GadgetBoy’s Niva 1.7TBi 101

This document is intended to explain the voodoo magic that is the GM/Lada Throttle Body Injection system as fitted to the Niva. It does not cover the Bosch Sequential system however the theory is the same. This article is **not** a repair manual nor is it intended to be however it may assist you in diagnosis of a fault and enable you to understand what the system does and how it does it. Remember, if you fiddle with anything **it’s your responsibility**.

TBI Throttle Body Injection is a very versatile, highly adaptable form of electronic controlled mechanical fuel injection. TBI provides the optimum mixture ratio of air and fuel at all stages of combustion. TBI has immediate response characteristics to constantly changing conditions and ensures the engine runs as close as possible to a stochiometric air / fuel mixture ratio, greatly reducing exhaust gas emissions. Because its air / fuel mixture is so precise, based upon much more than simple engine vacuum and other mechanical metering means, TBI naturally enjoys an increase in fuel economy over a simple mechanical form of fuel introduction such as an outdated carburetor.

The TBI form of EFI is controlled by the ECU (Electronic Control Unit) which controls the TBI based EFI system through all stages of operation according to data received regarding the current state of engine performance, speed, and load. The main component of this system is the TBI throttle body injector, which is mounted on top of the intake manifold, much like a carburetor. The throttle body injector is composed of two different parts; the throttle body itself, and the injector assembly. Hard to understand, isn't it? The throttle body is a large throttle valve which is controlled by a simple mechanical linkage to the accelerator pedal. Depressing the accelerator pedal will force the throttle valve open further and further, increasing the flow of air through the throttle valve and instructing the ECU to add more fuel, thus producing more power, faster speed, and acceleration.

Attached to the body of the TBI unit are two sensors; the TPS throttle position sensor, and the IAC idle air control assembly. The ECU uses the TPS to determine the accurate position of the throttle body valve, it's degree of cycling, and how open it is (0% to 100%). The ECU takes readings from the IAC in order to maintain a constant idle speed during normal engine operation, during all stages of power, load, and combustion.

The fuel metering assembly contains a fuel pressure regulator (FPR) which dampens the pulsations and turbulence generated from the very high pressure fuel pump. Think of the FPR as a conditioner that smoothes out the flow of fuel from the outside to the inside of the fuel metering assembly. The FPR also maintains a constant, steady pressure at the injector assembly. A single fuel injector is mounted over the throttle valve, synchronized, and raised slightly over a venturi (narrowing radius) throat. The injector is controlled by the ECU through an electrically initiated solenoid (switch). The precise amount of fuel delivered by each injector is varied by the amount of time that the solenoid holds the injector plunger open for operation.

A high pressure, high volume electric fuel pump is used with the TBI system. This pump is located within the fuel tank itself (which can be a bugger if you have to replace it). Once the ignition key is inserted into the ignition, and the ignition moved to the I position, the fuel pump relay instantly initiates the pump, beginning the transfer of fuel (via the pump) from the tank to the injector. A safety relay in the system shuts the pump off after two seconds, to keep the fuel from flooding. Failure of the fuel pump relay will allow the fuel pump to operate only after four pounds of oil pressure have built up. A high capacity fuel filter, similar to an in-line variety, is located on the left side of the vehicle, at the rear of the engine.

Two common mistakes when working with the EFI system. The fuel system is pressurized. If you remove a fuel line, you could/will get a face full of fuel! The fuel pump used on the EFI system is much more powerful than that found on a carburetor installation. For this very reason, the second problem is that you cannot use a EFI fuel pump to feed a carburetor, and you cannot use a normal carburetor mechanical style fuel pump (low pressure) to feed an EFI system. In order to work on any part of the EFI system, you must first depressurize your fuel system!!!!!

The ECU found in the Niva has the capability to 'learn' or modify it's programming with regard to differing fuel requirements over time. Don't get excited. This is not HAL from 2001: A Space Odyssey, and it's certainly not some super advanced neural net processor like the T800 Endoskeleton had in Terminator and T2. It's quite a bit simpler, but it’s a complex computer nonetheless, and it can adjust to different conditions easily. It learns, just like a human child, and that's the best way to put it. It doesn't forget when you turn your car off either. But, if you ever change your battery, or your battery goes dead for any reason, your computer will lose it's stored 'memory' and will have to relearn everything. It's a quick learner, but it's something you don't really want to go through all the time.

