

**Key Issues & Features:**

- Trust: The Oil of the Deal Process
- A Generation Starving for Meaning
- The Power of Women in the Wire Harness Industry
- 20 Years of Manufacturing Quality Solutions for Your Wiring Needs
- Paperless Manufacturing Solutions for ECOs in Wire Harness Manufacturing
- Electrical Wire Processing Technology Expo: Meet the Future Feeling Empowered
- The Evolution & Status of Standards for Aerospace Wiring Systems and Components...



**Z**-Tronix Inc. is proud to announce its twentieth year of excellence as California's fastest growing wire harness manufacturer. In an era where many old manufacturers outsource operations, Z-Tronix has achieved two decades of successfully manufacturing quality American made products. The company will commemorate the occasion with a "20 Years of Excellence Celebration" as a tribute to its employees for their dedication, customers for their loyalty

In 2009, second generation owners, Kamran and Amir Jahangard further transitioned and energized the company to include synergistic services that add value for its customers. This empowered Z-Tronix to manufacture custom solutions for customers' wiring needs while adding to its world class service capabilities.

**By Dave Kelly**  
**Daniels Manufacturing Corp**  
**Orlando, Florida USA**  
(In Cooperation with SAE  
International, NAVAIR, JSWAG,  
DLA Land & Maritime, and Participating  
Aerospace OEMs & Suppliers)

- OEMs and Integrators of MIL/AERO systems who purchase wire harnesses.

Continued on page 24



As Z-Tronix's customers grow they benefit by working with a company

that is both a distributor and manufacturer. Through higher product knowledge, Z-Tronix offers cost saving solutions for their customers' wiring needs. Real-time information keeps the supply chain ahead of any possible delays involved with obsolete parts. With over 20 years of industry experience, Z-Tronix helps customers maintain low costs while improving production and prototype builds. They are a tech-

*Continued on page 8*

The show's dynamic format provides endless educational and networking opportunities. This year's show is bigger than ever. With nearly 20 additional exhibitors, the show has grown by 15 percent. Industry-specific seminars, sponsored by Wire & Cable Technology International, are free with the price of admission and will cover various helpful topics including:

- **VW-1 High Temperature Wire for Appliance Applications**
- **Manufacturing Execution Systems: Your Competitive Advantage!**
- **How Do You Inspect Your Crimps?**
- **Using the Industrial Internet of Things (IIoT) to Improve Plant Floor Equipment & Productivity**
- **Theory and Best Practices for Automating Wire Twisting and Taping**
- **Advanced Crimp Theory for Small Wire Applications**

Other educational opportunities include two free clinic courses on wire processing presented by Schleuniger, Inc.

1. Ideal for the beginner to intermediate-level wire processing professional, Wire Processing Basics will address important wire processing terms, differences in wire types and

*Continued on page 17*

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US POSTAGE  
PAID  
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THE WIDEST  
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OF WIRE  
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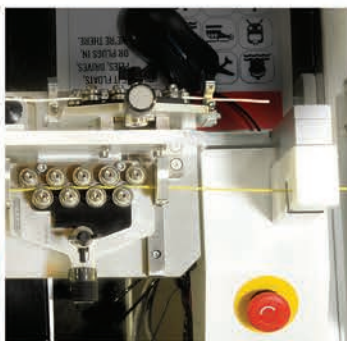
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March/April 2017

1 The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Dave Kelly is one of the foremost authorities on aerospace wiring standards. This road map is a must-read for those in or considering wire processing in the Military & Aerospace realm.

1 Electrical Wire Processing Expo: Meet the Future Feeling Empowered

Take a look at what's new in the world's premier wire processing event.

10 News Plugs

Read about the latest products on the market and points of interest about companies and people in the industry. Also a special look at Atkins & Pearce and their astounding 200 years in business.

13 The Power Women of the Wire Harness Industry

The is the first in a new series by Melissa Famia. Melissa will highlight women in the wire harness industry and kicks things off discussing her own experience.

18 Trust: The Oil of the Deal

Trust is a mandatory component of any deal. Loren Smith discusses harnessing your internal database, or "gut-check" when evaluating a deal?

21 A Generation Starving for Meaning

Unlike preceding generations, new workers are starved for meaning in the things they do. Paul Hoggendorn discusses the role of managers in this important task.

32 Wire Wisdom

Anixter provides a crash course in the specification of Photovoltaic Wire.

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*Wiring Harness News*  
PO Box 669  
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**Office Hours:**  
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NEWS PLUGS



TECH-SONIC Releases World's First Ultrasonic Wire Splicer

The new line of TECH-SONIC Servo Controlled Ultrasonic Metal Welding equipment combines the precision of servo control with the proven strength of ultrasonic welding to produce the most significant advance in ultrasonic welding technology in the last 20 years. Ultrasonic metal welding technology uses a welding horn to direct high frequency ultrasonic vibratory energy to the material surfaces between the metals being welded. The vibratory energy disperses the contamination and oxidation from the work pieces, creating a strong metallurgical bond. No materials are melted, no flux or fillers

are introduced, and no substrate degradation occurs, making the welding process not only very strong, but also energy efficient and environmentally friendly.

The patent-pending TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer (Figure 1), one in a new line of TECH-SONIC equipment, goes far beyond conventional ultrasonic wire splicers to combine an ultrasonic power generator and embedded high-speed digital microprocessor control with a servo controlled weld head utilizing feedback sensors for precise control. This unique combination provides a stress-free weld joint with the highest CPK values which were previously impossible using conventional, pneumatic wire splicers. Its unique capabilities are also revolutionizing the wire splicing industry with its small wire splicing capability and precision missing strand detection.

Using ultra-high-speed digital control based on load cell and motion sensors, the TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer provides Dynamic Force Control through real time force monitoring during welding to adjust both the ultrasonic amplitude and the applied force. This produces optimum welding conditions by reducing both power and force so it can weld wires of many different sizes to provide better quality welds while improving yields.

Conventional pneumatic wire splicers require bulkier tooling, as well as the application of higher pressure and



Servo Controlled Ultrasonic Wire Splicer

Continued on page 6



HVX

1500 Vdc

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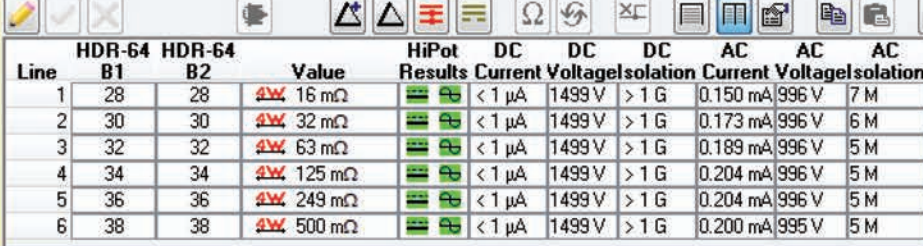
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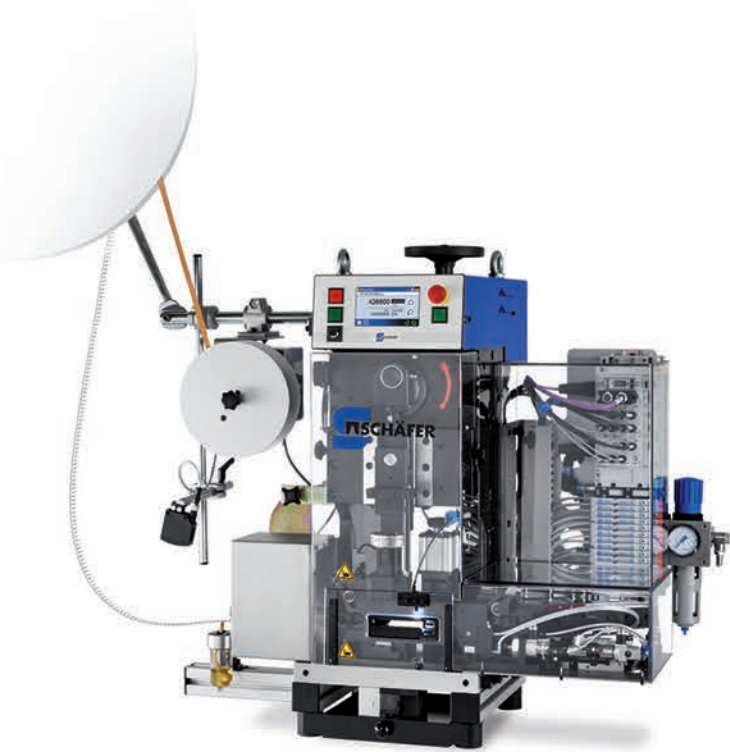
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NEWS PLUGS continued



Continued from page 4

ultrasonic power (typically exceeding 3 KW) to overcome energy losses. They also cause additional stress on the tooling, diminishing the life of the horn and anvils, and often resulting in wire breakage. Employing force feedback via precise servo control, the TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer can also detect missing strands more accurately and consistently than a pneumatic wire splicer. A typical pneumatic wire splicer can only detect missing strands if they are greater than 5% of the total cross section of wires. The TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer can detect missing strands less than 3% of the total cross section (Figure 2). Many automobile manufacturers require the wire harness producers to detect less than 3% of missing strands, and have determined that the limitations of the pneumatic process prevent them from providing consistently acceptable part quality.

The TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer

provides precise, reliable, and repeatable splicing for many types of wires, ranging from wire as small as 0.13 mm<sup>2</sup> to wire as large as 42 mm<sup>2</sup> (Figure 3). In many cases, the tooling can last over one million cycles. It utilizes a 3 kW- 20 kHz ultrasonic generator, with a 5 kW-20 kHz generator available upon request.

The TECH-SONIC US-3020WS2 Servo Controlled Ultrasonic Wire Splicer also provides for storage of unlimited

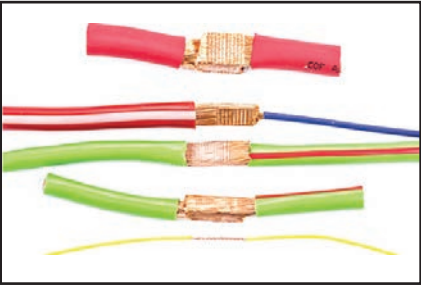


Figure 3: Ultrasonic splices.

user-defined wire splicing combinations, each having its own set of weld parameters, available by screen selection or barcode scanner input. It is based on the reliable Windows CE operating system and includes a TCP/IP interface for transfer of production information to a host system, where it can be saved and analyzed.

TECH-SONIC, Inc. is headquartered in Columbus, Ohio, with subsidiaries in

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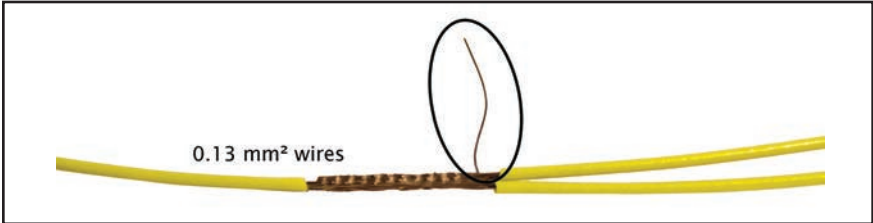
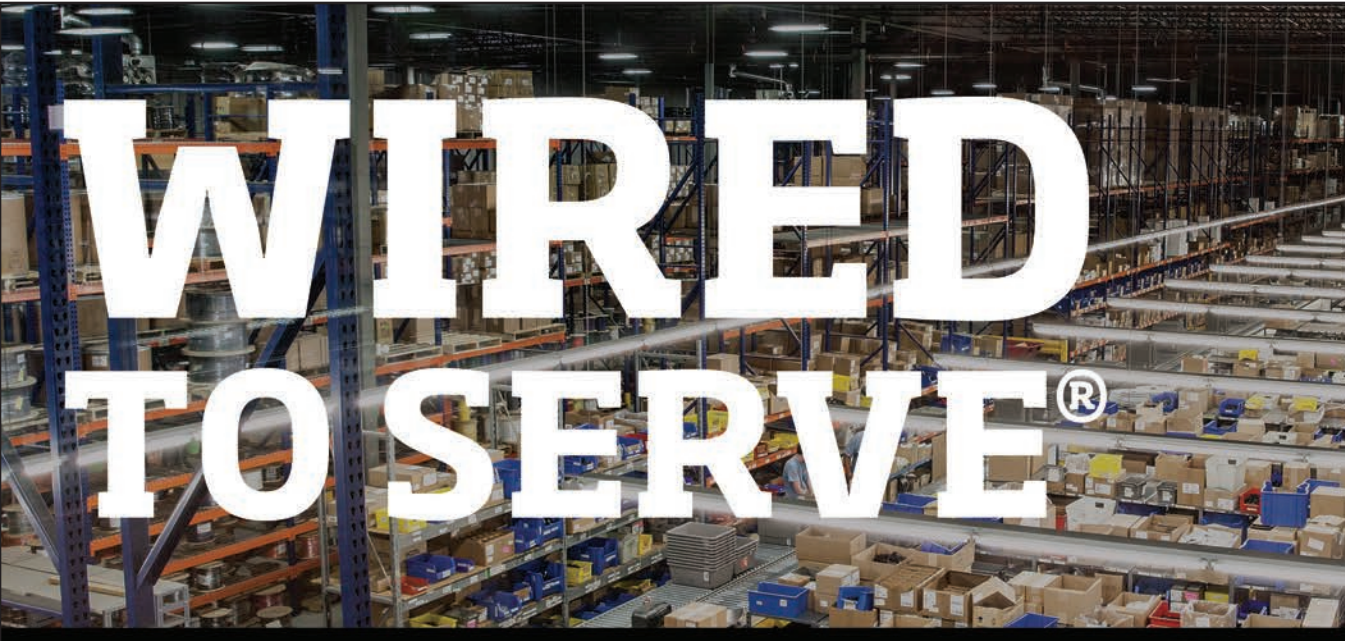


Figure 2: Missing strands.



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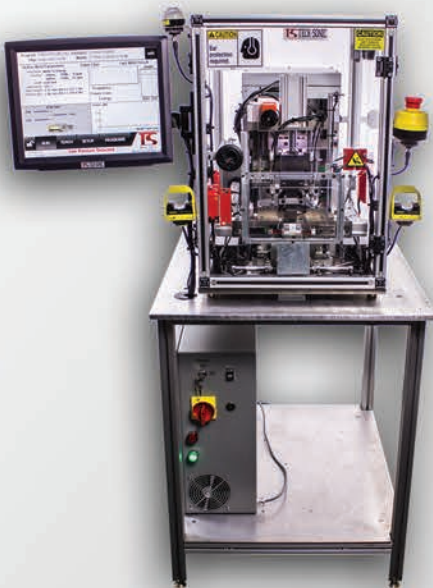
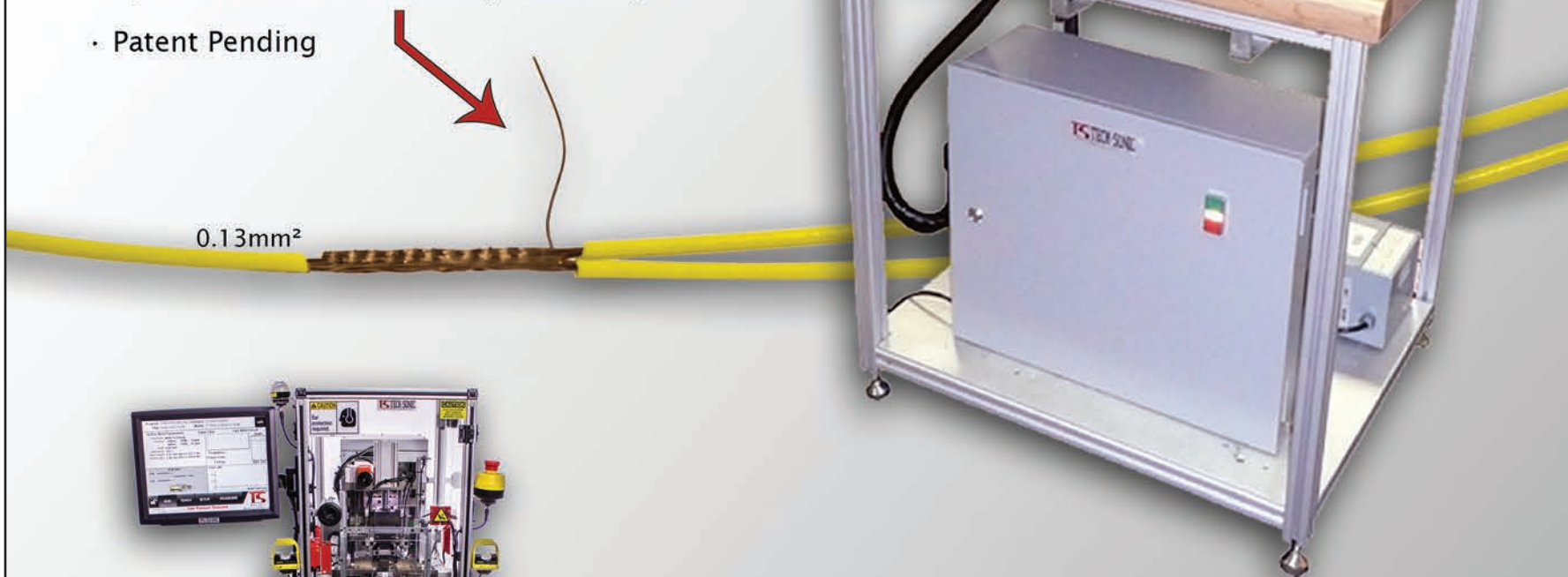


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- Patent Pending



## **US-3020SRT**

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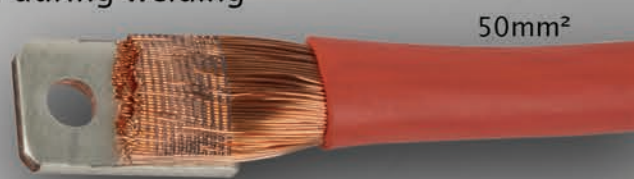
- Single missing strand detection capability
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Continued from page 1 \_\_\_\_\_

nologically emerging company in an old industry, with state of the art equipment. This keeps them leaner and meaner than their competition because they can build harnesses faster and quicker than most.

“My father always believed in taking care of the customer; no matter how big or small, all our customers are number one!” said Amir Jahangard, Regional Sales Director of Z-Tronix Inc. The product knowledge and the relationships they built over 20 years in the electronics industry

helps them quote faster, and they can even build products based on one sample. Z-Tronix keeps the customers the top priority, so they stay informed of product changes, obsolete parts as well as innovative new products before they hit the market. Their headquarters in Paramount, California keeps them close to U.S. largest shipping ports and they are also bilingual in both English and Spanish, which helps minimize communication issues.



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Z-Tronix is proud of their employees and their families because they truly are the foundation of the company. Today, the company employs over 120 people and currently stands as an ISO Certified manufacturer. They are motivated through all of their achievements as a team, as a family and as a company. The business prides itself on having little to no turnover through it's tightly knit family of employees; some of whom have worked with the family for over 20 years. Employees often bring in family to work there as well. Thus, Z-Tronix is constantly developing concurrent multi-generational personnel as future leaders. “We believe that high employee morale is crucial to the success of the company. We are a zero defect facility because when we care about our employees, they care about the triumphs of the company,” said Azim Mahboob, VP Operations of Z-Tronix Inc.

Z-Tronix has grown over the past 20 years exclusively by word of mouth and by being known as a quality “hidden gem” in the Los Angeles area. Looking ahead, they seek to continue what they’ve been doing in the past – designing and manufacturing quality custom solutions for their customers’ wiring needs. This translates into saved time and a reduction in labor cost. Plug and play manufactured product offers real value to their customers. “We want to keep producing them in the U.S.A. to support the American worker for as long as we can,” concluded Azim.



## THE EXPERTS IN CONNECTION.

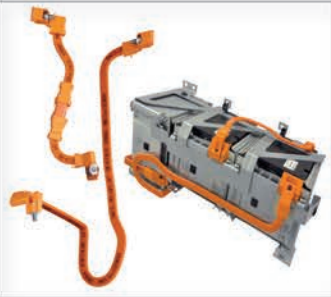
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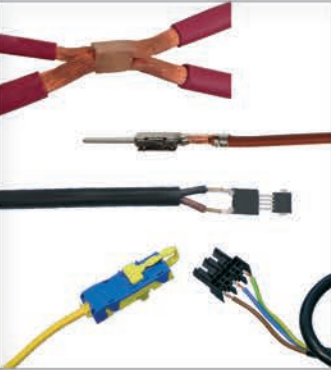
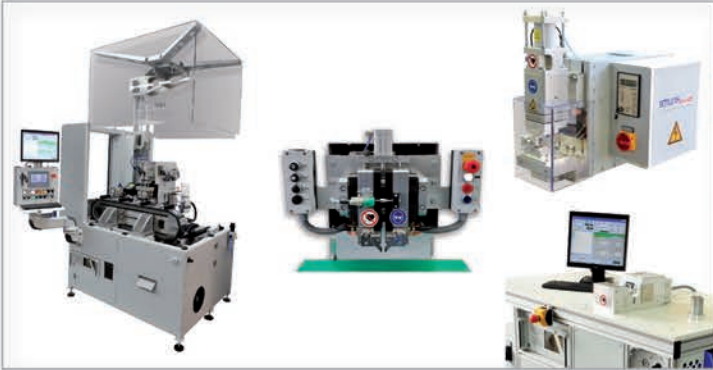
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## NEWS PLUGS continued



Continued from page 6

China, and sales and service offices in Mexico, India, Thailand and the Philippines. It has been designing and manufacturing high-tech ultrasonic metal welders since 1997. In recent years, the company has devoted its research and development to servo controlled ultrasonic metal welding – the “Holy Grail” of ultrasonic metal welding. As a pioneer in servo ultrasonic metal welding technology, it integrates the latest electronics, hardware, location and force sensors, and control software in new and unique ways.

