Appendix 3

AIR DATA COMPUTER, TYPE B, Ref. No. 6A/5404 and TYPE C, Ref. No. 6A/8743

SERVICING

FAULT DIAGNOSIS

LIST OF CONTENTS

	Para.		Para.
General	1	*Servo run-away*	16
Fault symptoms	4	*Incorrect servo follow-up*	18
Fault clearance	5	*Incorrect test set, Type 9B, G1 readings* ...	19
Diagnostic sequence	8	*No change in test set, Type 9B, G1 readings*	23
Gear train checks	10	*Test set, Type 9B, G1 readings correct in one direction only*	24
Slip clutch	12	*ILP1, test set, Type 9B*	25
Wiring checks	13		
Power supplies	14		

LIST OF TABLES

	Table
Fault tracing—general	1
Fault tracing—individual channels	2

LIST OF ILLUSTRATIONS

	Fig.
Data flow—block schematic diagram (serial 133/63 and above)	1

General

1. The majority of faults on equipment will occur in service and many of them will have more than one cause: some reported faults may not be obvious when the equipment is subjected to test. As a first step to fault diagnosis therefore the standard serviceability test should be carried out (App. 2).

2. Dependent upon the state of modification, the computer is made up of three or four separate computing channels and, apart from the height channel which is removed post-mod. ADS/134, each is made up of two servo units in cascade (Chap. 7, para. 3 to 15) viz.:—

(1) Mach number channel comprising:—
  (a) Log mach number gearbox.
  (b) Mach number output gearbox.

(2) Vertical speed channel comprising:—
  (a) Rate of climb gearbox.
  (b) Vertical speed output gearbox.

(3) True air speed channel comprising:—
  (a) Temperature gearbox.
  (b) True air speed output gearbox.

A schematic diagram showing data flow is given in fig. 1.

3. It will be apparent from the result of the standard serviceability test which channel is at fault (but see para. 19), and fault diagnosis is concerned with determining:—

(1) Which servo unit within the channel is faulty.

(2) Which sub-unit or component within that servo unit is the cause of the fault.

Fault symptoms

4. When a computer is subjected to the standard serviceability test (App. 2) one or more of the following symptoms may be exhibited during specific channel tests:—

(1) Servo run-away.

(2) Erratic servo follow-up.

(3) Sluggish servo follow-up.

(4) Hunting around the null.

(5) Incorrect test set, Type 9B, G1 readings of one function.

(6) Incorrect test set, Type 9B, G1 readings of more than one function.

(7) Incorrect test set, Type 9B, G1 readings of all functions.

(8) No change in test set, Type 9B, G1 readings irrespective of the value of parameter, or of the method, used to induce such a change.

(9) Correct test set readings in one direction, but incorrect in the reverse direction.

Fault clearance

5. Faults are cleared either by the adjustment or replacement of the component(s) concerned. A fault due to a component not held in the second line range of spares will result in that component (or in some cases the sub-unit associated with the component) being declared unserviceable.

6. When a suspect sub-unit or component is changed, the standard serviceability test should be repeated to ensure that only this sub-unit or component is at fault. If the fault persists after an item has been changed, then the next stage in the sequence should be investigated. Items replaced prior to the location of the fault should be tested fully before being declared unserviceable.

7. Fault diagnosis should continue until either the computer is repaired or a point is reached beyond which the level of servicing authorized permits no further investigation; at this stage the computer should be declared unserviceable.

Diagnostic sequence

8. When a fault is experienced the following general procedure is to be adopted:—

(1) Examine the gear train (para. 10).

(2) Locate the fault to a particular sub-unit or component.

(3) If sub-para. (2) cannot be satisfied, carry out the wiring checks (para. 13).

9. The following paragraphs discuss the probable cause of failure in the standard serviceability tests. When the investigation indicates that the fault is due to a particular sub-unit or component, the relevant test in App. 4 should be carried out before deciding upon a replacement item.

