# INSTRUCTIONS

## FOR

## THE INSTALLATION AND THE USE

## OF THE

## LOAD CELL

**Mod.** **S/N**

**For series: 500QD- 560QDT – QB700 –LD – LT – HC 2000 – BC 300 - MD 5000 – MB 400 – MR 400 – AP 7000 – ME – MF – 942 (Liftsentry) – 922 LCR 200 – EG – MB490- MP - PT500- KCI**

**DS Europe**

.a Manual N° 180909

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## NOTICE

# EC CONFORMITY DECLARATION

**Applied Directives:** 89/336/CEE modified by Directives 92/31/CEE and 93/68/CEE

**Standard to which is declared the conformity:**

EMC: EN 50081-2: 1994 - Generic emission standard
EN 55011
EN 50082-2: 1995 - Generic immunity standard
ENV 50140
ENV 50141
EN 61000-4-4
EN 61000-4-2
EN 61000-4-8
ENV 50204

**Manufacturer:** DS Europe srl

**Address:** via F. Russoli, 6 Milano (Italy)

**Type of product:** Amplified strain gauge transducers

Models:
**500QD - 560QDT – QB700 – LD – LT – HC 2000 – BC 300 - MD 5000MB 400 – MR 400 – AP 7000 – ME – MF – 942 (Liftsentry) – LCR 200 – EG – MB490- MP - PT500- KCI**

**Year of mark's apposition:** 1997

The product has been tested in a typical configuration, as prescribed in product's instruction manual.

DS Europe srl declares that the overlisted product complies with the requirements of the EMC Directive over mentioned.

DS Europe srl
Technical Direction

Milano, 25/11/98

# 1) PRELIMINARY REMARKS

**1.1** This instruction manual is an integral part of the supply-order and it is delivered with the material, even if not listed on the invoice and it can be downloaded from www.dseurope.com. Moreover, it is sent, under request, during the negotiation, whether the Customer tells about the installation or about the use of the cell.
When several cells are supplied, the quantity of manuals could decrease to one copy, if not requested the contrary

**1.2** The transducers described in the present manual have been designed for general purpose applications and, consequently, it is not possible to specify for all the possible applications specific limits of use.

Under the technical impossibility to ascertain the limits of use, it becomes obligatory for the Customer to put in progress all the safety rules and accessories in order to avoid: damages to Persons and things and damages for stopping of plants, etc.

In case of risky uses, it is obligatory for the Purchaser and for the User to inform immediately the Supplier so that he may suggest safety solutions or he may refuse the order and the supply.

**1.3** The load cells are only elements of machineries or plants; they are sold in thousands pieces/year, for disparate applications having them to satisfy different specifications and standards unknown to the Supplier.

Under these circumstances DS Europe is compelled to refuse any responsibility for the use, just listing, also on this manual, the most and common precautions for a correct use of its products.
Furthermore it is pointed out the need for a complete and focused insurance coverage particularly when these machinaries have as final destination U.S.A. and Canada.

**1.4** DS Europe load cells have an high professional quality, they are robust and are designed for the best in safety and in reliability: the cautions and limitations listed in this manual want to suggest and to remember to the Customer the importance to avoid damages.

**1.5** In the case of instructions and of data different among them, has priority and validity: first what enclosed with the transducers; second that is listed in this instruction manual, last what is listed in the bulletin. Our revisions are done following these priorities

# 2 ) T E R M I N O L O G Y OF THE FINAL TEST CERTIFICATE

## 2.1 REMARKS:

The final test certificate is issued only in English.
The various data are processed and printed directly by the computer, so without subsequent manipulation. As a result they appear with all the decimal numbers (no rounding) although, sometimes, the last digits are not-significant.
Positive polarity is not indicated, but negative polarity is shown by a minus sign.
The test is done in compression nevertheless differently indicated.
The following text comments only the main parameters of the certificate

## 2.2 RATED CAPACITY (= Full Scale):

It is the maximum weighing capacity. The unit of measure is the Kilogram force = Kgf = 0,9806 daN, (daN = decaNewton) where 0,9806 is the gravity in Milan.
The full scale (=rated capacity) is to be chosen in order to avoid overloads with static and dynamic forces well aligned along the load cell measuring axis.
Non linearity and all load cell technical specifications are to be calculated as a percentage onto the load cell rated capacity and not onto the applied force, that might be much lower compared to the full scale.
Resolution of the measured value, on electronics display, is depending on the ration between measured value/load cell rated capacity as well as on electrical noise, mechanical noise (=vibrations) and on the A/D converter bits of the digitizing electronics.

## 2.3 SENSITIVITY:

It is expressed in V/V FS (FS = full scale). It is the output voltage when the cell is supplied with 1 Volt and it is subjected to a weight equal to the full scale capacity value.

*Example:* 2.01146E-03 V/V FS means $2{,}011.10^{-3}$ V/V FS = 2,011 mV output signal for each power supply Volt fed to the load cell when Full Scale force is applied.
If load cell is fed 10Vdc power supply and Full scale force is applied onto load cell, maximum signal will be 20,11mV.

## 2.4 CALIBRATION EQUIVALENT LOAD VALUE (= Calibration with external electronics):

When yellow load cell conductor (black sheath cable) or grey conductor (grey sheat DIN47100 cable) with yellow conductor, or pin 5 with 2 of connector, the load cell provides an electrical signal that simulates a Kg load, applied onto the load cell, written on the load cell certificate.
Only load cells with not amplified mV signal have a built-in calibration circuit (with the exception of series BC300 that does not have enough room inside for housing the calibration circuit).
This calibration procedure can be used only when there is no load or preload or tare onto the load cell.
Some load cells can be used either in tension and compression therefore the calibration circuit signal could have an inverted polarity, compared to the normally measured signal, therefore after calibration it might be needed to reverse the connection of the load cell signal conductors (example: green with white conductors) in order to get a positive electrical signal.

The procedure for calibrating the electronic weighing system is as follows:
Introduce the calibration signal.
Adjust the span (=gain) of the signal-conditioner until the digital display shows the calibration value.
Remove the calibration signal and check the zero; if the zero needs further adjustment still continue the procedure with successive approximations.
Load cells with inside analog or digital electronics, because of CE regulations, cannot have the built-in calibration circuit.
Calibration circuit is to be deactivated after calibration: disconnect the calibration conductors or connector pins (example: disconnect yellow conductor from green and keep yellow insulated).

## 2.5 E = EXPONENT OF 10

An example clarifies better the meaning of this datum:

Sensitivity: 2.01146E-03 V/V FS means: $2{,}011.10^{-3}$ V/V FS = 2,011 mV/V FS.

## 3) TESTS DURING MANUFACTUING

Through in-process operations of the cells, at least, 5 operational tests are done, including also: the strain gauge bridge continuity, the insulation against the body of the cell and the stability of measure.

When finished, the cells are submitted to several thermal and mechanical cycling; then, during the final test certification are controlled: the zero unbalance, the creep, the return to zero, the validity and the stability of the technical specifications.