The computer's instructions are contained on a PROM (Programmable Read Only Memory), which means that the computer can change it's operation according to pending needs. It then stores this new information, and how it should act, on the PROM chip. Since the PROM isn't volatile, it doesn't lose it's information when the battery power is cut off or the keys are taken out of the ignition.

But the computer takes a little while to adapt. So if you add a snorkel and the car doesn't feel right, don't get depressed. The computer has just been handed a new parameter, it's working under new data and conditions, and it could take it a little while to figure out that the changed air flow isn't just a fluke, and that it should adjust to the new 'constant', but adjust it will. Be patient. The computer can make up for quite a bit of ham fistedness, but only to a limit.

And after that limit is exceeded? Well, you could always learn to program your own chips... But I don't think it will come down to getting that serious.

The system is very adaptable. The more you get away from the original operational parameters of the stock motor, the more the computer has to adapt. The more it has to adapt, the closer it gets to the point where it simply cannot adapt. If this limit is reached, and the computer cannot adapt any more, the ECU does the equivalent of a confused child in school. It raises it's hand and says "I don't understand what to do!" by turning on that annoying little "CHECK ENGINE" light.

Most people think that the CE light is a bad thing. This isn't true. While it can indicate a possible malfunction (repair or replacement) of a component within the system, it can also be a way to talk to your computer. A primitive way, but a good way nonetheless. We'll get to that later.

Think of your CHECK ENGINE light not as an indicator of failure, no, instead think of it as a text message from your ECU. When someone wants to talk to you, they text you, don't they? Your mobile on your belt vibrates or beeps or (if you are a total poser), plays some musical tune (like Crazy Frog...) that totally annoys everyone within listening distance. Well, think of the CE light as the same thing as a text from the ECU, only no vibration (you hope no vibration!) and no music. The CE is simply the ECUs way of saying "Hey, got a second? I need to talk to you!" It can't play a musical tune, so it does the only thing it can to get your attention; it flashes the CE light and keeps it lit until you answer its text.

It could be important, it could be minor. But the important thing to understand and to remember is that your ECU is asking you for a few minutes of your time in order to talk over some really important stuff. If you ever see your CE light come on, I think you need to stop what you're doing and have a chat with your computer. You do this with a paper clip! In the left hand footwell on the A-Panel there is a chunky plastic cover attached with Velcro or screws. Behind this you'll find a fuse box and a weird connector. This connector is your door to a beautiful relationship with your ECU. Make sure the ignition is off and get your paper clip and unfold it and re-bend it into a "U". Now insert the ends into the two left most contacts on the bottom row of the weird connector. This simple action translates the computer's language into something you can understand. The computer will talk to you in very short codes, called either error codes or trouble codes. There is no speech involved, but the computer will 'flash', blink on and off, your CE light. A long flash is read as the 'tens' place, and a short flash is the 'ones' place. So, if you are talking to your computer and the computer flashes the CE light two long times followed by three short blinks, then that is Code 23. Understand? It's not that hard. The codes are listed at the end of this document.

So, the next time that your computer wants to talk to you, listen! The computer is your friend and you don't ignore friends when they need to talk. And make

sure that your CE light is working properly. Remember, if the bulb is out, your ECU could be trying to talk to you, but you'll never know it!
Think of the ECU as a spider, in a web. At each end point of the web is a sensor or other control device. When something causes a disturbance in the web, the 'vibration' or sensor reading is sent down the 'web' to the 'spider' (ECU) which reads the information and reacts accordingly. Now, how TBI gets its input, well, that is supplied by various sensors located around the engine, in the engine bay, and around the vehicle itself. Let's talk about some of those now...

Sensors, Inputs and Outputs Used

TPS - Throttle Position Sensor, the TPS measures the position of the throttle. Really complicated stuff there. The position reading indication sent by the TPS to the ECU determines the amount of fuel to order the injector to inject, and modifies the duty cycle of the injector as needed. The degree of cycling of the throttle body valve is used to compute the duty cycle of the injector during high pressure fuel firing.

CTS - Coolant Temperature Sensor, the CTS measures engine coolant temperature.

MAP - Manifold Absolute Pressure, the MAP sensor measures the amount of load that is on the engine by sensing the difference between the pressure in the intake manifold and atmospheric pressure. It compares what's going on inside (kinetic) with what is going on outside (ambient). The MAP controls fuel mixture and timing. The MAP measures vacuum in the manifold.

