ERA EXCHANGE

YOUR GUIDE TO ELECTRICAL REBUILDING

July 2016 $12.95

PULSE WIDTH MODULATION
Old Trick – New Dogs

WHAT'S INSIDE THE CONNECTION
REALLY COUNTS!

MINITUNE UPGRADE
Achieving Accurate Readouts

PLAIN TALK | LET'S NOT RETREAT,
Let's Reload!

Electrical Rebuilder's ERA Association
Founded 2001

A WORD FROM THE PRESIDENT
Do You Have Web Presence?

Last month I wrote about advertising and the method that I use once each year to determined which medium is working best for my business. To sum up the most recent results in one sentence, the value of a phone book ad now pales in comparison to having a good presence on the web.

After randomly Google searching a few dozen ERA members, I was surprised that so many were lacking a web presence. Improving your shop's web presence may seem like an intimidating task, but it is essential to survive in tomorrow's business world. While I am not a web expert for sure, I have taken that step myself and I feel that I can speak from my own experience. I'd like to share a few tips to help you on your journey.

What does "good web presence" really mean? It means simply that anyone searching for the goods and services that you provide must be able to find you quickly using a web search like Google, Bing or Yahoo!

What will they find? If you have not done so recently, I strongly suggest that you do a series of web searches using key words like: alternator, starter, battery and the town and state in which you are located. Then search for your business by name, city and state. You may be amazed by the number of free listings that you already have. But those are not a strong web presence. They will help those who are already looking for you find you – like the business white pages once did. Those listings never drove customers to your door. If you remember, they were also free. You needed an ad in the Yellow Pages to attract business. Today, that ad is a website.

Without a website, you are losing opportunities every single day. A website does not have to be elaborate. It can be done as a do-it-yourself project, if you have some computer skills, time and patience. But your success will depend heavily on the amount of effort that you put into it. If your time is as short as mine, it is probably best to pay a local web professional to do it for you. What they can do in an hour might take you days to figure out.

> **"Without a website, you are losing opportunities every single day."**

Choosing the right professional is important. But before you begin looking for the person, you must first define what you want. Do research on your own. Look at your competition's websites. Look at the websites of other ERA member's. Look at the websites of other small businesses in your area. Write down or sketch your ideas. Decide what you want. Next month I'll share a little more.

Think of a website as a billboard along a busy highway – but one in which the drivers place themselves only in front of the billboards for the things that they need and are looking for right now.

Mike Dietrich

NEW ERA MEMBERS

E.G.I. Inc.
Deerpark, New York

Balmar LLC
Huntsville, Alabama

Allentown Auto Electric
Allentown, Pennsylvania

ABOUT THE COVER

Valeo alternator with PWM (Pulse Width Modulated) voltage regulator that was used by Hyundai.

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Rebuilding is Recycling!

PLAIN TALK — LET'S NOT RETREAT, Let's Reload!

BY ROB BUKSAR

Both in conversation and in print, I find myself referring to the past frequently, maybe too frequently - those heady days when living was easy and opportunity was boundless for the average guy. Why do I do it? Because it sure seems that most folks that I chat with seem to be a little narrow as to why they're going through the trials and tribulations they are.

Back when most of us began, 30 to 40 years ago, the streets of the U.S. were paved with gold. We had an overabundance of everything - food, clothing, shelter, jobs, business opportunities and last but not least, money, which went a long way. We were the world's breadbasket, the source for any and all industrial goods and the greatest creditor nation. Yes, almost everyone owed us money and was in our debt. We had no competitors and were the absolute top of the heap! Never in recorded history has a young nation with a relatively small population controlled as much wealth. The British did a formidable job in the last century but paled in comparison to the U.S. We only had 4% of the world's population yet we were consuming 60% of the world's resources!

Frankly, I think our country was singled out and blessed by the creator. I sure don't see any actions on our part that warranted those blessings. Nevertheless, I don't feel guilty about the prosperity but thankful as I think you should also.

When most of us began, there was so much domestic business, job opportunities and money, it was truly inconceivable. Formal education and or training were helpful, but not necessary! You didn't need a college degree or even a high school diploma to make a good buck. I've talked to many of you who are quite proud of your success without the benefit of finishing high school. Almost as if it's a badge of honor? I mean no disrespect or negative criticism. Yet, I think we all have to come to terms that we were the recipient of incredible blessings. Sweat equity paid huge. Some did better than others but it was still unprecedented compared to others who worked even harder in other parts of the world. It was wildly abundant!

There was no school or training for rebuilding. It was simple stuff. You took a few apart, located the problem, fixed or replaced what was broke, cleaned it up, painted it and sold it for a handsome profit.

The demand was so great for units and repaired parts that an industry grew-up around it. No marketing or sales skills were necessary. Just hang out a shingle and let word of mouth do its job. In a twinkling of an eye, we all had more business than we could contend with and a ton of money was made by all. It was the gift that kept on giving!

Bear with me, I'm getting close. There is an inherent problem or syndrome that often accompanies unwarranted, undeserved prosperity. This also occurs with a lot of promotions. After a few years of prosperity and being treated differently by any and all, the recipient of the good tidings begins to believe that he or she is really something special and deserving. Maybe even an expert or authority on just about anything. Why? Because the folks in our country treat celebrities and folks with wealth better than they treat their own families. Fame and fortune in our country in most cases can get murder plea-bargained down to a speeding ticket!

So, here's the bottom line. The world markets, economies and opportunities have changed and the U.S.A. is at the top of that list. It has already happened. Our population and many businesses, *especially small,* are not prepared for the demands of the present or future.

We all lack the skills because we didn't need them. We dropped out of high school and fell into a great job or business that needed work and our attendance but required little if any education. Why? Because the domestic demand for just about anything far exceeded the supply. Now, much of the world is industrialized and is competing for every dollar on the planet. You already know this but I want to say it anyway. The offshore guys and major corporations are kicking our butts! We are offering little to no competition because most us just don't know what to do.

