



Rotrex Technical Handbook

Official technical handbook for
Rotrex C-type superchargers

Revision updates

- Version 1.1 – Released 29-10-2012
 - Original
- Version 1.3 – Released 16-05-2013
 - Corrected the supercharger selection example section 3.2
 - Text changed to “*Incorrect pulley change voids warranty*” in section 6.3 to correspond to the latest version of Setup and Maintenance leaflet V9.0

Introduction

This document is intended for OEM developers and Rotrex distributors. For guidance and information please always contact the company who sold you the Rotrex supercharger or the company from whom you intend to buy the Rotrex supercharger (your Rotrex supplier). Rotrex only deals directly with approved distributors and OEM customers.

This document contains important information regarding Rotrex products and services related to the “C” range of superchargers (C8, C15, C30 and C38 product families). It is structured in 6 main sections:

Section 1 --“The ideal development cycle” – summarizes how best to develop a successful Rotrex installation.

Section 2 --“Rotrex technology basics” – provides essential information on how a Rotrex unit works and the benefits it brings to you and your customers.

Section 3 --“Choosing the right Rotrex” – provides a useful guideline to selecting the best Rotrex unit for a particular application.

Section 4 --“Designing and handling interfaces” – Provides a series of guides to design, manufacture and installation of critical systems interfacing with the Rotrex unit (pulley-belt drive, bracket, ducting and lubrication systems).

Section 5 --“Important notes and info sources” – highlights further key considerations and information resources.

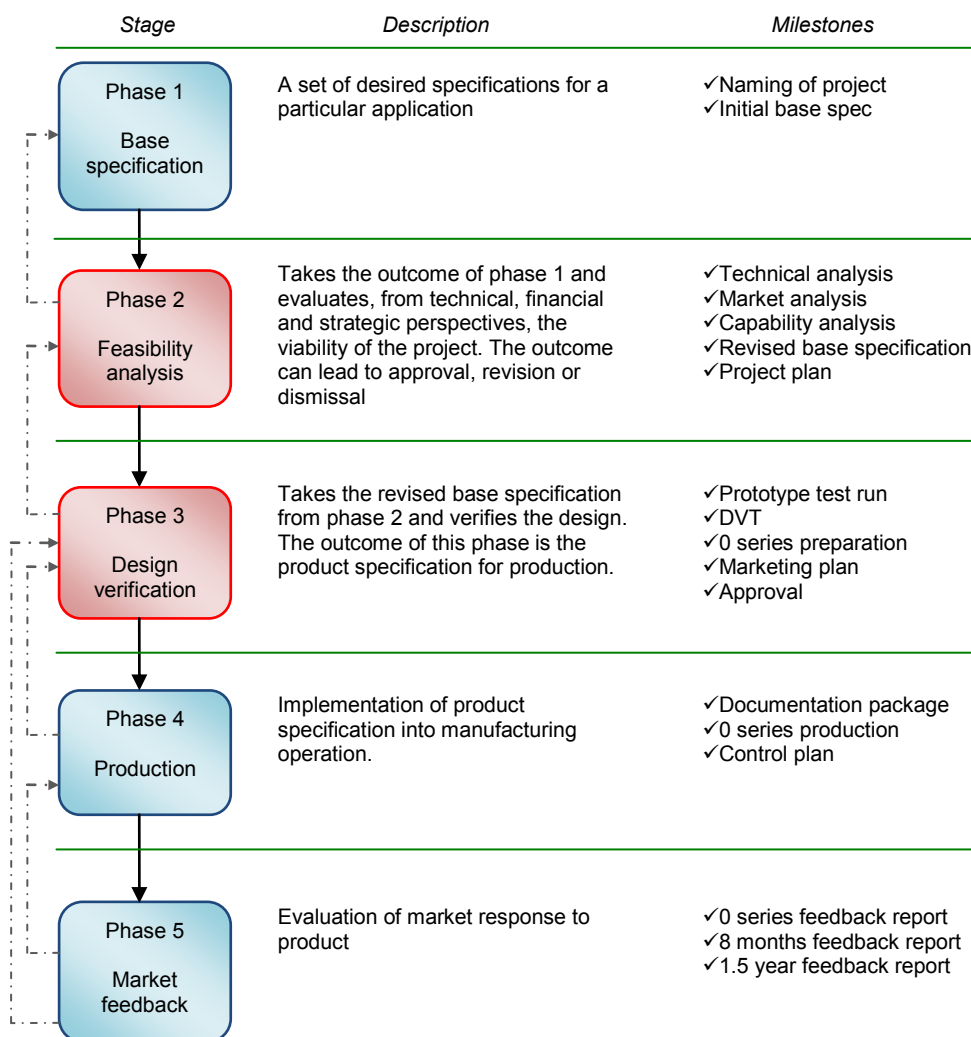
Section 6 --“Support material” – Contains a series of appendices with important drawings, specifications and forms supporting the guidelines.

Following the instructions and recommendations contained in this document is vital for a successful Rotrex installation. For the Rotrex warranty to apply, all the described requirements must be followed, however throughout this handbook we have further highlighted some of the more common mistakes to make it as easy as possible to successfully develop a new Rotrex application.

The advice and general guidelines contained in this handbook are mainly directed towards single boosting solutions. If you are considering multi-boosting (i.e. twin-charged and turbo-supercharged) please contact your Rotrex supplier for dedicated guidance and support. Multi-boosting delivers excellent results in some applications and the added system complexity calls for specific and targeted guidance.

1. The ideal application development cycle

Rotrex offers technical and commercial support to OEM customers and official Rotrex distributors along the entire development cycle in order to ensure a proper quality level in all Rotrex based applications. The diagram below represents an ideal application development cycle.

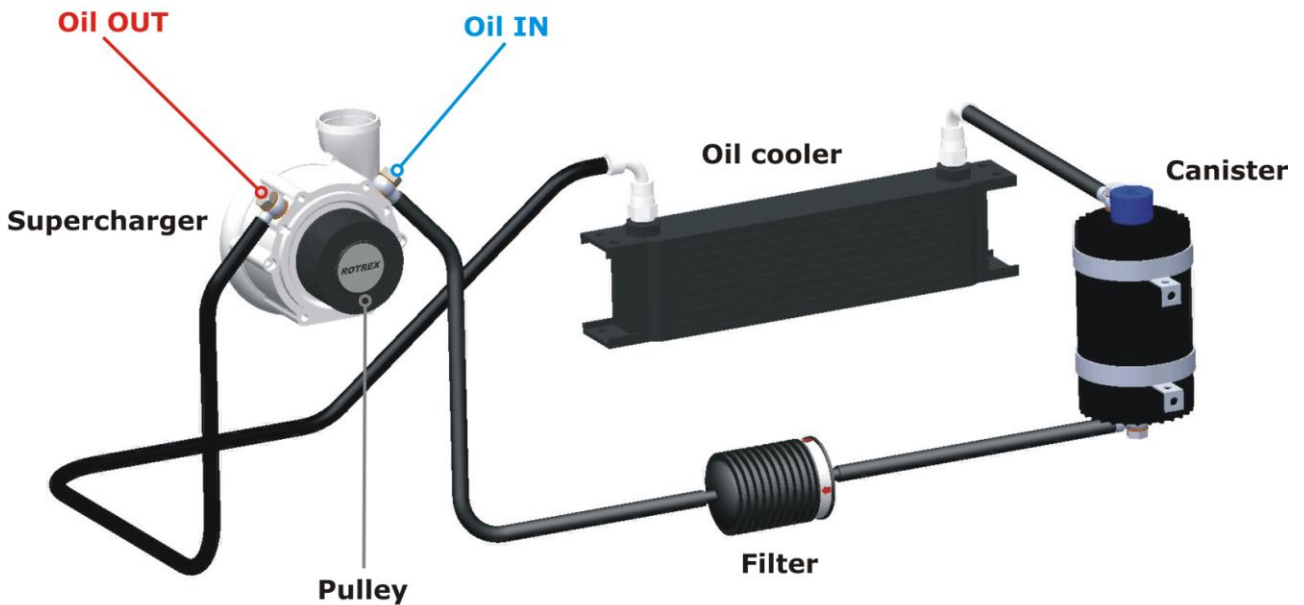


Phases 2 and 3 (in red) are the stages where Rotrex expertise is most important since it is here design feedback can prevent quality and operational issues more effectively. Therefore, Rotrex strongly recommends doing the following:

- A. Choose the Rotrex supercharger that best suits your application (after identifying a business opportunity, evaluating the market potential and the development effort/investment needed). For this purpose you will find useful information in section 3 of this document
 - B. Design the main interfaces (bracket, drive, ducting and lubrication systems). For this purpose you will find useful information in section 4 of this document
 - C. Inform your Rotrex supplier of the outcome of your technical and market analysis. The purpose is to revise key assumptions to provide constructive feedback aimed to prevent quality and operational issues. Section 6.5 of this document contains a form for this purpose
 - D. Create a revised base specification based on the feedback and adjust your initial design accordingly
 - E. Create a project plan (including test/validation program and estimated product launch date) and send a summary copy to your Rotrex supplier in order to coordinate joint efforts and synchronize key events
 - F. Design and implement a proper approval process for the application including testing and documentation verification ensuring product quality. For this purpose you will find useful information in section 5 of this document
 - G. Send regular updates along the process. In case of any doubt or difficulty don't hesitate to contact your distributor or Rotrex
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2. Rotrex technology basics

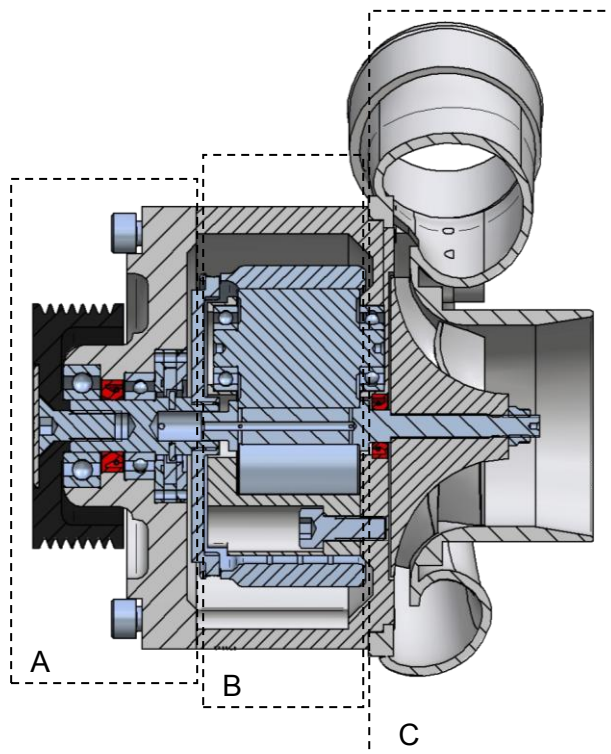
2.1 System overview



The picture above shows a standard Rotrex C-type supercharger system highlighting main components and their location.

- **Supercharger:** Centrifugal air compression through high speed traction drive featuring internal dry sump dual action oil vane pump
- **Oil cooler:** Acting as main cooling element
- **Canister:** Allowing service. De-foaming and venting of oil system. Acting as a secondary oil cooling element
- **Filter:** Protecting traction drive from any particles through cellulose and magnetic filtering
- **Pulley:** Connecting the supercharger to crankshaft via belt

2.2 Supercharger internal structure



As the cross section above shows, the supercharger contains three internal subsystems:

- A. Input & pump:** Connecting the pulley drive to the traction drive and powering the dual action vane pump. The dual action vane pump sucks oil from the canister, pumps it into the traction drive, sucks oil from the unit sump and pumps it back out into the canister through the cooler
- B. Traction drive:** Multiplying input speed powering the centrifugal compressor. The traction drive is covered in detail in the section “traction drive principles”
- C. Centrifugal compressor:** Providing boost through high efficiency turbo-compressor design

These interdependent subsystems work together, supported by the lubrication circuit, in order to deliver optimum performance and reliability.

