Repairs & Maintenance

320 Landing Gear

Despite my best efforts at a good, sound landing gear and hydraulics installation on my 320, it's been the source of many problems. I recently encountered the following two problems for which there is no explanation:

In late March, I'd completed some routine maintainence and gotten back in the air after several months of Winter downtime. After an hour-long flight, I flew into the pattern and selected "gear down". I immediately noticed there was no green for one of the mains and thought it was simply a misadjusted micro switch. I cycled the gear again and got three green, to my great relief ! Next day, I put the plane on the jackstand and found that I did indeed have a serious problem with the gear. The pump struggled and would just BARELY retract and extend them and the sequence was erratic. I could hardly imagine what the problem was. When I finally started disassembling the system, I found that the shafts were buckled on not one, but both of the main gear cylinders, enough that they could not be extended and retracted by hand! I checked and checked, but neither I nor a very sharp mechanical engineer could find a reason for the buckling. The only possible explanation was that the down stop was misadjusted for not only one, but both and why would they both buckle now, after hundreds of extensions over several years? Anyhow, I'm certain they had not been misadjusted. I replaced both cylinders with new ones.

I flew my 320 to Sun n' Fun on Saturday, April 8th and stayed the first three days of the event. I was happy to show off my plane and answer a continuous stream of questions. I entered my plane in the judging and later learned that it won "Outstanding Aircraft"! I departed Lakeland on Tuesday, April 11th. When I selected "Gear Up"...NOTHING happened!!! I tried whatever I could...flipped the gear switch repeatedly, opened and closed the free-fall valve, checked circuit breakers... still NOTHING!!! So, I had to fly around the pattern and land. I taxiied to the ramp at Hawthorne Aviation (other side of Lakeland airport from Sun'n'Fun) to start checking and troubleshooting, not a pleasant time! I hoped that I'd find something obvious; broken or loose wire or connection, maybe a pitot or static line pulled loose from the gear up safety switch...something! Well, I looked and looked and checked, but couldn't find anything wrong. Eventually, I realized that I could open the free-fall valve then use a pair of pliers to short across one of the relays, in order to apply 12 VDC directly to the pump motor and verify that it was operational. The pump ran! Then, I briefly thought "That's great...but, where do I go from here with no multimeter or tools! My next thought was "Let's see if the system will now operate normally" Well, thank God, it appeared to! So, I put everything back together and departed Lakeland, with the gear operating normally thereafter.

Now, here's something truly incredible....I had met Clark Baker at Sun'n' Fun and emailed him the day after I returned, never mentioning my gear problem. In his response he related that he had a problem with his gear when departing Lakeland. To quote Lance himself, "my jaw dropped" when he described the exact same problem and that he corrected it using the same troubleshooting technique that I had!

During initial troubleshooting, the pump would not operate in EITHER direction with the free-fall valve open. I can hardly imagine any explanation, other than a "hydraulic lock" holding both the high and low pressure limit switches open, which was released when I shorted a relay to jog the pump. The system has continued to operate normally since. Has anyone else had the same problem? If you should, try shorting a relay as described in order to clear it. Additionally, I recently spoke with George Shattuck, who told me that after shutting his plane down, he always opens the free-fall valve in order to release the down-lock pressure since it's unnecessary and only needlessly taxes the system.

Bill Rumburg william.rumburg@cdicorp.com
Chesapeake, VA 757-539-3411

320 Hydraulic Pump Motor Relays

The hydraulic pump motor (up or down) relay furnished with the kit is a Ford starter relay and can be purchased at any auto parts store for about $ 15. It's contacts are solenoid operated. There is also an auxiliary terminal to supply isolated 12V DC when the relay is energized, which is used to operate the amber "gear transition" light on the instrument panel.

Unfortunately, the contacts are subject to burning due to the high voltage developed across them as they open to de-energize the highly inductive motor, which is operating at full load. After approximately 200-300 cycles, the contacts will become intermittent and eventually fail. However, the arcing can be eliminated by connecting a suitable diode from ground to the motor's power terminal, as shown in the sketch below. The diode provides an unimpeded path from ground for current when the motor is de-energized and its magnetic field collapses. Were it not for the path provided by the diode, the highly inductive motor would attempt to maintain current flow by generating a high voltage arc across the relay contacts as they open.

