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ITU-T G.241

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GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER - TRANSMISSION SYSTEMS

PILOTS ON GROUPS, SUPERGROUPS, ETC.

ITU-T Recommendation G.241

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.241 was published in Fascicle III.2 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation G.241

PILOTS ON GROUPS, SUPERGROUPS, ETC.

(amended at Geneva, 1964; further amended)

1 Use of pilots

Experience has shown that, without the use of a group pilot transmitted throughout a group link, adequate stability of the channels of individual group links cannot be guaranteed in spite of the care given to the maintenance of the carrier systems on which they are routed.

It may be necessary, in the first place, to place an automatic regulator, controlled by the pilot, at the end of some of the group sections forming the group link to compensate for inevitable variations in attenuation on each of the sections. This regulator is not, of course, designed to correct automatically for faults.

It is desirable for the regulator to have a range of at least ± 4 dB. While no maximum range is specified, note should be taken that too great a range can prove unsatisfactory, e.g. due to noise or the masking of faults. A maximum range of approximately ± 7 dB has been found satisfactory by some Administrations.

An alarm should be given when the amplitude of the pilot at the input of the regulator departs from its nominal value by more than ± 4 dB. The conditions governing the use of these regulators are given in Recommendation M.160 [1].

It is also necessary to provide for measuring the level of the group pilot at the ends of group sections where it is not planned to use a regulator. In these cases, too, an alarm should be given when the level of the pilot departs from its nominal value by more than ± 4 dB.

Precisely similar considerations apply to the use of supergroup, mastergroup and supermastergroup pilots, and also to the use of basic 15-supergroup assembly pilots.

Note - When a group is through-connected from a cable section (on coaxial or symmetric pairs) to an open-wire line, transmission of the group pilot over the open-wire line, which is an advantage as regards maintenance of the complete group can, to a certain extent, facilitate "tapping" of conversations by means of radio receivers of a particular type in the territory traversed by the open-wire line. However, this risk of "tapping" is less than the similar risk arising from inadequate suppression of the carrier, because the frequency of the group pilot is more remote from the nearby carrier frequency, so that the quality of the overheard conversation would be necessarily degraded.

2 Nominal characteristics of pilots (group, supergroup, etc.)

When group, supergroup, etc., pilots are considered necessary, they should be permanently transmitted.

The frequency and the level of these pilots are shown in Table 1/G.241.

TABLE 1/G.241

Frequency and level of pilots

Pilot for	Frequency (kHz)	Absolute power level at a zero relative level point (dBm0)
Basic group	84.080[a)] 84.140[b)] 104.080[a), b), c)]	—20 —25 —20
Basic supergroup	411.860[a)] 411.920[a), c)] 547.920[a), b)]	—25 —20 —20
Basic mastergroup	1 552	—20
Basic supermastergroup	11 096	—20
Basic 15-supergroup assembly (No. 1)	1 552[d)]	—20

a) The group pilots 84.080 and 84.140 kHz and the supergroup pilots 411.860 and 411.920 kHz are used over groups and supergroups transmitting telephone channels and, in some cases, wide spectrum signals (data, facsimile, etc.). For each group (or supergroup) the two pilots at 84.080 and 84.140 kHz (or 411.860 and 411.920 kHz) should be transmitted simultaneously. However, only one of these two pilots need be used if there is agreement between the Administrations concerned (including the Administrations of transit countries).

It is now apparent that transmission of wide spectrum signals (data, facsimile, etc.) may demand use of the pilots 104.080 kHz and 547.920 kHz instead of those previously used. These latter pilots may also be used on groups and supergroups carrying only telephone channels. The choice of pilots to be used is a matter of agreement between the Administrations concerned (including the Administrations of transit countries).

b) However, the use of the pilots at 104.080 and 547.920 kHz might lead to the following difficulties:

1) The group pilot at 104.080 kHz is incompatible with the line pilots situated at 4 kHz from one end of a group, which are to be found in the following systems:

   — open-wire systems using frequency allocation 1 as shown in Figure 1/G.311;

   — symmetric-pair systems using variant B as shown in Figure 5/G.322, especially the transistorized system described in Recommendation G.323.

