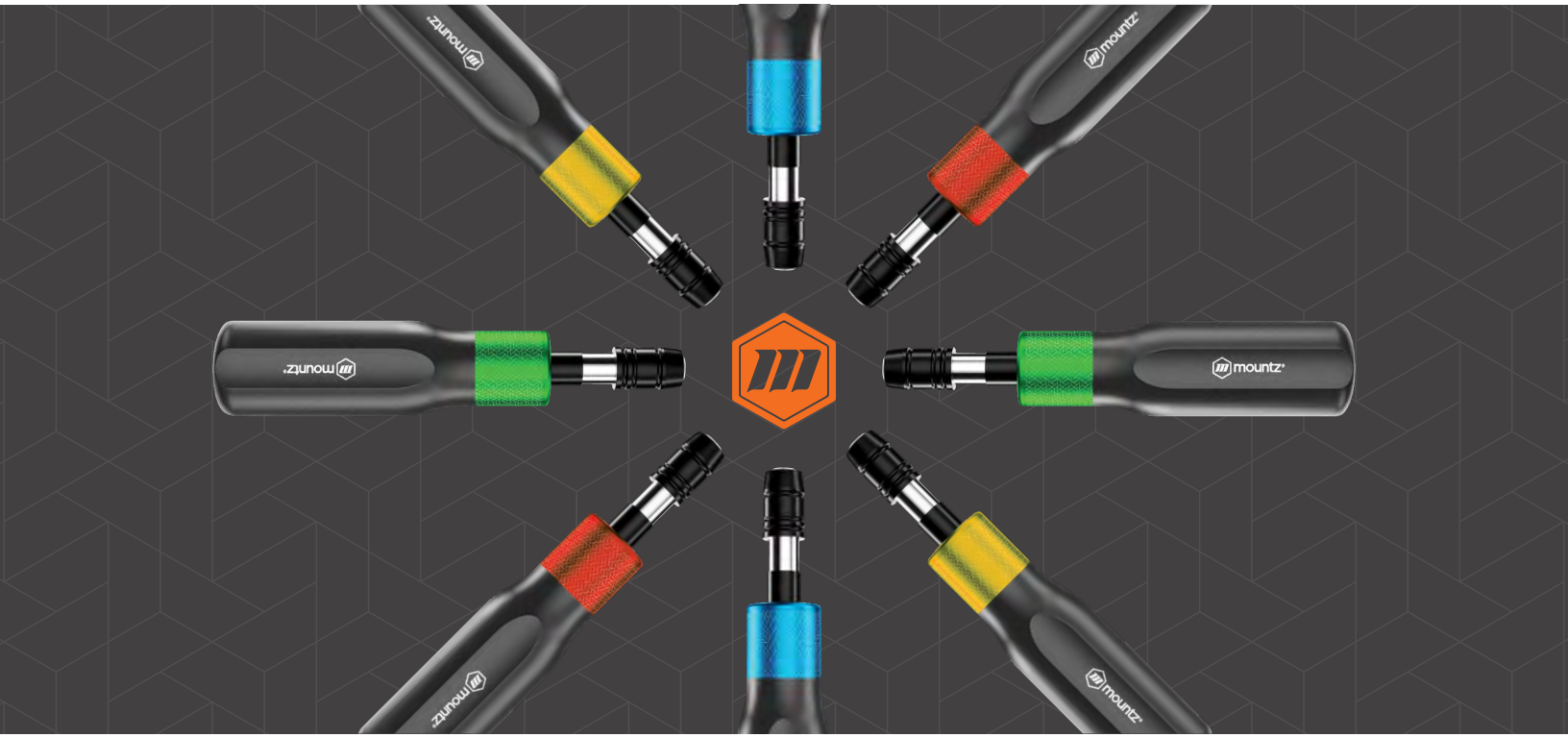
WHITE PAPER

FG PRESET PRECISION TORQUE SCREWDRIVER

mountz®
the torque tool specialists




# USING $C_{MK}$ AS A MEASURE IN DETERMINING TORQUE TOOL QUALITY

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# WHITE PAPER SYNOPSIS

Smarter manufacturing environments are demanding higher quality tools for precise assembly applications. Companies need partners they can trust to provide education on relevant data and proper torque testing techniques to ensure their tools are of the quality level they require. This white paper defines $C_{mk}$ and why this measure is important when evaluating torque tools. We outline the testing methodology Mountz underwent in evaluating its new line of preset precision screwdrivers in its world-class lab. Finally, those test results are unveiled justifying the claim that FG is the most advanced precision hand screwdriver in the world.

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## Accuracy and precision over time = repeatability

Most manufacturing facilities use torque assembly tools to fasten screws or bolts into their final products. These can be electric or pneumatic torque power tools, all types of torque hand tools, or smart fastening systems like DC controllers. Engineers need to make sure these assembly tools are precise, accurate, and repeatable so they meet their assembly process standards. Mountz proactively educates customers on the best way to determine the right tool for their process and how to determine the repeatability of tools used.

