

# Communications Products



## Short Form Catalog

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# ***Communications Products***

***SAW Filters***

***Optical Timing Products***

***Short Form Catalog***

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June 2000

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# SAW Filters Introduction

## Surface Acoustic Wave (SAW) Filter Applications

RFM designs and manufactures bandpass filters, delay lines, and notch filters, for a wide range of wireless telecommunication and data communication applications. We provide standard IF filters from 61 MHz to more than 1 GHz in surface-mount, dual-in-line (DIP) and TO39 packages. Our filter products offer a wide range of bandwidth, low insertion loss, low amplitude and group delay ripple, small size and high out-of-band rejection. In addition to our standard product offering, RFM provides custom filter design services for high volume applications that include cellular handsets, base stations, and repeaters (including the current standards GSM900, DCS1800, PCS1900, CDMA, TDMA and AMPs, DECT, and the next generation standards EDGE, WCDMA and CDMA2000), global positioning system (GPS), satellite and microwave radio, wireless local loop (WLL), wireless local area networks (WLAN), multimedia and fiber-optic transmission equipment.

## Filter Specifications

Unless otherwise noted in the tables, RFM references bandwidths, rejection levels and group delay deviation limits with respect to the operating frequency of the filter. Manufacturing tolerances and temperature drift effects over the filter's operating temperature range are included in these specifications already (customers do not need to add any additional tolerances). RFM filters are characterized in test fixtures that match the filter to 50 $\Omega$ . Data is taken on a Hewlett Packard 8753 series network analyzer (or equivalent) with proper calibration.

## Filter Matching and Layout Considerations

Filter matching involves transferring source and load impedance to the values needed at the input and output of the filter for proper operation. Most filters require different impedance values to match the input and the output. One common network topology used to match a SAW filter port to 50 $\Omega$  consists of a shunt capacitor across the 50 $\Omega$  impedance with a series inductor from this node to the filter port, as shown in Figure 1.

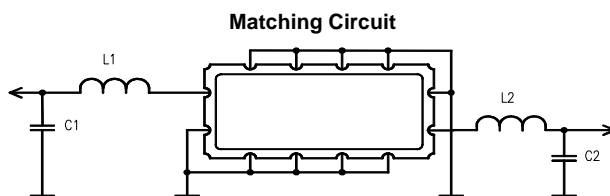


Figure 1

Low-loss SAW filters (less than about 17dB) can be matched using a network analyzer by transforming the filter's input and output reflection coefficients (S11 to S22) to approximately 50 $\Omega$  around the center frequency of the filter. SAW filters designed to operate with high insertion loss (higher than about 18dB) may need to be deliberately mismatched to reduce the passband ripple. RFM can provide matching component values for a number of matching network topologies, either for 50 $\Omega$  source and load impedances or for specified source and load impedance. Contact RFM's applications engineering group for assistance.

Please recognize that we have performed the match on our test fixture and demo board, which do not represent the parasitics of your PCB, so use our matching component values as the starting point only (you may need to adjust the matching on your PCB).

Matching network component values vary somewhat with circuit board layout, especially at frequencies above 200 MHz. Component values can be optimized by "rocking" them above and below nominal values to minimize amplitude and group delay ripple. Using matching network inductors with Qs below 30 can lead to excessive insertion loss and should be avoided. We also recommend that customers use matching components with a tolerance of 5%, or lower, if possible.

Achieving good ultimate rejection with a SAW filter depends on two things: avoiding stray coupling and avoiding ground loops. Stray inductive and capacitive coupling can occur between matching components, and between input and output circuit board traces. Inductors used in input and output matching networks should be oriented at right angles (or make sure their fluxes are perpendicular to each other) to minimize inductive coupling. Some designers mount the input and output matching components on opposite sides of the circuit board, taking advantage of the circuit board ground plane to provide shielding.

Ground loop coupling occurs when the input and output circuits of a filter share a common circuit trace. If RF currents flowing in the input circuit of the filter share any common length of circuit trace with the filter's output circuit, significant broadband RF energy can be coupled between input and output through this common impedance, compromising the filter's ultimate rejection.

Dual-in-line package (DIP) filters perform best when input and output connections are returned through the closest corresponding ground pin to minimize the current loop. In some instances, breaking the ground plane, as shown in Figure 2, will minimize ground loop currents and improve the filter's rejection.

## Isolating Filter Input/Output Currents

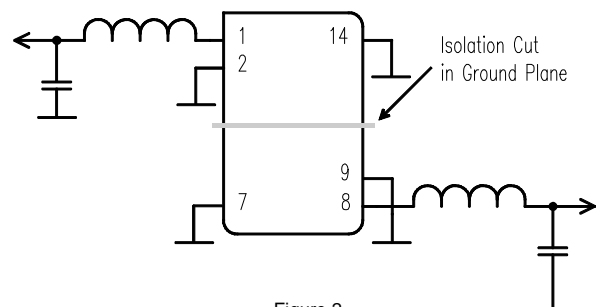


Figure 2

Surface-mount (SMT) package filters tend to be less layout critical with respect to ultimate rejection, provided ground returns are kept as short as possible. It is recommended that enough random grounding via holes be placed on the PCB under and around the SAW.

## Filter Simulation Tools

RFM offers tuned S-parameter files for most of its filters in HP/EEsof compatible format. Files are available in both Unix and DOS formats, and can be provided on disk or sent via e-mail.

For further information contact RFM's applications engineering group. Also, visit RFM's website at [www.rfm.com](http://www.rfm.com) for further information on our filter products.

# SAW Filters By Nominal Center Frequency

Nominal Frequency (MHz)	Typical Application (Actual may vary)	RFM Part Number
61	WLL	SF1137A
70	CDMA	BP1042
70	Wide Band IF	BP1051*
71	GSM	SF1071
71	GSM	SF1081A
71	GSM	SF1081A-1
71	GSM	SF1097A
75	Satellite Radio	SF1140B*
75	Satellite Radio	SF1141B*
82	Cable	PX1014A*
82.2	TDMA, CDPD	PX1004
85.38	CDMA	SF1101A*
86.85	TDMA, CDPD	PX1002
110.592	DECT	SF1056A
111.08	WLL, CDMA	SF1128A*
120	CDMA	SF1108*
125	GSM	SF1086A
125	GSM	SF1082A
127	Wide Band IF	SF1126A
135.3	WLAN	SF1072A
137.2	WLL	SF1114A-1
149	GSM	SF1076A
151.08	WLL, CDMA	SF1129A*
153.6	CDMA	SF1095A
160	CDMA	SF1111A
160	CDMA2000	SF1112A*
167	GSM	SF1058
167	GSM	SF1058-1
167	GSM	SF1058-T
167	GSM	SF1065-T
167	GSM	SF1089A
167	GSM	SF1113A*
170.6	GSM, EDGE	SF1088A
170.6	EDGE	SF1134A*
175	GSM	SF1093A
190	CDMA	SF1122A*

Nominal Frequency (MHz)	Typical Application (Actual may vary)	RFM Part Number
190	GSM	SF1075A
190	WCDMA	SF1124A*
191.08	WLL, CDMA	SF1130A*
199	GSM	SF1092A
199	GSM, EDGE	SF1115A
199	GSM	SF1115A-1*
208	GSM	SF1087A
211	GSM	SF1062
211	GSM	SF1062A
211	GSM	SF1091A
230	WCDMA	SF1102A
230	WCDMA	SF1102B*
246	GSM, EDGE	SF1133A*
254.4	WLAN	SF1054A
254.5	WLAN	SF1054A-1
280	WLL	SF1099A
285	WCDMA	SF1103B*
286	GSM	SF1083B
298.74	GPS	SF1120B
299	GSM	SF1084B
315	Satellite Radio	SF1142B*
315	Satellite Radio	SF1143B*
350	WLAN	SF1059A
350	WLAN	SF1059A-1
350	WLAN	SF1067A
350	WLAN	SF1073A
350	WLAN	SF1090A
350	WLAN	SF1090A-1
371	WLAN	SF1104A*
380	CDMA	SF1123A*
380	WCDMA	SF1125A*
499.25	Cable	SF1080A
549	Cable	SF1063A
622.08	SONET	BP1045A
1333	RF Front End	RF1046

# SAW Filters By Typical Application

Typical Application (Actual may vary)	Nominal Frequency (MHz)	RFM Part Number
Cable	499.25	SF1080A
Cable	549	SF1063A
Cable	82	PX1014A*
CDMA	70	BP1042
CDMA	85.38	SF1101A*
CDMA	120	SF1108*
CDMA	153.6	SF1095A
CDMA	190	SF1122A*
CDMA	380	SF1123A*
CDMA	160	SF1111A
CDMA2000	160	SF1112A*
DECT	110.592	SF1056A
EDGE	170.6	SF1134A*
GPS	298.74	SF1120B
GSM, EDGE	199	SF1115A
GSM, EDGE	199	SF1115A-1*
GSM, EDGE	246	SF1133A*
GSM	71	SF1071
GSM	71	SF1081A
GSM	71	SF1081A-1
GSM	71	SF1097A
GSM	125	SF1086A
GSM	149	SF1076A
GSM	175	SF1093A
GSM	190	SF1075A
GSM	125	SF1082A
GSM	167	SF1058
GSM	167	SF1058-1
GSM	167	SF1058-T
GSM	167	SF1065-T
GSM	167	SF1089A
GSM	167	SF1113A*
GSM, EDGE	170.6	SF1088A
GSM	199	SF1092A
GSM	208	SF1087A
GSM	211	SF1062A

Typical Application (Actual may vary)	Nominal Frequency (MHz)	RFM Part Number
GSM	211	SF1062A
GSM	211	SF1091A
GSM	286	SF1083B
GSM	299	SF1084B
RF Front End	1333	RF1046
Satellite Radio	75	SF1140B*
Satellite Radio	75	SF1141B*
Satellite Radio	315	SF1142B*
Satellite Radio	315	SF1143B*
SONET	622.08	BP1045A
TDMA, CDPD	86.85	PX1002
TDMA, CDPD	82.2	PX1004
WCDMA	190	SF1124A*
WCDMA	230	SF1102A
WCDMA	230	SF1102B*
WCDMA	285	SF1103B*
WCDMA	380	SF1125A*
Wide Band IF	127	SF1126A
Wide Band IF	70	BP1051*
WLAN	135.3	SF1072A
WLAN	254.4	SF1054A
WLAN	254.5	SF1054A-1
WLAN	350	SF1059A
WLAN	350	SF1059A-1
WLAN	350	SF1067A
WLAN	350	SF1073A
WLAN	350	SF1090A
WLAN	350	SF1090A-1
WLAN	371	SF1104A*
WLL	61	SF1137A
WLL	137.2	SF1114A-1
WLL	280	SF1099A
WLL, CDMA	111.08	SF1128A*
WLL, CDMA	151.08	SF1129A*
WLL, CDMA	191.08	SF1130A*

# SAW Filters By Minimum Bandwidth

Minimum Bandwidth (kHz)	Nominal Frequency (MHz)	RFM Part Number
30	86.85	PX1002
30	82.2	PX1004
30	82	PX1014A*
140	167	SF1058
140	167	SF1058-1
140	167	SF1058-T
140	167	SF1065-T
140	167	SF1089A
140	167	SF1113A*
180	149	SF1076A
180	170.6	SF1088A
200	71	SF1071
200	71	SF1081A
200	71	SF1081A-1
200	190	SF1075A
200	246	SF1133A*
200	199	SF1092A
200	199	SF1115A
200	199	SF1115A-1*
200	211	SF1062
200	211	SF1062A
200	549	SF1063A
220	71	SF1097A
300	170.6	SF1134A*
300	125	SF1086A
300	208	SF1087A
350	1333	RF1046
550	125	SF1082A
550	286	SF1083B
550	299	SF1084B
600	135.3	SF1072A
660	175	SF1093A
693	622.08	BP1045A
800	350	SF1059A
800	350	SF1059A-1
900	211	SF1091A

