# VS1011 to VS1073 Migration Guide

## Description

This document describes how to migrate from VS1011 to VS1073. It lists hardware and software differencies and other considerations.

This document applies to all versions of VS1011 and VS1073.

| Revision History | | | |
|---|---|---|---|
| **Rev** | **Date** | **Author** | **Description** |
| 1.15 | 2025-04-03 | HH | Initial release. |

# Contents

# 1   General

VS1073 has been vastly expanded from the VS1011. The most significant differences are:

- VS1011 and VS1073 have different operating voltage ranges.
  **VS1073 has an additional supply voltage pin CVDD.**
- VS1073 is only available in LQFP-48 packaging.
- Added HiFi stereo line input / mono microphone input.
- New decoder formats: Ogg Vorbis, AAC and HE-AAC, WMA, FLAC, ALAC, APE, DSD, AIFF, Opus, AC-3, G.722, 24-bit and 32-bit floating point WAV.
- Added MP3, Ogg Vorbis, FLAC, $\mu$-law, A-law, G.722, PCM / IMA ADPCM WAV encoding.
- Added SCI Multiple Read mode to be able to read encoded data without 100 % overhead.
- MPEG layers II (MP2) and III (MP3): new, more robust and accurate decoding. MP3 is now full accuracy compliant.
- Removed MP1 decoder.
- Added codec mode (both encoder and decoder work at the same time) that works with $\mu$-law, A-law G.722, IMA ADPCM, PCM WAV.
- The highest allowed internal clock speed has increased from 26.0 MHz to 98.304 MHz. (number based on engineering samples and subject to change; see *VS1073 Datasheet* for current information).
- VS1073 has a UART so it can be connected to VSIDE.
- VS1073 has an internal PLL and a control register for it.
- VS1073 has a digital 16-/32-bit I2S output for external DACs.
- VS1073 has GPIO pins.
- Many SCI registers changed.
- CRC checking added for MP3 files that contain CRC. CRC checking can be disabled.
- 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.
- RIFF-WAV header is generated automatically in WAV encoding (and codec) modes. The user still needs to fix the RIFF size and data size fields to make them valid WAV files.
- Sample-exact sample rate and volume change.
- A new parametric data structure contains lots of 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.

## 2   Hardware

VS1011 and VS1073 have a few hardware differences which are listed in this chapter.

### 2.1   Changed: Voltages

VS1073 requires three separate voltages instead of two for VS1011.

Analog voltage AVDD has stayed at 2.5...3.6 V (3.3...3.6 V in VS1073 if you use the higher 1.65 V reference voltage REF).

VS1011's DVDD which was 2.3...3.6 V has been replaced with IOVDD, which is 1.8...3.6 V in VS1073.

VS1073 also requires another power input CVDD 1.2...1.35 V for the processor core.

In other words, with VS1073 you need at least two supply voltages: one for CVDD and another for AVDD and IOVDD.

### 2.2   Changed: Clocking

VS1011 is clocked with a 24...26 MHz, fundamental frequency clock, or 12...13 MHz if the internal clock doubler is active.

VS1073 is clocked with either a 12...13 MHz or 24...26 MHz crystal. In the latter case an internal clock divider needs to be activated in register SCI_MODE for playback and recording, and another in SCI_STATUS for recording. An internal PLL can be used to increase the clock to a speed up to 98.304 MHz. The recommended crystal for VS1073 is 12.288 MHz.

### 2.3   New: HiFi Stereo Line Input

VS1073 features a differential microphone and one-sided HiFi stereo line-level input. It can encode that analog input into multiple formats, including MP3, Ogg Vorbis, FLAC, and PCM.

### 2.4   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 in LQFP-49.

Pin description changes:

