07/2014

Smart Programmable Sensor Interface

Data Sheet

MSSPSI

Description

For processing signals from a sensor or MEMS device, the Smart Programmable Sensor Interface (MSSPSI) is a monolithic CMOS integrated circuit. Small analog signals from a sensor or MEMS are anti-aliased, filtered and amplified before being converted into a digital signal output by the MSSPSI. These processing functions are controlled by an external uP through the MSSPSI's on-chip serial interface. The MSSPSI also includes offset adjust, low power modes and an on-chip temperature sensor.

The input is fed into a low noise amplifier followed by two 6th order Elliptic switched capacitor anti-aliasing filters. The gain of the filter is controllable via the serial interface up to 18 dB (6 dB) steps. The next stage is a 6 pole Butterworth switched capacitor highpass filter, also with up to 18 dB of controllable gain. Following this is a 7th order Elliptic switched capacitor lowpass filter. These internal filters can be bypassed via the serial interface. The 12 bit, 160 kSps A-to-D converter provides a digital output.

The MSSPSI operates with a supply voltage from 3.3 VDC up to 5.5 VDC. It is available in a 32 pin LQFP Package with an industrial temperature range.

Features

Low Power Modes

Low Noise Input: <30 nV/(Hz)$^{1/2}$ at 100 Hz

Anti Alias Filter with Adjustable Gain

Lowpass Filter with Adjustable Gain Stage

Programmable SC Highpass Filter with Gain Adjust

Programmable SC Lowpass Filter with Gain Adjust

Temperature Sensor

Offset Adjust

12 bit 160 ksps A-to-D Converter and 4 input Mux

Applications

Low Noise Sensors

MEMS Interface

Accelerometer Sensing

Pressure Sensing

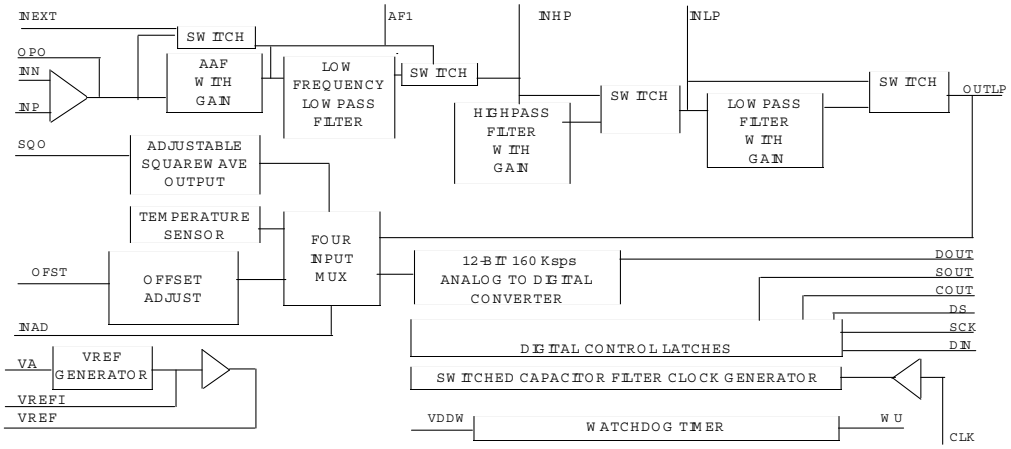
Vibration Sensing

Temperature Sensing

Test Equipment Cards/Data Acquisition Cards

Absolute Maximum Ratings

Power Supply Voltage	+6V
Storage Temperature Range	-60 to +150°C
Operating Temperature Range	-45 to +85°C



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Electrical Characteristics

(VDD = +5.0V, T = 25° C)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC Specifications						
Operating Voltage	VDD		3.3	5.0	5.5	V
Supply Current Regular	IDD	Power Control Bits 1111		6		mA
Supply Current Medium	IDD	Power Control Bits 1010		5		mA
Supply Current Low	IDD	Power Control Bits 0101		3		mA
Input Offset Voltage	IOV			5		mv
Input Bias Current	IBI			50		pA
Switch Input On Resistance	R_{IN}			20		kΩ
Temperature Voltage		T= 25°C		2.5		V
Temperature Voltage Slope		-20 to +80°C		+8.0		mV/°C
I/O Interface Voltage	VIO			3	VDD	V
Reference Voltage	VREF			VDD/2		V
AC Specifications						
Amp Unity Gain Bandwidth				2		MHz
Output Voltage Range				4		Vpp
Output Sink Capability				2		mA
Output Source Capability				0.2		mA
Input Impedance				1		MΩ
Input Referenced Noise Amp	e_n	fo=100 Hz		30		$nv/(Hz)^{1/2}$
Total Harmonic Distortion	THD	fo=1 kHz A weighted		-60		dB
Maximum Clock Frequency				20		MHz

