# Circular elements, general information, requirements

## General information

In a modern HVAC system, it is essential to install high quality ventilation systems and their components. The high installation and operating costs of the HVAC system impose very strict requirements on the quality of the duct system and its individual components. The ducts must meet high standards of tightness, be durable and easy to install. Fulfilling each requirement and producing, installing a high quality product will save you energy costs during downstream operation. Also, easy, convenient and quick installation of duct systems allows you to reduce work costs.

## Advantages to use

Easy and quick installation.
As standard, factory-fitted round duct connections are fitted with sealing gaskets. This avoids inconsistencies and human forgetting errors when installing gaskets manually. The correct choice of dimensions and mounting materials allows the assembly of a sealed ventilation system without damage to gaskets. This type of system can be installed in a variety of operating conditions. The contact surface of the gasket determines the air tightness of the duct system, so the larger it is and the more pressure it exerts, the better the result. In order to achieve this result, the gasket must be soft and elastic to fit as closely as possible to the surface. All important technological and technical aspects are taken into account to produce the highest quality product. The circular duct system uses an F-type integrated sealing gasket, which prevents the use of additional seals. Not using sealants saves assembly time, saves the environment, and eliminates any risk of vapour entering the supply air system. The gasket is fixed at the back of the part with special recesses where, when the whole system is connected, the gasket is correctly positioned and seals the duct system. The gasket material is a special F-shape and is manufactured with a unique formulation with an integrated lubricant, which ensures easy slip of the part during assembly of duct systems. They are made of specialized EPDM rubber. EPDM rubber is resistant to ozone, UV rays and temperature fluctuations. The permissible operating temperature range, which does not change its physical properties, is between -45 ° and + 85 °C for these gaskets. They are durable and do not change their physical properties throughout their life.

Fitting with rubber

With duct

## Tightness

Using only the highest quality materials and precise dimensions, we can ensure the tightness class C of the manufactured round system elements in accordance with the requirements of LST EN 12237 standard. Thanks to the use of EPDM double sealing gasket we can reach this class without the use of additional sealing materials. The profile of the gasket is made in a special shape so that attaching and joining the elements is easy and does not require a lot of force, however, extra effort is already required to disassembly the system, since the special shape of the gasket squeezes into the elements and prevents them from being accidentally disconnected, ensuring a high level of system sealing. Gathering the elements into a single duct system results in a continuous product where the gaskets are in contact with the inner surfaces throughout their entire area. All materials are tested in the manufacturing process. Check that the gaskets are of undamaged material, that they are not torn or that they are of the required dimensions. For different diameters, a gasket profile of different heights is used due to the greater tolerance limit. All manufactured products are checked with calibre for dimensional suitability. We produce round elements from d100 mm to d1250 mm in diameter.

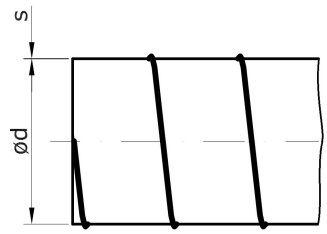
## Assembly of circular system

Make sure that the duct elements used for assembly are clean, have smooth edges, have a smooth surface not damaged gasket. Only use elements of the same diameter for assembly. If elements of different dimensions are needed, transitions of the desired shape must be used. Pay attention to the gasket, it should be smooth, not torn, covered with special talc and be in place in the groove. After measuring the lengths of the system and cutting the ducts, the two elements are later connected in a forward and backward rotation to the intended place. For systems up to 200 Pa, no additional screws can be used for the tightening of the gasket. Self-tapping screws or rivets should be used when needed for higher pressure systems. Make sure you do not damage the gasket when drilling. The permissible distance from the end of the duct for fasteners is about 10 mm. Also all joints can be additionally sealed with adhesive aluminium strips.

| Duct dimension Ød$_{nom}$, mm | Quantity of screws in one connection | |
|---|---|---|
| | >200 Pa | <200 Pa |
| 100 - 250 | - | 2 |
| 250 - 500 | 2 | 4 |
| 560 - 710 | 3 | 6 |
| 710 - 1250 | 6 | 10 |

# Circular elements, general information, requirements

## Dimension tolerance for ducts




According requirements of LST EN 1506 standard

| Ød$_{nom,}$ mm | s, mm | Dimension tolerances, mm | |
|---|---|---|---|
| 100 | 0,45 | 100,0 | 100,5 |
| 125 | 0,45 | 125,0 | 125,5 |
| 160 | 0,45 | 160,0 | 160,6 |
| 200 | 0,45 | 200,0 | 200,7 |
| 250 | 0,55 | 250,0 | 250,8 |
| 315 | 0,55 | 315,0 | 315,9 |
| 355 | 0,55 | 355,0 | 356,0 |
| 400 | 0,55 | 400,0 | 401,0 |
| 450 | 0,55 | 450,0 | 451,1 |
| 500 | 0,55 | 500,0 | 501,1 |
| 560 | 0,55 | 560,0 | 561,2 |
| 630 | 0,6 | 630,0 | 631,2 |
| 710 | 0,6 | 710,0 | 711,5 |
| 800 | 0,7 | 800,0 | 801,6 |
| 900 | 0,7 | 900,0 | 902,0 |
| 1000 | 0,9 | 1000,0 | 1002,0 |
| 1250 | 0,9 | 1250,0 | 1252,5 |