| Pad Name | LQFP Pin | Pin Type | New Function For VS1073 |
|---|---|---|---|
| MICP / LINE1 | 1 | AI | Microphone / line input left, new for VS1073 |
| MICN | 2 | AI | Microphone input, new for VS1073 |
| XRESET | 3 | DI | |
| DGND0 | 4 | DGND | |
| CVDD0 | 5 | CPWR | Core power, new for VS1073 |
| IOVDD0 | 6 | IOPWR | Only I/O Power in VS1073 |
| CVDD1 | 7 | CPWR | Core power, new for VS1073 |
| DREQ | 8 | DO | |
| GPIO2 / DCLK | 9 | DIO | |
| GPIO3 / SDATA | 10 | DIO | |
| GPIO6 / I2S_SCLK | 11 | DIO | Both functions new for VS1073 |
| GPIO7 / I2S_SDATA | 12 | DIO | Both functions new for VS1073 |
| XDCS / BSYNC | 13 | DI | |
| IOVDD1 | 14 | IOPWR | Only I/O Power in VS1073 |
| VCO | 15 | DO | For testing purposes (don't connect), new for VS1073 |
| DGND1 | 16 | DGND | |
| XTALO | 17 | AO | |
| XTALI | 18 | AI | |
| IOVDD2 | 19 | IOPWR | Only I/O Power in VS1073 |
| DGND2 | 20 | DGND | |
| DGND3 | 21 | DGND | |
| DGND4 | 22 | DGND | |
| XCS | 23 | DI | |
| CVDD2 | 24 | CPWR | Core power, new for VS1073 |
| GPIO5 / I2S_MCLK | 25 | DIO | Both functions new for VS1073 |
| RX | 26 | DI | UART receive, new for VS1073 |
| TX | 27 | DO | UART transmit, new for VS1073 |
| SCLK | 28 | DI | |
| SI | 29 | DI | |
| SO | 30 | DO3 | |
| CVDD3 | 31 | CPWR | Core power, new for VS1073 |
| TEST | 32 | DI | Connect to IOVDD instead of VDD on VS1073 |
| GPIO0 / SPIBOOT | 33 | DIO | |
| GPIO1 | 34 | DIO | |
| GND | 35 | DGND | I/O ground, new for VS1073 |
| GPIO4 / I2S_LROUT | 36 | DIO | Both functions new for VS1073 |
| 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 | Line input right, new for 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.

PCB traces from analog connections (particularly mic and line inputs) should be kept as short as possible.

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 of the hearing band. 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 chips 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.

If you don't want the product to play certain formats, you can use SCI_HDAT1 register to determine the currently playing file type. You can then skip the file if the format is something you don't want played. See the *VS1073 Datasheet* for detailed info.

When using VS1073, it is highly recommended that the latest version of VS1073a 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`

There is a whole new interface for recording which you will have to study.

VS1073 tests that are 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.

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.

# 4 SCI Registers

VS1011 and VS1073 have a few differencies in registers that are not compatible with each other. Care should be taken when porting VS1011 microcontroller software to VS1073. The following chapters list some of these differencies. For more info on the registers, see *VS1011 Datasheet* and *VS1073 Datasheet*.

## 4.1 Changed: SCI_MODE

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

SM_ENCODE is used to activate encoding on VS1073. See, however, for alternative ways in the *VS1073 Datasheet*.

SM_CLK_RANGE has been added to VS1073. This should be activated if the input clock XTALI is 24...26 MHz.

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_DO_NOT_JUMP has been added to VS1073. This instructs the user that it is not allowed to fast forward or rewind in a file. Typically this bit is set when decoding important headers, e.g. the first 4 KiB headers of an Ogg Vorbis file, or if the file type doesn't allow random access, like MIDI files.

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 1 for VS1011 and 8 for VS1073. The field has also been expanded to four bits in VS1073 (bits 6:4 on VS1011, 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.

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 $>=$ 3.3 V, setting this bit will set reference voltage to 1.65 V instead of the default 1.25 V and increases analog output and input swing accordingly.

## 4.3 Changed: SCI_CLOCKF

Bits in register SCI_CLOCKF has changed. See the datasheets for details.

The suggested crystal for VS1073 is 12.288 MHz. With VS1073 a conservative default for SCI_CLOCKF is 0x8000 (for $5.5\times$ clock = 67.584 MHz).

## 4.4 Changed: SCI_HDAT0 and SCI_HDAT1

These registers give info on the supported audio formats. The interpretation of the registers have changed for VS1073.

You can use SCI_HDAT1 register to determine the currently playing file type. You can then skip the file if the format is something you don't want played. See the *VS1073 Datasheet* for detailed info.

## 5   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.

## 6   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.

## 7   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.

## 8   Microcontroller Examples

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

# 9 Latest Document Version Changes

This chapter describes the most important changes to this document.

**Version 1.15, 2025-04-03**

- Initial release, using VS1011 to VS1063 Migration Guide as a basis.

## 10 Contact Information

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