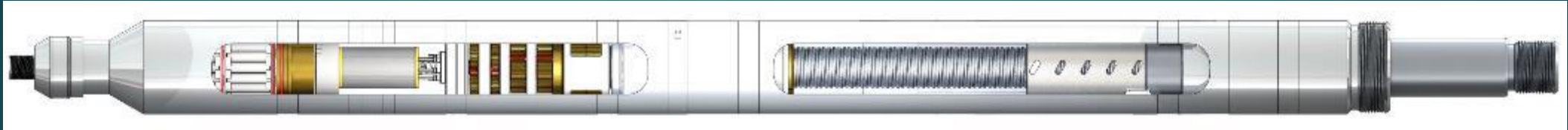


**kaseum**<sup>®</sup>

K-SET (PATENT APPLIED FOR)

# Setting Tool – the “K-Set”



*3.6” O.D. Plug Setting Tool*

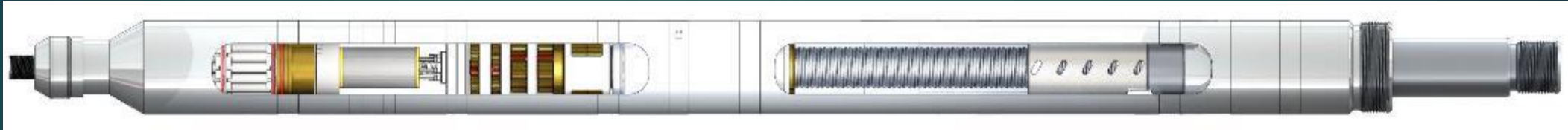
## Setting Tool theory of operation.

- ▶ Provide the linear differential movement required to deploy, set and disengage Wellbore Devices.

## K-Set theory of operation.

- ▶ Once an electronic setting command has been acknowledged the setting cycle will commence. Power is supplied from an alkaline battery pack and is routed to a small DC motor, which provides a high speed, low torque rotational input into a Gearbox. The Gearbox takes this high speed, low torque input and generates a low speed, high torque rotational output. This rotational output is coupled to a Linear Actuator mechanism, which converts the rotational movement to linear movement, and in turn pulls a Slick Rod slowly upwards. When the **K-Set** is connected to a wellbore device, this linear movement of the Slick Rod will allow the device to be expanded into the wellbore in a controlled manner, and then disengage the release mechanism of the wellbore device leaving it in-situ, whilst allowing the **K-Set** and the conveyance medium to be retrieved to surface.

# K-Set Features.



**3.6" O.D. Plug Setting Tool**

- ▶ Simple operation and maintenance/servicing requirements.
- ▶ Slickline, E-Line, Voltage Activation and Perf Mode capability. Only requires different PCM. Same tool. Always downhole power.
- ▶ Very short length: <60" O.A.L with 10" stroke.
- ▶ Non-explosive, electro-mechanical design rated to 15,000psi/135°C (for up to 6 hours). No dangerous goods, no travel or disposal restrictions (not classified under DG regulations) trapped pressure etc. Flashed Housing for 225 °C /10 °C per hour increase
- ▶ Comes in 3 OD sizes. 3.6", 2.75" Slimline 2.72" and 2.125" (Standard and Extended stroke). 2 additional sizes coming 2021 (1.69" Baker 5 and 4.1" >120 000lb tool)
- ▶ Nominal output force: 60klbs (3.6") 40klbs (2.75") 30klbs (2.125").
- ▶ Industry standard connections: Baker #20, Baker #10, Owen 2.125" MSST. Baker #5 crossover available
- ▶ No proprietary software or \*surface power supply required to activate\* Perf and V.A mode requires surface PSU/shooting panel
- ▶ Modular for life cycle maintenance ease. Simple design. Multi-function capability, not one and done.

# K-Set Modules



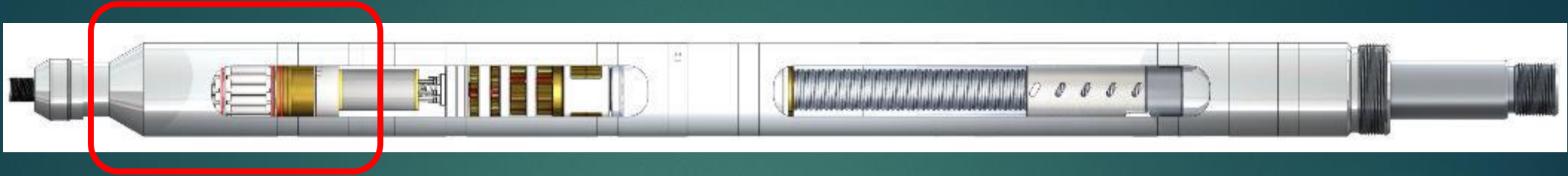
The K-Set consists of 4\* separate modules. They are:

- ▶ Power Comms Module (PCM) assembly.
- ▶ Motor Module.
- ▶ Gearbox Module.
- ▶ Linear Actuator Module.
- ▶ \*Safety Sub for Perf Mode only

The K-Set is designed to be kept together as a single unit, with only the PCM Housing to be removed during operational use.

