

Advanced control and safety unloading systems in use on the HAWK LIF FSFT

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Hawk LIF FSFT Control and Safety Systems

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Content

- Hawk Lead-In-Fighter Full-Scale-Fatigue-Test
- Control and Data Acquisition System
- Safety Unloading System



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Test Location



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The Australian Defence Science and Technology Organisation is conducting a Full Scale Fatigue Test under contract to BAE SYSTEMS of the Hawk Mk127 Lead In Fighter airframe at the DSTO Fishermans Bend facility in Melbourne, Australia

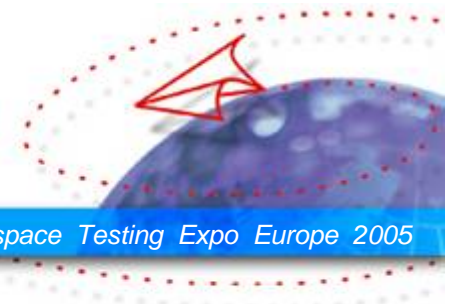
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BAE SYSTEMS Hawk Mk127 Lead In Fighter

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90 Control Channels



84 hydraulic actuators
in load
or displacement
control



6 pressurised
volumes under
pressure control



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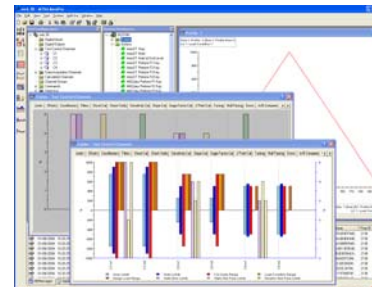
Control and DAS Hardware

- 96 Channels MTS Aero ST configured as four 24 channel chassis, mounted in two racks
- 1200 Channels of HBM Data Acquisition in two racks