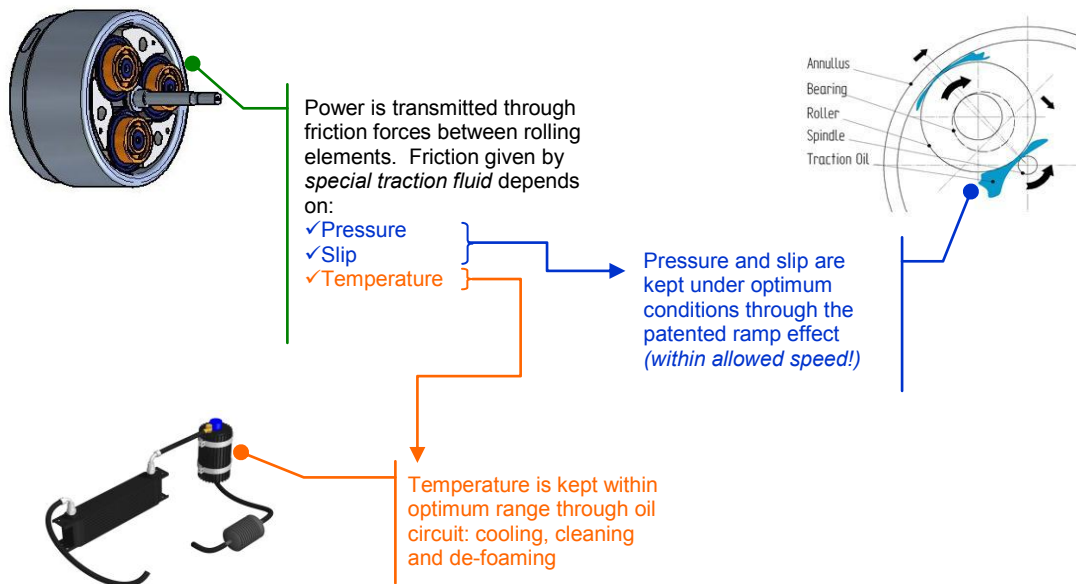
2.3 Traction drive principles and key benefits

A traction drive transmits power through friction forces between rolling elements. High speeds, low noise and high efficiency are just some of the advantages of traction drives over traditional gear transmissions.

The Rotrex patented traction drive uses a steel annulus with a small pre-span to secure contact between the roller planets and the sun shaft with a reasonable force. The ramp or wedge effect increases efficiency and reliability in the transmission by regulating the torque transfer capability on demand through self-adjusting planet geometry. This is a key operational feature since friction is highly dependent on surface pressure, slip and temperature conditions in the traction fluid.

Developed specially for its use in Rotrex superchargers, the special traction fluid momentarily increases viscosity under high surface pressure, enhancing the traction drive performance by securing the optimum friction between rolling elements while cooling and protecting the system.

The diagram below represents the dynamics explained above.



This unique traction drive delivers the following key benefits:

- Speed capability released up to 240.000 RPM (depending on model)
 - ✓ Allowing reliable utilization of highly efficient impellers delivering improved boost conditions
- Great power density (around 20 kW/kg) resulting in unparalleled compactness
 - ✓ Accelerating application development and simplifying installation = lower costs
- Low noise
 - ✓ Improving customer satisfaction
- High efficiency
 - ✓ Causing less heat and requiring less energy

3. Choosing the right Rotrex

3.1 General guidelines

Supercharger comparison table

Model	Input rotation direction	Air inlet hose diameter [mm]	Air outlet hose diameter [mm]	Max impeller speed [rpm]	Max pressure ratio	Max flow [kg/s]	Power range ¹ [engine kW]	Max adiabatic efficiency [%]
C8-6	CCW ²	34	28	240,000	1.97	0.048	20-40kW (27-55hp)	79
C8-8	CW ²	34	28	240,000	2.23	0.065	30-55kW (41-75hp)	74
C8-8	CCW ²	34	28	240,000	2.23	0.065	30-55kW (41-75hp)	74
C15-16	CW ³	60	45	201,500	2.46	0.15	60-125kW (82-170hp)	70
C15-20	CW ³	60	45	180,000	2.94	0.15	50-120kW (68-163hp)	75
C15-60	CW ³	60	45	150,000	2.34	0.22	90-175kW (122-238hp)	74
C30-64	CW ³	60	50	120,000	2.68	0.28	120-235kW (163-320hp)	72
C30-74	CW ³	60	50	120,000	2.82	0.31	135-255kW (184-347hp)	72
C30-84	CW ³	76	50	120,000	2.82	0.32	140-265kW (190-360hp)	72
C30-94	CW ³	76	50	100,000	2.52	0.39	145-320kW (197-435hp)	71
C38-61	CW ³	76	63	90,000	2.90	0.48	200-410kW (272-557hp)	73
C38-71	CW ³	76	63	90,000	2.82	0.55	210-455kW (286-620hp)	75
C38-81	CW ³	76	63	90,000	2.85	0.58	220-485kW (300-660hp)	72
C38-91	CW ³	76	63	90,000	2.94	0.63	260-530kW (354-720hp)	75
C38-92	CW ³	89	63	90,000	2.94	0.63	260-530kW (354-720hp)	75

¹ Power output is dependent on engine type, cooling of charge air, cam profile and timing, compression ratio etc.

² CCW: Counter Clock Wise rotation direction seen from the pulley side

³ CW: Clock Wise rotation direction seen from the pulley side

The amount of air delivered by the supercharger and consequently the boost pressure is determined by the supercharger model and the impeller speed in conjunction with the engine size and speed. The comparison table above shows the working area of each supercharger model within the C-range. For compressor maps please refer to the technical datasheets (see section 5.4). If in doubt please contact your Rotrex supplier.

Regardless of the supercharger type and model, always make sure to run it within its appropriate operating speed range specified in the technical datasheet. Exceeding these speed values will void warranty.

The optimum supercharger for a given application will depend on lots of variables of which many are hard to know accurately (i.e. volumetric efficiency or how this will be affected under boost conditions). This can very well be modelled using advanced engine calculation tools and theory. However, using a simple “rule of thumb” along with the information provided here and in the flowcharts will be adequate in many cases.

3.2 Supercharger selection example: boosting 105hp to 150hp

The following example runs through the process for a given engine in order to provide a more detailed explanation of how to choose the best supercharger fit for a given application. This example is to be seen as a basic guideline, and may vary depending on engine variables.

The key to selecting the right supercharger is to know what air flow and pressure ratio you will be running. With this information you can go through the supercharger compressor maps and choose the right model from there.

Generally speaking a normal gasoline combustion engine will produce about 120hp for every 0.1 kg/s of air (this figure is highly dependent on engine efficiency and may be considerably higher or lower depending on engine variables). By inserting the expected hp figure of the supercharged engine into the formula below, we now get the expected flow.

$$\text{Flow [kg/s]} = \frac{\text{hp}_{\text{supercharged}}}{1200}$$

Since the target power in this example is 150hp, we have the following flow:

The approximate pressure ratio needed to produce this power on the given engine can be approximated from the formula below. The pressure losses through the filter, pressure pipes, intercooler and intake system including the power to drive the supercharger are approximated to about 15%, thus multiplying by 1.15 in the formula.

$$\text{PR} = \frac{\text{hp}_{\text{supercharged}}}{\text{hp}_{\text{naturally aspirated}}} \times 1.15$$

This is true only when the engine runs under low to moderate boost (up to 0.7 bar \cong PR 1.7) and assuming the air entering the engine has been cooled to a temperature no more than 30°C above ambient temperature. Any other restrictions in the system (i.e. restrictive exhaust system, inlet filter, valve size, ducting etc.) will reduce the expected boosted power output.

Entering the values from this example we have the following PR:

After studying the supercharger selection table (above) and flowcharts in the technical datasheets, we can conclude that the C15-60 is a good match with an adiabatic efficiency above 72% at the point of 0.125 kg/s and PR 1.64.

4. Designing and handling interfaces

4.1 Pulleys and other drive types

Rotrex provides 7 and 8 ribbed PK-type pulleys ranging from 70 to 110mm in diameter in steps of 5mm (i.e. 70, 75, 80...). Check the technical datasheets for available pulley sizes for specific superchargers. Rotrex highly recommends using standard Rotrex pulleys. If you for some reason need to use a different design you can order the supercharger with our pulley adaptor. Important: follow the design, manufacturing and handling specifications/instructions stated in Sections 6.1 and 6.2 of this document. This will ensure a proper coupling and a healthy bearing arrangement. *Not following these specifications voids warranty and may result in permanent damage of the supercharger system and/or other systems in the vehicle/application.*

Repeatedly turning the pulley/pulley adaptor on a new unit in the wrong direction (see supercharger selection table, page 9) will result in detachment of the internal thread connection resulting in supercharger damage. Once the unit has run for some minutes in a vehicle this coupling tightens to some degree, however the unit will still be damaged if rotated in the wrong direction.

Never use an impact wrench when assembling or disassembling pulleys. Section 6.3 of this document explains the procedure for assembling and disassembling pulleys.

The supercharger must be delivered with the pulley/pulley adaptor pre-assembled to the installer or end user in order to avoid claims arising from incorrect pulley assembly.

In case of any questions or doubt don't hesitate to contact your distributor or Rotrex.

Use the formula in the box below to calculate the pulley size for a given application.

Pulley size calculation

$$RPM_{impeller} = \frac{RPM_{engine_max} \times PulleyDia_{crank} \times Ratio_{supercharger}}{PulleyDia_{supercharger}}$$

or reorganized for pulley diameter...

$$PulleyDia_{supercharger} = \frac{RPM_{engine_max} \times PulleyDia_{crank} \times Ratio_{supercharger}}{RPM_{impeller}}$$

Note:

C8 drive ratio: 1 : 12.52
 C15 drive ratio: 1 : 12.67
 C30 drive ratio: 1 : 9.49
 C38 drive ratio: 1 : 7.50

Example:

Engine max speed: 7200rpm
 Supercharger: C15-60
 Impeller speed: 142krpm
 Ratio of C15: 12.67:1
 Crank pulley: 123mm

$(7200 \times 12.67 \times 123) / 142000 = 79$
 By rounding up we get the appropriate pulley diameter to be 80mm

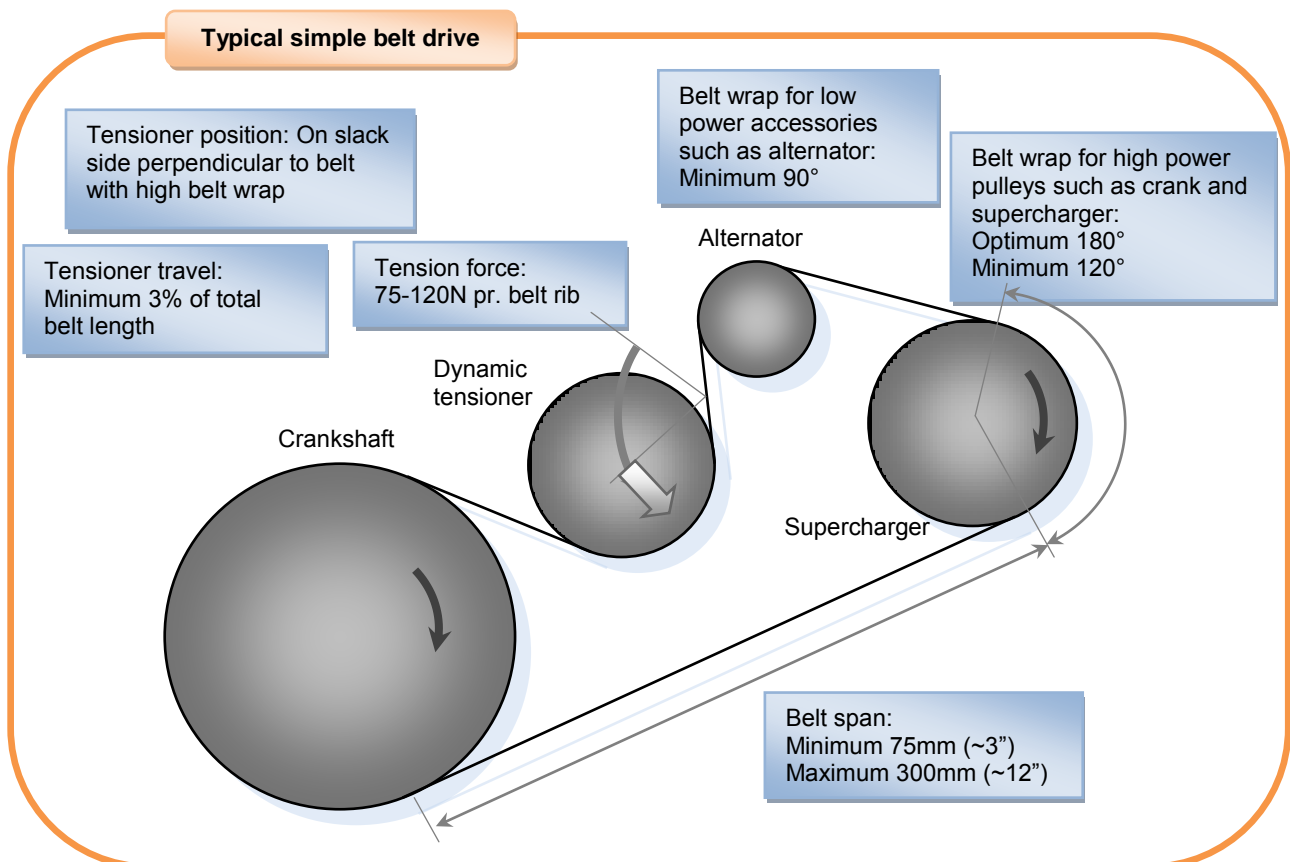
4.2 Belt drives

Due to the apparent simplicity of the belt drive, installers and designers tend to disregard its importance. The single most frequent source of supercharger installation problems can be traced back to the belt drive or design and manufacturing of belt drive components such as brackets, tensioners, pulleys and mounting points. *Paying special attention to the belt drive can improve performance, durability, service life and ease of service significantly.*

