

## VS1033 to VS1073 Migration Guide

### Description

This document describes how to migrate from VS1033 to VS1073. It lists hardware and software differences and other considerations.

This document applies to all versions of VS1033 and VS1073.

<b>Revision History</b>			
<b>Rev</b>	<b>Date</b>	<b>Author</b>	<b>Description</b>
1.15	2025-04-03	HH	Initial release.

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## 1 General

VS1073 has many updated features compared to VS1033. The most significant differences are:

- New decoder formats: Ogg Vorbis, AAC and HE-AAC, FLAC, ALAC, APE, DSD, AIFF, Opus, G.722.
- MPEG layer I (MP1) and MIDI decoders removed.
- VS1073 has a HiFi stereo line input instead of VS1033's single-channel input
- Encoding
  - Added MP3, Ogg Vorbis, FLAC,  $\mu$ -law, A-law, G.722, and PCM WAV encoding.
  - Added codec mode (encoder and decoder at the same time) that works with  $\mu$ -law, A-law G.722, IMA ADPCM, PCM WAV, 24-bit and 32-bit floating point WAV.
  - RIFF-WAV header is generated automatically in WAV encoding (and codec) mode. The user needs to fix the RIFF size and data size fields to make them valid WAV files.
- Added SCI Multiple Read mode to be able to read encoded data without 100% overhead.
- The highest allowed internal clock speed has increased from 50.0 MHz to 98.304 MHz (number based on engineering samples and subject to change; see *VS1073 Datasheet* for current information).
- Two I2S interface pins moved from GPIO0 and GPIO1 to GPIO6 and GPIO7.
- The I2S output is now capable of 16-bit audio up to 192 kHz, or 32 bits up to 96 kHz.
- VS1073 and VS1033 have different operating voltage ranges.
- SCI Registers SCI\_HDAT0, SCI\_HDAT1, and SCI\_CLOCKF changed.
- VS1073 keeps track of the valid data in MP3 bit reservoir, which allows noiseless start of decoding in the middle of an MP3 file.
- Reading of stream and audio buffer fill states possible.
- Sample-exact sample rate and volume change.
- Parametric data structure contains new functionality
  - Mono mode and pause mode for player
  - 5-channel equalizer
  - VU meter
  - AD mixer
  - PCM mixer
  - Sample rate finetuning
  - Speed shifter
  - EarSpeaker spatial processing
  - Potential to individually disable AAC, WMA, MP3 and FLAC decoders
- Added I2C memory boot option.
- Analog drivers are not powered up automatically if no audio is played.

Due to these new features the pinout and register interface has been changed accordingly.

See the VS1073 Datasheet and VS1073 Hardware Guide for details about the new features.

## 2 Hardware

VS1033 and VS1073 have a few external hardware differences which are listed in this chapter.

### 2.1 Changed: Voltages

Analog voltage AVDD has changed from 2.7...3.6 V in VS1033 to 2.5...3.6 V in VS1073 (3.3...3.6 V if you use the higher 1.65 V reference voltage REF).

Digital core voltage CVDD has changed from 2.4...2.7 V in VS1033 to 1.2...1.35 V in VS1073.

I/O voltage IOVDD has changed from CVDD-0.6...3.6 V in VS1033 to 1.8...3.6 V in VS1073.

In most cases you only need to change the CVDD regulator from 2.5 V to 1.2 V.

### 2.2 Changed: Analog Output Level

The Typical, Min and Max levels of the analog outputs are on average from 1 dB to 2 dB higher in VS1073 than in VS1033d. Typical: 1.85 Vpp vs. 1.5 Vpp, respectively.

### 2.3 Changed: PLL

The PLL control through the SCI\_CLOCKF register has been changed to allow for significantly higher clock rates.

This means that the value written to SCI\_CLOCKF needs to be verified.

A conservative default SCI\_CLOCKF value for VS1073 is 0x8000.

The internal PLL can be used to increase the clock to a speed up to 98.304 MHz.

### 2.4 New: HiFi Stereo Line Input

Both VS1033 and VS1073 feature a differential microphone and single-ended line-level input. However, VS1073 adds another channel to the analog-to-digital converter allowing stereo input. The input can be two line inputs or mic + line input depending on the configuration bit SM\_LINE1 in the SCI\_MODE register. VS1073's analog-to-digital converters are also more advanced, so they offer true HiFi sound.

### 2.5 Changed: LQFP-48 Pin Descriptions

LQFP-48 is a lead (Pb) free and RoHS compliant package. RoHS is a short name of *Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment*. See dimensions for the LQFP package from <http://www.vlsi.fi/>

The table on the following page describes the new pins and functions for VS1073 compared to VS1033.

