Driveability Corner

Mark Warren

Long-term and short-term fuel trim data can effectively be combined during a diagnosis, in ways that may not have been envisioned by the system's engineers.

Let's continue the long-term/short-term fuel trim (LTFT/STFT) discussion from the August column. Fig. 1 below is a fuel trim matrix from scan data recorded on a 2000 3.8L Ford Mustang. On this Ford, we drove the fuel trim (FT) lower (by adding fuel) and higher (by adding air).

You can see in row 257 in the matrix that the STFT was –6.3% and the LTFT was 2.3%; added together, total fuel trim (TFT) equals –4.0%. I multiplied the injector pulse width (IPW) of 2.70 milliseconds (mS) by 1.04 to determine a correct IPW at zero fuel trim. The calculated IPW for zero FT was 2.80mS.

As I mentioned last month, I got the actual IPW data from the scan tool (the fifth column in the matrix). I created a calculated IPW (column 6) by multiplying base IPW (top of column 5) by the total fuel trim (column 4). Column 7 is the percentage difference between the actual IPW (column 5) and the calculated IPW (column 6).

Analyzing the data, it looks like there's a pretty good overall correlation between FT and IPW, although some data did wander away from zero percentage difference. The data points that seemed to wander were most likely the result of the delay in scan data. Overall, the trend is good, until the last two rows. There you can see the percentages start to really ramp up. Why? Because this is where the system left stoichiometric (14.7:1). If you figure the other data points to be in fuel control (14.7:1) and the final points to be about 20% richer, then the air/fuel ratio for the last two columns would be 14.7 –20%, or 14.7 – 2.94 = 11.7. Hey, this is working pretty cool!

Remember, these recordings were all done under the same rpm and load conditions. Too

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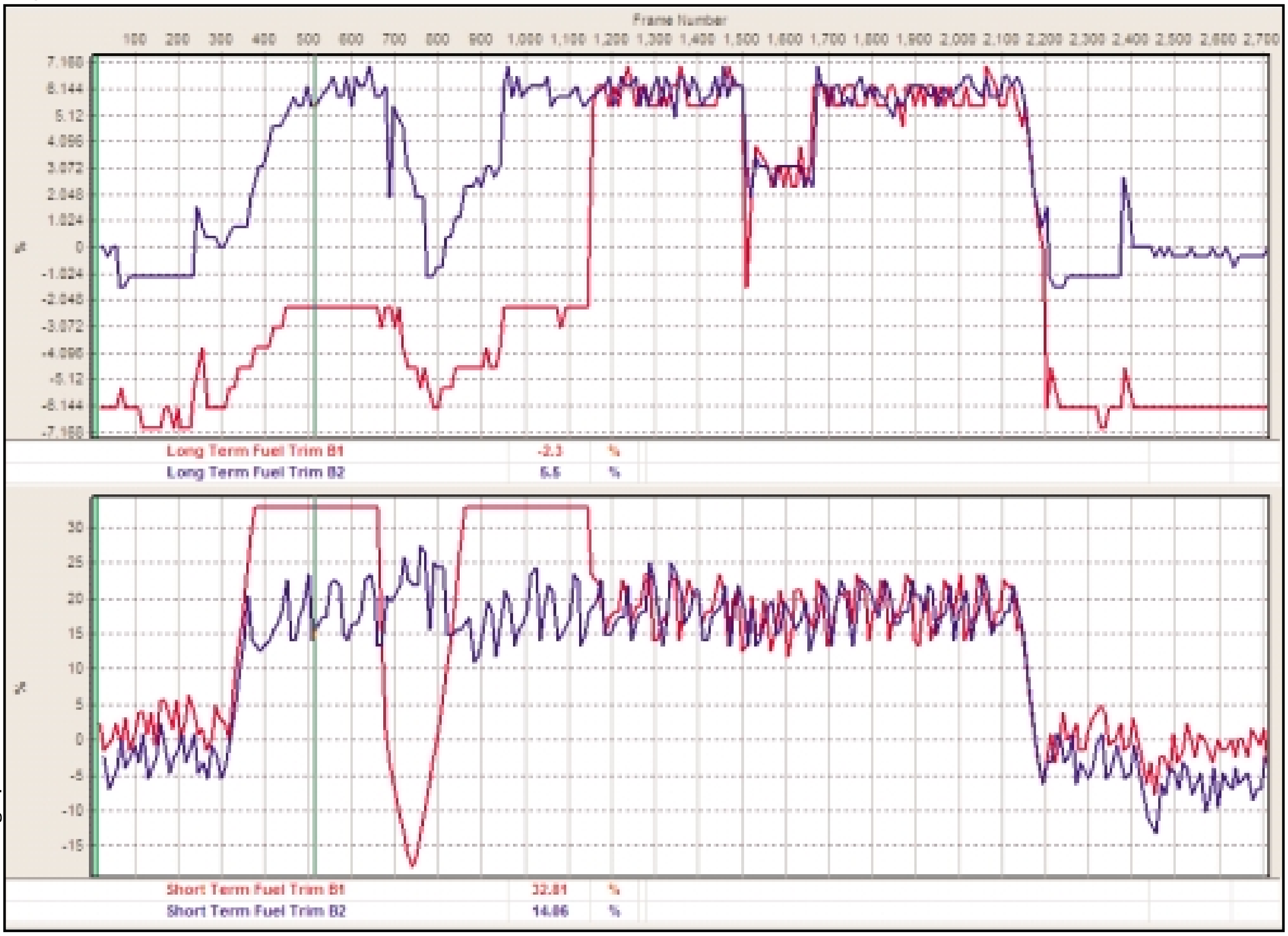
Fig. 1

