INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

G.728 Implementors' Guide

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

Digital terminal equipments – Coding of analogue signals by methods other than PCM

Implementors' Guide for ITU-T Recommendation G.728 ("Coding of speech at 16 kbit/s using low-delay code excited linear prediction")

Summary

This document is an Implementors' Guide for the ITU-T Recommendation of G.728 addressing issues found in particular in its Annex I "Frame or packet loss concealment for the LD-CELP decoder"

This revision contains all updates submitted up to and including those at Study Group 16 meeting in April 2006 and supersedes the G.728 Implementors' Guide approved 2004-01.

This document was approved by ITU-T Study Group 16 on 13 April 2006.

Change Log

Revision	Date	Description
1.0	30 January 2004	Approved by ITU-T Study Group 16 (TD 57/PLEN)
2.0	13 April 2006	Approved by ITU-T Study Group 16 (TD 255/PLEN)

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IMPLEMENTORS' GUIDE FOR ITU-T G.728:
"CODING OF SPEECH AT 16 KBIT/S USING LD-CELP"

1   Scope

This guide resolves defects in G.728 and addresses the following categories:

- editorial errors
- technical errors, such as omissions and inconsistencies
- ambiguities

In addition, the Implementors' Guide may include explanatory text found necessary as a result of interpretation difficulties apparent from the defect reports.

This Guide will not address proposed additions, deletions, or modifications to the Recommendations that are not strictly related to implementation difficulties in the above categories. Proposals for new features should be made through contributions to the ITU-T. This Implementors' Guide supersedes the G.728 Implementors' Guide approved 2004-01.

2   Introduction

ITU-T Recommendation G.728 defines coding of speech at 16 kbit/s using low-delay code excited linear prediction (LD-CELP) and comprises the following parts:

- G.728 (09/92)- Coding of speech at 16 kbit/s using low-delay code excited linear prediction
- G.728 Annex G (11/94) plus Corrigendum 1 (02/00) - 16 kbit/s fixed point specification
- G.728 Annex H (05/99) - Variable bit rate LD-CELP operation mainly for DCME at rates less than 16 kbit/s
- G.728 Annex I (05/99) - Frame or packet loss concealment for the LD-CELP decoder   In force
- G.728 Annex J (09/99) - Variable bit-rate operation of LD-CELP mainly for voiceband-data applications in DCME
- G.728 Appendix I (07/95) - Programs and test sequences for implementation verification of the algorithm of the G.728 16 kbit/s LD-CELP speech coder
- G.728 Appendix II (11/95) - Speech performance

This Implementors' Guide is a compilation of reported defects for all versions of the ITU-T G.728. In this edition of the Guide, reported defects identified as of 2004-01 are given for:

- Annex I - Frame or packet loss concealment for the LD-CELP decoder

The Guide must be read in conjunction with the Recommendation G.728, to serve as an additional source of information for implementors. The changes, clarifications and corrections defined herein are expected to be included in future versions of the affected Recommendations.

3   Defect Resolution Procedure

Upon discovering technical defects with any components of the texts covered by this Implementors Guide, please provide a written description directly to the editors of the affected Recommendation(s) with a copy to the respective Rapporteur. The template for a defect report is located at the end of this Guide. Return contact information should also be supplied so a dialogue

can be established to resolve the matter and an appropriate reply to the defect report can be conveyed. This defect resolution process is open to any interested party. Formal membership in the ITU is not required to participate in this process.

4   References

This document refers to the following G.720-series Recommendations:

–   G.728 (09/92)- Coding of speech at 16 kbit/s using low-delay code excited linear prediction

–   ITU-T G.728 Annex I (05/99), Frame or packet loss concealment for the LD-CELP decoder

5   Nomenclature

In addition to traditional revision marks, the following marks and symbols are used to indicate to the reader how changes to the text of a Recommendation should be applied:

Symbol	Description
[Begin Correction]	Identifies the start of revision marked text based on extractions from the published Recommendations affected by the correction being described.
[End Correction]	Identifies the end of revision marked text based on extractions from the published Recommendations affected by the correction being described.
...	Indicates that the portion of the Recommendation between the text appearing before and after this symbol has remained unaffected by the correction being described and has been omitted for brevity.
--- SPECIAL INSTRUCTIONS --- {instructions}	Indicates a set of special editing instructions to be followed.

6   Technical and Editorial Corrections

6.1   Error in fixed-point pseudo code for Block 97FE of G.728 Annex I

As described in Annex B of TD6-WP3, an error was found in the fixed-point pseudo code for Block 97FE of G.728 Annex I that computes the exponent of NLSETRMS. ET is a 15 bit normalized block floating point array with its exponent stored in NLSET, and not fixed Q2, as implied in the comment. At this point in the code, ET was copied from ETPAST. While ETPAST is in Q2 format, ET is normalized after the copy and may no longer be in Q2. The computation of the exponent, NLSETRMS, in line 6 of the original pseudo code incorrectly assumes NLSET is fixed at 2. This error is fixed in the corrected code. The software simulation used for testing the fixed-point G.728 Annex I corresponds to the corrected code and not the incorrect code.

