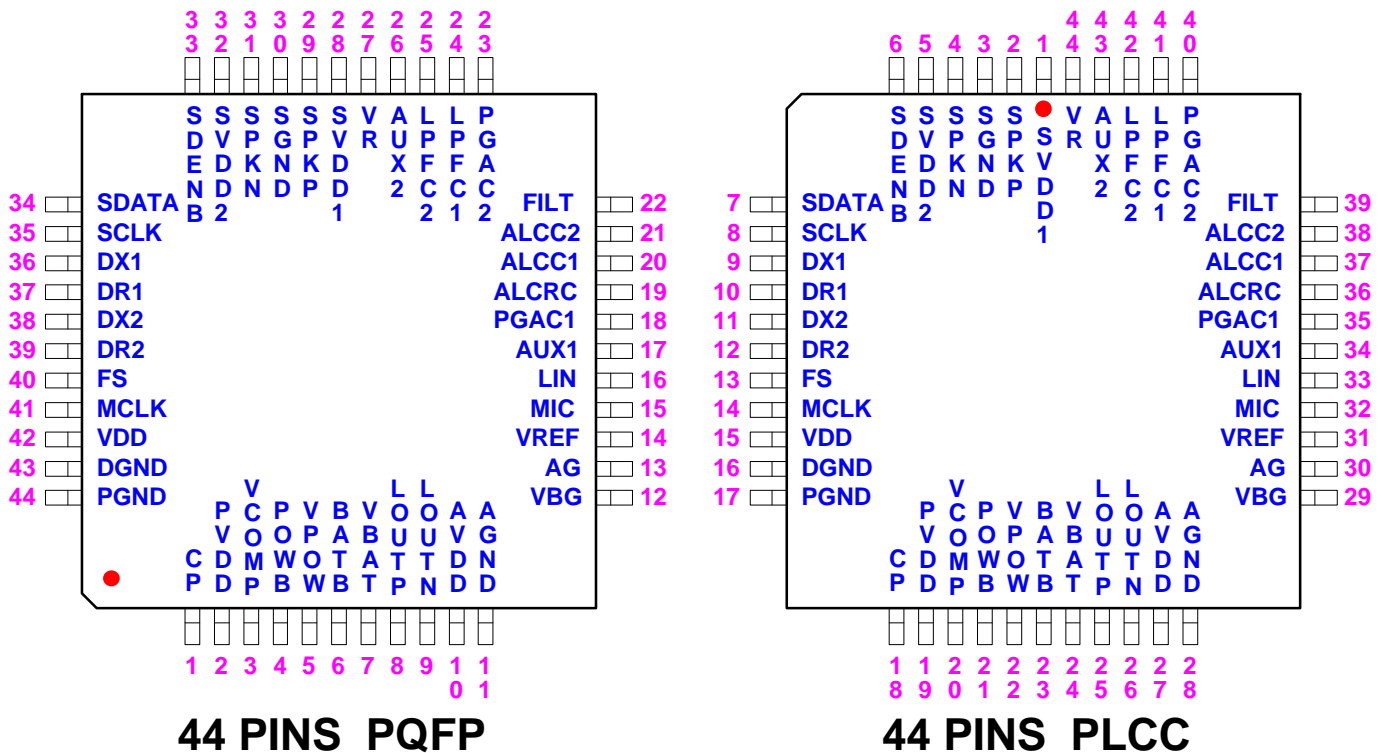


FEATURES

- . Built-in two single +5V power supply PCM CODECs
- . Support Digital Speakerphone application
- . Support automatic power-down function
- . Support 2.048 or 1.536 MHz master clock for 8KHz Frame Sync.
- . Support μ LA law and 16-bit format linear data
- . Support switch paths for DAM (digital answering machine) related applications
- . Support two comparators for power-low and battery-low detection
- 7. Support external L.P.F. for D/A output path
- . Support external volume control
- . On-chip differential line driver
- . On-chip ALC (automatic level control)
- . On-chip digital volume control
- . On-chip differential 8W power amplifier
- . On-chip programmable receive/transmit gain control
- . Easy interface to general purpose DSP
- . Easy Read/Write of control registers by MCU
- . Easy interface to FAX or Cordless Phone
- . 44-pin PQFP/PLCC package

PIN CONFIGURATION



PRODUCT OVERVIEW

The MX93002 PCM CODEC integrates key functions of the analog-front-end of DAM (with Digital Speakerphone) related products into an integrated circuit. The MX93002 PCM CODEC is especially powerful when applied to some DAM models which are intended to meet different countries' specifications in the same system hardware. User can achieve this goal by simply setting control firmware. This benefit will help DAM system makers to save developing time and R&D resources.

The MX93002 has two A/D, D/A converters so as to meet the requirement of the digital speakerphone application. The on-chip digital filters, which are carried out with 16-bit and 2's complement format, are used to get required frequency response of a PCM CODEC. The CODEC can support 8-bit u/A law and linear data format. For the latter, it is 16-bit format with 14-bit resolution.

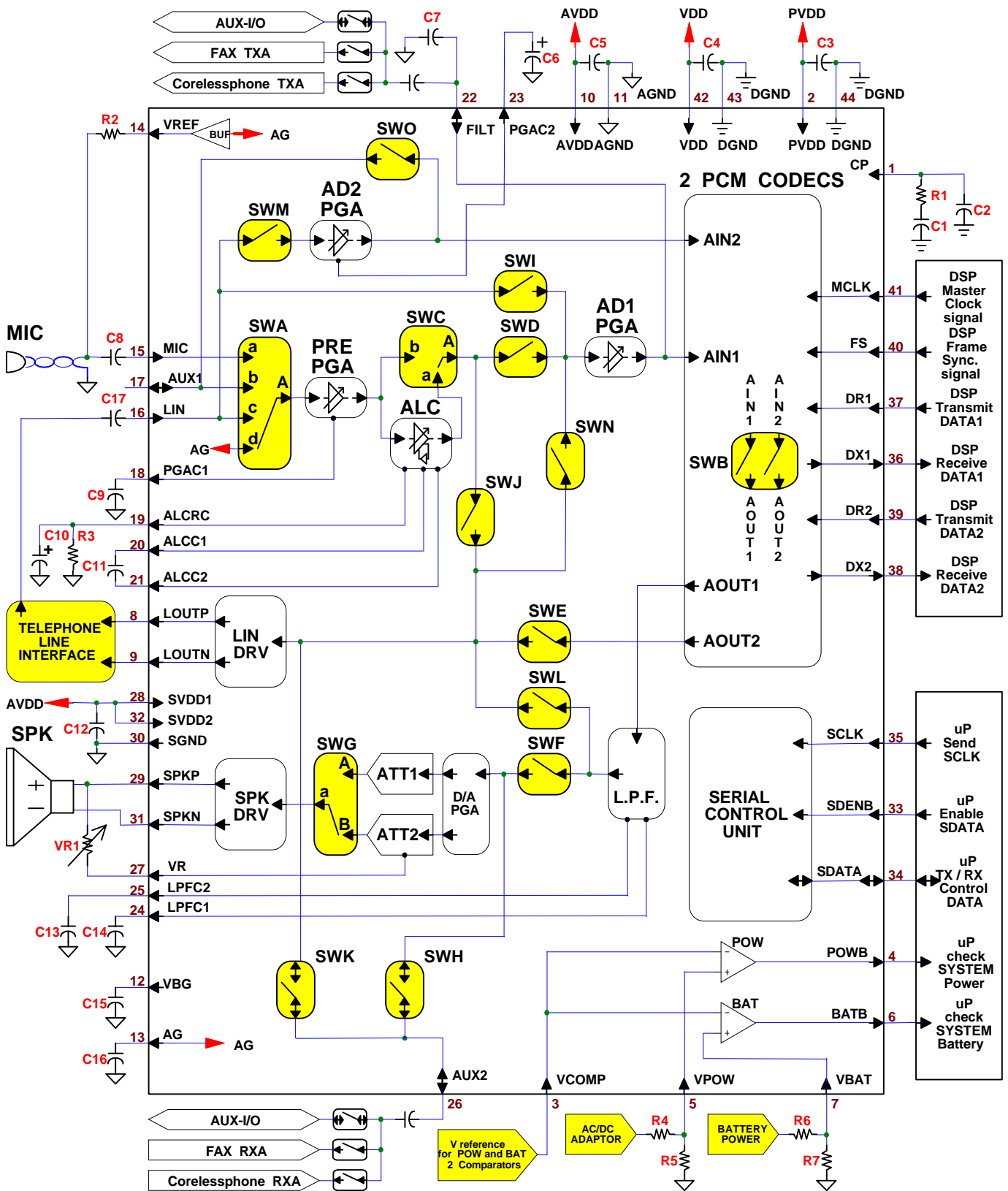
Before the A/D digitizing the voice-band analog signal into digital format, the analog signal can be processed by a built-in Automatic Level Control (**ALC**) and PRE-Programmable Gain Amplifier (**PRE-PGA**). The **ALC** circuit controls the signal level about 1.2Vpp and **AD1-PGA** can provide 0 ~ 18dB gain to get more larger signal. The **PRE-PGA** circuit is used to control the gain of different sources like **MIC**, **AUX1** or **LIN** input.

After the digital data is converted into analog signal by D/A converter, a fully differential line driver and speaker driver are supported to drive the telephone line and 8Ω speaker directly without needing any external amplifiers. Besides, the analog signal can be monitored by passing the on-chip volume control or external volume control.

The MX93002 supports many switches as well. User can program the control registers of the PCM CODEC to accomplish all specific operations of DAM (with digital speakerphone function) related products.

In order to let MCU (Micro controller) easily Read/Write the control registers of the MX93002, the sampling clock of the serial control data is clocked by external **SCLK** clock and synchronized by **SDENB**, where **SDENB** signal is coming from the MCU output port by detecting one of the rising edge of external **SCLK** clock.

BLOCK DIAGRAM (PQFP)



PIN DESCRIPTION

SYMBOL	PIN TYPE	PIN NBR. PQFP (PLCC)	DESCRIPTION
CP	I (D)	1 (18)	the output of internal PLL charge pump circuits; see the end of page 21 about lock-in time spec.
PVDD	P (D)	2 (19)	digital power supply; 5V power supply for internal PLL charge pump circuits
VCOMP	I (A)	3 (20)	the reference voltage for POW and BAT comparators use
POWB	O (A)	4 (21)	the output of POW comparator; active low
VPOW	I (A)	5 (22)	the Non-inverting input of POW comparator; the voltage is divided from system DC power for comparison with VCOMP ; with 7V Surge Protect
BATB	O (A)	6 (23)	the output of BAT comparator; active low
VBAT	I (A)	7 (24)	the Non-inverting input of BAT comparator; the voltage is divided from battery power for compare with VCOMP ; with 7V surge protect
LOUTP	O (A)	8 (25)	the Non-inverting output of LIN-DRV with PGA; PGA from 0 to 22.5dB; 1.5dB/step
LOUTN	O (A)	9 (26)	the Inverting output of LIN-DRV with PGA; PGA from 0 to 22.5dB; 1.5dB/step
AVDD	P (A)	10 (27)	analog power supply; 5V power supply for all internal analog circuits
AGND	P (A)	11 (28)	analog power ground
VBG	O (A)	12 (29)	band-gap reference; nominal 1.25V ϕ and should not be used to sink or source current
AG	O (A)	13 (30)	internal analog signal ground; nominal 2.25V ϕ and should not be used to sink or source current
VREF	O (A)	14 (31)	voltage reference; nominal 2.25V ϕ and can sink 450uA
MIC	I (A)	15 (32)	microphone input with PRE-PGA ; PGA from -15 to 21dB; see NOTE 1
LIN	I (A)	16 (33)	telephone line signal input with PRE-PGA ; PGA from -15 to 21dB; see NOTE 1
AUX1	I/O (A)	17 (34)	auxiliary signal input with PRE-PGA ; PGA from -15 to 21dB; see NOTE 1
PGAC1	O (A)	18 (35)	programmable gain amplifier (PRE-PGA) compensative capacitor
ALCRC	O (A)	19 (36)	automatic level control (ALC) time constant; see FIG. 5
ALCC1	O (A)	20 (37)	automatic level control (ALC) DC blocking capacitor output
ALCC2	O (A)	21 (38)	automatic level control (ALC) DC blocking capacitor input
FILT	I/O (A)	22 (39)	1. anti-aliasing filter; 2. as an I/O port for AIN (A/D input)
PGAC2	O (A)	23 (40)	Programmable Gain Amplifier Offset Capacitor

SYMBOL	PIN TYPE	PIN NBR. PQFP (PLCC)	DESCRIPTION
LPFC1	O (A)	24 (41)	the option of the external passive L.P.F. (Low Pass Filter); if the pin is NC then will by-pass L.P.F, where L.P.F. 3dB point : $f_c = 1/2\pi \times 3K\Omega (\pm 10\%)* CLPFC1$
LPFC2	O (A)	25 (42)	the option of the external passive L.P.F. (Low Pass Filter); if the pin is NC then will by-pass L.P.F, where L.P.F. 3dB point : $f_c = 1/2\pi \times 3K\Omega (\pm 10\%)* CLPFC2$
AUX2	I/O (A)	26 (43)	as an I/O port for SWK and SWH
VR	O (A)	27 (44)	external speaker volume control; use a 10K Ω variable resistor
SVDD1	P (A)	28 (1)	analog power supply; 5V power for SPK-DRV
SPKP	O (A)	29 (2)	the Non-inverting output of SPK-DRV with DA-PGA , ATT1 and ATT2 ; PGA from 0 to 9dB; Attenuator 1 & 2 from 0 to -45dB; see NOTE. 3
SGND	P (A)	30 (3)	analog power ground for SPK-DRV
SPKN	O (A)	31 (4)	the Inverting output of SPK-DRV with DA-PGA , ATT1 and ATT2 ; PGA from 0 to 9dB; Attenuator 1 & 2 from 0 to -45dB; see NOTE 3
SVDD2	P (A)	32 (5)	analog power ground for SPK-DRV
SDENB	I (D)	33 (6)	the enable signal for serial control data; active low; for starting to Receive/Transmit serial control data (A2~A0,D7~D0)
SDATA	I/O (D)	34 (7)	Bi-directional serial control data port; it is an interface for Microprocessor to Transmit/Receive serial control data
SCLK	I (D)	35 (8)	serial control data clock; the clock source of serial control data; from microprocessor
DX1	O (D)	36 (9)	transmit serial data
DR1	I (D)	37 (10)	receive serial data
DX2	O (D)	38 (11)	transmit serial data
DR2	I (D)	39 (12)	receive serial data
FS	I (D)	40 (13)	frame sync. input; 8KHz frame sync. Clock for the Transmit/Receive serial data
MCLK	I (D)	41 (14)	master clock input, if MCLK is continuously high or low then the MX93002 will get into power down mode automatically
VDD	P (D)	42 (15)	digital power supply; 5V power supply for all internal digital logic
DGND	P (D)	43 (16)	digital power ground
PGND	P (D)	44 (17)	digital power ground; for internal PLL charge pump circuits