Periodically, samples taken from production, are submitted to a full cycle of tests, in order to verify conformity of the production to product’s specifications.

**For the over listed all the cells are delivered perfectly working as clearly declared even in the "final test certificate".**

# 4) WORKING PRINCIPLE OF LOAD CELLS

## 4.1 MEASURED FORCE:

All the load cells (single - axis) measure the force only in the direction of their weighing axis (= measuring axis). The component vector-forces on other directions not only are not measured but they can deform the cell, they introduce supplementary errors and they can destroy it. When a cell is used in a scale or in a weighing system, it is submitted to the vertical gravity-force due to the weight (= mass) to be measured, therefore the weighing axis of the cell has to remain perfectly vertical in all the loading and measuring conditions.

**4.2.1** In a load cell are acting 2 vector-forces: the *force to be measured* applied to the cell and the *reaction force* of the fixing plane. Both these forces are the resultant (as value and as direction) of many distributed forces.
***Important***: the positions of the barycentre (= point of origin) and of the directions of these two forces must not change during the application of the load; moreover both these two forces and the axis of measure of the cell must coincide or must be parallel among them depending on the principle of working of the cell.
Conditions different from the over listed decrease of many times the measure quality.

## 4.2 DISTANCE BETWEEN THE FORCE AND THE WEIGHING AXES:

The force to be measured is to be aligned along the load cell measuring axis but for some load cell series it is enough to be parallel, therefore there are four types of load cells:

**4.2.2** **4.2.1** ***Series QB 700 - Series 500 QD – Series EG***: (for scales) with a flexing parallelogram.
The point of application of the force can be far, from the weighing axis of the transducer, up to several centimeters in the QB 700 and EG (see bulletins) and few centimeters in 500 QD.
This distance is increasing with the area of the flexing parallelogram.

**4.2.2.** ***Series MB 400 - MR 400 - MD 5000 - PT500 – 560QDT - KCI:*** with working principle = shear.
The point of application of the force can be far 2÷3 mm from the weighing axis of the transducer, with an error still acceptable for most of the industrial applications.

**4.2.3** ***Series LD - LT – HC7000 - HC 2000 - BC 300 – ME – MF – LCR 200 – MB490 – MP- AP 7000:*** with working principle = flexion.
The point of application of the force can be far 1÷2 mm from the weighing axis of the transducer, with an error still acceptable for most of the industrial applications

***Remarks***: from the over listed: category 4.2.1. can accept the weighing pan directly connected to the cell. For the other categories (from 4.2.2 to 4.2.5) it is always important the use of accessories (spherical joints, chains, etc.) in order to obtain that both axes always coincide.

# 5) CAUTIONS FOR INSTALLATION AND USE OF LOAD CELLS

## 5.1 PRELIMINARY REMARKS:

Have to be avoided risks of damages to Persons and things and damages due to the stopping of machineries and of plants.

For risky uses, during the negotiations or before the installation of the cell or when known, it is obligatory for the Purchaser and for the User to supply this information so that DS Europe can renounce to the order and to the delivery of the goods or to give, under the full responsibility of the User, instructions to reduce or to cancel the risks.

**Note: This chapter is referred mainly to high load (= FS) cells.**

## 5.2 CATEGORIES OF RISKS IN THE USE OF THE CELL:

All the accessories introduced to reduce the risks of the use of a load cell have not to introduce a "by-pass" to the measuring force; they have to act not over the 50% for the FS (= full scale); they have to bear overloads at least 10 times the FS of the cell and they have to apply a symmetric and balanced action in case of operation..

### 5.2.1 *Compression load cells:*

The use in compression is usually less risky and, when possible, it is preferable to convert the tension applications into compression ones.
The accessories for the overload and for the torque protections, etc. are made by metal blocks complete of distance regulation.
They are low cost components manufactured directly by the Customer.
The free play is regulated for an action around 20% over the FS.

### 5.2.2 *Tension load cells:*

The use in tension is usually risky, especially for hanging loads.
They need the best care to avoid damages.
In order of priority for tension applications, can be used the Series AP 7000 (the most advisable), the Series MD 5000, the series 500QD, the series 560QDT, and last the Series LT, BC 301 – BC 305 (only for static tension applications).

It is advisable to apply joints between load cell and the machine in order to have a good alignment between the force vector to be measured and the load cell measuring axis.
For cells used in tension, two complementary stopping blocks have to be actuated:

- ***Overload protector (= block):*** on which the cell goes to lay for the measure deformation when the overload exceeds about 20% over the FS (= full scale).
  It has to be robust, stiff and in position to bear at least 10 times the FS.
  Usually it has a play adjustment so to act when the overload reaches the 20% over the FS.

- Block in case of rupture of the cell: this is made by chains, flexible metal cables, etc., usually in a group of 2-3-4 symmetrical pieces.

- **Note**: even when the internal parts of the transducers include overload-protections, in case of danger, external overload protectors must be applied.

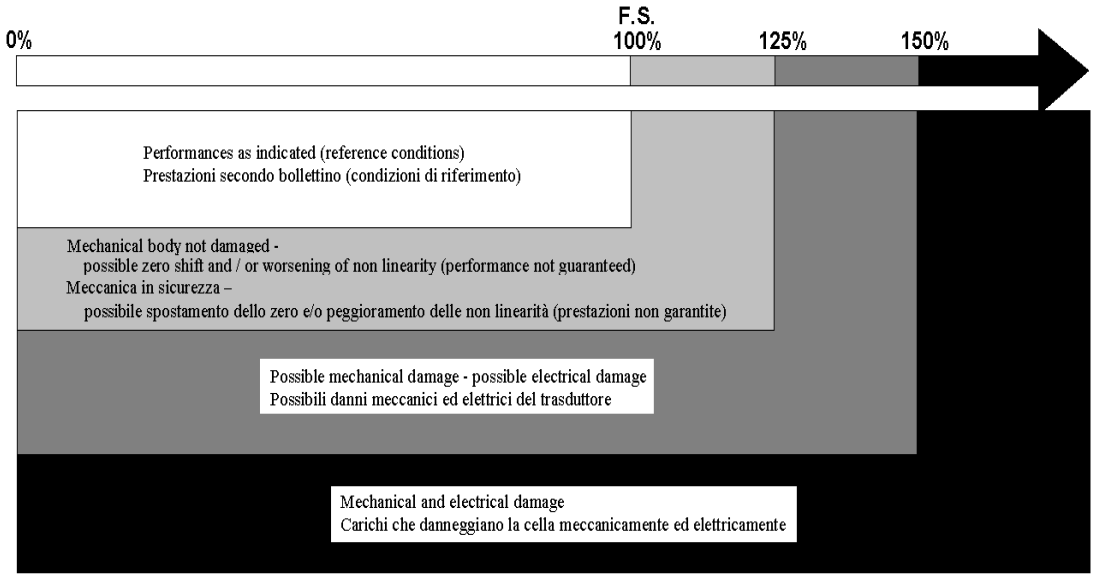
**5.2.3** ***Use of the cells under shocks, bumps and vibrations:***

Under shocks, bumps and vibrations the applied force is always the product of the mass applied to the cell multiplied by the acceleration (F = ma) and the cell is easily loaded over the max acceptable limit and it could break.

