NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C. 20594

September 15, 2003

SDAC Bench Test Addendum 2 to the Flight Data Recorder Group Chairman's Solid State Flight Data Recorder Factual Report

A. EVENT

NTSB #: DCA02MA001
Location: Belle Harbor, New York
Date: November 12, 2001
Time: 0916 Eastern Standard Time (EST)
Aircraft: Airbus Industrie A300-600, registration: N14053

B. ATTENDEES

FDR Group Chairman: Cassandra Johnson, National Transportation Safety Board (NTSB)
FDR Group Member: Yves Le Biannic, Airbus Industrie[1]
FDR Group Member: Maurice Ingle, American Airlines (AAL)
FDR Group Member: Jérôme Bauer, Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA)
FDR Group Member: TR Proven, Federal Aviation Administration (FAA)
Aircraft Performance Group Chairman: John O'Callaghan, NTSB
Aircraft Performance Group Member: Jim Wilson, Allied Pilots Association (APA)

The above attendees convened at Airbus Industrie in Toulouse, France on the 4th and 5th of February 2002 and conducted the System Data Analog Converter (SDAC)[2] bench test.

C. PURPOSES

I. TEST SERIES 1 TO 7 PURPOSE

The main purpose of the SDAC bench test was to define the filtering function and the associated processing delay of the SDAC. The SDAC applied a filter to the flight data recorder (FDR) flight control surface position parameters: rudder position, aileron left position, aileron right position, elevator position, and horizontal stabilizer position. The analog signals from the flight control surface position sensors are sent to the SDAC and processed into a filtered digital signal. The SDAC sends the filtered digital signal to the Digital Flight Data Acquisition Unit (DFDAU), which in turn sends the filtered digital signal to the FDR for recording.

[1] Airbus Industrie will be referred to as Airbus for the rest of the document.
[2] In other Airbus documents, the SDAC has also been referred to as the System Data Acquisition Concentrator.

Seven different test series, referred to as test series 1 to 7, were conducted to define the SDAC's filter and associated delay. For these tests, calibrated signals were generated and processed by the SDAC. Both the input test data and SDAC output data were recorded for comparison. Attachments I and II contain the SDAC bench test details.

II. TEST SERIES 8, 9, AND 10 PURPOSE

In addition to test series 1 to 7, the SDAC bench test attendees agreed to add test series 8, 9, and 10. The purpose of these tests were to define the DFDAU output values sent to the FDR when a position sensor's wiring was compromised by disconnecting the sensor signal wires (X, Y, Z, and Reference) individually and collectively. In particular, we wanted to understand what the FDR records when the SDAC sends a non-computed data (NCD) signal to the DFDAU. In order to replicate the FDR system on the accident aircraft, the same type of DFDAU (part number 775110-21-006) and FDR (FA2100) aboard the accident aircraft were used for these tests.

III. TEST SERIES 11 PURPOSE

The purpose of test series 11 was to input data into the SDAC and then compare the SDAC output data to the calculated filtered output data. The calculated filtered output data were computed by applying the filter defined by test series 1 to 7 to the input data. The input data were Airbus's first estimation of the accident aircraft's flight control surface movements.

E. SUMMARY

I. TEST SERIES 1 TO 7 AND 11 SUMMARY

Both the NTSB and Airbus analyzed the test results from test series 1 to 7 independently, and both reached the same conclusion that the SDAC applies a first order lag filter with a 0.434 second time constant. Test series 11 supports the conclusion that the SDAC's filter is a first order lag filter with a 0.434 second time constant. Attachment VI contains Airbus's analysis and results. Attachment III contains NTSB's plots of test series 1 to 7 and 11 where each plot contains the input calibrated data, the SDAC output data and the calculated SDAC output data[3].

II. TEST SERIES 8, 9 AND 10 SUMMARY

Both the NTSB and Airbus analyzed test series 8, 9, and 10 independently and both concluded that the FDR recorded 3 different values[4] with respect to disconnecting the wires individually and collectively. The first value recorded by the FDR was approximately 44° when only the X signal wire was removed with 0°, 10°, and –10° synchro inputs. The second value recorded by the FDR was approximately -46° when only the Y signal wire was removed with 0°, 10°, and –10° synchro inputs. Lastly, the last value recorded by the FDR was 0° when all other combination of signal wires were removed with 0°, 10°, and –10° synchro inputs. In the last scenario, the SDAC produced a NCD signal to the DFDAU.

[3] The calculated SDAC output data was computed by applying the first order lag filter with a 0.434 second time constant applied to the SDAC input data. NTSB refers to the calculated SDAC output as the "Filtered Input".
[4] The absolute values were the same. The following values are from NTSB.

These results can be seen in Attachment IV and V for NTSB's plots and Airbus's table, respectively.

F. ATTACHMENTS

The following table describes the Attachments included in this report.

Attachment	Total Pages	Description
I	4	SDAC Bench Test Description. Airbus Document TN 761.0006/2002
II	14	SDAC Bench Test Protocol Proposed. Airbus Document TN 517.0013/2002
III	112	NTSB's Plots of SDAC Bench Test Series 1 to 7 and 11.
IV	4	NTSB's Plots of SDAC Bench Test Series 8, 9, and 10 (Removing Wires).
V	216	Airbus's SDAC Bench Test Report & Analysis. Airbus Document LD_0007/2002
VI	27	Airbus's Result from SDAC Bench Test. Airbus Document TN 506.0008/2002

Table 1

G. TABULAR DATA

All of the input and SDAC output data were originally supplied by Airbus in tabular format (i.e., engineering units). Airbus also supplied the FDR data for each test in both tabular format and in raw[5] format.

The provided tabular data for test series 1 to 7 and 11 include the input data and the SDAC output data. This data includes multiple sets of data for each test because each test was run twice or three times so to prevent loss of data due to possible equipment failure. The FDR data were not provided for test series 1 to 7 and 11 since the FDR data were not needed to define the filter.

The provided tabular data for test series 8, 9, and 10 include the input data, the SDAC output data and the FDR data converted into engineering units by NTSB.

All tabular data provided in this report are electronic files and only exist in the docket.

Cassandra Johnson
FDR Specialist, Mechanical Engineer

[5] Refer to the Flight Data Recorder Group Chairman's Solid State Flight Data Recorder Factual Report for more information on raw FDR.

Attachment I
SDAC Bench Test Description
Airbus Document TN 761.0006/2002

1. GENERAL DESCRIPTION

The aim of this test installation is firstly to characterize the filtering function implemented in the SDAC on synchro surface position information, and secondly to determine the control surface deflection sequence which would have generated the same FDR recordings as experienced on A300-600 MSN 420.

The typical functional line on aircraft can be described as following :

An angular position sensor transmits a synchro type signal that transits through the SDAC, where it is filtered and converted into ARINC 429 signal. Then the signal transits through the DFDAU, where it is filtered and converted into ARINC 717 signal, it is finally recorded by the FDR.

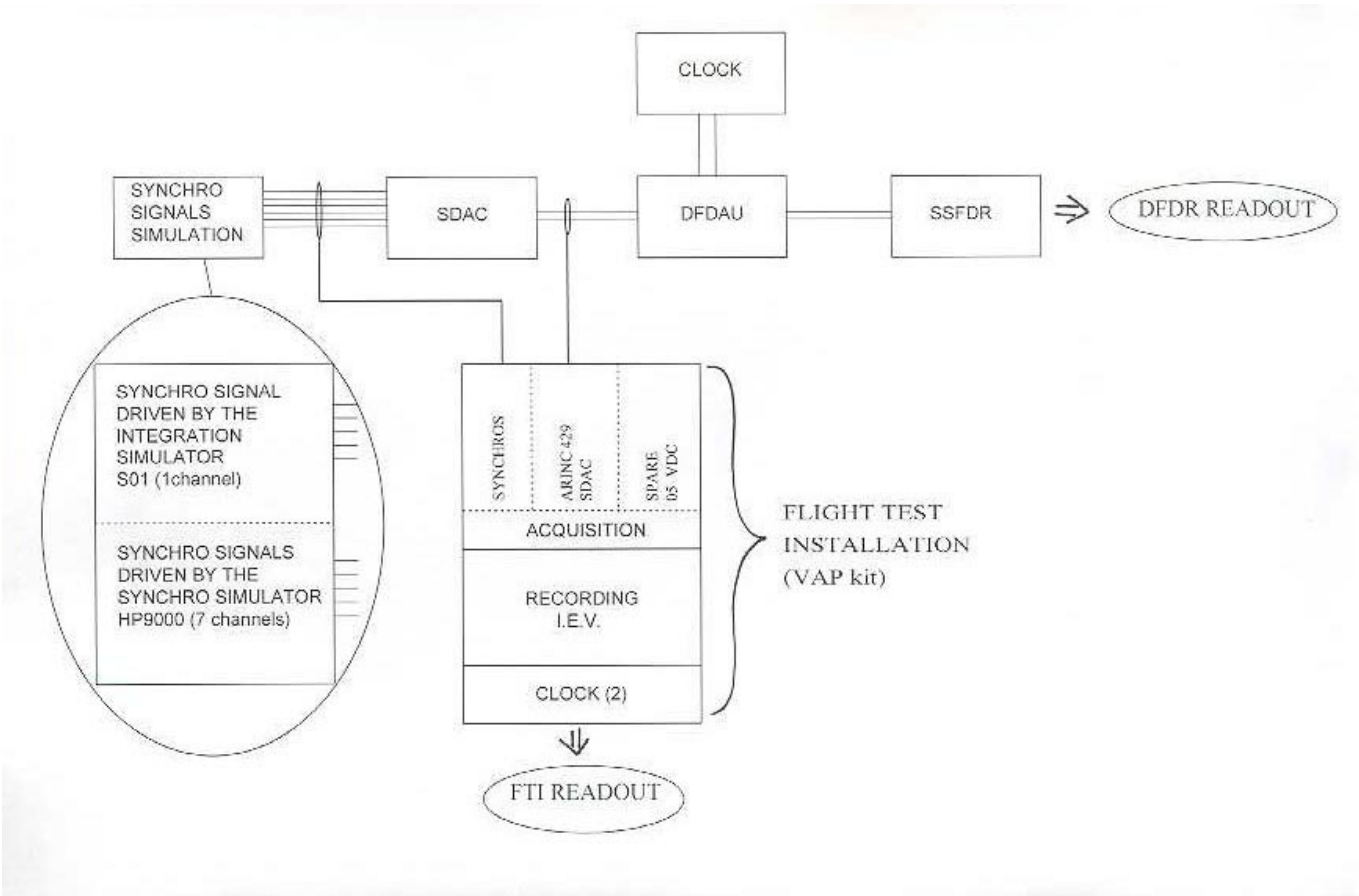
- To characterize the filtering function and processing delay of the SDAC, it is necessary to generate calibrated signals and to record them at the input and the output of the SDAC.

Then, the angular position sensors at the input of the SDAC, these have been replaced by computer driven analog boards to generate calibrated signals. And the input and the output of the SDAC are recorded by an autonomous recording mean which is a portable mini flight test installation.

- To determine the control surface deflection sequence which would generate the same FDR recordings as those experienced in the case of the A300-600 MSN 420, the signals at the output of the DFDAU are recorded by the FDR of the installation.

Note : The mini flight test installation is not capable of recording ARINC 717 signals. Therefore , the FDR data are processed in another site, with conventional means which are the same as those needed for FDR data analysis of current AIRBUS aircraft.

2. BLOCK DIAGRAM



3. PERFORMANCE AND LIMITATIONS

3.1. Synchro signal simulation

Two types of synchro signal generation means are used with the following characteristics :

A - Synchro signal simulation controlled by the computer of the integration simulator S01. The performance and limitations of this system are:

- Only one synchro signal can be driven,
- The refresh period of the control is 40ms,
- The signal is linearly interpolated between two successive points,
- The shape of the signal can be programmed,
- Analog board precision of 0.1°,
- The board is at about 15 meters from the SDAC.

B - Synchro signal simulation controlled by a HP9000 station. The performance and limitations of this system are the following :

- 7 synchro signals can be driven,
- The refresh period of the control is 1ms,
- The signal is a succession of values maintained during a defined time,
- The shape of the signal can programmed,
- Analog board precision of 0.1°

In fact, both simulations means, A and B, are complementary. They have different advantages and drawbacks :

System A :

Pros :

- the generated signals are continuous,
- it is easier to program certain shape of signals, like a trapezium.

Cons :

- only one synchro signal simulation capability,
- 40 msec refresh interval, cannot be modified

System B :

Pros :

- up to seven different synchro signals can be simultaneously generated,
- the refresh interval is very small : 1 msec.

Cons :

- the programming of certain shapes of simple signals like a trapezium takes as long as that of dynamic complex curves (point by point).
- The signal is not continuous, it is composed of a series of small steps (1 or n msec apart)

3.2. SDAC bay

The Part Number and the Serial Number of the SDAC used are P/N 66501-005-1, S/N 1033. The inputs of the SDAC are generated by the bay which simulates all necessary aircraft signals. A connecting box is used to inject the simulated synchro signal into the SDAC.

3.3. DFDAU, FDR and CLOCK mobile bay

A DFDAU, manufactured by TELEDYNE with 57 parameters transmitted at 64 words/second speed ,similar to the one installed on aircraft, will be used for the tests.

The clock has digital display. P/N : APE5100-1 S/N : 5.

The FDR used is a SSFDR manufactured by L3com, (different of the one installed on the aircraft) P/N 2100-4043-02 S/N 147496.

3.4. Autonomous recording mean

The recording mean which is used is a Flight Test Installation (called VAP) composed of an acquisition box, a recording set and a clock.

The signals recorded on this VAP kit are the following :

- rudder synchro (32 sps),
- both aileron synchro, LH and RH (32 sps),
- elevator synchro (32 sps),
- One spare input 0/5VDC discrete type (32 sps),
- The SDAC output bus (32 sps for each label), the transmit interval of the corresponding ARINC 429 words on the SDAC output bus is 125 msec (8sps),
- GMT (FTI clock).

The records are then processed by standard flight test tools.

Note : sps : sample per second,

SDAC : System Data Analog Converter,

DFDAU : Digital Flight Data Acquisition Unit,

FDR : Flight Data Recorder,

FTI : Flight Test Installation.

Attachment II
SDAC Bench Test Protocol Proposed
Airbus Document TN 517.0013/2002

1. PURPOSE OF THIS STUDY

The flight control surface position signals which are recorded by the FDR are received from a SDAC computer. The SDAC (System Data Acquisition Concentrator) acquires the position sensors, then processes and filters them. The purpose of this note is to provide the proposed test protocol using a laboratory test installation in order to identify the SDAC behavior.

An iterative process will then take place with successive simulations to find eventually the flight control surface position history from the data recorded by the DFDR, particularly during the flight control checks before departure, and during the last 10 seconds before the accident.

2. SDAC IDENTIFICATION

A test bench installation has been developed in the laboratory (see TN 761.0006/02) to simulate synchro signals of different shapes, then inject them in a real SDAC computer working in its nominal operation, and finally record its output signals thanks to real DFDAU/FDR units. In parallel, a laboratory/flight test installation allows the fine recording of all input and output signals.

The SDAC identification will be done by injecting several basic input signal described in Annex 1. These basic input signals are composed of steps, ramps, impulses and waves, which response are well known for a first order filter and more complex filters as well. This will allow to determine if the SDAC reacts as a pure first order filter or is the sum of several filters, this will be also possible to confirm the SDAC filter time constant.

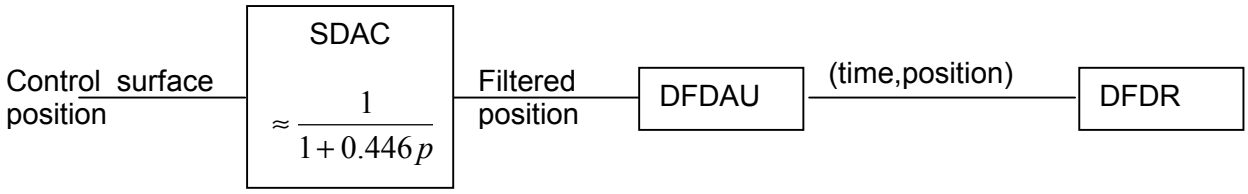
Several SDAC computers (say 3) will be tested to check tolerances on their output signals.

3. FLIGHT CONTROL SURFACE POSITION HISTORY RECONSTITUTION

3.1 INITIATION OF THE PROCESS

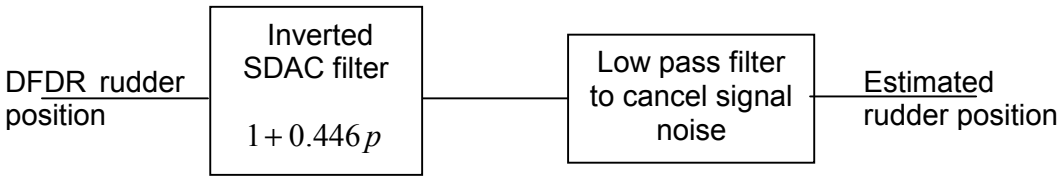
The first part of this process aims at finding the first estimate of the flight control surface position signals which will be injected in the laboratory test installation to reconstitute the flight control position as explained in section 3.2.

The data which are available for all this process are the DFDR position recording. The recorded information is coming from the DFDAU, which samples the data coming from the SDAC with a time stamp information. It has been assumed that the DFDAU does not introduce any signal distortion. On the other hand the SDAC, which collects the information of the primary control surface position, has a built in signal processing, which is a digital filter close to a first order filter with a 446 ms time constant.



Basically, to find the first estimate, the FDR recorded parameter signal is first smoothed by a cubic interpolation, then this signal goes through the inverted function of the SDAC filter (using its mathematical model) programmed in MATLAB. This results in a very noisy signal, which is processed through a low pass filter to obtain the estimate of the actual flight control surface position.

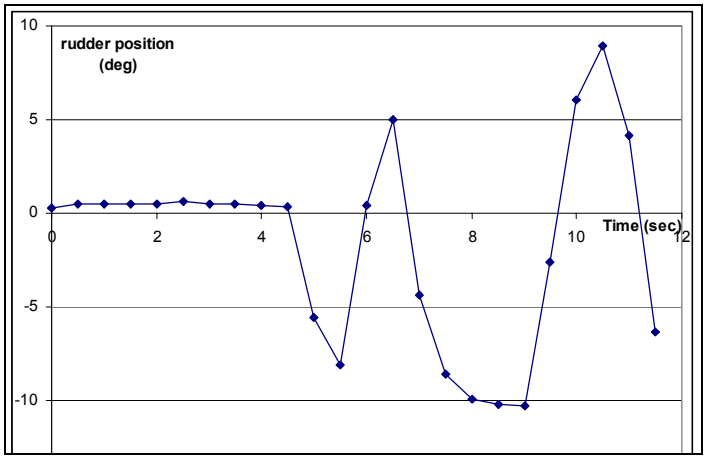
Matlab program :



3.1.1 Rudder

The DFDR parameter value recordings in the last moments of the accident for the rudder position are the following :

Time	dr	Time	dr
0,000	0,255	6,000	0,431
0,500	0,519	6,500	5,001
1,000	0,519	7,000	-4,395
1,500	0,519	7,500	-8,613
2,000	0,519	8,000	-9,932
2,500	0,607	8,500	-10,195
3,000	0,519	9,000	-10,283
3,500	0,519	9,500	-2,637
4,000	0,431	10,000	6,056
4,500	0,343	10,500	8,957
5,000	-5,537	11,000	4,122
5,500	-8,086	11,500	-6,328



Time 0 corresponds to 14h15 min 48 sec GMT on the DFDR.

The first estimated rudder position is shown on the following curve :

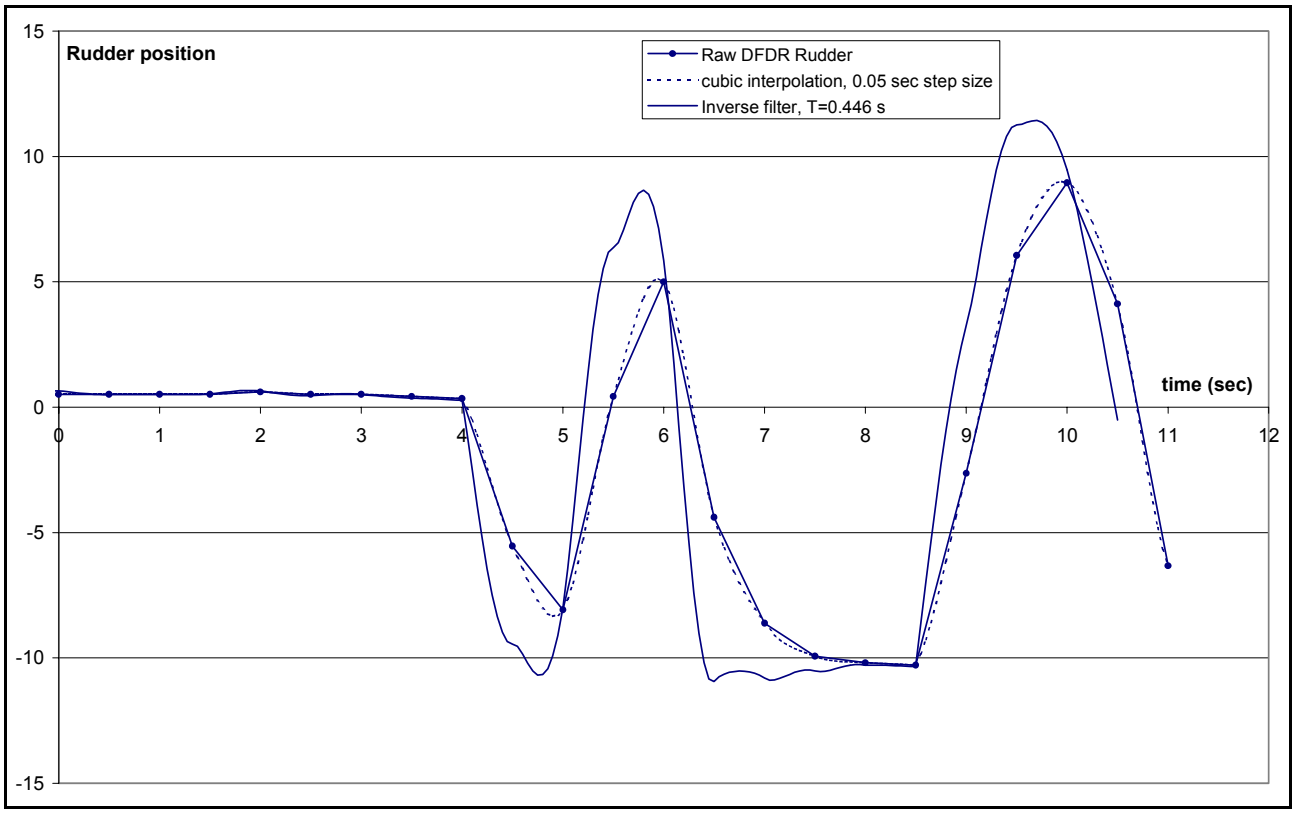


Figure 1- Estimated rudder position, status 0

3.1.2 Ailerons

Concerning the aileron position information, the data measured by the sensors follow the same signal flow as the rudder. So we can apply the same Matlab program to invert the aileron parameter signals given from the FDR recorded values.

On the DFDR we have one sample per second for each aileron. As they are not sampled at the same time it is possible to elaborate a two samples per second information. This operation is not easy as the ailerons are not symmetric. Actually, when one aileron has a –15 degree deflection, the symmetrical aileron has a 12.5 degree deflection. To cope with this problem, the left aileron position information has been chosen, and the right aileron position information has been corrected to take the asymmetry into account.

Then this elaborated aileron position information signal has been fed through the Matlab program to have the first actual aileron position estimation.

The first estimate of the actual aileron position is shown on the following curve :

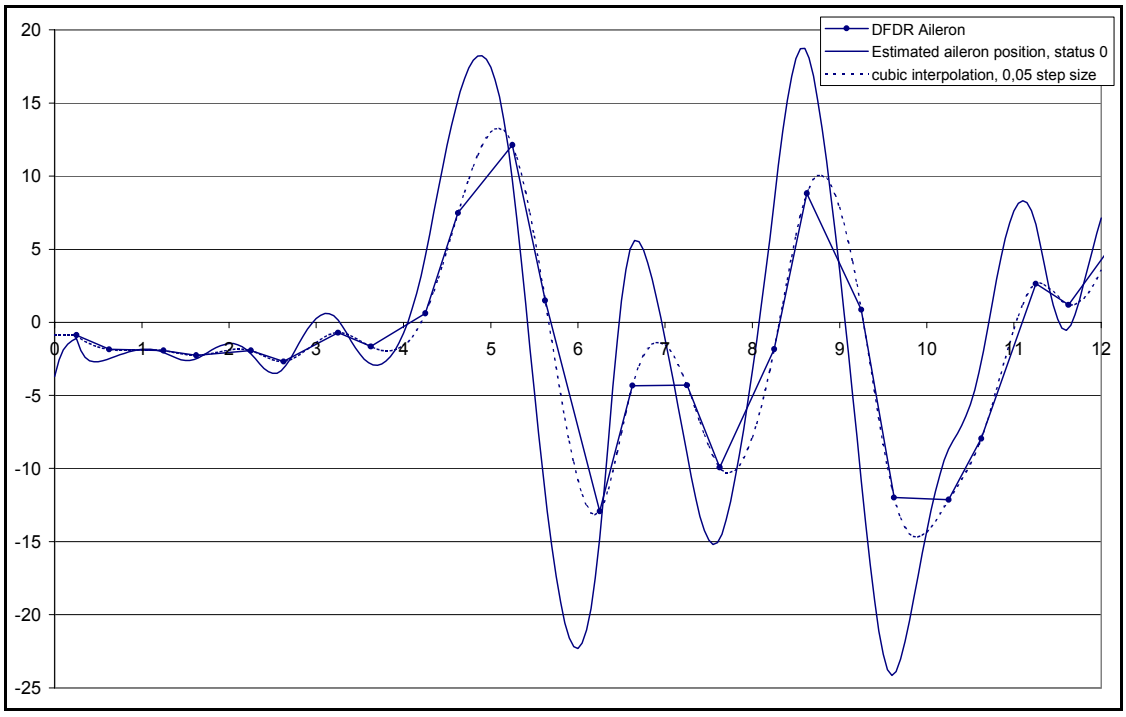


Figure 2- Estimated aileron position, status 0

3.1.3 Elevators

Once again the Matlbab program is used to invert the SDAC filter. It has been done with the DFDR recordings of the elevator position.

The first estimate of the actual elevator position is shown on the following curve :

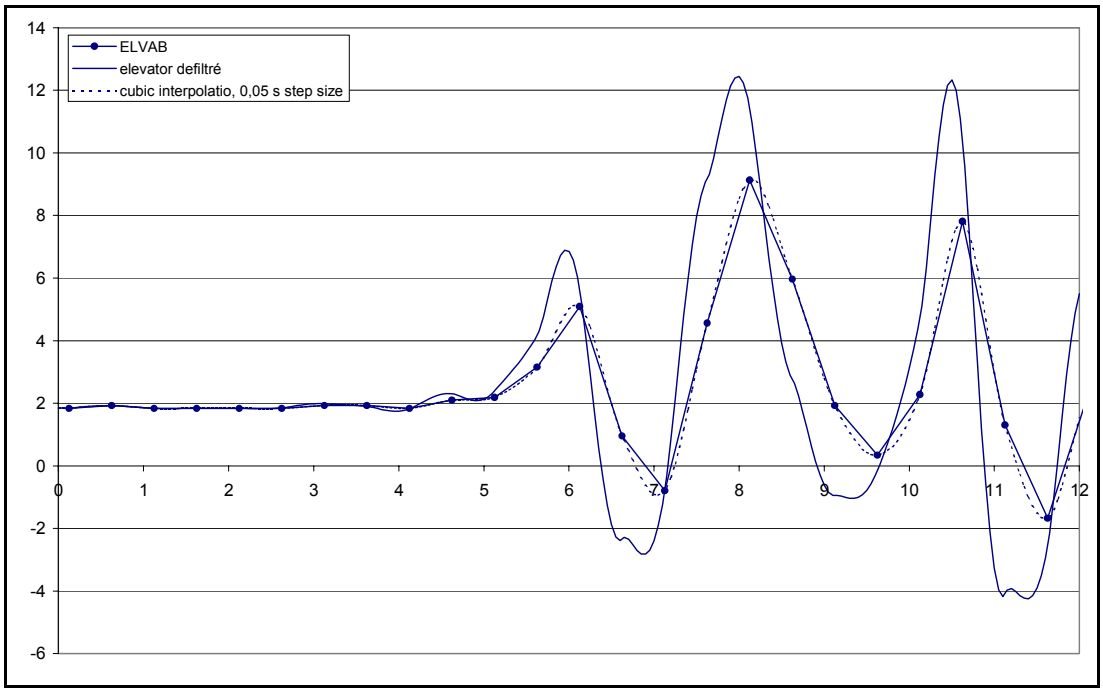


Figure 3 - Estimated elevator position, status 0

3.2 ITERATION TO RECONSTITUTE THE FLIGHT CONTROL POSITION HISTORY

As the estimate of the control surface position (status n) will go through this laboratory test bench installation it will be possible to compare its signature on the laboratory DFDR with the DFDR signature from AAL Flight 587. Then the differences will be analyzed in order to have a new set of data (status n+1) which will go through the test installation and hopefully have a closer signature.

Typical example obtained for the rudder position, for the set of data corresponding to a given loop :

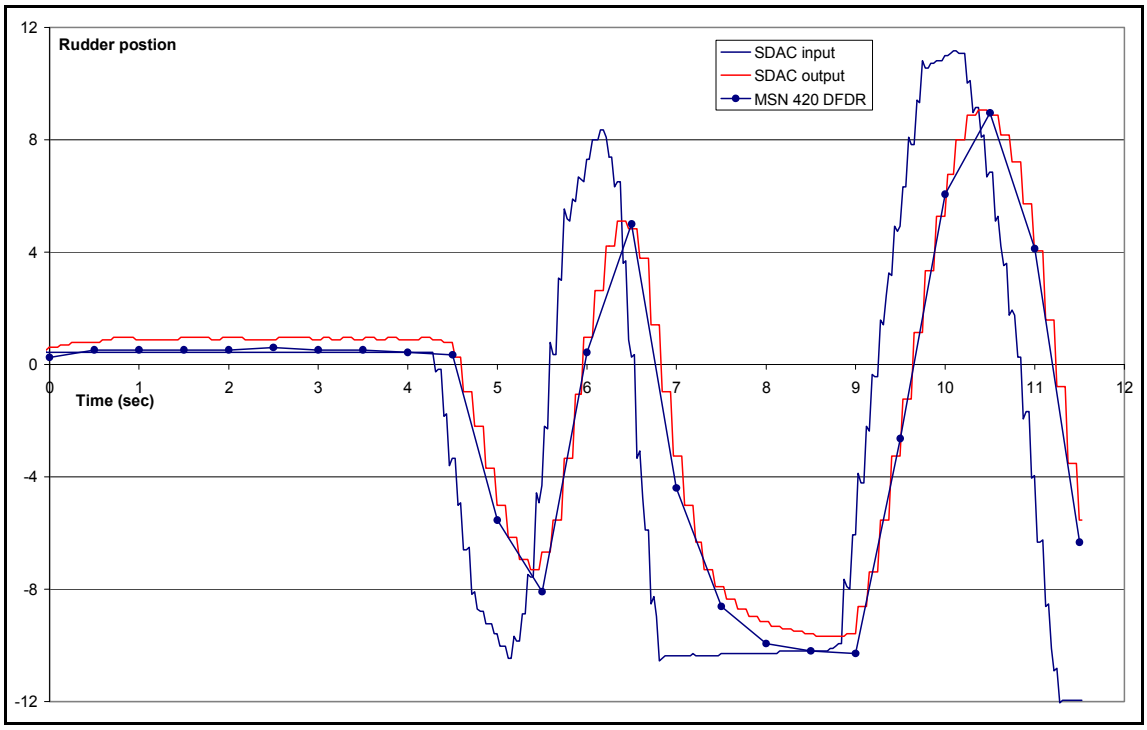


Figure 4 - Rudder position, status n result

4. ANALYSIS OFTHE RESULTS

The signals are recorded by different means :

- Plots on S01 simulator
- Mini flight test installation
- DFDAU/FDR

Refer to TN 761.0006/02, which describes the test installation in the laboratory, for further explanation.

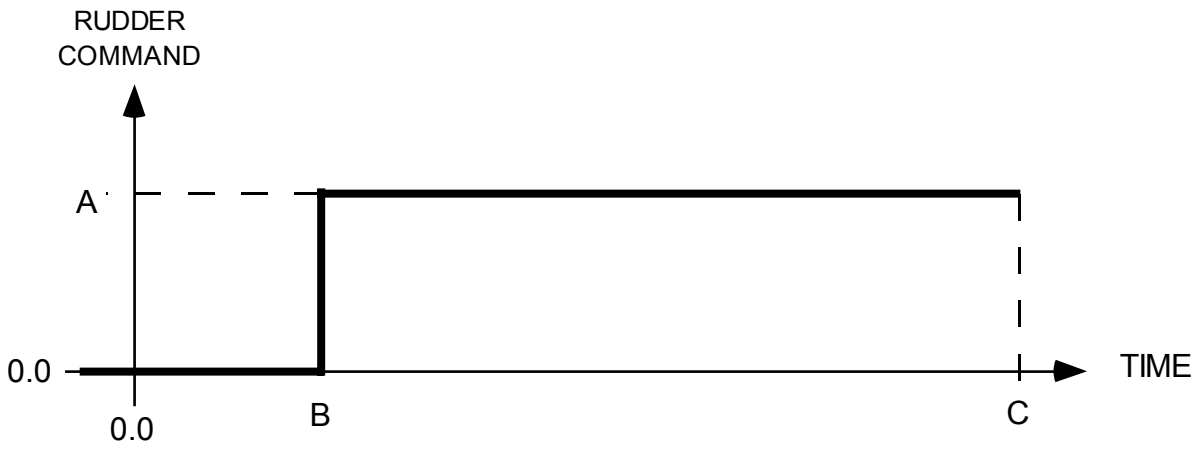
The results concerning the mini flight test installation and the FDR will be obtained after further processing in another site. These will be given in “Results Transmission Notes”, with the corresponding data analysis.

Each test will have a reference number :

- For the SDAC identification, these numbers will be as requested by NTSB (see annex 1)
- For the flight control surface position reconstitution, the reference numbers will be as follows:
  - RUDDER 0,1,2 etc
  - AILERON 0,1,2 etc
  - ELEVATOR 0,1,2 etc

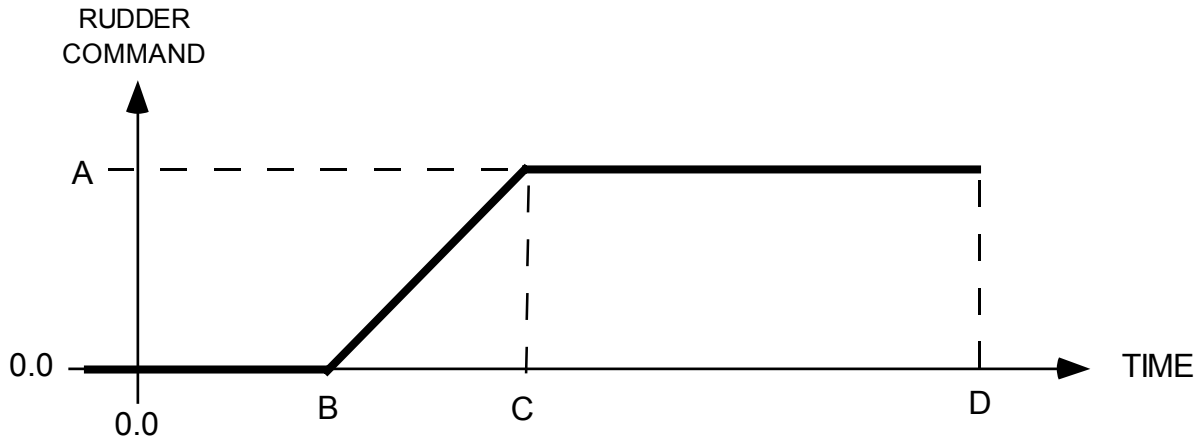
ANNEX 1

Test Series 1: Step Inputs



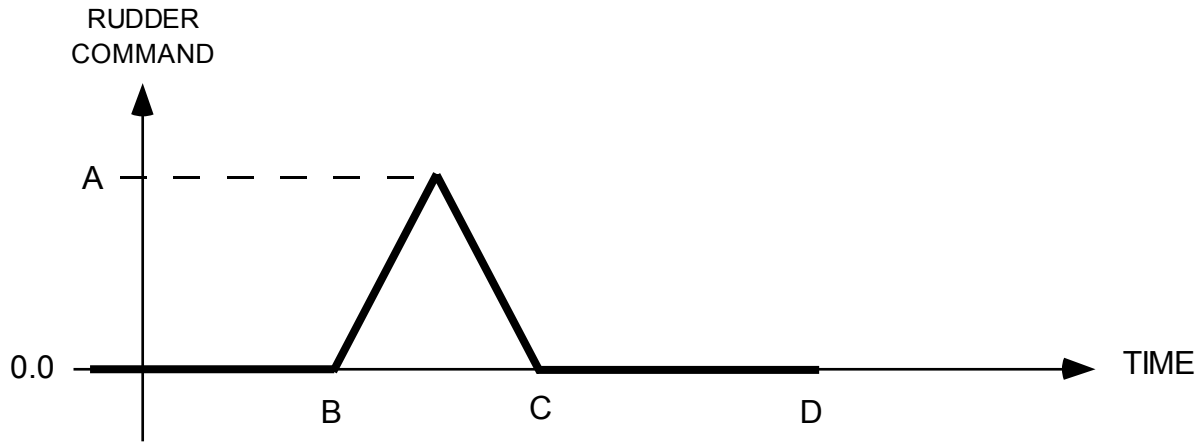
Test Number	A (degrees)	B (seconds)	C (seconds)
1.1	10	5	35
1.2	-10	5	35
1.3	20	5	35
1.4	-20	5	35
1.5	30	5	35
1.6	-30	5	35

Test Series 2: Ramp Inputs



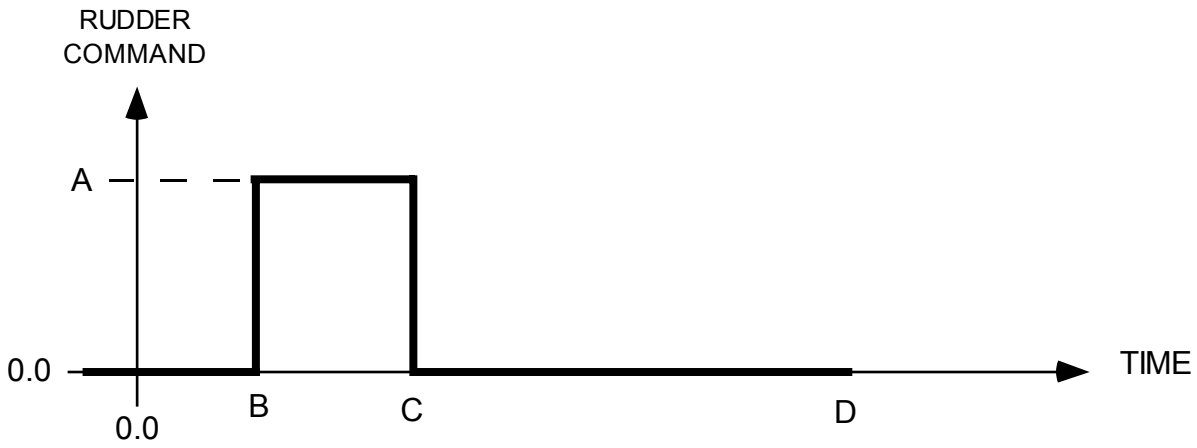
Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
2.1	10	5	25	35
2.2	10	5	15	25
2.3	10	5	10	20
2.4	10	5	7	17
2.5	10	5	6	16
2.6	10	5	5.5	16
2.7	10	5	5.25	16

Test Series 3: Double Ramp Inputs



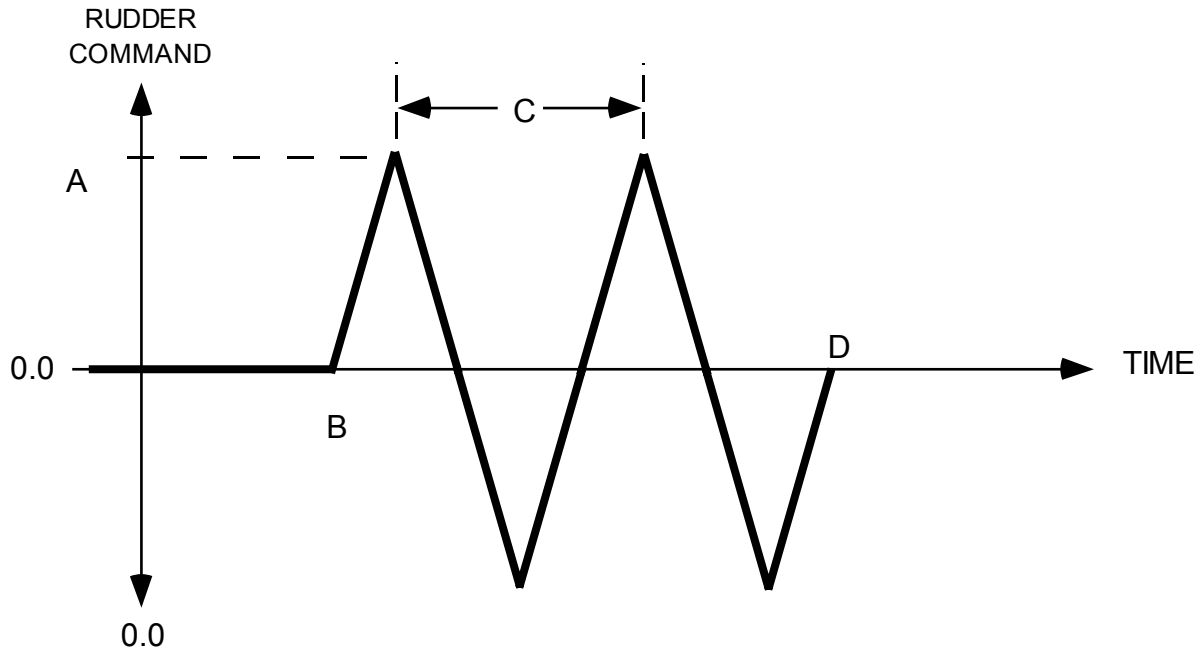
Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
3.1	10	5	25	35
3.2	10	5	15	25
3.3	10	5	10	20
3.4	10	5	7	17
3.5	10	5	6	16
3.6	10	5	5.5	16
3.7	10	5	5.25	16

Test Series 4: Square Impulse Inputs



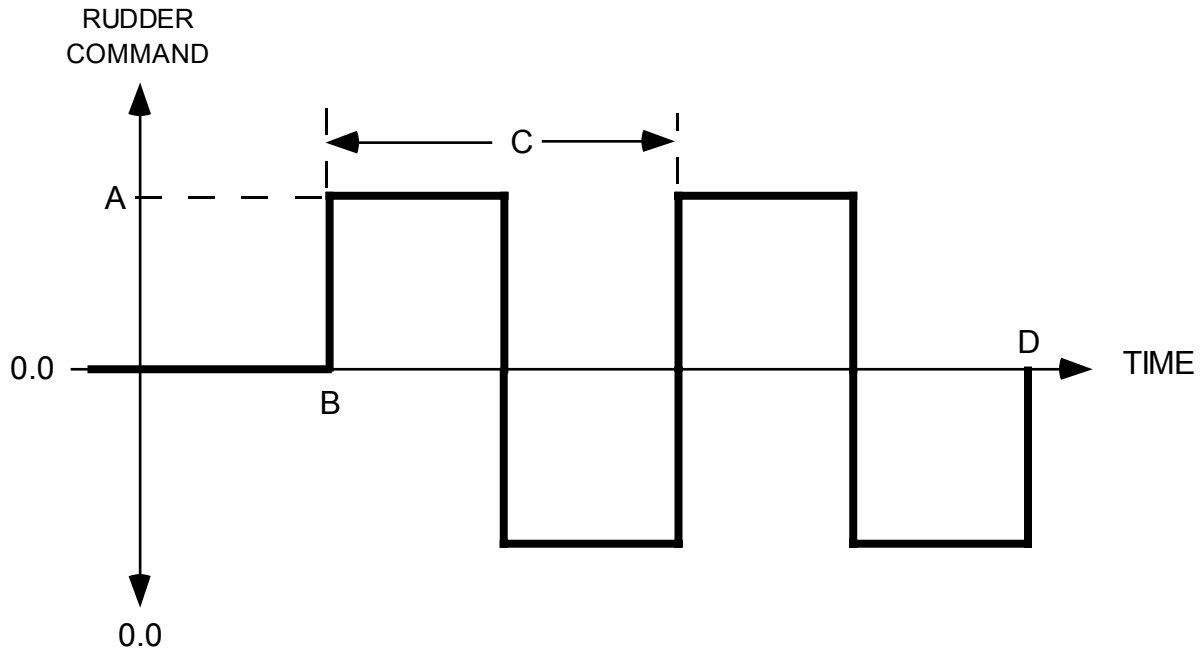
Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
4.1	10	5	25	35
4.2	10	5	15	25
4.3	10	5	10	20
4.4	10	5	7	17
4.5	10	5	6	16
4.6	10	5	5.5	16
4.7	10	5	5.25	16

Test Series 5: Saw Tooth Wave Inputs



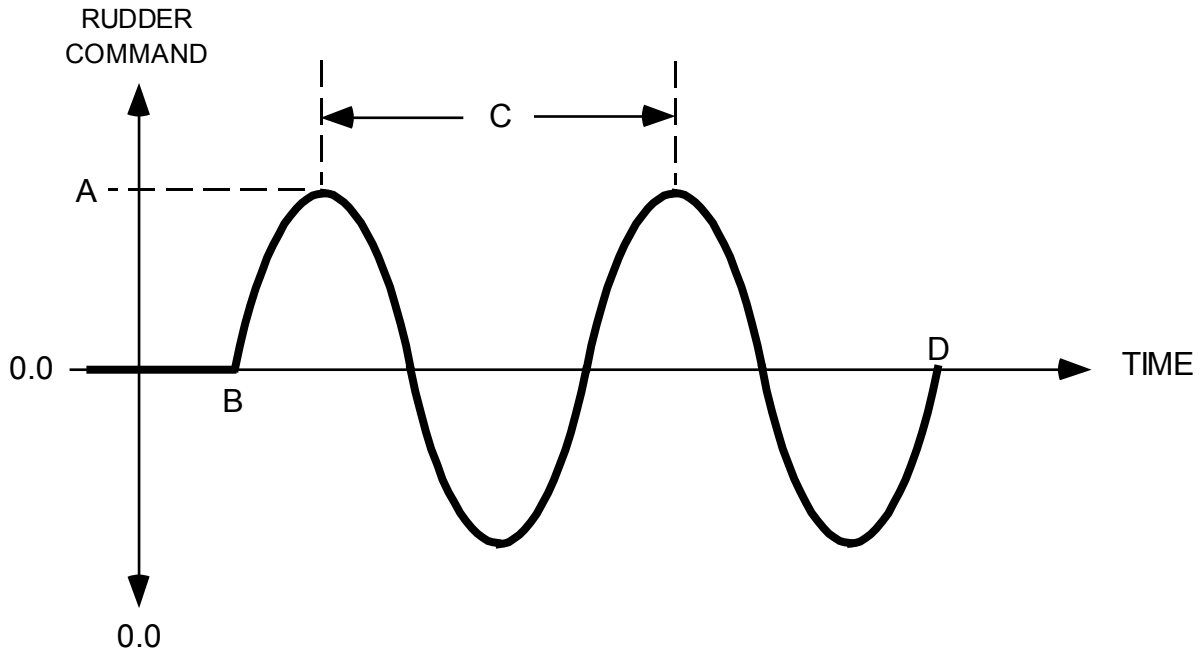
Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
5.1	10	5	20	65
5.2	10	5	10	35
5.3	10	5	5	20
5.4	10	5	2	17
5.5	10	5	1	16
5.6	10	5	0.5	16
5.7	10	5	0.25	16

Test Series 6: Square Wave Inputs



Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
6.1	10	5	20	65
6.2	10	5	10	35
6.3	10	5	5	20
6.4	10	5	2	17
6.5	10	5	1	16
6.6	10	5	0.5	16
6.7	10	5	0.25	16

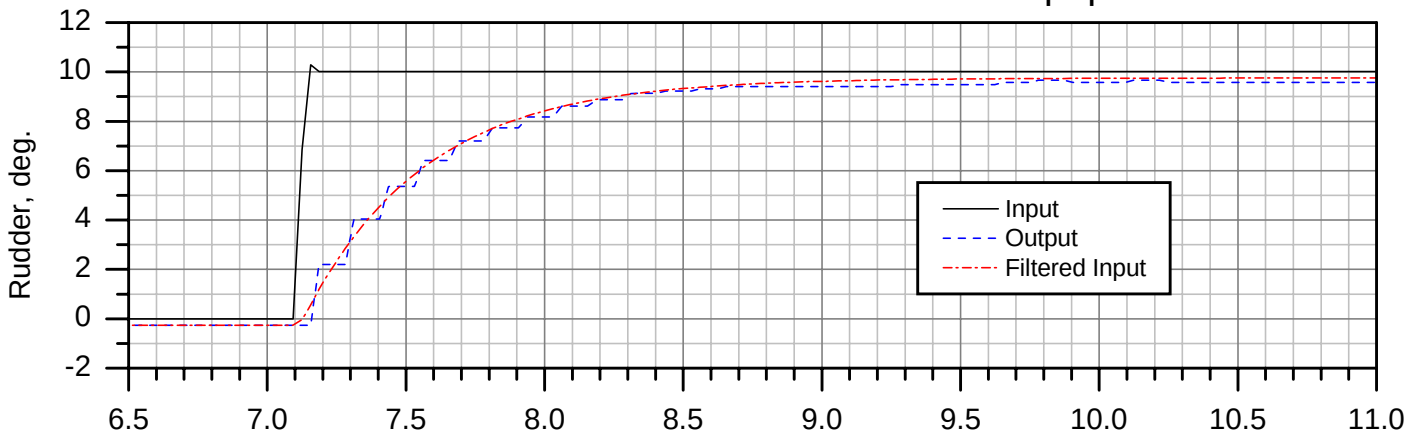
Test Series 7: Sine Wave Inputs

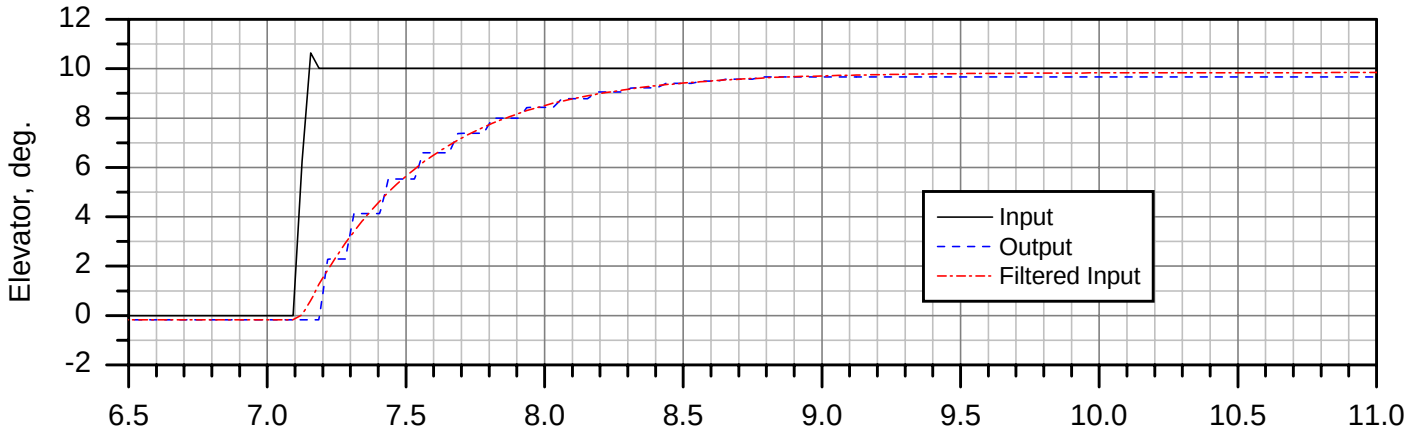


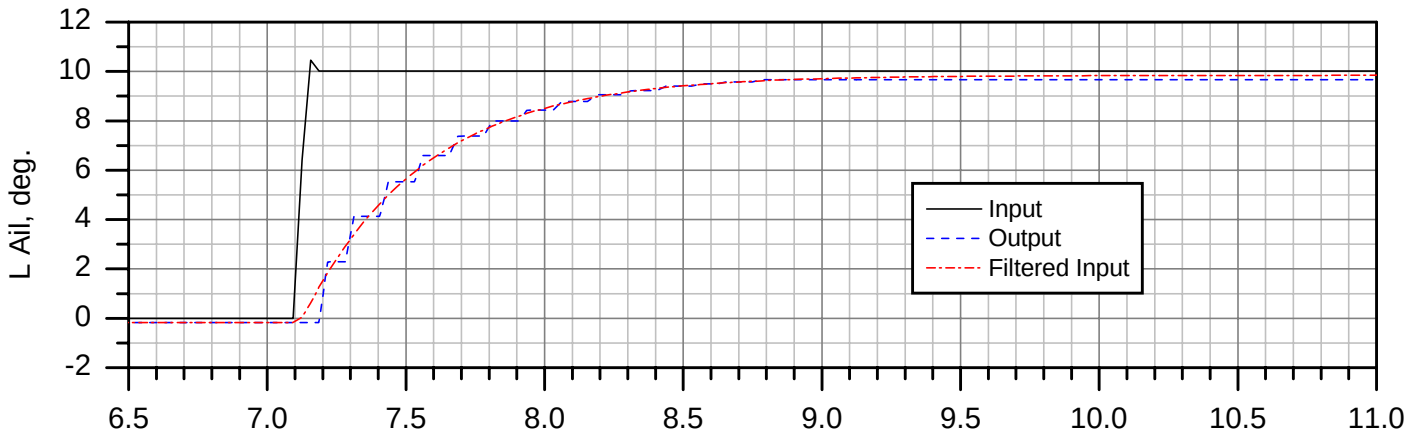
Test Number	A (degrees)	B (seconds)	C (seconds)	D (seconds)
7.1	10	5	20	65
7.2	10	5	10	35
7.3	10	5	5	20
7.4	10	5	2	17
7.5	10	5	1	16
7.6	10	5	0.5	16
7.7	10	5	0.25	16
7.8	10	5	0.125	16

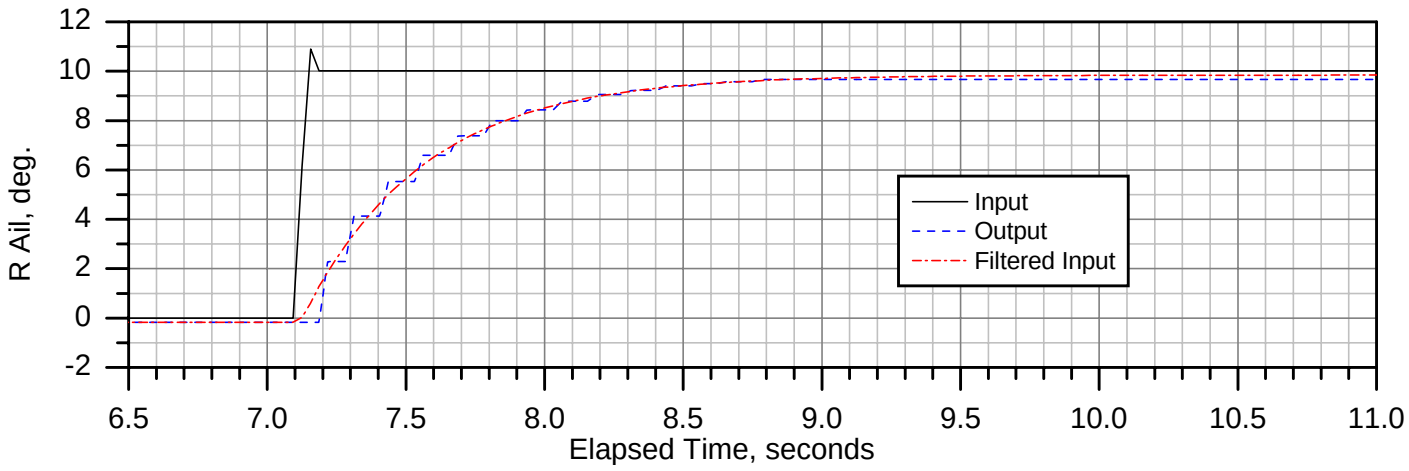
Attachment III
NTSB's Plots of SDAC Bench Test Series 1 to 7 and 11

A300-600 SDAC Bench Test Case 1p1p1

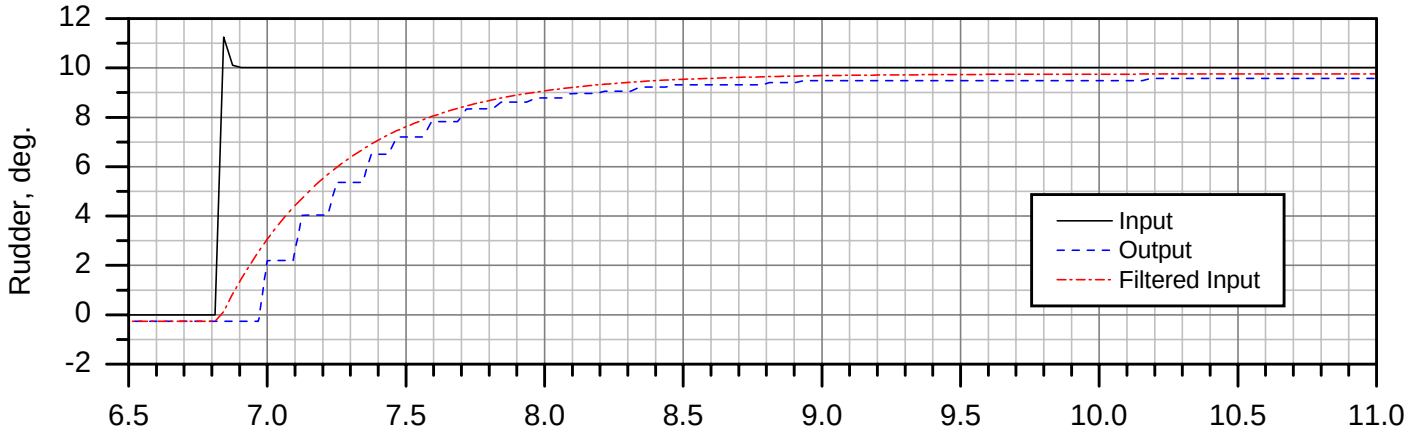


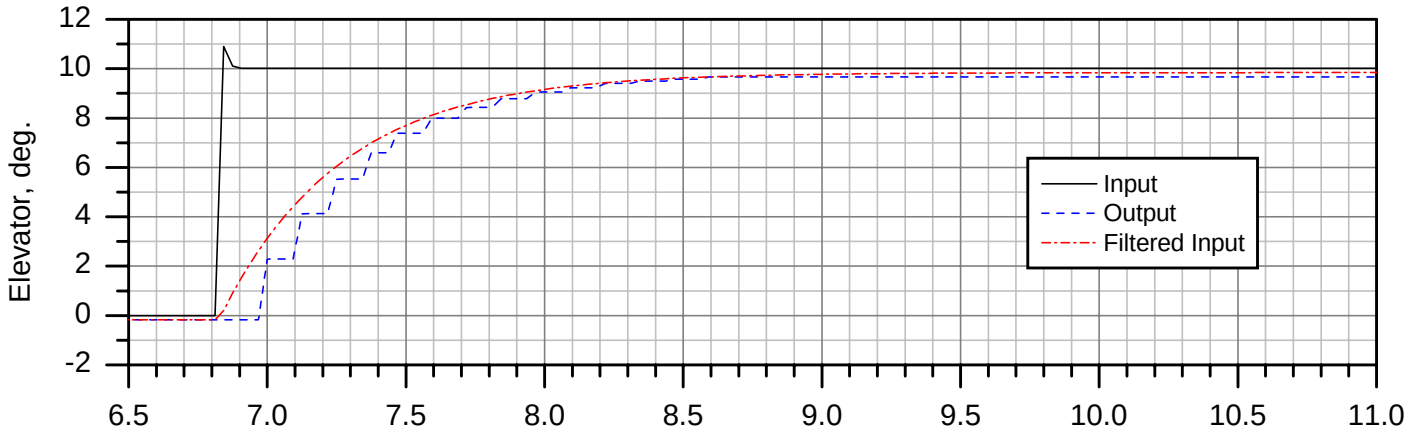


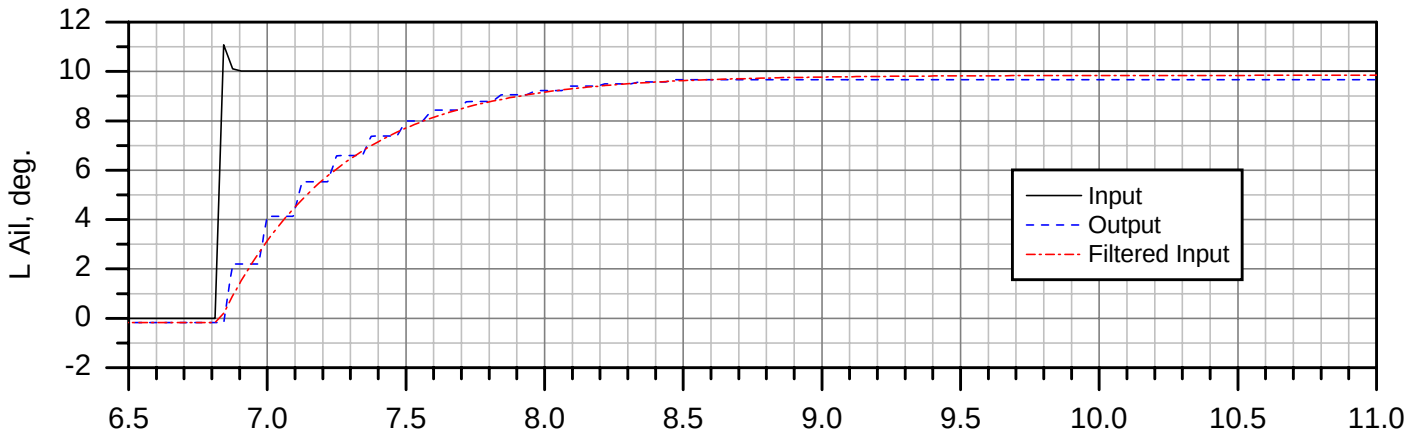


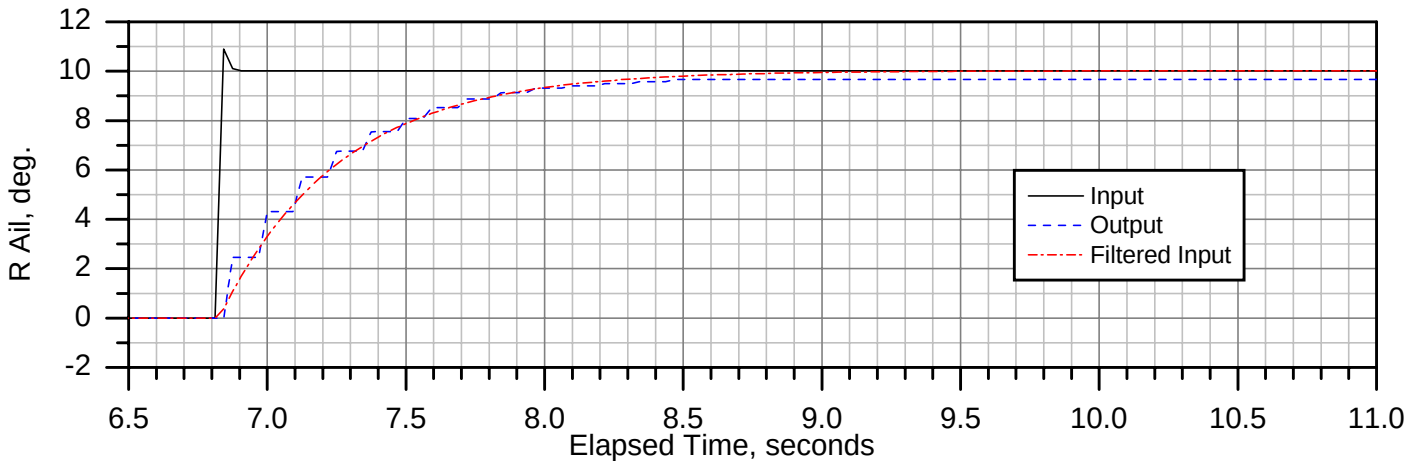


A300-600 SDAC Bench Test Case 1p1p2

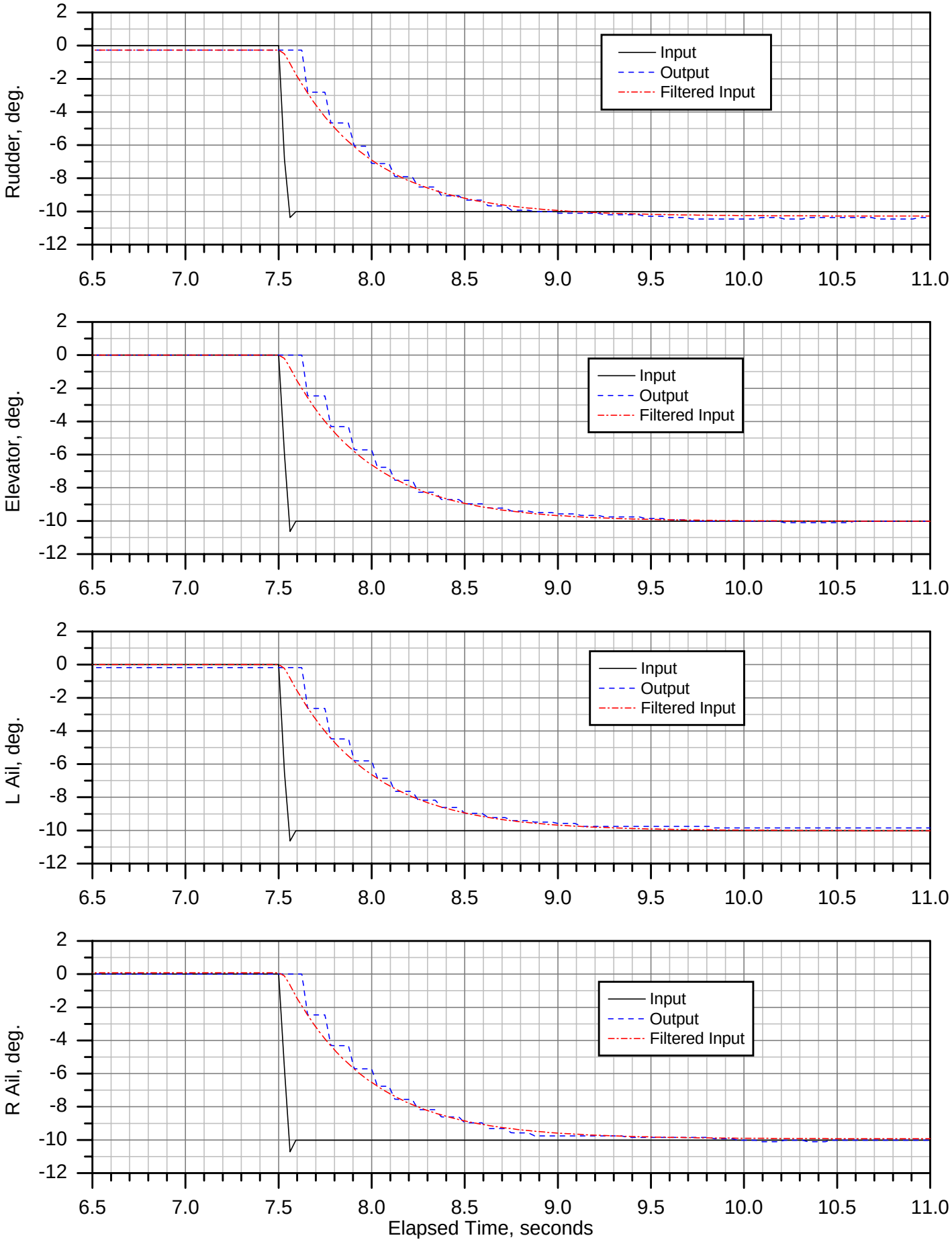


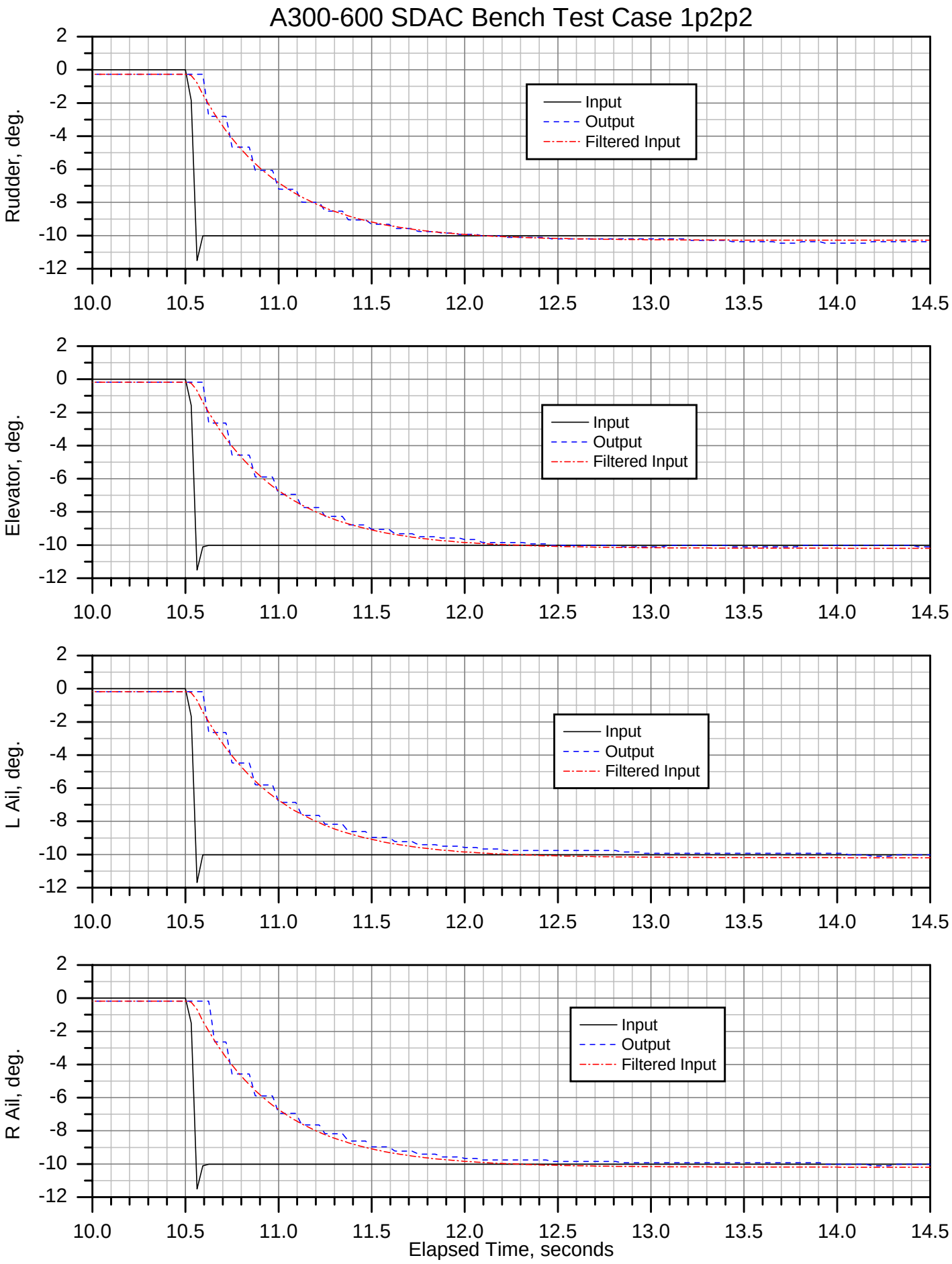




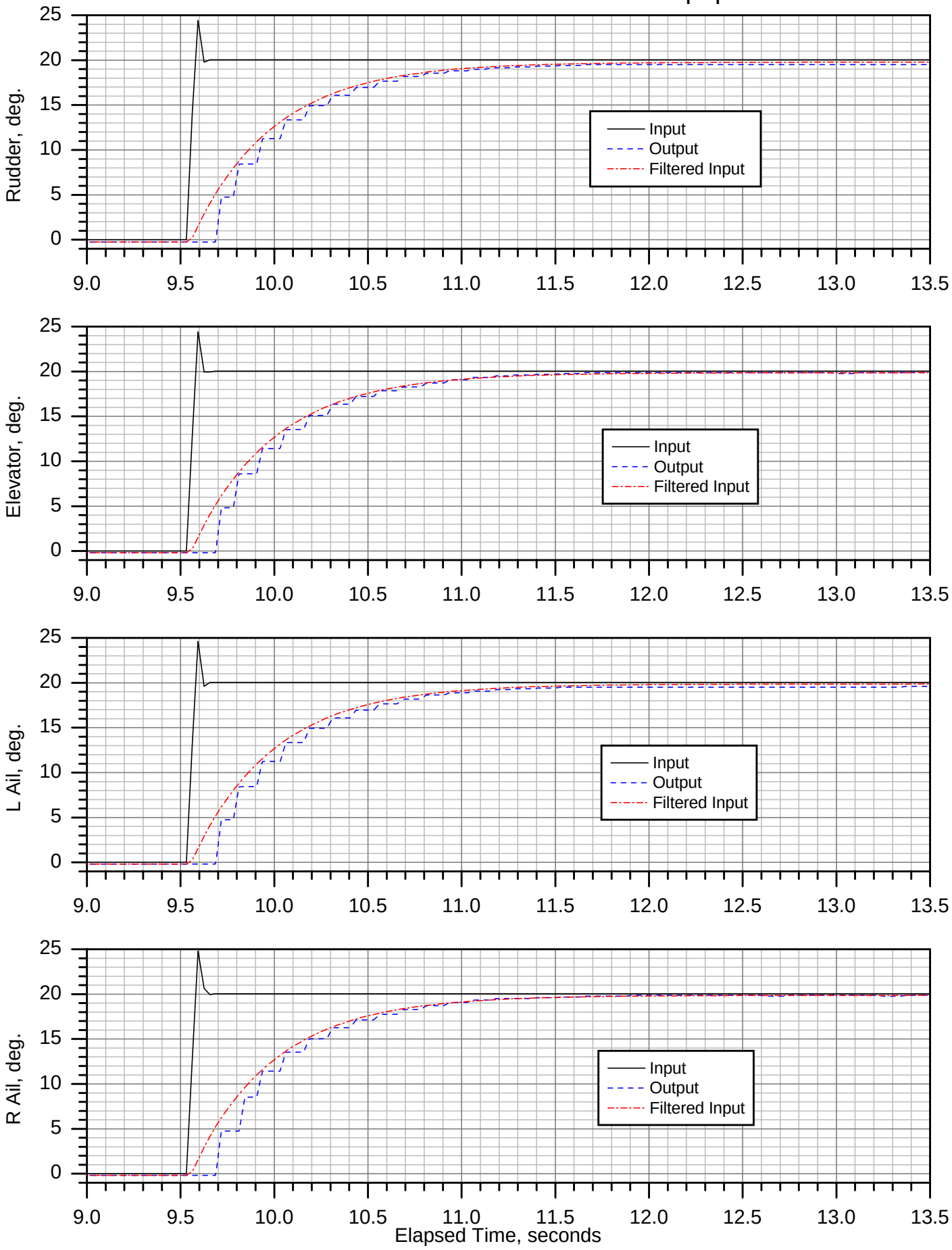


A300-600 SDAC Bench Test Case 1p2p1

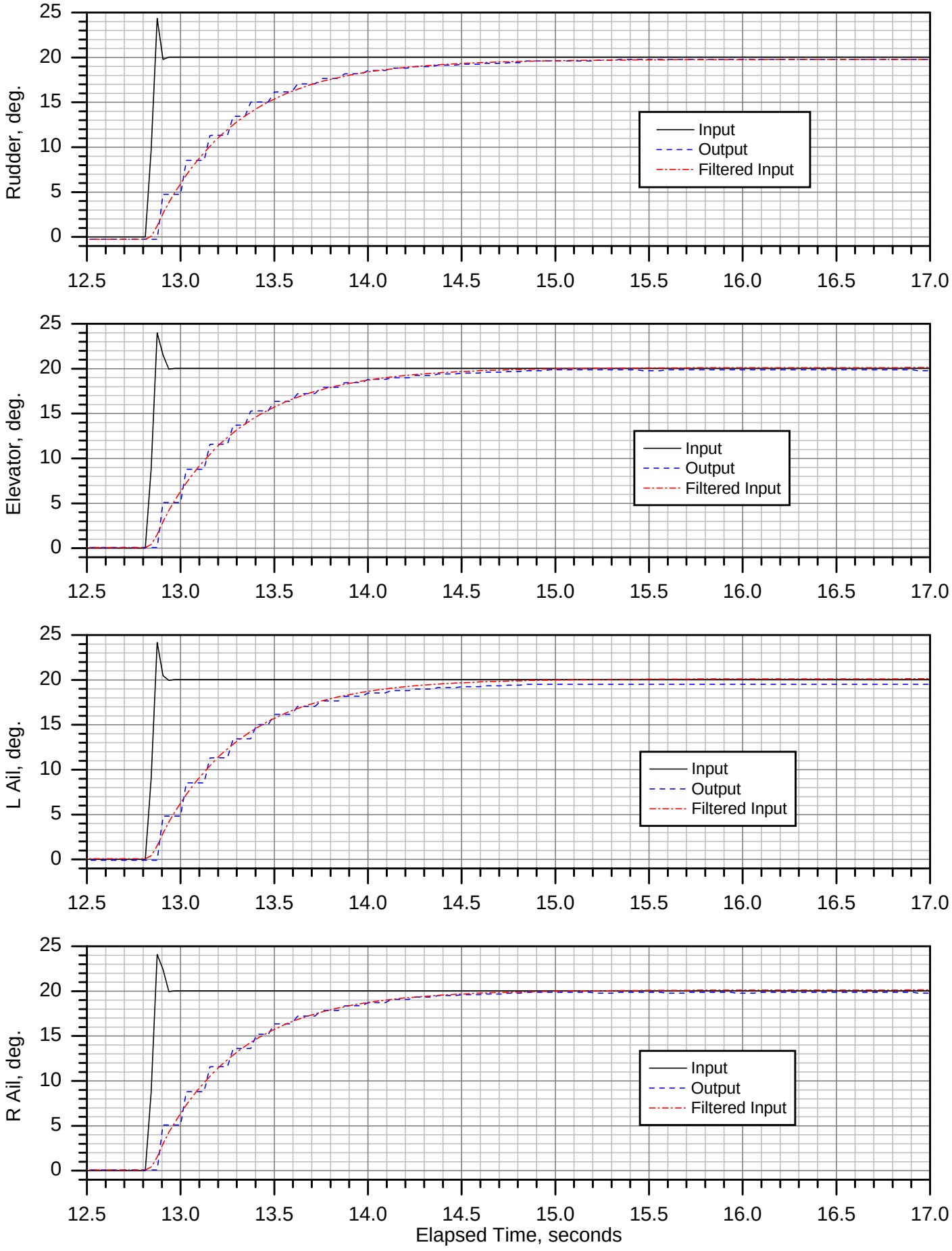


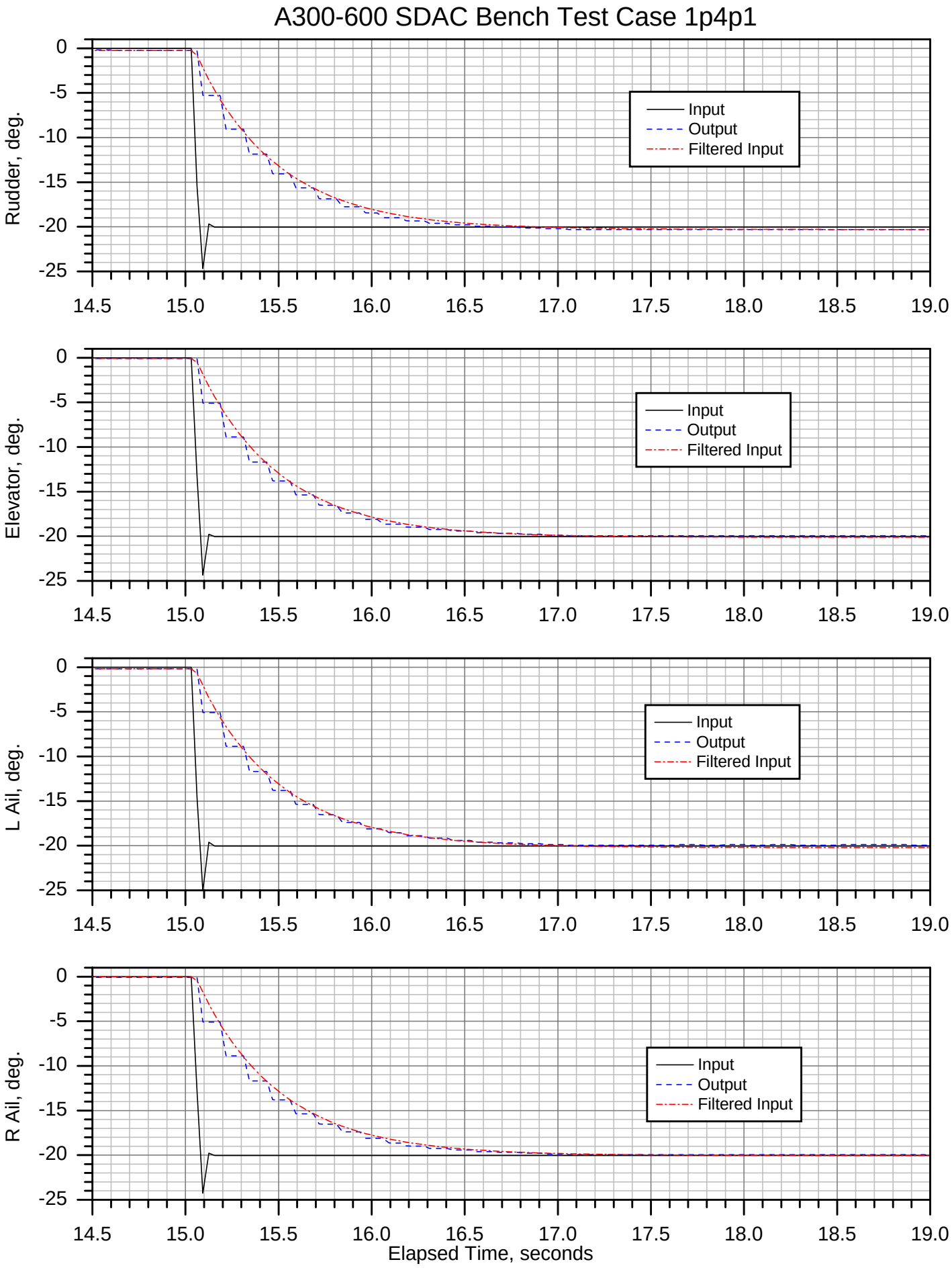

A300-600 SDAC Bench Test Case 1p2p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
2
0
-2
-4
-6
-8
-10
-12
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
Elapsed Time, seconds

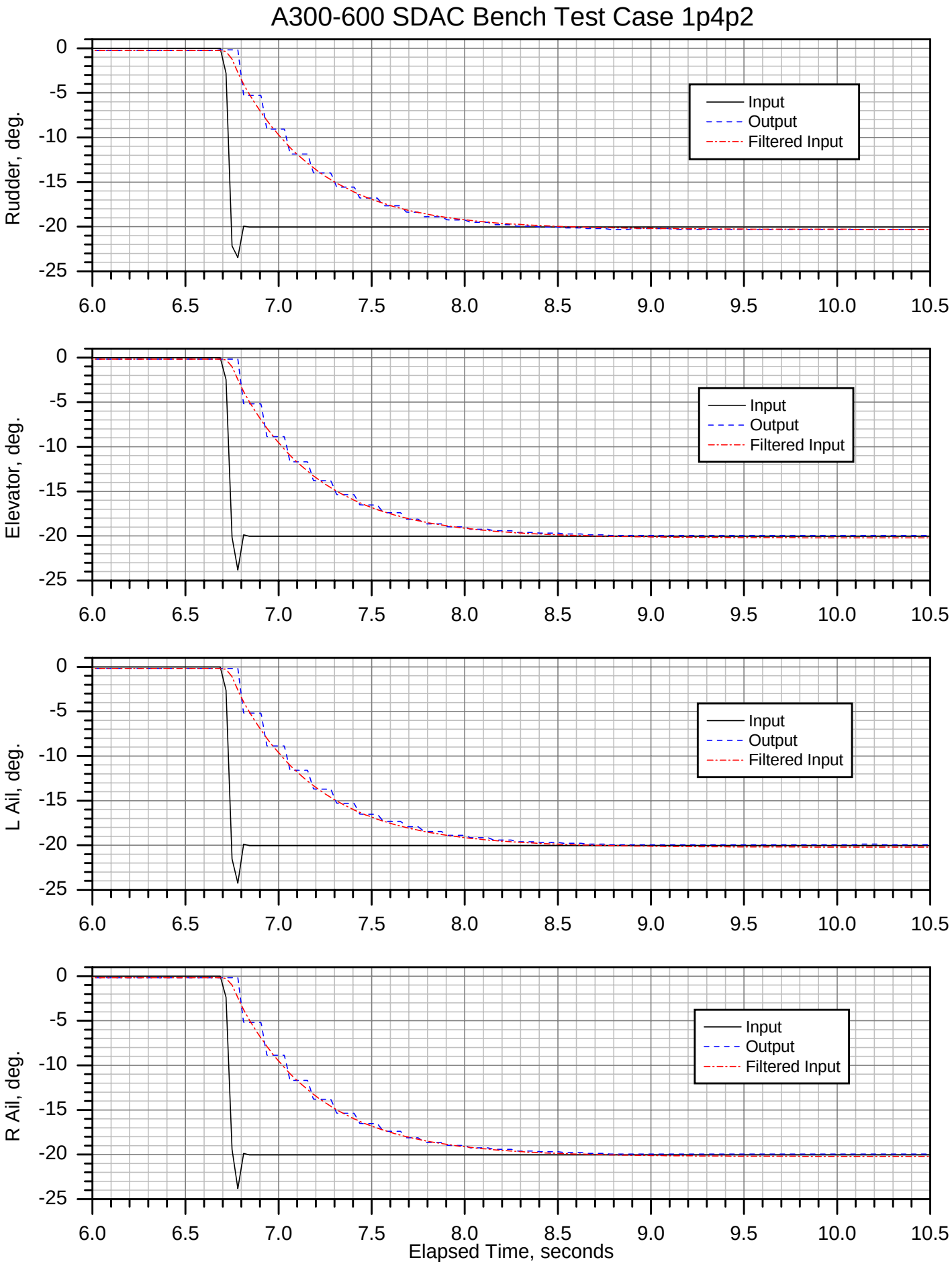
A300-600 SDAC Bench Test Case 1p3p1



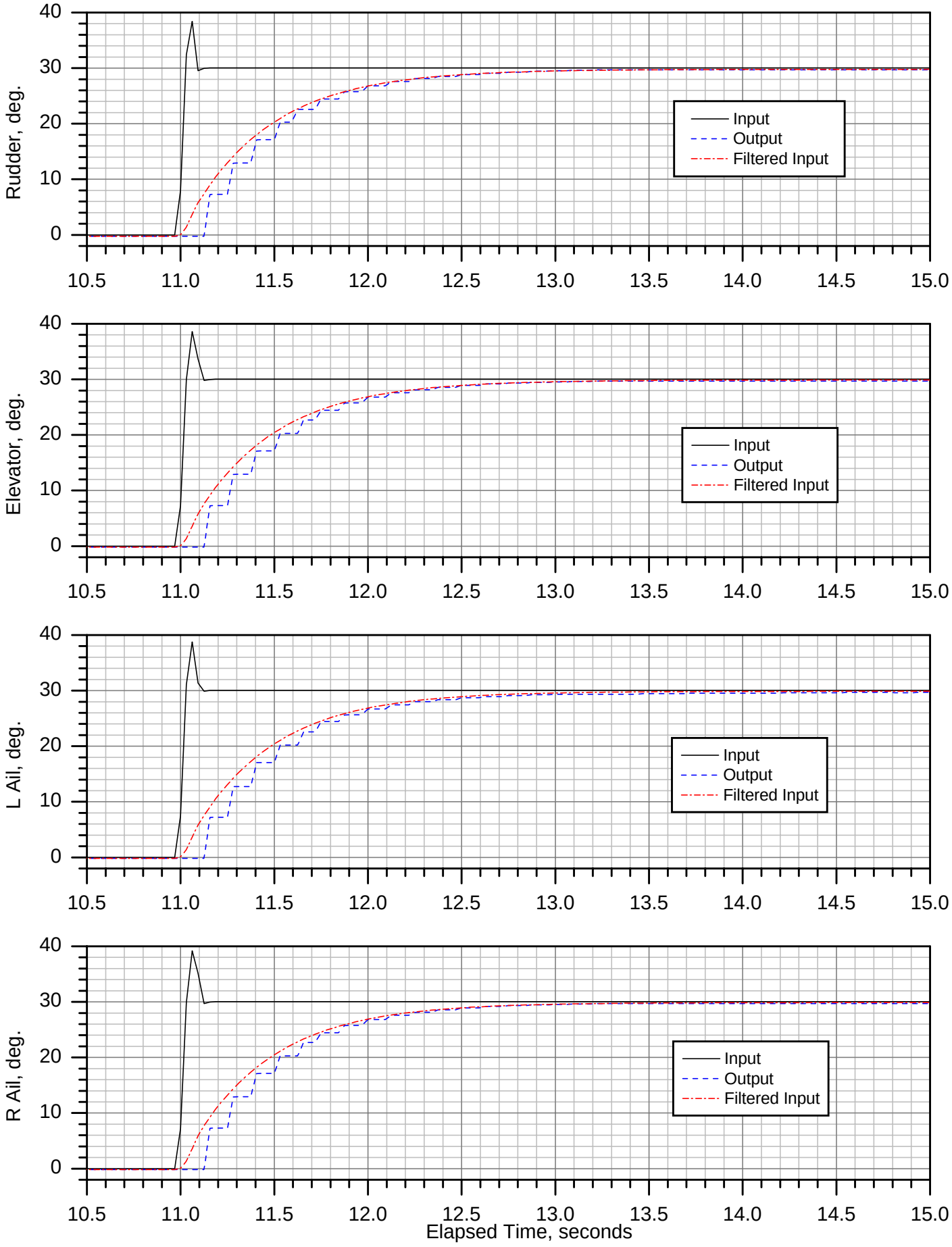
A300-600 SDAC Bench Test Case 1p3p2



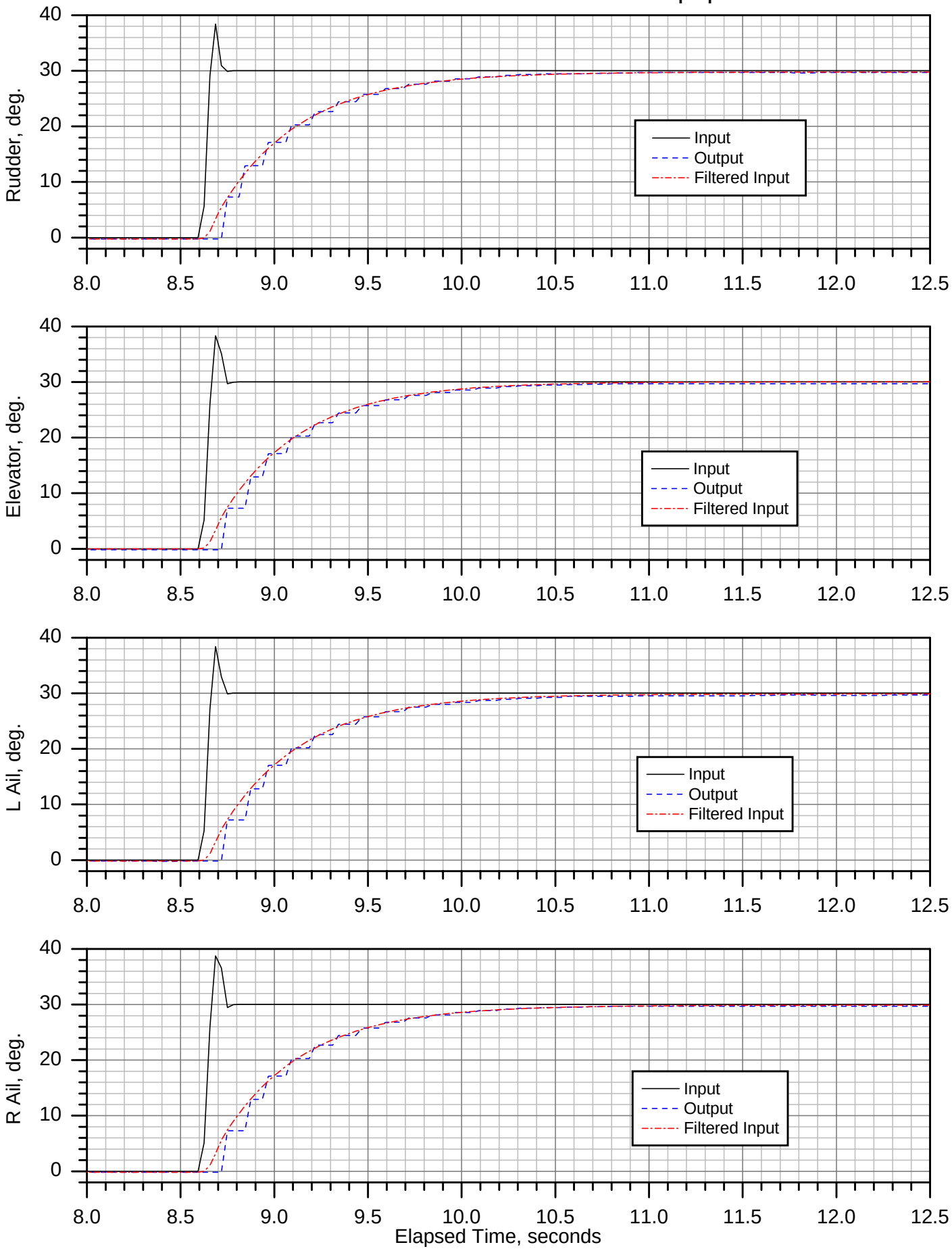

A300-600 SDAC Bench Test Case 1p4p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
0
-5
-10
-15
-20
-25
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5
19.0
Input
Output
Filtered Input
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 1p4p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
0
-5
-10
-15
-20
-25
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
Elapsed Time, seconds

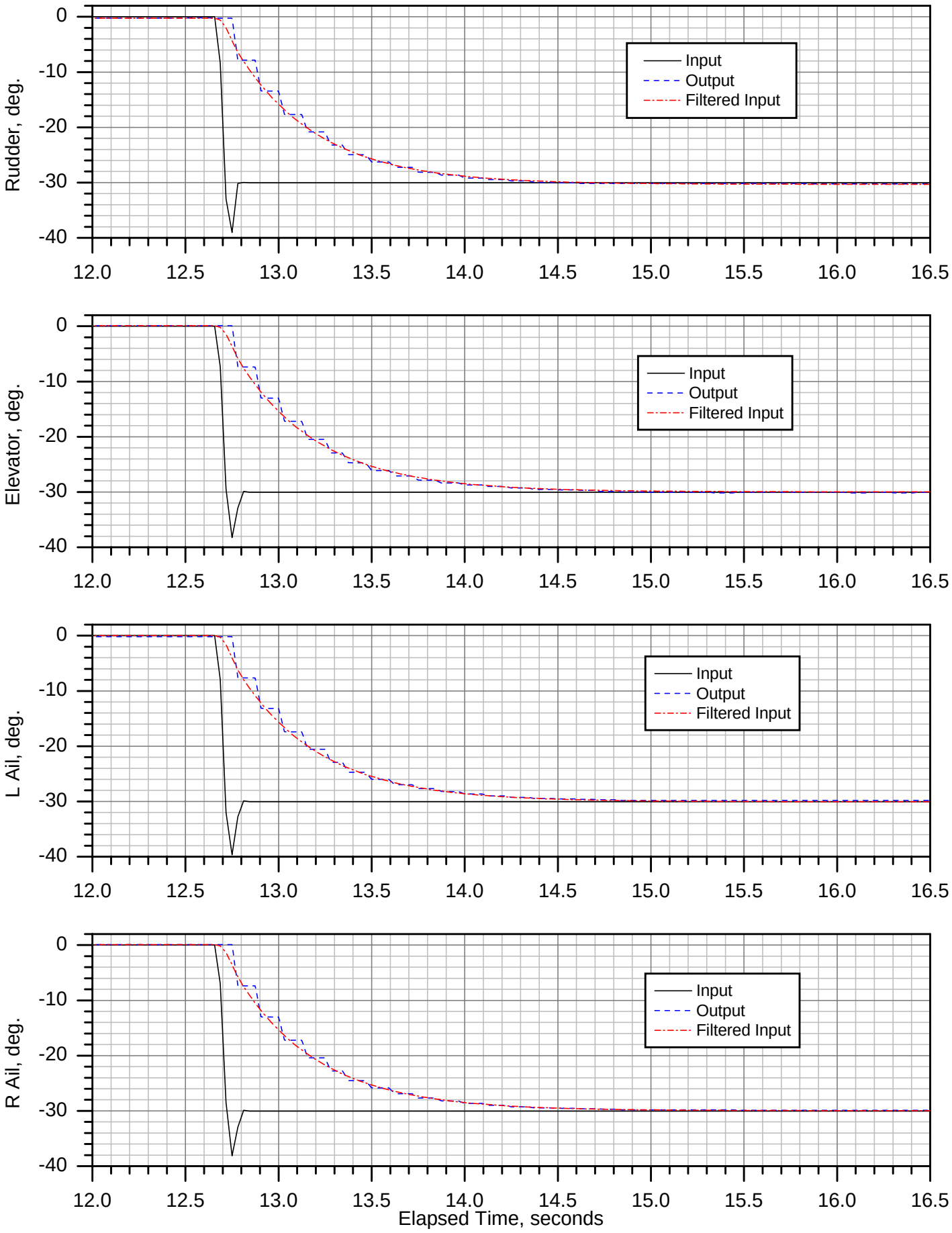
A300-600 SDAC Bench Test Case 1p5p1



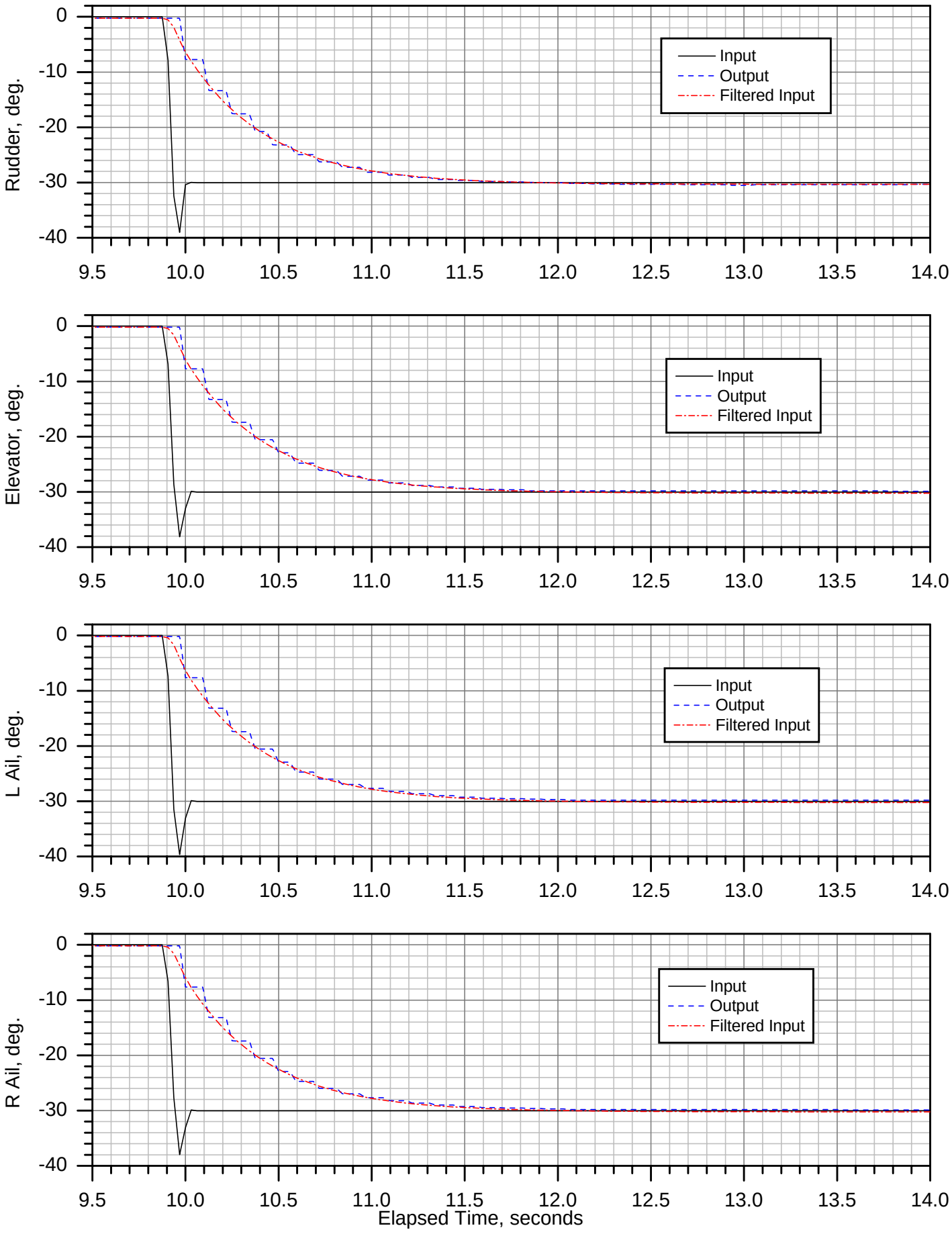
A300-600 SDAC Bench Test Case 1p5p2



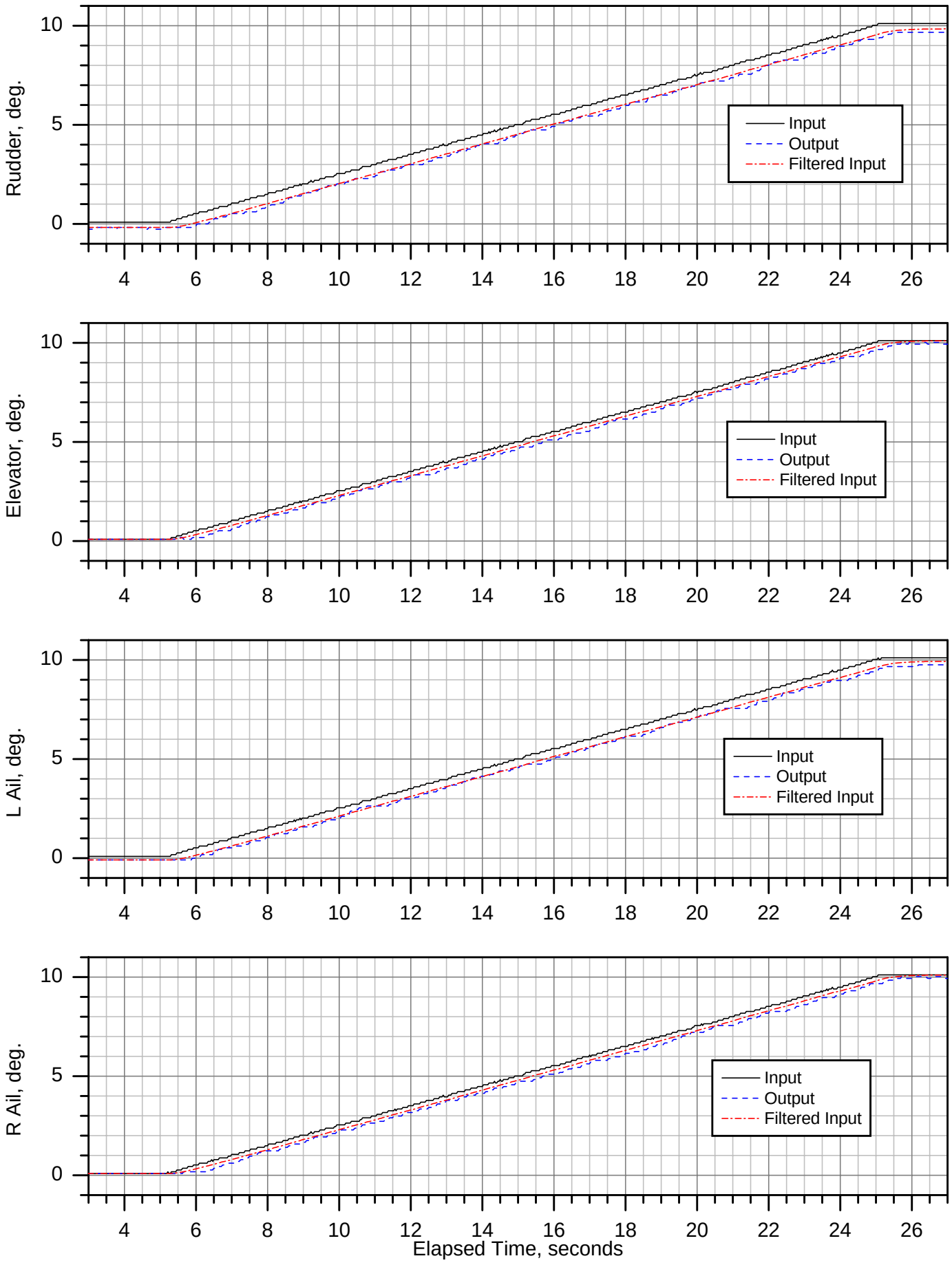
A300-600 SDAC Bench Test Case 1p6p1



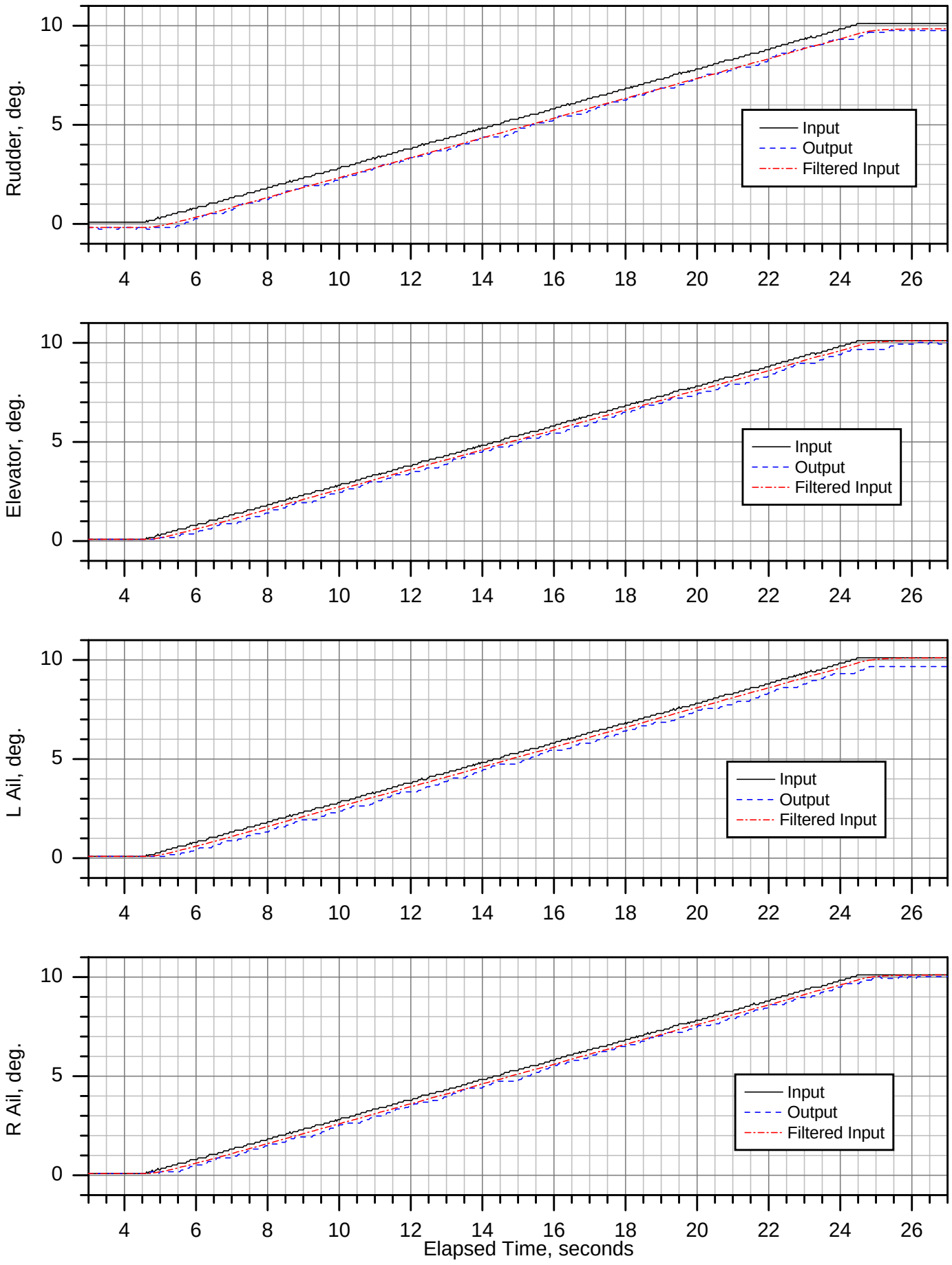
A300-600 SDAC Bench Test Case 1p6p2



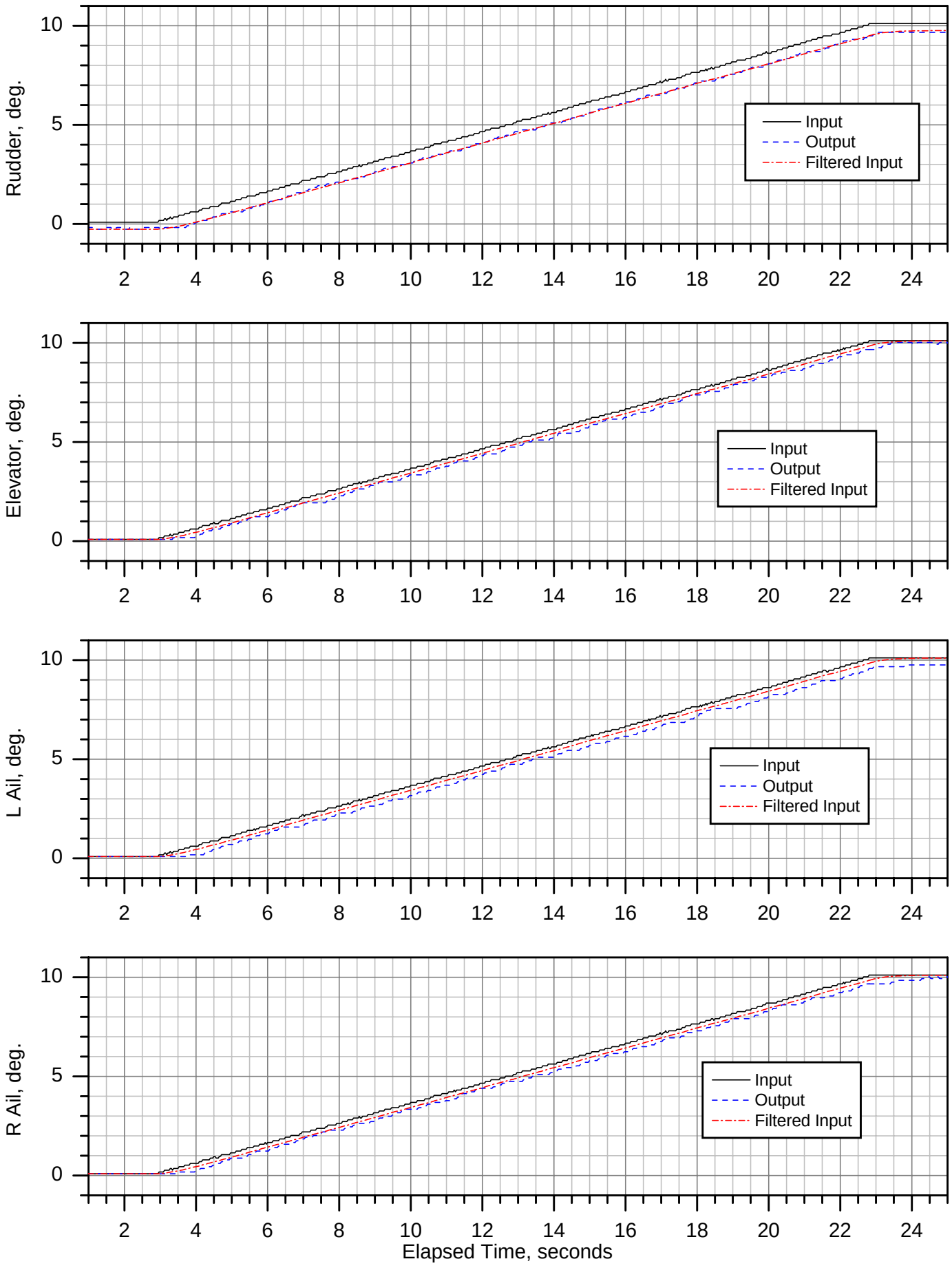
A300-600 SDAC Bench Test Case 2p1p1



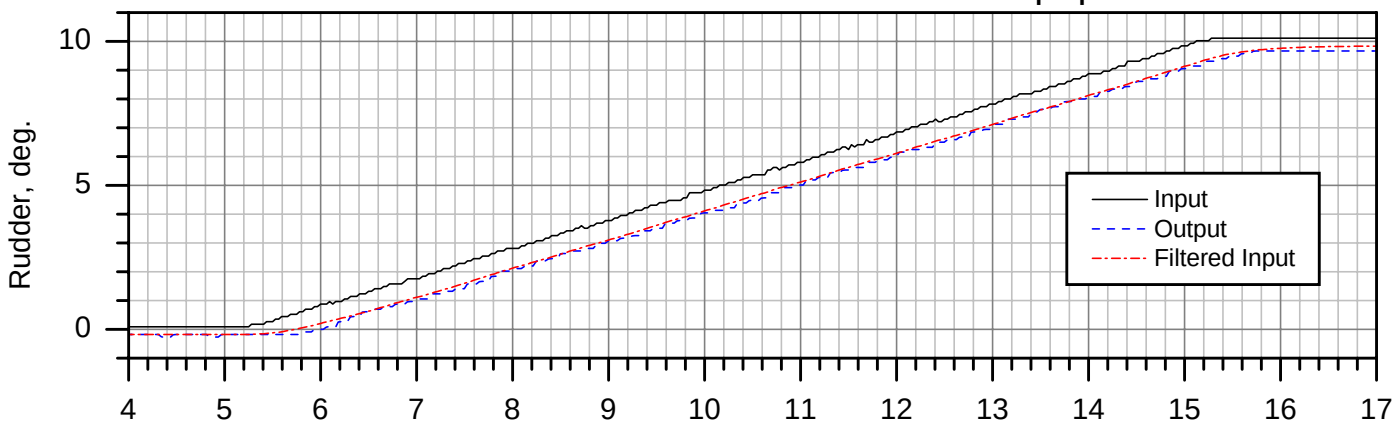
A300-600 SDAC Bench Test Case 2p1p2

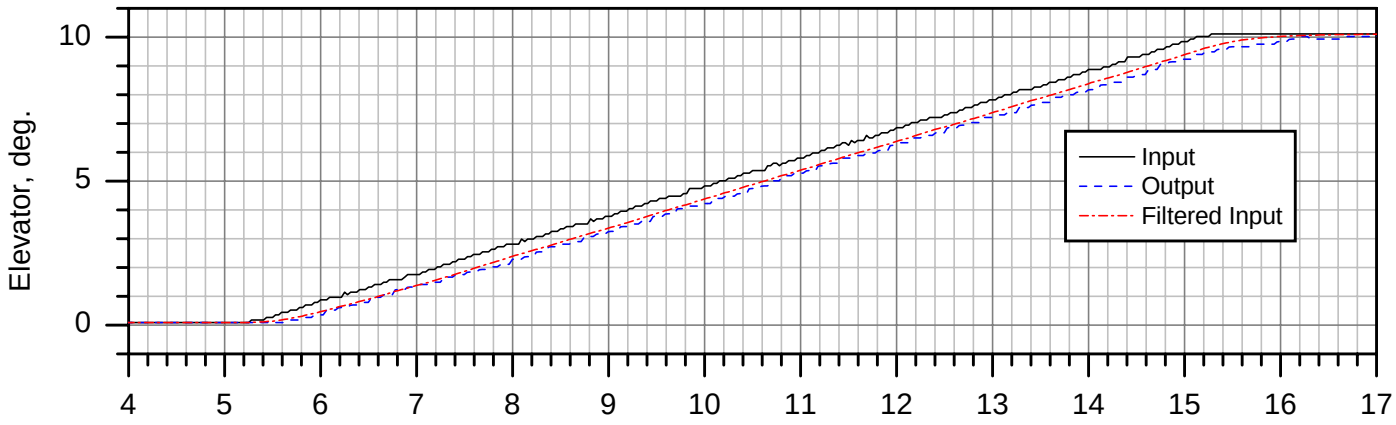


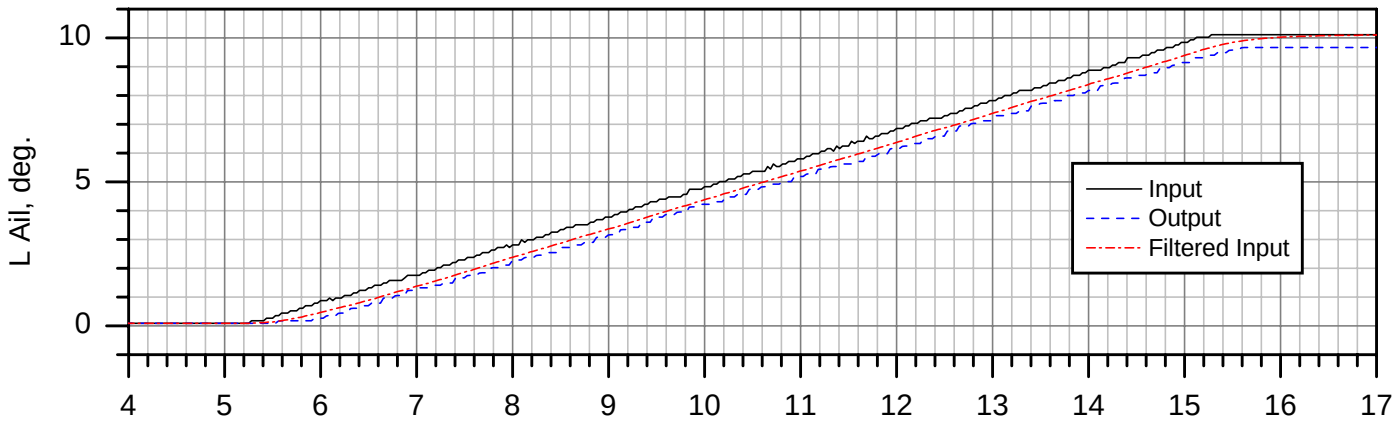
A300-600 SDAC Bench Test Case 2p1p3

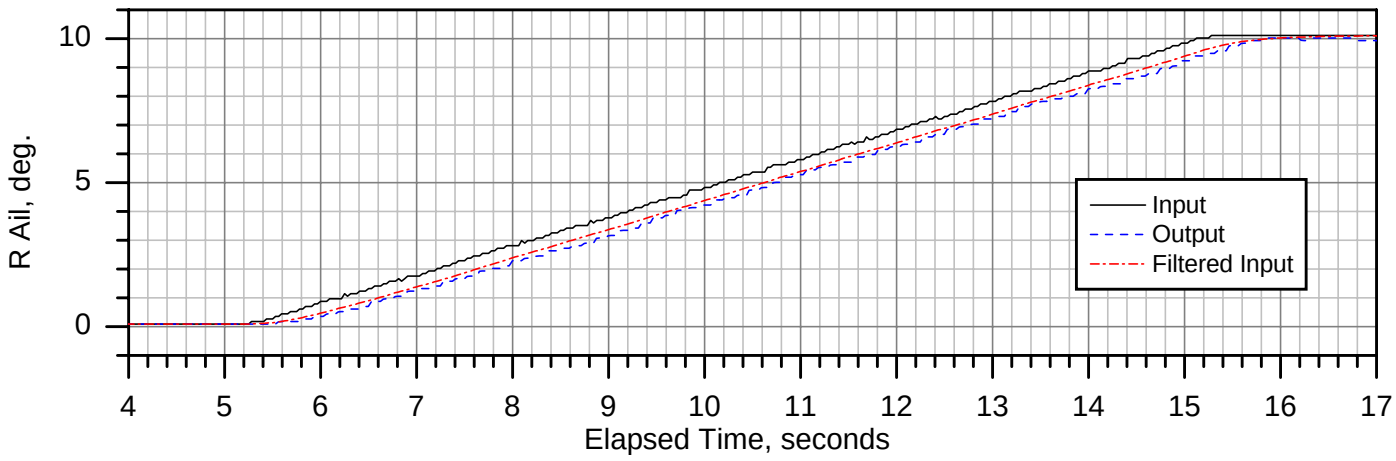


A300-600 SDAC Bench Test Case 2p2p1

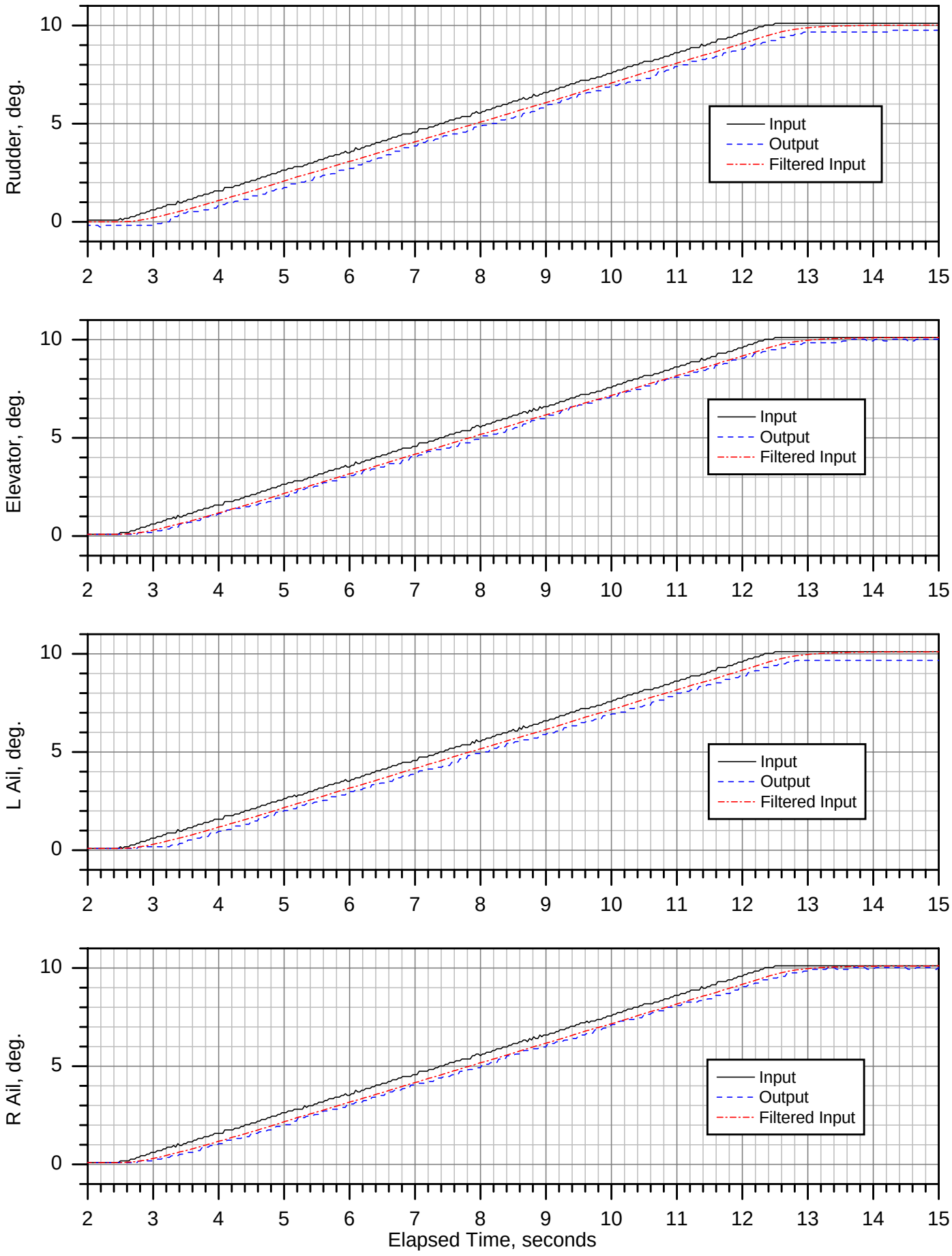




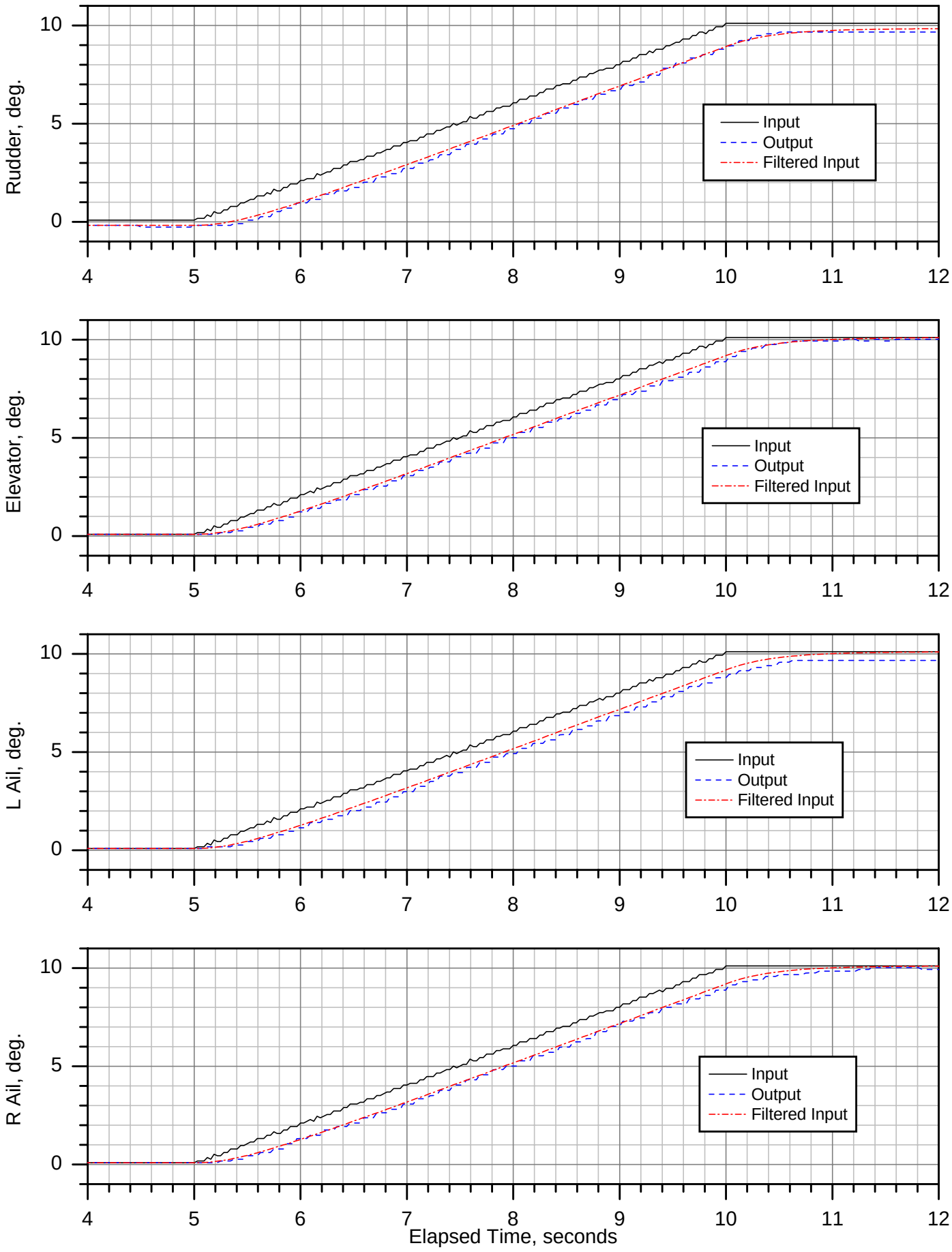




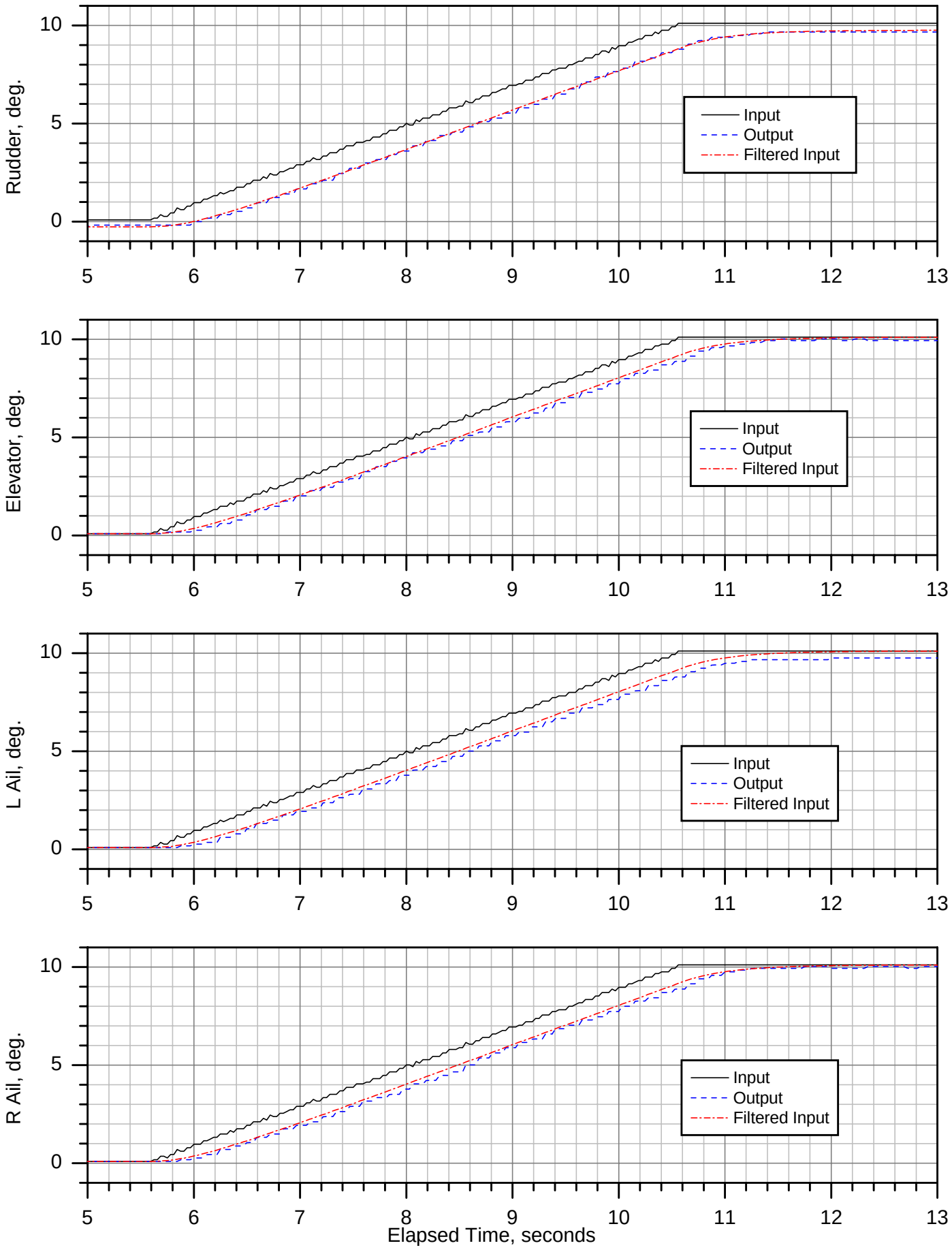
A300-600 SDAC Bench Test Case 2p2p2



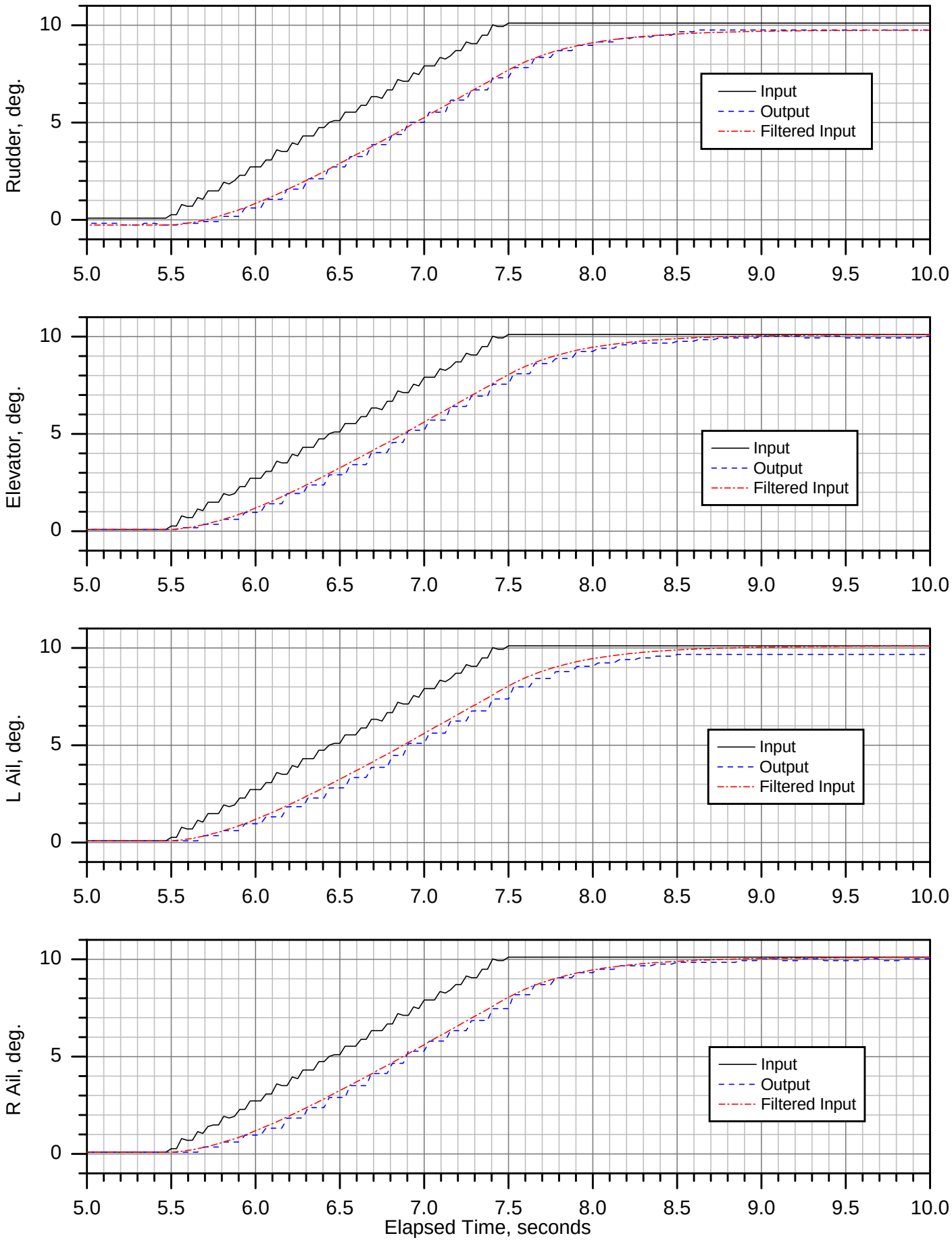
A300-600 SDAC Bench Test Case 2p3p1



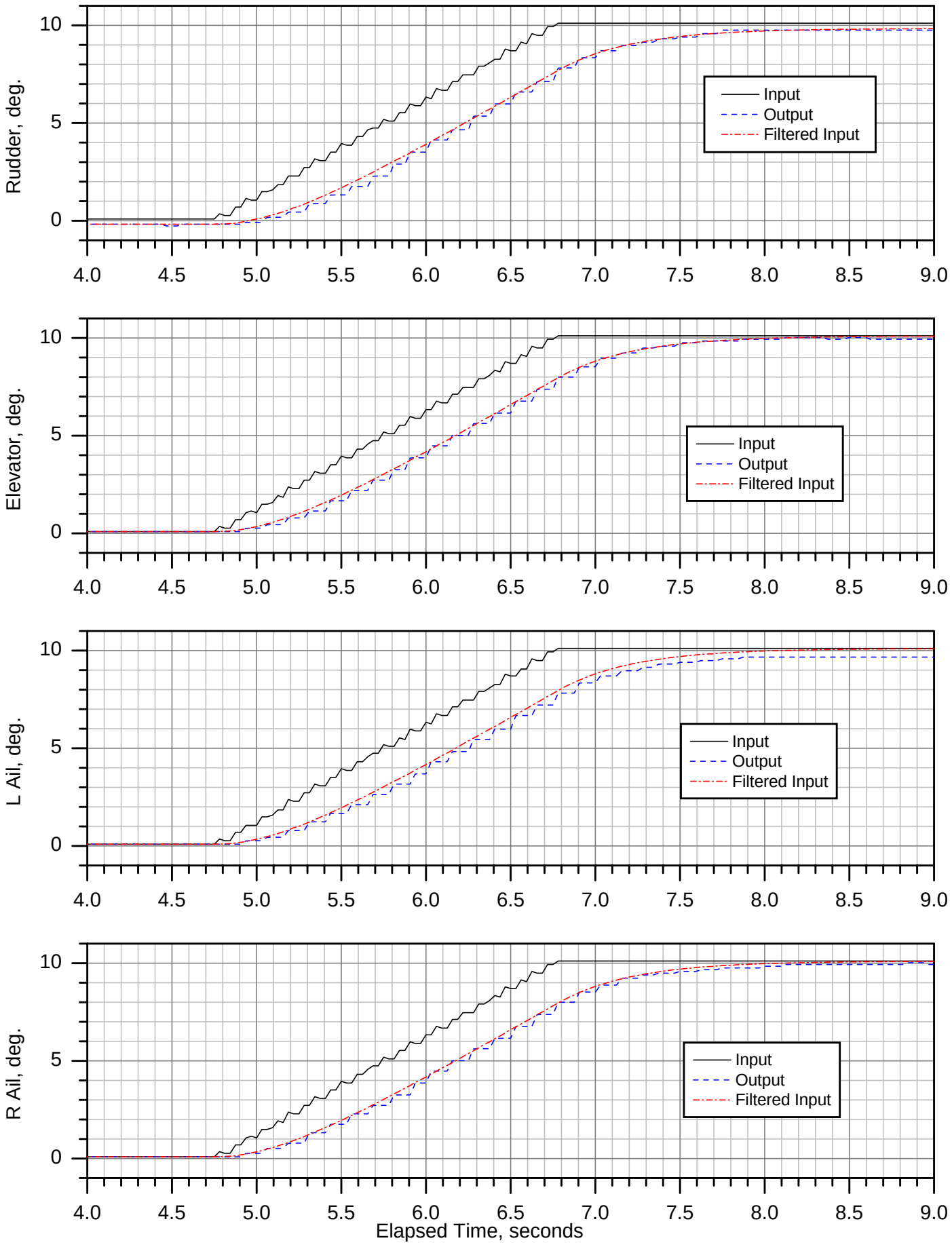
A300-600 SDAC Bench Test Case 2p3p2



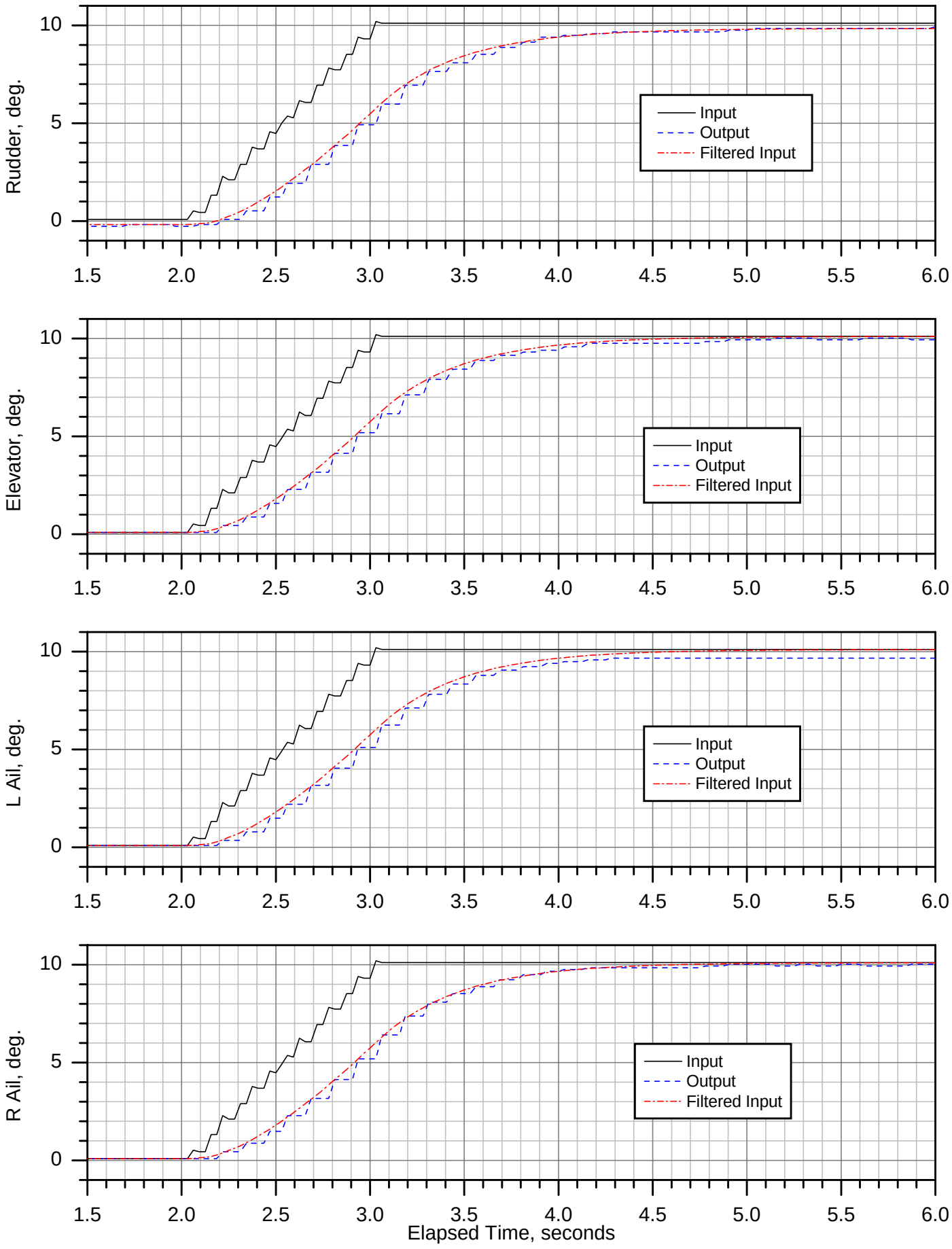
A300-600 SDAC Bench Test Case 2p4p1



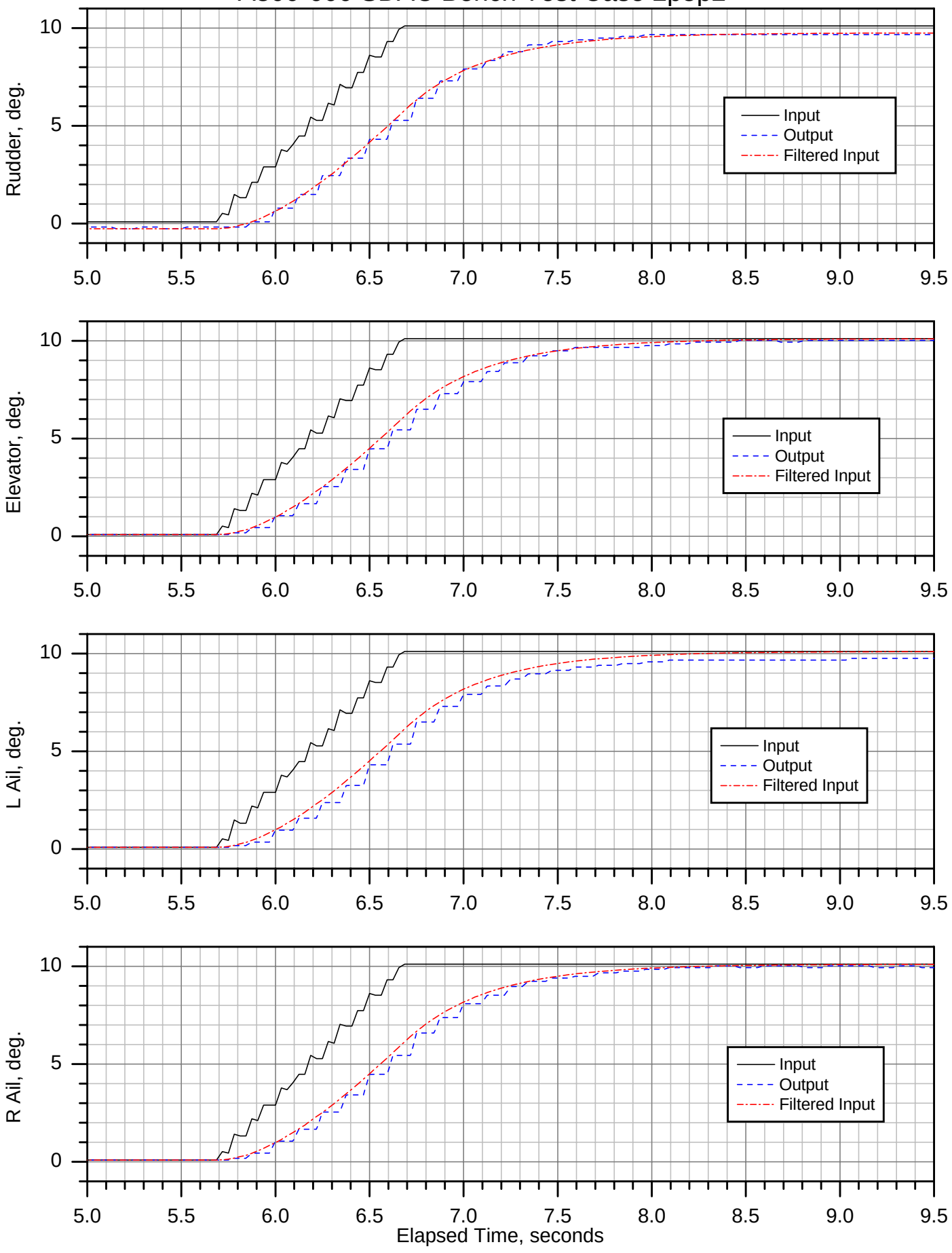
A300-600 SDAC Bench Test Case 2p4p2



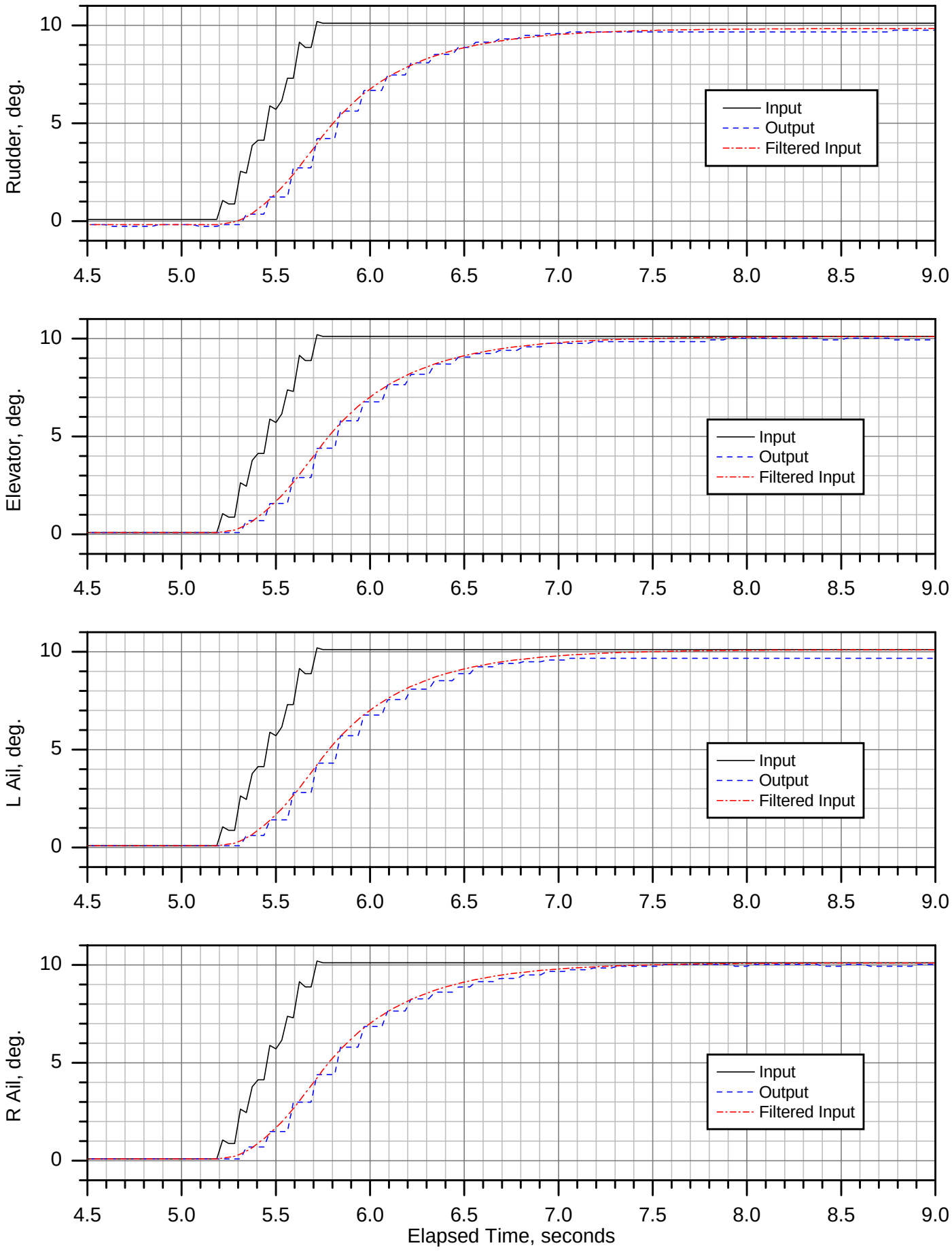
A300-600 SDAC Bench Test Case 2p5p1



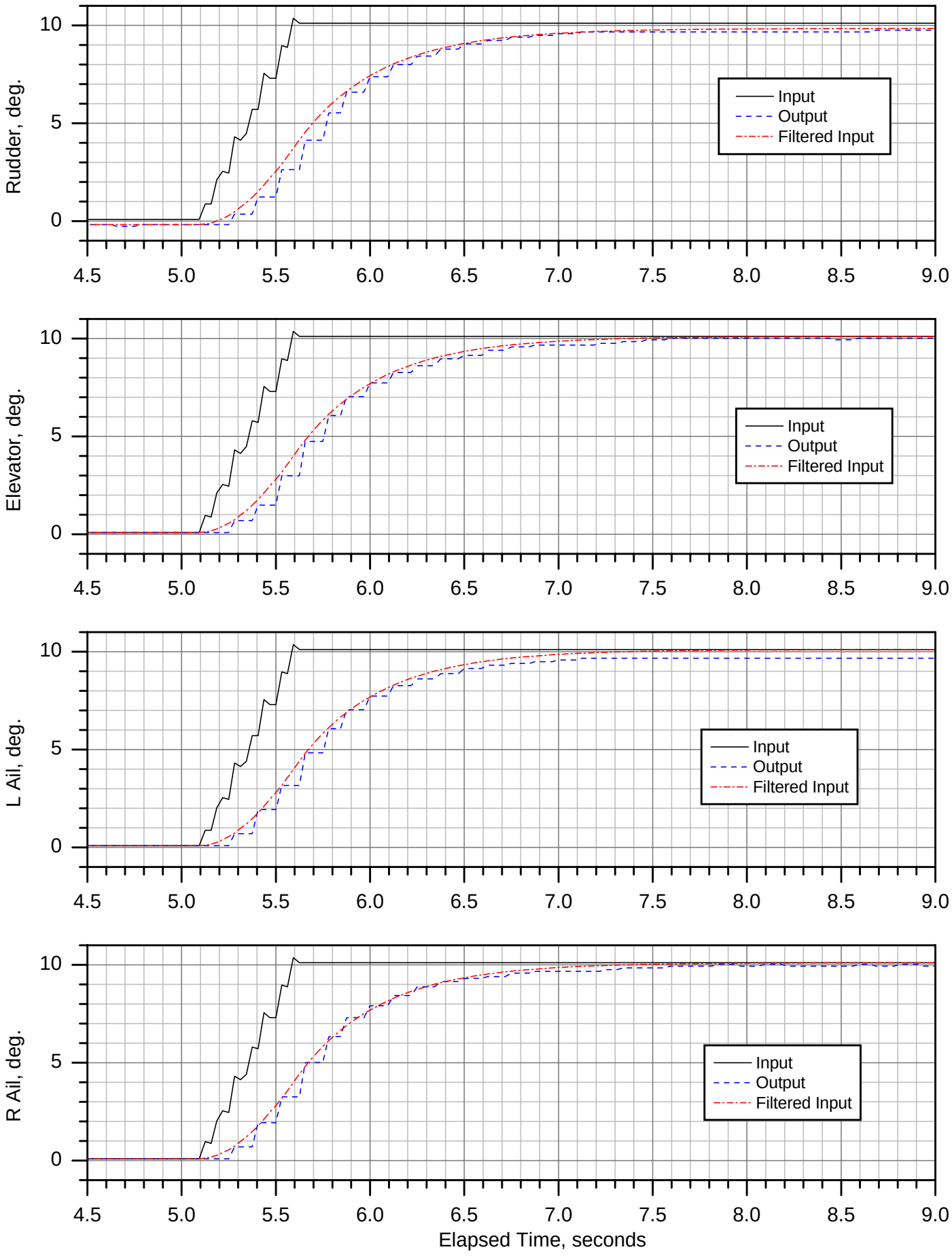
A300-600 SDAC Bench Test Case 2p5p2



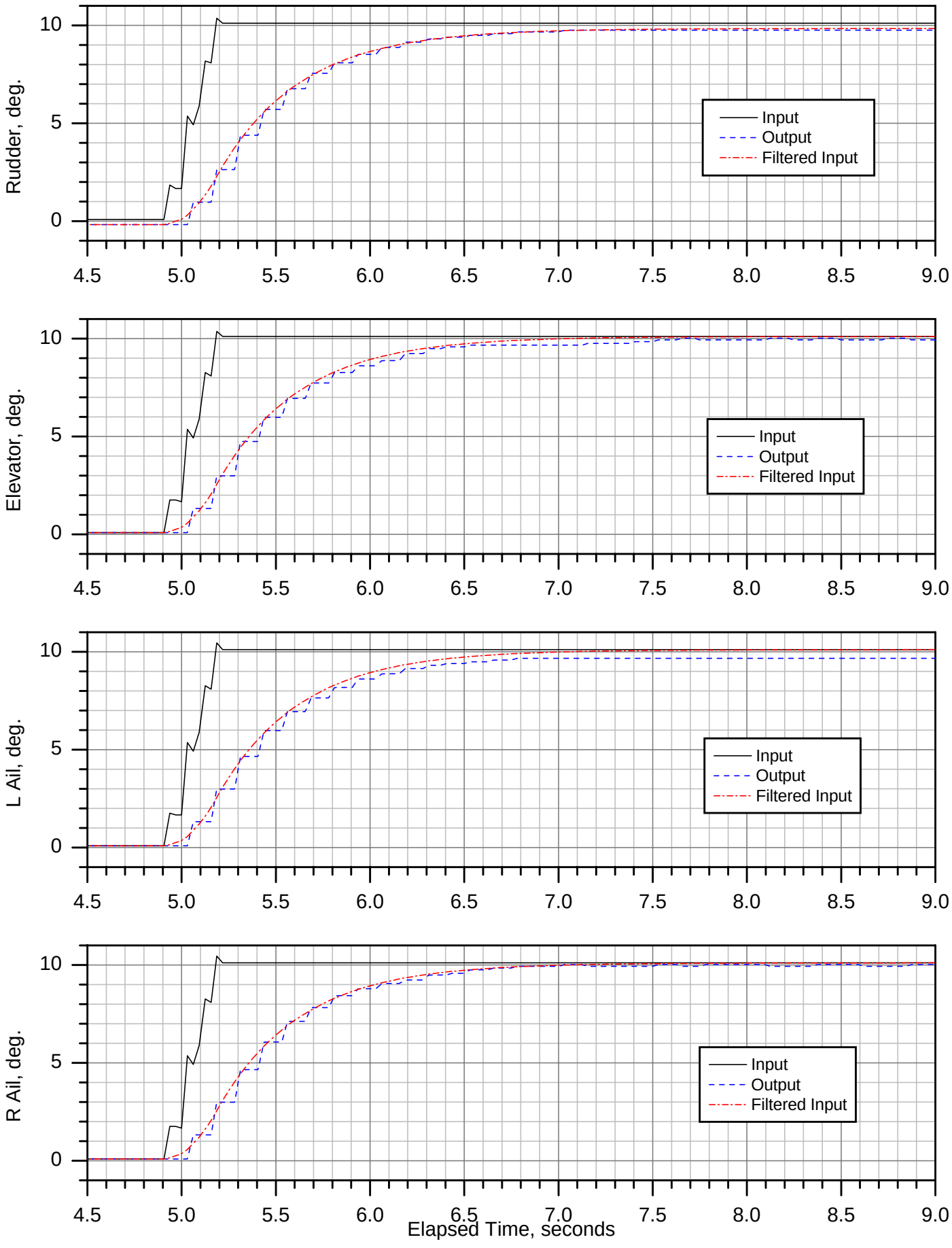
A300-600 SDAC Bench Test Case 2p6p1



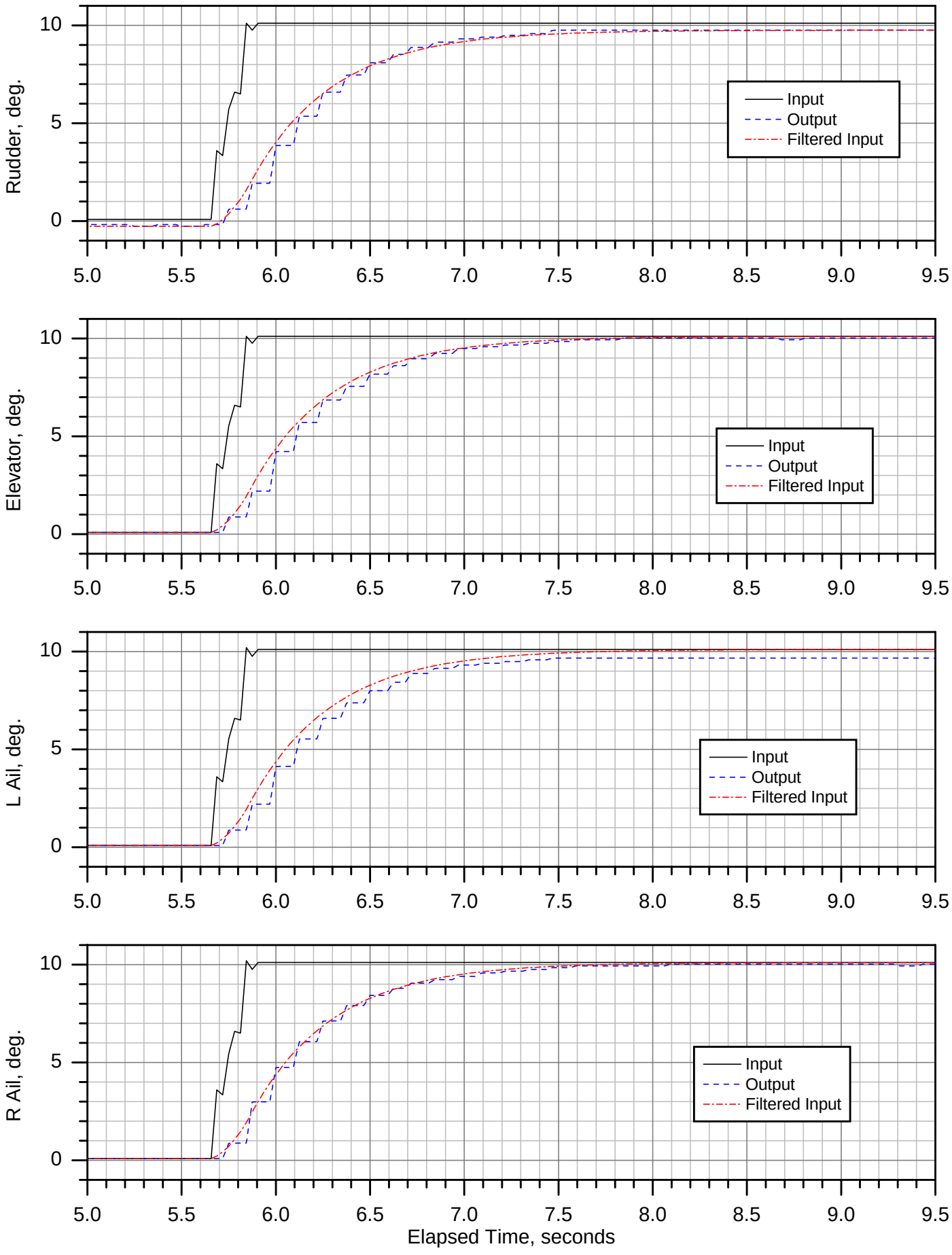
A300-600 SDAC Bench Test Case 2p6p2



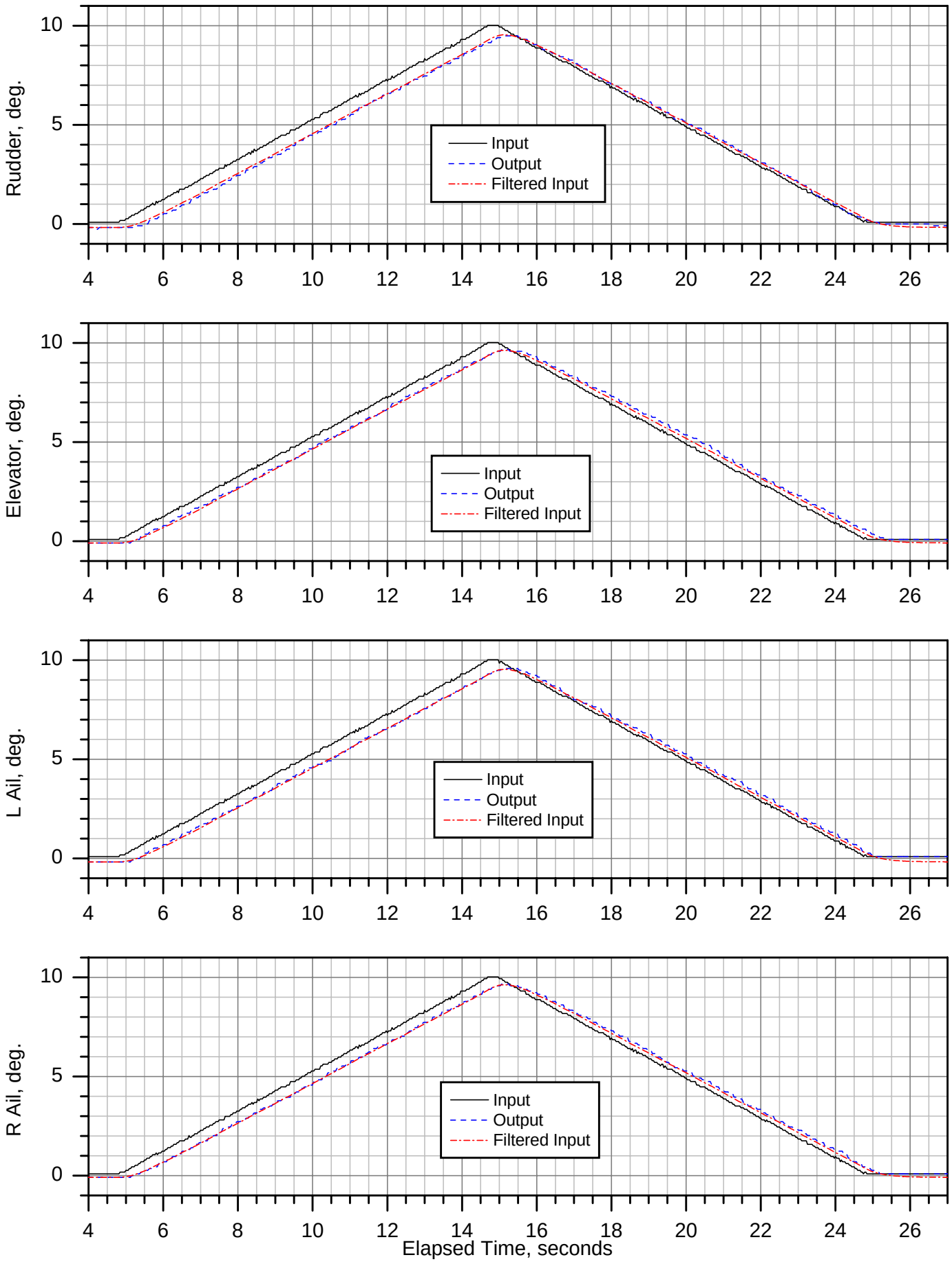
A300-600 SDAC Bench Test Case 2p7p1



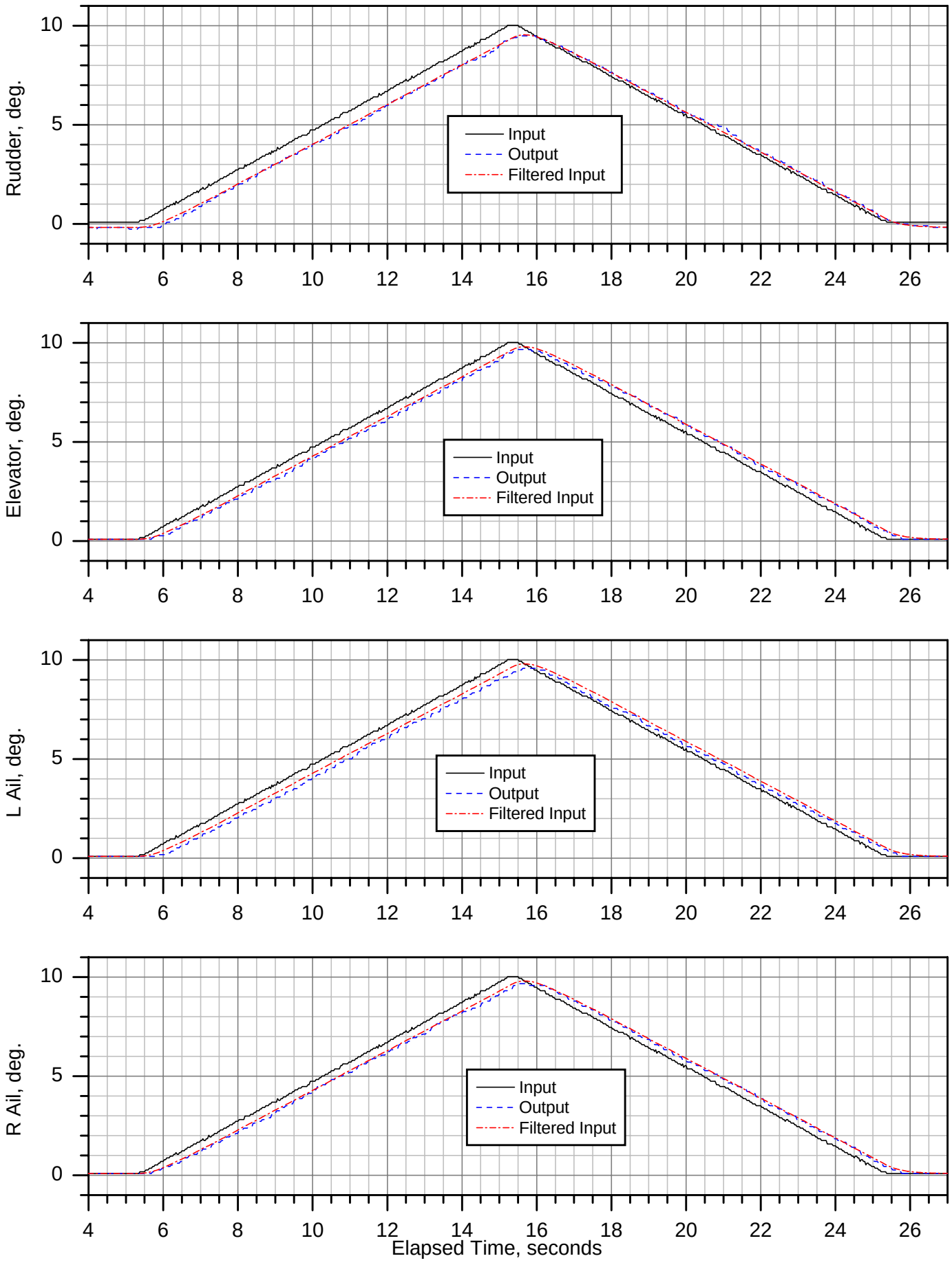
A300-600 SDAC Bench Test Case 2p7p2

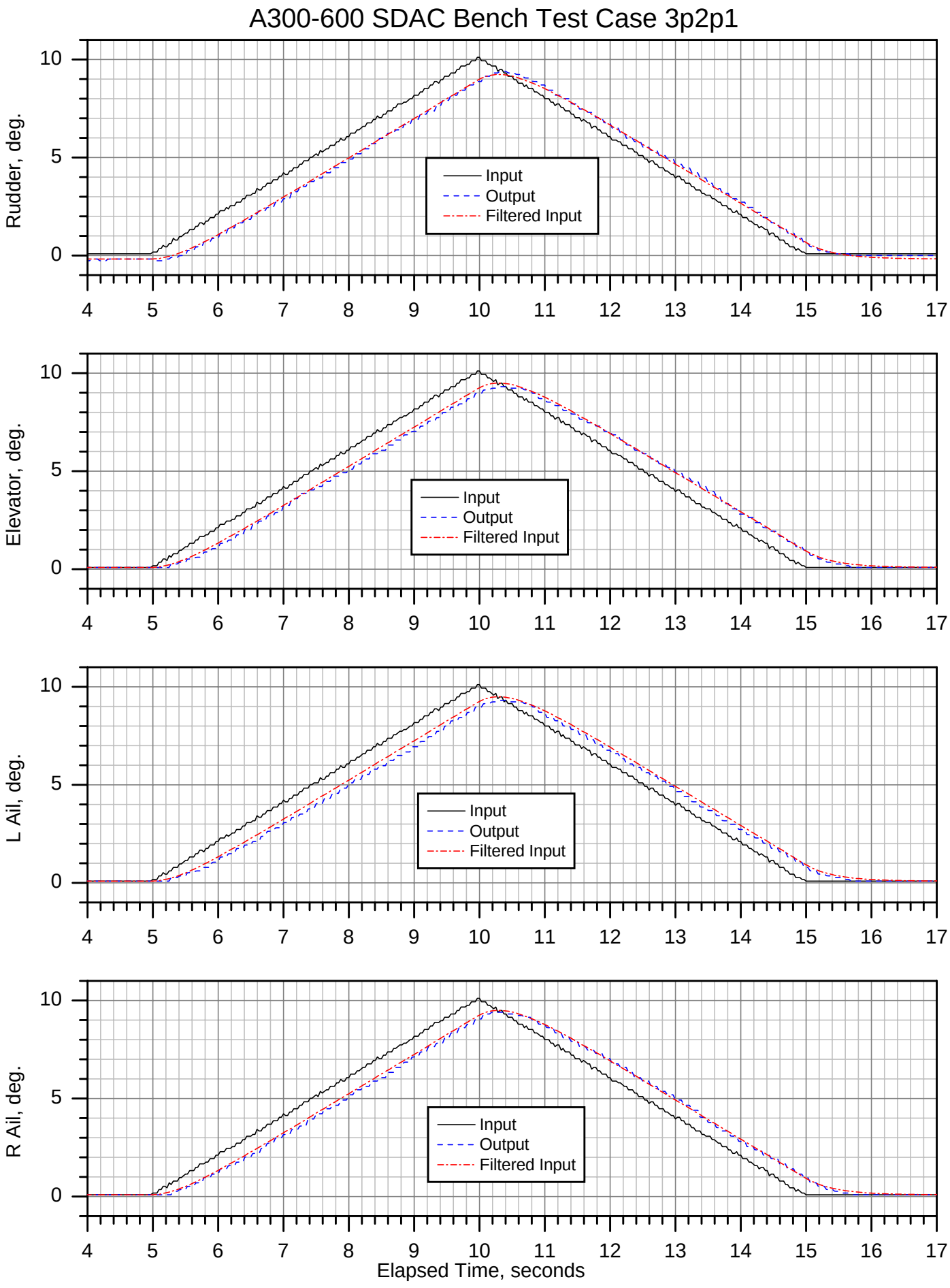


A300-600 SDAC Bench Test Case 3p1p1

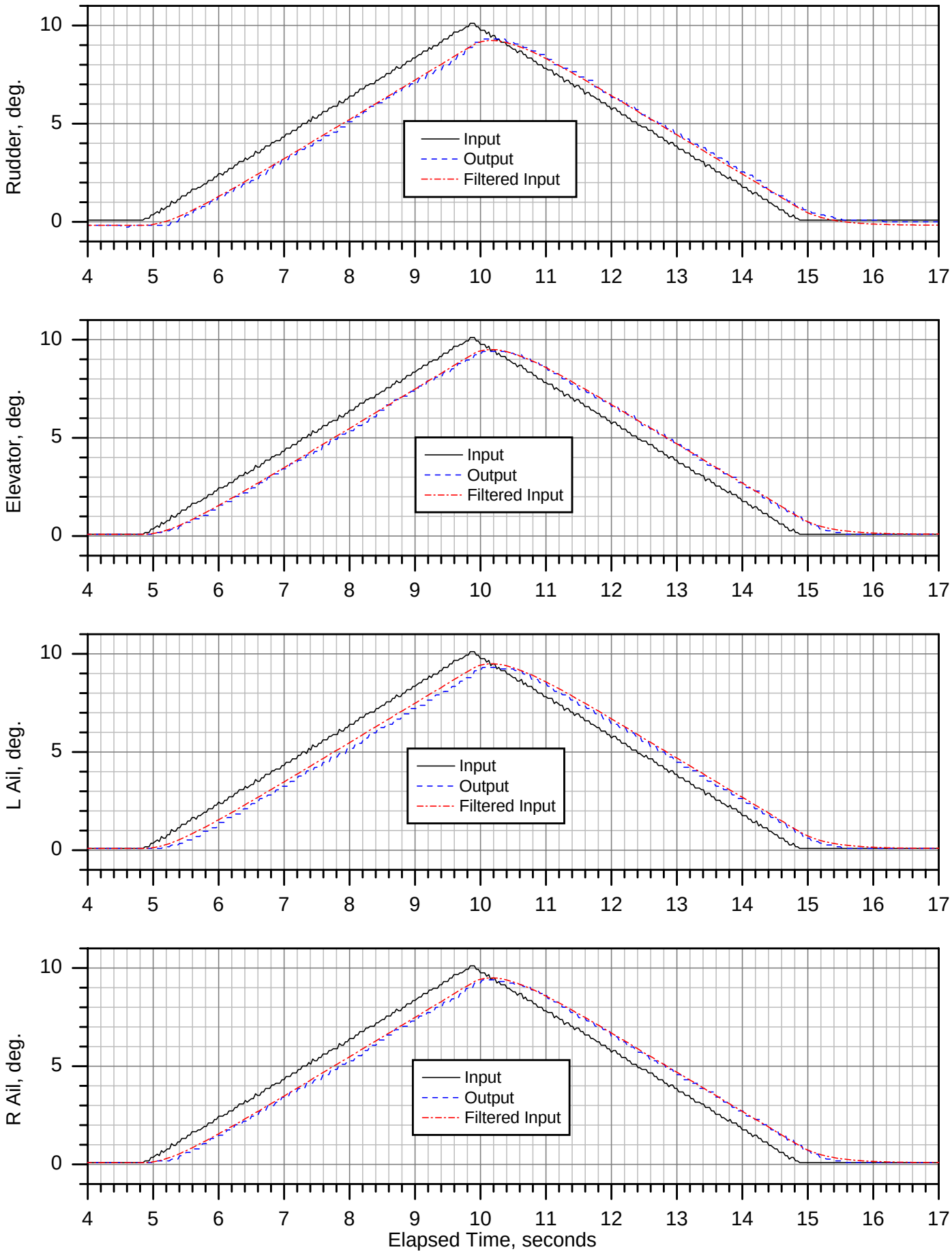


A300-600 SDAC Bench Test Case 3p1p2

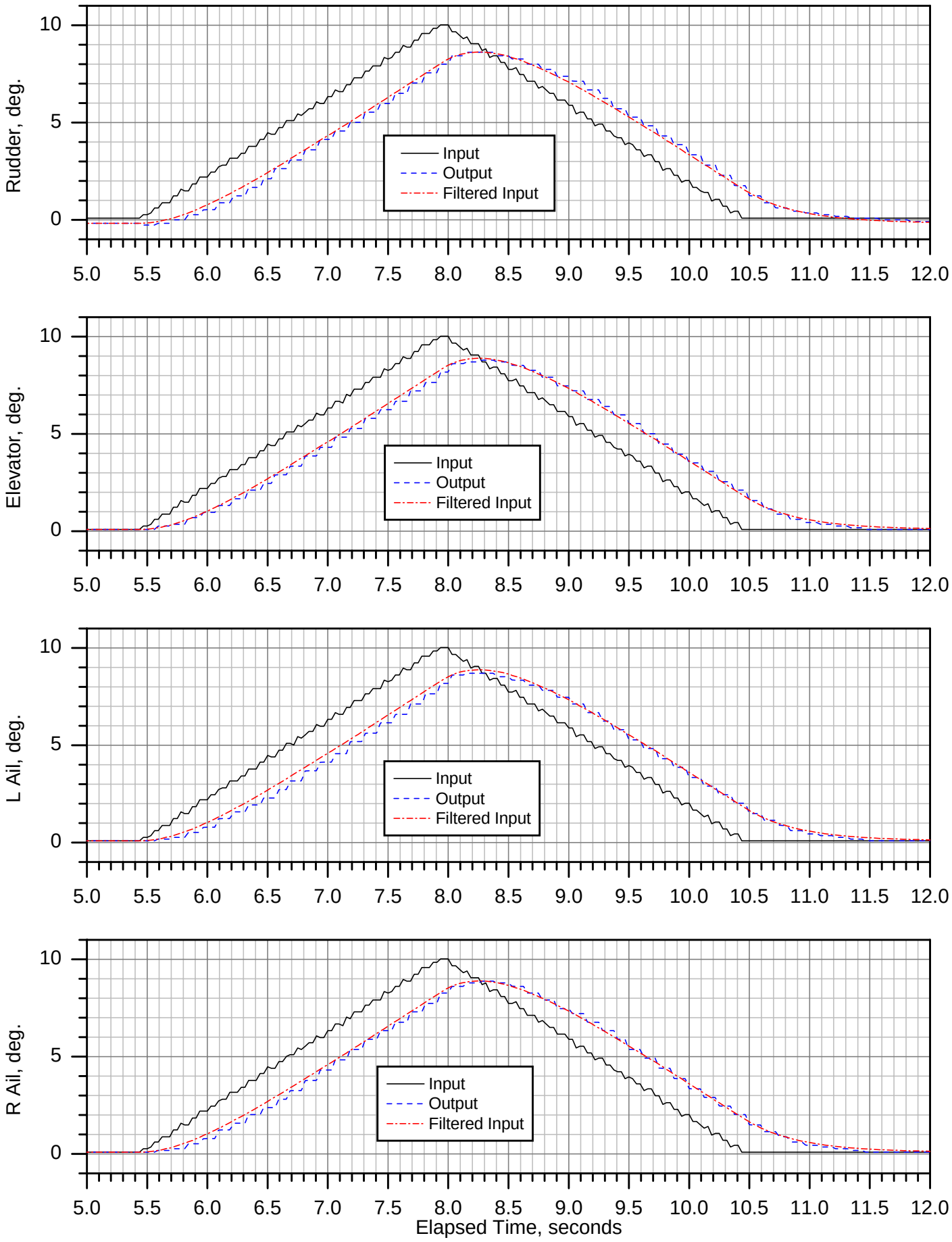



A300-600 SDAC Bench Test Case 3p2p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Elapsed Time, seconds