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global companies in electrical, automotive, EV, battery, wire harness, appliance, HVAC, solar, and military industries throughout the world, and its engineers have many years of experience in custom welding systems.

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### WEZAG Introduces CS10-APP Hand Tool Frame

To support the need for high quality crimp tools in the transportation market, WEZAG has introduced the CS10- APP. This innovative tool will accept the perishable tooling (Punches & Anvils) from existing Delphi applicators. Approved by Delphi under part number 35010771 it provides the

Transportation OEM's and their suppliers the ability to provide prototypes, low volume production, rework and perform on-site repairs using production approved tooling.



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CS10-APP Crimp Tool

Mike Lobkovich of WEZAG Tools Inc. adds that the Automotive OEM markets require a crimp tool that can meet the production quality crimp requirements. General crimp tools produce poor performance and geometry characteristics. Replacement of the entire harness due to a damaged crimp terminal is expensive and time consuming. The CS10-APP crimp tool will give the Transportation market high quality post production crimp tooling.

The frame can also be adjusted to accept other connector OEM's applicator tooling.

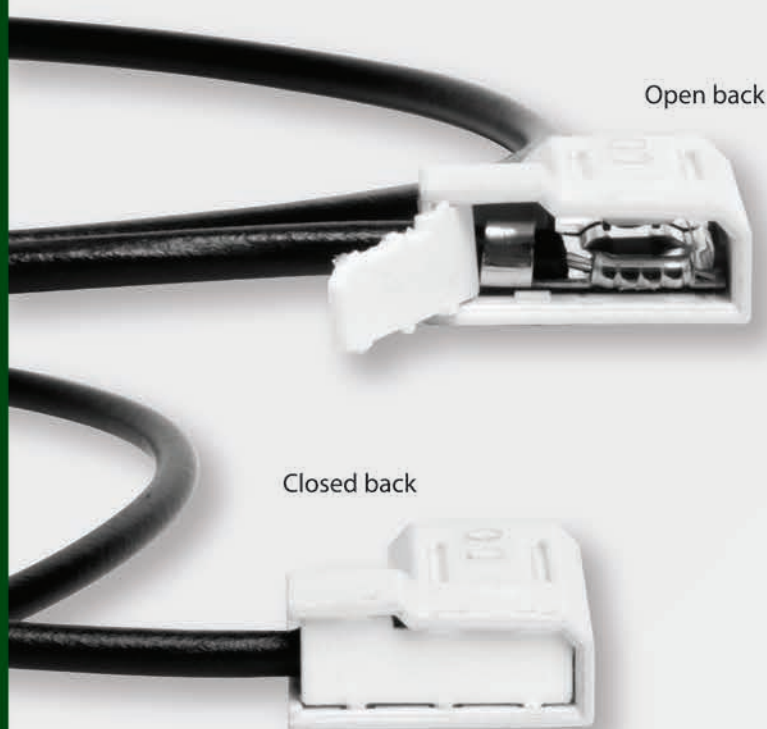
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# The Power Women of the Wire Harness Industry

As an introduction, I am an engineer who has worked in the wire harness industry throughout my 23-year career. Being the daughter of a very traditional Italian immigrant, I had little exposure to professional vocations but I am fortunate to have nonetheless graduated with not only a Bachelor of Industrial Engineering, but also a Master's in Electrical Engineering from Youngstown State University. In addition to commercial management positions, my background includes both product and process engineering, and encompasses positions working at a large, public corporation (GM/Delphi Packard Electric Systems) as well as at a smaller, privately-held company, St. Clair Technologies. Most recently, my partners and I have since embarked on an entrepreneurial journey having created a female-owned, Women's Business Enterprise Council-certified, engineering, warehousing, and manufacturing business that specializes in wire harness production. Also awaiting Women-Owned Small Business certification, the vision at Jana Diversity Solutions is to be the best supplier our customers have, not only their best diverse supplier.

Likely a result of the combination of being an engineer, raising 3 young ladies of elementary school age, and simply having read of the negatively changing status of the United States in terms of technological and economical leadership, I am passionate about encourag-



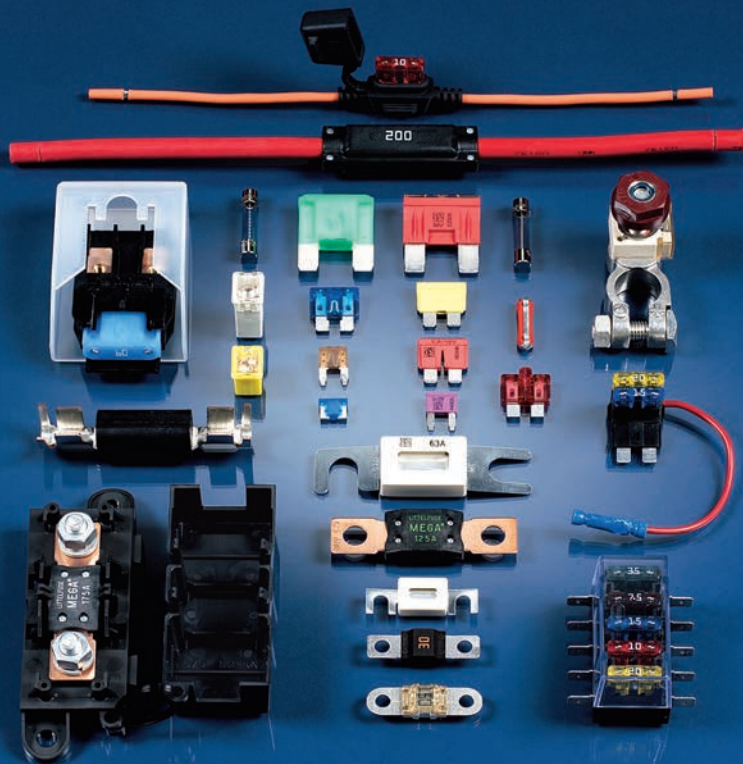
Melissa Famia

ing female students to attend and persist in engineering studies. According to a 2005 report written by committees for the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, the "scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength (Augustine, et al., 2005). Per the follow-up report published in 2010, Rising Above the Gathering Storm, Revisited, the unanimous viewpoint of the committee members is that "the outlook for America to compete for quality jobs has further deteriorated over the past five years." (Augustine, et al., 2010). While the United States

Continued on page 14

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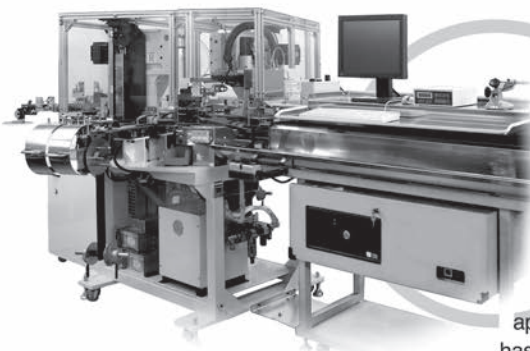
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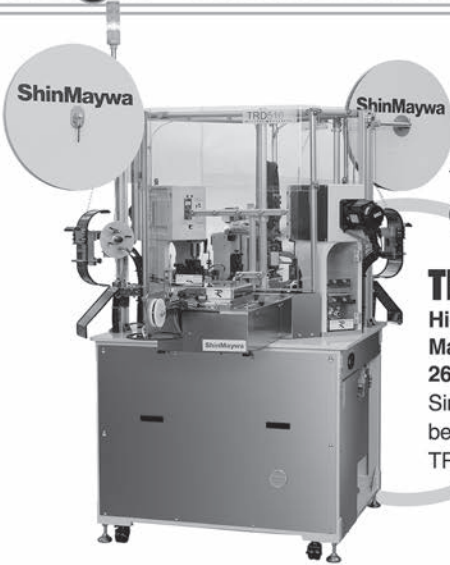
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# The Power Women of the Wire Harness Industry

Continued from page 13

needs to attract more students to engineering to enhance our global competitiveness and technological advantage, the emphasis should be heightened for females as engineering is still considered as “a profession where minorities and women remain underrepresented” (Clough, 2005).

My intent for future editions of Wire Harness News is to highlight successful engineering females working in the wire harness industry. The articles should serve to expose positive female role models and utilize their successes to ultimately attract more females to the engineering field, and more specifically to wire harness engineering career paths. My request is that the predominantly male and also female readership will take the time to read the articles and share the content with their daughters, or other family members and friends. I also hope that amateur engineers may further recognize opportunities available in the world of wire harnesses and persist in it. If you (or the proverbial “someone you know”)

are a positive, female role model in a leadership position in the wire harness industry, I ask you to contact me at [melissa.femia@janadiversity.com](mailto:melissa.femia@janadiversity.com) as I would like to highlight your story as a ‘power woman’ in wire harnessing in an upcoming article.

References

Augustine, N. R. Barrett, C., Cassell, G., Grasmick, N., Holliday, C., Hackson, S., & Murray, C. (2005). Rising above the gathering storm: Energizing and employing America for a brighter economic future. Washington, DC: National Academy of Sciences, National Academy of Engineering, Institute of Medicine.

Augustine, N. R., Barrett, C., Cassell, G., Grasmick, N., Holliday, C., Hackson, S., & Murray, C. (2010). Rising above the gathering storm, revisited: Rapidly approaching category 5. Washington, DC: National Academy of Sciences, National Academy of Engineering, Institute of Medicine.

Clough, G. W. (2004). The Engineer of 2020: Visions of engineering in the new century. National Academy of Engineering, Washington, DC.



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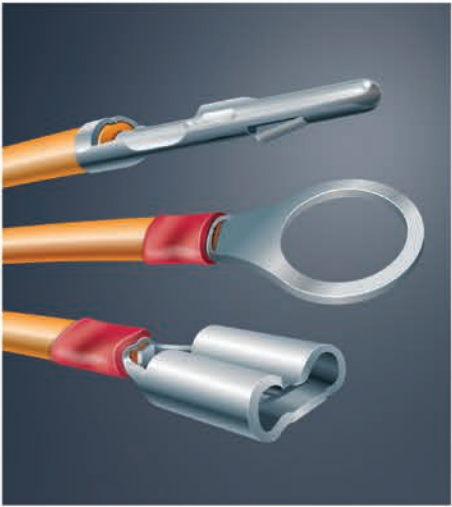
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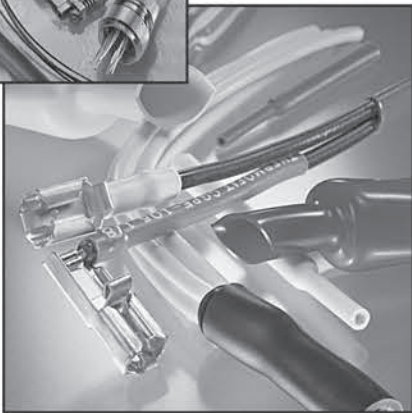
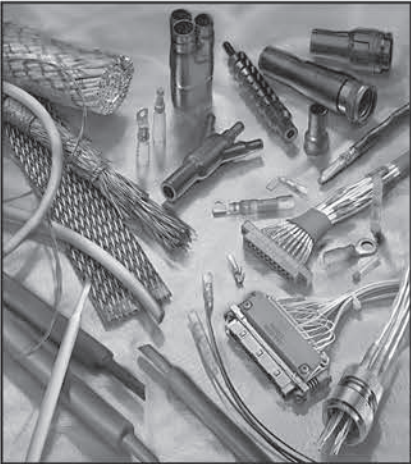
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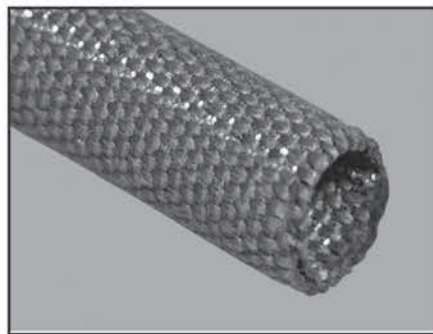
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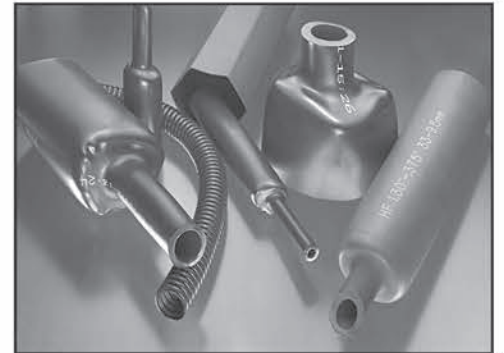
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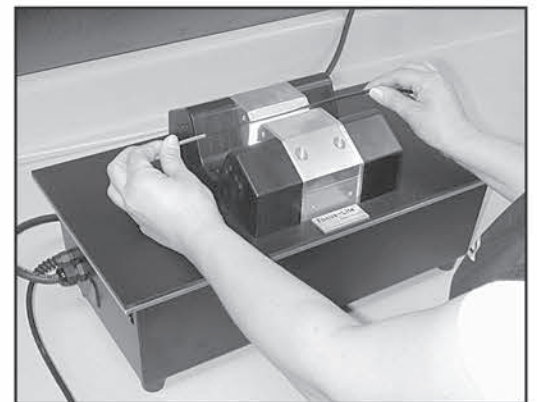
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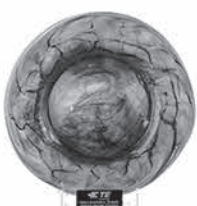
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# Electrical Wire Processing Technology Expo: Meet the Future Feeling Empowered

Continued from page 1 \_\_\_\_\_

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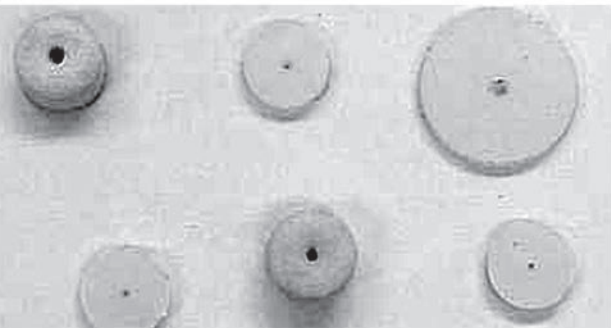
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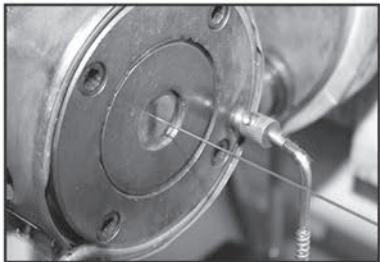
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# Trust: The Oil of the Deal Process

By Loren Smith



Loren Smith CEO  
Blue Valley Capital

It's often been noted that clichés become clichés because most carry so much truth. A great example is the cliché that trust is the oil that takes the friction out of the deal process. Absolutely! Just think of all the points in a deal when confidence in the other party is crucial.

The process begins by throwing out a large net to corral potential buyers. If we're successful in attracting a good number of prospects, how do we whittle them down to a select few? Certain data are relevant, granted, but our instincts about which buyers we'd be comfortable dealing with cannot be ignored.

If this seems too "gut level," consider the argument put forth by celebrated author Malcolm Gladwell in his bestseller Blink. Gladwell shows that many judgments we make in a matter of seconds are hardly rash because they are actually based on years of experience and observation—our internal database. His book persuasively makes the case that these reactions are often more reliable than the results of extensive analysis.

So in the opening stage of the deal process, the trust factor wields a dual edge. On the one hand, we benefit by trusting our instincts about which potential buyers appeal to us. And by what measure are we making that assessment? To a significant degree, it is

which buyers we feel we can trust to deal with us honestly and fairly.

Trust then looms large again when a prospective buyer—especially one already operating in the wire harness industry—asks us for information about our customers. Hmm. Can we trust this suitor? If our judgment is saying yes, we should say yes. How else can we make substantial progress with the buyer? Prospective buyers can't possibly make an intelligent decision about acquiring our company without evaluating the scope and depth of our customer relationships—as well as our company's potential.

And for a dose of courage about sharing confidential information, we can draw on trust in another way. If we are faring well in a competitive environment, we must be providing products



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that are right and on time. And we must be pretty good at maintaining rewarding customer relationships. So why worry about disclosing who our customers are? We need to trust our ability to build a loyal customer base.

If these initial steps, enhanced by ample trust, materialize in identifying a desirable buyer, we can move to the concluding stages—where trust continues to minimize friction. In signing the letter of intent, the buyer is trusting the seller to close off the competitive process, and the seller is trusting that all of the items in the letter of intent will hold up during the due diligence process. The trust factor here is key because between this point and the closing various positive and negative developments can occur. The seller must trust that the buyer will not interpret or twist normal

business occurrences in a manner that could lead the buyer to try to change the terms of the deal.

Trust even extends into the post-closing phase. Sellers need to believe they can trust the buyer to treat employees and customers as they would—a factor that for most sellers is as important as price. After all, there really is no viable legal mechanism to provide assurance on this score, so trusting the buyer’s integrity is vital.

Once we contemplate how crucial trust is in every stage of the sale process, we realize that it doesn’t just prevent friction. It is a mandatory component.

Loren Smith can be reached at [lms@blvcapital.com](mailto:lms@blvcapital.com) or [www.bluevalleycapital.com](http://www.bluevalleycapital.com)



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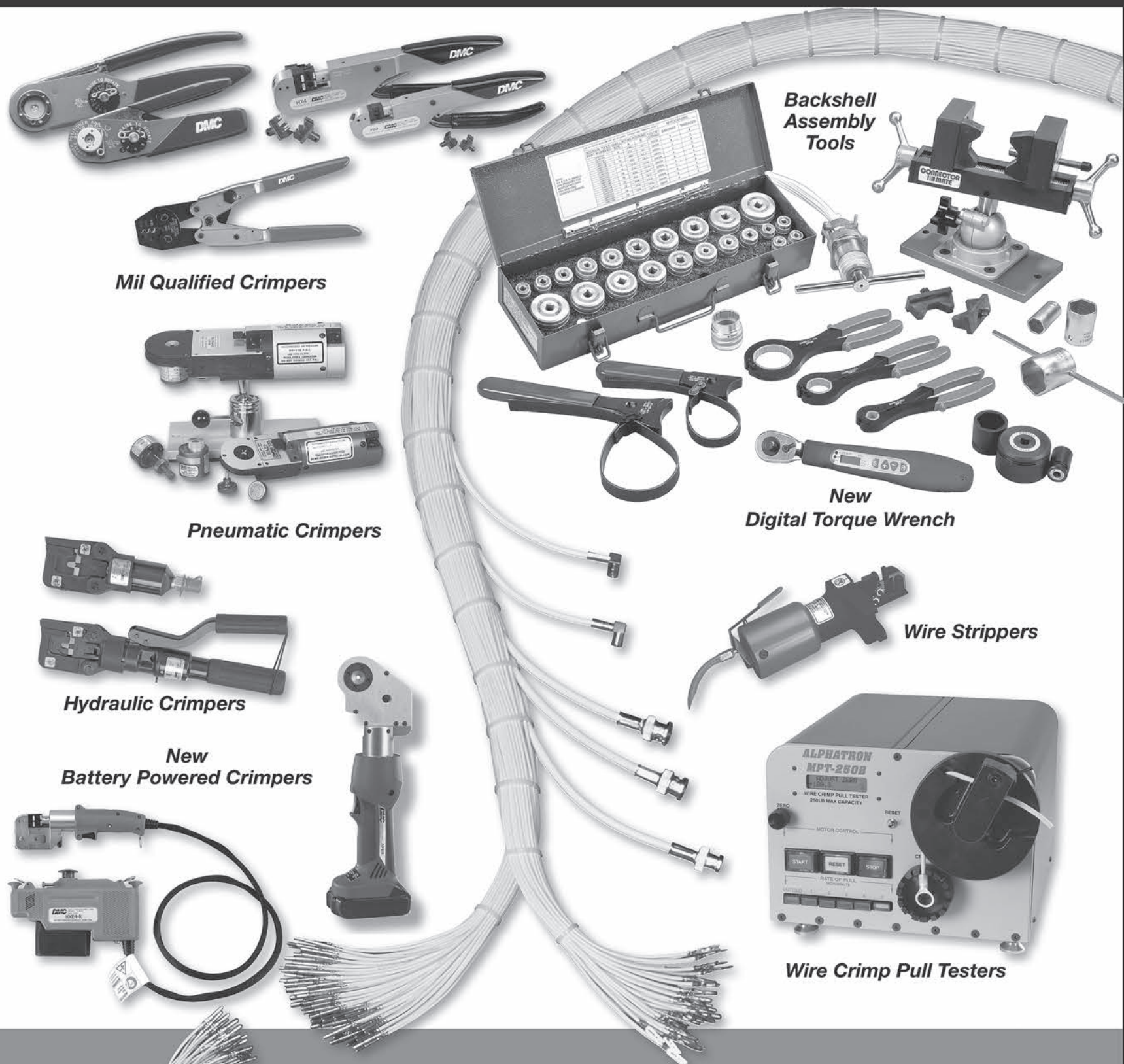
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# A Generation Starving for Meaning

By Paul Hogendoorn

*“10 nuggets for \$1.99 I’m going to text my mom!”*

I can’t watch this ad without being saddened. We have a generation that has more access to more information than any generation ever before, but it’s a generation that seems to have difficulty getting engaged in anything meaningful. I admit that it’s a very general statement, and not everyone can be painted by the same broad brush, but I sense there’s a lack of meaning in much of our young world today, and ads such as this only serve to illustrate that point. “I’m going to text everyone I know!”

