

16-Bit Stereo Audio DAC & Headphone Driver

Single Supply Voltage and Low Voltage

Low Power Consumption 8.9mW

Mute And Power Down Function

FEATURES

- Operation range: 2.5V~6.5V
- Excellent Power Supply Rejection Ratio(PSRR)
- Reduced pop-noise circuit
- Low power consumption
8.9mW at $V_{DD}=3.3V$
- Mute function
- Power down function
- Output voltage adjusted by the external resistors
- Component less
- No zero crossing distortion
- Fast setting time permits 2*, 4*, and 8* oversampling (serial input) or double speed operation at 4* oversampling
- Compatible with most of the Japanese input formats; time multiplexed, two's complement, TTL input level. The minimum HIGH voltage of TTL inputs(WS, DATA and BCK) can be 1.8V for some special application, but the operation voltage should not exceed 4.5V.
- Housed in 16 pin SSOP, QFN package

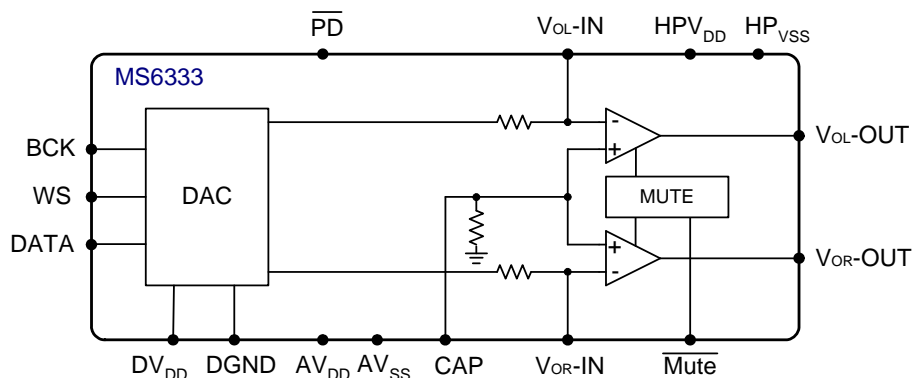
APPLICATIONS

- Multimedia system, MP3, PDA, Portable Digital Audio.

DESCRIPTION

The MS6333 is an integrated 16-bits voltage-output Digital-to-Analog Converter (DAC) and class AB stereo headphone driver. The MS6333 is with the excellent Power Supply Rejection Ratio(PSRR). It is fabricated in a CMOS process and features extremely low power dissipation, small package size and easy application. The accuracy of the matched coarse current sources, combined with the unique symmetrical decoding method, preclude zero-crossing distortion and ensures high quality audio reproduction. These unique features, combined with its exceptional performance, make the MS6333 ideally suited for use in digital audio equipment.

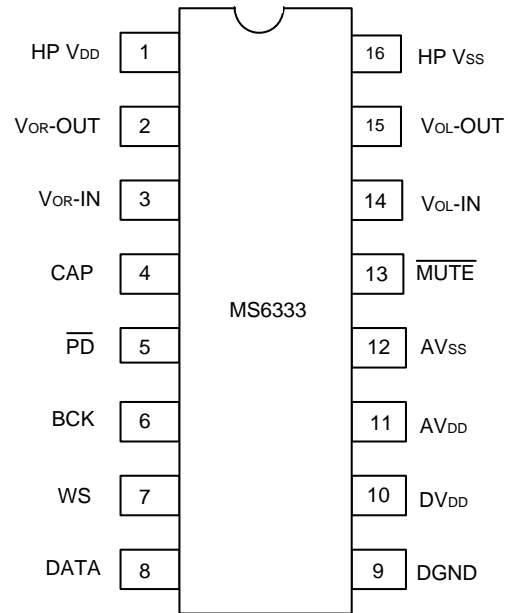
BLOCK DIAGRAM



PIN CONFIGURATION

SSOP16

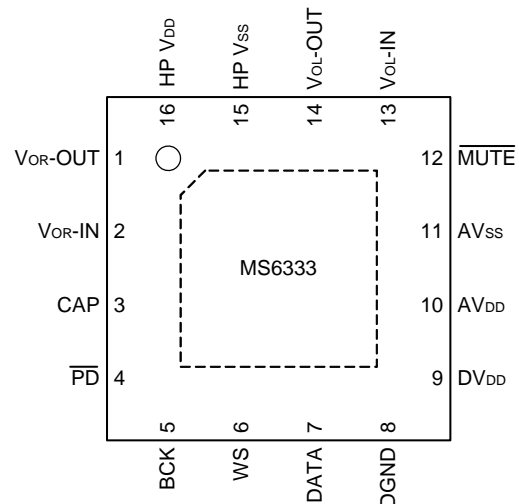
Symbol	Pin	Description
HP V _{DD}	1	Headphone supply voltage
V _{OR} -OUT	2	Right channel output
V _{OR} -IN	3	Right channel input (-)
CAP	4	Capacitor connected
/PD	5	Power down
BCK	6	Bit clock input
WS	7	Word select input
DATA	8	Data input
DGND	9	Digital ground
DV _{DD}	10	Digital supply voltage
AV _{DD}	11	Analog supply voltage
AV _{SS}	12	Analog ground
/MUTE	13	Mute function
V _{OL} -IN	14	Left channel input (-)
V _{OL} -OUT	15	Left channel output
HP V _{SS}	16	Headphone ground



