An Innovative License-Free Alternative To FRS/GMRS

The TriSquare TSX300 900-MHz FHSS Handheld Transceiver Is Positioned To Dominate The Consumer Two-Way Radio Market

by Bernard Bates

PopComm’s November 2007 cover story, “Digital Two-Way Radio Technology Reaches Consumer Market” covered the emerging trend of new 900-MHz FHSS (Frequency-Hopping Spread-Spectrum) radios becoming a serious license-free alternative to FRS/GMRS radios. Picking up where that article left off, this article will review one such radio, the TriSquare TSX300.

This new handheld transceiver sets a new price/performance standard, using innovative digital technologies to offer many features we’re accustomed to seeing only in PCS/cellular handsets. It’s about time two-way radio users and hobbyists started benefiting from these exciting new personal communications technologies.

FRS/GMRS Problems Create Opportunity

Back in 1999, TriSquare was a major OEM manufacturer of FRS/GMRS radios for several companies marketing under various well-known brand names. As the popularity of FRS/GMRS radios skyrocketed over the next five years, the market approached saturation and profit margins dropped to unsustainable low levels. And, not surprisingly, the widespread use of 50 to 80 million FRS/GMRS radios created severe congestion on the 22 FRS/GMRS channels at crowded events, metropolitan areas, and elsewhere. Tens of millions of users, including many large and small businesses, blatantly violated FCC regulations by using GMRS channels without obtaining the required $75 license, or by using FRS channels for business purposes.

At the same time, many FRS/GMRS radio users became increasingly aware of the glaring feature disparity between their simple two-way radios and their feature-rich cell phones (which offered private and interference-free voice communications, text-messaging, caller ID, call waiting, contacts lists, hands-free operation, ringtones, vibrating alerts, etc.).

Engineering A Solution

In 2004 TriSquare started engineering a solution. Its years of experience designing DSP (Digital Signal Processing) and SDR (Software-Defined Radio) technologies into consumer two-way radios, and the falling cost of digital components needed to implement these technologies, convinced the company that it was feasible to build feature-rich FHSS two-way radios for the consumer market to supplant FRS/GMRS. DSP and SDR technologies allow advanced features and functions to be designed and implemented in software, and then duplicated in firmware, at far lower cost than using many dedicated electronic components.

Fortunately, the FCC had issued its Part 15.247 regulations, which authorize unlicensed 1-watt FHSS voice and limited data transmissions in the 902–928 MHz ISM (Industrial, Scientific, and Medical) band if certain challenging technical requirements are met.

Was a practical solution buried in these obscure FCC regulations? Since FHSS can effectively create a nearly unlimited number of “virtual” radio channels (by using many different hopping sequences) it could solve the severe channel overcrowding and privacy problems vexing tens of millions of FRS/GMRS radio users. Because ISM spectrum is unlicensed, FCC licensing requirements wouldn’t be an issue.

eXtreme Radio Service Is Born

Armed with its two-way radio engineering expertise and these new FCC regulations, TriSquare filed 33 U.S. patent claims and bowed out of the FRS/GMRS OEM market in 2005 to focus on what it saw as a huge market opportunity for low-cost, license-free, short-range two-way voice and text-messaging products that...
are practically immune to channel over-crowding and interference.

TriSquare trademarked the names “eXtreme Radio Service” and “eXRS” for its new technology and made plans to overtake the stagnating FRS/GMRS radio market in just two to three years with a line of portable FHSS transceivers—starting with its flagship TSX300 (Photo A) and its entry-level TSX100 (which has a very limited feature set but is about one-third the price). TriSquare also laid plans to establish eXRS as a de facto standard for licensing to other companies.

These are ambitious goals, but TriSquare is gambling that its patent-pending eXRS technology—and the many new features it makes possible—will be a big hit with a general public accustomed to cell phone features and ergonomics, and who desire a private two-way radio solution with similar features.

### Complete Package

*Pop’Comm* asked TriSquare to send me an early production TSX300-2VP “Value Pack” for review (see Photos B and C), which is a retail peg-display package containing two TSX300 radio transceivers, two PTT/VOX headsets, two NiMH battery packs, two swivel belt clips, a dual desktop drop-in charging bay with AC adapter, and one illustrated user’s manual.

