

# HOWELL

## ENGINE DEVELOPMENTS, INC. FUEL INJECTION APPLICATIONS

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### INSTALLATION OF PRODUCTION GM AND 670 CFM 2 BARREL THROTTLE BODY FUEL INJECTION KITS ON FORMERLY CARBURETED ENGINES.

This system is based on the Production GM (Chevrolet) throttle body fuel injection system and electronics used from 1987 to 1991, on 305, 350, and 454 engines. All backup systems and "on vehicle" diagnostics function similarly to those model year engine packages.

This EFI system can be operated with computer controlled spark advance using the late model GM distributor, or it can be specified for used with conventional or aftermarket high performance ignition systems, using a tach signal for RPM input to the ECM. This feature allows use on Ford, Chrysler, and AMC engines, or any engine with a conventional coil.

Installation procedure will be separated into the following categories:

1. Special EFI parts required.
2. Removal of non-required parts from carbureted engine.
3. Installation of TBI and engine hardware.
4. Installation of electronic components and wiring harness.
5. Special calibration PROM and vehicle ECM.
6. Initial vehicle start-up and operation.
7. Initial driving impressions.
8. Tuning adjustments.
9. Trouble shooting problem description & solutions

Realizing that there may be a variety of engine configurations, sizes and usages, these instructions are for a typical mildly modified big block or small block engine. If you are using this system on a non-GM engine, or without ECM controlled spark timing, ignore any sections on timing or knock sensor control.

#### SPECIAL EFI PARTS REQUIRED

1. GM two barrel throttle body, or Holley 670 CFM throttle body in new or good condition, that contains injectors appropriate for the size engine being converted. Be sure that the TBI unit has a throttle lever that can be properly connected to your vehicle.
2. GM electronically controlled distributor (preferred in GM installations) or electronically controlled ignition with timing curve appropriate for your engine. NOTE: MSD ignitions are OK, but require a special tach filter to condition the signal to the ECM, and this should be specified when ordering your kit, as it is built into the harness by Howell.
3. Intake manifold appropriate for the TBI being used. A two barrel intake manifold is preferred for stock applications, but most modified engines will use a four barrel intake for performance reasons. Howell Engine Developments can supply an adaptor to match almost any intake manifold to the TBI unit, including Quadrajets and older 500CFM Holly 2 barrels.
4. Howell wiring harness to connect all engine sensors and TBI to the vehicle, and interface with your vehicle.
5. Vehicle ECM (computer), usually GM part # 1227747 or its equivalent.

6. Coolant sensor (GM). Intake manifold mounted so ECM can read engine temp.
7. MAP sensor to measure intake manifold vacuum, and feed information to the ECM
8. Oxygen sensor. Exhaust manifold or pipe mounted, so ECM can monitor the air-fuel ratio, and make corrections when operating in closed-loop. Vehicles with headers where the Oxygen sensor is located more than 2 feet from the cylinder head should be equipped with a heated Oxygen sensor to operate properly. These can be special ordered when the harness is being built, or added later with a separate kit.
9. Fuel pump relay. Turns high pressure fuel pump on and off at command of ECM.
10. Detonation (knock) sensor (for systems with ECM controlled spark advance only). Mounted directly to the cylinder block, usually in one of the water drain holes.
11. ESC module (for systems with ECM controlled spark advance only). Filters the knock signal and sends it to the ECM, so spark can be retarded to stop detonation.
12. In-line, or in-tank high pressure electric fuel pump, and EFI fuel filter.

### REMOVAL OF NON-REQUIRED PARTS FROM CARBURETED ENGINE

**NOTE:** Before removing anything, you may want to have the Oxygen sensor bung (Required in step 8 below) welded into your exhaust system by a muffler shop.

Remove the air filter, carburetor, distributor (if changing to ECM spark timing control), fuel lines, mechanical fuel pump, and push rod from the carbureted engine. You can fabricate or purchase a fuel pump block-off plate to seal the fuel pump cavity (it is a standard part for EFI GM engines).

