• Wire Labels Checking the Quality of Connections A Welding Machine for All Terminals • Preventing Safety Critical Electrical Failures with Grease How to Find the Right Contacts for Your Connector **QPL SAE AS23053 DSG-Canusa Qualified Heat Shrink Solution** Implications of Section 889 Regs on Federal Contactors IPC/WHMA to Help Grow Electrical Wire Processing Technology Expo





Company Profile: MCX, Inc.

By Joe Tito Wiring Harness News

olid foundations are a precursor for success for any business. MCX, Inc. was built on the principles of efficient manufacturing and continues to build on that platform today. Pam Dutton, President of MCX, Inc., recently spoke with WHN about the history of the company and how recent enhancements have them poised for even more success.

The company was founded by Pam's father, Arthur McCluskey Jr., in 1981, and was located in the Silicon Valley."He had been doing consulting work in what we would call lean manufacturing nowadays," Pam detailed. One of those consulting customers was a test equipment manufacturer who was building cable assemblies internally. Arthur was helping them build lean production lines and engineering practices to design products for manufacturability (DFM). "Prior to the consulting business, he had a wire harness and board house that

he sold because he wanted to get out of the PCB side for various reasons." she noted. Because of his manufacturing expertise and prior experience as a harness supplier, the customer encouraged Arthur to start the business with the objective of moving the wire harnesses out of their domain.

The location in Silicon Valley was ideal for the new endeavor. As Pam explained, "Computers were hitting the ground running at that point, and there was a big need for internal wiring and related assemblies." As electronics invaded all aspects of our lives, MCX, Inc. has expanded their customer base."We went from building products for buttoned-up IBM, to making assemblies today for everything from advanced military assemblies to harnesses for Jell-O shot machines."

By 1991 MCX, Inc was moved to Oregon at the request of their largest customer. After a lot of research, the town of Klamath Falls, Oregon seemed to offer many benefits."It's location 10 minutes inside Oregon puts us one day away from our California

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Label application on finished assembly at MCX.

clients as well as our Oregon clients." Their proximity to the Oregon Institute for Technology was another major plus for the company. It provides a major resource for technology advancement and is also a springboard for new markets.

One of the other major benefits of Klamath Falls is that it is in a HUB (Historically Underutilized Business) zone. "That means we have a higher unemployment rate than a normal community," Pam explained. "Being in a HUB zone doesn't help us with commercial work, but it does help in government or military work."

MCX, Inc. had always been a family business. A few years back, Pam grew concerned there would be no third generation to eventually take over the business, and began to work on a long-term successor strategy. In

2016, she decided to partner with an investment firm with a specialized focus on businesses in underserved communities. The partnership allows Pam to run the business in relative autonomy. "We've been working together about four years now, and they are who they said they were," she assured. "When you take on a partner you can lose control, but they are super hands-off." The firm allows MCX, Inc. to do what they know best, build cable assemblies, while they bring welcome expertise in overall business planning to the table.

Currently, the number one market for MCX, Inc. is with assemblies for medical devices. "Right now, in the middle of COVID, our medical business has really picked up," Pam noted.

Continued on page 13

Fred Knaack 1939 - 2020

t is with solemn hearts that we announce the passing of the founder of Wiring Harness

publication to his private partners vative and knew how to get things some 20 years ago.

Marilyn Magowan of Wiring Har-

done."

reason we did things right when we started the Expo," said Jay Partington In the early days, Fred worked of EPI Shows, the original and long-

News, Fred Knaack. Along with starting Wiring Harness News in 1994, he was also one of the founders of the Wire Harness Manufactures Association (WHMA). Because WHN and WHMA began around the same time, many have assumed, even to this day, that they were tied together. But Fred kept his publication endeavor operating as a separate entity, and sold the

ness News worked with Fred in the beginning, and remembers the upbeat and friendly atmosphere he cultivated."Fred was a fun guy and we all enjoyed his company." She added, "He was very kind to his employees and everybody he dealt with both professionally and personally." Marilyn also noted how seriously he took the business, saying, "Fred was very inno-

closely with Norm Sagon, another WHMA pioneer. "I knew Fred for more than 28 years with WHMA and WHN," Norm noted, "and also his father Gus, after whom we developed the WHMA 'Bud and Gus Award.'" Fred, along with Dennis Melugin, created the special recognition award in memory of their fathers Gus Knaack of Able Cable, and Bud Melugin of Lamcor, Inc. Recipients were nominated based on exemplary work and special achievements within the wire harness industry. The winner was voted on at the annual WHMA BOD meetings.

Always the idea guy, Fred was also instrumental when the original format of the EWPT Expo in Milwaukee was crafted. "Fred was the main

time managers of the show."He knew so much about the wire harness industry. Fred told us who to talk to (and who not to) then wrote, and rewrote, the prospectus for the show," Jay remembered.

Vernon Judy of Qualastat Electronics shared, "Fred enjoyed life and the people around him enjoyed Fred." Many similar responses were shared as we spoke with folks about their experiences with Fred.

Those who know Fred will not be surprised that he wrote his own obituary. Even if you never had the pleasure of meeting Fred Knaack, we strongly encourage you to read his funny and uplifting words on page 4.

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Jim Brown jim@wiringharnessnews.com Phone (708) 594-7764 *Wiring Harness News* (ISSN 1097-0789) is distribured bi-monthly to wiring harness & cable assembly shops, cord set manufacturers, and to companies (OEMs) that process electric and optical wire & cable.

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Frederick William Knaack 1939 - 2020

Frederick William Knaack, Age 81, Superior, WI.

Thope you enjoy reading my obituary as I am writing it myself. I have had a good life, but I hope everybody is very sad that I am gone and will miss me forever. I was born in Chicago, IL to Gustav and Edna Knaack, and spent many wonderful summers enjoying the Lake Geneva area. The best thing I ever did in my life was marry a beautiful woman, Lenore Rockne, and she gave me 4 amazing boys. The best thing Lenore ever did for herself was to divorce my sorry excuse for a husband. I am writing this so maybe one of you will read it and try to best the husband and father you can be because I screwed it all up. I have been lucky enough to spend many good years with my adult children.

I was in the Navy for two years as a photographer and loved every second it. I have been a magician (even live on the Art Linkletter show), a bartender, a pizza joint owner, general comedian, and a newspaper publisher. Are you a fan of wiring harnesses? My father, Gustav, owned Able Cable



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and I learned to love everything about wiring harnesses. This prompted me to start the Wiring Harness Association and the Wiring Harness News. I sold my portion of the Wiring Harness News 20 years ago and since that time, my dream has been to publish a funny newspaper for all of us that are getting old. We all just need to keep laughing and be able to make fun of our wrinkles and drooping body parts. . I wanted to leave a legacy for my grandchildren and hopefully, they will continue with my work. Obviously, if you are reading this, I am dead - so maybe don't try and reach all your goals like I did as I must have done everything I wanted to do and then kicked the bucket-I sure hope I didn't die from Covid-19. I wish I would have spent more time on Lake Geneva, and way more time in the Playboy Club. Why do all great things come to an end?

I leave behind some amazing people that I love more than they will ever know: My sons, Deryl, of Austin, TX, Kevin (Stacy) of Lake Nebagamon, WI, and Curtis (Pamela) of Lake Geneva, WI. My grandchildren, Michael Knaack, Curtis Knaack, Steven Knaack, Christopher Knaack, and Ryan Knaack. I also hit the lottery with step-grandchildren, Trevor (Sierra) Guenard, Olivia (Jacob) Zoltak, Wesley (Megan) Caple, Keenan Willow, and a bonus, Brian "B" Tapani. I have one step-great-grandchild, Adeline Guenard, nieces, Julie Knaack of Rockford, IL, Marcia Knaack of New Orleans, LA, Jenni (Tony) Benson of Rochester, MN, and two great nephews Caden and Brady Benson. In addition, I have two brothers, Richard (Sherri), of MN/FL and Robert (Cindy) of Woodstock, IL. To my brothers: Well, I guess you won the bet and I was the first to go. But good luck trying to get me to pay up! I am also survived by my former wife, Lenore (Stephen) Pfaff of Port Hueneme, CA and my cat, Tom-Tom, of Superior, WI.

Don't worry about me because I am now with my son, Galen "Rocky", my parents, Edna (Finer) and Gustav Knaack, many aunts, uncles, cousins, friends and my beloved "Spike". I have requested a private service in Lake Geneva, WI, to be held at a later date. In lieu of flowers, donations to Lakeland Animal Shelter, 3615 WI-67, Delavan, WI 53115, would be greatly appreciated to honor all the wonderful dogs and cats I have had. My remains were well taken care of by Downs Funeral Home, 1617 N 19th St., Superior, WI. To Gwen and Sue from The Dove Home Health Care: Thank you for taking care of me and putting up with all of my crap. Love you both!

