International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.728

Amendment 1

(05/2006)

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

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

Coding of speech at 16 kbit/s using low-delay code excited linear prediction

Amendment 1: Revised Annex J – Variable bit-rate operation of LD-CELP mainly for voiceband-data applications in DCME

ITU-T Recommendation G.728 (1992) – Amendment 1

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ITU-T Recommendation G.728

Coding of speech at 16 kbit/s using low-delay code excited linear prediction

Amendment 1

Revised Annex J – Variable bit-rate operation of LD-CELP mainly for voiceband-data applications in DCME

Summary

Annex J to ITU-T Rec. G.728 defines a 40 kbit/s extension optimized for voiceband data signals of the existing Annex G/G.728 – 16 kbit/s fixed point specification. The main difference between the codec described hereby and the codec described in Annex G/G.728 is the application of a Trellis-Coded Quantization (TCQ) approach to codebook search. The TCQ approach replaces the analysis-by-synthesis approach to codebook search of ITU-T Rec. G.728 only in voiceband data (VBD) mode.

The backward adaptation of the predictor achieved in VBD mode is almost identical to the backward adaptation achieved in speech mode (ITU-T Rec. G.728). Additionally, the same adaptation cycle is used for both speech mode (ITU-T Rec. G.728) and VBD mode. In speech mode, the 40 kbit/s reverts to the LD-CELP of ITU-T Rec. G.728.

This annex includes an electronic attachment containing test vectors for implementation verification of Annex J/G.728.

Amendment 1 provides corrections to inconsistencies identified in the description of the gain compensation module of Annex J/G.728. These changes do not affect the existing test vectors.

Source

Amendment 1 to ITU-T Recommendation G.728 (1992) was approved on 29 May 2006 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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ITU-T Recommendation G.728

Coding of speech at 16 kbit/s using low-delay code excited linear prediction

Amendment 1

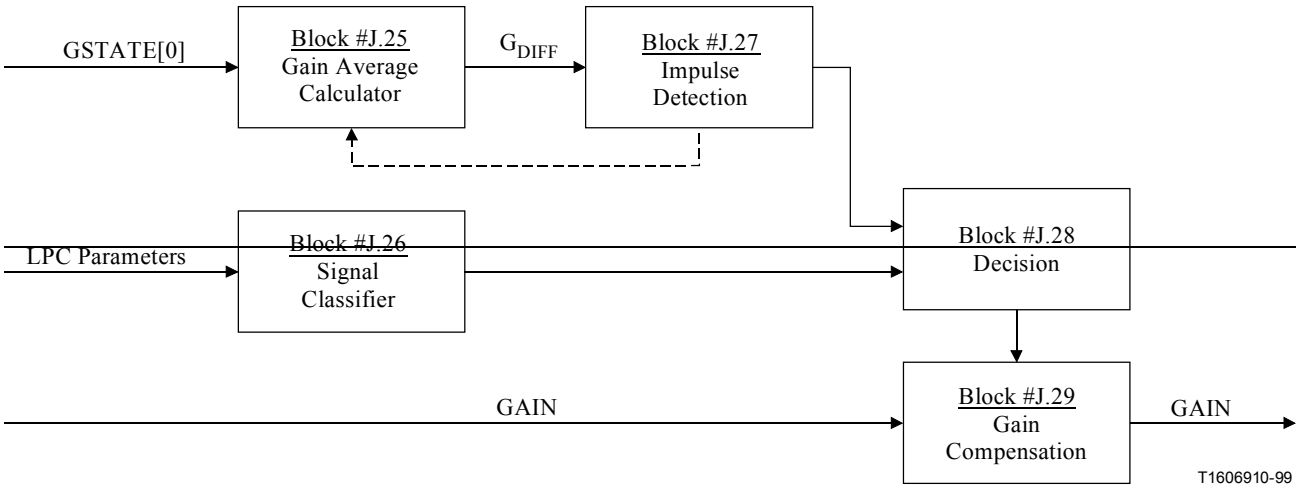
Revised Annex J – Variable bit-rate operation of LD-CELP mainly for voiceband-data applications in DCME

Modifications introduced by this amendment are shown in revision marks. Unchanged text is replaced by ellipsis (**…**)*. Some parts of unchanged texts* (*clause numbers, etc.*) *have been kept to indicate the correct insertion points*.

