Timewave Technology DSP-9+ and DSP-59+ Digital Signal Processors

Reviewed by Rus Healy, NJ2L
ARRL Technical Advisor

In the hot market for high-quality DSP audio filters, Timewave Technology is making its mark with two new models targeted at mainstream and more specialized amateurs. Both are significantly improved and upgraded versions of popular earlier models—the DSP-9 and DSP-59. Although both filters are designed around the same Analog Devices DSP hardware, the two offer significant differences in features and performance. Both feature high-quality construction with rugged cabinets and attractive, high-contrast Lexan front- and rear-panel labels.

How do they Differ?

The DSP-9+ is aimed at the operator who doesn't need elaborate adjustable filtering. This model offers a relatively limited—but very useful—selection of bandpass filters, as well as the specialized modes that have become staples of DSP audio filters: adaptive noise reduction and tone notching. The DSP-9+ also introduces AGC into the realm of external DSP filters.

Up the ladder of complexity is the DSP-59+, which caters to the needs of those who demand maximum flexibility. It offers considerably more bandwidth choices in SSB, CW and data modes than the DSP-9+, as well as selectable adaptive filtering aggressiveness.

With relatively few controls, the DSP-9+ is easy to learn and use; the DSP-59+ is significantly more involved. Both can drive a low-impedance speaker and stereo headphones.

The Bottom Line

These high-quality DSP audio processors are useful additions to your ham shack. The DSP-9+ serves SSB, CW and digital operators well with relatively straightforward operation. The more complex DSP-59+ supports the operator who's looking for finely tailored filter response with useful noise-reduction modes close at hand.

DSP-9+ Features

In addition to its adaptive random-noise filtering and tone notching capabilities, the DSP-9+ provides three selectable filter bandwidths in its voice and CW modes. For CW, bandwidths of 100, 200 and 500 Hz are available at center frequencies of 400, 500, 600 or 800 Hz (you select any two with an internal jumper). In voice modes, you have bandwidth choices of 1.8, 2.4 and 3.1 kHz or 1.6, 2.0 and 2.4 kHz. You select which three bandwidths you want via another internal jumper setting. In each case, the low-cutoff frequency of the voice

filters is 300 Hz. Performance-minded operators like DXers and contesters will get the most benefit from the narrower bandwidths, and more casual operators are most likely to be satisfied by the wider, default bandwidth choices.

Digital enthusiasts will be pleased to find filters for RTTY, AMTOR, PacTOR and HF packet. (The PacTOR filter is also useable for G-TOR.) The RTTY filter features a 250-Hz bandwidth. The bandwidth increases to 340 Hz for AMTOR, 440 Hz for PacTOR/G-TOR and 540 Hz for HF packet. Four center frequencies are available through an internal jumper; 2210 Hz (default) and 1360, 1700 and 2125 Hz. You can also order a European model with center frequencies of 2210, 1360, 1300 and 1530 Hz.

The DSP-9+ operates by means of seven push-button switches and one knob. The switches select bandwidth and adaptive-filter modes and combinations of modes. Each button is color coded by mode: blue for CW, green for voice and red for data. This makes a simple matter of selecting the filter mode you want at a particular time.

In the DSP-9+, Timewave included an automatic gain control feature. Its intended function is to keep signals at the desired output level under fading conditions, and it does a good job of that.

The DSP-9+ includes provisions for filter bypassing (for CW operation) or audio muting (for voice operation) during transmitting. An active-low input or a contact closure can be used to operate this function, depending on what your rig provides. This capability is particularly useful if you use a transceiver that supports monitoring transmit audio (or a CW sidetone) and you want to listen to that audio without manually bypassing the filter while you're transmitting.

By another jumper setting, the DSP-9+ can provide a high- or low-impedance load to your transceiver or receiver. Most modern radios operate best with the low-impedance termination (22 Ω), as opposed to the 2-kΩ option.

