APPLICATION NOTES

NT1004 *USBVision* ™

Video & Audio Interface solution via USB

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1. General

The NT1004 is an advanced version of the NT1003-1. The ASIC receives digital video in its input, scales the picture, compresses it, and transfers the compressed data to a host computer via the USB port. The main applications for the NT1004 are USB digital cameras, USB analog video adapter, and USB TV.

The NT1004 supports an external telephony Codec to establish an audio channel via the USB port. This enables the camera designer to add a built-in microphone. Also, the USB analog video adapter and USB TV applications no longer require an additional connection for the audio channel. Audio in I^2S format is supported if the NT1004 is combined with the NT1005.

An input Bulk data channel allows the NT1004 to transfer external data streams of up to 2Mbit/sec through the same USB port, simultaneously with the video and audio data. By combining the NT1004 with the low-cost NT1005 and the Philips SAA7113, the designer can add VBI, Teletext, Close-Caption, and IR controller capabilities to the USB TV.

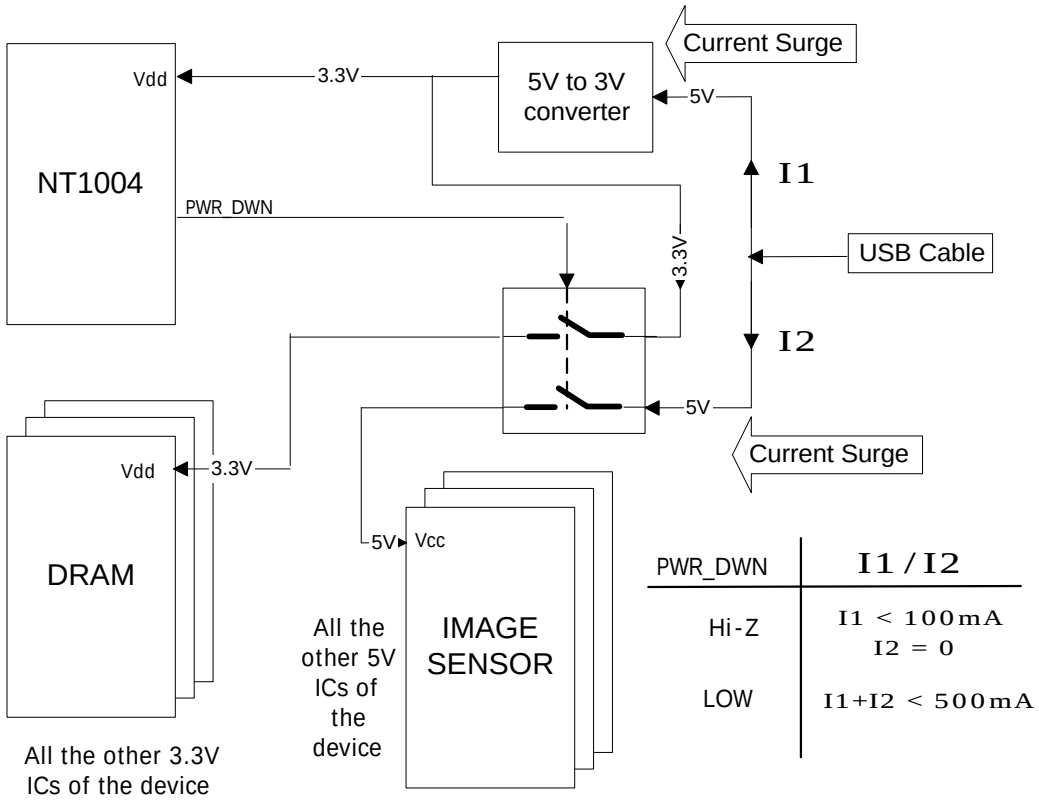
The input buffers of the NT1004 are 5-volt tolerant, so it can operate on both 3.3v and 5v video sources. It requires a single crystal of 12MHz, which produces less EMI noise than the 3rd harmony 48MHz crystal that the NT1003-1 used.

The NT1004 consumes about 60mA (@ 3.3v) during normal operation (30f/s, CIF), and is packed in 100-pin plastic LQFP. It is smaller than the NT1003-1 and not pinout compatible.

