Specifications for the SENTINEL™

FEATURES:

- Operating voltage and frequency: fosc=2MHz, 4.5~5.5V
- Dual 50mA current source
- One 10-bit analog input (A/D channel)
- 2-wire communication with host controller
- On-chip voltage regulator
- Up to six output current outputs (D/A channel)
- Low power consumption

Applications:

- 3-D graphics input device,
- 3-D game controllers,
- Smart lighting,
- Medical electronics

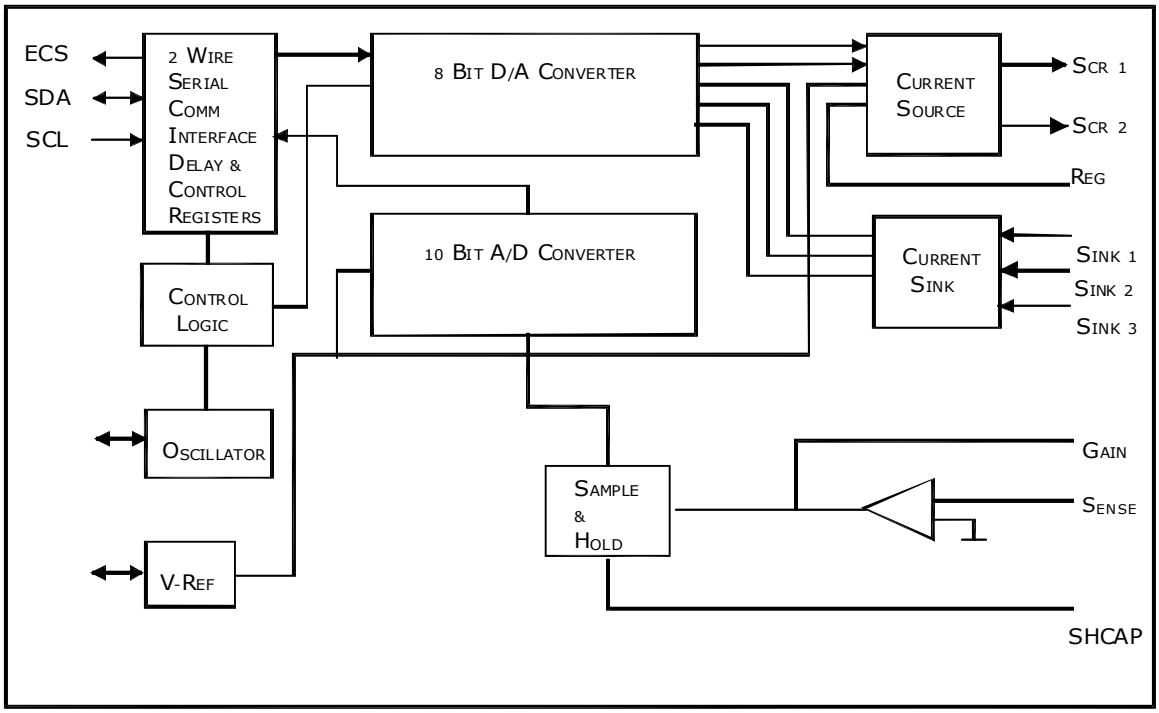
GENERAL DESCRIPTION:

The SENTINEL is a mixed signal CMOS monolithic device that acts as an analog front end or interface to a set of sensors. The device provides dual 8 bit programmable current sources, a clock oscillator for timing purposes, a voltage reference, a preconditioning amplifier, a sample and hold and a 10 bit A/D converter.

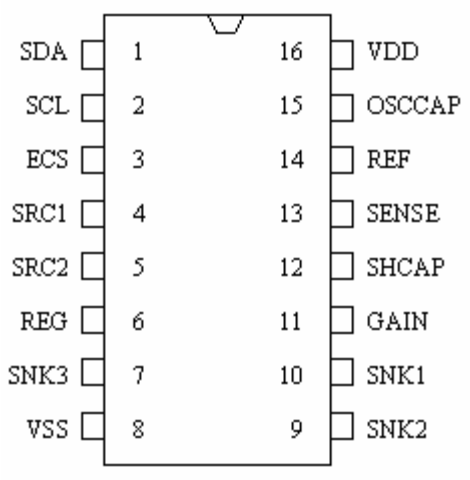
A serial communications interface using a two-wire channel is used to communicate with the device. A register file containing 6 real registers is provided for programming the current sources. Two additional registers are provided for trimming the clock oscillator and the delay for the current sources.

