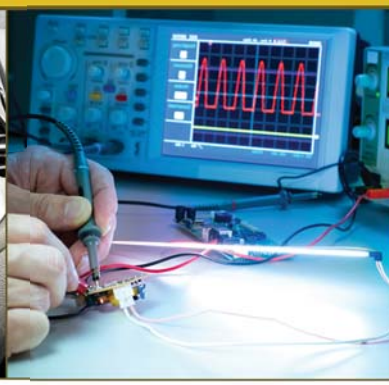
Vectron
a Knowles company

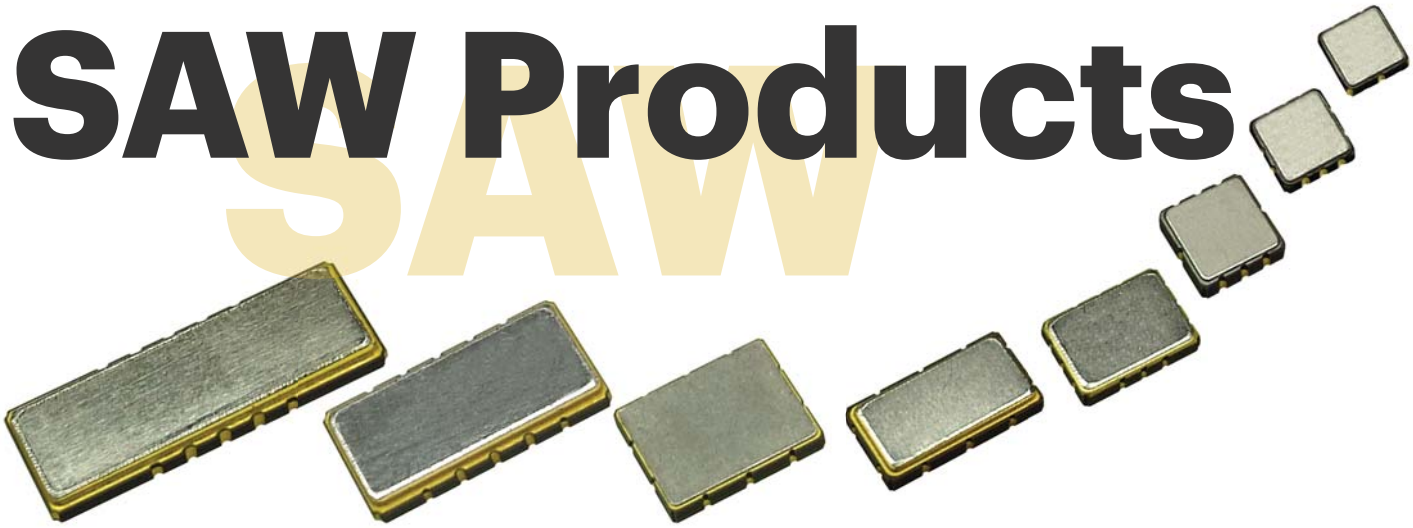
Helping Customers Innovate, Improve & Grow

GNSS Telecommunications LTE Industrial Scientific Military & Space Medical Wireless Navigation