Length tolerances according LST EN 1506 standard

| L, r, s mm | Tolerance |
|---|---|
| 0 - 15 | +0 -2 |
| 16 - 100 | +0 -5 |
| 101 - | +0 -10 |
| Overall dimensions L | ±0,5% |

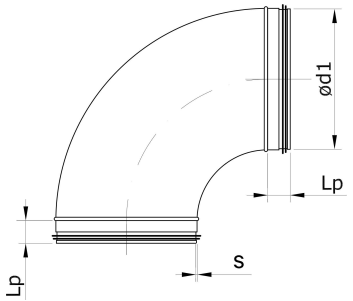
Angle tolerances according LST EN 1506 standard

| Angle dimensions | Tolerance |
|---|---|
| α° | ±2 |

Weight tolerances according LST EN 1506 standard

| Mass | Tolerance |
|---|---|
| kg, | ±10% |

## Dimension tolerance for fittings




According requirements of LST EN 1506 standard

| Ød1$_{nom,}$ mm | s, mm | Lp, mm | Dimension tolerances, mm | |
|---|---|---|---|---|
| 100 | 0,5 | 40 | 98,8 | 99,3 |
| 125 | 0,5 | 40 | 123,8 | 124,3 |
| 160 | 0,5 | 40 | 158,7 | 159,3 |
| 200 | 0,5 | 40 | 198,6 | 199,3 |
| 250 | 0,5 | 40 | 248,5 | 249,3 |
| 315 | 0,5 | 40 | 313,4 | 314,3 |
| 355 | 0,5 | 50 | 353,3 | 354,3 |
| 400 | 0,5 | 50 | 398,3 | 399,3 |
| 450 | 0,5 | 50 | 448,2 | 449,3 |
| 500 | 0,5 | 50 | 498,2 | 499,3 |
| 560 | 0,5 | 50 | 558,1 | 559,3 |
| 630 | 0,6 | 50 | 628,1 | 629,3 |
| 710 | 0,7 | 65 | 708,0 | 709,3 |
| 800 | 0,7 | 65 | 798,0 | 799,3 |
| 900 | 0,7 | 100 | 897,9 | 899,3 |
| 1000 | 0,9 | 100 | 997,9 | 999,3 |
| 1250 | 0,9 | 100 | 1247,8 | 1249,3 |

# Rectangular elements, general information, requirements

## General information

Rectangular ducts can be installed with or without circular ducts. Often, rectangular ducts allow for a much smaller ventilation system height where such a solution is needed. In addition, rectangular ducts can be made with a relatively large cross-sectional area, which makes it difficult to produce round ducts. The manufacturer undertakes to produce ducts with a high degree of tightness, durability and ease of installation in accordance with the requirements of the standards. Easy, convenient and quick installation of ventilation duct systems saves you time and costs, so we always recommend that you buy only ready-to-install products.

## Advantages to use

Factory-made rectangular ducts have L-shaped flange connections of appropriate size (depending on the duct length). Inside the flange is a sealing mastic that provides increased sealing between the sheet steel and the flange. The manufactured components allow quick assembly of the ventilation system of the desired size and configuration. All overlapping products are joined by 4 bolts and various clamping elements along the entire circumference of the flange. Factory-made rectangular ducts, as well as other elements, allow significant savings in system installation time compared to if the ducts were self-manufactured on site or assembled from individual parts. Factory-made elements prevent possible errors, as all ducts are controlled and inspected at every stage of production to meet all quality requirements. Therefore, we always recommend to use only fully prefabricated ducts and other parts. The wide range of dimensions allows the installation of duct systems of the required size on site. The standard system can be used in the temperature range -45 ° to + 85 °C. For duct connection between flanges, it is recommended to use a specialized duct sealing gasket, which, when properly applied, achieves a high system tightness. The larger the contact area, the higher the air-tightness of the duct system. Therefore, the gasket must be soft and elastic to fit as closely as possible to the surface. Rectangular elements are manufactured in accordance with standard LST EN 1505 “Ventilation for buildings. Sheet metal ducts and fittings of rectangular cross - section. Dimensions”. Elements of the duct system are suitable for low and medium pressure systems. All elements are made of specially mechanically formed and reinforced sheet steel and, if necessary, reinforced with special stiffening rods. If greater protection against corrosion is required, the elements, depending on the anti corrosion class requirements for the ventilation system, are made of aluminium zinc coated steel sheets or of various grades of stainless steel.

## Tightness

By using only the highest quality materials and precise dimensions, we can ensure that the rectangular system elements are manufactured with tightness class B and C according to LST EN 1507 standard. When assembling the duct system it is necessary to use a sealing gasket recommended by the manufacturer. The gasket must be soft, resistant to environmental influences and have good adhesion to surfaces. It is recommended to place the gasket on top of each other at the joints of the gaskets in order to maintain the best possible seal. All materials are tested in the manufacturing process to ensure that the dimensions are within tolerances or that the parts are assembled as required by the installation manual.