2) If the frequency allocation in the supergroup comprises groups A-E in accordance with Figure 2*c*/G.322 and 3/G.322, a supergroup pilot at 547.92 kHz will appear at frequency 103.92 kHz in group A. This frequency is liable to cause difficulties when group A is used for telephony. To avoid any disturbance, it might be necessary to introduce new routing restrictions.

3) Difficulties would arise if these pilots were used on groups having terminal equipment with carrier frequency spacing of 6 kHz in accordance with Recommendation G.234, unless one further channel is abandoned in some groups.

   Note - These difficulties have already arisen in some cases with the pilots recommended at present.

4) The choice of these frequencies would make it very difficult to use signalling at the virtual carrier frequency of a telephone channel in conformity with Recommendation Q.21 [2]. However, this point (and the preceding one) can be considered to be of purely national interest.

c) The supergroup pilot at 411.920 kHz may also be used when the supergroup contains one or more groups transmitting wideband signals. It is impossible to route a group equipped with a pilot at 104.080 kHz in the position of group 3 in a supergroup with a pilot at 411.920 kHz.

d) This pilot, after modulation of the 15-supergroup assembly to position No. 3 (see procedure 2 of Recommendation G.211, § 1), appears at the frequency of 11 096 kHz; this is identical with the frequency of the basic supermastergroup pilot.

3 Tolerances on the sent level of pilots

The following values are recommended for the frequency accuracy of the various pilots:

Pilot frequency 84.080 kHz and 411.920 kHz ..... ± 1 Hz

Pilot frequency 84.140 kHz and 411.860 kHz ..... ± 3 Hz

Pilot frequency 104.080 kHz and 547.920 kHz ..... ± 1 Hz

Pilot frequency 1552 kHz[1)] ..... ± 2 Hz

Pilot frequency 11 096 kHz ..... ± 10 Hz

Note - These tolerances can be taken as a basis for the specifications of the associated pilot receiving filters and stop filters, allowance also being made for recommendations concerning the accuracy of master oscillators.

The following recommendations are made concerning the tolerances for the sent pilot level:

1) The design of equipment should be such as to allow the sum of errors in the level of any group, etc., pilot as transmitted, due to finite level adjustment steps, change in number of groups supplied, and lack of adjustment facilities in individual groups, to be kept within ± 0.1 dB.

2) The change in output level of the pilot generator with time (which is a factor included in equipment specifications) must not exceed ± 0.3 dB during the interval between two maintenance adjustments, e.g. in one month.

3) To reduce pilot level variations with time, it is advisable to have a device to give an alarm when the variation at the generator output exceeds ± 0.5 dB, the zero of the warning device being aligned as accurately as possible with the lining-up level of the transmitted pilot.

The attention of Administrations is drawn to the difficulty which could result from an appreciable reduction in the absolute power level of the pilot sent to line; such a reduction is liable to cause "near singing", resulting from the operation of the automatic gain-control amplifiers. It would be desirable to make arrangements for overcoming this difficulty if it should arise.

4 Harmonics of pilots

4.1 It is recommended that the levels of harmonics of group and supergroup pilots should not exceed the values given in Table 2/G.241. The point where these limits should be met is the distribution frame (or equivalent point) at the output of the next higher stage of modulation, e.g. the supergroup distribution frame in the case of the group pilot. Account should be taken of the change of frequency.

TABLE 2/G.241

Maximum level of harmonics of pilots

Pilot	Nominal frequency of pilot (kHz)	Maximum level of harmonics		
		Second harmonics (dBm0)	Third harmonics (dBm0)	Each higher harmonics (dBm0)
Group	84.080 or 84.140	—73	—67	—75
Group	104.080	—67 (see note)	—67	—75
Supergroup	411.920 or 411.860	—75	—73	—75
Supergroup	547.920	—67	—67 (see note)	—75

Note - If the system includes 3-kHz spaced channels a maximum level of -73 dBm0 is recommended.

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1) This pilot, after modulation of the 15-supergroup assembly to position No. 3 (see procedure 2 of Recommendation G.211, § 1) appears at the frequency 11 096 kHz; this is identical with the frequency of the basic supermastergroup pilot.

4.2 In the case of the pilot (1552 kHz) for a mastergroup, it is recommended that the level of the second harmonic of the pilot should not exceed - 50 dBm0 and the level of each other higher harmonic should not exceed – 75 dBm0 measured at the output of the next higher stage of modulation.