SAW Products

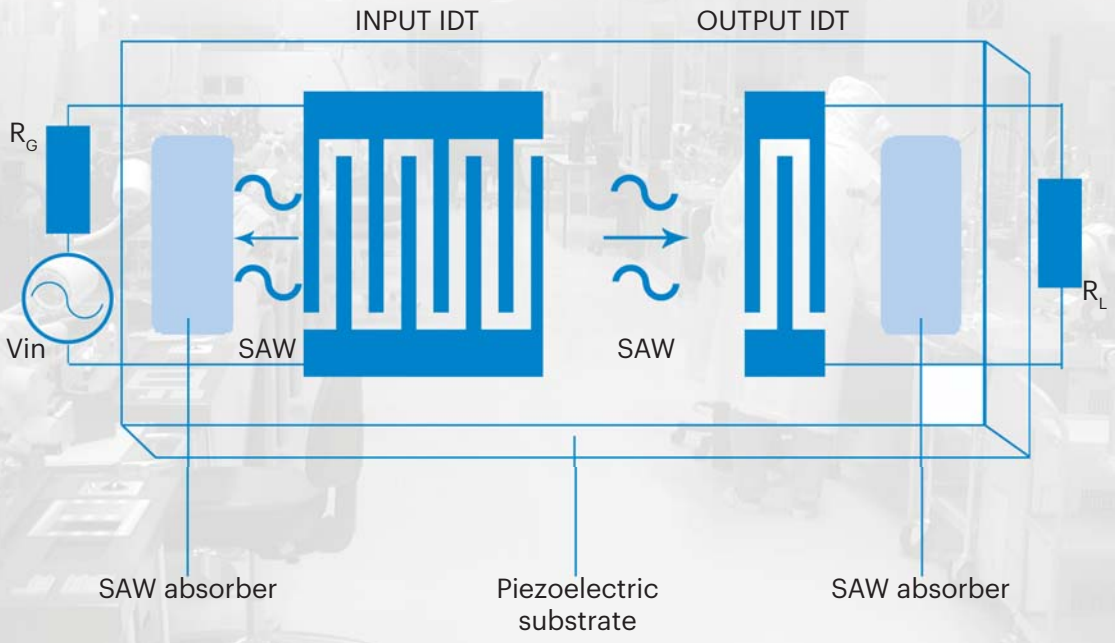


- SAW Modules
- SAW IF, RF and Integrated Multi-Band Filter Solutions
- Frequency Range from 30 MHz to 2.7 GHz
- High-Q SAW Resonators and Narrow-Band Filters
- High Volume Cost-Efficient Manufacturing Capabilities

How Do SAW Filters Work?

Surface Acoustic Wave (SAW) devices deploy Inter-Digital Transducers (IDTs) to convert electrical signals (MHz range) to mechanical acoustic waves (µm-range) and back again to electrical signals. The conversion makes use of piezo-electric properties to generate and detect acoustic waves. These acoustic wavelengths are 100,000 times shorter than electro-magnetic signals of the same frequency. Therefore, highly miniaturized filters can be realized for Radio Frequency (RF) signal processing.

To find the perfect solution for your individual application, a wide variety of SAW design techniques is used. These range from very narrow-band (low loss) designs to very wide-band (low shape factor) designs.



SAW Filter Impedance Matching Networks

The frequency response of Inter-Digital Transducers in a SAW device can be understood as a combination of a static capacitance between IDT 'fingers' and a highly frequency-dependent, dynamic response related to the electro-acoustic conversion. Depending on the strength of the dynamic part of the response and the employed design approach, some SAW filters require impedance matching networks to compensate their capacitive behavior in order to achieve their optimum frequency response. Intermediate Frequency (IF) filters regularly require such reactive matching networks (typically two-element L/C-networks), while RF filters for frontend applications are typically designed to operate in a pre-defined impedance environment (e.g. 50 Ω, 100 Ω, 200 Ω) without external circuitry.

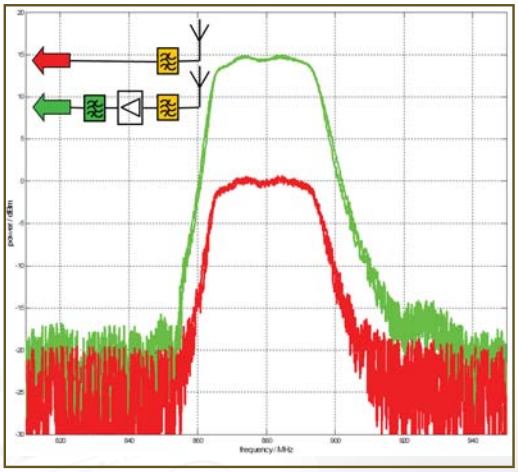
Vectron can provide SAW Filters with integrated 'balun' (conversion balanced ↔ single-ended) functionality and solutions for different terminating impedances at input and output ports (e.g. 50 Ω ↔ 200 Ω). Further to these common impedance levels, special solutions to match customized and complex terminating impedances or high-impedance level open-collector circuits are available.

