



Controller Programmable Sensor Interface

Preliminary Data Sheet

Description

The Controller Programmable Sensor Interface (MSCPSI) is a hybrid package containing two CMOS integrated circuits for processing signals from either a sensor or MEMS device. Small analog signals are amplified, anti-aliased, and filtered before being converted into a digital signal output by the MSCPSI. These processing functions are controlled by an internal PICTM processor through the MSCPSI's on-chip serial interface. The MSCPSI 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 MSCPSI operates with a supply voltage from 3.3 VDC up to 5.5 VDC. It is available in a 64 pin LQFP Package with an industrial temperature range.

There are 4 current levels that are selectable for the filter and 12-bit Analog-to-Digital Converter. Lower corner or sample frequency settings can be set for lower current operation. When the maximum corner or sample frequency is needed, the currents can be set greater.

Features

- Low Power Modes
- Low Noise Input: $<30 \text{ nV}/(\text{Hz})^{1/2}$ 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 4 input Mux
- 14-bit PICTM Processor with 2k FLASH memory
- 10-bit 10 ksps A-to-D Converter w/ 5 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

MSCPSI



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Electrical Characteristics _____

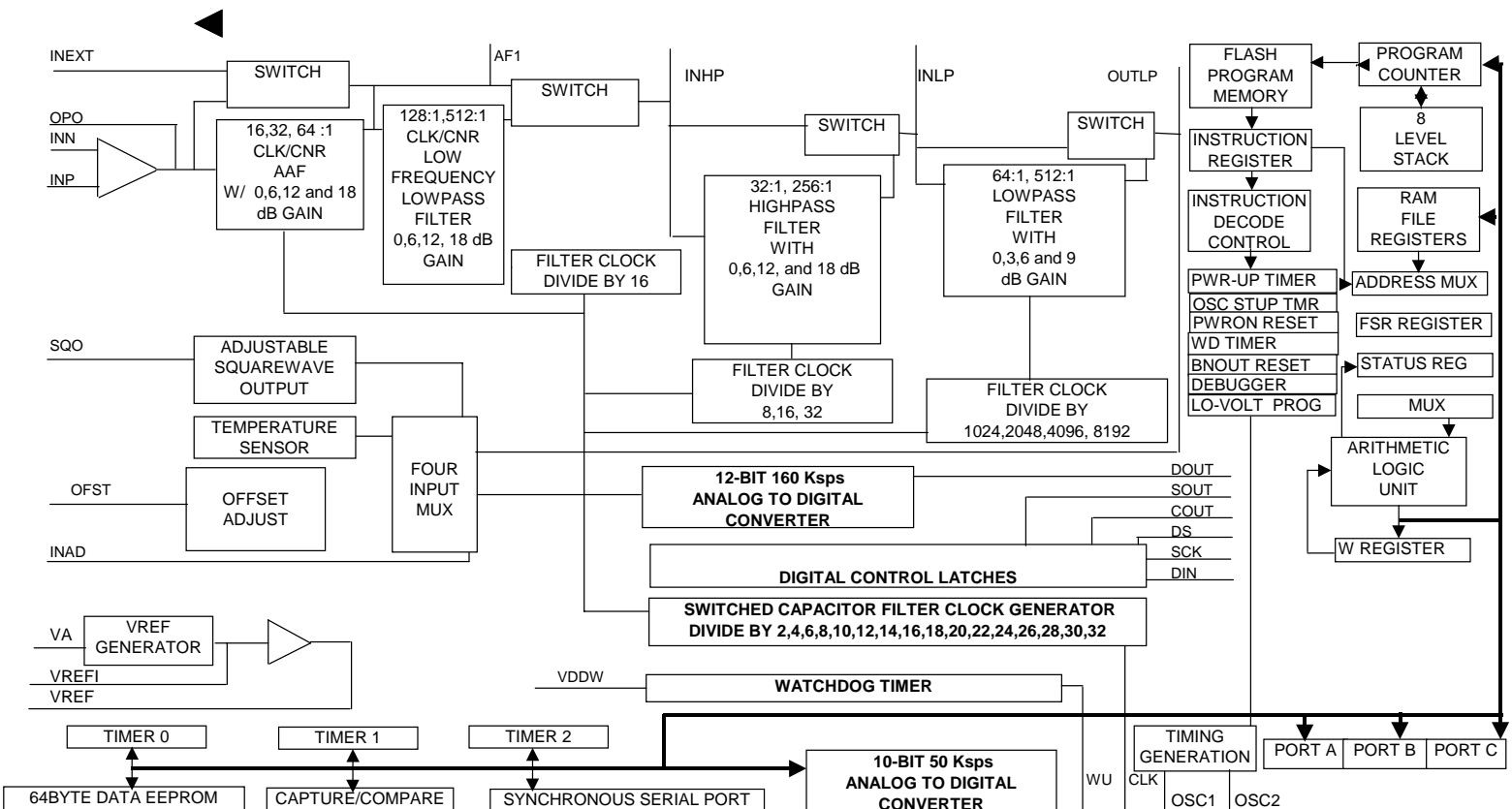
(VDD = +5.0V, T = 25° C)

