FUNCTIONAL SAFETY CERTIFICATE CML 16FS7080 Issue 0

1 Product intended for use in safety-related systems in accordance with IEC 61508 or related standard

2 Product **Range of Load Cells and Associated Amplifiers**

3 Manufacturer **Elite Transducers Ltd**

4 Address Unit 5 & 6
Zephyr House
Calleva Park
Reading
RG7 8JN
United Kingdom

5 The product is specified in the description of this certificate and the documents to which it refers.

6 Certification Management Limited, Unit 1 Newport Business Park, New Port Road, Ellesmere Port CH65 4LZ, UK, certifies that this product has been found to comply with the relevant requirements of **IEC 61508-2:2010** Functional safety of electrical/electronic/programmable electronic safety-related systems – system requirements.

The assessment results are recorded in the confidential reports listed in Section 16.

7 This certificate relates only to the design and construction of the specified product. Further requirements of the functional safety standard stated above apply to the integration of the product into a safety-related system and other system aspects such as installation, operation and maintenance.

8 Conditions and Restrictions Contained in the Elite Transducers SIL safety manual which forms an integral part of this certification

9 Scope of Assessment Hardware and systematic safety integrity by:

- 'Route 1H' (Failure Modes and Effects Analysis)
- 'Route 1S' (avoidance and control of systematic faults during design and manufacturer)

With reference to the CASS methodology

10 When used in a non-redundant configuration the product is limited to use in safety functions with a safety integrity level (SIL) no higher than **SIL 2**

11 Achievement of the SIL is dependent on:

a) Adherence to the product safety manual stated in this certificate which forms an integral part of this certification

b) Other system factors that are outside the scope of this certification

D R Stubbings MIET
Technical Director

12 The 'element safety functions' that can be performed by this product for which quantitative and qualitative reliability data has been assessed are as follows:

The table shows the relationship between the three element safety functions and some other key parameters and terms used in functional safety system design.

No.	Element safety function[1] suitable for use in SIL applications	Expected relationship between element safety function and EUC safe state	Safety function[2] mode[3] of operation supported	Dangerous failure[4] mode of the element considered for each analysis
1	An increasing strain causes the measurement signal to exceed a specified level is used to activate the safety function	EUC safe state is produced if measurement signal level exceeds specified limit	High demand Low demand	Failure to provide a measurement signal that exceeds a specified level for the corresponding strain
2	A decreasing strain causes the measurement signal to drop below a specified level is used to activate the safety function	EUC safe state is produced if measurement signal drops below specified limit	High demand Low demand	Failure to provide a measurement signal that drops below a specified level for the corresponding strain
3	A range of strain with a corresponding range of measurement signal between specified high and low limits is used to activate the safety function	EUC safe state is produced or maintained when either the measurement signal falls within, or outside, a range specified by high and low limits	Continuous demand High demand Low demand	Failure to provide a measurement signal for the corresponding strain that falls within, or outside, a range specified by high and low limits

IEC 61508 definitions associated with table above:

[1] *element safety function* = refer to IEC 61508-4, clause 3.5.3

[2] *safety function* = refer to IEC 61508-4, clause 3.5.1

[3] *mode of operation* = refer to IEC 61508-4, clause 3.5.16

[4] *dangerous failure* = refer to IEC 61508-4, clause 3.6.7

13 Description

All the load cells are based on a conventional strain gauge (Wheatstone Resistance Bridge) bonded onto a metal element which is mechanically stressed by the load being measured. Deformation (strain) in the metal element and hence the strain gauge resistors is then detected by the change in signal developed across the strain gauge bridge which is then amplified to a level suitable for measurement and control functions (e.g., 4-20mA or voltage). The type and mechanical rating of the load cell is defined by the physical dimensions and characteristics of the metal element and the mounting orientation. A key aspect of the manufacturing process is the preconditioning and calibration procedure used to characterise the load cell and ensure repeatable results.

All the load cells are based on the same basic and established design. The main differences between the various products in the range are:

- the strain gauge configuration – rationalised input (RI) or rationalised output (RO)
- the physical scale and mechanical aspects required to determine the rating and apply the force to the strain gauge
- the electrical parameters such as excitation voltage and resistance value

All the above factors have been shown to have a relatively small affect on the theoretical reliability analysis and the certified figures represent the worst case failure data which can be considered applicable to all load cells in the range.