Trace and record the use of any vacuum lines disconnected from the carburetor for later reconnection to the TBI if required.

**NOTE:** Some heavy duty trucks and motor homes without catalytic converters, use a full time AIR pump that adds air into the exhaust through ports in the exhaust manifolds. **YOU CANNOT USE AN OXYGEN SENSOR AND CLOSED LOOP SYSTEM ON THESE VEHICLES WITHOUT DISABLING THIS AIR PUMP.** Contact Howell Engine Developments for alternate solutions to this problem if your engine is in this category.

### INSTALLATION OF 2 BARREL TBI AND ENGINE HARDWARE

1. **AFTERMARKET INTAKE** – If you are using an aftermarket intake manifold, make sure it has adequate vacuum taps for brakes, transmission, etc. Also make sure it has a tapped hole for the EFI coolant sensor. Before installing on engine, make sure you have the correct adaptor plate to fit the TBI to the engine, with no vacuum leaks.
2. Install the ECM controlled HEI distributor (if using the complete GM system), and align the star cam and magnet points to match at TDC or a few degrees before TDC. Initial timing will be reset when the engine is running. You can use either the small diameter late model HEI distributor, or the older large cap HEI distributor, whichever you have available.
3. **FUEL LINES AND FUEL PUMP**—At this point you may want to fabricate and route your fuel lines from the high pressure fuel pump to the TBI, and returning to your fuel tank. **THE HIGH PRESSURE OR "IN" FITTING IS ON THE DRIVERS SIDE OF THE TBI.** The fuel pump supplied with all Howell kits is an in-line design that will supply 15 PSI or more to your TBI unit (pressure regulation takes place in the TBI unit). Mount the fuel pump horizontally, as close as possible to the fuel tank, no higher than mid fuel level, and clamped in rubber to isolate any pump noise. The pump has hose nipple ends for easy adaptation, and the high pressure end, or fuel out, is the end with the electrical terminals. Make sure the in-tank fuel pickup has a clean, fine, filter on it, and mount the supplied fuel filter between the pump and tank. (90 percent of electric fuel pump problems are caused by dirt getting into the pump

along with the fuel.) A dirty in-tank filter will starve the high pressure pump and give you vapor lock problems in hot weather and at high altitudes. It will also cause the pump to cavitate and significantly shorten its life. **NOTE: DO NOT** put extra "helper" fuel pumps between your fuel tank and the high pressure pump. These pumps invariably have less total capacity than the EFI pump and make the high pressure pump work to pull the extra fuel through the "helper" pump. **DO NOT** put extra fuel filters in the lines, one EFI grade fuel filter is sufficient.

You can use 3/8" or 5/16" steel lines, braided metal covered flexible lines, or a good grade of braid reinforced neoprene fuel line. 15 PSI of fuel pressure is not difficult to contain or seal at the connections.

You must run a 5/16" or 1/4" fuel return line from the TBI **BACK TO THE FUEL TANK**. You can dump the return fuel back into the tank just about anywhere you choose if there is no return fuel fitting on the fuel tank pickup plate. (Make sure you don't try to return fuel to a vapor vent fitting, as most of them are restricted. This will create excessive fuel pressure at the TBI unit and cause a very rich condition at idle.)

4. Install the TBI unit and connect the gas lines. Make sure the TBI and adaptor gaskets seal completely, or you may have idle speed problems.

5. Connect vacuum lines as appropriate for your engine. MAP and AIR diverter valves require full time vacuum. EGR and Cannister purge lines use ported vacuum (no vacuum when the throttle is closed). GM TBI units have a vacuum connector on the rear that is designed for MAP vacuum. Holley 670 TBI units have a similar connector, but **DO NOT USE IT FOR MAP VACUUM!!** Instead, use one of the full time vacuum ports on either side of the front of the TBI unit.

