EBAD

Ensign-Bickford Aerospace & Defense™

TiNi®

Space Mechanisms Product Catalog

NEA®

SPACE MECHANISMS | SATELLITE DEPLOYMENT | ELECTRICAL & POWER SOLUTIONS | PROPULSION MECHANISMS

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NEA TiNi

Space Mechanisms

EBAD has been at the forefront of design, development, and fielding of low-shock, non-explosive release mechanisms for space and defense applications. Our portfolio contains two industry leading brands: the NEA® family of Split Spool Release Devices (SSRD) and the TiNi™ family of Shape Memory Alloy (SMA) devices.

EBAD's non-explosive mechanisms were developed and fielded in the mid-1990s and have been used on more than 1,000 spacecraft, launch vehicles, and missile platforms with 100% on-orbit actuation. These mechanisms are used for many space-platform functions:

Missile and Launch Vehicle: stage, fairing, and shroud separation, ground hold-down, umbilical and stabilizer release, fuel line separation, and spacecraft deployment

Orbital Transfer Vehicles: release of solar arrays, antenna reflectors, and spacecraft deployment

Spacecraft: release of solar arrays, antenna reflectors, instruments, and other deployable elements

EBAD invites you to explore our product offering shown in this catalog. If you cannot find what your platform requires, reach out to our team of application engineers who can help customize a mechanism solution that is ***Right for Your Mission™.***

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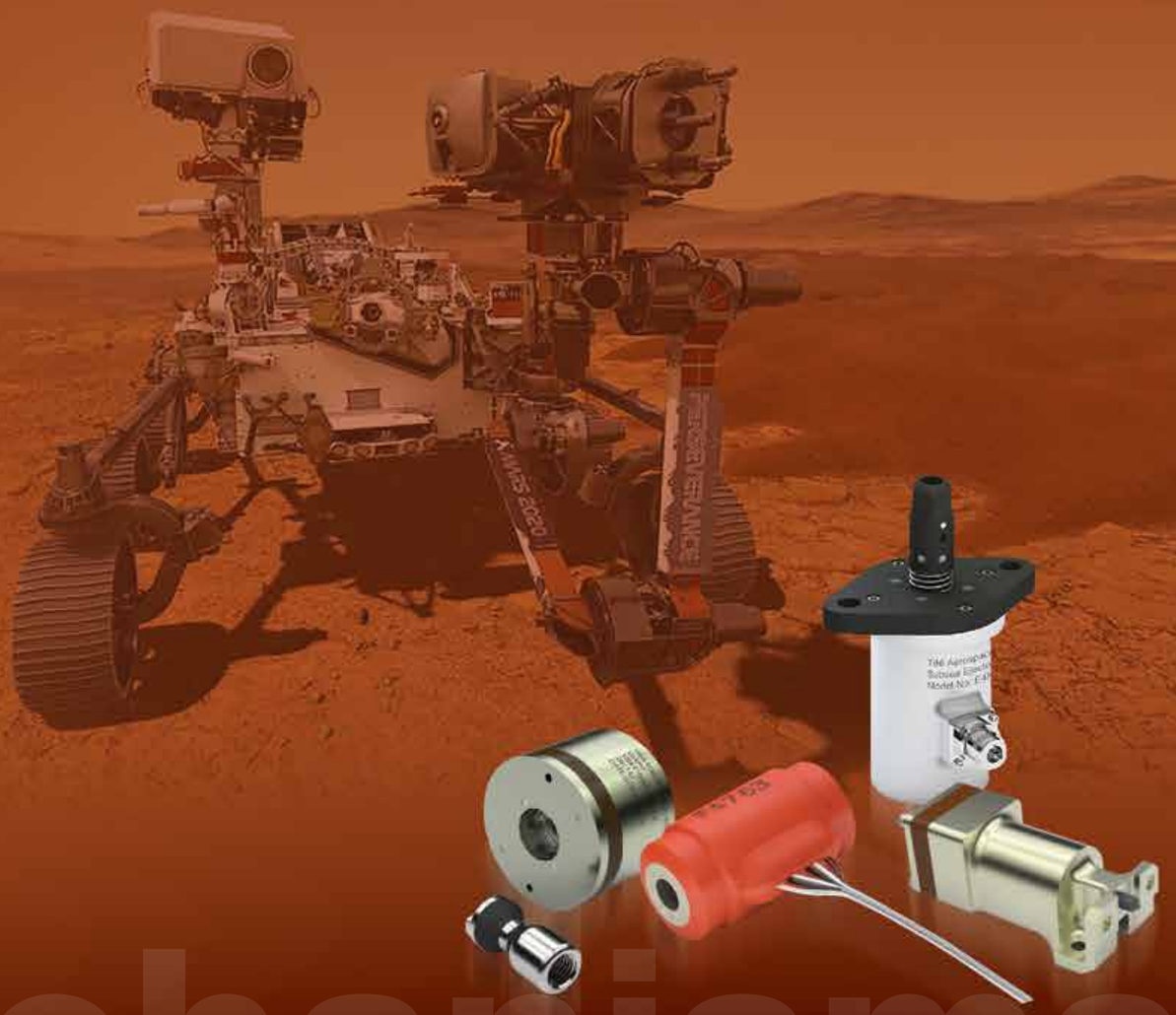
Space Mechanisms

PERFORMANCE FOR LEO CONSTELLATIONS TO DEEP SPACE MISSIONS

For decades, pyrotechnic mechanisms were used in space applications for Hold Down & Release of solar arrays and antennas. TiNi™ and NEA® technologies were first fielded in the mid-1990s after which they were broadly adopted in the space industry due to their non-explosive and low shock performance. These technologies have matured to encompass broad thermal environments seen on exploration missions such as Mars 2020 Perseverance Rover, BepiColombo, Rosetta-Philae, Hyabusa2-MASCOT, and James Webb Space Telescope.

For deployment of small and medium-sized commercial constellations of satellites, EBAD has developed high-preload, ultra-low shock deployment systems. These systems allow developers to design new satellites at a significantly lower shock level than ever imagined. EBAD has invested in innovative and complimentary technologies to provide our customers with a diverse portfolio of products for any mission, proving again that we are Right for Your Mission™.



Space Mechanisms

EJECTOR RELEASE MECHANISM (ERM) | TiNi™ FRANGIBOLT | HOLD DOWN & RELEASE MECHANISMS (HDRM) | PIN PUSHER/PULLER www.EBAD.com

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Ejector Release Mechanism (ERM)

HIGH LOAD HOLDING CAPABILITY AND FAST ACTUATION TIME

The EBAD TiNi™ Ejector Release Mechanism (ERM) is a uniquely simple and effective device which offers both high load holding capability and fast actuation time. The Actuator “Coupler” acts as a detachable nut and may be used to support and release loads up to 4,000 lbf.

The ERM can be reset within seconds while still attached to the structure via a simple tool provided by EBAD.

The EBAD TiNi™ Micro Latch was developed specifically for “New Space” applications such as hold down and release of Cubesats. It is small in size, fast acting, and a cost effective way to support and release preloads up to 50 lbf.

Space Mechanisms

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Mission Success

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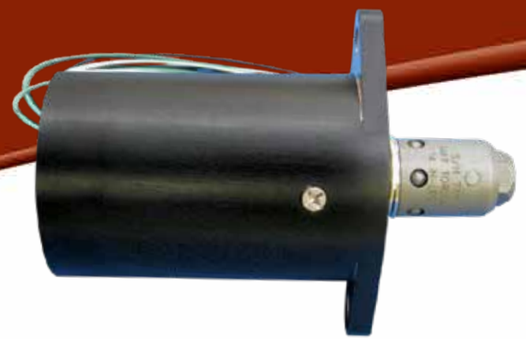


TiNi™ Ejector Release Mechanisms

Our TiNi™ Ejector Release Mechanisms are utilized in satellite applications to provide a simple and effective non-pyro field resettable separation system with allowances for up to 5º angular misalignment during deployment. Ranging in size from 250 lbf to 4,000 lbf of Max release load, the ejectors offer a versatile solution from satellite solar array deployments, satellite dispensing, off angle optical cover, and antenna releases.

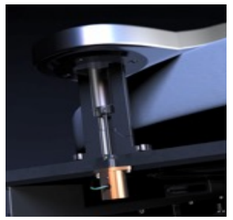
Principle of Operation

The ejector is a reliable fast operating device that ultilzes a Shape Memory Alloy (SMA) wire to release a latch to allow for the internal compression springs to retract an interal pin and allow for the external ball locks to disengage and release the coupler.

In the fully reset mode, the internal circuit is closed. When sufficient power is applied, the current raises the temperature of the SMA wire and subsequently contracts at its transition temperature. This allows internal ball locks to release and internal drive springs to retract a pin into the body of the device.

Once the pin drops, external ball locks are disengaged alowing the external springs to “kick off" the coupler. A spherical seat is incorporated to allow for up to 5º angular misalignment during deployment. After acutation, the circuit is open allowing no power to continue to heat the SMA wire and provides the user with positive feedback that the device has actuated.

The device is reset with a custom tool that aligns the coupler back onto the post and pulls the internal pins to reengage the external ball locks.



Before deployment

After deployment

Applications

Qualified in 2001, EBAD’s TiNi™ ejectors have extensive heritage in space applictions. Such applications include solar array and instrument deployment, satellite dispensing, hinged cover release, and other space applications where an off angle deployment is desired.

Key Features

- Non-pyrotechnic
- Easy to field reset and simple to use
- Minimum 50 cycles
- Redundant firing circuit
- Maximum reliability through design simplicity
- Flight pedigree and testability

Alternative applications include parachute releases, underwater acutations, and modifications into other mechanisms such as gas cylinder penetrators.

Construction

As a derivative of the EBAD TiNi™ Pin Pullers, our Ejector Release Mechanisms utilize a Shape Memory Alloy (SMA) wire, in which the wire is threaded through a latch and attached to the electrical contacts. The latch retains an internal ball bearings that keeps the compressed drive springs in place before actuation. Another smaller internal reset spring is installed to assist in the reset process.

Additional ball locks are incorporated between the output pin and the coupler. The kick off spring assists in keeping the external ball locks in place after actuation.

The ejector is fully vented and typically the enclosure is made with aluminum alloy. The coupler is custom 455 SS with a tiolon finish.

Alternative voltages utilize an internal resistor to protect the SMA wire from overheating.

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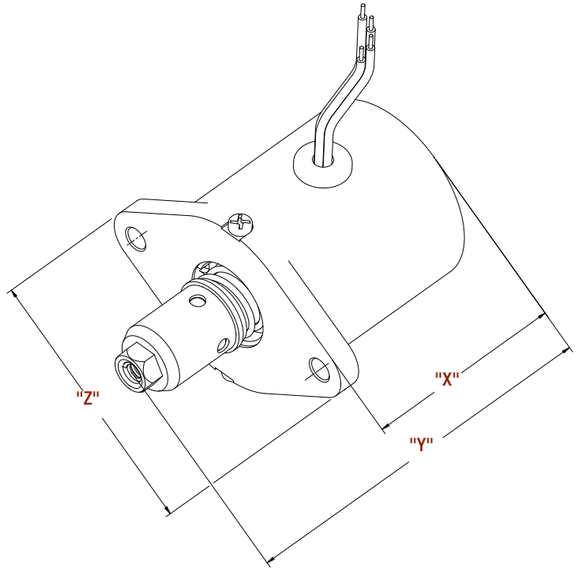
TiNi™ Ejector Release Mechanisms (ERM)

TiNi® ERM Ejector Release Mechanisms Family Technical Specifications

Ejector Family	E250	E500	E1000	E2000	E4000
Max Release Load	250 lbf (1,112 N)	500 lbf (2,224 N)	1,000 lbf (4,448 N)	2,000 lbf (8,900 N)	4,000 lbf (17,800 N)
Proof Load	350 lbf (1,557 N)	700 lbf (3,114 N)	1,400 lbf (6,230 N)	2,500 lbf (11,125 N)	5,000 lbf (22,400 N)
Max Torque	92 in-oz	14 in-lb	32 in-lb	70 in-lb	250 in-lb
Coupler Kick Off-Force	1.5 lbf	6.5 lbf	9.5 lbf	8.5 lbf	18 lbf
Max Misalignment Capability	+/- 5º engagement and deployment				
Mass	2.7 oz (75 g)	3.6 oz (100 g)	5.6 oz (160 g)	10.6 oz (300 g)	18.7 oz (530 g)
Operating Current	.75 to 2.5 A	1.25 to 4 A		2.25 A to 6.5 A	
Resistance	3.3±.3 Ω	2.2±.3 Ω	1.6±.3 Ω	2.2±.3 Ω	2.5±.3 Ω
Function Time @ 23°C	100 ms max @ 1.25 A	100 ms max @ 2.5 A		100 ms max @ 4A	
Cycle Life (min)	50				
Operating Temp	-65ºC + 70ºC				
Height (without coupler)[x]	1.375 in	1.625 in	2.00 in	2.65 in	3.3 in
Height (with coupler)[y]	2.195 in	2.475 in	2.95 in	3.93 in	4.8 in
Max Diameter (with flange)[z]	1.85 in	2.1 in	2.35 in	3.00 in	3.825 in
Std Coupler Engagement Size	.138 in-32	.164 in-32	.190 in-32	.250 in-28	.375 in-24

Contact EBAD about alternative voltages/resistance, mounting flanges, and coupler types

TiNi™ Ejector Release Mechanism E250 Mechanical Interface Drawing (for reference)



TiNi™ Ejector Release Mechanisms (ERM) Family of products

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TiNi™ Microlatch

Developed in the mid 2010's for the "New Space" small satellite market, the EBAD TiNi™ Microlatch offers a simple and effective non-pyro field resettable separation system for low preload deployments. Utilizing shape memory alloy, the microlatch offers a reliable alternative solution to other small release solutions utilizing nichrome burn wires or other technologies.

With a 50 lbf release load, this device is suitable for small solar array release, optical cover release, cube sat deployers, and applications requiring a small device.

Principle of Operation

The EBAD TiNi™ Microlatch is a reliable fast operating device that ultilzes a shape memory alloy (SMA) wire to release a latch to allow for the external ball locks to disengage and release the coupler.

In the fully reset mode, the internal circuit is closed. When sufficient power is applied, the current raises the temperature of the SMA wire and subsequently contracts at its transition temperature. This movement disengages a latch and opens the circuit.

With power disengaged, the device is simply reset by aligning the coupler and pressing it back on to the device.

Applications

Qualified in 2018, EBAD TiNi™ Microlatch offers a small and effective release for small solar array and instrument deployment, optical cover release and other space applications.

Key Features

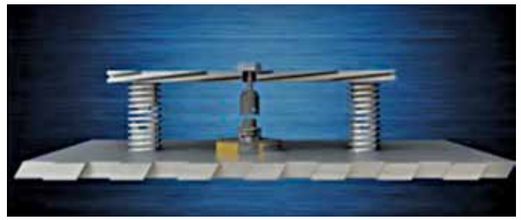
- Non-pyrotechnic
- Easy to field reset with no tooling
- Minimum 50 cycles
- Maximum reliability through design simplicity

Construction

As a derivative of the EBAD TiNi™ products, the mircrolatch utilizes a shape memory alloy (SMA) wire as the trigger mechanism.

By disengaging the latch, the external ball locks fall into the coupler mount, alowing kick off springs to eject the coupler.

The EBAD TiNi™ Microlatch is fully vented with the coupler manufactured from custom 455 SS with a tiolon finish and the kick off springs from 17-7PH SS. It comes in two voltage configuratinos.