Minimum Bandwidth (kHz)	Nominal Frequency (MHz)	RFM Part Number
900	120	SF1108*
1050	350	SF1067A
1100	70	BP1042
1152	110.592	SF1056A
1180	160	SF1111A
1200	350	SF1090A
1200	350	SF1090A-1
1260	85.38	SF1101A*
1260	111.08	SF1128A*
1260	151.08	SF1129A*
1260	191.08	SF1130A*
1260	153.6	SF1095A
1260	190	SF1122A*
1260	380	SF1123A*
1500	371	SF1104A*
1500	254.4	SF1054A
1500	254.5	SF1054A-1
1600	499.25	SF1080A
1650	61	SF1137A
2000	137.2	SF1114A-1
2100	350	SF1073A
2200	298.74	SF1120B
2700	280	SF1099A
3800	160	SF1112A*
3840	230	SF1102A
4200	75	SF1140B*
4200	315	SF1142B*
4800 Typical	190	SF1124A*
4800 Typical	380	SF1125A*
5000 Typical	230	SF1102B*
5000 Typical	285	SF1103B*
9000	70	BP1051*
12700	75	SF1141B*
12700	315	SF1143B*
30000	127	SF1126A



# SAW Filters Selection Guide

RFM Part Number	Nom. Freq. (MHz)	Typical Application	Min. Pass BW (kHz)	Pass BW Corners (dB)	IL		Max. Grp. Delay Var. (ns <sub>p-p</sub> )	Min. GDV BW (kHz)	Rejection Parameters (dB minimum attenuation)	
					Typ.	Max.				
					(dB)					
BP1042	70	CDMA	1100	3	22	28	175	1100	40 at fc±1 MHz	Ultimate 50 from 1 MHz to 105 MHz
BP1045A	622.08	SONET	693	3	15.5	17.5	Notes 3 & 4		25 at approx. fc±1.6 MHz	Typical 40 DC to 800 MHz, excluding main and first sidelobes
BP1051*	70	Wide-band IF	9000	3	23	25	60	8600	40 at fc±5.85 MHz	Ultimate: 60
PX1002	86.85	TDMA, CDPD	30	3	3	4	6000	20	11 at fc±60 kHz	65 at fc-880 kHz to fc-940 kHz
PX1004	82.2	TDMA, CDPD	30	3	3	4	6000	20	16 at fc±60 kHz	Typical 65 at fc-880 kHz to fc-940 kHz
PX1014A*	82	Cable	30	3	3	5	10000	30	Typical 50 at fc-120 to -60 kHz & +60 kHz to +120 kHz	Typical 60 at fc-400 to -120 kHz & fc+120 kHz to +400 kHz
RF1046	1333	RF F-E	350	1	6	8	Note 3 & 5		Typical 63 at fc-140 MHz & > fc+140 MHz	Ultimate: >55
SF1041	71	GSM	Replaced by similar SF1071 in identical package.							
SF1041-1	71	GSM	Replaced by similar SF1071 in identical package.							
SF1046	71	GSM	Replaced by similar SF1071 in identical package.							
SF1051A	110.592	DECT	Replaced by similar SF1056A in identical package.							
SF1052	71	GSM	Replaced by similar SF1071 in 6-pin DIP instead of 8-pin DIP package.							
SF1054A	254.4	WLAN	1500	3	8.5	10	250	100	60 at 90 MHz to fc-50 & fc+50 to 1000 MHz	40 at 0.33, 0.528, 0.594, 1.66 & 1.8 x fc
SF1054A-1	254.5	WLAN	1500	3	8.5	10	250	100	60 at 90 MHz to fc-50 MHz & fc+50 to 1000 MHz	40 at 0.33, 0.528, 0.594, 1.66 & 1.8 x fc
SF1056A	110.592	DECT	1152	3	8.5	10	200	1152	28 at fc-3.4 to fc-1.728 & fc+1.728 to fc+3.4 MHz	>40 at DC to fc-3.4 & fc+3.4 to 200 MHz
SF1058	167	GSM	140	1	7	8	500	360	5 at fc-400 to fc-250 & fc+250 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1058-1	167	GSM	140	1	8	10	500	360	5 at fc-400 to fc-250 & fc+250 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz

# SAW Filters Selection Guide

RFM Part Number	Rejection Parameters Continued (dB minimum attenuation)	Operating Temperature Range (°C)	Package Name
BP1042		-25 to +85	DIP14L-8
BP1045A		-40 to +85	SM9171-10
BP1051		Note 4	DIP14L-8
PX1002	Ultimate: 65	-20 to +70	SM13365-12
PX1004	Ultimate: 65	-20 to +70	SM13365-12
PX1014A*	Typical 65 at fc-40 to -0.4 MHz & fc+0.4 MHz to +40 MHz	-30 to +75	SM13365-12
RF1046		-55 to +85	TO39-3
SF1041			
SF1041-1			
SF1046			
SF1051A			
SF1052			
SF1054A		-10 to +60	SM9171-10
SF1054A-1		-10 to +60	SM9171-10
SF1056A	Ultimate: 45	-10 to +60	SM13365-12
SF1058	40 at 141 MHz to fc-600 kHz and fc+650 kHz to 193 Mhz	-10 to +85	DIP14L-8
SF1058-1	35 at 141 MHz to fc-600 kHz and fc+725 kHz to 193 MHz	-10 to +85	DIP14L-8

# SAW Filters Selection Guide

RFM Part Number	Nom. Freq. (MHz)	Typical Application	Min. Pass BW (kHz)	Pass BW Corners (dB)	IL		Max. Grp. Delay Var. (n <sub>SP-P</sub> )	Min. GDV BW (kHz)	Rejection Parameters (dB minimum attenuation)	
					Typ.	Max.				
					(dB)					
SF1058-T	167	GSM	140	1	8	9	750	360	5 at fc-400 to fc-250 & fc+250 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1059A	350	WLAN	800	3	8	10	250	800	35 at fc-8 to fc-2 & fc+2 to fc+8 MHz	40 at fc-50 to fc-8 & fc+8 to fc+50
SF1059A-1	350	WLAN	800	3	8	9	250	500	40 at fc-40 to fc-2 & fc+2 to fc+40 MHz	Ultimate: Typical >55
SF1062	211	GSM	200	3	6	9	500	100	Min. 5 at fc-400 to fc-200 & fc+200 to fc+400 kHz	Min. 25 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1062A	211	GSM	200	3	6	9	500	100	5 at fc-400 to fc-200 & fc+200 to fc+400 kHz	25 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1063A	549	Cable	200	0.5	7.5	9	See Note 3		Min. 40 at 529.04 to 545.75 MHz	Min. 35 at 551.4 to 569.04 MHz
SF1065-T	167	GSM	140	1	8	9	750	360	5 at fc-400 to fc-225 & fc+225 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1067A	350	WLAN	1050	3	9	10	250	800	Typical 40 at fc-4 to fc-1.8 & fc+1.8 to fc+4.0 MHz	Typical 45 at fc-50 to fc-8 & fc+8 to fc+50 MHz
SF1071	71	GSM	200	3	8	9.5	350	200	Min. 30 at fc-1.2 to fc-0.4 & fc+0.4 to fc+1.2 MHz	Min. 35 at fc-1.6 to fc-1.2 & fc+1.2 to fc+1.6 MHz
SF1072A	135.3	WLAN	600	3	8.5	10.5	350	600	Min. 40 at fc-15 to fc-1.35 & fc+1.35 to fc+15 MHz	Min. 50 at 20 MHz to fc-15 & fc+15 to 300 MHz
SF1073A	350	WLAN	2100	3	8	10	300	2100	40 at fc-10 to fc-4.5 & fc+4.5 to fc+10 MHz	Ultimate: Typical 50
SF1075A	190	GSM	200	2	9	12	300	200	4 at fc-6 to fc-1.8 & fc+1.8 to fc+6 MHz	9 at fc-10 to fc-6 & fc+6 to fc+10 MHz
SF1076A	149	GSM	180	1	8	9	500	180	10 at fc-750 to fc-600 & fc+600 to fc+750 kHz	20 at fc-1000 to fc-750 & fc+750 to fc+1000 kHz
SF1080A	499.25	Cable	1600	3	7.5	9	N/A	N/A	35 at fc-200 to fc-3.0 & fc+3.0 to fc+200 MHz	Ultimate: Minimum 40
SF1081A	71	GSM	200	3	6	8	1000	100	25 at fc-600 to fc-400 & fc+400 to fc+600 kHz	35 at fc-1 MHz to fc-0.6 & fc+0.6 to fc+0.8 MHz

# SAW Filters Selection Guide

RFM Part Number	Rejection Parameters Continued (dB minimum attenuation)		Operating Temperature Range (°C)	Package Name
SF1058-T	40 at 141 MHz to fc-600 kHz & fc+650 kHz to 193 MHz		-10 to +85	DIP14L-8
SF1059A	Ultimate: Typical 50		-20 to +70	SM9171-10
SF1059A-1			-20 to +70	SM13365-12
SF1062	Typical 35 at fc-800 to fc-600 & fc+600 to fc+800 kHz	Typical 45 at 191 MHz to fc-800 kHz & fc+800 kHz to 231 MHz	-10 to +70	DIP14L-8
SF1062A	30 at fc-800 to fc-600 & fc+600 to fc+800 kHz	35 at 191 MHz to fc-800 kHz & fc+800 kHz to 231 MHz	-40 to +85	SMP-87
SF1063A	Ultimate: Typical 50		-20 to +85	SM9171-10
SF1065-T	40 at fc-800 to fc-600 & fc+600 to fc+800 kHz	50 at fc-26 to fc-0.8 MHz & fc+1.5 to fc+26 MHz	-10 to +85	DIP18-8
SF1067A	Ultimate: Typical 50		-20 to +70	SM9171-10
SF1071	Min. 40 at fc-8.0 to fc-1.6 & fc+1.6 to fc+8.0 MHz	Min. 45 at 1 to 63 & 79 to 150 MHz	-10 to +85	DIP14-6
SF1072A			-40 to +85	SM13365-12
SF1073A			-20 to +60	SM9171-10
SF1075A	Ultimate: Minimum 45		-10 to +60	SM9171-10
SF1076A	27 at fc-1500 to fc-1000 & fc+1000 to +1500 kHz	Ultimate: Typical 45	-30 to +75	SM13365-12
SF1080A			-25 to +75	SM9171-10
SF1081A	40 at 69.6 to 69.8 MHz	35 at 31 to 69.6 and 71.8 to 111 MHz	-5 to +70	SMP-87

