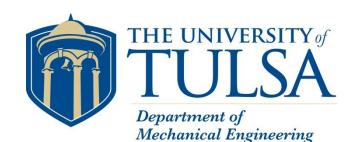
### EXTRACTING EVENT DATA FROM MEMORY CHIPS WITHIN A DETROIT DIESEL DDEC V

Jeremy Daily, Andrew Kongs, James Johnson, Jose Corcega The University of Tulsa



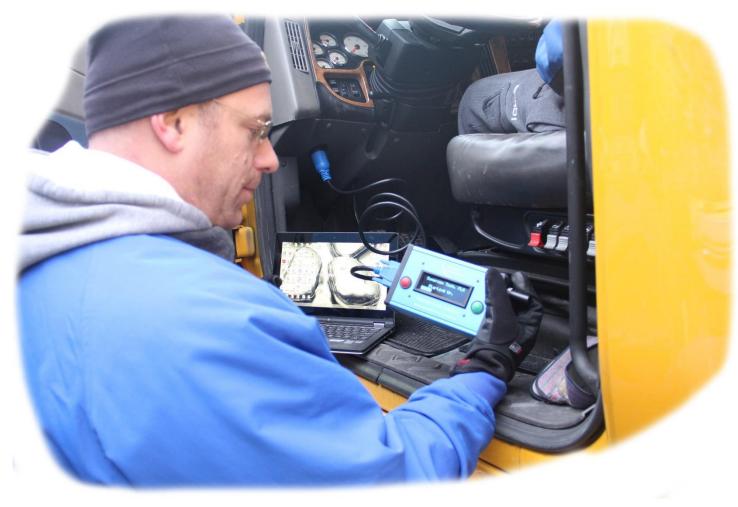


### Overview

- 1. Problem Definition
- 2. Figuring out what to look for (Produce Known Data)
- 3. Locating Known data in memory from an Exemplar ECM
- 4. Finding Data in the Subject ECM (Unknown)
- 5. Decoding and Presenting the data

### **Problem Statement**

#### We want to connect to a truck...



### ...and get data.

DDEC®	Reports	-	Hard	Brake	#1	
Print Date: 10/2/2013 University of Tulsa	2:30 PM			Trip: 09/17/12 12:26:1 Vehicle ID: Driver ID:	15 To 10/02/13 DDEC 6 TIB	8 (CST)
,				Odometer: Engine S/N:	619.0 06R1003832	mi
Trip Distance	619.0	mi		Trip Time	0:00:00	
Trip Fuel	0.00	gal		Fuel Consumption	0.00	gal/h
Fuel Economy	0.00	mpg		Idle Time	0:00:00	
Avg Drive Load	0	8		Idle Percent	0.00	elo
Avg Vehicle Speed	0.0	mph		Idle Fuel	0.00	gal
		-		Parked Regen Time	0:00:00	-

Incident Time: 10/2/2013 1:07:54 PM (CST) Incident Odometer: 619.0 mi

Time	Vehicle Speed (mph)	Engine Speed (rpm)	Brake	Clutch	Engine Load (%)	Throttle (%)	Cruise	Diag. Code
-0:59	23.5	0	No	No	0.00	0.00	No	Yes
-0:58	22.0	0	No	No	0.00	0.00	No	Yes
-0:57	20.0	0	No	No	0.00	0.00	No	Yes
-0:56	18.0	0	No	No	0.00	0.00	No	Yes
-0:55	16.0	0	No	No	0.00	0.00	No	Yes
-0:54	14.0	0	No	No	0.00	0.00	No	Yes
-0:53	12.0	0	No	No	0.00	0.00	No	Yes
-0:52	10.0	0	No	No	0.00	0.00	No	Yes
-0:51	8.0	0	No	No	0.00	0.00	No	Yes
-0:50	6.5	0	No	No	0.00	0.00	No	Yes
-0:49	4.0	0	No	No	0.00	0.00	No	Yes
-0:48	2.5	0	No	No	0.00	0.00	No	Yes
-0:47	1.0	0	No	No	0.00	0.00	No	Yes

### A direct approach may be needed

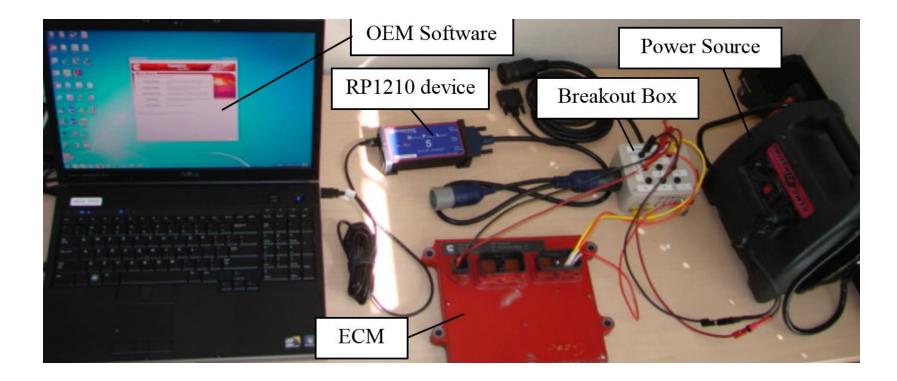
#### The electrical system is compromised.



