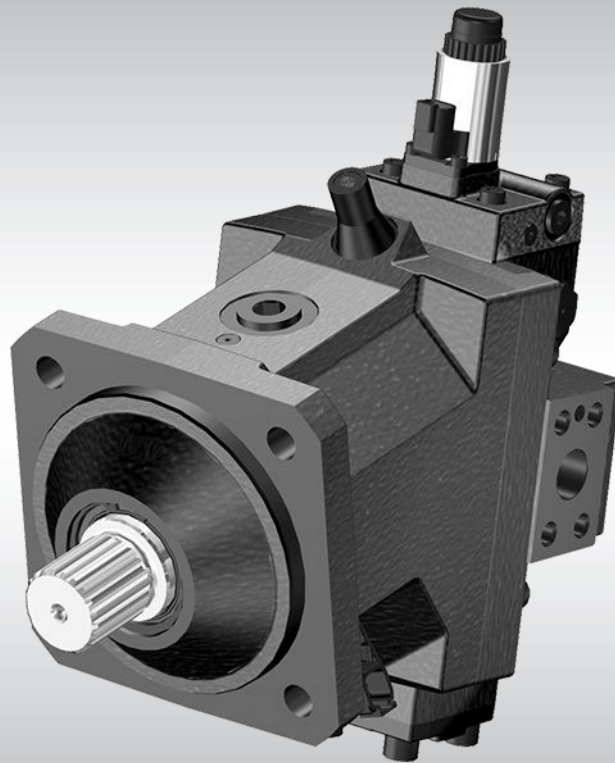




Functional Safety

Product Reliability Data (MTTF)

H1B060-250



Revision history*Table of revisions*

Date	Changed	Rev
February 2015	First edition	AA

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Overview

This MTTF data has been compiled by the engineering team responsible for the H1B Bent Axis Motor. These are professionals at Danfoss, who have the authority and technical knowledge to calculate the MTTF Data for this product based on the standards set in place by both the industry and/or Danfoss.

The purpose of this document is to assist in the transfer of MTTF information for the given product from Danfoss to the appropriate party in a way which will result in a clear understanding and documentation on how we derived it. This MTTF information is provided to assist in calculating the overall MTTF of a complete or partially complete piece of machinery.

Danfoss cannot be held responsible for the suitability of these calculated MTTF values for use in the calculation of the overall machinery MTTF values. The MTTF values for the H1B Bent Axis Motor are based on a specific machine use, operating environment, and/or duty cycle as stated by the standards set in place by both the industry and/or Danfoss. This communication along with any attached Danfoss drawings, sketches, or data is transmitted in confidence.

No information stated in this document or any attachments or supplements may be reproduced or disclosed in whole or in part without written permission of Danfoss. Further, neither these documents nor any attachments are a warranty of any sort by Danfoss or a guarantee of machine suitability for its intended purpose. It remains the responsibility of the machine manufacturer to ensure overall machine functionality and overall machine safety.

We recommend consulting the functional safety cross BA team before applying the document to the customer.

Danfoss Component

H1 Bent Axis Motor (060-250 cm³/rev)

The H1 family of closed circuit variable displacement bent axis motors is designed for use with all existing Danfoss hydraulic motors for the control and transfer of hydraulic power. H1 motors are compact and high power density where all units utilize an integral electro-hydraulic or hydraulic servo control that controls the speed and torque of output shaft speed for the flow provided by a pump. Shaft speed direction is defined through the hydraulic flow direction controlled by the pump. H1 motors are specifically compatible with the Danfoss family of PLUS+1[®] microcontrollers for easy Plug-and-Perform installation.

H1 motors can be used together in combination with other Danfoss pumps and motors in the overall hydraulic system. Danfoss hydrostatic products are designed with many different displacement, pressure, and load-life capabilities. Go to the Danfoss Power Solutions website or applicable product catalog to choose the components that are right for your complete closed circuit hydraulic system.

Intended Use

The H1 variable displacement bent axis motors are intended for closed circuit applications. The speed rate is proportional to the motor input flow and displacement.

The displacement can infinitely be controlled between zero and maximum displacement.

Output shaft speed direction is reversed by reversing the hydraulic flow direction at the pump.

Details regarding intended use, such as application examples and operating conditions, are available in Technical Information documents on our Danfoss page

<http://powersolutions.danfoss.com/literature/>

For any intended use other than the above you are invited to contact your local Danfoss representative for advice.