Communications consist of programming channel identification, sensor drive current and settling time delay. Control logic for the various operations resides on chip. External components consist of sensors and miscellaneous resistors and capacitors for timing. The device is configured in a SOIC-16 pin plastic package or can be delivered as a die for direct chip on board mounting. Additional options using the PA6001C are described at the end of this document.

FUNCTIONAL BLOCK DIAGRAM:



SENTINEL PIN DESCRIPTION



PA6001C, 16DIP-WB
QFN Pkg Option - CALL

Pin	Name	Description
1	SDA	Serial data I/O
2	SCL	Serial Clock
3	ECS	External Chip Select
4	SRC1	Current Drive
5	SRC2	Current Drive
6	REG	Establish level of current drive for SRC1, SRC2.
7	SNK3	Current sink 3.
8	VSS	Ground or common.
9	SNK2	Current sink 2.
10	SNK1	Current sink 1.
11	GAIN	Gain set for internal amplifier for sensing the response current.
12	SHCAP	External capacitor for sample and hold function
13	SENSE	Sense the output currents from photo-diodes or other sensing element.
14	REF	Reference voltage for the DAC.
15	OSCCAP	External capacitor for oscillator in analog section.
16	VDD	Positive supply voltage.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Units
Voltage at any pin	VMAX	7.0	Volt
Current at any pin	IMAX	100	mA
Operating Temperature	TMAX	100	Deg C
Storage Temperature	TST	160	Deg C
Soldering Temperature for 10 sec	TSOL	260	Deg C

Note: Sustained operation at or above these ratings may cause permanent damage to the device.

STATIC ELECTRICAL PARAMETERS

Parameter	Conditions	Min	Typ	Max	Units
VDD Supply	Operating	4.5	5.0	5.5	Volt
IDD Supply current	Except for current drive			2.5	mA
Temperature	Operating	0		70	Deg C
Voltage Reference	Max at REG output, depends on DAC output.			3.6	Volt

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95010 Rev0. 08/07

Patent Pending

DIGITAL SPECIFICATIONS

Parameter	Conditions	Min	Typ	Max	Units
CMOS High Level Output VOH	Iout=10µA	VCC-0.5			Volt
CMOS Low level Output VOL	Iout=100µA			0.5	Volt
CMOS High Level Input VIH		VCC-0.5			Volt
CMOS Low Level Input VIL				0.5	Volt
Clock rate				1	MHz
Data Length				20	Bits
CS Hold time				500	ns
CS Setup time				500	ns
Register File Rows				8	
Register File Columns				8	
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Register read/write setup time				500	ns
Register read/write hold time				500	ns
Delay Time		50		3200	µs

OSCILLATOR CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
OSC frequency range		100		2000	KHz
OSC frequency tolerance	Trimmed OSC			2.5	%
OSC Capacitance.			560		pF

Note: The oscillator requires an external capacitance which determines the Frequency. The oscillator provides timing for the A/D Conversion and the delay.

TRACK AND HOLD CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Hold Capacitance		50	100	220	nF
Settling Time		200	300	600	µs

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A/D CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
A/D resolution			10		Bits
A/D conversion time	OSC Frequency dependent				
A/D linearity			1		LSB
A/D FSR				3.6	Volt

CURRENT DRIVE CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Current Rise Time		500			ns
Current fall Time		500			ns
Current	Operating	2.0		30.0	mA
Current Turn ON time	To 90% of max			25.0	µs
Current Turn OFF time	To 10% of max			25.0	µs

SENSED CURRENT OR FEEDBACK CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Input sense current			25.0	500.0	µA

SENTINEL OPERATION

The SENTINEL typically needs some type of digital control and memory if required by the application for its operation. The host controls the SENTINEL operation and communicates with the memory via read/write commands transmitted over the serial interface. Only two signals are required to operate the serial interface, SDA and SCL. In a custom system on a chip, the customer may choose to implement all these macro blocks on the same chip, thereby evolving a new machine. *Since the SENTINEL is a fully tested and functional block. With the digital control and memory added, this is a perfectly viable choice and a low risk implementation.*

Data is clocked in to the SENTINEL on the positive edge of SCL. Normally SDA only changes when SCL is low. There are two exceptions: the START and STOP conditions.

START Condition: Positive transition on SDA when SCL is high.
STOP Condition: Negative transition on SDA when SCL is high.