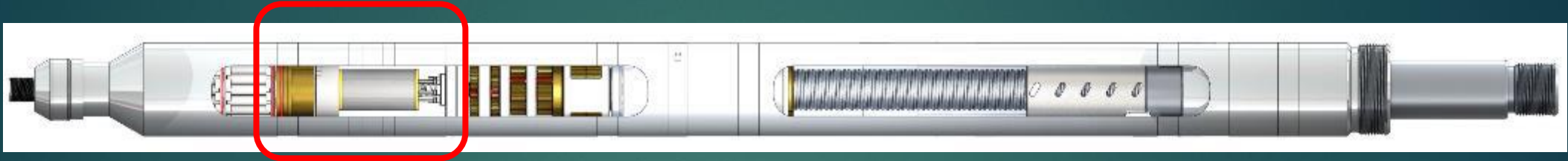


# PCM Assembly

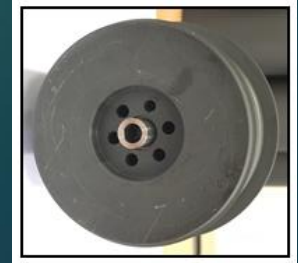
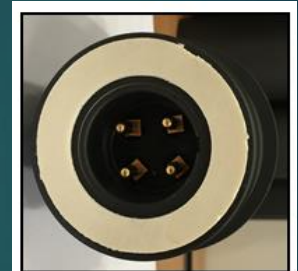


- ▶ **SINGLE USE.** Power and Comms Module (PCM).
- ▶ Power provided by (AlMn) alkaline cells (no dangerous goods) in both E-Line and Slickline. No puncture, battery leakage use gloves, vermiculite. Wash if contact with skin. Power isolated until connected. When connected PCM is always powered. Conserve battery life.
- ▶ Electronic controller on-board. No cumulative shock.
- ▶ Four operational features, three programable commands and an upload function.
- ▶ Programmable via Surface Interface Box or software application (K-Log).
- ▶ Data logging capability. Voltage, Current, Temp, Acceleration, CCL...
- ▶ 4-pin oriented connector, diagnostic LED feature flash good, no flash no good, PCM Electronic Locking feature.

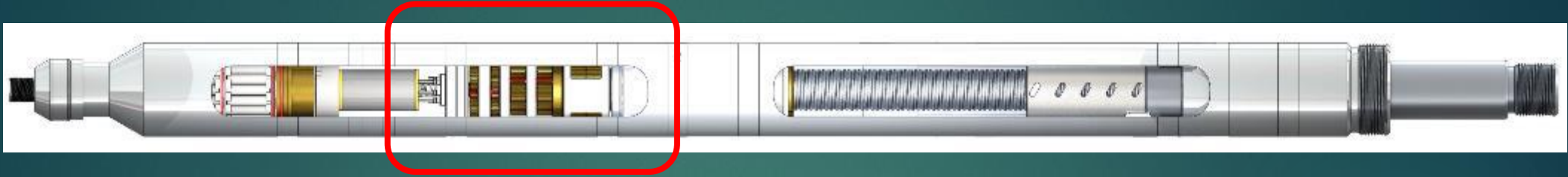
# Motor Module



- ▶ Small DC bi-directional Motor. High Speed Low Torque.
- ▶ Shock mounted design with self aligning coupling.
- ▶ Profiled body to allow for fitment of Rig up Spade.
- ▶ Easy to replace in the field in less than 2 minutes.
  - ▶ Self-contained module, self aligning.
  - ▶ No special tools to replace, no soldering, no wiring.
  - ▶ To be replaced every 25 runs. (temperature cycle, setting/shock cycle)