Gear train checks

10. The gear train should be examined in order to determine:—

(1) Whether any gear is damaged—broken teeth, distorted gear, etc.

(2) That all split clamps are tightened to the correct torque loading (App. 4, Table 6) with the two halves of the clamp placed symmetrically on the collar.

(3) That there is no undue backlash throughout the gear train.

11. If any gears are damaged the gearbox should be declared unserviceable. Split clamps, if loose, should be tightened to the correct torque loading, but before tightening those associated with any servo driven component carry out the relevant tests and adjustments for that component as detailed in App. 4. Check split gears for correct loading (1 to 1½ teeth). Excessive backlash necessitates the replacement of the complete gearbox. After any adjustment is made to the gear train the standard serviceability test should be carried out.

Slip clutch

12. If the split clamp associated with the slip clutch on any gearbox is loose, this can cause random errors or even no test set readings. It should be tightened, to the correct torque loading, in the correct position (App. 4, para. 13).

Wiring checks

13. Continuity checks are given in App. 2, para. 13. Should this fail and the fault cannot be located, the computer should be disconnected from all test equipment and, using a circuit diagram of the correct issue for the modification state of the equipment under test, the checks of App. 4, para. 7, made.

Power supplies

14. It is assumed that the power at the relevant pins of the plugs and sockets of the computer is correct in each instance as this is supplied by the test set, Type 9B. However, should a sub-unit or output component be suspect, then carry out the test of App. 4, para. 8.

15. (1) Should any test of para. 13 fail then a wiring fault exists and unless repairable the computer should be declared unserviceable.

(2) Should any test of para. 14 fail:

(a) At the servo-amplifier, then a wiring fault exists and unless repairable the computer should be declared unserviceable.

(b) At the gearbox, then change the complete gearbox and retest. If the fault still persists replace the original gearbox and declare the computer unserviceable.

Servo run-away

16. This fault will be apparent when power is supplied to the unit. Switch off immediately. It may be due to:—

(1) Loose split clamps in the gear train.

(2) A faulty servo-amplifier.

(3) Incorrect output from position feedback potentiometer.

Note . . .

The T.A.S. channel gearboxes will run away if the temperature probe is disconnected.

17. Proceed as in para. 10. If the clamps are tightened to the correct torque loading carry out the servo-amplifier tests (App. 4, para. 143). If these checks are correct and the fault persists check the position feedback output voltage.

Incorrect servo follow-up

18. Irrespective of the accuracy of the output, the servo-motor should follow-up the command signal rapidly and smoothly. At the null point one overshoot only in each direction should take place before the mechanism comes to rest. Failure in this respect points to a servo-unit error. If follow-up is sluggish or overshooting is incorrect the velocity feedback loop is suspect. Carry out the appropriate test in App. 4. Erratic follow-up may also be due to incorrect setting of the velocity feedback, a faulty tachogenerator, a faulty slip clutch or irregular output from a position feedback potentiometer. If having checked the feedback, and if necessary, changed the tachogenerator and the fault still persists, proceed to servo amplifier checks. If after these checks the fault still persists replace all original components, change the complete gearbox and retest.

Incorrect test set, Type 9B, G1 readings

19. Providing no compensating errors are present (e.g., incorrect potentiometer voltages) a fault in a servo amplifier will be apparent as an error on all outputs of its associated channel during the standard serviceability test. In this connection referring to fig. 1, it will be seen that the log Mach number servo unit outputs are routed to both the Mach number output servo unit and the true air speed servo unit. Therefore:—

(1) If all outputs from one of these channels are incorrect but all outputs from the other are correct then the log Mach number servo unit is cleared of fault. If the true air speed outputs are incorrect then MSW1 in the Mach number output gearbox or RV11 in the log Mach gearbox may be at fault. This can be caused by:—

(a) A faulty microswitch.

(b) Incorrect setting of the microswitch actuator.