Control and DAS Software

- MTS AeroPro™ 4.1 Software



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MTS Aero ST Hardware

48 channel rack
Aero ST



600 channel rack
HBM Data Acquisition



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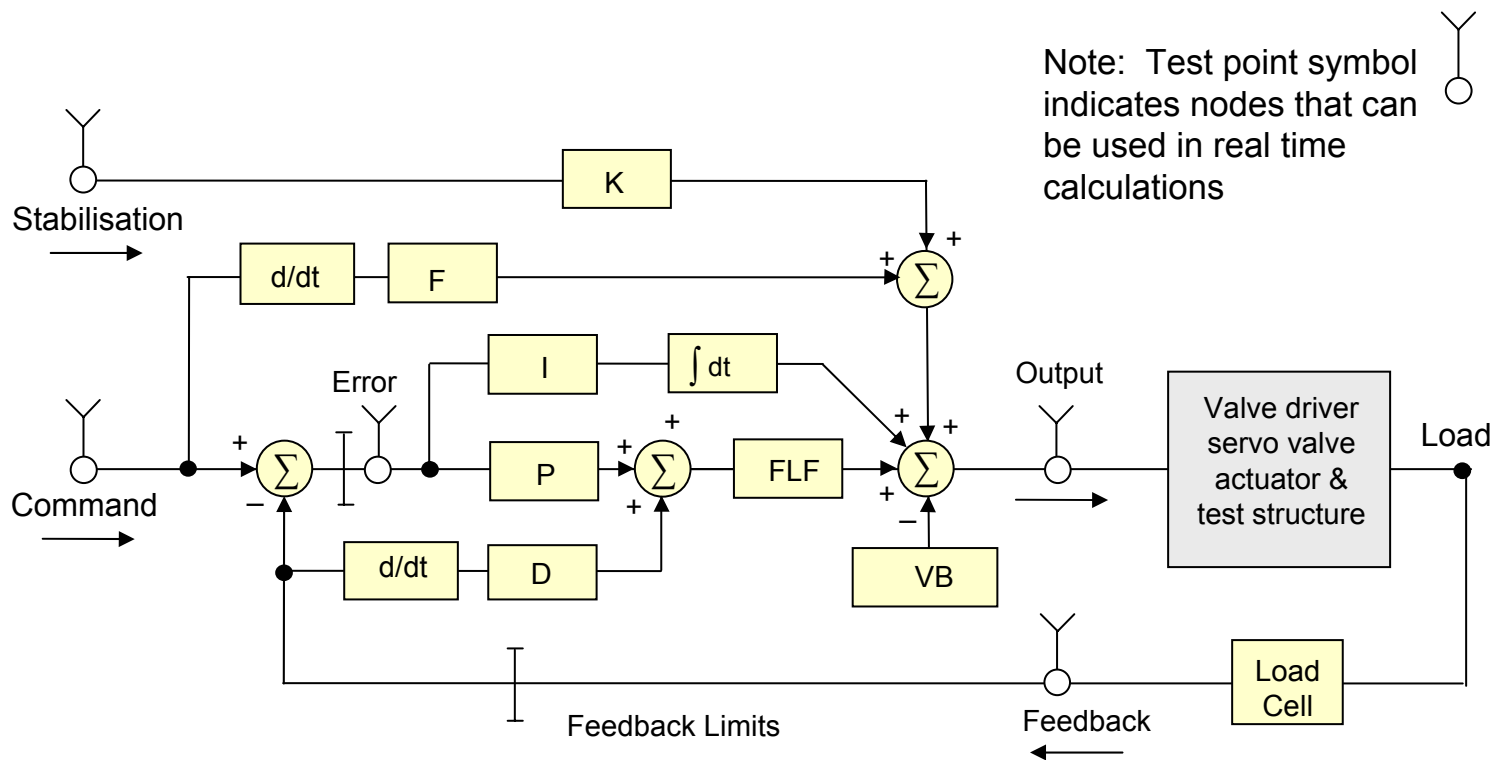
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Simplified AeroPro Control Law Block Diagram



Note: Test point symbol indicates nodes that can be used in real time calculations



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Legend: P – Proportional gain, I – Integral gain, D – Differential gain,
F - Feed-forward gain, K - Stabilisation gain , VB - Valve balance,
FLF -Forward Loop Filter

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Calculated Inputs and Outputs

- Attributes of virtual inputs and outputs:
 - calculated at system sync rate
 - functions of real inputs and outputs
 - functions of nodes from other control channels
 - functions of system states
- LIF FSFT Application:
 - custom control laws
 - real-time multi-channel interaction compensation
 - non-linear gain scheduling
 - reaction back-off