# SAW Filters Selection Guide

RFM Part Number	Nom. Freq. (MHz)	Typical Application	Min. Pass BW (kHz)	Pass BW Corners (dB)	IL		Max. Grp. Delay Var. (ns <sub>P-P</sub> )	Min. GDV BW (kHz)	Rejection Parameters (dB minimum attenuation)	
					Typ.	Max.				
					(dB)					
SF1081A-1	71	GSM	200	3	6	8	1000	100	25 at fc-600 to fc-400 & fc+400 to fc+600 kHz	35 at fc-1 to fc-0.6 & fc+0.6 MHz to fc+0.8 MHz
SF1082A	125	GSM	550	3	6	8	100	150	20 at fc-7.5 to fc-6 & fc+6 to fc+7.5 MHz	Ultimate: Typical >40
SF1083B	286	GSM	550	3	6	8	100	150	Min. 20 at 100 kHz to fc-6 & fc+6 MHz to 540 MHz	Ultimate: Typical >40
SF1084B	299	GSM	550	3	6	8	100	150	Min. 20 at 100 kHz to fc-6 & fc+6 to 540 MHz	Ultimate: Typical >40
SF1086A	125	GSM	300	1	5	8	150	300	2 at fc-0.6 to fc-0.4 & fc+0.4 to fc+0.6 MHz	8 at fc-1.2 to fc-0.6 & fc+0.6 to fc+1.2 MHz
SF1087A	208	GSM	300	1	4.5	7	150	300	2 at fc-0.6 to fc-0.4 & fc+0.4 to fc+0.6 MHz	8 at fc-1.2 to fc-0.6 & fc+0.6 to fc+1.2 MHz
SF1088A	170.6	GSM	180	1	7	8	1000	180	13 at fc-0.6 to fc-0.4 & fc+0.4 to fc+0.6 MHz	27 at fc-0.8 to fc-0.6 & fc+0.6 to fc+0.8 MHz
SF1089A	167	GSM	140	1	6	8	1000	140	5 at fc-400 to fc-225 & fc+225 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1090A	350	WLAN	1200	3	10	13	200	1200	30 at fc-2 to fc-1.8 & fc+1.8 to fc+2 MHz	40 at fc-7 to fc-2 & fc+2 to fc+7 MHz
SF1090A-1	350	WLAN	1200	3	10	13	200	1200	30 at fc-2 to fc-1.8 & fc+1.8 to fc+2 MHz	40 at fc-7 to fc-2 & fc+2 to fc+7 MHz
SF1091A	211	GSM	900	3	7	8	300	300	Min. 10 at fc-2 to fc-1.05 & fc+1.05 to fc+2 MHz	Min. 30 at fc-80 to fc-2 & fc+2 to fc+80 MHz
SF1092A	199	GSM	200	1	5.5	7	500	200	35 at fc-800 to fc-600 & fc+600 to fc+800 kHz	45 at 119 MHz to fc-800 kHz
SF1093A	175	GSM	660	2	8	9	260	600	5 at fc-0.9 to fc-0.6 & fc+0.6 to fc+0.9 MHz	17 at fc-1.2 to fc-0.9 & fc+0.9 to fc+1.2 MHz
SF1095A	153.6	CDMA	1260	0.5	16	18	140	1260	Min. 4 at fc-1.98 to fc-1.25 & fc+1.25 to fc+1.98 MHz	Min. 10 at fc-2.25 to fc-1.98 & fc+1.98 to fc+2.25 MHz

# SAW Filters Selection Guide

RFM Part Number	Rejection Parameters Continued (dB minimum attenuation)					Operating Temp. Range (°C)	Package Name
SF1081A-1	40 at 69.6 to 69.8 MHz	35 at 31 to 69.6 & 71.8 to 111 MHz				-40 to +85	SMP-87
SF1082A						-40 to +85	SM9171-10
SF1083B						-40 to +85	SM8558-8
SF1084B						-40 to +85	SM8558-8
SF1086A	20 at fc-1.8 to fc-1.2 & fc+1.2 to fc+1.8 MHz	25 at fc-3.4 to fc-1.8 & fc+1.8 to fc+3.4 MHz	30 at fc-9.5 to fc-3.4 & fc+3.4 to fc+9.5 MHz	43 at fc-13 to fc-9.5 & fc+9.5 to fc+13 MHz	50 at DC to fc-13 & fc+13 to 450 MHz	-10 to +85	SM13365-12
SF1087A	20 at fc-1.8 to fc-1.2 & fc+1.2 to fc+1.8 MHz	25 at fc-3.4 to fc-1.8 & fc+1.8 to fc+3.4 MHz	30 at fc-9.5 to fc-3.4 & fc+3.4 to fc+9.5 MHz	43 at fc-13 to fc-9.5 & fc+9.5 to fc+13 MHz	50 at DC to fc-13 & fc+13 to 450 MHz	-10 to +85	SM13365-12
SF1088A	40 at fc-1.6 to fc-0.8 & fc+0.8 to fc+1.6 MHz	43 at fc-3 to fc-1.6 & fc+1.6 to fc+3 MHz	47 at fc-5.8 to fc-3 & fc+3 to fc+5.8 MHz	50 at fc-35 to fc-5.8 & fc+5.8 to fc+35 MHz	45 at fc-75 to fc-35 & fc+35 to fc+75 MHz	-10 to +85	SMP-75
SF1089A	40 at fc-800 to fc-600 & fc+600 to fc+800 kHz	45 at fc-1500 to fc-800 & fc+800 to fc+1500 kHz	50 at 94 to fc-1.5 & fc+1.5 to 242 MHz			-10 to +85	SMP-97
SF1090A	50 at < fc-7 MHz & > fc+7 MHz					-20 to +70	SM9171-10
SF1090A-1	50 at < fc-7 MHz to > fc+7 MHz					-20 to +70	SM9171-10
SF1091A	Min. 40 at f>fc+80 & f<fc-80 MHz					-10 to +85	SM13365-12
SF1092A	45 at fc+800 kHz to 278 MHz					-10 to +85	SMP-75
SF1093A	30 at fc-6 to fc-1.2 & fc+1.2 to fc+6 MHz	50 at fc-155 to fc-6 & fc+6 to fc+125 MHz				-5 to +70	SM13365-12
SF1095A	Min. 17.5 at fc-3.66 to fc-2.25 & fc+2.25 to fc+3.66 MHz	Min. 20.5 at fc-4.90 to fc-3.66 & fc+3.66 to fc+4.90 MHz	Min. 32 at fc-6.7 to fc-4.9 & fc+4.90 to fc+6.7 MHz	Min. 37.5 at 65 MHz to fc-6.70 & fc+6.70 to 240 MHz		-40 to +85	SMP-75

# SAW Filters Selection Guide

RFM Part Number	Nom. Freq. (MHz)	Typical Application	Min. Pass BW (kHz)	Pass BW Corners (dB)	IL		Max. Grp. Delay Var. (ns <sub>P-P</sub> )	Min GDV BW (kHz)	Rejection Parameters (dB minimum attenuation)	
					Typ.	Max.				
					(dB)					
SF1097A	71	GSM	220	3	6.5	9	1500	180	5 at fc-350 to fc-250 & fc+250 to fc+350 kHz	20 at fc-500 to fc-350 & fc+350 to fc+500 kHz
SF1099A	280	WLL	2700	3	11	14	150	2700	40 at 10 MHz to fc-2.7 & fc+2.7 MHz to 1 GHz	
SF1101A*	85.38	CDMA	1260	5	10.5	12	Notes 3 & 4		33 at fc-5 to fc-0.9 & fc+0.9 to fc+5 MHz	40 at fc±5 MHz
SF1102A*	230	WCDMA	3840	1	15	17	150	3840	18 at fc-5 to fc-3 & fc+3 to fc+5 MHz	45 at fc-10 to fc-5 & fc+5 to fc+10 MHz
SF1102B*	230	WCDMA	Typical 5000	3	16	18	150	3800	40 at fc-25 to fc-5 & fc+5 to fc+25 MHz	38 at fc+5 to fc+25
SF1103B*	285	WCDMA	Typical 5000	3	15.3	17	150	3800	40 at fc-25 to fc-5 & fc+5 to fc+25 MHz	
SF1104A*	371	WLAN	1500	1	9.5	10.5	100	1500	Min. 40 at fc-15 to fc-5 & fc+5.0 to fc+15 MHz	Min. 45 at 100 MHz to fc-15 & fc+15 MHz to 1 GHz
SF1108*	120	CDMA	900	1.5	15	20	See Note 3 & 4		Min. 35 at fc-900 to fc-875 & fc+875 to fc+900 kHz	Min. 50 at fc±900 kHz
SF1111A	160	CDMA	1180	1.5	9	11	See Notes 3 & 4		40 at fc-10 to fc-1.25 & fc+1.25 to fc+10 MHz	50 at fc-10 to fc-10 & fc+10 to fc+20 MHz
SF1112A*	160	CDMA 2000	3800	1.5	18	20	See Note 3 & 4		38 at fc-3.2 to fc-2.55 & fc+2.55 to fc+3.2 MHz	50 at fc±3.2 MHz
SF1113A*	167	GSM	140	1	6	8	1000	140	5 at fc-400 to fc-225 & fc+225 to fc+400 kHz	15 at fc-600 to fc-400 & fc+400 to fc+600 kHz
SF1114A-1	137.2	WLL	2000	3	14	15	200	1650	Min. 20 at fc-1.665 to fc-1.5 & fc+1.5 to fc+1.665 MHz	Min. 40 at fc-8 to fc-1.665 & fc+1.665 to fc+8 Mhz
SF1115A	199	GSM, EDGE	200	1	5	7	500	200	20 at fc-800 to fc-600 & fc+600 to fc+800 kHz	30 at fc-30 MHz to fc-800 kHz
SF1115A-1*	199	GSM, EDGE	200	1	5	7	500	200	20 at fc-800 to fc-600 & fc+600 to fc+800 kHz	30 at fc-30 MHz to fc-800 kHz
SF1120B	298.74	GPS	2200	3	11	12	250	2000	50 dB at fc±10 MHz	

# SAW Filters Selection Guide

RFM Part Number	Rejection Parameters Continued (dB minimum attenuation)			Operating Temperature Range (°C)	Package Name
SF1097A	30 at fc-700 to fc-500 & fc+500 to fc+700 kHz	35 at fc-2500 to fc-700 & fc+700 to fc+2500 kHz	40 Ultimate at 10 MHz to fc-2.5 MHz and fc+2.5 MHz to 130 MHz	-20 to +80	SMP-08
SF1099A				-40 to +85	SM13365-12
SF1101A*	Ultimate: Typical 60			-30 to +80	SMP-75
SF1102A*				-40 to +80	SM13365-12
SF1102B*	Ultimate: Typical 50			-20 to +80	SMP-03
SF1103B*				-20 to +80	SMP-03
SF1104A*				-20 to +60	SM9171-10
SF1108*				-20 to +70	DIP18-8
SF1111A				-20 to +70	SMP-97
SF1112A*				-20 to +70	SMP-97
SF1113A*	40 at fc-800 to fc-600 & fc+600 to fc+800 kHz	45 at fc-1500 to fc-800 & fc+800 to fc+1500 kHz	50 at 94 MHz to fc-1.5 & fc+1.5 MHz to 242 MHz	-10 to +85	SMP-87
SF1114A-1	45 at fc±8 MHz			-10 to +85	SMP-75
SF1115A	30 at fc+800 kHz to fc+17 MHz	35 at fc-80 MHz to fc-30 MHz	35 at fc+17 MHz to fc+80 MHz	-35 to +85	SM9171-10
SF1115A-1*	30 at fc+800 kHz to fc+17 MHz	35 fc-80 MHz to fc-30 MHz	35 at fc+17 MHz to fc+80 MHz	-35 to +85	SMP-53-S
SF1120B				-20 to +75	SMP-03