M SCPSI

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				+7.5		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		V _{pp}
Output Sink Capability				2		mA
Output Source Capability				0.2		mA
Input Impedance				10		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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Pin Number	Pin Name	Description	Pin Number	Pin Name	Description
1	BIAS	Bias Input	30	VA	Positive Supply; Typically 5.0 VDC
2	OFST	Offset Adjust Output			
3	OPO	Op Amp Output	31	INAD	Input to A/D
4	N/C	Do Not Connect	32	OUTLP	Lowpass Filter Output
5	N/C	Do Not Connect	33	INLP	Lowpass Filter Input)
6	INN	Low Noise Op Amp Negative Input	34	RB4	Port B4
			35	RB5	Port B5
7	N/C	Do Not Connect	36	RB6	Port B6
8	INP	Low Noise Amp Positive Input	37	RB7	Port B7
			38	MCLRN	FLASH VPP/RESET
9	SQO	Square Wave Output	39	RA0	Port A0
10	VREFI	Voltage Reference Input	40	RA1	Port A1
11	VREF	Voltage Reference Nominally 2.5 VDC	41	RB2	Port A2
			42	RA3	Port A3
12	TEMP	Temperature Sensor Out	43	RA4	Port A4
13	AGND	Analog Ground Typically tied to 0 VDC	44	RA5	Port A5
			45	VSSD	DIGITAL GROUND (0 V)
14	DGND	Digital Ground Typically tied to 0 VDC	46	OSC1	CRYSTAL INPUT
			47	OSC2	CRYSTAL OUTPUT
15	TEST	Test pin Do not Connect	48	RC0	Port C0
16	CLK	Master Clock	49	RC1	Port C1
17	DS	Data Strobe Input	50	RC2	Port C2
18	SCK	Serial Data Clock	51	RC3	Port C3
19	DIN	Serial Data Input	52	RC4	Port C4
20	VIO	I/O VOLTAGE: typically 5.0 VDC	53	RC5	Port RC5
			54	RC6	Port C6
21	VDDW	Watchdog Timer VDD typically 3.3 VDC	55	RC7	Port C7
			56	DGND1	DIGITAL GROUND 1 (0 V)
22	VDD	DIGITAL POSITIVE SUP- PLY: Typically 5.0 VDC	57	VDDD	MICROPROCESSOR SUPPLY typically tied to 5.0 VDC
23	DOUT	Data Output	58	RB0	Port B0
24	N/C	Do Not Connect	59	RB1	Port B1
25	N/C	Do Not Connect	60	RB2	Port B2
26	SOUT	Strobe Out Denotes start of conversion	61	RB3	Port B3
			62	INHP	Highpass Filter Input
27	COUT	Calibrator Output	63	N/C	Do Not Connect
28	WU	Watchdog output	64	INEXT	External Input
29	AF1	Alias Filter 1 Output Drives >100kohms <12 pF			



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Serial Control Register

The MSCPSI 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
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

Address	Description
0000	Calibration Control Register; Controls signal on pin 18
0001	Offset DAC control level Controls volt age at pin 29; AAF and OpAmp current control