The classification of the tightness is shown in the table below.

| Tightness class | Leakage limit $(f_{max})m^3s^{-1}m^{-2}$ | Pressure limits ($p_s$) Pa | | | |
|---|---|---|---|---|---|
| | | Negative pressure | Positive pressure | | |
| | | | 1 | 2 | 3 |
| A | $0{,}027xp_{test}^{0{,}65}x10^{-3}$ | 200 | 400 | - | - |
| B | $0{,}009xp_{test}^{0{,}65}x10^{-3}$ | 500 | 400 | 1000 | 2000 |
| C | $0{,}003xp_{test}^{0{,}65}x10^{-3}$ | 750 | 400 | 1000 | 2000 |
| D | $0{,}001xp_{test}^{0{,}65}x10^{-3}$ | 750 | 400 | 1000 | 2000 |

Not only the recommended structural elements, but also the rules for the use of system tightness classes on objects, differ slightly in the installation of circular or rectangular ducts in different countries. As requirements for ventilation units changes a lot, requirements for duct systems also become stricter. Currently, much attention is paid to minimizing energy losses during the operation of the ventilation system. Therefore, it is recommended to design ventilation systems with as little pressure loss as possible. It also requires that the system be as tight as possible to minimize air loss, which also reduces energy costs when transporting air to and from the premises. The table below shows the requirements for tightness classes according to the different standards and regulations that apply in different countries.

| Tightness class acc. LST EN 1505 | STR 2.09.02 (Lithuania) | EN 13779 (Europe) | VDI 3803 VDI 6022 (Germany) |
|---|---|---|---|
| A | Minimum requirement | Do not use | Du not use |
| B | Recommend to use | Minimum requirement | Minimum requirement |
| C | High requirement | Recommend to use | Recommend to use |
| D | Special demand | Special demand | High requirement |

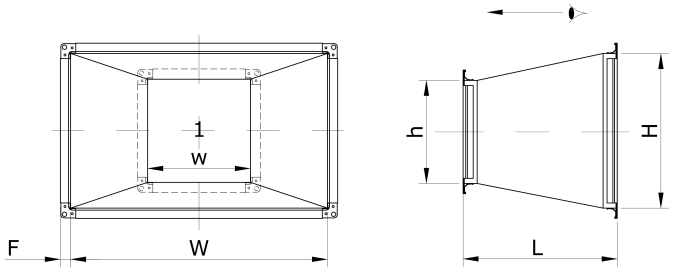
# Rectangular elements, general information, requirements

## Rectangular system product control

When installing duct systems in buildings, we recommend the following:
Check all items supplied by the duct system for bent or flanged connections and angles perpendicular to the duct surface. Discharge the elements carefully as they are easily damaged before being assembled into a duct system. Keep delivered items protected from rainfall, especially if they are covered with a protective clean film. Make sure the duct connections are clean before installing the duct system and then apply the gasket. In the corners the gasket should cross or apply in curved line. Fasten the flanges to the flanges with bolts. For flanges longer than 500 mm, additionally tighten with C profile or universal clamps. If possible, check the screw connections after a few days and tighten them again if necessary. If additional components are needed, blind rivets are best used. If you have used self-tapping screws for installation in the system, then the connection must be additionally sealed. Use only sealed and approved sealing materials that are not damaging sheet steel and are hygienic.

## Dimensions

When considering duct dimensions, nominal dimensions are always considered and tolerances are evaluated later. All dimensions of rectangular elements are understood as internal dimensions without external flange dimensions. The flanges are always outside. The duct dimension is always produced only with a plus tolerance. In all elements W and H are the dimension of the main duct and w and h are the dimension of the transition to the smaller duct. The length L, l1, l2, l3 is always measured as the effective parallel element length and is measured with the flange connection. This length is taken from the overall system design drawings. F denotes the flange connection size.




The standard dimensions of the duct system elements are between 200 mm and 2400 mm, any dimension H or W. However, ducts up to 5500 mm can be made to order.

## Dimension tolerances

The parts of rectangular ducts and elements are made of steel sheet, reinforced by forming the surface mechanically and connected by seams by pressing. The flange of the ducts are connected by forming rivets (clinch). Manufactured ducts meet the Class B and C tightness requirements at standard tested pressures of -750 Pa and +1000 Pa, it means that rectangular elements withstand second-class overpressure up to + 1000 Pa. On demand, even higher-pressure products are manufactured by changing the thickness of their steel sheets and increasing the number of reinforcing bars. At the customer's request, special ducts can be produced that meet the requirements of another country eg Germany, Sweden, etc. Rectangular elements are always based on the larger edge dimension, which is used to select steel sheet thickness, flange size, and other stiffening elements.

| Longest side wall, mm | Tolerance, mm | Sheet thickness, -750Pa+1000Pa | Sheet thickness, -750Pa+2000Pa |
|---|---|---|---|
| <1000 | 0 - 4 | 0,5 | 0,7 |
| >1000 <1500 | 0 - 4 | 0,6 | 0,8 |
| >1500 <2400 | 0 - 4 | 0,7 | 0,9 |
| >2400 | 0 - 5 | 0,8 | 1,0 |