O2 - Oxygen Sensor, the O2 sensor is mounted in your exhaust manifold or exhaust pipe. The O2 sensor measures the amount of oxygen in the exhaust stream. Too much oxygen indicates not enough fuel or a lean condition. Too little oxygen indicates too much fuel or a rich condition. The ECU then takes steps to correct this problem by adjusting the air / fuel (mixture) ratio.

The ECU also makes use of other inputs to determine proper fuel requirements. They are as follows:

- Absolute Engine RPM is obtained from data received from the ignition module.
- Battery Voltage is supplied to the ECU.
- The ECU knows when the engine is trying to start and adjusts fuel accordingly thanks to communication with the crank sensor.

The ECU controls the following items to maintain good power, mileage, idle and favourable emissions.

Fuel Injector - The ECU controls the amount of time that the injector is spraying fuel. This amount of time is called the 'duty cycle' of the injector. Within some parameters, it can be overdriven to increase performance, but too much is not a good thing. The faster an injector is forced to fire, the less efficient it becomes.

IACS - Idle Air Control Sensor, the IACS is an adjustable air leak into the engine. It is a power valve which moves back and forth, constricting and enlarging, in order to adjust the air mixture. The ECU controls the leak to get a good idle. The readings from the IAC allow the ECU to adjust the motor's operations and idle accordingly.

MATS - Manifold Air Temp Sensor- Also the Manifold Absolute Temperature Sensor, provides input on manifold temperature and allows the ECU to adjust mixture accordingly.

Ignition Timing - the ECU controls the amount of timing advance or retard needed depending on engine RPM, power load and detonation detected. Timing will be advanced as needed to meet performance load parameters. It will be retarded, again as needed, to minimize or eliminate detonation.

Idle - The ECU also has control over the idle RPM, for example when the engine is cold it idles a little higher. Temperature readings to determine if an engine is cold or not are taken from the coolant temp sensor, and from the oxygen sensor. Once temperature reaches operating ranges, the ECU idles the engine back down.

Fuel Pump - The ECU also controls the fuel pump, turning it on before start, and keeping it on during cranking and run. Fuel pump pressure is also controlled by commands sent to the pump by the ECU. More load equals greater fuel pressure.

VSS - The Vehicle Speed Sensor, which tells the ECU whether the engine is under load or on the over run.

OA -Octane adjuster. DO NOT TOUCH THIS!

Emissions Canister purge

The ECU has the following outputs to help us. This is data that the ECU sends to the driver / operator as part of it's operation:

CE - Check Engine light. It warns you of malfunctions with the system. When you see this light come on, get your paper clip.

ALDL - Assembly Line Diagnostic Link. This is the proper name for the weird connector. As well as using the paper clip to get codes from the CE light this is a data interface you can connect a scanner to or a computer with a suitable software package. This will give you considerably more information than the CE light. It can even be used to drive “Fast and Furious” style digital dashboards.

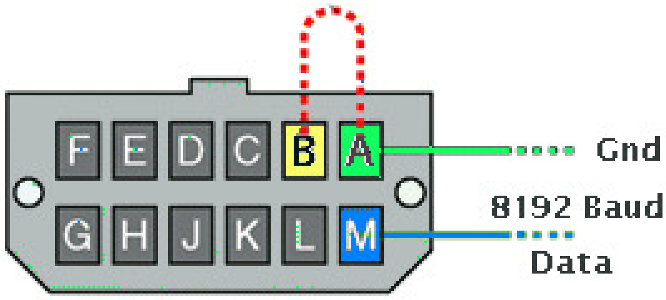
Reference.

Error codes.