2. Electrical

2.1 *USB Powered devices*

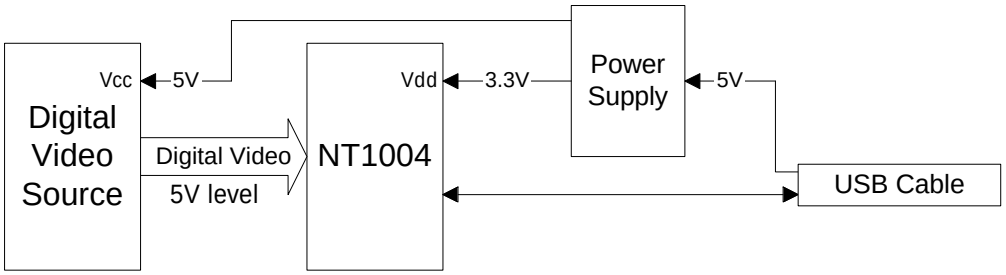
The NT1004 supports designs of USB powered devices. The USB standard requires that a USB-Powered device should consume no more than 100mA before being configured, and no more than 500mA during normal operation. To support that, the NT1004 has a special pin PWR_DWN for controlling a dual position power supply. On "power-on" position (PWR_DWN = Hi-Z) the power supply is supposed to provide 3.3v to the NT1004 only. Before the host computer configures the NT1004, its typical power consumption is around 180mW, so the current that is consumed from the USB port is much less than 100mA in this position. After configuration, the NT1004 S/W driver in the host computer sets the PWR_DWN signal to LOW level. In this position the power supply is supposed to switch the power to all the other ICs of the device (like DRAM, Image sensor, DSP, etc.). The designer should take care that the total power consumption of the device in this position will not require more than 500mA from the USB port. Also, care should be taken for the current surge at both the moment of plug insertion and the moment of switching to the "configured" position. The current surge should never exceed the limit that is defined by the USB 1.1 standard (maximum of 10uF capacitance at the device side).



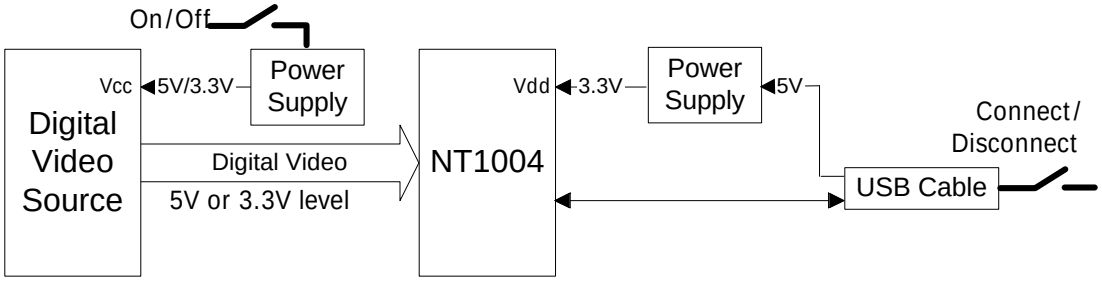
2.2 *5V Tolerant I/Os*

Most inputs of the NT1004 are 5-volt tolerant with backdrive protection. This means that the NT1004 can be hard wired to digital video sources that are fed from independent power supplies. For example, C-MOS sensors that provide 5v level digital outputs can be directly connected to the NT1004 video interface, though the NT1004 itself operates from 3.3v supply. Another example is an application of a camcorder, which includes the NT1004 inside and uses it as an interface to USB. In such an application it is recommended to supply the NT1004 directly from the USB power supply, in order not to increase the total power consumption from battery. While operated – but not connected to USB - the camcorder can drive the NT1004 with digital video signals, though the NT1004 is not powered at all.

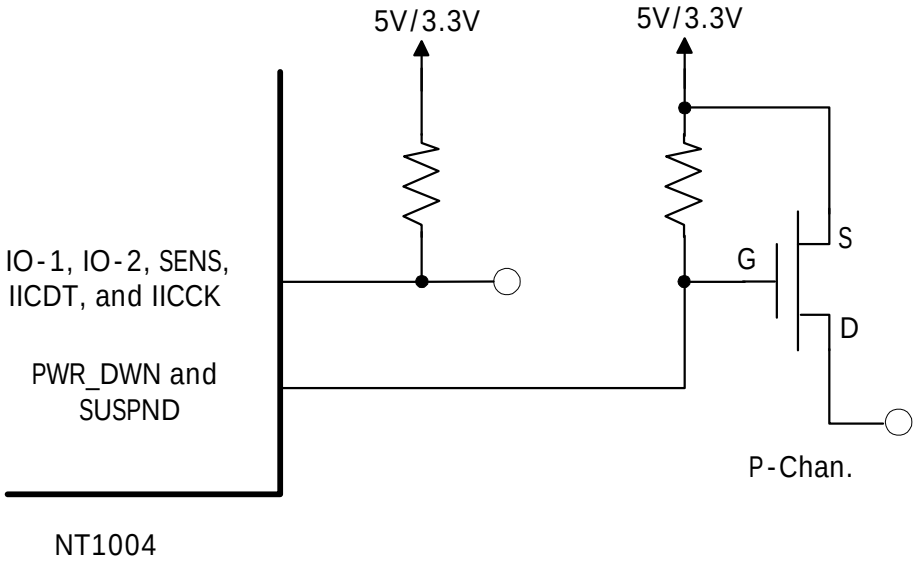
Example 1: Video source provides 5v-level digital signals



Example 2: Video source and NT1004 have independent power sources



Most of the Open Drain outputs of the NT1004 are also 5v-tolerant. The pins IO-1, IO-2, SENS, IICDT, and IICCK can be tied to 5v pull-up resistors to operate with 5v ICs. The pins PWR_DWN and SUSPND can be used to switch voltage sources of more than 3.3v as illustrated in the following figure.



