HydraForce

High Performance Hydraulic Cartridge Valves
and Electro-Hydraulic Control Systems

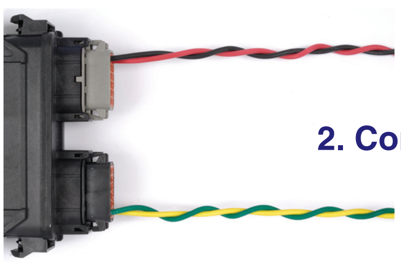
CoreTek Controllers

10 Common Pitfalls To Avoid When Going EH (Electro-Hydraulic)

I like to tell people that I prefer to learn from someone else's experience rather than my own because it tends to hurt a lot less. In keeping with that, here are some things I've experienced with electrohydraulics and some simple, easy solutions that will help you take some of the legwork out of developing an EH system.

1. Flashing an ECU on a Machine That's Running . . .

NEVER flash (upload software to) an ECU on a machine that's running. If there are outputs that turn on or off during the uploading process, this could put you in a very dangerous situation. Also, if you are running prototype software that hasn't been tested yet, it's too easy to accidentally turn an actuator on full speed and suddenly have an out of control machine. If what you are doing requires you to potentially hit the E-Stop button to avert disaster, you need to stop and rethink your setup. A simple and easy fix for this situation is to jack the machine up so the wheels aren't touching the ground, turn the engine off, but leave power to the ECU, and then flash the machine. Remember the phrase "unintended actuator motion" is the polite way of saying "out-of-control-wrecking-ball". An extra 15 minutes of care can save a life.



2. Controlling the Voltage Instead of the Current . . .

We want to control the CURRENT, not the voltage to a proportional valve coil. If we crack open our old college Physics book (don't worry, I don't have one either), we will find that the strength of a magnetic field is directly affected by the current through the magnetic loop. If we fix the voltage to a coil, it will heat up and as it does so it will increase its resistance approximately 30-40%. That means that if I put 6V across a 7.1 ohm (10 size E-Coil) at room temperature, I will initially draw 845 mA and as I heat up to its quiescent temperature, the resistance increases to about 10 ohms. This means I'm now my coil only draws 600 mA. This will cause my valve to deliver less flow. HF provides an extensive line of analog and digital close loop current controls which constantly monitor the resistance of a coil and adjust the voltage across it to maintain a constant current. They also take care of minimum and maximum current, as well as dithering the valve to reduce hysteresis. They are a small initial investment that will save you hours of headaches.

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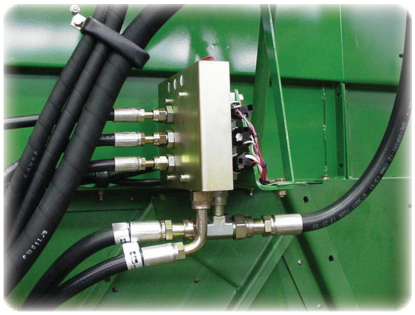
3. Forgetting to Harness that Wiring Harness . . .

When I troubleshoot electrical problems, about 75% of them boil down to WIRING HARNESS PROBLEMS. Common mistakes include crossed wires, broken wires, poor grounding, and improperly installed connectors. A good wiring harness should start with a good drawing. The same rules apply to wiring diagrams as hydraulic schematics. All voltages, terminations and pin assignments should be clearly labeled by their function. Wiring should be color coded. A really nice wiring diagram will have the wire length and gauge specified, as well as showing which groups of wires are bundled together in conduit or sheath. The NEC and SAE J1939 are both really well thought out in terms of wiring practices. I try to use all Deutsch components, especially in CAN lines. A good quality connector such as the Deutsch will provide years of faithful service and ease of maintenance.



4. Neglecting to Check Your "Connector" . . .

If you suspect a wiring harness problem, the first thing you should do is pull all of the connectors and make sure the socket or pin butts firmly up against the wedge lock. If the socket is not immediately visible, you don't have a good connection and need to push the wire further into the connector. You will be able to feel a socket snap into place on a Deutsch or AmpSeal connector. Deutsch sockets and pins can be removed from a connector by pulling out the wedge lock with a jeweler's screwdriver or a pair of needle nose pliers, and then using the screwdriver to pry up the locking pawl inside the connector. For an AmpSeal, simply pull up the wedge lock so it's loose and pull and twist the wire from behind to loosen it.

5. Resistance is futile . . . if you don't measure it!

Image courtesy of: www.indiaprwire.com

If you have a CAN line that's not communicating, the first thing you should check is to measure the resistance from CAN HIGH to CAN LOW. This should measure 60 or 120 ohms, preferably 60. If this resistance is lower or higher, you probably won't have reliable communication on the bus. There should be a 120 ohm resistor across the high and low lines at either physical end of the bus giving you a 60 ohm drop total. In a pinch, CAN networks work just fine with a single 120 ohm resistor in the middle, but the J1939 spec calls for one at each end. Great products to use here are the Deutsch CAN components which allow you to create modular CAN drops and have pre-packaged resistors with IP69 ratings. A well made CAN bus will eliminate about 75% of your connection problems.

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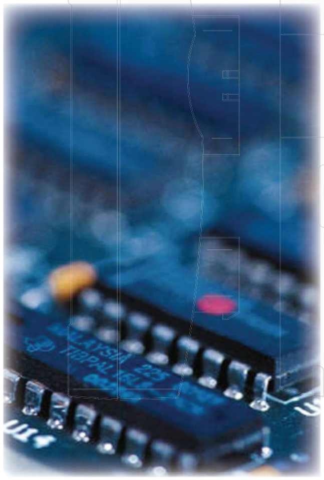
6. New Year's Resolution . . . right-size your transducers!