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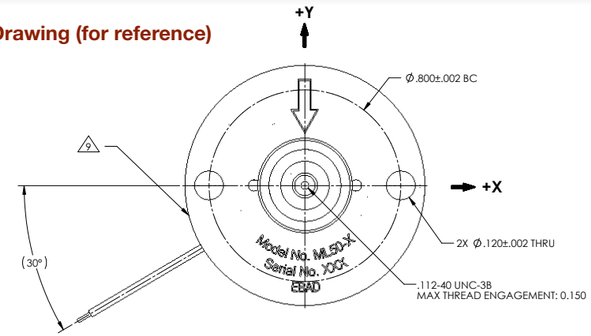
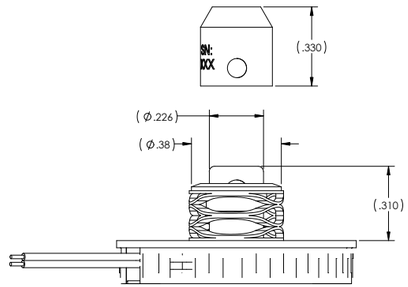
TiNi™ Microlatch Technical Specifications

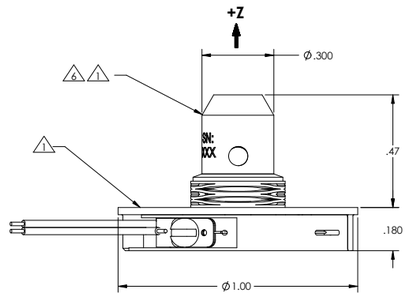
Parameter	ML50-1	ML50-2
Max Release Load	50 lbf (222 N)	
Proof Load	100 lbf (445 N)	
Max Torque	25 in-oz	
Coupler Kick-Off Force	7.5 lbf	
Mass	.53 (15 g)	
Voltage Range	3 to 5.5 V	10 to 18 V
Operating Current	1.5 to 3.75 A	
Resistance	1.75±.3 Ω	5.75±1 Ω
Function Time @ 23°C	120 ms max @ 1.75 A	
Cycle Life (min)	50	
Operating Temp	-50ºC + 60ºC	
Height (without coupler)	.5 in	
Height (with coupler)	.65 in	
Max Diameter (with flange)	1.00 in	
STD Coupler Engagement Size	.112 in-40	

TiNi™ Microlatch Mechanical Interface Drawing (for reference)





RELEASED VIEW



RESET VIEW

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Mission Success

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TiNi™ Flat Pack FP50

EBAD's TiNi™ products are non-pyrotechnic and field resettable, utilizing shape memory alloy to perform the necessary actuation for a variety of products and end applications. EBAD's TiNi™ products offer a variety of solutions for satellites, subsea, and aerospace/defense applications. Launch vehicle and missile products are manufactured with the utmost regard to quality assurance, and EBAD is committed to being the industry leader in both quality and performance.

Principle of Operation

Shape Memory Alloys (SMAs) refer to a group of materials that have the ability to return to a predetermined shape when heated. The shape memory effect is caused by a temperature dependent crystal structure. When an SMA is below its phase transformation temperature, it possesses a low yield strength crystallography referred to as Martensite. While in this state, the material can be deformed into other shapes with relatively little force. The new shape is retained, provided the material is kept below its transformation temperature. When heated above this temperature, the material reverts to its parent structure, known as Austenite, causing it to return to its original shape.

Applications

The TiNi™ Flat Pack FP50 is a miniature hold-down release mechanism (HDRM) used in a variety of low-load applications.

Typical applications include:
- Solar arrays, antenna reflectors, instruments, doors, sensors, and booms

Key Features

- Field resettable
- Auto shut-off switch
- Low height <.25"
- No debris generation
- Qualified to standard launch environments
- Range safety friendly
- Space-rated materials

Construction

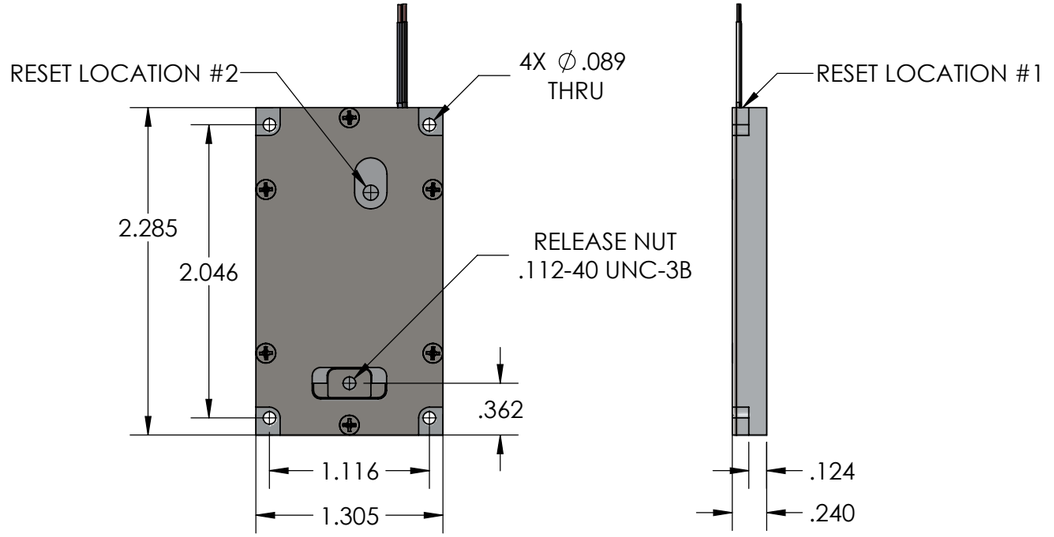
Utilizing a Shape Memory Alloy (SMA) wire, the wire is threaded through a bell crank and attached to the spring loaded electrical contacts. The bell crank retains the trigger, which keeps the drive springs on the slider compressed. Another smaller reset spring is installed to assist in the reset process.

TiNi™ Flat Pack FP50

TiNi™ Flat Pack FP50 Technical Specifications

Parameter	Capability
Mass	1.17 oz (33 g) max
Power	1.25 W @ .75 A
Operational Current	.4 A to 1.5 A
Resistance	3.3±.3 Ω @ 23°C
Max Release Load	50 lbf (222.4 N)
Proof Load	100 lbf (444.8 N)
Function Time	130 mSec @ .5 A (23°C) typical
Max Torque	15 in-oz (106 N mm)
Reusable	By manual reset
Life	50 cycles min
Operational Temperature	-65°C to + 70°C
Non-Operational Pre-Actuation	-150°C to + 70°C
Non-Operational Post-Actuation	-150°C to + 150°C

TiNi™ Flat Pack FP50 Mechanical Interface Drawing (for reference)



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TiNi™ Frangibolt

SIMPLE AND EFFECTIVE

The EBAD TiNi™ Frangibolt® Actuator is a simple and effective way to support and release loads up to 26,200 lbf. The principle of operation is simple: A Shape Memory Alloy (SMA) cylinder elongates to fracture a bolt or stud thereby achieving separation of two or more components. Since its outer space debut aboard the spacecraft Clementine (1994), the Frangibolt has been qualified and used in numerous other space applications, including GPS 3 and Mars Perseverance.

As with all of the TiNi™ product line, the Frangibolt® Actuator is non-pyrotechnic and field reset-able with a minimum qualified life of 60 cycles.

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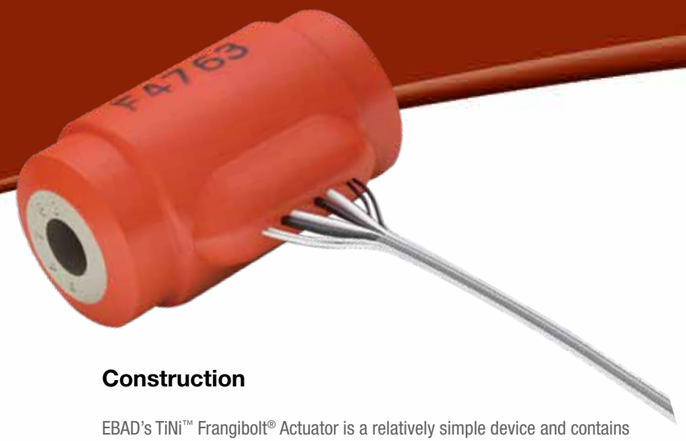


TiNi™ Frangibolt® Actuator

EBAD's Frangibolt® Actuators are utilized in satellite applications to provide a simple and effective non-pyrotechnic separation system between two components or structures. With the ability to customize the Titanium (Ti) fastener to meet the applications joint design, the frangibolt offers design flexibility in a compact package.

Easy to use, resetting the device is straightforward with our compression reset fixture and replacement of the notched Titanium (Ti) fastener.

Principle of Operation

The EBAD Frangibolt® Actuator is a simple and effective way to support and release loads up to 26,200 lbf. The principle of operation is simple - actuation occurs when power is applied to a Shape Memory Alloy (SMA) cylinder until it reaches its transition temperature. As the SMA cylinder heats up, it expands to its elongated length to produce strain on the bolt or stud thereby achieving separation of two or more components or structures and fracturing occurs at the predetermined notch. Standard fastener sizes range from #8 to 1" bolts.

Construction

EBAD's TiNi™ Frangibolt® Actuator is a relatively simple device and contains few components that increase its reliability. The device is comprised of a machined SMA cylinder, encapsulated with redudant resistive heaters and embedded RTD's. The whole asssembly is then wrapped in a silicone rubber compound to provide both thermal and electrical isolation.

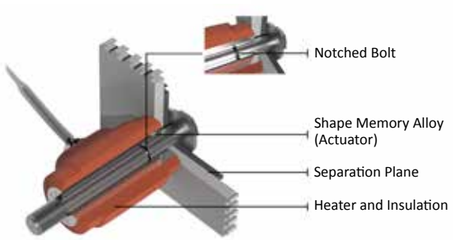
Applications

Since 1994, the frangibolt has extensive heritage in space applictions. Such applications include solar array and instrument deployment, instrument launch locks, optic covers, and other space applications where a small form factor is needed between two interfaces. In addition, EBAD manufactures subsea versions and the #4 Mini-Frangibolt® Actuator for smaller applications.

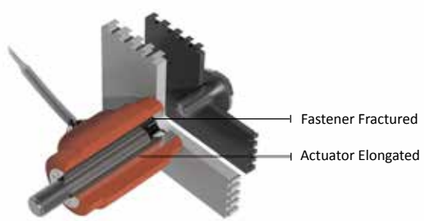
Key Features

- Non-pyrotechnic
- Easy to reset and simple to use
- Redundant Firing Circuit
- Maximum reliability thu design simplicity
- Flight pedigree and testability

EBAD's TiNi™ Frangibolt® Actuators must be ordered with custom to Titanium (Ti) notched fasteners that are manufactured per strict tolerances. Accessory hardware such as washer, lock nuts, and enclosures are available. In addition, switch washers, when wired in series can be used as an automatic shut-off switch to the frangibolt actuator once tension is released and the to Titanium (Ti) fastener is fractured.



Frangibolt before actuation



Frangibolt after actuation

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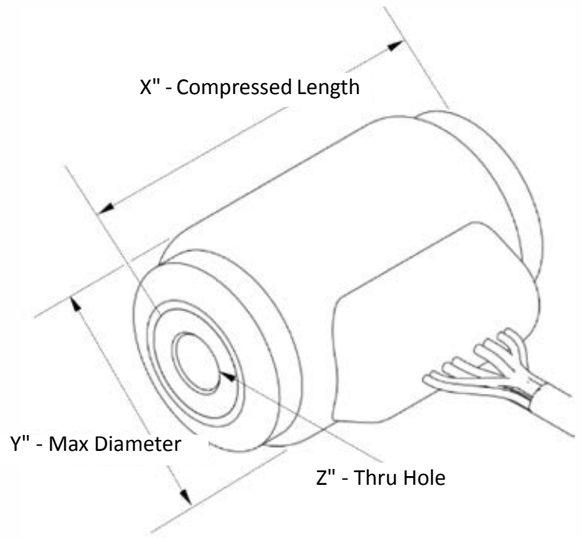
TiNi™ Frangibolt® Actuator

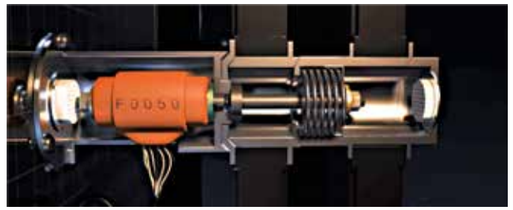
TiNi™ Frangibolt® Actuator Technical Specifications

Actuator Family	FC2	FC3	FC4		FC6		FC8	FB12
Ti Fastener Size	#8	#10	1/4"		3/8"		1/2"	1"
Mass	25 g	40 g	55 g		110 g		175 g	350 g
Power	25 W @ 28 V	49 W @ 28 V	80 W @ 28 V	111 W @ 100 V	112 W @ 28 V	143 W @ 100 V	105 W @ 36 V	145 W @ 29 V
Operational Voltage*	22-36 V	22-36 V	22-36 V	95-105 V	22-36 V	95-105 V	28-41 V	26-32.5 V
Current Draw	.9 A @ 28 V	1.75 A @ 28 V	2.9 A @ 28 V	1.1 A @ 100 V	4 A @ 28 V	1.4 A @ 100 V	4.8 A @ 36 V	5 A @ 29 V
Resistance	31±3 Ω	16±1.6 Ω	9.7±1.5 Ω	90±9 Ω	7±1 Ω	70±7 Ω	7.5±1 Ω	5.8±.4 Ω
Max Load Support	850 lbf (3,781 N)	1,400 lbf (6,227 N)	3,400 lbf (15,123 N)		6,000 lbf (26,689 N)		9,600 lbf (42,702 N)	26,200 lbf (116,543 N)
Function Time	30 s @ 28 V (23ºC)	35 s @ 28 V (23ºC)	35 s @ 28 V (23ºC)	25 s @ 28 V (23ºC)	60 s @ 28 V (23ºC)	40 s @ 100 V (23ºC)	80 s @ 28 V (23ºC)	CONTACT EBAD
Life	60 cycles min							CONTACT EBAD
Operating Temperature	-65ºC + 80ºC						CONTACT EBAD	CONTACT EBAD
Compressed Length (X")	.960 in	1.210 in	1.450 in		1.940 in		2.120 in	2.460 in
Diameter (Y")	.625 in	.760 in	.950 in		1.225 in		1.400 in	1.975 in
Thruhole (Z")	.169 in	.194 in	.257 in		.381 in		.520 in	.762 in

**Inquire with EBAD on alternative voltage ranges/options*

TiNi™ Frangibolt® Actuator Mechanical Interface Drawing (for reference)





Frangibolt before actuation

Frangibolt after actuation

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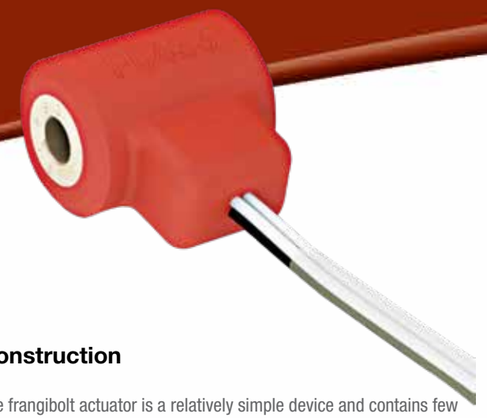


TiNi™ MINI Frangibolt® FD04

EBAD's Mini-Frangibolt® Actuators are utilized in satellite applications to provide a simple and effective non-pyro separation system between two components. With the ability to customize the #4 Titanium (Ti) fastener to meet the applications joint design, the mini-frangbolt offers design flexibility in one of our most compact packages.