Advertising and eating fast food is not what this column is about, but rather acknowledging that it is going to be a challenge for employers, and manufacturers in particular, to meet the needs of the coming young work force. As our older folks retire, we need to be able to attract, and then retain, a workforce that is very different from the preceding generations. They have different motivations, different needs, and different ways of looking at things. And the one thing they have need of, more than any previous generation, is “meaning”. This generation is starved for meaning – they have a huge appetite for it, but it’s not being filled.



Paul Hogendoorn

“A people without vision are doomed to perish”. This vision isn’t going to come from a political party or a government, it has to come from you and I – the people that help build businesses, communities, homes and families. Wherein the past, youth may have looked to political and government leaders for vision, the same does not hold true today. The older generations remember leaders like JFK and MLK, not just for their charisma and status, but for the vision they cast that set the course for generations afterward. That kind of political vision has not been seen for a long time.

Many of our companies today are still led by visionary leaders, but that vision needs to be connected directly all the way to the plant floor - not

*Continued on page 23*

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# A Generation Starving for Meaning

Continued from page 21

indirectly through management systems, or policies, or vision statements or slogans. For the millennials more than any generation before, the vision needs to be compelling and backed up by consistent and congruent action. It's not about how they might spend the money they make as it is about how they spend their time. One local manufacturing company I know hires a dozen young people at a time, hoping that 2 or 3 will stay beyond 3 weeks. The ones that leave would rather flip burgers at minimum wage than do a repetitive and unengaging job that pays far more. It's the time that they spend at their job that they measure, not the money they make at it.

It's also a generation used to constant communication, even if it's mundane. ("I'm going to text my mom" as an example.) The old paradigm of having one group do the work while another group measures their performance - without sharing it in real time - does not line up well with their life experience, or their expectation.

To attract this generation, our manufacturing jobs need to be more engaging, and they have to have more meaning. It doesn't have to be a "change the world" kind of meaning, but there has to be more of a reward to doing the job than just a paycheck. If they are a mother or father with children to feed and bills to pay, going home with a paycheck every week is reward enough. But, if

they don't own that kind of responsibility in life yet, the paycheck is nice, but it's not the be all and end all. The time spent at their job is as important as the money they make at it. In the next decade, our manufacturing companies need to pay attention to this difference and make the workplace a more meaningful place to be, and the jobs more meaningful things to do. If we don't, they'd rather work someplace else, perhaps serving up chicken nuggets for \$1.99.

Three suggestions for engaging the next generation at work:

1) Make sure goals are related directly to people's specific activities and the measurements are visible in real-time. (Last week's measurements are old news, if it's even news at all).

2) Identify the company's core 'people' values, and live them out demonstrably, outside of the company as well as inside it. (What is your company doing in the community or for special causes? Let your people adopt it and share in that. It brings added 'meaning' to the workplace.)

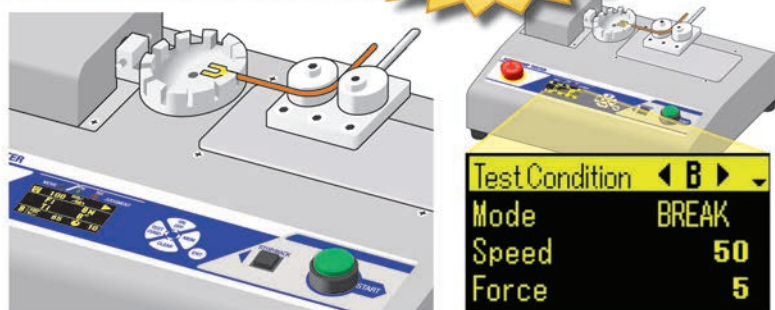
3) Provide ample channels for feedback, opinions and input. Be intentional about acknowledging it, even if you are not acting on it.

Paul Hogendoorn is co-founder of FreePoint Technologies. "Measure. Analyze. Share." (Don't forget to share!) He can be reached at paul.hogendoorn@getfreepoint.com or www.getfreepoint.com

## Wire Crimp Pull Testers

### Automatic Testers

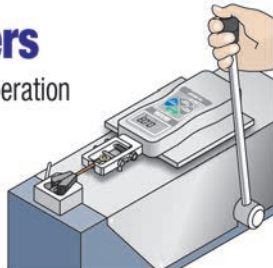
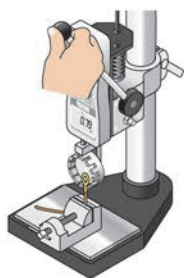
One Button Operation!



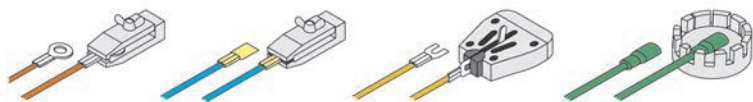
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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 1 \_\_\_\_\_

are benefits to participating and there is a need in the industry for participation because the experience levels on all of our standards committees is diminishing due to retirement and changes in leadership from engineering to accounting/finance in the Aerospace Industry.

This is a wake-up call from a 40+ year veteran of standards and specification development who sees the emphasis on standards increasing, while the level of authority, experience and leadership in



the standards committees is decreasing.

This is happening in the 20+ year aftermath of a major US Government policy shift to commercial, off the shelf components, and private, non-Government standards. The term "Mil-Spec" certainly

has a different meaning than it once did...

Aerospace and High Reliability Wiring System Standards were originally US Military Specs, and they support various organizations within the US Department of Defense (DoD).

In 1994 the Secretary of Defense (William J. Perry) imposed a directive to DoD (Referred to as the Perry Memorandum). It imposed commercial, off-the-shelf (COTS) procurement of parts, and a mandatory shift to non-Government Standards.

This article will provide a brief outline of the wiring component Standards, tooling/production equipment standards, and process standards which remain Government owned today, and the status of Converted Private Standards (SAE, NAS, NEMA, etc). We will also discuss Qualified Products Listings (QPLs & QPD).

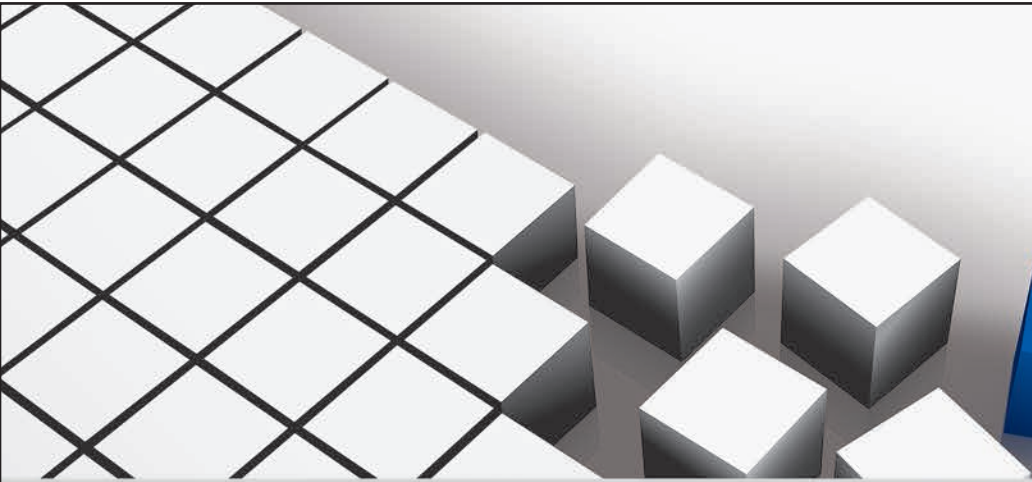
- Performance Standards were also a mandate of the Perry Memorandum which was intended to tie into the "COTS Theory".

- Minimum Performance Standards have their place, but the Detail Specifications which control the Material, Plating, Configuration, and all Significant Details have proven to be necessary for Aerospace Wiring System Components.

- A Third Party Qualification (QPL) System has also proven to have significant advantages.



The Evolution of Wire Harness Components, and Production Equipment is attributed to the pioneering efforts of a few people with the vision to write appropriate standards and manage



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the component technologies as the demand for more reliable technology emerged in the aerospace and other high-reliability wiring industries. This includes components designed and proven for high performance, but harsh environment wiring systems.

This article is about Standards, but it is also important to stress the need for Participation in the Standards Process. There is a need for more Original Equipment Manufacturers (OEMs), Wire Harness Manufacturers, and Suppliers to get involved and take ownership in the Industry Standards Committees that drive performance and availability of the com-

ponents used in the Electrical Wire Processing Industry.

Many of the new Unmanned Aircraft Systems (UAS) will create a more harsh environment for the Electronics because the aircraft operate outside the envelope of pilot and crew life support. Therefore, pressurization, speed, altitude, and harsh environment conditions are not limits to the design of the aircraft. At the same time as the environment for the wiring system may become more harsh and unforgiving, the demand for more electronic sensory, data speeds, and circuit redundancy places high demands on the EWIS system.



Continued on page 26

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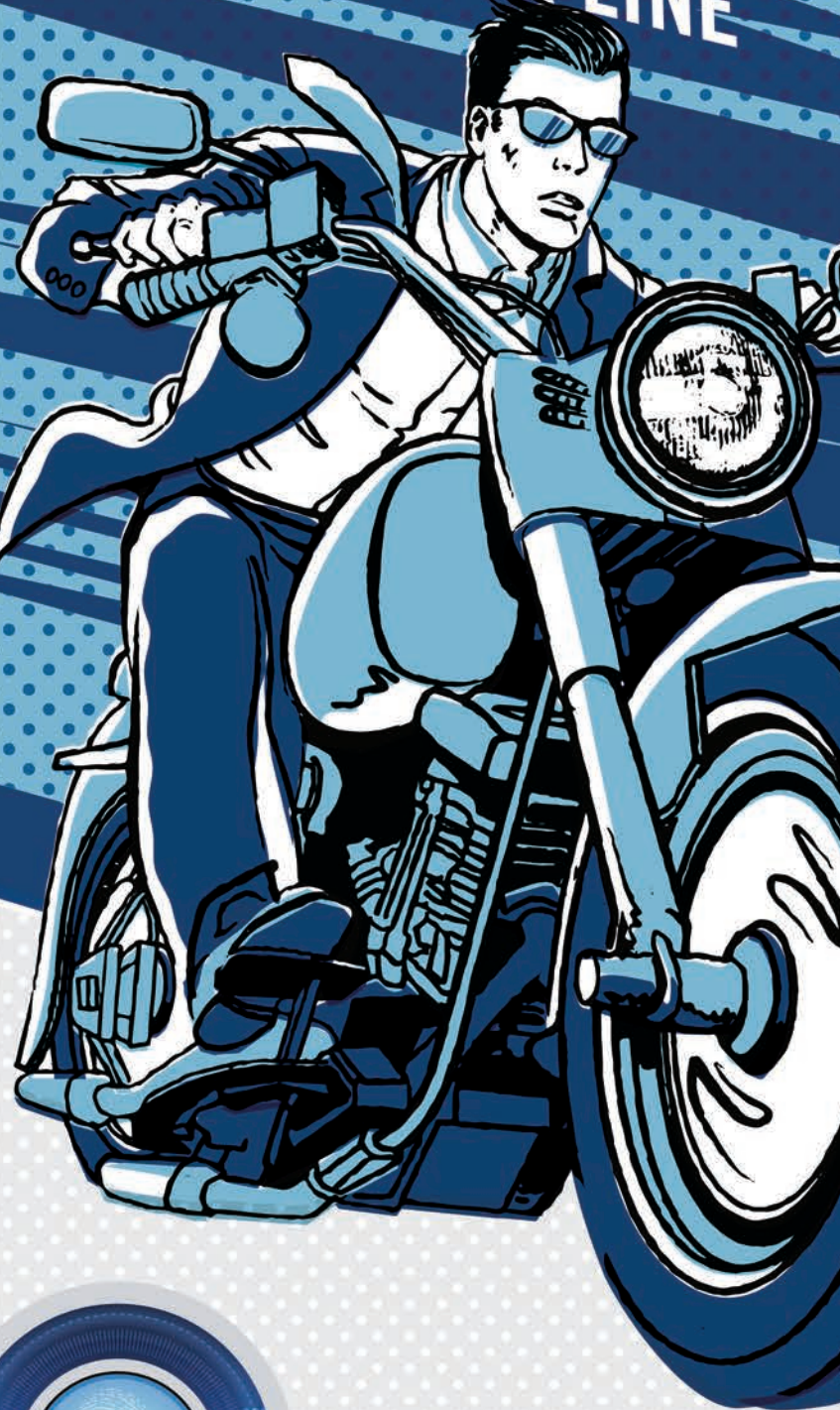
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- 3 - CARPENTER Model 70B Strippers
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- 1 - EUBANKS 4000-04 Tandem Cut and Strip Machine w/extra Blade Sets
- 3 - EUBANKS 8000-01 Cut and Strip Machines
- 1 - FELINS PakTyer 2000 Semi-Automatic Tying Machine
- 1 - IDEAL 'Stripmaster' Model 940 Wire Stripper, Part #45-940
- 2 - J.B. HYDE 24-C, 48-C Braiding Machines
- 2 - KAWA Splicing Machines, Model KW-IT, New
- 1 - KINGSLEY Model MCM-650 Sleeve and Tube Marker
- 2 - KODERA Model C556 Seal, Crimp and Tinning Machines
- 1 - KOMAX DPS 272 Coiler, 2012
- 1 - KOMAX Gamma 333PC Automatic Crimping Machine
- 2 - KOMAX Alpha 411 Automatic Crimping Machines
- 1 - LOCTITE Model 10-50 Posi-Link Volumetric Dual Cartridge Dispensing System
- 2 - MEGOMAT ASM3001 Wire Cutting/Crimping Machines
- 1 - METRONIC Alpha Jet C Inkjet Printer, 2006/07
- 1 - MORGAN Injection Molding Machine, Model G-100T
- 5 - MORGAN Injection Molding Machines, Model G-125T
- 1 - NEW ENGLAND BUTT 72-Carrier Braider (w/flat strap capability)
- 1 - NEW ENGLAND BUTT 48-Carrier Harness Braiders, rear delivery chute
- 1 - PANDUIT CP-861 Crimp Press
- 1 - RAMATECH Model ABW 800/300 Prefeed, 2005
- 1 - SCHLEUNIGER CC36S Automatic Crimping Machine
- 1 - SCHLEUNIGER CP1500 Heavy Duty Coiler
- 1 - SCHLEUNIGER CS9100 Cut/Strip Machine w/PF2000 Prefeed
- 1 - SCHLEUNIGER CT32 Crimp Press, 2008
- 1 - SCHLEUNIGER MS0600 MegaStrip w/PF4000 Prefeed
- 1 - SCHLEUNIGER OS9400 OmniStrip
- 1 - SCHLEUNIGER PT26 Pull Tester, 2008
- 4 - SCHLEUNIGER US2015 Bench Strippers
- 2 - SCHLEUNIGER US2100 Bench Strippers
- 2 - SCHLEUNIGER US2500 Bench Strippers
- 4 - SCHLEUNIGER WS1000 Wire Stackers
- 2 - SCHLEUNIGER Uni-A Applicators
- 1 - SONOBOND Sonic Welder
- 1 - SPECTRUM 'Sienna 210S' Radial & Axis Laser Wire Stripper (modified to Model 210D)
- 1 - TAYMER Hot Stamp Marker, Model SM1000
- 1 - TRI-STAR TECHNOLOGY Table Top Laser Marker, M100L FG-TT



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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components... *Continued from page 25* \_\_\_\_\_

Continued from page 25

These are the US Government Organizations that control and manage wiring system/components specifications. Their contact information is the following:

Defense Logistics Agency (DLA)  
Land & Maritime Division, (Formerly  
DESC):

DLA Land Maritime  
ATTN: (L&M-VAI)  
P. O. Box 3990  
Columbus, OH 43218-3990  
<http://www.dla.mil/LandandMaritime.aspx>

Naval Air Systems (NAVAIR):  
Naval Air Systems Command  
48298 Shaw Road, AIR-4.4.5.3  
Patuxent River, MD  
<http://www.navair.navy.mil/qpl/>

The **table on page 64** shows many of the common EWIS Component Standards which are managed by NAVAIR & SAE AE-8 Standards Committees, and the most common component standards which are owned and managed by DLA L&M, Columbus, Ohio (designated in the table as Preparing Activity - PA), and Qualified by (Listed in the table as Qualifying Activity - QA) (Fiber Optic Standards have been omitted to save space)

## QPL & QPD

Both NAVAIR & DLA maintain Independent, Third Party qualification, which provides Documented Testing, Plant Inspection/Audit, and Published Qualified Product Listings

(QPL) of Specification Controlled Components which are assigned to them as the Qualification Agency. It is no longer referred to as a QPL, it is now a Qualified Products Database (QPD).

The list of Qualified Products and Suppliers are provided in a Supplemental Information Sheet (SIS), and the QPD is available through the <https://assist.dla.mil> or <https://quick-search.dla.mil> websites.



## Detail Specifications vs Performance Specs

Many of the Specifications that remain MIL-Specs today are classified as “Performance” Standards with the prefix “MIL-PRF-”. A Specified Minimum Performance is a requirement, but the details and configuration of the components are not specified in exact detail.

Both Detail and Performance Standards have their place in the MIL/AERO EWIS Industry, but typically, the detail standards are the trusted OPL/QPD listed elements of the Aero-

*Continued on page 28*



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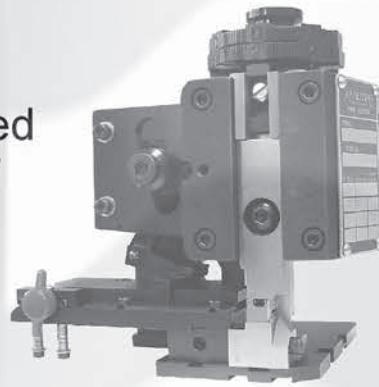


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Mini style applicators with mechanical feed mechanisms are supplied in a variety of feed configurations. Adaptable to most crimping presses.

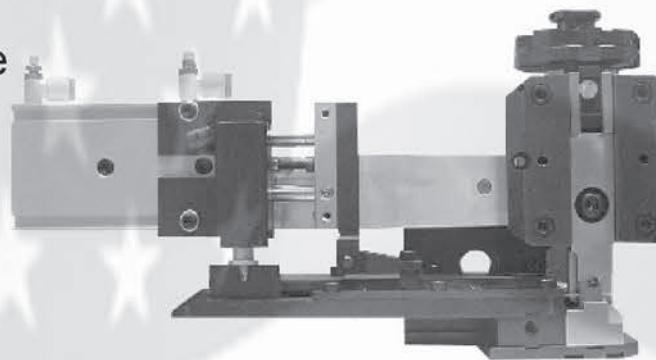


Model 1700

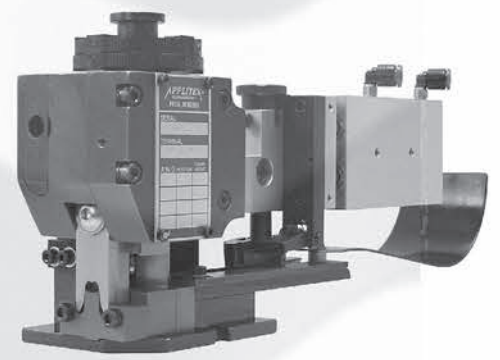


Model 2000

Pneumatic feed mini-style applicators can accommodate terminals with center to center distances up to 2 inches.

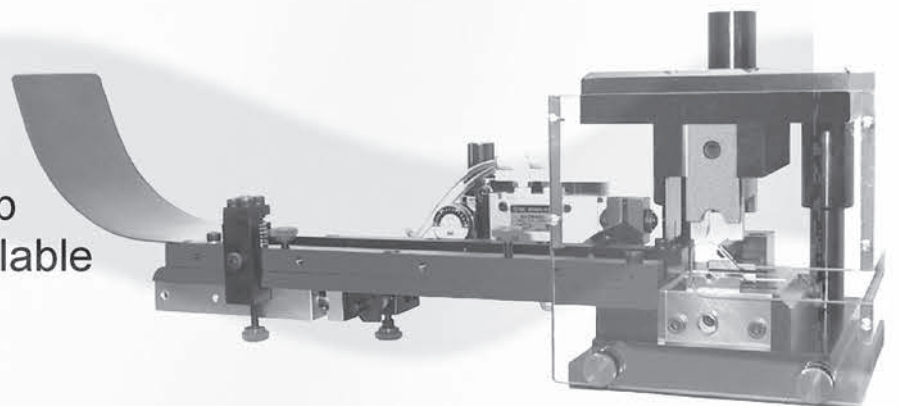


Model 1500



Model 2100

DSA applicators are designed for large terminals manufactured from heavy gage material with center to center distances up to 3 inches and widths to 3.5 inches. Available in left to right, right to left and rear feed configurations.



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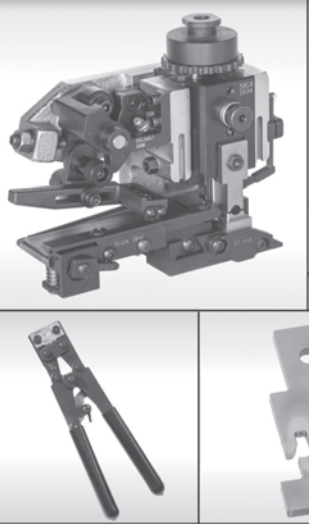
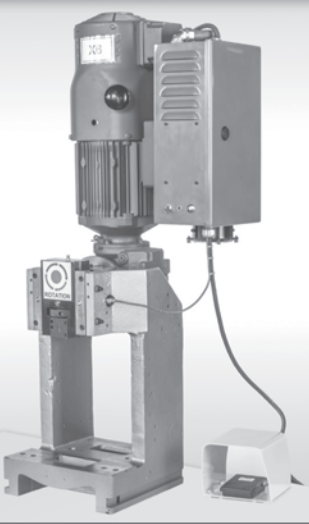
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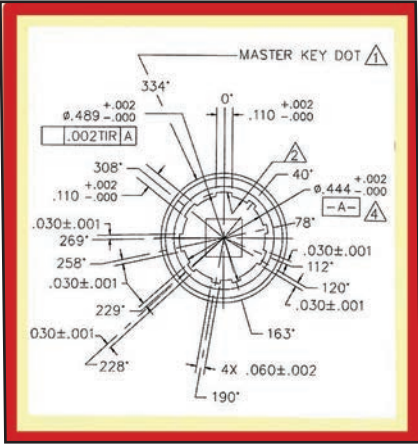
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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components... *Continued from page 26*

space Wiring System. The term “or equivalent” is common in both types of specifications, but it is only used in non-essential references of the detail specifications, and typically.



