



OKI

People To People Technology

MSM9831

A Brief Application Note

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With the MSM9831 manufactured by Oki Electric Industry Co., Ltd., Japan, comes a low-cost speech synthesiser with integrated mask ROM designed for applications which demand high voice quality, but suffice with relatively short playback times. Integration of this small device into existing digital systems or new designs is a child's play.

Half the size of currently available LSIs of that kind, the Oki MSM9831 emits a wide variety of high quality natural sounds, and opens the door for LSIs to be included in a wide range of applications. The MSM9831 can be used in various applications including voice guidance systems, vehicle navigation systems, and mechanical sound effects for digital appliances to improve the functionality of many of the existing electronic equipment.

As the world becomes increasingly digital, many of the sounds emitted by electronic appliances, sounds we have grown accustomed to, will begin to disappear. For example, think how strange it would be not to hear the steady clicking of your car's turn signal when it is activated. The MSM9831 has the ability to put sounds such as these back into electronic equipment, and allows manufacturers to make transition to digital technology as seamlessly as possible.

Algorithm

Unlike other OKI speech products, the MSM9831 utilises 8-bit Pulse Code Modulation (PCM) for the storage of speech data. Interestingly, the data is of non-linear nature and provides a fidelity equivalent to 10-bit linear PCM for the mid range of waveforms. Consequently, the signal-to-noise ratio is significantly improved.

Structure

With a set of selectable sampling frequencies ranging from 4 to 16kHz in 7 intervals and

the fixed 8-bit vertical resolution playback time and voice quality requirements can be selected to best suit a given application. For example at 8kHz sampling (64kbps bit-rate), the playback time is 6 seconds if the master clock is 4.096MHz. **Table 1** has

| Sampling Frequency [kHz] | Filter Cut-off Frequency [kHz] (-3dB) | Playback Time [sec] |
|--------------------------|---------------------------------------|---------------------|
| 4.0 | 1.2 | 11.8 |
| 5.3 | 1.6 | 8.9 |
| 6.4 | 2.0 | 7.4 |
| 8.0 | 2.5 | 5.9 |
| 10.6 | 3.2 | 4.4 |
| 12.8 | 4.0 | 3.7 |
| 16.0 | 5.0 | 2.9 |

TABLE 1. Values specified are for 4.096MHz clock frequency and are based on 378kbit free ROM area. Playback times are obtained by: memory / (sampling rate * bit number).

more details. In total, 31 playback channels can be addressed.

Also incorporated on-chip are a 10-bit current-type DAC and a high quality low-pass filter. Providing a wide power supply range from +2.0 to +5.5V, the MSM9831 is suitable for both 3V and 5V platforms whilst drawing merely 2mA maximum at +5V or 1.0mA at +3V within an ambient temperature from -40 to +85°C.

Block Functions

Figure 2 shows the block schematic diagram unveiling the simple but effective design. A serial interface is provided to control all functions in conjunction with an MCU which needs to provide only three output ports. **_PI** is the address input pin through which the channel number to be replayed is defined by means of pulses while **_ST** is kept on L. The number of pulses

input refers to the channel number to be played while 32 pulses reset the internal address counter. Playback then commences upon a rising edge of **_ST**. Playback is stopped by returning **_ST** to L without any pulse into **_PI**. **_PDWN** sets the device to standby mode.

AOUT is an open drain N-MOS output which provides the filtered audio signal in the form of changing output currents. Signals cannot be picked before the filter. Cut-off frequency and output frequency characteristics vary proportionally with the sampling frequency applied (**Figure 1**). In

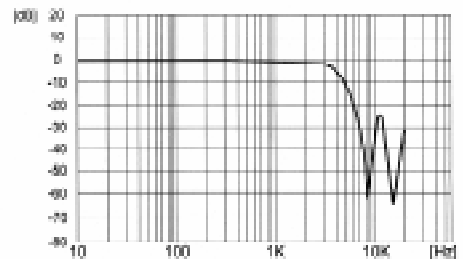


FIGURE 1. Characteristic of the low-pass filter at 8kHz sampling

standby mode, **AOUT** assumes half level in that current continues flowing, but an internal canceller circuit prevents occurrence of pop noise.