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Does Data Lie?

By Paul Hogendoorn

oes data lie, or does it always reveal the truth? It's an interesting question, at an extremely interesting time in world history. Readers of this column are likely to recall my oft-shared opinion that "context matters," and that the narrative is as important to collect and consider as the empirical data. This has never been as important as it is now, with all the data collected, analysed and shared about COVID-19.

Data may be empirical and unbiased in and of itself, but the collection and analysis applied to it are not. For this, we have to understand confirmation bias - a human condition that we all have to one degree or another. People tend to filter out messages they don't agree with and hold firmly to those they do, continually reinforcing what it is they already believe. Once an opinion or a bias has been established, it is very hard to have an outside influence change it. The filtering process is often applied to data analysis by selecting only specific subsets of the data, and tailoring the

analysis to arrive at a desired conclusion. Taken out of context, and with a specific intent in mind, data can be used to lead to a desired conclusion, leveraging the implied credibility and "truth" of data.

Regarding intent, people analyze data with an inherent confirmation bias built in. Even the "scientific method" begins with a hypothesis - a human assumption of what they suspect is correct, from which a series of tests is then designed to prove or disprove that assumption. Scientists, by and large, are extremely disciplined in their approach, and remain open to either possibility, genuinely driven with the pure intention of new discovery. The same is not true for anyone trying to influence the opinion of the masses on any topic - social, political, or now most notably, CO-VID-19. There is a steady stream of headlines each day revealing new "facts" and implied truths based on data, but the data is seldom presented in full and accurate context - because it no longer needs to be; the headlines and factoids are already feeding into a firmly entrenched confirmation bias Some may hold that to perform

true non-biased, empirical analysis, the human influence needs to be removed, and that perhaps this could be done by employing artificial intelligence (AI) and machine learning (ML) technologies. The problem here though, is that these technologies are already being used widely in society for exactly the opposite reason - to influence our behaviour by first learning it, then finding ways to influence it. Social media feeds AI systems that learn your behaviour, your opinions and predict your inclinations, then delivers you a steady diet of small messages designed to influence your next purchasing decision, or your next vote. Before the internet and social media, these things happened broadly, through newspapers, TV news and radio stations. Our confirmation bias was fed by our choice of what paper we subscribed to, and which news stations we watched or listened to. Regulations and oversight were in place to protect society. With social media as the I/O device into so many of our lives, and the power of AI and ML technologies as the processing engine, empirical data can be collected, analyzed, and reports engi-



Paul Hogendoorn

neered with even more power and impact, and with the perception of scientific neutrality - with less oversight, accountability, or protection for society.

Data is useful for many things, and data-driven decisions are valuable. But context and intent are key. In manufacturing companies, the purchasing group uses data as empirical proof they have lowered costs of tooling. Engineering however, uses data to show that the new tooling has a significantly lower meantime between failure. The quality depart-

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Does Data Lie?

ment uses data to prove that scrap rates have gone up and that warranty costs will rise for an extended period of time.All of them use data, but most often, the purchasing department

wins the day because its data and metrics are easiest to understand, resulting in a strong confirmation bias that needs to be overcome. The nearterm effect weighs heavier than the

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long-term cost. Purchasing gets the nod because they achieve their immediate-term goals while the effects only show up in financial statements indirectly sometime next year, or four years from now. The other voices have a long, hard uphill climb to influence the company to the eventual proper decision later, costing the company exponentially more than they may have saved with the shortterm decision.

And so it is with COVID. Politicians' approval ratings are at an all time high – whether right wing or left wing, and the six-o'clock news has not had this many regular, engaged viewers tuning in daily in a long while. It's an uphill battle for those with an opposing view.

Data doesn't lie, but that doesn't mean data is always telling the truth. For that, we have to be willing to dig deeper, understand context, and when necessary, examine intent. Technologies may provide us with ever-increasing amounts of data, and increasingly powerful analysis tools, but there are no shortcuts or optouts. It's still up to us personally to really understand what the data is telling us.

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W H I T E PRODUCTS

By Loren Smith

any years ago, as a new owner of a small (under \$1 million revenue) wire harness company, I found myself sitting with about a dozen other wire harness manufacturers in the conference room of a major construction equipment company. We had been invited to attend a presentation by the connector and terminal supplier that had just been chosen by the construction equipment manufacturer as its preferred provider of future designs.

One of the other harness firms, let's call it Big Guy Harness (BGH), had several individuals in attendance who over the course of the presentation conducted themselves rudely and arrogantly. I later learned those fellows were the top management of BGH, a company many times larger than all the other wire harness suppliers to the construction equipment industry combined.

My company, Monona Wire Corporation, was doing only a minuscule amount of business with most of BGH's customers. But as construction equipment manufacturers reduced their supplier base to a more manageable level (no one needed 14 harness suppliers), they did so by more diligently measuring performance. BGH, remaining aloof because of its years of supreme dominance, started to fall short of rising performance standards and began losing customers and encountering financial problems. Meanwhile, my company was fortunate to achieve performance levels that enabled us to gain market



Loren Smith CEO Blue Valley Capital

share, some of it at the expense of BGH--once 1000 times our size.

With my front row seat as an observer of BGH's decline, I received a lesson in what not to do. While failure, or success, is rarely a result of a single factor, you can often point to a

root cause.

At the root of the fall of BGH was its dismissive, inflexible culture.

The lofty attitude I had witnessed in the conference room permeated the company's key personnel, which manifested in performance issues, opening the door for competitors that were providing customers with more responsive performance. As BGH lost market share while still failing to address their culture issues, its financial performance spun out of control. Before long, despite its history of market leadership and revenue that had dwarfed its competi-

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tion, BGH ceased to exist.

Over the decades since, I have had the opportunity to observe the strengths and weaknesses of many wire harness companies - - with the clear relationship between success and culture always apparent. And a company's culture always starts at the top.

Loren Smith can be reached at lms@ blvcapital.com or www.bluevalleycapital.com.

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MCX, Inc.

The electrical test equipment market continues to be a solid source of revenue for them as well. Government and military orders are becoming a bigger part of MCX Inc.'s business, and the company just received their AS9100 certification to help them penetrate further into that realm. Current military work includes harnesses in support of drones and personal safety equipment. The company also does a lot of work in the commercial arena.

While on the subject of CO-VID, Pam mentioned the pandemic has had a major effect

on small fans for electronics coming from the hard-hit Malaysia and Singapore markets. "They are quoting 25week lead times right now, and that has put some of our customers behind the eight ball," she explained. "So, we've spent a lot of energy working with them to design in replacement fans that are readily available until the pipeline is refilled."

When queried about what makes MCX an unmistakable supplier to their customers, Pam related an interesting story that helped formulate their business philosophy. "Years ago, a customer told us to never answer a question 'no,' but instead answer, 'how much.'" MCX, Inc. had no-quoted an assembly the customer had submitted. "They said, 'If I offered you a million dollars, could you do it?' I said, 'Sure' and they said, 'Then how much will it cost between zero and a million dollars?"

That experience

Continued from page 1

for MCX, Inc. takes over. "We

try to work with them to figure

out solutions and think out-

side-the-box so they can meet

Another thing that makes

the needs of their end users."

MCX, Inc. an invaluable asset

to their customer base is their

dedicated quick-turn line. "We

will never tell a customer we

don't have any labor available.

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happen. Often times vou get

a new customer because they

have a problem, and problems

can't wait standard lead times,"

Pam asserted.

Ouality and Certifications

As mentioned earlier, MCX, Inc. is certified to AS9100, and manufacturers to IPC/WHMA A-620. They have certified A-620 trainers, and all of their 25 employees are certified specialists. "We've developed an extensive internal training program. We are in a lumber town and we can't really hire anybody with experience," Pam cited."Our program allows employees to go from unskilled labor to what we call Accomplished Assembler in about 18

Continued on page 14

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changed their whole way of thinking, and became the main busiphilosophy at ness MCX, Inc. "The customer has a need, and not meeting that need does neither one of us any good. So, the question becomes, how can I meet the need in the most cost effective manner." She conceded that often times, the customer's need may not justify the cost of building to the current print.That is where the spirit of DFM, baked into the original mold





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MCX, Inc.

months." It's a combination of people are all working on 5 IPC and hands-on training and is documented throughout the system. At any time, they can see what jobs a particular employee is qualified to perform. "If you give me someone who has a work ethic, we can do the rest," she informed. "At the end of 18 months, they are earning a living wage for our community, and that's why turnover is really low."

