



Analog Inputs & Outputs

Description

The SPPPF Series of dual channel programmable, FIR filter platforms, are factory configured, turnkey solutions that cover the audio bandwidth to +20 kHz. Each SPPPF-01 provides two independently tuned channels of on-board analog I/O with 9-bit, (512) tuning while each SPPPF-02 provides two independently tuned channels of on-board analog I/O with 8-bit, (256) tuning. SPPPF's are easy to use, plug-in modules with no external components, all packaged in a compact 2" x 2", low profile footprint. Each SPPPF contains its own anti-alias and reconstruction filters along with ADC's, DAC's and analog I/O. The SPPPF's provide brick wall, linear phase characteristics with low noise attenuation floors of -96 dB typical. Sampling at 48 kHz, the fixed point DSP utilizes 32-bit math to achieve 24-bits of precision for digital FIR filters with shape factors from 1.03 to 1.50.

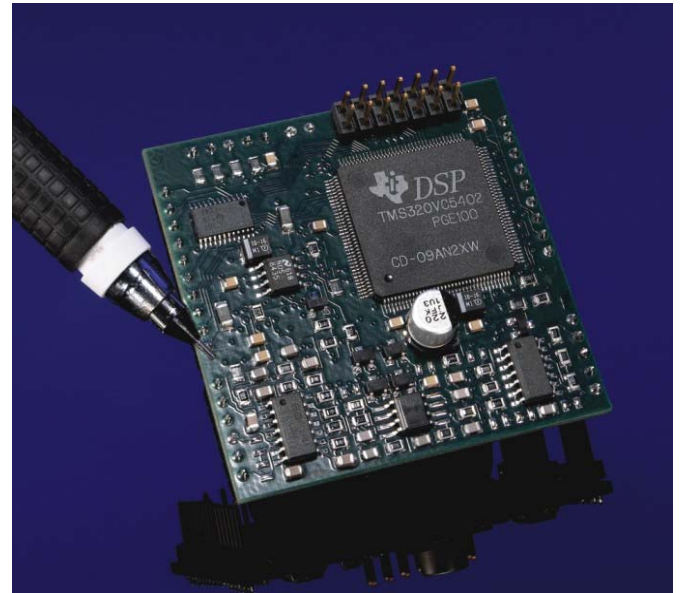
SPPPF's can be provided in several standard or custom frequency ranges utilizing a broad range of single or multi-rate brick wall algorithms. An SPPPF-02 (special LF clock 7.2 kHz) permits ultra low frequency ranges from 0.1 Hz to 25.6 Hz. All pre-programmed for your laboratory or field applications.

Features/ Benefits:

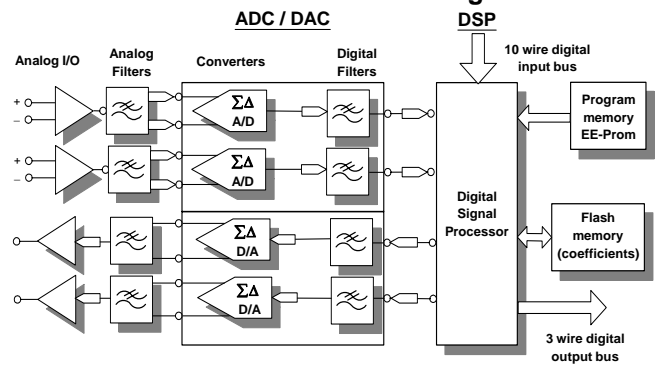
- Integrates the best of analog and digital signal processing to optimize standard and multi-rate FIR filter performance.
- Each channel can be programmed independently.
- Provides plug-in turnkey solutions with over 500 digitally programmable algorithms per channel.
- All standard and custom solutions combine Brick-wall Low-Pass, Band-Pass solutions with linear phase performance.
- Compact 2" x 2" dual channel design provides precision performance while minimizing board space requirements.