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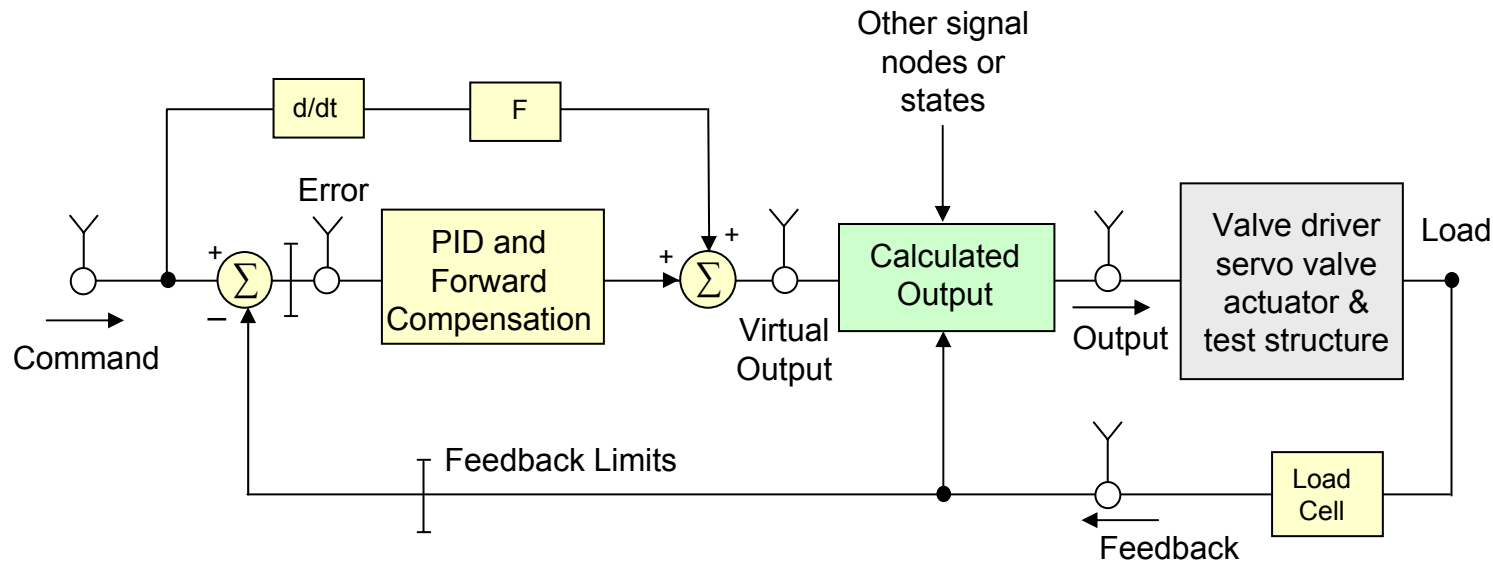
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Non Linear Gain Scheduling



If the servo valve flow gain is a non-linear function of the feedback load, then a Calculated Output function can