…

J.4.1.3 Block #J.30 – Backward Gain Adapter

…



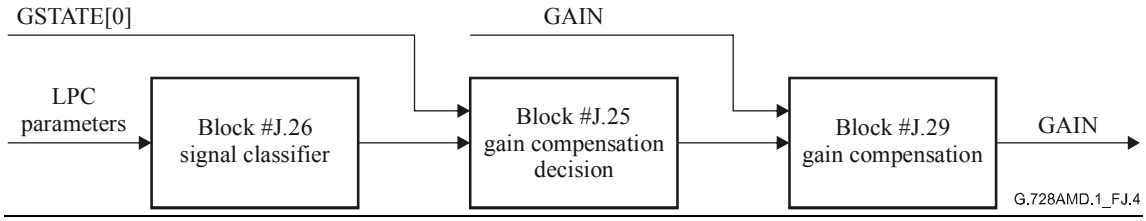


Figure J.4/G.728 – Gain compensation

3) Prediction error impulses might cause quantizer saturation. To avoid this, an additional group of ~~five~~ three blocks (see Figure J.4) produces temporal change in quantization gain. These blocks are:

Block #J.25 – Gain ~~Average Calculator~~Compensation Decision

A smoothing filter calculates the average of the gain estimation, G_{ave}, using the most recent vector gain value, GSTATE[0] (J.4.3.12, block #J.25 and Equation J.4-3). The difference between GSTATE[0] and G_{ave} is calculated (G_{diff}). and passed to the Impulse Detection block.

Block #J.27 – Impulse Detection block

This block detects sudden changes in the gain after a predetermined period of steady gain (see J.4.3.14, block #J.27). G_{diff} is compared against a fixed threshold. If G_{diff} is smaller than the threshold for a period greater than a predefined period of time, then the signal is considered "steady". An error impulse is detected if G_{diff} is greater than the threshold and the preceding signal has been "steady", in that case the Gain Compensation block (see J.4.3.14, block #J.29) is activated.

Block #J.26 – Signal Classifier

During certain VBD transmissions, error impulses are more likely to occur. Thus, upon their detection, gain compensation is maximized. The Signal Classifier block detects these transmissions using the LP coefficient (see J.4.3.13, block #J.26).

Block #J.28 – Decision

The Decision block accepts both the signal classifier block output and the Impulse Detection block output, and activates the Gain Compensation block (see J.4.3.15, block #J.28).

Block #J.29 – Gain Compensation

This block increases the gain factor for a fixed period of time (unless a certain gain factor peak is reached, in which case the period is extended).

$$G_{ave} = G_{const} \times G_{ave} + (1 - G_{const}) \times GSTATE[0] \qquad \text{(J.4-3)}$$

(See J.4.3.14, block #J.29).

J.4.1.4 Block #J.40 – The Predictor Block

• • •

J.4.3.10 Block #J.12 – TCQ Backward Gain Adapter

• • •

```
DLQ_GAIN = GAIN
DLQ_NLSGAIN = NLSGAIN
CALL BLOCK #J.25 | GAIN COMPENSATION DECISION
CALL BLOCK #J.29 | GAIN COMPENSATION
CALL BLOCK #J.15 | GAIN_inverse
```

J.4.3.11 Block #J.13 – vbd_log_calc_and_lim97

• • •

J.4.3.12 Block #J.25 – Gain Compensation Decision Gain Average Calculator

Input: GSTATE[0], UNSTEADY, GC_ATMP_SUM, GC_ATMP1

Output: GC_FLAG G_DIFF, G_CNT, GC_CNT, G_AVE

Operation: Calculation of a quasi-average value of the gain. Detection of narrow bandwidth signal. Search for a sharp gain increase after a predefined period of steady gain.

Internal Variables (C-definition)

- long int G_AVEDIFF.

```
GDIFF=GSTATE[0]-G_AVE;
If GDIFF < G_TRS                          | Do the next 2 lines
          G_AVE=((G_AVE<<G_CONST)-G_AVE+GSTATE[0])>>G_CONST
          G_CNT++
ELSE                                      | Do the next 6 lines
       IF G_CNT>G_LEN                     | Do the next 3 lines
          IF ((GC_ATMP_SUM*ATMP_CONST)>>3)<ABS(GC_ATMP1)  | Do the next 2 lines
             GC_FLAG=1                    | GAIN COMPENSATION FLAG
             GC_CNT=GC_LEN
       G_AVE=GSTATE[0]
       G_CNT=0
```

```
IF UNSTEADY=1                | Do the next 3 lines
       G_AVE=GSTATE[0]
       G_CNT=0
       UNSTEADY=0
ELSE                         | Do the next 3 lines
       IF GDIFF<G_TRS        | Do the next 2 lines
          G_AVE=((G_AVE<<G_CONST-G_AVE+GSTATE[0])>>G_CONST
          G_CNT++
```

J.4.3.13 Block #J.26 – Signal Classifier

Inputs: ATMP

Outputs: GC_ATMP_SUM,~~GC_SC_FLAG~~ GC_ATMP1

Operation: Detection of narrow bandwidth signal.