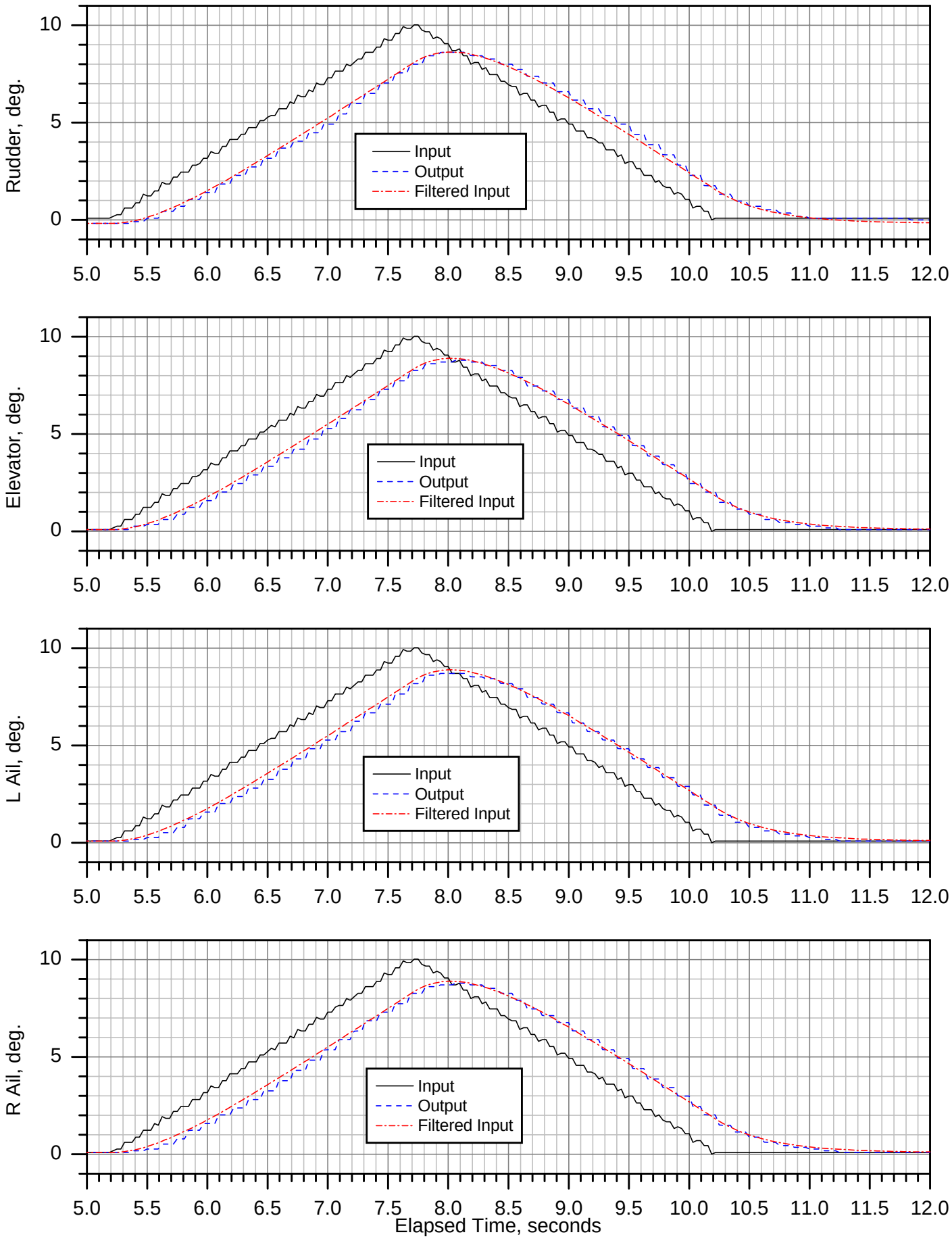
A300-600 SDAC Bench Test Case 3p2p2



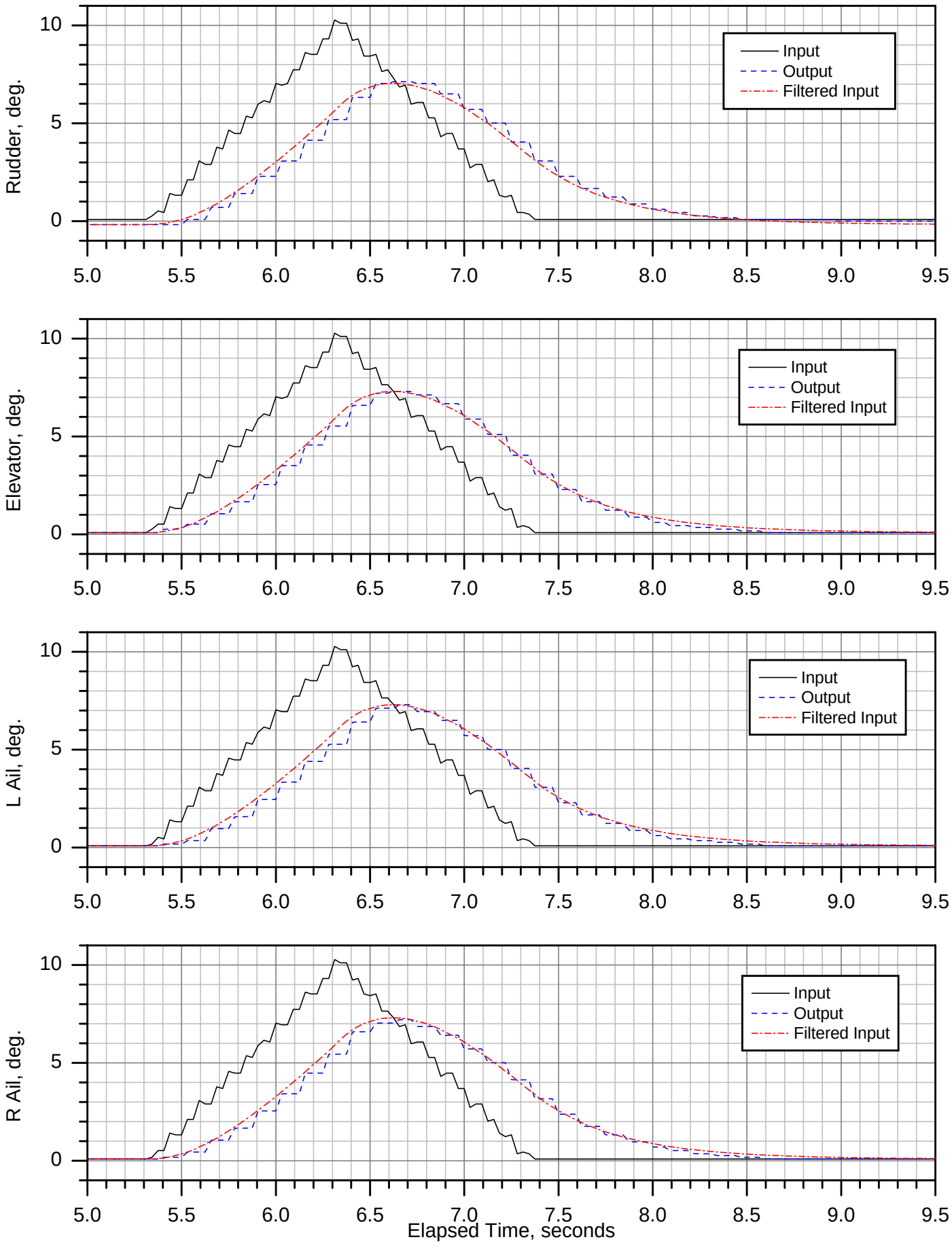
A300-600 SDAC Bench Test Case 3p3p1

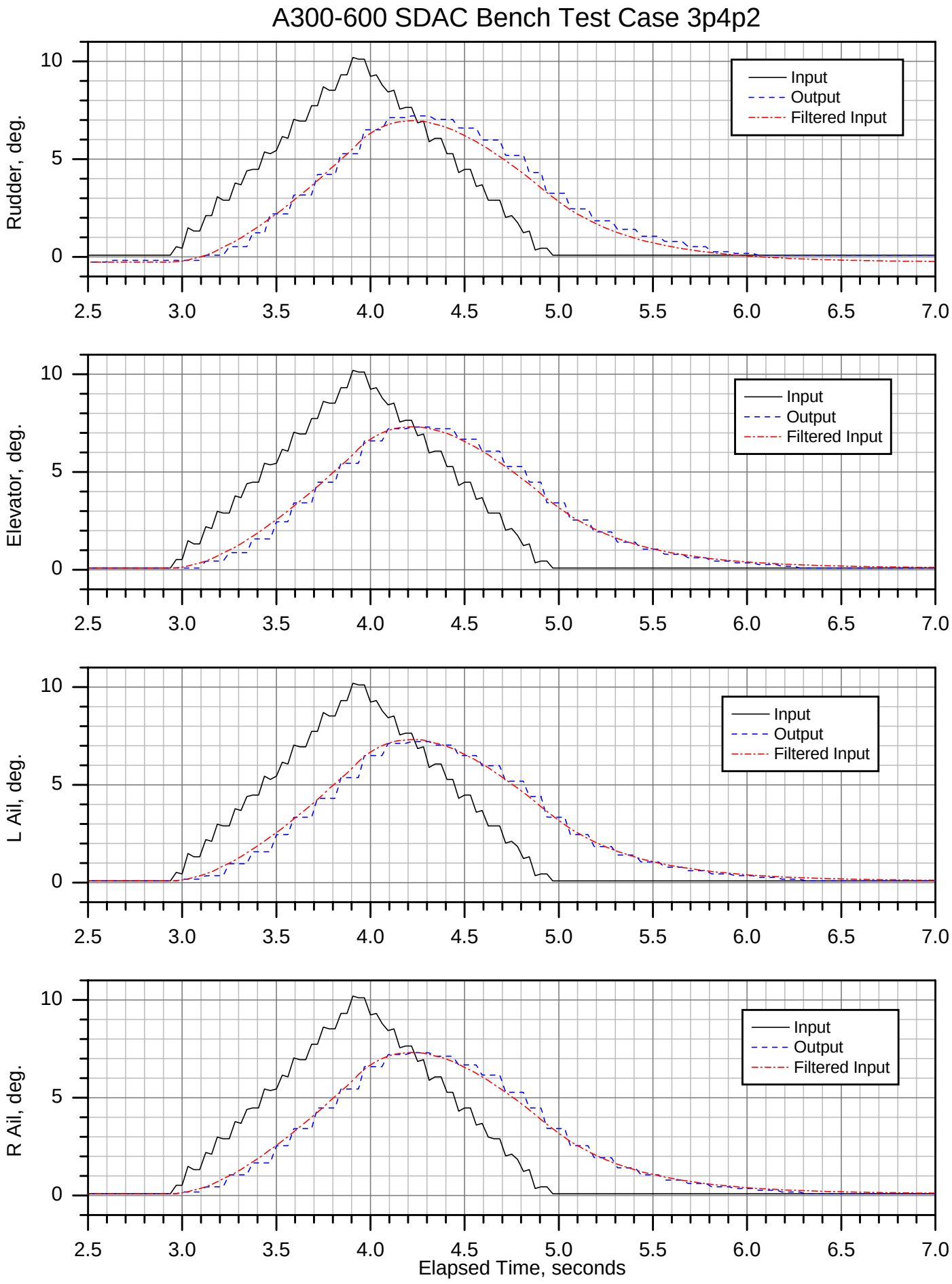


A300-600 SDAC Bench Test Case 3p3p2

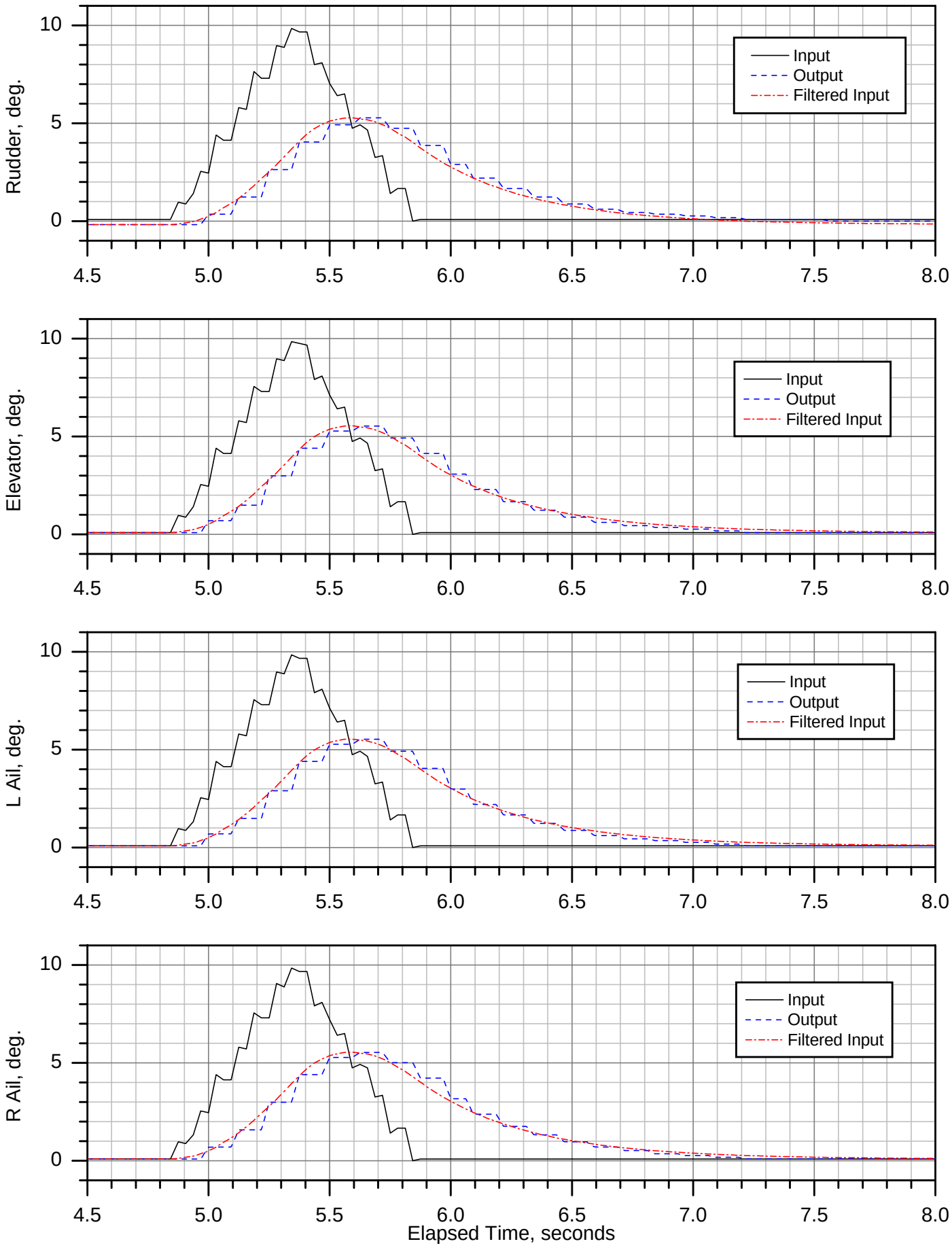


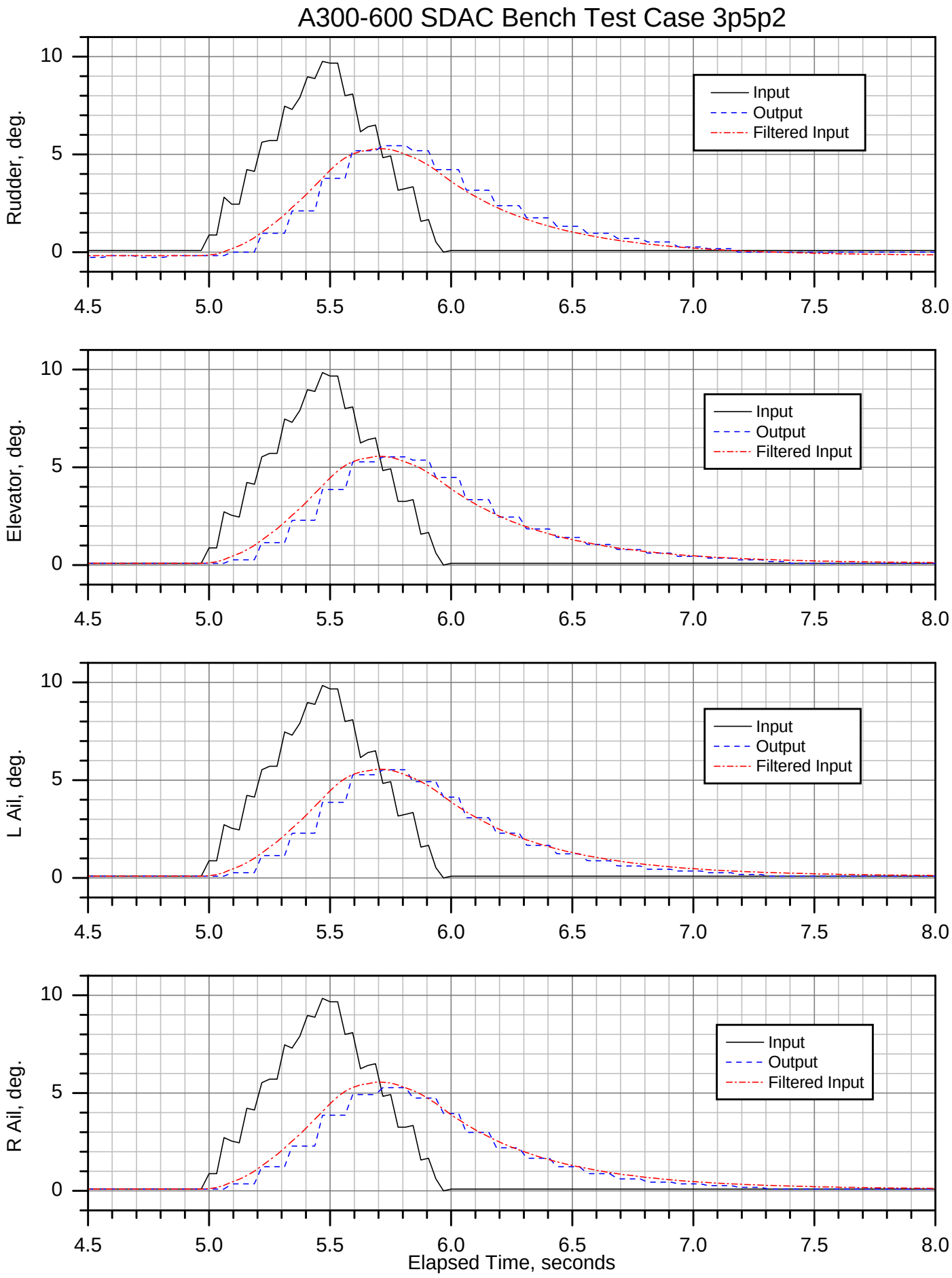
A300-600 SDAC Bench Test Case 3p4p1



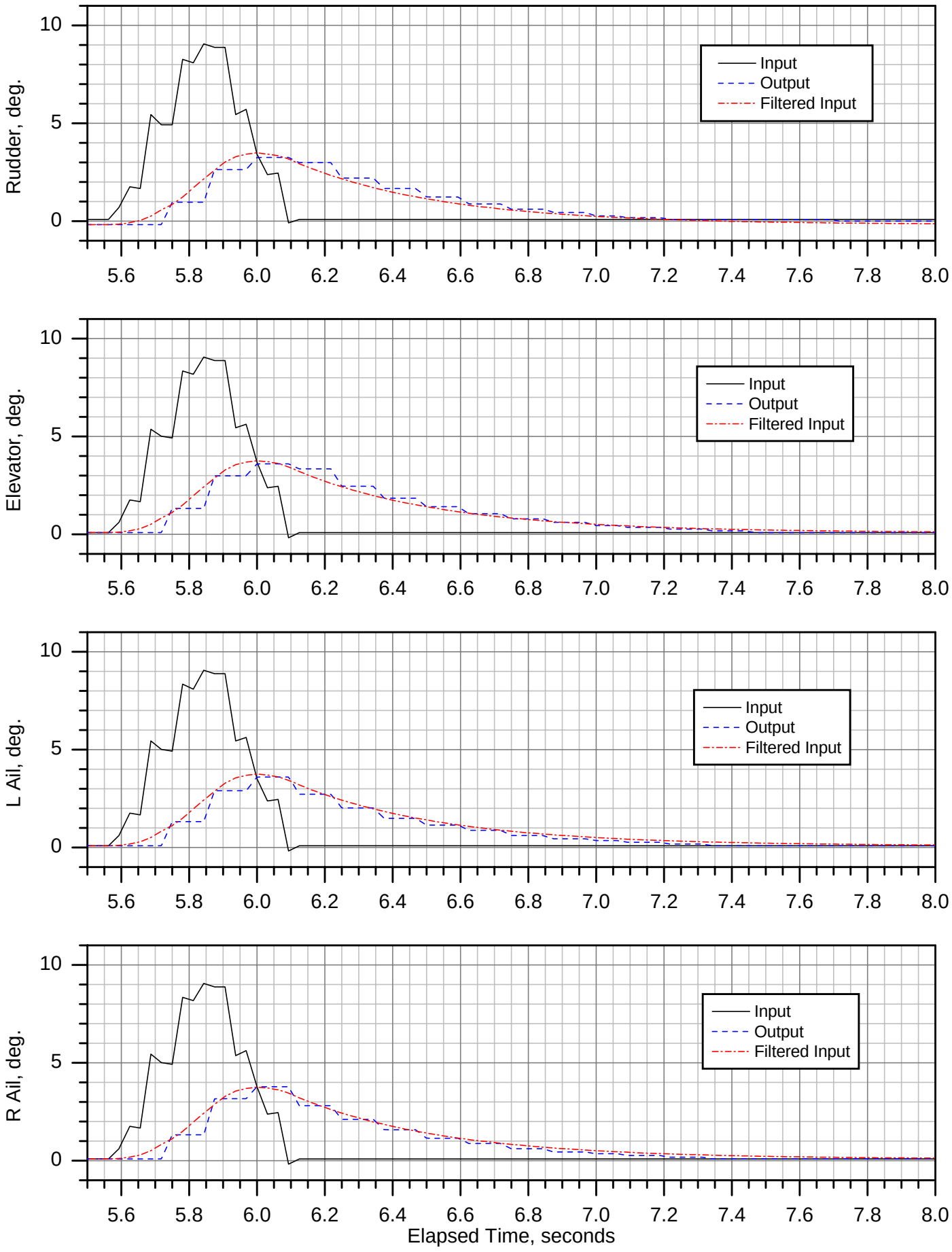

A300-600 SDAC Bench Test Case 3p4p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
Elapsed Time, seconds

A300-600 SDAC Bench Test Case 3p5p1

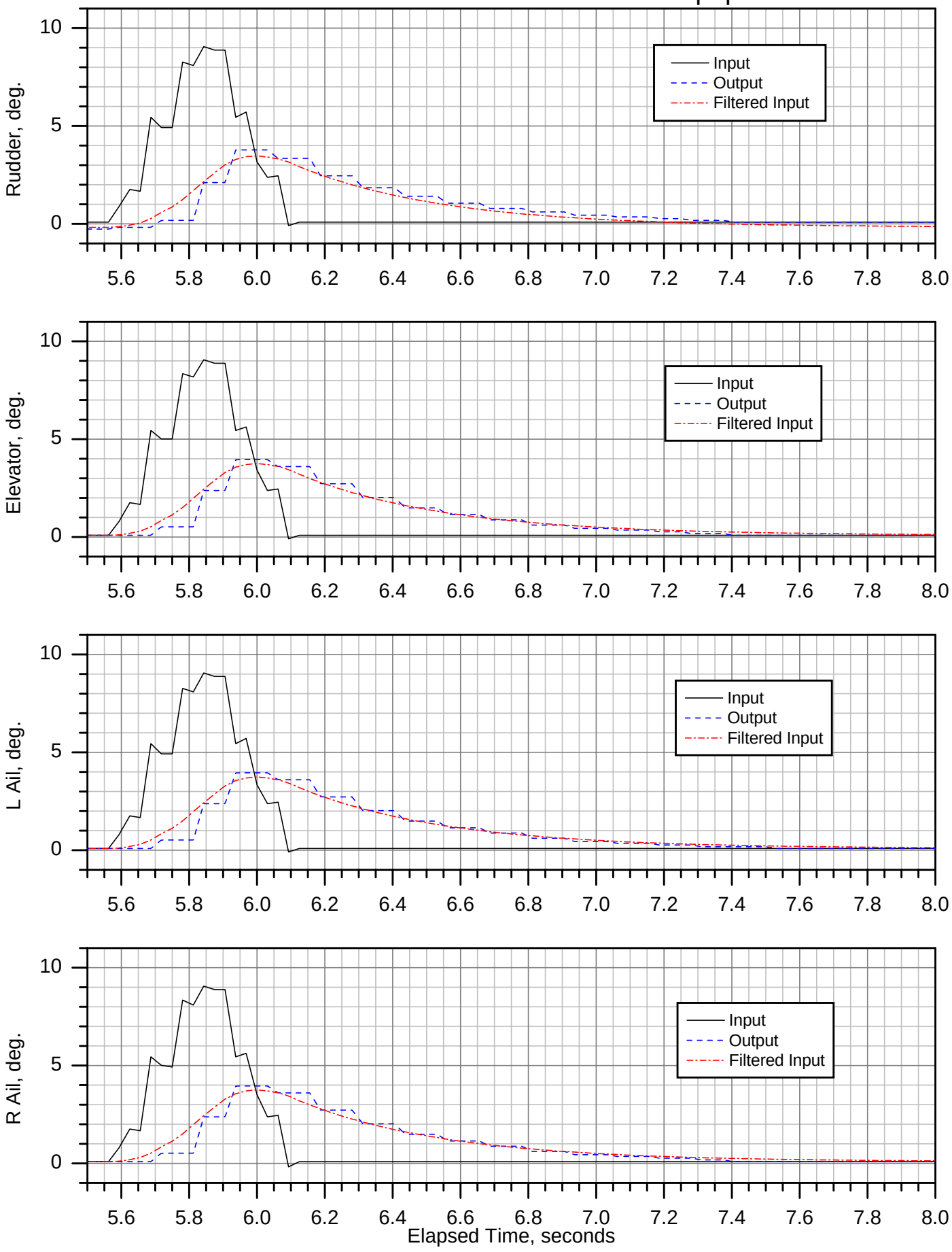



A300-600 SDAC Bench Test Case 3p5p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Elapsed Time, seconds

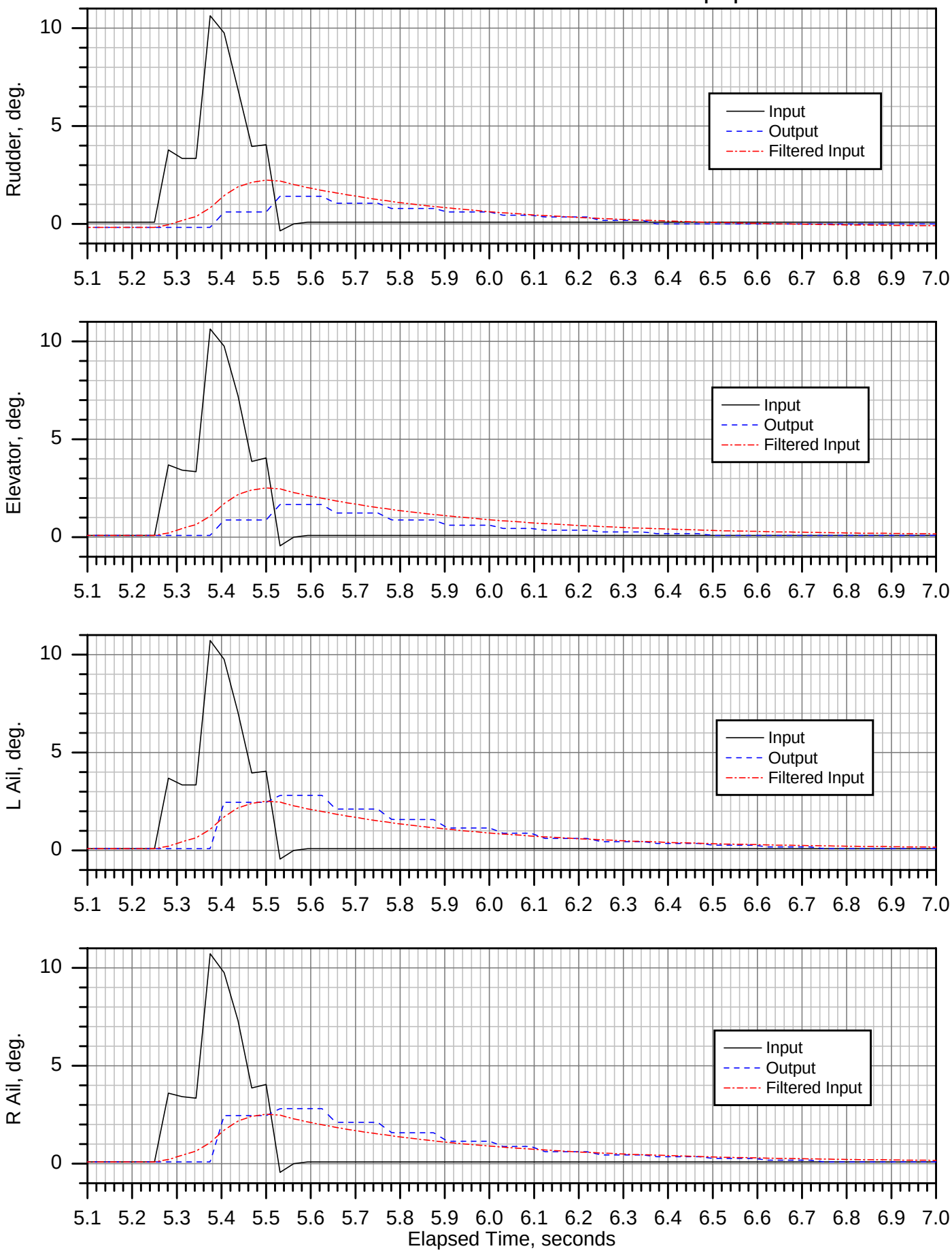
A300-600 SDAC Bench Test Case 3p6p1



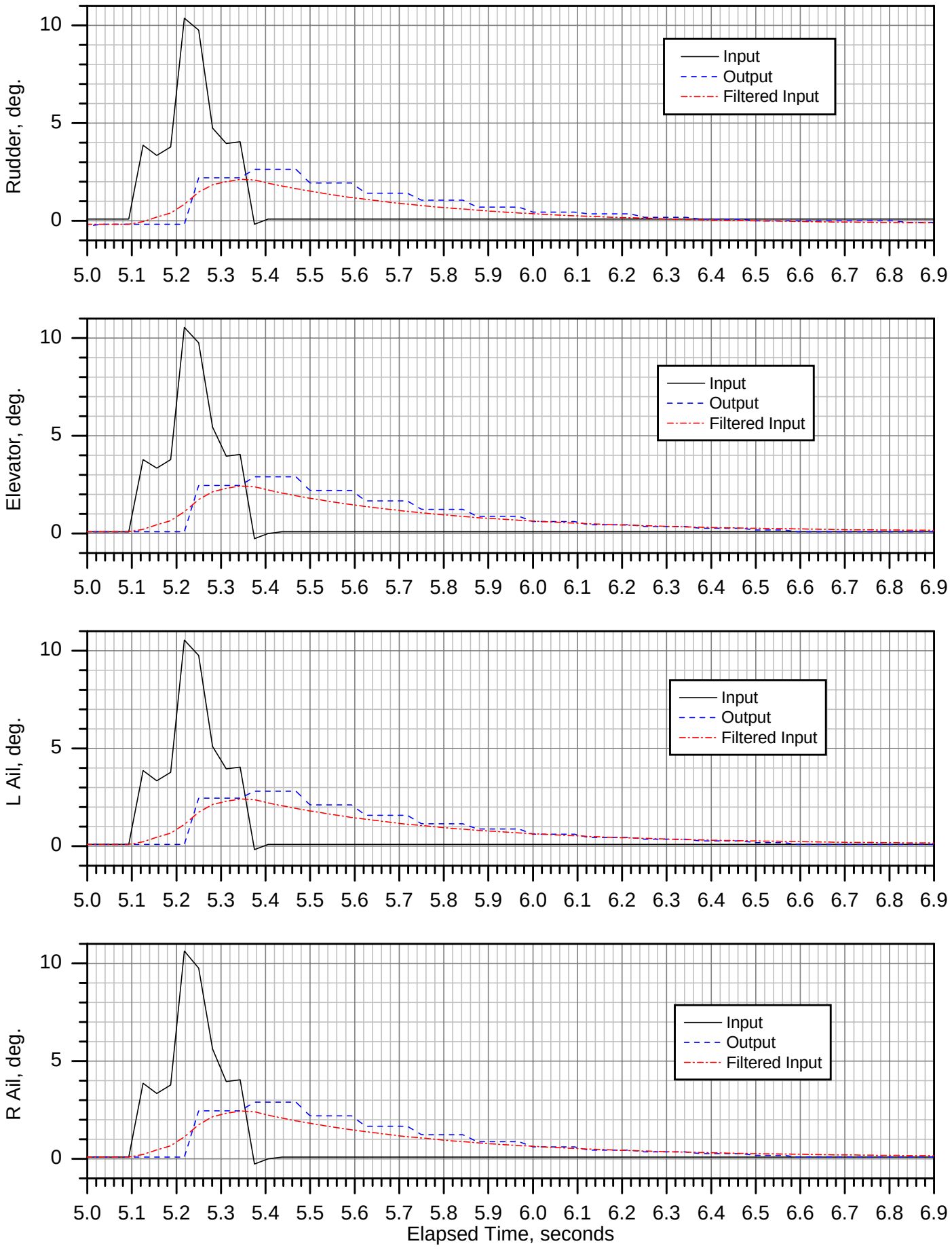
A300-600 SDAC Bench Test Case 3p6p2



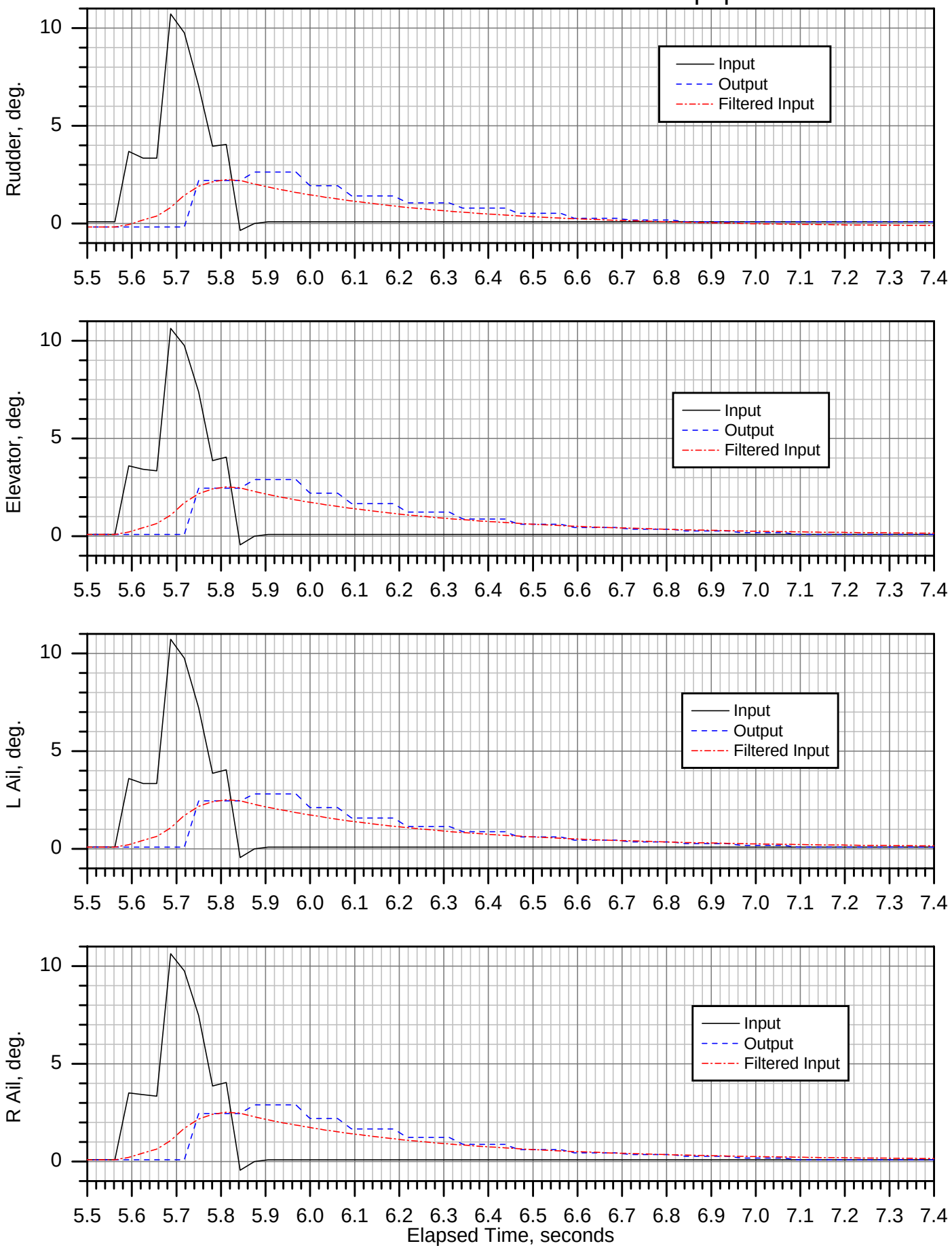
A300-600 SDAC Bench Test Case 3p7p1



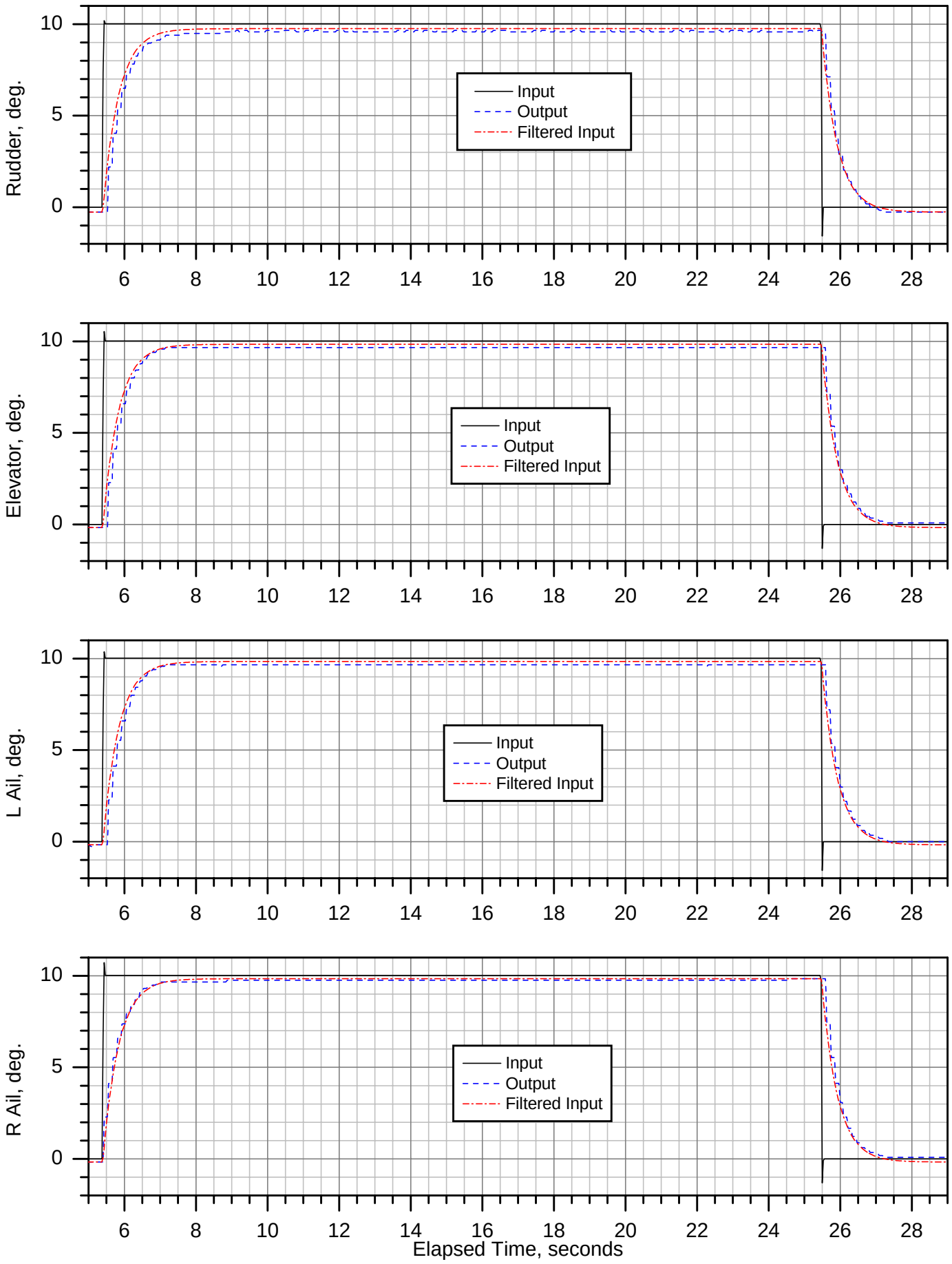
A300-600 SDAC Bench Test Case 3p7p2



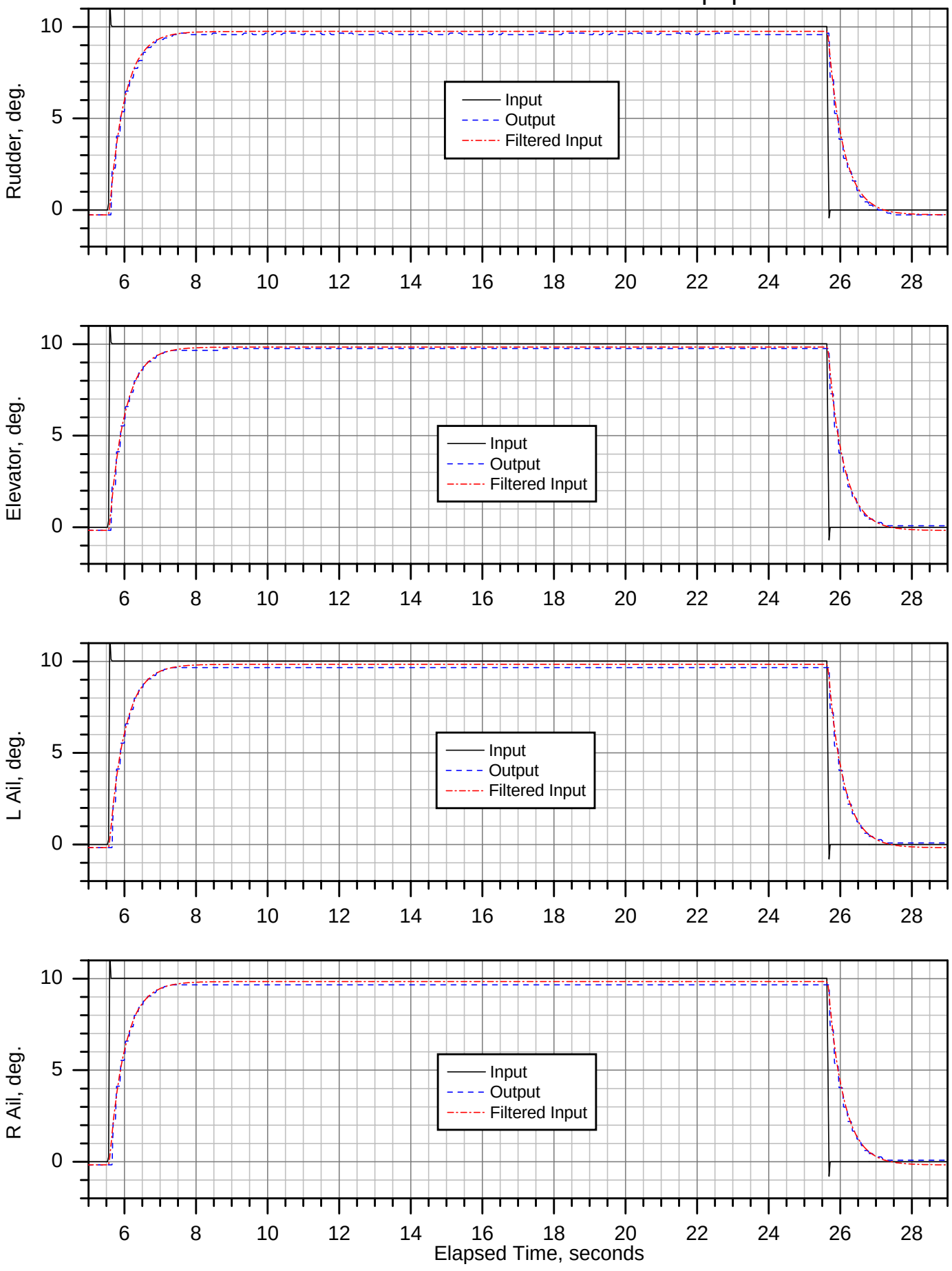
A300-600 SDAC Bench Test Case 3p7p3



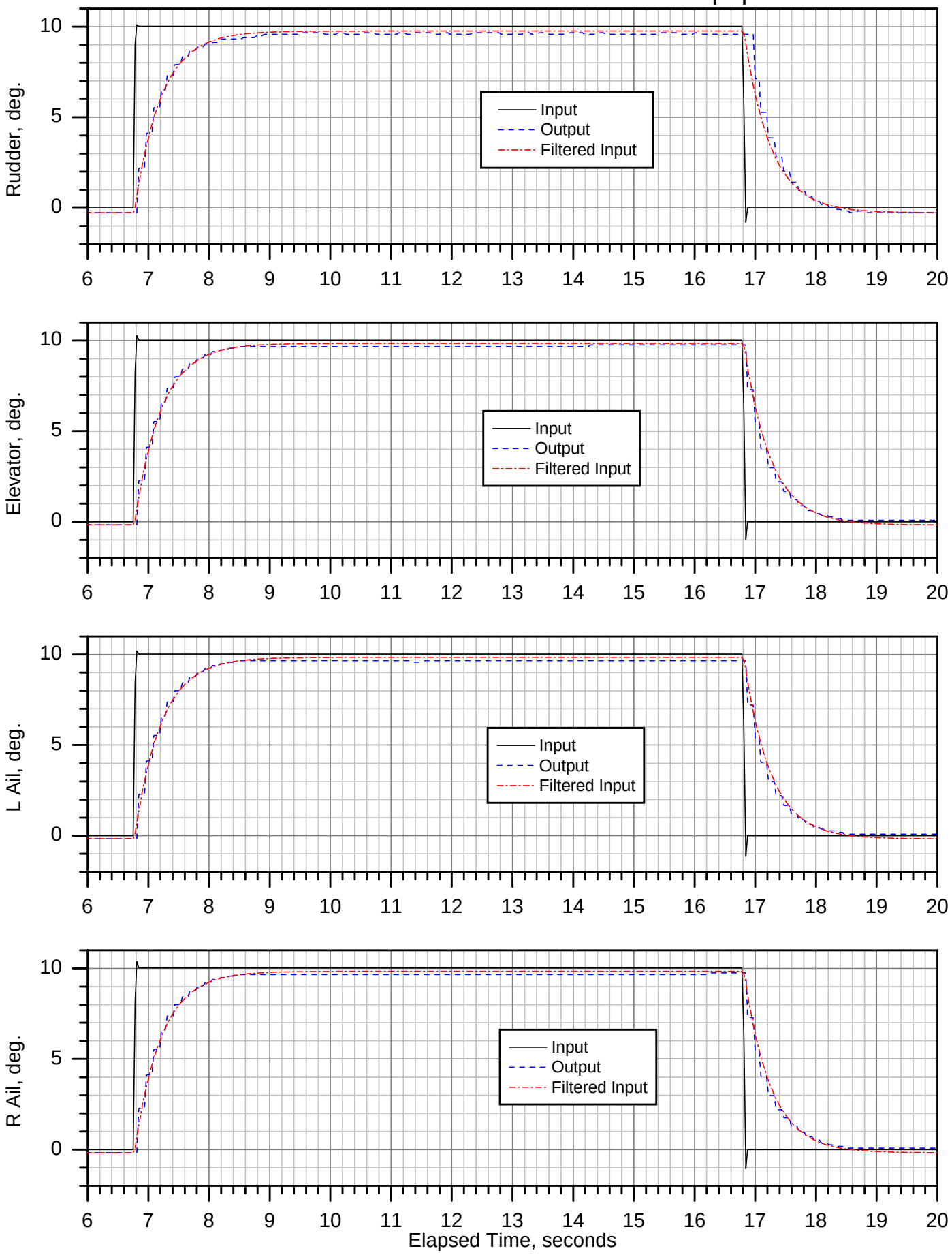
A300-600 SDAC Bench Test Case 4p1p1

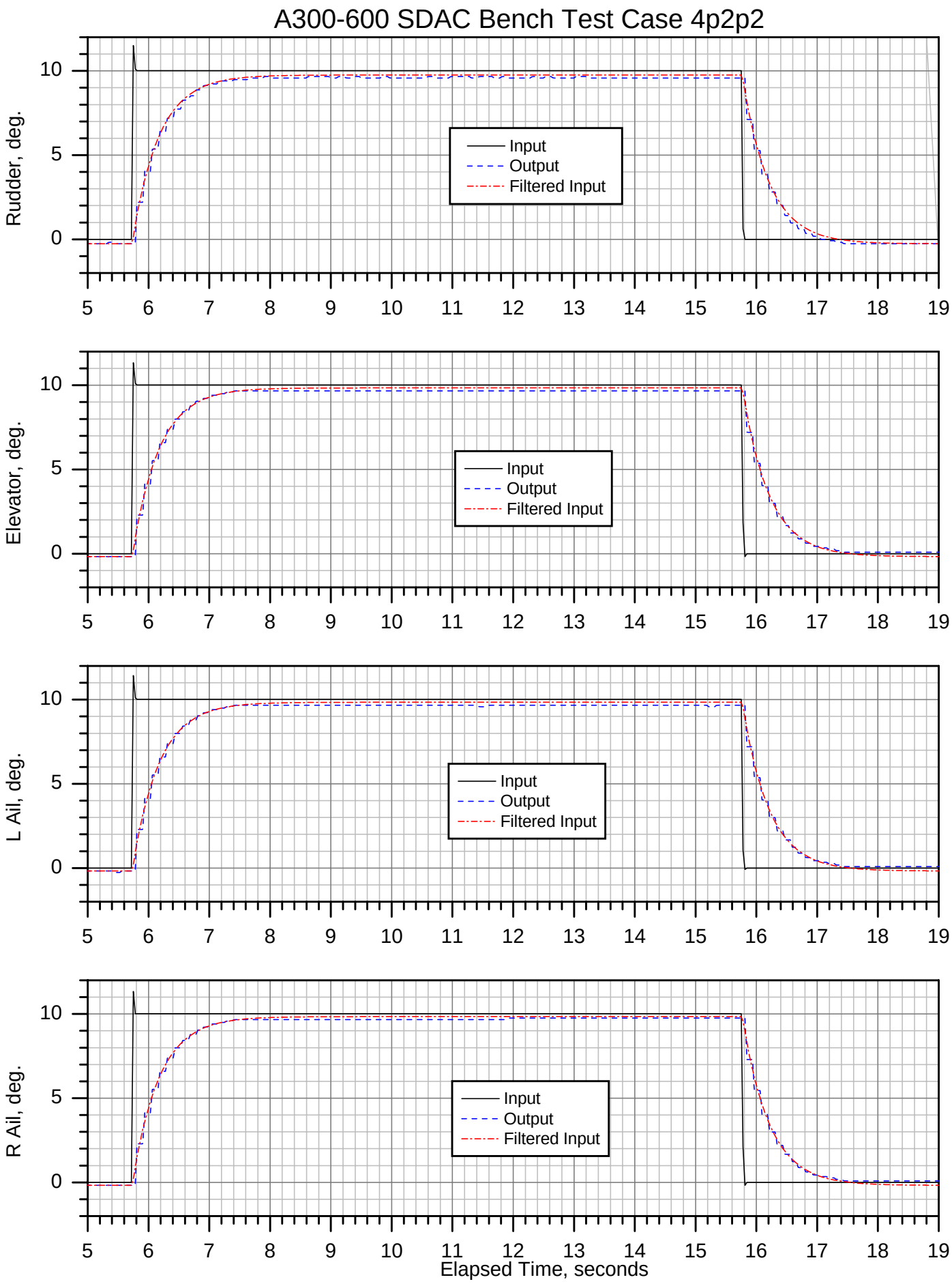


A300-600 SDAC Bench Test Case 4p1p2

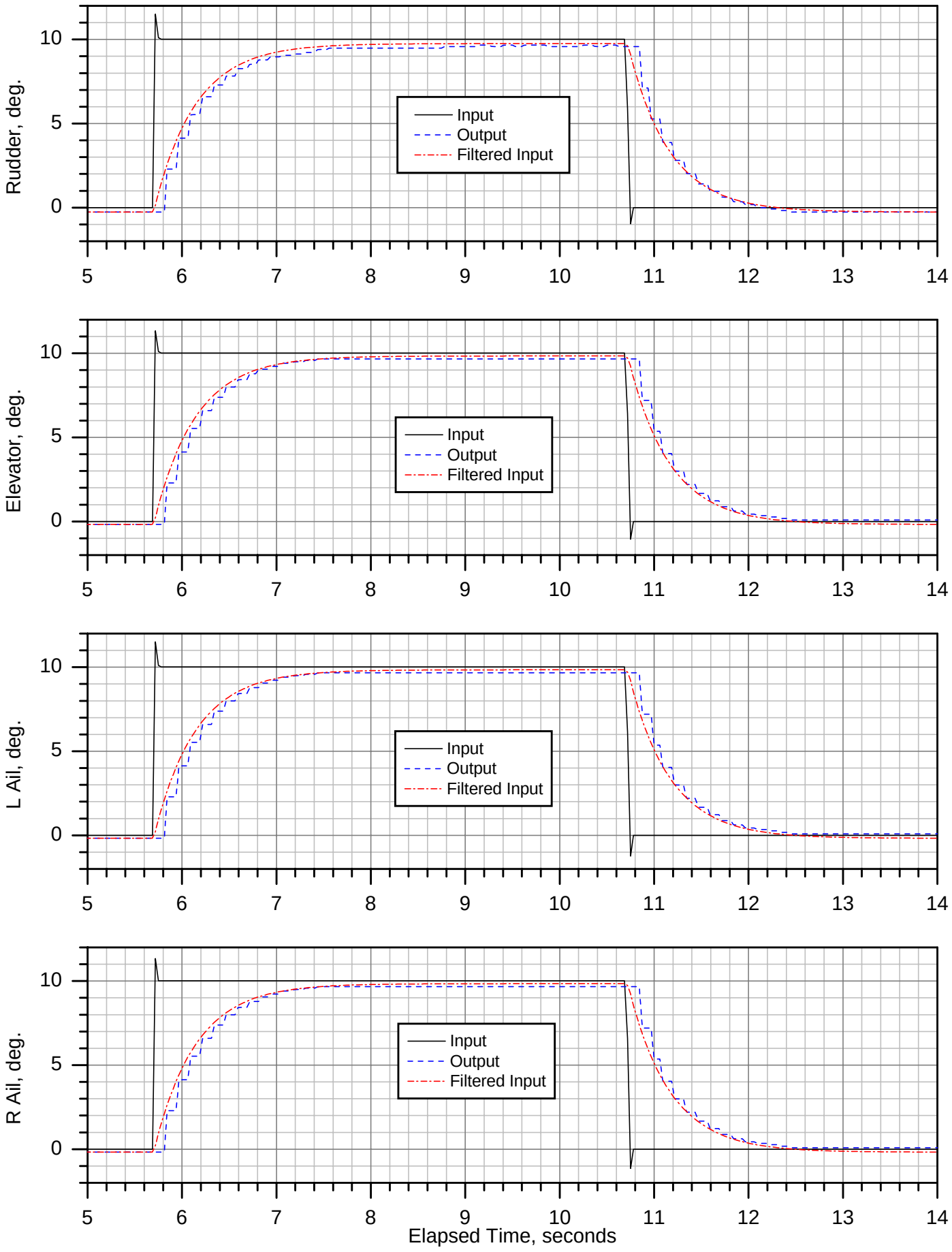


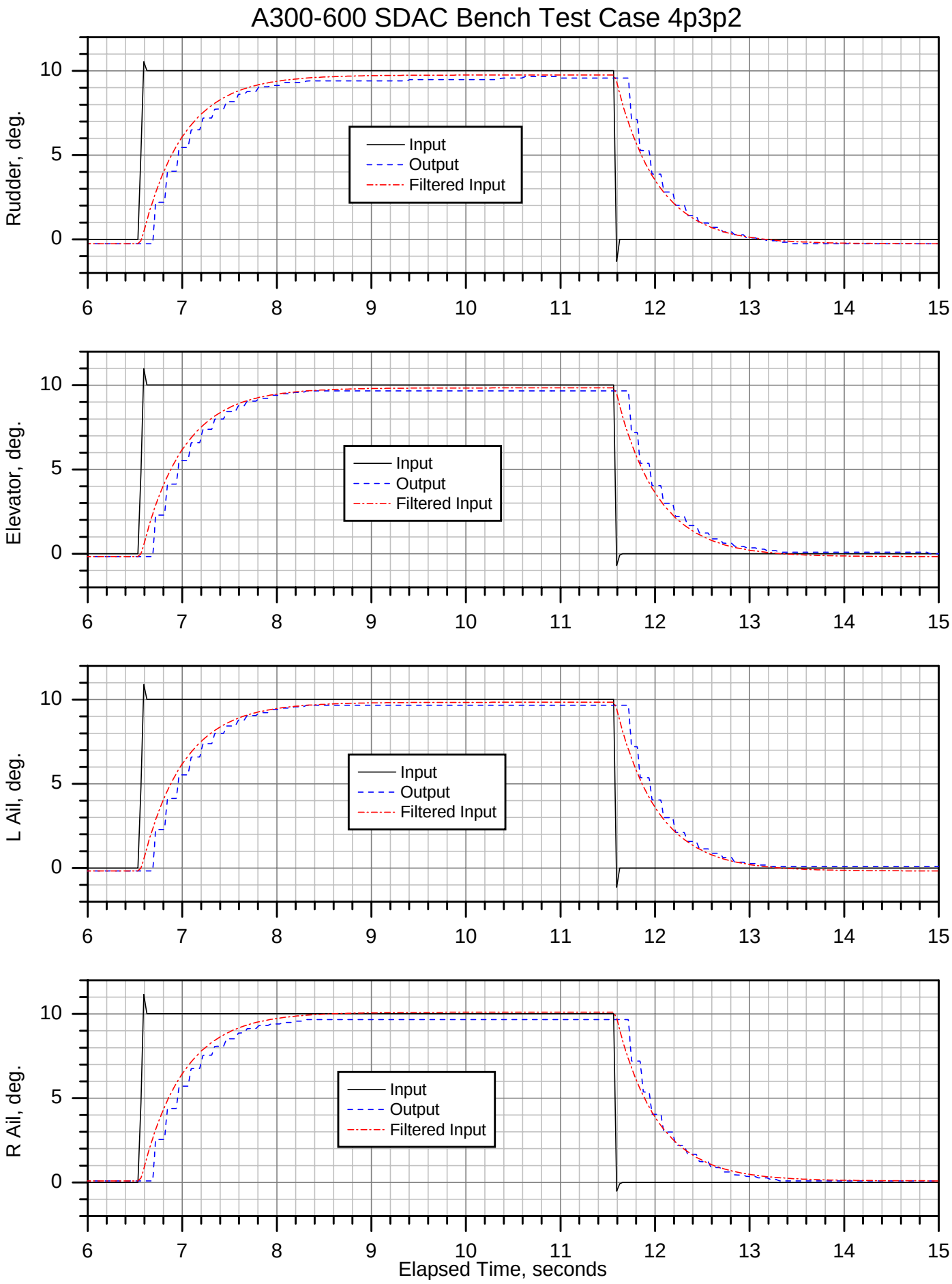
A300-600 SDAC Bench Test Case 4p2p1



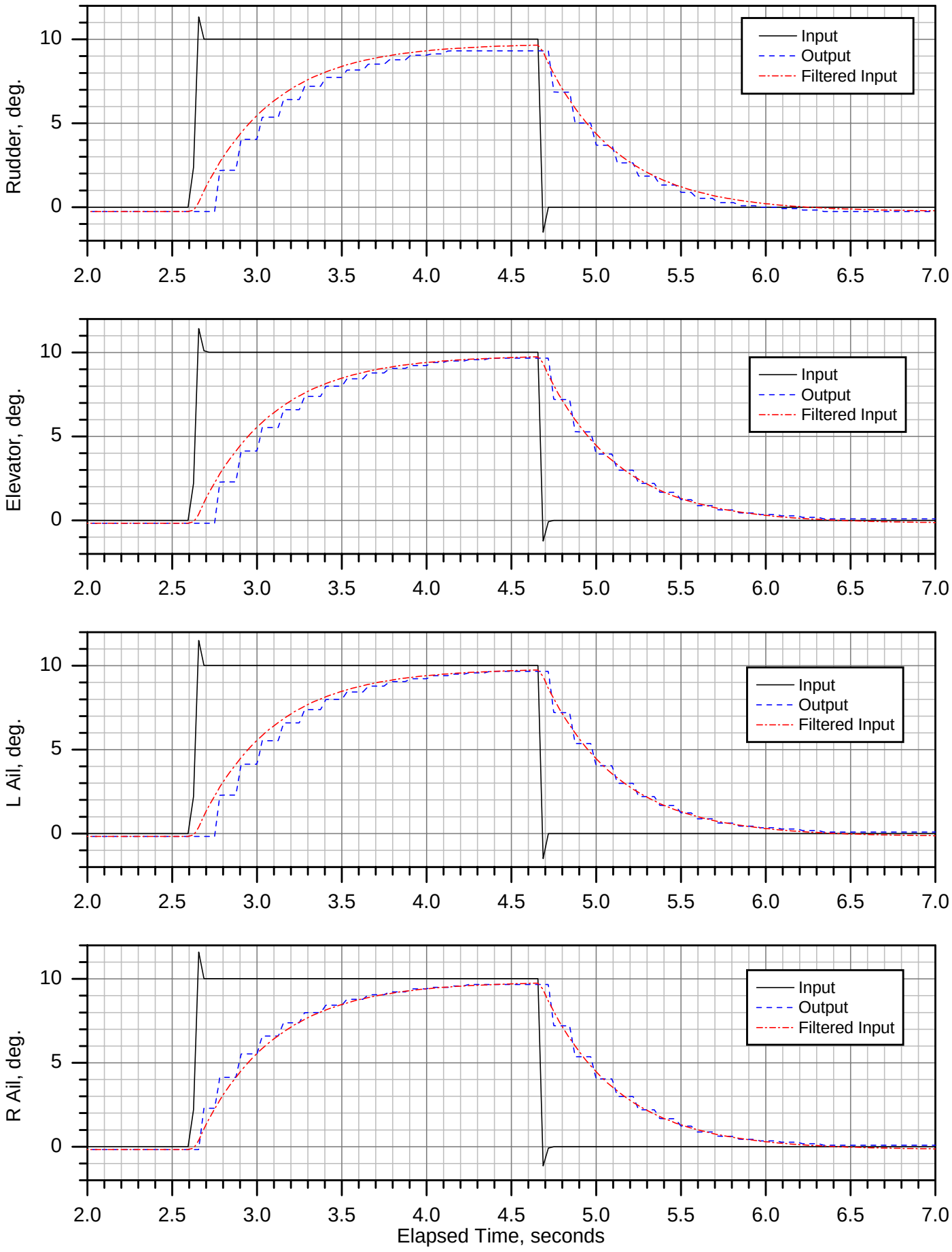

A300-600 SDAC Bench Test Case 4p2p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
Elapsed Time, seconds

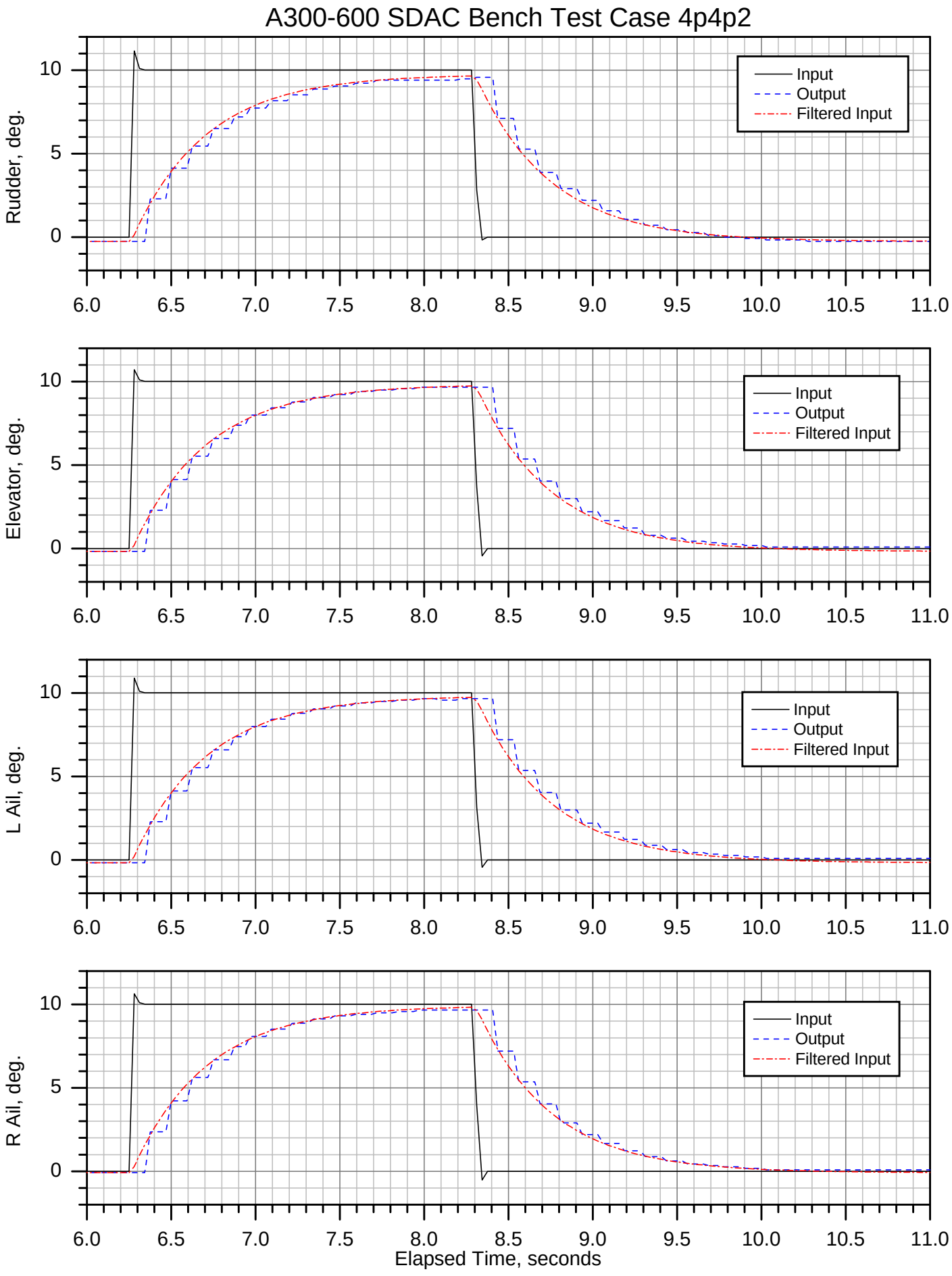
A300-600 SDAC Bench Test Case 4p3p1



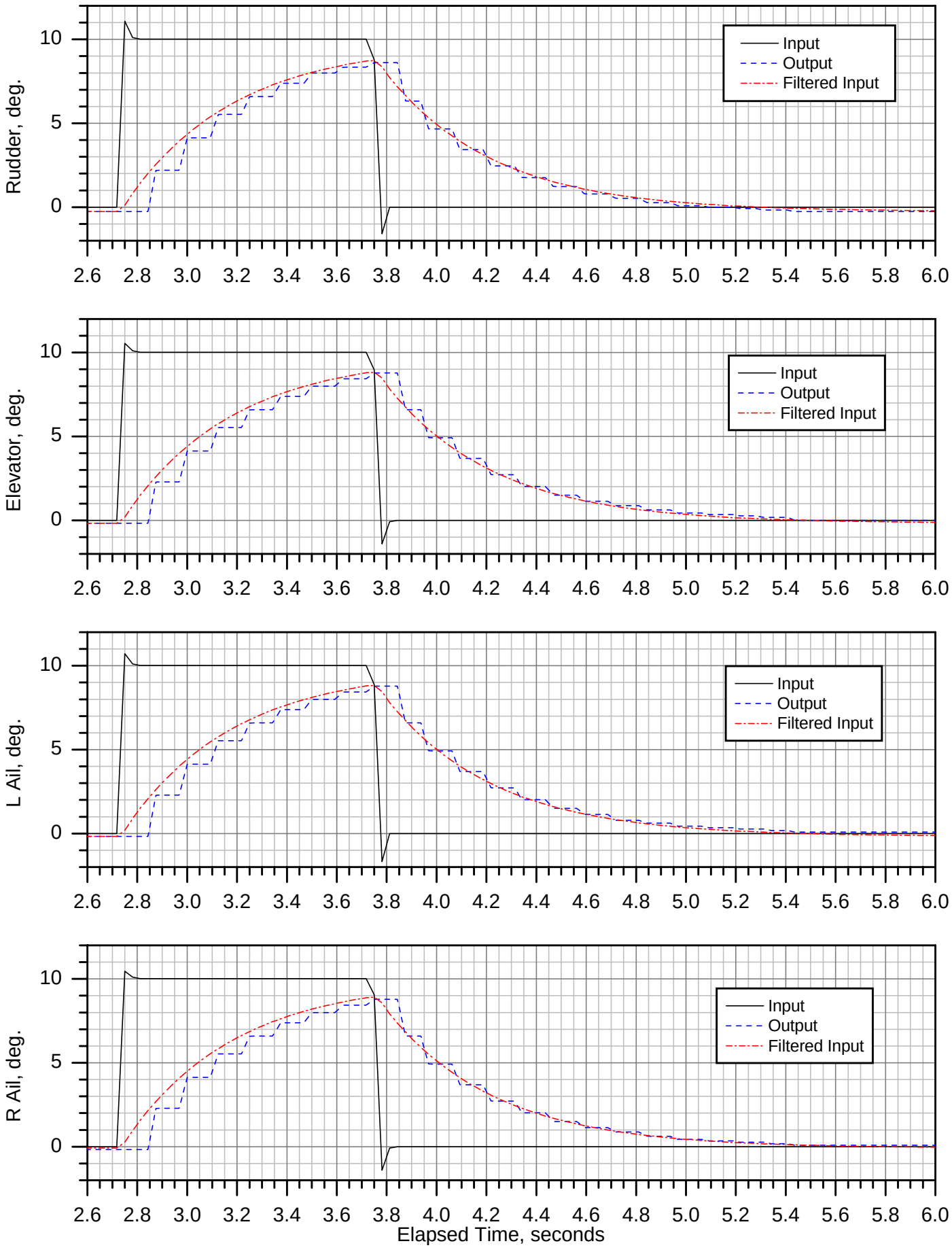

A300-600 SDAC Bench Test Case 4p3p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
6
7
8
9
10
11
12
13
14
15
Elapsed Time, seconds

A300-600 SDAC Bench Test Case 4p4p1

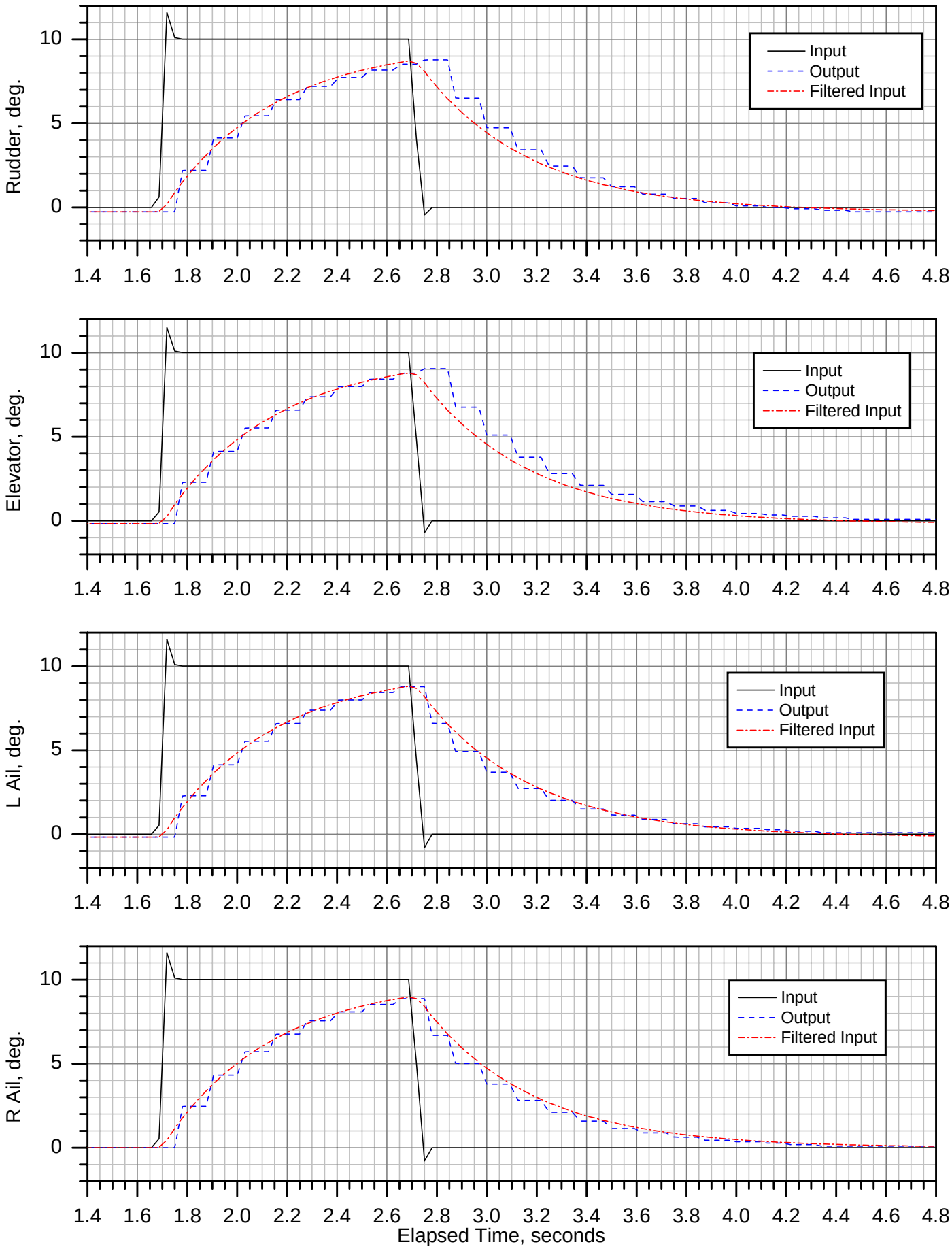



A300-600 SDAC Bench Test Case 4p4p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
Elapsed Time, seconds

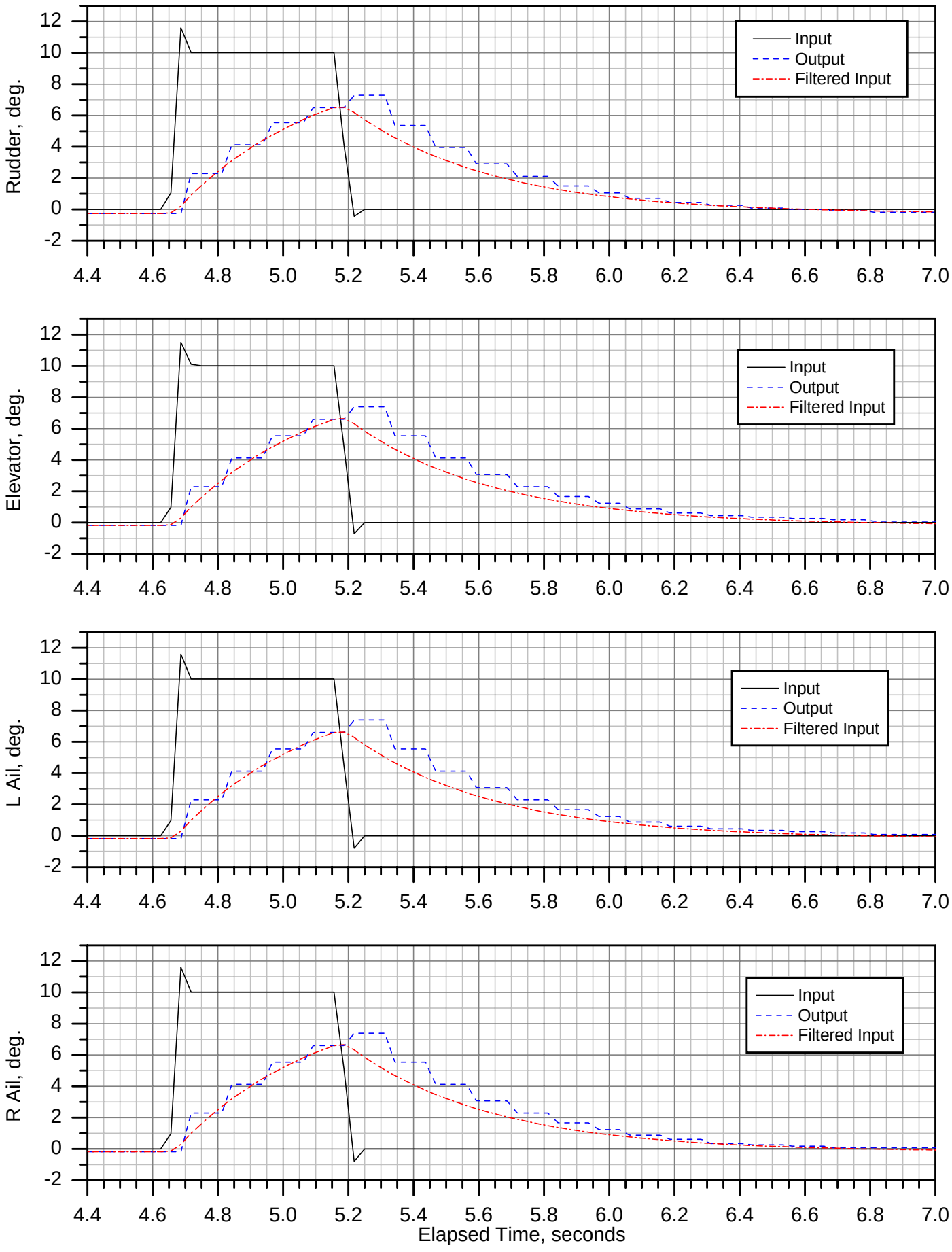
A300-600 SDAC Bench Test Case 4p5p1



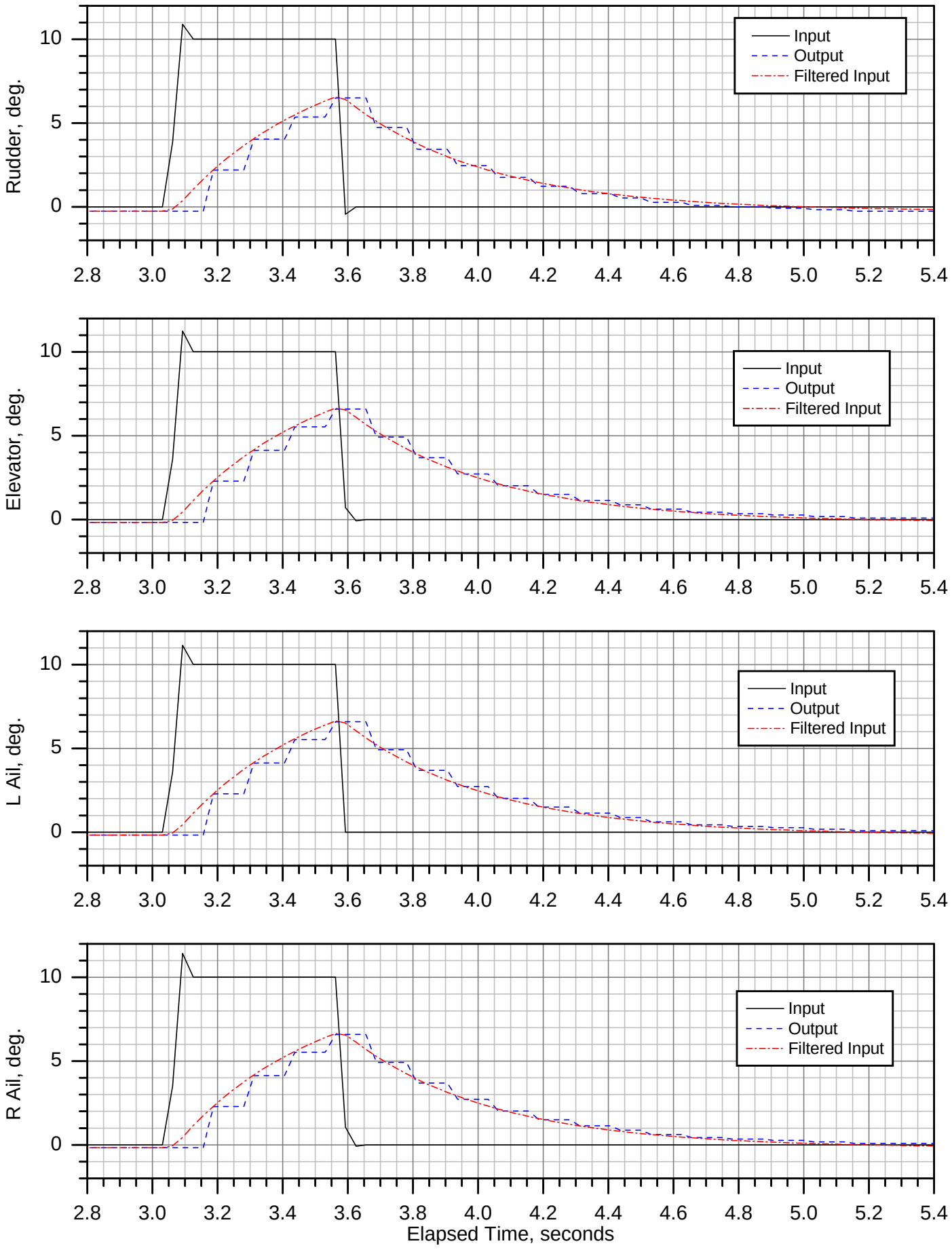
A300-600 SDAC Bench Test Case 4p5p2



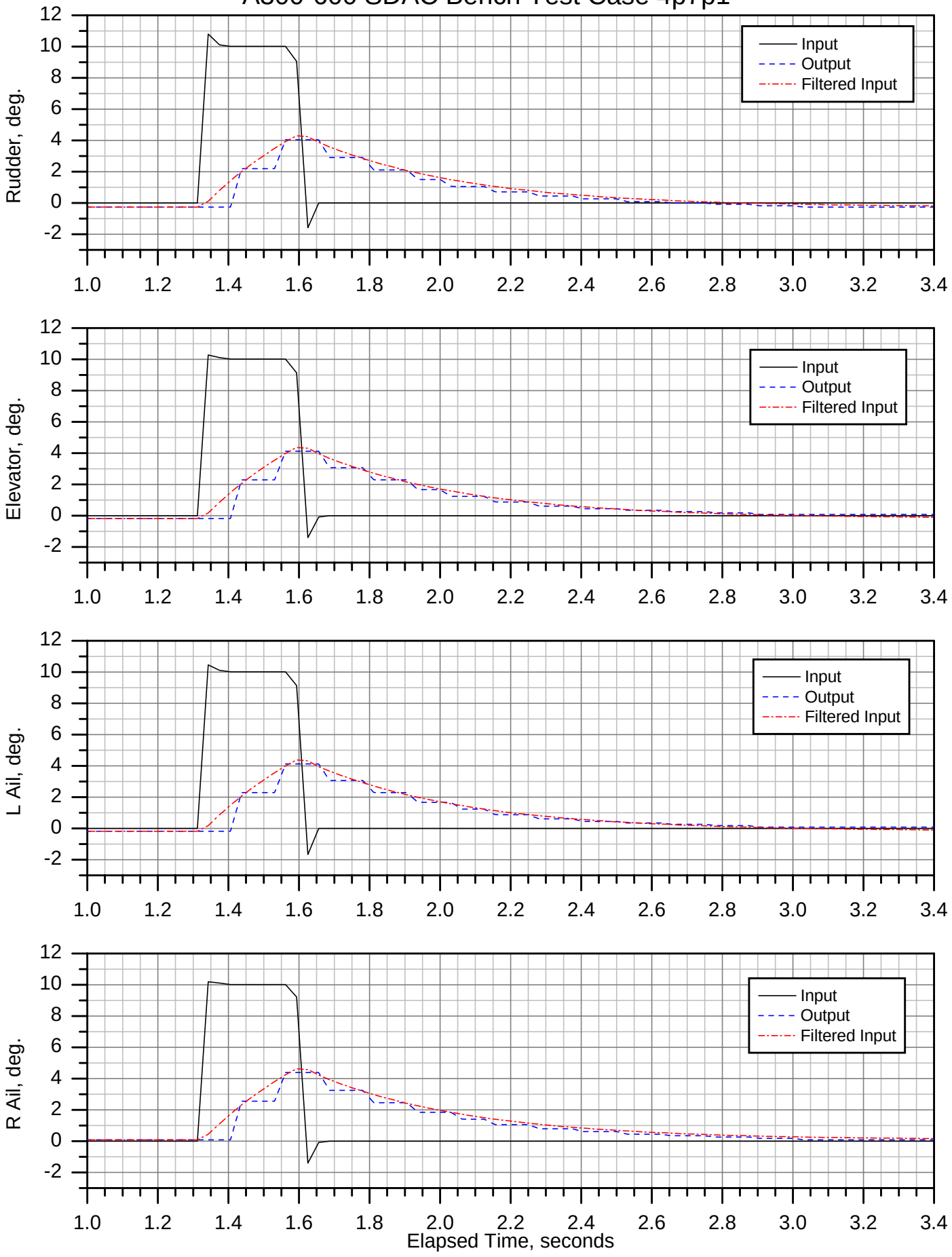
A300-600 SDAC Bench Test Case 4p6p1



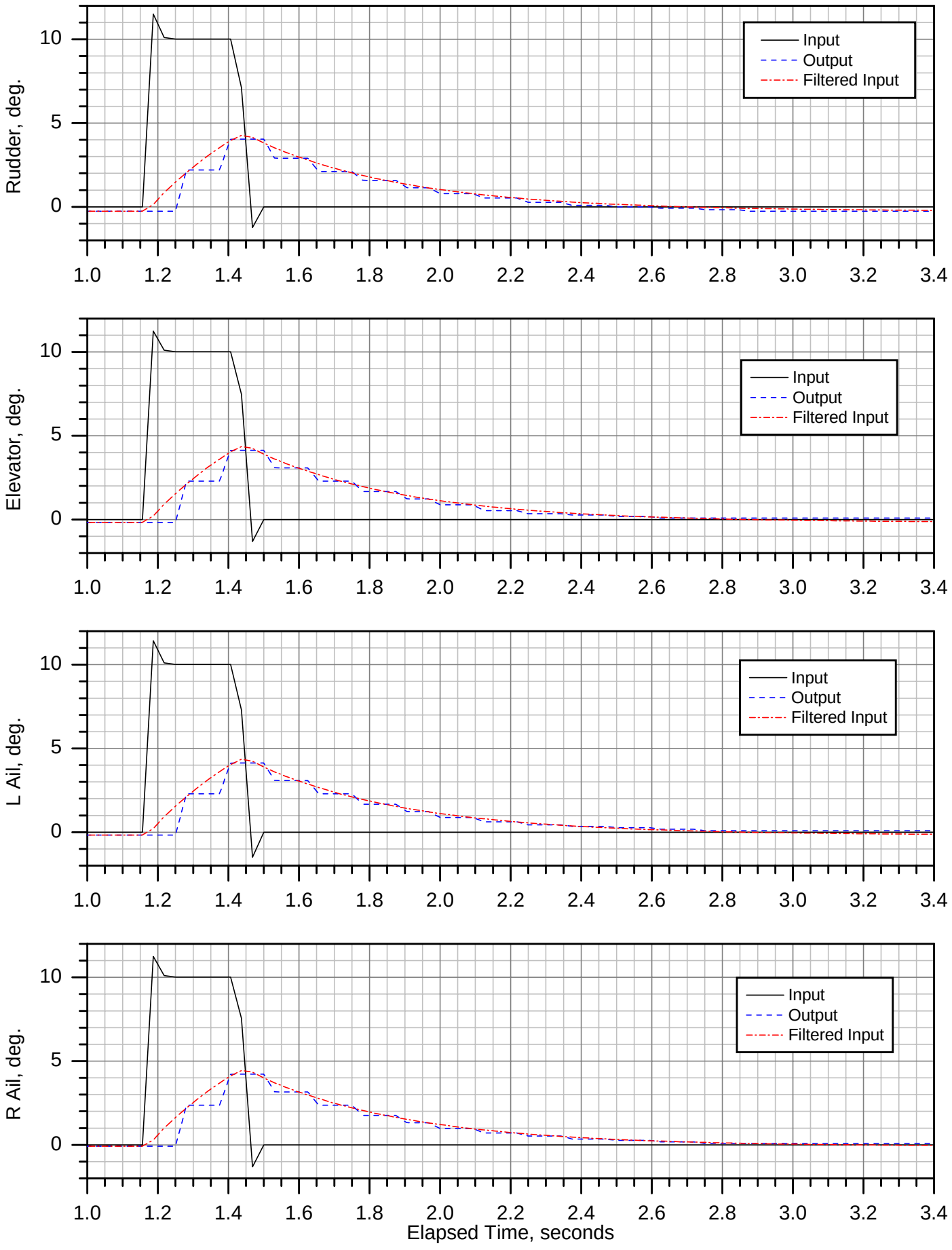
A300-600 SDAC Bench Test Case 4p6p2

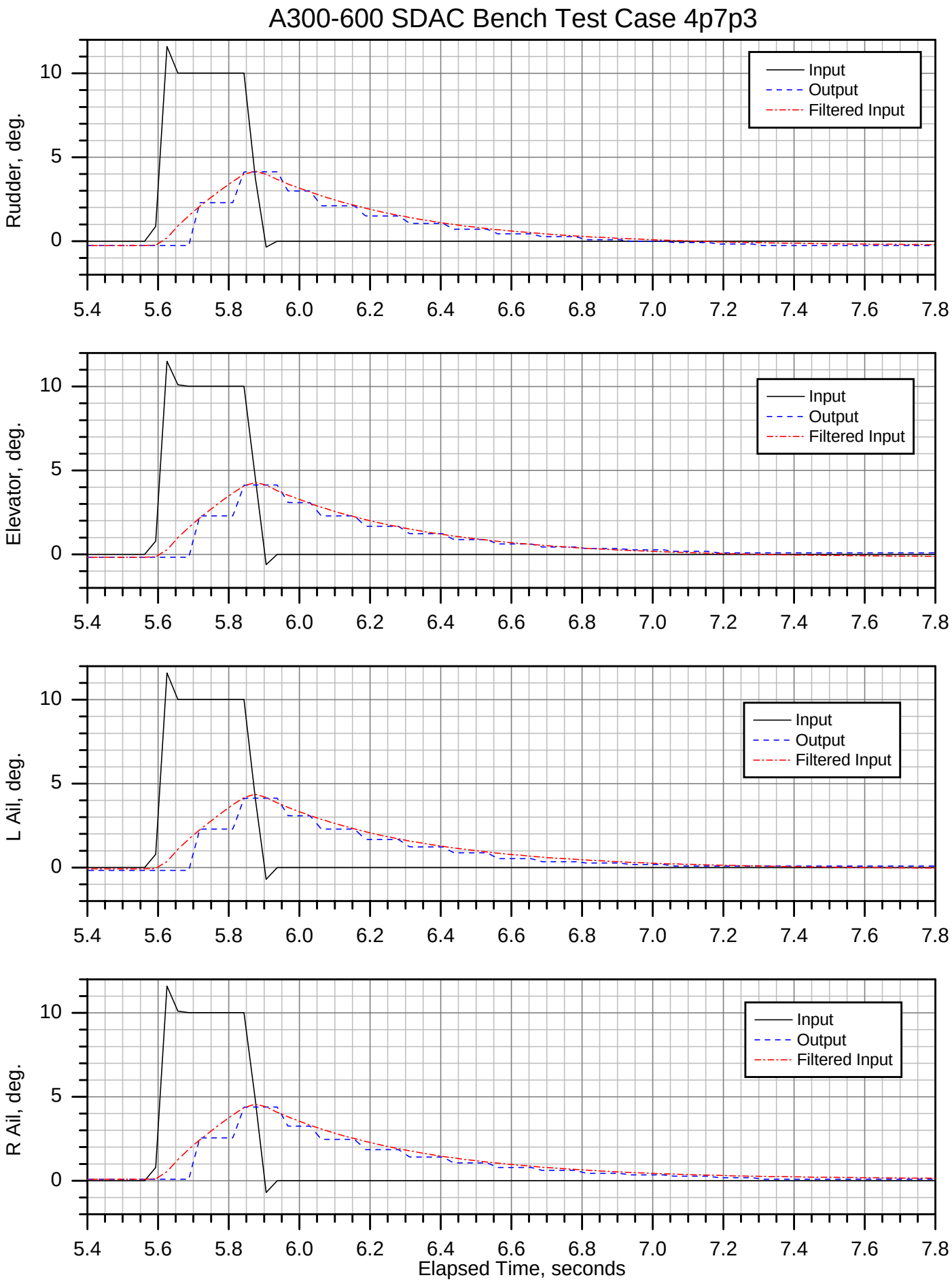


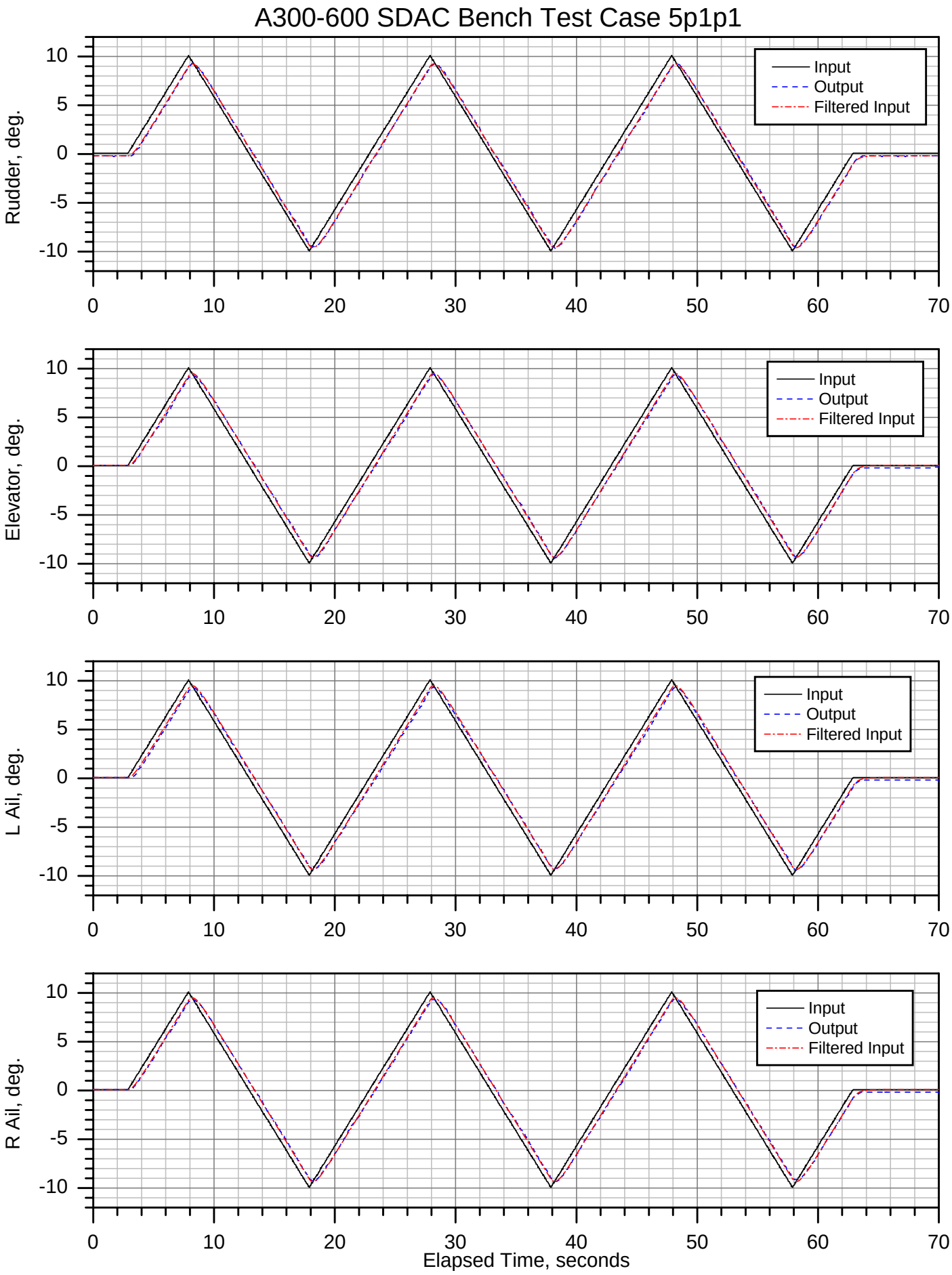
A300-600 SDAC Bench Test Case 4p7p1



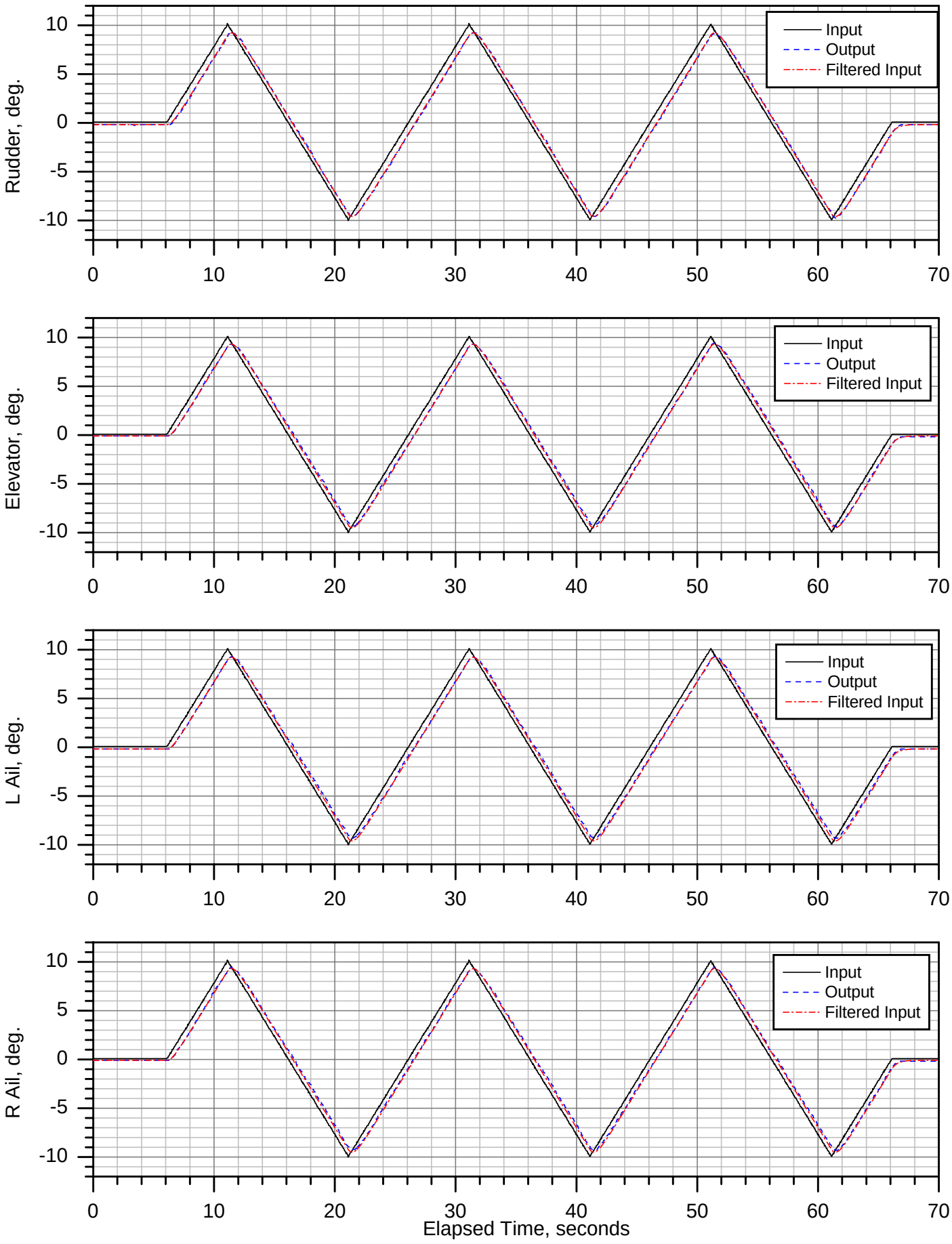
A300-600 SDAC Bench Test Case 4p7p2

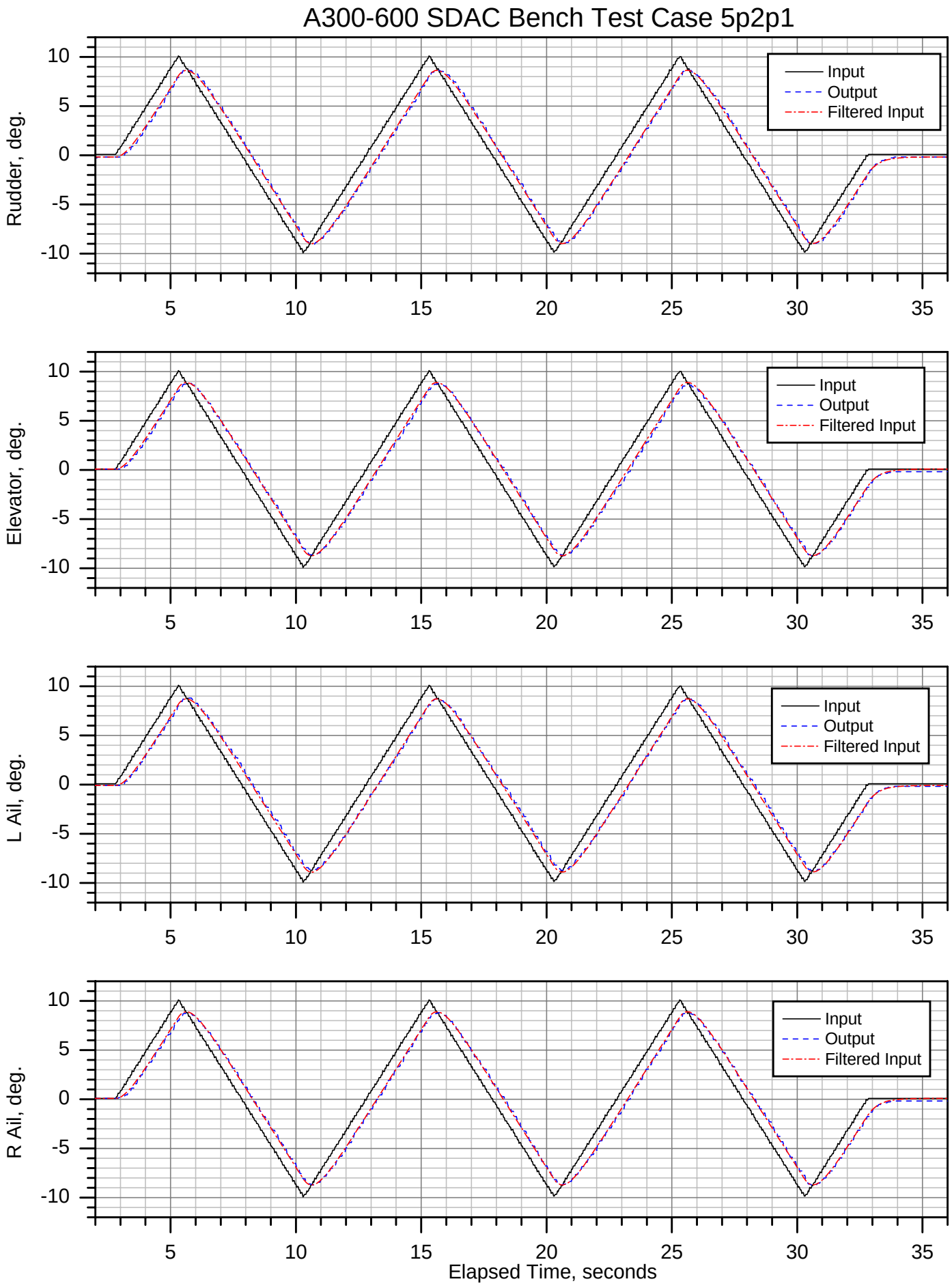



A300-600 SDAC Bench Test Case 4p7p3
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
Elapsed Time, seconds

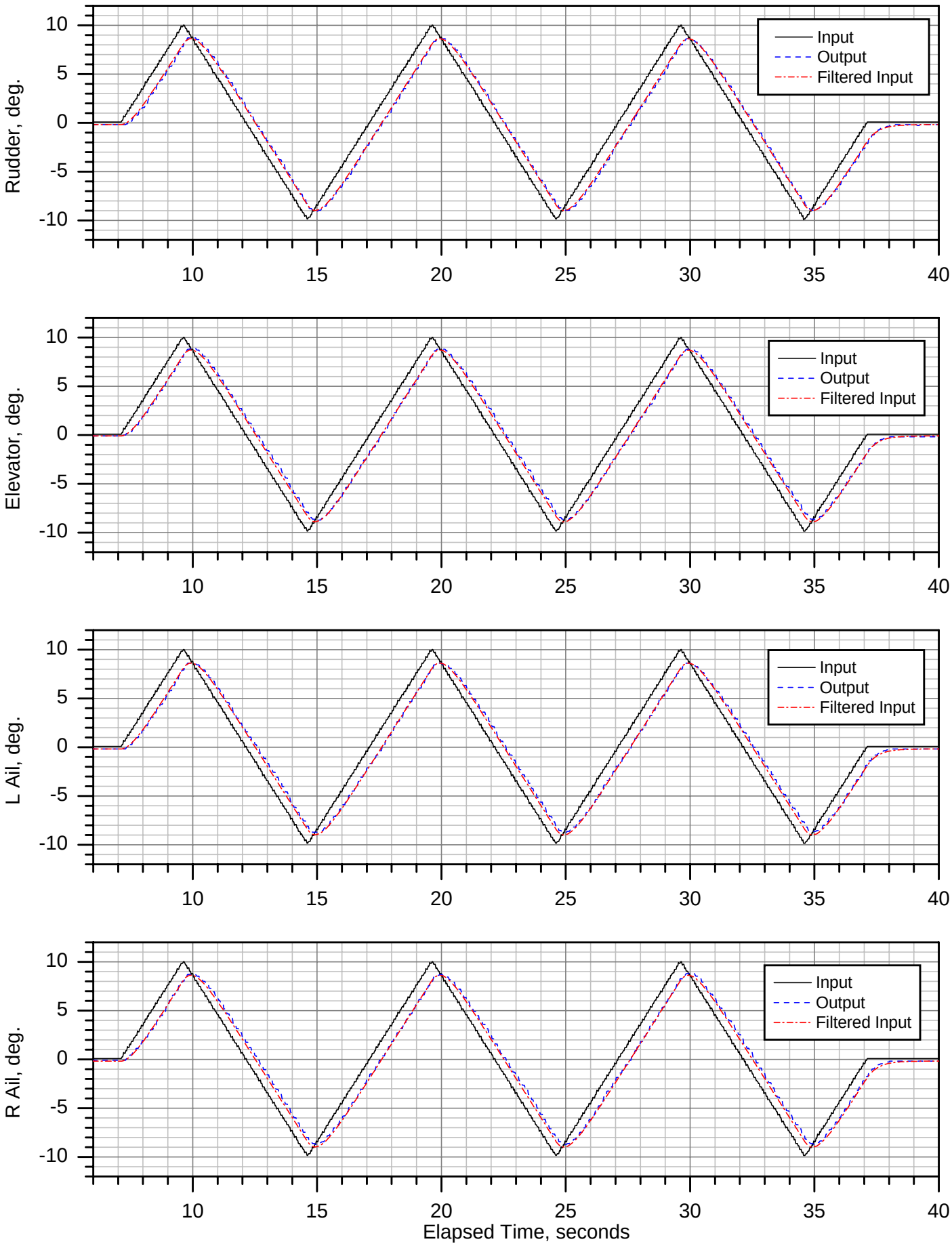

A300-600 SDAC Bench Test Case 5p1p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
0
10
20
30
40
50
60
70
Elapsed Time, seconds

A300-600 SDAC Bench Test Case 5p1p2

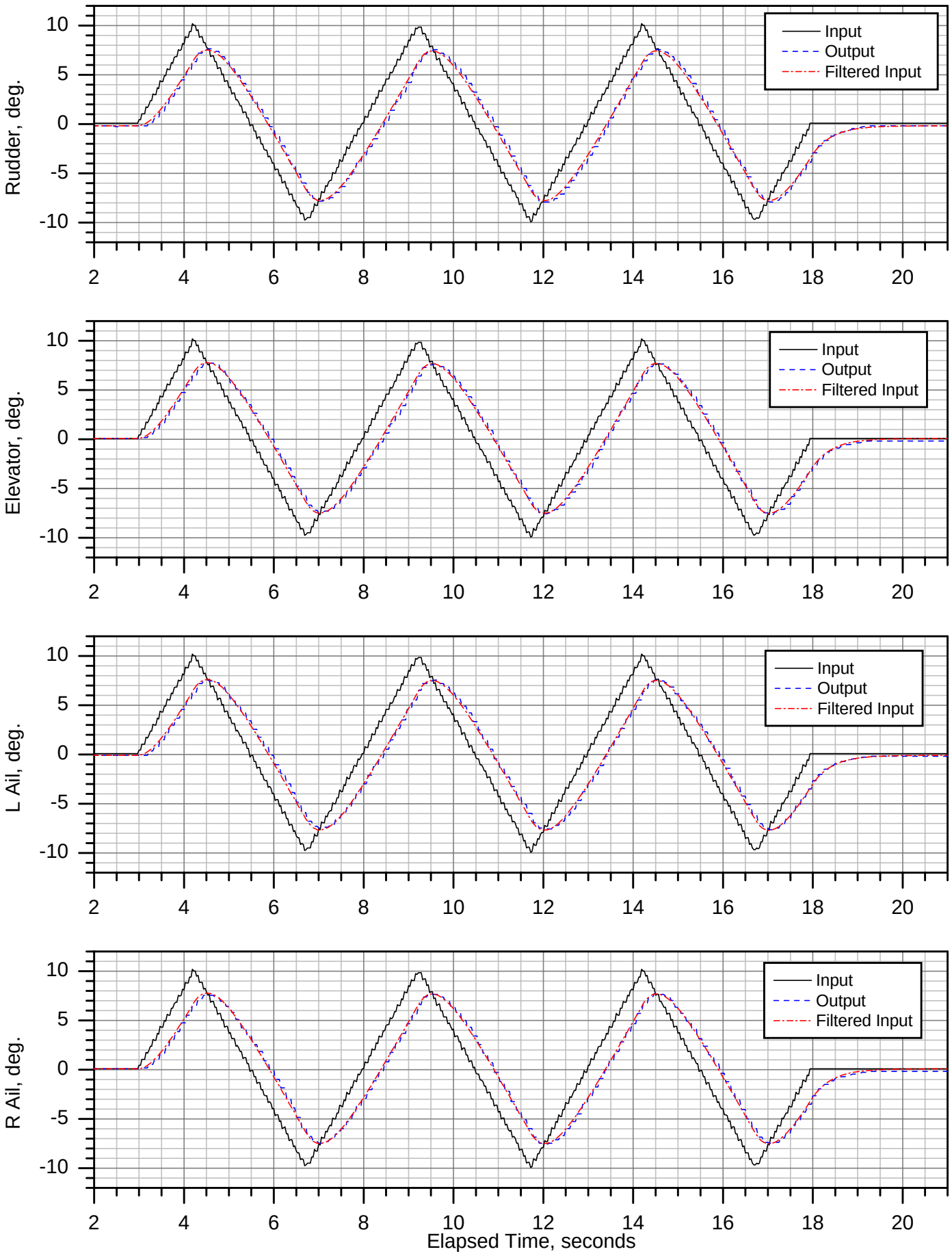


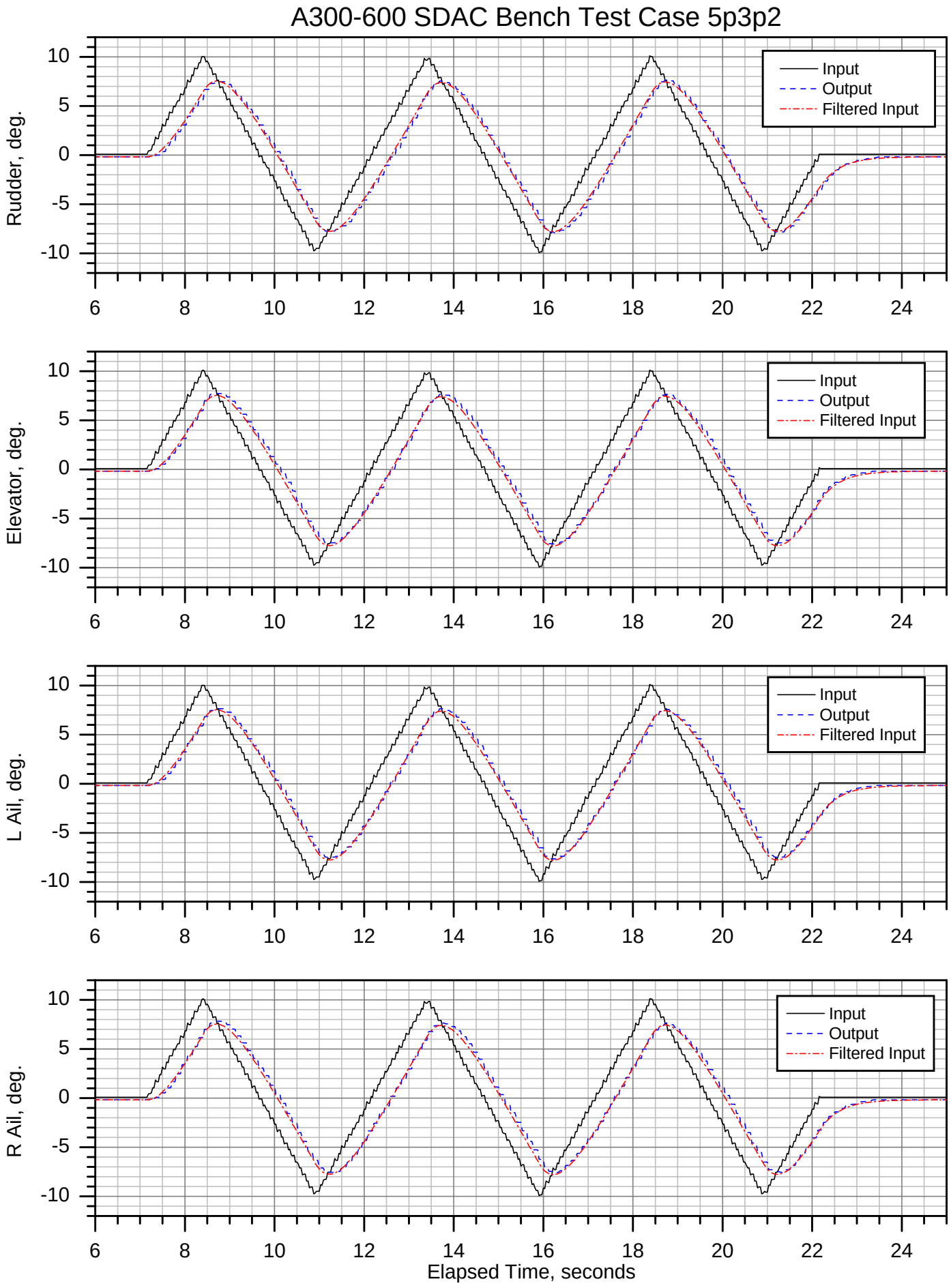

A300-600 SDAC Bench Test Case 5p2p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
5
10
15
20
25
30
35
Elapsed Time, seconds

A300-600 SDAC Bench Test Case 5p2p2

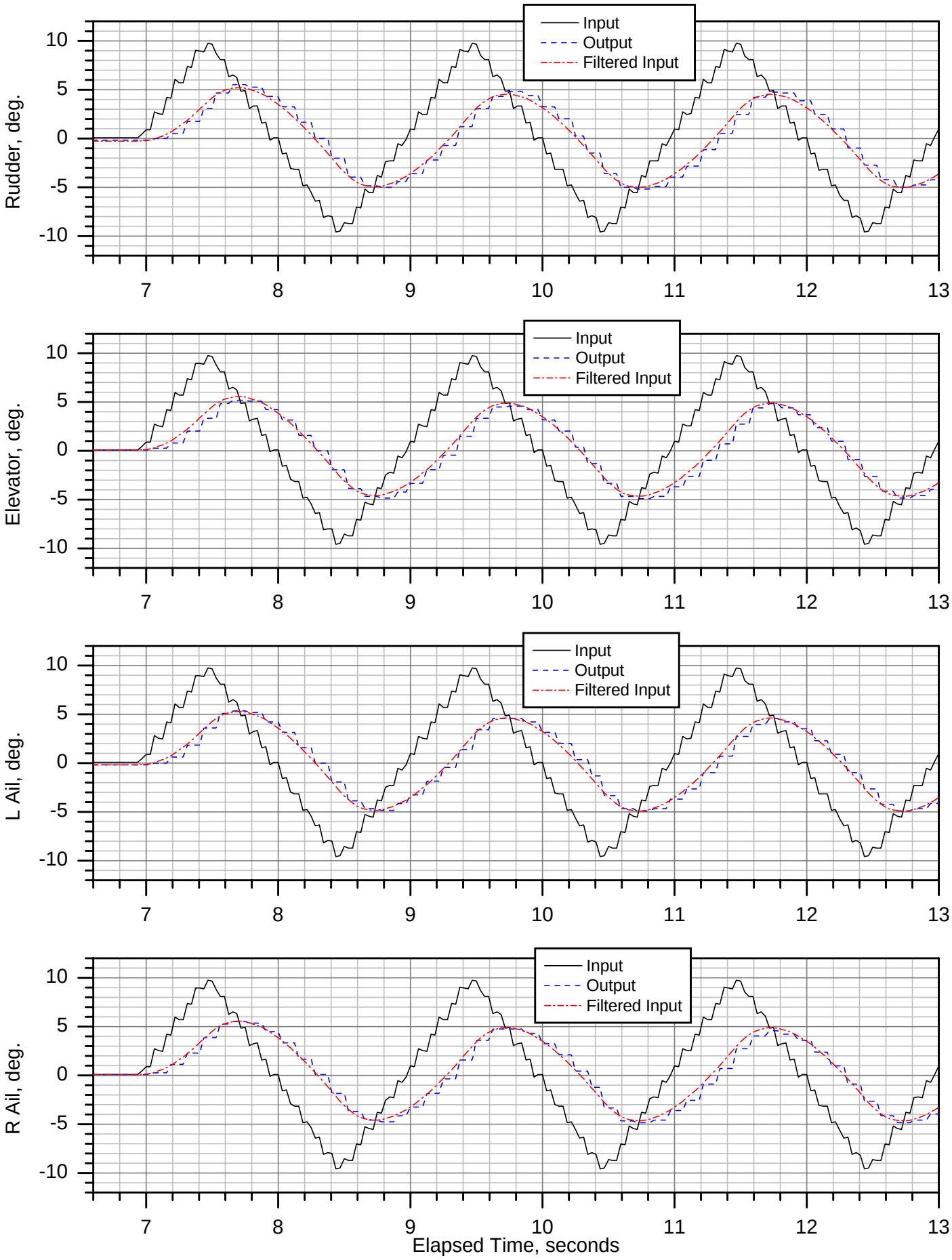


A300-600 SDAC Bench Test Case 5p3p1

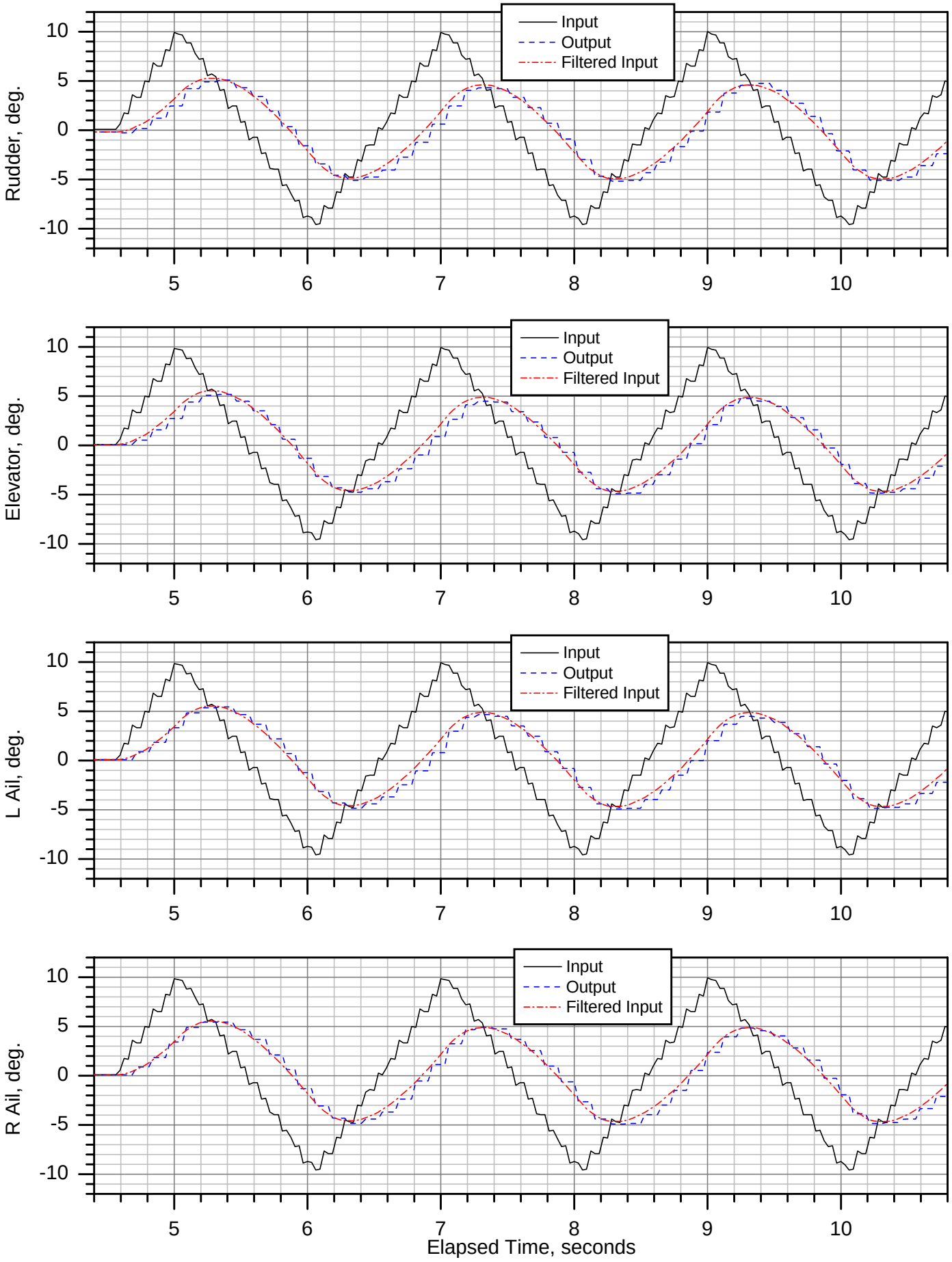


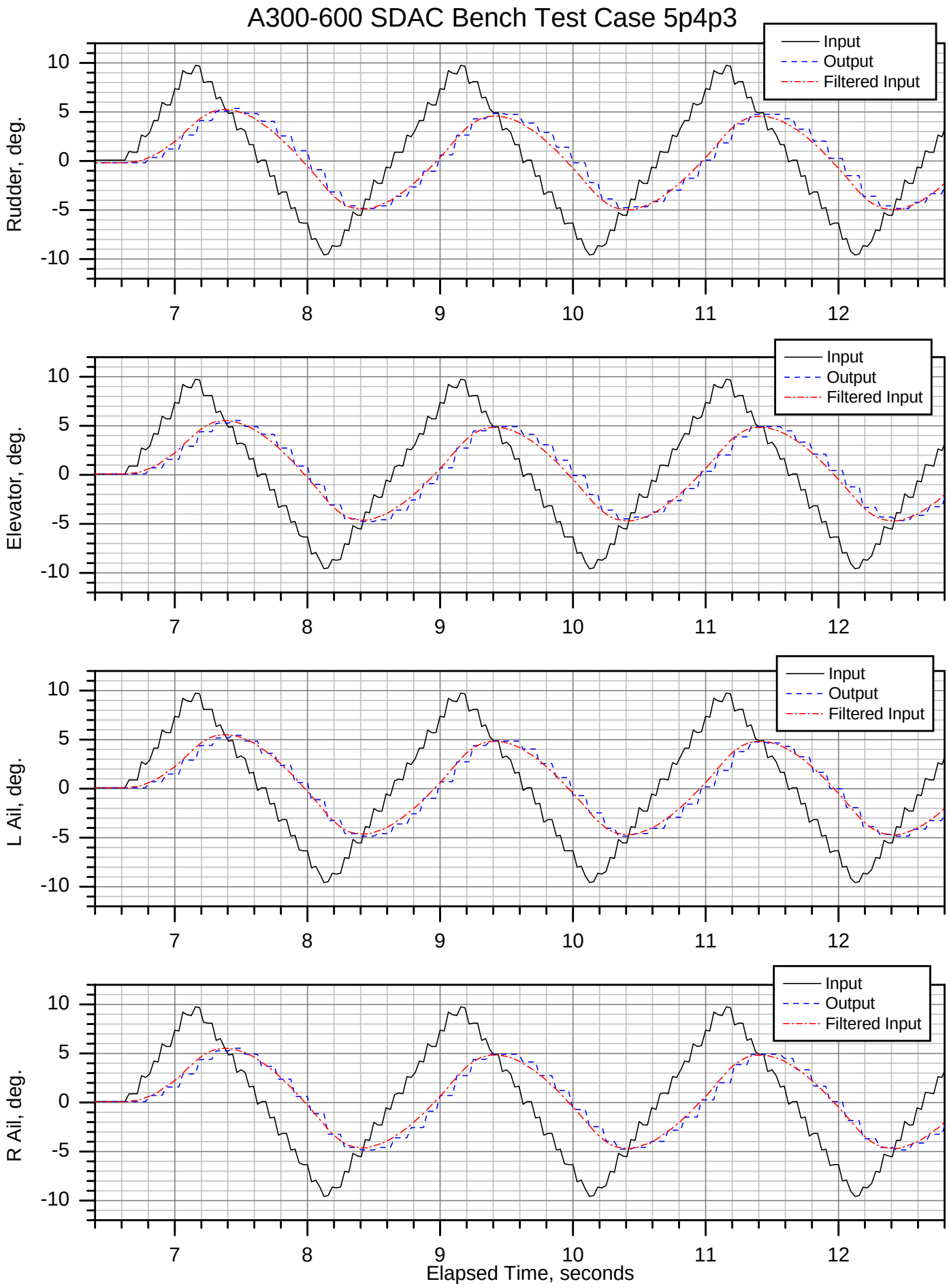

A300-600 SDAC Bench Test Case 5p3p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
6
8
10
12
14
16
18
20
22
24
Elapsed Time, seconds

A300-600 SDAC Bench Test Case 5p4p1

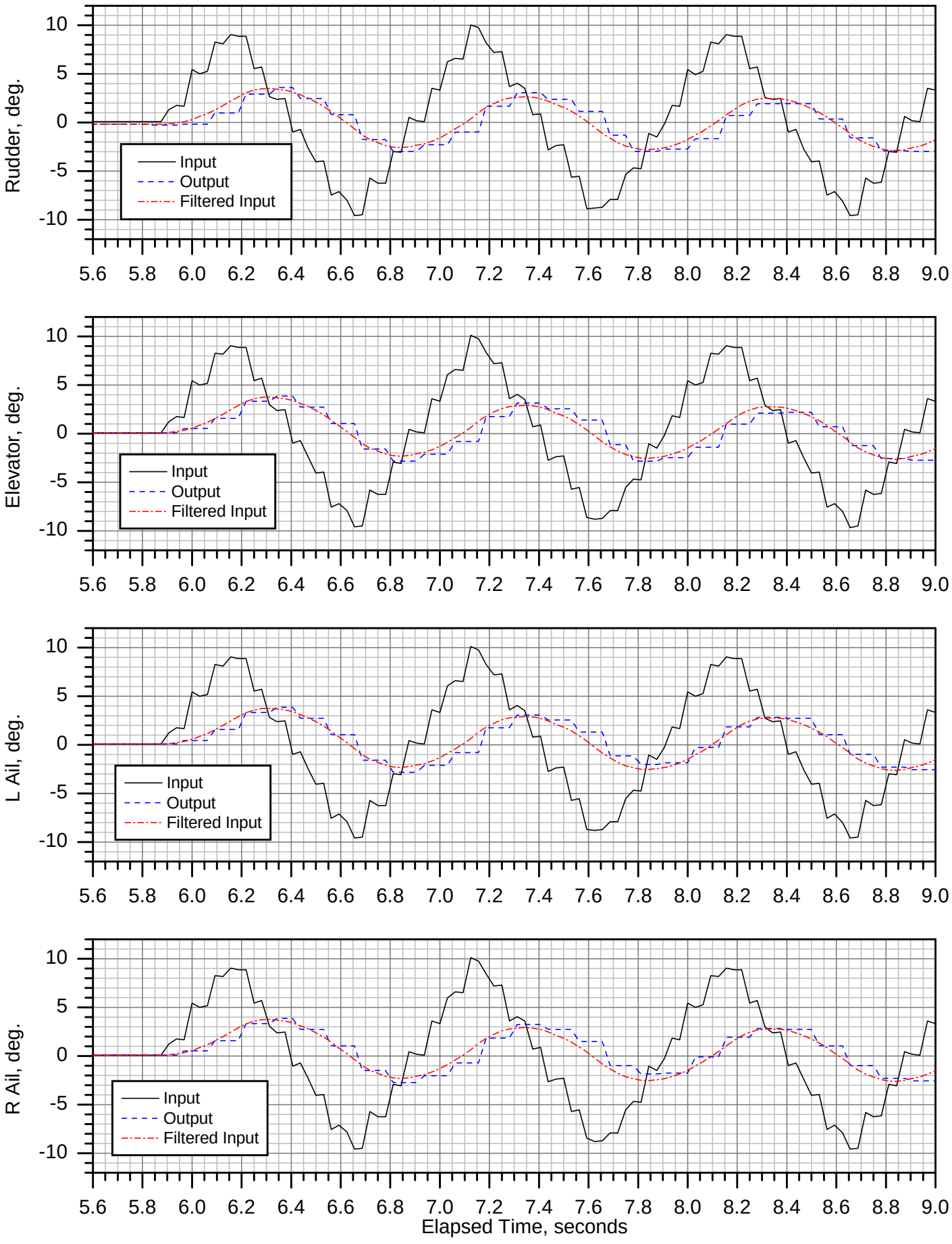


A300-600 SDAC Bench Test Case 5p4p2

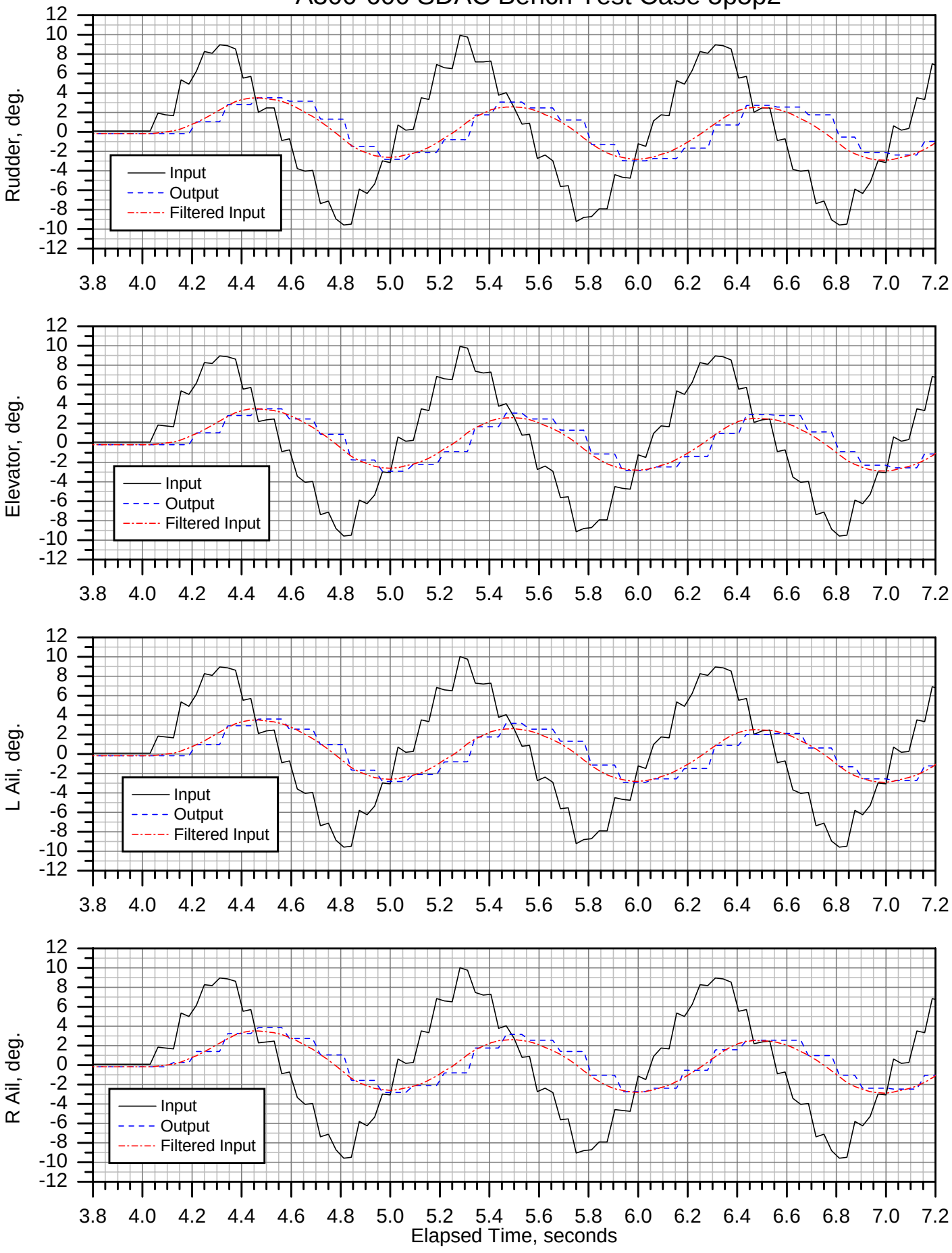


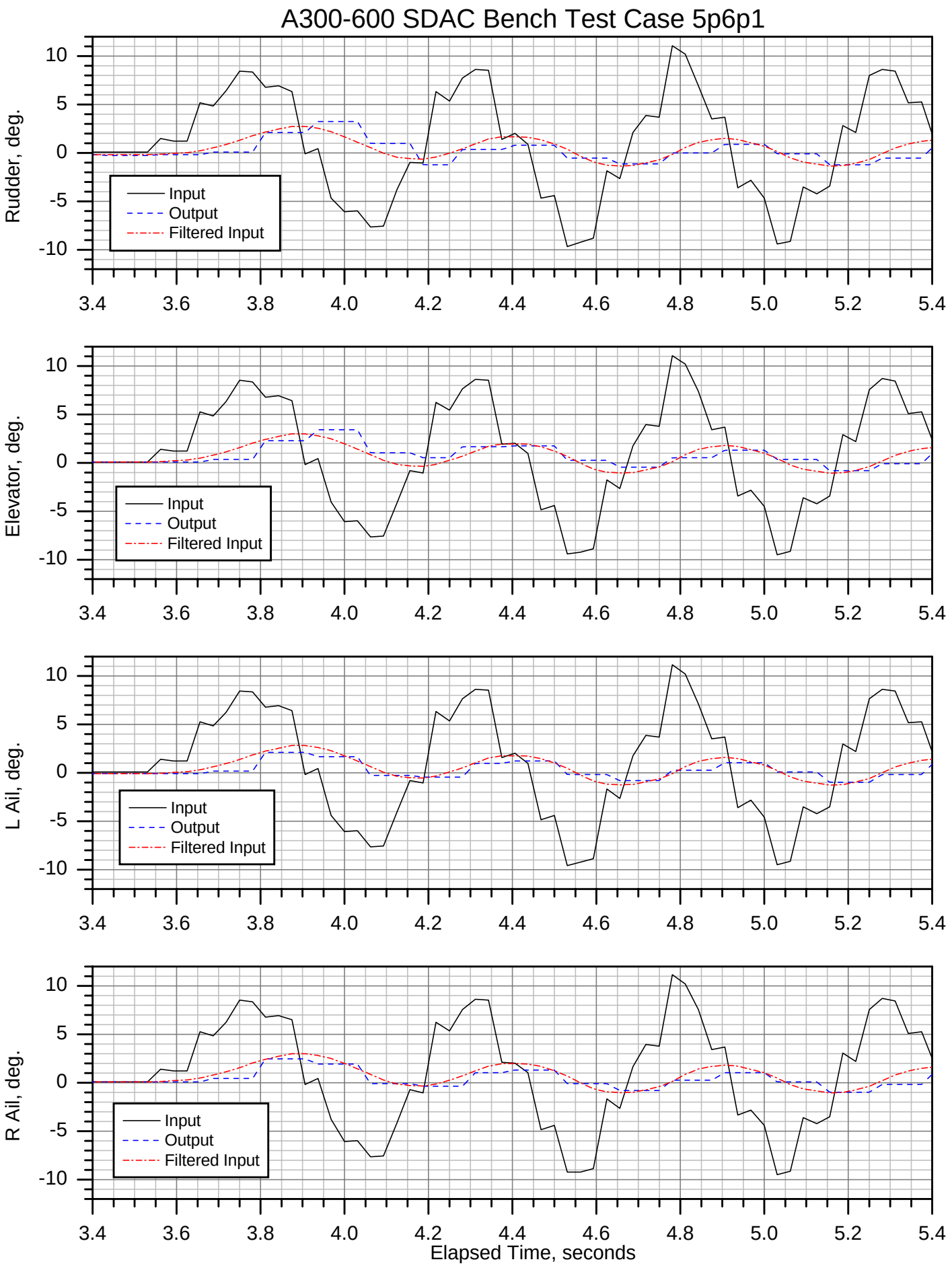

A300-600 SDAC Bench Test Case 5p4p3
Input
Output
Filtered Input
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
10
5
0
-5
-10
7
8
9
10
11
12
Elapsed Time, seconds