be derived so that the rate of change of Load is a linear function of the “Virtual Output” signal



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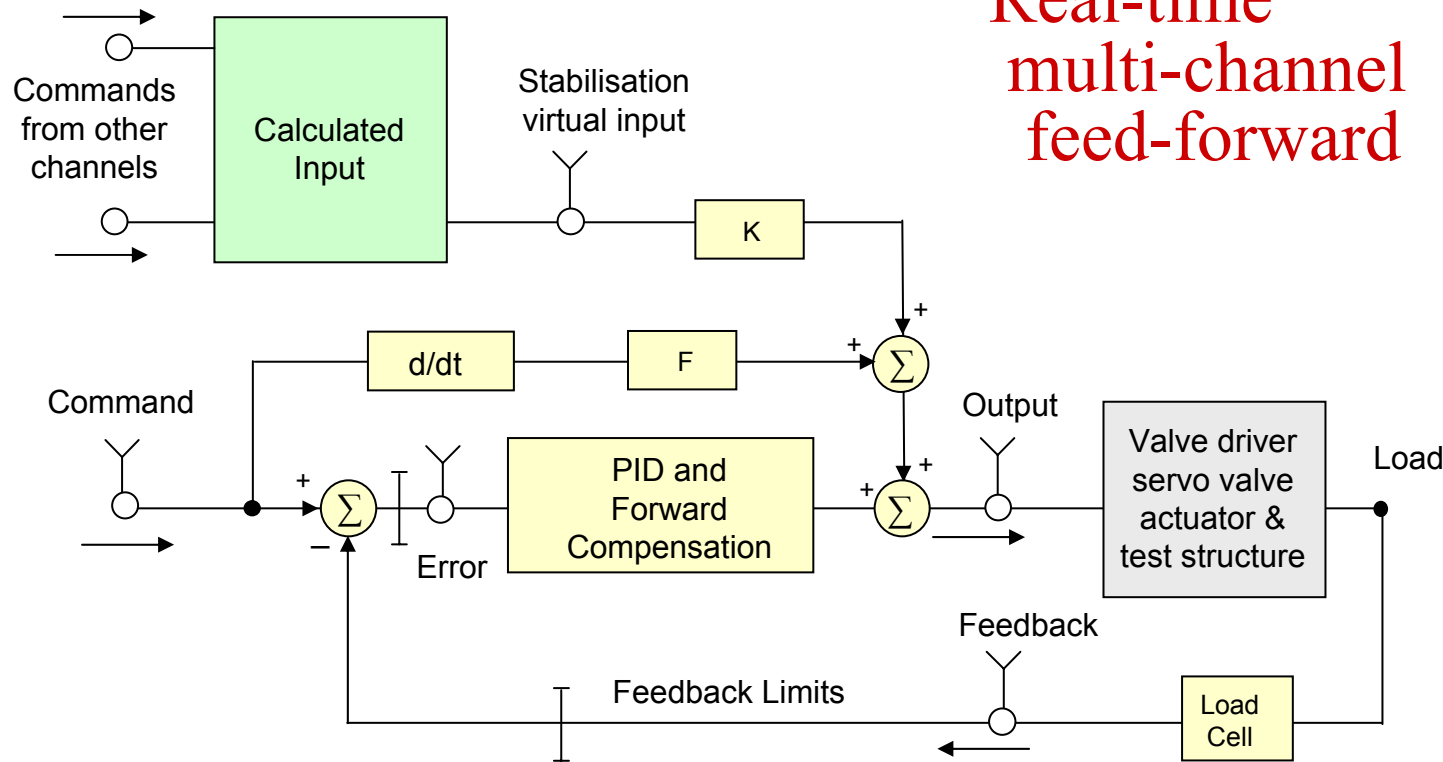
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Real-time multi-channel feed-forward



