DSP with eala / eala Stereo Expander / FIR Filter

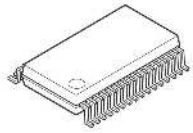
■ General Description

The NJU26040-18A is a digital audio signal processor that provides the function eala / eala Rebirth or eala expand speaker + 128tap FIR filter.

The NJU26040-18A processes a lot of sound sources, such as DVD, CD, AM/FM radio, and TV sound into spacious sound of natural surround by eala technology. Also even if there is a small speaker system, NJU26040-18A make rich sound with LPC technology.

The applications of NJU26040-18A are suitable for stereo outputs products such as DVD Receivers, AV Amplifiers, TV, radio-cassettes player or ordinary audio products such as small speakers system.

■ Package



NJU26040V-18A

■ FEATURES

- Software

- NJRC original eala surround is offered to the stereo I/O product.
- NJRC original “eala Rebirth” is sound enhancement for compression audio.
- NJRC original “eala Stereo Expander” is wider stereo effect.
- Stereo 128 tap FIR filter for NJRC **L**inear **P**hase **C**orrection (LPC) Technology is easier correction of speaker characteristic.
- 1’st order HPF for stereo input signal.
- Simplified passive matrix 6 channels output.
- Input Trim / Master Volume with smooth control.
- Watch Dog Clock output.

- Hardware

- 24bit Fixed-point Digital Signal Processing
- Maximum System Clock Frequency : 38MHz Max
- Digital Audio Interface : 3 Input ports / 3 Output ports
- Digital Audio Format : I^2S 24bit, Left-justified, Right-justified, BCK : 32fs/64fs
- Master / Slave Mode : Master Mode MCK : 1/2 fclk, 1/3 fclk
  ex. MCK = 384Fs(1/2) or MCK = 256Fs(1/3) at fclk=768Fs
- Power Supply : 3.3V
- Input terminal : 5V Input tolerant
- Package : SSOP32 (Pb-Free)
- Micro computer interface : I^2C bus (standard-mode/100kbps, fast-mode/400kbps)
  : 4-Wire Serial Bus (4-wire: clock, enable, input data, output data)

The detail hardware specification is described in the “ NJU26040 Series Data Sheet (NJU26040_E_REL.pdf)”.