Easy to use, resting the device is straightforward with our compression reset fixture and replacement of the notched #4 Titanium (Ti) fastener.

Principle of Operation

EBAD's Mini-Frangibolt® Actuator is a simple and effective way to support and release loads up to 150 lbf. The principle of operation is simple, in which actuation occurs by applying power to the internal heaters to raise the temperature of the Single Crystal Shape Memory Alloy (SCSMA) cylinder, until it reaches its transition temperature. As the SCSMA cylinder heats up, it expands to ~6% of it's elongated length to produce strain on the EBAD provided #4 Titanium (Ti) fastener and breaks at the predetermed notch.

EBAD's Mini-Frangibolt® Actuators must be ordered with custom Titanium (Ti) notched #4 fasteners that are manufactured per strict tolerances. Accessory hardware such as G10/Ti washer, lock nuts, enclosures are available. For cold operation, EBAD recommends utilizing our G10 washers to assist in thermal isolation. In addition, switch washers, when wired in series can be used as an automatic shut-off switch to the frangibolt actuator once tension is released and the Titanium (Ti) fastener is broken.

Construction

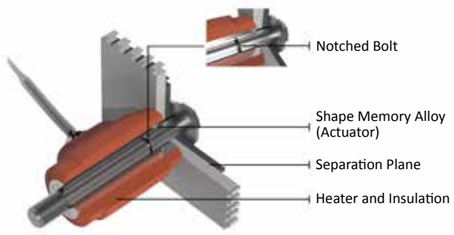
The frangibolt actuator is a relatively simple device and contains few components that increase its reliability. The device is comprised of a machined SCSMA cylinder, encapsulated with redudant resistive heaters and embedded RTD's. The whole asssembly is then wrapped in a silicone rubber compound to provide both thermal and electrical isolation.

Applications

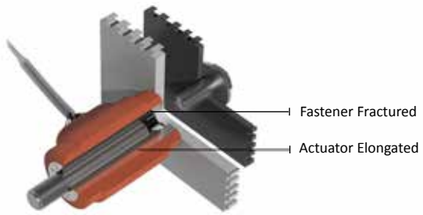
Since 1994, the frangibolt has extensive heritage in space applictions. Such applications include solar array and instrument deployment, instrument launch locks, optic covers and other space applications where a small form factor is needed between two interfaces. In addition, EBAD manufactures larger franigbolts for space and subsea applications.

Key Features

- Non-pyrotechnic
- Easy to reset and simple to use
- Redundant firing circuit
- Maximum reliability through design simplicity
- Flight pedigree and testability



Frangibolt before actuation



Frangibolt after actuation

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TiNi™ MINI Frangibolt® FD04

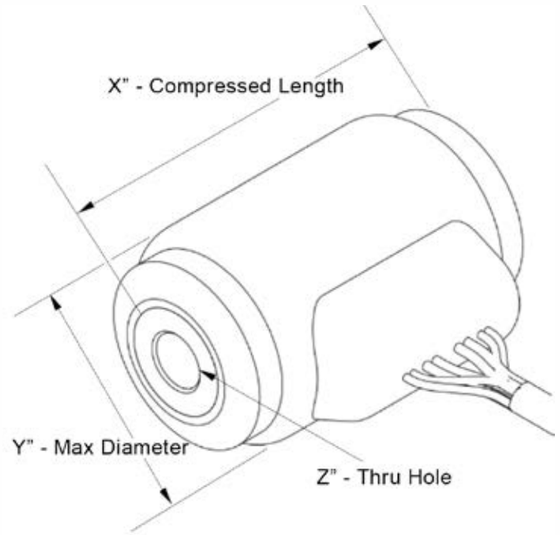
TiNi™ MINI Frangibolt® FD04 Technical Specifications

Actuator Family	FD04
Ti Fastener Size	#4
Mass	10 g
Power	9 W @ 7 V
Operational Voltage	6-8 V
Current Draw	1.25 A @ 7 V
Resistance	5.5±.5 Ω
Max Load Support	150 lbf (667 N)
Function Time	30 s @ 7 V (23°C)
Life	20 cycles min
Operating Temperature	-50°C + 70°C
Compressed Length (X")	.500 in
Diameter (Y")	.450 in
Thruhole (Z")	.116 in

Frangibolt before actuation

Frangibolt after actuation

TiNi™ MiniFrangibolt® FD04 Actuator Mechanical Interface Drawing (for reference)



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EBAD
Ensign-Bickford Aerospace & Defense
NEA TiNi

NEA® Hold Down & Release Mechanisms (HDRM)

HIGH PRELOAD, ULTRA-LOW SHOCK

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market. NEA® mechanisms were first fielded in 1998 aboard the Intelsat 8 (PAS-8) Geostationary satellite for antenna and solar array release. After that, there was broad industry adoption on LEO, GEO, and scientific missions. EBAD's NEA® mechanisms have been used on more than 750 spacecraft and have thousands of on-orbit actuations without failure.

Non-Explosive Actuator (NEA®) technology is used for medium-to-high preload applications. They have wide temperature performance and are best characterized by their ultra-low release shock. NEA® mechanisms are offered in a range of sizes and load capacities up to a 90,000 lbf (40,000 N pounds force).

EBAD makes thousands of space mechanisms each year, satisfying the most demanding quality requirements. We offer robust industrial capacity to meet the needs of high-volume constellation programs.

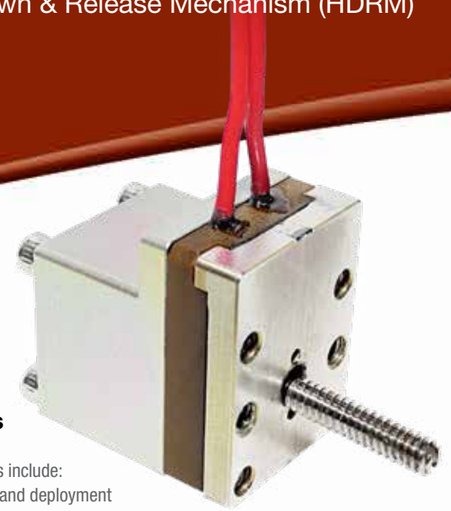
Space Mechanisms

NEA® Model 9040 Miniature
Hold Down & Release Mechanism (HDRM)

Ensign-Bickford Aerospace & Defense

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.



NEA® Model 9040 Miniature

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market. HDRMs are offered in a range of sizes. The NEA® Model 9040 supports release loads up to 250 lbf (1,100 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that can carry a preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves, which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by the electrical fuse wire. When sufficient electrical current is applied, the restraint wire unwinds, allowing the spool halves to separate, releasing the release rod and the associated preload.

Applications

Typical applications include:
- CubeSat release and deployment
- Scientific instruments
- Satellite, Spacecraft, and Payloads

Key Features

- Low cost
- Low mass
- Extremely low release shock
- Single circuit activation (not redundant)
- One-time use

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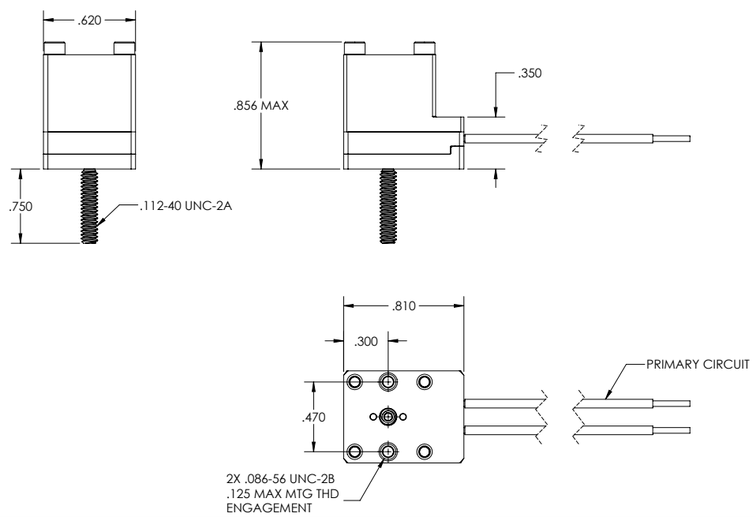
NEA® Model 9040 Miniature
Hold Down & Release Mechanism (HDRM)

NEA® Model 9040 Miniature Technical Specifications

Parameter	Capability
Proof Load Rating	300 lbf (1,300 N)
Release Load Rating	250 lbf (1,100 N)
Output Shock @ Preload[1]	<300 g's @ 250 lbf (1,112 N)
Fuse Wire Resistance	0.8 - 1.8 Ω
Actuation Current[2]	3.0 Amps for 50 ms
No-Fire Current[3] (continuity)	250 mA
Release Time[4]	<50 ms
Temperature Range[5]	-60°C to 125°C
Maximum Angular Misalignment	3° Cone
Mass[6]	<13.6 g (.03 lbm)

Notes:
[1] Shock is preload & setup dependent, contact applications engineering for shock at other preloads.
[2] Actuation can be achieved using a range of current, the value in the table is the value for qualifying this device.
[3] No fire current for 5 minutes or less at ambient temperature, consult EBAD applications engineers for other no-fire current requirements.
[4] Release time is dependent on actuation current, preload, and temperature. Contact applications engineering for more specific information on actuation time as a function of current.
[5] The values presented for qualification temperature range are not a measure of the limits of the device.
[6] Mass does not include harnessing and lead wires.

NEA® Model 9040 Miniature Mechanical Interface Drawing (for reference)



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NEA® Model 9100
Hold Down & Release Mechanism (HDRM)

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9100 Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market. Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9100 supports release loads up to 1,360 lbf (6,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9100's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

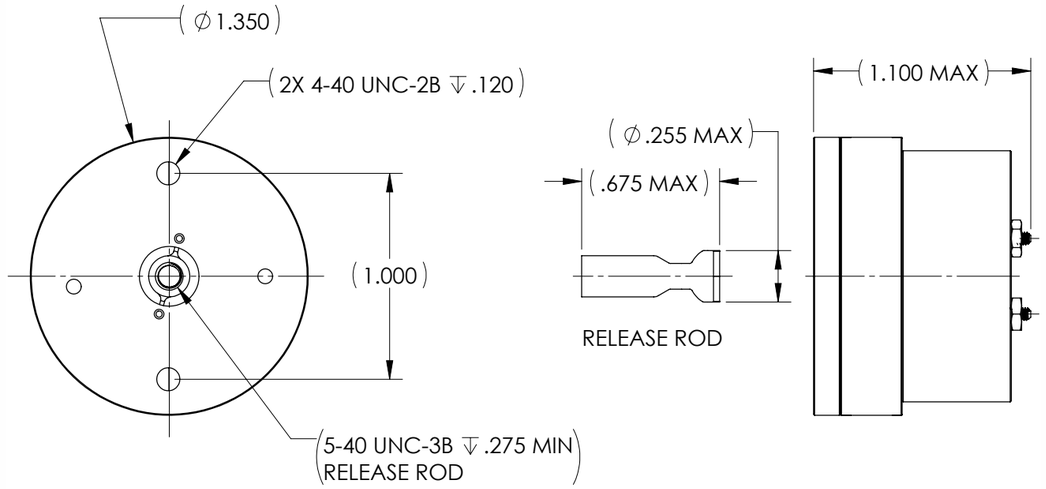
NEA® Model 9100
Hold Down & Release Mechanism (HDRM)

Model 9100 Technical Specifications

Parameter	Capability
Proof Load Rating	1,700 lbf (7,600 N)
Release Load Rating	1,360 lbf (6,000 N)
Shock @ Preload[1]	<300 g's @ 1,360 lbf (6,000 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mA at 10-5 Torr @ 110°C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	3° Cone
Mass[6]	70 g (0.15 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9100 Mechanical Interface Drawing (for reference)



Note: Model 9100 Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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Model 9102G Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The Model 9102G supports restrained preloads as high as 4,000 lb (17,800 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9102's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

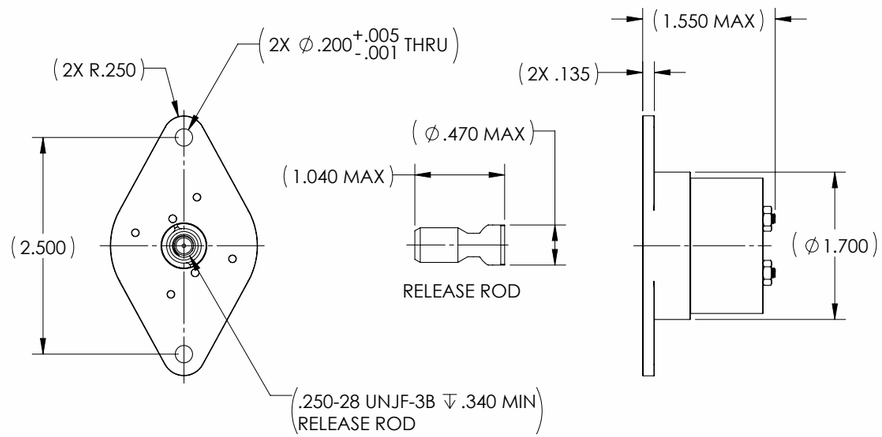
NEA® Model 9102G
Hold Down & Release Mechanism (HDRM)

Model 9102G Technical Specifications

Parameter	Capability
Proof Load Rating	5,000 lbf (2,220 N)
Release Load Rating	4,000 lbf (17,800 N)
Shock @ Preload[1]	4,000 lbf (17,800 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mA at 10-5 Torr @ 110°C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	3° Cone
Mass[6]	130 g (0.29 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9102G Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9102G Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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Model 9103 Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9103 supports release loads up to 7,868 lbf (35,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9100's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for arming and firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

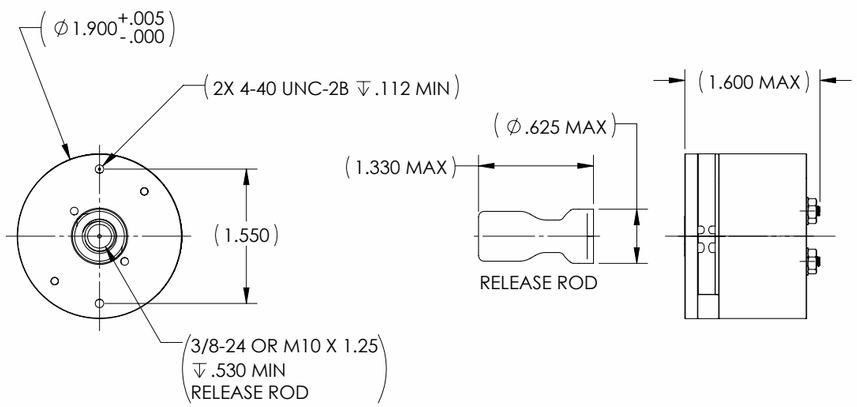
NEA® Model 9103
Hold Down & Release Mechanism (HDRM)

Model 9103 Technical Specifications

Parameter	Capability
Proof Load Rating	9,217 lbf (41,000 N)
Release Load Rating	7,868 lbf (35,000 N)
Shock @ Preload[1]	<750 g's @ 7,868 (35,000 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mA at 10-5 Torr @ 110° C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	3° Cone
Mass[6]	200 g (0.44 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9103 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9103 Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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NEA® Model 9103CC2
Hold Down & Release Mechanism (HDRM)

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Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9103CC2 Hold Down & Release Mechanism

EBAD is the global leader of non-pyrotechnic Hold Down & Release Mechanism (HDRM) for the space and defense markets. EBAD's industry-leading NEA® and TiNi® mechanisms are offered in a range of sizes and custom mounting configurations.

