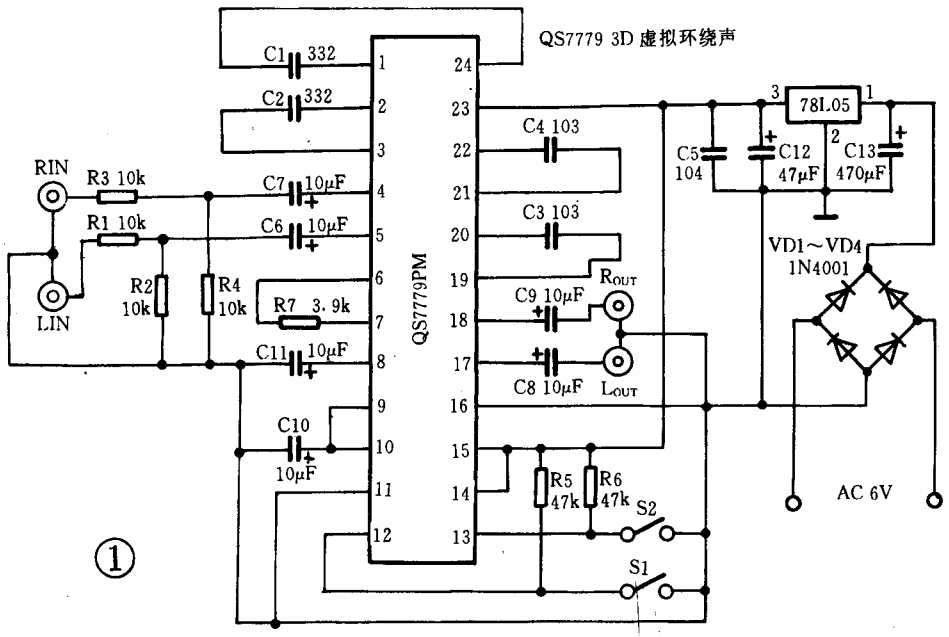
套件供应

最新标准虚拟杜比环绕声芯片 QS7779/QS7785

QS7779/QS7785是加拿大Qsound音频实验室推出的单片虚拟化环绕音效处理电路，是目前业界公认的处理效果最接近自然原声的虚拟杜比环绕芯片！QS7779为2入2出方式（2声道输入2声道输出），QS7785为2入5出方式（2声道输入5声道输出），两者内部都包括了杜比定向逻辑和DVD（AC-3）混合信号解码器，使用Qsound实验室的专利Qsurround虚拟环绕技术，并由Qsound实验室授权许可使用，该芯片的主要功能是：(1)如果输入普通的立体声信号，则进行立体声效果增强；(2)如果输入2声道的矩阵编码信号（杜比定向逻辑或混合AC-3信号）则先将其解码，再虚拟化合成为2声道或5声道输出。

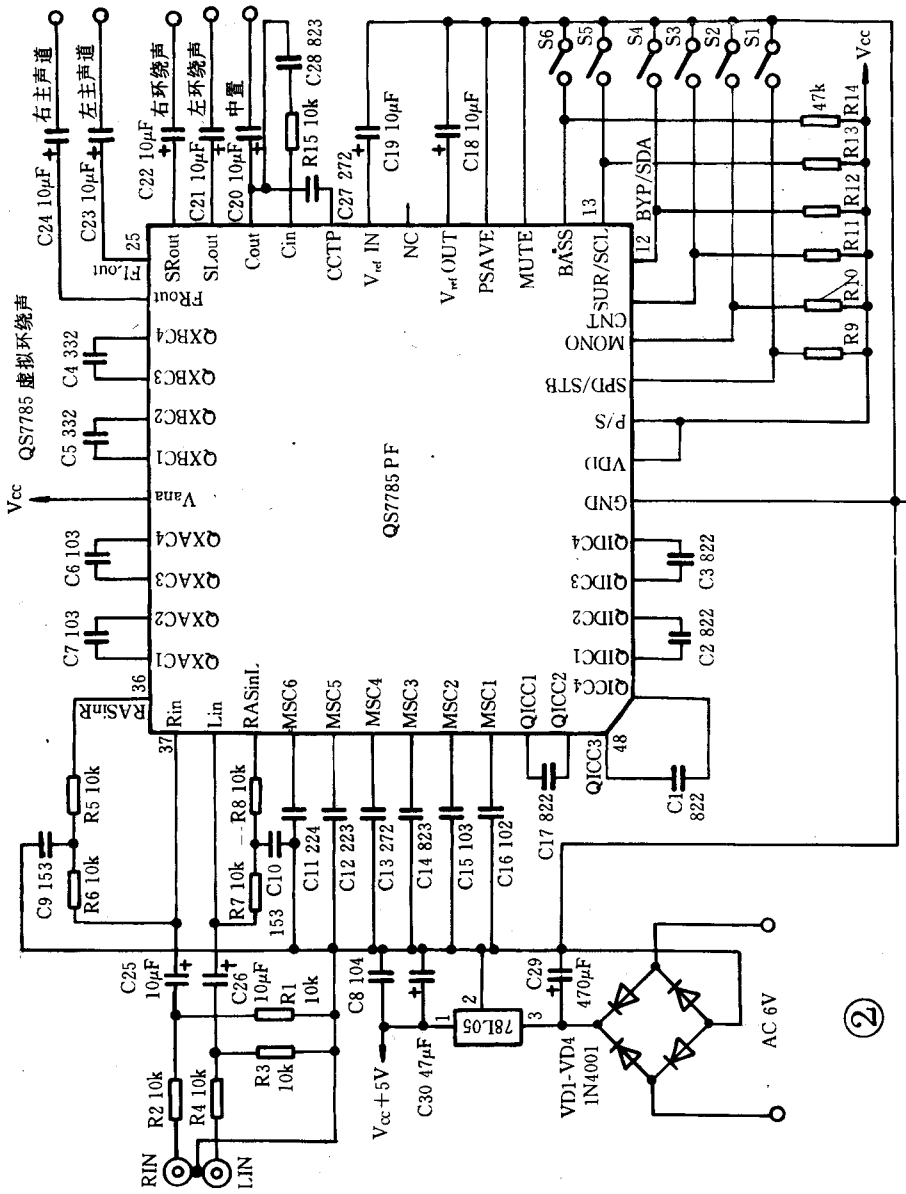
电路概述



①

QS7779主要特点（见图1，S1为增强开关；S2为直通开关）

1. 内带杜比定向逻辑和DVD（AC-



3)混合信号解码器，使用 2 只扬声器实现虚拟化环绕声，也可接中置输出。

2. 主要工作模式：直通，虚拟环绕声功能；3D 立体声增强分低增强和高增强 2 种方式，声场清晰自然，稳定耐听，也适合播放纯音乐。

3. 可用开关或 CPU 总线控制，带静音(MUTE)及省电(P-SAVE)模式。

4. 信噪比 110dB，动态范围 110dB，直流 5～13V 供电(约 6mA)。

QS7785(见图 2)

1. 内带杜比定向逻辑和 DVD(AC-3)混合信号解码器，解出的后环绕信号为 2 声道全频带，和 AC-3 环绕声等同，优于杜比定向逻辑系统。

2. 前方采用 3D 立体声增强技术，后方采用 3D 合成虚拟环绕技术，分 2 种增强方式(低增强和高增强)，具中置输出及低音增强功能。

3. 主要模式为：直通，单声道模拟立体声，虚拟环绕声，声场清晰自然，稳定耐听，也适合播放纯音乐。

4. 可用开关或 CPU 总线控制，带静音(MUTE)及省电(P-SAVE)模式。

5. 使用 5 声道实现环绕声，也可用 2 声道输出方式。

6. 信噪比 110dB，动态范围 110dB，直流 5～13V 供电(约 10mA)。

图 2 中 S1 为增强开关；S2 单声道开关；S3 为中置开关；S4 直通开关；S5 为环绕声道开关；S6 为低音开关。

·套件供应·

宁波美锋电气有限公司供：QS7779 板 120 元，QS7785 板 140 元，变压器 10 元，邮费 6 元，价目备索，款汇：315000 宁波 204 信箱美锋销售部收，电话：0574-7296914，7296041，mfi@mail.nbptt.zj.cn。

NIPPON PRECISION CIRCUITS INC.

QS7779PM/CM

3D Stereo Enhancement and 3D Virtual Stereo Surround with Dolby Pro Logic and Mixed DVD (AC-3) Decoder

OVERVIEW

The QS7779PM/CM is an audio processor IC which implements a decoder for stereo matrix encoded source materials such as the Dolby Surround Pro Logic and mixed DVD (AC–3) with surround virtualization using QSound™ technology developed and licensed by QSound Labs, Inc. This chip produces enhanced stereo sound for a stereo input signal and if the input signal contains matrix encoded surround sound, the chip decodes it and produces 3D virtualized surround sounds with two speakers.

FEATURES

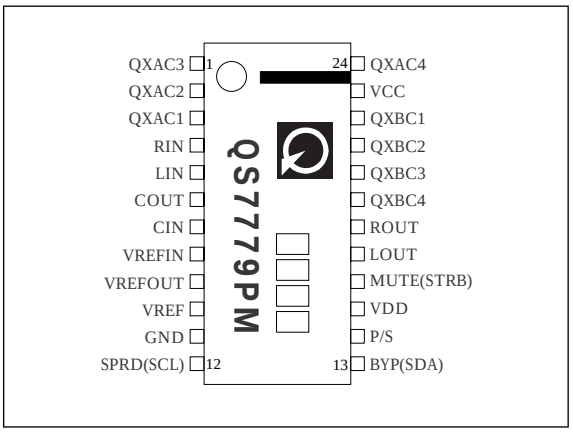
- Capable of decoding Dolby Surround materials such as Dolby Pro Logic or other matrix surround encoded materials (DVD/AC–3)
- Virtualized surround sound with two speakers
- 3D stereo sound enhancement
- Two enhanced levels
- Parallel and serial digital interface for mode control
  - QS7779CM for I^2C 2 control pins serial interface (Data, Clock)
  - QS7779PM for three-wire serial interface (Data, Clock and Strobe)
- Supply voltage (analog): 5 to 13V
  Supply voltage (digital): 4.5 to 5.5V
- 24-pin SSOP packaging

APPLICATIONS

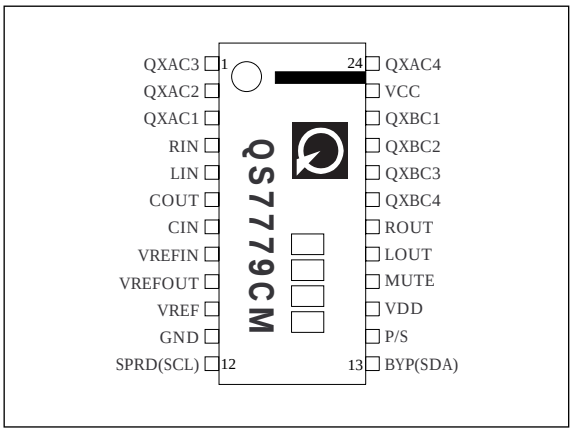
- DVD, Laser disk player
- Audio systems including TV, Radio and VCR
- Computer-based multimedia products, including sound cards and powered loudspeakers

PINOUT (Top view)

QS7779PM



QS7779CM



Using these products does not require any Dolby certifications.

