

Searching for the Elusive Diode Forward Voltage

COLUMN BY NATHAN UNGER

Hobby Harold was reading through some old issues of the ERE paper in the archive section of the Electrical



Rebuilders Association (ERA) Web site. He had typed the words “forward voltage” into the search box, and found several articles discussing how to measure the forward bias voltage when grading diodes and rectifiers.

“That,” he said to himself, “is what I want to get into.”

The first thing he needed was to get a voltmeter. He scorned the thought of getting just an ordinary one. His was going to be a deluxe handheld digital scope with multimeter all rolled into one.

He did a Google search and before long discovered something that made his eyes get big and wide. All the specs! All the functions! And what an incredibly low price for all that!

He scrolled to the “find a dealer” section, parted with a chunk of his hard-earned credit, and rubbing his hands together with glee, settled down to wait for the delivery truck which came a few days later.

His trembling hands ripped open the package and with something not unlike awe, he pulled his new tester out of its bubble wrap.

This thing would set him apart in the world of technicians because he could now accurately measure a diode’s forward voltage. He could now observe the diode ripple waveform of a charging alternator. He could test those new Ford PWM regulators properly. He could even set the timing on his car because it could read rpm and dwell from its handy little ignition wire clamp.

It also had a handy little diode test function in which it put a small current through a diode and displayed the voltage. Cool.

He took a common automotive rectifier out of his pile of cores and went

to work.

The first thing he noticed was that the voltages were all slightly different. He went to his bin of new diodes and checked a dozen and discovered the same thing.

“So just because the voltages are all different doesn’t mean the diodes are bad,” he thought. “I guess that means that if you want to build a rectifier that has matching diodes you would have to do that by actual testing, not just by part number. Hmmm.”

He further mused that in the real world, you would have to go by a limited range, not just an exact specification, something which you establish for each type and rating of diode.

After working on this all afternoon, Harry discovered that the voltages were getting higher and higher. He retested some of his original diodes and the readings were higher than before! Then the low battery icon in his tester display started to blink. When he changed the batteries, the diode voltages he retested were back to normal.

“Oh great,” he thought, “now I have to watch out that my voltmeter batteries don’t get low since it affects the calibration.”

His excitement over the new tester got tarnished, just a bit.

Then he noticed that one of the 10SI rectifier diodes he tested that seemed good actually had a cold solder joint with some of the solder having dripped out. Obviously his test method wasn’t catching all the problems.

He went back to the ERE archives, reread those articles and concluded that maybe his meter test was not loading the diode enough. After giving it some thought, he decided on another approach. He would hook the diode up to a car battery.

“But of course,” he murmured to himself, “one needs to have a way of protecting the diode.”

He poked around in a bin of miscellaneous junk and found an old 20A fuse.

“Perfect,” he exclaimed to no one in particular.

When he touched the positive wire to the fuse, which he’d connected to the diode, which in turn he’d connected to the negative terminal, nothing at

all happened.

“Oh, of course, I have the diode in backwards!”

When he turned the diode connections around and touched the positive wire from the battery, he saw a brilliant flash of light. The fuse seemed to have sort of a darkish, smoky-looking appearance. A quick continuity test of the fuse verified that there had been a fatality. He scratched his head, and tried a 30A fuse. Same problem.

About that time his wife phoned, “Supper’s on!”

He remembered that the hockey playoffs were about to start and got in his car, mulling over his experiences of the afternoon.

By the next morning, he had it figured out.

“The fuse cannot limit the current; it is only there to interrupt the circuit if the current gets too high,” he thought aloud.

Casting his eyes around his shop, he spied a box of old ignition ballast resistors.

“If it works for the ignition coil, it will work for my diode, too.”

Setting his ammeter on the 20A scale, he soon figured out a combination of resistors that would permit only 20A through the diode when powered by the 12V car battery.

He started checking diode voltages again, but this time the readings were at least 0.3V higher than with his diode test function on the meter. Furthermore, as he not so patiently watched his meter blinking and thinking, he noticed that the voltages were coming down, down, down. He leaned back and scratched his balding scalp.

“Higher, but coming down. Higher but coming down.”

Whatever could that mean? He touched the rectifier as he was poking around and that’s when he noticed that it had gotten uncomfortably warm.

He remembered from his high school science class that power in watts is volts times amps. Heat is measured in watts also. So he grabbed his calculator.

“20A through the diode times .942 volts across the diode equals 18.84 watts. That’s almost 19 watts of heat! No wonder it’s getting hot.

“Maybe,” he reasoned, “the voltage

comes down as the temperature goes up. But why was the forward voltage higher with the 20A test current than with the test current from the meter?"

Just then, a couple of rebuilder buddies from across town dropped by with coffees from the local Starbucks.

"Have you heard about the upcoming rebuilder's convention?" they said. "Mohammed Samii and Joe Davis are going to be there. You should come out with us."

"Ah, no, I can't really afford the time. I'm way too busy here in the shop. Besides, it's expensive to go. A few nights in a hotel, airfare, meals, I'd be into it for a thousand bucks before you know it. And the kids will want souvenirs, too. Naw, I'll skip it this time," Hobby Harold said.

"No really, it will be worth it," they implored. "You'll learn so much. You might even find out stuff that you've never heard of or thought of before. Stuff that could help you with this project you're working on. What are you doing anyway?"

Harold sighed, took a sip of coffee and started in: "Well, I'm trying to test the forward voltage of a diode. But because of manufacturing differences, different test current amounts, and diode temperature, the readings are all over the map. How am I supposed to know what's good and what's bad? And now my 12V battery is going dead. I should quit this now and put the battery on the charger overnight."

He sighed again and measured the battery voltage. After three seconds of blinking and thinking, the meter registered 11.2 volts.

"And that's another thing. Don't they make meters that can come up with a reading a little faster? By the time I ever saw the voltages, my diodes had gotten hotter, the voltage went lower, and who knows what the reading really should have been?"

One of his friends suggested that he set the meter on range hold. That way it wouldn't waste time scrolling up through the ranges. That helped some, but it was still too slow. Hobby Harold's "all in one" meter was starting not to look so good anymore.

"Oh well, at least there's still the

oscilloscope functions," he thought.

He turned to his friends, "Since I can't do anything about the way the diode is made, maybe I can come up with some standards for testing by designating a range of voltages. And if I use the same 20A test current on all my tests, then that will eliminate the inconsistencies created by varying currents. All I have to do is figure out what the relationship is between diode forward voltage and heat. But this would have to be done quickly, or the diode could be ruined with too much heat. But this meter is too slow. Maybe I'll try it in oscilloscope mode next..."

Here's what Hobby Harry had jotted down in his notebook:

- A fuse is not a current limiter; it is a current interrupter.
- An inexpensive multimeter will not come up with a reading very quickly, but if it has a range hold button, that may save some time.
- That same meter also may drift high in its readings if the batteries get low.
- Three things that affect a diode's forward voltage are: the manufacturing process by which the diode was made, the amount of current through the diode, and the temperature of the diode.
- Ask my wife to check the books to see if I can afford to go to the trade show.
- Work on this project some more next month.

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