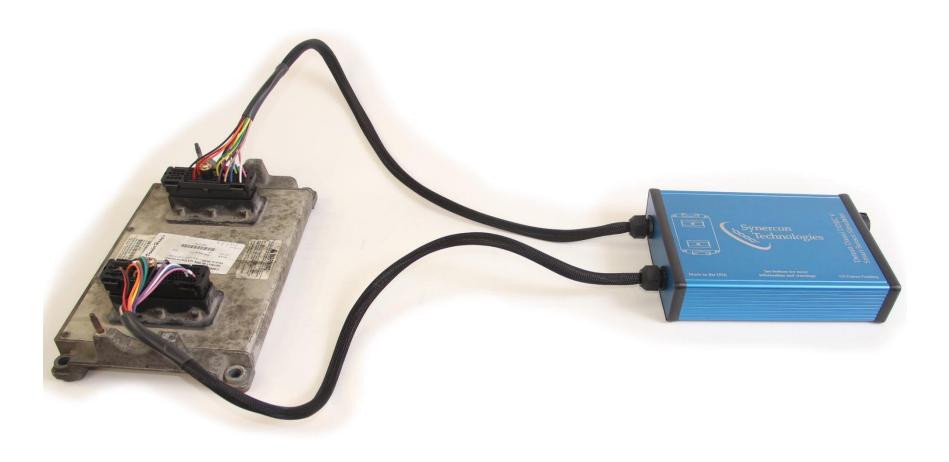


# Bench Top Download (or Image?)

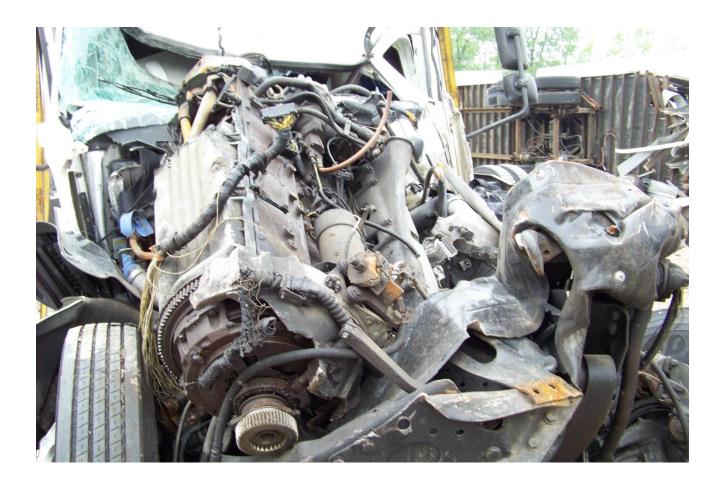
#### But this sets new faults.



# **Bench Top Download (Fault Free)**

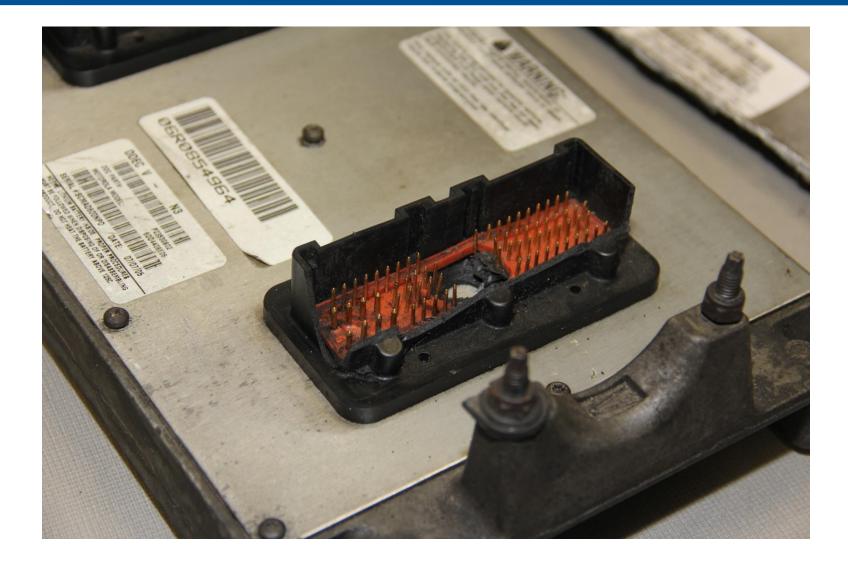


### But, sometimes it's not that easy.



The electrical system is compromised.

### **Recovered Modules**



### **Attempted Download**

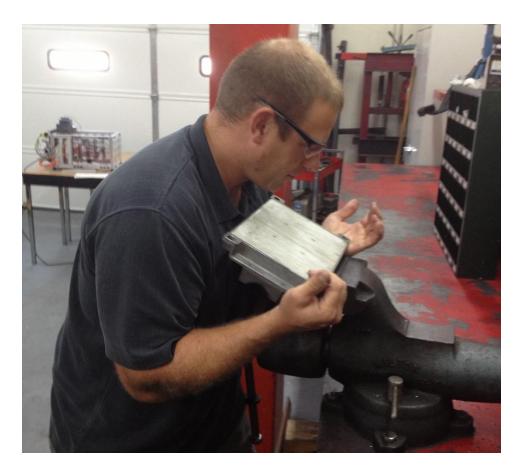
Able to connect, but throws a J1708 Network Error??

This isn't covered in the manual...

Let's take a peek inside the module.

## **Chip Access**

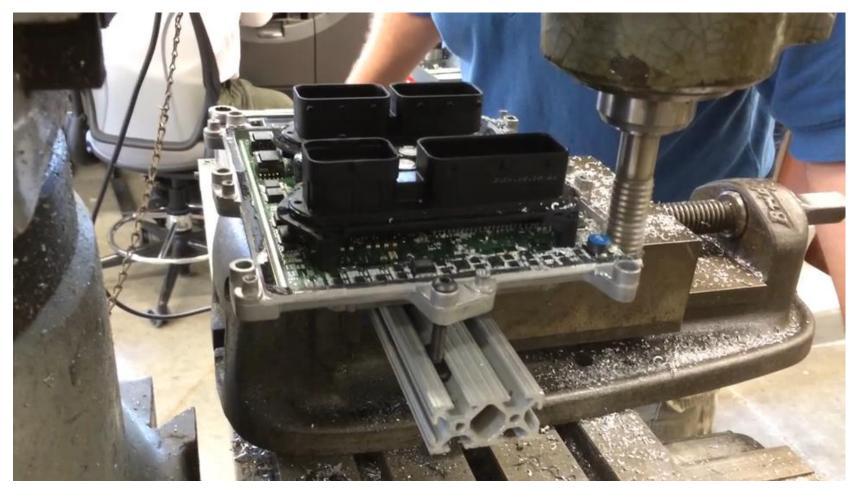
#### Accessing the chips the mechanical engineering way...