To analyze a belt drive properly you should contact a belt manufacturer with detailed information of all the components in the drive and the conditions it will be run under. From this, an estimated lifetime and frequency analysis can be made to give a reasonable evaluation of the durability of the belt drive.

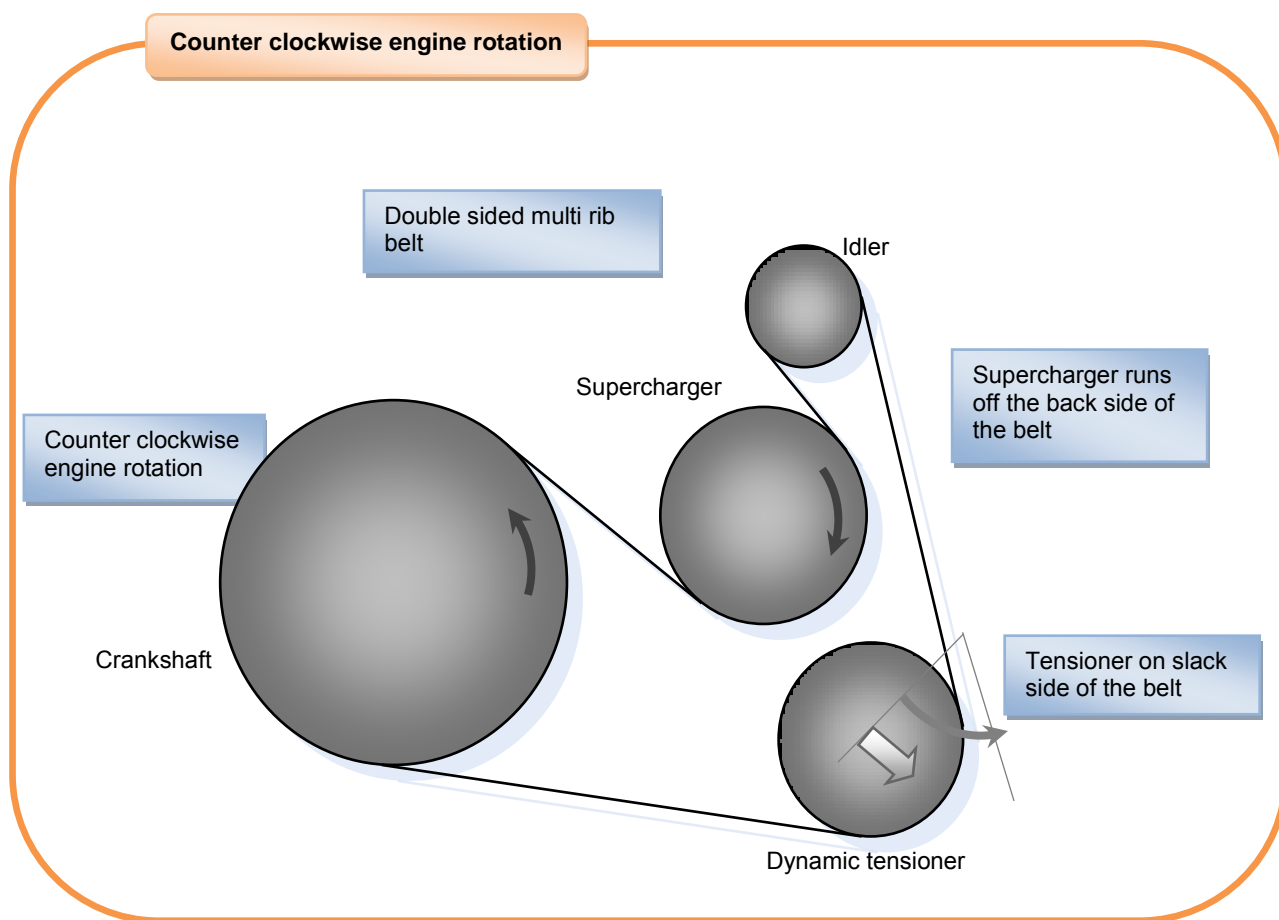
A more simplistic approach can be taken for prototype work. These guidelines are rule of thumb only and must be accompanied by many hours of extensive testing on multiple installations to get a true picture of the rigidity of the belt drive.

It is advisable to run the supercharger from a separate belt and crank pulley. Leaving the vehicle's existing belt drive untouched reduces the risk of wear and failure of the belt and sub components. For twin charger applications we advise to run each supercharger on a separate belt to maximize durability.



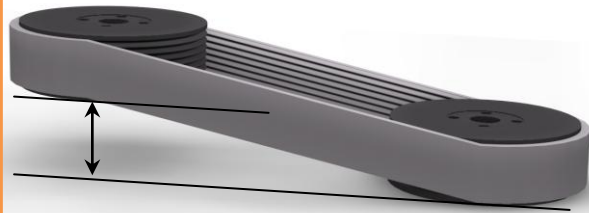
Although quite rare, there are some engines that rotate counter clockwise. When choosing a Rotrex supercharger please ensure correct rotational direction of the input, see section 3.1. By driving the supercharger from the back side of a double sided belt the rotational direction is reversed. This way it is possible to install superchargers to counter clockwise rotational engines.

The same method can be used to install a supercharger in a mirrored position compared to the other front end components so that a clockwise rotating engine drives a supercharger mounted in a mirrored position from the back side of the belt. This inverts the driving direction twice, resulting in a clockwise rotating engine and a clockwise rotating supercharger.

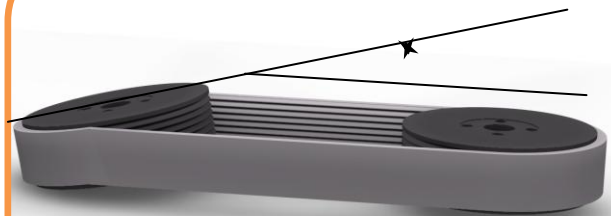


Belt misalignment is a common source of wear and noise problems. Bracket fixing points and tolerances including coatings are a source of belt misalignment issues. The following guidelines will help prevent problems when designing a system.

Parallel misalignment



Angular misalignment



A good rule of thumb to keep in mind is that noise which occurs at idling and low speeds is likely to be due to pulley misalignment. Noise that occurs at high speeds is likely to be due to belt tension problems. To identify or recreate the noise it is important to find the true cause and to cure the problem: Use a spray bottle filled with water to mist the belt lightly. If the noise level recedes for several seconds, then returns louder, a misalignment problem is likely. If the noise immediately increases after the belt is sprayed, slip is likely. Besides noise, belt dust and burnt rubber smell are other typical signs of misalignment, wrong belt tension or other problems in the drive.

In order to avoid bearing problems with the supercharger or any other front end accessory it is imperative that the belt runs within the specified design window. A maximum allowed belt force overhang is defined as; the middle of the belt must run at a maximum of 23mm from the supercharger bracket face. See section 6.1 for a specification of the belt overhang limitations.

Correct belt placement



Wrong belt placement



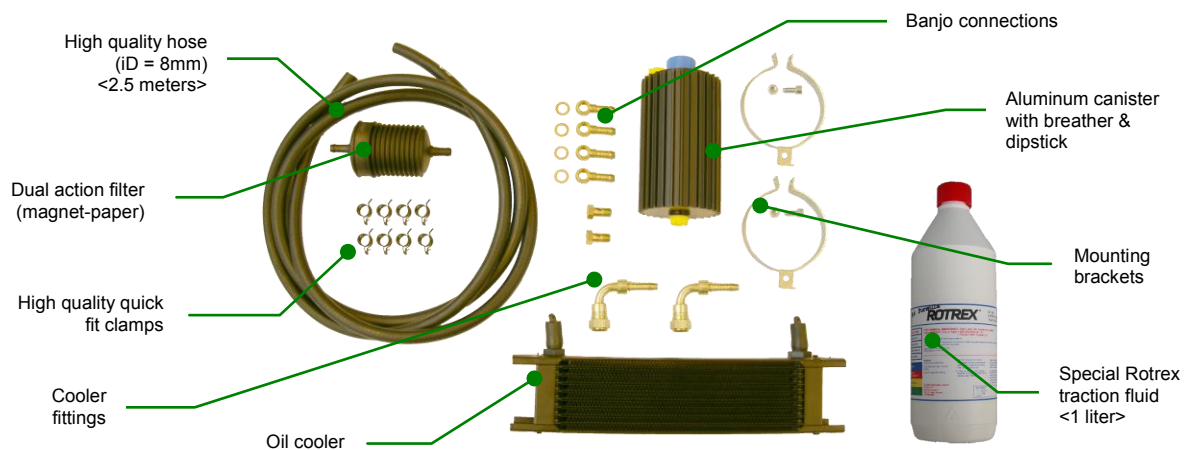
4.3 Brackets

Section 6.4 of this document provides the critical dimensions needed for the construction of the main bracket. Following these specifications is important to ensuring adequate fixation of the supercharger and pulley/belt at running conditions. In addition, the following guidelines are also important:

- Choose geometry and material that ensures optimum alignment, stability and durability
- Include a minimum of 3 strong fixing points to help preventing excessive vibration and bending during operation. Remember to avoid materials that will corrode when mounted onto aluminum
- Take into account possible manufacturing tolerances on anchoring points to engine and avoid rough cast surfaces since this can result in considerable belt misalignments that can cause belt slippage, noise and even failure
- Include surface treatment to prevent corrosion and improve looks. Remember that some surface treatments build a considerable layer on top of the material and this should be accounted for in order to remain inside the specified dimensional tolerance band

4.4 Lubrication circuit

The special Rotrex oil system is an integral part of the design and function of the Rotrex C-type supercharger. These superchargers have been developed and extensively tested with special Rotrex traction fluid. To maintain the ultimate level of performance and durability *it is very important that the unit is run exclusively with Special Rotrex traction fluid.*



The picture shows the Rotrex universal oil set. It contains everything needed (hoses, fittings, filter, cooler and canister) for your application development and commercialization. We strongly recommend using these oil sets as they have gone through extensive testing before approval. Consult your distributor or Rotrex if you need to modify the standard oil set in any way (even if the change seems trivial). *Any deviation from the universal oil set and its standard setup needs to be approved by Rotrex in writing for the supercharger to be covered by warranty.*

4.4.1 Designing a good lubrication circuit

The lubrication circuit path chosen within the engine bay needs to *ensure that oil temperature at the inlet of the supercharger never exceeds 80°C (176°F) as higher inlet oil temperature will damage the supercharger*. Therefore, it is recommendable to locate the cooling elements (main cooler and canister) in well ventilated areas. The oil cooler alone should be able to cool the oil sufficiently.