Applications

- Sound and Vibration Testing
- Signal Correlation / Data Analysis
- Speech Analysis, Research, Pathology
- Research and Development
- Automatic Test Equipment
- Data Acquisition Systems
- Seismic measurements



SPPPF-01 & 02 Block Diagram



SPPPF SOFTWARE SELECTION GUIDE

Dual Channel Low Pass Ranges

SPPPF-01

- SWLP-01** From 10 Hz to 521 Hz in 1.0 Hz steps
- SWLP-02** From 10 Hz to 5,210 Hz in 10 Hz steps
- SWLP-03** From 25 Hz to 12,800 Hz in 25 Hz steps
- SWLP-04** From 50 Hz to 20,950 Hz in 50 Hz steps
- SWLP-CXX** Consult factory for custom ranges.

Dual Channel Band Pass Ranges

- SWBP-01** 10 Hz BW from 50 Hz to 5,170 Hz in 10 Hz steps
- SWBP-02** 25 Hz BW from 50 Hz to 12,825 Hz in 25 Hz steps
- SWBP-03** 50 Hz BW from 50 Hz to 20,800 Hz in 50 Hz steps
- SWBP-CXX** Consult factory for custom ranges.

SPPPF-02

- SWLP-05** From 0.1 Hz to 25.6 Hz in 0.1 Hz steps



Analog Inputs & Outputs

Low Pass	Channel Configuration	F _{c1}	Step (Hz)	Tuning Range
SWLP-01	Two Independent LP FIR filters	10	1	10 Hz to 521 Hz
SWLP-02	Two Independent LP FIR filters	10	10	10 Hz to 5,210 Hz
SWLP-03	Two Independent LP FIR filters	25	25	25 Hz to 12,800 Hz
SWLP-04	Two Independent LP FIR filters	50	50	50 Hz to 20,800 Hz

SWLP-01 Theoretical Performance Table

(Range: 10Hz to 521Hz in 1Hz steps)

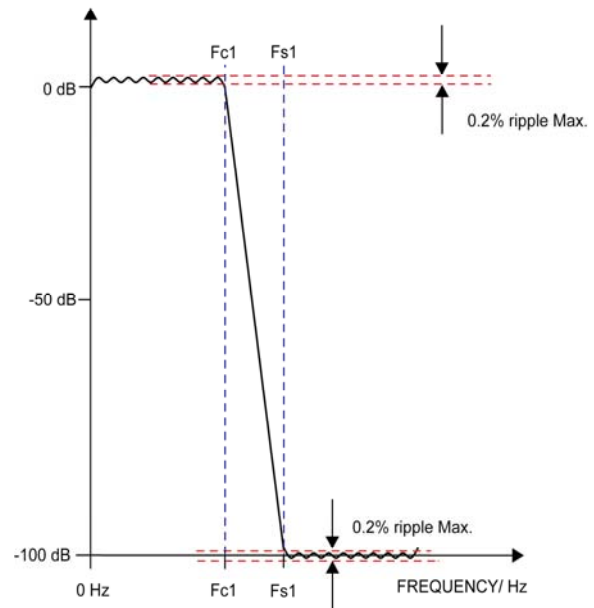
F _{c1} ¹ (Hz)	F _{s1} ² (Hz)	Shape Factor	Attenuation (dB)	Time Delay ⁴ (ms)
10	15	1.5	96	822
20	30	1.5	96	473
30	45	1.5	96	298
40	60	1.5	96	222
50	75	1.5	96	179
60	90	1.5	96	149
70	105	1.5	96	120
80	120	1.5	96	109
90	135	1.5	96	98
100	150	1.5	96	92
150	225	1.5	96	64
200	300	1.5	97	47
250	375	1.5	97	37
300	450	1.5	97	32
350	520	1.5	97	28
400	590	1.5	97	25
450	675	1.5	97	22
500	750	1.5	98	20

SWLP-02 Theoretical Performance Table

(Range: 10Hz to 5,120Hz in 10 Hz steps)

