Analog compander for KARAOKE echo systems

BA7725S / BA7725FS

The BA7725S and BA7725FS are analog companders designed for KARAOKE echo systems, and logarithmically compress the signal level by 1 / 2 and then logarithmically expand it by a factor of 2. These ICs can be used in combination with the BU9252S or BU9252F to create a digital echo system. These ICs have an internal line mixer amplifier for mixing line input and echo signals. The internal electronic volume control makes it possible to adjust the mixer level and loop level mixer with an external DC voltage.

●Applications

Circuits that require analog signal compression and expansion

●Features

1) Internal logarithmic 1 / 2 compression circuit and 2 × expansion circuit
2) Internal 2-channel buffer amplifier used as a tertiary low pass filter
3) Internal mixer amplifier that mixes line input and microphone input
4) Internal electronic volume control allows for adjustment of the echo mixer level and loop mixer level using an external DC voltage.
5) Internal microphone amplifier and microphone input ON / OFF switch

●Absolute maximum ratings (Ta = 25°C)

Parameter		Symbol	Limits	Unit
Power supply voltage		V_{CC}	13	V
Power dissipation	BA7725S	Pd	1000*1	mW
	BA7725FS		600*2	
Storage temperature		Tstg	– 55 ~ + 125	°C
Operating temperature		Topr	– 10 ~ + 70	°C

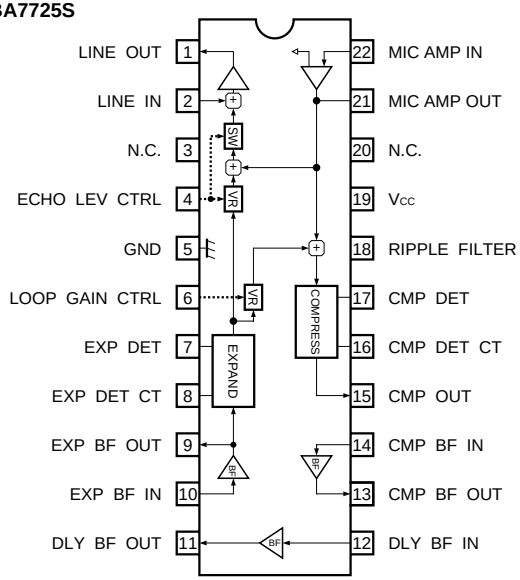
*1 Reduced by 10mW for each increase in Ta of 1°C over 25°C.
*2 Reduced by 6.0mW for each increase in Ta of 1°C over 25°C.

●Recommended operating conditions

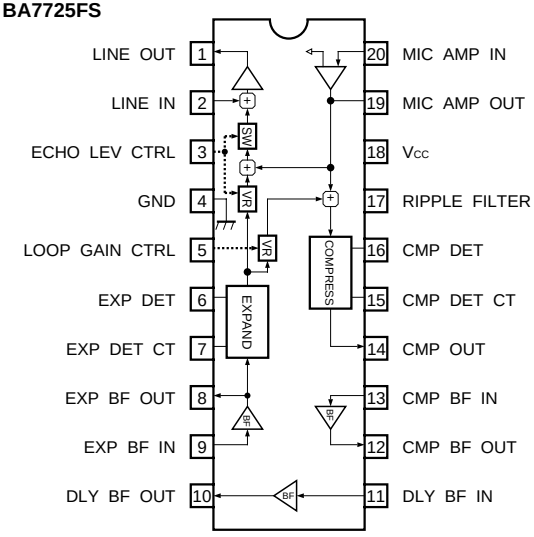
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	6.5 ~ 12.0	V