The first data bit following the START condition determines whether the SENTINEL is to be selected or a chip select signal generated on ECS. A stop condition also causes the chip select signal to be pulsed low. The stop condition can occur at any time and terminates any operation that may be in progress.

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The SENTINEL is selected with the first data bit being a 1. The next bit specifies a read (0) or a write (1) operation followed by a 4-bit address. If a write operation is specified the following bits are read in to the selected register*, high bit first*. If a read operation is selected the SENTINEL pulls SDA low when the data is ready to be transmitted and the data bits are then clocked out following the negative SCL transition.

There are 14 logical registers, 8 real read/write registers (LD1 – LD6, DLY and OSC) and 6 "sensor reading" read-only registers (CH1 – CH6). The 8 real registers are the 6 sensors (or current drive) registers, a delay register and an oscillator compensation register. The host initializes these registers with the corresponding calibration values stored in the neighboring digital controller/ memory if needed. The 6 sensor reading registers are not actual registers. A read operation of one of these pseudo registers causes the SENTINEL to take a reading of the sensor specified by the address and returns this value as the data portion of the read operation. The take-readings operation is triggered by the negative transition of SCL of the last address bit. The SENTINEL pulls the SDA line low when the reading has been taken and the data is ready to be clocked out.

The following table lists the available commands.
The SDA bits driven by the SENTINEL are underlined.

	Select	**R/W**	**Address**	**Ready**	**Data**
Read Sensor Drive Registers 1-6					
	0	0	0000	0	LLLLLLLL
	0	0	0001	0	LLLLLLLL
	0	0	0010	0	LLLLLLLL
	0	0	0011	0	LLLLLLLL
	0	0	0100	0	LLLLLLLL
	0	0	0101	0	LLLLLLLL
Read Delay Register					
	0	0	0110	0	DDDDD
Read Oscillator Register					
	0	0	0111	0	SSSSS
Obtain Current Readings from Channel 1-6					
	0	0	1000	0	RRRRRRRRR
	0	0	1001	0	RRRRRRRRR
	0	0	1010	0	RRRRRRRRR
	0	0	1011	0	RRRRRRRRR
	0	0	1100	0	RRRRRRRRR
	0	0	1101	0	RRRRRRRRR
Undef.					

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	0	0	1110		
	0	0	1111		
	Select	**R/W**	**Address**	**Ready**	**Data**
Write output current drive registers					
	0	1	0000		LLLLLLLL
	0	1	0001		LLLLLLLL
	0	1	0010		LLLLLLLL
	0	1	0011		LLLLLLLL
	0	1	0100		LLLLLLLL
	0	1	0101		LLLLLLLL
Write Delay Register					
	0	1	0110		DDDDD
Write Osc. Register					
	0	1	0111		SSSSS

After a read operation SDA is released to a high state following the last valid output bit. A write to a register occurs after the rising edge of the last data bit clocked in. Additional data bits clocked in after a write operation are either ignored or treated as a new command or used to write the next real register.

NORMAL OPERATION

Calibration values may be stored and initialized by the host if needed. This is achieved by generating a start condition, clocking in a 0 data bit at which point the SENTINEL will pull the digital chip select pin high. The host can now communicate with it, since its CS pin is high and the SENTINEL is ignoring SDA and SCL apart from waiting for a stop condition. The controller issues a stop condition, at which point the SENTINEL pulls the CS pin low. The host then issues another start condition followed by a 1, followed in turn by the address of the LD1 register, 0000. This is followed by the 8 data bits to be written to LD1. Then a stop condition is issued. LD2 through OC are written in the same fashion to complete the initialization sequence.

During normal operation, the host will obtain a set of readings from the SENTINEL by issuing a set of read commands in order. Detailing this sequence, the host first issues a start condition followed by a 1 to select the SENTINEL. Then a 0 will be issued indicating a read followed by the first sensors pseudo register's address, 1000. The host leaves the SCL signal low and lets SDA go high and waits for the SENTINEL to pull SDA low to indicate the take-reading operation is completed and the reading is available. The host then drives SCL to clock the data bits out of the SENTINEL and finishes with a stop condition. This process is repeated for sensors 2 through 6.

The host can issue a stop condition to terminate the take – reading operation prematurely. This may be useful for situations where the current drive may be causing a brownout in low power situations.

