Compatibility of Modules

UK Weighing Federation

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Type Examination Certificates

- They are issued following the examination of the test of the model against the harmonized standard
- This is EN45501 (2015)
- These will be issued by a notified body for the EU
- An approved body for the GB
- Certificate shall contain:
  - Conditions (if any) for its validity
  - Necessary data for identification of the approved instrument
  - Description of the functioning of the instrument
  - Technical elements (drawings, layouts) in an annex
- Certificate will be valid for up to 10 years

Type Examination Certificates

Certificates must be for the complete instrument

- Any change (modification) to the instrument that influences conformity to the essential requirements must be “approved “ by the notified body or approved body that issued the original TEC
- For well-defined instruments, such as complete bench scales, this is not a major problem
- Certification for instruments constructed from separate indicators and platforms became unwieldy and cumbersome and became a block on rapid innovations

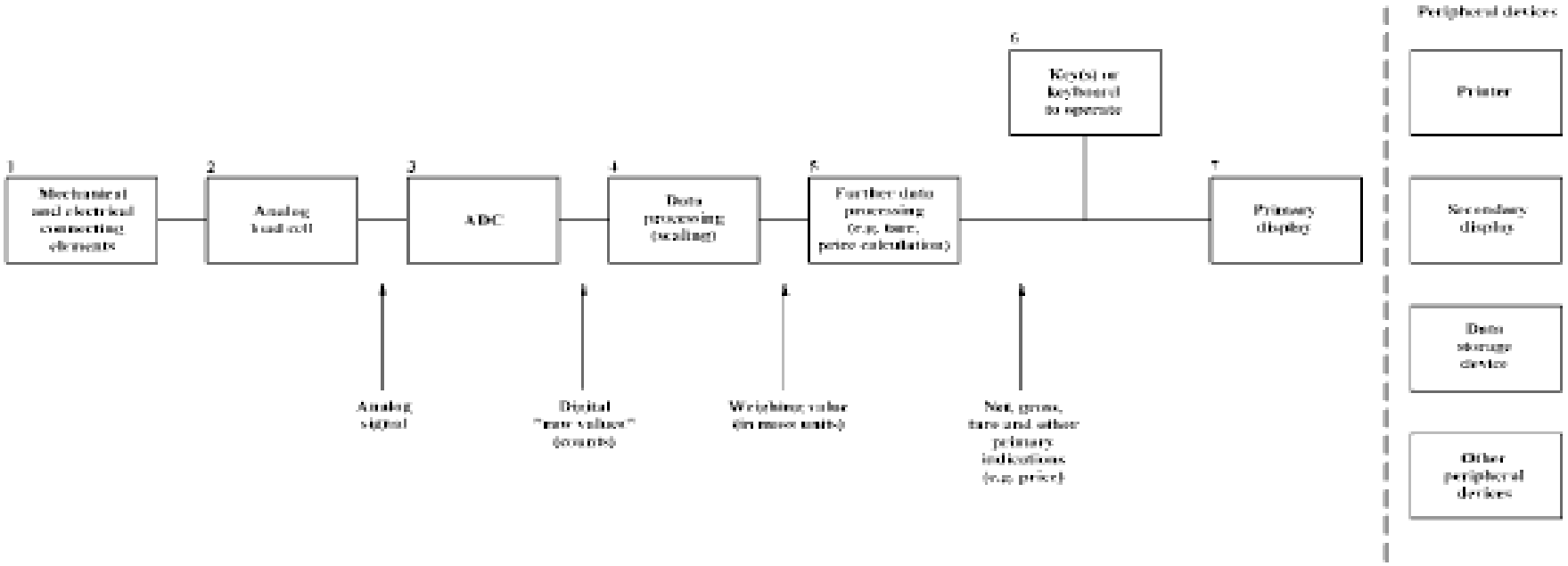
Modules and peripherals

The modular approach was envisaged in the OIML R76 and has been recognized in the EN45501

- WELMEC recognized a “new approach” was needed for EC type examinations
- Agreed to develop the concept of the modular approach
- Defined modules and peripherals in the Guide 2.5
- Modules further defined in T.2.2 in the EN45501
- Peripherals defined in T.2.3.5

Modules and peripherals

- T.2.2 Module - Identifiable part of an instrument that performs a specific function or functions, and that can be separately evaluated in accordance with specific metrological and technical performance requirements in the relevant standard. The modules of a weighing instrument are subject to specified partial error limits.
- NOTE Typical modules of a weighing instrument are: load cell, indicator, analogue or digital data processing device, weighing module, terminal, primary display.
- Evaluation Certificates and Parts Certificates in accordance with this standard can be issued for the modules mentioned in T.2.2.2 to T.2.2.7
- T.2.3.5 Peripheral device-Additional device which repeats or further processes the weighing result and other primary indications.
- EXAMPLES: Printer, secondary display, keyboard, terminal, data storage device, personal computer



Analog load cell	(T.2.2.1)	2
Digital load cell	(T.2.2.1)	2 + 3 + (4)*
Indicator	(T.2.2.2)	(3) + 4 + (5) + (6) + 7
Analog data processing device	(T.2.2.3)	3 + 4 + (5) + (6)
Digital data processing device	(T.2.2.4)	(4) + 5 + (6)
Terminal	(T.2.2.5)	(5) + 6 + 7
Primary display	(T.2.2.6)	7
Weighing module	(T.2.2.7)	1 + 2 + 3 + 4 + (5) + (6)

NOTE Numbers in brackets indicate options.

