



QX-1

QXpander Processor with Volume and Tone control

Device Specifications - Preliminary Information

Overview:

The QX-1 is an audio enhancement and control IC featuring QSound Labs' QXpander process. The patented QXpander technology produces a spatial or widened stereo image from ordinary left and right channel inputs. This audio enhancement is achieved while using normal stereo signals and standard stereo audio equipment. No special initial encoding of the input signals and no additional speakers are required.

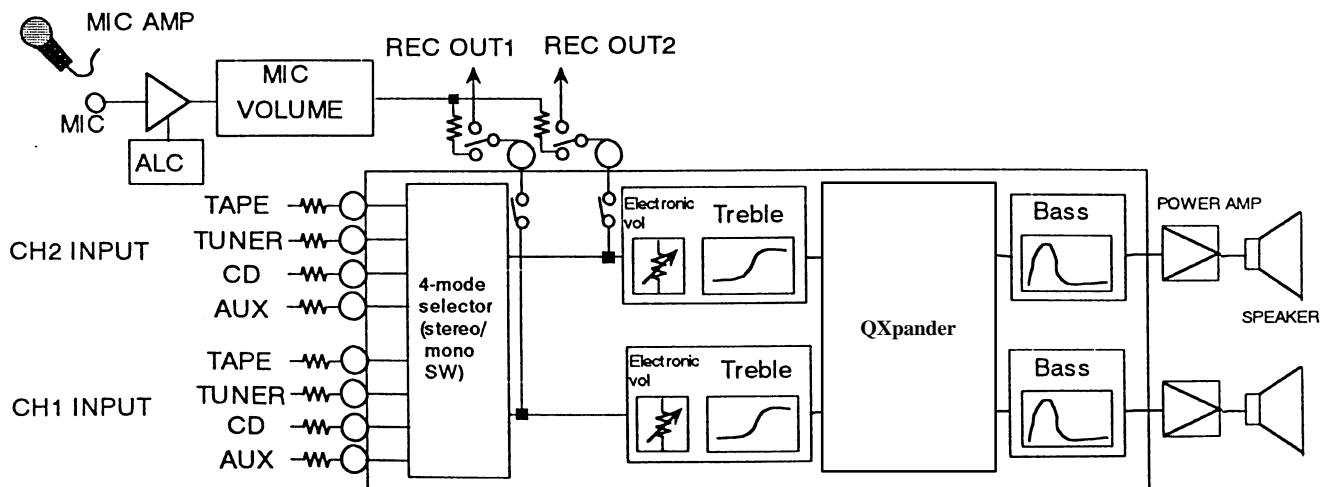
Feature:

- Built in QXpander technology
- Stereo sound enhancement
- Electronic volume control
- 2 band tone control
 - Bass (0 ~ +21dB/3dB step)
 - Treble (0 ~ +9dB/3dB step)
- 5 input selector (The fifth input can be used as REC OUT or MIC MIX)
- DC ± 2.25 to ± 2.75 volt supply
- 24-pin SSOP packaging

Application:

- Audio systems including TV, AV Amp, Mini System, VCR, DVD, VCD, SVCD and MP3 player
- Computer-based multimedia products, including sound cards and powered loudspeakers

System Block Diagram:



