

**Driveability and Emissions
Calculation Software**

Version 2.1
Copyright 2006, 2008

Version 2.1 Users Manual

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Introduction

Driveability and Emissions Calculation Software, or DECS, was written to make technicians lives easier. It incorporates many calculators that are used by automotive repair technicians, but unlike calculators used in the past, all of these calculations are now available in one easy to use application. DECS eliminates the need to open a volumetric efficiency calculator on one PC, open a website with a lambda calculator on another, etc. Every calculation you need for driveability or emissions issues is probably here.

In addition, DECS does all the conversions for you. For example, there is no longer a need to convert liters into cubic inches to arrive at a volumetric efficiency percentage. DECS does it for you. Displacement, temperature, air mass measurements, and even multiple fuel types are all converted for you.

Yes, multiple fuel types. Because of the changes being made in the automotive industry, DECS has included variables to accommodate many different types of fuels.

That being stated, let's look at the features included with DECS and how to use them.

Main Screen

Driveability / Emissions Calculation Software

Help About DECS [Download the Manual](#) www.DRIVEABILITYGUYS.com

LAMBDA / COMBUSTION EFFICIENCY CALCULATION

HC ppm Lambda

CO % Select fuel type: Air Fuel Ratio

CO2 % USA gasoline Combustion Efficiency

O2 % Stoich for selected fuel A/F Mixture Status

NOx ppm 14.7 :1 Oxygen Dilution Value

AIR FUEL RATIO TO LAMBDA CONVERSION

AFR :1 Fuel Type Gasoline Lambda

VOLUMETRIC EFFICIENCY / FUEL REQUIREMENT CALCULATION

Displacement Liters Volumetric Efficiency

RPM Max. Air Flow

MAF GPS Fuel Vol. Req. @ Stoich

Fuel type Gasoline (14.7 :1) Fuel Vol. Req. @ Stoich + 20%

----- Atmospheric Factors -----

Temp F BARO Ft above sea level Humidity %

OTHER OPTIONS

DECS main screen contains the most popular and widely used calculations that are included with the software. Lambda, combustion efficiency, volumetric efficiency, and fuel requirement comprise the bulk of the application. The next portion of this manual breaks each calculation down specifically to describe their effective uses individually.

The Lambda/Combustion Efficiency Calculator

LAMBDA / COMBUSTION EFFICIENCY CALCULATION

HC	<input type="text" value="1"/>	ppm			Lambda	<input type="text" value="0"/>
CO	<input type="text"/>	%	Select fuel type:		Air Fuel Ratio	<input type="text" value="0"/>
CO2	<input type="text"/>	%	USA gasoline	<input type="button" value="Calculate"/>	Combustion Efficiency	<input type="text" value="0"/>
O2	<input type="text"/>	%	Stoich for selected fuel		A/F Mixture Status	<input type="text" value="0"/>
NOx	<input type="text"/>	ppm	<input type="text" value="14.7 :1"/>		Oxygen Dilution Value	<input type="text" value="0"/>

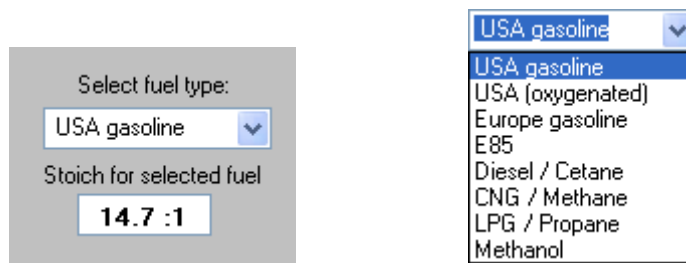
Lambda

Lambda is a chemical calculation spelled out by --- bretsneider in ---. It is a way to calculate if an engine was fueled correctly based on gas concentrations leaving the engine. Basically the engine ingests molecules. In our case, ambient air and a Carbon based fuel. During combustion these molecules change to other molecules, however the concentration of each atom that made up the pre and post combustion molecules did not change. By reverse engineering the chemical change the quality of fuel delivery can be determined. Or shall we say, “Was the engine fueled correctly?”

Because of the basic chemical theories at work here a catalytic convertor will also have no effect on the end result. Molecules come into the engine and atoms re-arrange themselves during combustion. These new molecules leave the engine and may have their atoms re-arranged again by the catalyst. Whatever the case, the concentration of atoms remains the same and allows the calculation to work.