The risk of damages is high and always not-qualifiable and submitted to the frequency and amplitude of the vibrations, to the resonance of the structures, to the fatigue processing of the materials, etc., usually unknown.

The ***main cautions*** to be taken are the following:

- Load cells can be used with forces up to 125%FS (FS=Full Scale). Forces to be measured, are to be well aligned along the load cell measuring axis. Forces can be applied between 125% and 150% only exceptionally. Full Scales of load cells (=FS) are to be chosen, in order to be equal or greater than 100% of the force to be measured.




**LOADS MUST BE STATIC AND ALIGNED WITH MEASURE AXIS**

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- Select a cell more suitable to accept overload (i.e.: prefer the Series AP 7000; on contrary the Series LT, BC 301 – BC 305 are only for strictly static measures).

- Insert overload and stopping blocks as listed in paragraph 5.2.2. Each block has to bear loads at least 10 times the full scale of the cell and higher loads in case of free fall or shocks.

- For hanging loads has to be introduced also a dumping system to reduce starting tears and hunting joints to avoid torsion and transversal loads.
  It is necessary to apply a mechanical protection that avoids damages to persons and goods in case of mechanical load cell breaking.

- By mechanical or by design tricks avoid that the cell and the structure connected enter into resonance also for short periods of start and stop of the machine (e.g. Series LCR 200 and EG). If necessary increase the full scale of the cell.

- Small measuring ranges (especially the 2-3-6Kg): it is necessary not to apply overloads, not only during the normal load cell use but also during handling and mechanical installation.

All these accessories have to be scaled and made by the Customer, in relation to the applications and the standards imposed.

# 6) MECHANICAL INSTALLATION OF LOAD CELLS

## 6.1 FIXING AREA OF THE CELL (See again the paragraph 4.2.1):

The fixing area of the cell has to touch the fixing base always **in all its points.**
Errors, even of 20÷30% FS, may occur from separated contact points which number and position change the axis of force in relation to the applied load.
Off centre loads produce measuring errors.
Load cells are calibrated on test benches with adapters that warrant a load cell fixation and alignment with ±0,05mm e ±1° tolerances.
Mechanical installation is always adding some errors to that one of the load cell therefore a machine application cannot have only the bare load cell intrinsic error.
Load cell errors are a percentage to be calculated onto their measuring ranges and not onto the force to be measured that can be much smaller.
In case more than one load cell is used, in the same machine application, then a combined error is to be considered too.

The ***main installation cares to be taken*** are the following:

**6.1.1** Fixing base in high strength steel with thickness, at least, 1,5 times that of the cell.

**6.1.2** Contact surface flat and finely machined and clean.

**6.1.4** **Very important:** Strong and even clamping of the screws by dynamometric wrench: to obtain an uniform and extended contact.
Use only high strength steel socket head screws and flat washers.
Safety is usually depending on a correct fixation of screws threads: it is suggested to use safety systems that prevents their accidental unlocking like by means of lock nuts.
After initial screw fixing the load cell electrical signal, without load, could shift a bit: it is necessary to perform a small mechanical cycling with a significant load (compared to the load cell measuring range) and then adjust the screw clamping again with the wrench.

**6.1.5** For the load cells with low full scales (up to 50 Kg), during the installation, avoid overloads and torsions that may damage the cell even if it is not electrically connected.

**6.1.6** Mechanical guiding systems, of the measured to force, along the load cell measuring axis, are to have a low fiction.

**6.1.7** Load cells are to be installed in application machines where there are relatively low vibrations (=mechanical noise) that might reduce the measured resolution.
Load cells are to be fixed to machine parts that are not linked, to anything else, by stiff links (like tubes and cables) that might introduce hysteresis in the measure.

**6.1.8** All load cell fixing parts, alignment systems and load guiding systems as well as the metal plate where load cell is fixed, are to be stiff and with enough thickness relatively to the applied load.

**6.1.9** Nothing is to be interposed between the load cell fixing area and the metal plate where it is fixed
An incorrect load cell fixation with glue under its fixation area, might introduce non repeatability a non return to zero errors.

**6.1.10** ***The under listed cells need particular instructions:***

▪ ***Series HC7000, HC 2000 and MP***:
The force, to be measured, is to be evenly shared onto the top and bottom contact surfaces in order to avoid additional errors as well as mechanical damages.
Load is to be applied in order to have it aligned with the hole axis: tubes and screws are advisable to be used as guiding systems with -0,15mm to -0,3mm tolerances.
It is to be applied an axial bearing on top and bottom of the load cell contact surfaces, to recover the non parallelism and non planarity of the mechanical fixing (5° is the maximum allowed misalignment).
The top and bottom contact surfaces are to be clean and well machined.
Load cell is not to move from its fixing position because of vibrations and side forces: it might be necessary to eventually install load cell onto a housing for the load cell bottom side.
This load cell housing is to have a 0,3mm larger diameter compared to the bottom of load cell diameter and its highness is not to touch the load cell external metal lid.
All fixing elements, alignment, force guiding and the metal plate where load cell is fixed are to be stiff and with enough thickness.

▪ ***Series MD 5000***:
The contact on all the surface of the two external bearings (and not only on two external contact lines) is imperative; the same on the central loading surface.
The cell has to work always as a supported beam never as a restrained beam even when different dilatation coefficients of the materials and great temperature changes occur.

▪ ***Series LCR 200***:
The radial load cell (= web tensiometer) is made up by 3 separated parts: the fixing base, the central measuring body, the lid.
The measuring axis of the cell coincides with the axis of the connector connected to the axis of the grub screw on the central body (opposite to the connector).
Make the holes and screw them on the structure in which the cell will be settled.
Split the cell in its parts.
Fasten the fixing base by high strength screws.
Assemble the separated parts and position the measuring axis of the cell with the resultant of the forces to be measured.

The body of the cell can rotate, about ±10 degrees, on its axis. Before the final clamping of the screws of the lid rotate the measuring body so to obtain the maximum electrical signal output from the cell: this maximum value means the coincidence of the weighing and of the measuring axes. Now make the final clamping of the fixing screws of the lid and of the grub screw on the central body.

Important: during the transport and the installation, the cell has not to be submitted to overloads that can destroy it.

Where possible, it is imperative to settle overload protectors (= blocks) in all the directions (x-y-z) between shaft or cylinder and frame or other fix points of the machine.

The overload protectors (blocks) have to be taken away in normal operation.

For the *electrical connection* of the not amplified cell: see chapter 7.

