

# TINY CONNECTORS SQUEEZE INTO HANDHELD WIRELESS DEVICES

BILL TRAVIS, SENIOR TECHNICAL EDITOR

CONNECTORS IN  
HANDHELD WIRELESS  
SYSTEMS MUST  
JUGGLE THE DEMANDS  
OF LOW COST,  
LIMITED SPACE, AND  
RIGOROUS TECHNICAL  
SPECS AT GIGAHERTZ  
FREQUENCIES.

Handheld wireless devices, such as cellular phones and pagers, pose a unique set of challenges to interconnect-product manufacturers. The adjective trio "smaller, faster, cheaper" takes on special significance in applications for handheld wireless devices. Tiny connectors in these portable systems must handle such diverse tasks as board-to-board (rigid-to-rigid, flex-to-flex, flex-to-rigid) interconnect, RF transmission, and mixed analog/digital transmission. Many new interconnect products meet the challenge.

However, there's really nothing new under the sun in RF technology, according to Ed Sayre, president of Northeast Systems Associates, an interconnect-technology consulting company. He maintains that transmission-line theory, developed largely at the Massachusetts Institute of Technology's (Cambridge, MA) Radiation Labs a couple of generations ago, remains valid for the wireless devices. Only the dimensions have changed. The principal challenge, Sayre says, lies in the high circuit density the handheld devices require. The challenge is

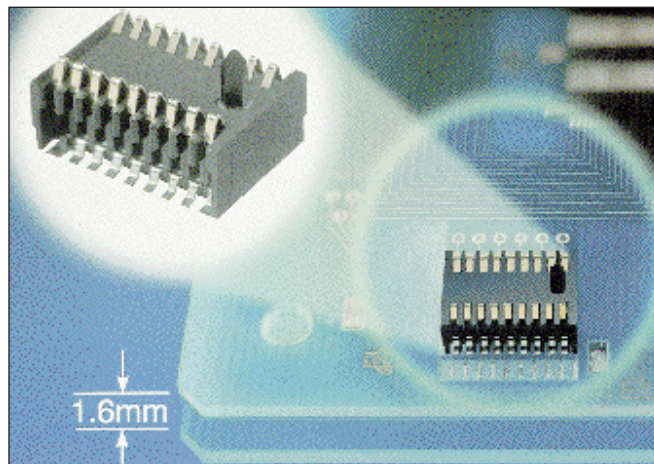
## @ a glance

- Cramped quarters and ultrahigh frequencies in wireless systems make special demands on RF connectors.
- Carefully consider the shielding requirements in your design; for inter-circuit connections, using miniature coax is often better than using microstrip pc-board patterns.
- In specifying custom interconnects, you can often use manufacturers' catalog parts as a starting point.

to develop tiny interconnect systems that provide economy of scale through automated assembly processes.

Even such seemingly mundane products as coaxial cables have had to adapt to meet the rigorous demands of wireless devices. Much of the RF transmission in the systems uses pc-board microstrip tracks, but in many cases, the shielding benefits of coax are required. In cramped spaces, the dimensions and rigidity of traditional coax cable are intolerable. For example, venerable RG-58 cable has a 0.195-in. outside diameter, much too large to squeeze into a pager, for example.

Cable manufacturers such as M/A-Com, a division of Amp, and Precision Tube Co have developed new families of coax cable with minuscule dimensions. **Table 1** gives salient features of a few types of miniature coax cable, using RG-58 as a basis



**A stacking connector from Elco provides parallel board stacking with separations as low as 1.6 mm.**

## WIRELESS-SYSTEM INTERCONNECT

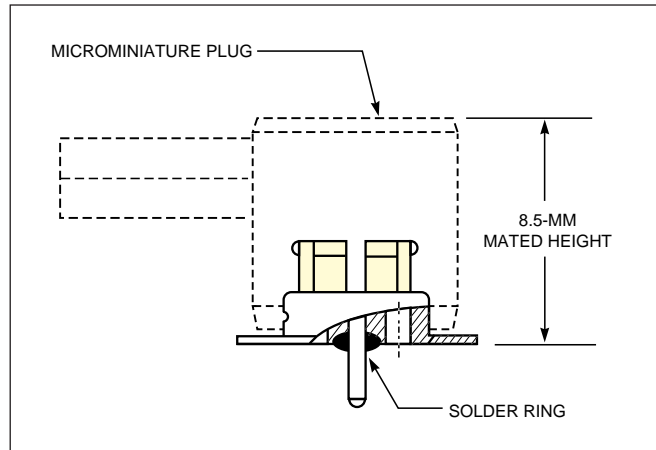
of comparison. Table 1 shows only the smallest coax sizes available from the two manufacturers. Both vendors also produce a range of intermediate-sized and larger cable.