F _{c1} ¹ (Hz)	F _{s1} ² (Hz)	Shape Factor	Attenuation (dB)	Time Delay ⁴ (ms)
10	15	1.5	96	822
20	30	1.5	96	473
30	45	1.5	96	298
40	60	1.5	96	222
50	75	1.5	96	179
60	90	1.5	96	149
70	105	1.5	96	120
80	120	1.5	96	109
90	135	1.5	96	98
100	150	1.5	96	92
200	300	1.5	97	47
300	450	1.5	97	32
400	600	1.5	97	25
500	750	1.5	98	20
600	900	1.5	98	16
700	1,050	1.5	98	13
800	1,200	1.5	98	12
900	1,350	1.5	98	10
1,000	1,500	1.5	98	9.4
1,500	2,230	1.5	98	3.3
2,000	2,800	1.4	98	3.3
2,500	3,300	1.4	98	3.3
3,000	3,800	1.3	98	3.3
3,500	4,300	1.3	98	3.3
4,000	4,800	1.2	98	3.3
4,500	5,300	1.2	98	3.3
5,000	5,800	1.2	98	3.3

FIG. 1 SPP-01 LOW PASS ALGORITHM TEMPLATE



Notes:

1. F_{c1} represents the 0dB corner frequency
2. F_{s1} stopband frequency.
3. All filters based on 48KHz sampling frequency, -96 dB stopband attenuation and 0.1 dB passband ripple.
4. Time delays are for the FIR filter only. Additional time delay for the ADC is approx. 0.2ms and the DAC is 1ms.



Analog Inputs & Outputs

SWLP-03 Theoretical Performance Table

(Range: 25 Hz to 12,800 Hz in 25 Hz steps)

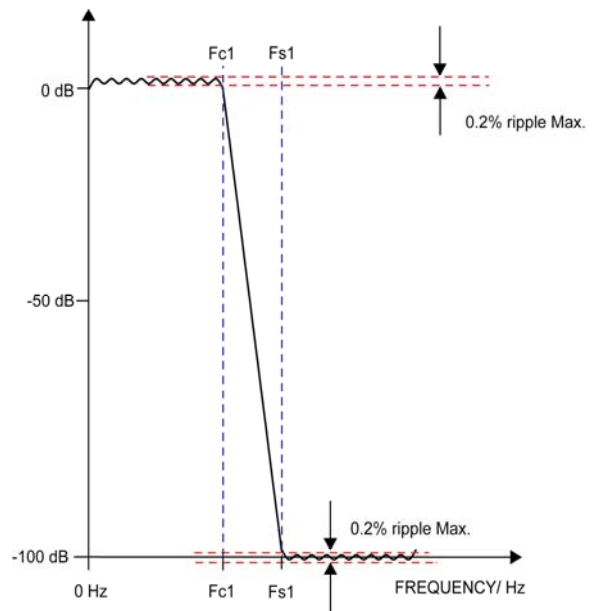
F _{C1} ¹ (Hz)	F _{S1} ² (Hz)	Shape Factor	Attenuation (dB)	Time Delay ⁴ (ms)
25	37.5	1.5	96	355
50	75	1.5	96	179
75	112	1.5	96	120
100	150	1.5	96	92
200	300	1.5	97	47
300	450	1.5	97	32
400	600	1.5	97	25
500	750	1.5	98	20
600	900	1.5	98	16
700	1,050	1.5	98	13
800	1,200	1.5	98	12
900	1,350	1.5	98	10
1,000	1,500	1.5	98	9.4
2,000	2,800	1.4	98	3.3
3,000	3,800	1.3	98	3.3
4,000	4,800	1.2	98	3.3
5,000	5,800	1.2	98	3.3
6,000	6,800	1.2	98	3.3
7,000	7,800	1.2	98	3.3
8,000	8,800	1.1	98	3.3
9,000	9,800	1.1	98	3.3
10,000	10,800	1.1	98	3.3
11,000	11,800	1.1	98	3.3
12,000	12,800	1.1	98	3.3
12,800	13,600	1.1	98	3.3

SWLP-04 Theoretical Performance Table

(Range: 50 Hz to 20,950 Hz with 50 Hz steps)