The NEA® Model 9103CC2 is based on the Model 9103, integrating a cup/cone shear load interface, a bolt extractor, a bolt catcher, and source shock reduction elements to form a HDRM that's ideal for multi-point satellite release. In a 4-point release configuration, the 9103CC2 is designed to dispense up to 600 kG* payloads separating laterally from a central dispensing structure. The 9103CC2 is delivered fully preloaded, so integration into space platforms is greatly simplified. The 9103CC2 is easily scaled up and down in load capacity by using a different NEA® HDRM model.

Principle of Operation

The NEA® Model 9103CC2 is an electrically initiated, one-shot mechanism that carries very high mechanical loads until commanded to release. The preload is applied through a release bolt that tightly restrains a cup/cone shear load interface. The bolt is held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release bolt and allowing the two halves of the cup/cone interface to separate.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to actuate (4) Model 9103CC2's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

*dependent on spacecraft center of gravity

Applications

Typical applications include retention and release of:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

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NEA® Model 9103CC2
Hold Down & Release Mechanism (HDRM)

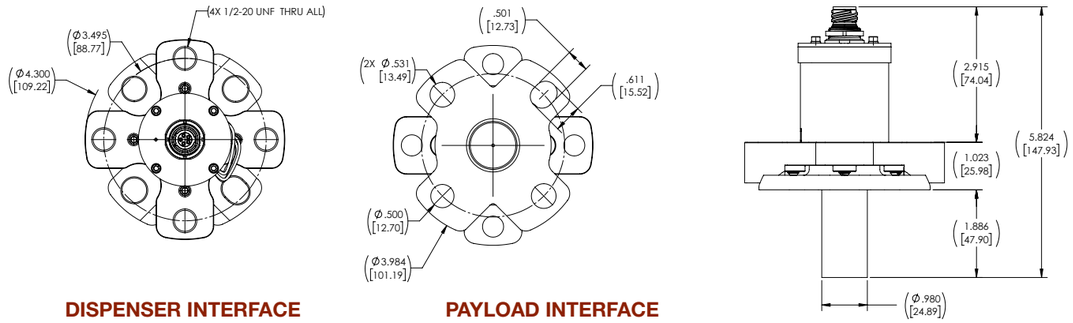
Model 9103CC2 Technical Specifications

Parameter	Capability
Preload (as Delivered)	8,500 lbf (37,800 N)
Demonstrated Export Shock (Satellite Interface)[1]	20 g @ 2 kHz, < 380 g to 10 kHz
Demonstrated Export Shock (Dispenser Interface)[1]	30 g @ 2 kHz, < 650 g to 10 kHz
Fuse Wire Resistance	1.2 Ω to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mAmps at 10-5 Torr @ 110°C
Release Time @ Actuation Current[4]	<15 mSec @ 7 Amps for 10 mSec
Release Simultaneity @ Actuation Current	+/- 2.5 mSec @ 7 Amps for 10 mSec
Fly Away Mass (Satellite Interface)	250 grams (0.55 lbm)
Total Mass	650 grams (1.43 lbm)
Operational Temperature Range[5]	-105°C to +105°C
Axial Load[6]	2,405 lbf (10,700 N)
Shear Load[6]	2,383 lbf (10,600 N)
Bending Moment[6]	484.5 Nm (357.3 ft-lb)
Torsion[6]	525.9 Nm (387.9 ft-lb)

Notes:

[1] Export shock measurement uses HDRM preload of 37.8 kN, NASA standard aluminum test plate, and accelerometers adjacent to the HDRM.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes or less as ambient temperature, consult EBAD applications engineers for other no-fire current requirements.
[4] Release time is dependent on actuation current, preload, and temperature.
[5] The values presented for qualification temperature range are not a measure of the limits of the device.
[6] Axial, shear, bending moment, and torsional loads are applied simultaneously. Safety factors applied are Yield (1.3) and Ultimate (1.55).

Model 9103CC2 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



DISPENSER INTERFACE PAYLOAD INTERFACE

Note: Model 9103CC2 HDRM shown. Different configurations available with alternate mounting features and connectors. Smaller and larger configurations available to accommodate different payloads.

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NEA® Model 9104
Hold Down & Release Mechanism (HDRM)

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9104 Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9104 supports release loads up to 15,000 lbf (67,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9104's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

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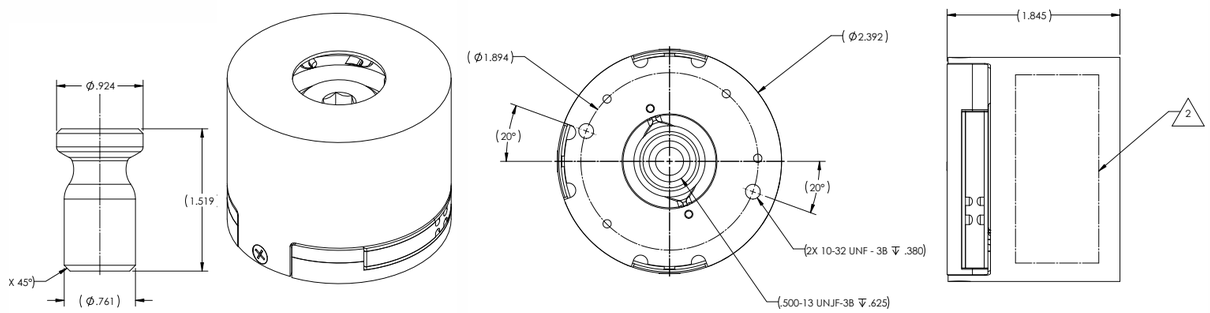
NEA® Model 9104
Hold Down & Release Mechanism (HDRM)

Model 9104 Technical Specifications

Parameter	Capability
Proof Load Rating	18,750 lbf (84,000 N)
Release Load Rating	15,000 lbf (67,000 N)
Shock @ Preload[1]	<750 g's @ 15,000 lbf (67,000 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mA at 10-5 Torr @ 110°C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	3° Cone
Mass[6]	300 g (0.66 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9104 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9104 Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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Ensign-Bickford Aerospace & Defense

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9106B Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9106B supports rrelease loads up to 32,000 lbf (142,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9106B's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

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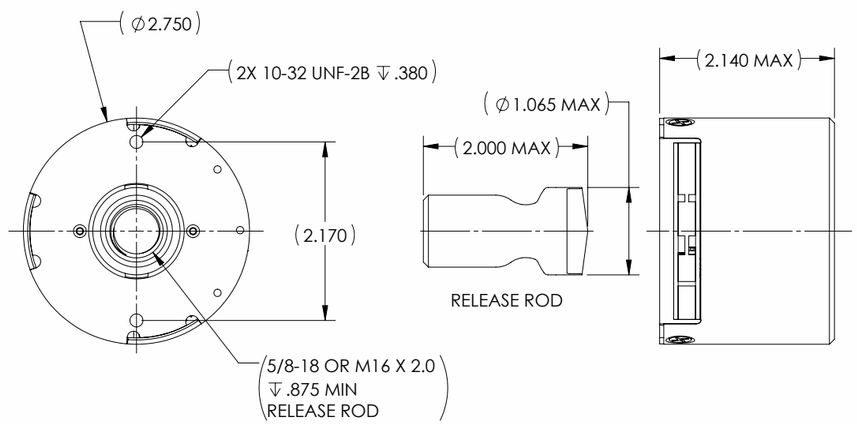
NEA® Model 9106B
Hold Down & Release Mechanism (HDRM)

Model 9106B Technical Specifications

Parameter	Capability
Proof Load Rating	40,000 lbf (178,000 N)
Release Load Rating	32,000 lbf (142,000 N)
Shock @ Preload[1]	<1,000 g's @ 32,000 lbf (142,000 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3] (continuity)	250 mA at 10-5 Torr @ 110°C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	6° Cone
Mass[6]	700 g (1.5 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9106B Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9106B Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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NEA® Model 9107
Hold Down & Release Mechanism (HDRM)

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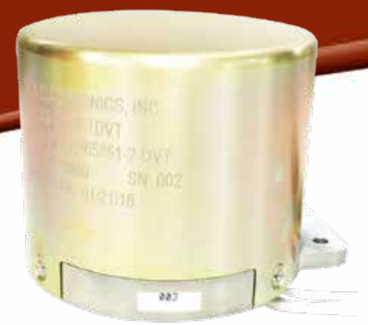


Model 9107 Hold Down & Release Mechanism

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9107 supports restrained preloads as high as 46,000 lbf (195,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

The actuation is simple and reliable and forms the basis of actuation for many of EBAD's other products including Pin Pullers, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9107's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

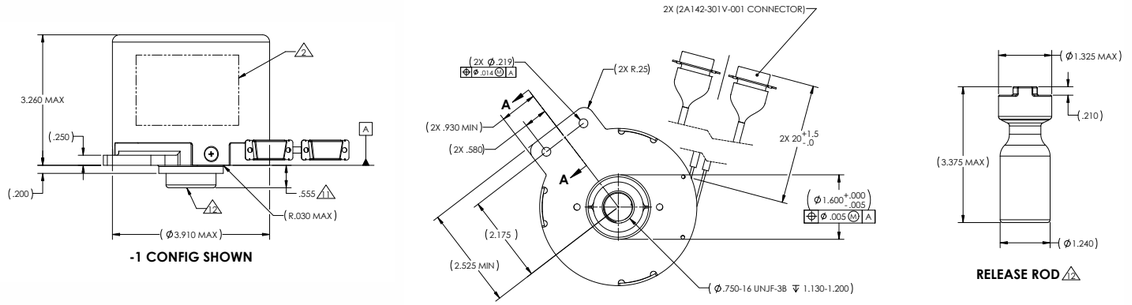
NEA® Model 9107
Hold Down & Release Mechanism (HDRM)

Model 9107 Technical Specifications

Parameter	Capability
Proof Load Rating	58,500 lbf (260,000 N)
Release Load Rating	46,000 lbf (195,000 N)
Shock @ Preload[1]	<1,100 g's @ 46,000 lbf (195,000 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 60 ms
No-Fire Current[3]	250 mA at 10-5 Torr @ 110°C
Release Time[4]	<50 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	2.6° Cone
Mass[6]	2,155 g (4.75 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9107 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9107 Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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NEA® Model 9108
Hold Down & Release Mechanism (HDRM)

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9108 Hold Down & Release Mechanism

EBAD is the global leader in non-pyro Hold Down & Release Mechanisms (HDRM). Hold Down & Release Mechanisms, also sometimes referred to as Separation Nut Release Mechanisms, are offered in a range of sizes. The NEA® Model 9108 supports release loads up to high as 72,000 lbf (320,000 N).

Principle of Operation

The NEA® HDRM is an electrically initiated, one-shot release mechanism that has the ability to carry a very high tensile preload until commanded to release. The preload is applied through a release rod held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release rod and the associated preload.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to fire (4) Model 9108's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

EBAD has the capability to pair our HDRMs with other hardware such as custom release rods, preload nuts, extractors, bolt catchers, mounting brackets, springs, connectors and electrical harnessing to provide low-shock, high reliability release assemblies.

Applications

Typical applications include:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

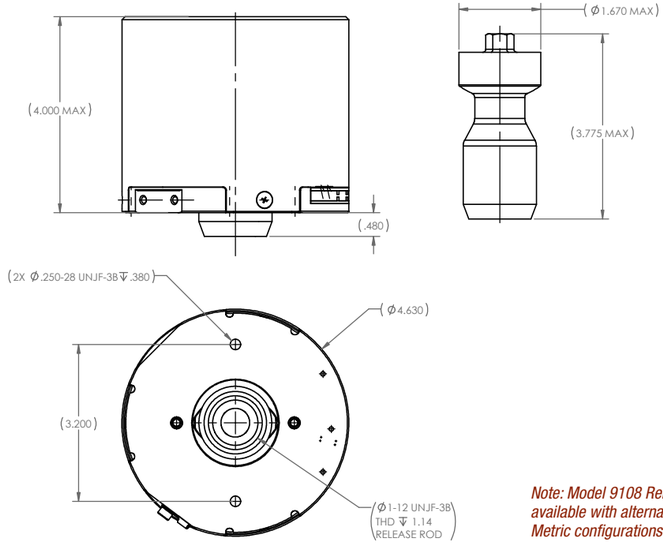
NEA® Model 9108
Hold Down & Release Mechanism (HDRM)

Model 9108 Technical Specifications

Parameter	Capability
Proof Load Rating	86,400 lbf (384,000 N)
Release Load Rating	72,000 lbf (320,000 N)
Shock @ Preload[1]	<1500 g peak at 76k lbf preload
Fuse Wire Resistance	0.75Ω to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 60 ms
No-Fire Current[3]	250 mAmps at 10-5 Torr @ 110°C
Release Time[4]	< 200 ms
Operational Temperature Range[5]	-135°C to +135°C
Maximum Angular Misalignment	3° Cone
Mass[6]	3,855 g (8.5 lbm)

Notes:
[1] Shock is preload and setup dependent.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes.
[4] Release time is dependent on actuation current, this assumes 4 A current applied.
[5] The values for operational temperature range are not the limits of the device.
[6] Mass does not include harnessing and lead wires.

Model 9108 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9108 Release Mechanism shown. Different configurations available with alternate release rods, mounting features, and connectors. Metric configurations are also available.

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NEA®/TiNi™ Pin Pullers

FAST ACTING FOR MANY AEROSPACE APPLICATIONS

EBAD NEA® Pin Pullers have an extensive history of use on a broad variety of spaceflight applications and are currently the baseline release device of choice on most major spacecraft buses. This history of reliability and mission success makes EBAD Pin Pullers our customers' lowest risk option. In addition to our line of standard NEA® Pin Pullers, EBAD can provide custom configurations and can also be integrated into our electromechanical gimbal actuators as part of a launch restraint system or range of motion limitation.

Space Mechanisms

NEA® Model 1120-05
Pin Puller

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 1120-05 Pin Puller

EBAD is the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market. Our patented split spool technology that has made our HDRMs the industry standard for non-pyrotechnic release mechanisms is also available in Pin Puller configurations.

Principle of Operation

EBAD Pin Pullers consist of a spring loaded plunger that is restrained using the same patented split-spool and fuse wire technology used in our Hold Down & Release Mechanisms. The spool subassembly includes two spool halves which are held together by a tight winding of a restraining wire that terminates in a fuse wire connecting two electrical terminals at the electrical interface to the device. The spool assembly, by virtue of the restraining wire winding, can prevent axial motion of the plunger. When sufficient electrical current is passed through the terminals and the fuse wire, the fuse wire heats up and breaks under the applied tension load. This allows the restraining wire to unwind, separating the spool halves and releasing the spring preloaded plunger.

The actuation method is simple and reliable and forms the basis of actuation for many of EBAD's other products including; Battery Cell Bypass Switches and Non-Pyrotechnic Valves.

