Screwdriving Technology

DEPRAG
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# The Optimal Solution for Your Screwdriving Requirements


# SELECTION GUIDE SCREWDRIVING TECHNOLOGY

Product and process engineers are familiar with the following situation: the screw joint, known as the largest joining technique in industry, presented an unwelcome surprise in practice due to variables that were not taken into consideration during the design and calculation phase of the product. It is now up to the engineer to find an assembly solution.

This guide provides assistance and information to help the engineer select a suitable assembly system for production assembly.

DEPRAG offers a very broad range of screw assembly tools for different kinds of assembly applications. Tools for the assembly of complex and sensitive products which have demanding requirements with regard to process data and security, a different approach than, for example, an impact wrench used in a rough assembly environment.

## 1 THE CORRECT TOOL FOR YOUR APPLICATION

**An overview of the different screw assembly tools and their applications**

### A Screwdriving Technology for Industrial Assembly

For industrial assembly DEPRAG offers a wide spectrum of solutions from the most basic to the very sophisticated, pneumatic screwdriver NANOMAT, MICROMAT or MINIMAT up to servo electric drive EC-Servo screwdrivers.

The classification of these tools is based upon various criteria, such as:
- categories: A, B, C
- manual or stationary application
- the drive type: pneumatic or electronic
- the tool form: straight execution, angle head design, pistol grip type
- the process requirements for quality control, data reporting, flexibility, documentation, etc.
- the measuring system: directly or indirectly

In many industrial assembly applications it is important to consider not only the screwdriver but the complete screwdriving system in relation to the particular application. The screwdriving process itself, and the required process control requirements have to be matched for example; the screwdriver, torque and angle measurement equipment, the automatic screw feeding system, to the complete set up of a manual work station or fully automated assembly system. Everything should be matched and considered as a system.

Here we offer an initial step in the selection of an appropriate screwdriving unit. However, a confirmation of the screwdriving sequence for your particular application can only be determined with an application analysis (e.g. screw joint analysis based upon your assembly components).

### B Screwdriving Technology for Special Applications

For various special applications DEPRAG offers a selection of solutions, e.g.

- **SENSOMAT –** the screwdriver equipped with a mechanical clutch mechanism lock out which assists with the assembly of self tapping or thread cutting or thread rolling screws. The screw is driven with the full torque if the motor until shortly before the head of the screw is seated. At this point the mechanical clutch of the screwdriver is enabled and the screw will seat at the preset torque value of the clutch. It is ideal for applications where the torque required to form the screw thread or cut the material is higher than the torque required to seat the screw.
- **Pulse screwdriver with shut-off –** the hydraulic impulse/impact driver for high speed screw or bolt assembly with no noticeable torque reaction, with torque shut-off.
- **Impact driver –** for high speed screw or bolt assembly in a torque range from 90 - 1200 Nm.
- **MINIMAT-T –** the depth control screwdriver with accurate shut-off after a pre-set thread engagement or screw depth, for example in the wood or gypsum processing industries.
- **VARIOMAT –** the all-rounder for the wood working industry.
- **DISSASSEMBLY screwdriver –** the reverse mode screwdriver with ramp up speed, easy loosening of assembled screws for the repair, rework or recycling industries.
- **Pneumatic screwdriver with slip clutch –** the classic for wood and sheet metal assembly.
- **Flat head screwdriver –** the solution for limited access or tight space applications for screws from M3 to M8.

**The selection of a screwdriver for industrial series production is very demanding. Therefore, the steps in the following guide are prepared to address the specific screwdriving requirements in this area.**

## 2 SELECTION OF THE ASSEMBLY TECHNIQUE BASED UPON THE REQUIRED NUMBER OF ASSEMBLIES

In principle it is important to understand which assembly technique is required for your production demands. With relatively low production volumes, short product life cycles or a high number of product variants, we would recommend a handheld or hand-guided screwdriver for manual assembly.
The manual screwdriver can be upgraded as production volumes increase, for example, with automatic feeding.
The reverse means that relatively high production volumes or long product life cycles lend themselves toward automatic assembly processes. For this semi-automated or fully automated assembly systems present themselves.

