

# PCM codec IC for digital cellular telephones

## BU8731KV

The BU8731KV is a PCM codec IC developed for use with digital cellular telephones. It contains analog input / output features such as a 14-bit linear precision,  $\mu$  / A-LAW codec, mic and speaker amplifiers, and switching transistor for the ringer drive. This all makes the BU8731KV perfect for PDC and CDMA-type cellular telephones.

### ●Applications

Digital cellular telephones

### ●Features

- 1) +3V single power supply ( $V_{DD} = 2.7V$  to  $3.3V$ ).
- 2) Built-in 14-bit precision linear,  $\mu$  / A-LAW codec.
- 3) Transmission filter for the codec unit conforms to ITU-T recommendations.
- 4) Built-in PLL circuit for system clock generation.
- 5) Clock frequency for PCM data transmission can be set anywhere between 64kHz (128kHz when linear) to 2048kHz.
- 6) Analog input / output functions:
  - Built-in mic amplifier.
  - Built-in receiver speaker amplifier (32 $\Omega$  BTL type).
  - Built-in earphone speaker amplifier (32 $\Omega$  single type).
- 7) DTMF signal and scale tone signal generator functions are built into the tone signal generator block.
- 8) Internal switching transistor for ringer drive.
- 9) VQFP 48-pin package.
- Built-in drive amplifier for reception REXT (600 $\Omega$ ).
- Built-in electronic volume control for gain adjustment (for reception, transmission, and tone).
- Data signal I / O circuit allows for connection to external devices.
- For the REXT output and earphone output, soft-mute function reduces pop noise when the power is turned on and off.

### ●Absolute maximum ratings ( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Limits	Unit
Digital power supply voltage	$DV_{DD}$	$-0.3 \sim +4.5$	V
Analog power supply voltage	$RXV_{DD}$	$-0.3 \sim +4.5$	V
	$TXV_{DD}$	$-0.3 \sim +4.5$	V
Digital input voltage	$V_{DIN}$	$DV_{SS} - 0.3 \sim DV_{DD} + 0.3$	V
Analog input voltage	$V_{AIN}$	$RXV_{SS} - 0.3 \sim RXV_{DD} + 0.3$	V
		$TXV_{SS} - 0.3 \sim TXV_{DD} + 0.3$	V
Input current	$I_{IN}$	$-10 \sim +10$	mA
Power dissipation	$P_d$	400*1	mW
Operating temperature	$T_{stg}$	$-50 \sim +125$	$^\circ\text{C}$
Storage temperature	$T_{opr}$	$-20 \sim +85$	$^\circ\text{C}$