# **Chip Access**

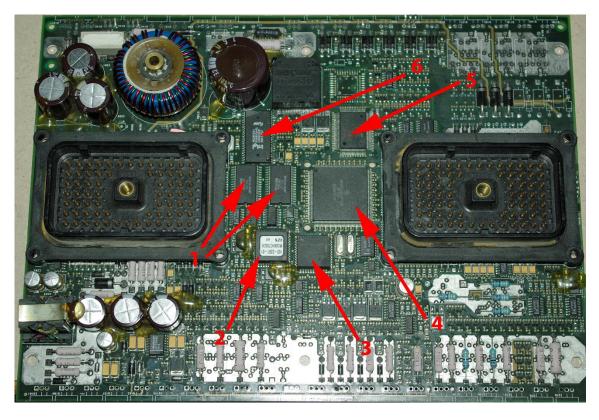
#### **Drastic measures**



# **Chip Identification**

#### **CAT ADEM III**

- 1. Toshiba SRAM
- 2. MC68HC705C9A 8bit Microcontroller (EEPROM)
- 3. Intel CAN 2.0 Controller
- 4. MC68336 32-bit Microprocessor (note: Mask-Rom + SRAM)
- 5. AMI IC Branded Caterpillar, Presumed ASIC
- 6. Intel AB28F800 5V Flash Storage



# **Chip Identification**

#### **DDEC IV**

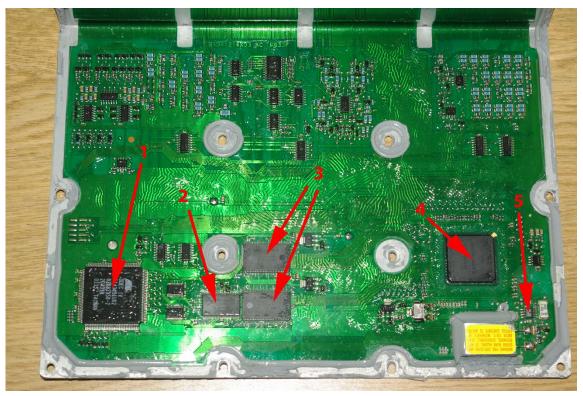
- 1. MC68332 32-bit CPU
- 2. Real-time Clock controller
- 3. Presumed Custom ASIC controller
- 4. CAN Controller
- 5. Intel Flash Storage IC AB28F400



# **Chip Identification**

### DDEC 5

- 1. Custom ASIC similar to later DDEC4
- 2. Cypress CY62137VLL SRAM
- 3. AMD AM29BL802CB Flash Storage ICs
- 4. MPC555LF8MZP40 32-bit CPU
- 5. Real-time clock IC EM V3020



### **Another DDEC 5**

Data is stored on flash memory.

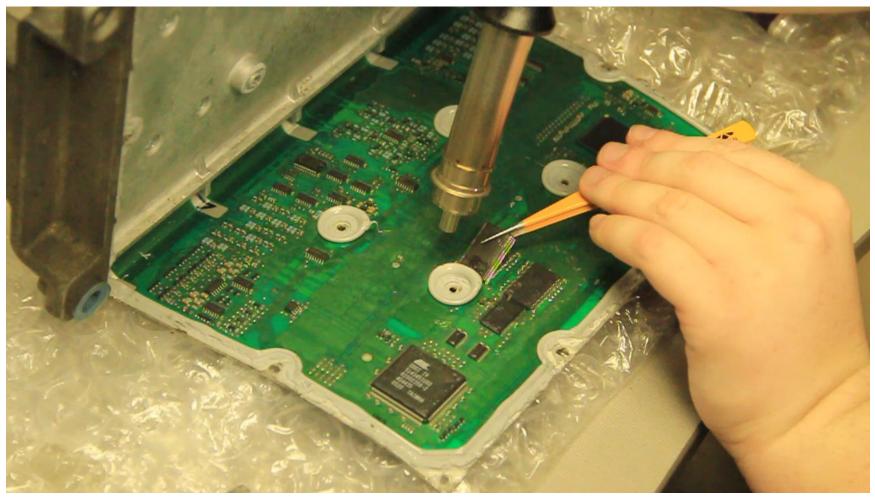
This DDEC5 used an Intel chip.

