



IP-22 TECHNICAL MANUAL

Release 1.00 (14/01/2022)



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1 GENERAL INFORMATION

1.1 RELEASES

Modifications from previous release are in red

1.1.1 Release list:

Version	Release Date	Author	Notes
1.00		Tatuus	Startup version



1.2 TECHNICAL CONTACTS

1.2.1 Chassis



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Web: www.tatuus.it



Carl Haas Automobile Imports Inc.

500 Tower Pkwy

Lincolnshire IL 60069

847-634-8200

1.2.2 Engine



Elite Engines Inc.

2875 East Progress Dr

West Bend WI 53095

www.eliteengines.com

1.2.3 Gearbox



Sadev

6 rue Grand'Montains

85110 Saint Prouant

Tel: +33 2 51 66 42 68

Fax: +332 51 66 49 60

Email : sadev@sadev-tm.com

Web: www.sadev-tm.com



Carl Haas Automobile Imports Inc.

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1.2.4 Electronic

COSWORTH

Cosworth Electronics

Cosworth LLC

5355 W 86th Street, Indianapolis, Indiana, 46268

Tel: [+1 317 442 7092](tel:+13174427092)

Email: ethan.duncan@cosworth.com,

Web: support.cosworth.com



Next Solution Snc

Via Belfiore, 31/D

23900 Lecco - Italy

Tel. +39 0341 289072

Fax +39 0341 370057

E-mail mail@nextsolution.it

1.2.5 Tires

COOPER TIRES



1.2.6 Brakes



Performance Friction

83 Carbon Metallic Highway
Clover, SC · 29710 ·
Tel: 803-222-2141
Fax: 803-222-8134
www.pfcbrakes.com



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500 Tower Pkwy
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1.2.7 Dampers



Carl Haas Automobile Imports Inc.

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1.2.8 Seat belts – Fire Extinguisher



OMP Racing

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16019 Ronco Scrivia (Ge) - Italy
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1.3 GENERAL AGREEMENT AND WARRANTY

Tatuus is proud of the quality, success and reputation of their products and is delighted that you have chosen to use the IP-22 chassis.

The design of each chassis is the subject of much research and development, technical analysis and detailed testing. However, as with all motorsport products, it is vital that they are correctly maintained and adjusted for each individual circumstance. This manual is intended to ensure that you obtain the maximum performance and reliability from this chassis.

We would stress that after each event or prolonged period of running (suggested to be 5,000km) the chassis should be carefully inspected and stripped as appropriate.

This manual contains lifing recommendations for critical components detailed in section 0. If in doubt please contact our Commercial Department who will advise you or if necessary put you in contact with one of our engineers.

It is important to ensure that all adjustments and tolerances are as specified. The use of parts not supplied by Tatuus will automatically invalidate any warranty or other liability which would normally be assumed by Tatuus.

Your attention is drawn in particular to the following statement:

‘Goods intended for motorsport or any related application, or for product development, evaluation or experimentation are supplied subject to the Customer recognizing that such goods may operate under extreme loads and conditions and that it is the Customer’s responsibility to ensure that the goods are correctly inspected, adjusted and maintained at all times to suit the specific conditions in which they may be used.’

‘Lightweight and weight optimized components are supplied subject to warranty only against manufacturing defects. It is possible that in certain conditions operating life may be reduced. Similarly prototype, experimental or components manufactured to the Customer’s design are supplied subject to warranty only against manufacturing defects.

Furthermore, such components, by their very nature, are not warranted as to their suitability for use or performance.’

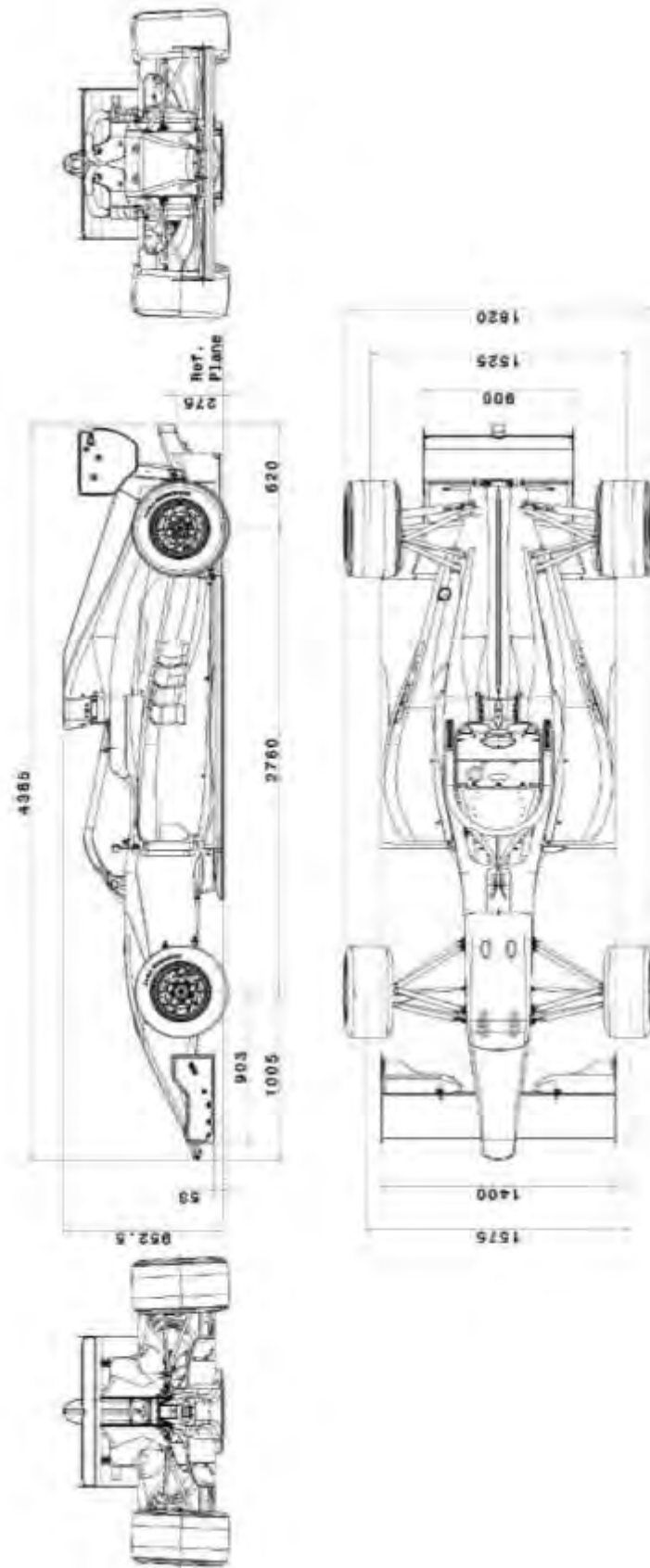
‘Tatuus shall have no liability to the Customer (other than liability for death or personal injury resulting from Tatuus’ negligence) for any loss or damage of any nature arising from any breach of any expressed or implied warranty, term or condition of the contract or from any negligence or breach of statutory or other duty on the part of Tatuus in connection with the performance or purported performance of or failure to perform the contract other than as set out in this Condition. In no circumstances shall Tatuus be liable for any claims for indirect or consequential injury or damage (including loss of profits) arising from any such matters.’

1.4 OVERVIEW

Front track	1575 mm
Rear track	1525 mm
Wheelbase	2760 mm
Overall length	Max 4385 mm
Overall width	Max 1820 mm
Overall Height	952.5 mm (from reference plane)

Weight	ND (refer to championship regulations)
Chassis	Composite Carbon fiber sandwich with Al/Nomex honeycomb, FIA F4 (Ann.J Art.274) homologated
Bodywork	Composite Carbon fiber
Front suspension	Push-rod / twin damper / spring
Rear suspension	Push-rod / twin damper / spring
Springs	Hyperco 4" 36mm
Dampers	Dynamic Suspension DSSV Formula 2-Way adjustable
Brakes	PFC
Tires	Cooper
Wheels	American Wheels 13"x10" front – 13"x12" rear
Engine	Mazda MRJ
Exhaust	Aros marmitte
Electronics	Cosworth Electronics
Electric system	Next Solution/Evotec
Gearbox	SADEV SL82 sequential 6 ratios,
Gearshift	Magneti Marelli EGA
Steering wheel	Cosworth Electronics
Battery	DEKA ETX15L
Fuel cell	PREMIER FT3
Seat belts	OMP 6-points, 3" shoulder and lap straps, HANS compatible

1.5 GENERAL INFORMATION



1.6 LIFING CHART

The following chart should be used to ensure that component life is not exceeded and premature failures are prevented by regular inspection. Check and replace in accordance with the recommended distances below. Mark all parts for lifing purposes and note in build records.

All parts not included in the list require inspection after 20,000km. Visual inspection should identify any parts with cracks, scratches, significant wear or corrosion.

NOTES: The table below is provided for guidance on the expected life of key components based on Tatuus' experience of this product in similar applications, however no warranty is implied by figures stated above and lifeing targets are no substitute for testing and regular inspection of the chassis. Check all components after any accident or abnormal usage. In doubt, replace the components.

For safety reasons, please contact immediately Tatuus if you discover premature wear or problems.

Many of the components stated above with a maximum 'typical' life of 20,000km may be found to perform successfully for extended mileage however extended running above 20,000km is done at customer's risk.