▪ ***Series BC 300***:
*Central pin***:**
The measuring force has to be applied only on the pin and not on the diaphragm, also for the models BC 301 – BC 305 with screwed pin.
Moreover the weighing force has to coincide with the pin axis without any transversal component of the applied force.

*External circular bearer:*
The support and the fixing have to be limited only to the external circular crown without extending to the internal area of the cell.
The setting can be done in several ways: by epoxy cements or by a housing without cement.

*Housing*: by a hollow with diameter 0,3÷0,6 mm larger than the cell.
*Important*: assure at least 0,2÷0,3 mm gap for the deformation of the measuring diaphragm).

▪ ***Mod.922 and 942 - Liftsentry***:
Fasten the link on a surface stressed to flexion (from 10 to 20 Kg/mm² ), if necessary, reduce the section of the structure.
Choose a measuring point far from junctions by screws or rivets (weld them) the two fixing surfaces must be coplanar and finely machined without paint.
Smear on them a thin layer of epoxy cement. Tighten diagramally the screws by means of a dynamometric wrench.
The hysteresis and the non-return to zero of the measure show a slipping of the surfaces. Do not use elastic washers.
Do not take care of a high residual out-of-zero: set it to zero by software or by the zero regulation.
Perform a small mechanical cycling, after having fixed the strain links, before calibration with external electronics.

To increase the flexion of the link the User can apply the following installation tricks (increase the flexion: up to 2 times):

- Two spacer blocks (height: 10÷15 mm.): each settled under the fixing ends of the link. They increase the distance from the neutral axis of the structure.
- Two spacer-extension blocks: each settled as above. They increase either distance from the neutral axis (as above) or the distance between the fixing ends of the link.

Both the blocks have to be welded to the structure. They are made by the User or supplied by DS Europe.

- **Mod. LD:**

Force to be measured is to be evenly shared on the top spherical surface of the centering pin.
It is recommended to use the ALD saddle adapter.

- **Mod AP7000:**

The elongated load cell metal frame means that load cell can be influenced by side forces and off center loads.
All side or off centre loads can produce dangerous situations because of concentrated mechanical strains that might yeld the load cell metal frame as well as break it.
With compression forces, it is necessary to completely fix the load cell threads up to the ledge in order to avoid damages due to the combined bending and compressive stress.
With tension forces the fixing top and bottom planes can be farther, compared to compression, using in any case all available threads.
An axial bearing is to be used in case of tension forces for correctly guiding the load along the load cell measuring axis.
The load cell metal frame has high stiffness and resonant frequencies (can change between the many models).
AP7000 can withstand in a good way vibrations.

## 6.2 PANS, PLANES AND STRUCTURES OF WEIGHING (see paragraph 4.2.1):

- **Cells with pan directly connected and solid with the load cell** (i.e.: QB 700 and EG):
  The pan has to be very stiff.
  Flexions of about 1 mm at the edges may reduce even 10 times the measure accuracy.
  To avoid increase of weight of the pan: bending beads or the use of aluminium die-casting pans are suggested.

- **Cells with overhanging structures** (i.e.: Series LD - MB 5000 – HC 2000 - ME –MF – BC 300-PT500 – MP – MB490 – 560QDT- 500QD):
  The applied force has to be always coincident with the weighing axis. Transversal components of the force or torque moments introduce errors and may damage the cell.
  It is advisable: the use of saddles (LD Series), spherical heads, thrust spherical plain bearings (HC 2000), rod ends, etc. and of stiff and strong overhanging structure welded together and never connected by screws or riveted joints.
  A flexion or a displacement of few millimetres of the barycentre of the applied force may introduce errors of 5÷20% FS.

## 6.3 WEIGHING SYSTEM WITH SEVERAL CELLS (see again the paragraph 4.2.1.):

The distance among the cells brings to the solution of the following installation problems:

***Important***: with several cell systems use only not-amplified load cells (see par. 8.1.2).

**6.4.1** ***The radial movement*** between the upper structure of the cell and the lower one, due to the difference of the thermal and mechanical expansion of the two structures: this problem is usually limited as the *upper structure* is, in general, in steel and the *lower structure* (= the bed-plate) is in the same metal or in reinforced concrete which has the same coefficient of thermal expansion of the steel.
If possible, for round reservoirs lay radially the reinforcing rods. The remaining expansion difference may be compensated by saddles, or by thrust spherical plain bearings or by roller plates.

**6.4.2** ***Flexion of the upper structure due to the load***: it is compensated by strengthening of the structure, by tie rods, by rod ends, by spherical bearings, etc.
In case of weighing vertical reservoirs, if possible, settle the shelfs with the load cells at half the height, that is, at the same elevation of the barycentre of the tank.
In general, the technical cares applied on the installation are important elements to define the quality results of the weighing system.

# 7) ELECTRICAL CONNECTIONS OF NOT AMPLIFIED LOAD CELLS

## 7.1 CABLE OR CONNECTOR?

For outdoor applications and for all the industrial environments, the cable connection is preferable.
The mating connector, even if sealed, has always inside dead volumes with air and the air, due to the thermal variations, exchanges humidity which, in long periods, brings oxidations on the electrical contacts, electrical jumpers of moist dust acting directly on the strain-gauge bridge and, consequently, introducing shifts of the zero and instability of the measure.

## 7.2 ELECTRICAL CONNECTION:

Load cells without built-in electronics (mV/V output)

| Meaning | Black sheath cable | Grey sheath DIN47100 cable | Connector | Load cells BC301-2-3 | Load cells BC304-5 |
|---|---|---|---|---|---|
| - Power supply | Black | Brown | 4 | Green | Black |
| + Power supply | Red | Yellow | 1 | Red | Red |
| - Signal | White | White | 3 | Colourless | White |
| + Signal | Green | Green | 2 | Blu | Green |
| Calibration | Yellow | Grey | 5 | | |
| Calibration activation | Yellow+Green | Grey+Green | 5+2 | | |

The screening sheath is not connected to the body of the cell.

## 7.3 POWER SUPPLY OF LOAD CELLS WITHOUT BUILT-IN ELECTRONICS:

The standard and recommended voltage is: 5 or 10 V stabilized.
The cells can accept up to 15 V.
The upper voltage value is limited: by the heat dissipation capability of the sensors, by the ambient temperature and by the warm-up time wanted.
In the "final test" the cells are tested with excitation: 10 V.
The highest the power supply, the highest the electrical signal but the longer it will be necessary to wait to reach thermal stability (=warm up time) of electrical signal because of heating due to flowing electrical current.
The external power supply generator is to have a low over imposed ripple noise (linear generators are to be preferred to switching types).

*Exceptions are the button cells models BC 301 – BC 302 – BC 303*. Due to their extreme compactness and its poor thermal dissipation capability, it is advisable an excitation voltage from 1 to 5 Volts.
To increase the thermal dissipation: bond the cell at the base by conductive cement and, by conductive silicon grease, fill the air gap between the upper surface of the cell (= diaphragm) and the weighing surface (separated together by the thickness of the central weighing pin).