# SAW Filters Selection Guide

RFM Part Number	Nom. Freq. (MHz)	Typical Appli- cation	Min. PassBW (kHz)	Pass BW Corners (dB)	IL		Max. Grp. Delay Var. (ns <sub>p-p</sub> )	Min. GDV BW (kHz)	Rejection Parameters (dB minimum attenuation)	
					Typ.	Max.				
					(dB)					
SF1122A*	190	CDMA	1260	5	9.5	10.5	See Note 3 & 4		Min. 35 at fc±1.25 MHz	Ultimate: 45 Typical
SF1123A*	380	CDMA	1260	5	7	8	See Note 3 & 4		Min. 35 at fc±1.25 MHz	Ultimate: 45 Typical
SF1124A*	190	WCDMA	Typi- cal 4800	1	12	14	4600	Typi- cal 125	Typical 10 at fc-3.6 to fc-3.2 & fc+3.2 to fc+3.6 MHz	Typical 30 at fc-5 to fc-3.6 & fc+3.6 to fc+5 MHz
SF1125A*	380	WCDMA	Typi- cal 4800	1	16	18	4800	Typi- cal 165	Typical 10 at fc-3.75 to fc-3.15 & fc+3.15 to fc+3.75 MHz	Typical 30 at fc-3.9 to fc-3.75 & fc+3.75 to fc+3.9 MHz
SF1126A	127	Wide Band IF	30000	1.3	14	15	30	24000	40 at < 107 MHz	37 at > 147.25 MHz
SF1128A*	111.08	WLL CDMA	1260	5	9	11	500	1000	27 at fc±900 kHz	Ultimate: >40
SF1129A*	151.08	WLL CDMA	1260	5	8	11	500	1000	27 at fc±900 kHz	Ultimate: >40
SF1130A*	191.08	WLL CDMA	1260	5	8	11	500	1000	27 at fc±900 kHz	Ultimate: >40
SF1133A*	246	GSM, EDGE	200	1	6	7	500	200	20 at fc-800 to fc-600 & fc+600 to fc+800 kHz	30 at fc-30 MHz to fc-800 kHz
SF1134A*	170.6	EDGE	300	1	6	9	1000	300	13 at fc-600 to fc-400 & fc+400 to fc+600 kHz	27at fc-800 to fc-600 & fc+600 to fc+800 kHz
SF1137A	61	WLL	1650	1	14	15	225	1650	Min. 20 at fc-1.5 to fc-1.665 & fc+1.5 to fc+1.665 MHz	Min. 34at fc-1.665 to fc-1.5 & fc+1.5 to fc+1.665 MHz
SF1140B*	75	Satellite Radio	4200	1	11.5	14	200	4200	Typical 40 at fc-7.15 to fc-24 MHz	Typical 40at fc+7.15 to fc+24 MHz
SF1141B*	75	Satellite Radio	12700	1	11	13	200	12700	Typical 40 at fc-6.35 to fc-28 MHz	Typical 40at fc+6.35 to fc+28 MHz
SF1142B*	315	Satellite Radio	4200	1	11.5	14	200	4200	Typical 40 at fc-4.6 to fc-24 MHz	Typical 40at fc+4.85 to fc+24 MHz
SF1143B*	315	Satellite Radio	12700	1	15	17	200	12700	Typical 40 at fc-10.3 to fc-28 MHz	Typical 40at fc+10.3 to fc+28 MHz

# SAW Filters Selection Guide

RFM Part Number	Rejection Parameters Continued (dB minimum attenuation)					Operating Temperature Range (°C)	Package Name
SF1122A*						-30 to +80	SM9171-10
SF1123A*						-30 to +80	SM9171-10
SF1124A*	Typical 40 at fc-10 to fc-5 & fc+5 to fc+10 MHz	Typical 45 at fc-20 to fc-1 & fc+1 to fc+20 MHz	Typical 45 at 165.7 MHz	Typical 40 at fc-60 MHz to fc-5 MHz	Typical 40 at fc+5 MHz to fc+60 MHz	-10 to +85	SM13365-12
SF1125A*	Typical >40 at fc-30 to fc-3.9 & fc+3.9 to fc+30 MHz	Typical 40 at 346 to 350 MHz	Typical 40 at 364 MHz			-10 to +85	SM13365-12
SF1126A						Note 3 & 4	SM9171-10
SF1128A*						-20 to +75	SM13365-12
SF1129A*						-20 to +75	SM13365-12
SF1130A*						-20 to +75	SM13365-12
SF1133A*	30 at fc+800 kHz to fc+17 MHz	35 at fc-80 to fc-30 MHz	35 at fc+17 to fc+80 MHz			-35 to +85	SM9171-10
SF1134A	40 at fc-1600 to fc-800 & fc+800 to fc+1600 kHz	43 at fc-3000 to fc-1600 & fc+1600 to fc+3000 kHz	47 at fc-5800 to fc-3000 & fc+3000 to fc+5800 kHz	Ultimate: 50		-10 to 85	SMP-75
SF1137A	Min. 40 fc-2.5 to fc-8 & fc+2.5 to fc+8 MHz	Min. 45 at fc<53 & fc>69 MHz				-10 to 85	SMP-75
SF1140B*	Ultimate: 45					-40 to 85	SMP-03
SF1141B*	Ultimate: 45					-40 to 85	SMP-03
SF1142B*	Ultimate: 45					-40 to 85	SMP-03
SF1143B*	Ultimate: 45					-40 to 85	SMP-03

# ***SAW Filters Selection Guide Notes***

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## **\*New Parts**

These parts are currently under development. Please see the RFM website ([www.rfm.com](http://www.rfm.com)) for up-to-date information.

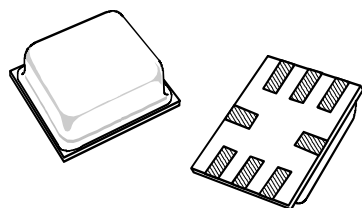
## **Notes:**

1. With the exception of the BP1045A, BP1051, SF1058-T, and SF1065-T, all of these filters require external impedance matching (not included). BP1045 bandwidth is shown for reference only. The 50 ohm loaded Q (3dB) is specified as 700 (min) and 900 (max).
2. The SF1058-T is an internally impedance matched (tuned) version of the SF1058.
3. Minimum 3dB bandwidths and insertion loss specifications shown here are approximate and are provided solely for the purpose of comparison among different filters. The nature of the individual filter specifications may be inconsistent with this form of direct comparison. Individual filter specifications take precedence in the event of any conflict with this short-form catalog.
4. See individual specification sheets for detailed specifications. All specifications are subject to change without notice.
5. See Low-power products short-form catalog for information on RF series filters.
6. These devices are covered by one or more of the following U.S. Patents: 4,353,046; 4,454,488; 4,491,757; 4,616,197; 4,902,925; 5,073,763; 5,051,644; 5,061,871; 5,374,908, and others pending.

# SAW Filters Packages

## SM5248-8 Case

### 8-Terminal Ceramic Surface-Mount Case 5.2 X 4.8 mm Nominal Footprint

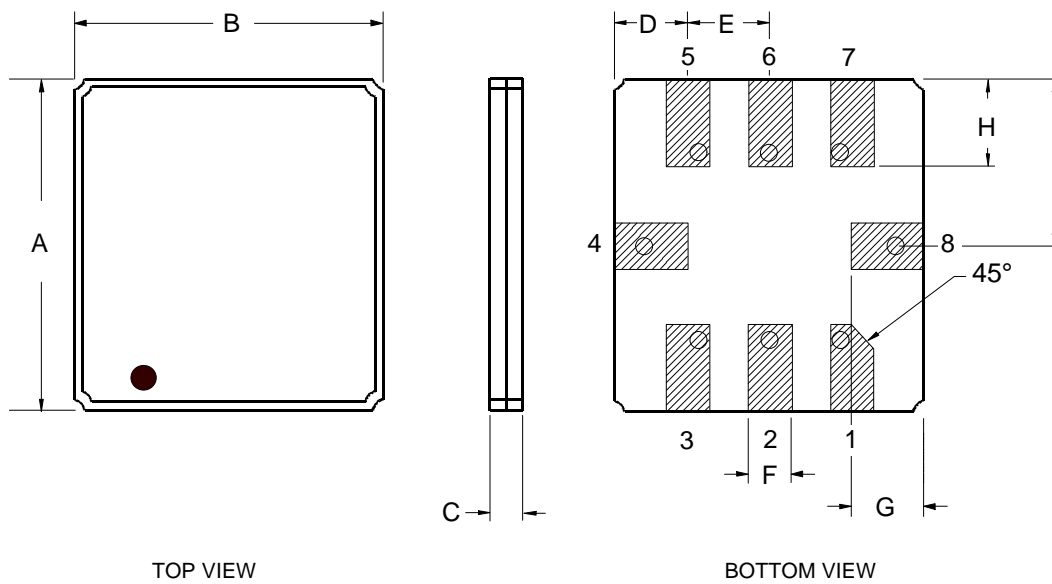


#### Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A		5.18			.204	
B		4.8			.189	
C		0.508			.020	
D		1.14			.045	
E		1.27			.050	
F		0.71			.028	
G		1.12			.044	
H		1.37			.054	
I		2.59			.102	

#### Electrical Connections

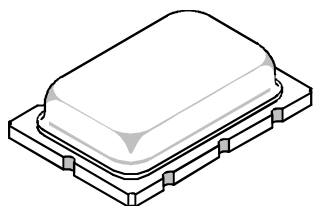
Connection		Terminals
Port 1	Input	2
Port 2	Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SM8558-8 Case

### 8-Terminal Ceramic Surface-Mount Case 8.5 x 5.8 mm Nominal Footprint

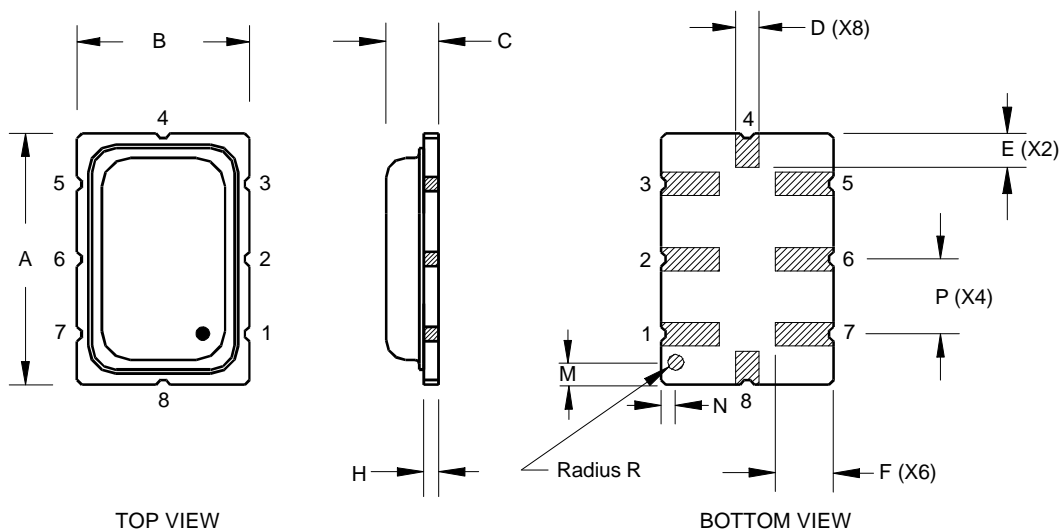


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	8.26	8.51	8.76	0.325	0.335	0.345
B	5.59	5.84	6.10	0.220	0.230	0.240
C		1.70	2.00		0.067	0.079
D		0.79			0.031	
E		1.14			0.045	
F		1.98			0.078	
H		0.51			0.020	
M		0.76			0.030	
N		0.51			0.020	
P		2.54			0.100	
R		0.51			0.020	

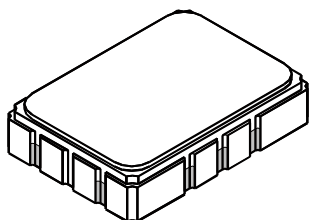
Electrical Connections

Connection		Terminals
Port 1	Input or Return	7
	Return or Input	1
Port 2	Output or Return	3
	Return or Output	5
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



