



INTERNATIONAL TELECOMMUNICATION UNION

**ITU-T**

**G.727 – Annex A**

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

(11/94)

**GENERAL ASPECTS OF DIGITAL  
TRANSMISSION SYSTEMS**

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**5-, 4-, 3- AND 2-bits SAMBPLE EMBEDDED  
ADAPTIVE DIFFERENTIAL PULSE CODE  
MODULATION (ADPCM)**

**ANNEX A: EXTENSIONS  
OF RECOMMENDATION G.727  
FOR USE WITH UNIFORM-QUANTIZED  
INPUT AND OUTPUT**

**ITU-T Recommendation G.727 – Annex A**

(Previously "CCITT Recommendation")

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## 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.727 – 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.

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**5-, 4-, 3- AND 2 bits SAMPLE EMBEDDED ADAPTIVE  
DIFFERENTIAL PULSE CODE MODULATION (ADPCM)**

*(Geneva, 1990)*

**Annex A**

**Extensions of Recommendation G.727 on 5-, 4-, 3- and 2-bit sample  
embedded 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.727 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.727. 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 inputs, SL. Likewise SO, the output value, must be right shifted by one bit to provide a 13-bit output.

Clause A.2 describes the changes in principles to use uniform-quantized PCM. Clause A.3 provides the changed computational details from Recommendation G.727.

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**

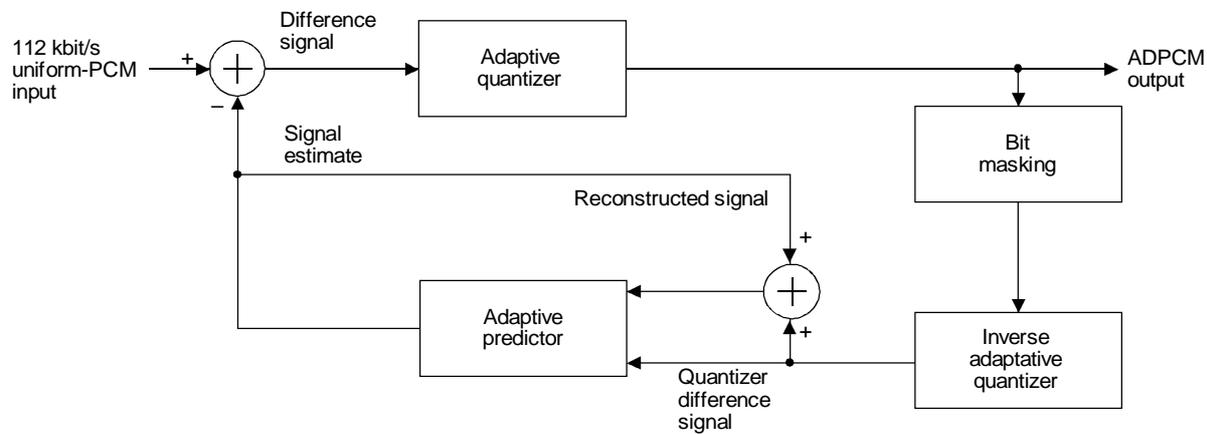
The core ADPCM algorithm is unchanged, but the PCM conversion and formatting blocks EXPAND and COMPRESS as well as the Synchronous Coding Adjustment shall not be used. Because there was an implicit limiting function in the COMPRESS block, a new block LIMO has been introduced to explicitly limit the output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

The input to the encoder is no longer  $s(k)$ , but  $s_I(k)$ , the uniform PCM signal. The output of the decoder is no longer  $s_O(k)$ , but  $s_{OF}(k)$ , the 14-bit limited version of  $s_r(k)_{FF}$ , the feed-forward reconstructed signal.

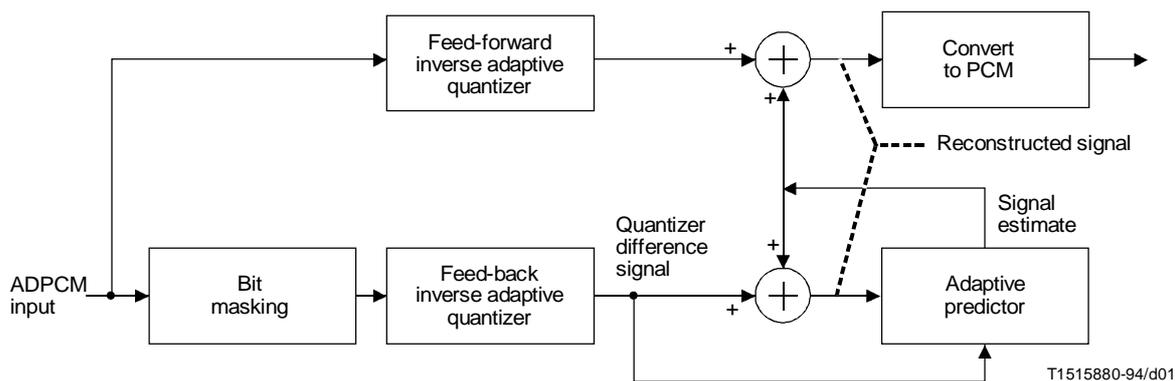
The Synchronous Coding Adjustment was introduced into Recommendation G.727 to compensate for cumulative distortion caused by multiple transcodings as a signal propagates through successive PCM and ADPCM links. However, it is not possible to use this technique with uniform-quantized PCM. Analysis has 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 end point of a digital transmission chain.