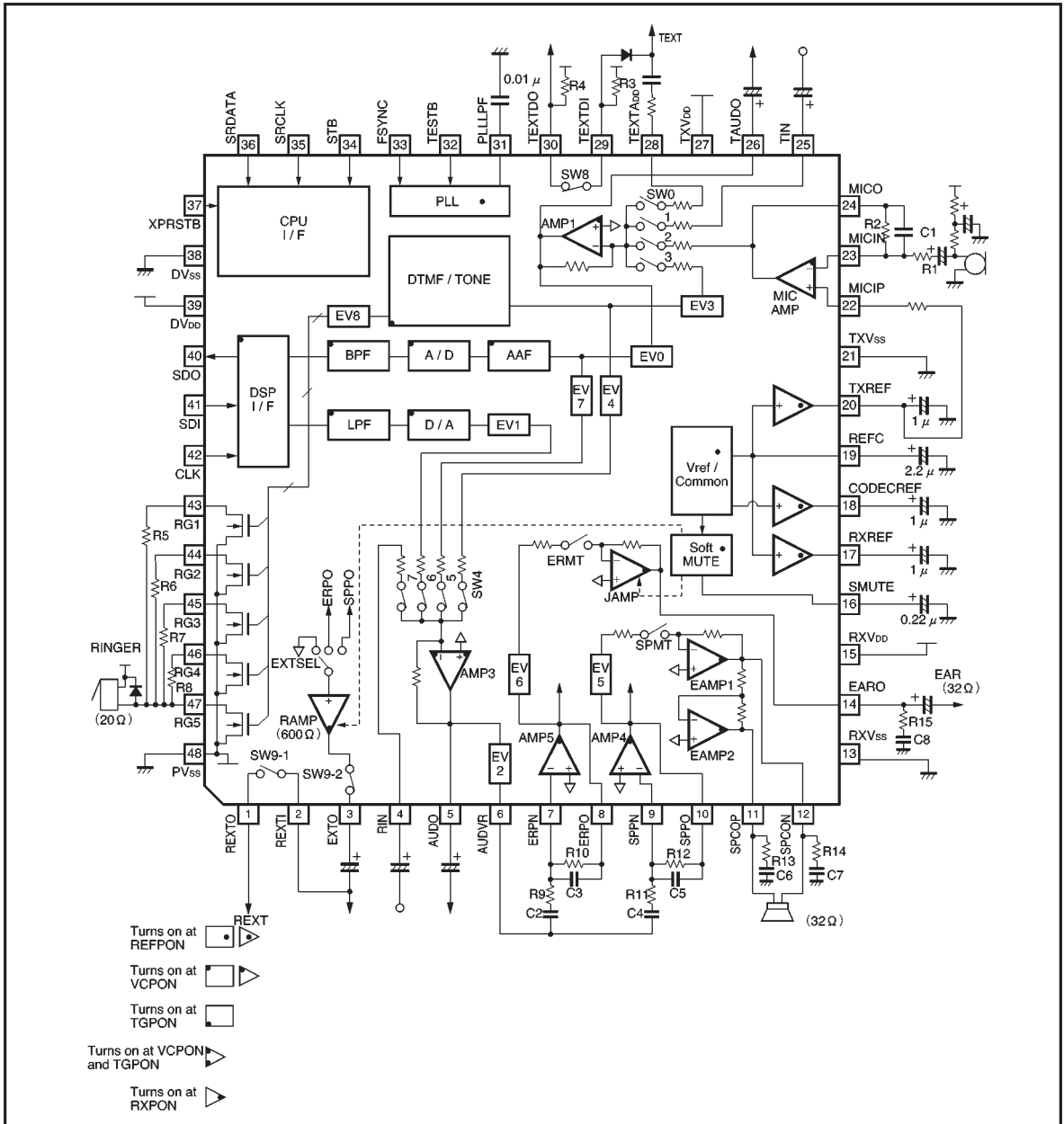
\*1 Reduced by 4.0mW for each increase in  $T_a$  of  $1^\circ\text{C}$  over  $25^\circ\text{C}$ .

● Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Digital power supply voltage	DV <sub>DD</sub>	2.7	—	3.3	V
Analog power supply voltage	RXV <sub>DD</sub>	2.7	—	3.3	V
	TXV <sub>DD</sub>	2.7	—	3.3	V

© Not designed for radiation resistance.

● Block diagram



## ● Pin descriptions

Pin No.	Pin name	I/O	Function	Minimum load resistance ( $\Omega$ )	Maximum load capacitance (F)
1	REXTO	I/O	Reception data output	—	—
2	REXTI	I/O	Reception data input	—	—
3	EXTO	O	Amplifier output for reception signal gain adjustment	600	—
4	RIN	I	Reception audio direct input	—	—
5	AUDO	O	Reception signal direct output	50k	50p
6	AUDVR	O	Reception signal external output	50k	50p
7	ERPNI	I	Amplifier inverse input for earphone gain adjustment	—	—
8	ERPO	O	Amplifier output for earphone gain adjustment	50k	50p
9	SPPNI	I	Amplifier inverse input for speaker gain adjustment	—	—
10	SPPO	O	Amplifier output for speaker gain adjustment	50k	50p
11	SPCOP	O	Receiver speaker amplifier non-inverse output	32 (BTL)	—
12	SPCON	O	Receiver speaker amplifier inverse output	32 (BTL)	—
13	RXVSS	—	Analog ground for reception	—	—
14	EARO	O	Earphone speaker amplifier output	32	—
15	RXVDD	—	Analog power supply for reception	—	—
16	SMUTE	I	Time constant for soft mute setting	—	0.22 $\mu$ *1
17	RXREF	O	Analog reference voltage output for reception	—	1 $\mu$ *1
18	CODCREF	O	Analog reference voltage output for codec	—	1 $\mu$ *1
19	REFC	O	Analog reference voltage output	—	2.2 $\mu$ *1
20	TXREF	O	Analog reference voltage output for transmission	—	1 $\mu$ *1
21	TXVSS	—	Analog ground for transmission	—	—
22	MICIP	I	Mic amplifier non-inverse input	—	—
23	MICIN	I	Mic amplifier inverse input	—	—
24	MICO	O	Mic amplifier output	50k	50p
25	TIN	I	Transmission audio direct input	—	—
26	TAUDO	O	Transmission analog output	50k	50p
27	TXVDD	—	Analog power supply for transmission	—	—
28	TEXTADD	I	Transmission signal incremental input	—	—
29	TEXTDI	I/O	Transmission data signal input	—	—
30	TEXTDO	I/O	Transmission data signal output	—	—
31	PLLLPF	I/O	Input/output filter connector for PLL circuit	—	0.01 $\mu$ *1
32	TESTB	I	Test input ( $\rightarrow$ DVDD)	—	—
33	FSYNC	I	PLL reference clock input	—	—
34	STB	I	CPU I/F strobe input	—	—
35	SRCLK	I	CPU I/F shift clock input	—	—
36	SRDATA	I	CPU I/F address data input	—	—
37	XPRSTB	I	System reset input (L: reset)	—	—
38	DVSS	—	Digital ground	—	—