F _{C1} ¹ (Hz)	F _{S1} ² (Hz)	Shape Factor	Attenuation (dB)	Time Delay ⁴ (ms)
50	75	1.5	96	179
100	150	1.5	96	92
200	300	1.5	97	47
300	450	1.5	97	32
400	600	1.5	97	25
500	750	1.5	98	20
600	900	1.5	98	16
700	1,050	1.5	98	13
800	1,200	1.5	98	12
900	1,350	1.5	98	10
1,000	1,500	1.5	98	9.4
2,000	2,800	1.4	98	3.3
3,000	3,800	1.3	98	3.3
4,000	4,800	1.2	98	3.3
5,000	5,800	1.2	98	3.3
6,000	6,800	1.2	98	3.3
7,000	7,800	1.2	98	3.3
8,000	8,800	1.1	98	3.3
9,000	9,800	1.1	98	3.3
10,000	10,800	1.1	98	3.3
11,000	11,800	1.1	98	3.3
12,000	12,800	1.1	98	3.3
13,000	13,800	1.1	98	3.3
14,000	14,800	1.1	98	3.3
15,000	15,600	1.1	98	3.3
16,000	16,800	1.1	98	3.3
17,000	17,800	1.1	98	3.3
18,000	18,800	1.1	98	3.3
19,000	19,800	1.1	98	3.3
20,000	20,800	1.1	98	3.3

AMPLITUDE FIG. 1 SPP-01 LOW PASS ALGORITHM TEMPLATE



Notes:

1. F_{C1} represents the 0dB corner frequency
2. F_{S1} stopband frequency.
3. All filters based on 48KHz sampling frequency, -96 dB stopband attenuation and 0.1 dB passband ripple.
4. Time delays are for the FIR filter only. Additional time delay for the ADC is approx. 0.2ms and the DAC is 1ms.



Analog Inputs & Outputs

Low Pass	Channel Configuration	F_{c1}	Step (Hz)	Tuning Range
SWLP-05*	Two Independent LP FIR filters	0.1	0.1	0.1 Hz to 25.6 Hz

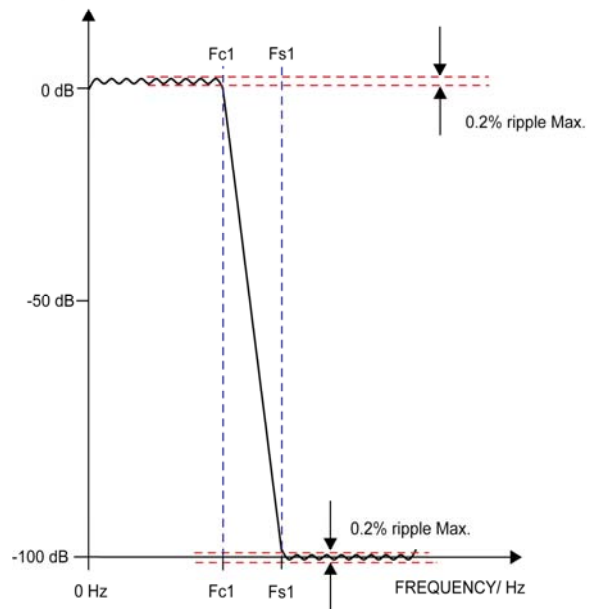
*This low frequency FIR filter software requires the SPPPF-02 hardware.

SWLP-05 Theoretical Performance Table

(Range: 0.1 Hz to 25.6 Hz with 0.1 Hz steps)

F_{c1}^1 (Hz)	F_{s1}^2 (Hz)	Shape Factor	Attenuation (dB)	Time Delay ³ (ms)
0.1	0.15	1.5	90	91.723
0.5	0.75	1.5	90	20.289
1	1.5	1.5	90	10.571
2	3	1.5	90	5.257
3	4.5	1.5	90	3.542
4	6	1.5	90	2.702
5	7.5	1.5	90	2.128
6	9	1.5	90	1.751
7	10.5	1.5	90	1.621
8	12	1.5	90	1.313
9	13.5	1.5	90	1.064
10	15	1.5	90	1.064
15	22.5	1.5	90	0.707
20	30	1.5	90	0.541
25	37.5	1.5	90	0.425

AMPLITUDE FIG. 1 SPP-01 LOW PASS ALGORITHM TEMPLATE



Notes:

1. F_{c1} represents the 0dB corner frequency
2. F_{s1} stopband frequency.
3. Time delays are for the FIR filter only. Additional time delay for the ADC is approx. 0.2ms and the DAC is 1ms.
4. Ultra low frequency Filters are based on a 7.2 kHz sampling frequency, have a -90 dB stopband attenuation and 0.1 dB passband ripple.
5. The shape Factor could be less than 1.5 for some filters.
6. The attenuation could be better than 90dB for some filters.



