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FORENSIC ANALYSIS OF ELECTRONIC AND COMPUTER VEHICLE CONTROLS

Eves EDR Data Findings
An Inductive Investigation of
2007 Toyota Tundra EDR Data

Eves_Toyo-ASA_Compar_LOF_1c.lof
4Aug10

Ron & Lori Eves
16453-18th Avenue
Surrey, B.C. Canada
V3S-9N2

Voice: 604-716-3277
Fax:
Cell: 604-716-3277
Email: ronald.j.eves@gmail.com

Re: **Christopher Eves**
2007 Toyota Tundra Double Cab
VIN: 5TBRT54197S453547 Mfg Dt:
SRS ECU P/N: 89170-0C311
SRS ECU S/N: 087706799L

Dear Mr. Eves

As you know, the subject SRS ECU was subject to a Toyota Read Out Tool (ROT) data retrieval 8Apr2010, performed by Toyota Engineer Barry Hare. That data retrieval, witnessed by me, produced only a partial hexadecimal data record, and its interpretation of that partial hexadecimal record produced inconsistent and implausible data translation results. Further, at that data retrieval event, Toyota declined to baseline its ROT with my exemplar SRS ECU, having a known full address-specific hexadecimal data (512 bytes) and multiple crash event records.

Subsequent to that time, Toyota repeatedly declined your requests to re-read the subject SRS ECU, and no other party (NHTSA, Transport Canada) expressed any responsible interest in re-reading the subject SRS ECU with its own Toyota-donated ROTs.

You then transferred all right and title for the subject SRS ECU to me, 17May2010. We agreed at that time that I would retrieve the full hexadecimal data and translate the event records as completely as possible, using my independent and proprietary methods, when we both deemed the time appropriate.

The time became appropriate in mid July 2010, and I did that on 28Jul2010. The balance of this report discusses both my findings and a comparison of my findings with the Toyota translation.

Yours very truly,

Bill Rosenbluth

W. Rosenbluth

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A. Background of this Analysis and ASA Assignment

Per the Washing State Police Report, the subject 2007 Toyota Tundra, double Cab, was driven by Christopher Eves, sole occupant, 26Oct07 on a rural road when it impacted a tree, causing fatal injuries to Mr. Eves.

Subsequent to the accident, Mr. Ron Eves, the victim's father, retrieved the event data recorder [EDR] from the subject vehicle.

Subsequent to the accident, it was learned that the subject vehicle was subject to one or more safety recalls for sudden-acceleration-related defects.

Subsequent to the accident, Mr. Ron Eves, the victim's father, attempted to have Toyota retrieve and translate the data in the subject EDR. He was unsuccessful until the intervention of Mike Kelly, Esq. That data was retrieved and translated by Toyota 8Apr10 with M. Kelly and Bill Rosenbluth (ASA) observing.

ASA was tasked with evaluating the veracity of the Toyota retrieval and translation and, if necessary, performing its own retrieval and translation using its independent and proprietary methods. That has now been done.

B. Opinions

1. Event-related airbag data was retrieved twice from the subject EDR using direct-EEPROM data retrieval techniques on 28Jul10.[1] Both retrievals were identical and they produced 512 bytes of address-specific data from the non-volatile memory contained in the serial EEPROM IC (Atmel 25040AN). By comparison, the 8Apr10 Toyota Data Retrieval identified only 350 bytes of non-address-specific data.[2] The ASA diagnostic tools to accomplish this were an Andromeda AR-32 and a Windows XP host computer. .

2. The subject EEPROM data retrieved was confirmed to be 100% correct because the subject module part number (P/N) and serial number (S/N) were correctly identified in EEPROM at address locations $016C - $0170 and $0190 - $0199 respectively. These

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1 EEPROM = Electrically Erasable Programmable Read Only Memory. EEPROM is fabricated using a special semiconductor construction that allows it to retain previously stored data even when the battery is disconnected. A similarly functioning technology, Flash Memory, is also used for this purpose. Flash memory is now commonly used in portable data storage devices, the most common of which are digital camera removable memory cards.

2 Address-specific EEPROM hexadecimal data is the only way to assure correct and repeatable data translations to engineering units.

data were calculated using self-derived SAE SLOT[3] information for the associated parameters in the 512 Byte serial EEPROM (Atmel #25040AN) in the 2007-2009 Tundra class SRS ECU's. Exhibit B.2 illustrates this point.

3. The subject EEPROM data retrieved contains one valid crash event record.

3.1. That crash event record contains translated pre-event speeds from -5sec to 0sec as 74.6, 74.6, 74.6. 74.6, 75.8, 74.6 (mph) respectively..

3.2. That crash event record contains translated non-meaningful acceleration data. With non-meaningful acceleration data, no crash-event Delta-V can be derived. The non-meaningful data was probably a residue from a prior non-deployment event.

3.3. One reason for non-meaningful acceleration data (after a known crash and deploy event) can be an electronic anomaly preventing RAM data (volatile) from being written to EEPROM after the crash event.

