The Sentinel: A High level View©

Introduction:

This paper presents a high level view of the Sentinel device. It keeps the details to a minimum and presents the macro description of the Sentinel device for a concise understanding of the Sentinel and its operation.

1.0 Basic description of the Sentinel device:

The Sentinel is a *low power, CMOS mixed signal monolithic device* which acts as an analog front end for a number of applications. Examples are, sensor interfaces, 3 – D computer peripherals, Instrumentation interface, Data acquisition and capture, data communications, electronic control and command.

The Sentinel requires a digital controller to operate, and may or may not, need additional memory depending on the application. The digital controller may be a microprocessor, microcontroller, a CPLD, a FPGA, discrete logic, a desktop PC, a laptop PC or any other kind of digital controller which may be easy to implement for a particular application.

In this sense the Sentinel is different from competing devices, in that it does not need to be tied in to a particular controller.

The Sentinel is packaged in a 16 pin package (SOIC, PDIP etc). It is also sold as a die. In addition the Sentinel and its complete system (digital controller, memory) can be delivered as a "Multichip System in a package"
(MSP™) if required.

The database of the Sentinel may be integrated (using CMOS) with additional features and functions to produce an Application Specific Standard product (ASSP).

The pre-designed cells (functional blocks) of the Sentinel are also available in the Chandler Chip™ configuration to implement systems on chip using the Sentinel and other peripherals as a custom design. Please call your nearest PROTEK ANALOG Sales office for more information.

The conceptual block diagram of the Sentinel is shown below.