The dimensions of standard products

Length tolerances according LST EN 1505 standard

| Dimensions | Tolerance |
|---|---|
| W, H, w, h, | +4 -0 |
| Overall dimensions L | ±0,5% |

Angle tolerances according LST EN 1505 standard

| Angle dimensions | Tolerance |
|---|---|
| α° | ±2° |

Weight tolerances according LST EN 1505 standard

| Mass | Tolerance |
|---|---|
| kg, | ±10% |

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# Rectangular elements, general information, requirements

## Dimensions

When calculating the various parameters of a rectangular duct, it is always necessary to calculate the hydraulic diameter and take all the system resistance, air velocity and air volume figures from the circular duct data. The formula can be used to calculate the hydraulic diameter of any duct:

$d_h = 2 * W * H / W + H, [m]$

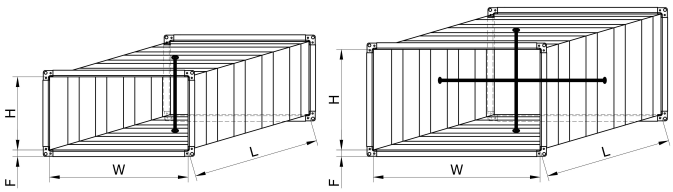
Bellow in table are shown dimensions: cross section area $A_c$ [m2], hydraulic diameter $d_h$ [mm], equivalent diameter $d_e$ [mm], and duct surface area $A_i$, of 1 meter duct [m2/m] according the requirements of standard LST EN 1505.

| Connection, side wall length [mm] | Dimension | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 | 800 | 1000 | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | $A_c$ | 0,020 | 0,030 | 0,040 | - | - | - | - | - | - | - | - |
| | $d_h$ | 133 | 171 | 200 | - | - | - | - | - | - | - | - |
| | $d_e$ | 149 | 186 | 218 | - | - | - | - | - | - | - | - |
| | $A_i$ | 0,60 | 0,70 | 0,80 | - | - | - | - | - | - | - | - |
| 250 | $A_c$ | 0,025 | 0,038 | 0,050 | 0,063 | - | - | - | - | - | - | - |
| | $d_h$ | 143 | 188 | 222 | 250 | - | - | - | - | - | - | - |
| | $d_e$ | 165 | 206 | 241 | 273 | - | - | - | - | - | - | - |
| | $A_i$ | 0,70 | 0,80 | 0,90 | 1,00 | - | - | - | - | - | - | - |
| 300 | $A_c$ | 0,030 | 0,045 | 0,060 | 0,075 | 0,090 | - | - | - | - | - | - |
| | $d_h$ | 150 | 200 | 240 | 273 | 300 | - | - | - | - | - | - |
| | $d_e$ | 180 | 224 | 262 | 296 | 327 | - | - | - | - | - | - |
| | $A_i$ | 0,30 | 0,90 | 1,00 | 1,10 | 1,20 | - | - | - | - | - | - |
| 400 | $A_c$ | 0,040 | 0,060 | 0,080 | 0,10 | 0,12 | 0,16 | - | - | - | - | - |
| | $d_h$ | 160 | 218 | 267 | 308 | 343 | 400 | - | - | - | - | - |
| | $d_e$ | 205 | 255 | 299 | 337 | 373 | 436 | - | - | - | - | - |
| | $A_i$ | 1,00 | 1,10 | 1,20 | 1,30 | 1,40 | 1,60 | - | - | - | - | - |
| 500 | $A_c$ | - | 0,075 | 0,10 | 0,13 | 0,15 | 0,20 | 0,25 | - | - | - | - |
| | $d_h$ | - | 231 | 286 | 333 | 375 | 444 | 500 | - | - | - | - |
| | $d_e$ | - | 283 | 331 | 374 | 413 | 483 | 545 | - | - | - | - |
| | $A_i$ | - | 1,30 | 1,40 | 1,50 | 0,60 | 1,80 | 2,00 | - | - | - | - |
| 600 | $A_c$ | - | 0,090 | 0,12 | 0,15 | 0,18 | 0,24 | 0,30 | 0,36 | - | - | - |
| | $d_h$ | - | 240 | 300 | 353 | 400 | 480 | 545 | 600 | - | - | - |
| | $d_e$ | - | 307 | 359 | 406 | 448 | 524 | 592 | 654 | - | - | - |
| | $A_i$ | - | 1,50 | 1,60 | 1,70 | 1,80 | 2,00 | 2,20 | 2,40 | - | - | - |
| 800 | $A_c$ | - | - | 0,16 | 0,20 | 0,24 | 0,32 | 0,40 | 0,48 | 0,64 | - | - |
| | $d_h$ | - | - | 320 | 381 | 436 | 533 | 615 | 686 | 800 | - | - |
| | $d_e$ | - | - | 410 | 463 | 511 | 598 | 675 | 745 | 872 | - | - |
| | $A_i$ | - | - | 2,00 | 2,10 | 2,20 | 2,40 | 2,60 | 2,80 | 3,20 | - | - |
| 1000 | $A_c$ | - | - | - | 0,25 | 0,30 | 0,40 | 0,50 | 0,60 | 0,80 | 1,00 | - |
| | $d_h$ | - | - | - | 400 | 462 | 571 | 667 | 750 | 889 | 1000 | - |
| | $d_e$ | - | - | - | 512 | 566 | 662 | 747 | 825 | 965 | 1090 | - |
| | $A_i$ | - | - | - | 2,50 | 2,60 | 2,80 | 3,00 | 3,20 | 3,60 | 4,00 | - |
| 1200 | $A_c$ | - | - | - | - | 0,36 | 0,48 | 0,60 | 0,72 | 0,96 | 1,20 | 1,44 |
| | $d_h$ | - | - | - | - | 480 | 600 | 706 | 800 | 960 | 1091 | 1200 |
| | $d_e$ | - | - | - | - | 614 | 719 | 812 | 896 | 1049 | 1184 | 1308 |
| | $A_i$ | - | - | - | - | 3,00 | 3,20 | 3,40 | 3,60 | 4,0 | 4,40 | 4,80 |
| 1400 | $A_c$ | - | - | - | - | - | 0,56 | 0,70 | 0,84 | 1,12 | 1,40 | 1,68 |
| | $d_h$ | - | - | - | - | - | 622 | 737 | 840 | 1018 | 1167 | 1292 |
| | $d_e$ | - | - | - | - | - | 771 | 871 | 962 | 1125 | 1270 | 1403 |
| | $A_i$ | - | - | - | - | - | 3,60 | 3,80 | 4,00 | 4,40 | 4,80 | 5,20 |
| 1600 | $A_c$ | - | - | - | - | - | 0,64 | 0,80 | 0,96 | 1,28 | 1,60 | 1,92 |
| | $d_h$ | - | - | - | - | - | 640 | 762 | 873 | 1067 | 1231 | 1371 |
| | $d_e$ | - | - | - | - | - | 819 | 925 | 1022 | 1195 | 1350 | 5,60 |
| | $A_i$ | - | - | - | - | - | 4,00 | 4,20 | 4,40 | 4,80 | 5,20 | 0,80 |
| 1800 | $A_c$ | - | - | - | - | - | - | 0,90 | 1,08 | 1,44 | 1,80 | 2,16 |
| | $d_h$ | - | - | - | - | - | - | 783 | 900 | 1108 | 1286 | 1440 |
| | $d_e$ | - | - | - | - | - | - | 976 | 1078 | 1261 | 1424 | 1573 |
| | $A_i$ | - | - | - | - | - | - | 4,60 | 4,80 | 5,20 | 5,60 | 6,00 |
| 2000 | $A_c$ | - | - | - | - | - | - | 1,00 | 1,20 | 1,60 | 2,00 | 2,40 |
| | $d_h$ | - | - | - | - | - | - | 800 | 923 | 1143 | 1333 | 1500 |
| | $d_e$ | - | - | - | - | - | - | 1024 | 1131 | 1323 | 1494 | 1650 |
| | $A_i$ | - | - | - | - | - | - | 5,00 | 5,20 | 5,60 | 6,00 | 6,40 |