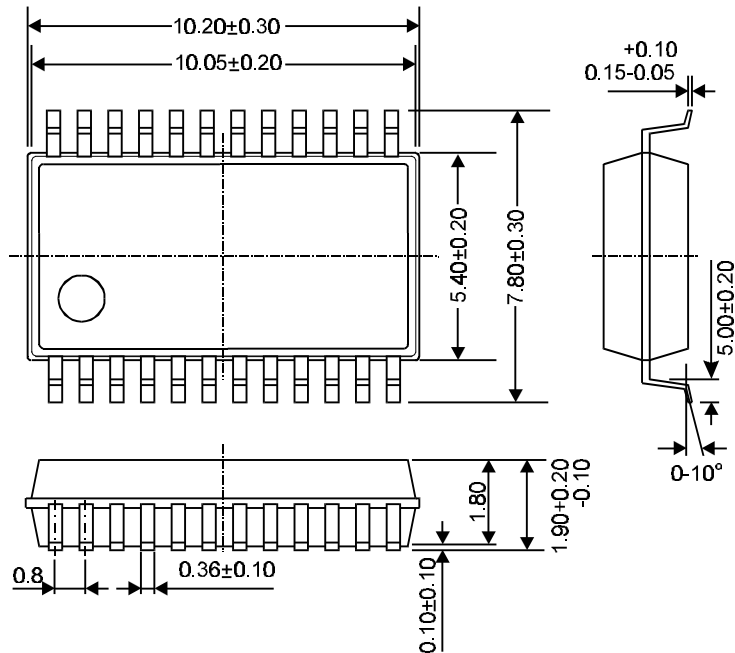


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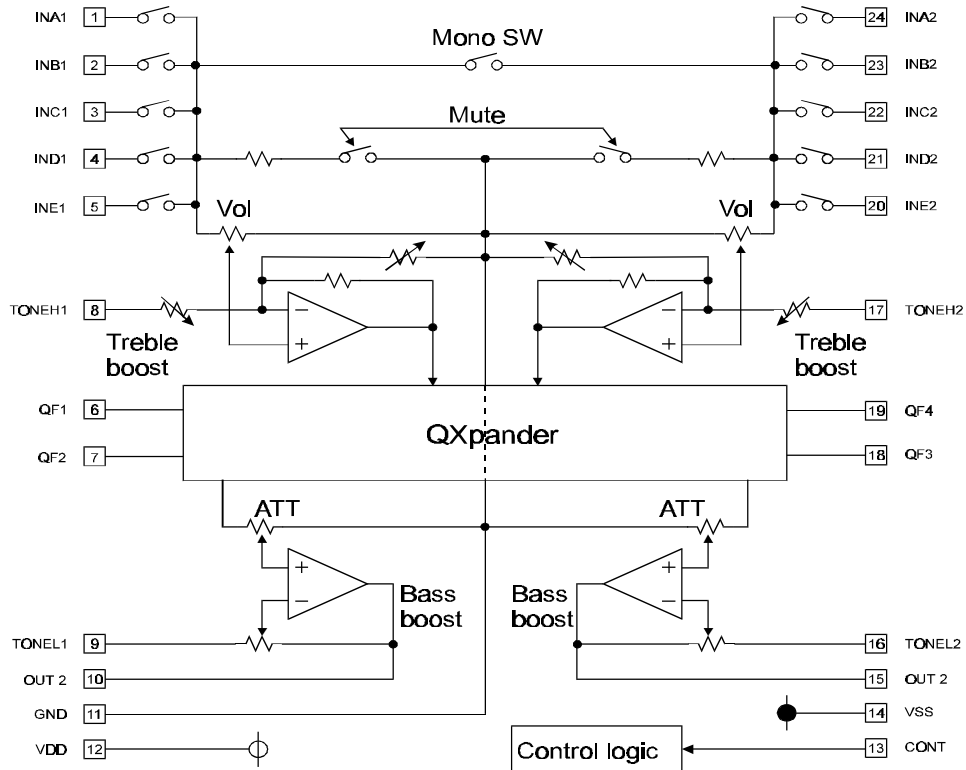
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Packaging Dimension:



IC Block Diagram:





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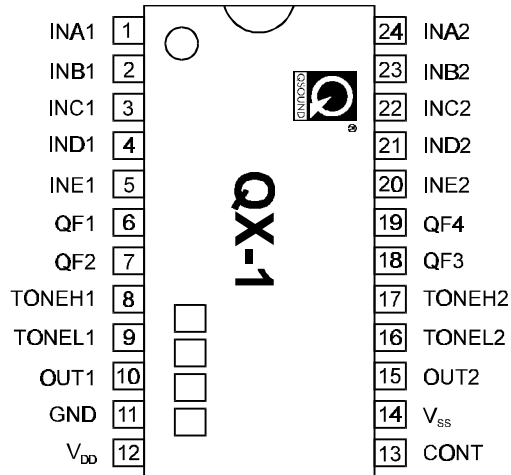
Device Specifications - Preliminary Information

Pin Description:

Number	Name	I/O	Description
1	IN A1	I	Channel 1 inputs*
2	IN B1	I	
3	IN C1	I	
4	IN D1	I	
5	IN E1	I	
6	QF1	I	Capacitor
7	QF2	I	Capacitor
8	TONEH1	I	Channel 1 treble control
9	TONEL1	I	Channel 1 bass control
10	OUT1	O	Channel 1 output
11	GND	-	Ground
12	V _{DD}	-	Supply voltage (+)
13	CONT	I	Control data input from a microcontroller
14	V _{SS}	-	Supply voltage (-)
15	OUT2	O	Channel 2 output
16	TONEL2	I	Channel 2 bass control
17	TONEH2	I	Channel 2 treble control
18	QF3	I	Capacitor
19	QF4	I	Capacitor
20	IN E2	I	Channel 2 inputs*
21	IN D2	I	
22	IN C2	I	
23	IN B2	I	
24	IN A2	I	

*IN E switching can be controlled independently.

