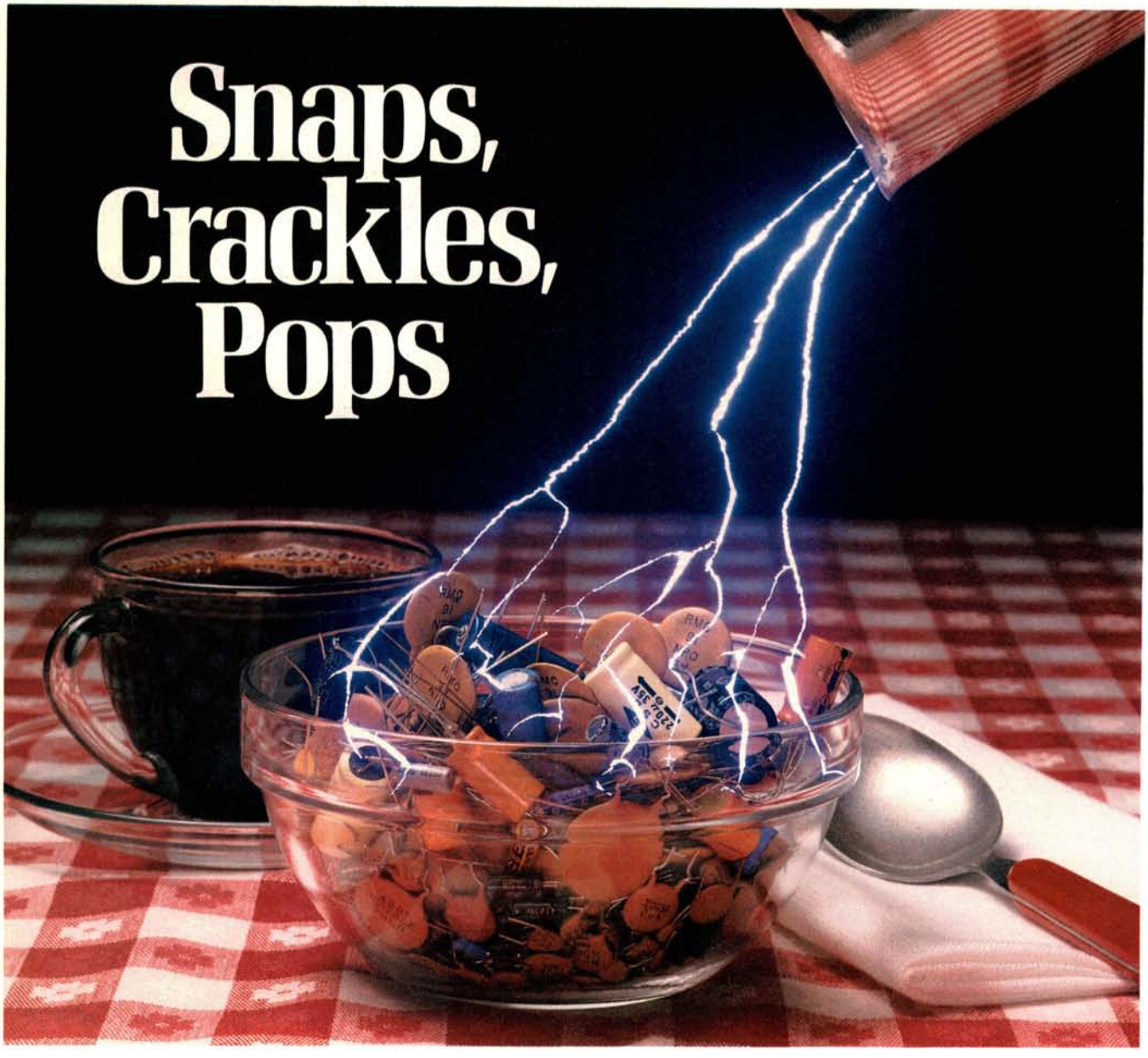
Snaps, Crackles, Pops



Ain't it fun to see someone walk across a carpeted floor, reach for a door knob, and throw a fat, blue spark from their fingertip? You hear the loud SNAP, and see them jump. Tee hee hee.

Then the same thing happens to you and it's not so funny. It hurts, and it sure does get your attention. What causes this? It's static electricity.