NOTE: /PD=0 power down; /PD=1 active
 /Mute=0 mute on; /Mute=1 mute off

QFN16

Symbol	Pin	Description
V _{OR} -OUT	1	Right channel output
V _{OR} -IN	2	Right channel input (-)
CAP	3	Capacitor connected
/PD	4	Power down
BCK	5	Bit clock input
WS	6	Word select input
DATA	7	Data input
DGND	8	Digital ground
DV _{DD}	9	Digital supply voltage
AV _{DD}	10	Analog supply voltage
AV _{SS}	11	Analog ground
/MUTE	12	Mute function
V _{OL} -IN	13	Left channel input (-)
V _{OL} -OUT	14	Left channel output
HP V _{SS}	15	Headphone ground
HP V _{DD}	16	Headphone supply voltage



NOTE: /PD=0 power down; /PD=1 active
 /Mute=0 mute on; /Mute=1 mute off

ORDERING INFORMATION

Package	Part number	Packaging Marking	Transport Media
16-Pin SSOP	MS6333TR	MS6333	2.5k Units Tape and Reel
16-Pin SSOP	MS6333U	MS6333	100 Units Tube
16-Pin SSOP (lead free)	MS6333GTR	MS6333G	2.5k Units Tape and Reel
16-Pin SSOP (lead free)	MS6333GU	MS6333G	100 Units Tube
16-Pin QFN (lead free)	MS6333QTR	6333	5k Units Tape and Reel
16-Pin QFN (lead free)	MS6333Q	6333	490 Units Tray

RoHS Compliance

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
V _{DD}	Positive Supply Voltage	6.5	V
V _{ESD}	Electrostatic Handling	-3000 to 3000	V
T _{STG}	Storage Temperature Range	-65 to 150	°C
T _A	Operating Ambient Temperature Range	-40 to 85	°C
T _J	Maximum Junction Temperature	150	°C
T _S	Soldering Temperature, 10 seconds	260	°C
R _{THJA}	Thermal Resistance from Junction to Ambient in Free Air		°C/W
	SSOP16	210	
	QFN16	120	

OPERATING RATINGS

Symbol	Parameter	Min	Typ	Max	Unit
V _{DD}	Supply Voltage	2.5	-	6.5	V

5V ELECTRICAL CHARACTERISTICS

($T_a=25^{\circ}\text{C}$, $V_{DD}=5\text{V}$, $V_{SS}=0\text{V}$, $f=1\text{kHz}$, $R_L=32\Omega$; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC Characteristics						
V_{CAP}	Voltage at CAP		2.45	2.5	2.55	V
V_{DC}	Output DC level		2.45	2.5	2.55	V
V_{FS}	Full scale output voltage	$V_{FS}=0.023663 * R_F * V_{DD}$	$V_{FS}-10\%$	V_{FS}	$V_{FS}+10\%$	V
I_Q	Quiescent current	Mute on, code 0000H	-	3.2	4.5	mA
		Mute off, code 0000H	-	5.9	7	mA
I_{PD}	Power down current	No digital input signal	-	17	25	μA
V_{TM}	Mute control voltage	Mute on	0	-	1.25	V
		Mute off	3.1	-	V_{DD}	V
PSRR	Power supply rejection ratio	CAP=2.2 μF (100Hz)	57	62		dB
		CAP=10 μF (100Hz)	68	73		dB
CS	Channel separation		78	85	-	dB
ATT	Mute attenuation		110	120	-	dB
AC Characteristics						
Res	Resolution		-	-	16	bits
THD+N	Total harmonic distortion plus noise	$R_F=22\text{k}$	-	-65	-60	dB
			-	0.056	0.1	%
S/N	Signal-to-noise ratio		86	92	-	dB
Po	Maximum output power	(THD+N)/S < 0.1%, 2 ch	130	140	-	mW
Vo	Maximum output voltage swing	(THD+N)/S < 0.1%	4.1	4.2	-	Vpp

3.3V ELECTRICAL CHARACTERISTICS

($T_a=25^{\circ}\text{C}$, $V_{DD}=3.3\text{V}$, $V_{SS}=0\text{V}$, $f=1\text{kHz}$, $R_L=32\Omega$; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC Characteristics						
V_{CAP}	Voltage at CAP		1.60	1.65	1.70	V
V_{DC}	Output DC level		1.60	1.65	1.70	V
V_{FS}	Full scale output voltage	$V_{FS}=0.023663 * R_F * V_{DD}$	$V_{FS}-10\%$	V_{FS}	$V_{FS}+10\%$	V
I_Q	Quiescent current	Mute on, code 0000H	-	2.7	4	mA
		Mute off, code 0000H	-	4.8	6	mA
I_{PD}	Power down current	No digital input signal	-	12	20	μA
V_{TM}	Mute control voltage	Mute on	0	-	1	V
		Mute off	2.7	-	V_{DD}	V
PSRR	Power supply rejection ratio	CAP=2.2 μF (100Hz)	58	63		dB
		CAP=10 μF (100Hz)	67	72		dB
CS	Channel separation		76	82	-	dB
ATT	Mute attenuation		100	110	-	dB
AC Characteristics						
Res	Resolution		-	-	16	bits
THD+N	Total harmonic distortion plus noise	$R_F=22\text{k}$	-	-65	-60	dB
			-	0.056	0.1	%
S/N	Signal-to-noise ratio		86	92	-	dB
Po	Maximum output power	(THD+N)/S < 0.1%, 2 ch	49	52	-	mW
Vo	Maximum output voltage swing	(THD+N)/S < 0.1%	2.5	2.6	-	Vpp