		Inspection [km]	Limit [km]
Chassis			
	Survival cell	10000	20000
	Front crashbox	10000	20000
	Rear crashbox	10000	20000
	Wheel tethers		12 months
	Nosebox studs	2500	5000
	Engine studs	5000	10000
	Floor stays	2500	5000
	Brake pedal	2500	5000
	Throttle pedal	5000	10000
Front suspension			
	Upright	5000	10000
	Wheel bearing	5000	10000
	Hubs	10000	20000
	Hub bolts	2500	5000
	Wheel spindle	5000	10000
	Drive pegs	2500	5000
	Wishbones	5000	10000
	Push-rods	5000	10000
	Suspension bracket	5000	10000
	Front ackermann	2500	5000
	Front anti-roll bar	2500	5000
	Rocker assy	5000	10000
	Wheels		see American wheels

Steering			
	Steering/toe arms	5000	10000
	Steering column	5000	10000
	Steering rack	5000	10000
	Rack/pinion	5000	10000
	Ball joint	1250	5000
Rear suspension			
	Upright	5000	10000
	Wheel bearing	5000	10000
	Outer hub	10000	20000
	Inner hub	5000	10000
	Hub bolts	2500	5000
	Wheel spindle	5000	10000
	Drive pegs	2500	5000
	Wishbones	5000	10000
	Push-rods	5000	10000
	Suspension bracket	10000	20000
	Bottom forward bracket	5000	10000
	Rear upright bracket	5000	10000
	Rear anti-roll bar	2500	5000
	Rocker assy	5000	10000
	Wheels		see American wheels
Front Wing			
	Front wing	5000	15000
	Front pillars	5000	15000
Rear wing			
	Front wing	5000	15000
	Front pillars	5000	10000
	Front endplates	5000	15000
Transmission			
	Wheel shaft	5000	10000
	Slave cylinder (sealings)	5000	10000
	Release bearing	5000	10000
Gearbox			
	Gearbox internals		see SADEV
	EGA	7500	15000
	EGA rubber mounting	2500	5000

Brake system			
	Brake pedal	2500	5000
	Brake balance bar	2500	5000
	Master cylinders	5000	10000
	Calipers		see PFC
	Disc bells		see PFC
	Brake discs		see PFC
	Oil lines	5000	10000
Cooling system			
	Radiators	5000	10000
	Water tank cap	2500	5000
	Pipelines	10000	20000
	Silicon hoses	10000	20000
Exhaust			
	Manifold	5000	10000
Electrical system			
	Battery	5000	10000
	Switch panel	5000	10000
	Master switch	5000	10000
	Marshall switches	5000	10000
	Chassis loom	10000	20000
	Gearbox loom	10000	20000
	Powerbox	10000	20000
	Steering wheel		see Cosworth
	GCU	10000	20000
Extinguisher system			
	Extinguisher bottle		see expire date
	Extinguisher mountings	5000	10000
	Extinguisher pipelines	10000	20000
	Extinguisher CU	10000	20000
Engine lubrication system			
	Oil lines	10000	20000
	Tank filter cartridge	5000	10000
Fuel system			
	Fuel tank		see expire date
	Fuel pump	5000	10000
	Fuel filter	2500	5000
	Fuel hoses	10000	20000

2 SAFETY

This chapter enlists the Homologated Safety Devices, these parts cannot be modified or repaired without the approval of Tatuus.

2.1 CHASSIS

The survival cell is the main safety and structural component of the car and it has been approved by the FIA, great attention must be paid in checking for structural failure not later than two years after delivery from Tatuus factory, and after each major accident. Chassis must be checked and repaired by a center authorized by Tatuus.

2.2 FRONT IMPACT STRUCTURE

Front impact structure is a safety and structural component of the car (approved by FIA crash test), great attention must be done in checking for structural failure not later than two years after delivery from Tatuus factory, and after each accident. Front nose must be checked and repaired by a center authorized by Tatuus except for the following specified exceptions:

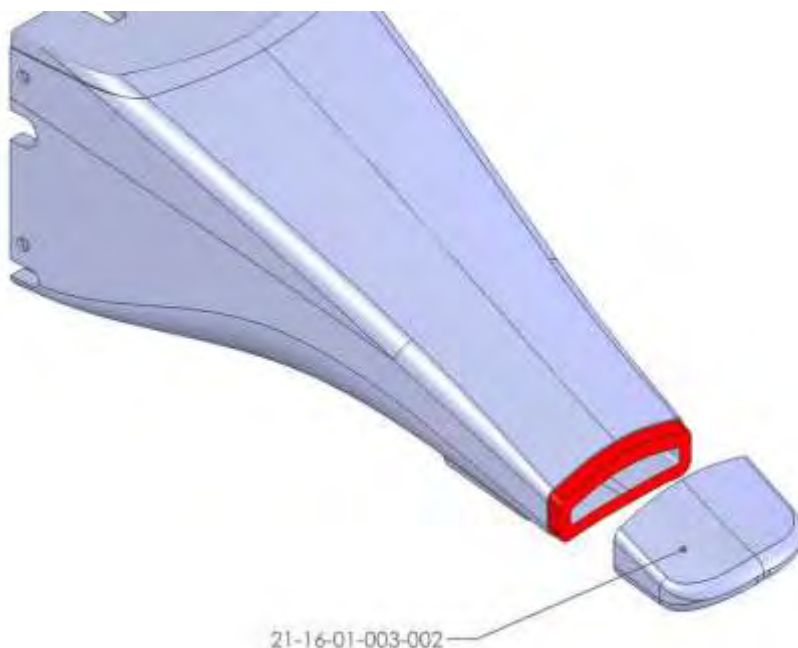
2.2.1 Front nose repair specification and procedure

Applicable requirements

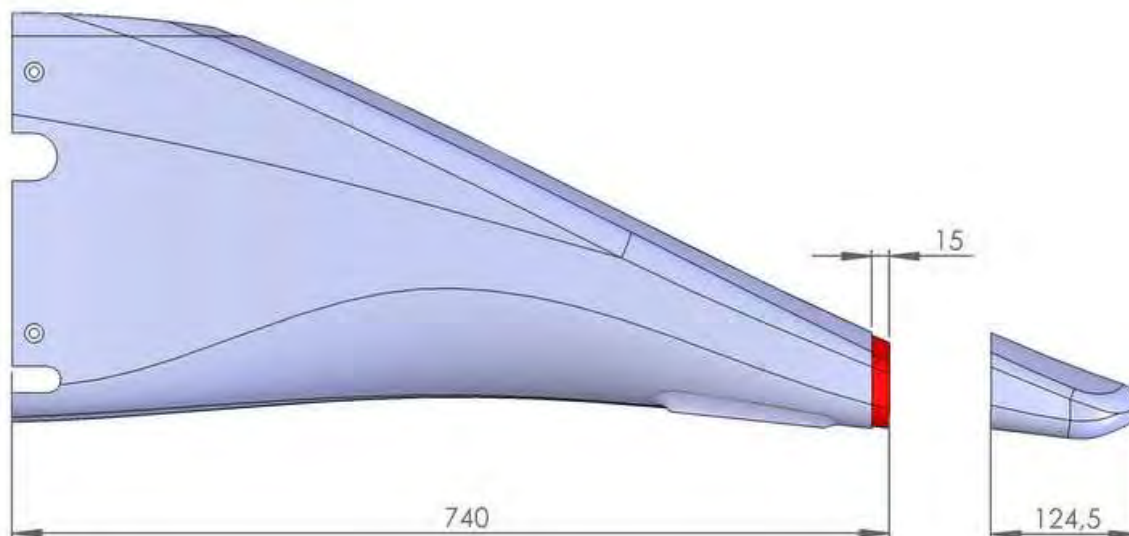
The following procedure is applicable only when the damage is contained in the first 100mm from the nose tip (715mm from the chassis bulkhead), all the other damages must be inspected by the manufacturer.

Replacement procedure

Spare nose tip is available as spare part, the reference code is 21 16 01 003 002



1. Trace a line parallel to the chassis bulkhead 715 mm from the bulkhead, you should find the line 15 mm from the old nose tip junction.
2. Cut off the nose tip forward the traced line.



3. Using sandpaper on the outer surface, reduce the thickness of the crashbox by about 1mm for a length of 15-25 mm (red area).
4. Attention must be paid to sandpaper the outer surface, at the depth of 1 mm you should find the resin between first and second ply.
5. Use sandpaper on the new nose tip inner surface to produce a rough surface that will match the outer surface of the crashbox.
6. Spread specific resin 3M 9323 over the junction surface, carefully respect the percentage between resin and catalyst:
7. 3M 9323 Mixing specification:

	Resin	Catalyst
Weight ratio	100 g	27 g
Volume ratio	100 g	31 g

8. Position the new nose tip cleaning the excess of resin; new nose tip can be hold in position with high temperature tape.
9. Cure the assembly on the oven following the specific temperature cycle for 3M 9323: 2 hours at 60°C.

2.3 REAR IMPACT STRUCTURE

Rear impact structure is a safety and structural component of the car (approved by FIA crash test), great attention must be paid in checking for structural failure not later than two years after delivery from Tatuus factory, and after each accident. Rear impact structure must be checked and repaired by a center authorized by Tatuus.

2.4 HALO

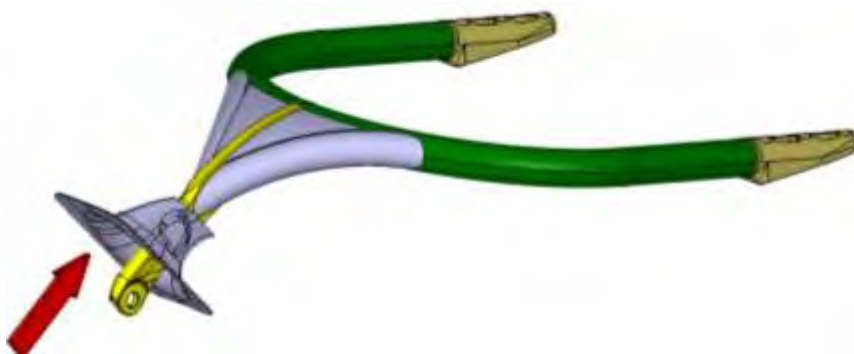
2.4.1 Installation procedure

General notes:

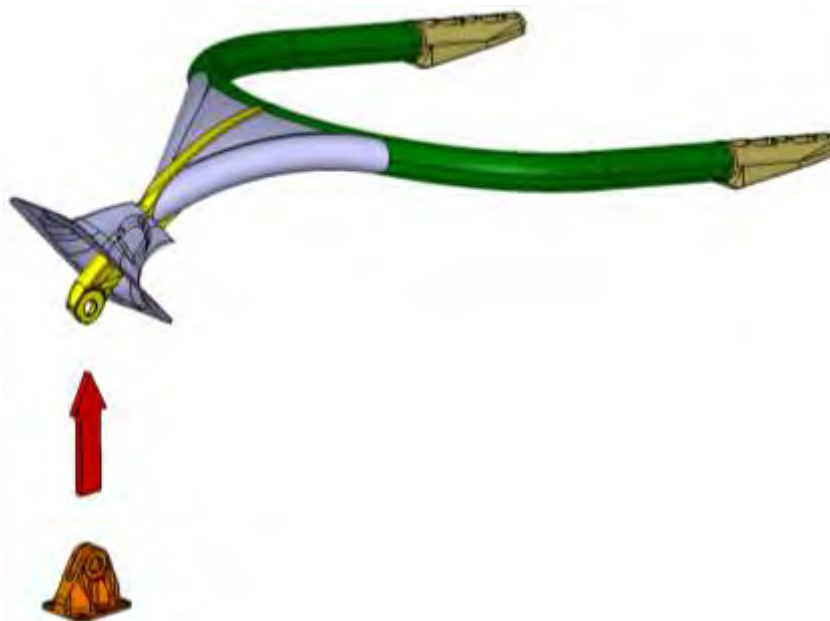
	grey arrow: unscrew/screw but not tighten
	green arrow: screw and tighten

When installing the HALO, apply on the bolts some water and oxidation resistant grease. For example, the PETRONAS TUTELA Z2 grease is suitable for this purpose.

