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OF ITU

G.726 – Annex A

(11/94)

GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS

40, 32, 24, 16 kbit/s ADAPTIVE DIFFERENTIAL PULSE CODE MODULATION (ADPCM)

ANNEX A: EXTENSIONS OF RECOMMENDATION G.726 FOR USE WITH UNIFORM-QUANTIZED INPUT AND OUTPUT

ITU-T Recommendation G.726 – ANNEX A

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation G.726 – Annex A was prepared by ITU-T Study Group 15 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 1st of november 1994.

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NOTE

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

CONTENTS

40, 32, 24, 16 kbit/s ADAPTIVE DIFFERENTIAL PULSE CODE MODULATION (ADPCM)[1]

(Geneva, 1990)

Annex A

Extensions of Recommendation G.726 on 40, 32, 24, 16 kbit/s adaptive differential pulse code modulation for use with uniform-quantized input and output

(Geneva, 1994)

(This annex forms an integral part of this Recommendation)

A.1   General

This annex extends the Adaptive Differential Pulse Code Modulation (ADPCM) algorithm specified in Recommendation G.726 to allow use of a uniform PCM interface at input and output.

The principal application for this extension is at the analogue end points of digital transmission links, especially telephone terminal equipment.

This annex defines a 14-bit uniform-quantized interface for Recommendation G.726. Use with other data widths requires scaling the data such that the most significant bit of the 14-bit uniform PCM corresponds to the most significant bit of the target data width. For example, a 13-bit input value must be left shifted by one bit to provide the input, SL. Likewise SO, the output value, must be right shifted by one bit to provide a 13-bit output.

Subclause A.2 describes the changes in principles to use uniform-quantized PCM. Subclause A.3 provides the changed computational details from Recommendation G.726. Appendix I/G.726 describes the digital test sequences.

> NOTE – Uniform-quantized PCM is defined by reference to Recommendation G.701 and to 3.6/G.711.

A.2   Changes to the ADPCM algorithm

The core ADPCM algorithm is unchanged, but the PCM conversion and formatting blocks EXPAND and COMPRESS as well as the Synchronous Coding Adjustment shall not be used. Because there was an implicit limiting function in the COMPRESS block, a new block LIMO has been introduced to explicitly limit the output to the range –8192 to +8191, inclusive.

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[1] This Recommendation completely replaces the text of Recommendations G.721 and G.723 published in Volume III.4 of the Blue Book. It should be noted that systems designed in accordance with the present Recommendation will be compatible with systems designed in accordance with Blue Book version.

The input to the encoder is no longer $s(k)$, but $s_l(k)$, the uniform PCM signal. The output of the decoder is no longer $s_d(k)$, but $s_o(k)$, the 14-bit limited version of $s_r(k)$, the reconstructed signal.

The Synchronous Coding Adjustment was introduced into Recommendation G.726 to compensate for cumulative distortion caused by multiple transcodings as a signal propagates through successive PCM and ADPCM links. However, it is not possible to use this technique with uniform-quantized PCM. Analysis has shown that cumulative distortion is not possible at 16, 24 or 32 kbit/s. However, because cumulative distortion is possible at 40 kbit/s, a 40 kbit/s decoder as described in this annex, shall be used only at the analogue endpoint of a digital transmission chain.

The 14-bit uniform-PCM output value shall not be re-compressed to A-law or μ-law PCM as this bypasses the Synchronous Coding Adjustment of Recommendation G.726.

