LT5 Specific Tuning Procedures

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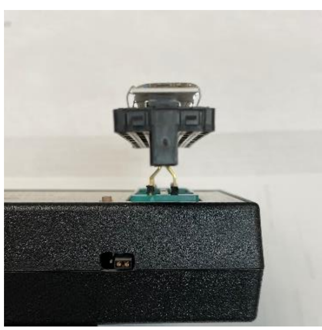
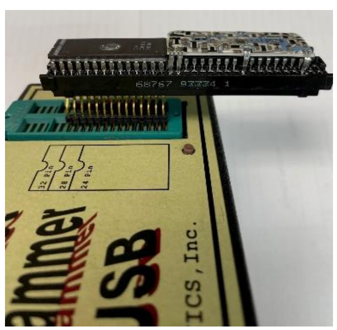
These procedures are for tuning the fuel and spark advance on a modified LT5 engine. For example, an engine with headers gains about 25 hp. Top End Porting if well done, adds 35 hp. An engine with these modifications needs additional fuel to support 25 + 35 = 60 hp.

These instructions do not include details about the tools that are needed, that information is available from other sources. In general, an engine data scanner is needed. DataCat is very good.

After collecting the fuel data from the engine, the information is used to modify the engine calibration data. The Tuner Cat OBDI tuner is very good.

The engine calibration data is downloaded to your computer with a memory chip reader. The Pocket Programmer works well. It is available from Transtronics 785-841-3089. They also have a UV eraser for the OE LT5 chips. The OE chip is a 27C256. Modern chips are electronically erasable. The 27SF512 works perfectly if the programming starting address is set to 08000 hex.

Here is an example of a programmer. The GM chip is connected with adapter pins. They are easy to fabricate. DigiKey part number 929647-05-36-ND. Bend them into a “S” shape.

There are other sources for the software and the equipment. What is listed above represents one way to do it.

Fundamental prerequisites that must be met before you start tuning:

- The ignition must be perfect. There must be no hint of a misfire.
- The fuel pressure should be 43 psi at idle and 51 psi at full throttle. These values are +/- 1 psi.
- The OE fuel injectors are 19/21 lb./hr. depending on the manufacturer. They will support up to 580 crankshaft hp.

Source File: C:\Program Files\CATS\Tuner\Cals\Master Cals\BFXB.BIN
5/25/2004

% Volumetric Efficiency #1 (Port Throttles Closed)

RPM	MAP (Kpa)																
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
400	55.9	55.9	55.9	55.9	55.9	59.0	66.4	68.0	69.1	70.3	71.1	72.3	73.0	74.2	75.4	76.6	78.1
500	52.7	52.7	52.7	52.7	52.7	55.9	59.0	62.5	66.0	69.1	71.1	72.3	73.0	74.2	75.4	76.6	78.1
600	52.7	52.7	52.7	52.7	52.7	55.9	59.0	62.5	66.0	69.1	71.1	72.3	73.0	74.2	75.4	76.6	78.1
700	52.7	52.7	52.7	52.7	52.7	52.7	59.0	62.5	66.0	69.1	71.1	72.3	73.0	74.2	75.4	76.6	78.1
800	52.7	52.7	52.7	52.7	52.7	52.7	62.5	66.0	69.1	70.3	71.1	72.3	73.0	74.2	75.4	76.6	78.1
900	52.7	52.7	52.7	52.7	62.5	64.1	65.2	66.4	67.2	68.4	69.1	69.9	70.7	71.9	72.7	73.8	75.0
1000	52.7	52.7	52.7	52.7	63.7	64.8	65.6	66.8	67.6	68.8	69.9	70.7	71.1	72.3	73.0	74.2	75.4
1100	47.7	53.1	59.8	62.1	64.5	65.2	66.0	67.2	68.0	69.1	69.9	70.7	71.5	72.7	73.4	74.6	75.4
1200	48.8	54.7	60.5	62.9	64.8	65.6	66.4	67.6	68.4	69.5	70.3	71.1	71.9	73.0	73.8	75.0	75.8
1300	49.2	54.7	60.9	62.9	64.8	65.6	66.4	67.6	68.8	69.5	70.3	71.5	72.7	73.4	74.2	75.4	76.2
1400	49.2	54.7	60.9	62.9	64.8	66.0	66.8	68.0	69.1	69.9	70.7	71.9	72.7	73.8	74.6	75.8	77.0
1500	49.6	54.7	61.3	63.3	64.8	66.0	67.2	68.4	69.1	69.9	70.7	71.9	72.7	73.8	74.6	75.8	77.0
1600	50.0	55.1	61.7	63.7	65.2	66.4	67.6	68.8	69.5	70.3	70.7	71.9	73.0	74.2	75.0	75.8	76.6
1700	50.4	55.5	62.1	64.1	65.6	66.8	68.0	69.1	70.3	71.1	71.9	73.0	73.8	75.0	75.8	76.6	77.3
1800	50.8	55.9	62.5	64.5	66.0	67.6	68.8	69.9	71.1	72.3	73.0	74.2	75.0	75.8	76.6	77.3	77.7
1900	51.2	56.3	62.9	64.8	66.4	68.0	69.1	70.7	72.3	73.4	74.2	75.4	76.2	77.0	77.3	78.1	78.5
2000	58.6	61.3	63.7	65.2	66.8	68.4	69.9	71.5	73.0	74.2	75.0	76.2	77.3	77.7	78.1	78.9	79.3