●Block diagram

BA7725S



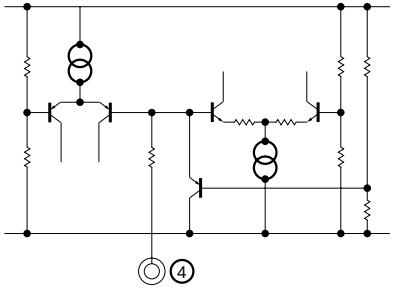
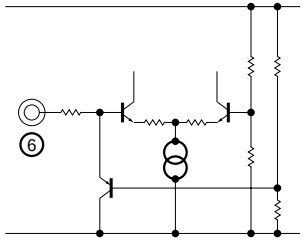
BA7725FS



●Pin descriptions

Pin No.		Pin name	Function
BA7725S	BA7725FS		
1	1	LINE OUT	Line output
2	2	LINE IN	Line input
3	—	N.C.	—
4	3	ECHO LEV CTRL	Microphone turns off when voltage drops below 1V. Set echo signal damping ratio between 2-9V (Vcc = 9.0V).
5	4	GND	Ground
6	5	LOOP GAIN CTRL	Setting the loop damping ratio. Set between 2-9V (Vcc = 9.0V).
7	6	EXP DET	Expand detection
8	7	EXP DET CT	Setting expand attack / recovery time Attack (R) = 5.6kΩ, recovery (R) = 85.6kΩ
9	8	EXP BF OUT	LPF BF output (expansion)
10	9	EXP BF IN	LPF BF input (expansion)
11	10	DLY BF OUT	Echo signal input BF output
12	11	DLY BF IN	Echo signal input BF input
13	12	CMP BF OUT	LPF BF output (compression)
14	13	CMP BF IN	LPF BF input (compression)
15	14	CMP OUT	Compression output
16	15	CMP DET CT	Setting the compression attack / recovery time Attack (R) = 5.6kΩ, recovery (R) = 85.6kΩ
17	16	CMP DET	Compression detection
18	17	RIPPLE FITER	Attached ripple rejection capacitor
19	18	V_{CC}	V_{CC}
20	—	N.C.	—
21	19	MIC AMP OUT	Microphone amplifier output
22	20	MIC AMP IN	Microphone amplifier input

●Input / output circuits

Pin name	Pin No.	Equivalent circuit
ECHO LEVEL CTRL	4	
LOOP GAIN CTRL	6	

Note: The BA7725FS is mounted on a 20-pin SSOP-A package with a different pin number than the BA7725S.
On the BA7725FS, the ECHO LEVEL CTRL pin is pin 3, and the LOOP GAIN CTRL pin is pin 5.