Pin Assignment:



SSOP pin assignment



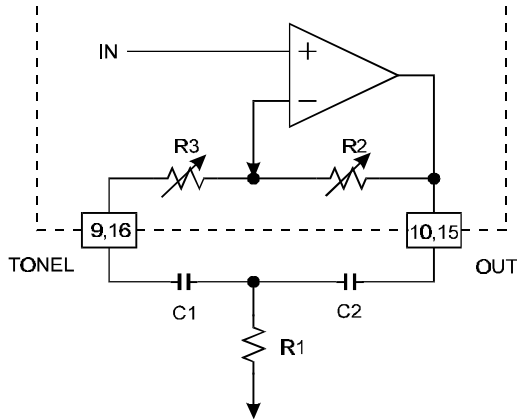
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Function Description:

(1) Bass boost



$$F_o = \frac{1}{2p\sqrt{R1(R2 + R3)C1C2}} \text{ (Hz)}$$

$$Q = \frac{1}{C1 + C2} \sqrt{\frac{C1C2R2}{R1}}$$

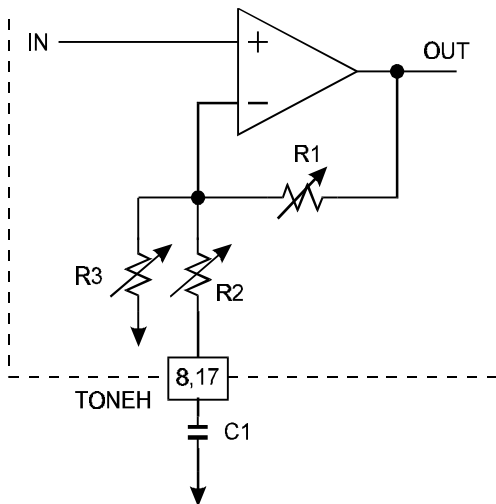
(C1=C2)

$$G_v = 20 \text{ LOG} \frac{\frac{R2 + R3}{R1} + 2}{\frac{R3}{R1} + 2} \text{ (dB)}$$

R2, R3 (typical)

Bass boost	3dB	6dB	9dB	12dB	15dB	18dB	21dB
Resistor R2	15.4	25.7	32.9	38.7	41.6	44.2	46
(k) R3	30.6	20.3	13.1	7.3	4.4	1.8	0

(2) Treble boost



$$F_c = \frac{1}{2pR2C1} \text{ (Hz)}$$

$$G_v = 20 \log \frac{R1 + \{(R2 + Zc) // R3\}}{(R2 + Zc) // R3} \text{ (dB)}$$

$$Zc = \frac{1}{j\omega C1} \text{ (\Omega)}$$

R2 (typical)

Treble boost	3dB	6dB	9dB
R2 (k)	5.3	2.2	1.2

R1, R3 (typical)

Gain	14 dB	16 dB	18 dB	20dB
R1 (k)	10.88	13.65	17.21	21.6
R3 (k0)	2.72	2.57	2.48	2.4



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Electrical Specification:

Absolute Maximum Ratings

(TA=25°C unless otherwise noted)

Parameter	Symbol	Rating	Unit
Supply voltage	V _{DD} -V _{SS}	6.0	V
Thermal derating	K _θ	5	mW/°C
Power dissipation	P _d	500	mW
Operating temperature	T _{OPR}	-20 to 75	°C
Storage temperature range	T _{STG}	-40 to 125	°C
Soldering temperature	T _{SLD}	255	°C
Soldering time	t _{SLD}	10	Sec

Recommended Operating Condition

Parameter	Symbol	Limits			Unit
		min.	typ.	max.	
Supply voltage (+)	V _{DD}	2.25	2.5	2.75	V
Supply voltage (-)	V _{SS}	-2.75	-2.5	-2.25	V
Control data input voltage	CONT	GND	-	V _{DD}	V