Each chip stores 1 megabyte



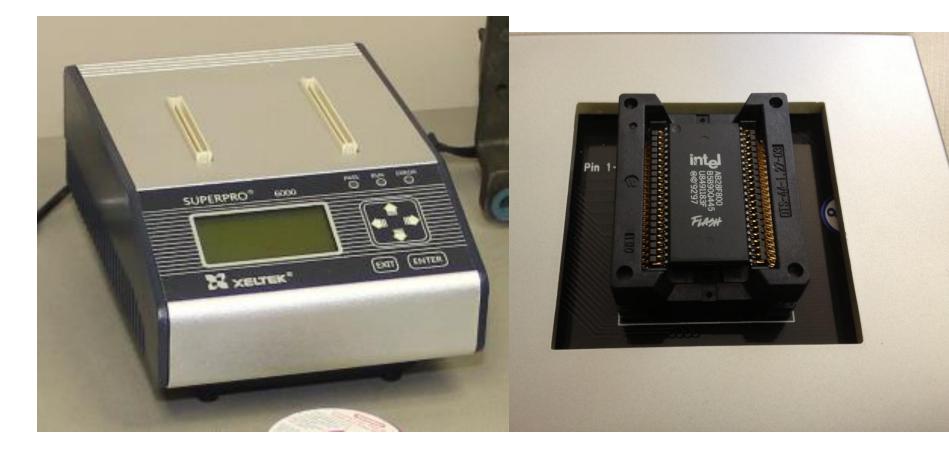
# **Chip Removal**

#### Hot air rework station to removing the flash memory



# **Reading the chip memory**

#### Xeltek Super Pro 6000 Universal Chip Reader



### Software to run the Chip Reader

#### Output is a raw binary file (\*.hex)

💦 SP6000 - SUPERPRO f	or Windows V3.0	
File Buffer Device (	Dption Project Help	
🖄 💾 🗗	- 😹 🞯 🖹 🥝	 LogicTest
Device AMD	AM29BL802CB@SSOP56 80000HM16 56Pins E/EPROM	•
Buffer Check	sun: 09071490H File =	•
Operation Option	Edit Auto Dev. Config Dev. Info Data Compare	
💥 Auto 💥 Program	Pins check error.         Success:0,Failure:0,Total:0.         Count down : disabled.         Preparing	•
🔀 Read 🔀 Verify	AMD AM29BL802CB@SSOP56 Unmatched adapter! Algo: FW16X_AC	
🔀 Blank_Check	Ready. Reading	
🔀 Erase	Read OK! 0:00'00"48 elapsed.	
🔀 Protect	Reading Read OK!	
💥 Unprotect	<pre>D:00'00"48 elapsed. Preparing Current time is 10/14/2013,15:24:25. Save file : C:\Users\Kenworth\Desktop\Chip Captures\DDEC-V Sgt Hickey\Chip A\chip-a-intel-hex-ddec-v-hickey.hex. Ready. Reading Read OK! 0:00'00"48 elapsed. Preparing Current time is 10/14/2013,15:28:10. Save file : C:\Users\Kenworth\Desktop\Chip Captures\DDEC-V Sgt Hickey\Chip B\ddec-v-chip-5-sgt-hickey-intel-hex.hex. Ready. </pre>	E
	Success:     O     Count down:     Disabled       Failure:     O     Count Total:     O       Total:     O     Remains:     O       Reset     Reset Count Down	
Ready		CANCEL
		▲ 隆 🛱 .atl (+) 3:29 PM 10/14/2013

### **Results in a Hex editor (Now What?)**

HxD - [C:\Users\jeremy-daily\Desktop\DDEC5 Play	ayground\ddec-v-chip1-intel-hex.hex]	
🔢 File Edit Search View Analysis Extras Wind	ndow ?	_ 8 ×
📄 🔿 🖛 📖 🧼 💷 💀 32 🔍 DOS/IBN	M-ASC V hex V	
DDEC5-DDEC Reports-baseline 100413123456AA.	🔝 ddec-v-chip1-intel-hex.hex 📓 ddec-v-chip2-intel-hex.hex 📓 chip-a-intel-hex-ddec-v-hickey.hex 📓 ddec-v-chip5-sgt-hickey-intel-hex.hex	chip2Bytes.hex
Offset(h) 00 01 02 03 04 05 06 07	08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F	
	) F2 03 18 00 59 08 00 00 14 00 6E 00 00 DD 00 00 00 00 FE 01 00 18 01 1≥₩≥₩↑.Ÿm¶.n	
	) 24 00 79 06 00 00 14 00 00 00 00 00 00 00 00 00 00 FE 01 00 37 02 00 00E©L♥\$.y♠¶	
	00 00 32 00 29 04 00 14 00 00 30 00 00 00 00 00 00 00 00 00 00	
	14 00 AC 00 00 00 00 00 00 00 00 FE 01 01 80 17B 01 92 01 FA FF FF 03 ≥♥0.α·	
	) 63 04 00 80 00 00 00 00 00 FE 01 00 00 03 00 00 00 00 FF 03 14 00♥¶.c♥C+.C₩0♥♥♥	
000F0560 90 12 00 00 14 00 94 01	. 00 40 00 00 00 00 00 FE 01 00 4B 00 00 00 F2 03 00 00 F2 03 18 00 E5 08 Ét¶.ö⊕.@₩⊖.K≥♥≥♥	
000F0580 00 00 14 00 AF 00 00 0D	) 00 00 00 00 FE 01 00 00 03 00 00 00 03 00 00 FF 03 14 00 E8 0E 00 00¶.»	
000F05A0 14 00 9C 01 00 40 00 00	) 00 00 00 FE 00 00 2C 01 77 03 2C 01 00 00 FF 03 00 00 80 16 40 06 2C 01 ¶.£⊕.€∎,⊕w♥,⊕ ♥Ç-@♠,⊕	
	) 00 FE 00 00 E1 02 64 00 E1 02 00 00 FF 03 00 00 20 03 40 01 32 00 11 04 ¿.@.L	
	: 00 00 00 02 C8 00 00 02 00 00 FF 03 00 00 90 03 B0 02 0A 00 01 04 00 40 .,.L.■●L.●♥È♥∰®B.©+.@	
	0 00 02 C8 00 00 02 00 00 FF 03 00 00 90 03 B0 02 0A 00 13 04 00 40 00 00	
	) 41 01 F3 03 00 00 F4 03 58 02 FF 00 00 00 32 00 2A 04 00 1A 00 00 30 00 └	
	. C7 00 14 02 58 02 3C 00 FF 00 00 00 32 00 2B 04 00 1A 00 00 20 00 00 FE .■	
	0 F 0 3 0 0 4 38 40 F 32 00 00 00 00 00 00 00 00 00 00 00 00 00	
	30 00 09 20 01 32 00 15 00 00 00 00 00 40 00 00 FE 00 00 00 00 00 00 00 00 00 00 00 00 00	
000F06E0 00 00 00 00 00 00 00 00	0 00 00 00 00 00 00 00 00 00 00 00 00 0	
000F0700 00 00 00 00 C8 00 00 15	5 88 64 A0 00 07 0D 88 5C 32 00 00 00 00 00 32 00 00 00 00 00 40 00 40 00ℓsèdá.•;è\22@.@.	
000F0720 10 0D 40 00 40 00 40 06	; 40 00 40 00 00 00 00 00 40 00 40 28 00 00 C0 02 C0 01 00 00 40 28 00 00 ▶>@.@.@.@.@.@.@.@.@.@.@.@.@@.@	
	) 00 40 50 C3 00 0A 80 0C 00 40 50 C3 01 0A <u>1A 01 00 40 50 C3 00 0A 1A 01</u> €1+d@►.@P <sup>+</sup> .@F <sup>+</sup> @F <sup>+</sup>	
	' 40 6B 00 8F C0 B2 00 00 00 00 00 00 073 00 6D 79 4D 44 46 36 4D 37 4C 4B .0↓#ÇG@x.Å\∰s.myMDF6M7LK	
	) 60 00 20 84 4D 44 48 35 30 4B 30 34 1A 27 0C 03 14 0B 00 00 60 00 B7 82 , <sub>T</sub> =\$\$, aMDH50K04→!**¶d, <sub>T</sub> é	
	। 12 C4 OC O3 14 OB OO OO 73 OO 6D 79 4D 44 46 36 4D 37 4C 4B 2C D6 O8 15 4 4D 44 48 35 30 4B 30 34 1A 2D OC O3 14 OB 40 00 60 00 B7 82 4D 44 48 35 8.9.`. #MDH50K04→-፣♥¶♂@.`., #MDH5	
	! 4D 44 48 35 30 4B 30 34 1A 2D 0C 03 14 0B 40 00 60 00 B7 82 4D 44 48 35 3 14 0B 40 00 00 00 00 00 00 00 00 00 00 00 00	
	10 06 CE 05 92 05 5A 05 26 05 F5 04 C6 04 98 04 6C 04 3F 04 14 04 E7 03 a. a. <b>································</b>	
	5 F7 02 BE 02 7F 02 37 02 E1 01 72 01 C6 00 00 00 00 00 00 00 40 01 80 02 , ▼i▼i▼^v ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥ ♥	
	0 00 00 00 00 00 00 00 00 00 00 00 00 0	
000F0880 18 01 18 01 68 01 90 01	. 50 46 70 17 B8 0B B8 0B C0 0D AC 0D 70 17 70 17 A0 0F 00 00 00 00 00 10 1010 μ0	
	) 00 00 00 00 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 B0 13	
	; B0 13 B0 13 B0 13 B0 13 50 11 21 11 F1 10 C2 10 93 10 64 10 34 10 05 10 ﷺ!!∰!!∰!!∰!!∰!!∰!!∰!!∰!!∰!!	
	0 05 10 05 10 05 10 05 10 05 10 05 05 00 05 00 00 CB 05 A0 05 A7 05 AE 05	
	5 D2 O5 DA 05 E1 05 E8 05 EF 05 F6 05 FE 05 06 0C 06 13 06 C2 05 1E 06 14 0 E 14 14 14 14 14 14 14 14 14 14 14 14 14	
	'EB 07 52 08 A4 08 29 1C EB 51 A3 B0 1E C5 7A D4 B7 DE 66 E6 84 EB A3 F0 {★ ★ δ·δ·Roño)LδQú∰ ↓ z ↓ fµäδú≡ ) FF FF FF FF FF FF FF FF C8 00 05 02 90 02 1C 03 98 03 10 04 8B 04 03 05 - p°r° ↓ \$	
	) FF FF FF FF FF FF FF FF C8 00 05 02 90 02 1C 03 98 03 10 04 8B 04 03 05 ⊤∫p⁵p⁵p⁵p⁵ 2 24 03 9F 03 18 04 91 04 09 05 9B 05 00 00 4A 00 95 00 DF 00 29 01 73 01 û♣ఓ.∎ØöØS♥f♥≀♦æ♦⊙♣J.Ò.悪.)@s@	
	27 03 97 03 16 07 91 07 09 05 95 05 00 00 74 00 95 00 μ7 00 29 01 /3 01 μ∰⊂.BORDENTYTT#**₩***	
	C D 05 26 06 80 06 D4 06 26 07 73 07 C0 07 0A 08 80 08 80 08 00 88 00 88 00 * 0 <b>+0 +0 +0 +0 +0 +0 +0 +0 +0 +0 +0 +0 +0 +</b>	
	88 00 82 00 7C 00 78 00 78 00 78 00 78 00 78 00 78 00 00 00 00 00 00 00 ê.ê.ê.ê.ê.ê.ê.	
	0 00 00 00 00 00 00 00 00 00 00 00 00 0	*
Offset: F0776 Block: F0776-F07FF	Length: 8A Overwrite	
BIOCK: FU//0-FU/FF	Length: 8A Overwrite	