**7.5** Load cells without built-in electronics are not amplified and do not have any zero and gain setting.
Most of these load cells have the built-in calibration circuit.
In case cable color codes do not match the electronics connection codes, it is recommended to consider valid the connection codes (conductor colors and terminal numbers) listed in the load cell final test certificate, then what is listed in this manual and lastly what is listed in the technical bulletin. (par. 1.5).

## 7.6 SIGNAL CONDITIONER:

Are recommended amplifiers with high stability; linearity, low noise and thermal drift; with high impedance ($\geq$ 1 MOhm) and differential input (Mod. EL625–EL621–EL624).

The "span" (= gain) regulation has to be large enough to convert, on a digital display, the electrical signal outputs into physical values (Kg, tons, etc.).

The signal conditioners with microprocessor are preferable (Mod. AN401Plus – Pitagora – SAP - 699).

# 8) ELECTRICAL CONNECTION OF AMPLIFIED LOAD CELLS

## 8.1 FOREWORD

**8.1.1.** Series 500 QD; 560QDT; LD; LT; AP 7000 (from 10 up to 100tons FS), PT500, EG, MD5000 and MP can be made with built-in amplifier electronics.
Series AP 7000 is usually made with built-in analog amplifier electronics (models from 250Kg up to 5ton FS are miniaturized and do not have enough room inside for housing the amplifier electronics).
Load cells AP7000, MD5000 and HC2000 have a 1mV/V typical sensitivity (without amplifier electronics) instead of the usual 2mV/V typical value: these series are normally under loaded, compared to their mechanical margins, in order to allow a higher safety against ruptures.

**8.1.2** **8.1.2.** In weighing system with several cells and a summing unit, **use cells not amplified** with a summing signal unit mod. Pitagora. The mod. Pitagora can sum up to eight load cell signals, at the same time, by singularly calibrating each of them in order to allow a high accuracy.

The amplified cells are not suggested as they are, usually, at different temperature conditions and the thermal drift of each amplifier and of each stabilizer, even if low, may add together in the summing unit.

**8.1.3** To satisfy the CE directives the amplified load cells have not the calibration lead.

## 8.2 CHOICE OF THE INTERNAL AMPLIFIER:

Two categories of amplifiers are available of which are listed the advantages and the dis advantages.:
The external power supply generator is to have a low ripple electrical noise (linear generators typically have lower noise than switching types).
Series AP7000 load cells can have inside an analog amplifying electronics only for 10 to 100 tons full scale, but those from 250Kg up to 5tons have only 1mV/V typical sensitivity because they do not have inside enough room left for any electronics.

### 8.2.1. *Voltage amplifiers:*

- A 5 = supply voltage: from 10,5 V to 28 Vdc; Signal output = ± 5 Vdc FS

- A 1 = supply voltage: from 18 V to 28 Vcc; Signal output = ±10 Vdc FS

The Model -A5 is preferable to the Model -A1, as the heat to be dissipated inside the cell is lower.
EG and 560QDT can have only built-in analog amplifier electronics with positive outputs 0 to +5 or 10V and not negative.

- *Advantages:*

  - The *Voltage stabiliser*, inside the cell, keep insensible the excitation of the cell to the voltage drops due to the length and to temperature changes of the connection-cable.
    With power voltages around 15 Vdc, distances cell/electronics of several kilometres are acceptable!

  - The *internal amplifier* and the high voltage output (± 5 V) bring the signal insensible to the external noise (great Signal/Noise ratio).

- *Disadvantages:*

  none.

**8.2.2** ***Current amplifier*** (see paragraph 8.6 and further diagram): (2 - wires)

- A 4 = supply voltage (= $V_{ps}$): from 15 to 40 Vdc; Signal output: 4-20 mA;
(Typical power supply is 24Vdc filt. Stab. with an external RL=250 Ohm load resistance)

- *Advantages:*

  - As for the voltage amplifiers (-A5; -A1).
  - Saving (insignificant) of a lead in the connecting cable.
  - Immunity to electrical noise on the cable and to drop of voltage due to cable resistance.

- *Disadvantages:*

  - Low output signal from the strain-gauge bridge, very high amplifier gain and, consequently, high sensitivity to the electrical disturbances of the signal before amplification reduce the potential resolution.
    In fact: excitation of the bridge (at zero load) =V=RI = $350 \cdot 3 \cdot 10^{-3}$ = 1,05 V;
    when, R= bridge resistance = 350 Ohm; I= 3mA (see Note below)
    From which: bridge output signal = $2 \cdot 1{,}05$ = 2,1mV FS
    against $2 \cdot 10$ = 20 mV/FS of the -A1 amplifier) (about 10 times less).

  - Limitation on the choice of the further electronics.
    *Note*: the total circuit at zero load is 4mA of which about 3 mA for the bridge and about 1 mA for the internal current amplifier.

## 8.3 ELECTRICAL CONNECTION OF AMPLIFIED LOAD CELLS:

The table lists the colours of the leads of the cable and the numbers of the pins of the connector.
The amplified load cells are supplied by cable excepted the Series AP 7000 (models with 10 up to 100tons FS), 500QDT, 560QDT, LD, LT and LCR 200 that can be supplied also with connector.
In order to maintain the greatest protection against electromagnetic disturbances, in relation to CE mark, for the amplified load cells is duty for the User/Installer the grounding of the cable screen toward the electronic side and the grounding of the metallic body of the load cell.

Load cells with built-in analog amplifier (outputs 0 to ±5V and 0 to ±10V)

| Meaning | Black sheath cable | Grey sheath DIN47100 cable | Connector |
|---|---|---|---|
| Common | Black | Brown | 4 |
| + Power supply | Red | Green | 1 |
| + Signal | White | White | 2 |

Load cells with built-in analog amplifier (outputs 4-20mA)

| Meaning | Black sheath cable | Grey sheath DIN47100 cable | Connector |
|---|---|---|---|
| Common | Black | Brown | 4 |
| + Power supply | Red | Green | 1 |
| + Signal | Red | Green | 1 |

## 8.4 ZERO AND GAIN REGULATIONS:

**8.4.1** *Important:* the gain (= span) regulation is done at the final test by DS Europe and it cannot be regulated by the Customer.
A regulation of it changes the values of sensitivity and of calibration listed on the "final test certificate" enclosed with the cell.

**8.4.2** Wait for a warm-up period of, at least, 30 minutes before doing the regulation of the zero and the further use of the cell.

**8.4.3** The regulations of "zero" and of "gain" are by multi turn potentiometers (= trimmers); they are reachable by screwed holes on the body of the cell, protected by a sealing screw. (Remember the point 8.4.1).

**8.4.4** The amplifier and the potentiometers are immersed in silicon gel, which is not an handicap for the regulation. For the regulation, a screwdriver (with shank: 1,5÷2 mm) bores the gel which, by itself, closes again when the screwdriver is pulled out.