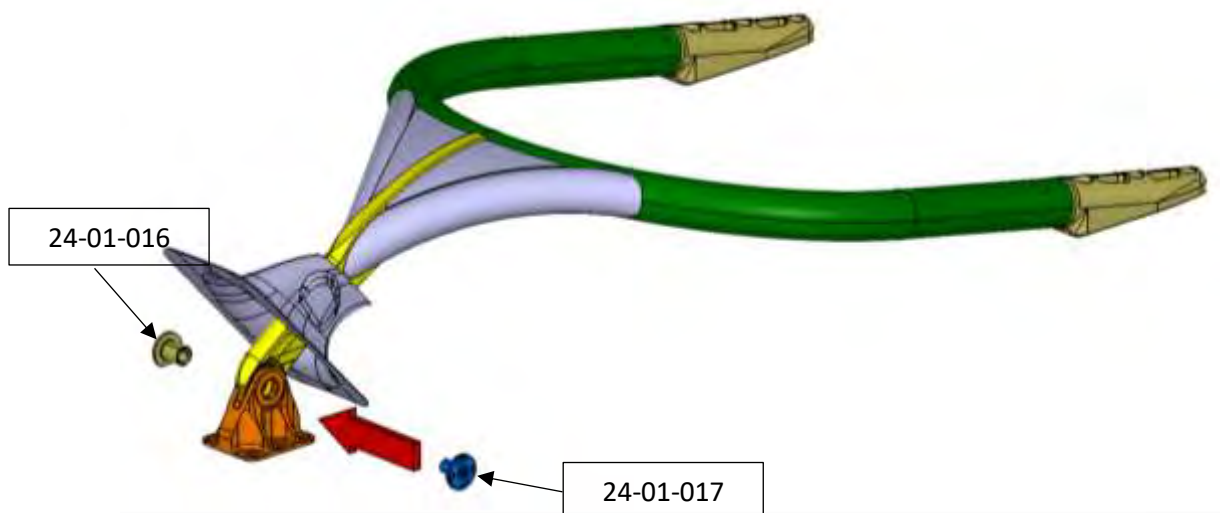
1. Insert the front fairing on the HALO center bar



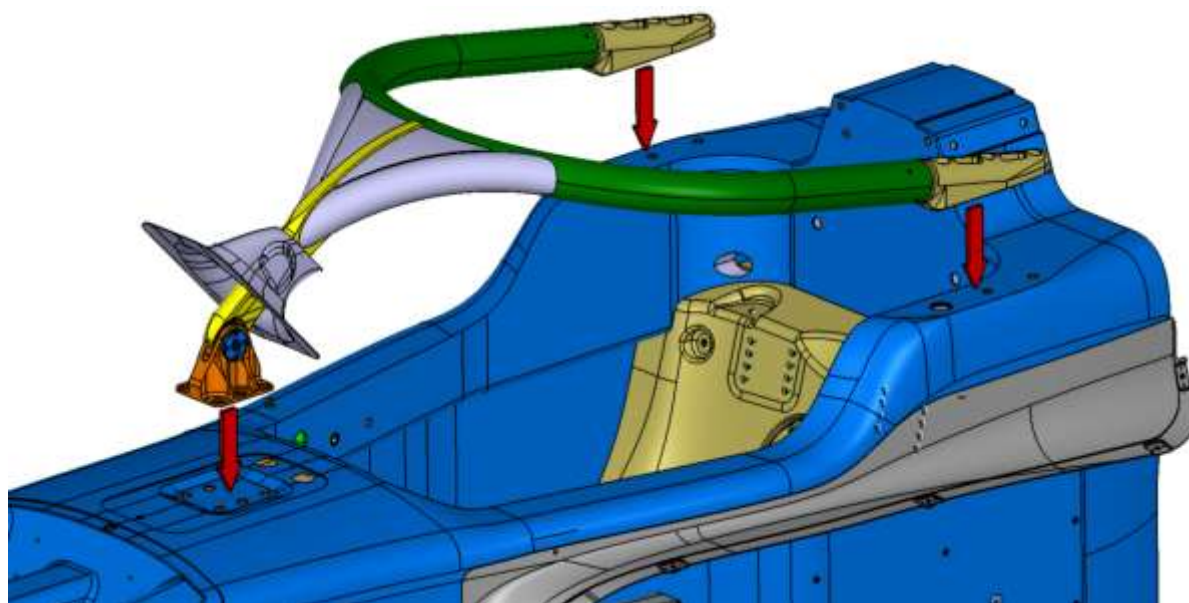
2. Install the front bracket (28-01-010) on the HALO



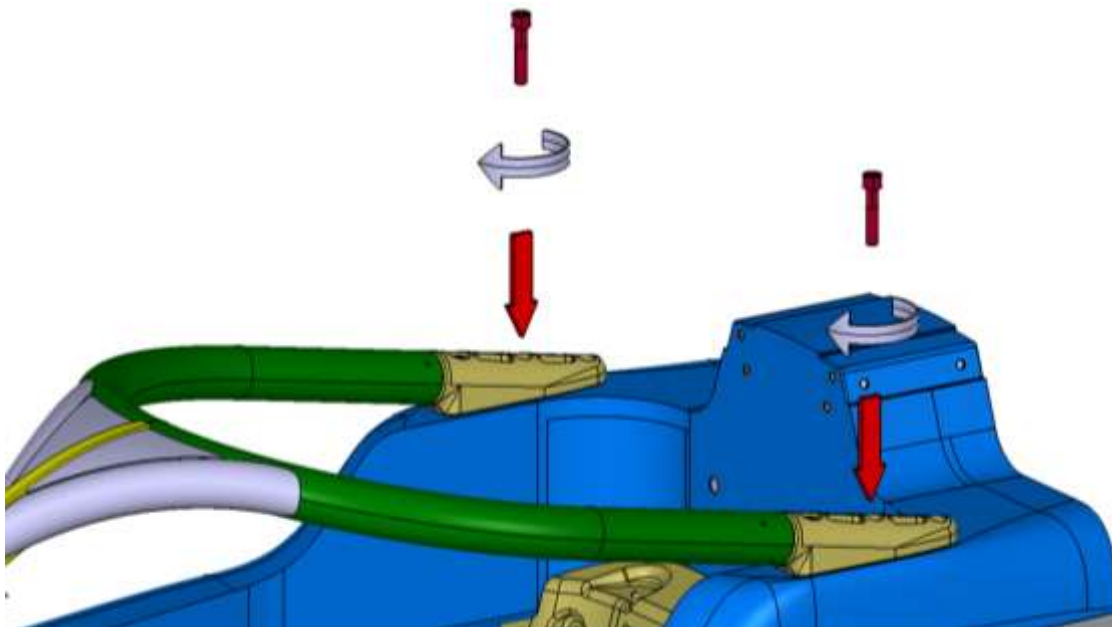
3. Fasten the HALO front fixing screw (24-01-017) and pin (24-01-016). **Do not apply any tightening torque.**



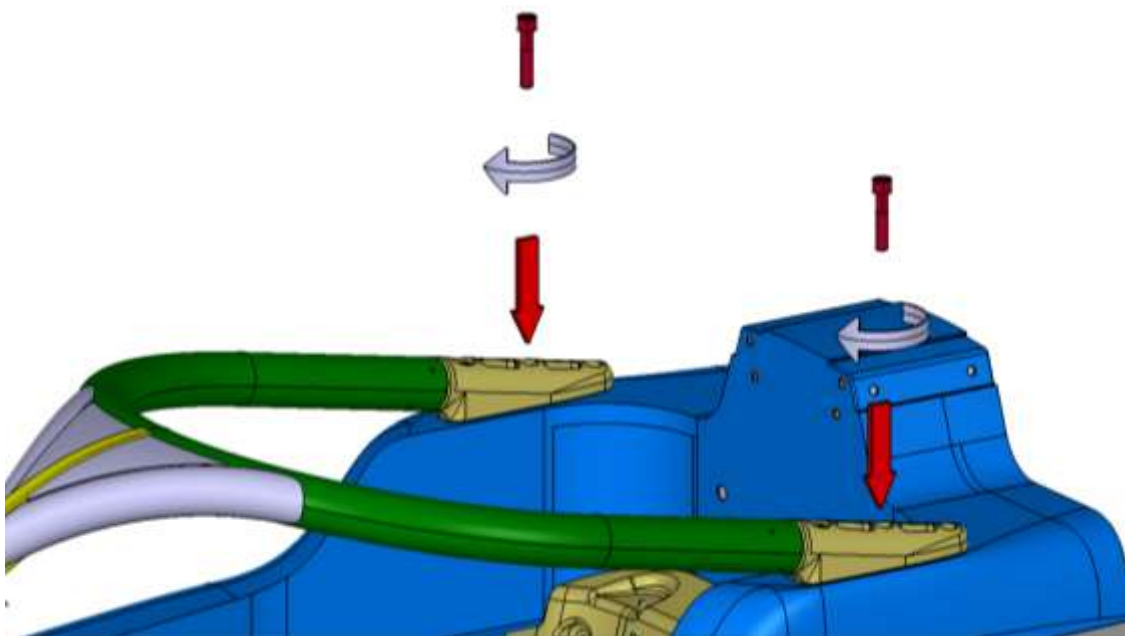
4. Please note that the HALO front fixing screw (24-01-017) shall be on the **left side** and the HALO front fixing pin (24-01-016) shall be on the **right side**.
5. **Do not apply any tightening torque.** Screw the HALO front fixing screw (24-01-017) until the screw's under-head gets in contact with the plane of the counterbore on the front bracket. At this point do not apply any tightening torque **but** loose the HALO front fixing screw (24-01-017) one turn (counter-clockwise).
6. Place the assembly obtained at point 3 on the chassis.