So, here is what I propose to all of my friends and neighbors beginning with myself. **Go for help** and don't be too proud to ask for it. My dad admonished the three of us never to get too proud to ask for help. Now, I'm making the same suggestion to all of you. I would hate to see independently-owned small business become a museum display instead of a viable reality.

"It only takes one idea or maybe even a change of direction to alter the outcome of a situation."

Keep this in mind if nothing else because it's really important. It only takes one idea or maybe even a change of direction to alter the outcome of a situation. Consider this. A new round of fame and fortune is only moments away in an idea that you don't know where to uncover!

So, here are a few of Rob's suggestions on where and how to uncover this idea and where to begin looking for help.

- Join your local Chamber of Commerce. Of course, they will be looking for your intellectual contribution, so give it. Keep in mind; this is not the place to grandstand. You have 2 ears, 2 eyes and one mouth. I suggest that you use the eyes and ears a lot more than your mouth. Consider joining the National Chamber of Commerce also.
- The U.S. Small Business Administration (sba.gov). They have loans and grants available.
- sba.gov(.gov)>starting-business. This site provides information about buying or leasing equipment or buying government surplus.
- practiblecommerce.com. 20 government sites to help small business. The government is screwed without us and wants to help. They are reducing barriers to entrepreneurs. Look into the start-up American Partnership, as well.
- small business.chron.com The federal government offers grants to qualifying small business.
- Bizcircle.att.com/ Grow your business by connecting with industry leaders today.
- score.org Score is a non-profit association dedicated to helping small business. They are successful retired executives.

What I just presented was a small sample of the information

sources out there. None of us have to remain in the dark or time-warp if we don't want to. Take some of your idle or profit-less time and put it to good work for yourself. If you don't know how to Google, get your child to help you because they do. If there are no kids around, go to the public library. The library is the most underutilized government asset in the entire system. They usually have little to do and will be glad to help.

Google federal governments help for small business.

Google your state government.

Most all of the major universities and business schools have very helpful web sites. There are free and at very least very affordable help all over just for the asking and looking.

Speaking for myself, I'm asked frequently if I am retired or ready to. My reply is, "And what, miss all the fun!" I hope that I am blessed with enough health and stamina to continue playing the great game of business. I would hate to leave the game board by being pushed off it via major corporations and off-shore concerns. Speaking for myself, I'm beginning to put a few points back on the board. I intend on putting up a bunch more. Please don't get discouraged, we're not too old to re-train and re-tool.

During Bill Clinton's first presidential campaign, he admonished everyone that a whole bunch of the labor-intense manufacturing jobs and industries that left and would continue leaving would not be coming back to the U.S. Every president has said the same since. They all have also said the government would help all (who were interested in the help) re-educate and in many cases re-tool for the future.

No one likes leaving their comfort zone. Yet, I suspect for those of us who refuse to move are going to be introduced to the drain. Look around you. Those who have already begun being proactive are doing well!

Let's move together and take a moment to fall back - not in retreat but in reload instead! Then let's come out blasting! The world loves a winner and that's what Americans are—winners! God Bless America and our little industry.

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1-630-832-8264

PULSE WIDTH MODULATION
Old Trick – New Dogs
Hyundai-Kia, Nissan-Infiniti, & Suzuki Go PWM

BY GENE KAISER

It has been 12 years since General Motors introduced alternators with a variable voltage set point. They called their system regulated voltage control or RVC for short. The charging voltage on vehicles with RVC can be fine tuned to fit battery state of charge and a variety of driving conditions. A control module determines what voltage is best and commands the regulator to use a specific voltage setting or Vset via a one-way PWM (pulse width modulation) signal. On most GM vehicles, that control module is the vehicle's PCM. But on some pickups and SUV's, a dedicated BGCM (battery generator control module) was used.

PWM is basically just a low voltage on-off signal that switches at a specific frequency, 5 volts at 128 Hz (hertz or cycles per second) in the case of GM's RVC systems. The "on" time, measured as a percentage, translates to specific voltage set points. Longer "on" time in the signal equates to a higher Vset.

Ford has been using a similar PWM signal to remotely control Vset dating back to 1998 on some of their vehicles. They have increased its use since then. The later Ford PWM plug code has changed terminal identification to LI-RC-BVS (Lamp Indicator, Regulator Control, and Battery Voltage Sense). It works the same as before, just an "old trick" that Ford renamed. The big difference between Ford and GM is the polarity of the PWM signal.

But most recently Ford appears to be moving away from PWM and more toward a LIN network to adjust Vset. The growing trend among auto manufacturers is to integrate the alternator into the vehicle's single wire communication network. Those systems use BSS or LIN protocol with a command terminal on the regulator that allows for two-way communication between the control module and the regulator. Network communication can be handled through a single wire using ground as a reference. That type of voltage control was explained in detail in the May issue of the Exchange.

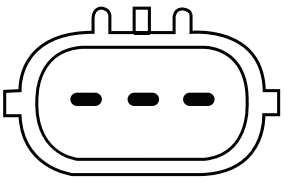
Today, many automotive manufacturer's are opting to use BSS or LIN to optimize charging system voltage. But so far, GM has not joined them. They have so far continued to use a one-way PWM signal. Suzuki, with close ties to GM, also used a PWM signal to change Vset on some models prior to leaving the US market in 2012.

Several years ago, Nissan-Infiniti and Hyundai-Kia each introduced their own remote voltage control systems, based upon PWM signals. These new PWM signals are very similar to GM's RVC and Ford's RC. Some of those vehicles are now out of warranty and their alternators are beginning to show up on rebuilder's front counters. Testing them is simple if you have the correct tool.

