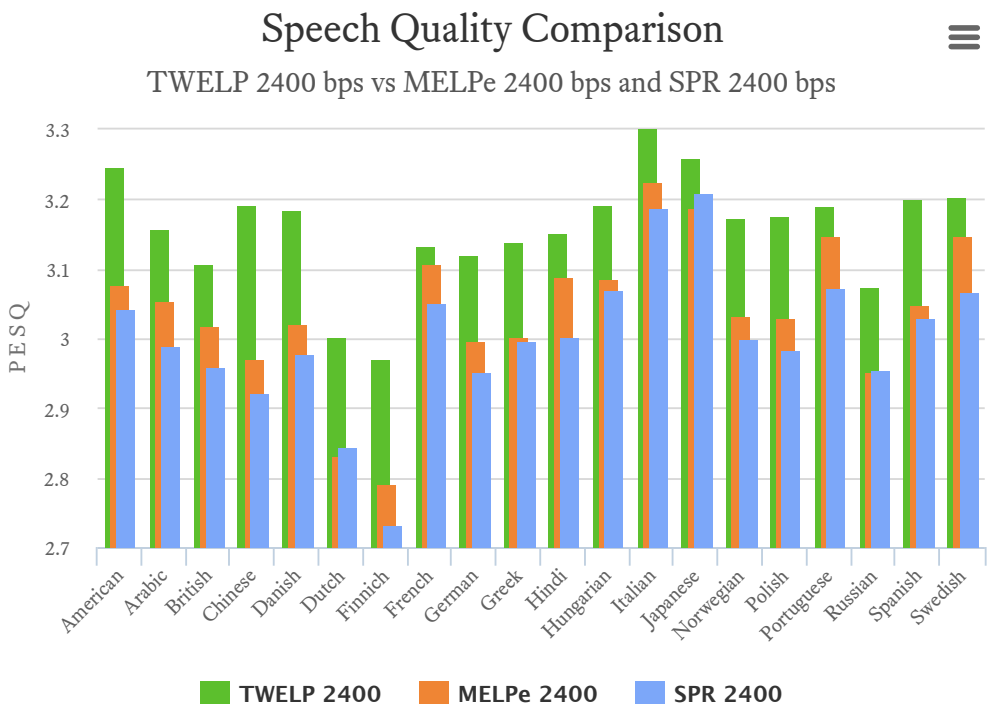
DSP Innovations

MELPe 2400 bps Vocoder

STANAG 4591 standard 2400 bps vocoder.

MELPe Technology Features. The MELPe 2400 bps Vocoder is based on well-known mixed MBE + LPC technology, where excitation function of the LPC-filter is a frequency-depending mixture of the pitch harmonics with noise, formed like in MBE vocoders.

Speech Quality. Here is the comparison with more modern SPR 2400 bps and TWELP 2400 bps vocoders in noiseless channel. MELPe 2400 bps vocoder, SPR 2400 bps vocoder and TWELP 2400 bps vocoder were tested, using ITU-T P.50 speech base for 20 different languages. ITU-T P.862 utility was used for estimation of the speech quality in PESQ terms:



A diagram demonstrates superiority of the TWELP 2400 bps over MELPe 2400 bps and SPR 2400 bps in speech quality in clear channel. TWELP 2400 bps vocoder provides the best speech quality, but consumes much more (~3 times more) computing resources and memory in comparison with SPR 2400 bps vocoder. Exact numbers of the speech quality are presented in the table below.

Language	TWELP 2400	MELPe 2400	SPR 2400
American	3.247	3.077	3.044
Arabic	3.157	3.053	2.988
British	3.106	3.019	2.960

Chinese	3.192	2.970	2.921
Danish	3.184	3.022	2.978
Dutch	3.004	2.830	2.845
Finnich	2.970	2.791	2.732
French	3.135	3.106	3.051
German	3.121	2.998	2.951
Greek	3.140	3.004	2.996
Hindi	3.152	3.089	3.003
Hungarian	3.192	3.086	3.069
Italian	3.325	3.226	3.187
Japanese	3.261	3.188	3.210
Norwegian	3.173	3.032	3.001
Polish	3.178	3.029	2.985
Portuguese	3.191	3.146	3.072
Russian	3.076	2.952	2.954
Spanish	3.201	3.048	3.030
Swedish	3.203	3.147	3.067
Average	**3.160**	**3.041**	**3.002**

Superiority of the TWELP 2400 bps vocoder is on average 0.12 and 0.16 PESQ appropriately

Speech Samples (WAV-files). A few independent experts listened SPR 2400 bps vocoder in comparison with MELPe 2400 bps vocoder and TWELP 2400 bps vocoder, using method of preferences. Majority of experts preferred TWELP to SPR and MELPe, having noted much more natural human-sounding of voice in the TWELP vocoder. Experts haven't found significant difference in sounding between SPR 2400 and MELPe 2400 vocoders.
You can play and listen short samples of the source speech as well as the speech processed by these vocoders for any of 20 languages, using links in the table below.
Also, you can download full set of the P.50 samples as zip-files for all languages simultaneously, using the links in the "Downloads" para in a bottom of the page.