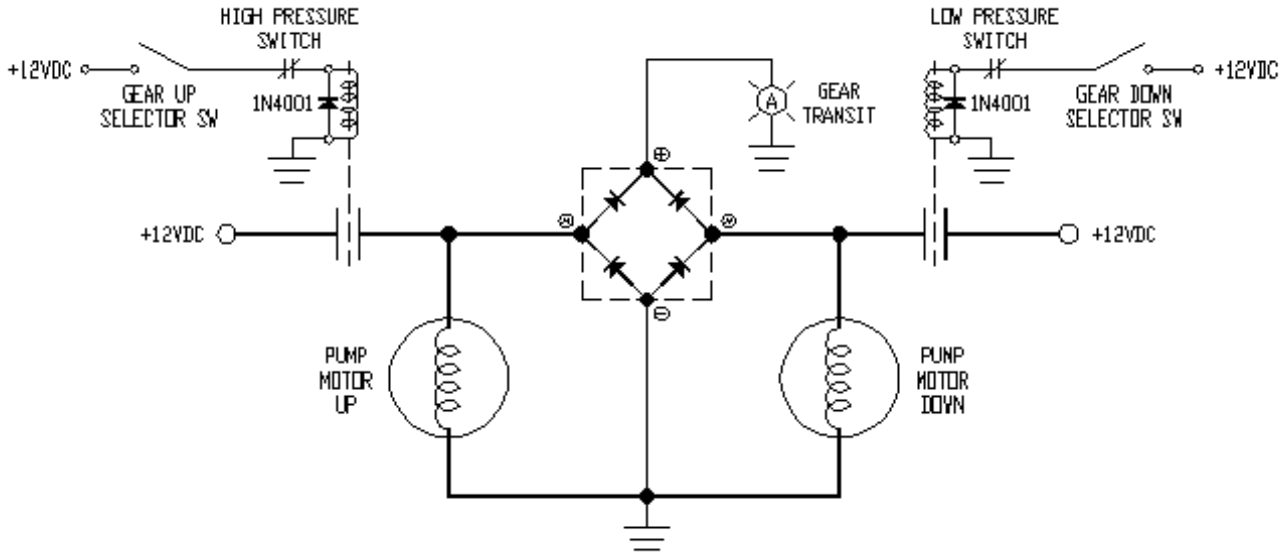
In addition, the use of a Bosch 60 A starter relay was recommended on the LML by John Cooper about two years ago as a superior replacement for the Ford relay. It is lighter weight, but heavier duty. The Bosch P/N is 0 332 002 150 and it can be ordered from Brandon Products Group (BPG) [(800) 422-3274] for only $ 13.27.

Replacing the Ford relays with Bosch relays will require some rework because of their different mounting and wiring configuration. Although the Bosch relays have "pre-contacts" to reduce arcing, installation of surge supressor diodes is still recommended. Unfortunately, the Bosch relay does not have an auxiliary terminal to supply isolated 12V DC to operate the amber gear transition light. However, that problem and the need for induced voltage suppression can both be solved by properly connecting the diodes in a single full-wave bridge.

