

Test Bench –Signal Quality V3

Purpose:

The purpose of this code is to test and verify the student developed Engine Control Unit (ECU) that is has been developed in senior design project PO7222 and PO8221. This test bench can be modified to test other ECU's but changes may need to be made to accommodate such units.

The main function of this code is to make sure the right types of signals are going to the ECU as well as the right signals from the ECU. The shape of all the different signals from the ECU is analyzed. The most important aspect of this testing phase is the shape of the signals. To make sure that the ECU will be receiving/sending the proper signals, the data acquisition board will graph charts and provide the necessary information to determine the quality of the signals through the circuits.

Suggested Test Procedure:

For this portion it is suggested to start by changing only minimal things at one time. This should be done by setting the RPM and the four inputs to the desired level running it and logging the data. From there the data should be analyzed then moved on to the next set of data points.

Pre Run Setup:

To Before you get started there are a few things that need to happen to make sure that the program will function as expected. First you need to make sure that the Nation Instruments (NI) box is hooked up to both power and the computer through a USB, once that is setup unscrew the top 2 knobs on the NI box to expose the following:



Once the cover has been taken off, cables need to be connected to their respective channels for proper operation. The respective channels are laid out in the following table:

Input / Output	Signal Quality	Motec Pin
Name	Pin Name (Pin Number)	
Crank****	AI 0 (1) & PFI 12 (89)	B1
Cam***	AI 1 (4) & PFI 13 (91)	B2
Injector #1	AI 2 (7)	A19
Injector #2	AI 3 (10)	A20
Injector #3	AI 4 (17)	A21
Injector #4	AI 5 (20)	A22
Ignition #1	AI 6 (23)	A3
Ignition #2	AI 7 (26)	A4

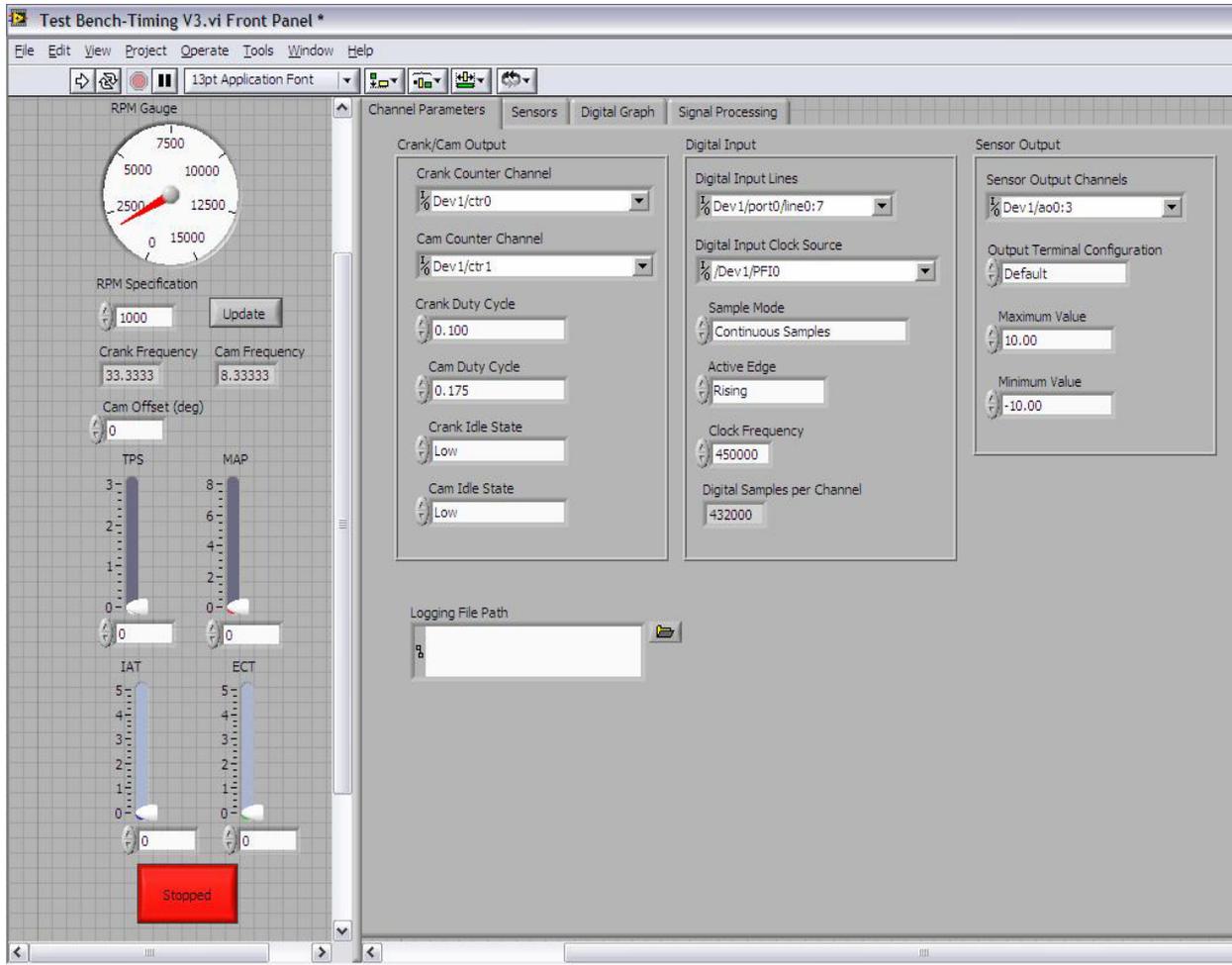
TPS	AO 0 (15)	A14
MAP	AO 1 (31)	A15
ECT	AO 2 (47)	B3
IAT	AO 3 (63)	B4
Ground	AI GND, AO GND & D GND	
Signal Generator		