4. Such an electronic anomaly was physically observed in the subject SRS ECU. In the subject ECU, the backing plate was deformed such that a short circuit, with arcing, existed between an energy storage capacitor positive lead and the backing plate (an electrical ground). These arcing artifacts were photographed.

5. The above pre-event speed findings appear to be intuitively consistent with the photographs provided in this matter, but that intuitive observation is certainly subject to Reconstruction Science verification.

6. The presence or absence of acceleration data in the Toyota EEPROM event records is not a disputable matter. ASA has retrieved data from many other Toyota SRS ECUs and has matched its translation and calibration (SLOT factors) to known (Totoya ROT) data translations. Of course, these comparisons were for results from ROT version 1, and unannounced to ASA, Toyota ROT version 2 was used for the Eves subject Toyota download, 8Apr2010. An example translation for an exemplar P/N 0C311 SRS ECU is shown in Section C below.

7. The Toyota ROT version 2, used for the Eves subject Toyota download, 8Apr2010 listed Delta-V in the collision as 177.2 mph and this was shown as being substantially derived (integrated) from four discrete acceleration pulses at 50ms, 70ms, 110ms and 130ms. Additionally, the Toyota data shows that no meaningful acceleration was

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[3] "SLOT" information is defined by the Society of Automotive Engineers (SAE) Recommended Practice J2178-2 (SAE J2178-2) to be Scaling, Limit, Offset and Transfer Function specifications that allow hexadecimal encoded engineering data to be interpreted into engineering units such as psi, seconds, volts, amps, Gs, etc.

registered until 50 ms in a presumable 74-75 mph frontal impact. This representation in Toyota's report are inconsistent and/or implausible for the following reasons:

7.1 The subject vehicle hit a stationary object, a tree. There is no physically realizable way for the stationary object impact Delta-V (177.2 mph) to be 102.6 mph greater than the vehicle approach velocity (74.6 mph).

7.2. The subject vehicle impact event clearly lasted 130 ms or longer, per Toyota's own report data. There should be at least 13 acceleration samples integrated to produce a true and accurate Delta-V. In fact only four acceleration samples are shown in the Toyota report. These are four near-identical magnitude acceleration pulses at 50ms, 70ms, 110ms and 130ms (resulting in approx 44 mph Delta-V cumulative increment steps on Toyota's report). Toyota EDR Delta-V data is normally derived from acceleration values every 10 ms, starting at 10 ms. The ASA translation shows varying acceleration samples through 150 ms. Thus, it is possible that the ROT version 2 data translation program may actually be using the wrong data to get its integration result. Typical and correct Toyota SRS ECU records, including the subject acceleration record, are shown in Section C below.

8. Thus, while the above Toyoto ROT pre-event speed translations appear to be intuitively consistent with the photographs provided in this matter, the Toyota ROT acceleration/Delta-V translations appear to be wildly inaccurate and thus, untrustworthy given the verified data as retrieved and included in this report.

9. Below is my technical report and analysis, including data charts illustrating this absolute and comparative data for the examples that I tested.

10. My findings and opinions are the product of extensive inductive and deductive reverse engineering processes. As such, they have varying confidence levels and these are discussed in this report. Thus my findings and opinions may be amended on receipt of new or additional engineering documentation from the vehicle manufacturer, other engineering expert reports, and/or other materials related to the function of the subject-class SRS ECU.

C. ASA Tests, Findings and Analysis -

1. Ronald Eves (father) retrieved the Christopher Eves' subject vehicle SRS ECU (Supplemental Restraints System Electronic Control Unit, a/k/a Event Data Recorder, EDR) after a fatal accident, 26Oct07. After protracted negotiations with Toyota, a portion of which included ASA involvement, the subject SRS ECU was subject to a Toyota Read Out Tool (ROT) data retrieval 8Apr2010, performed by Toyota Engineer Barry Hare. The Subject 2007 Tundra in its post-crash condition is shown in Exhibit

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C.1.1. The subject SRS ECU is shown in Exhibit C.1.2.

2. That data retrieval produced only a partial hexadecimal data record and its interpretation of that partial hexadecimal record produced inconsistent and implausible data translation results. Further, at that data retrieval event, Toyota declined to baseline its ROT with an ASA exemplar SRS ECU, having known full address-specific hexadecimal data (512 bytes) and multiple crash event records.

Subsequent to that time, Toyota repeatedly declined to re-read the subject SRS ECU, and no other party (NHTSA, Transport Canada) expressed any responsible interest in re-reading the subject SRS ECU with its own (Toyota-donated) ROTs.

On 17May10 right title and all interest in the subject SRS ECU was transferred to W. Rosenbluth. On 27Jul10 Ron Eves agreed with W. Rosenbluth that it was then appropriate for W . Rosenbluth to retrieve the full hexadecimal data and translate the event records as completely as possible using ASA independent and proprietary methods.