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Where several other channels interact with a control channel, the effects of the interaction can be cancelled out by using a Calculated Input that is a weighted sum of the rate of change of the disturbance channel commands.

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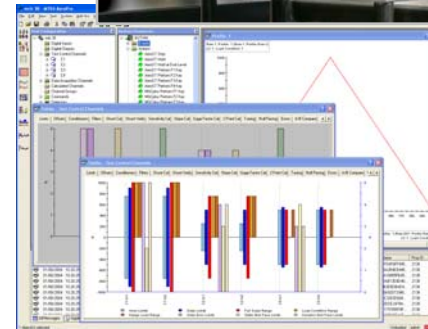
Unload System Hardware

- Two separate 48 Channel MTS Aero ST systems
- 90 MOOG Controlled Abort Manifolds
- 5 MOOG Passive Abort Manifolds



Unload System Software

- MTS Aero 793 Software with Multipurpose TestWare® Software



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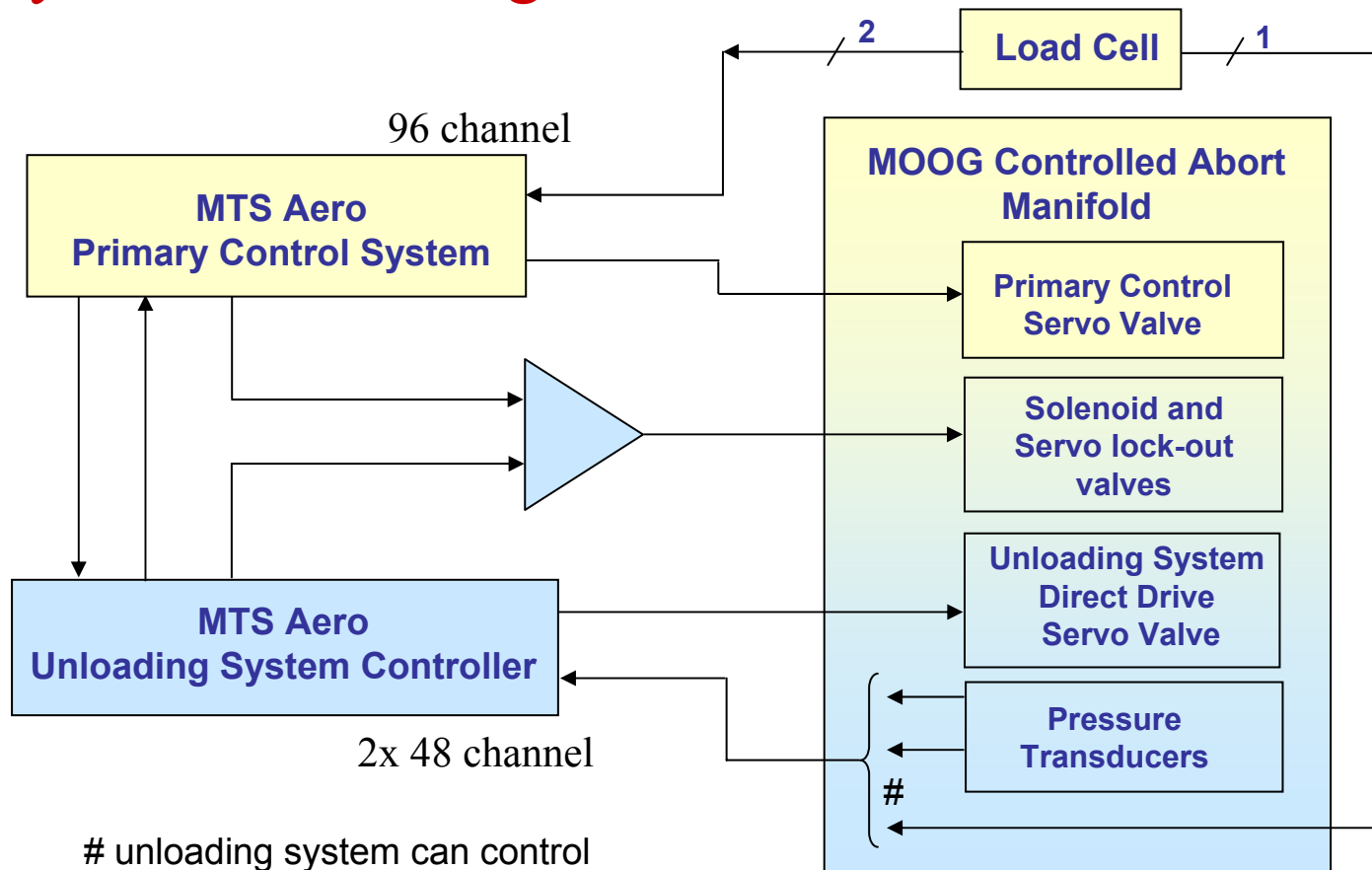
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Primary Control and Unload System Block Diagram



unloading system can control by load or differential pressure



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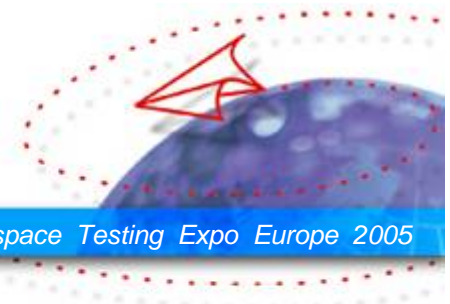
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MOOG Australia – Controlled Abort Manifold



Based on DSTO passive unload valve pack,
common manifold for the controlled abort and passive abort models