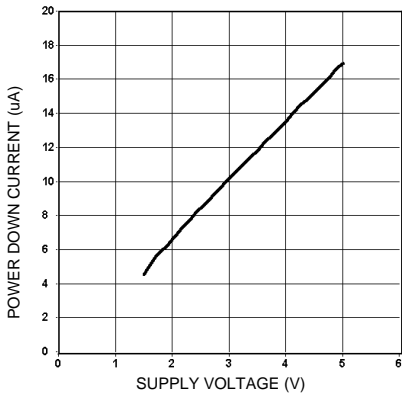
2.7V ELECTRICAL CHARACTERISTICS

($T_a=25^{\circ}\text{C}$, $V_{DD}=2.7\text{V}$, $V_{SS}=0\text{V}$, $f=1\text{kHz}$, $R_L=32\Omega$; unless otherwise specified)

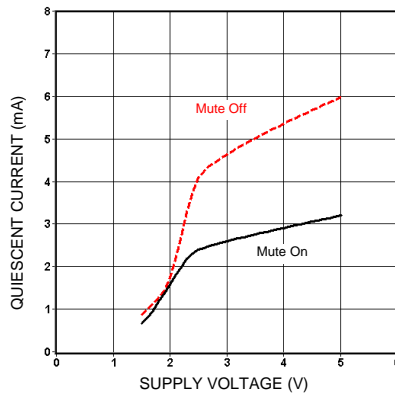
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC Characteristics						
V_{CAP}	Voltage at CAP		1.30	1.35	1.40	V
V_{DC}	Output DC level		1.30	1.35	1.40	V
V_{FS}	Full scale output voltage	$V_{FS}=0.023663 * R_F * V_{DD}$	$V_{FS}-10\%$	V_{FS}	$V_{FS}+10\%$	V
I_Q	Quiescent current	Mute on, code 0000H	-	2.5	3.7	mA
		Mute off, code 0000H	-	4.4	5.6	mA
I_{PD}	Power down current	No digital input signal	-	9	17	μA
V_{TM}	Mute control voltage	Mute on	0	-	0.9	V
		Mute off	2.5	-	V_{DD}	V
PSRR	Power supply rejection ratio	CAP=2.2 μF (100Hz)	58	63	-	dB
		CAP=10 μF (100Hz)	67	72	-	dB
CS	Channel separation		76	82	-	dB
ATT	Mute attenuation		100	110	-	dB
AC Characteristics						
Res	Resolution		-	-	16	bits
THD+N	Total harmonic distortion plus noise	$R_F=22\text{k}$	-	-64	-60	DB
			-	0.063	0.1	%
S/N	Signal-to-noise ratio		84	90	-	dB
Po	Maximum output power	(THD+N)/S < 0.1%, 2 ch	28	33	-	mW
Vo	Maximum output voltage swing	(THD+N)/S < 0.1%	1.9	2	-	Vpp

TYPICAL PERFORMANCE CHARACTERISTICS

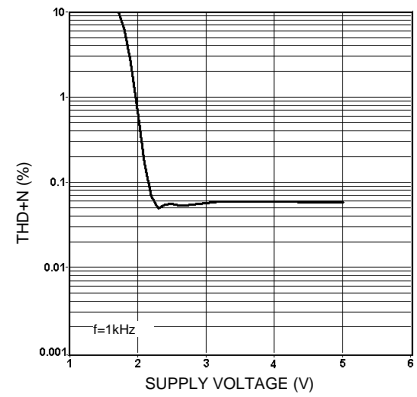
($T_a=25^\circ\text{C}$, $R_L=32\Omega$, $R_F=24\text{k}$, sampling rate=4fs; unless otherwise specified)



