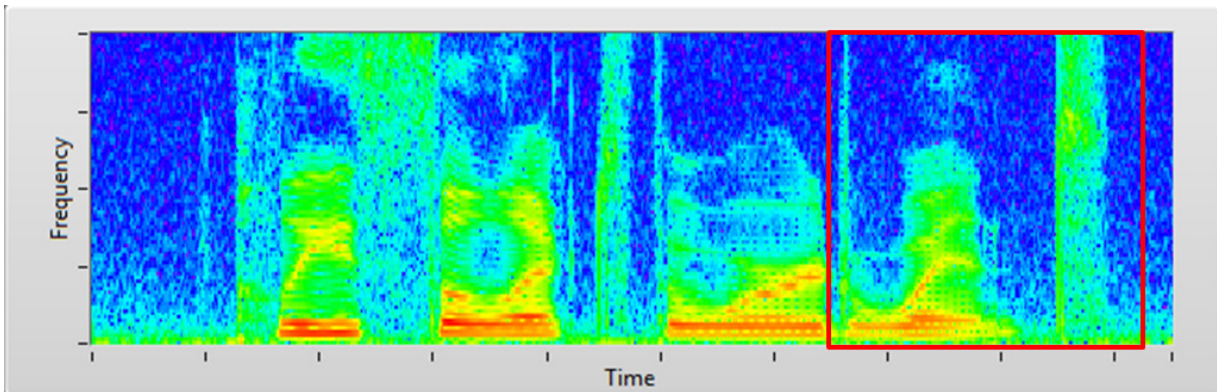


# ABC-MRT: ARTICULATION BAND CORRELATION MODIFIED RHYME TEST

An APx software option for the objective measurement of speech intelligibility



A Time-Frequency display of the sentence "Please select the word *went*."

## APPLICATIONS

- Measuring the intelligibility of speech in outdoor or indoor spaces over a communication system.
- Indoor spaces include offices, vehicles, enclosures or auditoriums.
- Communications systems may be face-to-face, or public address systems, telephone networks, intercoms, radio links, broadcast systems or special systems for speech communication.
- Also intended for use evaluating the contribution of individual components such as microphones, loudspeakers, headsets, codecs, encryptors, etc., to the intelligibility of speech communications systems.

## HIGHLIGHTS

- Works with any APx analyzer hardware.
- Requires APx500 v4.5.2 or later measurement software.
- Download the installer, and purchase a software option key to enable the measurement.
- For in-depth information about APx and ABC-MRT, download the Audio Precision Technote 134.
- Uses real speech (English) as stimulus.

## STANDARDS and REFERENCES

- ANSI/ASA S3.2
- NFPA 1981:2007

## Overview

Perceptual audio measurements began as audio evaluation by groups of people, who rated what they heard for quality or intelligibility. This kind of testing is expensive and time consuming, so alternative methods have been developed to provide similar results using hardware and software tools.

For objective measurement of speech intelligibility, Audio Precision offers two software options for our APx analyzers: ABC-MRT and STI. This data sheet focuses on ABC-MRT.

## ABC-MRT

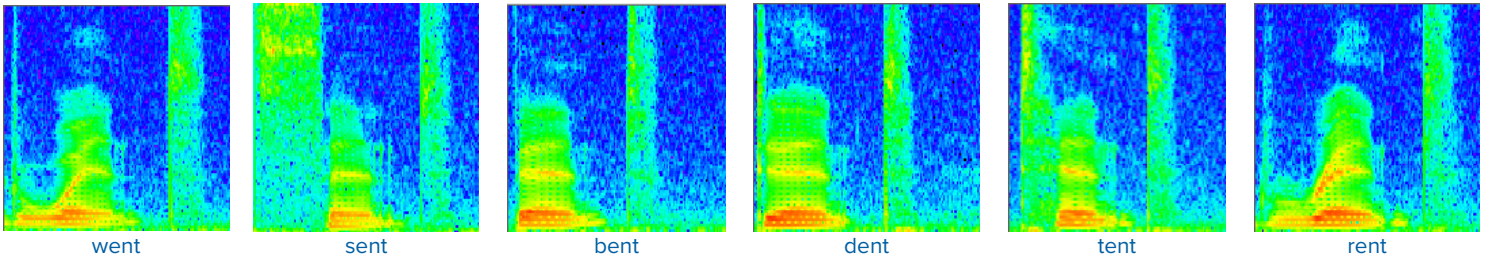
ABC-MRT is an acronym for Articulation-Band Correlation Modified Rhyme Test. It follows the paradigm of the Modified Rhyme Test, a well-known technique for assessing speech intelligibility that is based on subjective assessment by human subjects. ABC-MRT was developed by the Institute for Telecommunication Sciences (ITS) of the United States National Telecommunications and Information Administration (NTIA). It uses a form of automatic speech recognition (ASR) to conduct a type of automated Modified Rhyme Test that does not involve human subjects.

A key factor to the success of subjective MRT tests is the elimination of context, because context can help listeners to guess at words they do not recognize, resulting in an incorrect estimate of intelligibility. Rhyme testing minimizes context by presenting listeners with sets of rhyming single-syllable words in random order.

