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SERIES J: TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Circuits for analogue television transmission

Test signals and measurement techniques for transmission circuits carrying MAC/packet signals

ITU-T Recommendation J.67

(Formerly CCITT Recommendation)

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ITU-T Recommendation J.67

Test signals and measurement techniques for transmission circuits carrying MAC/packet signals

Summary

The purpose of this Recommendation is to give the tools of the transmission methodology of the MAC packet family signals. This Recommendation is devoted to the traditional MAC packet signals (D/D2).

This Recommendation begins with the definition of the test signals and the test lines that are the basis of the transmission methodology. Furthermore, the main quality measurement parameters are defined, as well as the corresponding application methods.

Source

ITU-T Recommendation J.67 was revised by ITU-T Study Group 9 (2001-2004) and approved under the WTSA Resolution 1 procedure on 9 March 2001.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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Introduction

A clear description of what is meant by the transmission circuit is essential for defining the measurement problem. The figure below shows a studio encoder driving the transmission circuit, and a studio decoder driven by the transmission circuit. MAC is a multiplex of luminance, chrominance, and sound/data signals. The video inputs to the encoder are the luminance component and the two colour difference components. These are also present at the output of the decoder. The measurement methods described in this Recommendation are for automatic measurements of the transmission circuit between the MAC encoder and the MAC decoder.

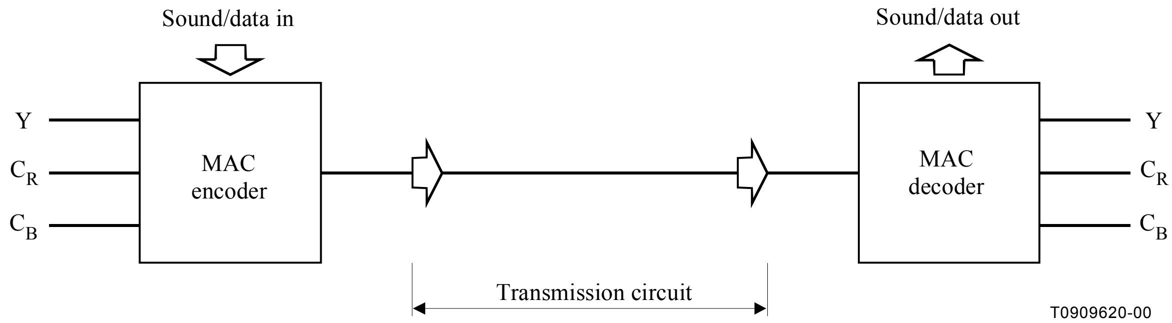

Figure Intro./J.67 – Transmission of MAC signals

ITU-T Recommendation J.67[1]

Test signals and measurement techniques for transmission circuits carrying MAC/packet signals

1 Scope

The purpose of this Recommendation is to give the tools of the transmission methodology of the MAC packet family signals. Thus, MAC/packet signals, whose quality parameters are defined in clause 2 should be measured using the test signals defined in clause 3 and Annex A, and measured using the methods defined in clause 4.

2 Definition of the quality parameters of a MAC/packet signal

2.1 MAC signal

2.1.1 Waveforms and line allocations

The MAC analogue waveform is directly derived from the standard 4:2:2 sampling ratio used for digital television (ITU-R BT.601). MAC coding produces a sequential transmission of a chrominance signal, compressed in a 3:1 ratio, and the luminance signal, compressed in a 3:2 ratio.

Given the sampling frequencies defined for the digital television standard (13.5 MHz for luminance and 6.75 MHz for chrominance), the consequent MAC sampling frequency is 20.25 MHz. The resulting nominal bandwidth required for the coded MAC signal is 8.4 MHz. After decompression the luminance bandwidth is 5.6 MHz.

It is important to note that, even though the MAC signal is derived through a sampling process, the resulting signal has an analogue form for transmission. A remarkable feature of the MAC coding system is that there is no absolute limit for the bandwidth. This characteristic can be used to broadcast the MAC signal in a narrow-band channel.

2.1.2 Quality parameters

2.1.2.1 Nominal signal amplitude

The nominal amplitude of a MAC signal is 1 V. It is defined as the difference between the white level and the black level of the reference signal of line 624.

2.1.2.2 Distortions

2.1.2.2.1 Gain/frequency response

The gain/frequency characteristic of the circuit is defined as the variation in gain between the input and the output of the circuit over the frequency band extending from the field repetition frequency to the nominal cut-off frequency of the MAC signal, relative to the gain at a suitable reference frequency.

2.1.2.2.2 Phase distortion

The phase-frequency distortion is defined as the difference in degrees relative to a linear phase characteristic over a frequency band extending from, ideally, 0 Hz to a defined upper frequency.

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[1] Formely ITU-R CMTT.772.

2.1.2.2.3 Group-delay distortion

The group-delay distortion, expressed in ns, is defined by the difference between the group delay for each measured frequency and the group delay for a given reference frequency.

2.1.2.2.4 Long-time waveform distortion

If a test signal, simulating a sudden change of the luminance from a black level to a white level or vice versa, is applied to the input of a circuit, a long-time waveform distortion is present if the variations of the clamp level (medium grey) of the output signal do not precisely follow those of the clamp level of the input signal. This failure may be either in exponential form, or more frequently in the form of damped very low frequency oscillations.

2.1.2.2.5 Field-time waveform distortion

If a square-wave signal with a period of the same order as one field and of nominal luminance amplitude is applied to the input of the circuit, the field-time waveform distortion is defined as the change in shape of the square wave at the output. A period at the beginning and end of the square wave, equivalent to the duration of a few lines, is excluded from the measurement.

2.1.2.2.6 Line-time waveform distortion

If a square-wave signal with a period of the same order as one line and of nominal luminance amplitude is applied to the input of the circuit, the line-time waveform distortion is defined as the change in shape of the square wave at the output. A period at the beginning and end of the square wave, equivalent to a few picture elements, is excluded from the measurement.

2.1.2.2.7 Short-time waveform distortion

If a short pulse (or a rapid step-function) of nominal luminance amplitude and defined shape is applied to the input of the circuit, the short-time waveform distortion is defined as the departure of the output pulse (or step) from its original shape.

