Prüfbericht - Produkte
Test Report - Products

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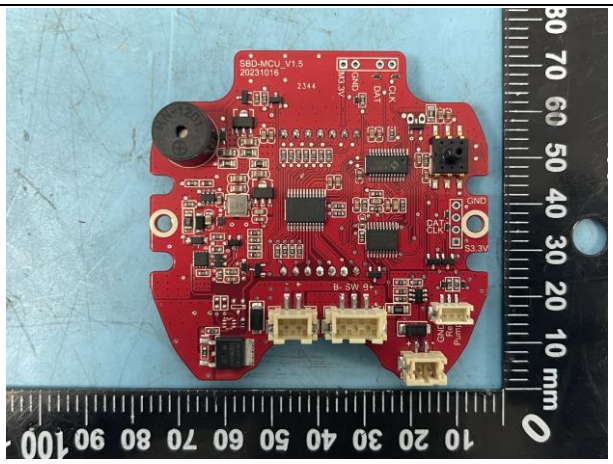
Prüfbericht-Nr.: *Test report no.*:	**CN24MR0D 001**	**Auftrags-Nr.:** *Order no.*:	180287141	Seite 1 von 12 *Page 1 of 12*
Kunden-Referenz-Nr.: *Client reference no.*:	N/A	**Auftragsdatum:** *Order date:*	2024.01.05	
Auftraggeber: *Client*:	Nemo Power Tools Limited 21st Floor, CMA Building 64 Connaught Road CENTRAL HONG KONG			
Prüfgegenstand: *Test item*:	Controller of cordless lifting tool			
Bezeichnung / Typ-Nr.: *Identification / Type no.*:	SBD-MCU-V1.5			
Auftrags-Inhalt: *Order content*:	Performance Levels Evaluation			
Prüfgrundlage: *Test specification*:	ISO 13849-1:2015 IEC 62841-1:2014 (as reference) EN 62841-1:2015+A1 (as reference) UL 62841-1:2015 R6.22 (as reference)			
Wareneingangsdatum: *Date of sample receipt*:	2024.01.15			
Prüfmuster-Nr.: *Test sample no:*	A003643496-001			
Prüfzeitraum: *Testing period*:	2024.01.16 – 2024.03.12			
Ort der Prüfung: *Place of testing*:	TÜV Rheinland / CCIC (Ningbo) Co., Ltd.			
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland / CCIC (Ningbo) Co., Ltd.			
Prüfergebnis*: *Test result**:	Pass			



geprüft von:
tested by:

X Eason Shi

Signed by: Eason Shi

Datum:
Date: 2024.06.11

genehmigt von:
authorized by:

X Herman Wang

Ausstellungsdatum:
Issue date: 2024.06.11

Signed by: Herman Wang

Stellung / Position: Eason Shi / PE

Stellung / Position: Herman Wang / Authorizer

Sonstiges / *Other*: For details, see page 3.

Client contact: iris@grabo.com

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*: Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
** Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Table of Contents

General Information

This report is for evaluating performance level of SCF (safety critical function) for **Controller of cordless lifting tool.**

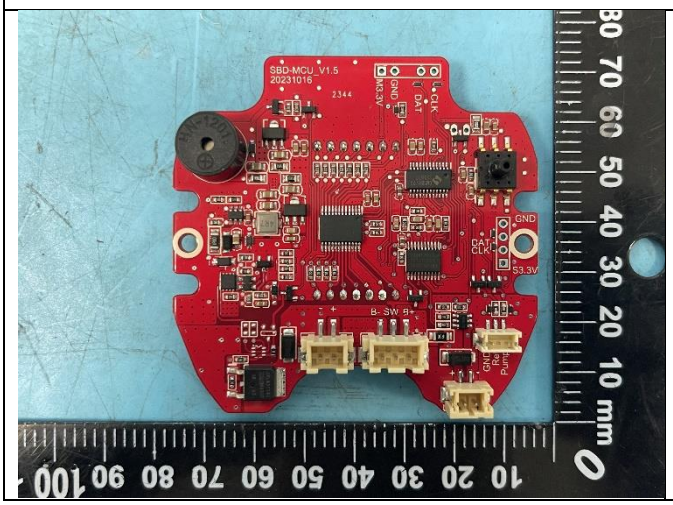
The evaluating method is complied with the requirements of ISO 13849-1:2015 specified in IEC 62841-1:2014, EN 62841-1:2015+A1 and UL 62841-1:2015 R6.22.

