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| **Abstract:** | This document defines common test conditions (CTC) and software reference configurations for biomedical waveform coding (H.BWC) experiments. Test conditions and configurations are recommended for the use in applicable technical contributions to VCEG. In addition, this document specifies five datasets to be used as well as an evaluation procedure. |

#### 1 Introduction

Common test conditions (CTC) are desirable to conduct experiments in a well-defined environment and facilitate the comparison of the outcome of experiments.

This document defines one test configuration for each of the following three categories of biomedical waveform data:

* Electrocardiography (ECG) data
* Electroencephalography (EEG) data
* Electromyography (EMG) data

#### 2 Datasets

Five datasets are specified for testing according to the following table:

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| Dataset name | Datasetcategory | Source |
| MIT | ECG | Connect to server[[1]](#footnote-1): ftp://ftp.hhi.fraunhofer.de/Download file: MIT\_ECG\_Dataset.zipAll files inside of MIT\_ECG\_Dataset.zip are to be used for this dataset. |
| CHBMIT | EEG | Connect to server1: ftp://ftp.hhi.fraunhofer.de/Download file: EEG\_Data\_New/chbmit\_edf\_hyphenChannelsRemoved.zipA subset of 137 files inside of chbmit\_edf\_hyphenChannelsRemoved.zip are to be used for this dataset, as identified below:chb01\_07.edf, chb01\_11.edf, chb01\_14.edf, chb01\_18.edf, chb01\_20.edf, chb01\_22.edf, chb01\_24.edf,chb01\_27.edf, chb01\_32.edf, chb01\_40.edf, chb02\_01.edf, chb02\_07.edf, chb02\_10.edf, chb02\_12.edf,chb02\_14.edf, chb02\_15.edf, chb02\_20.edf, chb02\_26.edf, chb02\_33.edf, chb02\_35.edf, chb03\_07.edf,chb03\_24.edf, chb04\_02.edf, chb04\_06.edf, chb04\_11.edf, chb04\_17.edf, chb05\_20.edf, chb05\_21.edf,chb05\_27.edf, chb05\_30.edf, chb05\_31.edf, chb05\_35.edf, chb05\_37.edf, chb06\_06.edf, chb06\_07.edf,chb06\_12.edf, chb06\_14.edf, chb06\_18.edf, chb07\_04.edf, chb07\_08.edf, chb07\_15.edf, chb08\_02.edf,chb08\_18.edf, chb08\_29.edf, chb09\_01.edf, chb09\_04.edf, chb09\_10.edf, chb10\_31.edf, chb11\_02.edf,chb11\_12.edf, chb11\_14.edf, chb11\_16.edf, chb11\_19.edf, chb11\_56.edf, chb11\_92.edf, chb12\_10.edf,chb12\_21.edf, chb12\_33.edf, chb12\_36.edf, chb12\_39.edf, chb13\_03.edf, chb13\_06.edf, chb13\_10.edf,chb13\_12.edf, chb13\_13.edf, chb13\_14.edf, chb13\_16.edf, chb13\_18.edf, chb13\_55.edf, chb14\_04.edf,chb14\_17.edf, chb14\_19.edf, chb14\_37.edf, chb14\_39.edf, chb15\_04.edf, chb15\_09.edf, chb15\_10.edf,chb15\_11.edf, chb15\_15.edf, chb15\_26.edf, chb15\_28.edf, chb15\_30.edf, chb15\_31.edf, chb15\_33.edf,chb15\_46.edf, chb15\_49.edf, chb16\_01.edf, chb16\_12.edf, chb17a\_03.edf, chb17a\_05.edf, chb17b\_59.edf,chb17c\_03.edf, chb17c\_04.edf, chb18\_10.edf, chb18\_11.edf, chb18\_12.edf, chb18\_13.edf, chb18\_17.edf,chb18\_18.edf, chb18\_27.edf, chb18\_29.edf, chb19\_01.edf, chb19\_08.edf, chb19\_09.edf, chb19\_12.edf,chb19\_15.edf, chb19\_24.edf, chb19\_29.edf, chb20\_02.edf, chb20\_04.edf, chb20\_12.edf, chb20\_21.edf,chb21\_01.edf, chb21\_03.edf, chb21\_12.edf, chb21\_19.edf, chb22\_04.edf, chb22\_07.edf, chb22\_08.edf,chb22\_10.edf, chb22\_18.edf, chb22\_20.edf, chb22\_23.edf, chb22\_26.edf, chb22\_27.edf, chb22\_51.edf,chb23\_06.edf, chb23\_07.edf, chb23\_09.edf, chb24\_01.edf, chb24\_07.edf, chb24\_09.edf, chb24\_13.edf,chb24\_15.edf, chb24\_17.edf, chb24\_19.edf, chb24\_20.edf |
| NMR55 | EEG | Eduardo López-Larraz and María Sierra-Torralba and Sergio Clemente and Galit Fierro and David Oriol and Javier Minguez and Luis Montesano and Jens G. Klinzing (2024). Bitbrain Open Access Sleep Dataset. OpenNeuro. doi:10.18112/openneuro.ds005555.v1.0.0 |
| NMR57 | EEG | Haydn G. Herrema and Michael J. Kahana (2024). Free Recall with Closed-Loop Stimulation at Encoding (Encoding Classifier). doi:10.18112/openneuro.ds005557.v1.0.0 |
| Ozdemir | EMG | Connect to server1: ftp://ftp.hhi.fraunhofer.de/Download file: MENDELEY\_Dataset.zipThe files in folder 'raw' inside of MENDELEY\_Dataset.zip are to be used for this dataset. |

Additional demonstrations of the performance of proposed technologies on other types of data are also highly welcome.