Applications

Typical applications include:

- Antennas
- Scientific instruments
- Solar arrays
- Reflectors
- Satellite and spacecraft payloads
- Booms and masts
- Stage separation
- Caging mechanisms

Key Features

- Extremely low release shock
- Extended operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Range safety friendly
- Space-rated materials
- Field refurbishable with spare initiators and reset tool

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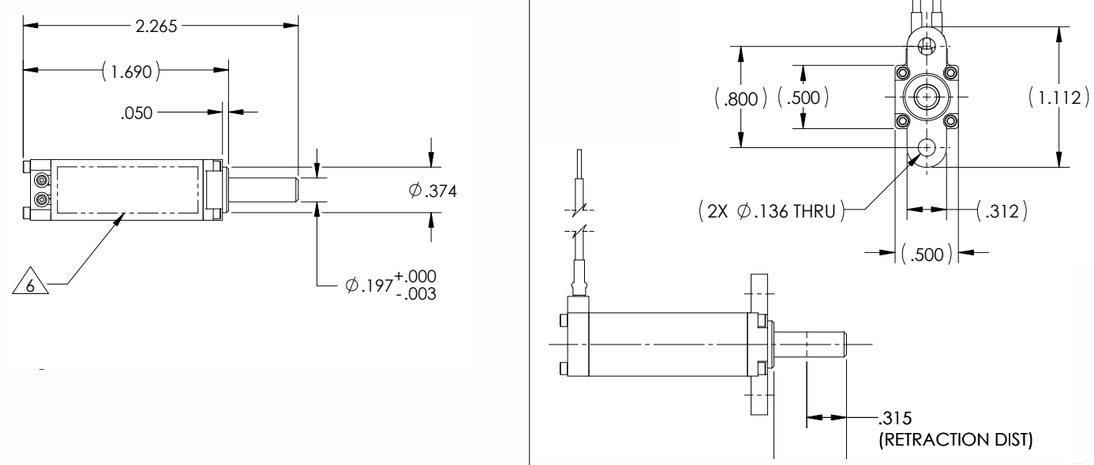
NEA® Model 1120-05
Pin Puller

Model 1120-05 Technical Specifications

Parameter	Specification
Mass	47 g (1.66 oz) max
Side Load	35 lbf (155 N)
Function Time[1]	35 ms max @ 3.0 A
Emitted Shock[2]	<1,000 g's
Electrical	
Nominal Actuation Current	4 Amps for 25 ms
Resistance	1.95 to 1.6 Ω @ 23°C
Insulation Resistance	>100 MΩ @ 250 VDC
No-Fire Limit	210 mA for 5 min @ Ambient
Performance	
Pull Force (Beginning of Travel)	Beginning: 63.51 N (14.27 lbf)
Pull Force (End of Travel)	End: 27.49 N (6.29 lbf)
Pull Stroke	8.0 mm (0.315 in)
Field-Refurbishable	With additional fuse wire assemblies (max 10 times)
Temperature[3]	
Non-Operational Pre-Actuation	-60°C to +110°C (-76°F to +230°F)
Operational	-60°C to +110°C (-76°F to +230°F)
Non-Operational Post-Actuation	-60°C to +110°C (-76°F to +230°F)

Notes:
[1] Function time is dependent on actuation current and temperature. Contact EBAD for more information.
[2] Shock is setup dependent, contact EBAD for details.
[3] The values presented are for qualification temperature range and not a measure of the limits of the device.

Model 1120-05 Pin Puller Mechanical Interface Drawing (for reference)



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Mission Success

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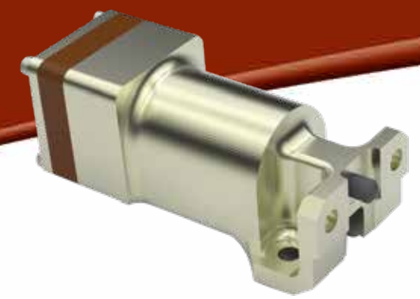

Model 2545 Pin Puller

The same split-spool technology that made EBAD the global leader in non-pyrotechnical Hold Down & Release Mechanisms is also available in EBAD's NEA® Pin Puller mechanisms. The NEA® Model 2545 Pin Puller can provide pull forces from 25 lbf to 45 lbf (111 N to 200 N).

Principle of Operation

The NEA® Pin Puller consist of a spring-loaded plunger that is restrained using the same patented split-spool and bridge wire technology used in our Hold Down & Release Mechanisms. The spool subassembly includes two spool halves which are held together by a tight winding of a restraining wire that terminates in a bridge wire connecting two electrical terminals at the electrical interface to the device. The spool assembly, by virtue of the restraining wire winding, can prevent axial motion of the plunger. When sufficient electrical current is passed through the terminals and the bridge wire, the bridge wire heats up and breaks under the applied tension load. This allows the restraining wire to unwind, separating the spool halves and releasing the spring-preloaded plunger.

The actuation method is simple and reliable and forms the basis of actuation for many of EBAD's other products including: Release Mechanisms, Battery Cell Bypass Switches, and Non-Pyrotechnic Valves.

Applications

Typical applications include:

- Antennas
- Scientific instruments
- Solar arrays
- Reflectors
- Satellite and spacecraft payloads
- Booms and masts
- Stage separation
- Caging mechanisms

Key Features

- Extremely low release shock
- Redundant or non-redundant actuation circuit
- Can be operated with pyrotechnic initiation circuitry
- Range safety friendly
- Space-rated materials
- Factory refurbishment

NEA® Model 2545
Pin Puller

Model 2545 Technical Specifications

Parameter	Capability
Pull Force at Beginning of Stroke	45 lbf (200 N)
Pull Force at End of Stroke	25 lbf (111 N)
Fuse Wire Resistance	1.2 to 2.0 Ω @ 25°C
Actuation Current[1]	4 Amps for 25 ms
No-Fire Current[2] (continuity)	250 mA
Release Time[3]	<50 ms
Qualification Temperature Range[4]	-101°C to +172°C
Mass[5]	182 g (0.40 lb)

Notes:

[1] Actuation can be achieved using a range of current, the value in the table is the value used for qualifying this device.

[2] No-fire current for 5 minutes or less as ambient temperature, consult EBAD applications engineers for other no-fire current requirements.

[3] Release time is dependent on actuation current, contact applications engineering for more specific information on actuation time as a function of current.

[4] The values presented for qualification temperature range are not a measure of the limits of the device.

[5] Mass does not include harnessing and lead wires.

Model 2545 Pin Puller Mechanical Interface Drawing (for reference)

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TiNi™ Pin Puller

Ensign-Bickford Aerospace & Defense

NEA TiNi

Mission Success

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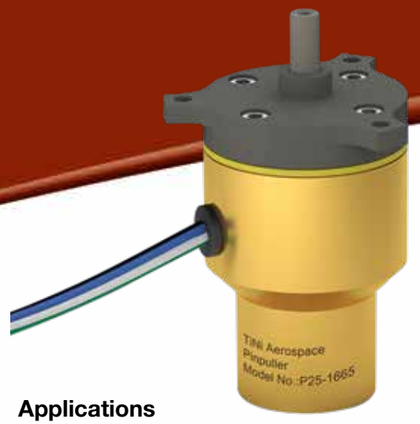

TiNi™ Pin Puller

EBAD's TiNi™ Pin Pullers are utilized in satellite applications to provide a simple and effective non-pyro separation system between two components where a pull force is required. Ranging in size from a 5 lbf (22 N) to 1,000 lbf (4,450 N) pull force, the pin pullers offer a versatile solution from small satellite solar array deployments, launch locks for optical payloads and antenna releases.

Easy to use, resting the device is straightforward with our custom reset tools and requiring no parts to replace.

Principle of Operation

The pin puller is a reliable fast operating device that ultilzes a Shape Memory Alloy (SMA) wire to release a latch to allow for the internal compression springs to retract the pin.

In the fully reset mode, the internal circuit is closed. When sufficient power is applied, the current raises the temperature of the SMA wire and subsequently contracts at its transition temperature. This allows internal ball locks to release and internal drive springs to retract the pin into the body of the device. Once retracted, the circuit is open allowing no power to continue to heat the SMA wire and provides the user with positive feedback that the device has actuated.

The device is reset with a custom tool that either pulls the pin out from the front or pushes it out from the rear.

Construction

Utilizing a Shape Memory Alloy (SMA) wire, the wire is threaded through a latch and attached to the electrical contacts. The latch retains an internal ball bearings that keeps the compressed drive springs in place before actuation. Another smaller internal reset spring is installed to assist in the reset process.

The pin puller is fully vented and typically the enclosure is made with aluminum alloy with a titanium flange. The output pin is made with stainless steel with a tiolon finish.

Alternative voltages utilize an internal resistor to protect the SMA wire from overheating.

Applications

Since 1996 Mars Global Surveyor mission, EBAD's TiNi™ Pin Pullers have extensive heritage in space applictions. Such applications include solar array and instrument deployment, instrument launch locks, optic cover releases, and other space applications where a pull force is needed. In addition, the pin pullers have high non-actuated side load capability that can withstand rigourous launch vehicle environmental levels.

Key Features

- Non-pyrotechnic
- Easy to field reset and simple to use
- Minimum 50 cycles
- Redundant firing circuit
- Maximum reliability thru design simplicity
- Flight pedigree and testability

Alternative applications include missile fin locks and underwater acutations with our subsea versions.

TiNi™ Pin Puller Launch lock example (before actuation)

TiNi™ Pin Puller Launch lock example (after actuation)

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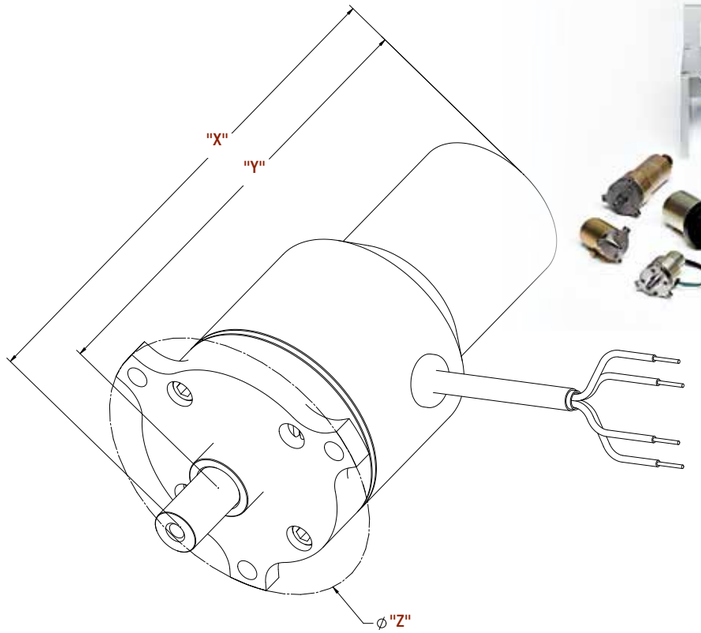
TiNi™ Pin Puller Family Technical Specifications

Pin Puller Family	P5		P10	P25	P50	P100	P1000
Pull Force	5 lbf (22 N)		10 lbf (44 N)	25 lbf (111 N)	50 lbf (222 N)	100 lbf (445 N)	1,000 lbf (4,450 N)
Side Load (actuation)	7 lbf (31.1 N)	10 lbf (44.5 N)	20 lbf (89 N)	50 lbf (222 N)	100 lbf (445 N)	200 lbf (890 N)	500 lbf (2,224 N)
Side Load (non-actuation)	20 lbf (8.9 N)	100 lbf (444.8 N)	330 lbf (1,468 N)	400 lbf (1,823 N)	490 lbf (2,180 N)	600 lbf (2,670 N)	Contact EBAD
Mass	.73 oz (18 g)	1.06 oz (30 g)	1.7 oz (48 g)	2.6 oz (75 g)	5.3 oz (150 g)	12.7 oz (360 g)	17 oz (482 g)
Operating Current	.5 to 2 A	.4 to 1.5 A	.6 to 2 A	1.25 A to 4.5 A	2.25 A to 6.5 A	2.25 A to 6.5 A	2.75 A to 8.75 A
Resistance	5.2±.5 Ω	7.7±.5 Ω	5.8±.5 Ω	3.1±.3 Ω	2.7±.3 Ω	3.1±.3 Ω	2.2±.3 Ω
Function Time @ 23ºC	130 ms max @ .5 A		100 ms max @ 1 A	130 ms max @ 2 A	100 ms max @ 4 A	100 ms max @ 4 A	75 ms max @ 4 A
Cycle Life (min)	100				100	100	50
Operating Temp	-65ºC + 70ºC				-65ºC + 70ºC	-65ºC + 70ºC	-60ºC + 70ºC
Height (before pin retraction) [x]	1.25 in	1.625 in	1.72 in	2.54 in	3.50 in	4.255 in	4.605 in
Height (after pin retraction)[y]	1.00 in	1.375 in	2 in	2.16 in	3.00 in	3.635 in	3.88 in
Max diameter (with flange)[z]	1.25 in	1.25 in	1.6 in	1.8 in	2.00 in	2.55 in	2.44 in x 2.44 in
Front/Rear Resettable	Yes	Yes	Yes	Front Std; Rear Optional with growth in device			Contact EBAD

Contact EBAD about alternative voltages/resistance and pin type

TiNi™ Pin Puller Mechanical Interface Drawing (for reference)



TiNi™ Pin Puller Family of products

ENSIGN-BICKFORD AEROSPACE & DEFENSE COMPANY
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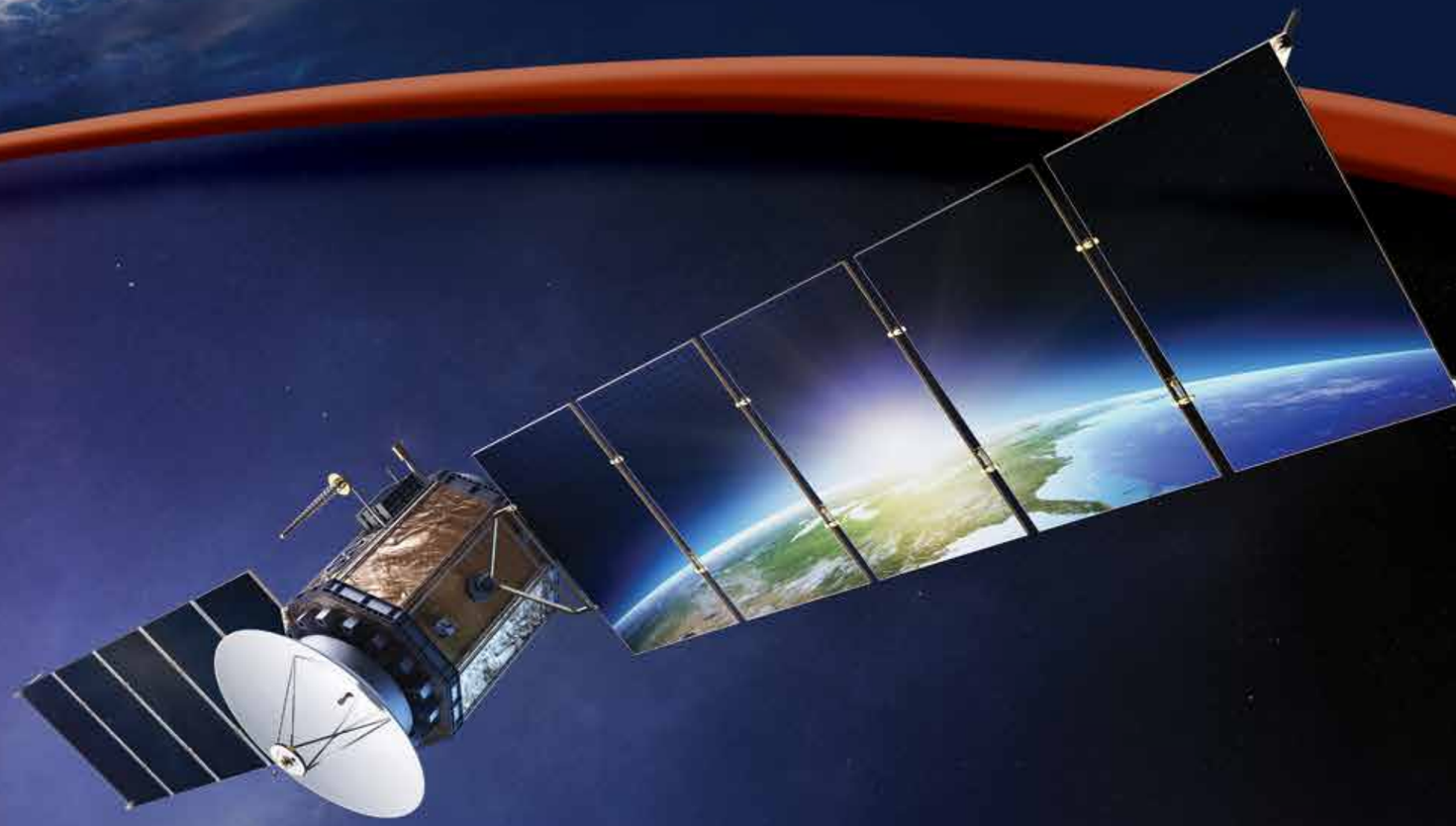
EBAD
Ensign-Bickford Aerospace & Defense
NEA TiNi

Satellite Deployment

ULTRA-LOW SHOCK RELEASE OF SMALL AND MEDIUM SPACECRAFT

EBAD continues to pioneer space mechanisms with our Satellite Deployment technologies. NEA® Hold Down & Release Mechanisms and resettable TiNi™ Ejectors provide a diverse set of technologies to help customers solve the most challenging separation events. Our non-explosive mechanisms have become the technology of choice for deployment of satellite constellations.