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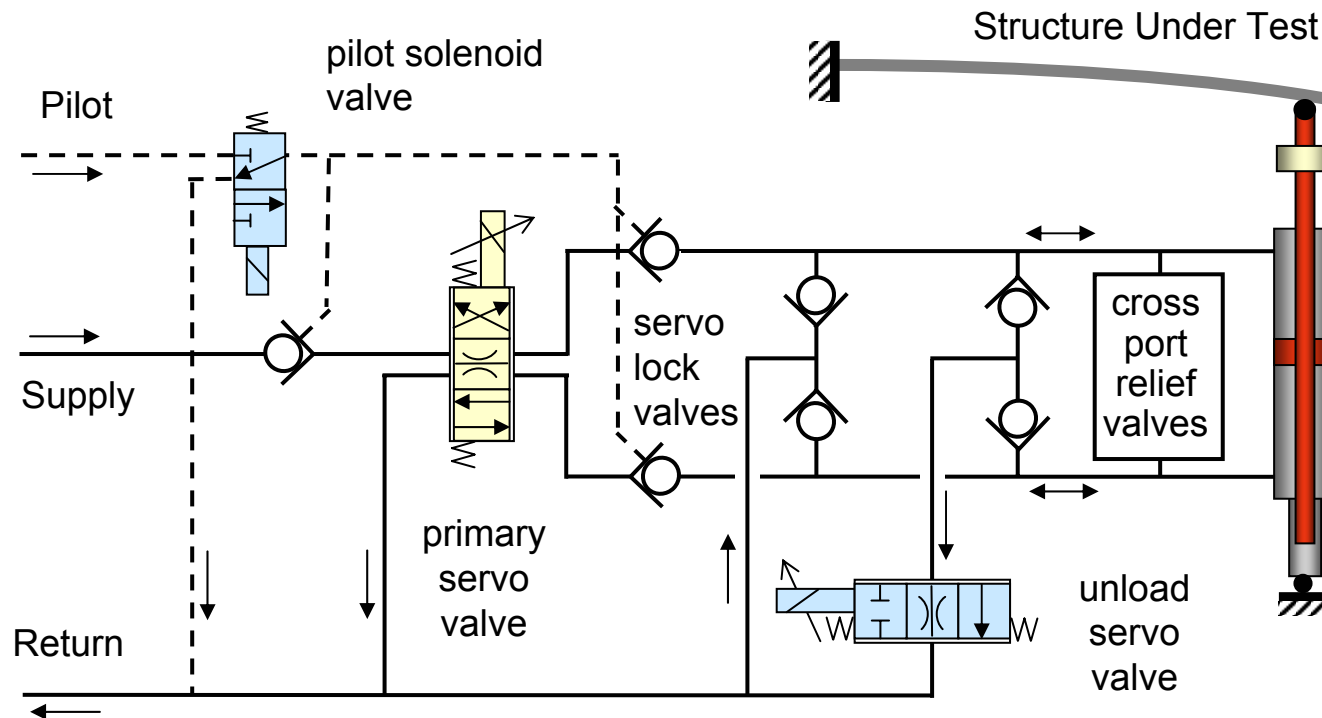
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CAM Hydraulic Circuit



Loss of pilot pressure or de-energising pilot solenoid switches from primary control to unload control