When a uniform PCM interface is implemented, references to Figure 1/G.726 shall be replaced with references to Figure A.1.

a) Encoder

b) Decoder

T1514710-93/d01
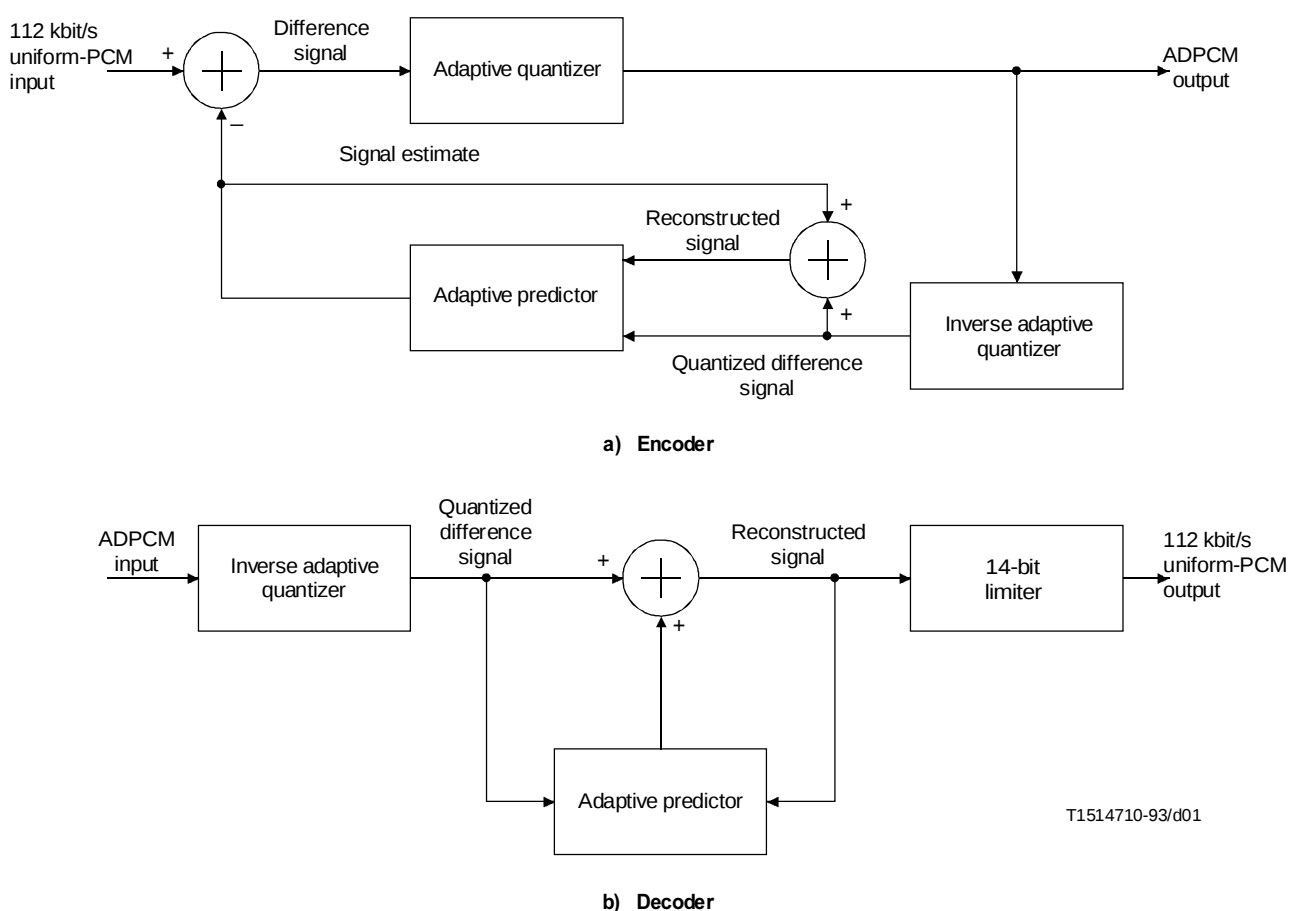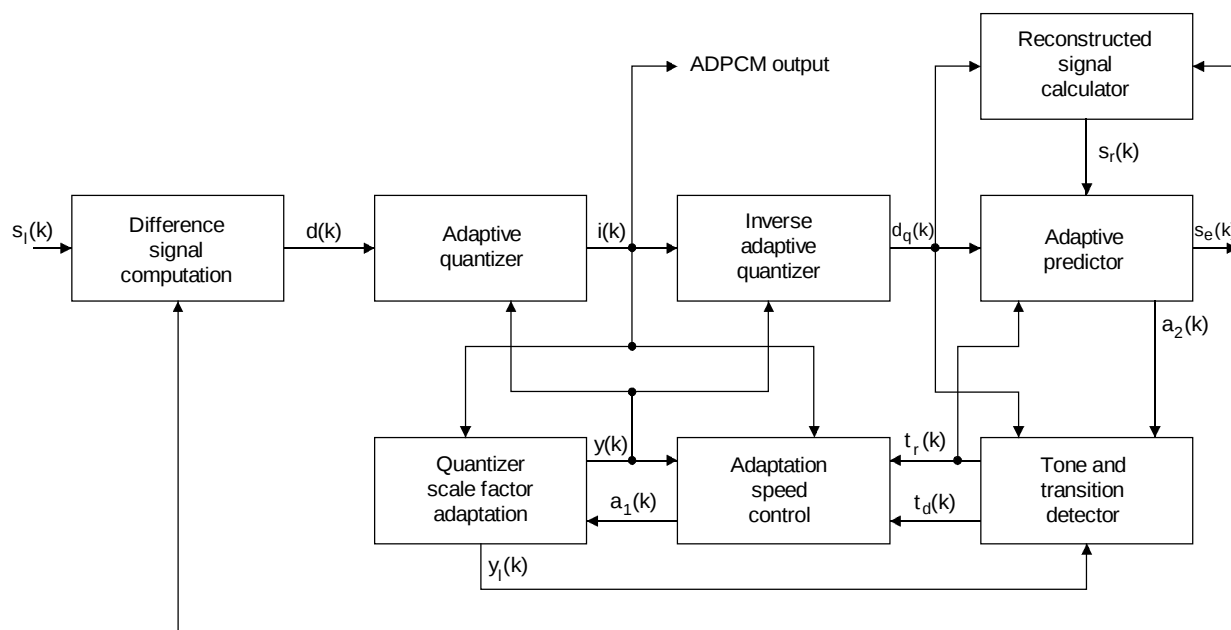
FIGURE A.1/G.726