# Rectangular elements, general information, requirements

## Stiffness of rectangular elements

The rectangular system is very sensitive to the change in pressure. The ducts and elements of the rectangular system are less pressure resistant and therefore most of the system elements are manufactured with additional reinforcement with internal stiffening elements. Also, in order to maximize the rigidity of the sheet steel, all rectangular ducts and other elements are made of corrugated sheet metal. Sheet steel forming reinforces the surface stiffness of the ventilation element. This makes the ducts less flexible and easier to withstand pressure changes. The formation of the sheet can also reduce the noise of the rectangular system when pulsing air flows through it. The corrugation of the duct sheet and additional stiffening with internal stiffening elements allows the production of rectangular ducts in accordance with the strength requirements of LST EN 1505 standard. The stiffening diagram is shown below and the amount of stiffeners used is dimension dependent.

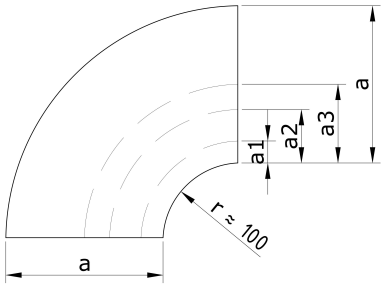



| H , mm | W, mm | L, mm | Stiffeners |
|---|---|---|---|
| <1000 | <1000 | 1500 | 0 |
| <1000 | >1000<1400 | 1500 | 1 |
| <1000 | >1401<2100 | 1500 | 2 |
| <1000 | >2101<2800 | 1500 | 3 |
| <1000 | >2801<3500 | 1500 | 4 |
| <1000 | >3501<4200 | 1500 | 5 |
| >1000<1400 | >1000<1400 | 1500 | 1 cross, 2 stiffeners |
| >1401<2100 | >1401<2100 | 1500 | 2 cross, 4 stiffeners |
| >2101<2800 | >2101<2800 | 1500 | 3 cross, 6 stiffeners |

Rectangular elbows of various dimensions are manufactured with airflow diverting feathers. Depending on the speed and dimensions of the system, designers can determine what products are required, but LST EN 1505 specifies standard solutions that are recommended for elbows installed in a normal system. When the rectangular elbow has an internal radius of curvature of about 100 mm, install the airflow deflector feathers as shown in the table. Elbows smaller than 45° are also recommended to install pointing feathers, but this is determined by the designer based on system speeds.