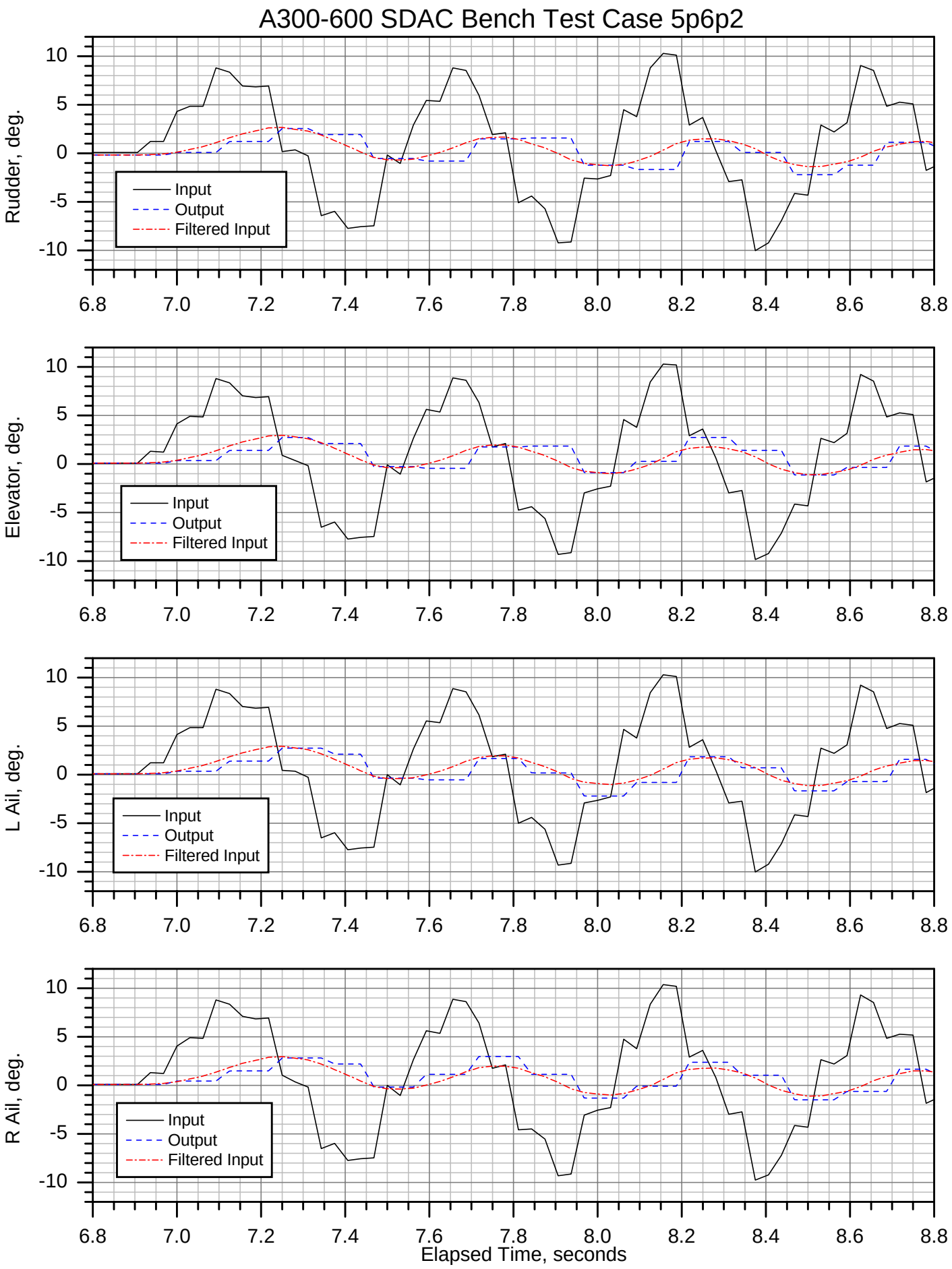
A300-600 SDAC Bench Test Case 5p5p1

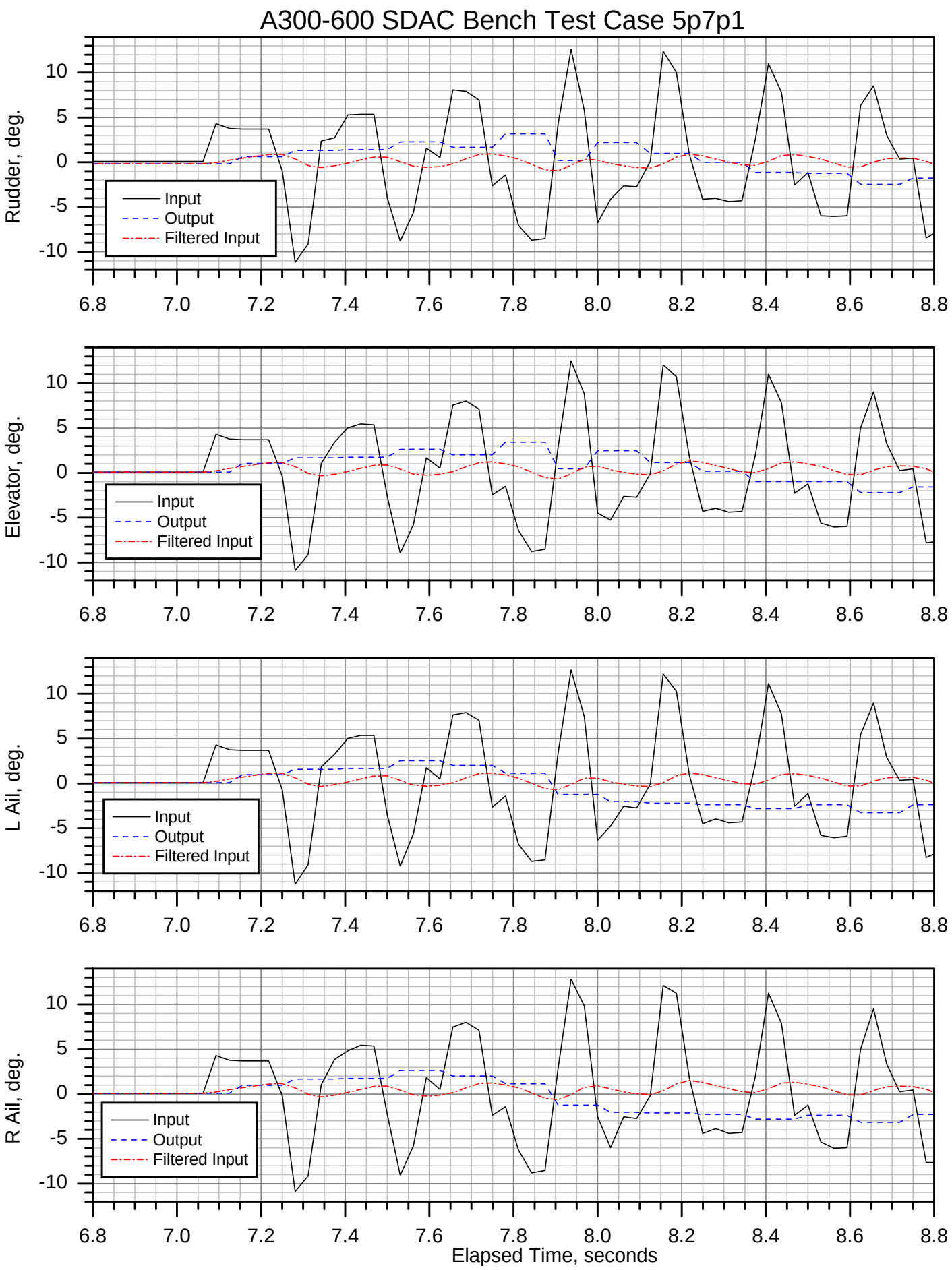


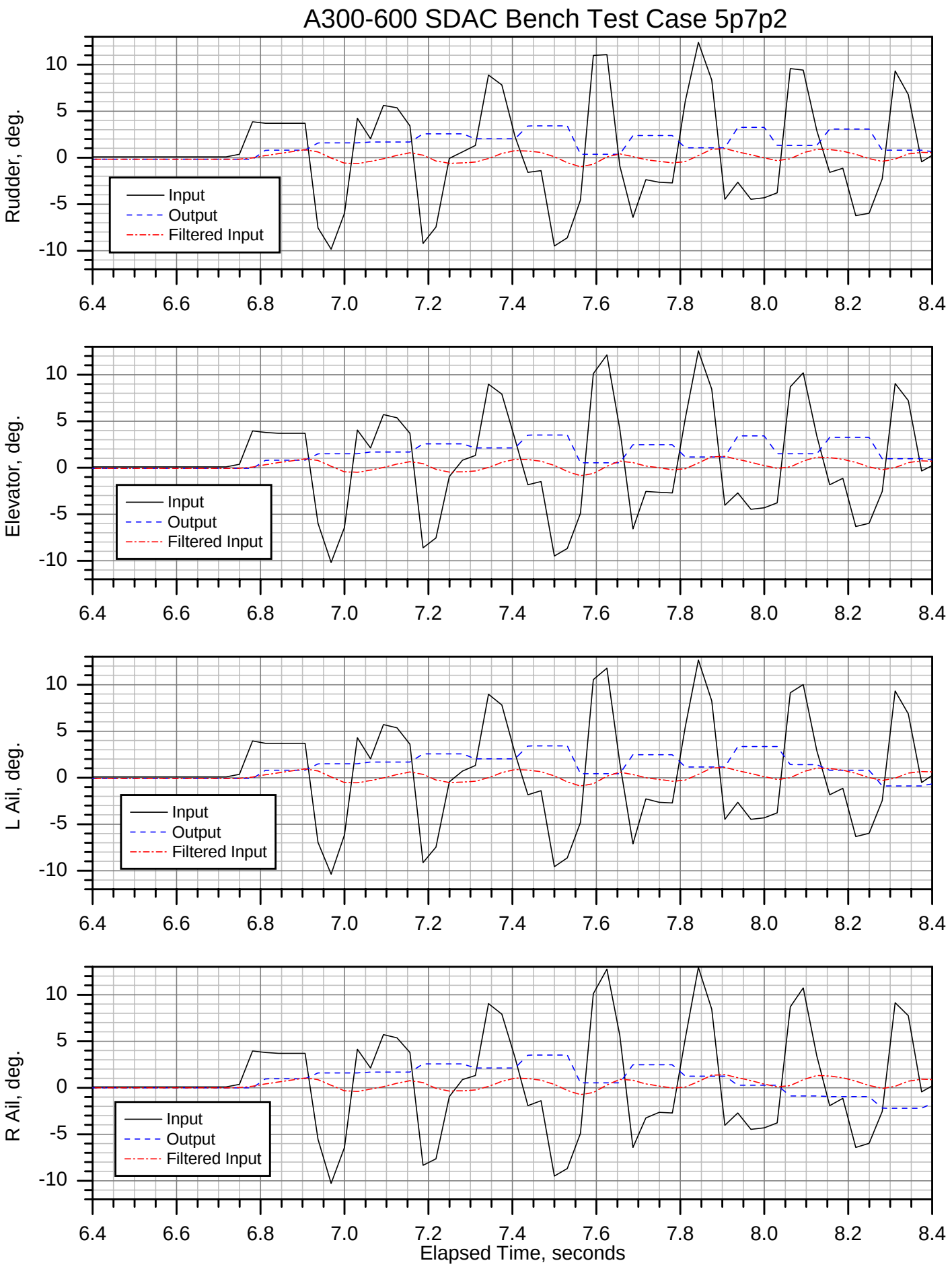
A300-600 SDAC Bench Test Case 5p5p2



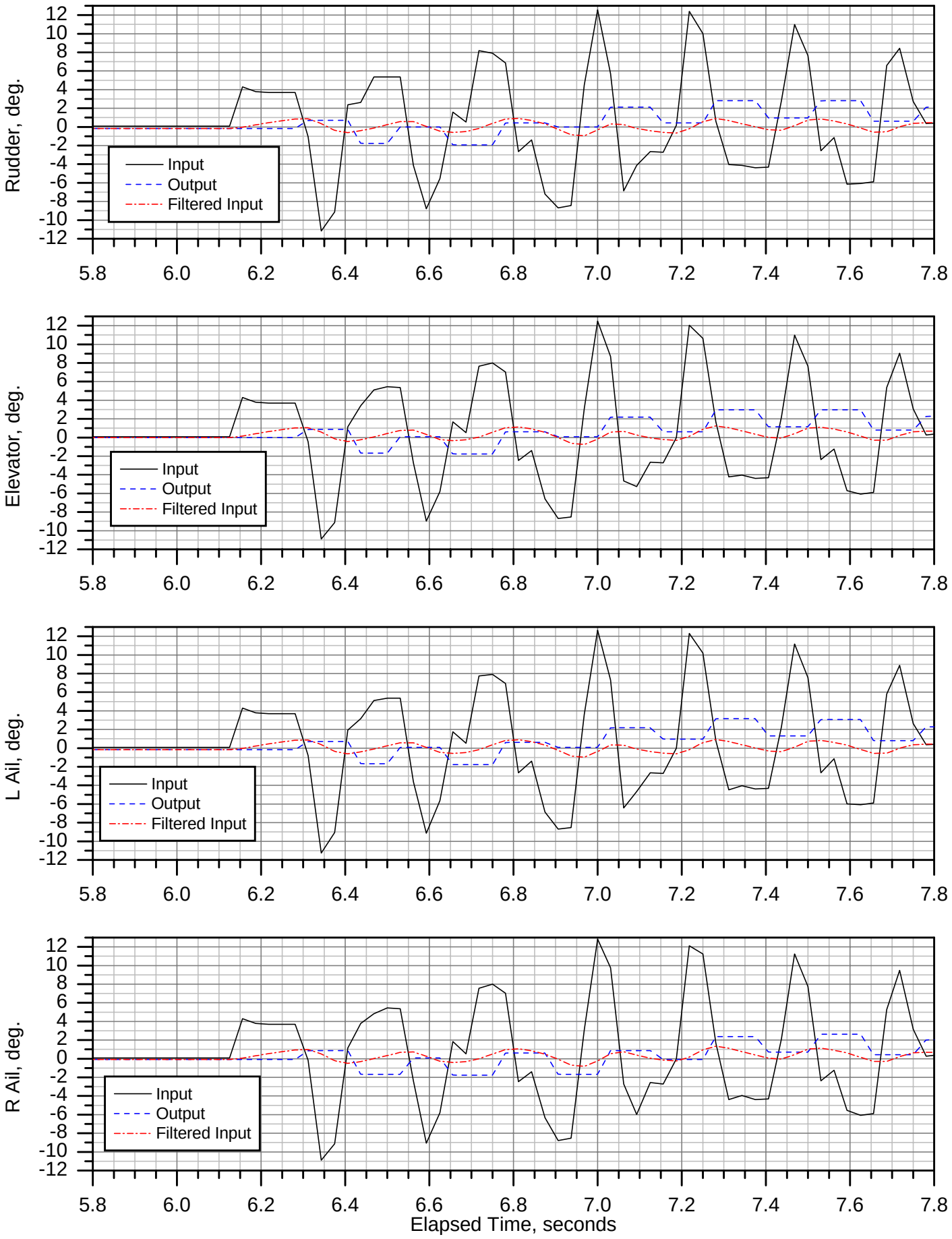

A300-600 SDAC Bench Test Case 5p6p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
Elapsed Time, seconds

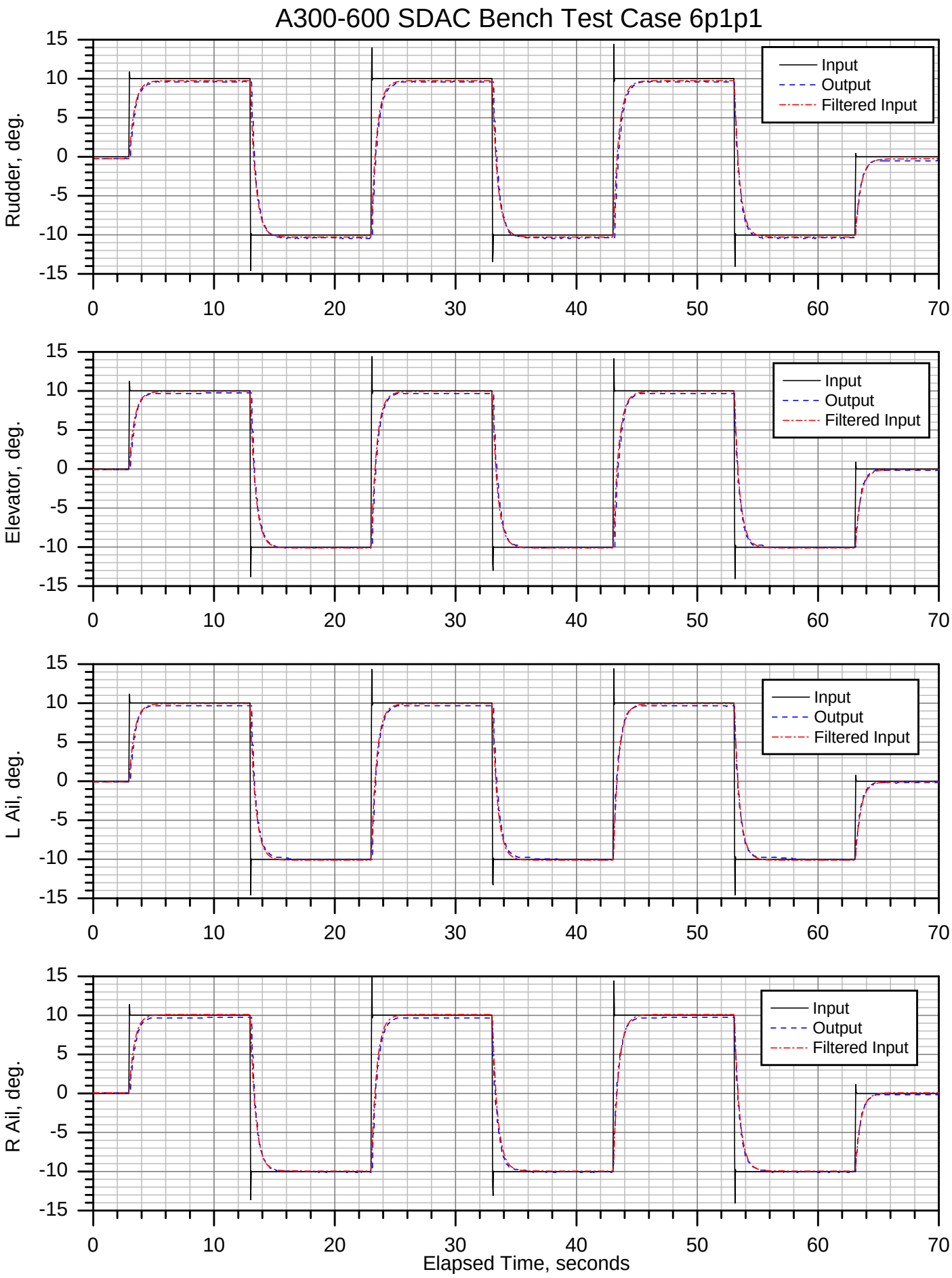

A300-600 SDAC Bench Test Case 5p6p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
Elapsed Time, seconds

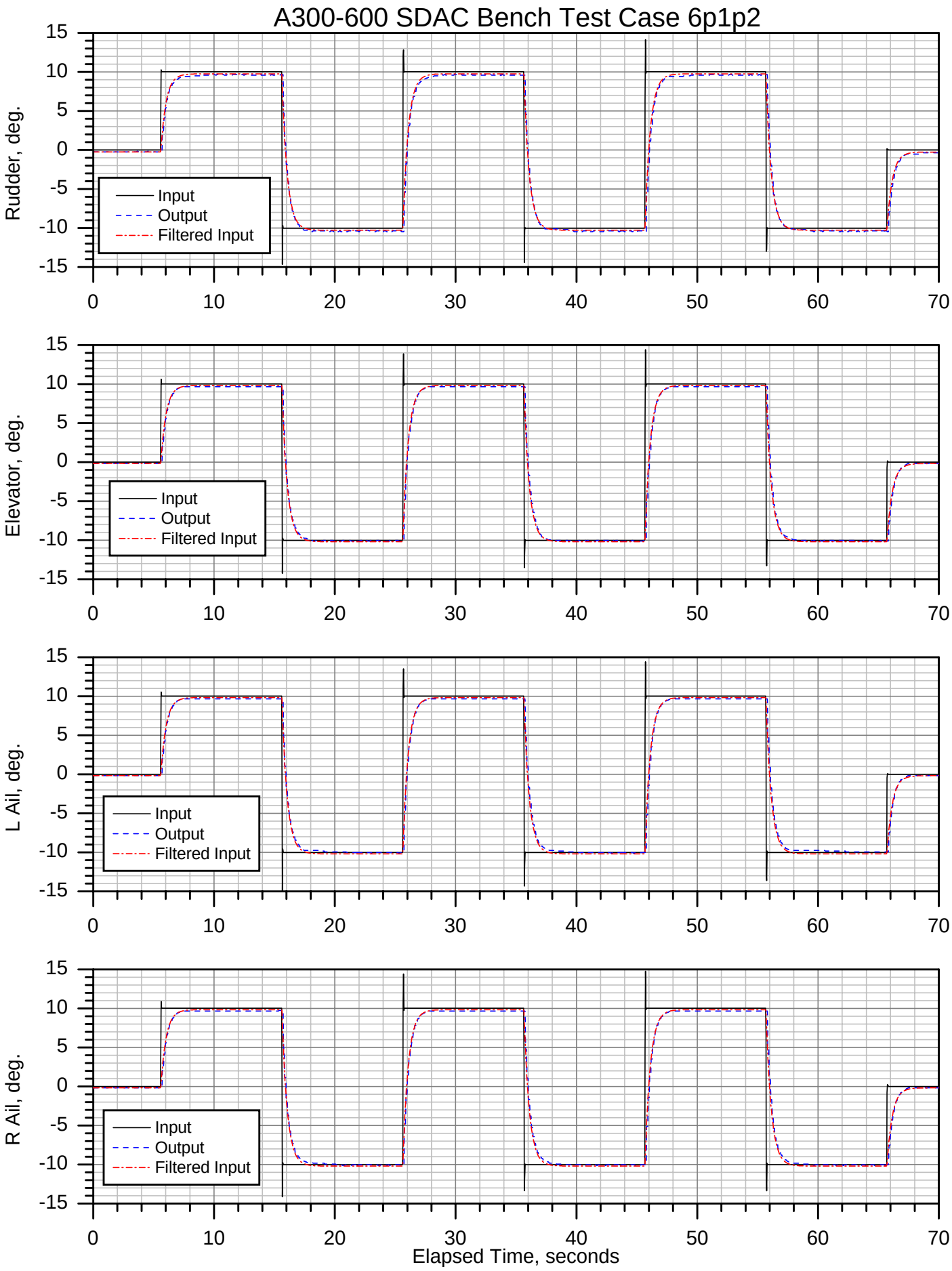

A300-600 SDAC Bench Test Case 5p7p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
Elapsed Time, seconds

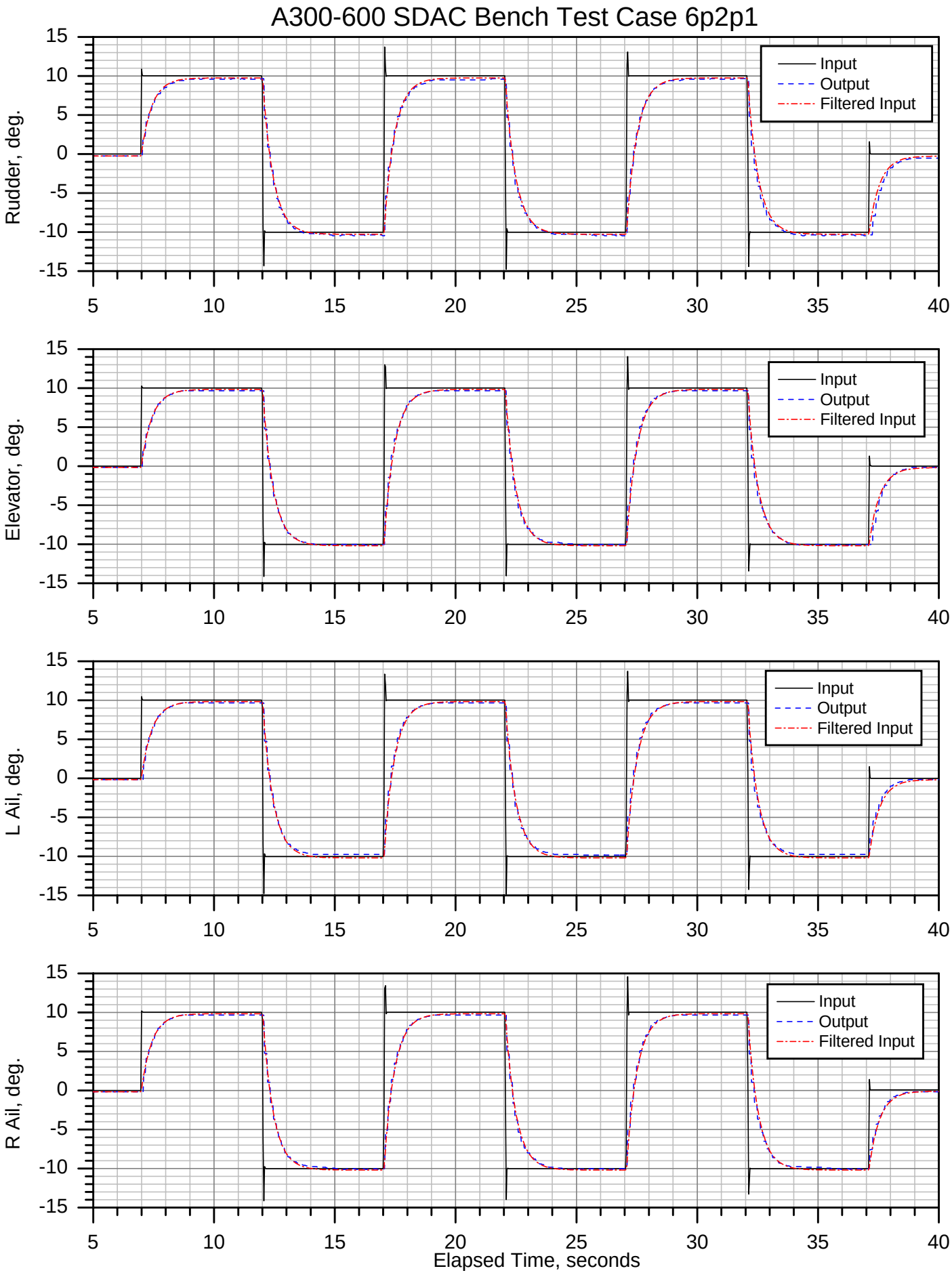

A300-600 SDAC Bench Test Case 5p7p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
Elapsed Time, seconds

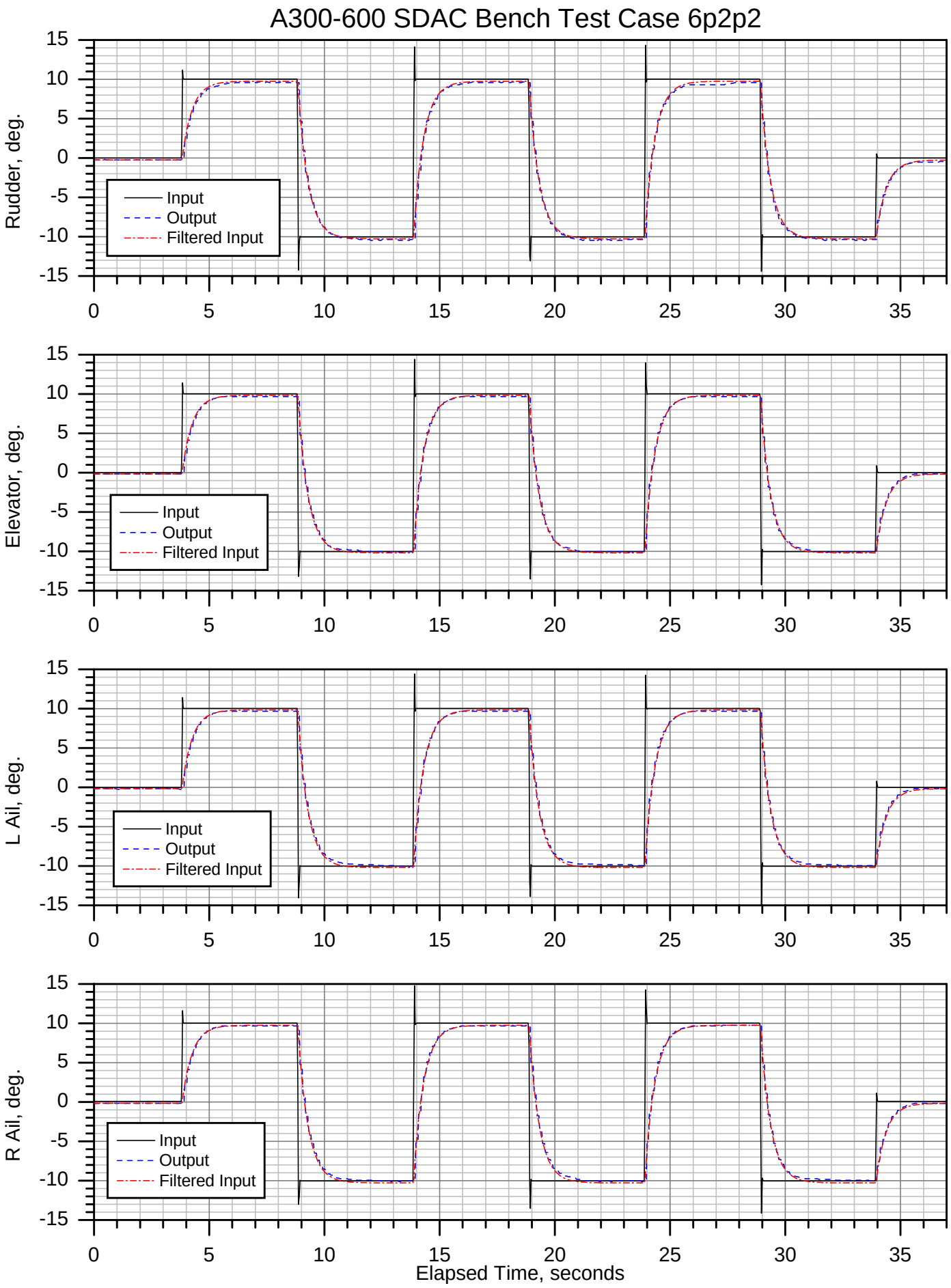
A300-600 SDAC Bench Test Case 5p7p3

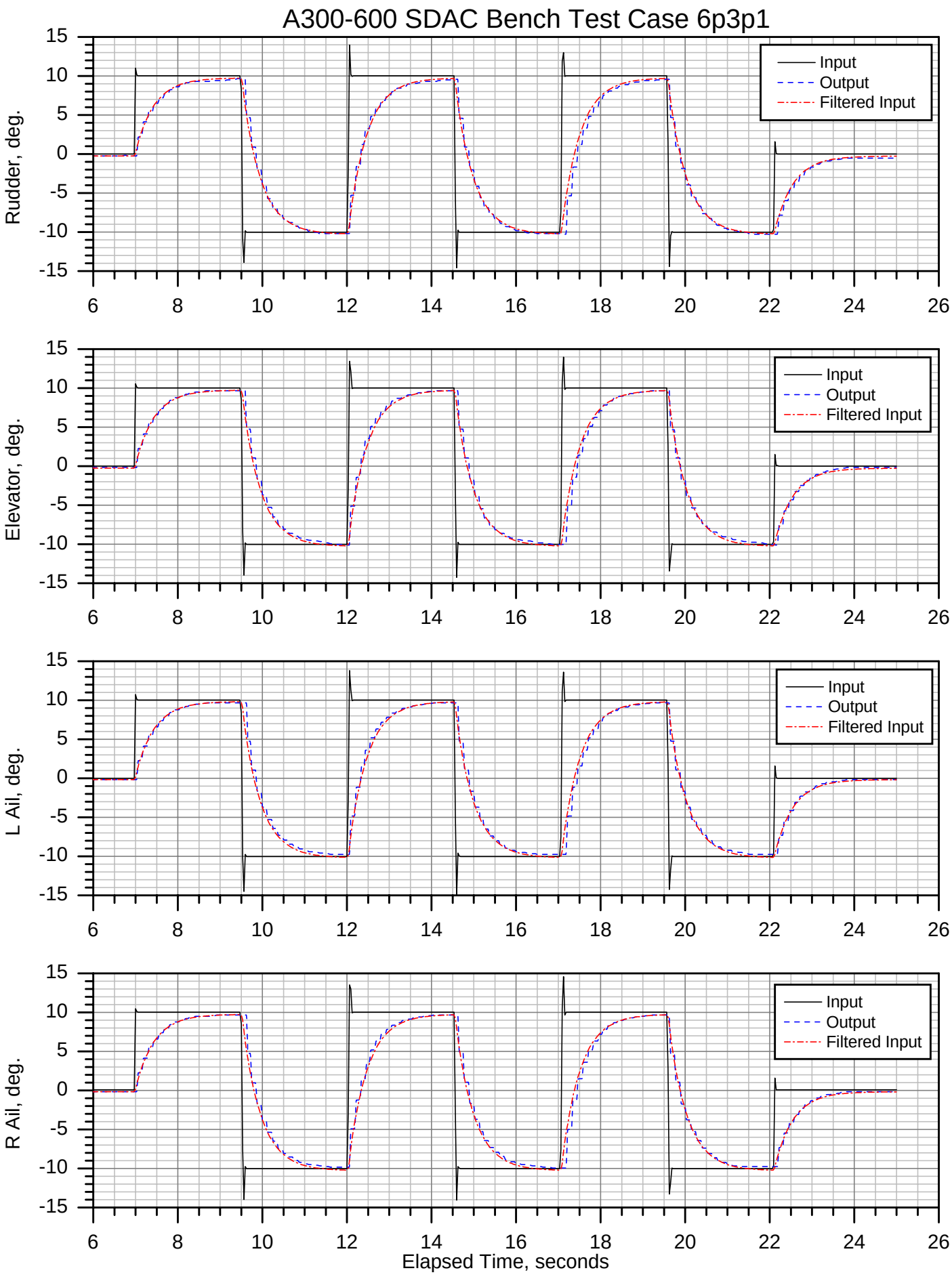


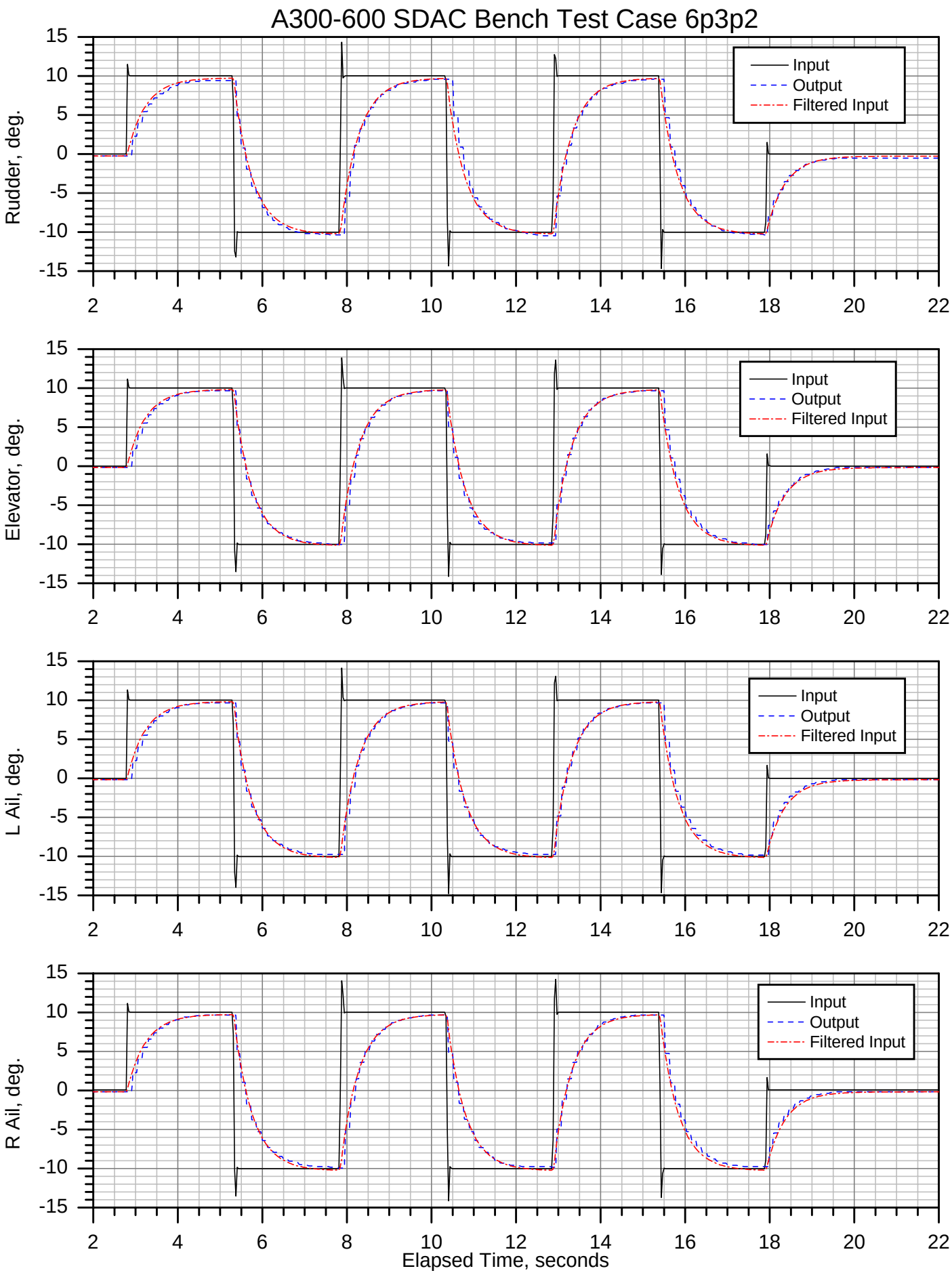

A300-600 SDAC Bench Test Case 6p1p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
0
10
20
30
40
50
60
70
Elapsed Time, seconds

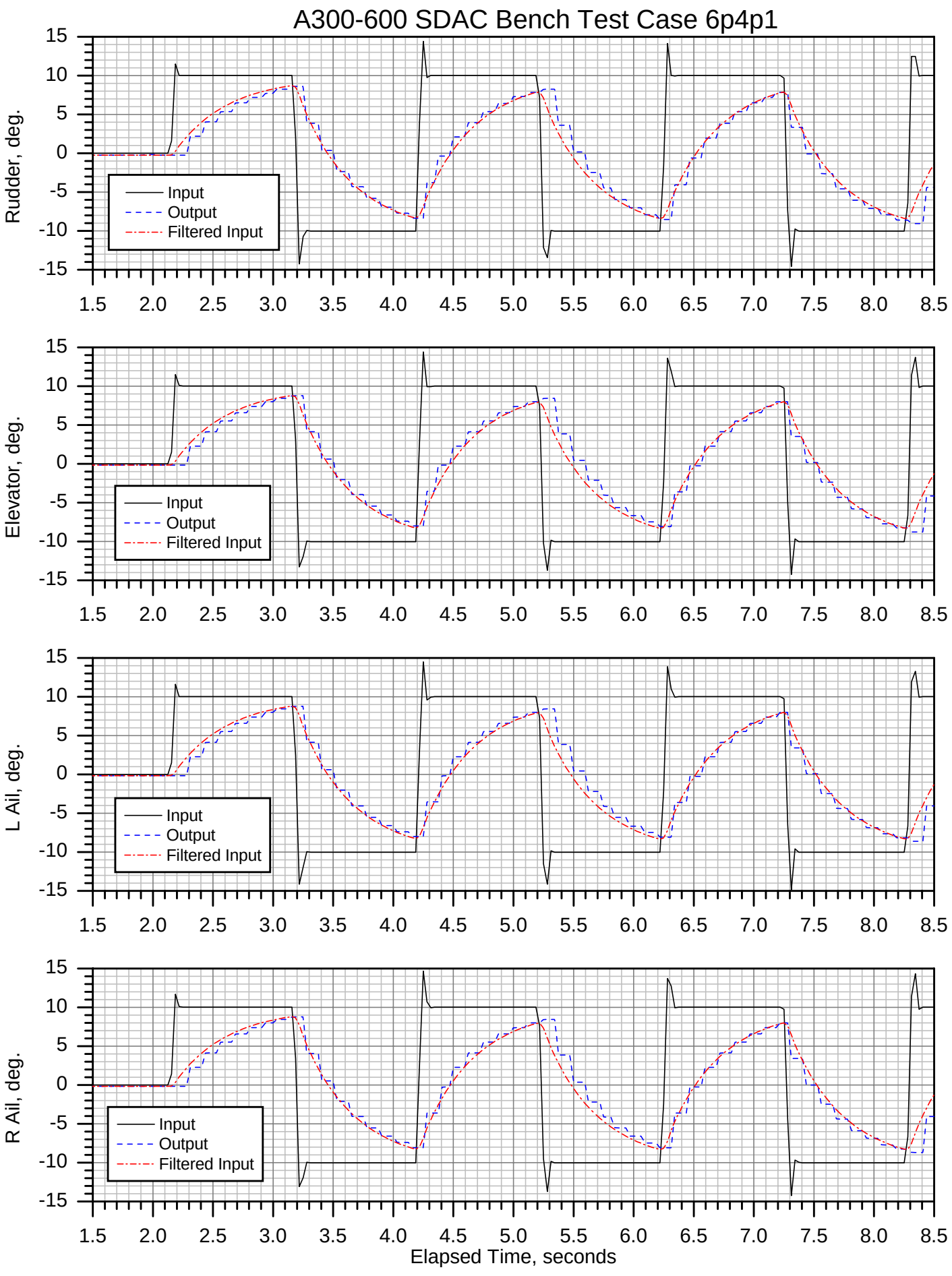

A300-600 SDAC Bench Test Case 6p1p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
0
10
20
30
40
50
60
70
Elapsed Time, seconds

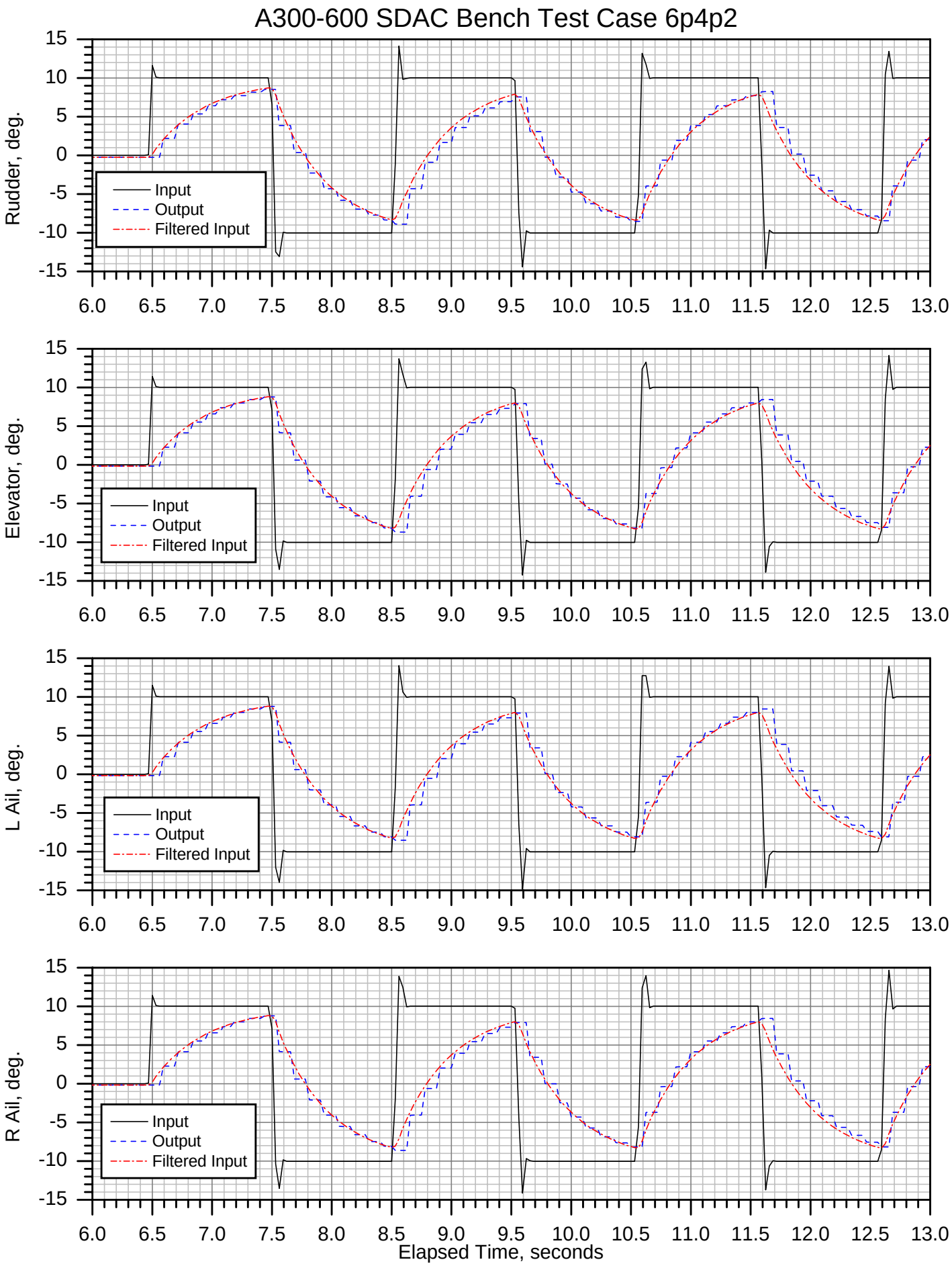

A300-600 SDAC Bench Test Case 6p2p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
5
10
15
20
25
30
35
40
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 6p2p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
0
5
10
15
20
25
30
35
Elapsed Time, seconds

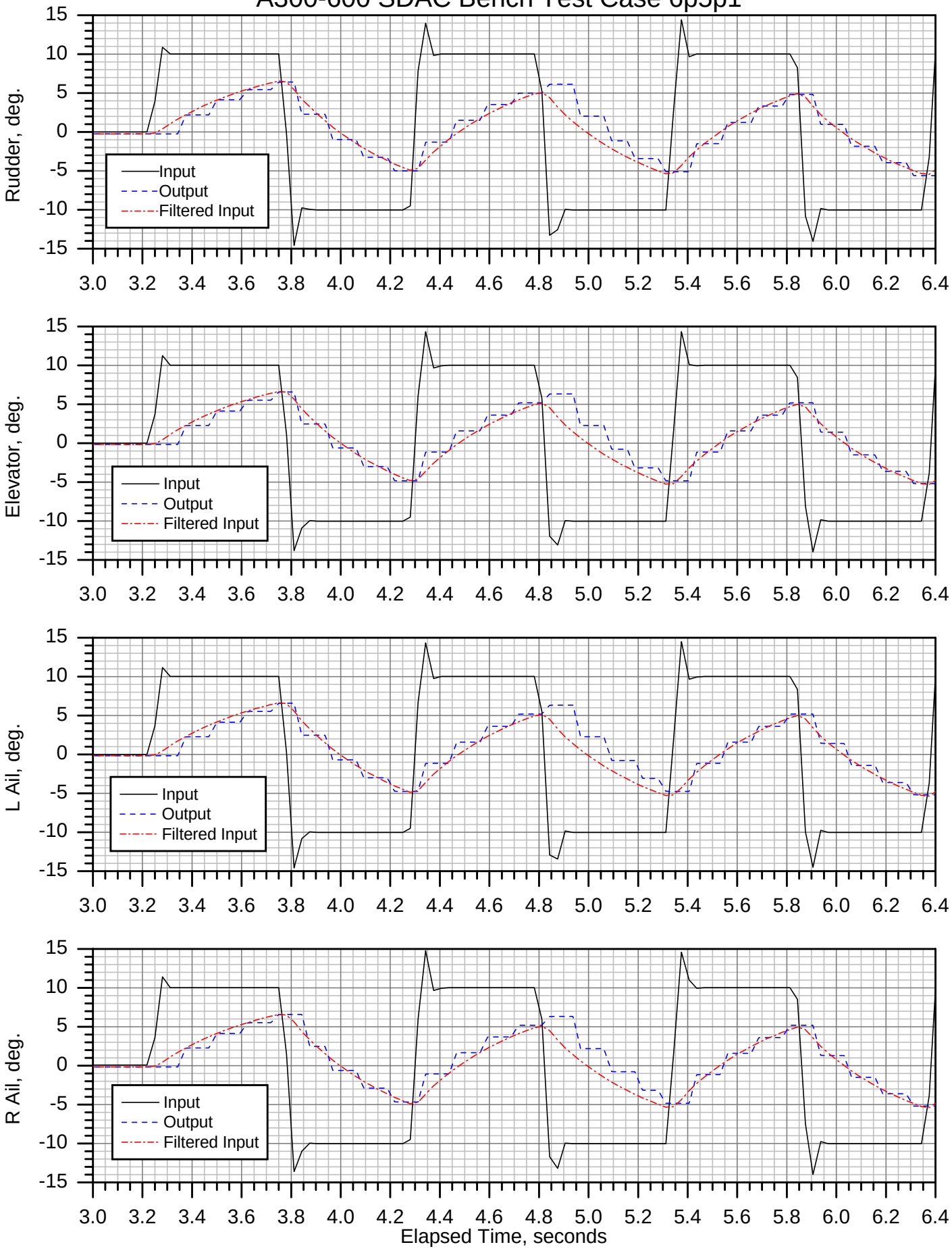

A300-600 SDAC Bench Test Case 6p3p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
6
8
10
12
14
16
18
20
22
24
26
Elapsed Time, seconds

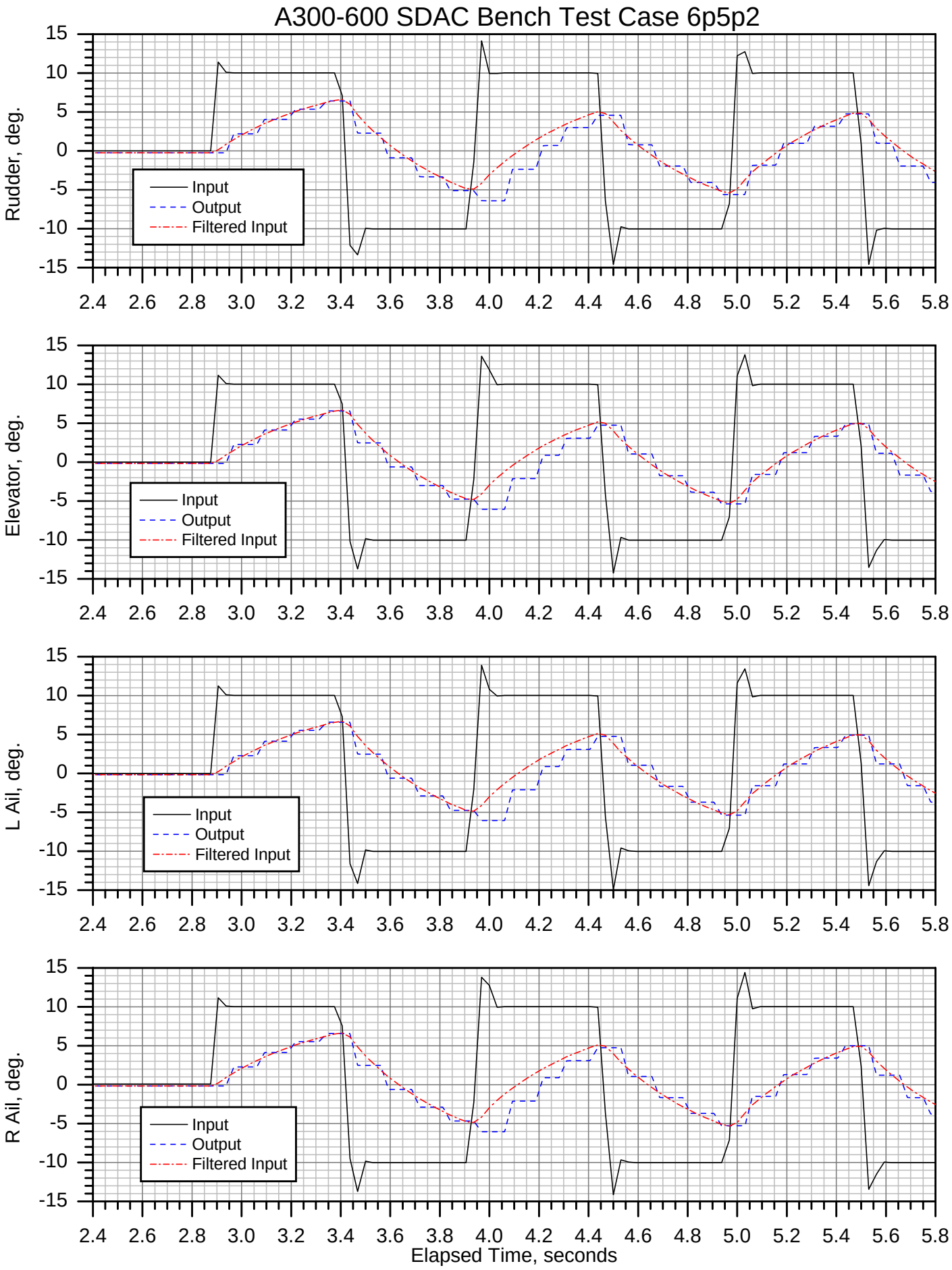

A300-600 SDAC Bench Test Case 6p3p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
2
4
6
8
10
12
14
16
18
20
22
Elapsed Time, seconds

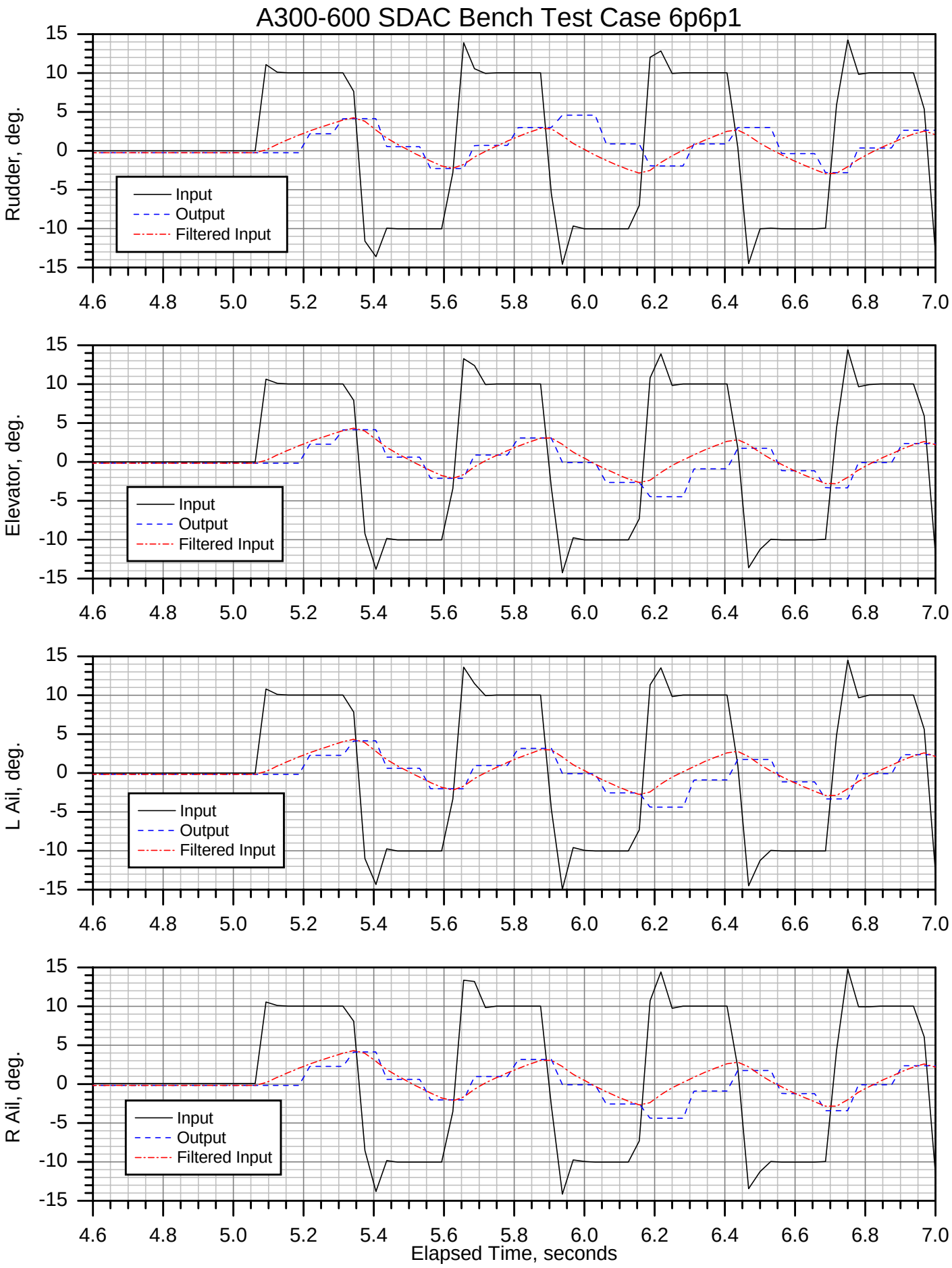

A300-600 SDAC Bench Test Case 6p4p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Elapsed Time, seconds

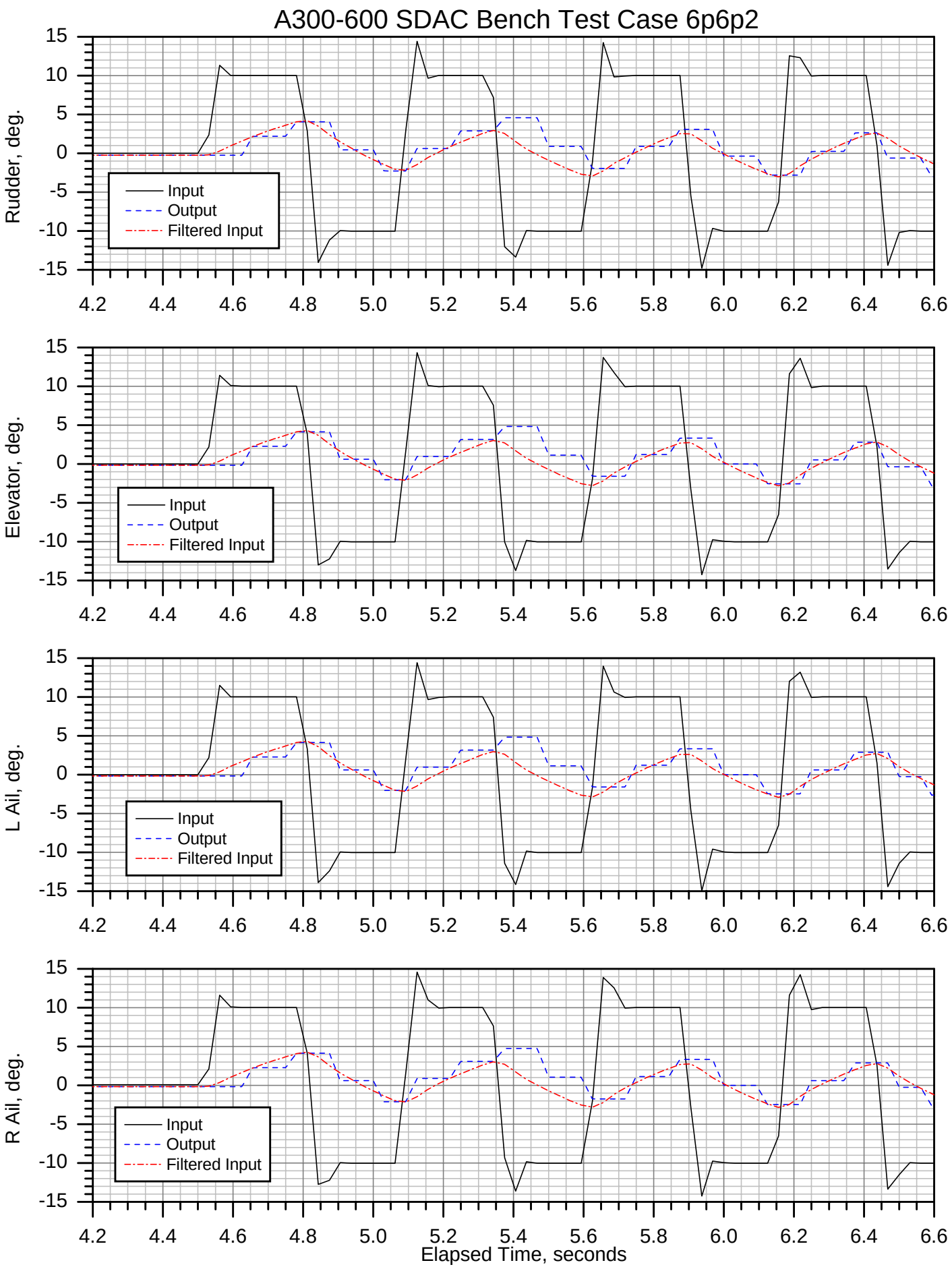

A300-600 SDAC Bench Test Case 6p4p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
Elapsed Time, seconds

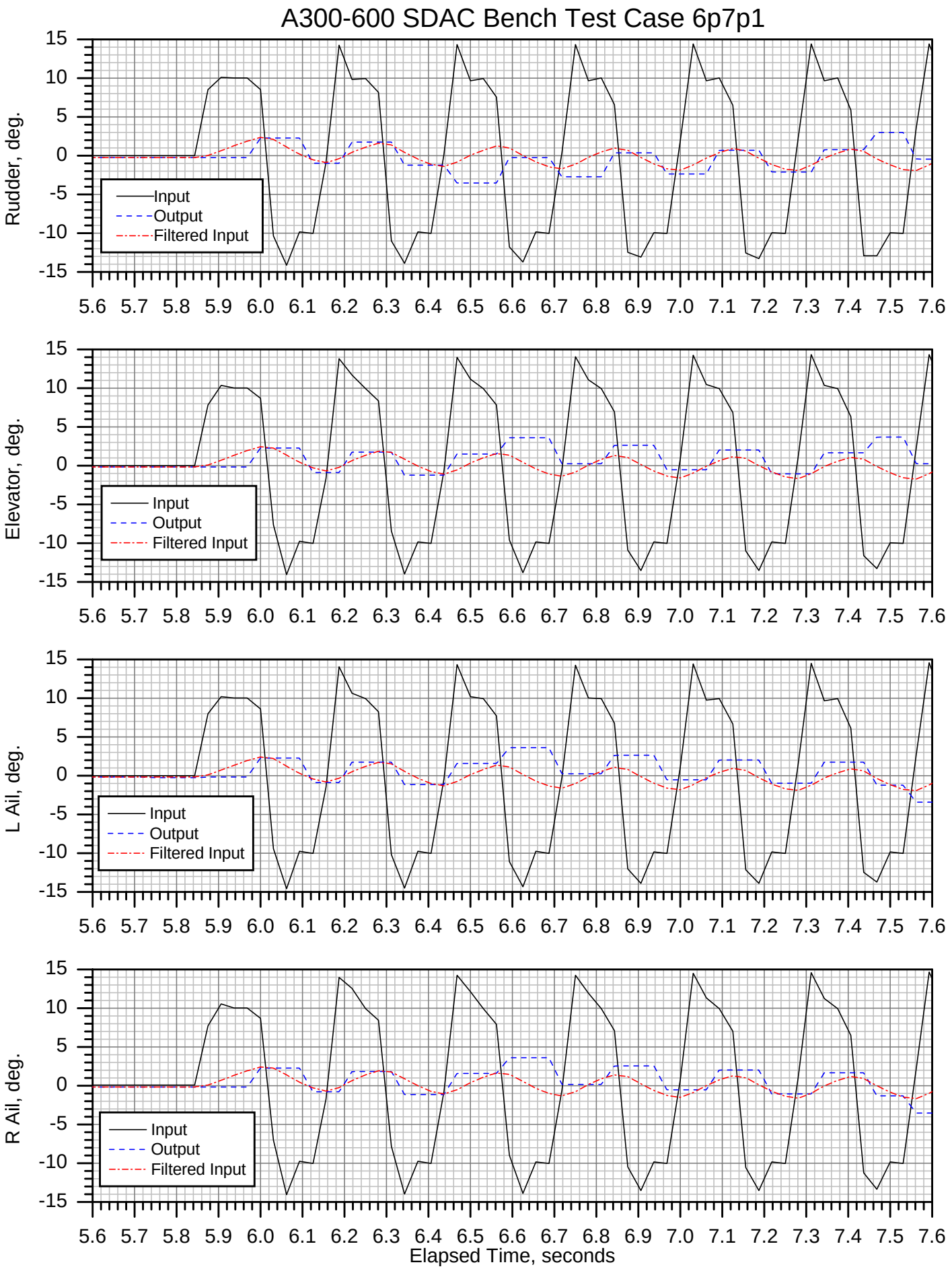
A300-600 SDAC Bench Test Case 6p5p1

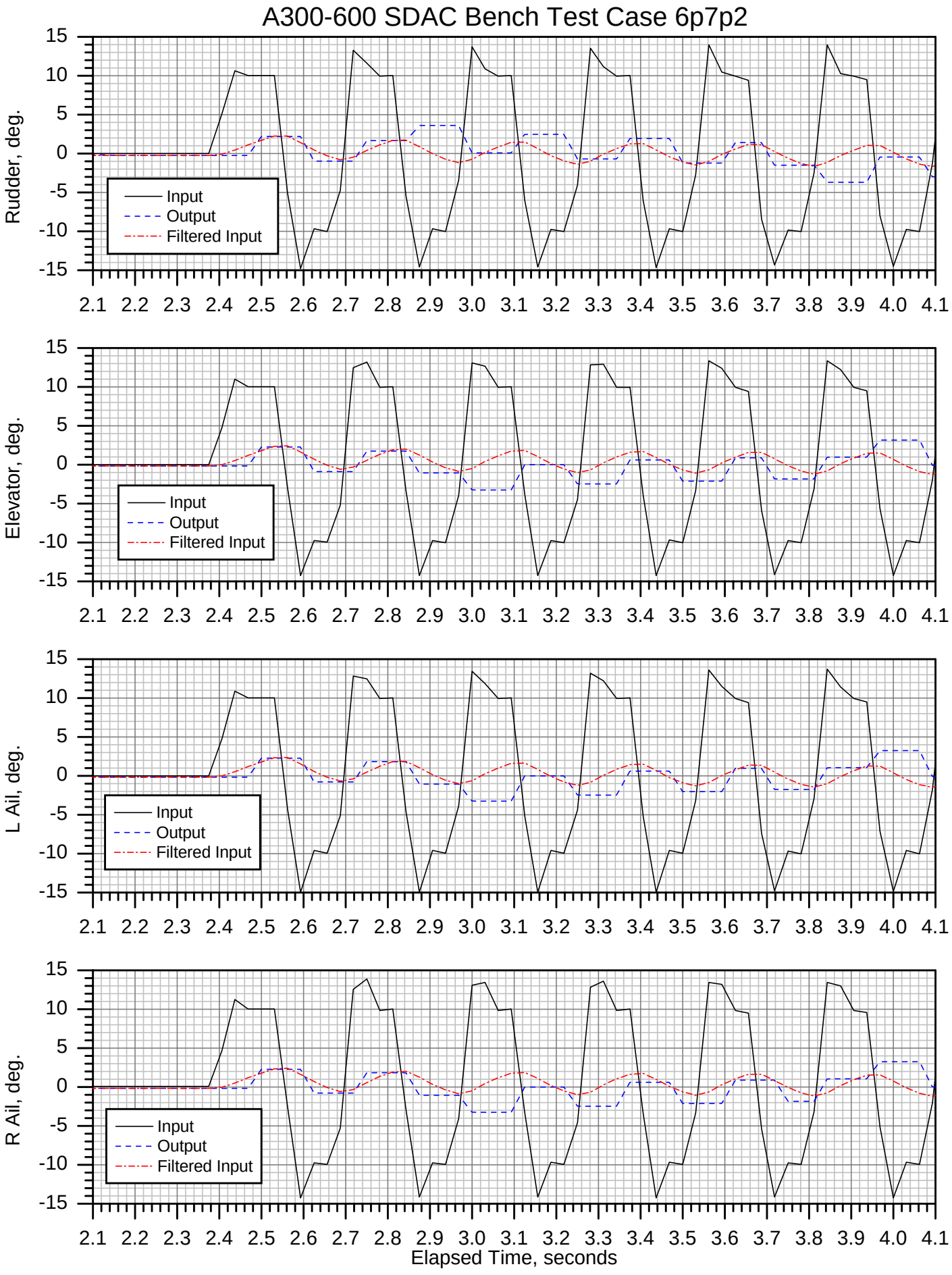


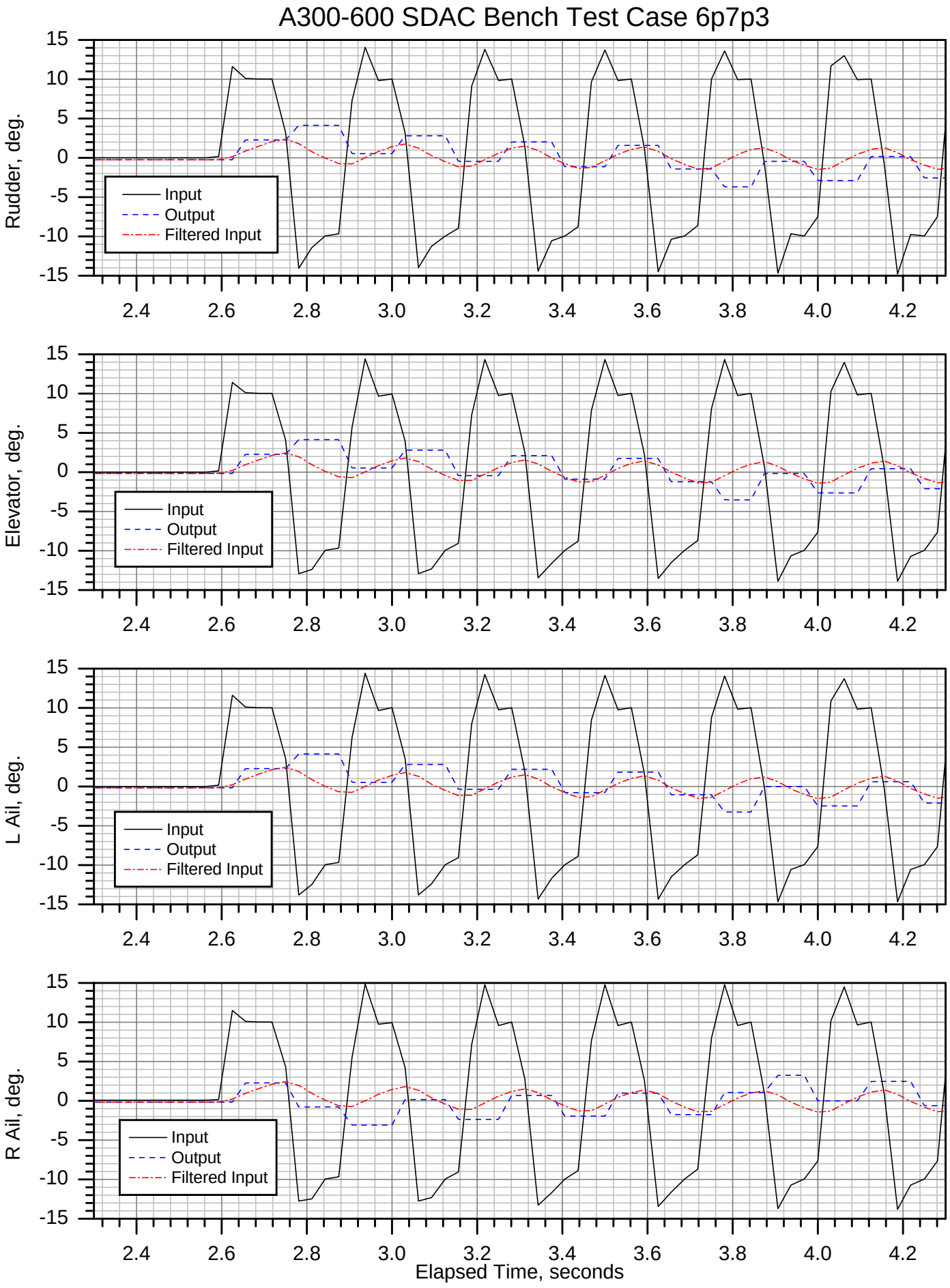

A300-600 SDAC Bench Test Case 6p5p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
Elapsed Time, seconds

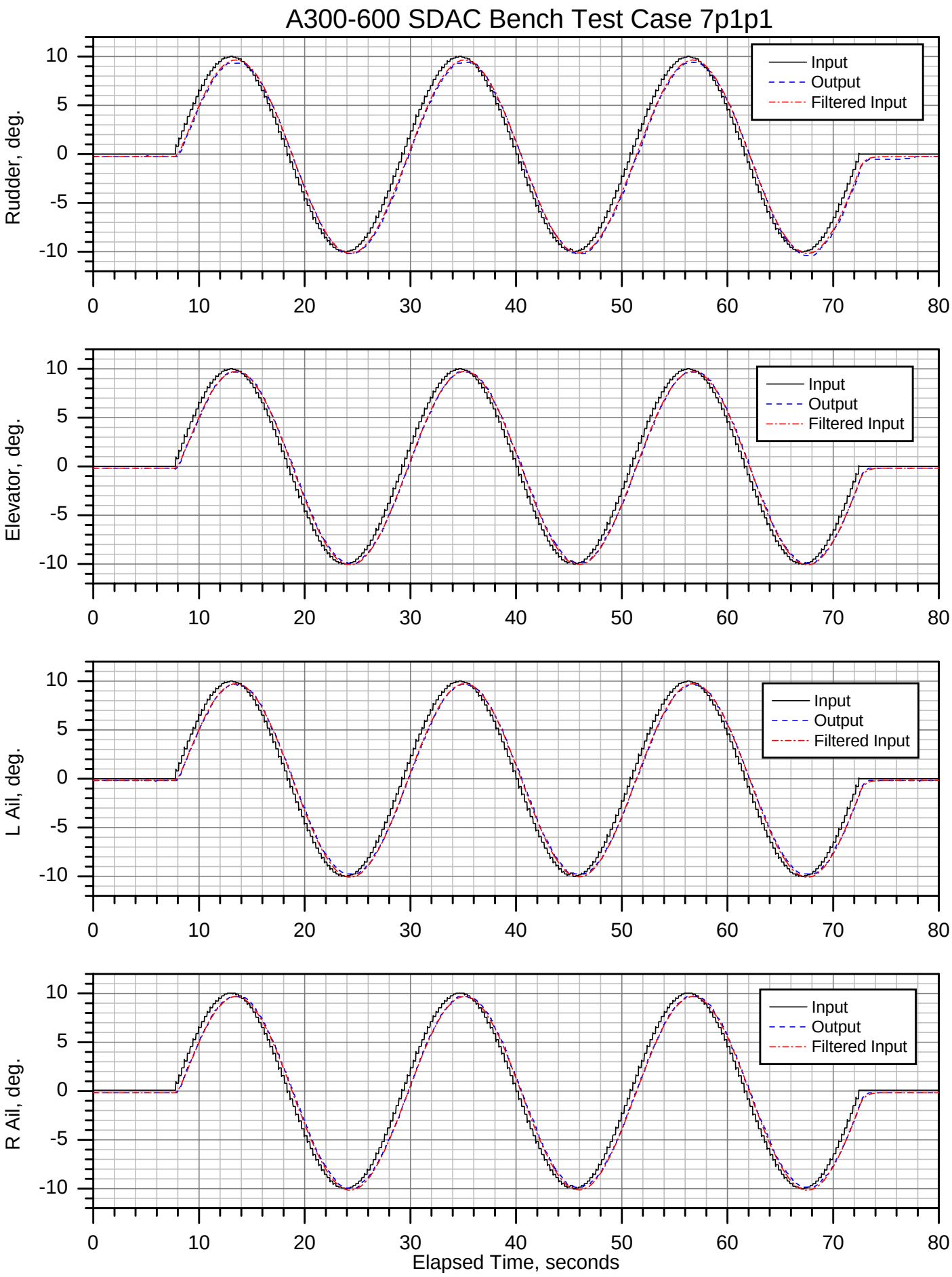

A300-600 SDAC Bench Test Case 6p6p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 6p6p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
Elapsed Time, seconds

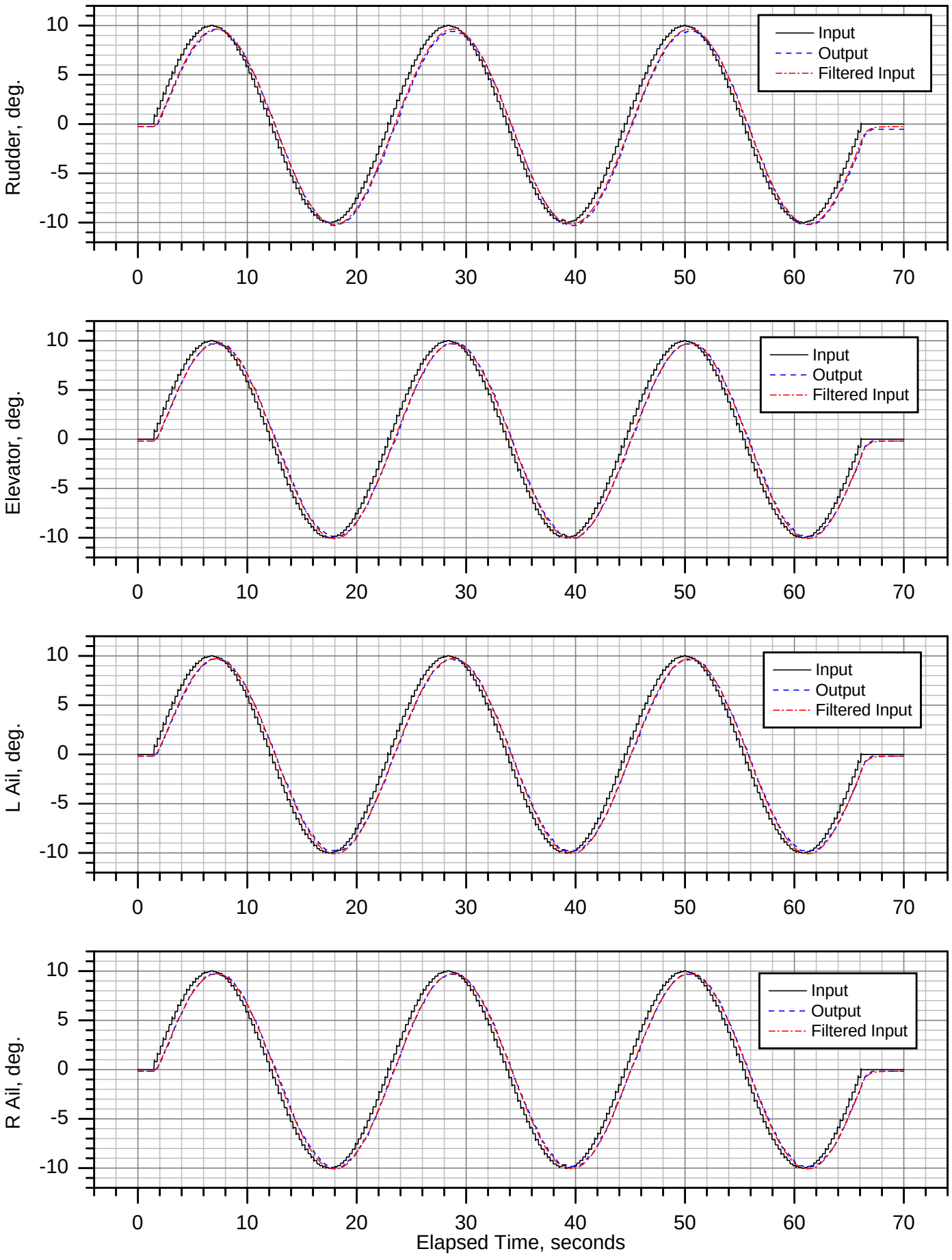

A300-600 SDAC Bench Test Case 6p7p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
5.6 5.7 5.8 5.9 6.0 6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9 7.0 7.1 7.2 7.3 7.4 7.5 7.6
Elapsed Time, seconds

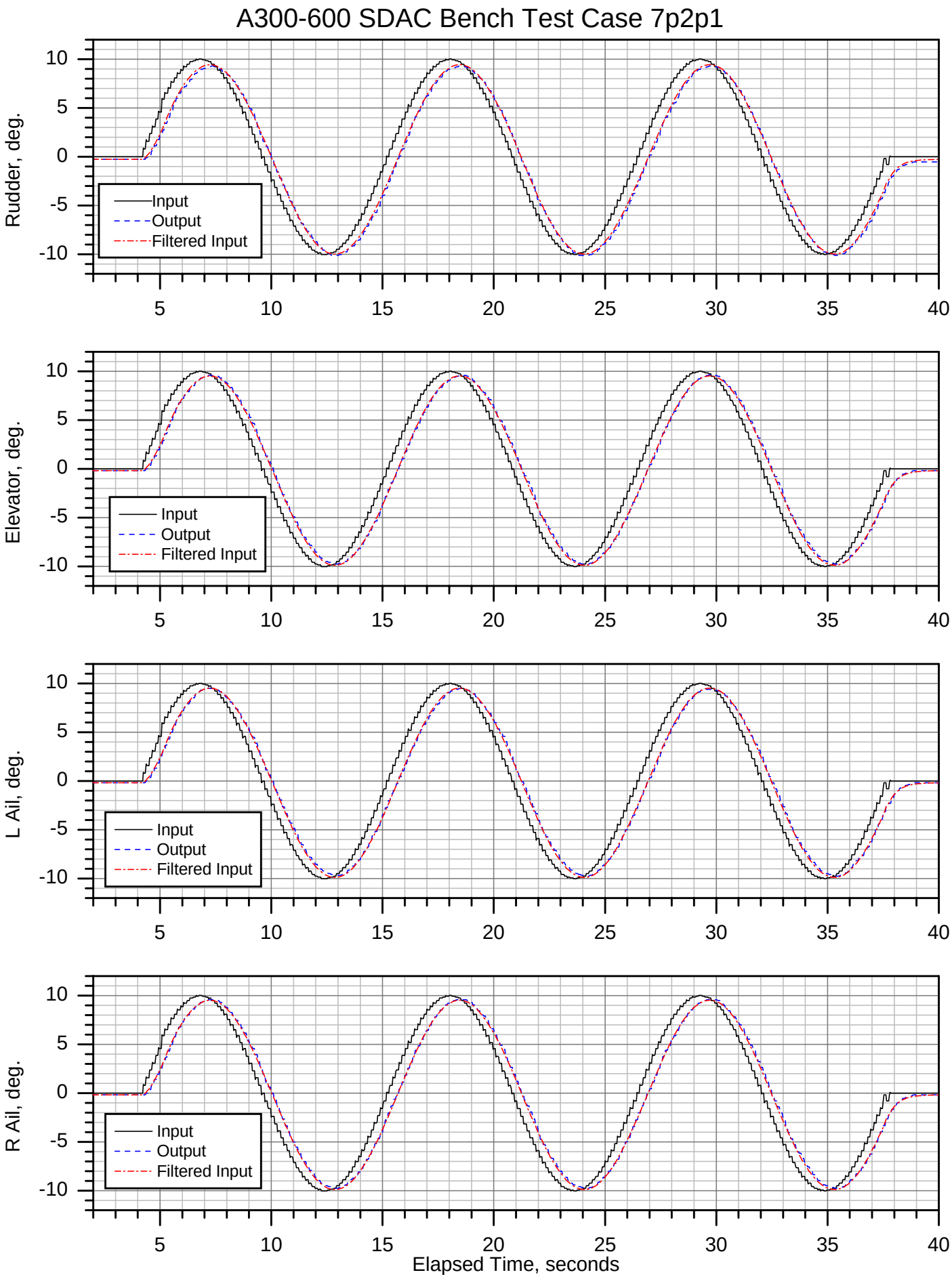

A300-600 SDAC Bench Test Case 6p7p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 6p7p3
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
15
10
5
0
-5
-10
-15
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
Elapsed Time, seconds

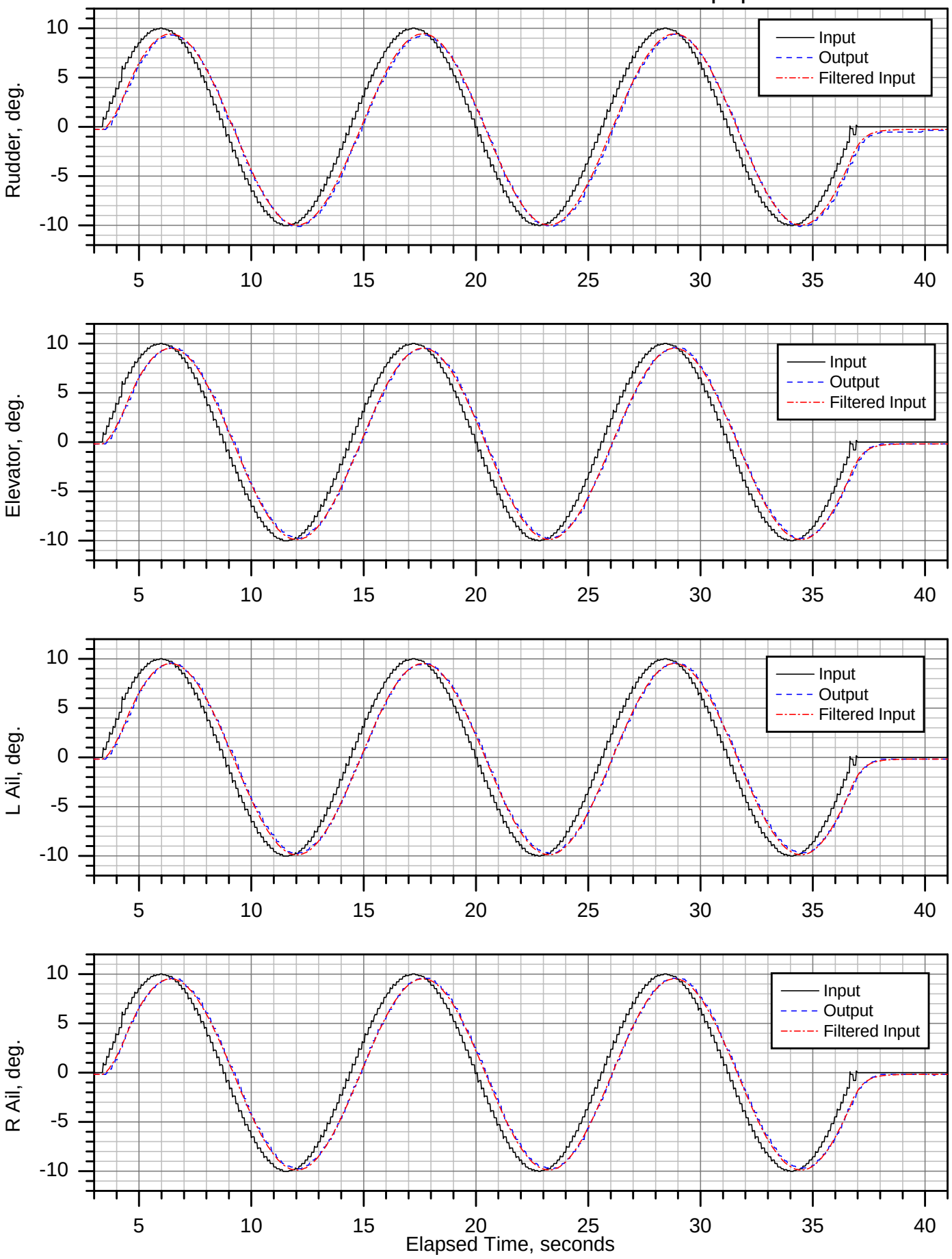

A300-600 SDAC Bench Test Case 7p1p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
0
10
20
30
40
50
60
70
80
Elapsed Time, seconds

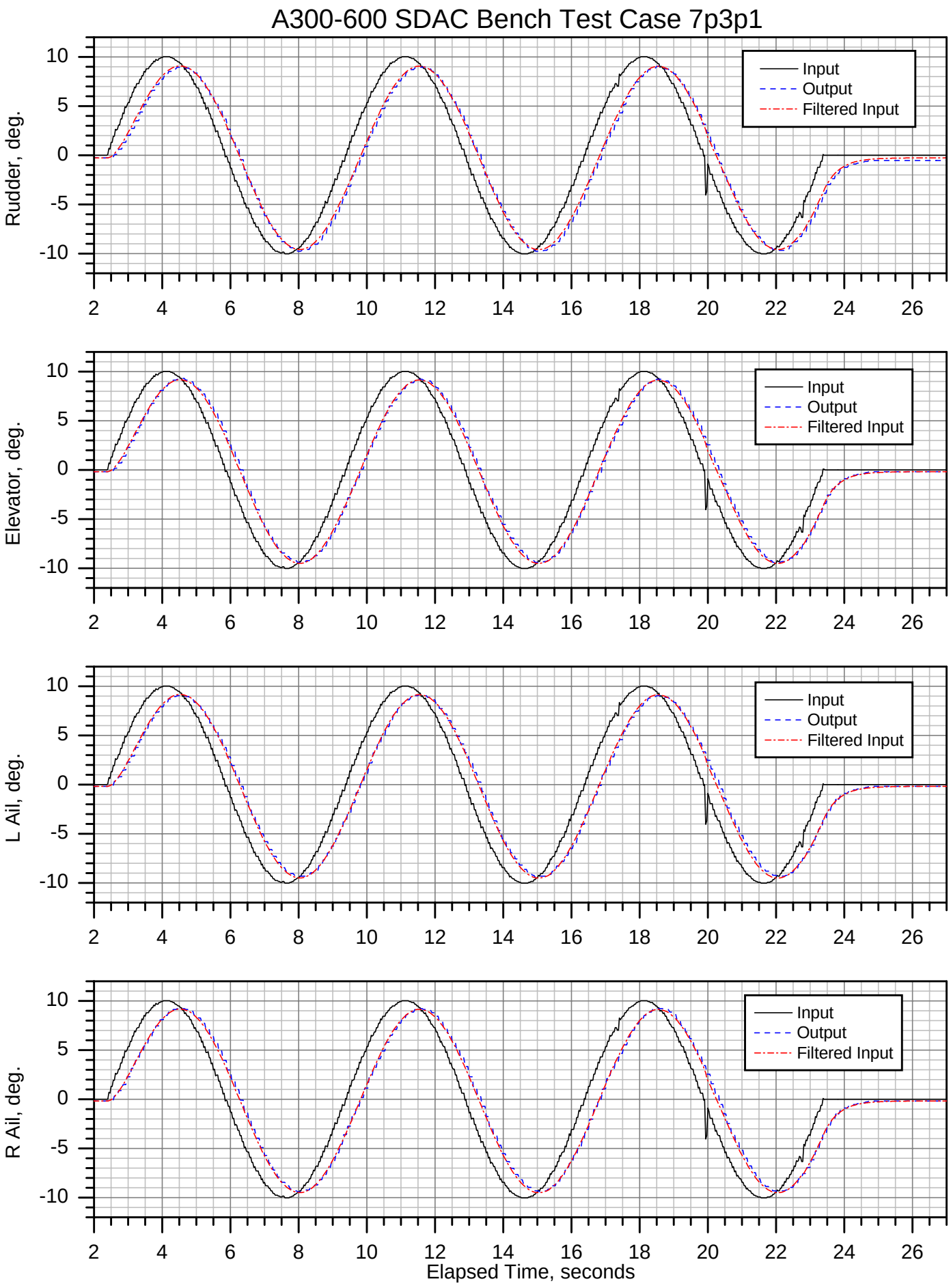
A300-600 SDAC Bench Test Case 7p1p2



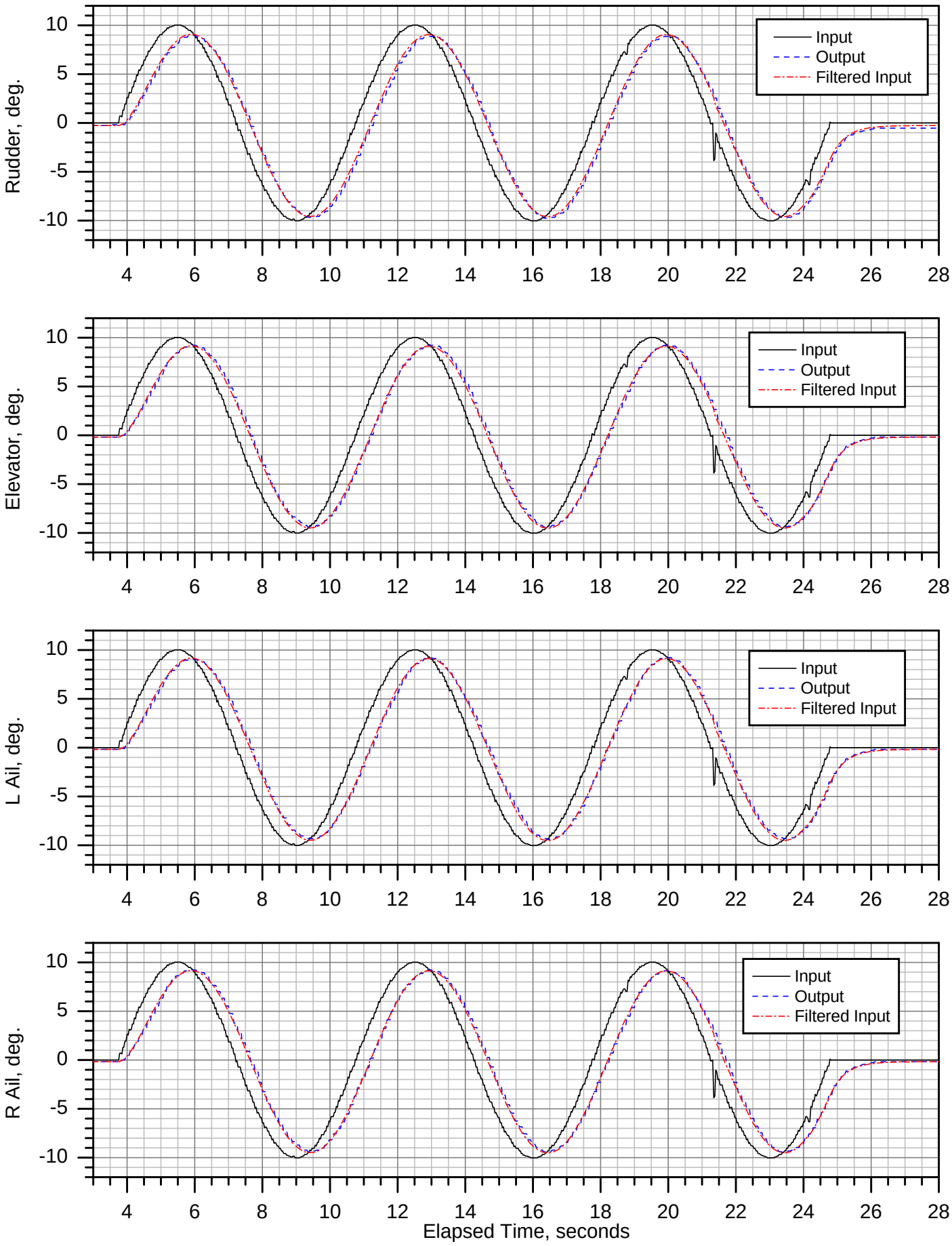

A300-600 SDAC Bench Test Case 7p2p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
5
10
15
20
25
30
35
40
Elapsed Time, seconds

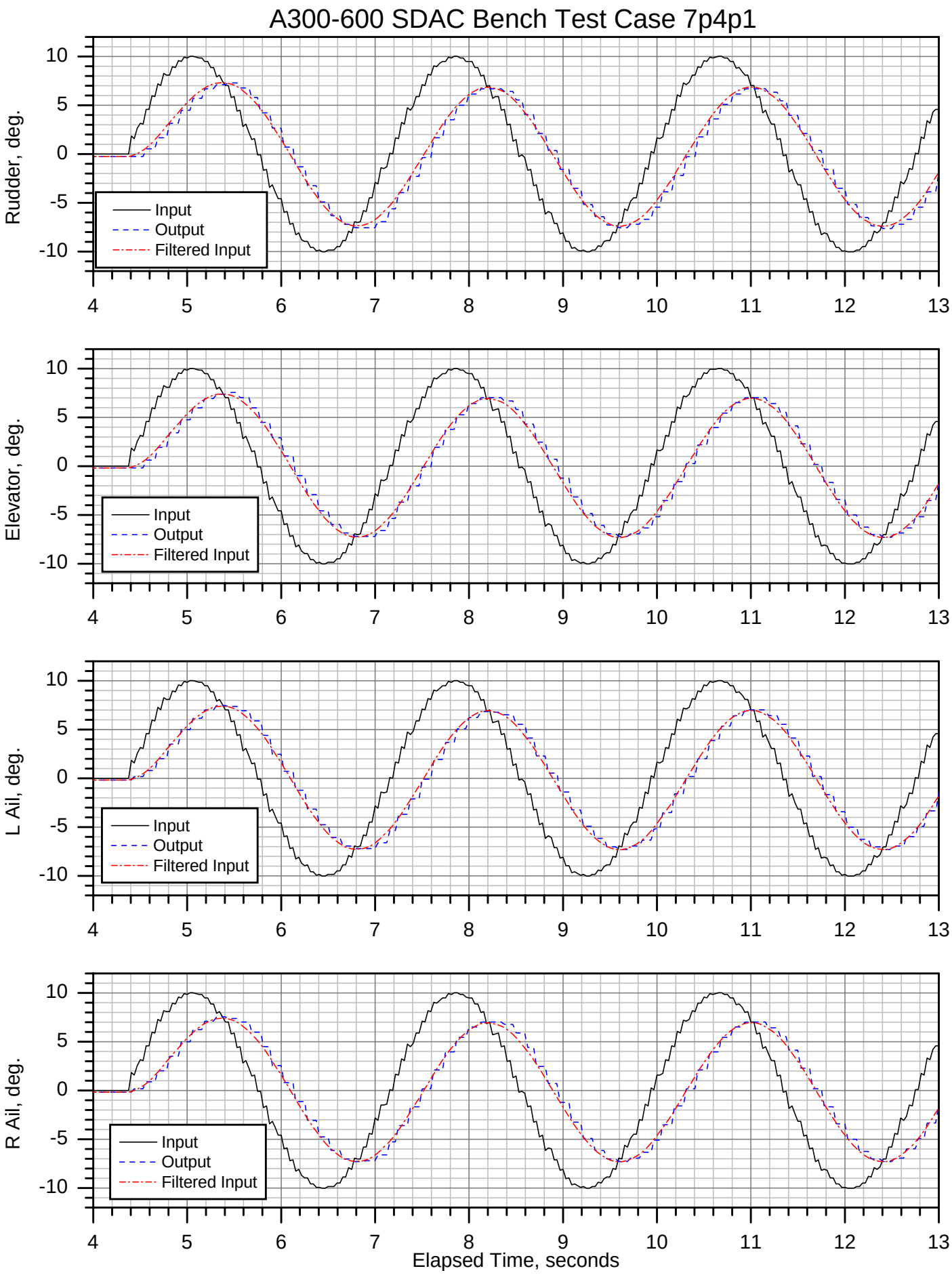
A300-600 SDAC Bench Test Case 7p2p2

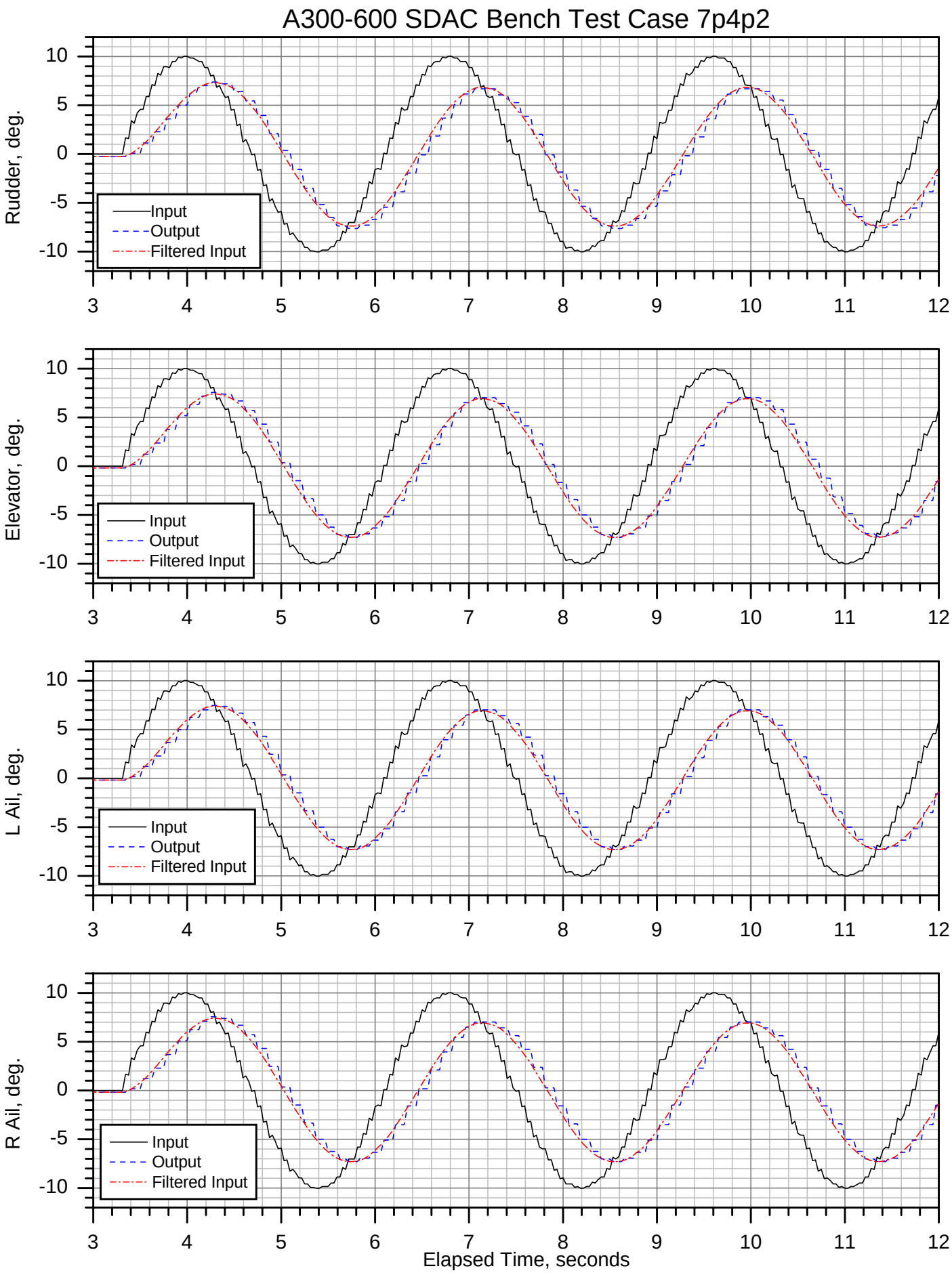


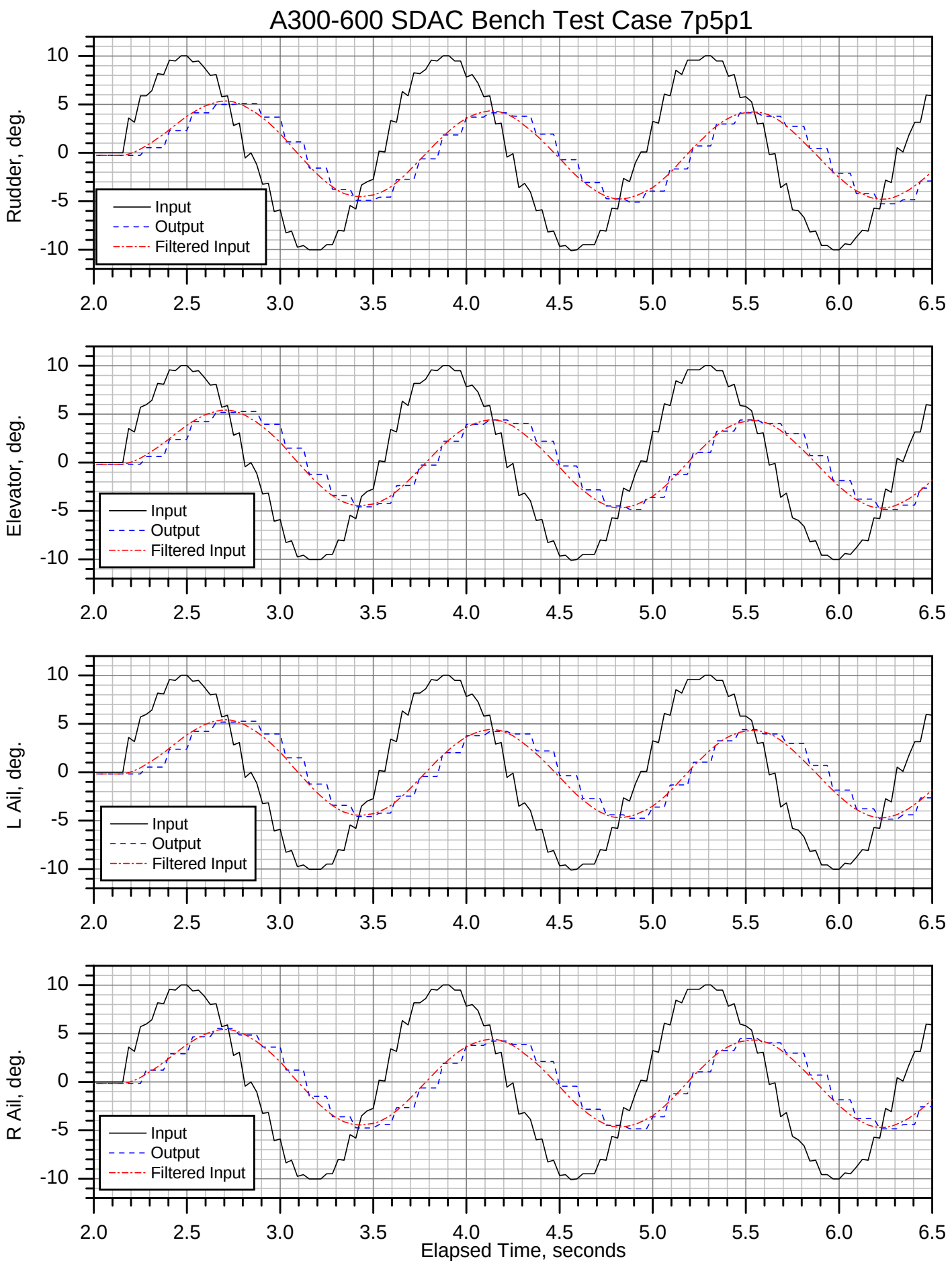

A300-600 SDAC Bench Test Case 7p3p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
2
4
6
8
10
12
14
16
18
20
22
24
26
Elapsed Time, seconds

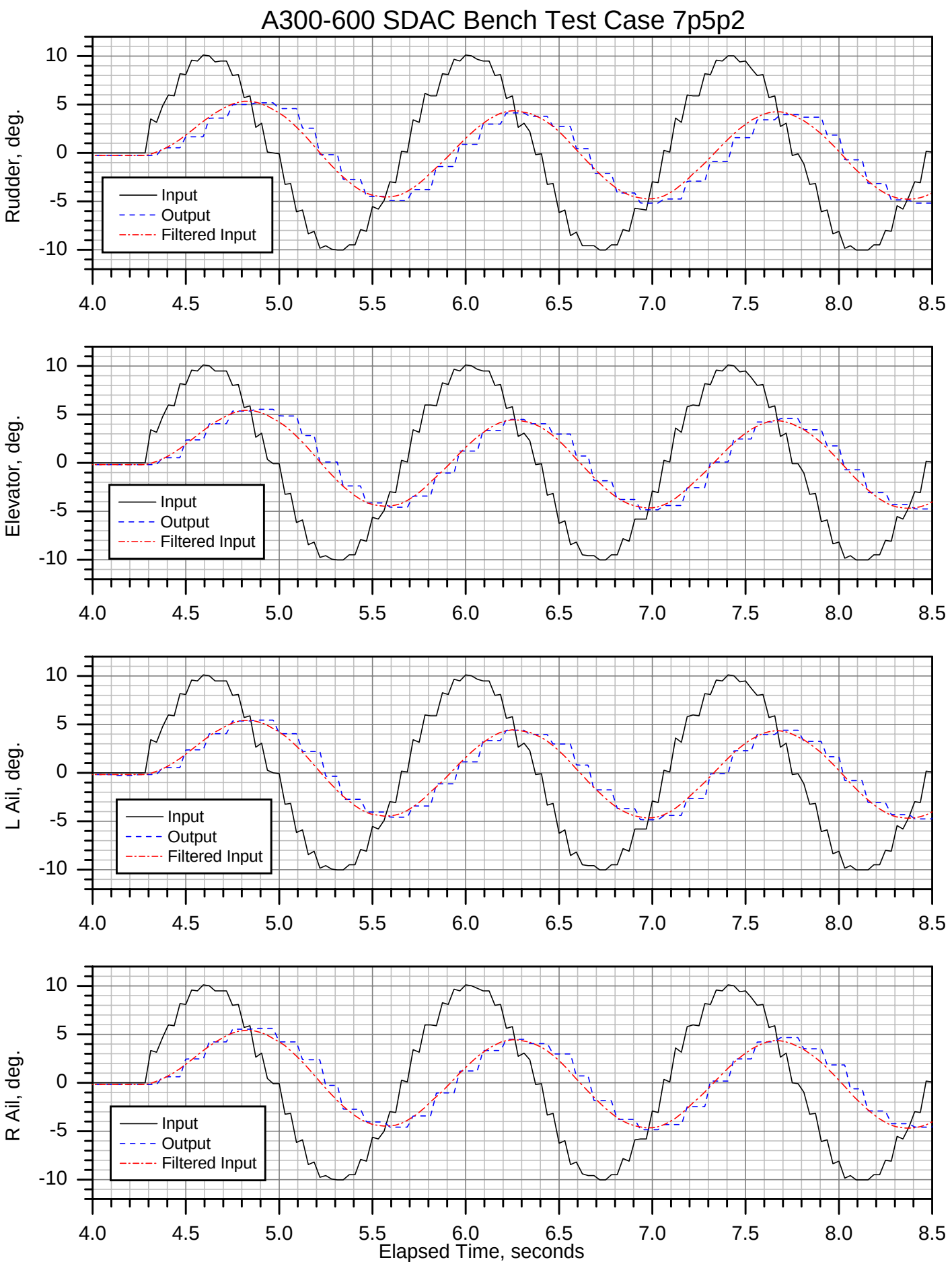
A300-600 SDAC Bench Test Case 7p3p2

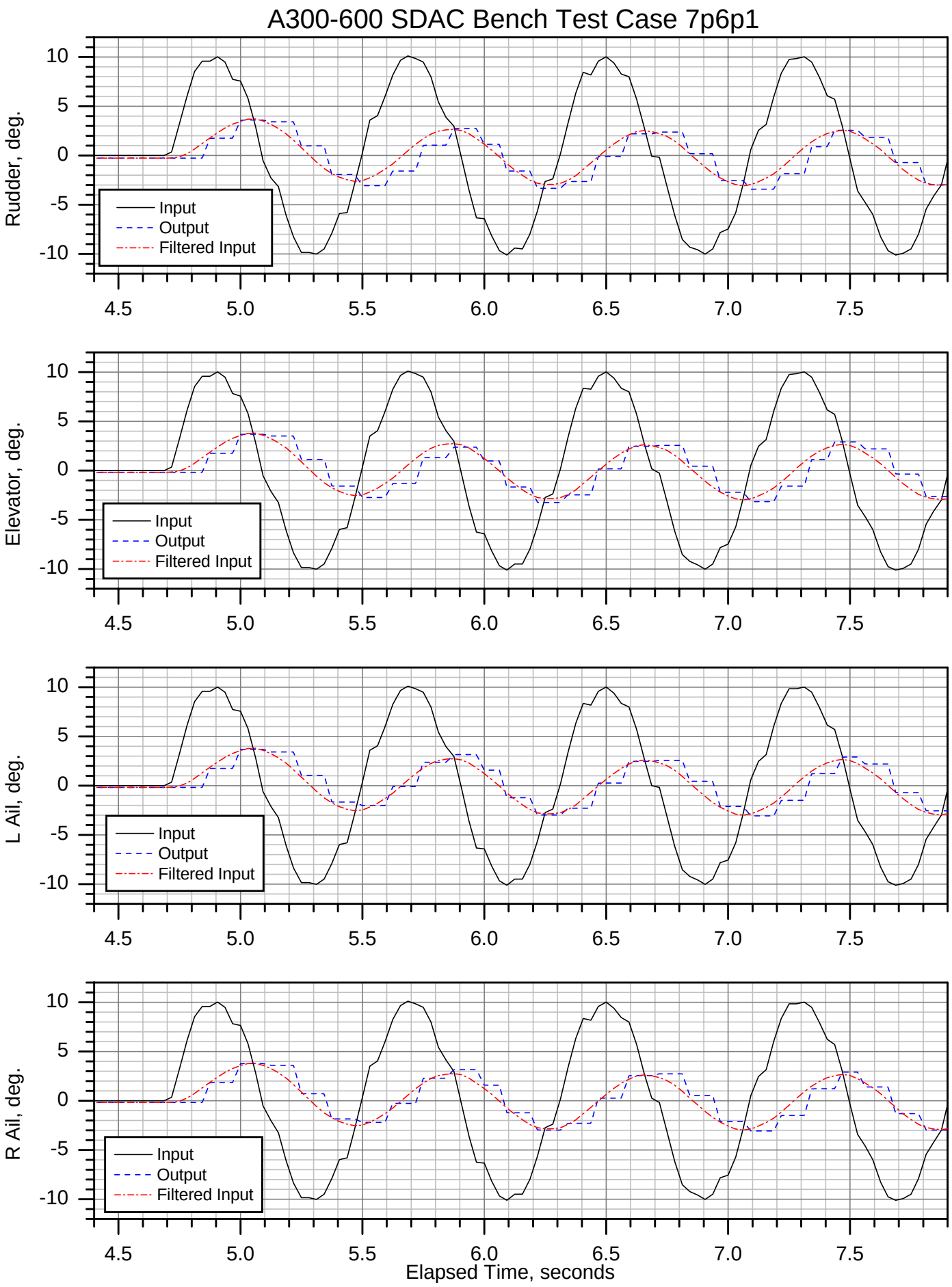


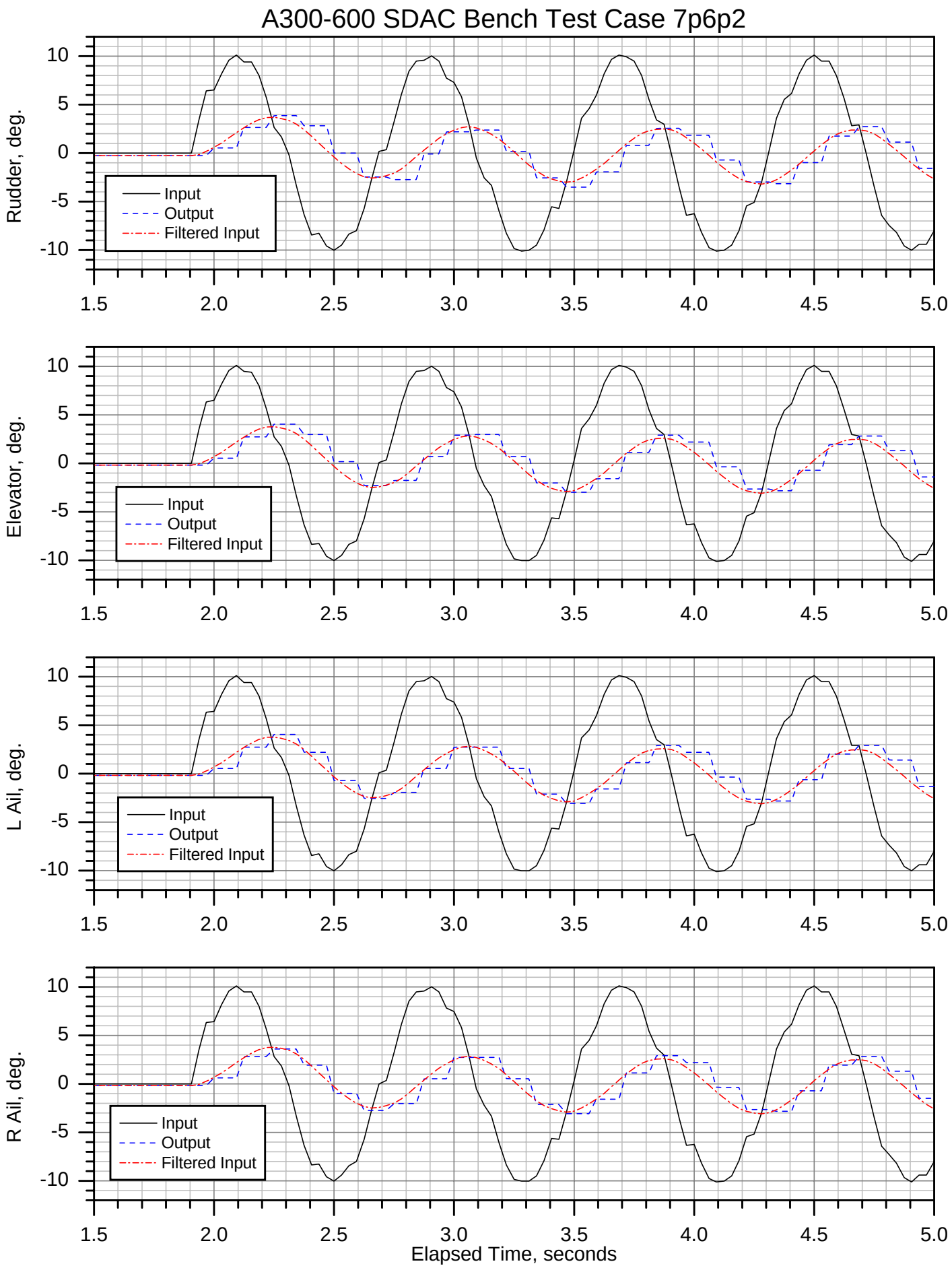

A300-600 SDAC Bench Test Case 7p4p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4
5
6
7
8
9
10
11
12
13
Elapsed Time, seconds

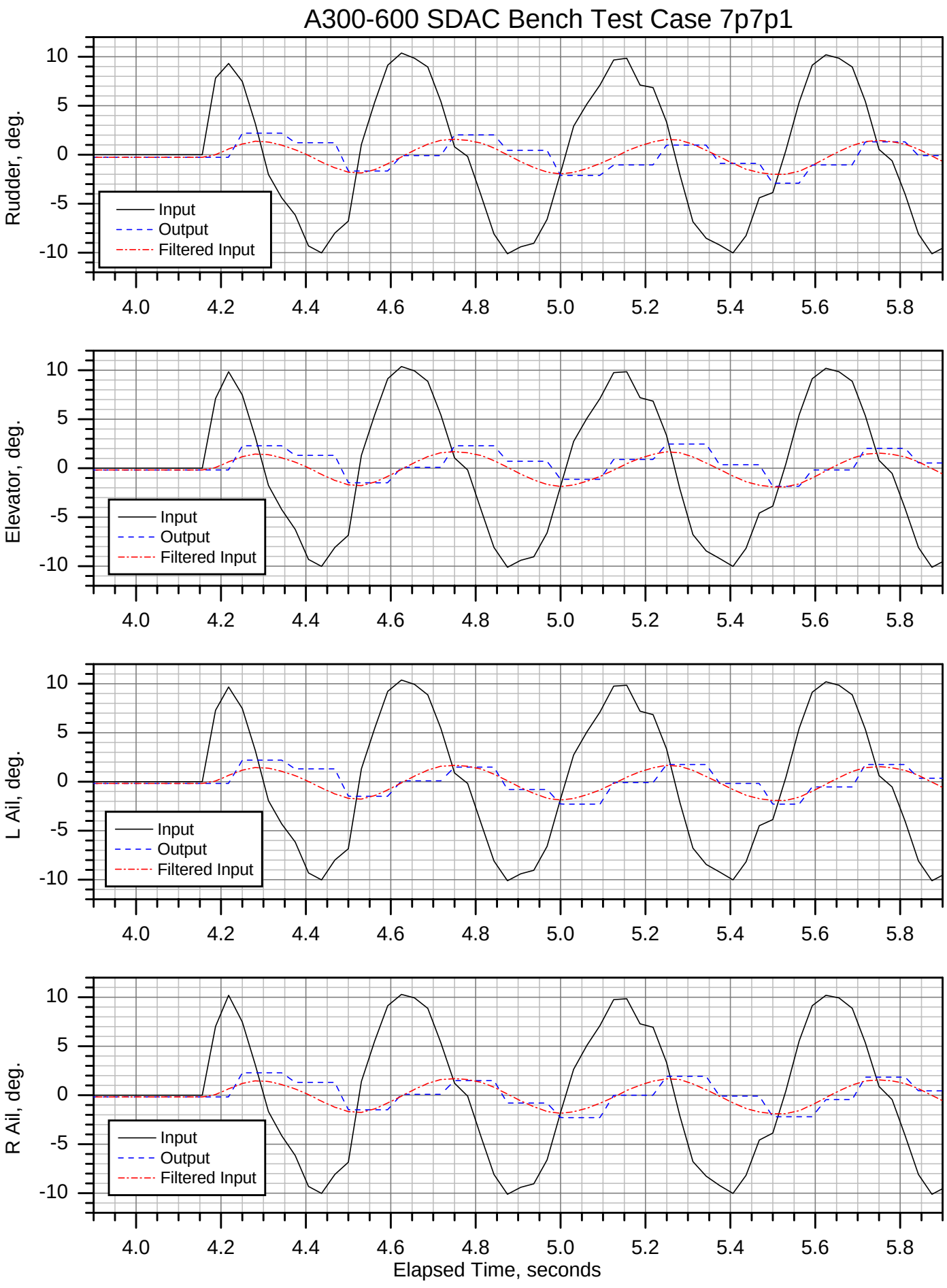

A300-600 SDAC Bench Test Case 7p4p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
3
4
5
6
7
8
9
10
11
12
Elapsed Time, seconds

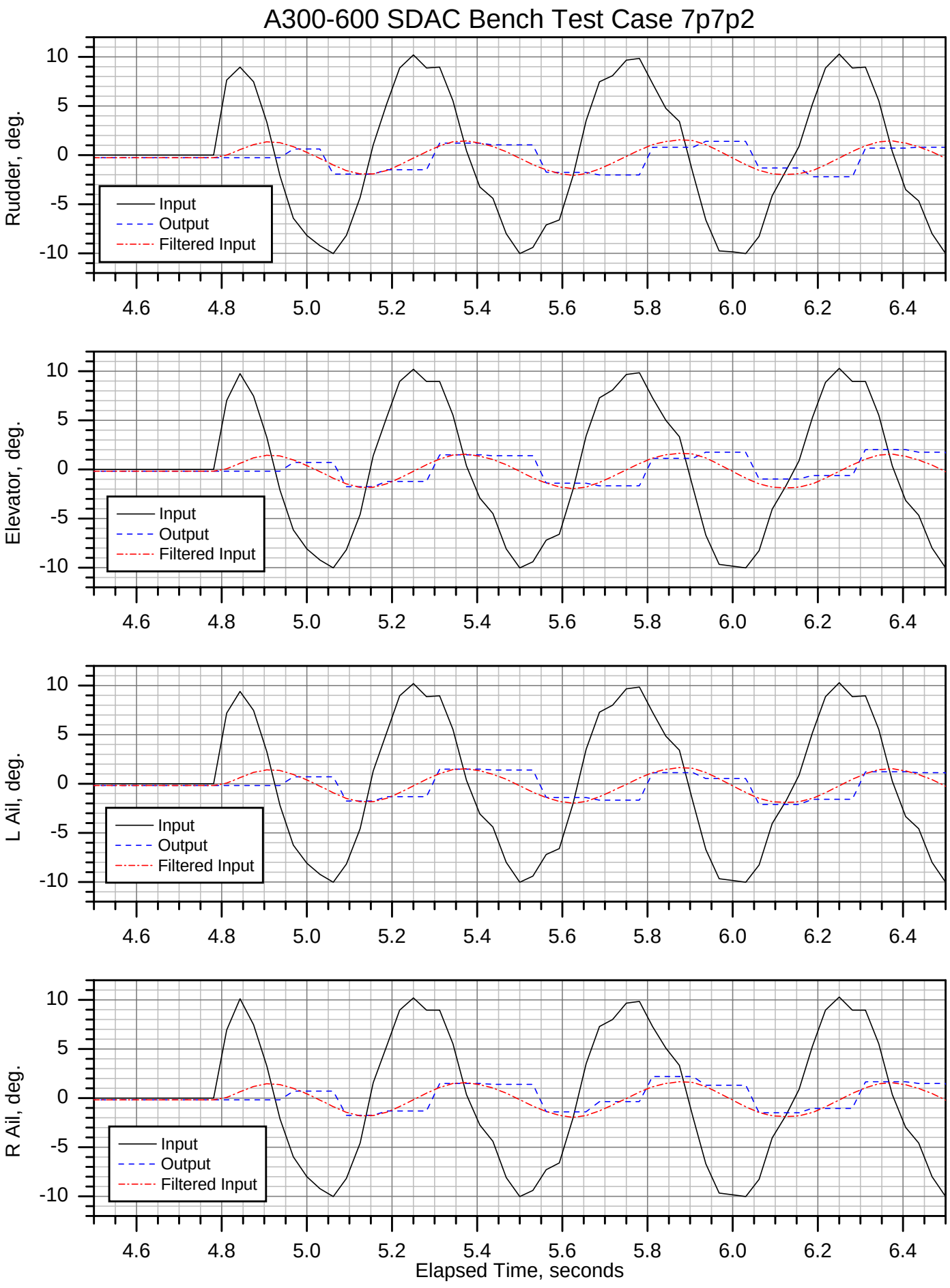

A300-600 SDAC Bench Test Case 7p5p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 7p5p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Elapsed Time, seconds

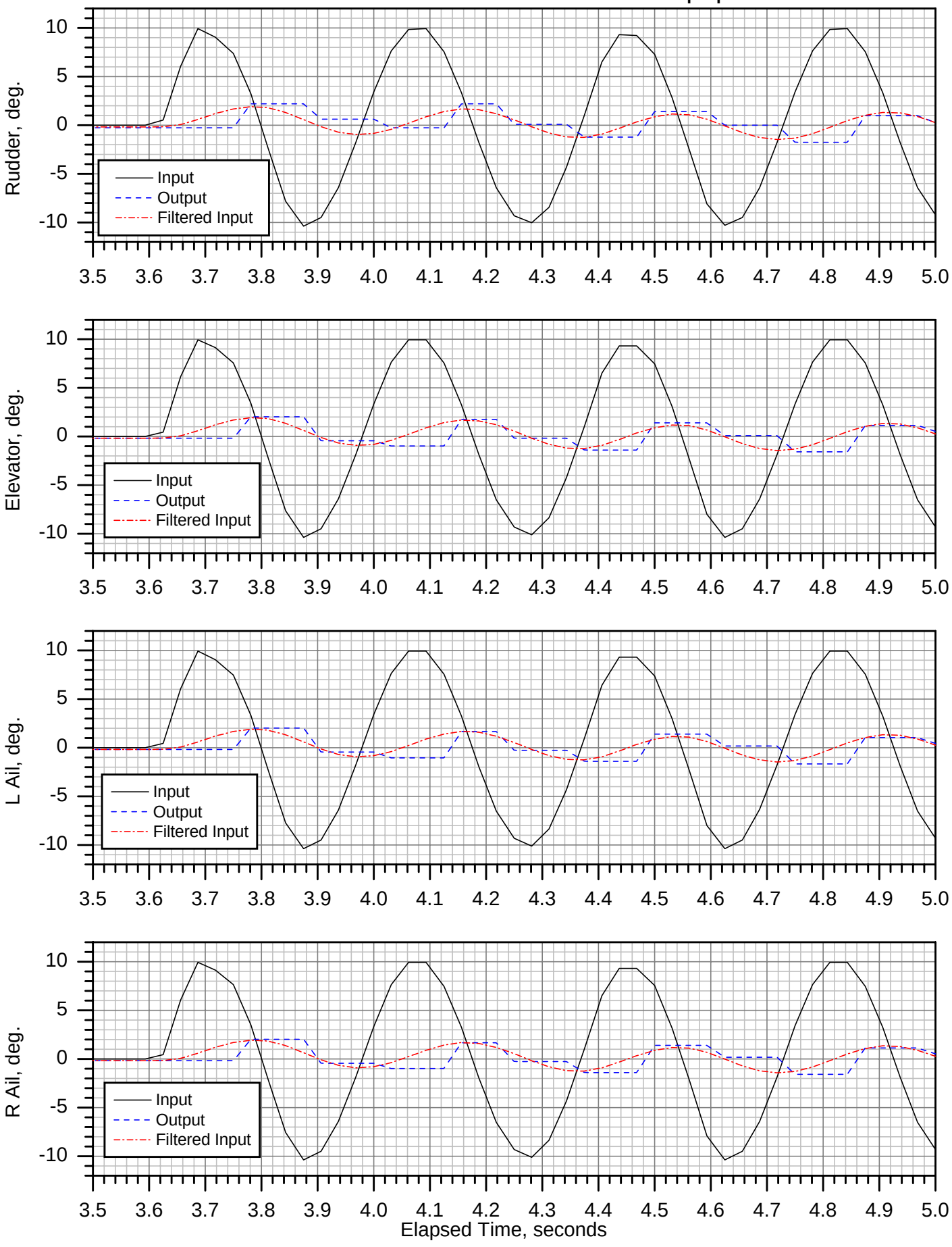

A300-600 SDAC Bench Test Case 7p6p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.5
5.0
5.5
6.0
6.5
7.0
7.5
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 7p6p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Elapsed Time, seconds

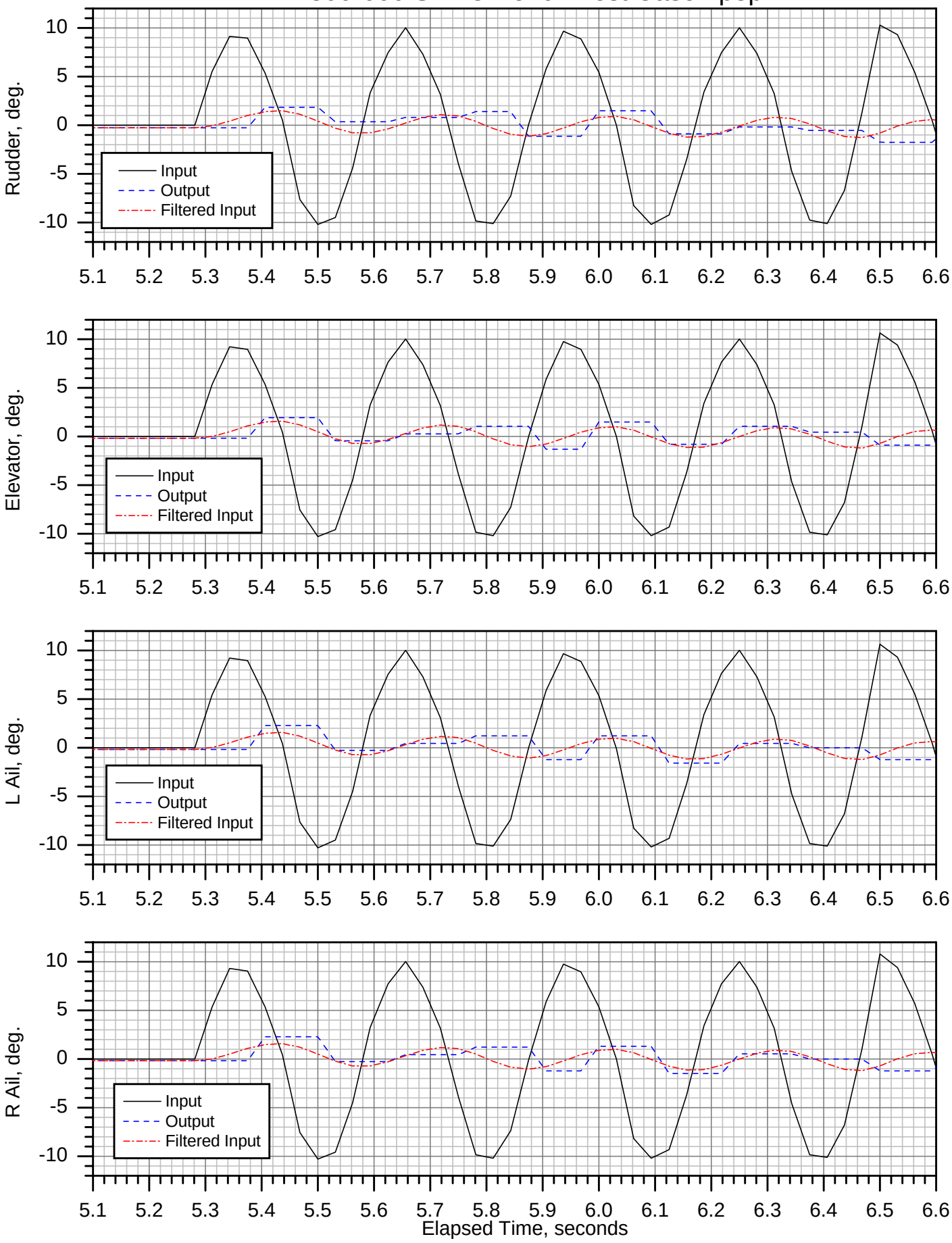

A300-600 SDAC Bench Test Case 7p7p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
Elapsed Time, seconds

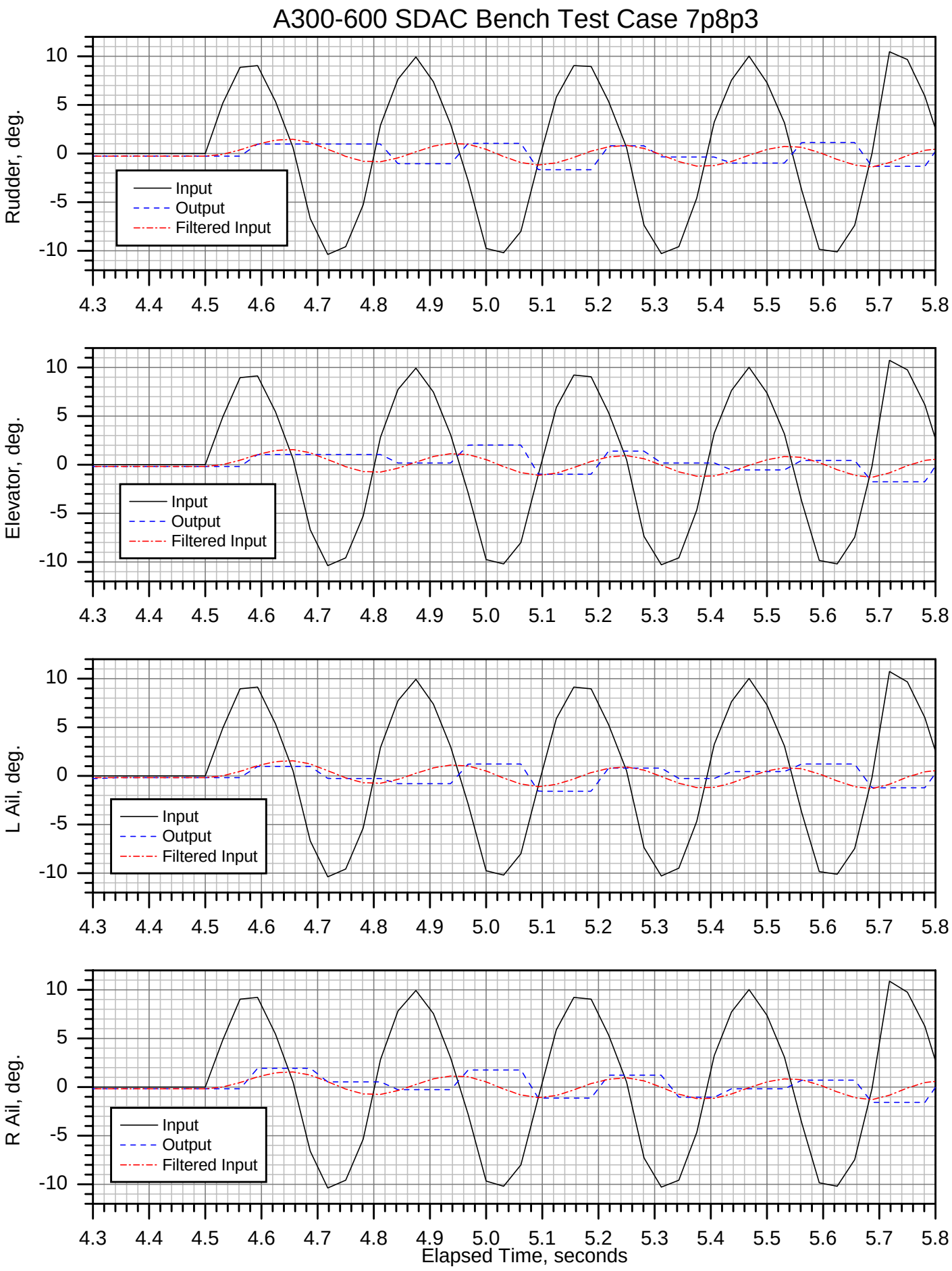

A300-600 SDAC Bench Test Case 7p7p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
Elapsed Time, seconds

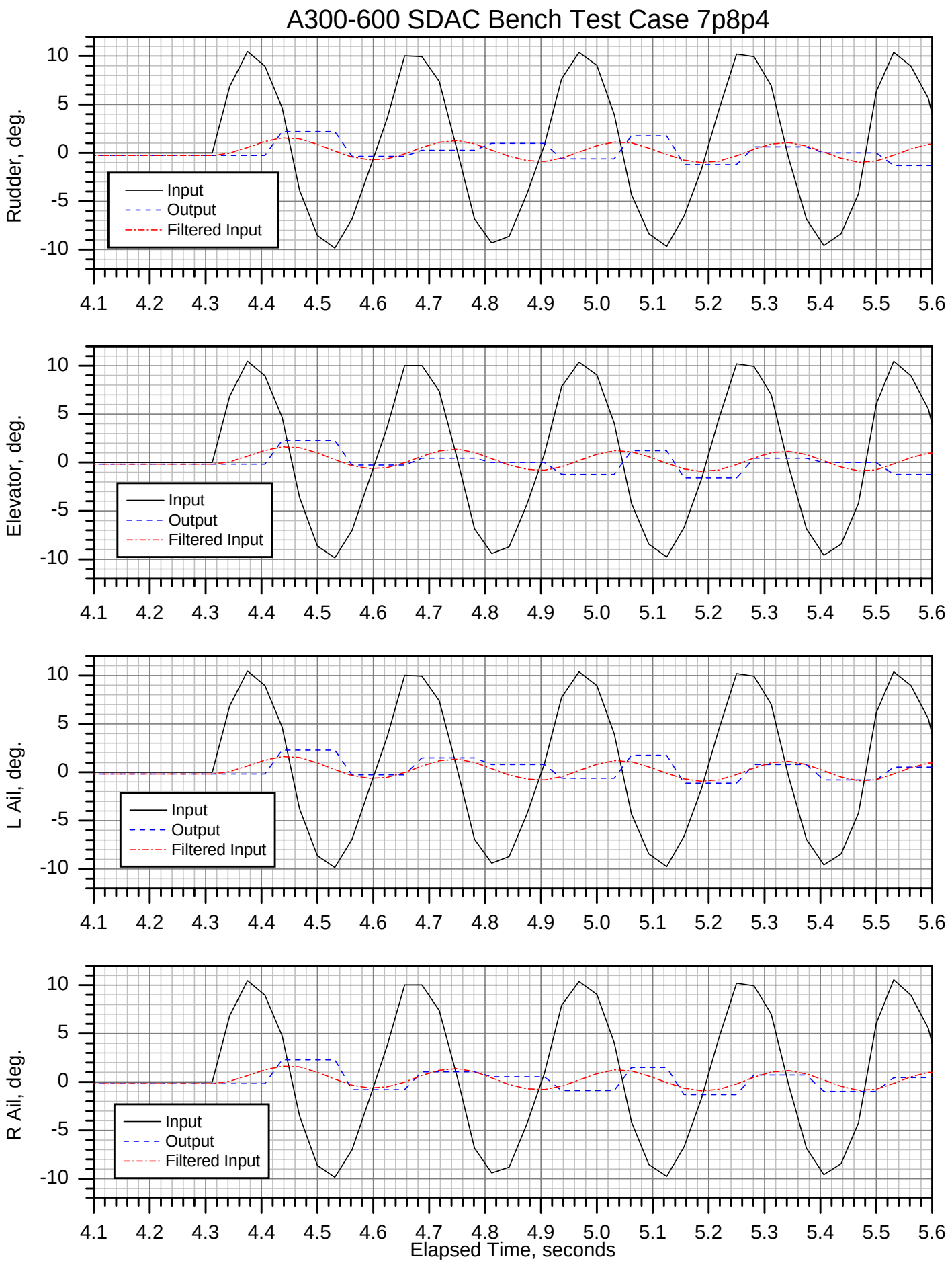
A300-600 SDAC Bench Test Case 7p8p1



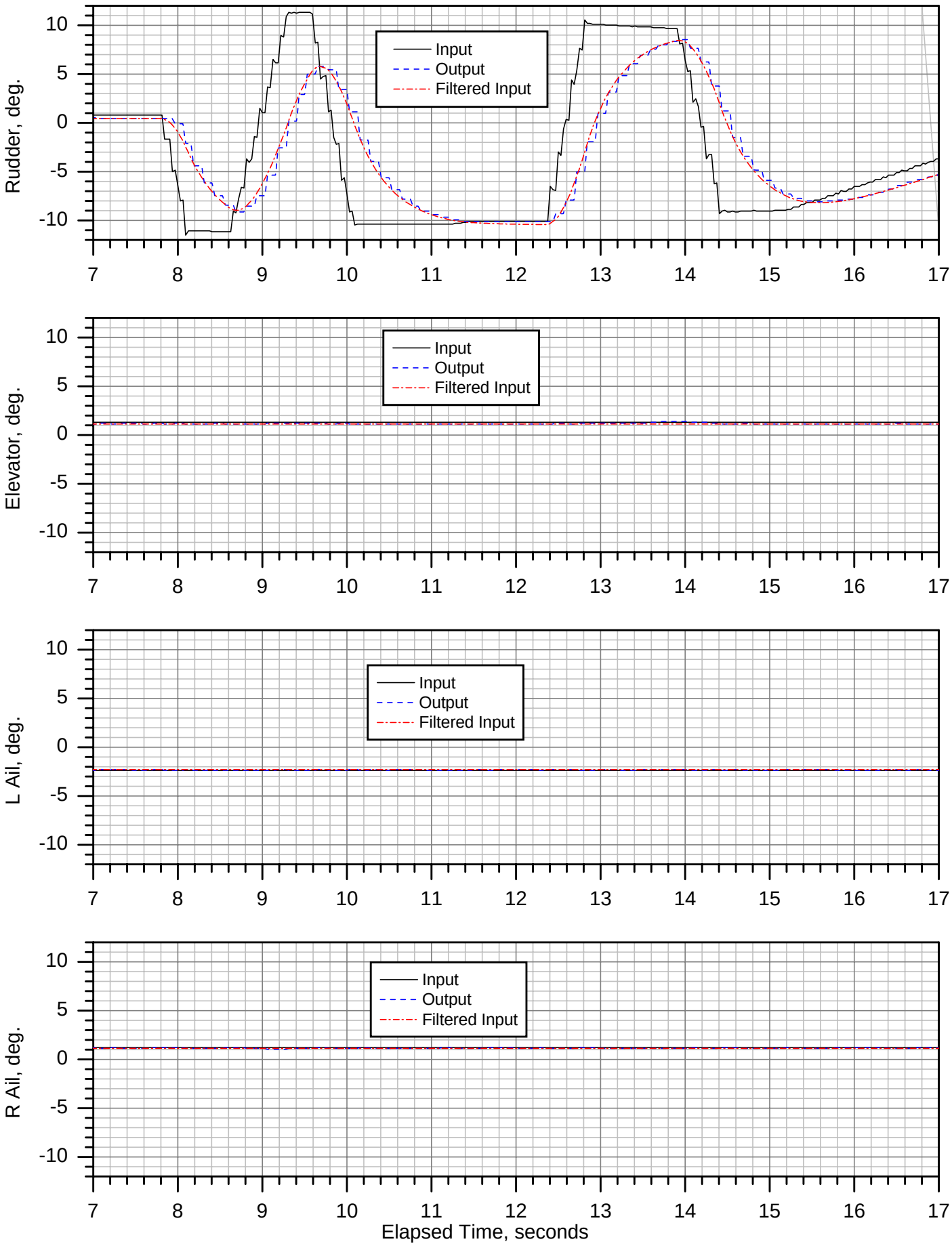
A300-600 SDAC Bench Test Case 7p8p2

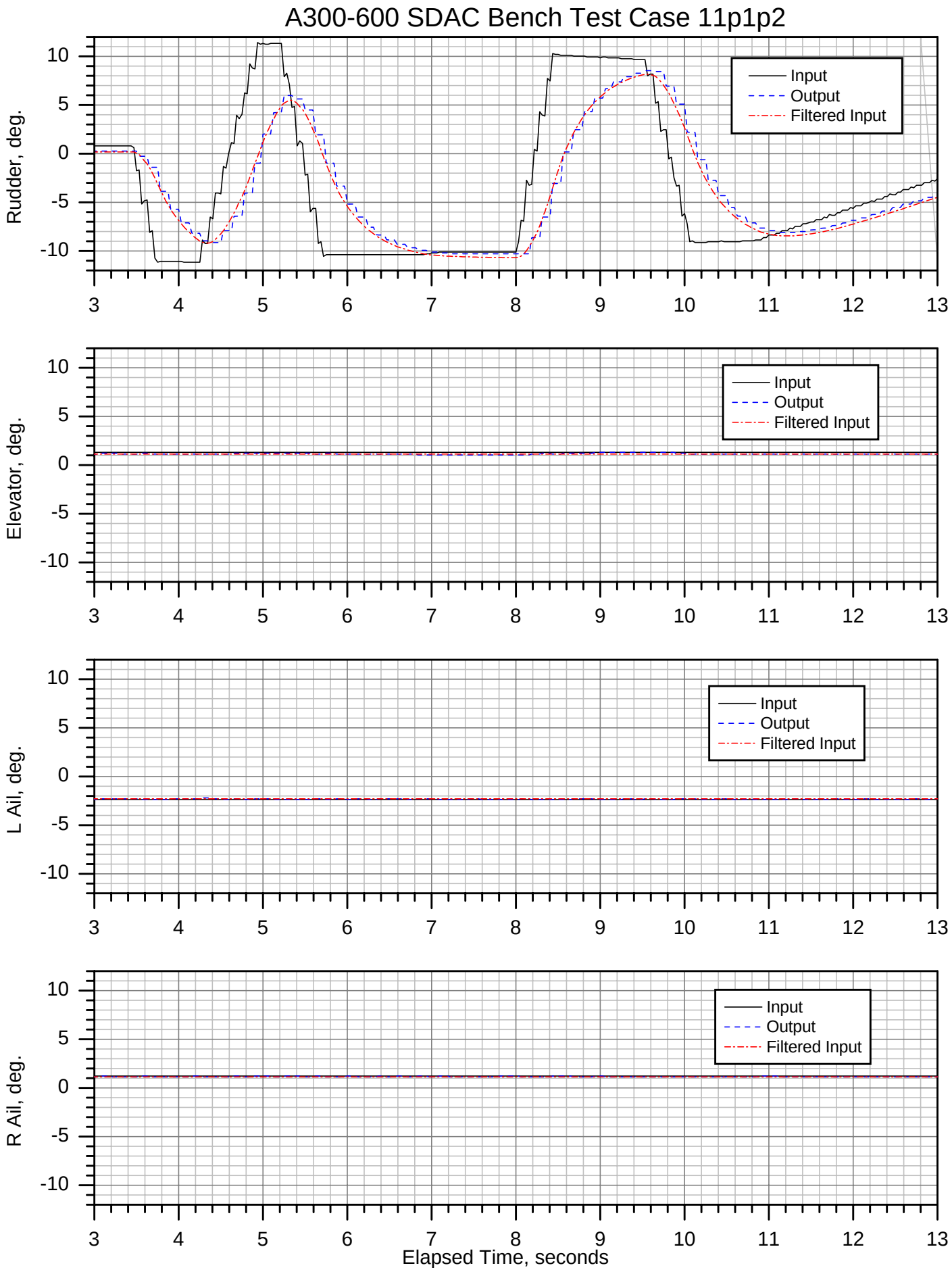


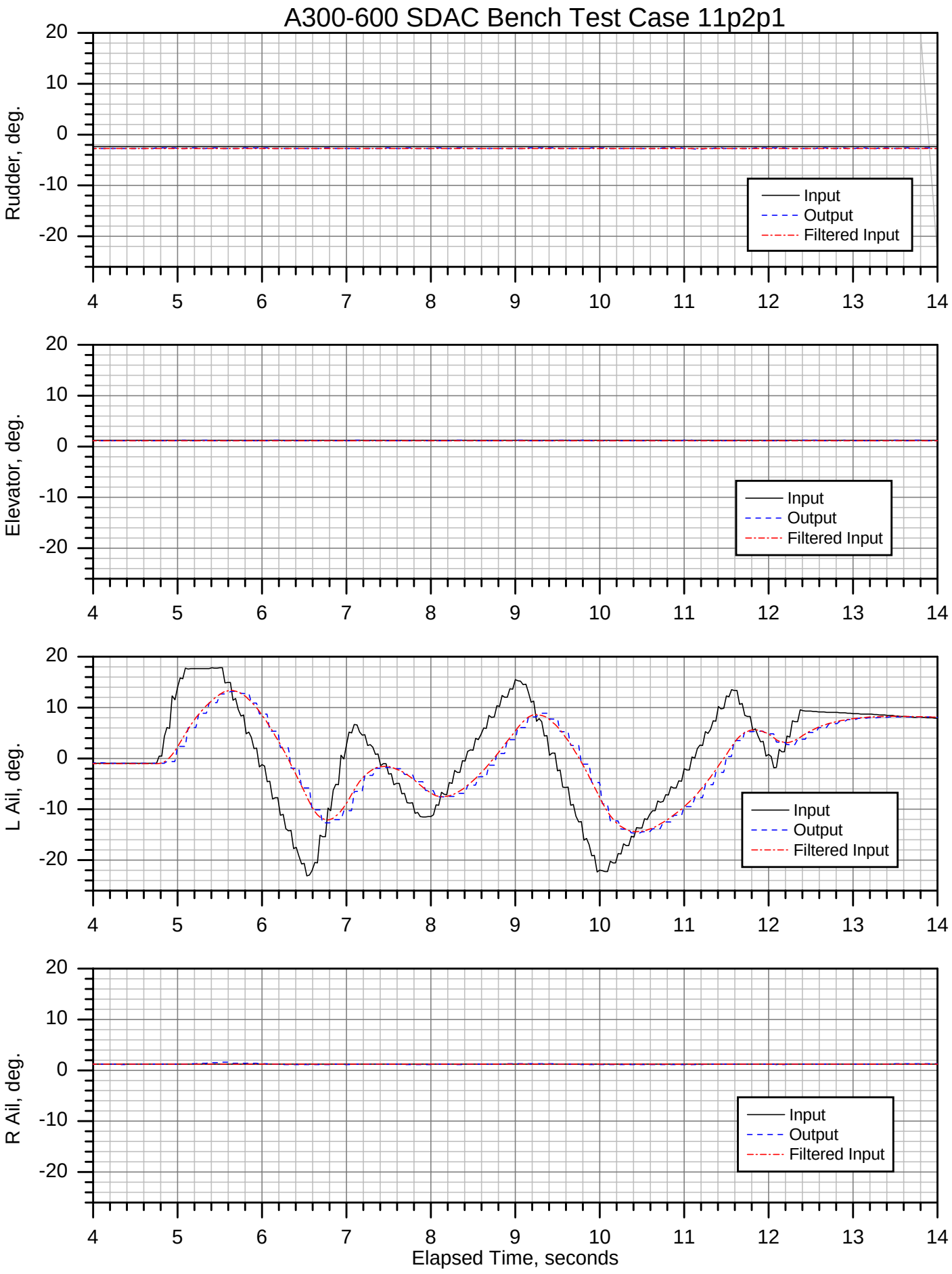

A300-600 SDAC Bench Test Case 7p8p3
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
Elapsed Time, seconds

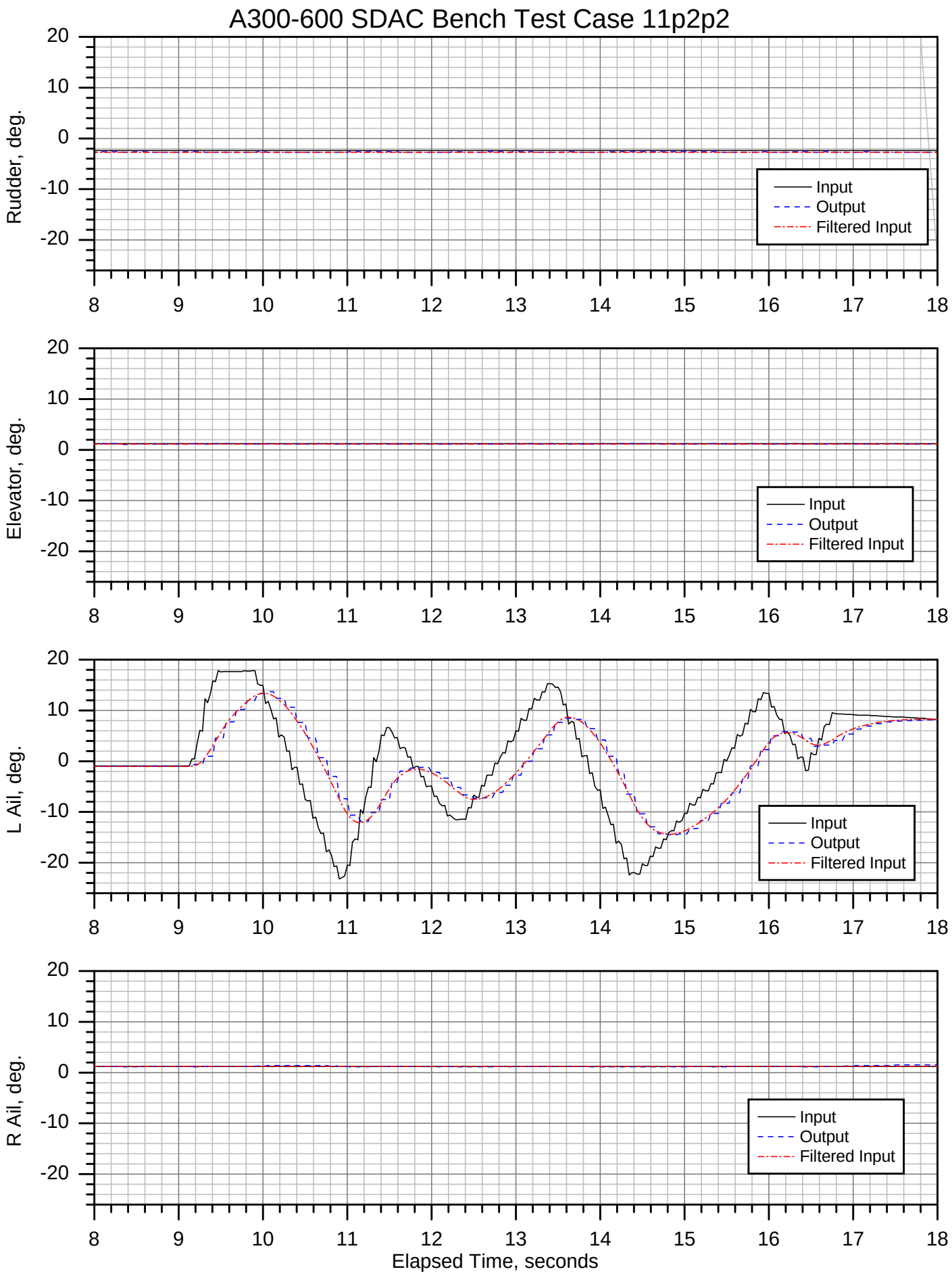

A300-600 SDAC Bench Test Case 7p8p4
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
Elapsed Time, seconds

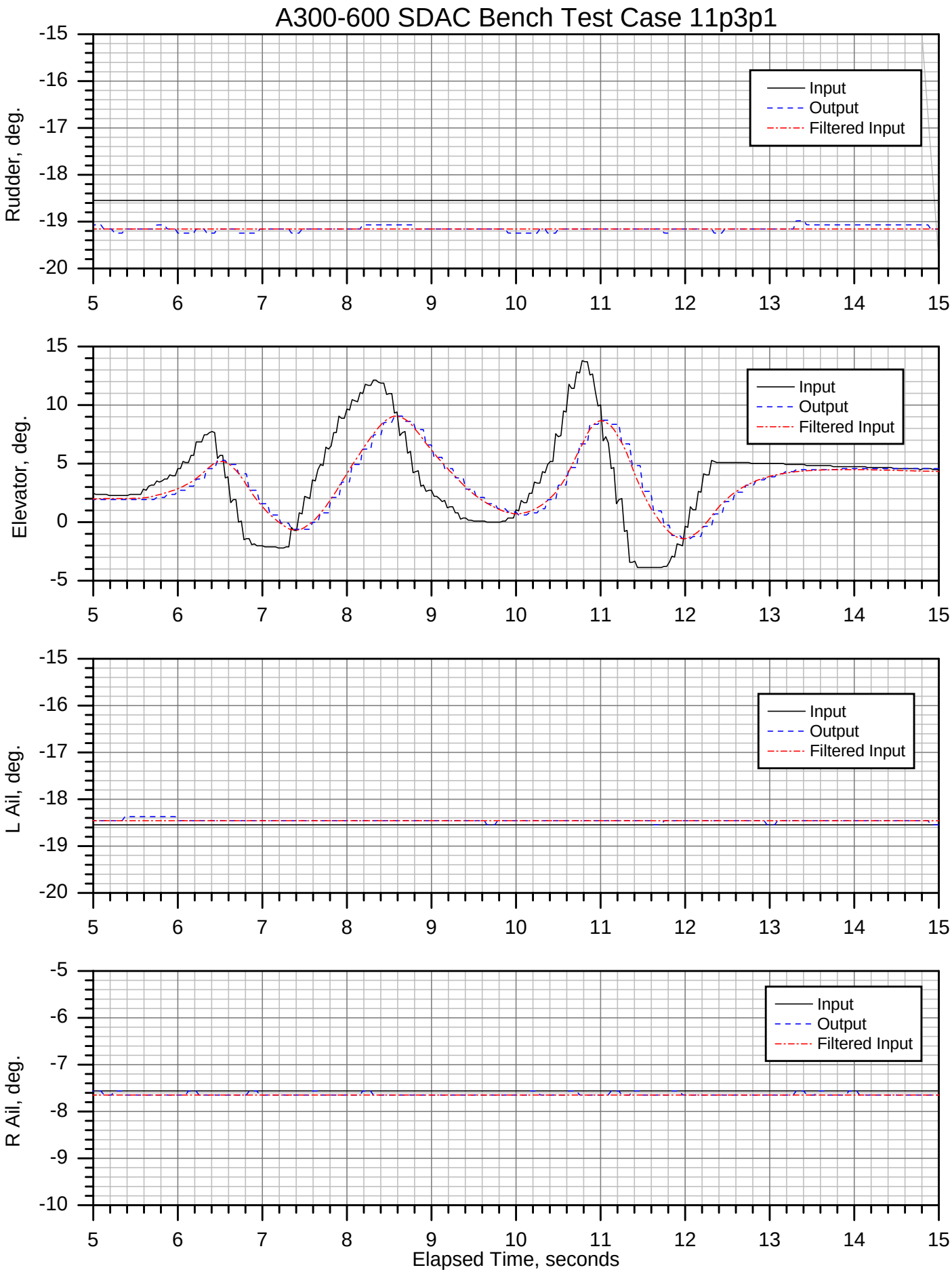
A300-600 SDAC Bench Test Case 11p1p1

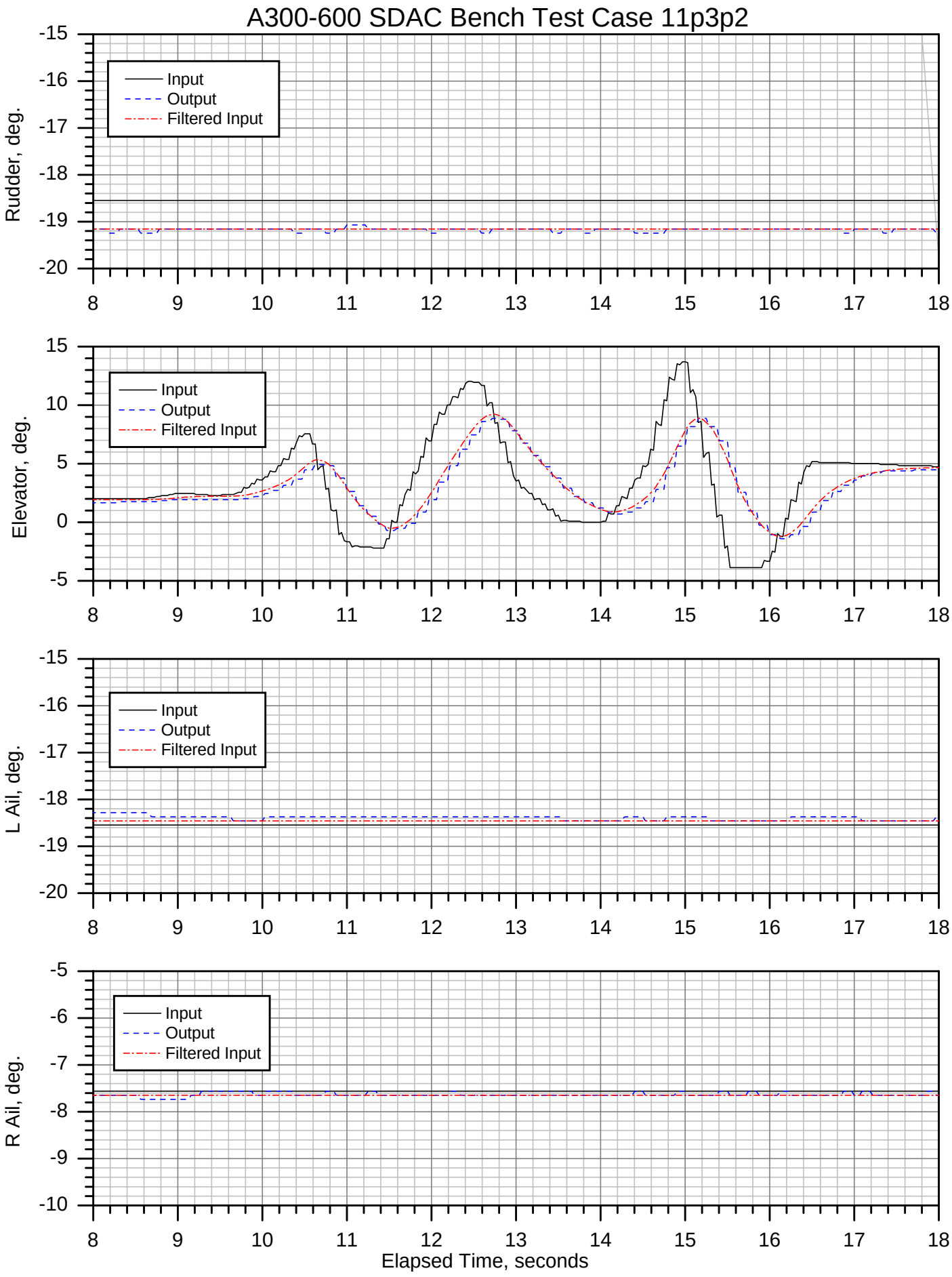



A300-600 SDAC Bench Test Case 11p1p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
10
5
0
-5
-10
3
4
5
6
7
8
9
10
11
12
13
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 11p2p1
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
20
10
0
-10
-20
4
5
6
7
8
9
10
11
12
13
14
Elapsed Time, seconds

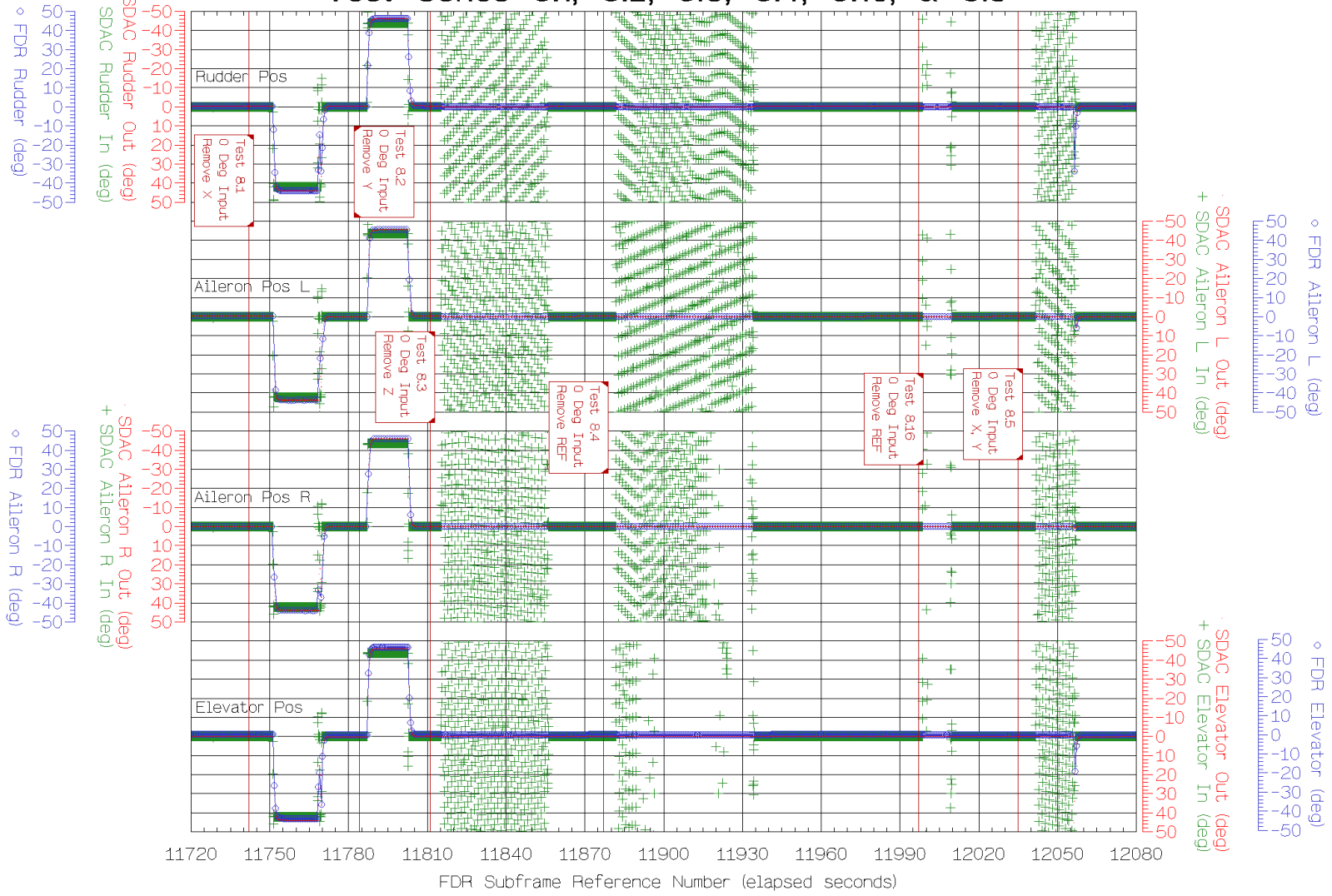

A300-600 SDAC Bench Test Case 11p2p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
20
10
0
-10
-20
8
9
10
11
12
13
14
15
16
17
18
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 11p3p1
Rudder, deg.
-15
-16
-17
-18
-19
-20
Input
Output
Filtered Input
Elevator, deg.
15
10
5
0
-5
L Ail, deg.
R Ail, deg.
-6
-7
-8
-9
-10
5
6
7
8
9
10
11
12
13
14
15
Elapsed Time, seconds


A300-600 SDAC Bench Test Case 11p3p2
Rudder, deg.
Elevator, deg.
L Ail, deg.
R Ail, deg.
Input
Output
Filtered Input
Elapsed Time, seconds

Attachment IV
NTSB's Plots of SDAC Bench Test Series 8, 9, and 10 (Removing Wires)

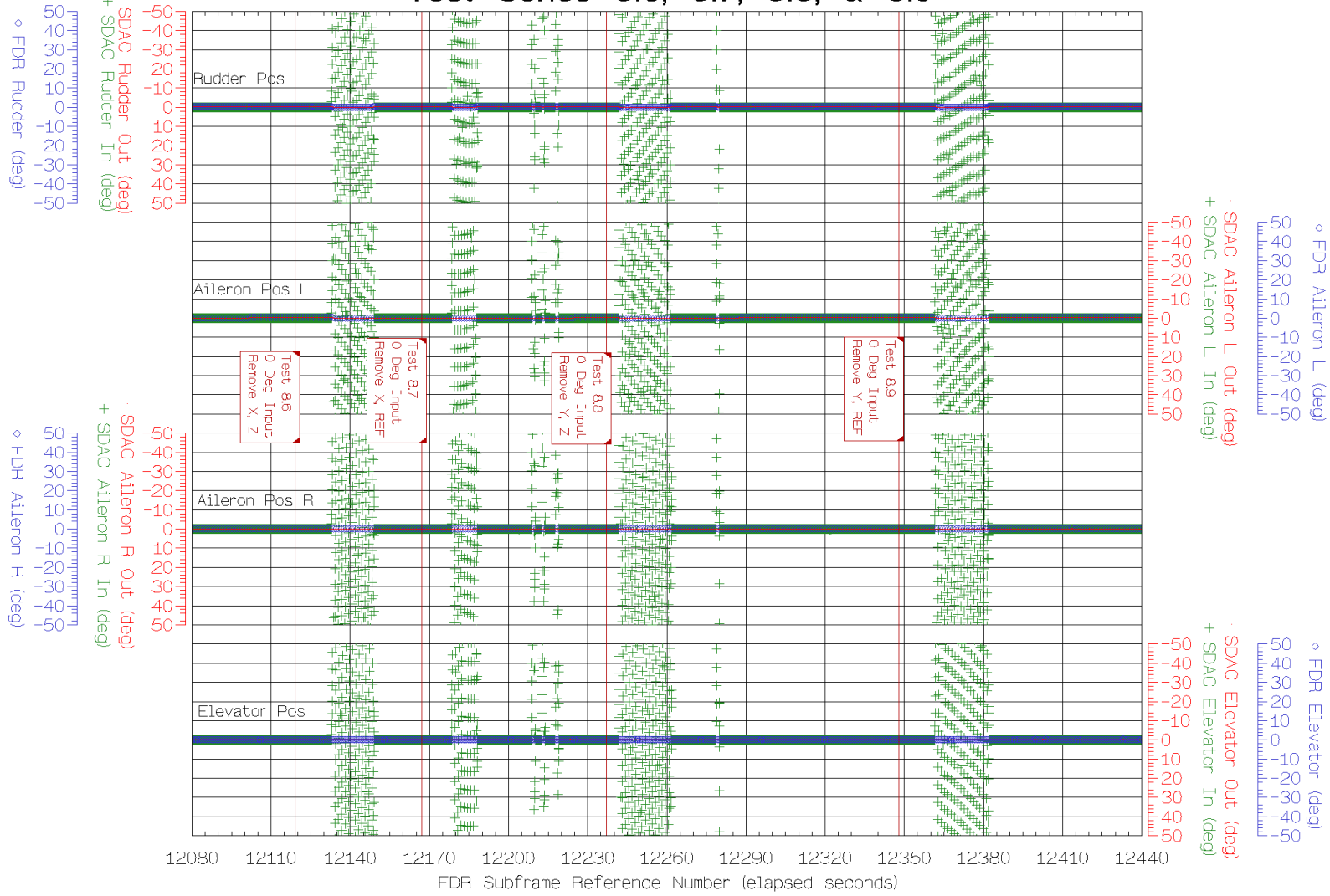
A300-600 SDAC Bench Test (Removing Wires)
Test Series 8.1, 8.2, 8.3, 8.4, 8.16, & 8.5



RemWires_1b.plt (Revised: August 18, 2003)

National Transportation Safety Board
NTSB # DCA02MA001

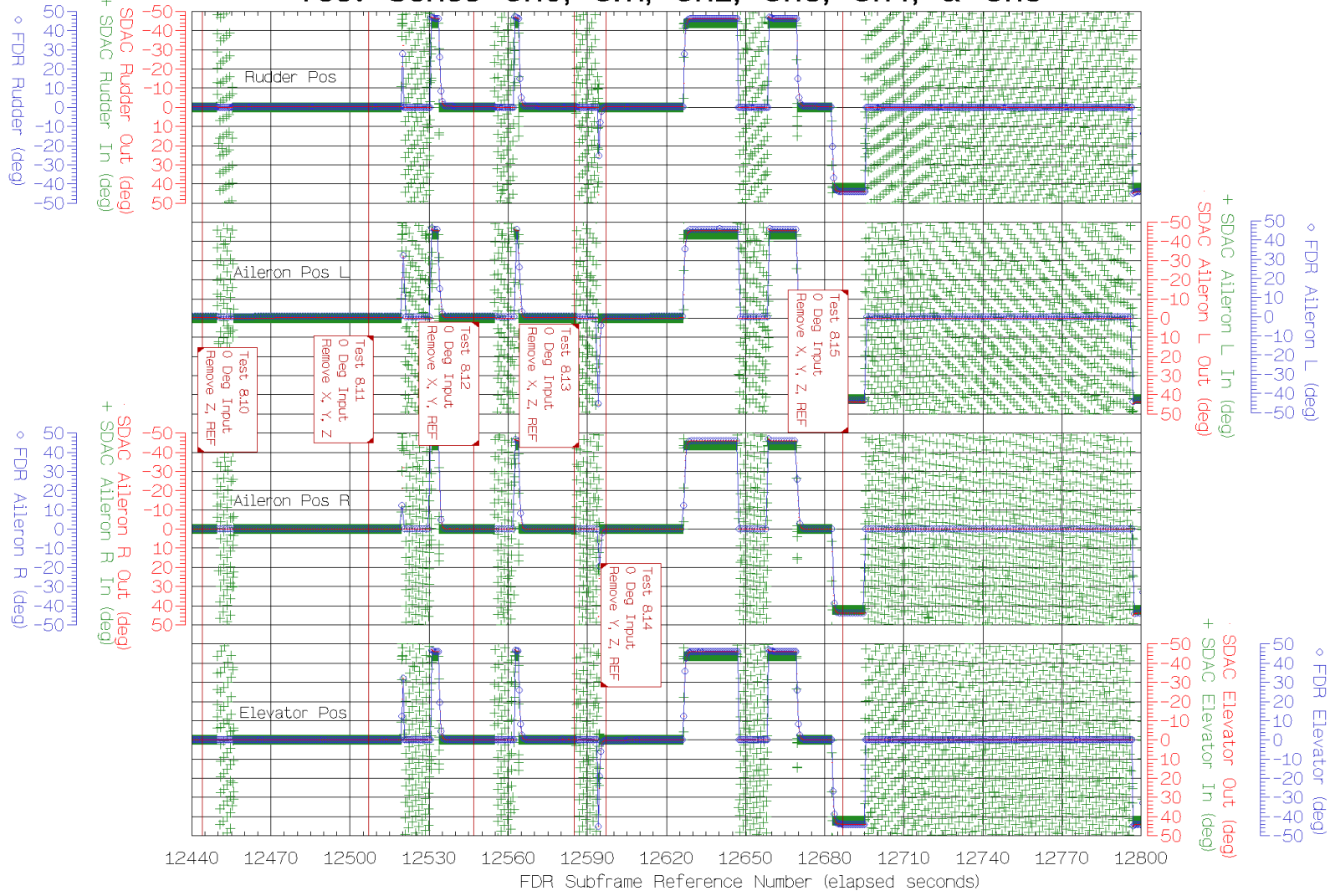
A300-600 SDAC Bench Test (Removing Wires)
Test Series 8.6, 8.7, 8.8, & 8.9



RemWires_2b.plt (Revised: August 18, 2003)

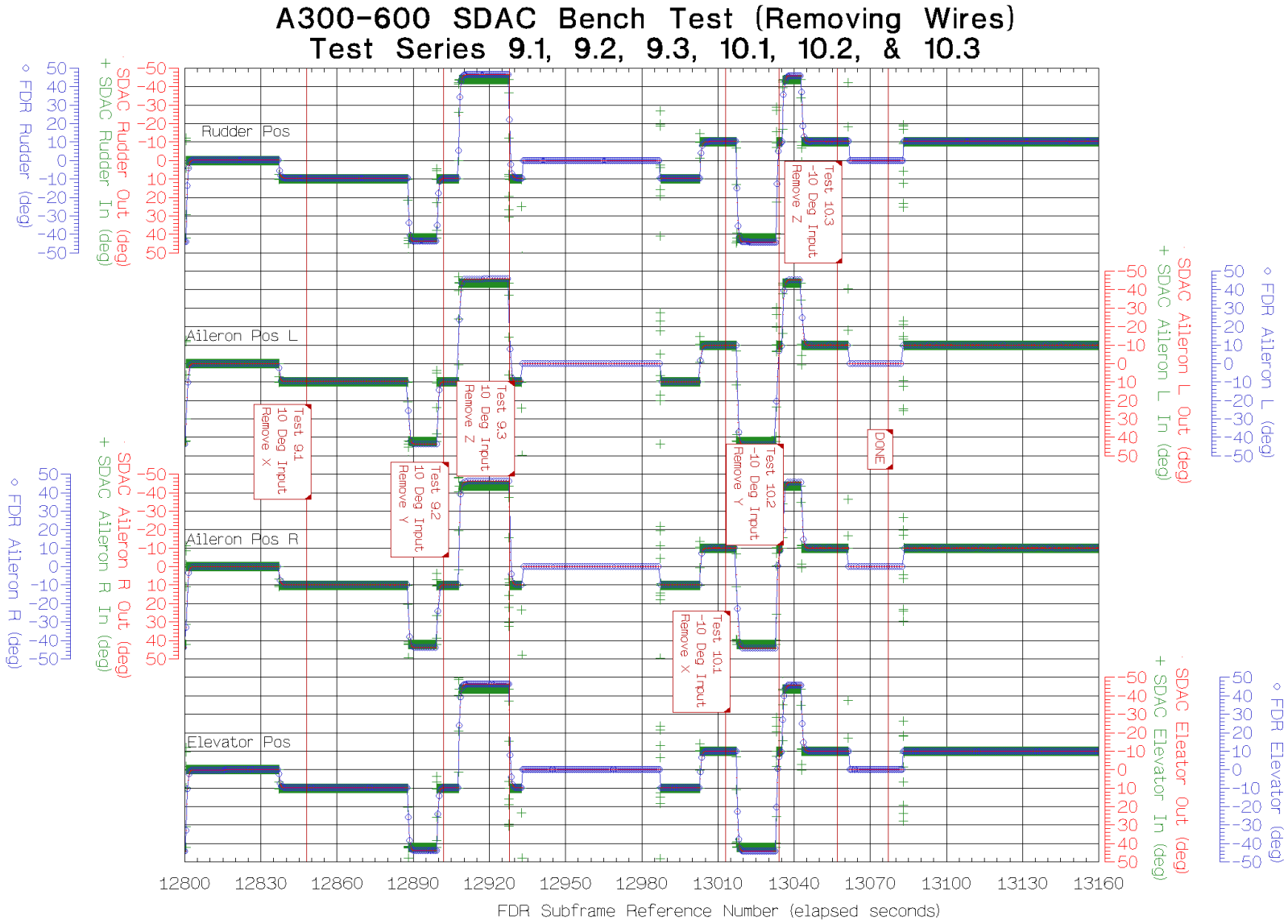
National Transportation Safety Board
NTSB # DCA02MA001

A300-600 SDAC Bench Test (Removing Wires)
Test Series 8.10, 8.11, 8.12, 8.13, 8.14, & 8.15



RemWires_3b.plt (Revised: August 18, 2003)

National Transportation Safety Board
NTSB # DCA02MA001



RemWires_4b.plt (Revised: August 18, 2003)

National Transportation Safety Board
NTSB # DCA02MA001

Attachment V
Airbus's SDAC Bench Test Report & Analysis
Airbus Document LD_0007/2002

AIRBUS
Integration Test Centre

DEPARTMENT : EYTXO DATE : 05/03/02
REFERENCE : LD__0007/02 ISSUE : 1.0

TEST REPORT & ANALYSIS

FDR bench test
SDAC identification

AIRCRAFT : - AIRCRAFT N°: VPRS :
TEST PROGRAM : ATA : 31
PROJECT : OF :

AUTHORS :
CHATILLON Laurent

SUMMARY :
This note aims at supplying the engineering data of the SDAC bench tests which were run in relation with the accident at JFK airport of A300-600 MSN 420. These runs were performed in Toulouse the 4th and the 5th of February 2002 with the NTSB, BEA, FAA, APA and AAL.