That was done on 28Jul10 and the balance of this report discusses translations and findings from data retrievals on a baselined exemplar and the subject SRS ECU. Also included is a comparison of ASA findings with the Toyota ROT version2 subject SRS ECU translation.

3. At the start of this assignment, I then initiated a combined inductive/deductive analysis to determine if

3.1 EEPROM data could be reliably retrieved
3.2 EEPROM data could be reliably reset for successive tests.
3.3 The raw EEPROM data could be translated and interpreted to provide event parameters for crash event records in those ECUs.

My findings are that I have accomplished items 3.1 through 3.3, and that the acceleration and much of the pre-event data are congruent with known Toyota ROT version 1 readouts. This is explained below.

4. The first step to accomplish this assignment was to purchase two salvage exemplar “0C311" ECU’s because the specific EDR version (P/N) in the Eves’ truck is an "0C311." I conducted an internal photomicrographic inspection of these in my lab and that inspection identified that the non volatile event data is saved in serial EEPROM device adjacent to the Micro Controller Unit (MCU). The EEPROM device in the “0C311" exemplars is an ATMEL 25040AN EEPROM. I also purchased and

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read an 0C271 EDR, which also contains an ATMEL 25040AN EEPROM device. [4] The ASA direct EEPROM read methodology allows me to read the serial EEPROM without disturbing or changing its contents. Fred Chandler assists me im almost all of these data retrievals.

5. We have also read multiple other Toyota Model EDRs of the same approximate design vintage (2000 - 2009). This includes, Camry, Lexus, Prius, Avalon, etc., EDRs. We always read each EDR EEPROM 2x when we read it. Some Toyota EDRs , similar but not identical, were read multiple times, and reset multiple times, as we subjected them to successive impinged-acceleration pulses in order to perform our own calibration(s). In all, we have read and/or reset & reread Toyota EDR EEPROMs several dozen times.

6. To date our analysis has identified that, in Toyota “Electronic Throttle Control System-intelligent” (ETCS-i) vehicles (in general, vehicles having CAN bus interfaces between the engine controller and the SRS ECU), the SRS ECU has the internal design ability to save multiple event records, each record containing acceleration point values and pre-event values [including vehicle speed, accelerator mode, brake apply, RPM and seatbelt usage].

   We have further proceeded to calibrate our identified acceleration values both ***inductively*** (using multiple varying-magnitude test accelerations impinged on exemplar ECUs), and ***deductively*** (using prior Toyota ROT reports and assumptions of partial hexadecimal data mapping).

   For impinged-accelerations tests, the monitors included a calibrated independent accelerometer and a data acquisition system recording 2000 9-channel sample words/second (aggregate = 18,000 sample words/sec). This method is similar to that described in Niehoff [1], Chidester [2] and Prasad [3].

7. All of our EEPROM reads have evidenced address-specified data paragraphs 16 bytes wide. That is an output format of the reading tool we use. The Bosch Vetronix CDR tool (an Industry Standard EDR tool that does not Read Toyota EDRs), when it presents actual EEPROM data (e.g., from GM SDMRs and Ford RCMs), presents that data in an address-specified data table format (variously 8 bytes or 16 bytes wide). In general, addressed-data table lengths vary according to EEPROM byte capacity (earlier Toyota EDRs had 256 byte EEPROMs). The 16 byte table is reasonably standard in the industry because it naturally fits a hexadecimal-stepped address notation scheme (one hexadecimal byte allows a count of 16 data items).

8. Based on our history of prior read Toyota EDR exemplars, and a combination of

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4 The Tundra EDR P/Ns vary according to Cab Type -- because a different calibration is needed for different body structures.

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inductive and deductive reverse-engineering efforts, we were able to identify in the subject “0C311" ECUs the existence of four event records and associated pre-event data. Of course, without absolute specification confirmation, our work product has to incorporate a confidence level - and this confidence level varies by data element. Below, the ASA derived parameters are used to illuminate and/or evaluate Toyota ROT outputs for the Eves subject SRS ECU.

9. At the 8Apr10 Toyota ROT Eves’ subject SRS ECU download, I had one known and prior-read exemplar (with prior known crash data) available to baseline the Toyota ROT before the subject SRS ECU was read. However, at the Eves download, Toyota attorneys instructed their engineer to not read that exemplar unit with the Toyota ROT. Instead they read a new exemplar with no crash data. The new exemplar obviously had all null event data records, so that null-exemplar readout had little, if any, value as an engineering calibration baseline.

10. Additional to precluding the ASA exemplar, the 8Apr10 Toyota ROT output was presented as only 350 bytes of non-address-specific data. As stated above, the non-address-specified data, and only 350/512 bytes at that, appears to be designed to obfuscate truthfulness in the download, because any attempt to correlate that with the known address-specified data would need to incorporate dual assumptions (specific address & sub-portion relative location) . This represents an artificial impediment to truthful EDR reporting.

11. The methodology and documentation discussed in my analysis above, and a comparison to the Toyota ROT output, is most clearly explained in the following exhibits:

Exhibit C.11.1 shows the subject SRS ECU Toyota ROT version 2 EEPROM data output (350 bytes of “Memory Data”, non-address-specified hexadecimal data).