MRT is based on 50 lists of six rhyming words of the form consonant–vowel–consonant. The six words in each list differ only in the beginning or ending consonant. A trial consists of presenting the listener with a sentence containing a carrier phrase and the keyword, e.g., "Please select the word *bent*." The listener then selects the word that he or she heard from a list of six options presented on a visual display (e.g., *went*, *sent*, *bent*, *dent*, *tent*, and *rent*). The words are presented in random order and the rate of correct word identification is used to calculate the MRT Intelligibility Score, a value between 0 and 1, where 1 represents a perfect score.

Researchers at ITS have developed a very effective objective estimator of speech intelligibility that follows the paradigm of the MRT, known as Articulation Band Correlation Modified Rhyme Test (ABC-MRT).

# APx ABC-MRT SPEECH INTELLIGIBILITY SOFTWARE OPTION



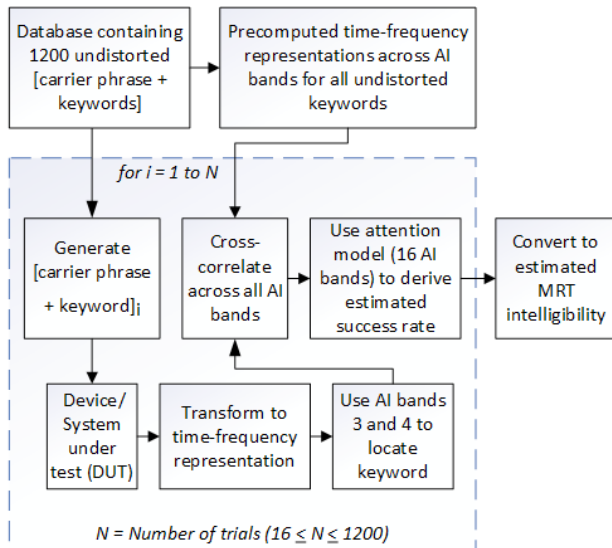
Time-Frequency spectrograms of the six keywords in the list.

At its core, the ABC-MRT method uses a highly specialized automatic speech recognition (ASR) algorithm that emulates the MRT task – recognizing keywords transmitted through a communication system. Many ASR tools are available today, and these systems are complex in the sense that they are required to work with huge vocabularies, with any speaker and to be robust to impaired speech. ASR in the context of MRT is much simpler: The required vocabulary is tiny, it involves only a few speakers who are known in advance, and context need not be considered.

The figure at the top of the first page of this data sheet is a spectrogram of the sentence, “Please select the word went,” as spoken by Female 1 in the ITS ABC-MRT speech database. It shows frequency from 0 to 10 kHz on the vertical axis, and a

time span of approximately 2.0 seconds on the horizontal axis, with color representing the signal level from low (blue) to high (red). The portion of the spectrogram containing the keyword “went” is highlighted with a red rectangle. The figure at the top of this page shows the spectrograms of the six keywords from the same list as the word “went.” By studying the images, you can see how the correct word could be identified based on the T-F pattern.

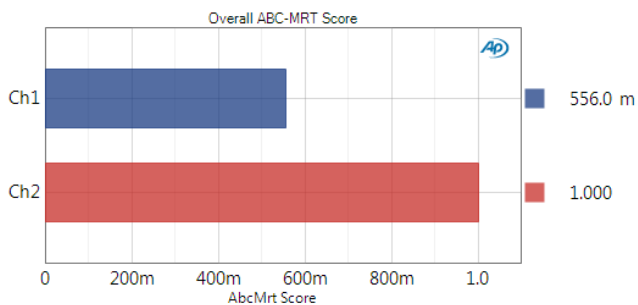
The APx download includes 1,200 .wav files of original MRT recordings, and 1,200 corresponding T-F template patterns. APx controls allow you to specify a DUT “condition” and to run a certain number of repeated trials for each condition. Results include an overall ABC-MRT Score result, an ABC-MRT Score by Trial result, and an ABC-MRT Details tabular result.



Block diagram of the APx implementation of the ABC-MRT algorithm.

Trial	Talker	List	Word	Score (Ch1)	Score (Ch2)
1	F1	39	4	1.000	1.000
2	F3	16	3	0.688	1.000
3	M4	28	6	1.000	1.000
4	M3	22	3	0.000	1.000
5	F1	39	2	1.000	1.000
6	F3	29	2	0.563	1.000
7	M4	02	4	0.688	1.000
8	M3	39	3	0.625	1.000
9	F1	48	6	0.125	1.000
10	F3	44	4	0.938	1.000
11	M4	46	4	0.250	1.000
12	M3	06	2	0.563	1.000
13	F1	40	3	1.000	1.000
14	F3	26	2	0.063	1.000

APx ABC-MRT Details tabular result.



APx Overall ABC-MRT Score meter result.

## Perceptual Audio Software Options

In addition to the ABC-MRT option discussed in this data sheet, Audio Precision also offers the following APx software options:

- **STI (speech intelligibility)**  
STI measures speech intelligibility using a shaped noise signal designed to model the modulation depth, modulation rate and spectral content of speech.
- **PESQ (speech quality)**  
PESQ is an established method for evaluating speech quality in low-bandwidth devices such as telephones, smart phones and hands-free devices.
- **POLQA (speech quality)**  
POLQA is the successor to PESQ, extending perceptual audio test to encompass the wideband measurement of speech quality, acoustic interfaces and more.

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