The supercharger must be positioned above the canister and oil cooler in order to prevent any potential oil leakage from the supercharger. Remember that the canister needs to be accessible for service and maintenance purposes.

When routing the oil supply and return lines, care must be taken to prevent cracks and cuts on the oil lines since leakage could result in permanent damage of supercharger system and/or other systems in the vehicle. To avoid problems, follow these specifications:


- The supercharger must be positioned above the canister and oil cooler in order to prevent any potential oil leakage from the supercharger
- Oil lines must be routed in safe distance from the exhaust system or other hot parts to prevent excessive heating of the oil and wear of the oil hoses
- Make sure there is clearance to other moving parts such as the ventilator fan, belts and pulleys
- When creating the oil circuit, use only Rotrex standard oil hoses
- Always use special hose scissor or a sharp knife when cutting the oil hoses to prevent damage of the hoses during mounting. If a hose is damaged during assembly, it must be replaced
- To prevent restricted oil flow only use large radius bends and make sure there are no kinks in the oil line routing
- Engine vibration and movement must be taken into account when routing the oil lines
- It is important to place the oil cooler where external clogging (debris, stones, sand etc.) can be prevented. If the cooler is clogged it loses function and will potentially overheat the supercharger which will lead to failure
- During assembly it is important to prevent debris and other contamination entering the oil system
- Maximum oil system length (including the oil cooler and canister) is 6.0 m
- Maximum allowable elevation between oil system components is 1.0 m

Failure to comply with these specifications can compromise the overall reliability and may result in permanent damage of the supercharger and/or other systems in the application. If the application requires customized oil routing (not using the parts included in the Rotrex package seen in this section 4.4), please contact your Rotrex supplier.

4.4.2 Installation, startup and maintenance


Please follow these recommendations when installing the oil circuit:

1




Place the oil canister with the cap **below** or **level** with the supercharger's shaft. Use the bracket supplied in the oil set. Make sure the canister is placed upright. Leave the plastic plugs in place to prevent debris from entering the system.

2




Mount the oil cooler in front of other coolers in a location with good air flow. Place the oil cooler **below** or **level** with the supercharger's shaft. The threads for the fittings must be facing upwards to prevent air pockets.

3



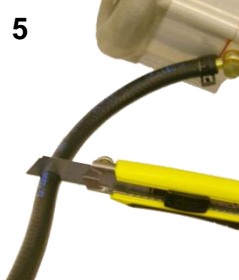
With a pair of pliers compress a hose clamp and slide it over one end of the hose. Press a banjo fitting into the hose end and secure it with the hose clamp.

4




With the supercharger properly in place fit one end of the hose to the oil inlet using the banjo fitting and banjo bolt. Make sure to use a copper washer on each side of the banjo fitting to prevent leaks.

5



Now find a suitable place for the oil filter somewhere along the oil inlet hose. Cut the hose using a sharp knife. Again slide a hose clamp over each end of the hose.

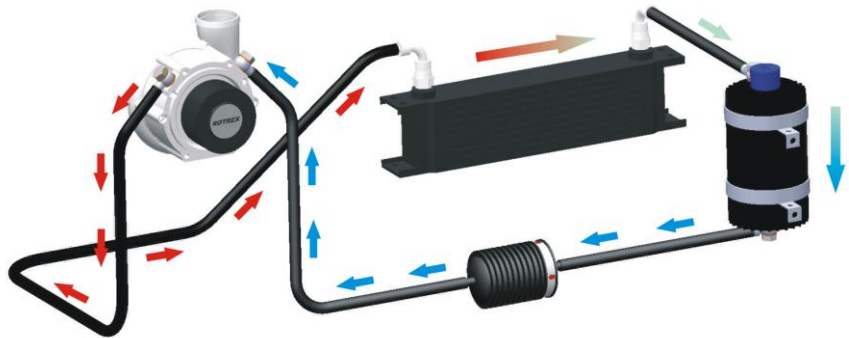
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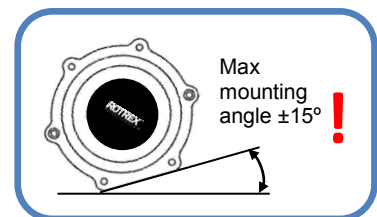
Now press the filter studs into the hose ends as shown and secure with hose clamps. Observe the flow direction of the filter! Following the same method, continue fitting the remaining parts of the oil system.

The picture on the right shows the finished oil circuit (figure illustrates clockwise rotation).

The arrows indicate the flow direction; oil flowing from the canister through the filter into the compressor oil inlet and outlet flowing through the cooler before entering the oil canister at the top.



In order to ensure that the internal dual action oil pump works properly, the flat surface of the supercharger must be installed facing downwards and horizontal within $\pm 15^\circ$. Mounting the supercharger outside this tolerance will prevent the scavenge side of the pump to work properly and jeopardizes the traction drive. *Not following this specification voids warranty and may result in permanent damage of the supercharger system and/or other systems in the vehicle.*

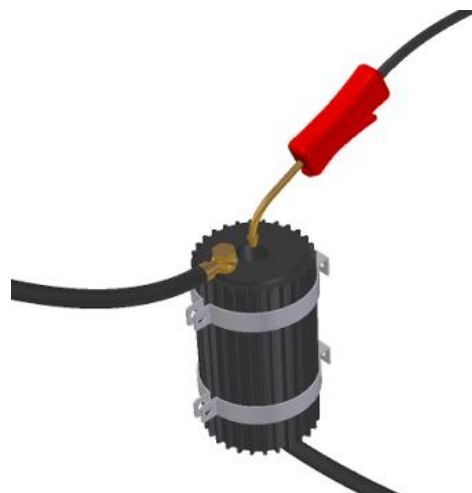


To ensure proper oil circulation and adequate lubrication, it is important to prime the oil system before the engine is started for the first time after the supercharger installation.

The priming process is done the easiest with all oil components in place and installed.

Please carefully follow this priming procedure:

1. Carefully fill the oil canister with traction fluid without exceeding the maximum mark on the dip stick. Make sure the thread of the dip stick cap is fully engaged when taking the oil level measurement
2. Loosen the banjo bolt at the oil line attached to the supercharger inlet marked "oil inlet" a couple of turns allowing air to escape the system
3. **Carefully** apply pressurized air to the oil filler hole of the canister. Do **not** pressurize the system to more than one bar or 15psi. Use a rag or a sponge as a seal between the air gun and the canister

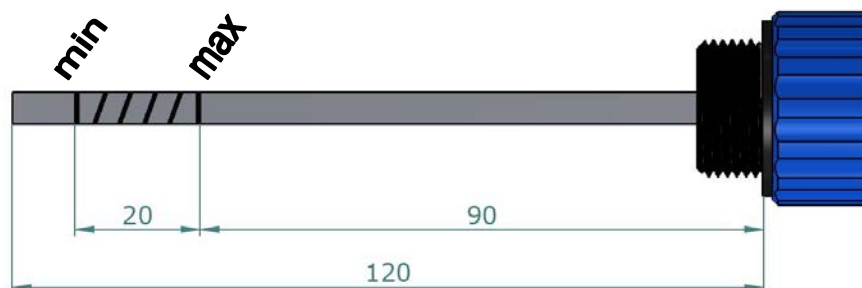


4. When oil appears at the “oil inlet”, tighten the banjo bolt and the system is primed
5. Carefully top up the oil canister to the maximum mark on the dip stick
6. Turn on the engine and rev it to 2-3000 rpm and make sure the oil starts flowing by visual inspection, looking into the oil canister. *Do not rev the engine more than specified, as this can cause damage to the supercharger.* Oil flow is established when the oil level decreases immediately after startup. Immediately after starting the engine (within 5 seconds) top up traction fluid before the oil level reaches the bottom of the canister. Top up oil to between the min and the max indicators on the dipstick. Note that this is the correct and only way to check the oil level (checking the oil level with the system turned off does not give a correct reading).
Remember to check the oil level with the cap thread fully engaged and be careful not to exceed the maximum marking on the dipstick
7. Let the engine idle for 5 minutes while checking the oil system for leaks
8. Check the oil level again using the correct procedure described below
9. A run-in period of 100 km (65 miles) is highly recommended. During this run-in period, drive the vehicle moderately and avoid unnecessary revving or heavy acceleration

Warning: Not following the priming and startup procedures will cause damage to the supercharger and the oil system!

To check the oil level, first rev the engine to 2000-3000 rpm, and then check the oil level. The correct oil level is between the min and max indicators on the dipstick measured with the thread of the cap fully engaged. *Measuring oil level in any other way will not give a true reading of the oil volume in the system and can lead to overfilling or starvation and consequent damage, foaming or leaks.*

Rotrex has introduced a new improved dipstick (shown below) designed to lowering the oil level in the canister. This will reduce the risk of oil overflow. The only difference between the new and the old design is the markings on the dipstick. If you are using the old style dipstick you should use the new dipstick markings when measuring the oil level, please find these measurements below:



The recommended maintenance procedure and frequency is to *change oil and filter every 80,000 km (50,000 miles) or two years, whichever comes first. Please see below procedure for correct oil and filter replacement:*

1. To avoid traction fluid spilling into the engine compartment, use a hose clamp pliers to clamp the oil hose as close to the oil filter as possible on the oil canister side (filter inlet).
2. Slide away the two hose clamps on the oil filter and remove the oil filter. Keep in mind that the oil filter still contains some traction fluid, thereby making sure excessive oil spill is avoided
3. Mount the new oil filter – make sure to mount the filter into the correct direction, please note the arrows on the filter indicating the correct oil flow direction. Slide the two oil hose clamps back to correct position.
4. Remove the hose clamp pliers prior to continue with the oil change.
5. Clean all the oil hose connections on the oil canister to prevent from any debris or dirt that subsequently might be entering the oil circuit.
6. Remove the top banjo bolt and sealing washers and plug the oil hose into a temporary open oil reservoir or can (minimum capacity 1 liter).
7. Remove the canister cap.
8. Start up the engine and let it idle while Rotrex traction fluid is continually added to the canister. All the time observe the canister thus making sure it never gets drained. Continue to pour in Rotrex traction fluid until approximately 800 ml has been added and then stop the engine. Keep an eye on the temporary oil reservoir where the residual old oil will drain into.
9. Remount the canister's oil inlet hose, remember to replace the copper washers with new ones.
10. Top up the canister according to chapter 4.4.2 on page 19 in this document.

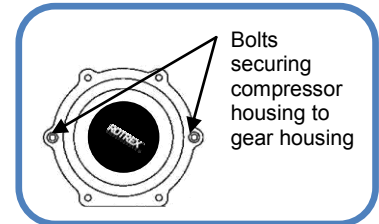
Please note: the above procedure is a general Rotrex procedure that may not apply to your specific installation. Contact your Rotrex supplier for more detailed information about your installation.

4.5 Air ducting

4.5.1 Compressor house adjustment

Rotrex can deliver superchargers with 6 different air outlet positions following your order specifications. It is possible to change the preset outlet direction carefully applying the following procedure:

- A. First identify the desired outlet direction of the compressor housing respecting the $\pm 15^\circ$ to horizontal specified in section 4.4.2
- B. Loosen the two large counter bore bolts securing the compressor housing to the gear housing. Do this carefully and only a couple of turns on each screw at a time – making sure the compressor housing does not come off at an angle damaging the impeller
- C. With the bolts completely removed, the compressor housing can be rotated by hand while still on the gear housing. Again pay attention not to damage the impeller during this operation
- D. With the compressor outlet at the desired location fit the two bolts and tighten to the torque stated in the respective datasheet. Tightening of the two large counter bore bolts must be done carefully, turning each bolt a couple of turns – making sure the compressor housing does not mount with at an angle damaging the impeller



Not following this procedure may result in impeller unbalance and ultimately cause permanent damage of supercharger system and/or other systems in the vehicle.