Exhibit C.11.2 shows the actual subject SRS ECU ASA EEPROM data output (512 bytes of address-specified hexadecimal data).

Exhibit C.11.3 shows the subject SRS ECU Toyota ROT version 2 translated Pre-event data.

Exhibit C.11.4 shows the subject SRS ECU Toyota ROT version 2 translated Delta-V data

Exhibit C.11.5 shows the subject SRS ECU ASA translated acceleration and Delta-V data and the translated Pre-event data (data window on data chart).

Exhibit C.11.6 shows the subject SRS ECU electrical shorting artifacts on the PCB (energy storage capacitor +V connection) and on the backing plate (ground).

Exhibit C.11.7 shows the exemplar SRS ECU (declined by Toyota). Note the identical P/N (0C311).

Exhibit C.11.8 shows shows the exemplar SRS ECU ASA EEPROM data output (512 bytes of address-specified hexadecimal data).

Exhibit C.11.9 shows the exemplar SRS ECU, Event Record 2, ASA translated acceleration and Delta-V data and the translated Pre-event data (data window on data chart). Data window values shown clearly have high confidence of validity, data values shown with strikeouts have a lower confidence of validity.

Exhibit C.11.10 shows the exemplar SRS ECU, Event Record 3, ASA translated acceleration and Delta-V data and the translated Pre-event data (data window on data chart). Data window values shown clearly have high confidence of validity, data values shown with strikeouts have a lower confidence of validity.

Exhibit C.11.11 shows the methodology used to accomplish the EEPROM direct-read employed for this analysis.

Exhibit C.11.12 shows the methodology used in other Toyota SRS ECUs to impinge acceleration pulses on those ECUs, read the recorded acceleration counts, and then calibrate the recorded acceleration counts with the known external accelerometer output.

E. Error and Methodology Analysis

I have considered the elements of my report and tests that may be subject to errors and or ambiguities. These elements are as follows:

1. **Analog voltage and current measurements:** All measurements were calibrated using meters and equipment calibrated to 1% or better accuracy. This measurement accuracy falls well within the operational tolerance band accepted for the components at issue.

2. **Download data and interpretation:** Digital data by its binary nature is either right or wrong. For every data download made in these tests, the download was done twice, and after each download, the retrieved data (in a computer buffer) was compared to the data still existing on the Device Under Test (DUT). Additionally, the twice retrieved data was also compared. Those comparisons were all correct. Lastly, for the subject Toyota ECU series, the P/N and S/N are displayed in the EEPROM data and these were confirmed to be correct (See Exhibit B.2). This cross-media confirmation is about as absolute a confirmation as one ever sees in engineering.

3. **Methodology Comparison:** The concept of subjecting an acceleration sensitive Device Under Test (DUT) to an acceleration pulse while monitoring that acceleration pulse with an independent accelerometer, and then comparing the two results is a time tested way of industry testing. Recognized industry references for tests using the same methodology are found in Niehoff [1], Chidester [2] and Prasad [3] .

4. **Delta-V Variance Comparison:** Finally, there is the ultimate test, a comparison of ECU-derived peak Delta-V versus independent-accelerometer-derived peak Delta V. The derived Delta-V in the instant exercise is the product of deductive reverse engineering and, when that process has been completed, it has been shown, to be substantially correct, well within the tolerance of typical similar-test references.

   In exercises where my SLOT factors are derived from impinged-acceleration tests, I have also compared my Delta-V variances to those in published exercises of similar tests. Specifically, references to actual vehicle frontal crash test EDR vs accelerometer variances are shown in Niehoff [1] (± 5.5 %), Chidester [2] (± 10%), Prasad [3] (Ford RCM, -6.97%). The average of these is ± 7.5 %. In those cases, the derived Delta-V in my exercises is generally well within the tolerance of the above references.

5. **Conformity with Accepted Industry Practices and Standards.**

   The industry accepted method for characterizing SRS ECU performance is to subject the ECU device under test (DUT) to impingement by a known and independently monitored acceleration pulse, and then to compare the DUT performance to the known characteristics of the impinged acceleration pulse. Typical industry pulse exciters are shown in MB Dynamics [4], PTM Electronics, Inc. [5] and Unholtz-Dickie [6]. One of my two exciters, as used for another Toyota ECU, is shown in Exhibit C.11.12.. Notwithstanding the method of excitation, the methodology and veracity of independent pulse monitoring is identical to the one used in typical industry tests.[5] In summary, the test objective is to measure the fidelity of DUT acceleration response versus the known acceleration input. The derived Delta-V in the instant exercise is the product of deductive reverse engineering and has been shown, by virtue of that process to be substantially correct, well within the tolerance of the above references.