SAE INTERNATIONAL

# NEED TO DECODE AND INTERPRET SOME DATA

# ITS ALL BINARY (HEX)!!

### Human Readable Hex

### Letters and numbers are encoded using ASCII. Strategy: Look for known ASCII, like VIN and Serial Number.

HxD - [C:\Use		erem	v-dai	lv\Do	ocum	nents	\Dro	pbo	x\Svr	nerco	n Te	chno	oloai	es\C	onsu	Itina	\13-	001-	1216	i Leiz	erm	an D	DEC		EC V Chip Data	DDEC	-V f		X
File Edit	-				-																							-	8 ×
			•	_	<u> </u>					_	de	c		·															
Chip2.bin	FD	Chip	A.bir	1	Uı	ntitle	d1	FD AO	Chip	B.bir	1																		
Offset(d)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23					-
00073728	ED	FO	BF	EB	СВ	C5	D9	D3	E5	DF	F3	EB	FF	F9	FF	FF	FF	FF	FF	FF	C4	BE	D2	СВ	íð;ëËÅÙÓåß	óëÿù	ÿÿÿÿÿ	ÿÄ∗ÒË	
00073752	DE	D8	EB	E5	F9	F2	FF	FF	FF	FF	FF	FF	BC	FF	C9	СЗ	D7	DO	E4	DE	F2	EB	FF	F8	ÞØëåùòÿÿÿÿ				_
00073776	FF	FF	FF	FF	FF	FF	C2	BB	DO	C8	DD	D6	EA	E4	F8	F2	FF	FF	FF	FF	FF	FF	В9	FF	ÿÿÿÿÿÿ»ĐÌ	ÝÖêä	øòÿÿÿ	ŸŸŸŸ'Ÿ	
00073800	C7	C0	D5	CE	EЗ	DC	F1	EA	FF	F8	FF	FF	FF	FF	FF	FF	BE	B8	CA	C4	D6	DO	E1	DC	ÇÀÕÎãÜñêÿø	ÿÿÿÿ	ÿÿ%,Ê	ÄÖÐÁÜ	
00073824	EE	E8	F9	F3	FF	FF	FF	FF	B6	FF	C0	BB	СВ	C6	D5	DO	EO	DA	EA	E5	F4	EF	FF	FA	1èùóÿÿÿÿ¶;				
00073848	FF	FF	В9	В4	C2	BD	СВ	<b>C7</b>	D5	DO	DE	DA	E8	E3	F1	EC	FA	F6	В3	FF	BC	B8	C6	C2	ÿÿ¹´Â₩ËÇÕĐ	)ÞÚèã	ñìúö'	ÿ₩,ÆÂ	
00073872	CF	СВ	D9	D4	E3	DE	EC	E7	F6	F1	FF	FA	7E	7E	7E	7E	7F	7E	82	80	80	83	80	80	ÏËÙÔãÞìçöŕ	iÿú~~	~~.~,	€€f€€	
00073896	80	80	80	80	FF	80	FF	FF	FF	FF	FF	FF	46	31	4A	55	36	41	4B	43	36	33	57	4C	<b>EEEEÿEÿÿÿ</b>	ÿÿ¥F1	JU6AK	C63WL	
00073920	32	33	39	33	D5	34	DO	D3	CB	CE	C8	C9	C8	C8	C4	C4	C4	C4	C4	C4	C4	C4	00	00	2393Õ4 <b>ÐÓËÍ</b>	ÈÉÈÈ	ÄÄÄÄÄ	ÄÄÄ	
00073944	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00					
00073968	00	00	00	00	00	00	00	00	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	rocaril	1111	11111	1111	
00073992	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC					_		-							. 📕	
00074016	EC	EC	EC	EC	EC	EC	DD	E8	EC	EC	EC	EC	EC	EC	- 8	0	80	)	I	EP	10	iÞ:	ĺÇ	öñ	ÿú~~~~	·~,	€€f	f€€L	
00074040	EC	DC	EC	EC	EC	EC	EC	EC	EC	EC	F2	EC			E	-	11												
0.0000000				720					-		1.0				2	7	40	-							ÿÿF1JU				
Offset: 73908		E	Block	7390	J8-7:	3925					Le	ngth	: 18		0	0	00	)	2	39	ıзć	Ď4	ÐÓ	ËÎ	ÈÉÈÈÄÄ	<u>ă Ă Ă</u>	ÄÄZ	i	ŕ
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																-		_											
															E	С	EC	-		• •	•	• •		ìì	111111	iìì	.iii	lìì	