Pam elaborated on the importance of employment longevity at the company. Her key managers have all been with the company over a decade, and her trainers and quality

Continued from page 13 _

plus years."It's super critical to us," she emphasized, "our turnover is low and that helps us be more cost effective, and we know exactly what we can do."

In addition to these quality standards, Pam is also leading the company in a cyber security certification called CMMC. "It's going to be a requirement for all government contractors and subcontractors. It's cutting edge right now, they won't even have the certifiers until the first quarter of 2021, but we are jumping on the train because we see the benefit of doing the work," she detailed.

Marketing

MCX, Inc. has always had direct and commissioned sales staff. From the beginning, the main marketing strategy at MCX, Inc. is to become a stronger supplier so they can increase their footprint within existing customers. It's served them well, and is the big reason they sought the AS9100 certification.

In addition to building a lean operation with an expert staff, MCX, Inc has invested in automation to make them competitive with overseas pro-

Continued on page 16



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MCX, Inc. Continued from page 14 _____

ducers. With this solid infrastructure in place, the partner company suggested boosting marketing efforts a couple years back. Along with a new website utilizing cutting-edge SEO, the company began to branch into a somewhat aggressive trade show marketing campaign. "We've done the Medical Design & Manufacturing show in Anaheim and a smaller show here in Oregon called NEDME," Pam listed. They have also done the Design-2-Part show for contract manufacturers in San Jose. "We were also registered for the AeroDef Show in Dallas last March, but that was cancelled."

With trade shows off the table for the time being, the company has looked for new ways to fill the lead funnel including email marketing. They have also worked with the Small

Business Administration through Southern Oregon University to get a list of leads for military and government opportunities. "Unfortunately, they didn't have email addresses, so we've gone old-school and we're doing post cards," Pam explained. "I think it's too fresh to determine the overall effectiveness, and it's something we will likely do multiple times, but compared to the price of a trade show, it's pretty cost effective."

One of the most striking things about the conversation is how Pam and her father were well ahead of the power curve as far as facility and organizational planning. MCX, Inc. has made great decisions to meet both internal and external challenges, and they are definitely well-poised for growth.



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QPL SAE AS23053 – DSG-Canusa Qualified Heat Shrink Solutions

By Peter Schwab Shawcor

ver the past 10 years, The Heat Shrinkable Tubing & ID Markers group within the SAE AE8-D Wire and Cable Committee has worked to define and formalize the standard for heat shrink tubing in the military and aerospace sector. The newest standard, SAE AS23053, replaced the old US military standard, AMS-DTL-23053 in October 2016. As part of the new version of the specification, a QPL (Qualified Product Listing) would be implemented and maintained by NAVAIR (Naval Air Systems Command), a system command group operated by the US Navy in Patuxent River, Maryland. The QPL itself is a tool used by suppliers and sub-suppliers of products for the US government to expedite product identification and acceptance; basically, if you make products that meet the spec, and you can prove that you meet the spec through product testing (internal and external) and on-site audits, your products can be listed in NAVAIR's QPL. This attention to (and rigid interpretation of) the standard conveys a formal sense of conformance to our customers - any products listed on the QPL are certified to the standard by none other than the US Government themselves. Through strict traceability and auditing of the material, this is the true gold standard of heat shrink for products that will eventually end up on US and allied military platforms fighter jets, ships, munitions, land vehicles and more.

As one of the leading manufacturers of heat shrink products and shrink equipment, Shawcor have always considered the strategic important markets, Aerospace, Military, and Mass Transit, as an important avenue to be involved in the new standard and QPL. Our inclusion on the Qualified Products List represents years of product testing and inspections at our facilities, assuring our customers of complete conformance to the processes and requirements of both SAE and the US Military. With the latest September 2020 update to NAVAIR's QPL, Shawcor is launching the following DSG-Canusa branded, QPLapproved products:

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POWER WOMEN OF THE WIRE HARNESS INDUSTRY ____

By Melissa Femia

evon Gonteski is the feature engineer in this edition of The Power Women series. Originally from the East Coast, Devon attended elementary and middle school in New Jersey, subsequently high school in Colorado as her father's job transferred the family there. Her mother worked after her younger sister was born while her father had a career in communications. Devon's dad often brought home equipment and technology from the workplace, sometimes setting up and testing video chat equipment or other new products. At one point, she recalls, he acquired and modified an old projector and ended up creating a theatre room with it. Interested in science and knowledge from a young age, she could often be found avidly watching the Discovery Channel.

Despite early science-related in-

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terests and introductory technical exposure, Devon was interested in liberal arts in high school. Enrolling and completing the International Baccalaureate program, she took the standard level science and math courses while choosing to enroll in the higher-level English classes. Following the liberal arts path to university, she decided to pursue a degree in Philosophy in college. Preferring to live in the East, Devon chose to attend The Catholic University of America located in Washington, D.C. Within her Freshman year, however, she grew dissatisfied with her academic path; she did not enjoy the Philosophy program as much as she had hoped and decided she wanted to move toward a more STEM-related field. She considered Electrical Engineering but opted on a path towards a bachelor's in Physics instead.

Moving along the Physics track, Devon found herself often one of two or three women in the majority of her physics courses during college. With at most only around a dozen students in the entire undergraduate program, she recalls being frustrated at the lack of study partners and groups. While perhaps unintentional, Devon felt that she had something to prove as one of the only women in the technical program. Luckily, upon forming a friendship with another female student, they were able to collaborate with each other to teach each other the



Melissa Femia

material. Devon actually attributes a lot of her college success to having had a female friend with whom she could do coursework.

Amidst her collegiate years, Devon worked as an intern at the university's School of Engineering and the Vitreous State Laboratory. Post college, Devon submitted many resumes and had workforce interviews, ultimately choosing an employer that she met via a networking opportunity. As she recollects, her first interview for an internship with the company Lectromec, she was not offered the position, but nine months later and around the time that Devon completed her degree, she returned for an interview as a full-time junior engineer.

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Devon Gonteski

cializing in wire and cable testing. Devon's first-day training began with her creating wire bundles-cutting cable into pieces to be used for testing. She remembers that a client was visiting the facility that day, and the client asked her how long she was in her position. Of course, she answered that this was her first day, assuming the customer asked because she was fumbling with the wires clumsily. At that point, she figured she had some efficiency gains to make! Outside of creating test batches, Devon spent her early time familiarizing herself with test standards and various aspects of the lab environment. After gaining comfort in those areas, she was able to complete tests herself. After a couple of years, Devon is now a mentor figure to new employees

and went from being the trainee to acting as a trainer. She loves the role and finds it very satisfying to master concepts, then teach others and watch them thrive.

When Devon started her job with Lectromec, she was the solo female technician in the lab. Since then, the company has grown to include several more. As the company utilizes unique testing equipment, there are limited suppliers. As a result, Lectromec often builds the specialized test fixtures in-house both for their own use and for other companies. Whether creating test bundles or manufacturing the equipment, she loves her position and the work environment, feeling very supported by all of the surrounding individuals.

Devon's advice to others is to stay positive and recognize that any goal is achievable if you invest the time and energy. Regardless of what anyone says negatively, have confidence and self-value. Try to live in the moment.

Thank you, Devon, for your contribution to The Power Women series.

If you are interested in sharing the stories but missed the original WHN distribution, the articles are available on the Jana Diversity Solutions website at www.janadiversity.com, or at wiringharnessnews.com.

If you know a female engineer who would make a great candidate to feature in the Power Women series, please direct them to me at melissa. femia@janadiversity.com

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Contact Selection: How to Find the Right Contacts for Your Connector

ust as selecting the right electrical connector is a crucial step in designing a reliable system, so is choosing the correct contacts to use with that connector. The right choice of contacts, however, might not always be clear because electrical contacts come in a variety of sizes, contact types, layouts, platings, and termination types — all of which are related to specific application requirements.

What are Electrical Connector Contacts?

Electrical connector contacts are the pins or sockets that form the electrically conductive portion of a connector. When two connectors are correctly mated, electricity can flow through the contacts. Because we depend on the contacts for reliably transmitting signals and power, making an informed decision when choosing them cannot be overemphasized.

The starting point for selecting connector contacts is the electrical specifications for the application.The application's defined electrical voltage and current requirements will help determine not only what connectors are available to choose from, but which contacts are most appropriate for use. The contacts are a critical part of having a connector that can perform within the rated voltage and current specifications.