Simplified block diagrams
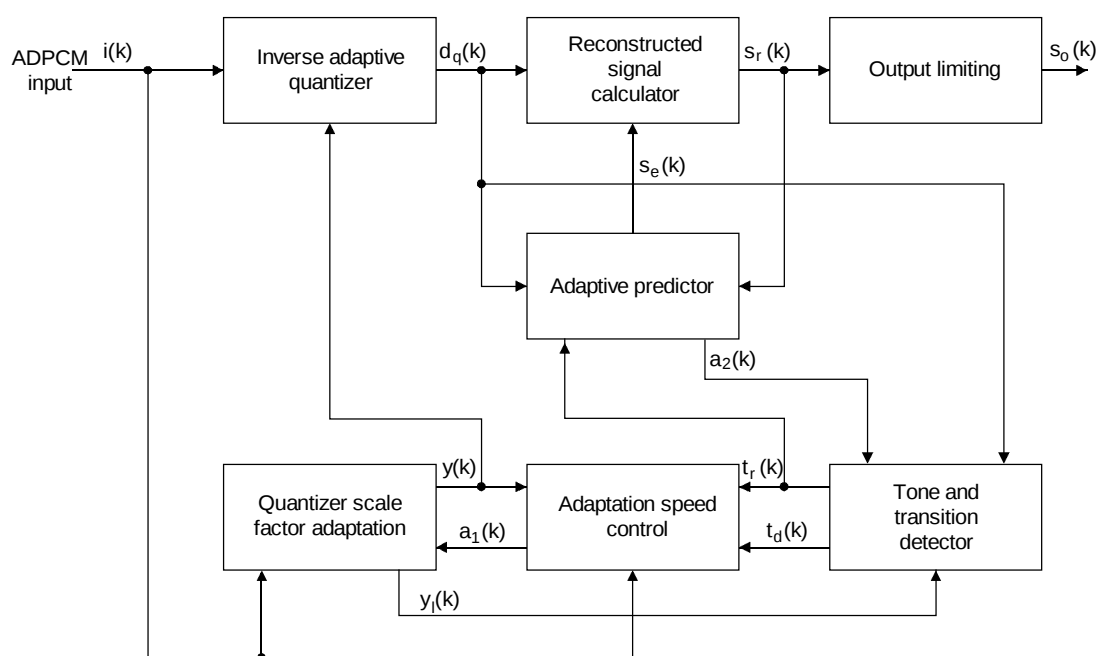
When a uniform PCM interface is implemented, Figure A.2 shall be used instead of Figure 2/G.726.