6. **THROTTLE CABLE**—Use the original vehicle throttle cable (and transmission cable) if at all possible. The variety of engine and chassis designs prevents Howell from offering a universal throttle cable kit. There are some aftermarket kits available, or frequently you can rework your production vehicle throttle bracket to use. There is sufficient torsion return spring built into both the GM and Holley 2 barrel TBI units so that a separate throttle return spring is not necessary

7. **AIR CLEANER**—Production air cleaners from carbureted engines do not fit well on TBI units. The injector nozzles extend above the air cleaner flange too far. If you space them up enough to clear, the spacer becomes an airflow restriction. Production TBI air filters can usually be modified slightly, and will fit and clear the injectors and throttle lever. If necessary, a 1/2" spacer can be used. Aftermarket open element air cleaners of a flat bottom design may give some additional power over stock air cleaners. K&N makes an excellent 14 by 4" flat base open element air cleaner that will fit most trucks under their part number 60-1260. Don't run a TBI unit without an air cleaner (even at the drag strip), it will cost you significant power.

8. **OXYGEN SENSOR**—If you are using late model exhaust manifolds, the Oxygen sensor boss may be located in one of the manifolds. If you are using headers, try to get a set that has an Oxygen sensor boss in one collector. If you have to install your own nipple for the sensor, Howell has a suitable nipple that can be welded into one of your exhaust pipes near an exhaust manifold flange, or in the collector of either header. Only one Oxy sensor is used.

## INSTALLATION OF ELECTRONIC COMPONENTS AND WIRING HARNESS

The Howell TBI wiring harness supplied with your system does all the interconnecting wiring from the engine sensors and TBI to the GM vehicle ECM. It is designed to fit most installations. You will need a hole in the firewall or engine cover sufficient to pass the engine

connectors through from inside the vehicle to the engine compartment. The harness Grounds that attach to the engine, and the distributor connector (on ECM controlled spark timing systems), locate the harness position at the back of the engine.

1. Secure the harness grounds to the back of the cylinder head, or rear intake manifold bolt, plug in the distributor connector, and route the labeled purple wire to the starter solenoid. On systems using conventional or aftermarket distributors, connect the labeled white wire to the ignition coil negative side, or tach signal. The Oxygen sensor wire should be long enough to attach to your mounted Oxygen sensor. If necessary to extend it, cut and solder splice on the harness side, not the Oxy sensor lead.
2. Moving forward, connect the injector connectors to the injectors, and push the rubber seal into the air cleaner flange on the TBI unit (GM TBI's). On Holley 670's connect to the 4 pin harness off the front of the TBI unit. Plug in the TPS and Idle Air Control motor on right side of TBI unit. The labeled MAP sensor connector also branches off here and connects to your MAP sensor. It can be mounted on a production or fabricated bracket.
3. Further forward, the coolant sensor and EGR solenoid are connected. This completes the engine attachment, unless your engine has knock and ESC module connectors. If so, these plug into their unique sockets.
4. At the rear of the engine, a separate branch tees off the main trunk, and contains the fuel pump relay, battery power, fuel pump power fuses and connectors, and EST timing disconnect (on ECM timing controlled systems). These items can be attached to your firewall permanently.
5. Inside the vehicle, mount the ECM, fuse block, diagnostic connector, and "Service Engine Soon" light in a convenient location. CAUTION: The ECM needs some air circulation for cooling, so don't put it under a carpet. Use a Radio Shack or automotive bulb socket and 12V bulb for the SES light, and mount it where you can see it while driving.
6. Using the Weatherpack connector and terminals supplied, connect the under-dash fuse block to a 12V source that has current when your ignition is in the RUN AND CRANK positions. Use 16 or 14 gauge automotive wire for this connection.
7. Using the supplied weatherpack connector and terminal, supply battery power to the fused location on the harness on the firewall near the fuel pump relay. (This is the orange colored circuit). Use 14 gauge or heavier automotive wire for this lead.
8. Using a supplied weatherpack connector, run a power lead from the fuel pump power location on the firewall near the fuel pump relay (red colored circuit), to the high pressure fuel pump. Use 16 or 14 gauge wire. Run the fuel pump ground to the frame, or back to the engine to ground. This completes the electrical harness installation.