M/A-Com, for example, offers 20 types of 50 and 75 $\Omega$  cables with outer diameters ranging from 0.052 to 0.425 in. (RG-214). Precision Tube's cables range from 0.02 to 0.25 in. in diameter. The characteristic impedance of a cable is a function of the ratio of the diameters of the inner and outer conductors, as well as the dielectric constant of the insulating medium. Precision Tube's cables are available with impedances of 10 to 93 $\Omega$ .

An important parameter in applications for handheld wireless devices is the minimum bend radius. The 1-in. radius of RG-58, for example, is clearly a severe constraint in cramped quarters. The smaller cables address the limited-space issue by offering minimum bend radii as small as 0.0625 in. The choice of dielectric material largely determines the temperature rating of the cable. For M/A-Com's cables, PE (solid-polyethylene) dielectric is suitable for cables operating at temperatures as high as 85°C; FEP (fluorinated

ethylene propylene), at temperatures as high as 105°C; PTFE (polytetrafluoroethylene), at temperatures as high as 250°C.

Smallness, naturally, comes with a compromise: higher resistance; hence, increased attenuation. RG-58, for example, has a 28-dB loss per 100 ft; M/A-Com's largest cable (RG-214) has a 12-dB loss. The tiny cables incur losses as high as 85.3 dB per 100 ft. However, in handheld devices using only a few inches of cable, the loss is relatively inconsequential. In addition to offering a range of sizes and impedances, Precision Tube also has an extensive selection of conductor materials. The



**Surface-mount, low-profile coax receptacles from Molex come in impedances of 50 or 75 $\Omega$ .**

choices allow designers to select a cable with any desired degree of rigidity and springiness or to choose ferrous vs nonferrous conductors for their magnetic characteristics. The choices are:

- silvered aluminum tube,
- silvered beryllium-copper wire,
- silvered copper wire,
- silvered copper tube,
- silvered copper-covered steel wire,
- silvered stranded copper wire,
- stranded silvered copper wire,
- stranded silvered copper-covered steel wire, and
- tinned copper wire.

### Connecting the coax

Miniature coaxial cable offers space-saving benefits in small systems, but large, bulky connectors would nullify a large part of the benefits. Some recent coax-interconnect products accommodate the cramped quarters in applications for handheld wireless devices and provide low-loss cable-to-board interconnect. The E FL connector system from Hirose Electric, for example, has a mated height of only 3 mm from the pc board; its footprint area is only 9.4 mm<sup>2</sup>

on the receptacle side. The E FL specs VSWR of 1.3 or less from dc to 2 GHz and costs \$1.94 per mated pair (100). The surface-mount receptacles come in tape-and-reel format for automated assembly.

A range of subminiature RF connectors is available from Molex Inc. For example, a 73100 Series pc-board receptacle mates with the company's low-profile plugs (Figure 1). The system is rated at 100 mating cycles and specs VSWR of 1.2 or less from dc to 2 GHz. The receptacles come in tape-and-reel format for automated assembly. The system in

**TABLE 1—50 $\Omega$  COAXIAL CABLE**

Type	RG-58	M/A-Com Omni-Flex 100	M/A-Com Omni-Flex 200	Precision Tube CA50020	Precision Tube CA50034
Outer diameter (in.)	0.195	0.075	0.052	0.02	0.034
Minimum bend radius (in.)	1	0.375	0.375	0.0625	0.125
Inner-conductor diameter (in.)	0.035	0.01	0.01	0.0044	0.0079
Dielectric material	PE	FEP	PTFE	PTFE	PTFE
Power rating at 1 GHz (W)	53	20	20	2.9	7.3
Attenuation/100 ft at 1 GHz (dB)	28	60	60	85.3	49.9