Additionally, it is essential to verify that the connector can handle the power requirements related to the connectors, especially in connection to heat generation. Consider this: as electrical current goes through the connector, heat is generated in the contacts, and the more contacts there are, the more heat will be generated. The connector itself must be able to handle the heat generated in the contacts.

Contact Layout and Sizes

Many applications require a specific connector layout or number of wires. Part of meeting the electrical requirements of an application involves verifying that the correct num-

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Contact Selection: How to Find the Right Contacts for Your Connector

Continued from page 23

ber of contacts based on that layout and number of wires are being used. Each connector layout is designed for specific contact sizes, so selecting a connector layout compatible with your needs will narrow down which contact sizes you have to choose from (and simplifies the selection process).

Contact Type

The three main contact type categories include: stamped, formed, and machined. Stamped and formed contacts are often grouped because they are similar. They are well suited to high volume production because of how easy they are to manufacture (i.e., feeding strips of thin metal into an automated crimping machine). Machined contacts are preferred for low volume orders because they require more effort to fabricate. However, they may be necessary for power applications that require heavyduty usage.

Contact Plating

Another key consideration when selecting contacts for an electrical connector is the plating: contact plating affects both the conductivity and the durability of the connection. Gold plating offers excellent conductivity, and its high lubricity means it can withstand high mating cycles. Its primary disadvantage is high cost, so it may be most beneficial to use for smaller contacts. Tin, on the other hand, is usually used for bigger contacts since more material is required

Continued on page 27









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Contact Selection: How to Find the Right Contacts for Your Connector

Continued from page 25 _

for its larger surface area and therefore, greater associated cost. It also performs exceptionally well for lowvibration or static conditions.

Contact Termination Type

The termination type is also crucial when selecting the contact type for an application because it has a significant impact on both the assembly equipment and the processes used in manufacturing connectors. The two most common options are crimp contacts and solder contacts.

A crimp contact is terminated to a wire by crimping with an appropriate die and tool. After termination, an insertion tool is typically used to insert the crimped contact into the connector. The contact can be removed using a specialized removal tool unless it is a removable crimp contact, in which case it will either be front or rear release without the need for a unique tool. Because crimp contacts can be removed, they are often easier to repair in the field.

Solder contacts, unlike crimp contacts, cannot be removed by the user because they are bonded into the insulator. In this case, the contact is terminated to the wire with solder. While this termination type may not be as simple to repair, it is easier to seal against the ingress of moisture.

It is important to note that while some connectors include contacts by default, others may require that the contacts be ordered separately. (see ote below from PEI-Genesis who supplied this article.)

Note from PEI-Genesis

Trying to find the right combination of layout, size, type, plating, and termination type for your contacts can be tricky. While some connectors include contacts by default, others may require that the contacts be ordered separately. At PEI-Genesis, our team of experts can help you find the right contacts for your system, even if it involves engineering custom connector solutions.

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Checking the Quality of Connections



Checking for Intermittent Connections

Overview:Today, most companies manufacturing and/or integrating cables and wire harnesses, will test electrical integrity with programmable, automatic multiconductor testers – time-saving, productivity-boosting equipment that checks for and locates faults across all conductors of the Unit Under Test (UUT) without operator intervention.

Resistance measurement capability within a multiconductor cable tester is not simply for measuring the values of resistors.

As well as measuring any embedded resistors, the resistance-measuring feature of a cable tester is needed when measuring the quality of the connection and the quality of the non-connection. This test is recommended whether or not products have embedded resistors. To check the quality of a connection, you must check for good intended connections as well as good intended non-connections (Fig. 2), and for that you need a tester that a) measures resistance, b) allows you to set up limits, also known as dual thresholds, and c) allows you to check for intermittent connections.

Without performing these checks, you run the risk of releasing or accepting faulty product. It is important to know and understand the parameters against which your cable or harness has been judged to have "passed".

What are "Dual Thresholds"?

Dual threshold set-up is required to check for connection quality (Fig. 3).

Without measuring resistance, the tester will tell you when your intended connection is connected (passing a simple continuity check), but not whether that connection is compromised by something that affects the total resistance of that connection perhaps, for example, because of poor soldering. In short, resistance measurement capability within a tester is not simply for measuring the values of resistors.

___ Continued on page 31

Good Connection	C Good NON-Connection
R < 1.0 Ω	A = B
Typical Resistance "R"	Typical Insulation Resistance IR







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Cable and Harness Manufacturing

Continued from page 29 ____

Good C	onnection F	aulty Connection o	r Embedded Resistor Goo	disolation
- F	ŧ		+	
Lower Limit of	Maximum Con	nductor	Minimum Isolation	Upper Limit o
Measurement	Resistance Per	rmitted	Resistance Permitted	Measuremen
t	(User Program	mmed)	(User Programmed)	t
HVX21 - 1 mΩ*, 0.0	2Ω°, 0.1 Ω			HVX21 - 5 GΩ
HVX -1 mΩ*, 0.0.	2Ω*, 0.1 Ω			HVX - 1 GΩ
M4 - 0.02 Ω				M4 - 6 MΩ
M3Z -0.1 O				M3Z - 5 MΩ

Figure 3. Dual Thresholds

For most cables, you do not need to measure the actual resistance of each wire. Rather, you would like to confirm that the resistance of a good connection does not exceed a maximum limit, and that the isolation between unconnected wires does not fall below a minimum limit. We refer to these two limits as thresholds.

CableEye measures embedded resistors automatically when the resistor value falls between the high and low thresholds. When you save a cable in the database, the resistance values associated with any embedded resistors are saved along with the tolerance, wire list, and other cable information. Thus, embedded resistors become one of the characteristics of the stored cable and must be present in a test cable to successfully match against the saved data.

For this example (Fig. 4), the Maximum Conductor Resistance Permitted has been user defined within the software as 0.5 Ω and the Minimum Isolation Resistance Permitted has been set to 1 M Ω .The cable measured contains a resistor between pins 5 and 5. The 2.70 k Ω resistor falls not only between the upper and lower limits of measurement shown on the drawing above (e.g. 0.02 Ω and 6 M Ω for the Model M4), but also between the user-programmed resistance limits, so it is displayed as an embedded resistor.

Conductors between SH, 1, 2, 3, 4, 6, 8 and 9 are all under 0.5 Ω , and are displayed as good quality connections.

The connection between pins 7 and 7 is above 0.80Ω , which is above the Maximum Conductor Resistance permitted. This line is highlighted as a fault, and the cable is failed.

You can easily experiment with your own tester if you have a selection of resistors and a test interface fixture with screw terminals. Connect the resistors to the test interface fixture and adjust the resistance thresholds to see how the tester displays the results.Figure 4: Example of Netlist (Top) and Wiring (Bottom) ResultsWhat Constitutes an Acceptable Connection Resistance?The Maximum Conductor Resistance Per-

mitted sets the highest value of resistance acceptable for a "good" connection.

Wire connections in a cable that exceed your maximum resistance threshold will be flagged as defective. High-resistance connections like this may be caused by incomplete crimps, by insufficient mating between the knife-pin and wire conductor in IDC flat cables, or by cold solder joints in soldered connections. These marginal connections may then result in circuit misoperation, intermittent connections, or physical heating in the cable if enough current flows through that connection.

In a properly managed cable assembly shop, high resistance connections occur rarely. However, resistance testing is needed to ensure that absolutely no bad cables make their way into a customer's product. This is especially important for product destined for mission-critical applications such as aerospace, military, and medical devices. For example, you may set CableEye HVX-series continuity and HiPot systems to check for an acceptable connection resistance of as little as a few milliohms (refer to Fig. 3 for other models). Such low resistance checking is often recommended for shells and shields.

The best test systems will allow you to optimize your test by letting you set different thresholds for different conductors in your cable or harness. For example, you may set the Maximum Conductor Resistance Permitted to a very small value only for the shells and shields, and other values for the other conductors.

If you set this value to less than 5 Ω , the measurement time may increase by a factor of two or more due to the increased sensitivity you are asking for, and you may pick up marginally higher resistance values that will have no effect on the function of the cable. Other than for shells and shields, use the smallest threshold of 0.5 Ω or less only when you test power cables or any cables that are expected to carry significant current (20 gauge or thicker wire).





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Continued on page 55





Figure 4: Example of Netlist (Top) and Wiring (Bottom) Results

transitions and preventing connection cross up.