Right now a connector is not made because the circuit board does not have the correct connector. The wires are labeled so you must simply match the names.

Layout:

To start there are two main panels or screens that divide the window vertically. The left panel will be referred to as the control panel. The control panel is used to specify the inputs to the ECU mainly the RPM, Manifold Absolute Pressure (MAP), Throttle Position Sensor (TPS), Intake Air Temperature (IAT), Engine Coolant Temperature (ECT) Cam offset, and the On/stopped button.

Left Panel:



RPM gauge: Displays the RPM that's the cam and crank signals are outputting

RPM Specifications: This is where you input the desired RPM for the test bench to generate. This can be changed by either typing in the desired number or pressing the arrows to change the number. As a general rule this was designed for the formula cars engine with work between 1-15000 RPM. If you put 0 RPM there will be an error and the program will not run.

Update: The update button is used to change the RPM while the program is running. If you change the value in the RPM Specification box without hitting update it will continue to generate the signals at the previous value.

Cam Frequency: This box displays the cam frequency at the give RPM and cannot be changes it is just a display.

Crank Frequency: This box displays the crank frequency at the give RPM and cannot be changes it is just a display.

Cam Offset (deg): in this box you enter how many degrees the cam and crank are offset from each

other. This value is in degrees and then the program converts it over to a delay in seconds.

TPS: This is the Throttle Position Sensor and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is white in color and matches the color of the graph on the sensor tab (will be explained later). This produces a output between 0-5V, and will be entered in a percentage between 0 and 100%. When the Sensor is at 0% throttle it sends 0V and the throttle plate is closed. When it reads 100% throttle the throttle is wide open and sends 5V.

MAP: Manifold Absolute Pressure and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is red in color and matches the color of the graph on the sensor tab (will be explained later).This sensor reads the amount of pressure in the intake manifold and will send a 0-8V output to the ECU.