TN 761.0006/02 describes the SDAC bench test.
TN 517.0013/02 explains the test protocol proposal.

The purpose of these tests was to identify the SDAC behaviour and more precisely:
1. its filtering characterisation,
2. the F/CTL surfaces history reconstitution.
3. In addition, during the tests, the NTSB and the BEA asked for test series in order to simulate with respect to the loss of synchro signals.

On Friday the 8th of February, the raw data were read out and the engineering data were available on CD-ROMs which were given to the FDR group. Some plots were presented too.

This note presents :
1. the CD-ROM contents and organisation,
2. the plots of the recorded parameters.

KEY WORDS : /ACCIDENT/
LINKS : CONFIDENTIALITY : NP
CUSTOMER: CANCELS PREVIOUS ISSUES : N LANGUAGE : E

External document :
Reference : A-NTSB
Issue :
Date : 008177
Sender :

SIGNATURES
Y. LEBIANNIC

Number of sheets : 10 Annex : Total : 10

TEST REPORT & ANALYSIS

FDR bench test
SDAC identification

TEST REPORT & ANALYSIS

FDR bench test
SDAC identification

1. Introduction

This note presents the following topics:

1. the CD-ROM : its contents and its files and directories organisation
2. Some plots of the SDAC response for the whole tests

The tests aim is:

- For the test series n° 8, 9, 10 : SDAC response to different kinds of loss of synchro signals
- For the test series n° 1 to 7: SDAC filtering characterisation
  - Test series n°1 to 7: calibrated inputs
- For the test series n°11: a first estimation of the flight control surfaces movement of the A300-600 MSN 420

2. CD-ROM contents

2.1. Test description

The complete tests report is available in the CD-ROM in Cd/TEST_REPORT.xls.

The tests series from 1 to 7 are described in the TN 517.0013/02. They have been defined by the NTSB.

The whole tests series description is summed up in annex 1 too.

Note: Most of the inputs test have been run twice or three times to prevent a possible FTI or FDR record problem.

2.2. Raw data

The FDR raw data are available in the CD-ROM in Cd/DFDR raw data directory.

There are 3 files corresponding to:

- d9999v1009uaa6 : tests done on the 04/02 afternoon i.e. test n°2, 3 and 5 (c.f. ANNEX 1)
- d9999s0010uaa6 : test done on the 05/02 morning i.e. test n°1, 4, 6, 7, 8, 9, 10 (c.f. ANNEX 1)
- d9999s0011uaa6 : test done on the 05/02 afternoon i.e. test n°11 (c.f. ANNEX 1)

2.3. Engineering data

The whole engineering data are available in Cd/TEST DATA-ENG UNIT directory

2.3.1. Engineering data CD-ROM architecture

2.3.1.1. Directories structure

The Cd/TEST DATA-ENG UNIT directory is divided into 74 directories which corresponds to the 74 tests. The directories name convention is:

The directory called Test.X.Y corresponds to the test Y of the test series X.

2.3.1.2. Files structure

Each elementary directory (c.f. 2.3.1.1) contains two kinds of ASCII tab files:

- Files related with FTI records : their names are data_fti_X
- Files related with FDR records : their names are data_fdr_X

The files named data_fti_X and data_fdr_X correspond to the X^{th} run of the test

2.3.1.3. Example

The engineering data of the 2^{nd} run of the test 5.4 of the fifth test series are available in:

1. For the parameters recorded by the FTI: Cd/TEST DATA-ENG UNIT/Test.5.4/data_fti_2
2. For the parameters recorded by the FDAU: Cd/TEST DATA-ENG UNIT/Test.5.4/data_fdr_2

2.3.2. Engineering data description

For each test, the following data are available (c.f. TN 513-0013/02):

- The rudder, LH aileron, RH aileron and the elevator position inputs and outputs of the SDAC recorded by the FTI
- The rudder, LH aileron, RH aileron and the elevator position outputs of the SDAC recorded by the FDAU
- The bench test clock recorded by the FTI (3 recorded parameters Hour, Minute, second)

This table sums up the parameters one can find in a **data_fti** file (i.e. recorded by the FTI) :

Parameter name	Definition
GMT	FTI clock
GMT MS	GMT converted in milliseconds
HRS	Bench test clock hours
MIN	Bench test clock minutes
SEC	Bench test clock seconds
AILROUT	Right Hand Aileron position SDAC output recorded by the FTI
AILRIN	Right Hand Aileron position SDAC input recorded by the FTI
AILLOUT	Left Hand Aileron position SDAC output recorded by the FTI
AILLIN	Left Hand Aileron position SDAC input recorded by the FTI
RUDDOUT	Rudder position SDAC output recorded by the FTI
RUDDIN	Rudder position SDAC input recorded by the FTI
ELEVOUT	Elevator position SDAC output recorded by the FTI
ELEVIN	Elevator position SDAC input recorded by the FTI

This table sums up the parameters one can find in a **data_fdr** file (i.e. recorded by the FDAU) :

Parameter name	Definition
GMT	FDR GMT supplied by the bench test clock
GMT MS	GMT converted in milliseconds
AILR	Right Hand Aileron position recorded by the FDAU
AILL	Left Hand Aileron position recorded by the FDAU
ELVR	Elevator position recorded by the FDAU
RUDD	Rudder position recorded by the FDAU

To be noted: in both data_fti and data_fdr files, the time step value is always 31.25 ms to make easier the FTI and FDR data comparison using EXCEL. Nevertheless, for the data which sampling period is greater than 31.25 ms, the following convention is used :

The last acquired data value is repeated until it is refreshed (because the files generator tool cannot creates empty cells).

3. Plots

3.1. SDAC filtering characterisation

In ANNEX 3, for each test (of a test series), one can find the following plots:

1. A general plot related with **one** of the several runs of the test: the four F/CTL surfaces parameters are plotted. For these plots the time scale is always the same:
   - for aperiodic inputs (test series n°1, 2, 3, 4, 8, 9, 10): 2 s/8 mm
   - for periodic inputs (test series n°5, 6, 7, 11): 5 s/8 mm
2. A zoom on one F/CTL surface parameters (usually the Right aileron one) for the same run. When it could be useful (for high frequency periodic inputs as 5.7, 6.7, 7.7 and 7.8 Test), several zooms were plotted to :
   - Minimise sampling rate influence,
   - Have a adequate time scale.

3.2. Loss of synchro signals

3.2.1. Tests results

In ANNEX 4, for each wire disconnection test series, one can find the following plots:

1. A zoom on the Status matrix of the whole F/CTL surfaces position which is recorded by the FTI
2. A zoom on one F/CTL surface (usually the Right aileron one) recorded by the FTI
3. A zoom on one F/CTL surface (usually the Right aileron one) recorded by the FDAU

TEST REPORT & ANALYSIS

FDR bench test
SDAC identification

The next table sums up the SDAC outputs behaviour for the whole wires disconnection tests:

Test	Synchro input value	Disconnected wires	SDAC inputs range(*)	SDAC outputs	
				Status Matrix (**)	value
8.1	0°	X	42°	NO	44°
9.1	10°	X	42°	NO	44°
10.1	-10°	X	42°	NO	44°
8.2	0°	Y	-44°	NO	-46°
9.2	10°	Y	-44°	NO	-46°
10.2	-10°	Y	-44°	NO	-46°
8.3	0°	Z	[-180° 180°]	NCD	0°
9.3	10°	Z	88°	NCD	0°
10.3	-10°	Z	-92°	NCD	0°
8.4	0°	REF	[-180° 180°]	NCD	0°
8.16	0°	REF	[-180° 180°]	NCD	0°
8.5	0°	X and Y	[-180° 180°]	NCD	0°
8.6	0°	X and Y	[-180° 180°]	NCD	0°
8.7	0°	X and REF	[-180° 180°]	NCD	0°
8.8	0°	Y and Z	[-180° 180°]	NCD	0°
8.9	0°	Y and REF	[-180° 180°]	NCD	0°
8.10	0°	Z and REF	[-180° 180°]	NCD	0°
8.11	0°	X, Y and Z	[-180° 180°]	NCD	0°
8.12	0°	X, Y and REF	[-180° 180°]	NCD	0°
8.13	0°	X, Z and REF	[-180° 180°]	NCD	0°
8.14	0°	X, Z and REF	[-180° 180°]	NCD	0°
8.15	0°	X, Y, Z and REF	[-180° 180°]	NCD	0°

(*) : the SDAC inputs the FTI records are provided by the synchro analogic signals thank to a Analogic Numerical Converter (ANC). As a consequence, the recorded SDAC inputs behaviour correspond to the wire disconnection response of the ANC which is not necessary the SDAC one.

(**) : NO = Normal Operation

NCD = Not Computed Data

A-NTSB

008183

3.2.2. Comments

For the disconnection of the X or Y input wire (one among both) : the recorded SDAC input is erroneous but constant. The SDAC response seems to be identical to a step input (45° when X wire is disconnected and –45° when Y is) since the SDAC outputs status matrix is still Normal Operation and the outputs value is close to 45° (for X wire disconnection) and –45° (for Y wire disconnection).

For the Z one : the SDAC outputs become Not Computed Data (NCD) and their value is 0°.

Since at least 2 input wires are disconnected, the SDAC delivers as an output a 0° value with a NCD status.

ATTACHMENT

ANNEX 1:
Tests description

ANNEX 1.1:
Tests definition

	Inputs type	Parametric value
Tests series n°1	step	Magnitude
Tests series n°2	ramp	Slope
Tests series n°3	Double ramp	Slope
Tests series n°4	Square impulse	Period
Tests series n°5	Saw tooth wave	Period
Tests series n°6	Square wave	Period
Tests series n°7	Sine wave	Period
Tests series n°11	First FCTL surfaces movement estimation	None
Tests series n°8	Wires disconnection	None
Tests series n°9	Wires disconnection	None
Tests series n°10	Wires disconnection	None
Tests series n°11	F/CTL surfaces engineering estimation	None

ANNEX 1.2:
Tests LOG

	A9999	BENCH TEST	DATE: 4/02/02
GMT	TEST		
13.45.30	FDR ON		
13.46.00	IEV ON		
	TEST SERIE N°2		
13,50,05	TEST 2.1		
13,51,20	TEST 2.1 (BIS)		
13,53,35	TEST 2.1 (TER)		
14.00.23	TEST 2.2		
14.01.20	TEST 2.2 (BIS)		
14.03.25	TEST 2.3		
14.04.09	TEST 2.3 (BIS)		
14.06.31	TEST 2.4		
14.07.11	TEST 2.4 (BIS)		
14.08.17	TEST 2.5		
14.09.32	TEST 2.5 (BIS)		
14.11.09	TEST 2.6		
14.11.46	TEST 2.6		
14.12.51	TEST 2.7 (BIS)		
14.13.27	TEST 2.7 (BIS)		
	TEST SERIE N°3		
14.23.24	TEST 3.1		
14.24.16	TEST 3.1 (BIS)		
14.26.27	TEST 3.2		
14.27.24	TEST 3.2 (BIS)		
14.28.55	TEST 3.3		
14.29.39	TEST 3.3 (BIS)		
14.31.34	TEST 3.4		
14.32.12	TEST 3.4		
14.33.22	TEST 3.5		
14.33.57	TEST 3.5		
14.35.00	TEST 3.6		
14.35.35	TEST 3.6		
14.36.11	TEST 3.6		
14.37.15	TEST 3.7		
14.37.55	TEST 3.7		
14.38.29	TEST 3.7		
	TEST SERIE N° 5		
14.45.33	TEST 5.1		
14.47.11	TEST 5.1		
14.52.17	TEST 5.2		
14.53.12	TEST 5.2		
14.56.28	TEST 5.3		
14.57.07	TEST 5.3		
15.01.42	TEST 5.4		
15.02.24	TEST 5.4		
15.03.17	TEST 5.4		
15.06.31	TEST 5.5		
15.07.10	TEST 5.5		
15.09.59	TEST 5.6		
15.10.52	TEST 5.6		
15.14.22	TEST 5.7		
15.14.22	TEST 5.7		
15.15.56	TEST 5.7		
15.26.00	IEV OFF		
15.30.00	DFDR OFF		

	A9999	BENCH TEST	DATE: 5/02/02
GMT			
08.41.00	IEV ON		
08.41.30	FDR ON		
	TEST SERIE N°1		
08.45.13	TEST 1.1		
08.46.58	TEST 1.1		
08.48.06	TEST 1.2		
08.49.20	TEST 1.2		
08.50.23	TEST 1.3		
08.51.22	TEST 1.3		
08.53.00	TEST 1.4		
08.53.51	TEST 1.4		
08.55.05	TEST 1.5		
08.56.03	TEST 1.5		
08.56.57	TEST 1.6		
08.57.54	TEST 1.6		
	TEST SERIE N°4		
08.59.14	TEST 4.1		
09.06.19	TEST 4.1		
09.09.11	TEST 4.2		
09.10.30	TEST 4.2		
09.11.30	TEST 4.3		
09.12.26	TEST 4.3		
09.13.51	TEST 4.4		
09.14.54	TEST 4.4		
09.16.01	TEST 4.5		
09.16.50	TEST 4.5		
09.18.34	TEST 4.6		
09.22.07	TEST 4.6		
09.22.35	TEST 4.7		
09.23.20	TEST 4.7		
09.23.55	TEST 4.7		
	TEST SERIE N°6		
09.24.42	TEST 6.1		
09.26.30	TEST 6.1		
09.28.21	TEST 6.2		
09.30.08	TEST 6.2		
09.31.31	TEST 6.3		
09.32.27	TEST 6.3		
09.34.41	TEST 6.4		
09.36.21	TEST 6.4		
09.37.37	TEST 6.5		
09.38.17	TEST 6.5		
09.40.04	TEST 6.6		
09.41.13	TEST 6.6		
09.41.59	TEST 6.7		
09.43.10	TEST 6.7		
09.44.22	TEST 6.7		

	A9999	BENCH TEST	DATE: 5/02/02
GMT	TEST		
	TEST SERIE N°7		
09.45.26	TEST 7.1		
09.47.10	TEST 7.1		
09.50.42	TEST 7.2		
09.52.31	TEST 7.2		
09.54.16	TEST 7.3		
09.55.17	TEST 7.3		
09.56.47	TEST 7.4		
09.57.56	TEST 7.4		
10.01.50	TEST 7.5		
10.02.42	TEST 7.5		
10.03,37	TEST 7.6		
10.04,44	TEST 7.6		
10,05,56	TEST 7.7		
10,07,16	TEST 7.7		
10,09,53	TEST 7.8		
10,18,20	TEST 7.8		
10,20,28	TEST 7.7		
10,24,04	TEST 7.8		
10,26,19	TEST 7.8		
	TEST SERIE N°8		
	-REMOVING WIRES 0° SYNCHRO INPUT-		
10.31.45	TEST 8.1 X RESOLVER ANGLE INDICATION=44°		
10.32.27	TEST 8.2 Y RESOLVER ANGLE INDICATION=-46°		
10.32.54	TEST 8.3 Z RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.34.00	TEST 8.4 ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.36.00	TEST 8.16 ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.36.38	TEST 8.5 XY RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.38.02	TEST 8.6 XY RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.38.50	TEST 8.7 X. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.40.00	TEST 8.8 Y.Z RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.41.51	TEST 8.9 Y. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.43.27	TEST 8.10 Z ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.44.30	TEST 8.11 X.Y.Z RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.45.10	TEST 8.12 X.Y. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.45.48	TEST 8.13 X.Z. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.46.00	TEST 8.14 X.Z. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
10.47.30	TEST 8.15 X.Y.Z. ref RESOLVER ANGLE INDICATION=none and SDAC OUTPUT=NCD		
	TEST SERIE N°9		
	-REMOVING WIRES 10° SYNCHRO INPUT-		
10.50.11	TEST 9.1 X RESOLVER ANGLE INDICATION=43,77°		
10.51.05	TEST 9.2 Y RESOLVER ANGLE INDICATION=-46,67°		
10.51.31	TEST 9.3 Z RESOLVER ANGLE INDICATION=88,66° and SDAC OUTPUT=NCD		
	TEST SERIE N°10		
	- REMOVING WIRES -10° SYNCHRO INPUT-		
10.52.56	TEST 10.1 X RESOLVER ANGLE INDICATION=44,12°		
10.53.17	TEST 10.2 Y RESOLVER ANGLE INDICATION=-45,96°		
10.53.40	TEST 10.3 Z RESOLVER ANGLE INDICATION=267,85° and SDAC OUTPUT=NCD		
10.54.00	DONE		
11.06.00	FTI OFF		
11.06.20	FDR OFF (clock go + accident ask off) SYNCHRO RESOLVER ANGLE INDICATOR		

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	A9999	BENCH TEST	DATE: 5/02/02
GMT	TEST		
14.20.30	FTI ON		
14.20.45	FDR ON		
14.24.52	TEST 11.1 : 1st RUDDER INPUT ENGINEERING ESTIMATION		
14.25.33	TEST 11.1 : 1st RUDDER INPUT ENGINEERING ESTIMATION		
14.38.21	TEST 11.2 : 1st LEFT AILERON INPUT ENGINEERING ESTIMATION		
14.39.24	TEST 11.2 : 1st LEFT AILERON INPUT ENGINEERING ESTIMATION		
14.53.36	TEST 11.3 : 1st ELEVATOR INPUT ENGINEERING ESTIMATION		
14.54.24	TEST 11.3 : 1st ELEVATOR INPUT ENGINEERING ESTIMATION		
14.56.30	FTI OFF		
14.57.12	FDR OFF		

ANNEX 2:
Parameters definition

FTI Parameters

Parameter	Definition	Resolution	SPS
GMT	FTI clock		
HRS	Bench test clock hours		8
MIN	Bench test clock minutes		8
SEC	Bench test clock seconds		8
AILROUT	Right Hand Aileron position SDAC output recorded by the FTI	0,088 °	32
AILRIN	Right Hand Aileron position SDAC input recorded by the FTI	0,088 °	32
AILLOUT	Left Hand Aileron position SDAC output recorded by the FTI	0,088 °	32
AILLIN	Left Hand Aileron position SDAC input recorded by the FTI	0,088 °	32
RUDDOUT	Rudder position SDAC output recorded by the FTI	0,088 °	32
RUDDIN	Rudder position SDAC input recorded by the FTI	0,088 °	32
ELEVOUT	Elevator position SDAC output recorded by the FTI	0,088 °	32
ELEVIN	Elevator position SDAC input recorded by the FTI	0,088 °	32
AILRSSM	Right Hand Aileron position SDAC output status matrix		32
AILLSSM	Left Hand Aileron position SDAC output status matrix		32
RUDDSSM	Rudder position SDAC output status matrix		32
ELEVSSM	Elevator position SDAC output status matrix		32

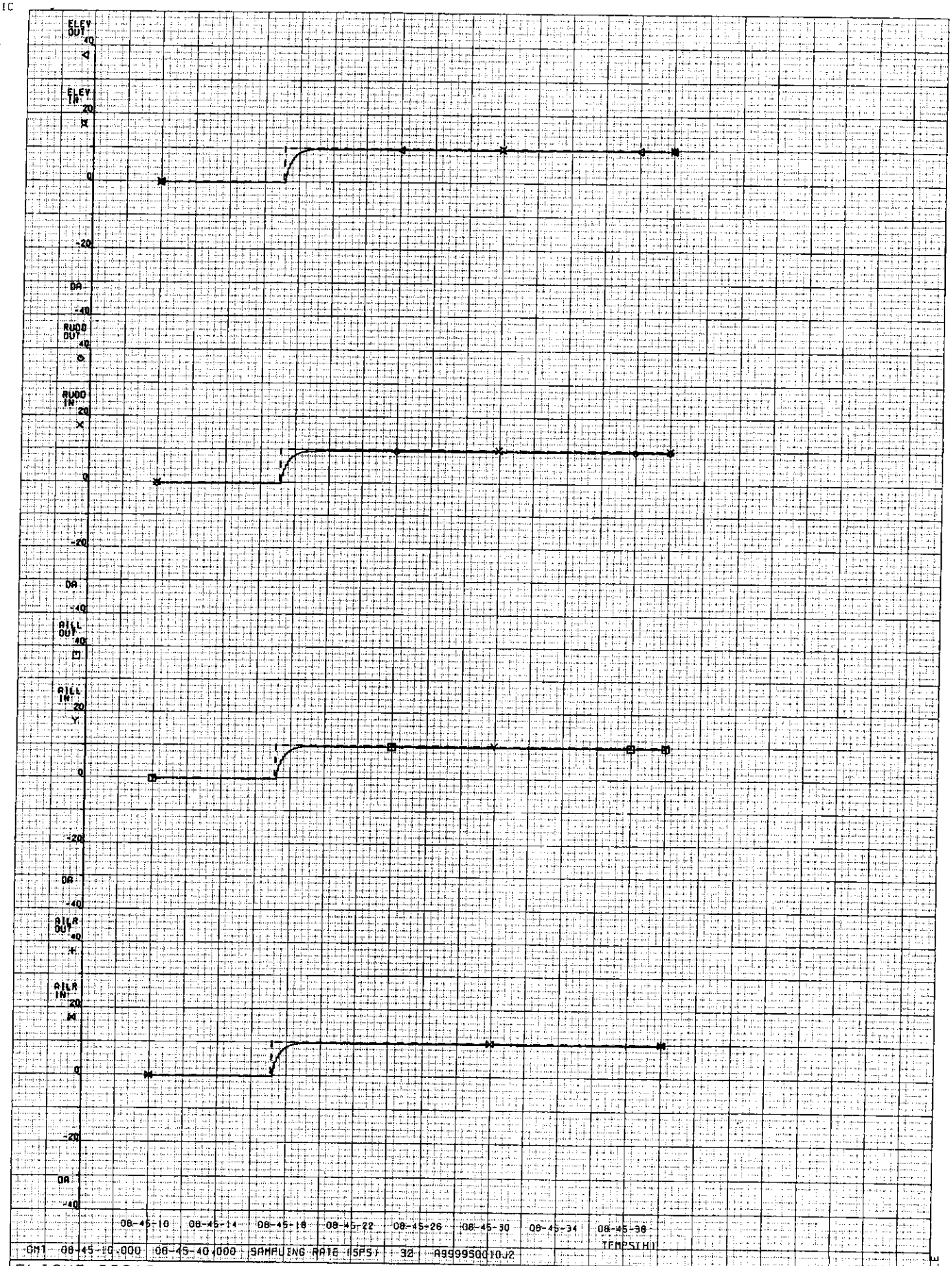
FDR Parameters

Parameter	Definition	Resolution	SPS
GMT	FDR GMT supplied by the bench test clock		
AILR	Right Hand Aileron position recorded by the FDAU	0.088 °	1
AILL	Left Hand Aileron position recorded by the FDAU	0.088 °	1
ELVR	Elevator position recorded by the FDAU	0.088 °	2
RUDD	Rudder position recorded by the FDAU	0.088 °	2

ANNEX 3:
SDAC filtering characterisation Plots

ANNEX 3.1:
Test series n°1

AVIC



FLIGHT S0010 TEST 1.1 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

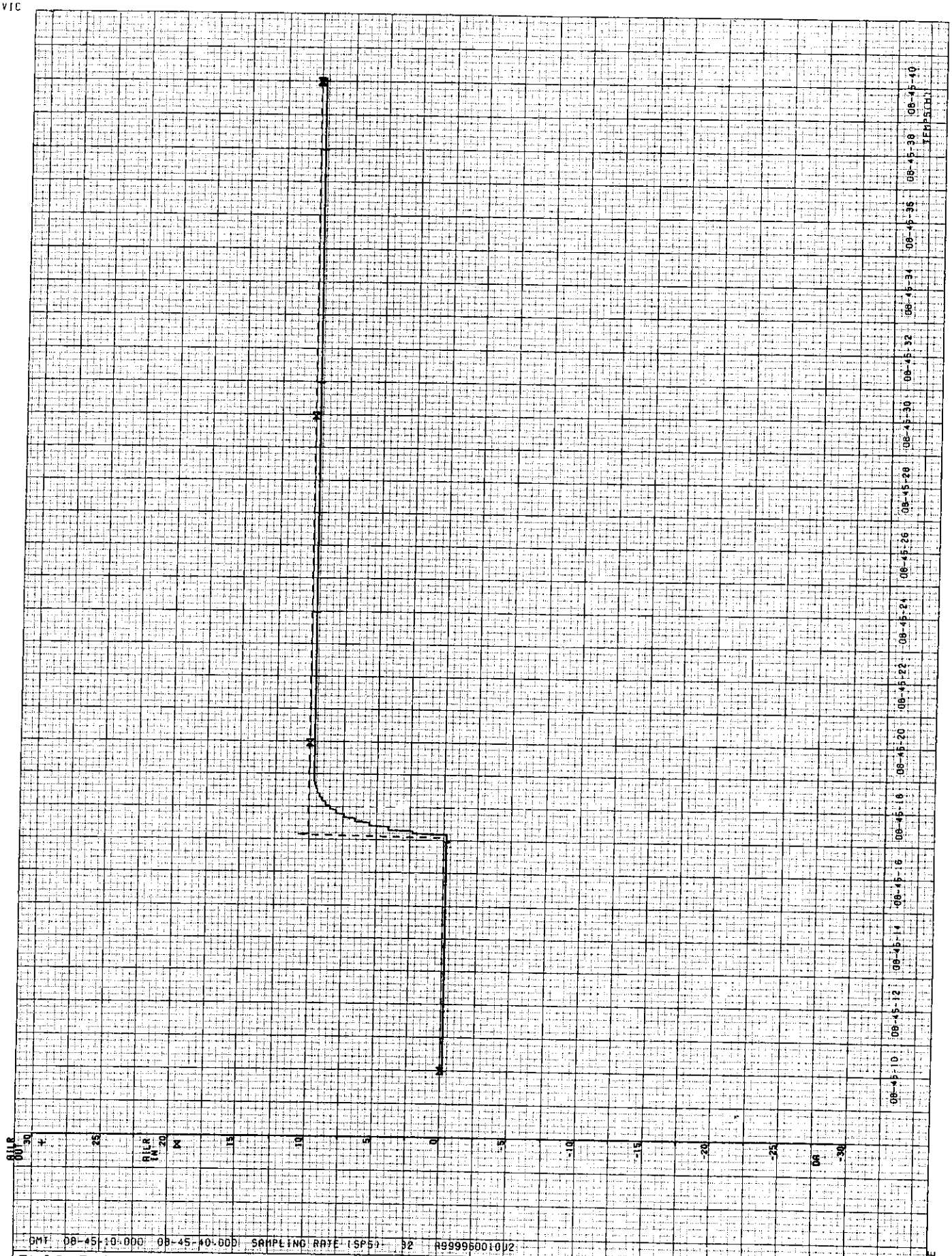
AIRCRAFT A9999 FIGURE 3.1.1

(C) AEROSPATIALE

005.1 SERIE/SOACAAL.AD

008196

AVIC



FLIGHT S0010 TEST 1.1 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3.1.2

(C) AEROSPATIALE

310.1 SERIE/SDACAAL.AD

008197

FLIGHT S0010

TEST 1.1 FTI

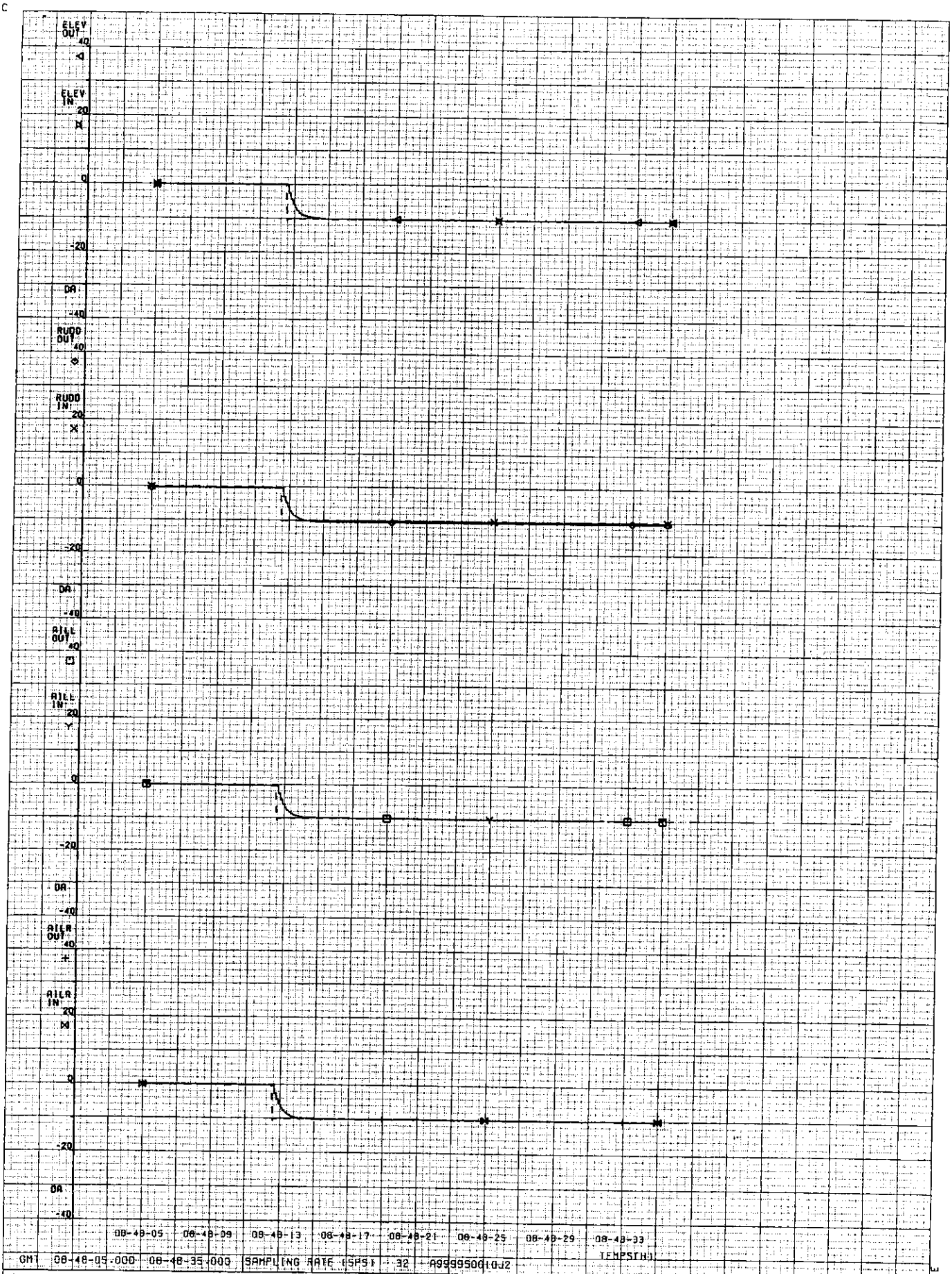
A-NTSB

098198

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 3.13

AVIC



FLIGHT S0010 TEST 1.2 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

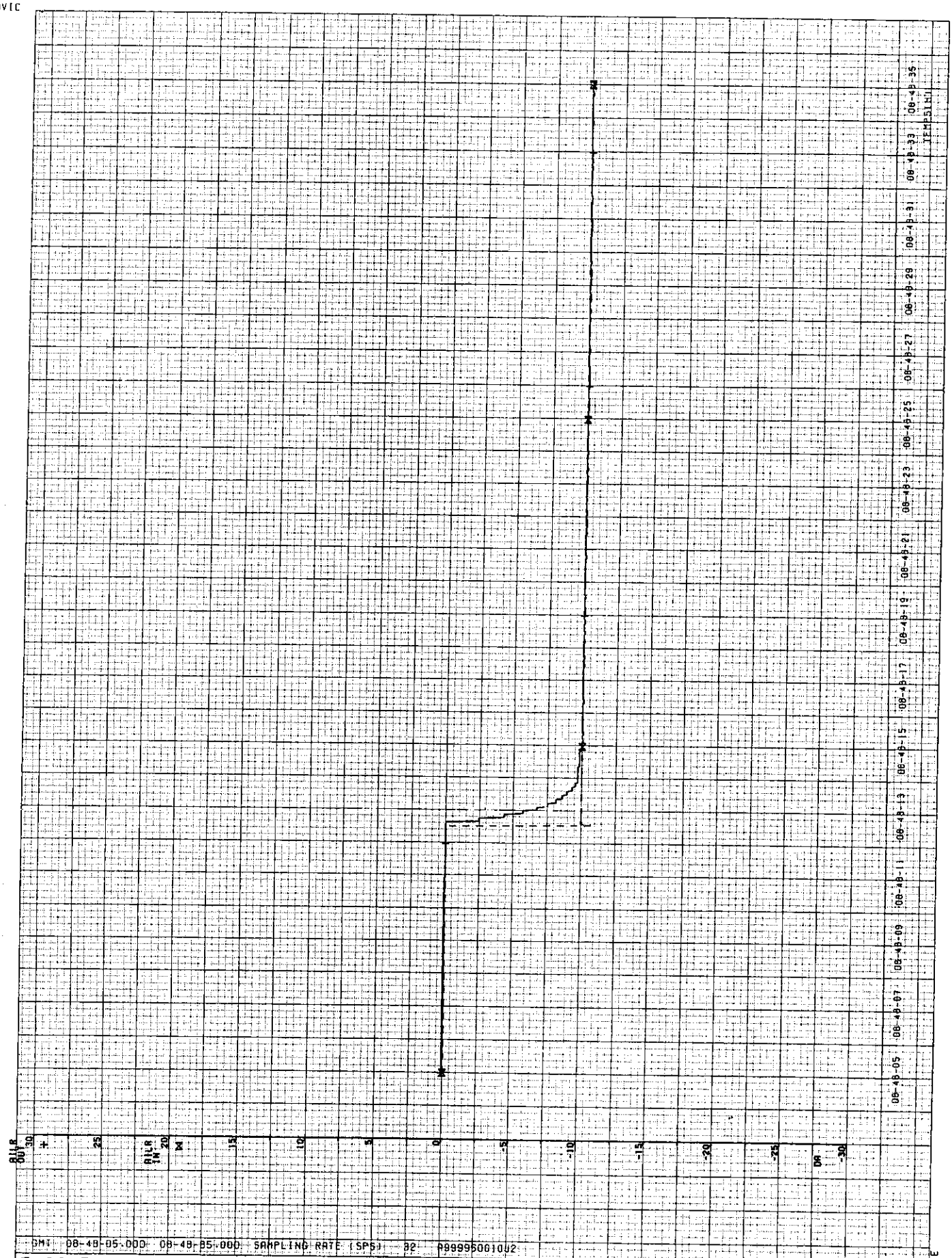
AIRCRAFT A9999 FIGURE 3.1.4

(C) AEROSPATIALE

005.1 SERIE/SOACAAL.AB

008199

AVIC



GMT 08-48-05.000 08-48-85.000 SAMPLING RATE (SPS) 32 A89996001002

FLIGHT S0010 TEST 1.2 FIRST TRY FTI

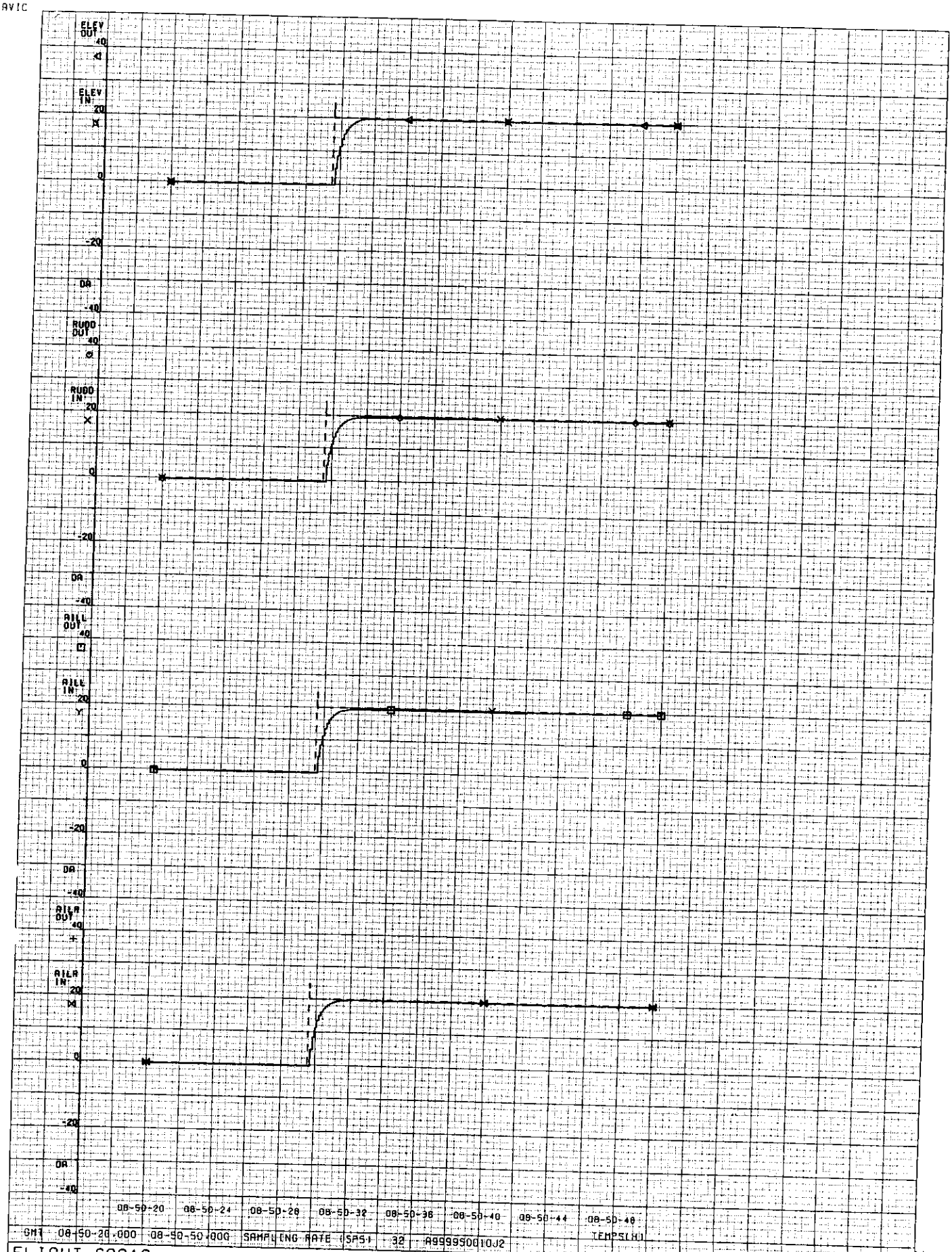
A-NTSB

008260

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.5

SERIE/SDACAAL.AD



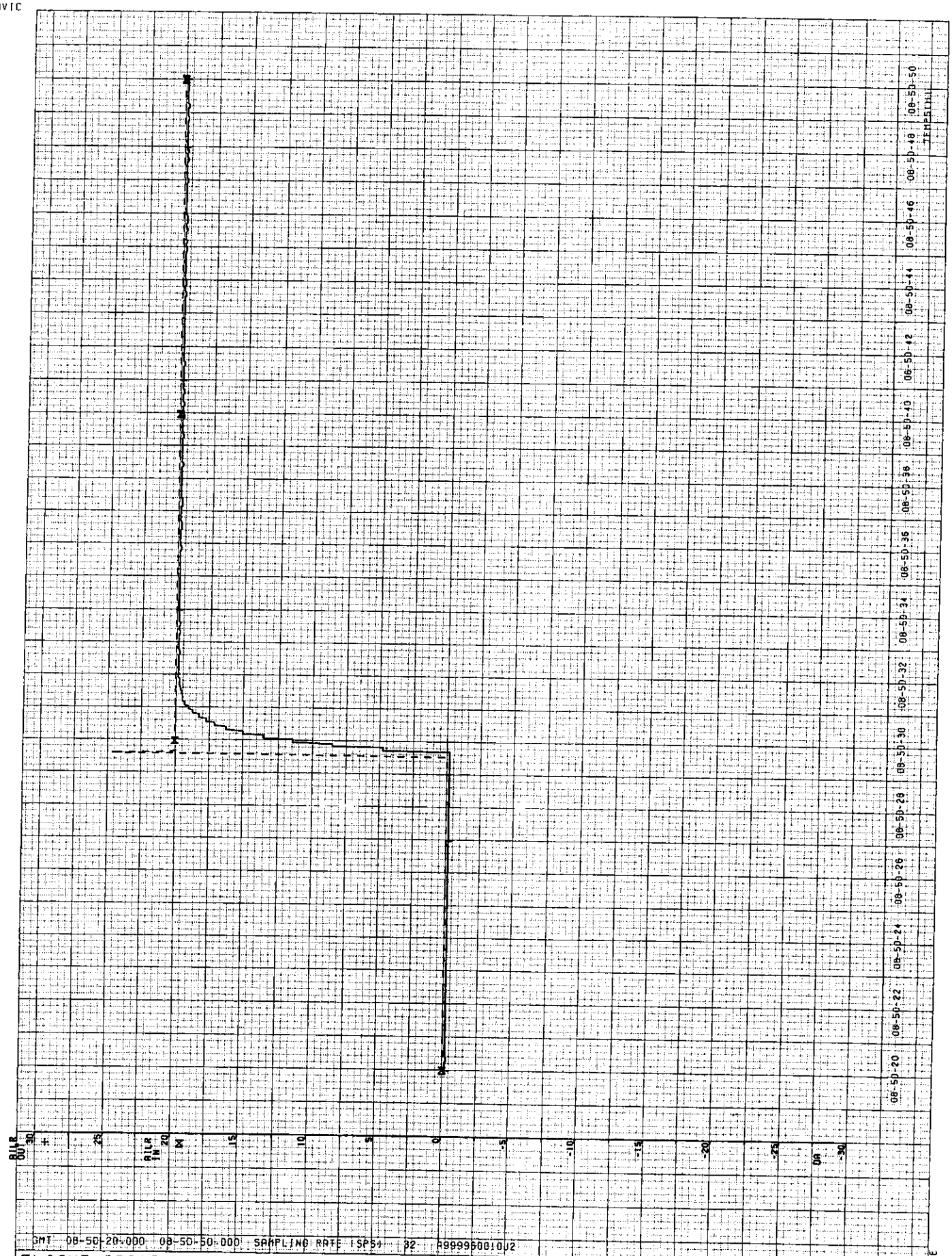
FLIGHT S0010 TEST 1.3 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.6

AVIC



FLIGHT S0010 TEST 1.3 FIRST TRY FTI

A-NTSE

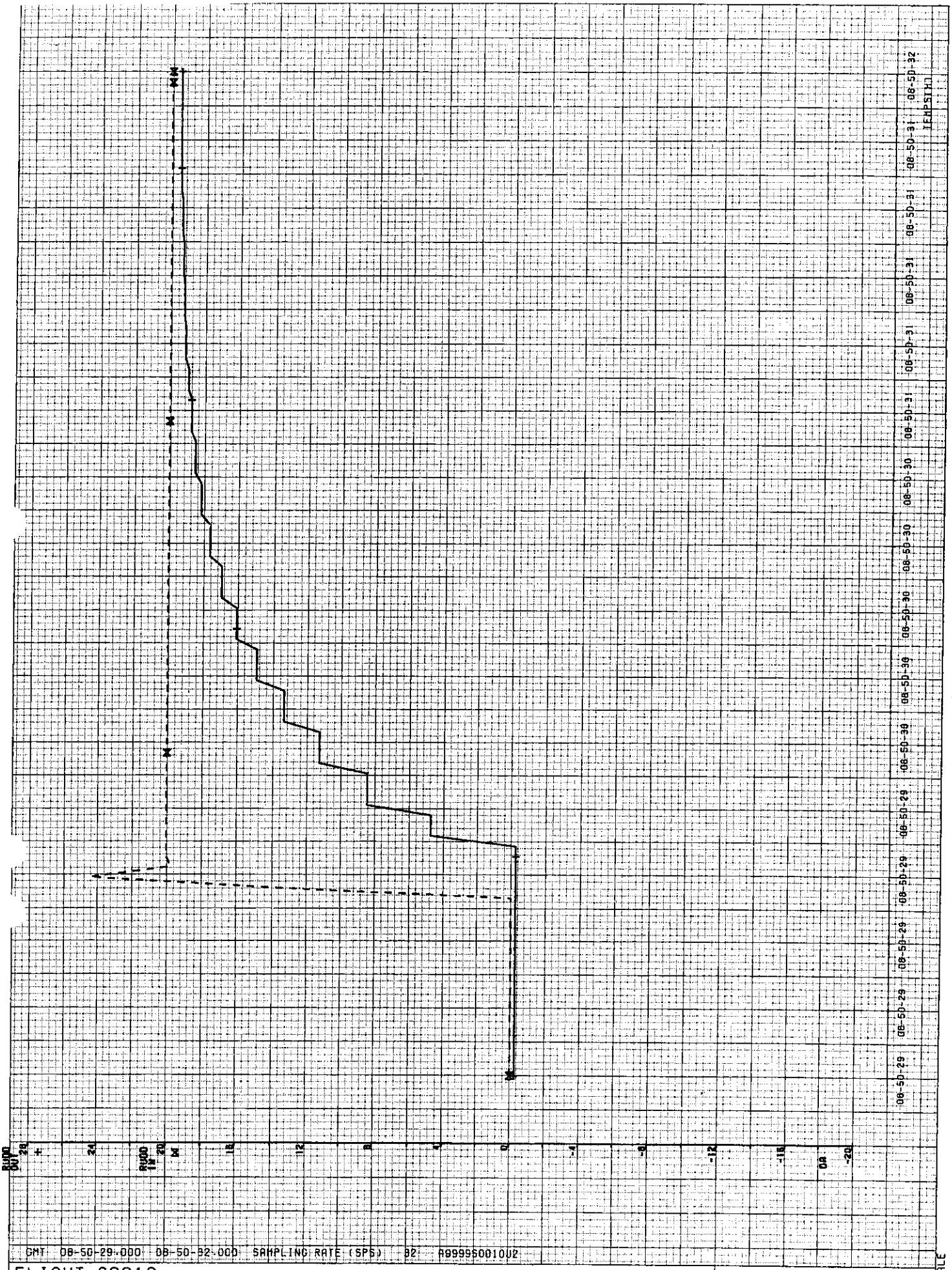
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.7

(C) AEROSPATIALE

310.1 SERIE/SOACAAL.AO

098202



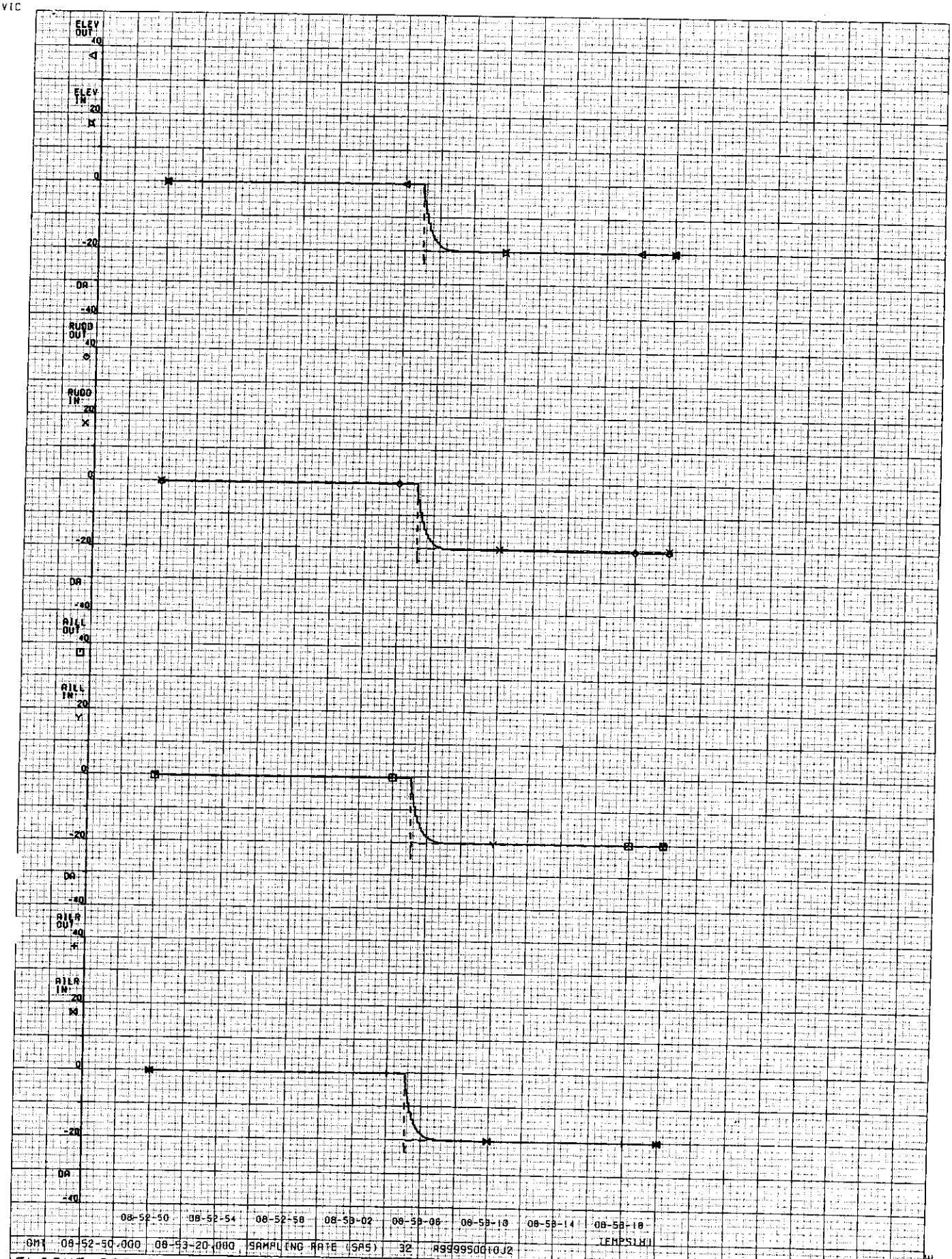
FLIGHT S0010

TEST 1.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.18



FLIGHT S0010 TEST 1.4 FIRST TRY FTI

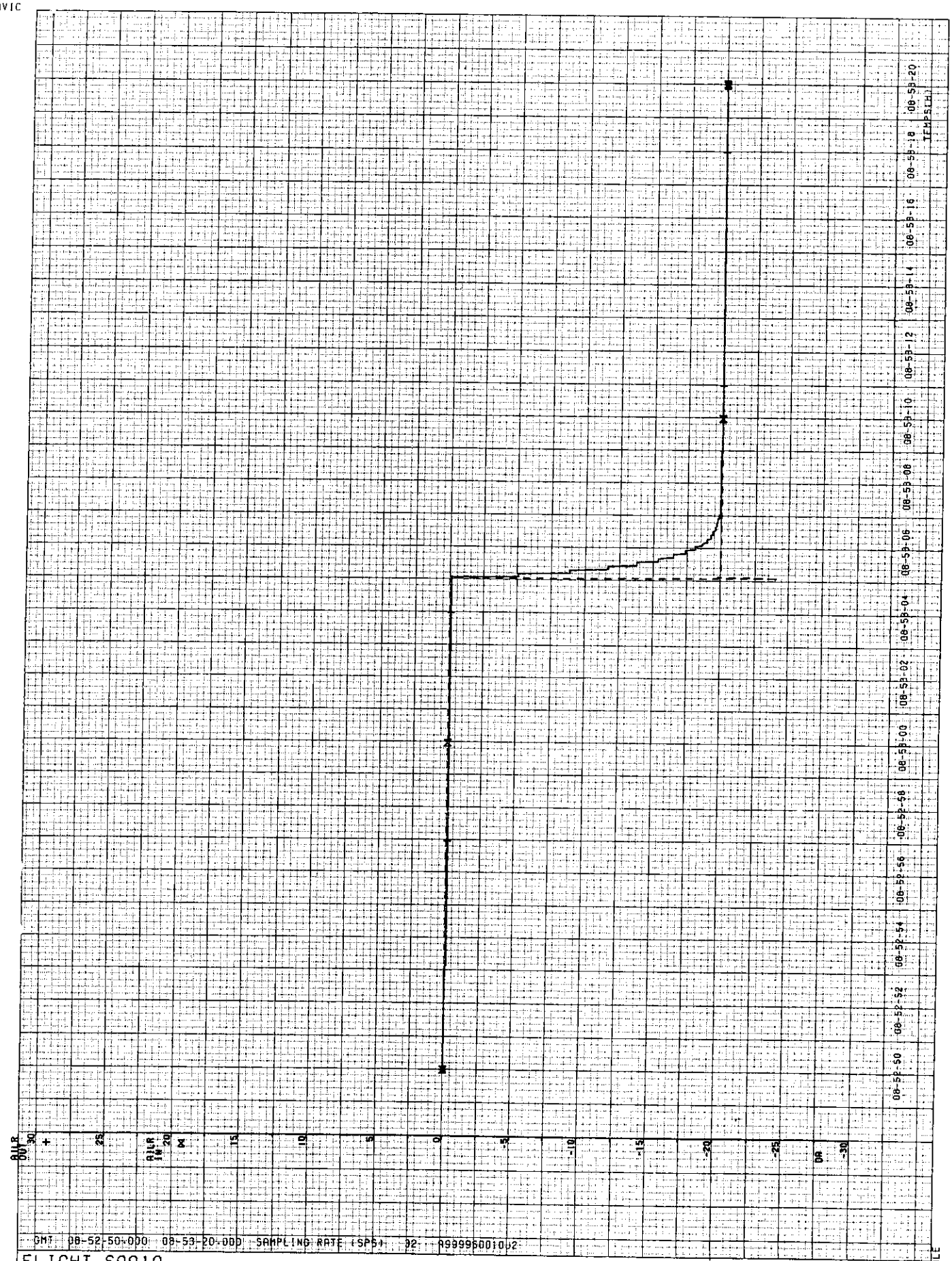
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.9

008204

AVIC



FLIGHT S0010 TEST 1.4 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

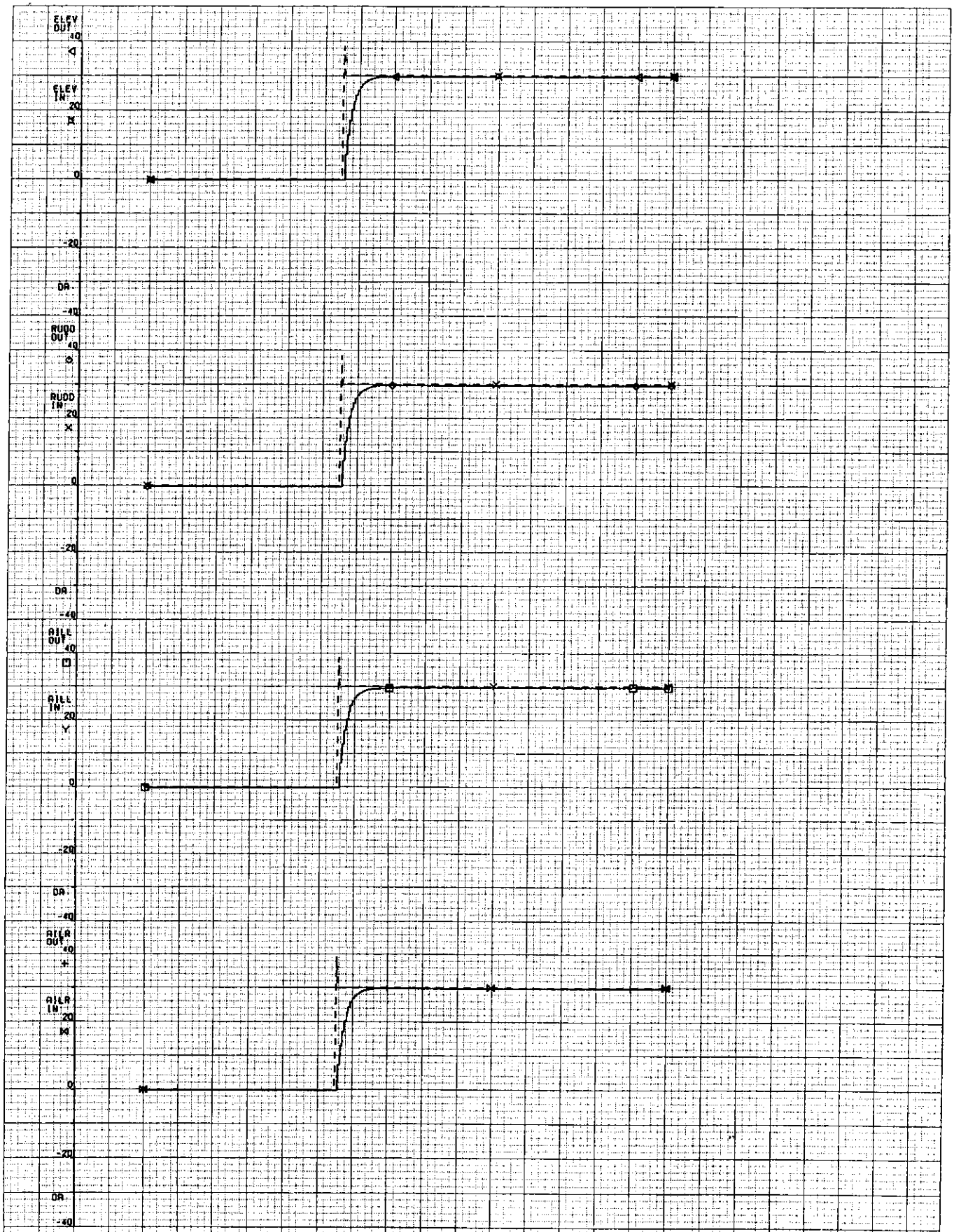
A-NTSB

AIRCRAFT A9999 FIGURE 3.1.10

© AEROSPATIALE

310.1 SERIE/SOACAAL.AD

098205



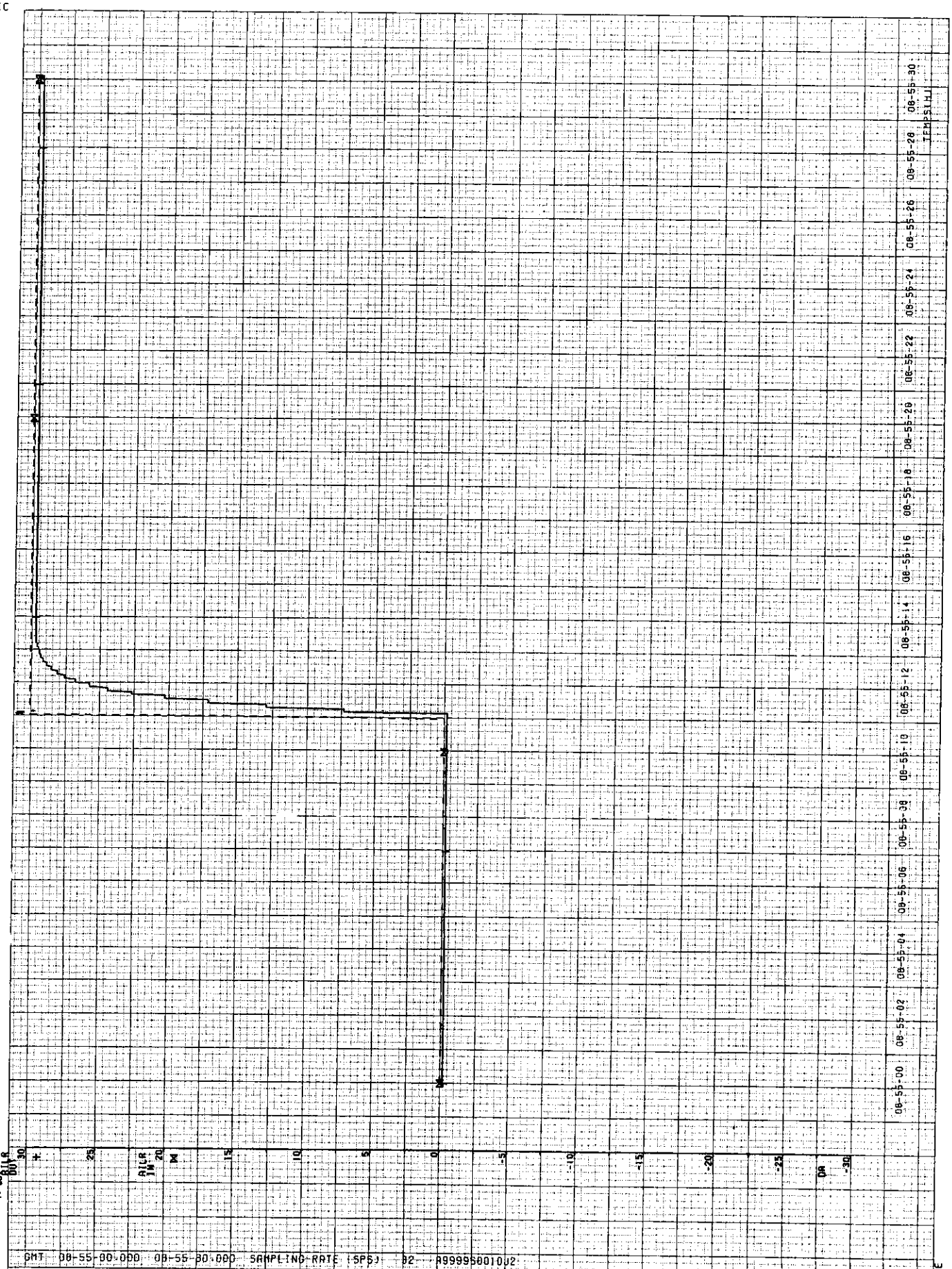
FLIGHT S0010 TEST 1.5 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.11

AVIC



FLIGHT S0010 TEST 1.5 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

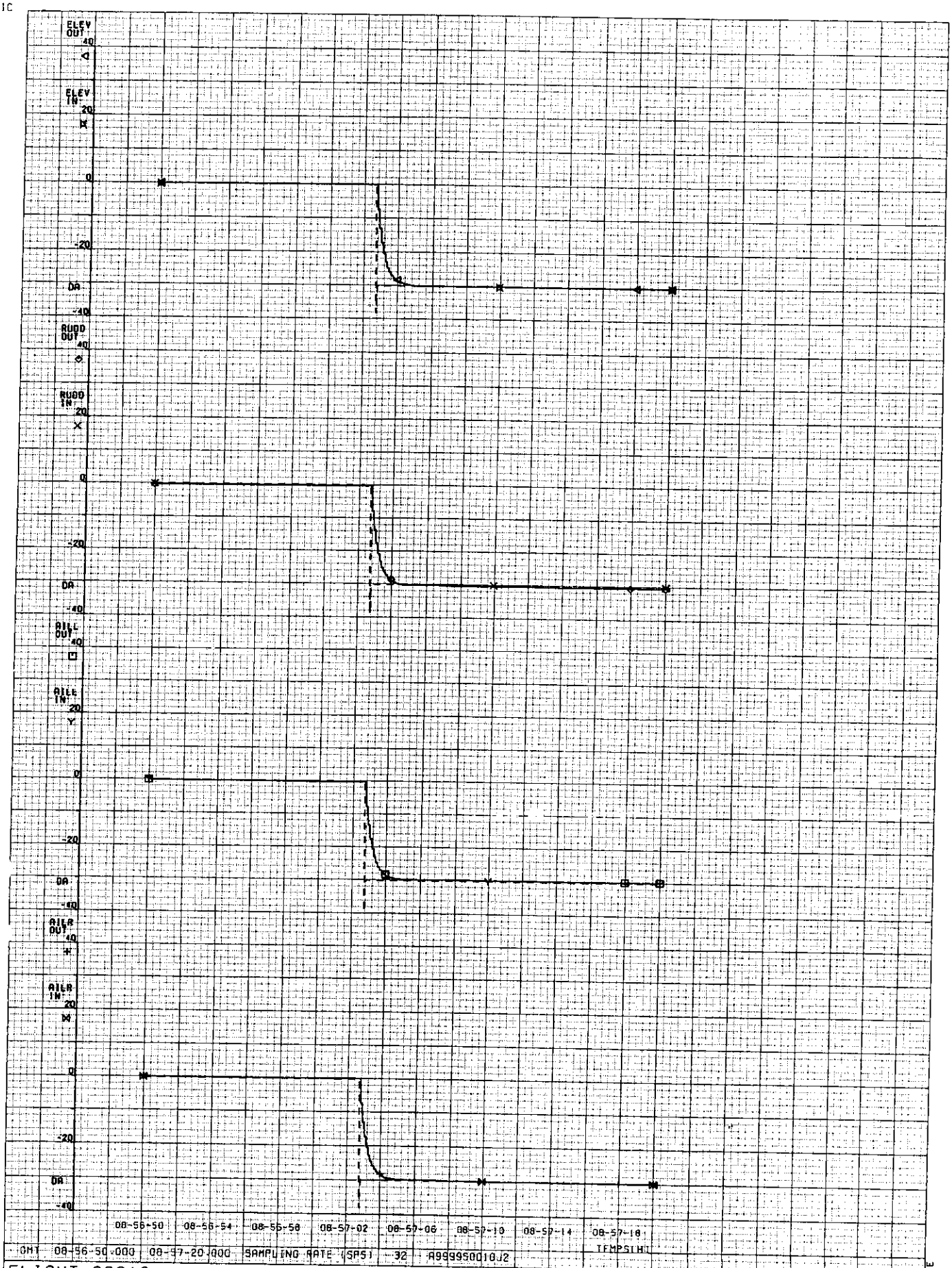
AIRCRAFT A9999 FIGURE 3.1.12

(C) AEROSPATIALE

310.1 SERIE/SDACAAL.AD

098207

AVIC



FLIGHT S0010 TEST 1.6 FIRST TRY FTI

A-NTSB

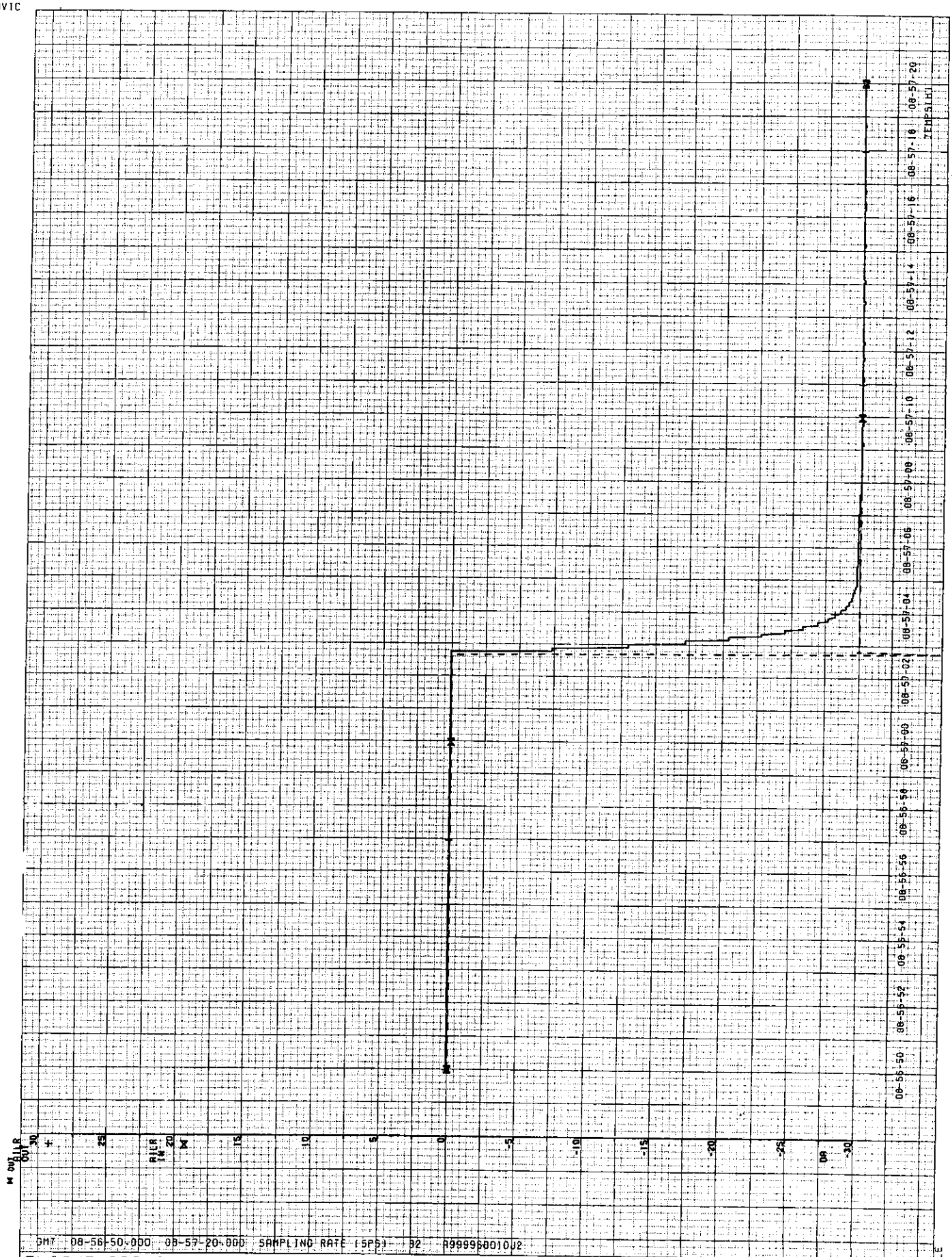
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.1.13

(C) AEROSPATIALE

DOS-1 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 1.6 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

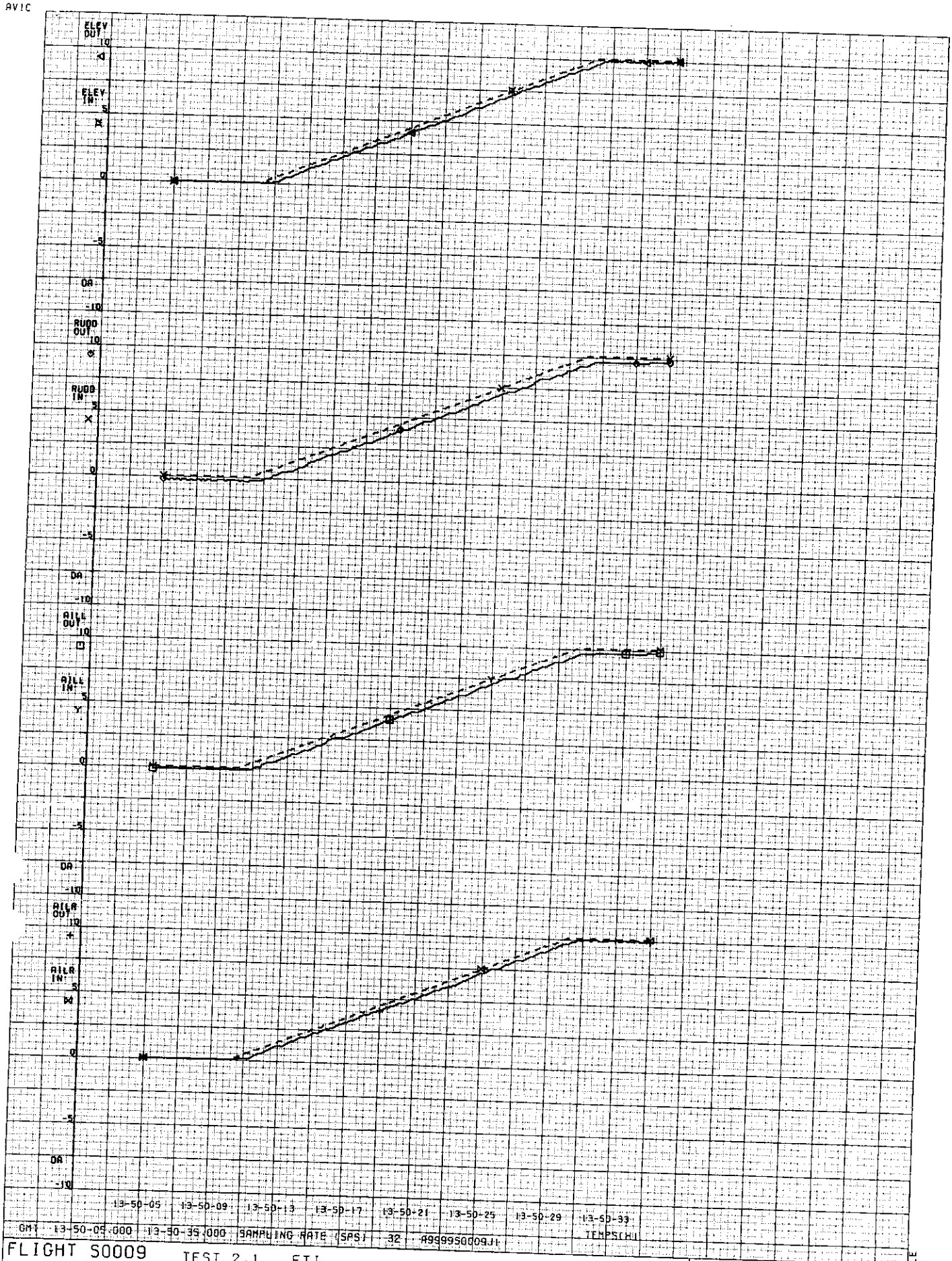
AIRCRAFT A9999 FIGURE 3.1.14

(C) AEROSPATIALE

310.1 SERIE/SOACAAL.AD

008209

ANNEX 3.2:
Test series n°2



FLIGHT S0009 TEST 2.1 FTI

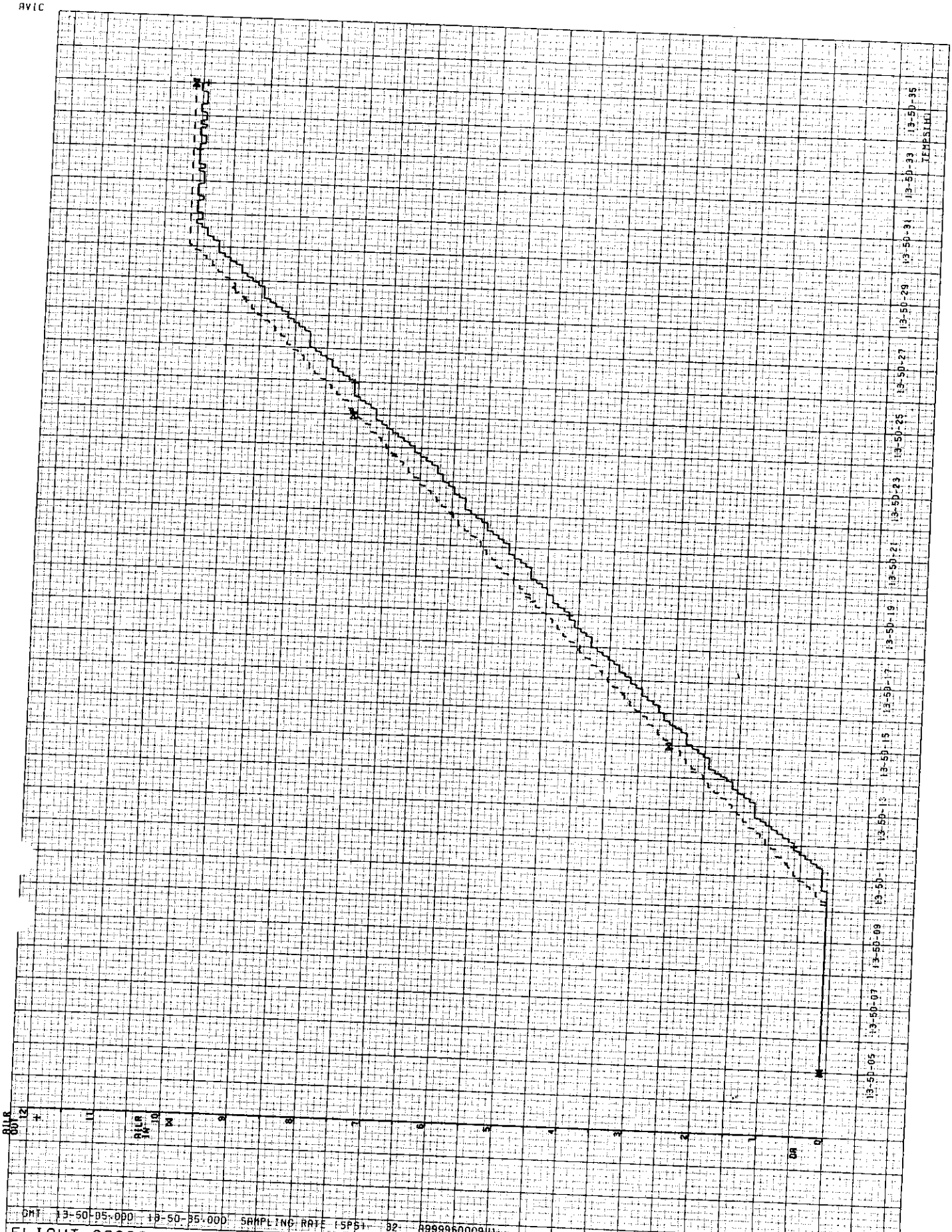
AEROSPATIALE FLIGHT TESTS

A-NTSB

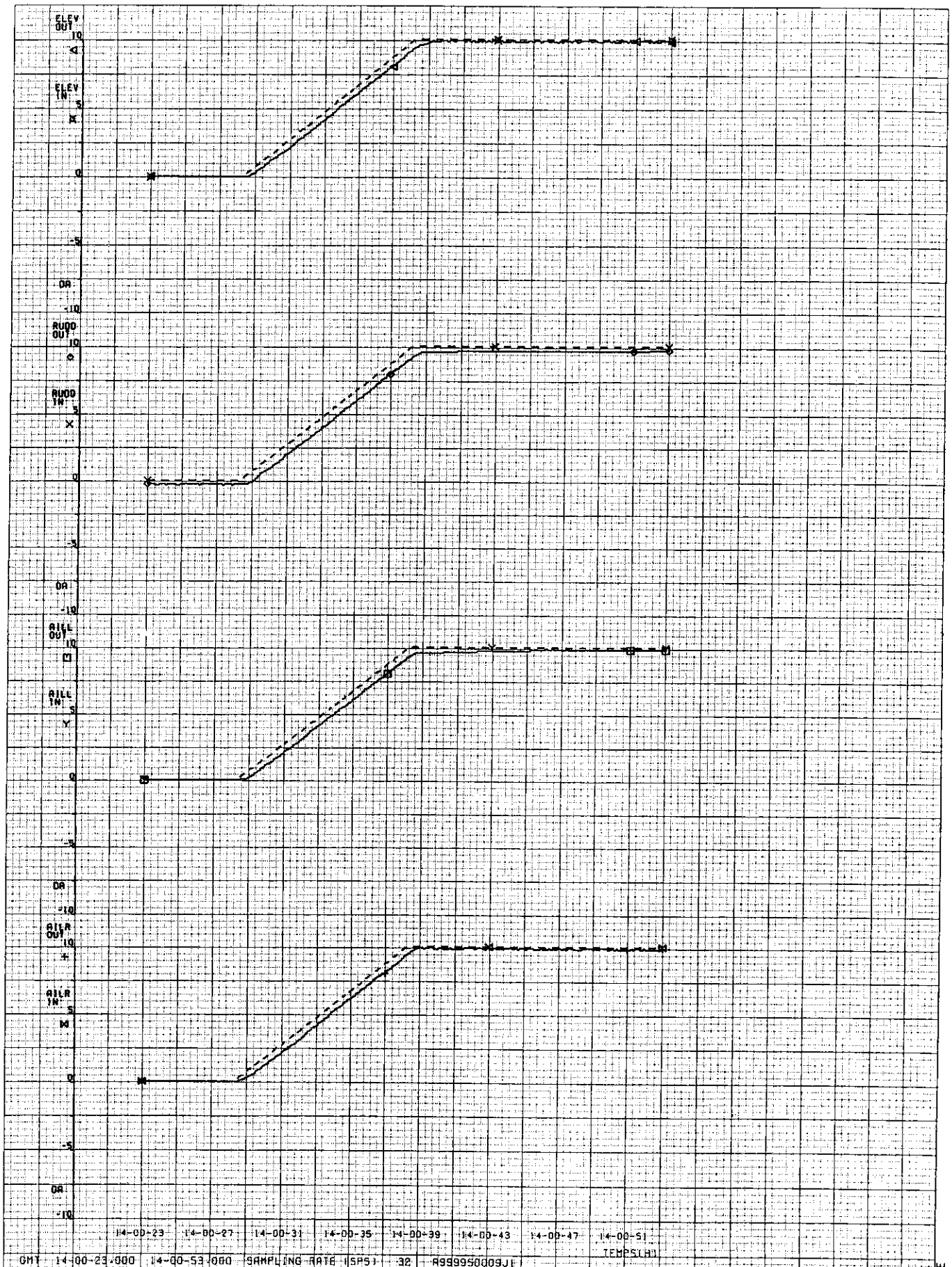
AIRCRAFT A9999 FIGURE 3.2.1

(C) AEROSPATIALE

SERIE/SDACAAL.AD


13-50-05
13-50-07
13-50-09
13-50-11
13-50-13
13-50-15
13-50-17
13-50-19
13-50-21
13-50-23
13-50-25
13-50-27
13-50-29
13-50-31
13-50-33
13-50-35
TEMPS(HH)
AILR OUT
AILR IN
GMT 13-50-05.000 13-50-35.000 SAMPLING RATE (SPS) 32 A999960009U1
FLIGHT S0009 TEST 2.1 FTI
A-NTSB
AEROSPATIALE
FLIGHT TESTS
AIRCRAFT A9999
FIGURE 3.2.2
AEROSPATIALE

AVIC



FLIGHT S0009 TEST 2.2 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

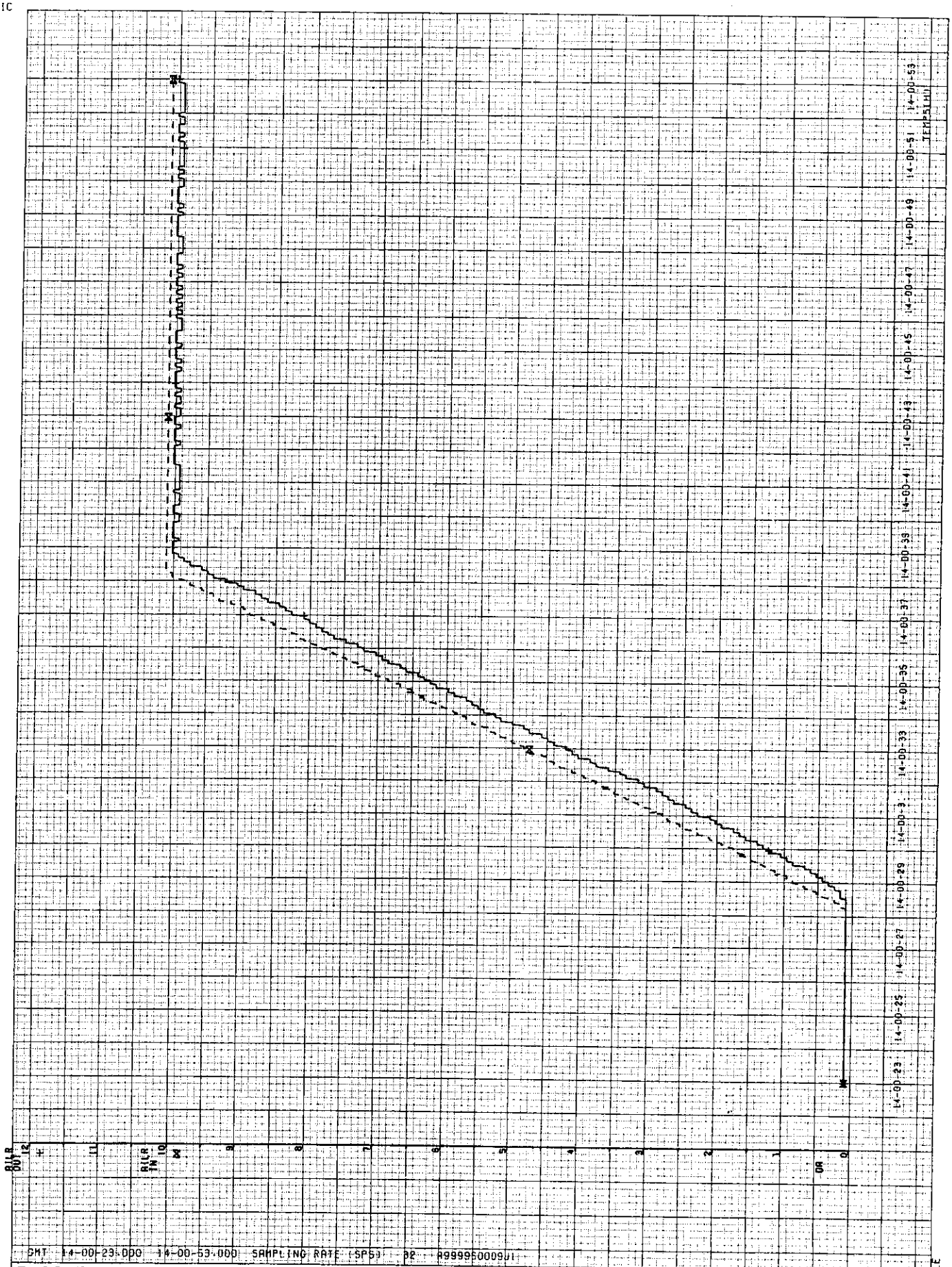
AIRCRAFT A9999 FIGURE 3.2.3

(C) AEROSPATIALE

005.2 SERIE/SOACAAL.AD

008213

AVIC



FLIGHT S0009 TEST 2.2 FTI

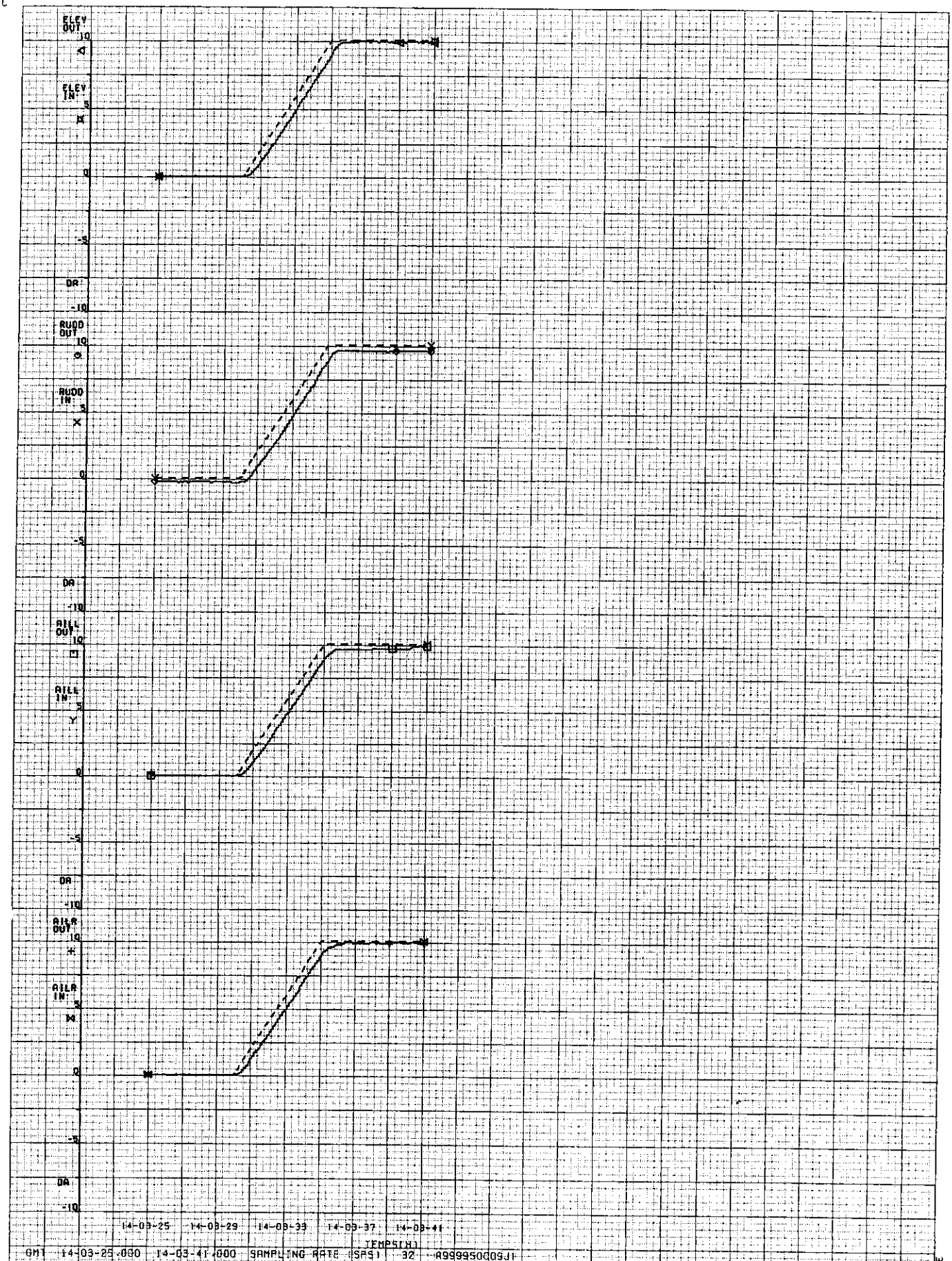
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.2.4

(C) AEROSPATIALE

310.2 SERIE/SDACRAL.AD



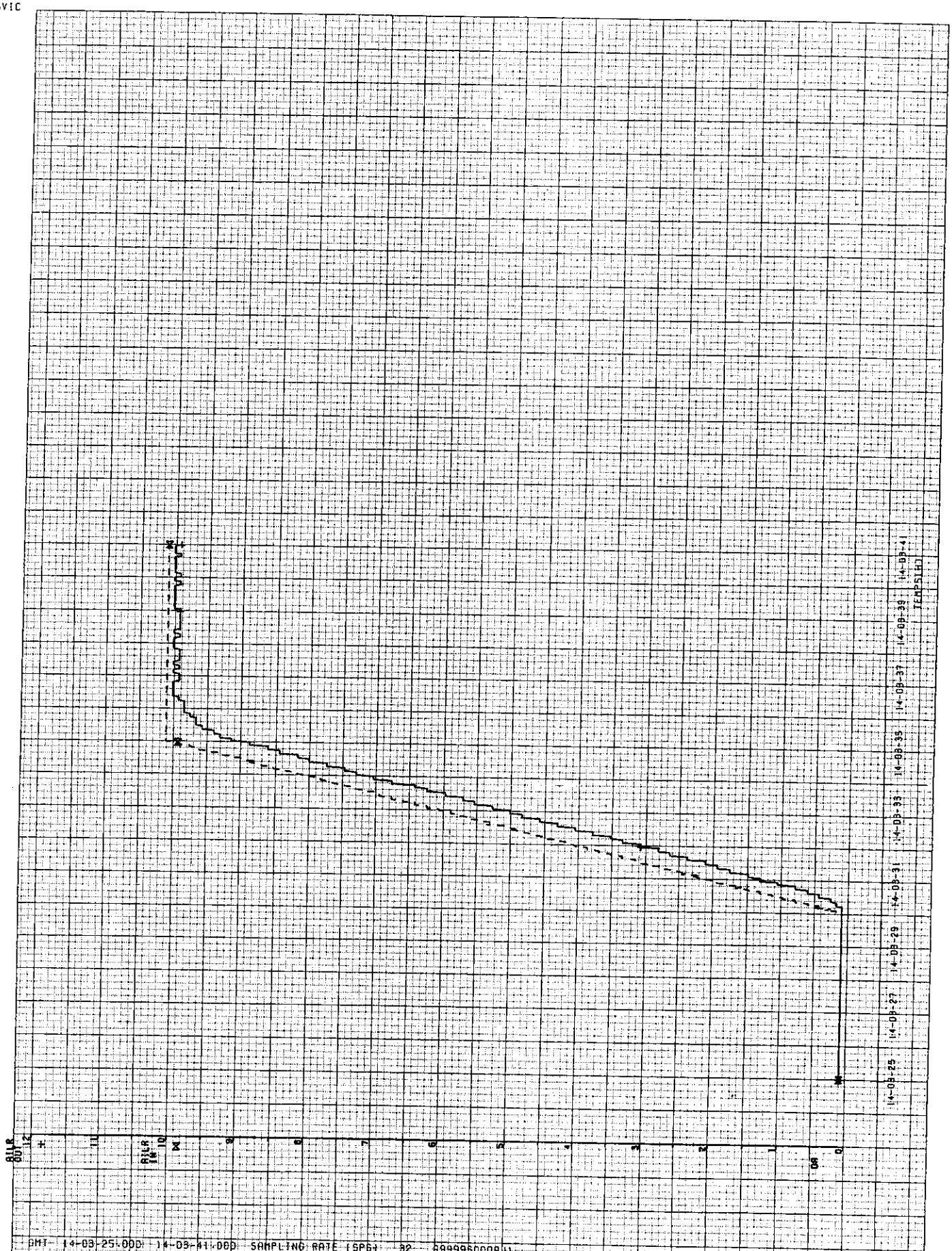
FLIGHT S0009 TEST 2.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.2.5

AVIC



FLIGHT S0009 TEST 2.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

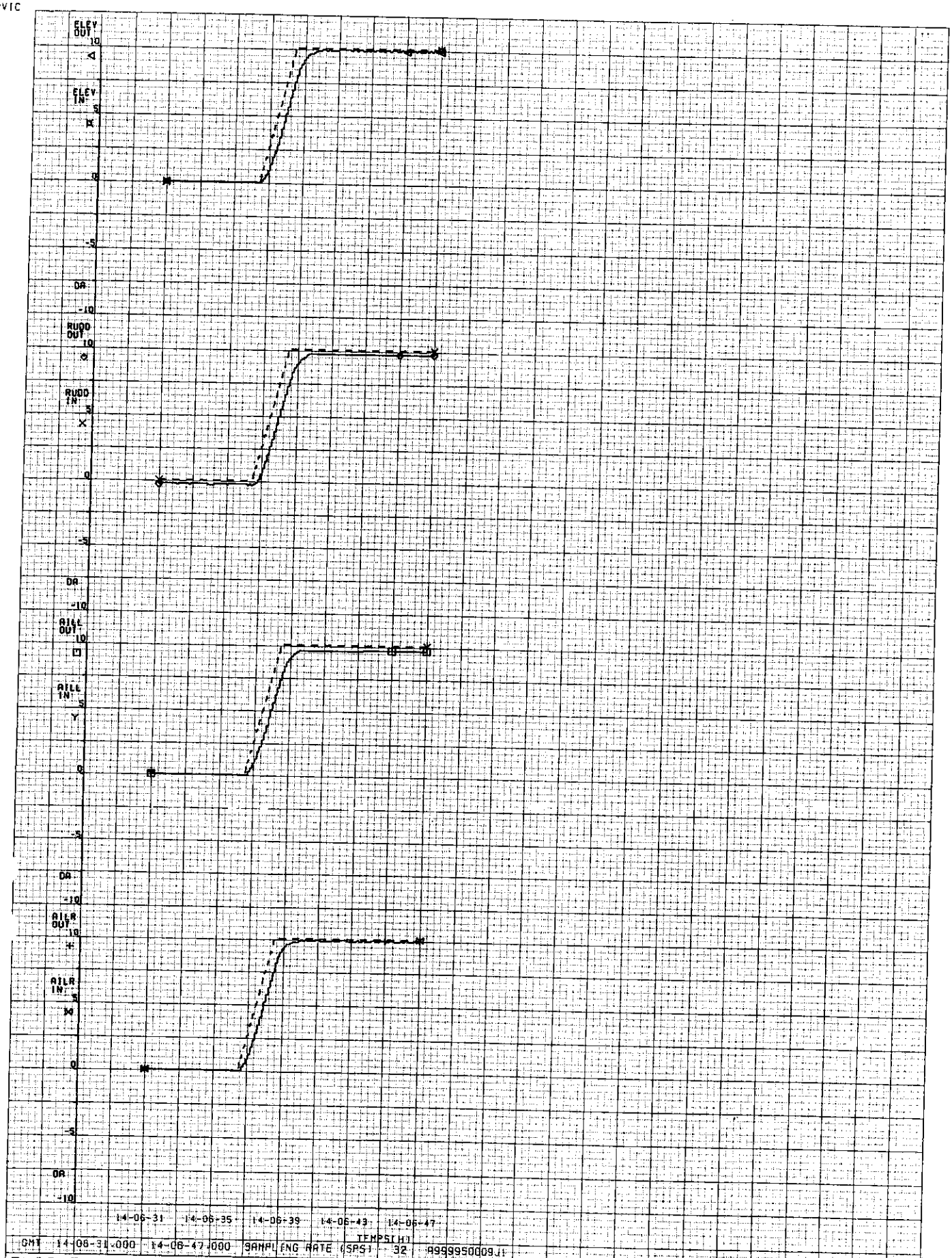
AIRCRAFT A9999 FIGURE 3.2.6

(C) AEROSPATIALE

310-2 SERIE/SOACAAL.AD

99216

AVIC



FLIGHT S0009 TEST 2.4 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

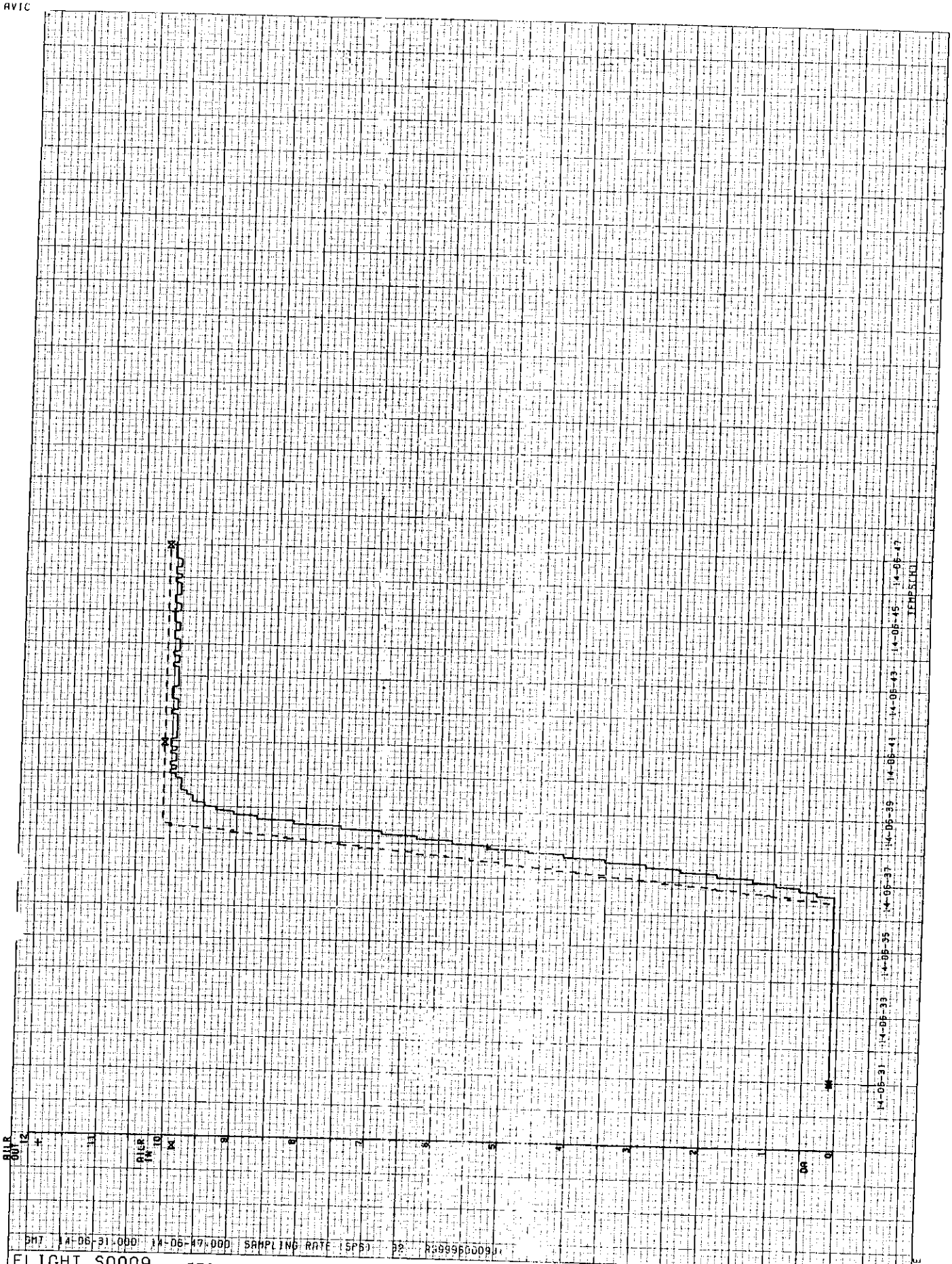
AIRCRAFT A9999 FIGURE 3.2.7

CT AEROSPATIALE

405.2 SERIE/SOACAAL.AD

008217

AVIC



FLIGHT S0009 TEST 2.4 FTI

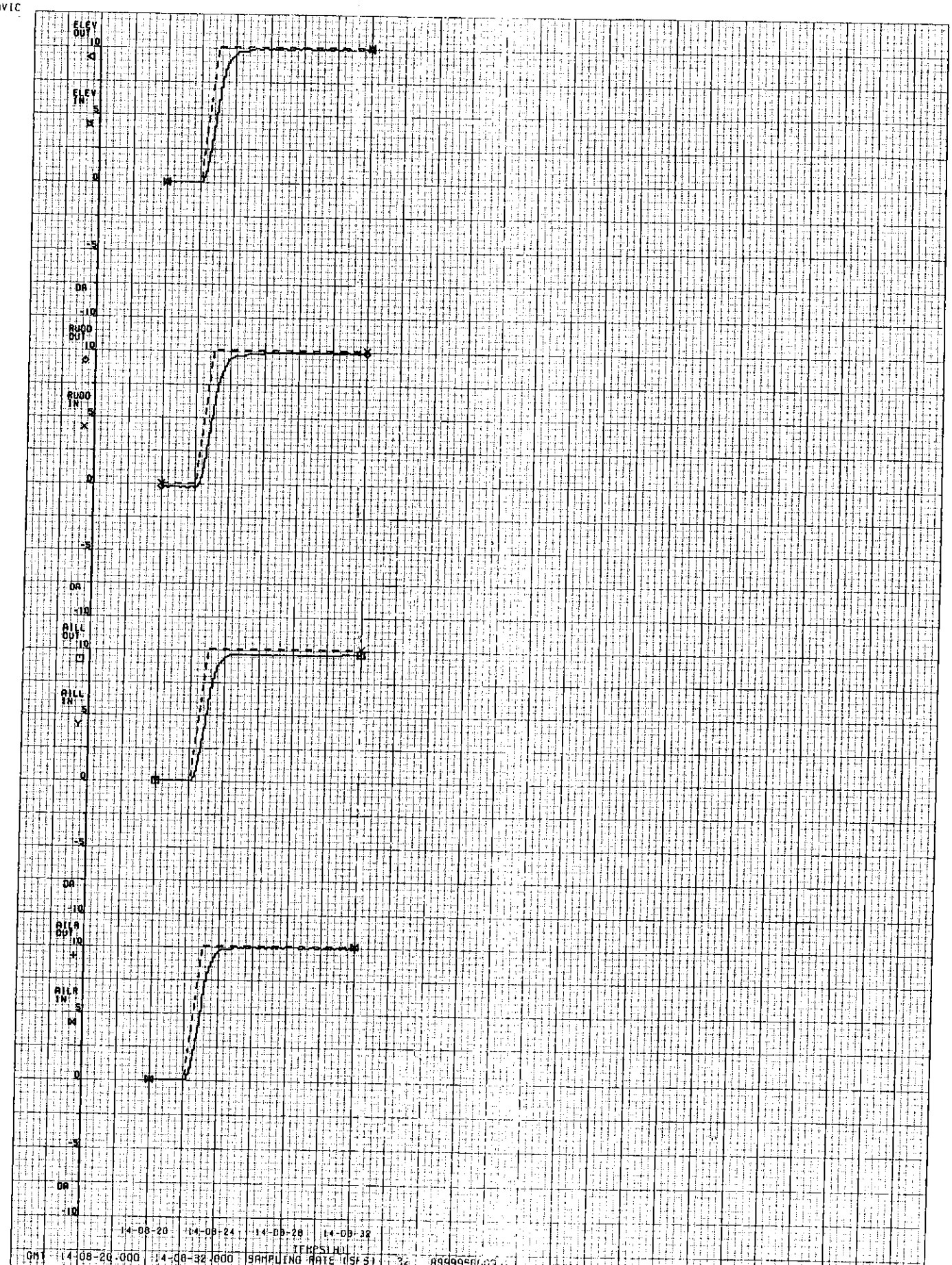
AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3.2.8

SERIE/SDACRAL.AD

AVIC



FLIGHT S0009 TEST 2.5 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

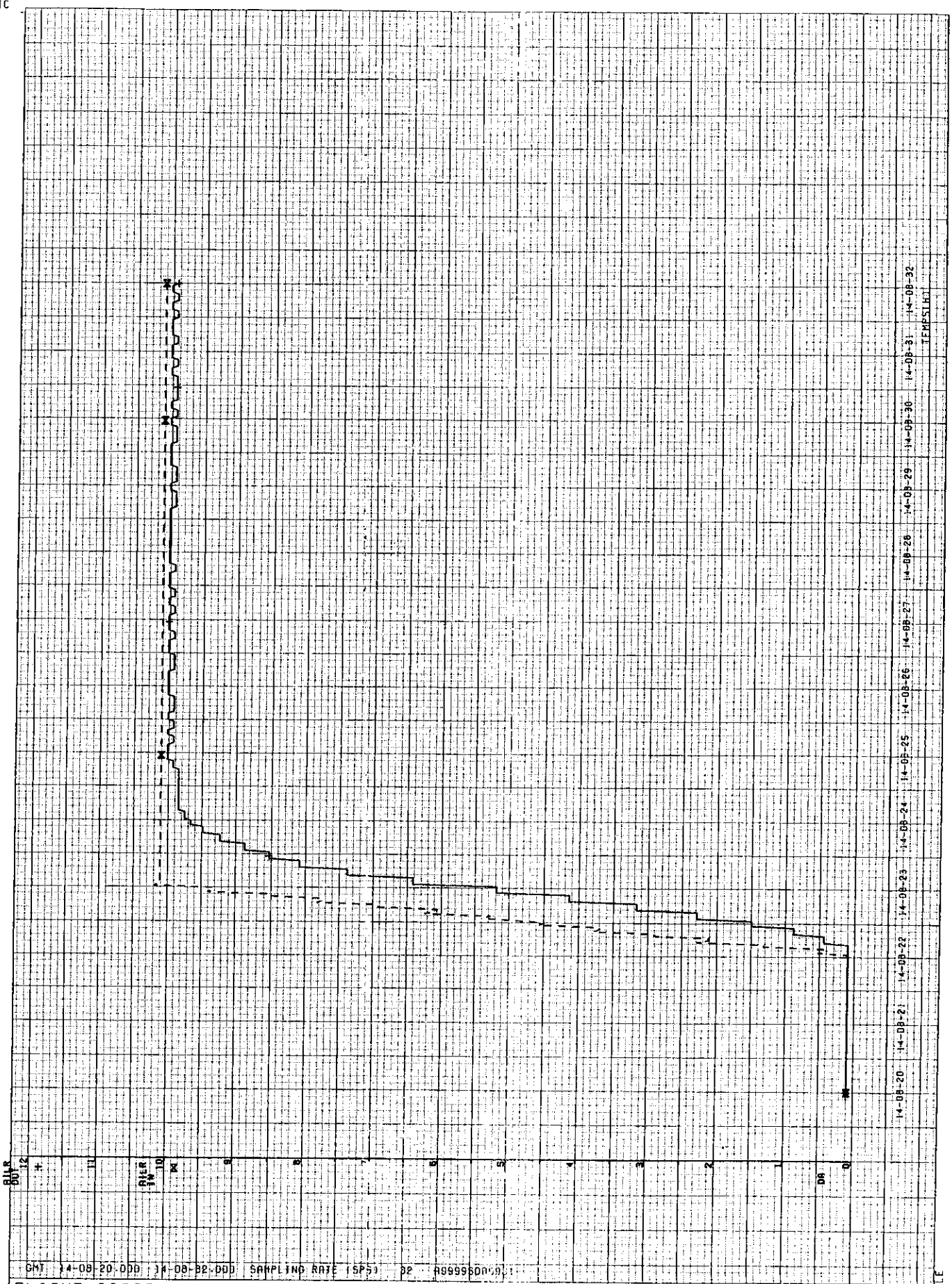
AIRCRAFT A9999 FIGURE 3.2.9

(C) AEROSPATIALE

005-2 SERIE/SDACAAL-AD

098219

AVIC



FLIGHT S0009 TEST 2.5 FTI

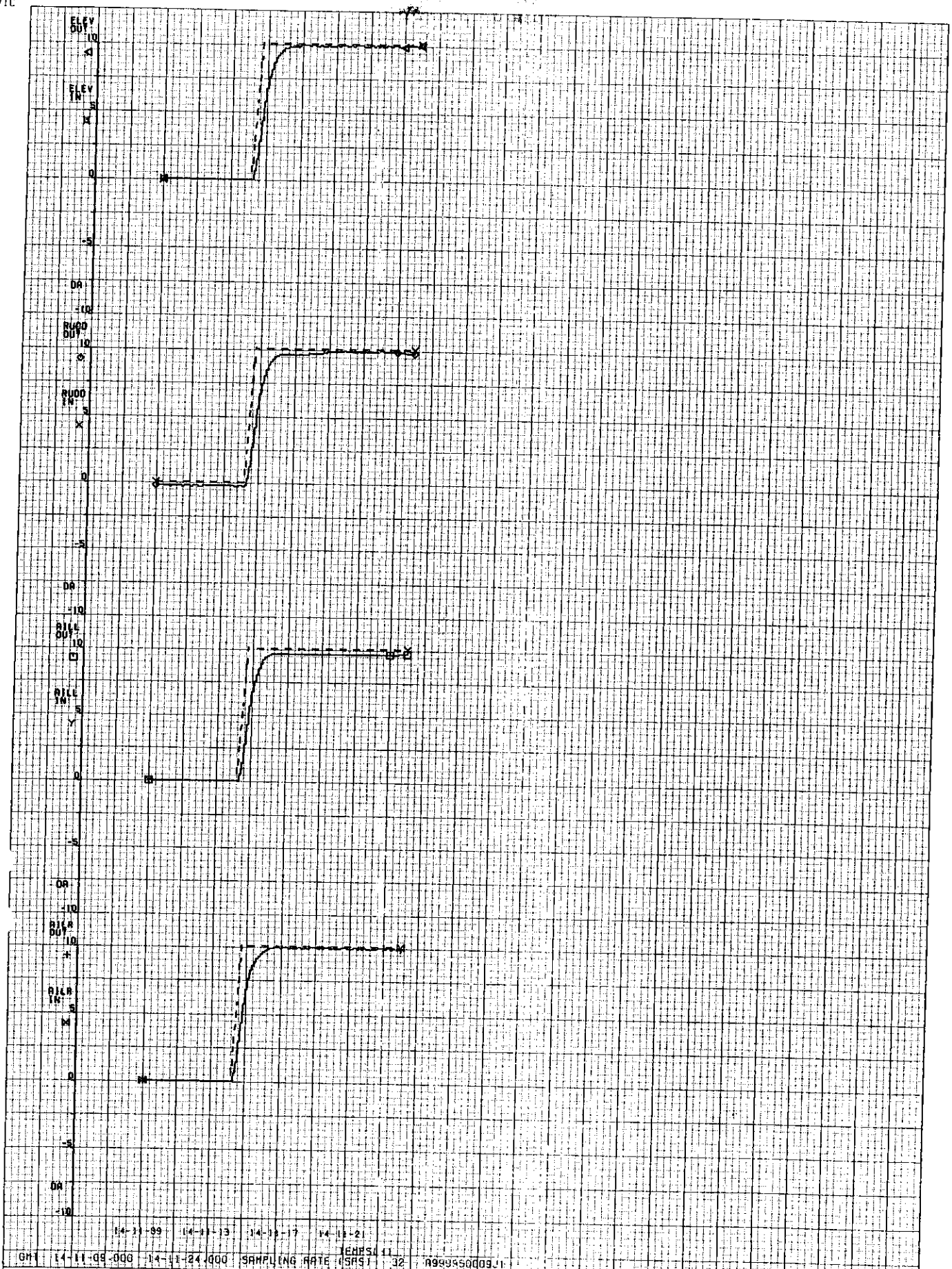
AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3.2.10

008220

AVIC



FLIGHT S0009 TEST 2.6 FTI

A-NTSB

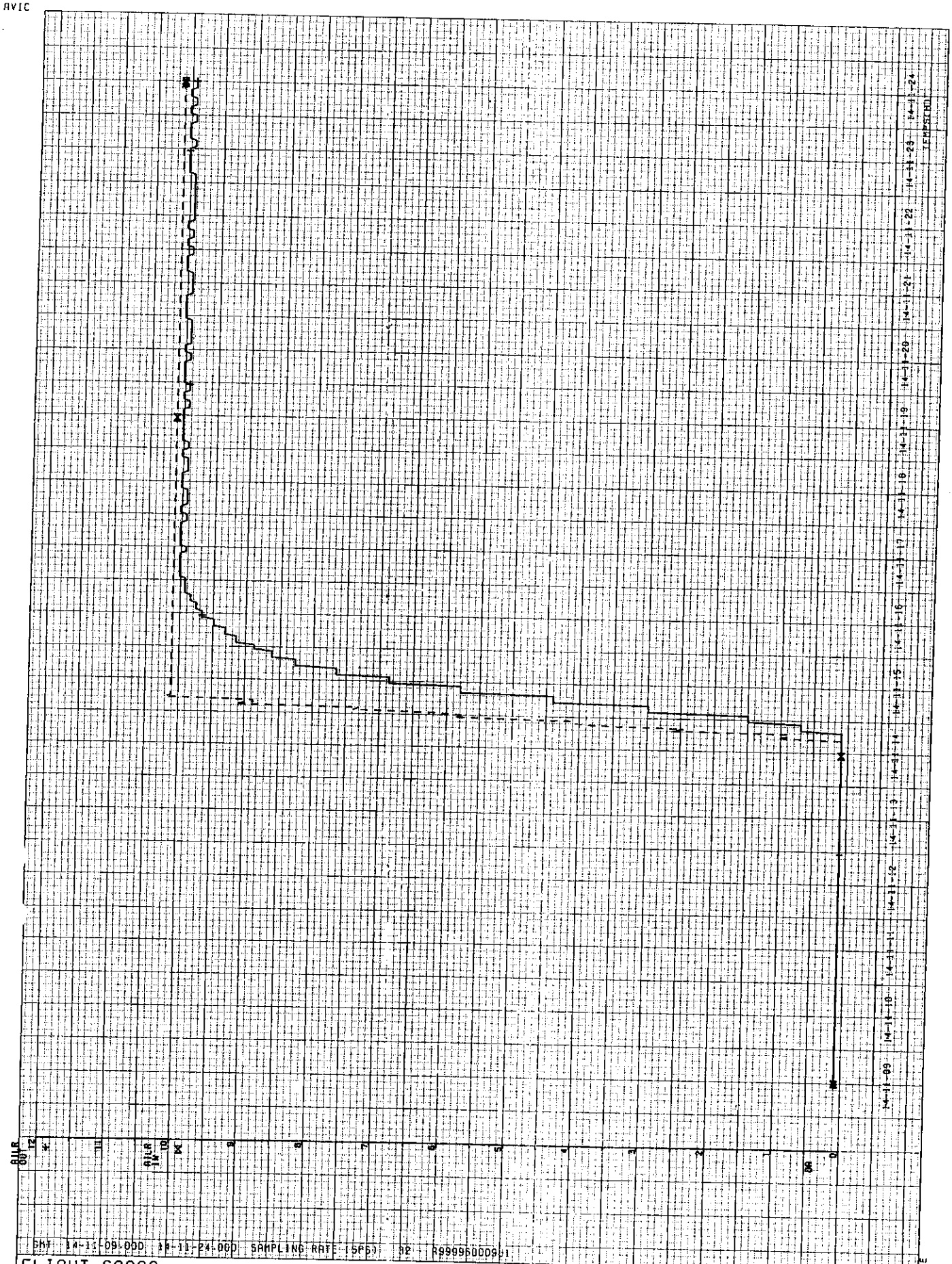
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.2.1

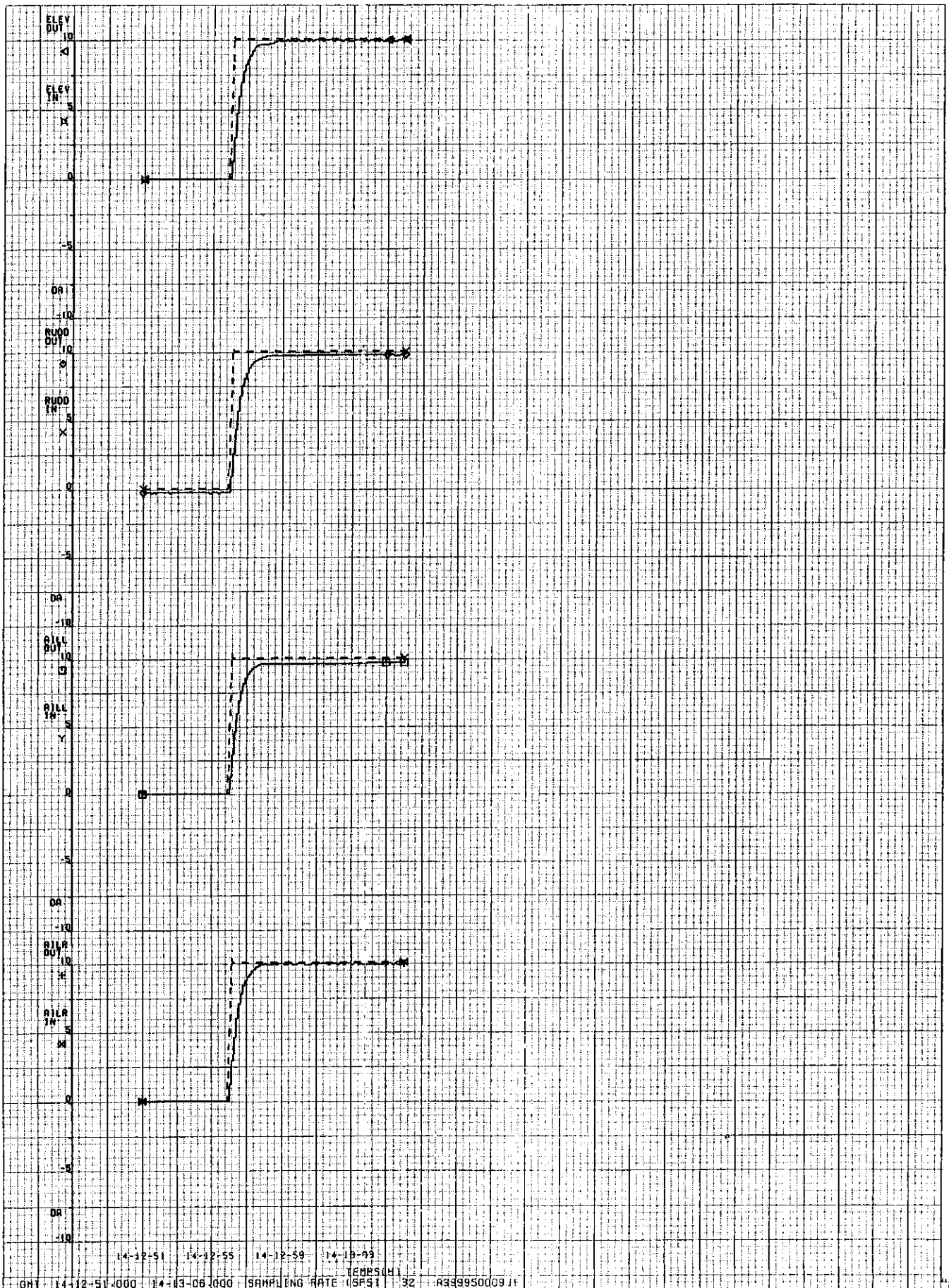
(C) AEROSPATIALE

005.2 SERIE/SDACAAL.AD

AVIC



310.2 SERIE/SOACRAL.AD



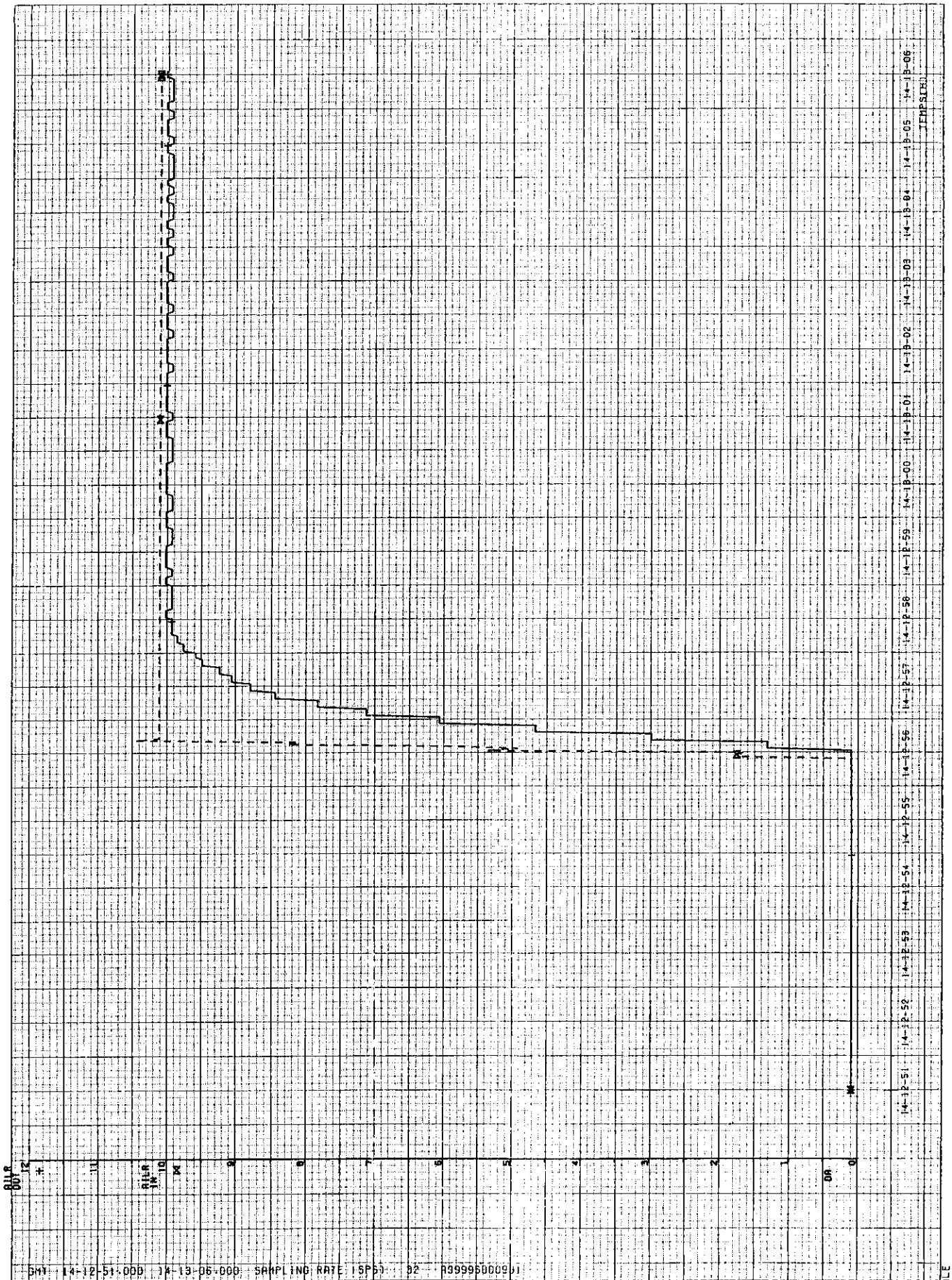
FLIGHT S0009 TEST 2.7 FT1

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.2.13

AVIC



FLIGHT S0009 TEST 2.7 FTI

AEROSPATIALE
FLIGHT TESTS

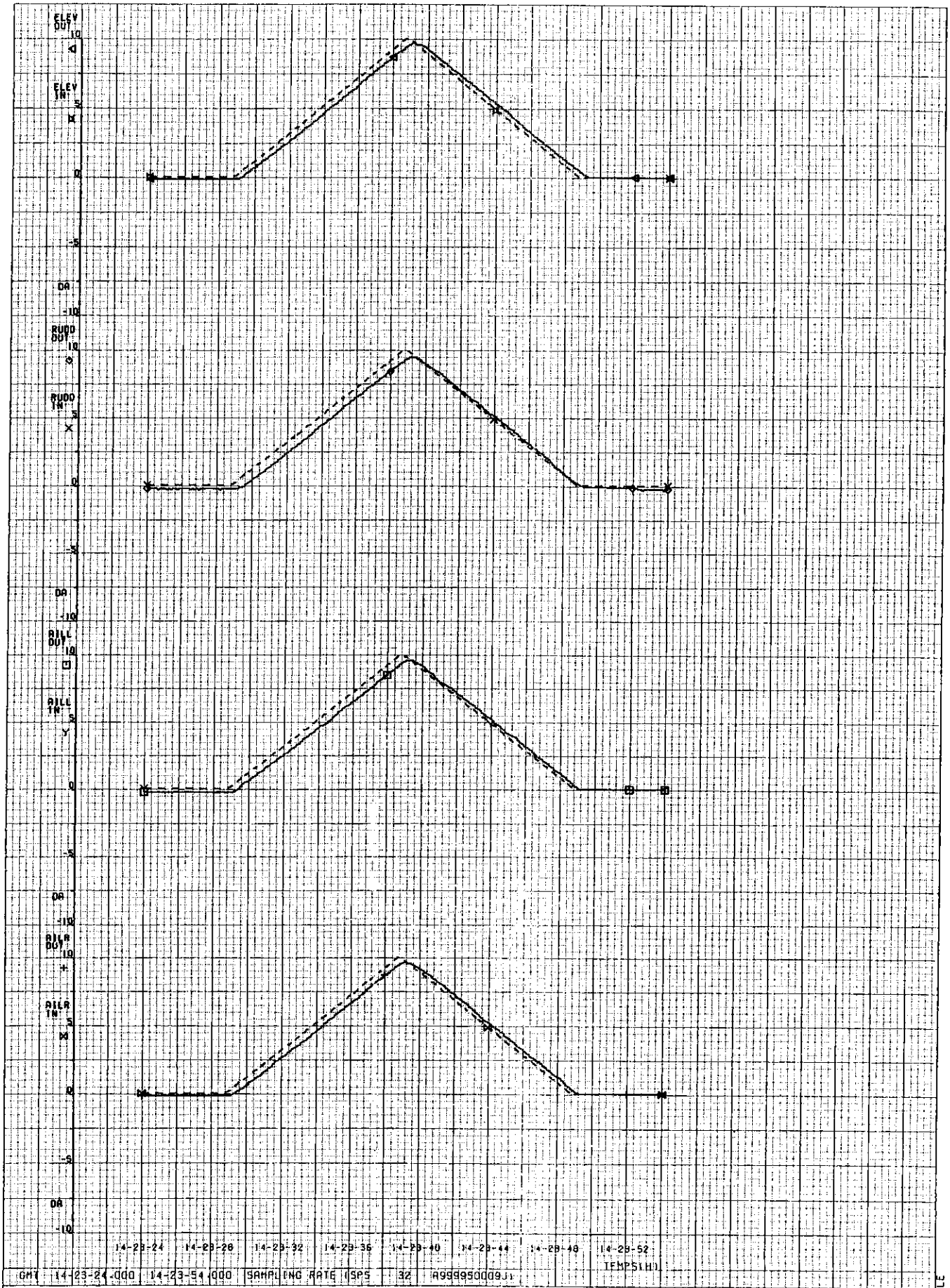
AIRCRAFT A9999 FIGURE 3.2.14

A-NTSB

310.2 SERIE/SDACAAL.AD

AEROSPATIALE

ANNEX 3.3:
Test series n°3



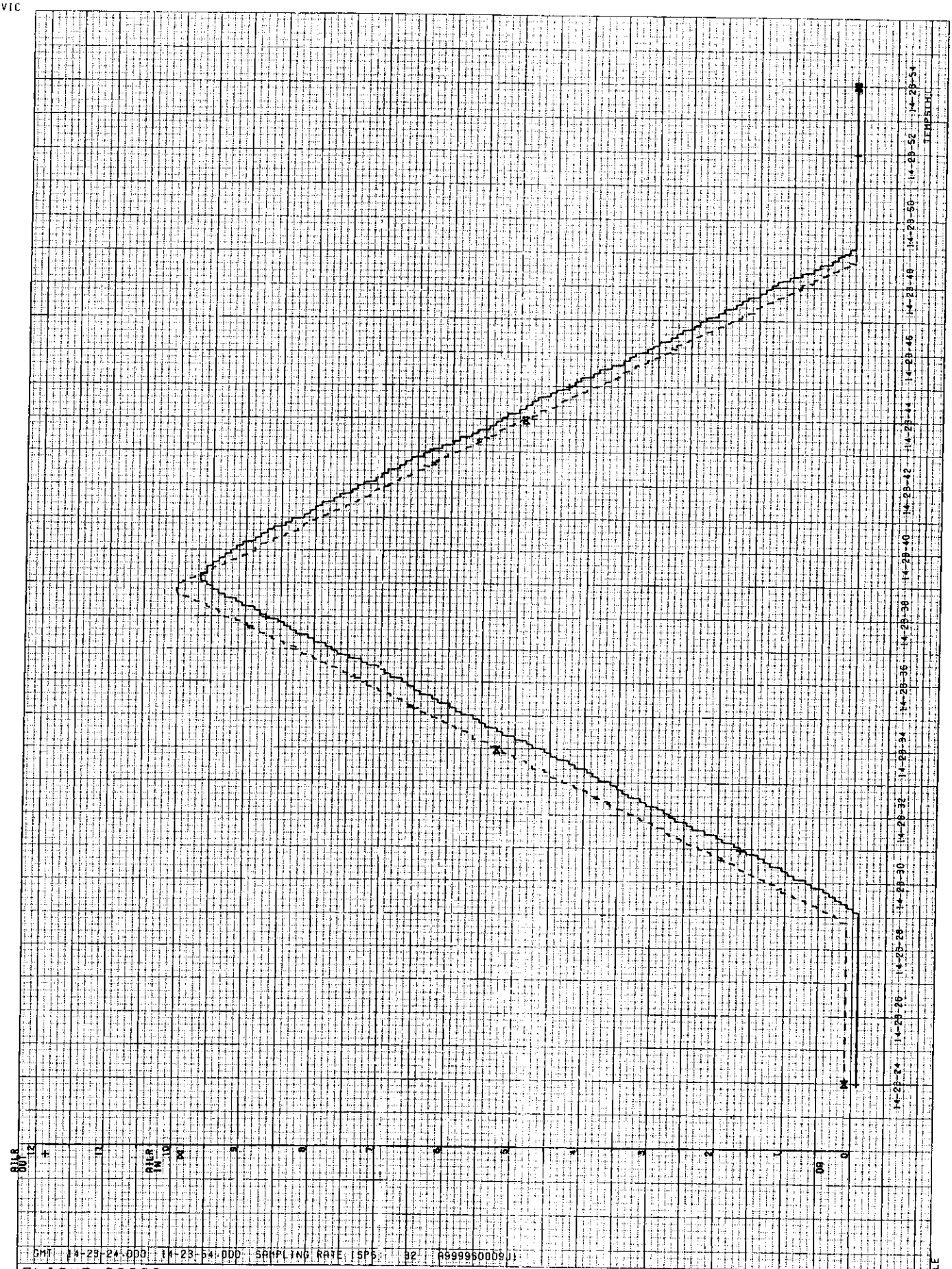
FLIGHT S0009 TEST 3.1 FT1

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 33.1

AVIC



FLIGHT S0009 TEST 3.1 FTI

AEROSPATIALE
FLIGHT TESTS

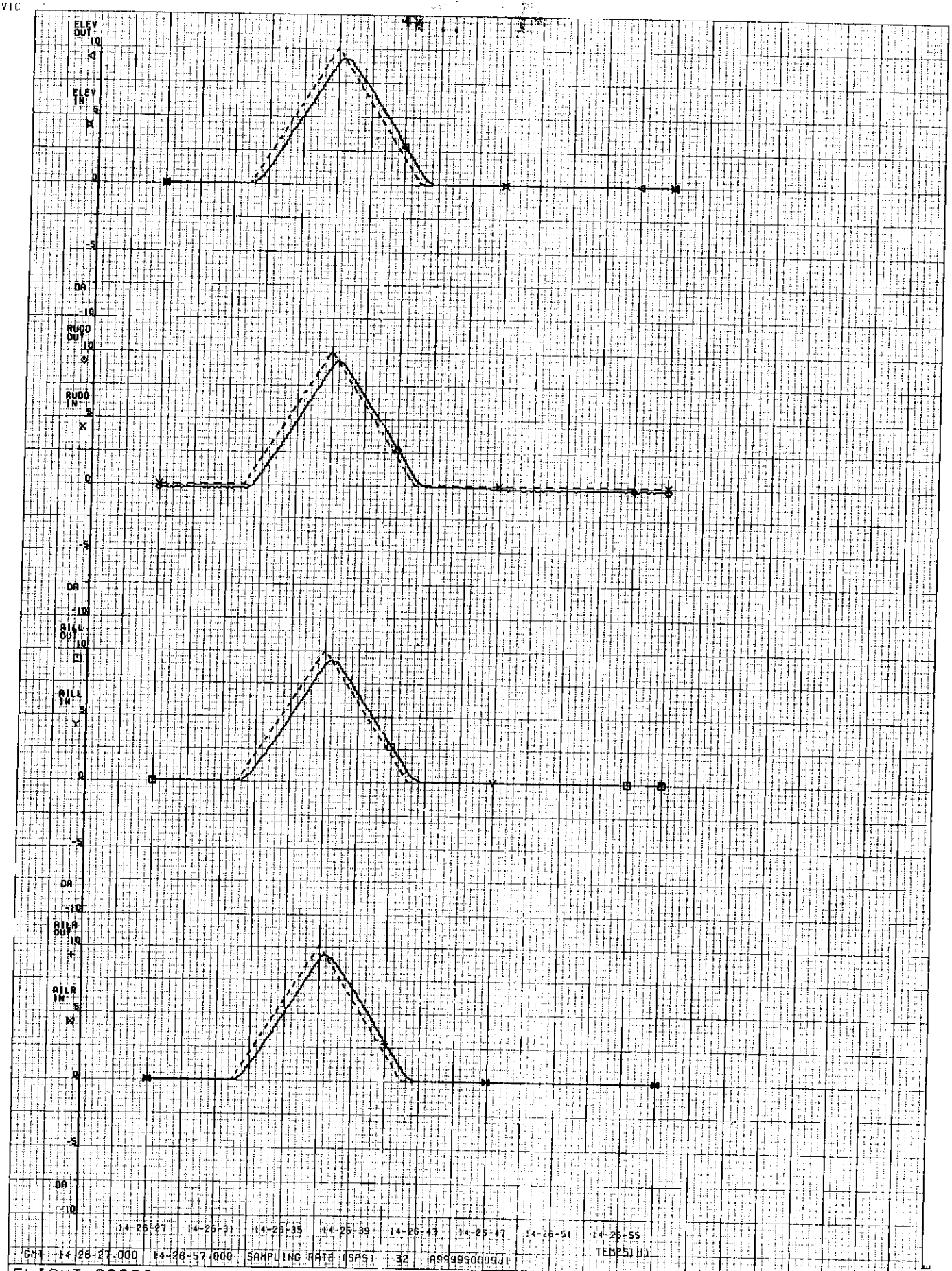
A-NTSB

AIRCRAFT A9999 FIGURE 33.2

(C) AEROSPATIALE

310.3 SERIE/SDACAAL.AD

AVIC



FLIGHT S0009 TEST 3.2 FTI

AEROSPATIALE
FLIGHT TESTS

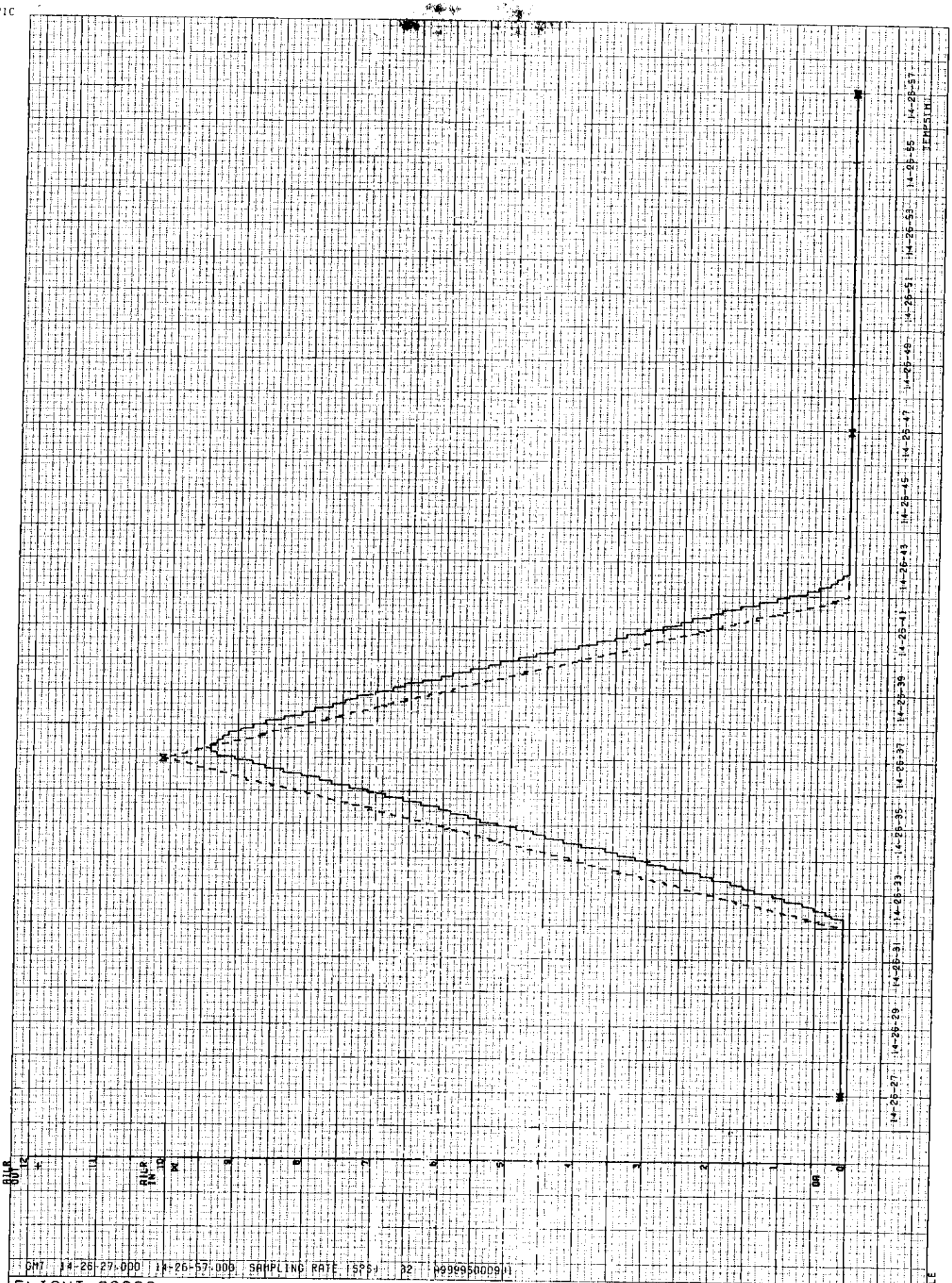
A-NTSB

AIRCRAFT A9999 FIGURE 3.3.3

(C) AEROSPATIALE

005.3 SERIE/SDACAAL.AD

AVIC



GMT 14-26-27.000 14-26-57.000 SAMPLING RATE (S*64) 32 A9999S0009.H1

FLIGHT S0009 TEST 3.2 FTI

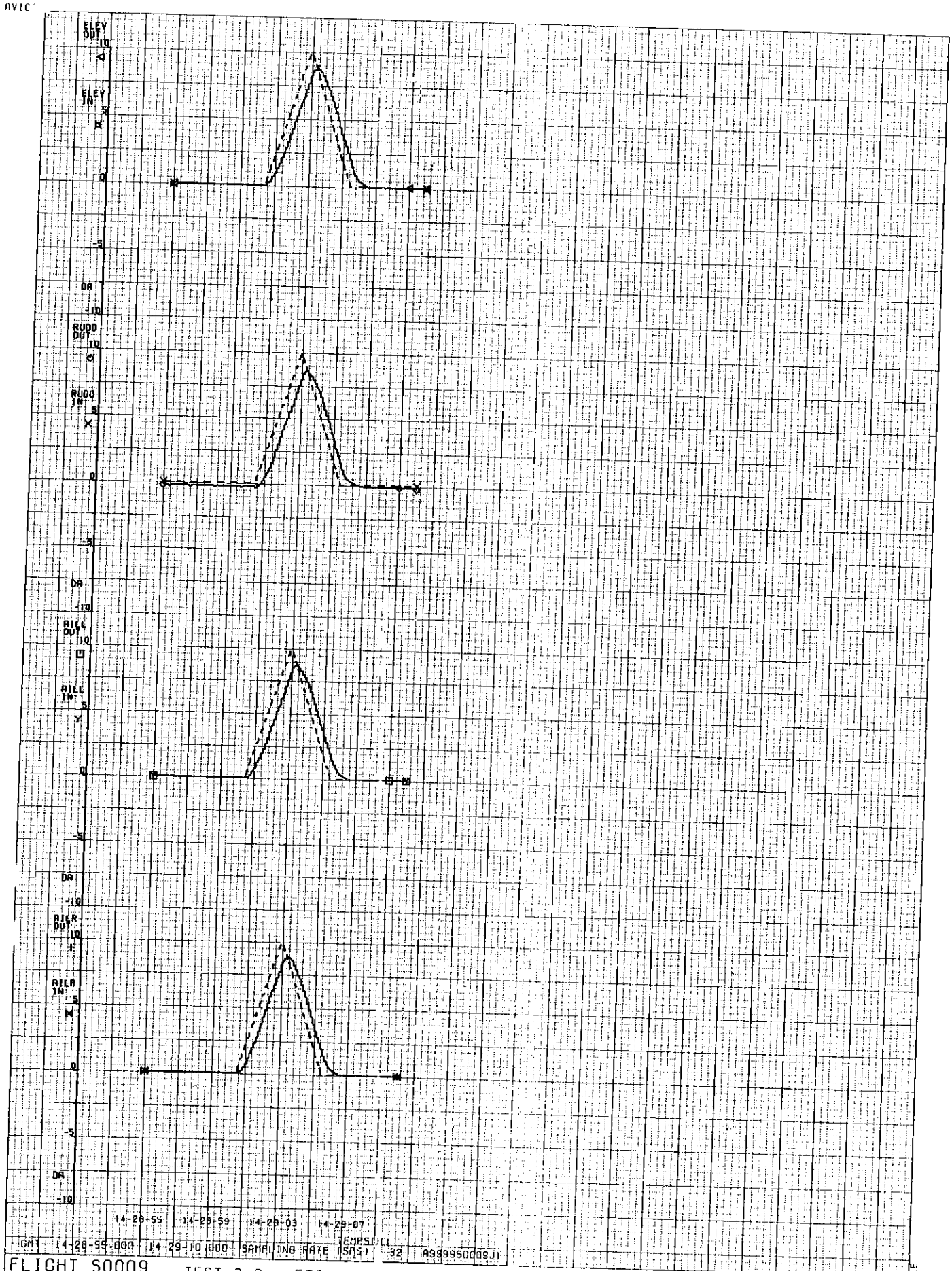
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.4

(C) AEROSPATIALE

098229



FLIGHT S0009 TEST 3.3 FTI

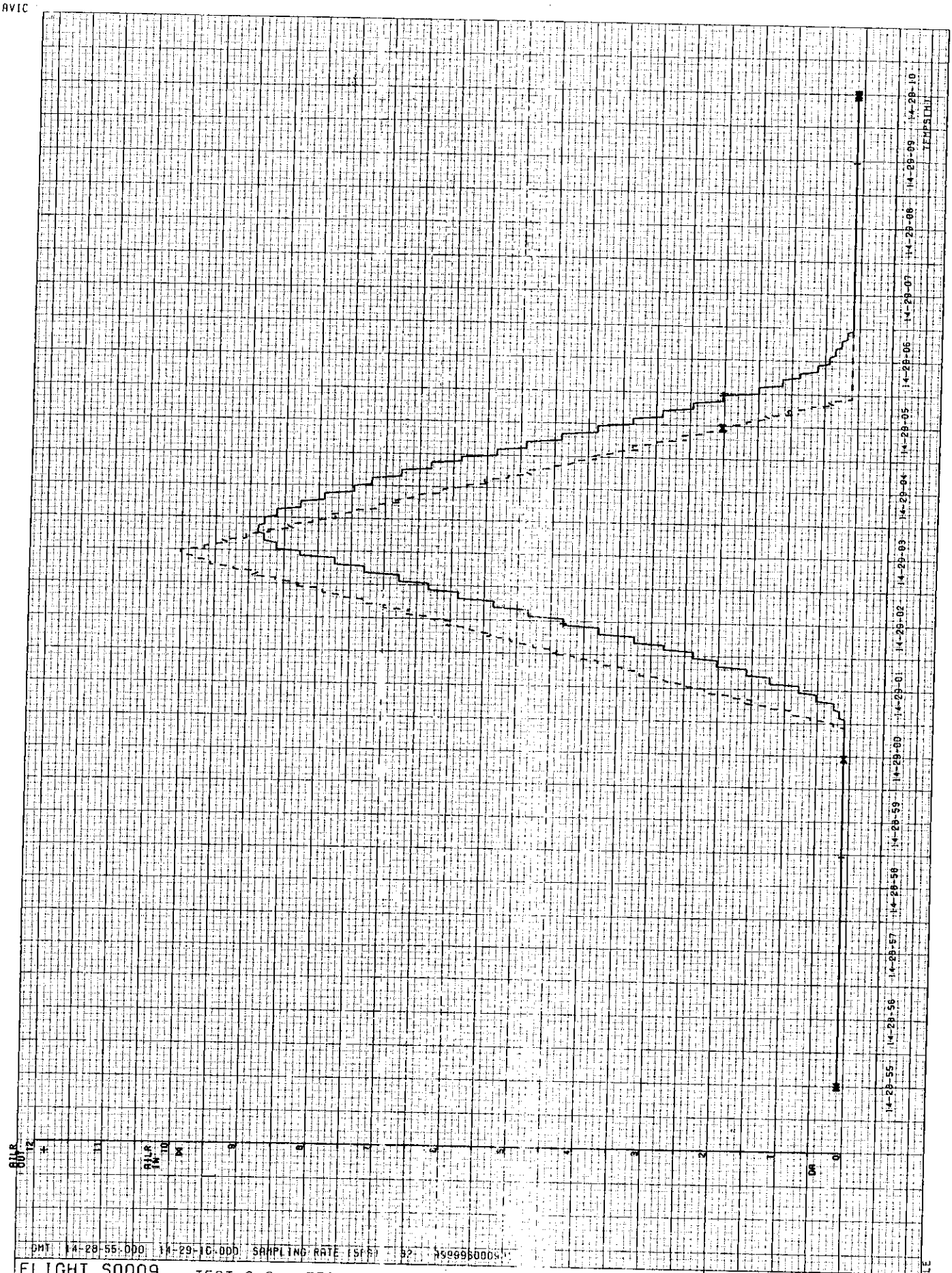
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.5