### SPECIAL CALIBRATION PROM AND VEHICLE ECM

The heart and control center of your new electronic fuel injection is the Electronic Control Module (ECM). It receives information from the engine sensors (coolant temp, manifold vacuum, engine speed, and rich/lean information from the Oxygen sensor), looks up the appropriate fuel and spark timing, and orders the injectors and distributor to deliver them. The correct fuel and spark settings are pre-programmed into the CALIBRATION PROM, and must match your engine closely for everything to work correctly. With conventional distributor ignitions, we control the fuel only with the calibration prom.

You can mount your vehicle ECM in any convenient location where it is protected from the outside elements, and has some air circulation for cooling. Typically, this will be under the dash, inside the glove compartment, or under a passenger seat. NOTE: We recommend you

don't permanently mount the ECM in a difficult to reach location until the vehicle is up and running to your satisfaction. (The ECM does not need to be grounded separately.)

We use two GM part number ECM's (1227747 & 1228747) for most TBI installations. These are numbers used in most truck applications from 1987 thru 1991. They are rugged, proven designs, the result of millions of GM dollars spent on their development. They have the ability to learn a part throttle calibration that perfectly matches your engine, and retain in memory. They also employ back-up or limp home modes that keep you from being stranded in case of an engine sensor failure.

An added benefit of the GM ECM is its ability to alert you to potential sensor or electrical problems with a "Service Engine Soon" light, built into all of our harnesses. This light and a common paper clip also allow you to diagnose any reported problems retained in the ECM memory. Procedures for this are outlined in any GM TBI service manual, or the Howell service manual that accompanies your TBI kit.

The CALIBRATION PROM supplied with your TBI kit is mounted inside the ECM, under a plate retained by two screws. In the event you need to replace it, follow instructions below:

1. Remove the ECM from its mounted location, depress the latches, and remove the harness ECM connectors one at a time.
2. Remove the ECM cover (retained by two screws).
3. Remove the larger of the two cal proms under the cover, by carefully prying and lifting it straight up.
4. Install the replacement cal prom. (It will only go in one way, so can't be installed wrong.) Replace the cover.
5. Reverse the removal sequence, and reinstall the ECM in its vehicle mounting.

**CAUTION:** Do not remove the cal prom with harness still connected to the ECM. It may be damaged by 12V power that is always present in the vehicle when the battery is connected.

### INITIAL VEHICLE START-UP AND OPERATION

With everything mounted and connected, the vehicle should be ready for start-up. When the ignition key is first turned on, listen for fuel pump operation. It should turn on for 2 or 3 seconds, and then the ECM will turn it off until you engage the starter. The first time ignition is turned on, it may not be sufficient to fill the TBI and fuel line with fuel. Cranking for a few seconds should complete the filling. The engine should start up and smooth out after a few seconds to purge air from the injectors. Check for fuel leaks and make sure none of your altered wiring or fuel lines are in a position where the exhaust system heat can damage them. **MAKE SURE THE COOLING SYSTEM IS FULL.**

If the engine does not start immediately, it may be because the fuel pump cannot displace air in the line and prime itself. Loosen the high pressure line at the TBI, and cycle the pump by turning on the ignition key to displace the air. Wrap a rag around the fitting to prevent gas from spraying around the engine compartment. Look at your "SERVICE ENGINE SOON" light when attempting to start for the first time. The light should come on when the ignition is turned on, STAY ON during cranking, and go off when the engine starts.