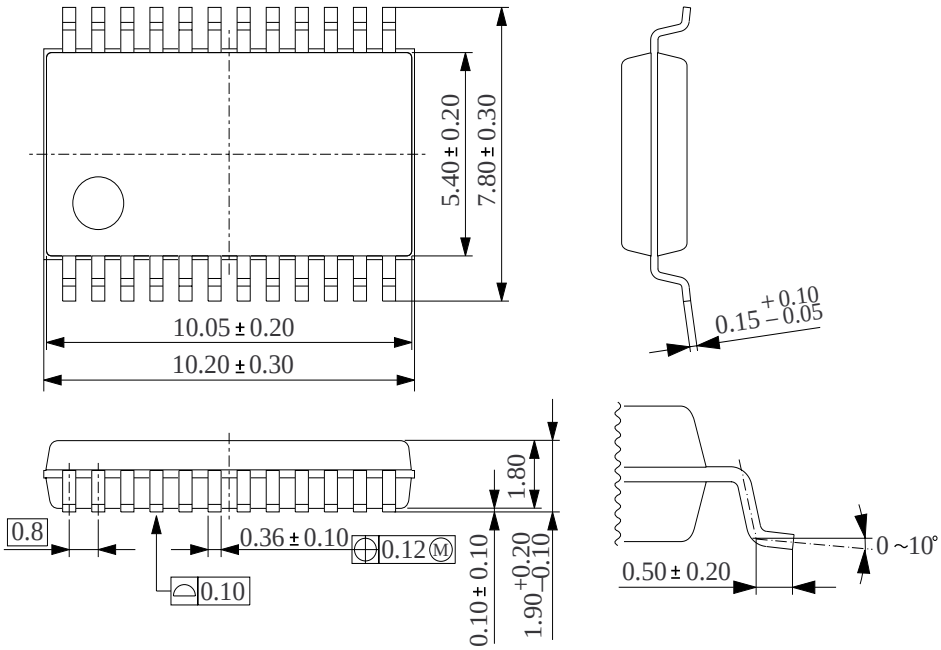
ORDERING INFORMATION

Device	Package
QS7779PM	24-pin SSOP
QS7779CM	24-pin SSOP

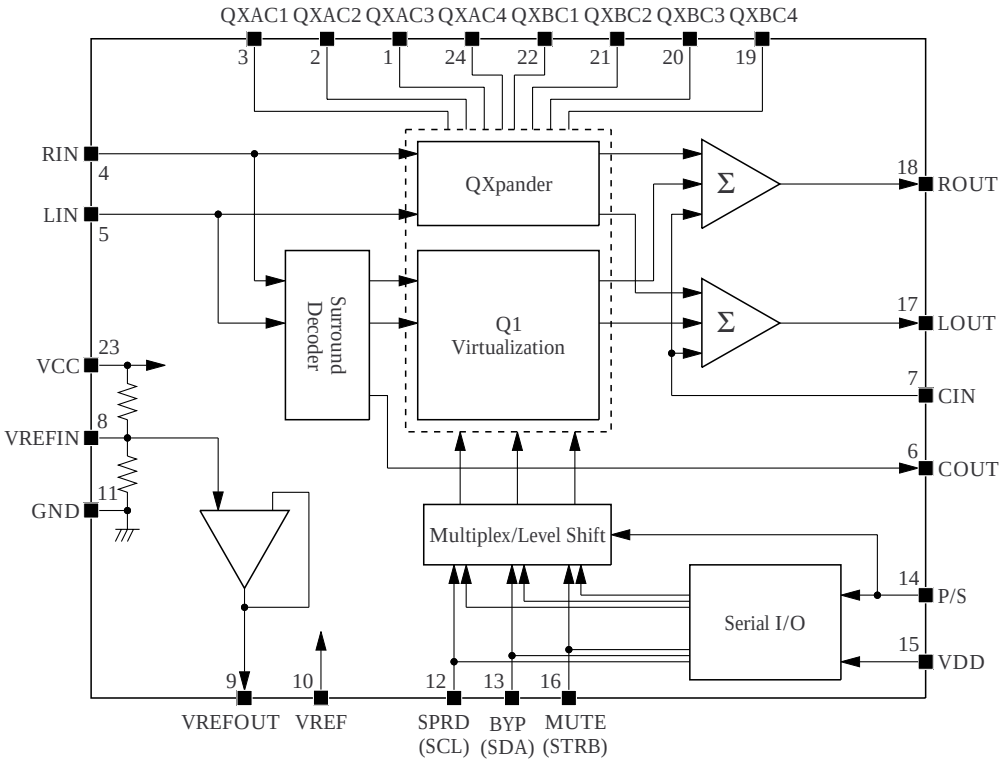
I^2C bus is a registered trademark of Philips Electronics N.V.
Dolby and the double-D symbol are registered trademarks of Dolby Laboratories Licensing Corporation.

PACKAGE DIMENSIONS

(Unit: mm)



BLOCK DIAGRAM



PIN DESCRIPTION

Number	Name		I/O	Description
	Parallel	Serial		
1	QXAC3		I	Capacitor 3 for QEXPANDER filter A
2	QXAC2		I	Capacitor 2 for QEXPANDER filter A
3	QXAC1		I	Capacitor 1 for QEXPANDER filter A
4	RIN		I	Right channel signal input
5	LIN		I	Left channel signal input
6	COUT		O	Decoded center signal output
7	CIN		I	Center signal input for summing with the right and the left signal outputs
8	VREFIN		O	Internally generated reference voltage (V_{CC}/2)
9	VREFOUT		O	Buffered reference voltage (V_{CC}/2)
10	VREF		I	Signal reference input
11	GND		–	Ground 0V
12	SPRD	–	I	Enhancement control (H: spread maximum, L: spread minimum)
	–	SCL[1]	I	Serial data shift clock
13	BYP	–	I	Bypass control (H: Bypass on, L: Qsurround on)
	–	SDA[2]	I/O	Serial data input. ACK data output for I^2C (QS7779CM)
14	P/S		I	Interface mode control (H: parallel I/O, L: serial I/O)
15	VDD		–	Digital power supply DC4.5 to 5.5V
16	MUTE	–	I	Output mute control (H: mute on, L: mute off)
	–	STRB	I	Serial data strobe (not applicable to I^2C of QS7779CM)
17	LOUT		O	Left signal output
18	ROUT		O	Right signal output
19	QXBC4		I	Capacitor 4 for QEXPANDER filter B
20	QXBC3		I	Capacitor 3 for QEXPANDER filter B
21	QXBC2		I	Capacitor 2 for QEXPANDER filter B
22	QXBC1		I	Capacitor 1 for QEXPANDER filter B
23	VCC		–	Analog power supply DC5 to 13V
24	QXAC4		I	Capacitor 4 for QEXPANDER filter A

1. QS7779CM:CMOS input. No protective diode between the terminal and VDD.
   QS7779PM:CMOS input. Protective diode is in between the terminal and VDD.
2. QS7779CM:Nch open drain terminal. No protective diode between terminal and VDD.
   QS7779PM:CMOS input. Protective diode is in between the terminal and VDD.

SPECIFICATIONS

Absolute Maximum Ratings

GND = 0V

Parameter	Symbol	Rating	Unit
Supply voltage (analog)	V_{CC}	– 0.3 to 15	V
Supply voltage (digital)	V_{DD}	– 0.3 to 7	V
Input voltage (analog)	V_{IANA}	– 0.3 to V_{CC} + 0.3	V
Input voltage (digital)	V_{IDIG}	– 0.3 to V_{DD} + 0.3	V
I^2C input voltage (SDA, SCL)	V_{IOPEN}	10	V
Power dissipation	P_D	250	mW
Storage temperature	T_{stg}	– 40 to 125	°C
Soldering temperature	T_{SLD}	255	°C
Soldering time	t_{SLD}	10	sec

Recommended Operating Conditions

GND = 0V

Parameter	Symbol	Limits	Unit
Supply voltage (analog)	V_{CC}	5 to 13	V
Supply voltage (digital)	V_{DD}	4.5 to 5.5	V
Operating temperature	T_{OPR}	– 20 to 70	°C

DC Electrical Characteristics

V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25 °C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit
			min	typ	max	
LIN, RIN analog input impedance	Z_{AIN1}		16	20	24	kΩ
CIN analog input impedance	Z_{AIN2}		4	5	6	kΩ
Reference voltage out	V_{REFOUT}		–	$V_{CC}/2$	–	V
HIGH-level input voltage	V_{IH}		$0.7 \times V_{DD}$	–	–	V
LOW-level input voltage	V_{IL}		–	–	$0.3 \times V_{DD}$	V
Input leakage current	I_{LEAK}		– 3	–	3	µA
SDA, SCL input leakage current (I^2C input pin)	I_{LOPEN}	V_{IN} = 10V	– 3	–	3	µA
SDA LOW-level output voltage	V_{OL}	Acknowledge signal out I_{OL} = 3mA	0	–	0.4	V
Supply voltage (analog)	V_{CC}		5	–	13	V
Supply voltage (digital)	V_{DD}		4.5	–	5.5	V
Current consumption (analog)	I_{CC}		–	5	6.5	mA
Current consumption (digital)	I_{DD}		–	0.3	0.5	mA
Standby current (analog)	I_{CCSAVE}		–	0.1	0.2	mA

Noise/THD Characteristics

V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25 °C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit
			min	typ	max	
Noise voltage	N_{BYP}	BYP = HIGH (Bypass mode), A-wgt, LOUT, ROUT	–	10	20	μV_{RMS}
Noise voltage	N_{QS}	BYP = LOW (Qsurround mode), SPRD = HIGH, A-wgt, LOUT, ROUT	–	20	40	μV_{RMS}
THD	THD_{QS}	LIN = RIN = $1V_{RMS}$, BYP = LOW (Qsurround mode), SPRD = HIGH, f = 1kHz	–	–	0.1	%

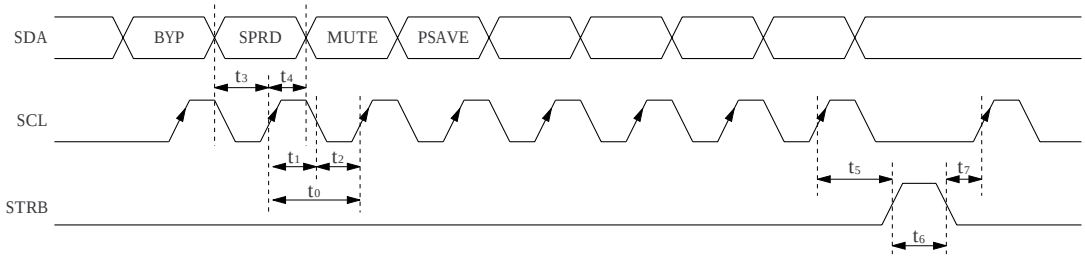
AC Electrical Characteristics

V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25 °C unless otherwise noted.

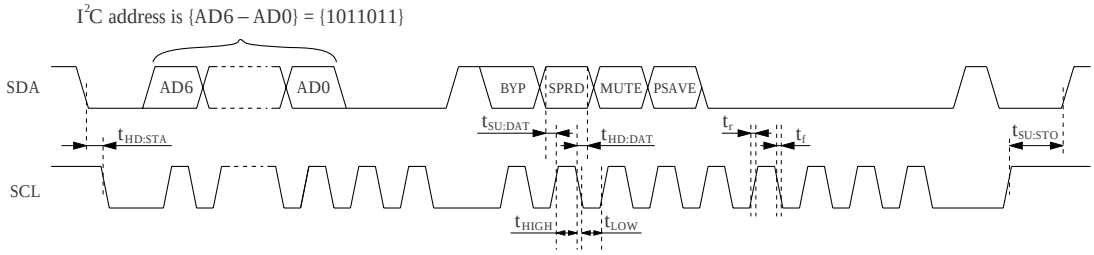
Parameter	Symbol	Condition	Limits			Unit
			min	typ	max	
Maximum input voltage 1	V_{FIN1}	LIN = RIN, BYP = LOW, SPRD = HIGH, f = 1kHz	1.4	–	–	V_{RMS}
Maximum input voltage 2	V_{FIN2}	LIN = – RIN, BYP = LOW, SPRD = HIGH, f = 1kHz	0.5	–	–	V_{RMS}
Bypass gain	G_{BYP}	BYP = HIGH, f = 1kHz, LIN to LOUT, RIN to ROUT	– 2	0	2	dB
Forward gain	G_F	SPRD = HIGH, BYP = LOW, f = 1kHz, LIN to LOUT, RIN to ROUT	6.6	8.6	10.6	dB
Crosstalk gain	G_{XF}	SPRD = HIGH, BYP = LOW, f = 1kHz, LIN to ROUT, RIN to LOUT	0.5	2.5	4.5	dB
SCL clock pulse cycle	t_0	PM version	100	–	–	ns
SCL HIGH-level clock pulse width	t_1	PM version	40	–	–	ns
SCL LOW-level clock pulse width	t_2	PM version	40	–	–	ns
SDA set-up time	t_3	PM version	15	–	–	ns
SDA hold time	t_4	PM version	30	–	–	ns
STRB set-up time	t_5	PM version	50	–	–	ns
STRB clock pulse width	t_6	PM version	100	–	–	ns
STRB hold time	t_7	PM version	50	–	–	ns
SCL hold time (I^2C)	$t_{HD:STA}$	CM version	4.0	–	–	µs
SCL set-up time (I^2C)	$t_{SU:STO}$	CM version	4.0	–	–	µs
SDA hold time (I^2C)	$t_{HD:DAT}$	CM version	5.0	–	–	µs
SDA set-up time (I^2C)	$t_{SU:DAT}$	CM version	250	–	–	ns
SCL HIGH-level clock pulse width (I^2C)	t_{HIGH}	CM version	4.0	–	–	µs
SCL LOW-level clock pulse width (I^2C)	t_{LOW}	CM version	4.7	–	–	µs
SCL rise time (I^2C)	t_r	CM version	–	–	1000	ns
SCL fall time (I^2C)	t_f	CM version	–	–	300	ns

Serial Interface

Three-wire serial interface (for QS7779PM)



I²C serial interface (for QS7779CM)



FUNCTIONAL DESCRIPTION

Operating Mode

This chip can be set to a desired operating mode by control pins for the parallel interface (P/S pin sets to HIGH) or control bits for the serial interface (P/S pin sets to LOW). The control pins or bits configurations are shown in the following table.

