- **eXpressDSP Digital Media (XDM) interface complaint**
- **Optimized in Linear ASM, Scheduled ASM and C implementation with Intrinsic**
- **Bit-exact with OPUS open source standard version 1.1**
- **Based on OPUS coding algorithm for speech/music signals sampled at either 48 kHz, 24 kHz, 16 kHz, 12 kHz or 8 kHz.**
- **Operates on variable frame sizes of 2.5ms, 5ms, 10ms, 20ms, 40ms, and 60ms.**
- **Supports bit rates ranging from 6 kbps to 510 kbps.**
- **Supports mono and stereo (2) channels at Encoder input and as well at Decoder output.**
- **Supports Forward Error Correction (FEC) at the Encoder.**
- **Supports run-time data buffers relocation and table relocation**
- **Supports Big Endian and Little Endian modes of operation**
- **Run-time control of the complexity level. Supported values from 0 to 10.**
- **Run-time control of DTX.**
- **Supports RTP payload format specified in by the reference C code (RFC 6716)**
- **Supports packet loss concealment as specified by the reference C code**
- **Validated on C6455 DSK using Code Composer Studio version 5.2 with the code generation tools version 7.3.2**
- **This codec can be used on any of TI's C64x+ based platforms such as DM644x, DM64x, DM643x, OMAP35xx, OMAP3430, DM646x and their derivatives**

description

OPUS Codec was developed as an open source standard in the year 2012 and standardized by the Internet Engineering Task Force (IETF) as RFC 6716. The codec operates on variable frame lengths (2.5ms, 5ms, 10ms, 20ms, 40ms, and 60ms) of 16-bit PCM speech/audio signals sampled at 8 Khz, 12 Khz, 16 Khz, 24 Khz, or 48 Khz and generates a compressed bit stream having bit rates in the range of 6 kbps to 510 kbps respectively.

OPUS Codec has incorporated the compression techniques from Skype's SILK Codec and Xiph.org's CELT Codec. The Encoder provides an option of selecting the complexity, which varies from 0 – 10. The Codec supports both Constant Bit Rate (CBR) and Variable Bit Rate (VBR) and also a constrained VBR mode. The Codec supports mono and stereo (2) channels at encoder input and

as well as at the decoder output. The encoder supports Forward Error Correction (FEC), which increases the robustness against the packet losses. The Decoder supports Packet Loss Concealment (PLC).

OPUS Codec is designed for interactive speech and music transmission over Internet and also intended for storage and streaming applications. OPUS Codec can be used in a wide range applications such as Voice over IP (VoIP), Video Conferencing, In-Game chat, and remote live music performances. OPUS Codec has been integrated into WebRTC chrome as well

summary of performance

This section describes the performance of OPUS Encoder/Decoder on C6455 DSK.

Table 1. Configuration Table

CONFIGURATION	ID
Encoder – Big Endian	OPUS_001
Encoder – Little Endian	OPUS _002
Decoder – Big Endian	OPUS _003
Decoder – Little Endian	OPUS _004
Full Duplex – Big Endian	OPUS _005
Full Duplex – Little Endian	OPUS _006

Table 2. Cycles Information – Profiled on C6455 DSK with Code Generation Tools version 7.3.2

CONFIGURATION ID	PERFORMANCE STATISTICS (IN MEGACYCLES /SEC) [1,2,3]									
	AVERAGE					PEAK				
	NB	MB	WB	SWB	FB	NB	MB	WB	SWB	FB
OPUS_001	8.55	10.96	13.31	9.98	16.49	10.27	13.06	15.18	10.98	24.11
OPUS_002	8.48	10.87	13.28	10.18	16.62	10.16	12.93	15.14	11.15	24.32
OPUS_003	1.43	1.83	2.41	7.61	17.85	1.77	2.86	2.92	9.03	18.78
OPUS_004	1.44	1.83	2.42	7.66	17.60	1.77	2.86	2.94	9.03	18.49
OPUS_005	9.98	12.79	15.72	17.59	34.34	12.04	15.92	18.1	20.01	42.89
OPUS_006	9.92	12.7	15.7	17.84	34.22	11.93	15.79	18.08	20.18	42.81

[1] Measured with program and data memory, stack, and I/O buffers in internal Memory (L2 SRAM) and L1P and L1D caches are thrashed at frame boundaries.
[2] Average and peak MCPS measurements can vary by +/-5%.
[3] Measured with frame size = 20ms, Complexity=3, VBR Enabled, FEC disabled

Table 3. Memory Statistics – Generated with Code Generation Tools Version 7.3.2

CONFIGURATION	MEMORY STATISTICS[5]				
	PROGRAM MEMORY	DATA MEMORY			TOTAL
		INTERNAL	EXTERNAL	STACK	
OPUS_001	259.63	94.41	0	3	357.04

OPUS_002	257.75	94.41	0	3	355.16
OPUS_003	124.41	69.14	0	2.25	195.8
OPUS_004	122.34	69.14	0	2.25	193.73
OPUS_005	311.91	120.45	0	3	435.36
OPUS_006	310.09	120.45	0	3	433.54

[5] All memory requirements are expressed in kilobytes (1-kilobyte = 1024 bytes).

Table 4. Internal Data Memory Split-up

CONFIGURATION	DATA MEMORY – EXTERNAL[6]		
	SHARED		INSTANCE[7]
	CONSTANTS	SCRATCH	
OPUS_001	18.07	43.41	32.93
OPUS_002	18.07	43.41	32.93
OPUS_003	18.07	25.03	26.04
OPUS_004	18.07	25.03	26.04
OPUS_005	18.07	43.41	58.97
OPUS_006	18.07	43.41	58.97

[6] All memory requirements are expressed in kilobytes (1-kilobyte = 1024 bytes).
[7] Does not include I/O buffers.

notes

- I/O Buffers:
  - Encoder (Decoder) Input buffer size = 11520 (3825) bytes
  - Encoder (Decoder) Output buffer size = 3825 (11520) bytes
- Total Data Memory for N *Non-Pre*-Emptive Instances =
  Constants + Runtime Tables + Scratch + N*(Instance + I/O buffers + Stack)
- Total Data Memory for N *Pre*-Emptive Instances =
  Constants + Runtime Tables + N*(Instance + I/O buffers + Stack + Scratch)

references

- *opus_api -1.1.pdf – OPUS 1.1*
- *opusfile_api-0.2.pdf – OPUS file 0.2*
- *rfc6716.pdf – Definition of the OPUS Audio Codec*
- *www.opus_codec.org*
- *OPUS Encoder/Decoder on C64x+ User's Guide*

glossary

Constants	Elements that go into .const memory section
Scratch	Memory space that can be reused across different instances of the algorithm
Shared	Sum of Constants and Scratch
Instance	Persistent-memory that contains persistent information - allocated for each instance of the algorithm

acronyms

DSK	DSP Starter Kit
DTMF	Dual Tone Multi Frequency
DTX	Discontinuous Transmission
Kbps	Kilo bits per second
RTP	Real Time Protocol
XDM	eXpress DSP Digital Media
PLC	Packet Loss Concealment
VAD	Voice Activity Detection
FEC	Forward Error Correction
IETF	Internet Engineering Task Force
RFC	Request For Comments
VBR	Variable Bit Rate

CBR	Constant Bit Rate
NB	Narrow Band
MB	Medium Band
WB	Wide Band
SWB	Super Wide Band
FB	Full Band

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