Nissan Infiniti PWM

Nissan and Infiniti began using PWM to adjust voltage in some models as early as 2006. Their first applications to apply the technology were both Mitsubishi alternators with L-S-C terminals, C being PWM from the PCM (see Figure 1). You may notice that the plug code for this alternator is 325, which covers 25 different Lester numbers as of this writing. However, only some of the alternators covered by the 325 plug code use PWM. On the others, the C could be any type of communication including a field monitor. You can see in the Infiniti's charging system diagram (see Figure 2) that the C terminal is connected to a control module called an Intelligent Power Distribution Module (IPDM) which in turn is part of the ECM's network.

Many different tools are available that can test PWM alternators. In the photos, we are using our Regitar RRT001 test box, which will allow you to operate the regulator under a wide range of duty cycles instead of just one or two. The Nissan and Infiniti alternators are the same polarity as GM's RVC so we have set the switch to GM on the test box. In the photos, you can see how changing the PWM signal input affects the



PLUG CODE 325

Figure 1 – Plug Code 325. On Nissan-Infiniti, the C terminal receives a PWM signal from the control module to adjust the Vset (regulator's voltage set point).

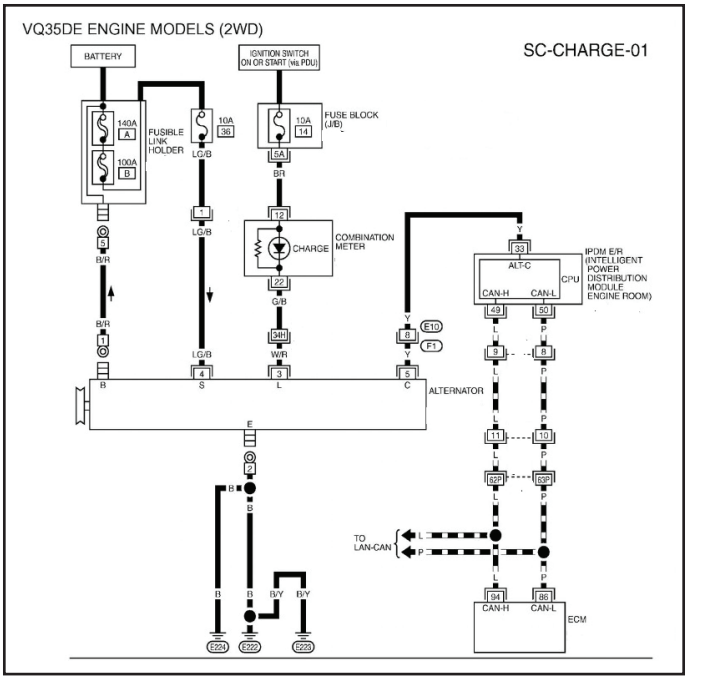


Figure 2– On this Infiniti system diagram, you can see that the C terminal is connected to an IPDM, which generates the PWM signal that controls the Vset.

regulator's Vset. The duty cycle on this "C" pin operates just like the GM and Ford regulators that were controlled by PWM. You may wonder if you really need to test operation at different duty cycles. In most cases, one or two will verify correct voltage range. But you have to also watch the charge warning lamp. I prefer to verify that the lamp operation is correct throughout the operating range, making sure the lamp does not illuminate when it should not but lights when it should.

In the photos you can see how I connected a PWM regulator to a similar Mitsubishi alternator with a dummy regulator installed in it (see Figure 3). The lamp connects to "L" and battery sense connects to "S" just like many L-S units in past. When I start bench this unit should turn itself on, turn the warning lamp off and regulate at 14.5V (see Figure 4). We then apply load to the unit to test the stator, rectifier and output. At this point I like to remove the load and keep unit running at about 4,000 RPM and remove power from the sense terminal. That should do two things, send the regulator into secondary regulation of about 15.5V and turn the indicator lamp on, showing that there is a problem (see Figure 5).

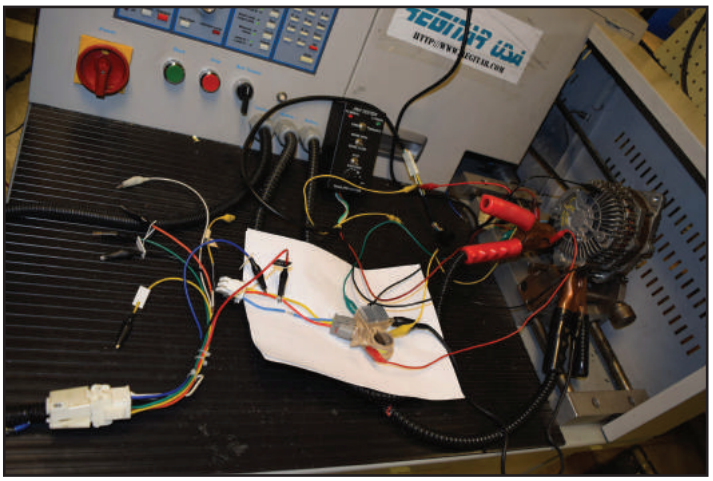


Figure 3 – For regulator testing, the PWM regulator is connected to a Mitsubishi alternator with a dummy regulator.

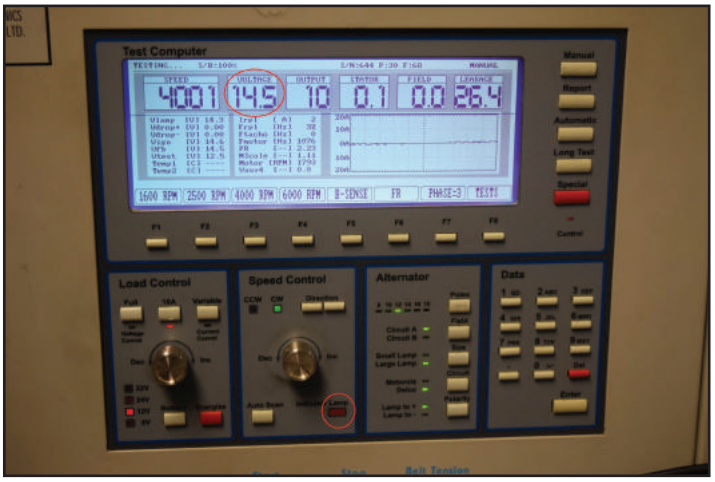


Figure 4 – This is the readout after excitation without any input to the C terminal. It is charging at the default rate of 14.5v.

