used to modulate the transmitter—has a frequency response as near flat as it is possible to obtain. The claim made for the instrument under review is ±0·1 dB over the symmetrical video sweep of 7–0–7 Mc/s.

The remaining 0·3 dB of the total tolerance is sufficient to take into account variations in r.f response due to the mixer (Unit 6) and also of the U.H.F Converter TM6936 if the transmitter is operating in Bands IV or V.

RECEIVER

Providing the receiver input circuit has a reasonably good v.s.w.r, the only measurement error likely to be introduced by it is that due to detector non-linearity. This can be avoided if, instead of displaying the detected signal on the oscilloscope, output is taken from the 4·5 Mc/s intermediate frequency. Both of these outputs, detected and i.f, are available from sockets on the front panel of the instrument.

ADDITIONAL FEATURES

Video Measurements

The video generator can be used for setting-up amplifiers and other modulation equipment in addition to its main function. When used for this purpose the swept video signal is changed from a frequency band of 7–0–7 Mc/s to 0–20 Mc/s by means of a front panel switch. Sweep width is variable up to the maximum figure quoted.

Frequency Markers

Frequency markers may be superimposed on the display as shown in Fig. 4; they occur at 1 Mc/s intervals with respect to the carrier frequency on a sideband display, each fifth marker being distinctive in appearance.

The instrument is simple to operate, and if the waveforms from the five test points on the front panel are comparable with drawings in the Instruction Book provided with the instrument, correct functioning of the equipment is assured.