Mode No.	Control Pins/Bits				Operation (Output signal)		Description
	BYP	SPRD	MUTE	PSAVE	LOUT	ROUT	
1	1	×	0	0	LIN	RIN	Bypass mode
2	0	0	0	0	QX(LIN)	QX(RIN)	Stereo enhanced and virtual surround mode with lower enhanced level
3	0	1	0	0	QX+(LIN)	QX+(RIN)	Stereo enhanced and virtual surround mode with higher enhanced level
4	×	×	1	0	–	–	Mute mode
5	×	×	1	1	–	–	Power save mode. This function is available with serial interface only

Note1. ×: Don't care.
Note2. MUTE = 1 when PSAVE = 1

Mode description

Mode No.	Operating description
1	Bypass mode. Outputs the stereo signal as it is input.
2	Stereo Enhanced and virtual surround mode with lower enhanced level. The Dolby Surround Pro Logic signal (Lt, Rt) input. Available Surround Effect with two speakers by Qsurround technology. Virtual location of each signal is; The Front signal: Virtually outside of the speakers. The Rear signal: Virtually behind the listeners.
3	Stereo Enhanced and virtual surround mode with higher enhanced level. The Dolby Surround Pro Logic signal (Lt, Rt) input. Available Surround Effect with two speakers by Qsurround technology. This mode outputs the signals much more spread sound than Mode 2.
4	Mute mode. No signal at output pins.
5	Power save mode. This function is available with serial interface only.

Center signal output

CIN and COUT are used to emphasize the center signal.

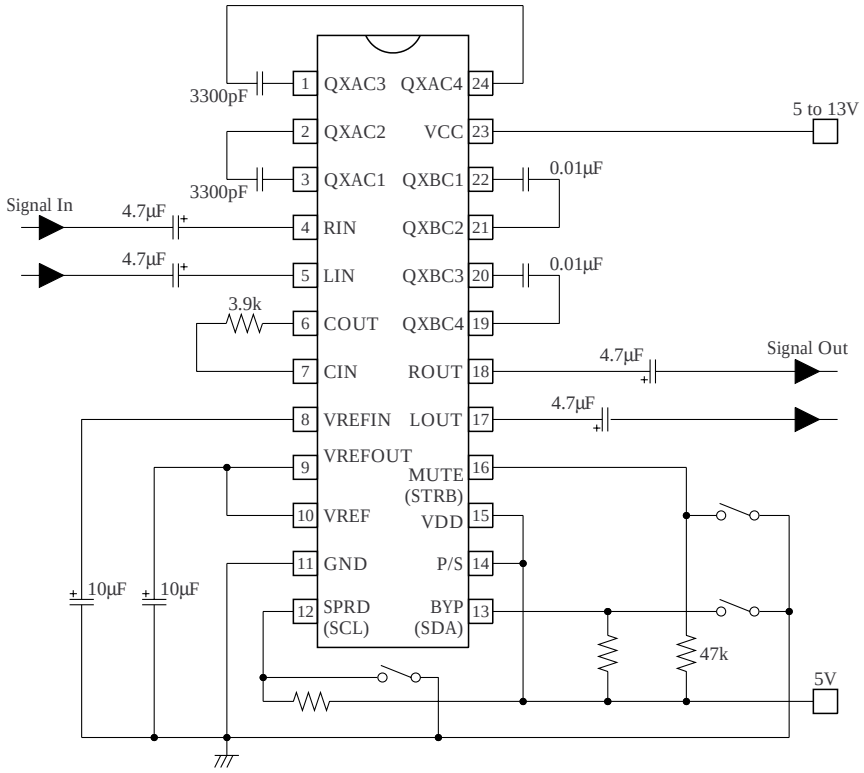
Pin	Description
CIN	Outputs the doubled signal to ROUT and LOUT always.
COUT	Outputs the half level of signal ((RIN+LIN)/2).

How to use CIN and COUT.

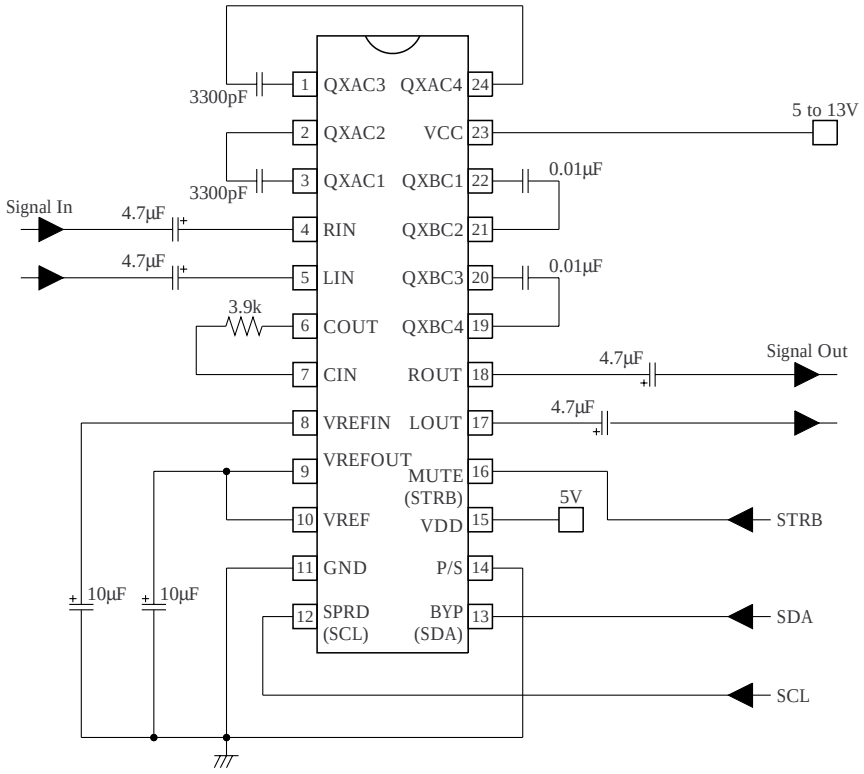
- Connect CIN and COUT with a resistor to make the center signal emphasized.
- Input resistance for CIN is 5kΩ. For example, connecting a 5kΩ resistor between CIN and COUT makes output of (RIN+LIN)/2 to ROUT and LOUT.
- Directly connecting CIN and COUT makes ROUT and LOUT output (RIN+LIN).

TYPICAL APPLICATION CIRCUIT

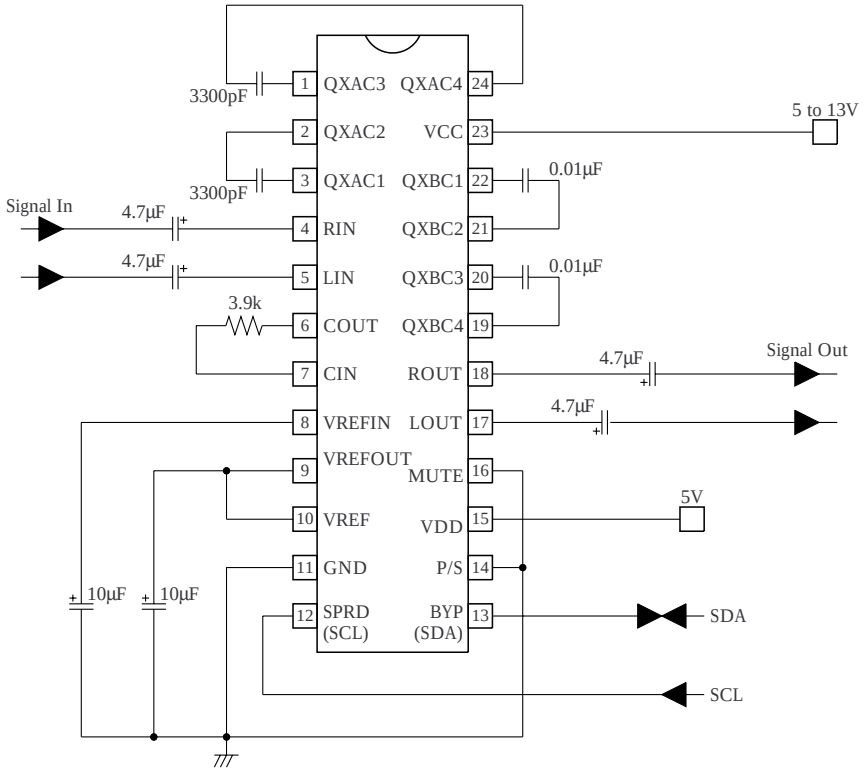
QS7779PM/CM with parallel interface



QS7779PM with serial interface



QS7779CM with serial interface



NPC
NIPPON PRECISION CIRCUITS INC.

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4-3, Fukuzumi 2-chome
Koto-ku, Tokyo 135-8430, Japan
Telephone: 03-3642-6661
Facsimile: 03-3642-6698

NC9817AE 1999.6

QS7779CM/QS7779PM

QSurround Matrix Surround Decoder/Virtualizer

Device Specifications - Preliminary Information

Overview:

The QS7779 is an audio processor IC which implements a decoder for a stereo matrix encoded source material such as Dolby Surround, along with surround virtualization using QSurround™ technology developed by QSound Labs, Inc. This chip also produces an enhanced stereo sound field for a stereo input signal. If the input signal contains matrix encoded surround sound, the chip automatically decodes it and produces virtualized surround sounds for two-speaker playback.

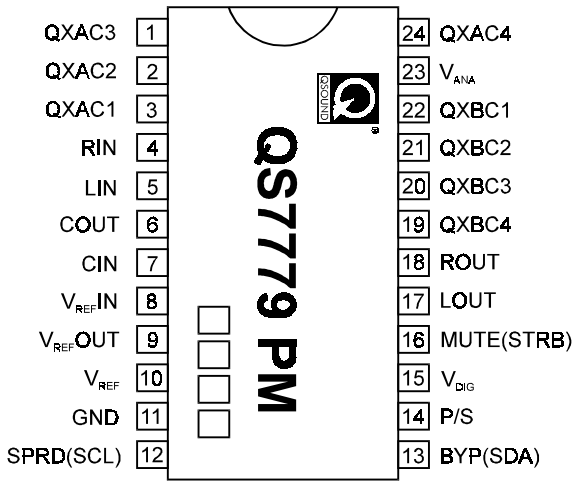
Feature:

- Dolby Surround decoder capability
- Virtualized surround sound with two speakers
- Stereo sound enhancement
- Center channel output option
- Two enhancement levels
- Parallel and serial digital interface for mode control
  - — QS7779CM for I^2C 2 control pins serial interface (Data, Clock)
  - — QS7779PM for 3 control pins serial interface (Data, Clock and Strobe)
- DC 5 to 13 volt supply
- 24-pin SSOP packaging

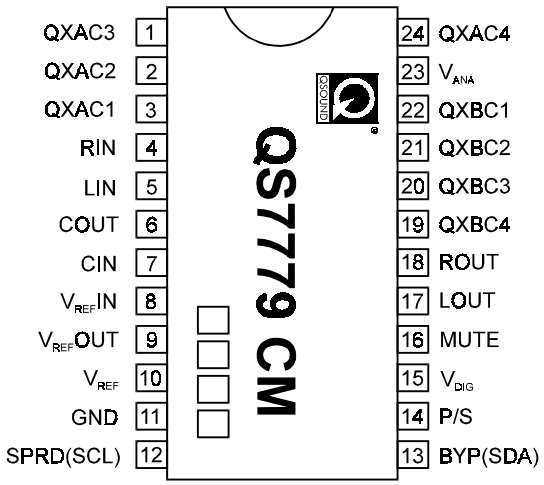
Application:

- Audio systems including TV, AV amps, Mini System, DVD, VCD, SVCD and VCR
- Computer-based multimedia products, including sound cards and powered loud speakers

Pin Configuration:



Three-Wire Serial Interface



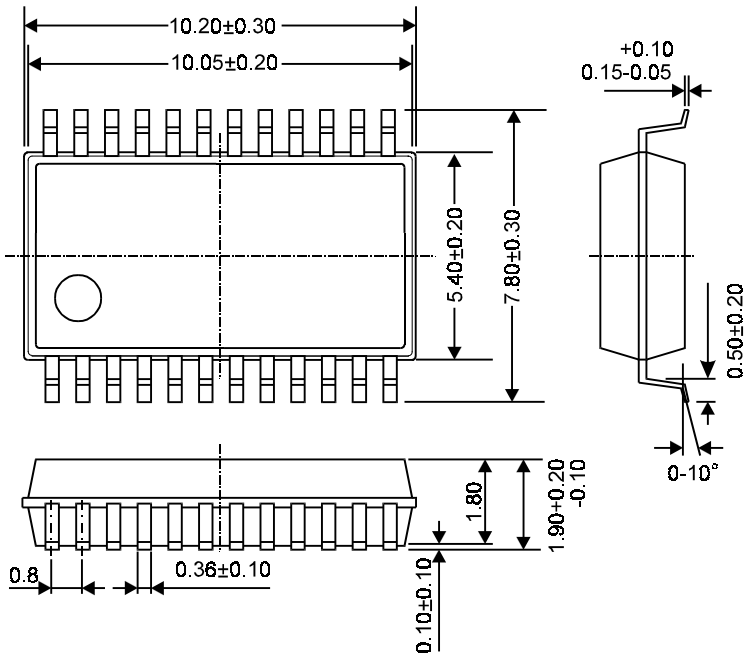
I^2C Serial Interface

QS7779CM/QS7779PM

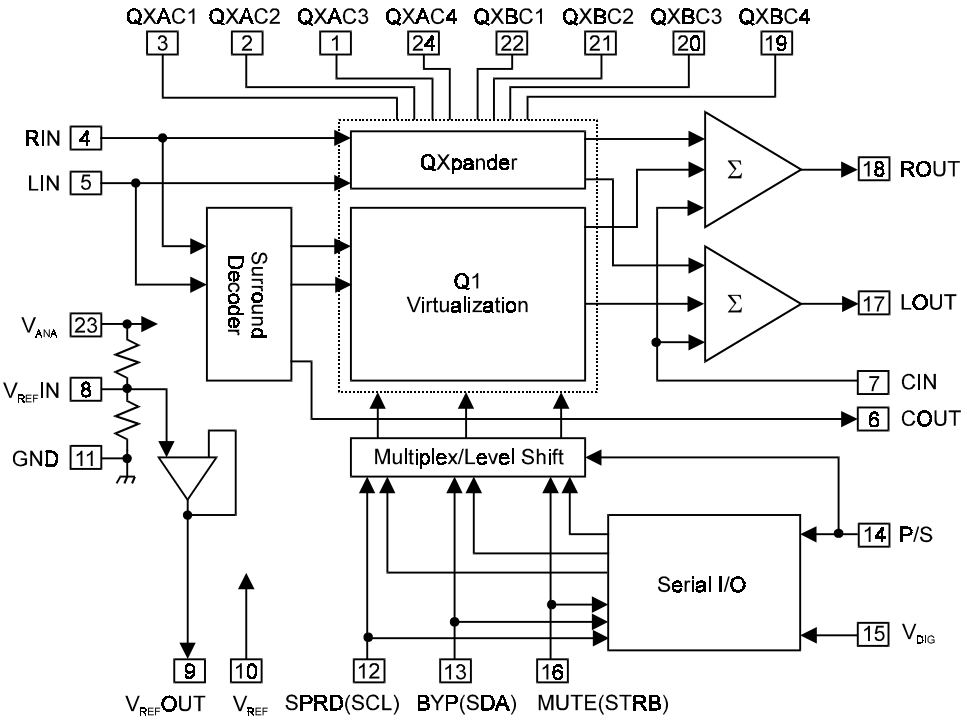
QSurround Matrix Surround Decoder/Virtualizer

Device Specifications - Preliminary Information

Packaging Dimension:



IC Block Diagram:



Pin Functions:

Number	Name		I/O	Description
	Parallel	Serial		
1	QXAC3		I	Capacitor
2	QXAC2		I	Capacitor
3	QXAC1		I	Capacitor
4	RIN		I	Right channel signal input
5	LIN		I	Left channel signal input
6	COUT		O	Decoded center signal output
7	CIN		I	Center signal input for summing to the right and the left signal output
8	V_{REF}IN		O	Internally generated reference voltage (V_{ANA}/2)
9	V_{REF}OUT		O	Buffered reference voltage (V_{ANA}/2)
10	V_{REF}		I	Signal reference input
11	GND		O	Ground
12	SPRD		I	Enhancement control (H: spread maximum, L: spread minimum)
		SCL	I	Serial data shift clock
13	BYP		I	Bypass control (H: Bypass On, L: Enhance process On)
		SDA	I/O	Serial data input (also ACK data output for I^2C of QS7779CM)
14	P/S		I	Interface mode control (H: parallel I/O, L: serial I/O)
15	V_{DIG}		-	Digital power supply
16	MUTE		I	Output mute control (H: mute on, L: mute off)
		STRB	I	Serial data strobe (Not applicable to I^2C of QS7779CM)
17	LOUT		O	Left signal output
18	ROUT		O	Right signal output
19	QXBC4		I	Capacitor
20	QXBC3		I	Capacitor
21	QXBC2		I	Capacitor
22	QXBC1		I	Capacitor
23	V_{ANA}		-	Analog power supply
24	QXAC4		I	Capacitor

Electrical Specification:

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage range (analog)	V_{ANA}	-0.3 to 15, and V_{ANA}>V_{DIG}-0.3	V
Supply voltage range (digital)	V_{DIG}	-0.3 to 7	V
Input voltage range (analog)	V_{IANA}	-0.3 to V_{ANA} +0.3	V
Input voltage range (digital)	V_{IDIG}	-0.3 to V_{DIG} +0.3	V
Power dissipation	P_D		mW
Storage temperature range	Tstg	-40 to 125	°C
Soldering temperature	T_{SLD}	255	°C
Soldering time	t_{SLD}	10	Sec

Recommended Operating Condition

Parameter	Symbol	Limits	Unit
Operating voltage (analog)	V_{ANA}	5 to 13 and V_{ANA}≥V_{DIG}	V
Operating voltage (digital)	V_{DIG}	4.5 to 5.5	V
Operating temperature range	T_{OPR}	0 to 70	°C

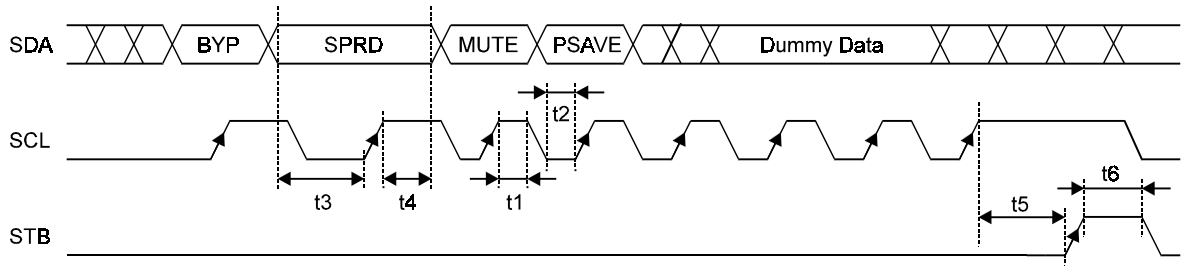
Electrical Characteristics

(V_{ANA}=9V,V_{DIG}=5V TA=25°C unless otherwise noted)

Parameter	Symbol	Condition	Limits/min	Limits/typ	Limits/max	Unit
Input voltage	V_{IN}	V_{ANA} = 12VDC;f = 1kHz;no clipping			1.2	V_{RMS}
Internal Gain	A_V	V_{ANA} = 12VDC;f = 1kHz;spread = max		+8.6		dB
Internal Gain bypass	A_B	V_{ANA} = 12VDC;f = 1kHz;Bypass		-0.1		dB
Analog input impedance	Z_{AIN}	L_{IN}, R_{IN}		20		kΩ
Reference voltage out	V_{REFOUT}			V_{ANA}/2		V
HIGH level input voltage	V_{IH}		2.4			V
LOW level input voltage	V_{IL}				0.5	V
HIGH level input current	I_{IH}	V_{IN}= V_{ANA}				µA
LOW level input current	I_{IL}	V_{IN}=GND				µA
SCL width HIGH	t_1		4.0			µS
SCL width LOW	t_2		4.7			µS
Set-up time, SDA to SCL	t_3		250			nS
Hold time, SCL to SDA	t_4		5.0			µS
Set-up time, SCL to STRB	t_5		250			nS
STRB width HIGH	t_6		5.0			µS
Hold time, SDA to SCL	$t_{HD;STA}$		4.0			µS
Set-up time, SCL to SDA	$t_{SU;STA}$		4.0			µS
Hold time, SCL to SDA	$t_{HD;DAT}$		5.0			µS
Set-up time, SDA to SCL	$t_{SU;DAT}$		250			nS
SCL width HIGH	t_{HIGH}		4.0			µS
SCL width LOW	t_{LOW}		4.7			µS
SCL rise time	t_R				1000	nS
SCL fall time	t_F				300	nS
Operating current (analog)	I_{ANA}				10	mA
Operating current (digital)	I_{DIG}				0.3	mA
Standby current (analog)	$I_{ANASAVE}$				0.1	mA
Standby current (digital)	$I_{DIGSAVE}$				0.035	mA
Signal to Noise Ratio	S/N	V_{ANA} = 12VDC;f = 1kHz;unweighted		96		dB
Frequency Response	f	V_{ANA} = 12VDC;f = 1kHz;Bypass	20		20k	Hz
Total Harmonic Distortion	THD	V_{ANA} = 12VDC;f = 1kHz;V_{IN} = 1 V_{RMS}		0.025		%

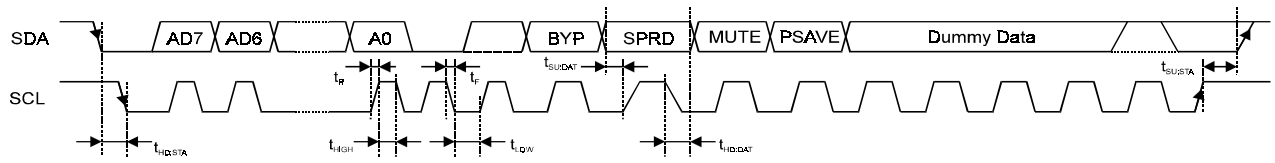
Serial Interface:

Serial interface with 3 control pins (for QS7779PM)



Serial interface with I²C (for QS7779CM)

I2C address is {AD7-AD0} = {10110110}



Operating Mode:

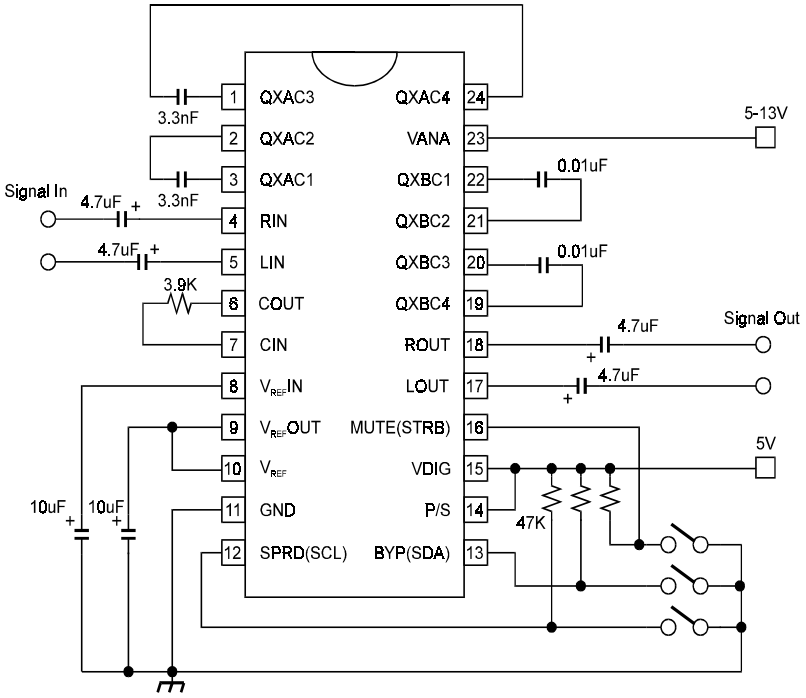
This chip can be set to desired operating mode by control pins for the parallel interface (P/S pin sets to 1) or control bits for the serial interface (P/S pin sets to 0). The control pins or bits configurations are shown in the following table.