\*1 Recommended value.

Pin No.	Pin name	I / O	Function	Minimum load resistance ( $\Omega$ )	Maximum load capacitance (F)
39	DV <sub>DD</sub>	—	Digital power supply	—	—
40	SDO	O	PCM signal output	—	—
41	SDI	I	PCM signal input	—	—
42	CLK	I	PCM signal shift clock input	—	—
43	RG1	O	Ringer drive transistor output 1	100 (for 3V)	—
44	RG2	O	Ringer drive transistor output 2	60 (for 3V)	—
45	RG3	O	Ringer drive transistor output 3	40 (for 3V)	—
46	RG4	O	Ringer drive transistor output 4	30 (for 3V)	—
47	PG5	O	Ringer drive transistor output 5	20 (for 3V)	—
48	PV <sub>SS</sub>	—	Ground for ringer	—	—

● Electrical characteristics (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $DV_{DD} = RXV_{DD} = TXV_{DD} = 3.0\text{V}$ ,  $FSYNC = 8\text{kHz}$ )

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈DC characteristics〉						
Current consumption*1	$I_{DD1}$	—	8.0	(11.5)	mA	All power on (FSYNC=8kHz)
	$I_{DD2}$	—	7.0	(10.2)	mA	Reference, audio, SPC on (FSYNC=8kHz)
	$I_{DD3}$	—	6.0	(8.6)	mA	Reference, audio, earphone on (FSYNC=8kHz)
	$I_{DD4}$	—	5.4	(7.8)	mA	Reference, audio, RAMP on (FSYNC=8kHz)
	$I_{DD5}$	—	5.1	(7.3)	mA	Reference and audio on (FSYNC=8kHz)
	$I_{DD6}$	—	3.7	(5.3)	mA	Reference and tone on (FSYNC=8kHz)
	$I_{DD7}$	—	3.3	(4.8)	mA	Only reference on (FSYNC=8kHz)
	$I_{DD8}$	—	0.1	20	$\mu\text{A}$	Complete power down (FSYNC=fixed)
Digital input high level voltage	$V_{IH}$	0.8 $DV_{DD}$	—	—	V	—
Digital input low level voltage	$V_{IL}$	—	—	0.2 $DV_{DD}$	V	—
Digital input high level current	$I_{IH}$	—	—	10	$\mu\text{A}$	$V_{IH}=DV_{DD}$
Digital input low level current	$I_{IL}$	-10	—	—	$\mu\text{A}$	$V_{IL}=0\text{V}$
Digital output high level voltage	$V_{OH}$	$DV_{DD}$ -0.5	—	—	V	$I_{OH}=-1\text{mA}$
Digital output low level voltage	$V_{OL}$	—	—	0.5	V	$I_{OL}=1\text{mA}$

\*1 The power supply voltage ( $DV_{DD}$ ,  $RXV_{DD}$ , and  $TXV_{DD}$ ) is 3V. There is no load on the digital and analog output pins.

Digital input pins other than the FSYNC and CLK pins are connected to  $DV_{DD}$  or  $DV_{SS}$ .

Analog input pins are connected to TXREF or RXREF with the proper resistance.

With soft mute off (SMUTE=0).