#### 3 Reference software

The reference software is available at: <https://vcgit.hhi.fraunhofer.de/vceg-sw/bwc>

#### 4 Encoding configurations

For each of the dataset categories, two configuration files for running the encoder executable are available in the software repository:

* ECG: cfg/combinedPresetECG.cfg, cfg/combinedPresetECG\_IndepChannel.cfg
* EEG: cfg/combinedPresetEEG.cfg, cfg/combinedPresetEEG\_IndepChannel.cfg
* EMG: cfg/combinedPresetEMG.cfg, cfg/combinedPresetEMG\_IndepChannel.cfg

The first configuration file realizes a joint coding of the channels while the second configuration file realizes an independent coding of the channels.

Each input sequence is to be encoded several times in order to achieve different bit rates.

A further config parameter InputBitDepth needs to be specified for encoding. It is set to 12 for the MIT dataset and to 16 for all other datasets.

The config parameter StepSizeForQP controls the quantization step size and thus the resulting size of the bit stream.

The following three lists specify values for parameter StepSizeForQP to be used when encoding sequences from the respective dataset category:

ECG: [1, 1.125, 1.5, 2, 3, 4, 5.5, 7, 9, 11, 13.5, 16, 19, 22]

EEG: [1, 1.125, 1.5, 2, 3, 4, 5.5, 7, 9, 11, 13.5, 16, 22, 33, 44, 55,
 66, 77, 88, 99, 110]

EMG: [1, 1.5, 2, 3, 4, 5.5, 7, 9, 11, 13.5, 16, 19, 22, 25.5, 29, 33,
 37, 41.5, 46, 51, 56, 60.5]

Each of the values produces one individual bitstream per input sequence.

#### 5 Error measures and bit rate

Two error measures are employed to objectively evaluate the compressed representations of the bitstreams. Let *N* be the number of channels and let *M* be the number of samples per channel of an input sequence. Furthermore, let $a\_{i,j}$ be the *j*-th sample (with $0\leq j<M$) of channel *i* (with $0\leq i<N$) and let $\tilde{a}\_{i,j}$ be the corresponding reconstructed sample after decoding a bitstream.

The first error measure is$ PSNR\_{1}$ and it shall be calculated as follows:

$$MSE\_{i}=\frac{1}{M}\sum\_{j=0}^{M-1}\left(a\_{i,j}-\tilde{a}\_{i,j}\right)^{2},$$

$$MSE=\frac{1}{N}\sum\_{i=0}^{N-1}MSE\_{i},$$

$$PSNR\_{1}=-10\*log\_{10}\left(\frac{MSE}{\left(2^{B}-1\right)^{2}}\right).$$

The second error measure is $PSNR\_{2}$ and it shall be calculated as follows for the channels that have non-zero MSE:

$$PSNR\_{i,MSE\ne 0}=-10\*log\_{10}\left(\frac{MSE\_{i,MSE\ne 0}}{\left(2^{B}-1\right)^{2}}\right),$$

$$PSNR\_{2}=\frac{1}{N\_{MSE\ne 0}}\sum\_{i=0}^{N\_{MSE\ne 0}-1}PSNR\_{i,MSE\ne 0},$$

where $N\_{MSE\ne 0}$ is the number of channels that have non-zero MSE.

The value of *B* that shall be set to 16.

The bit rate is measured by the number of bits per sample (BPS), defined as

$$BPS=\frac{\#number of bits in the bitstream file}{N∙M}.$$

#### 5 Experimental evaluation

The anchor to be used as reference corresponds to a simulation run according to the encoding specification of section 4 of the tag with the highest version number in the reference software git repository as specified in section 3. This tag shall be announced after each meeting by the AhG chairs as soon as it is available.

A Bjøntegaard Delta rate is calculated for each input sequence between the technology under test and the anchor. A corresponding Python script for calculating the corresponding BD rate values can be found attached. This script implements the BD rate calculation according to the document JVET-H0030. Also, curves which plot the PSNR against the rate for the technology under test and the anchor are to be provided for each input sequence. Moreover, for each test sequence, the percentage changes of the geometric means of the runtimes relative to the anchor, taken over the working points from Section 4, shall be reported both for the encoder and for the decoder.

Results shall be produced both in the joint channel coding mode and in the independent channel coding mode.

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1. Credentials for accessing the FTP server can be obtained upon request. [↑](#footnote-ref-1)