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- applications
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*polyolefin, 5" length

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

Ethylene Propylene **Diene Monomer** (EPDM) Insulated Wire and Cable

EPDM rubber was developed in the early 1960s as chemical companies and chemists set out to produce unique synthetic elastomers. After its first initial discovery, the DuPont chemical company was the first to refine the rubber into the product that we know today. The Ethylene Propylene Diene Monomer compound is created by chemically cross-linking the elastomer.

EPDM wire and cable products are nearly identical with many of the physical properties of natural rubber insulations and jacketing compounds with an added property of providing a weather-resistant jacket. EPDM compounds have much better resistance to heat, light and ozone as compared to unsaturated rubbers like natural rubber, SBR, PCP (Neoprene®) or Polychloroprene. As such, EPDM can be formulated to be resistant to temperatures as high as 150°C, and, properly formulated, can be used

outside for many years or decades without degradation. The one major problem with EPDM compounds is that they are extremely poor in applications where oil is present. EPDM is not to be used in applications where hydrocarbons, such as kerosene, gasoline and hydrogenated solvents, are present.

EPDM insulation and jackets are compounded with fillers such as carbon black and calcium carbonate and with plasticizers such as paraffinic oils, and have useful rubbery properties only when crosslinked. Crosslinking typically is performed via continuous vulcanization (CV) with sulfur, but is also accomplished with peroxides (for better heat resistance) or with phenolic resins. High-energy electron beam radiation (irradiated or E-Beam) is used for producing high-quality EPDM wire and cable products.

EPDM has good low-temperature properties, with elastic properties to temperatures as low as -40°C. As the demand for UV-resistant wire and cable increased, so did the use of EPDM

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for both hook-up wire and electrical cables. EPDM offers great flexibility, durability and is resistant to moisture. It also performs well in high temperatures and in high-voltage applications. Typically, EPDM wire and cable is used for high-temperature applications (125° to 150°C), such as appliances. Another use of EPDM compounds is in the manufacturing of medium-voltage test leads. EPDM insulated products can be used as appliance wire and as lead wire for motors, ballasts, transformers, coils or solenoids, where high temperature and/or high voltage is required. Common standards include UL 3284, UL

3374; CSA 1254 from sizes 18 AWG to 4/0.

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- EPDM are common insulators for welding cables (Anixter 5J part numbers)
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Preventing Safety Critical Electrical Failures with Grease

By Jeffery Wheeler Nye Lubricants

The number of electronic components in the average car has mushroomed over the past several decades and shows no signs of slowing. A single car has upward of 700 connectors, and that number is expected to increase to thousands per vehicle with the proliferation of electric vehicles (EVs) and autonomous driving technology. Electronics and electrical systems are increasingly replacing mechanical ones as designers add modern comforts that consumers demand, including infotainment systems and safety features. These amenities require electrical connections, and to speed assembly, terminals are arranged in large connectors that are assembled once and, hopefully, forgotten.

However, increasing electrification means more connectors and the potential for failures that are significantly more serious than a quiet radio. Brake pedal sensors, wheel speed sensors, and sensors for air-

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The risk of electrical system failures is already apparent. In 2012, there were about 20 recalls related to electrical component failures, and in 2016 this number grew to almost 60, according to a report by AlixPartners. Something seemingly as small as connector reliability could mean the difference between safe operation and dangerous, costly recalls. As connectors and electrical systems evolve and become more sensitive to resistance changes, connector lubricants must progress to keep up with application needs.

As car makers lengthen warranties and increase reliance on electrical and electronic systems, the challenge for connector and wiring harness manufacturers is to extend the operating life of connectors in ever more harsh environments. Lubrication aids wiring harness manufacturers on and beyond the assembly line to ensure solid connections and provide a layer of protection against fretting and environmental corrosion.

bag deployment are a few examples Fretting Corrosion, A Silent Killer

The risk of safety-critical electrical failures puts increasing pressure on connector suppliers to ensure their connectors will operate reliably for the life of the vehicle. One of the most common reasons for electric connector failure is fretting corrosion - wear that forms on electrical connectors and contacts when they are exposed to micromotions from vibration and/ or thermal expansion caused by heating or cooling cycles. Throughout the vehicle, connectors are subject to vibration from the engine, drive train, suspension system, and related components. Micromovements wear through metal coatings into the base material that then oxidize, eventually creating an open connection and ultimately, power failure or signal loss. As this oxide layer builds up, it acts as an insulator between the contacts, creating an open circuit and voltage drop across the terminal. Fretting corrosion has been reported on some of the most popular connectors used today for ADAS, including FAKRA, USB-A and USB-C connectors.

Sometimes un-mating and re-mating connectors is enough to solve intermittent power failures. However, unless a connector lubricant is applied, the connector will continue to wear and will eventually oxidize and corrode. Connector grease has two primary benefits. The grease reduces physical wear between the connecting surfaces as they undergo micromotions and fretting wear. This wear

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Preventing Safety Critical Electrical Failures with Grease

Continued from page 36

reduction preserves the connectors' layered coatings designed to prevent oxidation and minimize resistance. It also insulates the system from the surrounding environment, preventing insulative oxide layer buildup, which increases resistance and signal loss. Although connector lubricants are non-conductive, they still allow the microscopic asperities of the contacts to transfer signal and power, while filling in the valleys of the connectors where oxides and wear debris can form. Dielectric properties become especially important in multi-pin connectors, eliminating the possibility of a short between pins.

Insertion Force and Connector Reliability

The force required to mate separable connectors is of particular concern to wiring harness manufacturers and connector manufacturers alike. NIOSH warns that employees who perform repetitive wiring tasks on assembly lines may be at risk of developing carpal tunnel syndrome and other musculoskeletal disorders of the hand, wrist, and arm. The risk of injury is exacerbated in the auto industry because workers often mate connections in hard-to-reach positions. These connectors require more force to mate the connections, increasing assembly technicians' risk of musculoskeletal disorders. As the number of connectors in the average vehicle increases and more force is required to mate an entire assembly, reducing insertion force per connector will become key to protecting the health of those putting together wiring harnesses.

Insertion force isn't just a problem on the assembly line, high insertion force also negatively impacts the quality of connections. Most connectors have locking devices, but high insertion force can prevent proper mating, and the connector can separate. A properly selected lubricant lowers insertion force by decreasing the coefficient of friction between mating surfaces. It reduces mechanical wear by placing a film of oil between the mating surfaces. Lower insertion force ensures solid connections and reduces physical strain on assembly line workers, which can reduce worker compensation claims.

Environmental Corrosion

The automotive environment challenges even the highest quality connector. In the engine compartment, connectors must survive rapid heating and cooling cycles as well as corrosive gasses, fuel, water, salt water, and road grit. Power mirrors, door locks, and other external systems face water and detergent baths in car washes. High levels of humidity threaten connector performance between door panels. Inside the passenger compartment temperatures can soar when exposed to sun and drop well below freezing in cold climates.

All these conditions are catalysts for oxidation and corrosion, which create resistive oxides and in turn result in intermittent faults or electri-

Continued on page 41

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cal failure. Aside from fretting protection, connector greases also act as a seal to protect connectors against keeping out water, dirt, and other corrosive elements that can lead to power failure. For automotive assemblies, a connector grease with good water washout and salt spray properties are recommended.

Is a properly designed connector enough to ensure that it will operate reliably for the life of a vehicle? Connector quality depends on many factors, including materials, contact geometry, normal force, and design of springs, crimp mechanisms, and housings. But connector redesign is often a costly task that involves added resources and delays the launch of a product. When the cost of electrical failure is driver safety, great care should be taken to ensure connectors

operate reliably and without interruption. Readily available lubricants backed by application data are a costeffective solution to reduce insertion force and protect connectors against fretting corrosion, environmental corrosion.

About Jeff Wheeler

Jeff Wheeler is a Regional Engineering Manager at Nye Lubricants where he specializes in lubrication solutions for connectors and other electric and autonomous vebicle components. Prior to working for Nye, Jeff worked as an engineer for the United States Steel Corporation. Jeff holds a Bachelor of Science degree in Chemical Engineering from Michigan State University.

About Nye Connector Greases

For more than

assembly can withstand harsh environmental conditions. To address these needs, our connector greases have superior salt spray resistance with little water washout or grease evaporation. With some wire harness assemblies, material compatibility can become an issue as you must ensure that the lubricant will not eat through plastic components. NyoGel® 760G, along with our other connector greases, are resistant to harsh chemicals and are compatible with a wide range of plastics and elastomers.