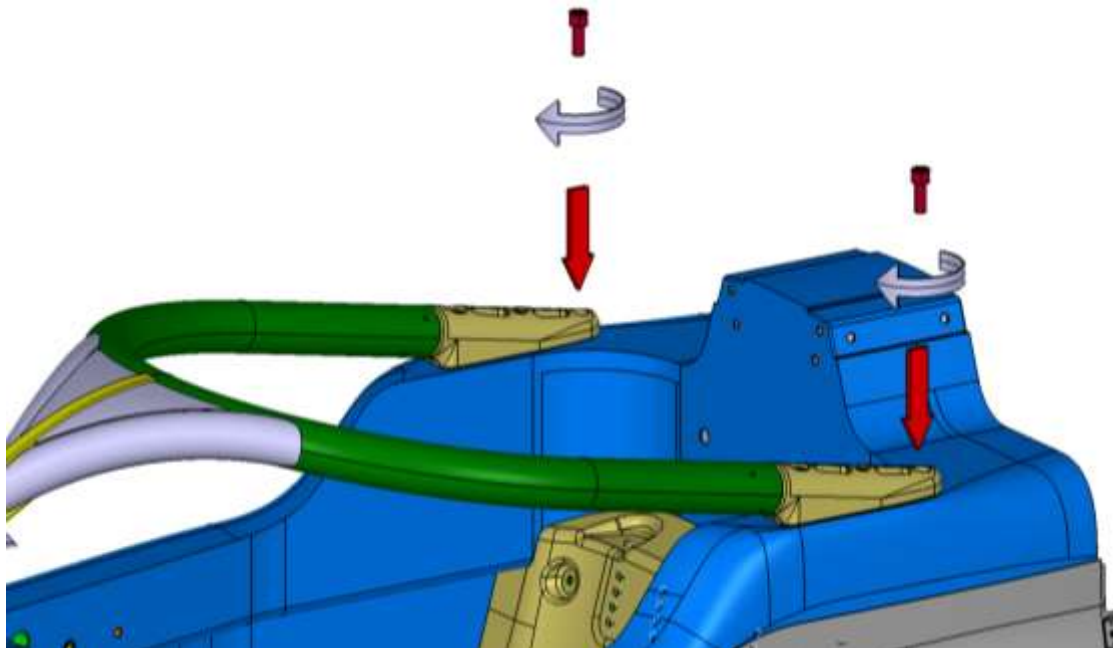
7. Fasten the two shoulder bolts (24-01-033). **Do not apply any tightening torque.** Screw the bolts until the screw's underhead gets in contact with the plane of the counterbore on the HALO foot. At this point do not apply any tightening torque **but** loose the bolt one turn (counterclockwise).



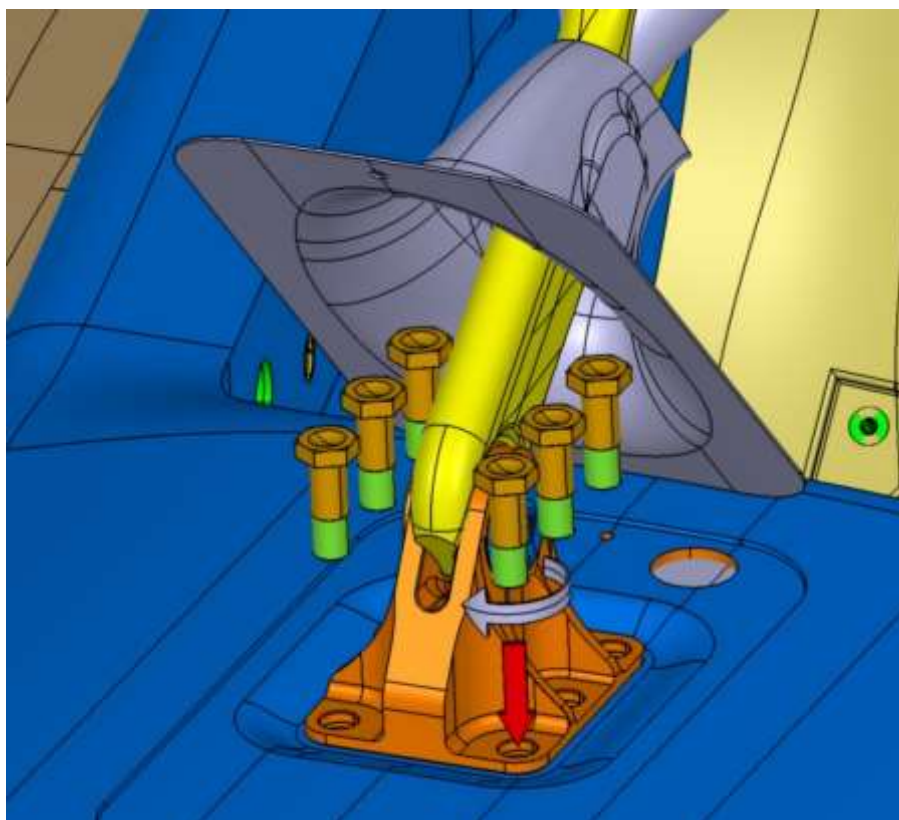
8. Fasten the two M12X55 bolts. **Do not apply any tightening torque.** Screw the bolts until the screw's underhead gets in contact with the plane of the counterbore on the HALO foot. At this point do not apply any tightening torque **but** loose the bolt one turn (counterclockwise).



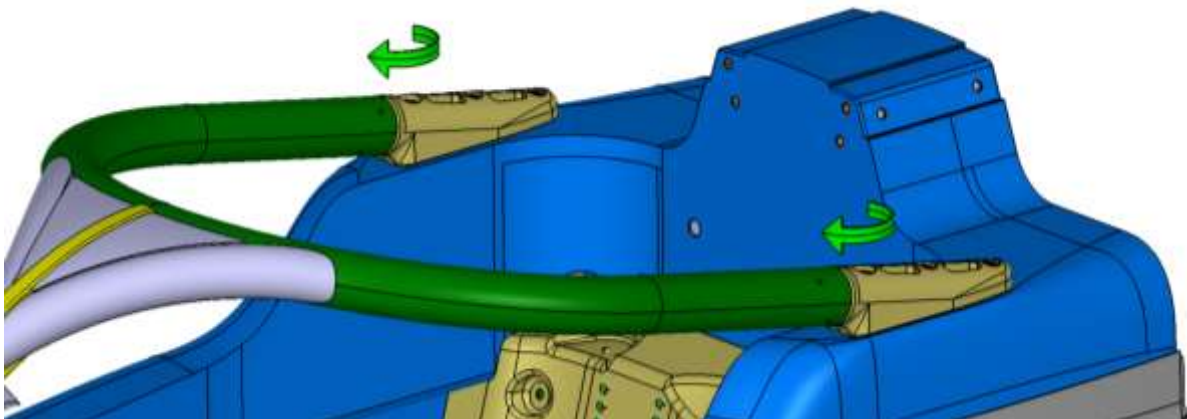
9. Fasten the two M12X30 bolts. **Do not apply any tightening torque.** Screw the bolts until the screw's underhead gets in contact with the plane of the counterbore on the HALO foot. At this point do not apply any tightening torque **but** loose the bolt one turn (counterclockwise).



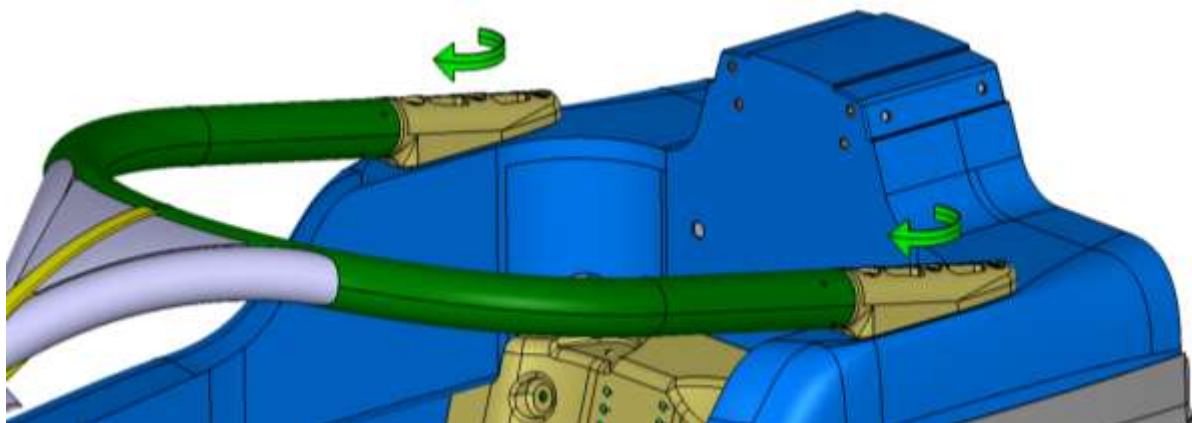
10. Fasten the six NAS1307-16 bolts. **Do not apply any tightening torque.** Screw the bolts until the screw's underhead gets in contact with the plane of the counterbore on the front bracket. At this point do not apply any tightening torque **but** loose the bolt one turn (counterclockwise).