## SMP-03 Case

### 10-Terminal Ceramic Surface-Mount Case 7 x 5 mm Nominal Footprint

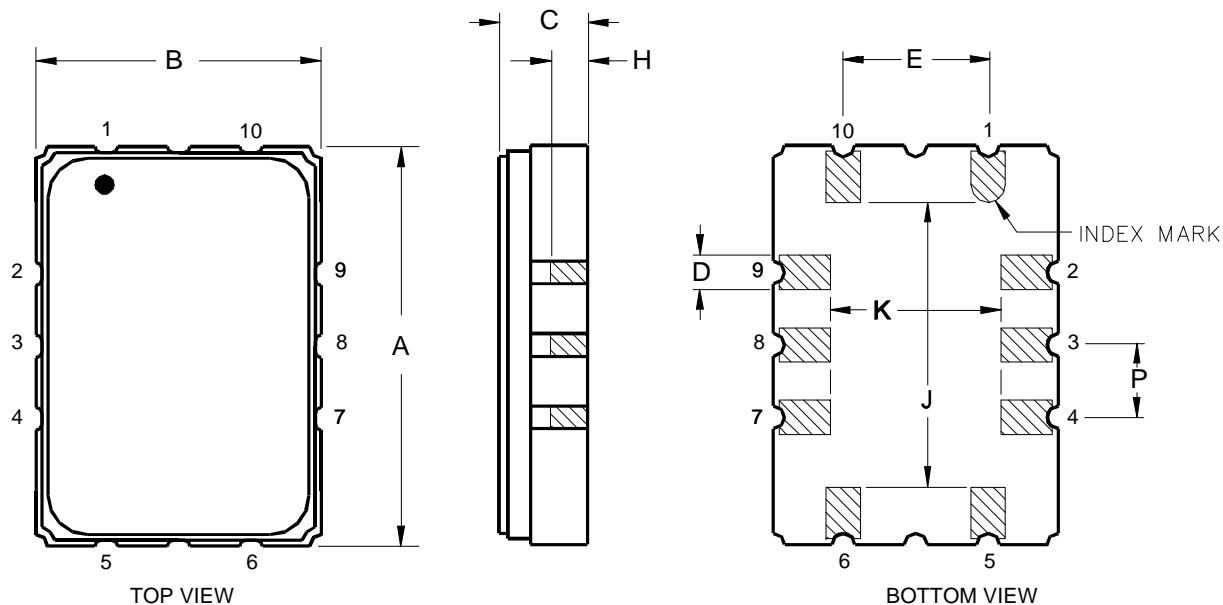


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	6.80	7.00	7.20	0.268	0.276	0.283
B	4.80	5.00	5.20	0.189	0.197	0.205
C		1.65	2.00		0.065	0.079
D		0.60			0.024	
E		2.54			0.100	
H		1.0			0.039	
J		5.00			0.197	
K		3.00			0.118	
P		1.27			0.050	

Electrical Connections

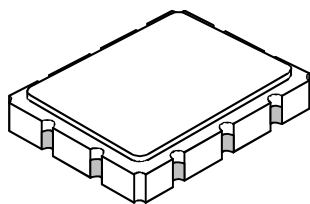
Connection		Terminals
Port 1	Input or Return	10
	Return or Input	1
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SM9171-10 Case

### 10-Terminal Ceramic Surface-Mount Case 9.1 x 7.1 mm Nominal Footprint

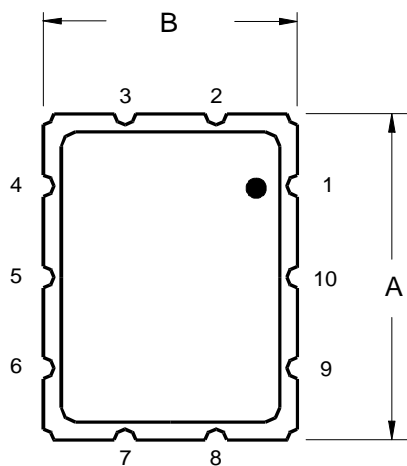


#### Case Dimensions

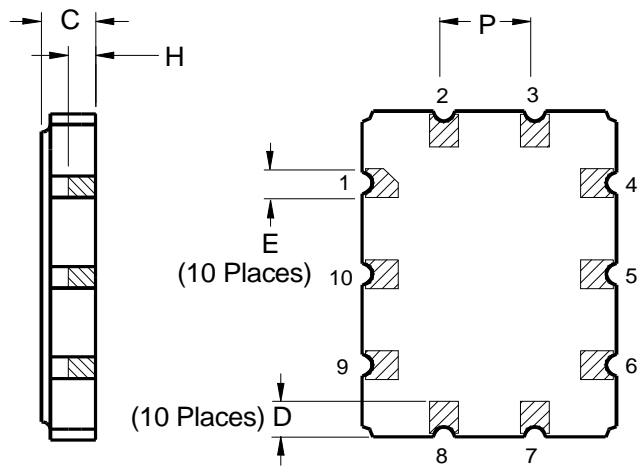
Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	8.86	9.09	9.40	0.349	0.358	0.370
B	6.88	7.11	7.40	0.271	0.280	0.291
C		1.91	2.00		0.075	0.079
D		0.99			0.039	
E		0.79			0.031	
H		1.0			0.039	
P		2.54			0.100	

#### Electrical Connections

Connection		Terminals
Port 1	Input or Return	6
	Return or Input	5
Port 2	Output or Return	1
	Return or Output	10
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



TOP VIEW

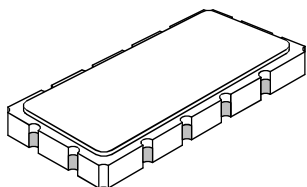


BOTTOM VIEW

# SAW Filters Packages

## SM13365-12 Case

### 12-Terminal Ceramic Surface-Mount Case 13.3 x 6.5 mm Nominal Footprint

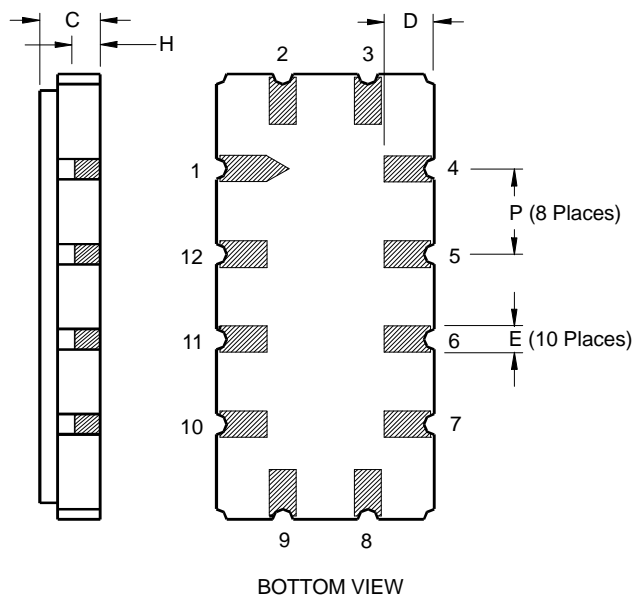
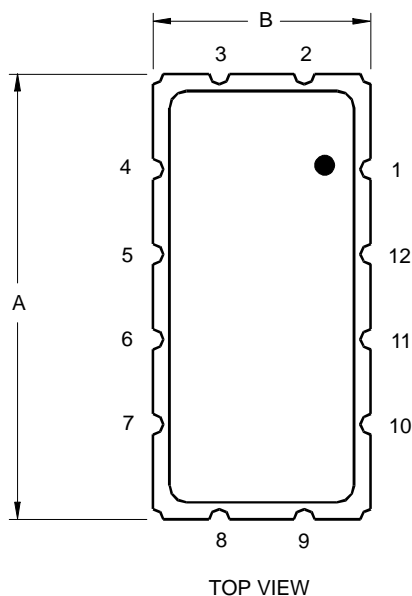


#### Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	13.08	13.31	13.60	0.515	0.524	0.535
B	6.27	6.50	6.80	0.247	0.256	0.268
C		1.91	2.00		0.075	0.079
D		1.50			0.059	
E		0.79			0.031	
H		1.0			0.039	
P		2.54			0.100	

#### Electrical Connections

Connection		Terminals
Port 1	Input or Return	2
	Return or Input	3
Port 2	Output or Return	8
	Return or Output	9
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot

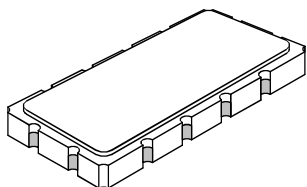




# SAW Filters Packages

## SMP-53 Case

### 12-Terminal Ceramic Surface-Mount Case 13.3 x 6.5 mm Nominal Footprint

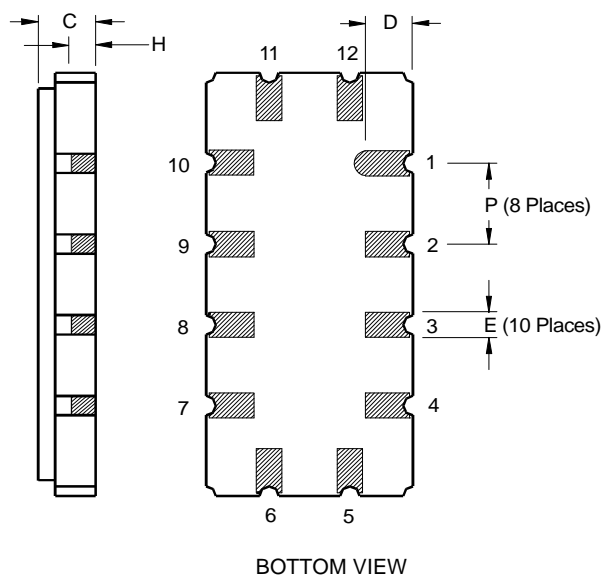
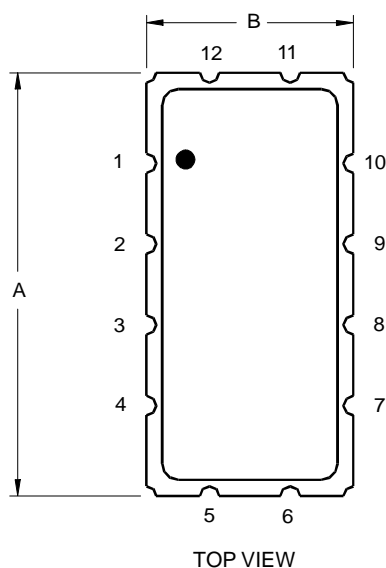


#### Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	13.08	13.31	13.60	0.515	0.524	0.535
B	6.27	6.50	6.80	0.247	0.256	0.268
C		1.91	2.00		0.075	0.079
D		1.50			0.059	
E		0.79			0.031	
H		1.0			0.039	
P		2.54			0.100	

#### Electrical Connections

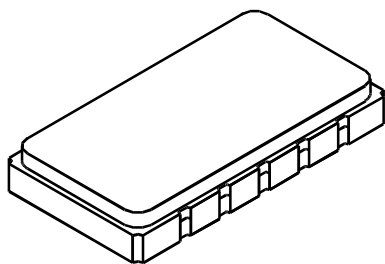
Connection		Terminals
Port 1	Input or Return	11
	Return or Input	12
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SMP-53-S Case