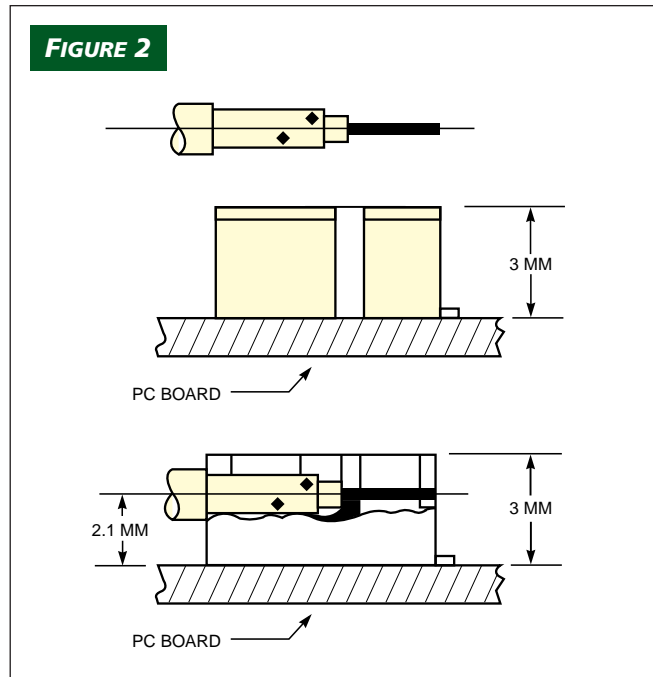
**Notes:**

PE=solid polyethylene.  
FEP=fluorinated ethylene propylene.  
PTFE=polytetrafluoroethylene.

## WIRELESS-SYSTEM INTERCONNECT

Figure 1 has 75 $\Omega$  characteristic impedance; 50 $\Omega$  versions are available with reduced mating height. The snap-on plug accommodates RG-179 cable with a 0.11-in. outside diameter.

M/A-Com, too, produces a variety of subminiature RF connectors. The SMA com Series, for example, uses the company's White Bronze plating system that contains no ferrous materials. The company maintains that the nonmagnetic plating provides improved intermodulation characteristics in telecommunications applications. Another interconnect system from M/A-Com provides solderless cable terminations (Figure 2). The SMT/QuickGrip system provides a low-cost means for directly terminating coax to pc boards. Figure 3 shows



**A solderless coax-interconnect system from M/A-Com uses a self-aligning hand tool for inserting the company's miniature coax cables.**

the VSWR-vs-frequency characteristic of the system. A self-aligning hand tool inserts the company's Omni-Flex 100 or 200 cables into the receptacle, which accommodates multiple insertions, allowing easy cable replacement for repairs.

A series of RF connectors from Amphenol targets the international wireless market by complying with the MMCX (miniature micro coax) interface, as specified in the European CECC22000 specification. The Micro-Mate Series of 50 $\Omega$ , low-profile connectors operates from dc to 6 GHz and comes in single-pack, bulk-pack (100 per bag), and tape-and-reel formats. Amphenol and Siemens also address the GSM (Global System for Mobile communications)

## FOR MORE INFORMATION...

For more information on the interconnect systems discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

### Amp Inc

Harrisburg, PA  
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### Keystone Electronics Corp

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### Northeast Systems Associates

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## WIRELESS-SYSTEM INTERCONNECT

cellular-phone industry with a variety of small interconnect products. Surface-mount connectors from both companies accommodate SIM (single-inline-module) cards that encrypt conversations, store numbers and messages, and identify users for billing purposes.

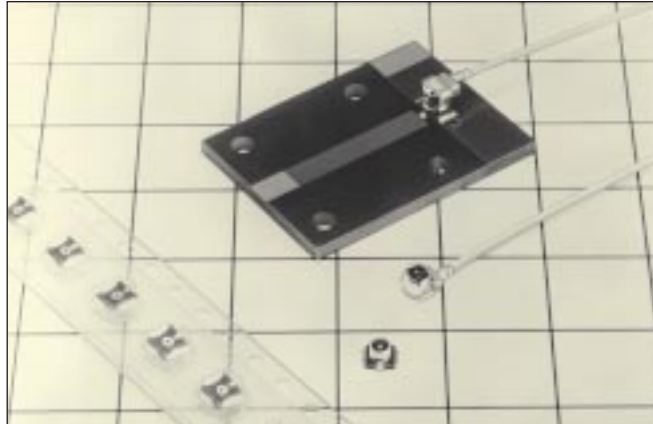
### Connecting the boards

Board connections also present tough challenges in wireless applications. The dimensions of pagers and cellular phones don't leave much height or lateral area

for interconnecting boards. A recently announced one-piece board-to-board interconnect system from Elco, an AVX Corp division, allows board-to-board spacing as tight as 1.6 mm. The 9158 Series provides dual-row contacts with 1-mm pitch and four to 40 positions. The connectors spec 100-M $\Omega$  insulation resistance and 25-m $\Omega$  contact resistance. They use gold-plated beryllium-copper contacts with tin-lead solder tails. Available in tape-and-reel format, the 9158 connectors cost \$0.04 (100,000) per contact.

Handheld wireless systems make extensive use of flex circuitry. Elco's 6239 Series of ZIF flex-circuit connectors specs a height of just 1.5 mm above the pc board. The connector has a "flip-top" design that allows opening and closing in one simple operation. The 6239 Series is available with as many as 30 contacts; the 6240 Series offers as many as 50 contacts with a slight compromise in height (2 mm). The 0.5-mm-pitch 6239 and 6240 connectors come in tape-and-reel format and cost \$0.04 (10,000) per contact.