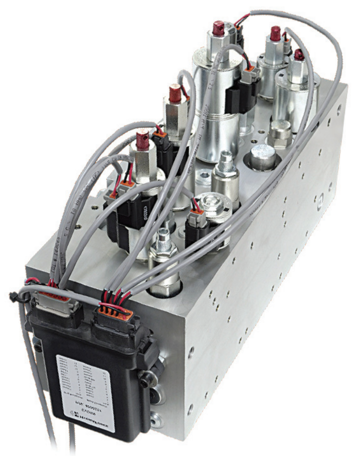
RESOLUTION is our friend! Let's think like a computer for a minute. Computers can't read a continuous analog value, such as 0 to 5 volts, but we've become pretty adept at tricking them. When you give a computer an analog signal, it takes this value and uses a special chip called an analog to digital converter (ADC) to convert the signal to a discrete value (think of this as a bunch of switches).

The more switches you have, the better representation of a signal you have (keep in mind, most likely your controller has an optimal number of those switches on it already). If I have 8 switches, my signal will be divided into 2^8 or 256 discrete quantities (bits). If I take my 5V signal and divide up amongst those bits, I have a resolution of 0.0195V or 19.5 mV. This means that my ECU will only be able to measure the signal in 19.5 mV increments. This is probably fine for a joystick, but not so much for a pressure transducer if I'm attempting very fine pressure control. This is known as 8-bit resolution. If I have 10 switches to represent a signal, I have 2^10 combinations or 1024 bits to divide up the signal. Now I can accurately represent 5000 mV / 1024 or 4.9 mV increments which gives me much better accuracy than the 8-bit encoder previously mentioned.

Another thing to keep in mind with regards to discrete resolution is to size your transducers according to the quantities they will be measuring for the greatest accuracy. So if I want to measure system pressure, I would probably use a 0 to 3000 PSI or 0 to 5000 PSI transducer. If I want to measure a pilot signal, I would use a 0 to 500 PSI transducer because pilot pressures are generally in the 0 to 400 PSI range. Using as much of a transducers range as possible will give you MUCH more accurate measurements than trying to use a transducer with an all-encompassing range.

7. Specification "Creep" . . .

Beware of SPECIFICATION CREEP! Features that people are excited about today will be expectations tomorrow. Pull out your iPhone. Remember in the 80's when we were excited to have a mobile phone which required a brief case full of batteries and only got questionable reception? Now it's our expectation that our phones will be able to make calls, keep track of our email, operate as a GPS, and play Angry Birds. This phenomenon of increasing expectation is known as specification creep. The same holds true for hydraulics. I've noticed that drive systems are especially tricky. If someone drives a machine long enough, they will home in on every little idiosyncrasy of the machine no matter how well tuned out it is. A machine that drove smoothly yesterday will suddenly feel jerky today with the bucket in the air, the brakes applied, and the lunar ascension in Sagittarius. Specification Creep is impossible to avoid, it's our natural tendency as engineers to make something better, but the effects can be minimized – here's how: Keep an original system close at hand next to the prototype you're testing. Have the tester jump back and forth between the two machines. This will keep expectations grounded in reality and give them a good basis for comparison to show them that yes, improvements are being made.



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8. Time to do it right, vs. time to do it over . . .

Don't be afraid to START FROM SCRATCH. Sometimes we work ourselves into a corner. A circuit or a piece of software will become so complicated and unwieldy that it's more work and trouble to fix than to just start over. Do yourself a favor: start over! Write down any lessons you may have learned and move on. Just don't get carried away – no matter how many times you write software, even for the same machine, you'll always think of a better way to do it next time.

9. Trying to fix hardware with software . . .

Don't try to fix a HARDWARE PROBLEM using SOFTWARE. This is a really easy hole to fall into. We tend to think that closed loop control and high tech calibration schemes can improve the accuracy of valves. While this is true to some extent, it's also true that you will make the control guy's life much easier if you give him good hardware to start out with. Closed loop control, for example, demands fast response, low hysteresis valves. Trying to save money on a flow control valve when using a PID loop will eventually come back to you in the form of increased development and setup costs. Start off on the right foot and buy the correct hardware for the job. Once you've proven out your control scheme using top of the line hardware, you can look at cost cutting by going to less expensive components. Spending the money up front will generally lead to much shorter development times and happier electrical engineers.

10. Neglecting to organize your software . . .

GOOD SOFTWARE ORGANIZATION is a key to success! Don't try to develop the entire machine control in one large program, break it down into small, manageable and easily tested subroutines. Commenting code is one thing that everyone hates doing, but if it's properly documented, it's much easier to pass the project onto someone else, or even remember what you were thinking six months down the line. It's much easier to read and troubleshoot code that uses engineering units such as milliamps, PSI, etc rather than arbitrary 16-bit numbers. Take the time in the beginning to do the conversions and you will thank yourself when you're troubleshooting a machine over the phone. Speaking of troubleshooting over the phone, the more easily diagnosed your software is using a service tool, the less time you'll need to spend talking about it on the phone.

About the Author: David Ruxton is an application engineer at HydraForce Inc. He has over 10 years experience designing Electro Hydraulic machinery.