2.1.2.2.8 Distortions due to echoes

This distortion is that caused by the superposition of the direct signal in the RF paths and an attenuated version of that signal delayed in time and shifted in phase relative to the direct signal.

2.1.2.2.9 Low frequency non-linear distortion

For a particular value of average picture level, the low frequency non-linear distortion is defined as the departure from proportionality between the amplitude of the input signal and the output signal, when the input signal is shifted from the black level to the white level within the duration of a line period.

2.1.2.3 Noise

2.1.2.3.1 Continuous random noise

The signal-to-noise ratio for continuous random noise is defined as the ratio, expressed in decibels, of the nominal amplitude of the luminance signal (1 V) to the r.m.s. amplitude of the noise measured after band limiting. A signal-to-weighted-noise ratio is defined as a ratio, expressed in decibels, of the nominal amplitude of the luminance signal, to the r.m.s. amplitude of the noise measured after band limiting and weighting with a specified network.

One possibility is that wideband random noise should be measured in a bandwidth of 8.4 MHz using a constant impedance noise-weighting network with a time constant of 90 ns. Such a network is based partly on the assumption that with the trend towards larger picture displays and with the improved picture quality available from the MAC/packet television standard, future subjective tests will more commonly employ a viewing distance of four times the picture height, rather than six times, as at present.

The second possibility uses the existing unified weighting network, scaled according to the 3:2 compression ratio, as a common weighting network for all MAC systems. This filter gives the same results as would be obtained from a signal in decompressed form with the unified weighting filter described in ITU-T J.61[2]. It also takes account of the noise carried in the more-compressed colour-difference signals. The possibly greater noise sensitivity due to the higher bandwidth HD-MAC signals when these use the same networks that are designed for present-day MAC signals is also considered. The definition of this network and its amplitude/frequency response are given in Figure 1.

2.1.2.3.2 Low frequency noise

The signal-to-noise ratio for low frequency noise is defined as the ratio, expressed in decibels, of the nominal amplitude of the luminance signal (1 V) to the mean square value of the noise.

2.1.2.3.3 Interference

The signal-to-interference ratio is defined as the ratio, expressed in decibels, of the nominal amplitude of the luminance signal (1 V) to the peak-to-peak amplitude of the interfering signal.

2.2 Data signals

2.2.1 Data signal waveform

The data signals have very different characteristics within the family of MAC systems. They are defined in the former CCIR special publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service".

2.2.2 Quality parameters for digital signals

2.2.2.1 Bit-error ratio

The bit-error ratio (BER) is defined as the ratio of the number of detected bit errors to the number of transmitted bits over a given period of time.

2.2.2.2 Eye diagram

The eye diagram is defined as the superposition of all the configurations of the data signals.

2.2.2.3 Equivalent impairment

The data signal quality is evaluated by adding a Gaussian noise signal to the received signal and plotting the bit-error ratio versus the noise level. For a given bit-error ratio, the difference in dB between the measured noise level and the theoretical level produces, by definition, the "equivalent impairment".

2.2.2.4 Decoding margin

Another method to evaluate the data signal quality by adding a Gaussian noise is to measure the level of added noise to obtain a given bit-error ratio. This is, by definition, the "decoding margin".

[2] Formerly ITU-R CMTT.567.

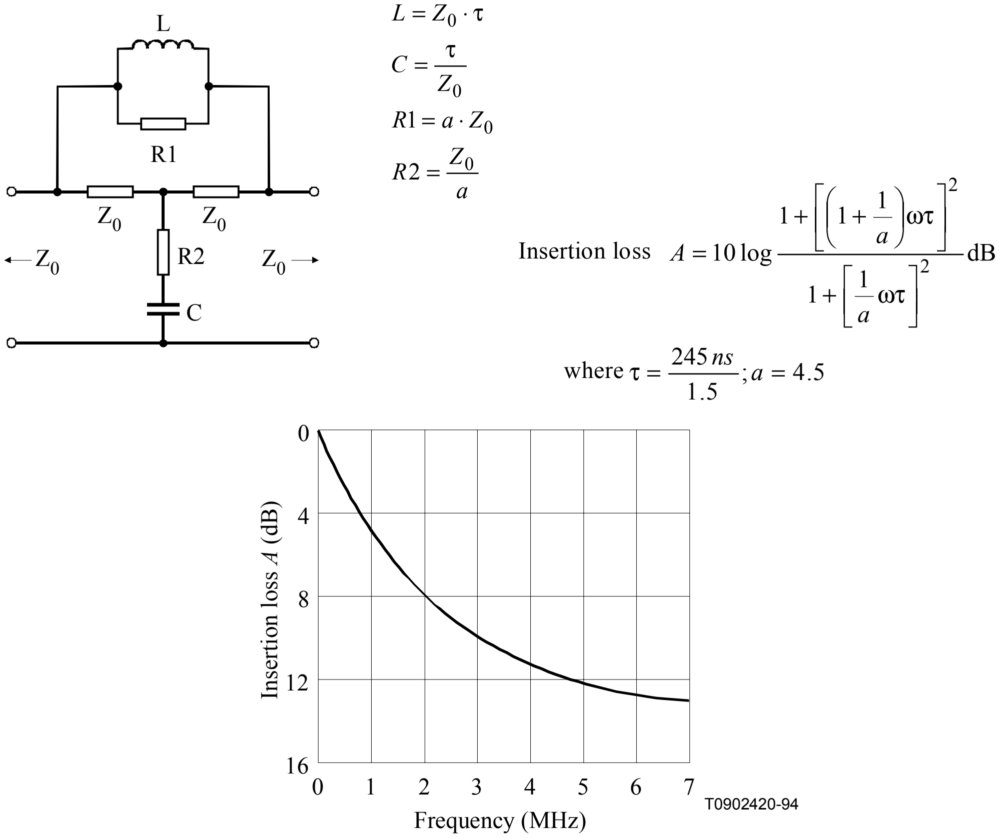

Figure 1/J.67 – Unified random noise weighting filter for MAC circuits using a compression ratio of 3:2

3 Description of the test signals for MAC/packet systems

3.1 General remarks

Three insertion test signals are defined, primarily for automatic measurement. In addition, three optional waveforms may be used either in test line or as full field signals for monitoring purposes (see Annex A).