- Electrical characteristics (unless otherwise noted, Ta = 25°C, DV<sub>DD</sub> = RXV<sub>DD</sub> = TXV<sub>DD</sub> = 3.0V, FSYNC = 8kHz, gain of each attenuator = 0dB)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions		
〈Transmission characteristics〉								
Signal to total power distortion ratio (A→D) TEXTADD→SDO	S <sub>DT</sub>	24	—	—	dB	1020Hz reference	—45dBm0	C-Wgt
		29	—	—			—40dBm0	
		35	—	—			0~—30dBm0	
Signal to total power distortion ratio (D→A) SDI→AUDO	S <sub>DR</sub>	24	—	—	dB	1020Hz reference	—45dBm0	C-Wgt
		29	—	—			—40dBm0	
		35	—	—			0~—30dBm0	
Transmission level characteristics (A→D) TEXTADD→SDO	G <sub>TX</sub>	—0.9	—	0.9	dB	1020Hz reference	—55dBm0	Reference level =—10dBm0 C-Wgt
		—0.6	—	0.6			—50dBm0	
		—0.3	—	0.3			0~—40dBm0	
Transmission level characteristics (D→A) SDI→AUDO	G <sub>TR</sub>	—0.9	—	0.9	dB	1020Hz reference	—55dBm0	Reference level =—10dBm0 C-Wgt
		—0.6	—	0.6			—50dBm0	
		—0.3	—	0.3			0~—40dBm0	
Transmission output level	V <sub>OTX</sub>	0.275	0.346	0.436	V <sub>rms</sub>	1020Hz, 0dBm0 input reference	MICO→SDO	MICO output level is measured
		0.275	0.346	0.436	V <sub>rms</sub>		TEXTADD →SDO	TEXTADD input level is measured
Reception output level	V <sub>ORX</sub>	0.291	0.346	0.411	V <sub>rms</sub>	1020Hz, 0dBm0 input reference	SDI→AUDO	—
Transmission noise during no conversation	V <sub>NTX</sub>	—	—75	—65	dBm0C	—	MIC→SDO	C-Wgt
Reception noise during no conversation	V <sub>NRX</sub>	—	—79	—70	dBm0C	—	SDI→AUDO	C-Wgt
Transmission loss frequency characteristics (A→D) TEXTADD→SDO	G <sub>RX</sub>	24	—	—	dB	1020Hz, 0dBm0 input reference	0.06kHz	—
		0	—	2.5			0.2kHz	
		—0.3	—	0.3			0.3~3.0kHz	
		—0.3	—	0.9			3.4kHz	
		0	—	—			3.6kHz	
		6.5	—	—			3.78kHz	
Transmission loss frequency characteristics (D→A) SDI→AUDO	G <sub>RR</sub>	—0.3	—	0.3	dB	1020Hz, 0dBm0 input reference	0.0~3.0kHz	—
		—0.3	—	0.9			3.4kHz	
		0	—	—			3.6kHz	
		6.5	—	—			3.78kHz	

Parameter		Symbol	Min.	Typ.	Max.	Unit	Conditions		
〈Tone generator〉									
Tone output level	HTONE	$V_{TNH}$	-16	-14	-12	dBV	Set at 2kHz	→AUDIO	30kHz LPF
			-16	-14	-12			→SDO	
	LSTONE	$V_{TNL}$	-16	-14	-12			→AUDIO	
Tone distortion		$S_{DTN}$	—	-40	-29	dB	HTONE set at 2kHz	→AUDIO	30kHz LPF
〈Attenuator〉									
Absolute gain	EV0	$G_{V0}$	10	12	14	dB	MICO→SDO, EV0=12dB		
	EV1	$G_{V1}$	1	3	5		SDI→AUDIO, EV1=3dB		
	EV2	$G_{V2}$	-2	0	2		SDI→AUDVR, EV2=0dB		
	EV3	$G_{V3}$	4	6	8		→SDO, EV3=6dB		
	EV4	$G_{V4}$	4	6	8		→AUDIO, EV4=6dB		
	EV5	$G_{V5}$	12	14	16		SPPO→SPCOP-SPCON, EV5=8dB		
	EV6	$G_{V6}$	6	8	10		ERPO→EARO, EV6=8dB		
	EV7	$G_{V7}$	-7	-5	-3		MICO→AUDIO, EV7=-5dB		
Volum level setting	EV0	$G_{EW0}$	-31	—	0	dB	→SDO		
	EV1	$G_{EW1}$	-7	—	0		→AUDIO		
	EV2	$G_{EW2}$	-31	—	0		→AUDVR		
	EV3	$G_{EW3}$	-31	—	0		→SDO		
	EV4	$G_{EW4}$	-31	—	0		→AUDIO		
	EV5	$G_{EW5}$	-15	—	0		→SPCOP-SPCON		
	EV6	$G_{EW6}$	-15	—	0		→EARO		
	EV7	$G_{EW7}$	-15	—	0		→AUDIO		
Volume step width	EV0	$\Delta G_{E0}$	0.2	1	1.8	dB	→SDO		
	EV1	$\Delta G_{E1}$	0.2	1	1.8		→AUDIO		
	EV2	$\Delta G_{E2}$	0.2	1	1.8		→AUDVR		
	EV3	$\Delta G_{E3}$	0.2	1	1.8		→SDO		
	EV4	$\Delta G_{E4}$	0.2	1	1.8		→AUDIO		
	EV5	$\Delta G_{E5}$	0.2	1	1.8		→SPCOP-SPCON		
	EV6	$\Delta G_{E6}$	0.2	1	1.8		→EARO		
	EV7	$\Delta G_{E7}$	0.2	1	1.8		→AUDIO		