Figure 5 – This is the readout after B+ has been removed from the S terminal to test lamp operation. The regulator has entered secondary regulation because of the lack of sense voltage. Note that the indicator lamp has been turned on to indicate a problem.

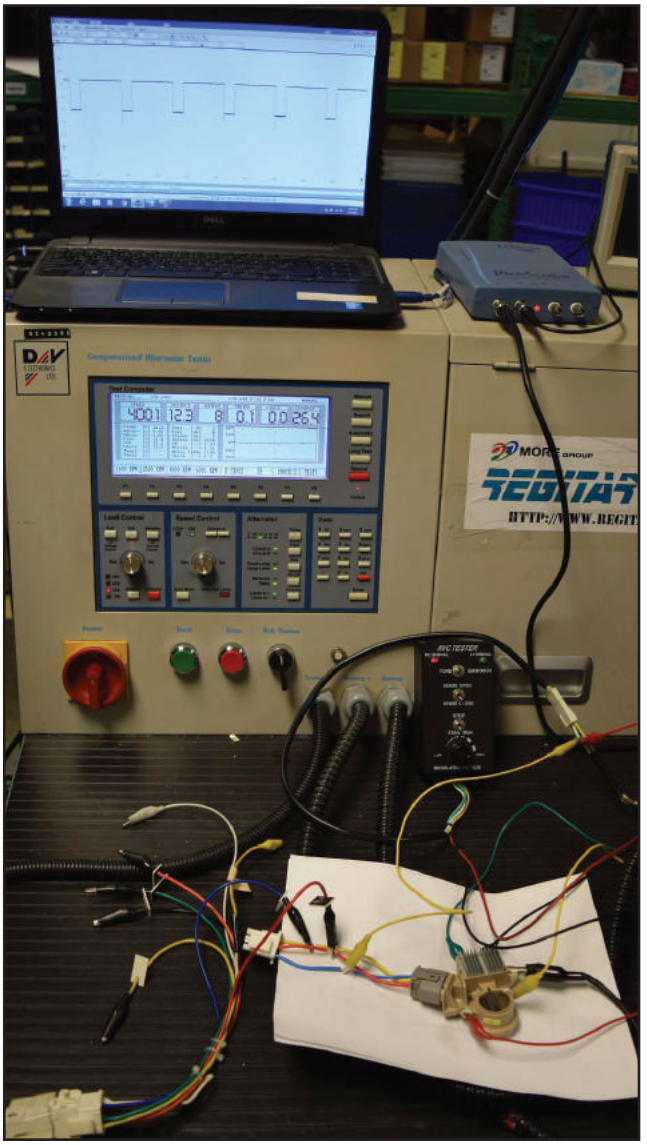


Figure 6 – Here we are testing the PWM on a low duty cycle. The Picoscope above shows the signal at 20% on, 80% off. Note that the Vset is 12.3v.

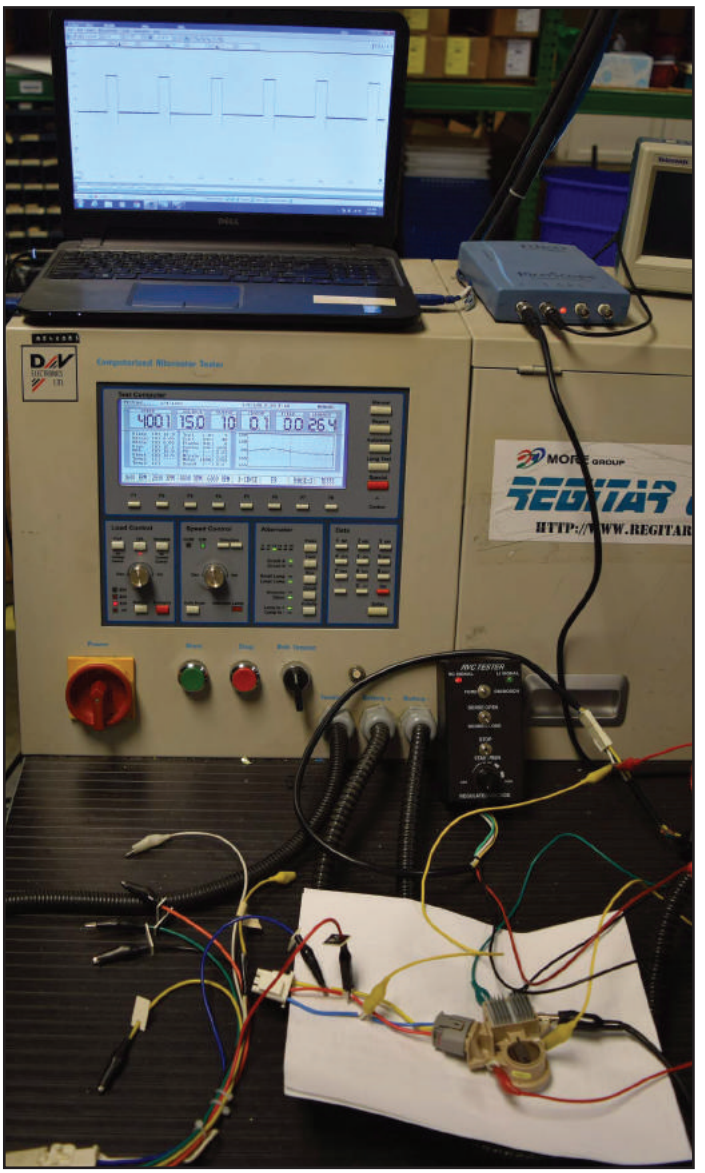


Figure 7 – Here we are testing with the "on" time at 80%. The charge voltage has increased to 15v.