### 10-Terminal Ceramic Surface-Mount Case 13.3 x 6.5 mm Nominal Footprint

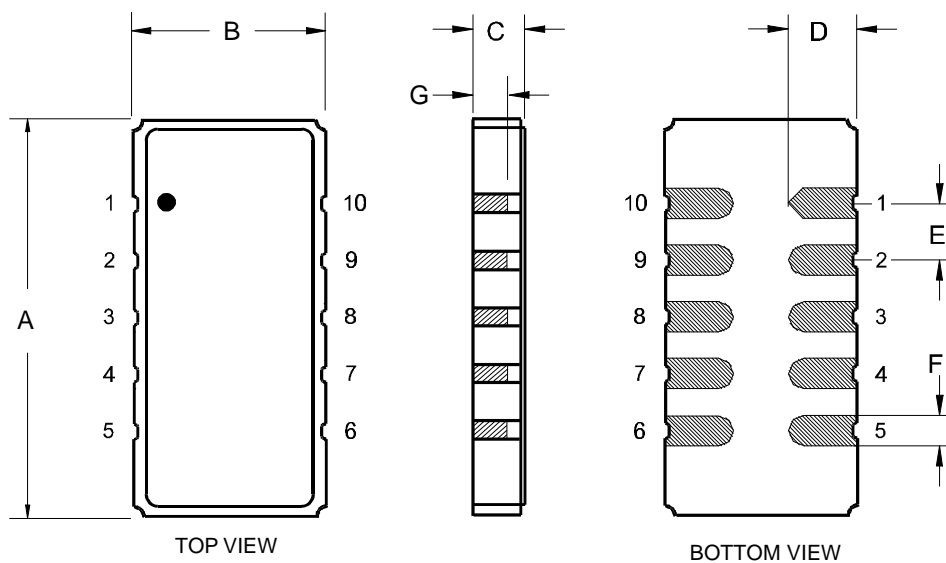


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A		13.3			.524	
B		6.5			.256	
C			2.00			.078
D		2.3			.091	
E		1.91			.075	
F		1.02			.040	
G		1.0			0.039	

Electrical Connections

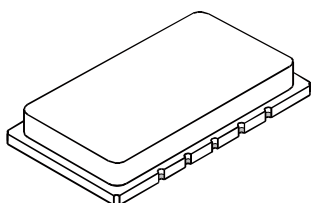
Connection	Terminals
Port 1 Hot	10
Port 1 Gnd Return	1
Port 2 Hot	5
Port 2 Gnd Return	6
Case Ground	All others
Single Ended Operation	Return is ground
Differential Operation	Return is hot



# SAW Filters Packages

## SMP-08 Case

### 10-Terminal Ceramic Surface-Mount Case 14 x 8 mm Nominal Footprint

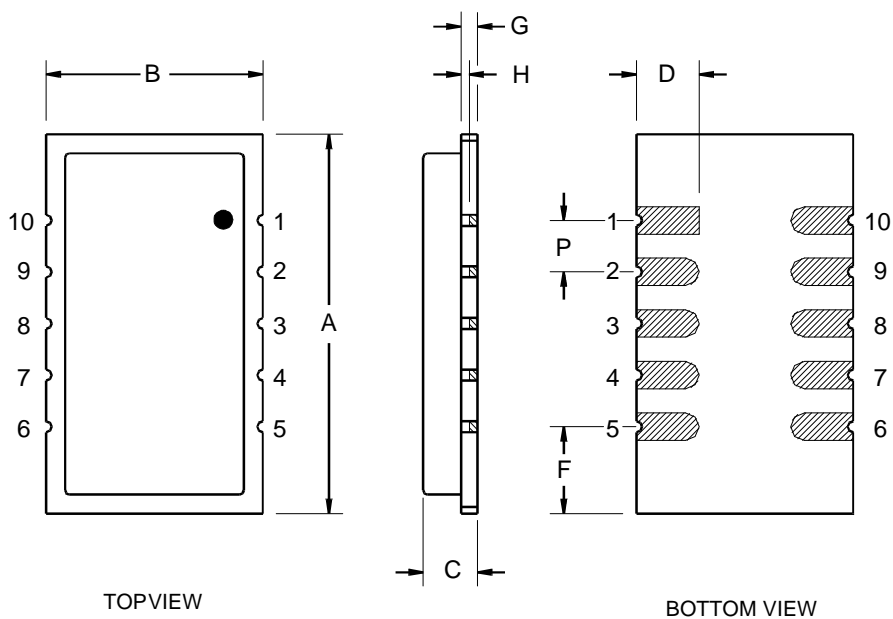


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	13.69	14.00	14.30	0.539	0.551	0.563
B	7.70	8.00	8.30	0.303	0.315	0.327
C		1.70	2.00		0.067	0.079
D		2.30			0.091	
E		1.02			0.040	
F		3.19			0.126	
G		0.60			0.024	
H		1.0			0.039	
P		1.905			0.075	

Electrical Connections

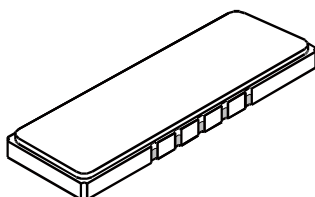
Connection		Terminals
Port 1	Input or Return	10
	Return or Input	1
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SMP-75 Case

### 10-Terminal Ceramic Surface-Mount Case 19 x 6.5 mm Nominal Footprint

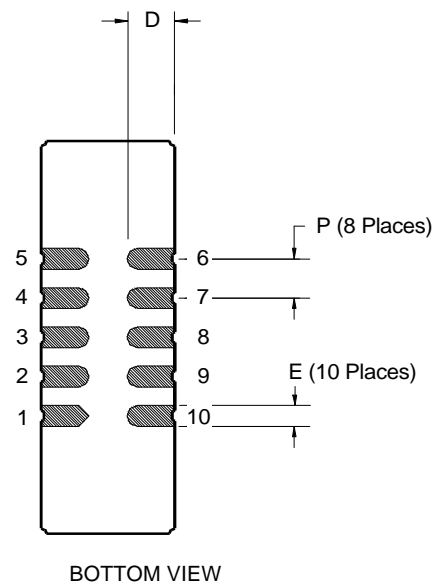
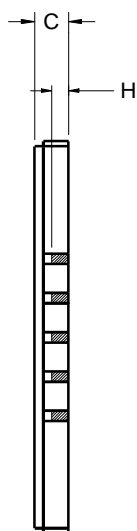
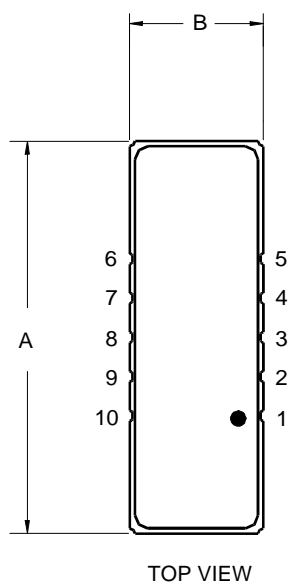


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	18.80	19.00	19.30	0.740	0.748	0.760
B	6.30	6.50	6.80	0.248	0.256	0.268
C		1.75	2.00		0.069	0.079
D		2.29			0.090	
E		1.02			0.040	
H		1.0			0.039	
P		1.905			0.075	

Electrical Connections

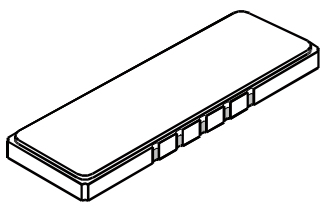
Connection		Terminals
Port 1	Input or Return	10
	Return or Input	1
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SMP-87 Case

### 10-Terminal Ceramic Surface-Mount Case 22.1 x 8 mm Nominal Footprint

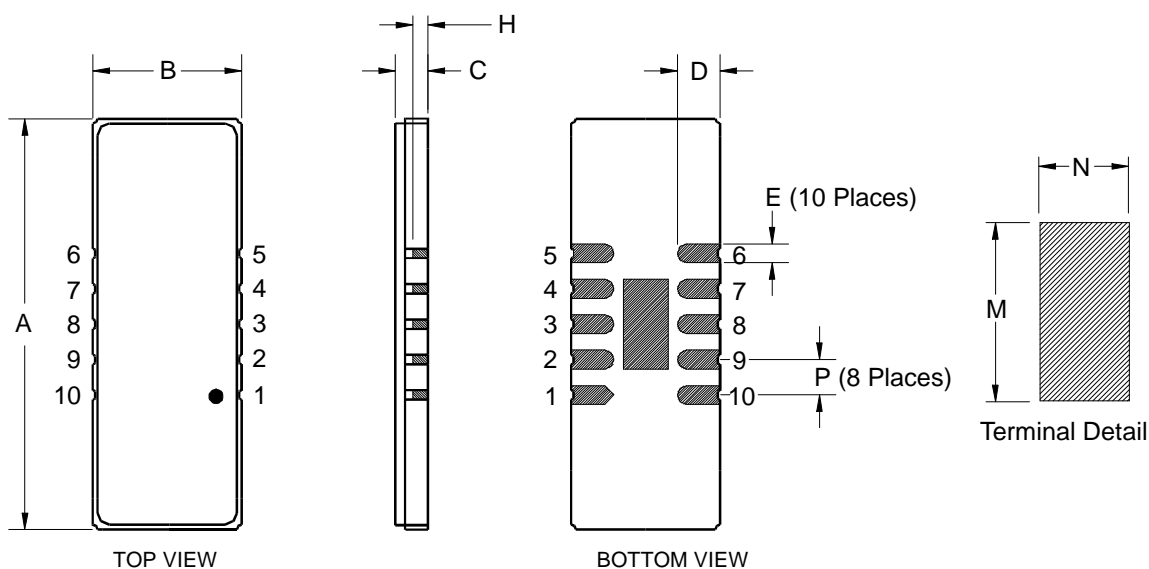


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	21.90	22.10	22.40	0.862	0.870	0.882
B	7.80	8.00	8.30	0.307	0.315	0.327
C		1.78	2.00		0.070	0.079
D		2.29			0.090	
E		1.02			0.040	
H		1.0			0.039	
M		4.83			0.190	
N		2.41			0.095	
P		1.905			0.075	

Electrical Connections

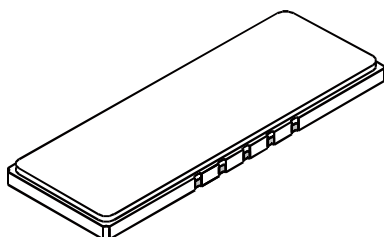
Connection		Terminals
Port 1	Input or Return	10
	Return or Input	1
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# SAW Filters Packages

## SMP-97 Case

### 10-Terminal Ceramic Surface-Mount Case 24.6 x 9 mm Nominal Footprint

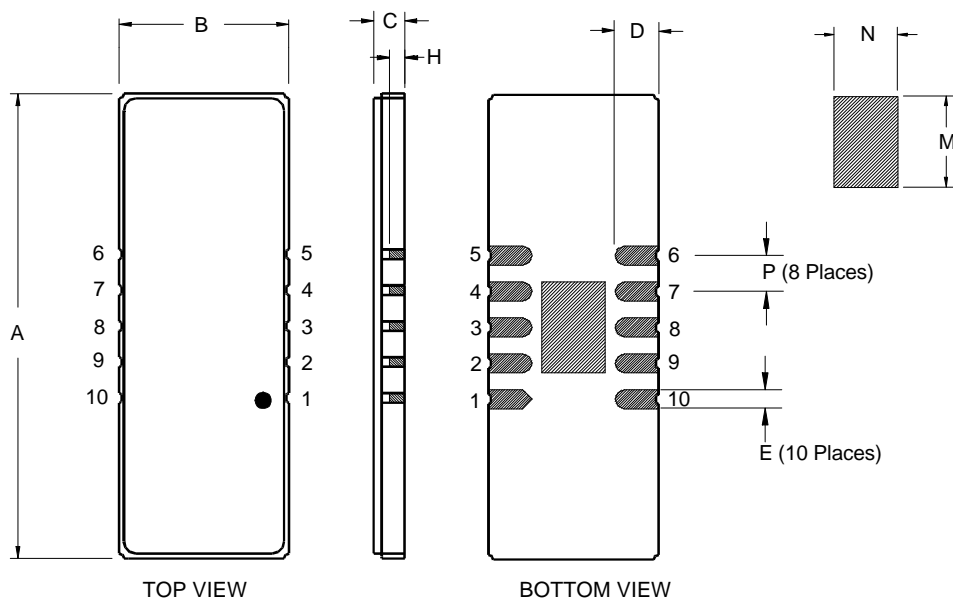


Case Dimensions

Dimension	mm			Inches		
	Min	Nom	Max	Min	Nom	Max
A	24.41	24.64	24.94	0.961	0.970	0.982
B	8.80	8.99	9.30	0.349	0.354	0.366
C		1.75	2.00		0.069	0.079
D		2.29			0.090	
E		1.02			0.040	
H		1.0			0.039	
M		4.83			0.190	
N		3.40			0.134	
P		1.905			0.075	

