

Focus on CSIR services in flutter excitation

The purpose of a flutter exciter is to impart a vibration into a structure. An excitation system, carried by the flight test aircraft, allows for energy input into the aircraft structure to excite all the natural modes. During flutter flight testing these structural vibrations are measured by accelerometers and the responses are used to determine if flutter onset is likely or not. A flutter excitation system improves the signal to noise ratio of the accelerometer responses and provides higher fidelity structural data. The flutter exciters used by the CSIR include:

Bonkers – Explosive charge that provided a single excitation. This was used on Buccaneers, Impalas, Mirage F1's, etc.

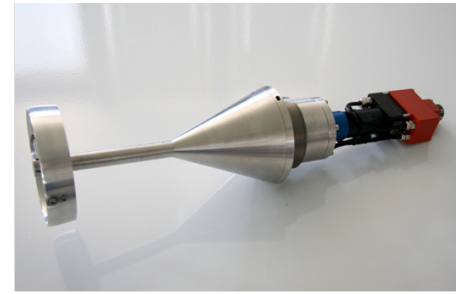
Rotating cylinder exciters – CSIR co-developed this type of flutter exciter. The rotating cylinder provided excitation over a programmable frequency range and duration.

Annular wing exciters – This type of system is currently used on civilian and high speed military aircraft. The annular wing excitation system provides excitation over a programmable frequency range and duration.

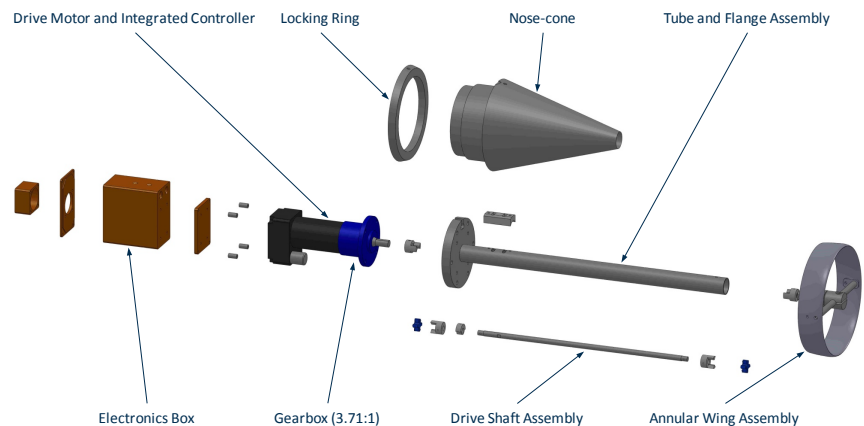
Excite

The exciters comprise

- an annular wing to induce oscillating loads
- an electric motor (with integrated onboard motion controller) to drive the annular wing
- two full-strain gauge bridges and electronics housed at the back of each motor to receive encoder signals used to drive the motors through a differential encoder line receiver, strain gauge amplifiers and a DC-DC converter to power the circuit.



Flutter exciter



Store Mounted Flutter Exciter Assembly

Flutter exciter components

Overview of the system

The flutter exciter system (FES) includes a port exciter, a starboard exciter, a cockpit control unit (CCU) and a 27VDC-11.7A ground station with associated cables. Typically a logarithmic sweep from 1Hz-40Hz is done. The exciter is compact enough to be fitted into a store and thus not influence the flutter characteristics of the store configuration being cleared. Vertical (Z) and lateral (Y) excitation forces are measured through two full strain gauge bridges. Strain gauge signals are amplified on board (Gain=500, cut-off frequency=50Hz). Feedback to the pilot is done through the VFR screen of the CCU and LED indication lights.