Control Pins/Bits				Description
BYP	SPRD	MUTE	PSAVE	
1	X	0	0	Bypass mode.
0	0	0	0	Stereo enhanced and virtual surround mode with lower enhanced level
0	1	0	0	Stereo enhanced and virtual surround mode with higher enhanced level
X	X	1	0	Mute mode. No signal at output pins.
X	X	X	1	Power save mode. This function is available with serial interface only

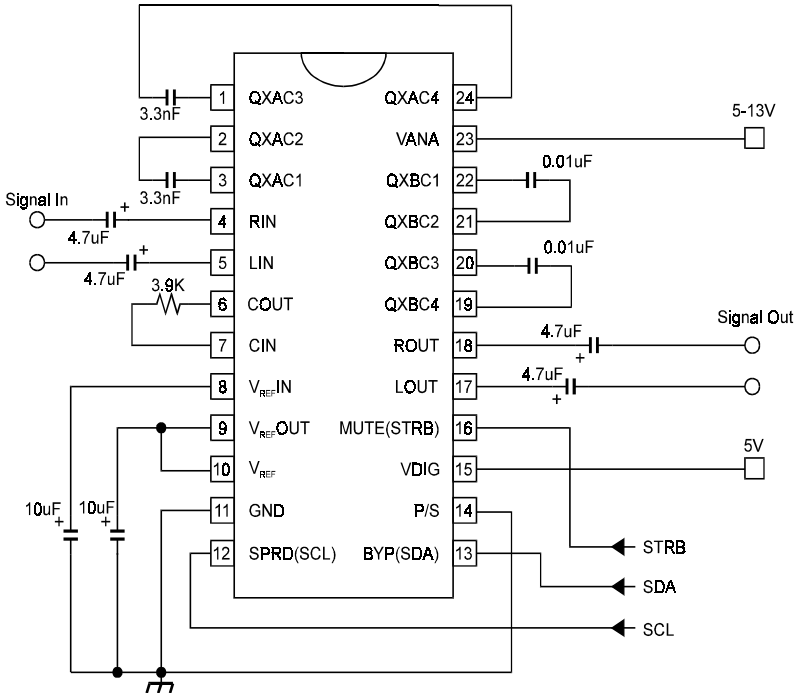
NOTE-1) X: don't care
NOTE-2) PSAVE is not available with the parallel interface.

Application (QS7779PM):

Parallel Interface

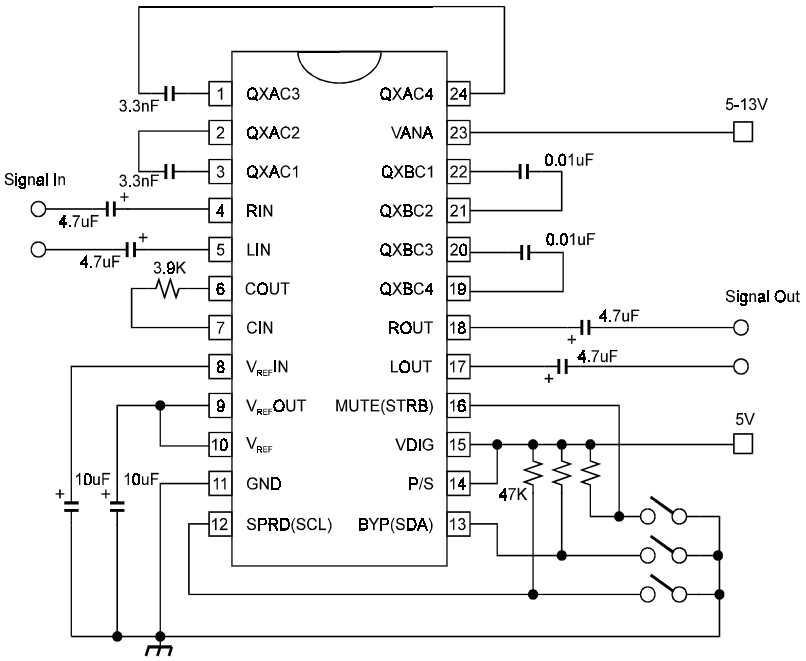


Serial Interface

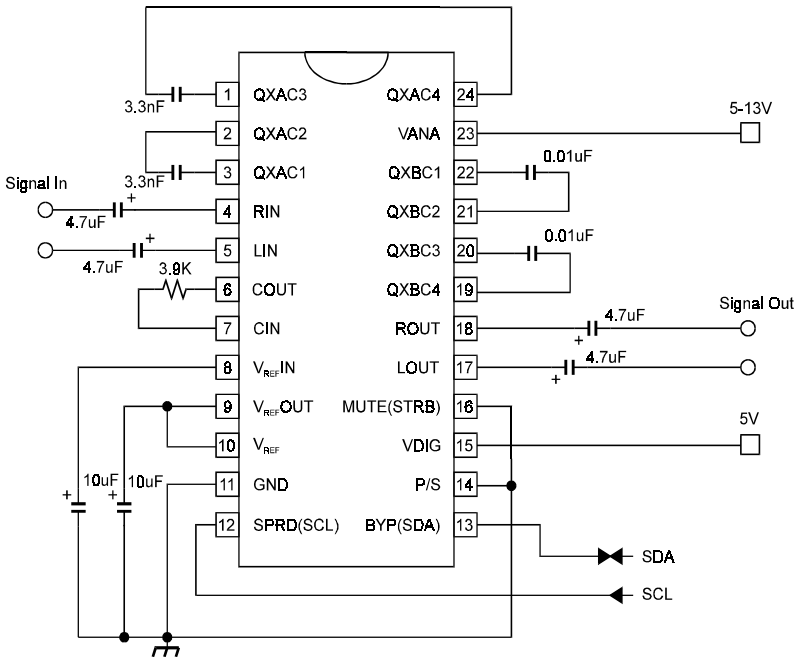


Application (QS7779CM):

Parallel Interface



Serial Interface



NIPPON PRECISION CIRCUITS INC.

QS7785PF/CF

3D 2/4-Channel Stereo Surround Synthesizer

OVERVIEW

The QS7785PF/CF is an audio processor IC that generates 2, 4, 5-channel stereo surround signals from 2-channel stereo or mono sources using QSurround™ technology developed and licensed by QSound Labs, Inc.

It can create 2-channel left and right surround effect signal for front speakers, and a rich enhanced surround signal using front speakers and surround speakers for 4-channel output. It also features a center signal output for clear listening of vocal and speech signals.

FEATURES

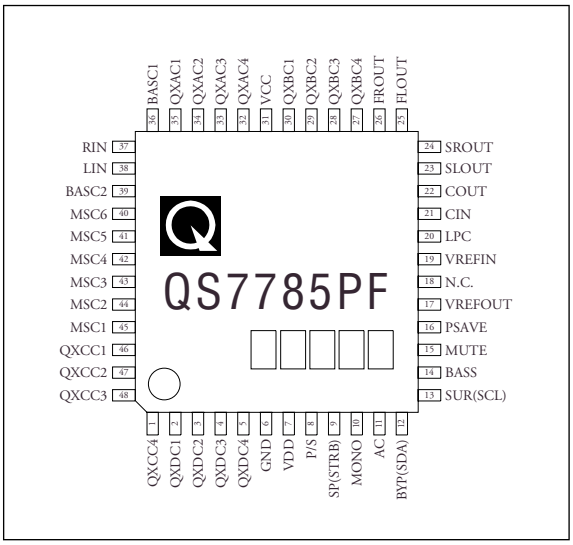
- Surround signal output for 2-channel front speakers
- Surround signal output for 4-channel front + surround speakers
- Center speaker output for voice signals
- Parallel and 2 serial interfaces for mode control supported
  - QS7785CF: I^2C bus 2-wire serial interface (Data and Clock)
  - QS7785PF: 3-wire serial interface (Data, Clock and Strobe)
- 5 to 13V analog supply
- 4.5 to 5.5V digital supply
- 48-pin QFP package

APPLICATIONS

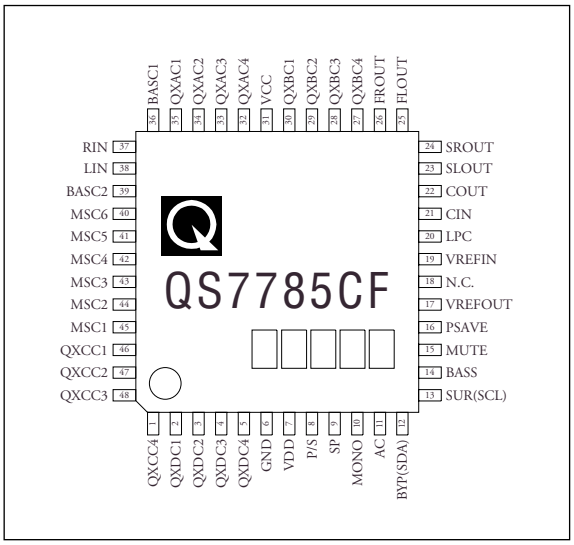
- TV, radio and VCRs
- Car audio
- Multimedia products

PINOUT (Top view)