●Electrical characteristics (unless otherwise noted, Ta = 25°C, Vcc = 9V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply current	I_{CC}	4.3	5.7	7.6	mA	No input
⟨LINE THROUGH⟩ INPUT : LINE IN, OUTPUT : LINE OUT						
Line through output level	V_{OLL}	– 9.0	– 8.0	– 7.0	dBV	V_{IN} = – 26.0dBV
Line through output distortion	THD_{LL}	—	0.15	0.5	%	V_{IN} = – 26.0dBV, MIC OFF,*1
Line through maximum output level	V_{OML}	+ 5.0	+ 7.2	—	dBV	THD = 1%,*1
Line through noise level	V_{ONL}	—	– 92	– 77	dBV	MIC OFF, Rg = 600Ω,*2
⟨MIC THROUGH⟩ INPUT : MIC AMP IN, OUTPUT : LINE OUT						
Microphone through output level	V_{OML}	– 10.5	– 8.5	– 6.5	dBV	V_{IN} = – 52dBV
Microphone through output distortion	THD_{ML}	—	0.2	0.5	%	V_{IN} = – 52dBV,*1
Microphone through input conversion noise	V_{ONM}	—	– 114	– 104	dBV	Input shorted
Microphone through crosstalk	CT_{ML}	—	– 91	– 75	dBV	V_{IN} = – 44dBV, MIC OFF,*2
⟨COMPRESS⟩ INPUT : MIC AMP IN, OUTPUT : CMP BF OUT						
Compress output level	V_{OMC}	– 6.5	– 4.5	– 2.5	dBV	V_{IN} = – 52dBV
Compress output distortion	THD_{MC}	—	0.5	2.0	%	V_{IN} = – 52dBV,*1
Compress noise level	V_{ONC}	—	– 55	– 45	dBV	Rg = 600Ω,*2
Compress characteristics	CMP	—	– 11.0	—	dB	V_{IN} = – 42dBV → – 62dBV Output level differential
⟨EXPAND⟩ INPUT : DLY BF IN, OUTPUT : LINE OUT						
Expand output level 1	V_{ODL1}	– 11.7	– 9.7	—	dBV	V_{IN} = – 5.0dBV, V_4 = 9.0V
Expand output distortion	THD_{DL}	—	0.25	2.0	%	V_{IN} = – 5.0dBV, V_4 = 9.0V,*1
Expand characteristic	EXP	—	– 19.5	—	dB	V_{IN} = 0dBV → – 10.0dBV Output level differential
Expand output level 2	V_{ODL2}	—	– 54	– 44	dB	V_{IN} = – 5.0dBV, V_4 = 2.0V (VR = Min. time) Output level differential relative to V_{ODL1}
⟨Loop⟩ INPUT : DLY BF IN, OUTPUT : CMP BF OUT						
Loop output level 1	V_{ODC1}	– 7.5	– 5.5	—	dBV	V_{IN} = – 5.0dBV, V_6 = 9.0V
Loop output level 2	V_{ODC2}	—	– 42	– 32	dBV	V_{IN} = – 5.0dBV, V_6 = 2.0V (VR = Min. time) Output level differential relative to V_{ODC1}
⟨Mode holding voltage⟩						
MIC OFF holding voltage	V_{4OFF}	0.0	—	1.0	V	—
MIC ON holding voltage	V_{4ON}	2.0	—	9.0	V	—

*1 BW = 0.4-30kHz

*2 DIN AUDIO

Unless otherwise noted, V4 = 9.0V (MIC ON), V6 = 9.0V (Max. LOOP GAIN)

●Measurement circuit

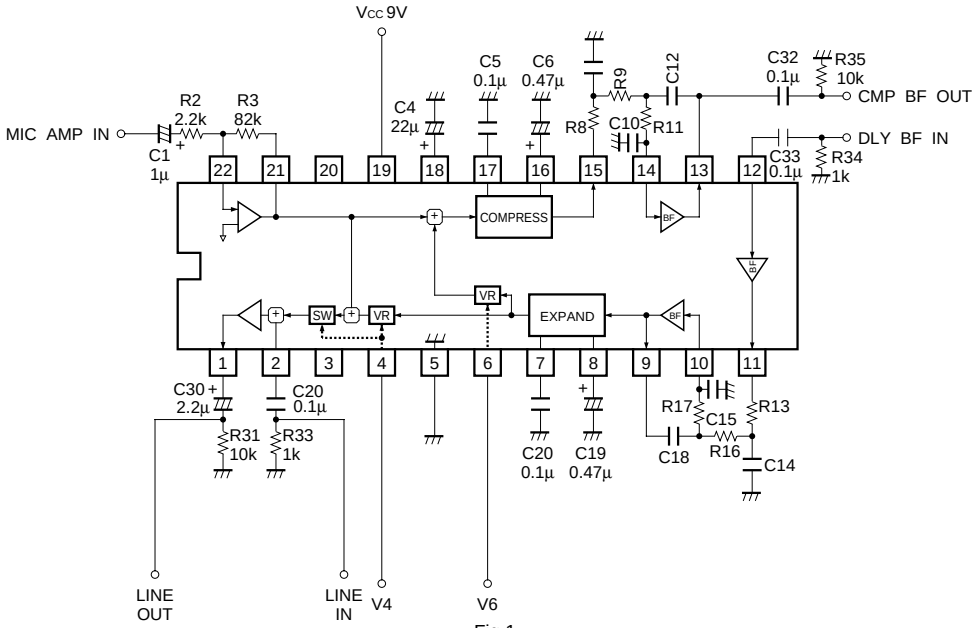


Fig.1

The above measurement circuit applies to a BA7725S mounted to a 22-pin SDIP package. A BA7725FS mounted to a 20-pin SSOP-A package lacks N.C. pins 3 and 20; other than this difference, the above circuit diagram applies.