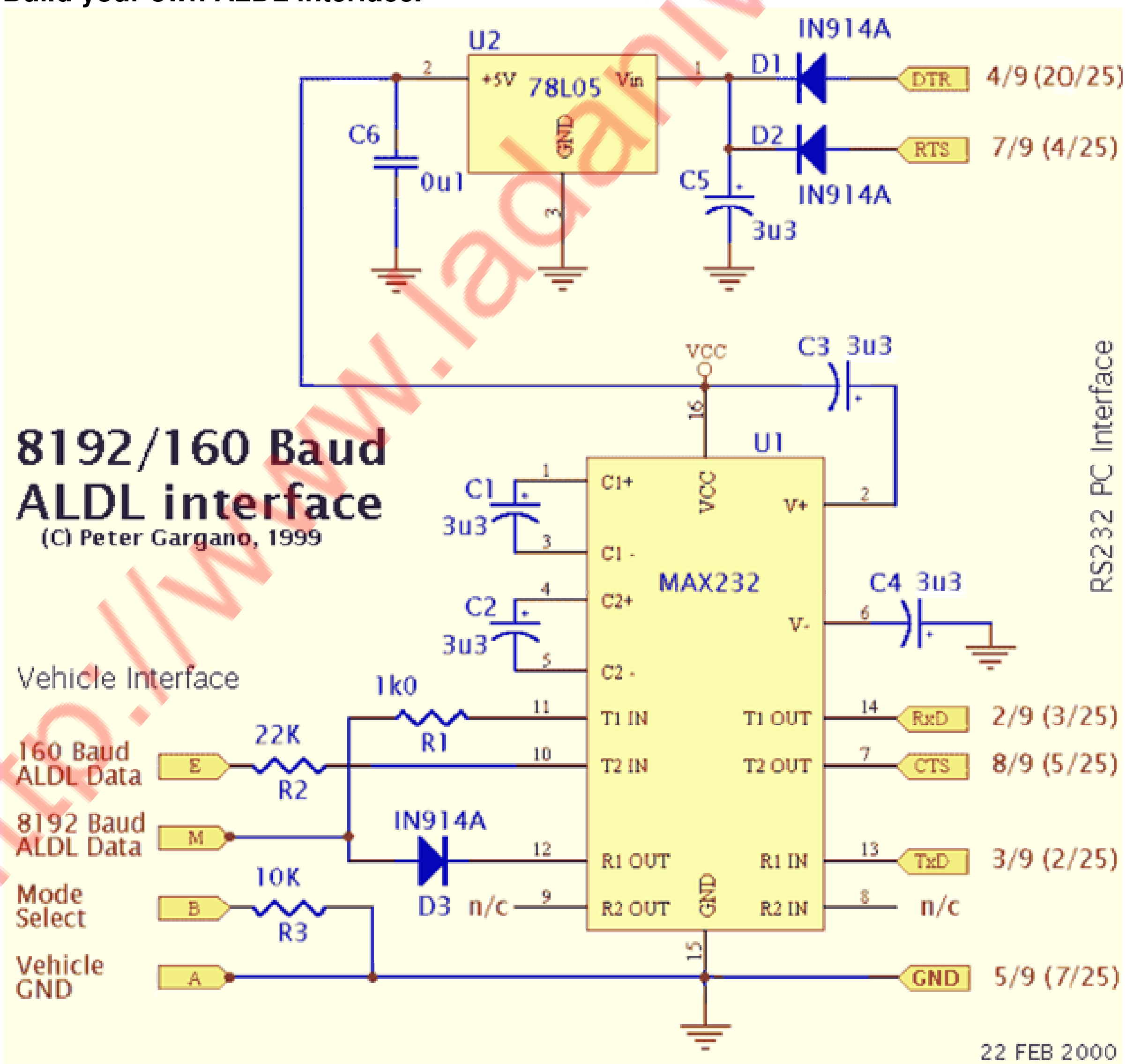
Code	Explanation
12	No spark pulses at CPU or else good system, no codes
13	Oxygen sensor output remained at .35-.55 volts for more than one minute after warmup. Possible open circuit.
14	Coolant sensor indicated a temperature above 130C for 3 seconds after engine ran for 20 seconds. Probably a short
15	Coolant sensor indicated a temperature below -30C for 3 seconds when MAT > - 13 or engine running over 1 minute. Probably open circuit
21	Throttle pos sensor above 2.5 volts for 2 seconds when engine speed below 1600 rpm
22	Throttle pos sensor below .2 volt for 2 seconds while engine running
23	MAT sensor shows < -30 degrees C for 3 seconds after engine running 1 minute or coolant > 30C. Probably an open circuit.
24	No speed sensor pulses when engine between 2000-4000 rpm, throttle closed, high vacuum, not in neutral and all for 5 seconds
25	MAT sensor showed above 145 degrees C for 2 seconds after engine ran for over 1 minute. Possible short circuit.
33	MAP sensor voltage too high (> 4.00 v). Possible vacuum leak to sensor or faulty sensor.
34	MAP sensor voltage too low (< 0.25 v) with ignition on or engine running >1200 rpm and throttle open >20%
35	Closed throttle idle speed is more than 75 rpm above or below correct value for more than 45 seconds
41	No Crankshaft reference pulses. Ignition voltage < 11 volts etc.
42	Open or short on EST or BYPASS line to ignition module.
44	O2 sensor showed < 0.250 volt for over 20 seconds while operating closed loop
45	O2 sensor showed > 0.550 volt for over 50 seconds while in closed loop with engine running over 1 minute and throttle open more than 2%
51	Check that CALPAK is in place, fully inserted, and no bent pins
53	Car's alternator has produced >16.9 volts for over 2 seconds. Check charging system
54	Octane adjuster signal too high or too low.
55	ECU A to D error. Check ECU grounds, or excessive input voltage

The Paper Clip trick.