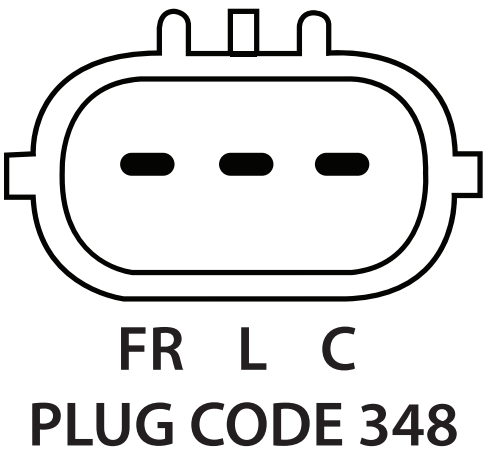


Figure 8– The Hyundai and Kia applications use plug code 348. This system is similar to Ford's RC applications.

Reconnecting B+ to S should return the regulator to a normal voltage setting. Then, we send a square wave PWM signal like that used in all RVC systems from the center pin in our test box plug. With the alternator still running at 4,000 RPM I can turn the knob to change the Vset by changing the duty cycle of the regulator. (see Figures 6 and 7). The Picoscope above in the photos shows the PWM signal. You can see that the field is on 20% and off 80% in the first photo. In the second picture the field is on 80% and off 20%.

Always let the unit you're testing warm up and perform a load dump test. It's also a good idea to run the unit at a high RPM and watch for any voltage fluctuations on your meter(s).

Hyundai Kia PWM

The second PWM system that we will explain is being used on some Hyundai and Kia vehicles with Valeo alternators. The terminals on these alternators are C-FR-L, or plug code 348 (see Figure 8). Note that C in this case receives the PWM signal directly from the vehicle's PCM. On these applications, the lamp terminal L is used to excite or turn-on the regulator. The FR is just like Ford's FR in that the PCM monitors the field to keep up with the precise amount of mechanical load that is being placed on the engine by the alternator.

The PCM can change the Vset by changing the duty cycle of the field, just like Ford did with their RC terminal. In the photo (see Figure 9) we have connected "L" to test the indicator lamp and our test box (switched to Ford) is connected to the "C" pin. We have also connected the FR pin to a voltmeter to monitor voltage on the field.

Running this alternator at 4,000 RPM, the lamp goes off and the unit begins to charge at 14.3V. We now can control the duty cycle by adjusting the PWM signal from the test box. The voltage should change, just like other PWM controlled regulation. After we check the regulator for its Vset response to changes in the signal, we can load the unit and watch the FR voltage change just like it did on Ford's "LI" pin. Once we are applying a load to the unit we can watch the voltage change on our voltmeter and know that the FR pin is working correctly (see Figure 10) .

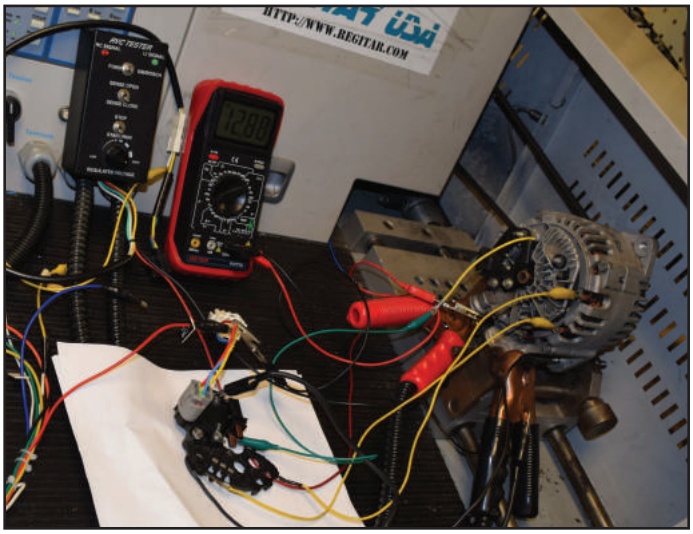


Figure 9 – Here we have a Valeo/Hyundai PWM regulator connected to a Valeo alternator with a dummy regulator. Notice that we are reading voltage on the FR terminal with the DVM.

Figure 10 – Here is the readout on the Valeo/Hyundai alternator running at 4,000 RPM under a 100 amp load. Notice that the FR terminal voltage on the DVM has dropped as expected.

Subaru PWM

Just about all C-PWM regulators operate at the same frequency and square wave signal. At another time we will explain the Subaru system, but with this L-S-C regulator, the input to the lamp pin is what you must test properly.

In Conclusion

All charging systems in which the alternator's voltage set point may be adjusted by the vehicle's PCM are command or COM charging systems. The medium of communication may differ, having titles like, BSS, LIN, RLO, RVC, RC or PWM. Technically, that should also include the early Honda alternators with which the PCM could simply ground the C terminal to drop the Vset. All of these systems make an adjustable Vset possible, controlled by an electronic module outside of the alternator. They also all share the same primary purpose which is to save fuel. However, they cannot all be tested the same way.

It is our business to know and understand all of these charging systems. We must make ourselves familiar with the terminology and methods of testing - which test lead or box must be used to evaluate each alternator that we encounter. It is our job to be confident that we have the knowledge and tools to test our own work properly.

We have come a long way since seeing those first C terminals in the late 80's. They may have functioned differently and the exact methods are constantly changing. But the means used, adjusting regulator Vset, has remained pretty much the same. Here at REGITAR we have begun to ID all new C terminals as PWM, BSS, LIN in the hope it will help you whenever you have to test an alternator that you may not yet be familiar with.

Gene Kaiser is Quality Control and Technical Manager for Regitar-USA.

WHAT'S INSIDE THE CONNECTION REALLY COUNTS!