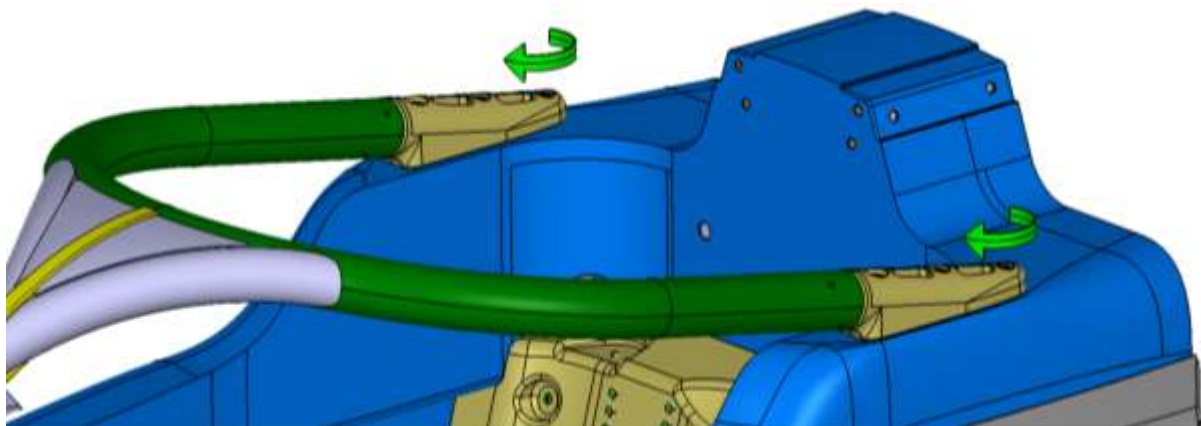
11. Tighten the two shoulder bolts 24-01-033. **Do not tighten to target value one bolt first and then the other.** Apply the tightening torque gradually, keeping the balance on the two bolts. Target value is **51Nm**.



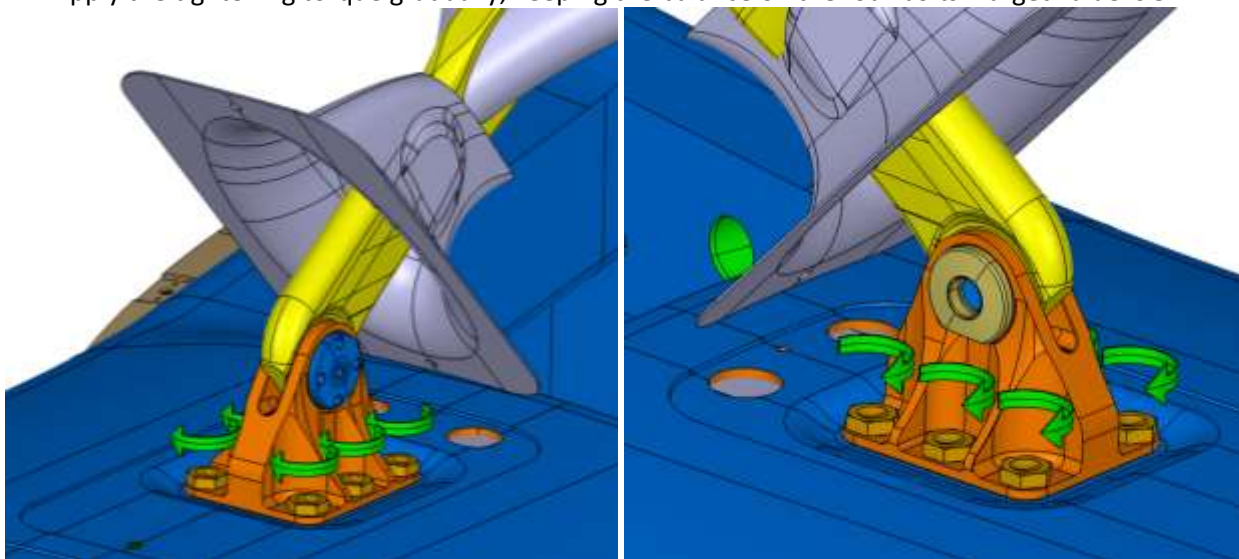
12. Tighten the two M12X55 bolts. **Do not tighten to target value one bolt first and then the other.** Apply the tightening torque gradually, keeping the balance on the two bolts. Target value is **51Nm**.



13. Tighten the two M12X30 bolts. **Do not tighten to target value one bolt first and then the other.** Apply the tightening torque gradually, keeping the balance on the two bolts. Target value is **51Nm**.

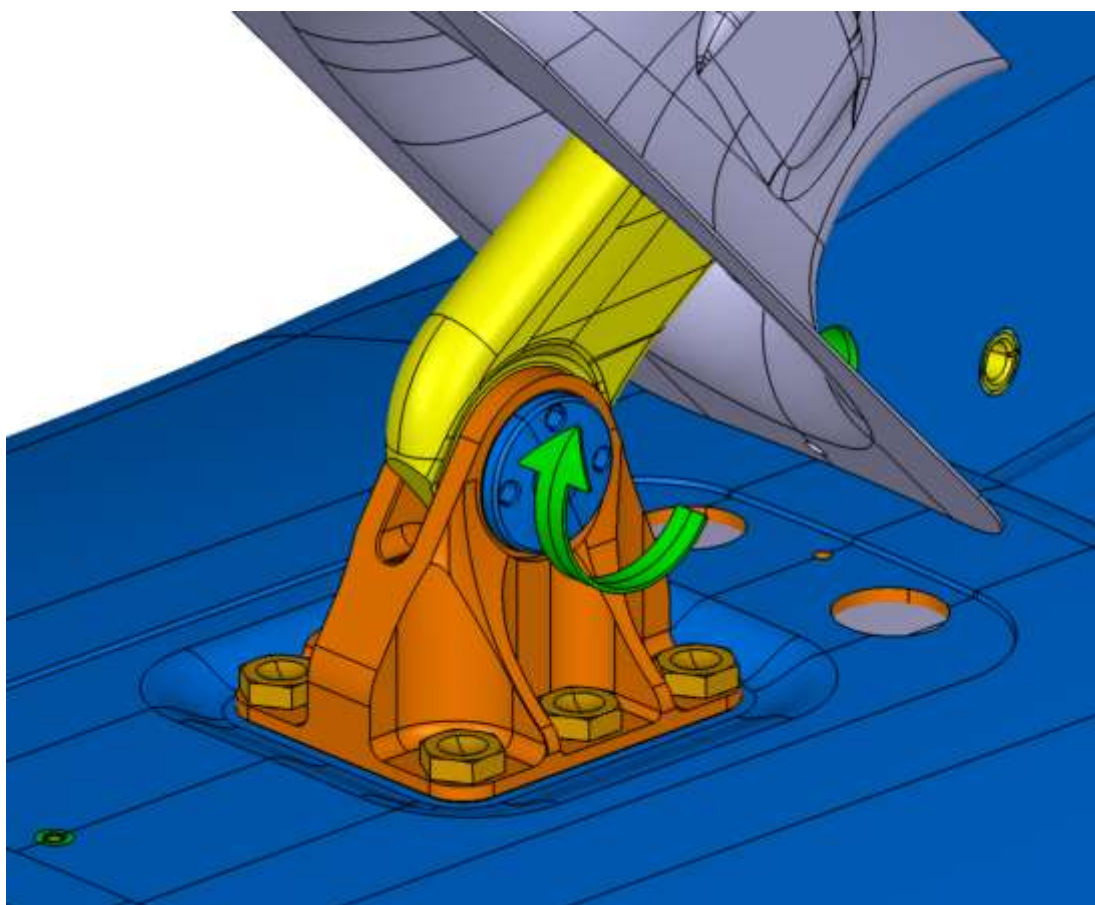


14. Tighten the six NAS1307-16 bolts. **Do not tighten to target value one bolt first and then the other.** Apply the tightening torque gradually, keeping the balance on the four bolts. Target value is **51Nm**.

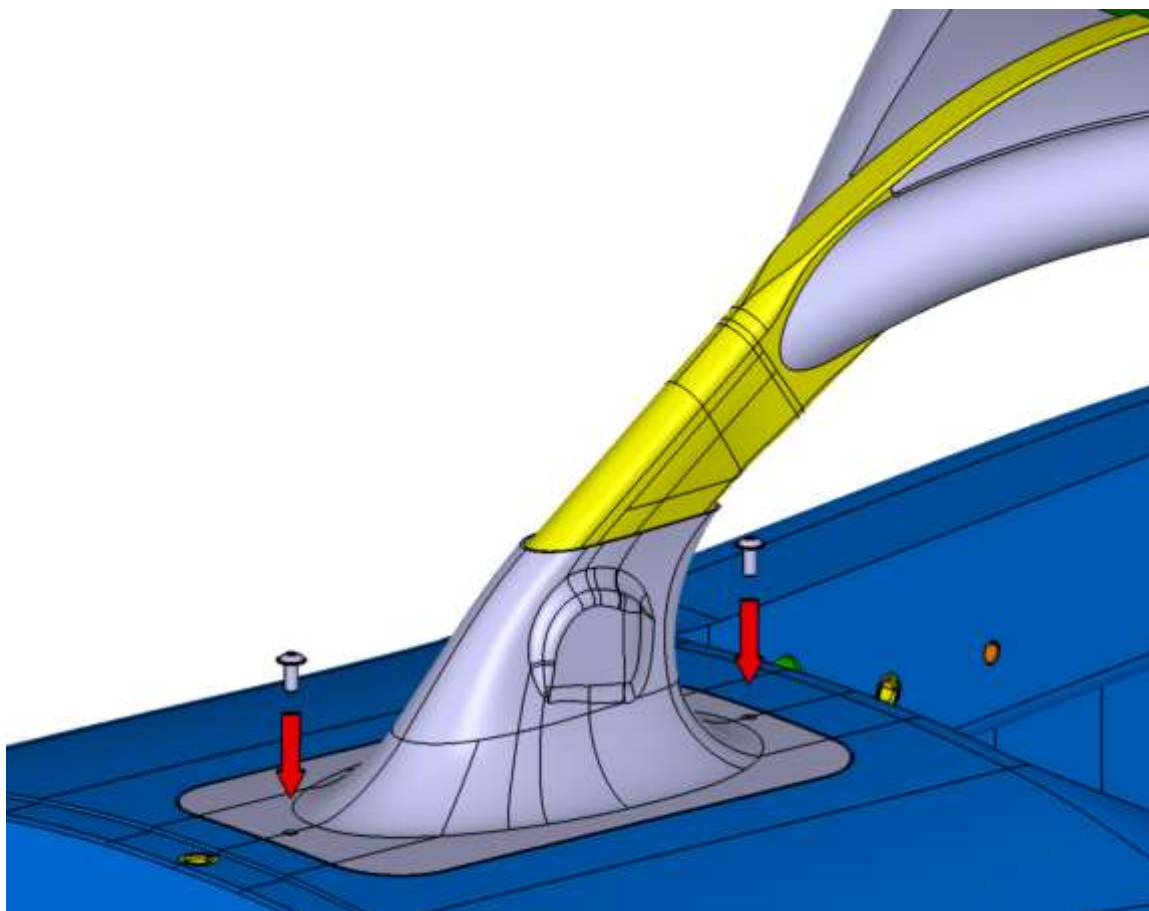


15. Double check the tightening torque on each bolt starting from the two shoulder bolts (24-01-033), then on the M12 bolts and finally on the NAS1307-16 bolts.