Analog Inputs & Outputs

Band-Pass	Channel Configuration	BW=Fc2-Fc1	Step (Hz)	Tuning Range
SWBP-01	Two Independent FIR BP filters	10	10	50 Hz to 5,170 Hz
SWBP-02	Two Independent FIR BP filters	25	25	50 Hz to 12,825 Hz
SWBP-03	Two Independent FIR BP filters	50	50	50 Hz to 20,790 Hz

SWBP-01 Theoretical Performance Table

(BW = 10 Hz, Range: 50 Hz to 5,170 Hz in 10 Hz steps)

F _{S1} ² (Hz)	F _{C1} ¹ (Hz)	F _{C2} ¹ (Hz)	F _{S2} ² (Hz)	F _{S2} /F _{C2}	Delay (ms)	Atten. (dB)
20	50	60	90	1.5	149	96
25	60	70	105	1.5	132	96
30	70	80	120	1.5	120	96
35	80	90	135	1.5	107	96
40	90	100	150	1.5	95	96
45	100	110	165	1.5	89	96
95	200	210	315	1.5	47	97
145	300	310	465	1.5	30	97
195	400	410	615	1.5	23	97
245	500	510	765	1.5	19	97
295	600	610	915	1.5	15	97
345	700	710	1,065	1.5	13	98
425	800	810	1,185	1.5	13	98
470	900	910	1,340	1.5	10	98
570	1,000	1,010	1,440	1.5	10	98
1,180	2,000	2,010	2,830	1.4	3.1	98
2,180	3,000	3,010	3,830	1.3	3.1	98
3,180	4,000	4,010	4,830	1.3	3.1	98
4,180	5,000	5,010	5,830	1.2	3.1	98
4,350	5,170	5,180	6,000	1.2	3.1	98

SWBP-02 Theoretical Performance Table

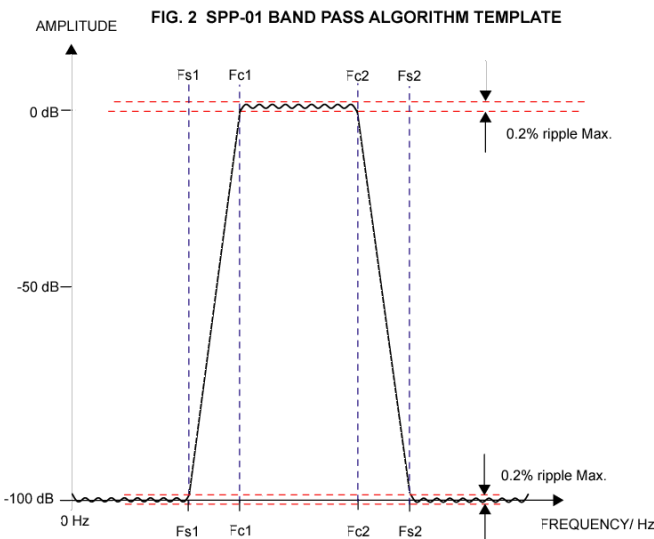
(BW = 25 Hz, Range: 50 Hz to 12,825 Hz with 25 Hz steps)