~~Internal Variables (C-definition)~~

- ~~int GC_ATMP_SUM~~
- ~~int GC_ATMP1~~

```
GC_ATMP_SUM=0
GC_ATMP1=ATMP[1]
FOR I=2,3,...LPC+1,           |Do the next line
       GC_ATMP_SUM=GC_ATMP_SUM+ABS(ATMP[I])
```

```
IF ((GC_ATMP_SUM*ATMP_CONST)>>3)<ABS(GC_ATMP1)
          GC_SC_FLAG=1
ELSE
          GC_SC_FLAG=0
```

~~J.4.3.14 Block #J.27 – Impulse Detection~~

~~**Inputs**: GDIFF, GC_LEN, GC_SC_FLAG~~

~~**Outputs**: GC_ID_FLAG~~

~~**Operation**: Search for a sharp gain increase after a predefined period of steady gain.~~

```
IF GDIFF > G_TRS              | Do the next 4 lines
       IF G_CNT>GC_LEN
          GC_ID_FLAG=1
       ELSE
          GC_ID_FLAG=0
```

~~J.4.3.15 Block #J.28 – Gain Compensation Decision~~

~~**Inputs**: GC_ID_FLAG, GC_SC_FLAG~~

~~**Outputs**: GC_FLAG, GC_CNT, UNSTEADY, GC_NLS_LIMIT, GC_COMPENSATION~~

~~**Operation**: Decision logic for the Gain Compensation block.~~

```
GC_LEN=0
GC_NLS_LIMIT=16383
GC_COMPENSATION=0
IF GC_SC_FLAG=1          | Do the next 3 lines
      GC_LEN=GC_CNT_INIT
      GC_NLS_LIMIT=GC_NLS_LIMIT_INIT
      GC_COMPENSATION=GC_COMPENSATION_INIT
IF GC_ID_FLAG=1          | Do the next 3 lines
      UNSTEADY=1
      GC_FLAG=1                  | GAIN COMPENSATION FLAG
      GC_CNT=GC_LEN
```

J.4.3.164 Block #J.29 – Gain Compensation

Inputs: GC_FLAG, DLQ_NLSGAIN, GC_CNT, GC_COMPENSATION, GC_NLS_LIMIT

Outputs: GC_FLAG

Operation: Decrease DLQ_NLSGAIN by a fixed value for a predefined period of time.

```
IF GC_FLAG = 1                          |Do the next 8 lines
      IF DLQ_NLSGAIN>GC_NLS_LIMIT-1 | Do the next 7 lines
          If DLQ_NLSGAIN>GC_NLS_LIMIT  | Do the next line
              GC_CNT=GC_CNT-1
          DLQ_NLSGAIN=DLQ_NLSGAIN-GC_COMPENSATION
          IF DLQ_NLSGAIN < GC_NLS_LIMIT | Do the next line
              DLQ_NLSGAIN=GC_NLS_LIMIT
          IF GC_CNT=0   | Do the next line
              GC_FLAG=0
```

~~IF GC_FLAG=1 | Do the next 7 lines~~
~~IF DLQ_NLSGAIN>GC_NLS_LIMIT | Do the next 6 lines~~
~~GC_CNT=GC_CNT-1~~
~~DLQ_NLSGAIN=DLQ_NLSGAIN-GC_COMPENSATION~~
~~IF DLQ_NLSGAIN< GC_NLS_LIMIT~~
~~DLQ_NLSGAIN= GC_NLS_LIMIT~~
~~IF GC_CNT=0~~
~~GC_FLAG=0~~

J.4.3.175 Block #J.16 – logarithmic calculator

• • •

J.4.10 Internal Processing Variables and Constants

• • •

Table J.4/G.728 – Internal Processing Constants

Name	Value	Symbol	Description
…			
ATMP_CONST	3		A threshold for detection of narrow bandwidth signal in the Signal Classifier
G_TRS	~~1~~ 1800		Gain Compensation G_{diff} threshold
GC_NLS_LIMIT~~_INIT~~	7		Gain Compensation limiter
GC_COMPENSATION~~_INIT~~	3		The value subtracted from the gain NLS when a Gain Compensation occurs

Name	Value	Symbol	Description
G_LEN	80		The period of time in which the Gain was steady prior to activation of Gain Compensation
GC_~~CNT_INIT~~LEN	11		The period of time in which the Gain Compensation is active

…

J.4.11 Initial Values

…

Table J.5/G.728 – Initial Values

Name	Initial Value
…	
GAVE	0
~~UNSTEADY~~	~~1~~
G_CNT	0
~~GC_SC_FLAG~~	~~0~~
~~GC_ID_FLAG~~	~~0~~
GC_CNT	0
GC_FLAG	0

…

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