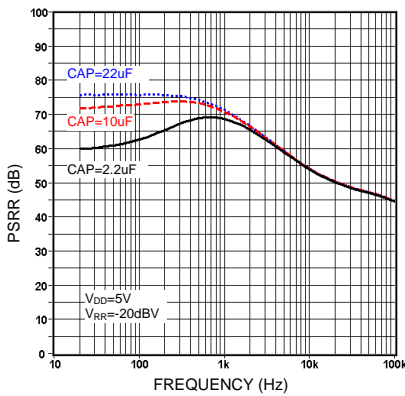
Power down current vs. supply voltage



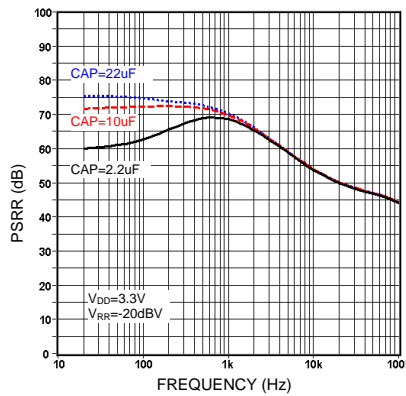
Quiescent current vs. supply voltage



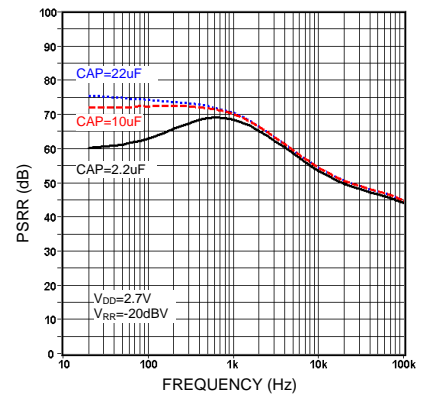
THD+N vs. supply voltage



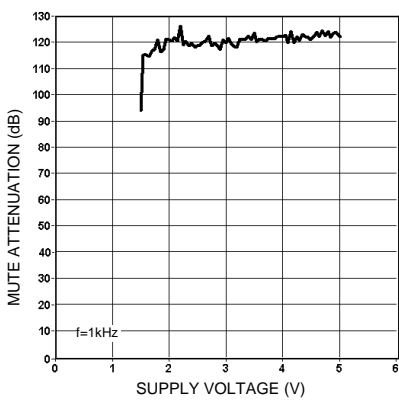
PSRR vs. frequency



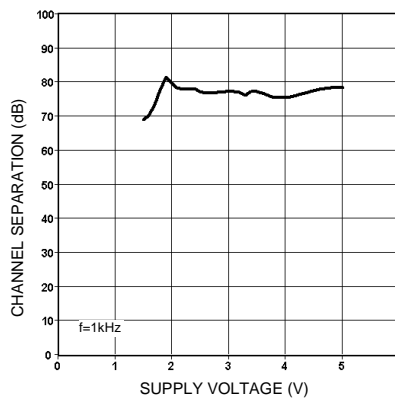
PSRR vs. frequency



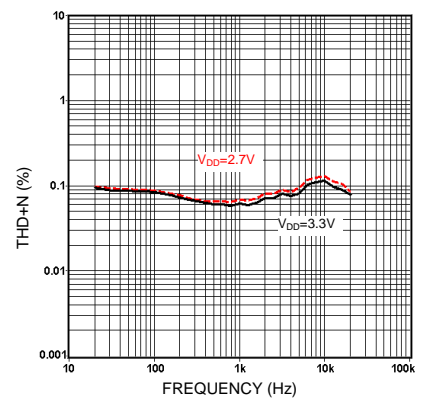
PSRR vs. frequency



Mute attenuation vs. supply voltage



Channel separation vs. supply voltage



THD+N vs. frequency

TIMING AND DATA FORMAT

The MS6333 accepts input serial data formats of 16-bit word length. Left and right data words are time multiplexed. The MSB must always be first. The format of data input is shown in Figs. 1 and 2.

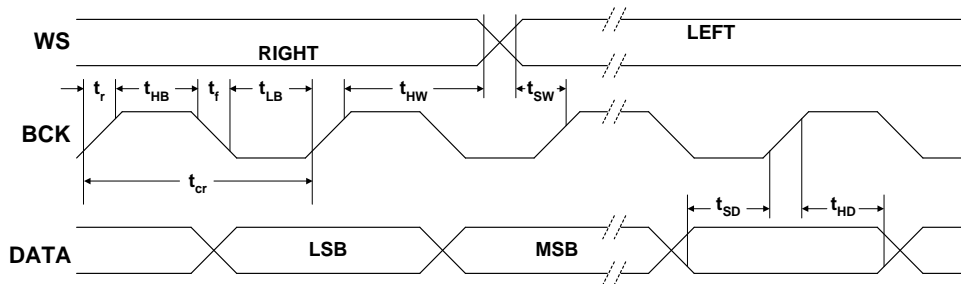


Fig.1 Timing and input signals.

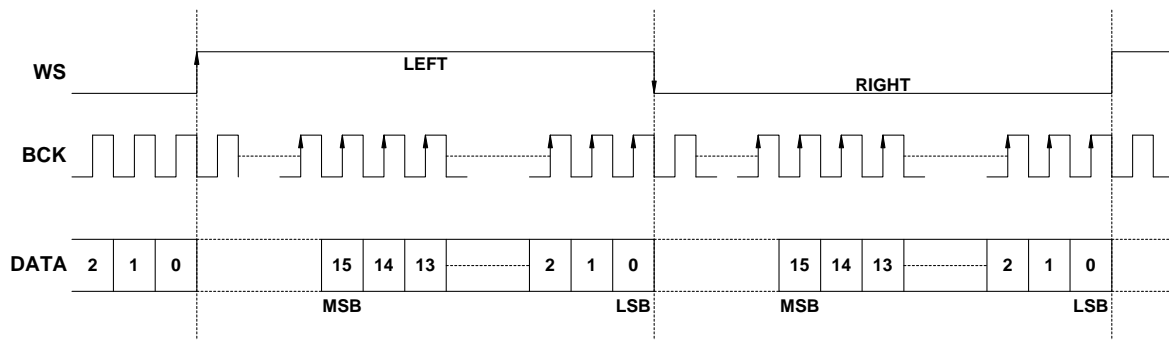


Fig.2 Format of input signals.