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5 An independent and calibrated accelerometer monitored by a calibrated Data Acquisition system with a sampling rate significantly above the base accelerometer output bandwidth to avoid aliasing {Nyquist sampling rate}. For the ASA tests, various accelerometers, with an electrical bandwidth of 500Hz - 1KHz, were sampled as one of the channels in a sample word. Depending on the fixturing used, the sample words were recorded at 2000 - 5000 sample-words/second. This far exceeds the anti-aliasing requirement, and far exceeds SAE J211 specified Class 60 rate (-4dB Bandwidth ≈ 100 Hz) for chassis data.

Additionally, sufficient detail is given in this report so that any other independent investigator can derive his/her own methodology and repeat these tests to audit my results.

Lastly, the test nomenclature, sampling rates, geometric conventions, documentation and procedures are consistent with SAE and ASTM references shown in [7] - [12] as applicable.

F. Reference Case Documents & Materials

1. Washington State Collision Report, 26Oct07

2. Manufacturer Service Data
   2007 Toyota Tundra Service Data

3. Manufacturer Engineering Data
   None supplied

4. ASA Inspections and Tests

   1. Lab Tests, ASA, Reston, various dates.

5. Other Expert Reports
   1. Toyota ROT version 2, Readout, 8Apr10.

6. Depositions
   None supplied

7. Subject Vehicle Records
   None supplied

8. Photos provided by Ron Eves.

G. Reference Industry Publications & Specifications

[1] Niehoff, P, Gabler, H, Brophy, J, Chidester, J, Hinch, J, Ragland, C, *Evaluation of Event Data Recorders in Full Systems Crash Tests*, National Highway Traffic Safety Administration Paper # 05-0271 http://www.harristechnical.com/downloads/05-0271-W.pdf.

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[2] Chidister, C, Hinch, J, Mercer, T, Schultz, K, *Recording Automotive Crash*

Event Data, International symposium on Transportation Recorders, May 1999, Arlington, VA.
http://www.nhtsa.dot.gov/Cars/Problems/studies/record/chidester.htm

[3] Prasad, Aloke, Performance of Selected Event Data Recorders, VRTC, NHTSA, 2001.
http://www.nhtsa.gov/staticfiles/DOT/NHTSA/NRD/Articles/EDR/PDF/Research/EDR-round-robin-Report.pdf

[4] Automotive Electronic Control Unit (ECU) & Sensor Test Solutions,
MB Dynamics
25865 Richmond Road, Cleveland OH 44146 US
http://www.mbdynamics.com/CSTS-Solutions.php

[5] Accelerometer Test Systems
PTM Electronics, Inc.
ECU Test Specialists
http://www.ptmelec.com/AirbagTester.htm

[6] Unholtz-Dickie (UD) vibration test equipment
Postal Address
6 Brookside Drive
Wallingford, CT 06492
http://www.udco.com/sseries.shtml

[7] ASTM E2493-07, *"Standard Guide for the Collection of Non-Volatile Memory Data in Evidentiary Vehicle Electronic Control Units"*, 2007 . Published by ASTM International, 100 Barr Harbor Drive, West Conshocken, PA., 19428-2959.

[8] SAE J211 Instrumentation and Test Conventions

[9] SAE J1733 Sign Convention for Vehicle Crash Testing

[10] SAE J670e Vehicle Dynamics Terminology

[11] SAE J1538 SRS_Glossary

[12] SAE J2178-2 Class B Data Networks, Data Parameter Definitions

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Exhibit B.2 A portion of the translation of the subject address-specified EEPROM data as retrieved 28Jul2010. This portion shows the subject module part number (P/N) and serial number (S/N) were correctly identified in EEPROM at address locations $016C - $0170 and $0190 - $0199 respectively.

EEP Addr	Hex Value		Translated Value	Concatenated Representation	
0169	00	00000000			
016A	2A	00101010	*		
016B	ED	11101101	í		
016C	30	0 ACM Toyo P/N	0		
016D	43	0 ACM Toyo P/N	C		
016E	33	0 ACM Toyo P/N	3		
016F	31	0 ACM Toyo P/N	1		
0170	31	0 ACM Toyo P/N	1	EEP P/N	0C311
0171	02	00000010	|		
0172	02	00000010	|		
0173	06	00000110	|		
0174	06	00000110	|		
0175	03	00000011	|		
0176	03	00000011	|		
0177	FF	11111111	ÿ		
0178	FF	11111111	ÿ		
0179	FF	11111111	ÿ		
017A	FF	11111111	ÿ		
017B	FF	11111111	ÿ		
017C	FF	11111111	ÿ		
017D	FB	11111011	û		
017E	EF	11101111	ï		
017F	EE	11101110	î		
0180	EE	11101110	î		
0181	EE	11101110	î		
0182	EE	11101110	î		
0183	EE	11101110	î		
0184	FF	11111111	ÿ		
0185	FF	11111111	ÿ		
0186	33	00110011	3		
0187	FF	11111111	ÿ		
0188	EE	11101110	î		
0189	E1	11100001	á		
018A	FF	11111111	ÿ		
018B	FF	11111111	ÿ		
018C	FF	11111111	ÿ		
018D	FF	11111111	ÿ		
018E	FF	11111111	ÿ		
018F	FF	11111111	ÿ		
0190	30	0 ACM Toyo Serial No	0		
0191	38	0 ACM Toyo Serial No	8		
0192	37	0 ACM Toyo Serial No	7		
0193	37	0 ACM Toyo Serial No	7		
0194	30	0 ACM Toyo Serial No	0		
0195	36	0 ACM Toyo Serial No	6		
0196	37	0 ACM Toyo Serial No	7		
0197	39	0 ACM Toyo Serial No	9		
0198	39	0 ACM Toyo Serial No	9		
0199	4C	0 ACM Toyo Serial No	L	EEP S/N	087706799L
019A	FF	11111111	ÿ		