QS7785PF



QS7785CF



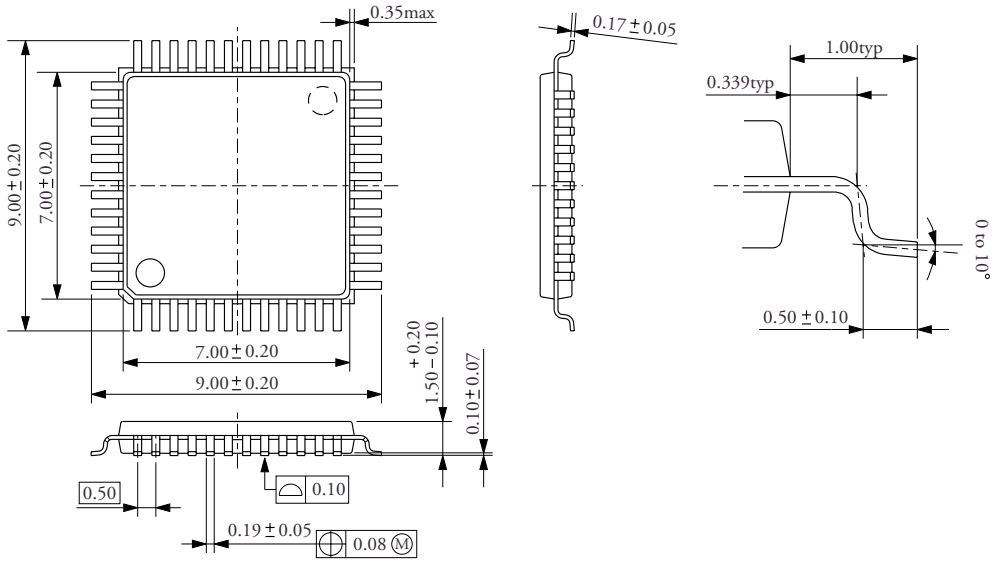
ORDERING INFORMATION

Device	Package
QS7785PF	48-pin QFP
QS7785CF	48-pin QFP

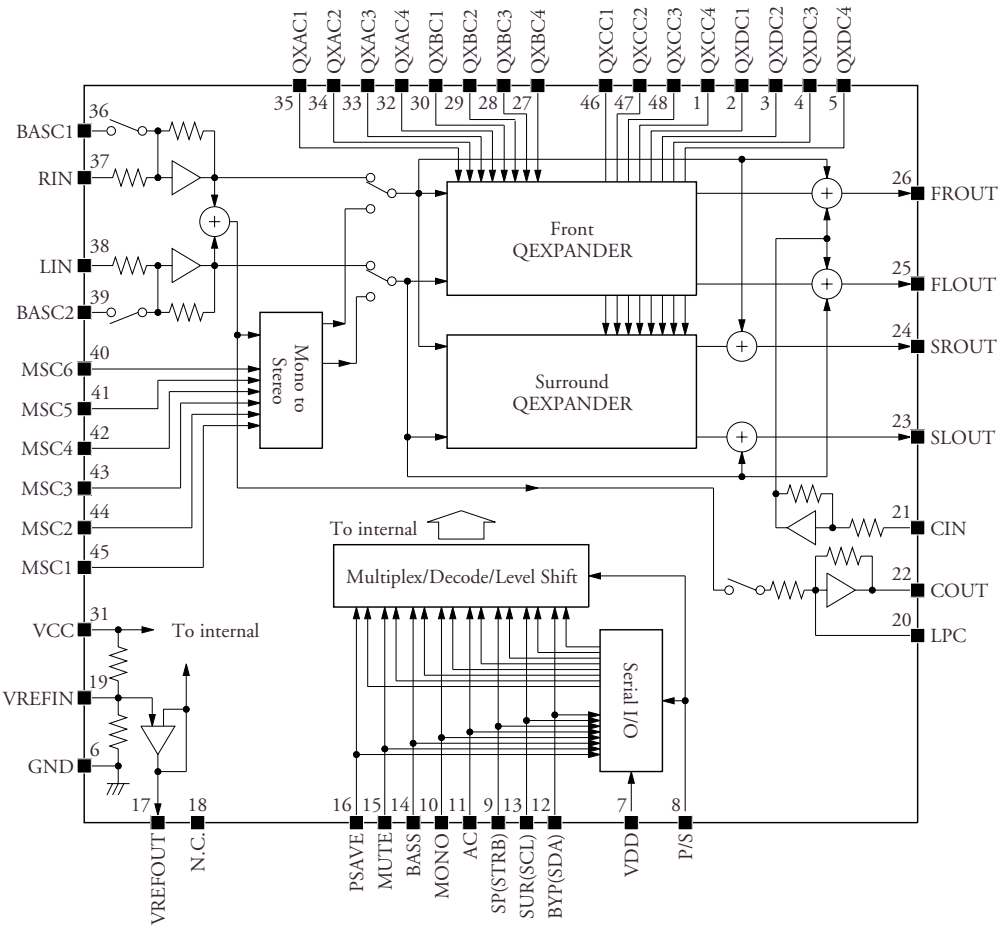
I^2C bus is a registered trademark of Philips Electronics N.V.
Dolby and the double-D symbol are registered trademarks of Dolby Laboratories Licensing Corporation.

PACKAGE DIMENSIONS

(Unit: mm)



BLOCK DIAGRAM



PIN DESCRIPTION

Number	Name		I/O	Description
	Parallel	Serial		
1	QXCC4		O	QEXPANDER C capacitor 4
2	QXDC1		I	QEXPANDER D capacitor 1
3	QXDC2		O	QEXPANDER D capacitor 2
4	QXDC3		I	QEXPANDER D capacitor 3
5	QXDC4		O	QEXPANDER D capacitor 4
6	GND		–	Ground
7	VDD		–	4.5 to 5.5V digital supply
8	P/S		I	Input mode control (HIGH: parallel, LOW: serial)
9	SP	–	I	Enhancement control (HIGH: high spread, LOW: low spread)
	–	STRB	I	Serial data strobe (not applicable to QS7785CF)
10	MONO		I	Mono-to-stereo convert select (HIGH: mono to stereo mode, LOW: normal mode)
11	AC		I	Center output control (HIGH: center on, LOW: center off)
12	BYP	–	I	Bypass control (HIGH: bypass, LOW: Qsurround)
	–	SDA	I/O	Serial data input (also serves as ACK signal output for I^2C bus)
13	SUR	–	I	Surround speaker control (HIGH: surround speaker on, LOW: off)
	–	SCL	I	Serial clock signal input
14	BASS		I	Bass boost mode control (HIGH: bass boost on, LOW: bass boost off)
15	MUTE		I	Mute signal control (HIGH: mute on, LOW: mute off)
16	PSAVE		I	Power save control (HIGH: power save on, LOW: power save off)
17	VREFOUT		O	$V_{CC}/2$ reference voltage output
18	NC		–	No connection
19	VREFIN		I	$V_{CC}/2$ reference voltage output (biased internally to $V_{CC}/2$)
20	LPC		I	Center output lowpass filter
21	CIN		I	COUT output signal feedback input for front-channel output
22	COUT		O	Center signal output
23	SLOUT		O	Surround left-channel signal output
24	SROUT		O	Surround right-channel signal output
25	FLOUT		O	Front left-channel signal output
26	FROUT		O	Front right-channel signal output
27	QXBC4		O	QEXPANDER B capacitor 4
28	QXBC3		I	QEXPANDER B capacitor 3
29	QXBC2		O	QEXPANDER B capacitor 2
30	QXBC1		I	QEXPANDER B capacitor 1
31	VCC		–	5 to 13V DC analog supply
32	QXAC4		O	QEXPANDER A capacitor 4
33	QXAC3		I	QEXPANDER A capacitor 3
34	QXAC2		O	QEXPANDER A capacitor 2
35	QXAC1		I	QEXPANDER A capacitor 1
36	BASC1		I	Bass boost right-channel signal input

Number	Name		I/O	Description
	Parallel	Serial		
37	RIN		I	Right-channel signal input
38	LIN		I	Left-channel signal input
39	BASC2		I	Bass boost left-channel signal input
40	MSC6		I	Mono/stereo conversion filter capacitor 6
41	MSC5		I	Mono/stereo conversion filter capacitor 5
42	MSC4		I	Mono/stereo conversion filter capacitor 4
43	MSC3		I	Mono/stereo conversion filter capacitor 3
44	MSC2		I	Mono/stereo conversion filter capacitor 2
45	MSC1		I	Mono/stereo conversion filter capacitor 1
46	QXCC1		I	QEXPANDER C capacitor 1
47	QXCC2		O	QEXPANDER C capacitor 2
48	QXCC3		I	QEXPANDER C capacitor 3

SPECIFICATIONS

Absolute Maximum Ratings

GND = 0V

Parameter	Symbol	Rating	Unit
Supply voltage range (analog)	V_{CC}	–0.3 to 15	V
Supply voltage range (digital)	V_{DD}	–0.3 to 7	V
Input voltage range (analog)	V_{IANA}	–0.3 to V_{CC} + 0.3	V
Input voltage range (digital)	V_{IDIG}	–0.3 to V_{DD} + 0.3	V
I^2C signal input voltage (SDA, SCL)	V_{IOPEN}	10	V
Power dissipation	P_D	250	mW
Storage temperature range	T_{stg}	–40 to 125	°C

Recommended Operating Conditions

GND = 0V

Parameter	Symbol	Rating	Unit
Supply voltage range (analog)	V_{CC}	5 to 13	V
Supply voltage range (digital)	V_{DD}	4.5 to 5.5	V
Operating temperature range	T_{opr}	–20 to 85	°C

DC Characteristics

V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25°C

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Analog input impedance	Z_{AIN1}	LIN, RIN	16	20	24	kΩ
	Z_{AIN2}	CIN	8	10	12	
Reference voltage output	V_{REFOUT}		–	V_{CC}/2	–	V
HIGH-level input voltage	V_{IH}		0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}		–	–	0.3V_{DD}	V
Input leakage current	I_{LEAK}	Digital inputs, V_{DD} input voltage	–3	–	3	µA
	I_{ILOPD}	SDA, SCL, 10V input voltage	–3	–	3	
LOW-level output voltage	V_{OL}	ACK signal output from SDA, 3mA sink current	0	–	0.4	V
Supply voltage (analog)	V_{CC}		5	–	13	V
Supply voltage (digital)	V_{DD}		4.5	–	5.5	V
Current consumption (analog)	I_{CC}		–	6	8	mA
Current consumption (digital)	I_{DD}		–	0.3	0.5	mA
Standby current (analog)	I_{CCSAVE}		–	0.1	0.2	mA

Noise and THD Characteristics

V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25°C

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Bypass noise voltage	N_{BYP}	BYP = HIGH, SUR = MONO = SP = LOW, “A”-wgt, FLOUT, FROUT	–	10	20	$µV_{RMS}$
Qsurround noise voltage (front)	N_{QSF}	SUR = SP = HIGH, BYP = MONO = LOW, “A”-wgt, FLOUT, FROUT	–	20	40	$µV_{RMS}$
Qsurround noise voltage (surround)	N_{QSR}	SUR = SP = HIGH, BYP = MONO = LOW, “A”-wgt, SLOUT, SROUT	–	15	30	$µV_{RMS}$
Bypass total harmonic distortion	THD_B	BYP = SUR = HIGH, MONO = SP = LOW, LIN = RIN = 1V_{RMS}, f = 1kHz, FLOUT, FROUT, SLOUT, SROUT	–	–	0.1	%
Qsurround mono total harmonic distortion	THD_{QM}	BYP = LOW, SUR = MONO = SP = HIGH, LIN = RIN = 1V_{RMS}, f = 1kHz, FLOUT, FROUT, SLOUT, SROUT	–	–	0.1	%

AC Characteristics

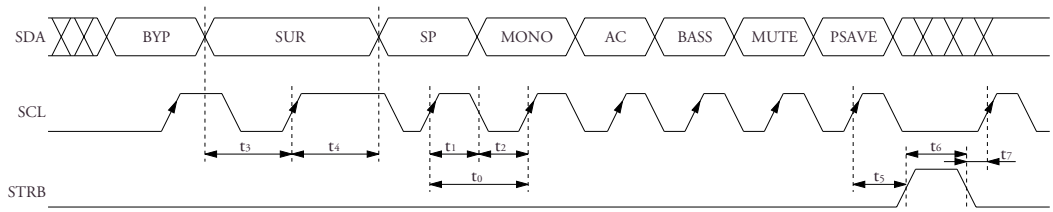
V_{CC} = 9V, V_{DD} = 5V, GND = 0V, Ta = 25°C