## 8.5 POSITION OF ZERO AND GAIN REGULATIONS:

**8.5.1** ***Series LD-LT and Series AP 7000****:*

The zero and gain regulations are reached thorough a large screwed hole protected by a sealing screw.

The *zero regulation* (about ±10% FS) is the nearest to the external enclosure and the most easy to be reached.

The gain regulation is the most internal one and far from the external enclosure and difficult to be reached. This regulation is done by DS Europe and it has not to be touched by the Customer.

- *Series LD and LT:*
  When the cell is installed and it has the label on the upper position and the regulations on the lower position, the *zero regulation* is the most external on the right and the only one that may be regulated.

- *Series AP 7000:*
  When the cell is installed and the cable is on the upper position the *zero regulation* is the most external on the left and the only that may be regulated.

**8.5.2** ***Series 500 QD and 500 QDT:*** (see the "overall dimensions" of the bulletin)

The zero and gain regulations are reached by separated screwed holes.

As listed in the "overall dimensions" of the bulletin, when the cell is installed, the cable exits on the left, the two holes are vertically lined up on the right, then the zero hole is in the upper position. *Do not touch the gain regulation* on the lower position.

**8.5.3** ***Series ME-MF:***

The zero and gain regulations are reached removing the metal cover and the rubber gasket having unscrewed the 2 fixing screws.

**Important:** remove only the cover without the central screw (support of the internal electronics).

Take-away the filler silicon grease and uncover the transparent silicon gel below.

On the printed board are settled 2 multiturn potentiometers.

The *zero pot* is the nearest to the centre; the *gain pot* is the most external and *it has not to be regulated*.

When the zero regulation is finished, fill entirely by silicon grease the cavity up to the metal cover to be fixed by the 2 screws.

**8.5.3** ***Series EG:***

The zero and gain regulation trimmers can be reached by removing the circular metal lid, on the load cell.

**8.5.4** Series PT500:

The zero and gain regulation trimmers can be reached by removing the rear metal lid by unscrewing the screws.

**8.5.5** Series MP e 560QDT:

The electronics is sealed inside the load cell metal frame and it is not possible to reach the zero and gain trimmers.

## 8.6 WORKING AREA OF THE CURRENT AMPLIFIER -A4: (2 -wires):

*NOTE*: see the diagram of the "Pressure transducer" valid also for the current amplifier -A4 of the load cells.

**8.6.1** The diagram states the relation between the Power supply voltage: $V_{ps}$ of the cell (=abscissa) and the load resistor value: RL (= ordinate).
The amplifier -A4 rightly works within all the points of the "Area of $V_{ps}$ "defined by the line (on the left) of "minimum $V_{ps}$ allowed" and by the line (on the right) of "maximum $V_{ps}$ allowed".

Great attention has to be put on the choice of the electronics to be connected to the self-amplified cell (-A4) regarding the supply voltage (= $V_{ps}$ ) and the load resistor (=RL).
The best acceptable points of the working area (= "area of $V_{ps}$ ) have to be 15÷30% far from the left line (= minimum $V_{ps}$ allowed) within the "Area of $V_{ps}$ ".
It is not convenient to exaggerate on the supply voltage (= $V_{ps}$ ) to avoid useless thermal dissipation inside the transducer.

*Two explanatory examples:*

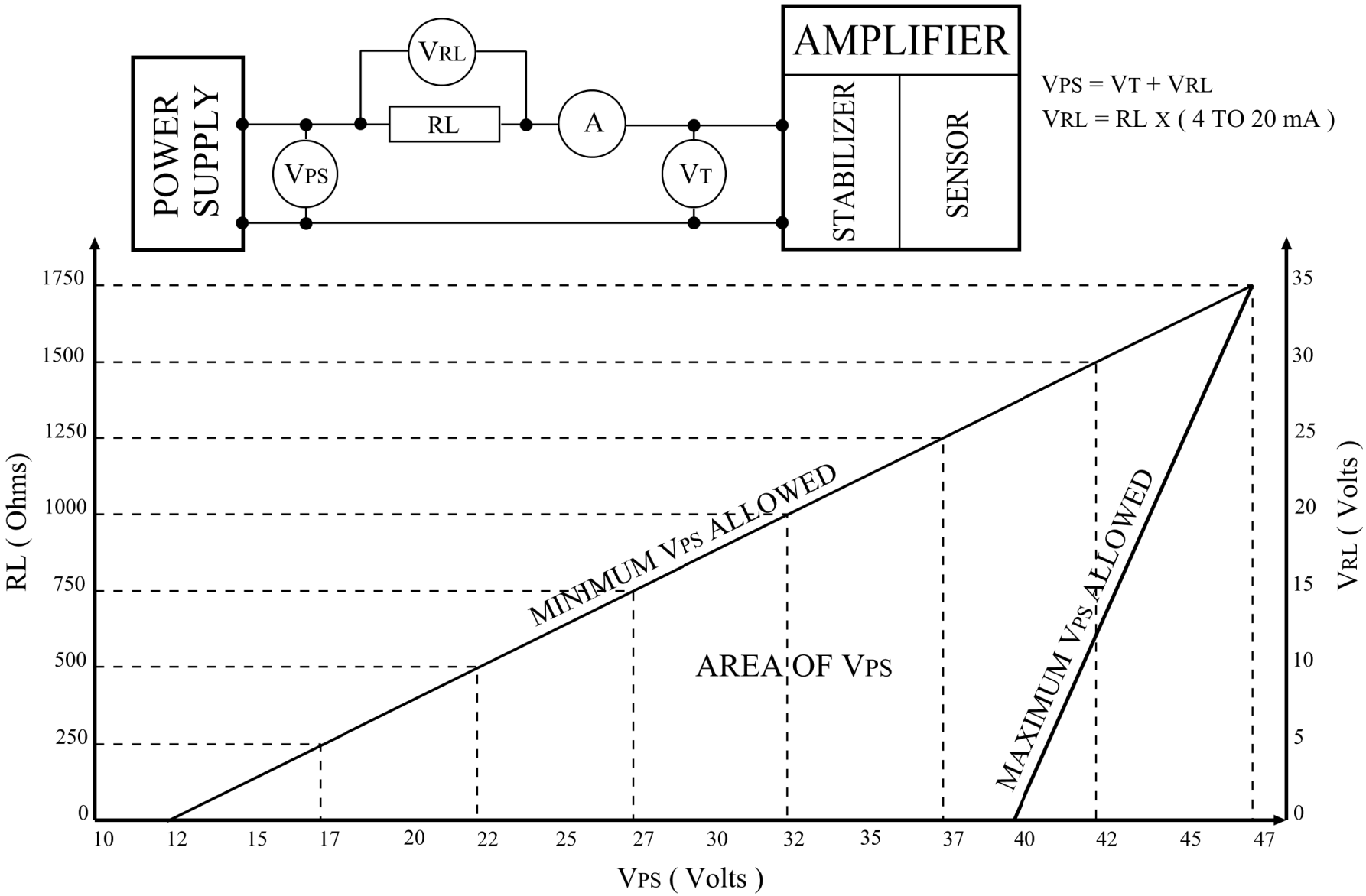
*1) $R_L$ = 250 ohms = external load resistor.*

| | | |
|---|---|---|
| Supply voltage = $V_{ps}$ = 15 V: | | not sufficient. |
| " " " = 17 V: | | just at the limit; not advisable. |
| " " " = 20÷24 V: | | advisable. |
| " " " = 28 up to 41 V: | | not advisable; useless thermal dissipation. |