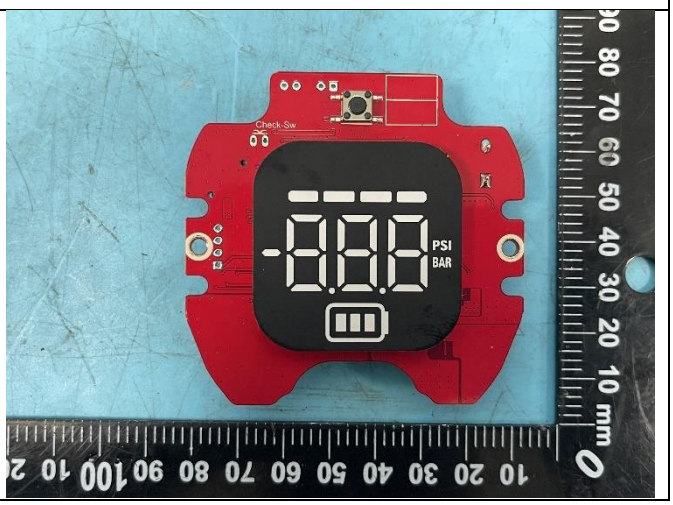
This report is only valid for the conditions as below:

1. The controller hardware version **SBD-MCU-V1.5.**

AND
2. The type of cordless lifter tool: **DCE590, DCE592** and etc**.**

Photo Document for controller SBD-MCU-V1.5:





ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
1	**Scope**	Informative	--
2	**Normative references**	Informative	--
3	**Terms, definitions, symbols and abbreviated terms**	Informative	--
4	**Design considerations**		
4.1	Safety objectives in design	Informative PL level is referred to Table 4 of IEC 62841-1:2014, EN 62841-1:2015+A1 and UL 62841-1:2015 R6.22 and determination the PL as ISO 13849-1:2015	P
4.2	Strategy for risk reduction	Informative PL level is referred to Table 4 of IEC 62841-1:2014, EN 62841-1:2015+A1 and UL 62841-1:2015 R6.22 and determination the PL as ISO 13849-1:2015	P
4.3	Determination of required performance level (PLr)	Informative PL level is referred to Table 4 of IEC 62841-1:2014, EN 62841-1:2015+A1 and UL 62841-1:2015 R6.22 and determination the PL as ISO 13849-1:2015	P
4.4	Design of SRP/CS	Informative	--
4.5	Evaluation of the achieved performance level PL and relationship with SIL	Informative	--
4.6	Software safety requirements	Failure of software will not create any loss of SCF from A.1	N/A
5	**Safety functions**	Informative	--
6	**Categories and their relation to MTTFD of each channel, DCavg and CCF**		P
6.1	General	Informative	--
6.2	Specifications of categories		P
6.2.1	General		P
	Each SRP/CS shall comply with the requirements of the relevant category, see 6.2.3 to 6.2.7. The following architectures typically meet the requirements of the respective category.	Please refer to Part A & B	P