EBAD makes thousands of space mechanisms each year, satisfying the most demanding quality requirements. We offer robust industrial capacity to meet the needs of high-volume constellation programs. This provides satellite integrators with high performance, low risk solutions for satellite deployment.



LOW SHOCK | FAST ACTING | RELIABLE | LOW RISK | TEMPERATURE INSENSITIVE | COMPATIBLE

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NEA® Model 9103CC2
Hold Down & Release Mechanism (HDRM)

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

Model 9103CC2 Hold Down & Release Mechanism

EBAD is the global leader of non-pyrotechnic Hold Down & Release Mechanism (HDRM) for the space and defense markets. EBAD's industry-leading NEA® and TiNi™ mechanisms are offered in a range of sizes and custom mounting configurations.

The NEA® Model 9103CC2 is based on the Model 9103, integrating a cup/cone shear load interface, a bolt extractor, a bolt catcher, and source shock reduc-tion elements to form a HDRM that's ideal for multi-point satellite release. In a 4-point release configuration, the 9103CC2 is designed to dispense up to 600 kG* payloads separating laterally from a central dispensing structure. The 9103CC2 is delivered fully preloaded, so integration into space platforms is greatly simplified. The 9103CC2 is easily scaled up and down in load capacity by using a different NEA® HDRM model.

Principle of Operation

The NEA® Model 9103CC2 is an electrically initiated, one-shot mechanism that carries very high mechanical loads until commanded to release. The preload is applied through a release bolt that tightly restrains a cup/cone shear load interface. The bolt is held in place by two separable spool halves which are in turn held together by tight winding of restraining wire. The restraint wire is held in place by redundant electrical fuse wires; actuation of either circuit allows release, assuring maximum reliability. When sufficient electrical current is applied, the restraint wire unwinds allowing the spool halves to separate releasing the release bolt and allowing the two halves of the cup/cone interface to separate.

EBAD has developed a companion HDRM Firing Unit (HFU) that multiplexes a single Launch Vehicle firing order to actuate (4) Model 9103CC2's in diagonal pairs or simultaneously. The HFU assures proper current application to the HDRM to assure tight actuation simultaneity between the HDRMs. The HFU provides safety interlocks for Arming and Firing and provides status of HFU and HDRM for integration operations and launch readiness assurance.

*dependent on spacecraft center of gravity

Applications

Typical applications include retention and release of:

- Antennas, reflectors, solar arrays, and deployable radiators
- Booms, masts, and scientific instruments
- Satellite and spacecraft deployment
- Launch vehicle and missile stage and fairing separation
- Missile payload separation

Key Features

- Non-explosive hold down & release function
- High restrained preload
- Extremely low release shock
- High simultaneity of multiple hold-down points
- Wide operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Space-rated materials
- Factory refurbishments
- More than 20 years of flight heritage
- Flight pedigree on more than 750 space platforms

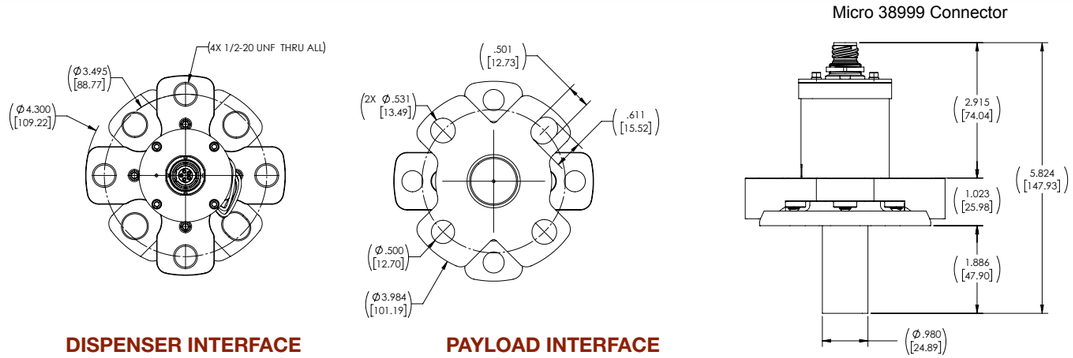
NEA® Model 9103CC2
Hold Down & Release Mechanism (HDRM)

Model 9103CC2 Technical Specifications

Parameter	Capability
Preload (as Delivered)	8,500 lbf (37,800 N)
Demonstrated Export Shock (Satellite Interface)[1]	20 g @ 2 kHz, < 380 g to 10 kHz
Demonstrated Export Shock (Dispenser Interface)[1]	30 g @ 2 kHz, < 650 g to 10 kHz
Fuse Wire Resistance	1.2 Ω to 2.0 Ω @ 25°C
Actuation Current[2]	4 Amps for 25 ms
No-Fire Current[3]	250 mAmps at 10-5 Torr @ 110°C
Release Time @ Actuation Current[4]	<15 mSec @ 7 Amps for 10 mSec
Release Simultaneity @ Actuation Current	+/- 2.5 mSec @ 7 Amps for 10 mSec
Fly Away Mass (Satellite Interface)	250 grams (0.55 lbm)
Total Mass	650 grams (1.43 lbm)
Operational Temperature Range[5]	-105°C to +105°C
Axial Load[6]	2,405 lbf (10,700 N)
Shear Load[6]	2,383 lbf (10,600 N)
Bending Moment[6]	484.5 Nm (357.3 ft-lb)
Torsion[6]	525.9 Nm (387.9 ft-lb)

Notes:
[1] Export shock measurement uses HDRM preload of 37.8 kN, NASA standard aluminum test plate, and accelerometers adjacent to the HDRM.
[2] Actuation can be achieved using a wide range of current.
[3] No-fire current for 5 minutes or less as ambient temperature, consult EBAD applications engineers for other no-fire current requirements.
[4] Release time is dependent on actuation current, preload, and temperature.
[5] The values presented for qualification temperature range are not a measure of the limits of the device.
[6] Axial, shear, bending moment, and torsional loads are applied simultaneously. Safety factors applied are Yield (1.3) and Ultimate (1.55).

Model 9103CC2 Hold Down & Release Mechanism (HDRM) Mechanical Interface Drawing (for reference)



Note: Model 9103CC2 HDRM shown. Different configurations available with alternate mounting features and connectors. Smaller and larger configurations available to accommodate different payloads.

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Ensign-Bickford Aerospace & Defense

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

NEA® 8" Payload Release Ring (PRR-8)

For nearly 60 years EBAD has supplied launch vehicles and the space market hardware to support initiation, separation, and flight destruct. The NEA® 8" Payload Release Ring (PRR-8) utilizes the flight-proven technology of the NEA® mechanism product line to release payloads from a launch vehicle.

Principle of Operation

The NEA® 8" Payload Release Ring consists of four NEA® release mechanisms, two ring halves, and separation springs with corresponding holders. The four NEA®'s are utilized to compress the separation springs and hold the two ring halves together. The PRR-8 is then attached to the payload. The PRR-8, and attached payload, are mounted to the launch vehicle utilizing twenty four fasteners.

The NEA® 8" Payload Release Ring is electrically connected to the launch vehicle via redundant connectors. The connector will be connected to each of the NEA® release mechanisms. An additional connector is provided in order to provide communication between the launch vehicle and the payload.

The payload is released when the launch vehicle applies current to the PRR-8 connector. The NEA® 8" Payload Release Ring connector distributes the current to the four NEA® release mechanisms, which actuate and allow the separation springs to separate the payload from the launch vehicle.

Applications

- Typical applications include:
  - Launch vehicle payload release
  - Ø8" circular port with 1/4" fasteners
  - (4) NEA® Mechanisms configured in a ring pattern – with very significant in-orbit heritage
  - Low mass, low shock release
- Other port sizes can be developed

Key Features

- Low release shock
- Redundant actuation circuit
- Payloads up to 100 kg[1]
- Low mass (see Specifications Table)
- Can be operated with standard launch vehicle circuitry
- Launch vehicle to payload connector interface
- No debris generation
- Meets standard tip off requirements
- Customizable separation velocity (4 – 8 push off springs)
- Range safety friendly
- Space-rated materials

[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 100 kg mass is acceptable with a CoG of 10" from the launch vehicle or less.

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NEA® 8" Payload Release Ring (PRR-8)

NEA® 8" Payload Release Ring (PRR-8) Technical Specifications

Parameter	Capability
Payload Capability	100 kg[1]
Shock Output[2]	<300 g's
Release Time[3]	40 ms
Total Mass	4.7 lb (2.1 kg)
Fly Away Mass	1.6 lb (0.7 kg)
Temperature Range	-90°C to +135°C
Maximum Tip off[4]	1° per sec
Spring Energy, J	3.57
Number of Springs	4 to 8
Outer Diameter	10.50 in (26.70 cm)
Inner Diameter	5.15 in (13.10 cm)
Height	2.44 in (6.2 cm)

Notes:

[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 100 kg mass is acceptable with a CoG of 10" from the launch vehicle or less.

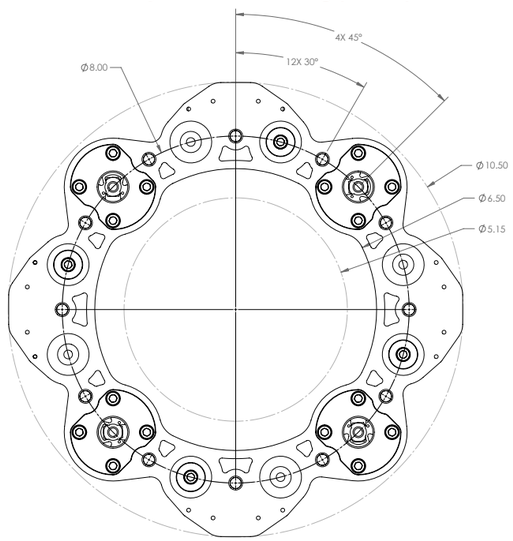
[2] Indicates payload side. Shock output was measured by mounting the ESPA ring launch vehicle interface to an aluminum 6,061 0.75" x 0.24" x 24" test fixture, and to a secondary plate of the same characteristics on the payload interface.

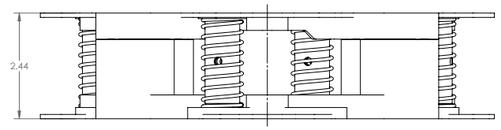
[3] Release time is based on the current supplied, the stated time is based on the SpaceX electrical interface, capable of simultaneously applying 5A to 4 separate lines.

[4] Tip off is dependent on the center of gravity, contact EBAD for details.

Contact EBAD for additional technical data

NEA® 8" Payload Release Ring (PRR-8) Mechanical Interface Drawing (for reference)





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Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

NEA® 15" Payload Release Ring (PRR-15)

For nearly 60 years EBAD has supplied launch vehicles and the space market hardware to support initiation, separation, and flight destruct. The NEA® 15" Payload Release Ring (PRR-15) utilizes the flight-proven technology of the NEA® mechanism product line to release payloads from a launch vehicle.

Principle of Operation

The NEA® 15" Payload Release Ring consists of four NEA® release mechanisms, two ring halves, and separation springs with corresponding holders. The four NEA®'s are utilized to compress the separation springs and hold the two ring halves together. The PRR-15 is then attached to the payload. The PRR-15, and attached payload, are mounted to the launch vehicle utilizing 24 fasteners.

The NEA® 15" Payload Release Ring is electrically connected to the launch vehicle via redundant connectors. The connector will be connected to each of the NEA® release mechanisms. An additional connector is provided in order to provide communication between the launch vehicle and the payload.

The payload is released when the launch vehicle applies current to the PRR-15 connector. The NEA® 15" Payload Release Ring connector distributes the current to the four NEA® release mechanisms, which actuate and allow the separation springs to separate the payload from the launch vehicle.

Applications

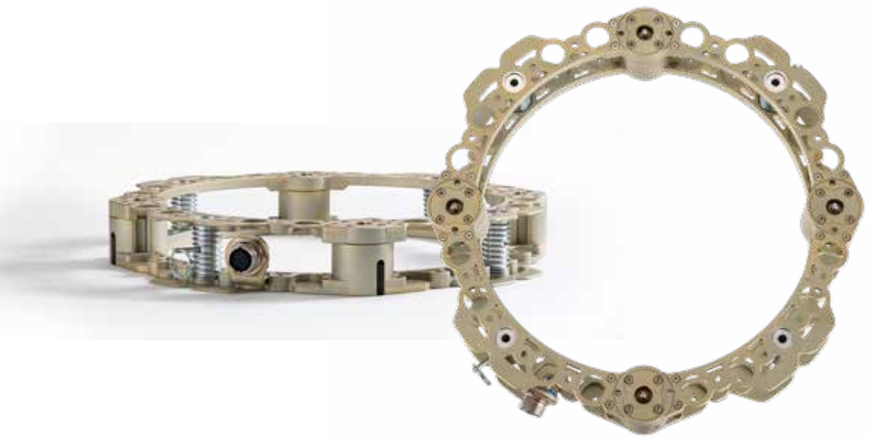
Typical applications include:

- Launch vehicle payload release
- Ø15" circular port with 1/4" fasteners
- Other port sizes can be developed

Key Features

- Low release shock
- Redundant actuation circuit
- Payloads up to 250 kg[1]
- Low mass (see Specifications Table)
- High stiffness (see Stiffness Table)
- Can be operated with standard launch vehicle circuitry
- Launch vehicle to payload connector interface
- No debris generation
- Meets standard tip off requirements
- Customizable separation velocity (4-20 push off springs)
- Qualified to standard launch environments
- Space-rated materials
- Factory refurbishment

[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 250 kg mass is acceptable with a CoG of 15" from the launch vehicle or less.



NEA® 15" Payload Release Ring (PRR-15)

NEA® 15" Payload Release Ring (PRR-15) Technical Specifications

Parameter	Capability
Payload Capability	250 kg[1]
Shock Output[2]	<300 g's
Release Time[3]	<40 ms
Total Mass	6.4 lb (2.9 kg)
Fly Away Mass	2.2 lb (1 kg)
Temperature Range	-40°C to +102°C
Spring Energy, J	3.57
Number of Springs	4 to 20

Notes:

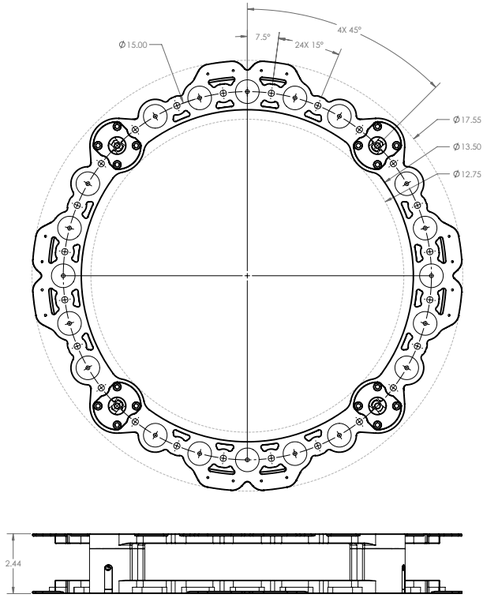
[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 250 kg mass is acceptable with a CoG of 15" from the launch vehicle or less.