Cockpit control unit

The CCU consists of

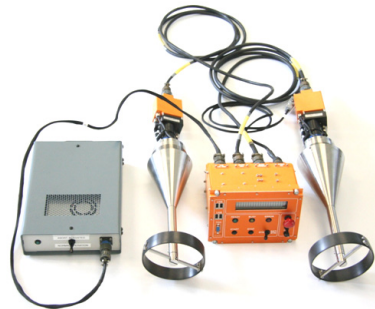
- an embedded control computer to communicate with each exciter and record frequency sweep data
- indication lights and an alpha numeric display to inform the pilot of its status
- a motor controller and master electric motor with an integrated encoder to generate a control signal for both the port and starboard flutter exciters
- the start button is used to initiate a frequency sweep and the stop button is used to abort a frequency sweep, if necessary
- it also contains a frequency sweep mode switch to select either symmetric or anti-symmetric excitation
- a master switch and abort button, either of which can be used to cut power to the FES should the need arise
- an additional (external) abort switch that has the same function as the master switch and primary abort button
- a circuit breaker to limit the current draw of the system and to act as an additional emergency switch (when pulled)
- a ready (green) light that indicates to the pilot that the motion control computer has booted up correctly and that a frequency sweep can be initiated
- a busy (yellow) light to indicate that the flutter exciter motors are in the

- process of rotating the annular wings along a frequency sweep profile
- an error (red) light that indicates that a problem with the FES has been encountered or that the maximum current draw of the motors has been exceeded
- a 20x2 alphanumeric display to indicate certain parameters (for example frequency sweep start frequency, end frequency, period and progress) to pilots.

Ground station

The ground station setup has the following components

- ground power supply
- CCU and two exciters
- USB mouse and keyboard
- computer monitor (screen)
- various cables



Some of the ground station setup components

Control software

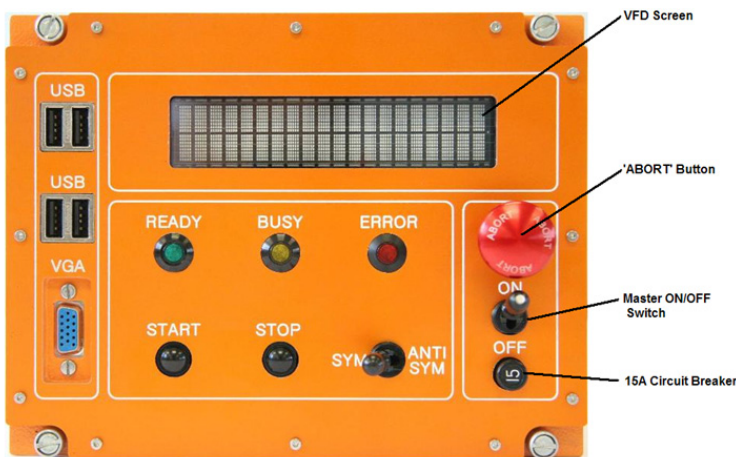
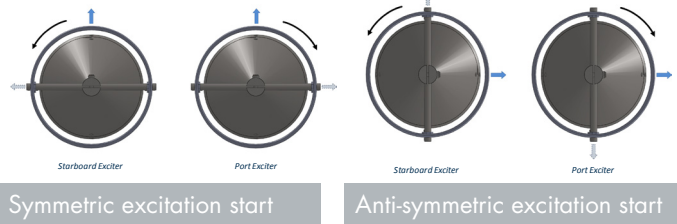
The source code is written in MS Visual C++ 2008. There are three separate threads:

- Main thread required for initial setup and to ensure that program runs indefinitely;
- Motion control thread to control motors and acquire motor data (highest priority)
- DIO thread to monitors switch inputs and operate lights).

A terminal program running on a PC is used to configure the master and slave motors.

Basic functionality

The port and starboard flutter exciter motors are slaved (the master motor is housed in the CCU). The flutter vanes (or annular wings) are positioned for symmetric/anti-symmetric excitation with optical switches. Symmetric excitation starts with: Exciter vane "bars" in a horizontal position. Anti-symmetric excitation starts with: Exciter vane "bars" in a vertical position. An error is indicated if current draw on either motor exceeds set limit by an illuminated red LED. There are four methods to stop/abort a sweep in the case of an emergency: "STOP" button (software stop); "ABORT" button (cuts power); Master switch (cuts power); Master 15A circuit breaker (cuts power).



Cockpit control unit

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