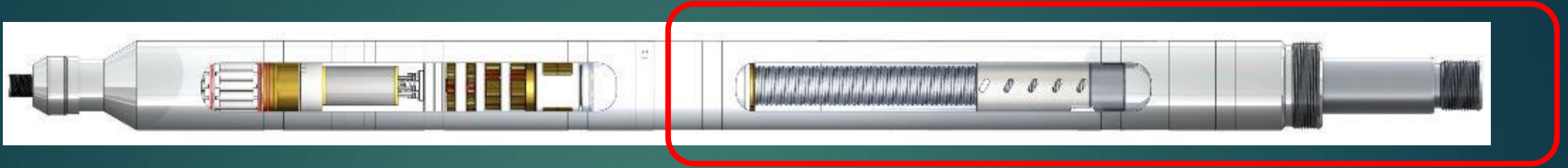


# Gearbox Module



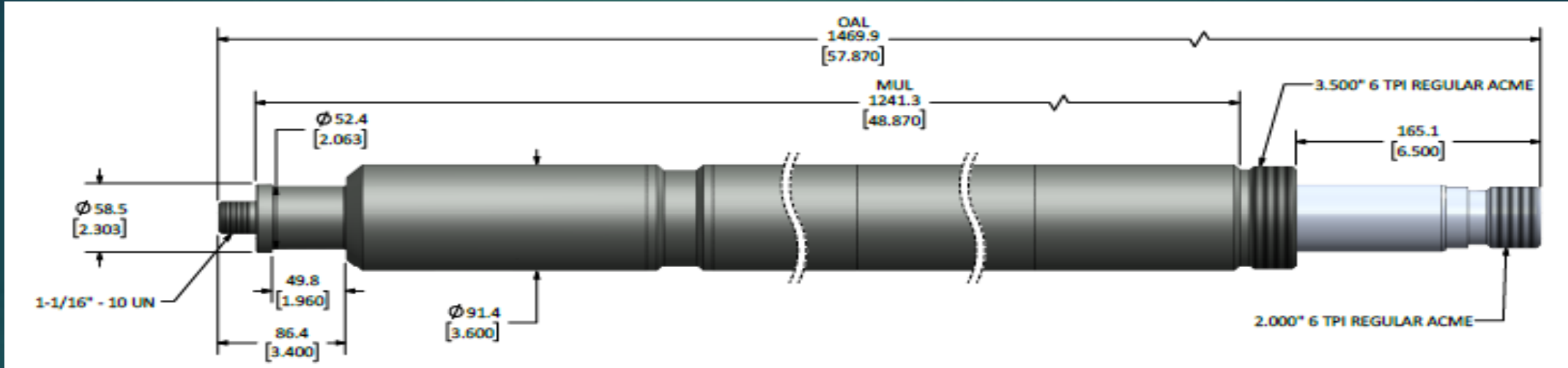
- ▶ Custom-designed Gearbox module to provide Low Speed High Torque/load Output.
- ▶ High shock protection, easy to replace in the field in less than 2 minutes.
  - ▶ Self-contained module.
  - ▶ No special tools to replace, no soldering, no wiring.
  - ▶ **Left Hand thread** make up due to high A.C torque during set.

# Linear Actuator Module



- ▶ Custom-designed Ball Screw mechanism.
- ▶ Slow, controlled setting stroke (Pull) aiding in centralisation and non-violent set.
- ▶ Tool pulls upwards, contrary to Baker style tools. Initially see a small weight increase during set.
- ▶ Positive Hydrostatic Assistance during Setting Cycle. Atmospheric chamber.
- ▶ Output. Nominal 10" Stroke as standard. Dynamic Seal on Slick Rod, no damage.
  - ▶ Longer stroke versions available (1" stroke: 2" OAL ratio)
- ▶ Easy to Reset, no mechanical redress required.
  - ▶ Self-contained module
  - ▶ No special tools to replace, no soldering, no wiring

# K-Set Specifications



- ▶ Top Connection: 1-3/16" GO Box or 1-1/16" SR Pin
- ▶ Max tensile rating 25klbs at GO Box 30klbs on SR Pin

Specification	3.6" OD	2.75" OD	2.125" OD
Nominal Output Force	60klbs	40klbs	30klbs
Bottom Connection	Baker #20	Baker #10	2.125" Owen MSST
Weight	49kg (108lbs)	30.2kg (66.2lbs)	19.2kg (43.2lbs)
Fishing Neck	Size 3"	Size 3" (E-Line) Size 2-1/2" (SL)	Size 2-1/2"
Time for 10" Stroke	17 mins	16 mins	17 mins
Piston Area (Hydro Assist)	4in <sup>2</sup>	2.4in <sup>2</sup>	1.49in <sup>2</sup>

# K-Set Accessory Equipment

- ▶ Field Test Kit.
  - ▶ 10sq.in Hydraulic Piston on 3.6" and 2.75"
  - ▶ 5sq.in Hydraulic Piston on 2.125"



- ▶ Surface Interface.
  - ▶ E-Line and Slickline capability.
  - ▶ Li-ion batteries or DC power.
  - ▶ Real time data plot in E-Line Mode.



# K-Set User functionality

There are 4 operations a user can conduct with K-Set, 3 programmable commands and an upload function. The three commands are:

- ▶ Perform/Program Pull (E-Line or Slickline Countdown Timer).
- ▶ Surface Test.
- ▶ Reset Tool.