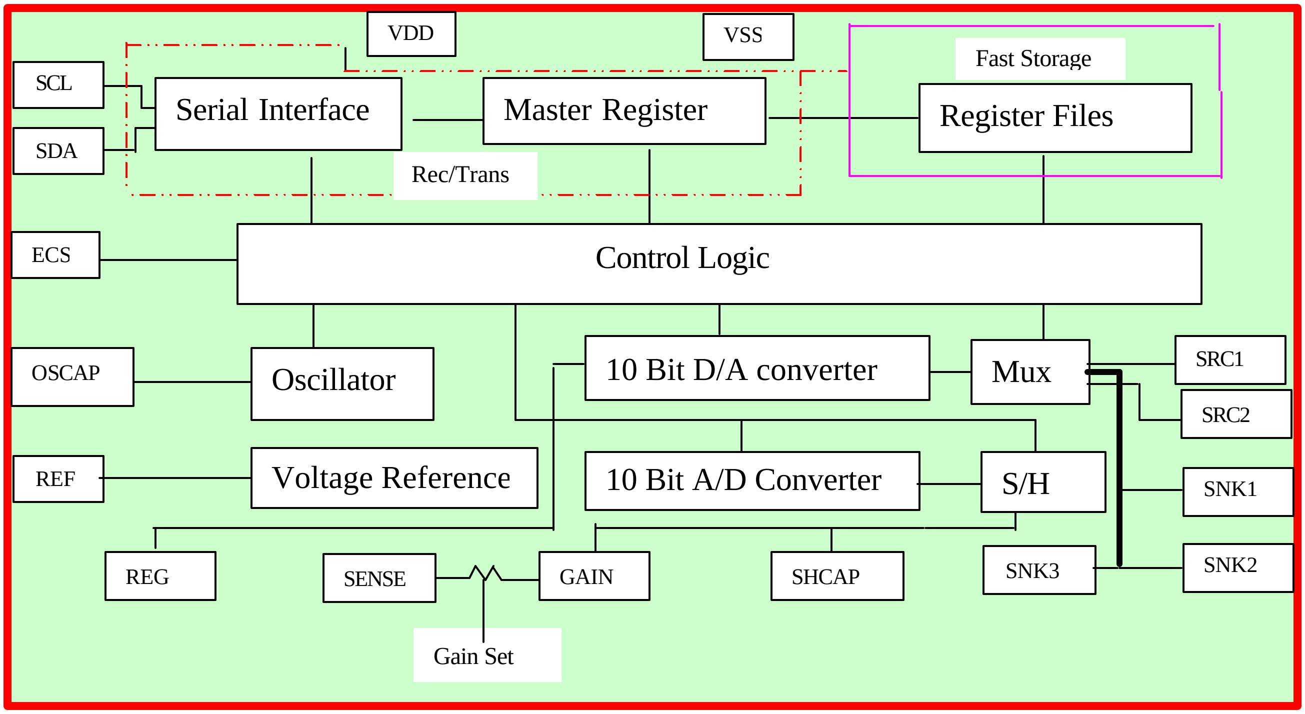

FIGURE 1. Conceptual Block Diagram of the SENTINEL

The basic functional blocks are:

- Communications interface in red dotted lines: Master register and Serial interface.
- Fast register storage memory
- An 8 bit current output dynamic digital to analog converter
- A 10 bit Analog to digital converter
- Auxiliary circuits, Voltage reference (untrimmed). RC Oscillator, currents sinks with multiplexing capabilities, Sample and hold amplifier, a transimpedance amplifier.

The Pin functions and descriptions are tabulated in TABLE 1.0 below.

TABLE 1. Pin descriptions

Pin no	Name	I/O	Description
1	SDA	Bi-dir	Serial Data
2	SCL	Input	Serial Clock
3	ECS	Output	EEPROM Select/Chip Select/Memory select
4	SRC1	Output	Source current from the DAC channel 1.
5	SRC2	Output	Source current from the DAC channel 2
6	REG	Output	Resistor from here to ground establishes the current drive from the DAC
7	SNK3	Output	Selectable current sink for the DAC source currents channel 1 (MUX operation)
8	VSS	Power	Ground
9	SNK2	Output	Selectable current sink for the DAC source currents channel 2 (MUX operation)
10	SNK1	Output	Selectable current sink for the DAC source currents channel 3 (MUX operation)
11	GAIN	Output	Gain setting pin and output for the internal amplifier used in the analog input channel.
12	SHCAP	Input	External capacitor for the sample and hold operation
13	SENSE	Input	Analog input pin
14	REF	Output	Reference voltage for data conversion
15	OSCAP	Input	External capacitor for the oscillator
16	VDD	Power	5.0V power

The following sections describe the pin functions and associated operations for the SENTINEL and should be used as a guide when using the SENTINEL. The SENTINEL is a robust device and if the communications
with the device are established as per the SENTINEL protocols it will be a joy to use!!

2.0 Functionality and Operation:

Basic operations are:

- Communicating with the Sentinel
- Digital to analog conversion
- Analog to digital conversion

All communications with the SENTINEL is done via the three signals (and pins), SDA (Pin 1), SCL (Pin2) and ECS (Pin 3). SDA is serial data (addresses, commands and data) and is a *bidirectional* port. Data is sent to, and received from, the SENTINEL using this pin.

SCL is the clock that shifts the data and also works with SDA to provide the command signaling for the communications as described below.

ECS is the memory select/chip select pin which enables users who want to use external selectable chips (memory or other device) to enable these when required while inhibiting the rest of the SENTINEL operations.

The key to the successful use of the SENTINEL is to understand these signals and the serial interface. (In fact it is a *very simple* interface). Once communications is established the rest of the operations all fall into place easily.

There are *three modes* of communications that use the SDA and the SCL pins. These are:

M1: MEMORY SELECT/CHIP SELECT MODE
M2: WRITE MODE
M3: READ MODE

In the WRITE mode, commands and data *are sent to* the Sentinel. The data can be stored in its fast storage of 8 registers. In the READ mode data is read out of the Sentinel using its communications interface.

The WRITE mode is used for generating *the ECS signal* which is an external device select signal. i.e when ECS is asserted high, the rest of the Sentinel is disabled. During the ECS time an external device (such as an EEPROM is selected for operation).

In the WRITE mode *8 bit data* can be written to its 6 storage registers to do functions such as calibration, generate DAC current outputs *proportional to stored data (0 to 256 levels per DAC).* Maximum currents can be up to 50mA per DAC current output.