16. Tighten the HALO front fixing screw (**24-01-017**)

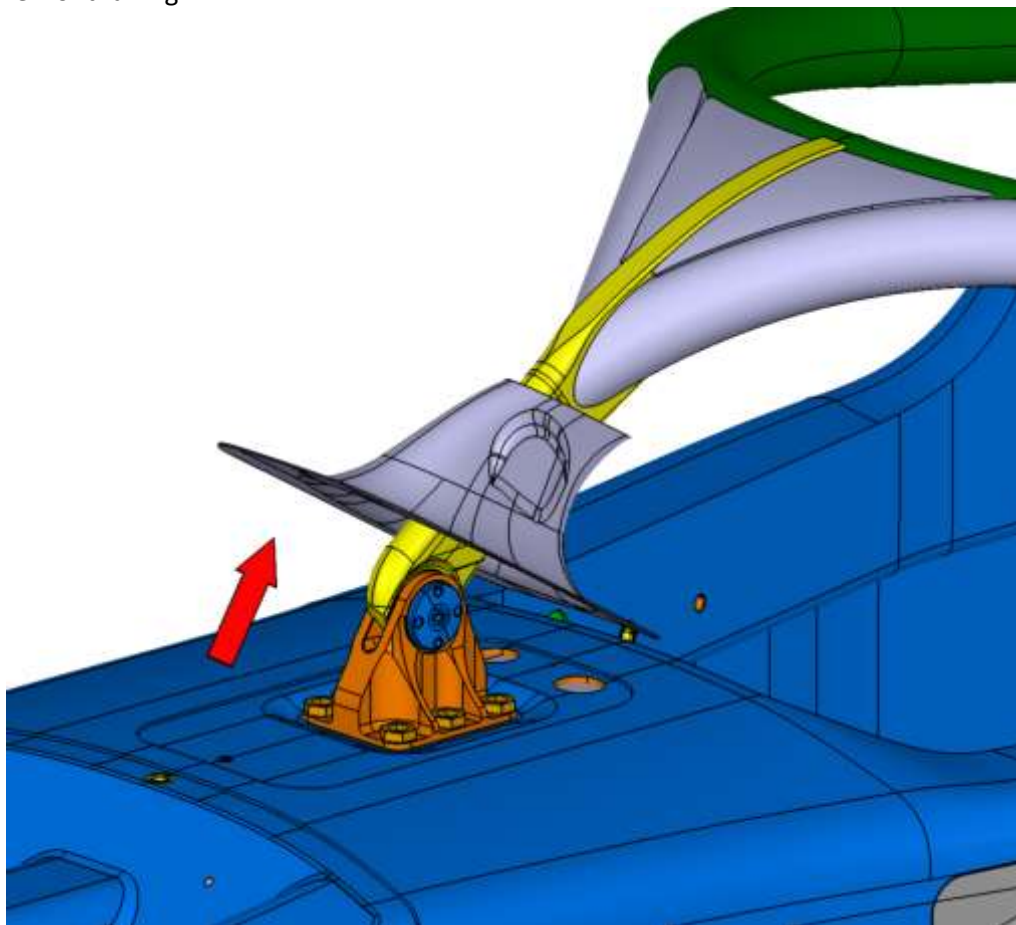


17. Position the front fairing and fix it with two button head bolts (UNI7380-TX-M5X10).

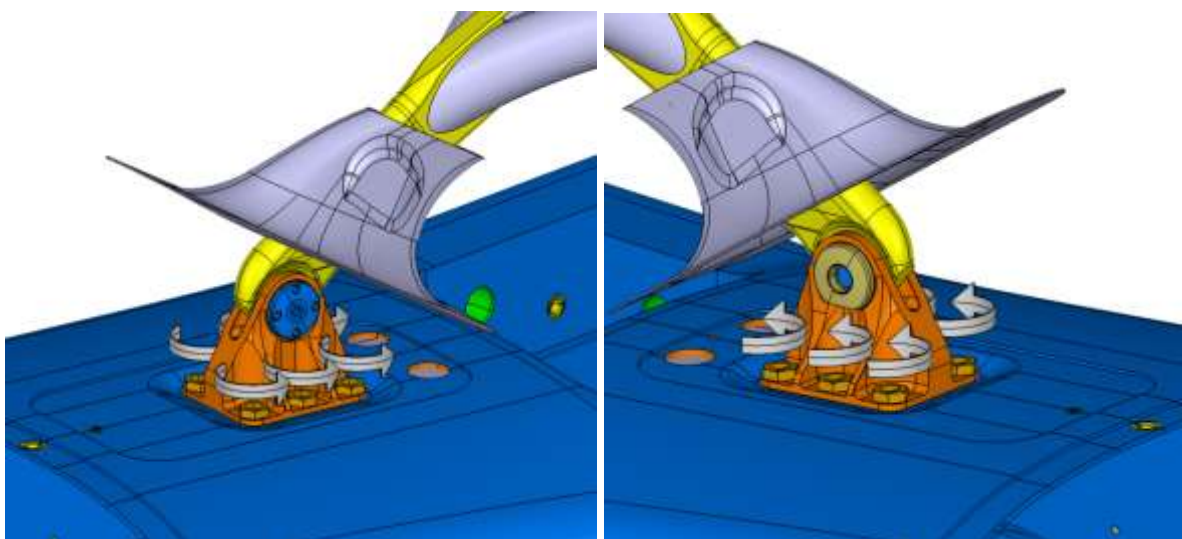


2.4.2 Disassembly procedure

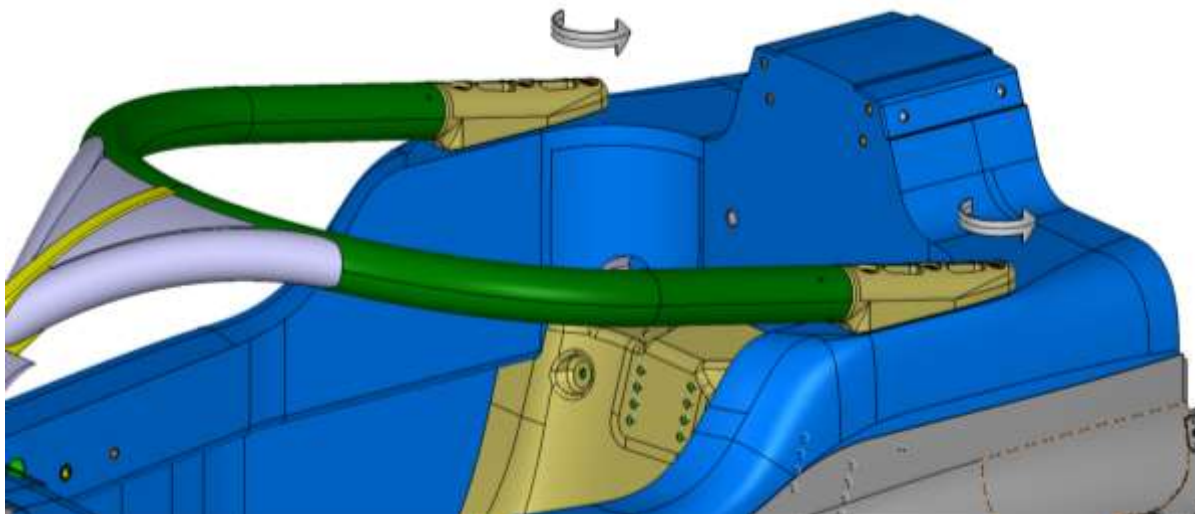
1. Lift the front fairing



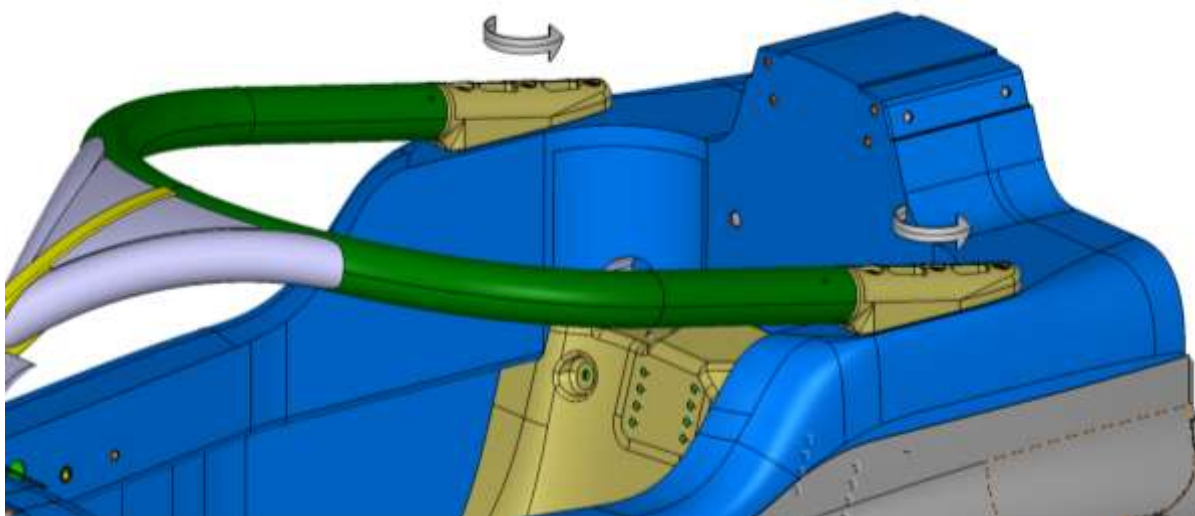
2. Unscrew and remove the six NAS1307-16 bolts. **Do not unscrew one bolt first and then the others.** Loose the bolts gradually, keeping the balance on all of them.