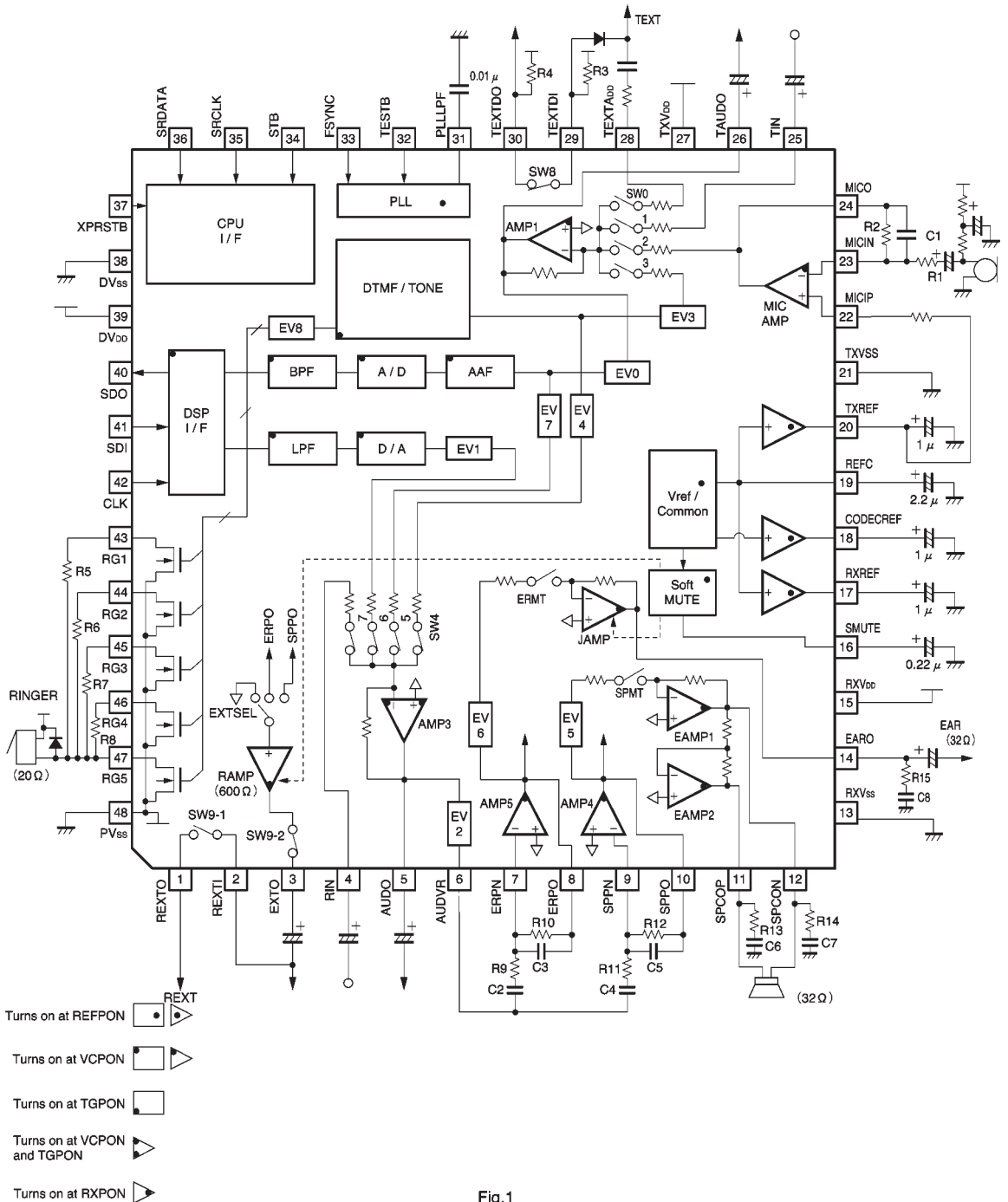
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	
〈Mic amplifier〉							
Closed-loop gain	G <sub>CMC</sub>	0	—	40	dB	→MICO	MIC AMP
〈Reception driver〉							
Closed-loop gain	G <sub>CAM4</sub>	0	—	40	dB	→SPPO	AMP4
	G <sub>CAM5</sub>	0	—	40		→ERPO	AMP5
Voltage gain	G <sub>VRA</sub>	−1.5	0	1.5	dB	→EXTO	RAMP, R <sub>L</sub> =600 Ω
Output power	P <sub>OJA</sub>	2	15	—	mW	→EARO	JAMP, R <sub>L</sub> =32 Ω
	P <sub>OE A</sub>	6.4	40	—		→SPCOP-SPCON	EAMP2-EAMP1, R <sub>L</sub> =32 Ω
Maximum output level	V <sub>om</sub>	−2	—	—	dBV	→EXTO	RAMP, R <sub>L</sub> =600 Ω
〈Ringer drive〉							
Maximum output drive current	I <sub>O(MAX.)</sub>	150	—	—	mA	VSAT (RG5) <0.7V	
Driven output voltage 1	V <sub>O1</sub>	—	—	0.7	V	I <sub>o</sub> =150mA, RG5	
Driven output voltage 2	V <sub>O2</sub>	—	—	0.6	V	I <sub>o</sub> =100mA, RG4	
Driven output voltage 3	V <sub>O3</sub>	—	—	0.5	V	I <sub>o</sub> =75mA, RG3	
Driven output voltage 4	V <sub>O4</sub>	—	—	0.4	V	I <sub>o</sub> =50mA, RG2	
Driven output voltage 5	V <sub>O5</sub>	—	—	0.3	V	I <sub>o</sub> =30mA, RG1	
OFF leak current	I <sub>L</sub>	—	0.1	3	μA	V <sub>o</sub> =3V, RG1~RG5=OFF	
〈PLL block〉							
PLL lead-in time	T <sub>PL</sub>	—	5	(100)	ms	Guaranteed design value	