Electrical Connections

Connection		Terminals
Port 1	Input or Return	10
	Return or Input	1
Port 2	Output or Return	5
	Return or Output	6
Ground		All others
Single Ended Operation		Return is ground
Differential Operation		Return is hot



# Optical Timing Products Introduction

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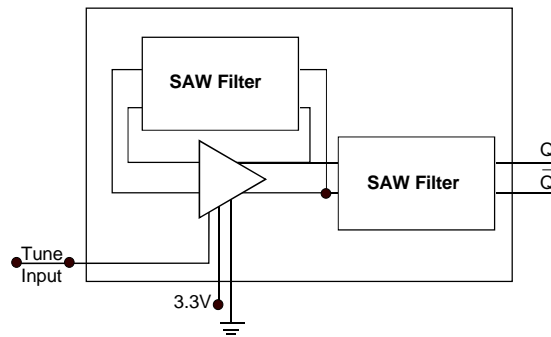
RFM retains a long history of providing stable, SAW based frequency control products for computer timing, analog communications, test instrumentation and military applications. Today, RFM also designs and manufactures optical timing products based on our patented "Diff Sine" technology to meet the increasing demand for bandwidth in communication systems. These products have been specifically developed for applications such as dense wave division multiplexing (DWDM) equipment where timing integrity and elimination of system noise in circuits are critical. Example applications include:

- Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) Equipment
- DWDM Backbone Timing and Recovery
- Terabit Routers

The OP4005 is a 622.08 MHz differential clock with near perfect symmetry and extremely low jitter with or without noise on the power planes. The OP4006 is a 666.5 MHz Clock for forward error correction timing. RFM's "Diff Sine" architecture, shown below, is the basis of each of these high performance optical products. Parts under development include the OP4004 product, centered at 625 MHz, for 10 GBit Ethernet timing.

Contact the local RFM Representative in your area or RFM directly for more information. Also, visit RFM's website at [www.rfm.com](http://www.rfm.com) for further information on all of our products.

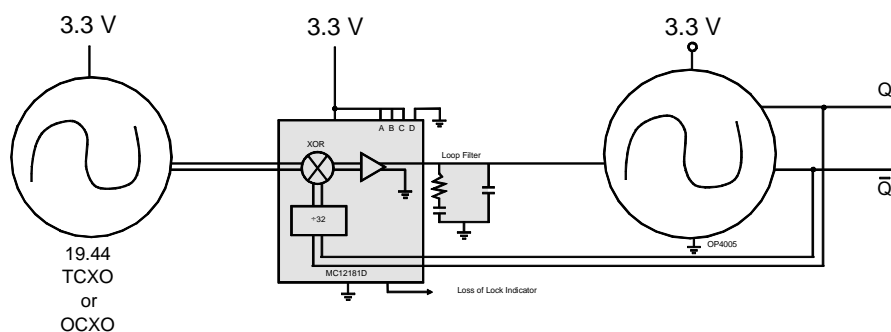
## Voltage Controlled Differential Sinewave Clock



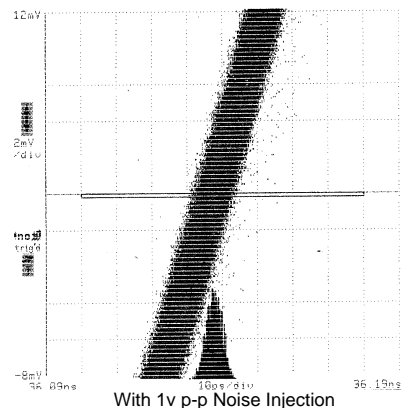
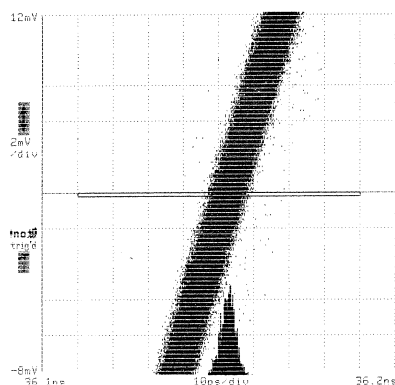
# Optical Timing Products Selection Guide

RFM Part No.	Nom. Freq. (MHz)	Typical Application	Tune Range (ppm)	Tuning Linearity	Jitter p-p	Power Supply Current 3Vdc	Ambient Temperature Operating (°C)	Pkg. Name
OP4004	625	Phase Lock Loop	700	3%	12ps	40ma	-40 to +85	Dip 16-8
OP4005	622.08	Phase Lock Loop	700	3%	12ps	40ma	-40 to +85	Dip 16-8
OP4006	666.51	Phase Lock Loop	700	3%	12ps	40ma	-40 to +85	Dip 16-8

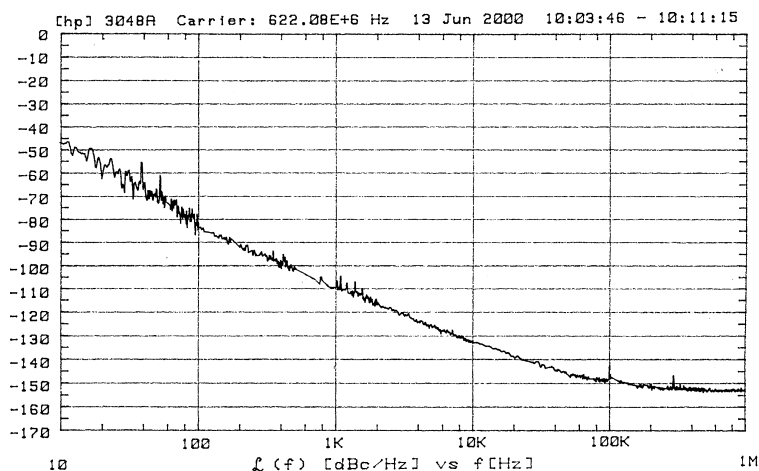
High Performance PLL for use in Stratom Clocks



Typical Jitter  
10ps p-p



OP4005 622.08 MHz Phase Noise



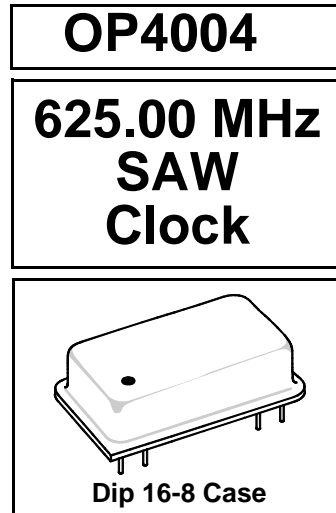


- **Quartz SAW Stabilized and Filtered**
- **Fundamental-Mode Oscillation at 625.00 MHz**
- **Voltage Tunable for Phase Lock Loop Operations**

The output of this device is generated and filtered by narrowband quartz SAW elements at 625.00 MHz. The configuration of this clock is intended to provide a pure signal for Optical Clocking applications in noisy signal environments. The Q/Qbar differential output swing of  $\pm 1$  volt about 0 vdc has symmetry better than  $\pm 1\%$  into loads from 40 ohms to 70 ohms; determined by customer application. The long term frequency accuracy is determined by a external reference source allowing this device to complete a Phase Lock Loop design without the usual noise and jitter problems associated with PLLs.

## Absolute Maximum Ratings

Rating	Value	Units
DC Supply Voltage	0 to 4	VDC
Tune Voltage	0 to 4	VDC
Ambient Temperature (storage)	-55 to 100	°C



## Electrical Characteristics

Characteristic		Sym	Notes	Min	Typical	Max	Units
Operating Freq.	Absolute Frequency	f <sub>O</sub>	1, 2		625.00		MHz
	Tune Range		1		700		ppm
	Tune Voltage		1	0		+3	VDC
	Tuning Linearity		1, 8		3%	5%	
	Modulation Bandwidth				500		kHz
Q and $\overline{Q}$ Output	Voltage into 50 $\Omega$ (VSWR≤1.2)	V <sub>O</sub>	1,3	0.60		1.1	V <sub>P-P</sub>
	Operating Load VSWR		1,3			2:1	
	Symmetry		3, 4, 5	49		51	%
	Harmonic Spurious		3, 4, 6			-30	dBc
	Nonharmonic Spurious		3, 4, 6, 7			-60	dBc
Q and $\overline{Q}$ Period Jit-	No Noise on V <sub>CC</sub>		3, 4, 6, 7		12		pS <sub>P-P</sub>
	200 mV <sub>P-P</sub> from 1MHz to ½ f <sub>O</sub> on		3				pS <sub>P-P</sub>
Output DC Resistance (between Q & $\overline{Q}$ )			1, 3	50			K $\Omega$
DC Power Supply	Operating Voltage	V <sub>CC</sub>	1, 3	3.13	3.3	3.46	VDC
	Operating Current	I <sub>CC</sub>	1, 3		40	55	mA
Operating Ambient Temperature		T <sub>A</sub>	1, 3	-40°C		+85°C	°C
Lid Symbolization (YY=Year, WW=Week)		RFM OP4004 YYWW					

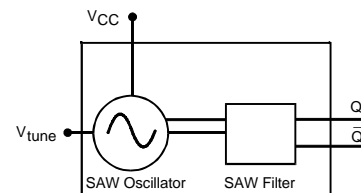


**CAUTION: Electrostatic Sensitive Device. Observe precautions for handling. COCOM CAUTION: Approval by the U.S. Department of Commerce is required prior to export of this device.**

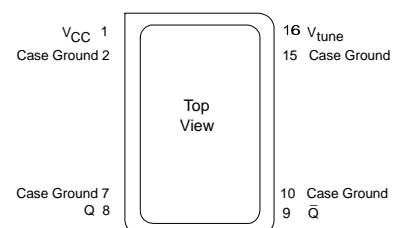
### Notes:

1. Unless otherwise noted, all specifications include any combination of load VSWR,  $V_{CC}$ , and  $T_A$ . In addition, Q and  $\bar{Q}$  are terminated into 50  $\Omega$  loads to ground. See *Typical Test Circuit*.
2. One or more of the following United States patents apply: 4,616,197; 4,670,681; 4,760,352.
3. The design, manufacturing process, and specifications of this device are subject to change without notice.
4. Only under the nominal conditions of 50  $\Omega$  load impedance with VSWR  $\leq 1.2$  and nominal power supply voltage.
5. Symmetry is defined as the pulse width (in percent of total period) measured at the 50% points of Q or  $\bar{Q}$ . (See: Timing Definitions.)
6. Jitter and other spurious outputs induced by externally generated electrical noise on  $V_{CC}$  or mechanical vibration are not included in this specification. External voltage regulation and careful PCB layout are recommended for optimum performance.
7. Applies to period jitter of Q and  $\bar{Q}$ . Measurements are made with the Tektronix CSA803 signal analyzer with at least 1000 samples.
8. Linearity is a function of the percentage variation from a permitted linear deviation versus the amount of frequency tune range. See *Linearity Definition*.

## BLOCK DIAGRAM



## ELECTRICAL CONNECTIONS



# Optical Timing Products

- **Quartz SAW Stabilized and Filtered**
- **Fundamental-Mode Oscillation at 622.08 MHz**
- **Voltage Tunable for Phase Lock Loop Operations**

The output of this device is generated and filtered by narrowband quartz SAW elements at 622.08 MHz. The configuration of this clock is intended to provide a pure signal for OC-12 Clocking applications in noisy signal environments. The Q/Qbar differential output swing of  $\pm 1$  volt about 0 vdc has symmetry better than  $\pm 1\%$  into loads from 40 ohms to 70 ohms; determined by customer application. The long term frequency accuracy is determined by an external reference source allowing this device to complete a Phase Lock Loop design without the usual noise and jitter problems associated with PLLs.