The 14-bit uniform-PCM output value should not be re-compressed to A-law or  $\mu$ -law PCM as this bypasses the Synchronous Coding Adjustment.

When a uniform PCM interface is implemented, Figure A.1 shall be used instead of Figure 1/G.727.



a) Encoder

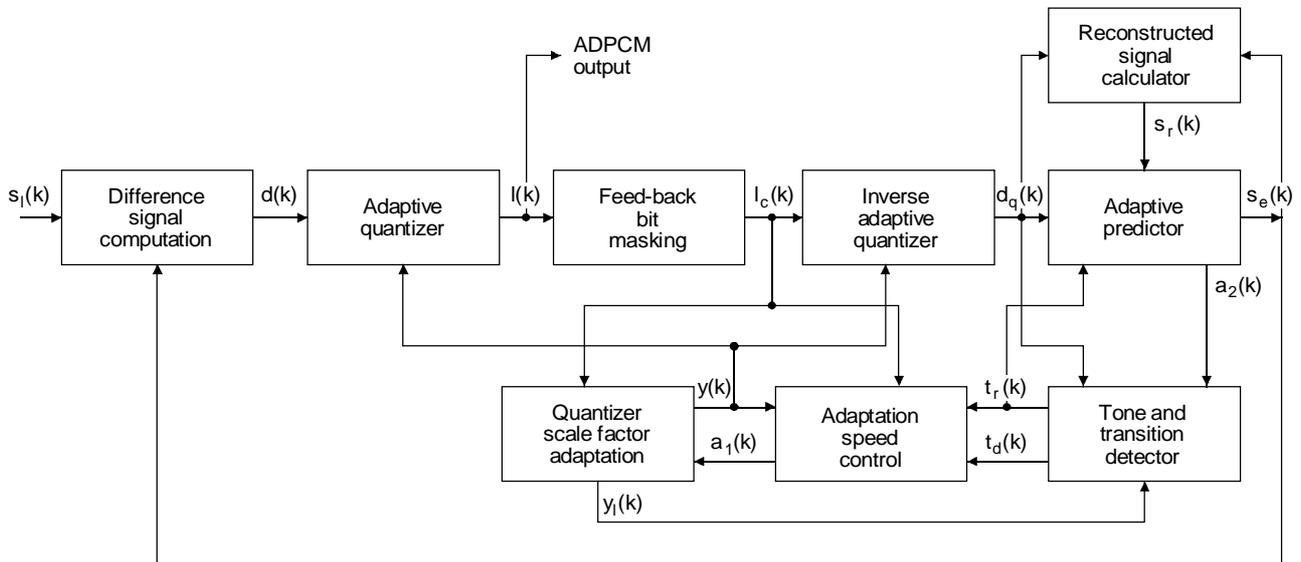


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b) Decoder

FIGURE A.1/G.727  
Simplified block diagrams

When a uniform PCM interface is implemented, Figure A.2 shall be used instead of Figure 2/G.727.



T1514770-93/d02

FIGURE A.2/G.727  
Encoder block schematic

When a uniform PCM interface is implemented, Figure A.3 shall be used instead of Figure 3/G.727.

### A.3 Computational details of changes to Recommendation G.727 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.727.

#### A.3.2 Description of internal processing variables

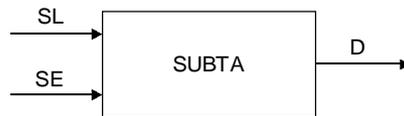
For uniform PCM implementation, the internal processing variables shall be the same as in Table 6/G.727, with the exception of the variable: DLNX, DLX, DSX, DX, SL, SLX and SP, which shall not be used.

#### 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.727.

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





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FIGURE A.4/G.727  
Difference signal computation

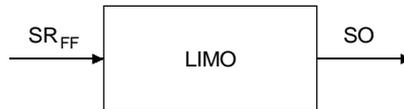
**A.3.4 Output PCM format conversion and synchronous coding adjustment deleted**

When a uniform PCM interface is implemented the blocks COMPRESS, EXPAND and SYNC (see 6.2.10/G.727) shall not be used. Figure 13/G.727 shall also not be used.

In addition, 6.2.10/G.727 shall be replaced by the following subclause:

**A.3.5 Output limiting (decoder only)**

See Figure A.5.



T1514800-93/d05

FIGURE A.5/G.727  
Output limiting

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LIMO (decoder only)

Input:  $SR_{FF}$

Output:  $SO$

Function: Limit output to 14-bit two's compliment value

$SO =$

8191,	$SR_{FF} > 8191$ and $SR_{FF} < 32\,768$
$SR_{FF} \& 16\,383$ ,	$SR_{FF} < 8192$ or $SR_{FF} > 57\,344$
57 344,	$SR_{FF} > 32\,767$ and $SR_{FF} < 57\,344$

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