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Block Diagram

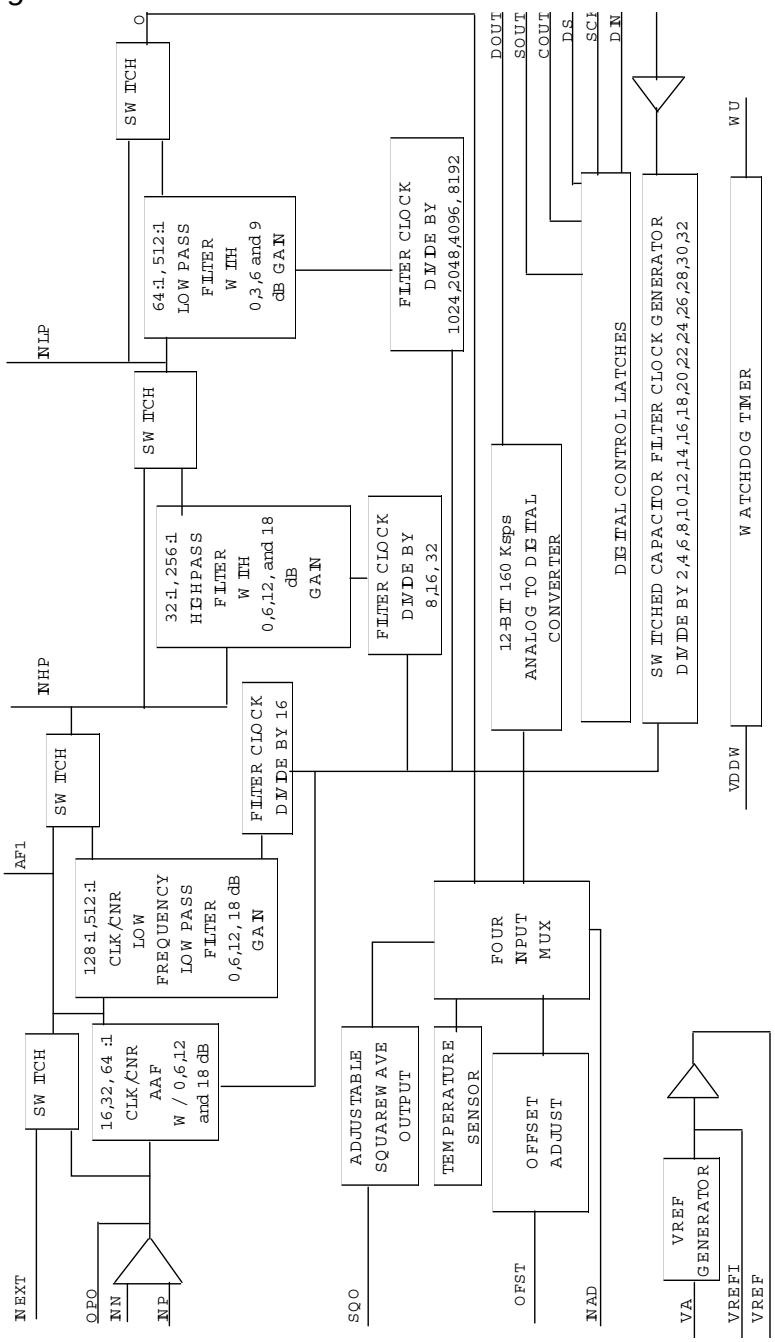

FIGURE 2: DETAILED BLOCK DIAGRAM

MSSPSI

MSSPSI

Pin Number	Pin Name	Description	Pin Number	Pin Name	Description
1	INP	Low Noise Amp Positive Input	16	DOUT	Data Output
			17	SOUT	Strobe Out Denotes start of conversion
2	SQO	Square Wave Output Adjustable to 400 mVpp 255 frequency steps			
3	VREFI	Voltage reference input A 0.1 µF cap to AGND is connected to this pin	18	COUT	Calibrator Output
			19	WU	Watchdog output
4	VREF	Voltage Reference Nominally 2.5 VDC	20	AF1	Alias Filter 1 Output Drives ›100kohms ‹12 pF
5	TEMP	Temperature Sensor Output	21	VA	Positive Supply; Typically 5.0 VDC
6	AGND	Analog Ground Typically tied to 0 VDC	22	INAD	Input to A/D
7	DGND	Digital Ground Typically tied to 0 VDC	23	OUTLP	Lowpass Filter Output
			24	INLP	Lowpass Filter Input)
8	N/C	Do Not Connect	25	INHP	Highpass Filter Input
9	CLK	Master Clock	26	N/C	Do Not Connect
10	DS	Data Strobe Input	27	INEXT	External Input
11	SCK	Serial Data Clock	28	BIAS	Bias Input
12	DI	Serial Data input	29	OFST	Offset Adjust Output
13	VIO	IO Interface Voltage Nominally 3.0 VDC	30	OPO	Op Amp Output
			31	N/C	Test Only; Do not connect
14	VDDW	Watchdog timer VDD			
15	DVDD	DIGITAL POSITIVE SUPPLY; Typically 5.0VDC. 0.1 µF capacitor to ground	32	INN	Low Noise Op Amp Negative Input

Serial Control Register

The MSSPSI uses serial data control with address and data clocked in with 21 cycles of the CLK clock. The data strobe (DS) resets the internal address data shift register. The address is a 4 bit nibble followed by a 16 bit word.

Address	Description
0000	Calibration Control Register; Controls signal on pin 18
0001	Offset DAC control level Controls votage at pin 29; AAF and OpAmp current con trol
0010	Amp and Antialias filter1 and 2 control
0011	Highpass Filter Control Register
0100	Lowpass Filter Control Register
0101	A/D converter and Watchdog timer Control Register
0110	Watchdog Timer Count Register

