NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

October 25, 2012

17 – Electronic Devices Factual Report

Specialist's Factual Report
by Bill Tuccio

1. EVENT

Location:	Borrego Springs, California
Date:	September 8, 2012
Aircraft:	Edward R. Moore MXS
Registration:	N21MX
Operator:	Private
NTSB Number:	WPR12LA407

On September 8, 2012, about 1235 Pacific daylight time (PDT), an experimental Edward R. Moore MXS, N21MX, departed controlled flight and impacted terrain near Borrego Valley Airport (L08), Borrego Springs, California. The pilot was operating the airplane under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The commercial pilot was fatally injured; the airplane sustained substantial damage by impact forces. The local personal aerobatic flight departed L08, about 1225. Visual meteorological conditions prevailed, and no flight plan had been filed.

2. DETAILS OF DEVICE INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following devices:

Device 1:	Garmin GPSMAP 496
Device 1:	Serial Number: 19713373
Device 2:	Electronics International EDC-33P
Device 2:	Serial Number: Unknown
Device 3:	Electronics International MVP-50P
Device 3	Serial Number: 103635

2.1. Garmin GPSMAP 496 Device Description

The Garmin GPSMAP 496 is a battery-powered portable 12-channel GPS receiver with a 256-color TFT LCD display screen. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD radar, lightning, METARs, TAFs, and TFRs. A built-in AOPA Airport Directory and Safe Taxi Airport Diagrams are included for selected fields. The unit stores date, route-of-

flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 250 feet, and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed tracklog – including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured.

Tracklog storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory[1]. The unit contains hardware and software permitting the download of recorded waypoint, route, and tracklog information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol. The unit can also communicate with external devices such as a computer using a built in USB port. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed.

2.1.1. Garmin GPSMAP 496 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and information was extracted using the manufacturer's software normally, without difficulty.

2.1.2. Garmin GPSMAP 496 Data Description

The data extracted included 38 sessions (9,999 total data points) from June 23, 2012[2] through September 8, 2012. The accident flight was the last session, recorded starting at 19:16:03 UTC and ending at 19:36:39 UTC on September 8, 2012 (207 total data points).

2.1.3. Garmin GPSMAP 496 Parameters Provided

Table 1 describes data parameters provided by the GPS device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters.

Table 1: GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.
[2] All dates and times are referenced to Coordinated Universal Time (UTC).

Parameter Name	Parameter Description
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet, MSL[3])
Groundspeed	Average groundspeed between current and previous data point (knots)
Track	Average true course between current and previous data point (degrees)

2.1.4. Garmin GPSMAP 496 Overlays and Tabular Data

All graphical overlays generated in this report were generated using Google Earth. All times are expressed in UTC on September 8, 2012.

Figure 1 is a graphical overlay of the entire accident flight with select points annotated. The GPS track began recording at 19:16:03. The aircraft departed the L08 airport at about 19:26:12 and maneuvered north of the airport. The last data point recorded was at 19:36:39, though the altitude reported was invalid (i.e., 211,772 feet). The point prior to the last point was recorded at 19:36:05 at an altitude of 709 feet MSL.

Figure 2 is a graphical overlay of the accident flight taxi and departure with select points annotated. The aircraft was approaching the L08 runup area at 19:23:55. The aircraft taxi motion resumed about 19:25:38. The aircraft began its takeoff roll about 19:26:12.

Figure 3 is a graphical overlay of all data points recorded at the end of the accident flight, except the last point as it had an invalid altitude recorded. At 19:35:32 the aircraft was heading westerly, at about 4,216 feet MSL. At about 19:35:36, the aircraft began to lose altitude while changing direction by 360 degrees to the left. By the end of the 360 degree turn, the aircraft had descended to 2,743 feet at 19:35:44. The aircraft then continued to descend and calculated ground speed slowed, as it began to change direction towards the south. The last point with a reasonable altitude reported was at 19:36:05 at 709 feet MSL.

Tabular data used to generate figures 1 through 3 are included as Attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

[3] MSL means altitude above mean sea level

Figure 1. Accident flight as recorded by Garmin 496.