@ PIN TYPE : "I" : Input Port; "O" : Output Port; "I/O" : Bi-direction Port; "P" : Power
 "(D)" : Digital Pin; "(A)" : Analog Pin

BASIC COMPONENTS REQUIRED

REFERANCE	PART	DESCRIPTION
*R1	68KΩ	the resistor for internal PLL charge pump circuits
R2	2KΩ	current limit resistor; to limit MIC bias current, please follow MIC specification
R3	560KΩ	ALC release time constant; see FIG. 10
R4, R5		to scale down DC power supply (VPOW) for reference to VCOMP to check power low
R6, R7		to scale down battery power (VBAT) for reference to VCOMP to check battery low
*C1	100pF	the capacitor for internal PLL charge pump circuits
*C2	6pF	the capacitor for internal PLL charge pump circuits
C8, C17	0.1uF	DC blocking capacitor (0.1~10uF)
C11	0.22uF	DC blocking capacitor (0.1~10uF); H.P.F. 3dB point : $f_c \approx \frac{1}{2\pi \times 4.4K\Omega \times C6 (0.22uF)} = 164Hz$
C6	10uF	DC offset canceling compensative capacitor (4.7~10uF, the larger the better)
C9	0.1uF	DC offset canceling compensative capacitor (0.1~1uF, the larger the better)
C3, C4, C5, C12, C16	0.1uF	De-couple capacitor (0.1~10uF)
C15	0.1uF	De-couple capacitor (0.01~10uF); see FUNCTIONAL DESCRIPTION
C10	10uF	ALC attack time constant; see FIG. 9
*C7	5000pF	anti-aliasing capacitor
C13, C14		passive L.P.F. ; 3dB point : $f_c \approx \frac{1}{2\pi \times 3K\Omega \times C13}$ (where C13 = C14)
*VR1	10KΩ	to attenuate the input signal from SWH or SWF , if use digital volume control, then do not need a resistor between VR and SPKP

@ where : " * " mark shows the requirement of the component can not be changed.

FUNCTIONAL DESCRIPTION

. Clock Rate (REG4 bit(2))

- . The clock rate (**MCLK**) must be set before user uses the function of the MX93002;
- . Programmable clock rate :
 1. 2.048MHz (Frame Sync. 8KHz);
 2. 1.536MHz (Frame Sync. 8KHz);

. Data Format (REG4 bit(1,0))

- . The data format must be set before user uses the function of the MX93002;
- . Programmable Data Format
 1. 16-bit linear data format. It can have 14-bit resolution and higher linearity than u/a-law format has;
 2. 8-bit u-law data format;
 3. 8-bit a-law data format;

. PCM CODEC

- . The block includes **A/D & D/A** converters and all digital filters;
 1. **A/D & D/A** Converters
 - A/D** Channel :
 - A. Input Range : 0 ~ 3Vpp (3Vpp as A/D 0dB full swing (0dBFS));
 - B. Digital Filters : For the purpose of out-of-band noise filtering, IIR digital filters are implemented on the same chip (>26dB / 60Hz; <1dB / 300Hz ~ 3.4KHz; >14dB / 3.6KHz ~ 4.6KHz; >32dB / >4.6KHz);
 - D/A** Channel :
 - A. Output swing : 0 ~ 3Vpp (3Vpp as D/A 0dB full swing (0dBFS));
 - B. Digital Filters :
 - a. G.711 specification;
 - b. The digital input applied to D/A converter can not be a DC signal other than idle (bits all zero), as limit cycles in the embodiment method at a level of -70dBm will present at the analog output.

. Power Down Mode

- . The MX93002 will recover from power-down mode when MCLK keeps a consistent clock (1.536 or 2.048MHz);
- . Support system power (Adapter and Battery) detection. The function will work well even under 3V power supply;
- . Support automatic power-down control when **MCLK** keeps high or low;
- . Support 4 power-down modes for special applications:

MODE FUNCTION	REG 6 (7,6) (SLEEPA,SLEEP) = (0,0)	REG 6 (7,6) (SLEEPA,SLEEP) = (0,1)	REG 6 (7,6) (SLEEPA,SLEEP) = (1,0)	REG 6 (7,6) (SLEEPA,SLEEP) = (1,1)
VBG reference	on	off	off	on
POW & BAT	on	off	on	on
all analog blocks	off	off	off	on
A/D and D/A	off	off	off	off

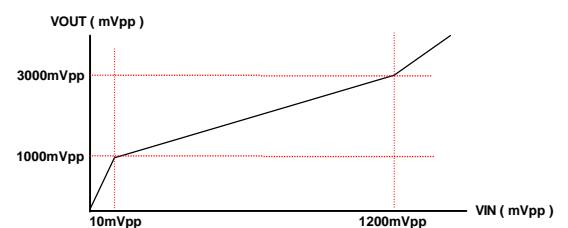
Table 1

. 3-Channel Input (MIC,AUX1,LIN) with PRE-PGA (Pre-Programmable Gain Control)

- . Input Range : 0 ~ AVDD-2Vpp;
- . **PRE-PGA** gain step from 21dB to -15dB (21, 18, 15, 12, 9, 7.5, 6, 4.5, 3, 0, -3, -6, -9, -12, -15dB);
- . Driving Capacity : more than 400uA at **FILT** and **AUX2** output;
- . Input Impedance : more than 25K Ω ;
- . THD : less than 70dB at **FILT** output;
- . There is just one path which can be selected at the same time;
- . The gain setting of the path will be mapped to the **PRE-PGA** when user changes the path of Input.

. ALC (Automatic Level Control)

- . Input Range : 0 ~ 1.2Vpp (Loop Gain : 40dB);
- . Output Characteristic : see **FIG. 5 ~ FIG. 7**;
- . Loop Gain : 42dB max (with external RC time constant);
- . Driving Capacity : more than 400uA at **FILT** and **AUX2** output;
- . THD : less than 40dB at **FILT** output (Loop Gain : 40dB).



. AD1 PGA

- . Input Range : 0 ~ AVDD-2Vpp;
- . **AD1-PGA** can support gain step from 0dB to 18dB (0, 4, 8, 18dB);

. AD2 PGA

- . Input Range : 0 ~ AVDD-2Vpp;
- . **AD2-PGA** can support gain step from -6dB to 39dB (-6, -3, 0, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39dB);

. FILT as I/O Port

- . Input Range : 0 ~ AVDD-2Vpp;
- . Input Impedance : more than 1K Ω ;
- . Output Impedance : less than 1K Ω ;
- . Load Capacitance : 5000pF;

. AUX1 & AUX2 as I/O Port

- . Input Range : 0 ~ AVDD-2Vpp;
- . Input Impedance : more than 15K Ω ;
- . Output Impedance : less than 15K Ω ;

. External passive L.P.F. (Low Pass Filter)

- . External capacitors (**LPFC1** and **LPFC2**) can be changed to attenuate high frequency noise at **SPKP** and **SPKN** output;
- . When external capacitors (**LPFC1** and **LPFC2**) are NC (no connection), then passive **L.P.F.** will be by-passed;
- . Output of the Line Driver (**LOUTP** and **LOUTN**) can be chosen to pass or by-pass the **L.P.F.**;
- . **LPFC1/LPFC2** can be a D/A output pin and output impedance is around 3K Ω /6K Ω ;

. Line Driver (LIN-DRV)

- . Not only support the programmable gain from 0 to 22.5dB, but also fully differentially drive 6Vpp over 600Ω;
- . If switches **SWE**, **SWJ**, **SWK** and **SWL** are opened, then the line driver will be muted to -70dB and power-down automatically;
 1. output swing : Single Ended (only use **LOUTP** or **LOUTN**) : 0 ~ 3Vpp (over 600Ω load, at LIN-DRV = 0dB);
Fully differential (use **LOUTP** + **LOUTN**) : 0 ~ 6Vpp (over 600Ω load, at LIN-DRV = 0dB);
 2. **LIN-DRV** gain step from 0dB to 22.5dB (1.5dB/step);
 3. THD : less than 70dB at 6Vpp output over 600Ω load;

. D/A PGA

- . Input Range : 0 ~ AVDD-2Vpp;
- . **DA-PGA** can support gain step from 0dB to 6dB (2dB/step);

. Attenuator (ATT1 & ATT2)

- . Speaker output signal can be attenuated either by internal register or external resistor;
- . If switches **SWF** and **SWH** are opened, then attenuator will be muted to -70dB automatically;
 1. **ATT1** (internal register) : 16 steps programmable, from -45dB to 0dB (-45, -39, -33, -27, -24, -21, -18, -15, -12, -9, -7.5, -6, -4.5, -3, -1.5, 0dB);
 2. **ATT2** (external variable resistor) : from -45 ~ 0dB (determined by external 10KΩ potentiometer);
 3. THD : less than 70dB;
 4. input range for **AUX2** : 0 ~ AVDD-2Vpp;
 5. input impedance for **AUX2** : more than 15KΩ;

. Speaker Driver (SPK-DRV)

- . If switches **SWF** and **SWH** are opened, then **SPK-DRV** will be power-down automatically;
 1. Maximum output swing : 6Vpp with 8Ω load at fully differential output (**SPKP** + **SPKN**);
 2. THD : less than 60dB (at 6Vpp/8Ω load);

. Voltage Reference (VREF & VAG)

- . Two 2.25V ϕ voltage references are on-chip generated, where **VREF** is for external circuit use and **VAG** is for internal circuit use;
- . **VREF** can be used to bias the microphone, the level shift circuit or other applications;
 1. **VREF** driving capacity : more than 400uA;
 2. User can use the **VREF** to provide DC bias to external components;

. Bandgap Reference (VBG)

- . A bandgap circuit generates a voltage source (**VBG**) which is around 1.2V ϕ . It is with low temperature coefficient and good power supply rejection;
- . If user changes VBG bypass capacitor (C15) then the MX93002 warm-up time will be changed; see **The Timing Diagram of CODEC Function**;

. Serial Control Interface

- . Use **SCLK** for synchronization with **SDATA** to read/write the internal control registers;
- . All registers will keep original setting when the MX93002 returns from power-down or sleep mode;
 1. When **SDENB** (serial data enable) signal active low, the MX93002 starts to receive serial control data (**SDATA**);
 2. Set **SDENB** from low to high when transmitting **SDATA** is complete;
 3. **SDATA** format : 3 addresses from A2 to A0, 8 data from D7 to D0 (A2 is MSB and D0 is LSB);

. Two Comparators for System Applications (RING and CPC)

- . To detect Ring and CPC (Calling Party Control) or other applications;
 1. input range : 0 ~ AVDD-2Vpp (with 7V surge protection);
 2. input impedance : more than $10^{12}\Omega$;
 3. input offset voltage : less than 10mV;
 4. output impedance : less than 10K Ω ;
 5. slew rate : 3V/us max.;

. Switches

- . There are three registers (REG0, REG3 and REG6) which are used to control all of the switches so that user can direct many different signal paths, for examples:

1. Record signal from **MIC** and play signal to **SPKP/N** or play signal to **LOUTP/N**:

A. Record signal from **MIC** or Record signal from **LIN**:

- a. System initialization [set **MIC** gain (REG2 bit(3~0)), set **LIN** gain (REG1 bit(7~4), set **ALC** gain 0/6dB (REG5 bit(1)) and set **A/D-PGA** gain (REG6 bit(1,0))]

- b. Record signal from **MIC** : set REG0 = 0X0048

MIC ⇒ **SWA** ⇒ **PRE-PGA** ⇒ **SWC (ALC on)** ⇒ **SWD** ⇒ **AD1-PGA** ⇒ **PCM CODEC AIN1**

- c. Record signal from **LIN** : set REG0 = 0X00C8

LIN ⇒ **SWA** ⇒ **PRE-PGA** ⇒ **SWC (ALC on)** ⇒ **SWD** ⇒ **AD1-PGA** ⇒ **PCM CODEC AIN1**

B. Play signal to **SPKP/N** or play signal to **LOUTP/N**:

- a. System initialization [fix the value of **L.P.F.** , set (REG6 bit(5)), set **D/A-PGA** gain (REG6 bit(3,2), set **ATT1** gain (REG3 bit(3~0)) and **LIN-DRV** gain (REG1 bit(3~0))]

- b. Play signal to **SPKP/N** (use digital volume control) : set REG 0 = 0X0003

PCM CODEC AOUT1 ⇒ **L.P.F.** ⇒ **SWF** ⇒ **DA-PGA** ⇒ **SWG (ATT1)** ⇒ **SPK-DRV** ⇒ **SPKP/N**

- c. Play signal to **LOUTP/N** : set REG 0 = 0X0004

i. **PCM CODEC AOUT1** ⇒ **L.P.F.** ⇒ **SWL** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

ii. **PCM CODEC AOUT2** ⇒ **SWE** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

- d. Play signal to **SPKP/N** (use digital volume control) and **LOUTP/N** : set REG 0 = 0X0007

i. **PCM CODEC AOUT1** ⇒ **L.P.F.** ⇒ **SWF** ⇒ **DA-PGA** ⇒ **SWG (ATT1)** ⇒ **SPK-DRV** ⇒ **SPKP/N**
PCM CODEC AOUT2 ⇒ **SWE** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

ii. **PCM CODEC AOUT1** ⇒ **L.P.F.** ⇒ **SWF** ⇒ **DA-PGA** ⇒ **SWG (ATT1)** ⇒ **SPK-DRV** ⇒ **SPKP/N**
⇒ **SWL** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

2. Room Monitoring:

A. System initialization [set **MIC** gain (REG2 bit(3~0)), set **ALC** gain 0/+6dB (REG5 bit(1)), set **LIN-DRV** gain (REG1 bit(3~0)), set REG3 bit(6,5) and set REG6 bit(1,0)]

B. Switches path:

a. Remote Monitoring:

MIC ⇒ **SWA** ⇒ **PRE-PGA** ⇒ **SWC (ALC on)** ⇒ **SWJ** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

b. Local Detecting DTMF:

LIN ⇒ **SWI** ⇒ **AD1-PGA** ⇒ **PCM CODEC AIN1**

3. Digital Speakerphone:

A. System Initialization [set **MIC** gain (REG2 bit(3~0)), set **AD1-PGA** gain (REG6 bit(1,0)), fix the value of **L.P.F.**, set **DA-PGA** gain (REG6 bit(3,2)), set **ATT1** gain (REG3 bit(3~0)), set **LIN** gain (REG1 bit(7~4)), set **SWM** REG4 bit(4), set **LIN-DRV** gain (REG1 bit(3~0))]

B. Switches path : set REG0 = 0X00AF

a. CODEC 1 : Record signal from **MIC** and Play signal to **SPKP/N** (use digital volume control)

MIC ⇒ **SWA** ⇒ **PRE-PGA** ⇒ **SWC (ALC off)** ⇒ **SWD** ⇒ **AD1-PGA** ⇒ **PCM CODEC AIN1**
PCM CODEC AOUT1 ⇒ **L.P.F.** ⇒ **SWF** ⇒ **SWG (ATT1)** ⇒ **SPK-DRV** ⇒ **SPKP/N**

b. CODEC 2 : Record signal from **LIN** and Play signal to **LOUTP/N**

LIN ⇒ **SWM** ⇒ **AD2-PGA** ⇒ **PCM CODEC AIN2**
PCM CODEC AOUT2 ⇒ **SWE** ⇒ **LIN-DRV** ⇒ **LOUTP/N**

. Power Consumption (with 600W line load and 8W speaker load)

Max. Power Consumption Operation	LIN-DRV Dis/Enable	SPK-DRV Dis/Enable	Analog circuits	Digital circuits	Unit
Stand-by	Disable	Disable	27	8	mA
Operating	Disable	Disable	27	8	mA
	Enable	Disable	31	8	
	Disable	Enable	240	8	
Power-down	Enable	Enable	250	8	uA
	Disable	Disable	460	335	
Power-down with SLEEP = 1	Disable	Disable	20	400	uA

@ Test condition : 1. at **LIN-DRV** (with 600Ω load) / **SPK-DRV** (with 8Ω load) full swing output

2. see **LIN-DRV** and **SPK-DRV** Descriptions

3. at the case of Temperature from -2℃ To 72℃ and Voltage from 4.4V to 5.6V

CONTROL REGISTERS DEFINITION
REGISTER 0

ADDRESS BIT	A2	A1	A0
DATA	0	0	0

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER-ON	0	0	0	0	0	0	0	0
DESCRIPTION	SWA		SWB	SWC	SWD	SWE	SWF	SWG

- (**SWA**) D(7,6) = (1,1) : path of **SWA** is "c ⇒ A", **PRE-PGA** setting follows **LIN GAIN SETTING**
 = (1,0) : path of **SWA** is "b ⇒ A", **PRE-PGA** setting follows **AUX1 GAIN SETTING**
 = (0,1) : path of **SWA** is "a ⇒ A", **PRE-PGA** setting follows **MIC GAIN SETTING**
 = (0,0) : path of **SWA** is "d ⇒ A", (GROUNDING to **AG**)
- (**SWB**) D(5) = (1) : path of **SWB** is "CLOSE", D(5) = (0) : path of **SWB** is "OPEN"
- (**SWC**) D(4) = (1) : path of **SWC** is "b ⇒ A", D(4) = (0) : path of **SWC** is "a ⇒ A"
- (**SWD**) D(3) = (1) : path of **SWD** is "CLOSE", D(3) = (0) : path of **SWD** is "OPEN"
- (**SWE**) D(2) = (1) : path of **SWE** is "CLOSE", D(2) = (0) : path of **SWE** is "OPEN"; see **NOTE 4**
- (**SWF**) D(1) = (1) : path of **SWF** is "CLOSE", D(1) = (0) : path of **SWF** is "OPEN"
- (**SWG**) D(0) = (1) : path of **SWG** is "a ⇒ A", **ATTENUATOR 1 (ATT1)**
 = (0) : path of **SWG** is "a ⇒ B", **ATTENUATOR 2 (ATT2)**

REGISTER 1

ADDRESS BIT	A2	A1	A0
DATA	0	0	1

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER-ON	0	0	0	0	0	0	0	0
DESCRIPTION	LIN GAIN SETTING (PRE-PGA)				LIN-DRV GAIN SETTING			

- (**LIN GAIN SETTING**) D(7~4) = (F) ~ (0) : 21dB ~ -15dB; see **NOTE 1**
- (**LIN-DRV GAIN SETTING**) D(3~0) = (F) ~ (0) : 22.5dB ~ 0dB 1.5dB/step; see **NOTE 2**

REGISTER 2

ADDRESS BIT	A2	A1	A0
DATA	0	1	0

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER-ON	0	0	0	0	0	0	0	0
DESCRIPTION	AUX1 GAIN SETTING (PRE-PGA)				MIC GAIN SETTING (PRE-PGA)			

- (**AUX1 GAIN SETTING**) D(7~4) = (F) ~ (0) : 21dB ~ -15dB; see **NOTE 1**
- (**MIC GAIN SETTING**) D(3~0) = (F) ~ (0) : 21dB ~ -15dB; see **NOTE 1**

REGISTER 3

ADDRESS BIT	A2	A1	A0
DATA	0	1	1

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER-ON	0	0	0	0	1	1	1	1
DESCRIPTION	<i>SWH</i>	<i>SWI</i>	<i>SWJ</i>	<i>SWK</i>	<i>ATT1</i> GAIN SETTING			

(*SWH*) D(7) = (1) : path of *SWH* is "CLOSE", D(7) = (0) : path of *SWH* is "OPEN"

(*SWI*) D(6) = (1) : path of *SWI* is "CLOSE", D(6) = (0) : path of *SWI* is "OPEN"

(*SWJ*) D(5) = (1) : path of *SWJ* is "CLOSE", D(5) = (0) : path of *SWJ* is "OPEN"

(*SWK*) D(4) = (1) : path of *SWK* is "CLOSE", D(4) = (0) : path of *SWK* is "OPEN"

(*ATT1* GAIN SETTING) D(3~0) = (F)~(0) : - 45dB ~ 0dB; see **NOTE 3**

REGISTER 4

ADDRESS BIT	A2	A1	A0
DATA	1	0	0

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER_ON	0	1	0	1	1	0	0	0
DESCRIPTION	<i>AD2-PGA</i> GAIN SETTING				<i>SWM</i>	RATE	DATA FORMAT	

(*AD2-PGA* GAIN SETTING) D(7~4) = (0) ~ (F) : -6dB ~ 39dB; see **NOTE 3**

(*SWM*) D(3) = (1) : path of *SWM* is "CLOSE", D(3) = (0) : path of *SWM* is "OPEN"

(RATE) D(2) = (1) : master clock (**MCLK**) use 1.536MHz, D(2) = (0) : master clock (**MCLK**) use 2.048MHz

(DATA FORMAT) D(1,0) = (1,1),(1,0) : Linear Coder/Decoder (16-bit format)

= (0,1) : a-Law Coder/Decoder (8-bit format)

= (0,0) : u-LAW Coder/Decoder (8-bit format)

@ Linear 16-bit format : 14-bit resolution with 2 LSB = 0

SIGN \ SCALE	MIN	MAX
POSITIVE	0000 0000 0000 0000	0111 1111 1111 1100
NEGATIVE	1111 1111 1111 1100	1000 0000 0000 0000

REGISTER 5

ADDRESS BIT	A2	A1	A0
DATA	1	0	1

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER_ON	0	0	0	0	0	0	0	0
DESCRIPTION	ALC1	SPKHI	ADA	AIADID	DAYT	ADYT	ALC0	TDSPCK

D (5 ~ 2 and 0) : reserved

(SPKHI) D(6) = (0) : **SPKP/N** can drive 8Ω load when **SPK-DRV** turns on

D(6) = (1) : **SPKP/N** appears high impedance (10KΩ) and **SPK-DRV** will keep a quiescent current when

SPK-DRV turns on

- (ALC1 , ALC0) D(7,1) = (0,0) : **ALC** open loop gain is 38dB
- = (0,1) : **ALC** open loop gain is 42dB
- = (1,0) : reserved
- = (1,1) : external **ALC** option (**PRE-PGA** Output : **ALCC1**, **SWC** path “a” Input : **ALCC2**)

REGISTER 6

ADDRESS BIT	A2	A1	A0
DATA	1	1	0

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER_ON	0	0	0	0	0	0	0	0
DESCRIPTION	SLEEPA	SLEEP	SWL	SPK-MUTE	SPK-DRV GAIN SETTING		AD1-PGA GAIN SETTING	

- (SLEEPA , SLEEP) D(7,6) = (0,0) : when the MX93002 gets into power down mode, all the blocks of the MX93002 will be disabled except the **VBG** reference and 2 comparators (**POW**, **BAT**)
- D(7,6) = (0,1) : when the MX93002 gets into power down mode, all the blocks of the MX93002 will be disabled
- D(7,6) = (1,0) : when the MX93002 gets into power down mode, all the blocks of the MX93002 will be disabled except 2 comparators (**POW**, **BAT**)
- D(7,6) = (1,1) : when the MX93002 gets into power down mode, all the analog blocks of the MX93002 will be still functional and can be programmed by control registers
- (**SWL**) D(5) = (1) : path of **SWL** is "CLOSE", D(5) = (0) : path of **SWL** is "OPEN"; see **NOTE 7**
- (SPK-MUTE) D(4) = 1 : force **SPK-DRV** mute to -70dB, D(4) = 0 : force **SPK-DRV** un-mute
- (**SPK-DRV** GAIN SETTING) D(3,2) = (0,0) ~ (1,1) : 0dB ~ 8dB; 2dB/step; see **NOTE 5**
- (**AD1-PGA** GAIN SETTING) D(1,0) = (0,0) ~ (1,1) : 0dB ~ 18dB; see **NOTE 2**

REGISTER 7

ADDRESS BIT	A2	A1	A0
DATA	1	1	1

DATA BIT	D7	D6	D5	D4	D3	D2	D1	D0
POWER_ON	0	0	0	0	0	0	0	0
DESCRIPTIN			SWO	SWN	READ	REGISTER ADDRESS		

- (**SWO**) D(5) = (1) : path of **SWO** is "CLOSE", D(5) = (0) : path of **SWO** is "OPEN"
- (**SWN**) D(4) = (1) : path of **SWN** is "CLOSE", D(5) = (0) : path of **SWN** is "OPEN"; see **NOTE 7**
- (READ) D(3) = 1 : read data from Register 0 ~ 7, D(3) = 0 : write data to Register 0 ~ 7
- (REGISTER ADDRESS) D(2~0) : When READ = 1, then
 - a. READ will be cleared automatically;
 - b. if next uP **SDENB** signal active low, the content of REGISTER ADDRESS will be dumped out through CODEC **SDATA** interface;

SPECIFICATIONS
Absolute Maximum Rating

PARAMETER	MIN	TYP	MAX	UNITS
AVDD to AGND	-0.3		6.0	V
VDD to DGND	-0.3		6.0	V
Voltage at any Digital Input or Output	DGND-0.3		VDD+0.3	V
Current at any Digital Input or Output			8	mA
Operating Ambient Temperature Range	0		70	°C J
Storage Temperature Range	-65		150	°C J
Lead Temperature (Soldering, 10 seconds)				

Power Supply

PARAMETER	MIN	TYP	MAX	UNITS
<i>Power Supply Voltage :</i>				
Digital and Analog	4.5	5.0	5.5	V
<i>Power Supply Current :</i>				
<i>Stand-by :</i>				
Digital			8	mA
Analog			27	mA
<i>Operating :</i>				
Digital			8	mA
Analog (see Page 11)			255	mA
<i>Power-Down :</i>				
Digital			400	uA
Analog (at REG4 bit 6 SLEEP = 0)			460	uA
Analog (at REG4 bit 6 SLEEP = 1)			20	uA

Electrical Characteristics (**BOLD** characters are guaranteed for AVDD = VDD = 5V ±5%, temperature = 0 ~ 70°C J Typical specified at AVDD = VDD = 5V, temperature = 25°C J “*” mark : guaranteed by design)

Digital Interface

PARAMETER	MIN	TYP	MAX	UNITS
High Level Input Voltage (VIH)	2.2			V
Low Level Input Voltage (VIL)			0.6	V
High Level Output Voltage (VOH)	2.4			V
Low Level Output Voltage (VOL)			0.4	V
Input Low Current (IIL)	-10	±2	10	uA

Input High Current (I _{IH})	-10		10	uA
--	-----	--	----	----

Analog Input Ports

PARAMETER	MIN	TYP	MAX	UNITS
<i>MIC / LIN / AUX1 :</i>				
Input Voltage		3.0		V _{pp}
* Input Capacitance			15	pF
* Input Impedance	20			KΩ

Analog Output Ports

PARAMETER	MIN	TYP	MAX	UNITS
<i>Line Driver :</i>				
Gain Range	0		22.5	dB
Step Size		±1.5		dB
Step Variation		±10		%
Fully Differential (LOUTP+LOUTN) Full Swing / with 600Ω load		6.0		V _{pp}
Single Ended (LOUTP) Full Swing / with 600Ω load		3.0		V _{pp}
* External Load Capacitance			200	pF
* Output Impedance		600		Ω
<i>Speaker Driver :</i>				
Fully Differential (SPKP+SPKN) Full Swing / with 8Ω load		6.0		V _{pp}
Single Ended (SPKP) Full Swing / with 8Ω load		3.0		V _{pp}
* External Load Capacitance			100	pF
* Output Impedance			8	Ω
the Quiescent current (when REG5 bit(6) SPKHI = 1)			4	mA

Analog I/O Ports

PARAMETER	MIN	TYP	MAX	UNITS
<i>FILT :</i>				
<i>as Input Port :</i>				
* Input Capacitance	5000			pF
* Input Impedance	1			KΩ
<i>as Output Port :</i>				
* External Load Capacitance			5000	pF
* Output Impedance			1	KΩ
<i>AUX2 :</i>				
<i>as Input Port :</i>				
* Input Capacitance	15			pF
* Input Impedance	15			KΩ
<i>as Output Port :</i>				
* External Load Capacitance			15	pF

* Output Impedance			15	KΩ
--------------------	--	--	----	----

Gain Variation

PARAMETER	MIN	TYP	MAX	UNITS
<i>PRE-PGA :</i>				
Gain Range	-15		22.5	dB
Step Size		±1.5, ±3		dB
Step Variation		±10		%
<i>AD1-PGA :</i>				
Gain Range	0		18	dB
Step Size		±4, ±10		dB
Step Variation		±10		%
<i>AD2-PGA :</i>				
Gain Range	-6		39	dB
Step Size		±3		dB
Step Variation		±10		%
<i>DA-PGA :</i>				
Gain Range	0		6	dB
Step Size		±2		dB
Step Variation		±10		%