MSCPSI

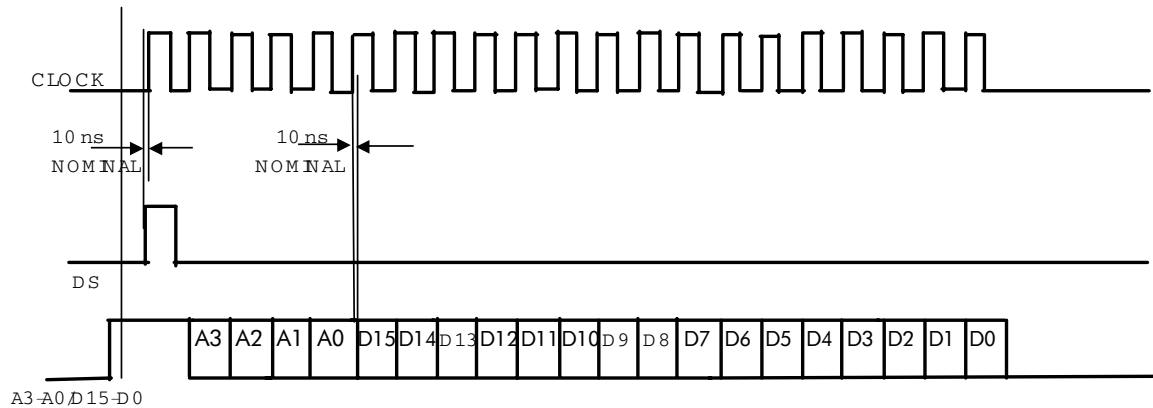


FIGURE 2: TIMING DIAGRAM OF ADDRESS/DATA INPUT



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MSCPSI

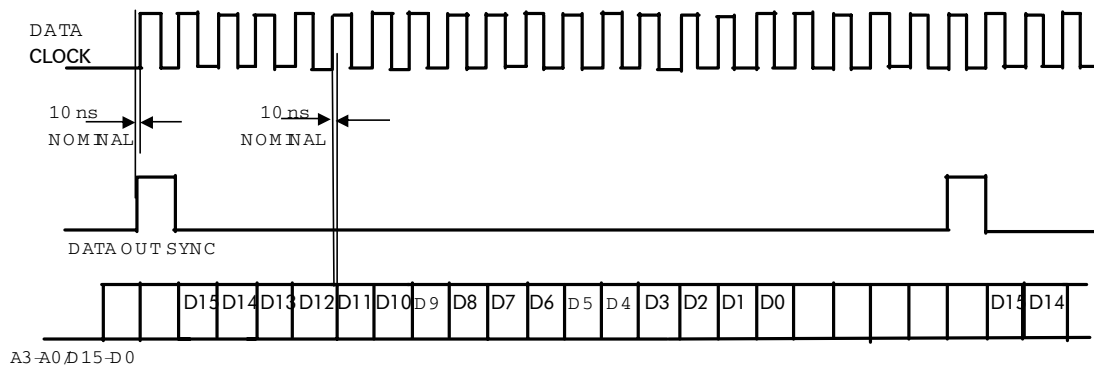


FIGURE 3: TIMING DIAGRAM OF DATA OUTPUT

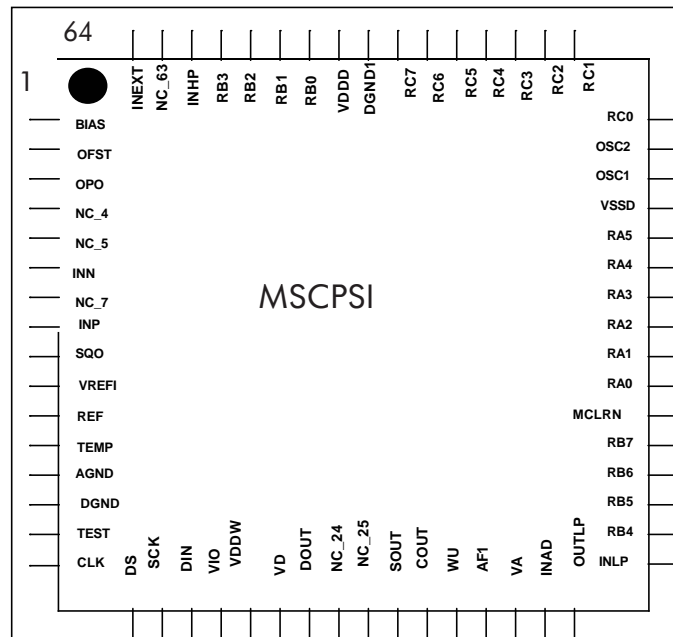


FIGURE 4: PINOUT OF MSCPSI (TOP VIEW)

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

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Serial Interface Registers (continued)

ADDRESS NIBBLE				DATA WORD																DESCRIPTION
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
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
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Amp current
0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	-4 mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	Nor. AAF current
0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	Nor. Amp current
0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	-252mV DAC
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	Max. AAF current
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	Max. Amp current
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	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
0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	Max. Amp current
0	0	0	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	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
0	0	0	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	Max. Amp current
0	0	0	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	2.52mV DAC



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Serial Interface Registers (continued)

ADDRESS NIBBLE				DATA WORD																DESCRIPTION
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
0	0	1	0	0	AAF2 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	AAF1 Gain	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 6dB AAF1 Amp to AAF AAF2 to HP 44 Hz AAF2 12kHz AAF1
0	0	1	0	0	1	0	1	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 (continued)

ADDRESS NIBBLE				DATA WORD																DESCRIPTION
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
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
0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	1	0	1	0	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
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1	0	HP TO LP
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1	0	10kHz HP
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1	0	18dB HP
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	AAF to LP
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	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
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	EXT to LP
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	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
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	HP to LP
0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	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
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	1	HP TO LP
0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	1	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
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	AAF to LP
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	20 Hz HP
0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	12dB HP
0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	EXT to LP
0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	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
0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	HP to LP
0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	155 Hz HP

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ADDRESS NIBBLE				DATA WORD																DESCRIPTION
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
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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ADDRESS NIBBLE				DATA WORD																DESCRIPTION
A3	A2	A1	A0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
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	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Default

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Watchdog Timers Operation

The MSCPSI 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. The MSCPSI watchdog timer provides an independent pulse to indicate if a processing problem has occurred with the system.