There are six inputs for DECS Lambda calculation. Five of these inputs are required: HC, CO, CO2, O2, and Fuel Type. An additional input is Oxides of Nitrogen (NOx), but it has little bearing on the equation. Other than the Fuel Type input, these numbers are collected from tail pipe readings with an exhaust gas analyzer.

Fuel Type options



Fuel Type options default to gasoline because it is the most commonly used fuel source currently in use. However, DECS has included multiple choices so that an accurate Lambda number can be obtained for any given situation. The chemical composition of a particular fuel directly effects the Lambda calculation; therefore the appropriate fuel must be chosen to obtain the correct results. Notice that directly below the Fuel Type drop down box is a display window that alerts the user of the stoichiometric air fuel ratio for the selected fuel.

Combustion Efficiency

Combustion efficiency (or CE) is another chemical equation that operates on similar principals to that of the Lambda calculation. It is a measure of how well the fuel that was introduced to the engine was actually burned. Because Lambda and combustion efficiency share the same inputs, combustion efficiency has been incorporated into the same calculator. Note: the Fuel Type selection is also critical for the CE calculation to be accurate.

Output Results

Once the inputs have been entered and the “Calculate” button has been clicked the outputs will be displayed on the right of the screen. The first output is Lambda. A perfect Lambda value would be 1. Variances from this ideal number indicate either a rich or lean condition.

The second output is air fuel ratio. It can be compared to the ideal air fuel ratio that appears in the box directly beneath the chosen fuel type.

The third output is combustion efficiency. It is displayed as a percentage.

The next output is Air Fuel Mixture Status. This output displays the amount, either rich or lean, of how skewed the engine was fueled. It is displayed as a percentage also.

The final output is Oxygen Dilution Value. This output is a result of monitoring user entered gas values and deeming them realistic, much like rationality testing in an OBDII PCM. Issues such as air injection or exhaust leaks that skew exhaust gas readings, and equally these calculations, are flagged by this calculation. This output is expressed in a value ranging from 0 to 100 with 100 being ideal. If a dilution value below 75 is obtained, DECS will alert the user that the calculated values could be inaccurate due to dilution issues.

Examples

LAMBDA / COMBUSTION EFFICIENCY CALCULATION				
HC	<input type="text" value="22"/>	ppm	Lambda	<input type="text" value="1.002"/>
CO	<input type="text" value=".07"/>	%	Air Fuel Ratio	<input type="text" value="14.73:1"/>
CO2	<input type="text" value="14.7"/>	%	Combustion Efficiency	<input type="text" value="92%"/>
O2	<input type="text" value=".1"/>	%	A/F Mixture Status	<input type="text" value="0.2% Lean"/>
NOx	<input type="text" value="12"/>	ppm	Oxygen Dilution Value	<input type="text" value="98.3"/>

Select fuel type:

Stoich for selected fuel:

In the above example a known good vehicle's tail pipe gasses have been entered into the calculator. We can see a Lambda value of near 1. Air fuel ratio is very close to stoichiometric standards. Combustion efficiency indicates the introduced fuel was burned well. And, our Oxygen dilution values confirm that our outputs are reliable because excessive amounts of Oxygen are not present in the exhaust gas sample. This example illustrates a good test result.

LAMBDA / COMBUSTION EFFICIENCY CALCULATION

HC	<input type="text" value="128"/>	ppm				Lambda	<input type="text" value="1.08"/>
CO	<input type="text" value=".07"/>	%	Select fuel type:			Air Fuel Ratio	<input type="text" value="15.89:1"/>
CO2	<input type="text" value="12.7"/>	%	<input type="text" value="USA gasoline"/>	<input type="button" value="Calculate"/>		Combustion Efficiency	<input type="text" value="62%"/>
O2	<input type="text" value="1.7"/>	%	Stoich for selected fuel			A/F Mixture Status	<input type="text" value="8% Lean"/>
NOx	<input type="text" value="18"/>	ppm	<input type="text" value="14.71 :1"/>			Oxygen Dilution Value	<input type="text" value="85"/>

In this example we can see that the Lambda result is highlighted in red. When Lambda strays to far from 1, DECS alerts the user of a potential problem by changing colors. As you can see, the A/F ratio and A/F mixture status also look poor. Combustion efficiency is also red because of its poor number. However, Oxygen dilution value remains acceptable. Therefore, the resulting Lambda and CE numbers can be trusted. This vehicle obviously has a problem, and the outputs from DECS can be trusted for diagnostic purposes.