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	The following figures show not examples but general architectures. A deviation from these architectures is always possible, but any deviation shall be justified, by means of appropriate analytical tools (e.g. Markov modelling, fault tree analysis), such that the system meets the required performance level (PLr). The designated architectures cannot be considered only as circuit diagrams but also as logical diagrams. For categories 3 and 4, this means that not all parts are necessarily physically redundant but that there are redundant means of assuring that a fault cannot lead to the loss of the safety function. The lines and arrows in Figures 8 to 12 represent logical interconnecting means and logical possible diagnostic means.	Please refer to Part A & B	P
6.2.2	Designated architectures		P
	The structure of a SRP/CS is a key characteristic having great influence on the PL. Even if the variety of possible structures is high, the basic concepts are often similar. Thus, most structures which are present in the machinery field can be mapped to one of the categories. For each category, a typical representation as a safety-related block diagram can be made. These typical realizations are called designated architectures and are listed in the context of each of the following categories. It is important that the PL shown in Figure 5, depending on the category, MTTFD of each channel and DCavg, is based on the designated architectures. If Figure 5 is used to estimate the PL the architecture of the SRP/CS should be demonstrated to be equivalent to the designated architecture of the claimed category. Designs fulfilling the characteristics of the respective category in general are equivalent to the respective designated architecture of the category.	Please refer to Part A & B	P
6.2.3	Category B		P
6.2.4	Category 1		N/A

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	For category 1, the same requirements as those according to 6.2.3 for category B shall apply. In addition, the following applies. SRP/CS of category 1 shall be designed and constructed using well-tried components and well-tried safety principles (see ISO 13849‑2). A “well-tried component” for a safety-related application is a component which has been either a) widely used in the past with successful results in similar applications, or b) made and verified using principles which demonstrate its suitability and reliability for safetyrelated applications. Newly developed components and safety principles may be considered as equivalent to “well-tried” if they fulfil the conditions of b). The decision to accept a particular component as being “well-tried” depends on the application. NOTE 1 Complex electronic components (e.g. PLC, microprocessor, application-specific integrated circuit) cannot be considered as equivalent to “well tried”. The MTTFD of each channel shall be high. The maximum PL achievable with category 1 is PL = c. NOTE 2 There is no diagnostic coverage (DCavg = none) within category 1 systems. In such structures (singlechannel systems) the consideration of CCF is not relevant. NOTE 3 When a fault occurs it can lead to the loss of the safety function. However, the MTTFD of each channel in category 1 is higher than in category B. Consequently, the loss of the safety function is less likely. It is important that a clear distinction between “well-tried component” and “fault exclusion” (see Clause 7) be made. The qualification of a component as being well-tried depends on its application. For example, a position switch with positive opening contacts could be considered as being well-tried for a machine tool, while at the same time as being inappropriate for application in a food industry — in the milk industry, for instance, this switch would be destroyed by the milk acid after a few months. A fault exclusion can lead to a very high PL, but the appropriate measures to allow this fault exclusion should be applied during the whole lifetime of the device. In order to ensure this, additional measures outside the control system may be necessary. In the case of a position switch, some examples of these kinds of measures are		N/A

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	— means to secure the fixing of the switch after its adjustment, — means to secure the fixing of the cam, — means to ensure the transverse stability of the cam, — means to avoid overtravel of the position switch, e.g. adequate mounting strength of the shock absorber and any alignment devices, and — means to protect it against damage from outside.		
6.2.5	Category 2		N/A

