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ITU-T

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STANDARDIZATION SECTOR
OF ITU

G.729

Annex F
(02/00)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Terminal equipments –
Coding of analogue signals by methods other than PCM

Coding of speech at 8 kbit/s using Conjugate
Structure Algebraic Code-Excited Linear Prediction
(CS-ACELP)

Annex F: Reference implementation of G.729
Annex B DTX functionality for Annex D

ITU-T Recommendation G.729 – Annex F

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION G.729

CODING OF SPEECH AT 8 kbit/s USING CONJUGATE STRUCTURE ALGEBRAIC CODE-EXCITED LINEAR PREDICTION (CS-ACELP)

ANNEX F

Reference implementation of G.729 Annex B DTX functionality for Annex D

Summary

This annex provides the DTX functionality for the 6.4 kbit/s CS-ACELP algorithm of G.729 Annex D using the basic algorithm in G.729 Annex B.

This annex includes an electronic attachment containing version 1.1 of reference C code and test vectors for fixed-point implementation of CS-ACELP at 6.4 kbit/s and 8 kbit/s with DTX functionality.

Source

Annex F to ITU-T Recommendation G.729 was prepared by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 17 February 2000.

FOREWORD

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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.

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

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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Recommendation G.729

CODING OF SPEECH AT 8 kbit/s USING CONJUGATE STRUCTURE ALGEBRAIC CODE-EXCITED LINEAR PREDICTION (CS-ACELP)

ANNEX F

Reference implementation of G.729 Annex B DTX functionality for Annex D¹

(Geneva, 2000)

F.1 Scope

This annex provides a description of integrating the G.729 Annexes B and D, hereby defining DTX functionality for Annex D. It presents a standard way of performing this integration and expansion of the functionality thereby guiding the industry and ensuring a standard speech quality and compatibility worldwide. The integration has been performed with focus on several constraints in order to satisfy the need of the industry:

- 1) Bit-exactness with the main body and individual annexes.
- 2) Minimum additional program code, memory, and complexity usage.
- 3) Stringent quality requirements to new functionality inline with quality and application areas of the according standard annexes.

F.2 Normative references

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T Recommendation G.729 (1996), *Coding of speech at 8 kbit/s using conjugate structure algebraic code-excited linear prediction (CS-ACELP)*.
- [2] ITU-T Recommendation G.729 Annex B (1996), *A silence compression scheme for G.729 optimized for terminals conforming to Recommendation V.70*.
- [3] ITU-T Recommendation G.729 Annex D (1998), *6.4 kbit/s CS-ACELP speech coding algorithm*.

F.3 Overview

Recommendation G.729 main body [1] and Annexes B [2] and D [3] provide a bit-exact, fixed-point specification of a CS-ACELP coder at 8 kbit/s, with DTX functionality and lower bit-rate extension capability at 6.4 kbit/s. Exact details of these specifications are given in bit-exact, fixed-point C in an electronic file attached to this annex. This annex describes and defines the integration of the G.729 Annexes B and D.

¹ This annex includes an electronic attachment containing version 1.1 of reference C code and test vectors for fixed-point implementation of CS-ACELP of 6.4 kbit/s and 8 kbit/s with DTX functionality.

F.4 New functionality

This subclause presents a brief overview of the modifications/additions to the algorithms in order to facilitate the integration of Annexes B and D.

F.4.1 Annex B DTX operation with Annex D

Integrating Annexes B and D functionality in order to provide DTX operation with Annex D is straightforward. The VAD (Voice Activity Detection), SID coding (Silence Description), and CNG (Comfort Noise Generation) of Annex B are reused without any modifications. Care is taken to update the parameters for the phase dispersion for the postfilter in Annex D during discontinued transmission (see F.5.1).

F.5 Algorithm Description

This subclause presents the algorithm description of the necessary additions to the algorithms of the individual annexes in order to facilitate the integration. All remaining modules originate from the main body, Annex B, or D.

F.5.1 Update of state variables specific to Annex D during discontinued transmission

The only state variables specific to Annex D are the state variables of the phase dispersion module (see D.6.2 of ITU-T G.729 – Annex D [3]) at the decoder. In case of inactive frames, the same update procedure as in case of nominal bit rate (8 kbit/s) is followed using as adaptive and ACELP gain estimations the gain values computed by the comfort noise excitation generator (see B.4.4 of ITU-T G.729 – Annex B [2]).

F.6 Description of C source code

Annex F of G.729, integrating the G.729 Annexes B and D, is simulated in 16-bit fixed-point ANSI-C code using the same types of fixed-point data and the same set of fixed-point basic operators as in the G.729 software. The ANSI-C code represents the normative specification of this annex. The algorithmic description given by the C code shall take precedence over the texts contained in the main body of Recommendation G.729 and in Annexes B, D and F. The following subclauses summarize the use of this simulation code, and how the software is organized.