14 Certified Data in support of use in safety functions

The assessment has been carried out with reference to the Conformity Assessment of Safety-related Systems (CASS) methodology[1] using the Route 1_H[2] approach.

A Failure Mode and Effect Analysis (FMEA) has established the failure modes and failure rates shown in the table below. Component failure data has been taken mainly from supplier data sheets, the Siemens SN 29500 database or Technis FARADIP.THREE v 8.1 and engineering judgment.

Reliability Block Diagram: — **Load cell** — **Amplifier** —

Parameter	*Symbol*	*From FMEA*		*From FMEA*		*RESULT*
Dangerous failures:	λD	1.8E-08	+	5.5E-08	=	7.3E-08
Dangerous diagnosed failures:	λDD	1.1E-08	+	3.2E-08	=	4.3E-08
Dangerous undiagnosed failures:	λDU	7.0E-09	+	2.3E-08	=	3.0E-08
Safe failures:	λS	4.6E-09	+	2.3E-08	=	2.8E-08
Diagnostic coverage:	DC	62%		58%		59%
Safe failure fraction:	SFF	70%		70%		70%
Type of element:	Type A/B	‘A’		‘A’		‘A’

[1] www.61508.org/cass
[2] Refer to IEC 61508-2, 7.4.4, for a definition of this term

The SIL capability data for the load cell plus associated amplifier is shown below:

Parameter	Symbol	Basis or derivation	Value	Limit	Notes
Safe failure fraction	SFF	(λDD+λS)/(λD+λS)	70%	SIL 2	(1)
Hardware fault tolerance	HFT	Single device, no redundancy	0		
Type	A / B	Meets IEC 61508-2:2010, 7.4.4.1.2	A		
Proof Test Interval	T	For PFD_{AVG} illustration	8760		(2)
Mean Time To Repair	MTTR	For PFD_{AVG} illustration	24		(2)
Channel equivalent down time	t_{CE}	(λDU/λD)(T/2+MTTR)+(λDD/λD)MTTR	1.8E+03		
Probability of dangerous failure per hour	PFH	λD	7.3E-08	**SIL 2**	(3)
Probability of undiagnosed dangerous failure per hour	PFH	λDU	3.0E-08	**SIL 3**	(4)
Probability of Failure on Demand (average)	PFD_{AVG}	(λDU + λDD) t_{CE}	1.3E-04	**SIL 3**	(5)

Notes:

(1) Limit of SIL application in regard to 'Architectural Constraints' (IEC 61508-2, Table 2). ***This dictates the overall SIL limit for the element***

(2) Figure used for illustration of PFD_{AVG} achievable

(3) Limit of SIL application in regard to PFH for high demand functions (if the sensor is <35% of total PFH budget), if user does not detect and act on out-of-range signals (<4mA and >20mA)

(4) Limit of SIL application in regard to PFH for high demand functions, if user does detect and act on out-of-range signals (<4mA and >20mA)

(5) Limit of SIL application in regard to PFD_{AVG} for low demand functions, if illustrative values for T and MTTR (above) are used

15 Safety manual & Management Procedure

The following safety manual(s) relate to this product:

Document Name	Document Description	Revision	Date
SM-01	SIL Safety Manual	01	21/04/2016
11-01	Functional Safety Management Procedure	01	17/03/2016

The Elite Transducers SM-01, SIL Safety Manual (version 1.0), contains the conditions and restrictions for safe use when the products are used as elements in safety-related systems. It must be adhered to by safety system designers and users. It is a certified document and shall not be modified without referral to the certification body.

Note: Drawings that describe the equipment or component are listed in the Annex

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16 Certificate history and evaluation reports

Issue	Date	Associated report	Notes
0	29 Apr 2016	RPT16003-1-A R1020A/00	First issue

Note: Drawings that describe the equipment or component are listed in the Annex.

17 Conditions of manufacture

The following conditions are required of the manufacturing process for compliance with the certification.