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Bypass-mode maximum input voltage	V_B	BYP = SUR = HIGH, MONO = SP = LOW, LIN = RIN, f = 1kHz	1.7	2.3	–	V_{RMS}
Qsurround enhanced-mode maximum input voltage	V_{Q+}	BYP = MONO = SUR = LOW, SP = HIGH, LIN = RIN, f = 1kHz	1.8	2.4	–	V_{RMS}
Qsurround-mode maximum input voltage (surround speakers on)	V_{QS}	BYP = MONO = SP = LOW, SUR = HIGH, LIN = RIN, f = 1kHz	1.3	1.7	–	V_{RMS}
Mono/stereo conversion enhanced mode maximum input voltage	V_{M+}	BYP = SUR = LOW, MONO = SP = HIGH, LIN = RIN, f = 1kHz	0.8	1.0	–	V_{RMS}
Mono/stereo conversion mode maximum input voltage (surround speakers on)	V_{MS}	BYP = SP = LOW, MONO = SUR = HIGH, LIN = RIN, f = 1kHz	0.8	1.0	–	V_{RMS}
Bypass gain	G_{BYP1}	BYP = HIGH, MONO = SUR = SP = LOW, LIN to FLOUT, RIN to FROUT, f = 1kHz	–2	0	2	dB
Bypass gain (surround speakers on)	G_{BYP2}	BYP = SUR = HIGH, MONO = SP = LOW, LIN to SLOUT, RIN to SROUT, f = 1kHz	–2	0	2	dB
Qsurround mode gain	G_Q	BYP = MONO = SUR = SP = LOW, LIN to FLOUT, RIN to FROUT, f = 1kHz	3.9	5.9	7.9	dB
Qsurround mode crosstalk gain	G_{QX}	BYP = MONO = SUR = SP = LOW, LIN to FROUT, RIN to FLOUT, f = 1kHz	–1.5	0.5	2.5	dB
Qsurround mode gain (surround)	G_{QS}	BYP = MONO = SP = LOW, SUR = HIGH, LIN to SLOUT, RIN to SROUT, f = 1kHz	–2.3	–0.3	1.7	dB
Qsurround mode crosstalk gain (surround)	G_{QXS}	BYP = MONO = SP = LOW, SUR = HIGH, LIN to SROUT, RIN to SLOUT, f = 1kHz	–1.9	0.1	2.1	dB
Qsurround enhanced mode gain	G_{Q+}	BYP = MONO = SUR = LOW, SP = HIGH, LIN to FLOUT, RIN to FROUT, f = 1kHz	4.7	6.7	8.7	dB
Qsurround enhanced mode crosstalk gain	G_{QX+}	BYP = MONO = SUR = LOW, SP = HIGH, LIN to FROUT, RIN to FLOUT, f = 1kHz	1.3	3.3	5.3	dB
Mono/stereo conversion mode left-channel gain	G_{ML}	BYP = SUR = SP = LOW, MONO = HIGH, LIN = RIN, FLOUT, f = 1kHz	2.6	4.6	6.6	dB
Mono/stereo conversion mode right-channel gain	G_{MR}	BYP = SUR = SP = LOW, MONO = HIGH, LIN = RIN, FROUT, f = 1kHz	3.6	5.6	7.6	dB
Mono/stereo conversion enhanced mode left-channel gain	G_{ML+}	BYP = SUR = LOW, MONO = SP = HIGH, LIN = RIN, FLOUT, f = 1kHz	2.4	4.4	6.4	dB
Mono/stereo conversion enhanced mode right-channel gain	G_{MR+}	BYP = SUR = LOW, MONO = SP = HIGH, LIN = RIN, FROUT, f = 1kHz	3.3	5.3	7.3	dB
Mono/stereo conversion mode surround left-channel gain	G_{MSL}	BYP = SP = LOW, MONO = SUR = HIGH, LIN = RIN, SLOUT, f = 1kHz	–3.8	–1.8	0.2	dB
Mono/stereo conversion mode surround right-channel gain	G_{MSR}	BYP = SP = LOW, MONO = SUR = HIGH, LIN = RIN, SROUT, f = 1kHz	–1.6	0.4	2.4	dB
SCL clock pulse period	t_0	QS7785PF	100	–	–	ns
SCL clock HIGH-level pulsewidth	t_1	QS7785PF	40	–	–	ns
SCL clock LOW-level pulsewidth	t_2	QS7785PF	40	–	–	ns
SDA setup time	t_3	QS7785PF	15	–	–	ns
SDA hold time	t_4	QS7785PF	30	–	–	ns
STRB setup time	t_5	QS7785PF	50	–	–	ns
STRB pulsewidth	t_6	QS7785PF	100	–	–	ns
STRB hold time	t_7	QS7785PF	50	–	–	ns

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
SCL hold time (I^2C)	$t_{HD:STA}$	QS7785CF	4.0	–	–	µs
SCL setup time (I^2C)	$t_{SU:STO}$	QS7785CF	4.0	–	–	µs
SDA hold time (I^2C)	$t_{HD:DAT}$	QS7785CF	5.0	–	–	µs
SDA setup time (I^2C)	$t_{SU:DAT}$	QS7785CF	250	–	–	ns
SCL clock HIGH-level pulsewidth (I^2C)	t_{HIGH}	QS7785CF	4.0	–	–	µs
SCL clock LOW-level pulsewidth (I^2C)	t_{LOW}	QS7785CF	4.7	–	–	µs
SCL rise time (I^2C)	t_r	QS7785CF	–	–	1000	ns
SCL fall time (I^2C)	t_f	QS7785CF	–	–	300	ns

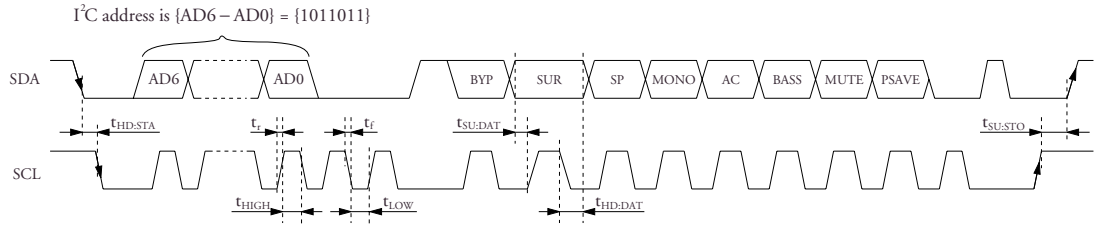
Serial Interface Timing

3-wire (QS7785PF) timing



Pin	Description
SDA	Data signal. Sets mode settings. See “Operating Modes.”
SCL	Clock signal. Data is read on the rising edge.
STRB	Strobe signal. Mode switches occur on the rising edge of this signal.

I^2C 2-wire (QS7785CF) timing



Pin	Description
SDA	Data signal. Sets slave address and mode settings. Address value, {1011011}, is shown in the figure above. See “Operating Modes.”
SCL	Clock signal. Data is read on the rising edge.

FUNCTIONAL DESCRIPTION

Operating Modes

The QS7785PF/CF operating mode can be controlled over either a parallel interface (P/S = HIGH) or one of two serial interfaces (P/S = LOW). The operating mode, control pins and SDA signal relationship is shown in the table below. Refer to "Serial Interface Timing" for the SDA signal format.

Output mode

No.	Input signals	Control pins/SDA signal				Output signals[1]	
		BYP	MONO	SUR	SP	FROUT/FLOUT	SROUT/SLOUT
1	Stereo only	0	0	0	0	Stereo Q	–
2		0	0	0	1	Stereo Q+	–
3		0	0	1	0	Stereo Q	Stereo Q1
4		0	0	1	1	Stereo Q+	Stereo Q1
5	Mono only	0	1	0	0	Mono → Stereo Q	–
6		0	1	0	1	Mono → Stereo Q+	–
7		0	1	1	0	Mono → Stereo Q	Mono → Stereo Q1
8		0	1	1	1	Mono → Stereo Q+	Mono → Stereo Q1
9	Stereo/Mono	1	0	0	×	Stereo bypass	–
10		1	0	1	×	Stereo bypass	Stereo bypass
11		1	1	0	×	–	Stereo bypass
12	Stereo only	1	1	1	×	Stereo bypass	Stereo Q1

1. – (dash) = no output signal.
   × = indicates don't care.
   1 = HIGH, 0 = LOW

Output signal description

Output signal	Description
Stereo Q	Mixed front-channel Qsurround processed signal and input stereo signal output
Stereo Q+	Same as Stereo Q with increased Qsurround signal component and reduced input stereo signal component.
Stereo Q1	Mixed surround-channel Qsurround processed signal and input stereo signal output.
Mono → Stereo Q	Mono signal converted to virtual stereo signal, and then processed in the same way as Stereo Q signals.
Mono → Stereo Q+	Mono signal converted to virtual stereo signal, and then processed in the same way as Stereo Q+ signals.
Stereo bypass	Input stereo signal is output as-is without processing.

Mono signals should be input on both LIN and RIN.

In output mode 1, the output signal is a mixed signal comprising the front-channel Qsurround processed signal and the input stereo signal, that is output on the 2-channel front speakers only.

In output mode 2, the signal path is the same as in output mode 1, but the surround effect is enhanced by increasing the component of the Qsurround processed signal and reducing the component of the input stereo signal.

In output modes 3 and 4, both the front speakers and surround speakers are used to form a 4-channel system for a rich surround space. The front-channel signal is the same as in output modes 1 and 2. The surround-channel signal is a mixed signal comprising an enhanced surround effect Qsurround processed signal and the input stereo signal.

In output modes 5 to 8, the input signal is a mono signal. The mono signal is first converted to a virtual stereo signal and then processed in the same way as in output modes 1 to 4, respectively. In modes 5 and 6, the surround signal is output on 2-channel front speakers only. In modes 7 and 8, the surround signals are output on 4-channel front and surround speakers.

In output modes 9 to 11, the input stereo signal is output to the speakers without processing. The bypass function works for both stereo and mono input signals, and is used to listen to the original signals. In mode 9, the stereo signal is output on front speakers only. In mode 10, the stereo signal is output on both front and surround speakers. In mode 11, the stereo signal is output on surround speakers only.

In output mode 12, the input stereo signal is output on front speakers, and a surround effect enhanced signal is output on the surround speakers.

Center signal output

Control pins/SDA signal[1]					Output signal
BYP	MONO	SUR	SP	AC	COUT
×	×	×	×	0	–
×	×	×	×	1	(RIN + LIN) / 2

1. – (dash) = no output signal.
   × = indicates don't care.
   1 = HIGH, 0 = LOW

The center signal is output on COUT. See "Center Control."

Bass boost mode

Control pins/SDA signal[1]						Output signal		
BYP	MONO	SUR	SP	AC	BASS	FROUT/FLOUT	SROUT/SLOUT	COUT
×	×	×	×	×	0	Bass boost OFF	Bass boost OFF	Bass boost OFF
×	×	×	×	×	1	Bass boost ON	Bass boost ON	Bass boost ON

1. × = indicates don't care.
   1 = HIGH, 0 = LOW

The bass boost function is used to enhance the bass frequency component. See "Bass Boost."

Mute and power save

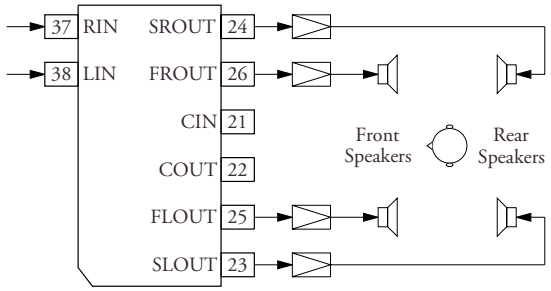
Control pins/SDA signal[1]								Output signal		
BYP	MONO	SUR	SP	AC	BASS	MUTE	PSAVE	FROUT/FLOUT	SROUT/SLOUT	COUT
×	×	×	×	×	×	0	0	Available	Available	Available
×	×	×	×	×	×	1	0	–	–	–
×	×	×	×	×	×	1	1	–	–	–

1. – (dash) = no output signal.
   × = indicates don't care.
   1 = HIGH, 0 = LOW

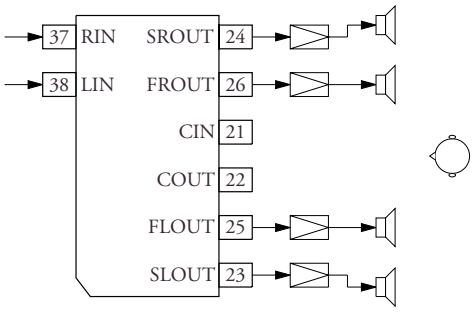
When PSAVE is HIGH, the analog stages of the device are turned OFF to save power. When MUTE is HIGH, all outputs are muted.

Speaker Arrangement

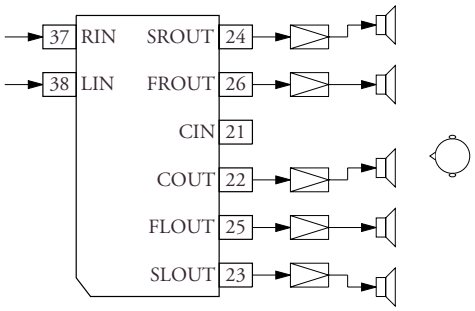
The QS7785PF/CF supports the following speaker arrangements.



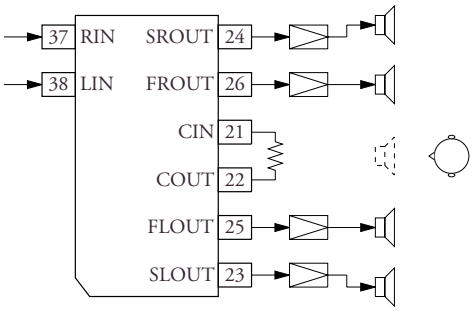
Type A. Two front speakers in front and two surround speakers in rear



Type B. Front speakers and surround speakers in front



Type C. Front speakers and surround speakers in front with actual center speaker



Type D. Front speakers and surround speakers in front with center

Type A

The front speakers are placed in front and the surround speakers are placed behind the audience to create a full rich enhanced space. Since the output signal for each channel has undergone Qsurround processing, the audio enhancement can be reduced to an adequate level even for television and similar signals where the left and right channels are located close to each other.