The oscillator circuit (**XT** and **_XT**) can be used in two ways. A ceramic oscillator rating 3.5 to 4.5MHz (typically 4.096MHz) across **XT** and **_XT** provides the conventional means of operation. Additionally, an external clock can be input to **XT** while **_XT** is left open. The set of sampling frequencies will vary proportionally with the clock and therefore take influence on the playback time and quality.

Internal Mask ROM

The built-in 384KBit ROM reserves 2 Kbit area for a so-called Phrase Control Table, **PCT**, which allows the user to compile sentences consisting of preinstalled words with the same simple control as for individual word addressing. If sentences were stored as phrases they would occupy more memory since

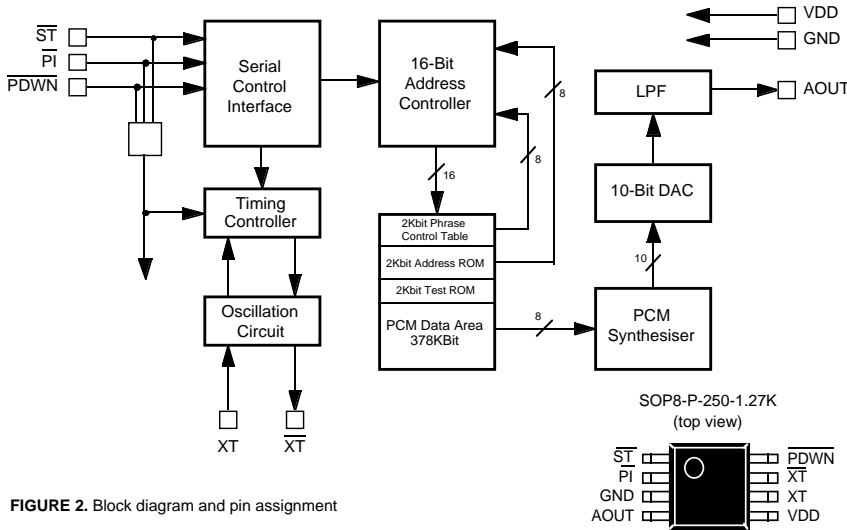


FIGURE 2. Block diagram and pin assignment

certain words have to be stored multiple times. Not only does the PCT reduce requirement for memory, but also it relieves the MCU considerably.

| Address [Hex] | Words in ROM |
|---------------|---------------|
| 01 | "it will be" |
| 02 | "sunny" |
| 03 | "cloudy" |
| 04 | "today" |
| 05 | "tomorrow" |
| 06 | "partly" |
| : | |
| 1F | 320ms silence |

The PCT is addressable from 01h to 1Fh corresponding to 31 channels. Up to eight word ROM

| Address [Hex] | ROM addresses assigned | Sentence compiled |
|---------------|------------------------|--|
| 01 | 01 02 04 | "it will be sunny today" |
| 02 | 01 03 05 | "it will be cloudy tomorrow" |
| 03 | 01 03 04 | "it will be cloudy today" |
| 04 | 01 02 1F 06 03 05 | "it will be sunny, partly cloudy tomorrow" |
| : | | |
| : | | |
| 1F | | |

TABLE 2. Example of ROM data and Phrase Control Table pattern.

addresses can be assigned to any of these addresses, including silence insertion from 32 to 996ms in intervals of 32ms. Table 2 shows a typical example.

The small table contains word phrases and their corresponding addresses as stored in the ROM. These addresses can be referred to by the PCT which contains in its address registers the individual ROM addresses of words which are part of a desired sentence. Upon selection of either of the addresses, a complete sentence can be replayed without need for picking every word one by one from the ROM.