According to the variants of your products there are flexible XY-single spindle systems or, based upon a specific screw hole pattern, multi spindle screwdriving stations available.

## 3 SELECTION OF THE DRIVE TYPE – ELECTRICAL POWER OR COMPRESSED AIR?

There are basically two different drive types, electric or compressed air. Electronic and pneumatic screwdrivers are characterized by clear specific capabilities, the selection of one or the other is defined by the requirements of the specific application.

**The following factors should be considered in the selection:**

| Criterion | Electronic Drive | Pneumatic Drive |
|---|---|---|
| A: - Flexibility (variability in screw tightening limits)<br>- Flexible Screwdriving Procedures | high<br>high | low<br>low |
| B: Process Reliability | high | middle |
| C: Torque Accuracy | high | high |
| D: Data Collection and Statistical Process Control | high | middle |
| E: Documentation Requirements | high | middle |
| F: Initial Investment | high | low |
| G: Operating Costs | low | low |
| H: Availability of the type of energy | available | normally available |
| I: Service Life | high | high |

Individual factors or combinations thereof influence the selection of the drive medium. E.g.: the absence of compressed air is an exclusion criterion for the pneumatic screwdriver. Or: the requirement of flexibility, such as variable screw tightening parameters or head contact recognition is a clear criterion for the use of an electronic driven and free programmable screwdriving tool.

**Criterion A: Flexibility**

If your application presents the possibility or the necessity that one of the parameters, torque, angle, speed, drive direction or depth of screw engagement, may change, we strongly recommend the use of an electronic programmable screwdriver. EC screwdriver systems (MINIMAT-EC-Servo, NANOMAT-EC, MICROMAT-EC, MINIMAT-EC) offer free programmability of the screwdriving parameters. Changes to the screw tightening process can be easily implemented, even from one screw position to the next.

The reverse, it is determined that consistent parameters apply to all screws in an assembly, means that a standard pneumatic shut-off driver (NANOMAT, MICROMAT, MINIMAT or MINIMAT-E screwdriver) may be a suitable solution.

**Criterion B: Process Reliability**

Process reliability is a very broad concept and has a notable impact as to the scope and cost of the selected screwdriving system. The requirements for process reliability should be clearly defined in advance.
Whilst for one screwdriving application a simple pass/fail signal may be sufficient, the next application may demand that documentation and final values for each step in the screw run down process are recorded, controlled and evaluated.

Simple pass fail signals are available with both pneumatic and electric (EC screwdrivers). To record, control, document and evaluate the screw assembly steps we would usually apply a screwdriving system based upon the EC/EC-Servo technique.
Additional consideration may be required in conjunction with the assembly of product safety critical components (i.e. automotive brake components). This may be in the form of confirmation and evaluation of screwdriving results via an independent torque sensing system or in the need of redundancy, via the EC screwdriving system in connection with the use of an additional torque measuring system.

**Criterion C: Torque Accuracy**

DEPRAG pneumatic screwdriver series NANOMAT, MICROMAT, MINIMAT or MINIMAT-E are all equipped with a highly accurate mechanical shut-off clutch which offers the outstanding repeatability of less than ±3% standard deviation over millions of assembly cycles.

The standard deviation is only an indication as to the precision of the DEPRAG screwdriver. The machine capability index (Cmk) is the operative value in declaring a tool capable for industrial application. DEPRAG pneumatic and MINIMAT-E screwdrivers with shut-off clutch conform with a Cmk value of ≥1.67 with 15% tolerance in relation to 6 Sigma according to ISO 5393. In other words a Cmk value of 1.67 means that there is a failure rate of 0.6 per million screw assemblies.

DEPRAG screwdriver systems based upon the EC or EC-Servo technique have the potential for greater accuracy: depending upon the configuration and the programming of the tightening sequence they are capable of torque repeatability of less than 1% standard deviation or, according to the machine capability index a Cmk value of ≥1,67 at a tolerance of ±5% at 6 Sigma according to ISO 5393 and also a failure rate of 0,6 per 1 million screwdriving cycles and that at ½ of the tolerance window.