### **2 Byte Reversals**

The flash memory is used such that the bytes are stored with bytes that are reversed.

The VIN from the raw memory says: F1 JU 6A KC 63 WL 23 93 \04

After swapping every 2 bytes, it becomes: 1FUJA6CK36LW32394

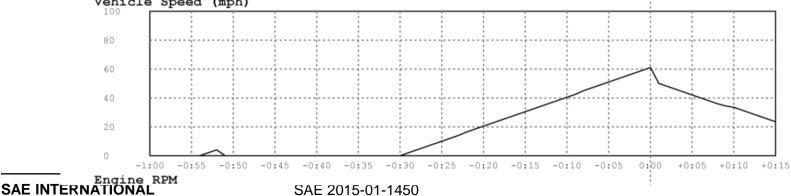
This is 18 bytes, but VINs are 17 characters

We can also find serial numbers (search for "R6")

#### Issue: Still need to decode the data...

# Strategy: Get an exemplar ECM and put a known speed record on it to find the Hard Brake and Last Stop Events.

#1 DDEC® Reports - Hard Brake Print Date: 10/4/2013 1:23 PM Trip: 12/12/05 20:56:39 To 10/04/13 (PST) DDC Vehicle ID: DDEC5-TEST Driver ID: Odometer: 532323.9 mi , Engine S/N: 06R0760090 Trip Distance 473875.7 mi Trip Time 20869:22:45 Trip Fuel 94635.50 gal Fuel Consumption 4.53 gal/h Fuel Economy 5.01 mpg Idle Time 11330:35:08 46 % Avg Drive Load Idle Percent 54.29 % Avg Vehicle Speed 7417.38 gal 49.7 mph Idle Fuel Incident Time: 10/04/13 7:14:18 (PST) Incident Odometer: 532323.0 mi Vehicle Speed (mph)



### Get help from the Network logs

DDEC Reports downloads data in 9 groups called data pages.

Use J1587 Transport layer to reconstruct the network traffic.

\*.XTR file is close to a network log.

Borrowing from last year, we can map the XTR file contents to DDEC Reports elements. (2014-01-0495)

Enables pattern matching for data elements like Mileage and Times.

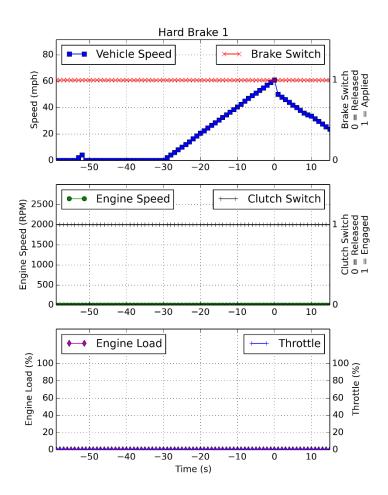
### Find the Data pattern (Hard Brake)

HxD - [C	:\User	s\je	remy-	daily\	Doc	cume	ents	Dro	pbo>	x∖DA	RPA	CFT	МКІ	\Bas	eline	e Dat	a∖De	etroil	Dies	el\D	DEC	5\DC	DEC F	Repo	rts\D	DEC	5-DI	DEC	Repo	orts-l	base	line	10041	3123456AA.XTR]
🔝 File E	dit Se	earc	h Vie	w A	naly	ysis	Extr	as	Wind	dow	?																							
- <u> </u>		ann		e	32		-	ANS	SI		-	de	c	•	-																			
			-	h in l	50								-1.1	_		dec-		D		<b>.</b> :				FP) -	at-ad		ША			I		FD		5-DDEC Reports-baseline 100413123456AA.XTR
Chip1.	bin   i	8) (	Chip2.	pin	ÂŎ	aae	2C-V-	cnip	)-A-s	sgt-r	пске	y-int	el.he	x	ة a	aec-	v-cn	ір-в-	sgt-	піске	ey-in	tei.ne	ex	àõ C	at-ac	iem-	-ш-те	est-ir	ntel-I	nex.r	nex	80	DDEC	5-00EC Reports-baseline 100415125450AA.XTR
Offset	(d)	00	01 (	02 0	)3 (	04	05	06	07	80	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
000040			00 0		-						02														04									Qÿ.ç9Q.°ãìÚ.fòw-Š.
000040			02 0					_			86					00												8A				C6 01		≠%ËF†žŠ.ŒE. °EÂ+Êë<*.SÍ(
000040			E7 (												_										00									¶cÞ9Q.K6
000041		_	00 0																		00			60		00						00		· · · · · · · · · · · · · · · · · · ·
000041	60	00		60 C	00	00	00			60			00			60						60						60					00	
000041			00 (		00											00					00			00		60	00		00	00		60		· · · · · · · · · · · · · · · · · · ·
000042			00 0		00		00		00						00	00 60			00	00	00	00 60	00	60	00	00	00	00	00	60	00	00		•••••
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# Last Stop Data