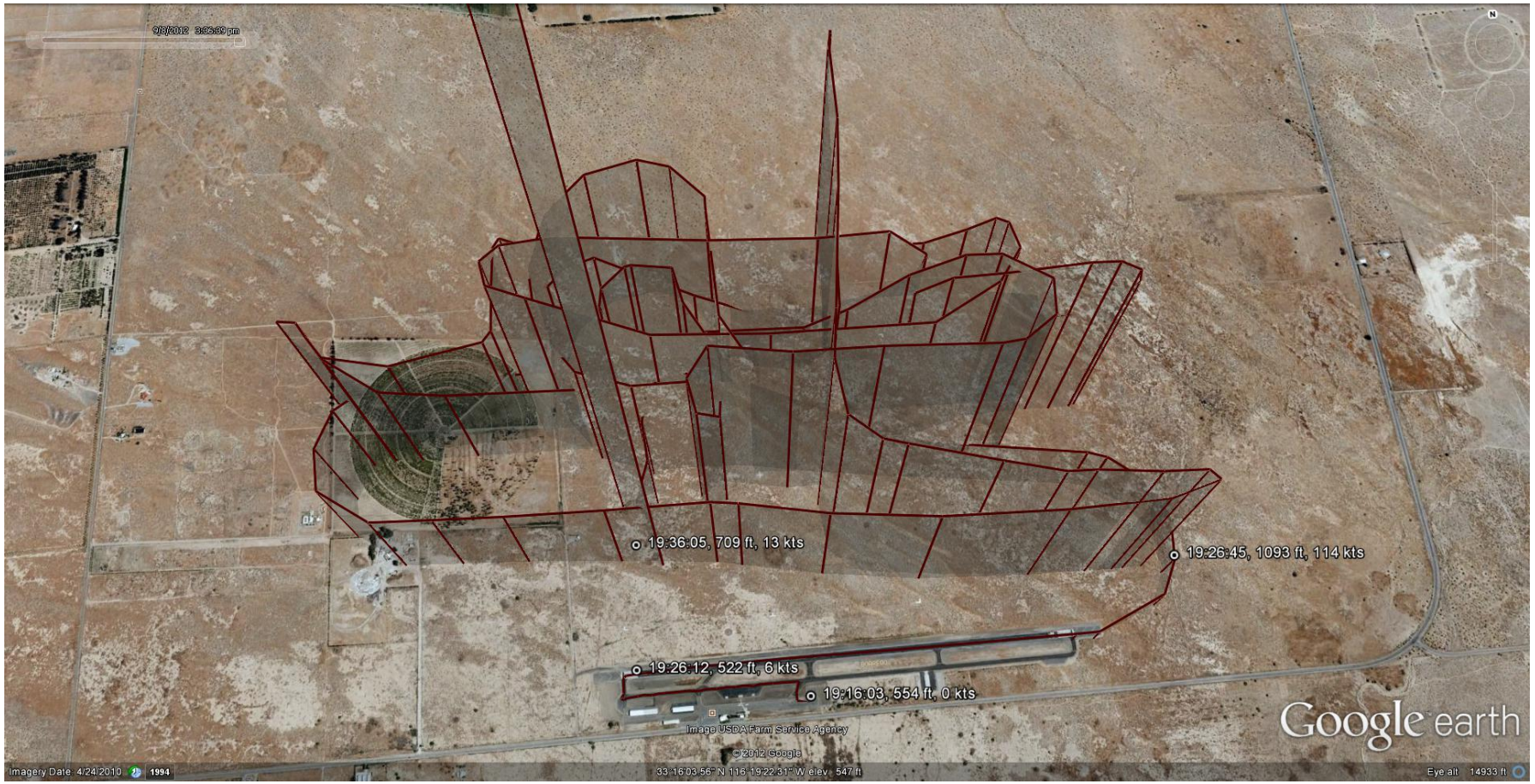