*2) RL = 750 ohms = external load resistor.*

| | | |
|---|---|---|
| Supply voltage = $V_{ps}$ = 24 V: | | not sufficient. |
| " " " = 27 V: | | just at the limit; not advisable. |
| " " " = 30 V: | | advisable. |
| " " " = 35 up to 43 V: | | not advisable; useless thermal dissipation. |

Low values of RL and of $V_{ps}$ are always preferable (the example 1 is preferable to the example 2).
Due to the limitations and to the disadvantages of the current amplifiers -A4 are always advisable the voltage amplifiers; particularly the version -A5 (= output ±5 V).


AMPLIFIER
POWER SUPPLY
VRL
RL
A
VPS
VT
STABILIZER
SENSOR
VPS = VT + VRL
VRL = RL X ( 4 TO 20 mA )
RL ( Ohms )
VRL ( Volts )
VPS ( Volts )
MINIMUM VPS ALLOWED
MAXIMUM VPS ALLOWED
AREA OF VPS
1750
1500
1250
1000
750
500
250
0
35
30
25
20
15
10
5
0
10
12
15
17
20
22
25
27
30
32
35
37
40
42
45
47

# 9) ELECTRICAL CONNECTIONS OF DIGITAL LOAD CELLS

Load cells with built-in CAN Open output DS406 profile

| CAN Open | Micro connector 5 pins (M12 |
|---|---|
| CAN_V+ | 2 |
| CAN_GND | 3 |
| CAN_L | 5 |
| CAN_H | 4 |

Load cells with built-in RS422 output

| RS422 | Gray sheath DIN47100 cable | Connector |
|---|---|---|
| + Power supply | White | 1 |
| - Power supply | Brown | 2 |
| + RXD | Green | 3 |
| - RXD | Yellow | 4 |
| + TXD | Grey | 5 |
| - TXD | Pink | 6 |

Load cells with built-in RS485 output

| RS485 | Gray sheath DIN47100 cable | Connector |
|---|---|---|
| + Power supply | White | 1 |
| - Power supply | Brown | 2 |
| + Data | Green+Grey | 3+5 |
| - Data | Yellow+Pink | 4+6 |

# 10) PROTECTION AGAINST ELECTRICAL NOISE

**10.1** The signal outputs from the load cells are always low and they may be seriously spoilt by the external electrical disturbances.
The *main cares* to be taken are the following:

**10.2** For the connection cell-signal conditioner always use cable with braiding shield 100%.
The cell and the cable have to be set up far from electric motors, power switches, etc. The cables have to run into separated raceways.

**10.3** The braiding shield is insulated from the cell body and it has to be grounded at the electronics side only.
When the screen is insufficient, the cable can be put in a tube of normal iron (paramagnetic, with low percentage of carbon) (= good electromagnetic screen) with an external insulating sheath to avoid to pick up the stray currents of the metal structures connected.

**10.4** When mating connectors are needed along the cable, the shield has to go through a pin and not through the metal shell of the connector and the connector has to be insulated and covered by plastic tape.

**10.5** Avoid to use earth nets of industrial plants, always rich of electrical disturbances, but use separated ground taps.
The ground tap has to be at the centre of all the ground leads of the instrumentation only.
Never connect the ground in series but each directly connected to the ground tap as a sun (= ground tap) with separated planets (= the instruments).

**10.6** *Follow all the local laws imposed for electrical connections and for the earth connections*.

**10.7** To satisfy to the EMC normative it is imposed to connect the body of the transducer and the shield of the cables to a good earth, without disturbances, as for the CE mark.

# 11) ENVIRONMENT PROTECTION

## 11.1 CONNECTION BY CABLE:

In ambient with humidity or dust and for outdoor applications, use connections by cable only.
The connector has to be excluded.
In long periods, the connectors are never hermetically sealed and the internal air dead volumes exchange humid air with outside. Oxidations of the electrical contacts, jumpers of humid dust and decrease of electrical insulation may occur.
Decreases of the insulation to several megaohms among the signal leads and against the body could create zero unbalance and output instability.

## 11.2 CELLS FOR OUTDOOR APPLICATIONS:

Common features of nearly all DS Europe load cells (excluded la Series QB 700, EG, MP, 942 e BC 300) are the great protection for industrial purpose and for outdoor applications.
This protection is done filling the cell by silicon gels and rubbers, which allows a tightness greater than that realized by weldings.
In fact, in long periods, the internal air dead volume, on welded mechanics, exchanges air and humidity through the cable never hermetically sealed even if clamped.

*The Series LD is the most advisable for heavy and outdoor applications.*
In these Series the strain-gauges, the electrical circuits are settled in the inferior cavity filled by sealing silicon filler and covered, like an umbrella, by the body of the load cell.
To increase further the tightness of the cell is useful to spread a layer of silicon sealing rubber between the circular fixing rim and the base.

For heavy applications also the following Series can be used, in order of priority: AP 7000 - MD 5000 - HC 2000 - 500 QD– 560QDT - PT500 – MB490-KCI.

To support better the environmental conditions varnishes and lacquers can be used to cover the body of the cells, the cavities, the cables alternating epoxy with silicon varnishes.

# 12) TESTS FOR THE APPLICATION OF THE CE MARK

## 12.2 AMPLIFIED TRANSDUCER:

They are subjected to CE mark.
Those one *without internal amplifier* are considered "passive components" and therefore *any certification is necessary.*

## 12.2 TEST CENTER AND LIST OF THE TESTS:

The tests have been done at a *Test Centre "competent body" internationally approved.*
For the compatibility tests have been chosen the standards **EN 50081-2 (*for emission*) and EN 50082-2 (*for immunity*)**, the most severe for industrial applications.

**12.2.1** *Normative reference: EN 55011*: Test category: Emission; Port: enclosure; Type of test: radiated interference field strength; Frequency range: 30 to 1000 MHz.

**12.2.2** *Normative reference: ENV 50140*: Port: enclosure; Test category: Immunity; Type of test: radiated radio-frequency, electro-magnetic field; Frequency range: 80 to 1000 MHz; Test level: 10 V/m.

**12.2.3** *Normative reference: ENV 50141*: Port: DC I/O power port; Test category: Immunity; Type of test: RF common mode; Frequency range: 0,15 to 80 MHz; Test level: 10 V.