F _{S1} ² (Hz)	F _{C1} ¹ (Hz)	F _{C2} ¹ (Hz)	F _{S2} ² (Hz)	F _{S2} /F _{C2}	Delay (ms)	Atten. (dB)
15	50	75	110	1.5	130	96
25	75	100	150	1.5	96	96
40	100	125	185	1.5	77	96
90	200	225	335	1.5	43	96
140	300	325	485	1.5	30	97
190	400	425	635	1.5	23	97
240	500	525	785	1.5	19	97
290	600	625	935	1.5	16	97
340	700	725	1,125	1.5	14	97
390	800	825	1,275	1.5	12	98
440	900	925	1,385	1.5	10	98
490	1,000	1,025	1,500	1.5	9.2	98
1,260	2,000	2,025	2,765	1.4	3.2	98
2,260	3,000	3,025	3,765	1.3	3.2	98
3,260	4,000	4,025	4,765	1.2	3.2	98
4,260	5,000	5,025	5,765	1.2	3.2	98
5,260	6,000	6,025	6,765	1.2	3.2	98
6,260	7,000	7,025	7,765	1.2	3.2	98
7,260	8,000	8,025	8,765	1.1	3.2	98
8,260	9,000	9,025	9,765	1.1	3.2	98
9,260	10,000	10,025	10,765	1.1	3.2	98
10,260	11,000	11,025	11,765	1.1	3.2	98
11,260	12,000	12,025	12,765	1.1	3.2	98
12,085	12,825	12,850	13,590	1.1	3.2	98

SWBP-03 Theoretical Performance Table

(BW = 50 Hz, Range: 50 Hz to 20,800 Hz in 50 Hz steps)

F _{S1} ² (Hz)	F _{C1} ¹ (Hz)	F _{C2} ¹ (Hz)	F _{S2} ² (Hz)	F _{S2} /F _{C2}	Delay (ms)	Atten. (dB)
5	50	100	145	1.5	98	96
25	100	150	220	1.5	64	96
75	200	250	375	1.5	40	96
125	300	350	525	1.5	28	97
175	400	450	675	1.5	22	97
225	500	550	825	1.5	18	97
275	600	650	975	1.5	15	97
325	700	750	1,125	1.5	14	97
375	800	850	1,275	1.5	12	97
425	900	950	1,425	1.5	9.9	97
475	1,000	1,050	1,575	1.5	9.4	97
1,260	2,000	2,050	2,790	1.4	3.2	98
2,260	3,000	3,050	3,790	1.3	3.2	98
3,260	4,000	4,050	4,790	1.2	3.2	98
4,260	5,000	5,050	5,790	1.2	3.2	98
5,260	6,000	6,050	6,790	1.2	3.2	98
6,260	7,000	7,050	7,790	1.2	3.2	98
7,260	8,000	8,050	8,790	1.1	3.2	98
8,260	9,000	9,050	9,790	1.1	3.2	98
9,260	10,000	10,050	10,790	1.1	3.2	98
10,260	11,000	11,050	11,790	1.1	3.2	98
11,260	12,000	12,050	12,790	1.1	3.2	98
12,260	13,000	13,050	13,790	1.1	3.2	98
13,260	14,000	14,050	14,790	1.1	3.2	98
14,260	15,000	15,050	15,790	1.1	3.2	98
15,260	16,000	16,050	16,790	1.1	3.2	98
16,260	17,000	17,050	17,790	1.1	3.2	98
17,260	18,000	18,050	18,790	1.1	3.2	98
18,260	19,000	19,050	19,790	1.1	3.2	98
19,260	20,000	20,050	20,790	1.1	3.2	98



Notes:

1. F_{C1} and F_{C2} represent the 0dB corner frequencies
2. F_{S1} and F_{S2} stopband frequencies.
3. All filters based on 48KHz sampling frequency, -96 dB stopband attenuation and 0.1 dB passband ripple.
4. Time delays are for the FIR filter only. Additional time delay for the ADC is approx. 0.2ms and the DAC is 1ms.