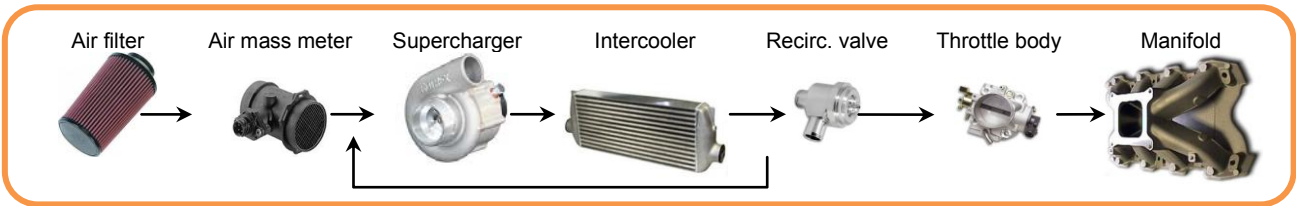
The supercharger should be delivered to the end user or installer with a pre-set outlet direction. In order to support this, every Rotrex unit includes a warning label as shown to the right.

In case of any question or doubt don't hesitate to contact your Rotrex supplier.



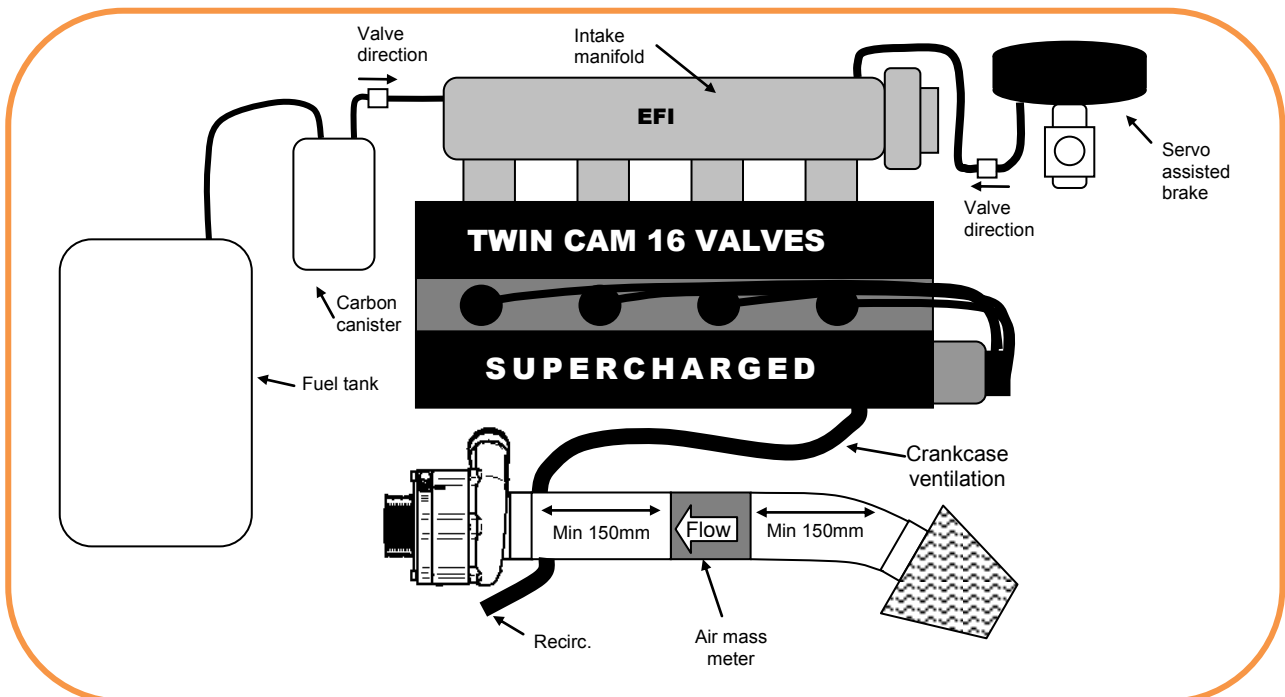
4.5.2 Ducting

Proper attention to air ducting is core to a healthy forced induction system. This section should help in the understanding of the main aspects involved when designing a ducting system for the supercharger installation.



A re-circulation valve is optional, but recommended in most applications to prevent surge under deceleration. It is critical to use an appropriate size for the specific installation and install it correctly. Surge can occur when the supercharger increases pressure ratio at low air flow (left border of the flow map, see technical datasheets). Under surge, air flow through the compressor can no longer be maintained and momentary backflow occurs resulting in a characteristic chirping sound. Surge can be caused by a blocked inlet air stream, such as a throttle valve or a clogged air filter. **Continuous operation in surge will cause damage to the supercharger.** To prevent surge, it is necessary to relieve the system from excessive pressure through recirculation or blow-off. A re-circulation valve will prevent surge by allowing air to circulate from outlet to inlet of the supercharger under vacuum conditions.

The crankcase ventilation system (Positive Crank Ventilation PCV) is to be connected to the inlet of the supercharger to prevent pressurizing the crankcase. If the vehicle is equipped with an air mass meter (AMM), the crankcase ventilation must be connected downstream of the AMM to prevent oil vapours from corrupting the signal of the AMM.



It is recommended to have at least 150mm unrestricted flow before and after the air mass meter to avoid problems with the readings caused by turbulent flow from recirculation valves and other ducting that may cause turbulent air flow.

Check if other systems such as carbon canister and EGR need to be adjusted in order to work properly under boost.

It is imperative that there is an air filter on the inlet of the supercharger. If this is neglected, there is a risk of damage to the supercharger from objects being sucked into the inlet and damaging the host. *Not using an air filter which can remove particles larger than 20 microns voids warranty.* An open filter arrangement, such as K&N cone filters, will in some cases give induction noise from the impeller. To prevent induction noises use a closed filter box as seen on most OE applications.

It is important to position the throttle body downstream (after the supercharger) to avoid excessive vacuum, potentially collapsing hoses and damaging the supercharger. *Positioning the throttle body upstream (before the supercharger) voids warranty.*

To maintain air cleanliness, it is important to position the air filter where external clogging can be prevented. The air filter should be mounted where it cannot be covered or sprayed with water or mud. Also, if the air filter gets clogged, the air flow is restricted and will cause a pressure drop, resulting in temporary loss of pressure and air flow. The filter used for the application must be able to last the oil-maintenance interval found in section 4.4.2.

Do not make unnecessary sharp bends on the air ducting as bends will cause pressure drop resulting in loss of output. *Using a minimum of bends on the inlet and outlet hoses will significantly increase the adiabatic efficiency of the supercharger and increase the success rate for reaching the desired point of operation.* Also, some applications require various sensors which could potentially interfere with the air flow and decrease the adiabatic efficiency.

All air ducting on the inlet side of the supercharger must be of a material that does not collapse and restrict the airflow under vacuum. A Partially blocked air filter will result in significant vacuum which can cause surge or easily collapse a soft hose. Rotrex urges the customer to use a minimum of soft materials for the entire air ducting.

Rotrex also recommends hose diameters for both inlet and outlet to match the supercharger compressor housings inlet and outlet diameters. For specific diameters see section 3.1. If the inlet ducting, disregarding our recommendations, requires many bends, sensors or narrow pipe diameters, extensive application testing is required.

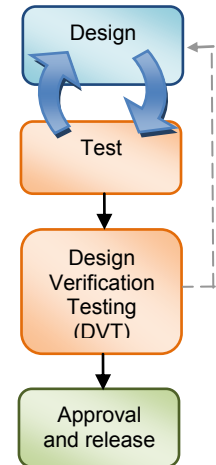
Hoses, pipes, filters, valves etc. must be fastened with proper clamps to prevent air leakages in the system. To ensure correct tightening torque, use the recommended specifications delivered by the clamp manufacturer. Also, Rotrex recommends contacting the clamp manufacturer to help choose the optimal clamps for the application.

5. Important notes and info sources

5.1 Testing and verification

Once the application design process has come to the prototype phase it is necessary to test it thoroughly before launching it in order to verify the system is working as expected and to rectify unforeseen issues. As the diagram to the right indicates, it is important to separate iterative development testing and verification testing. Iterative development testing is all the “trial and error” testing done during the design process and verification testing is the test program designed to verify that the final design complies with minimum performance and reliability target levels.

The intensity and strictness of the testing and verification process will depend on a wide variety of factors (i.e. experience, system complexity, cost-benefit criteria, resource constraints, etc.) and therefore the best advice here is to apply common sense and follow a conservative approach. Shortcuts never pay.



Rotrex recommends taking the following steps during the testing phase:

- A. Verify proper oil conditions: the exact amount of oil needed depends on the components of the oil circuit chosen. Determine the appropriate oil amount needed for the application during the testing phase. Remember to use the correct oil level check procedure described in section 4.4.2 of this document. Adjust oil accordingly and document the amount needed since this information will be very important to include in your application documentation (refer to section 5.2). Once oil flow and level are verified, it is necessary to check that the oil remains below the maximum temperature during harsh climate and operating conditions. Dedicated desert/hot climate testing is highly recommended. Rotrex recommends installing a monitoring/logging system of the oil canister temperature during all testing, placing the sensor as far down in the canister as possible. The temperature values measured must not exceed 80°C (176°F) under any condition
- B. Verify vehicle performance: check that the vehicle performs as desired on the dyno and in the field and double-check that the supercharger is running within the allowed speed range. Keep a close eye on electronic control performance over time and under different variables such as fuel grades and altitude. Rotrex recommends building a monitoring/logging system into the test vehicles to make sure the most important parameters are well within acceptable values. To ensure performance uniformity, perform tests under the most typical configuration variations (i.e. common modifications such as air filters, exhaust system changes etc.)
- C. Belt routing and tension: despite all efforts to get a good routing during the design phase you may need to make adjustments. A proper belt drive is very important to prevent issues such as boost loss due to belt slippage, short belt drive life and noise. During the test phase mentioned above you can check for evidence of misalignment or wrong tension by listening, smelling and watching the supercharger operate at different points. Burned rubber smell, belt “dust”, belt oscillation and unstable boost are typical signs of a problem. Excessive belt tension and misalignment can eventually cause a failure in the belt and/or supercharger pulley
- D. Installation, safety and maintenance: it is important to check that your application is “user friendly” and safe to use, both for the installer and for the final user. Remember to document installation procedures since every step should be included in your application documentation (refer to section 5.2)

As mentioned in section 2, the iterative process will be shorter and more effective if you involve your Rotrex supplier as early as possible. The feedback provided and the guidelines given in the previous sections will help you deal with eventual difficulties.

At some point during the iteration process you will find a design you are satisfied with. Only then should you begin the Design Verification Testing phase (DVT). The DVT is a program designed to prove that the final design fulfills minimum quality requirements. *Rotrex recommends running the final application on more than one vehicle for a minimum of 25000 km (15000 miles) per vehicle under harsh driving conditions (city and highway) monitoring vehicle performance, traction fluid conditions (mainly temperatures and level) and belt drive conditions constantly and thoroughly – as well as other engine parameters affected by supercharging.* Perform dyno tests to monitor performance variations across vehicles and environments during the DVT phase. If a problem is identified during this phase you should go back to the design phase and take corrective actions. Again, follow a conservative approach and common sense... shortcuts never pay and can harm profitability and reputation severely.

5.2 Installer and end user documentation

A good application contains clear thorough instructions to ensure installers and end users know how to handle, install and maintain the system properly. This documentation is an important instrument to increase customer satisfaction, reduce claims and avoid negligent use or intentional system abuse.

In every Rotrex supercharger, a supercharger setup and maintenance instructions leaflet is included (a copy can be downloaded from www.rotrex.com). This leaflet is intended to guide installers and end users on the main requirements and considerations needed to ensure the integrity of the supercharger. However, *the responsibility to provide clear and thorough documentation and information about your application is in your hands* since Rotrex cannot control the design, manufacture and distribution of your application. Consider the supercharger setup and maintenance leaflet only as a small complement to your documentation and information package.

5.3 Claim handling

Section 6.6 of this document contains a sample of the Rotrex standard customer claim form. If you have a problem with a Rotrex supercharger fill out this form and send it to the company who sold you the Rotrex supercharger. Please try to include as many details as possible since this information will be the key to determining the cause of the problem and to the effective implementation of any needed corrective action. Important notes on claim handling:

- Contact the company who sold you the Rotrex supercharger to ask what to do next
 - If asked to return the claimed unit then always return it with the entire pulley system attached at the time of failure (pulley, pulley ring, sprocket or jackshaft)
 - Always make sure the entire oil system is replaced before installing a new supercharger
-

5.4 Important information sources

Rotrex website - www.rotrex.com - provides up to date information about the latest installations within the official distributor network and other interesting news. You will also find the latest technical information such as technical datasheets and the setup and maintenance instructions leaflet.