As far as possible, essential signal elements have been allocated to the luminance period of the line (samples 590 to 1286). This will enable these signals to be used also for testing MAC coders and decoders.

Only in a restricted sample range between 245 and 1277 do the proposed signals vary from the 0 mV level. This allows blanking and reinsertion of the test signals at appropriate points of the transmission chain (e.g. between terrestrial and satellite section).

The spectral content of all waveforms is restricted to 8.5 MHz (–6 dB).

High frequency signal amplitudes are restricted to ±250 mV to avoid non-linear distortion and to allow conversion into an AM-VSB-MAC-system with Nyquist filtering at the transmitting end.

3.2 Definition of elementary waveforms

3.2.1 Basic definitions

T is the MAC sampling period ≈ 49.38 ns

k is the MAC sample number (see ITU-R BO.650 and the former CCIR special publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service")

3.2.2 Transition

A transition is a signal defined for a duration 4 *T* according to the shaping:

0.000 – 0.114 – 0.500 – 0.886 – 1.000

(Hamming window integral on 4 *T*)[3].

3.2.3 Pulse

A pulse is a signal defined for a duration 6 *T* according to the shaping:

0.000 – 0.130 – 0.630 – 1.000 – 0.630 – 0.130 – 0.000

(Blackman window on 6 *T*)[4].

3.2.4 Ramp

A ramp is a signal defined for a duration *n T* in the equation:

$k = 0$ to n: $y_k = k / n$ for a rising ramp

$y_k = 1 - k / n$ for a falling ramp

3.2.5 Complex wobbulation

A complex wobbulation is made up of two signals defined for a duration 512 *T* according to equations:

Real part:

$k = 0$ to 512: $$y_k = \left(\cos \frac{\pi (k - 256)^2}{512} \right) W(k)$$

Imaginary part:

$k = 0$ to 512: $$y_k = \left(\sin \frac{\pi (k - 256)^2}{512} \right) W(k)$$

where:

$W(k)$ is a window defined as:

$k = 0$ to 28: $W(k) = 0$

$k = 28$ to 53: $$W(k) = \sin^2 \frac{\pi (k - 28)}{50}$$

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[3] Hamming: $y(t) = 0.54 + 0.46 \cos \pi \frac{t}{2T}$

[4] Blackman: $y(t) = 0.42 + 0.50 \cos \pi \frac{t}{3T} + 0.08 \cos 2\pi \frac{t}{3T}$

$k = 53$ to 459: $W(k) = 1$

$k = 459$ to 484: $$W(k) = \sin^2 \frac{\pi(484-k)}{50}$$

$k = 484$ to 512: $W(k) = 0$

The complex wobbulation signals are transmitted in a 4-frame sequence in positive and negative (inverted) polarity as follows:

– Even frame: real part not inverted
– Odd frame: imaginary part not inverted
– Even frame: real part inverted
– Odd frame: imaginary part inverted
– Even frame: real part not inverted,
etc.

3.2.6 Modulated pulse

A pulse modulated at a frequency f (MHz) is a signal defined for a duration 81 T according to the equation:

$k = 0$ to 81: $$y_k = \cos^2 \frac{4\pi fk}{81} \sin^2 \frac{\pi k}{81}$$

3.2.7 Burst

A burst, modulated at a frequency f (MHz) is a signal defined for a duration 81 T in the equation:

$k = 0$ to k_1: $$y_k = \sin \frac{8\pi fk}{81} \cdot \left[\frac{1}{2\pi} \left(\frac{2\pi k}{k_1} - \sin \frac{2\pi k}{k_1} \right) \right]$$

$k = k_1$ to $81 - k_1$: $$y_k = \sin \frac{8\pi fk}{81}$$

$k = 81 - k_1$ to 81: $$y_k = \sin \frac{8\pi fk}{81} \cdot \left[\frac{1}{2\pi} \left(\frac{2\pi(81-k)}{k_1} - \sin \frac{2\pi(81-k)}{k_1} \right) \right]$$

$f = 1$ to 6: $k_1 = 15$

$f = 7$: $k_1 = 25$

$f = 8$: $$y_k = \sin \frac{8\pi fk}{81} \cdot \sin^2 \frac{\pi k}{81}; \; k = 0 \text{ to } 81$$

3.3 Test signal description

3.3.1 Test signal No. 1 (see Figure A.1 and Table A.1)

Test signal No. 1 is a mandatory signal and allocated to line 312. It is intended for automatic measurement and composed of a bipolar bar signal with inverse polarity in even and odd frames. Positive and negative Blackman pulses are contained in the even frame signal only.

The first part of the signal ($k = 225$ to 612) is provisionally set to 0 mV.

3.3.2 Test signal No. 2 (see Figure A.2 and Table A.2)

Test signal No. 2 is a mandatory signal and allocated to line 623. It is intended for automatic measurement of noise and non-linear distortion. It comprises a rising ramp (even frames) and a falling ramp (odd frames). This allows separation of linear distortions (e.g. tilt) from non-linear ones.

3.3.3 Test signal No. 3 (see Figure A.3 and Table A.3)

Test signal No. 3 is a mandatory signal and allocated to line 624. The first part of this line is already defined in the MAC/packet standards. The second part of this line contains a complex wobbulation.

3.3.4 Test signal No. 4 (national option) (see Figure A.4 and Table A.4)

This optional signal is intended for evaluation of linear distortions on a waveform monitor. This signal consists of a bipolar pulse and bar signal and eight modulated pulses (1 to 8 MHz) of 500 mV amplitude. It may be used also with full amplitude (1000 mV) if non-linear distortions are unlikely to occur.

If used as a test line signal it should be inserted on line 311.

3.3.5 Test signal No. 5 (national option) (see Figure A.5 and Table A.5)

This optional signal comprises an 8-riser staircase waveform and is intended for evaluation of non-linear distortions using a waveform monitor.

If used as a test line signal it should be inserted on line 1.

3.3.6 Test signal No. 6 (national option) (see Figure A.6 and Table A.6)

This national option is intended for display of the amplitude frequency response on a waveform monitor and is composed of eight multiburst signals (1 to 8 MHz) of 500 mV amplitude preceded by a reference bar. It may be used also with full amplitude (1000 mV) if non-linear distortions are unlikely to occur.