## Stiffness of rectangular elements

| Duct dimension a, mm, according LST EN 1505 | Quantity of feathers | Distance between feathers | | |
|---|---|---|---|---|
| | | a1 | a2 | a3 |
| > 400 <= 800 | 1 | a/3 | - | - |
| > 801 <= 1600 | 2 | a/4 | a/2 | - |
| > 1601 <= 2000 | 3 | a/8 | a/3 | a/2 |




## Design of rectangular elements

With the help of our Rectangular Parts Design Program, we can produce fast and high quality parts of any shape. The program asks for the overall dimensions, and the software automatically calculates all the part tiles and materials needed for the production and preparation of the parts. Issues the operator the necessary part tiles, which are fed to the cutting machine for cutting. This eliminates any human input data errors. Using a computer program we produce high quality and precise parts.

## Assembly of rectangular system

Make sure the duct elements used for assembly are clean, have smooth edges, and have a smooth surface. Use only elements of the same dimensions for assembly. If you need to combine elements of different dimensions, you need to use different shape transitions. Pay attention to the gasket, it must be smooth, not torn, in place at the inner edge of the flange, and preferably only in one corner with X overlapping at one end and glued at the other corners. All rectangular ducts are connected by flanges using bolts, staples or push-in type C profiles. It is necessary to connect the screws in the corners for even air distribution and for better sealing of the gasket. It is recommended that the parts be joined to one another with flanges of the same height, but in exceptional cases, flanges of different denominations can be used with hook type universal clips. It is recommended to hang each duct segment on the threaded rod and traverse system before connection to flange. Do not leave the ducts hanging on the flanges only. The ducts can be hung with various hanging elements that are most convenient for the particular situation.

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# Ducts and fittings, general information, requirements

## Materials

Standard fittings and ducts are manufactured from sheet steel coated with zinc coating. The core material is hot-dip galvanized sheet steel with a yield strength of 190 to 210 N / mm2 and is zinc-coated Z200- Z275 - coating means that 200 - 275 g of zinc per m2 are used on both sides of the sheet. If you need to recalculate what the zinc coating thickness will be, you can do it using the formula:

$$\text{Zinc thickness} = \frac{\text{Weight of zinc (kg)}}{\text{Side quantity} \cdot \text{zinc density (kg/m3)}} = \frac{0{,}275}{2 \cdot 7140} \cdot 10^6 = 19\ \mu m$$

This coating provides normal corrosion protection of the products (class C3-L/C2-M) when used for indoor or outdoor ventilation systems. It may be the case that custom-made ducts are not standard 0.5 mm thickness but 0.9 mm, then it should be understood that the duct has a fixed external dimension and the ducts made of thicker tin will have a smaller inner diameter. Such a duct will not fit standard fittings and must be custom-made for this other thickness duct.

## Corrosion

ISO 12944 describes various coatings and their corrosion resistance. There are classes of corrosion categories:
C1 - very low corrosion risk. Heated buildings with clean air. Offices, shops, schools, hotels.
C2 - Low risk of corrosion. Unheated buildings where condensation is likely. Warehouses, gyms, etc.
C3 - medium risk of corrosion. A suburban and urban area with low levels of sulphur dioxide, acid and salt pollution.
C4 - High risk of corrosion. Urban and industrial areas with moderate sulphur dioxide pollution and / or coastal areas with low levels of salt in the atmosphere.
C5i - Very high corrosion risk. Industrial areas with high air humidity and aggressive atmosphere. Also, coastal areas or offshore sites with high salinity
C5m - Very high corrosion risk. Sea and ship areas with high air humidity and aggressive atmosphere.
Additionally, each class is divided into three groups based on longevity awareness. Durability is not a warranty period, but it is always much longer.
Durability groups:
L - Low - 2 to 5 years.
M - average - 5 to 15 years.
H - high - over 15 years.

## Materials

For all standard elements galvanized steel sheet with corrosion resistance class C2-M /C3-L is used, where C2-M - (low risk class with durability 20 years) and C3-L - (medium risk class) with longevity up to 10 years). We also produce ducts from several types of stainless steel sheets according to the customer's needs.
Low-end stainless steel EN 1.4301 (AISI 304) corresponds to corrosion class C4/C5 and is used where galvanized sheet is highly likely to be damaged by external agents. Where there is a chance of high humidity or high temperatures with airborne chemicals.
High-grade stainless steel EN 1.4404 (AISI 316L) meets the requirements of class C5 and uses a very high corrosion class in industrial premises. Enriched with molybdenum additives, this stainless steel is often used for swimming pools where chlorine and its compounds must be of the highest resistance. Steel is characterized by high hardness and strength, which requires the production of products with extremely high-end industrial equipment. For products made of other materials, the same level of tightness class C is maintained. Other class ducts can be made to order.
The products are made of sheet steel with AZ 150 aluminium zinc compound coating and meet the high requirements of corrosion protection class C4. This type of material has a lighter shade than a galvanized surface, with less visible fingerprints left after assembly or installation. Products made from this material are made to order and are not stocked.