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	For category 2, the same requirements as those according to 6.2.3 for category B shall apply. "Well–tried safety principles" according to 6.2.4 shall also be followed. In addition, the following applies. SRP/CS of category 2 shall be designed so that their function(s) are checked at suitable intervals by the machine control system. The check of the safety function(s) shall be performed — at the machine start-up, and — prior to the initiation of any hazardous situation, e.g. start of a new cycle, start of other movements, immediately upon on demand of the safety function and/or periodically during operation if the risk assessment and the kind of operation shows that it is necessary. The initiation of this check may be automatic. Any check of the safety function(s) shall either — allow operation if no faults have been detected, or — generate an output (OTE) which initiates appropriate control action, if a fault is detected. For PLr = d the output (OTE) shall initiate a safe state which is maintained until the fault is cleared. For PLr up to and including PLr = c, whenever practicable the output (OTE) shall initiate a safe state which is maintained until the fault is cleared. When this is not practicable (e.g. welding of the contact in the final switching device) it may be sufficient for the output of the test equipment OTE to provide a warning. For the designated architecture of category 2, as shown in Figure 10, the calculation of MTTFD and DCavg should take into account only the blocks of the functional channel (i.e. I, L and O in Figure 10) and not the blocks of the testing channel (i.e. TE and OTE in Figure 10). The diagnostic coverage (DCavg) of the functional channel shall be at least low. The MTTFD of each channel shall be low-to-high, depending on the required performance level (PLr).		N/A

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	Measures against CCF shall be applied (see Annex F). The check itself shall not lead to a hazardous situation (e.g. due to an increase in response time). The test equipment may be integral with, or separate from, the safety-related part(s) providing the safety function. The maximum PL achievable with category 2 is PL = d. NOTE 1 In some cases category 2 is not applicable because the checking of the safety function cannot be applied to all components. NOTE 2 Category 2 system behaviour is characterized by — the occurrence of a fault can lead to the loss of the safety function between checks, — the loss of safety function is detected by the check. NOTE 3 The principle that supports the validity of a category 2 function is that the adopted technical provisions, and, for example, the choice of checking frequency can decrease the probability of occurrence of a dangerous situation. NOTE 4 For applying the simplified approach based on designated architectures, refer to the assumptions in 4.5.4.		N/A
6.2.6	Category 3		N/A
6.2.7	Category 4		N/A
6.3	Combination of SRP/CS to achieve overall PL		N/A
7	**Fault consideration, fault exclusion**	Informative	--
8	**Validation**	Informative	--
9	**Maintenance**	Informative	--
10	**Technical documentation**	Informative	--
11	**Information for use**	Informative	--
G.2	**Measures for the control of systematic failures**		
	The following measures should be applied. — Use of de-energization (see ISO 13849-2) The safety-related parts of the control system (SRP/CS) should be designed so that with loss of its power supply a safe state of the machine can be achieved or maintained.	Loss of power supply will lead to safe state.	P

ISO 13849-1:2015			
Clause	Requirement - Test	Result - Remark	Verdict
	— Measures for controlling the effects of voltage breakdown, voltage variations, overvoltage, undervoltage SRP/CS behaviour in response to voltage breakdown, voltage variations, overvoltage, and undervoltage conditions should be predetermined so that the SRP/CS can achieve or maintain a safe state of the machine (see also IEC 60204‑1 and IEC 61508‑7:2000, A.8).	The power is supplied from a battery pack, the voltage of which is stable. The voltage breakdown by re-moving battery pack and under voltage by low battery will make the system in a safe state.	P
	— Measures for controlling or avoiding the effects of the physical environment (for example, temperature, humidity, water, vibration, dust, corrosive substances, electromagnetic interference and its effects) SRP/CS behaviour in response to the effects of the physical environment should be predetermined so that the SRP/CS can achieve or maintain a safe state of the machine (see also, for example, IEC 60529, IEC 60204‑1).	The package of the PCB protects it from the physical environment.	P
	— Program sequence monitoring shall be used with SRP/CS containing software in order detect defective program sequences A defective program sequence exists if the individual elements of a program (e.g. software modules, subprograms or commands) are processed in the wrong sequence or period of time or if the clock of the processor is faulty (see EN 61508‑7:2001, A.9).		N/A
	— Measures for controlling the effects of errors and other effects arising from any data communication process (see IEC 61508‑2:2000, 7.4.8)		N/A
	In addition, one or more of the following measures should be applied, taking into account the complexity of the SRP/CS and its PL: - failure detection by automatic tests; - tests by redundant hardware; - diverse hardware; - operation in the positive mode; - mechanically linked contacts; - direct opening action; - oriented mode of failure; - over-dimensioning by a suitable factor, where the manufacturer can demonstrate that deraing will improve reliability — where over-dimensioning is appropriate, an over-dimensioning factor of at least 1,5should be used.		P

Part A Requirement for SCF

A.1 Performance level

The SCF is required according to IEC 62841-1:2014(as reference), EN 62841-1+A1(as reference) & UL 62841-1:2015 R6.22 (as reference).