If used as a test line signal it should be inserted on line 313.

4 Measurement methods

4.1 General remarks

The measurement techniques described below use the test signals in clause 3 above and are to be used for automatic measurement. These methods are based largely on digital signal processing techniques.

4.2 Measurements related to the vision signal

4.2.1 Low-frequency noise

Low-frequency noise (below line frequency) is measured on a 50% white picture signal. High-frequency noise is reduced by averaging the signal value within each line. The spectral noise density is estimated by Fourier transform of the 625 signal values derived from one frame. The obtained analysis pitch is 25 Hz, allowing separation between the different sources of noise in the frequency band 25 Hz to 7.8 kHz.

4.2.2 High-frequency noise

High-frequency noise measurement is carried out using test signals No. 2a and 2b (ramp signals).

One method consists of estimating the noise level by averaging a large number of observations of the same complete test line and subtracting this average waveform from each observation. The result is the true noise content. From this, the true spectral noise density can be calculated.

The other method for weighted and unweighted random noise measurement uses the 200 kHz high-pass filter as specified in ITU-T J.64[5] to remove the ramp signal. The filter also reduces the influence of static non-linearities to the noise measurement.

4.2.3 Dynamic non-linearity

When comparing the shape of the two polarities of the Blackman pulse and the Hamming slopes in test signal No. 1, information on high-frequency non-linearity can be obtained.

4.2.4 Static non-linearity

Static non-linearity is measured using test signals No. 2a and 2b. The two polarities are used to separate linear from non-linear effects.

One method is to sample the ramp signals and to remove the noise by averaging. After removal of linear distortion, the processed waveform is approximated by a polynomial of degree *k*. Analysis of the coefficients of the polynomial provides information on the overall non-linear characteristic. It should be noted that any difference between the above-mentioned processed waveform and the polynomial indicates the presence of quantization distortion.

The second method also uses the ramp signals but is analogous to the luminance non-linearity measurement on the 5-riser staircase described in ITU-T J.64 and provides comparable results. The ramp level is measured at timing instants which are equally separated from one another by 9 µs, and centred with respect to the active period of 50.5 µs. The amplitude value at each of the six timing instants is calculated as the arithmetic mean of the ramp signal from 0.5 µs before to 0.5 µs after the timing instant. This reduces the influence of quantization errors and superimposed high-frequency noise. The six samples are processed to a single figure as described in 2.9/J.64.

4.2.5 Amplitude and phase/group delay frequency response

The complex wobbulation signal (test signal No. 3) is processed through a Fourier transform into amplitude and phase frequency response. The latter can be processed further into group delay. Prior to applying the sampled complex wobbulation signal to the FFT, non-linearities can be minimized using the two opposite polarities and noise can be reduced by averaging.

4.3 Specific data signal measurements

4.3.1 Bit-error ratio measurement

The bit-error ratio can be measured during programme transmission on synchronization words, the Golay code on packet headers, and on dummy packets. In the case of duobinary coding, the violation rate of this code gives an excellent estimate of the bit-error ratio.

4.3.2 Decoding margin measurement and equivalent impairment

Bit-error ratio measurements give no indication on the actual safety margin for possible additional distortions.

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[5] Formerly ITU-R CMTT.569.

One method of deriving such information is to measure the error ratio using variable deviations from the threshold levels until a predefined error ratio is reached. A second method adds Gaussian noise to the received signal until the predefined error ratio is reached.

4.3.3 Analysis of eye diagrams

The analysis of the eye diagrams of a two-level or a duobinary data signal – either made by means of an oscilloscope or microprocessor – provides eye-height and eye-width indications and additional information about the location of the optimum sampling phase and threshold levels with respect to their nominal values.

ANNEX A

Test signal elements

NOTE – Detailed definitions of the test signal elements contained in Tables A.1 to A.6 and Figures A.1 to A.6 (e.g. transition, pulse, etc.) are given in clause 3.