## Powder painting

All products made of galvanized sheet steel can be powder coated in any colour of the RAL palette. Parts are painted internally and externally with polyurethane or epoxy polyester powder, depending on the required corrosion resistance of the painted part or C3 or C4. The thickness of the staining ranges from 80 to 120 µm. The painted surface is smooth glossy. Powder coated products may cause slight discolouration due to intense UV rays, which is why it is recommended to store the painted products in the shade under direct sunlight to avoid discolouration of the same products.

# Ducts and fittings, general information, requirements

## Temperature range of used materials

Temperature limits are based on technical product data sheets and long-term experience in the manufacture and operation of products. The table below lists only some of the most common materials in articles. If the temperature in the table is not within the temperature range given on the data sheets, the data sheet information should be followed. At high temperatures and within close limits, the product is highly likely to become discoloured, soften or harden. In most cases, the temperature ranges are those that do not change the material's performance, unless the permissible short-term temperature is constant.

## Material classification of reaction to fire

| Material | Reaction to fire EN13501-1 | Reaction to fire BS476/7 |
|---|---|---|
| Galvanized, aluminium zinc steel and stainless steel | A1 | Non flammable |
| Mineral wool | A1 | Non flammable |
| Aluminium profile | C | Class 1 |

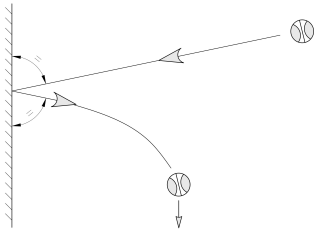
| Product type | Material | Temperature rage | | | |
|---|---|---|---|---|---|
| | | Constant temperature | | Short-term temperature | |
| | | Minimum °C | Maximum °C | Minimum °C | Maximum °C |
| Pressed and welded parts | Galvanized steel sheet ZA | - | 200 | - | 250 |
| | Stainless steel sheet AISI | - | 500 | - | 700 |
| | Aluminium zinc steel sheet AZ | - | 300 | - | 350 |
| Roll formed, spot welded and connected with flange parts | Butyl or gel type mastic | -30 | 90 | - | - |
| | Silicone type sealant | -40 | 100 | -50 | 120 |
| Insulated flexible ducts | Polyester | -30 | 120 | - | 140 |
| | PVC | -40 | 80 | - | 90 |
| The gasket of fittings and dampers | EPDM rubber | -30 | 100 | -45 | 120 |
| Close cell rubber gaskets | EPDM rubber | -30 | 100 | -45 | 120 |
| Close cell polyethylene gasket | Polyethylene | -30 | 80 | - | - |
| Aluminium parts and dampers | EPDM rubber | -30 | 100 | -45 | 120 |
| | Polyamide | -30 | 150 | -50 | 200 |
| | Aluminium | - | 200 | - | 300 |
| Plenum boxes | ABS plastic | -30 | 90 | - | 100 |
| | Synthetic close cell rubber FEF | -50 | 110 | - | 120 |
| Flexible connections | Polyester fabric | -30 | 80 | - | 100 |
| Dampers actuators | ABS | -30 | 80 | - | 100 |
| | Polyamide | -30 | 150 | -50 | 200 |
| | Electric components | -30 | 70 | - | 80 |
| Silencers, attenuators | Polyester fabric | -30 | 120 | - | 140 |
| Acoustic materials | Mineral wool | - | 200 | - | 250 |
| | Synthetic close cell rubber FEF | -50 | 110 | - | 120 |
| | Synthetic wool | -30 | 75 | - | 85 |
| Fire dampers | Fuse, Pb and SN alloy | -30 | 60 | - | - |

# Ducts and fittings, general information, requirements

## Noise in the air

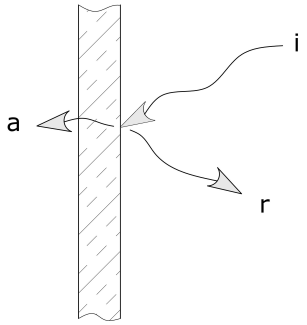
When designing a ventilation system, even when using the very best components and materials, noise is inevitably raised, always present and propagated from the noise source, reflecting from various surfaces in all directions. It is already the case that in a ventilation system, the supply and exhaust of air requires the air to be pumped by fans, which are always more or less noisy. When installing ventilation systems, noise can be absorbed or reflected from different surfaces. Noise is the airborne waves that change their sound level with distance. A correct and good installation of the ventilation system requires a common understanding of noise, which will further explain what to do to reduce noise in the system and gain a general understanding of possible solutions.
Airborne waves are very similar to waves on the water surface when a stone is thrown, only we do not see the waves in the air but only hear. Airborne waves move from the source of noise in the same direction in all directions, until they are attenuated over a distance.

Air waves propagate just like in water. The molecule pushes another molecule and transmits kinetic energy as it moves back and forth. When moving, waves in the air propagate evenly to the noise barrier, which, when impacted, is reflected at the same opposite angle to the barrier. Airborne noise decreases with increasing distance from the source of the noise, until it disappears completely from the range of human audible sound. Like every moving body, waves in the air lose their energy and are suppressed. Loss of energy results from friction into molecules, or from barriers in the path of the wave, where kinetic energy is converted into heat. In terms of sound, these are very small losses of thermal energy that a person does not feel.