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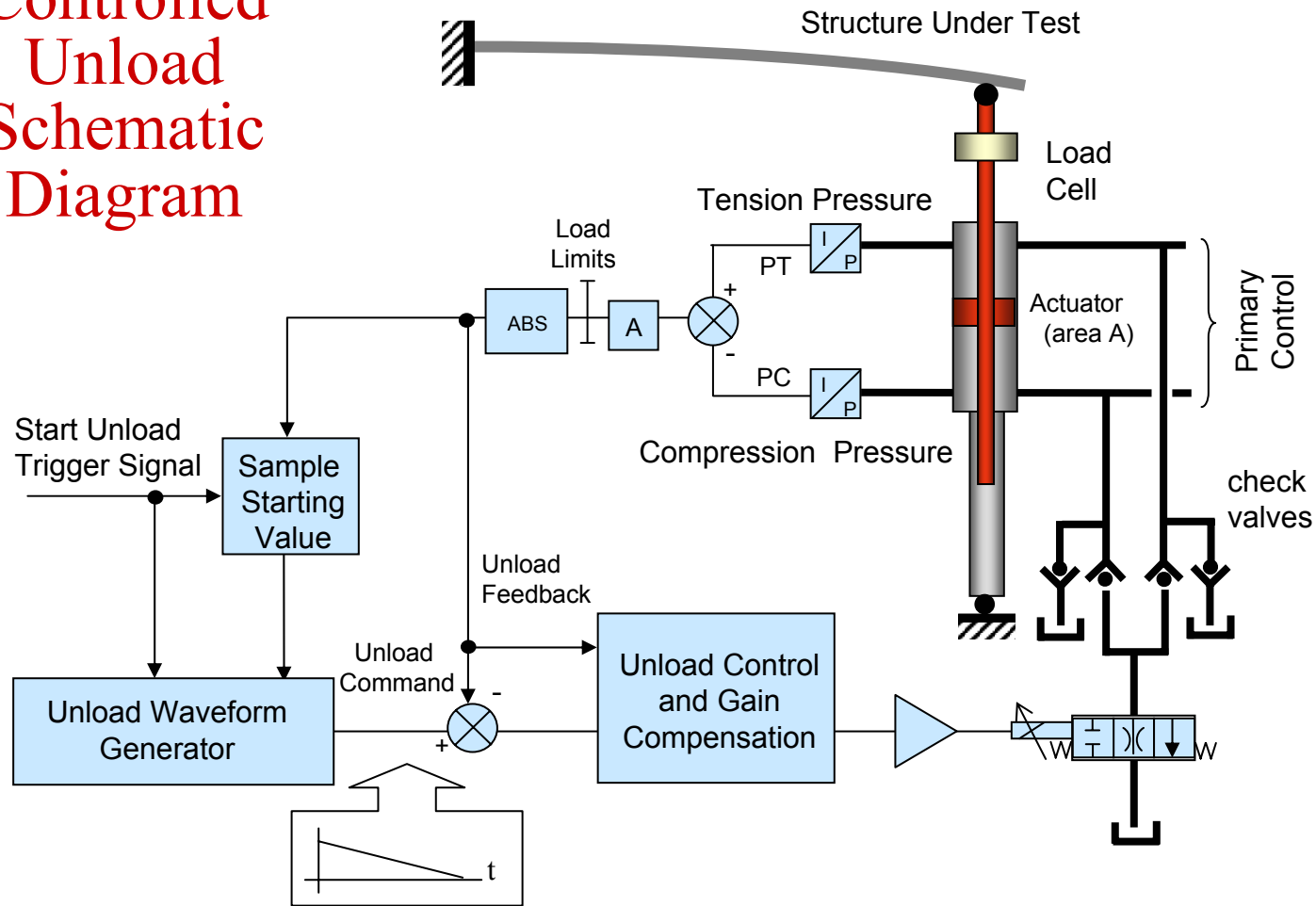
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Controlled Unload Schematic Diagram