Test certificates, parts certificates and evaluation certificates

- The system allows for modules to be tested separately and an individual certificate produced
- TEST CERTIFICATES (TC) These can be test certificates which are tools designed to facilitate the type examination of NAWI's To obtain a test certificate the modules or peripherals must be in conformity with the essential requirements of Directive 2014/31 and harmonized standards or applicable WELMEC Guides
- EVALUATION CERTIFICATES(EC) A certificate that describes the relevant metrological characteristics of a part of a measuring instrument. An evaluation certificates can be sent to a market surveillance authority of a member state., but will not have general acceptance in a type examination certificates
- PARTS CERTIFICATE(PC) The majority of the characteristics of a parts certificate are the same as an EC. Parts that have been issued with a PC are eligible for general acceptance in an EU type examination certificate

Manufacturers

- The definition of manufacturer depends on the context
- The manufacturer of a complete instrument must take the certificates from the individual modules and ensure compatibility
- If you are the manufacturer of the complete instrument it is your responsibility to undertake the calculations before verification

Authorizing Modules and Peripherals- Compatibility of modules

- Where the EC type examination certificate covers a variety of modules it is necessary for the manufacturer to demonstrate before initial verification that the incorporated modules are compatible to each other and to the weighing instrument.
- This compatibility is established by the completion of a compatibility of modules form
- These forms cover the complete instruments, the electronic indicator and the load cell(s), plus 4 conditions referred to in EN 45501 and another 6 conditions which are for technical reasons as a result of the section itself.
- The form and the detail can be found in the WELMEC Guide 2.0 (Section 10)
- There are on-line forms which can be used – PTB ; Delta

Compatibility calculations

- Basically good engineering practice
- Can be grouped as follows:
  - Ratings/specifications
  - Load cell characteristics
  - Indicator input requirements
  - Connecting elements
  - Errors

Ratings & specifications

- Condition 1
  - Accuracy class of weighing instrument, e.g. class III
- Condition 2
  - Temperature limits of the weighing instrument, e.g. -10°C to +40°C
- Condition 4
  - Verification scale intervals of the electronic indicator, e.g. indicator approved to a maximum of 10,000 divisions
- Condition 6a
  - Verification scale intervals of load cell(s), e.g. C3 load cell maximum 3,000 divisions

10 Conditions which must be met for the compatibility of modules

- **Condition (1):** Accuracy class of weighing instrument, compatible to class of indicator and load cell(s)
- This will be 3 criteria; the accuracy of the load cell (invariably C) and the accuracy of the indicator must be greater than the accuracy of the weighing instrument

(1) Accuracy class of weighing instrument (WI) compatible to class of indicator (ind) and load cell (LC)

LC	&	IND	equal or better	WI	I. O. ?
C	&	III	equal or better	III	YES

10 Conditions which must be met for the compatibility of modules

- **Condition (2):** Temperature limits of the weighing instrument compared with the temperature limits of the load cell(s) and the electronic indicator
- This is the lower and upper limits of the temperature range
- This information will be found in the test certificates

(2) Temp.limits of the weighing instr.(WI) compared with the temp.limits of the load cell (LC) and the indicator (IND)

	LC		IND		WI
T_{min}	30	&	30	≤	30
T_{max}	40	&	40	≥	40

10 Conditions which must be met for the compatibility of modules

- **Condition (4):** Number of verification scale intervals of the weighing instrument must not exceed maximum number of verification scale intervals of the electronic indicator
- The condition below is for a 50-ton weighbridge with 20kg divisions and an indicator with 3000 divisions

(4) Number of verification scale intervals of the weighing instrument and the indicator

	n_{ind}	≥	$n=Max/e$
One range weighing instrument	3000	≥	2500

10 Conditions which must be met for the compatibility of modules

- **Condition (6a):** Compatibility of the maximum number of verification scale intervals of load cell(s) to the number of verification scale intervals of the weighing instrument (EN 45501, F.2.5)
- Nlc can be found in the load cell certificates, in some load cells certificates this is nmax
- There are other calculations for multi range and multi-interval