■ Function Block Diagram

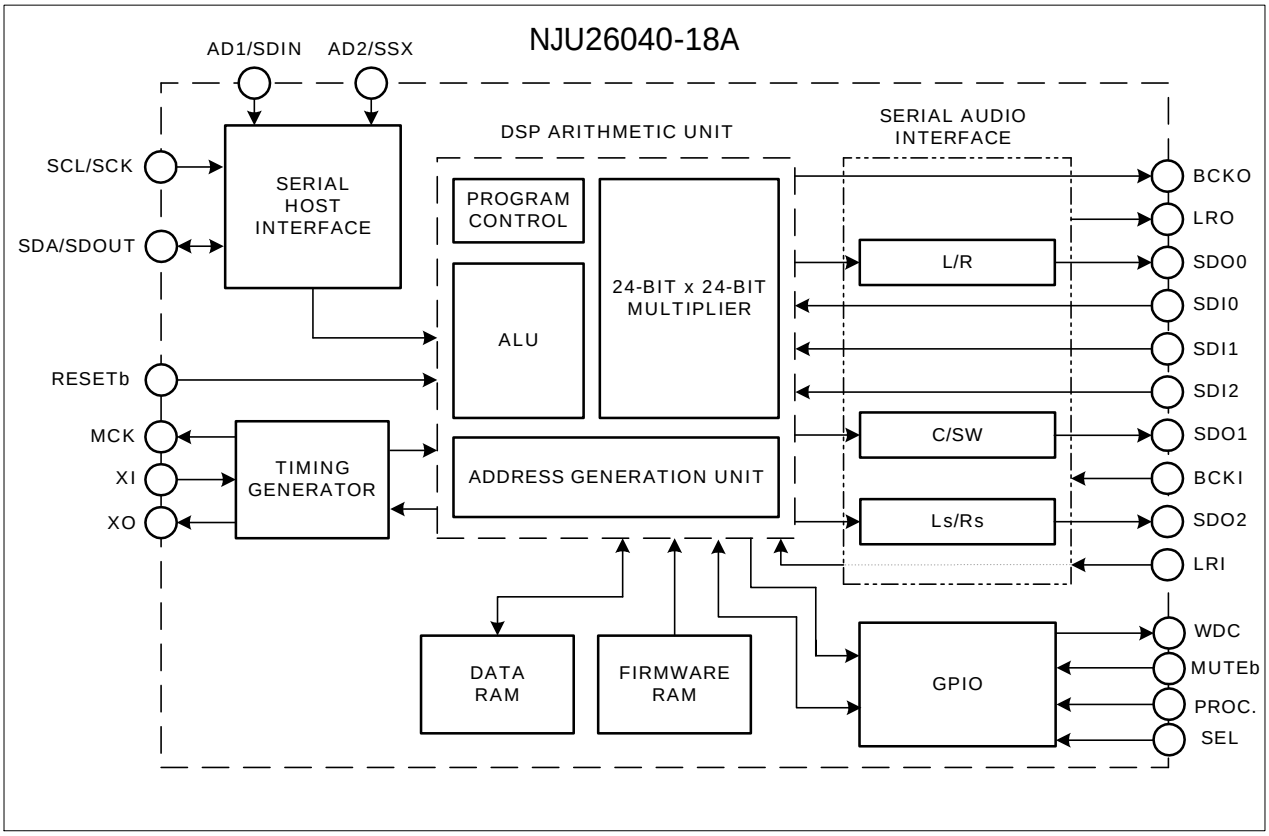


Fig. 1 NJU26040-18A Block Diagram

■ DSP Block Diagram

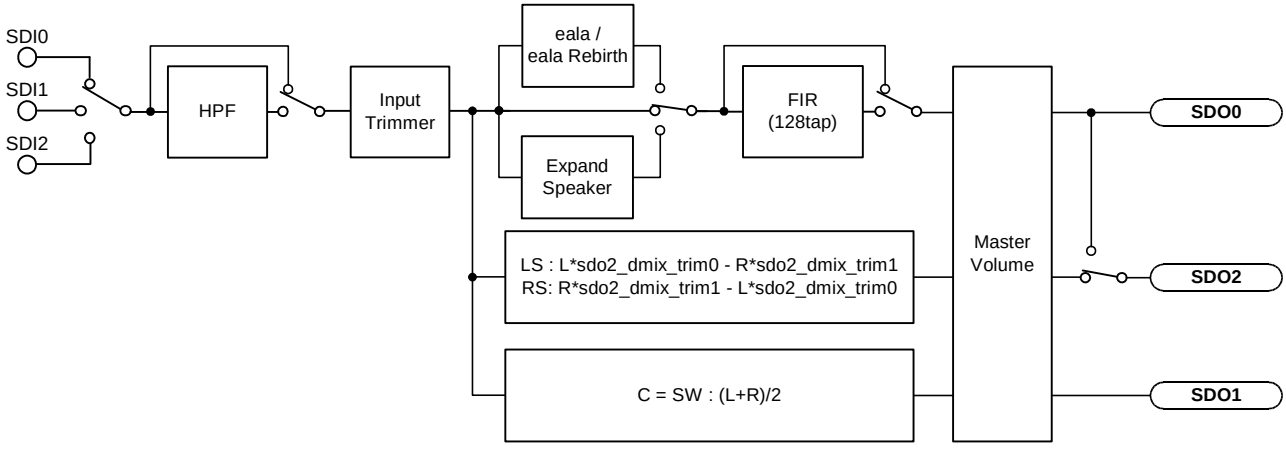


Fig. 2 NJU26040-18A Function Diagram

■ Pin Configuration

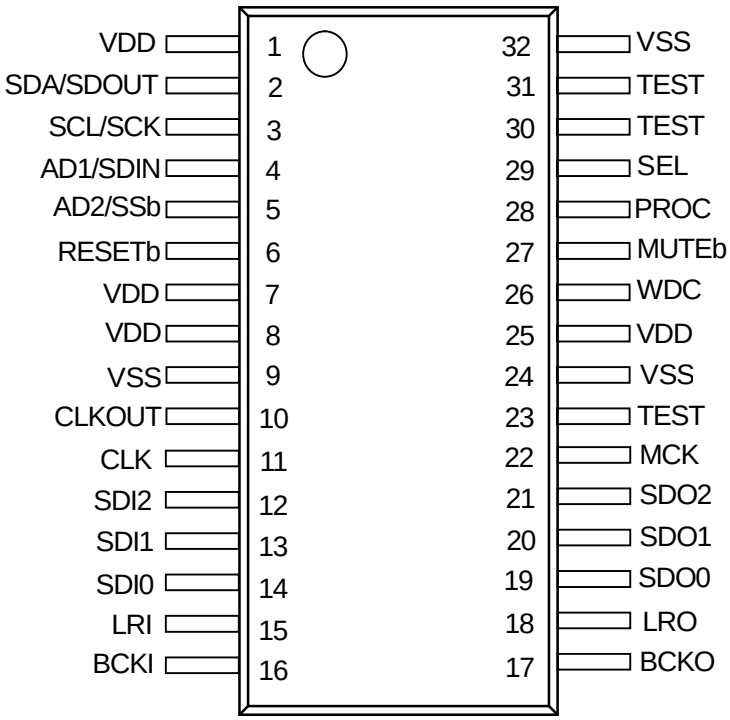


Fig. 3 NJU26040-18A Pin Configuration

■ Pin Description

Table 1 Pin Description

Pin No.	Symbol	I/O	Description
1, 7, 8, 25	VDD	-	Power Supply +3.3V
2	SDA / SDOUT	OD	Serial Data Input/Output (I^2C) / Serial Data Output (4-wire Serial) This pin requires a pull-up.
3	SCL / SCK	I	Serial Clock (I^2C) / Serial Clock (4-wire Serial)
4	AD1 / SDIN	I	Address Select 1 (I^2C) / Serial Data Input (4-wire Serial)
5	AD2 / SSb	I	Address Select 2 (I^2C) / Serial Enable (4-wire Serial)
6	RESETb	I	Reset (RESETb = "Low" : DSP reset)
9, 24, 32	VSS	-	GND
10	CLKOUT	O	OSC Clock Output
11	CLK	I	OSC Clock Input
12	SDI2	I	Audio Data Input 2
13	SDI1	I	Audio Data Input 1
14	SDI0	I	Audio Data Input 0
15	LRI	I	LR Clock Input
16	BCKI	I	Bit Clock Input
17	BCKO	O	Bit Clock Output
18	LRO	O	LR Clock Output
19	SDO0	O	Audio Data Output 0 (L/R)
20	SDO1	O	Audio Data Output 1 (C/SW)
21	SDO2	O	Audio Data Output 2 (Ls/Rs)
22	MCK	O	Master Clock Output for A/D, D/A
23, 30, 31	TEST	I -	for Test (connect to VSS)
26	WDC	I/O+	Output for Watch Dog Timer (Open drain output)
27	MUTEb	I/O-	Master Volume status after reset, "Low" : Mute "High" : 0dB
28	PROC	I/O-	DSP status after reset, "Low" : Wait start command "High" : Do signal procedure without start command
29	SEL	I/O-	Select serial host interface "Low" : I^2C bus "High" : 4-wire serial bus

Note : I : Input
I - : Input (Pull-down)
O : Output
OD : Bi-directional (Open Drain) This pin requires a pull-up resistance.
I/O+ : Bi-directional (with Pull-up resistance)
I/O- : Bi-directional (with Pull-down resistance)

■ Digital Audio Interface

The NJU26040-18A audio interface provides industry standard serial data format of I^2S. The NJU26040-18A audio interface provides three audio data inputs, three audio data outputs as shown in table 2, table 3.