DSP-59+ Features

By giving you a staggering total of 225 possible high- and low-pass filter combinations as well as 330 bandpass filter combinations, Timewave has made the DSP-59+ one of the most flexible filters on the market. Depending on your needs, you can set the high-pass filter cutoff frequency in 15 increments between 200 Hz and 1.6 kHz, and the low-pass filter cutoff in 15 steps between 1.7 and 4.2 kHz. This version also supports a CW bandpass with 15 bandwidth choices between 25 Hz and 600 Hz. You can also select one of 13 CW center frequencies between 400 Hz and 1 kHz.

For data modes, you can select 15 bandwidths from 25 Hz to 600 Hz with a center frequency of 2210 Hz. You can also select optional center frequencies of 1300, 1360, 1530, 1700 or 2125 Hz. At a given time, some combination of these bandwidths and center frequencies is right for just about everyone.

The DSP-59+ has several operating modes, with different combinations of high- and low-pass filtering, noise reduction, tone removal and bandpass filtering. In each mode-switch position, the controls that select bandwidths, cutoff frequencies

Table 2
Timewave Technology DSP-9+ DSP filter, serial no. 62461

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Power requirements: 12-16 V dc, 1 A.	12 V at 410 mA (full audio output) and 160 mA with no input signal.
Input impedance: 22 Ω or 2 kΩ.	Not measured.
Input-to-output delay: Voice filters, 10 ms max; CW filters, 30 ms max; data filters, 18 ms max.	Voice filters, 9 ms max; CW filters, 30 ms max; data filters, 18 ms max.
Voice filter bandwidths: 300 Hz to 3.4, 2.7 and 2.1 kHz or (jumper selectable) 300 Hz to 2.7, 2.3 and 1.9 kHz.	At –6 dB points: Factory default medium, 246 to 2760 Hz; narrow, 246 Hz to 1960 Hz.
Voice filter shape factor: Not specified.	At –6 and –60 dB points: 2.4 kHz filter, 1.08; 1.6 kHz filter, 1.11.
Data filter bandwidth: RTTY, 250 Hz; AMTOR, 340 Hz; PacTOR, G-TOR, 440 Hz; HF packet, 540 Hz. Selectable mark/space frequency pairs.	At –6 dB points: RTTY, 350 Hz; AMTOR, 450 Hz; PacTOR, G-TOR, 530 Hz; HF packet, 640 Hz.
Data filter shape factor: Not specified.	At –6 and –60 dB points: RTTY, 1.49; AMTOR, 1.31; PacTOR, G-TOR, 1.3; HF packet, 1.23.
CW filter bandwidth: 100 Hz, 200 Hz and 500 Hz.	At –6 dB points: Wide, 538 Hz; narrow, 136 Hz.
CW filter shape factor: Not specified.	At –6 and –60 dB points: 500-Hz filter, 1.11; 100-Hz filter, 1.47.
CW filter center frequency: 400, 500, 600 or 800 Hz (select any two with internal jumpers).	As specified.
Random noise reduction: Up to 20 dB.	As specified.
Automatic notch filter depth: Up to 50 dB.	50 dB with a single 1-kHz tone.
Time to notch: Not specified.	Undesired signal is notched by approximately 50% after 4 ms.
Speaker output: At 13.8 V dc, less than1% distortion, 1.6 W into 8 Ω and 3.2 W into 4 Ω.	At 1% THD: 1.6 W into 8 Ω and 2.7 W into 4 Ω.
Line output: –6 dB referenced to input level into 10 kΩ.	As specified.
Size (height, width, depth): 1.75×6×6 inches; weight, 2 lb.	

and other key operating parameters use color-coded labels to help you find the right settings. This is a helpful way to label the panel, because if all the labels were the same color, this filter's many combinations of settings would make it really hard to operate!

Like the DSP-9+, the DSP-59+ provides switchable filter bypassing or audio muting during transmitting. An active-low input or a contact closure can be used to operate this function, depending on what your rig provides. By selecting the proper jumper setting, the DSP-59+ can provide a high- or low-impedance load to your transceiver or receiver.

The DSP-59+ includes a handy audio-signal generator mode, which has a variety of uses. The generator mode is selectable from the front panel. It produces sine wave test signals at the frequency of *each* bandpass, high-pass and low-pass filter. The test signals include single sine waves, two-tone signals for SSB testing and mark/space tones for TNC or communications processor testing.

