

**Summary of Download and Analysis of
One N1 Digital Electronic Engine
Control from
San Clemente, CA
Learjet 36A Accident Aircraft
Registration N56PA**

1 INTRODUCTION AND SUMMARY

1.1 PURPOSE

From October 30, 2023 through March 4, 2024, the investigation of one N1 Digital Electronic Controls (N1 DEECs) was conducted at the request of and under the cognizance of the National Transportation Safety Board (NTSB).

1.2 BACKGROUND

The N1 DEEC S/N 105-CM0005 was installed on a TFE731-2C-2B engine, serial number P74358 (LH)¹, of a Learjet 36A aircraft, Registration Number N56PA, Serial Number 36A-023. The aircraft experienced an in-flight fire and made a series of descending turns prior to impact near San Clemente Island, CA, on May 10, 2023 at 0749 PDT. The three occupants on board were fatally injured and the aircraft was destroyed. The aircraft had departed Point Mugu Naval Air Station (KNTD), Oxnard, CA as the lead airplane in formation with a second Learjet airplane at 0723 PDT. Only one N1 DEEC was recovered with the aircraft wreckage. The DEEC was submerged in distilled water after recovery from the ocean.

Prior to downloading the data, the circuit card was removed from the N1 DEEC and rinsed with deionized water then placed in a temperature chamber for 169 hours at 50° Celsius to dry. The chip containing the non-volatile memory exhibited corrosion and an initial download attempt was not successful. The chip manufacturer was requested to support and successfully extracted the data from the chip's die. The extracted data was copied to an exemplar chip and was downloaded using proprietary software.

1.3 N1 DEEC S/N 105-CM0005 ANALYSIS

The data shows the following:

- Throughout the accident flight, until the FCU PLA Circuit Failure Fault (at approximately time stamp² 50 seconds), the engine appears to be operating and correctly responding to Power Lever (PLA) movements.
- At time stamp 50 seconds through the remainder of the dataset, the N2 and PLA parameters indicate N2 Signal Fail and No Valid Data,

¹ For the purpose of this background information, the identification of the N1 DEEC was determined by the data downloaded from the NVM chip. The assignment of the N1 DEEC to the left hand engine is based on the SN in the downloaded data and position of that engine SN as determined by the wreckage review.

² The time stamp represents the number of seconds remaining until the end of recorded data.

respectively. This coincides with faults indicating a failure of the FCU PLA circuit and the N2 Monopole Circuit being open or shorted.

- When a FCU PLA Circuit Failure Fault occurs, the computer switches to manual mode (time stamp 50 seconds). When in manual mode, fuel is being metered solely by the hydraulic-mechanical fuel control. Metering is based on fuel, P3, PLA input, and N2 speed. The PLA input is a mechanical connection to the fuel control through push/pull links and flexible cables. The mating of the fuel control to the fuel pump provides for the fuel supply and return and the mechanical N2 speed. The FCU PLA circuit and N2 Monopole circuit faults would not prohibit engine operation in manual mode.
- The recorded ITT datapoints are consistent with the expected ITT values for the recorded N1 speeds. The PLA and N2 data are consistent with the expected values for the recorded N1 speeds up until the final twenty seconds of data, consistent with the introduction of circuit faults.
- The DEEC records data when the engine is operating, which is defined as when N2 exceeds a minimum threshold and ITT exceeds a specified value. The DEEC continues to record data as long as power is applied. The recording will end when power to the DEEC is removed or when WOW = 1 (on ground), engine shutdown has occurred, and five minutes has elapsed. As the data does not capture an N1 decrease consistent with engine shutdown, it is unknown if the end of the dataset corresponds with loss of DEEC power prior to or corresponding to aircraft impact.

1.4 CONCLUSIONS

The download of the incident recorder data and fault history data from the N1 DEEC was completed successfully. The DEEC data indicated at the subject DEEC was associated with engine SN P74358, which had been identified as the LH engine during the wreckage review. The engine was operating and responding to PLA inputs and under DEEC control until the PLA Circuit Failure fault occurred. The engine then appears to be operating in manual mode. The DEEC data ends prior to a recorded engine shut down. It is unknown if the end of the dataset corresponds with loss of DEEC power prior to or corresponding to aircraft impact.