Attenuator

PARAMETER	MIN	TYP	MAX	UNITS
<i>Attenuator 1 (Digital Volume) :</i>				
Gain Range	-45		0	dB
Step Size		±6, ±3, ±1.5		dB
Step Variation		±10		%
* Mute Attenuation	-57			dB
<i>Attenuator 2 (External Volume) :</i>				
Gain Range	-45		0	dB
the Requirement of External Resistor (from SPKP to VR)		10		KΩ
* Mute Attenuation	-57			dB

Bandgap (VBG pin)

PARAMETER	MIN	TYP	MAX	UNITS
Output Voltage	1.16	1.2	1.24	V
* Output Current		Hi-z		

Voltage Reference (VREF pin)

PARAMETER	MIN	TYP	MAX	UNITS
-----------	-----	-----	-----	-------

Output Voltage	2.0	2.25	2.5	V
* Output Current		450		uA

Two Operational Amplifier / Comparators (RING, CPC)

PARAMETER	MIN	TYP	MAX	UNITS
* Input Offset Voltage			10	mV
* Input Voltage			7	V
* Input Impedance	10 ¹²			Ω
* Output Impedance	10			KΩ
* Open Loop Gain			78	dB
* Unit Band Gain Width			2	MHz
* Slew Rate			3	V / us
* Input Comm. Mode Range		3.5		V

Two Comparators (POW, BAT)

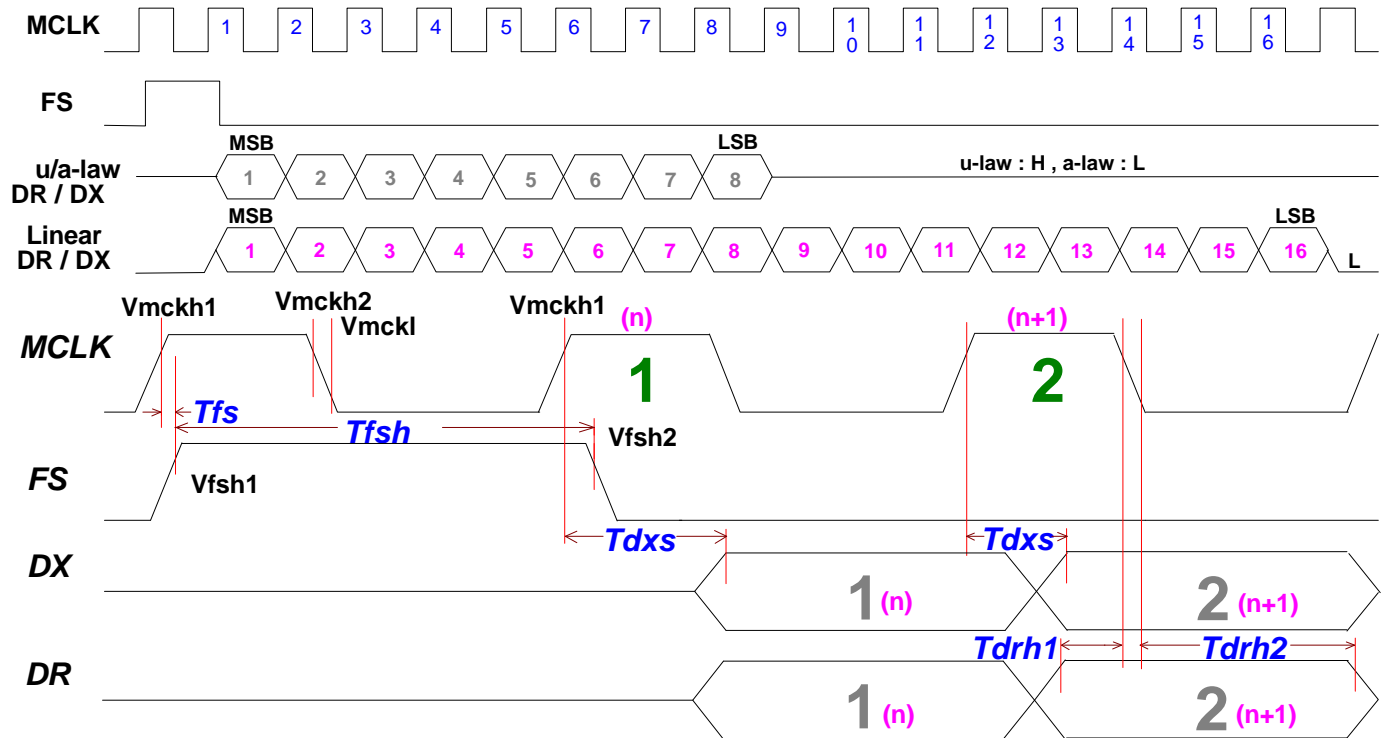
PARAMETER	MIN	TYP	MAX	UNITS
Input Voltage (VCOMP, VPOW, VBAT)			AVDD	V
* Hysteresis		15		mV
* Output Impedance of POWB and BATB pins	10			KΩ

TIMING DESCRIPTION

TIMING	DESCRIPTION	MIN	TYP	MAX	UNIT
1/Tmck	frequency of master clock (from Vmckh1 to next Vmckh1) at RATE = 0	1.638	2.048	2.560	MHz
Trmck	rise time of master clock			50	ns
Tfmck	fall time of master clock			50	ns
Tfs	from Vmckh1 to Vfsh1	0			ns
Tfsh	holding time for frame sync. From Vfsh1 to Vfsh2	MCLK			ns
Tdxs	setting time for CODEC transmit data from Vmckh1(n) to DX(n) data ready	110			ns
Tdrh1	holding time for CODEC received data from DR(n) data ready to Vmckh2(n)	0			ns
Tdrh2	holding time for CODEC received data from Vmckl(n) to DR(n) ending	150			ns
Tupen1	from Vsclkh1 to Venl	40		SCLK	ns
Tupen2	from Vsclkh1 to Venh	40		SCLK	ns
Tups1	setting time for uP transmitting SDATA from Vupenl to uP SDATA(n) ready (@ where Tupen1+Tups1 must < SCLK)	40		SCLK	ns
Tups2	setting time for uP transmitting SDATA from Vsclkh1(n+1) to uP SDATA(n+1) ready	40		SCLK	ns
Tuph	holding time for uP transmitting SDATA from Vsclkh1(n+1) to uP SDATA(n) ending	40		Tups2	ns
Tcdrd	from Vsclkh1(n+1) to CODEC reading SDATA(n)			20	ns
Tupo2i	from Vupenl to uP changing its SDATA interface to input port	40		FS	ns
Tcdi2o	from Vsclkh1 to CODEC changing its SDATA interface to output port			20	ns
Tcds1	setting time for CODEC transmitting SDATA from Vcdi2o to SDATA(n) ready			20	ns
Tcds2	setting time for CODEC transmitting SDATA from Vsclkh1(n+2) to SDATA(n+1) ready			20	ns
Tcdh	holding time for CODEC transmitting SDATA from SDATA(n) ready to Vsclkh1(n+2)			SCLK	ns
Tcdo2i	from Venh to CODEC changing its SDATA interface to input port			20	ns
Tuprd	from Vsclkh1(n+1) to uP reading SDATA(n)	40		SCLK	ns
Tupi2o	from Vsclkh1 to uP changing its SDATA interface to output port	40		FS	ns
Vmckh1	logic high when CODEC MCLK rising				
Vmckh2	logic high when CODEC MCLK falling				
Vmckl	logic low when CODEC MCLK falling				
Vfsh1	logic high when CODEC FS rising				
Vsclkh1	logic high when SCLK rising				
Vcdi2o	CODEC changes its SDATA interface to output port				
Venh	logic high when uP SDENB rising				
Venl	logic low when uP SDENB falling				

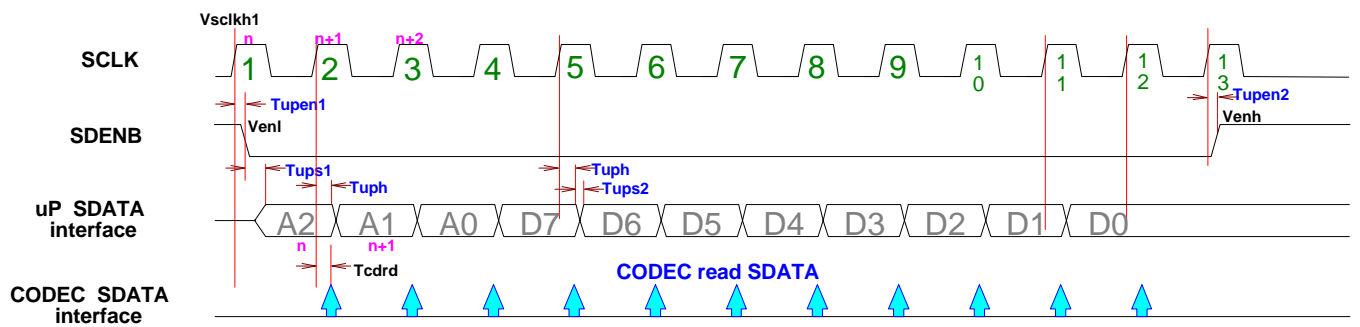
TIMING DIAGRAM

Master Clock, Frame Sync. & Data Timing Diagram

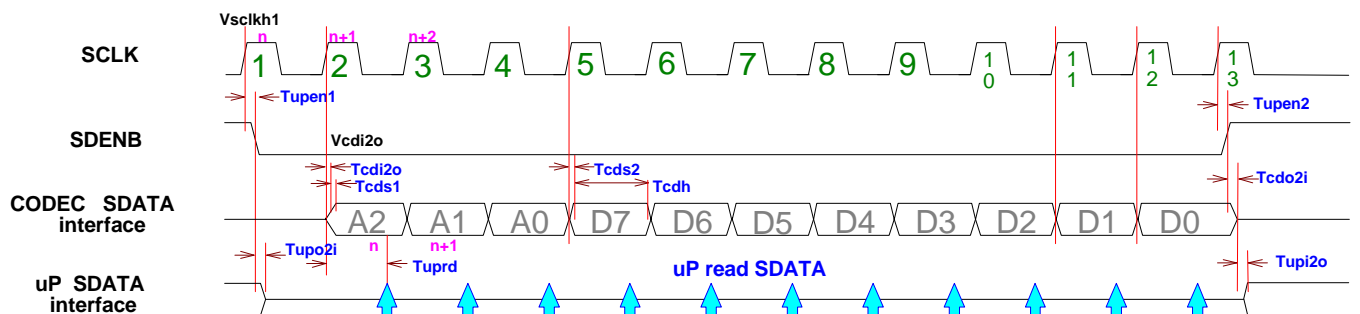


Control Registers R/W Timing Diagram

CODEC READ SDATA

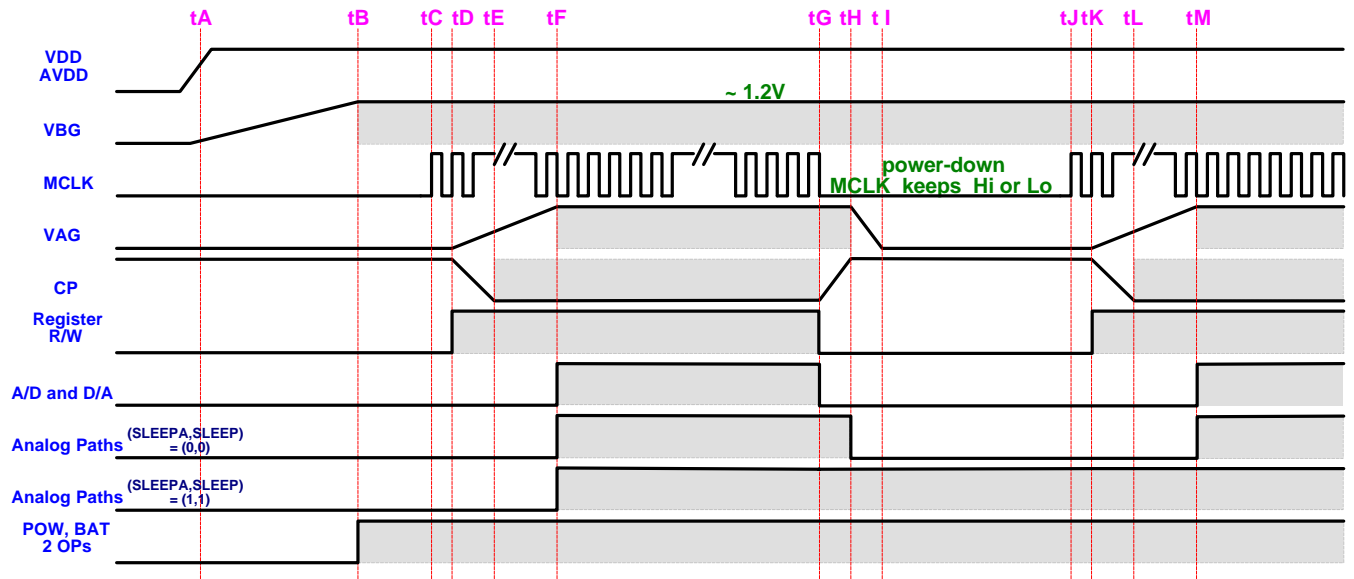


CODEC WRITE SDATA



The Timing Diagram of CODEC Function

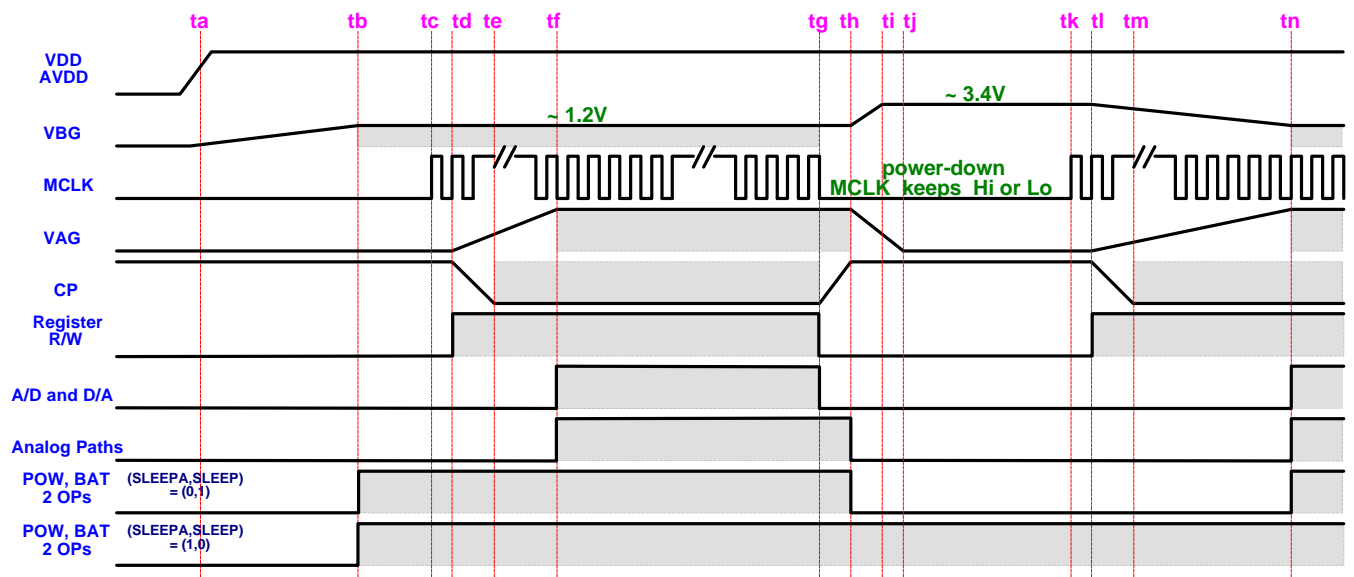
(SLEEP_A, SLEEP) = (0,0) or (1,1)