FIGURE A.2/G.726

Encoder block schematic

When a uniform PCM interface is implemented, Figure A.3 shall be used instead of Figure 3/G.726.

FIGURE A.3/G.726

Decoder block schematic

A.3 Computational details of changes to Recommendation G.726 for uniform-quantized PCM

A.3.1 Input and output signals

When a uniform PCM interface is implemented, Table A.1 shall be used instead of Table 1/G.726.

TABLE A.1/G.726

Input and output signals

	Name	Number of bits	Description
Encoder			
Input	SL	14	Uniform PCM input word
Input	R *(optional)*	1	Reset
Output	I	5	40 kbit/s ADPCM word
Output	I	4	32 kbit/s ADPCM word
Output	I	3	24 kbit/s ADPCM word
Output	I	2	16 kbit/s ADPCM word
Decoder			
Input	I	5	40 kbit/s ADPCM word
Input	I	4	32 kbit/s ADPCM word
Input	I	3	24 kbit/s ADPCM word
Input	I	2	16 kbit/s ADPCM word
Input	R *(optional)*	1	Reset
Output	SO	14	Uniform PCM output word
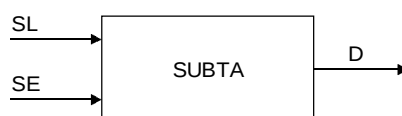
A.3.2 Description of internal processing variables

For uniform PCM implementations, the internal processing variables shall be the same as in Table 6/G.726, with the exception of the variables DLNX, DLX, DSX, DX, SL, SLX and SP, which shall not be used.

A.3.3 Changes to input PCM conversion and difference signal computation

When a uniform PCM interface is implemented, Figure A.4 shall be used instead of Figure 4/G.726.

When a uniform PCM interface is implemented, the EXPAND block shall not be used.

T1514740-93/d04

FIGURE A.4/G.726

Difference signal computation
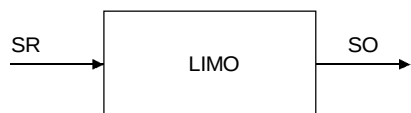
A.3.4 Output PCM format conversion and synchronous coding adjustment deleted

When a uniform PCM interface is implemented the blocks COMPRESS, EXPAND and SYNC (see 4.2.8/G.726) shall not be used. Figure 11/G.726 shall also not be used.

In addition, 4.2.8/G.726 shall be replaced by the following subclause:

A.3.5 Output limiting (decoder only)

See Figure A.5.

T1514750-93/d05

FIGURE A.5/G.726

Output limiting

LIMO (decoder only)

Input: SR
Output: SO
Function: Limit output to 14-bit two's compliment value

$$SO = \begin{cases} 8191, & SR > 8191 \text{ and } SR < 32\,768 \\ SR\ \&\ 16383, & SR < 8192 \text{ or } SR > 57\,344 \\ 57\,344, & SR > 32767 \text{ and } SR < 57\,344 \end{cases}$$