In the scan data, fuel listed as long term and short term. Also known as Block and Integrator. The system is self-tuning. Perfect fuel is represented as data value 128. Values less than 128 indicate that the fueling is rich and the control system is using the oxygen sensors to remove fuel. Values greater than 128 indicate that the fueling is lean and fuel is being added.

For example, let’s say that when the engine is idling the scan data shows the Block value as 120 and the Integrator as 128. Calculate a correction value. These are the fuel trim values.

120 + 128 /2 = 248. Perfect fueling would be 128 + 128 = 256. Calculate a percentage difference between 248 and 256.

248 / 256 = .97 or -3 x 2 = -6%

When an unmodified engine is idling, the idle speed is 650 rpm and the MAP or manifold pressure is 40 Kpa. The engine's operating point is highlighted in the chart above. 52.7 VE x .97 (3%) = 51.1. Use the tuner program to change 52.7 to 51.1

In reality the engine operating point can bounce around a little. Use the change by percent function of the tuner program to modify a range from 35 to 45 Kpa and 600 to 700 rpm.

Verify the change with a new data collection. It is very important to confirm that the change that you made has the intended effect. If not find out why or don't make the change. Changes that are not confirmed by the scan data may be in error. If the system does not respond to your change as you expect it to, maybe something is going wrong.

Adjusting the fueling at full throttle.

In general, when the engine is loaded more than about 50% the control system goes into Power Enrichment mode. You can see this when the fuel trim values snap to 128 and 128. To measure the fueling at full throttle a wide band oxygen sensor system is needed. Innovate is an example. A fitting for the oxygen sensor needs to be installed on the exhaust system.

PE % Change to Fuel/Air Ratio Vs. RPM

RPM	% Change
400	0.0
800	0.0
1200	0.0
1600	0.0
2000	0.0
2400	0.0
2800	0.0
3200	0.0
3600	0.0
4000	0.0
4500	0.0
5000	0.0
5500	0.0
6000	0.0
6500	0.0
7000	0.0
7500	0.0

Source: C:\Program Files\CATS\Tuner\Cals\Master cals\bfxb.bin

I tune the AFR at full load to 12.3:1 up to 5000 rpm. I use 12.6:1 from 5000 rpm on up. The formula for the use of this table is as follows. A 1% change entered into this table will change the AFR by .1. For example, if you want to add .5 AFR of fuel enter 5.0 into the table at the appropriate engine speed. The limit of this table's control is 10%. Entering values over 10 will not change the fueling.

If the PE table does not provide enough adjustment range, you can use the main VE table.