4.3 In the case of the pilot (11 096 kHz) for a supermastergroup, it is recommended that the level of any harmonic should not exceed -75 dBm0 measured at the output of the next higher stage of modulation.

4.4 In the case of the pilot (1552 kHz) for 15-supergroup assemblies, it is recommended that the level of the second harmonic should not exceed -50 dBm0, measured at the output of the supergroup translating equipment.

Where the 15-supergroup assembly is not combined with other assemblies, there is no particular requirement on the level of the third and higher harmonics.

Where the 15-supergroup assembly is combined with other assemblies, the level of the third and higher order harmonies should not exceed -75 dBm0, measured at the combined output.

5 Protection of group, supergroup, etc., pilots against interference by noise

Automatic regulators operated by group, supergroup, etc., reference pilots should be so designed that the interfering effect of noise does not exceed 0.02 dB for any significant period. If, for example, the regulator operates on the mean signal voltage, this corresponds to a long-term interfering signal of -20 dB relative to the pilot level. When the interference is of short duration compared with the time constant of the regulator, high levels of interference may be experienced without causing an error in regulation exceeding 0.02 dB.

5.1 *Group and supergroup pilots*

If the pilot pick-off filter has a bandwidth of 50 Hz (25 Hz on each side of the nominal pilot frequency) the ratio between pilot and noise will always be considerably greater than 20 dB in the case of carrier systems over land-lines. This ratio is still respected if the unweighted power of the noise in a telephone channel reaches 10^6 pW at zero relative level (level of -30 dBm0), which very rarely occurs on radio-relay links conforming to the conditions of Recommendation G.441.

In the case of very long group or supergroup links on such radio-relay links, the pilot-to-noise ratio will be smaller than 20 dB only for a period of less than some ten-thousandths of any month. In that case the resultant error in regulation will be negligible, as the duration of the very high-level noise will be short compared with the necessarily long time-constant of the regulator. In any case, such high-level bursts are not expected to occur with any significant frequency and the chief factor limiting the interference caused to a pilot by noise is therefore the effective bandwidth of the pick-off filter.

5.2 *Other pilots*

Similar consideration applies also to mastergroup, supermastergroup and basic 15-supergroup assembly pilots. However, the bandwidth of the pick-off filter will certainly be greater than 50 Hz and more reliance will have to be placed on the relatively long time-constant of the regulator to minimize the effect of short-duration high-level noise.

Note 1 - Recommendations concerning the protection and suppression of pilots at certain points appear in Recommendation G.243.

Note 2 - When use is made of procedure 1, described in Recommendation G.211, the spacing between the 11 096 kHz supermastergroup pilot and the audio-frequencies transposed in the adjacent channels is 28 kHz and 60 kHz.

This same spacing is only 4 kHz with procedure 2, described in Recommendation G.211.

In view of this, a supermastergroup regulator is not necessarily suitable for the transmission of a 15-supergroup assembly over a supermastergroup link.

6 Protection of group or supergroup pilots against signals transmitted in telephone channels

This protection is ensured in the channel and group translating equipment, in accordance with Recommendation G.232, § 12 and the Recommendation cited in [4].

7 Protection of group or supergroup link pilots transmitting wide-spectrum signals

7.1 To protect the group or supergroup link pilots (used to establish wideband circuits) against other wide-spectrum signals (data, facsimile, etc.), it is recommended that the power spectrum emitted about the pilot frequency be limited in the equipment which transmits these signals. This limitation is so calculated that the group or supergroup regulators installed on the link will not receive interference of more than 0.1 dB, and the values to be specified therefore depend on the characteristics of the regulators (passband of the pilot filters, regulation operating time constant).

With regard to continuous spectrum signals, the spectrum density in the band $f_0 \pm 25$ Hz must not exceed –70 dBm0/Hz.

The limits to be set for discrete components are fixed by the Figure 1/G.241 which allows for the existing characteristics of regulators activated by pilots at frequencies (f_0) of 84.08 or 104.08 kHz in group links and of 411.92 or 547.92 kHz in supergroup links.

Such a limitation of the transmitted spectrum, obtained by a suitable choice of modulation characteristics, dispenses with the need to insert a bandstop filter to protect the pilot (such a filter would introduce harmful distortion of the group delay). However, if it is not possible to impose such a limitation on the emitted spectrum by this method, or if no guarantee can be secured that this limitation will be respected, the Administrations operating the transmission networks should, in order to protect the group regulators against interference caused by the wideband signals, insert bandstop fitters (which would produce the smallest possible distortion to the group delay) at the input of the group or supergroup links under consideration, producing the limitation indicated by Figure 1/G.241.