- How do Private MIL/AERO Specifications Happen?**
- The Request for a New Standard must come from a User of the Item (OEM). A Supplier can recommend a Standard but a User must request it before it can be considered as a committee project.
  - The Standards Committee makes the decision to accept the task.
  - A Sponsor (Person who will draft and coordinate the Standard) is assigned.
  - A Draft of the Standard will be developed by the Sponsor, and Posted to the Committee for a Ballot.
  - The first Ballot is 28 Days, and during that time, a majority approval

- will move it to the next Ballot level.
- The next Ballot is called the Affirmation Ballot (15 Days), and it begins when the Sponsor resolves all disapprovals and comments from the previous Ballot. If significant technical comments are received in the 28 day initial Ballot, another 28 day Ballot is likely to present and resolve technical changes. Editorial and nontechnical comments would not justify repeating the 28 day committee Ballot.
  - When all disapproval votes are resolved, the Ballot is considered to be accepted by the technical committee (Preparing Activity in the case of a Military Standard), and it moves to a higher committee (Aerospace Council) where it is reviewed for format and content, and, when approved by the Aerospace Council, it is moved to publication. There it receives the final edit for format and date, and is added to the list of Approved Standards.
  - This process applies to Standards which evolve thru SAE Technical Committees, but Standards published and supported by NEMA, NAS, IEC, and other Standards Organizations follow a similar path to approval and publication.

**Who can become a QPL/QPD Listed Supplier for Products that apply to Aerospace Standards?**

The Guidelines are followed carefully by the QPL Agencies of the US Government, and they conform to



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The Cap allows you to prevent electrical fire and to confirm completion of electrical wire connections with nothing but a glance.

This cap is made of temperature sensitive material and its color will fade to white when the temperature reaches 60°C. When the temperature drops below that point, the color will return.

Because of the ease of detection, workers, supervisors, inspectors, and others can quickly take necessary actions to respond in case of imminent danger.

Color coded caps help workers to classify electric wires without the need of labels.



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the rules set forth by the DoD 4120.24-M Defense Standardization Program, Policies and Procedures, and the SD-6 Provisions Governing Qualification.

The most basic list of qualifications for a manufacturer wishing to become a QPL/QPD supplier are the following:

- A supplier has to meet the Quality requirements with a solid in-house inspection system.
- It has to control the design of the QPL Product.
- It has to be the shipping point for the QPL Product.
- It has to provide the records and documentation required by the product spec and SD6.
- The product has to meet all requirements of the specification.

There is a process whereby the supplier supplies product and information for test and evaluation. All products produced and sold after the QPL/QPD approval are controlled and monitored by a system which assures the user that the product is the same quality and configuration as to the product which was originally qualified. The system requires the supplier to communicate all design and/or process changes with the Qualifying Activity, and have them retested or approved prior to supplying them to a customer.

**The SAE Standards Committee Structure for Wiring System Standards:**

The Technical Committees/Preparing Activity for Wiring System Standards are grouped under the AE-8 Organization, and they are structured as follows:

**SAE AE-8 Steering Committee:** Members of this group are AE-8 Committee Chairmen, and select Military and Industry Leaders. The Steering Group deals with management issues to support the technical work of the AE-8 Committees.

**SAE AE-8A Installations Committee:** This group is comprised of aerospace Manufacturers, Suppliers, and Military leaders who define the acceptability, use, and process for EWIS and related components, for Aircraft Wiring Systems. The AS50881 (formerly MIL-STD-5088) Aerospace Vehicle Wiring (Handbook of Electrical Wiring for Military and Civil Aircraft) is the primary focus of the SAE AE-8A Committee, but new

technology and methods are often discussion topics as they relate to aerospace wiring.

**SAE AE-8B Relays and Circuit Breaker Committee:** It is only natural that the current controlling devices would be included in the wiring standards group. This Committee has the responsibility for AS5363 Electromechanical Power Controller/Relays, AS5692 Arc Fault Circuit Breakers, AS58091 Trip Free Circuit Breakers, AS55941 Toggle Switches and related hardware.

**SAE AE-8C1 Connectors and Accessories Committee:** The many standards that relate specifically to circular and rectangular electrical connectors are managed, coordinated, and dealt with in this group. As stated earlier, many of the electrical connectors which are standard components of aerospace wiring are Military owned standards, but many are also SAE

standards. SAE AE8-C1 has a vital technical role in the connectors which are SAE Standards and which are Military Standards because this group has the contacts, backshell accessories, and other standards that embody interconnects in the EWIS systems. Some of the standards assigned to this committee are: AS39029 Contacts, AS85049 Backshells, Strain Reliefs, and other Connector Accessories, AS50151 (Formerly MIL-C-5015) Connectors, AS 81511 Connectors, AS 81582 Connectors, AS81659 Rack and Panel Connectors (ARINC 404 reference), AS81790 External Power Connectors, AS85028 Rack and Panel Connectors (ARINC 600 reference), AS95234 Reverse Bayonet Connectors (Based on MIL-C-5015/AS50151 connector interface configurations).

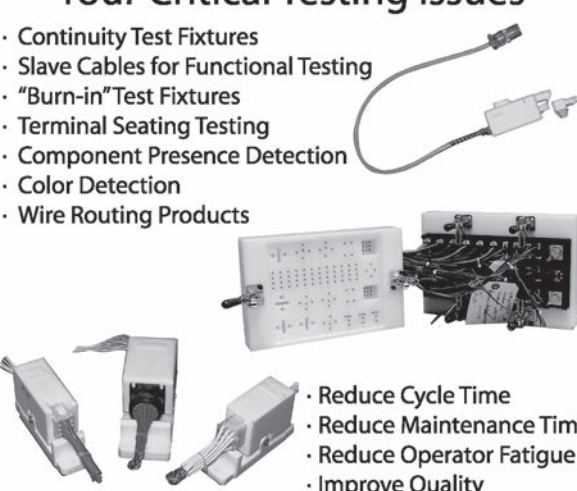
The SAE AE-8C1 Committee provides leadership and Liaison with EIA Test Standards Com-

Continued on page 56

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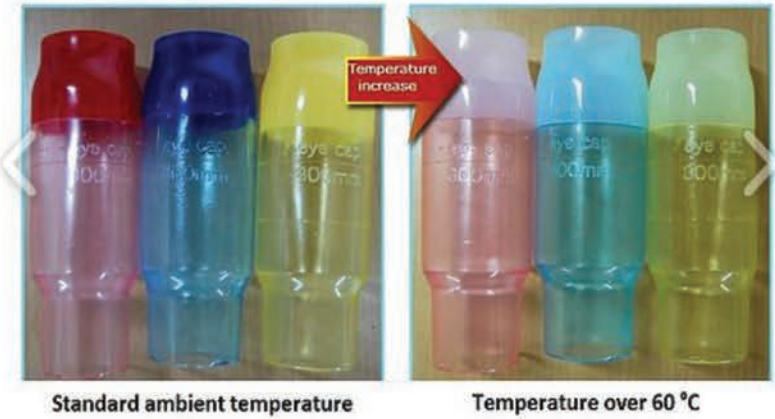


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## Al Mello Retires

After 39 years, Al Mello has stepped down as CEO of The Mello Company, Inc. Ed Byrne, who has worked with Al for many years, has taken over the reins as President and CEO. The Mello Company is a sales representative, distributor and manufacturing company serving Texas, Oklahoma, Arkansas and Louisiana. I had an opportunity to chat with both Al and Ed about the transition.

Al talked about how much he has enjoyed seeing the many different in-

dustries, operations, and applications for their products over the years. But he was quick to mention the best part of his work has been the people encountered along the way. "With both the principles that we represented, and the customers we have developed over the years, the people have always been the highlight of the job."

I asked Al about the changes he has seen in the industry through the years. "Certainly the customer base, at least in our territory, and changed," he explained. "I've been doing this for

39 years and in the first half of those years, we were able to develop a pretty large customer base of automatic wire cutting and stripping equipment all along the Mexican border." He noted in more recent years, most of that equipment and customer base has moved away from the border.

But both Al and Ed agreed that there seems to be a trend towards reshoring and near-shoring, along with new business, that is bringing customers back to the region. "I've had several inquiries from some new companies moving into Texas who are looking for equipment," Ed claimed, "so hopefully that becomes a trend as we start supporting our own manufacturing here in the US."

The conversation turned to Ed's involvement in The Mello Company. "In the early 80's I was working for a little semiconductor plant, and Al pulled me out and put me to work in sales," Ed recalled. Ed left the company to work for a circuit board test manufacturer in the 90's, but took what Al had taught him and ran with it, noting that his experience with Al was "fantastic information."

The two kept in touch and in 2010 Al said, "Hey, one of these days I want to retire so let's talk about plans for you rejoining the company." Ed quit his job of 15 years at Texmac Inc., where he spent 10 years as Western Regional Sales Manager, and went back to work for Al. The plan was set for Ed to purchase The Mello Company.

Ed had glowing words for Al, describing him as a great mentor in sales and customer relations. Al was quick to describe Ed as a quick learner, and



Al Mello

it was obvious these gentlemen have a great deal of respect for one another. "It's been a fun ride the whole time...well, mostly fun," Al joked.

So it's on to the honey-do list and traveling for Al and his wife, Luanne. He has been quite involved with his church as a volunteer and will continue to do more of that. But don't count him out. As Al warned me, "I'm retired but I'm still around, so watch your back!"

*Last month I was having a conversation with a friend who asked me what I liked about the wire harness industry. Growing up, my father was in the beer business, and I got to spend a lot of time with him. His distributors and associates were awesome people who understood that building relationships was their business. I found the same type of people in this industry and specifically thought of Al during that conversation. Al Mello represents the class and dignity I find appealing in the industry, and all of us at WHN wish him the very best.*

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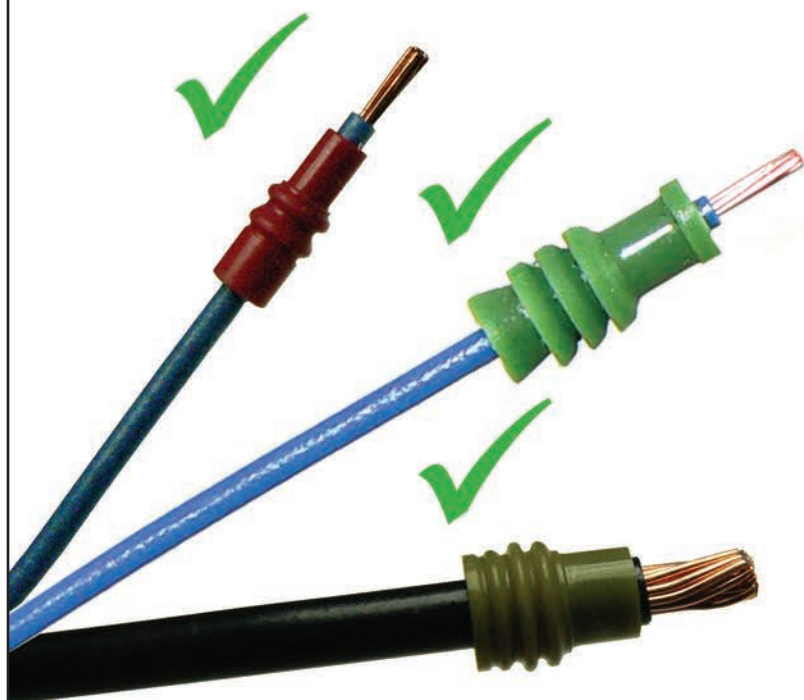
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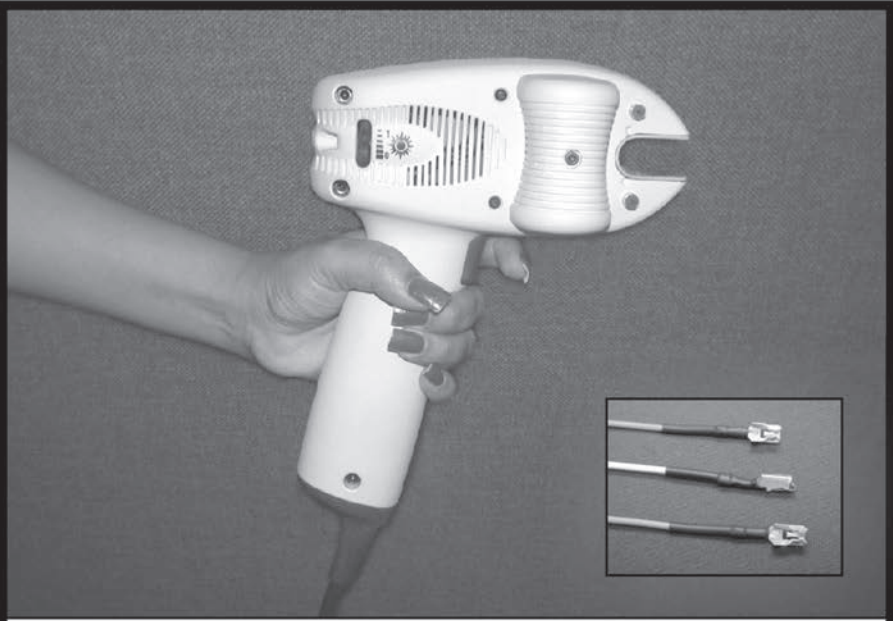
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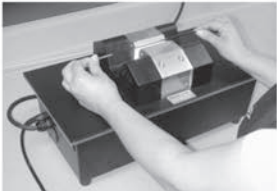
\*polyolefin, 5" length

The Focus-Lite™ FLG3™ by Judco Manufacturing, Inc., is the solution to all your heat-shrink operations. You can say goodbye to the high labor cost, excessive heat, and inefficiencies of other methods. The Focus-Lite™ **reduces the time** necessary to shrink most types of heat shrink tubing. It also **improves the process** control and **overall quality** of your shrink operation. The FLG3™ can be used for **high volume** benchtop applications and is completely **portable and mobile** for board mounted harnesses and tight space assemblies.

Focus-Lite™ technology uses radiant energy to shrink heat-shrink tubing in a fraction of the time of traditional methods.

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In every issue of Wiring Harness News Anixter will bring you informative articles about wire and cable technology.

PHOTOVOLTAIC  
WIRE (UL)

Photovoltaic wire, also known as PV wire, is a single-conductor wire used to connect the panels of a photovoltaic electric energy system. PV systems, or solar panels, are electric-power production systems that capture sunlight in order to produce electricity through an energy conversion process. Electricity is produced at the panel and wiring is needed to convey the electrical back to a collection point or piece of equipment. Photovoltaic wire is a specific kind of wire created for PV applications.

WHAT IS PV WIRE?

In the United States, PV wire is a single-conductor product that meets the requirements of UL 4703 Standard for Photovoltaic Wire. The current construction requirements outlined by UL 4703 are as follows:

- Conductor size: 18 AWG through 2000 kcmil
- Conductor material: copper, copper-clad aluminum, aluminum
- Insulation: XLPE, EPR
- Voltage: 600 V, 1 kV, 2 kV
- Sunlight resistant
- Temperature rating: 90°C wet,

105°C dry, 125°C dry, and 150°C dry

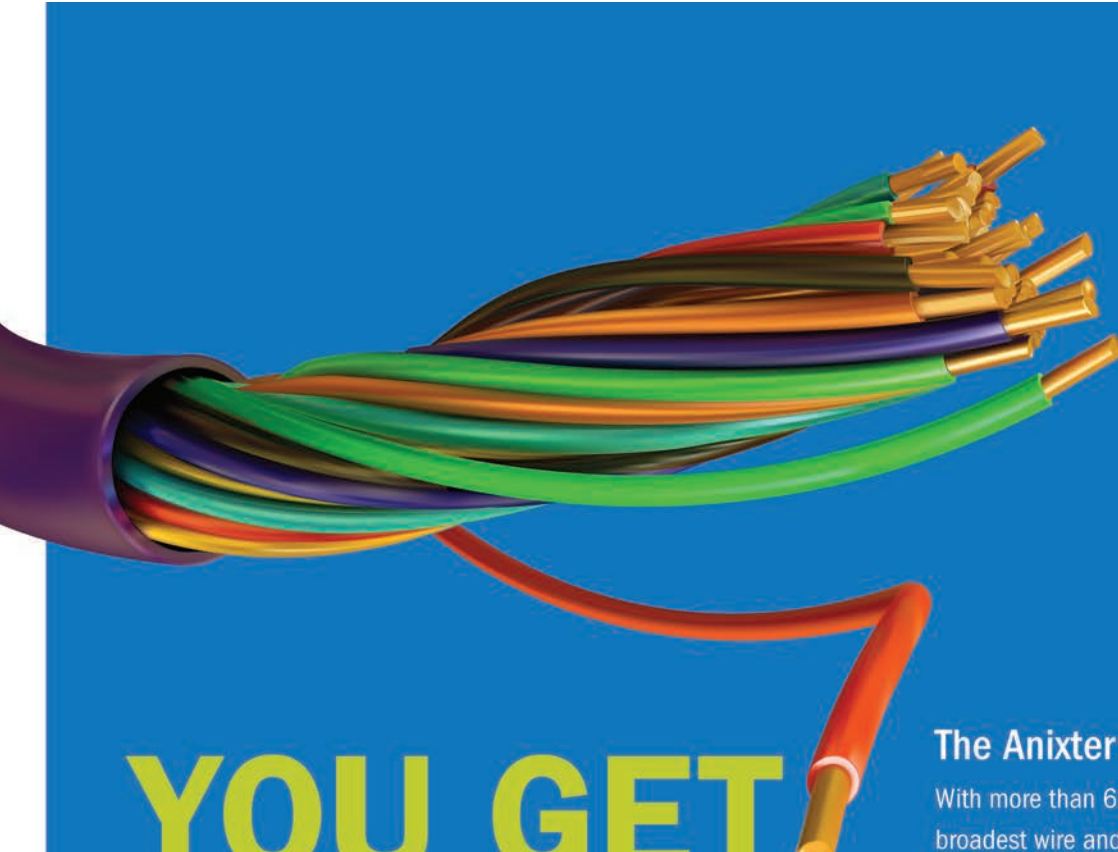
- Optional direct burial rating
- Optional multi-ratings: USE-2, RHW-2
- Construction: Single conductor, non-armored

PV wire sizes for panels are commonly constructed of copper conductors in 12 AWG, 10 AWG and 8 AWG sizes. Feeders sizes are commonly 1/0 AWG and larger, contain aluminum conductors and are rated 2 kV. PV wire 1 kV and 2 kV constructions often contain the same insulation thickness. 2 kV PV wires are a standard construction for systems that require cables rated over 600 V.

CODE WIRING REQUIREMENTS

The NEC (National Electrical Code) developed Article 690 Solar Photovoltaic (PV) Systems for guidance on electrical energy systems, array circuits, inverters and charge controllers for PV systems. The NEC is commonly used in the United States for various installations (local codes may apply).

The 2017 NEC Article 690 Part IV Wiring Methods permits various wiring methods in photovoltaic systems. For single conductors, UL Listed USE-2 (Underground Service



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Entrance) and PV wire types are permitted in exposed outdoor locations in PV source circuits within the PV array. PV wire is further permitted to be installed in trays for outdoor PV source circuits and PV output circuits without needing to be rated for tray use. Restrictions do apply if the PV source and output circuits are operating over 30 volts in accessible locations. In these cases, Type MC or suitable conductors installed in raceways are required.

The NEC does not recognize Canadian type designations such as RWU90, RPV, or RPUV cables for solar applications that do not contain a suitable dual UL listing. For installations in Canada, the 2012 CEC Section 64-210 provides information on the permitted wiring types for photovoltaic applications.

**PV WIRE ADVANTAGES**

PV modules operate at high temperatures and are exposed to a variety of environmental conditions. The NEC limits various PV array applications to USE-2 or PV wire. These cables need to meet the required

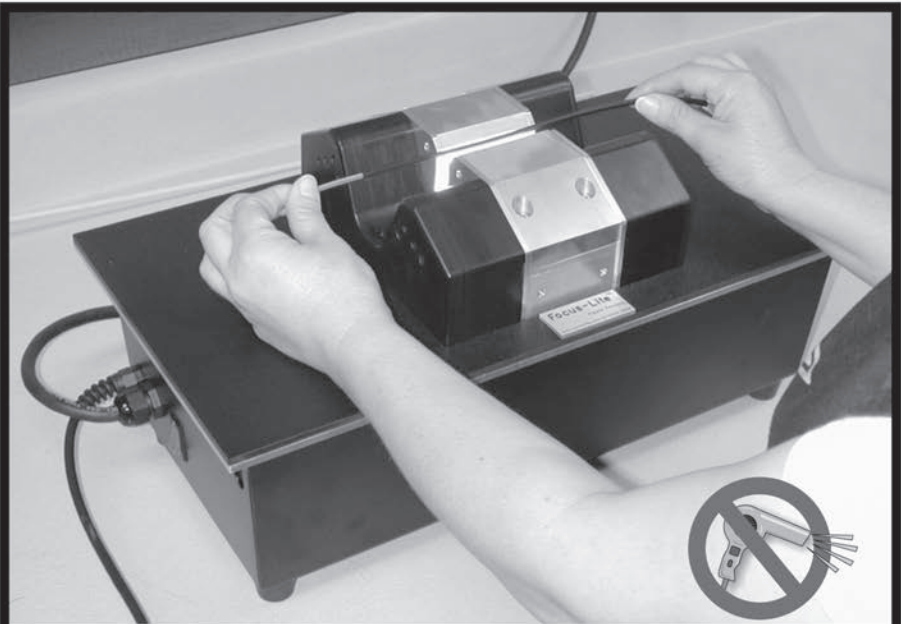
sunlight resistance and temperature ratings for the environment.