F.6.1 Use of the simulation software

The C code consists of two main programs **coderf.c** and **decoderf.c**, which simulate encoder and decoder, respectively. The encoder is run as follows:

coderf inputfile bitstreamfile dtx_option rate_option

The decoder is run as follows:

decoderf bitstreamfile outputfile

The **inputfile** and **outputfile** are 8 kHz sampled data files containing 16-bit PCM signals. The **bitstreamfile** is a binary file containing the bit stream; the mapping table of the encoded bit stream is contained in the simulation software. The two parameters are used for the encoder: **dtx_option** and **rate_option** where:

dtx_option = 1: DTX enabled 0: DTX disabled, the default is 0 (DTX disabled).

rate_option = 0 to select the lower rate (6.4 kbit/s); = 1 to select the main Recommendation G.729 (8 kbit/s); or a **file_rate_name**: a binary file of 16-bit word containing either 0, 1 to select the rate on a frame-by-frame basis; the default is 1 (8 kbit/s).

F.6.2 Organization of the simulation software

The files can be classified into three groups:

- 1) Files identical to software files of G.729 main body [1], Annex B [2], Annex D [3] are listed in Table F.1.
- 2) Files adapted from software files of G.729 Annex B or Annex D, listed in Table F.2, some minor modifications have been introduced to cope with the integration.
- 3) Files integrated G.729 software files of Annex B and Annex D, listed in Table F.3.

Table F.1/G.729 – List of software files identical to software files of G.729 main body, Annex B or D

File name	Description	Identical to
Basic_op.c	Basic operators	Main
Oper_32b.c	Extended basic operators	Main
Dspfunc.c	Mathematical functions	Main
Gainpred.c	Gain predictor	Main
Lpcfunc.c	Miscellaneous routines related to LP filter	Main
Pre_proc.c	Pre-processing (HP filtering and scaling)	Main
P_parity.c	Compute pitch parity	Main
Pwf.c	Computation of perceptual weighting coefficients (8 kbit/s)	Main
Pred_lt3.c	Generation of adaptive codebook	Main
Post_pro.c	Post processing (HP filtering and scaling)	Main
Typedef.h	Data type definition (machine dependent)	Main
Basic_op.h	Basic operators prototypes	Main
Oper_32b.h	Extended basic operators prototypes	Main
Filter.c	Filter functions	Main
Lspgetq.c	LSP quantizer	Main
De_acelp.c	ACELP decoding	Main
Lpc.c	LP analysis	B
Lspdec.c	LSP decoding routines	B
Qua_lsp.c	LSP quantizer	B
Tab_ld8k.c	ROM tables	B
Taming.c	Pitch instability control	B
Dtx.c	DTX Decision	B
Dtx.h	Prototype and Constants	B
Qsidgain.c	SID Gain Quantization	B
QsidLSF.c	SID-LSF Quantization	B
Tab_dtx.c	ROM tables	B
Pst.c	Postfilter routines	B
Vad.c	VAD	B
ld8k.h	Function prototypes	B
Vad.h	Prototype and Constants	B

**Table F.1/G.729 – List of software files identical to software files of G.729
main body, Annex B or D (concluded)**

File name	Description	Identical to
Tab_ld8k.h	Extern ROM tables declarations	B
Sid.h	Prototype and Constants	B
Octet.h	Octet transmission mode definition	B
Tab_dtx.h	Extern ROM table declarations	B
Util.c	Utility functions	B
Pitchd.c	Pitch search	D
Declag3d.c	Decode adaptive-codebook index	D
Acelpcod.c	ACELP codebook search	D
Deacelpd.c	Decode ACELP codebook	D
Qua_g8k.c	Gain quantizer	D
Dec_g8k.c	Decode gain	D
Qua_g6k.c	Gain quantizer	D
Dec_g6k.c	Decode gain	D
Tabld8kd.c	ROM tables for G.729 at 6.4 kbit/s	D
Tabld8kd.h	Extern ROM declarations for G.729 at 6.4 kbit/s	D
ld8kd.h	Function prototypes for G.729 Annex D	D

**Table F.2/G.729 – List of software files adapted from software files of G.729
Annexes B and D**

File name	Description	Adapted from
Calcexc.c	CNG Excitation Calculation	B
Dec_sidf.c	Decode SID Information	B
Phdisp.c	Phase dispersion	D

**Table F.3/G.729 – List of software files integrating software files from G.729 main body,
Annexes B and D**

File name	Description	Integrated from
Coderf.c	Main encoder routine	Main+B+D
Cod_ld8f.c	Encoder routine	Main+B+D
Decoderf.c	Main decoder routine	Main+B+D
Dec_ld8f.c	Decoder routine	Main+B+D
Bitsf.c	Bit manipulation routines	Main+B+D
Ld8f.h	Constant and Function prototypes for G.729 Annex F	Main+B+D