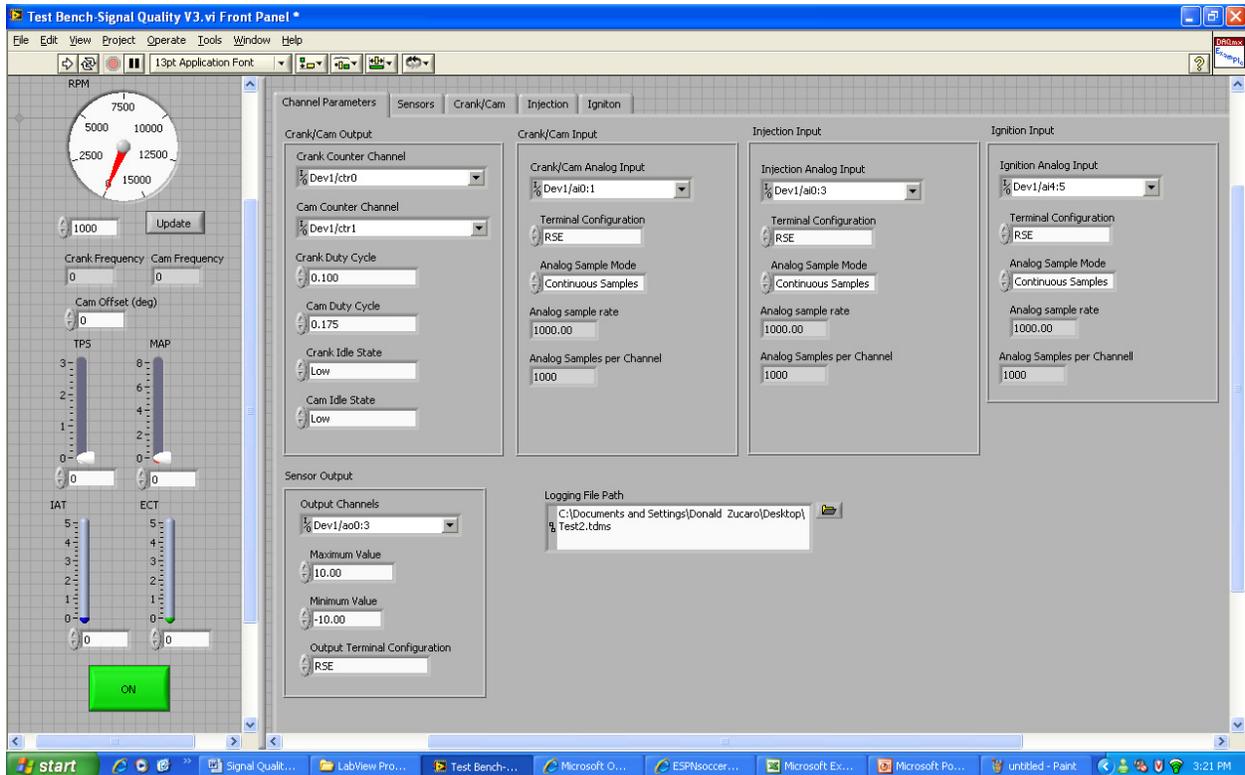
IAT: Intake Air Temperature sensor and Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is blue in color and matches the color of the graph on the sensor tab (will be explained later). This Signal tells the ECU the temperature of the air entering the engine and is in between 0-5V.

ECT: This shows and stands for Engine Coolant Temperature and is controlled by wither moving the slide or entering a value in the box below the slide. The slide is green in color and matches the color of the graph on the sensor tab (will be explained later). This will send a 0-5V signal to the ECU where it will determine if a correction is required

Right Panel:

The right panel consist of tabs, where we set the proper parameters and where a graphical representation of the inputs and outputs.

Channel Parameters: the first tab is where we let the program know what all the channels are going to be doing. The is separated into six different sections that are separated by a rectangular box as showned in the picture



The Crank/Cam output section specifies the channels where the Crank and Cam signals are going to be simulated from the test bench to the ECU. Each Crank and Cam requires the use one counter timer each. The counter channels should be as in the picture above. In this section the Crank and Cam duty cycles are both specified to whatever the user wants to set it at. The crank idle state and cam idle state determines how the signal is going to end once the program is shut off, either on the high end of the signal or the low end.

The Crank/Cam input section specifies the channels where the Crank and Cam are going to be read back in. Since there are only one Crank and one Cam, two channels (Channels 0 -1) are needed that need to be specified in the Crank/Cam analog input just as showned in the picture. In this section the terminal configurations can be changed for the channels, even though it will only properly run when it is set at RSE, the option to be changed it is available. Depending on RPM the analog sample rate and the analog samples per channels are shown.