Upload Function:

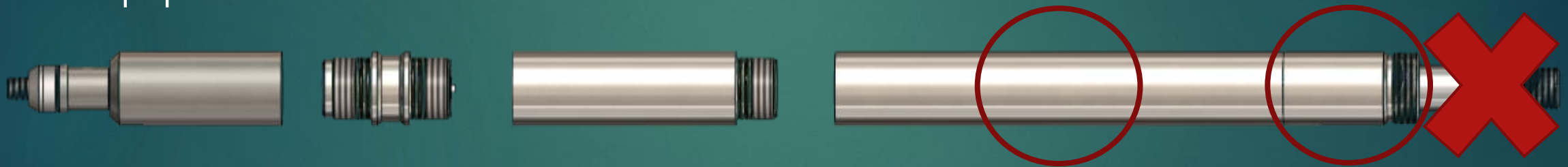
- ▶ Upload Data. Can only be done on K-Log.

All operations are single select options, with the only user input variable being the input of a Countdown Timer Delay.

# Fitting the Wellbore Device Interface

**THE SLICK ROD MUST NEVER BE  
GRIPPED/CLAMPED/SCRATCHED/DAMAGED**

The Slick Rod is a sealing surface and must not be used as a back up point when making up the Wireline Adaptor. Use the Linear Actuator Housing as the Back-up point



The Outer Sleeve Adaptor can be made up directly to the K-Set Outer Adaptor. Use the Outer Adaptor as the Backup Point

# Programming a Pull command.

In Slickline Mode the Pull command is initiated once the user specified Countdown Time Delay has expired.

In E-Line mode the tool is commanded to pull via the Surface Interface Box. Once selected the Pull command will begin.

- ▶ The Countdown Time Delay is the amount of time required from the point at which the user connects the PCM to the K-Set main assembly until the time at which the K-Set **begins** the setting cycle. Once the PCM is connected to the Motor Module the Countdown Time Delay will begin. Ensure the LED confidence check is observed.
- ▶ Like most time critical memory operations there is a protection system to abort the operational if the tool power (and therefore timer) is interrupted. The K-Set uses a 'single time use' arming code that is written electronically when programmed and read on initial connection. Once read it is deleted so if there is an additional start up (power glitch, disconnect – reconnect) then the tool will fail safe.
- ▶ If the K-Set is operated in a hot environment then the Countdown Timer will experience a small amount of time drift. As a rule of thumb, if the expected well temperature is greater than 80°C then the user should allow up to an additional 3%-time delay in the Countdown Timer (i.e. when waiting for the setting cycle to complete wait an additional 2 minutes for each 60 minutes programmed).
- ▶ Run to the required setting depth and sit stationary prior to the Pull command initiating. Once the K-Set begins stroking the plug will begin setting into the wellbore. The K-Set will take approximately 17 minutes to stroke its full length. During this time the user should check for any indications that the plug has set and disconnected from the K-Set (tool string weight fluctuation, pressure differences, movement on the conveyance wire etc.) and the K-Set should remain stationary during this setting process. Once the 17-minute run time has expired and a good indication is observed, then the K-Set can be recovered to surface.



# Programming and performing a Surface Test

It is recommended that the K-Set's function is checked periodically by means of a simple load test, whereby the K-Set is commanded to perform a dummy setting cycle to 50% of the nominal load.

Once the 'Surface Test' command has been initiated the K-Set will pull to a nominal current limit, stop and wait, and then 'Reset' to the 'Ready to Run' position.

K-Set OD Size	Force Gauge Assembly	Force Gauge Piston Area	Expected Pressure reading	Acceptable pressure reading	Resultant force
3.6" OD	941	10in <sup>2</sup>	3000psi	≥2700psi	≥27,000lbs
2.75" OD	2129	10in <sup>2</sup>	2000psi	≥1800psi	≥18,000lbs
2.125" OD	1203	5in <sup>2</sup>	3000psi	≥2700psi	≥13,500lbs