As a trusted supplier, we work directly with design engineers to form a partnership and assist with proper grease selection to ensure performance, avoid warranty claims, and prevent costly, time-consuming repairs. For design engineers outside of the automotive industry, we also offer specialty connector greases with low outgassing properties or low toxicity to meet the unique requirements of wire harnesses in aerospace, medical, and semiconductor applications. To accommodate different requirements, Nye offers a variety of grease packages to suit both high-volume production dispensing and small volume manual dispensing. If you would like to learn more about how our connector lubricants can work in your wire harness assembly, please contact Jeff Wheeler at jwheeler@nyelubricants.com





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Wire Labels: Continuous Vs. Ladder Style Heat-Shrink Sleeves

ne of the most common types of wire identification is with the use of labels. There are two basic categories of wire identification labels: adhesive labels and heat-shrink sleeves. This article deals with heat-shrink labels. (For a quick overview of adhesive labels take a look at, Basics of Adhesive Wire Labels on page 44.)

First, it's probably a good idea to review some of the main reasons for wire identification.

Identifying wires and cables is a critical component to a cable management solution. This is true whether wires are going into a panel/box, or being shipped as a harness. Overall, labeling can be a great way to improve customer satisfaction. Here are some specific advantages:

- 1. Provides professional looking panel or harness with clear identification of wires and blocks.
- 2. Improves connection of wiring to panel

- 3. Insures accuracy of wire placement.
- 4. Allows easy tracking of wires and cables.
- 5. Reduces human error in initial assembly as well as field repairs.
- 6. Reduces time in troubleshooting problems.
- 7. Branded sleeves can help OEMs track authorized repairs and help with tractability with products in the field.

Ladder Versus Continuous Heat-Shrink Labels

Heat-shrink labels generally offer a more professional look and are a much more durable option over adhesive labels. They fit over the end of a cable and shrink when exposed to heat for a snug fit. A heat source is typically used to shrink the sleeve onto the wire, but some users leave the material unshrunk so the label



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can be moved to be more readable after installation. Since the sleeve will not fit over most terminals, lugs or contacts, they are generally not used on terminated wires. For terminated wires, adhesive labels or some other method of marking will likely be used.

Ladder Style

Ladder style labels (Figure 1) come on a reel in pre-cut lengths and are taped on the back to hold them in place. They come in a couple of different lengths, with two-inch being the most common and least expensive.At an additional cost, ladder style labels can be ordered with perforations on each label so that one label can be split into multiples.



Figure 1. Ladder Style Labels

These labels can be printed on both sides and are typically only offered in military grade polyolefin (MIL 23053 or SAE-AMF-DTL-23053/5). The cost of ladder style labels is typically calculated between \$.15 - \$.80 per inch depending on specifications.

One of the big advantages of ladder sleeves is the carrier. It allows for easy application and tracking during assembly.



Figure 2. Continuous Style Labels

Continuous Style

Continuous style labels (Figure 2) come as a flattened continuous tube on a reel. The material is the same polyolefin used for ladder style labels. The printer can print the information on both sides of the sleeve, and will also make perforated cuts on the material at desired lengths. The operator simply pulls apart the labels for application. The cut depth of the perforation can be adjusted to make it more difficult or very easy to pull apart.

Generally, both ladder and continuous tubing can be run through the same printing systems. It is about a four-minute changeover, however, so if a lot of continuous label printing is done, it is suggested to have a bespoke printer. As the use of continuous style shrink sleeves typically represents a 70% savings in material cost versus ladder style, this cost can be easily justified.

Continuous sleeve tubing is available in the same military grade as the ladder style. There is also the option for a less expensive UL approved material suitable for most applications.

There is one caution with continuous sleeve tubing. It is best to choose a printer that is center justified and will accept narrower base rollers. This will allow for better printing performance at the middle, all the way up to the edges of the material.



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> Terminal to bus bar Connection bolt on aluminum conductor



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Basics of Adhesive Wire Labels

dhesive labels are a great economical way to identify wires in an assembly. (For a look at the overall importance of identifying wires with labels see *Wire Labels: Continuous Vs. Ladder Style Heat Shrink Sleeves* on page 42) As with any technology, the selection of the proper material is the key to success with adhesive labels.

dhesive labels are a greatLabel materials have varying degreeseconomical way to iden-
tify wires in an assembly.of memory. They come flat and have
a tendency to want to remain flat. Ab-
sent proper material selection, a label
can begin to unpeel or flag up.

Common materials are foil, polyester and vinyl. The most common material used is vinyl due to its durability and conformability.

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There are three main types of adhesive labels, wrap around, self-laminating and cable flags.

- **Wrap-around** labels (Figure 1) are available in different sizes and can be printed on a thermal transfer or laser printer with the legends needed to mark wires or cables. These labels can be ordered pre-printed.



Figure 1. Wrap-around Lable

- **Self-laminating** labels (Figure 2) are available in different sizes and can be printed on a thermal transfer or laser printer. They will have a white printable area and a clear laminating tail that will wrap around the wire and cover up the printable area for extra protection.



Figure 2. Self-laminating Lable

- **Cable flag** labels (Figure 3) can fit several lines of data and even barcodes. Cable flags are also adhesive labels, but rather than wrapping flat around the wire, they adhere to themselves and stand out like a flag. Due to the thinness at the neck of the material that wraps around the wire, these labels are generally less durable than other types. They make up for this lessened durability with increased labeling space, making it easy to fit multiple lines of data on a small wire or cable.



Figure 3. Cable Flag Label

About Dasco Label

Many Thanks to Ken Shultz of Dasco Labels for compiling this material. Dasco provides extensive labeling solutions for the wire processing industry. Dasco specializes in leading customers to a labeling system that's right for the application. You can purchase labels and printers online at www.dasco.com or contact them at 877-855-2235.



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IPC/WHMA to Help Grow Electrical Wire Processing Technology Expo



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 better. IPC got involved in wire

 WHMA announced that it was selected to manage the Electrical Wire Processing Technology Expo (EWPTE), to be held in Milwaukee, Wis., starting in 2021. What does IPC/WHMA bring to the table? David Bergman, WHMA executive director and IPC vice president, standards and technology, and Alicia Balonek, senior director, tradeshows and events, explain.

Q. Why IPC/WHMA? How can this help EWPTE grow?

A. IPC is an industry association with more than 60 years of providing excellent service to the electronics manufacturing industry with a mission to help companies build electronics

harness in the early '90s when our members requested workmanship standards for wiring harnesses.We collaborated with the Wiring Harness Manufacturers Association and together developed IPC/WHMA-A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies. After developing the standard, the two organizations created a certification program for wiring harnesses. IPC/WH-MA-A-620 and its certification program have grown globally to become one of our most popular standards and training programs, with 17-20,000 individuals trained to IPC/WHMA-A-620 every year. The synergy between IPC and WHMA led

to the two organizations signing an affiliation agreement in 2019, enabling an even closer working relationship and the opportunity for more services for WHMA members.

Q. What does IPC/WHMA bring to the table from the show perspective?

A. IPC got involved in producing shows for our members in the early '90s with Surface Mount International (now SMTA). Subsequently, IPC was asked by our suppliers to the PCB industry to develop IPC Printed Circuits Expo. In the late 90's, IPC merged with the Surface Mount Equipment Association Manufacturers (SMEMA) which directly led to the launch of IPC's APEX trade

show. These efforts made it very clear to us that there is a tremendous benefit to bringing enduser customers and manufacturers together with suppliers in an industry trade show event. This is the logic behind IPC/ WHMA's bid to manage EWPTE and our vision is to bond the associations and EWPTE together.

Q. Why is IPC/ WHMA the best organization to take on this event?

A. WHMA's aspirations are to:

• LEAD - By providing knowledge and best practices

• EDUCATE - By developing standards and distributing information

• CONNECT - By fostering relationships

EWPTE is the perfect place to take action on all three aspirations, along with IPC's vision to help the world build electronics better. It's good for IPC/WHMA and good for the show.

Q: Now that IPC/ WHMA are producing EWPTE, will this mean





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a whole new look and feel?

A. EWPTE has a 20year history of success. Our goal is to build on that and make it even better. IPC/WHMA's promise to our members are for a focused, fair, and costeffective event. It has worked for IPC's flagship event IPC APEX EXPO and WHMA's Annual Wire Harness Conference and it is our belief it will work here. So, tweaks and enhancements are being planned, but not wholesale overhauls. We recognize that there is a comfortable family feel to the event, and we don't

intend to lose that, but to instead grow the family.

Q. You have stated that you will develop a technical conference component to this event. How will that be developed and what will it include? Can you highlight particular conference tracks?