AEROSPATIALE

AVIC



FLIGHT S0009 TEST 3.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

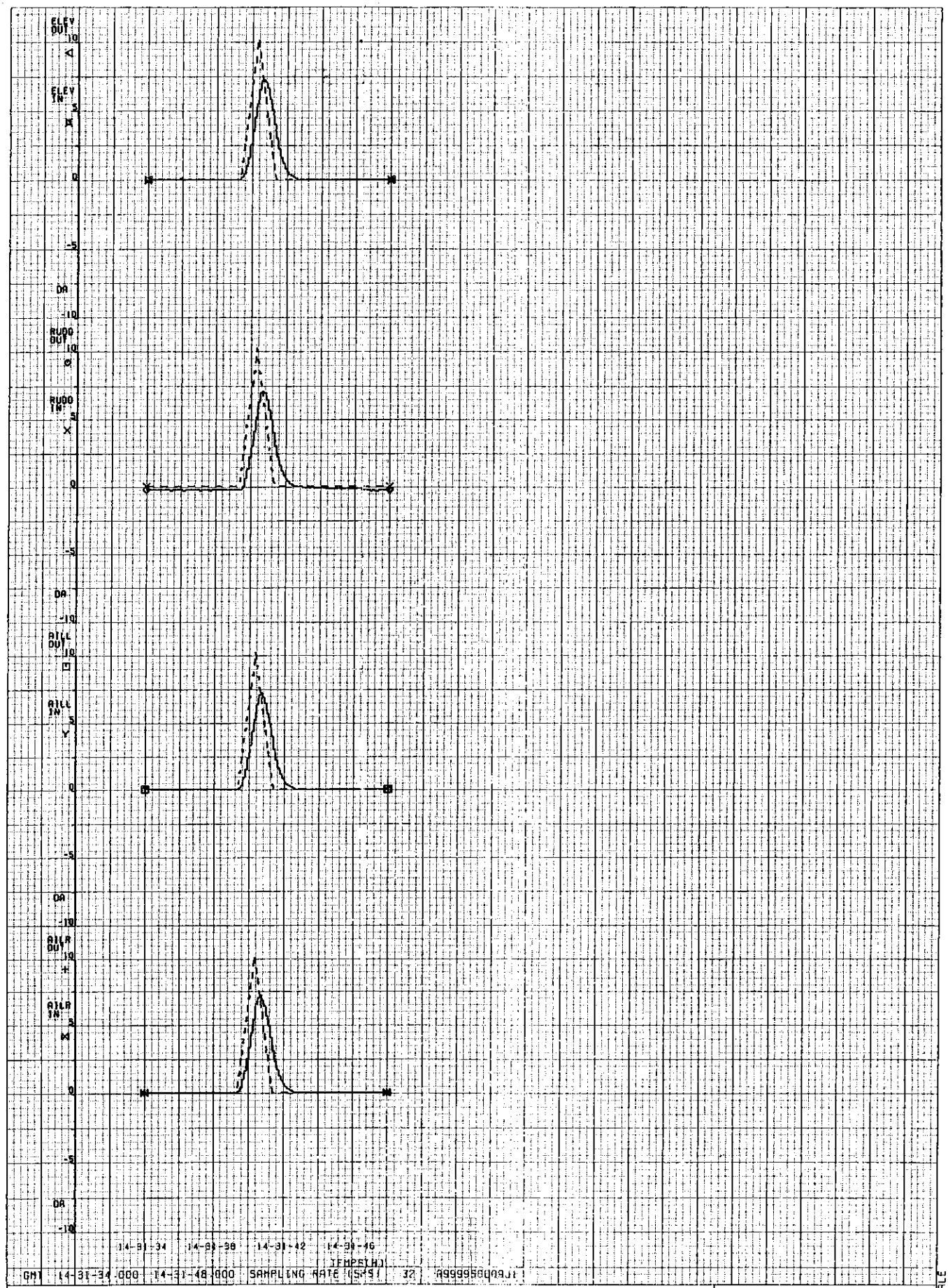
AIRCRAFT A9999 FIGURE 3.3.6

AEROSPATIALE

310-3 SERIE/SDACAAL.AD

008231

AVIC



FLIGHT S0009 TEST 3.4 FTI

A-NTSB

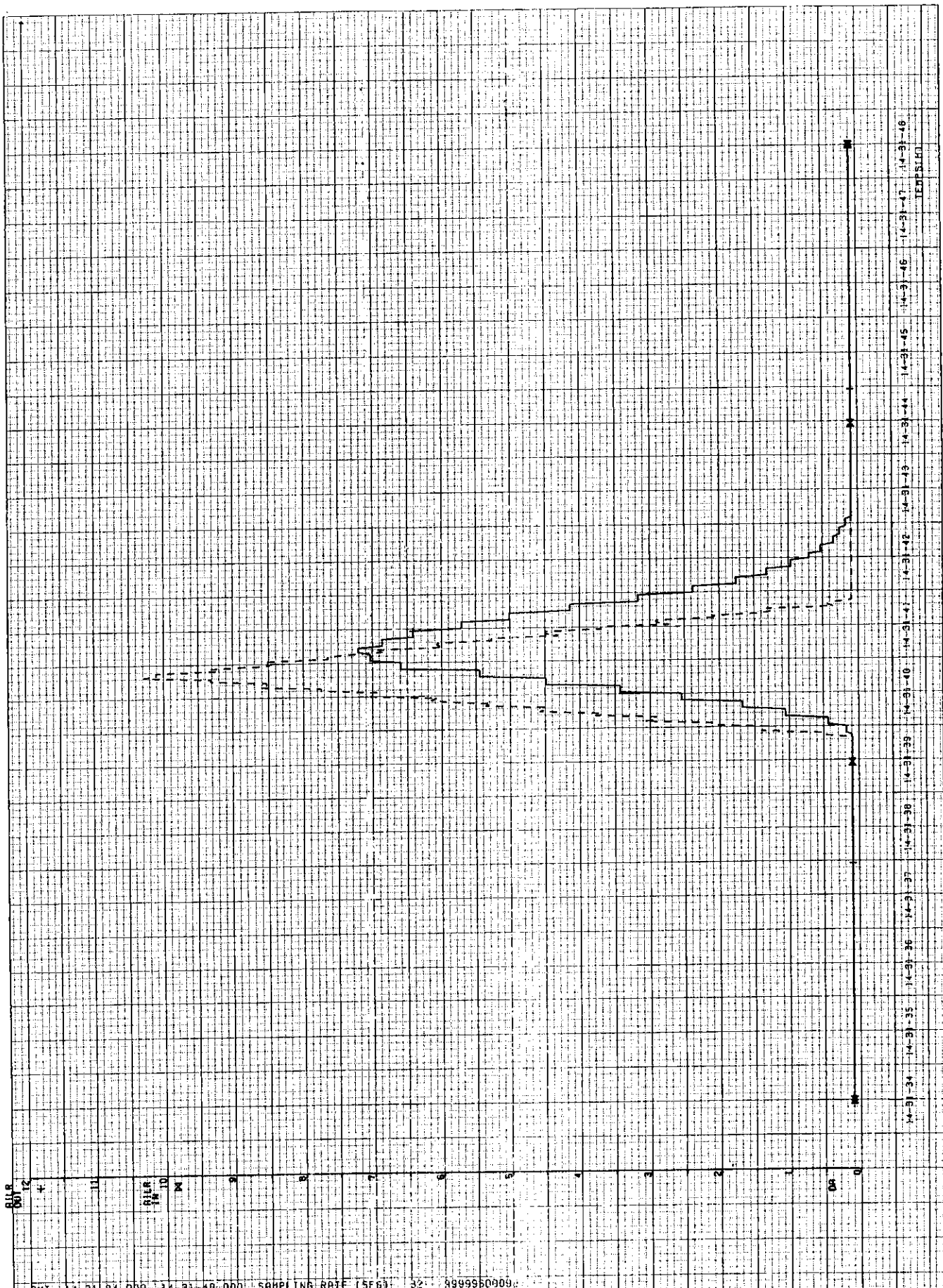
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.7

© AEROSPATIALE

808232

AVIC



FLIGHT S0009 TEST 3.4 FTI

AEROSPATIALE
FLIGHT TESTS

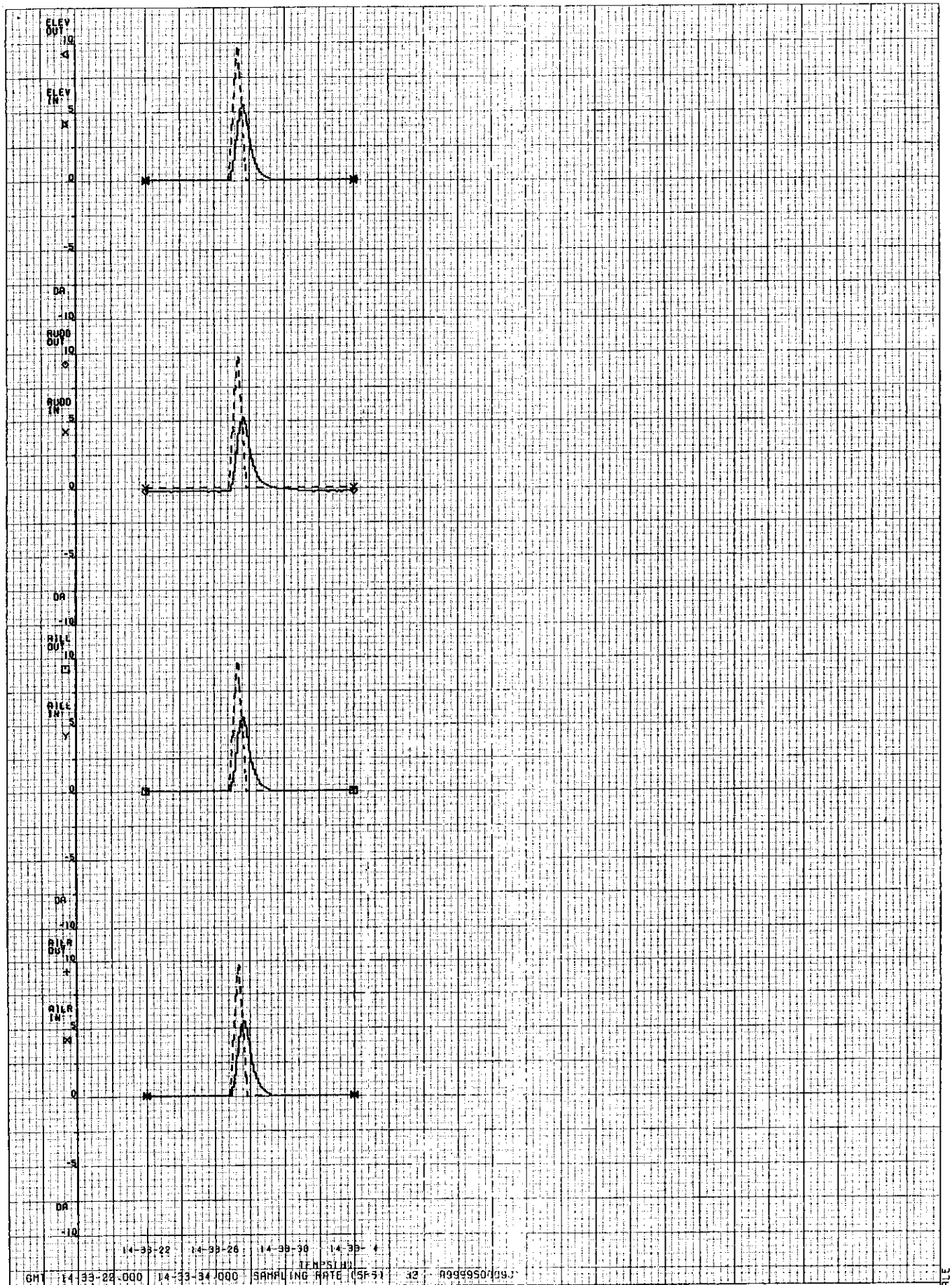
AIRCRAFT A9999 FIGURE 3.3.8

A-NTSB

(C) AEROSPATIALE

310.3 SERIE/SDACAAL.AD

008233



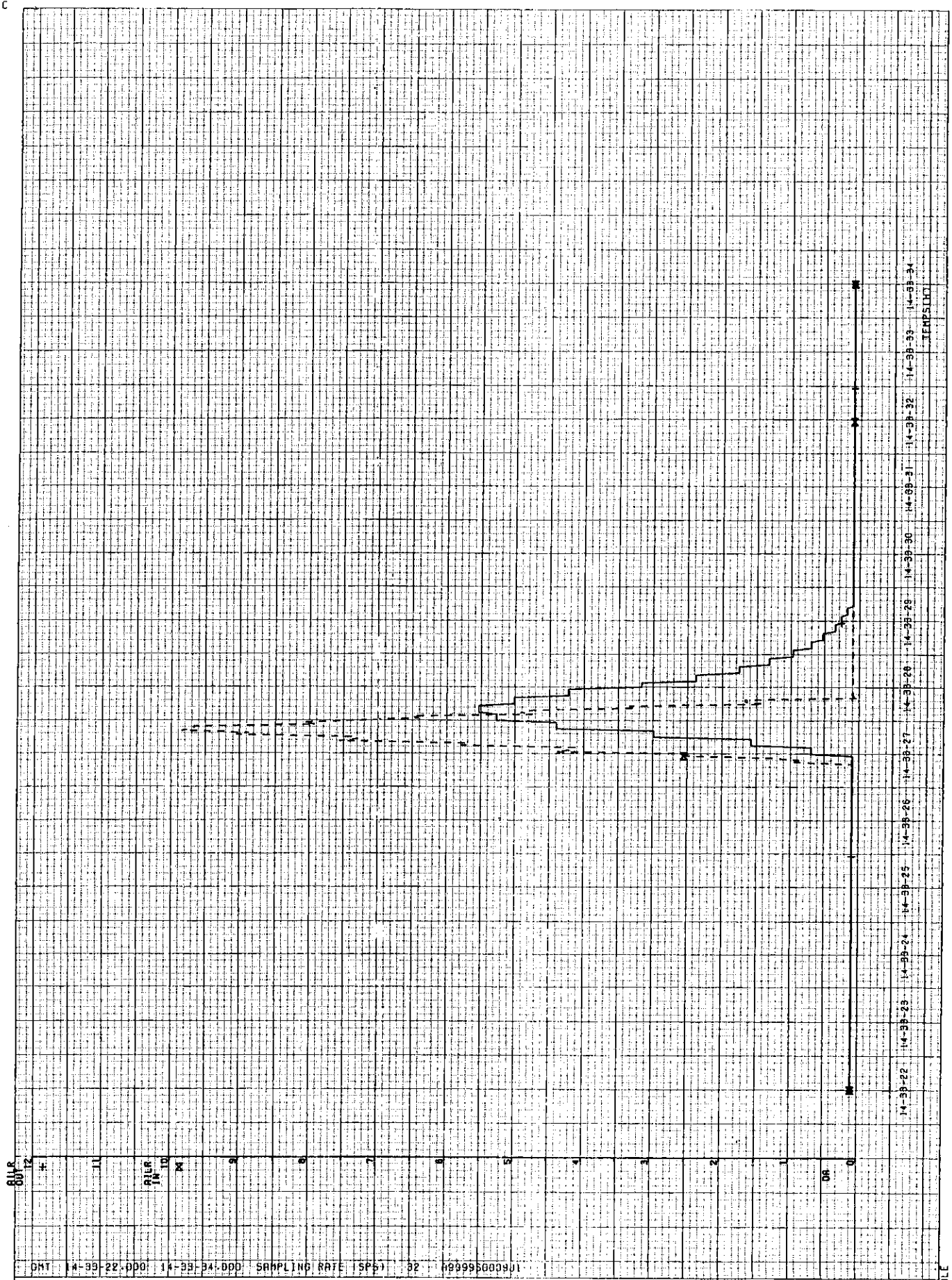
FLIGHT S0009 TEST 3.5 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 339

(C) AEROSPATIALE



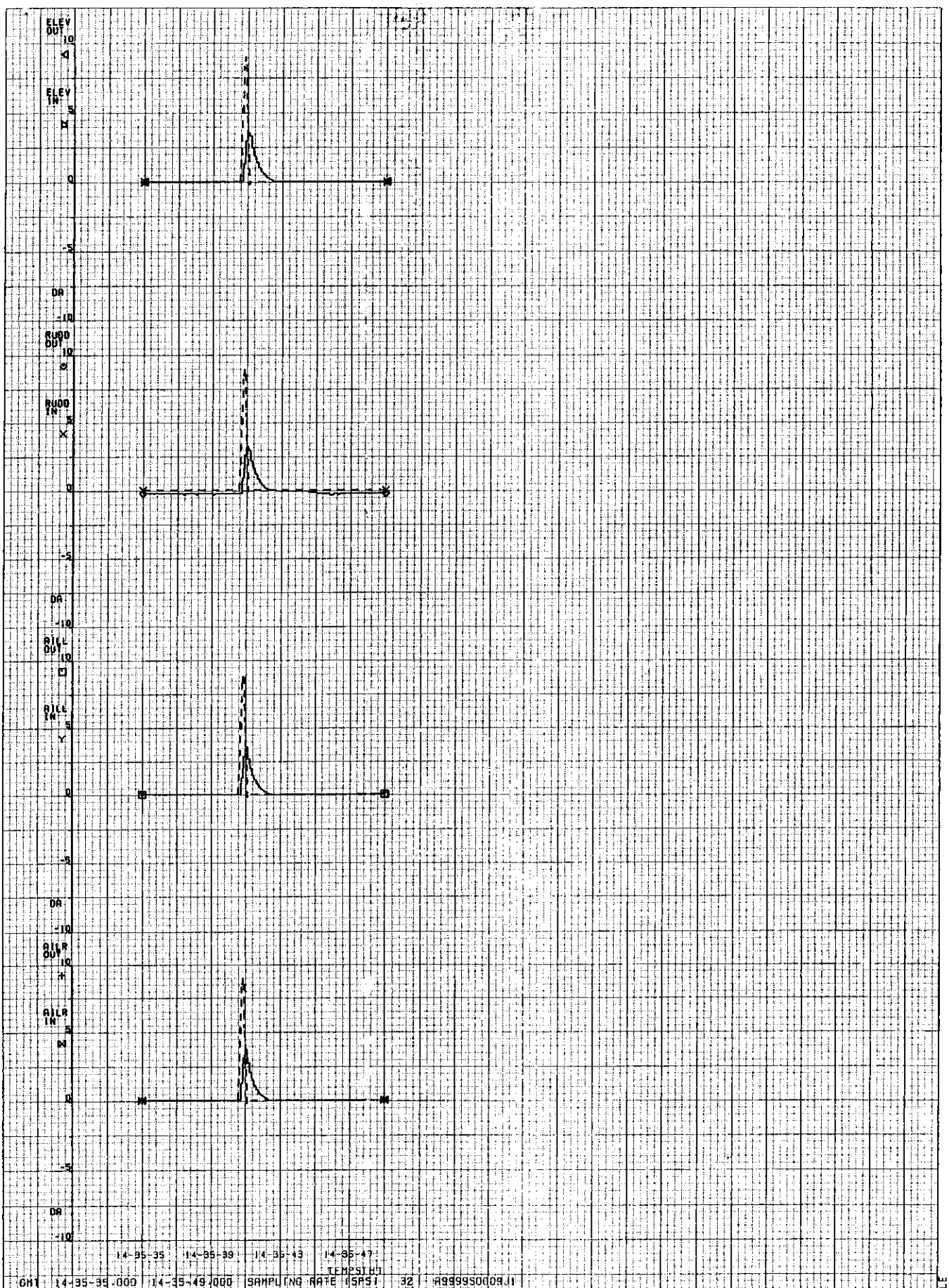
FLIGHT S0009 TEST 3.5 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.10

008235



FLIGHT S0009 TEST 3.6 FTI

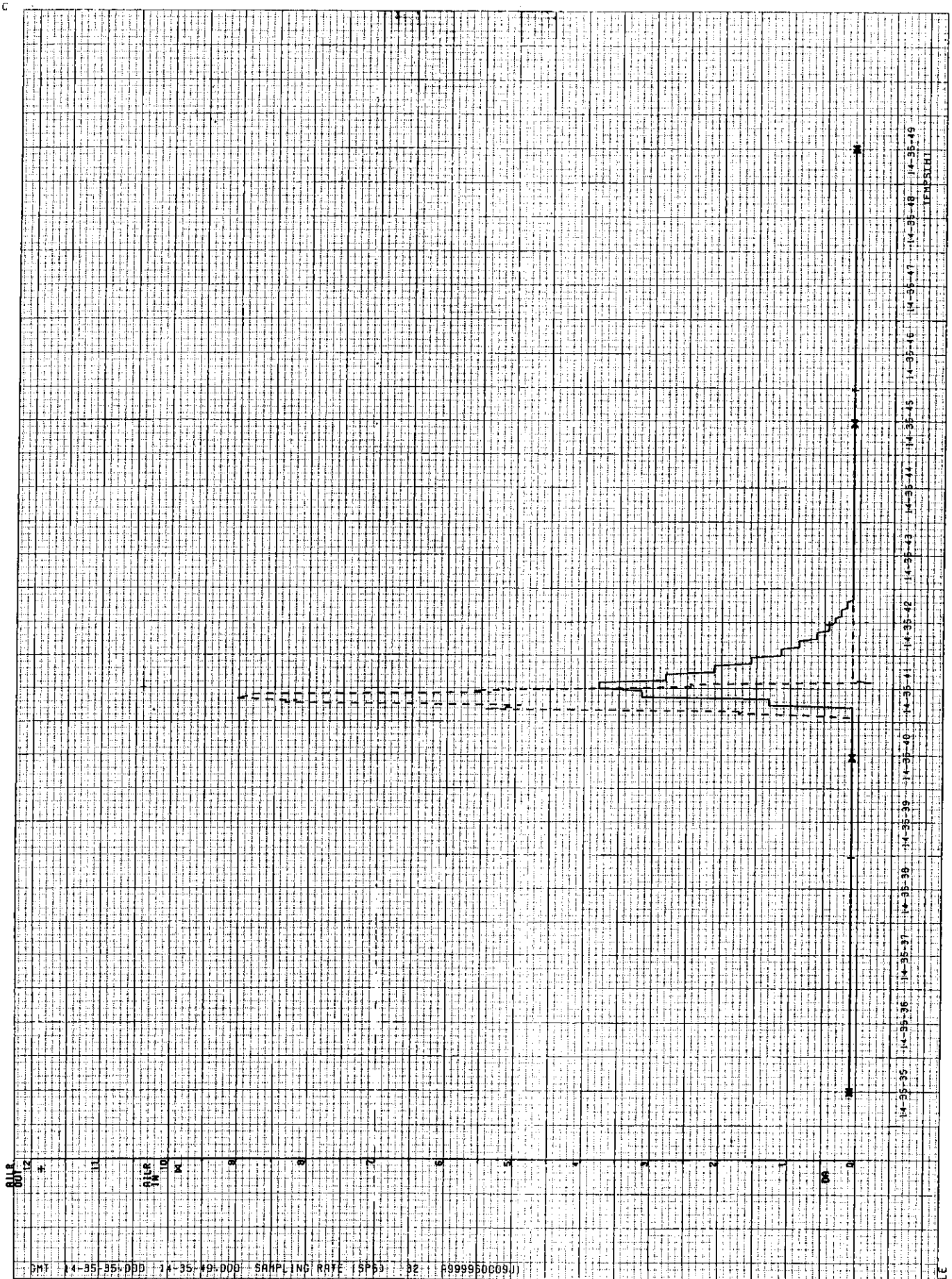
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.11

IC: AEROSPATIALE

AVIC



FLIGHT S0009 TEST 3.6 FTI

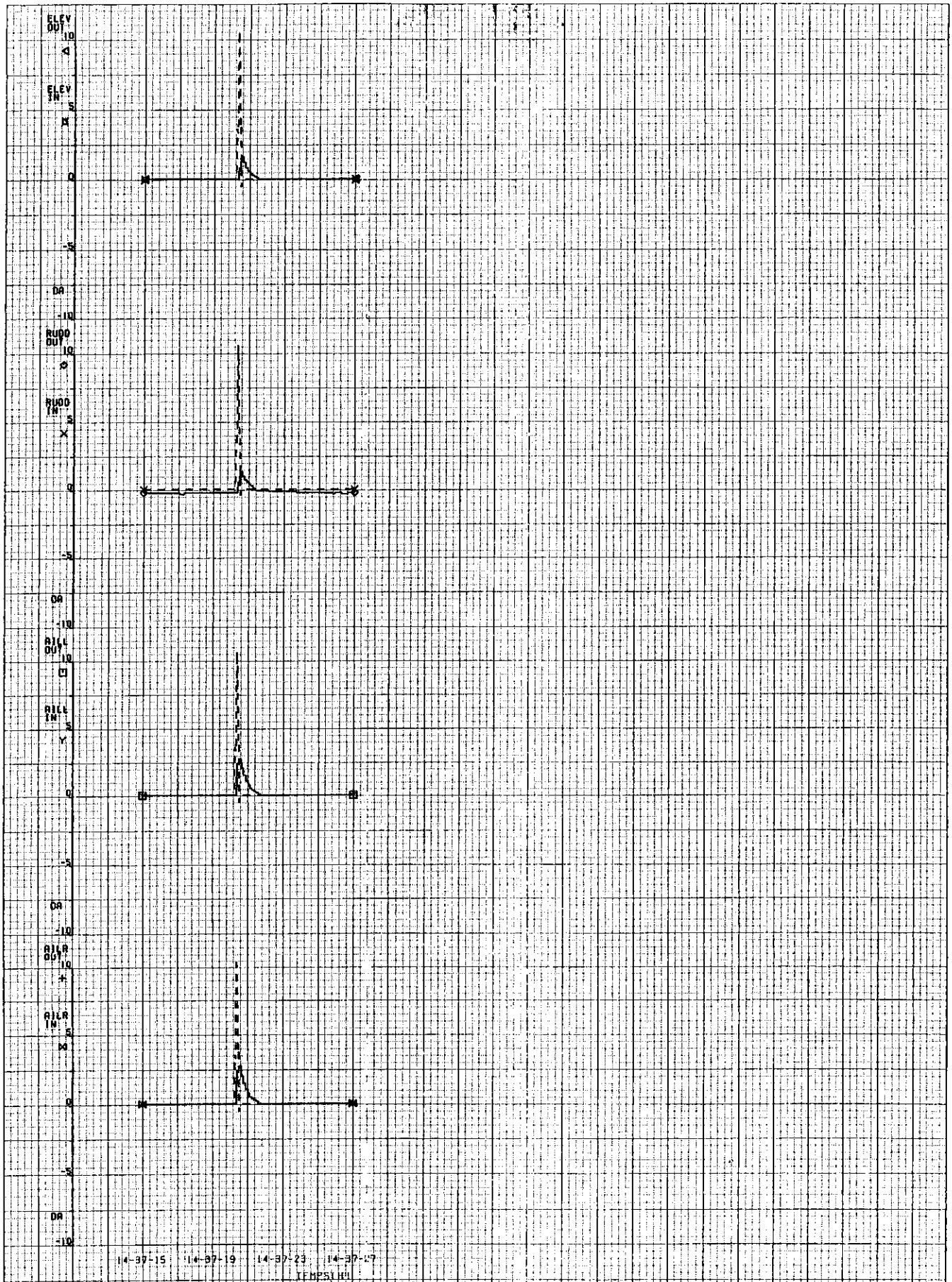
AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 33.12

(C) AEROSPATIALE

310.3 SERIE/SOACAAL.AD



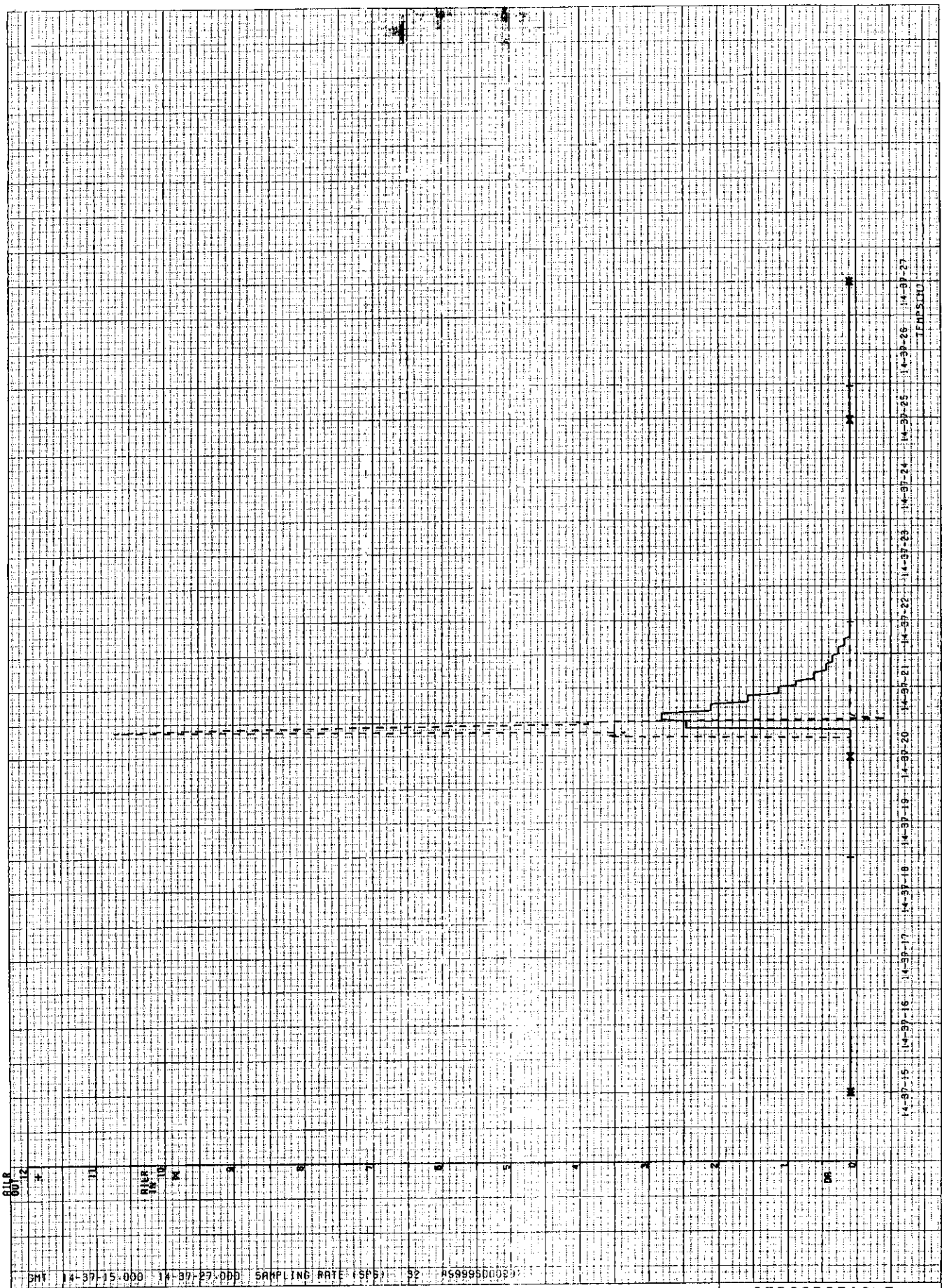
FLIGHT S0009 TEST 3.7 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.3.13

AVIC



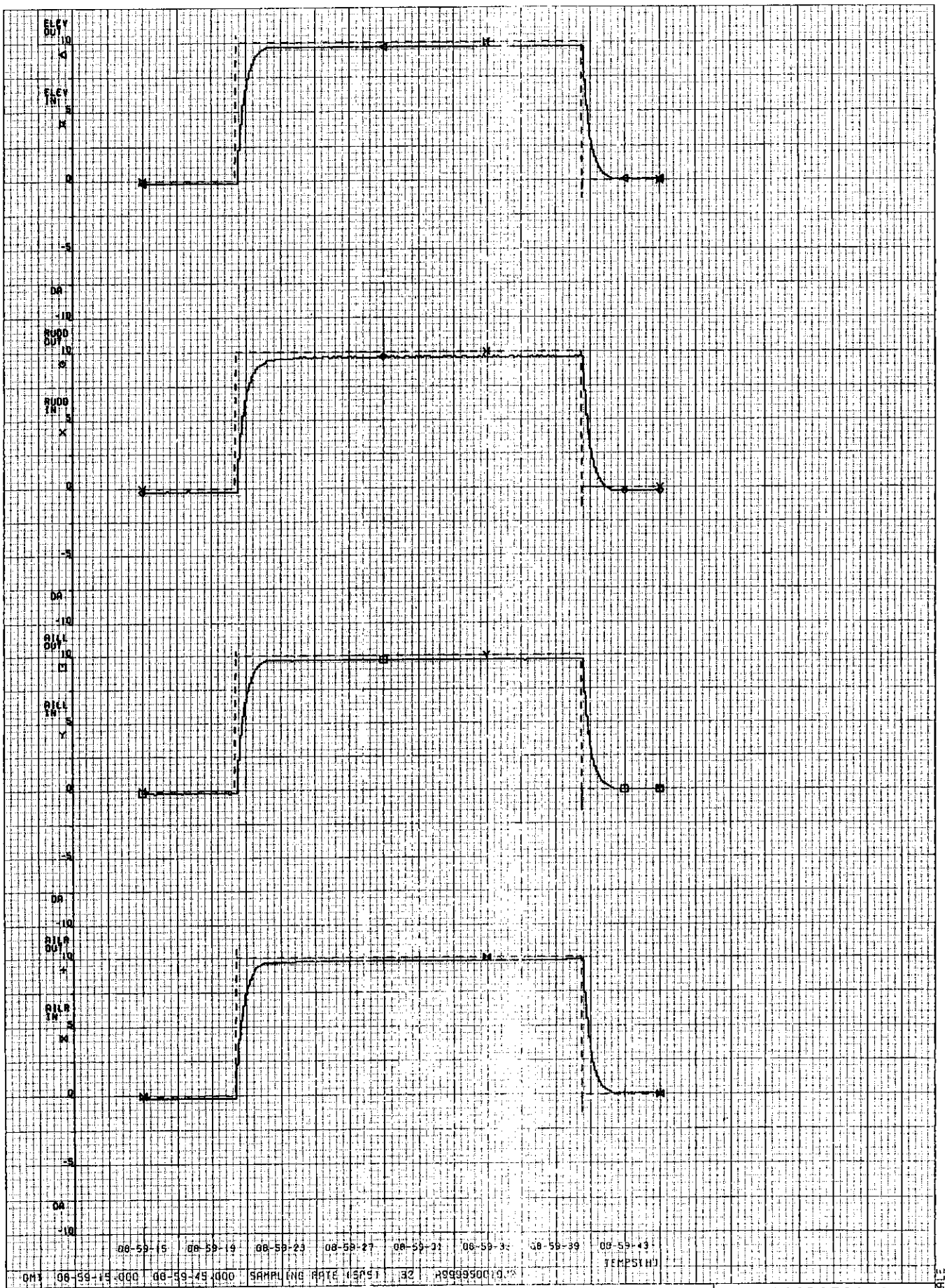
FLIGHT S0009 TEST 3.7 FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3.3.14

ANNEX 3.4:
Test series n°4



FLIGHT S0010 TEST 4.1 FIRST TRY FTI

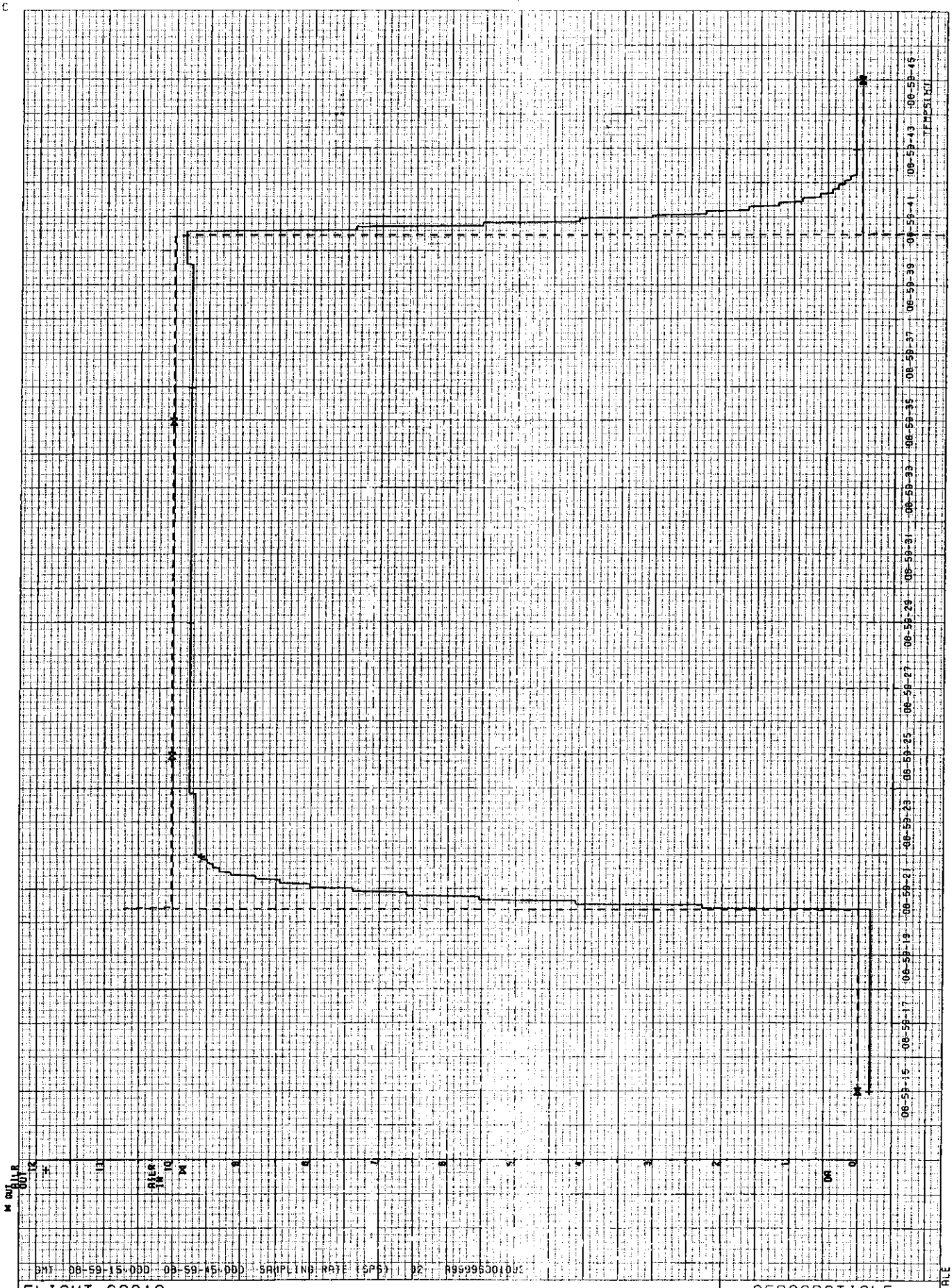
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.1

008241

AVIC



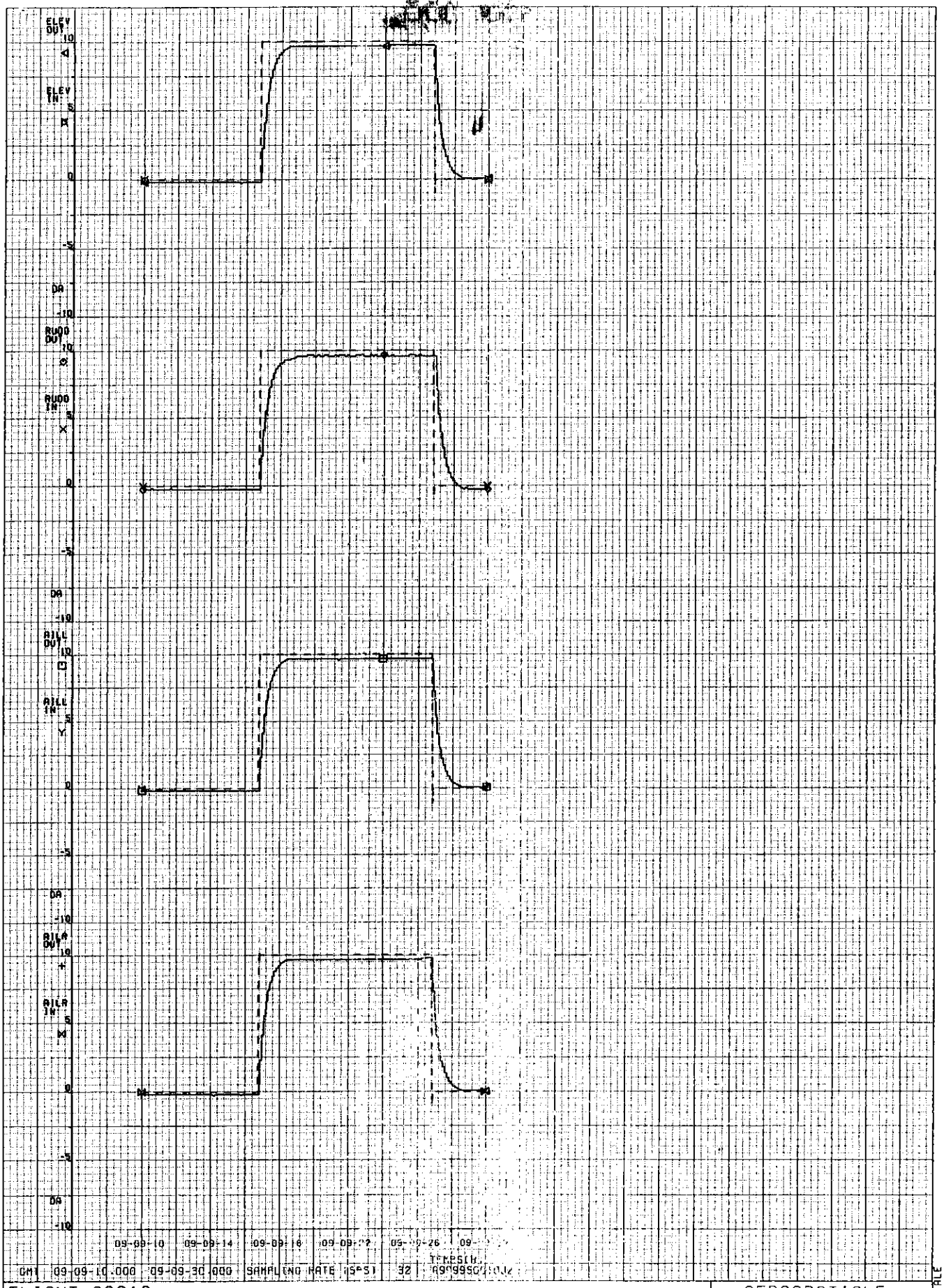
FLIGHT S0010 TEST 4.1 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.2

SERIE/SDACAAL.AO



FLIGHT S0010 TEST 4.2 FIRST TRY FTI

A-NTSB

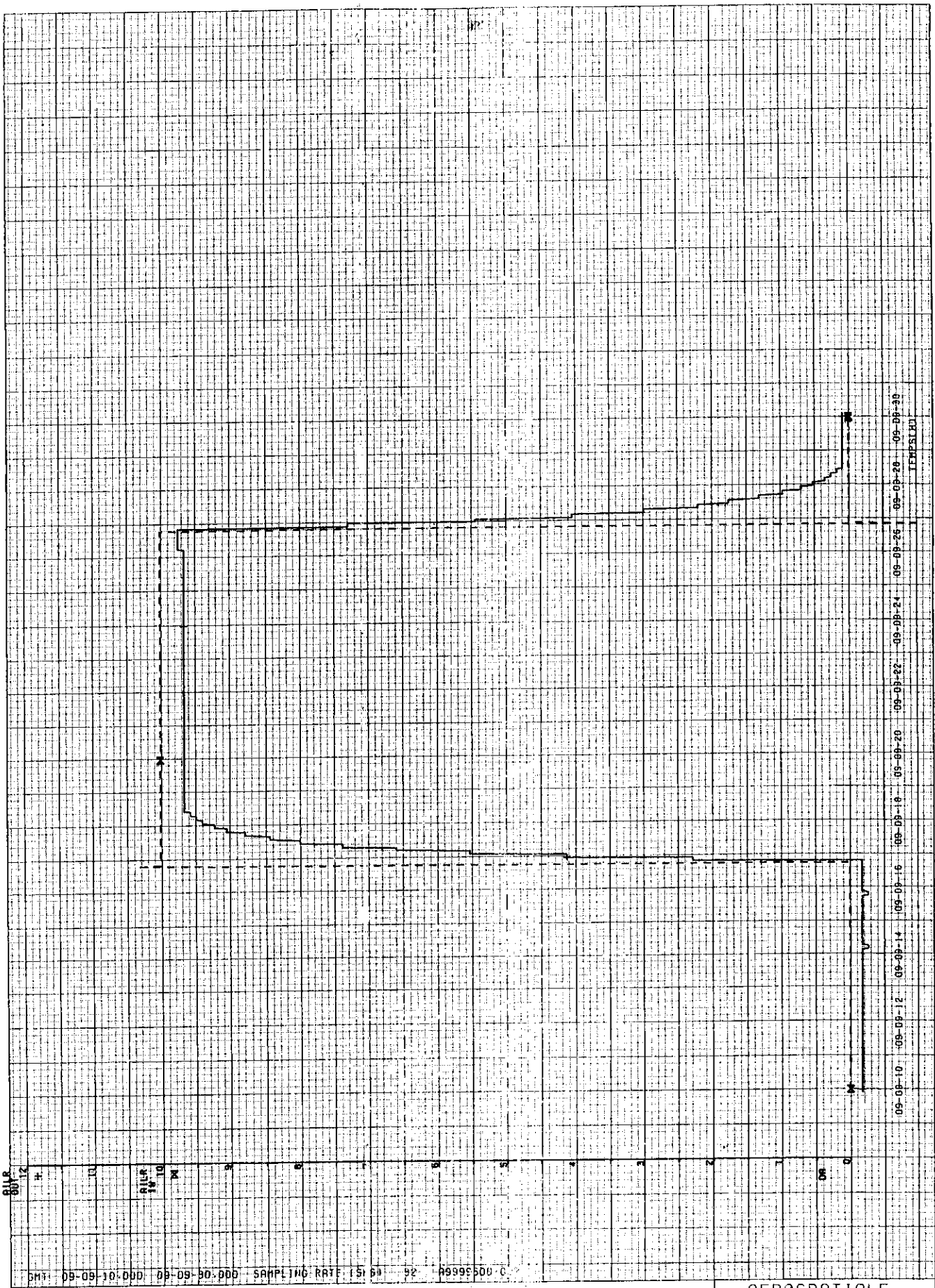
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.3

(C) AEROSPATIALE

008243

AVIC



FLIGHT S0010 TEST 4.2 FIRST TRY F/I

A-NTSB

AEROSPATIALE
FLIGHT TESTS

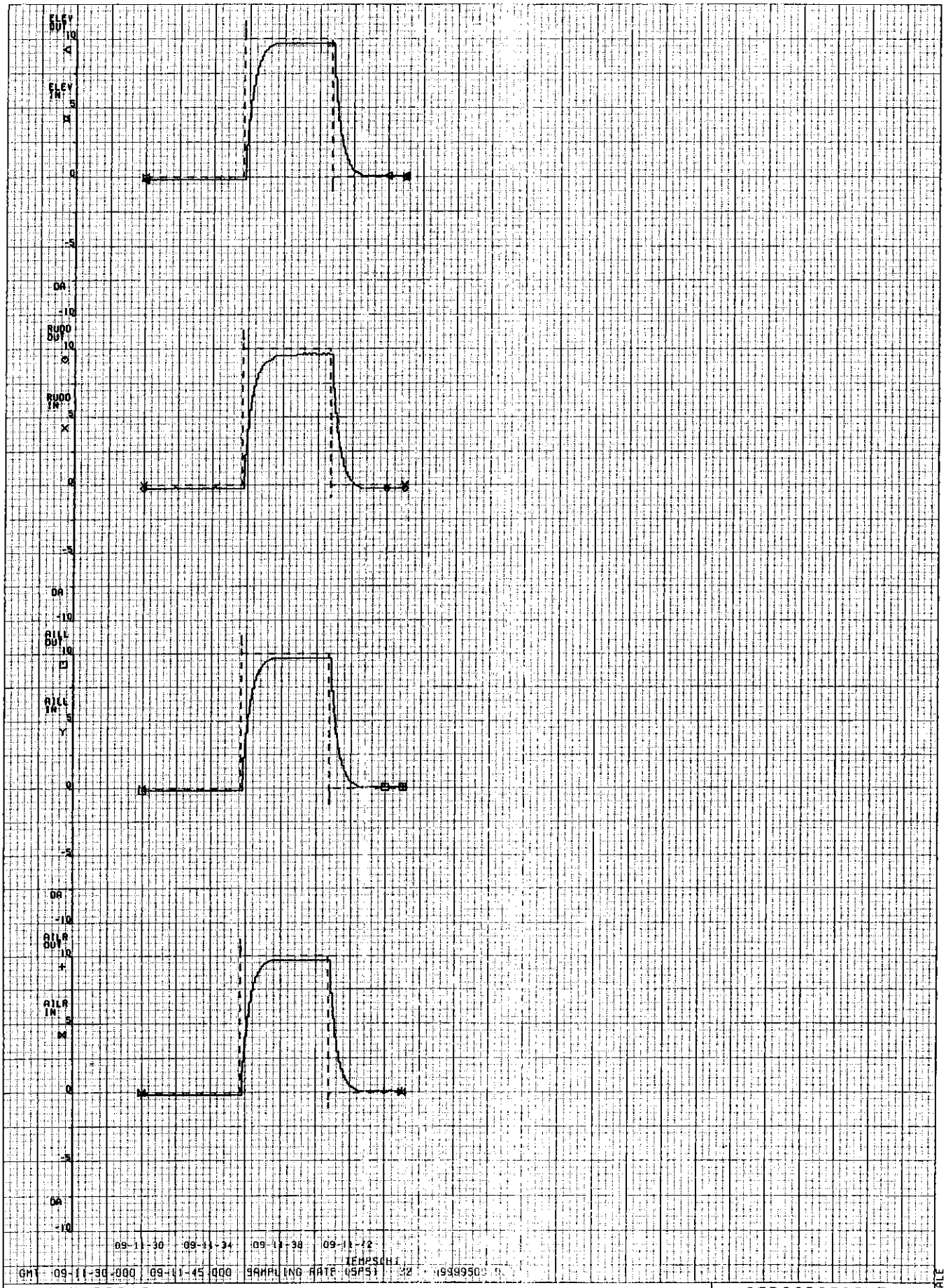
AIRCRAFT A9999 FIGURE 34.4

(C) AEROSPATIALE

310-4 SERIE/SDACAAL.AD

008244

AVIC



FLIGHT S0010 TEST 4.3 FIRST TRY FT

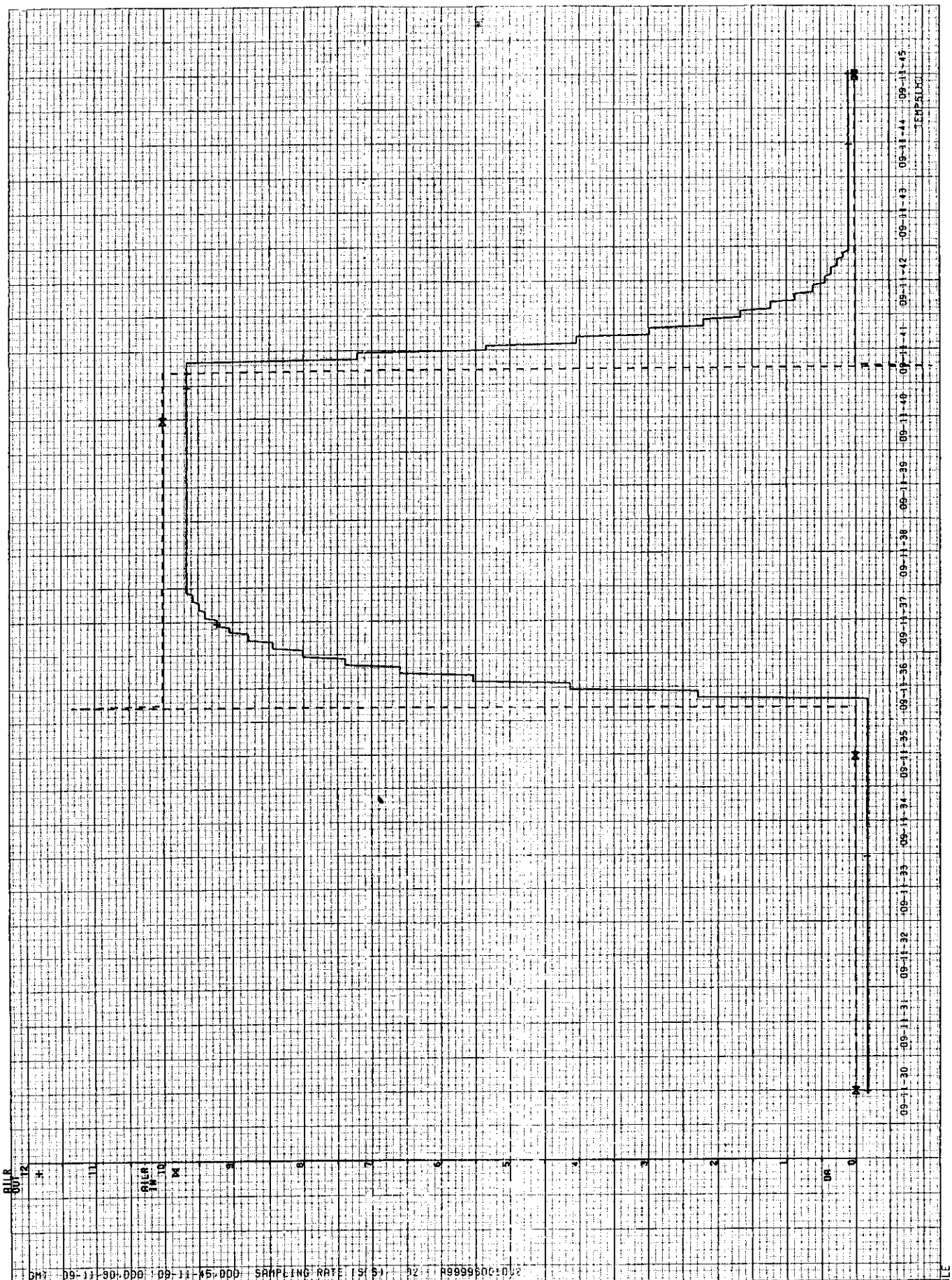
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.5

908245

AVIC



FLIGHT S0010 TEST 4.3 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.6

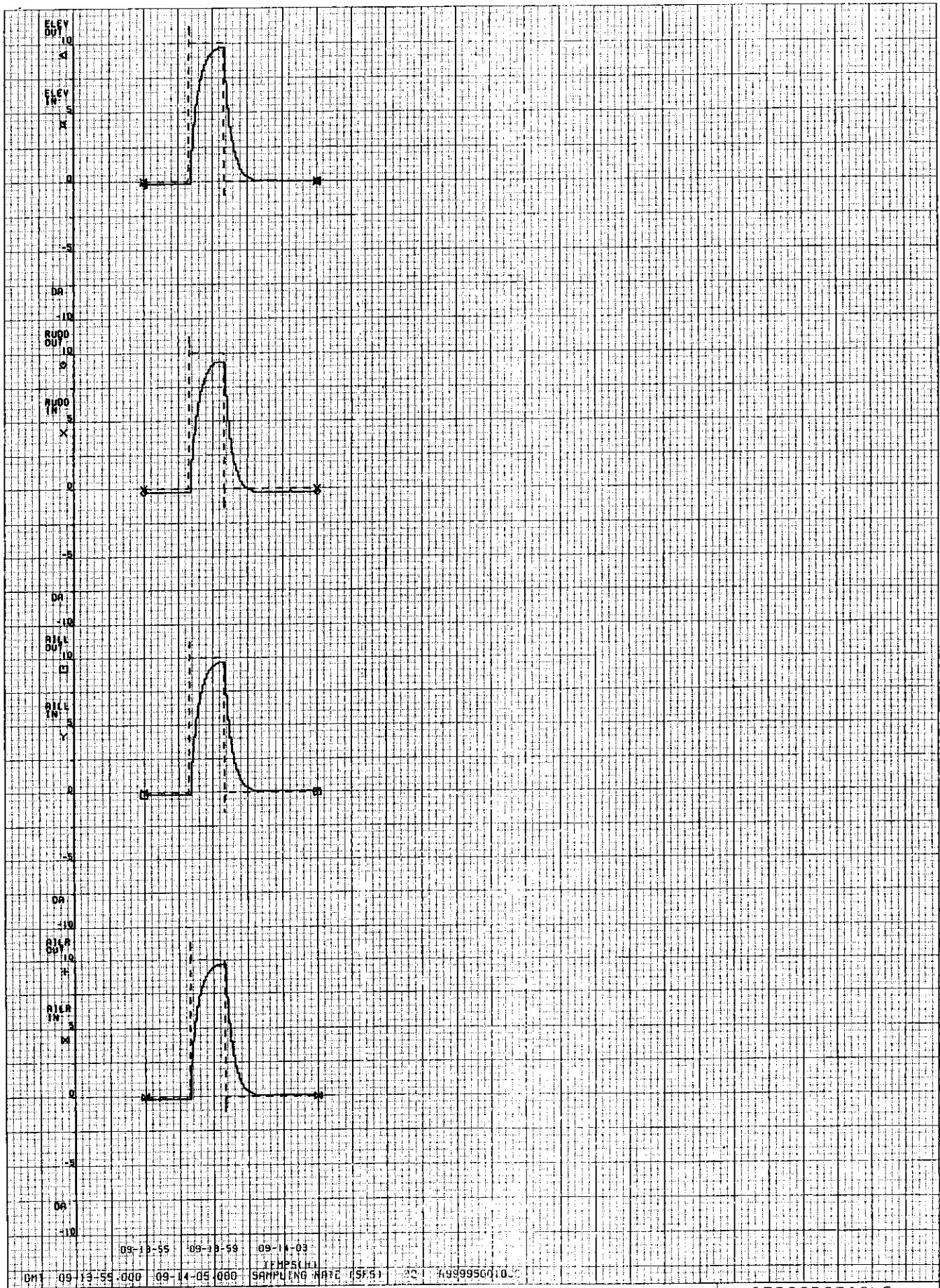
(C) AEROSPATIALE

A-NTSB

310.4 SERIE/SDACAAL.AD

008246

AVIC



FLIGHT S0010 TEST 4.4 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

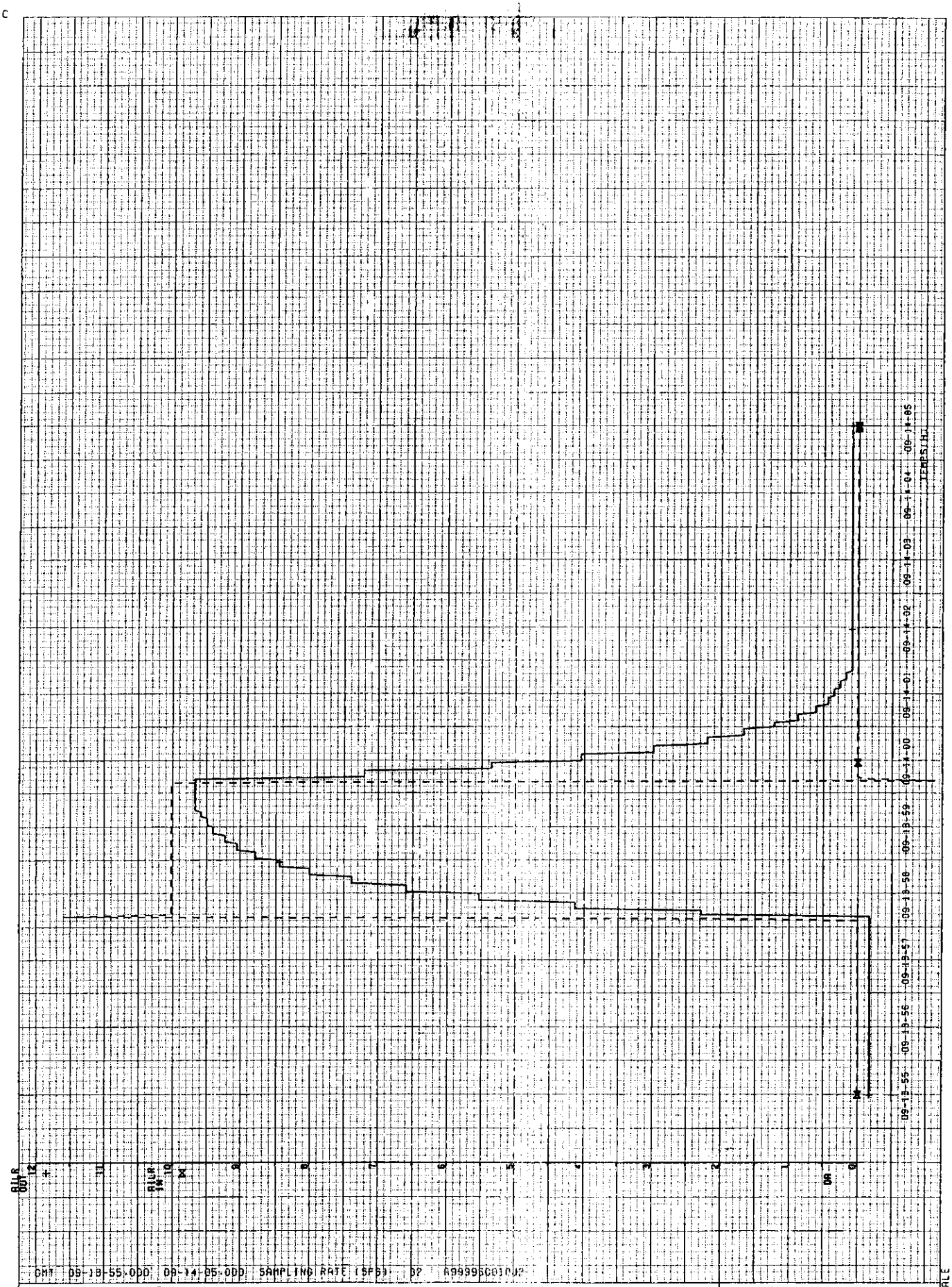
AIRCRAFT A9999 FIGURE 3.4.7

© AEROSPATIALE

005.4 SERIE/SDACAAL.AD

008247

AVIC



FLIGHT S0010 TEST 4.4 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

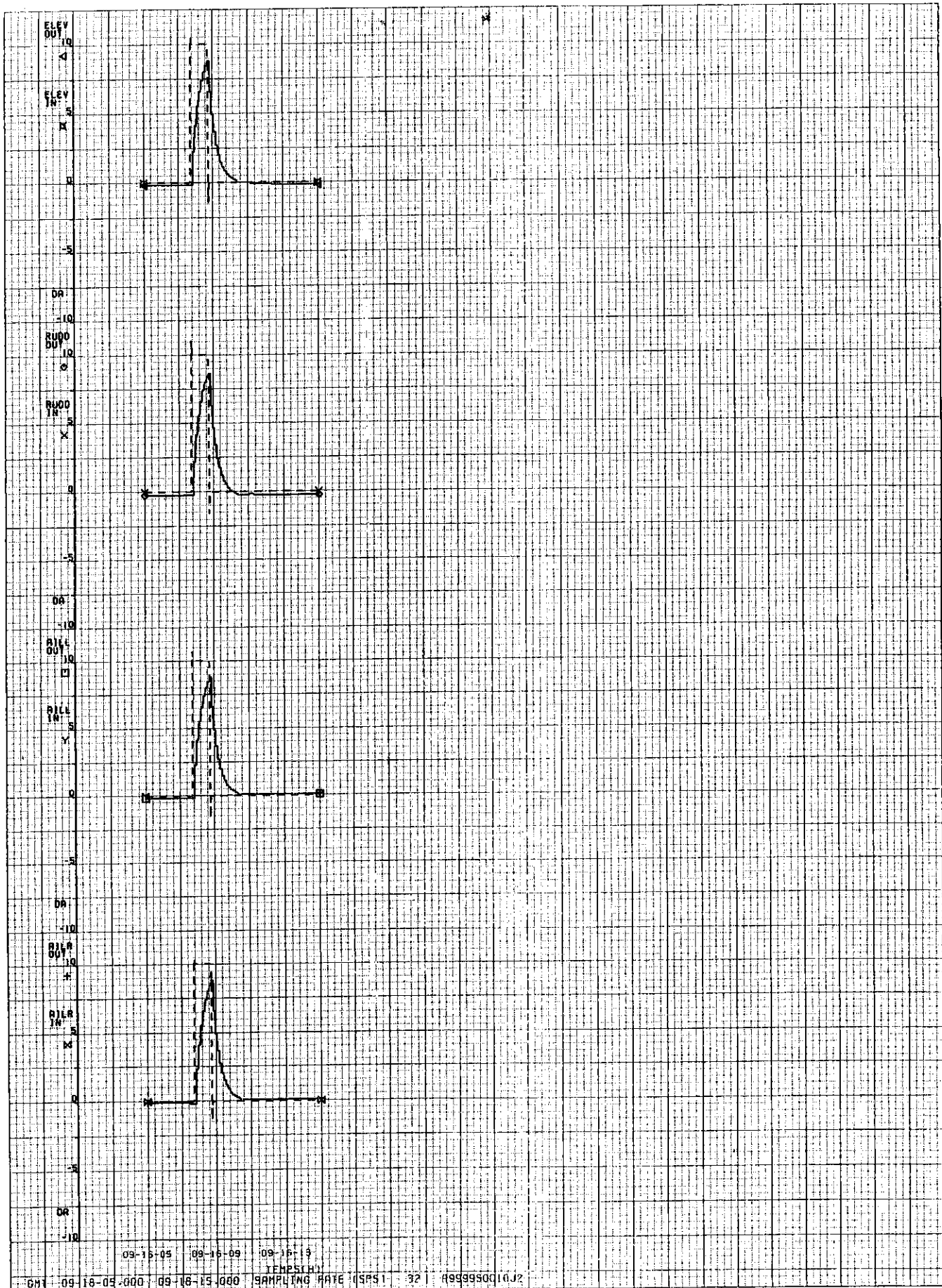
AIRCRAFT A9999 FIGURE 3.4.8

(C) AEROSPATIALE

310.4 SERIE/SDACARL.AB

008248

AVIC



FLIGHT S0010 TEST 4.5 FIRST TRY FT1

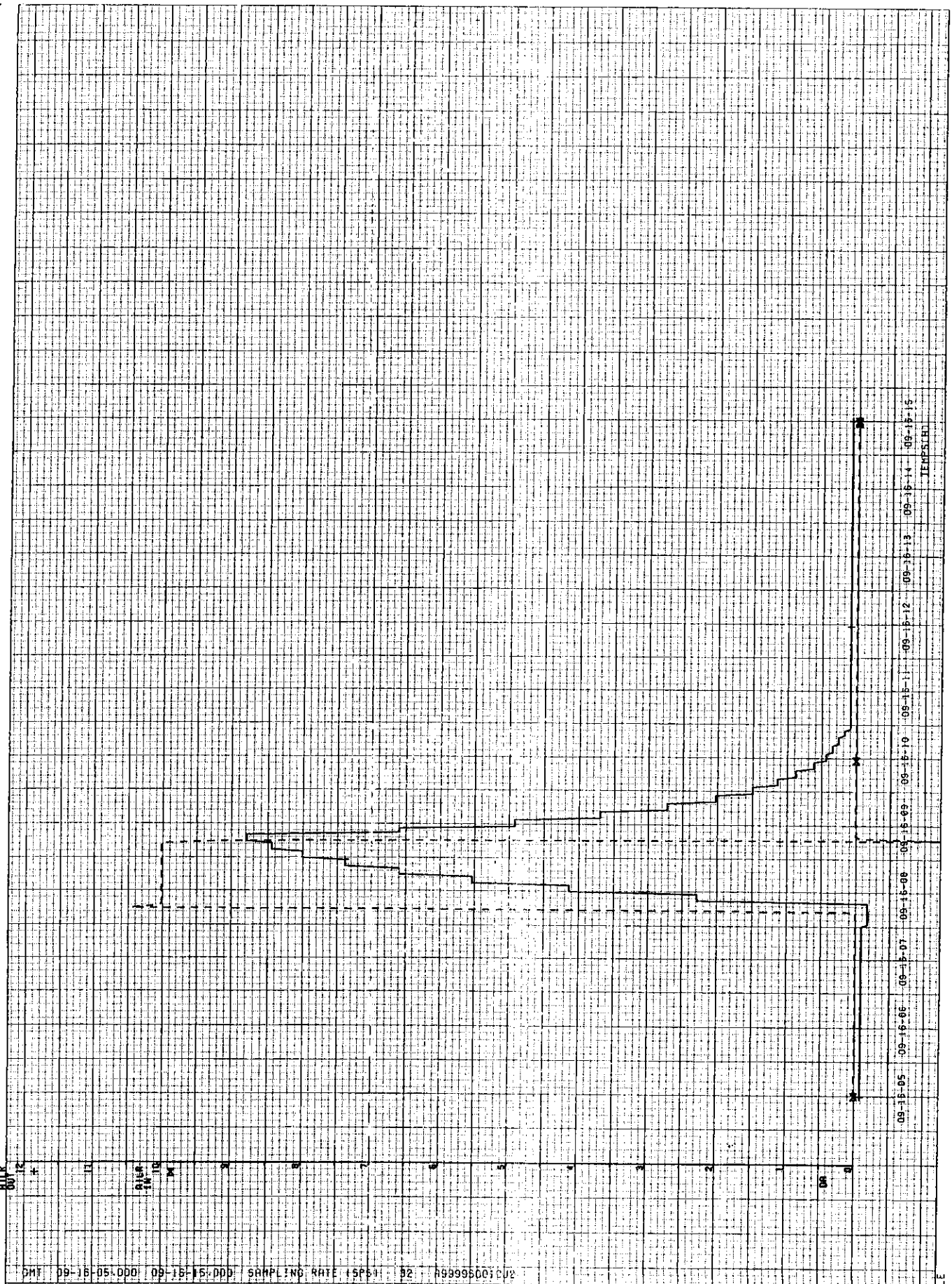
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.9

SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 4.5 FIRST TRY FTI

A-NTSB

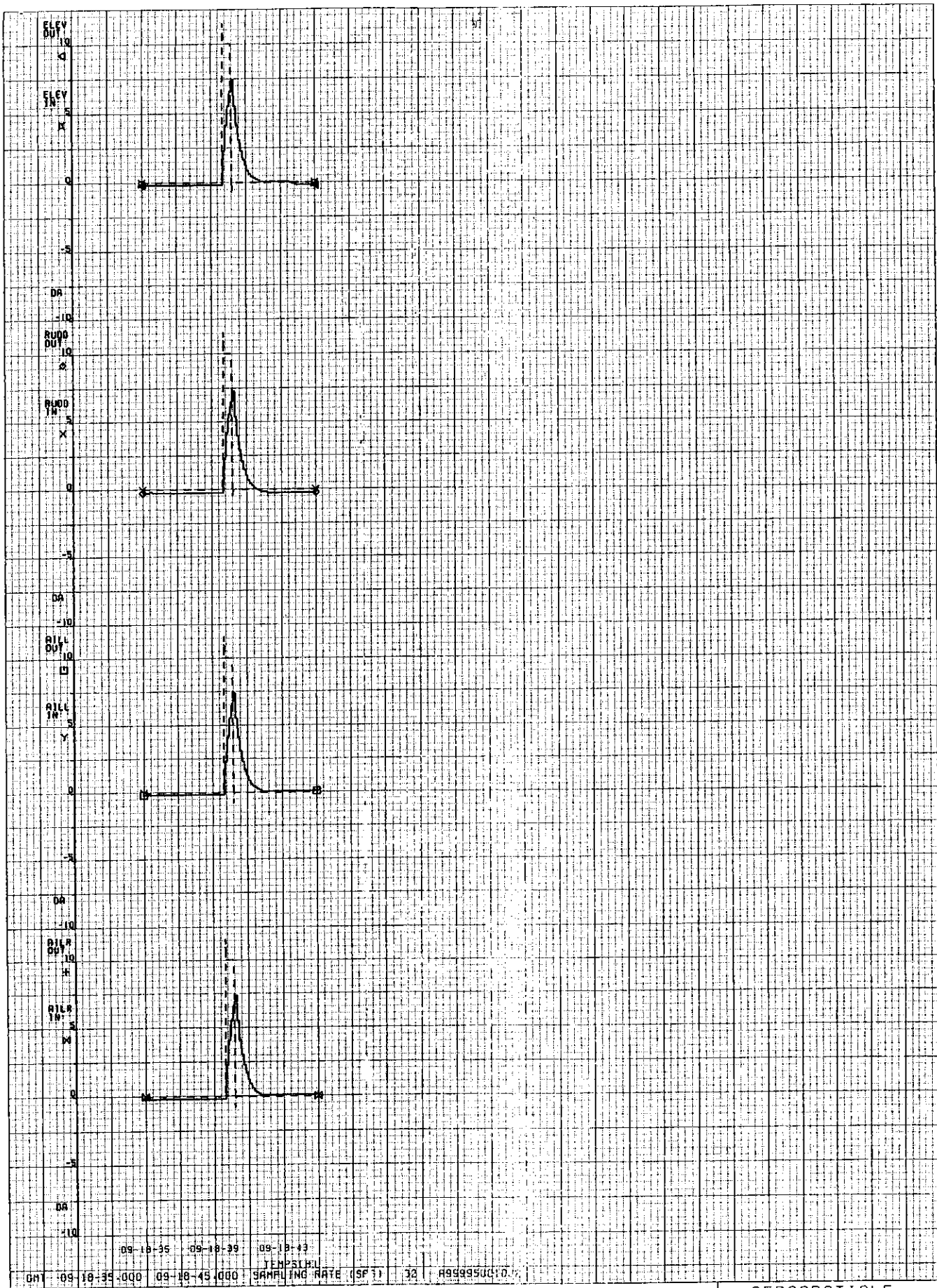
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.10

© AEROSPATIALE

310.4 SERIE/SDACRAL.AD

008250



FLIGHT S0010 TEST 4.6 FIRST TRY FTI

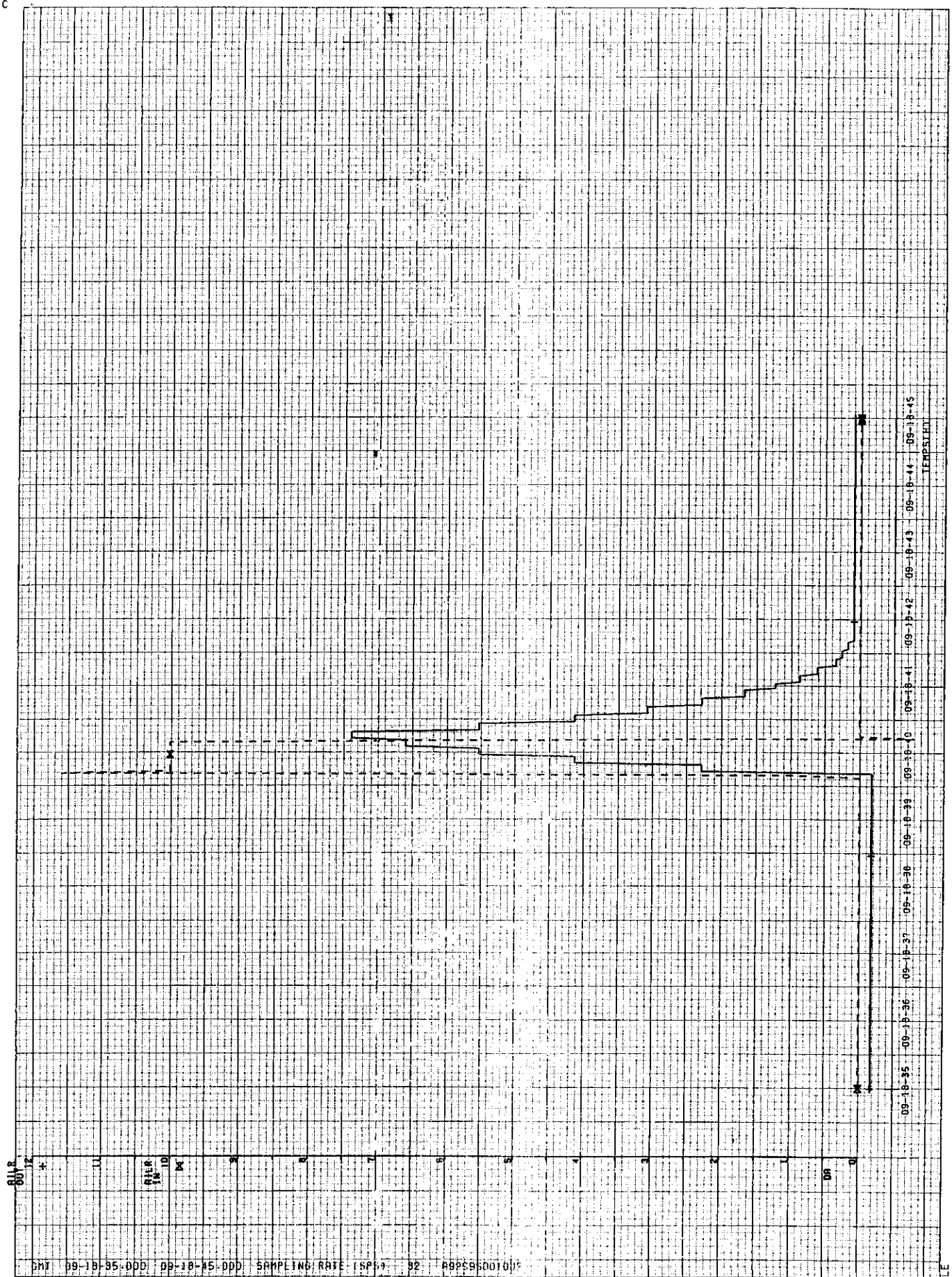
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.1

008251

AVIC



FLIGHT S0010 TEST 4.6 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

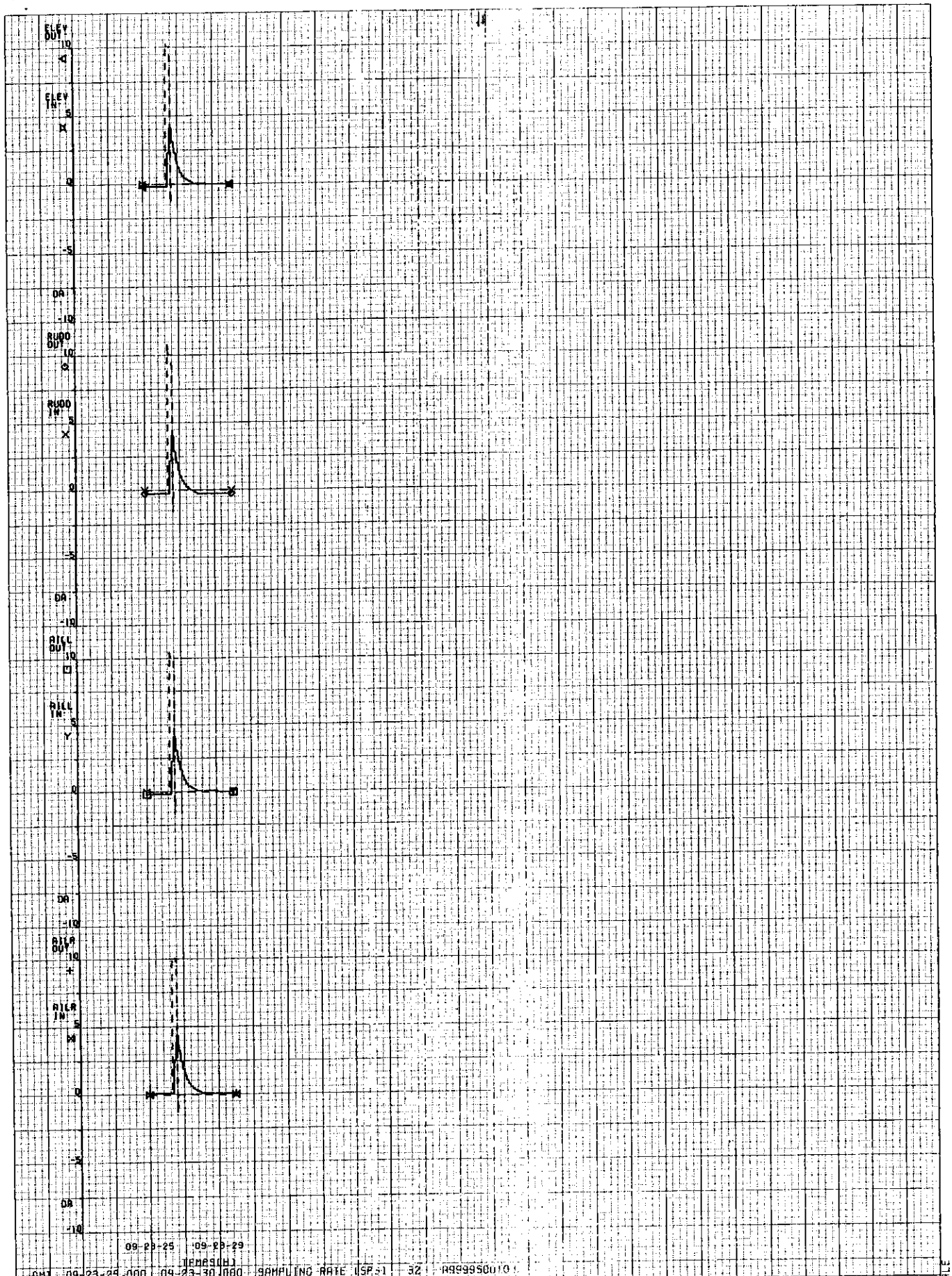
AIRCRAFT A9999 FIGURE 3.4.12

(C) AEROSPATIALE

310.4 SERIE/SOACAAL.AD

008252

AVIC



FLIGHT S0010 TEST 4.7 FIRST TRY FTI

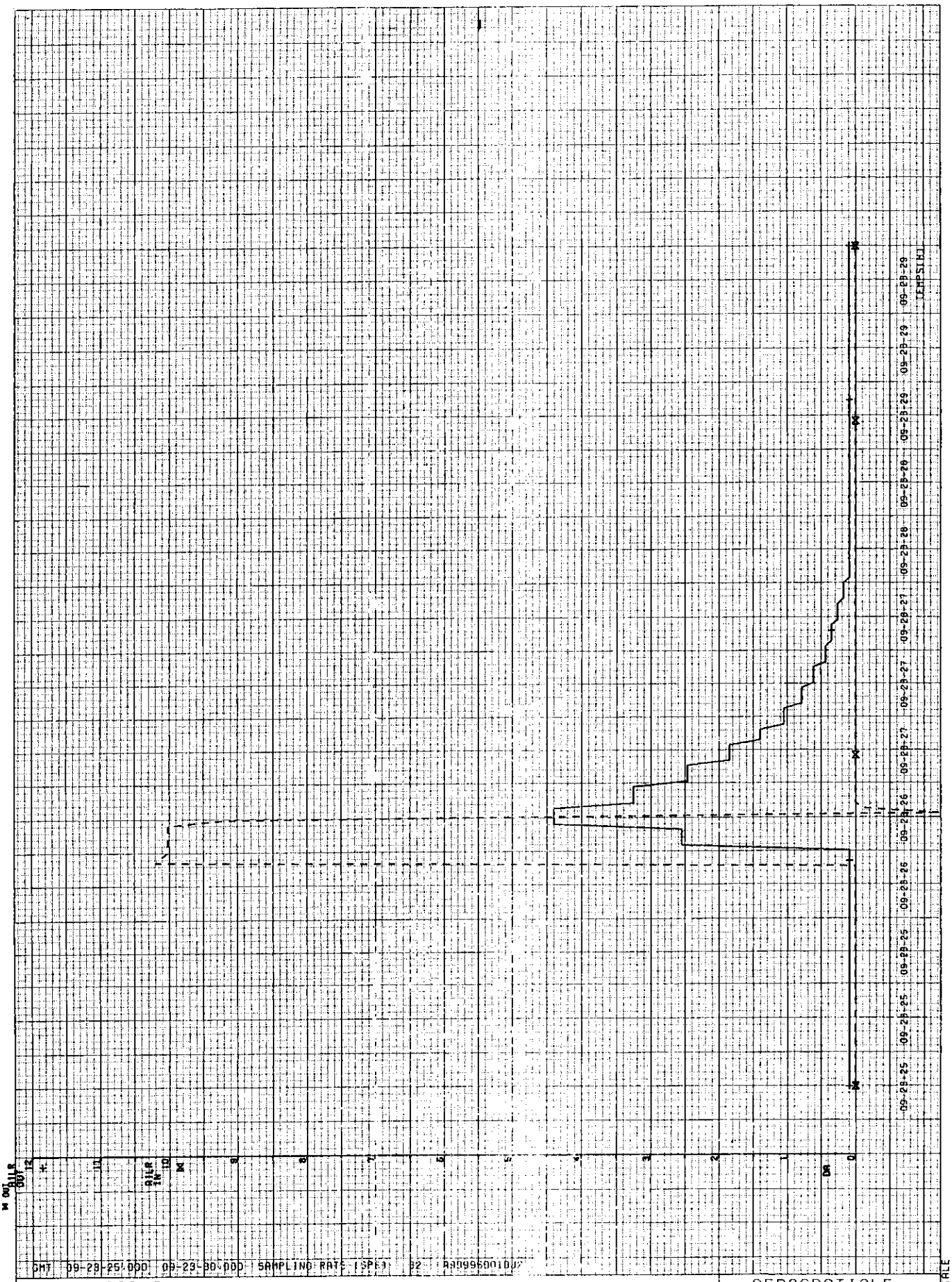
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.13

005.4 SERIE/SDACARL.RD

AVIC



FLIGHT S0010 TEST 4.7 FIRST TRY FT!

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.4.13

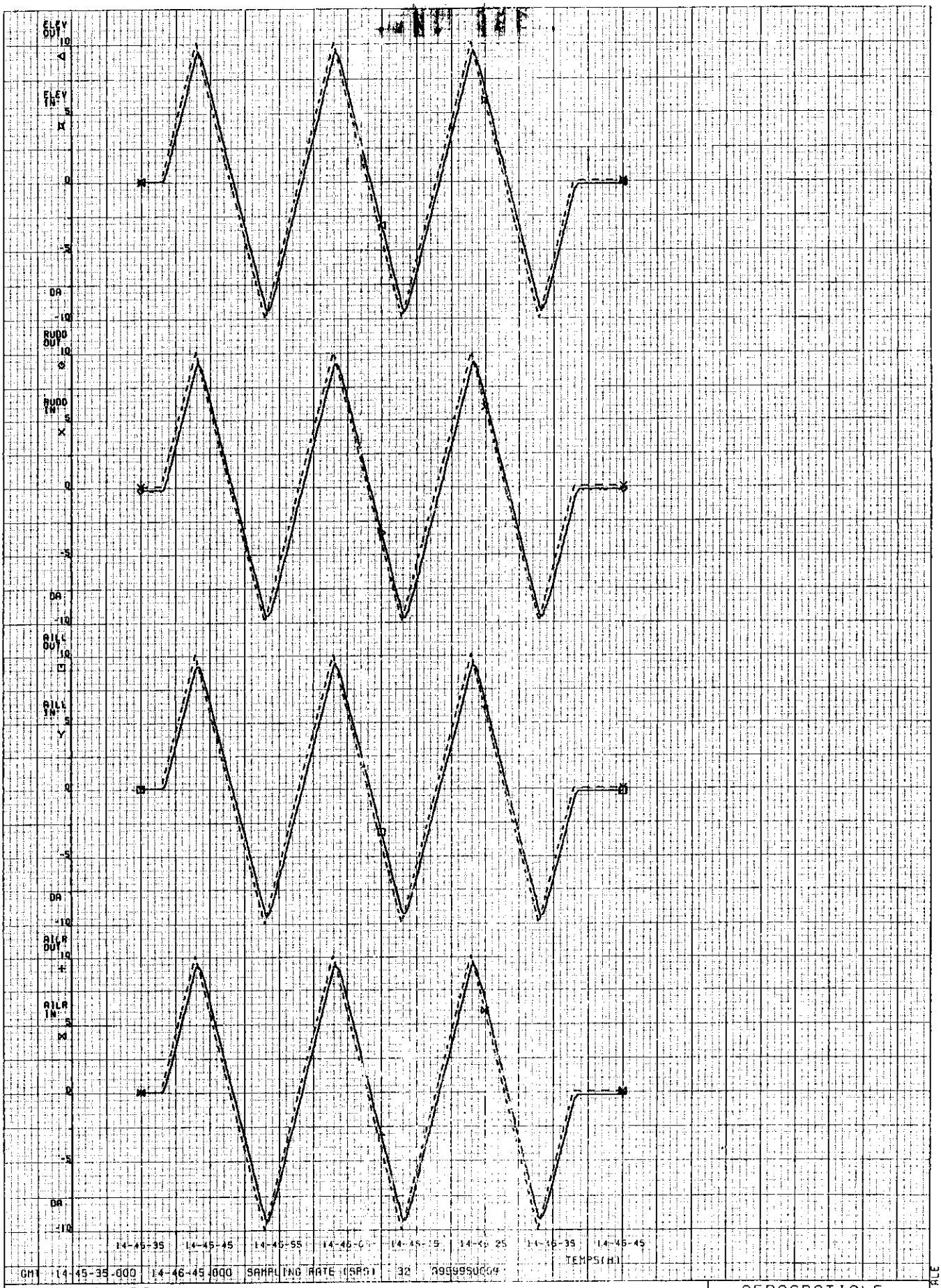
(C) AEROSPATIALE

310-4 SERIE/SDACAAL.AD

008254

ANNEX 3.5:
Test series n°5

AVIC



FLIGHT S0009 TEST 5.1 FTI

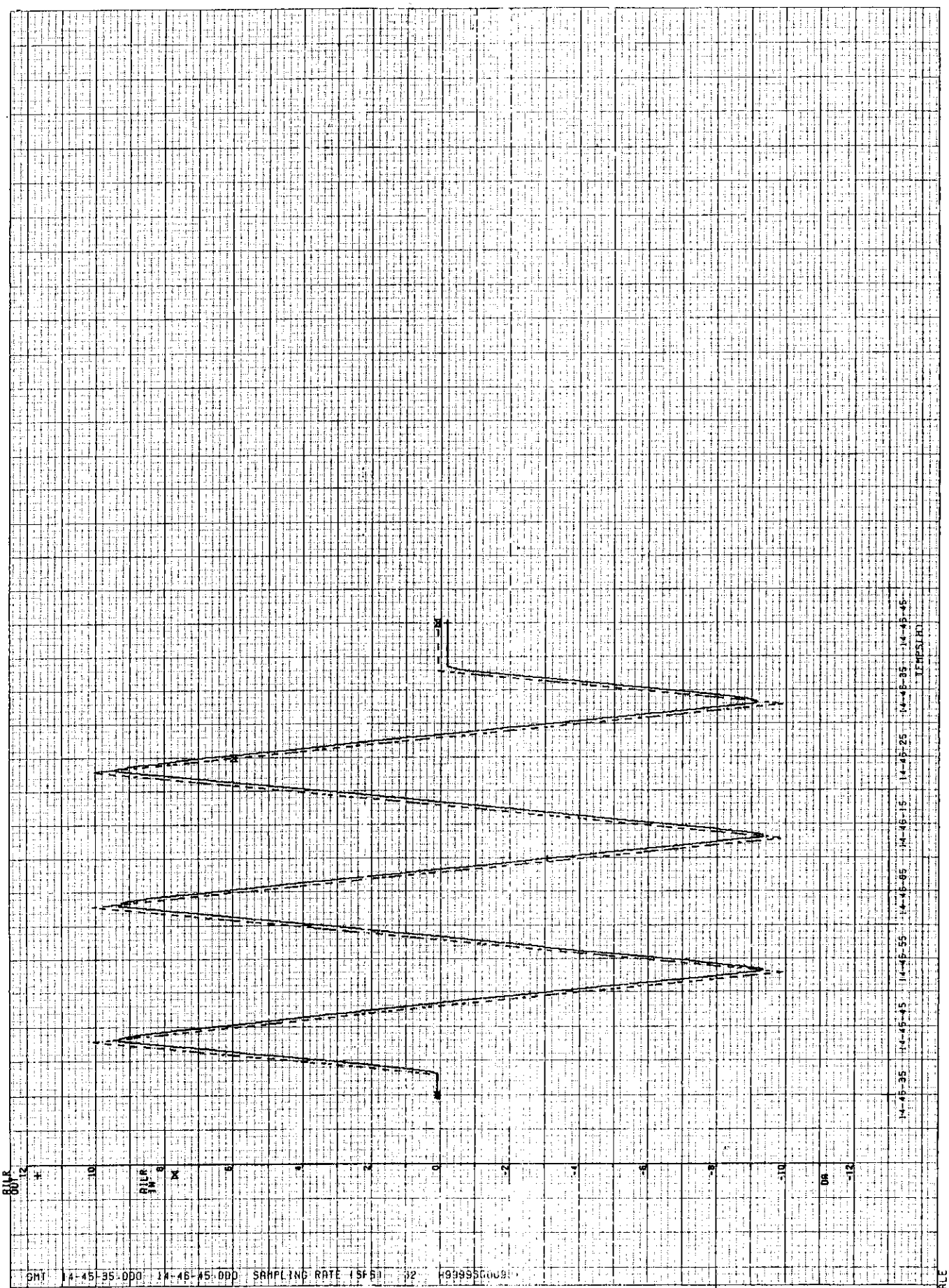
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.1

(C) AEROSPATIALE

008256



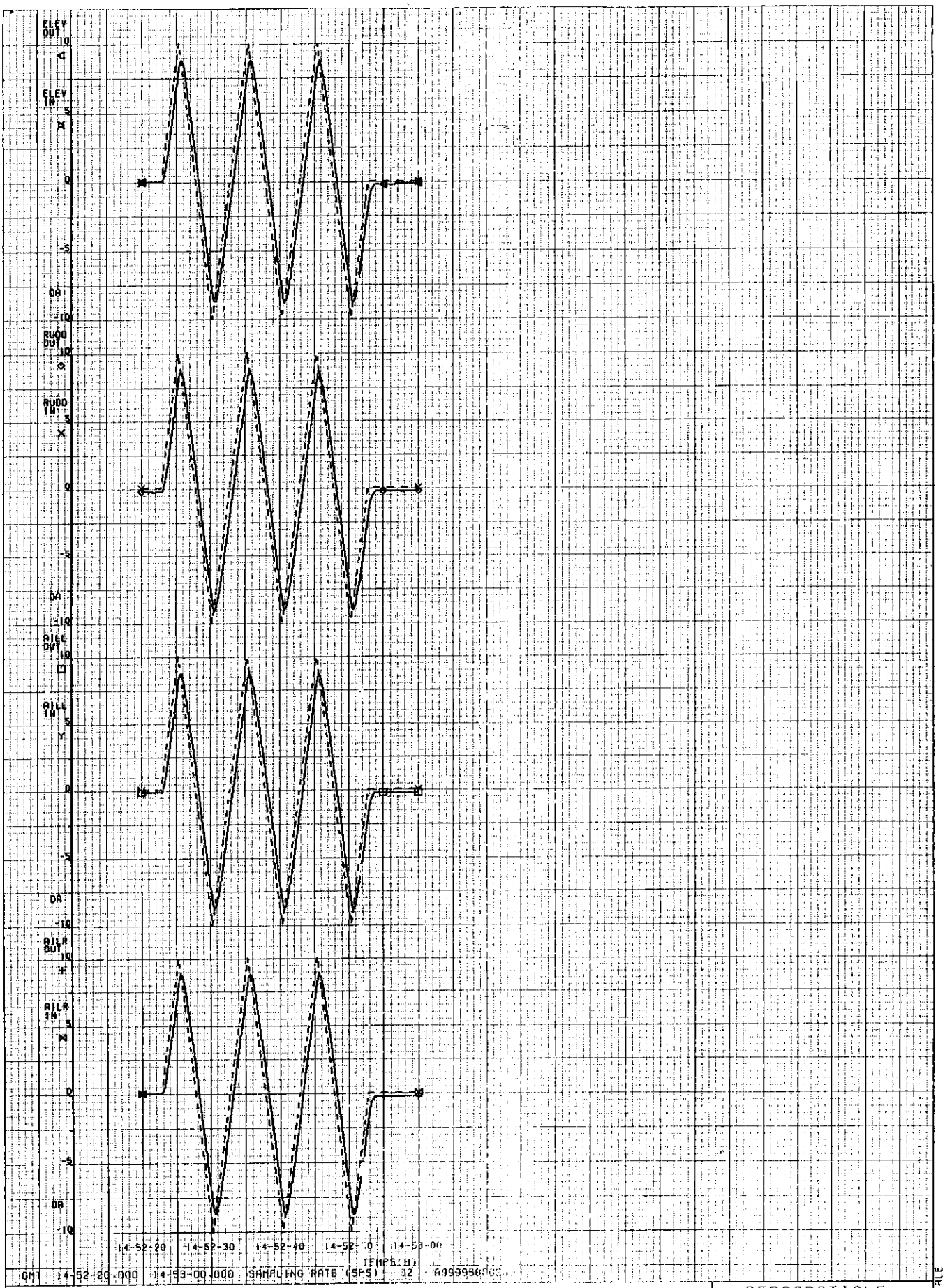
FLIGHT S0009 TEST 5.1 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.2

008257



FLIGHT S0009 TEST 5.2 FTI

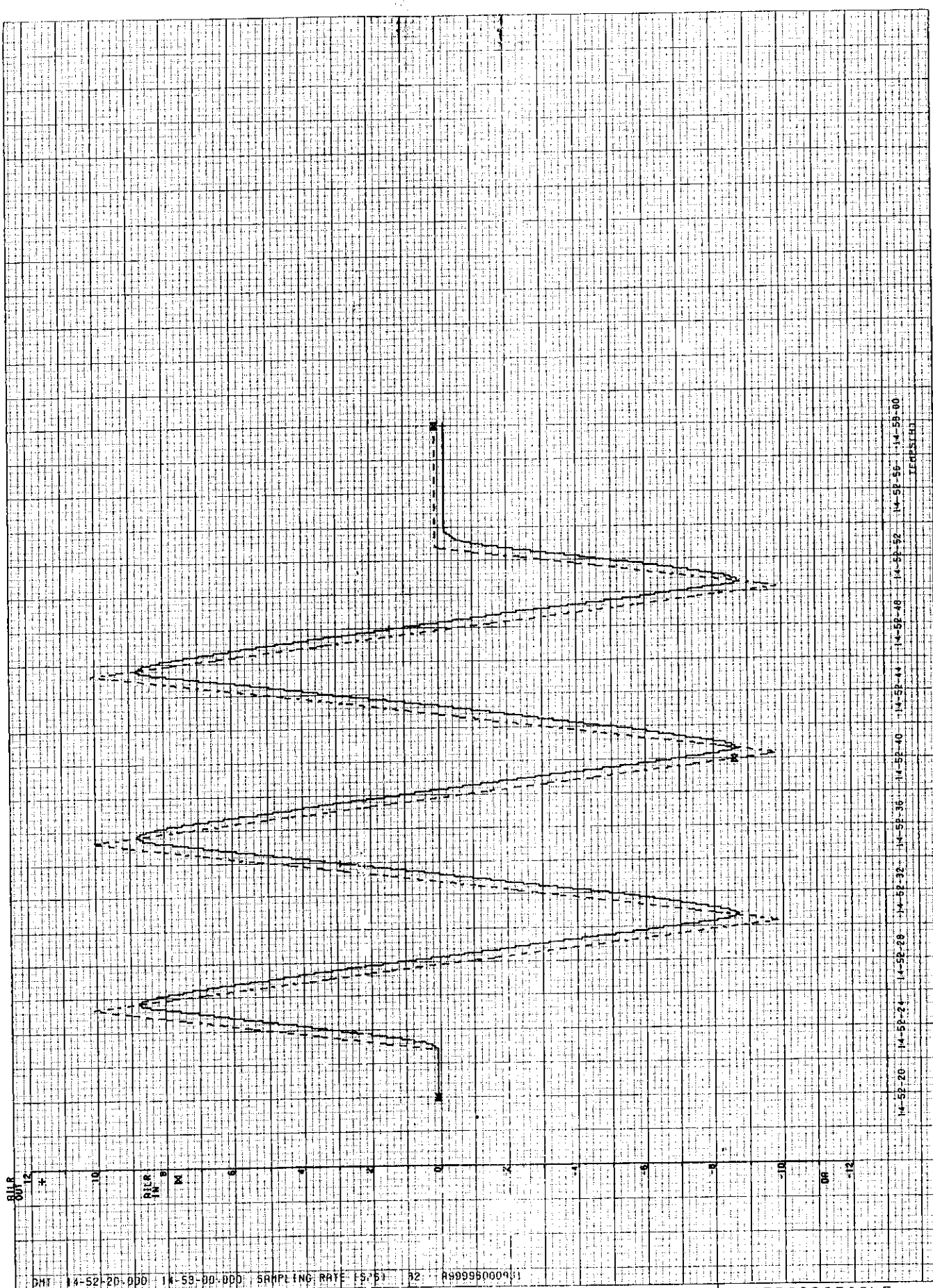
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.3

(C) AEROSPATIALE

AVIC



FLIGHT S0009 TEST 5.2 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

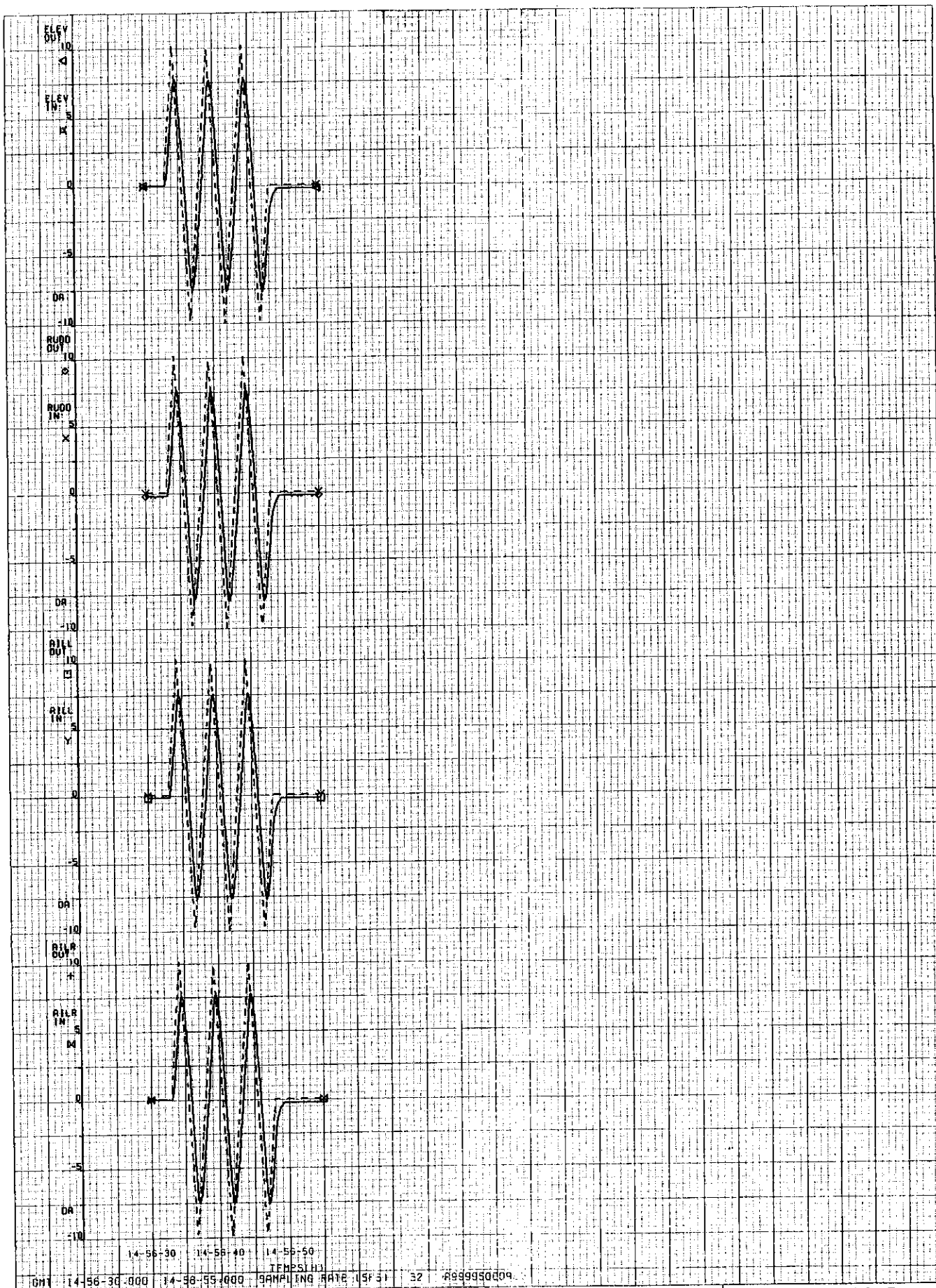
AIRCRAFT A9999 FIGURE 3.5.4

CET AEROSPATIALE

310.5 SERIE/SDACAAL.AD

008259

AVIC

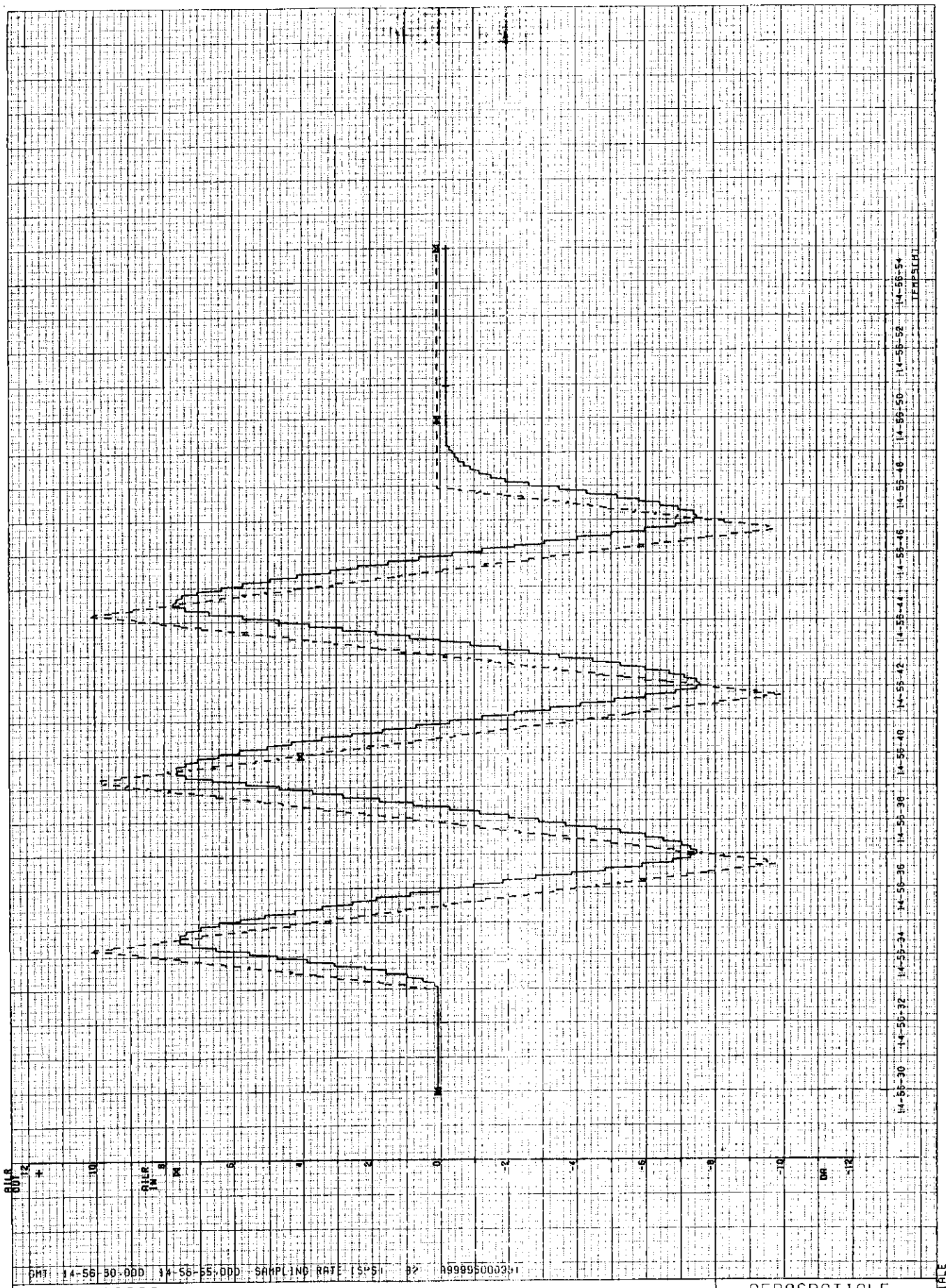


FLIGHT S0009 TEST 5.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.5



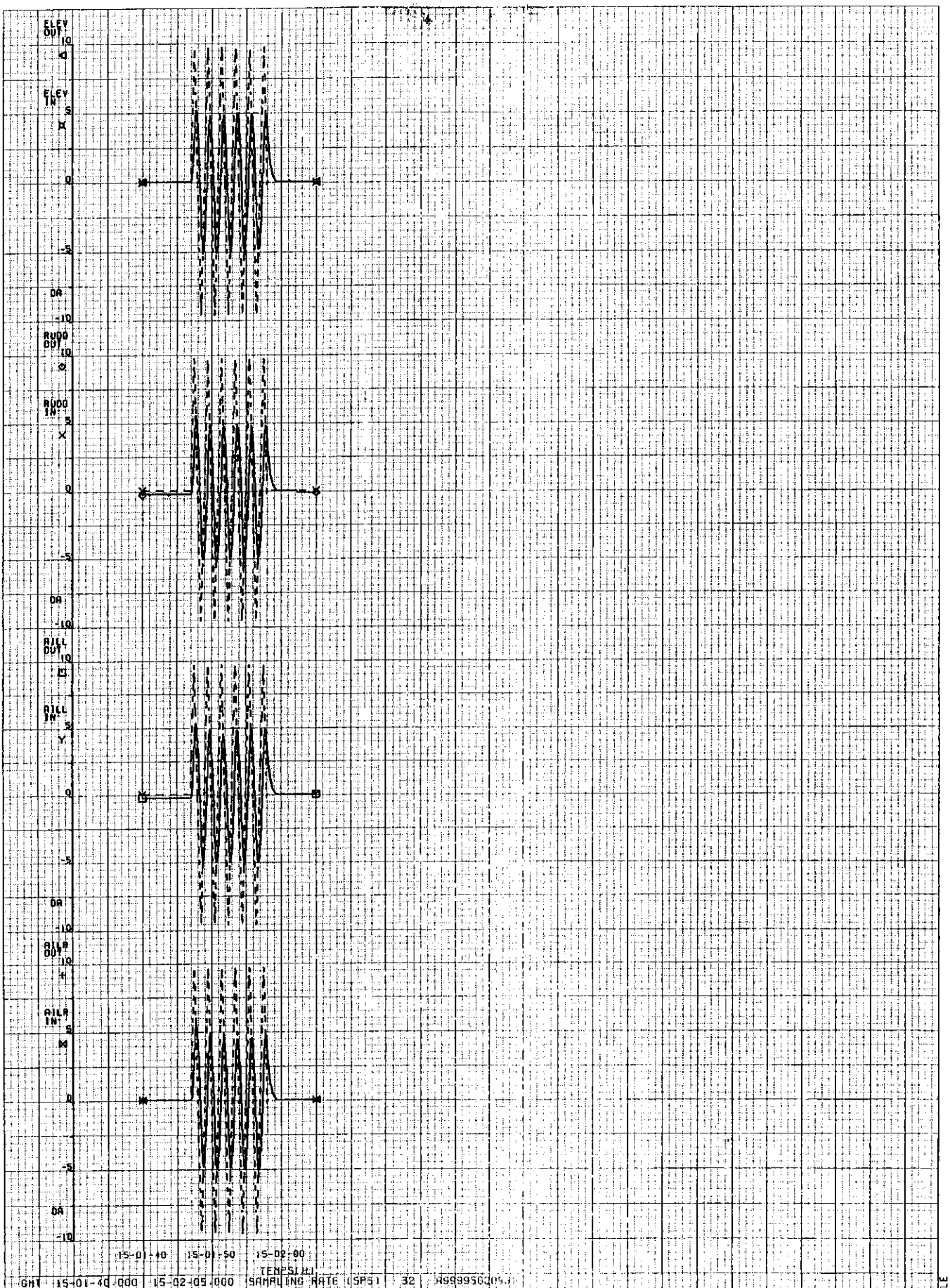
FLIGHT S0009 TEST 5.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.6

AVIC



FLIGHT S0009 TEST 5.4 FTI

A-NTSB

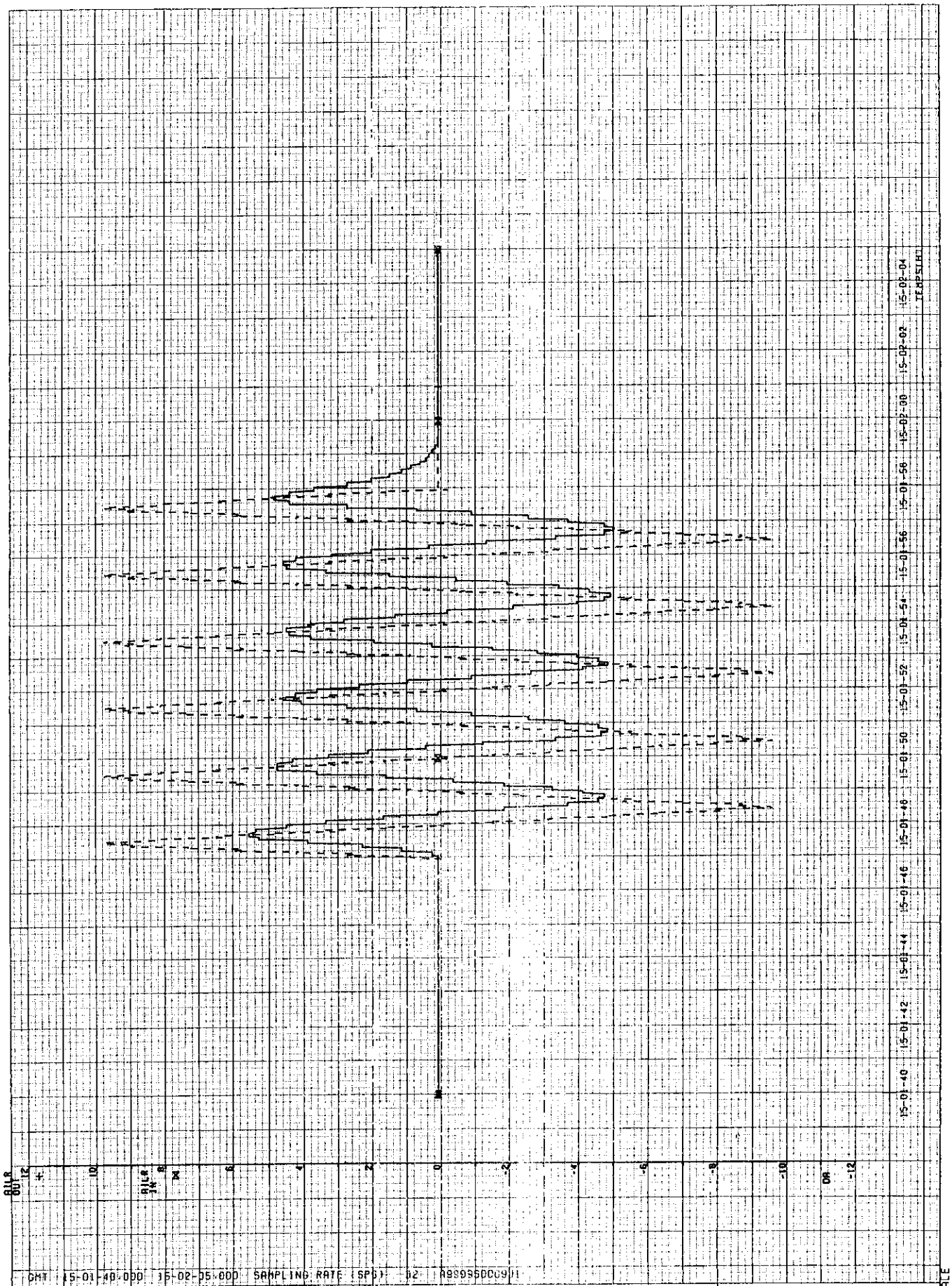
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.7

(C) AEROSPATIALE

008262

AVIC



FLIGHT S0009 TEST 5.4 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

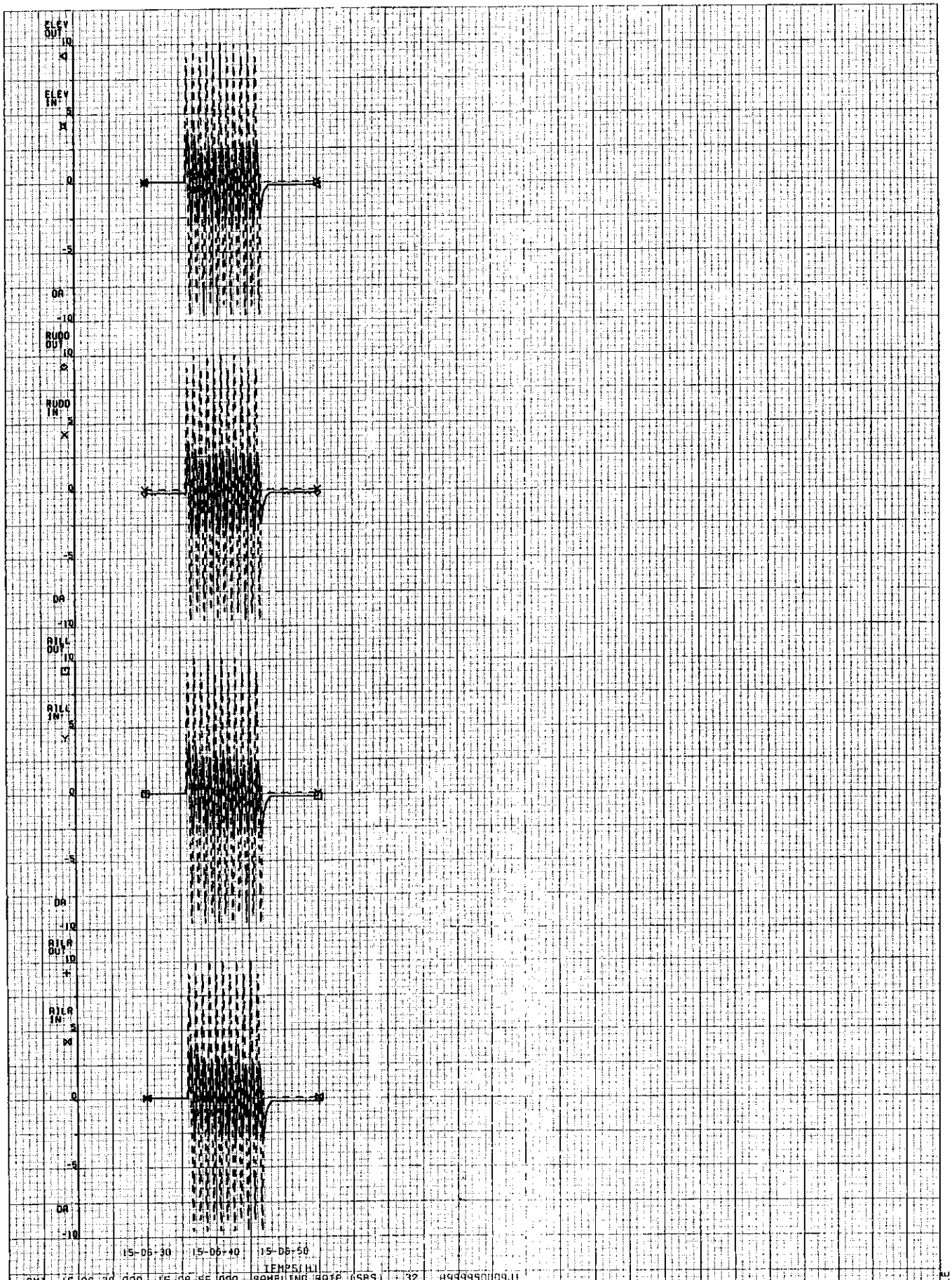
AIRCRAFT A9999 FIGURE 3.5.8

(C) AEROSPATIALE

310.5 SERIE/SDACRAL-AD

808263

AVTC



FLIGHT S0009 TEST 5.5 FTI

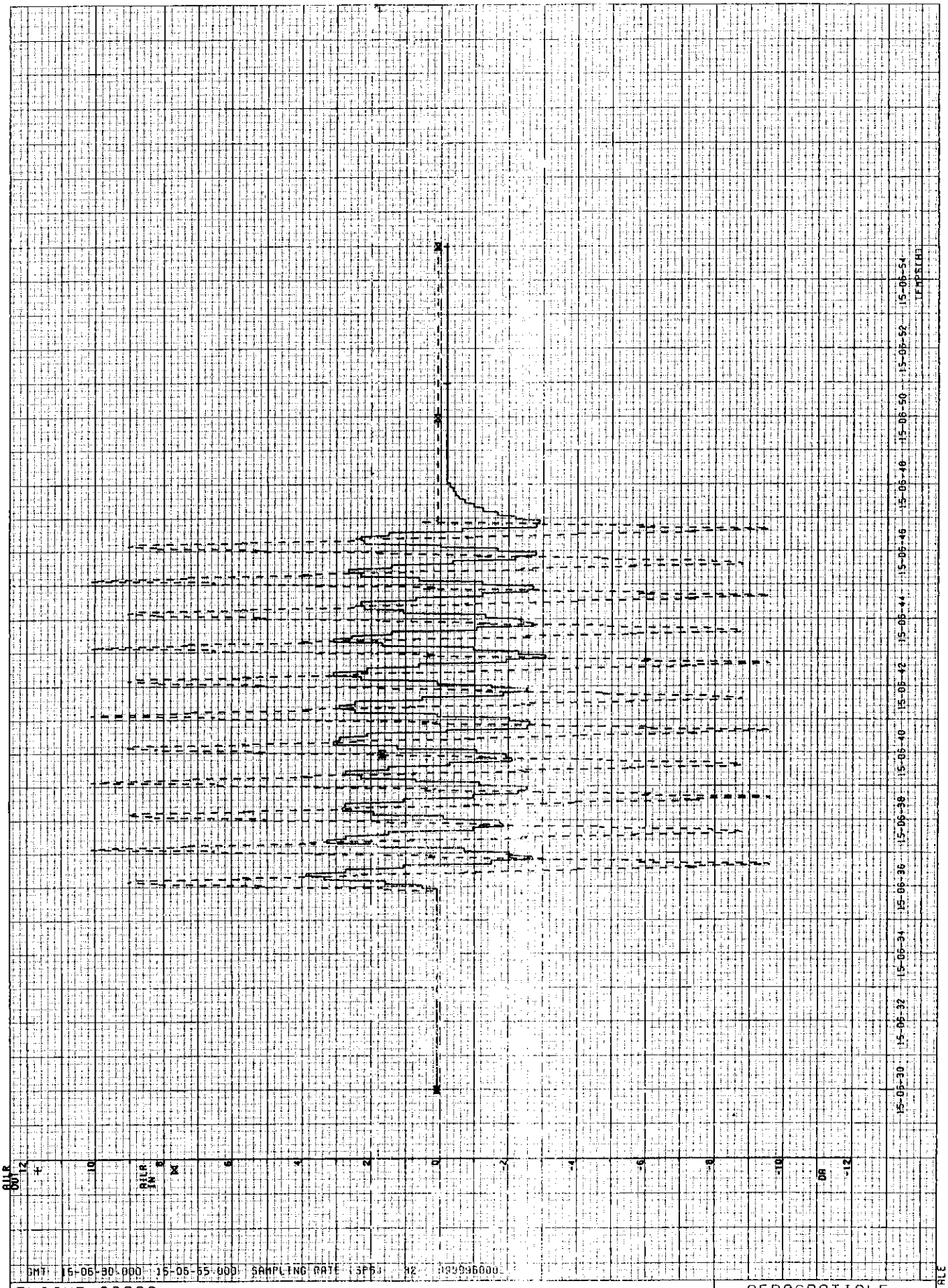
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 35.9

(C) AEROSPATIALE

008264



FLIGHT S0009 TEST 5.5 FT1

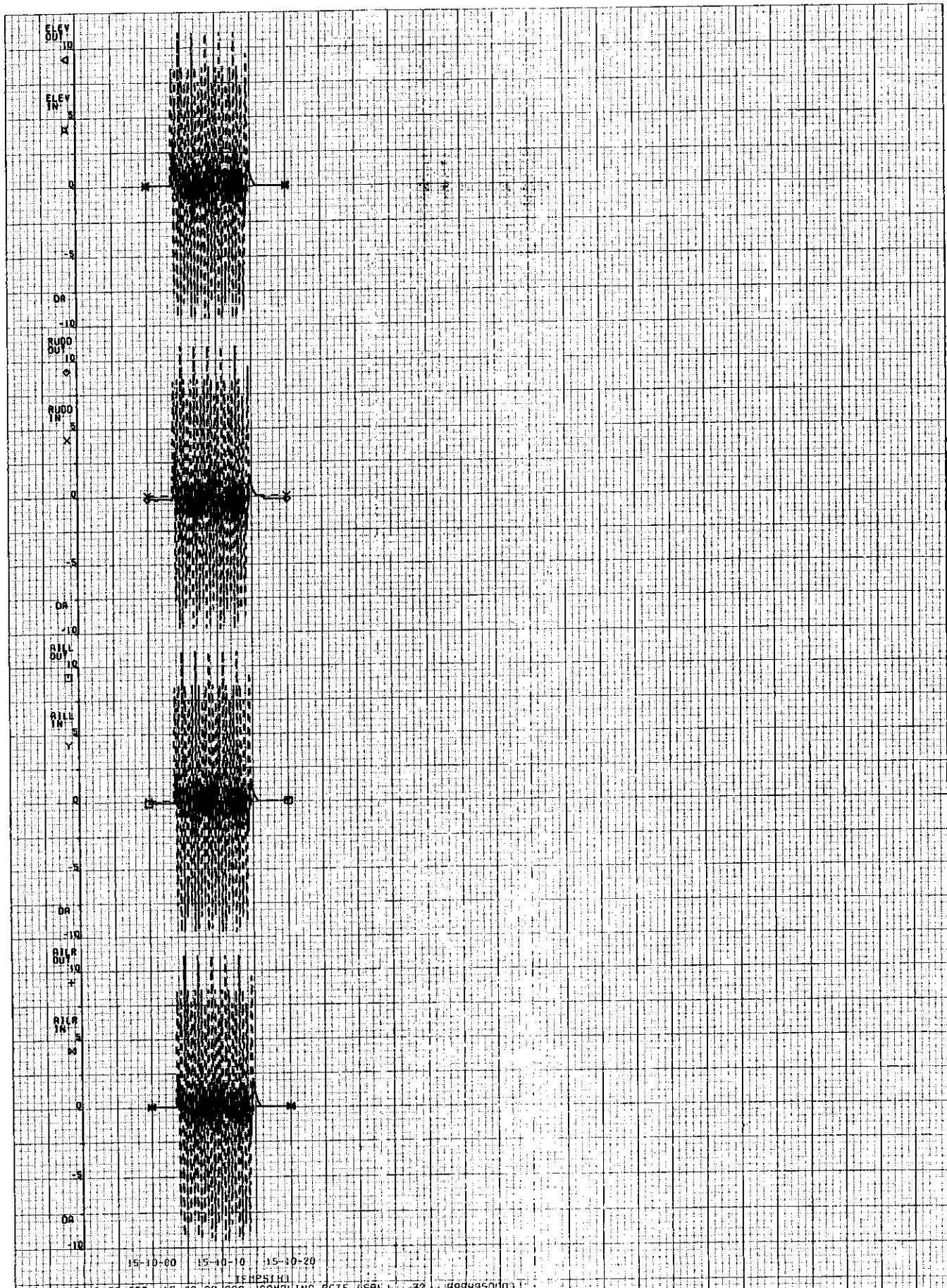
A-NTSB

308265

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 35.10

AVIC

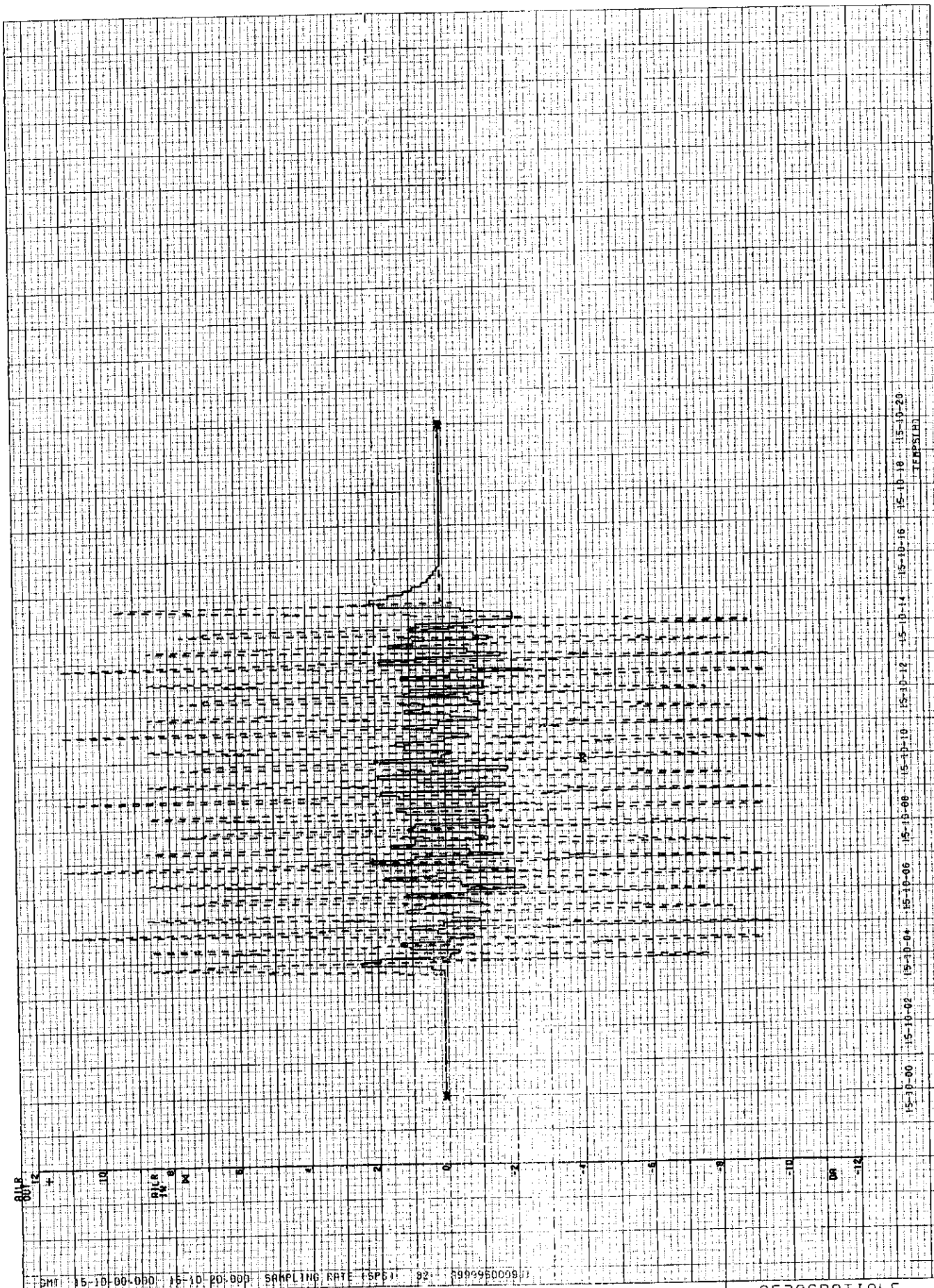


FLIGHT S0009 TEST 5.6 FTI

AEROSPATIALE
FLIGHT TESTS

AEROSPATIALE

AVIC



FLIGHT S0009 TEST 5.6 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

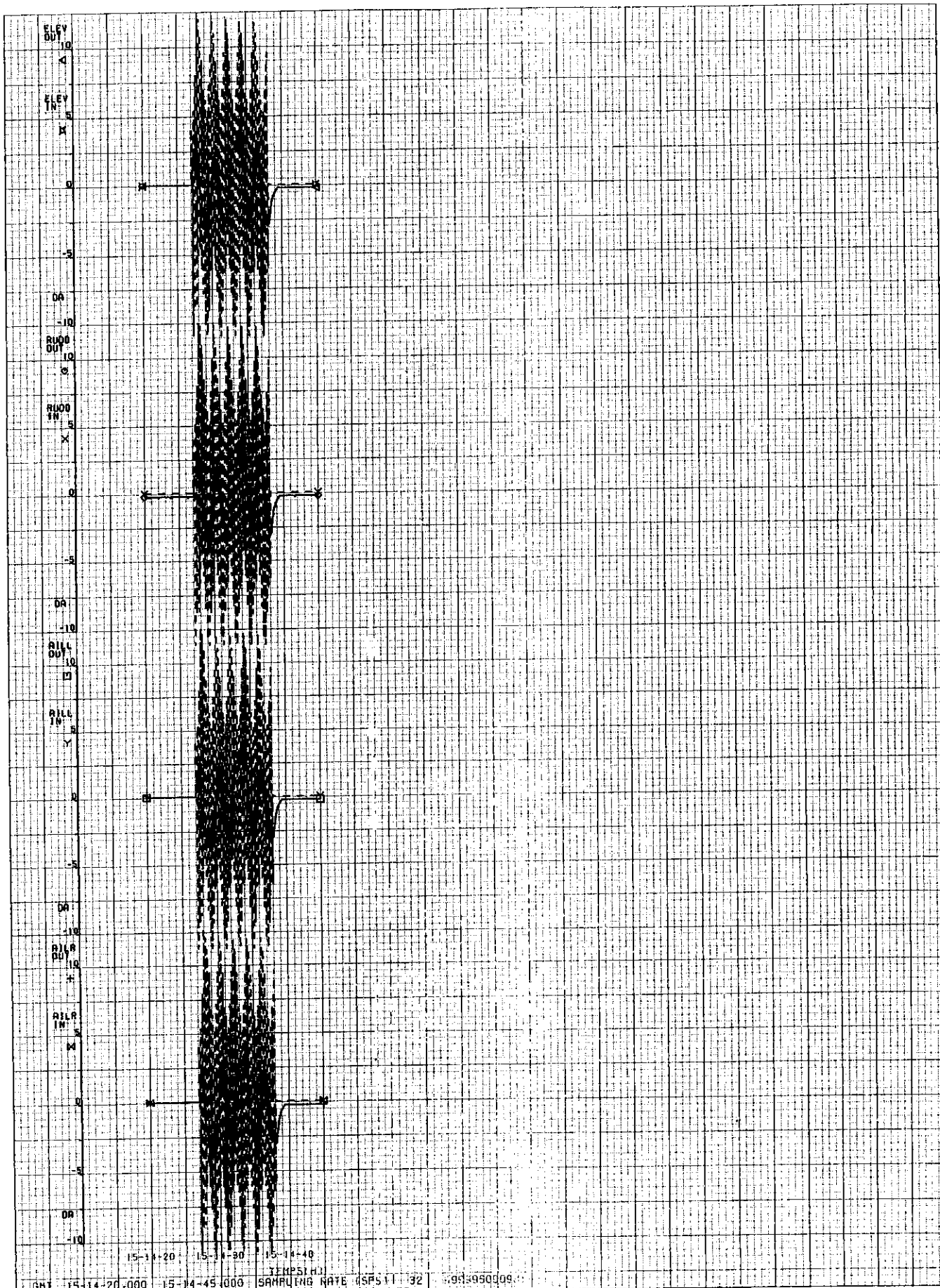
AIRCRAFT A9999 FIGURE 35.12

© AEROSPATIALE

310-5 SERIE/SOACAAL.AD

098267

AVIC



FLIGHT S0009 TEST 5.7 FTI

A-NTSB

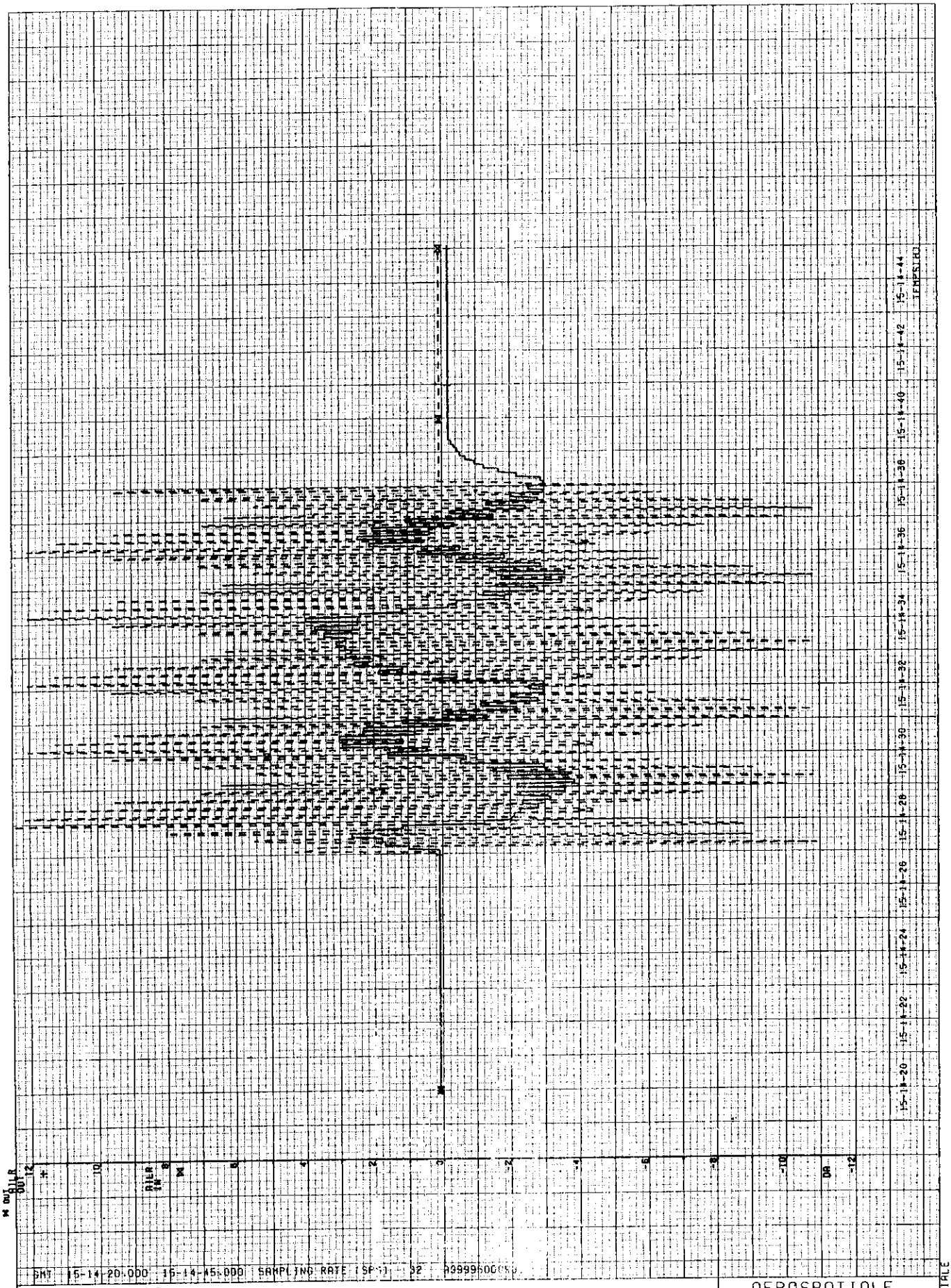
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.13

© AEROSPATIALE

008268

AVIC



FLIGHT S0009 TEST 5.7 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

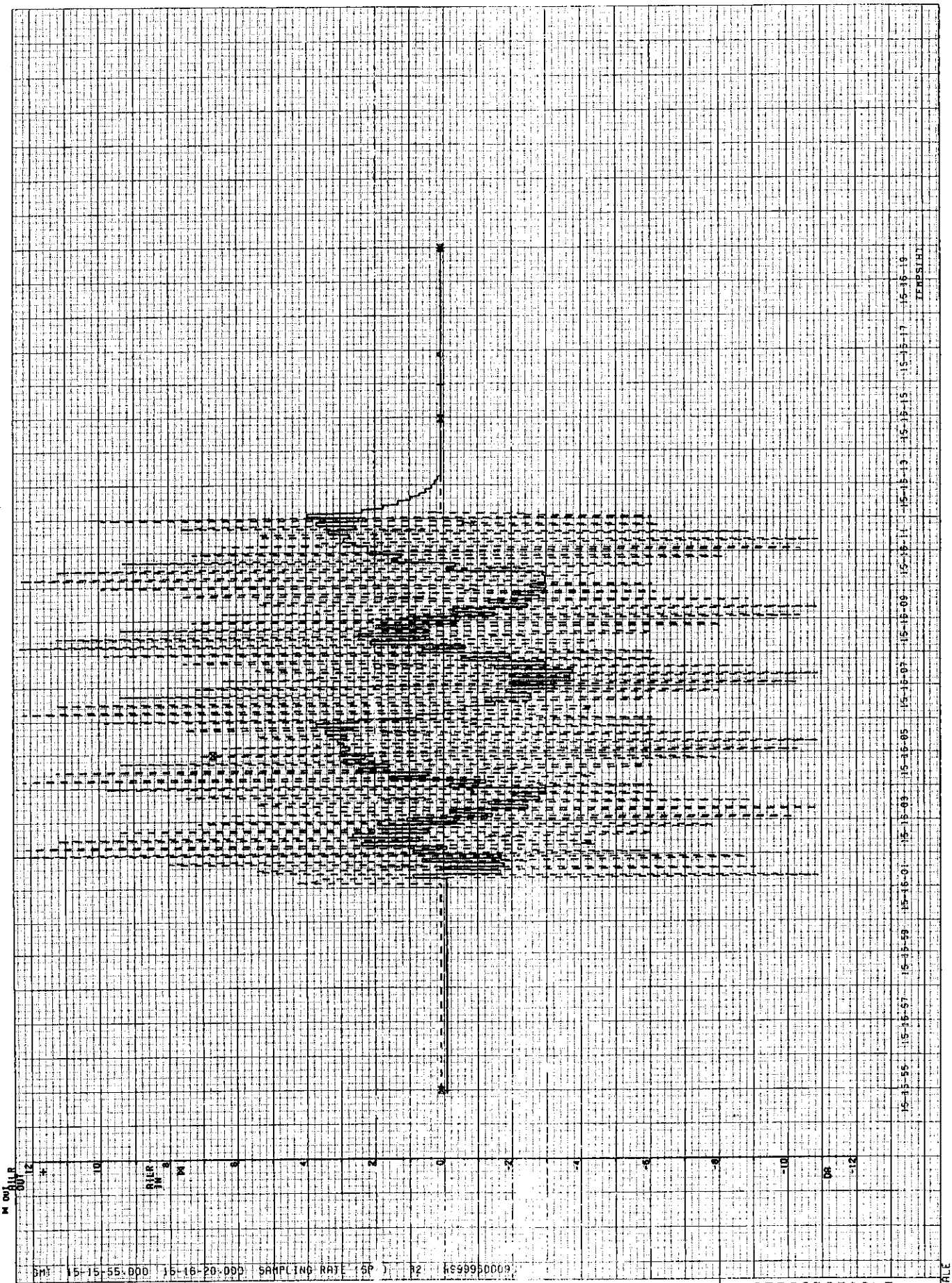
AIRCRAFT A9999 FIGURE 3.5.14

(C) AEROSPATIALE

310.5 SERIE/SDACAAL.AD

068269

AVIC



FLIGHT S0009 TEST 5.7 FTI

A-NTSB

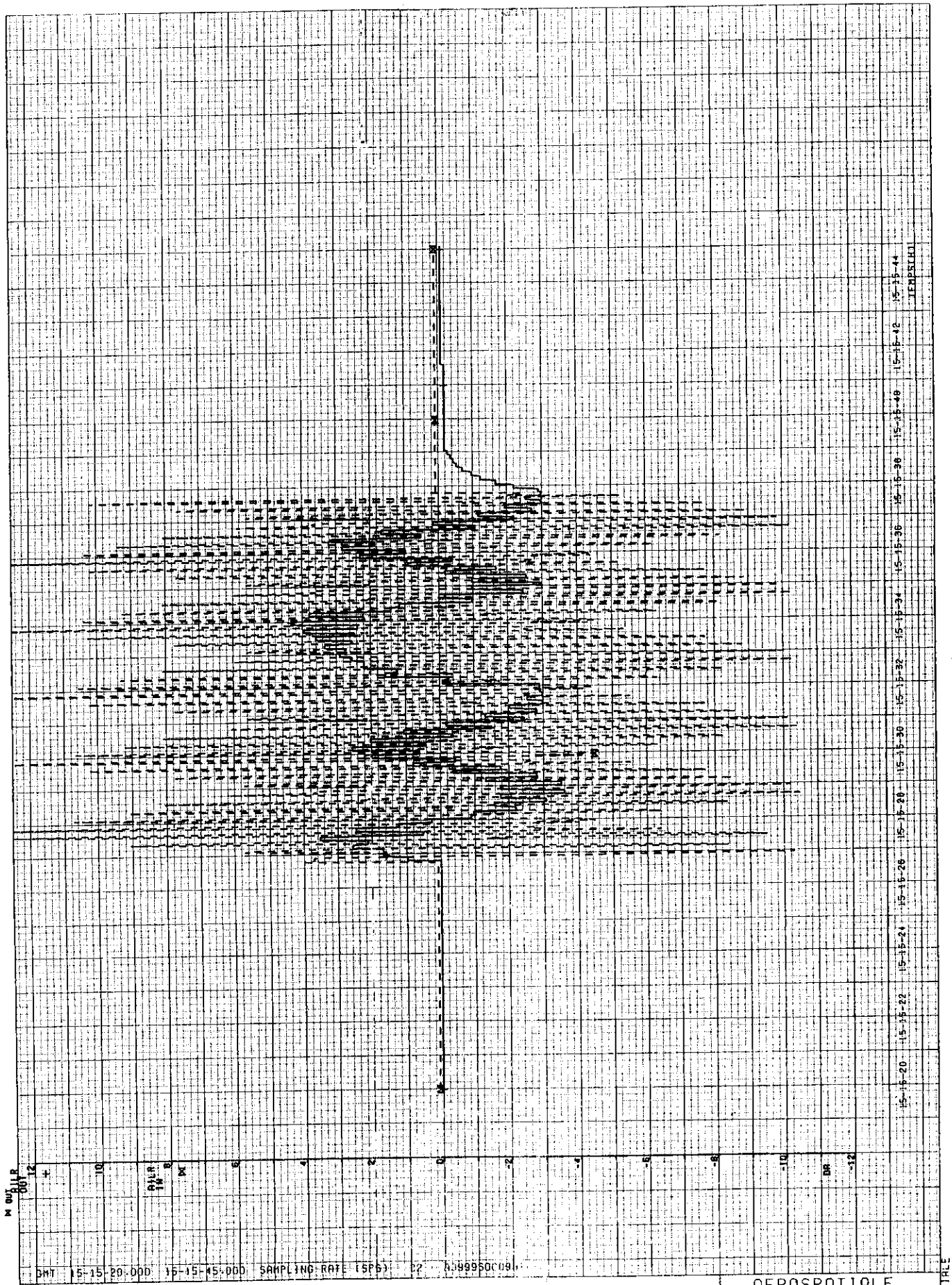
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.15

(C) AEROSPATIALE

310.5 SERIE/SDACAAL.AD

008270



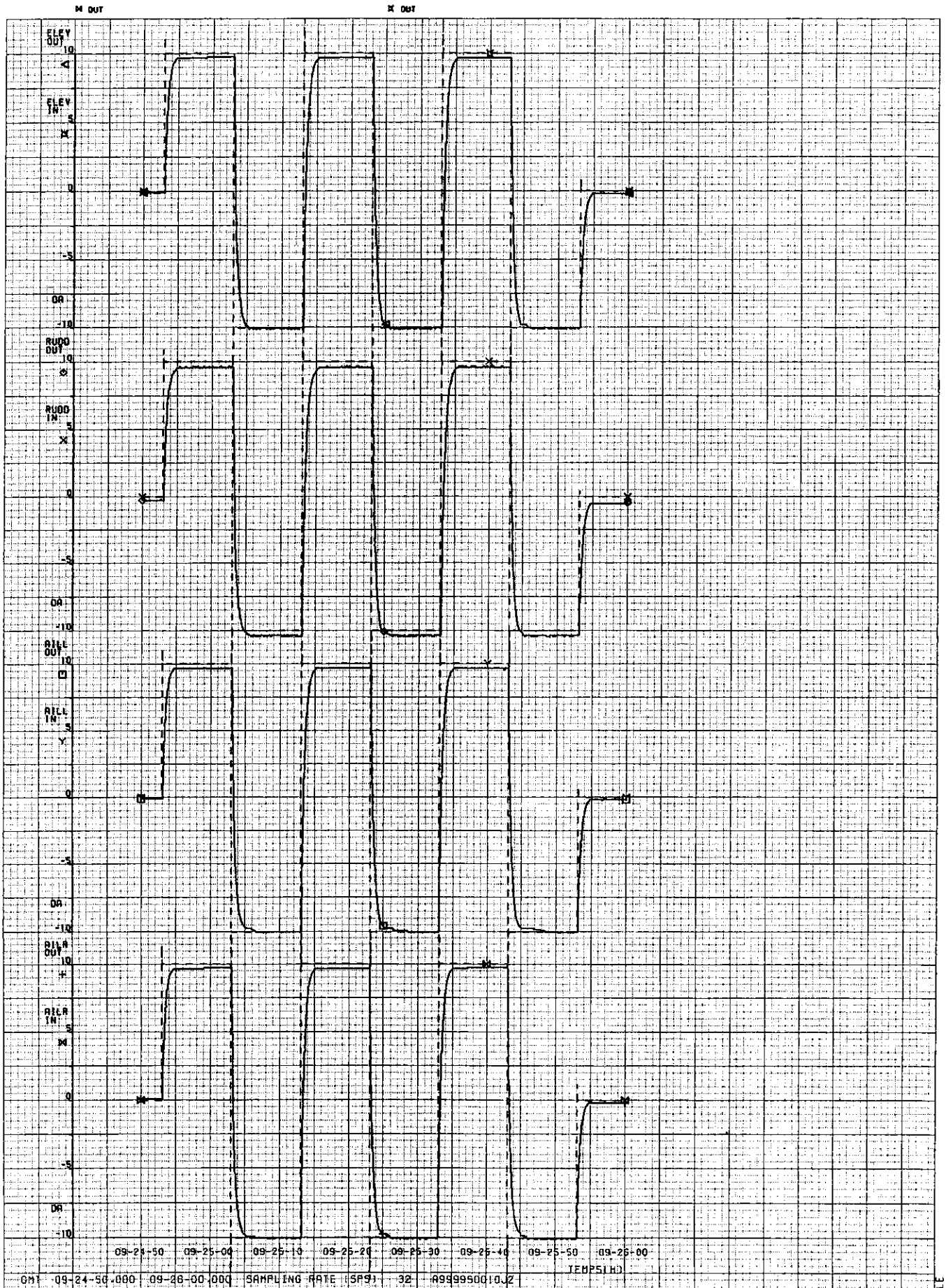
FLIGHT S0009 TEST 5.7 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.5.16

ANNEX 3.6:
Test series n°6



FLIGHT S0010 TEST 6.1 FIRST TRY FTI

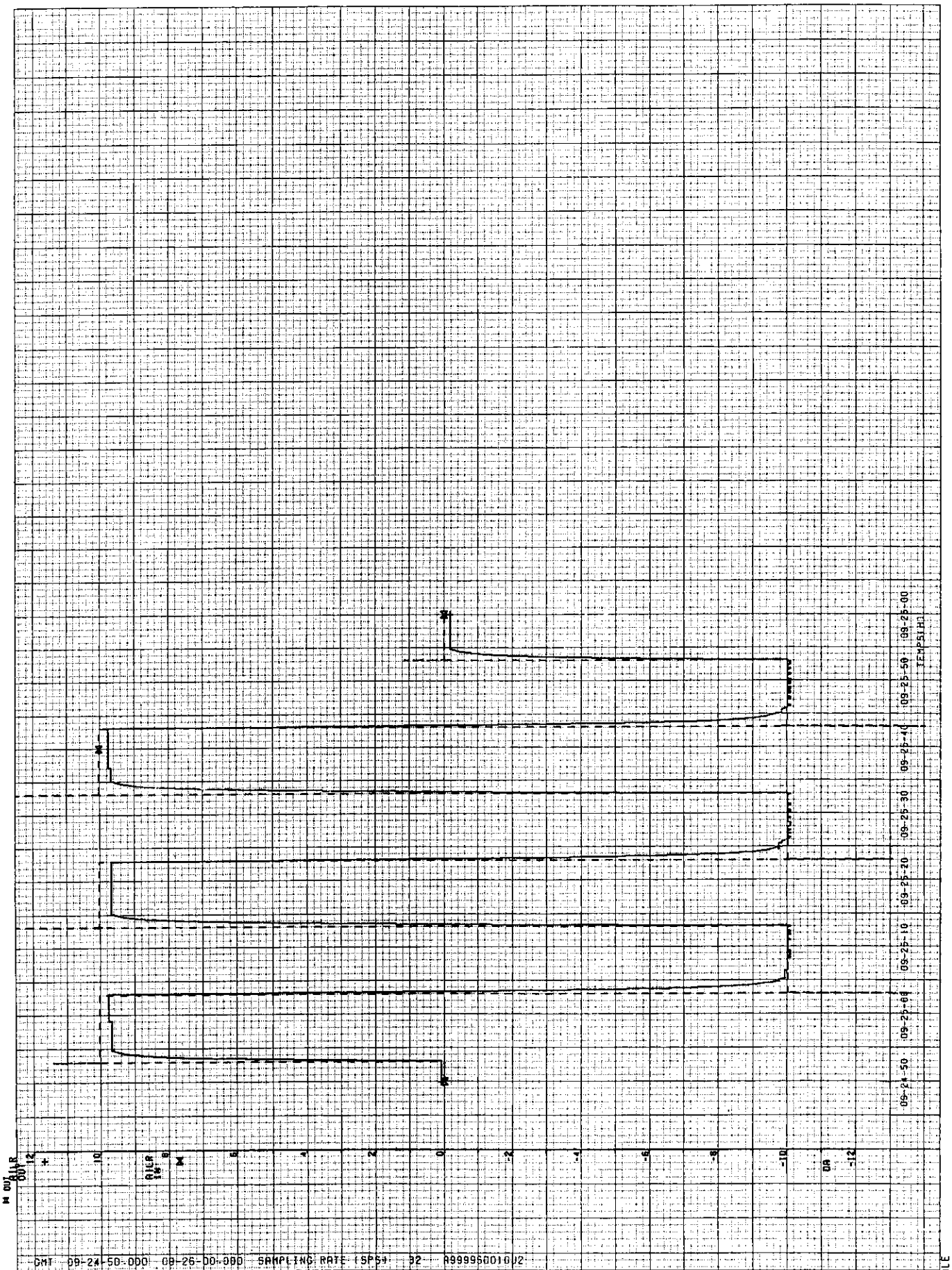
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 3.6.1

SERIE/SOACAAL.AD

AVIC



CMT 09-24-50-000 09-26-00-000 SAMPLING RATE (SPS) 32 A9999S0010U2

FLIGHT S0010 TEST 6.1 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

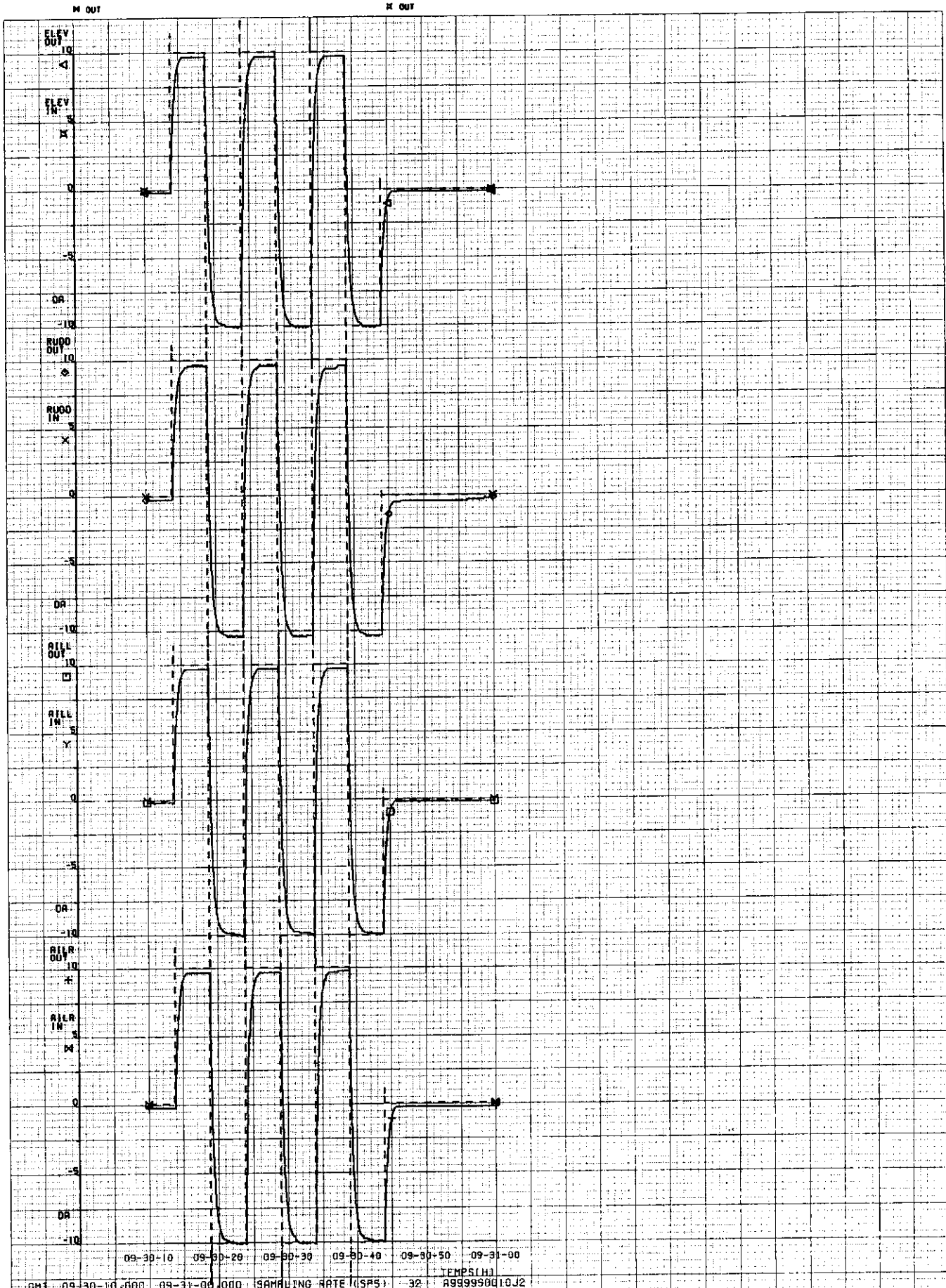
A-NTSB

AIRCRAFT A9999 FIGURE 36.2

(C) AEROSPATIALE

310-6 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 6.2 SECOND TRY FTI

A-NTSB

008275

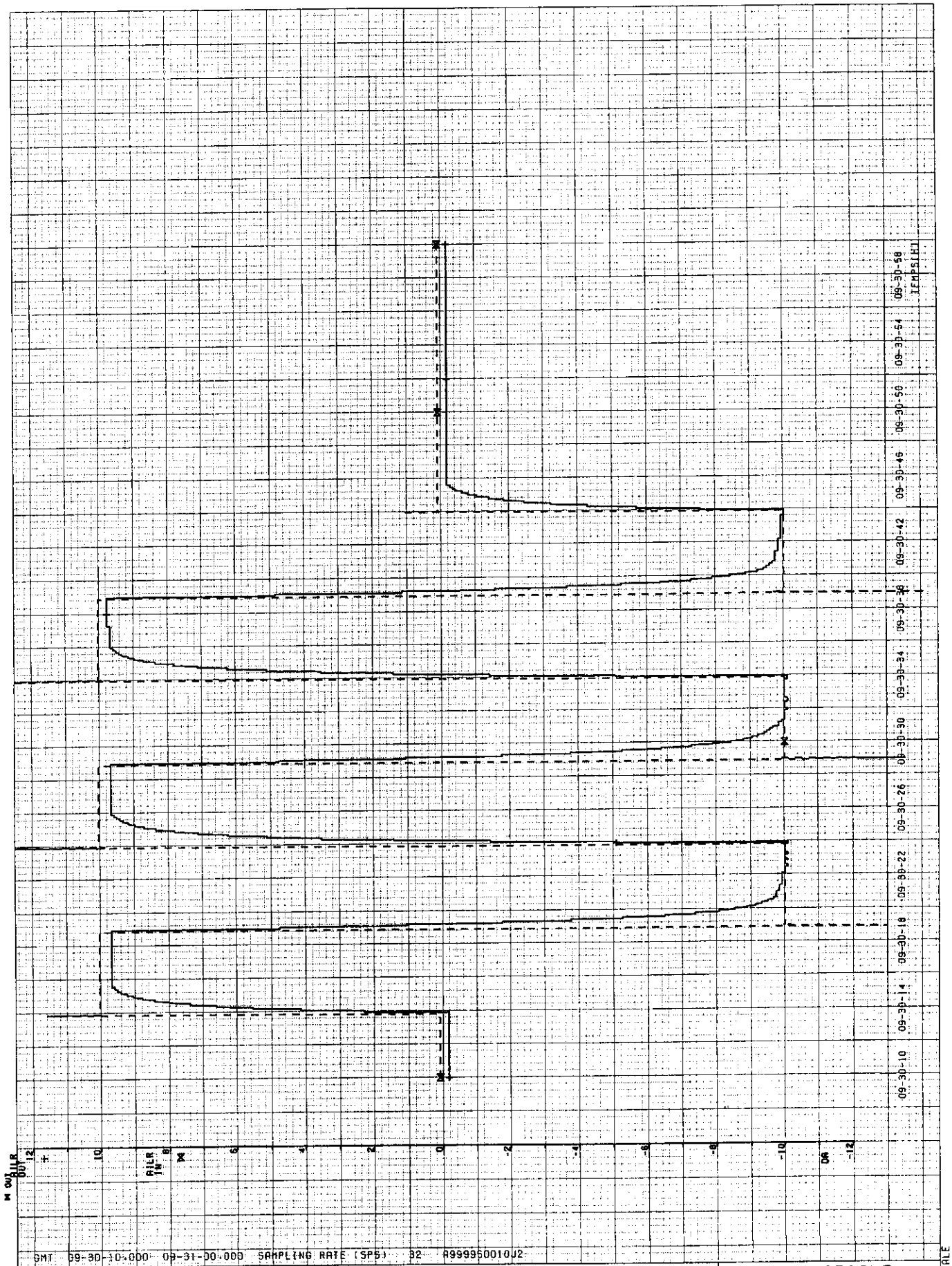
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 363

(E) AEROSPATIALE

005.6 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 6.2 SECOND TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

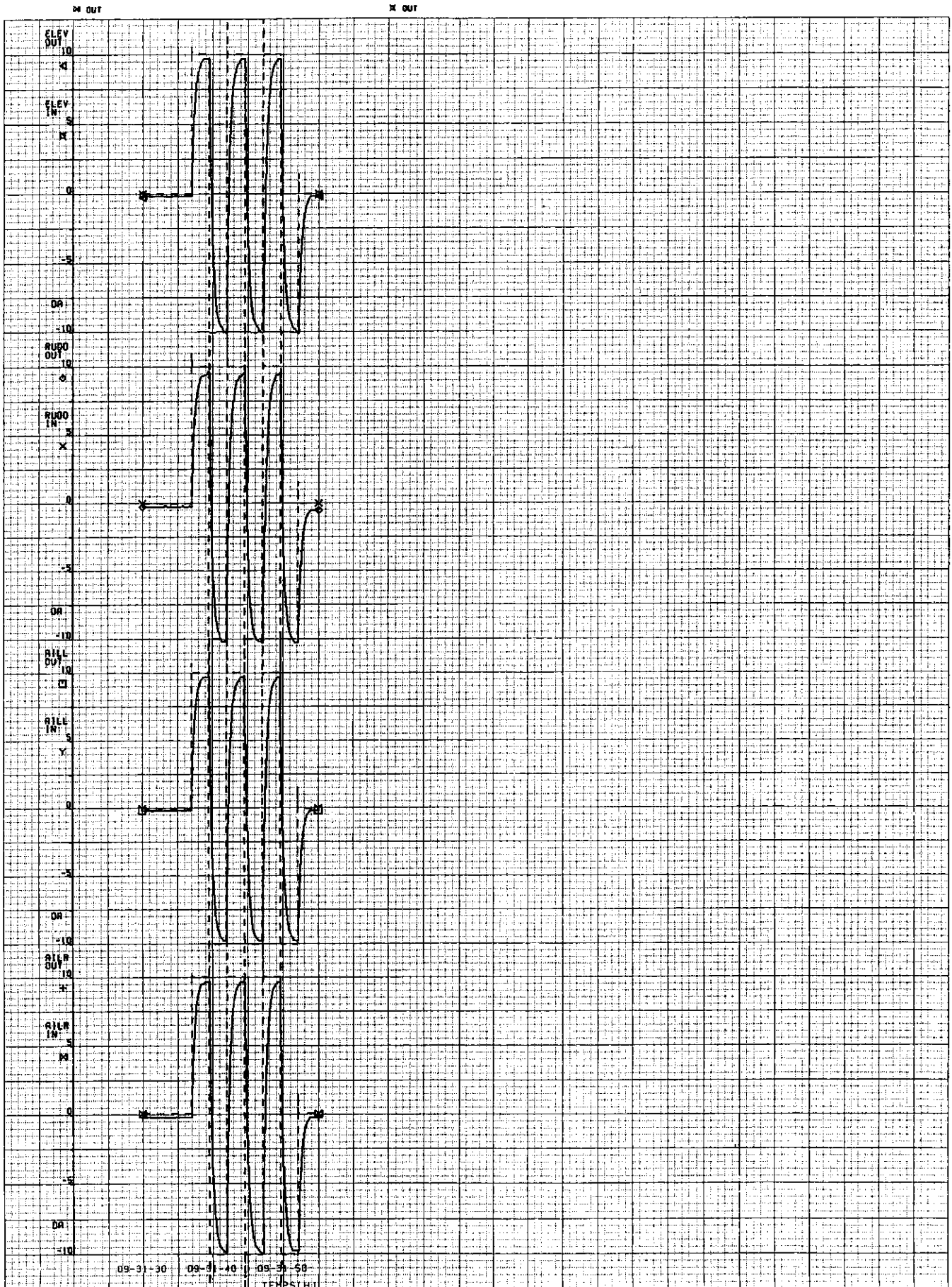
AIRCRAFT A9999 FIGURE 3.6.4.