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# Hard Brake 1 Comparison

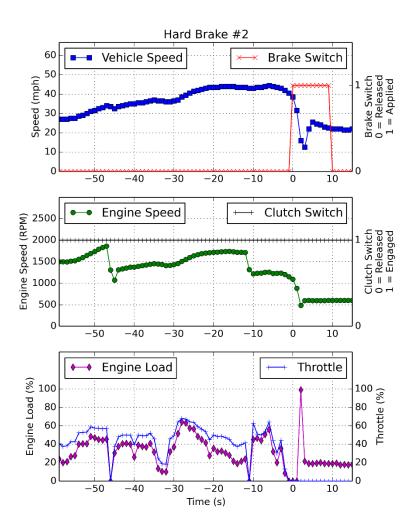


DDEC@ rint Date: 10/4/2013 DC	• <b>Reports - H</b> • 1:23 PM		#1 :56:39 To 10/04/13 (PST) DDEC5-TEST
-		Odometer: Engine S/N:	532323.9 mi 06R0760090
rip Distance rip Fuel uel Economy vg Drive Load vg Vehicle Speed	473875.7 mi 94635.50 gal 5.01 mpg 46 % 49.7 mph	Trip Time Fuel Consumption Idle Time Idle Fercent Idle Fuel	20069:22:45 4.53 gal/h 11330:35:00 54.29 % 7417.38 gal
ncident Time: 10/04/	13 7:14:18 (PST)	Incident Odometer:	532323.0 mi
Vehicle Speed (m	ph)		
80			
60			
40			
20			\
	0:50 -0:45 -0:40 -0:35	-0:30 -0:25 -0:20 -0:15 -0:10	-0:05 0:00 +0:05 +0:10 +0:
Engine RPM			
800			
600			
400			
200			
	0:50 -0:45 -0:40 -0:35	-0:30 -0:25 -0:20 -0:15 -0:10	-0:05 0:00 +0:05 +0:10 +0:
Percent			
80			
60			
40			
20			
		-0:30 -0:25 -0:20 -0:15 -0:10	-0:05 0:00 +0:05 +0:10 +0:
Brake Applied	Load	Throttle	
Released -1:00 -0:55 -	0:50 -0:45 -0:40 -0:35	-0:30 -0:25 -0:20 -0:15 -0:10	-0:05 0:00 +0:05 +0:10 +0:
Clutch Engaged			
Released -1:00 -0:55 -	0:50 -0:45 -0:40 -0:35	-0:30 -0:25 -0:20 -0:15 -0:10	-0:05 0:00 +0:05 +0:10 +0:

100413123456AA.XTR

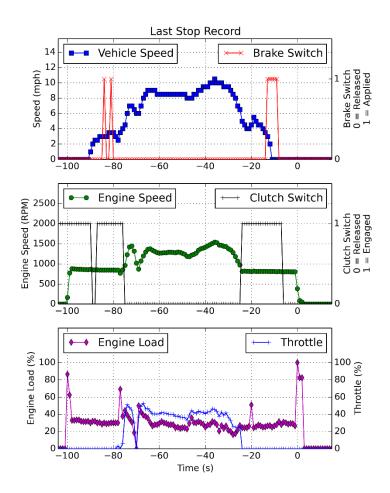
ECM S/W: 2.000 Version: 8.02-00278-00000 Page 1/2

### Hard Brake 2 Comparison



	🛛 Reports - Hard		#2
rint Date: 10/4/2013 GC	4 1:23 EM	Venic_e ID:	:6:33 76 10/04/13 (39T) BDEC:-TEST
_		Drivor ID: Gdomotor:	532323.9 mi
) -		Engine S/N:	C6R6760090
tip Dis ance	/73875.7 ml	erip ins	70369528577
io e el	94635.50 gal	Fiel Constration	4.53 gz172
uel Koonomy	5.91 mpg	dla 'ima	11330:35:08
vg Drive Lozó	46 k	dla Fersen	54.29 9
vg Va <sup>y</sup> cle Speed	/9.7 mp>	dla Fuel	7717.38 gal
noidant Times 10/13,	(09 2:58:35 (DSC)	Inciden: Odometer:	500421.0 mi
Vehicle Speed (s	ph)		;
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, <u> </u>		<u></u>	<u> </u>
-1:000 -0:00 -	((z, y)) = ((z, 4)y = -((z, 4)) = -((z))(y = -((z))))	$-(e_{2}, \theta_{1}) + (e_{2}, \phi_{1}) + (e_{2}, \phi_{1}) + (e_{2}, \phi_{1})$	$-(2\pi)(2\pi) = (2\pi)(1) = +(2\pi)(2\pi)(1) = -(2\pi)(2\pi)(1)$
Engine RPM	· · · ·		
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v 1:0 3:05	9100 0140 0166 6100 0100	3:25 0:20 0:17 0:10	- 0160 0160 (0100 (0100 C
Brake	Toad	Trottle	into one carbo carbo carbo
Applied ;	1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Science interview	0180 0148 0140 0178 0120	Delt basis de la Cation	1940 - 9400 - 10400, 105-0 - 40
Clutch			
Lopaped :			
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-1:00 -0:00 -	0:00 -0:45 -0:40 -0:500 -0:30	$ 0  t^{-1} S = - 0  t^{-1} S = - 0  t^{-1} S = - 0  t^{-1} 0$	-0:00 0:00 +0:05 +0:10 -0

## Last Stop Comparison



#### DDC Venicle ID: DDEC:-TEST Driver ID: Odemoter: 532323.9 mi -Engine S/N: C6R6760090 Trip Distance Trip +tel +tel Economy /73975 7 m<sup>-</sup> -rip inc. Fuel Consumption 94635.50 gal 4.53 gz17h 5.01 mpg 11330:35:08 dla 'ima Avg Drive Lozo 46 8 54.29 9 dla Fernan 7/17.38 gA1 Avg Var cle Speed 79.7 mp<sup>2</sup> dla Fuel Last Stop Plas: 01/17/10 5:33:00 (PS1) Last Stop Odometer: 532322.8 mi Vehicle Speed (mph) 30 13 0 -114 $-0.54\,\%$ -0.20 0.900-11-Engine RPM 2000 1500 1000 206 ó -1:64 -1:00 -1:15 -1100 -0115 -Cr30 -0:11 0.600 10112 Percent 80 1120 3145 0.00 сŔЭ. 0.10 1365 1:15 1126 Brake Local T rottle Applied 30,000 2545 o áco. 1011 Clutch Asleusei -1:40 -1:00-3:45 -0:00 -6:16 0.600-0.11