A. This is still in the early planning stages. Historically there have been exhibitor sponsored workshops and seminars which are very popular with the attendees of the Milwaukee event. These will continue. We have reached out to OEMs and fabricators that come to the event to determine what educational topics will attract more of their peers. the latest materials compo-

We will pull together a program committee that can provide firsthand feedback.

Q. How will you increase the global reach of EWPTE?

A. IPC/WHMA has hundreds of wiring harness manufacturing members and thousands of companies that have expressed interest in wiring harness technology. This is the advantage of binding the associations and the show together. Our goal is to reach out to these thousands of companies and motivate them to participate in the show.

Q. You will be managing the upcoming EWPTE May 11-13, 2021. Will you include a virtual component if the pandemic situation continues?

A. We have had hybrid elements to our show productions for many available years. However, our exhibitors have not embraced the usage of these available tools. If the pandemic continues, maybe this will change. We will be actively promoting the virtual/hybrid tools to our exhibiting members and encouraging companies to take advantage of them.

And finally, the opportunity to network with peers, suppliers, and customers to refresh existing relations and make new connections.

Q: Why is this event so important for wire and cable manufacturers? How does this event differ from WHMA's annual wire harness conference?

A. EWPTE is the largest show of its kind for the wiring harness manufacturing industry in the United States. If WHMA members are going to go to one event, it would be this one. Many WHMA members send multiple staff to check out and hopefully buy

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and their industry knowledge. nents and equipment.

The WHMA Annual Conference held in Q1 each year serves a different audience. This meeting is targeted more to the executives of harness manufacturing companies and is intended for business leader networking. WHMA's annual conference is smaller than EWPTE, and while there are a number of tabletop exhibits, it does not compare to the business activity that takes place at the Milwaukee Center.

Q. Where can people go for more information on the 2021 show?

A. Those interested in learning more about EWPTE 2021, can visit www.electricalwireshow.com.



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Q. What are the three top reasons to attend EWPTE in 2021?

A.Certainly the trade show activity would be first: come and see the latest industry solutions on the show floor. Attendees should also plan to check out the educational offerings: improving oneself

- Four processing stations for added flexibility
- High durability and longevity



A Welding Machine for All Terminals

By Saeed Mogadam TELSONIC Solutions LLC

U tilization of ultrasonic metal welding, especially for wire/cable terminations has become increasingly popular and accepted by the automotive industry. Both wire harness manufacturers and OEMs have gained more knowledge on the technology and, as a result, have made substantial progress in product development of connectors. The suppliers of welding equipment, in the meantime, have made significant contributions to this growth by making continuous advancements in the technology. The introduction of a new connector for any automotive application starts with the product designer and ends with the best solutions from the equipment supplier. Factors influencing the welding feasibility and its quality are illustrated in figure 1. The process of design and material selection, along with the plating conditions, is the responsibility of the connector manufacturers. However, the equipment supplier must make sure that the welding process, equipment, and the human interface, is made simple, yet consistent and easy to maintain. This process of close collaboration between the connector manufacturer and the welding machine supplier is an established process. Thus, the Ultrasonic metal welding process for wire harnesses and cable terminations/assemblies is more acceptable than ever.

Factors Influencing the Weld Quality

Today, new terminals in all different shapes and forms are being designed and utilized for automotive applications. The latest and most common applications are for high voltage cable terminations and battery cable assemblies. Such a variety in the automotive terminal designs has heightened the demand for universal welders. A universal welding machine must be simply adaptable to most terminals, if not all. Such welding equipment allows manufacturers to utilize the same machine for a wide spectrum of designs and manufacturing process requirements. And yet, the universal welder must be able to do a variety of terminations with minimal change-over, tooling replacement and stringent quality control.

Continued on page 50





Figure 1: Factors influencing the weld quality

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A Welding Machine for All Terminals



To address these developing requirements, the universal welder must be designed with standardized flexible modules to make the adaption to every termination very simple on the same machine. All modules must be capable of controlling the process with quality standards such as USCAR38 and with minimal change-over or replacement. The MPX-TC universal welder was developed by Telsonic to meet the industry demands for simplicity and consistent quality. The machine works on the principles of longitudinal vibrations which is most common in the industry. The machine is available with a wide range of power offerings from 2.4 KW to 7.2 KW for copper cables up to 50 mm². The im-

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Continued from page 48 _____

ages below illustrate the variety of terminals commonly used in the industry today.

In its simplest form, a universal system can be a benchtop welding machine for battery applications or any spot welding. At the same time by adding standardized modules, the MPX can perform manual operations for terminations as well as complex tasks such as semi-automatic terminations and more. These modules are designed to be robust and allow for 24/7 operations. Once the terminal design is defined and accepted to be feasible, the MPX can simply be configured by adding standard and/ or optional modules (possibly just two components) to complete a fully functional machine.

The MPX universal welding machine advantages are:

• Minimal changeover for similar terminals or perhaps different size cables with the same terminal.

• Easy integration of modular subassemblies when terminals require additional steps such as **insulation crimping** or **automatic feeding**.

The flexibility of the MPX allows the manufacturer to utilize the same machine for many different terminals. For high volume production, the machine is common to all applications and allows the plant staff to be easily trained on the operation, and quality control, while using fewer parts. The maintenance of the equipment on the manufacturing floor is thereby reduced and simplified. All welding and quality control parameters can be transferred among machines. The standardization of the machines offers better quality, interchangeability, higher production rate, lower maintenance, and overall effective manufacturing costs. This machine is also ideal for application development and feasibility at customers' sites or at Telsonic application laboratory. Furthermore, customers will have the advantage of shorter manufacturing and delivery time.

Specific configurations of the ma-

chine are defined by the terminal design (Flat, 3D, with side walls) and process requirements. Here is the view of the MPX-TC with all standardized module and options for different terminals and requirements.



Basic Machine for Flat terminals with or without walls



Terminal Feeding Module



Crimper Module

Standard modules in MPX-TC consists of:

• The MPX actuator: the welding system

• The gather mechanism, also known as downholder: this is to control the width of the weld nugget according to the USCAR 38 requirements

• Anvil fixture: acoustically designed to be universal and have minimum deflection during welding

• Cable stop to control the weld position: two vertical and horizontal motions for all terminals

• Bad weld cutter (optional): this is a requirement by some standards, where the bad weld needs to be cut automatically

• Cable clamp: to hold and position the single or bundle of wires during welding

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• Gather inserts with single vertical motion are universal for all flat terminals. For the terminals with walls, the gather inserts are slightly different. The single vertical motion is for faster cycle time and less adjustment.

Custom tools and optional modules are fewer, compared to any other welding equipment

Different cable sizes might require a different size sonotrode (horn). Also, when terminals are geometrically different, then one should design the nest to position/load the terminal correctly each time. Therefore, the only custom tools that one needs for different situation are mostly the sonotrode and nest.

Common Applications Used By Industry

In cases of flat terminals with different cable sizes, the machine requires just the nest and sonotrode for change-over.



3D flat terminal with 35 mm² cable



Terminals with walls require gather inserts with recess in addition to the sonotrode and nest.



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Terminals with insulation crimp, like ground lug (GL), also known as eyelet terminals, will require installing the crimping module to the standard MPX-TC.



GL terminal with multiple wires



The GL terminal is used to connect multiple ground wires together in one location. An automotive harness can have over 10 GL terminals depending on the vehicle complexity. But they all come in different shapes for mounting on the automobile chassis. These traditional terminals are available in 4 and 7 mm (inside wall width), with a maximum of 20 mm² total cross-sectional area for all wires. Recently, some OEMs are using newer GL terminals that have no walls and

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are flat. The trend in the harnesses is that there will be more GL terminals in the future. In either case, the MPX welder can easily switch from one with walls to flat versions.

Flat terminals on the reel (carrier strip) will require the feeding unit module, the reel mount, and the contact strip separator, as well as a sonotrode and a nest.

Continued on page 52





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A Welding Machine for All Terminals



Lear MAK Terminal with 16 mm².



MAK terminals designed and produced by Lear corporation are another popular connection system in automotive wire harnesses. There could be as many as 10 terminals in the harness for north American automobiles and perhaps more for European cars. It is mostly used for following modules in a typical automobile:

• Perfuse centers: harness connection to fuse arrays

• Cooling/rad fan: pigtail or inline connection

- Power steering
- E-turbo charger

• Pluggable power feeds to IP distribution boxes

MAK terminals are available as MAK12 or MAK8 and have been used primarily on low voltage applications. The MAK12 is specified for cables up to 35 mm². This terminal is now used more often for high voltage (HV) applications and in electric vehicles than for low voltage applications in the harness. In one of the future car programs, the battery distribution unit has 10 MAK terminals as part of the design. It is normally available on a reel. Therefore, the MPX machine uses the feeding unit as well as the terminal separator in the welding area.