As illustrated in the block diagram, the PCT reduces the ROM area by 2Kbit, however,

better memory economy and less MCU intervention compensate well.

Typical Application

The simple application of MSM9831 is illustrated by Figures 3 and 4 showing two means of oscillation and audio amplification.

In principle, playback is started with the timing as displayed by Figure 5. It is further possible to re-input an address whilst playback is ongoing and of course to stop it when _ST is lowered for 0.35 to 2000μs and raised again. 350μs (@8kHz sampling frequency) after the raising edge, playback will stop.

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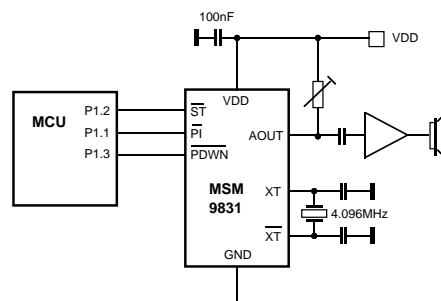


FIGURE 3. Typical application with ceramic oscillator.

Note that this stop timing varies proportionally with the sampling frequency.

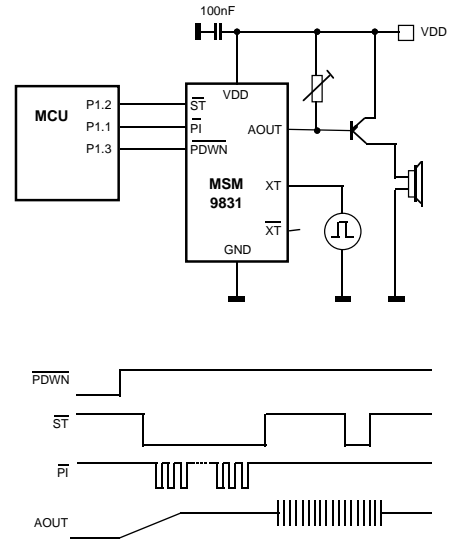


FIGURE 5. Principle playback and stop timing.

Small Package

MSM9831 comes in a small SOP package measuring only 5 x 6.8mm by area with a maximum mounting profile of 2.05mm. The lead pitches are 1.27mm (50mils) and reflow soldering is applicable. This small package given and the few external components required make it easy and cost effective to realise speech add-ons to miniature digital electronic products.

| Item | MSM9831 | MSM9802 | MSM9803 | MSM9805 | MSM98P05 | MSM9836 |
|-----------------|----------|-------------------------------|-------------------------------|-------------------------------|---------------------|----------|
| ROM Size | 384KBit | 512KBit | 1MBit | 2MBit | 2MBit OTP | 3MBit |
| Playback Time * | 11.8 sec | 16 sec | 32.4 sec | 65.1 sec | 65.1 sec | 98 sec |
| Phrases | 31 | 56/63 | 56/63 | 56/63 | 56/63 | 127 |
| Operating Modes | MCU | SA/MCU | SA/MCU | SA/MCU | SA/MCU | MCU |
| MCU Control | serial | parallel | parallel | parallel | parallel | parallel |
| Phrase Control | yes | yes | yes | yes | yes | yes |
| Oscillation | 4.096MHz | 256kHz/ 4.096MHz | 256kHz/ 4.096MHz | 256kHz/ 4.096MHz | 256kHz/ 4.096MHz | 4.096MHz |
| Active current | 8mA | 16mA | 16mA | 16mA | 16mA | 16mA |
| Packaging | 8-SOP | 18-DIP, 24-SOP, 30-SSOP | 18-DIP, 24-SOP, 30-SSOP | 18-DIP, 24-SOP, 30-SSOP | 20-DIP, 24-SOP | 24-SOP |

TABLE 3. MSM9800 series of non-linear PCM speech playback LSIs with internal mask ROM.
* Playback times are given for 4kHz sampling frequency.