Also in the WRITE mode, calibration data for *trimming the oscillator* frequency can be written into the oscillator trim register. This causes a change in oscillator frequency with the code stored in the oscillator register.

WRITE mode is also used to *store the amount of time the DAC will stay ON* after it is turned ON. (The DAC is turned ON for a limited amount of time to save power. This ON time of the DAC is determined by the value written to the delay register)

So WRITE is used for:

? DAC current generation data in 6 real registers
? Oscillator frequency trim data in oscillator register
? DAC on time DELAY register
? ECS signal to select external device

The READ mode is used to read out data, and measurement results, A/D conversion results, check various register contents etc.

The CHIP SELECT mode is used to generate an ECS signal. When the ECS signal is generated the Sentinel major operations are disabled and the ECS pin is asserted high for a known time. This allows the selection of external devices such as memories, other peripherals, controllers, relays, etc.

Once the initializing operations are complete, DAC data, oscillator trim, etc. the Sentinel is ready for use as a versatile component with measurement , control, interface and communications capabilities. A typical cycle of operation may be:

1.0 Ask the DAC to generate a known current using the value stored in a real register.
2.0 Use the DAC current generated to energize a sensor. Up to 3 sensors can be multiplexed using the Sentinel.
3.0 Take the analog output of the sensor, convert to digital using the Analog to Digital converter and send it via the serial communications interface to a host where it can be analyzed.
4.0 If the sensor output needs trimming change the DAC current) up or down), convert the analog output and repeat as many times as needed to get the required result.

In this case the Sentinel is being used a mixed signal feedback system controller.

Or

5.0 Set up the registers in such a manner so that a calibrated voltage can be generated across an external resistor connected to the DAC output. Measure this voltage and continue the cycle until required voltage is obtained to within the accuracy of the A/D converter.

Or

6.0 See additional applications below.

4.0 Advantages and limitations

Advantages:

- Low power multipurpose programmable analog front end device (1.5mA).
- Can be used with a multiplicity of controllers. Not tied to any one controller.
- Can be acquired as an Application Specific Standard Product or as an enhanced custom device to a customers specifications with add on features not included in the standard device.
- May be acquired as a multi device package with a controller and memory.
- Simple to use once the basics are understood.
- Very robust and forgiving device.
- Very cost effective device.
- Literally 100's of applications in the low voltage, low power, medium frequency range such as lighting, EL compensation, sensor interfaces, feedback control, measurement, toys and games, medical electronics, communications, etc.

Limitations:

A. The Sentinel is a medium to low frequency device. A maximum oscillator frequency of 2 Mhz has been tested. Internally this is divided by 2. So internally a 1 mHz signal is available. The DAC requires 12 cycles to generate an analog voltage. This means that the fastest the DAC output can be obtained is 12 microseconds.

B. The A/D conversion takes up to 65 cycles. Therefore the fastest A/D tested is at greater 60 usec conversion time.

C. The DAC resolution is 8 bits.

D. The A/D resolution is 10 bits

E. The voltage reference is not trimmed, so if very accurate absolute results are needed an external reference must be used. The same is true of the oscillator.

F. The Sentinel needs an external digital controller of some kind: micro, FPGA, CPLD, discrete logic etc. In short a host.

G. The operating voltage is 5.0V

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5.0 Conclusions and discussions:

The SENTINEL is a compact low power, medium speed analog front end designed for multiple applications in the sensor, instrumentation, computer peripheral, control, data acquisition, low frequency data communications etc., applications. It is very robust in its operation and very flexible. It can be used with a variety of digital controllers.

Its applications include operations such as simple low power A/D conversion (10 bit), complete closed loop systems such as a DAC, sensor, A/D, control systems.

It is very simple to use once the operation is understood The entire communications interface consists of two wires! Since these are serial signals it can be used remotely (with either a wireline or a wireless interface).

In the ultimate analysis the applications of the device and its usage is limited only by the imagination of the user. Once its various operating modes are understood it will be found to be a very useful little device indeed.

Notes:

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