LAMBDA / COMBUSTION EFFICIENCY CALCULATION

HC	<input type="text" value="22"/>	ppm				Lambda	<input type="text" value="1.707"/>
CO	<input type="text" value=".2"/>	%	Select fuel type:			Air Fuel Ratio	<input type="text" value="25.11:1"/>
CO2	<input type="text" value="11"/>	%	<input type="text" value="USA gasoline"/>	<input type="button" value="Calculate"/>		Combustion Efficiency	<input type="text" value="89%"/>
O2	<input type="text" value="12"/>	%	Stoich for selected fuel			A/F Mixture Status	<input type="text" value="70.7% Lean"/>
NOx	<input type="text" value="18"/>	ppm	<input type="text" value="14.71 :1"/>			Oxygen Dilution Value	<input type="text" value="74.2"/>

In this final example we can see a big red (or rather yellow) flag. An Oxygen dilution value of less than 75 triggers the Lambda related outputs to be highlighted in yellow. This is because the values reported in these boxes are probably incorrect due to the presence of excess Oxygen. If this situation arises, air injection should be disabled and exhaust systems should be checked for leaks to insure the accuracy of these calculations.

A/F Ratio to Lambda Calculator

AIR FUEL RATIO TO LAMBDA CONVERSION

AFR :1 Fuel Type Lambda

The air fuel ratio to Lambda conversion calculator is used to convert an air fuel ratio to a Lambda number. It is dependent on what type of fuel is being burned, so be sure to enter the correct fuel.

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Remember, an A/F ratio output on your exhaust gas analyzer may not be correct if it does not distinguish between fuel types. Do not trust the A/F ratio output of your equipment unless you know what type of fuel the given tool is calculating for. DECS gives you the option of fuel type so you can obtain accurate results.

Volumetric Efficiency and Fuel Requirement Calculation

VOLUMETRIC EFFICIENCY / FUEL REQUIREMENT CALCULATION

Displacement Liters Volumetric Efficiency

RPM Max. Air Flow

MAF GPS Fuel Vol. Req. @ Stoich

Fuel type Gasoline (14.7 : 1) Fuel Vol. Req. @ Stoich + 20%

----- Atmospheric Factors -----

Temp F BARO Ft above sea level Humidity %

Volumetric efficiency is a measure of how well an engine can pump air compared to its theoretical maximum. It is useful for picking out exhaust restrictions, air metering issues, intake restrictions, etc.

The inputs required are Displacement, RPM, and MAF. The Fuel Type input is required for the Fuel Requirement calculation that will be addressed later in this manual.



Drop down boxes have been provided to make data entry easier and eliminates the need to perform other conversions before using DECS.

There are optional inputs listed under “Atmospheric Factors” that allow for fine tuning of the result to your location.

----- Atmospheric Factors -----

Temp F BARO Ft above sea level Humidity %

F
C

Ft above sea level
in/hg
kPa
Bar

Drop down boxes are provided here also so DECS can make the adjustments for you.

The BPCC, or Barometric Pressure Conversion Chart, button has been provided as a quick visual way to compare BARO readings when using tools that display in different units.

in Hg	kPa	Bar	ft above sea
22.7	77	0.770	7000
23.3	79	0.788	6500
23.8	80	0.805	6000
24.3	82	0.822	5500
24.8	84	0.840	5000
25.3	86	0.857	4500
25.8	87	0.874	4000
26.3	89	0.892	3500
26.8	91	0.909	3000
27.4	93	0.926	2500
27.9	94	0.944	2000
28.4	96	0.961	1500
28.9	98	0.978	1000
29.4	100	0.996	500
29.9	101	1.013	0

Examples

VOLUMETRIC EFFICIENCY / FUEL REQUIREMENT CALCULATION

Displacement

RPM

MAF

Fuel type

Volumetric Efficiency

Max. Air Flow

Fuel Vol. Req. @ Stoich

Fuel Vol. Req. @ Stoich + 20%

----- Atmospheric Factors -----

Temp BARO Ft above sea level Humidity %

The previous example illustrates a VE entry for a 5.7 Liter GM truck that was driven at wide open throttle and had its peak recorded RPM and MAF values entered.