(6a) Maximum number of verification scale intervals of load cell and number of scale intervals of the weighing instrument

	n_{LC}	≥	$n=Max/e$
One range weighing instrument	3000	≥	2500

Load cell characteristics

- Condition 5
  - The load on a load cell should not exceed the rated maximum
- Condition 6 (b/c/d)
  - The dead load of the instrument needs to be compatible with the specifications for the load cell (condition 6d). Special consideration needs to be given for the dead load output return for multi interval and multiple range instruments for which the operation may have gone in to a coarser interval or higher range before returning to zero (conditions 6b and 6c).
- Condition 7
  - The verification interval should not be less than the minimum specified for the load cell

10 Conditions which must be met for the compatibility of modules

- **Condition (5):** Maximum capacity of load cell(s) must be compatible to Max of the weighing instrument
- Determined in terms of the correction factor Q which must be less than e max
- DL(Dead Load) is the weight of the load receptor and mounted constructions on the load receptor (weight units)
- NUD-non uniformly distributed load (weight units)
- IZSR is the initial zero setting range ; this is the zero setting at power up (different from the zero setting in operation which is typically limited to +/- 4%) (weight units)
- T+ additive tare

(5) Maximum capacity of load cells must be compatible to *Max* of the weighing instrument

Factor Q (EN 45 501 No 4.12.1): $Q = (Max+DL+IZSR+NUD+T+)/Max$ = 1.00

$(Q*Max*R)/N$	≤	E_{max}
8333.373333	≤	10000

10 Conditions which must be met for the compatibility of modules

- Condition 6 (b/c/d)
  - 6d will apply to all instruments and is the minimum dead load
  - 6b and c are additional calculations for multi-range / multi interval instruments

(6d) Minimum dead load of the load cells to the actual dead load of the load receptor

$DL*R/N$	≥	E_{min}
0	≥	0

10 Conditions which must be met for the compatibility of modules

- **Condition (7):** Minimum load cell scale interval (EN 45501 No 4.12.3) must be compatible to verification scale interval of the weighing instrument (EN45501 F.2.6)
- The minimum load cell interval (v min) shall not be greater than than the verification scale interval e , multiplied by the reduction ratio (R) and divided by the square root of the number of load cells
- If v min is not known nlc can be used

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval must be compatible

$e^*R/\sqrt{N}$	≥	$v_{min} = E_{max}/Y$
8.16	≥	1.00

Indicator input requirements

- Condition 8
  - The signal voltage back to the indicator must not be less than the rated minimum (rated as the input voltage per verification scale interval).
- Condition 9
  - The effective load cell resistance must be within the allowed range for the indicator

10 Conditions which must be met for the compatibility of modules

- **Condition (8):** Actual input voltage per verification scale interval must not be less than the minimum input voltage per verification scale interval for the electronic indicator

(8) Minimum input voltage for the indicator, minimum input voltage per verification scale interval and actual output of the LCs

minimum input voltage	$U = C^*U_{exc}^*R^*DL/(E_{max}\cdot N)$	≥	U_{min}
(unloaded WI)	0.00	≥	0.0
input voltage per verification interval	$\Delta u = C^*U_{exc}^*R^*e/(E_{max}\cdot N)$	≥	Δu_{min}
	5.00	≥	1.0

10 Conditions which must be met for the compatibility of modules

- **Condition (9):** Actual load cell impedance must be within the allowed range of load cell impedance for the electronic indicator

(9) Allowed impedance range for the electronic indicator and actual load cell impedance

R_{Lmin}	≤	R_{LC} / N	≤	R_{Lmax}
87	≤	175	≤	1050

Connecting elements

- Condition 10
  - Cable length per wire cross section of the connection cable between the junction box for the load cell(s) and the indicator must not exceed the value specified for the indicator

10 Conditions which must be met for the compatibility of modules

- **Condition (10):** Cable length per wire cross section of the connection cable between the junction box for the load cell(s) and the indicator must not exceed the value specified for the indicator
- L- length of cable this is often 1
- A- is the cross-sectional area of the cable

(10) Cable length per wire cross section of the connection cable between the load cell(s) and indicator

(L/A)	≤	$(L/A)_{max}$
0.50	≤	5.00

Errors

- Condition 3
  - “Sum of the squares of the fractions pi of the maximum permissible errors of load cell(s), connecting elements and indicator (EN 45501, No. 3.5.4) must not exceed 1”

10 Conditions which must be met for the compatibility of modules

- **Condition (3):** Sum of the squares of the fractions pi of the maximum permissible errors of load cell(s), connecting elements and indicator (EN 45501, No. 3.10.2) must not exceed
- These values can be found in the test certificates
- P con is the fraction of the maximum permissible error of the weighing instrument applied for connecting elements. This will apply to instrument with mechanical connecting elements and it is assumed that it will be 0.5(OIML R76 3.10.2.10

(3) Sum of the squares of the fractions p_i of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤1
0	+	0.25	+	0.49	≤1