Language	Source speech	SPR 2400 bps	MELPe 2400 bps	TWELP 2400 bps
American	▶	▶	▶	▶
Arabic	▶	▶	▶	▶
British	▶	▶	▶	▶
Chinese	▶	▶	▶	▶
Danish	▶	▶	▶	▶
Dutch	▶	▶	▶	▶
Finnich	▶	▶	▶	▶
French	▶	▶	▶	▶
German	▶	▶	▶	▶

Greek	▶	▶	▶	▶
Hindi	▶	▶	▶	▶
Hungarian	▶	▶	▶	▶
Italian	▶	▶	▶	▶
Japanese	▶	▶	▶	▶
Norwegian	▶	▶	▶	▶
Polish	▶	▶	▶	▶
Portuguese	▶	▶	▶	▶
Russian	▶	▶	▶	▶
Spanish	▶	▶	▶	▶
Swedish	▶	▶	▶	▶

Superiority In Quality Of The Non-speech Signals. In contrast to other LBR vocoders (MELPe, AMBE+2, etc.), TWELP vocoders provide high quality of non-speech signals, including police, ambulance, fire sirens, etc. This feature in conjunction with high quality natural human-sounding of voice makes TWELP vocoders well suitable for replacement of analog radio by digital radio and also for other applications where high quality transmitting of non-speech signals is relevant along with high quality transmitting of speech signals.

Source type	Source signal	MELPe 2400 bps	SPR 2400 bps	TWELP 2400 bps
Siren only	▶	▶	▶	▶
With voice	▶	▶	▶	▶

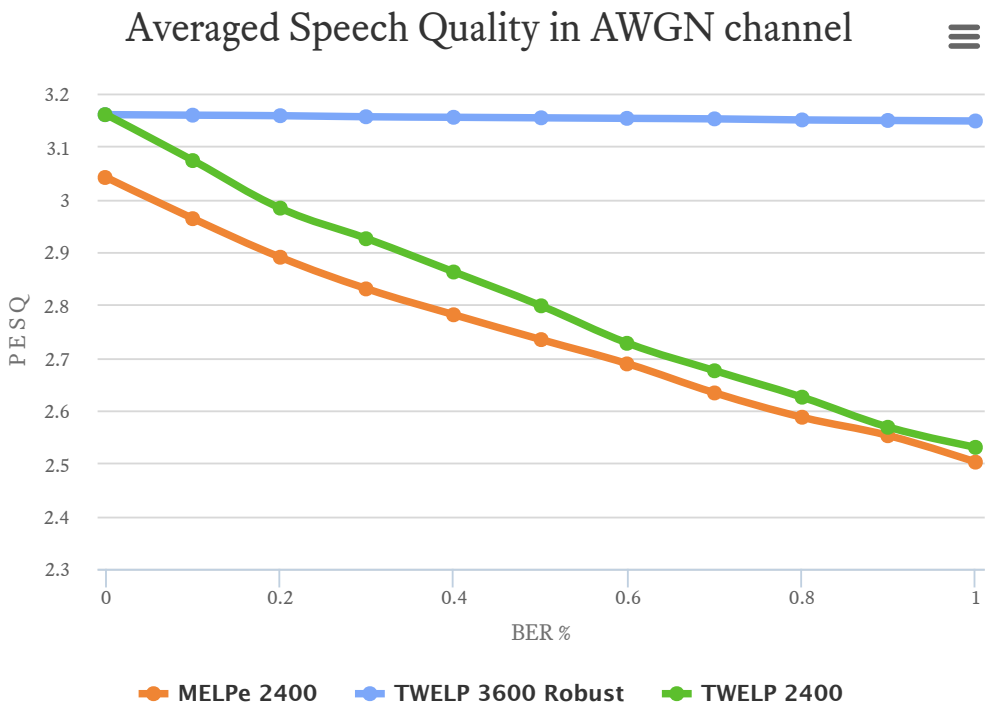
High Robustness To Acoustic Noise. In contrast to other LBR vocoders, TWELP vocoders are well robust to acoustic noise thanks to robust reliable method of pitch estimation and other features of TWELP technology.