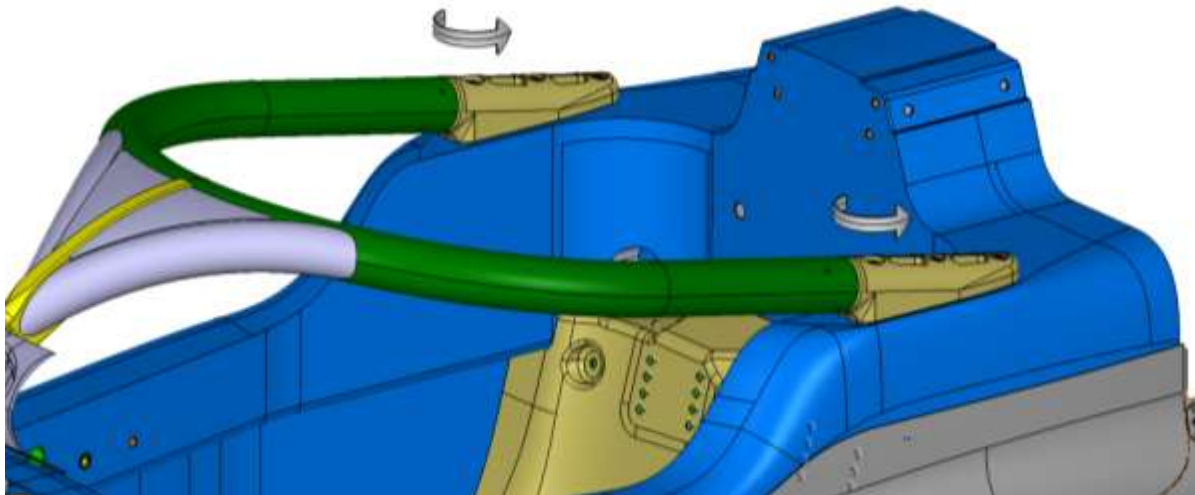
3. Unscrew and remove the M12X30 bolts. **Do not unscrew one bolt first and then the other.** Loose the bolts gradually, keeping the balance on the two bolts.



4. Unscrew and remove the M12X55 bolts. **Do not unscrew one bolt first and then the other.** Loose the bolts gradually, keeping the balance on the two bolts.



5. Unscrew and remove the two shoulder bolts (24-01-033). **Do not unscrew one bolt first and then the other.** Loose the bolts gradually, keeping the balance on the two bolts.



2.4.3 HALO painting and certification

It is reminded the HALO is a type 1 component. As stated by the FIA technical regulation:

“Type 1: These parts must be supplied by the manufacturer and used exactly as supplied. Repairs may be carried out only by the manufacturer.”

“The adding of color or thin adhesive film up to a thickness of 0.5 mm is not considered as a modification, provided that the color or film fulfils only an optical function.”

By the requirements above, it is not allowed to the team/customer to remove the paint from the HALO, please note it comes from Tatuus only painted black.

In addition, by FIA requirement the HALO must be equipped with a homologation label and FIA hologram. Both the label and the hologram must only be fitted by Tatuus.

The homologation label and the hologram must be visible, they cannot be covered by wrapping or paint. It is suggested to protect the homologation label and the hologram with a transparent film (i.e., helicopter tape).

If the hologram needs to be re-placed or re-fitted, the HALO should come back to Tatuus for inspection and re-certification. Please get in contact with Tatuus for timeline and quote for the activity.

2.5 STEERING COLUMN

The steering column has an integrated collapsible section [1] to absorb impact energy. Extreme attention must be paid on this part to avoid any damage or overload.

IMPORTANT: in case of impact the aluminum crashbox must be replaced and column carefully inspected.

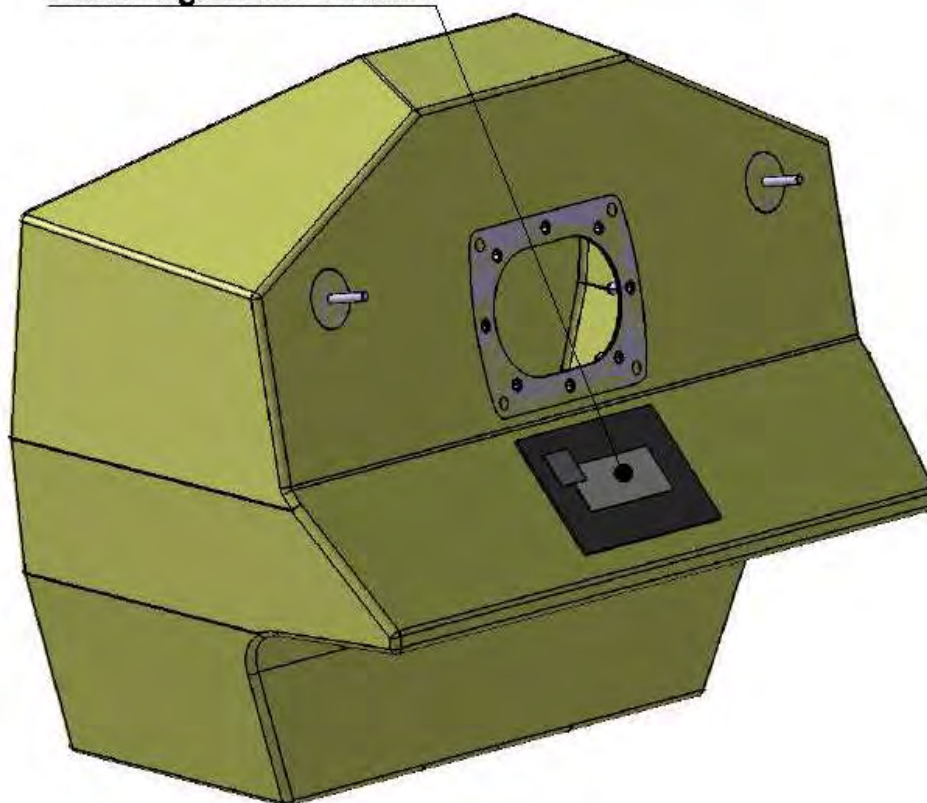


2.6 FUEL CELL

Premier FT3-1999

Rubber bladders should be used for no more than 5 years after the date of manufacture, unless inspected and recertified by the manufacturer for a period of up to another 2 years.