(C) AEROSPATIALE

310.6 SERIE/SOACAAL.AD

008276

AVIC



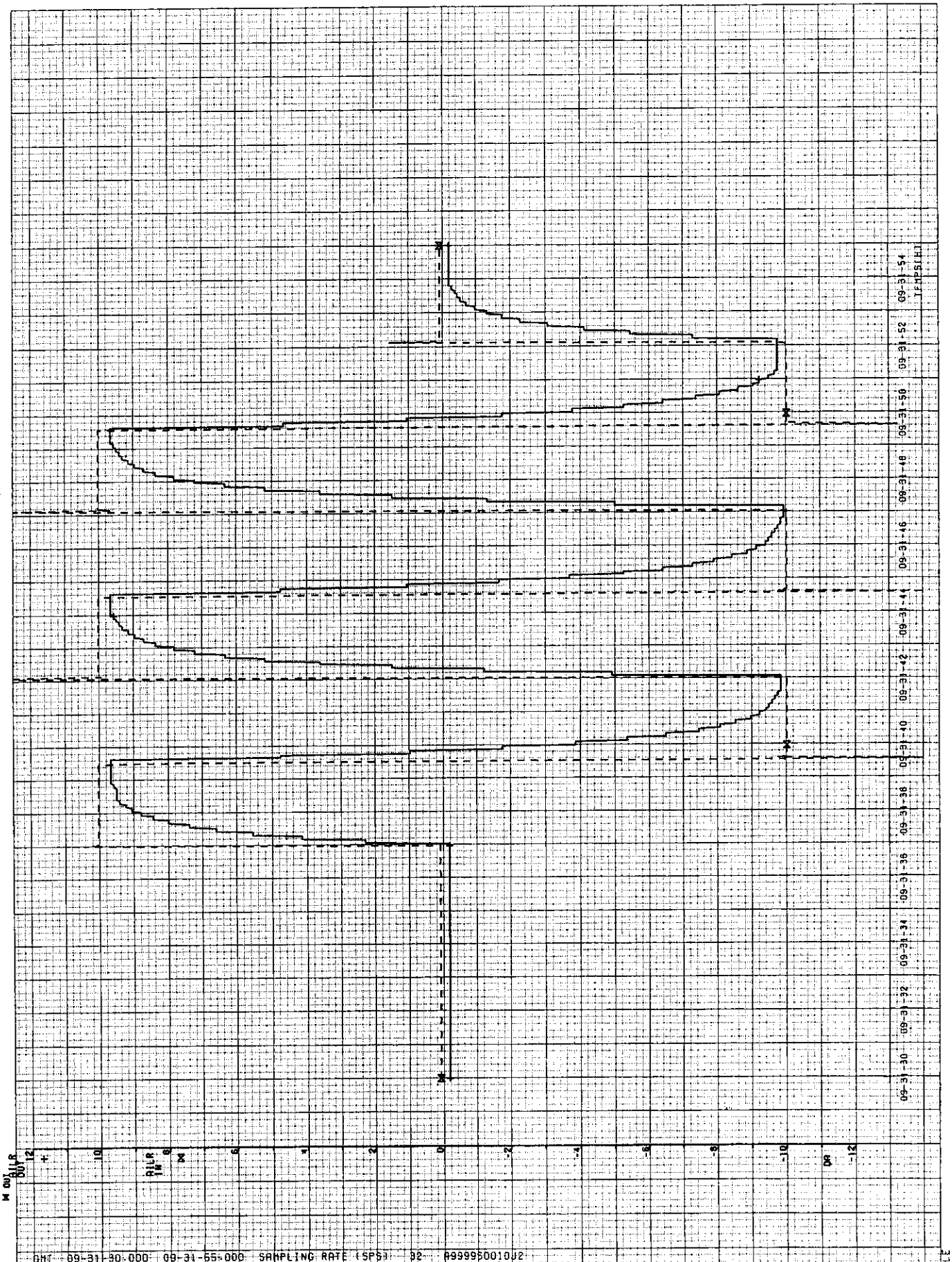
FLIGHT S0010 TEST 6.3 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.5

AVIC



FLIGHT S0010 TEST 6.3 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

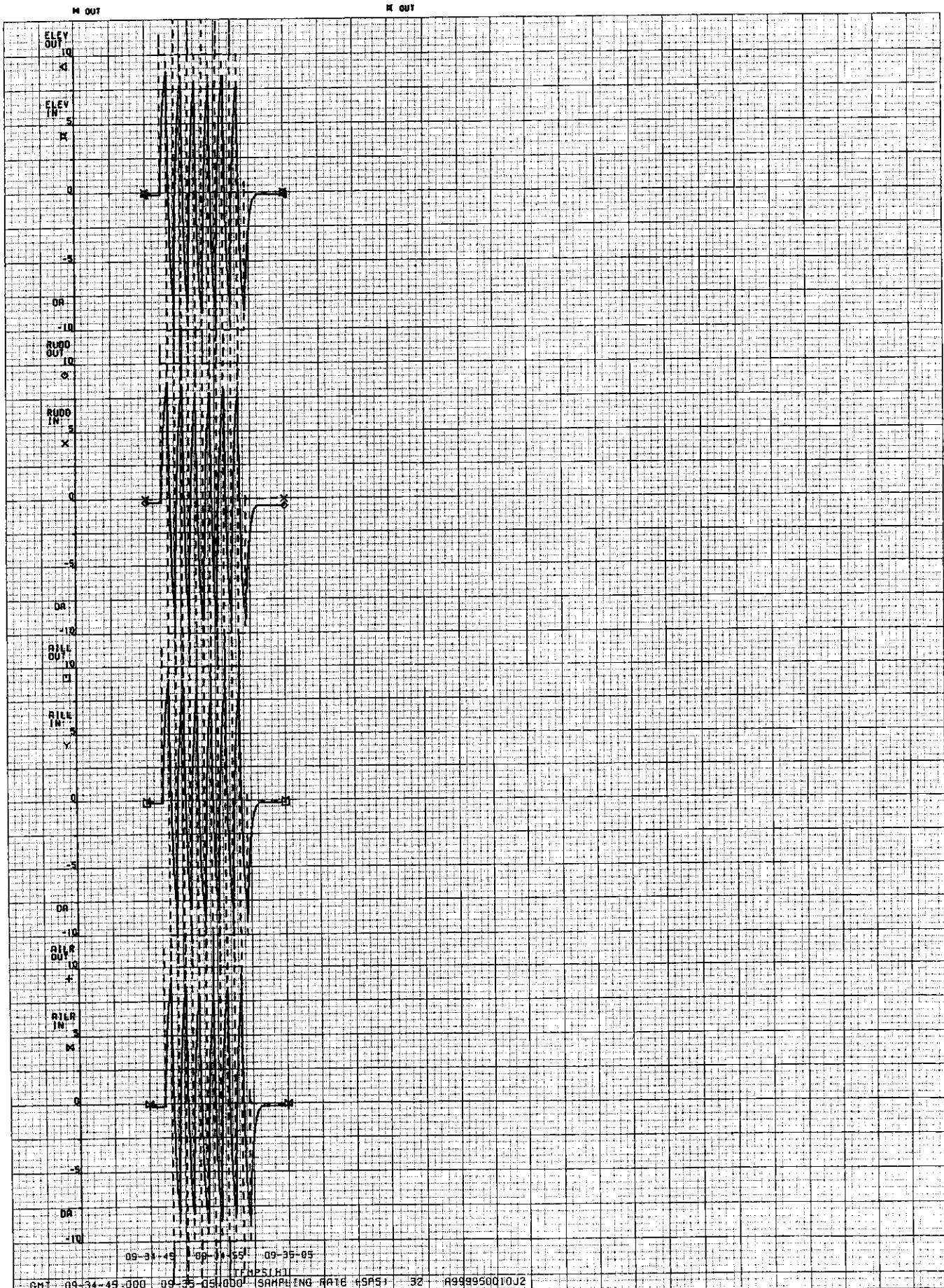
AIRCRAFT A9999 FIGURE 3.6.6

(C) AEROSPATIALE

310.6 SERIE/SOACAAL.AD

908278

AVIC



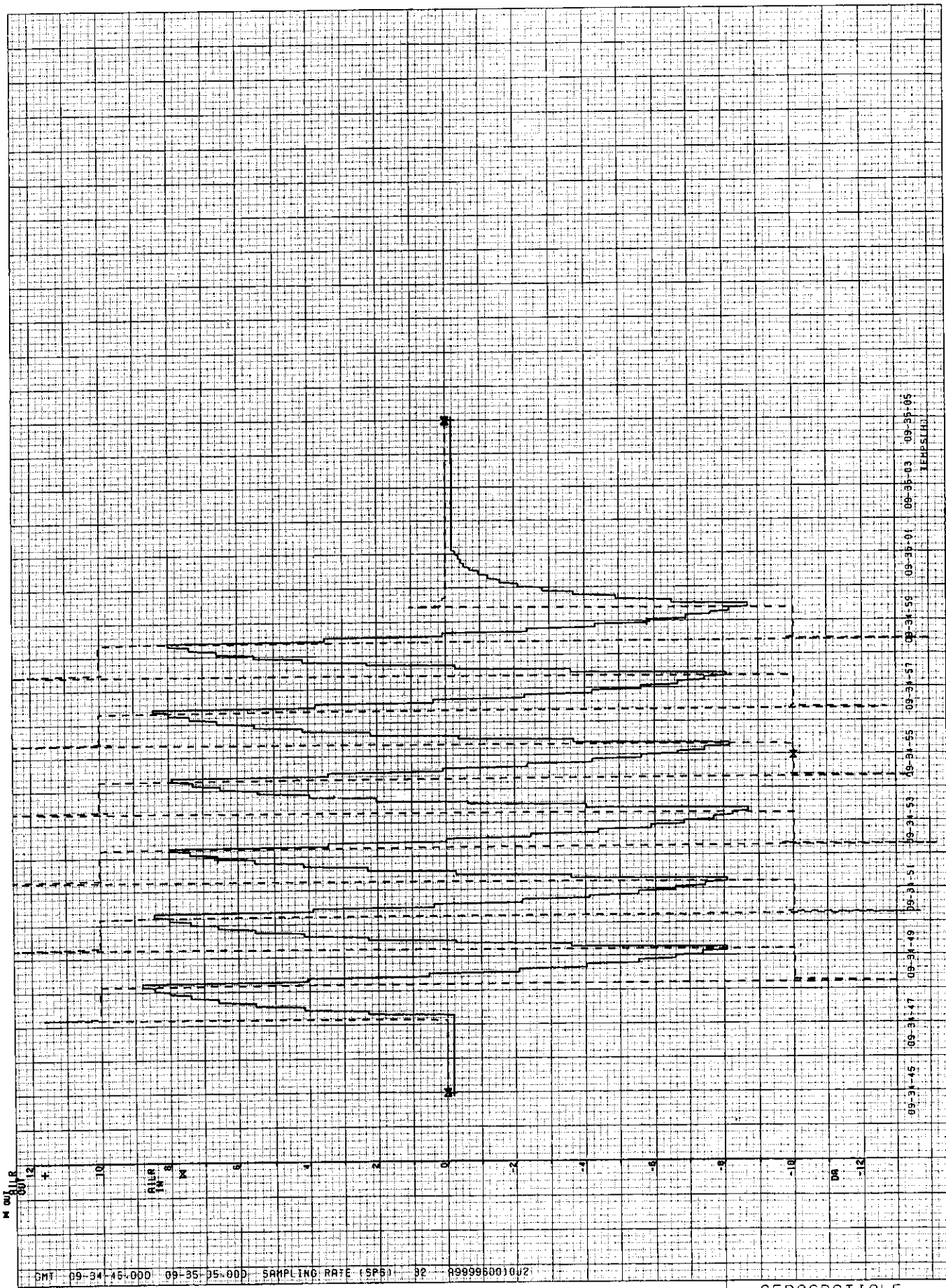
FLIGHT S0010 TEST 6.4 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.7

SERIE/SDACAAL.AD



FLIGHT S0010 TEST 6.4 FIRST TRY FTI

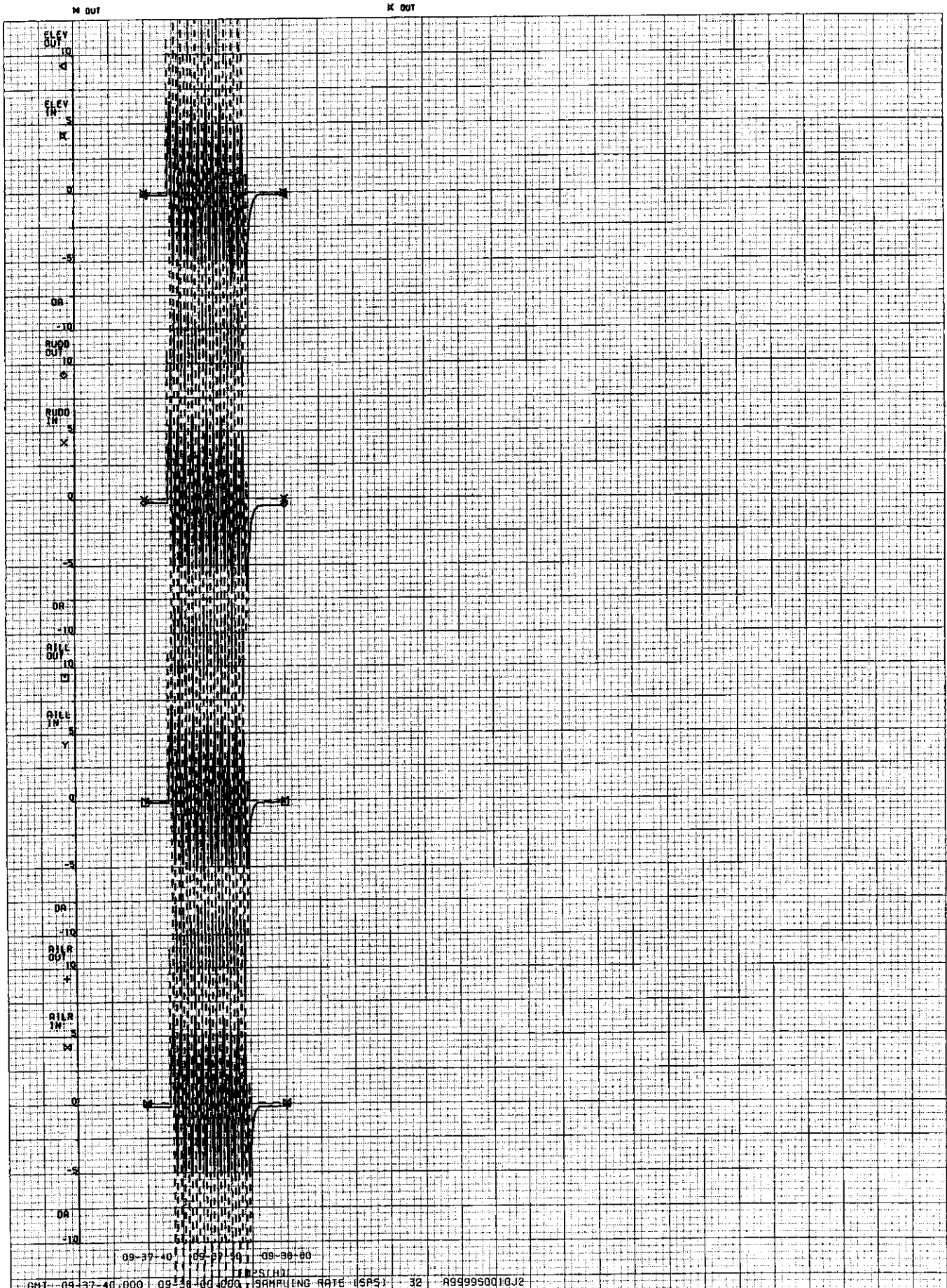
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.8

098280

AVIC



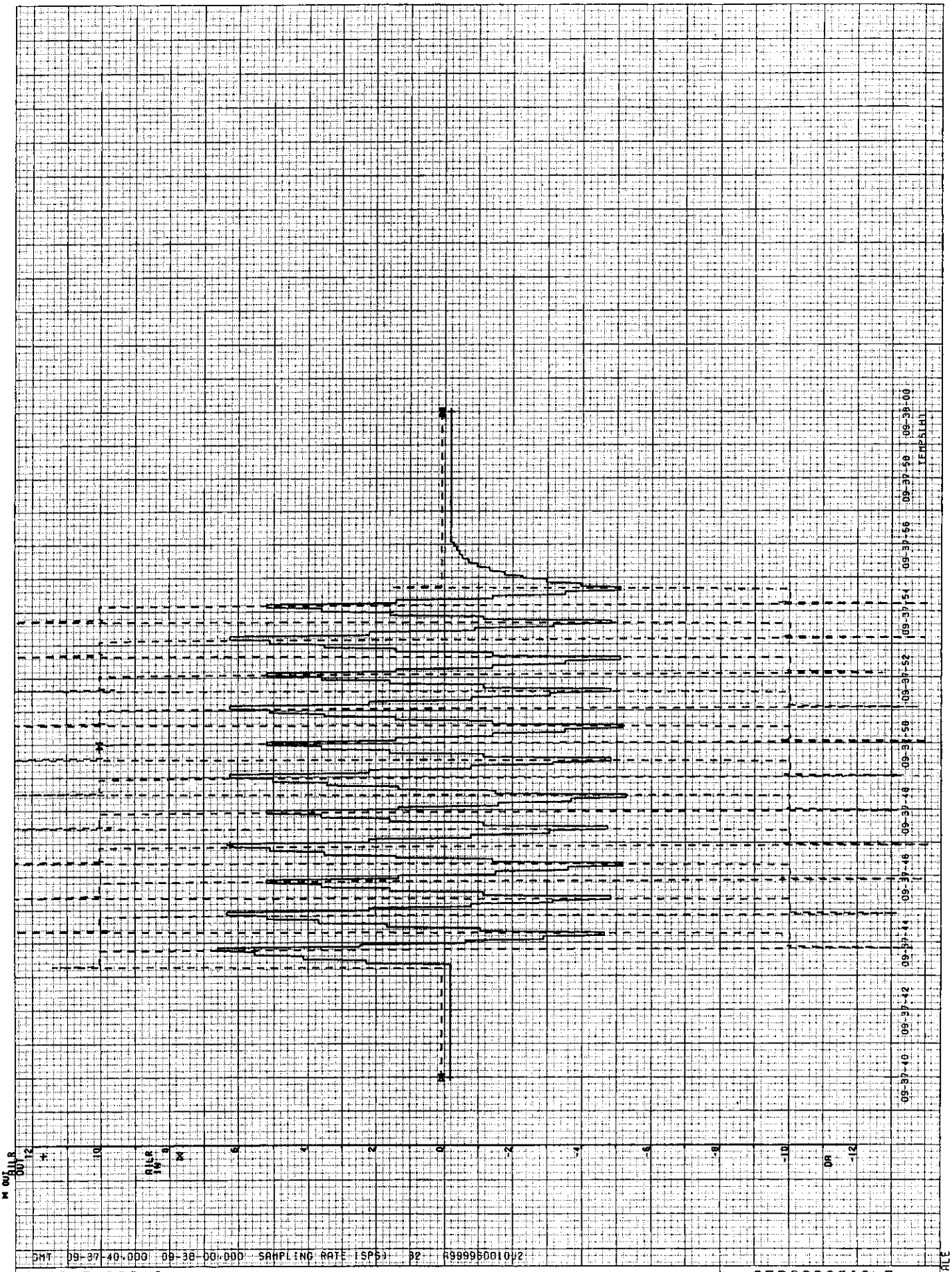
FLIGHT S0010 TEST 6.5 FIRST TRY FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 36.9

SERIE/SDACRAL.AD



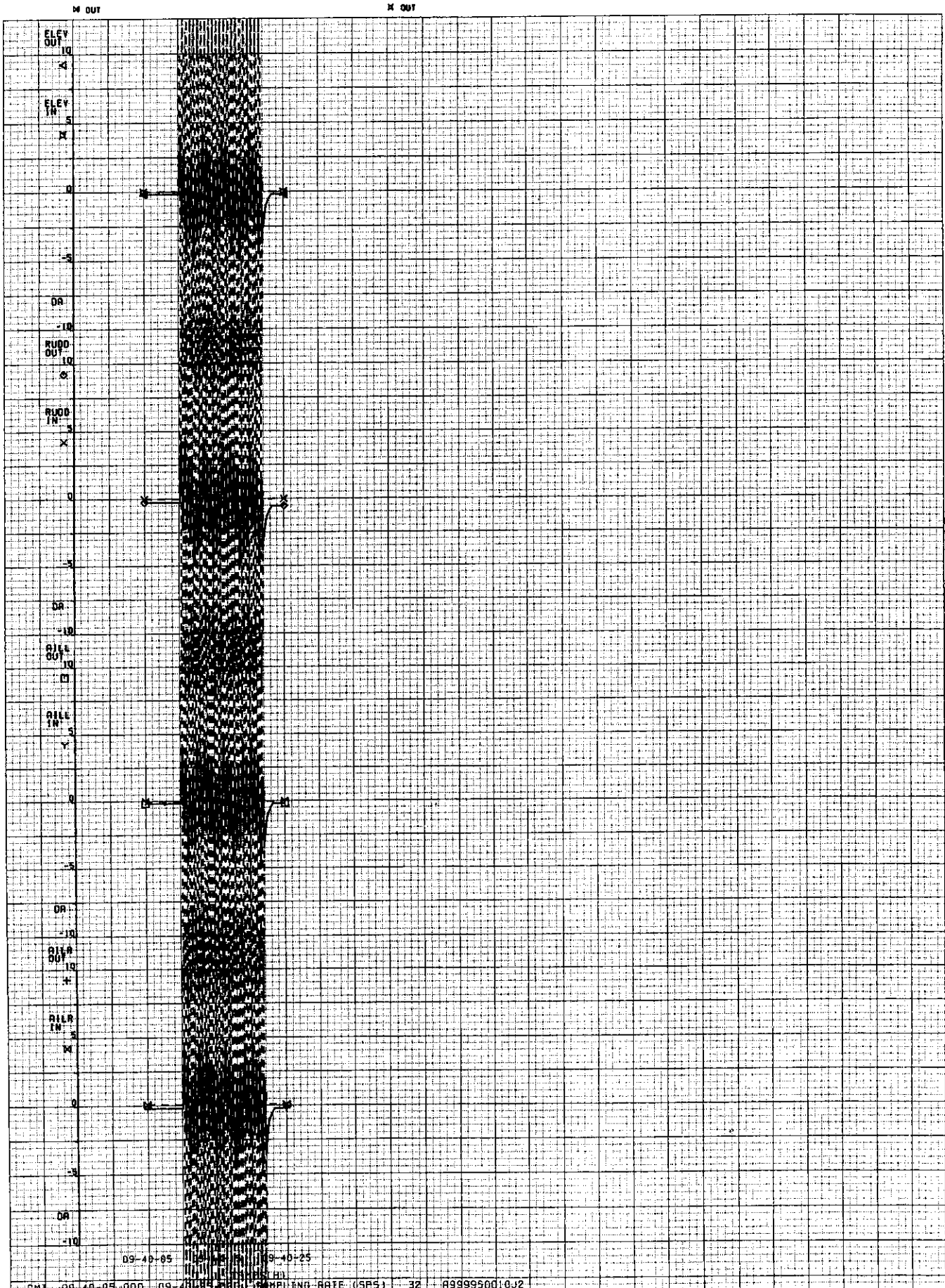
FLIGHT S0010 TEST 6.5 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.10

AVIC



FLIGHT S0010 TEST 6.6 FIRST TRY FTI

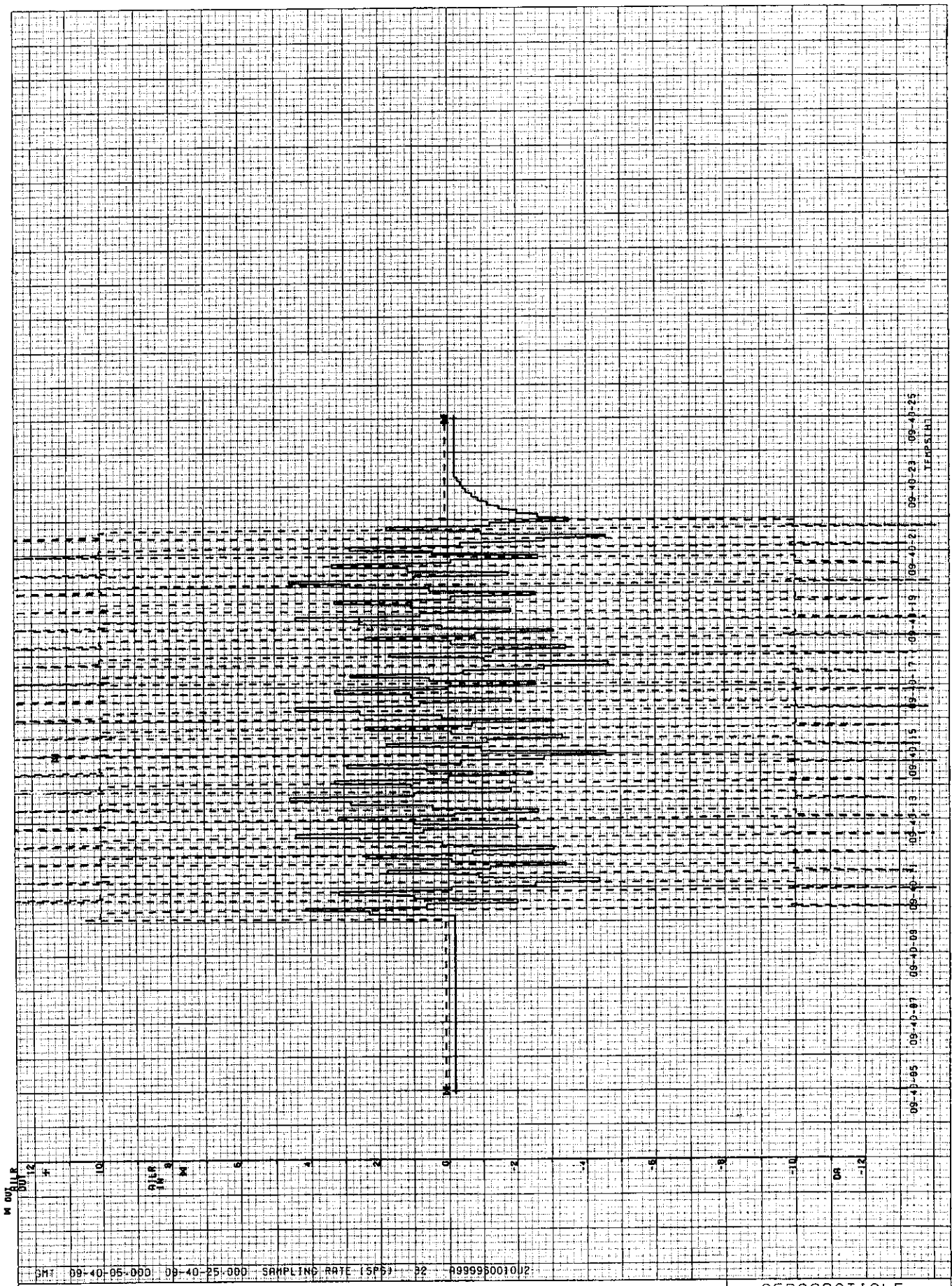
A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.11

005-6 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 6.6 FIRST TRY FTI

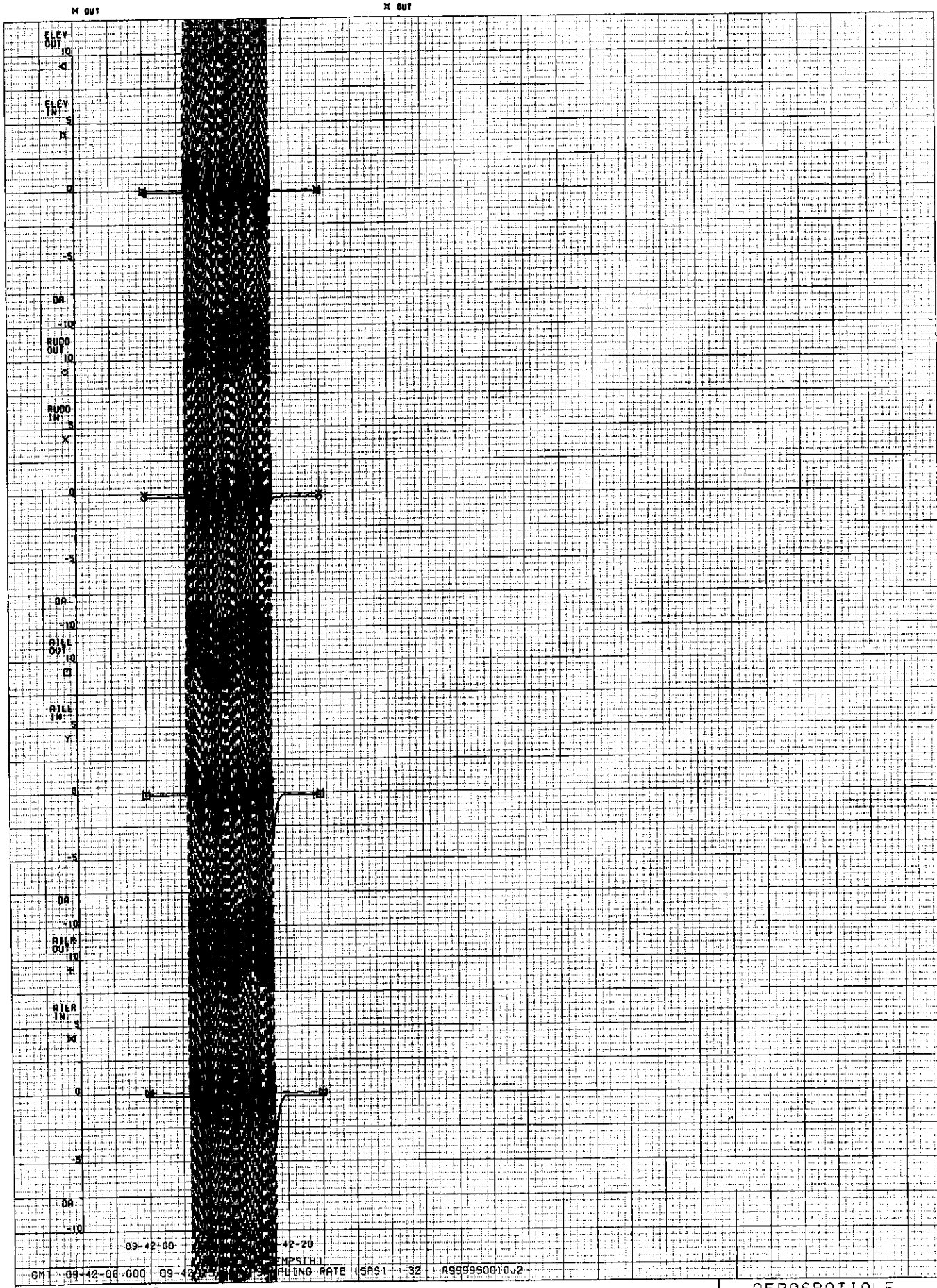
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.12

(C) AEROSPATIALE

AVIC



FLIGHT S0010 TEST 6.7 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

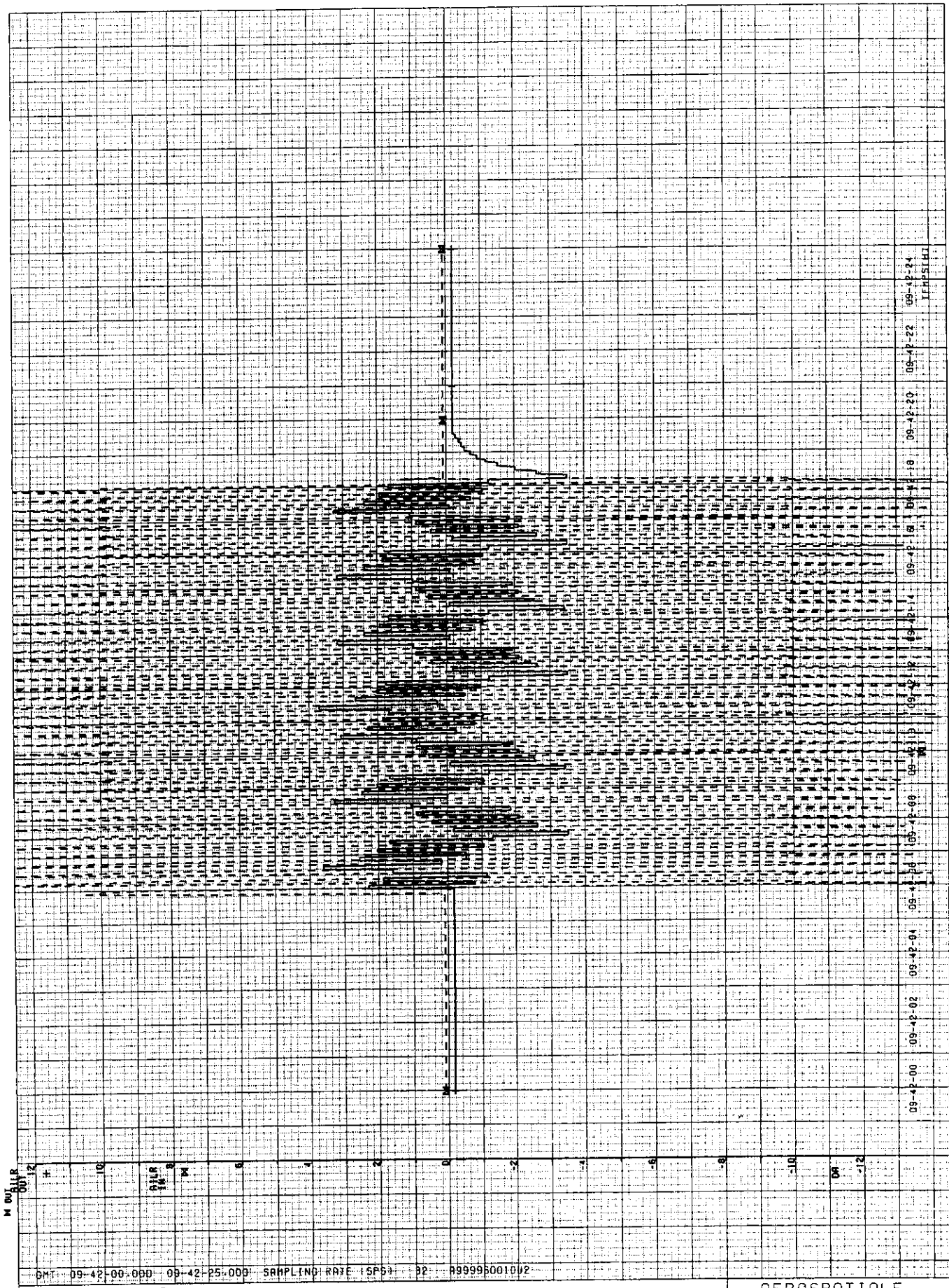
AIRCRAFT A9999 FIGURE 3.6.13

ICI AEROSPATIALE

005.6 SERIE/SDACAAL.AD

008285

AVIC



GMT 09-42-00.000 09-42-25.000 SAMPLING RATE (SPS) 32 A9999S0010U2

FLIGHT S0010 TEST 6.7 FIRST TRY FTI

A-NTSB

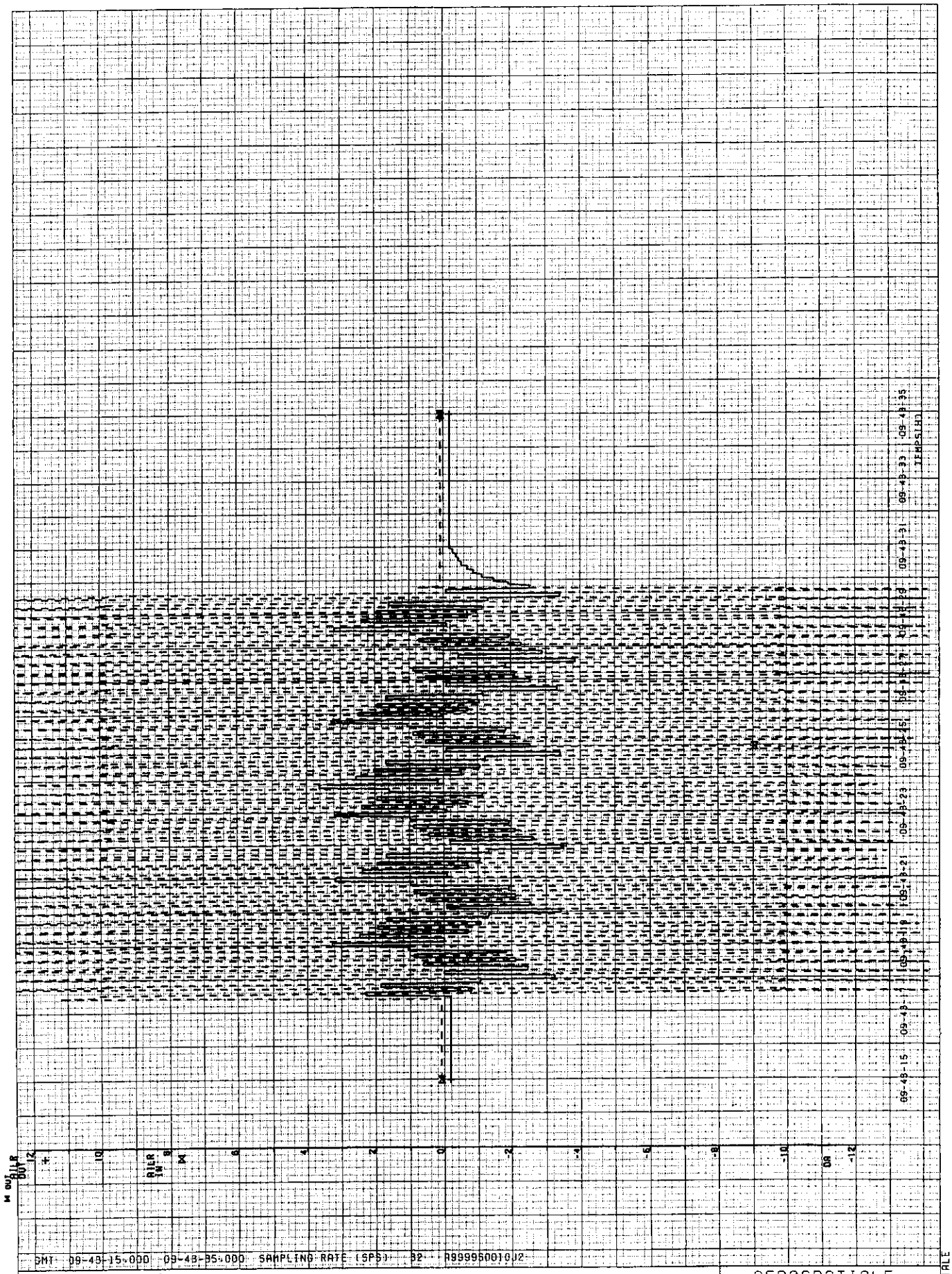
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.6.14

(C) AEROSPATIALE

SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 6.7 SECOND TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

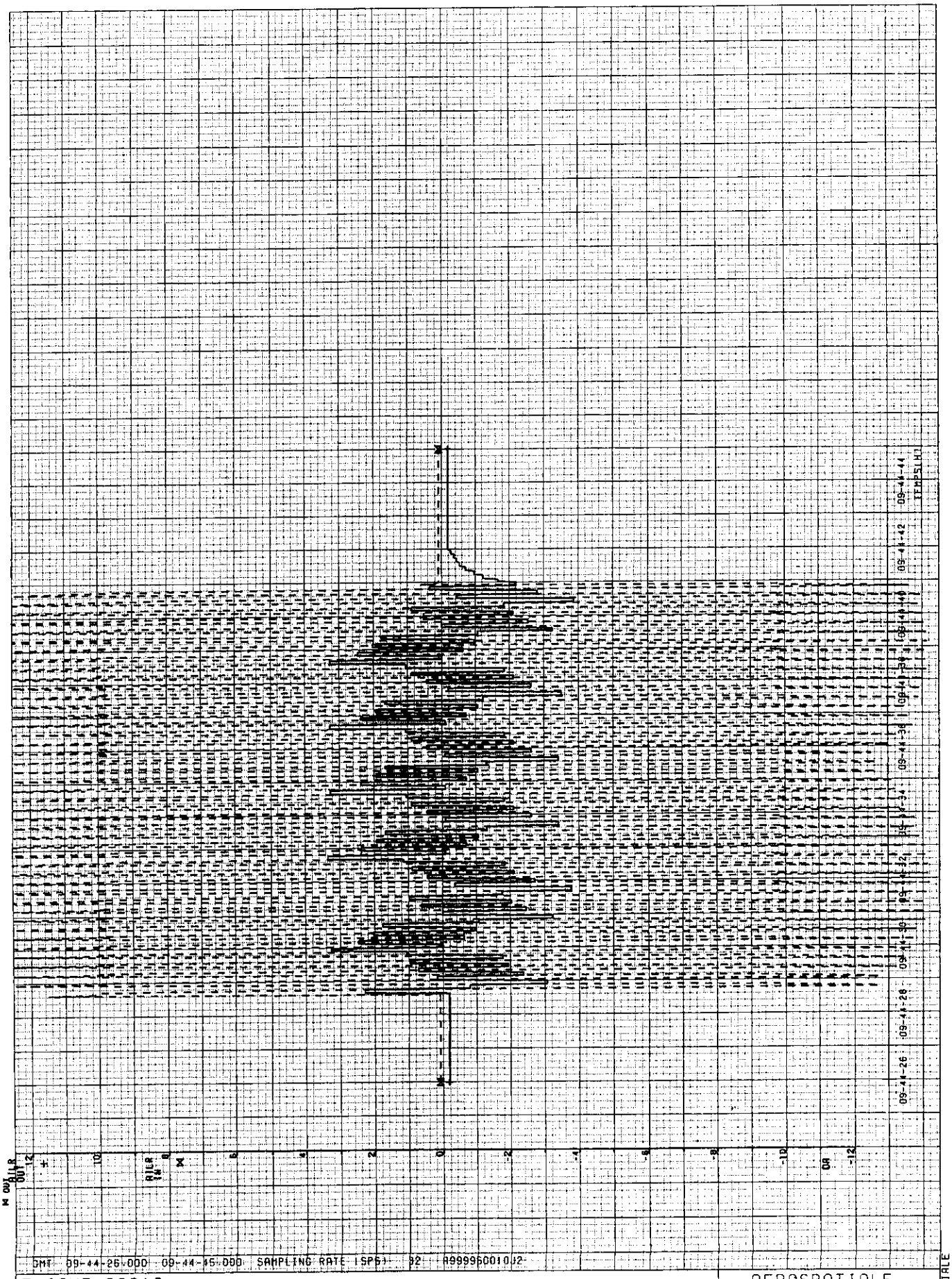
AIRCRAFT A9999 FIGURE 3.6.15

(C) AEROSPATIALE

310.6 SERIE/SDACAAL-AD

008287

AVIC



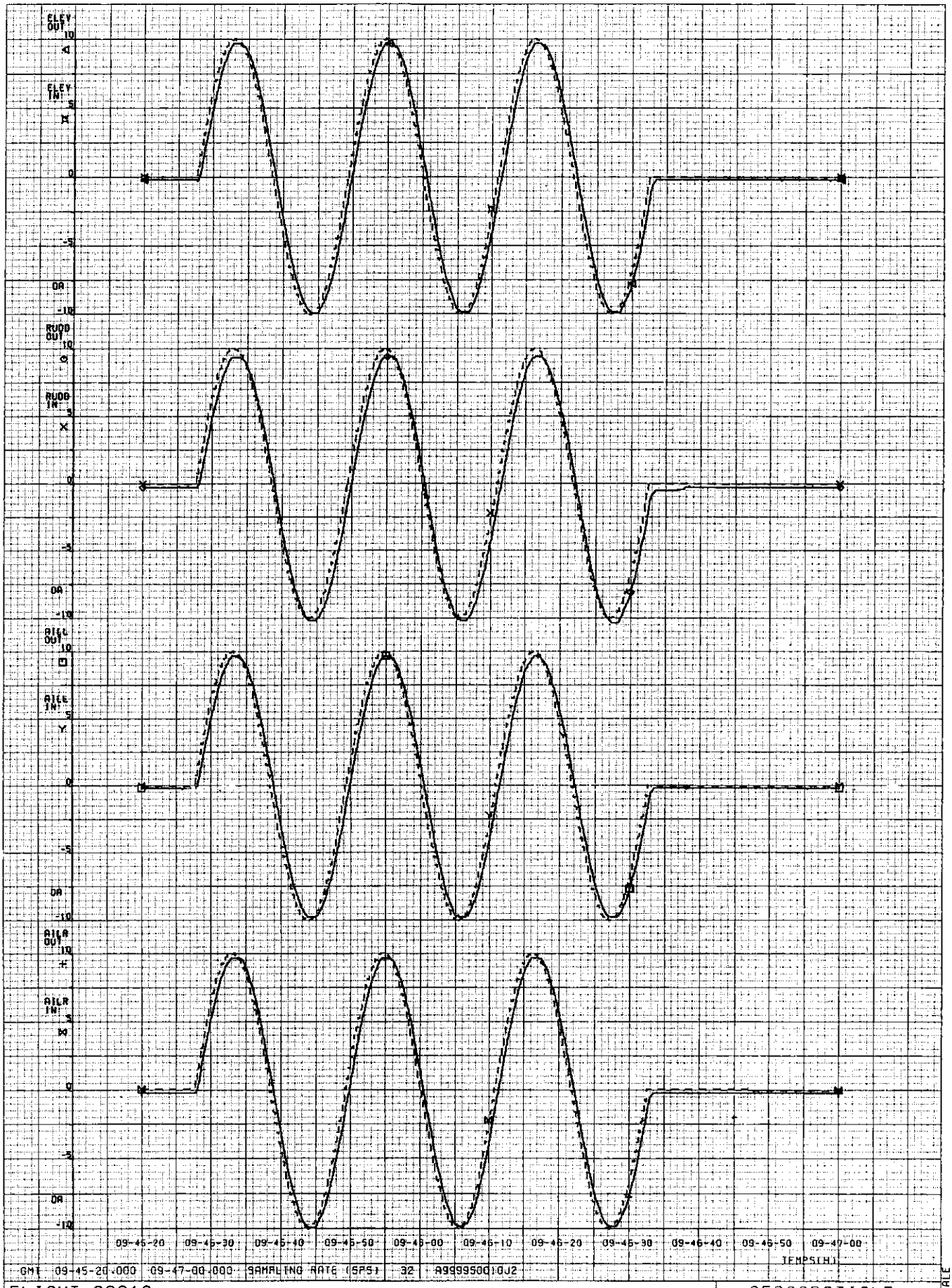
310.6

SERIE/SDACAAL.AD

008288

ANNEX 3.7:
Test series n°7

AVIÉ



FLIGHT S0010 TEST 7.1 FIRST TRY FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

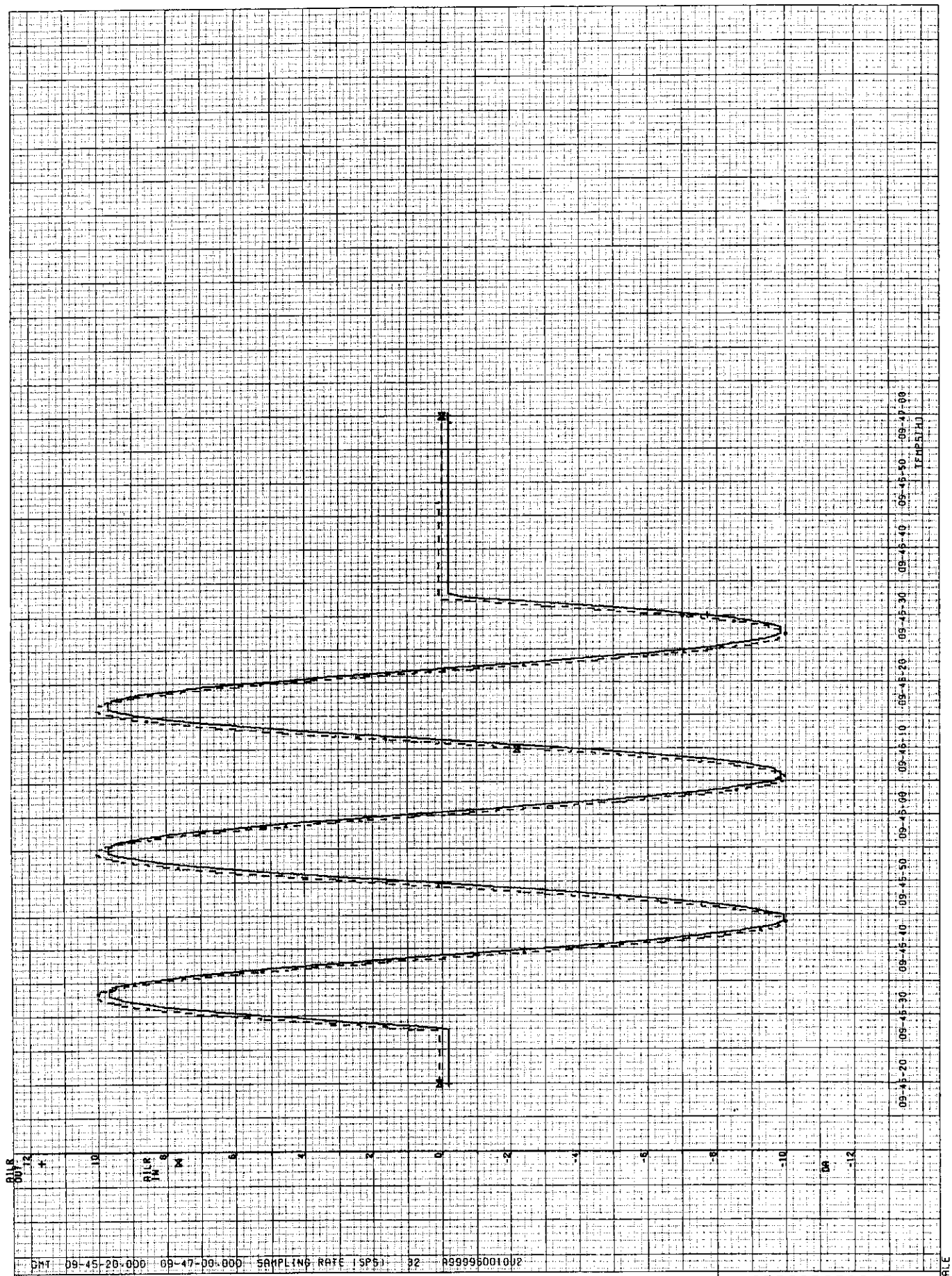
AIRCRAFT A9999 FIGURE 3-7.1

(C) AEROSPATIALE

SERIE/SDACAAL.AD

308260

AVIT



GMT 09-45-20.000 09-47-00.000 SAMPLING RATE (SPS) 32 A99995001002

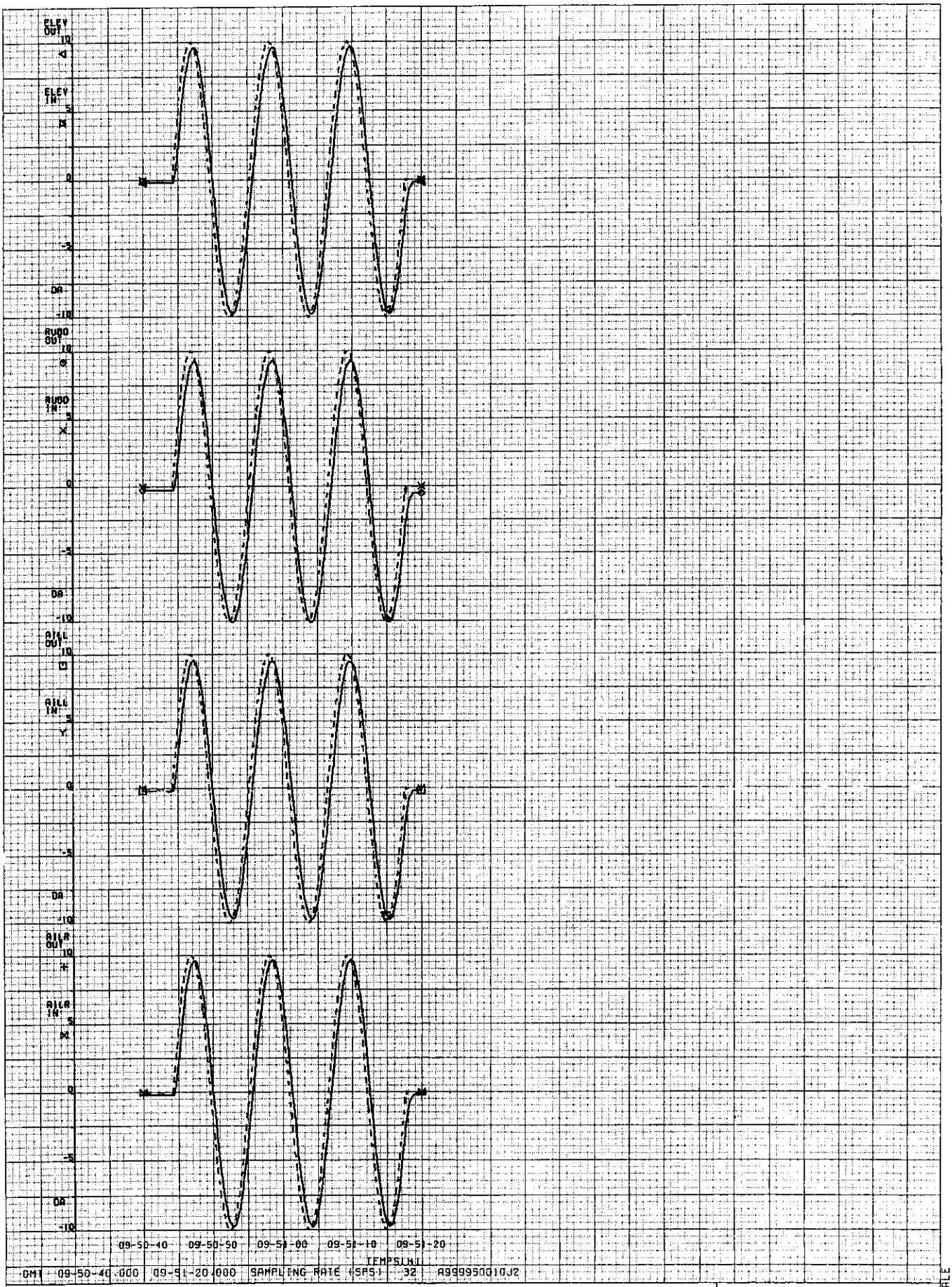
FLIGHT S0010 TEST 7.1 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3.7.2

(C) AEROSPATIALE



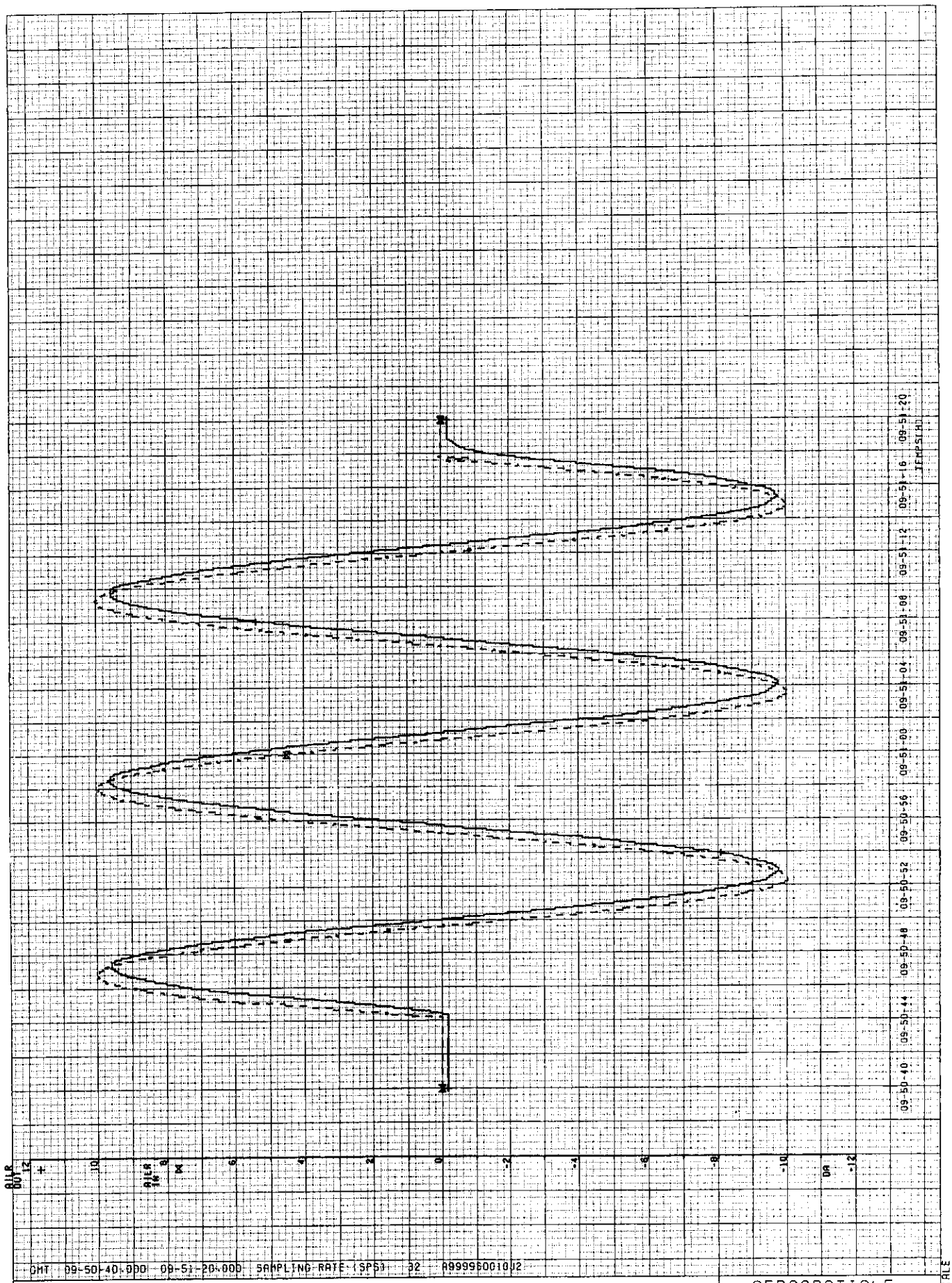
FLIGHT S0010 TEST 7.2 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.3

AVIC



FLIGHT S0010 TEST 7.2 FIRST TRY FTI

A-NTSB

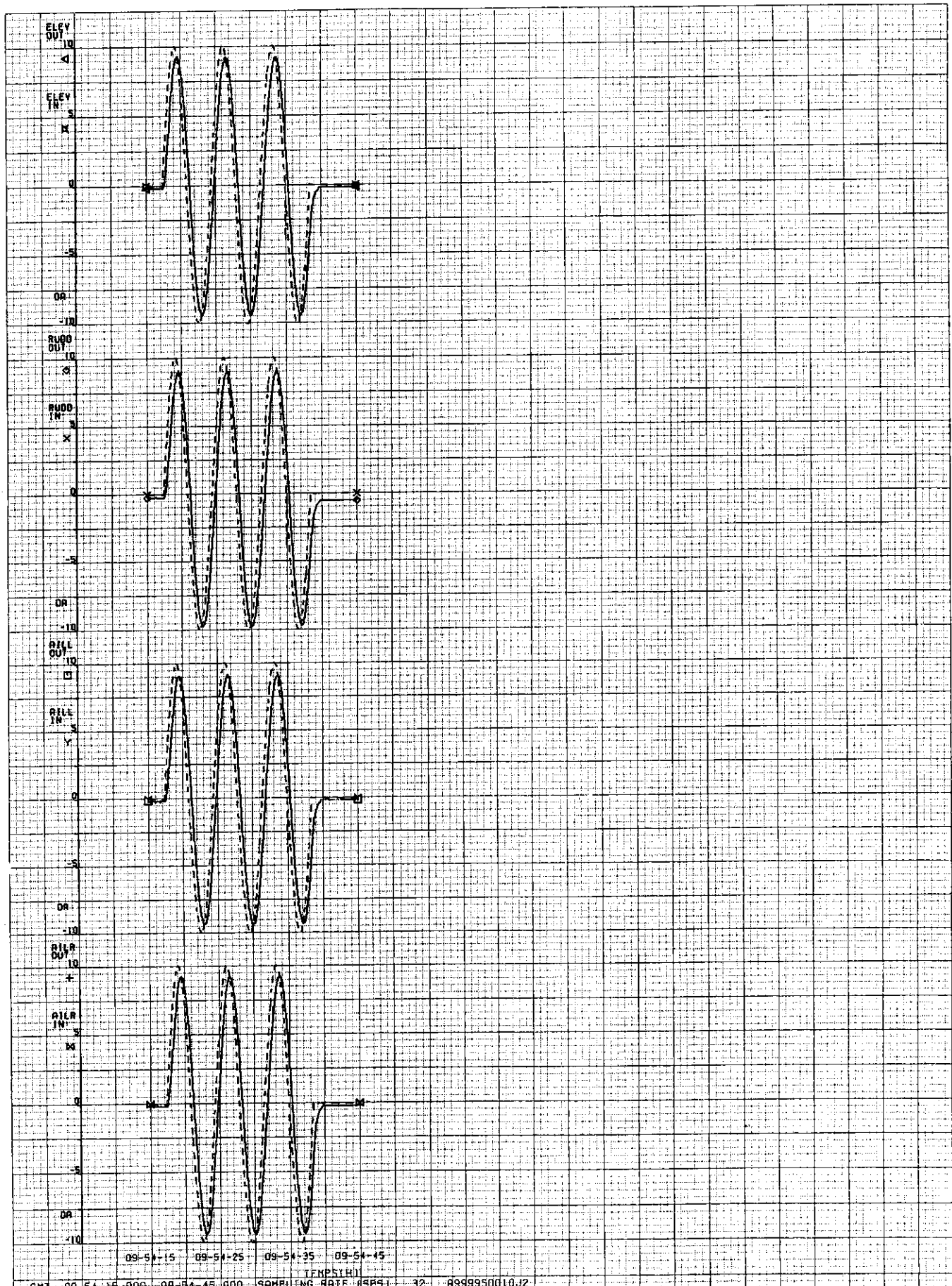
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.4

(C) AEROSPATIALE

310.7 SERIE/SOACABL.AD

AVIC

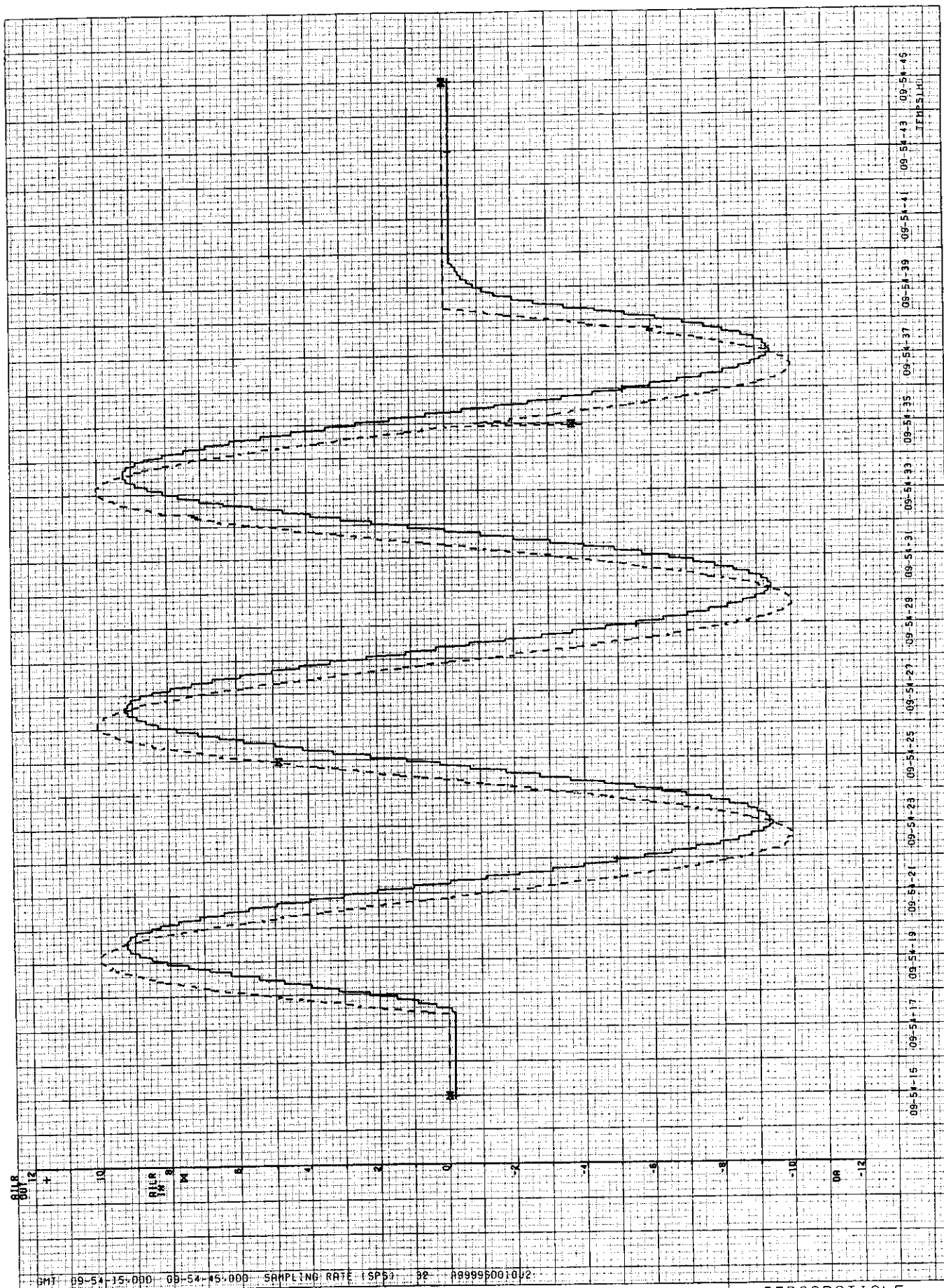


FLIGHT S0010 TEST 7.3 FIRST TRY FTI

AEROSPATIALE
FLIGHT TESTS

AEROSPATIALE

AVIC



GMT 09-54-15.000 09-54-45.000 SAMPLING RATE (SPS) 32 A9999S0010U2

FLIGHT S0010 TEST 7.3 FIRST TRY FTI

A-NTSE

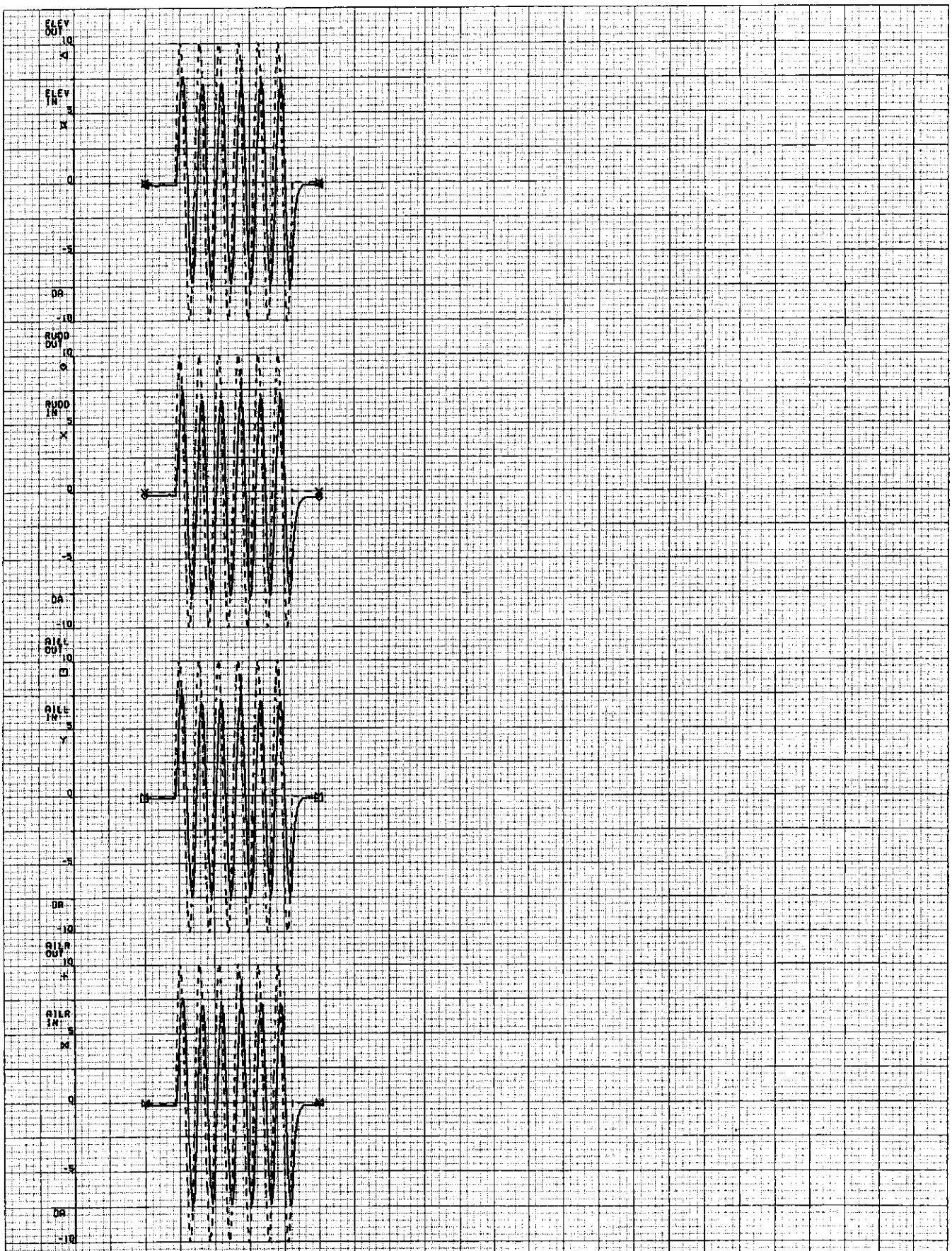
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.6

(C) AEROSPATIALE

SERTE/SDACAAL.AD

AV1C



FLIGHT S0010 TEST 7.4 FIRST TRY FTI

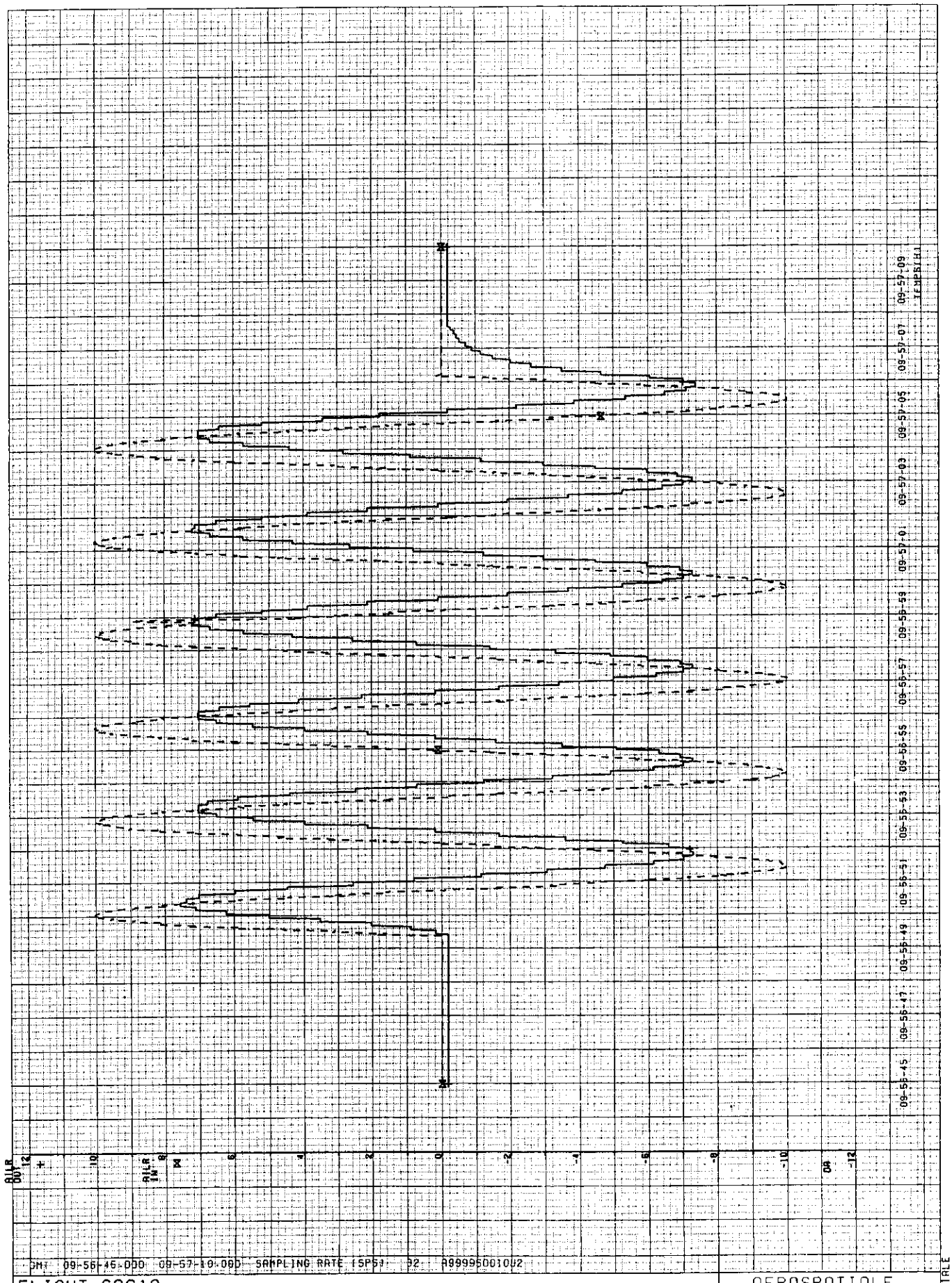
A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.7

(C) AEROSPATIALE

AVIC



GMT 09-56-46.000 09-57-10.000 SAMPLING RATE (SPS) 32 A99995001002

FLIGHT S0010 TEST 7.4 FIRST TRY FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

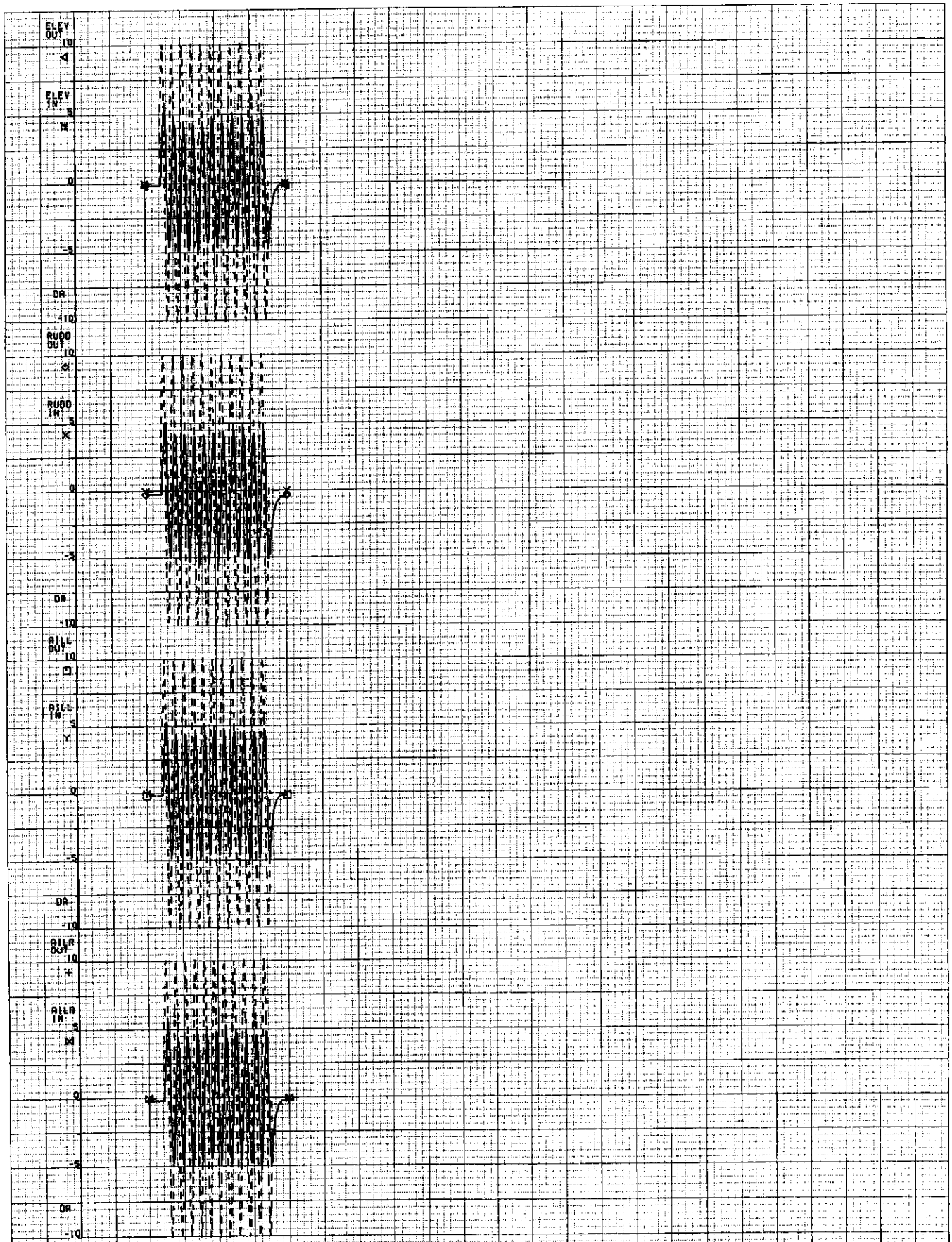
AIRCRAFT A9999 FIGURE 3.7.8

AEROSPATIALE

310.7 SERIE/SOACRAL.AO

008297

AVIC



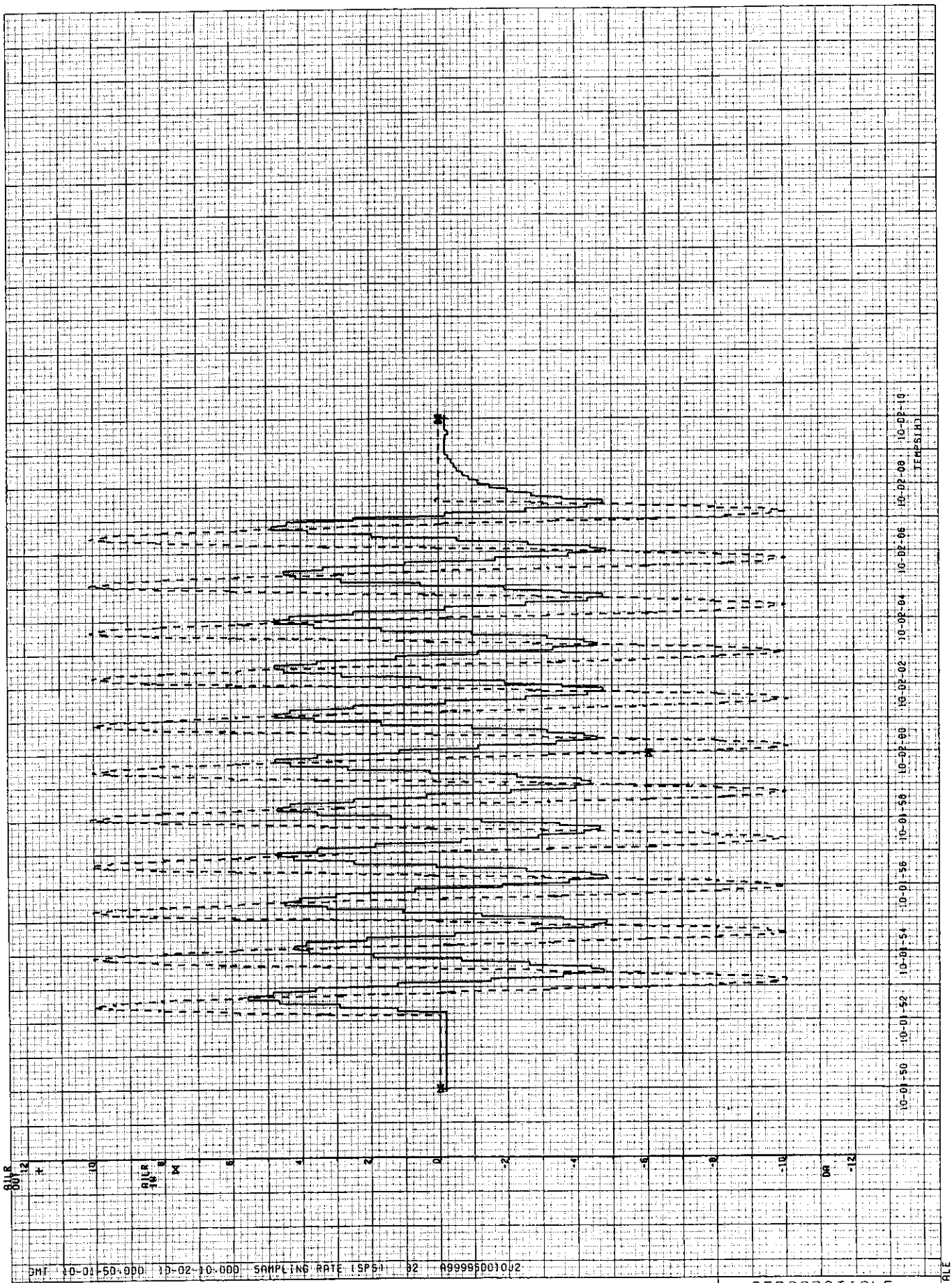
FLIGHT S0010 TEST 7.5 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.2.9

AVIC



FLIGHT S0010 TEST 7.5 FIRST TRY FTI

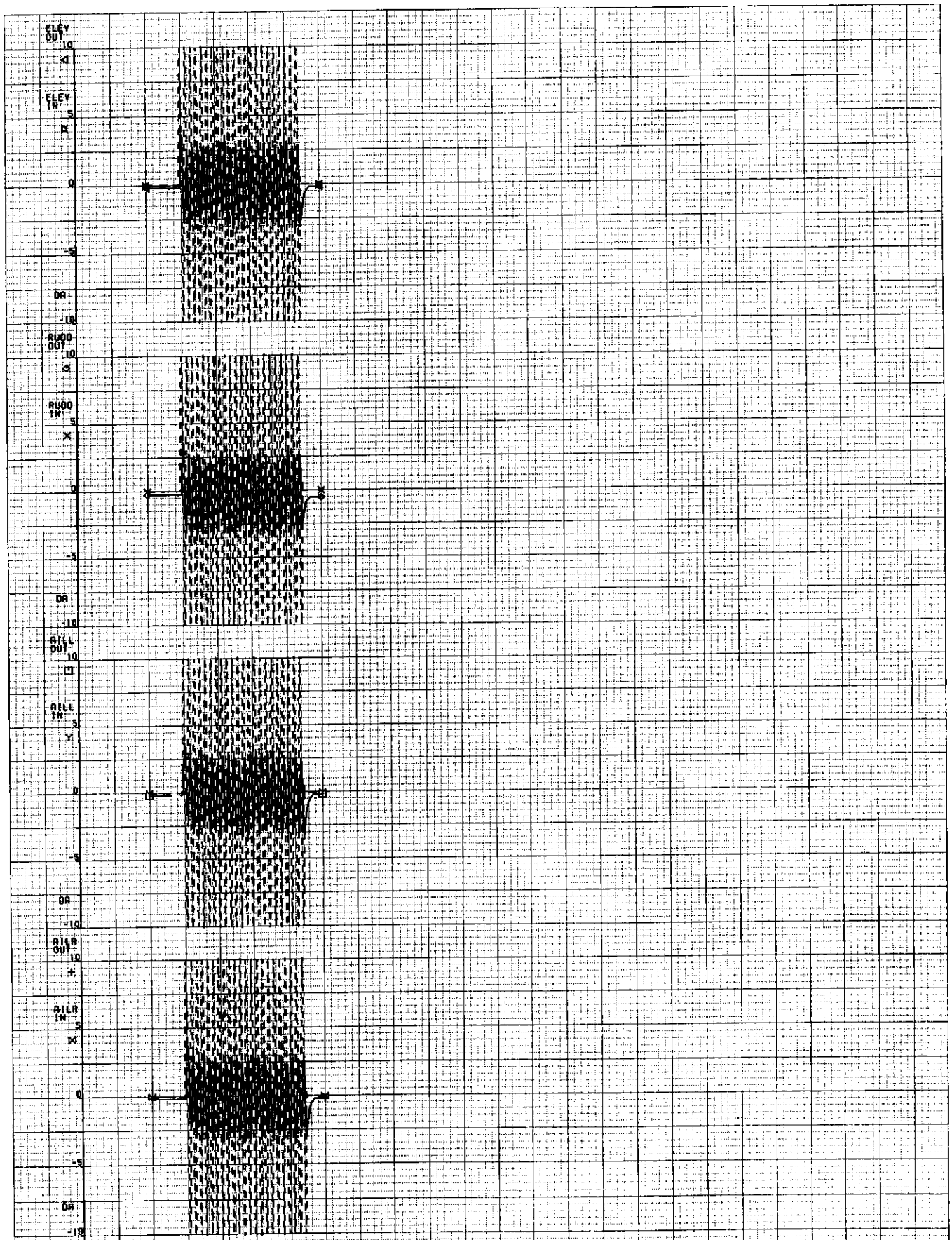
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 37.10

CET AEROSPATIALE

AVIC



FLIGHT S0010 TEST 7.6 FIRST TRY FTI

A-NTSB

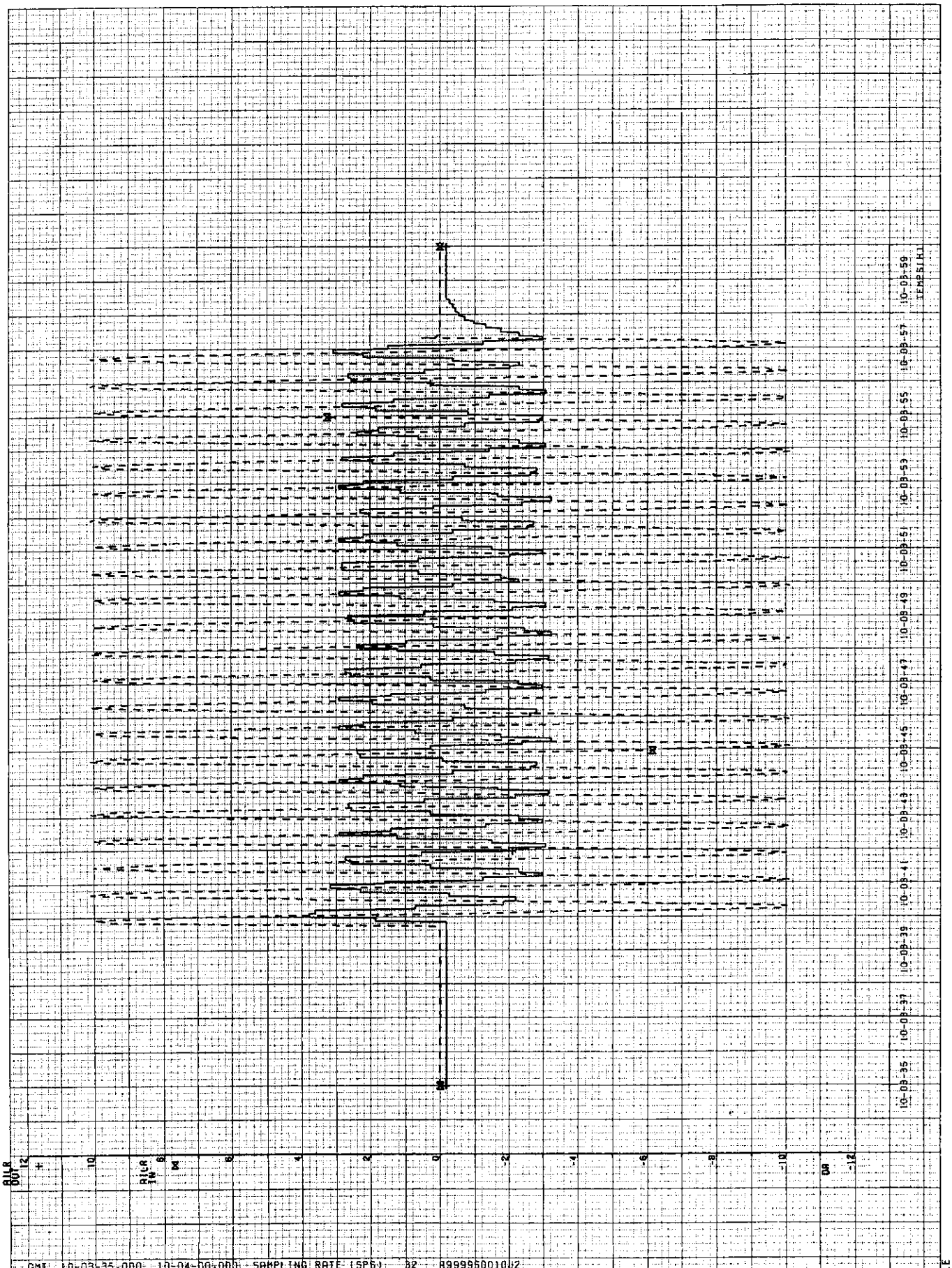
908300

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.11

(C) AEROSPATIALE

SERIE/SDACAAL.AD



FLIGHT S0010 TEST 7.6 FIRST TRY FTI

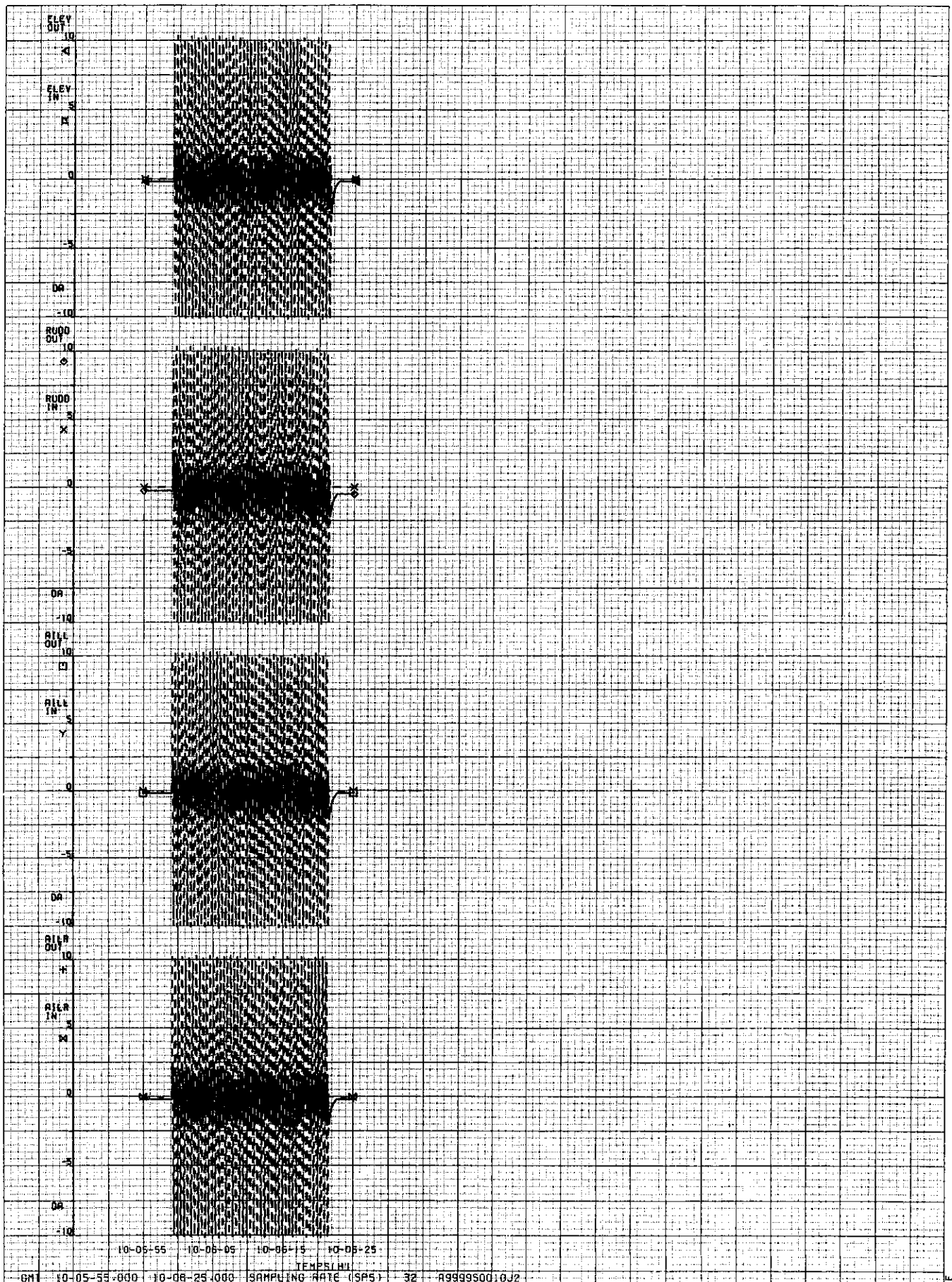
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.12

CI AEROSPATIALE

AVIC



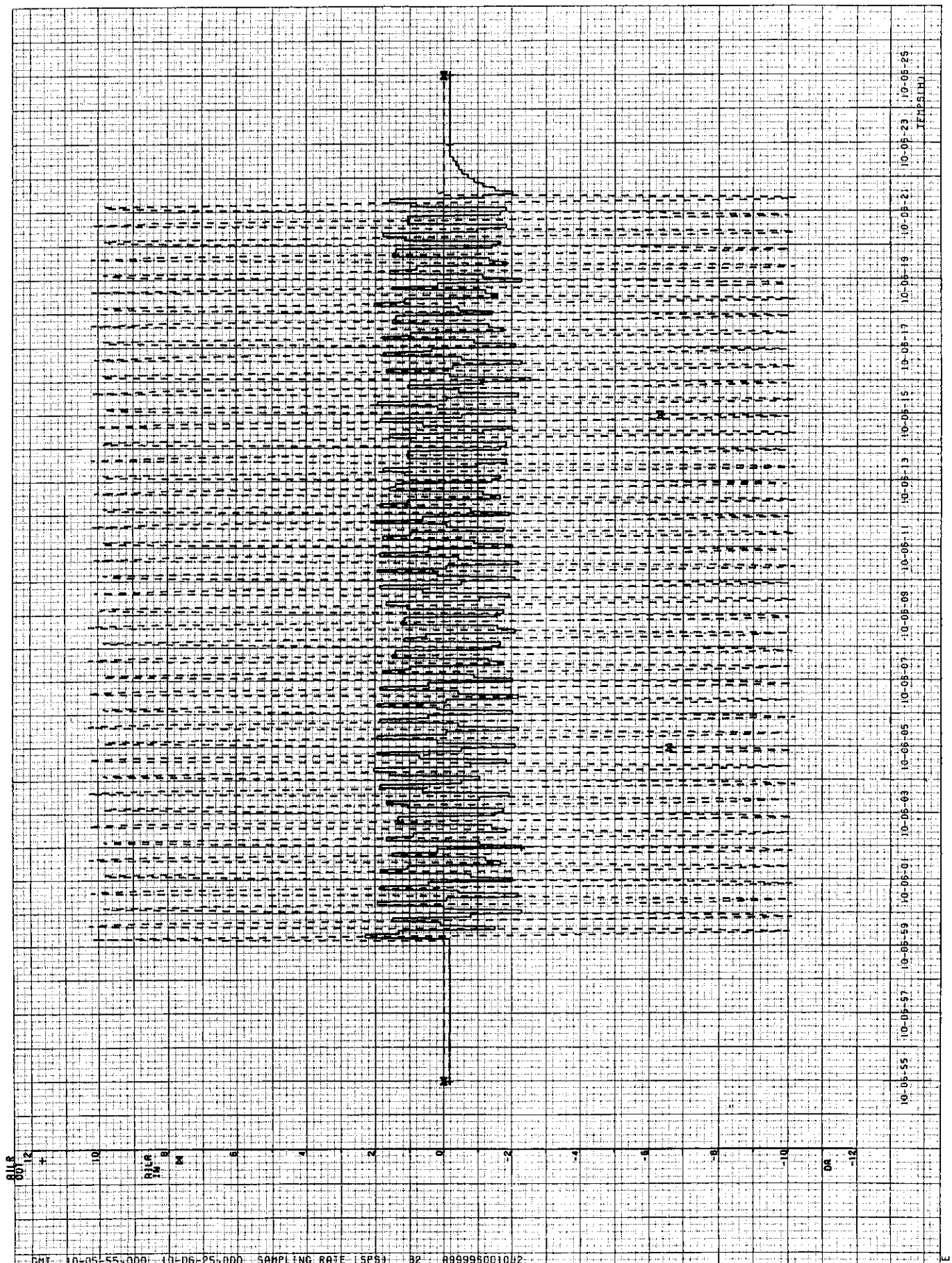
FLIGHT S0010 TEST 7.7 FIRST TRY FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.13

AVIC



GMT 10-05-55.000 10-06-25.000 SAMPLING RATE (SPS) 32 A99995001002

FLIGHT S0010 TEST 7.7 FIRST TRY FTI

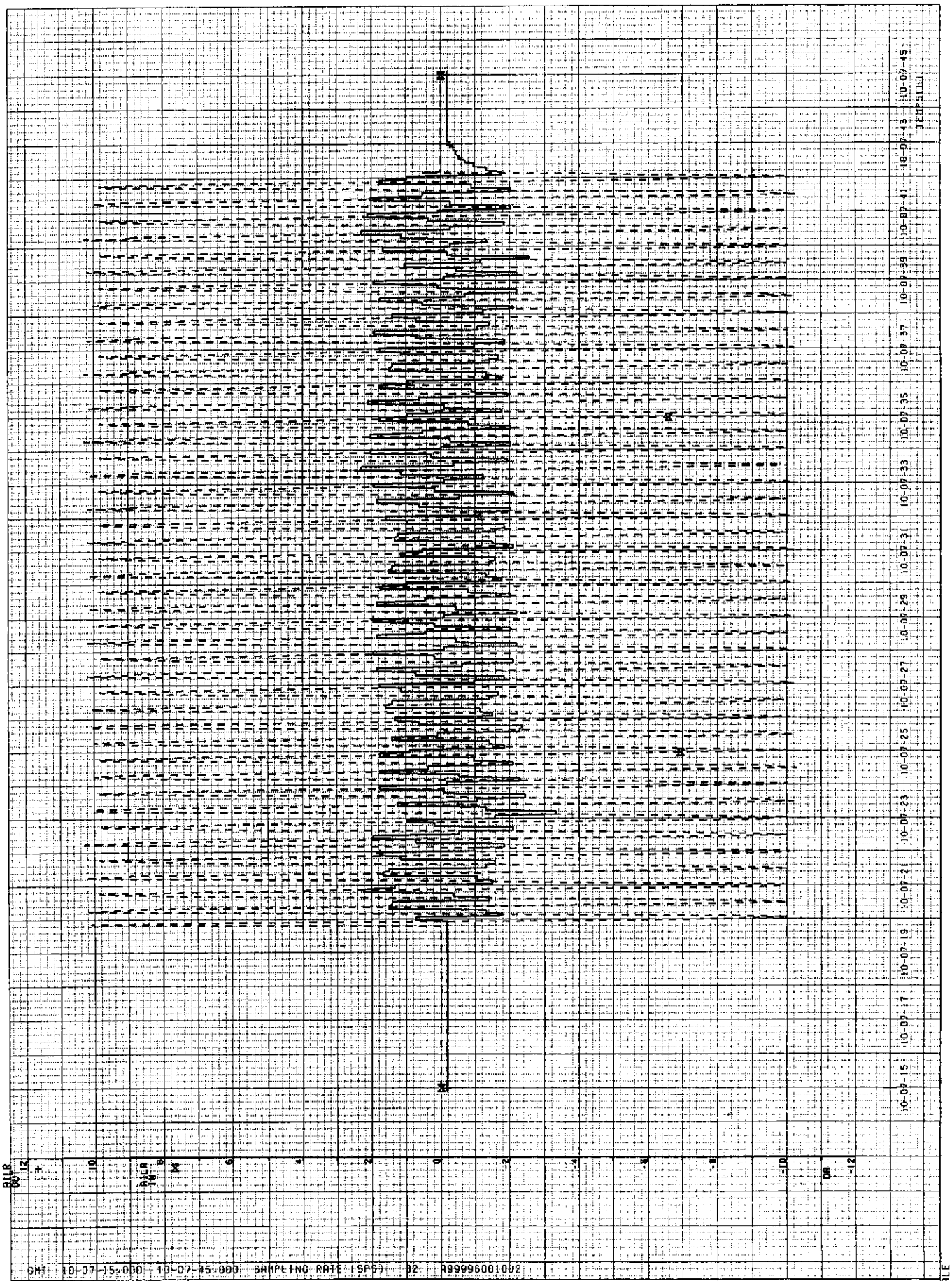
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.14

(C) AEROSPATIALE

008303

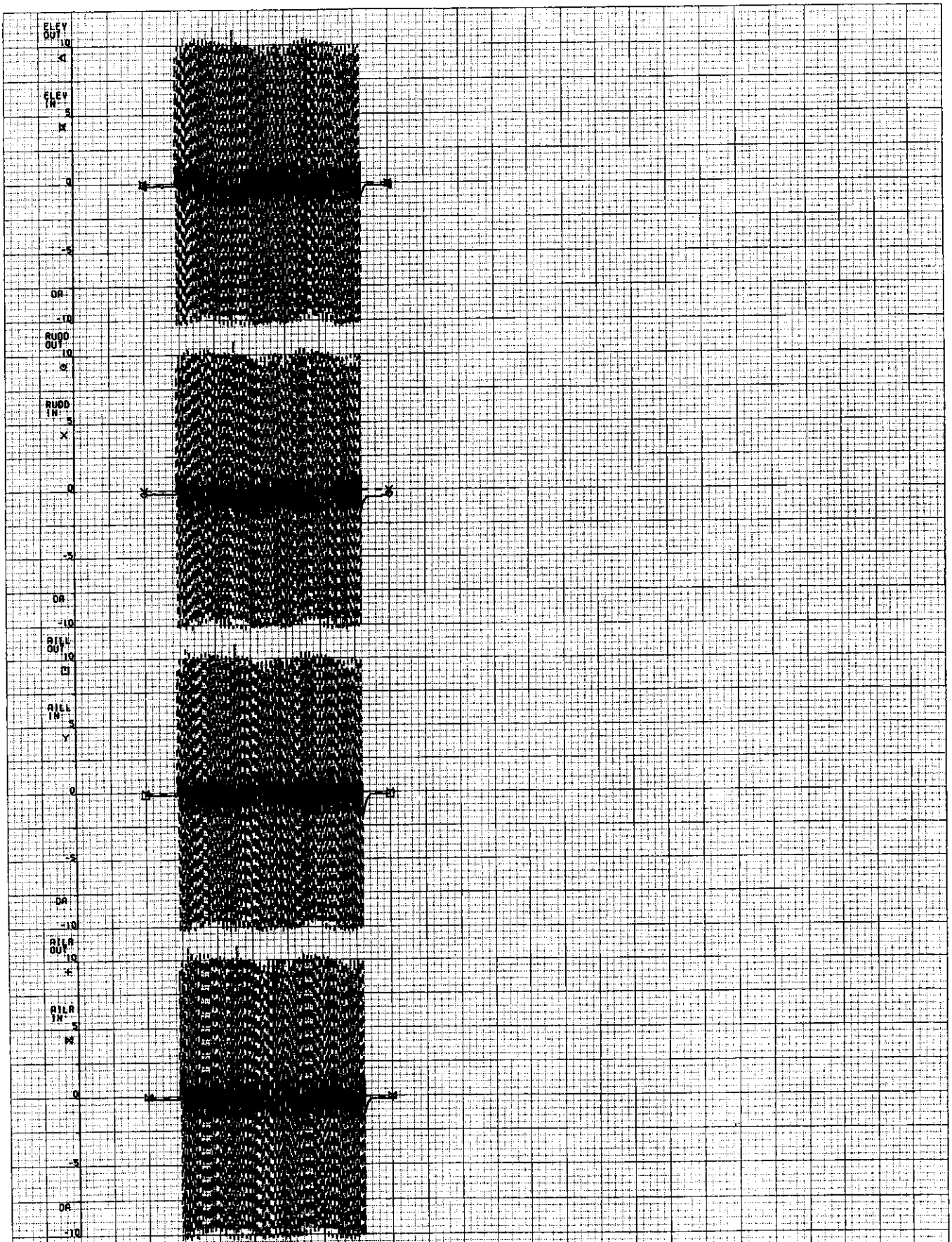


FLIGHT S0010 TEST 7.7 SECOND TRY FTI

AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT A9999 FIGURE 3-7-15



FLIGHT S0010 TEST 7.8 FTI

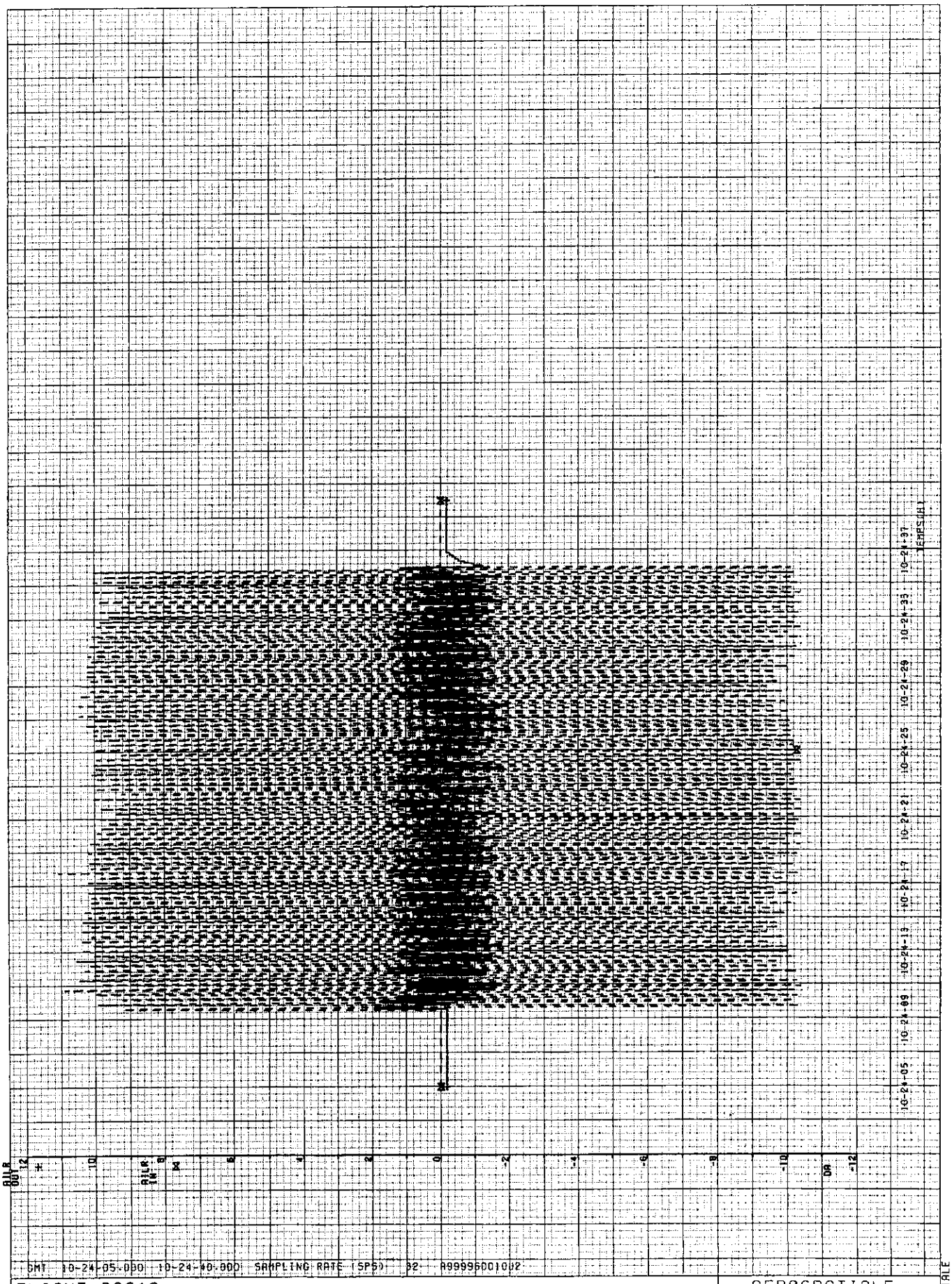
A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.16

ICT AEROSPATIALE

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

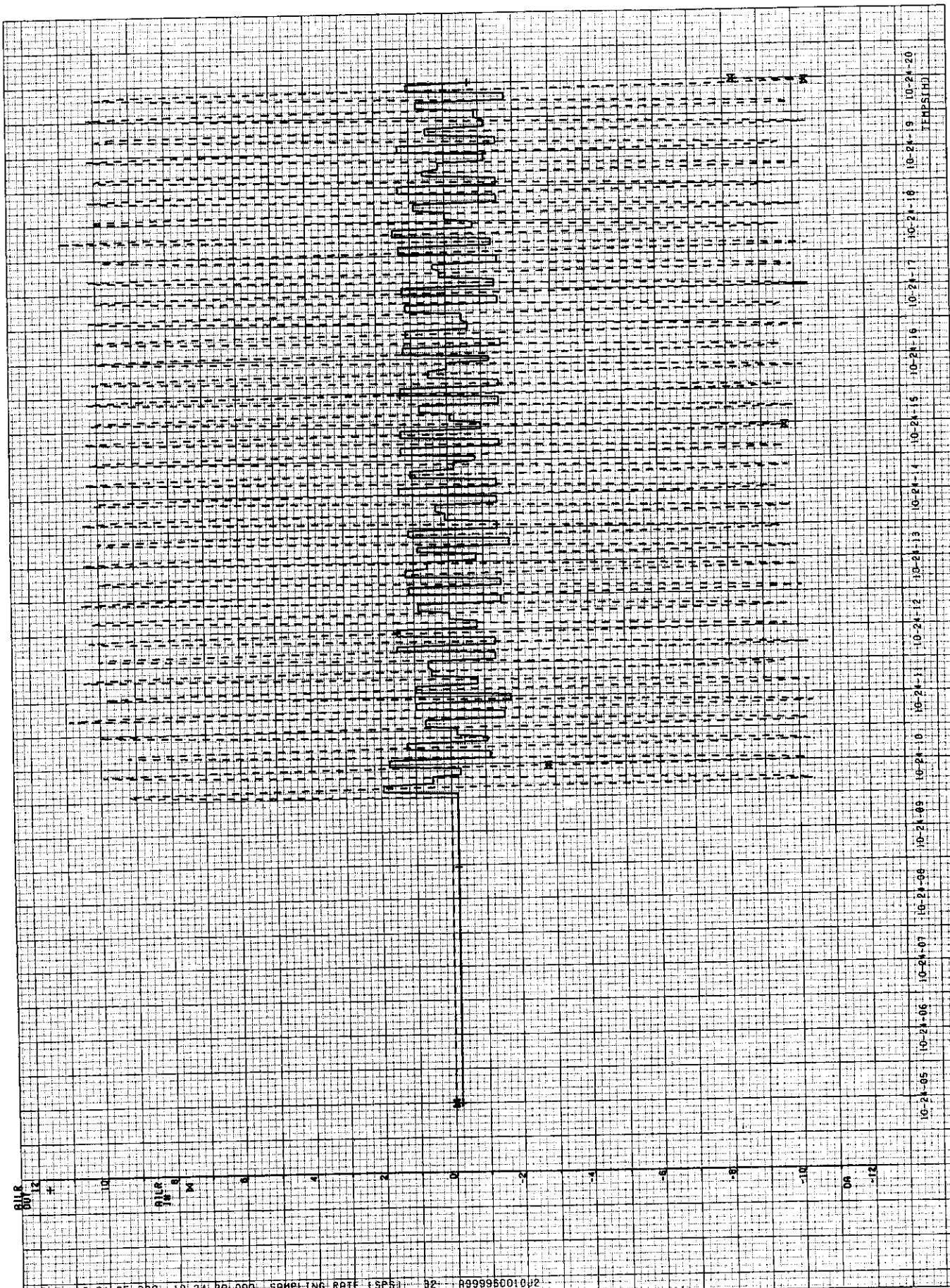
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.17

(C) AEROSPATIALE

008306

AVIC



GMT 10-24-05.000 10-24-20.000 SAMPLING RATE (SPS) 32 A9999S00102

FLIGHT S0010 TEST 7.8 FTI

A-NTSB

008307

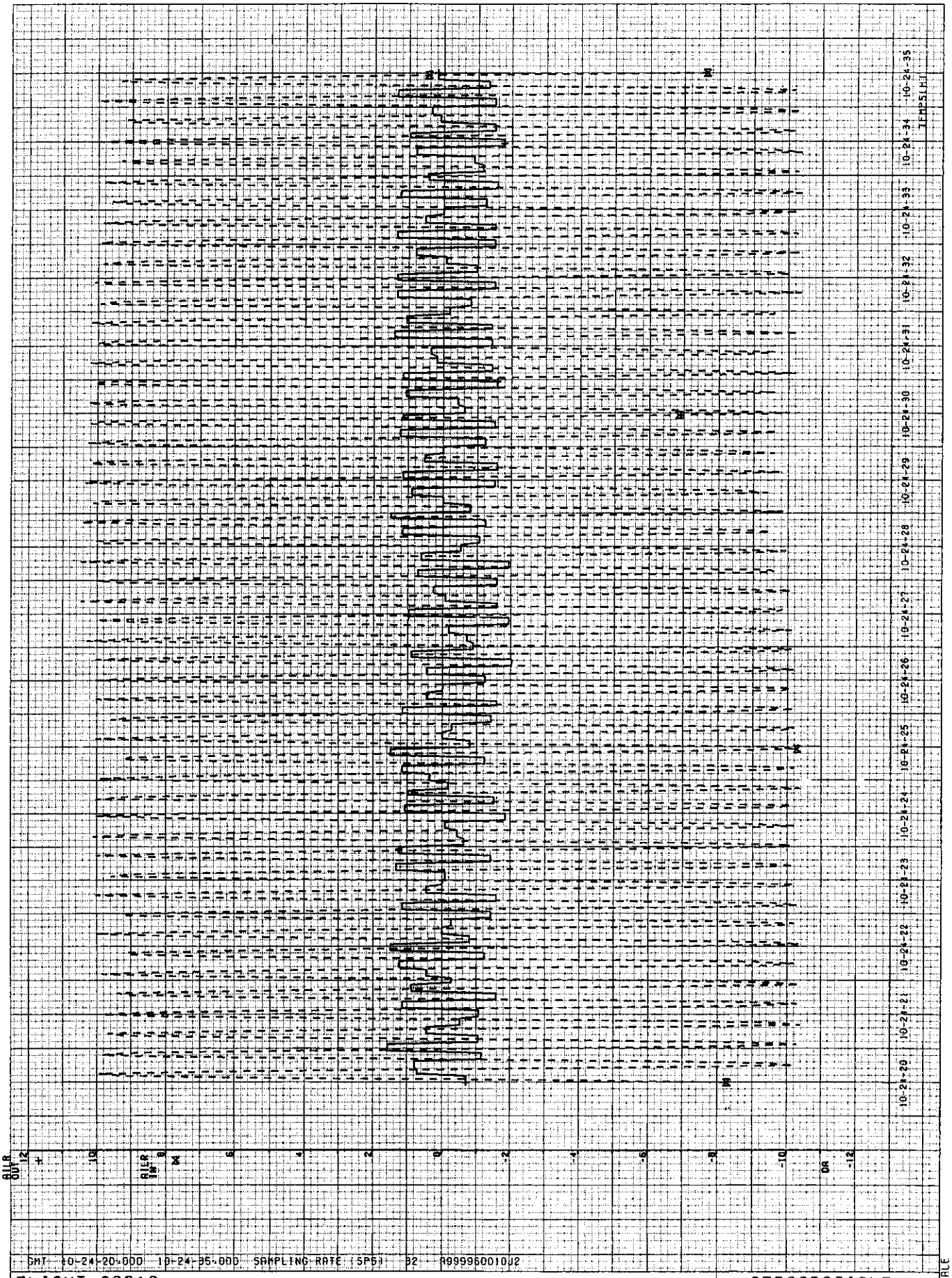
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3-7.18

(C) AEROSPATIALE

SERIE/SOACAAL.AD

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

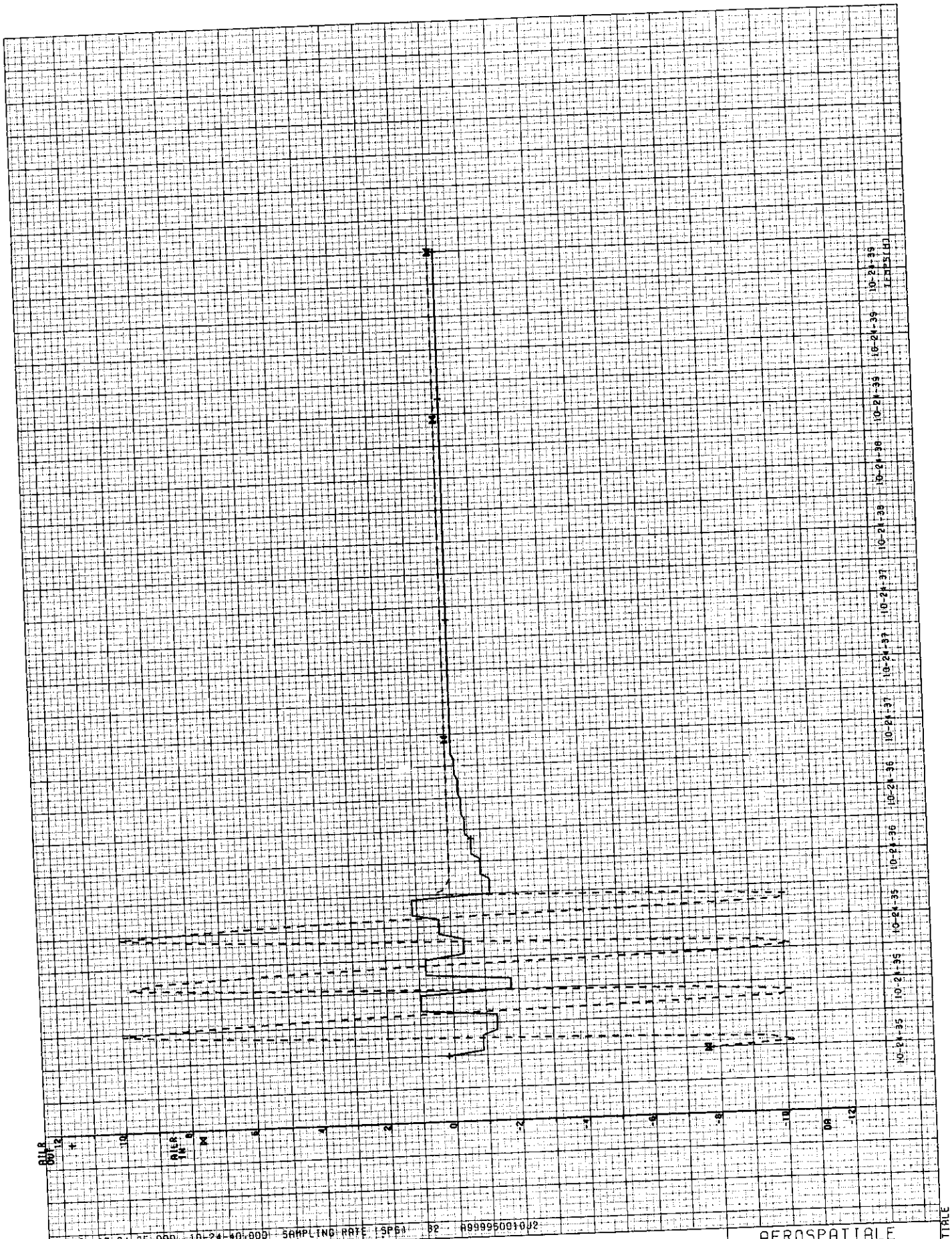
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.19

(C) AEROSPATIALE

008308

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

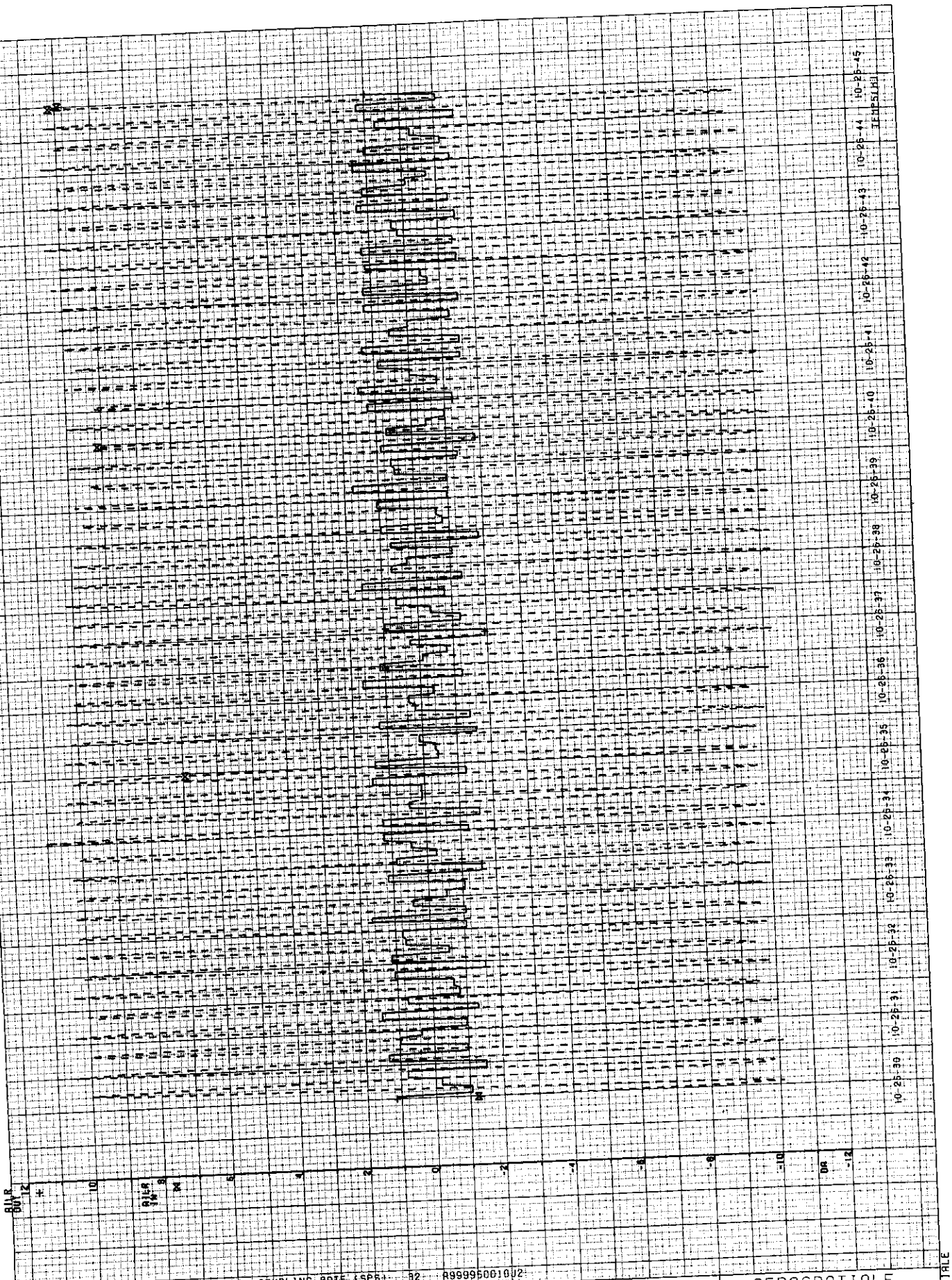
AIRCRAFT A9999 FIGURE 3.7.20

(C) AEROSPATIALE

SERIE/SOACAAL.AD

008309

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

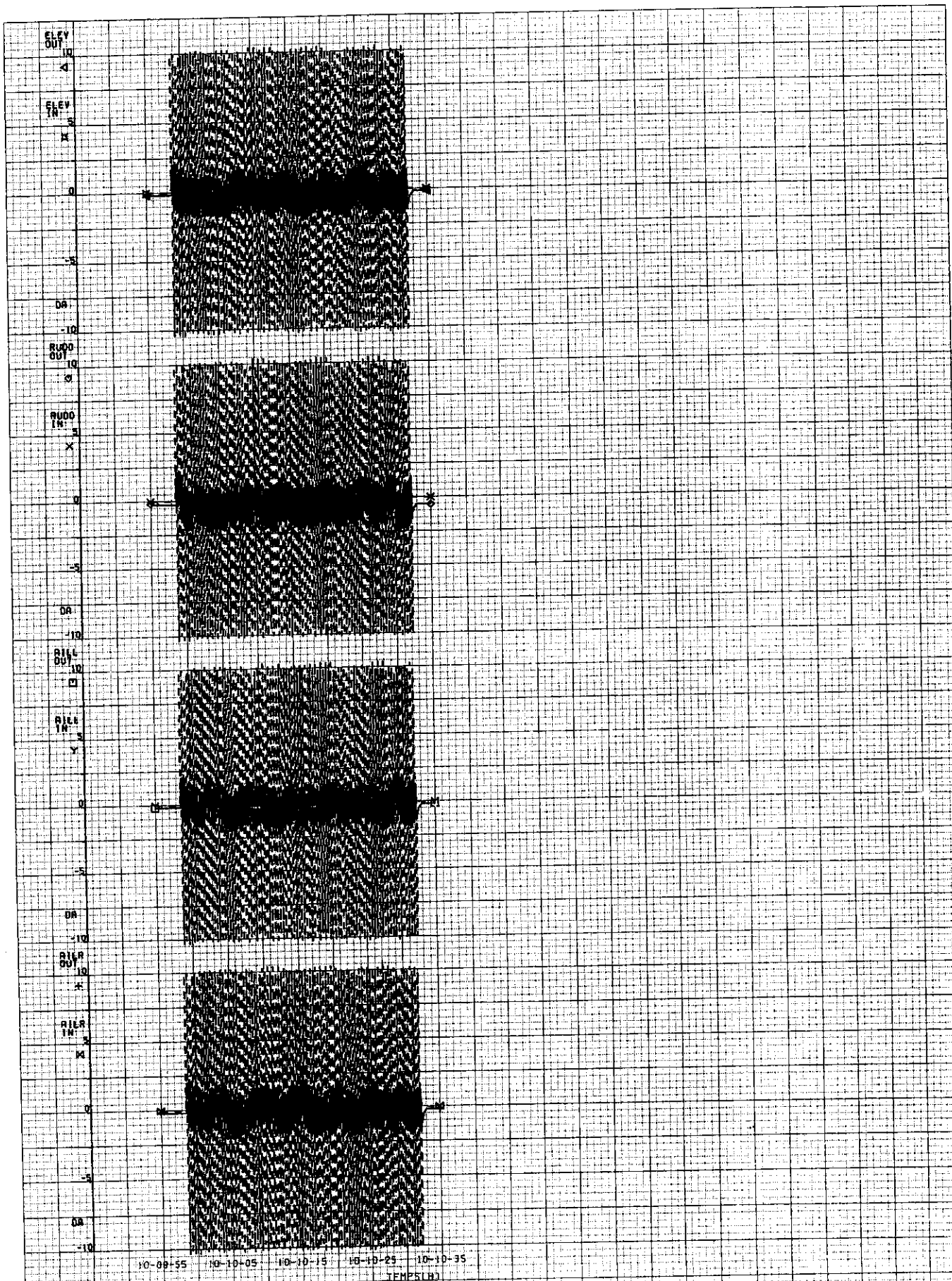
AIRCRAFT A9999 FIGURE 3.7.21

(C) AEROSPATIALE

908310

310.7 SERIE/SDACAAL.AD

AV.C



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

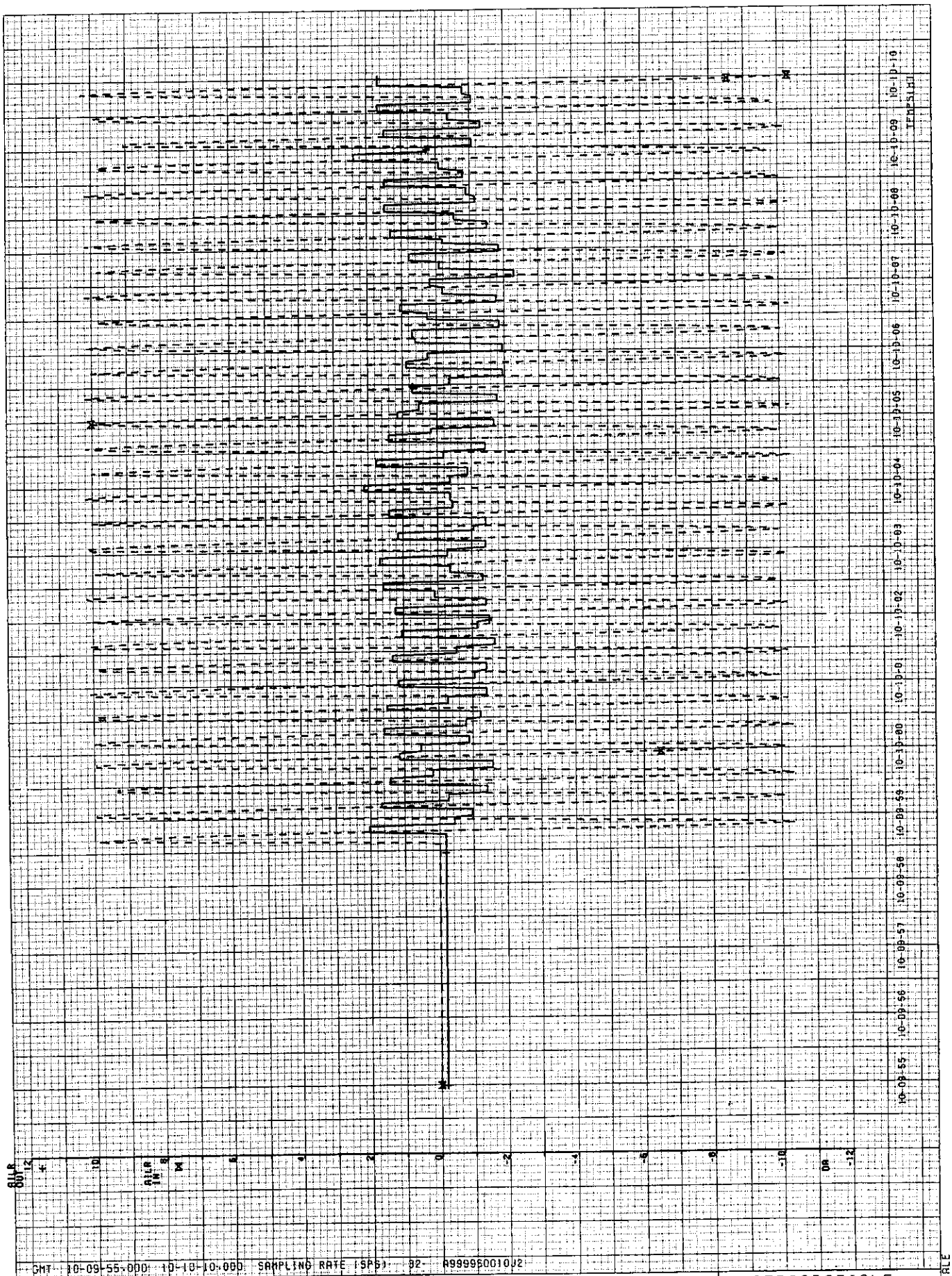
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.22

(C) AEROSPATIALE

008311

AVIC



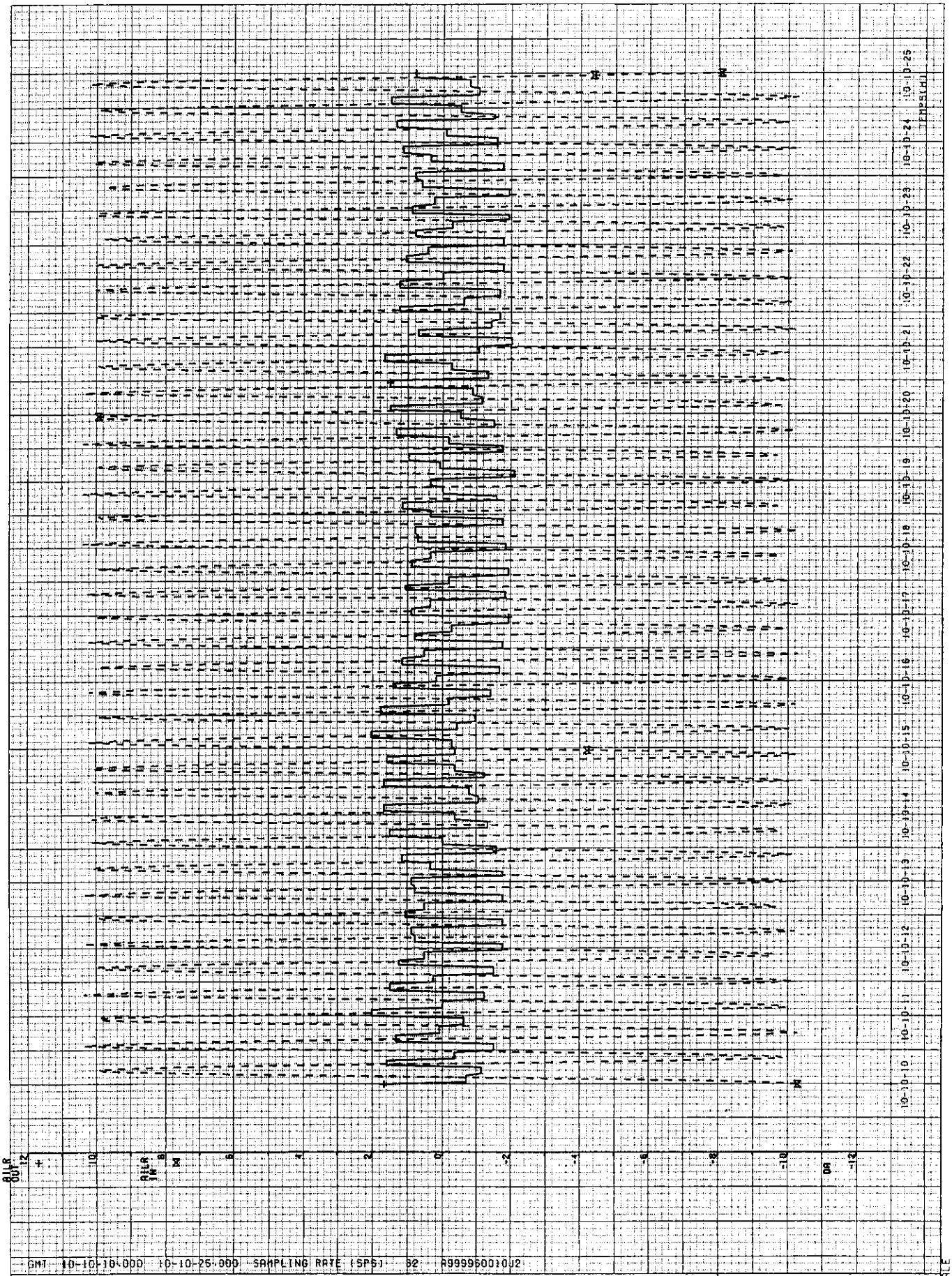
FLIGHT S0010 TEST 7.8 FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.23

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

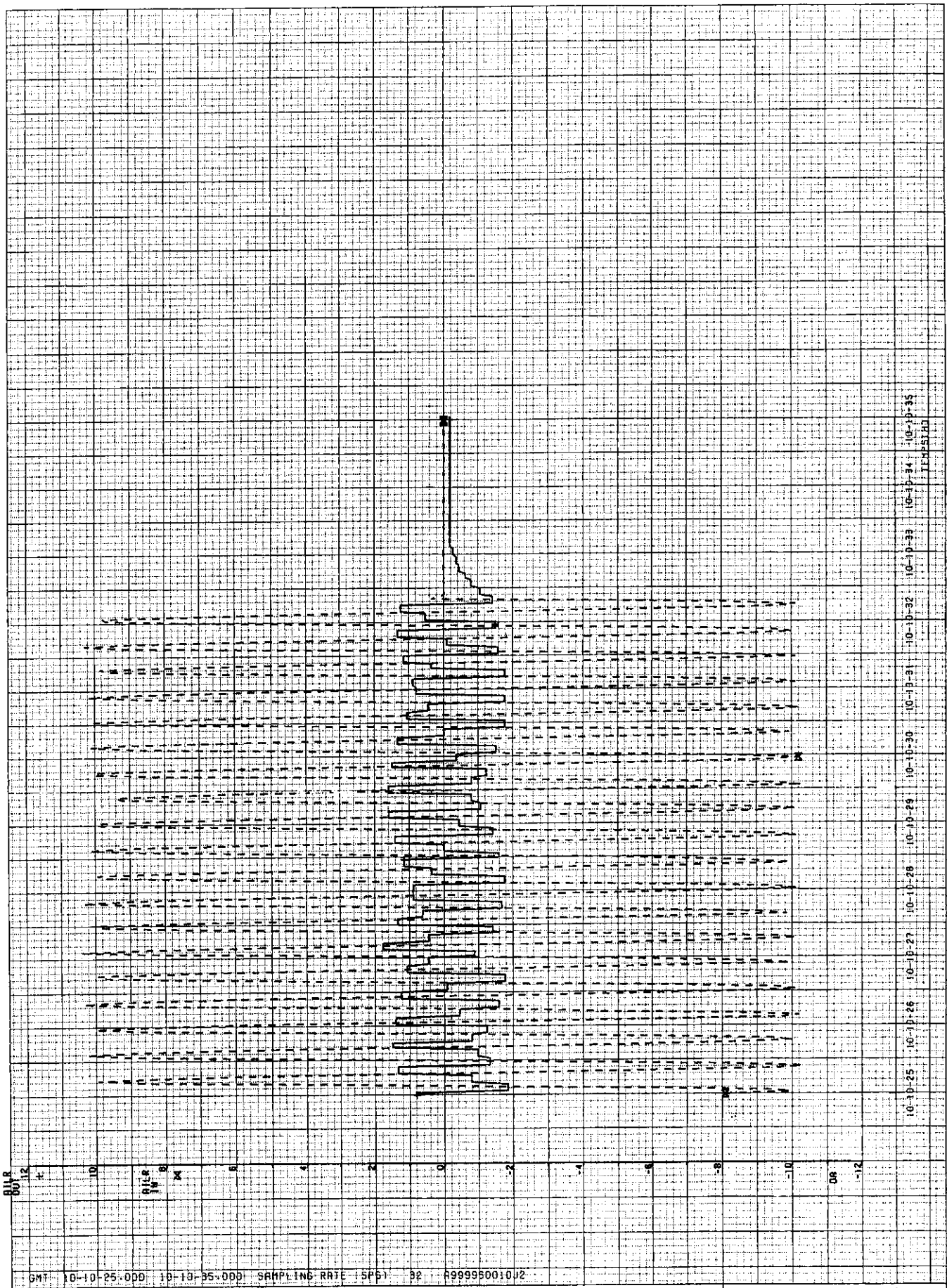
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.24

(C) AEROSPATIALE

008313

AVIC



GMT 10-10-25.000 10-10-35.000 SAMPLING RATE (SPS) 32 A9999500102

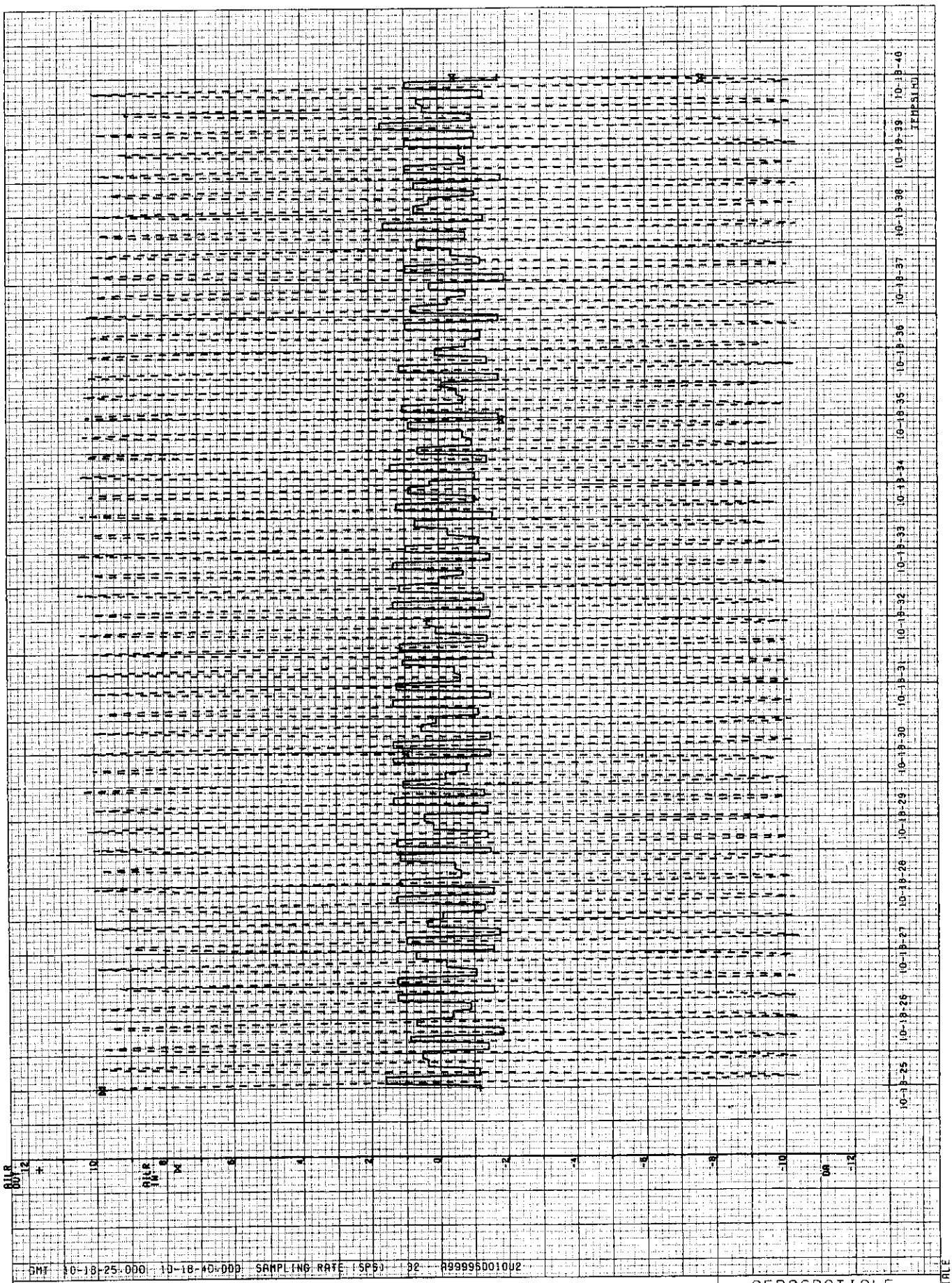
FLIGHT S0010 TEST 7.8 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.7.25

AVIC



FLIGHT S0010 TEST 7.8 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

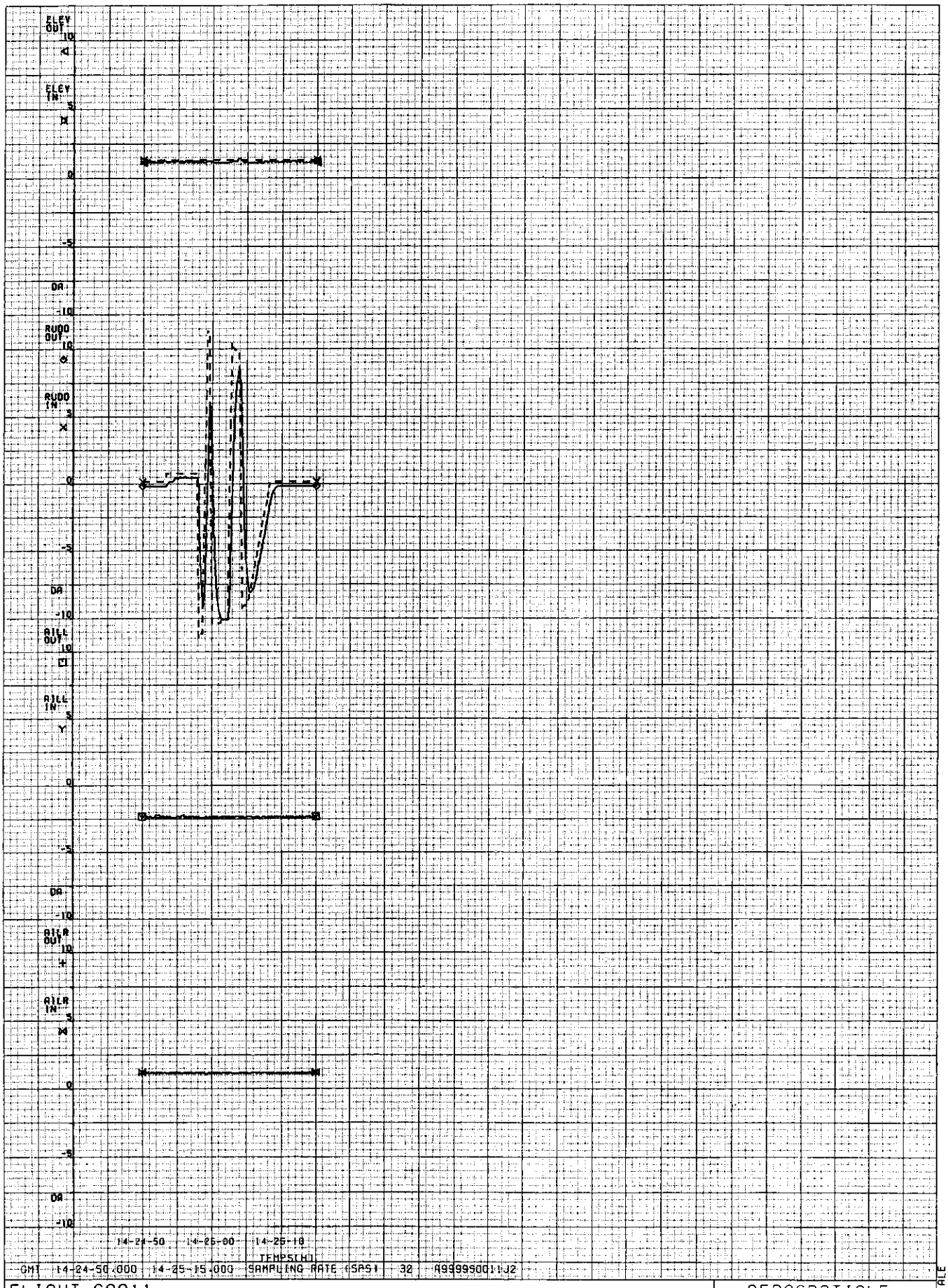
AIRCRAFT A9999 FIGURE 3.7.26

(C) AEROSPATIALE

008315

ANNEX 3.8:
Test series n°11

AVIC



FLIGHT S0011 TEST 11.1 FTI

A-NTSB

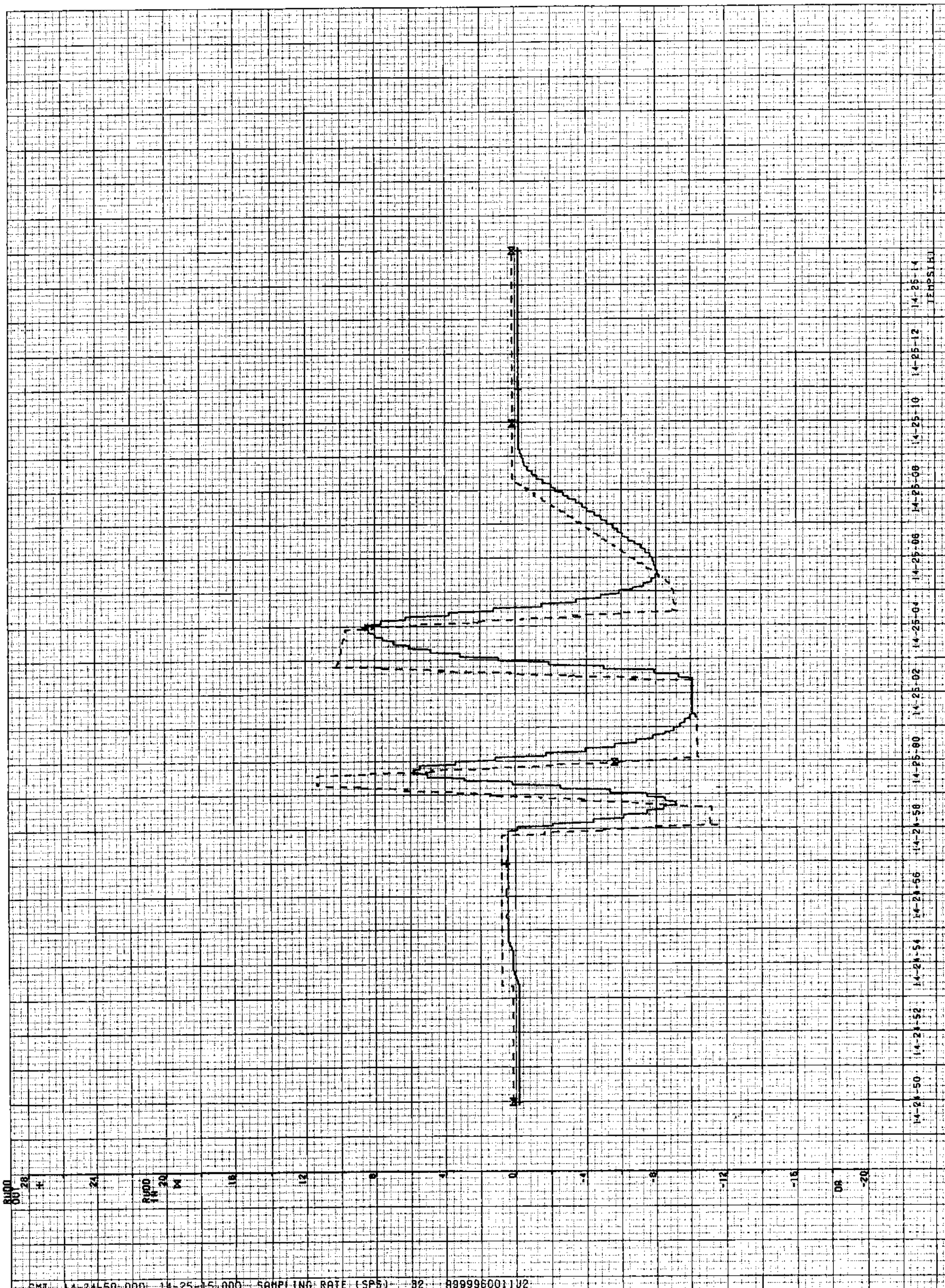
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.8.1

(C) AEROSPATIALE

005.11 SERIE/SDACAAL.AD

AVIC



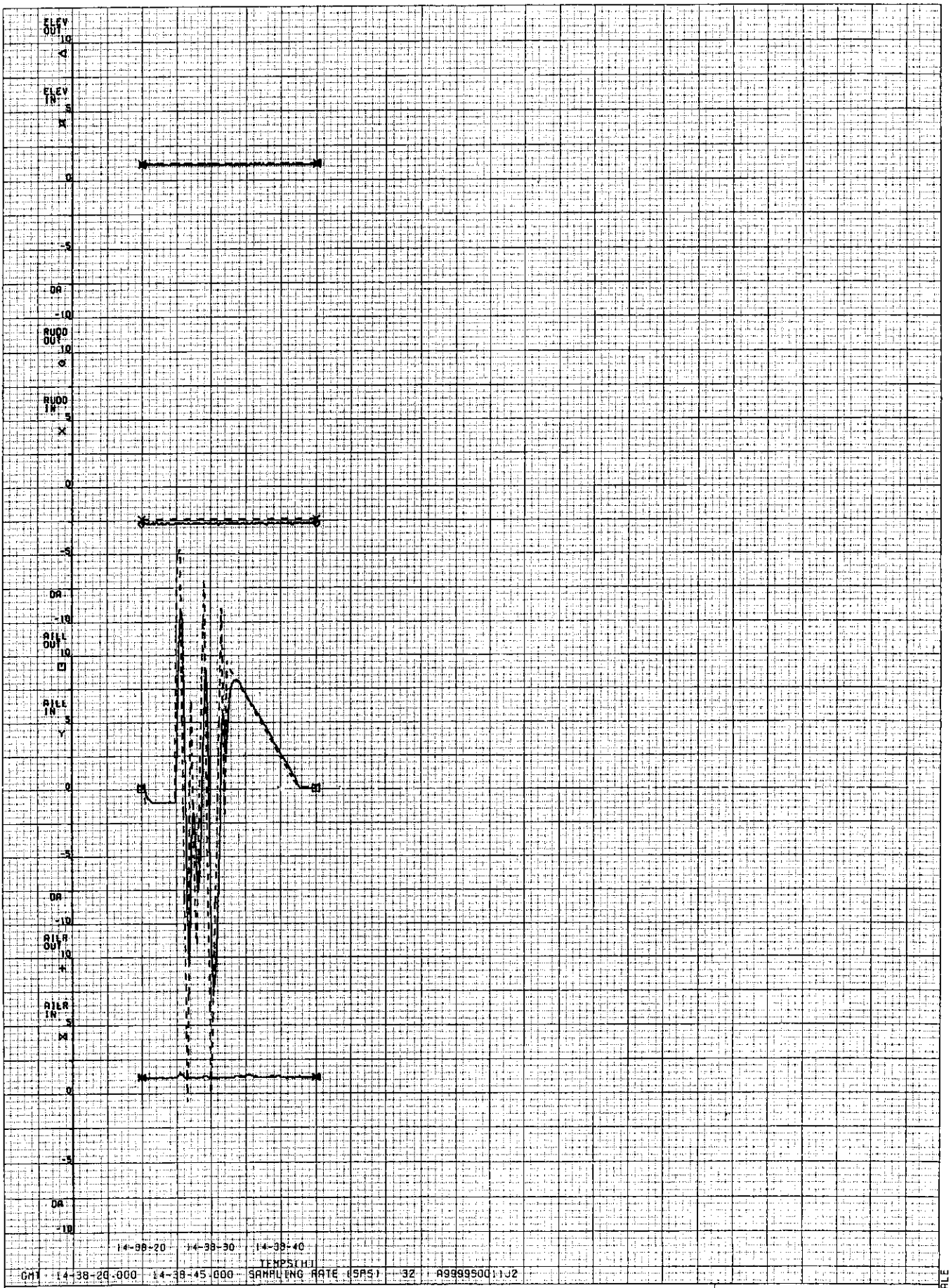
FLIGHT S0011 TEST 11.1 FTI

A-NTSB

AEROSPATIALE FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.8.2

AVIC



FLIGHT S0011 TEST 11.2 FTI

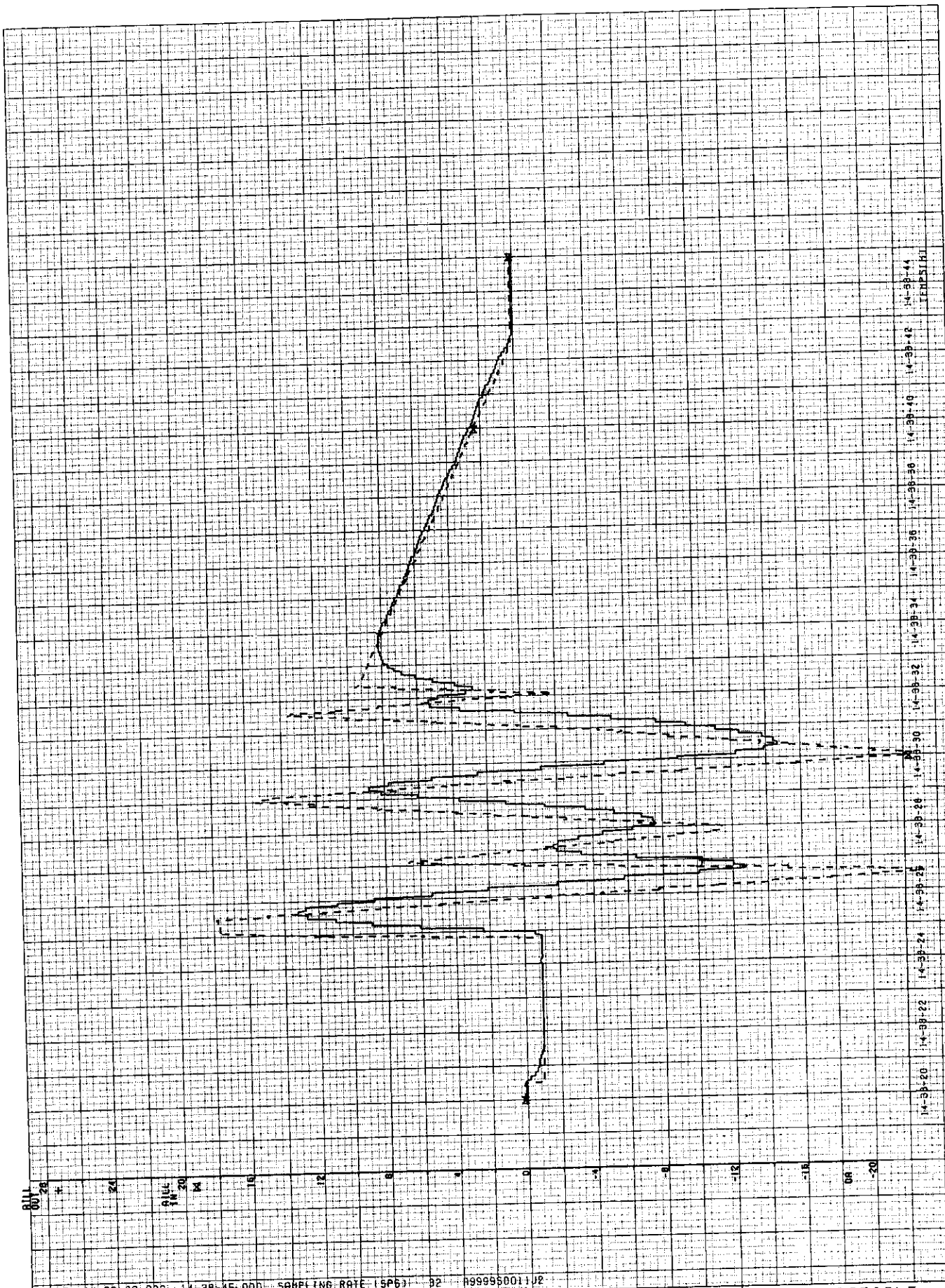
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.8.3

(C) AEROSPATIALE

AVIC



GMT 14-38-20.000 14-38-45.000 SAMPLING RATE (SPS) 32 A9999S0011J2

FLIGHT S0011 TEST 11.2 FTI

A-NTSE

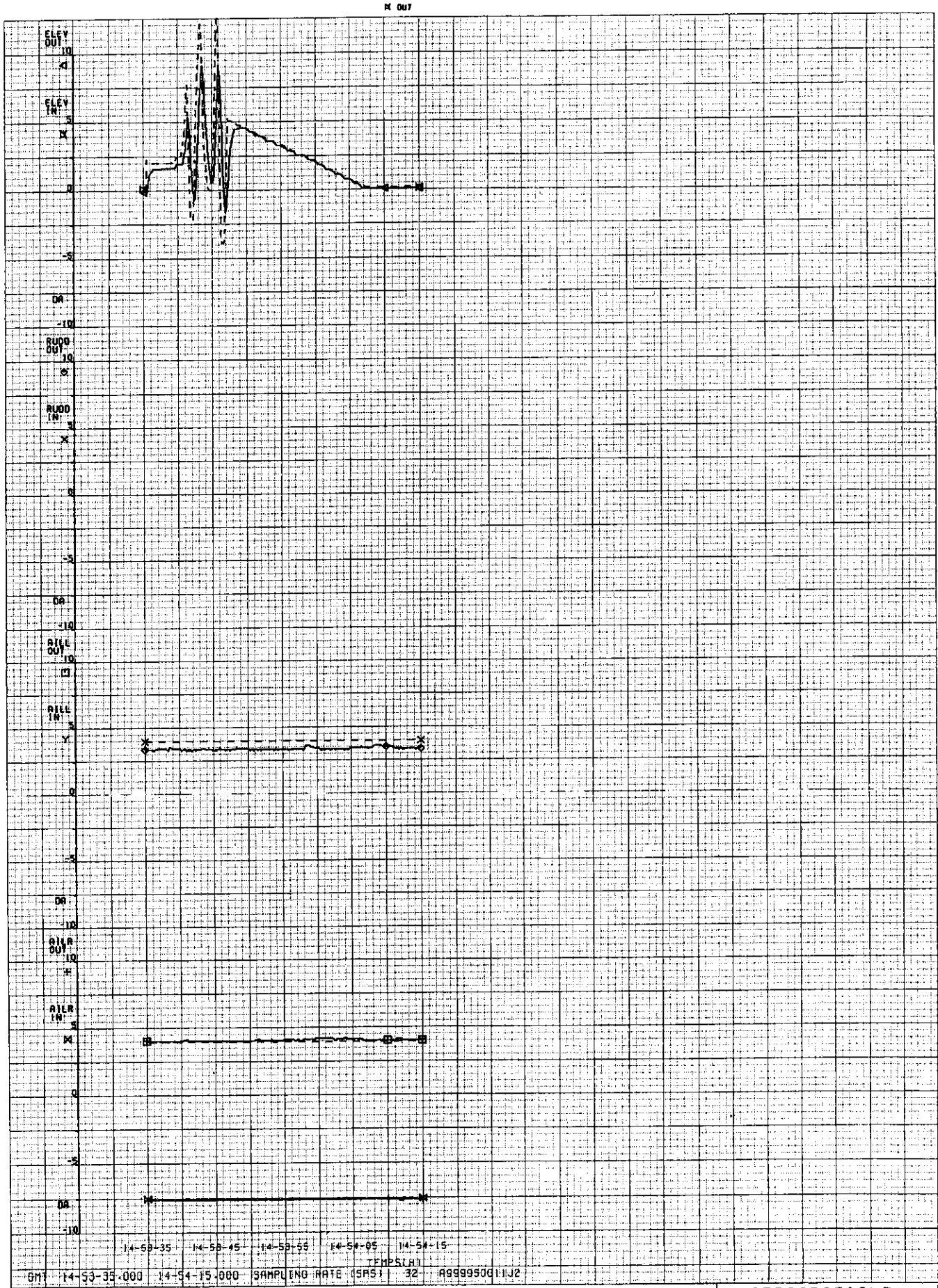
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.8.4