**12.2.4** *Normative reference: ENV 50141*: Port: signal lines; Test category: Immunity; Type of test: RF common mode; Frequency range: 0,15 to 80 MHz; Test level: 10 V.

**12.2.5** *Normative reference: EN 61000-4-4*: Port: DC I/O power port; Test category: Immunity; Type of test: Fast transient (burst). Common mode; Test level: 3.

**12.2.6** *Normative reference: EN 61000-4-4*: Port: signal lines; Test category: Immunity; Type of test: Fast transient (burst) common mode; Test level: 3.

**12.2.7** *Normative reference: EN 61000-4-2*: Port: Enclosure; Test category: Immunity; Type of test: ESD; Test level: ±4kV.

**12.2.8** *Normative reference: EN 61000-4-8*: Port: Enclosure; Test category: Immunity; Type of test: Power frequency magnetic field. Frequency range: 50 Hz; Test level: 4.

**12.2.8** *Normative reference: ENV 50204*: Port: Enclosure; Test category: Immunity; Type of test: Radio frequency electromagnetic field. Pulse modulated: 900 + 5 MHz; Test level: 3.

### Notes:

1) **The tests have given positive results.**

2) The test Laboratory and the EC normatives compel reserve on the paper-works and on the data of the tests; they neither can be advertised nor photocopied and they remain at disposal only to the Competent Authorities in our Factory.

# 13) CONTROLS AND LIFE OF A LOAD CELL

## 13.1 STARTING PERIOD:

During the first months from the cell construction, are discharged the superficial stresses due to the machining and the stresses included in the cements; they follow possible little variations of zero and sensitivity.

For laboratory precise tests, it is advisable a control and a calibration after the first 6 months of life of the cell and, further, every year period.

For industrial applications the changes are insignificant and the recalibration useless.

## 13.2 CREEP:

On a cell loaded for a long period can appear creep of the metal body, of the cements, of the plastic backing of the gauges.

This creep is shown as a variation of the measure and, unloading the cell, as a non-return to zero. The variations are acceptable in industrial applications.

## 13.3 LIFE OF A CELL FOR USE WITH RISKS OF DAMAGES:

(See Chapter 5). After a maximum period of 5 years the cell must be substituted in use with risks of damages.

A finished cell cannot be submitted to a complete check-up by ultrasound and magnetoscopic tests, to discover fatigue deteriorations, microfractures, etc., due to unknown shocks and vibrations.

This rule is imposed by several safety recommendations

# 14) POSSIBLE DAMAGES THAT MIGHT HAPPEN TO A LOAD CELL

A load cell can rarely be repaired and the repair is almost always more expensive than the replacement of a new cell, in that disassembly means destruction of parts and repair with subsequent control carried out by specialist staff outside the production cycle.

The main damages that can happen to a cell are the following:

## 14.1 YIELD (OR BREAKING) OF THE MECHANICAL PARTS:

- *Problem:* the electrical zero has a high value, generally varying form test to test, and on electronics display it is shown a force value without any real force on the load cell.
  The linearity is poor with also high hysteresis.
  It might eventually happen also a strain gauge damage: in this case also a fluctuating or drifting value might be red with a static force on the load cell.

- *Causes:* applied load, bending and torsional moments above the maximum accepted by the cell; this damage occurs also when the cell is not electrically connected and by force transients (shocks) not shown in the digital display (because of longer reading time).

- *Solutions: a* repair is not possible, It is recommended to substitute the load cell and to apply an anti overload protection as well as a low friction force guiding system to protect the load cell.

## 14.2 STRAIN GAUGE DAMAGE:

- *Problem:* the electrical zero has a high value and the bridge resistances across the excitation or across the output signal leads shows different values or even an infinite resistance.
  Electronics display shows a high measured value without any force applied onto load cell.

- *Causes:* load cell supplied with voltage exceeding the maximum allowed, over voltages (electrical weldings, on the machine frame, without electrically insulating the load cell), transients, electrical discharges introduced through the signal leads or through the power supply leads.

- Solution: a repair is possible but is normally more expensive than a replacement by a new cell.

## 14.3 POOR INSULATION AGAINST THE BODY OF THE CELL:

- *Problem:* excessive zero-drift, notable instability of the zero, insulation below one Mohm.

- *Causes:* water penetration, persistent high humidity in the cell, electrical discharges between the electrical circuit and the body of the cell.

- Solution: if the cause is the penetration of water, it is recommended to bake the cell in an oven at 85°C for at least 10 days, hoping that no conductive residue will remain; if the causes are electrical discharges with carbon residues the repair is more expensive than the replacement by a new cell.

## 14.4 DAMAGED ELECTRICAL CONNECTIONS:

- *Problem*: a highly fluctuating output signal (especially if cable or connectors are moved) or no signal at all.

- *Causes:* electrical connection cable or connector mechanically damaged by vibrations, shocks, bumping against sharp edges or by long term dynamic movements.

- *Solutions*: cable or connector is to be substituted. Cable should be applied in proper connection channel as well as mechanically fixed to the machine in order to reduce vibration effects.

## 14.5 BUILT-IN DAMAGED ELECTRONICS:

- Problem: no output signal.

- *Causes:* overvoltage, short circuit or misconnections.

- *Solutions:* repair might be possible depending on damage type.

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# SALES CONDITION

## (for all DS Europe products)

**WARRANTY:**

From raw material through in-process operations to the final test and to finished piece, DS Europe product is subject to rigorous inspections and to continuous quality controls to assure a production free from defects in parts, in materials and workmanship.

When the product is submitted to warranty claims and it results defective from normal use within 6 months from the date of shipment, it will be repaired or substituted free of charge in our factory; the transport, insurance expenses, custom's duties are to be prepaid and borne by the Customer.

The material delivered has to be controlled within 10 days from the receipt; after this period the material is considered as accepted.

The responsibility is strictly restricted to the above provision and DS Europe declines any liability for damages to Persons and things, for damages of stopping of plants, of machineries due to the applications and due to the use of its products.

**B) RESPONSABILITY FOR DAMAGES:**

DS Europe products are only parts of more complex machineries and of plants sold in thousands of pieces/year, for thousands of different applications with different local standards and specifications unknown to the Supplier.

For installations and for uses which directly or indirectly may involve risks of damage to Persons and things, of damage for stopping of machineries, of plants is precise obligation for the end User, for the Distributor, or for the Retailer to inform immediately and before the installation DS Europe which will stop the negotiation and which will cancel the delivery of the product.

Nevertheless DS Europe is at disposal to suggest, without any responsibility, protection accessories, test certificates, Consulting Companies or research and test Laboratories so to reduce or to zero the risks of damages.

It is underlined to read the "instructions of installation and of use" of the products that may be sent, under request, even during the negotiations.

**C) REMARKS:**

These "sale conditions" are integral part of the bulletins, of the invoices, of the instruction manual, also if not written on them.

DS EUROPE S.R.L.

Sale conditions N°221194 dated November 22, 1994.