DDEC® Reports - Last Stop Record

Trip: 12/10/05 20:06:39 To 10/04/13 (EOT)

Print Date: 10/4/2013 1:23 PM

100413123456AA.XTR

ECM S/W: 2.000 Version: 8.02-002/8-00000

#### SAE INTERNATIONAL

Page 1/1

# **Daily Engine Usage**

#### DDEC® Reports - Daily Engine Usage

Print Date: 8/21/2013 11:08 AM University of Tulsa 800 S. Tucker Dr Tulsa, OK 74104 (918) 631-3056

Date Range:	01/18/07	То	01/07/00	(EST)
Vehicle ID:			TIB DDEC	:4
Driver ID:				
Engine S/N:			06R049953	34

Date:	1/18/2007		1
Start Time:	00:00:00	EST	
Odometer:	1006109.00	mi	
Distance:	548.80	mi	
Fuel:	95.25	gal	
Fuel Economy:	5.76	mpg	
Average Speed:	59.54	mph	

2007		Total(hh:mm)	09:13	06:00	08:47
):00 E	EST	Hour (EST)	Drive(min)	Idle(min)	Off(min)
9.00 n	ni	00:00-02:00 02:00-04:00	0 0	120 120	0 0
8.80 n	ni	04:00-06:00 06:00-08:00	96 104	24 16	0
5.25 g	gal	08:00-10:00	110	10	0
5.76 n	npg	10:00-12:00	54	66	0
9.54 n	mph	12:00-14:00 14:00-16:00	120 69	4	47
		16:00-18:00 18:00-20:00 20:00-22:00 22:00-24:00	0 0 0 0	0 0 0 0	120 120 120 120

# Daily Engine Usage Log Data - .XTR file

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4						_							-							
	ao Base	lineDL	DEC4.X	IK																_
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	00001	1776	00	01	00	03	00	03	00	00	9C	FF	00	00	60	00	00	00	œÿ`	
	00001	1792	11	00	0A	02	00	00	00	00	01	00	03	00	03	00	00	9C	œ	
	00001	808	FF	00	00	60	00	00	00	11	00	0A	02	00	00	00	00	01	ÿ`	
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	00002	2064	98	0B	DD	00	47	80	74	29	8D	51	99	00	00	00	0D	16	~.Ý.G.t).Q™	
	00002	2080	05	1D	04	29	78	3D	00	45	00	00	25	61	73	43	02	12	)x=.E%asC	
	00002		00	21	00	1E	00	00	00	00	6B	43	73	29	8D	51	99	00	.!kCs).Q™.	
	00002	2112	00	00	00	00	00	00	00	0E	00	00	00	00	00	00	00	00		Ŧ
0	ffset: 19	56		В	lock:	1956	5-199	1					Le	ngth	: 36				Overwrite	зđ

#### **Interpreted Data**

Bytes Sequence	Hex Value (s)	Decimal	LSB Value	Meaning	Value
0-1	70 15	5488	0.1 mile	Distance	548.8 miles
2-3	7D 01	381	0.25 gal	Fuel	95.25 gallons
4-7	50 B4 77 29	695710800	1 sec from epoch	Start Time	17 Jan 2007 at 23:00:00 CST
8-11	25 85 99 00	10061093	0.1 mile	Odometer	1006109.3 miles
12-23	78 78 18 10 0A 42 00 04 00 00 00 00	120 120 24 16 10 66 0 4 0 0 0 0	1 Minute	Idle Time	Same as Decimal
24-35	00 00 60 68 6E 36 78 45 00 00 00 00	0 0 96 104 54 120 69 0 0 0 0	1 Minute	Drive Time	Same as Decimal

All other data are calculated.

Interestingly, the .XTR file contains minutes, but the chip memory contains seconds.

# **Chip Memory Contents**

XTR file has 36 Bytes for 1 day in the Daily Engine Usage Log.

However... The memory record containing the Daily Engine Usage data is contained in a circular 30-day buffer with each day holding 66 bytes.

This was determined by locating the odometer readings since the MSB's were the same. There were 66 bytes from one 4-byte odometer reading to another.

Data Description	Unit	Location and sequence	Word Size (LSB last)	LSB Value	Example
Start Time Stamp	Seconds	1, 0, 3, 2	U32	1	Figure 16
Odometer	Miles	5, 4, 7, 6	U32	1/640	Figure 17
Distance Traveled	Miles	9, 8, 11, 10	U32	1/640	Figure 18
Fuel Used	Gallons	12, 13	U16	0.125	Figure 19

# Daily Engine Usage Time

XTR file = 24 bytes

Memory Chips = 48 bytes, so there twice the bytes that are in memory but not transmitted on the network.

XTR file has minutes coded as single bytes (0-255)

Memory stores times in seconds as 2 bytes (16 bit) (0-65536)

Only Drive time and Idle time in each 2 hour block are recorded in memory.

Drive + Idle seconds in memory contents did not always sum to 7200 seconds ( 2 hours)

# **Decoded Daily Engine Usage Log**

Start Da te	Start Ti me	Odome ter	Distan ce	Fuel	Total Da	ily Time	00:00-	02:00	02:00-	04:00	04:00	-06:00	06:00	-08:00	08:00-10
Central S Tin		Miles	Miles	Gallons	Idle (HH:MM)	Drive (HH:MM)	Idle	Drive	Idle	Drive	Idle	Drive	Idle	Drive	Idle C
Thu, 07 Jan 2010		530196 .8	346.5	76.750	15:23	08:04	82:33	26:49	65:43	54:17	20:38	99:22	55:49	41:00	00:44
Fri, 08 Ja 2010	n 02:00: 00AM		470.0	111.625	13:60	09:58	120:00	00:00	108:47	11:12	00:00	120:0 0	05:12	114:48	00:00
Sat, 09 Jan 2010		531013 .3	506.1	111.750	13:57	09:43	120:00	00:00	120:00	00:00	49:13	49:57	03:28	116:33	116:25