PV wires are manufactured for use in photovoltaic applications, while USE-2 cable types are typically manufactured for underground service entrance applications. Both cable types commonly contain XLPE insulation and can be sunlight resistant and/or rated for direct burial.

PV wire is set apart from USE-2 wire in terms of insulation thickness, voltage ratings and operating temperatures. PV wire contains thicker insulations suitable for protection against various harsh environments. USE-2 is rated up to 600 V, while PV wire is available in three voltage ratings: 600 V, 1 kV, and 2 kV. USE-2 cable types' maximum cable operating temperature is 90°C, while PV wire can be rated to higher temperatures.

PV wire is one of the few single-conductor wire types that can be rated over 600 V and be direct buried per the NEC without needing to be shielded.

Continued on page 34



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The Focus-Lite™ is equipped with an adjustable timer for repeatable shrinking, time after time. It also has a dimmer switch that controls the power for sensitive components. Visit our website at [www.judco.net](http://www.judco.net) and see our full line of Focus-Lite™ products.



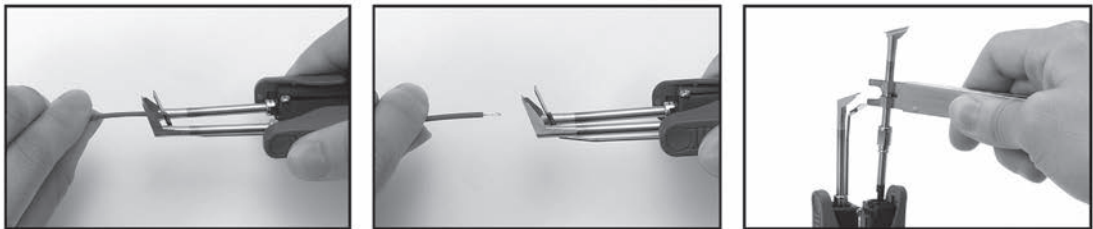
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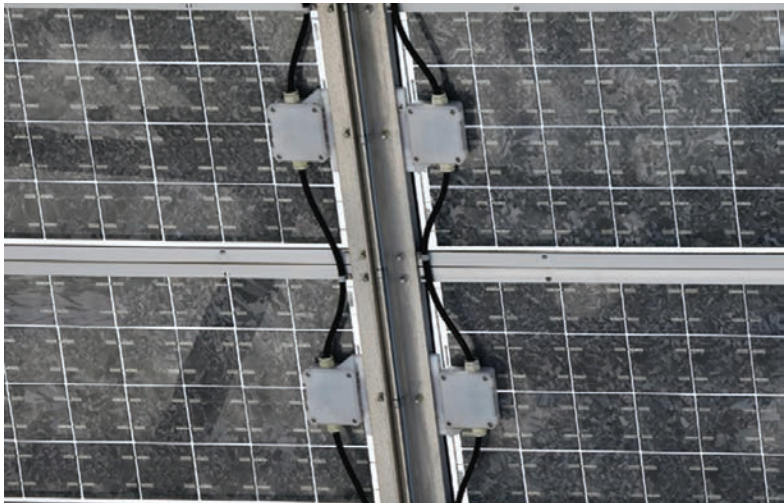
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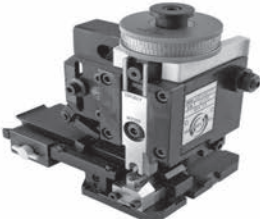
**WIRE MANAGEMENT**

PV modules are frequently pre-installed with single-conductor wires and quick-connect plugs for easy field installation. However, managing the wire installation can be difficult in harsh or tight environments or where rodents may be a problem. Installers need to ensure wires are secured and held in place to decrease wear and tear on the cable's outer layer.

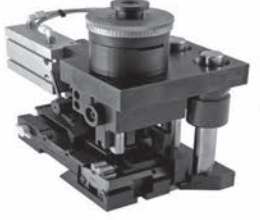
Installers commonly use wire clips that can hold wires to the module frames. Another solution used in the field is sunlight-resistant zip ties to secure the wires. Since PV is approved for use in trays, where rodents are a problem or where cables cannot practically be directly buried, wire trays can be attached to the bottom of a solar array above ground. Local or industry code may require further support and securing methods.



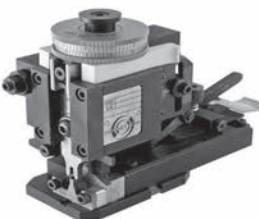
## APPLICATORS / CRIMPING PRESSES / TOOLING



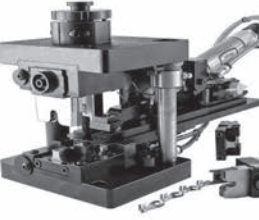
Mini  
Left to Right



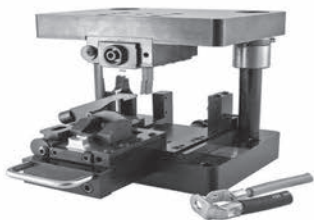
Mini (2 Post) Air  
Left to Right



Mini  
End Feed



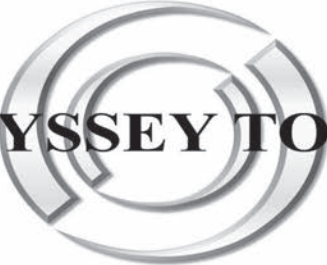
Med. Duty Air  
End Feed  
Quick Change Tool Pack



Heavy Duty Slide  
Quick Change Tool Pack



Med. Duty Slide  
Quick Change Tool Pack



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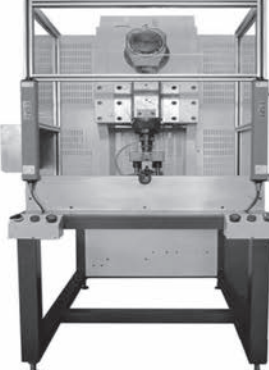
2.2 Ton



4 Ton



8 Ton



20 Ton

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## NEWS PLUGS continued



### Atkins & Pearce Weaving it's Way into 3rd Century

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Atkins & Pearce's commercial achievements span across the Machine Age, the Industrial

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Today, Atkins & Pearce's advanced, high-capacity footprint generates an annual output of just over 10 billion feet or enough narrow technical textiles to wrap the Earth 76 times.

Atkins & Pearce is most known for its long history of delivering dependable high quality textile components. They are viewed as a technology enabler across a wide range of technical textile platforms and are counted on for their vast textile know-how wherever industry intersects with high performance fibers.

"We strive to be viewed not as a supplier of parts, but as a highly reliable long-term partner willing to commit capital, expertise and excellence in execution. By doing this we materially enhance our customer's ability to achieve their growth strategy faster and with less risk," said Jeb Head, Atkins & Pearce-Owner and President.

Atkins & Pearce's limits in converting fibers is hard to define; however, the primary markets they support are:

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For more information about our 200th anniversary or to learn more about the company and its products, please visit [www.atkinsandpearce.com](http://www.atkinsandpearce.com) or contact Stephanie Smith at 859-356-4211 (Stephanie.smith@atkinsandpearce.com), or Thomas Dierker at 859-356-4266 (Thomas.dierker@atkinsandpearce.com).

# Tinned wires...

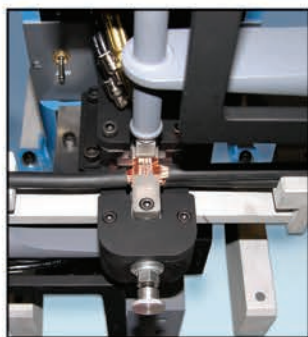
# ...can be ultrasonically spliced with our welders

60mm<sup>2</sup>

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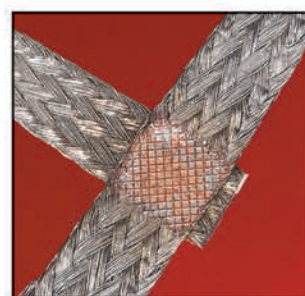
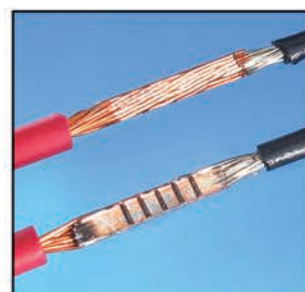
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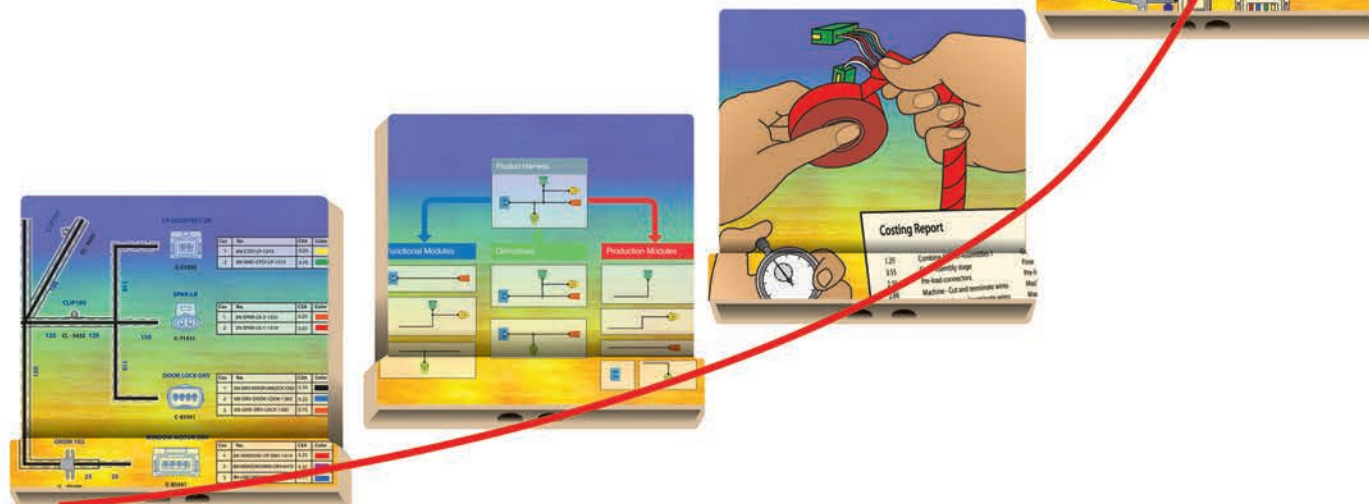
### Reduces harness manufacturing costs & turnaround time

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NEWS PLUGS continued



IPC/WHMA Announces A-620 Revision C

IPC/WHMA is pleased to announce that Revision C of the IPC/WHMA A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies has been released! The A-620 Standard provides the electronics industry with the most current criteria for the performance and acceptance of cable and wire harness assemblies. Revision C provides some significant changes that include:

- Criteria on Safety Wires
- Requirements for Individual Wire Seals
- Significant Updates and Improved Graphics
- Improved Section on Jack Posts
- A New Section on Raceways and Grommets

For further information please visit [www.ipc.org](http://www.ipc.org) or [www.whma.org](http://www.whma.org).

APX Labs Announces Corporate Name Change to Upskill

New branding reflects power of wearable technology in creating an enabled, connected global industrial hands-on workforce in the Fourth Industrial Revolution

APX Labs announced it has changed the company’s name to “Upskill” to better reflect its mission of elevating the impact of people in the modern industrial workplace.

Since 2010, APX Labs (now Upskill) has been the leader of enterprise wearable technologies, providing solutions to some of the world’s leading manufacturers, including Boeing, Johnson & Johnson, Rio Tinto, Jabil, Shell, Bell Helicopter, Lockheed Martin and GE.

Moving forward Upskill’s enterprise software platform, Skylight, will continue to deliver wearable solutions that increase worker productivity, decrease errors, and create a more connected and effective operation via wearable devices. As discussed in the last issue, Upskill helped Boeing drive productivity improvements in their wire harness assembly operations by 25 percent and improve quality by minimizing errors to virtu-

ally zero. Upskill’s change comes at a pivotal time for U.S. manufacturers. As more companies realize the benefits of connected workers and wearables, factories, warehouses and field operations globally are transforming to combine the best attributes of man and machine. Technologies such as Skylight will play a critical role in this transformation and the U.S. economy. And Upskill’s mission becomes even more important as the incoming Trump administration looks for ways to bring back manufacturing jobs and help close the skills gap for hands-on workers in the modern enterprise.

Heilind Partners with HARTING to Expand Connector Offering

Heilind Electronics, a leading distributor of electronic components, has added HARTING to its growing portfolio of connector manufacturers. With over 70 years of experience, HARTING is a global leader in the development and manufacture of industrial interconnect solutions.

Based in Germany, the HARTING Technology Group has production facilities in Europe, Asia, and the United States. Heilind will be conducting business with the U.S. facility in Elgin, Illi-

nois -- one of three HARTING locations that manufactures HIS (HARTING Integrated Solutions) backplane products and custom cable assemblies. As an authorized distributor of HARTING products, Heilind will offer the company’s connector and cabling

Continued on page 42



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## NEWS PLUGS continued

Continued from page 41

solutions, network components, and RFID systems. Key products include PushPull connectors, M8, M12, and 7/8" overmolded cordsets, and Han-Modular® rectangular connectors, which allow the combination of multiple media in a single connection point.

"We are pleased to be partnering with a global leader in the interconnect business," said Alan Clapp, Heilind's Vice President of Supplier Business. "HARTING's products will help



**Heilind has added HARTING to its portfolio of connector manufacturers. Above are some HARTING products Heilind will be stocking.**

fulfill our customers' requirements in high-demand markets

and critical applications. In order to provide the quickest and broadest access to this new line, we will be stocking over 2,800 line items over the next few weeks."

HARTING products are used in a variety of industries, including mechanical and plant engineering, broadcast and entertainment, factory automation, power generation and distribution, industrial electronics, and telecommunications.

To contact our Heilind sales team to request a quote for HARTING products, visit [www.heilind.com](http://www.heilind.com)

#### BURNDY Announces Business Development Team

BURNDY is proud to announce the creation of the new Business Development Team, lead by Mike Hennings. The goal of this new team is to be the leading provider of connector and tooling solutions to targeted vertical markets while leveraging our product breadth and depth.

The new Business Development Specialists to cover these Top End-Customers are:

- Renewable Specialist - Melissa Dailey

- Oil & Gas Specialist - Damon Dotson

- Telecom/Data Center Specialist - Mike Hennings, Business Development Manager

- Utility Specialists Transmission - Gary Ditroia

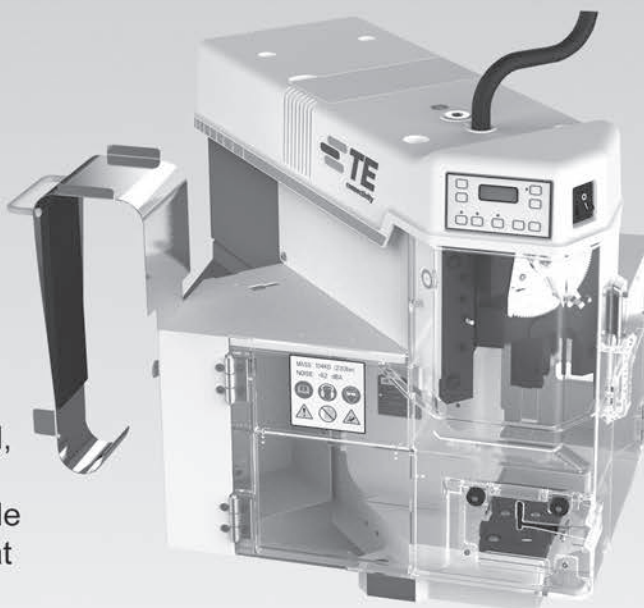
- Utility Specialists Distribution & Substation - John Vann

- Tooling Specialist - Bob Poirier

## AMP-O-LECTRIC MODEL G II TERMINATOR

TE Connectivity's (TE) Model G II is the latest and most advanced design in the long-standing series of their AMP-O-LECTRIC machines for terminating wire using reeled terminals and contacts. This unit is designed and built to continue the tradition of work-horse terminators from TE.

The new terminator improves key performance areas for operators. For operator convenience, TE improved access to, and significantly updated, lighting in the under cabinet and target area. A variable speed option was also added to provide more flexibility for those complex applications that benefit from slower ram and feed speeds.



The Model G II terminator is one of the quietest machines available and the improved guarding meets applicable CE and domestic safety requirements. The improved guarding also creates open access for quick and smooth installation of both end-feed and side-feed applicator styles.

### User Friendly

At the push of a button, you can power the motor on or off, jog forward or reverse, switch to split-cycle operation, turn the work light off or on, power the air feed on or off, or reset the batch counter. And, it's all reported on an LCD display. The controls will also detect and report errors in the machine, and stop cycling when a bad crimp is detected by the CQM II. The operator must then push the reset button to continue. The Model "G II" will accept all existing TE miniature applicators.

### Product Features

- Quiet operation
- Improved guarding and lighting
- Tool-less changeover of applicators
- Precision manual adjust for crimp height
- Total and batch counter
- Accepts all existing TE applicators, with minor modifications
- Reduced maintenance requirements
- Split-cycle operation
- Standardized 1 5/8 [41.3] stroke
- Operates on either 120 or 220 VAC, 50 or 60 Hz



**Visit with us in Booth 1651**



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BURNDY's new business development specialists team.

Each Business Development Specialist will manage top projects in their vertical with a focus on the end user to drive specification position. They will act as the point person for cross territorial communication and work with Product Management on developing new products.

Headquartered in Manchester, New Hampshire, BURNDY has over 90 years of dedicated customer support in both service and product. Our customers need to look no further than BURNDY for all their connector, tool, and accessory needs. BURNDY is the only manufacturer to have the BURNDY® Engineered

System of coordinating dies, connectors and tools. The three elements have been specifically designed to work together and engineered to meet stringent, accepted quality standards allowing the user complete confidence in the integrity of the connection.

For additional information, contact us at 47 East Industrial Park Drive, Manchester, New Hampshire 03109; call Customer Service at 1-800-346-4175; or visit our website at [www.BURNDY.com](http://www.BURNDY.com). Since 2009, BURNDY LLC has been a key brand under Hubbell Incorporated. More information can be found at [www.Hubbell.com](http://www.Hubbell.com).



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## NEWS PLUGS continued

**CableEye® 4-Wire Calibration Verification Board, CB52**

CAMI Research Inc. (Acton, MA) announces another new interface board for its CableEye cable and harness testing systems. Populated with precision resistors it allows users to determine

empirically whether the HVX optional, add-on, 4-Wire measurement function requires calibration.

Configuration

A leader in development of PC-based cable and wire harness, continuity and hipot test systems for over 20 years, CAMI offers the CableEye suite of products complete with accessories – including connector boards. The selection of these test fixture boards is constantly growing and is currently

numbering over 60 – most of which are populated with ‘families’ of connectors. The CB52 attaches to the tester like a regular connector board.

Sold as a SINGLE board, the CB52 contains a series of eleven precision low-value resistors for checking against the system’s calibrated values. The precision resistor values span a significant enough range to provide complete confidence of valid calibration.

Note that this is a ‘Plug & Play’ interface, requiring NO 4-wire fixturing to operate.

Application

The CB52 is intended for periodic calibration verification of the Kelvin 4-wire resistance measurement module – an optional, add-on module that may be purchased with any new hipot system, or added to an existing

high voltage tester as an upgrade. To ensure that 4-wire resistance measurements remain accurate, CAMI recommends running the verification check every quarter. A 4-wire measurement module that is out of calibration will give inaccurate results. Some (maybe all) resistance measurements will be incorrect. Consequently, it may Pass what should Fail and, conversely, Fail what should Pass. In other words product yield will be contaminated due to unreliable measurements.

Companies interested in quality product and maximum yield will ensure their testers are calibrated. Those with quality certifications such as six sigma or ISO9001 will be required to calibrate. The CB52 will allow these quality-focused companies to optimally determine when calibration is necessary and to schedule maintenance accordingly.