The modifications are:

1. delete the comment "ET is Q2, so AA0 is Q4" from line 3.

2. Change "**4**" to "**NLSET + NLSET**" in line 6.

The corrected code should appear as below:

```
AA0 = 0
For K = 1, ...,IDIM do the next line | compute energy of
excitation
```

*[**Begin Correction**]*

```
  AA0 = AA0 + ET(K)*ET(K)
```

*[**End Correction**]*

```
Call VSCALE(AA0,1,1,30,AA0,NLS)      | scale AA0
ETRMS = AA0 >> 16                    | take high word of AA0
```

*[**Begin Correction**]*

```
NLSETRMS = (NLSET + NLSET + NLS) - 16 | NLS of ETRMS
```

*[**End Correction**]*

6.2   Correction to Table 2/G.728

As described in TD 118/WP3, on page 26 of ITU-T G.728 (Table 2/G.728), the equivalent symbol α_{i-1} for variable GPTMP is not correct.

The original incorrect line as it appears in G.728 is listed below:

| GPTMP | 1 to LPCLG+1 | $-\alpha_{i-1}$ | | Temporary array for log-gain linear predictor coefficients | |

The corrected line should appear as below:

| GPTMP | 1 to LPCLG+1 | $-\hat{\alpha}_{i-1}$ | | Temporary array for log-gain linear predictor coefficients before bandwidth expansion | |

6.3   Adaptive postfilter output 16-bit limitation

As described in TD 118/WP3, after the adaptive post filter, the value should be limited to 16-bits (similar limitation is applied to the signal prior to the adaptive post filter, page 43 of G.728.

The original incorrect pseudo code as it appears in G.728 (blocks 75 & 76, page 51) is listed below:

```
For   K = 1,2,..,IDIM, do the following:
      SCALEFIL = AGCFAC * SCALEFIL +            | Lowpass filtering
      (1 — AGCFAC) * SCALE                      | Scale output
      SPF(K) = SCALEFIL * TEMP(K)
```

The corrected pseudo code should appear as below:

```
For   K = 1,2,...,IDIM, do the following:
      SCALEFIL = AGCFAC * SCALEFIL +          | Lowpass filtering
      (1 — AGCFAC) * SCALE
      SPF(K) = SCALEFIL * TEMP(K)             | Scale output
      If SPF(K) > MAX, set SPF(K) = MAX       | Limit the range
      If SPF(K) < MIN, set SPF(K) = MIN
```

6.4   Check whether M2 out of range

As described in [TD 118/WP3](#), on page 48 of the main body of G.728, a pseudo-code line should be introduced.

The original incorrect pseudo code as it appears in G.728 (block 82, page 48) is listed below:

```
If    M1 < KPMIN, set M1 = KPMIN            || Check whether M1 out of range
CMAX = most negative number of the machine
```

The corrected pseudo code should appear as below:

```
If    M1 < KPMIN, set M1 =  KPMIN           || Check whether M1 out of range
If    M2 > KPMAX, set M2 =  KPMAX           || Check whether M2 out of range
CMAX = most negative number of the machine
```

6.5   Correction of the reference definition for MAX and MIN values

It should be clarified that the value of MAX is 4095 and the value of MIN is -4095. This implies that the following clarifications should be introduced in the algorithm specification. In section 5.13, first paragraph, the end of the last sentence should be reworded.

The original incorrect text as it appears in G.728 (clause 5.13, page 44) is listed below:

> To safeguard possible overloading of signal levels, a magnitude limiter is built into the procedure so that the filter memory clips at MAX and MIN, where MAX and MIN are respectively the positive and negative saturation levels of A-law or μ-law PCM, depending on which law is used.

The corrected text should appear as below:

> To safeguard possible overloading of signal levels, a magnitude limiter is built into the procedure so that the filter memory clips at MAX and MIN, where MAX and MIN are the positive and negative saturation values of 4095 and -4095, respectively.

7   Implementation Clarifications

None.

Annex: G.728 Defect Report Form

DATE:	
CONTACT INFORMATION	
NAME:	
COMPANY:	
ADDRESS:	
TEL:	
FAX:	
EMAIL:	
AFFECTED RECOMMENDATIONS:	
DESCRIPTION OF PROBLEM:	
SUGGESTIONS FOR RESOLUTION:	

NOTE - Attach additional pages if more space is required than is provided above.

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