A More Profitable
Plastics Industry

Produced by Electrivert Incorporated

Hot Runner wiring solutions for **higher productivity and lower costs**

SUMMARY:

- Proper cable installation and application will reduce downtime, repair & replacement cost
- Reliability is often lacking in cable assemblies produced under current industry practice
- Current industry design standards need to be re-evaluated

The plastics industry has undergone substantial changes over the last several years, seeing declining business and reduced profits. Companies are looking inward to improve their manufacturing processes, streamline their supply chains, lower maintenance costs and improve their bottom lines. Manufacturers are frustrated with the costs associated with failing power and thermocouple cable assemblies. These costs include tool or controller damage, cable repair or replacement, loss of production, customer relations, overtime expenses and much more.

Power and thermocouple assemblies come in a variety of configurations, many of which are based on rectangular connectors similar to those made by HARTING®. Unfortunately, in many cases components from different suppliers are mixed and matched in the same assembly and/or application. This contributes to increased failure rates. Key factors are connector manufacturing quality, design tolerances, cable types, cable gauges and strain relief selection. To minimize this, you need properly sized, UL listed connector and cable components.

The failures on the production floor are simple to understand. Uncovering their root causes and solutions takes a bit more research and insight into cable assembly construction and use over their life cycles. Common failure modes and remedies are summarized below:

FAILURE	CAUSES	RECOMMENDED SOLUTIONS
Pin Push-Out / Broken Pins	• Pin stress or fatigue due to high number of mating cycles • Connector or pin alignment issues • Loose pins due to cycle count, abuse, heat or tolerance issues • Foreign matter in the connector or receptacle • Connector or latch lever damage allowing excessive play in the connector	• Use high quality components from a respected producer • Minimize "mixing" of manufacturers to reduce tolerance issues • Use machined versus stamped pins • Use screw terminal inserts versus crimp • Upgrade to newer connector/insert designs • Overmolded connectors which hold the components in place more consistently • Add guide pins and bushings to ensure proper alignment • Use UL tested components • Provide proper cable installation and maintenance training • Investigate a custom solution with a quality supplier
Pin Burn-Out / Short Circuits	• Similar to Pin Push-Out and Broken Pins • Using a 10 Amp connector for 15 AMP power circuits • Cable failure • Connector failure • Accidentally plugging Thermocouple cable into power plug	• Retrofit equipment with connectors rated for 15 Amps or higher • Use machined versus stamped pins • Use cable rated for 15 Amps • High flex cable to minimize cable failure
Latching Lever/Bail Damage Smashed / Damaged Hoods	• Forcing the latch closed when the connector is misaligned • Excessive physical loading • Physical abuse while changing out tools	• Add guide pins and bushings to ensure proper alignment • Use hoods and receptacles that have reinforced bails • Overmolded cable assemblies
Cable Pull-Out	• Plastic strain relief nuts • Improper sizing of strain relief components • Excessive physical loading • Physical abuse while changing out tools	• Properly sized metal strain relief nuts and correct cable glands • Metal basket weave • Incorporate strain relief loops into your installation • Provide proper cable installation and maintenance training
Cable Burn-Out / Cable Failure & Cut Cables	• Improper wire gauge • Short circuits • Broken pins • Repeated cable flexing or motion • Pinching cable in machine while swapping tooling or cycling machine • Other physical abuse	• Size power cable according to the required load • Stranded versus solid conductor thermocouple wire • Use flex rated cable • Use flex rated cable conduit if appropriate • Provide training on proper cable installation and maintenance
General Failures	• Inferior Non UL Components	• Use UL listed connector and cable products.

Pin Push-Out / Pin Breakage

Pin push-out decreases or eliminates contact with the mating pin.

SOME CAUSES ARE:

- High number of mating cycles
- Improper alignment and/or forcing the connectors together
- Tolerance mismatches between connector manufacturers
- Loose tolerances from the manufacturer
- Connector damage due to over-current or heat

The simplest solution to reduce or eliminate pin push-out or breakage is to use high quality components from a respected manufacturer. Avoid using multiple brands of connectors unless you have verified that there are no tolerance issues.

Machined contacts can reduce the occurrence of pin-push out and are more durable than stamped or formed contacts. Since machined contacts are solid, they provide improved electrical characteristics due to greater contact surface and tend to stay fixed in the connector more reliably. Female machined contacts have more "wall" material than stamped or formed contacts. This improves pin holding forces between male and female contacts. They can also withstand greater amounts of abuse. Additional benefits of machined contacts are:

- Uniform thermal transfer, reducing hot spots and pin burn-out
- Uniform contact surfaces improving current characteristics
- Greater resistance to unintentional abuse minimizes bin breakage

Connector misalignment can cause pin push-outs and pin breakages. Guide pins and bushings are very inexpensive, easy to install and reduce the chances of connector misalignment. Guide pins simply replace the connector insert mounting screws.

Upgrade your connectors to a newer design. A common standard for Hot Runner power cables is an older 25 pin connector with crimped pins. This can be switched out to a 32 pin crimp connector that fits a 16B sized hood and housing.