Source File: C:\Program Files\CATS\Tuner\Cals\Master Cals\BFXB.BIN
5/25/2004

% Volumetric Efficiency #2 (Port Throttles Open)

RPM	MAP (Kpa)														
	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
2000	66.0	66.8	68.0	68.8	69.9	71.1	72.7	73.4	74.6	75.0	75.8	76.6	77.3	80.5	83.2
2200	66.0	66.8	67.2	68.4	69.9	71.5	73.0	74.2	75.4	75.8	75.8	76.6	77.7	80.5	83.6
2400	66.4	66.8	66.8	68.4	70.3	71.9	73.4	74.2	75.4	75.8	75.8	77.0	78.5	81.3	84.0
2800	68.4	68.8	69.1	69.5	74.2	75.0	75.8	77.0	78.1	78.5	78.5	79.7	81.3	82.8	84.8
3200	69.5	70.3	71.5	74.6	77.7	77.7	77.7	78.9	80.5	80.9	81.6	82.4	83.6	85.2	87.1
3600	70.3	71.9	73.0	76.2	79.7	80.1	80.1	81.6	83.2	84.0	85.2	85.9	86.7	89.8	93.0
4000	75.8	75.8	75.8	78.9	82.0	82.4	82.4	84.0	85.9	87.9	89.8	91.0	92.2	95.3	98.4
4500	76.2	77.0	77.7	81.3	84.8	85.2	85.5	87.5	89.8	92.6	95.3	96.1	97.3	99.2	101.6
5000	77.7	78.1	79.7	83.6	87.5	87.9	88.7	89.8	91.4	93.8	96.1	96.9	97.7	100.0	102.3
5500	77.7	78.5	79.3	81.6	84.0	85.9	87.9	89.5	91.4	93.8	96.1	96.5	97.3	99.6	102.0
6000	77.3	78.1	78.9	79.7	80.5	82.0	84.0	85.2	86.3	89.1	92.2	92.2	92.2	95.3	98.8
6500	75.0	76.2	77.0	77.3	77.3	78.5	80.1	80.5	80.9	83.2	85.5	86.7	87.9	92.6	97.7
7000	72.3	73.4	75.0	75.4	75.8	77.0	78.1	78.5	79.3	81.6	84.0	85.2	86.7	91.8	96.9

Here is the formula to change the AFR by 1% at 6000 rpm and 95 Kpa. 95.3 / 100 = .95. For example, a .95 change to the VE will add about .1 to the AFR. Values over about 110 will not add any more fuel. 95.3 + .95 = the new VE value 96.25

If this is not enough fuel you can make what I call a global fueling change.

ECM CONSTANTS

Cylinder Volume	0.712	Liters	
Fuel Cuttoff Speed	255	MPH	
Fuel Cutoff RPM	7072	RPM	
Fuel Resume Speed	254	MPH	
Fuel Resume RPM	6972	RPM	
Injector Flow Rate	22.8	lb/hr	
RPM Threshold To Enable CARS	1200	RPM	
% TPS Threshold To Disable CARS	29.7	% TPS	
Vehicle Speed Threshold To Disable CARS	19	MPH	
Vehicle Speed Threshold To Enable CARS	12	MPH	
Speed Threshold To Disable + Reset CARS	1	MPH	
Coolant Temp. Threshold To Enable CARS	44.75	Deg C	
RPM/Speed Ratio Threshold For 1st Gear	188	Ratio	
Min. RPM/Speed Ratio For 4th Gear	97	Ratio	
Max RPM/Speed Ratio For 4th Gear	110	Ratio	
Fan 1 On Oil Temp. Threshold (Low RPM)	109.25	Deg C	
Fan 1 On Oil Temp. Threshold (High RPM)	104.00	Deg C	
Fan 1 Hysteresis for Oil Temp Thresh	1.4	Deg C	
High RPM Threshold for Oil Temp Fan	3500	RPM	
Fan 1 On Cool Temp, Low Speed, A/C On	107.75	Deg C	226 Deg F
Fan 1 On Cool Temp, High Speed	112.25	Deg C	
Fan 2 On Cool Temp, Low Speed, A/C On	112.25	Deg C	234 Deg F
Fan 2 On Cool Temp, High Speed	114.50	Deg C	
Fan 2 Disable Speed Threshold	55	MPH	
Fan Cool Temp Hysteresis Thresh, Low Spd	5.25	Deg C	
Fan Cool Temp Hysteresis Thresh, Hi Spd	6.00	Deg C	
Fan Cool Temp High Speed Switch Point	12	MPH	