Torque tools behave differently depending on various factors, such as: type of material used on the product, type of screws or bolts used, lubrication, environment, weather, and manufacturing process tolerances. Users tend to take a tool's accuracy stated on a catalog or website and assume the entire tool's range will behave the same. This is an incorrect assumption. An assembly tool's specified accuracy does not always  transfer 100% to the application.

Mountz has focused on ensuring that future generations of drivers will deliver the most consistent torque on the market through proven accuracy and precision, as demonstrated by the results of stringent $C_{mk}$ testing.

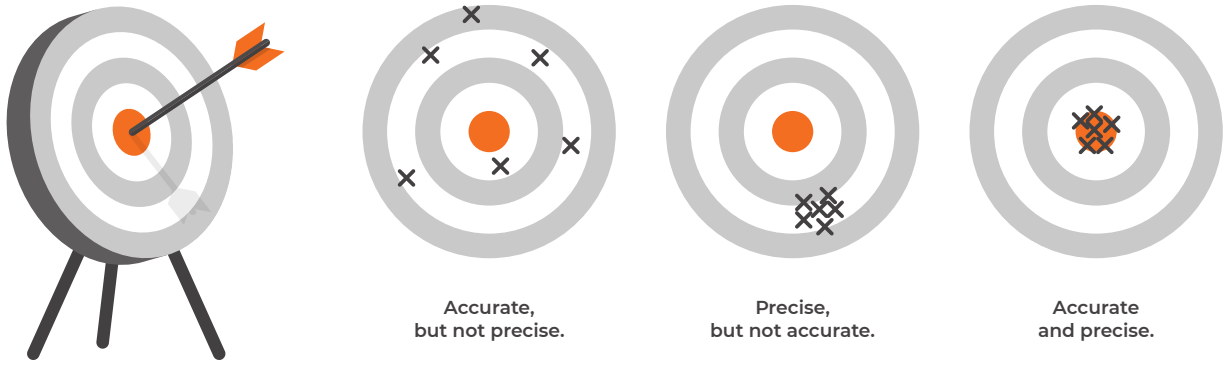
## What is $C_{mk}$

$C_m$ & $C_{mk}$, also known as the machine capability index, is used to indicate the capability of a machine. Derived from the data taken during a continuous production run, this index is closely related to the commonly known $C_p$ and $C_{pk}$, which measures long-term capability over a process. However, the machine capability index $C_{mk}$ helps to define how suited a machine is for a specific task given the process requirements.

### $C_M$ (CAPABILITY MACHINE/TOOL)

The $C_m$ index describes machine capability. It is the number of times the spread of the machine fits into the tolerance width. The higher the value of $C_m$, the more precise the tool.

ACCURACY AND PRECISION



### $C_{MK}$ (CAPABILITY MACHINE/TOOL INDEX)

To study the position of the machine's capability in relation to the tolerance limits, use the $C_{mk}$ index, which describes the capability corrected for position and can also be described as how precise and accurate the tool is. It is not much use having a high $C_m$ index if the machine setting is severely off-center in relation to the middle of the tolerance range. Typical acceptance criteria when utilizing $C_{mk}$ calculations is a value of 1.67, or 5 sigma (see Table 1).

Using the $C_{mk}$ calculations, users can gain confidence in a machine's capability of maintaining a controlled and accurate function over the entirety of its uninterrupted operational interval.

## $C_{mk}$ tests on the Mountz FG preset hand screwdriver

To validate the capability of the next generation of Mountz hand tools, a rigorous $C_{mk}$ test was conducted to prove the capability of the new hardware. Engineers conducted tests on four individual drivers of each range, at 10, 20, 60, and 100% of the tool capacity. The upper and lower tolerance limits were set based on the average of the first 12 torque applications, which is considered in this experiment as the set point of the driver. Most companies base their claims off of recording the first 10-20 data points, followed by unrecorded torque applications, and finally rechecking with 10-20 post-cycle data points. The Mountz testing consisted of an uninterrupted 20,000 points which were recorded and used for the $C_{mk}$ calculation.

TABLE 1

| 6 SIGMA AND PROCESS CAPABILITY | | | |
|---|---|---|---|
| SIGMA LEVEL | DPMO | % GOOD | $C_{MK}$ |
| 1 | 691462.0 | 30.9 | 0.33 |
| 2 | 308530.0 | 69.1 | 0.67 |
| 3 | 66807.0 | 93.1 | 1.00 |
| 4 | 6210.0 | 99.4 | 1.33 |
| 5 | 233.0 | 99.98 | 1.67 |
| 6 | 3.4 | 99.99966 | 2.00 |


Mountz $C_{mk}$ precision, accuracy, and lifecycle testing station.

## Results of $C_{mk}$ tests on the Mountz FG preset hand screwdriver

For torque screwdrivers, a standard interval of operations before calibration is a maximum of 5,000 cycles, as defined in ISO 6789-1:2017(E). As an acceptance criteria for the new line, Mountz designed a $C_{mk}$ test around the operational life of the tool remaining in spec to calibration tolerance. With the 5,000 cycle standard, Mountz ran four sets of each model at at 10, 20, 60, and 100% of full scale with the resulting $C_{mk}$ shown in Table 2. At 5,000 cycles, the Mountz line of FG drivers all tested well beyond 6 sigma capabilities.