Table 2 Serial Audio Input Pin

Pin No.	Symbol	Description
12	SDI2	Audio Data Input 2 (L/R)
13	SDI1	Audio Data Input 1 (L/R)
14	SDI0	Audio Data Input 0 (L/R)

Table 3 Serial Audio Output Pin

Pin No.	Symbol	Description
19	SDO0	Audio Data Output 0 (L/R)
20	SDO1	Audio Data Output 1 (C/SW)
21	SDO2	Audio Data Output 2 (Ls/Rs)

■ Host Interface

The NJU26040-18A can be controlled via Serial Host Interface (SHI) using either of two serial bus formats:I^2C bus or 4-Wire serial bus.(Table 4) Data transfers are in 8-bit packets (1 byte) when using either format.

Table 4 Serial Host Interface Pin Description

Pin No.	Symbol	Setting	Host Interface
29	SEL	"Low"	I^2C bus
		"High"	4-Wire serial bus

Table 5 Serial Host Interface Pin Description

Pin No.	Symbol (I^2C bus / Serial)	I^2C bus Format	4-Wire Serial bus Format
2	SDA / SDOUT *	Serial Data Input/Output (Open Drain Input/Output)	Serial Data Output (Open-Drain Output)
3	SCL / SCK *	Serial Clock	Serial Clock
4	AD1 / SDIN *	I^2C bus address Bit1	Serial Data Input
5	AD2 / SSb *	I^2C bus address Bit2	Serial enable

Note : SDA pin is a bi-directional open drain.
This pin requires a pull-up resistance in both I^2C bus and 4-Wire serial mode.
When the power supply (V_{DD}= +3.3V) is supplied to NJU26040-18A, these pins become +5.0V Input tolerant.

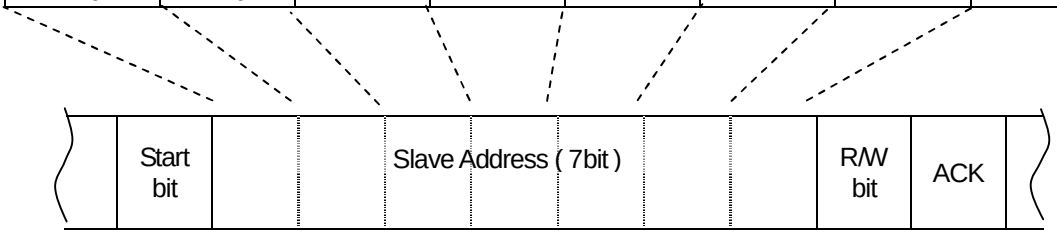
■ I²C bus

I²C bus interface transfers data to the SDA pin and clocks data to the SCL pin.

AD1 and AD2 pins are used to configure the seven-bit SLAVE address of the serial host interface. (Table 6) This offers additional flexibility to a system design by four different SLAVE addresses of the NJU26040-18A. An address can be arbitrarily set up by the AD1 and AD2 pins. The I²C address of AD1/AD2 is decided by connection of AD1/AD2 pins.

Table 6 I²C bus SLAVE Address

bit7	bit6	bit5	bit4	bit3	AD2 bit2	AD1 bit1	R/W bit0
0	0	1	1	1	0	0	R/W
0	0	1	1	1	0	1	
0	0	1	1	1	1	0	
0	0	1	1	1	1	1	



* SLAVE address is 0 when AD1/2 is “Low”. SLAVE address is 1 when AD1/2 is “High”.

Note : The serial host interface supports “Standard-Mode (100kbps)” and “Fast-Mode (400kbps)” I²C bus data transfer.

■ 4-Wire Serial Interface

SHI bus communication is full-duplex; a write byte is shifted into the SDIN pin at the same time that a read byte is shifted out of the SDOUT pin. Data transfers are MSB first and are enabled by setting the Slave Select pin Low (SSb=0). Data is clocked into SDIN on rising transitions of SCK. Data is latched at SDOUT on falling transitions of SCK except for the first byte (MSB) which is latched on the falling transitions of SSb.

SDOUT is Hi-Z in case of SSb = “High”. SDOUT is Open-drain output in case of SSb = “Low”. SDOUT needs a pull-up resistor when SDOUT is Hi-Z.