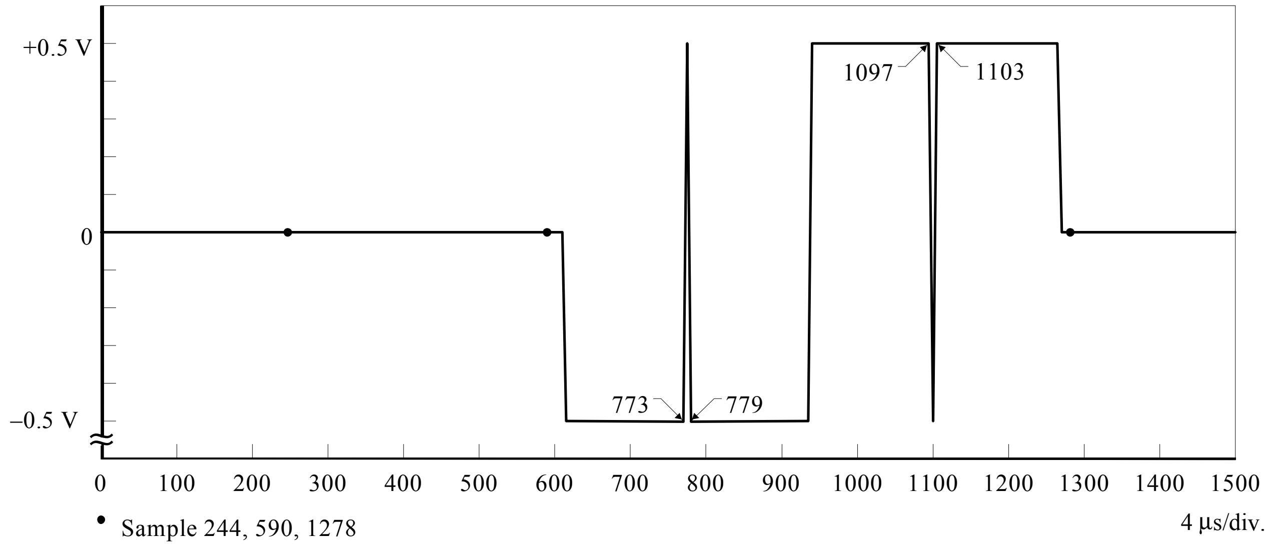
Table A.1/J.67 – Definition of signal 1

a) Even frames

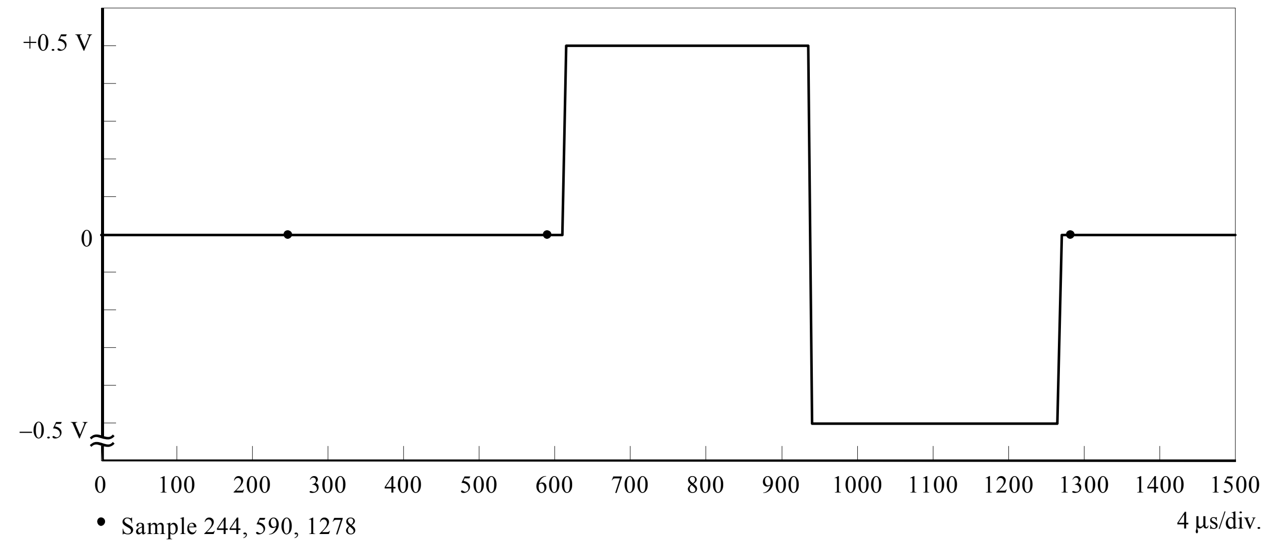
k = 255 to 612: level 0 mV
k = 612 to 616: transition from 0 mV to −500 mV
k = 616 to 773: level −500 mV
k = 773 to 779: pulse (base −500 mV; peak +500 mV)
k = 779 to 936: level −500 mV
k = 936 to 940: transition from −500 mV to +500 mV
k = 940 to 1097: level +500 mV
k = 1097 to 1103: pulse (base +500 mV; peak −500 mV)
k = 1103 to 1260: level +500 mV
k = 1260 to 1264: transition from +500 mV to 0 mV
k = 1264 to 1292: level 0 mV

b) Odd frames

k = 255 to 612: level 0 mV
k = 612 to 616: transition from 0 mV to +500 mV
k = 616 to 936: level +500 mV
k = 936 to 940: transition from +500 mV to −500 mV
k = 940 to 1260: level −500 mV
k = 1260 to 1264: transition from −500 mV to 0 mV
k = 1264 to 1292: level 0 mV



b) Test signal No. 1a – Even frame



b) Test signal No. 1b – Odd frame

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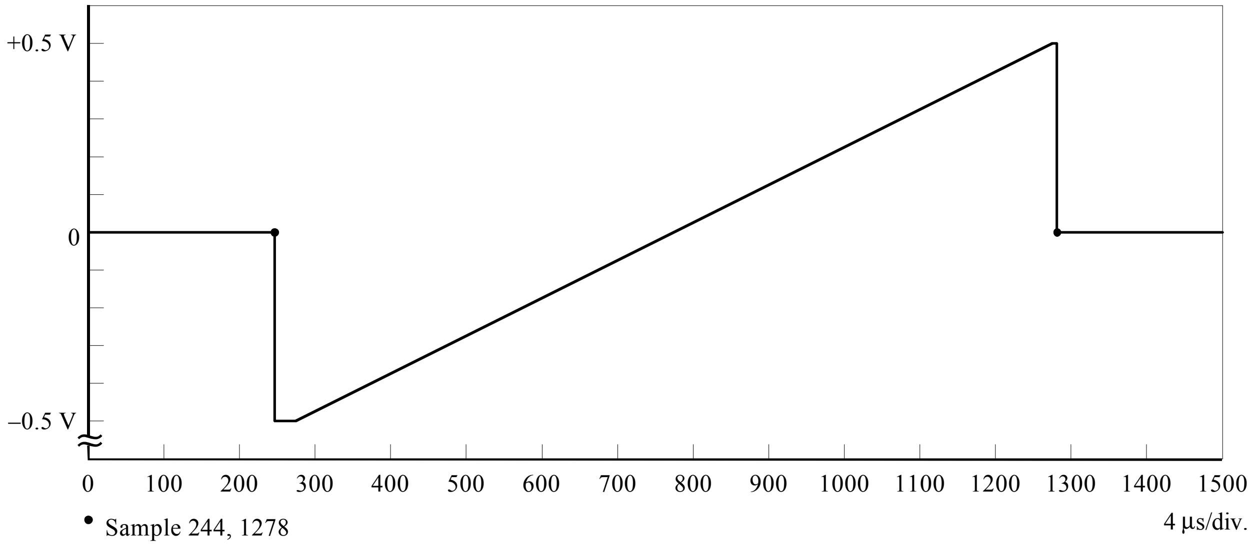
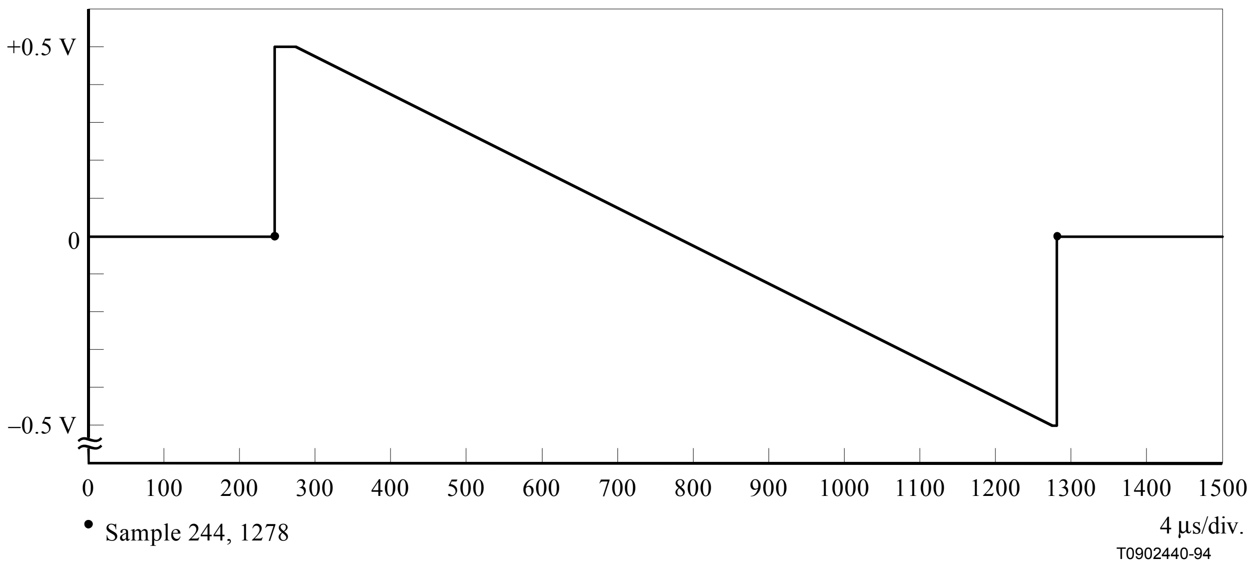
Figure A.1/J.67