For further information email: [sales@camiresearch.com](mailto:sales@camiresearch.com) or visit [www.camiresearch.com](http://www.camiresearch.com)

**Mentor Graphics Expands Comprehensive ISO 26262 Qualification Program**

Building on its extensive portfolio of electrical and electronic design automation solutions for automotive markets, Mentor Graphics Corporation

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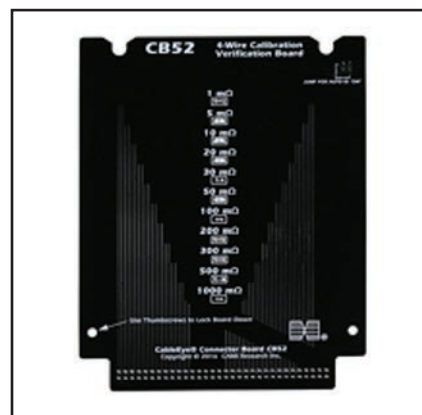
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**CableEye® 4W Calibration Verification Board**

Continued on page 46



**Visit with Schiffer Corporation in Booth 1259**  
**Visit with Carpenter Manufacturing Inc In Booth 1305**

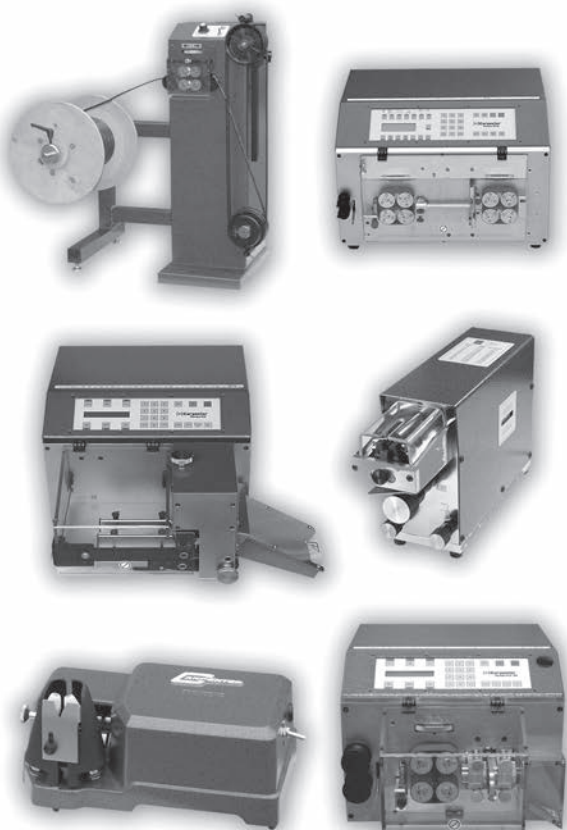
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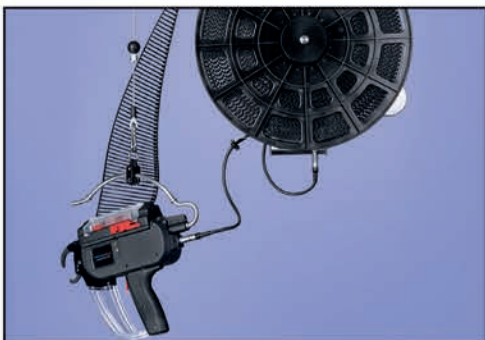
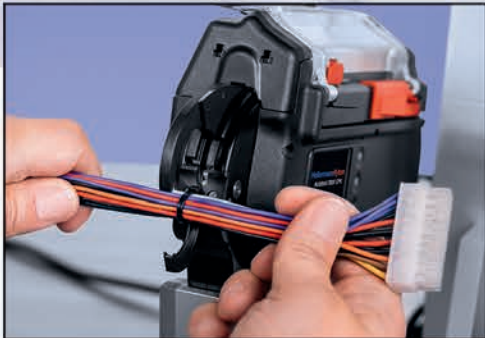


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NEWS PLUGS *continued*

*Continued from page 44*

(NASDAQ: MENT) introduced Mentor Safe – one of the industry's broadest and most comprehensive ISO 26262 qualification programs.

The program includes the Nucleus® SafetyCert™ real time operating system, the Volcano™ VSTAR AUTOSAR operating system and BSW stack, and a growing array of ISO 26262 certified documentation and qualification reports for Mentor tools supporting design and verification of system-on-chip

(SoC), system, mechanical and thermal applications. The Mentor Safe program enables customers to integrate Mentor tools and software into their safety-critical designs and verification flows at all criticality levels up to and including ASIL D.

The latest design automation products certified under the Mentor Safe program are from the company's portfolio of Tessent® silicon test and yield analysis tools. Independent compliance firm SGS-TUV Saar recently certified the Software Tool Qualification Reports for nine Tessent® solutions for any tool confidence level (TCL).

Mentor is a long-established auto-

motive systems supplier, engaged with nearly every leading OEM and Tier 1 supplier, and providing design tools and embedded software in the areas of connectivity, electrification, autonomous drive and vehicle architecture. The company's distinguished track record in supplying automotive-grade electrical and electronic systems spans nearly 30 years.

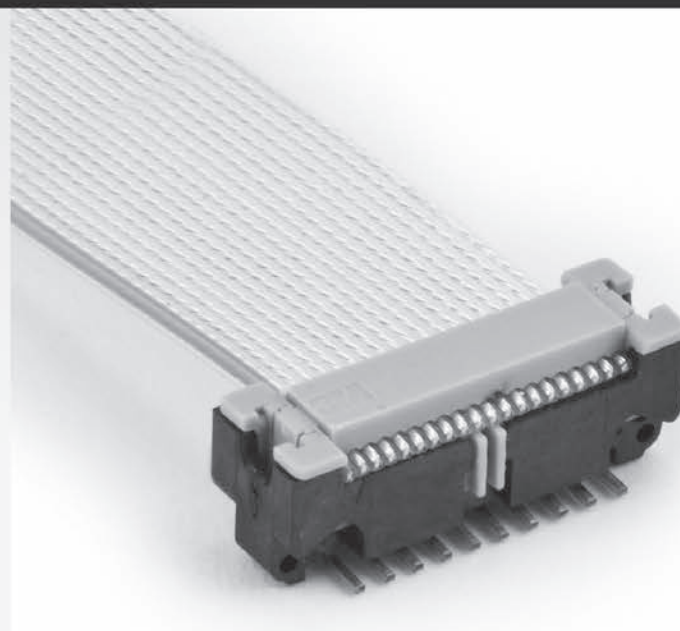
"As vehicles grow increasingly sophisticated, functional safety has become an essential market requirement for electronics software and hardware design technologies," said Brian Derrick, Vice President and General Manager at Mentor Graphics. "We es-

tablished the Mentor Safe program to help our customers rapidly navigate the increasingly complex process of functional safety certification with confidence, allowing them to spend more time creating value-added solutions that help to differentiate and win in highly competitive markets."

Mentor Safe products will ship with comprehensive enablement collateral providing descriptions and best practices information in the use of program-qualified products. More information on the Mentor Safe program and certified Mentor Graphics products and solutions is available at <http://go.mentor.com/mentorsafe>.

## 3M™ CABLE-TO-BOARD 1.27MM (.050") CONNECTOR SYSTEM, 450 SERIES

The 451 and 452 Series interconnect products from 3M also deliver on performance, reliability and cost savings. The ribbon cable wiremount socket assembly incorporates 3M insulation displacement contact (IDC) technology in the connector, helping maintain secure connections and high signal integrity. The IDC connector's mass termination capability allows the termination of 30 lines in a single cycle, reducing the need for expensive automated termination equipment and allowing manual cable assembly operations. Available friction-latch configurations and an optional strain-relief accessory can further increase connection reliability. An optional, unique header ejector latch mechanism provides positive latch and ejection capability with minimal size addition.



The shrouded boardmount header is available in a variety of configurations in order to maximize design flexibility while minimizing PCB footprint. Tape-and-reel packaging for the SMT version of the header is available for automated placement applications, and PCB standoffs help enable pin-in-paste processing capability. The 1.27mm 451 and 452 series interconnect products from 3M deliver on performance, reliability and space savings.

### 451 and 452 Series Features:

- Extremely small: .050" pitch
- Enables mass termination
- Innovative header ejector latch mechanism
- Multiple configurations available

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# Mando Can Do.



When Armando Zacarias goes out on a Eubanks service call, unusual things happen.

“Once I helped round up a cow that got loose in a customer’s plant.

“Another time, while driving to a customer’s site, our rep’s car caught fire. We eventually arrived there that night and finished the job in time for the morning shift,” Mando reports.

Customers report something unusual too: Mando’s “can-do” attitude.

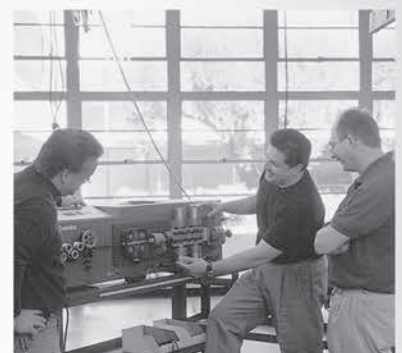
George Price, vice president of J&M Products, for example, writes how Mando takes time to answer questions, explain machine operation and even gave “tips on stripping some shielded cable that others said could not be done.”

“Can’t be done” is not in Mando’s vocabulary—either English or Spanish. On his own initiative, he solves problems, leads training classes, helps boost plant efficiencies, and makes lasting friendships while doing it.

Mando exemplifies the Eubanks

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# Paperless Manufacturing Solutions for ECOs in Wire Harness Manufacturing

By David Oeters  
Corporate Communications for  
CIMx Software

Wire and cable harness companies must deliver under very short lead times to meet customer demands. This puts pressure on manufacturers to build quickly and error-free. Customers also require Engineering Change Orders (ECOs) on harnesses – a costly and time-consuming process. The manufacturer often bears the cost of the ECO to stay competitive, especially if they cannot calculate the cost of production.

Without the right tools, customer requirements increase scrap and rework, delay shipments and cause material shortages.

To keep costs low and retain customers, wire harness manufacturers can only pass on production charges when absolutely necessary. A system that estimates the original production costs, manages changes to the order and calculates the resulting costs is critical; otherwise, the risk of errors and cost overruns dramatically increases.

## Visibility of Work and Cost

Wire harness manufacturers need a solution that provides complete visibility of production and cost factors, so a real-time assessment of the impact of an ECO can be made the moment it is received. Mistakes occur when supervisors are forced to make a best-guess estimate on how to manage the change.

Accelerating and error-proofing communication between the sales

group, engineering and operators is critical. When engineers and supervisors are forced to walk the shop floor to manage a change order, delays, errors and wasted time drive up production costs.

Companies using paper to manage production cannot support the demands of modern wire harness manufacturing. Paperless Manufacturing provides the only solution that directly addresses the core needs these companies have, simultaneously meeting the stringent requirements of their customers and increasing profit margins.

## Solving ECOs for Wire Harness Manufacturers

Paperless Manufacturing automates ECOs, eliminating production errors, controlling costs and making production processes predictable.

Wire harness companies using Paperless Manufacturing start by controlling their existing work, increasing accuracy, productivity, and their ability to predict costs. As they digitize production planning, companies maximize their use of existing planning, further controlling costs.

Paperless Manufacturing gives every member of the team immediate access to the work required. Operators access just the area of the production plans they need to complete their work; as changes are made, they are immediately available to the shop floor, eliminating the possibility of building to the wrong information.

By eliminating errors in production, all orders are made to specification and scrap becomes an issue of the past. When scrap is eliminated, many companies find it is easier to

maintain inventory control. Inventory is used only where needed.

## The Results of Paperless Manufacturing

Paperless Manufacturing enables manufacturers to manage the entire production process from a single location. When a customer calls with an order change, the sales or customer service team can evaluate the customer's change request based on the current cost, schedule and production numbers.

Engineers use current production information to make the required changes or hold production until new requirements are available. The production floor continues work on other orders as they wait on the new requirements, increasing efficiency. Paperless Manufacturing facilitates communication for the team, eliminating delays, confusion or errors typical of paper-based production operations.

Paperless Manufacturing enables companies to process customer change order requests quickly and without mistakes. With digital communication between operators and engineers, manufacturers significantly reduce scrap, rework and expedited shipping costs.

Companies using Paperless Manufacturing react to change with accuracy and efficiency, error-proofing their processes and improving profitability.

Contact CIMx Software today at [info@cimx.com](mailto:info@cimx.com) for more information on Paperless Manufacturing for Wire Harness Manufacturers, or visit us on the web at [www.cimx.com/wire-cable-harness-assembly](http://www.cimx.com/wire-cable-harness-assembly).

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# Can You Keep Up?

## Mechtrix Prefeederers Optimize Your Capabilities

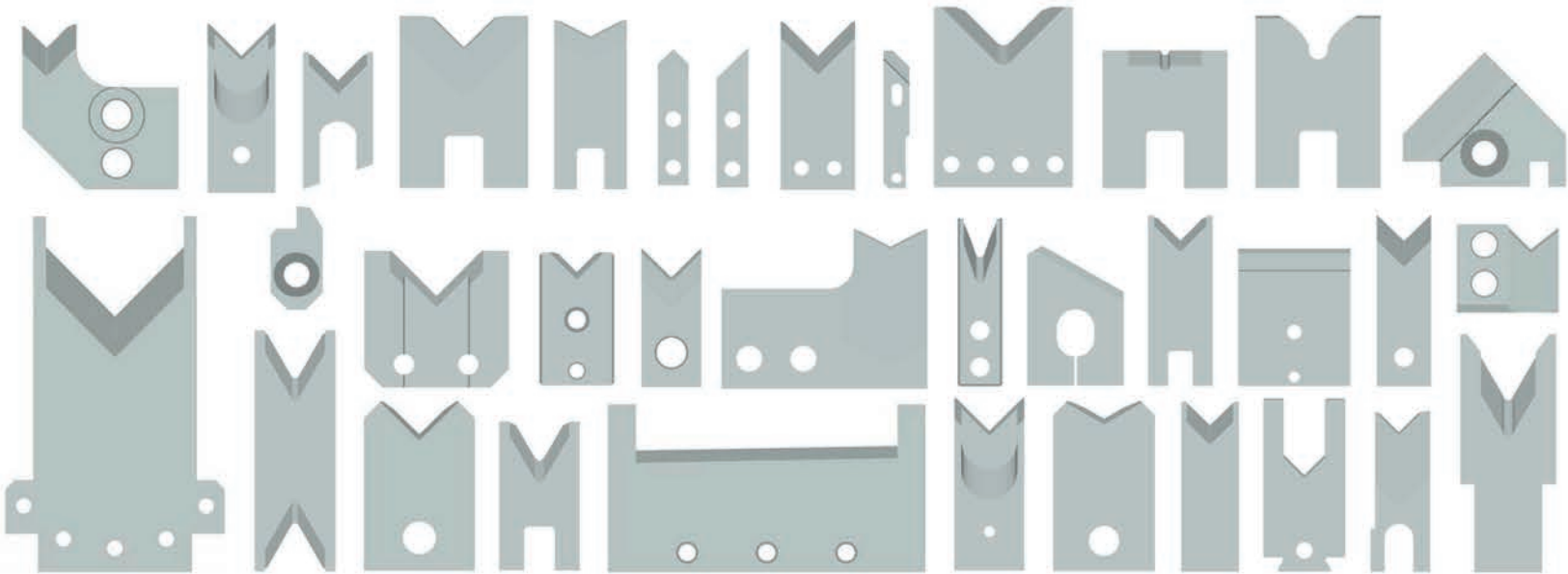
- MPF-33 Prefeederers for bench-top wire processing machines
- MPF-35 Prefeederers for high speed fully automatic wire processing machines



## Mechtrix Stripping Blades

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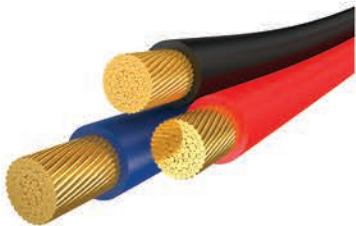
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## Mechtrix Equipment

Mechtrix has designed a number of unique machines to solve specific wire processing problems. These machines range in complexity from our patented center stripping machines to terminal paper winding machines and include the following:

- |                                               |                                          |
|-----------------------------------------------|------------------------------------------|
| • Wire Prefeeder Equipment                    | • Terminal Carrier Strip Cut-off Devices |
| • Heavy Duty Benchtop Wire Stripping Machines | • Terminal Paper Winding Machines        |
| • Automatic Center Stripping Machines         | • Terminal Applicators                   |



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NEWS PLUGS continued

BOSTONtec Improves  
Harness Assembly Productivity

The result of a three-year cooperative development project with major wire harness fabricators, the BOSTONtec Wire Harness Board Frame is designed to help increase operator productivity and reduce workplace injuries.

“While many wire processing tasks are now highly automated, the method of dressing boards continues to be labor intensive,” says Rob Doucette, BOSTONtec applications engineer. “Our wire harness board frame workstation moves the task to the operator reducing movement and increasing

comfort.”

OSHA estimates employers spend \$20 billion a year on work-related musculoskeletal disorders caused by lifting heavy items, bending, reaching overhead, pushing and pulling loads, working in awkward body postures and performing the same or similar tasks repetitively.

The BOSTONtec height adjustable frame raises or lowers at the touch of a button so operator can work comfortably from sitting or standing position. The unit has an electric or manual tilt mechanism to easily adjust the angle of the boards to multiple positions. This flexibility not only improves productivity and operator comfort, companies also notice an increase in wiring accuracy.

BOSTONtec focuses on providing quality, ergonomic workstations and



accessories designed to increase productivity and improve quality of work life. With more than 20 years of design and manufacturing experience, we are

a leader in modular workstations and customizable designs to meet the specific requirements of fulfillment, assembly, medical and light duty applications. BOSTONtec is a member of Wire Harness Manufacturer's Association (WHMA). For more information, or to contact BOSTONtec, visit the website at [bostontec.com](http://bostontec.com).

Artos Engineering  
Offers CAO Software  
Interface for Cr.11  
and Cr.22 Systems

Artos Engineering Company, a Brookfield-based manufacturer of wire processing equipment, now offers an optional Cutting Area Optimization (CAO) software interface for its Cr.11 and Cr.22 lines of automated wire crimping systems.

The CAO software solution from DiIT of Germany ([www.diit.de](http://www.diit.de)) is the leading manufacturing execution system used to optimize wire harness production in the cutting and preassembly areas and can control cutting areas between 2 and 200 machines.

“We have responded to customer demand and are pleased to offer an interface with CAO,” says John Olsen II, Artos Engineering Company president. “The CAO software solution is flexible, scalable and efficient and because it’s modular, it can be used by small as well as larger companies.”

“CAO interfaces installed on Artos CR.11 and CR.22 systems help customers realize significant efficiencies in setup, machine utilization, quality control, scheduling, labor costs and inven-

Continued on page 52

BOSTONtec  
Ergonomic Workstations

WIRE HARNESS BOARD FRAME  
The frame is the result of three years of cooperative development with several major wire harness fabricators

Electric height adjustable

Allows operator to work comfortably sitting or standing

Manual tilt adjusts boards from horizontal through vertical position

Decreases repetitive motion injuries

Increases wiring accuracy

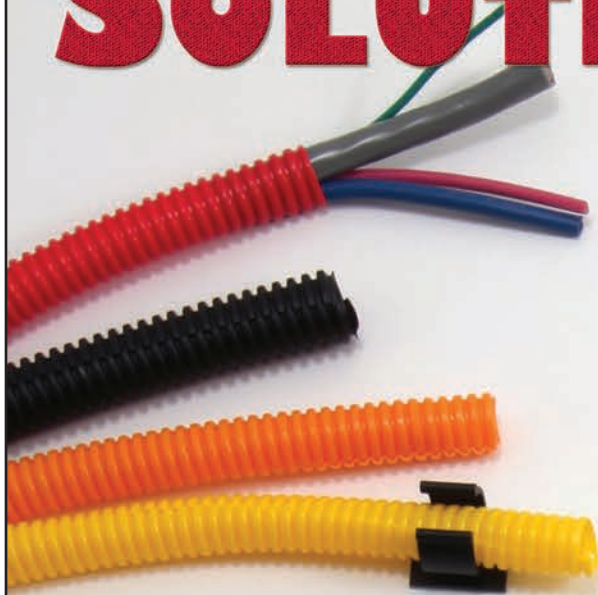
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NEWS PLUGS continued



Continued from page 50  
tory,” says Olaf Hermann of DiIT AG. “We’re looking forward to working with Artos as we continue to help customers optimize their wire harness production processes.”

Artos, in cooperation with DiIT, will provide interface updates for the CAO software solution on a continuous basis.

Founded in 1911 and based in Brookfield, Wis., Artos Engineering Corporation is an independently-owned manufacturer of wire processing equipment serving the aerospace, automotive and manufacturing industries.

For more information, visit [www.artosengineering.com](http://www.artosengineering.com).

Molex Showcases Impulse™ Orthogonal Direct Backplane Connector

Molex debuted the Impulse™ Orthogonal Direct Backplane Connector System at the DesignCon 2017 Expo, in Santa Clara, CA. Designed for high-density data center applications, the new Impulse connector system supports data rates of 56 Gbps NRZ and 112 Gbps PAM4 with superior signal integrity.

The 2.00mm column-to-column pitch of the Impulse system delivers high-speed connectivity in a compact size. The innovative signal interface improves insertion loss over traditional in-line interface, pushing resonance beyond 35 GHz.

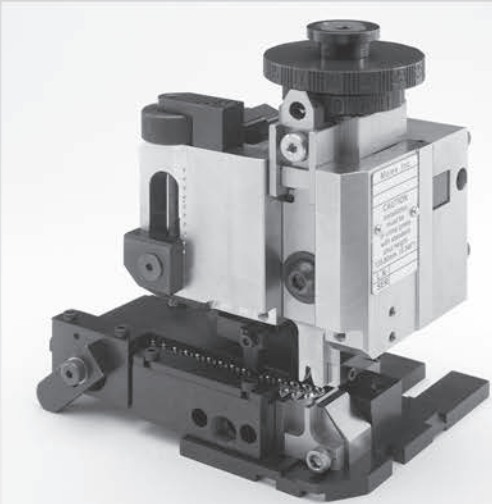
“Data centers are expected to deliver ever-faster data rates. However, as speeds increase, insertion loss and ICR margin become issues,” said Bratislav Kostic, new product development manager, Molex. “Impulse orthogonal direct connectors offer exceptional signal integrity performance, improved airflow and cost savings by eliminating the need to build and install mid-plane connections.”

The Impulse connector design provides an innovative contact interfaces in which all signal contacts are pre-loaded, positioned and protected in individual slots. Robust guiding features ensure proper connector alignment and mating.