With a $C_{mk}$ well over the typical 1.67 $C_{mk}$ (5 sigma) acceptance criteria for each model, the decision was made to increase the calibration window to determine the true calibration life of the tool.

For the calibration life of the tool, engineering tested the units with 20,000 uninterrupted cycles as the new operational interval. The $C_{mk}$ results of the 20,000 torque application test are shown in Table 3.

The new 20,000 torque application interval across four set points of each driver came to a minimum of 1.68 $C_{mk}$.

## FG Preset Hand Screwdriver: Unmatched quality on a scale of 5 sigma+

FG Preset Hand Screwdrivers have been designed and proven to far exceed the highest standards available in the market.

- FG Preset Hand Screwdrivers are guaranteed to a minimum of 1.670 $C_{mk}$ that represents 5 Sigma and it also can be interpreted as less than 23. 3 defects (DPMO) over 100,000 cycles in a production process.
- $C_{mk}$ calculation is based on 20,000 readings at 10, 20, 60, and 100% of tool scale with 6% tolerance.
- ISO 6789-1:2017(E) Type II, Class F recommends 5,000 cycles before re-calibration of the tool. FG Preset Hand Screwdrivers are proven to dramatically exceed the standard as these tools are offered at 20,000 cycles before first recalibration required.
- Life cycle testing that exceeds 100,000 cycles before any maintenance required.

**TABLE 2**

| 5,000 TORQUE CYCLES $C_{MK}$ RESULT | |
|---|---|
| TOOL | $C_{MK}$ |
| 8i | 2.59 |
| 20i | 2.11 |
| 40i | 2.62 |

**TABLE 3**

| 20K $C_{MK}$ DATA | | |
|---|---|---|
| TOOL | SETTING | $C_{MK}$ |
| 8i | 10% | 1.87 |
| 8i | 20% | 2.29 |
| 8i | 60% | 2.64 |
| 8i | 100% | 1.75 |
| 20i | 10% | 1.88 |
| 20i | 20% | 2.34 |
| 20i | 60% | 1.74 |
| 20i | 100% | 2.0 |
| 40i | 10% | 1.79 |
| 40i | 20% | 3.61 |
| 40i | 60% | 3.07 |
| 40i | 100% | 1.68 |

## FG Preset Hand Screwdriver: The most advanced hand tool in the world

Engineered, assembled, and extensively tested in the Silicon Valley, the FG line of precision preset hand drivers clearly stand above the competition as the most advanced hand driver in the world.

TABLE 4

| PRODUCT OVERVIEW | | | |
|---|---|---|---|
| **FEATURE** | **WHAT IS IT?** | **ADVANTAGE** | **END USER BENEFIT** |
| $C_{mk}$ Testing | • Tool's capability in relation to tolerance limits | • International Standard raises the bar for all hand torque tools<br>• Meets highest requirement and standard in the market | • Traceability<br>• ISO compliance |
| Cycles Before Calibration | • ISO 6789-1:2017 calls for at most 5,000 torque applications | • Exceeds standards<br>• Mountz 4x ISO standards: 20,000 cycles before re-calibration | • Longer time on the production line<br>• Reduces calibration budget and down time |
| Consistency | • Lifecycle testing of well over 3 million combined torque applications | • Confidence every tool meets requirements | • Reduces need to replace tools/parts<br>• Lower required tool inventory |
| Cam & Clutch Design | • Cam-over design to eliminate overtorque<br>• Cam design for optimal performance<br>• Anti-backlash, one way, CW and CCW all available | • Eliminates fastener breakage issues<br>• Multiple cam options for numerous applications<br>• Dependable torque applications | • Higher line productivity<br>• Error proofing assembly process |
| Handle Flutes | • Brand new 4-flute handle design | • Reduced number of flutes<br>• Ergonomic design | • Ergonomic<br>• Easy to clean<br>• Sleek and comfortable |
| Needle Thrust Bearing | • Rotary bearing to allow rotation between parts | • Reduces axial load torque dependency<br>• Reduces friction influence on tool output<br>• Longer life on internal components | • Higher accuracy<br>• Durability |
| Metal End Cap | • Eliminates possibility of damage to end cap | • Aluminum—durable & doesn't strip out hex feature like plastic | • Fewer parts need replacement<br>• Easier to service |
| Bit Retention (Universal Bit Holder) | • ¼ inch female hex bit holder that grips any type of bit<br>• Patented One Touch bit release | • Safe and secure<br>• No band / spring and captive ball to fall out | • Better quality and productivity on line<br>• Bits don't fall out or into assembly operation |
| Locking Mechanism | • Double locking mechanism to prevent accidental torque setting change | • Avoids torque setting drift | • Longer period before re-calibration<br>• Higher accuracy over time |



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