DATA FILE CHRONOLOGY

TFE731 TURBOFAN ENGINES

Honeywell E&S

Engine Serial Number
074358

DEEC Serial Number	Download Count	Date/Time
105-CM0005	93	03/05/24 11:34

DEEC TIME STAMP (H:M:S.T)	ELAPSED TIME (H:M:S.T)	EVENT
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Flight Number 6 End

10247:53:27.0	0:33:00.9	Engine Rolldown
10247:53:26.6	0:33:00.5	Fault number 80
10247:53:26.3	0:33:00.2	Manual Mode Transfer
10247:53:26.3	0:33:00.2	Fault number 38
10247:53:26.2	0:33:00.1	Fault number 211
10247:53:26.1	0:33:00.0	Fault number 26
10247:53:26.1	0:33:00.0	Fault number 237
10247:53:26.1	0:33:00.0	Slow Scan 2 end Manual Mode Transfer event
10247:53:09.6	0:32:43.5	Fault number 37
10247:53:09.3	0:32:43.2	Fault number 85
10247:53:07.9	0:32:41.8	Fault number 80
10247:52:51.0	0:32:24.9	Fault number 211
10247:52:48.2	0:32:22.1	Fast Scan 2 end Manual Mode Transfer event
10247:52:39.3	0:32:13.2	Fault number 12
10247:52:38.3	0:32:12.2	Manual Mode Transfer
10247:52:38.3	0:32:12.2	Fault number 237
10247:52:38.2	0:32:12.1	Fault number 210
10247:52:18.3	0:31:52.2	Fast Scan 2 begin Manual Mode Transfer event
10247:48:41.1	0:28:15.0	Slow Scan 2 begin Manual Mode Transfer event
10247:36:11.3	0:15:45.2	Engine Cruise Performance
10247:30:17.4	0:09:51.3	Aircraft Take Off
10247:20:26.1		Engine Start

Flight Number 6 Start

Flight Number 5 End

10246:53:27.1	2:41:35.9	Engine Rolldown
10244:31:31.3	0:19:40.1	Engine Cruise Performance
10244:23:39.6	0:11:48.4	Aircraft Take Off
10244:11:51.2		Engine Start

Flight Number 5 Start

Flight Number 4 End

10243:59:27.3	2:36:43.1	Engine Rolldown
10241:37:48.6	0:15:04.4	Engine Cruise Performance
10241:31:28.1	0:08:43.9	Aircraft Take Off
10241:22:44.2		Engine Start

Flight Number 4 Start

Flight Number 3 End

10236:11:27.5	2:25:59.3	Engine Rolldown
10233:57:55.9	0:12:27.7	Engine Cruise Performance
10233:54:38.2	0:09:10.0	Aircraft Take Off
10233:45:28.2		Engine Start

Flight Number 3 Start

Flight Number 2 End

10233:35:26.7	4:10:25.2	Engine Rolldown
10229:48:51.7	0:23:50.2	Engine Cruise Performance
10229:39:00.0	0:13:58.5	Aircraft Take Off

DATA FILE CHRONOLOGY

Engine Serial Number
074358

DEEC TIME STAMP (H:M:S.T)	ELAPSED TIME (H:M:S.T)	EVENT
10229:25:01.5		Engine Start
Flight Number 2 Start		
Flight Number 1 End		
10229:16:53.3	0:57:38.7	Engine Rolldown
10228:29:22.2	0:10:07.6	Engine Cruise Performance
10228:24:38.6	0:05:24.0	Aircraft Take Off
10228:19:14.6		Engine Start
Flight Number 1 Start		

ENGINE FAULT HISTORY

TFE731 TURBOFAN ENGINES

Honeywell E&S

Engine Serial Number
074358

DEEC Serial Number	Download Count	Date/Time
105-CM0005	93	03/05/24 11:34

NO.	TIME STAMP (H:M:S.T)	FAULT	FAULT	LRU	FAULT DESCRIPTION
		SEVERITY CODE	CODE		

Deec Serial Number	Download Count	Date/Time
105-CM0005	93	03/05/24 11:34

Total Number of Faults = 12

1	10247:53:26.6	4	80	SBV A	Surge Bleed Valve A Solenoid Open circuit
2	10247:53:26.3	4	38	TT2	TT2 Short Circuit (TT2 < 190 ohms)
3	10247:53:26.2	4	211	FCU	Fuel Control PLA Circuit Failure
4	10247:53:26.1	2	26	ITT	ITT thermocouple circuit open Circuit fail, Defaults to 260 C
5	10247:53:26.1	2	237	NOTICE	ECTM Data buffers filled. Download Required to prevent data loss.
6	10247:53:09.6	4	37	TT2	TT2 Open Circuit (TT2 > 730 ohms)
7	10247:53:09.3	4	85	SBV B	Surge Bleed Valve B Solenoid Circuit Open
8	10247:53:07.9	4	80	SBV A	Surge Bleed Valve A Solenoid Open circuit
9	10247:52:51.0	4	211	FCU	Fuel Control PLA Circuit Failure
10	10247:52:39.3	4	12	N2	N2 Monopole Circuit open or shorted (across pins or to ground)
11	10247:52:38.3	2	237	NOTICE	ECTM Data buffers filled. Download Required to prevent data loss.
12	10247:52:38.2	4	210	FCU	Fuel Control PLA Circuit Failure

Phoenix Air Group Inc, Learjet 36A, N56PA
San Clemente CA, May 10, 2023
1-5120 Seconds of Data

P74358 Eng 1: Left Engine S/N
0 Eng 2: Right Engine S/N
0