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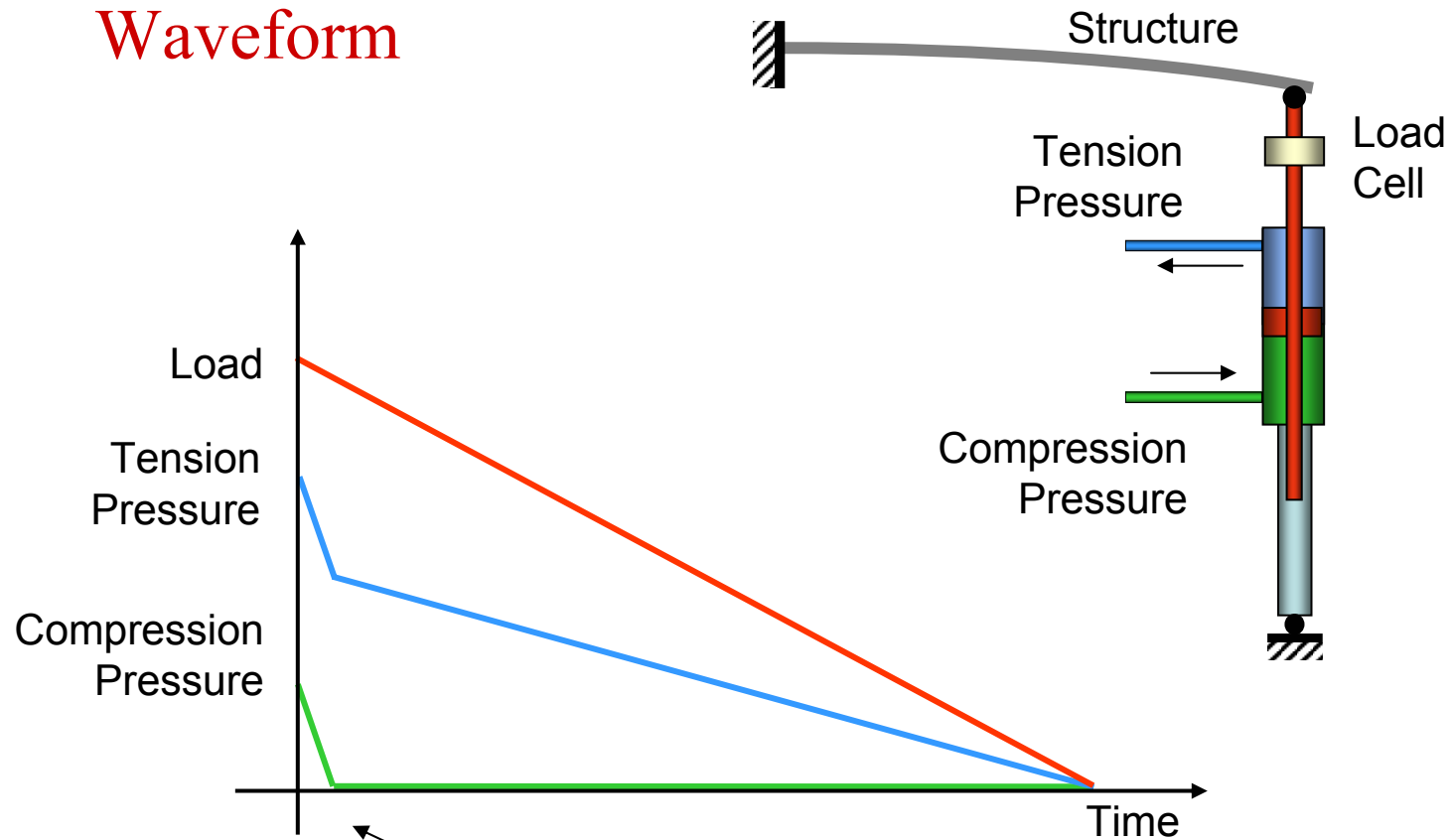
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Controlled Unload Waveform



Initial movement causes one chamber to drop to zero pressure



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Multi-channel Spring Rig

- Two Channel Primary Control
- Two Channel Controlled Unload
- Variable stiffness pneumatics
- MTS Flextest GT controller
 - Development work
 - Commissioning subsystems
 - Operator Training



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Conclusion

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New Developments Featured on Hawk LIF FSFT

- First multi-box MTS Aero ST / AeroPro System
- Improved control law compensation and valve balancing
- Calculated inputs and outputs to customise control laws
- Test data in a long term XML data archiving format
- MTS / MOOG controlled unload system

Note: DSTO has been either a contributor to many of these developments or has been involved with testing and validation of these new capabilities.



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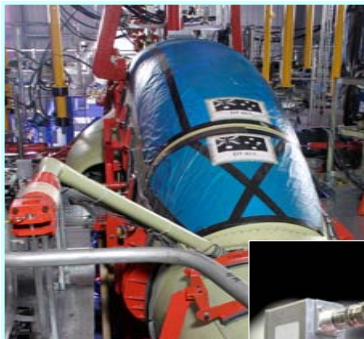


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Questions?



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