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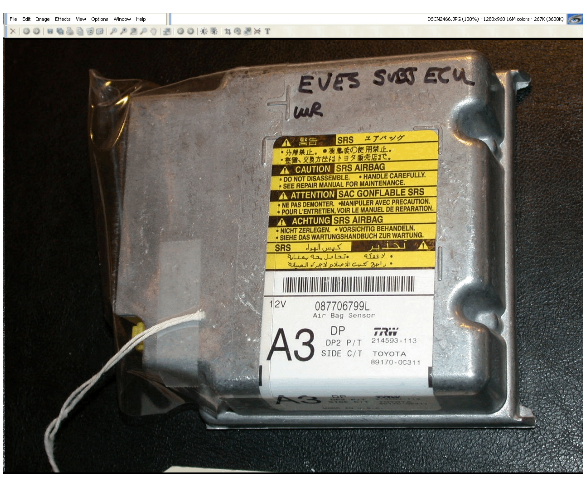
Exhibit C.1.1 Subject Vehicle

Exhibit C.1.2. Subject SRS ECU



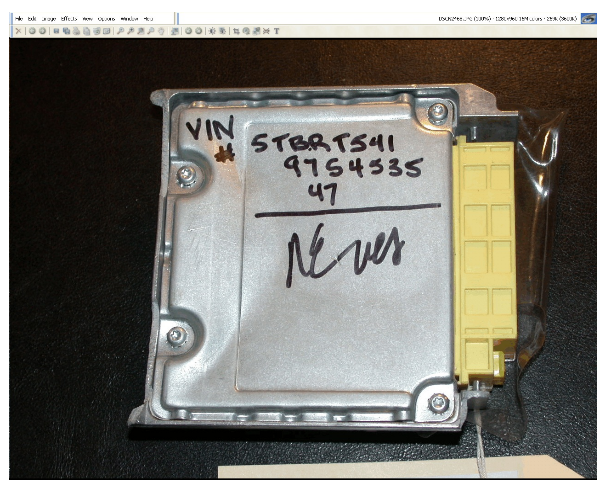


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Exhibit C.11.1 shows the subject SRS ECU Toyota ROT version 2 EEPROM data output (350 bytes of “Memory Data”, non-address-specified hexadecimal data) from Eves subject SRS ECU.