(c) Incorrect positioning of the microswitch cam (the most unlikely cause).

(d) Incorrect setting of RV11 or faulty potentiometer.

(e) Wiring fault.

(2) If in both of these channels all outputs are incorrect the log Mach number servo unit is suspect.

(3) If the synchro output in one of these channels is correct then the log Mach number servo unit is probably cleared of fault.

20. A synchro output, if well within tolerance at the first test point, should be correct throughout its range; if it is only just within tolerance it is possible that other readings may be incorrect. Failure in this respect may be due to:—

(1) Incorrect alignment of the synchro or the associated compensating cam (where applicable).

(2) Random errors due to dirty sliprings.

(3) Loosened split clamps in the gear train.

21. If a synchro output is correct throughout its range, then the servo-amplifiers associated with the channels are cleared of fault. If at the same time potentiometer outputs are incorrect, then the fault lies with the circuitry (mechanical or electrical) associated with the incorrect outputs.

22. Random errors throughout the range of test may be caused by:—

(1) Dirty sliprings—synchros only.

(2) Loosened split clamps, which may produce erratic follow-up as well.

(3) Irregular potentiometer wiper operation, which if occurring in position feedback potentiometers may produce erratic servo follow-up.

No change in test set, Type 9B, G1 readings

23. (1) Check the gearboxes for gear rotation, as input functions are changed.

(2) Proceed as in para. 10, paying particular attention to axis 2, and the output axes of any gearbox not rotating.

(3) Check the servo amplifier associated with any gearbox not rotating. If both gearboxes in the same channel do not rotate check the first in the chain initially.

Test set, Type 9B, G1 readings correct in one direction only

24. This is most likely to be caused by backlash in the gears and the relevant gearbox should be replaced and the channel retested. Instances have occurred, however, where the transistor amplifier has had reduced output in one direction under small input signal conditions.

ILP1, test set, Type 9B

25. When ILP1 fails to light or lights incorrectly the fault will probably be associated with MSW2 in the Mach No. gearbox. Likely causes are similar to those for MSW1 (para. 19, sub-para. (1)).