The Molex OD portfolio of backplane connectors includes the Impact™ (sub 25 Gbps) and Impact™ zX2 (28 Gbps), Impel™ (40 Gbps) and Impel™ Plus (56 Gbps), and Impulse (56/112 Gbps). All of these scalable solutions deliver a stable channel impedance and help decrease system-level applied costs by eliminating the chassis mid-plane.

“As data rates climb, data centers need easy scalability in equipment to minimize future infrastructure investments. Impulse orthogonal direct backplane connectors are forward compatible to meet future data rate needs without having to replace infrastructure,” adds Kostic.

For more information about Molex orthogonal direct backplane connectors, please visit [www.molex.com/link/impulse.html](http://www.molex.com/link/impulse.html).



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The FineAdjust applicator offers minimal setup time, is versatile, reliable, easy to install and is designed for mid-volume to high-volume, semi or fully-automatic operations.

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## Crimp Monitors – Training and Support

By Mike Reeve  
VP Business Development  
OES Inc

The crimp quality is critical to every connection point in the electrical wire harness. Crimp Monitors continue to be the technology that wire harness manufacturers depend on for assurance of crimp quality. However crimp monitor performance, capability, and function in the manufacturing environment is not always completely understood.

The capability of the crimp monitor to effectively detect crimp defects, without the consequence of causing unnecessary scrap, is influenced by the following three elements:

- The repeatability of the crimping process.
- The crimp monitor's capability and setup.
- The headroom of the crimp.

These three elements can be further separated into sub-categories for a clearer insight into the crimp monitor performance. For example, the repeatability of the crimp process is influenced by the equipment and setup (crimp press and applicator tools), the materials being crimped, and the wire presentation. When

a crimp monitor issue arises, such as defects not detected, good crimps called bad, or a combination of both, knowledge and experience is critical for navigating to the actual root cause (or causes) for fast and proper corrective action on the plant floor.

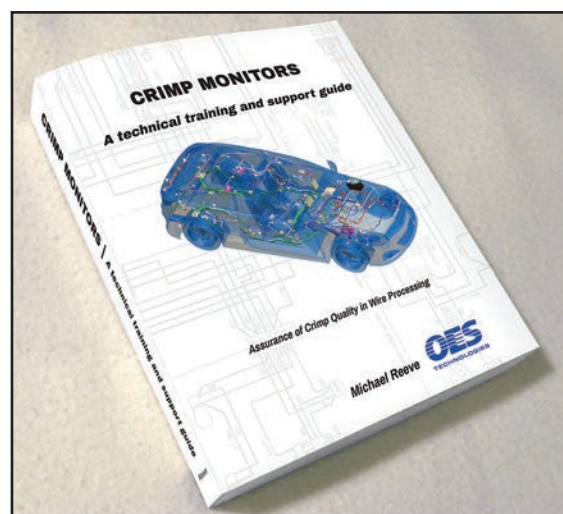
The crimp monitor's capability and setup is the second category, and can be determined and understood by benchmarking. This is a process of testing the crimp monitor capability to differentiate good crimps from the target crimp defects. Benchmarking will reveal the crimp monitor capability (and also the limitations) for the crimping process.

The third category is the headroom which is a measurement for specific crimping process. The headroom is important to understand because it can expose crimp monitoring performance issues.

Crimp monitors have limitations for certain crimping processes. In some cases, alternative

and complimentary sensing technologies are required to provide effective defect detection, and that will meet the new automotive crimp specifications. It is important to understand these crimp monitor limitations so that realistic performance expectations are set, and to know when to consider alternative and complimentary sensor technologies.

This brings me to the purpose of this article. For over 20 years OES has been supplying crimp monitor technology to the wire processing industry. We have had the privilege of working side by side with many machine suppliers, wire harness manufacturers, and central engineering groups to develop, test, and advance crimp monitor technology. Much knowledge and experi-



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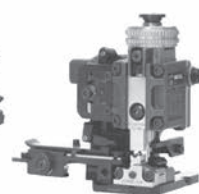
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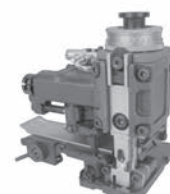
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ence has been gained and shared. I feel that this is now an appropriate time to communicate the knowledge and experience that OES has gained on this subject. “Crimp Monitors – a Technical and Training Guide” is a book that I have written with the support of our technical team, and also with input from customers, colleagues, and partners within the industry.

This book is intended to provide the reader with a practical understanding of crimp monitors, their purpose, function, and importance for the assurance of crimp quality in wire processing. Many commonly asked and re-occurring questions and misconceptions are explained including how to optimize, benchmark, and validate crimp monitors for different crimping processes.

Connectivity of crimp monitors to a central crimp data management system is an effective way to improve operational efficiencies, productivity, and profitability in this highly competitive industry. This book provides a guideline and comprehensive plan on how to implement a crimp data management system.

This book is also intended to serve as an educational tool and quick reference guide to help support operations personnel to understand crimp monitor systems, their application for different crimping equipment and processes, and best practices for their optimum performance on the plant floor.

I am hopeful that this will be a helpful resource and reference guide to the wire processing industry for years to come. For further information visit [www.oes-inc.com](http://www.oes-inc.com).



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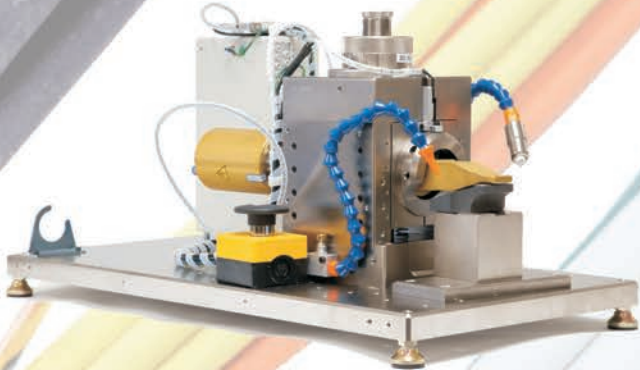


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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 29

mittee, DLA (MIL-DTL-38999, MIL-DTL-83723, MIL-STD-1760, and many others).



**SAE AE-8C2 Terminating Devices and Tooling Committee:**  
The SAE AE-8C2 Committee is the Preparing Activity and has ownership of the following documents which deal with Terminals, Terminal Junctions, Splices, and Tools for all Committee Standards.

- AS5259 Large Gage Crimp Tool
- AS7928 Terminal and Splice Specification
- AS25036 & AS20659 Insulated & Uninsulated Terminals
- AS22520 Crimp Tools
- AS81969 Ins/Rem Tools
- AS81714 Terminal Junctions
- AS81790 Clamps, Straps and Hardware
- AS5768 Wire Strippers
- Liaison with UL, NEMA & other Private Organizations

**SAE AE-8D Wire and Cable Committee:**  
The SAE AE-8D Committee is the Preparing Activity and has ownership of the following documents which



deal with Wire, Cable, Conductors, Specialized Tubing, and other Materials that apply to Wire and Cable Technologies.

- AS22759 High Performance Wire
- AS29606 Conductor
- AS50861 Wire
- AS5419 Thermocouple Conductors
- AS5756 Multi-Conductor Cable

- AS6070 High Speed Data Cable
- AIR6894 Laser Wire Stripping Tools and Methods
- AS81044 Crosslinked Wire
- AS85485 Filter-line Wire
- AS23053 Sleeving and Tubing



**SAE AS-3 Fiber Optic Committee:**  
The SAE AS-3 Committee is the Preparing Activity and has ownership of the Fiber Optic Component and Cable Standards that comprise the Aerospace fiber Optic Technologies. Many Information Documents for the Selection, Use, and Maintenance of Fiber Optics have evolved from this Committee.

- AS5382 Fiber Optic Cable
- AS5590 Connectors for Fiber Optic Terminus
- AS5659 WDM LAN Standard
- AS6479 Fusion Splicing Equipment and Process
- MA5405 Fiber Optic Splice
- Liaison with ARINC and Military Groups

**Standards Committee work is a Volunteer Function and Service on a Standards Committee is for the purpose of Technical Contributions.**  
Each Participant on a Standards Committee is reminded that He/She is serving as an Individual, Not in the Interest of a Commercial Organization, and they are present to offer Technical Expertise to the Process of Developing Standards.

**Where is the Payback?**  
Most large Aerospace companies/organizations develop and manage their own private standards, but there are significant cost savings when an Industry standard can be written into their process & procurement.  
Government specifications are designed to primarily serve the Military need which is typically maintenance, support, and procurement.

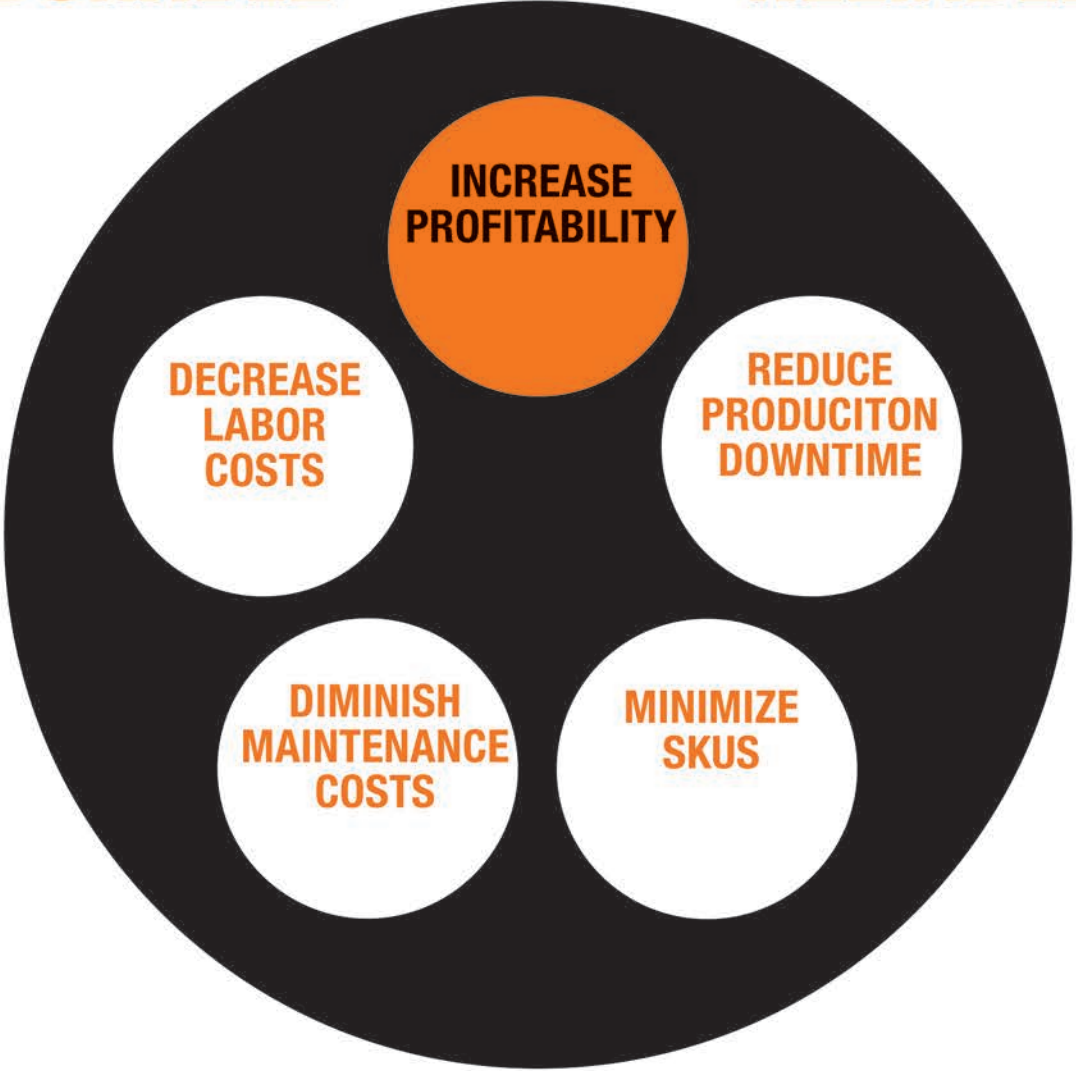


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Private specifications from organizations like SAE, ARINC, NEMA, IEEE, EIA, and IPC provide a good solution to those needs, but they don't happen without knowledgeable volunteers who will dedicate the time and expertise to writing, checking, and editing each standard.

Understanding the Scope of Aerospace Wiring Components:

How Many Connectors and Wiring Components does an Aircraft have?

Within the standards, there is usually a base standard (Referred to as the Procurement Standard) with the basic information, tests, materials, qualification, and some configurational requirements. In addition to the Base standard, there are usually Detail Standards. The Detail Standards can often number into the hundreds. Above is a listing of the quantities of detail standards in a few of the common groups:



E2C Hawkeye – 8,747 Connector P/Ns

|                  |               |                      |
|------------------|---------------|----------------------|
| • Wire:          | AS22759       | 196 Detail Standards |
| • Connectors:    | MIL-DTL-39012 | 126 Detail Standards |
|                  | MIL-DTL-38999 | 4 Series,            |
| • Contacts:      | AS39029       | 125 Detail Standards |
| • Backshells:    | AS85049       | 134 Detail Standards |
| • Terminal Lugs: | AS7928        | 45 Detail Standards  |

Standards that Serve as Guidelines:

AS50881(Aerospace Vehicle Wiring) is sometimes referred to as the "authorizing" document for aerospace manned and unmanned vehicle wiring. Approved components and practices are covered by this document, and AS50881 compliance is a contract requirement in most Military vehicle procurement contracts.

AS50881 is discussed and updated frequently by the SAE AE-8A Standards Committee.

The NA-01-1A-505-1 Military Wiring Process Manual serves as guidelines for assemblers and maintainers.

- The NA-01-1A-505-1 is the Process Bible for Military Aircraft Wiring.
- It is Diligently Updated, Maintained, & Managed By NAVAIR, Pax River, MD.
- These are Joint Services Documents.
- There are Four extensively detailed Volumes, with the following Titles:
  - o Vol. 1 - Aircraft Electric and Electronic Wiring
  - o Vol. 2 - Aircraft Circular Electrical Connectors and Accessories
  - o Vol. 3 - Aircraft Rectangular Electrical Connectors and Accessories
  - o Vol. 4 - Aircraft Fiber Optic Cabling

Continued on page 58



UH-60M Blackhawk 1,978 Connector P/Ns



C130 – 1,791 Connector P/Ns

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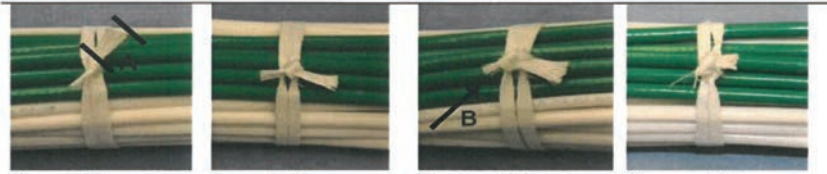
# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 57

## MIL-HDBK-522 Inspection Guidelines

This is essentially the Military counterpart to IPC/WHMA-A-620B. This document was published to provide guidelines for Inspecting Aircraft Wiring. This Document is being used for Inspection of Maintenance, and for Airworthiness Review. An example of the format and content are as follows:

MIL-HDBK-522



**Acceptable**

The ends of the tying material should be approximately even in length, cut square at the ends and measure between 1/4" and 1/2" from the knot as shown (A).

**Acceptable**

The cut ends of the knot are uneven in length indicating poor trimming technique. However, the length of both ends are within the allowable limits.

**Unacceptable**

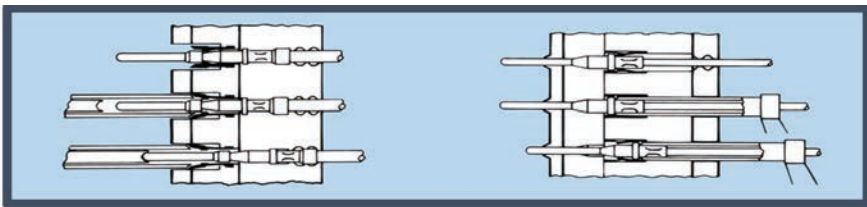
The tying material is trimmed short of the required 1/4" (B) minimum length.

**Unacceptable**

The loose ends of the spot tie knot have been trimmed closer than the 1/4" minimum requirement.

## The Evolution of Connectors:

Rear Release Contact Connectors are preferred on the basis of mating errors, and superior ability to survive the harsh environments of shock and vibration. But, MILSPEC front release connectors came first. In the 1960s there were three highly used MILSPEC Connector Series which were the MIL-C-26482, the MIL-C-5015, and the MIL-C-26500. A common rear release connector standard was developed which had three configura-



tions to mate with the front release MILSPEC Connectors. These connectors were MIL-C-83723 Series 1, 2, & 3 were created to be a Rear Release Connector which was Inter-matable, and Inter-mountable with MIL-C-26482, Mil-C- 5015, & MIL-C-26500 Respectively. Currently the front release and rear release versions of these connectors are available, and are available as MIL-DTL-83723

The Terms Front Release and Rear Release refers to the method by which the removal tool unlocks the contacts, and removes the contacts from the connector assembly. Rear release connectors have the ability to seal around the contacts, and avoid mismatching of the pin and socket contacts. This is a common problem with front release contact systems.

During the same time period, there were two new rear release connector series emerging in the Aircraft Industry, and being introduced as MILSPEC Connectors. They were MIL-C-81511, and MIL-C-38999.

They both currently exist & are commonly used in Aerospace systems, but the MIL-DTL- 38999 is by far the most popular circular connector in the history of Aerospace.

There are four series in the family of MIL-DTL-38999 Connectors, but the Series III is by far the High Runner.

## The Four Series of MIL-DTL-38999:

- **Series 1:** Bayonet Coupling, Odd Shell Size Designators (9 thru 25), Scoop-Proof.
- **Series 2:** Bayonet Coupling, Even Shell Size Designators, (8 thru 24), Low Profile, Not Scoop Proof.
- **Series 3:** Triple Start Coupling, Fluted Coupling Ring, Odd Shell Size Designators (9 thru 25), Scoop-Proof.
- **Series 4:** Breach Coupling, Odd Shell Size Designators (9 thru 25), Scoop-Proof.

• All series are environmental sealing connectors.

• There are many specialized versions of the MIL-DTL-38999 Connector Family. One such variant is the MIL-STD-1760 Lanyard Release Connector System. This is the power and data interface with all Under-Wing Armament and Mission Stores which are releasable. Prior to publishing the MIL-STD-1760 Standard Interface document, connector interface made it impossible to attach weapons and other payloads to some aircraft.

## Color Bands on Connectors

o Blue Bands on Connectors generally indicate the connector has contacts which release from the rear of the connector (Wire Side).

o Connectors without color bands would likely indicate the connector contacts release from the front (Mating Side) or have Solder Contacts (not releasable).

# Wardwell Harness Braiding Machine



*The Wardwell Harness Braider is the ideal machine for over braiding on harnesses. It works equally well with wire materials or with textile and synthetic threads. The improvements to this type of standard machine include: a motor driven capstan take-up for accurate coverage of the harness, a new tubular frame, a self lubricating horn gear, a new operator station and sound reduction, among many others.*

## Technical Features

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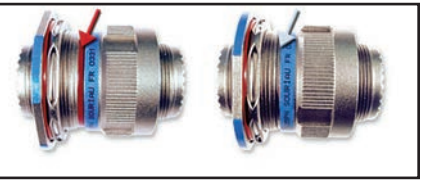


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Red Bands on Circular Connectors are usually there as a visual check for the complete mating of threaded connectors. The two views of a mated pair of connectors below show in the first example the partially mated plug (red band showing on receptacle), and in the second view, they are visually mated because the red band is hidden.

**Contacts for Aerospace Connectors:**

- AS39029: Is the Specification for Pin and Socket Machined Contacts (Power and Coax).
- There is currently a Base Specification for Test & QPL/QPD.
- 126 Detail Standards for Power, Coaxial, Twinax, Quadrax, and Thermocouple. Contacts to be used in MIL-Approved Connectors.
- AS22520 Crimp Tools & AS81969 Insertion /Removal Tools are defined in the Contact Detail Standards.
- The contact part number suffix is referred to as the Basic Identification Number, (BIN) which is a three digit code based on the same color coding scheme as other electronic components such as resistors. See the above chart for specific details:

Recent Contact Changes (additional part numbers) to meet application needs of the MIL-DTL-38999 series III Connectors:

- AS39029/56 & 58 (Pin and Socket Contacts) were recently cloned into other Specifications needed to meet the requirements of certain user groups of MIL-DTL-38999 Series 3 Connectors.

- AS39029/106 & /107 Specifications were added to provide 1,500 Mating & Unmating Cycles in AS29600 Composite Connectors.
- AS39029/117 and /118 were added to provide durability performance in the high vibration requirements of Stainless Steel Jet Engine Connectors. These Specs have contacts with thick Gold Plating, and also Rhodium Plating (twice as many part numbers).
- AS39029/121 & /122 were added to align and harmonize the contact performance requirements of the diverse applications of MIL-DTL-38999 Series 3. A smaller contact (Size 23) with very high density spacing was also added to these contact standards.

### CONTACT COLOR CODE AND BIN\*

WIRE BARREL END      MATING END

3rd COLOR BAND (3rd DIGIT)  
2nd COLOR BAND (2nd DIGIT)  
1st COLOR BAND (1st DIGIT)

|            |            |
|------------|------------|
| 0 - Black  | 5 - Green  |
| 1 - Brown  | 6 - Blue   |
| 2 - Red    | 7 - Violet |
| 3 - Orange | 8 - Gray   |
| 4 - Yellow | 9 - White  |

Continued on page 60

## SDE STANDARD DIE ENVELOPE CRIMP TOOLING

The SDE\* Advantage!  
\*Standard Die Envelope

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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 59

## Rack and Panel Connectors (for slide-in rack mounted components):

• ARINC 404: For many years the Workhorse Connector for Slide-In Electronics Racks has been the ARINC 404 (MIL-DTL-81659). It is available in 2 Series with Front or Rear Release Contacts, and many



combinations of Inserts and Contact Size/Arrangements.