SCF No.	SCF	PL Requirement
SCF 01	Power switch – prevent unwanted pump switch-on & provide desired pump switch-off	a

Part B Details for SCF

B.1 SCF 01 Power switch – prevent unwanted pump switch-on & provide desired pump switch-off

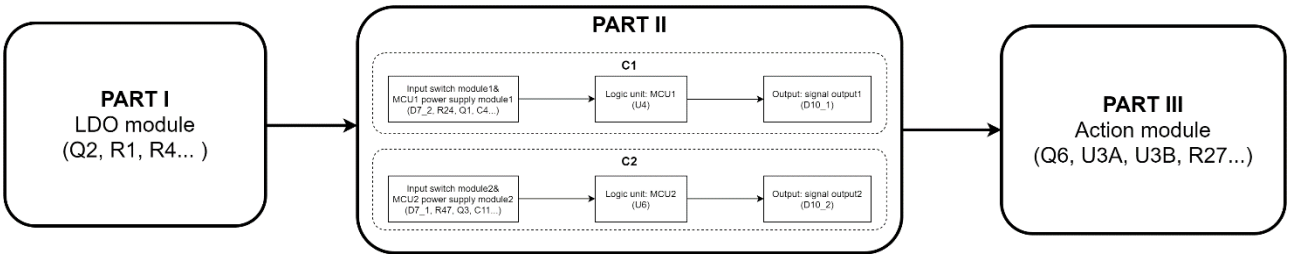


Figure B.1

Part C Calculation of $MTTF_D$

C.1 SCF 01 Power switch – prevent unwanted pump switch-on & provide desired pump switch-off

C.1.1 Calculation of $MTTF_D$ for SCF 01-PART I

$$MTTF_{D\ PART\ I} = \frac{1}{\sum_{j=1}^{N} \frac{n_j}{MTTF_{D\,j}}} = 86.1249438\ years$$

C.1.2 Calculation of MTTFD for SCF 01-PART II

$$MTTF_{D\ C1} = \frac{1}{\sum_{j=1}^{N} \frac{n_j}{MTTF_{D\,j}}} = 46.4933\ \text{years}$$

$$MTTF_{D\ C2} = \frac{1}{\sum_{j=1}^{N} \frac{n_j}{MTTF_{D\,j}}} = 80.87141\ years$$

$$MTTF_{D\ PART\ II} = \frac{2}{3}\left[MTTF_{D\ C1} + MTTF_{D\ C2} - \frac{1}{\frac{1}{MTTF_{D\ C1}} + \frac{1}{MTTF_{D\ C2}}}\right] = 65.22891\ years$$

C.1.3 Calculation of MTTFD for SCF 01-PART III

$$MTTF_{D\ PART\ III} = \frac{1}{\sum_{j=1}^{N} \frac{n_j}{MTTF_{D\,j}}} = 304.4383948\ years$$

C.1.4 Calculation of MTTFD for SCF 01

$$MTTF_{D\ Final} = \frac{1}{\frac{1}{MTTF_{D\ PART\ I}} + \frac{1}{MTTF_{D\ PART\ II}} + \frac{1}{MTTF_{D\ PART\ III}}} = 33.0830041\ years$$

According to cl.18.8 of IEC 62841-1:2014(as reference), EN 62841-1+A1(as reference) & UL 62841-1:2015 R6.22 (as reference), SCF 01 can achieve to PL = a.

---End of Test Report---