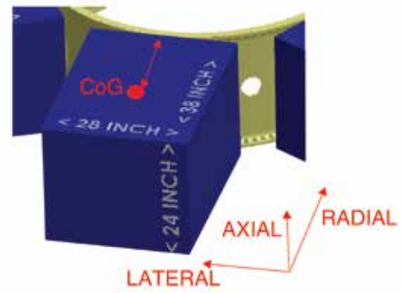
[2] Indicates payload side. Shock output was measured by mounting the ESPA ring launch vehicle interface to an aluminum 6061 0.75" x 24" x 24" test fixture, and to a secondary plate of the same characteristics on the payload interface.

[3] Release time is based on the current supplied, the stated time is based on the SpaceX electrical interface, capable of simultaneously applying 5A to 4 separate lines.

Contact EBAD for additional technical data

NEA® 15" Payload Release Ring (PRR-15) Mechanical Interface Drawing (for reference)





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Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

NEA® 24" Payload Release Ring (PRR-24)

For nearly 60 years EBAD has supplied launch vehicles and the space market hardware to support initiation, separation, and flight destruct. The NEA® 24" Payload Release Ring (PRR-24) utilizes the flight-proven technology of the NEA® mechanism product line to release payloads from a launch vehicle.

Principle of Operation

The NEA® 24" Payload Release Ring consists of four NEA® release mechanisms, two ring halves, and separation springs with corresponding holders. The four NEA®'s are utilized to compress the separation springs and hold the two ring halves together. The PRR-24 is then attached to the payload. The PRR-24, and attached payload, are mounted to the launch vehicle utilizing 36 fasteners.

The NEA® 24" Payload Release Ring is electrically connected to the launch vehicle via redundant connectors. The connector will be connected to each of the NEA® release mechanisms. An additional connector is provided in order to provide communication between the launch vehicle and the payload.

The payload is released when the launch vehicle applies current to the PRR-24 connector. The NEA® 24" Payload Release Ring connector distributes the current to the four NEA® release mechanisms, which actuate and allow the separation springs to separate the payload from the launch vehicle.

Applications

Typical applications include:

- Launch vehicle payload release
- Ø24" circular port with 1/4" fasteners
- Other port sizes can be developed

Key Features

- Low release shock
- Redundant actuation circuit
- Payloads up to 500 kg[1]
- Low mass (see Specifications Table)
- High stiffness (see Stiffness Table)
- Can be operated with standard launch vehicle circuitry
- Launch vehicle to payload connector interface
- No debris generation
- Meets standard tip off requirements
- Customizable separation velocity (4-30 push off springs)
- Qualified to standard launch environments
- Space-rated materials
- Factory refurbishment

[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 500 kg mass is acceptable with a CoG of 24" from the launch vehicle or less.

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NEA® 24" Payload Release Ring (PRR-24)

NEA® 24" Payload Release Ring (PRR-24) Technical Specifications

Parameter	Capability
Payload Capability	500 kg[1]
Shock Output[2]	<300 g's
Release Time[3]	<40 ms
Total Mass	10.58 lb (4.8 kg)
Fly Away Mass	3.5 lb (1.6 kg)
Temperature Range	-90°C to +135°C
Spring Energy, J	3.57
Number of Springs	4 to 30

Notes:

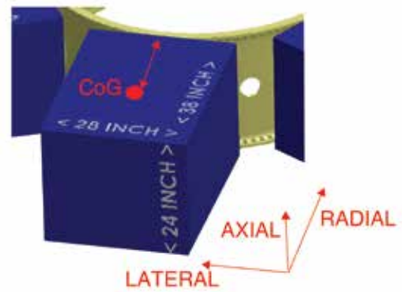
[1] Maximum allowable payload mass is dependent on the Center of Gravity of the payload. A 500 kg mass is acceptable with a CoG of 24" from the launch vehicle or less.

[2] Indicates payload side. Shock output was measured by mounting the ESPA ring launch vehicle interface to an aluminum 6061 0.75" x 24" x 24" test fixture, and to a secondary plate of the same characteristics on the payload interface.

[3] Release time is based on the current supplied, the stated time is based on the SpaceX electrical interface, capable of simultaneously applying 5A to 6 separate lines.

Contact EBAD for additional technical data

NEA® 24" Payload Release Ring (PRR-24) Mechanical Interface Drawing (for reference)



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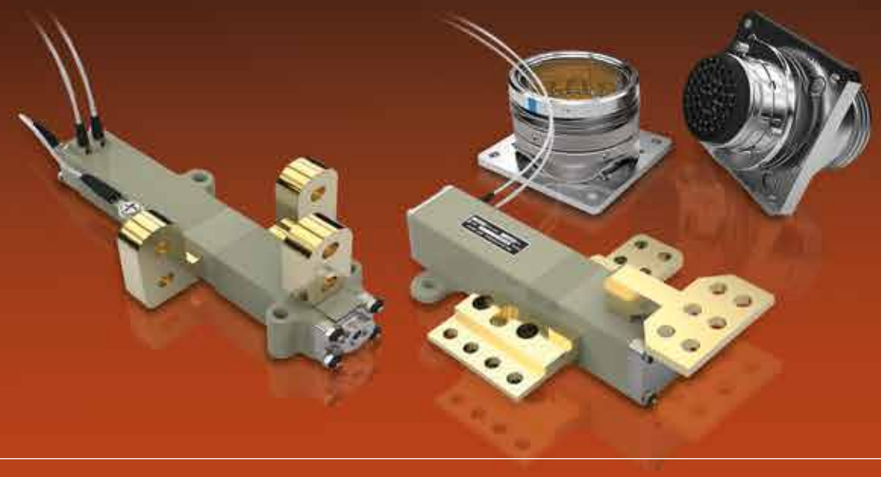
Electrical & Power Solutions

RELIABLE IN-FLIGHT POWER DEVICES

EBAD offers a variety of specialized electrical and power solutions for launch vehicle, satellite, and spacecraft platforms. NEA® Battery Cell Bypass Switches have been used for decades on Geosynchronous satellite power systems as electrically initiated, one-shot switches that bypass and isolate failed battery cells. Our Zero Separation Force (ZSF) and Dead Face (DF) connectors are widely used on launch and spacecraft platforms for reliable separation of electrical interfaces.



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Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

8020 Series Battery Cell Bypass Switch

EBAD, the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market, brings this same highly reliable technology to battery protection applications with our complete line of Battery Cell Bypass Switches. Battery Cell Bypass Switches provide critical protection to battery assemblies in the event that one battery cell suffers an anomaly.

Principle of Operation

The NEA® Battery Cell Bypass Switch is an electrically initiated, one-shot switch that bypasses and isolates failed battery cells. The switch consists of a spring-loaded plunger with highly conductive metal plated electrical contacts arranged in a Single-Pole, Double-Throw configuration providing Make-Before-Break functionality after the switch is actuated and the plunger moves in the housing. The plunger is restrained using the same patented split-spool and bridge wire technology used in our Hold Down & Release Mechanisms.

Typically, switches are placed in series between battery cells and, when activated, bypass and isolate failed cells from the battery assembly. The design and construction of the bypass switch assure that there is no contact bounce during high dynamic loads seen during satellite launch. When activated, there are two features that ensure reliable system operation; Make-Before-Break functionality assures there is no voltage dropout during switching and low switch contact resistance assures high continuous current carrying capability, ensuring reliable system operation for the duration of your mission.

Several NEA® switch models come with built-in Zener diodes that are used to autonomously redirect current through the actuation fuse wire when a failed cell is detected. This autonomous operation device can save considerable cost associated with battery cell sensing and switch actuation circuitry.

Key Features

- Available in non-autonomous and autonomous configurations
- Switch circuit can carry up to 100 A of continuous current
- Single-Pole, Double-Throw (SPDT) Make-Before-Break power switch
- High reliability and long service life
- Low power switch resistance
- Lightweight
- Extended operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Range safety friendly
- Space-rated materials
- Factory refurbishment

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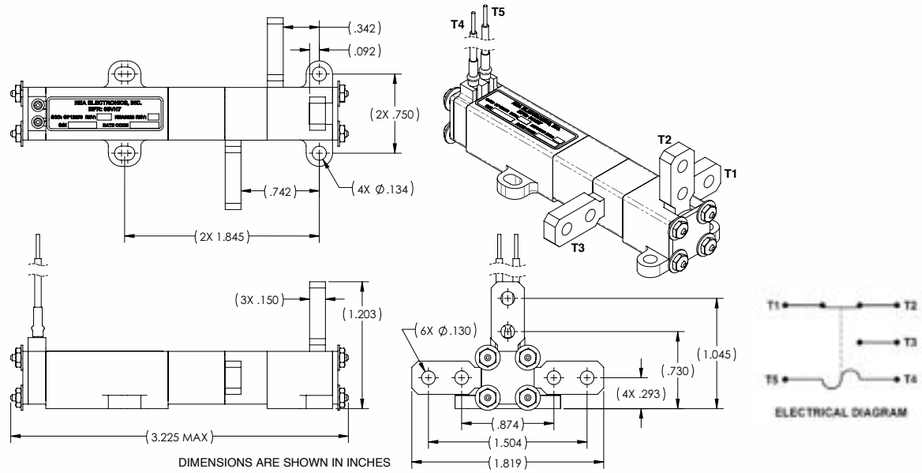
NEA® 8020 Series
Battery Cell Bypass Switch

8020 Series Technical Specifications

Parameter	Capability
Continuous Current Ratings	100 A
Switch Resistance	<300 µΩ @ 100 A
Fuse Wire Resistance	0.5 to 1.6 Ω @ 25°C
Minimum Actuation Current[1]	1.2 A
Nominal Actuation Current	4 Amps for 25 ms
No-Fire Current[2] (continuity)	250 mA
Actuation Time[3]	<50 ms
Make Before Break Duration	<1 ms
Qualification Temperature Range[4]	-55°C to +85°C
Mass[5]	70 g (2.47 oz)

Notes:
[1] Actuation can be achieved using a range of current, the value in the table is the value used for qualifying this device.
[2] No-fire current for 5 minutes or less as ambient temperature, consult an EBAD applications engineer for other no-fire current requirements.
[3] Actuation time is dependent on actuation current, contact applications engineering for more specific information on actuation time as a function of current.
[4] The values presented for qualification temperature range are not a measure of the limits of the device.
[5] Mass is representative and varies slightly with different specific part numbers within the series but does not include harnessing and lead wires.

Model 8020 Battery Cell Bypass Switch Mechanical Interface Drawing (for reference)



Note: Model 8020 Battery Cell Bypass Switch as an example. Other models available with alternate mounting feet, terminal configurations and optional zener diodes for autonomous operation.

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Mission Success

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NEA® 8030 Series
Battery Cell Bypass Switch

8030 Series Battery Cell Bypass Switch

EBAD, the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market, brings this same highly reliable technology to battery protection applications with our complete line of Battery Cell Bypass Switches. Battery Cell Bypass Switches provide critical protection to battery assemblies in the event that one battery cell suffers an anomaly.

Principle of Operation

The NEA® Battery Cell Bypass Switch is an electrically initiated, one-shot switch that bypasses and isolates failed battery cells. The switch consists of a spring-loaded plunger with highly conductive metal plated electrical contacts arranged in a Single-Pole, Double-Throw configuration providing Make-Before-Break functionality after the switch is actuated and the plunger moves in the housing. The plunger is restrained using the same patented split-spool and bridge wire technology used in our Hold Down & Release Mechanisms.

Typically, switches are placed in series between battery cells and, when activated, bypass and isolate failed cells from the battery assembly. The design and construction of the bypass switch assure that there is no contact bounce during high dynamic loads seen during satellite launch. When activated, there are two features that ensure reliable system operation; Make-Before-Break functionality assures there is no voltage dropout during switching and low switch contact resistance assures high continuous current carrying capability, ensuring reliable system operation for the duration of your mission.

Several NEA® switch models come with built-in Zener diodes that are used to autonomously redirect current through the actuation fuse wire when a failed cell is detected. This autonomous operation device can save considerable cost associated with battery cell sensing and switch actuation circuitry.

Key Features

- Available in non-autonomous and autonomous configurations
- Switch circuit can carry up to 250 A of continuous current
- Single-Pole, Double-Throw (SPDT) Make-Before-Break power switch
- High reliability and long service life
- Low power switch resistance
- Lightweight
- Extended operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Range safety friendly
- Space-rated materials
- Factory refurbishment

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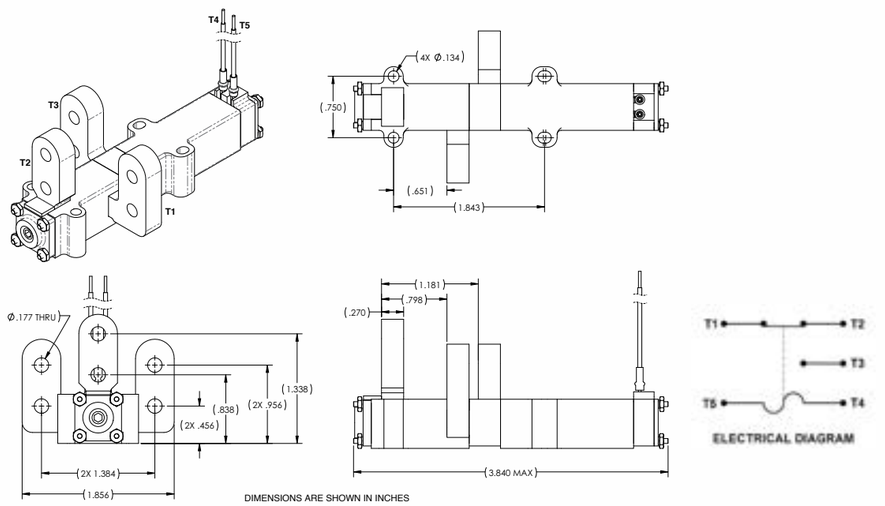
NEA® 8030 Series
Battery Cell Bypass Switch

8030 Series Technical Specifications

Parameter	Capability
Continuous Current Ratings	250 A
Switch Resistance	<200 µΩ @ 250 A
Fuse Wire Resistance	0.5 to 1.6 Ω @ 25°C
Minimum Actuation Current[1]	1.2 A
Nominal Actuation Current	4 Amps for 25 ms
No-Fire Current[2] (continuity)	250 mA
Actuation Time[3]	<50 ms
Make Before Break Duration	<1 ms
Qualification Temperature Range[4]	-55°C to +85°C
Mass[5]	130 g (4.59 oz)

Notes:
[1] Actuation can be achieved using a range of current, the value in the table is the value used for qualifying this device.
[2] No-fire current for 5 minutes or less as ambient temperature, consult an EBAD applications engineer for other no-fire current requirements.
[3] Actuation time is dependent on actuation current, contact applications engineering for more specific information on actuation time as a function of current.
[4] The values presented for qualification temperature range are not a measure of the limits of the device.
[5] Mass is representative and varies slightly with different specific part numbers within the series but does not include harnessing and lead wires.