Simplicity of a universal welding machine cannot be achieved without well thought and established operating software. This is the reason that equipment manufacturers have invested in developing better software in the last few years. Telsonic developed a universal software that can work with all Telsonic welding equipment including the MPX-TC. Telso®Flex with its intuitive HMI touch screen, makes the changeover and operation even easier and more reliable. The Telso®Flex is a pioneering controls technology with a highlevel quality monitoring, machine troubleshooting, and networking from remote location.

The demands on a system control can change over time due to adjustments in the production environment. For example, adjustments to the process workflows require different interfaces, or a different operating language is needed due to production relocations. Due to its modern architecture, the Telso®Flex software can be adapted to these needs and upgraded with add-ons. New functions can also be installed later.

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duction, the quality must be continuously monitored, and trends must be recognized. In this way, an impending production failure can be recognized and avoided. When producing large batches, the batch size of the packaging unit can also be specified, and the operator can be informed to provide support. The software offers topic-related assistance for maintenance and servicing to shorten the unproductive time.

In a wider spectrum, there are applications involving flat bus bar to larger cables, smaller area for the specific cable size, and short cables, where the vibrations may affect the connection at the other end of the cable. In addition, geometrical shapes or much larger cables will require special welding equipment. Here are some examples of other applications utilized by the industry.





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Implications of Section 889 Reqs on Federal Contactors

By Christine Siebert

n August 12, 2020, Director of National Intelligence John Ratcliffe issued a memorandum to the Department of Defense (DOD) that waives the applicability of Section 889 of the National Defense Authorization Act for Fiscal Year 2019 as applied to DOD. Section 889 prohibits agencies from procuring telecommunications equipment and services from Huawei Technologies Company, Hangzhou Hikvision Digital Technology Company, Hytera Communications Company, Dahua Technology Company, and ZTE Corporation (and associated subsidiaries or affiliates). DOD originally released a memorandum on July 23, 2020, to begin implementing



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Section 889, which was set to take effect on August 13, 2020, by law, but Director Ratcliffe's memorandum delays its implementation. (Part A is currently active.) His waiver allows DOD contractors to continue using banned Chinese telecommunications equipment until September 30, 2020, Part B.

Section 889 has two parts: Part A (buy ban)

• Prohibits government from procuring or entering contracts to directly acquire systems using covered telecommunications equipment or services as a "substantial or essential component," or critical technology.

Part B (use ban)

• Prohibits government from procuring from or entering contracts with entities that use covered telecommunications equipment or services as a substantial or essential component, or critical technology, of any system for any purpose

There are potential consequences of noncompliance (up to \$23,000). All contractors, including small businesses, must pay closer attention to their own operations and supply chains to make sure that they are not using, or that they can swiftly remove, all "covered telecommunications equipment" within their operations. There is an exception for some telecom equipment "that cannot route or redirect user data traffic or [cannot] permit visibility into any user data or packets that such equipment transmits or otherwise handles."

At a minimum, discussions between contractors and their subcontractors and suppliers will need to go into detail to verify that the prohibited equipment is not somewhere in the contractor's supply chain. Contractors should also make certain that they thoroughly document the steps taken and any information acquired from their subcontractors and suppliers so that, if questioned, the "reasonableness" of the inquiry can be promptly demonstrated to follow the "Reasonable Inquiry" rule. The bottom line for federal contractors regarding Section 889 compliance may simply mean continuous monitoring and documenting of supply chains but it will only need to be reported annually instead of per contract.

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What Constitutes a Short Circuit?

The Minimum Isolation Resistance Permitted sets the lowest value of isolation resistance acceptable for unconnected wires.

In addition to certifying that a wire connection passes a low resistance test, we must also ensure that internal short circuits do not exist. While this seems obvious, we need to define exactly what constitutes a short circuit.

To certain sensitive electronic devices, especially in medical applications, a "short circuit" may exist in a cable when as much as a 1 M Ω (or higher) resistance path appears between two pins.

In contrast, the high output drive capability of present-day CMOS digital circuits can easily maintain the logic '1' minimum voltage across a short circuit of as small as several hundred ohms.

Ideally, we would like an infinite resistance between isolated conductors. As a practical matter, though, a lesser amount will be quite adequate for most applications.We recommend a minimum isolation threshold of 1 $M\Omega$ for general purposes, although you may set the isolation threshold to a higher value, depending on your tester model. Refer to Fig. 2 to determine the maximum value that you can set your isolation threshold to.

Note that the contact resistance of dry human skin is about 2 or 3 M Ω . To minimize the likelihood of false negatives during production testing, we recommend setting the isolation threshold above 1 M Ω only when you

are testing cables that will be used in a high voltage or extremely low current application.

Why Check for Intermittent Connections?

We define an intermittent connection as a temporary but radical change in resistance between two points occurring unpredictably when motion or stress is applied or when a change in temperature causes expansion or contraction of an electrical contact.

Poorly mated pins, broken wires, and poor bonding, among other things, may cause intermittent connections. Checks for intermittent faults are performed after a successful, static continuity and resistance check.

An intermittent open circuit applies to a low resistance connection which, for a short period of time, becomes disconnected (high resistance). An intermittent short circuit applies to two normally unconnected conductors which, for a brief period of time, short together (low resistance).

The intermittence test is dynamic: During the test, you flex the connectors and apply stress (including pull) to the cable (Fig. 1) while the tester sends a continuous stream of test pulses under fast cycle times. A full cycle comprises a complete sweep through all test points.

The CableEye software offers two methods for checking for intermittent connections; one detects continuity differences only (opens/shorts) and another detects and reports re-

Continued on page 57







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Cable and Harness Manufacturing

sistance variations. Furthermore, to report the resistance variations there are two options, 2-Wire or 4-Wire resistance measurements. The Continuity Only Test offers the fastest scan rate.

The test is properly performed when the sample rate is high enough to statistically capture enough random events to raise the confidence level in the test result to an acceptably high degree. Companies running stringent quality programs (such as Six Sigma) will be looking for the fastest cycle time possible. They need testers that deliver diagnostic information above a simple PASS/FAIL, so they can provide quantitative and qualitative data to their process-improvement feedback loop.

In advanced testers such as Cable-Eye systems, when the test runs, a tone will sound if any faults are found, the error count will increment, and a wiring diagram will display all accumulated intermittent connections highlighted (Fig. 4). In this case, we see an intermittent short between pins 2 and 3 and an intermittent open between 1 and 1 were detected.With 19 full test cycles being completed every second, in 570 test cycles, 22 error events were detected.

It is clear that this is a faulty cable and this test has correctly identified it as such – in addition to identifying and locating the errors. If this dynamic test had not been performed, this cable would have been falsely determined to "PASS": all tester indicators, labels, and reports would incorrectly show as "PASS".

Note that with a slower test cycle frequency, fewer of these error events would have been detected.At a slow enough rate, despite running an intermittence test, none might be detected resulting in a false "PASS". It is important to pay attention to the cycle rate setting.

Clearly, checking for faults in this way will be able to tell you exactly which, if any, wire has a break. Generally, the most likely location of a break is at the end of the wire i.e. at the connector. If a cable has been pulled (experienced tension), it is possible that a break might occur along the



Figure 5: Example of Netlist (Top) and Wiring (Bottom) Results

length. Cables for robotic applications might break along the length especially if the repetitive motion causes the cable to rub against a hard point or exceed the recommended radius of curvature. Figure 5: Realtime intermittence testing identifies a) the number of passes and errors, b) the type of error (color-coded), c) the location of the error.Conclusion It is a common misconception that measuring resistance is only required if the product has embedded resistors. We have shown the importance of checking the quality of connections and that this requires the ability to measure resistance, to set upper and lower limits, and to check for intermittent connections.

It is also a common mistake to assume that a cable is fault-free just

Continued from page 55 ____

because a tester PASS light lit up, or because you have an auto-generated printed report with a "PASS" title.

Be sure you understand the pass parameters against which the tester is making the determination.

Check that your test system is capable of measuring the quality of the connections, and that it has been set up to do so with the right values for your product and its application.

If you are subcontracting your harness and cable manufacturing, ask your supplier to confirm this information and, if necessary, to reset the pass criteria on their tester.

Our thanks to CAMI Research Inc. for this paper. If you would like to contact CAMI, you can do so at (978) 266 2655, or go to camiresearch.com.

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