Interfacing

Both filters require 12 to 16 V dc via a Timewave-provided coaxial connector. Any clean supply that can source at least 1 A is sufficient. Timewave doesn't recommend switching power supplies because they're sometimes inadequately filtered, but if you use a high-quality supply, this shouldn't cause any problem. I used the DSP-9+ and -59+ with two switching power supplies with no ill effects. Audio inputs and speaker outputs use rear-panel phono jacks, and both units provide 1/8-inch stereo headphone jacks. The audio amplifiers in these filters can drive 4- or 8-ohm speakers to room-filling levels. Both units provide line-level outputs for driving TNCs, terminal units or other external modems, as well as key-line interfaces to control audio muting or bypassing, as mentioned earlier. The DSP-9+ and the DSP-59+ are equipped with phono jacks for all audio connections on their respective rear panels.

Performance

Both filters provide the expected benefits of no-ringing, steep-skirted filters. Deep notch filtering is also a given, when that mode is selected. These filters act fast enough take out even relatively fast CW, which helps to quickly eliminate carriers during SSB operation with intermittent interference.

On CW, the DSP-9+ and -59+ work just as well in comparable situations (bandwidths and center frequencies). It's mainly the DSP-59+'s multitude of choices that set it apart from the DSP-9+. For almost all operation, however, I found three bandwidth choices to be enough, even with a rig that provides only one IF bandwidth on CW. Especially useful with both models is the ability to perform random-noise reduction in conjunction with bandpass filtering.

Random-noise filtering is something Timewave does well. These filters remove most line noise, which is traditionally hard to filter out. However, they also both impose a reverb-like quality during random-noise reduction—especially when the tone-removal filtering is enabled. This effect is best likened to listening to a speaker at the opposite end of a rather long hallway. Although it's fairly easy to mentally tune out, this effect gives desired signals an artificial quality. In its defense, however, I must

Table 3
Timewave Technology DSP-59+ DSP filter, serial no. 46426

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Power requirements: 12-16 V dc, 1 A.	12 V at 410 mA (full audio output) and 160 mA with no input signal.
Input impedance: 22 Ω or 2 kΩ.	Not measured.
Input-to-output delay: Voice filters, 10 ms max; CW filters, 30 ms max; data filters, 18 ms max.	Voice filters, 9 ms max; CW filters, 28 ms max; data filters, 16 ms max.
High-pass and low-pass filters: High-pass corner frequencies, 200 Hz to 1.6 kHz in 100-Hz steps. Low-pass corner frequencies, 1.7 to 3.4 kHz in 100-Hz steps.	Tested in HP/LP mode at recommended voice setting of 300 Hz to 2.7 kHz. At –6 dB points, 253 Hz to 2.76 kHz.
Data filter bandwidth: 25 to 600 Hz in 15 steps.	Tested 250, 450 and 550 Hz bandwidths. At –6 dB points: 331, 540 and 650 Hz.
Data filter center frequency: 2210 Hz, 1700 (default),1360, 1300, 1530 or 2125 Hz.	As specified.
Data filter shape factor: Not specified.	At –6 and –60 dB points: 250 Hz filter, 1.78; 450-Hz filter, 1.33; 550-Hz filter, 1.29.
CW filter bandwidth: 25 to 600 Hz in 15 steps.	Tested 250 and 500 Hz bandwidths. At –6 dB points: 288 and 538 Hz.
CW filter center frequency: 400 to 1000 Hz in 50-Hz steps.	As specified.
CW filter shape factor: Not specified.	250-Hz filter, 1.22; 500-Hz filter, 1.13.
Random noise reduction: Up to 20 dB.	As specified.
Automatic notch filter depth: Up to 50 dB.	50 dB with a single 1-kHz tone.
Time to notch: Not specified.	Undesired signal is notched by approximately 50% after 4 ms.
Speaker output: At 13.8 V dc, less than1% distortion, 1.6 W into 8 Ω and 3.2 W into 4 Ω.	At 1% THD: 1.6 W into 8 Ω and 2.7 W into 4 Ω.
Line output: –6dB referenced to input level into 10 kΩ.	As specified.
Size (height, width, depth): 1.9×7.6×8.5 inches; weight, 2 lb.	

say that the random-noise reduction, in conjunction with an appropriately chosen bandwidth, makes weak signals on noisy bands literally jump out of the noise. And I'll trade intelligibility for completely natural-sounding audio any time!