The watchdog timer in the controller portion of the MSCPSI is independent and is accessed using firmware code and utilizing the clrwtd command.

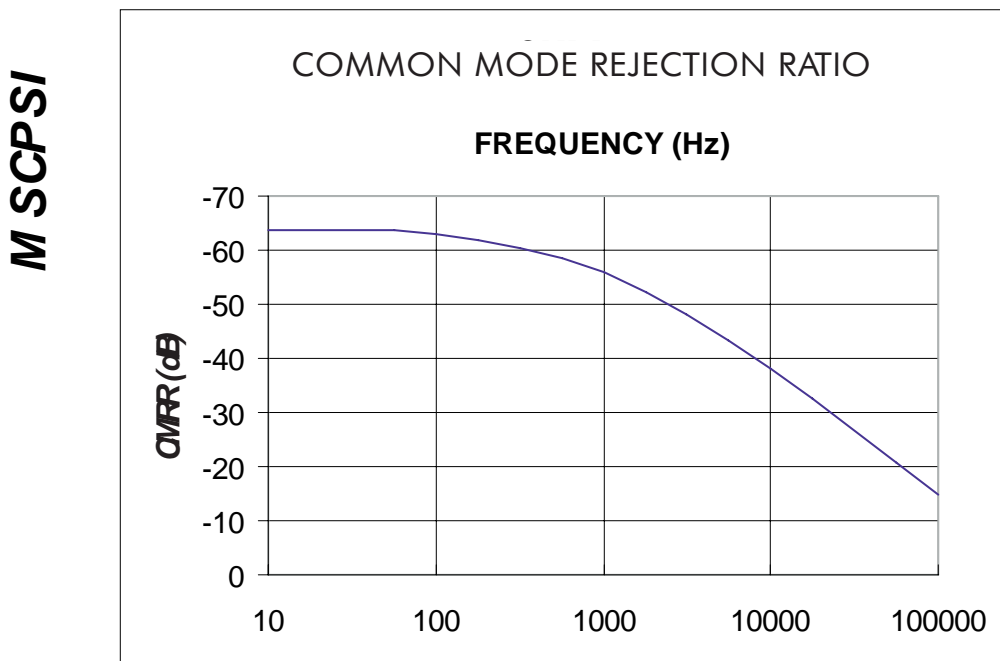


FIGURE 6: INPUT AMPLIFIER COMMON MODE REJECTION RATIO

Controller Programmable Sensor Interface

Preliminary Data Sheet

Controller Commands

There are 35 instructions in the command set of the MSCPSI. There are in 4 groups: Arithmetic Instructions, Execution Instructions, Microcontroller Control Instructions and Bit Manipulation Instructions.

MSCPSI

Arithmetic Instructions

movf	Move f
clrf	Clear f
clrw	Clear W
movwf	Move W to f
addwf	Add W to f
subwf	Subtract W from f
andwf	And W with f
iorwf	Inclusive Or W with f
xorwf	Exclusive Or W with f
comf	Complement f
swapf	Swap nibbles in f
rlf	Rotate left f through Carry
rff	Rotate right f through Carry
incf	Increment f
decf	Decrement f
incfsz	Increment f; skip if zero
decfsz	Decrement f; skip if zero
movlw	Move Literal to W
addlw	Add Literal to W
sublw	Subtract W from Literal
andlw	And Literal with W
iorlw	Inclusive Or Literal with W
xorlw	Exclusive Or Literal with W

Execution Change Instructions

call 0x00	Call Subroutine
Return	Return from Subroutine
goto 0x00	Go To address
retfe	Return from Interrupt
retlw	Return with Literal in W

Microcontroller Instructions

clrwtd	Clear Watchdog timer 2
sleep	Place Controller in Standby
nop	No Operation

Bit Manipulation Instructions

bcf	Bit Clear f
bsf	Bit Set f
btfs	Bit Test f, skip if clear
btfs	Bit Test f, skip if set

For additional information on using these commands, consult the PICmicro™ Mid-Range MCU Family Reference Manual at www.microchip.com. PICmicro™ is a trademark of Microchip Corporation.

STANDARD PRODUCTS

MSRFIF	Radio Frequency Interface Front End
MSCPSI	Controller Programmable Sensor Interface
MSLOSC	15 Hz to 64 kHz All Silicon Sine Source
MSSPSI	Smart Programmable Sensor Interface
MSEPAF	Electrically Programmable Active Filter
MSCBT	Communications Baseband Transceiver
MSLV14	14 MHz Video Lowpass Filter
MSGEQ5A	Five Band Spectrum Analyzer
MSGEQ7	Seven Band Spectrum Analyzer
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

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