**IF THE LIGHT GOES OFF DURING CRANKING, IT MEANS YOU HAVE POWERED THE ECM AND INJECTORS FROM AN ACCESSORY FUSE BLOCK TERMINAL, AND THE ENGINE WILL NOT START.** Your switched 12V power must come from a terminal that is hot with key on, and during cranking, and goes off when the ignition is turned off.

On ECM controlled spark timing systems, set the initial spark timing to your desired setting with the "EST Disconnect" unplugged. Re-connect this plug after setting the initial

timing. NOTE: Running with the EST disconnect uncoupled will turn on the SES light, and store a code 42 in the ECM memory. You may want to disconnect the battery power for 30 seconds to clear this code after setting the timing. With conventional distributor ignitions, set your timing in the normal manner.

### INITIAL DRIVING IMPRESSIONS

The calibration prom supplied with your TBI system is based on several years of driving and dyno testing experience. It should be a good match for your engine. However, the GM ECM has the remarkable ability to reprogram and adapt a new program to match your engine exactly. It does this by reading information from the Oxygen sensor and adjusting the calibration until it matches GM's original intent. It will keep this program in its memory as long as the battery is connected and charged. If you disconnect the battery, the ECM will lose the learned program from memory and go back to the original Howell program. However, it will immediately start learning again as soon as you start driving the vehicle and it goes into closed loop.

On full GM systems with spark control, all of your vehicle emission controls, knock sensor, and oxygen sensor are still functional as designed by GM. On systems with conventional distributors, the Oxygen sensor and diagnostic features still function.

Any electronic or engine control problems can still be diagnosed by a GM dealer or tune-up shop, using their computer diagnostic equipment that plugs into the under dash ALDL connector. When diagnosing with a scanner, enter the engine as a 1989 or 90 TBI light truck application. Our service manual also gives a technique for do-it-yourself diagnostics using a jumper, the ALDL connector, and the "Service Engine Soon" light on the dash.

### TUNING ADJUSTMENTS

GM throttle bodies have no fuel pressure adjustment, and are pre-set to approx 12psi. Holley 670 TBI's have an adjustable pressure regulator and are preset by Howell from 12 to 15 psi, depending on the application. With this system you have the ability to optimize wide open throttle power by adjusting fuel pressure, or lean down for improved economy. If you choose to do this, contact Howell Engine Developments for assistance in tuning. NOTE: Be aware that leaning out an engine at WOT can shorten engine life, by increasing the running temperatures of pistons, valves, and exhaust manifolds. Unlike GM we don't prevent your tampering with fuel pressure. Therefore, we can't be responsible if you get in trouble. No guarantee is expressed or implied by Howell for the rest of your engine, only our parts are guaranteed. If you feel you need to do serious tuning or recalibration for your application, contact us at 810-765-5100, and we will work out a new calibration.

### TROUBLE SHOOTING PROBLEMS: DESCRIPTION AND SOLUTIONS

**SYMPTOM:** Engine cranks but won't fire or start.

**CHECK:** To see if there is spark while cranking. This can be done with an inductive timing light or with a spark plug connected to a plug wire and grounded against any metal surface on the engine. If there is spark, go on to the next check. If not, fix.

**CHECK:** Observe to see if SES light comes on when ignition key is turned on. If not, harness may not be powered up or grounded correctly. Check grounds, fuses, and power

with a voltmeter or test light. If powered up and grounded correctly, SES light should come on, and fuel pump activate for 3 seconds.

**CHECK:** Observe SES light while cranking. If it goes off during cranking, you are connected to an accessory terminal on your vehicle fuse block. Correct by running switched 12V wire to an ignition power source.

**CHECK:** Observe, or have someone under vehicle verify whether fuel pump comes back on while cranking engine. If not, you are not getting a tach reference signal from your tach lead connected to the coil negative, and the ECM doesn't know the engine is cranking. MSD ignitions will act like this without the correct tach filter from Howell Engine Developments. If pump is activated while cranking, go the next step.