BY DAN MARINUCCI

Applying silicone paste **inside** connections is an effective but often overlooked way to protect them from the elements. Here's why it may be a problem-solver for you.

All automotive electricians agree that protecting electrical connections from rain, snow, road salt, salt air, etc., is vitally important. But they may disagree on cost-effective ways to accomplish this goal. Mind you, silicone paste isn't the only technique available. However, I've used it since the late 1970s and had excellent results with it. You may find it to be helpful, too.

Back in 1977, I was fortunate to interview several engineers who told me about silicone paste, which some people called dielectric grease or silicone grease. Others call it spark plug boot grease; some automakers recommended using this silicone lube to prevent spark plug boots from sticking to the spark plugs. Advocates of silicone paste boasted that severe underhood temperatures would not melt this grease – even when used inside plug boots near hot exhaust manifolds.

Those engineers also said that silicone paste would protect the insides of common electrical connections. What's more, it would do this without increasing the resistance of that connection. (In other words, the silicone grease would not affect a connection on which there already was adequate metal-to-metal contact between the two sides of that connection.)

However, what the silicone paste **would** do is fill all those tiny, unavoidable air gaps between two metal terminals. Filling those tiny gaps would – and does – prevent everything from salt air to salt water from penetrating the connection and damaging it. Since the late 1970s, I have used silicone paste inside countless connections on countless vehicles. Countless times, I have disconnected these connections years later; cleaned off the silicone paste and the metal terminals still looked fresh with **no** hint of corrosion. Furthermore, I have never seen underhood heat melt silicone paste.

To the best of my recollection, I got my first DVOM (Digital Volt-Ohmmeter) in 1978 or '79. The digital meter's response and sensitivity fascinated me. So I used it to practice voltage drop tests on both healthy as well as suspect connections. (This means turning on the circuit and measuring the voltage change **across** a connection.) Repeatedly, I experimented by opening good connections, treating them with silicone paste and checking voltage drop a second time. Since the late 1970's, I have never, **ever** measured an increase in voltage drop after treating a connection with silicone paste!

No, you don't need to treat every electrical connection with silicone paste. But it may be a problem solver for you on those connections that are extra-vulnerable to the elements. Note that some companies sell silicone paste as described earlier: Silicone grease, spark plug boot grease, etc.

A variety of companies sell silicone paste / grease in a variety of packages. One of your suppliers probably offers this kind of product. You also can search the Internet for dielectric grease, silicone paste, etc. I happen to prefer the eight-ounce, brush-top can of silicone paste offered by 3M (Part No. 08946). Surely I don't use it as frequently as a busy shop does. But an eight-ounce can has lasted 10 years for me.

You may be able to protect some electrical connections by coating the **outside** of the connection. Sometimes, trying to cover the outside of a connection alone isn't as effective as you had hoped. But treating the inside of a connection with a dab of silicone paste may provide that little extra level of confidence you're seeking – especially with a connection that's exposed to the weather in some way.

Figure 1 – Here's an eight-ounce can of 3M's version of the silicone paste or dielectric grease. Today, this costs approximately 25 bucks – but it works and lasts!

Figure 2 – This is common Honda battery terminal that I have cleaned and treated with a film of silicone paste. Years of experience has shown me that I remove the battery cables from this battery years from now, the battery post will still look just like this one.

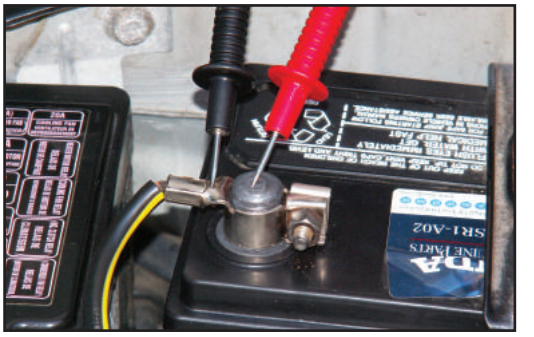


Figure 3 – Here, a helper cranks the engine while I hold one voltmeter lead on the battery post and the other lead on the battery terminal itself. Performing countless voltage drop tests just like this has shown me that the reading on a healthy connection is usually less than 0.10 volt. Beware, many battery connections that look good outside are actually corroded inside!

MINITUNE UPGRADE
Achieving Accurate Readouts

BY JIM RINAUDO

OK, I admit it, I use my Minitune a lot. I got it cheap and modified it until it did what I wanted quickly without a lot of different setups. I was tired of the cyclops gauge not reading accurately, so I decided to upgrade to digital panel meters after finding a deal on eBay. Some of you have asked me questions about them so I thought I would document the upgrade.

The main advantage of switching to digital gauges is that I could replace the single meter on the Minitune with any number of different meters. This would allow me to have both a DC voltmeter and a separate amp gauge so I could see them and adjust accuracy for each. I would be able to calibrate the meters with a known standard, a Fluke 87V that I get calibrated every year.

There is little room inside the Minitune so an add-on was the easiest way to do the upgrade. Having external meters would allow me to change my mind about what got shown where. It was as simple as getting a 6X6X6 plastic electrical box and cutting out holes for the meters. A little bit of filing was needed but it is a lot easier than cutting square holes in thick sheet metal. Besides, I did not want to ruin the "vintage" look of that gorgeous Minitune panel.

Digital panel meters, both the cheap ones from China and the good ones from, well, somewhere else, can provide a wide range of measurements. Going digital gives you quick and precise measurements without trying to see that tiny needle - guessing if it is between the 2 marks that you can see. Analog meters are simple, easy to hook up, and work without an additional power supply, but finding quality ones with BIG faces (for us youth challenged) that are accurate are almost as expensive as buying good digital meters on eBay.

If you have not tried using these meters, they do have a learning curve. But if you can troubleshoot a modern alternator, you can learn this with a little effort. When shopping for a new meter, ask a few simple questions.