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[MEMORYDATA]
0=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
10=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, 80, 00, 00, 00, ff,
ff, ff, ff, 80, 00, ff, ff, 00, 00, fc, 03, ff, ff
20=a9, 02, 55, 01, 3c, 00, 23, 00, 3d, ff, 27, 00, 56, ff, 3c, 01, 26, 04, 3c,
02, 26, ff, 55, 00, 3c, ff, 26, 00, 3c, 00, 26, 00
30=55, fa, 07, 01, 00, 70, 00, 00, 00, 00, 00, 00, 00, 00, 00, 00, 00, 00, 80,
00, 80, 00, aa, aa, ff, ff, ff, ff, ff, ff, ff, ff
40=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
ff, ff, ff, ff, ff, ff, ff, ff, 00, ff, ff, ff, ff
50=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
60=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
00, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
70=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
80=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff,
ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
90=ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff, ff
e8=ff, ff, ff, 00, 01, 00, 00, ff, ff, ff, ff, fe, ff, 00, fe, 00
f0=ff, ff, 00, ff, fe, ff, 00, ff, ff, ff, 00, 00, 01, 01, ff, fd, fd, fe, 00,
00, 01, 01, 02, 01, 00, 00, 03, 00, 00, 02
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Exhibit C.11.2 shows the subject SRS ECU ASA EEPROM direct-read data output [512 bytes of address-specified hexadecimal data]. Notice the subject ECU S/N in the immediate ASCII translation section on the right of the hexadecimal data table. A photo os the subject SRS ECU label is included for reference.

```
000: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
010: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
020: FF FF FF FF FF FF FF FF FF FF FF FF FF FF 80 00 ÿÿÿÿÿÿÿÿÿÿÿÿÿÿ€.
030: 00 00 FF FF FF FF 80 00 FF FF 00 00 FC 03 FF FF ..ÿÿÿÿ€.ÿÿ..ü.ÿÿ
040: A9 02 55 01 3C 00 23 00 3D FF 27 00 56 FF 3C 01 ©.U.<.#.=ÿ'.Vÿ<.
050: 26 04 3C 02 26 FF 55 00 3C FF 26 00 3C 00 26 00 &.<.&ÿU.<ÿ&.<.&.
060: 55 FA 07 01 00 70 00 00 00 00 00 00 00 00 00 00 Uú...p..........
070: 00 00 80 00 80 00 AA AA FF FF FF FF FF FF FF FF ..€.€.ªªÿÿÿÿÿÿÿÿ
080: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
090: FF FF FF FF FF FF FF FF FF FF FF 00 FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿ.ÿÿÿÿ
0A0: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0B0: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0C0: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0D0: FF FF FF 00 FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿ.ÿÿÿÿÿÿÿÿÿÿÿÿ