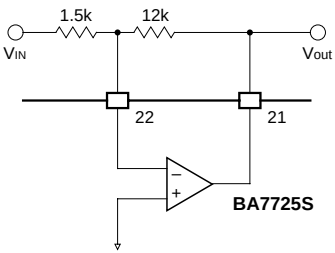
●Circuit operation

(1) MIC AMP IN / LINE OUT gain

Microphone amplifier gain (determined by R9 and R10) + line amplifier gain (+12dB)

The audio signal is input via pin 22 (BA7725S) or pin 20 (BA7725FS) and amplified by the internal microphone amplifier, whose gain can be set with (attached) R9 and R10.

Note: Microphone amplifier gain must be set above +15dB.



Microphone amplifier frequency characteristic measurement circuit

Fig.2

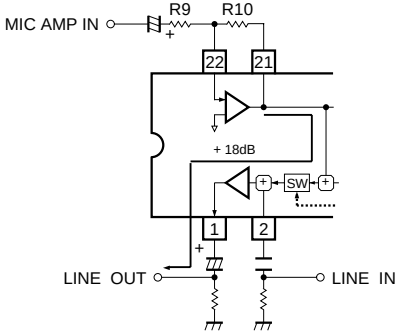
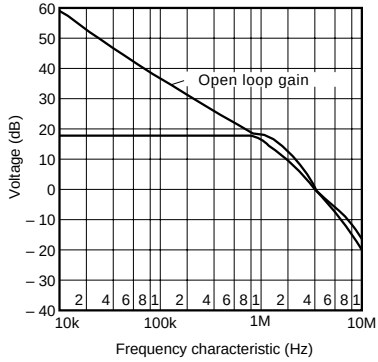


Fig.4



Microphone amplifier frequency characteristics

Fig.3

(2) LINE IN / LINE OUT gain

Line amplifier gain is fixed at +18dB.

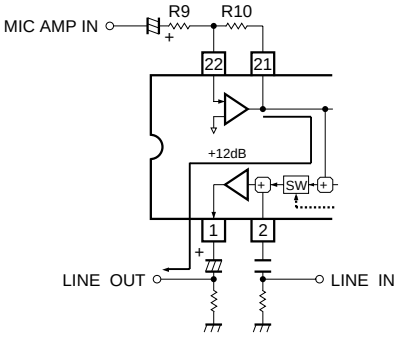


Fig.5

After being amplified by the internal microphone amplifier, the audio signal is logarithmically compressed by 1 / 2 then input to the tertiary low pass filter, which comprises an internal BF and attached capacitor and resistor.

(3) Echo level control

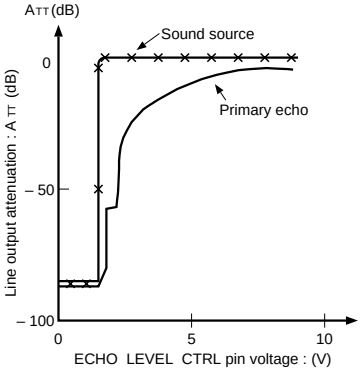
The DC voltage supplied to pin 4 (BA7725S) or pin 3 (BA7725FS) determines when the microphone switch is turned on and off and controls the echo level.

Microphone switch control

Mode	Threshold voltage	Operation
MIC OFF	L (1.0V Max.)	Only line audio is output.
MIC ON	H (2.0V Min.)	Line input and level-controlled microphone input are mixed and output.