Data format (BCK, WS, DATA)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Input LOW level		-	-	0.8	V
V_{IH}	Input HIGH level		2	-	-	V
		*Note	1.8	-	-	V
I_{IL}	Input Leakage Current LOW		-	-	10	μA
I_{IH}	Input Leakage Current HIGH		-	-	10	μA
f_{BCK}	Input Clock Frequency		-	-	18.4	MHz
BR	Bit Rate Data Input		-	-	18.4	Mbits/s
f_{WS}	Word Select Input		-	-	384	kHz
t_r	Rise Time		-	-	12	ns
t_f	Fall Time		-	-	12	ns
t_{cr}	Bit Clock Cycle Time		54	-	-	ns
t_{HB}	Bit Clock High Time		15	-	-	ns
t_{LB}	Bit Clock Low Time		15	-	-	ns
t_{SD}	Data Set-up Time		12	-	-	ns
t_{HD}	Data Hold Time to Bit Clock		2	-	-	ns
t_{HW}	Word Select Hold Time		2	-	-	ns
t_{SW}	Word Select Set-up Time		12	-	-	ns

*Note: For the minimum input HIGH level as 1.8V, the operation voltage should not exceed 4.5V.

POWER DOWN AND MUTE FUNCTION

A microcontroller or microprocessor control power and mute function timing on MS6333 is shown in Figure 3. It could prevent pop noise effectively when power on and power off. The signals of power down function and mute function are ignored during initial time 350ms when power on. It is better to control mute function after 1sec. The sequence is mute on and then power down when power off.

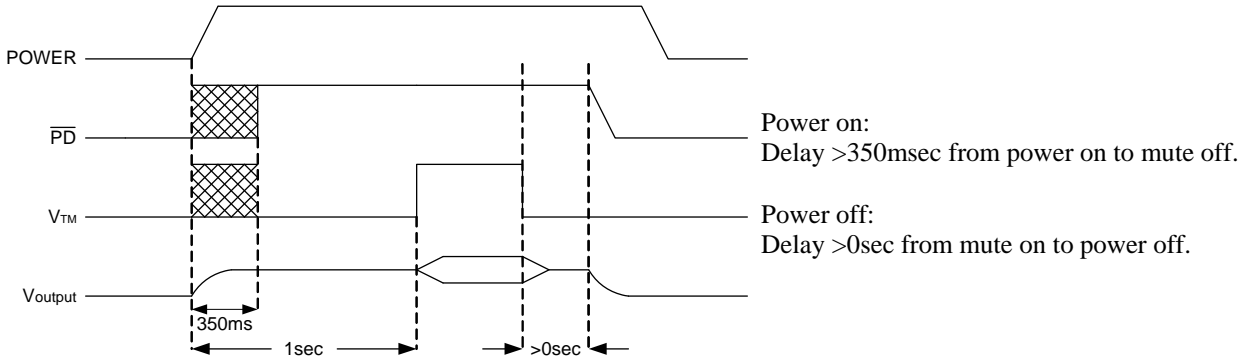
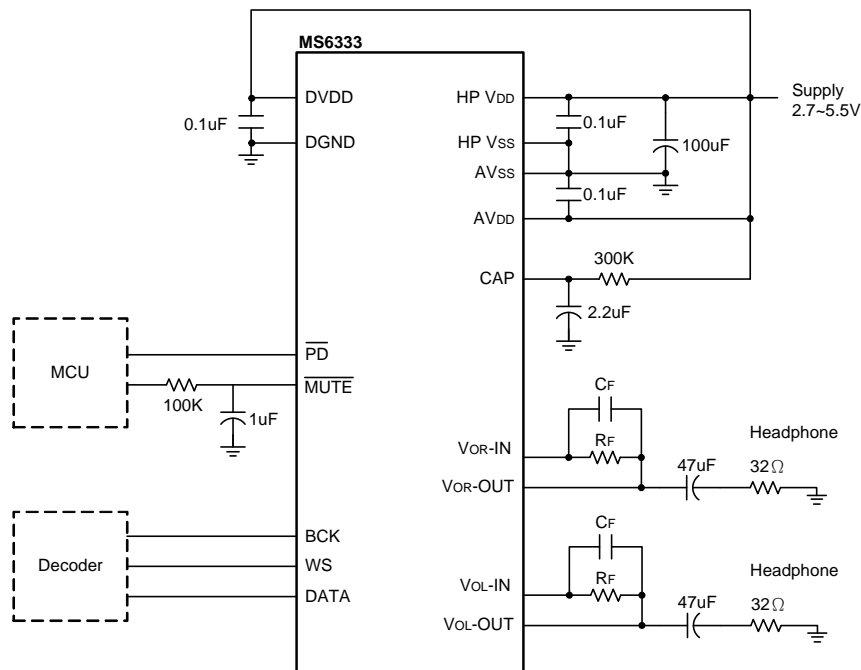


Fig.3 Power and mute function timing.

APPLICATION INFORMATION

Basic application example

A typical example of an MP3-application with the MS6333 is shown in Fig.4. Power voltage of digital and analog can be used single supply voltage.



Note : $V_o = 0.023663 * R_F * V_{DD} V_{pp}$
 R_F / C_F to decide $-3dB$ point
 V_{TM} : Mute control voltage
 For $V_{DD} = 3V$, $R_L = 32\Omega$, $R_F = 24k$, $C_F = 390pF$, $V_o = 1.7V_{pp}$
 $R_L = 16\Omega$, $R_F = 22k$, $C_F = 470pF$, $V_o = 1.56V_{pp}$

Fig.4 MP3 Basic application circuit.