Pin description changes:

Pad Name	LQFP Pin	Pin Type	New Function For VS1073
MICP / LINE1	1	AI	LINE1 = left channel line input option added.
MICN	2	AI	
XRESET	3	DI	
DGND0	4	DGND	
CVDD0	5	CPWR	
IOVDD0	6	IOPWR	
CVDD1	7	CPWR	
DREQ	8	DO	
GPIO2 / DCLK	9	DIO	
GPIO3 / SDATA	10	DIO	
GPIO6 / I2S_SCLK	11	DIO	Moved from GPIO0 for VS1073
GPIO7 / I2S_SDATA	12	DIO	Moved from GPIO1 for VS1073
XDCS / BSYNC	13	DI	Can be read as a GPI pin
IOVDD1	14	IOPWR	
VCO	15	DO	
DGND1	16	DGND	
XTALO	17	AO	
XTALI	18	AI	
IOVDD2	19	IOPWR	
DGND2	20	DGND	
DGND3	21	DGND	
DGND4	22	DGND	
XCS	23	DI	Can be read as a GPI pin
CVDD2	24	CPWR	
GPIO5 / I2S_MCLK	25	DIO	
RX	26	DI	
TX	27	DO	
SCLK	28	DI	Can be read as a GPI pin
SI	29	DI	Can be read as a GPI pin
SO	30	DO3	The state of SO while xCS is low can be set in VS1073
CVDD3	31	CPWR	
XTEST	32	DI	
GPIO0	33	DIO	
GPIO1	34	DIO	
GND	35	DGND	
GPIO4 / I2S_LROUT	36	DIO	
AGND0	37	APWR	
AVDD0	38	APWR	
RIGHT	39	AO	
AGND1	40	APWR	
AGND2	41	APWR	
GBUF	42	AO	
AVDD1	43	APWR	
RCAP	44	AIO	
AVDD2	45	APWR	
LEFT	46	AO	
AGND3	47	APWR	
LINE2	48	AI	This line input is now right-channel line input in VS1073

Pin types:

Type	Description
DI	Digital input, CMOS Input Pad
DO	Digital output, CMOS Input Pad
DIO	Digital input/output
DO3	Digital output, CMOS Tri-stated Output Pad
AI	Analog input

Type	Description
AO	Analog output
AIO	Analog input/output
APWR	Analog power supply pin
DGND	Core or I/O ground pin
CPWR	Core power supply pin
IOPWR	I/O power supply pin

### 3 Application Considerations

This chapter gives general info on applications using VS1073.

#### 3.1 Hardware Design

VS1073 requires 10 nF capacitors near the ADC pins as well as series resistors to cut the capacitive load for the other device that drives the inputs. See figure *Typical Connection Diagram Using LQFP-48* in the *VS1073 Datasheet* for details.

Outputs of the DACs need RC filters when connecting them to an external power amplifier. The DAC type for VS1073 has been changed for improved distortion but with a cost of some additional high frequency noise outside the audible band of 0 . . . 20 kHz. Without the filters there may be excessive noise with some audio amplifiers, particularly digital ones. See figure *Typical Connection Diagram Using LQFP-48* in the *VS1073 Datasheet* for details.

#### 3.2 Software Considerations

VS1073 has a set of extra parameters to give the user additional control over the chip's functions. For example fast forward and rewind for WMA and AAC is supported through the extra parameters interface. See *VS1073 Datasheet Chapter Extra Parameters* for more info.

When using VS1073, it is highly recommended that the latest version of VS1073 Patches is loaded and running. This package corrects several bugs in the VS1073 ROM firmware and also adds some new features. The package can be downloaded from <http://www.vlsi.fi/en/support/software/vs10xxpatches.html>

VS1073 allows both stereo and mono recording, and the recording interface has been changed extensively. If you want to create a valid file from your MP3, Ogg Vorbis, FLAC, or IMA ADPCM recording, you have to ask VS1073 to stop recording, and read all data that comes from it before recording actually ends. This ensures that your file ends correctly.

## 4 SCI Registers

VS1033 and VS1073 have a few differences in registers that are not compatible with each other. Care should be taken when porting VS1033 microcontroller software to VS1073. The following chapters list some of these differences. For more info on the registers, see *VS1033 Datasheet* and *VS1073 Datasheet*.

### 4.1 Changed: SCI\_MODE

SM\_LAYER12 allows decoding of MP2 files on VS1073.