Note - The general problem of protecting the reference pilots from interference when a group or supergroup is used for the transmission of wide-spectrum signals arises because the protection of these pilots is not always secured by means of a band-clearing filter connected immediately before injection of the pilot. In normal telephone use such protection may depend upon the existence of filters in telephony channel or group translating equipment; however, these may not be in circuit when a wideband transmission path is set up.

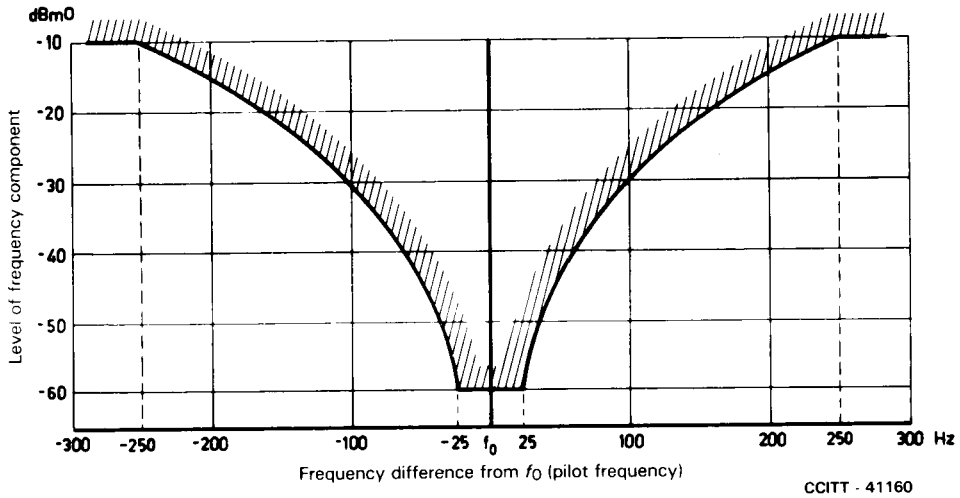

FIGURE 1/G.241

Maximum permissible level of discrete frequency components of wide-spectrum. (group and supergroup) signals in the vicinity of group and supergroup pilot frequencies

The use of a group containing the supergroup pilot should always be avoided (see Recommendation H.14 [5]). This means that no special suppression of the wideband signal has to be provided in the group for the purpose of the supergroup pilot.

7.2 *"Delayed transfer"*

It may be imagined that some data-processing devices record the wideband signal in the form in which it reaches them from the network, and then retransmit this recorded signal over the network on a group or supergroup link. On this assumption, the pilot will be recorded at the same time as the signal; it will therefore be retransmitted with it and will then interfere with the pilot injected on the new link. In this case, the recording or retransmitting device should be equipped with a frequency-stop filter providing an attenuation of at least 40 dB at the pilot frequency under consideration, and contributing as little distortion as possible to the group delay. However, if Administrations have inserted, at the input of wideband links, the cut-off filter for protection of the pilot as mentioned in § 7.1 above, the aim sought in the present paragraph will have been reached and the frequency-stop filter will be superfluous.

7.3 *Multipoint links*

In the case of multipoint links on tree-shaped networks, the pilot should be blocked at each confluence point on all the confluent links except one, by means of a filter like the one mentioned in § 7.2 above, leaving only one pilot protected against interference from the other pilots. It is also possible to block the pilots on all the confluent links and to transmit a locally produced pilot beyond that point of the link.

References

[1] CCITT Recommendation *Stability of transmission,* Vol. IV, Rec. M.160.

[2] CCITT Recommendation *8-channel terminal equipments,* Orange Book, Vol. III-1, Rec. G.234, ITU, Geneva, 1977.

[3] CCITT Recommendation *Systems recommended for out-band signalling,* Vol. VI, Rec. Q.21.

[4] CCITT Recommendation *8-channel terminal equipments,* Orange Book, Vol. III-1, Rec. G.234, § f), ITU, Geneva, 1977.

[5] CCITT *Recommendation Characteristics of group links for the transmission of wide-spectrum signals,* Vol. III, Rec. H.14.