A MP3 with FM application

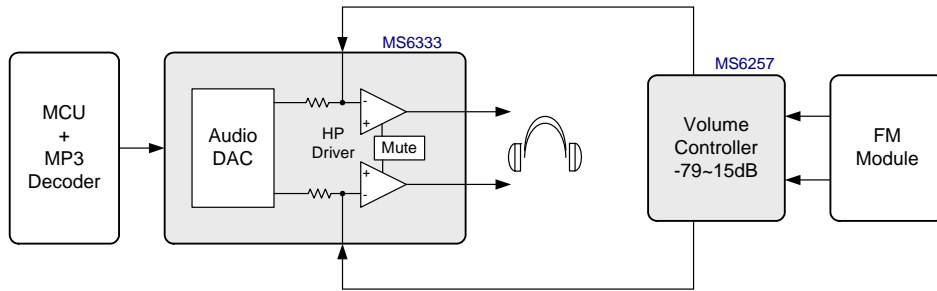


Fig.5 MP3 with FM block diagram

MS6333 combined with FM function by using MS6257 as volume controller (-79dB to +15dB)

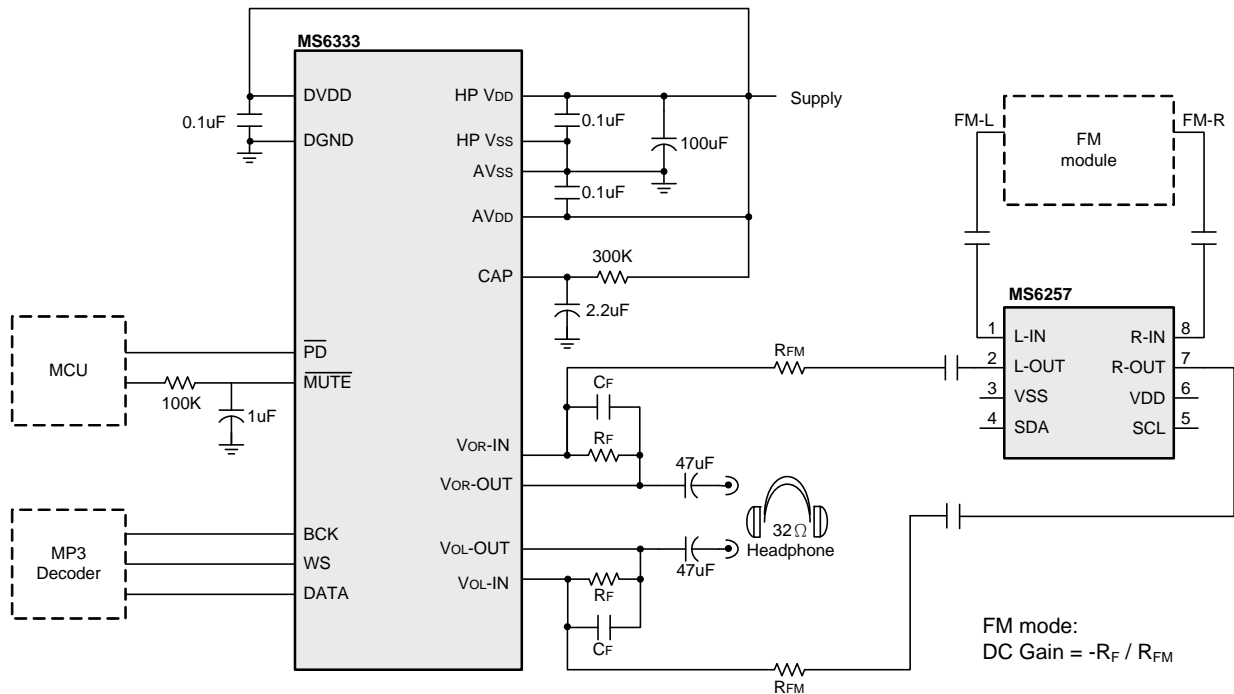


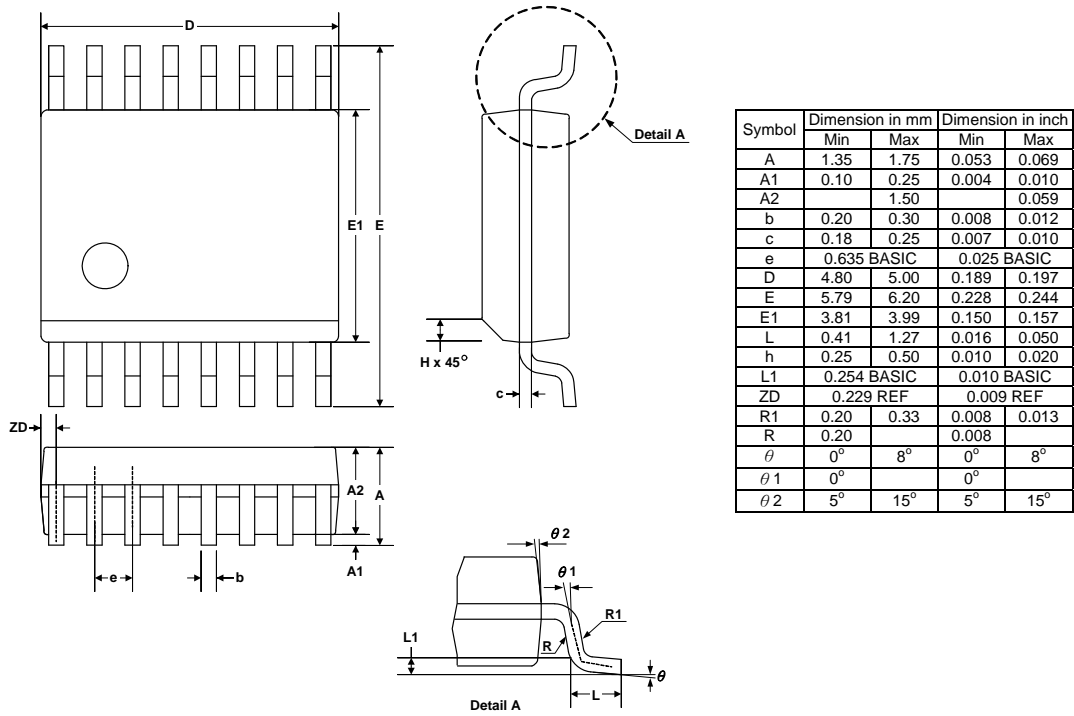
Fig.6 FM application circuit using MS6333 and MS6257.

