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**ITU-T**

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OF ITU

**G.711.1**  
**Amendment 5**  
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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,  
DIGITAL SYSTEMS AND NETWORKS

Digital terminal equipments – Coding of voice and audio  
signals

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Wideband embedded extension for G.711 pulse  
code modulation

**Amendment 5: New Appendix IV extending  
Annex D superwideband for mid-side stereo**

Recommendation ITU-T G.711.1 (2008) –  
Amendment 5



ITU-T G-SERIES RECOMMENDATIONS  
**TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS**

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
General	G.700–G.709
<b>Coding of voice and audio signals</b>	<b>G.710–G.729</b>
Principal characteristics of primary multiplex equipment	G.730–G.739
Principal characteristics of second order multiplex equipment	G.740–G.749
Principal characteristics of higher order multiplex equipment	G.750–G.759
Principal characteristics of transcoder and digital multiplication equipment	G.760–G.769
Operations, administration and maintenance features of transmission equipment	G.770–G.779
Principal characteristics of multiplexing equipment for the synchronous digital hierarchy	G.780–G.789
Other terminal equipment	G.790–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

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# Recommendation ITU-T G.711.1

## Wideband embedded extension for G.711 pulse code modulation

### Amendment 5

#### New Appendix IV extending Annex D superwideband for mid-side stereo

(This appendix does not form an integral part of this Recommendation.)

#### Summary

Appendix IV to ITU-T G.711.1 defines a coding scheme for mid-side (MS) stereo using ITU-T G.711.1 Annex D (ITU-T G.711.1-SWB). By introducing the mid-side stereo coding into stereo terminals, interoperability with the monaural devices could be obtained in very low complexity.

The basic coding scheme is as follows:

- a) Two channels of the left-right (LR) stereo are converted to those of the MS stereo and then the signals of each channel are independently encoded using ITU-T G.711.1-SWB.
- b) At the decoder side, the MS channels of the bitstream from the encoder are decoded respectively and then the decoded signals of the MS channels are reversed to those of the LR channels.

The LR-MS conversion and its inverse are conducted in a conventional way. On the encoder side, additional two arithmetic operations per sample are required for the LR-MS conversion and one operator for the MS-LR conversion in the decoder. In an STL2009 [b-ITU-T G.191] basic operator implementation, the conversion complexity amounts to about 0.2 WMOPS in total. The coding algorithm for each channel is identical to the one in ITU-T G.711.1 Annex D.

#### History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.711.1	2008-03-15	16
1.1	ITU-T G.711.1 (2008) Amend. 1	2008-11-13	16
1.2	ITU-T G.711.1 (2008) Amend. 2	2009-03-16	16
1.3	ITU-T G.711.1 (2008) Amend. 3	2010-10-14	16
1.4	ITU-T G.711.1 (2008) Amend. 4	2010-11-13	16
1.5	ITU-T G.711.1 (2008) Amend. 5	2011-03-25	16

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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## Table of Contents

	<b>Page</b>
Appendix IV – Mid-side stereo coding.....	1
IV.1    Scope .....	1
IV.2    Description of the mid-side stereo coding.....	1
IV.3    Computational complexity .....	2
Bibliography.....	3



# Recommendation ITU-T G.711.1

## Wideband embedded extension for G.711 pulse code modulation

### Amendment 5

#### New Appendix IV extending Annex D superwideband for mid-side stereo

## Appendix IV

### Mid-side stereo coding

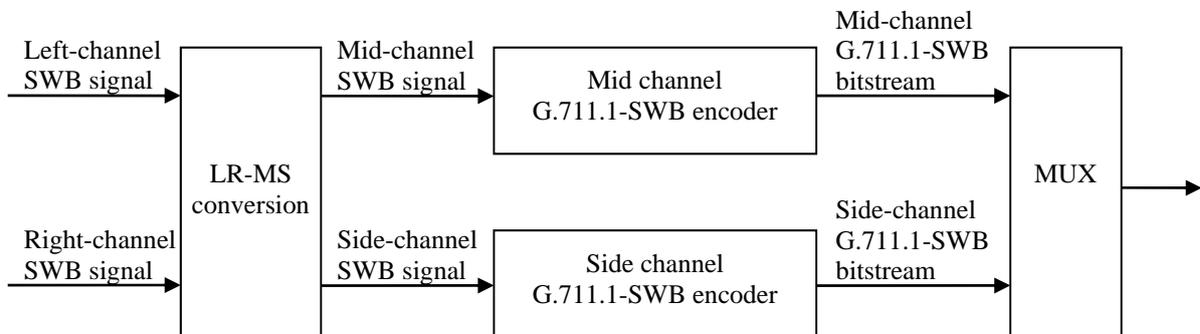
#### IV.1 Scope

This appendix defines a stereo encoding scheme for ITU-T G.711.1 Annex D (ITU-T G.711.1-SWB) mid-side (MS) stereo. By using MS stereo, very low transcoding/down-mix effort between MS-stereo bitstreams and monaural bitstreams is achieved. To ensure inter-operability, out-of-band signalling should be separately defined to differentiate MS stereo implementations.