Electrical Characteristics

(V_{DD}=2.5V, V_{SS}=-2.5V, f=1kHz, V_i=100mV(rms), VOL=0dB, BASS=0dB, TREBLE=0dB, VOL/TREBLE SHARE AMP=18dB, MODE=BYPASS, RL=10k, TA=25°C unless otherwise noted)

Parameter	Symbol	Condition	Limits			Unit	
			min.	typ.	max.		
Circuit current of positive power supply	I _{DD}	Quiescent	-	30	45	mA	
Circuit current of negative power supply	I _{SS}	Quiescent	-	-30	-45	mA	
Voltage gain (selector)	Gv1	Vol/Treble share amp gain = 18dB Bypass	16	18	20	dB	
Voltage gain (tone control)	Gv2	Vol/Treble shared amp gain = 18dB QXpander mode V _i =20mVrms	25.5	27.5	29.5	dB	
Maximum output voltage	V _{OMAX}	RL = 10k, THD = 1%	1.2	1.6	-	Vrms	
Total harmonic distortion	THD	BW = 400~30kHz	-	0.02	0.08	%	
Output noise voltage	No1	JIS-A, Rg=5.1kΩ, VOL = -∞ Bypass	-	6	15	μVrms	
	No2	JIS-A, Rg=5.1kΩ, VOL = -∞ QXpander mode	-	11	30	μVrms	
Maximum attenuation	ATT _{MAX}	Output reference level (V _o = 1 Vrms), ATT = -∞, JIS-A	-	-95	-90	dB	
Bass Boost	GB1	f=1kHz, V _o =80mVrms	3dB	1.5	3	4.5	dB
	GB2		6dB	4.5	6	7.5	dB
	GB3		9dB	7.5	9	10.5	dB
	GB4		12dB	10.5	12	13.5	dB
	GB5		15dB	13.5	15	16.5	dB
	GB6		18dB	16.5	18	19.5	dB
	GB7		21dB	19.5	21	22.5	dB
Treble Boost	GT1	f=1kHz, V _o =80mVrms	3dB	1.5	3	4.5	dB
	GT2		6dB	4.5	6	7.5	dB
	GT3		9dB	7.5	9	10.5	dB



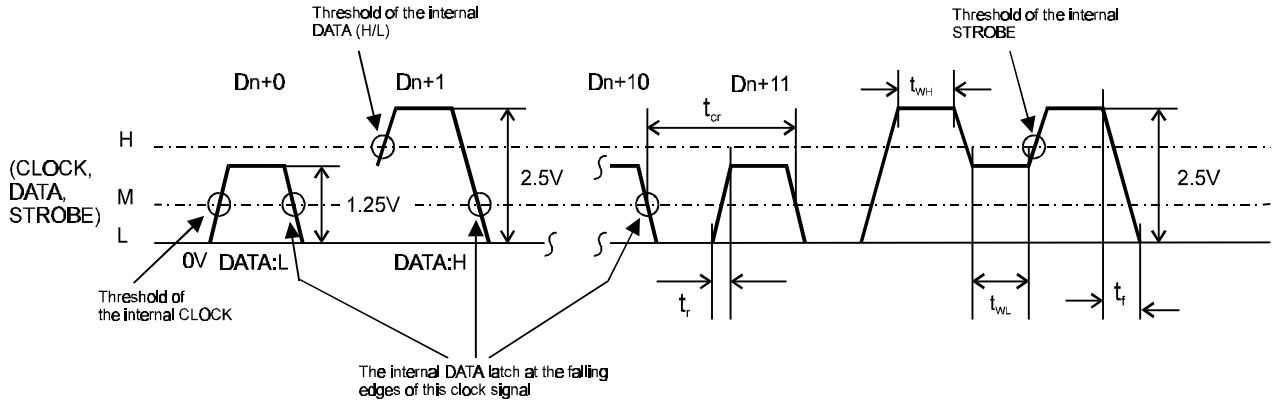
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Device Specifications - Preliminary Information

Control Signals Specification:

(1) Wave form



(2) Control signal voltage

Digital input signal	Condition	Limits			Unit	
		min.	typ.	max.		
L signal	L	$V_{DD} = 2.5V, V_{SS} = -2.5V$	GND	-	0.4	V
M signal	M	$V_{DD} = 2.5V, V_{SS} = -2.5V$	1.0	1.25 ($V_{DD}/2$)	1.5	V
H signal	H	$V_{DD} = 2.5V, V_{SS} = -2.5V$	2.1	-	V_{DD}	V