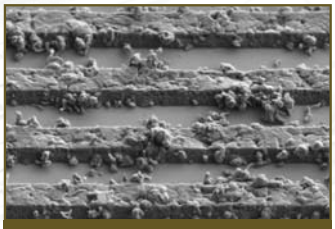
Power Handling Capabilities

Increased signal power level is a key approach when good signal–to–noise ratio in RF transmission systems or outstanding noise floor in oscillator signals is required. While small size is one of the key advantages of Surface Acoustic Wave (SAW) filters compared to competing technologies, the combination of high power levels and small size results in high power densities and therefore risk of premature failure for highly miniaturized solutions.

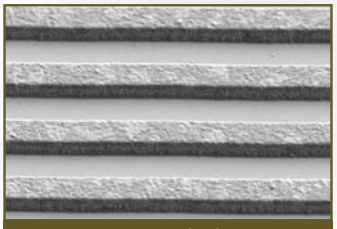
A SAW device's power handling capability depends on numerous factors, such as the employed design approach, the device's center frequency, the exposure signal's frequency and modulation scheme and its duty cycle or the ambient temperature.

Vectron's innovative high-power technology significantly reduces degradation effects of micro-acoustic stress caused by high RF signal power, therefore allows realizations of SAW filters with substantially improved power handling capabilities and superior life time and helps system designers to achieve their performance goals.





Standard SAW IDT after extended high power exposure



IDT in Vectron's high power technology after comparable exposure

Advantages of Vectron International

Vectron International has been a key supplier of micro-acoustic electronic components like SAW filters, SAW resonators and monolithic crystal filters (MCF) since the early 1990s. We work closely with our customers to understand the application to develop the optimum solution that meets your requirements. Our design capabilities and cost-optimized production facilities allow us to offer components for high volume and high performance markets.

Vectron's Commitment to Quality

Vectron is, and will remain, a world-class supplier to its global market and will apply innovative, forward-looking ethical principles in complying with the requirements of that market. We are highly committed to recognizing the needs of our customers and to responding to those needs with superior quality, service, responsiveness and specification compliance. All of our employees are dedicated to these principles with total customer satisfaction and continual improvement as their constant goal.

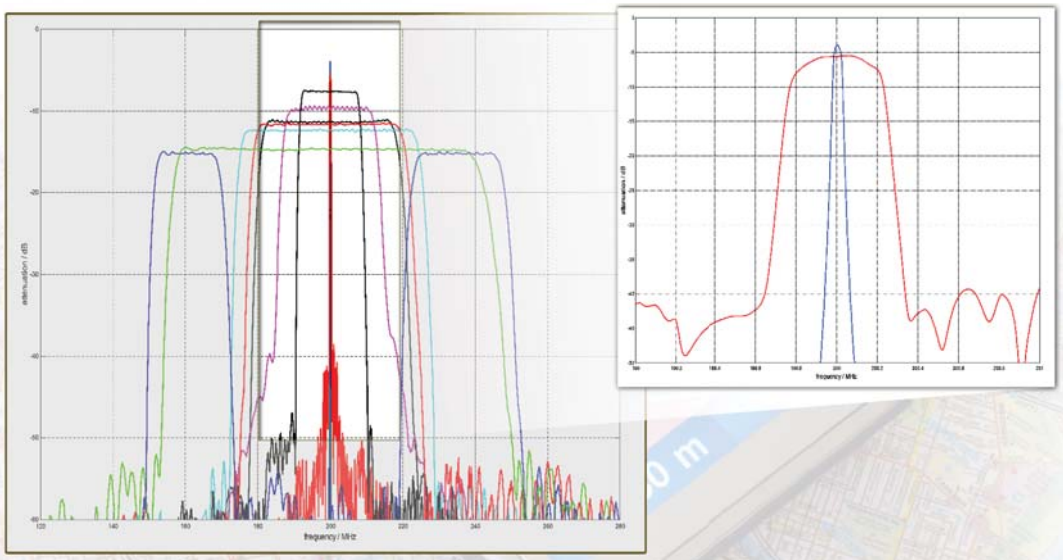
IF Filters

To achieve high-performance heterodyne RF transceiver systems, highly selective filters for the Intermediate Frequency (IF) stage are mandatory. For such filters, system designers focus on highly linear amplitude and phase response within the desired filter pass band as well as the steepest possible roll-off to achieve maximum adjacent channel suppression. Vectron uses a large variety of different SAW filter design approaches to fulfill these requirements for all kinds of applications, in line with moderate insertion attenuation to limit amplification requirements and power consumption in the IF stage.