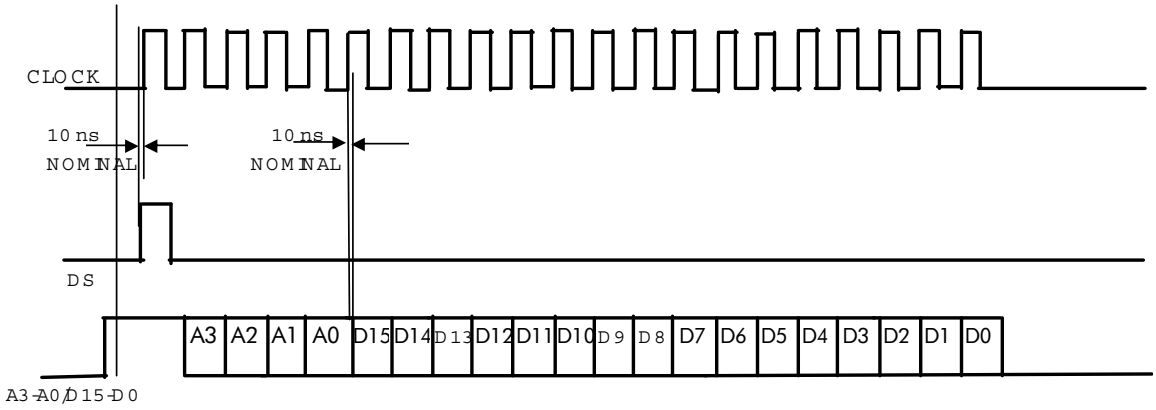

FIGURE 3: TIMING DIAGRAM OF ADDRESS/DATA INPUT

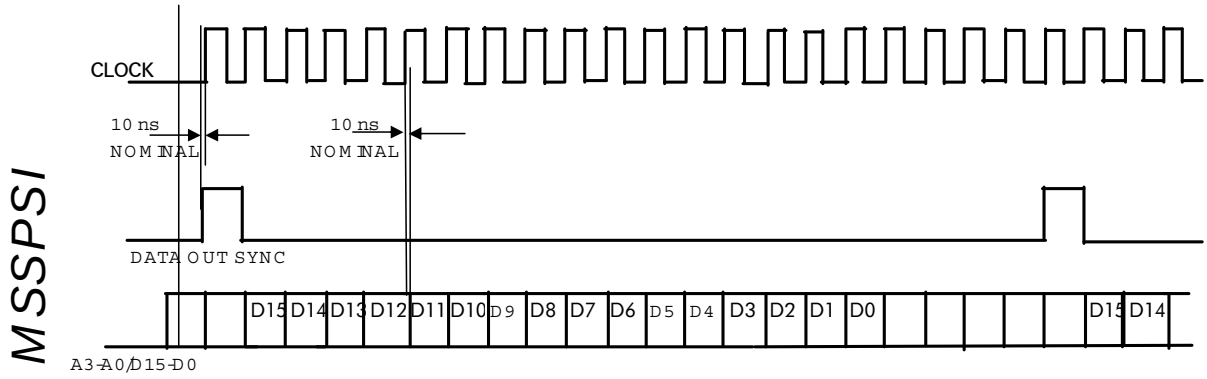

FIGURE 4: TIMING DIAGRAM OF DATA OUTPUT

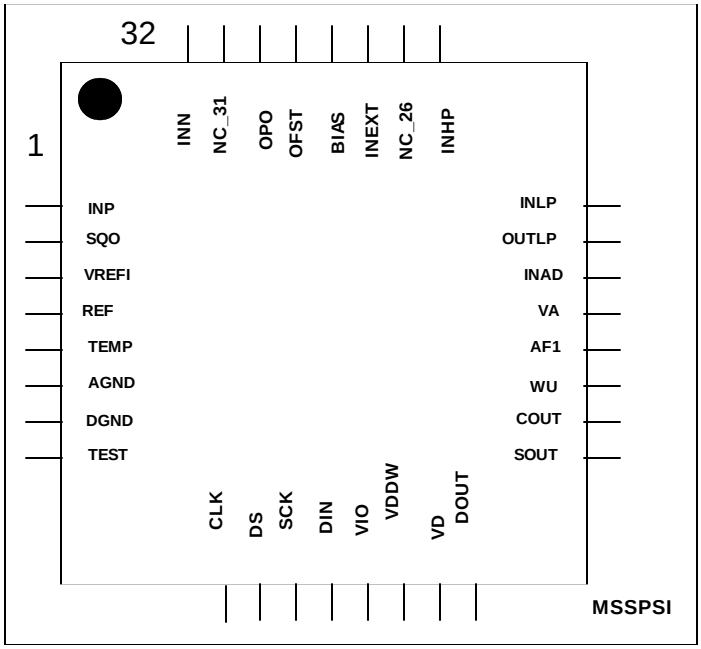

FIGURE 5: PINOUT OF MSSPSI (TOP VIEW)

Serial Interface Registers

ADDRESS				NIBBLE	DATA WORD																
A3	A2	A1	A0		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
0	0	0	0		0	0	0	0	CALOSC	CALPD	CAL	LEV	CALIBRATION			FREQUENCY	[D7-D0]				
0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Power on Default
0	0	0	0		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	10kHz
																					40mvpp
0	0	0	0		0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	5kHz
																					160mvpp
0	0	0	0		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	3.3kHz
																					270mvpp
0	0	0	0		0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	2.5kHz
																					400mvpp
0	0	0	0		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	2kHz
																					400mvpp
0	0	0	0		0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	1.15kHz
																					400mvpp
0	0	0	0		0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	590Hz
																					400mvpp
0	0	0	0		0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	307Hz
																					400mvppO
0	0	0	0		0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	152Hz
																					400mvppO
0	0	0	0		0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	78Hz
																					400mvpp
0	0	0	0		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	39Hz
																					400mvpp
0	0	0	0		0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	CAL OFF
0	0	0	0		0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	CAL PD

MSSPSI

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Serial Interface Registers

ADDRESS NIBBLE				DATA WORD															
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
0	0	0	1	0	0	0	AAF	IDD	OPAMP	IDD	0	0	OFFSET	DAC	SCALE	RANGE	[D6-D0]			
0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	1	Power on Default
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low AAF current Low Amp current -4 mV DAC
0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	Nor. AAF current Nor. Amp current -252mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	Max. AAF current Max. Amp current -2.52mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	Maxr. AAF current Max. Amp current 4mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	Max. AAF current Max. Amp current 252mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	Max. AAF current Max. Amp current 2.52mV DAC