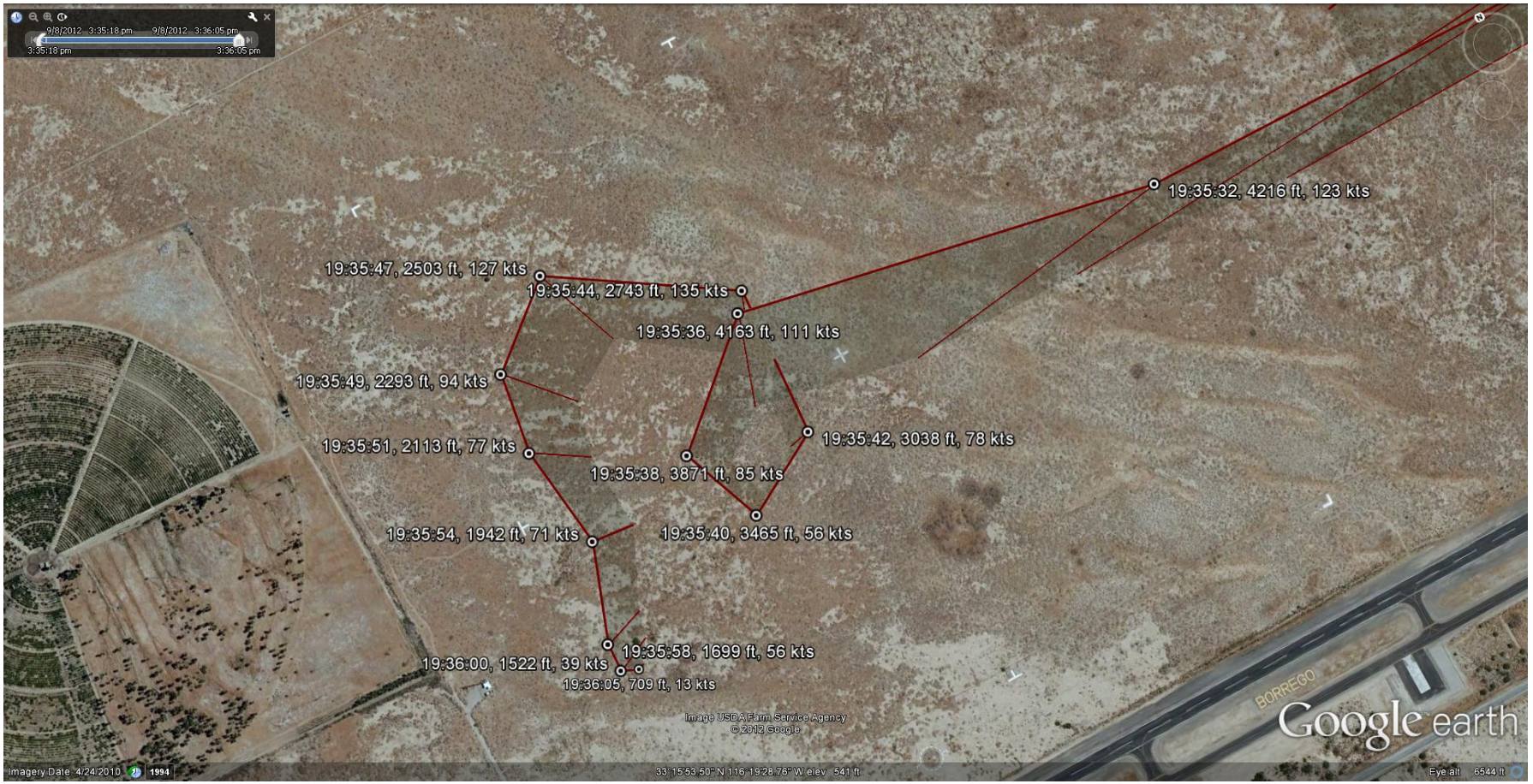