VOLUMETRIC EFFICIENCY / FUEL REQUIREMENT CALCULATION			
Displacement	5.7	Liters	Volumetric Efficiency 57%
RPM	4336		Max. Air Flow 246 GPS 33 Lb/M 426 CFM
MAF	140	GPS	Fuel Vol. Req. @ Stoich 0.36 Gal/M 1.38 L/M
Fuel type	Gasoline (14.7:1)		Fuel Vol. Req. @ Stoich + 20% 0.44 Gal/M 1.66 L/M
----- Atmospheric Factors -----			
Temp	70	F	BARO 0 Ft above sea level BPCC Humidity 30 %

This example shows how the same test drive can confirm a VE issue based on the entered data. In this case the problem was an air metering issue, specifically the MAF sensor.

Fuel Requirement Calculation

The fuel requirement calculation is automatically performed during a VE calculation. Its outputs reflect the required amount of fuel to maintain the correct air fuel ratio for the conditions and entered fuel type. A second set of outputs has been provided (+20%) to account for acceleration enrichment.

The Fuel Requirement Calculator can also be used to figure desired fuel quantity for a volume test when specs are not on hand. To determine the full amount an engine would require simply enter the displacement and red line RPM. The VE numbers are unimportant because we did not enter an air flow reading. But the fuel output displays a fuel volume spec for volume testing purposes.

VOLUMETRIC EFFICIENCY / FUEL REQUIREMENT CALCULATION

Displacement	<input type="text" value="1.8"/>	<input type="button" value="Liters"/>		Volumetric Efficiency	<input type="text" value="0%"/>	
RPM	<input type="text" value="5500"/>	<input type="button" value="Calculate"/>	Max. Air Flow	<input type="text" value="99 GPS"/>	<input type="text" value="13 Lb/M"/>	<input type="text" value="170 CFM"/>
MAF	<input type="text" value="0"/>	<input type="button" value="GPS"/>	Fuel Vol. Req. @ Stoich	<input type="text" value="0.14 Gal/M"/>	<input type="text" value="0.54 L/M"/>	
Fuel type	<input type="button" value="Gasoline (14.7 : 1)"/>		Fuel Vol. Req. @ Stoich + 20%	<input type="text" value="0.17 Gal/M"/>	<input type="text" value="0.65 L/M"/>	

----- Atmospheric Factors -----

Temp	<input type="text" value="70"/>	<input type="button" value="F"/>	BARO	<input type="text" value="0"/>	<input type="button" value="Ft above sea level"/>	<input type="button" value="BPCC"/>	Humidity	<input type="text" value="30"/>	<input type="button" value=" %"/>
------	---------------------------------	----------------------------------	------	--------------------------------	---	-------------------------------------	----------	---------------------------------	-----------------------------------

In this example, a 1.8 liter engine operating at 5500 RPM would require approximately .65 liters per minute.

Additional Emissions Calculations Screen

DECS Emissions Calculations
✕

Catalyst Efficiency Calculation

	Pre Cat		Post Cat		
HC	<input type="text"/>	ppm	<input type="text"/>	ppm	<input type="button" value="Calculate"/>
					HC Conversion <input type="text" value="0"/>
CO	<input type="text"/>	%	<input type="text"/>	%	<input type="button" value="Calculate"/>
					CO Conversion <input type="text" value="0"/>
NOx	<input type="text"/>	ppm	<input type="text"/>	ppm	<input type="button" value="Calculate"/>
					NOx Conversion <input type="text" value="0"/>

Emissions Reduction Goal Calculation

Test Standard	<input type="text"/>	GPM			
Test Reading	<input type="text"/>	GPM	<input type="button" value="Calculate"/>	Goal	<input type="text" value="0"/> GPM est.
Your Baseline	<input type="text"/>	GPM est.			

These additional calculations are accessible from the button on the bottom of the DECS main screen. These calculators relate more specifically to emissions issues.

The first calculation is Catalyst Efficiency. Pre and post converter gasses are entered and DECS calculates the percentage of gas reduction. As with all calculators included with DECS specific help files are provided. The following is the example of the Catalyst Efficiency Help screen.

The screenshot shows a window titled "Catalyst Efficiency Help". It contains the following text:

The catalyst efficiency calculator is used to determine how well a catalytic converter processes each gas. There is one line for each gas (HC, CO, and NOx) that allows individual analysis.

This calculation requires tapping into the exhaust stream before the catalytic converter. Pre converter and post converter gasses are compared and a reduction percentage is calculated.

	Pre Cat		Post Cat			
HC	285	ppm	52	ppm	Calculate	HC Conversion: 82 %
CO	.7	%	.1	%	Calculate	CO Conversion: 86 %
NOx	40	ppm	2	ppm	Calculate	NOx Conversion: 95 %

In the above example, the user inputs the pre and post cat numbers into the highlighted boxes. The calculator then displays an efficiency percentage for each gas.