Another name for static electricity is ESD or Electro-Static Discharge, a term that better describes the phenomenon that causes this problem.

ESD used to be one of those curiosities of science that was treated like a toy. It was great fun to rub your feet on a carpet and then sneak up behind someone and zap them on the ear. SNAP. Tee hee hee.

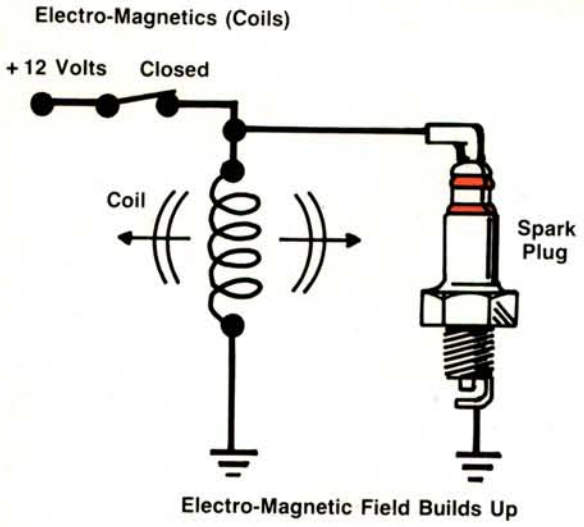
Well the fun and games are over, friends. Now ESD is serious business. ESD can permanently damage solid-state electronic circuits inside automobile computers. One good SNAP of ESD and a solid state engine controller, digital dash, or a digital radio can be completely disabled.

And the worst part of all is that you may be zapping components with discharges too small to feel. This is an expensive mistake indeed. We better stop and take a long look at ESD and learn how to deal with it, because we can't always tell when it's around, doing its dirty work.

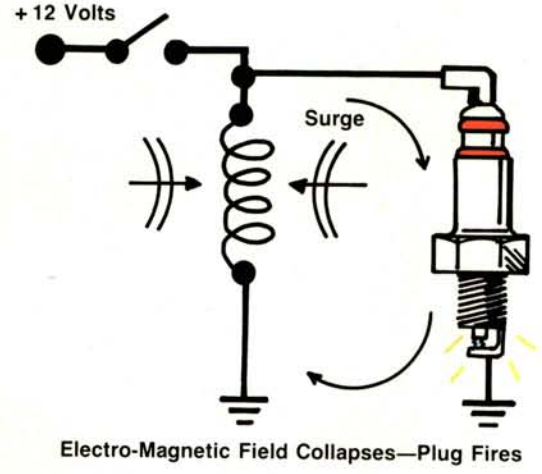
First, There Are Electro-Magnetics . . .

Most of you are familiar with the theory behind electro-magnetics. Look at **Figure 1**. When DC current passes through an ignition coil, the coil charges. This charge exists in the form of an electro-magnetic field surrounding the coil.

Figure 1



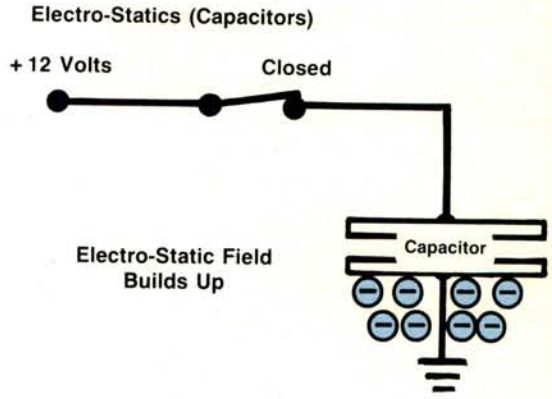
When the current through the coil is interrupted, the field collapses. The energy stored in the coil is rapidly released in the form of a voltage surge.



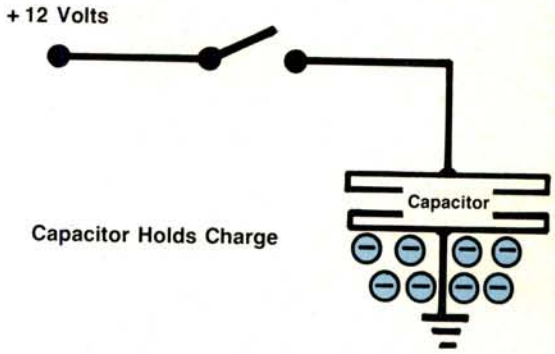
Let's call this surge EMS for Electro-Magnetic Surge. This redistribution of electro-magnetic energy can provide a voltage surge great enough to jump the gap of a spark plug. If you've ever experienced the wrong end of a spark plug wire when this surge occurs, you have a vivid idea of what happens.