Operation:

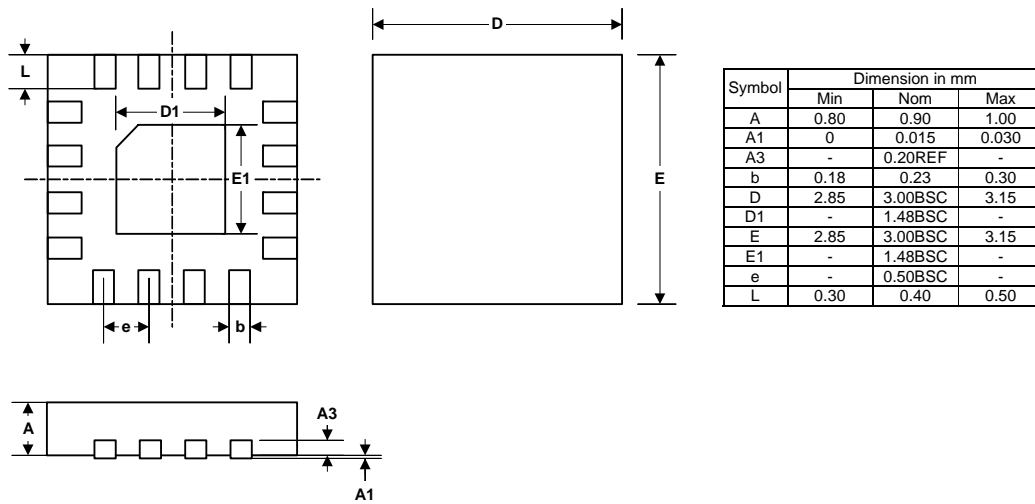
It may have two sources to play, one is DAC, the other is LINE-IN. To play DAC, the LINE-IN signal (such as from FM module and MS6257, MS6257 is a stereo audio volume controller) must be muted. To play LINE-IN, the last input DATA for DAC should 0000HEX code in order to keep a DC with half V_{DD} at the headphone outputs. For both plays, /MUTE should keep HIGH.

EXTERNAL DIMENSIONS

SSOP16

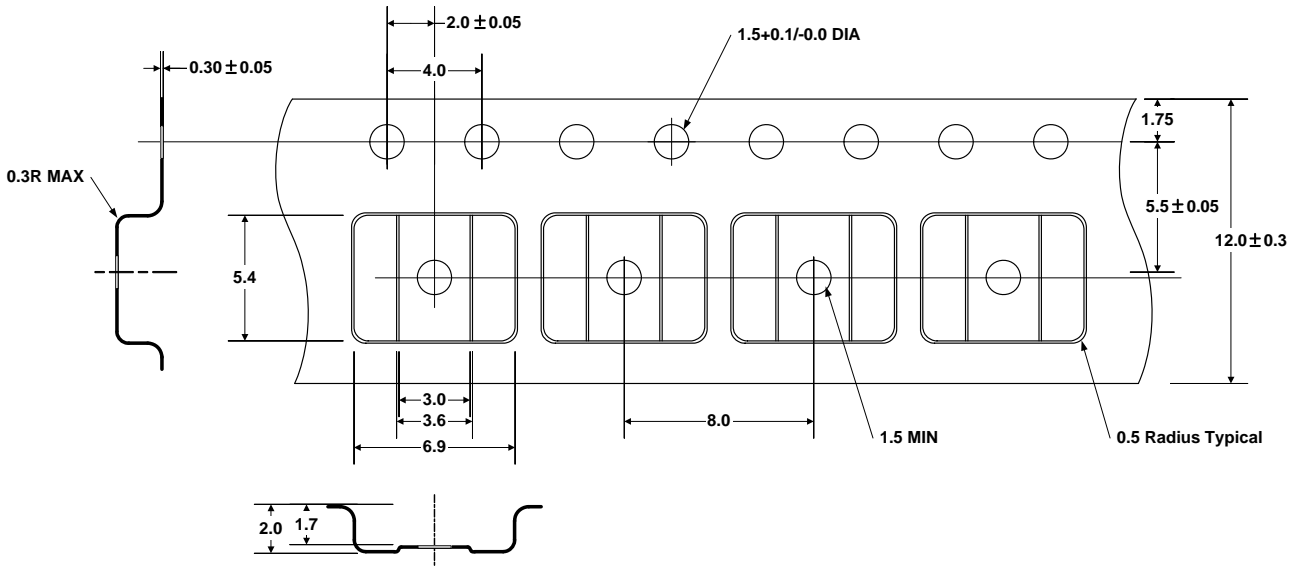


QFN16 (3x3mm)