This data point is intended to keep the fueling constant for changes in fuel injector size. We can use it in reverse to make large changes to the fueling. A change of 1 lb/hr will change the AFR by .4 or 10 fuel trim counts. For example, 22.8 – 1 = 21.8 will add .4 AFR of fuel. In the example, 13.5:1 AFR would change to 13.1

Be aware while this will add the fuel that you need at full throttle, it will also add fuel to all of the fueling maps. The entire calibration will be richer, so you will need to remove fuel from all of the other rpm and load points.

Adjusting the spark advance.

Source File: C:\Program Files\CATS\Tuner\Cals\Master Cals\BFXB.BIN
5/25/2004

Spark Advance #1 (Port Throttles Open)

RPM	MAP (Kpa) 25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
400	25.3	25.3	25.3	25.3	23.2	20.0	18.3	15.5	14.1	12.3	10.2	8.1	6.0	5.3	3.9	3.9
600	28.1	28.1	28.1	28.1	27.1	25.3	22.1	20.0	17.2	14.1	12.3	10.2	8.1	6.0	5.3	5.3
800	35.2	35.2	35.2	30.2	30.2	28.1	24.3	22.1	19.0	16.2	14.1	12.3	9.1	7.0	6.0	6.0
1000	35.2	35.2	35.2	35.2	33.0	30.2	25.3	23.2	20.0	17.2	15.1	13.0	11.3	9.1	8.1	7.0
1200	35.2	35.2	35.2	35.2	33.0	30.2	26.4	24.3	21.1	18.3	16.2	14.1	12.3	11.3	10.2	9.1
1400	35.2	35.2	35.2	35.2	33.8	30.2	27.1	25.3	22.1	19.0	17.2	16.2	14.1	13.0	12.3	11.3
1600	35.2	35.2	35.2	35.2	33.8	30.2	27.1	25.3	22.1	20.0	18.3	17.2	16.2	15.1	14.1	14.1
1800	35.2	35.2	35.2	35.2	33.8	30.2	27.1	25.3	23.2	21.1	20.0	19.0	18.3	17.2	16.2	16.2
2000	35.2	35.2	35.2	35.2	33.8	30.2	28.1	25.3	24.3	24.3	22.1	21.1	20.0	19.0	18.3	18.3
2200	35.2	35.2	35.2	35.2	33.8	30.2	28.1	26.4	25.3	25.3	24.3	24.3	22.1	21.1	20.0	20.0
2400	35.2	35.2	35.2	35.2	33.8	30.2	28.1	27.1	26.4	26.4	25.3	25.3	24.3	23.2	22.1	21.1
2800	35.2	35.2	35.2	35.2	33.8	32.7	30.2	30.2	28.1	26.4	25.3	25.3	24.3	23.2	23.2	23.2
3200	35.2	35.2	35.2	35.2	34.1	34.1	32.0	30.2	28.1	26.4	25.3	25.3	24.3	23.2	23.2	23.2
3600	35.2	35.2	35.2	35.2	35.2	35.2	33.8	31.3	28.1	26.4	24.3	23.2	22.1	22.1	22.1	22.1
4000	35.2	35.2	35.2	35.2	35.2	35.2	33.8	31.3	27.1	25.3	23.2	22.1	21.1	21.1	20.0	19.0
4500	32.0	32.0	32.0	32.0	32.0	32.0	28.8	28.1	27.1	25.3	24.3	23.2	22.1	22.1	21.1	21.1
5000	28.1	28.1	28.1	28.1	28.1	28.1	27.1	26.4	25.3	25.3	24.3	24.3	24.3	24.3	23.2	23.2
5500	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
6000	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
6500	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
7000	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
7500	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3

Adjust the spark advance for maximum power. Engines with 11 to 11.5:1 compression like 28 to 30 degrees at peak power.

To adjust the advance by one degree at 6500 rpm multiply the outlined range by + or – 4% or 1.04 or .96

If the knock sensor is reporting detonation in the maximum torque range at about 4500 rpm the spark advance can be reduced in that rpm range.

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