Then, There Are Electro-Statics . . .

Let's also understand the basics of Electro-Statics. When DC voltage from a battery is connected across a capacitor (condenser), the capacitor charges up to a level equal to that particular battery voltage level. The voltage is stored in the form of an electro-static charge that can contain considerable energy.



A capacitor is made of thin conductive plates separated by a non-conductive layer of insulation. The electro-static charge consists of billions of electrons on one plate of the capacitor, and none by comparison on the other plate.

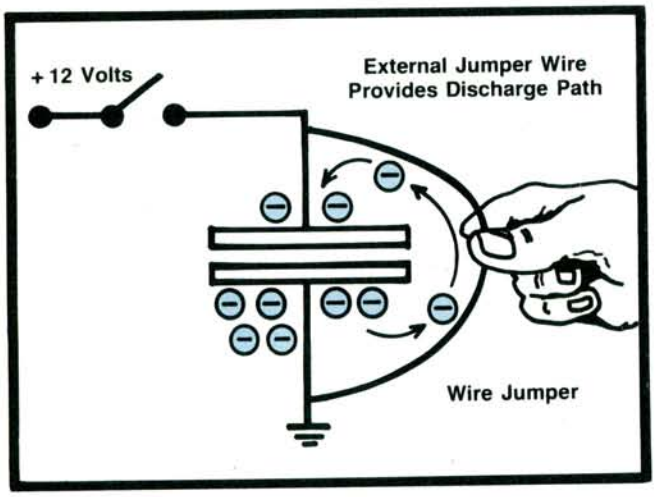


When the charging voltage is removed, the electrons remain trapped on the one plate of the capacitor. As a result, the capacitor stores, or holds the charge.

The electrons exert a lot of pressure trying to get half of their number over to the other plate. Electrons, like water, would like to find their own level. If the capacitor is asked to store a charge for a long time, there will be a few defectors who manage to cross over to the positive side through the insulation (dielectric) separating the conductive plates.

If the two plates are connected by a conductor, however, the electrons will rush from the negative to the positive side until the charge of the two plates is equalized and the capacitor is discharged.

Like the electro-magnetic coil, the capacitor releases this energy in a rapid surge of current through the external conductor. The capacitor discharges as the electro-static energy redistributes itself equally on both plates of the capacitor.



This rapid surge is called Electro-Static Discharge, or ESD. This is the stuff we have to be careful with. This is the stuff that can zap that computer into a worthless pile of junk.

If the external path between the two conductive plates happens to be a tiny, sensitive semi-conductor, the surge of current may be enough to fry that circuit. It's just like blowing tiny fuses inside the electronic component.

You know how worthless a blown fuse is in a circuit. The same is true for electronic components zapped by ESD. They are useless too.

The Punch Line

So guess what you are. That's right, you are a giant, living, breathing capacitor. Your body is electrically similar to that condenser, not that coil. In fact, the average person has about 150-200 pico-farads of capacitance. The farad is the unit of capacitance, and tells how many electrons a capacitor can hold.

Pico farads are a trillionth of a farad, not much as farads go. But your body is still one fine capacitor, even at that level. That's why we're more concerned here with ESD than we are with EMS.

