

Every person that ever drives a Think must read and comply with the following:

Before putting the key in the ignition and turning it on, and also before turning the key off, always turn the blower off. (The blower is also called the fan and

is controlled by a knob on the heating and air conditioning control panel on the center console. There are settings from 0 to 4, and the left-most/counterclockwise-most, 0, is the off position.) Otherwise it is possible to permanently immobilize your car. We recommend making a label/sticker and posting it prominently on the dash or center console, not blocking other indicators, to remind you and anyone who might ever drive your car to always turn the blower off before starting up or shutting down the car.

Seriously, every person who ever might even just move a Think around in a driveway or ***even merely sit in the passenger seat*** while waiting and listening to the radio must read and comply with the paragraph above or **risk killing the car with no possibility of revival.**

If you are curious why this is required, please read further for a more detailed explanation of the problem. If you are not curious, that's fine, but please just always turn off the blower before you turn the key on and before you turn the key off. **If you forget to turn the blower off before you turn the key off, it's okay, just stop! Whatever you do, do not turn the key back on.** With the car still off, turn the blower selector knob to off. If you need to turn the key back on, just wait ten seconds and this time remember to double check that the blower is turned off before turning the key on and also before turning the key off. Also please make a reminder label or sticker for anyone else that might ever turn the ignition key in your car. Did I mention that you need to make sure the blower is off before turning the key on or off?

Explanation:

When your Think electric car is turned off, all of the potentially dangerous high voltage is isolated inside the battery pack under the car for safety. This is common for all hybrid and electric vehicles. The high voltage is only permitted to flow to the Power Conversion Unit (under the hood) when the car is turned on. The clicking that you hear when starting up and turning off the car are "contactors," aka relays or electro-mechanical switches, opening and closing for this purpose. If you listen each time you start up and shut down your car there is probably a familiar rhythm to the clicks. When the high voltage battery is initially connected to the PCU when the key is turned on, there is a rush of electrical current to charge up a large capacitor in the PCU. To prevent that rush of electrical current from getting too out of hand and burning up components, there is a precharge circuit which simply puts a resistor in series with the battery/capacitor circuit. The resistor is capable of dissipating a relatively large amount of energy over the short time that it takes to charge the capacitor.

We have recognized that there has been a problem concerning the precharge circuit since the beginning, but did not understand the cause until somewhat recently (March 2014). When the precharge circuit fails, the precharge resistor overheats and creates a brief fireball on the circuit board

where it is mounted, the Master Lithium Energy Control module, or MLEC (usually spoken EM-lek). Usually the burnt resistor causes an open in the precharge circuit (i.e. no current can flow), and the resulting symptoms are a car that will not start: The green car “ready” light on the center console next to the PRNDE does not turn on; the Power Limit light flashes; and the usual clicking sequence of the contactors ends abnormally. The fire from the overheated resistor can cause other wires to burn creating open and/or short circuits which can, along with the fire, damage other parts of the circuit board. The result is that symptoms are not always the same when an MLEC has failed. The precharge circuit might not fail immediately after it has overheated, but could continue to function indefinitely or fail at any time thereafter. (The amount of energy dissipated in the resistor, and therefore the magnitude of the fire, depends on the voltage/state of charge of the battery when the incident occurred.)

The repair for this failure has always been to lift the vehicle on a hoist, remove the high voltage battery from underneath, remove the MLEC from the high voltage battery assembly and replace it. The whole procedure takes under 2 hours (after the car is towed to the repair facility and the parts are available). With continued failures of MLECs, we have depleted all inventory of new MLECs, and no new MLECs are being manufactured. We have also repaired the MLEC circuit boards by replacing the burnt resistors with new and repairing any wiring problems. But because the damage due to the failure mode (fire) is not always contained to only the resistor, some MLEC circuit boards are damaged in ways that we can neither diagnose nor repair. Therefore any further MLEC failures might result in a condition that permanently immobilizes your car.

We now know of at least one scenario that causes this problem to occur. The scenario that we have identified *might* be the only way in which a precharge resistor can overheat, but we cannot say with certainty that there are not other scenarios that might also cause the same problem. But by avoiding the scenario we describe here, you will be reducing the chances of inadvertently junking your car. (Hopefully you will be reducing your chances by 100%.)