Analog Inputs & Outputs

Performance Characteristics

Available bandwidth	DC to +20 kHz
Frequency accuracy	$< \pm 0.05$ %
Amplitude accuracy at unity gain	$< \pm 0.1$ dB
Total broad band noise (Ref. to input 3.53 V_{RMS})	≤ -96 dB Max
Total Harmonic Distortion (10V peak to peak)	≤ -96 dB Max. to 20 kHz
Channel-to-Channel Phase Tracking	$< \pm 0.10^\circ$
Cross Talk (Different signals on each channel)	DC to 20K ≤ 100 dB Typ

SPPPF-01 Suggested 9-Bit Programming Table

MSB	---	---	---	---	---	---	---	LSB	Bit Weight
2^8 D_8	2^7 D_7	2^6 D_6	2^5 D_5	2^4 D_4	2^3 D_3	2^2 D_2	2^1 D_1	2^0 D_0	Program Address
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	1	2
0	0	0	0	0	0	0	1	1	4
0	0	0	0	0	0	1	1	1	8
0	0	0	0	0	1	1	1	1	16
0	0	0	0	1	1	1	1	1	32
0	0	0	1	1	1	1	1	1	64
0	0	1	1	1	1	1	1	1	128
0	1	1	1	1	1	1	1	1	256
1	1	1	1	1	1	1	1	1	512

Typical Program Selection Port Protocol
Data Format

- Logic "0" 0VDC Min – 2VDC Max
- Logic "1" 3.5VDC Min – 5Vdc Max

Bit Weighting (Binary Coded)

D_0	LSB
D_8	MSB
D_9	Channel Select

The program selection data word bus consists of D_0 to D_8 for 9-bit programming (D_9 is for channel 1 or 2 select. **Channel 1** is LOW and is logic 0. **Channel 2** is logic 1 and is HIGH at 5 volts. For SPPPF-02/SWLP-05, D_8 is not used and D_7 is the MSB.

Analog Input Characteristics

Maximum Input Impedance	1.0 M Ω
Input Voltage	± 10 V peak

Analog Output Characteristics

Minimum Load Impedance	10 k Ω
Maximum Capacitive Load	50 pF
Output Voltage	± 10 V peak
Offset Voltage	2 mV Typ. 10mV Max.

Power Supply ($\pm V_s$)

Analog V_s range ± 12 Vdc Min. to ± 15 Vdc Max.
Care must be taken to stay above the minimum V_s in order to maintain the linearity and distortion performance of the DSP platform.

Analog Supply Current at Max. V_s	70 mA Typ.
Digital PS Voltage	+5 Vdc
Digital Supply Current	370 mA Typ.
Power Consumption at Max. V_s	4.0 watts Typ.

Temperature

Operating	0 to +70°C
Storage	-25 to +85°C
Size	2.0" x 2.0" x 0.5"

Note:

- Custom filters are available, consult factory for a quotation.
- Custom programs will be assigned a unique suffix (CXX) at time of order.
- An **SPPDB-01** development board can double as a mounting assembly, to facilitate product evaluation or laboratory use.

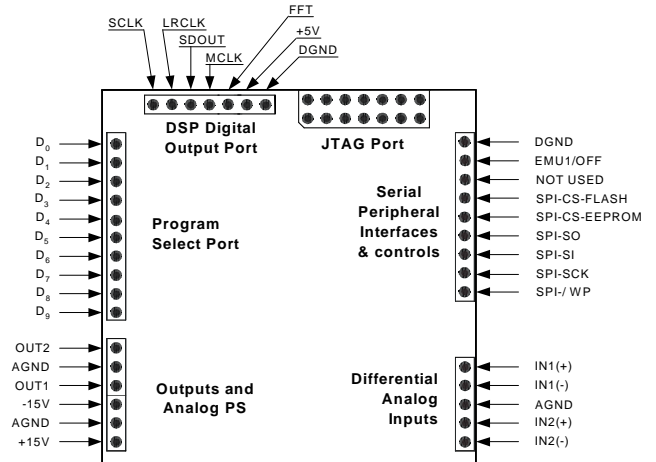
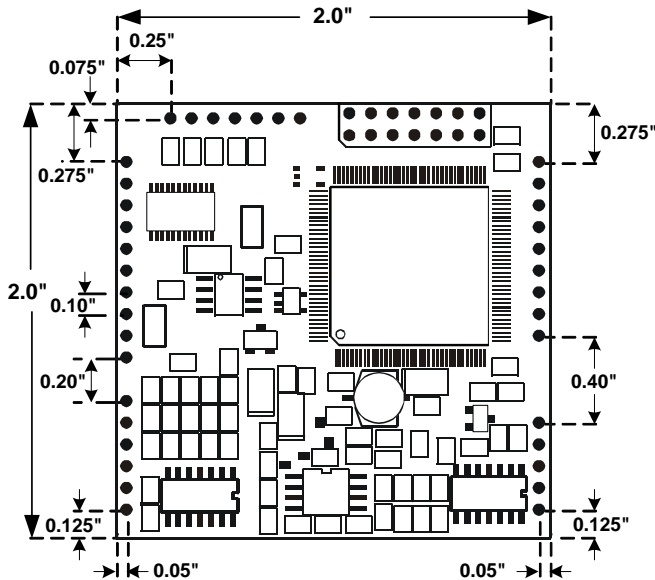
SPPPF-02 Suggested 8-Bit Programming Table