@ Analog Paths : Analog I/O, Switches, PGA and Attenuator

@ : Stable

(SLEEP_A, SLEEP) = (0,1) or (1,0)



@ Analog Paths : Analog I/O, Switches, PGA and Attenuator

@ : Stable

The Timing Description of CODEC Function

TIMING	DESCRIPTION	MIN	TYP	MAX	UNIT
tA, ta	VDD / AVDD ; \bar{V}_{DD} 0VDC				
tC	MCLK started				
tC ⇒ tG tc ⇒ tg	MCLK keeps				
tG, tg	Power-down started (MCLK keeps High or Low)				
tJ, tl	Power-down ended (MCLK started)				
tF ⇒ tI	MCLK keeps High or Low				
tA ⇒ tB ta ⇒ tb	the charge time of VBG (where VBG bypass cap. = 0.1uF)	140	190	290	ms
tC ⇒ tD tJ ⇒ tK tc ⇒ td tk ⇒ tl	the charge time of internal clock detector circuit			20	us
tD ⇒ tE tK ⇒ tL td ⇒ te tl ⇒ tm	the lock-in time of PLL (C1=100pF, C2=6pF, R1=68KΩ)	50	110	160	us
tD ⇒ tF tK ⇒ tM td ⇒ tf	the charge time of VAG (where VAG bypass cap. = 0.1uF)	1.5	2	2.5	ms
tG ⇒ tH tg ⇒ th	the discharge time of internal clock detector circuit			50	us
tH ⇒ tI th ⇒ tj	the discharge time of VAG (where VAG bypass cap. = 0.1uF)	0.3	0.5	0.7	ms
th ⇒ ti	the delay time of VBG disable (where VBG bypass cap. = 0.1uF)	6	10	15	ms
tl ⇒ tn	the re-charge time of VBG (where VBG bypass cap. = 0.1uF) the re-charge time of VAG (where VAG bypass cap. = 0.1uF)	400	500	700	ms

@ when change **VBG** bypass capacitor (C15) :

- i. from 0.1uF to 1uF : $(tA \Rightarrow tB)' ; \bar{V}_{DD} * (tA \Rightarrow tB)$
- ii. from 0.1uF to 0.01uF : $(tA \Rightarrow tB)' ; \bar{V}_{DD}/10 * (tA \Rightarrow tB)$

A/D Path Characteristics (0dBFS : reference to Fin = 1.02KHz and A/D Input is Full Swing)

PARAMETER	MIN	TYP	MAX	UNITS
Dynamic Range (at -51dBFS)	77			dB
THD+N (at Vin = -6dBFS)	-56			dB
Interchannel Isolation of LIN/MIC/AUX1 (at Vin = 0dBFS)		76		dBFS
Gain Variation (at Vin = -6dBFS)	-0.3		0.3	dBFS
Max. Overload Level	3.0	3.25	3.50	Vpp
<i>Frequency Response (Measure Responce from 60Hz to 4000Hz, see FIG. 3) :</i>				
60Hz	-25		-28	dB
150Hz		-7	-8	dB
200Hz		-3	-4	dB
300 ~ 3200Hz	-0.8		+0.8	dB
3400Hz	-1.60		-1.85	dB
3600Hz		-4.5		dB
3800Hz	-10.3		-10.7	dB
4000Hz		-45		dB
4500Hz and Up	-69.5			dB

D/A Path Characteristics (0dBFS : reference to Fout = 1.02KHz and D/A Output is Full Swing)

PARAMETER	MIN	TYP	MAX	UNITS
Dynamic Range (at -51dBFS)	77			dB
THD+N (at Vin = -6dBFS)	-47			dB
Gain Variation (at Vin = -6dBFS)		± 0.1		dBFS
<i>Out of Band Energy (with 1.02KHz Image) :</i>				
3.8KHz ~ 20KHz	-46			dBFS
Output Level (at AUX2)		3.0		Vpp
<i>Frequency Response (Measure Responce from 60Hz to 3800Hz, see FIG. 4) :</i>				
60Hz ~ 300Hz		-0.1		dB
300Hz ~ 2800Hz	- 0.6		+ 0.1	dB
3000Hz		-1.1		dB
3200Hz		-2.1		dB
3400Hz		-3.7		dB
3600Hz		-6.3		dB
3800Hz		-10		dB

Noise (Test Condition : 1. A/D 1 or 2 Input Signal is 1.02KHz/0dB (Full Swing)
 2. D/A 1 or 2 Output Signal is 1.02KHz/0dB (Full Swing))

PARAMETER	MIN	TYP	MAX	UNITS
<i>Idle-Channel Noise</i>				
<i>(Input Grounded and Measurement Bandwidth from 0 to 4000Hz) :</i>				
A/D Path	-71			dB
D/A Path	-76			dB
<i>VDD Power Supply Rejection</i>				
<i>(A/D & D/A Input Grounded and VDD = 5.0V_{DC}+100mV_{rms}) :</i>				
<i>A/D Channel : (Test Condition 1)</i>				
Fin = 0 ~ 4KHz		-54		dB
Fin = 4 ~ 25KHz		-80		dB
Fin = 25 ~ 50KHz		-82		dB
<i>D/A Channel : (Test Condition 2)</i>				
Fin = 0 ~ 4KHz		-65		dB
Fin = 4 ~ 25KHz		-80		dB
Fin = 25 ~ 50KHz		-95		dB
<i>AVDD Power Supply Rejection</i>				
<i>(A/D & D/A Input Grounded and AVDD = 5.0V_{DC}+100mV_{rms}) :</i>				
<i>A/D Channel : (Test Condition 1)</i>				
Fin = 0 ~ 4KHz		-72		dB
Fin = 4 ~ 25KHz		-85		dB
Fin = 25 ~ 50KHz		-87		dB
<i>D/A Channel : (Test Condition 2)</i>				
Fin = 0 ~ 4KHz		-41		dB
Fin = 4 ~ 25KHz		-53		dB
Fin = 25 ~ 50KHz		-60		dB
<i>Crosstalk :</i>				
A/D 1 to A/D 2 (Test Condition 1)	-77			dB
A/D 1 to D/A 1 (Test Condition 1)		-92		dB
A/D 1 to D/A 2 (Test Condition 1)		-79		dB
A/D 2 to A/D 1 (Test Condition 1)	-86			dB
A/D 2 to D/A 1 (Test Condition 1)		-86		dB
A/D 2 to D/A 2 (Test Condition 1)		-86		dB
D/A 1 to A/D 1 (Test Condition 2)		-100		dB
D/A 1 to A/D 2 (Test Condition 2)		-94		dB
D/A 1 to D/A 2 (Test Condition 2)		-86		dB
D/A 2 to A/D 1 (Test Condition 2)		-99		dB
D/A 2 to A/D 2 (Test Condition 2)		-94		dB
D/A 2 to D/A 1 (Test Condition 2)		-86		dB

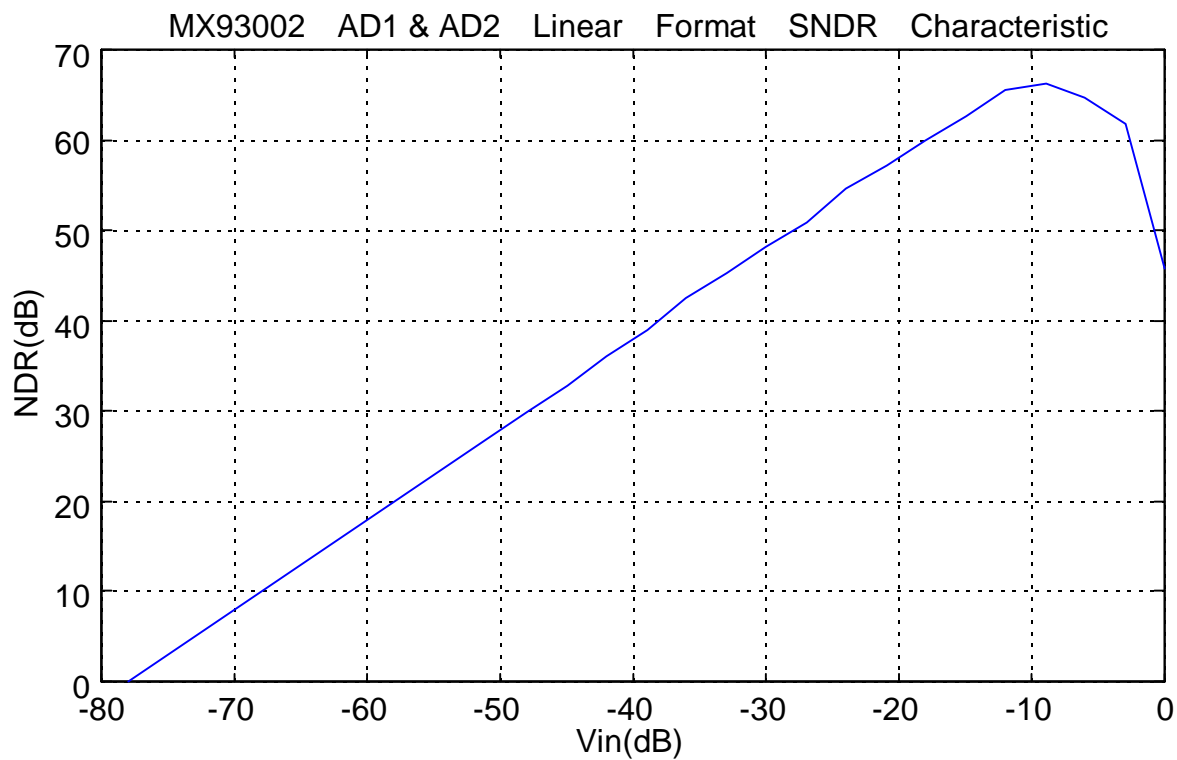
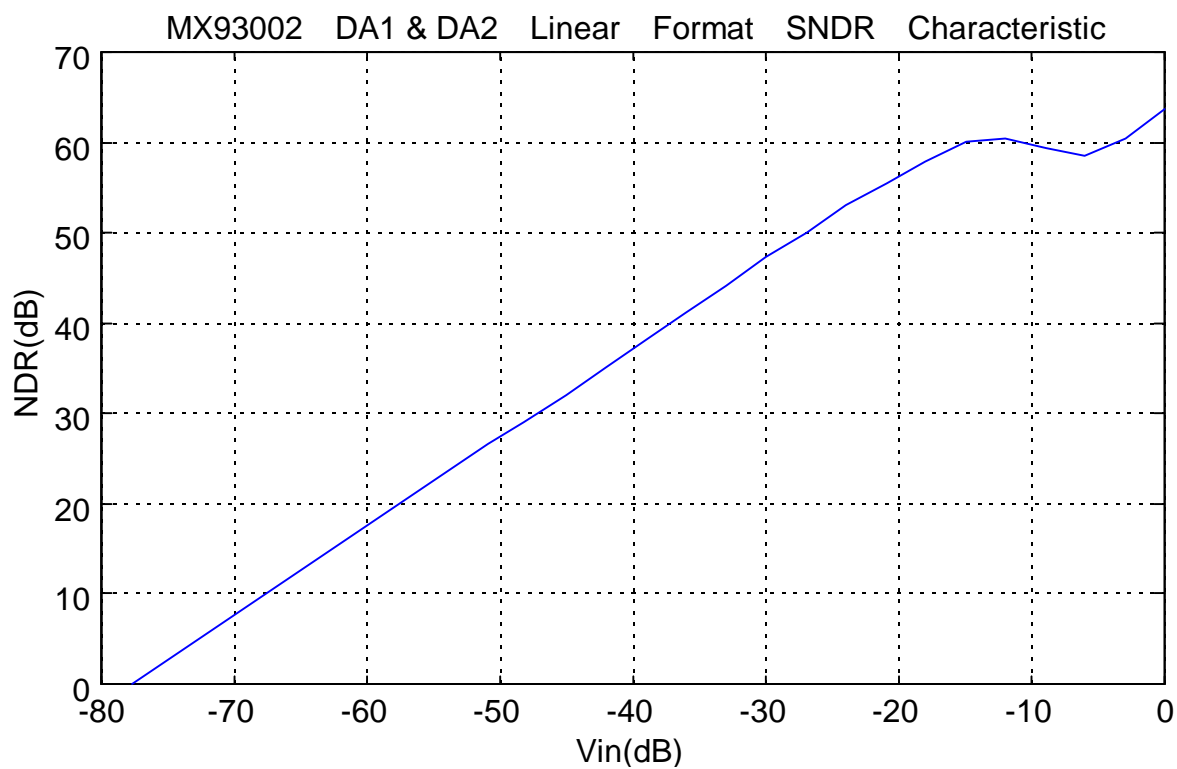
FIG. 1**FIG. 2**