Figure 2. Accident flight take-off as recorded by the Garmin 496.

Figure 3. End of Accident Flight as recorded by the Garmin 496.



2.2. Electronics International EDC-33P Device Description

The Electronics International (EI) EDC-33P is an engine data converter. The unit converts all engine and aircraft sensor data to serial data which is then transmitted to the EI MVP-50P via two wires. The unit measures 4.5" long by 3.5" wide by 2.2" high and is typically mounted in an equipment bay. The unit has no user interface and records no data.

2.2.1. Electronics International EDC-33P Data Recovery

The EDC-33P does not record data and thus no data was recovered.

2.3. Electronics International MVP-50P Device Description

The Electronics International (EI) MVP-50P is a panel-mounted, active TFT matrix, color, electronic engine display allowing the operator to monitor and record parameters related to engine operations and user customizable parameters. The device is available in both a TSO'd and non-TSO'd version[4]. Depending on the installation, engine parameters monitored may include: Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), Oil Pressure and Temperature, Manifold Pressure, Outside Air Temperature, Engine Revolutions Per Minute (RPM), Fuel Flow, Fuel Levels, and Battery Voltage and Amperage. User customizable parameters may be defined by installation, examples include but are not limited to sensors for door states, annunciators, and flight control positions.

The unit can also calculate, in real time, percent of maximum horsepower, fuel used, shock cooling rate, and EGT differentials between highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

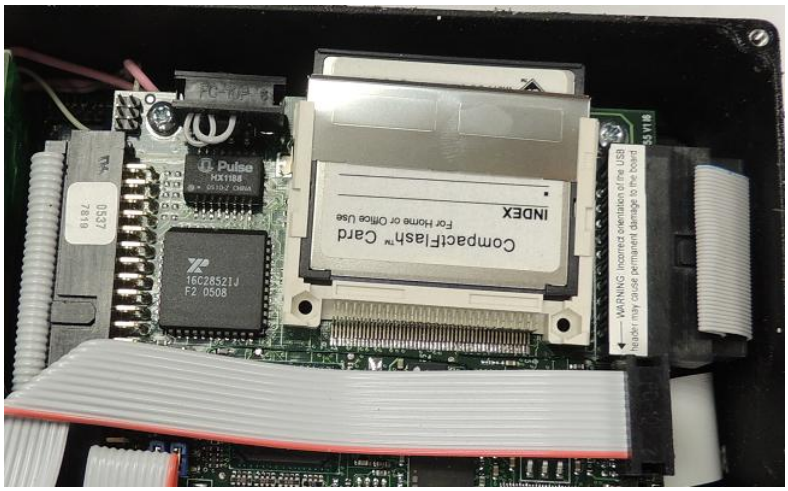
The unit contains non-volatile memory for data storage of the parameters recorded and calculated. The rate at which the data is stored is selectable by the operator. The recording function also records minimum and maximum values for each flight. The data is stored in engineering units in (.CSV) format on an internal CF card, using a Linux file system format. The (.CSV) data can be downloaded to a FAT16[5] USB memory device via a USB port on the front of the unit and MVP-50P built-in menu options.

2.3.1. Electronics International MVP-50P Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage. However, an internal examination revealed internal connectors had become dislodged. After repairing the internal connections, power was applied to the unit, but the screen would not display information. The internal CF card (see figure 4) was removed, and the (.CSV) data files were recovered without difficulty.

[4] Equipment installed in a manufactured airplane is defined by a Technical Standard Order (TSO).
[5] FAT means File Allocation Table and is a method of organizing files on an electronic device. The FAT16 format is an older format using a 16-byte addressing scheme.

Figure 4. CF card in EI MVP-50P.



2.3.2. Electronics International MVP-50P Data Description

The data extracted included over 800 flights. The recorded data contained timestamps indicating the oldest data was recorded in 2008, however the time source used was not verified for this report. The accident flight was the last recorded flight on the device, containing 532 data points recorded over a 15 minute, 20 second time period in MVP-50P recorded times from 12:32:10 to 12:48:10 on September 8, 2012. The data sampling interval varied between 1 and 3 seconds.

2.3.3. Electronics International MVP-50P Timing

The time source recorded on the MVP-50P engine history data could not be verified. The MVP-50 engine parameters were compared to the Garmin GPS 496 data points, and it was determined that the RPM increase at MVP-50P recorded time of 12:38:01 aligned with the Garmin GPS 496 recorded time of 19:26:12 UTC. Using this relationship, 06:48:11 (24,491 seconds) was added to the MVP-50P times to correct the recorded time and convert to UTC.

2.3.4. Electronics International MVP-50P Parameters Provided

Table 2 describes data parameters from the MVP-50P used in this report.

Table 2: MVP-50 Data Parameters

Parameter Name	Parameter Description
Time	Time (UTC) for recorded data point (HH:MM:SS)
CHT, 1-6	Cylinder Head Temperature, Cylinders 1 through 6 (degF)
EGT, 1-6	Exhaust Gas Temperature, Cylinders 1 through 6 (degF)

Parameter Name	Parameter Description
Volts	Battery Voltage (Volts)
RPM	Propeller Revolutions per Minute (RPM)
MP	Manifold Pressure (inHg)
Fuel_Main	Main Fuel Tanks (gallons)
Fuel_P	Fuel Pressure (psi)
Fuel_Flow	Fuel Flow (gph)
HP	Horsepower (%)
Oil T	Oil Temperature (degF)
Oil P	Oil Pressure (psi)

2.3.5. Electronics International MVP-50P Plots and Tabular Data

Figure 5 is a plot of all major parameters recorded by the MVP-50P during the accident flight. The recording began at 19:20:24. Before the presumed takeoff, there was a brief period of RPM values of about 1,700 between 19:24:22 and 19:24:57. The presumed takeoff was at 19:26:12, when CHT, EGT, RPM, MP, Fuel Flow, Oil Pressure, and HP all increased. During the flight, MP, RPM, Fuel Flow, and Oil Pressure all fluctuated. The manifold pressure and RPM decreased at 19:35:35; thereafter the RPM increased slightly as the recording ended.

Figure 5. EI MVP-50P plot of all major parameters - accident flight.