#### IV.2 Description of the mid-side stereo coding

##### IV.2.1 Encoding scheme

The mid-side stereo encoding is realized by left-right (LR) to MS conversion and two ITU-T G.711.1-SWB encoders, as shown in Figure IV.1.



**Figure IV.1 – Encoder block diagram of MS stereo using ITU-T G.711.1-SWB**

The LR stereo signal is converted into MS stereo using LR-MS conversion and then those two channels are encoded using mid- and side-channel ITU-T G.711.1-SWB encoders. Those two encoders are identical instances of what is defined in Rec. ITU-T G.711.1 Annex D.

The LR-MS conversion uses the following two equations:

$$\begin{aligned} S_{SWB}^M(n) &= \frac{S_{SWB}^L(n) + S_{SWB}^R(n)}{2} \\ S_{SWB}^S(n) &= \frac{S_{SWB}^L(n) - S_{SWB}^R(n)}{2} \end{aligned} \quad n = 0, \dots, 159 \quad (\text{IV-1})$$

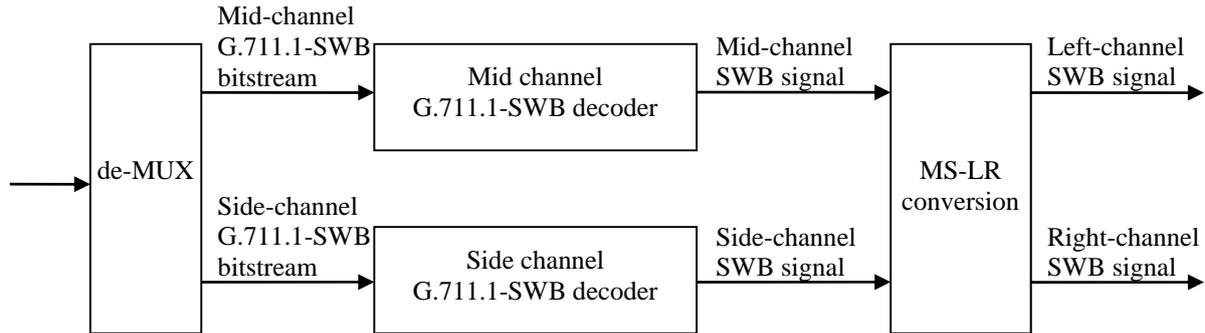
The multiplexer places the mid- and side-channel ITU-T G.711.1-SWB bitstreams in the order given in Figure IV.2.

Mid-channel ITU-T G.711.1-SWB bitstream	Side-channel ITU-T G.711.1-SWB bitstream
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**Figure IV.2 – Bitstream order of ITU-T G.711.1-SWB MS stereo**

### IV.2.2 Decoding scheme

The mid-side stereo decoding is realized by MS to LR conversion and two ITU-T G.711.1-SWB decoders, as shown in Figure IV.3.



**Figure IV.3 – Decoder block diagram of MS stereo using ITU-T G.711.1-SWB**

Mid- and side-channel bitstreams are fed to mid- and side-channel ITU-T G.711.1-SWB decoders and then the obtained mid- and side-channel superwideband signals are converted into an LR stereo signal using MS-LR conversion. Again, the two decoders are identical instances of what is defined in Rec. ITU-T G.711.1 Annex D.

The MS-LR conversion uses the following two equations:

$$\begin{aligned}
 S_{SWB}^L(n) &= S_{SWB}^M(n) + S_{SWB}^S(n) \\
 S_{SWB}^R(n) &= S_{SWB}^M(n) - S_{SWB}^S(n)
 \end{aligned}
 \quad n = 0, \dots, 159 \quad (IV-2)$$

### IV.3 Computational complexity

The LR-MS conversion in the encoding, described above, requires two arithmetic operations per sample and the MS-LR conversion in the decoding also needs one operation. In an STL2009 [b-ITU-T G.191] basic operator implementation, the conversion complexity amounts to about 0.2 WMOPS in total.

## **Bibliography**

- [b-ITU-T G.191] Recommendation ITU-T G.191 (2010), *Software tools for speech and audio coding standardization*.





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