# GEC AVIONICS
Combat Aircraft Controls Division

Tornado aircraft

SEMI-AUTOMATIC GROUND TEST STATION (SAGE)
for the Tornado Flight Control System

The SAGE, Semi-Automatic Ground Test Equipment for the primary/automatic Tornado Flight Control System (FCS) was developed by GEC Avionics for the Royal Air Force. The system is currently in full operational service with all RAF and Royal Saudi Air Force Tornado squadrons providing fully automatic testing and fault diagnostics of FCS computers.

GEC Avionics is the prime contractor for the Tornado FCS and as such has been able to apply it's intimate knowledge of the system to the design of a dedicated suite of test equipment and procedures to enable the rapid and comprehensive test of the complete system. This first-hand knowledge of the FCS also allows timely incorporation of modifications to SAGE to reflect any updates to the FCS.

By design, the SAGE equipment retains the high degree of flexibility inherent to manual test systems but also provides the benefit of significant test time reduction through automatic testing. All SAGE units are housed in standard modular racks to maintain flexibility and faciliate transportation.
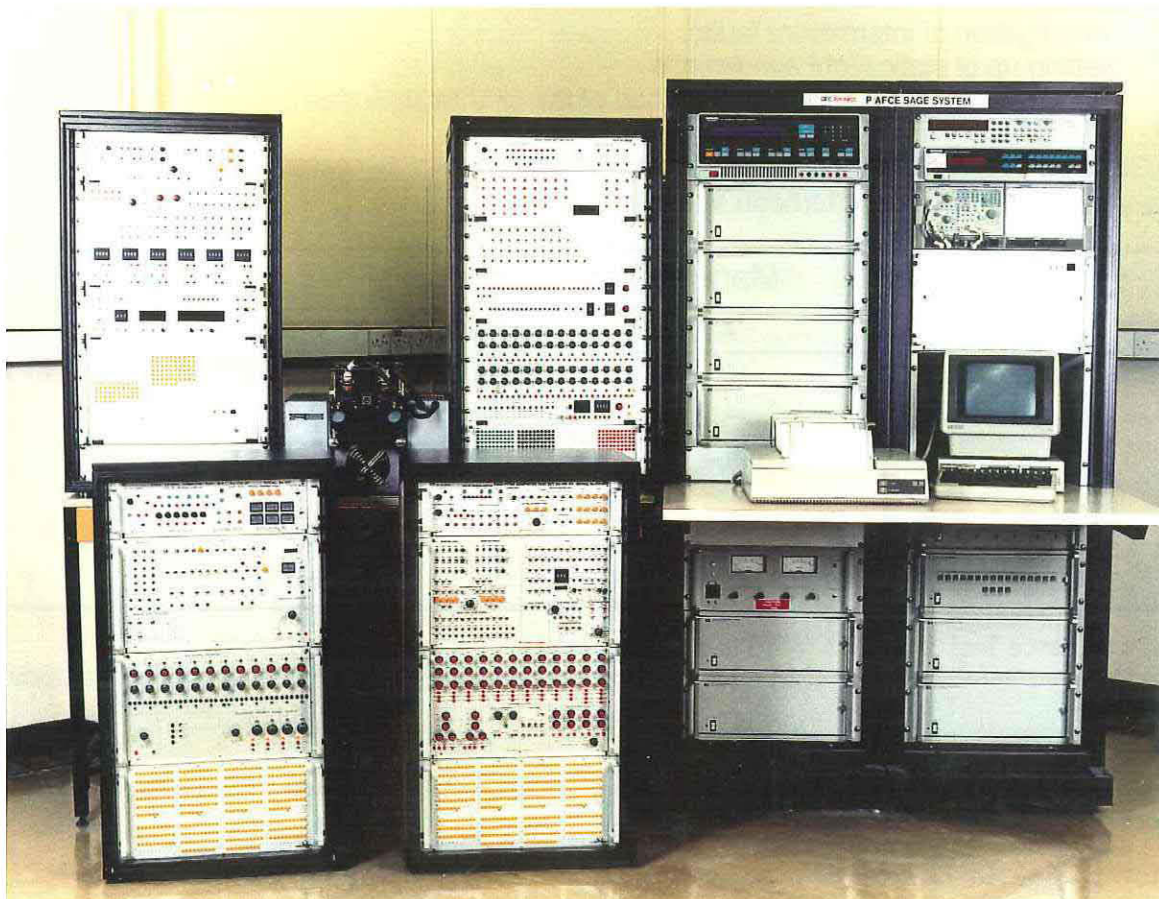
SAGE for the Tornado Flight Controls System

SAGE components

The SAGE test system provides a flexible test capability for the computers and equipment modules of the Tornado FCS and comprises:

- SAGE Control Console
- Pitch Command and Stability Augmentation System (CSAS) Special to Type Test Equipment (STTE)
- Lateral CSAS STTE
- Spin Prevention and Incidence Limiting System (SPILS) STTE
- Automatic/Flight Director System (AFDS) STTE
- Module STTE and adaptor

The SAGE Control Console provides the standard automatic stimulus and measuring equipment which is bus controlled by a personal computer and provides the operator interface via a keyboard and VDU.

SAGE features

- Automatic self-test routines for SAGE Control Console
- Utilises modular plug-in printed circuit boards
- Ease of handling and maintainence
- Robust and reliable construction
- Ease of programming using the BASIC HOL

SAGE test philosophy

The primary purpose of SAGE is to provide fully automatic computer and module testing of the FCS. In addition the computer testing includes automatic fault diagnostics to module level.

The significant advantage of the SAGE design concept over other Automatic Test Equipment (ATE) is its ability to allow manual testing of the computers thereby facilitating:

- Investigation of intermittent faults
- Setting up of static flight simulations
- Familiarisation training in the operation of the LRU being tested.

The SAGE test times for LRUs shown in the table below enable one system to fully meet the servicing and repair requirements of a typical Tornado airbase.

L R U	Manual Test	Automatic Test	
	ATP (*1)	ATP (*1)	SST (*2)
AFDC 1	40 Hours	4 Hours	45 Minutes
AFDC 2	40 Hours	4 Hours	35 Minutes
Lateral	40 Hours	4.5 Hours	2 Hours
Pitch	40 Hours	5.25 Hours	2.5 Hours
SPILS	30 Hours	3 Hours	(* 3)

(*1) The Acceptance Test Procedure (ATP) is a full test used to clear an LRU after repair.
(*2) The Standard Servicibility Test (SST) is an end to end test used to clear an LRU, assuming no repair action has been performed.
(*3) The SST for SPILS is defined as the ATP.

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