17.1 Where the product incorporates certified parts or safety critical components the manufacturer shall ensure that any changes to those parts or components do not affect the compliance of the certified product that is the subject of this certificate.

17.2 The manufacturer shall operate a procedure to analyse failure data from field returns on an on-going basis. CML shall be notified in the event that field failure data is worse than that certified.

17.3 The quality management system for the functional safety aspects of this product shall be monitored periodically by CML.

17.4 This certificate has a validity of 3 years from issue date.

18 Conditions of use

The following conditions relate to safe installation and/or use of the equipment.

18.1 The user of this product and its certified data for the design of safety functions shall do so in accordance with the instructions, conditions and restrictions contained in the safety manual stated above.

18.2 All information related to any product failure shall be collected under a dependability management process (e.g., IEC 60300-3-2) and reported to the manufacturer.

Certificate Annex

Certificate Number	CML 16FS7080
Product	Range of Load Cells and Associated Amplifiers
Manufacturer	Elite Transducers Ltd

The following documents describe the product defined in this certificate:

Issue 0

Drawing No	Sheets	Rev	Approved date	**Title**
10005-GA-30	1 of 1	F	29/04/2016	N-10005-GA GENERAL ASSY - 1F
10006-GA-30	1 of 1	F	29/04/2016	N-10006-GA GENERAL ASSY - 1F
10010-GA-30	1 of 1	F	29/04/2016	N-10010-GA GENERAL ASSY - 1F
10020-GA-30	1 of 1	F	29/04/2016	N-10020-GA GENERAL ASSY - 1F
10014-GA-30	1 of 1	G	29/04/2016	N-10014-GA GENERAL ASSY - 1G
10009-GA-30	1 of 1	G	29/04/2016	N-10009-GA GENERAL ASSY - 1G
10024-GA-30	1 of 1	G	29/04/2016	N-10024-GA GENERAL ASSY - 1G
10044-GA-30	1 of 1	E	29/04/2016	N-10044-GA GENERAL ASSY - 1E
10196-GA-30	1 of 2	K	29/04/2016	N-10196-GA GENERAL ASSEMBLY - 1K
10196-GA-30	2 of 2	K	29/04/2016	N-10196-GA GENERAL ASSEMBLY - 2K
10197-GA-30	1 of 2	J	29/04/2016	N-10197-GA GENERAL ASSEMBLY - 1J
10197-GA-30	2 of 2	J	29/04/2016	N-10197-GA GENERAL ASSEMBLY - 2J
10254-GA-30	1 of 2	F	29/04/2016	N-10254-GA GENERAL ASSY - 1F
10254-GA-30	2 of 2	F	29/04/2016	N-10254-GA GENERAL ASSY - 2F
10038-GA-30	1 of 1	E	29/04/2016	N-10038-GA GENERAL ASSY - 1E
10036-GA-30	1 of 1	E	29/04/2016	N-10036-GA GENERAL ASSY - 2E
10255-GA-30	1 of 2	D	29/04/2016	N-10255-GA GENERAL ASSY - 1D
10255-GA-30	2 of 2	D	29/04/2016	N-10255-GA GENERAL ASSY - 2D
10257-GA-30	1 of 2	D	29/04/2016	N-10257-GA GENERAL ASSY - 1D
10257-GA-30	2 of 2	D	29/04/2016	N-10257-GA GENERAL ASSY - 2D
10329-GA-30	1 of 1	C	29/04/2016	N-10329-GA GENERAL ASSY - 1C
10330-GA-30	1 of 1	C	29/04/2016	N-10330-GA GENERAL ASSY - 1C
10337-GA-30	1 of 1	C	29/04/2016	N-10337-GA GENERAL ASSY - 1C
10010-GA-30	1 of 1	F	29/04/2016	N-10010-GA GENERAL ASSY - 1F
10337-GA-30	1 of 1	C	29/04/2016	N-10337-GA GENERAL ASSY - 1C
10329-GA-30	1 of 1	C	29/04/2016	N-10329-GA GENERAL ASSY - 1C
10330-GA-30	1 of 1	C	29/04/2016	N-10330-GA GENERAL ASSY - 1C
10021-CD-30	1 of 1	B	29/04/2016	N-10021-CD CIRCUIT DIAGRAM