Product Line-Up

MSM9831 is the smallest in a series of non-linear PCM speech synthesizers from OKI. MSM9836, MSM9805, MSM9803 and MSM9802 provide 3, 2, 1 and 0.5MBit internal ROM, respectively and allow for up to 63 or 127 playback channels. In principle, the MSM9831 is a downsized version of the MSM9802 with less ROM, less playback channels, simplified control interface, smaller package and lower cost.

Application Products

Typical applications for the MSM9831 are primarily in the field of consumer and AV goods, but not exclusively. For example:

- ◇ Automotive
- ◇ Telephones, Handies
- ◇ Facsimilie
- ◇ Peripheral Equipment
- ◇ Security Systems
- ◇ Digital Still Cameras
- ◇ Digital Video Cameras
- ◇ Household Appliances
- ◇ Clocks
- ◇ Toys, etc.

Code Development

Speech or sound codes are generated with a development system from OKI for the PC, designated the AR204. It consists of a 16-Bit ISA card, Windows 95® software and a ROM programming unit (**Photo 1**).

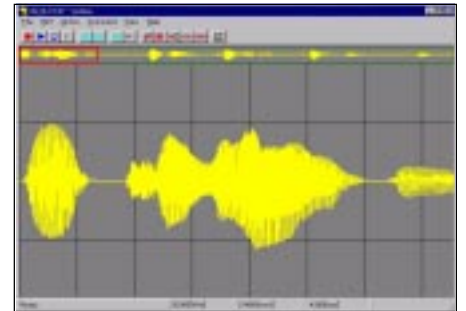


PHOTO 1. The AR204 development system's working screen.

Aided by this system, the user can record voice and edit it so as to best suit his needs. ROM address and PCT address allocations can be assigned easily by the AR204 software. It also performs selection of oscillator mode, playback of individual ROM phrases and PCT playback simulation. The so developed data is converted to a HEX file and programmed into an EPROM. That EPROM will then contain the data with which OKI will produce the mask for the MSM9831 and other devices in the series.



□ Oscillator

In particular, SMD type crystal oscillators exhibit narrow tolerances for stable startup and continuous oscillation. Once oscillation fails, the entire circuit will size operation like a vehicle without fuel. Oscillation margin is the capability of a circuit to activate and keep oscillation going on reliably. It is therefore important to determine which crystal impedance value is tolerated by its hosting circuit in its designated operating environment. This can be facilitated in the following manner:

1. First of all:

- ◇ 1-1 For best results, use a crystal with known R_O
- ◇ 1-2 For R_V , use a precision potentiometer with maximum resistances of 1, 2, 5 or 10k Ω , while 5k Ω is a commonly used value.

2. How to:

- ◇ 2-1 Set R_V to its minimum value and check whether normal oscillation sets in.
- ◇ 2-2 Set R_V to maximum value to stop oscillation. If oscillation

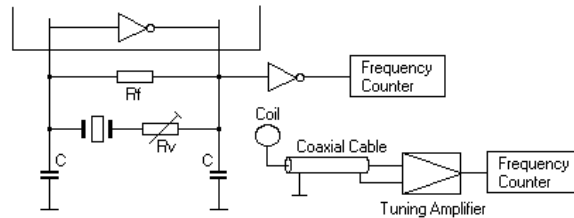


FIGURE 6. Recommended measuring circuit.

still does not stop use a R_V with larger maximum resistance value.

- ◇ 2-3 From this no-oscillation state reduce R_V gradually until oscillation starts.
- ◇ 2-4 For maximum safety, repeat 2-1 to 2-3.

- ◇ 2-5 Measure the current value of R_V and record it as for instance R_{VX} .
- ◇ 2-6 Calculate +R as $R_{VX} + R_O$

Pictured in **Figure 6** are typical examples for measuring circuits showing direct pick up and inductive pick-up in conjunction with a frequency counter.

To accurate measure oscillation, the use of a frequency counter is useful, since spectrum analysers are not designed to distinguish main oscillation and spurious mode. A start-up detector should be used and connected where it will least affect circuit characteristics.

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