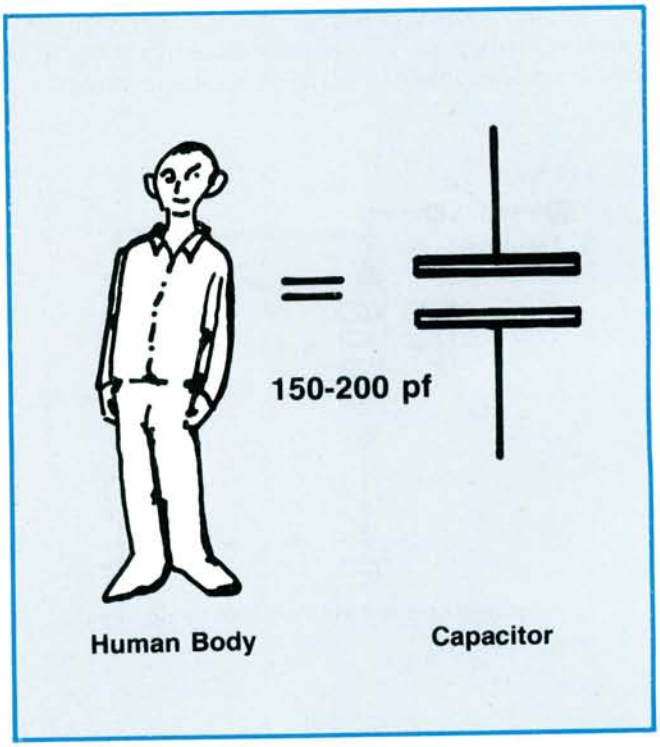
Even at 150-200 pf, your body can be charged with several thousand volts. **Figure 2** is a chart that shows the amount of electro-static charge that can accumulate on the human body during normal activities.

We are a population of walking talking computer destroying capacitors just looking to pick up a stray charge during our daily activities. Our bodies will either pick up electrons creating a negative charge, or lose electrons creating a positive charge.

When we come in contact with an object that has a polarity opposite our charge, a transfer of electro-static energy, or ESD takes place between our body and that object. The result is that familiar, and sometimes painful SNAP, if the charge transfer is high enough.

Figure 2

Electro-Static Charges Generated On The Human Body By Normal Activities		
Activity	Electro-Static Voltage Generated At A Relative Humidity Of: 10-20%	65-90%
Walking across carpet	35000 volts	1500 volts
Walking across a vinyl floor	12000 volts	250 volts
Movement of your arms and legs at a workbench	6000 volts	100 volts
Movement of vinyl envelope containing work order	7000 volts	600 volts
Picking up a poly bag from a workbench	20000 volts	1200 volts
Sliding across a plastic car seat	25000 volts	1500 volts



Controlling ESD Inside The Vehicle

Normally, electronic circuits in a car are operated at no more than 14.5 volts. It's not hard to imagine the damage that can be caused by an ESD voltage SNAP of several thousand volts. What makes the ESD situation even worse is that you can't even feel an ESD

discharge below 3000 volts.

The result is that many technicians cause ESD damage to electrical components and don't even realize, much less believe, that they have fried a delicate component.

We repeat. You may be zapping components and not even know it!

Just because you're not shuffling across a carpeted floor in the service area doesn't mean you're not exposed to stray electrons. Your normal activities during the day as you work on cars will bring you in contact with enough electrons to charge you to many thousands of volts.

And just because you touched a metal door handle and discharged yourself five minutes ago, doesn't mean you haven't been recharged since then. The only option for a technician handling delicate electronic components is to maintain a constant external path between his body and ground. That way a charge can't build up, since it is always running to ground.

The accepted method to ground your body is to wear an approved wrist strap. There are several of these devices on the market. They are available from electronic supply stores in your area.

While a technician is grounded to the car, he should not "hand off" a component to an ungrounded technician standing nearby. This defeats the whole purpose of a ground strap or grounded work station, since the second technician may expose the component to ESD.

ESD Outside The Vehicle

If the electronic component is moved to another location away from the vehicle, it should be stored in an approved static-free container, such as a bag made of static-free plastic material.

ESD suppression is the responsibility of every member of the auto service industry. It begins with the manufacturer and passes on through the parts distribution network to the end user, the repair technician. Everyone in that chain must take precautions to minimize the effects of ESD. Manufacturers must adhere to static-free manufacturing processes, and parts networks must transport and store electronic components in approved, static-free containers.

Service technicians should not unpack and install electronic components unless they are properly grounded with a working wrist strap. Even the defective electronic component being returned should be

repackaged in the proper, static-free container by a properly grounded technician.

Electronic components that are sensitive to ESD are often marked with a caution label. Believe this label. Do what it says to safeguard the component. Electronic components most sensitive to ESD are those that contain integrated circuits. A good rule of thumb is to treat any electronic component as if it were an ESD sensitive component, since most all of them are.

The Heartbreak Of ESD

ESD can do its damage at any point in the service chain. The unseen danger is that ESD damage may not cause an immediate component failure. If you completely fry a component, it's pretty obvious you have trouble since the component refuses to do anything.