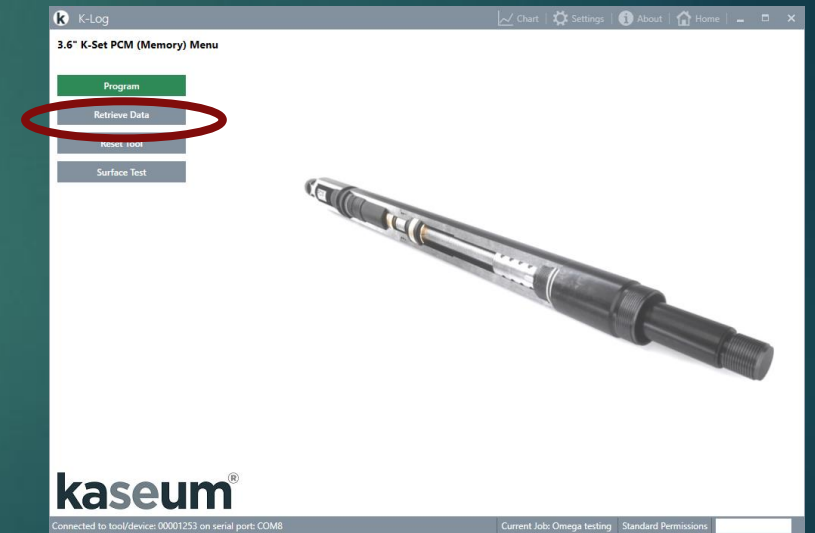


# Deploying the K-Set

- ▶ Never Grip/clamp the Slick Rod during make up.
- ▶ New PCM every run.
- ▶ The maximum recommended running speed for the K-Set is 150ft/min.
- ▶ Once the perform Pull command is initiated the setting cycle will **begin**.
- ▶ Allow at least 20 minutes for the setting cycle to be conducted. During this time monitor all available signs for successful set and disengagement of the plug. (Weight indicator fluctuations increase first, pressure changes, movement on the conveyance medium etc.)
- ▶ Once a successful operation has been established, or once the Countdown Timer and an additional 20 minutes along have elapsed, the K-Set can be recovered to surface.
- ▶ Download tool data from the PCM. PCM is now considered spent and should not be used for any additional setting and surface test operations.

# Data Interpretation

- ▶ Connect PCM to software.
- ▶ Upload Data.
- ▶ Sample rate default is 10hz countdown timer data. 20Hz when setting.
- ▶ Stored channels are CCL, Current, Voltage, Op Mode, Acceleration, Pulse Number and Temperature
- ▶ Voltage  $\approx$  Speed, Current  $\approx$  Load
- ▶ Hydrostatic assistance. Higher pressure will mask load increase.



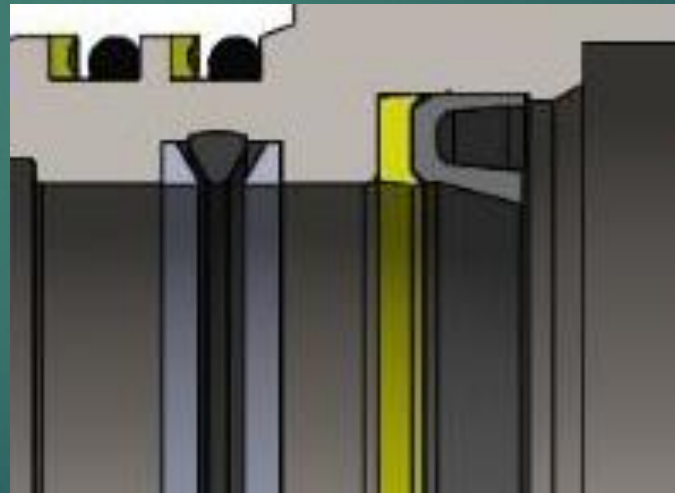
# Performing a Reset

After the K-Set has completed the setting cycle the Slick Rod will be fully retracted inside the main tool assembly. The user must 'Reset' the K-Set in order to ready it for future deployments. A 'Reset' is in essence running the K-Set in reverse, which will push the Slick Rod back to its original 'Ready to Run' position. This function is electronically controlled and requires no user mechanical intervention. The 'Reset' function is not operation critical, so used PCM's should be utilized to perform this function.



# Maintenance

- ▶ Keep the main tool assembly as a complete assembly.
- ▶ Metal Seal. Common O-rings.
- ▶ Re-torqueing of broken out connections. Seal angle. torque
- ▶ Motor Module replacement.
- ▶ Service intervals:
  - ▶ 25 Runs – Motor.
  - ▶ 50 Runs or 2 years – Elastomers.
  - ▶ 100 Runs – Full inspection.