Introduction

This technical report states the $MTTF_d$ for an H1 motor configuration. The motor configuration is discriminated between a motor with feedback system and without a feedback system. The calculation of the $MTTF_d$ values of each function is described in [Component Information and Calculations](#) on page 7.

Results

The following table shows the $MTTF_d$ values of motor configurations and special functions.

Results of $MTTF_d$ on motor level

ID	Motor Configuration	$MTTF_d$ [years]
1	Motor with electrical control	>150

Standards and Assumptions

The calculations are performed with reference to the Danfoss Global Standard GS-0078. The standard GS-0078 defines the following options for how to determine the MTTF/MTTF_d value for a specific component or product. The process/algorithm selected will depend on:

- Whether the component is purchased or manufactured
- The availability of Danfoss field usage history
- The availability of industry standard field usage history (primarily for electronic components)
- Similarity of design to existing products
- Knowledge of the design process

Some calculation options are listed below:

- The methods outlined in ISO 13849-1 2006 Annexes C and D
- Comparison to similar products already in production
- Industry MTTF databases for widely available components (i.e. electronics)
 - MIL-HDBK-217
 - Siemens SN29500
 - Manufacturer's Information
- MTBF data from Verification testing in PDLP
- Danfoss design practices and procedures for hardware and software design
- Defects data from Danfoss CQAR database and/or customer data
- Information on sold products originates from Danfoss SAP
- Information on application profiles originates from Danfoss technical support knowledge
- Safety function = Not certified safety functions (no CE)

[The assumptions and raw data of the calculation are listed in an internal document "MTTFd for H1B060-250_internal_Danfoss.docx". This document is stored in the H1 database \(Link access is needed\).](#)

Component Information and Calculations

The following table lists the $MTTF_d$ for each individual motor function. Please refer to [F1: Safe Controllability \(Motor at Demanded Displacement\)](#) on page 7 for further understanding of functions and the $MTTF_d$ values.

MTTF_d for H1B060-250

ID	Function	Specification/performance	Input	Output	MTTF _d [years]
F1	Safe controllability (motor at demanded displacement)	See TI manual for specification/performance of function and boundaries shown in	Current/voltage supply C1/C5/C6	Motor speed	> 150

Customer is responsible for correct port selection due to input signal.

F1: Safe Controllability (Motor at Demanded Displacement)

An input signal to the control solenoids C1, C5, and C6 will lead to a certain displacement of the motor and based on the system flow through the motor a certain output speed at the motor shaft (e.g., vehicle speed) results out of that. The following table describes the failures and failed parts that can lead to a failure of the function.

Detailed boundaries to ensure safe controllability:

- Control: Proportional control C1 (Input current is either constant or changes according to the defined ramps)
- Control: 2-Position control C1 (Input current / voltage are switched either on or off)
- Control: Proportional pressure control override (Prop.-PCOR) (Input current is either constant or changes according to the defined ramps)
- Control: 2-Position pressure control override (PCOR) (Input current / voltage are switched either on or off)
- Control: Brake pressure defeat (BPD) (Input current / voltage are switched either on or off)

It is the customer's responsibility to consider how to deal with a loss of SAFE CONTROLLABILITY during analysis of the functional safety concept for the complete system.

Listed below are potential causes for failures that are impacting SAFE CONTROLLABILITY. These are considered in the $MTTF_d$ calculation.

Failure	Failed Part	Description
Motor not at demanded displacement	Controller (wrong signal)	Motor output speed cannot be controlled as demanded
	Broken wire to solenoid	
	Solenoid coil defect	
	Sticky control spool/solenoid armature	
	Broken connection servo system to valve segment	

References**List of References**

ISO 13849-1,2	Safety of machinery – Safety-related parts of control systems
GS-0078	MTTF calculations for Danfoss products
CQAR	Customer Quality Action Report. Danfoss global tool based process for managing defects on Danfoss hydrostatics products
11037153	H1 Bent Axis Motor Technical Information
H1B Website	http://powersolutions.danfoss.com/products/piston-pumps-and-motors/Closed-circuit-axial-piston-motors/
MS-192BA	Market Specification for H1 Motors Section <i>Required Safety Functions</i>



Products we offer:

- Bent Axis Motors
- Closed Circuit Axial Piston Pumps and Motors
- Displays
- Electrohydraulic Power Steering
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