## Absolute Maximum Ratings

Rating	Value	Units
DC Supply Voltage	0 to 4	VDC
Tune Voltage	0 to 4	VDC
Ambient Temperature (storage)	-55 to 100	°C

## Electrical Characteristics

Characteristic	Sym	Notes	Min	Typical	Max	Units
Operating Freq.	Absolute Frequency	$f_O$	1, 2	622.08		MHz
			1	700		ppm
	Tune Range		1	0	+3	VDC
	Tune Voltage		1, 8	3%	5%	
	Modulation Bandwidth			500		kHz
Q and $\bar{Q}$ Output	Voltage into 50 $\Omega$ (VSWR $\leq 1.2$ )	$V_O$	1,3	0.60	1.1	V <sub>P-P</sub>
	Operating Load VSWR		1,3		2:1	
	Symmetry		3, 4, 5	49	51	%
	Harmonic Spurious		3, 4, 6		-30	dBc
	Nonharmonic Spurious		3, 4, 6, 7		-60	dBc
Q and $\bar{Q}$ Period	No Noise on $V_{CC}$		3, 4, 6, 7	12		ps <sub>P-P</sub>
	200 mV <sub>P-P</sub> from 1MHz to $\frac{1}{2} f_O$ on		3			ps <sub>P-P</sub>
Output DC Resistance (between Q & $\bar{Q}$ )			1, 3	50		K $\Omega$
DC Power Supply	Operating Voltage	$V_{CC}$	1, 3	3.3	3.46	VDC
	Operating Current	$I_{CC}$	1, 3	40	55	mA
Operating Ambient Temperature		$T_A$	1, 3	-40°C	+85°C	°C
Lid Symbolization (YY=Year, WW=Week)		RFM OP4005 YYWW				



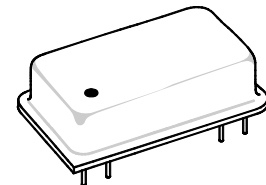
**CAUTION: Electrostatic Sensitive Device. Observe precautions for handling. COCOM CAUTION: Approval by the U.S. Department of Commerce is required prior to export of this device.**

### Notes:

1. Unless otherwise noted, all specifications include any combination of load VSWR, VCC, and TA. In addition, Q and  $\bar{Q}$  are terminated into 50  $\Omega$  loads to ground. See *Typical Test Circuit*.
2. One or more of the following United States patents apply: 4,616,197; 4,670,681; 4,760,352.
3. The design, manufacturing process, and specifications of this device are subject to change without notice.
4. Only under the nominal conditions of 50  $\Omega$  load impedance with VSWR  $\leq 1.2$  and nominal power supply voltage.
5. Symmetry is defined as the pulse width (in percent of total period) measured at the 50% points of Q or  $\bar{Q}$ . (See: Timing Definitions.)
6. Jitter and other spurious outputs induced by externally generated electrical noise on  $V_{CC}$  or mechanical vibration are not included in this specification. External voltage regulation and careful PCB layout are recommended for optimum performance.
7. Applies to period jitter of Q and  $\bar{Q}$ . Measurements are made with the Tektronix CSA803 signal analyzer with at least 1000 samples.
8. Linearity is a function of the percentage variation from a permitted linear deviation versus the amount of frequency tune range. See *Linearity Definition*.

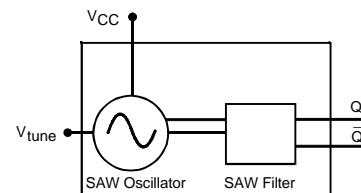
**OP4005**

**622.08 MHz  
Sonet SAW  
Clock**

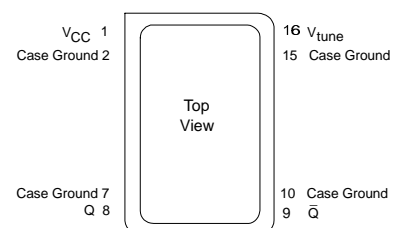


**Dip 16-8 Case**

## BLOCK DIAGRAM



## ELECTRICAL CONNECTIONS



- **Quartz SAW Stabilized and Filtered**
- **Fundamental-Mode Oscillation at 666.51 MHz**
- **Voltage Tunable for Phase Lock Loop Operations**

The output of this device is generated and filtered by narrowband quartz SAW elements at 666.51 MHz. The configuration of this clock is intended to provide a pure signal for Optical Clocking applications in noisy signal environments. The Q/Qbar differential output swing of  $\pm 1$  volt about 0 vdc has symmetry better than  $\pm 1\%$  into loads from 40 ohms to 70 ohms; determined by customer application. The long term frequency accuracy is determined by a external reference source allowing this device to complete a Phase Lock Loop design without the usual noise and jitter problems associated with PLLs.

## Absolute Maximum Ratings

Rating	Value	Units
DC Supply Voltage	0 to 4	VDC
Tune Voltage	0 to 4	VDC
Ambient Temperature (storage)	-55 to 100	°C

## Electrical Characteristics

Characteristic		Sym	Notes	Min	Typical	Max	Units
Operating Freq.	Absolute Frequency	f <sub>O</sub>	1, 2		666.51		MHz
	Tune Range		1		700		ppm
	Tune Voltage		1	0		+3	VDC
	Tuning Linearity		1, 8		-3%	5%	
	Modulation Bandwidth				500		kHz
Q and $\overline{Q}$ Output	Voltage into 50 $\Omega$ (VSWR≤1.2)	V <sub>O</sub>	1,3	0.60		1.1	V <sub>P-P</sub>
	Operating Load VSWR		1,3			2:1	
	Symmetry		3, 4, 5	49		51	%
	Harmonic Spurious		3, 4, 6			-30	dBc
	Nonharmonic Spurious		3, 4, 6, 7			-60	dBc
Q and $\overline{Q}$ Period	No Noise on V <sub>CC</sub>		3, 4, 6, 7		12		pS <sub>P-P</sub>
	200 mV <sub>P-P</sub> from 1MHz to ½ f <sub>O</sub> on		3				pS <sub>P-P</sub>
Output DC Resistance (between Q & $\overline{Q}$ )			1, 3	50			K $\Omega$
DC Power Supply	Operating Voltage	V <sub>CC</sub>	1, 3	3.13	3.3	3.46	VDC
	Operating Current	I <sub>CC</sub>	1, 3		40	55	mA
Operating Ambient Temperature		T <sub>A</sub>	1, 3	-40°C		+85°C	°C
Lid Symbolization (YY=Year, WW=Week)		RFM OP4006 YYWW					



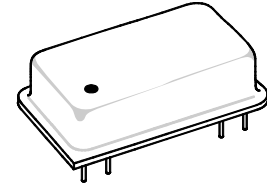
**CAUTION: Electrostatic Sensitive Device. Observe precautions for handling. COCOM CAUTION: Approval by the U.S. Department of Commerce is required prior to export of this device.**

### Notes:

1. Unless otherwise noted, all specifications include any combination of load VSWR, VCC, and TA. In addition, Q and  $\bar{Q}$  are terminated into 50  $\Omega$  loads to ground. See *Typical Test Circuit*.
2. One or more of the following United States patents apply: 4,616,197; 4,670,681; 4,760,352.
3. The design, manufacturing process, and specifications of this device are subject to change without notice.
4. Only under the nominal conditions of 50  $\Omega$  load impedance with VSWR  $\leq 1.2$  and nominal power supply voltage.
5. Symmetry is defined as the pulse width (in percent of total period) measured at the 50% points of Q or  $\bar{Q}$ . (See: Timing Definitions.)
6. Jitter and other spurious outputs induced by externally generated electrical noise on  $V_{CC}$  or mechanical vibration are not included in this specification. External voltage regulation and careful PCB layout are recommended for optimum performance.
7. Applies to period jitter of Q and  $\bar{Q}$ . Measurements are made with the Tektronix CSA803 signal analyzer with at least 1000 samples.
8. Linearity is a function of the percentage variation from a permitted linear deviation versus the amount of frequency tune range. See *Linearity Definition*.

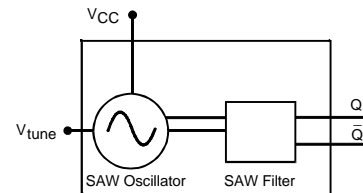
# OP4006

## 666.51 MHz Sonet SAW Clock

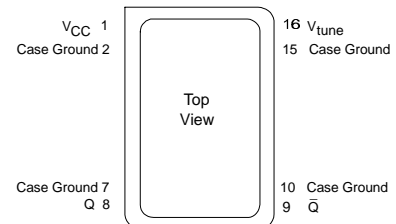


Dip 16-8 Case

## BLOCK DIAGRAM



## ELECTRICAL CONNECTIONS





# ***RFM's Other Product Lines***

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## **About RF Monolithics, Inc.**

Since 1983, RF Monolithics, Inc. (RFM) has pioneered the use of advanced surface acoustic wave (SAW) and RF technology in short-range wireless data systems. RFM ships more than 50 million products annually to customers in 40 countries for short-range wireless applications in the industrial, computing, consumer electronic and automotive markets. The Company's product offerings for short-range wireless applications range from discrete SAW devices to the 2nd generation ASH transceiver hybrids. RFM's extensive experience and customer support structure is unparalleled in the short-range wireless industry.

RFM was founded in 1979 and became public in 1994 (NASDAQ - RFMI). The Company's headquarters are located in its 95,000 square foot facility in Dallas, Texas USA. For further information see RFM's web site at [www.rfm.com](http://www.rfm.com) or contact the Company at USA (972) 448-3700.

## **RFM's Other Product Lines**

RF Monolithics, Inc. has additional product lines serving many different electronics markets including automotive, communications, consumer, home automation, and industrial.

### **Frequency Control Modules**

RFM's frequency control modules include high-frequency digital clocks and analog, quartz-stabilized oscillators. These SAW-based products cover a frequency range from 200 MHz to 1.3 GHz. As broadband telecommunication systems demand more performance to support Internet requirements, bandwidth becomes the key element that allows information to flow efficiently. RFM's "Diff Sine" technology provides the necessary performance for high-speed digital telecommunication systems. "Diff Sine" products are available in fixed frequency or tunable technology to serve different application needs. Each technology will help eliminate system noise present in broadband telecommunications and provide clean timing to maximize throughput around the system's backbone. Our analog products provide a clean, single-ended local oscillator for air traffic control systems, identification friend or foe (IFF) systems and communications systems for various applications.

### **Low-power Products**

RFM's Low-power Products Group combines Low-power Components and Virtual Wire® Short-range Radio products. Low-power Components consist of surface-mount and leaded package resonators and coupled-resonator filters. These resonators and coupled-resonator filters are essential to tiny radio frequency transmitters and receivers that enable a variety of wireless consumer, automotive, industrial and commercial applications. Some of these devices include remote keyless entry, wireless security systems and remote meter readers. Due to the superior performance of our surface-mount resonators, RFM is one of the world's largest manufacturers of these products.

The Virtual Wire® Short-range Radio products provide integrated one- and two-way solutions for short-range wireless control and data communication applications. These products are based on RFM's patented second-generation amplifier-sequenced hybrid (ASH) technology and include miniature transmitters, receivers, and transceivers. Using this technology, wireless communication links can be implemented in products as small as a watch. Furthermore, Virtual Wire® products greatly simplify the design and regulatory certification of short-range radio systems. RFM's short-range radio systems are used in home automation applications, tire pressure monitoring, RFID tags, wireless game controllers, and several new market applications.



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