Serial Interface Registers

ADDRESS NIBBLE				DATA WORD																
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
0	0	1	0	0	AAF2	Gain	AAF1	Gain	AAFIN	AAFC	AAF2 CNR	AAF1 CNR			1	0	1	1	1	
0	0	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1	1	1	Power on Default
0	0	1	0	0	0	1	0	1	0	1	0	0	1	1	1	0	1	1	1	6dB AAF2
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6dB AAF1
																				Amp to AAF
																				AAF2 to HP
																				44 Hz AAF2
																				12kHz AAF1
0	0	1	0	0	0	1	0	0	0	1	0	1	0	1	1	0	1	1	1	12dB AAF2
																				12dB AAF1
																				Amp to AAF
																				AAF2 to HP
																				156Hz AAF2
																				8.5kHz AAF1
0	0	1	0	0	1	1	1	1	0	1	0	1	0	0	1	0	1	1	1	18dB AAF2
																				18dB AAF1
																				Amp to AAF
																				AAF2 to HP
																				156Hz AAF2
																				2.6kHz AAF1
0	0	1	0	0	1	1	1	1	1	0	1	1	0	0	1	0	1	1	1	18dB AAF2
																				18dB AAF1
																				EXT to AAF
																				AAF1 to HP
																				156Hz AAF2
																				2.6kHz AAF1
0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	1	1	0dB AAF2
																				0dB AAF1
																				EXT to AAF
																				HPIN to HP
																				156Hz AAF2
																				2.6kHz AAF1

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Serial Interface Registers

ADDRESS				NIBBLE				DATA WORD														
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION		
0	0	1	1	0	0	0	0	0	0	HP	GAIN	HPCONF	HP	CNR	HP	CLOCK						
0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	Power on Default		
0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	6dB HP		
																				HP to LP 1.5Hz HP		
0	0	1	1	0	0	0	0	0	0	1	0	1	0	1	1	1	0	1	0	12dB HP		
																				HP TO LP 10kHz HP		
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1	0	18dB HP		
																				AAF to LP 1.25kHz HP		
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	12dB HP		
																				EXT to LP 1 Hz HP		
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0dB HP		
																				HP to LP 78 Hz HP		
0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	12dB HP		
																				HP TO LP 10 Hz HP		
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	1	18dB HP		
																				AAF to LP 20 Hz HP		
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	12dB HP		
																				EXT to LP 621 Hz HP		
0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0dB HP		
																				HP to LP 155 Hz HP		

Serial Interface Registers

ADDRESS NIBBLE				DATA WORD																
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
0	1	0	0	0	0	0	0	LP	GAIN	A/D	CUR	LP	CUR	LP	LPC	LP	CLOCK			
													CONF		CNR					
0	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0	1	Power on
																				Default
0	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	1	1	1	9dB LP
																				LOW A/D I
																				MED LP CUR
																				HP OUT
																				1.3kHz LP
0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1	1	0	0	0	6dB LP
																				MAX A/D I
																				MAX LP CUR
																				LP OUT
																				2.6kHz LP
0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0dB LP
																				MED A/D I
																				MED LP CUR
																				HP OUT
																				813Hz LP
0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	1	3dB LP
																				MLO A/D I
																				MED LP CUR
																				HP OUT
																				2.4Hz LP
0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	1	3dB LP
																				LOW A/D I
																				MED LP CUR
																				HP OUT
																				10Hz LP

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Serial Interface Registers

ADDRESS NIBBLE				DATA WORD																
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
0	1	0	1	0	0	0	WUT	RST	SLP	MCLOCK	DIVIDER		A/D	CLOCK		A/D		MUX		
0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	Power on Default
0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	WUT ENABLE
																				NO RESET
																				NO SLEEP
																				10 MHz CLK
																				160kHZ A/D
																				A/D INPUT
0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	WUT ENABLE
																				NO RESET
																				NO SLEEP
																				5.12MHz CLK
																				80kHZ A/D
																				FLT INPUT
0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	WUT ENABLE
																				NO RESET
																				NO SLEEP
																				20 MHz CLK
																				160kHZ A/D
																				TEMP INPUT
0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	WUT ENABLE
																				NO RESET
																				NO SLEEP
																				20 MHz CLK
																				40kHZ A/D
																				CAL INPUT
0	1	1	0	WAKEUP TIMER COUNT [D15-D0]																
0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Default