The DSP-59+ lets you choose the filter algorithm's *correlation* to optimize filter performance over a wide range of band conditions. Correlation is a signal characteristic that describes its spectral and time-changing content; a carrier is highly correlated, and noise is just the opposite. Voice signals are somewhere between these extremes. By moving an internal jumper, you can choose from among four correlation settings, which correspond to how aggressively the filter removes noise. Lower correlation settings remove less noise while preserving high audio quality. Higher settings treat more of the input audio as noise, which causes the filter's DSP algorithms to remove more undesired noise while having a somewhat more intrusive effect on the desired signal. In practice, I found that the noise-reduction mode works best with relatively low correlation settings (more aggressive noise reduction). You can't increase correlation so much that it makes desired signals unintelligible, so why not go for the best noise reduction you can get?

I particularly like the DSP-59+'s ability to select from 13 CW center frequencies between 400 and 1000 Hz. It's nice to be able to adjust this from the front panel, for the times when I use the filter with my high-offset (700 Hz) radio. The DSP-9+, on the other hand, gives enough flexibility for most single-radio users with its four center-frequency choices.

Although the inclusion of AGC in both filters isn't a substitute for good receiver AGC, it does keep fading SSB signals at a relatively constant level in your headphones. You barely notice it in regular operation, but it's a subtle help in hearing the weak ones.

The DSP-9+ and DSP-59+ both turned in excellent performances in the data modes. A Sunday afternoon spent on the jam-packed 20-meter digital subband proved their worth. Without resorting to narrow IF filtering, I was able to separate and copy signals with ease. The filter skirts are extremely sharp, so careful tuning and a stable transceiver are critical. If I tuned too rapidly, I'd sweep right through several signals without knowing it. The better approach is to do your initial hunting in the "wider" modes, then select narrower filters after you've located a signal.

I found that switching in the DSP-9+'s tone filter significantly increases the noise level in any of the filter's voice modes, especially when the input signal level is fairly weak and the band noise is high. With stronger signals, this isn't as noticeable. At first, I thought something was wrong with the review unit, but after using the filter for a while, I have to conclude that this is related to the filter's AGC attempting to raise the audio-output level, as receiver AGC does under weak- or no-signal conditions.

With no input signal, the DSP-9+ and DSP-59+ generate significant audio noise in high-quality stereo headphones. This is barely audible when the audio **GAIN** control is set for normal listening levels, but when you turn up the knob, significant high-frequency hiss and what sound like clock-related repetitive sounds, which change with the selected mode, are clearly audible. It seems that a high-quality audio filtering product should be free of any such behavior, but in fairness, it seems to have little effect on the DSP-9+ and -59+ operation.

Documentation

Photocopied and stapled instructions accompanied each filter. These manuals include concise instructions, complete specifications, and even schematics for all the parts of both filters that any ham is likely to ever need to repair. Although there are several tables, the documentation would benefit from the inclusion of more graphics. Of value to new users: Clear instructions showing how to wire the DSP-9+ input and output connectors, complete with Radio Shack part numbers. Like most US-based companies, Timewave offers telephone and fax technical support. Customer support can be an important factor in making a buying decision.

Conclusions

Timewave Technology has brought a couple of useful and high-quality products to today's increasingly crowded audio-processing arena. Both filters have a place in the ham market. The DSP-9+ should serve the majority of SSB, CW and digital operators well, and it does so with relatively straightforward operation and interfacing requirements. The DSP-59+, more complex on both fronts, does a solid job of supporting the operator who's looking for tailored filter response with useful noise-reduction modes close at hand.

Thanks for Steve Ford, WB8IMY, for his contributions to this review.

Manufacturer's suggested retail price: Prices: DSP-9+, $219; DSP-59+, $299. Manufacturer: Timewave Technology, Inc, 2401 Pilot Knob Rd, St Paul, MN 55120; tel 612-452-5939, fax 612-452-4571.

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