After installing the two 4.8V, 750mAH NiMH battery packs and dropping the radios into the dual desktop trickle charger for the night, I noted it had built-in protection against overcharging and short-circuiting batteries. The charger takes about 12 hours to fully replenish battery packs that are fully discharged. The next morning (about 11 hours later) the radio’s LCD battery gauge indicated they were fully charged.

A nice feature is the option to use three standard AA alkaline cells instead of the included NiMH pack, so in an emergency you’re never at the mercy of the slow trickle charger. Additional NiMH battery packs are sold separately, in case you want to keep a spare set charging and ready for action at all times. The plastic battery cover fit loosely, but TriSquare informed me this was an early production problem that has since been fixed. Rated NiMH battery life is 15 hours based on a 5/5/90 duty cycle (5% transmit, 5% receive, 90% standby), while standard AA alkaline cells should provide about 45 hours of 5/5/90 use. My test results were consistent with those ratings.

### Physical Features And User Interface

The TSX300’s appearance and user interface blurs the distinctions between two-way radios and cell phone handsets (see Figure 1). It not only looks a lot like some cell phones, it also shares many of their features. The housing is rugged ABS/PC plastic and slightly larger than a second-generation non-flip PCS/cellular handset. Its sides curve slightly inward and are ribbed to fit comfortably in your hand, so you can operate the full keypad one-handed with your thumb.

For day/night readability the 16-button keypad has silver-painted translucent silicone keys, which are laser-etched with numerals and all letters of the alphabet. An Up/Down button and two Left/Right “Softkeys” allow selection of dynamically displayed functions and menu options—similar to how many cell phone menus work. Above the keypad is the large backlit bitmapped LCD that displays up to seven lines of text and icons, depending on the screen and function being viewed.

Other TSX300 cell phone-like features include SMS-like text messaging with message-waiting indicator, ring-
For a complete list of (COMSEC) is a concern, such a publicly
ber. But if communications security
”because it
whether someone is on the radio, you can
nmual number generator algorithm selects
To paraphrase an
navigating through the fairly intuitive
s little confusing at first, but after reading
My Radio
are not the same as the
communications is not uncommon.
nailing between groups of people and
Channels, or Contacts, are used for com-
that channel, regardless of what
The TriSquare TSX300 is a hybrid
digital/analog two-way radio designed to
make the best and most economical use of
both technologies. Its proprietary
eXRS FHSS scheme uses 700 frequen-
cies spaced 2.5 kHz apart between
906.275 and 923.750 MHz. Heavy con-
centrations of cordless telephone traffic
around the top and bottom of the license-
free 902–928 MHz ISM band led
TriSquare engineers to avoid interference
on those frequencies, as well as with the
most commonly used portions of the 33-
cm amateur radio band, which is allocat-
ed on a shared/secondary basis (many of
TriSquare’s engineers are hams).
Depending on which 10-digit channel
code is chosen, an embedded pseudoran-
dom number generator algorithm selects
a different set of 50 frequencies to hop
and cycle through every 20 seconds. Each
400-millisecond hop frame contains both
voice and data.
Since each radio “knows” (based on the
channel selection) what the hopping fre-
quencies are as well as their order, the
receiving radio(s) need only know when
to start hopping to remain synchronized.
The receiver starts hopping when the pre-
amble signal is received, and stops hop-
ing 20 seconds after no signal is received.
The transmitter’s microphone audio is dig-
itized, modified by a DSP algorithm to
extract only the most useful information,
summed with a digital timing and position
signal, and time-compressed to allow
proper hop framing and provisioning of
the control data (caller ID, private call,
etc.) within each frame. The receiver’s
DSP extracts the modified audio, performs
digital noise reduction, and expands it
back to the original voice signal timing
(slightly delayed after processing).

This scheme is less DSP-intensive
than full-fledged vocoders, such as
VSELP (Vector Sum Excited Linear
Predictive) used by Motorola’s DTR
series of two-way 902–928 MHz FHSS
radios (see “The Motorola DTR410

Figure 2. TriSquare TSX300 features and specifications.
Frequency-Hopping Radio,” December 2007, Pop’Comm). As a result, the TSX300’s audio reproduction sounds less synthetic and isn’t severely distorted by non-speech background sounds. It’s also near real-time audio, so there’s no annoying delay caused by vocoder latency.