(3) Control signal timing

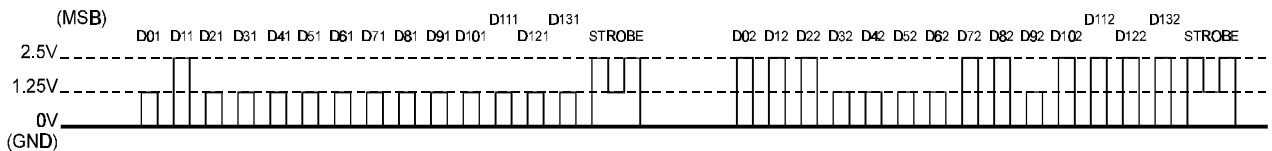
Symbol	Parameter	Limits			Unit
		min.	typ.	max.	
t_{cr}	Cycle time	8	-	-	μsec
t_{wh}	Pulse width ("H" level)	3.6	-	-	μsec
t_{wlc}	Pulse width ("L" level)	3.6	-	-	μsec
t_r	Rise time	-	-	0.4	μsec
t_f	Fall time	-	-	0.4	μsec

(4) Control signal example (Refer to page 7 on the control data)

An example of the mode control

BYPASS/QXpander SW: QXpander
 VOL/TREBLE SHARE AMP GAIN: 20dB
 INPUT : INA
 VOLUME : 0dB
 MUTE : OFF

MODE: STEREO
 BASS: 18dB
 TREBLE: 6dB
 RECOU: ON(INE)





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Device Specifications - Preliminary Information

Control Data Format

(1) INPUT DATA

(MSB) ← Input order

	D01	D11	D21	D31	D41	D51	D61	D71	D81	D91	D101	D111	D121	D131
Slot1	0	Bypass/ QXpander SW	Vol/Treble share amp gain SW 0:20dB 1:18dB 2:16dB 3:14dB		INPUT 0:IN A 1:IN B 2:IN C 3:IN D			D2~D6: (a) Master volume condition				MUTE ON/OFF 0:OFF 1:ON (INPUT ALL OFF)	CHIP/SLOT SELECT 0:select 1:no select 2:no select 3:no select	

	D02	D12	D22	D32	D42	D52	D62	D72	D82	D92	D102	D112	D122	D132
Slot2	1	1	1	0	Mode select 0:stereo 1:mono 1 only 2:mono 2 only 3:mono 1+2		Bass(boost) 0: 0dB, 1: 3 dB, 2: 6dB, 3: 9dB, 4:12dB, 5:15dB, 6:18dB, 7:21dB			Treble(boost) 0:0dB, 1:3dB 2:6dB, 3:9dB		IN E ON/OFF 0:OFF 1:ON	CHIP/SLOT SELECT 0:no select 1:no select 2:no select 3: select	

(a) Master volume

ATT	D61	D71	D81	D91	D101
-0.0dB	0	0	0	0	0
-2.0dB	1	0	0	0	0
-4.0dB	0	1	0	0	0
-6.0dB	1	1	0	0	0
-8.0dB	0	0	1	0	0
-10.0dB	1	0	1	0	0
-12.0dB	0	1	1	0	0
-14.0dB	1	1	1	0	0
-16.0dB	0	0	0	1	0
-18.0dB	1	0	0	1	0
-20.0dB	0	1	0	1	0
-22.0dB	1	1	0	1	0
-24.0dB	0	0	1	1	0
-26.0dB	1	0	1	1	0
-28.0dB	0	1	1	1	0
-30.0dB	1	1	1	1	0
-32.0dB	0	0	0	0	1
-34.0dB	1	0	0	0	1
-36.0dB	0	1	0	0	1
-40.0dB	1	1	0	0	1
-44.0dB	0	0	1	0	1
-48.0dB	1	0	1	0	1
-52.0dB	0	1	1	0	1
-56.0dB	1	1	1	0	1
-60.0dB	0	0	0	1	1
-64.0dB	1	0	0	1	1
-68.0dB	0	1	0	1	1
-72.0dB	1	1	0	1	1
-76.0dB	0	0	1	1	1
-80.0dB	1	0	1	1	1
-84.0dB	0	1	1	1	1
-∞	1	1	1	1	1

Input select

Input select		D41	D51	D111	D112
IN A	IN E off	0	0	0	0
IN B		1	0		
IN C		0	1		
IN D		1	1		
IN A to D all off	IN E on	X	X	1	1 ^{*1}
IN A-D select		A:0	0	0	1 ^{*2}
		B:1	0		
		C:0	1		
		D:1	1		