Type B

The front speakers and surround speakers are both placed in front of the audience, perhaps because it is not possible to place speakers behind the audience. If the surround speakers are turned to face outwards, to spread the surround signal, the surround effect can be obtained.

Type C

A center speaker can be added in the center to reproduce vocal and speech signals for easy listening. The center signal is output on COUT. The signal is comprised of LIN and RIN signals, producing a sound image in the center.

Type D

If a center speaker is not available or not required, COUT can be connected to CIN using a resistor and the center signal is then added to the front-channel signal. The presence of the center signal added to the front channels reproduces the center signal sound image with virtually the same effect as that obtained using a center speaker. The connection using a resistor can be utilized for voice and similar fixed-band signals. See “Center Control” for a description of the method.

Center Control

The center signal output on COUT is enabled when AC is HIGH.

This section describes the output function whereby fixed frequency sound sources, such as vocal and speech signals, can be output on the center signal. As mentioned for "Type C" and "Type D" speaker arrangements, the center signal can be output by direct connection to a speaker or by adding the signal to the front-channel output using a resistor connection between CIN and COUT.

Using a center speaker

When using a speaker, a capacitor Ca can be connected between LPC and COUT, forming a lowpass filter. The −3dB cutoff frequency of the filter is given by the following equation.

$$f = \frac{1}{2\pi Ca \times R1}$$

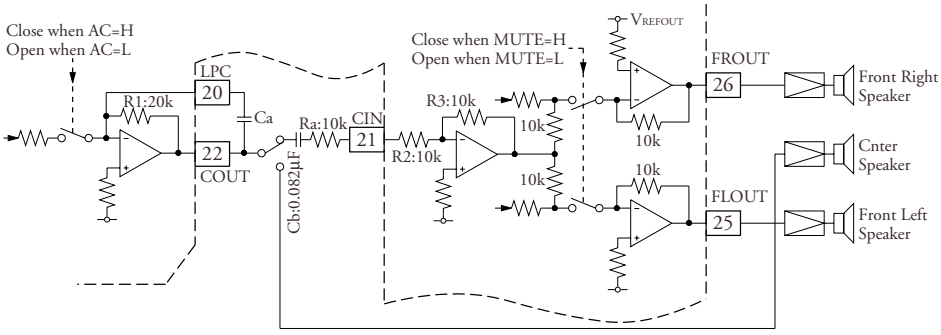
Frequencies higher than voice tones are cut from the signal sent to the center speaker for clear reproduction of voice-band signals.

Adding to the front-channel output

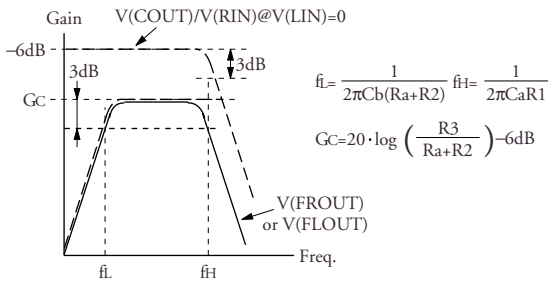
With this connection, the bass frequency components can be removed from a signal. Capacitors Ca and Cb and resistor Ra can be connected between CIN and COUT to form a highpass filter. The −3dB cutoff frequency of the filter is given by the following equation.

$$f = \frac{1}{2\pi Cb(Ra + R2)}$$

The input signal on CIN is added equally to both front-channel outputs FLOUT and FROUT. Frequencies lower than voice tones are cut from the signal added to the front-channel outputs for clear reproduction of voice-band signals.



Center output connection

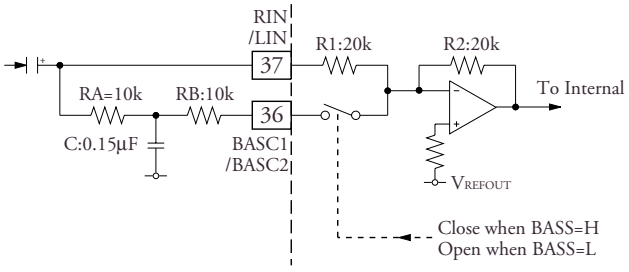


Center output frequency response

Note: Internal resistance value, R1 and R2, may vary ± 15%.

Bass Boost

With a signal input connected to BASC1 and BASC2, a bass boost function can be implemented. When BASS is HIGH, resistors RA and RB and capacitor C are connected to form a lowpass filter. The lowpass filter signal and the original signal (RIN, LIN) are combined to boost bass frequencies.



Bass boost connection (Gb = 6dB, f_C = 300Hz)

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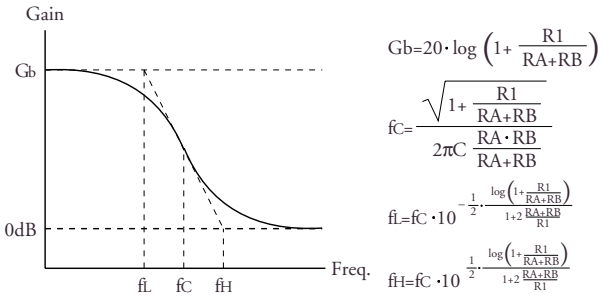
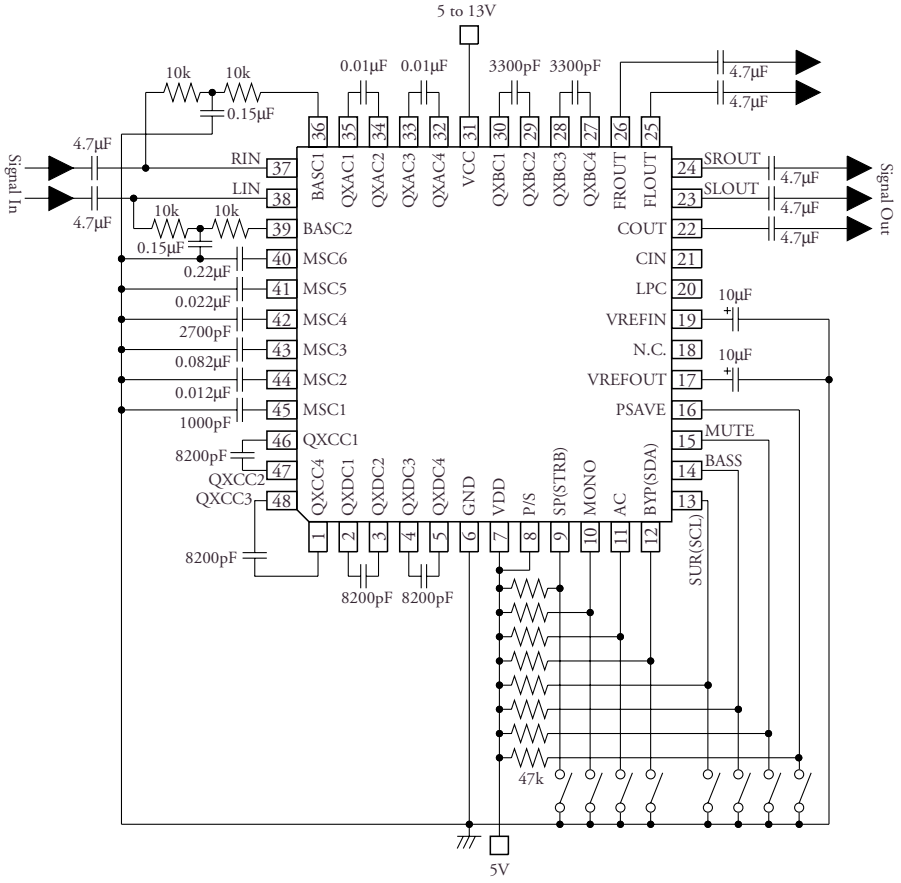


Bass boost frequency response

TYPICAL APPLICATIONS

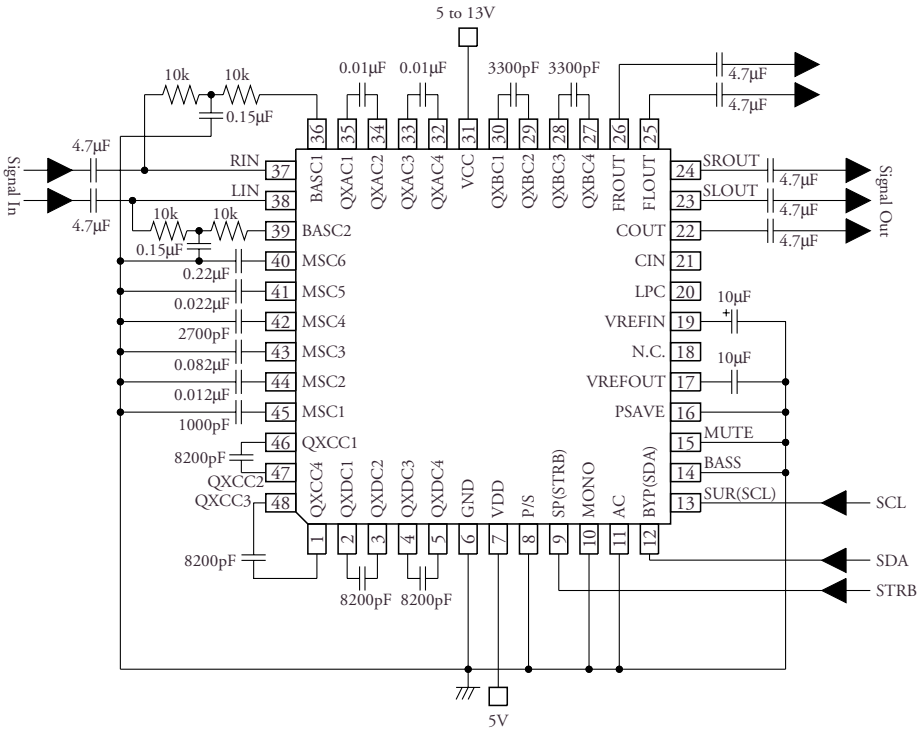
Parallel Interface



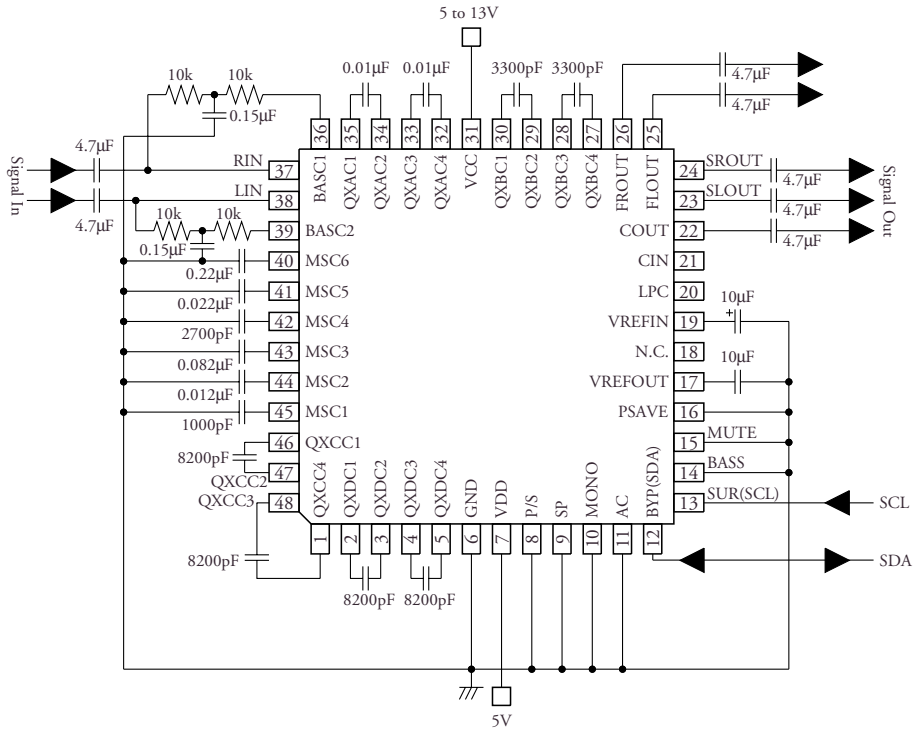
A capacitor for decoupling should be connected between supply and ground.

Serial Interface

QS7785PF



QS7785PF



A capacitor for decoupling should be connected between supply and ground.

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