(C) AEROSPATIALE

SERIE/SOARCAAL.AD

AVIC



FLIGHT S0011 TEST 11.3 FTI

A-NTSB

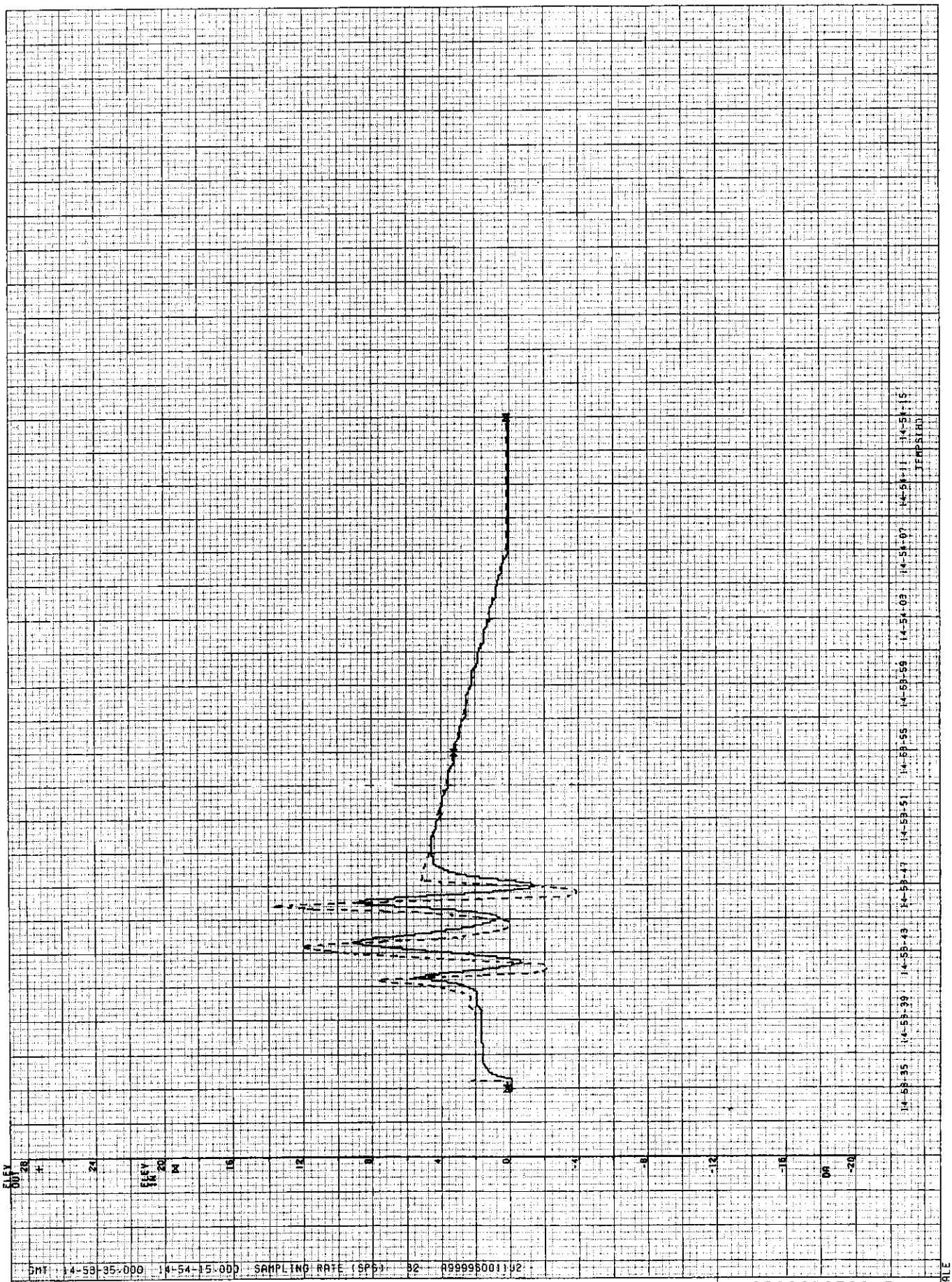
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 3.8.5

(C) AEROSPATIALE

908321

AVIC



FLIGHT S0011 TEST 11.3 FTI

A-NTSB

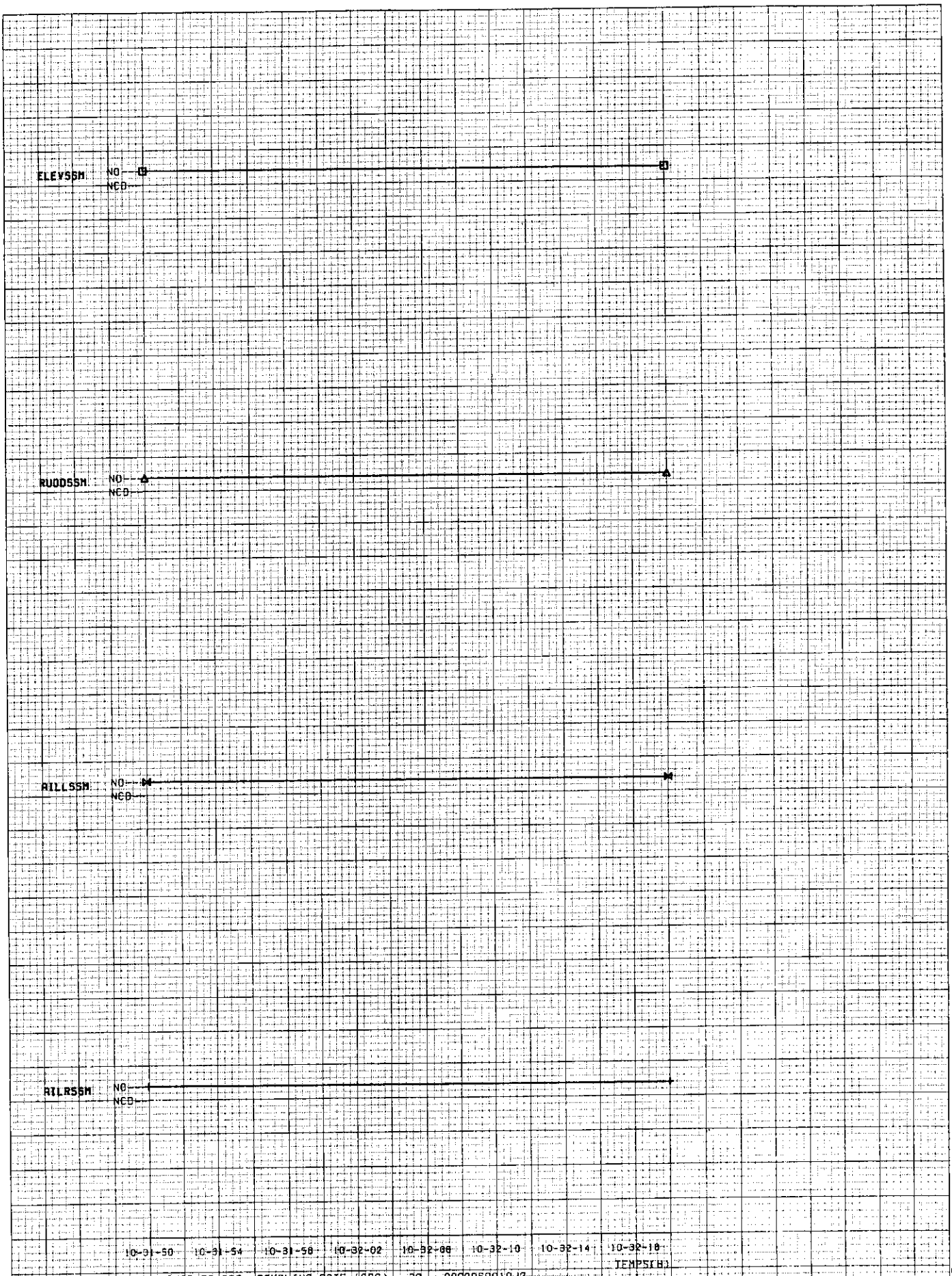
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 386

(C) AEROSPATIALE

ANNEX 4:
inputs wires disconnection

ANNEX 4.1:
Test series n°8



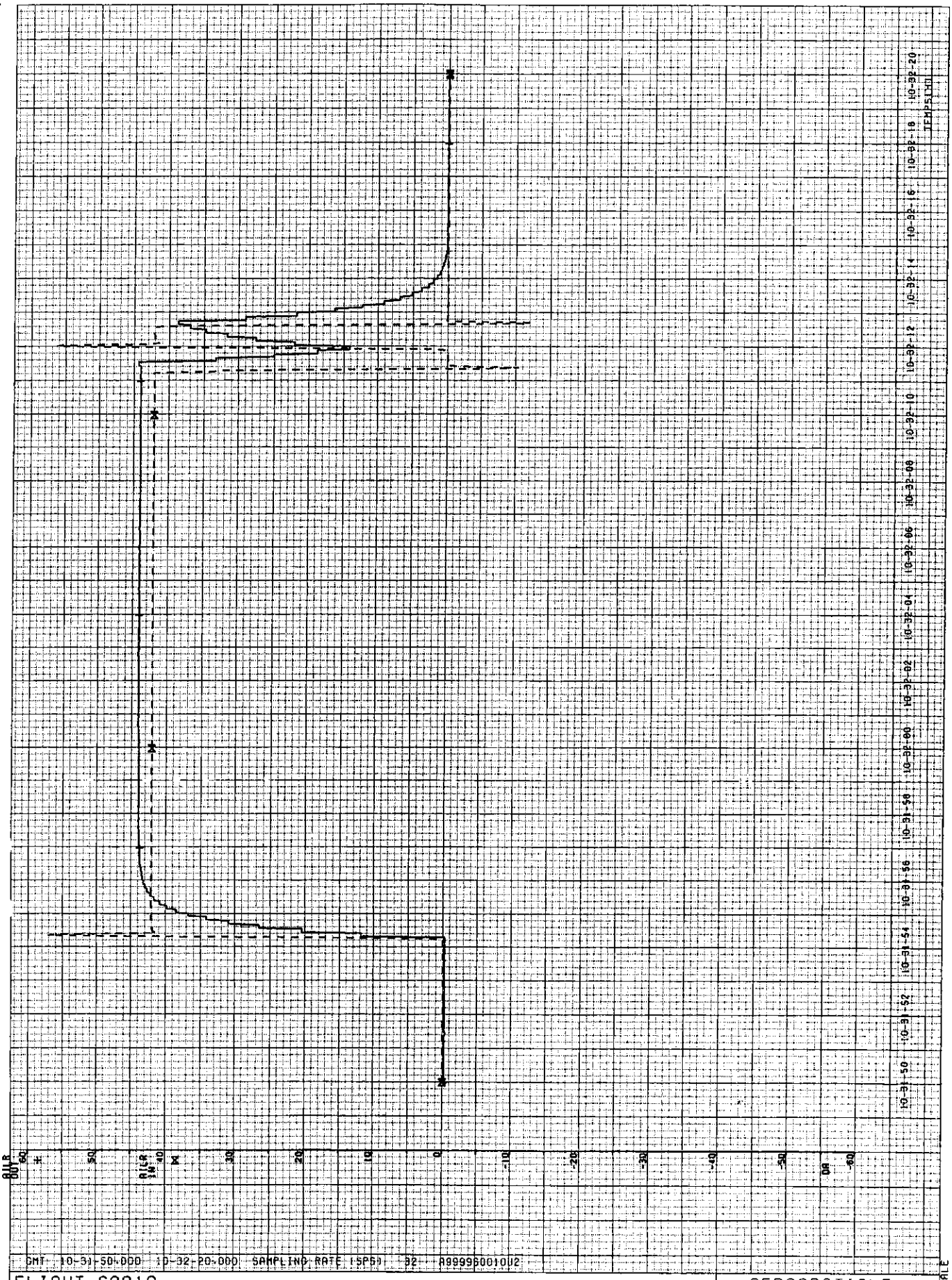
FLIGHT S0010 TEST 8.1 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 8.1 FTI

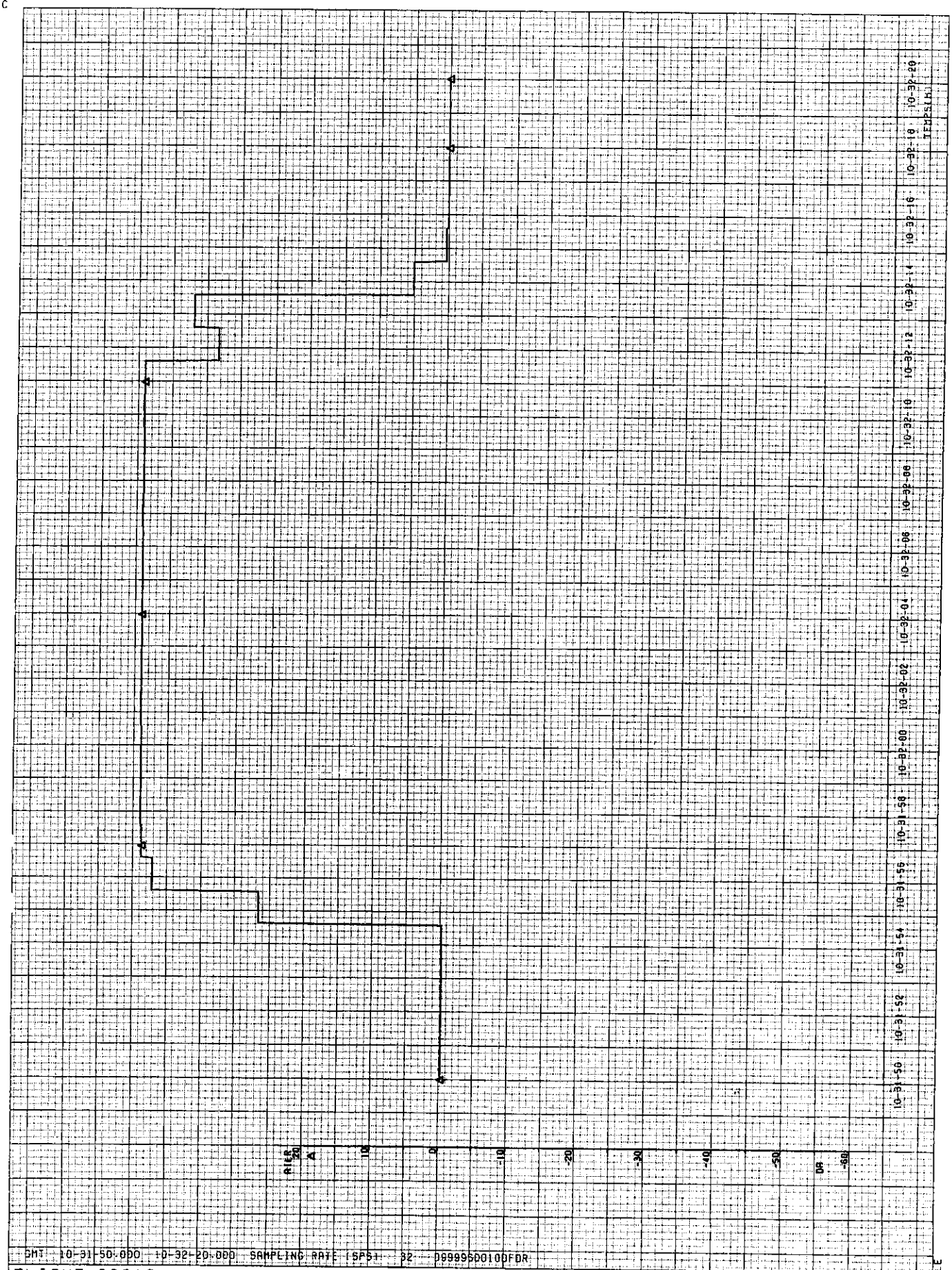
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.1

008326

AVIC

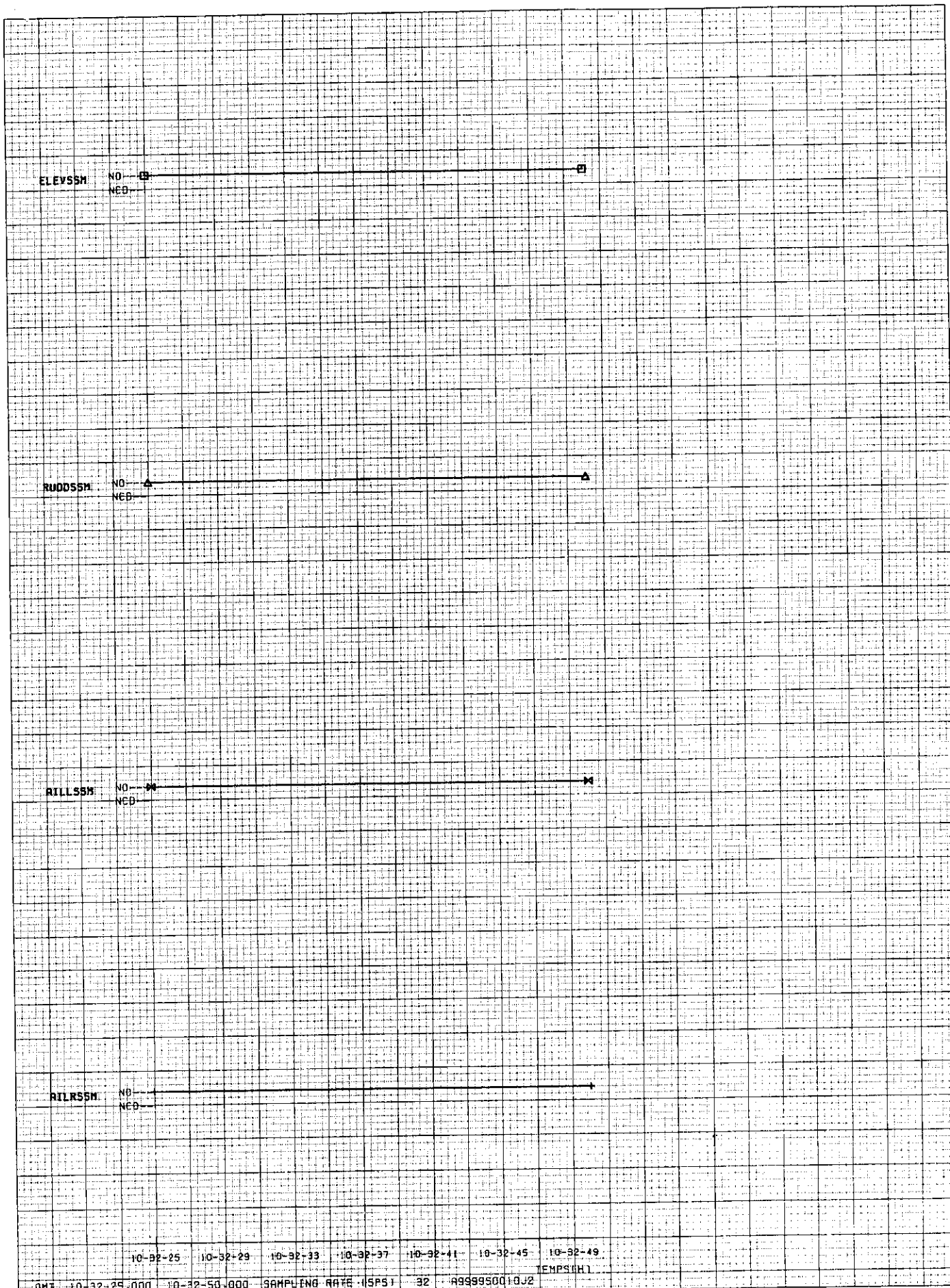


FLIGHT S0010 TEST 8.1 OFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 4.1.2



FLIGHT S0010 TEST 8.2 FTI

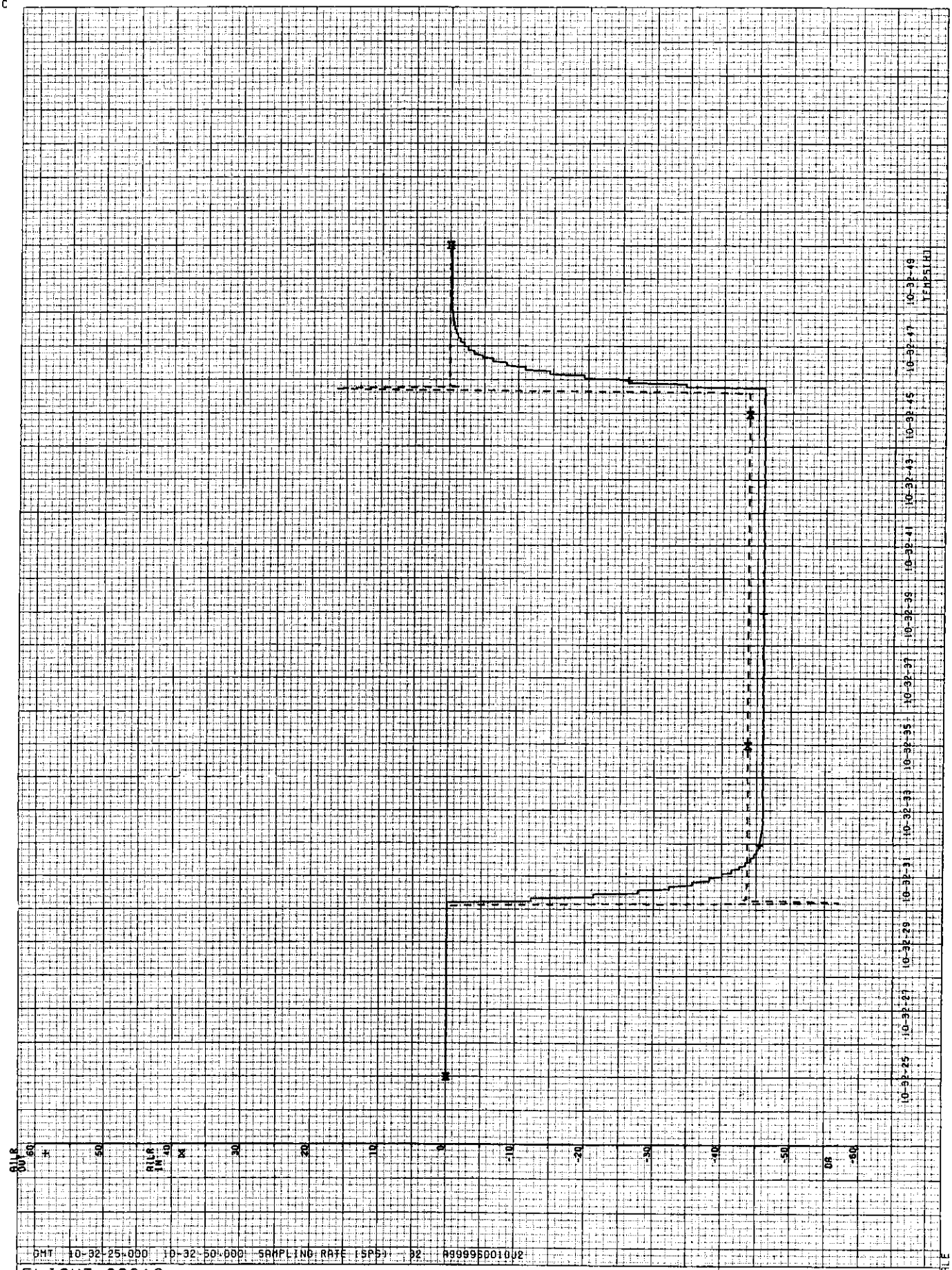
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

SERIE/SDACARL.A0

EDITION OU 28/02/2002 A 14H49



FLIGHT S0010 TEST 8.2 FTI

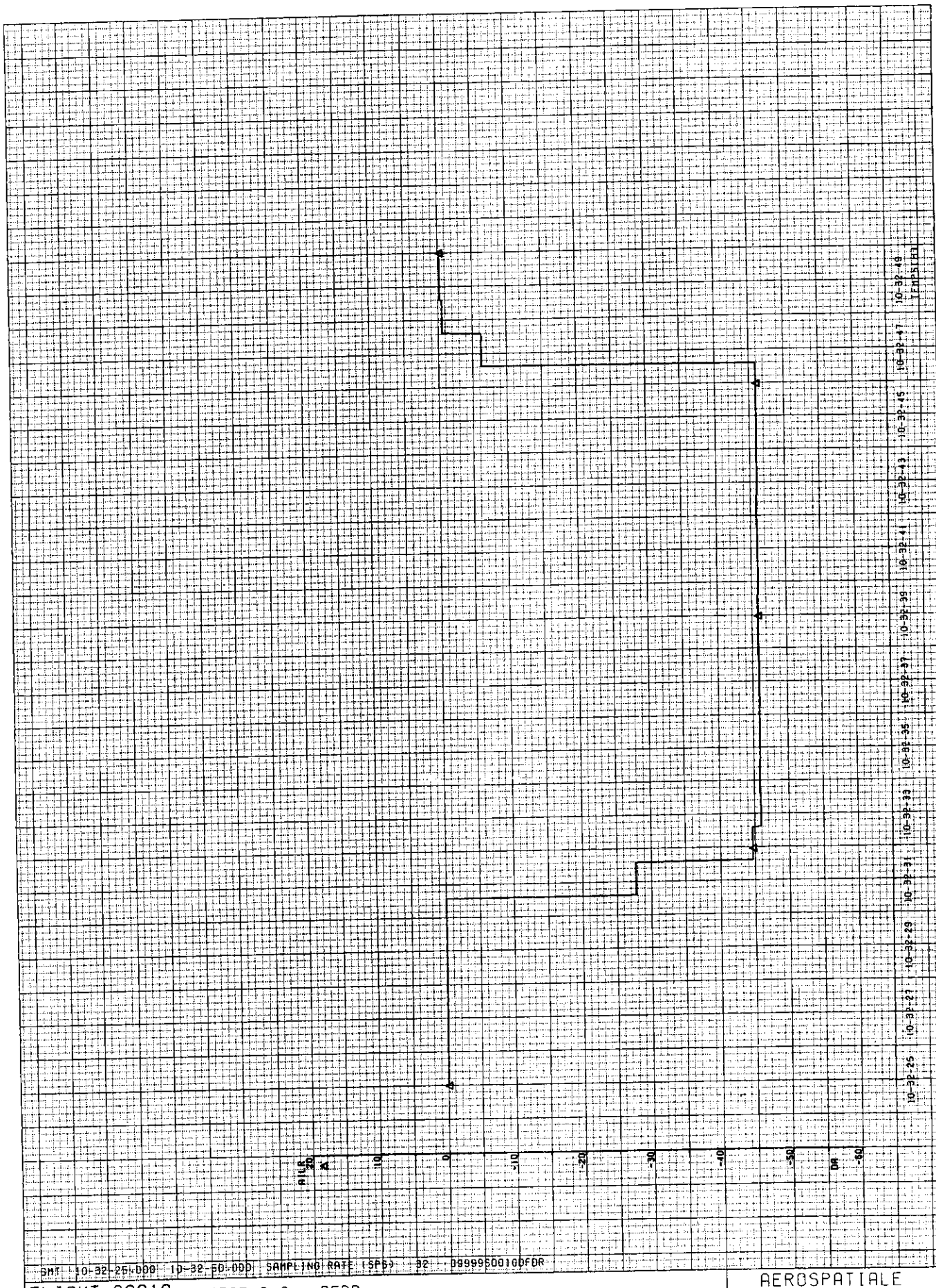
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 4.13

(c) AEROSPATIALE

AVIC



FLIGHT S0010 TEST 8.2 OFDR

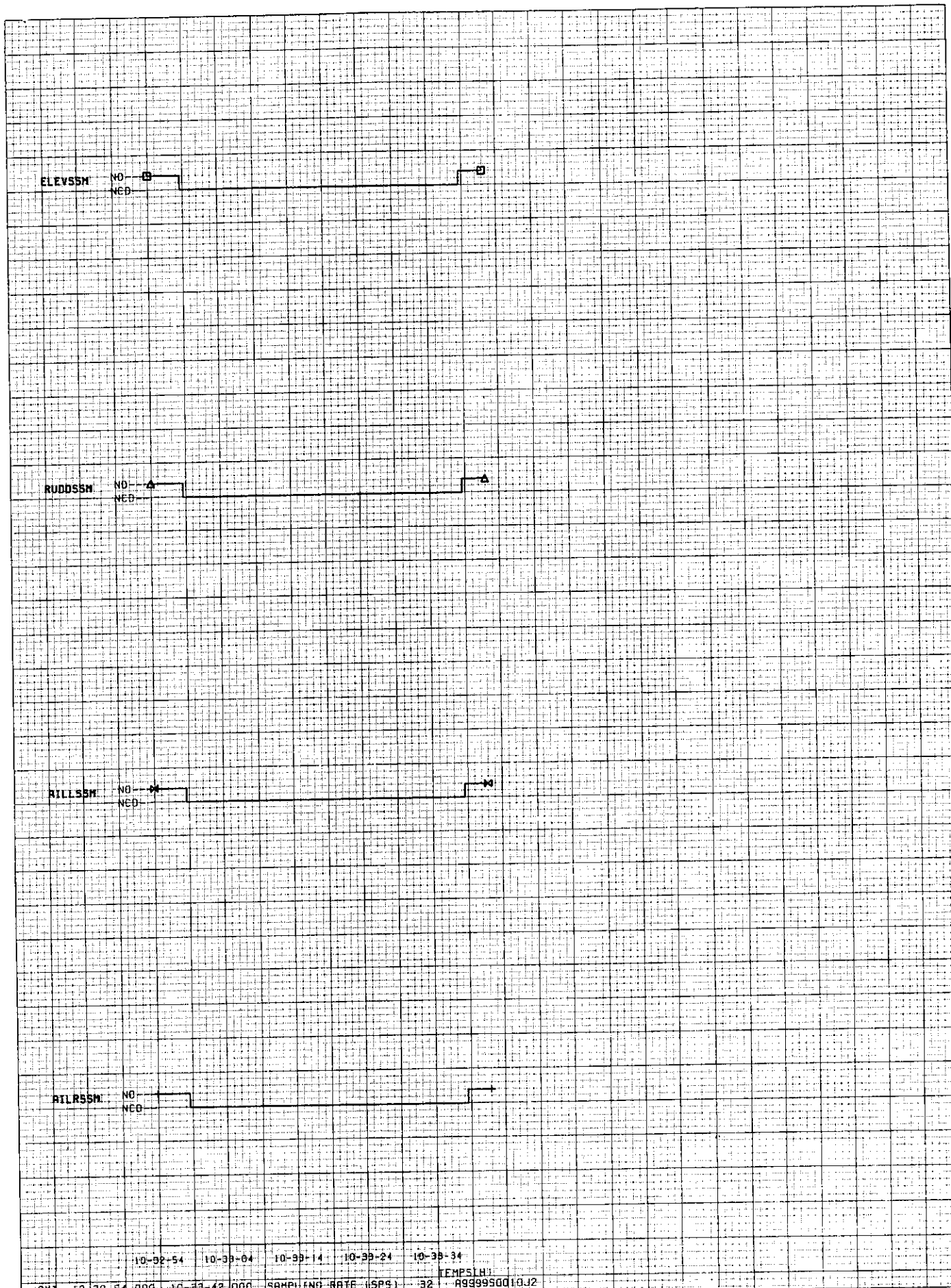
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 4.1.4

(C) AEROSPATIALE

310-A SERIE/SDACARL.AD



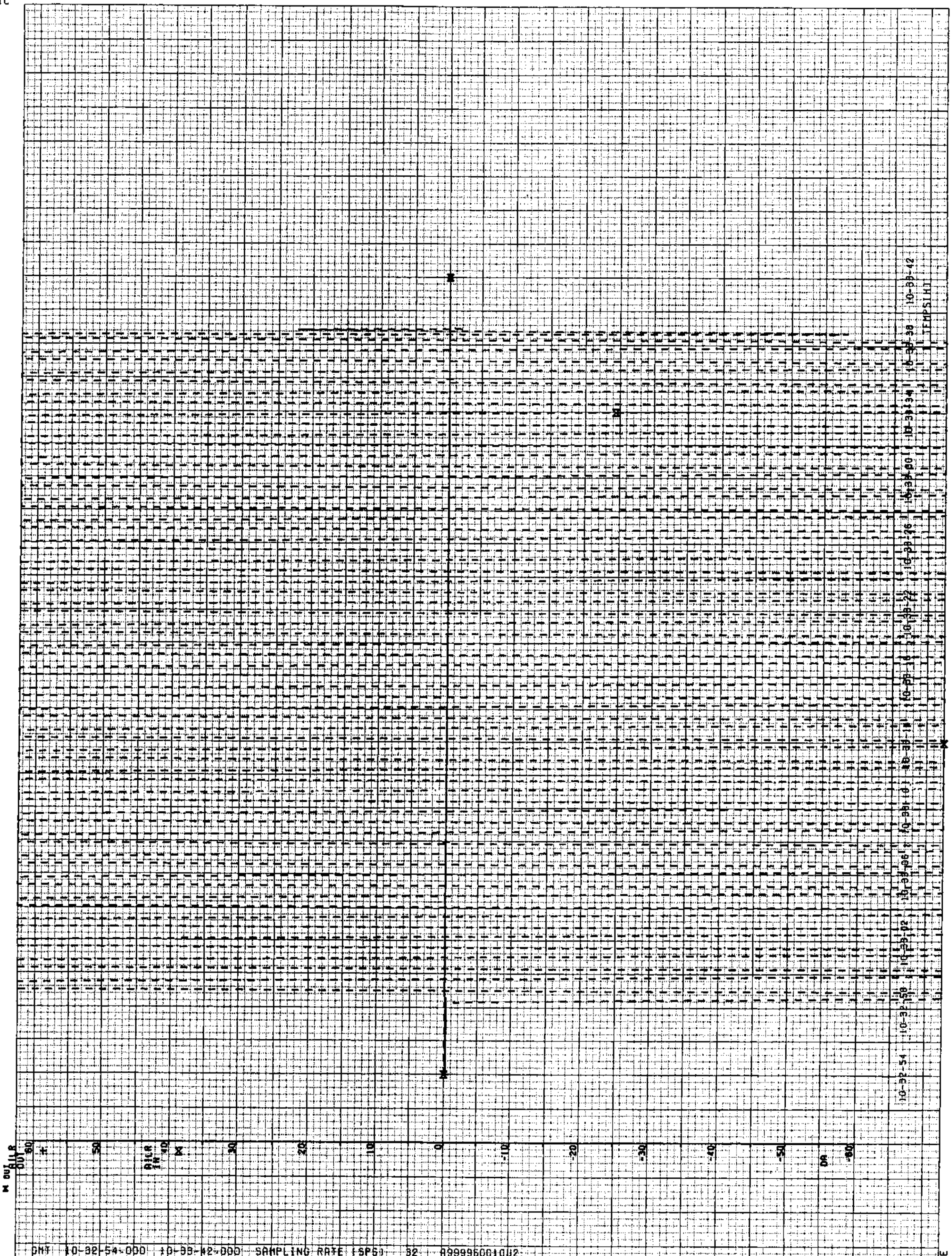
FLIGHT S0010 TEST 8.3 FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 8.3 FTI

AEROSPATIALE FLIGHT TESTS

A-NTSB

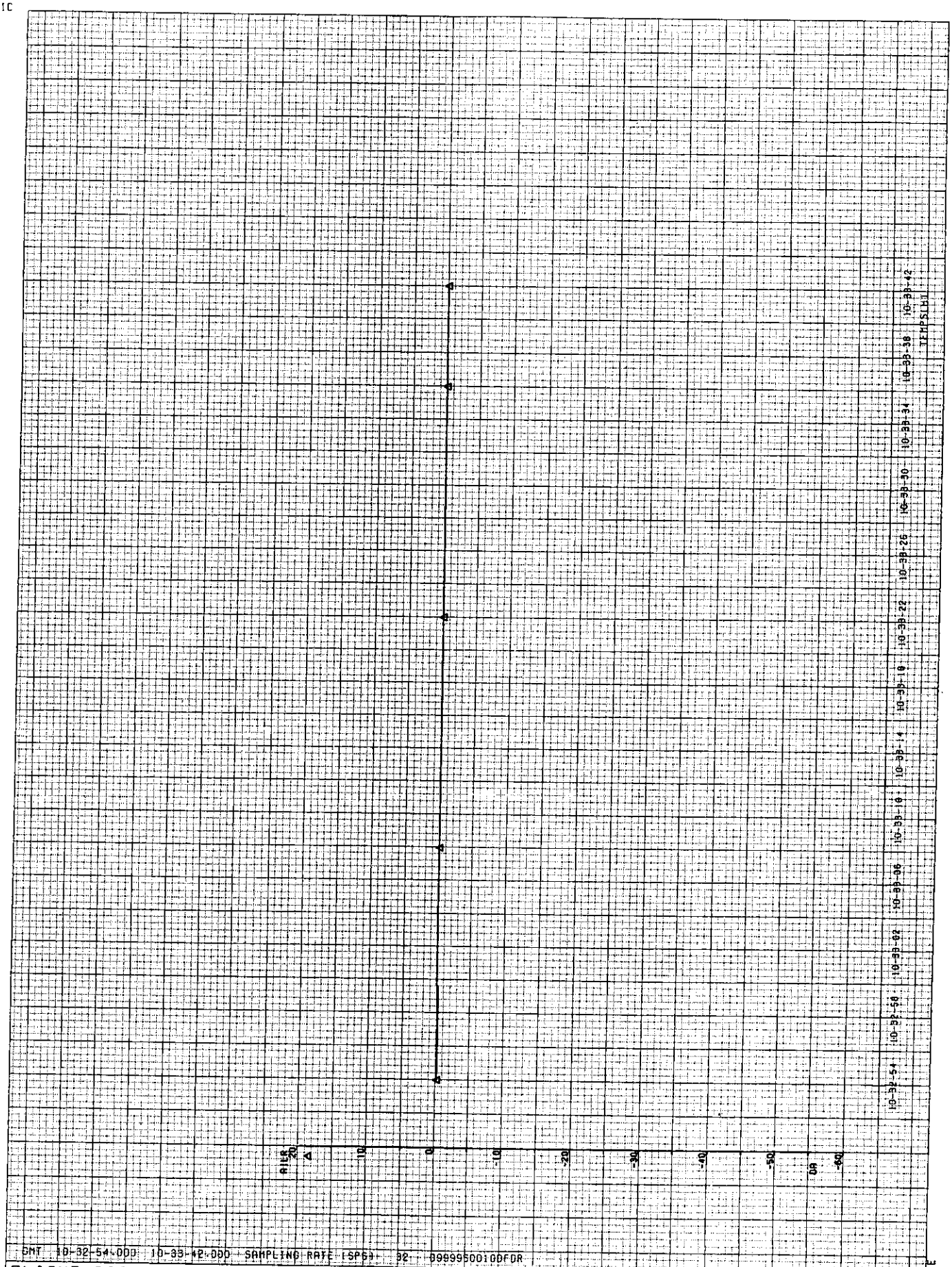
AIRCRAFT A9999 FIGURE 4.15

(C) AEROSPATIALE

310-8 SERIE/SOACAAL.AD

008332

AVIC



FLIGHT S0010 TEST 8.3 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

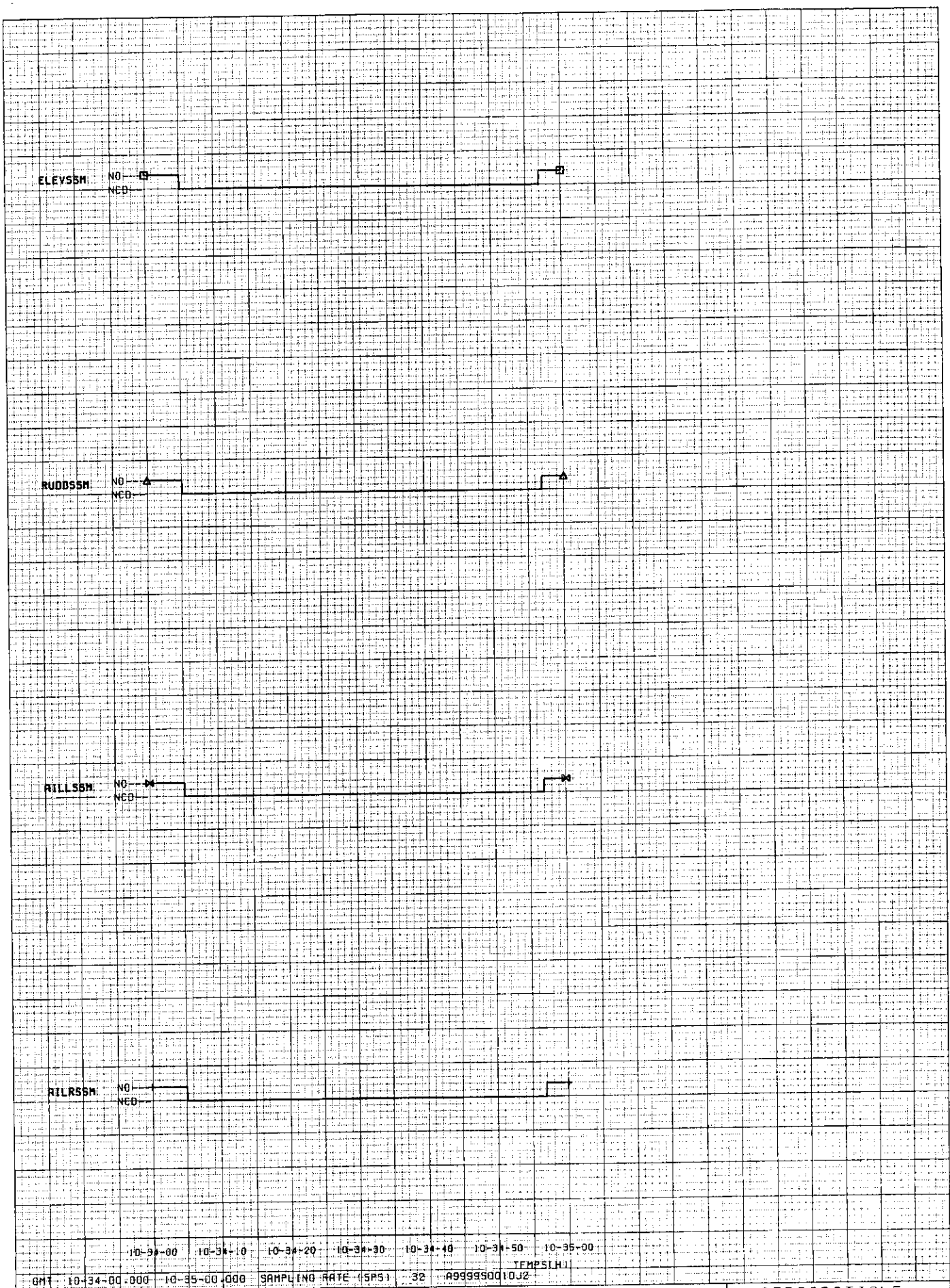
AIRCRAFT 09999 FIGURE 4.1.6

(C) AEROSPATIALE

310.8 SERIE/SDACAAL.AD

008333

AVIC



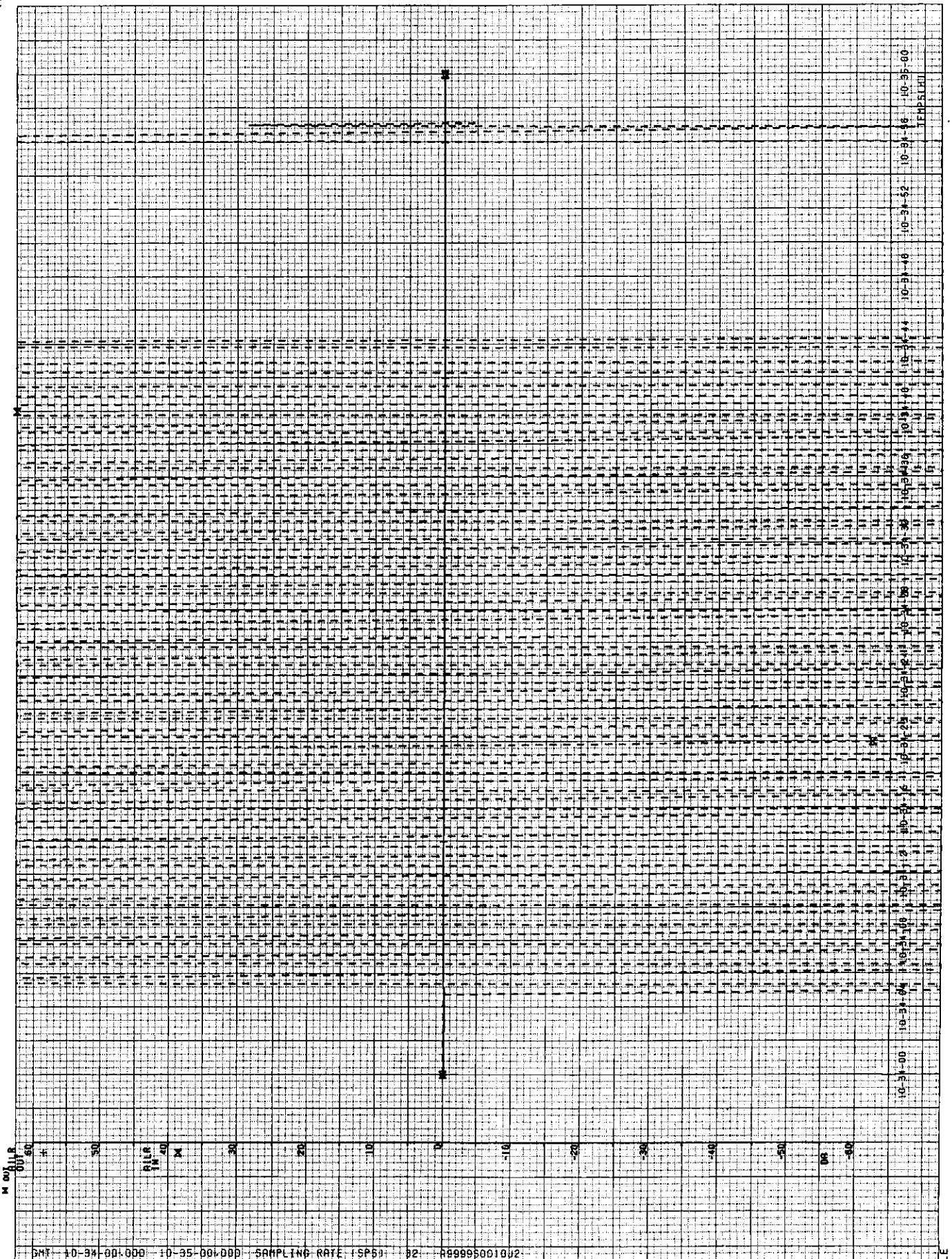
FLIGHT S0010 TEST 8.4 FTI

A-NTSE

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 8.4 FTI

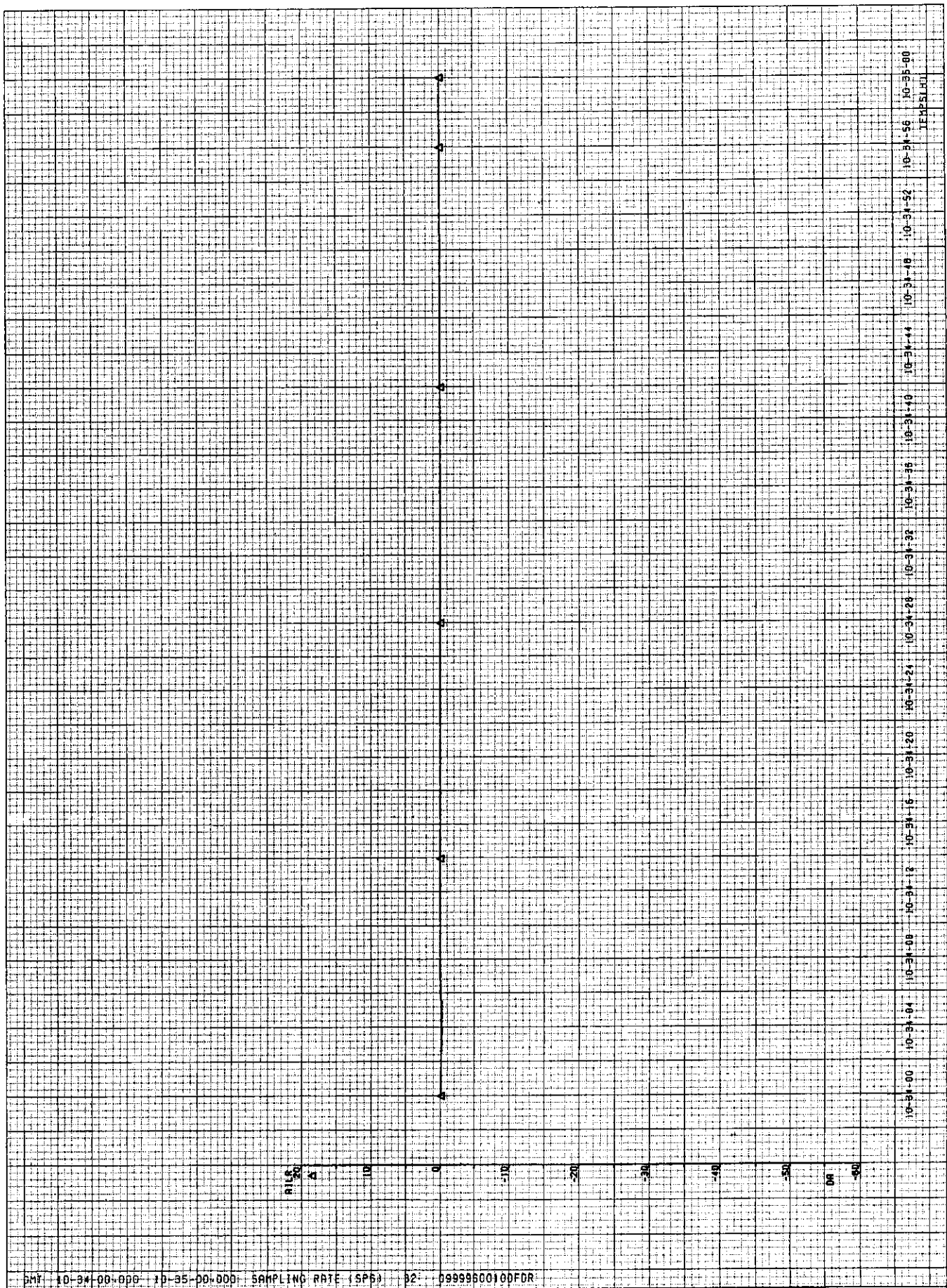
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 4.1.7

(C) AEROSPATIALE

AVIC

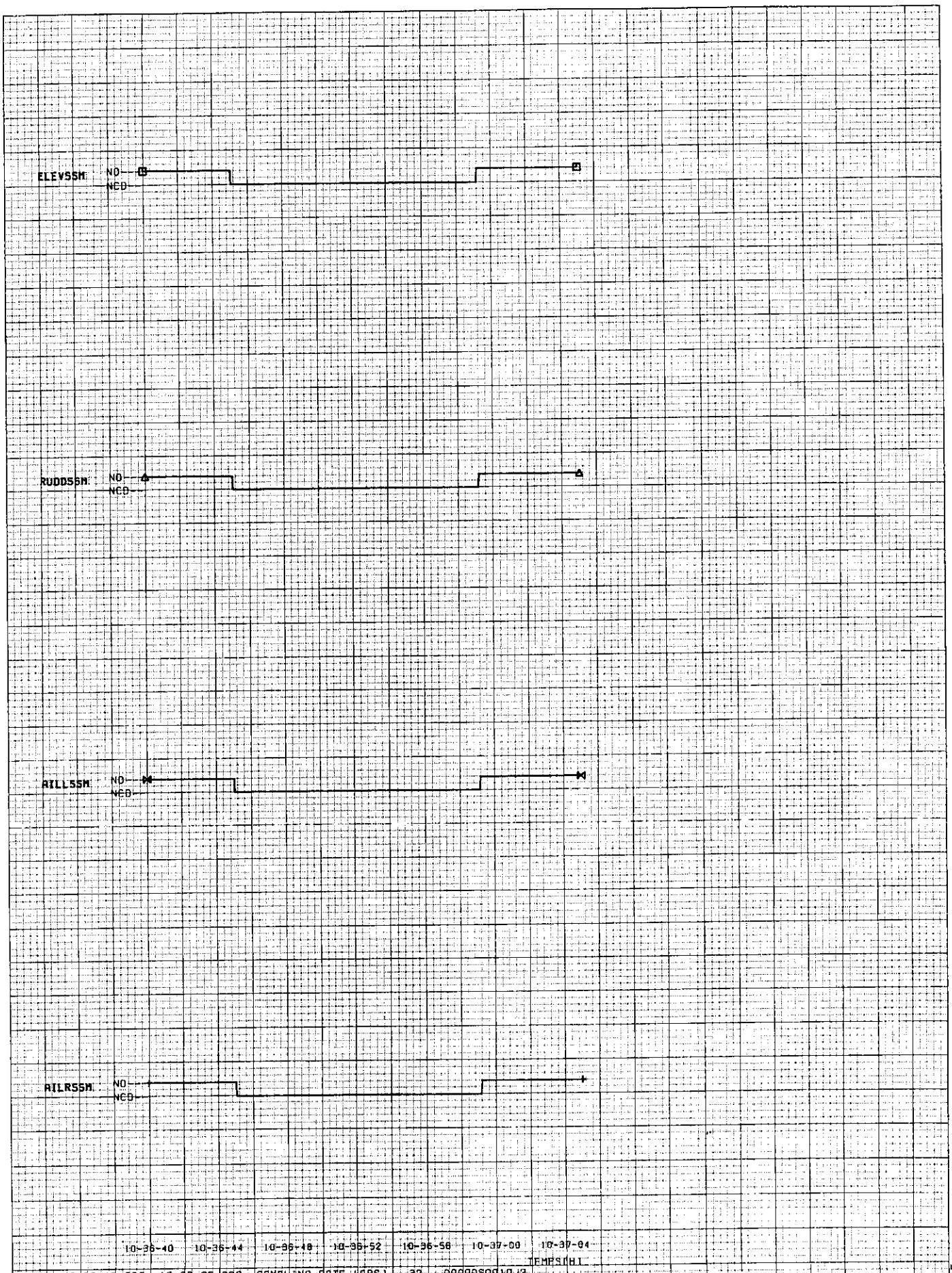


FLIGHT S0010 TEST 8.4 DFDR

AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT 09999 FIGURE 4.1.8



FLIGHT S0010 TEST 8.5 FTI

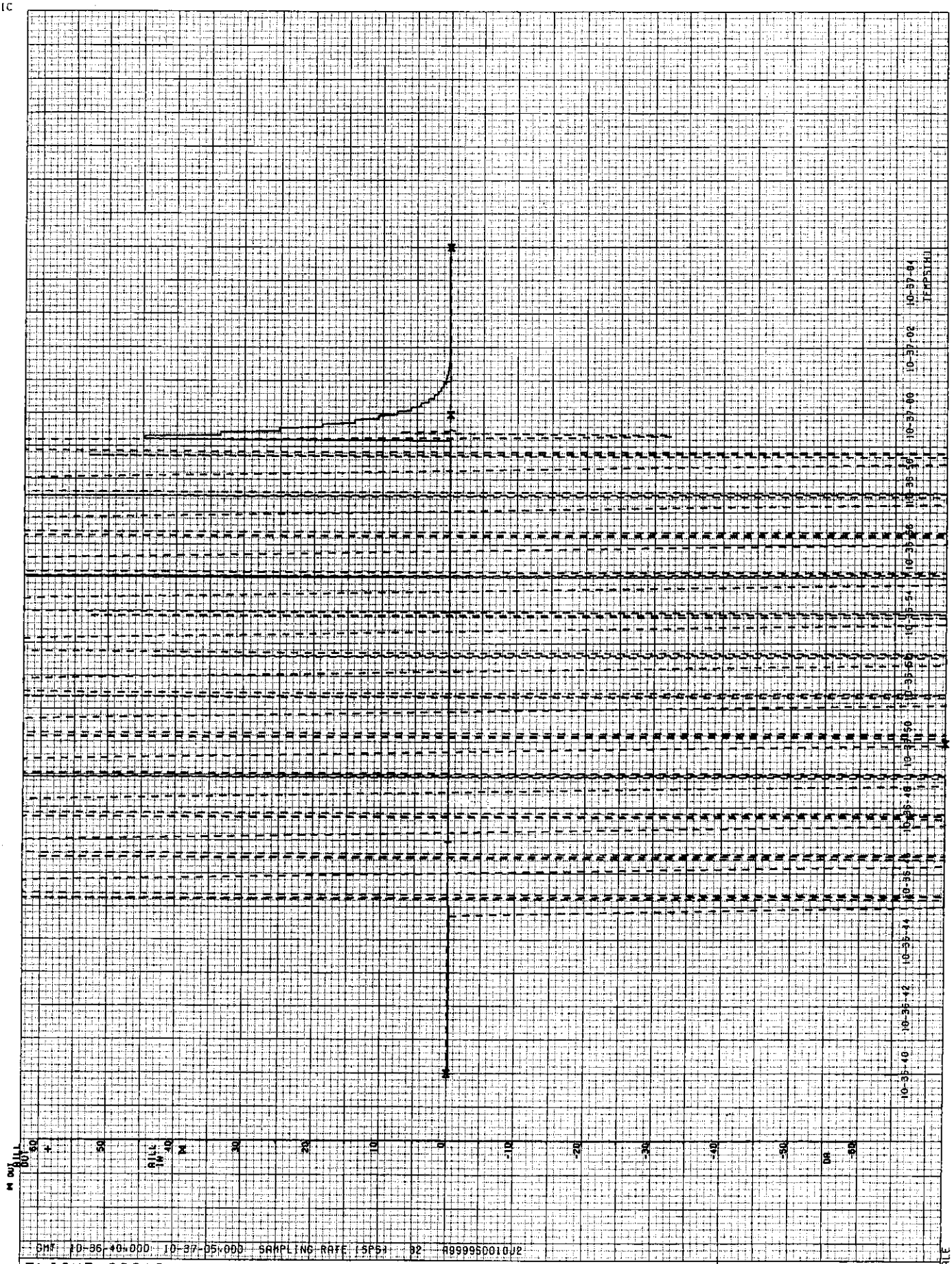
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

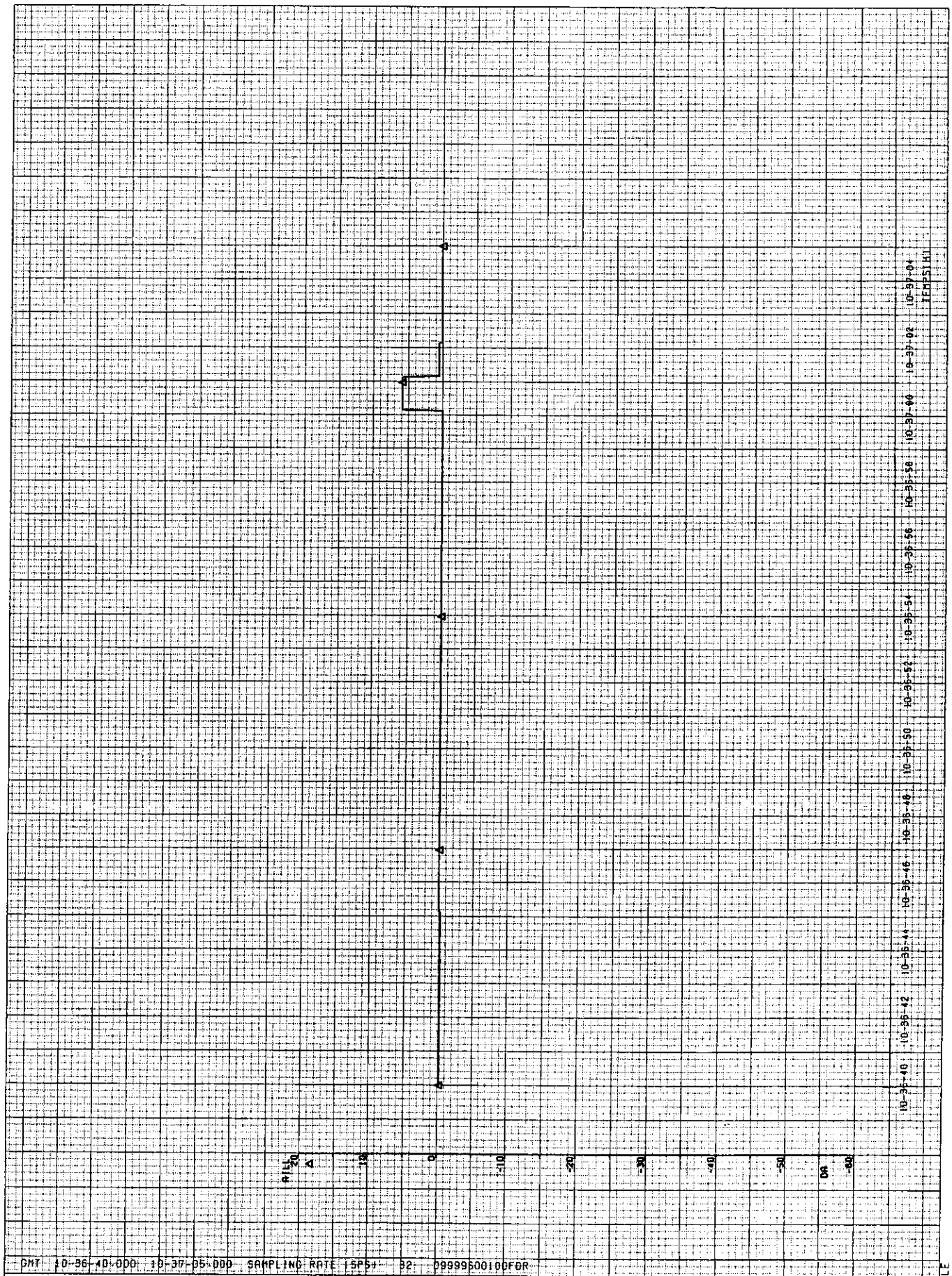
(E) AEROSPATIALE

AVIC



311.8 SERIE/SDACAAL.AD

AVIC



GMT 10-36-40.000 10-37-05.000 SAMPLING RATE (SPS)= 32 09999S00100FDR

FLIGHT S0010 TEST 8.5 DFDR

AEROSPATIALE
FLIGHT TESTS

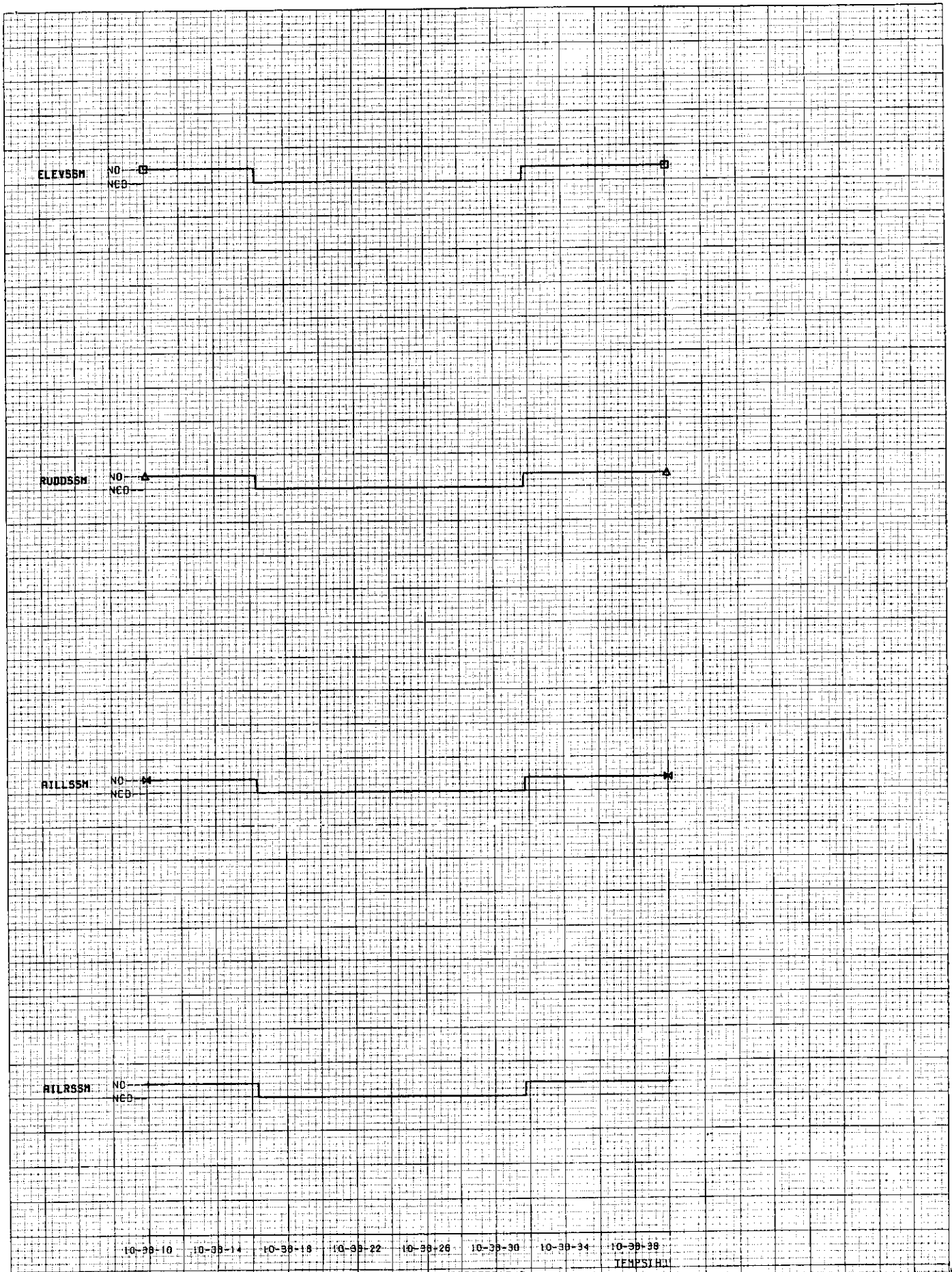
A-NTSB

AIRCRAFT D9999 FIGURE 4.1.10

(C) AEROSPATIALE

311.8 SERIE/SDACARL.AD

008339



FLIGHT S0010 TEST 8.6 FTI

A-NTSB

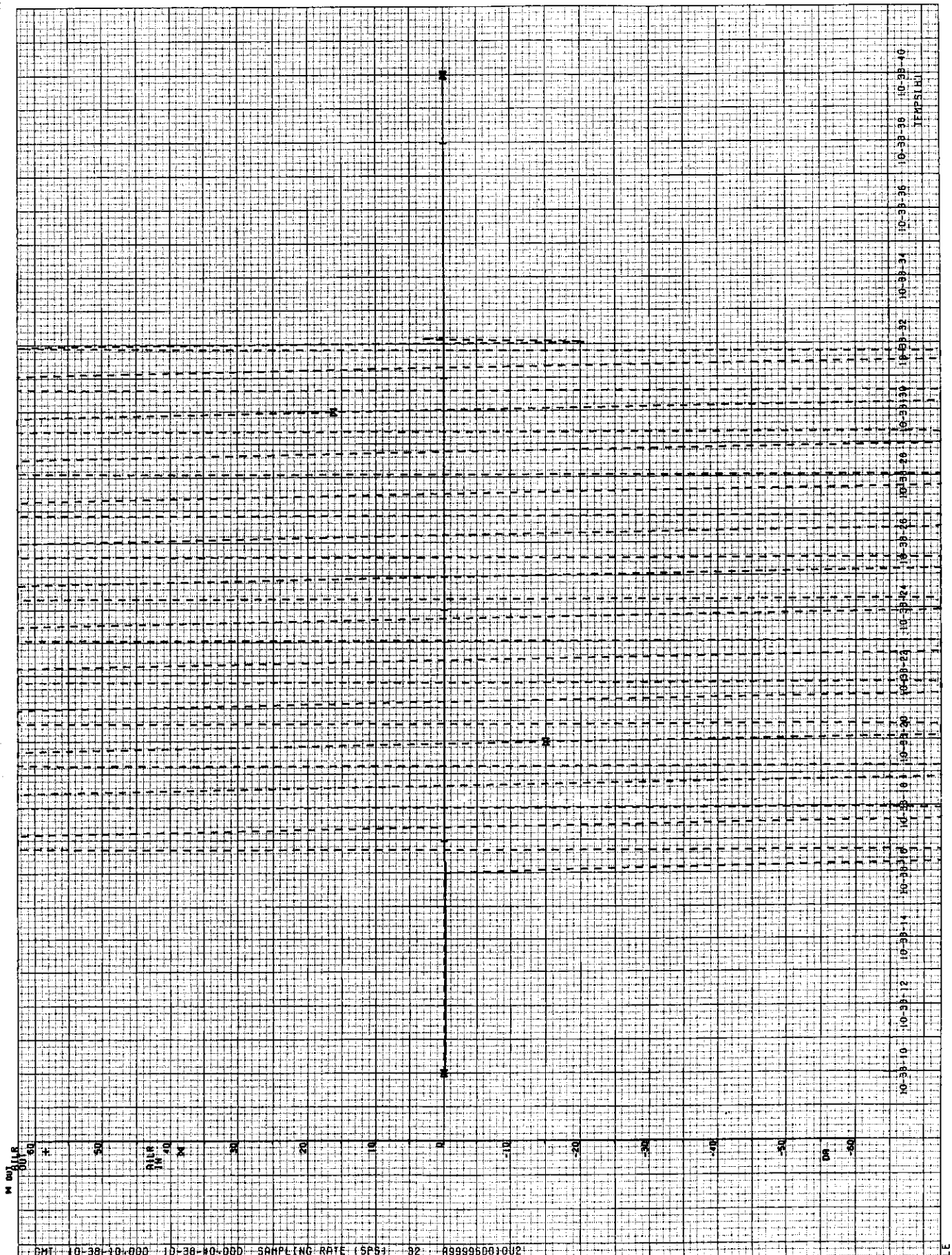
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

SERIE/SDACARL.AB

EDITION DU 28/02/2002 A 14H49

AVIC



FLIGHT S0010 TEST 8.6 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

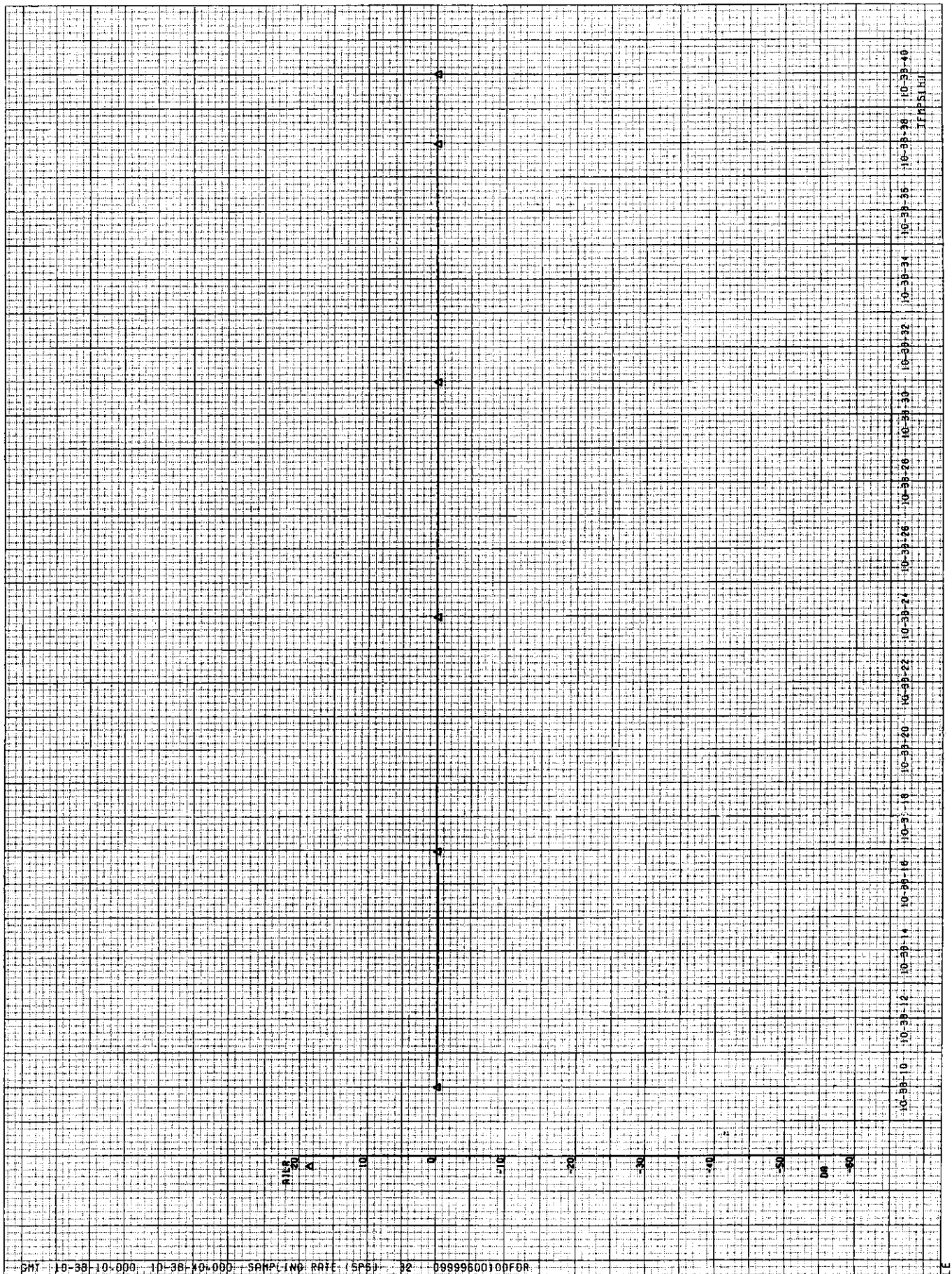
AIRCRAFT A9999 FIGURE 4.1.11

(c) AEROSPATIALE

310-8 SERIE/SOACAAL.AD

008341

AVIC



GMT 10-38-10.000 10-38-40.080 SAMPLING RATE (SPS) 32 0999960010DFDR

FLIGHT S0010 TEST 8.6 DFDR

A-NTSB

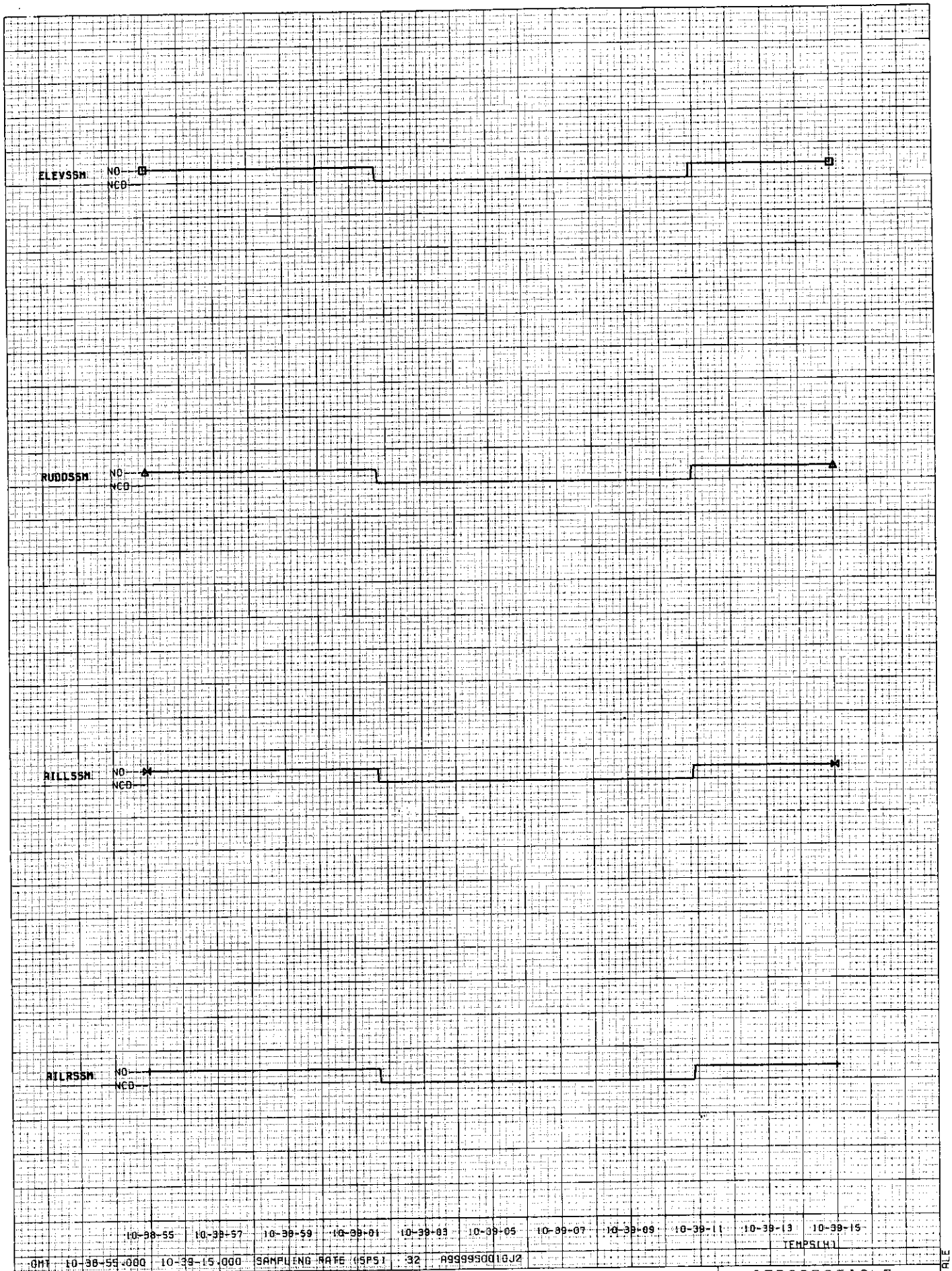
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.1.12

(C) AEROSPATIALE

310.8 SERIE/SOACAAL.AD

008342



FLIGHT SOO10 TEST 8.7 FTI

A-NTSB

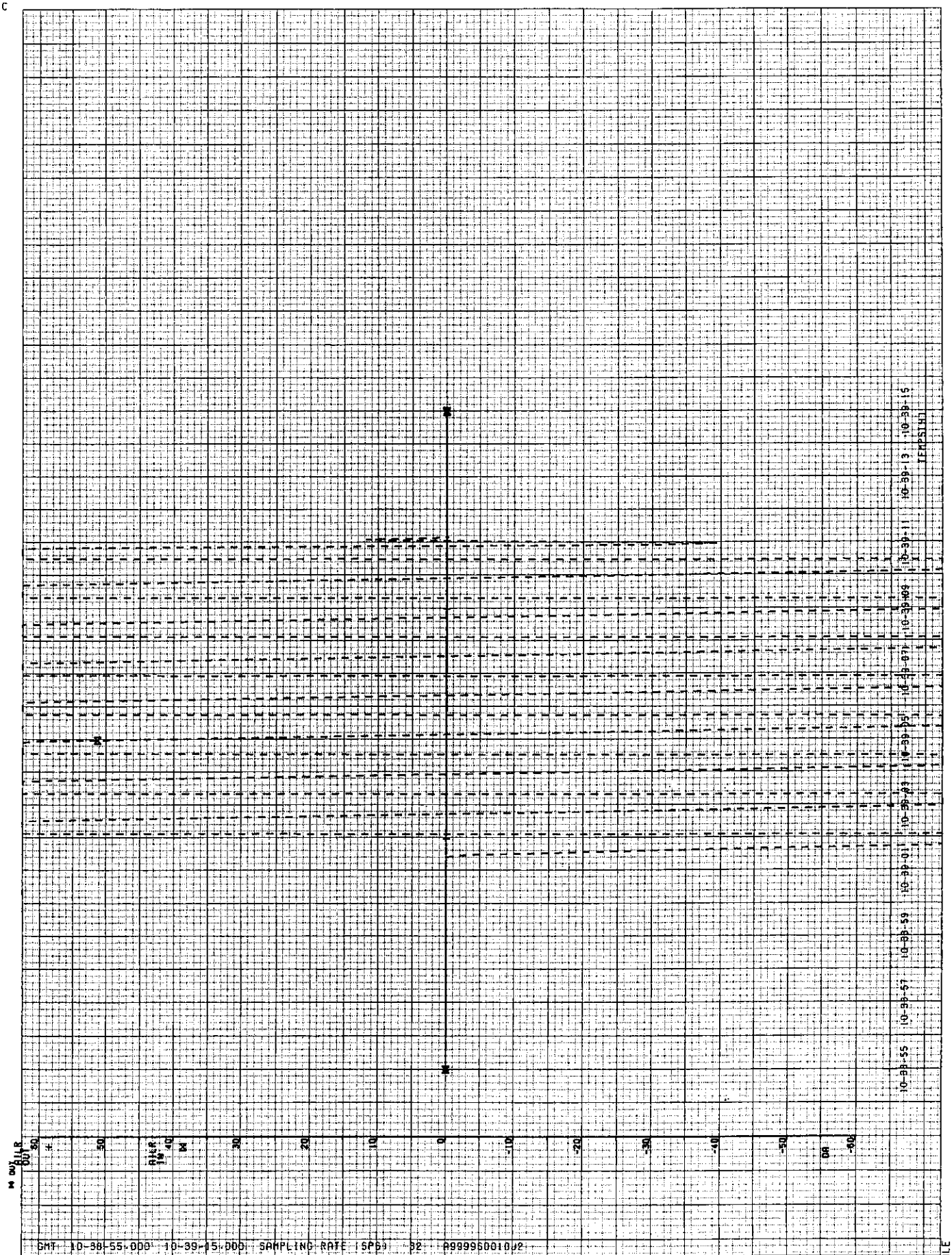
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

SERIE/SDACAAL.AD

EDITION DU 28/02/2002 A 14H49

AVIC



FLIGHT S0010 TEST 8.7 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

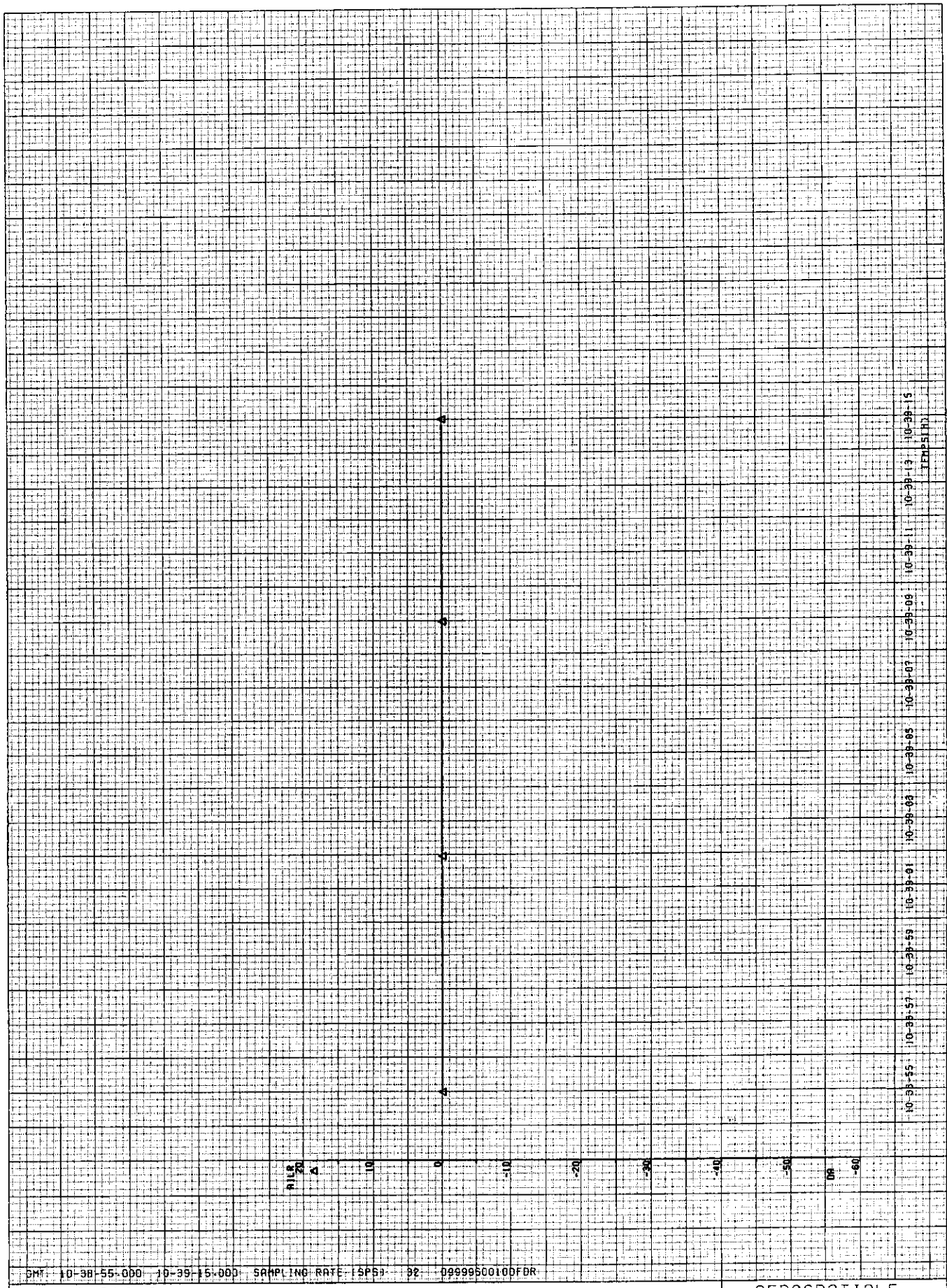
AIRCRAFT A9999 FIGURE 4.1.13

(C) AEROSPATIALE

310.8 SERIE/SDACAAL.AD

008344

AV C



GMT 10-38-55.000 10-39-15.000 SAMPLING RATE (SPS) 32 099995001ODFDR

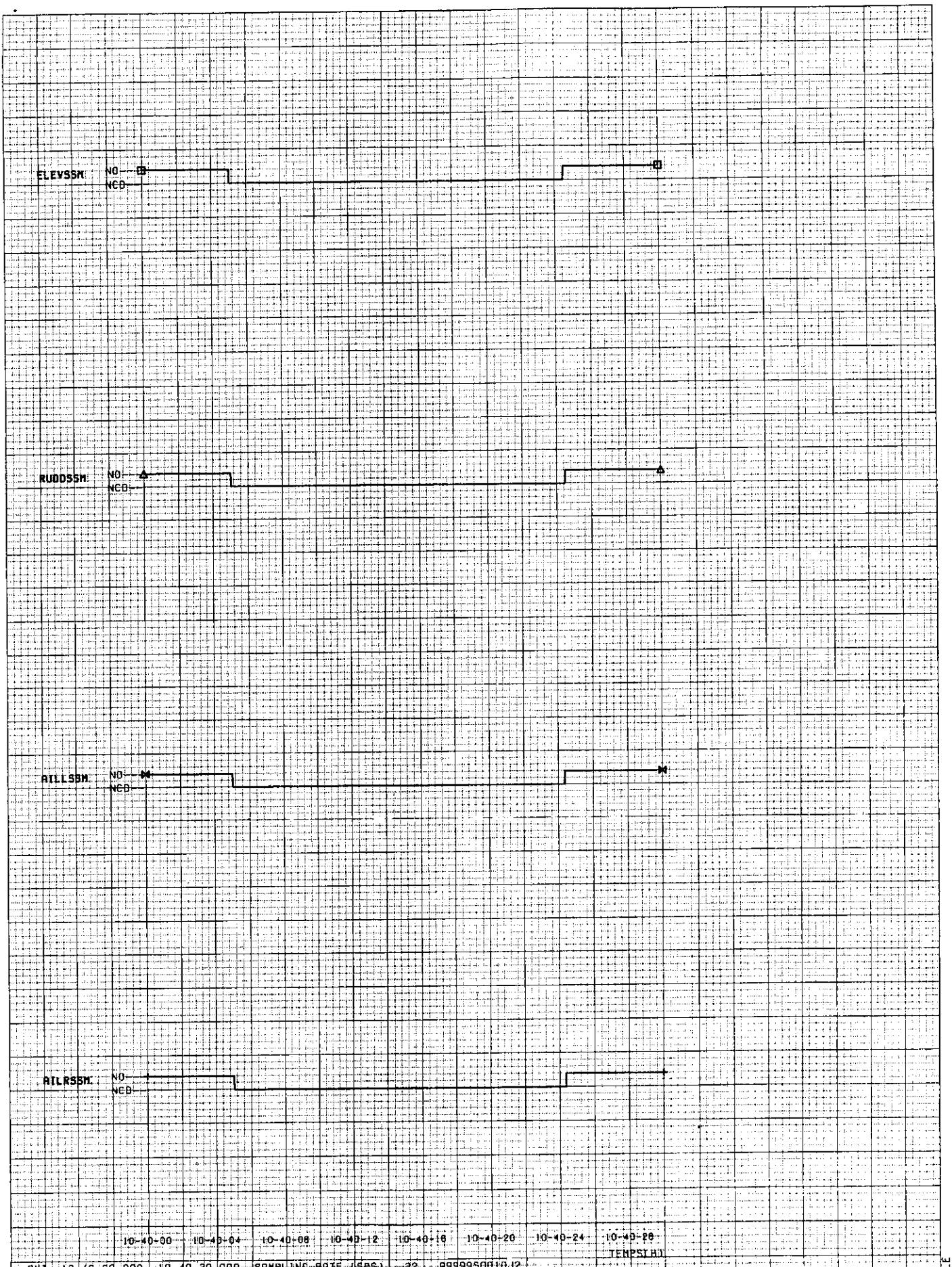
FLIGHT S0010 TEST 8.7 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 4.1.14

CEI AEROSPATIALE



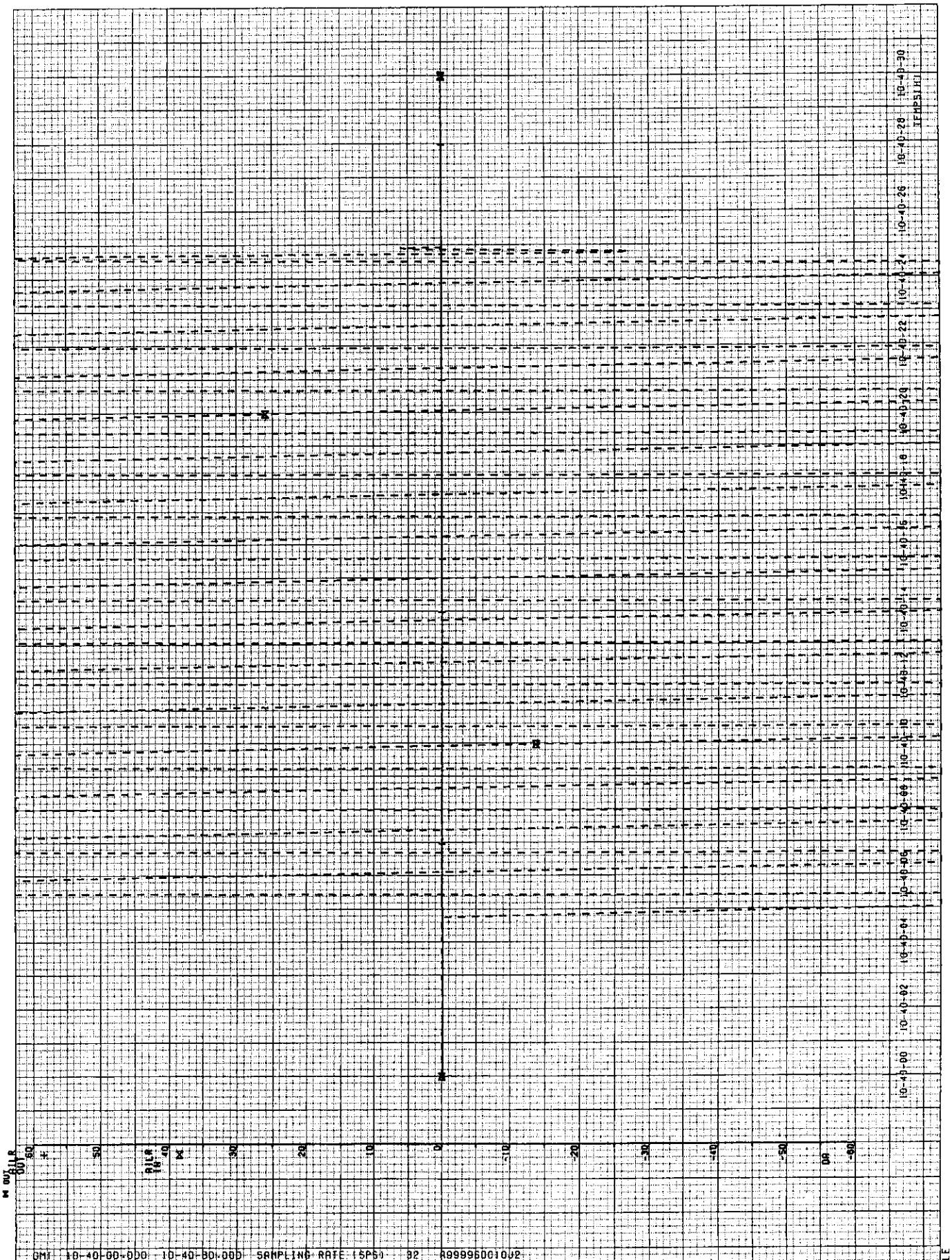
FLIGHT S0010 TEST 8.8 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AV'C



FLIGHT S0010 TEST 8.8 FTI

A-NTSB

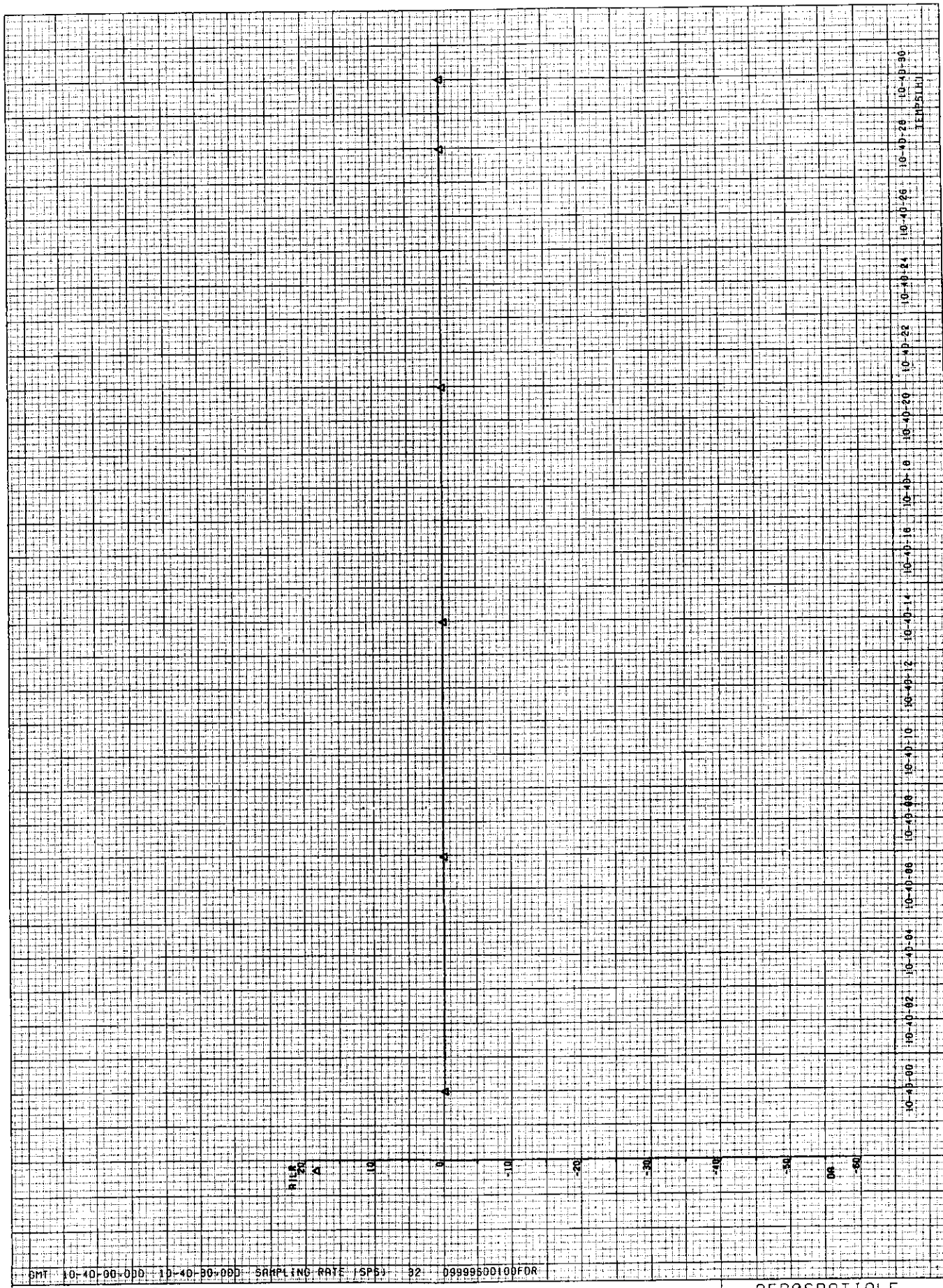
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.15

(C) AEROSPATIALE

008347

AVIC



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FLIGHT S0010 TEST 8.8 DFDR

A-NTSB

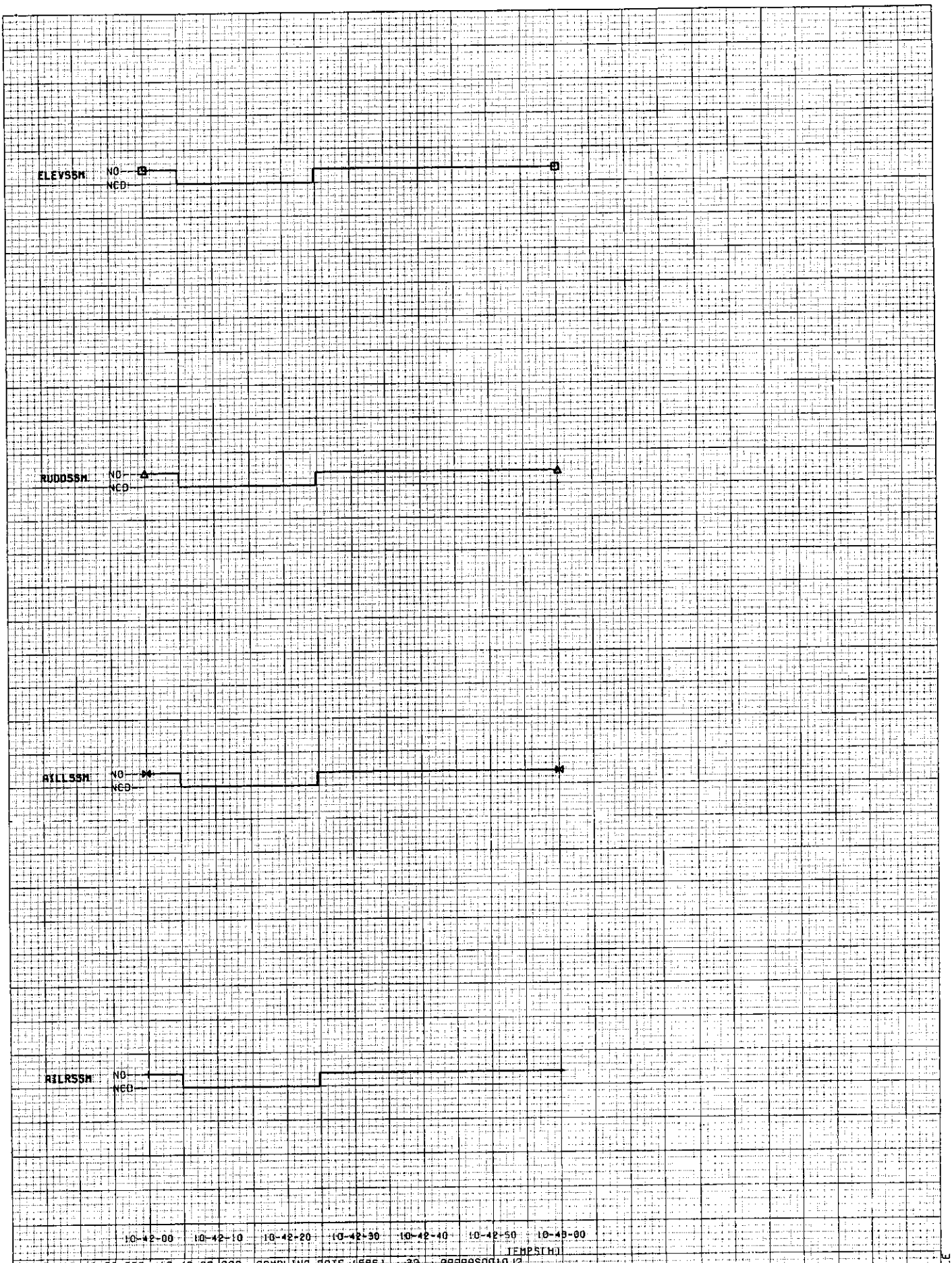
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.1.16

(C) AEROSPATIALE

310.8 SERIE/SDACRAL.AD

008348



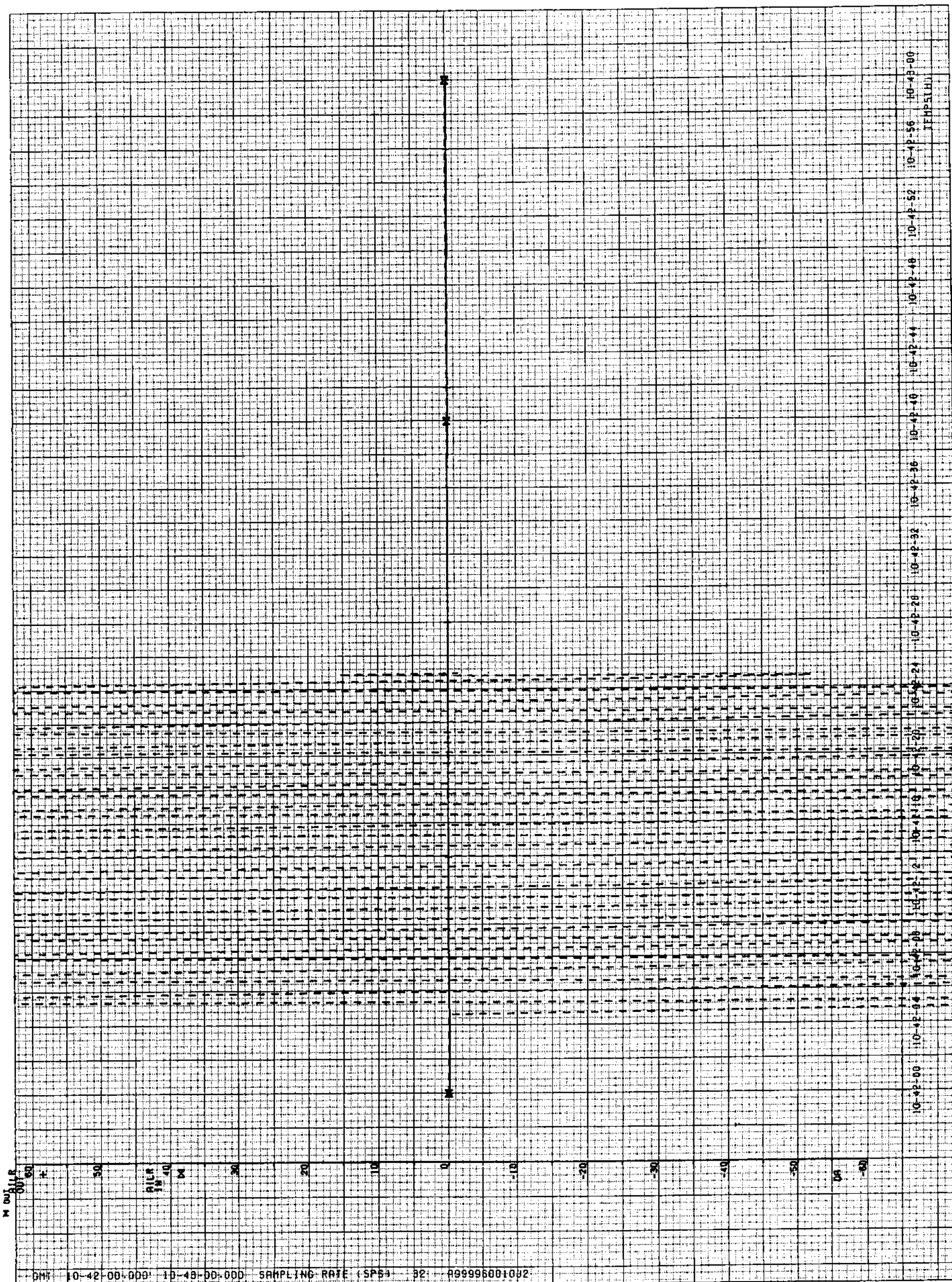
FLIGHT S0010 TEST 8.9 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

RVTC



FLIGHT S0010 TEST 8.9 FTI

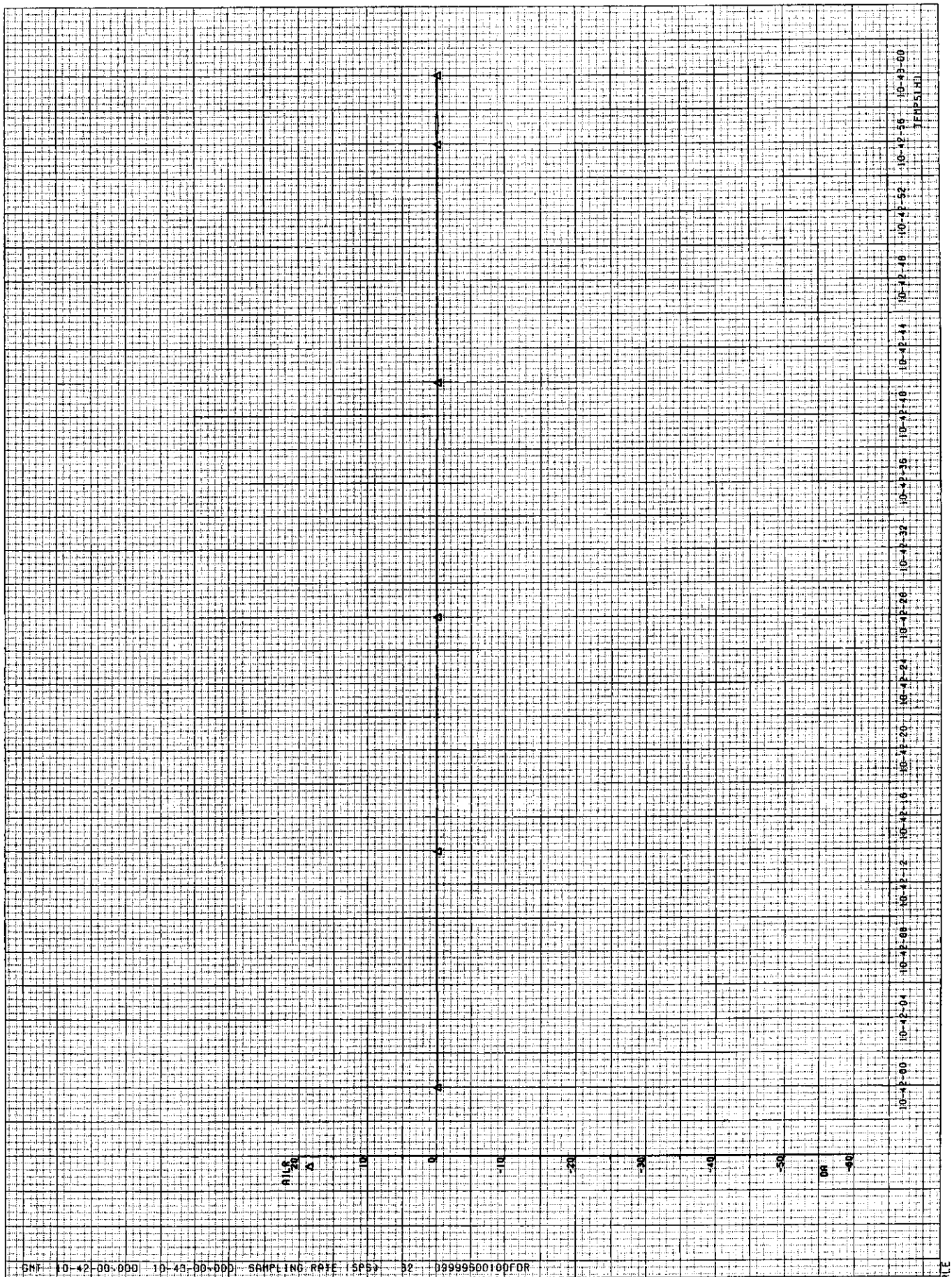
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.17

A-NTSB

310.8 SERIE/SDACAAL.AD

AVIC



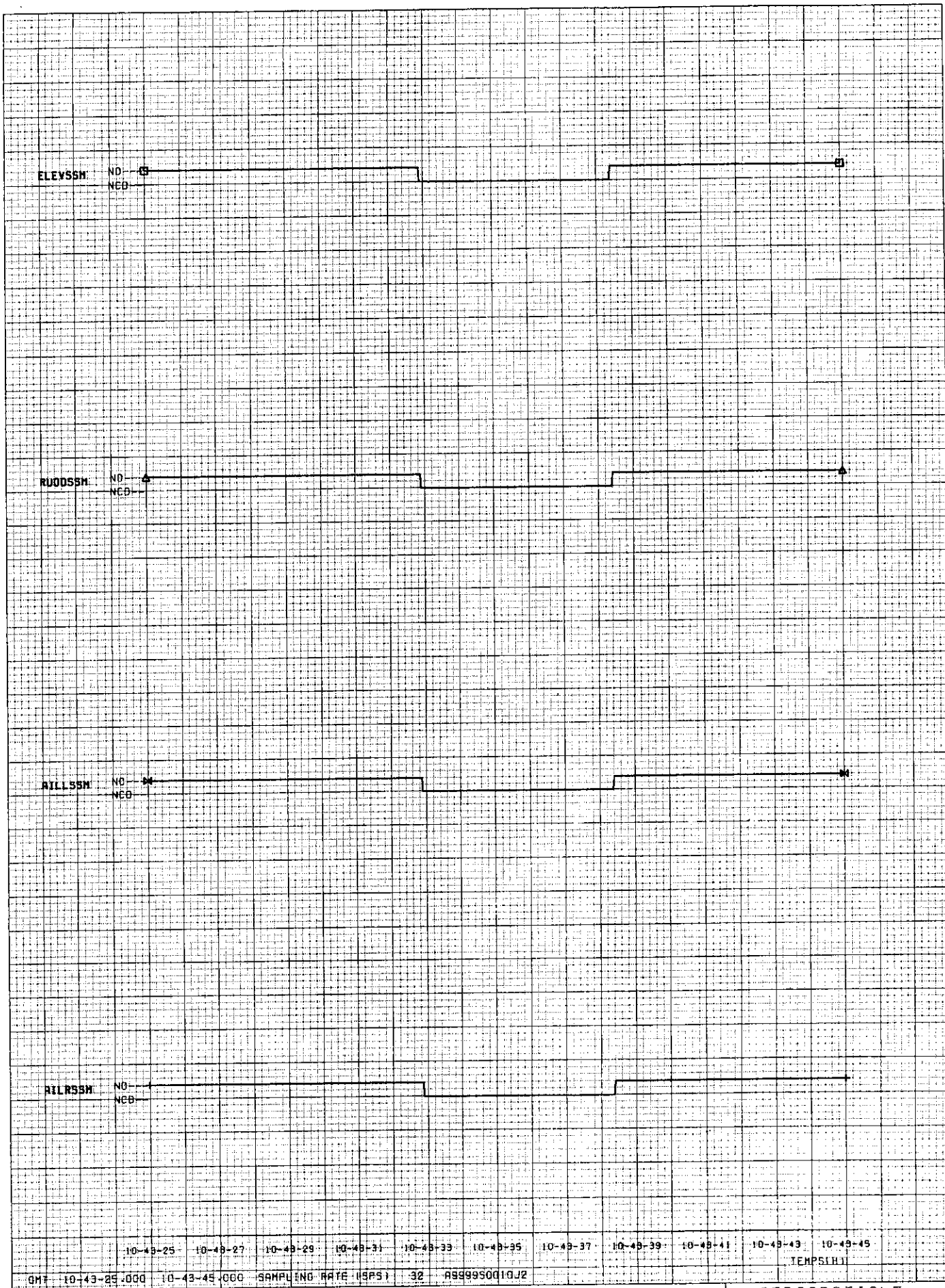
FLIGHT S0010 TEST 8.9 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 4.1.18

008351



FLIGHT S0010 TEST 8.10 FTI

A-NTSB

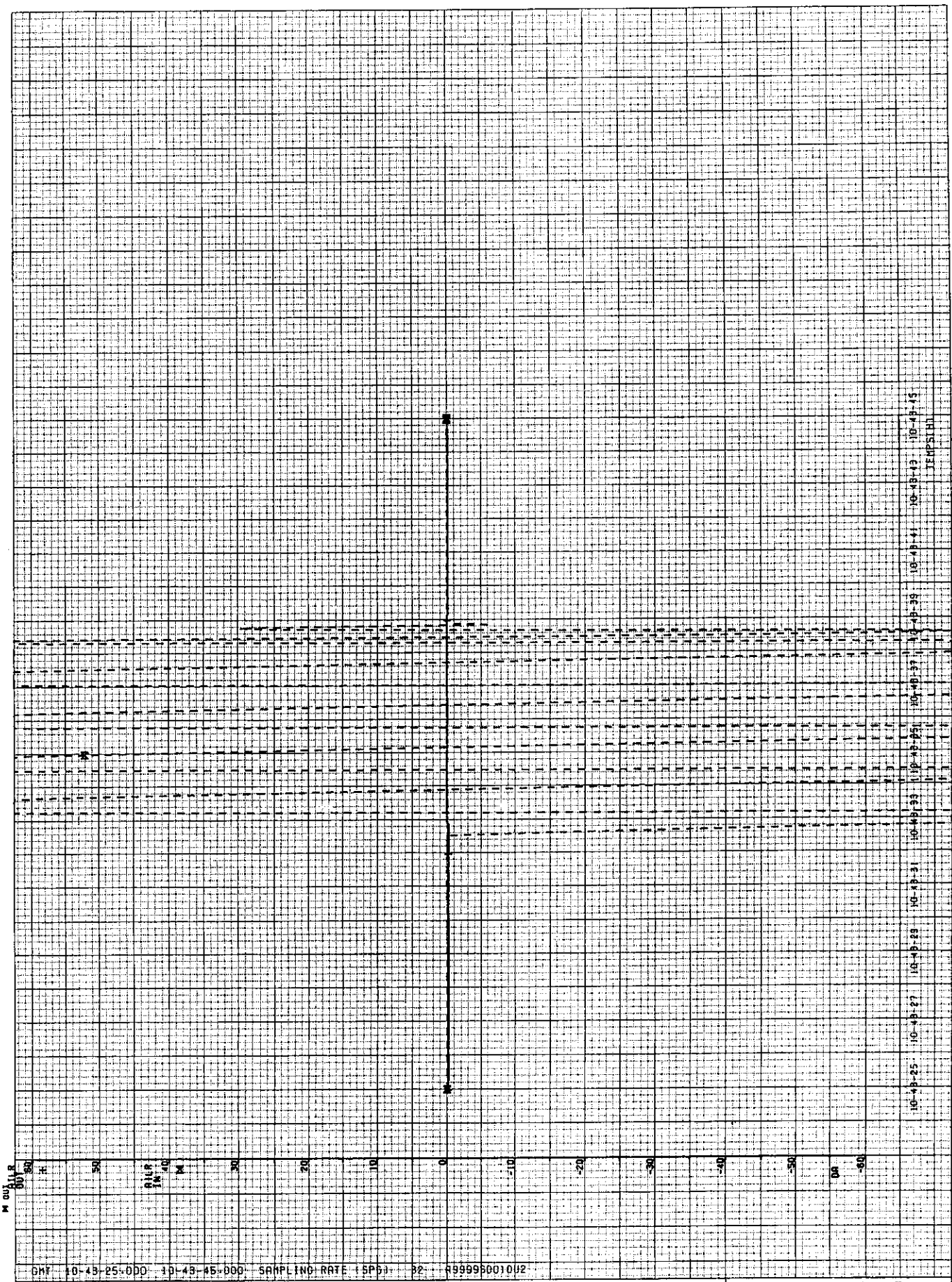
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

SERIE/SDACAAL.A0

EDITION DU 28/02/2002 A 14H49

AVIC



FLIGHT S0010 TEST 8.10 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

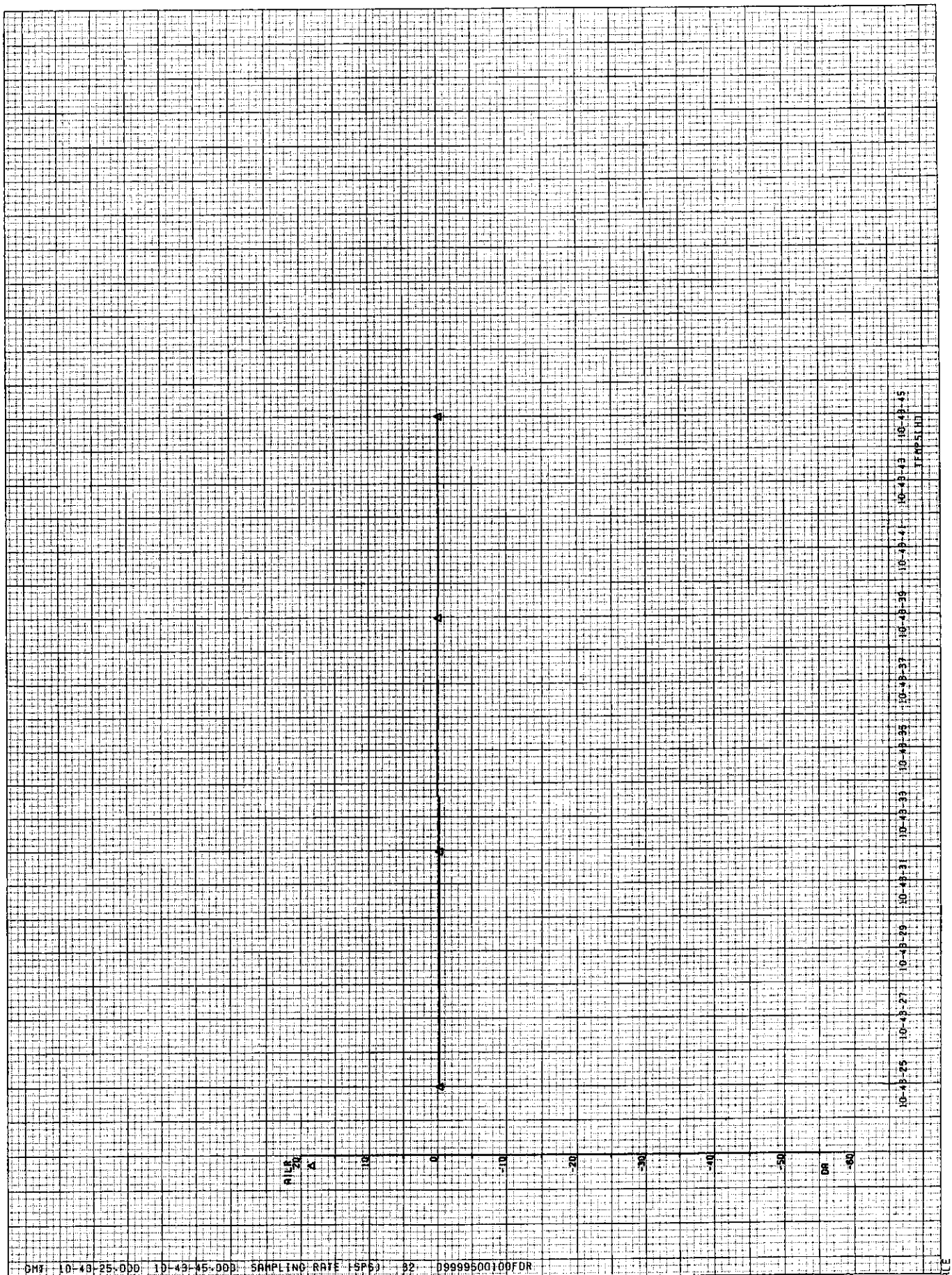
AIRCRAFT A9999 FIGURE 4.1.19

(C) AEROSPATIALE

310.8 SERIE/SDACARL.AD

008353

AVIC



GMT 10-48-25.000 10-49-45.000 SAMPLING RATE (SPS) 32 0999960010DFDR

FLIGHT S0010 TEST 8.10 DFDR

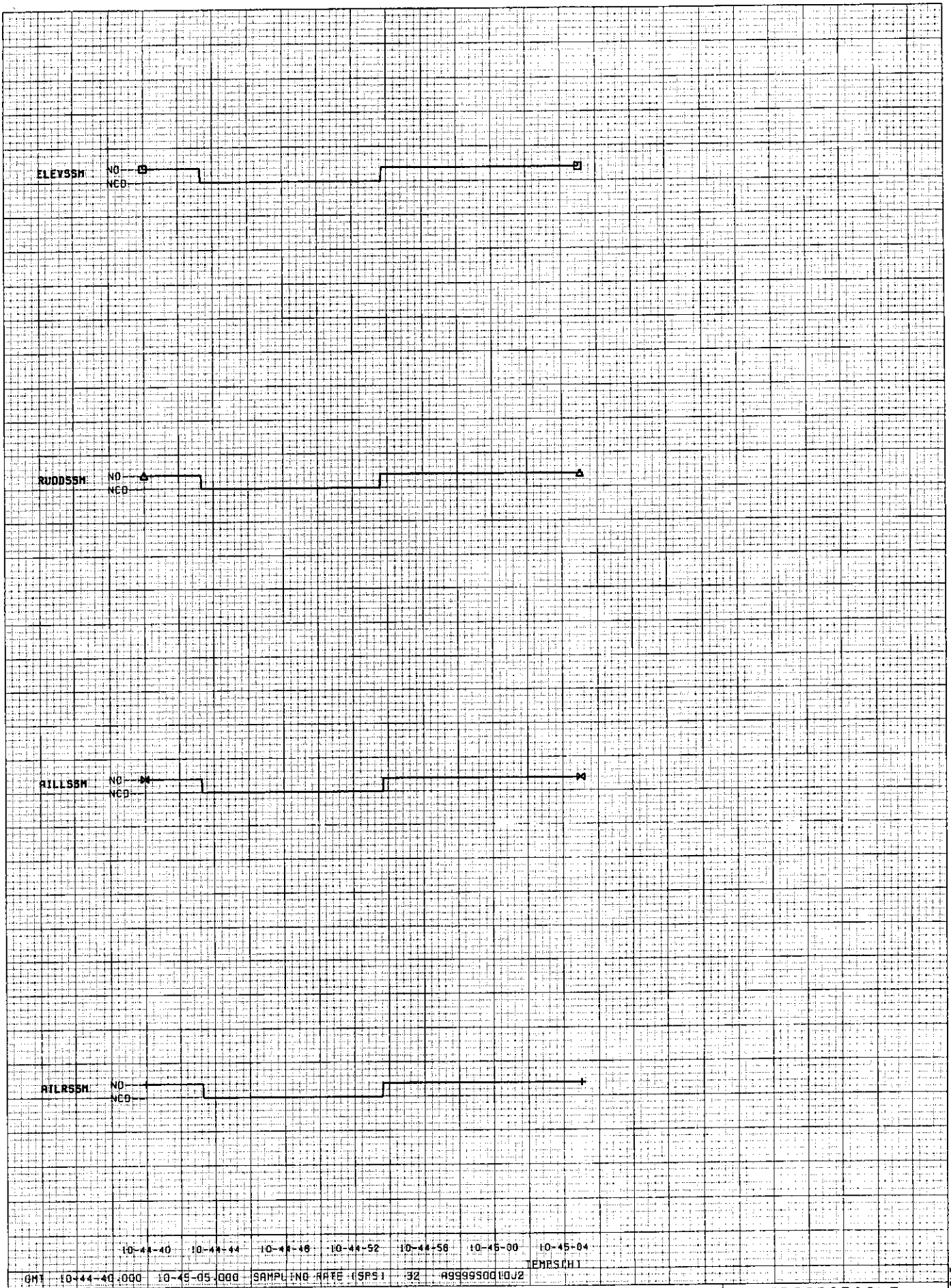
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 4.1.20

(C) AEROSPATIALE

A-NTSB

310.8 SERIE/SDACAAL.AD



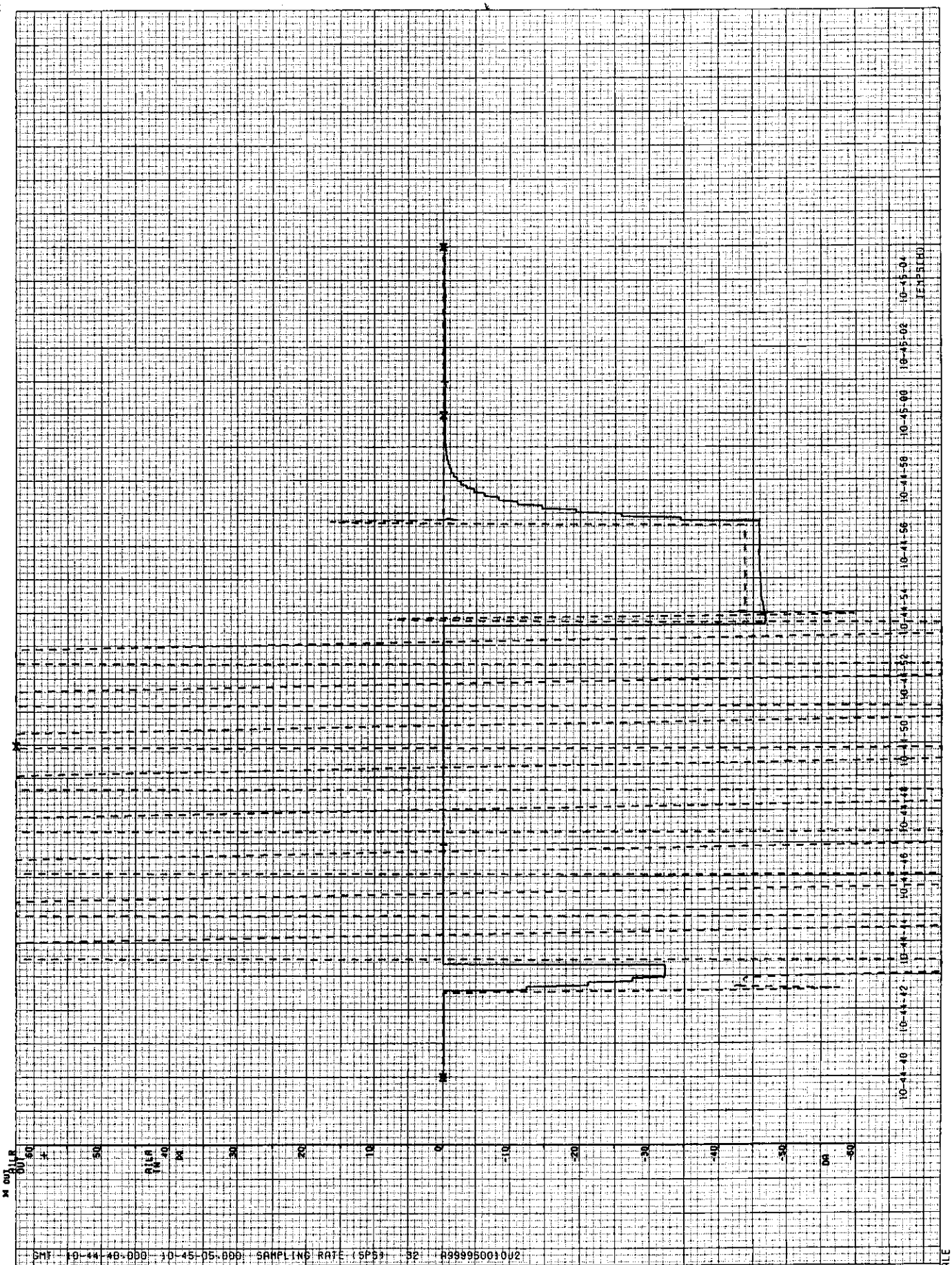
FLIGHT S0010 TEST 8.11 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 8.11 FTI

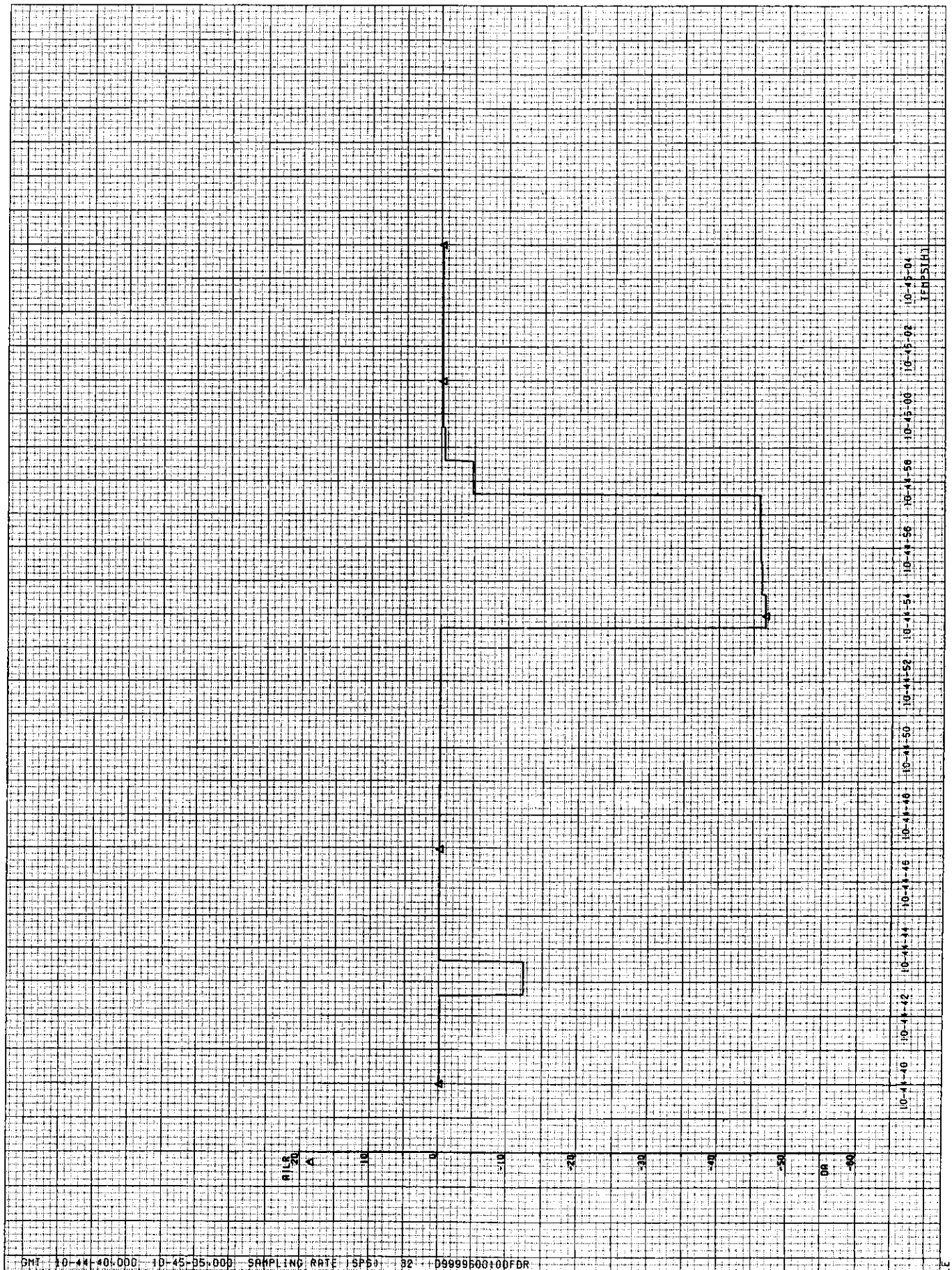
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.21

(C) AEROSPATIALE

AVIC



FLIGHT S0010 TEST 8.11 DFDR

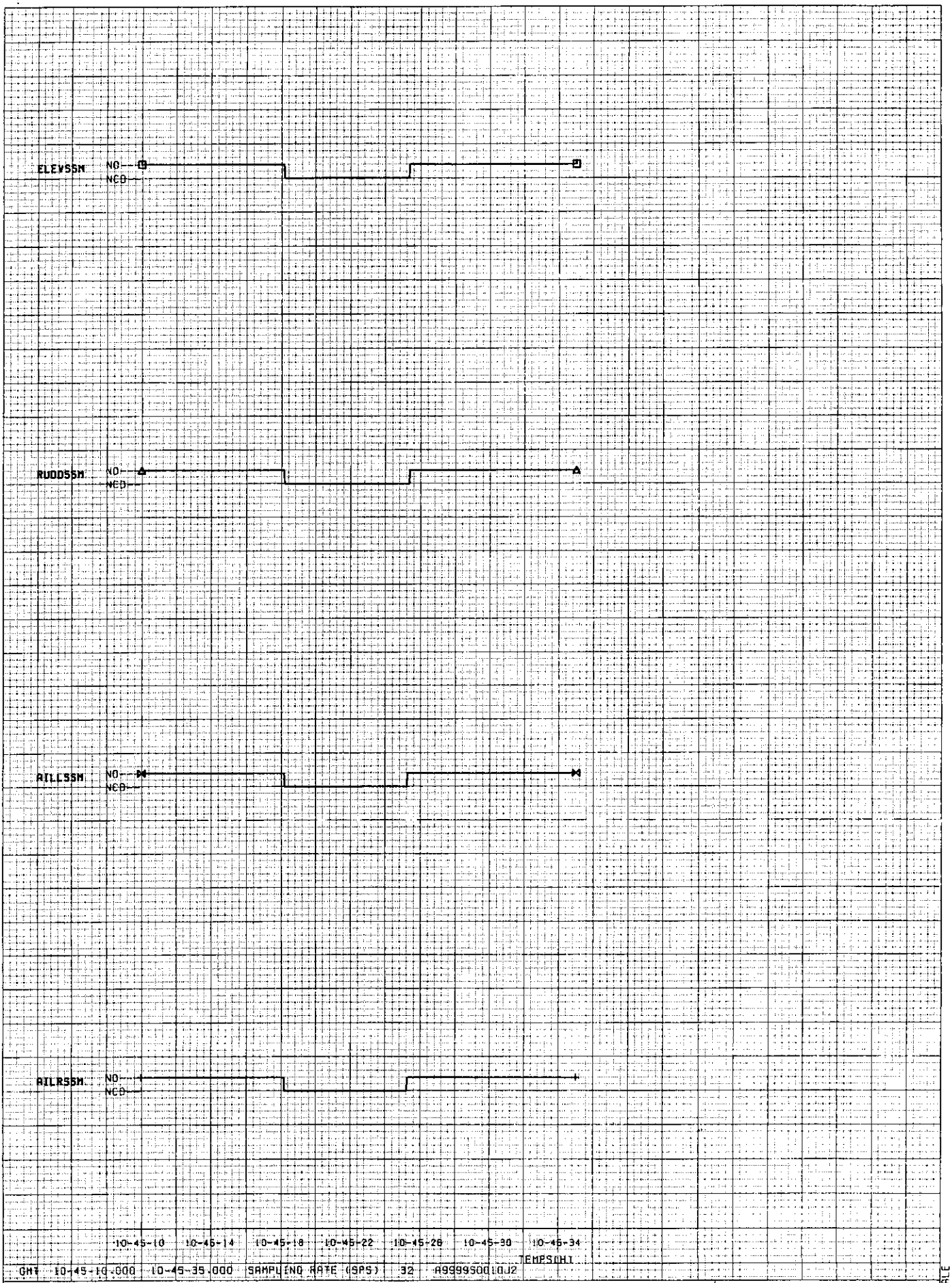
AEROSPATIALE
FLIGHT TESTS

A-NTSB

AIRCRAFT D9999 | FIGURE 4.1.22

(C) AEROSPATIALE

310-8 SERIE/SDACAAL.AD



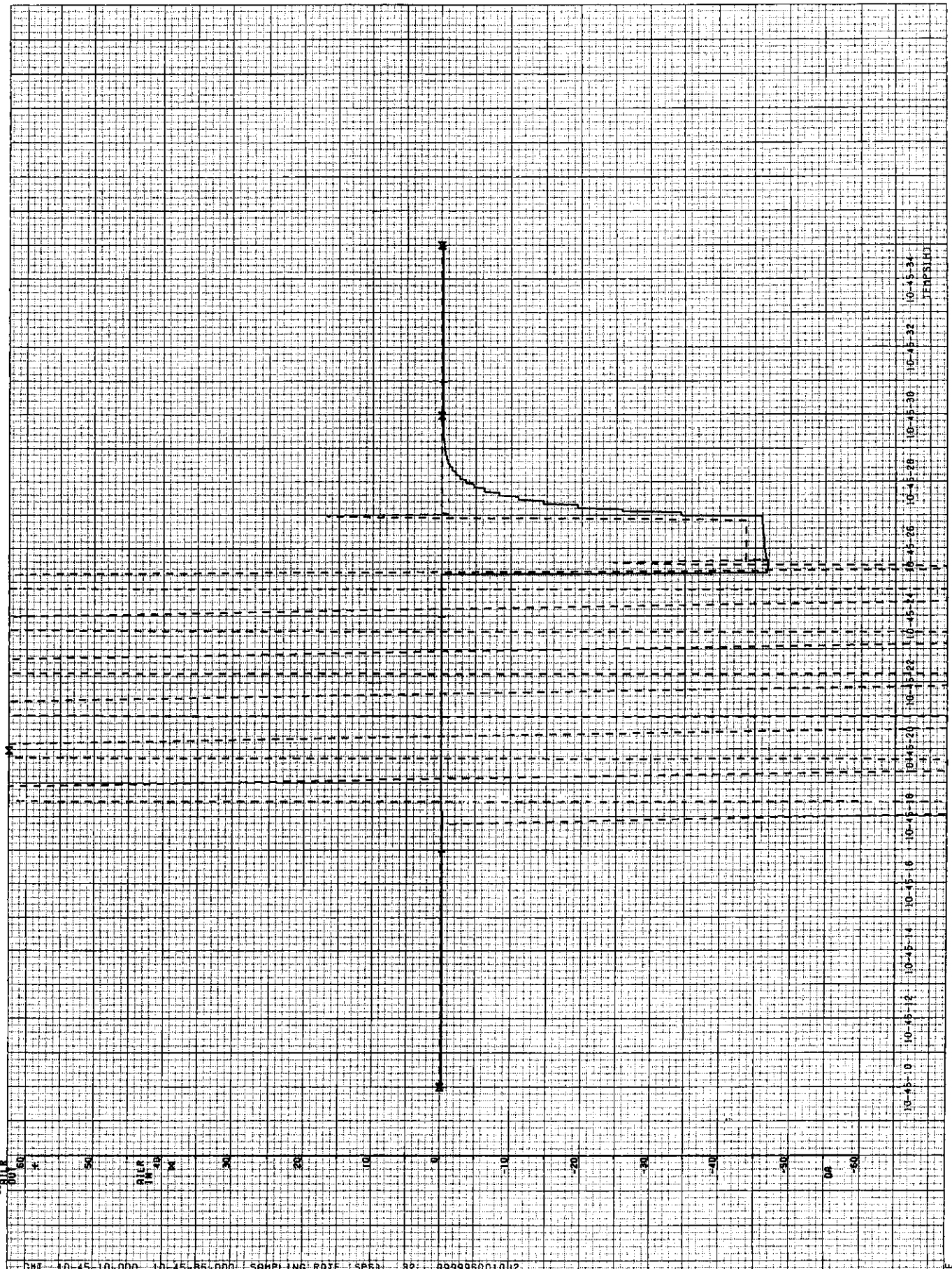
FLIGHT S0010 TEST 8.12 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 8.12 FTI

A-NTSB

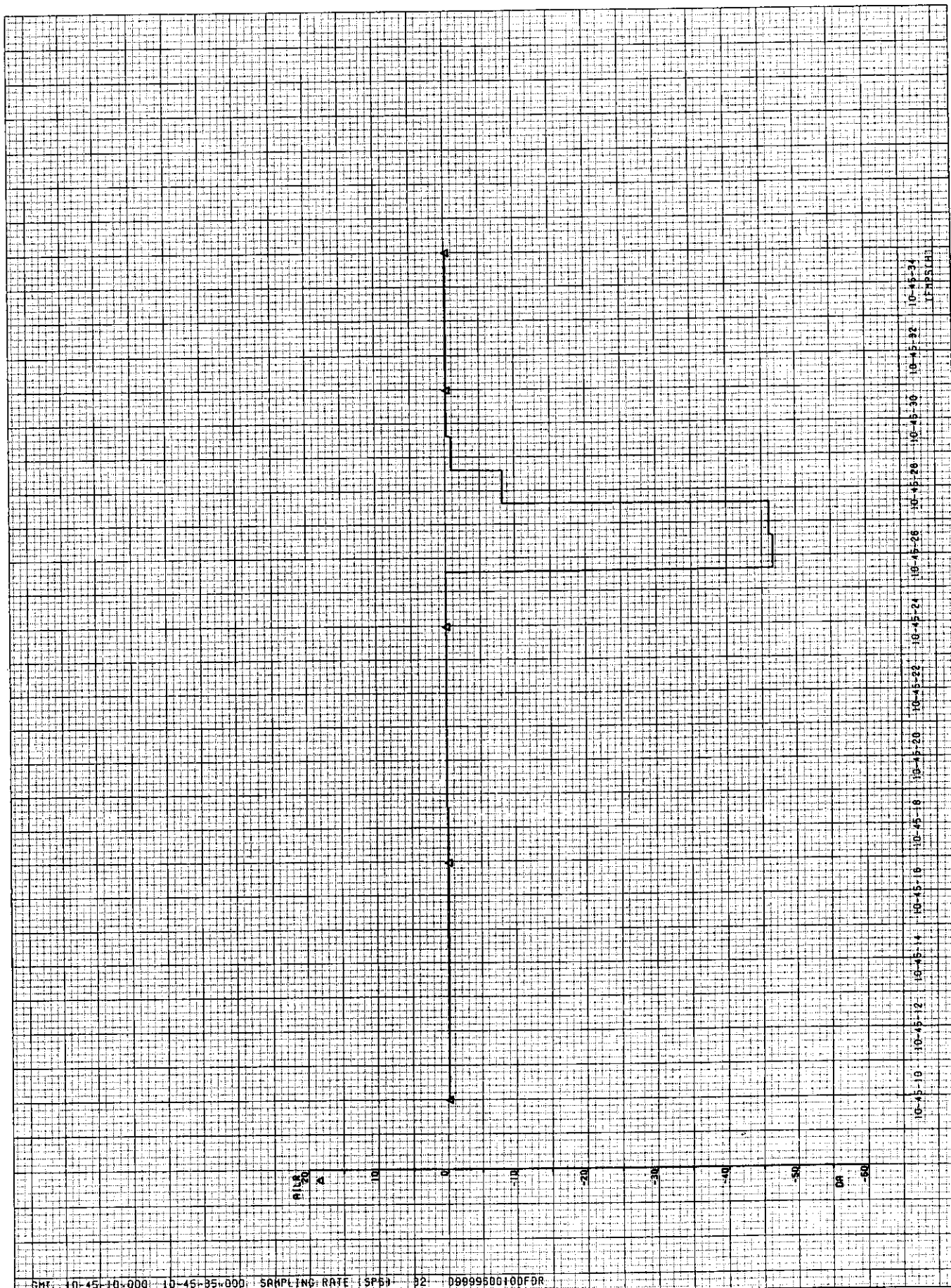
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.23

(C) AEROSPATIALE

008359

AVIC



GMT 10-45-10.000 10-45-35.000 SAMPLING RATE (SPS) 32 D0999500I0DFDR

FLIGHT S0010 TEST 8.12 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

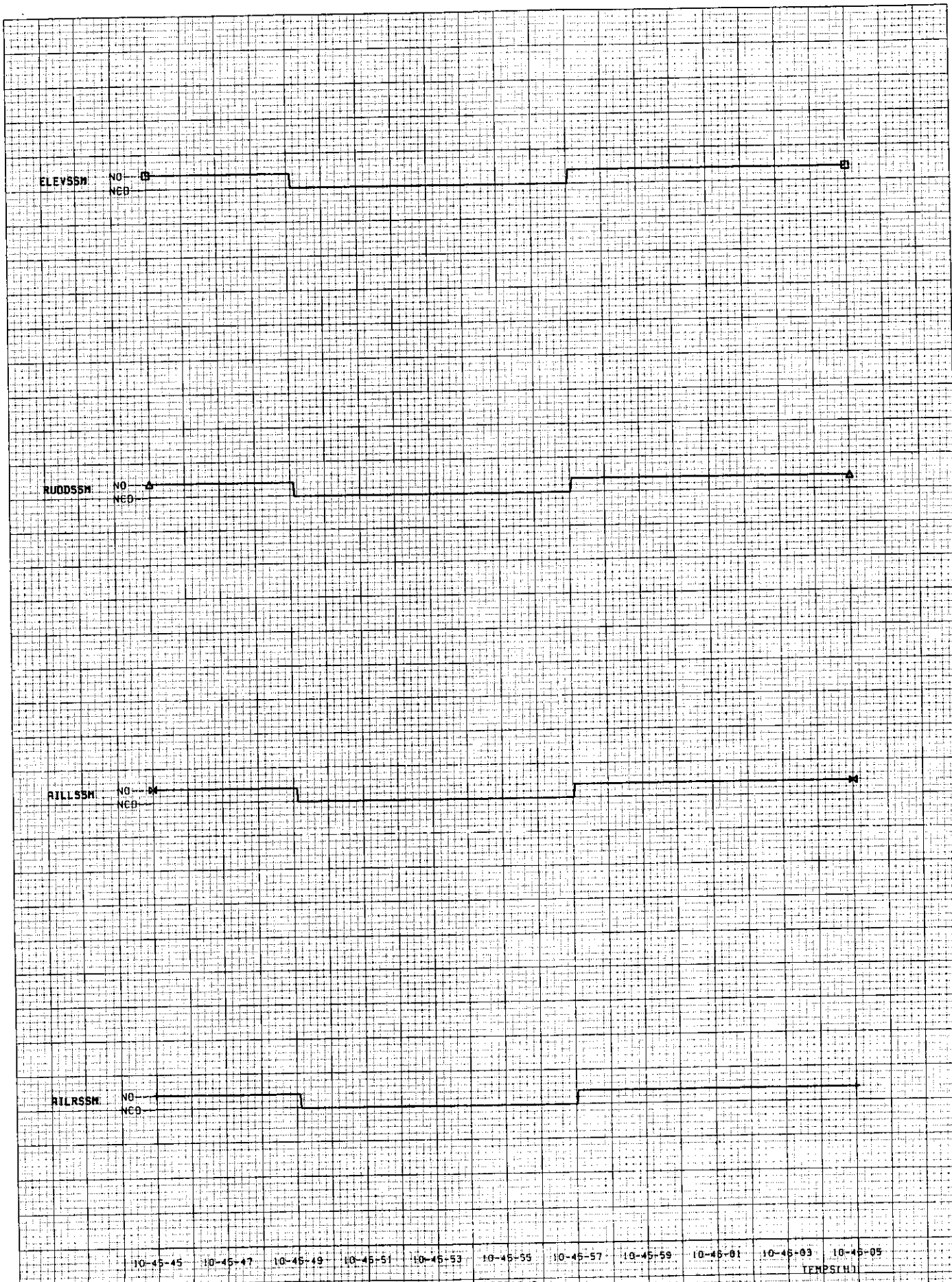
AIRCRAFT D9999 FIGURE 4-1.34

(C) AEROSPATIALE

310-8 SERIE/SOACAAL.AD

008360

AVIC



FLIGHT S0010 TEST 8.13 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

(C) AEROSPATIALE

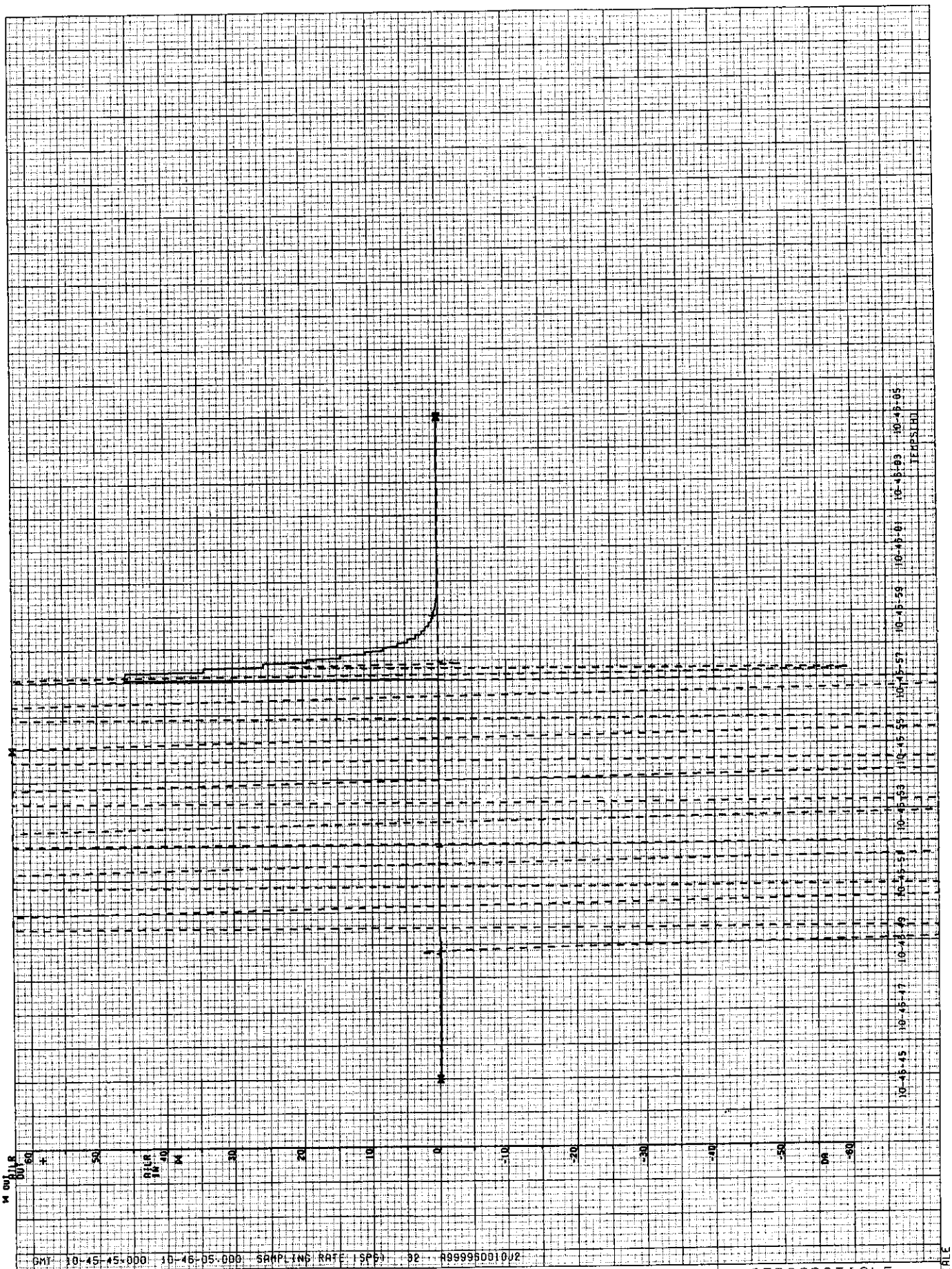
999

SERIE/SDACAAL.AD

008361

EDITION OU 28/02/2002 A 14H49

AVIC



FLIGHT S0010 TEST 8.13 FTI

A-NTSB

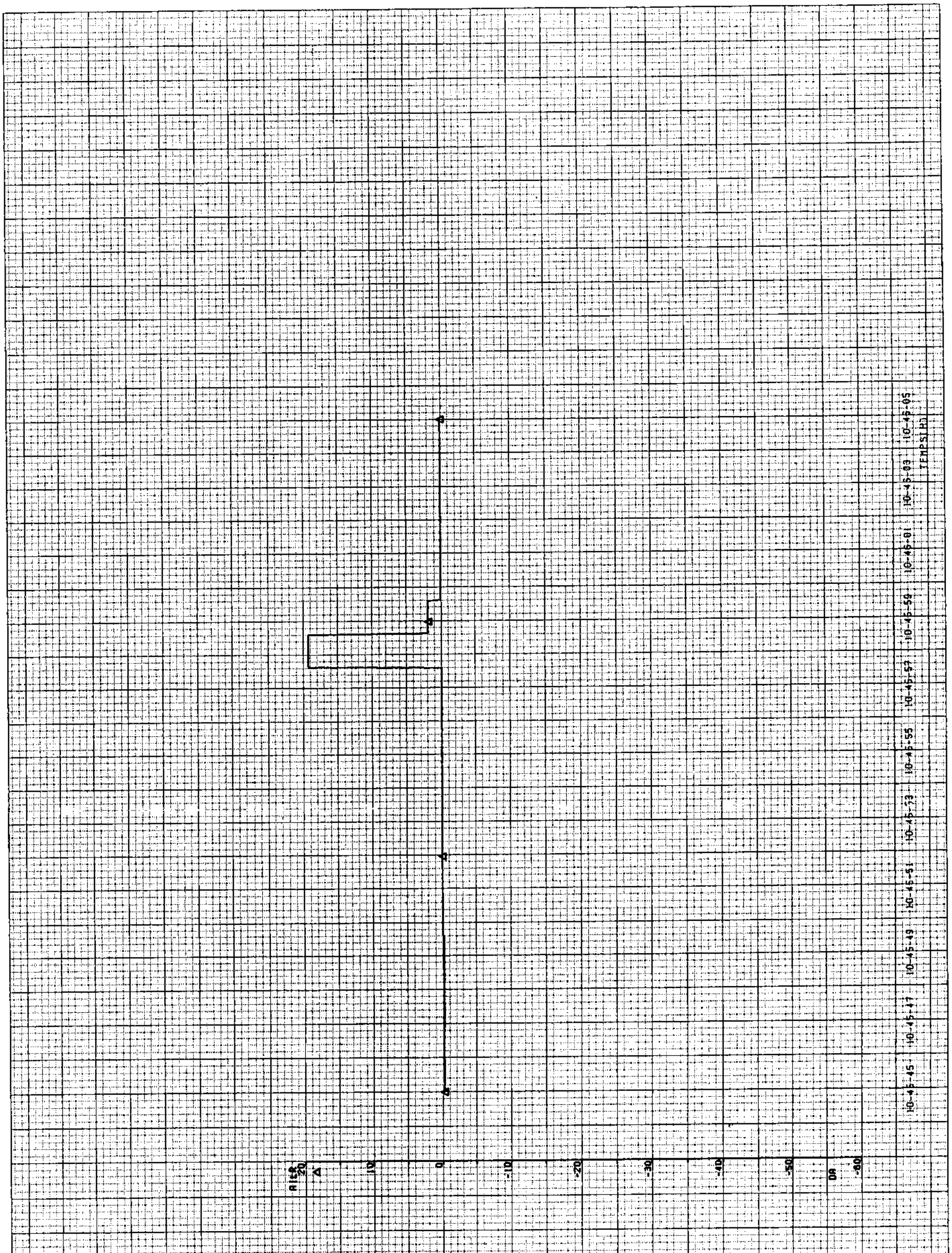
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 4.1.25

(C) AEROSPATIALE

008362

AV1C



GMT 10-45-45.000 10-46-05.000 SAMPLING RATE (SPS) 32 D9999S0010DFDR

FLIGHT S0010 TEST 8.13 DFDR

A-NTSB

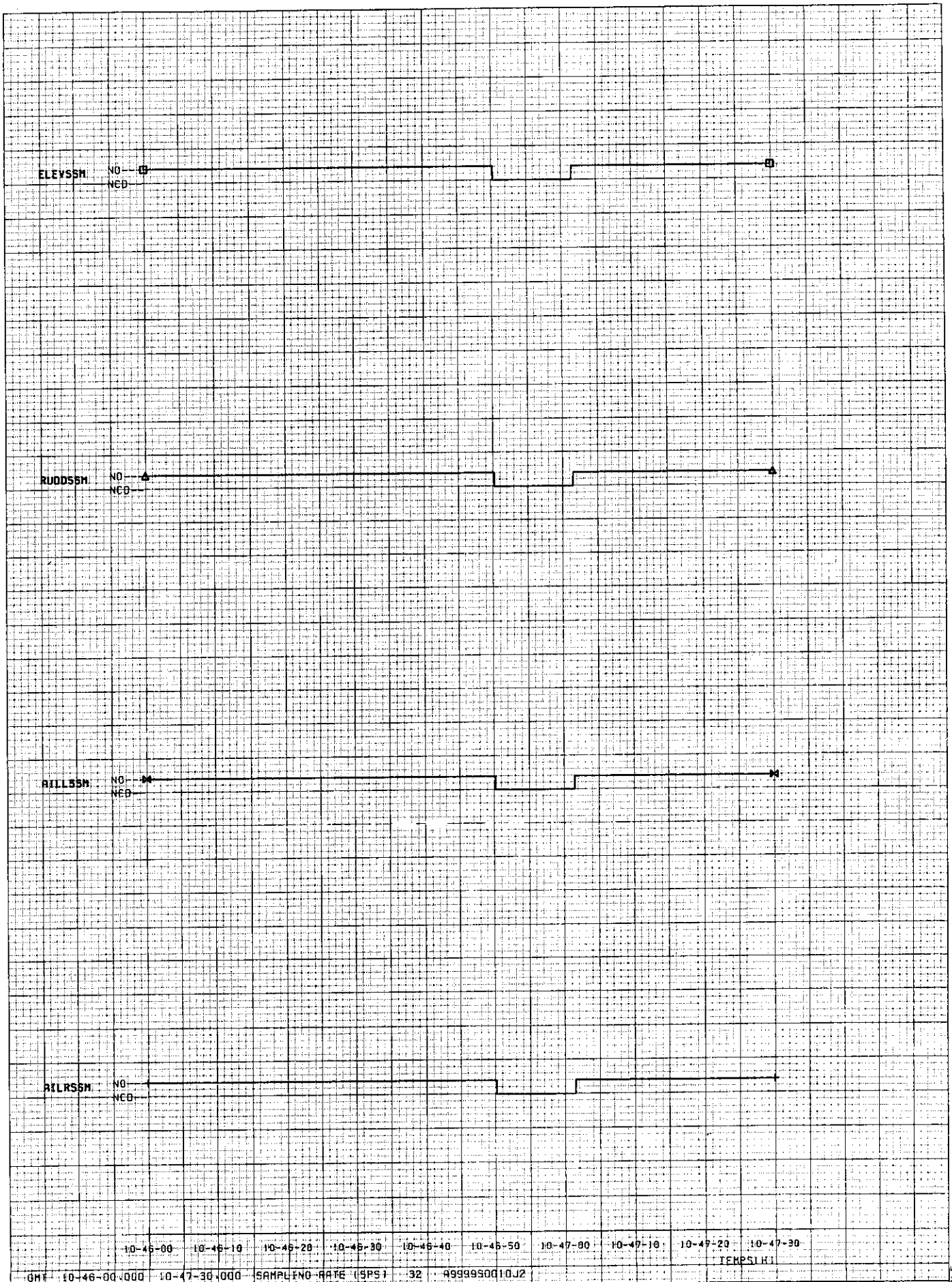
008363

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.1.26

310.8 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 8.14 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