## ● Digital AC characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	
〈Serial data interface / timing〉						
Data clock frequency	$\mu$ /A-LAW	f <sub>CLKU</sub>	64	—	2048	kHz
	Linear	f <sub>CLKL</sub>	128	—	2048	kHz
Frame sync signal frequency	f <sub>SYNC</sub>	7.996	8.000	8.004	kHz	
Communication sync signal timing	T <sub>SR</sub>	100	—	—	ns	
	T <sub>SS</sub>	100	—	—	ns	
	T <sub>SH</sub>	100	—	—	ns	
Digital input rise time	T <sub>IR</sub>	—	—	20	ns	
Digital input fall time	T <sub>IF</sub>	—	—	20	ns	
SDI setup time	T <sub>RS</sub>	100	—	—	ns	
SDI hold time	T <sub>RH</sub>	100	—	—	ns	
〈Register write timing〉						
SRCLK frequency	f <sub>CLK</sub>	—	—	3	MHz	
SRDATA input setup time	t <sub>suda</sub>	100	—	—	ns	
SRDATA input hold time	t <sub>hda</sub>	100	—	—	ns	
Input setup time (SRCLK high vs. STB high)	T <sub>sud</sub>	333	—	—	ns	
Input hold time (SRCLK high vs. STB low)	t <sub>hld</sub>	1000	—	—	ns	
STB strobe pulse width	f <sub>pwd</sub>	667	—	—	ns	

● Measurement circuit



● External dimensions (Units: mm)