MSB								LSB	Bit Weight
2^7 D_7	2^6 D_6	2^5 D_5	2^4 D_4	2^3 D_3	2^2 D_2	2^1 D_1	2^0 D_0		Program Address
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	1	2
0	0	0	0	0	0	1	1	1	4
0	0	0	0	0	1	1	1	1	8
0	0	0	0	1	1	1	1	1	16
0	0	0	1	1	1	1	1	1	32
0	0	1	1	1	1	1	1	1	64
0	1	1	1	1	1	1	1	1	128
1	1	1	1	1	1	1	1	1	256

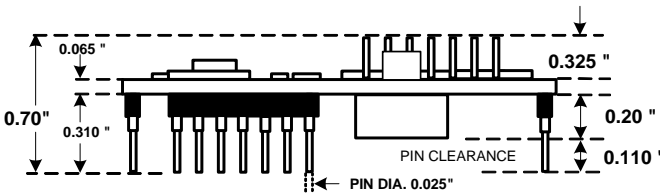


Package and Order Information

Analog Inputs & Outputs



SPP-01 TOP VIEW PIN IDENTIFICATION

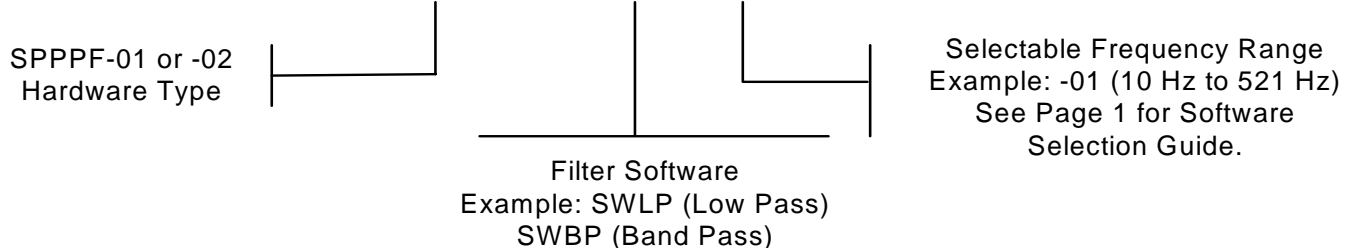


SPP-01 AND SPPPF-01 TOP VIEW AND DIMENSIONS All normal pin spacing 0.10"

- D₀ – D₈ 9-bit Frequency Select Pins
- D₉ Channel Select
- Out 1 & 2 Filter Outputs
- Inputs Channels 1 & 2 +/- differential
- ± 15 Vdc Analog Dc Power In
- + 5 Vdc Digital Power In
- A Gnd Analog Ground
- D Gnd Digital Ground

ORDERING INFORMATION

SPPPF-01 / SWLP - 01



Consult factory for custom non-standard frequencies and ranges. The SPPDB – 01 Mounting Assembly is available for these filters.

We hope the information given here will be helpful. The information is based on data and our best knowledge, and we consider the information to be true and accurate. Please read all statements, recommendations or suggestions herein in conjunction with our conditions of sale, which apply, to all goods supplied by us. We assume no responsibility for the use of these statements, recommendations or suggestions, nor do we intend them as a recommendation for any use, which would infringe any patent or copyright. SPPPF-01DS/04/03