Table A.2/J.67 – Definition of signals 2a and 2b
Signal 2a: even frames

k = 225 to 244: level 0 mV
k = 244 to 248: transition from 0 mV to −500 mV
k = 248 to 268: level −500 mV
k = 268 to 1268: −500 mV to +500 mV ramp
k = 1268 to 1274: level +500 mV
k = 1274 to 1278: transition from +500 mV to 0 mV
k = 1278 to 1292: level 0 mV
NOTE – Signal 2b (odd frames) has timing as above, levels inverted.



a) Test signal No. 2a – Even frame

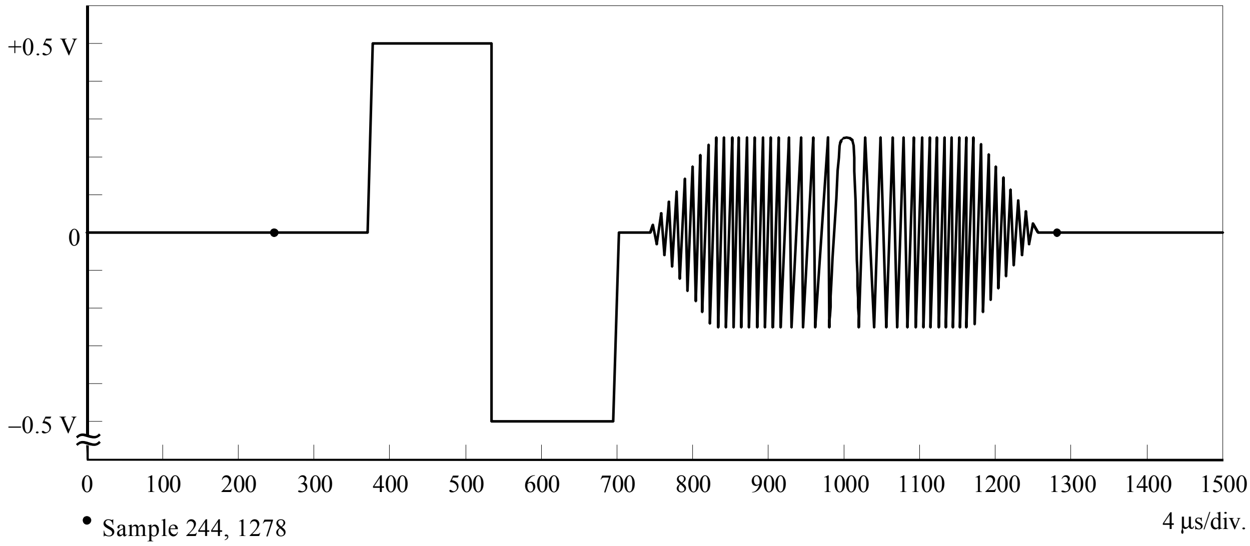


b) Test signal No. 2b – Odd frame

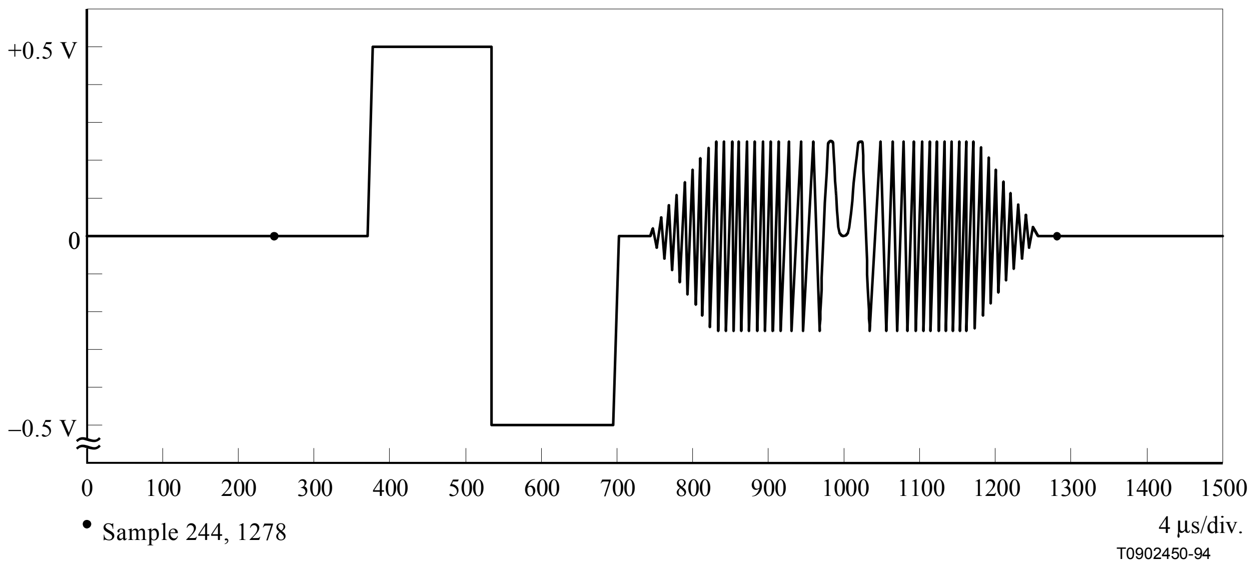
Figure A.2/J.67

Table A.3/J.67 – Definition of signals 3a and 3b

k = 255 to 370:	level 0 mV
k = 370 to 374:	transition from 0 mV to +500 mV
k = 374 to 532:	level +500 mV
k = 532 to 536:	transition from +500 mV to −500 mV
k = 536 to 694:	level −500 mV
k = 694 to 698:	transition from −500 mV to 0 mV
k = 698 to 739:	level 0 mV
k = 739 to 1251:	complex wobbulation of amplitude ±250 mV transmitted in a 4-frame sequence: real part positive, imaginary part positive, real part negative, imaginary part negative.
k = 1251 to 1292:	level 0 mV



a) Test signal No. 3a – Even frame – Positive polarity of complex wobbulation signal



b) Test signal No. 3b – Odd frame – Positive polarity of complex wobbulation signal

Figure A.3/J.67

Table A.4/J.67 – Definition of signal 4

k = 225 to 244: level 0 mV
k = 244 to 248: transition from 0 mV to +250 mV
k = 248 to 324: level +250 mV
k = 324 to 330: pulse (base +250 mV; peak −250 mV)
k = 330 to 406: level +250 mV
k = 406 to 410: transition from +250 mV to −250 mV
k = 410 to 486: level −250 mV
k = 486 to 492: pulse (base −250 mV; peak +250 mV)