THIS CONVERSION OFFERS THREE VERY IMPORTANT BENEFITS:

- Uses robust machined contact versus smaller stamped/formed D-Sub contacts typically found in the 25 pin connector
- Rated for 16 Amps versus the 10A rating of the 25 pin connector
- Newer design holds the pins in more reliably

Lastly, standardize on screw terminal connectors or upgrade to overmolded cable assemblies. These "encapsulate" or "capture" the pins so pin push-out is not possible. Broken pins can be drastically reduced. The 24 pin screw terminal connector used on Hot Runner Thermocouple cable assemblies is an excellent example. By adding "Coding Pins", it is possible to standardize on this connector for Power and Thermocouple cable assemblies.

Pin burn-out / Short circuits

Pin burn-out is a catastrophic connector failure caused by current overload or a short circuit. Using a 10 Amp connector for a 15 Amp circuit is a major contributing factor. The typical 25 pin crimp connector used in Hot Runner Power Cable assemblies is rated for 10 Amps. Other causes include cable failures, broken pins and pin push-out. Reducing costs associated with pin burn-out issues is simple; use UL listed connectors and cables rated for at least 15 Amps.

Connector Damage

Mechanical damage can be a more difficult issue. Connectors get caught in the tools, run over by fork lifts, dropped and any number of other scenarios. Broken latches, damaged latch "bails", cracked or smashed hoods and broken mounts are just a few examples of connector damage found on plastic injection presses.

Latches are damaged by excessive physical loading on the latch while it is plugged in, being latched while there is a misalignment issue or random physical abuse. Switching from top entry (straight) to side entry (90 degree) hoods may help to reduce the mechanical loading on the latch assemblies. This may not be possible due to physical constraints of the system. Most standard hoods and housings come in both single lever and dual lever designs. Dual lever designs distribute the physical load better. Guide pins and bushings can also be installed to prevent connector misalignment.

Overmolded rectangular cable assemblies are an additional option.
THE KEY BENEFITS ARE:

- Two-stage molding process reduces downtime and maintenance costs
- Eliminates conductor stress and contact push back to help reduce system failures
- 250 lbs pull out force ratings eliminate cable pull-out
- Omni-directional flex strain relief reduces cable failures and cable pull-out
- Overmolding process ensures reliable connections in harsh environments
- Decreases downtime and maintenance costs related to damaged hoods or latch pins
- Available in Flex or Static/Tray for total design flexibility

Lastly, proper training can provide the greatest improvement.

Cable Pull-Out

Excessive mechanical loading and improper strain relief selection are the primary causes of cable pull-out, allowing the cable to work itself out of the backside of the connector. This increases the likelihood of cable failure, pin push-out and short circuits.

SOME CONTRIBUTING FACTORS ARE:

- Low cost plastic strain relief compression nuts
- Improperly sized cable glands
- Mechanical loading perpendicular to the connector
- Excessive cable bend radiuses
- Cable jacket degradation

Proper strain relief design is the solution. Select cable glands based on the cable OD and installation environment to ensure a tight fit and to maximize holding force. Do not use plastic compression nuts. These can loosen due to the expansion and contraction of temperature variations, vibration or gland nut failure. Plastic strain relief nuts will degrade over time due to heat exposure, ozone or UV exposure and should therefore be checked often. Metal strain relief nuts can be tightened more securely than plastic and will not degrade over time.

Jacket materials on hot runner cables can be degraded by chemicals, heat, ozone and UV exposure. Make sure that you select the appropriate jacket material for your manufacturing environment. Two common jacket materials are PVC and TPE.

Cable Failure

CABLE FAILURE IS COSTLY. COMMON CAUSES OF CABLE FAILURE ARE:

- Current overload – running 15 Amp circuits through a 10 Amp cable.
- Physical abuse – pinching/cutting/smashing the cable in tooling or other equipment
- Heat - internal or adjacent to the cable
- Stress due to repetitive movement
- Improper strain relief and tight bend radius

Proper wire sizing is the most effective way to minimize costs associated with short circuits or burnt up cables. Do not use a connector rated for 10 Amps for a 15 Amp application. Cables intended for 15 amps should be 16 Awg, or more depending on the cable length.

Flex rated cable, such as the Alpha XM® Series (Flex Control) or Alpha F® Series (Continuous Flex), reduce failures caused by repeated flexing. Individual wires run through a flex rated conduit also reduces failures. Flexible power cable solutions are fairly simple. Flexible thermocouple cable solutions are more challenging. Sourcing flex rated thermocouple wire and cable can be difficult and costly. Typical Thermocouple wire uses a solid conductor which does not accommodate flexing and will fail. Thermocouple cable assemblies should use stranded thermocouple cable or single pair stranded thermocouple wire in flex rated conduit. The reduced failure rates will offset the added cost.

About Electrivert, Inc

Founded in 1994, Electrivert, Inc. is a leading manufacturer and full-service provider of industrial control panels and molded, mechanical and custom cable assemblies. Electrivert's industrial control panels and cable assemblies are used in industrial machinery and factory automation across the U.S. and the world. Electrivert, Inc. is a part of the Minowitz Manufacturing Group in Roseville, MI.

RESOURCES:

Hi-Watt, Inc – Fraser, Michigan – Hot Runner / Temperature Control Products and Systems
http://www.hiwatting.com

Wikipedia – 11/10/2011 - http://en.wikipedia.org/wiki/American_wire_gauge

HARTING, Inc. NA – Elgin, IL – Industrial Rectangular Connector Manufacturer
http://www.harting-usa.com

Alpha Wire & Cable – Elizabeth, NJ – Wire and Cable Manufacturer
http://www.alphawire.com