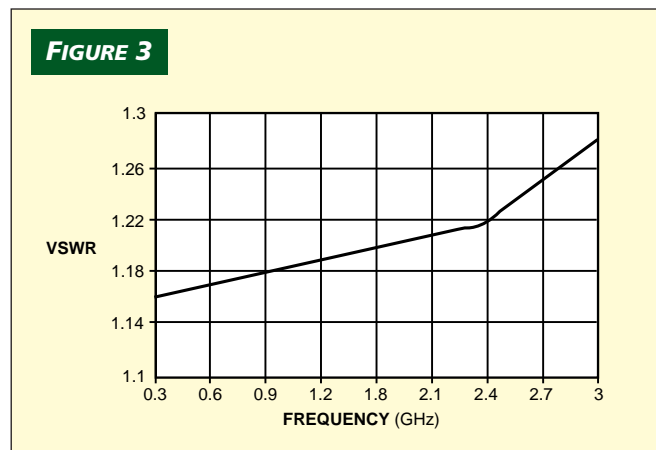
Another flex-circuit interconnect system from Thomas & Betts, which the company claims is the smallest available, is a 68-position system that measures 19.5 $\times$ 5 mm with a 2.45-mm profile. The FF-1 Series has dual-row contacts with 0.5-



**A microminiature coax connector from Hirose Electric has a mated height of only 3 mm, with a 9.4-mm<sup>2</sup> footprint.**

mm pitch. The flex circuit uses a matching dual row of contacts and attaches to a stainless-steel cover plate. Upon being secured to the connector body, the plate brings the flex-circuit contacts firmly into position with the connector contacts. The contacts are gold-plated phosphor-bronze, with 50-m $\Omega$  maximum contact resistance. A 68-position FF-1 connector costs \$2.04 (1500).

A "zero-profile" header system from Samtec offers 0.41-mm-sq post headers on a 1.27-mm pitch. The headers come with an insulator carrier that you can discard after soldering the pins. When mated with Samtec's CLP Series sockets, the header system presents a 2.21-mm profile. The dual-row headers are available with as many as 50 pins per row in three lead styles and two plating options.



**The solderless coax-interconnect system in Figure 2 provides VSWR lower than 1.2 from dc to 2 GHz.**

These products are all standard, off-the-shelf units. Much of the connector business for applications for handheld wireless devices, however, consists of custom developments. Amp, for example, offers a staggering array of RF-transmission and board-interconnect products for handheld wireless systems. Most of the company's catalog products serve as starting points for customization. One example is a one-piece compressive stacking interconnect system, which you use in place

of a two-piece connector for board stacking. The compressive side of the connector mates with pads on the stacked pc board.

One off-the-shelf family of products from Amp provides board-to-board and cable-to-board interconnect, using receptacles and headers. The LPS Series provides contact on either 1.27- or 2-mm centers and encompasses footprints of two to 40 positions. The system uses drawn, seamless, four-point, heat-treated beryllium-copper contacts that provide 10-m $\Omega$  maximum initial contact resistance. The receptacles offer profiles of 1 to 2.4 mm, depending on the housing style.

### Connecting CompactFlash

Many handheld systems, including some cellular phones, use matchbook-sized CompactFlash cartridges for mass storage. A recently announced low-profile 50-position header from 3M Electronic Products Division is smaller than the industry-standard 68-position PC Card header. The header, mated to the socket in the CompactFlash card, meets all performance requirements of the PC Card standard, including providing 10,000 mating cycles. An optional add-on ejector offers simple pushbutton removal of the CompactFlash card from the header. You can add the ejector to

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**Subminiature coaxial cable from Precision Tube offers virtually infinite variations in impedance, dimensions, and materials.**

the header after board assembly. The header costs \$3.90; the ejector, \$1.99 (1000).

In discussing any product category, a natural tendency is to cover the glamorous “high-tech” products and neglect the nuts-and-bolts parts that are perhaps unexciting but essential to any system. An example is the array of small interconnect products—lugs, posts, clips, spacers, battery holders, and (literally) nuts and bolts—that hold together a handheld wireless system. Two prominent producers of these small stamped or screw-machine parts are Beau Interconnect and Keystone Electronics Corp.

To sum up, the advent of handheld wireless systems has spurred interconnect-product manufacturers to invest significant development efforts in miniaturization, RF performance, contact reliability, and low-cost assembly techniques. Some unique and innovative interconnect systems allow wireless-system vendors to produce high-performance devices you can carry in your pocket.



You can reach Senior Technical Editor Bill Travis at 1-617-558-4471, fax 1-617-558-4470, e-mail [b.travis@cahners.com](mailto:b.travis@cahners.com).

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