Adding fuel - FT Negative & Adding Air - FT Positive - Ford 2000 3.8L Mustang						
Frame	**STFT %**	**LTFT %**	**Total FT %**	**Actual IPW**	**Total FT % x Base IPW**	**Difference %**
Calculated	0	0	0	2.80		
257	-6.3	2.3	-4.0	2.70	2.69	0%
322	-4.7	-18.0	-22.7	2.00	2.16	8%
335	-5.5	-13.3	-18.8	2.00	2.27	14%
334	-5.5	-13.3	-18.8	2.20	2.27	3%
347	-5.5	-7.0	-12.5	3.00	2.45	-18%
355	-6.3	-3.1	-9.4	2.70	2.54	-6%
401	-6.3	0.8	-5.5	2.80	2.65	-6%
425	-5.5	9.4	3.9	2.90	2.91	0%
450	-5.5	14.8	9.3	2.90	3.06	6%
701	-4.7	20.3	15.6	3.00	3.24	8%
771	-4.7	26.6	21.9	3.20	3.41	7%
803	-4.7	32.8	28.1	3.40	3.59	5%
950	-2.3	32.8	30.5	3.00	3.65	22%
1187	6.3	14.8	21.1	2.80	3.39	21%

Fig. 2



Screen data graph: Mark Warren

often I see techs looking at STFT and LTFT only under idle conditions in the service bay. Be sure to observe and record fuel trim parameters under all driving conditions. Vacuum leaks will skew fuel trim high at idle but may have little effect at higher engine rpm or air consumption. Fuel starvation will show first at high fuel demand/higher load and rpm.

Once again, it appears from the data that total fuel trim is a good diagnostic tool. Always check STFT and LTFT and add them for TFT. While the PCM usually attempts to return STFT to zero, it can't when LTFT rails. Also, our testing shows that some manufacturers delay the zeroing of STFT for quite some time. Always check both!

We ran one vehicle for more than an hour while doing this testing. LTFT was near zero when we started and about 11% when we finished. Did we create a problem? After a little thought, we removed the gas cap: *Bang!* Back to zero. This vehicle purged the canister at the rpm we were using and, after running for more than an hour, the fuel got pretty hot (Tucson in July).

Too often techs look at LTFT and STFT under idle conditions in the service bay. Be sure to record and look at FT parameters under all driving conditions.

When doing fuel trim diagnostics, you might need to consider fuel temperature and/or slosh when checking fuel trim at low rpm and load. Either disconnect the purge hose or just remove the gas cap like we did to see if this is skewing your FT data.

Sometimes when reading fuel trim, you may see it suddenly—and surprisingly—zero from a railed condition. Watch the open-loop/closed-loop command. A jump to open-loop as a result of railing or wide-open-throttle conditions will cause fuel trim to go to zero.

Most manufacturers specify that FT should be between +10% and –10%. Look at Fig. 2 above. We created a vacuum leak on the same Mustang (starting at frame 300). If you look at the beginning of the recording, LTFT on bank 1 (upper graph, red trace) is –6.0% and STFT on bank 1 (lower graph, red trace) is about 0.0%.

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Bank 1 has a total FT of about –6.0%. Bank 2 (blue trace) is 0.0% LTFT and –2.0% STFT, for a TFT of –2.0%. So, bank 1 and bank 2 are about 4.0% apart, which is acceptable.

We pulled a vacuum hose at frame 300 and measured fuel trim at the curser near frame 500. Bank 1 LTFT is –2.3% and STFT is 32.81%, for a TFT of about 30.5%. Bank 2 LTFT is 5.5% and STFT is 14.06%, for a TFT of 19.56%. As you can see, the bank-to-bank difference in TFT is about 10%—way too much.

I've often seen fuel at 7% on one bank and –7% on the other. While both of these are within the manufacturer's specification of ±10%, they're 14% apart. You'll also need to check bank-to-bank FT differences across all rpm and load ranges.

Fuel trim is an important parameter to use and understand. Be sure to consider all factors involved, including bank-to-bank differences, before drawing conclusions. M