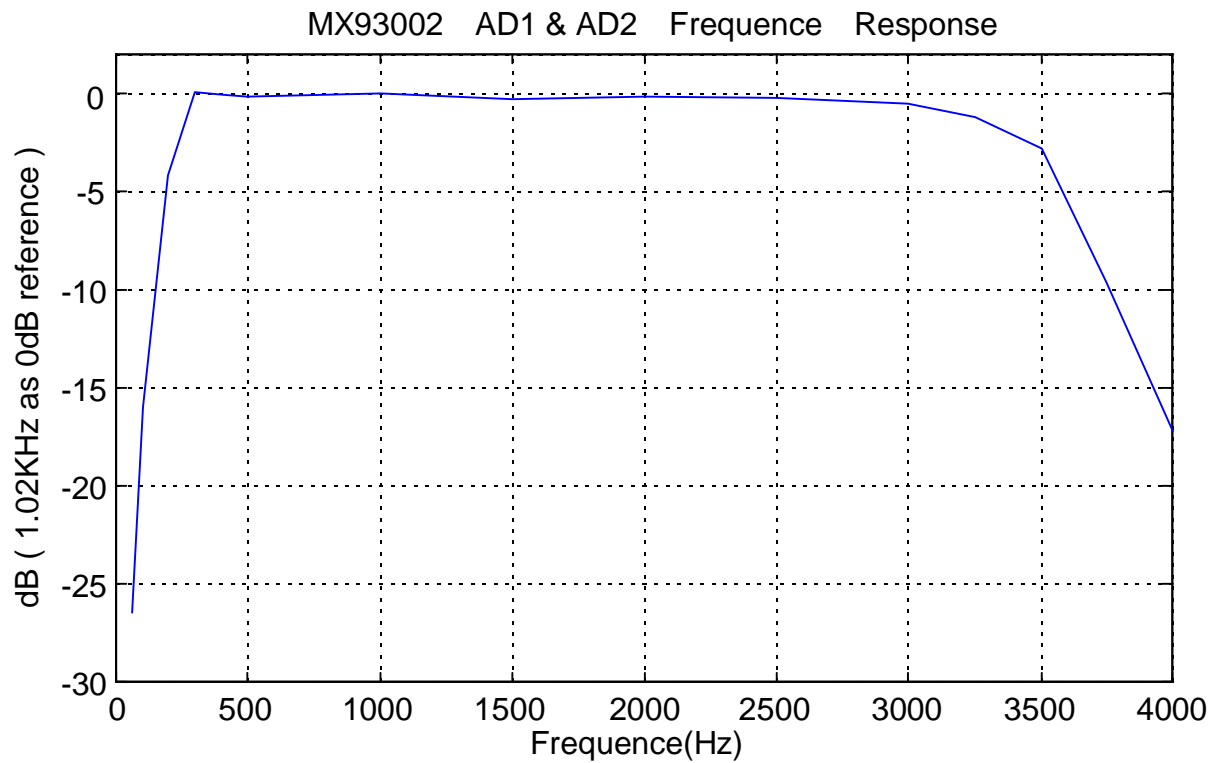
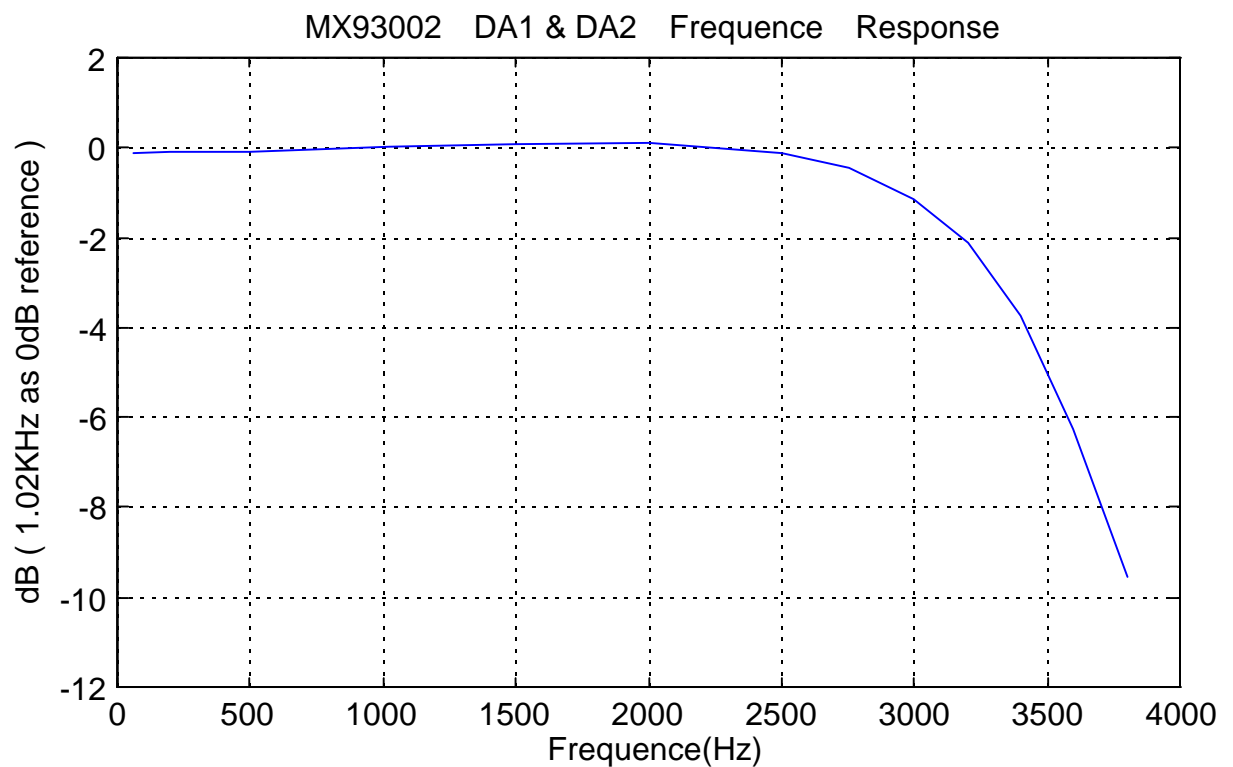
FIG. 3**FIG. 4**