• ARINC 600: (MIL-DTL-83527) was added to the mix to achieve higher contact density, and more precise mating & Lockout features



• Other Rectangular Connectors are available for a variety of Applications.

## Miniature and Sub Miniature Connectors:

• A Variety of Miniature & Sub-Miniature Rectangular Connectors are defined by MILDTL- 24308, MIL-DTL-83513, or MIL-DTL-83507.



• The Standards for Miniature Circular Connectors are still in the works by DLA, L&M.



• NANO Class Connectors Conform to MIL-DTL-32139, and feature contact spacing as tight as .025 (Center to Center).

## MIL-PRF-39012 Coaxial Connectors for RF Cable:

MIL-PRF-39012 are single cable coax connectors, and they are divided into Six Categories. The categories have to do with how they are terminated, and the level of detail for the inner components of the connectors. They are defined as follows:

• Category A - Connectors, which do not require special tools to assemble.

• Category B - Connectors, which require Supplier Defined Assembly Tools.

• Category C - Connectors which assemble with MIL-Standard Tools.

• Category D - Connectors which are fully defined (Inner and Outer Crimp), and all Tools defined in the Detail Standard.

• Category E - Semi-Rigid Cable Connectors with Solder Termination.

• Category F - Semi-Rigid Cable Connectors with Solder-less Termination.

Shown on page 61 are typical examples of MIL-PRF-39012 Coaxial Connectors and a typical cable stripping detail.

## Shielding on Wire and Cables for EMI/RFI Protection:

• The Penetration of Radio Frequency (RF) Field Interference into sensitive digital Circuits has created a need for metallic shielding on many wires, and wire bundles in the Aerospace Wiring Industry.

• The increased use of composite plastic aircraft structures have made the wiring and electronics far more vulnerable to lightning and electrical energy fields, at the same time that digital electronics have become more sensitive to electrical distortion.

• The solution has been to install over-braided shielding over the wire harness. The tooling and the process to work with these materials have become very specialized;

• EMI/RFI Shield-Termination Bands are defined by AS85049/128, and the respective Installation Tools are QPL/QPD to AS81306/1

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TE Connectivity's (TE) PIDG, PLASTI-GRIP, SOLISTRAND and FASTON Terminals and Splices are designed for complete and uniform reliability in the most difficult circuit environments. The many millions of TE terminals that are still deployed twenty years after installation are a testament to the rigorous testing and research that went into their design and manufacturing. Many of the TE PIDG terminals meet or exceed the requirements of SAE AS7928, Type II, Class 1 and 2.

TE's design of the crimping dies and construction of the terminal allows for uniform insulation thickness under crimping pressure, transmitting pressure evenly to the center of the crimp area. This produces a crimp and terminal that are alike in appearance and performance. PIDG products are available as rings, spades, flanged spaded, slotted rings, splices in several other varieties and sizes.

### PIDG Terminals & Splices

- Terminals are made of high conductivity copper
- Most product is UL and CSA approved - Insulation is UL 94V-2 rated
- Product is rated for use up to 105 degrees C and 300 Volts for terminals and 600 Volts for splices
- PIDG terminals have copper sleeve for improved wire insulation support
- The body has serrations for maximum contact and tensile strength
- Insulation sleeves and the corresponding tooling are color-coded by wire-size for easier identification



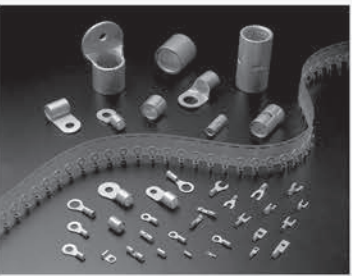
### PLASTI-GRIP Terminals & Splices

- Vinyl insulation sleeve provides good dielectric strength and supports the wire insulation so that no bare wire is exposed
- Most product is UL and CSA approved
- Most product rated to 105 degrees C, with an operating voltage of 600 V
- Insulation is 94V-0 rated
- Funneled wire entry on terminal prevents turned back wire strands and permits rapid wire insertion during high speed production
- Serrations in the crimp barrel provide maximum contact and tensile strength after crimping



### SOLISTRAND Terminals & Splices

- Constructed of fine grade high conductivity copper for optimal electrical performance
- The brazed seam increases metal strength around the entire barrel area assuring withstanding harsh industrial environments. It also prevents pinched and stubbed wires.
- Product is rated for 170 degrees C maximum and therefor suitable in all standard applications.
- Applied with "W" crimp tooling



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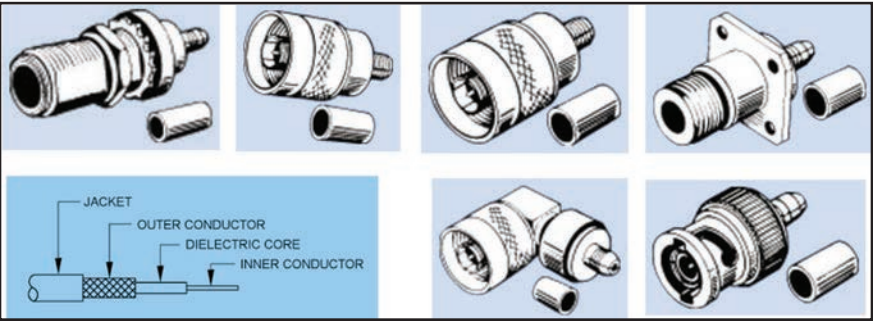
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Typical examples of MIL-PRF-39012 Coaxial Connectors and a typical cable stripping detail.



The tooling and the process to work with these materials have become very specialized.

(one step termination) and AS81306/2 (two step termination).

- AIR5464 has been published to provide guidance in selecting Shielding Materials.
- In addition to braded wire shielding, metal-clad fiber shielding is also approved.

- Multi-piece contacts have to be assembled with all components in the correct order.
- M27500 Cable (NEMA Standard) is the Shielded Twisted Pair Cable for most current high speed data applications, but new cable options are emerging.

**Shielding for High Speed Data and Ethernet Circuitry:**

- There are several AS39029 Contact Standards for Coaxial, Twinax, and Quadax Contacts for MIL-DTL-38999 Series I, III, & IV Connectors.

Continued on page 62



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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 61

• AS6070 is being introduced as the Lightweight, High-Performance Ethernet Cable.

• The complexities of processing and terminating this cable are overridden by the digital performance. The Bandwidth and digital signal speed are said to be comparable to fiber optics.

**Wire Termination Tools and Connector Assembly Tooling:**

• AS22520 Crimp Tool & Accessories Standards have a base specification and 47 detail standards, whereas the AS81969 Insertion & Removal Tool Standards is a base and 45 details. These specifications were taken forward as SAE Standards from MIL-C-22520 and MIL-I-81969, and the specifications which are required for QPL/QPD connector assembly have been recently published.



Typical wire termination and connector assembly tooling.



Shielded Twisted Pair Cable

**Tooling for Large Gage Wire Termination:**

• AS5259 has recently been published to bring many of the Large Gage (Size 8 thru 4/0) Tools and Dies

into a Common Specification for QPL and Reference in Component Specs.

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**Features:**

- 20% smaller footprint than a typical double ended lead maker.
- The UNIQA-PRO can ramp up your throughput by approximately 4X over a standard wire prep. and benchtop applicator.
- User-friendly PC control.
- Available in three different models to fit your needs: Basic machine with a passive wire collection system, basic machine with a passive wire collection system, crimp force monitor, and terminal scrap chopper, and a high force machine with an active wire collection system, crimp force monitor, and terminal scrap chopper.



**Applications:**

- Appliance industry
- Medical equipment
- Wire sizes ranging from 12 AWG – 26 AWG
- Anywhere manufacturers want to keep labor costs down without a large capital investment

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Harness Assembly Board

**The Evolution of Aerospace Wire:**

The Universal Objective in Aerospace, is to **SAVE WEIGHT!** Copper is very heavy metal, and the smaller the diameter, the more weight-saving benefit is achieved.

Thinner and more efficient Insulation, High Strength Alloys, & Improved Plating have been the three factors in the overall reduction of copper content in Aerospace Wire, and EWIS systems.

- AS22759 is the leading standard for Aerospace wire, but AS81044, and AS81381, are also approved Aerospace wire with common use in aircraft and other systems.

- The AS22759 currently has 196 Detail Specifications in the family of standards.

- The combinations of copper alloy, plating, and insulation material /configuration have led to the large number of detail standards.

- AS29606 is the Conductor Specification which requires separate QPL and Control.

**How does Aerospace Wire Differ from Commercial Equipment Wire:**

- The extremes of temperature, vibration, abrasion, and weight restrictions are factors which drive the design of Aerospace wire. The insulation is thinner, and more durable (chafe resistant), and all Aerospace wire is plated (silver, tin, and nickel are the common plating materials).

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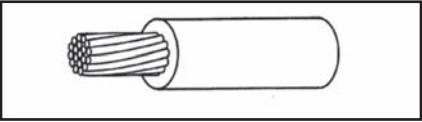




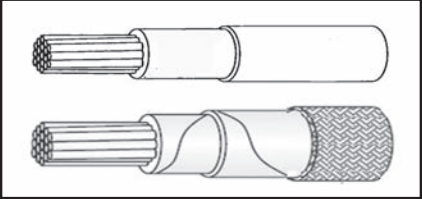
# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 63

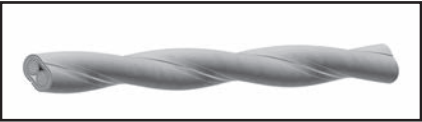
- Composite Wire is the term given to multi-layer insulation, with different materials in each layer. This design adds to the durability, flexibility, and temperature resistance of wire. Cross-link radiation is used as a processing technique in many wire insulation materials to make the insulation tougher by bonding the molecules of the insulation.
- Smooth extruded Insulation is the traditional finish for Aerospace wire insulation, but Tape Wrap Wire is also widely used and specified by some detail standards.
- Typical construction of common aerospace wire is shown (right):



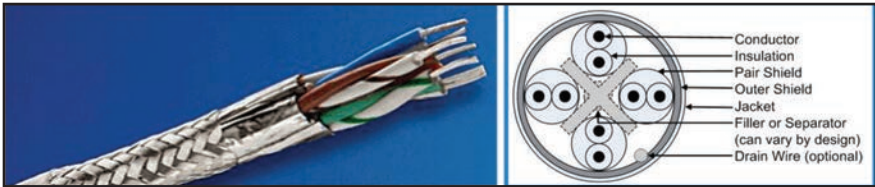
Standard Extruded Insulation



Multi-Layer Composite Wire Construction



Shielded Twisted Pair Wire (Typical M27500 Configuration)



**Aerospace Fiber Optic Standards:**  
The dependency on reliable high speed data channels in Aircraft and Aerospace Electronics has created a need to ruggedize and overcome a plethora of problems inherent to Fiber Optic Cable and Connectors.  
The shortest path to Airworthy Fiber Optic Systems was to “Re-Purpose” Electrical Connectors and related Wiring System Components. The SAE AS-3 Standards Committee (and a group of ARINC Working Groups have done an excellent job

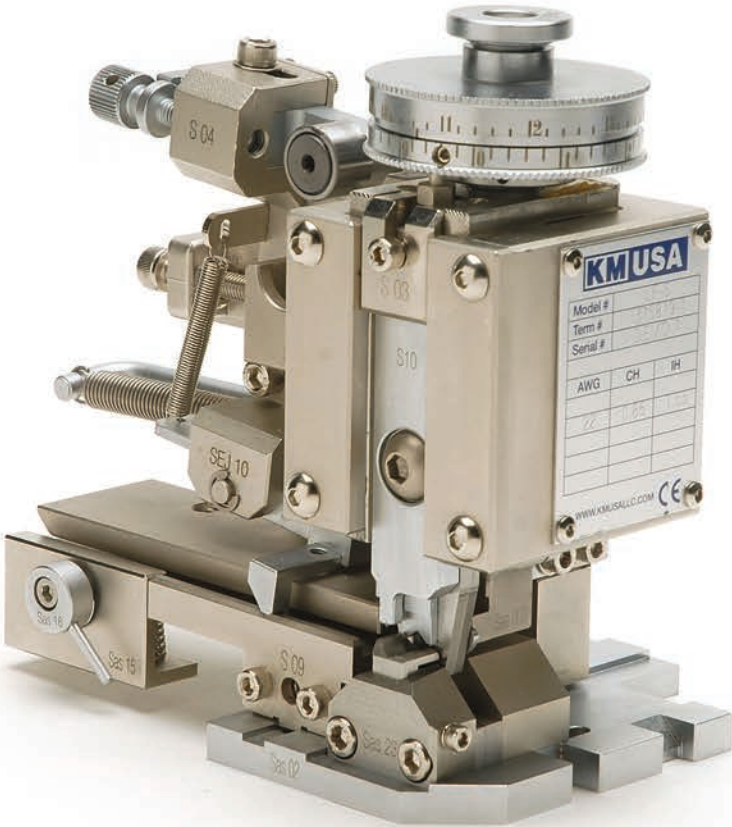
of meeting that need, and advancing Aerospace Fiber Optic Technology.  
  
The Specifications for Components of the Fiber Optic Network are the following:  
• AS5590 & AS6251 – Close Tolerance Connectors  
• AS6250 – Fiber Optic Termini  
• AIR6258 – Fiber Optic Sensors for Aerospace Applications  
• Cleaning and Inspection of Fiber Optic Termini is a Mandate. ARP6283 provide those guidelines.  
• ARP5602A Includes 10 slash

sheets that provide detailed knowledge and hands-on competencies for six certifications that include:  
  
o Introduction to Aerospace Fiber Optics  
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The F-35 Joint Strike Fighter Aircraft is the new generation aircraft to provide a replacement warfighter aircraft for many aging aircraft in the US and Allied Forces fleets. Lockheed Martin designers used very sophisticated fiber optic networks in the design of this aircraft and its predecessor (F-22).

- o Aerospace Fiber Optics QA Inspector
- o Aerospace Fiber Optics Engineer

Conclusion:

This information is intended to bring appreciation for the complexity and extreme environmental issues which drive EWIS Systems in Aircraft, Spacecraft, Shipboard, Land Transport Systems, and other Aerospace Systems which require wiring. We have

highlighted the Standards that apply, and tried to bring an understanding of the complex families of components, materials, and processes that they represent and control. This is also a call to action for Wire Harness Manufacturers and Suppliers to get involved in the Standards Development and Maintenance Process.

Continued on page 66



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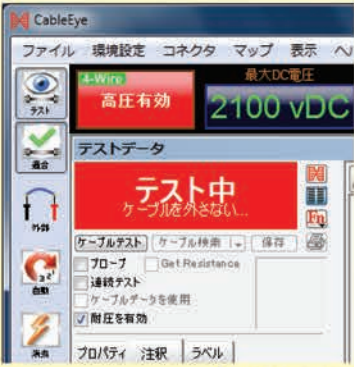
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# The Evolution & Status of Standards for Aerospace Wiring Systems and Components...

Continued from page 63

*\*NEMA is the designator for “National Electrical Manufacturers Association” (www.nema.org).*

1. The table is reasonably complete in that it covers the Qualification Standards, but many of the components, wire, and tooling have different part numbers, and detail specifications which are subordinate to the standards listed.
2. Copies of Military Specifications can be downloaded at <https://assist.dla.mil> or <https://quicksearch.dla.mil> websites.

## About the Author:



Dave Kelly is a Senior Manager with the Daniels Manufacturing Corp (DMC), which is a supplier to the Wire Processing Industry of Tooling for Connector Assembly and Wire Harness Production. DMC is also a leader in Aircraft and Aerospace Maintenance Support Equipment including Tool Kits to support the EWIS system of a complete aircraft.

Mr. Kelly has been employed by DMC for 43 years, and holds the title: Standards and Industry Liaison. During that time, he has held several positions involved with Engineering Management, Product Management, Development/Design/Testing, and Product Application Support for the DMC Field Engineering Team.

He is currently responsible for Qualification, Product Compliance, Standards Committee Representation, Industry Surveillance, and General Technical Support & Product Management where it is needed.

Mr. Kelly holds seven patents for tooling relating to Wiring, and received one Phase 1 SBIR Award for Wire Stripping Technology.

He served on the National Parts Advisory Industry Panel to the Secretary of Defense (Kasper Weinberger) during the Ronald Reagan Administration, and was a delegate to the International Standards Organization (ISO) from 1987 to 1992.

He served as Chairman of the SAE AE-8C2 Standards Committee (Terminating Devices and Tooling) from 1988 to 2007, and he is currently the Vice Chairman of SAE AE-8C2.

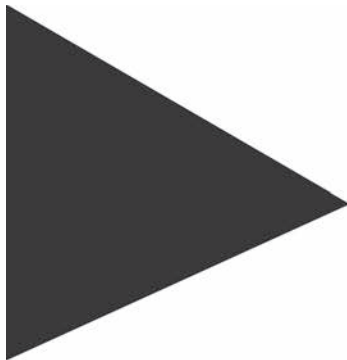
Mr. Kelly is an active participant of various Industry and Government Committees that manage and define Wiring System Components. These include: SAE AE-8 (Executive Steering Committee for Aero Electrical Electronics Distribution Systems), SAE AE-8A (Electrical Wiring and Fiber Optic Interconnect Systems Installation), SAE AE-8C1 (Electrical Connectors and Accessories Standards Committee), SAE AE-8C2 (Terminating Devices and Tooling Standards Committee), SAE AE-8D (Aerospace Wire and Cable Standards Committee), SAE AS-3 (Fiber Optics and Applied Photonics Standards Committee), Joint Services Wiring Action Group (JSWAG – Sponsored by NAVAIR, and involved in the support of Allied Forces maintenance of Wiring in Military Aircraft, and related systems/equipment).

He is a Technical Advisor to the Electronic Industries Association (National Aerospace Standards), and has served on the Board of Directors, for the Wire Harness Manufacturers Association. Mr. Kelly is also a Technical Contributor to IPC/WHMA-A-620.

*Note:* “Go to [wiringharnessnews.com/aerospace-standards](http://wiringharnessnews.com/aerospace-standards) to see the entire article, complete with additional illustrations. For more information on aerospace standards and connector tooling, contact Dave Kelly at [davek@dmc-tools.com](mailto:davek@dmc-tools.com)”

| Specification (Numerical Order)   | Description                                                            | P/A        | Q/A     | Remarks                                                            |
|-----------------------------------|------------------------------------------------------------------------|------------|---------|--------------------------------------------------------------------|
| MIL-DTL-17                        | Coaxial Cable                                                          | DLA L&M    | DLA L&M | RG-xxx Designations Reside in this Base Spec.                      |
| SAE AS5259                        | Large Gage Crimp Tools, Dies, and Gages                                | SAE AE-8C2 | NAVAIR  | Hydraulic Tools for Gages 8 thru 4/0                               |
| SAE AS6070                        | Aerospace Cable for High-Speed Data                                    | SAE AE-8D  | NAVAIR  | Multi-Inner Wire, Shielded Cables                                  |
| MIL-PRF-6106                      | Relay/Component Socket                                                 | DLA L&M    | DLA L&M | Rear Release                                                       |
| SAE AS 7928                       | Terminals (Lugs and Splices)                                           | SAE AE-8C2 | NAVAIR  | Includes Specs of Different Base Nos for many Wire Terminations    |
| MIL-DTL-12883                     | Relay/Component                                                        | DLA L&M    | DLA L&M | Rear Release Socket                                                |
| SAE AS21608                       | Shield/Jumper Termination Ferrule                                      | SAE AE-8C2 | NAVAIR  | Inner and Outer Ferrules for Coax                                  |
| SAE AS22520                       | Crimping Tools and Accessories                                         | SAE AE-8C2 | NAVAIR  | Base Specification & 48 Detail Specs                               |
| SAE AS22759                       | Aerospace Wire                                                         | SAE AE-8D  | NAVAIR  | Discrete Wire of Various Plating, Material Insulation, & Size      |
| MIL-DTL-22992                     | Class L Circular, High Power                                           | DLA L&M    | DLA L7M | Front Release                                                      |
| SAE AS23190                       | Straps and Clamps for Wire Harness                                     | SAE AE-8C2 | NAVAIR  | Bundling and Mounting Components                                   |
| MIL-DTL-24308                     | D- Subminiature                                                        | DLA L&M    | DLA L&M | Rear Release                                                       |
| MIL-DTL-26482                     | Circular, Series 1 and Series 2                                        | DLA L&M    | DLA-L&M | Front Release (Ser. 1) Rear Release (Ser. 2)                       |
| MIL-DTL-26500                     | Circular                                                               | DLA L&M    | DLA L&M | Front Release                                                      |
| MIL-DTL-26518                     | Rectangular (Rack Panel)                                               | DLA L&M    | DLA L&M | Front Release                                                      |
| WC 27500                          | Multi Inner Wire Cable for High Speed Data                             | NEMA*      | NAVAIR  |                                                                    |
| MIL-DTL-28748                     | Rectangular (Rack & Panel)                                             | DLA L&M    | DLA L&M | Front Release                                                      |
| MIL-DTL-28804                     | Rectangular (Jackscrew Coupling)                                       | DLA L&M    | DLA L&M | Rear Release                                                       |
| MIL-DTL-28840                     | Circular (Threaded Coupling, Shipboard)                                | DLA L&M    | DLA L&M | Front Release                                                      |
| SAE AS 29600                      | Circular Composite Shells and Accessories                              | SAE AE-8C1 | NAVAIR  | Rear Release                                                       |
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