2.3 *VDDA and GNDA pins*

The NT1004 has dedicated power supply pins for some internal analog elements:

Pins 37 (VDDA) & 36 (GNDA) are used for the PLL.
Pin 42 (VDDA) is used for the 12MHz Crystal Oscillator.
Pins 98 (VDDA) & 1 (GNDA) are used for the USB Transceiver.

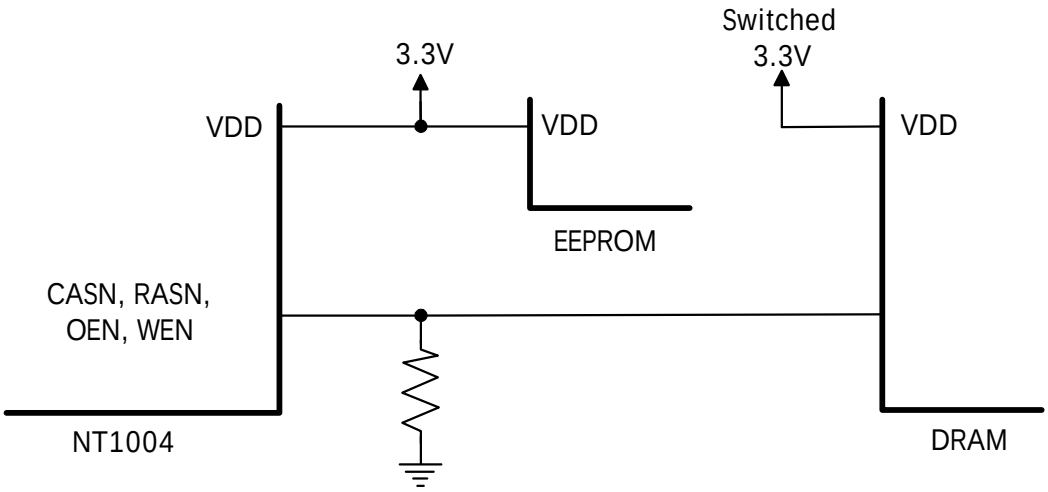
It is recommended to use a separate filtered supply source for all the VDDA pins. Also, the GNDA pins should be connected very close to the power supply ground.

2.4 *DRAM and EEPROM Power Management*

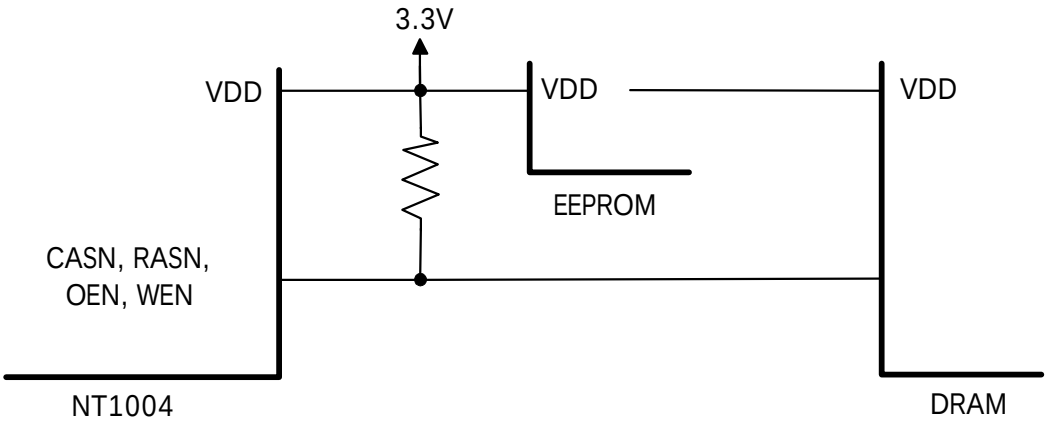
The external serial EEPROM consumes only 10uA in the stand-by position. It is recommended to connect its Vcc pin (pin # 8) to the same source that the NT1004 uses for its VDD pins.