FIG. 5

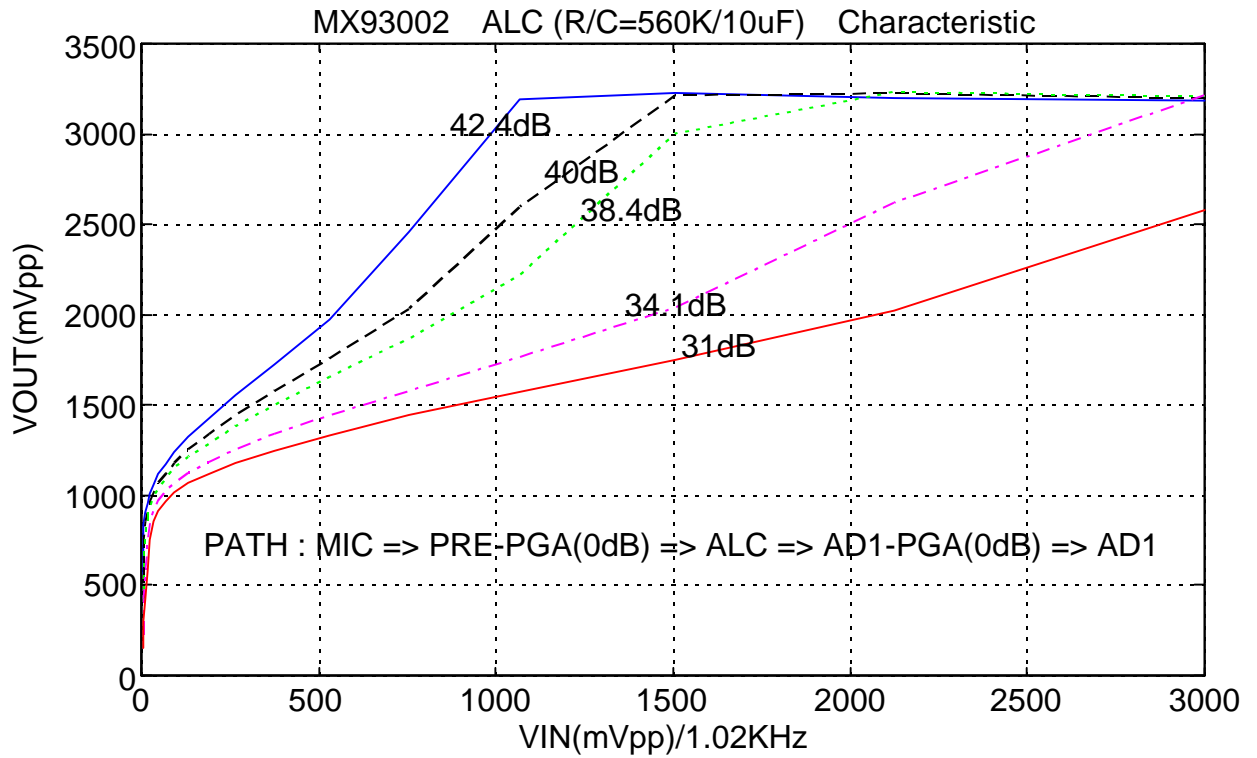


FIG. 6

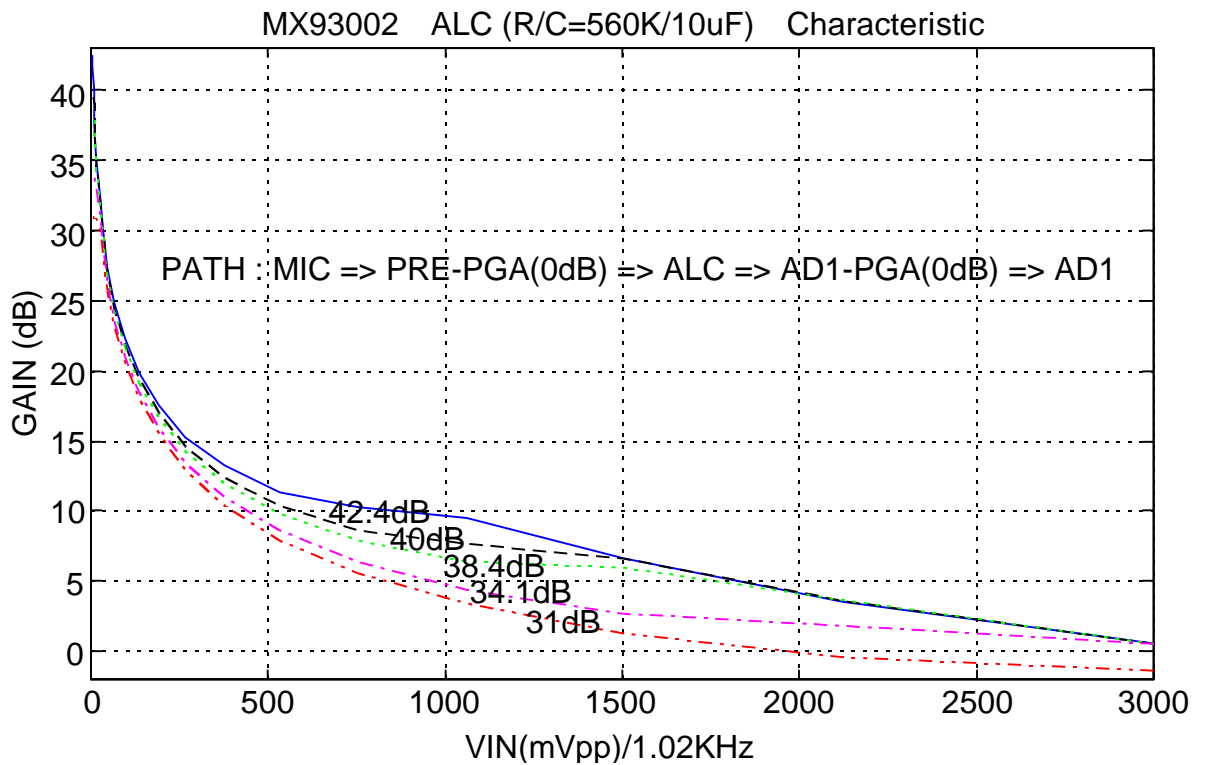


FIG. 7

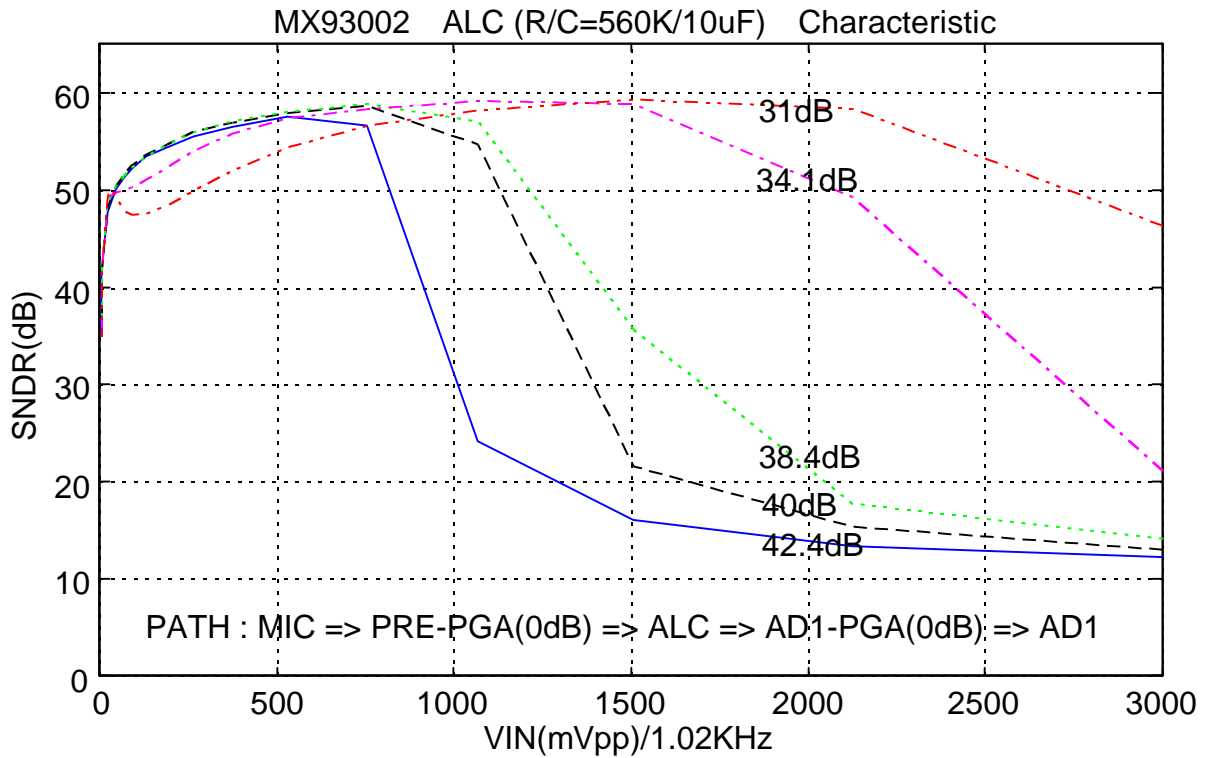


FIG. 8

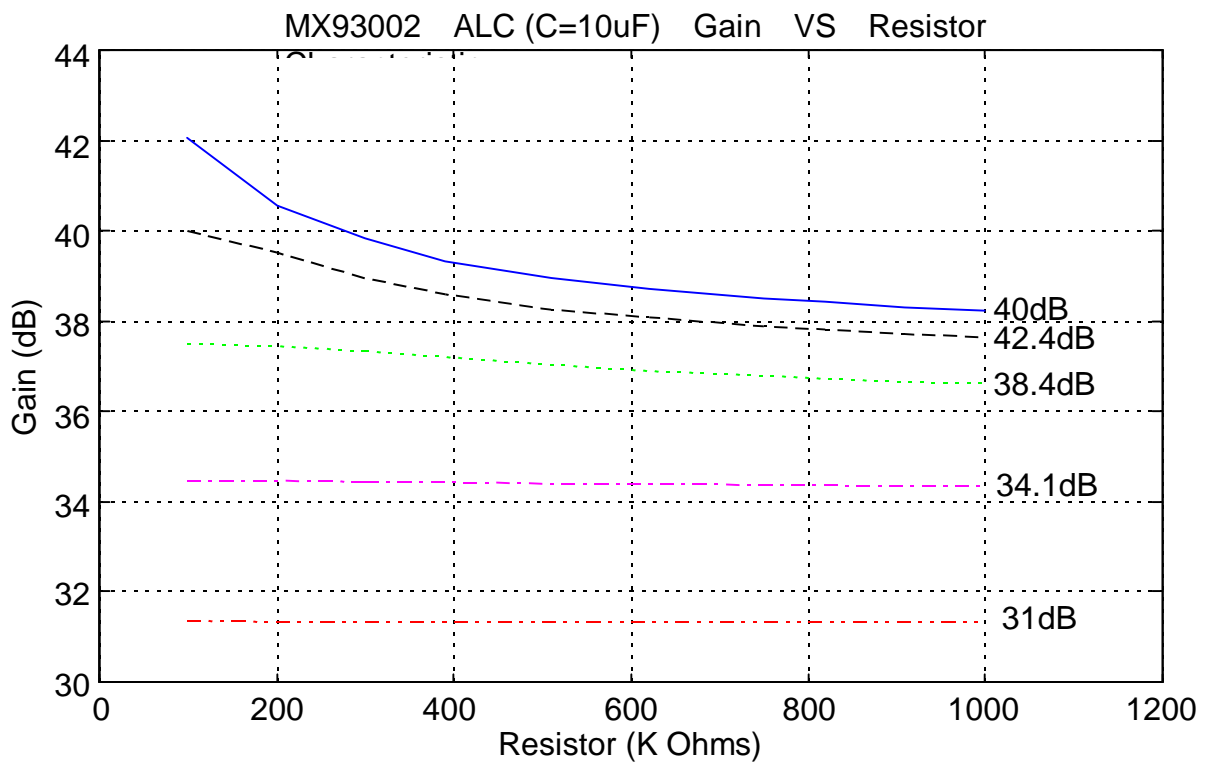


FIG. 9

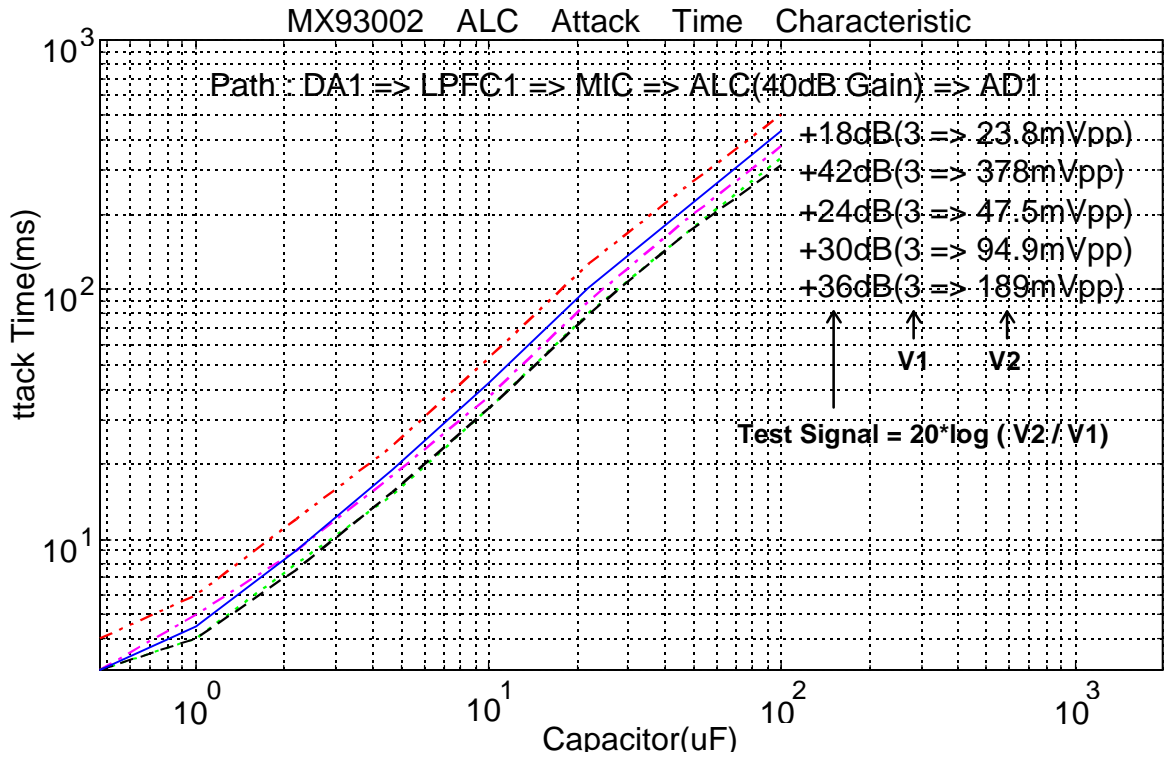


FIG. 10

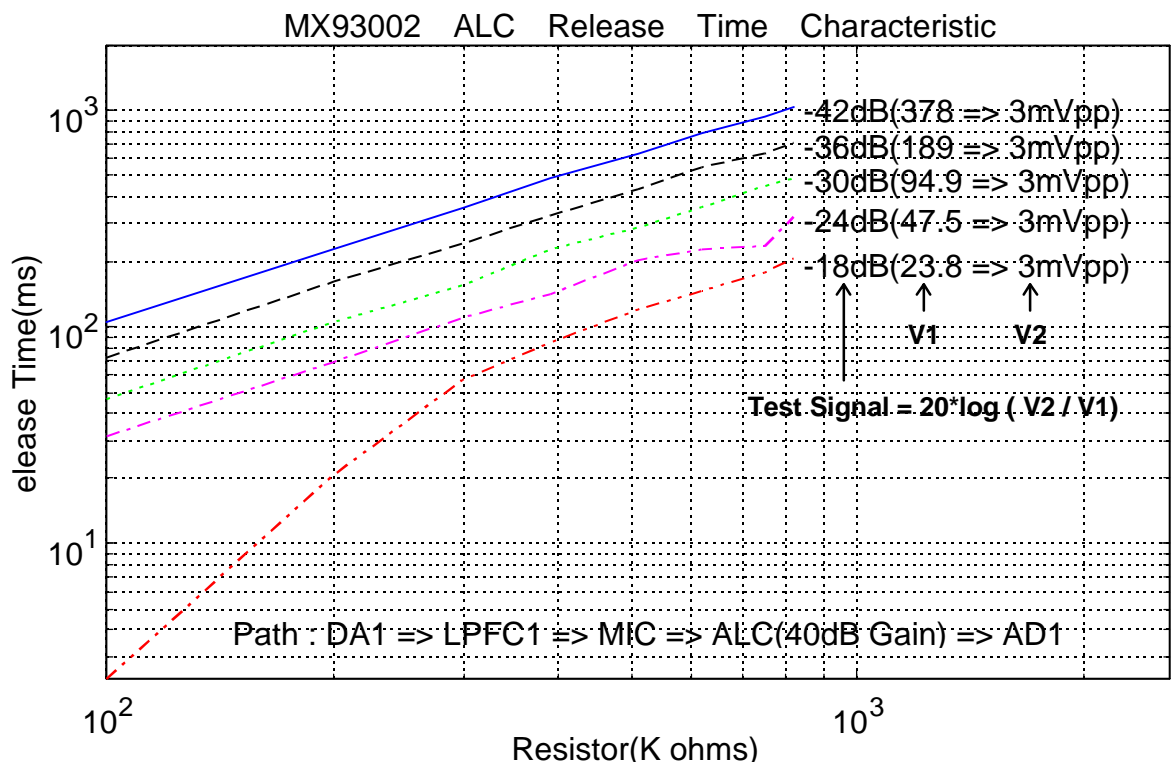


FIG. 11

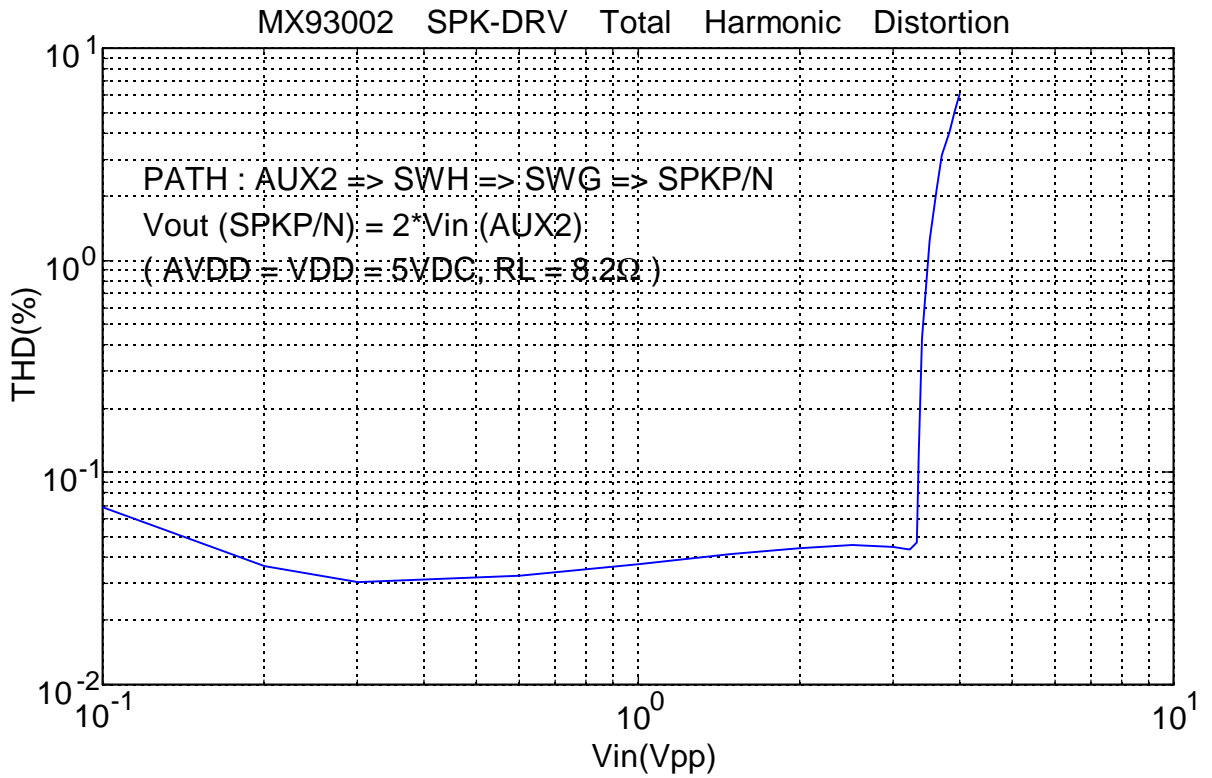
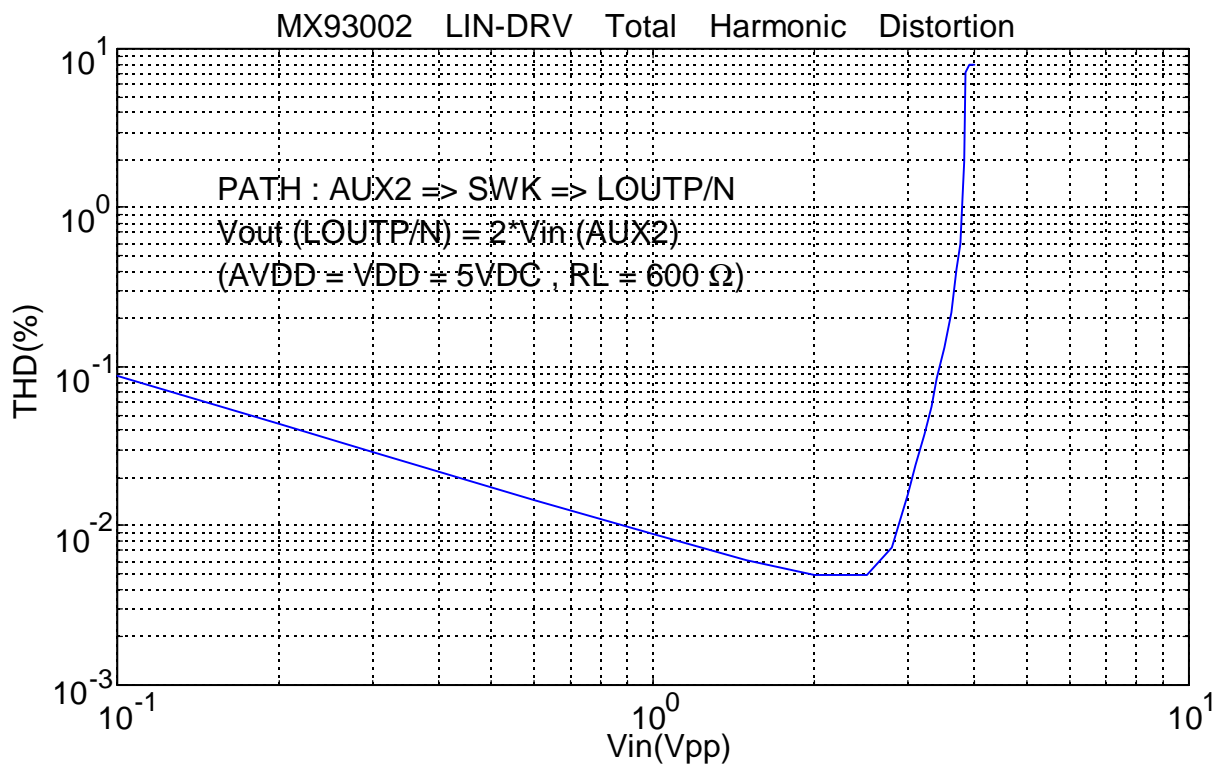