Audio Quality

TSX300 audio is quite intelligible but sounds slightly “fuzzy,” like low bitrate compressed audio. Speech sounds relatively natural compared to the synthetic speech sound of some vocoders and has ample volume except in very noisy environments (where the included PTT/VOX headset can be used.) Hands-free (VOX) has three sensitivity settings and works in either speakerphone or headset mode, although the most sensitive isn’t very. The included PTT/VOX headset fits comfortably around your earlobe and into your ear canal and has an inline PTT/VOX mode switch and momentary PTT button. By de facto design convention, the TSX300 works with many third-party audio accessories, such as XLT Communications’ line of single 2.5-mm plug speaker mics, earbud mics, and throat mics designed for Motorola and Cobra FRS/GMRS radios.

Channel Overcrowding Solved?

FRS channel overcrowding and mass unlicensed use of GMRS channels has frustrated many FRS/GMRS radio users over the years, but TriSquare’s eXRS technology could alleviate that. According to TriSquare, and the Kansas State University engineering study it commissioned, more than 100,000 eXRS users within talk range can enjoy uninterrupted communications in the 902–928 MHz ISM band. By comparison, several dozen FRS/GMRS users within the same talk range could render their bands unusable. Channel overcrowding, as we know it, could become a thing of the past.

Operational Range

There are many variables that determine the effective range of two-way radios, but TriSquare took the high road by refusing to make any specific distance claims—unlike so many FRS/GMRS vendors that make outlandish claims like “range up to 25 miles and more!” Instead, TriSquare guarantees its eXRS radios will “meet or exceed the range performance of other UHF HTs.” Testing confirmed this claim, with range comparable to a pair of 2-watt 70-cm amateur radio Handie-Talkies in simplex mode. Outdoors over flat terrain the TSX300’s effective range was about one and a half miles, and over three miles from hill to hill. These radios performed particularly well inside tall office buildings. From the 55th floor of Philadelphia’s Liberty Place tower, usable voice and text communications with another TSX300 in the lobby was achieved. Whether the 900-MHz signals bounced around inside the structure or outside and back in is unknown, but neither a pair of FRS/GMRS radios nor the aforementioned pair of 70-cm amateur HTs could accomplish this. Perhaps the TSX300’s 33-cm band wavelength, which is much shorter than the lower frequencies used by those other two-way radios, passes more easily through a tall building’s metal framework and window frames. Obviously, the TSX300 would be an excellent business radio in a multi-floor office building where other two-way radios can’t cut it and where COMSEC is a concern.
On the road between automobiles, the TSX300’s range was reduced to less than a mile, probably due to signal attenuation by vehicles’ steel bodies and other obstructions.

Text Messaging

Upper-case text messages of up to 80 characters can be sent between TSX300 radios. Four custom text messages can be stored for repeat sending, plus there are six permanent “canned” text messages to choose from (YES, NO, OK, WHERE ARE YOU?, CAN YOU TALK? CAN’T TALK RIGHT NOW). A triple-beep and/or vibrate alert tells you when a text message is received, and a message-waiting envelope icon is displayed until the message is read. Text messages are sent “in the blind”; there’s no error-correction or handshaking to acknowledge a message was received accurately or at all. Half-duplex synchronous data transmission makes this impossible in real time, but it would be nice if the TSX300 could automatically transmit an ACKnowledgement signal to the sender after receiving a text message. If the radios are within range, text-message delivery shouldn’t be a problem. Oddly, the character set’s punctuation is limited, offering just !?, @#$&().

Cloning

The settings of one TSX300 can be wirelessly cloned to another TSX300 held next to it. Selected Contacts, the full Contacts list, or the entire radio configuration can be cloned. This feature can save lots of time and aggravation for a group of users or a business needing to program several radios for interoperability. Plus, there’s no cloning cable to buy or lose. Neat!