The external DRAM consumes two much current in its standby mode (100-300uA). That is why it is recommended to switch off the power DRAM supply during the Suspend position. When entering the Suspend position, the NT1004 automatically turns the PWR_DWN pin to Hi-Z, which results in switching off the DRAM and all the other ICs of the application circuit. This could not be done in the old NT1003 chip, where the DRAM control outputs were set to HIGH in the Suspend mode. In the NT1004 this was corrected, and the control pins are set to Hi-Z instead, which require that external pull-down resistors will be connected to them. If, from some reason, the designer wishes to power the DRAM the same as it used to be in the NT1003, the Vcc pin (pins # 1,6,,) should be connected to the same source that the NT1004 uses for its VDD pins, and external pull-up resistors should be connected on all the DRAM control signals.

Recommended power connections for EEPROM and DRAM. DRAM is powered-off in SUSPEND mode.

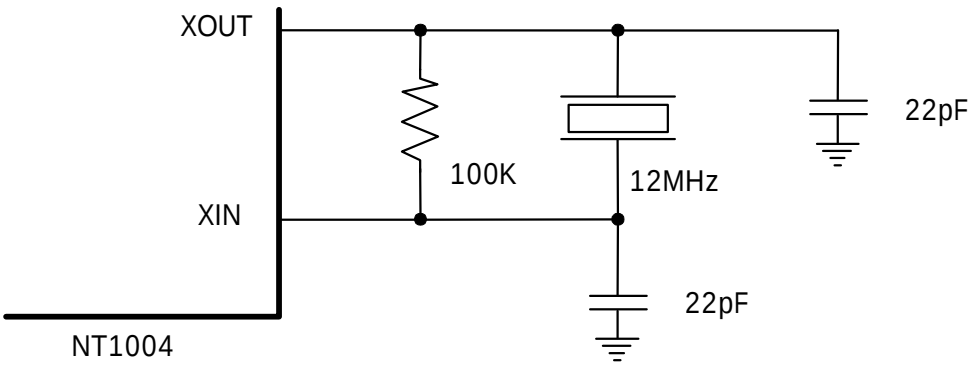


"NT1003-style" power connections for EEPROM and DRAM.



2.5 *12 MHz Crystal Oscillator*

The Crystal Oscillator of the NT1004 is designed to drive a 12MHz crystal. An internal PLL converts the frequency to 48MHz. This is in order to reduce EMI and to simplify the external circuit.



2.6 *Audio Interface*

The NT1004 has audio interface for telephony Codecs, using the LFST format (Long Frame Sync Timing). The Oki MSM7508B, MSM7716, and the Fujitsu MB86435 can be directly connected to this interface. To connect a digital audio source that uses the I^2S format, the user must add the NT1005 chip to the NT1004 circuit. This is recommended for USB TV applications, where the NT1005 has some additional functionalities.

The audio pipe is isochronuos, and consumes up to 0.5Mbit/sec of the total USB bandwidth. The sampling rate is selectable between 8Ks/sec and 16Ks/sec, and the number of bits per sample can be any number between 8 and 16 (8-bits is normally u-LAW or A-LAW). The best audio quality that is available in this BW limitation is of Stereo, 16Ks/sec, 16-bit/samp (2*16,000*16 = 0.5Mbit/sec.).

3. Functional

3.1 *Serial Control Interface*

The NT1004 supports all the serial control modes that were supported by the NT1003. The IIC mode of operation was enhanced by adding the bits CONTINUE and NO_STOP to the SER_CONT register (Reg.9). By using these bits, the user can send any number of data bytes between the START and STOP sequences (It was limited to 4 data bytes in the NT1003).

3.2 *DRAM Size*

The NT1004 supports both 4Mbit and 16Mbit DRAMs (the 4Mbit mode is compatible to the NT1003 mode). Usage of 16Mbit DRAMs allows better video quality for VGA cameras, better NTSC still images (4:2:2, 640x480), PAL still images (4:2:2, 768x576), and some other new functions.

A special pin was added to support 16Mbit DRAMs (pin #85 DA9. Should be left open if 4Mbit DRAM used). Also, the NT1004 DRAM registers (Regs.18-26) were modified to support the 16Mbit DRAM mode (usage remains the same for 4Mbit DRAMs).

3.3 *VGA-size video*

To compress VGA-size video in the NT1004 it requires a “reference” frame buffer and a “compressed data” buffer. The reference frame is stored in the 4:2:0 format, and occupies 640x480x12 = 3,686,400 bit = 460,800 Bytes. The compressed data buffer should contain up to 4 compressed frames, which is about 640x480x3 = 921,600 bit = 115,200. These two buffers require a 16Mbit DRAM for implementation.

3.4 *Digital Video Input Formats*

The NT1004 supports all video-input formats that the NT1003 supported. A problem in the CCIR 656 8-bit format was fixed, and an additional 12-bit format was added (in the 12-bit format, the U and V components use a 4-bit bus – U0-U3).

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