# K-Set User Golden Rules

- ▶ The PCM should only be used ONCE. The PCM is a single use item and a new PCM should be used for each operation. An operation is defined as a single 'Surface Test' and a single Setting Cycle. Re-using a PCM that has already been deployed in a setting operation WILL RESULT IN MIS-RUNS AND MAY RESULT IN A PARTIAL SET SITUATION
- ▶ DO NOT use any tooling on the Slick Rod. The Slick Rod is a dynamic sealing surface and it is IMPERATIVE that the Slick Rod is not marked, damaged or clamped on.
- ▶ When making up/breaking out Inner Running Adaptors to the Slick Rod use the Linear Actuator Housing as a back-up point. DO NOT torque through connections. The Slick Rod is keyed into the Linear Actuator Housing, so this is the most suitable back-up point when tightening Adaptors to the Slick Rod.
- ▶ When making up/breaking out Setting Sleeve Running Adaptors use the Outer Adaptor as a backup point. DO NOT torque through connections.
- ▶ When making up the PCM Housing use the Motor Sub as a backup point. DO NOT torque through connections.
- ▶ DO NOT breakout the external connections below the Motor Module.
- ▶ Current  $\approx$  Load. The higher the hydrostatic assistance the less work, and therefore less load, will need to be done by the K-Set.
- ▶ The Gearbox Module to Linear Actuator Module connection is a LEFT-HAND THREAD MAKE UP
- ▶ As a rule of thumb, the user should allow up to an additional 2 minutes for each 60 minutes of Countdown Timer when in a hot environment.

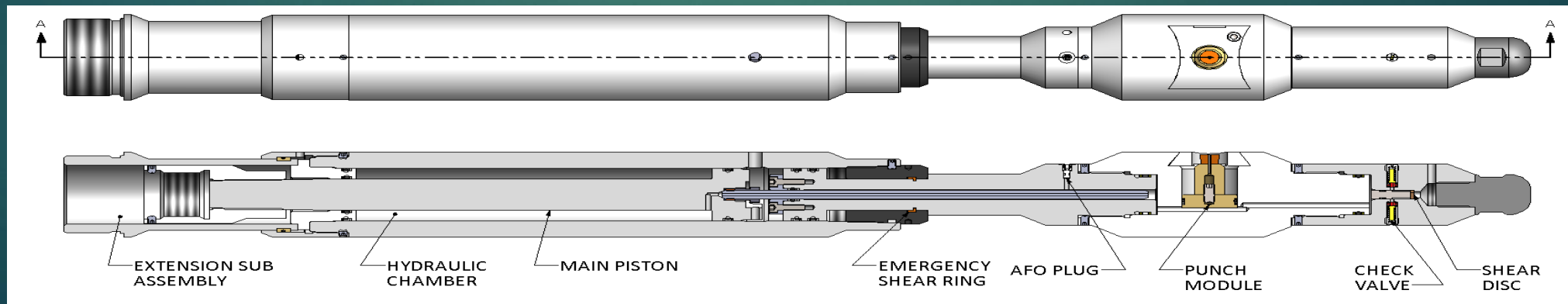
# K-Punch design overview

- ▶ The **K-Punch** is connected to a **K-Set Setting Tool** prior to deployment to make up the running string. The Slick Rod of the **K-Set** is directly connected to the Main Piston of the **K-Punch**, meaning that any movement generated by the **K-Set** will be transmitted directly to the Main Piston of the **K-Punch**.
- ▶ The **K-Punch** is a simple hydraulic system that is directly energised or relieved by manipulating the Main Piston upwards or downwards. Once the running string is stationed at the required punching depth the operation can begin.
- ▶ An electronic 'Punch' command is initiated and the **K-Set** will begin stroking upwards, pulling the Main Piston of the **K-Punch**, and pressurising the hydraulic chamber within. As the pressure increases the Punch Piston(s) are forced outwards and the connected Punch Button(s) will contact the wall of the tubing.
- ▶ The hydraulic chamber pressure will continue to rise until a sufficient pressure, and therefore force, has been generated to penetrate the Punch Button through the tubing wall, where the Punch Button will be ejected in to the Annulus leaving behind a communication port to the annular space.
- ▶ Once all Punch Buttons have penetrated, the **K-Punch** will vent the hydraulic chamber by means of a Shear Disc rupture event. The **K-Set** is then commanded to 'Retract' and the Punch Piston(s) are retracted into the tool, allowing the running string to be recovered to surface.
- ▶ The **K-Punch** consists of 2 separate assemblies. They are:
  - ▶ Hydraulic Actuator assembly.
  - ▶ Punch Module(s)