*1) The IN E input impedance is about 5kΩ

*2) IN E can be controlled independently. It can be used as Rec output

(c) Mode control

Mode	D42	D52
stereo	0	0
mono1 only	1	0
mono2 only	0	1
mono1+2	1	1

(d) Treble control

Treble	D92	D102
0dB	0	0
3dB	1	0
6dB	0	1
9dB	1	1

(e) Bass control

Bass	D62	D72	D82
0dB	0	0	0
3dB	1	0	0
6dB	0	1	0
9dB	1	1	0
12dB	0	0	1
15dB	1	0	1
18dB	0	1	1
21dB	1	1	1

(f) Chip/Slot control

Chip/Slot	D12X	D13X
select (slot1)	0	0
no select	1	0
no select	0	1
select (slot2)	1	1

(g) Treble amp gain SW

Gain SW	D21	D31
20dB	0	0
18dB	1	0
16dB	0	1
14dB	1	1

(h) Bypass/QXpander SW

Bypass/QXpander SW	D11
Bypass	0
QXpander	1



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(2) Notes on control data

1. Power up noise is reduced if the micro controller initialization of the QMDV-1 is delayed for approximately 100mS. Allow time for system power to stabilize.
2. The power up state is shown as below, when $(VDD - VSS) \leq 3.3V$ (TYP).

Parameter	Condition
Gain SW	18dB
Input select	ALL OFF
Master volume	- ∞
MUTE	ON (Input ALL OFF)
Bypass/QXpander	Bypass
Mode select	stereo
Bass	0dB
Treble	0dB
IN E	ON

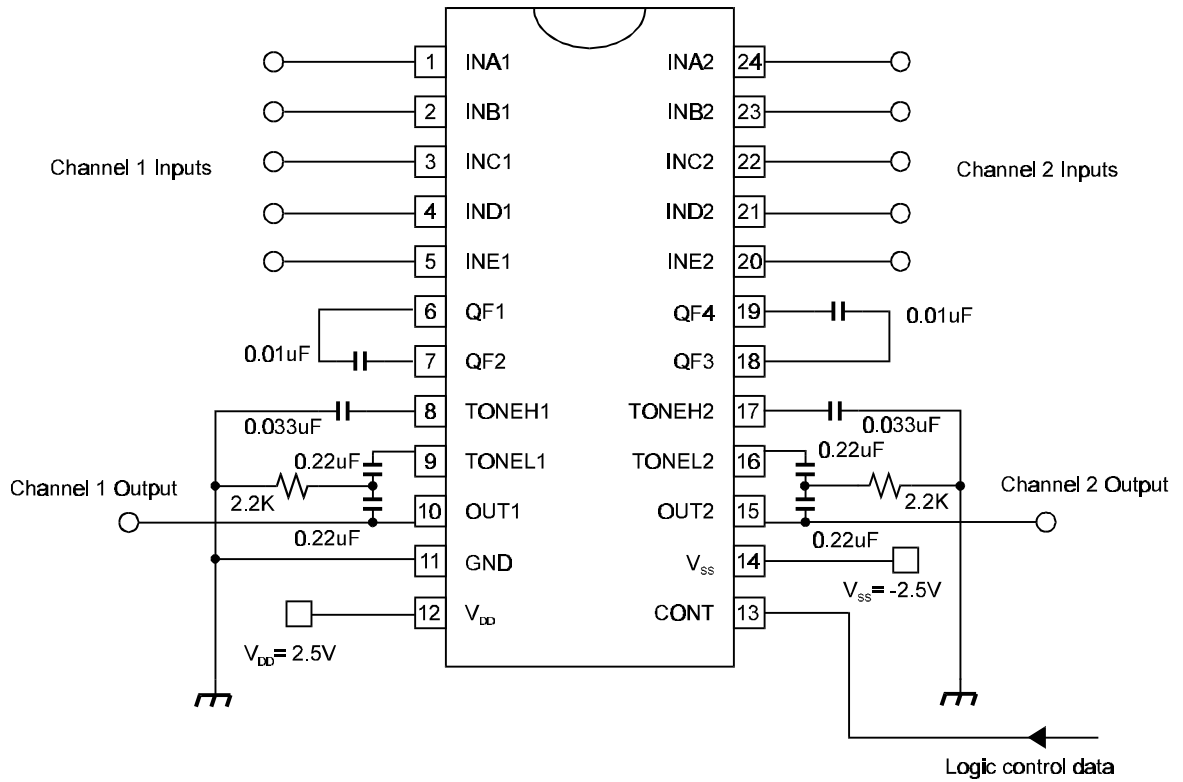


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Application Example 1:



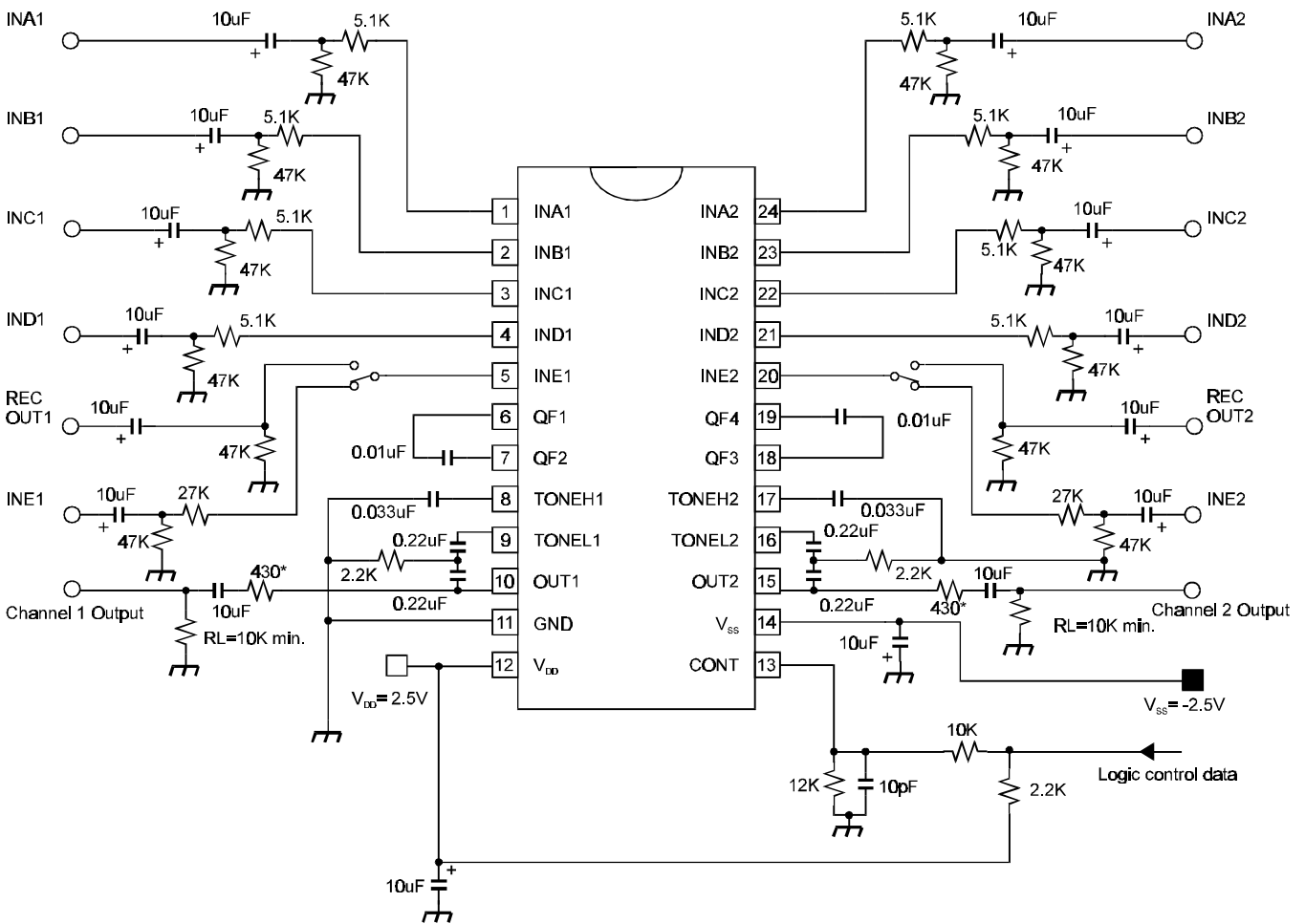


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Application Example 2:



*These resistors are recommended to eliminate the possibility of oscillation due to capacitance load