6. Support material

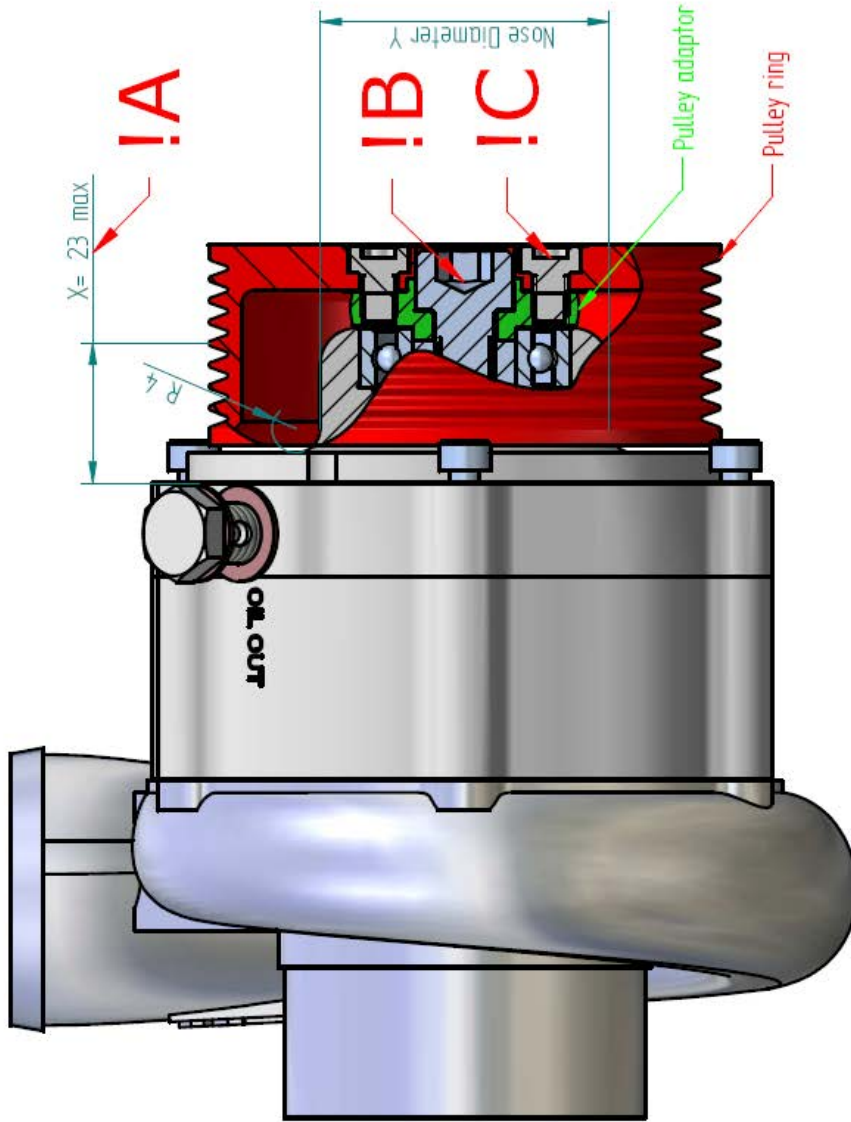
6.1 Pulley ring design guide

C-range Pulley ring design guide

Design requirements

Not meeting these demands will void warranty and may cause significant damage to the S/C

- **!A** Center of belt must be placed as close as possible to S/C and the distance X should never be more than 23mm.
- **!B** Do not unmount or engage center bolt
- **!C** Only use pulley ring bolts as specified
- Pulley ring bolts 6 pcs: M6x8
Cylinder head torx ISO 14580 grade 8.8
- Pulley ring bolt tightening torque 10 Nm
- Nose diameter Y:
C15 = 048mm
C30 = 053mm
C38 = 060mm
- Pulley ring should be made from quality steel or aluminum
- Use surface treatment that does not significantly reduce friction coefficient
- Contact surfaces on pulley ring and pulley adaptor must be clean when mounting.
- Secure pulley while mounting.
Do NOT use the center bolt (B)
- Always consult Rotrex before making your own pulley ring



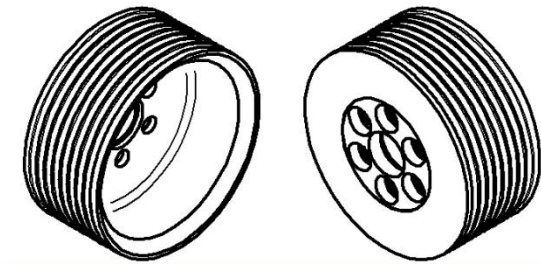
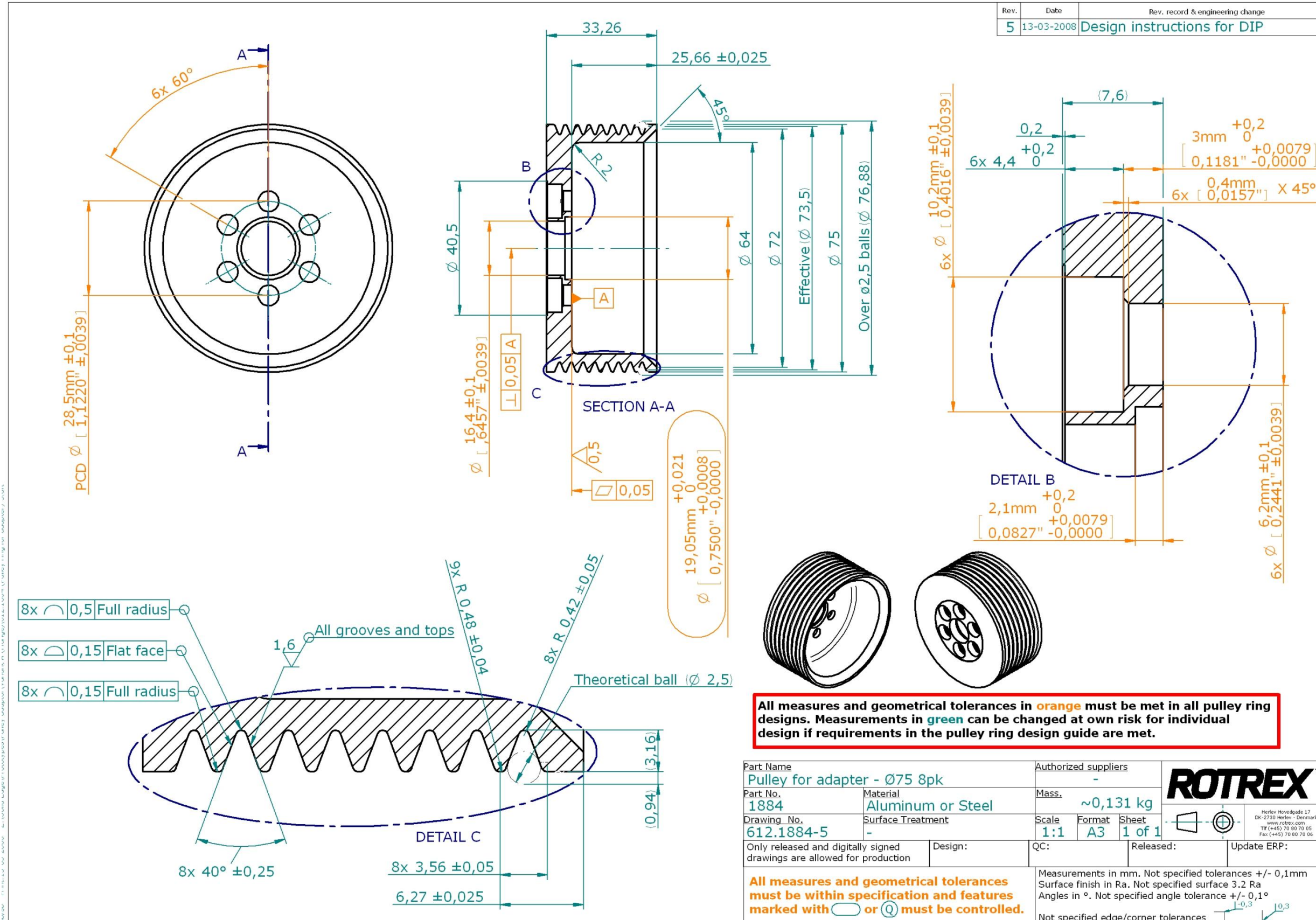
ROTRIX™

Rotrex Hovedkøle 17
DK-2750 Høje Tåstrup, Denmark
Tel.: (+45) 70 80 70 05
Telex: (+45) 70 80 70 08

Measurements in mm
Surface finish in Ra

6.2 Pulley ring drawing

Rev.	Date	Rev. record & engineering change
5	13-03-2008	Design instructions for DIP




All measures and geometrical tolerances in orange must be met in all pulley ring designs. Measurements in green can be changed at own risk for individual design if requirements in the pulley ring design guide are met.

Part Name Pulley for adapter - $\varnothing 75$ 8pk		Authorized suppliers -		ROTREX™ Herlev Hovedgade 17 DK-2730 Herlev - Denmark www.rotrex.com Tel (+45) 70 80 70 05 Fax (+45) 70 80 70 06
Part No. 1884	Material Aluminum or Steel	Mass. ~0,131 kg		
Drawing No. 612.1884-5	Surface Treatment -	Scale 1:1	Format A3	Sheet 1 of 1
Only released and digitally signed drawings are allowed for production		Design:	QC:	Released: Update ERP:
All measures and geometrical tolerances must be within specification and features marked with $\sqrt{\quad}$ or \varnothing must be controlled.		Measurements in mm. Not specified tolerances $\pm 0,1\text{mm}$ Surface finish in Ra. Not specified surface 3.2 Ra Angles in $^\circ$. Not specified angle tolerance $\pm 0,1^\circ$ Not specified edge/corner tolerances $\sqrt{0,3}$ $\sqrt{0,3}$		

6.3 Pulley disassembly procedure

6.3.1 Steel pulleys

Unmounting Steel pulley with counterbore screw



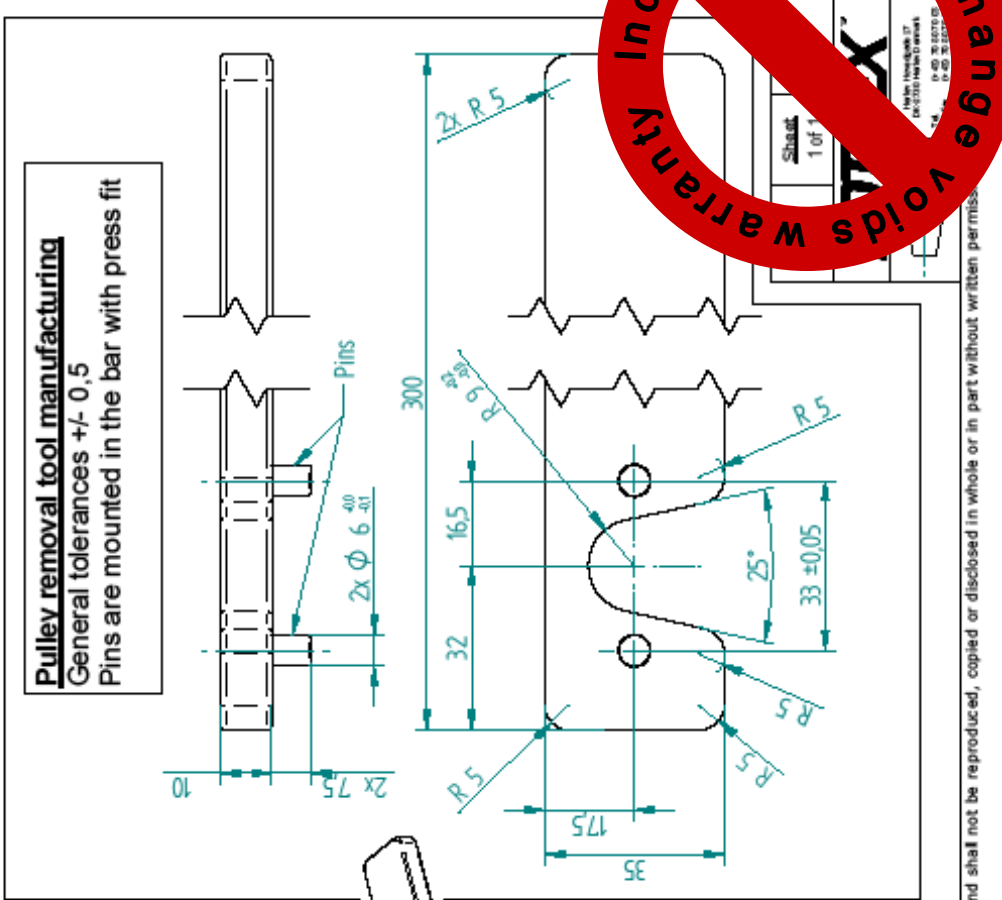
Pulley removal tool manufacturing
 General tolerances +/- 0,5
 Pins are mounted in the bar with press fit