Extensive use of resonant and recursive design approaches – in the digital world, the latter is known as 'Infinite Impulse Response' (IIR) filters – ensure maximum performance in combination with minimum size, whereas other design approaches – equivalent to 'Finite Impulse Response' (FIR) filters – allow for realization of filter shape factors (ratio of stop-band and pass-band width) very close to the theoretical limit, i.e. even below 1.05.

Vectron's SAW IF filters are found in all kinds of high-performance RF systems, from Communications to Military and Space systems, in Medical and Industrial electronics, and in countless other applications.

Hundreds of readily developed IF filter solutions in frequency ranges between 30 MHz and 1 GHz, covering fractional bandwidth ranges between 0.01 % and >50 %, are available off the shelf. Selected examples at a center frequency of 200MHz are shown below.



RF Filters

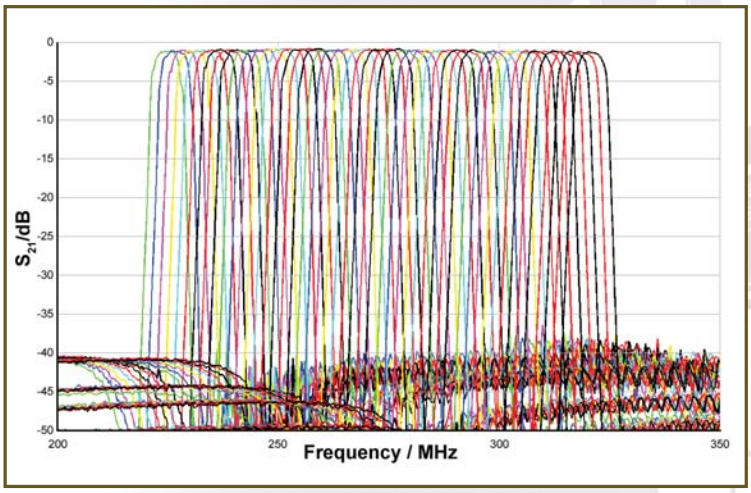
The strong influence of a front end filter's insertion attenuation on the transceiver system's performance requires the application of low-loss filter design principles, utilizing various kinds of electrically or acoustically coupled high-Q SAW resonators.

Vectron uses numerous design techniques to realize the required solutions. While filter solutions consisting of a network of one-port SAW resonators offer advantages in terms of minimum insertion attenuation and RF power handling capabilities, filter principles using acoustically coupled resonators are chosen for high out-of-band rejection and for applications requiring integrated impedance transformation (e.g. 50 Ω $\leftrightarrow$ 200 Ω) or 'balun'(single-ended $\leftrightarrow$ balanced) functionality. Combinations of both approaches ensure optimum design-to-application.

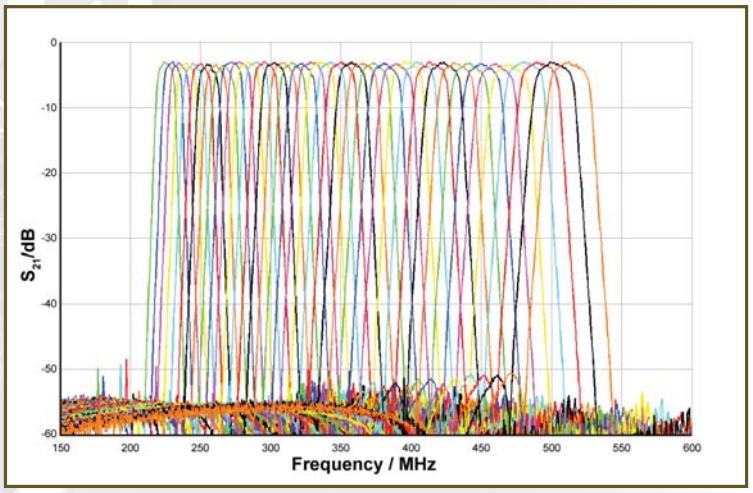
Besides a comprehensive, constantly growing portfolio of RF frontend filters for Communication applications, e.g. most LTE frequency bands, Vectron also offers highly temperature-stable filters for narrow-band RF filtering applications, covering fractional bandwidth ranges of less than 0.1 %. Such devices are widely used in Professional Communication applications, Military Radio systems and Test and Measurement applications, in functionality both as filtering devices and as high-Q frequency-determining components for high-frequency oscillators.