## Noise absorption

When soft material is used to absorb noise then the airborne waves fall into the layers of soft material, where they collide with the fibre molecules, reflect in different directions, begin internal friction, release energy due to friction, and absorbs the waves. Part of the noise wave bounces back into the air, but in a different direction and energy. This is called - absorption in the pores. The sound absorption and reflection of different materials are different, which is why the installation of the same attenuator in different rooms often produces a quite distinct sound difference. The ability of various materials to absorb noise is expressed by the damping factor α.



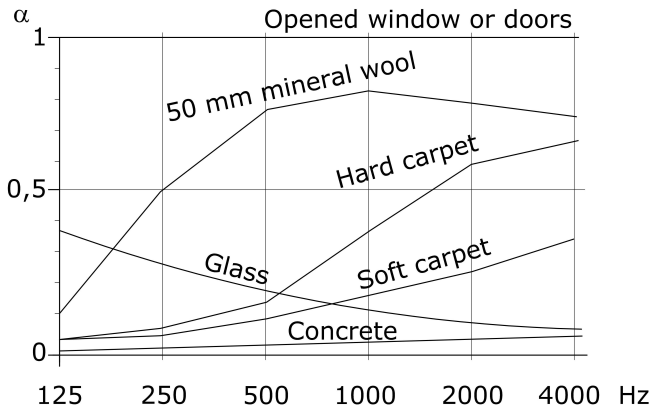

$i = \alpha + r$

$\alpha = a/i$

If the propagating waves are reflected and nothing is absorbed, then a = 0 and we get that the damping factor is also α = 0.
i = 0 + rα = 0 / i = 0
If the propagating waves are absorbed and nothing is reflected, then r = 0, and the damping factor is equal to α=1.
i = a + 0α = a / a = 1
In a room dominated by solids (concrete, and solid structure marble, or stone), the noise will be reflected for a long time, and the echo will spread throughout the room until it is absorbed and heard. In this environment, the attenuation coefficient will be close to 0, and if we compare the noise sliding through the open window (when the noise exits), it has a relatively strong attenuation and a attenuation coefficient close to 1. In acoustically uninsulated rooms, the noise level is high and lasts for a long time, resulting in relatively high noise levels.
When there are soft materials in the room, they absorb strongly the noise waves and we have a well acoustically insulated room. Simply furniture, carpets, or even curtains, acoustically absorbs noise waves, making the room more quiet compare with empty room.

# Ducts and fittings, general information, requirements

## Sound absorption




The noise in the ventilation system moves in all directions and starts to vibrate when it hits the duct wall. This way the duct vibrates at the same frequency as the noise source. The duct's movement is very small, so we can't see that vibration with the naked eye, but we can feel it with our fingers. Such a duct functions as a membrane damper - panels made to vibrate from the noise source's energy. But this movement of the duct is not only due to friction in the duct but also due to the flexibility of the duct material and the movement of the joints through the gaskets. If you compare round duct systems with rectangular duct systems, the same size round system would be much more stable and robust, resulting in less vibration and less noise. However, in the calculations, this damping, which occurs in ducts per linear meter, is not an estimation and is left as a safety factor because the damping efficiency is very low. For example, at 1kHz, the noise reduction is 0.1 to 0.3 dB per linear meter of duct. The larger the cross-sectional area of the duct, the less the damping inside, which is why it is always worthwhile to conduct additional duct branches and distribute the air circulation, thus reducing the propagation of noise.

## Effective absorption

If we add silencers to the duct system, air damping will be more effective because some of the energy will be suppressed in the metal part and the other part will be absorbed in the soft material - e.g. in stone wool. The more often noise waves can hit a soft, porous surface, the faster the kinetic energy of the noise will decrease and the less it will vibrate our eardrum membrane. As a result, the installed curved silencers have very high noise reduction. In them, the noise waves change the direction of movement very many times, thus suppressing themselves.

## Installation of the silencers

When installing a ventilation system, the best location of the damping element is where the highest wave turbulence may be. Also, where possible, porous materials should be mounted in angular elements, where the damping effect is most pronounced. However, if there is significant noise turbulence, then direct damping can be effective as it additionally provides noise reflection from the walls, which often additionally suppresses the propagation of noise in the duct. The more noise waves hit the soft porous surface, the more they will be suppressed. Therefore, silencers are usually mounted immediately behind the fan.

## Facts

A young person hears a sound from 20 Hz to 20,000 Hz with a wavelength of 17 m to 17 mm.
The human hearing sound is usually measured at 1 kHz.
The sound heard by the human at uniform Hz is highly dependent on the sound pressure, the higher the pressure, the higher the noise in the ear.
Different people hear the sound differently.
The average tolerance of the sound measurements is about ±4 dB.
The same noise level will be heard differently when passing through a diffuser with furniture and indoors. There will be less noise in rooms with furniture, soft ceilings and floors.
A room that has a regular square shape is acoustically noisier than a room with walls at different angles, different partitions, columns.