**Criterion D: Data Collection and Statistical Process Control**

For data collection and statistical process control, it is necessary for screwdriver systems to store and process the data or communicate the raw data to a parent processor. In this case the EC or EC-Servo technique offers a full system solution.

**Criterion E: Documentation Requirements**

Both, pneumatic and EC/EC-Servo offer systems which can collect torque and angle data. The EC/EC-Servo technique systems offer documentation as a basic function, whereas the pneumatic screwdrivers require the addition of torque and angle sensors along with a monitoring system and the initial economic advantage is thereby reduced.

**Criterion F: Initial Investment**

The features and functionality of the EC/EC-Servo technique are reflected in the cost of the equipment. Basically the higher the requirement of the screwdriving system (process security, functionality, data capture, etc.) the higher the investment.
Here the original pneumatic and the electric screwdriver with mechanical shut-off clutch offer substantial cost advantages.

**Criterion G: Operating Costs**

To realistically evaluate the operating costs a number of factors must be taken into account such as:
- comparison of energy costs
- maintenance costs: while the pneumatic screwdriver can be fully maintained and repaired on site by trained maintenance staff the EC screwdriving systems must be returned to the manufacturer
- training costs for personnel (e.g. screwdriver system software training)
- calibration procedures for measuring instruments
- resistance to external influences (dust, humidity,…)
- investment costs

**Criterion H: Availability of Type of Energy**

Non availability of compressed air is a clear exclusion criterion for pneumatic screwdrivers.

**Criterion I: Service Life**

DEPRAG screwdrivers are designed for high duty cycle industrial application and have a high service life. This applies equally to both electronic and pneumatic drive types.

## 4 THE CORRECT HOUSING TYPE FOR YOUR APPLICATION

Screwdrivers are available in a variety of designs.

Applications where the screw is assembled in the vertical axis usually lend themselves to a screwdriver with a straight housing execution, whereas screws assembled in the horizontal axis usually demand the use of a pistol housing style. Other styles are the 90 degree angle head for tight spaces or high torque values (more leverage), screwdriver spindles with cylindrical housings for stationary installations and a variety of customer specific solutions.

## 5 TORQUE, ANGLE AND SPEED

In general the goal of a screw assembly is the joining of two or more components to a defined preload; however, direct methods to measure the achieved preload force of a screw joint in industrial mass production are impractical and expensive. The applied torque value is therefore accepted as the determining process variable in screw assembly.

The accuracy of the applied torque is directly related to the achieved preload force and as such is a consideration for the quality of the screw joint: the more accurate and repeatable the screwdriver system the more reliable is the screw joint or screw assembly.

In addition to the torque value it is also possible to measure the angular displacement or rotations of the screw. Here a defined angle measurement window for a known screw joint can be defined from a threshold torque value to the final torque value. When both measurements (torque and angle) are within a specified tolerance range, the screw joint is considered a pass.

Screwdriver speed is also a factor which must be defined per the application, for example, high speed with a self forming screw into plastics can generate frictional heat that can have a negative influence in the intended forming of the screw threads.

Joint settling, surface finishes, and dimensional accuracy, i.e. how well the assembly components fit together, are also an influence on the screw assembly process and must be taken into consideration. Joint settling, for instance as encountered in a pump assembly where the joint includes a gasket or seal, can be addressed with different approaches, i.e. torque retention, or two or more simultaneous peak torque applications can solve the problem. Other screw tightening methods can be derived from a combination of parameters. For example, the Clamp Force Control (CFC) enables the recognition of the screw head displacement and from this is derived a clearly defined final tightening process using torque and/or angle values. The friction value procedure is frequently used for testing processes. Here, the results of the friction value measurement are used to evaluate the quality of gears, threads or to determine minimum friction e.g. with self-locking threaded pins. Screw assembly to difference torque or angle independent from the friction torque is still an option.

Extensive screw joint analysis is an excellent tool for determining the necessary screw tightening parameters and solutions per application.

## 6 APPLICATION CONSULTATION

Decades of experience in screwdriving technique, professionally equipped analytical and testing laboratories (DAkkS accredited - traceable) and an extensive team of application specialists are at your service.

Our consultants are also available for on site assistance to help full fill your required specifications. Please contact us.

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