FIG. 12



NOTE 1 : *PRE-PGA* gain step; from -15dB to 22dB

1111	1110	1101	1100	1011	1010	1001	1000
21dB	18dB	15dB	12dB	9dB	7.5dB	6dB	4.5dB
0111	0110	0101	0100	0011	0010	0001	0000
3.0dB	1.5dB	0dB	-3dB	-6dB	-9dB	-12dB	-15dB

NOTE 2 : *AD1-PGA* gain step; from 0dB to 18dB

00	01	10	11
0dB	4dB	8dB	18dB

NOTE 3 : *AD2-PGA* gain step; from -6dB to 39dB; 3dB/step

1111	1110	1101	1100	1011	1010	1001	1000
39dB	36dB	33dB	30dB	27dB	24dB	21dB	18dB
0111	0110	0101	0100	0011	0010	0001	0000
15dB	12dB	9dB	6dB	3dB	0dB	-3dB	-6dB

NOTE 4 : *LIN-DRV* gain step; from 0dB to 22.5dB; 1.5dB/step

1111	1110	1101	1100	1011	1010	1001	1000
22.5dB	21dB	19.5dB	18dB	16.5dB	15dB	13.5dB	12dB
0111	0110	0101	0100	0011	0010	0001	0000
10.5dB	9dB	7.5dB	6dB	4.5dB	3dB	1.5dB	0dB

NOTE 5 : *SPK-DRV* gain step; from 0dB to 6dB; 2dB/step

00	01	10	11
0dB	2dB	4dB	6dB

NOTE 6 : *ATT1* (Attenuator 1) gain step; from 0dB to -45dB

1111	1110	1101	1100	1011	1010	1001	1000
-45 dB	-39 dB	-33 dB	-27 dB	-24 dB	-21 dB	-18 dB	-15 dB
0111	0110	0101	0100	0011	0010	0001	0000
-12 dB	-9 dB	-7.5 dB	-6 dB	-4.5 dB	-3 dB	-1.5 dB	0 dB

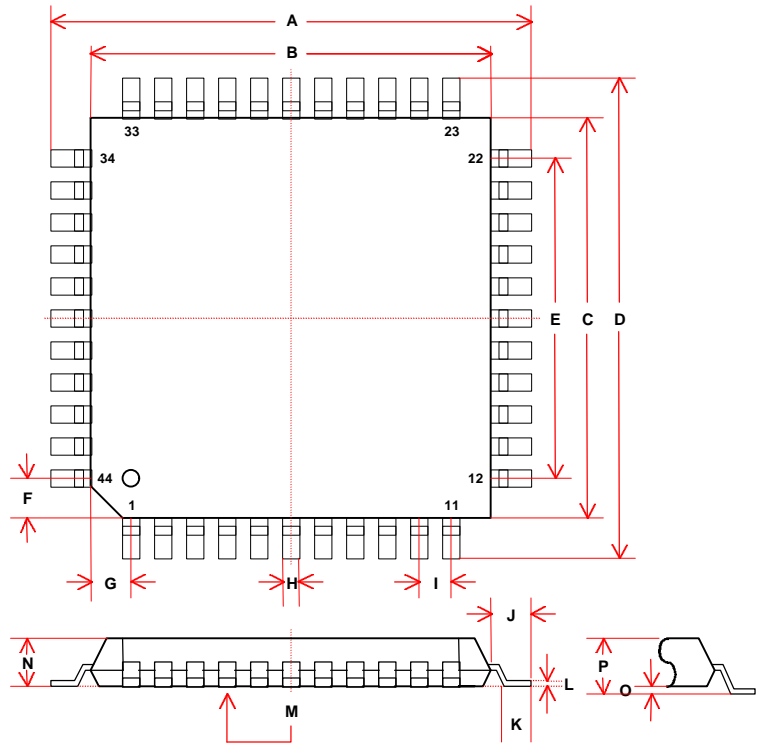
- NOTE 7 :**
1. **SWE**, **SWJ** and **SWL** can not be turned on at the same time;
 2. **SWJ** and **SWN** can not be turned on at the same time;
 3. If **SWE**, **SWJ** or **SWL** is turned on, then **SWK** will be taken as an output port;
 4. If **SWK** is taken as an input port, **SWK**, **SWE**, **SWJ** and **SWL** cannot be turned on at the same time;

Physical Dimensions

44-PIN PQFP

Item	Millimeters	Inches
A	13.20 ± 0.20	0.5196 ± 0.008
B	10.00 ± 0.05	0.3937 ± 0.002
C	10.00 ± 0.05	0.3937 ± 0.002
D	13.20 ± 0.20	0.5196 ± 0.008
E	8.00 [REF]	0.3149
F	1.00 [REF]	0.0393 [REF]
G	1.00 [REF]	0.0393 [REF]
H	.30 [TYP.]	0.0118 [TYP.]
I	.80 [TYP.]	0.0314 [TYP.]
J	1.6 ± .1 [TYP.]	0.06629 ± 0.004
K	0.80 ± .1 [TYP.]	0.0314 ± 0.004
L	0.15 [TYP.]	0.006 [TYP.]
M	0.120 MAX.	0.0040 MAX.
N	2.55 MAX.	0.100 MAX.
O	0.25 ± 0.1	0.0100 ± 0.004
P	2.55 MAX.	0.100 MAX.

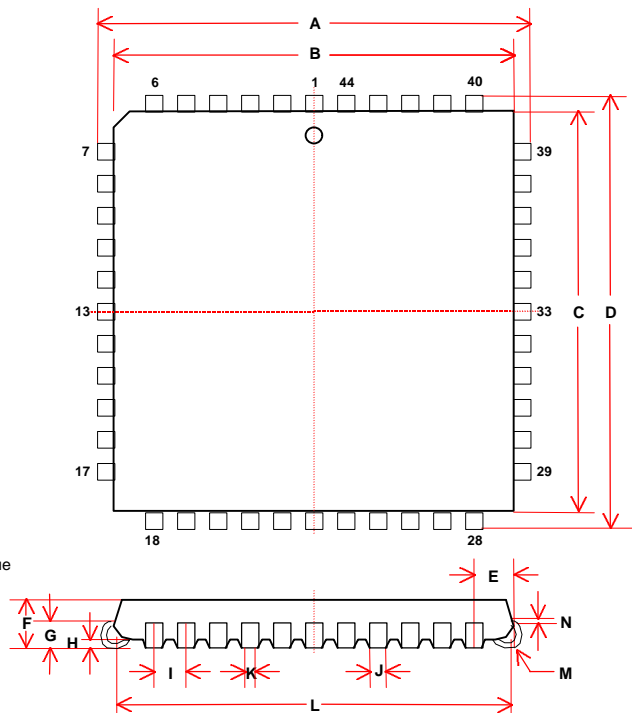
NOTE : Each lead centerline is located within .25mm [.01 inch] of its true position [TP] at a maximum material condition .

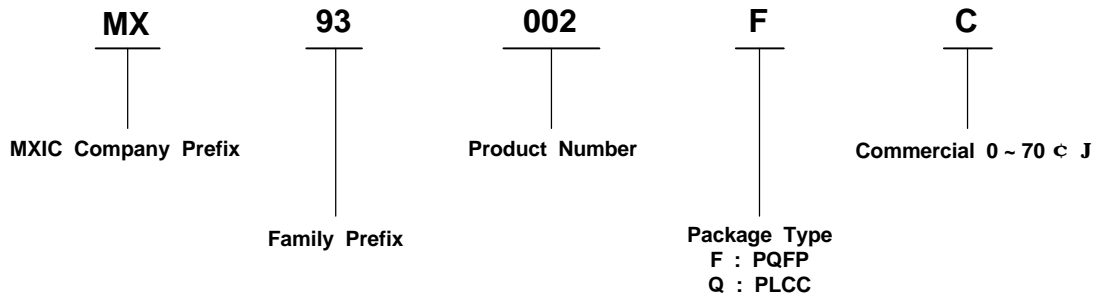


44-PIN PLCC

Item	Millimeters	Inches
A	17.53 ± 0.12	0.690 ± 0.005
B	16.59 ± 0.12	0.653 ± 0.005
C	16.59 ± 0.12	0.653 ± 0.005
D	17.53 ± 0.12	0.690 ± 0.005
E	1.95	0.077
F	4.70 MAX.	0.185 MAX.
G	2.25 ± 0.25	0.100 ± 0.010
H	0.51 MIN.	0.020 MIN.
I	1.27 [TYP.]	0.050 [TYP.]
J	0.71 ± 0.1	0.028 ± 0.004
K	0.46 ± 0.10	0.018 ± 0.004
L	15.50 ± 0.51	0.610 ± 0.020
M	0.63 R	0.025 R
N	0.25 [TYP.]	0.010 [TYP.]

NOTE : Each lead centerline is located within .25mm [.01 inch] of its true position [TP] at a maximum material condition .



Ordering Information

MACRONIX INTERNATIONAL Co., LTD.

No. 3 Creation Road III, Science-Based Industrial Park, Hsin Chu, Taiwan, R.O.C.

TEL : (03)578-8888

FAX : (03)578-8887

Taipei Office :

12F, No. 4, Sec.32 3, Min-Chuan E. Rd., Taipei, Taiwan, R.O.C.

TEL : (02)2509-3300

FAX : (02)2509-2200

MACRONIX INC.

1348 Ridder Park Drive, San Jose, CA95131 U.S.A.

TEL : (408)453-8088

FAX : (408)453-8488

MACRONIX JAPAN

NKF Bld. 8F, 1-2 Higashida-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210, Japan

TEL : (044)246-9100

FAX : (044)246-9105

ECN (Engineering Change Notice)

February 17, 1998 Ver 2.1

1. Change the diagram of the MX93002 about **SPK-DRV** (page 3)
 Ver 2.0 : **ATT1/ATT2** ⇒ **SPK-DRV** (with 0, 3, 6, 9dB gain)
 Ver 2.1 : **D/A-PGA** (with 0, 2, 4, 6dB gain) ⇒ **ATT1/ATT2** ⇒ **SPK-DRV**
2. Change NOTE 5 and “page-9 line 13” **DA-PGA** gain from 0, 3, 6, 9dB to 0, 2, 4, 6dB
3. Change the figure of **AD1/AD2** and **DA1/DA2** frequency response (**FIG. 3/FIG. 4**)
4. Change the font size of **FIG.1** to **FIG. 12**
5. Change page-22 line 10 form “**FIG. 2**” to “**FIG. 3**” and page-22 line 35 form “**FIG. 3**” to “**FIG. 4**”
6. Change the specification of DA path characteristic (page 23)

Ver 2.0

PARAMETER	MIN	TYP	MAX	UNITS
60Hz ~ 300Hz		±0.2		dB
300Hz ~ 3400Hz		0.8		dB
3400Hz ~ 3600Hz	-0.26		0.8	dB
3600Hz ~ 3800Hz		-12.4		dB

Ver 2.1

PARAMETER	MIN	TYP	MAX	UNITS
60Hz ~ 300Hz		-0.1		dB
300Hz ~ 2800Hz	- 0.6		+ 0.1	dB
3000Hz		-1.1		dB
3200Hz		-2.1		dB
3400Hz		-3.7		dB
3600Hz		-6.3		dB
3800Hz		-10		dB

March 17, 1998 Ver 2.2 ----- Modify the description of “The Timing Diagram of CODEC Function”

1. Change page-21 about more detailed description of register R/W.
2. Change page-20 “Master Clock, Frame Sync. & Data Timing Diagram”

June 8, 1998 Ver 2.3 ----- Modify the bypass and timing description of “CP” pin and FUNCTION DESCRIPTION

1. Change page-6 BASIC COMPONENTS REQUIRED about the value of CP
2. Change page-21 “The Timing Description of CODEC Function” of VAG; from “1.8ms” to “0.5ms, 1.8ms and 2.2ms” and add “@ the lock-in time of PLL : MAX ⇒ 5.5ms; MIN ⇒ 1.5ms” to the end of page
3. Add “PIN DESCRIPTION” about CP in page-4, see the end of page-21 about the lock-in time of PLL
4. In Page 7, the power-down mode description is modified as follows,
 “. The MX93002 will recover from power-down mode when MCLK keeps a consistent clock (1.536 or 2.048MHz)”

June 25, 1998 Ver 2.4

1. Change the value of CP in Page-6.
2. Correct typing error from C14 to C17 in Page-3 (Block Diagram) and Page-6 (Basic Component Required).
3. Correct typing error from “2 address” to “3 addresses” in Page-10.
4. Correct readings of item-L, O, P of 44-QFP package dimension description in Page-31.
5. More detail descriptions about **The Timing Diagram/Description of CODEC Function** in Page-21 and Page-22.

6. More detail description for Fig-9 and Fig-10 in Page-29.

September 16, 1998 Ver 2.5

1. Revise Power Consumption Specification in Page-11;
2. Revise Power Supply Specification in Page-15;
3. Revise Analog Output Ports Specification in Page-16;
4. Revise Gain Variation and Attenuator Specifications in Page-17;
5. Change the description: “..If switches **SWF** and **SWH** are opened, then attenuator will be muted to -70dB automatically; ..” to “..If switches **SWF** and **SWH** are opened, then attenuator will be muted to -57dB automatically; ..” in Page-9;
6. Change the description: “ ..(SPK-MUTE) D(4) = 1 : force **SPK-DRV** mute to -70dB, D(4) = 0 : force **SPK-DRV** un-mute ..” to “..(SPK-MUTE) D(4) = 1 : force **SPK-DRV** mute to -57dB, D(4) = 0 : force **SPK-DRV** un-mute ..” in Page-14;
7. Revise A/D Path Characteristics in Page-23;
8. Revise D/A Path Characteristics in Page-23;
9. Revise Noise Characteristics in Page-24;