This is the scenario in which a precharge resistor will definitely be overheated. If you follow this description of events you will almost certainly cause your car to not start and may cause it to never start again:

1. The car is running normally and the heater is turned on. (By “heater is turned on”, we mean that the blower (aka fan) is turned to any position but off, and the temperature selector knob could really be in just about any position at all. We don’t know exactly the internal logic of the Climate and Demist Control Module (CDCM), so on a very cold day even with the temperature selector knob turned to the coldest setting it might decide that the outside air is too cold and turn on the heater element and you might not even notice. The further the knob is turned in the hot direction, the greater chance the heater element is energized. The CDCM will not turn the heater element on unless the blower is turned on, though.)
2. The car is parked and the key is turned off.
3. If, within a few seconds of the key being turned off, the key is turned back on again, the precharge resistor will burst into flames.

Because the precharge resistor mounted on the MLEC is well sealed inside the high voltage battery assembly away from the cabin, you will not notice any visual, audible or olfactory sensation other than the no-start symptoms listed above. The key does not even have to be turned all the way to the start position (the cranking position for a conventional internal combustion car) to cause the failure—only to the on position. You might be tempted to perform this rapid key off-on behavior when you (1) decided that you wanted to hear the rest of whatever was playing on the radio, (2) forgot to put your windows up, (3) decided that you should do a better parking job, or any number of other reasons. None of these behaviors (a quick key off and back on) will have any negative impact on your car as long as your heater is not turned on. But if your heater is on, you may very well have just killed your car for good. This is why we are recommending that everyone who ever casts a sideways glance at a Think form a habit of verifying that the blower is off before turning the key on and also before turning the key off. Please also make a visual reminder and post it in your car for anyone else who might even just be sitting in the passenger seat waiting.

The CDCM is programmed to not start the powering heater element until a set amount of time has passed after the key is turned to the on position. This gives the battery sufficient time to go through its precharge process. However, when the key is turned off, the CDCM does not immediately shut down. In fact, the CDCM stays on for several seconds after the key is turned off, and if the key is turned back on within a few seconds, to the CDCM it's as if the key was never turned off and does not heed the startup programming that normally requires it to wait before turning the heater on. So when the battery goes through its normal precharge start-up procedure, instead of current flowing through the precharge resistor only to charge up the capacitor inside the PCU, the current is also flowing to power the heater element. That excess electric current causes the power dissipated in the resistor to far exceed its rating resulting in a brief fireball.

Observant drivers may notice the following: Normally when the key is turned off, the contactors audibly click open almost immediately. However, if the heater is turned on, there is a short pause after the key is turned off before the contactors click open. This is because the heater is still drawing current, and the battery management system would rather not open contactors until current has dropped to zero. But after a short time the battery has no choice but to open the contactors under load. If you notice that there is an unusual pause before the familiar sound of the contactors clicking open, do not fear. You have done no harm. It is okay that the contactors open while loaded—they are designed to do so 10,000 times (or at least I think I heard that somewhere). All you have to remember in order to not kill your car is to do nothing! Do not turn your car back on for several seconds, and before you do, turn the blower off—If you heard the pause I am quite certain that you forgot to turn it off before turning the key off. We all make mistakes sometimes.

An advisory similar to this was sent out several months ago (maybe even over a year ago). It recommended turning off *all* electrical loads powered by the 12V system before turning the key on or off. This includes headlights, radio, anything that might be plugged into the power port above the fuse panel on the passenger side of the dash. Also don't be laying on the horn while you turn the key on or off. This advisory to turn off all 12V loads is still the best and most conservative recommendation. I have never been able to ascribe the MLEC failure to anything other than the heater, but I never go very

long without being proven wrong about something, and we may very well find some other module that tries to load the high voltage battery during the precharge phase of some anomalous start-up. You may have not heard the recommendation about turning off 12V loads or you may have just not heeded it because it's not exactly convenient to turn the radio on and off all the time, but please, please, heed this warning about turning off the blower.

If somehow after this berating someone still manages to overheat their precharge resistor, we will attempt to repair the MLEC and install a new resistor, but we cannot guarantee that our efforts will be capable of making the car functional again (and will still cost about 2 hours labor). Think North America has been in communication with the battery manufacturer Enerdel about procuring more MLECs, but the outlook is not good.

Obviously, it is not ideal that this failure even be possible regardless of the operator's actions. It is a design flaw with the car. I can imagine various ways of retrofitting the car that would eliminate this problem completely, but designing such a fix is a proposition that I could not undertake in my free time. For those of you in the Pacific Northwest, I do take your satisfaction with your Think very personally, and I hate to leave the burden of ensuring that it does not self-destruct to the customer, but for now it's all I can do. Cheers,

John Mayer

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