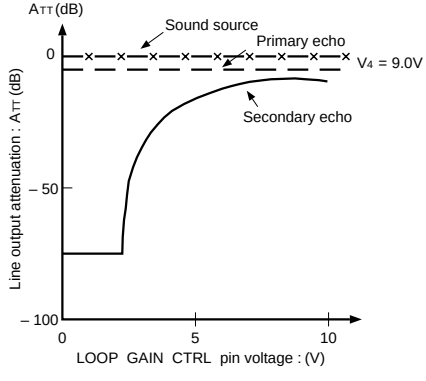
Echo level control

Attenuation of the primary echo signals from sound source can be controlled by changing the DC voltage impressed on pin 4 (BA7725S) or pin 3 (BA7725FS) between 2V and 9V.



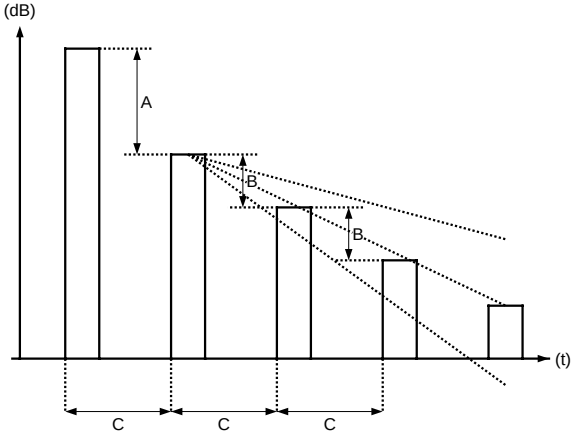
Line output attenuation vs.
echo level control pin voltage

Attenuation of primary echo signals can be controlled by changing the DC voltage impressed on pin 6 (BA7725S) or pin 5 (BA7725FS) .



Line output attenuation vs.
loop gain control pin voltage

Relationship between echo gain and loop gain



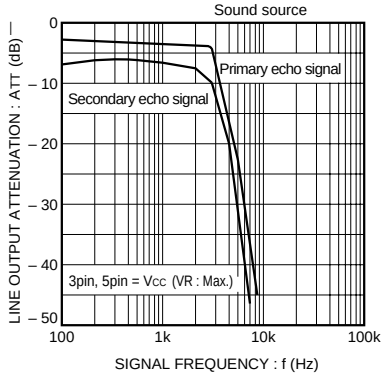
A : Echo signal attenuation
B : Loop signal attenuation
C : Delay time

Fig.8

(4) Echo signal frequency characteristicis

The figure below shows the attenuation of signals output from pin 1 when the audio signal is input to pin 22 (BA7725S) or pin 20 (BA7725FS). (This is the attenuation when the input signal is output without being passed through the BU9252S / F, and when the primary and secondary echo signals are passed through an attached low pass filter with the same constant shown in "Application example," and then processed by the BU9252S / F delay circuit.)

Note: These are the values when using the constant shown in "Application example."

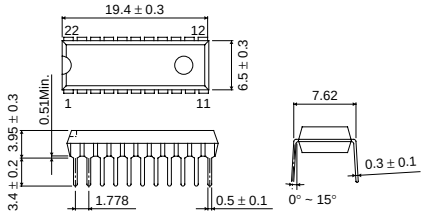


Echo signal frequency characteristics

Fig.9

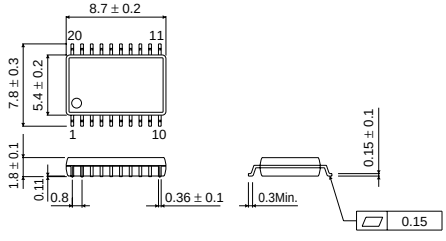
●External dimensions (Units: mm)

BA7725S



SDIP22

BA7725FS



SSOP-A20