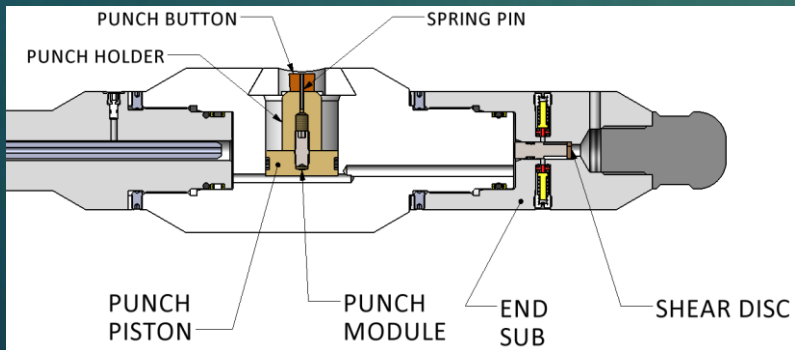
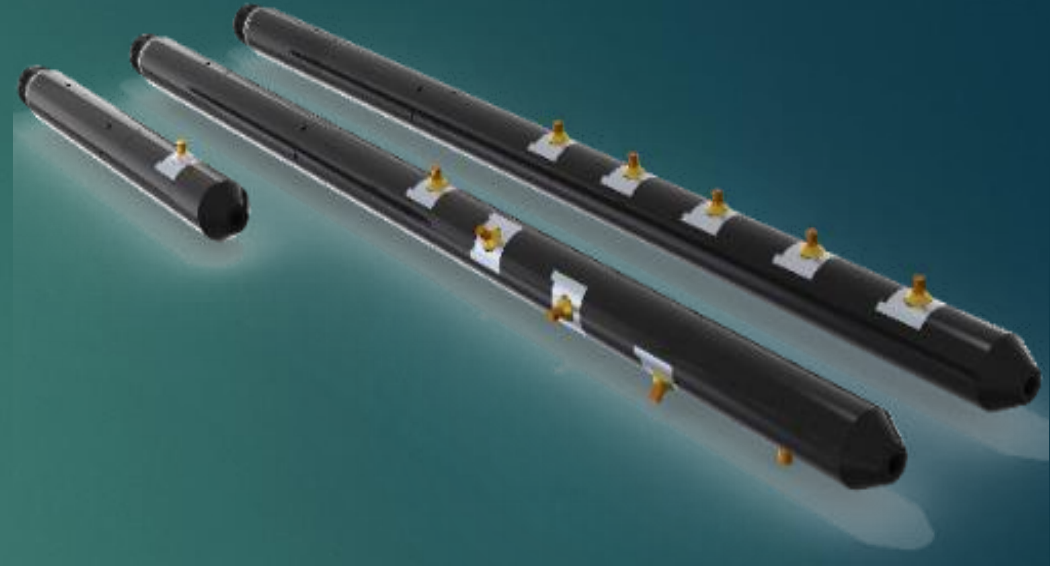
# K-Punch - Hydraulic Actuator

- ▶ The Hydraulic Actuator assembly is a simple piston operated hydraulic chamber. When the Hydraulic Actuator assembly is interfaced with the **K-Set** the movement generated by the **K-Set** is applied directly to the Main Piston of the **K-Punch**, which will increase or decrease the hydraulic chamber pressure accordingly. A 'Punch' command will cause this hydraulic chamber to reduce in volume, therefore increasing the pressure, which is used to deploy the Punch Pistons. When a 'Retract' command is issued the hydraulic chamber volume is increased causing the pressure to reduce, allowing the Punch Pistons to retract.
- ▶ When connected to the **K-Set** the Main Piston of the **K-Punch** screws directly to the **K-Set** Slick Rod, transmitting the linear stroke of the **K-Set** directly to the hydraulic chamber of the **K-Punch**.
- ▶ The Hydraulic Actuator assembly also has several features that are integral to the correct and safe deployment of the **K-Punch**. **These include:**
- ▶ **A Relief Shear Disc;** to vent the hydraulic chamber into the external atmosphere after all the Punch Buttons have been deployed, whilst also protecting the hydraulic system from over-pressurisation.
- ▶ **Check Valves,** to allow the hydraulics to be vented at the end of the punching cycle but permit the ingress of well fluid.
- ▶ An **Axial Force Only Plug;** (hereby referred to as an A.F.O. Plug) to allow the hydraulic chamber to be vented manually, and in a controlled manner, if a risk of internal trapped pressure on return to surface is thought to be present.
- ▶ An **Emergency Release Shear Ring;** to allow the hydraulics to be vented in an emergency situation downhole. In the unlikely event that a complete tool failure occurs during the punching cycle then the running string can be jarred up to release a shear ring that will vent the hydraulic chamber.



# K-Punch module(s)

- ▶ The Punch Module contains the Punch Button arrangement used to penetrate the tubing wall.
- ▶ The Punch Module, or Modules, can be fitted onto the Hydraulic Actuator assembly and orientated to the required phasing with the addition of Shim Washers.
- ▶ Each Punch Module has an internal hydraulic chamber that connects into the Hydraulic Actuator assembly hydraulics.
- ▶ Within the Punch Housing a punching arrangement that comprise a Punch Piston, Button Holder, Spring Pin and Punch Button is fitted. When the hydraulic chamber is pressurised, this punching arrangement moves out radially to contact the tubing wall.
- ▶ Once sufficient pressure, and therefore force, has been reached the Punch Button will penetrate the tubing and be ejected into the annular space, providing hydraulic communication between the tubing and annulus.