Note: The connector is upside-down in the Niva.



Build your own ALDL interface.



Software

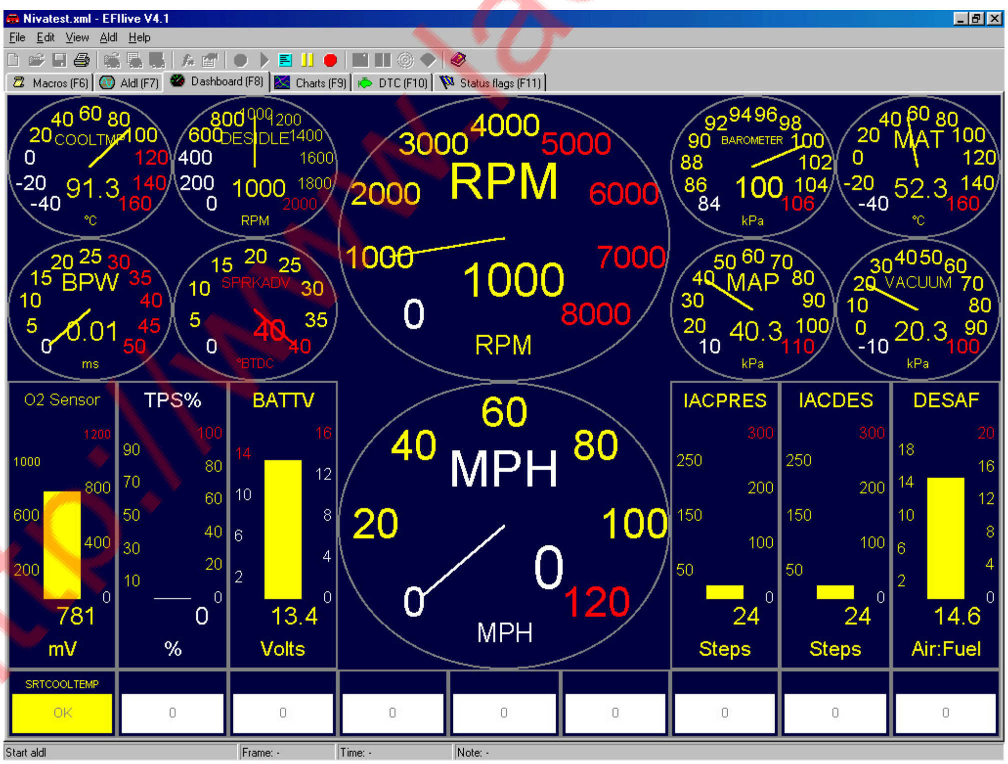
There are many software packages available that will enable you to read the information your ECU provides. As well as outputting error codes the ECU also outputs realtime information of all the sensors and current parameters, much like the telemetry of an F1 racing car! (I kid you not). Using the above interface, which can be built for about $5, and suitable software you can monitor this information on a PC or laptop. Simple handheld scanners that will display basic information can be bought for as little as $20.

As I said, there are many packages available in freeware, shareware and commercial forms. Simply Google for OBD software and you'll see what I mean. My personal favourite is EFiLive V4. http://www.efilive.com Version 4 is the ALDL/OBD version.

EFiLive is a commercial package. Yes! It costs money! However it's only about $140 and it'll pay for itself the first time you actually need it! Not only that but it's damn good fun too!