Integrated Filter Solutions

The complexity of RF transceiver systems is increasing with the integration of numerous frequency bands into one radio unit. Vectron is offering multi-band SAW filter solutions to cope with the challenges resulting from decreasing guard bands between radio channels and multi-channel usage within single radios. Besides selected diplexer and duplexer solutions, Vectron is offering custom-designed discrete or integrated filter bank solutions to support radios with multiple transmission bands with constant absolute or constant relative channel bandwidths.



Fixed Absolute Bandwidth

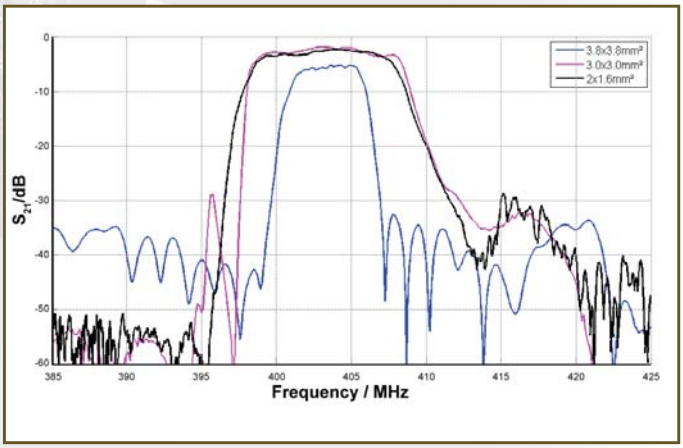


Fixed Relative Bandwidth

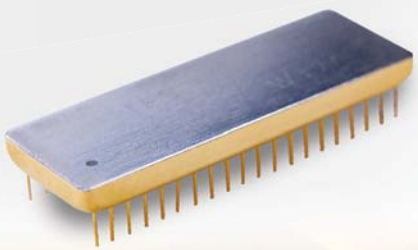
Industrial, Scientific and Medical Applications

The need for high power efficiency in many RF systems for ISM (Industrial, Scientific, and Medical) applications requires SAW filters with low insertion attenuation. To achieve this, resonant or recursive SAW filter design principles are applied, allowing to achieve lowest insertion attenuation or steep filter transitions.

A variety of solutions for ISM and MICS (Medical Implant Communication Service) band applications are readily available, suiting different filtering requirements in terms of insertion attenuation, stop-band rejection and transition regions. High-performance resonators in the respective ISM and MICS bands, to support SAW-based oscillator applications, are available as well.



Product	Center Frequency/MHz	Bandwidth/ MHz	Insertion Attenuation/ dB	Package size / mm²
TFS403A	403.5	3.0	5.5	3.8x3.8
TFS403B	403.5	3.0	2.5	3.8x3.8
TFS403G	403.5	3.0	3	2.5x2.0
TFS403L	403.5	3.0	4.0	2.0X1.6
TFS433V	433.92	0.32	3.0	3.8x3.8
TFS433Z	433.92	0.32	3.0	5.0x5.0
TFS868C	868.30	0.50	5.5	3.8x3.8
TFS868H	868.30	0.40	3.8	3.8x3.8
TFS915L	915.0	0.70	5.5	3.8x3.8
TFS915P	915.0	26.0	2.9	3.8x3.8



Navigation Applications

Vectron offers a comprehensive family of RF front-end and inter-stage filters for Global Navigation Satellite Systems (GNSS) applications, supporting the full range of single- and multi-mode (GPS, Glonass, Galileo, Beidou) and single- and multi-band (lower / upper L-band) system applications.