# K-Punch Head Orientation & Phasing (E-Line & Slickline)

- The Punch Heads can be positioned to the required phasing by adding Shim Washers in between each Punch Head - as per figures 55 & 56 (Note - shim washers are provided as standard parts of all Punch Head Kits)
- Kaseum recommends the Punch heads be aligned (0 Deg Phased) or equispaced – refer to below table as example with 6 Punch heads

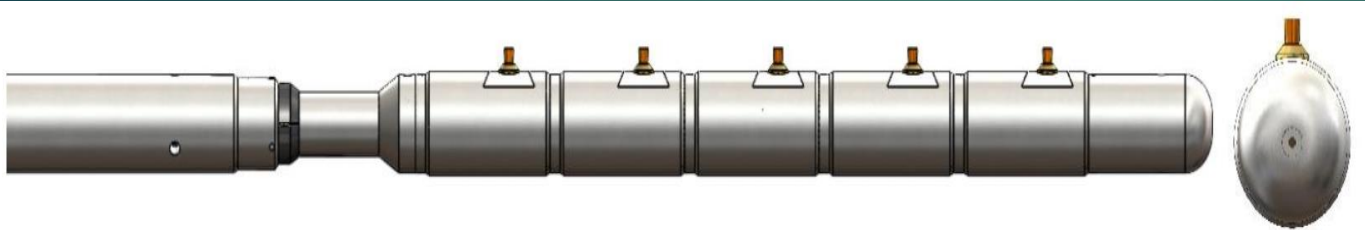


Figure 55 - Image showing 5 Punch Heads phased at 0°



Figure 56 - Image showing 5 Punch Heads phased at 72°

Number of Heads	Recommended phasing angle
1	N/A
2	0° or 180°
3	0° or 120°
4	0° or 90°
5	0° or 72°
6	0° or 60°

# K-Set & K-Punch options

## K-SET & K-PUNCH Options with Slickline and ELINE (Rev 9)

K-SET PN (Slickline & ELINE)	Make up Length (SL & EL) (m)	K-Set OD"	K-Punch Hydraulic Actuator PN	(Hyd Actuator) Make up Length (m) (with 1 Punch Module)	Total Length (m) (with 1 Punch Module) (add 5" to 7" per add. Module)	K-Punch (Hyd Actuator) OD" (with 1 Punch Module)	K-Punch Module PN	K-Punch Module OD"	Max. # of Punch Module / Holes	Punch Button OD" *	Flow Area (Sq Inches) per Hole	Flow Area (Total Sq Inches) with all Modules	Suitable for Tubing
2.125" OD K-Set Tool with 2.16" & 2.59" OD K-Punch Options													
001435 / 01434	1.28	2.125"	002524	1.05	2.33	2.16"	002521	2.16"	8 7	0.375" 0.563"	0.110 0.249	0.880 1.743	2 7/8"
001435 / 01434	1.28	2.125"	002325	1.05	2.33	2.59"	003725	2.59"	3	0.715"	0.402	1.206	3 1/2" x 7.7 to 12.7#
							002502	3.60"	3	0.715"	0.402	1.206	4 1/2" x L80
							002500	3.85"	3	0.715"	0.402	1.206	5" x L80
							002546	4.50"	3	0.715"	0.402	1.206	5 1/2" x L80
2.75" OD K-Set Tool with 2.59" OD K-Punch Options													
002323 / 002320	1.400 / 1.348	2.75"	002325	1.16	2.56	2.59"	003725	2.59"	3	0.715"	0.402	1.206	3 1/2" x 7.7 to 12.7#
	Conversion Kit		002813				002502	3.60"	3	0.715"	0.402	1.206	4 1/2"
							002500	3.85"	3	0.715"	0.402	1.206	5"
							002546	4.50"	3	0.715"	0.402	1.206	5 1/2"
3.6" OD K-Set Tool with 3.6" OD K-Punch Options													
001430 / 001422	1.241	3.6"	002532	1.315	2.556	3.60"	002502	3.60"	5 8	0.715" 0.450"	0.402 0.159	2.010 1.272	4 1/2" Tubing
							002500	3.85"	5	0.715"	0.402	2.010	5"
							002546	4.50"	5	0.715"	0.402	2.010	5 1/2"
							003434	5.75"	3	0.625"	0.307	0.921	7" L80, 23# & 29#
								5.75"	3	0.563"	0.249	0.747	7" P110, 23#
								5.75"	3	0.500"	0.196	0.588	7" P110, 29#
					(17.12" long per module) (with 3 Punch Buttons per Head)		003455	8.25"	3	0.625"	0.307	0.921	9 5/8" L80, 47#
					(22.18" long per module) (with 3 Punch Button per Head)				3	0.450"	0.159	0.477	9 5/8" P110, 47#