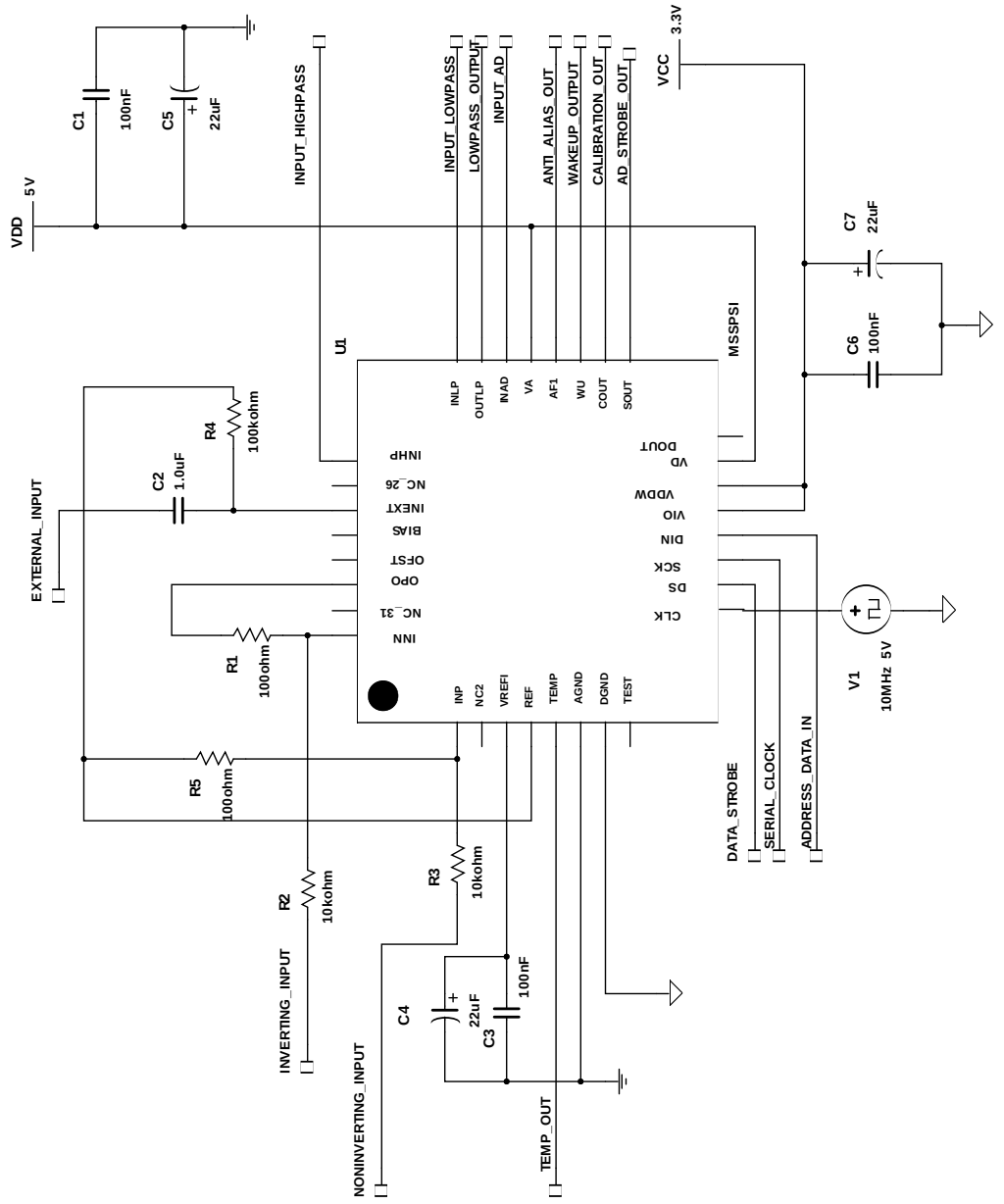

FIGURE 6: TYPICAL SCHEMATIC

MSSPSI

Watchdog Timer Operation

The MSSPSI watchdog timer times to 18 hours from 2.3 seconds in 1 second increments. The watchdog timer is activated with bit 12 of Address Nibble 0110 (0x06). The timer is first deactivated (bit 12 is set) then activated (bit 12 is reset) to start the timer.