Model 8030 Battery Cell Bypass Switch Mechanical Interface Drawing (for reference)



Note: Model 8030 Battery Cell Bypass Switch as an example. Other models available with alternate mounting feet, terminal configurations and optional zener diodes for autonomous operation.

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NEA TiNi

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.

NEA® 8040 Series
Battery Cell Bypass Switch

8040 Series Battery Cell Bypass Switch

EBAD, the global leader in non-pyrotechnic Hold Down & Release Mechanisms (HDRM) for the spacecraft market, brings this same highly reliable technology to battery protection applications with our complete line of Battery Cell Bypass Switches. Battery Cell Bypass Switches provide critical protection to battery assemblies in the event that one battery cell suffers an anomaly.

Principle of Operation

The NEA® Battery Cell Bypass Switch is an electrically initiated, one-shot switch that bypasses and isolates failed battery cells. The switch consists of a spring-loaded plunger with highly conductive metal plated electrical contacts arranged in a Single-Pole, Double-Throw configuration providing Make-Before-Break functionality after the switch is actuated and the plunger moves in the housing. The plunger is restrained using the same patented split-spool and bridge wire technology used in our Hold Down & Release Mechanisms.

Typically, switches are placed in series between battery cells and, when activated, bypass and isolate failed cells from the battery assembly. The design and construction of the bypass switch assure that there is no contact bounce during high dynamic loads seen during satellite launch. When activated, there are two features that ensure reliable system operation; Make-Before-Break functionality assures there is no voltage dropout during switching and low switch contact resistance assures high continuous current carrying capability, ensuring reliable system operation for the duration of your mission.

Several NEA® switch models come with built-in Zener diodes that are used to autonomously redirect current through the actuation fuse wire when a failed cell is detected. This autonomous operation device can save considerable cost associated with battery cell sensing and switch actuation circuitry.

Key Features

- Available in non-autonomous and autonomous configurations
- Switch circuit can carry up to 400 A of continuous current
- Single-Pole, Double-Throw (SPDT) Make-Before-Break power switch
- High reliability and long service life
- Low power switch resistance
- Lightweight
- Extended operating temperature range
- Can be operated with pyrotechnic initiation circuitry
- Range safety friendly
- Space-rated materials
- Factory refurbishment

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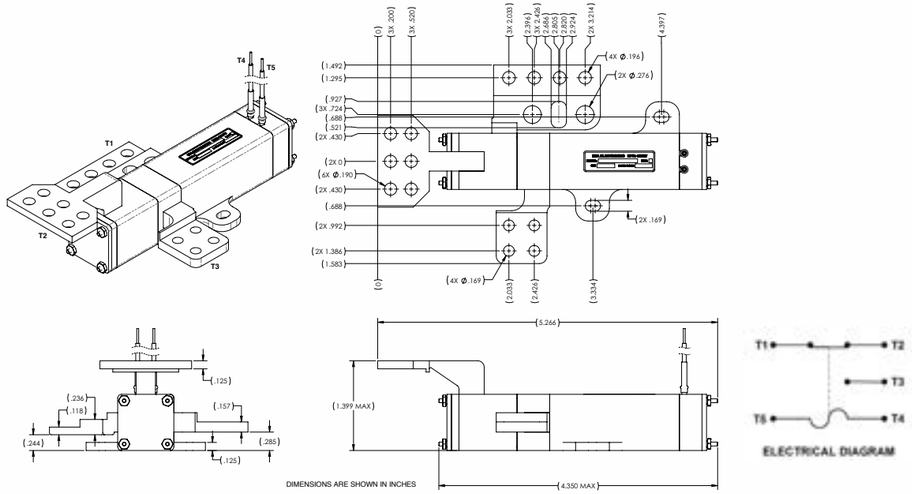
NEA® 8040 Series
Battery Cell Bypass Switch

8040 Series Technical Specifications

Parameter	Capability
Continuous Current Ratings	400 A
Switch Resistance	<150 µΩ @ 400 A
Fuse Wire Resistance	0.95 to 1.6 Ω @ 25°C
Minimum Actuation Current[1]	1.2 A
Nominal Actuation Current	4 Amps for 25 ms
No-Fire Current[2] (continuity)	250 mA
Actuation Time[3]	<50 ms
Make Before Break Duration	<1 ms
Qualification Temperature Range[4]	-55°C to +85°C
Mass[5]	270 g (9.52 oz)

Notes:
[1] Actuation can be achieved using a range of current, the value in the table is the value used for qualifying this device.
[2] No-fire current for 5 minutes or less as ambient temperature, consult an EBAD applications engineer for other no-fire current requirements.
[3] Actuation time is dependent on actuation current, contact applications engineering for more specific information on actuation time as a function of current.
[4] The values presented for qualification temperature range are not a measure of the limits of the device.
[5] Mass is representative and varies slightly with different specific part numbers within the series but does not include harnessing and lead wires.

Model 8040 Battery Cell Bypass Switch Mechanical Interface Drawing (for reference)



Note: Model 8040 Battery Cell Bypass Switch shown as an example. Other models available with alternate mounting feet, terminal configurations and optional zener diodes for autonomous operation.

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NEA® Zero Separation Force (ZSF100/200) & In-Flight Disconnect (IFD)

Mission Success

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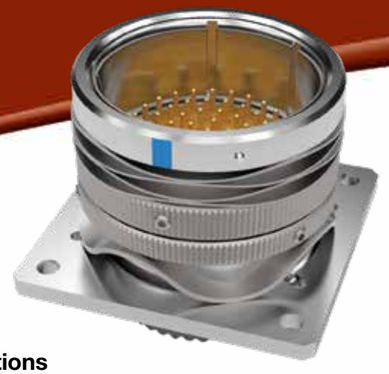

NEA® Zero Separation Force (ZSF100/200) & In-Flight Disconnect (IFD)

EBAD's Zero Separation Force (ZSF) and In-Flight Disconnects (IFD) connectors are reliable in-flight electrical disconnects for satellite and spacecraft separation, missile staging, and umbilical separation. Connector pairs are designed to provide precision zero, positive or negative separation force, eliminating the need for lanyard pull actuation.

Principle of Operation

The NEA® ZSF100/200 and IFD electrical interconnects incorporate standard MIL-DTL-38999 inserts and MIL-C-39029 pin and socket contacts.

Each mated connector pair is factory calibrated to compensate for connector pin engagement and other retention forces, assuring precise and smooth separation. ZSF and IFD connectors feature a floating shell, eliminating jamming during mating and separation. Blind engagement of the plug and receptacle pairs is possible, since the connectors allow for linear and angular misalignment. Connectors can be mounted from the rear of the panel or bracket, allowing for ease of installation. All of the in-flight disconnects are backshell ready, and if required, can be provided with the overall system.

EBAD has the capability to pair our connectors with our non-explosive Hold Down & Release Mechanisms (HDRM) and other hardware such as brackets, alignment pins, springs, and harnessing to provide low-shock, high reliability stage and umbilical disconnect assemblies.

Applications

Typical applications include:

- Satellite, spacecraft, and payloads
- Stage separation
- Umbilical disconnects
- Panel disconnect assemblies

Key Features

- Zero, positive, or negative separation force
- Mounts from rear of panel or bracket
- Tolerates wide range of linear and angular misalignment permitting blind engagement
- Standard MIL-DTL-38999 inserts
- Full range of keying configurations
- Service Class H
- Utilizes MIL-C-39029 pin and socket contacts
- AS85049 compatible backshell
- Backshell hardware available
- Complete harness and disconnect assemblies available

NEA® Zero Separation Force (ZSF100/200) & In-Flight Disconnect (IFD)

Model ZSF100/200 and IFD Configurations

Connector Model	Style	Shell Size[1]	Insert Arrangement[1]	Mates With
ZSF100	Plug	21	11, 16, 35, 41, 75	ZSF200
ZSF100	Plug	25	, 62	ZSF200
IFD100	Plug	19	35	IFD200
IFD100	Plug	25	4, 20	IFD200
ZSF200	Receptacle	21	11, 16, 35, 41, 75	ZSF100
ZSF200	Receptacle	25	62	ZSF100
IFD200	Receptacle	19	35	IFD100
IFD200	Receptacle	25	4, 20	IFD100

Notes:

[1] Existing shell sizes and insert arrangements shown. Other MIL-DTL-38999 shell size and insert arrangements available.

Model ZSF100/200 and IFD Technical Specifications

Parameter	Capability
Separation Force	0 lbf (0 N) (or adjustable to customer spec)
Engagement Force	20 lbf (90 N)
Linear Misalignment	0.76 mm (0.03 in) min
Maximum Angular Misalignment	10° Cone
Qualification Temperature Range[1]	-55°C to +200°C
Mass[2]	117 g (0.29 lb)
Shell Material/Finish	aluminum/nickel finish, SS

Notes:

[1] Existing shell sizes and insert arrangements shown. Other MIL-DTL-38999 shell size and insert arrangements available.

[2] Representative of ZSF200 25-62 insert arrangement with electrical contacts. Contact EBAD for other configurations.

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NEA TiNi

Propulsion Mechanisms

RELIABLE, NON-PYROTECHNIC ISOLATION SYSTEMS

NEA® and TiNi™ mechanisms provide one-shot isolation of liquids and gasses used on launch vehicle, satellite, and spacecraft platforms. EBAD's mechanisms are a low-risk choice and provide reliable actuation. As with all our TiNi™ products, our propulsion mechanisms are field-resettable.

Our designs are available in a variety of embodiments and flow rates, and EBAD can provide customer configurations that include modifications to the mechanical interfaces, pressure and flow rate capabilities, and material compatibilities.

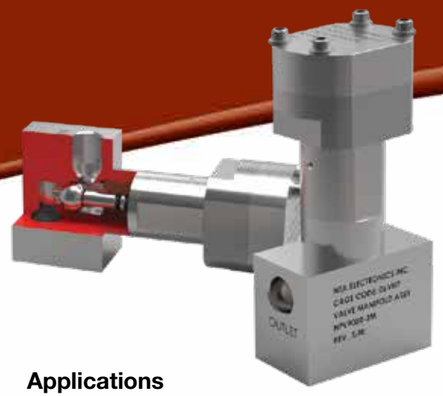
LOW SHOCK | RELIABLE | FAST ACTING | COMPATIBLE

www.EBAD.com

NEA® Model NPV9000
Non-Pyrotechnic Valve

Mission Success

Ensign-Bickford Aerospace & Defense Company (EBAD) is dedicated to supporting our customers in the aerospace and defense industry through on-time delivery of innovative products that exceed expectations and assure mission success.



Model NPV9000 Non-Pyrotechnic Valve

EBAD's highly reliable Hold Down & Release Mechanisms technology has been adapted for use in Non-Pyrotechnic Valves. The electrically redundant valves offer low shock and positive isolation with both liquid and gas lines.

Principle of Operation

The NEA® Non-Pyrotechnic Valves consist of a spring-loaded plunger that is restrained using the same patented split-spool and bridge wire technology used in our Hold Down & Release Mechanisms. The spool subassembly includes two spool halves which are held together by a tight winding of a restraining wire that terminates in a bridge wire connecting two electrical terminals at the electrical interface to the device. The spool assembly, by virtue of the restraining wire winding, can prevent axial motion of the plunger. When sufficient electrical current is passed through the terminals and the bridge wire, the bridge wire heats up and breaks under the applied tension load. This allows the restraining wire to unwind, separating the spool halves and releasing the spring-preloaded plunger, which is directly connected to a ball and cone valve mechanism.

The actuation method is simple and reliable and forms the basis of actuation for many of EBAD's other products including; Battery Cell Bypass Switches and Pin Pullers.

Applications

The Non-Pyrotechnic Valves are most suited to one shot applications that are inaccessible and require maximum reliability such as:

- Spacecraft fuel lines
- Nuclear coolant valves
- Tamper proof hydraulic valves for security applications

Key Features

- Electrically Redundant
- Low Shock
- Positive Isolation
- Operating pressure between 0 to 24.1 MPa
- Hermetically-sealed designs are available
- Predictable actuation times
- Contamination free actuation
- Material selections compatible with gas and liquid mediums

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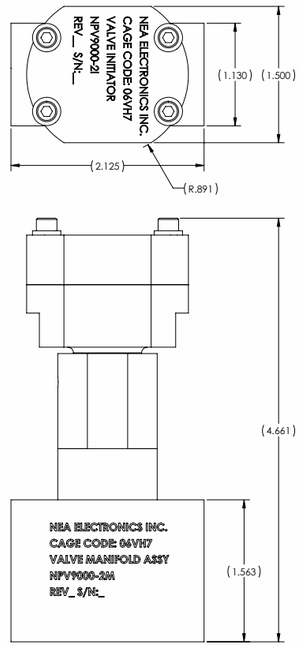
NEA® Model NPV9000
Non-Pyrotechnic Valve

Model NPV9000 Technical Specifications

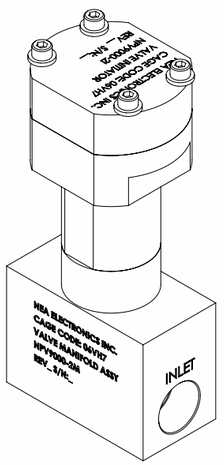
Parameter	Capability
Maximum Operational Pressure	24.1 MPa (3,500 psi)
Minimum Operational Pressure	0 MPa (0 psi)
Minimum Actuation Current[1]	2 A
Actuation Time[2]	30 ms
Cold Temperature Limit	-28.9°C (-20°F)
Hot Temperature Limit	48.9°C (120°F)
Mass[3]	907.2 g (2.00 lbm)

Notes:
[1] Actuation can be achieved using a range of current, the value in the table is the value used for qualifying this device.
[2] Actuation time is dependent on actuation current, contact applications engineering for more specific information on actuation time as a function of current.
[3] Mass does not include harnessing and lead wires. Mass value shown is for reference only.

Model NPV9000 Non-Pyrotechnic Valve Mechanical Interface Drawing (for reference)



NOTE: Orientation of the NPV9000 Initiator (top) with respect to the Manifold (bottom) may vary from unit to unit. Marking information may also vary based on customer requirements.



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ISO 9001: 2015 and AS9100D Certified
(Equivalent to: EN 9100:2016 and
JISQ 9100:2016)

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RIGHT FOR YOUR MISSION™

About Us

Ensign-Bickford Aerospace & Defense Company (EBAD)

Innovating for Your Mission Success

Solutions require innovation. In 1836, William Bickford's invention of safety fuse, a superior initiator for mining explosives, heralded not only a safer era for miners, but the formation of the Ensign-Bickford company. From this single but significant milestone, EBAD has developed global industry influence and extensive capabilities. Ideas, insights, and engineering breakthroughs have made us developers of the most reliable and precise Space and Defense energetic and mechanism solutions available.

Delivering on Our Promises

Our history of providing high-reliability solutions is unequaled, as is our commitment to meeting delivery, safety, and performance requirements. Our ability to deliver solutions to stringent customer requirements to a diverse Space and Defense customer base has set us apart from our competitors. The employees at each of our facilities across the country strive every day to meet our commitments, equipping our customers for mission success.

Evolving with Our Customers

The application of Ensign-Bickford products to Strategic platforms in the 1950s enabled these new missiles to achieve higher levels of mission performance. For more than 60 years since, our customers have relied on EBAD's mission-proven technologies that can evolve with mission needs. Whether our products are used for Launch Vehicle stage separation, Missile motor ignition, Satellite solar array release, or Warfighter door breaching, our products and capabilities enable your mission success today, and in the future.

We are Right for Your Mission™

No other company can match the range of innovative energetic and mechanism solutions that we've developed and manufactured; this breadth of technology innovation and applications engineering is the foundation on which our success—and yours—rests. Every day the employees of EBAD strive to prove that we are Right for Your Mission™.

08-2023