0E0: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0F0: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
100: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
110: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
120: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
130: AE BB BF 3C A0 C3 C5 7F 50 A8 1C 01 38 EE EE EE ®»¿< ÃÅ•P¨..8îîî
140: FC E0 AE BB BF 3C A0 C3 C5 7F 50 A8 F9 FC F9 FC üà®»¿< ÃÅ•P¨ùüùü
150: F9 FF E0 07 90 04 00 00 00 00 00 00 00 00 00 00 ùÿà.•...........
160: 00 00 FF 23 F9 00 00 00 00 00 2A ED 30 43 33 31 ..ÿ#ù.....*í0C31
170: 31 02 02 06 06 03 03 FF FF FF FF FF FF FB EF EE 1......ÿÿÿÿÿÿûïî
180: EE EE EE EE FF FF 33 FF EE E1 FF FF FF FF FF FF îîîîÿÿ3ÿîáÿÿÿÿÿÿ
190: 30 38 37 37 30 36 37 39 39 4C FF FF FF FF FF FF 087706799Lÿÿÿÿÿÿ
1A0: 3C 23 00 05 00 00 2A ED 40 23 00 06 00 00 2A ED <#....*í@#....*í
1B0: 44 23 00 06 00 00 2A ED 48 23 00 07 00 00 2A ED D#....*íH#....*í
1C0: 4C 23 00 07 00 00 2A ED 4C 23 00 07 00 00 2A ED L#....*íL#....*í
1D0: FF FF FF 00 01 00 00 FF FF FF FF FE FF 00 FE 00 ÿÿÿ....ÿÿÿÿþÿ.þ.
1E0: FF FF 00 FF FE FF 00 FF FF FF 00 00 01 01 FF FD ÿÿ.ÿþÿ.ÿÿÿ....ÿý
1F0: FD FE 00 00 01 01 02 01 00 00 03 00 00 02 02 0A ýþ..............
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Exhibit C.11.3 shows the subject SRS ECU Toyota ROT version2 translated Pre-event data.

Pre-Crash Data

s	Speed	Engine	Accelerator	Brake
-5.0	74.6	2000	OFF	OFF
-4.0	74.6	2000	OFF	OFF
-3.0	74.6	2000	OFF	OFF
-2.0	74.6	2000	OFF	OFF
-1.0	75.8	2400	MIDDLE	OFF
-0.3	74.6	2000	OFF	OFF

Exhibit C.11.4 shows the subject SRS ECU Toyota ROT version2 translated Delta-V data (mph).

Post-Crash Data

ms	Vel Chg	ms	Vel Chg	ms	Vel Chg
10.0	0.3	70.0	88.2	130.0	177.2
20.0	0.5	80.0	88.4	140.0	177.2
30.0	0.5	90.0	89.1	150.0	177.2
40.0	0.5	100.0	89.4		
50.0	44.4	110.0	133.3		
60.0	44.4	120.0	133.3		

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Exhibit C.11.5 shows the subject SRS ECU ASA translated acceleration and Delta-V data and the translated Pre-event data [data window on data chart].

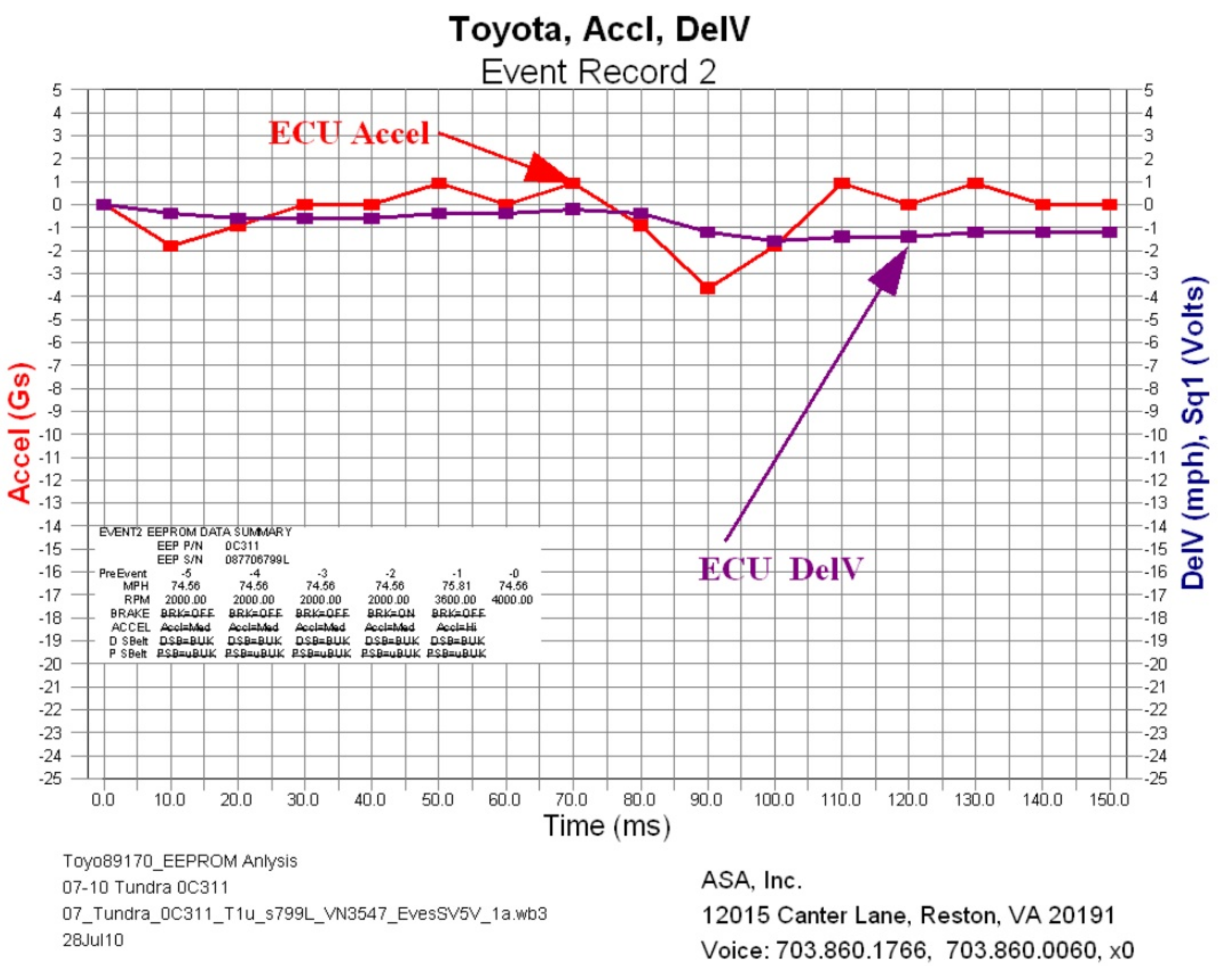

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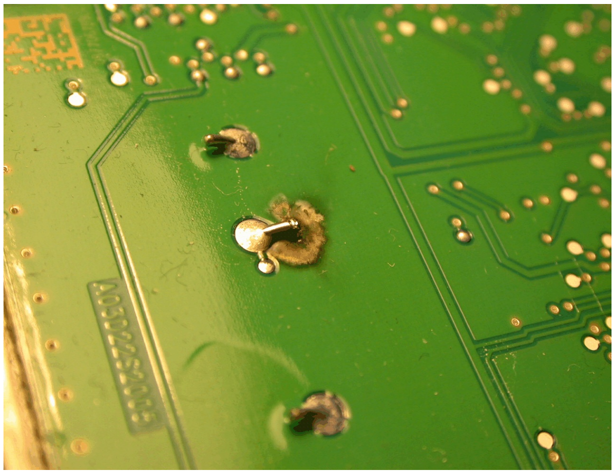
Exhibit C.11.6 shows the subject SRS ECU electrical shorting artifacts on the PCB (energy storage capacitor +V connection) and on the backing plate (ground).



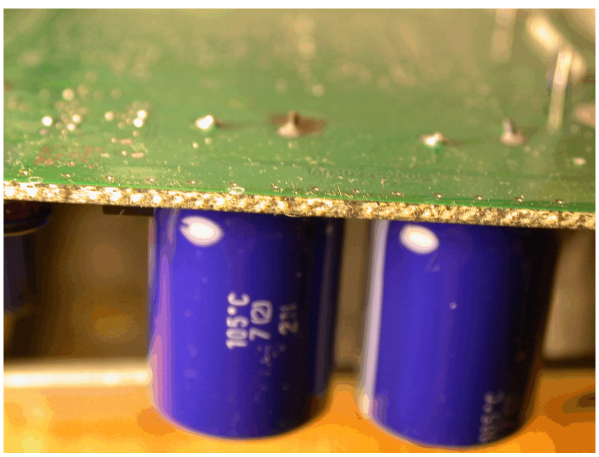


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Exhibit C.11.7 shows the exemplar SRS ECU (declined by Toyota). Note the identical P/N (0C311).