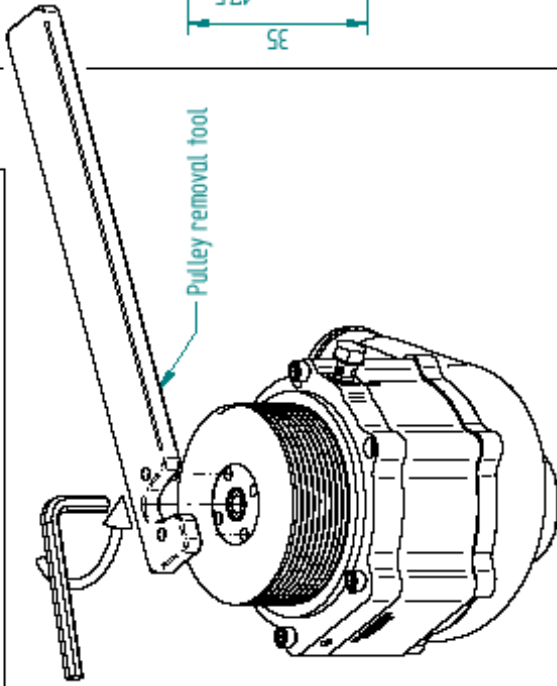
Disassembly process

1. Place S/C with pulley up
2. Remove sticker
3. Secure pulley with Pulley Removal Tool
4. Unscrew pulley bolt with 8mm hexagon key (DIN912 - M10x20 - Grade 12,9 - Dacromet)

Mounting process

5. Lubricate drive shaft thread before mounting.
6. Contact surfaces on pulley and S/C must be clean when mounting.
7. Secure pulley with Pulley Removal Tool
8. Pulley bolt tightening torque 70Nm





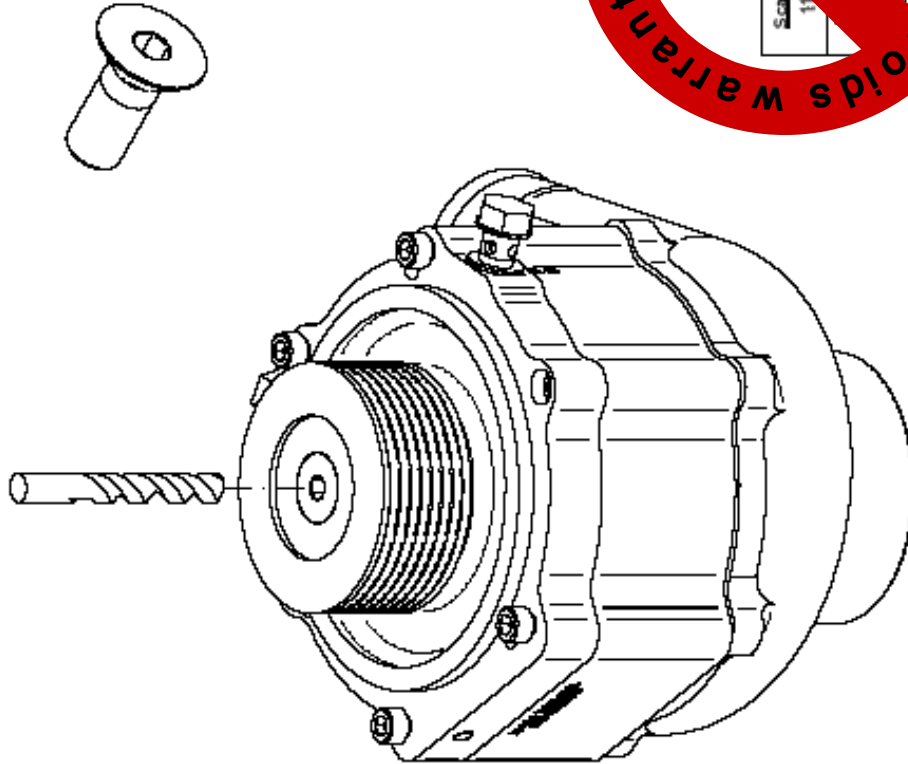
Pulley removal tool

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6.3.2 Aluminum pulleys

Unmounting Aluminium pulley with countersunk screw
Aluminium pulley is only for C15

- Disassembly process**
1. Make sure to cover all oil and air holes in S/C
 2. Place S/C with pulley up
 3. Remove sticker
 4. Secure pulley with hand
 5. Drill a hole in the top of the screw with a 9,5mm drill, until the head comes off
 6. This will not ruin the pulley
- Mounting process**
7. Replace with new
DIN 7991 M10x1.5 x25, grade 10.9
 8. Lubricate drive shaft thread before mounting.
 9. Contact surfaces on pulley and S/C must be clean when mounting.
 10. Pulley bolt tightening torque 50Nm



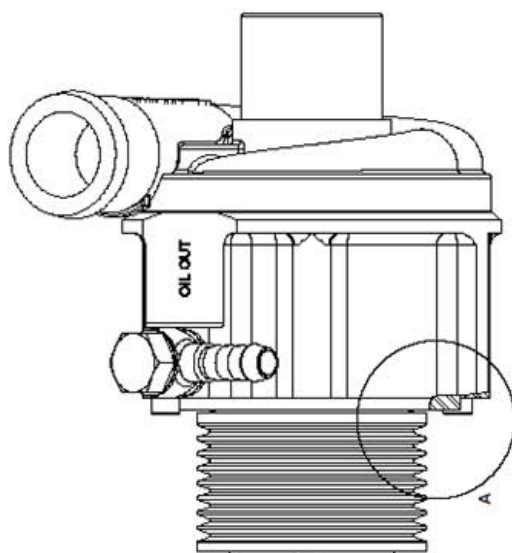
Incorrect pulley change voids warranty

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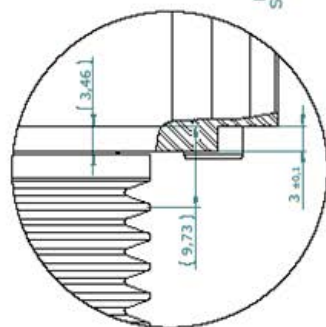
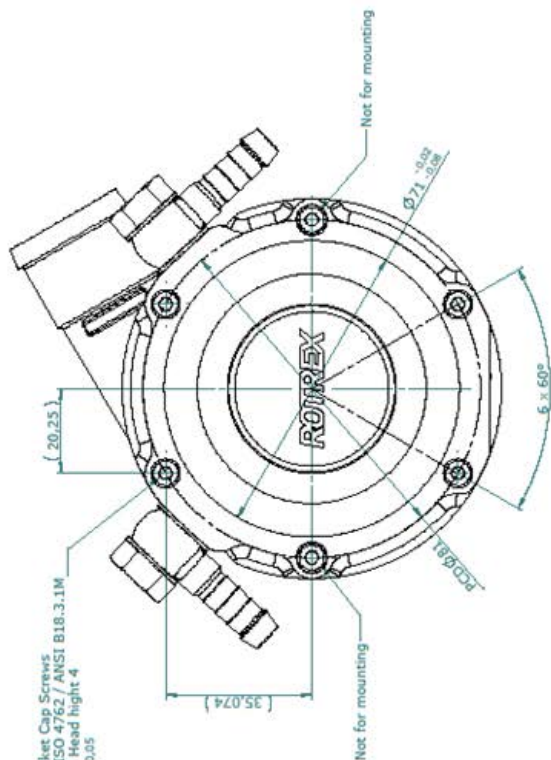
6.4 Bracket design guide

6.4.1 Bracket design guide for C8

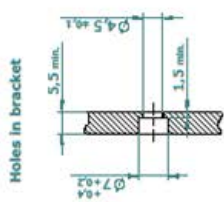
Rotrex C8 Bracket Design Guide



4 x M4 Socket Cap Screws
DIN 912 / ISO 4762 / ANSI B18.3.1M
Head $\varnothing 7$ / Head height 4
PCD $\varnothing 81.5 \pm 0.05$



DETAIL A
SCALE 2 : 1



Holes in bracket

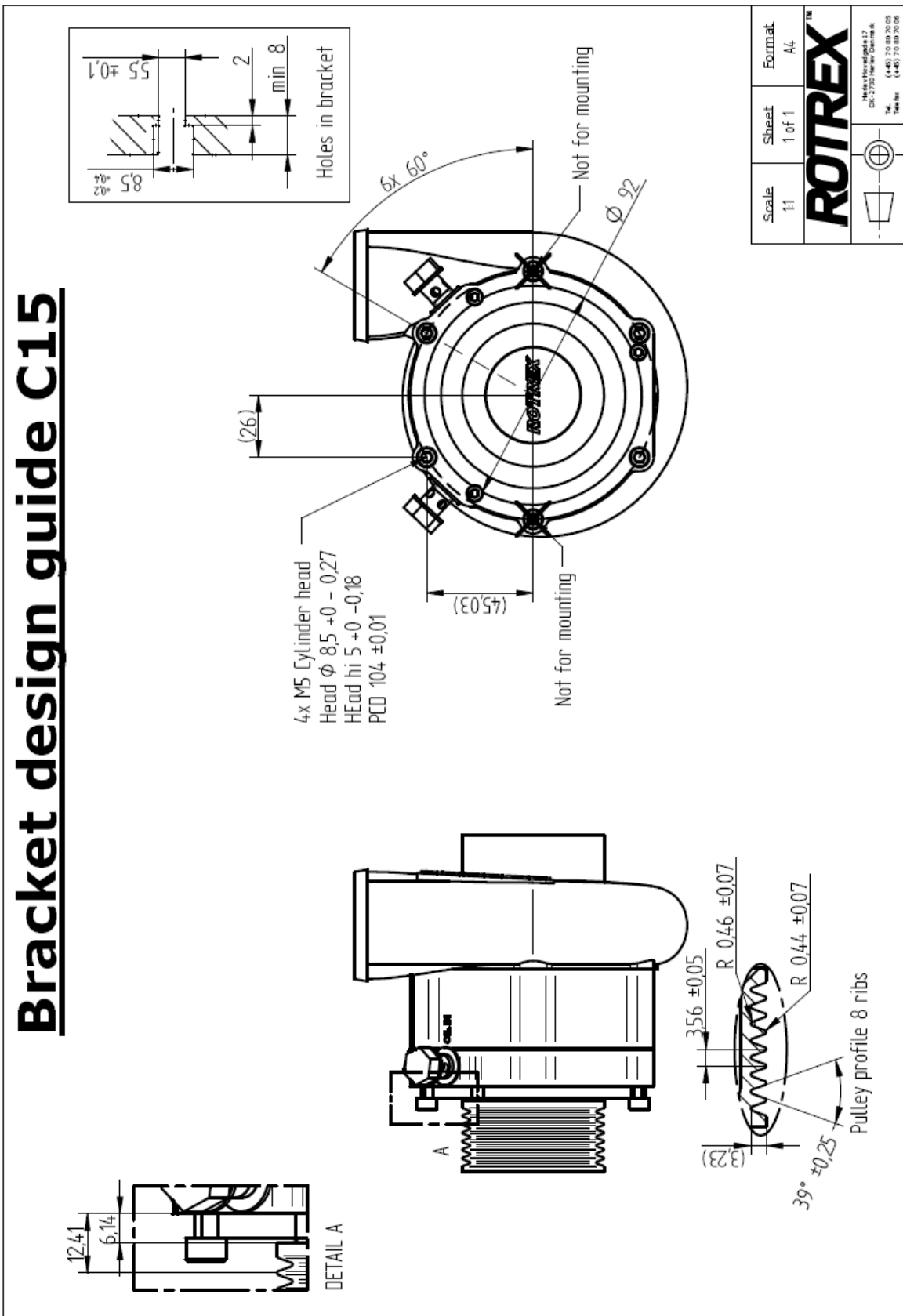
Recommended bracket material:
first choice - carbon steel
second choice - high grade aluminum alloy