The Injection input section specifies the channels where the Injectors are going to be read back in. Since there are four injectors, four channels (Channels 2 -5) are needed that need to be specified in the Injector analog input just as showned in the picture. In this section the terminal configurations can be changed for the channels, even though it will only properly run when it is set at RSE, the option to

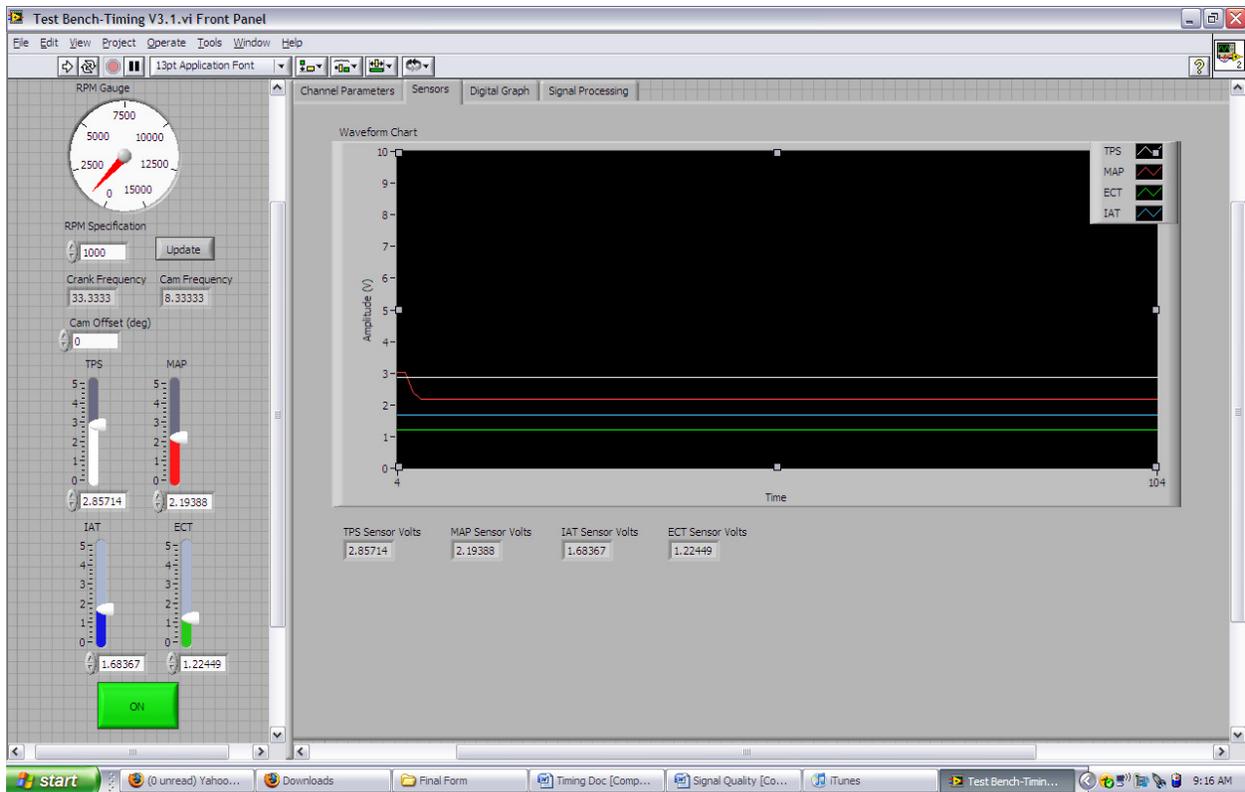
changed it is available. Depending on RPM the analog sample rate and the analog samples per channels are shown.

The Ignition input section specifies the channels where the Injectors are going to be read back in. Since there are two ignitions, two channels (Channels 6 -7) are needed that need to be specified in the Ignition analog input just as shown in the picture. In this section the terminal configurations can be changed for the channels, even though it will only properly run when it is set at RSE, the option to change it is available. Depending on RPM the analog sample rate and the analog samples per channels are shown.