TABLE 1

Fault tracing—general

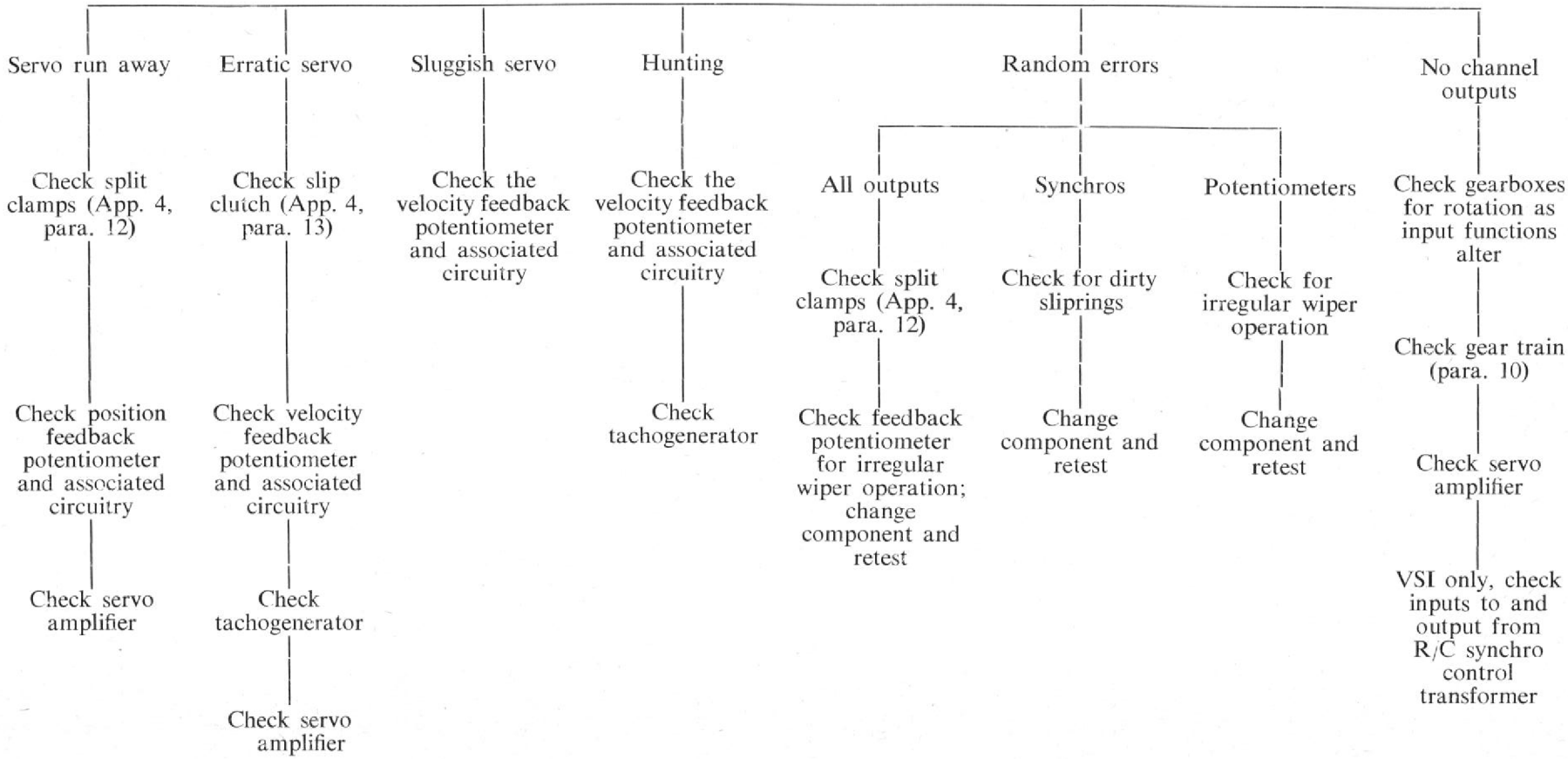

TABLE 2

Fault tracing—individual channels

Item (a)	Fault (b)	Mach No. channel (c)	Vertical speed channel (d)	True air speed channel (e)
1	All outputs incorrect.	If TAS outputs are incorrect, check log Mach No. servo-amplifier, feedback potentiometer, log S_0 potentiometer. If TAS outputs are correct check Mach No. output feedback potentiometer, servo-amplifiers.	Check voltage to VSI gearbox RV4 (units serial 132/63 and under 10V(X) and 10V(Y), units serial 133/63 and above—–6V(A) and +9V d.c.). Check VT1 and VT2 in R/C gearbox tendency chopper and shaping unit, check servo-amplifiers.	See col. (c). If Mach number outputs are correct, check operation of MSW1 and, if necessary, output from RV11 in log Mach gearbox. Check RV4 in temperature gearbox, check RV2 and RV4 in TAS gearbox, check servo amplifier.
2	Synchro output correct, potentiometer outputs incorrect. **Note . . .** *This fault can be caused in service by incorrect potentiometer supply voltage from o.u.e.*	Set up output potentiometers, check split clamps on output potentiometer spindles.	Set up RV5.	Set up RV5/RV6, check split clamp on potentiometer spindle.
3	Potentiometer outputs correct, synchro output incorrect.	Set up synchro, check sliprings, check split clamp on synchro spindle.	Set up VSI gearbox synchro, check sliprings, check split clamp on synchro spindle.	Set up synchro, check sliprings, check split clamp on synchro spindle.
4	No outputs.	See Table 1.	See Table 1.	See Table 1

