Development of Low Shock Release Device

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【Development Point】

・The high shock of conventional pyrotechnic Lock Release Device constrains onboard hardware arrangement.

・Improvement is demanded to enforce competitiveness of our satellite products.

⇒ Development of Low Shock Release Device (LSRD) is necessary.

【Development Goal】

・The conventional pyrotechnic lock release device produces over 1,000(X9.8 m/s² srs){Gsr s}. We aim less than 100(X9.8 m/s² srs){Gsr s} shock output.
Pyro Compatibility

Solar Array Paddle (Stowed)

Pyro Device

I/F

Lock Release Mechanism

<Pyro Device>

LSRD

<LSRD>
High shock of conventional pyrotechnic Lock Release Device

about 1,600(X9.8 m/s^2){G} max

Preload: 7.35kN
Test was performed on aluminum plate: 230X230X20mm
Measured: 57mm from source
High shock of conventional pyrotechnic Lock Release Device

about 4,000($\times$9.8 m/s$^2$ srs){G$_{srs}$} max

Preload: 7.35kN
Test was performed on aluminum plate: 230X230X20mm
Measured: 57mm from source

SRS: Shock Response Spectrum
Objective:
- Reduction of lock release shock
  ⇒ Relaxation of constraints of onboard hardware

Impact shock:
- Low Shock Release Device: 100 (X9.8 m/s² srs){Gsrs}
- Pyrotechnic lock release device:
  1,000 (X9.8 m/s² srs){Gsrs}

Application:
- Lock and release device for Solar Array Paddle
- Lock and release device for optical instruments

Challenge:
- Originality of the mechanism
- High reliance
- Cost competitiveness
- Interface compatibility with conventional device
- Reuse operation capability
LSRD Spec

- LSRD(Prototype) development specification

  Load retention/Release system: Ball screw + Separation holder
  Trigger system            : SMA (Shape Memory Alloy)
  Lubricant system          : Solid lubrication
  Retention load            : 10kN
  Shock output              : 100 (X9.8 m/s² srs)\(\times 9.8\) m/s²\(s\)
  Dimension                 : Smaller than \(\phi 60 \times 50\)mm (body only)
  Mass                      : Less than 350g
  Trigger signal            : Pyrotechnic I/F compatible
  Operation time            : Less than 200ms
  Temperature               : Op/Non-Op \(-55\)℃〜\(+70\)℃
  Operation endurance       : More than 100 times of operation.
  Redundancy                : Redundant trigger electrical system
  U.S.A. EL/TAA concern     : Completely free.
Operation principle

• Release the link structure by energizing and heating the SMA wire in the Trigger structure. By the upper displacement of the ball screw, the Separation holder moves up to unhook the Rod.

1. Releasing lock and Beginning of Separation.

2. Unloading the rod axial force

3. Unleashing the Separation holder

4. Releasing the Hook

5. Stopping of rotor rotation, then completing its separation

The axis of the ball screw stops as it reaches the case. The Rotor stops its rotation.
Shock test configuration: Long Rod Case
Negligible Low Shock of LSRD

about 20 (X9.8 m/s\(^2\))\{G\} max

Preload: 10kN
Test was performed on aluminum plate: 530X530X5mm
Measured: 54mm from source
Configuration: Long rod

Example of LSRD(Prototype) Acceleration Time History
Negligible shock of LSRD

about 100 (X9.8 m/s² srs){Gsrs} max

Preload: 10kN
Test was performed on aluminum plate: 530X530X5mm
Measured: 54mm from source
Configuration: Long rod

Example of LSRD(Prototype) SRS
Feasibility has been confirmed in program JFY04,05 (Joint research with JAXA).
Development phase has been started as JFY06 JAXA standard component.
Preliminary Design Review was completed in February 2007.
It is in critical designing phase, now.
Qualification tests is planned to complete in JFY08.

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Schedule