**CHECK:** With air cleaner removed, observe TBI injectors to verify if any fuel is being sprayed while cranking. If not, the fuel pump may not be primed. Loosen the high-pressure line (on drivers side of TBI), wrap a shop rag around it and activate the pump by turning on the ignition key. When fuel comes out, re-tighten clamp and try again to start engine. If fuel spray is there but minimum, tee into the high pressure line and check fuel pressure. It should be 11 to 15 psi. If system does not come up to pressure, you may have a low voltage problem. Using a voltmeter, check from ECM fuse block to ground while cranking. Compare this reading with voltage across the battery terminals while cranking. They should be within 1 volt of each other. If greater than 1 volt, temporarily run a hot wire from ECM fuse block to battery and see if the engine will start. If so, fix low voltage problem to fuse block.

**CHECK:** With air cleaner removed, observe injectors to see if too much fuel is being sprayed. If so, hold accelerator fully open and crank. This is called the "clear flood mode" and injectors should cease to spray so that excess fuel can be cleared, and the flooded engine started. This condition can be caused if your bypass return fuel line is restricted or plugged. Temporarily correct for this by attaching a length of hose to the bypass return outlet of the TBI and running it to a 5 gallon can. If engine starts and runs with proper fuel, correct the problem with the restricted bypass return. (Bypass return pressure should not exceed 5-6 psi).

**SYMPTOM:** Engine starts but runs poorly at idle or dies.

**CHECK:** System voltage at ECM fuse block. Must be within .5V of battery voltage while running. Possibly poor connection through production firewall bulkhead connector (common in older vehicles) or inadequate wiring to ECM fuse block. Temporarily run a bypass 14 gauge wire from battery to the ECM fuse block to see if that improves running. If so, supply ECM fuse block with power from battery through an ignition controlled relay.

**CHECK:** For possible rich condition and black smoke at idle and low speeds. Test for excess bypass return pressure causing TBI fuel pressure above 12 PSI.

**CHECK:** If you are having problems with deceleration stall coming up to a stop, or rolling low idle, refer to idle air adjustment instructions below.

Before beginning adjustment, grind the throttle stop screw plug flat and drill into the plug to allow a T-20 Torx driver to access the adjusting screw (GM TBI only).

1. Jumper the A and B terminals of the ALDL connector.
2. Turn the ignition key on, but do not start engine (this will close idle air control).
3. Disconnect the 4 pin idle air control connector.
4. Remove the jumper from the ALDL connector and start the engine.
5. With engine running at idle, adjust throttle stop for desired **MINIMUM** idle speed.
6. Turn engine off and reconnect idle air control.
7. This should correct the problem. If not contact Howell at 810-765-5100

## WARRANTY

Howell Engine Developments products have a 30-day unconditional warranty. The product can be returned within 30 days from shipping for a 100% refund (less shipping charges) provided that it is returned post paid, without damage or modification, and has not been installed.

Howell Engine Developments, Inc. warrants this product against manufacturing defects for the period of 90 days from date of shipping. This warranty covers all parts, but does not cover outside labor to diagnose or repair **WITHOUT SPECIFIC PRIOR APPROVAL** from Howell Engine Developments. This warranty does not cover any failures caused by misuse, accidents, or shipping incidents. Warranty failures will be repaired or replaced at the discretion of Howell Engine Developments, Inc.

Any damages that may have occurred during shipping should be reported immediately to the shipper and not Howell Engine Developments, Inc. Howell is not responsible for any damages to equipment and possible liability injury that could result from improper use of the product. Howell Engine Developments, Inc. maximum total liability under any conditions is the repair or replacement of the product.

## PRODUCT RETURN POLICY

Most products can be returned for credit within 30 days of shipping. All returns must be as new for maximum credit and free of modification and scratches. A 15% restocking charge will apply to any used returned components in good condition and a 25% charge will apply to all components requiring repairs or unusable as returned. All return shipping must be prepaid.

Ref 8-6-01 BH