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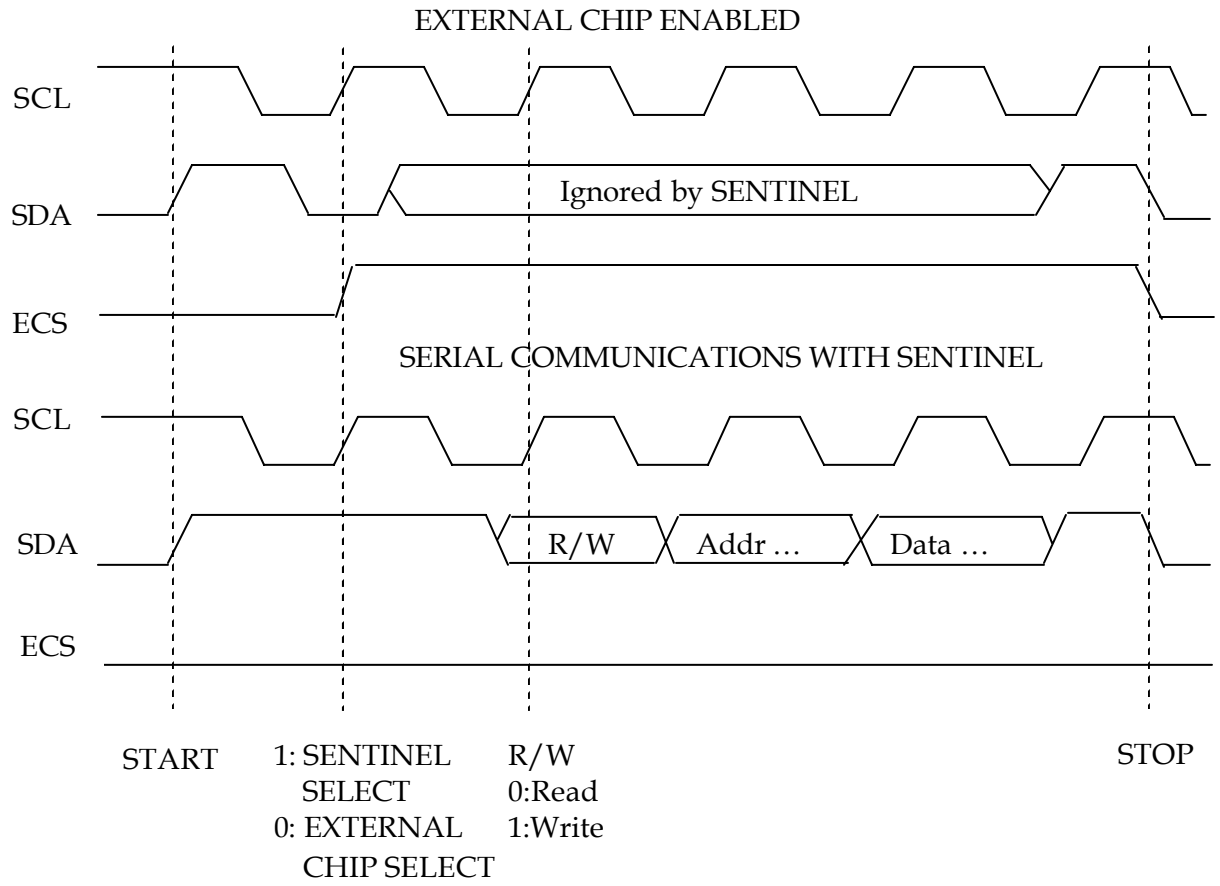
SENTINEL OPERATION TIMING PROTOCOL



SUMMARY OF OPERATION

The SENTINEL generates two current drives. These drives are used to power driven elements. The driven element state is sensed by a set of sensors. The sensor output current is sensed by an amplifier, which pre-conditions the outputs for A/D conversion. The SENTINEL does a A/D conversion and stores the output into a register for transmission to the outside world on command. The current drives are determined by a DAC and a voltage reference and a reference resistor determine the reference current. Registers are provided for storage and control of the operation. An oscillator sets the timing of the operation. A few external components are needed such as the oscillator capacitance, the current setting resistor, the sample and hold capacitance and the gain setting resistor. Other components for system level operation are the memory, which stores calibration coefficients and the digital controller.

The SENTINEL device is available either as SOIC-16 pin packaged device or die for COB mounting. For a full custom application the SENTINEL device can be integrated as a custom device with a host-controller or EPLD to generate a new device. This is a full custom development option at the customer's request only.

The typical application areas of SENTINEL include 3-D graphics input device, 3-D game controllers, serial input devices, appliances, sensor interfaces, smart lighting, toys and games, instrumentation, bio-medical applications.

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