Scale	Sheet	Format
1:1	1 of 1	A3
ROTRIX™		

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6.4.2 Bracket design guide for C15

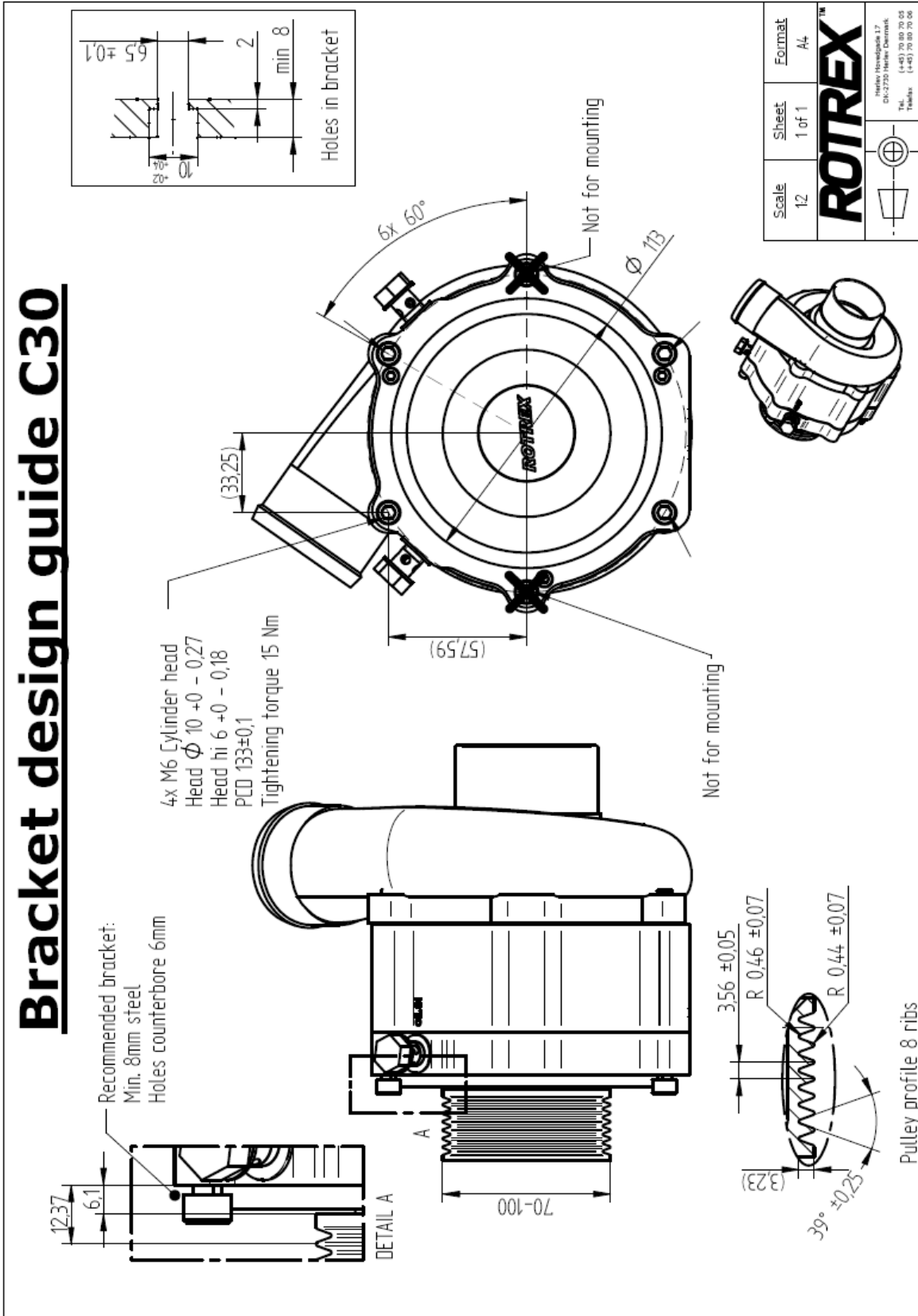
Bracket design guide C15



Scale	1:1	Sheet	1 of 1	Format	A4
ROTTREX™					
Made in Poland 046 17 DIX 2720-Nowy Czestochowa TEL. (+48) 78 80 70 05 FAX (+48) 78 80 70 06					

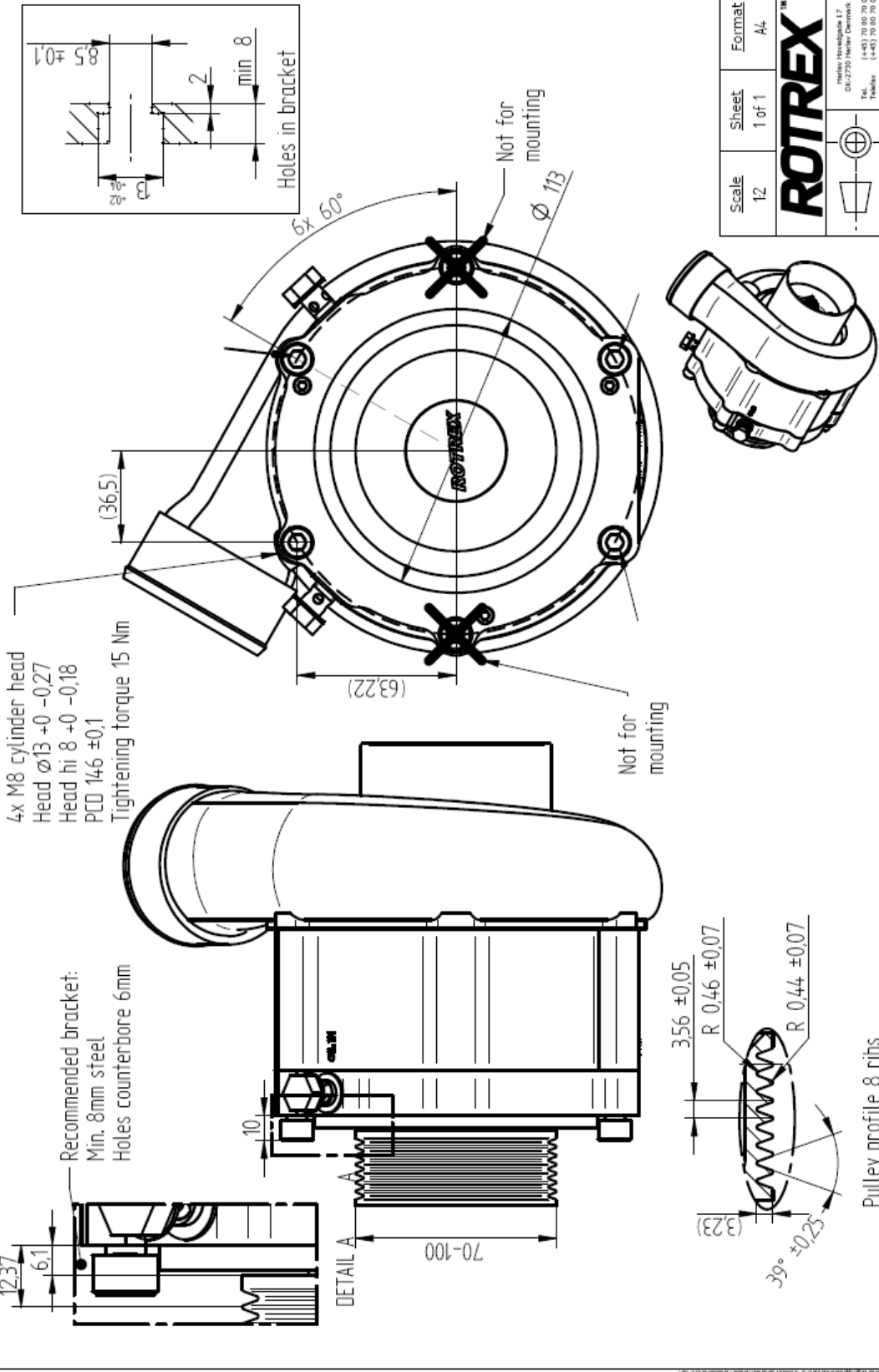
6.4.3 Bracket design guide for C30

Bracket design guide C30



6.4.4 Bracket design guide for C38

Bracket design guide C38



6.5 New Application Development Feedback Form

Dear Rotrex Customer: this document is intended to collect as much information as possible about your application in the early stages of its development. Completing this form thoroughly and submitting it with good complimentary information will help us providing useful feedback aimed to improve your development process.

Customer information		
Company		Date
Address		
Engineering contact		
	Tel	
	Email	
Purchasing contact		
	Tel	
	Email	

General project information	
Vehicle brand, model and code	
Engine code and description	
Expected yearly sales volume	
Desired application launch date	

Basic assumptions	
Base power	
Expected power	
Chosen supercharger	- Select -

Complementary attachments *	
Please attach to this form as many of the following documents as possible:	
Belt drive diagram	<input type="checkbox"/>
Drawings/sketch of main bracket	<input type="checkbox"/>
Picture of engine bay including bracket attachment points and oil circuit diagram	<input type="checkbox"/>
Others (please specify)	<input type="checkbox"/>

** If 3D models are included please make sure they are in STEP or IGES formats*

Other notes or comments

6.6 Customer Claim Form

Dear customer: this document is intended to collect as much information as possible about your claim. Please help us find the cause of the problem by being as accurate and detailed as possible. Thank you for helping us to improve our products and please feel free to make any suggestions.

Rotrex claim no.	Filled in by Rotrex
Claim reception date	Filled in by Rotrex
Contact name at Rotrex	Filled in by Rotrex

Company Please state your company	
Main contact Please write the name of your main contact regarding this claim	
Phone number Telephone number where the main contact can be reached	

Unit serial no. The serial no. can be found on the bottom side of the supercharger	
Installation date Date of S/C installation (Year and Month)	
Vehicle Brand/Model/Type/Engine State the details on the application vehicle	
S/C mileage when problem first encountered Something out of the ordinary was observed at S/C mileage...	
S/C mileage when claimed Claim at S/C mileage... (May be same as above)	
Climate conditions State the country/region, min and max temperatures of the area	region min max °C/°F
Oil reservoir type Rotrex plastic, aluminum reservoir or custom type	<input type="checkbox"/> Plastic <input type="checkbox"/> Aluminium <input type="checkbox"/> Custom
Oil cooler Does the application use an oil cooler – if so state type	<input type="checkbox"/> None <input type="checkbox"/> Rotrex std. 10 rib <input type="checkbox"/> Other
Tensioner type What type of tensioner does the drive belt run with	<input type="checkbox"/> None <input type="checkbox"/> Fixed <input type="checkbox"/> Auto
Air filter type State if a filter is used for the inlet air and what type	<input type="checkbox"/> None <input type="checkbox"/> OE paper type <input type="checkbox"/> Open type
Run-in period Approximate run in period	<input type="checkbox"/> None Km <i>or</i> Miles
Max input speed What is the maximum S/C input speed of the application	<input type="checkbox"/> Unknown rpm @ S/C input
Drive type Standard Rotrex pulley or custom pulley fitted?	<input type="checkbox"/> Std. multi-rib belt <input type="checkbox"/> Other
Oil volume To what level was the oil reservoir filled	<input type="checkbox"/> Full <input type="checkbox"/> Within min/max marks <input type="checkbox"/> Empty

Claim description Please describe as comprehensibly as possibly the reason for your claim and the circumstances under which they appear.	
--	--