k = 492 to 607: level −250 mV
k = 607 to 688: pulse modulated at 1 MHz
k = 688 to 690: level −250 mV
k = 690 to 771: pulse modulated at 2 MHz
k = 771 to 773: level −250 mV
k = 773 to 854: pulse modulated at 3 MHz
k = 854 to 856: level −250 mV
k = 856 to 937: pulse modulated at 4 MHz
k = 937 to 939: level −250 mV
k = 939 to 1020: pulse modulated at 5 MHz
k = 1020 to 1022: level −250 mV
k = 1022 to 1103: pulse modulated at 6 MHz
k = 1103 to 1105: level −250 mV
k = 1105 to 1186: pulse modulated at 7 MHz
k = 1186 to 1188: level −250 mV
k = 1188 to 1269: pulse modulated at 8 MHz
k = 1269 to 1274: level −250 mV
k = 1274 to 1278: transition from −250 mV to 0 mV
k = 1278 to 1292: level 0 mV

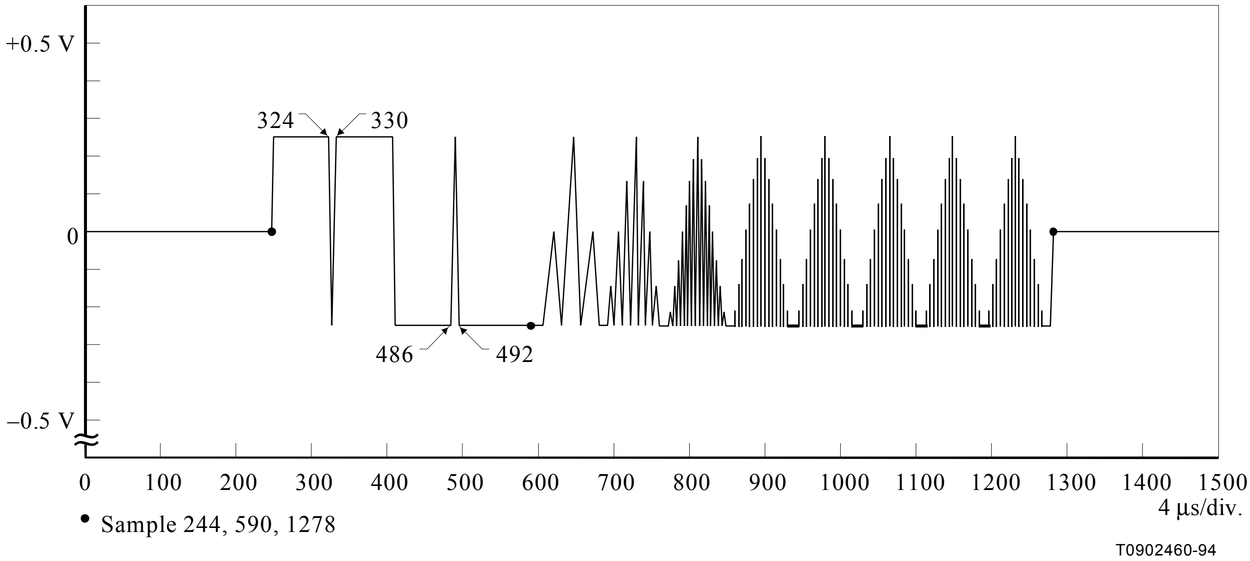


Figure A.4/J.67 – Test signal No. 4

Table A.5/J.67 – Definition of signal 5

k = 225 to 598: level 0 mV
k = 598 to 602: transition from 0 mV to –500 mV
k = 602 to 674: level –500 mV
k = 674 to 678: transition from –500 mV to –375 mV
k = 678 to 749: level –375 mV
k = 749 to 753: transition from –375 mV to –250 mV
k = 753 to 824: level –250 mV
k = 824 to 828: transition from –250 mV to –125 mV
k = 828 to 899: level –125 mV
k = 899 to 903: transition from –125 mV to 0 mV
k = 903 to 974: level 0 mV
k = 974 to 978: transition from 0 mV to +125 mV
k = 978 to 1049: level +125 mV
k = 1049 to 1053: transition from +125 mV to +250 mV
k = 1053 to 1124: level +250 mV
k = 1124 to 1128: transition from +250 mV to +375 mV
k = 1128 to 1199: level +375 mV
k = 1199 to 1203: transition from +375 mV to +500 mV
k = 1203 to 1274: level +500 mV
k = 1274 to 1278: transition from +500 mV to 0 mV
k = 1278 to 1292: level 0 mV