NOAA Weather Receiver

The built-in NOAA weather receiver works, but is not very sensitive. It receives strong local stations fine, but not weaker distant NOAA stations that most scanners and dedicated weather radios can pull in. The 900-MHz antenna probably has lots to do with this. Still, it’s a nice extra feature in strong signal areas, but I wouldn’t trust my life with it hiking or camping in the remote wilderness far from any NOAA stations.

Documentation

As with any feature-rich digital consumer electronics product, reading the manual is worthwhile. The most basic two-way radio features are intuitive enough to use right away. The 35-page owner’s manual is well written and walks the user through the TSX300’s many features with illustrated step-by-step instructions, but the small booklet isn’t much bigger than the radio itself so its small print may be hard for some people to read. Fortunately, it can be downloaded in PDF format from TriSquare’s website and enlarged as necessary. It’s interesting reading if you’re simply curious about the coming trend of FHSS two-way radio for the masses.

What I Liked

There’s a lot to like in the TSX300 (see Figure 2), and its many features make it an exceptional price/performance value. It’s clear that much thought went into the design of this radio and its accessories. Following are some features I particularly liked:

• Exceptional communications privacy
• No interference from other users
• Advanced technology made easy
• All accessories included
• Geek/coolness appeal
• Good ergonomics
• No license required
• Non-volatile memory
• NiMH or alkaline batteries

What I Disliked

The more features any product has, the more likely there’ll be some nitpicking, so here’s mine:

• Ringtones cannot be assigned to specific callers, and the five ringtones are similar-sounding and unimaginative.
• NOAA weather receiver is insensitive and cannot receive weaker distant stations.
• Text-messaging character set is missing several commonly used punctuation characters like the semicolon, colon, quotation marks.
Two-Way Radio Privacy For The Paranoid

There are lots of reasons people might want private two-way radio communications, including for personal or family matters, proprietary business operations, secret hunting and fishing spots, outdoor action/strategy games, political/social direct actions, etc. With CB/MURS/FRS/GMRS radios, all of that is easily and likely to be overheard on a handful of public channels. Worse, your kids could be subjected to unsavory messages by strangers, or even lured by criminals monitoring those channels. Granted, this is not a widely documented problem, but why risk it if you don’t have to?

Until very recently, “privacy” and “consumer two-way radios” were contradictory terms. Now there’s a paradigm shift that people will have to get used to. For instance, with 10 billion eXRS channels you won’t be able to find and make new friends like you can by randomly overhearing people on CB/MURS/FRS/GMRS channels, or be able to scan and listen to what they’re saying and doing. COMSEC can be a double-edged sword.

Arguably, TriSquare’s eXRS technology might offer the general public more short-range COMSEC than landline or cellular/PCS network phone calls, which can now be remotely and instantly monitored by many people at local, state, and federal government agencies thanks to CALEA (Communications Assistance for Law Enforcement Act) and the Patriot Act. Not that most of us worry about that sort of thing, but being “off the network” can offer peace of mind to the paranoid among us.

If it’s privacy you want, you may feel reassured knowing how unlikely it is that another eXRS radio user could monitor your communications without knowing your radios’ 10-digit channel codes. An eXRS channel code is somewhat like a simple encryption key with 10 billion (10^9) permutations—far more than any other eXRS radio user could try manually in a lifetime. Neither scanners nor other manufacturers’ two-way radios can receive eXRS’ FHSS radio signals—further reducing the likelihood of interception. The characteristic of FHSS that rapidly slices and scatters a signal to appear as noise across a wide swath of radio spectrum makes it inherently difficult to track and demodulate.

Still, if you’re really paranoid, you should know that a well-equipped and determined eavesdropper could use a highly specialized surveillance receiver like the WJ-8654 Microceptor to track and demodulate eXRS’ FHSS radio signals. More affordable fast-sweeping receivers like those from Optoelectronics aren’t quite fast enough to track and demodulate a 400-msec FHSS signal. But if you’re worried about that, you probably won’t be using inexpensive consumer two-way radios anyway.

It’s safe to say the TriSquare TSX300 offers unprecedented two-way radio communications privacy to consumers, who can feel safe from eavesdropping by all but the most determined and well-funded spooks.