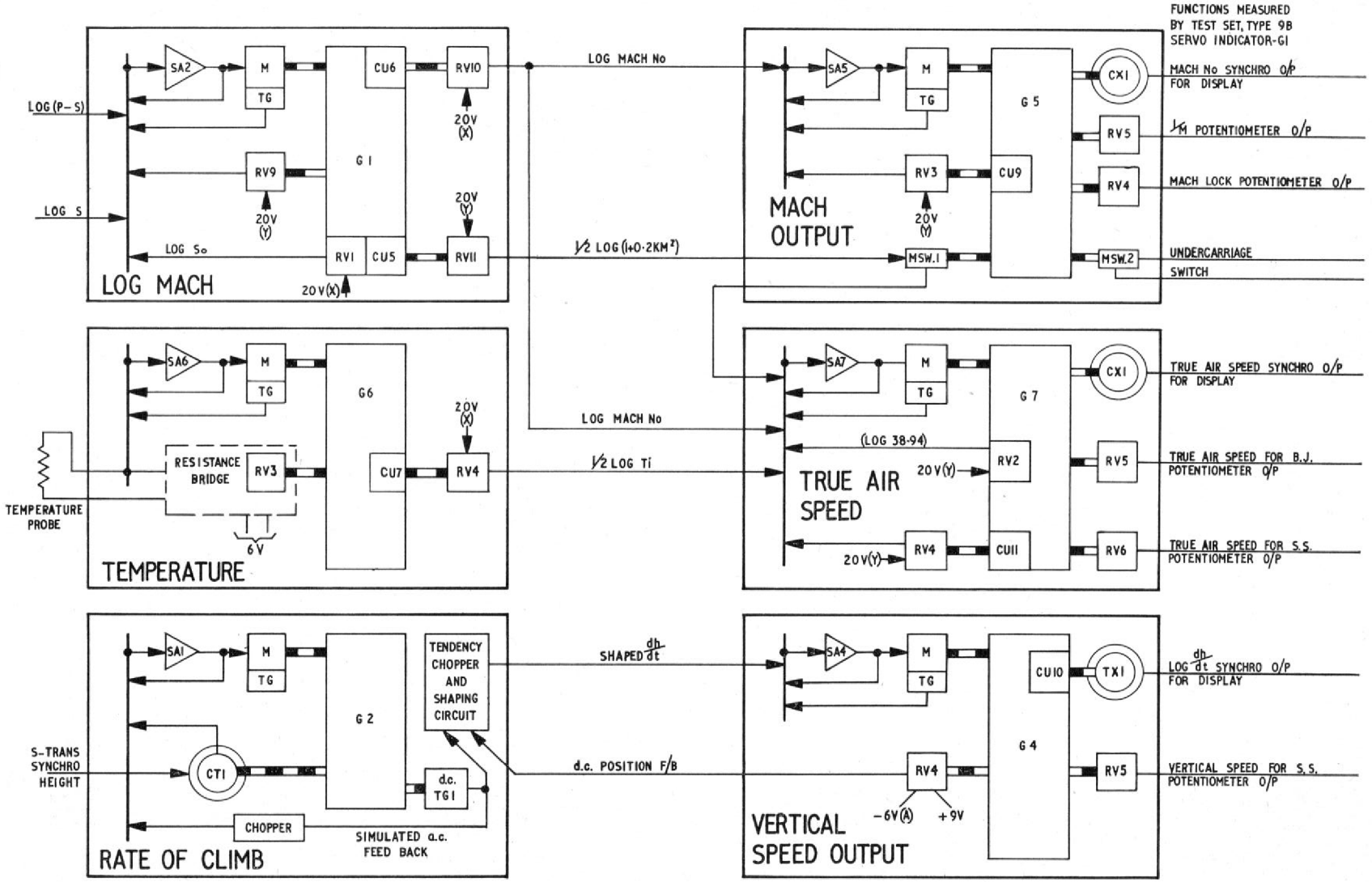

Fig. 1. Data flow—block schematic diagram (serial 133/63 and above)

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