Moreover, vocoder includes in-built Noise Cancellation—Speech Enhancement (NCSE) functionality that improves speech quality in noisy acoustic environment.

NCSE Mode	Source signal	MELPe 2400 bps	SPR 2400 bps	TWELP 2400 bps
Disabled	▶	▶	▶	▶
Enabled	▶	▶	▶	▶

High Robustness To The Channel Errors. The diagram and table below show a dependence of the averaged speech quality for AWGN-noisy channel for different BER in comparison with other vocoders.

SPR vocoder is more robust to the channel errors in comparison with MELPe and TWELP vocoders. Also, special "robust" versions of the SPR and TWELP vocoders include FEC that are integrated with vocoder on base of "joint source-channel coding" approach that provides high speech quality simultaneously in noisy channel as well as in noiseless channel. FEC can operate with "soft decisions" as well as with "hard decisions" from a modem. "Soft decisions" mode provides much better robustness in comparison with the "hard decisions" mode.



BER %	MELPe 2400	TWELP 3600 Robust	TWELP 2400
0.00	3.041	3.160	3.160
0.10	2.963	3.159	3.073
0.20	2.890	3.158	2.983
0.30	2.830	3.156	2.925
0.40	2.781	3.155	2.862
0.50	2.734	3.154	2.798
0.60	2.688	3.153	2.727
0.70	2.633	3.152	2.675
0.80	2.587	3.150	2.625
0.90	2.552	3.149	2.568
1.00	2.502	3.148	2.530

Additional functionality. MELPe vocoder software includes NPP (Noise Pre-Processor) module.

Technical Characteristics And Resource Requirements:

Technical characteristics

Bit Rate (bps)	Algorithm	**Frame size** (ms)	**Algorithmic delay (including frame size)** (ms)	**Sampling rate** (kHz)	**Signal format**	**Bit stream format**
2400	MELPe	22.5	42.5	8	Linear 16-bit PCM	54

Resources for ARM Cortex-M4 platform (preliminary)

Module	**MIPS* peak**	**Memory** (KBytes)				
		Program	**Data**			
			Constants	**Channel**	**Heap**	**Stack**
NPP	26.6	56	17.9	13.9	5.9	0.5
Voice Encoder	44.7					
Voice Decoder	30.4					
Total	101.7					

Resources for TI's C64 DSP platform

Module	MIPS* peak	Memory (KBytes)				
		Program	Data			
			Constants	Channel	Heap	Stack
NPP	8.6	85	17.5	13.9	5.9	0.5
Voice Encoder	11.5					
Voice Decoder	6.0					
Total	26.1					

Resources for TI's C55 DSP platform

Module	MIPS* peak	Memory (KBytes)				
		Program	Data			
			Constants	Channel	Heap	Stack
NPP	20.9	31.8	17.4	16.3	5.9	0.5
Voice Encoder	18.1					
Voice Decoder	16.8					
Total	55.8					

* DSPINI continues optimization of the MELPe code in order to minimize computational complexity of the vocoder.

Guarantee And Support. DSPINI guarantees a quality and accordance of all technical characteristics of the product to requirement of current specifications. Testing and other method of quality control are used for guarantee support.

Any Platforms. DSPINI can port this vocoder software into any other DSP, RISC or general- purposes platform inshort time: 1-2 months.

Licensing Terms. Our license covers a right to use our optimized code, but doesn't cover IP-holders rights on the MELPe technology (TI, Microsoft, Thales, etc.).

Customization. The vocoder can be customized under any specific requirements- other bit rate, frame size, any other robustness to channel errors, etc. Please contact with us for details.

Related Software. This vocoder may be effectively used in a bundle with other DSPINI's products:

- Linear and acoustic echo cancellers,
- Multichannel noise cancellers (including two-microphone adaptive array),
- Wired or radiomodems for any types of channels and bitrates,
- Other products.

Downloads:

- Datasheet (pdf)
- ITU-T P.50 source speech samples (zip)
- MELPe 2400 bps speech samples (zip)
- SPR 2400 bps speech samples (zip)
- TWELP 2400 bps speech samples (zip)
- PC-evaluation package (zip) — on request
- User's Guide document (pdf) — on request

Please contact us by e-mail:
request@dspini.com
or by phone:
+44 20 81 33 00 44
+33 9 70 40 33 99