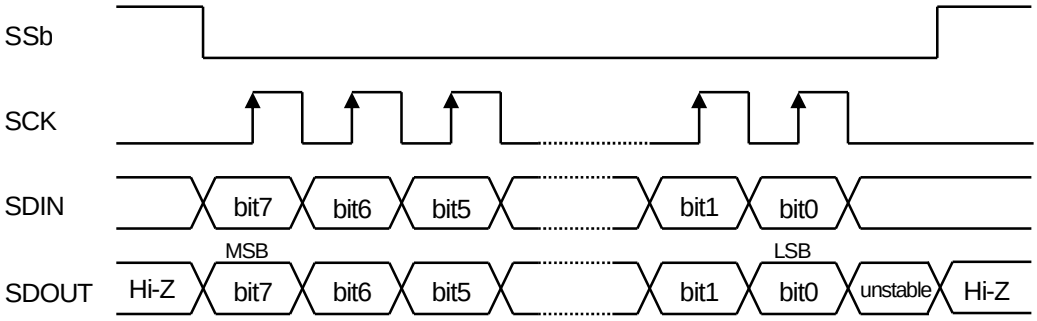


Fig.4 4-Wire Serial Interface Timing

Note: When the data-clock is less than 8 clocks, the input data is shifted to LSB side and is sent to the DSP core at the transition of SSb=”High”. When the data-clock is more than 8 clocks, the last 8 bit data becomes valid. After sending LSB data, SDOUT transmits the MSB data which is received via SDIN until SSb becomes “High”.

■ Pin setting

The NJU26040-18A operates default command setting after resetting the NJU26040-18A. In addition, the NJU26040-18A restricts operation at power on by setting PROC pin and MUTEb pin (Table 7). These pins are input pin. However, these pins operate as bi-directional pins. Connect with V_{DDIO} or V_{SSIO} through 3.3kΩ resistance.

Table 7 Pin setting

Pin No.	Symbol	Setting	Function
28	PROC	"High"	The NJU26040-18A operates default setting after reset.
		"Low"	The NJU26040-18A does not operate after reset. Sending start command is required for starting operation.
27	MUTEb	"High"	Master volume is set 0dB after reset.
		"Low"	Master volume is set mute after reset.

■ Watch Dog Clock

The NJU26040-18A outputs clock pulse through WDC (No.26) pin during normal operation. (Table 8)

Table 8 Watch Dog Clock Output Cycle

WDC Output Cycle (Low/High) Time
128ms

The NJU26040-18A generates a clock pulse through the WDC terminal after resetting the NJU26040-18A. The WDC clock is useful to check the status of the NJU26040-18A operation. For example, a microcomputer monitors the WDC clock and checks the status of the NJU26040-18A. When the WDC clock pulse is lost or not normal clock cycle, the NJU26040-18A does not operate correctly. Then reset the NJU26040-18A and set up the NJU26040-18A again.

Note: If input and output of an audio signal stop and an audio interface stops, WDC can't output.
That is because it has controlled based on the signal of an audio interface.

■ NJU26040-18A Command Table

Table 9 NJU26040-18A Command

No.	Command System	Command Description
1	Set Task Command	Set task mode and input select.
2	System Status Configuration Command	Configure serial audio interface format.
3	Sampling Rate Configuration Command	Setup sampling rate.
4	Smooth Control Setup Command	Setup smooth control.
5	Input Trimmer Setup Command	Setup input trimmer.
6	Master Volume Setup Command	Setup master volume.
7	Ls/Rs Downmix Trim Setup Command	Setup Ls/Rs generator.
8	Eala Setup Command	Setup eala parameters.
9	Input HPF Setup Command	Setup input HPF cutoff frequency (Fc).
10	L Channel Coefficient Setup Command	Setup L channel FIR coefficient.
11	R Channel Coefficient Setup Command	Setup R channel FIR coefficient.
12	Software Reset Command	Do software reset.
13	Start Command	Start audio procedure.
14	Version Number Command	Request firmware version number.
15	Revision Number Command	Request firmware revision number.

Notes : In respect to detail command information, request New Japan Radio Co., Ltd.

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