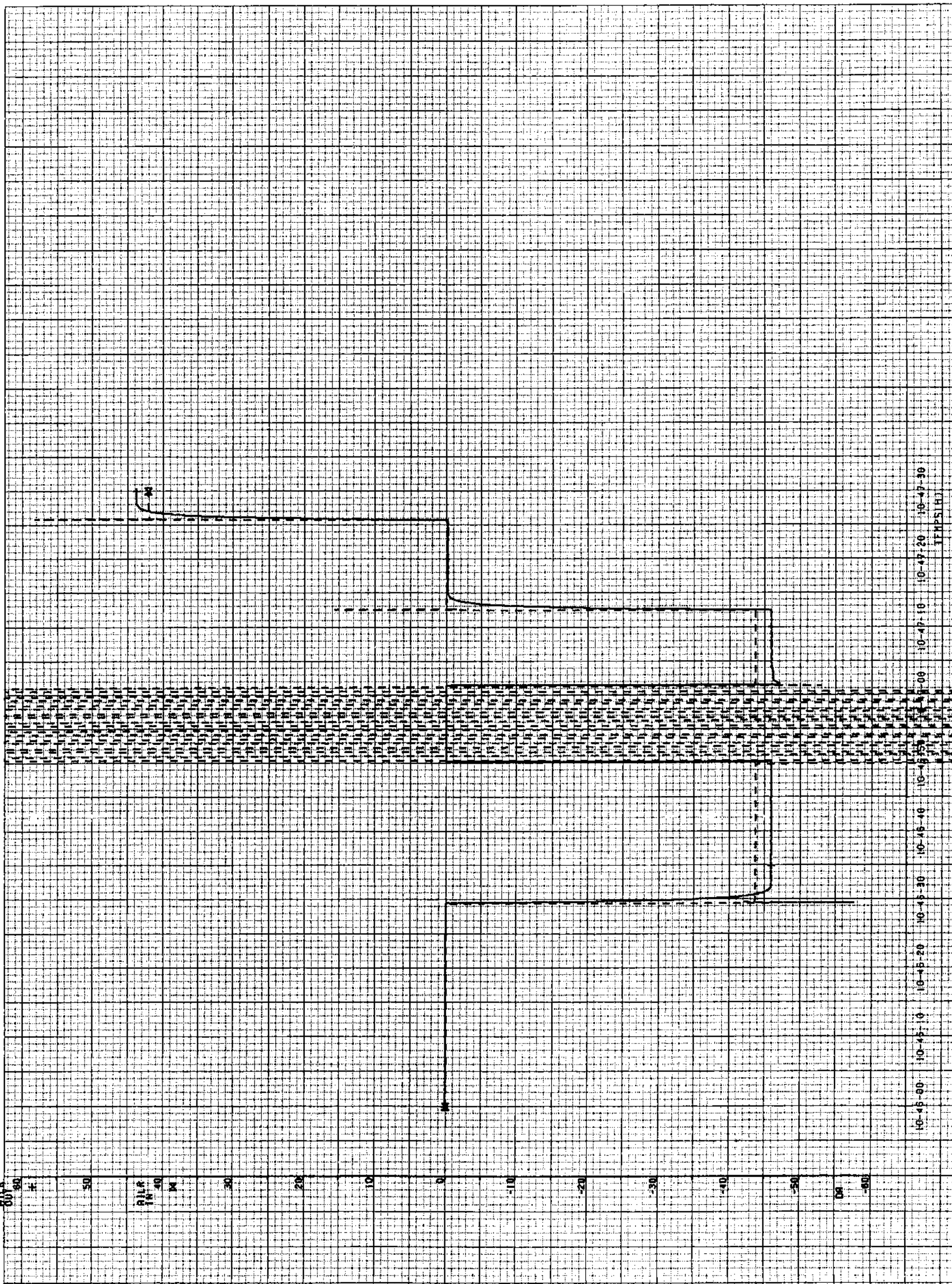
(C) AEROSPATIALE

999 SERIE/SDACARL.AD

EDITION DU 28/02/2002 A 14H49

008364

AVIC



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FLIGHT S0010 TEST 8.14 FTI

AEROSPATIALE
FLIGHT TESTS

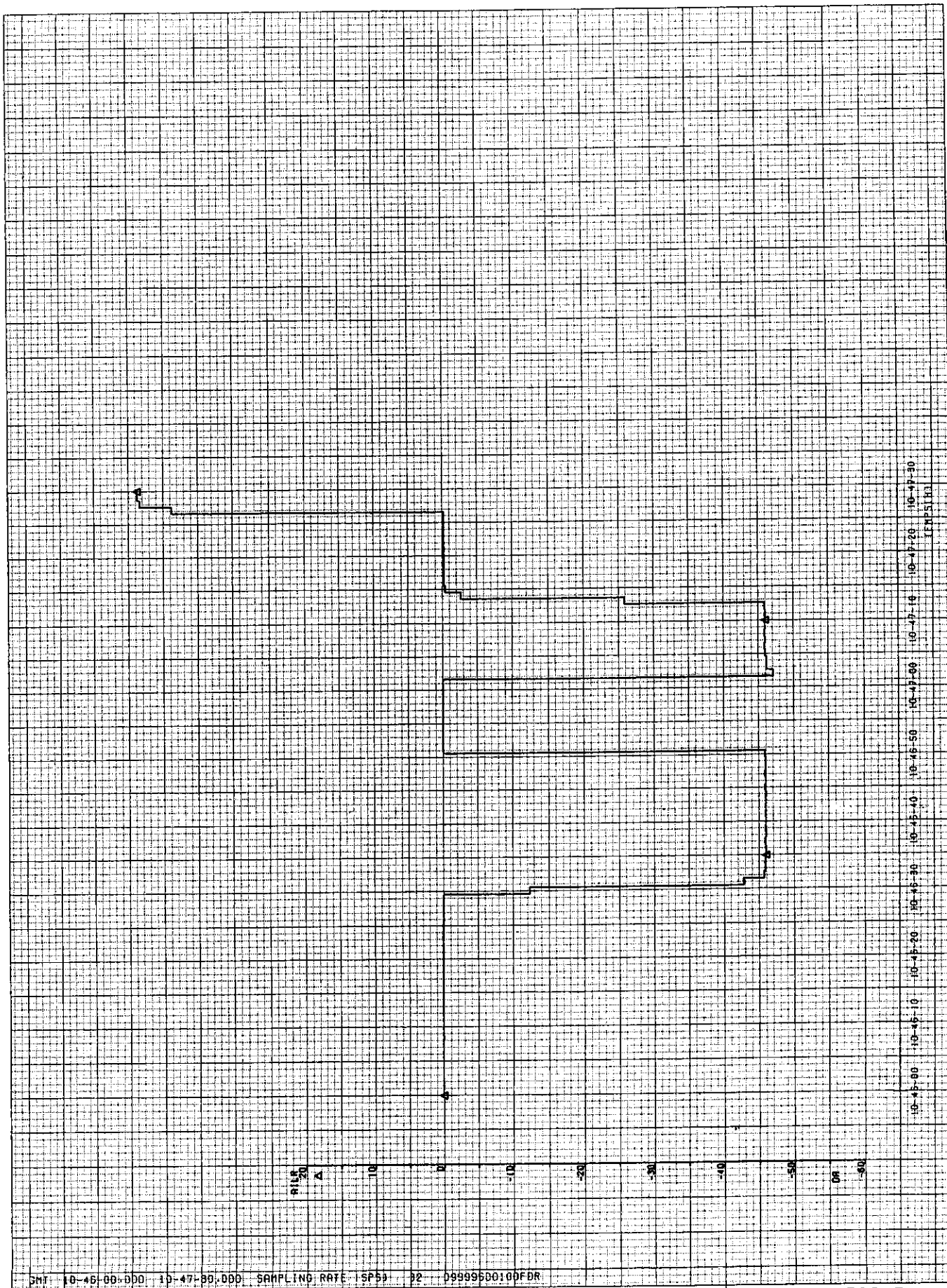
A-NTSB

AIRCRAFT A9999 FIGURE 4.1.27

(C) AEROSPATIALE

310.8 SERIE/SDACAAL.AD

AVIC



FLIGHT S0010 TEST 8.14 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

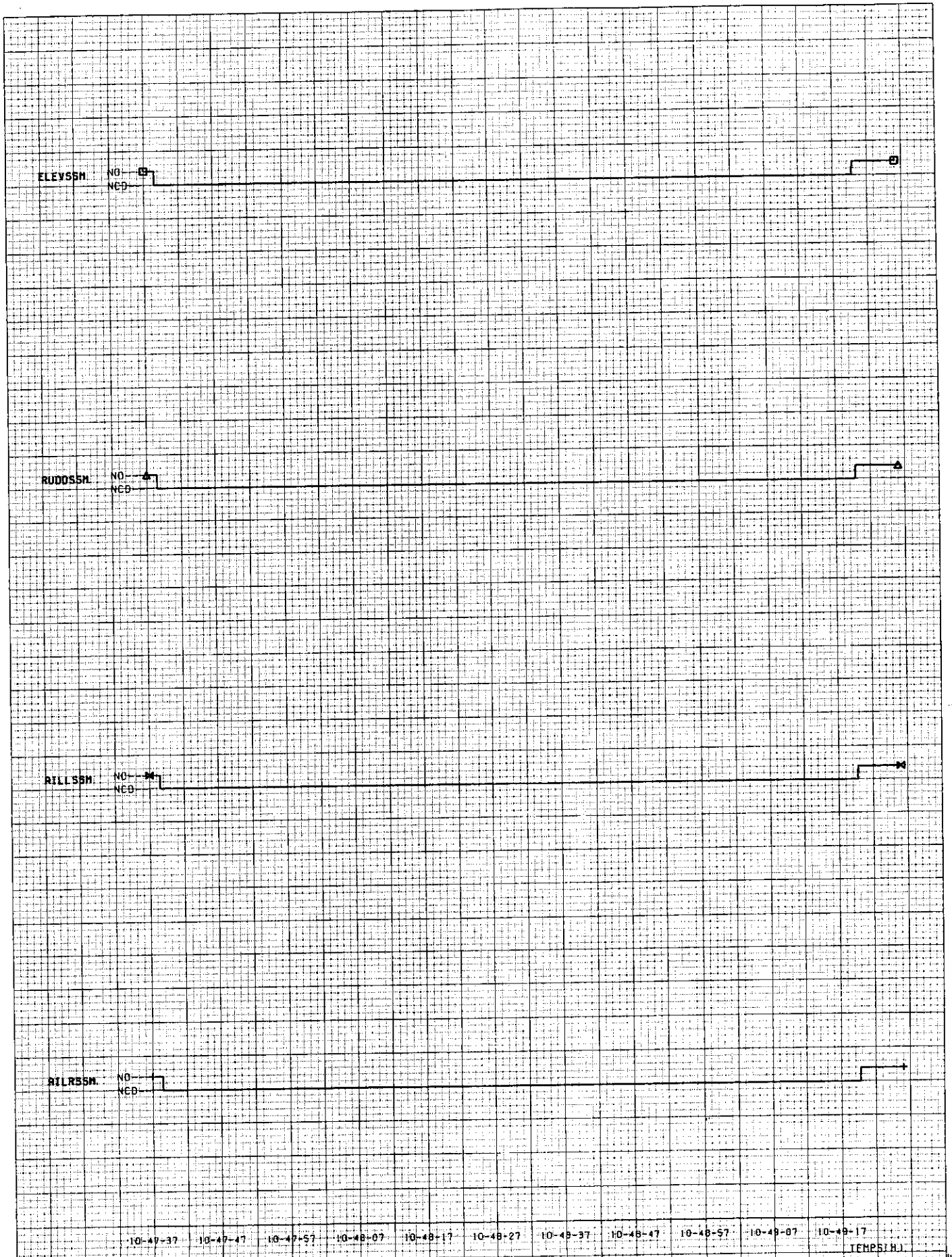
AIRCRAFT 09999 FIGURE 4.1.28

(C) AEROSPATIALE

310-8 SERIE/SORCAAL.AD

008366

AVIC



FLIGHT S0010 TEST 8.15 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

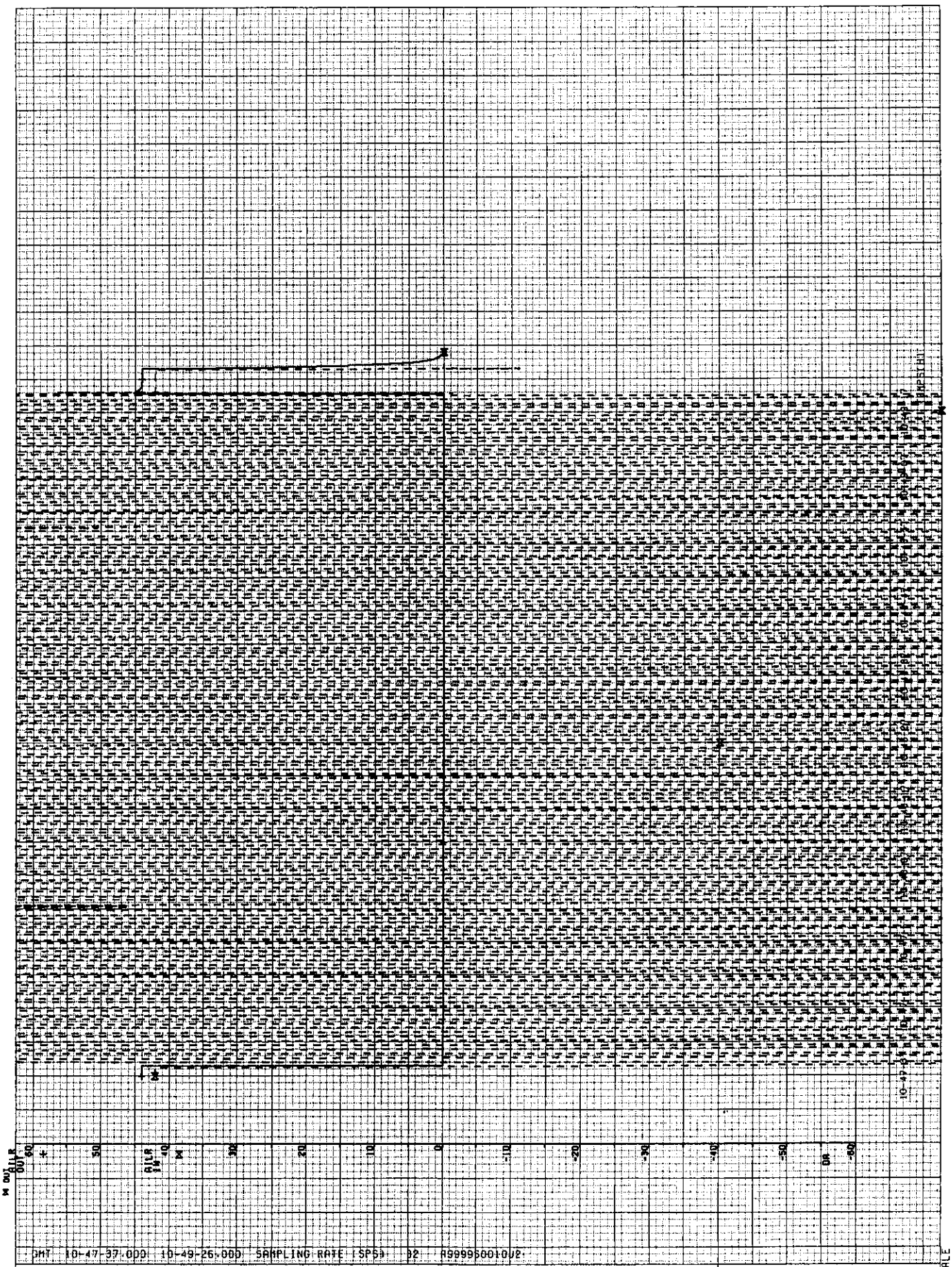
AIRCRAFT A9999 | FIGURE

EDITION DU 28/02/2002 A 14H49

SERIE/SDACAAL.AD

008367

AVIC



FLIGHT S0010 TEST 8.15 FTI

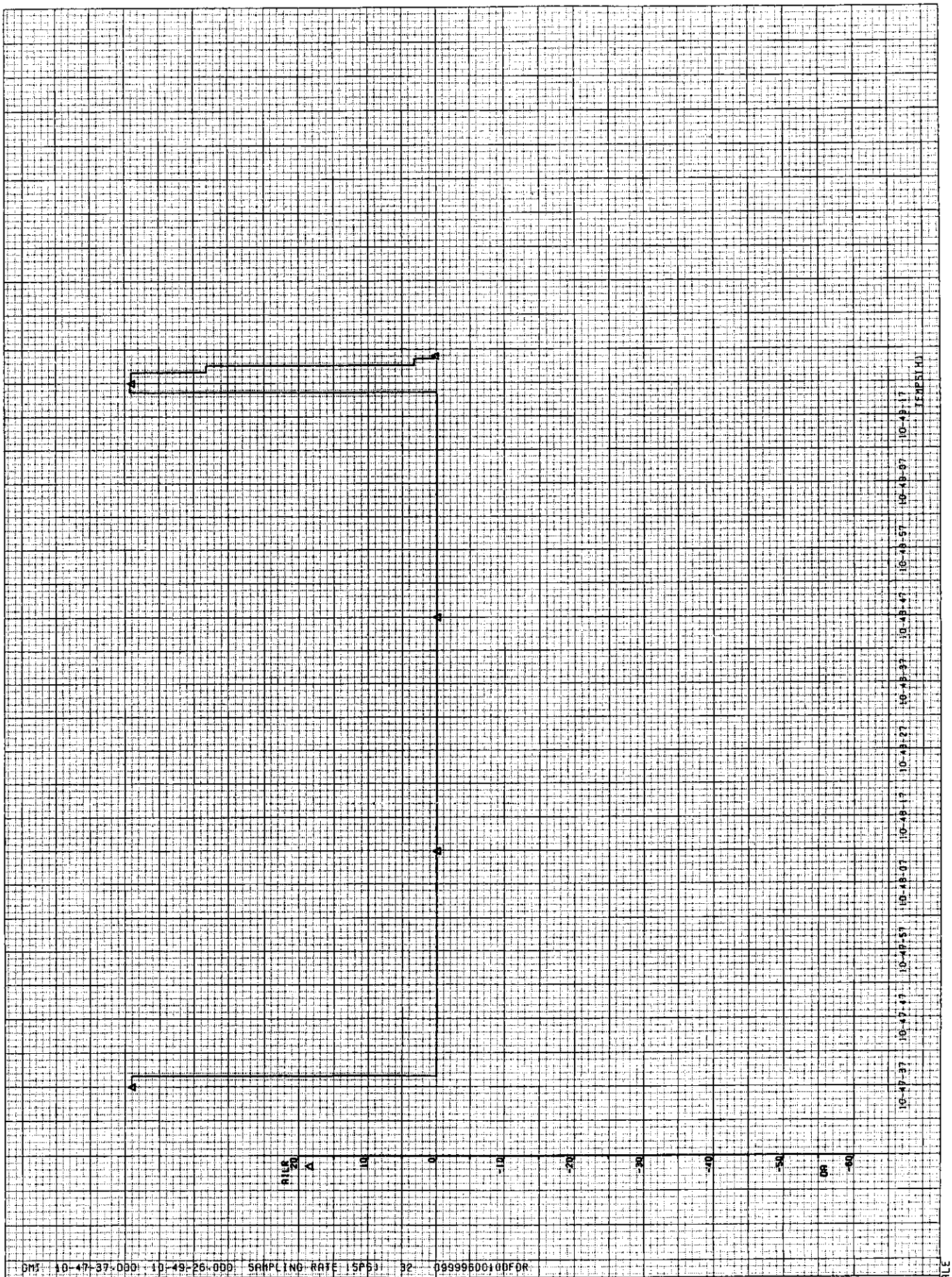
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE 4.1.25

© AEROSPATIALE

008368

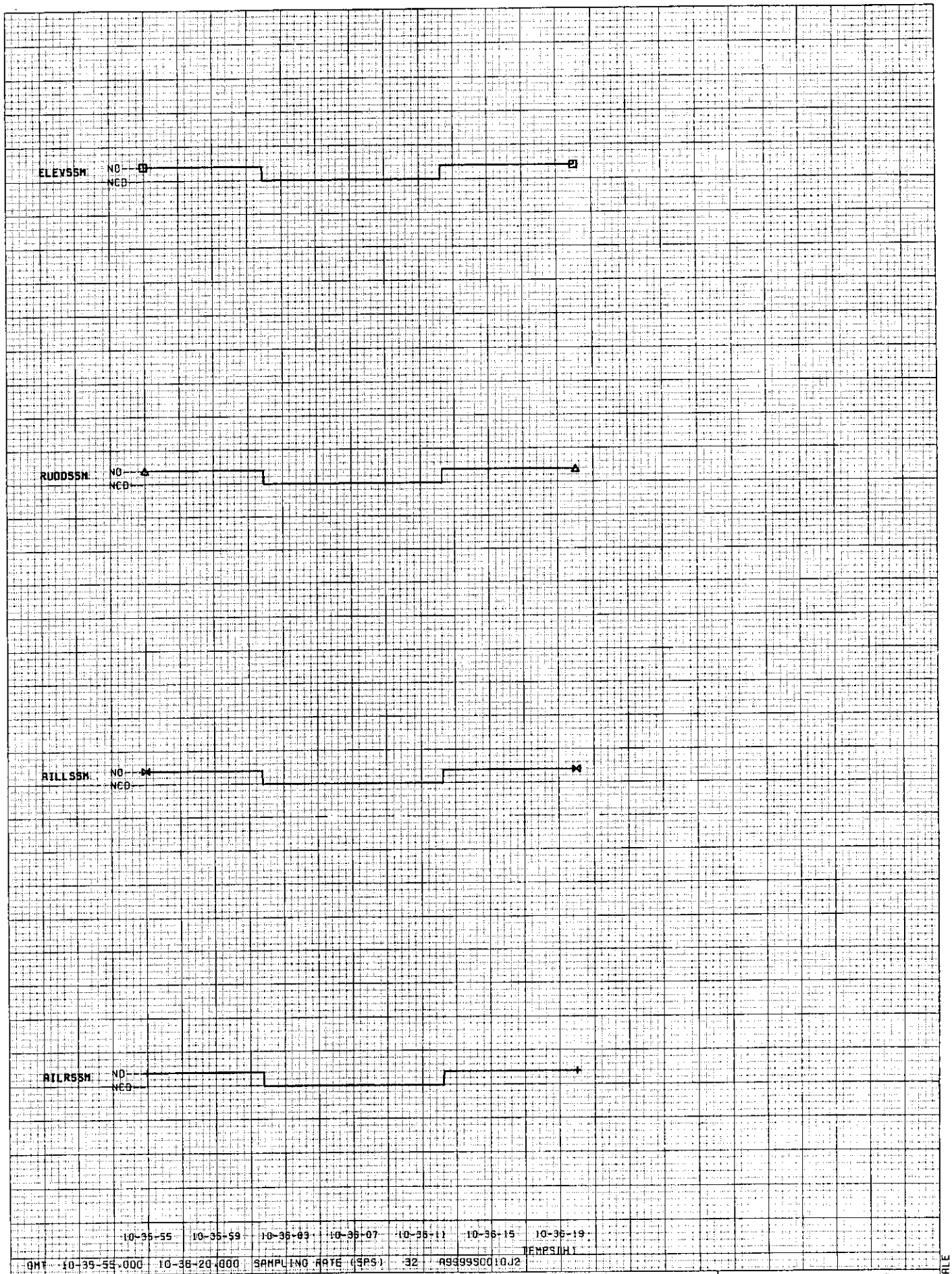


FLIGHT S0010 TEST 8.15 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.1.30



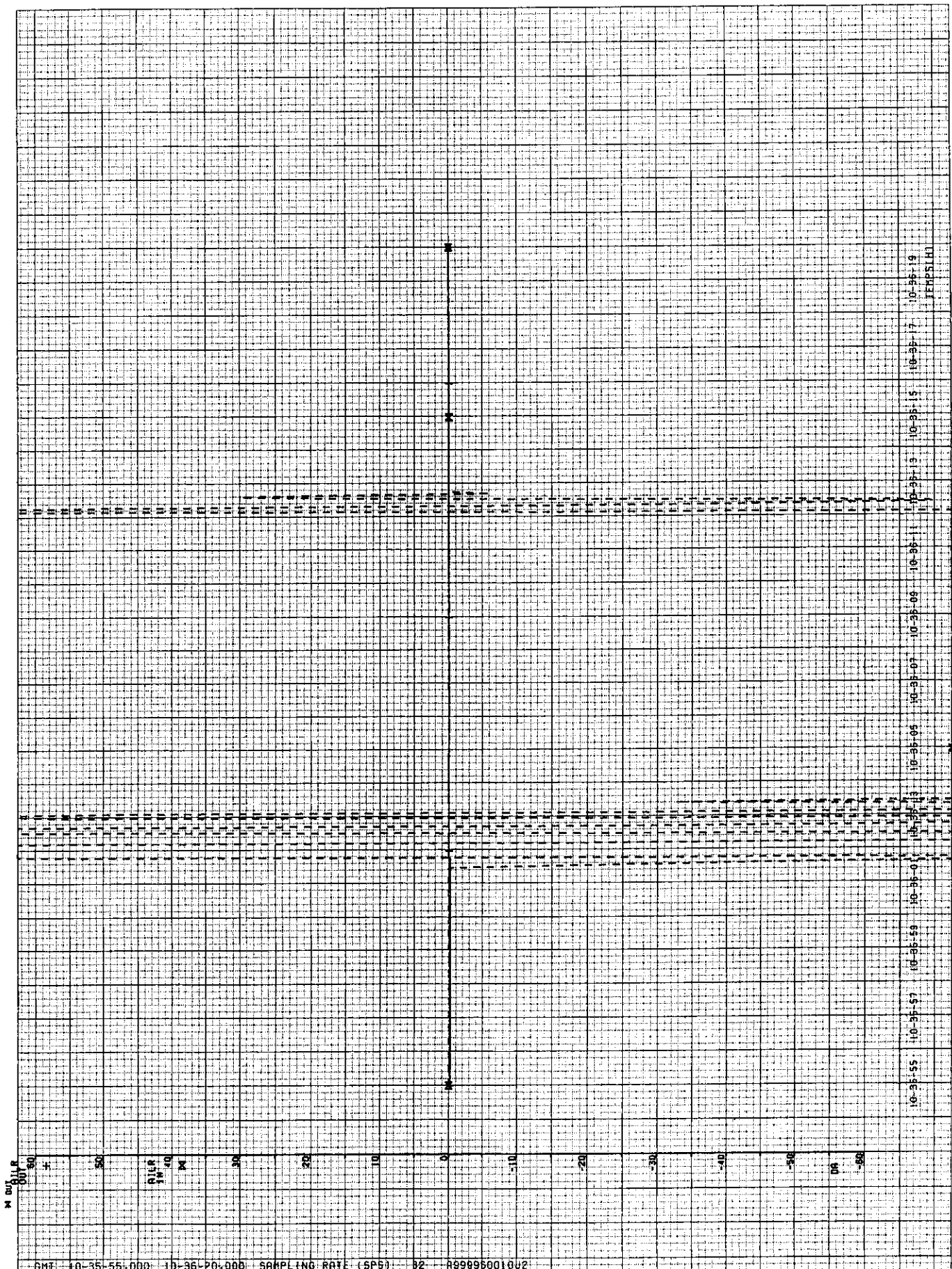
FLIGHT S0010 TEST 8.16 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



GMT 10-35-55.000 10-36-20.000 SAMPLING RATE (SPS) 32 A9999600100U2

FLIGHT S0010 TEST 8.16 FTI

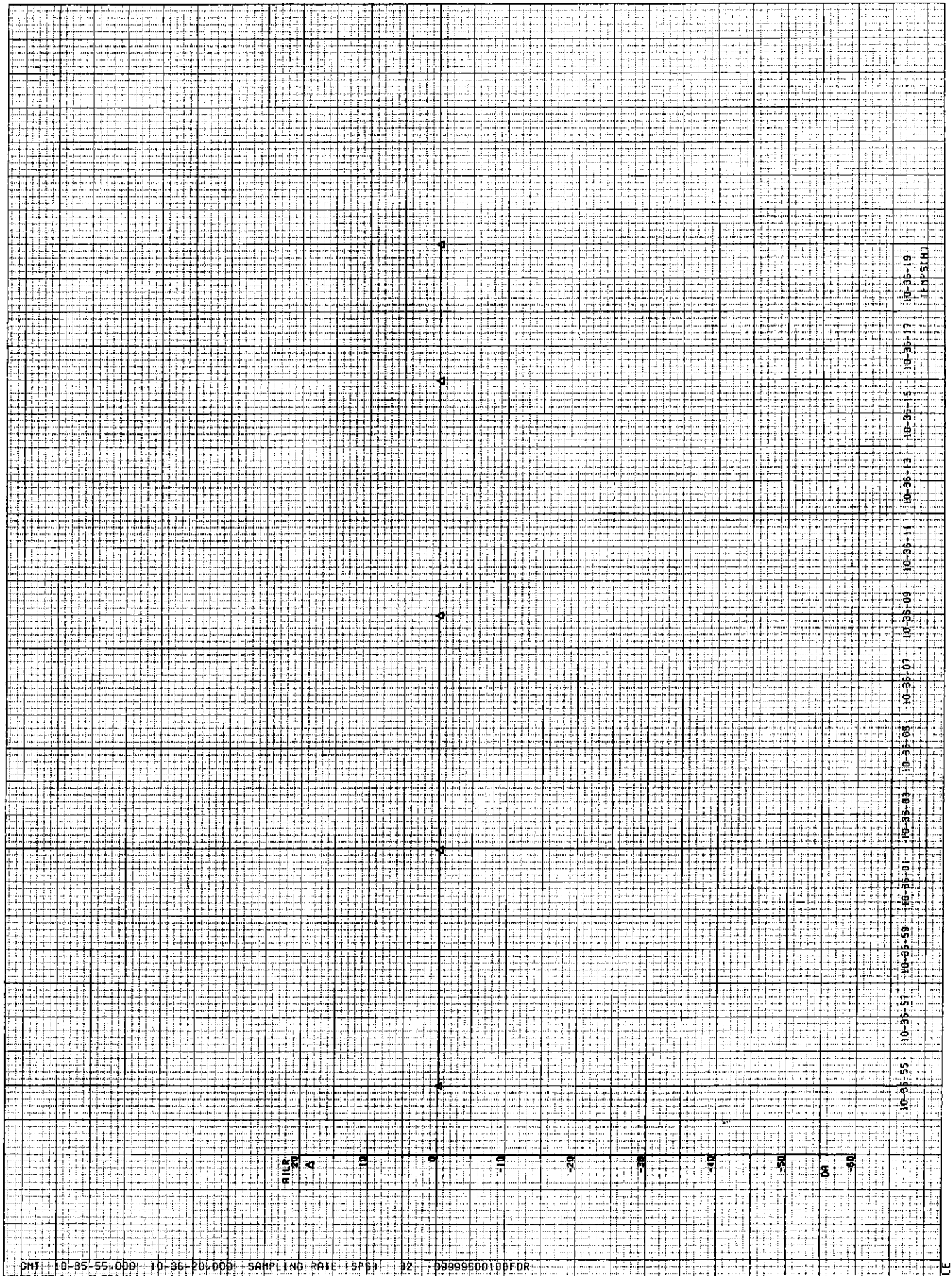
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.1.31

(C) AEROSPATIALE

AVIC



GMT 10-35-55.000 10-36-20.000 SAMPLING RATE (SPS) 32 099996D0100FDR

FLIGHT S0010 TEST 8.16 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

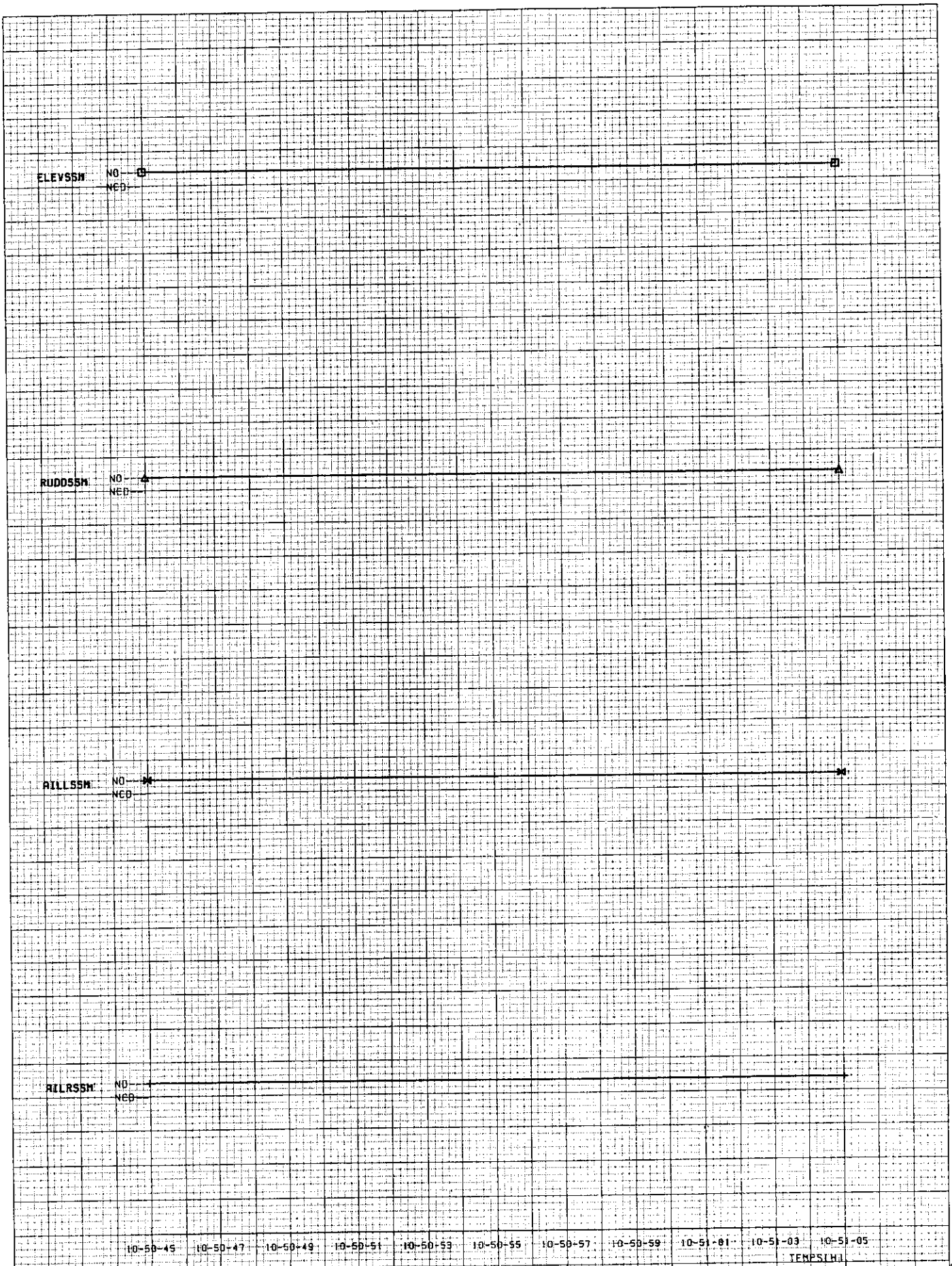
AIRCRAFT D9999 FIGURE 4.1.32

(C) AEROSPATIALE

310.8 SERIE/SDACAAL.AD

008372

ANNEX 4.2:
Test series n°9

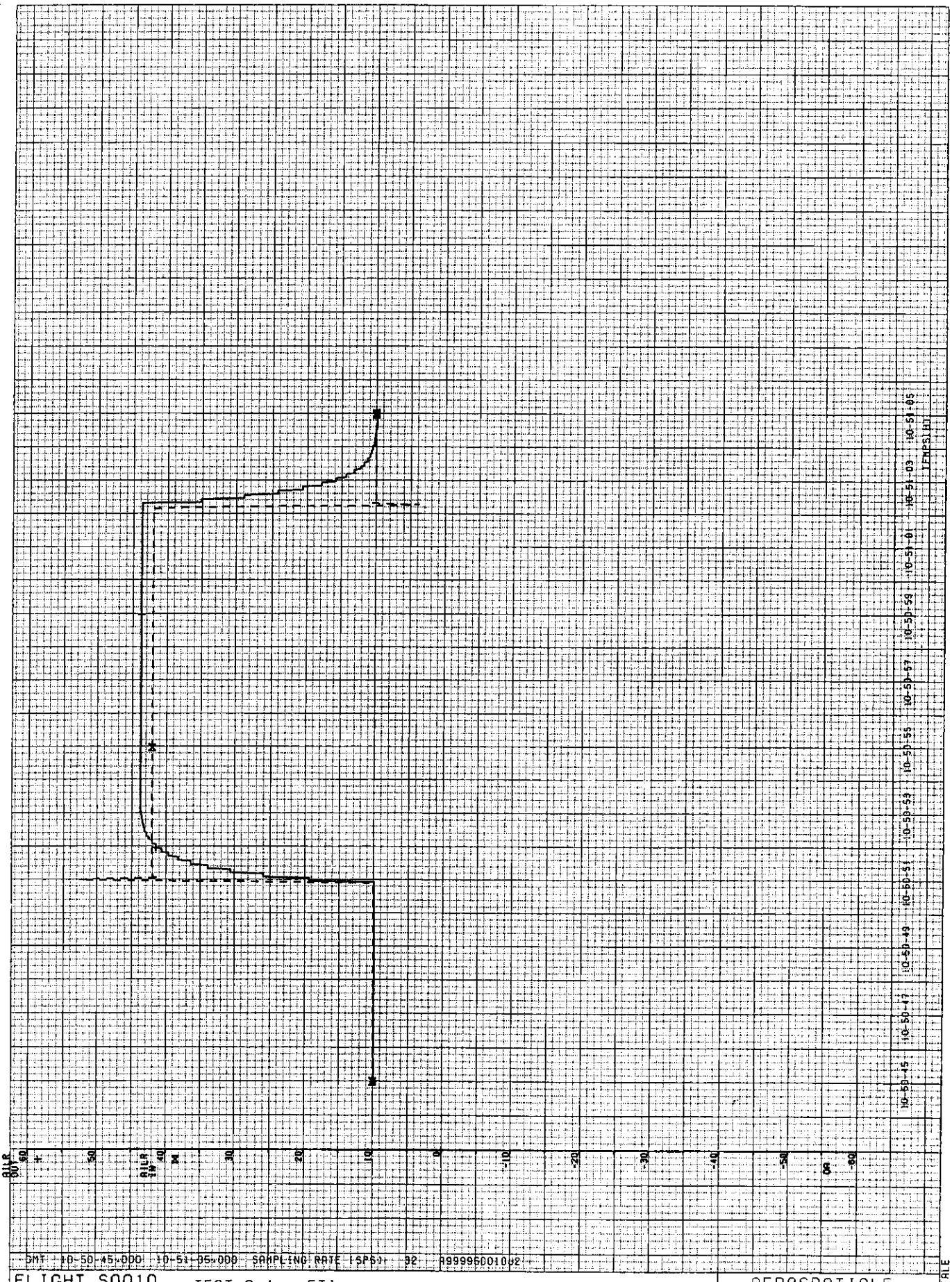


FLIGHT SOO10 TEST 9.1 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE



FLIGHT S0010 TEST 9.1 FTI

A-NTSB

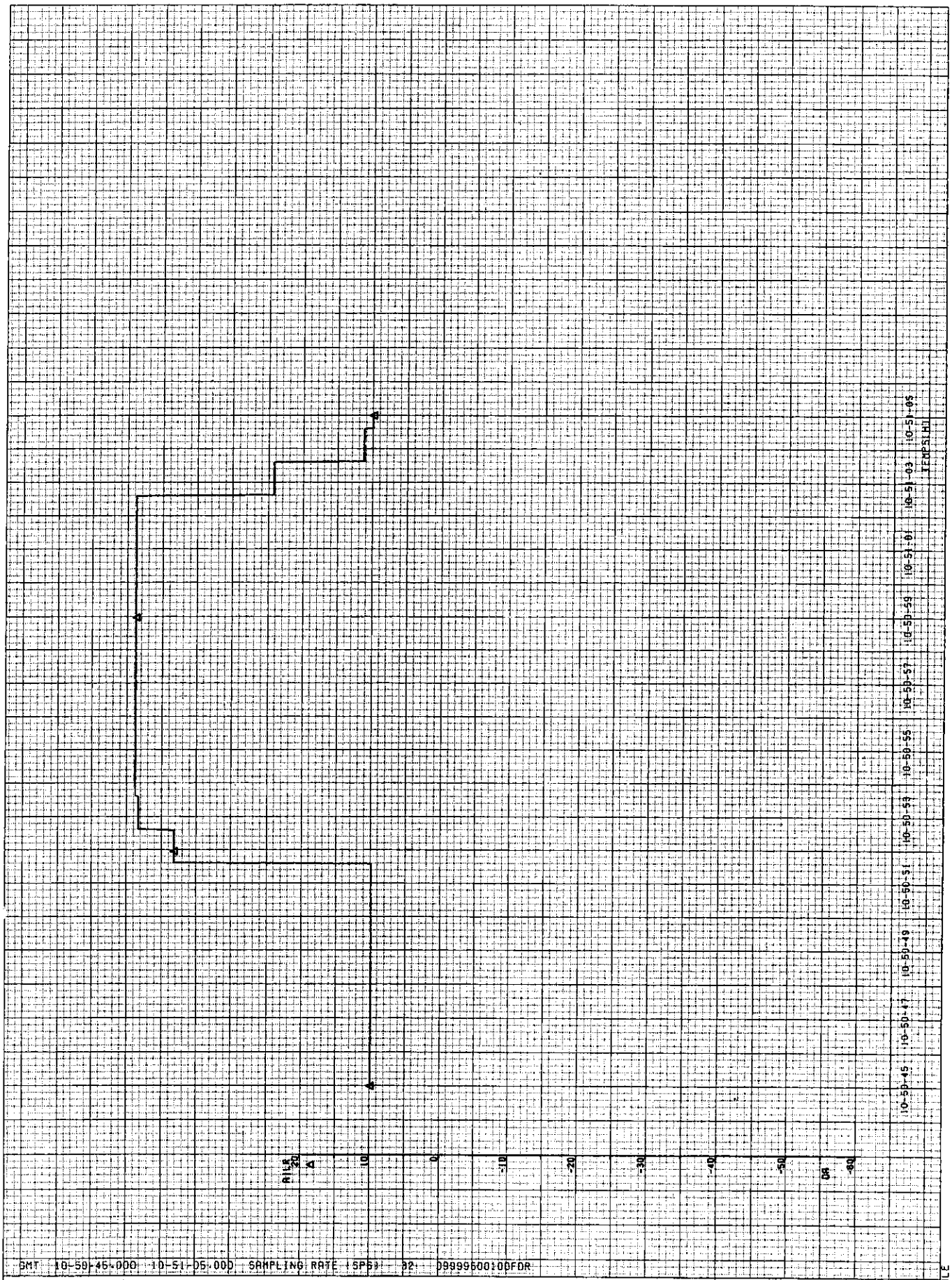
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.2.1

(c) AEROSPATIALE

008375

AVIC



GMT 10-59-45.000 10-51-05.000 SAMPLING RATE :SPS3 32: 09999600100FDR

FLIGHT S0010 TEST 9.1 OFDR

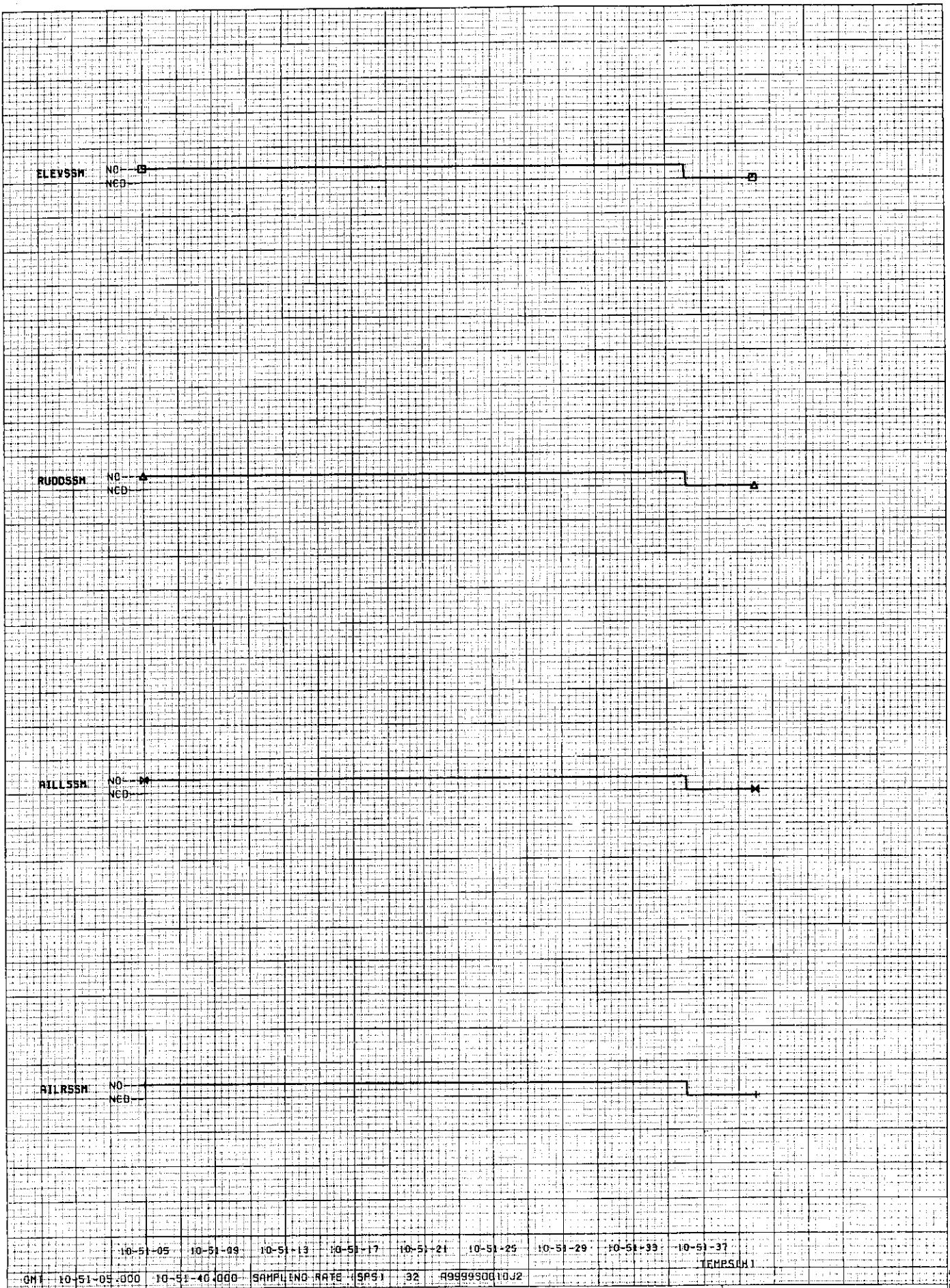
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.2.2

(C) AEROSPATIALE

310.9 SERIE/SDACAAL.AD

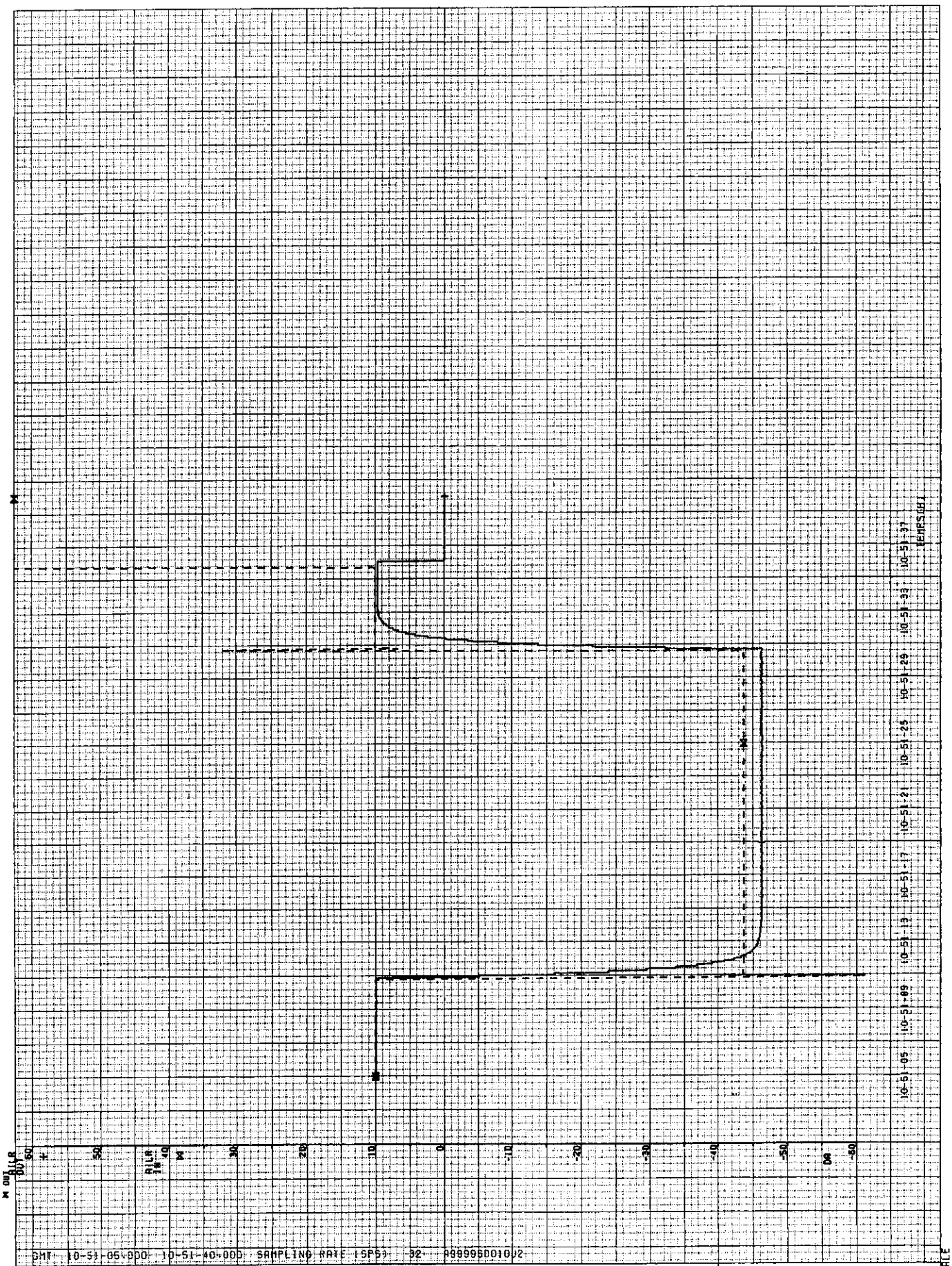


FLIGHT S0010 TEST 9.2 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE



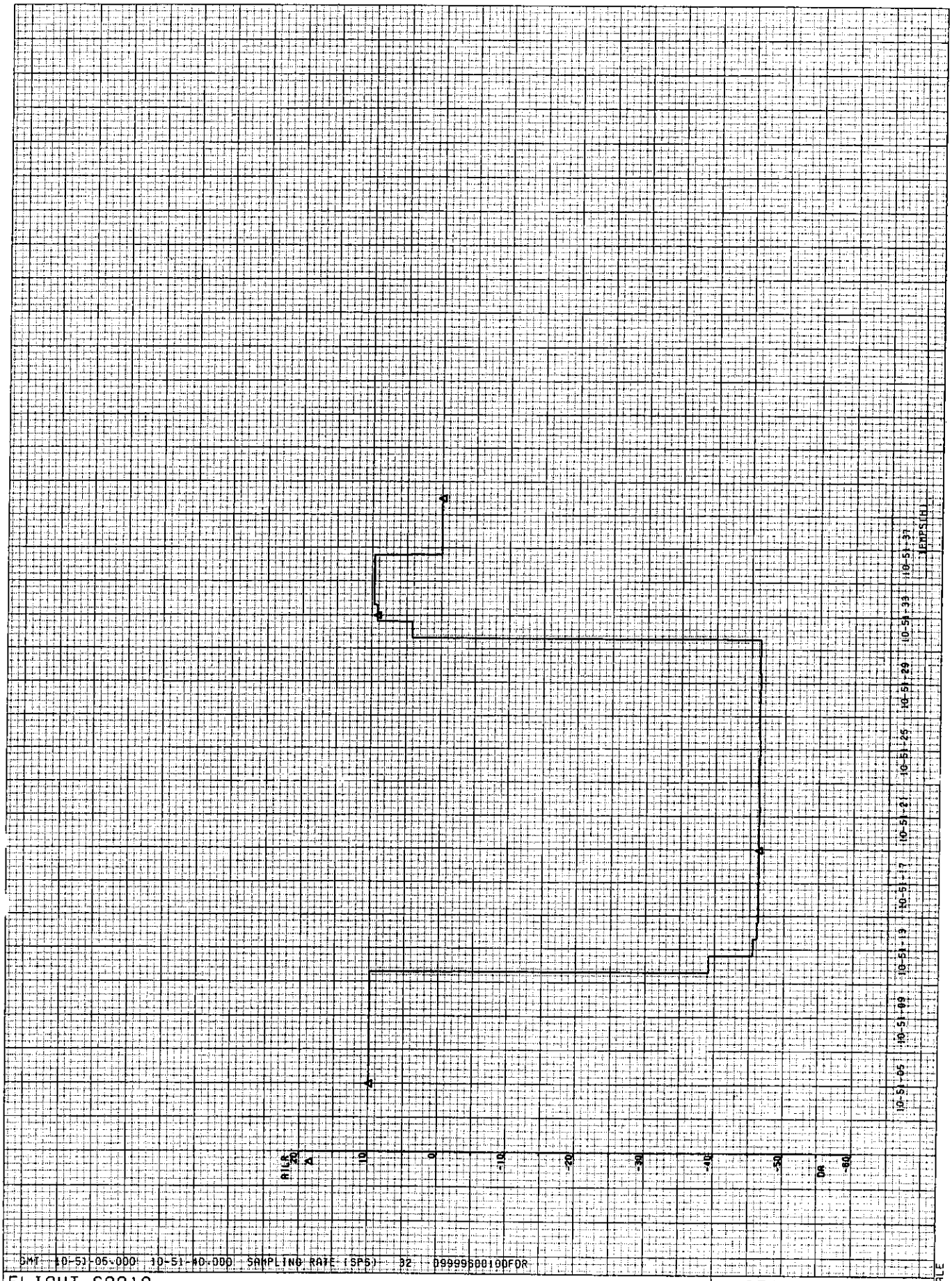
FLIGHT S0010 TEST 9.2 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.2.3

AVIC



FLIGHT S0010 TEST 9.2 DFDR

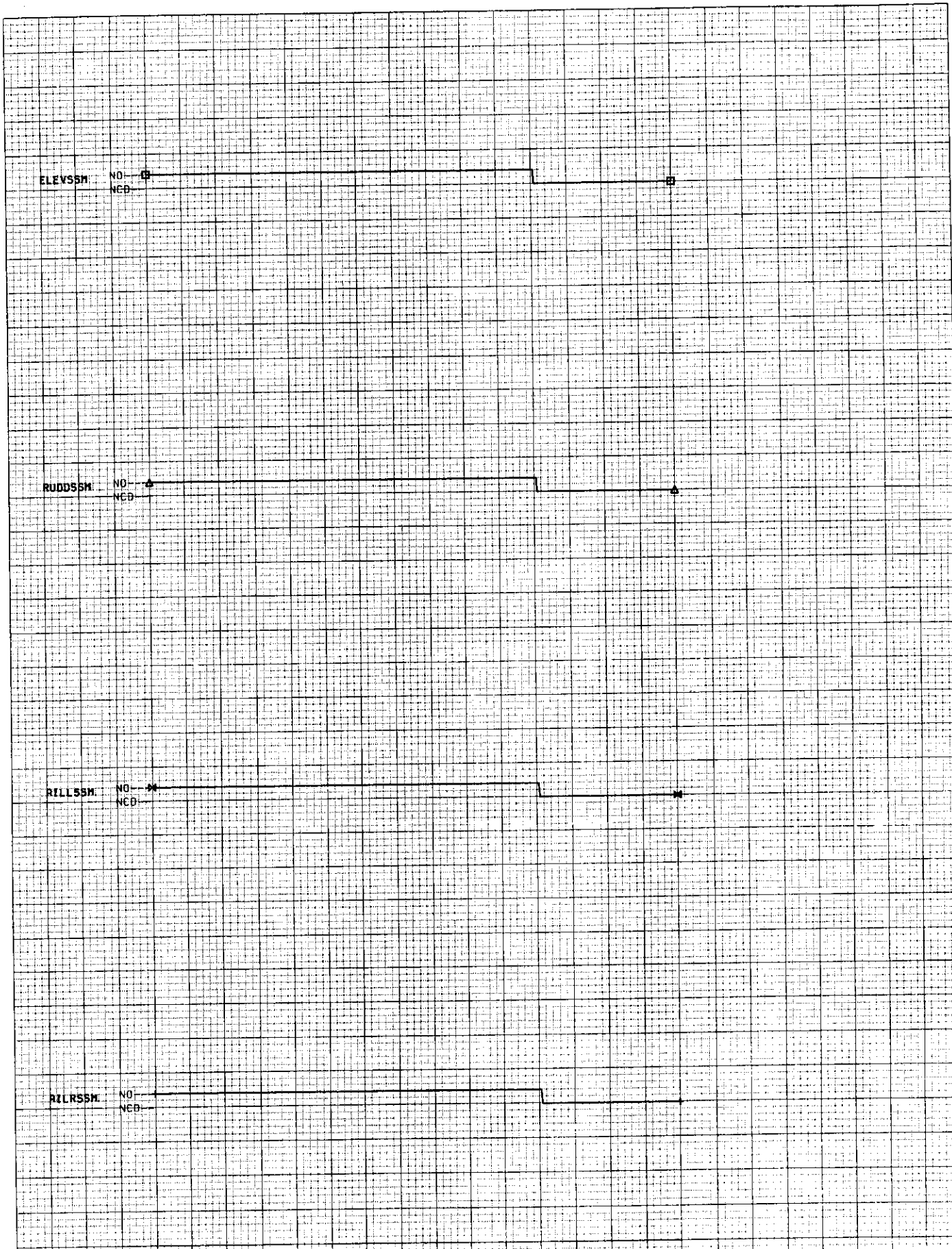
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.2.4

ET AEROSPATIALE

310.9 SERIE/SDACAAL.AD



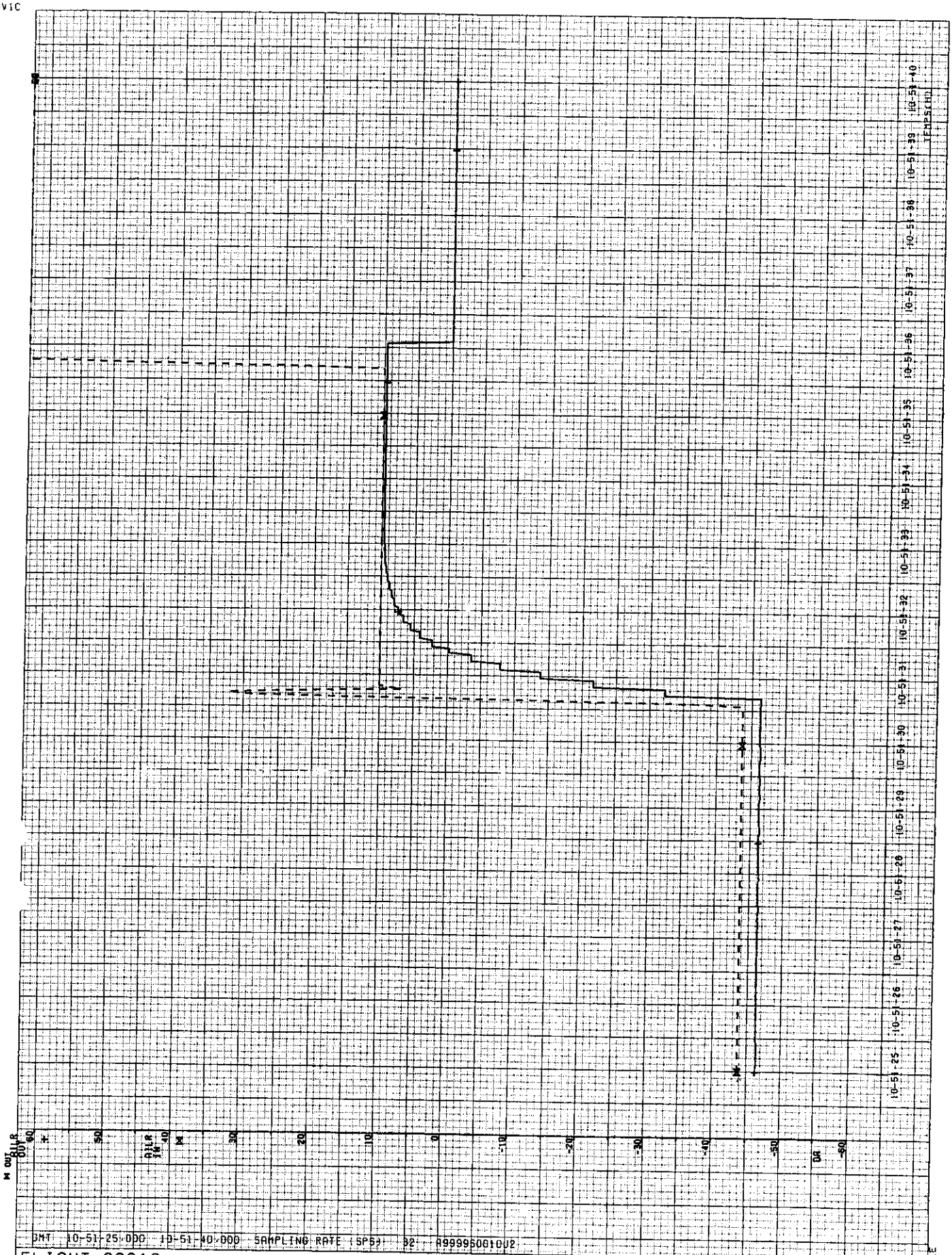
FLIGHT S0010 TEST 9.3 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 9.3 FTI

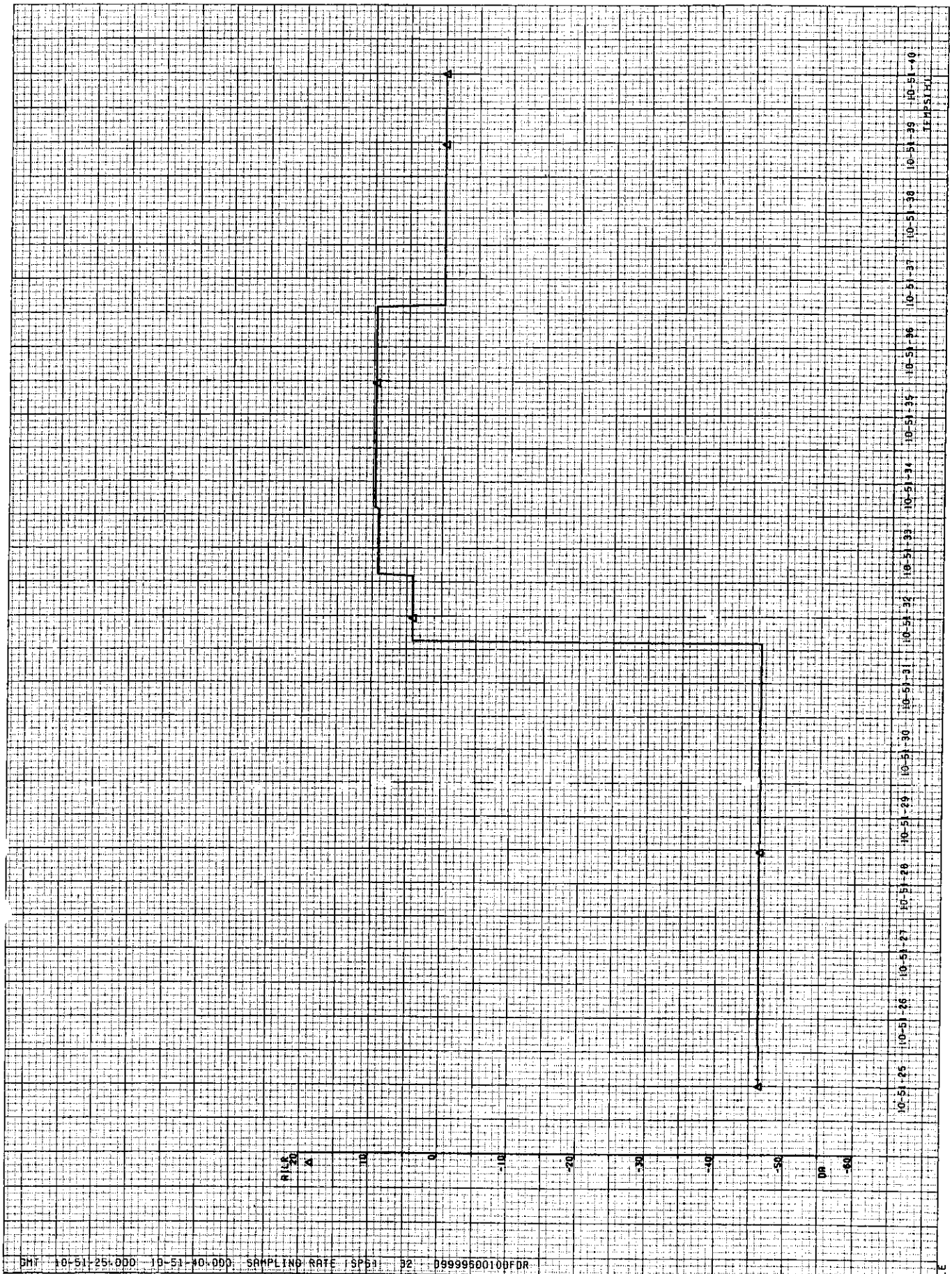
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 4.7.5

(C) AEROSPATIALE

SERIE/SDACAAL.AD



GMT 10-51-25.000D 10-51-40.000D SAMPLING RATE (SPS) 32 : D9999500100FDR

FLIGHT S0010 TEST 9.3 DFDR

A-NTSB

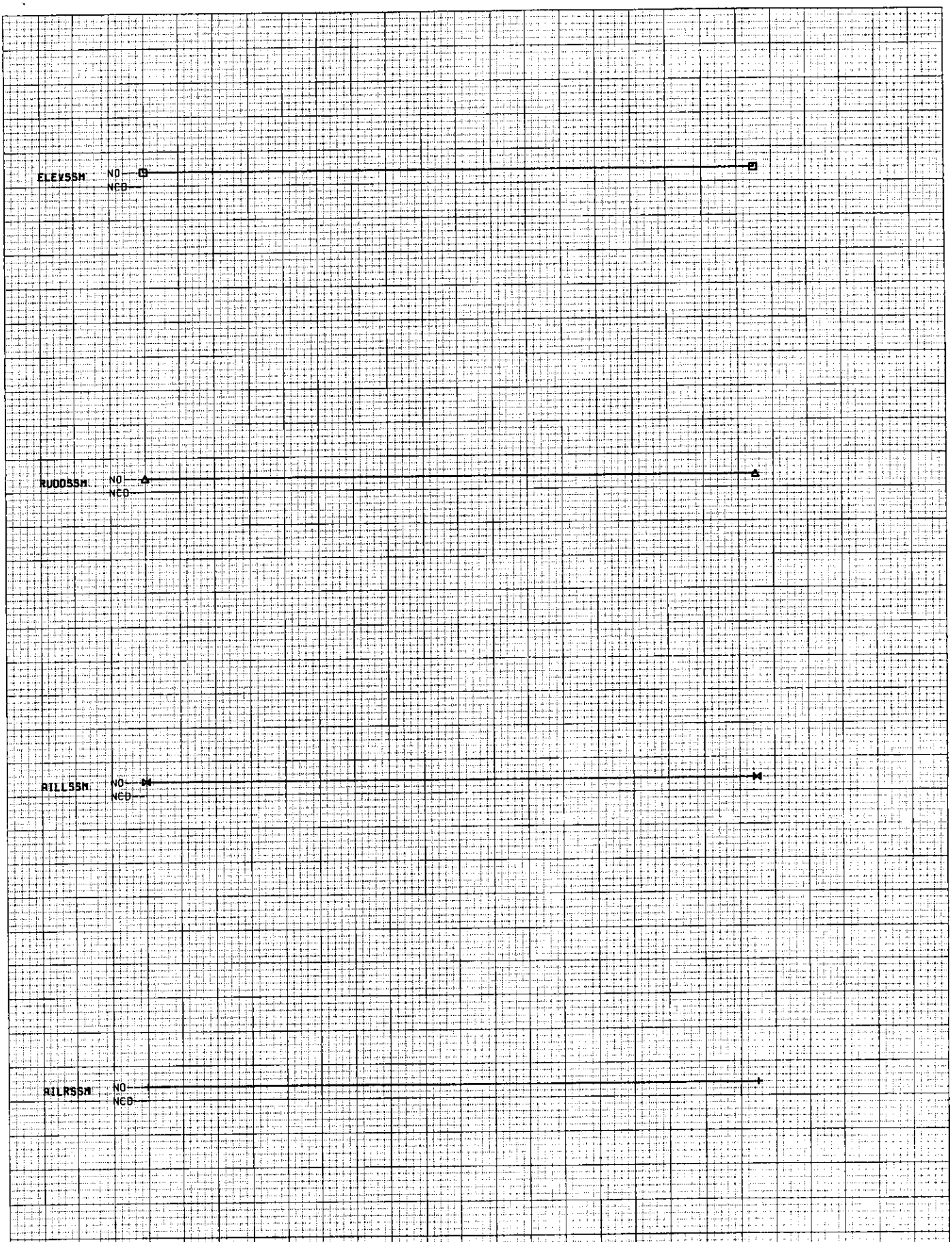
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.2.6

(C) AEROSPATIALE

ANNEX 4.3:
Test series n°10

AVIC

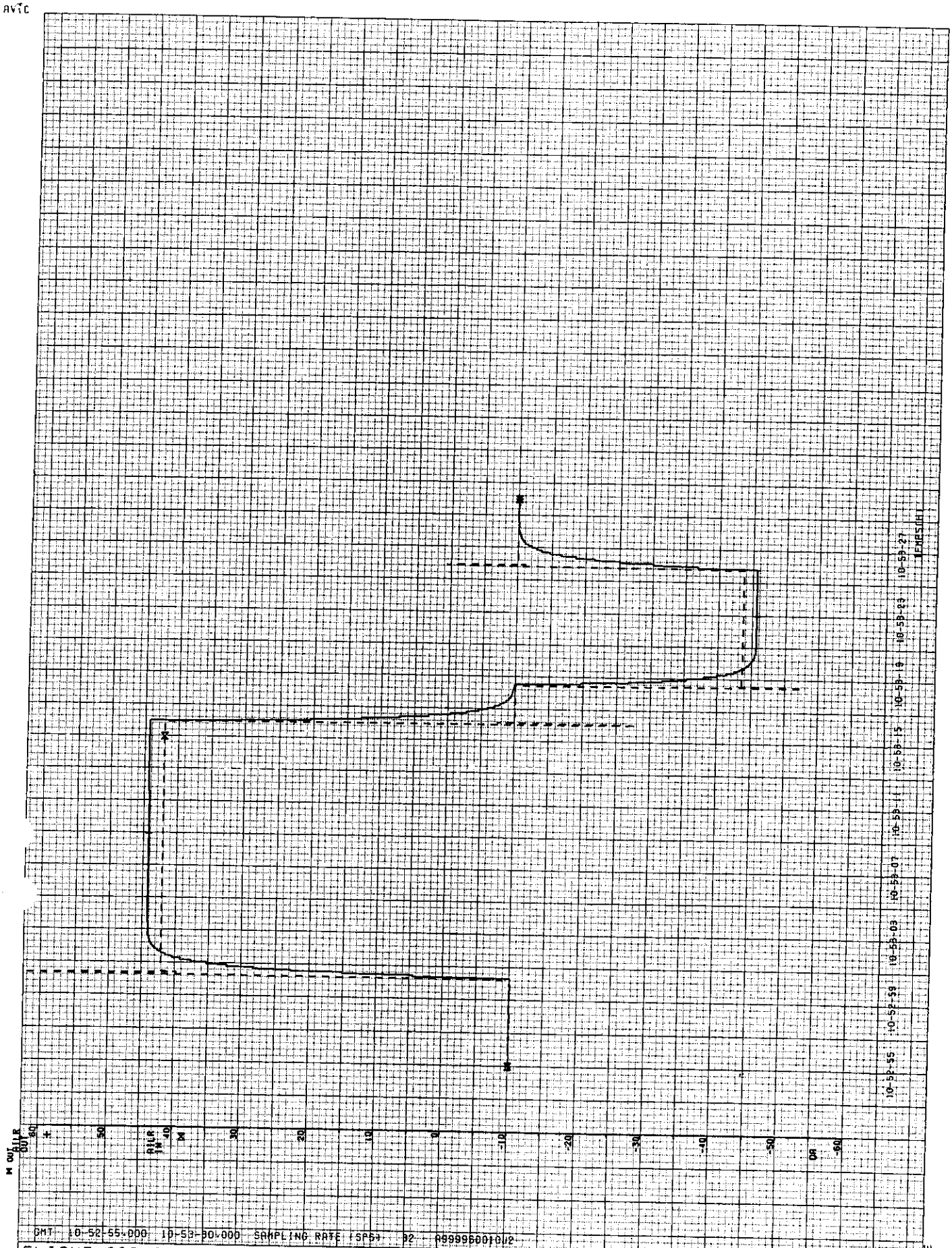


FLIGHT S0010 TEST 10.1 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE



FLIGHT S0010 TEST 10.1 FTI

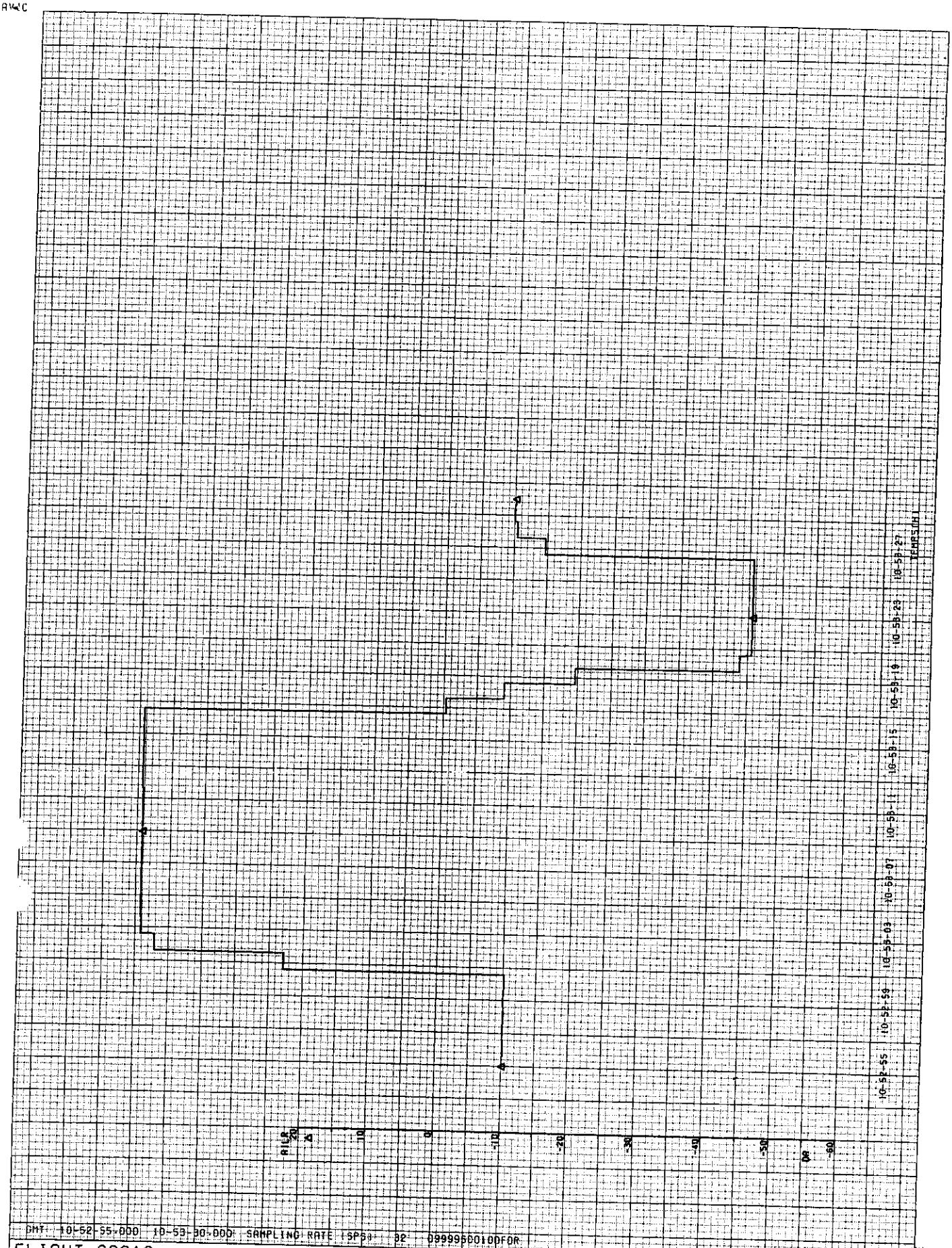
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 43

(C) AEROSPATIALE

AWC



GMT +10-52-55.000 10-53-30.000 SAMPLING RATE (SPS) 32 099995D010DFDR

FLIGHT S0010 TEST 10.1 DFDR

A-NTSB

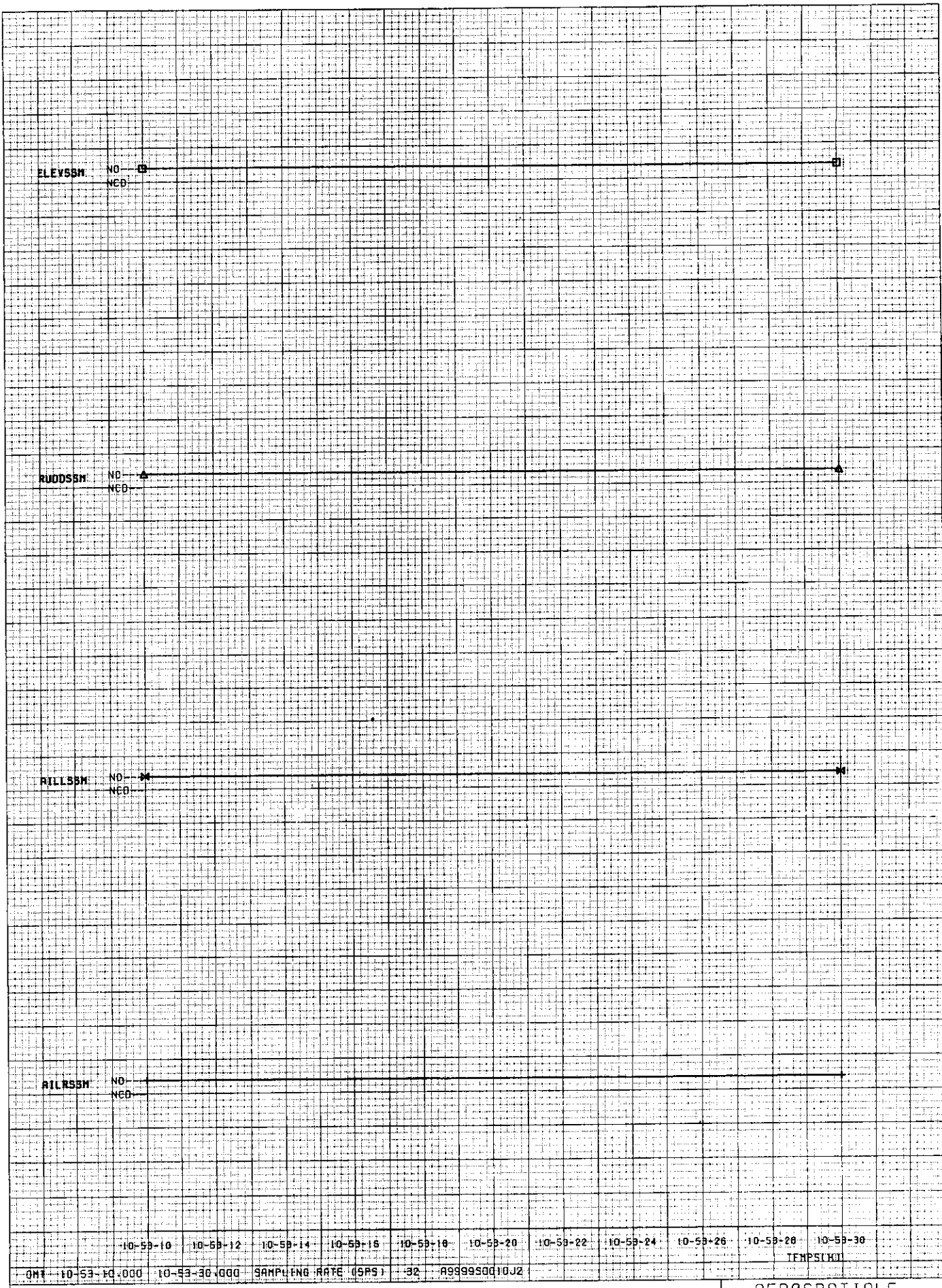
AEROSPATIALE
FLIGHT TESTS

AIRCRAFT 09999 FIGURE 43

(C) AEROSPATIALE

10.10 SERIE/SORCAAL.AD

AVIC



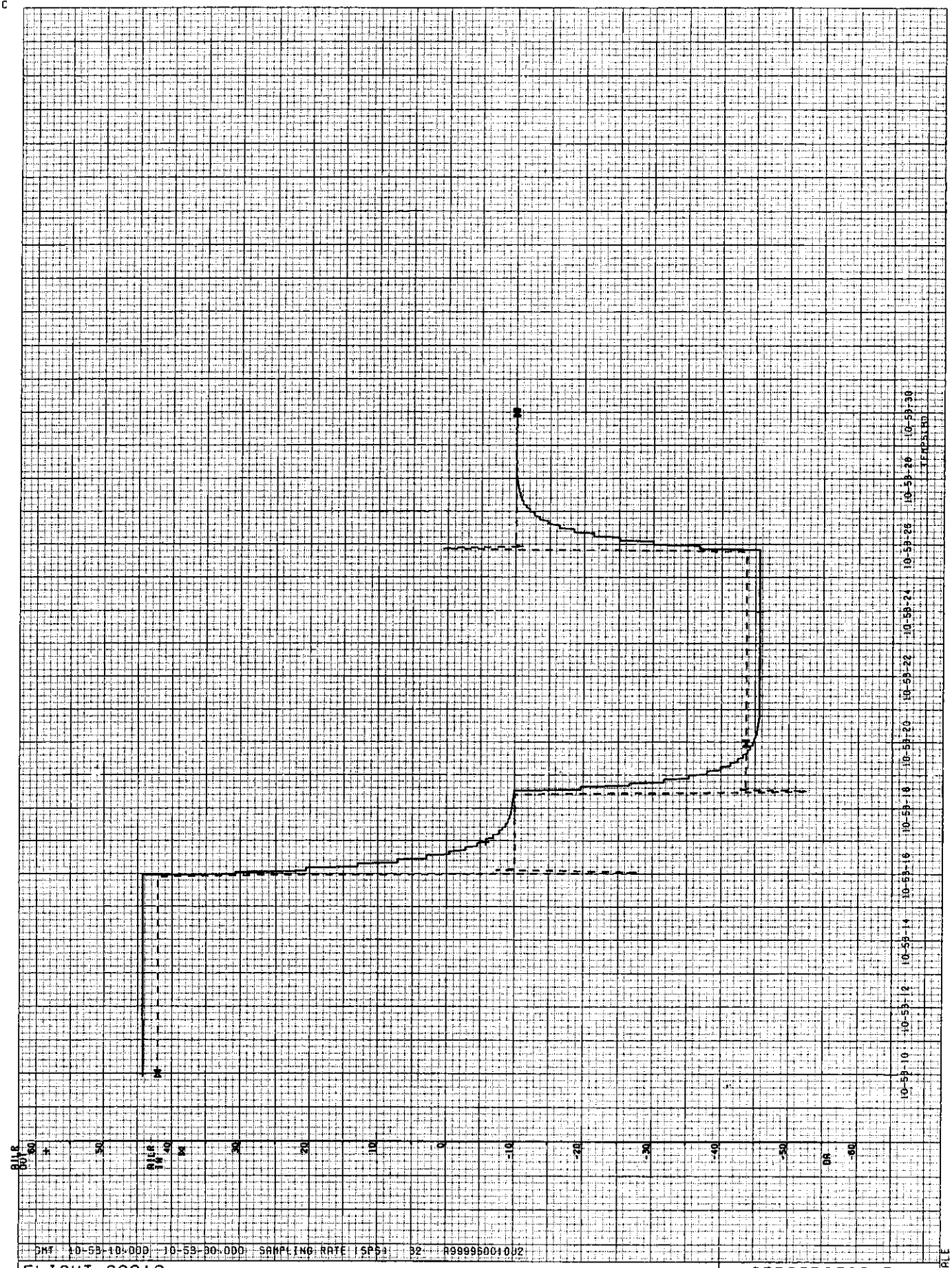
FLIGHT S0010 TEST 10.2 FTI

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE

AVIC



FLIGHT S0010 TEST 10.2 FTI

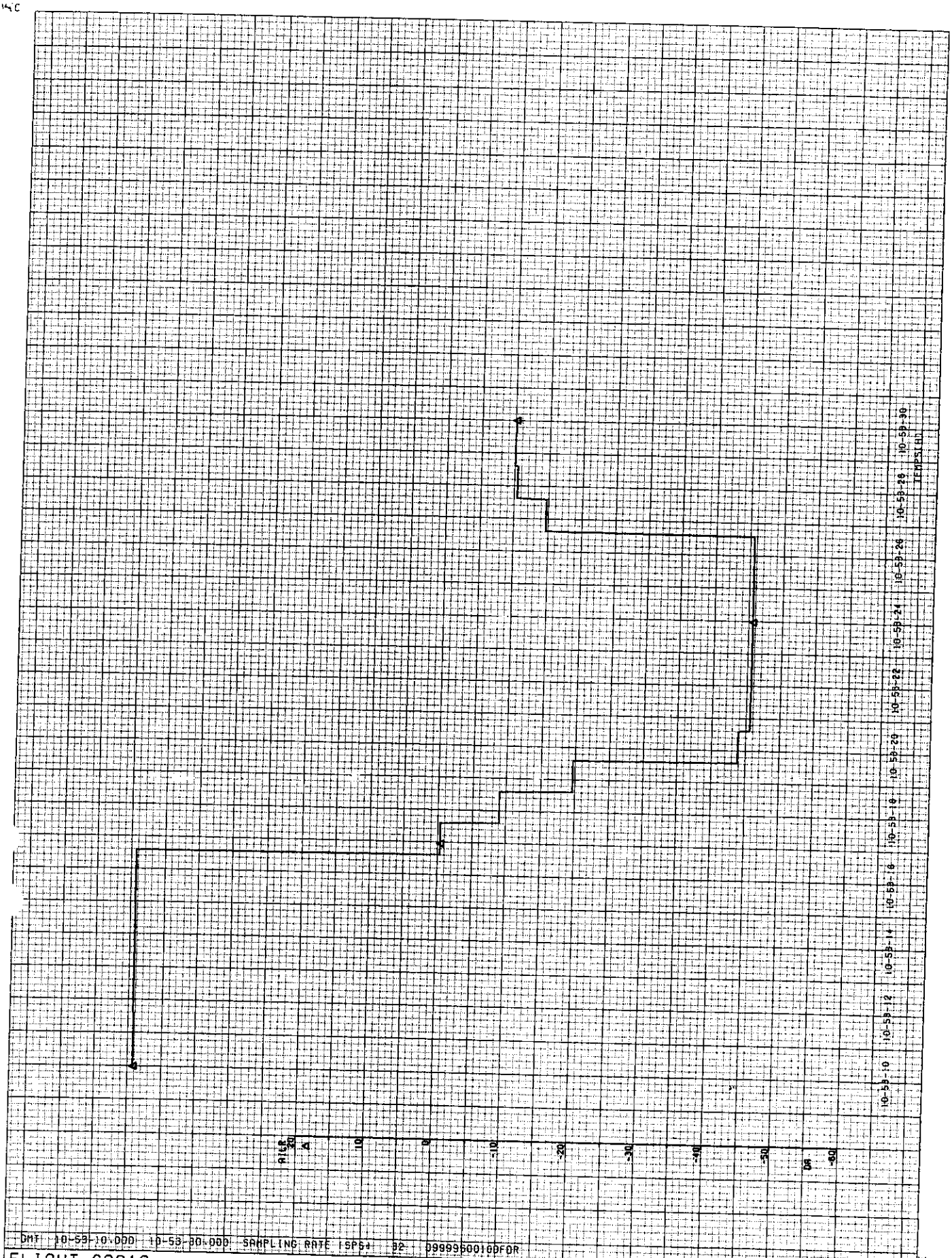
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 FIGURE 43

(C) AEROSPATIALE

008388



GMT 10-58-10.000 10-58-30.000 SAMPLING RATE (SPS)= 32 D9999S0010DFDR

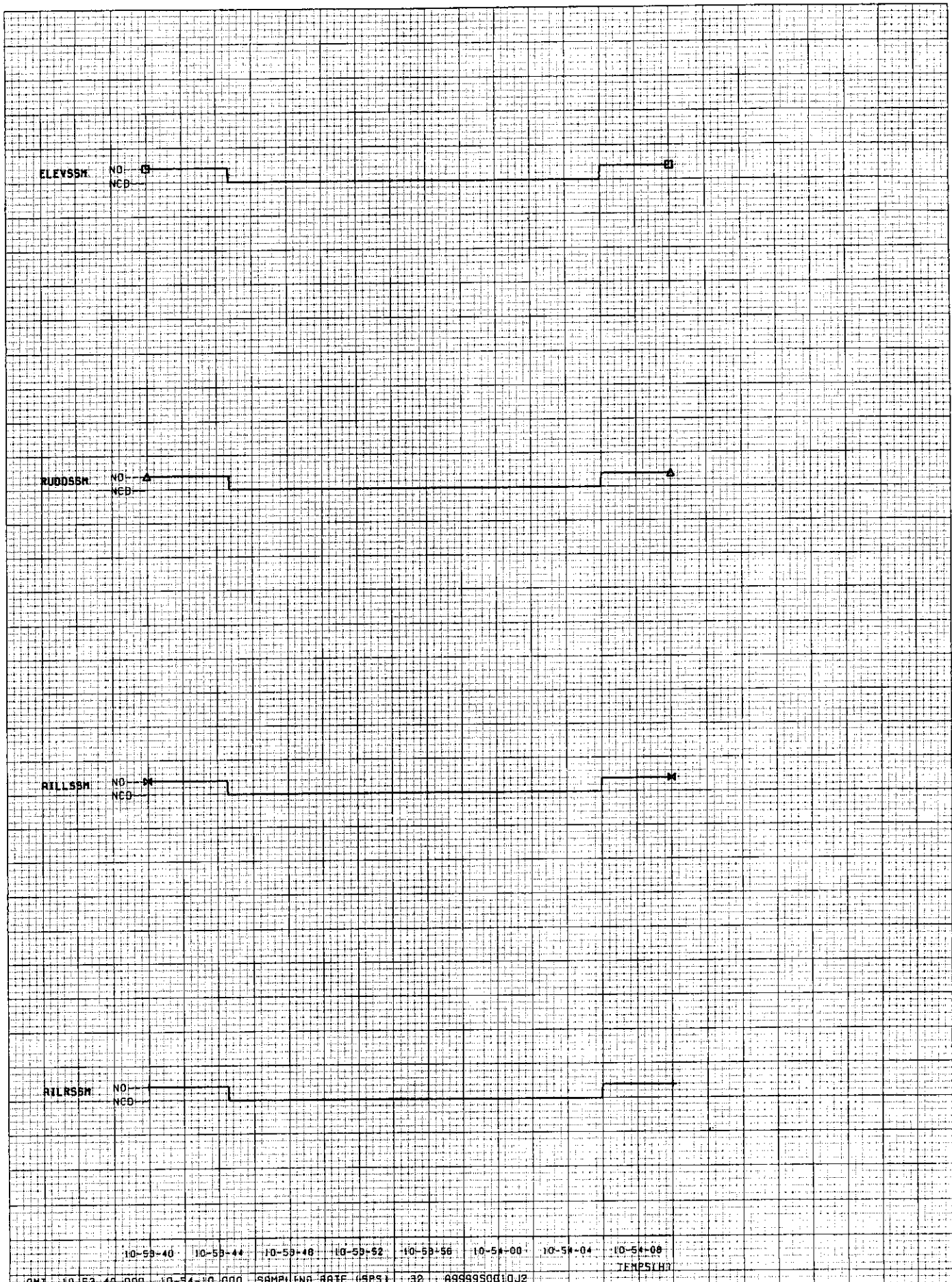
FLIGHT S0010 TEST 10.2 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 43.4

SERIE/SOACAAL.AD

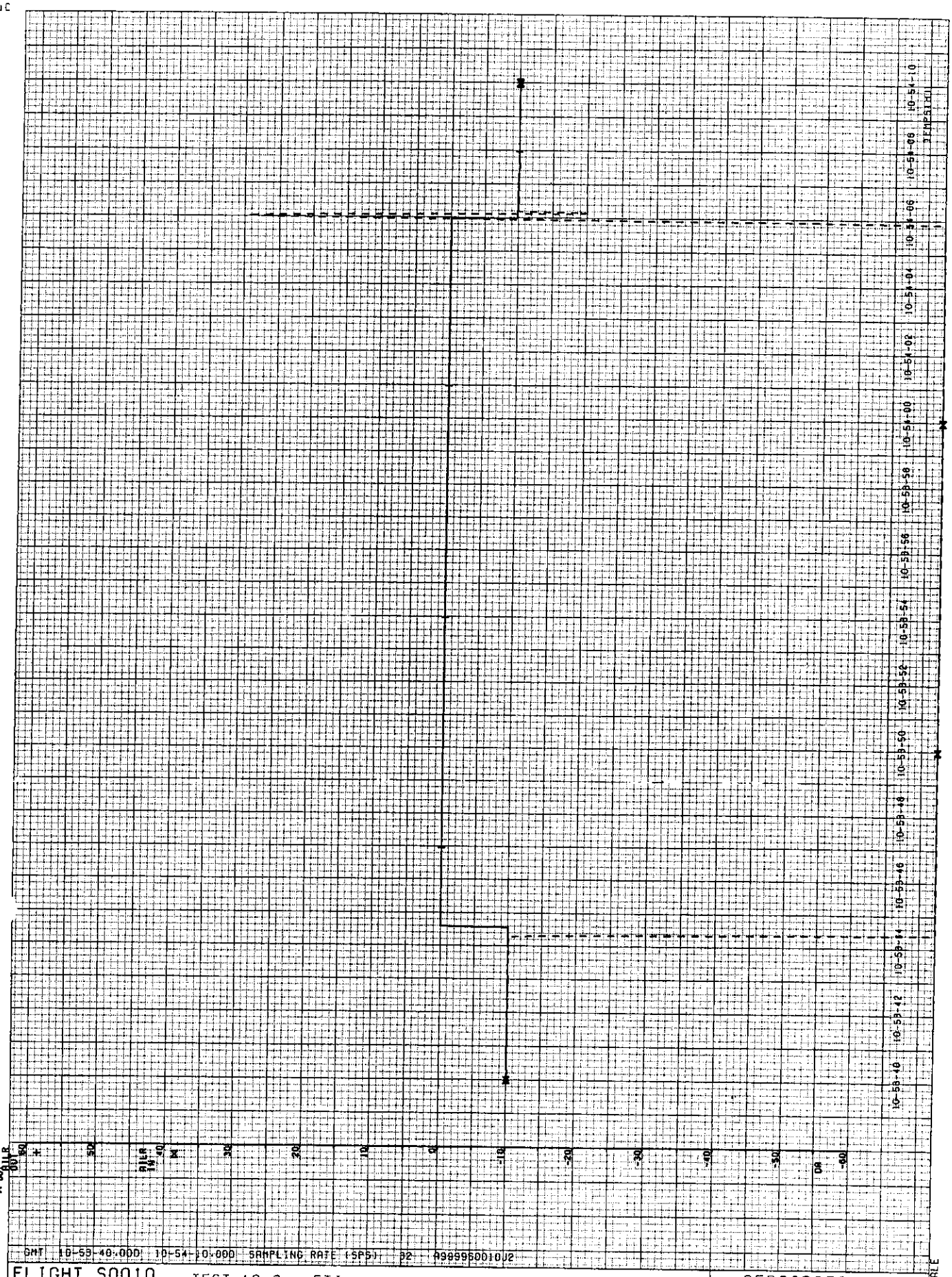


FLIGHT S0010 TEST 10.3 FTI

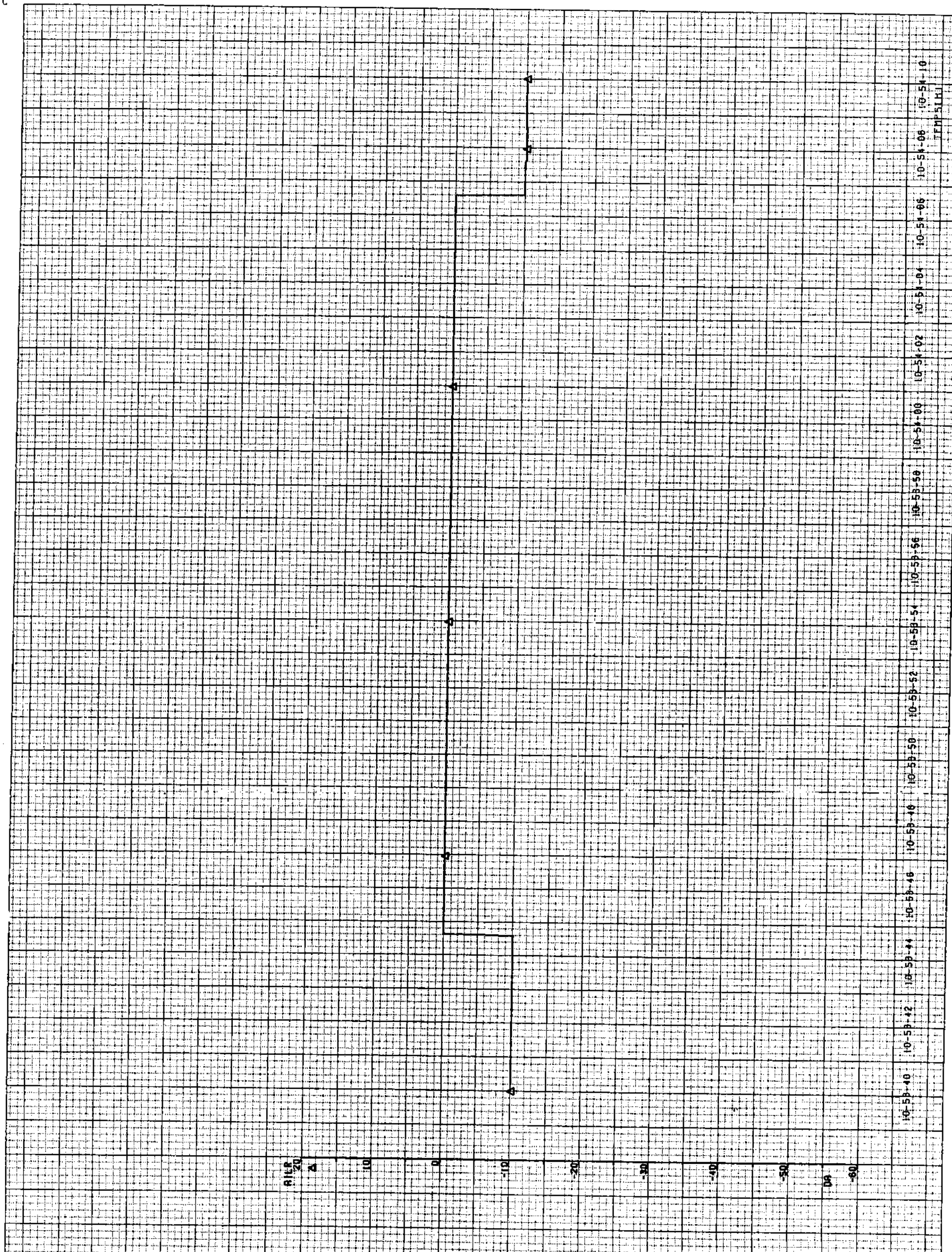
A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT A9999 | FIGURE


GMT 10-58-40.000 10-54-20.000 SAMPLING RATE (SPS) 32 A9999600I0U2
FLIGHT S0010 TEST 10.3 FTI
A-NTSB
AEROSPATIALE
FLIGHT TESTS
AIRCRAFT A9999
FIGURE 4.3.5
008391

A5IC



GMT 10-53-40.000 10-54-10.000 SAMPLING RATE (SPS) 32 D9999S00100FDR

FLIGHT S0010 TEST 10.3 DFDR

A-NTSB

AEROSPATIALE
FLIGHT TESTS

AIRCRAFT D9999 FIGURE 4.3.6

Attachment VI
Airbus's Result from SDAC Bench Test
Airbus Document TN 506.0008/2002

SDAC FUNCTIONS - SYNCHRO SIGNAL FILTERING

1 - Scope of the document

1.1 - Introduction

For the AAL 587 accident investigation, the restitution of the real dynamics of certain parameter signals from the FDR recordings, and in particular the actual flight control surface position versus time, has necessitated some work. This is due to the fact that the corresponding signals are filtered through the SDAC for convenience of the A/C system users, and sampled by the DFDAU/FDR.

1.2 - Purpose of the document

This document provides information and explanations requested by the BEA and NTSB on the processing of the flight control surface position synchro signals by the SDAC, and demonstration of the acceptability of the use of filtered signals for recording by the FDR.

Other reference documents :

- 517.0013/2002 : AAL 587 - Protocol for SDAC identification then reconstitution of the flight control surface position history
- 761.0006/02 : description of the test installation to characterize the SDAC effects in the recording of the control surface positions
- 763.0114/02 : minutes of the meeting on week 6 / 2002 between the NTSB, BEA, FAA, APA, AAL, AIRBUS on SDAC synchro signal filtering, and SDAC, DFDAU, FDR test installation
- LD_0007/02 : FDR bench test / SDAC identification
- 506.0009/2001 : AAL 587 - Time delays for recorded parameters
- 517.0082/2002 : AAL 587 Handling Qualities investigations

2 - Purpose of the SDAC and its integration in the A/C system architecture

The SDAC (System Data Analog Converter) acquires A/C system parameter signals in analog or discrete form then converts them into digital format to ARINC 429. The ARINC 429 words are sent via 2 high speed rate buses (100 Kbauds) to the ECAM SGUs, FWCs and AIDS (see slide 1 of attachment 1 which provides a block-diagram of the A/C system architecture).

It serves the following purposes :

- display of the A/C system parameter indications on the ECAM System Display Unit
- elaboration of the ECAM cautions in case of A/C system failures
- data concentration for parameter recording (to alleviate the work of the DFDAU, which has not the capability of acquiring directly all A/C system sensor signals the recording of which is required).

3 - Design of the SDAC

The SDAC includes 11 boards :
- power supply,
- CPU and A/D converter
- family multiplexer,
- synchro
- and 7 discrete and analog (reluctances, HLAC, HLDC, etc.) boards.

There are 4 major interface families :
- analog input interface (Vac, Vdc, reluctance, resistance)
- frequency input interface
- discrete input interface
- synchro input interface.

The CPU is built around a MOTOROLA 6800 eight bit microprocessor : it is called the central processor in the text. The duration of one cycle is 62.5 ms. It performs the following functions :

- routes the input signals to adequate interface,
- sequences all the SDAC functions
- manages all data
- executes arithmetic and logic operations on digital values obtained after the input interfaces (like computation of scale factors)
- performs parallel formatting of ARINC 429 words, which will then be transmitted by a dedicated LSI circuit

Each parameter entering the SDAC is successively and fully taken into account, i.e. acquisition, conversion into digital form, digital processing and ARINC transmission. A buffer store located between the CPU Arithmetic and Logic Unit and the ARINC transmitter ensures fixed-rate transmission in a constant order for the various O/P parameters.

As of today, the P/N of the SDAC is 66501, and its software version is STD 06/07 (no change since year 1985).

4 - Processing of the synchro signals

4.1 - Constitution of the synchro signal interface board

Refer to slide 2 of attachment 1.

The synchro input signals are multiplexed to an autonomous synchro/digital converter circuit.

The synchro input interface is managed by a CPU which is built around a MOTOROLA 6800 eight bit microprocessor and which is called the slave processor. It is controlled by the central processor.

The SDAC synchro signal input interface has a total processing capability of 26 synchro signals. In fact, only 15 signals are acquired then processed :

- hydraulic circuit fluid quantity (3)
- flight control surface positions (5)
- pack bypass turbine valve position (2)
- pack flow (2)
- cargo valve positions : regul aft, fresh forward, fresh bulk (3).

For their processing, the signals are shared in 2 groups :

Group 1 includes synchro signals N° 1, 2, 3, 4, 5, 6, 7, 8, 9, 21.

Group 2 includes synchro signals N° 10, 11, 12, 13, 14 (rudder position), 15 (elevator position), 16 (pitch trim stab position), 17 (left aileron), 18 (right aileron), 22. Therefore all flight control surface position synchro signals belong to the second group.

Each group is processed only once every 2 cycles of the central processor : at each cycle, the central processor, which acts as the master processor, tells the slave processor to acquire and process the signals of one group. Then, under request (IT), it tells the slave processor to send it the results of the synchro / digital conversion for the synchro signals of the other group, i.e. of the previous cycle.

For their processing by the slave processor, the synchro signals are multiplexed at the SDAC input. The x, y, z voltages are sampled against a 26 Vac reference peak value to obtain U1 = Vx - Vz and U2 = Vy - Vz voltages. The U1 and U2 signals are then converted from analog to digital via an analog to digital converter : this gives numbers N1 and N2. And the slave processor will elaborate the θ angle value from N1 and N2 by solving the equations :

$K1 \cos \theta = N1 + N2$
$K2 \sin \theta = N1 - N2.$

The central processor will receive the digital value of θ from the slave processor. The exchanges between them are made through a double Peripheral Interface Adapter (PIA), one being coupled to the slave , and one to the master.

The filter software task executes every 125 ms, i.e. every 2 cycles of the central SDAC processor. The software task for transmission of the SDAC ARINC O/P signals also executes every 125 ms, in the same cycle as the filter task, after it.

4.2 - Monitoring

The monitoring of the synchro interface is ensured by using the 25th synchro input and injecting a calibrated test signal into it. The central processor compares the value θ which is obtained with a reference O/P value. This tests the whole processing chain as well as the master / slave dialogue.

5 - Final processing of the synchro signal before O/P signal transmission - Filtering

5.1 - General

The central processor receives the digital value of θ from the synchro interface board. Then it computes arithmetic and logic operations on θ (scale factor, linear (or not) law, filtering) and finally it formats the ARINC 429 words (label, SDI, data bits, SSM, parity).

The parameter signals are filtered to eliminate noise and provide seamless signals for the users.

The filter is the same for all the SDAC synchro signals. It is a first order filter. Its Laplace transformation function is : $1 / 1 + \tau p$, with τ = time constant of the filter and $p = j \omega$ ($\omega = 2 \pi N$, N being the frequency of a sinusoidal I/P signal).

5.2 - Algorithm of the filter

If the synchro signal input is represented by the variable **e** and the filtered value by the variable **s**, and if n is the number of the cycle being currently executed by the central processor of the SDAC, the algorithm of the SDAC is the following :

$$S_{2n} = 0.25 \times e_{2n-1} + 0.75 \times S_{2n-2}$$

The source code is written in assembly language. See the code of the filter task in Attachment 2.

Explanations :

The successive values of 0.25 x e are put in the RESCAL table, and the successive values of S in the TRESUL table.

The application with a step input signal of 10° gives the following results:

Before t = 0, $e_0 = 0$
Just at t = 0, a step synchro signal input of 10° is sent to the SDAC input :

n = 0, t = 0 $e_0 = 10$ $RESCAL_0 = 0$ $S_0 = TRESUL_0 = 0$	The main processor tells the slave to acquire then process the synchro signals of the 1st group
n = 1, t = 0.0625 sec. $e_1 = 10$ S_1 not computed	The main processor tells the slave to acquire then process the synchro signals of the 2nd group, and to pass the results for the synchro signals of the 1st group
n = 2, t = 0.125 sec. $e_2 = 10$ $RESCAL_2 = 0.25 \times e_1 = 2.5$ $S_2 = TRESUL_2 = RESCAL_2 + 0.75 \times TRESUL_0 = 2.5$	The main processor tells the slave to acquire then process the synchro signals of the 1st group, and to pass the results for the synchro signals of the 2nd group
n = 3, t = 0.1875 sec. $e_3 = 10$ S_3 not computed	The main processor tells the slave to acquire then process the synchro signals of the 2nd group, and to pass the results for the synchro signals of the 1st group
n = 4, t = 0.250 sec. $e_4 = 10$	The main processor tells the slave

$RESCAL_4 = 0.25 \times e_3 = 2.5$ $S_4 = TRESUL_4 = RESCAL_4 + 0.75 \times TRESUL_2 = 2.5 + 0.75 \times 2.5 = 4.375$	to acquire then process the synchro signals of the 1st group, and to pass the results for the synchro signals of the 2nd group
$n = 5$, $t = 0.3125$ sec. $e_5 = 10$ S_5 not computed	The main processor tells the slave to acquire then process the synchro signals of the 2nd group, and to pass the results for the synchro signals of the 1st group
$n = 6$, $t = 0.375$ sec. $e_6 = 10$ $RESCAL_6 = 0.25 \times e_5 = 2.5$ $S_6 = TRESUL_6 = RESCAL_5 + 0.75 \times TRESUL_4 = 2.5 + 0.75 \times 4.375 = 5.781$	The main processor tells the slave to acquire then process the synchro signals of the 1st group, and to pass the results for the synchro signals of the 2nd group

.....

And so on.

5.3 - Value of the time constant τ (TAU) of the filter

The equation of the filter is : $s(t) = (1 - \exp [- t / \tau]) \times e(t)$
So its time constant τ can be given by the mathematical equation giving its response to a unit step :

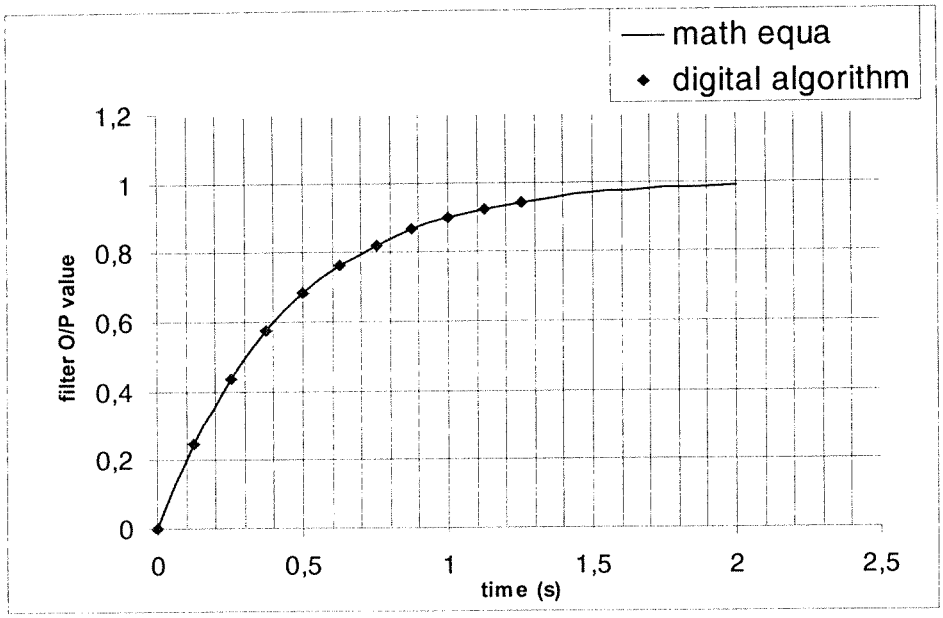
$0.25 = 1 - \exp [- t / \tau]$ with time $t = 0.125$ sec.
$\exp [- 0.125 / \tau] = 0.75$
$- 0.125 / \tau = \text{Log } 0.75 = - 0.287682$

$\tau = 0.125 / 0.287682 = 0.4345$ sec.

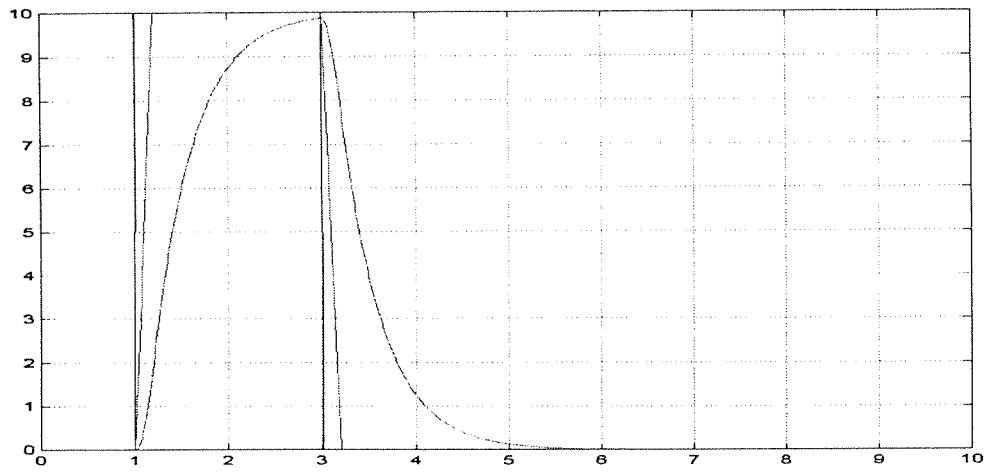
As shown in the above paragraph, the digital algorithm yields the same result.

5.4 - Curves

The two curves below give the response of a first order filter with a 0.434 sec. time constant to a step input and a trapezium-shaped input. Attachment 3 provides extensive test results showing the response of an actual SDAC to a set of various input signals (tests conducted in AIRBUS laboratory in TOULOUSE during week 6/2002 with the NTSB, BEA, FAA, APA, AAL).



1st order filter with a time constant τ = 434 ms - Response to a 1° step input signal injected at time t = 0



1st order filter with a time constant τ = 434 ms - Response to a trapezium input signal : e = 0 at t = 1 // e = 10 at t = 1.2 // e = 10 until t = 3 // e = 0 at t = 3.2 and further on.

6 - Considerations on filtering aspects - Justification

6.1 - General

In the frame of an accident investigation, to restore real parameters from FDR recordings, engineers have to work from samples the rate of which is defined by regulations, and they also have to cope with filtering aspects and transport delays of computers which convey the signals. This chapter provides simple considerations on these two aspects, sampling and filtering.

6.2 - Sampling and Filtering are necessary harms

Sampling :

Today, the capabilities of existing Flight Data Recorder Systems are limited, and the Airworthiness Authorities and the A/C manufacturer have had to select required parameters and corresponding sampling rates, from 8 sps (samples per second) down to 0.25, depending on the possible dynamics of the parameter signals.

The sampling rate of all the recorded parameters is defined in the regulations (FAR 121-344 appendix M).

As far as the flight control surface position parameters are concerned, 2 sps is the nominal rate.

Sampling necessarily entails a loss of information. It may clip off rapid, extreme control movements.

Filtering :

There are two aspects :

a) physical sensors may deliver noisy signals, and for a correct operation, the computers which use them have to filter them through various kinds of filters (1st order filters, 2nd order filters, others ...), which have short time constants, and damping terms as necessary, to eliminate harmful high frequency signals which are out of the useful signal bandwidth.

b) signals may also be filtered through filters having longer time constants, for various purposes. For example, the parameters which are to be displayed are filtered to obtain readable parameter indications on the electronic displays, i.e. to avoid jerky movements of analog tapes or pointers, or constantly changing digits on digital counters.

The flight control position parameters are filtered. The signals from the physical sensors are not available, the parameter values are available only from the SDAC which acquires them and processes them (including filtering for their use by the ECAM and FWS) before transmission.

The characteristics of the SDAC filter are the following :

Bandwidth : 0.37 Hz
Response for a 1 Hz cosine signal : - 9 dB amplitude, 195 ms delay, i.e. :
if $e(t) = \cos 2\pi t$, $s(t) = 0.34 \times \cos 2\pi (t - 0.195)$.

6.3 - Justification

The 2 sps (or 2 Hz) defined sampling rate for the flight control surface positions leads to consider 1 Hz as an admitted bandwidth for their deflection variations.

Therefore the above characteristics of the SDAC filter were considered as acceptable, because it is a 1st order, and its break frequency lower than 1 Hz ensures the proper cutting-off of the higher frequency signal components.
As regards attenuation and phasing, correct input signals can be retrieved thanks to the possibility to reconstitute the actual history of the parameter changes by using the A/C simulation model and checking consistency between all parameters, flight control surface positions as well as flight parameters (pitch, roll, heading, accelerations, etc.).

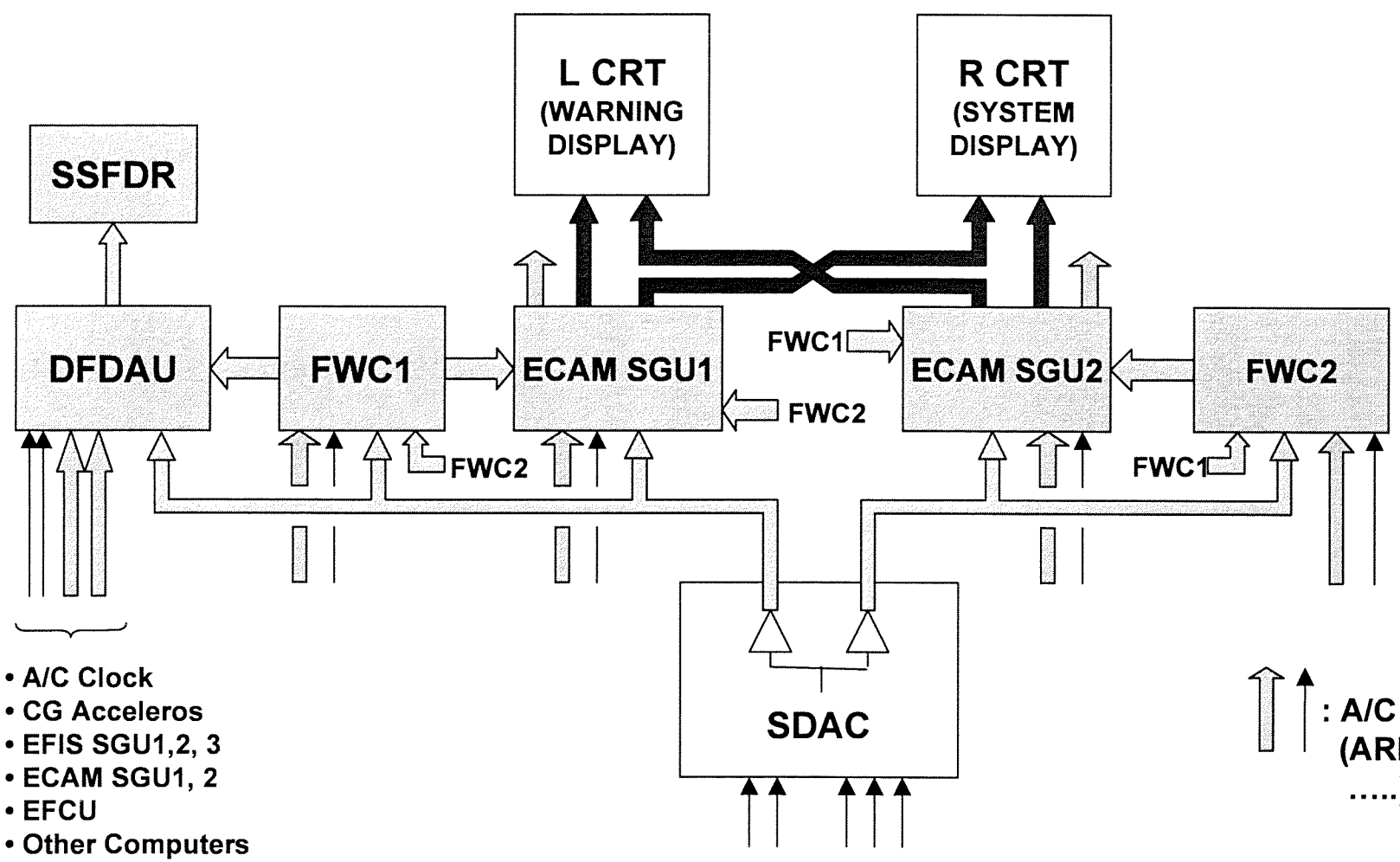
7 - Conclusion

The AIRBUS A300-600 A/C design for the recording of the flight control surface positions, with its sampling and filtering characteristics, has been found acceptable since fairly representative input signals can be restored.

Their correlation with other parameters is possible, in particular with the flight parameters because such variation of a flight control surface position will result in such A/C movement and resulting flight parameter changes (variations of pitch angle, bank angle, angular rates, accelerations, ...), as given when running the A/C Flight Handling Quality model tool.

In this manner, the I/P data history can be reconstructed, comparing through successive iterations the O/P results of the A/C model tool with the recorded flight parameters, until they match each other.
In conclusion, given the range and dynamics of the flight control surface position signals, and based on the results of all studies, simulations and real tests which have been performed (see reference notes in chapter 1), the signals delivered by the SDAC are considered as usable.

PURPOSE OF THE SDAC



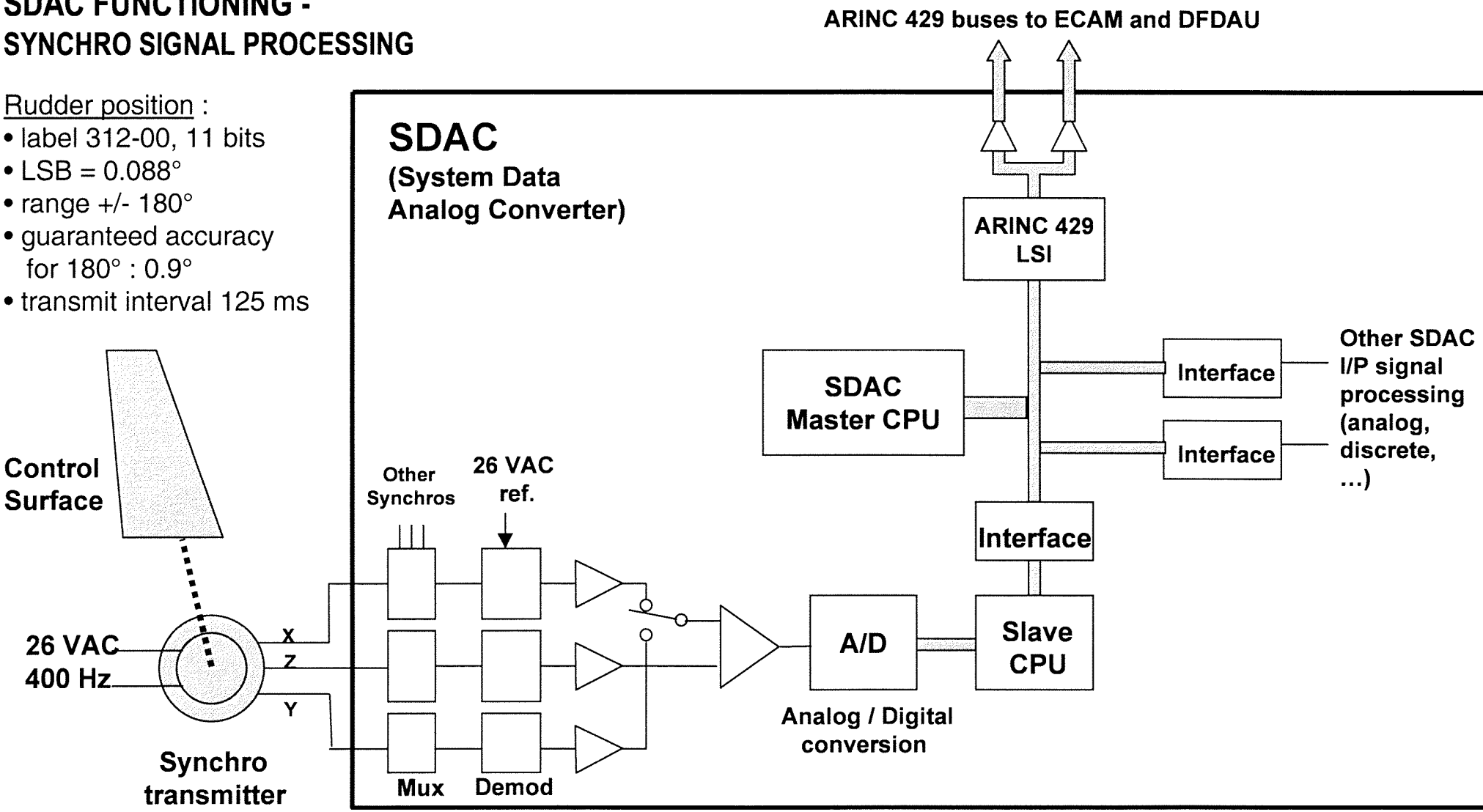
- A/C Clock
- CG Acceleros
- EFIS SGU1,2, 3
- ECAM SGU1, 2
- EFCU
- Other Computers
- Discrete & analog signals

506.0008/2002 - Attachment 1

AIRBUS

SDAC FUNCTIONING -
SYNCHRO SIGNAL PROCESSING

Rudder position :
- label 312-00, 11 bits
- LSB = 0.088°
- range +/- 180°
- guaranteed accuracy for 180° : 0.9°
- transmit interval 125 ms



```
        BRA     OUT1            ;OCTAN 3 (90-135)
BE:     LDAA    #00001100B      ;(270 DEG.)
        CLRB
        BSR     SP              ;OCTAN 6 (225-270)
OUT1:   RTS
;
;************  RESUTATS DES CALCULS DANS : RESCAL,RESCAL+1  *************
;
SP:     SUBB    ANGLE+1
        SBCA    ANGLE
        STAA    RESCAL
        STAB    RESCAL+1
        RTS
       .PAGE
;*****************************************************************************
;                                                                            *
;  REFERENCE    LOGICIEL  :  56501 - 700 - 04                                *
;                                                                            *
;  NOM            :  FILTRE        * ECRIT PAR    : GUYADER      LE 08/01/82 *
;                                  *                                         *
;  ECRIT POUR     :  6800          * VERSION NUM : 01                       *
;                                  * REVU PAR     :              LE   /  /   *
;  MODE D'APPEL :                  * VERIFIE PAR  :              LE   /  /   *
;                                  *                                         *
;*****************************************************************************
;
; FONCTION    :  FILTRAGE NUMERIQUE DE L'ANGLE DE SYNCHRO                     *
;                F = 1/4 RESCAL + 3/4 TRESUL                                 *
;----------------------------------------------------------------------------*
;
; REGISTRES UTILISES  :A B X                                                 *
;           DETRUITS  :A B X                                                 *
;                                                                            *
; RAM       UTILISEE  :RESCAL TRESUL RESUL                                   *
;           DETRUITE  :RESCAL TRESUL RESUL                                   *
;                                                                            *
; ROM       UTILISEE  :                                                      *
;                                                                            *
; I/O       UTILISEES :                                                      *
;                                                                            *
;----------------------------------------------------------------------------*
;
; PARAMETRES D'ENTREE  : RESCAL ,TRESUL POINTE PAR B                         *
;                                                                            *
; PARAMETRES DE SORTIE : RESCAL,TRESUL POINTE PAR B                          *
;                                                                            *
;----------------------------------------------------------------------------*
;
; SOUS PROGRAMMES UTILISES :DIV4                                             *
;                                                                            *
; MODULES          UTILISES :ADDTAB                                          *
;                                                                            *
;----------------------------------------------------------------------------*
;                    93 MCY. SI PAS FILTRAGE                                 *
; TEMPS D'EXECUTION :242 MCY. MAX EN FILTRAGE                                *
;                    211 MCY. MINI EN FILTRAGE                               *
;----------------------------------------------------------------------------*
;
; TAILLE MEMOIRE     : 103 OCTETS                                            *
;                                                                            *
;----------------------------------------------------------------------------*
```

```
;
; COMMENTAIRES :TRESUL: RESULTAT PRECEDENT PRIS DANS LA TABLE TRESUL
;              RESCAL: RESULTAT DU CALCUL PUIS RESULTAT DU FILTRAGE
;LES RESULTATS SONT CODES SUR 12 BITS: 1LSB=0.08789 DEGRE
;
;
;
;-------------------------------------------------------------------------
;
; EVOLUTIONS    :
;
;
;*************************************************************************
      .PAGE
FILTRE: BSR    ADDTAB
        LDAA   0,X
        BMI    FILTR3
;
;PREPARATION DU PARAMETRE FILTRE (CIRCULAIRE)
;
        LDAA   RESCAL
        LDAB   RESCAL+1
        SUBB   1,X
        SBCA   0,X
        LDAA   RESCAL
        LDAB   RESCAL+1
        BCS    FILTR1
;RESCAL>TRESUL
        SUBA   #00001000B      ;RESCAL-180
        BCS    FILTR2
        SUBB   1,X
        SBCA   0,X
        BCS    FILTR2
        LDAA   0,X             ;(RESCAL-180)>TRESUL
        ADDA   #00010000B      ;TRESUL+360
        STAA   0,X
        BRA    FILTR2
;RESCAL<TRESUL
FILTR1: ADDA   #00001000B      ;RESCAL+180
        SUBB   1,X
        SBCA   0,X
        BCC    FILTR2
        LDAA   RESCAL          ;(RESCAL+180)<TRESUL
        ADDA   #00010000B      ;RESCAL+360
        STAA   RESCAL
;
FILTR2: LDAA   RESCAL
        LDAB   RESCAL+1
;
;FILTRE F=1/4RESCAL +3/4TRESUL
;
        BSR    DIV4
        STAA   RESUL           ;1/4RESCAL
        STAB   RESUL+1
        LDAA   0,X
        LDAB   1,X
        ASLB
        ROLA                   ;2TRESUL
        ADDB   1,X
        ADCA   0,X             ;3TRESUL
```

```
        BSR     DIV4            ;3/4TRESUL
        ADDB    RESUL+1
        ADCA    RESUL           ;1/4RESCAL +3/4TRESUL
        ANDA    #11101111B      ;VALEUR FILTRE>360 MASQUER LE BIT
FILTR4: STAA    0,X
        STAB    1,X
        STAA    RESCAL
        STAB    RESCAL+1
        RTS
FILTR3: LDAA    RESCAL
        LDAB    RESCAL+1
        BRA     FILTR4
DIV4:   LSRA
        RORB
        LSRA
        RORB
        ADCB    #0
        ADCA    #0
        RTS
        .PAGE
;*****************************************************************************
;                                                                             *
;  REFERENCE    LOGICIEL  :  56501 - 700 - 04                                 *
;                                                                             *
;  NOM              :  ADDTAB       * ECRIT PAR    : GUYADER      LE 08/01/82 *
;                                   *                                         *
;  ECRIT POUR       :  6800         * VERSION NUM  : 01                       *
;                                   * REVU PAR      :              LE   /  /   *
;  MODE D'APPEL     :  JSR          * VERIFIE PAR   :              LE   /  /   *
;                                   *                                         *
;*****************************************************************************
;                                                                             *
;  FONCTION    :  ADRESSAGE DE LA TABLE TRESUL (FILTRE)                       *
;                                                                             *
;-----------------------------------------------------------------------------*
;                                                                             *
;  REGISTRES UTILISES  :B X                                                   *
;            DETRUITS  :B X                                                   *
;                                                                             *
;  RAM       UTILISEE  :TRESUL                                                *
;            DETRUITE  :                                                      *
;                                                                             *
;  ROM       UTILISEE  :                                                      *
;                                                                             *
;  I/O       UTILISEES :                                                      *
;                                                                             *
;-----------------------------------------------------------------------------*
;                                                                             *
;  PARAMETRES D'ENTREE  :B                                                    *
;                                                                             *
;  PARAMETRES DE SORTIE :X                                                    *
;                                                                             *
;-----------------------------------------------------------------------------*
;                                                                             *
;  SOUS PROGRAMMES UTILISES :                                                 *
;                                                                             *
;  MODULES          UTILISES :  CALADD                                        *
;                                                                             *
;-----------------------------------------------------------------------------*
;                                                                             *
;  TEMPS D'EXECUTION :  21MC +CALADD                                          *
                                                                              *
```

```
;
;-----------------------------------------------------------------------*
;                                                                        *
; TAILLE MEMOIRE     :  9 OCTETS                                         *
;                                                                        *
;-----------------------------------------------------------------------*
;                                                                        *
; COMMENTAIRES :                                                         *
;                                                                        *
;                                                                        *
;                                                                        *
;                                                                        *
;                                                                        *
;                                                                        *
;-----------------------------------------------------------------------*
;                                                                        *
; EVOLUTIONS    :                                                        *
;                                                                        *
;                                                                        *
;************************************************************************
        .PAGE
ADDTAB: DECB
        ASLB
        LDX     #TRESUL
        JSR     CALADD
        RTS
        .PAGE
;************************************************************************
;                                                                        *
;  REFERENCE   LOGICIEL  :  56501 - 700 - 04                             *
;                                                                        *
;  NOM             :  ITRESU       * ECRIT PAR    : GUYADER    LE 08/01/82 *
;                                  *                                     *
;  ECRIT POUR      :  6800         * VERSION NUM  : 01                   *
;                                  * REVU PAR     :            LE  /  /  *
;  MODE D'APPEL :  JSR             * VERIFIE PAR  :            LE  /  /  *
;                                  *                                     *
;************************************************************************
;                                                                        *
; FONCTION     :  INIT DE TOUTE LA TABLE TRESUL (FILTRE) EN LA           *
;                 DESACTIVANT (1 DANS LE MSB DE CHAQUE VALEUR)           *
;-----------------------------------------------------------------------*
;                                                                        *
; REGISTRES UTILISES   :A X                                              *
;           DETRUITS   :A X                                              *
;                                                                        *
; RAM       UTILISEE   :TRESUL                                           *
;           DETRUITE   :TRESUL                                           *
;                                                                        *
; ROM       UTILISEE   :                                                 *
;                                                                        *
; I/O       UTILISEES  :                                                 *
;                                                                        *
;-----------------------------------------------------------------------*
;                                                                        *
; PARAMETRES D'ENTREE    :                                               *
;                                                                        *
; PARAMETRES DE SORTIE  :TRESUL (80/00) DANS TOUTE LA TABLE              *
;                                                                        *
;-----------------------------------------------------------------------*
;                                                                        *
```

```
; SOUS PROGRAMMES UTILISES :
;
; MODULES          UTILISES :
;
;-----------------------------------------------------------------------
;
; TEMPS D'EXECUTION :  826 MC
;
;-----------------------------------------------------------------------
;
; TAILLE MEMOIRE    :  14 OCTETS
;
;-----------------------------------------------------------------------
;
; COMMENTAIRES :
;
;
;
;
;
;
;
;-----------------------------------------------------------------------
;
; EVOLUTIONS    :
;
;
;
;*************************************************************************
      .PAGE
ITRESU: LDX    #TRESUL-1
      LDAA   #10000000B
INITT1: INX
      STAA   0,X
      CPX    #TRESUL+48
      BNE    INITT1
      RTS
      .PAGE
;*************************************************************************
;
;  REFERENCE   LOGICIEL  :  56501 - 700 - 04
;
;  NOM           :  HDTRES       * ECRIT PAR    : GUYADER      LE 08/01/82
;                                *
;  ECRIT POUR    :  6800         * VERSION NUM  : 01
;                                * REVU PAR     :              LE   /  /
;  MODE D'APPEL  :  JSR          * VERIFIE PAR  :              LE   /  /
;                                *
;*************************************************************************
;
; FONCTION    :  DESACTIVER LA POSITION DE LA TABLE TRESUL (FILTRE)
;                DESIGNEE PAR B (1 DANS LE MSB DESIGNE)
;-----------------------------------------------------------------------
;
; REGISTRES UTILISES  :A B X
;           DETRUITS  :A B X
;
; RAM       UTILISEE  :TRESUL CSYNC
;           DETRUITE  :TRESUL CSYNC
;
; ROM       UTILISEE  :
;
```

ATTACHMENT 3

The curves on the next pages show the response of a real SDAC to simulated synchro input signals, for various shapes of input signals (step, ramp, sine wave, etc.). These curves were established thanks to the tests conducted with the NTSB, BEA, FAA, APA, AAL and AIRBUS during week 6 / 2002.

They also show, for all these input signals, the calculated SDAC outputs using the digital filter algorithm, and the Laplace transfer function (1 / 1 + 0.434 s) of the filter.

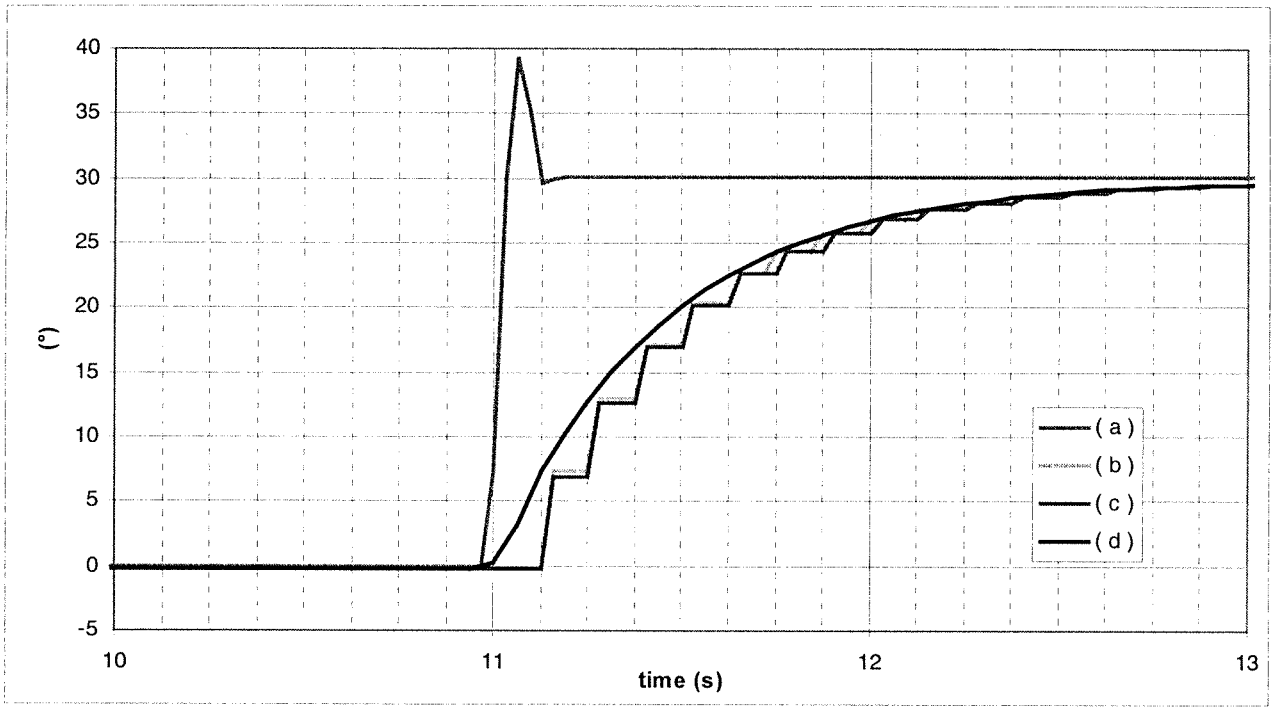
Notes :

1. because the sampling period of the SDAC is 125 ms and that of the mini portable FTI is 31,25 ms, there are sometimes only 3 successive equal SDAC outputs (instead of 4). For example, if the latter value is 31,26 ms, there will be only 3 SDAC outputs. This is the reason why the SDAC output recorded signal looks in advance with respect to the calculated output, which is not.

2. for the bench test series 1.5 (step input), one can believe the SDAC filter includes a 125 ms delay function but it does not. As a matter of fact, the SDAC acquired the input value at the very beginning of the 0° to 30° transition and its output was close to 0°.

3. the overshoot in the step input signals is due to the inductance of the synchro simulation board.

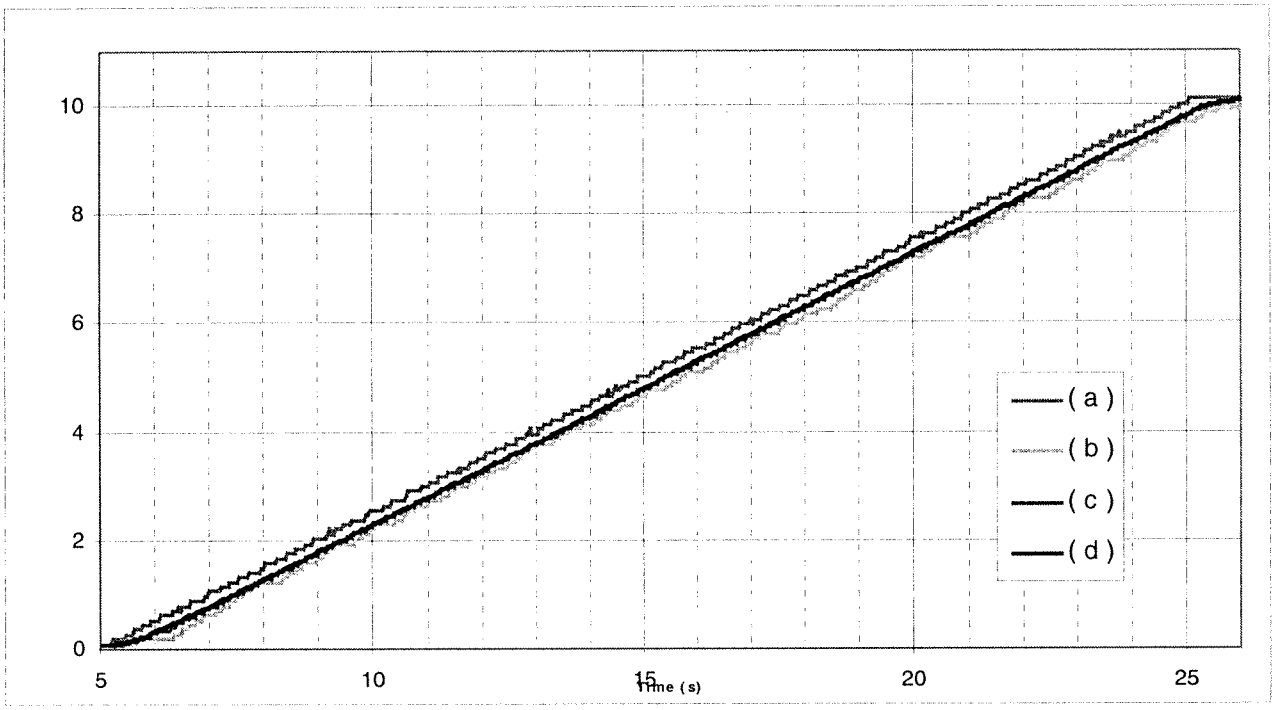
Bench test series 1.5: step input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

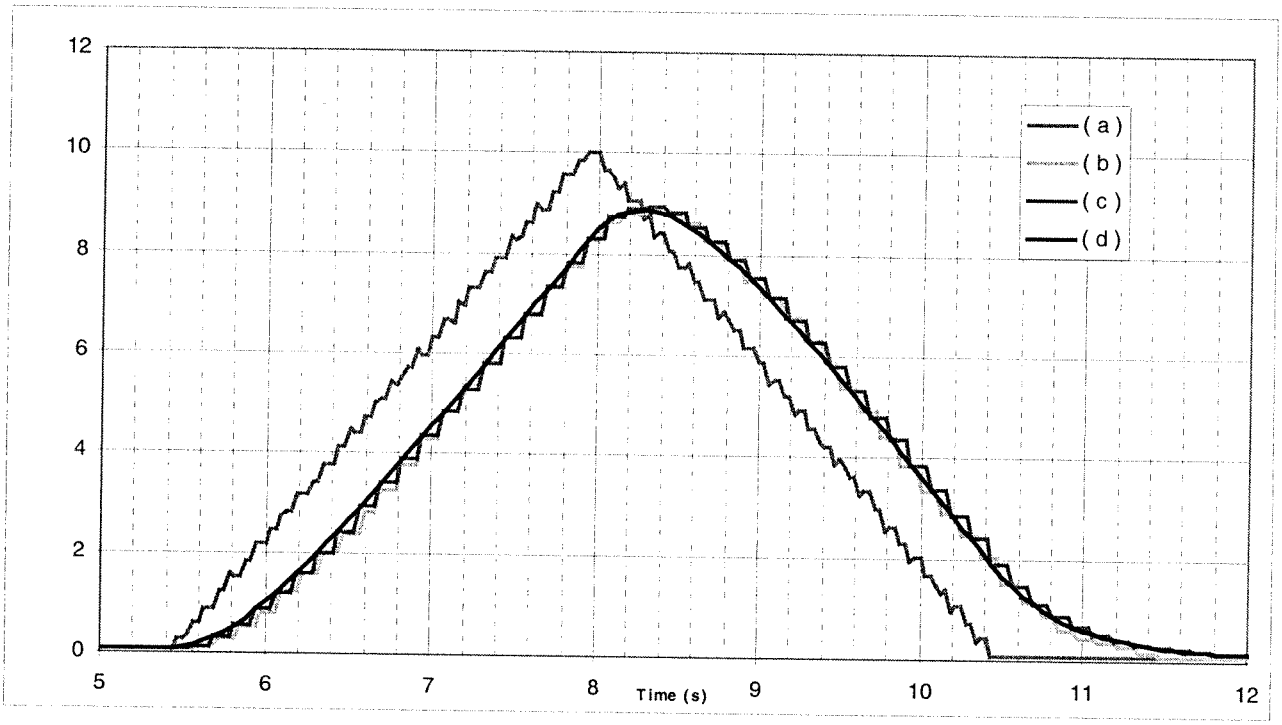
Bench test series 2.1: ramp input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

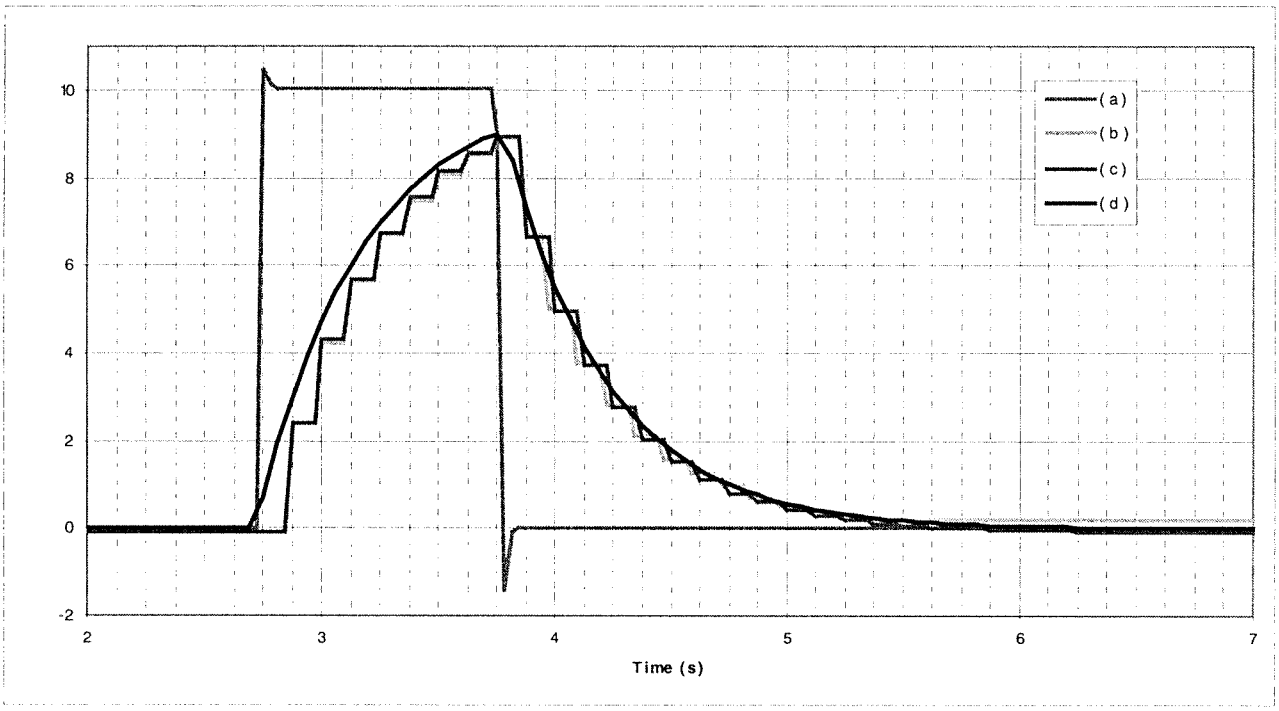
Bench Test series 3.3: double ramp input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

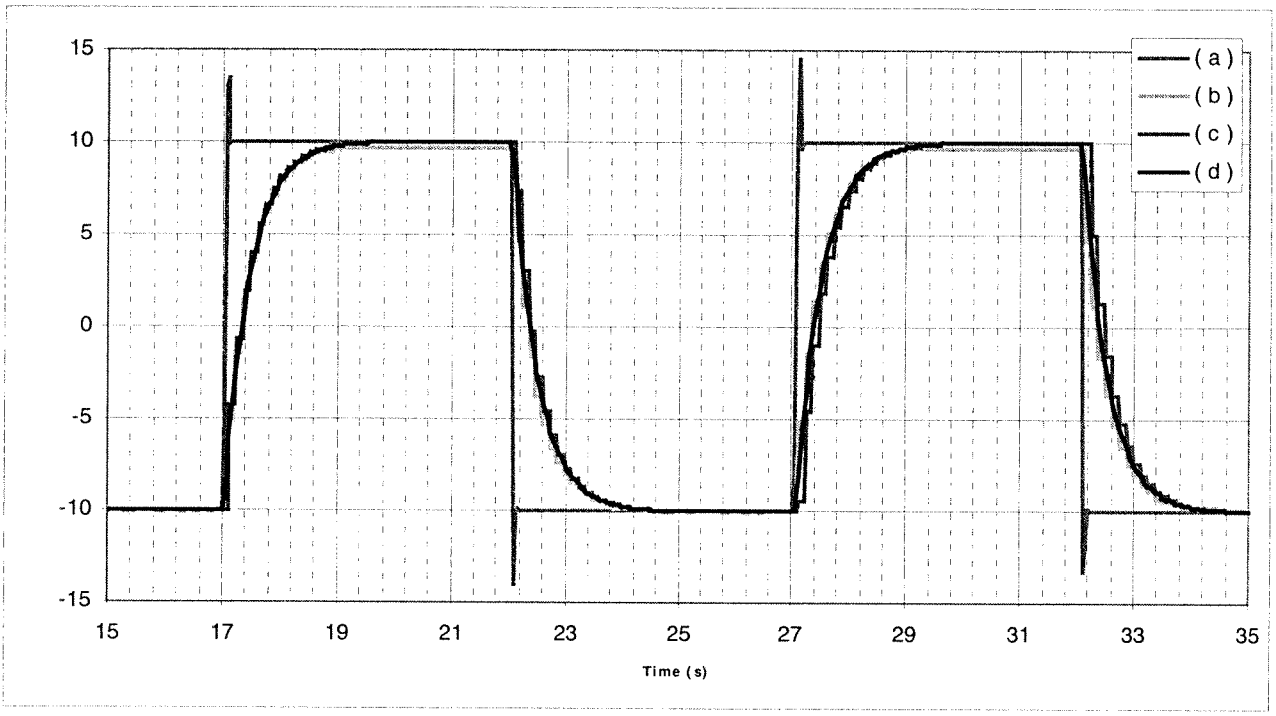
Bench test series 4.5: impulse input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

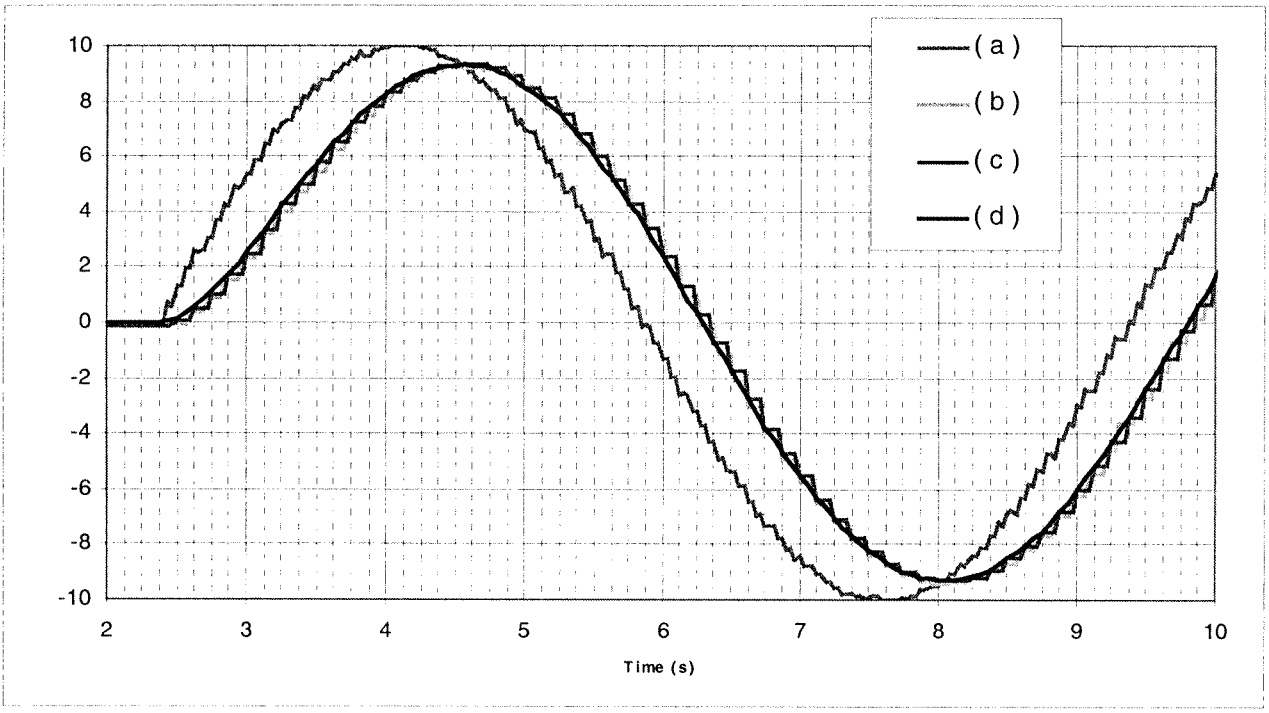
Bench test series 6.1: square wave input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

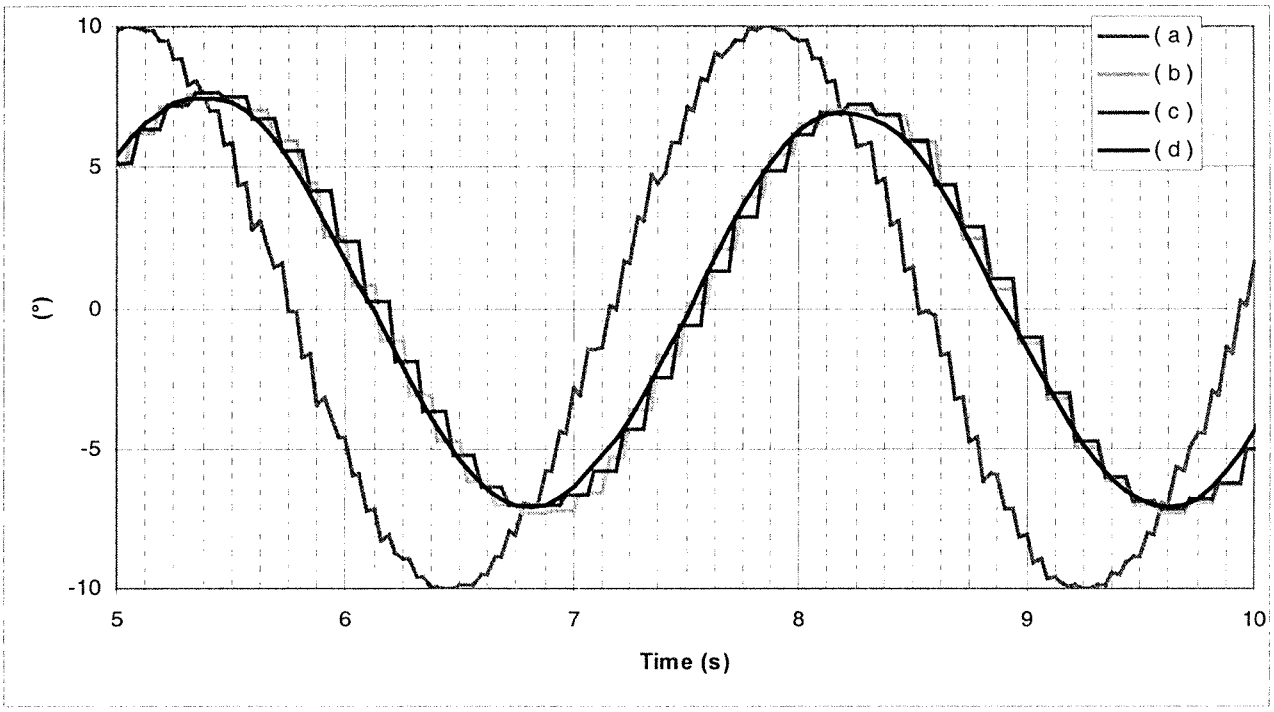
Bench test series 7.3: sine wave input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

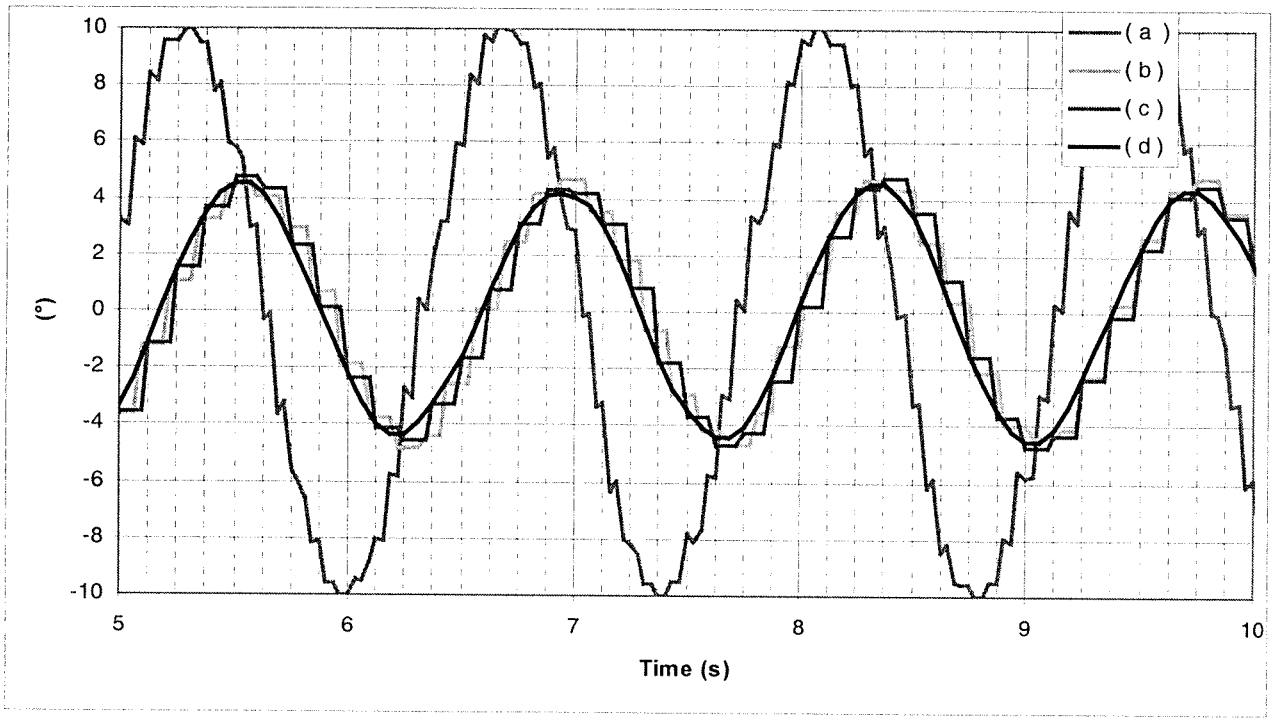
Bench test series 7.4: sine wave input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

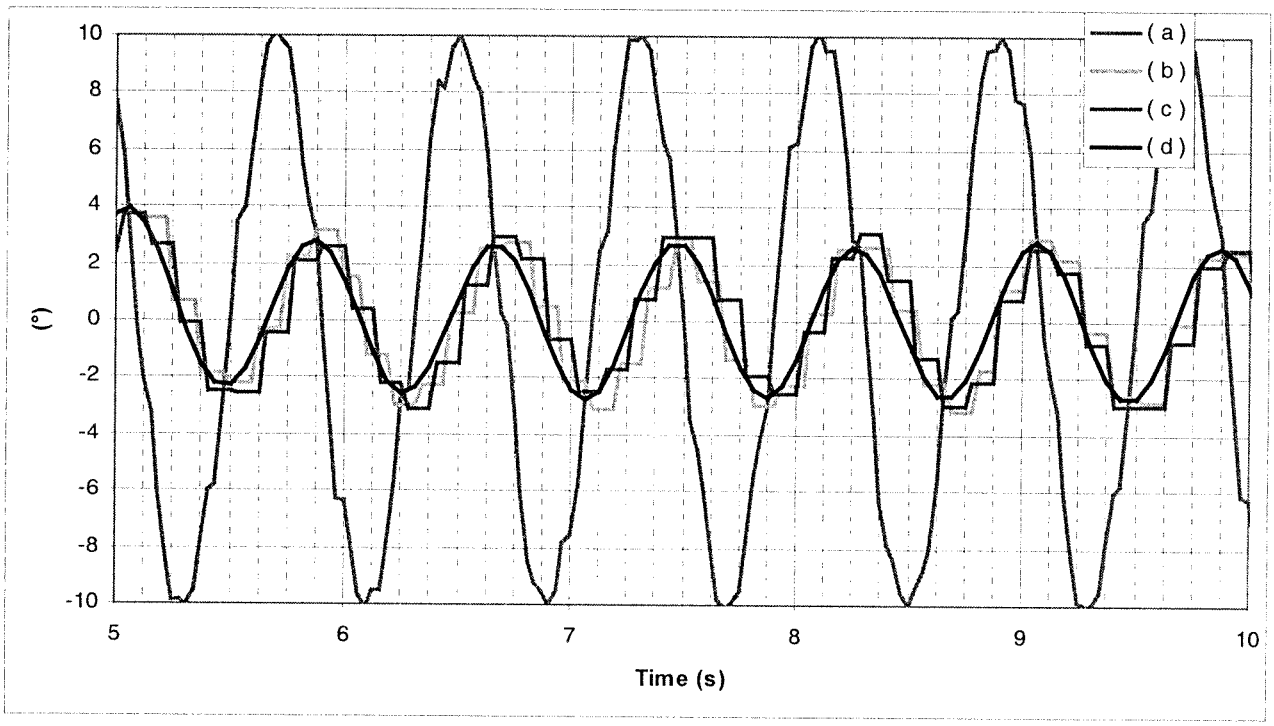
Bench test series 7.5: sine wave input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

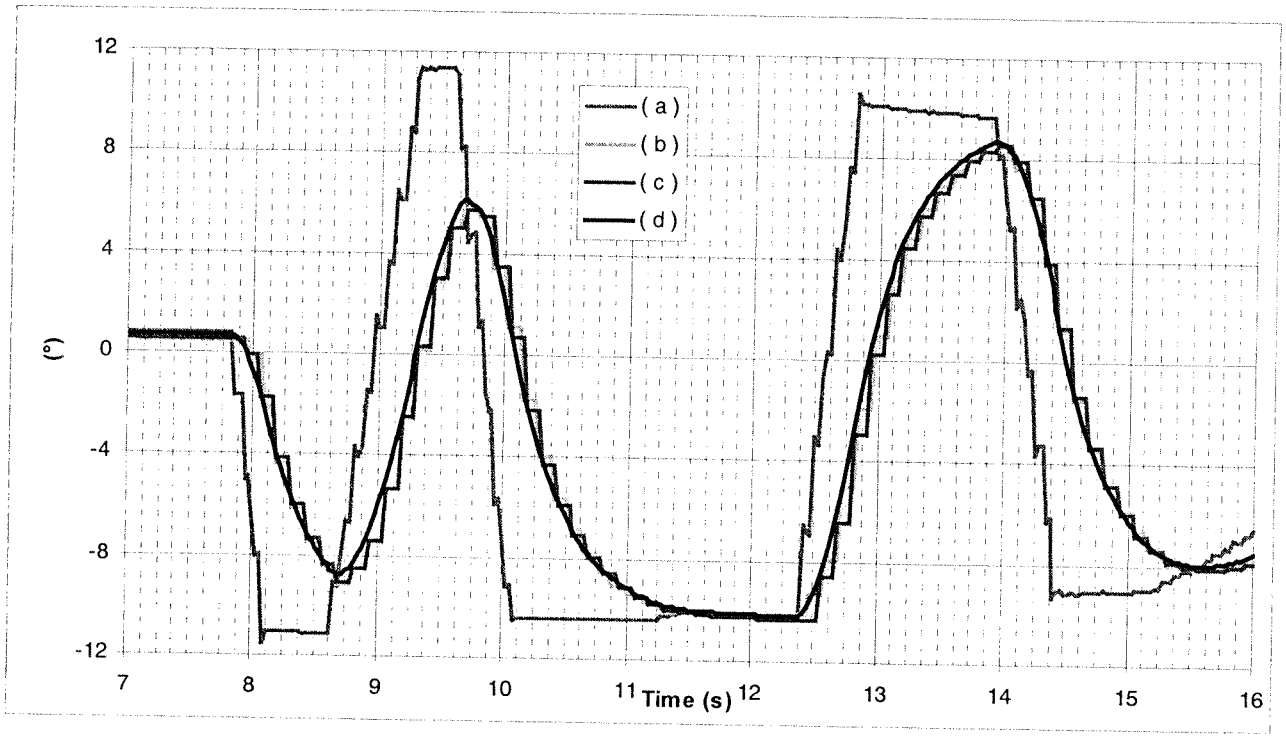
Bench test series 7.6: sine wave input



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI

Bench test series 11.1: rudder history FIRST iteration



(a) *simulated synchro input signal injected into SDAC
(b) *actual SDAC output signal
(c) calculated SDAC output using the digital algorithm
(d) calculated SDAC output using the filter Laplace transfer function $\frac{1}{1 + 0{,}434.s}$

*: the plots show the signals such as recorded by the portable mini FTI