The Sensor Output section specifies the channels used to simulate the four main sensors; Throttle Position Sensor (TPS), Manifold Absolute Pressure (MAP), Intake Air Temperature (IAT) and Engine Coolant Temperature (ECT). To specify the proper channels (Channels 0 -3), they are set on the Output Channels just like in the picture above. It is also necessary to set maximum and minimum values to protect the board from very high voltages. The channels configuration can also be changed but it is recommended to run it at RSE.

The last section is simply a path for the file where all the data that is logged will be saved.

Sensors: In this tab we can visually see on a graph all four sensors outputs. Each graph is color coded on the right hand side of the graph. At the bottom of the graph some digital display is also shown just for a more accurate reading of the actual numeric value. In order to see the graphs, the output channels need to be connected as well as properly defined in the channel parameters tab. A picture of the graph is shown in the figure below.



Crank/Cam: In this tab we can graphically see both the Crank/Cam signals that the test board generated. It has the ability to graph both at the same time as well as the individual graphs. At the right hand corner the different signals are color coded. At the bottom of the graph there is a couple options. The Graph Signals specifies whether to plot both signals together or separate. If it was chosen to graph separately the Signal option allows you to select which signal to graph by itself. The Polarity menu creates a cursor either on the low pulse or the high pulse of the specified signal on the Signal option. Pulse number allows to choose which pulse to highlight. The references level gives references to the cursor to be formed. It is recommended to be set up as the picture below, but it is possible to change it according to specific needs. There are also 3 more indicators, Period, Pulse Duration and Duty Cycle gives the values corresponding to the right pulse. Here is a picture of what the graph should look like.

Working picture of the Crank and Cam

Injection: In this tab we can graphically see all Injector signals that the test board is reading from the ECU. It has the ability to graph all at the same time as well as the individual graphs. At the right hand corner the different signals are color coded. At the bottom of the graph there is a couple options. The Graph Signals specifies whether to plot both signals together or separate. If it was chosen to graph separately the Signal option allows you to select which signal to graph by itself. The Polarity menu creates a cursor either on the low pulse or the high pulse of the specified signal on the Signal option. Pulse number allows to choose which pulse to highlight. The references level gives references to the cursor to be formed. It is recommended to be set up as the picture below, but it is possible to change it according to specific needs. There are also 3 more indicators, Period, Pulse Duration and Duty Cycle

gives the values corresponding to the right pulse. Right below those indicators there are three more that shows the user the highest and smallest value read, as well as the amplitude of the pulse, which should be the difference between the high and low state. In order to activate these six indicators a measure button was placed on the bottom right corner of the tab. A log button was also placed on the opposite side. Both these buttons are separately activated once the button is clicked. To turn them off simply click on the button again. The log file will be saved on the specified destination on the channel parameters tab. Here is a picture of what the graph should look like.

Working picture of the Injection

Ignition: In this tab we can graphically see all Ignition signals that the test board is reading from the ECU. It has the ability to graph all at the same time as well as the individual graphs. At the right hand corner the different signals are color coded. At the bottom of the graph there is a couple options. The Graph Signals specifies whether to plot both signals together or separate. If it was chosen to graph separately the Signal option allows you to select which signal to graph by itself. The Polarity menu creates a cursor either on the low pulse or the high pulse of the specified signal on the Signal option. Pulse number allows to choose which pulse to highlight. The references level gives references to the cursor to be formed. It is recommended to be set up as the picture below, but it is possible to change it according to specific needs. There are also 3 more indicators, Period, Pulse Duration and Duty Cycle gives the values corresponding to the right pulse. Right below those indicators there are three more that shows the user the highest and smallest value read, as well as the amplitude of the pulse, which should be the difference between the high and low state. Here is a picture of what the graph should look like. Both these buttons are separately activated once the button is clicked. To turn them off simply click on the button again. The log file will be saved on the specified destination on the channel parameters tab. Here is a picture of what the graph should look like.

Working picture of the Injection

Logging:

The logged data from the LabView program is a TDMS file. In order to be able to manipulate the data in an excel spreadsheet, it is necessary to download the following excel ad – in that can be downloaded from our project website or at our project DAV address. If downloading from the website, it is necessary to specify the file extension in the file name for proper downloading. The file extension is that of a Zip file (.zip)

Once the file has been downloaded and installed it is possible to export the tdms file to excel using the new functions now available in excel.