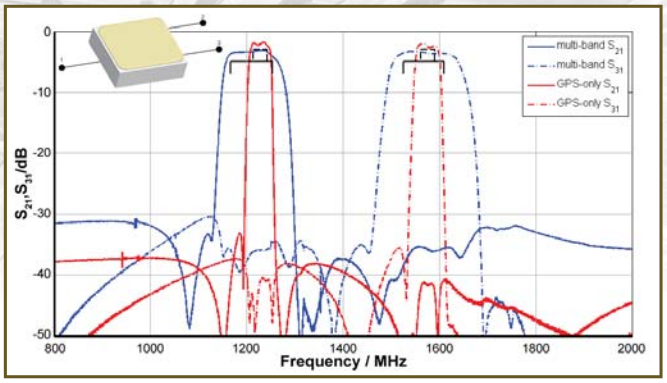
GNSS Band	f_{start}	f_{stop}	Single-Band Solution	Multi-Band Solutions						Diplexers	
E5a	1164	1189	TFS1176 (se)	TFS1188 (se)		TFS1209 (se)	TFS1191 (se)		TFS1225C (se)	TDX1210	
E5b	1189	1214	TFS1204A (se)								
B2	1192.14	1222.14			TFS1225D (bal)		TFS1191B (bal)	TFS1238 (se)			TDX1227
L2	1215	1237	TFS1227B (se) TFS1227C (bal)	TFS1237 (se) TFS1237C (bal)							
G2	1237	1254	TFS1245A(bal)								
B3	1248.52	1288.52					TFS1255A (se)				
E4	1254	1258									
E6	1260	1300	TFS1278A (se)								
L-band	1525	1559	TFS1542D (se)							TDX1210	TDX1227
SAR	1544	1545						TFS1580A (se)	TFS1581 (bal) TFS1581B (bal)		
B1	1555.42	1595.42	TFS1575Z (se)	TFS1575Z (se)			TF-S1575AG (se)				
E2	1559	1563									
L1	1563	1587	TFS1575D (se)			TFS1590 (se) TFS1590C (bal)					
L1 C/A	1574.22	1576.62	TFS1575AD (se)								
E1	1587	1591									
G1	1593	1610	TFS1601A (bal)								

Systems

GPS	Glonass	Beidou	Galileo	Others

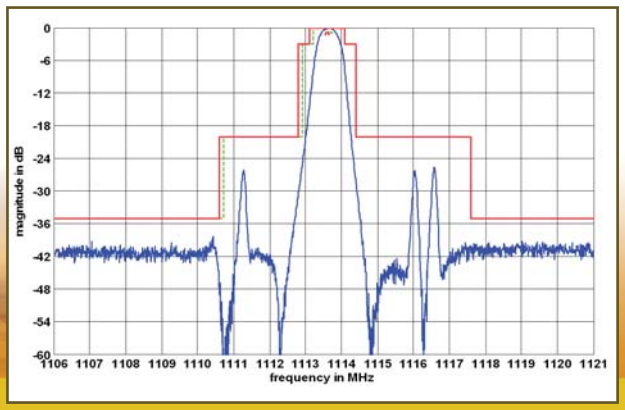
'se' - single-ended (unbalanced operation)
'bal' - balanced (differential operation)

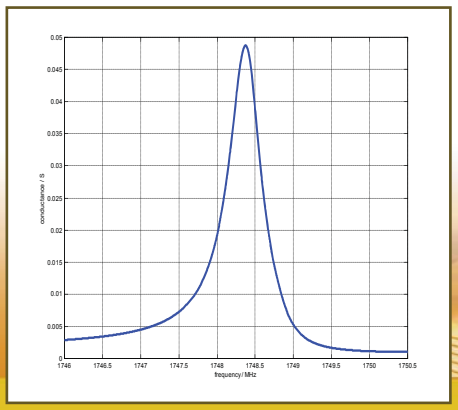
A comprehensive range of IF filters for professional navigation systems, designed for high isolation between signals in multi-mode systems, is available off the shelf.