Once you have the software you will need a "definition file" for the Niva. Here's one I prepared earlier: http://www.turbo-nutter.com/nivalive.zip

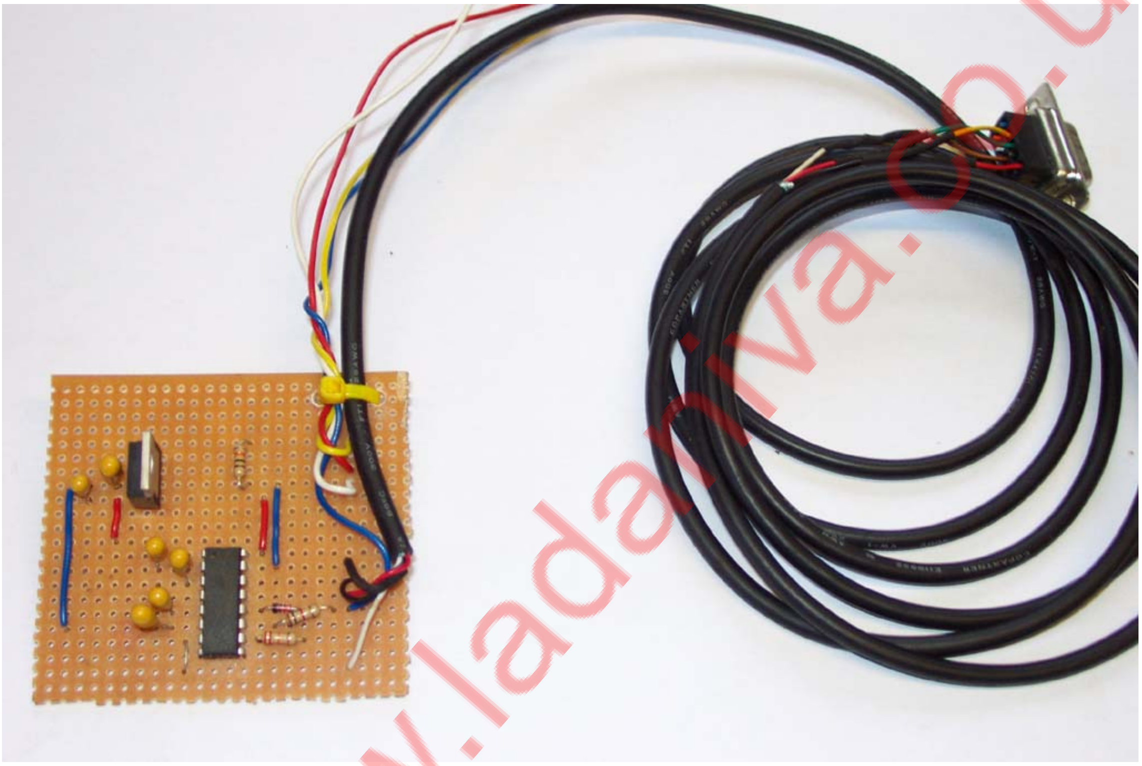
Here's a screenshot to make you drool!



As well as displaying live information EFiLive can also record the telemetry and you can play it back later in the comfort of your living room.

Interfaces

You can buy interfaces/cables for about $20 but you can also build one using the circuit diagram above. The components will cost about $5. I'm no wizard with a soldering iron but I managed it!



This is now permanently mounted in my car in a little box immediately below the ECU diagnostic port.

Parts

When you work out you need a Coolant Temperature Sensor (for example) you need to get able to get one! Alan Bird at Lada UK http://www.lada.co.uk has them and will ship worldwide. Now I don't want to do Alan out of business (he's an excellent chap) but …… if you're in Australia (for example) you may not want to wait 3 weeks for something to arrive! **REMEMBER** the Niva TBi system is a bog standard off-the-shelf GM system. The parts you need are in thousands of cars! A good motor parts shop will have either the original GM part or an aftermarket replacement. The trick is **not** to ask for a Lada part ….. believe me, you will get funny looks and scratched heads! Bring the original to the motor parts shop, find the oldest assistant and ask for "one of these" please. Failing that, any early 90's GM car in the junkyard should have what you need.

The one exception to this is the ECU itself. It's not the ECU that's unique it's what's known as the "calibration module". This is what programs the ECU to the Niva. If you have managed to toast your ECU, which is not easy to do I may add, the chances are the calibration module is OK. It is possible to get another ECU and swap the module. I absolutely, totally and utterly do **NOT** recommend this but it is possible. Do this at your own risk!

One final note. If you're reading this article from a CD you purchased off eBay you've been had! This article and a wealth of Niva documentation are available **FREE** from http://www.turbo-nutter.com

Have fun,

GadgetBoy
ladaniva@turbo-nutter.com

This document was re-written for the Niva from Black Echo's article http://www.goingfaster.com/spo/tbi.html with his kind permission.