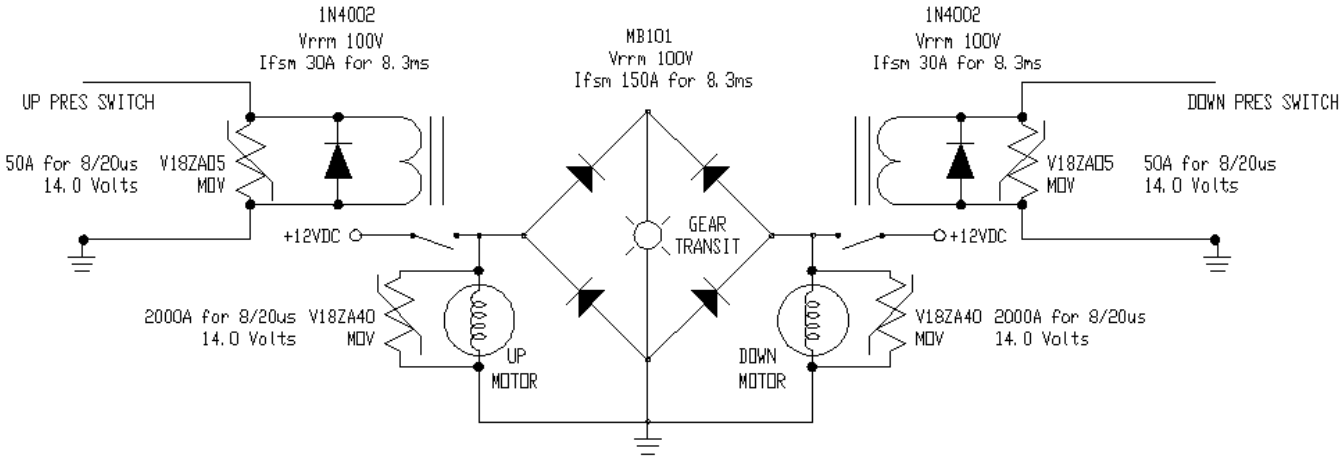
The full-wave bridge is a simple flat-pak, approximately 1-1/2" x 1-1/2" square, with a # 10 hole in the center for mounting. It consists of four diodes connected internally and has four “Fast-On” terminals for external connection as shown in the sketch. When properly wired, two of the diodes function to supply isolated 12V DC for the amber gear transition light (this was unnecessary with the Ford relay) and the remaining two provide a ground path to protect the relay contacts as described above. Only one diode bridge is required. It is available from Mouser Electronics [(800) 346-6873] for only $ 4. The Mouser P/N is 625-GBPC3504. It's rated 400 A IFM surge (maximum forward current) and 400 V PRV (peak reverse voltage). You can also order it on the Web at http://www.mouser.com

In a similar fashion, the pressure switch contacts can also be protected from the high voltage induced by the relay operating coil. Simply connect a diode across the operating coil as shown, to provide an unimpeded path from ground for the current when the contacts open and prevent arcing across the pressure switch contacts.

Bill Rumburg william.rumburg@cdicorp.com
Chesapeake, VA 757-539-3411



[Note: During the time Bill’s article was being prepared for publication, Ed Armstrong was brought into the fray because of an interesting set of drawings he had posted on his company website. They showed several ways of incorporating both diodes and MOV’s (metal oxide varistors) to address not only the arcing caused by the flyback voltage from a collapsing inductive load, but the resulting circuit noise as well. We discussed the differences between placing MOV’s across the switch contacts (common practice by Bob Nuckolls in the preparation of wirebooks for various projects) vs across the load, and Ed opined that it is always better to suppress the surge at the source. While clamping off the induced voltage at the switch still protects its contacts, the surge that travels through the wire leading to it is creating an electro-magnetic field along that wire’s length. The wire, in essence, becomes a wide-band antenna and the “signal’ it transmits as noise can be responsible for the occasional clatter one hears in the headset as it’s picked up by the various radios. Ed’s “Ultimate” solution incorporates both the full wave bridge and MOV’s on the motor side of the relays and additional MOV’s and separate diodes on the coil side. The resulting schematic is presented here for your convenience. (The 1N4002 diodes shown may be a bit of overkill for the Bosch coils, as they only draw 260ma during operation, but it is my understanding that it’s better to have excess protection than not enough.)<Marv>]



MOVs, Metal Oxide Varistors. Commonly called Varistors when searching in catalog indexes.

V18Z series starts to conduct at 14Volts. The min spec is 1mA at 14.4 volts. If your electrical system's voltage goes higher than 14.4 volts, use the V22Z series. This starts conducting at 18 volts.

8/20us means a pulse that starts at zero, rises to it's peak in 8 micro seconds, then decays to zero again in 20 micro seconds. this kind of pulse is what you typically see as spikes and noise in electrical systems.

The V18ZA05 is a small radial leaded disk only 5mm in diameter

The V18ZA40 is also a small radial leaded disk only 20mm (0.78") in diameter. I chose this one for the energy rating of 80 joules. Joules is Voltage * Current * time. We have 14V * 50Amps * however long it takes for the motor coils to discharge. say 10ms this would be 7 joules. The next size lower is only 3.5 joules that is why I chose this larger size.

These MOVs are manufactured by Harris Semiconductor. Available from Newark Electronics. 1800-463-9275 use the Harris part number.

The diodes and Bridge Rectifier are Motorola, they are also Available from Newark Electronics and many others.