Oscillator and Narrow-Band Filtering Applications

Vectron offers a unique portfolio of narrow-band, high-Q and temperature- and aging-stable filters and resonators in frequency ranges up to 2.5 GHz, suiting professional and high-reliability requirements for narrow-band filtering or extreme precision SAW-based oscillator applications.





SAW Filters for Wireless and Telecommunication Applications

Vectron offers a comprehensive portfolio of available SAW filter solutions for today's Communication systems. Within the 4th generation mobile telecommunication standard LTE, RF filter solutions for most bands are available in high reliability packaged versions, with more solutions under development.
All RF filter products are optimized towards lowest insertion attenuation, and steepest filter transitions, to support highest signal-to-noise ratio requirements.

LTE Band	Center Freq. uplink / MHz	Center Freq. downlink / MHz	Mode	Band-width / MHz	Filter Uplink	Filter Downlink
1	1950	2140	FDD	60	TFS1950B	TFS2140D
2	1880	1960	FDD	60	TFS1880	TFS1960
3	1747.5	1842.5	FDD	75	TFS1747	TFS1842
4	1732.5	2132.5	FDD	45	TFS1732A	-
5	836.5	881.5	FDD	25	TFS836G	TFS881D
7	2535	2655	FDD	70	TFS2535D	TFS2655A
8	897.5	942.5	FDD	35	TFS897D	TFS942G
9	1767.4	1862.4	FDD	35	-	TFS1864
10	1740	2140	FDD	60	TFS1747	TFS2140D
11	1437.9	1485.9	FDD	20	-	TFS1489
12	707	737.5	FDD	18	TFS707	TFS737
13	782	751	FDD	10	TFS781A	TFS751
14	793	763	FDD	10	TFS793	-
15	1910	2610	FDD	20	TFS1910B	-
16	2017.5	2592.5	FDD	15	TFS2017B	TFS2595A
17	710	740	FDD	12	TFS707	TFS740
18	822.5	867.5	FDD	15	TFS826	TFS867A
19	837.5	882.5	FDD	15	-	TFS881D
23	2010	2190	FDD	20	TFS2010	-
24	1643.5	1542	FDD	34	TFS1643	TFS1542A
33	1910	-	TDD	20	TFS1910B	-
34	2017.5	-	TDD	15	TFS2017B	-
35	1880	-	TDD	60	TFS1880	-
36	1960	-	TDD	60	TFS1960	-
38	2595	-	TDD	50	TFS2595A	-
39	1900	-	TDD	40	TFS1900	-
41	2593	-	TDD	194	TFS2593A	-

A wide variety of SAW IF filters for multiple Communication applications, ranging from kHz-bandwidth narrow-band signals to full-band LTE IF filtering applications, is available in various frequency ranges, supporting popular chipset designs.

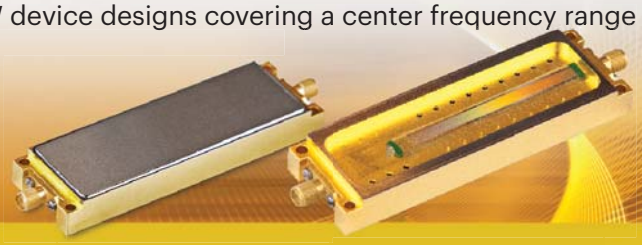
Please visit www.vectron.com for a comprehensive selection of our SAW solutions for Wireless and Telecommunications applications.

Military and Space Applications

- Surface-Mount, Through-Hole and Connector-Type Packages available
- Qualification according to MIL-STD-883 and / or pre-defined (e.g. ESCC 3502) or custom Space Qualification Plans
- Ruggedized SAW Modules with Internal Matching
- High-Reliability versions of standard designs available

The Military & Space family of Vectron SAW Products offers highest reliability levels for harsh and mission-critical environments. With each application having unique requirements, Vectron offers not only a wide range of packaging technologies for ruggedized applications, but also the full range of SAW device designs covering a center frequency range from 30 MHz to 2.7 GHz.

Additional to multi-layer ceramic and metal can assembly technologies, package designs with integrated matching circuitry in electrically and environmentally isolated cavities offer superior electrical performance in combination with outstanding environmental reliability.



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