SM\_OUTOFWAV has been renamed SM\_CANCEL because it is used as a general playback or recording cancellation bit regardless of the format being played / recorded.

SM\_PDOWN has been removed.

SM\_STREAM has been removed from VS1073. To sync streams using VS1073, use sample rate finetuning.

SM\_ADPCM has been renamed SM\_ENCODE because VS1073 can also encode in other formats than IMA ADPCM.

SM\_ADPCM\_HP has been removed in the VS1073.

SM\_LINE1 (was SM\_LINE\_IN) switches between differential microphone (MICP/MICN) and line input (LINE1) operation. This bit is set after reset by default and selects the line input mode. Clear this bit to select the differential mode and to enable the microphone amplifier.

A new register bit SM\_SCIMULTIREAD (12) activates the option for SCI Multiple Read operations. With this operation, the same SCI register can be read multiple times, making it twice as fast to read high-bitrate encoded audio data (e.g. PCM or FLAC).

## 4.2 Changed: SCI\_STATUS

SS\_SWING bits have been added to VS1073. Typical users will not need to touch these bits. The same is true for new bits SS\_VCM\_OVERLOAD and SS\_VCM\_DISABLE.

SS\_VER is 5 for VS1033 and 8 for VS1073. The field has also been expanded to four bits in VS1073 (bits 6:4 on VS1003, bits 7:4 on VS1073). Note that bit 7 is 0 in all earlier VS10XX IC's, so all four bits can be read regardless of IC version.

Due to a hardware volume control, there are no longer digital filter scaling (AVOL) bits in SCI\_STATUS. These bits have been replaced by SS\_AD\_CLOCK and SS\_REFERENCE\_SEL.

SS\_AD\_CLOCK can be set to divide the Analog-to-Digital modulator frequency by 2 if XTALI is in the 24...26 MHz range.

SS\_REFERENCE\_SEL has been added to VS1073. If AVDD  $\geq$  3.3 V, setting this bit will set reference voltage to 1.65 V instead of the default 1.25 V. The setting increases analog output and input swing accordingly.

## 4.3 Changed: SCI\_CLOCKF

The values for setting up SCI\_CLOCKF have changed. Changing the format was necessary because the old format was insufficient for setting the new, higher clock frequencies that VS1073 can handle.

## 4.4 Changed: SCI\_HDAT0 and SCI\_HDAT1

When decoding MP3 files, SCI registers SCI\_HDAT0 and SCI\_HDAT1 used to show the 32 bits of the MP3 header, and for other files they would show other, relevant information to the files. In VS1073, the contents of these registers is unified between all audio formats.

## 4.5 SCI\_VOL

Operation and format of the volume control register SCI\_VOL has not changed.

VS1073 contains hardware volume control that changes volume when zero-crossing is detected in the data (or after a timeout). This minimizes the audible disturbance when volume is changed.



## 5 Memory Tests

In VS1073 tests started through SDI require additional 7-8 zero bytes to be sent to SDI for them to start. These bytes are shown in the datasheet examples. Read Chapter *SDI Tests* of the *VS1073 Datasheet* for details.

## 6 Sine Tests

SDI-bus activated Sine Test has been removed. New, more versatile sine and sweep tests may be activated through the SCI bus. Read Chapter *Sine and Sweep Tests* of the *VS1073 Datasheet* for details.

## 7 User Applications

Because memory addresses have changed, the user applications, plugins and patches are different between VS1063 and VS1073.

The new SCI Multiple Read functionality removes the 100% overhead that was an earlier inconvenience with reading high-bitrate data.

## 8 Analog Wake-Up

Unlike VS10XX audio ICs up to VS1063, VS1073 does not wake up its analog drivers automatically after power-up. It will wake them up only after audio has been decoded for a while. If the user wants to turn up the analog drivers manually, then turn SCI\_STATUS register bit SS\_APDOWN2 (bit 3) off after waiting for a short while after reset. If you turn SS\_APDOWN2 on too quick after a reset, you may hear a small, single click.

## 9 Licenses

If the end product plays formats that require licenses, refer to the *Licenses* chapter of the VS1073 Datasheet. To the best knowledge of VLSI Solution, patents related to MP3 have expired years ago and do not require licenses anymore.

## 10 Microcontroller Examples

Examples on how to control VS1073 using a microcontroller are available at <http://www.vlsi.fi/en/support/software/microcontrollersoftware.html>

## 11 Latest Document Version Changes

This chapter describes the most important changes to this document.

### Version 1.15, 2025-04-03

- Initial release, using VS1033 to VS1063 Migration Guide as a basis.

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