First: Can it be calibrated? Some meters lack any means of calibration. With a good meter and power supply, I can calibrate all the meters that I have. As a matter of principle, you should check all meters for accuracy annually.

Second: Can the meter be scaled to the inputs to read out what you need? In my case, a 400 millivolt input reads 250 on the meter for amps and I can program these points into the meter. This will allow the meter to read out in amps directly without any math on my part.

Third: Does the meter have power requirements other than the inputs? This is important as a lot of import meters use 5 or 12VDC which is really not convenient at all. 120 VAC power is best because most of our component testers are powered that way and it is easy to get a switched supply.

Finally: Are the inputs selectable or fixed? Some meters can measure only a certain range like an analog meter while others can be programmed. Make sure that the meter that you buy can read the values that you want to measure. Many high end meters such as the Red Lion PAX series, have different letters to denote which measurements can be selected and what the range is. A PAXD is a DC meter that can read volts, amps, or ohms by changing the jumpers on the main board. A PAXH is an AC meter that reads the same values as the DC meter. These are really handy to have around since you can set them to whatever you need. My box of old meters will be up for sale soon because they have all been replaced with essentially 2 meters.

Now, how much will this cost? There are many really cheap imports available and I have bought a few on Amazon to try out. Some do work OK, some work OK but not for very long, and some do not work at all. I still use a cheap AC volt/frequency meter on my big 15kW dummy load. But it is small, hard to read and only comes on when I power up the dummy load.

Bear in mind that these meters have no support, reliability is unknown and input power is usually DC. Some will only read when power is applied to the circuit so you don't know if there is no power or the meter is bad. But hey, they are cheap. Buy 2 and experiment.

Single measurement, better quality meters will measure a single value such as 0-200mv, 200 VDC, etc. They are usually non-scalable so readout must be matched to input directly but they are cheaper than a fully programmable meter. I have a 200

millivolt unit and a shunt that produces 1 mv per amp of current so the two match up well and I can read amps directly from the meter. Lots of them are available on eBay, especially the 200 millivolt variety. Omron, Simpson, and Red Lion are some of the names to look for. I like to stay below $40 for them as I am thrifty.

The programmable and multi-use measurement meters are the top of the line. They are the handiest to keep for emergencies once you get accustomed to programming them. They can be programmed to read one of several values, scaled to display any value, and function with any value of inputs. You can use a single type meter in many applications but when you get a good deal on programmables, it is hard to go back. As I said before, all of those individual meters can be replaced by two meters, one DC and one AC programmable meter.

For this project I selected a Red Lion PAX series meter for several reasons. One, I got a good deal on five and bought the lot. They have big bright red led numbers so be-speckled folks like me can actually see them through the top of the bifocals. They have front panel programming so you can change the program without removing them and many are available on eBay as well as being available new if you have the bucks. They use 110 VAC power which the tester provides for switching on and off.

But the biggest reason I chose this meter is that Red Lion has great support and documentation which is worth more than the meter in many cases. My thanks to Steve at Red Lion for his assistance on some of the technical details. Pretty soon he will get to claim me as a dependent because of the time he spent on the phone helping me learn to program these things. Good technical support is invaluable when you need it.

The photos show the finished product (*see Figures 1, 2 and 3*). The DC volt meter is on top. Since I only use the Minitune for the 12 volt units, I set the meter on the 20 VDC range and programmed it to read that. It is pretty straight forward - just set the jumper for 20 volts maximum and program both the input and output to zero and full scale. The meter will do the rest. Now I have a voltmeter that can read to 3 decimal places. What a time saver it is. The original analog meter was off by over a full volt.

The lower meter is programmed to display DC Amps and uses the 2 volt scale which is 2000 millivolts. The Minitune has a built in shunt and with some experimenting I discovered that it is about 1 millivolt per amp. I scaled the meter and checked it with some known loads to see if it worked. Bingo, I had digital precision. I will eventually go back into the machine and measure the shunt's actual resistance value with a milli-ohm meter to verify that.

Now a brief word about shunts used with amp meters. They are nothing more than very low value, very high power resistors. The specifications of a shunt usually state the max amps and the millivolt voltage drop across the shunt that are produced at that current. The panel meter is merely measuring the voltage drop across the low value resistor. The problem is that if your meter is not scalable, you need to get a shunt that will correspond to the displayed value in your meter or you will have to do mental gymnastics each time you use it.

I have a 20 amp/50 mv shunt that is too difficult to get to work with my 200 mv meter. But it works fine when I scale the PAXD. A shunt is a linear device so at half current they produce half the millivolts and it can be scaled using only the end points (zero

and maximum).

It is well to remember that the max rating on the shunt is the current it can carry without overheating or permanently changing value. This means that you can run 200 amps through a 100 amp shunt but you won't do it for long. Metallic element shunts will change value permanently if overheated and throw off your measurements a great deal. I use a 200 amp shunt on my golf cart battery charger bench and it works fine. Or, you can make your own shunt - a link is listed at the end of this article for doing that.

This set up gives me the ability to disconnect the box if I need to get into the Minitune. Using the new programmable meters has a learning curve, but after the basics are mastered, you will find that most meters work the same way. They are well worth the time it takes to put them into your bench. They provide increased accuracy, are easier to read, and allow quicker testing. Not to mention that repairs on something that you did yourself are much easier than trying to figure out what a manufacturer did even if you have right documents to troubleshoot it. Coupled with Red Lion support and repair service, you can't beat the flexibility of digital panel meters.

As a side note, I am going to mention rate meters because they are commonly used to measure RPM and the subject has come up before on the ERA Forums. Rate meters are also available from Red Lion and others. The are very accurate and easy to see.

Given that measuring RPM is just a mater of timing between pulses from a sensor, a rate meter simply gets the time between pulses and converts that time into RPM. The Red Lion PAXR rate meter is programmable for all types of sensors and number of pulses per revolution. A rate meter requires a sensor that can count the speeds in the range that you need to measure and it must be compatible with the meter. The sensor will convert the motion of the shaft into pulses and send those pulses to the meter which has a built in time standard to accurately compute RPM based on the number of pulses in a given time period.