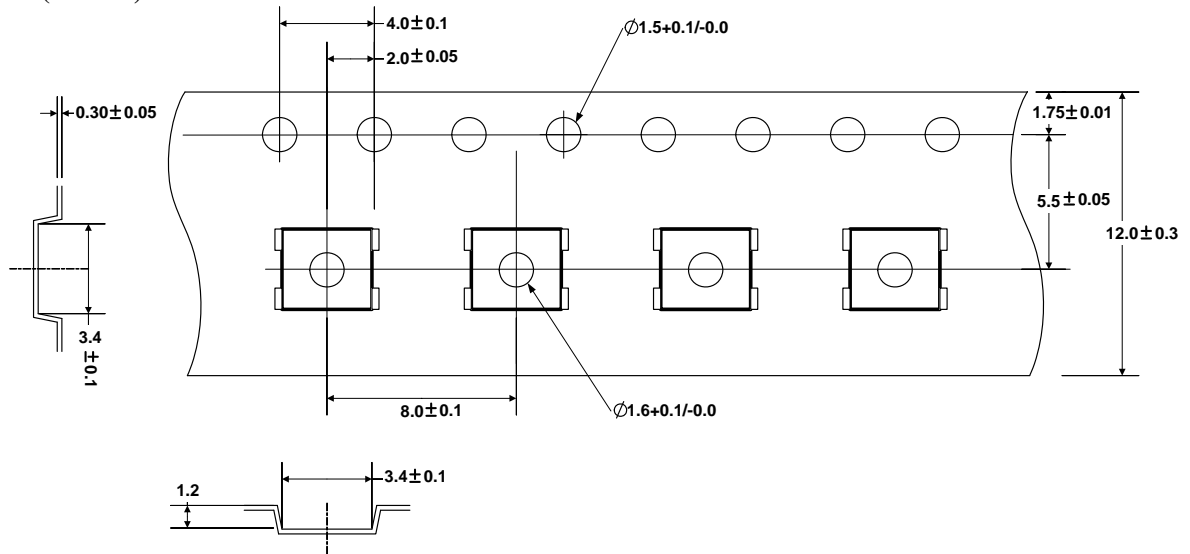


TAPE AND REEL (Unit : mm)

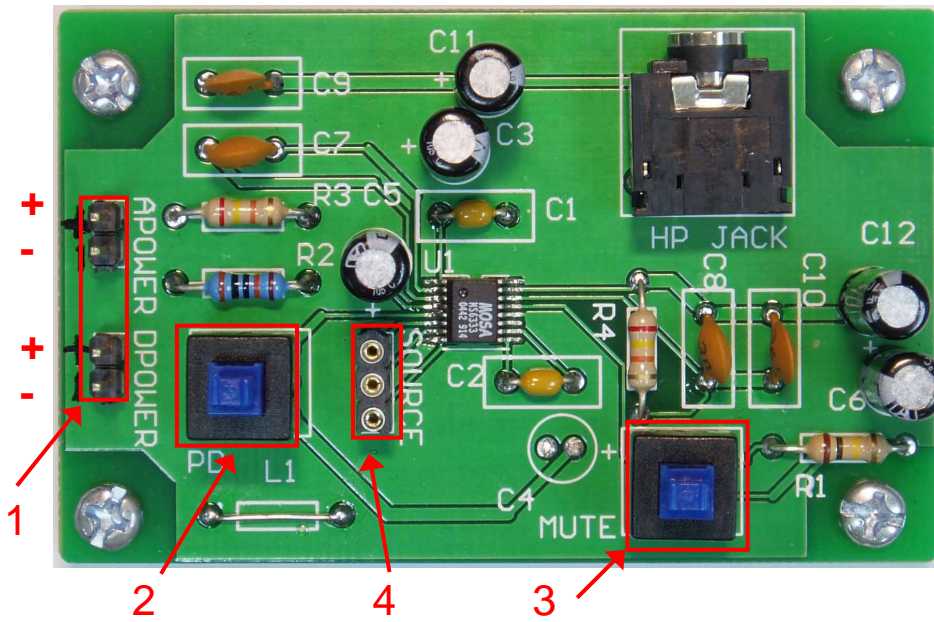
SSOP16



QFN16 (3x3mm)



Demo Board



Function description

Label 1: Supply Voltage

Supply voltage range is 2.5V to 6.5V, both the analog and the digital are the same voltage.

Label 2: Power Down

The Power Down is enabled when the PD switch is pressed.

The Power Down is disabled when the PD switch is not pressed.

Label 3: Mute Function

The chip is mute on when the MUTE switch is pressed.

The chip is mute off when the MUTE switch is not pressed.

Label 4: Source

The source is digital audio input, the audio format is right justified. (BCK, WS, DATA)

Circuit