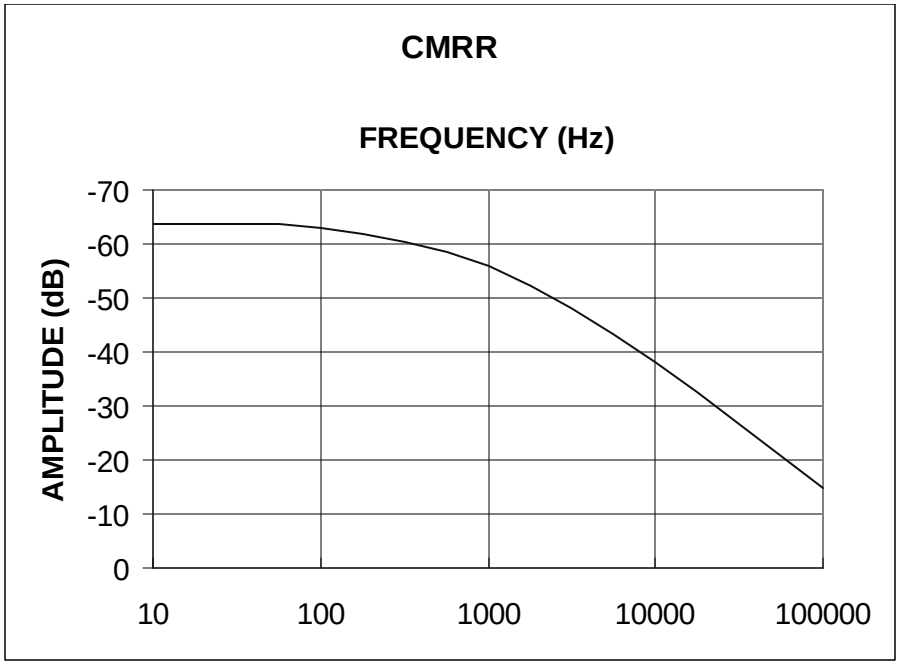

FIGURE 7: INPUT AMPLIFIER COMMON MODE REJECTION RATIO

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STANDARD PRODUCTS

MSGEQ5A	Five Band Graphic Equalizer
MSGEQ7	Seven Band Graphic Equalizer
MSHFS1-6	Selectable High Frequency LP/BP Filter
MSFS1-6	Selectable Lowpass/Bandpass Filter
MSCAHF	Selectable High Frequency Active Lowpass/Bandpass Filter
MSU1F1-4, MSU2F1	Resistor Programmable Universal Active Filter
MSU1HF1-4, MSU2HF1	High Frequency Resistor Programmable Universal Active Filter
MSELP	Switched Capacitor Elliptic Lowpass Filter with Op Amps
MSNBLP	Switched Capacitor Butterworth Lowpass Filter
MSLE/B/C5L/M	Switched Capacitor General Purpose Lowpass Filter
MS2LFS	Dual Selectable Low Voltage Lowpass/Bandpass Filter
MSLFS	Selectable Low Voltage Lowpass/Bandpass Filter
MSHN1-6	Selectable High Pass/Notch Filter
MSRAAF	Resistor Programmable Active Audio Filter
MSRAHF	Resistor Programmable Active High Frequency Filter
MSDET	Tone Detector
MSEPAF	Electrically Programmable Active Filter
MSCBT	Communications Baseband Transceiver
MSLV14	14 MHz Video Lowpass Filter

Smart Programmable Sensor Interface
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MSSPSI

Mixed Signal Integration
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San Jose, California 95131-1332
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Fax: (408)-434-6417

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9694 Madison Boulevard Suite A-14
Madison, Alabama 35758
Telephone: 256-772-1922
Facsimile: 256-772-0323

In Arizona, Utah, Colorado, Montana, Wyoming, Idaho, New Mexico and southern Nevada contact:

Nelco Electronix
6970 S. Holly Circle #205
Centennial, CO 80112
Telephone: 720-493-9630
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Kowloon Bay, Hong Kong
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1355-3, Seocho-Dong, Seocho-Ku,
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