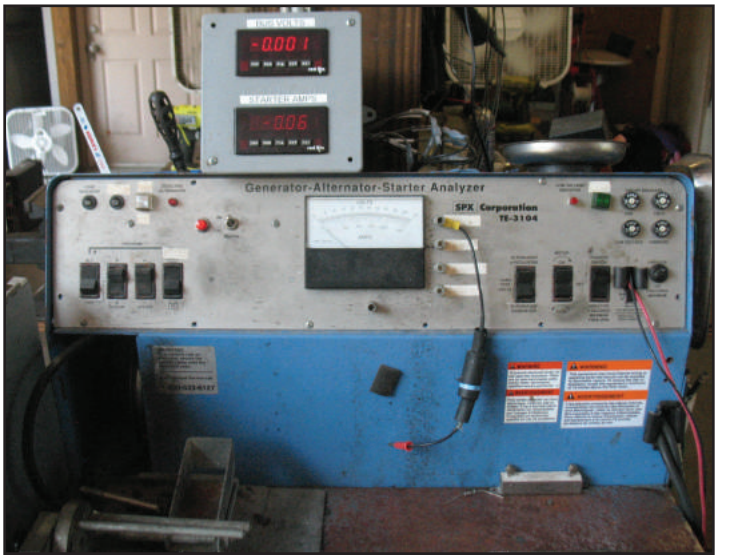


Figure 1 – This is a view of the Minitune bench after the upgrade. Notice the size of the display numerals on the digital panel compared to those on the original analog meter.

The two main types of sensors are magnetic and photo electric. Magnetic is used where you have gears or splines on a shaft and can permanently mount the unit very close to the shaft where it can detect changes in a magnetic field. I use this sensor for the shaft speed of my main drive motor because the shaft is splined. There are 32 splines on the shaft so I had to program the meter to read 32 pulses for 1 revolution. Measuring the speed of a gear is another use and the same principle.

Photoelectric sensors are non-contact type sensors that create a pulse each time a reflective marker passes wherever the sensor is pointed. I have a photo electric sensor for alternator and starter shaft speeds on my big tester. Photo electric sensors need either a reflective strip or two tone paint job to see the speed. I am working on using a painted super magnet that just sticks to the end of the shaft on the starter.

This is where the programmable PAXI rate meter can really come in handy. It can be programmed for the number of counts per revolution so that you may use a target with stripes. Most of the time, using a simple "paint it black then paint half of it white" works. But to avoid painting anything, I sometimes use a small painted super magnet for a target. Just make sure it is shielded in case the speed exceeds what the magnet can hold. You do not want to have a magnet flying across your work area!

If you are having problems with your RPM meter on any test bench, just get a rate meter, select the sensor and you have fixed your problem for a long time and probably get better accuracy to boot. Give Steve at Red Lion a call and he will help you select the meter and sensor that you need for your particular application.

Helpful Websites:

- redlion.net
- resistorguide.com/shunt-resistor/
- sentex.ca/~mec1995/gadgets/shunts/shunts.html

Jim Ridaudo is the owner and operator of EMF Rebuilding Inc, in Foley, Alabama.

Figure 2 – In this close up of the digital display, you can see programming buttons on the bottom of each meter.

Figure 3 – This rear view of the digital meters gives you some idea of how many different inputs this meter is capable of processing.

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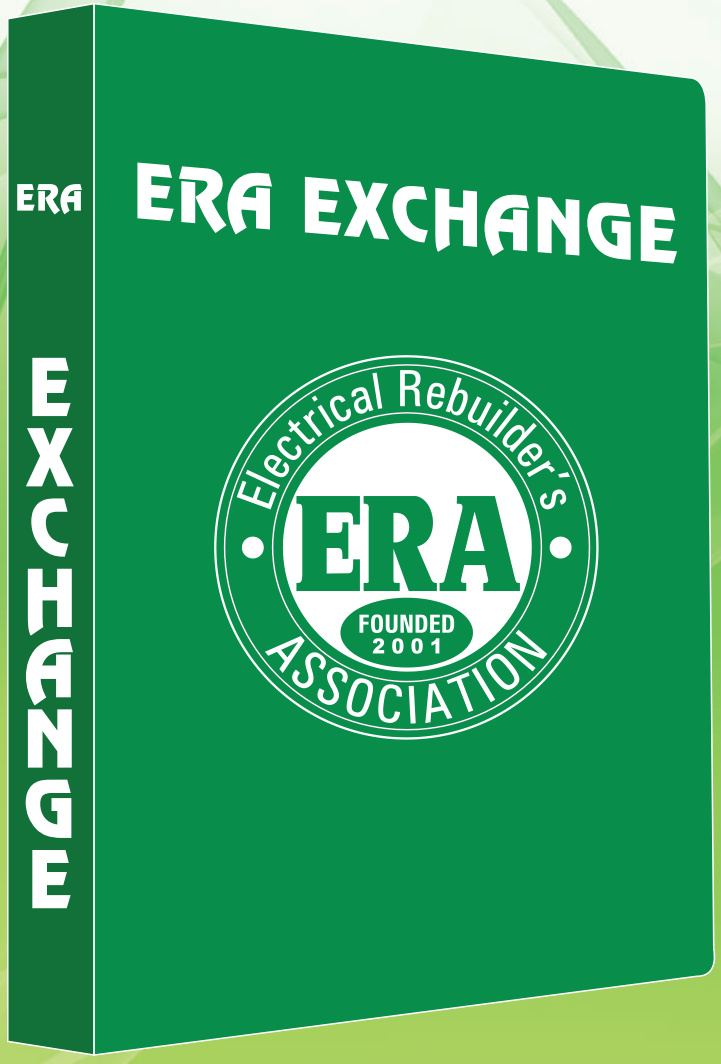

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