The next calculation is the Emissions Reduction, or goal, calculation. It is very useful for repair verification of an IM-240 failure when you are limited to a conventional gas analyzer

? Emissions Reduction Calculation Help

The Emissions Reduction calculation is a ratio based formula that helps you equate gas readings from constant sampling gas analyzers to conventional gas analyzers. The calculator outputs a goal that can be used for repair verification. This calculation is very valuable when diagnosing dynamic emissions test failures.

Test Standard	2	GPM			
Test Reading	2.34	GPM	Calculate	Goal	2.67 GPM est.
Your Baseline	3.12	GPM est.			

For the above example: A vehicle failed the state emissions inspection for hydrocarbons. The test standards are 2 GPM and the test reading was 2.34 GPM. Do a baseline test drive and get the estimated GPM reading from your exhaust analyzer. Lets say that your estimated GPM for HC was 3.12. Plug these three numbers into the Emissions Reduction Calculator (yellow highlighted boxes) and it will output a goal of 2.67 GPM (circled in red). After the vehicle is repaired a second test drive is performed. If the estimated GPM output by the gas analyzer is below the goal of 2.67 GPM then the reduction achieved would be sufficient to pass the state's emissions inspection.

Note: Every test drive is unique. Set higher standards to guarantee a pass.

Be sure to register your copy of DECS with a valid email address. Information about training materials can be emailed to you as they become available.

A complete article on the effective use of emissions reduction calculator is available for download here:

http://www.driveabilityguys.com/uploads/Did_I_fix_the_failure.pdf

CONVERSION CALCULATORS

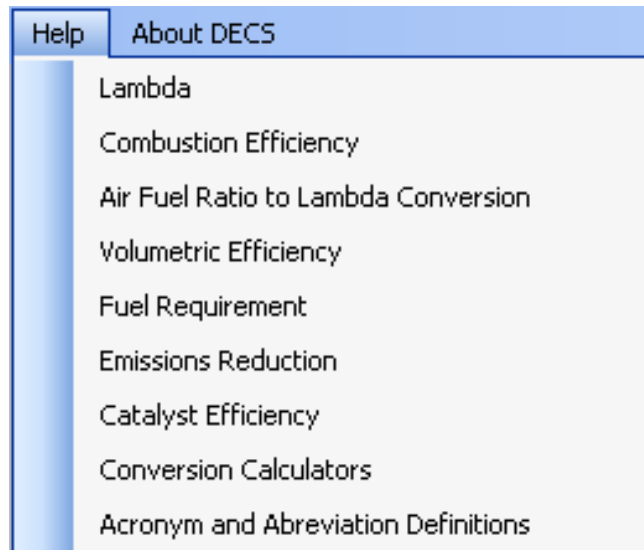
Input	Unit	Convert	Output 1	Unit 1	Output 2	Unit 2
<input type="text"/>	GPS	Convert	0	CFM	0	Lb/Min
<input type="text"/>	CFM	Convert	0	GPS	0	Lb/Min
<input type="text"/>	Lb/Min	Convert	0	GPS	0	CFM
<input type="text"/>	Gal	Convert	0	Liters		
<input type="text"/>	Liters	Convert	0	Gal		
<input type="text"/>	Culn	Convert	0	Liters	0	cc
<input type="text"/>	Liters	Convert	0	Culn	0	cc
<input type="text"/>	cc	Convert	0	Culn	0	Liters
<input type="text"/>	in Hg	Convert	0	kPa	0	Bar
<input type="text"/>	kPa	Convert	0	in Hg	0	Bar
<input type="text"/>	Bar	Convert	0	in Hg	0	kPa

The conversion calculator window is a collection of many of the basic conversions incorporated within many of DECS advanced calculations. Inputs are entered in the text boxes on the left side of the screen and conversions are output on the right side.

DECS SUPPORT

Support is available by emailing: decs@driveabilityguys.com

HELP FILES



DECS includes a complete set of help file that are accessible from the drop down menu the top left of the main screen.

DECS REGISTRATION

Registering DECS software qualifies you for free updates whenever they become available. DECS can be registered in a variety of ways: via email to decs@driveabilityguys.com , at www.driveabilityguys.com (fill out the form on the contact page), or via conventional mail (The Driveability Guys, PO Box 683, Wheaton, IL 60187).

In all cases, required information should include:

Name
Address
Email
DECS serial number

Updates will be mailed out in CD form.