But ESD may introduce a condition known as "latent failure" that is far more difficult to detect since the component is damaged, but still works—for the moment. Latent failures may not show up for weeks or months, but they will show up, and cause a needless repeat failure.

There's another aspect of latent failure that will soon affect us all. It's becoming standard practice to rebuild certain electronic components and put them back in the parts distribution system. These components include engine computers, digital dash displays, and digital radios. But latent failures may not show up during the rebuilding process.

Therefore, it is the responsibility of everyone in the vehicle service industry to do their part to keep electronic components free of ESD damage.

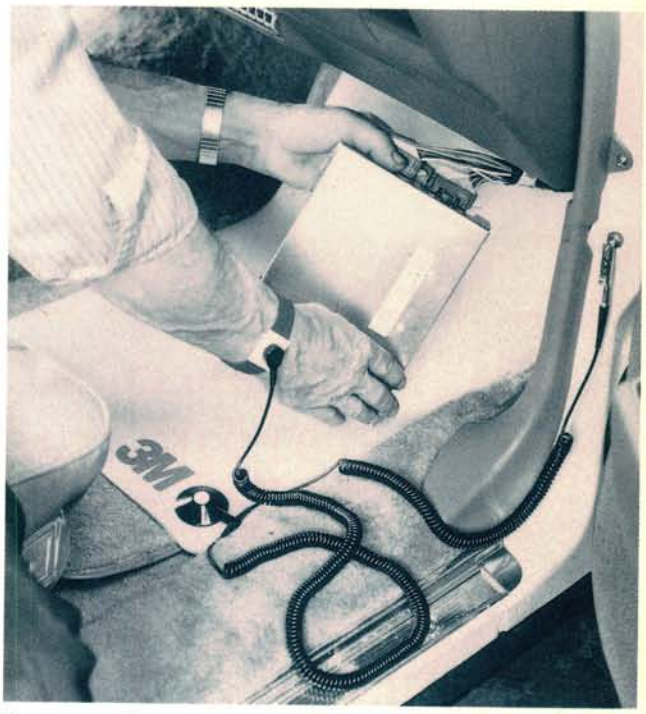
Service personnel should become aware of service information that deals with ESD. Refer to shop manuals, other technical service publications, and service bulletins.

Treat static electricity like it is always there, because it is.

Six Common Myths About ESD

Myth One: If the humidity is high, there is no danger from ESD.
Truth One: While it's true that low humidity aggravates ESD problems, high humidity is no guarantee that ESD damage cannot occur.
Myth Two: Electronic components are safe once they're installed in the car.
Truth Two: Electronic components are always in danger from ESD. Here's an example. Did you ever see someone grab a radio antenna and bend it over, just to see it snap back? The ESD on that character's body may be enough to kill the radio, even if it's turned off.
Myth Three: If an electronic component is working properly, it hasn't been damaged by ESD.
Truth Three: Latent damage may have occurred. Although the component is working now, it may be weakened, and fail prematurely as a result of latent damage.
Myth Four: Using a grounded wrist strap suppresses ESD.
Truth Four: A defective wrist strap can look just fine, but have an open connection that makes it useless. Check your wrist strap on a regular basis with a digital ohmmeter for the proper resistance reading, usually 1 meg ohm.
Myth Five: Electronic components enclosed in a metal case are considered safe from most of the effects of ESD.
Truth Five: The wires connecting the electronic component can carry ESD inside the component. This exposes semi-conductor components inside the box to the ravages of ESD.
Myth Six: "This entire article is hogwash. It's a big deal about nothing. I've never used a wrist strap in my life, and I've never ruined a single component. Not even once."
Truth Six: Tee hee hee. We know better. The problem is that you might not know that you've created a latent damage condition. And even worse, you've probably had occasion to scratch your head over a repeat failure or a mystery glitch in an electronic system and never made the association between ESD damage and your problem. Think about it.

—By Vince Fischelli



One manufacturer, 3M Company, has developed an approved ESD work station to be used while working in the passenger compartment of the vehicle. The kit includes a static suppressing floor mat with a ground connection to the vehicle frame. The wrist strap that comes with the kit is then grounded to the floor mat. When the technician puts on the wrist strap, he is grounded to the vehicle. The metal frame of the vehicle has enough mass to absorb the ESD from the technician's body.