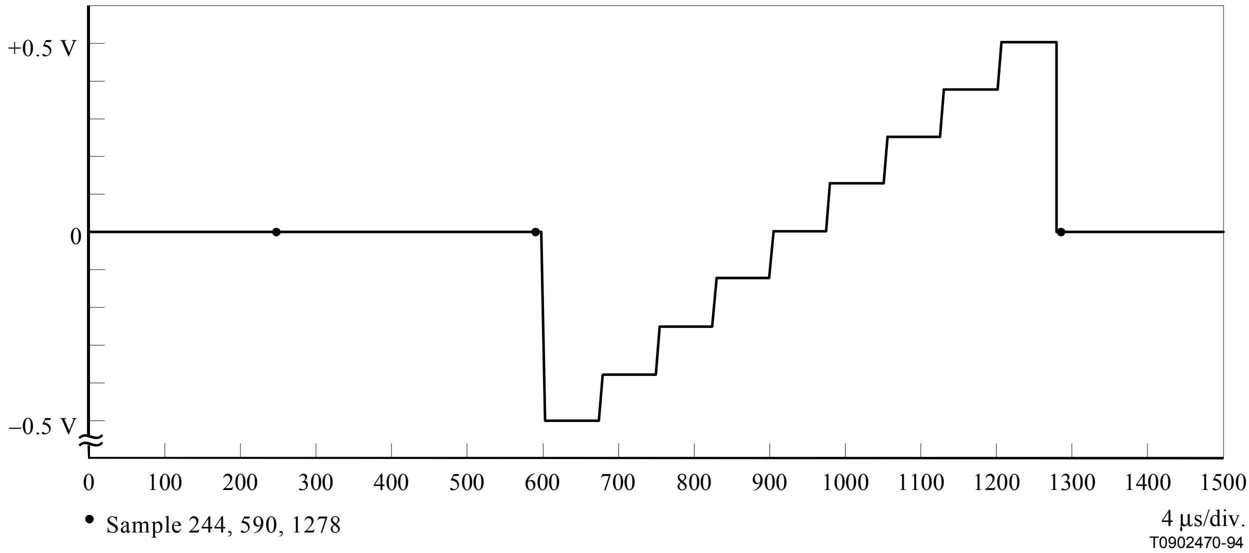


Figure A.5/J.67 – Test signal No. 5

Table A.6/J.67 – Definition of signal 6

k = 225 to 244: level 0 mV
k = 244 to 248: transition from 0 mV to –250 mV
k = 248 to 365: level –250 mV
k = 365 to 369: transition from –250 mV to +250 mV
k = 369 to 486: level +250 mV
k = 486 to 490: transition from +250 mV to 0 mV
k = 490 to 607: level 0 mV
k = 607 to 688: burst 1 MHz
k = 688 to 690: level 0 mV
k = 690 to 771: burst 2 MHz
k = 771 to 773: level 0 mV
k = 773 to 854: burst 3 MHz
k = 854 to 856: level 0 mV
k = 856 to 937: burst 4 MHz
k = 937 to 939: level 0 mV
k = 939 to 1020: burst 5 MHz
k = 1020 to 1022: level 0 mV
k = 1022 to 1103: burst 6 MHz
k = 1103 to 1105: level 0 mV
k = 1105 to 1186: burst 7 MHz
k = 1186 to 1188: level 0 mV
k = 1188 to 1269: burst 8 MHz
k = 1269 to 1292: level 0 mV

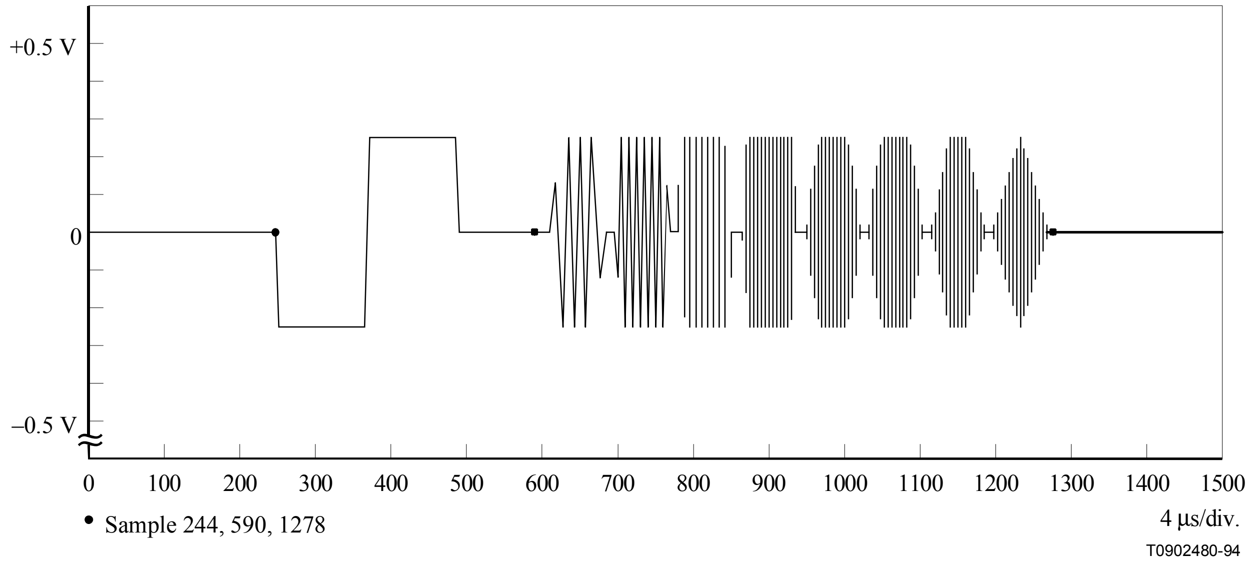


Figure A.6/J.67 – Test signal No. 6

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