Homologation label



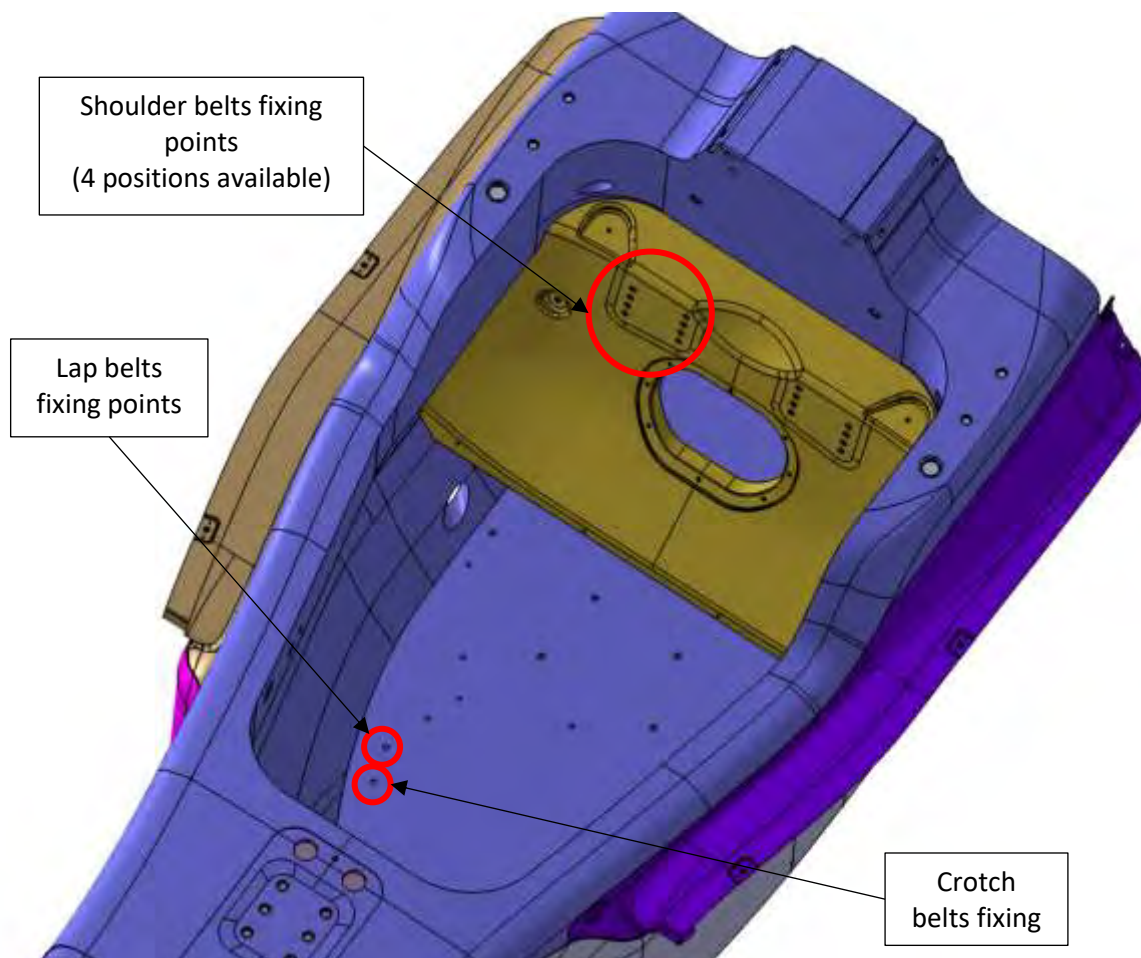
2.7 FUEL COUPLING

Staubli SPT08.3655/L/JV
 SPT08.7655/L/JV

2.8 SEAT BELTS

OMP HANS Superleggera 6 points

FIA D-255.T798

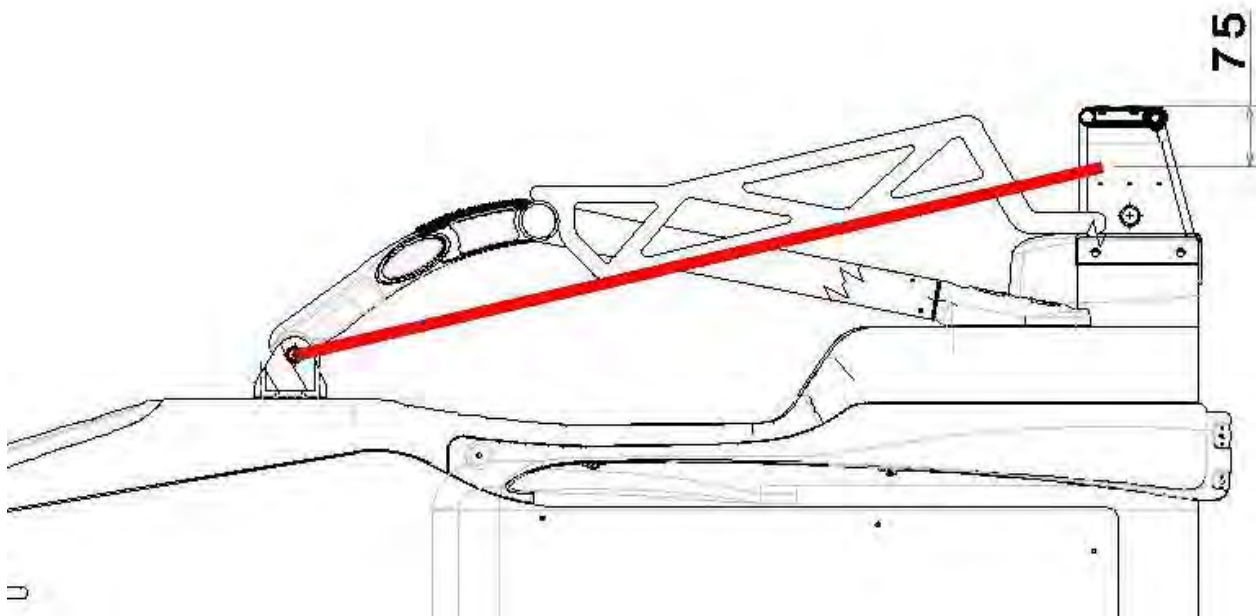


2.9 DRIVER INSTALLATION

Please find below the relevant articles from the 2020 FIA F4 1st gen technical regulation:

15.2.1 (car homologated as from 01/01/2019)

The driver's helmet and steering wheel must be arranged such that they lie below a line drawn between the front fixing axis of the secondary roll structure and a point 75mm vertically below the highest point of the principal roll structure.



2.10 RAIN LIGHT

Tatuus 12x High intensity LED

A minimum of 85% of the LED's must be operational at any time.

2.11 WHEEL TETHERS

Cortex 4kJ (FIA 8864-2013 standard)

It is recommended to replace wheel tethers if:

- The cable has been on the car for more than 12 months
- Accident
- The cable has been damaged, i.e. the braid or tape have been damaged exposing the fiber
- The cable has been over-tensioned

2.12 FIRE EXTINGUISHER

Information about OMP products is also available at www.ompracing.it and www.ompamerica.com

2.12.1 Precaution for use

The extinguishing liquid is an irritant to the eyes, skin, and respiratory tracts, and is harmful if swallowed. Avoid ingestion, inhalation, contact with the eyes, and prolonged and repeated contact with the skin.

In the event of contact with the eyes, wash thoroughly with water. In the event of accidental contact with the skin, immediately wash the affected body part with plenty of soap and water.

In the event of inhalation, bring the subject to a well ventilated area. If any signs of illness occur, seek medical assistance. In the event of ingestion, do not induce vomiting, but seek immediate medical assistance. The extinguishing liquid contains ethylene glycol.

Before every race, replace the battery in the electrical control. If the battery is dead, the system will not activate. See section 7 for replacing the battery.

Before every race, make sure that the needle on the bottle gauge is in the green zone. When the bottle gauge needle is outside the green zone, the extinguishing system is drained and must be charged.

If the bottle gauge needle is outside the green zone, contact your OMP authorized dealer to charge the system. An intact tamper-proof seal and gauge needle in the green zone ensure that the system is compliant and indicate that it is ready for use.

2.12.2 Homologation and intended use

Only use original OMP parts and components when installing the system. Using non-original components invalidates the homologation of the system and voids the warranty. CEFAL 3 and CESAL 3 extinguishing systems can extinguish a fire in the type of vehicle for which they are suited under design conditions. Nonetheless, keeping in mind the large number of variables involved in a fire that are difficult to anticipate and control, it cannot be guaranteed that this goal will be achieved under all conditions.

CEFAL 3 and CESAL 3 extinguishing systems are intended to provide protection for the vehicle occupants and not for the vehicle itself.

When the control box lever switch is in the OFF position, the extinguishing system is disabled. Check that the switch is in the ON position before using the vehicle.

The Electrical Control Unit is not water proof. If the Control Unit circuit get wet, unwanted activation of the extinguishing system might occur. Care should be taken to install the Control Unit in an area where it is protected from direct splash of water.

Before connecting the control unit to the bottle, use a multimeter to check that:

whit the lever switch on the control unit in the OFF position, when either of the activation buttons is pressed the potential difference between the ends of the wires is about 7 - 8V with the lever switch on the control unit in the ON position, when either of the activation buttons is pressed the potential difference between the ends of the wires is about 9V when neither of the activation buttons are pressed the potential difference between the ends of the wires is 0V.

(PLEASE NOTE: after pushing either of the activation buttons, potential built up in the system needs to be discharged before it gets back to zero. This can easily be achieved by touching the connectors). Before connecting the cable to the valve, switch the control unit to OFF mode.

With the control unit switch in the OFF position, connect the bottle's explosive capsule. Make sure the connector retention ring is tightly screwed onto the bottle.

If the bottle is connected with the Control Unit switch in the ON position, the system might go on. Always make sure that the bottle connector is tightly screwed before setting the Control Unit Lever Switch to ON.

With the switch still in the OFF position, press one of the two buttons and check that the LED turns on, thus indicating that the system is connected correctly.

The LED verifies the functionality of the system and turns on ONLY when the extinguisher valve is connected to the system. If the LED does not turn on after having connected the system, check the connections and/or try replacing the battery.

If the LED turns and correctly with the lever in the OFF position, your system is ready to be put into operation by moving the switch to the ON position.

2.12.3 Technical specifications

Bottle operating pressure:	16,5 Bar
Minimum pressure:	12 Bar
Maximum pressure:	18 Bar
Battery power:	9V alkaline battery
Electrical valve igniter:	9V non-polarized
Liquid extinguisher:	
Name:	Sabolite
Usage temperature:	- 15°C / + 60°C
Appearance:	red liquid
Density at 20° C:	1.07 Kg/dm ³
PH:	7 ±1
Boiling point:	-100°C
Biodegradability:	rapidly biodegradable R.O.D. 220'000 mgO ₂ /l
Chemical Comp.	aqueous solution containing hydrocarbon surfactants, fluorosurfactants, and antifreeze agents
Ecotoxicity	rapidly biodegradable
Hazardous components	ethylene glycol, urea

2.12.4 Maintenance

Before every race:

Check that the pressure gauge needle is inside the green area on the scale. If the needle is not inside the green area, have the system recharged. Check that the tamper-proof seal is whole and intact. If the tamper-proof seal has been compromised, have the system checked and replaced if necessary. Replace the 9V battery that powers the system's electrical control. Put the system's electrical control unit lever switch in the OFF position and make sure that the LED on the control unit turns on, both when you push the system activation button located on the control unit, and when you push the external button located near the bottom of the windshield. If the LED does not turn on when you push either of the control buttons, check the electrical connections and/or replace the control unit battery and repeat this check. If the LED remains off contact technical support.

Before the race, put the lever switch in the ON position.

When the control box lever switch is in the OFF position, the extinguishing system is disabled. Check that the switch is in the ON position before using the vehicle.

Every 2 years:

Have OMP or an OMP licensee perform the compulsory overhaul on the bottle. The date for the first overhaul is shown on the extinguisher label.

Clean the system as follows:

- Disassemble the nozzles from their connectors and the connectors from the hose.
- Blow compressed air through the hose and into the connectors and nozzles.
- Blow the nozzles from the sprayer side toward the connector.
- Visually check that there is no rust on any of the system components. Replace all rusted components.
- Visually check the plastic and rubber on the connectors for wear. Replace any worn components.
- Reassemble the system.

After an accident not involving fire in which the system is not activated:

- check that all the fastening screws in the system are tight, especially those securing the bottle. If any of the screws have come unfastened, replace them with new ones.
- check that the bottle fasteners have not been warped in any way. If there are any deformations replace the fastening brackets.
- visually check the integrity of the hoses and orientation of the nozzles. Replace any damaged components.
- perform all the checks described in the "before every race" section.

After activation of the system when no fire was present:

- have the bottle recharged by OMP or an OMP licensee.
- clean the system as described in the section "in the event the vehicle is flooded".
- perform all checks required in the event of an accident not involving fire and in which the system is not activated.

After activation of the system when fire was present:

- have the bottle recharged by OMP or an OMP licensee
- replace the protective sheathes on the hoses.
- clean the system.
- perform all checks required in the event of an accident not involving fire and in which the system is not activated.

2.12.5 Warranty

OMP extinguishing systems are guaranteed for a period of 24 months from the date of purchase in accordance with EC Directive 99/ 44.

In countries outside the European Union, the warranty period may be different: in this case the period dictated by the law in the country in which the extinguishing system was purchased will apply.

The warranty allows you to request replacement or repair of the extinguishing system free of charge from the dealer from which you purchased the product if during the warranty period manufacturing defects arise that are not attributable to use outside that described in this instruction manual.

Extinguishing systems with a damaged tamper-proof seal will not be serviced under the warranty, as they will be considered to have been tampered with.

The warranty will be voided in the event that the extinguishing system is used incorrectly or in the event of inappropriate maintenance.

Any use of the extinguishing system that deviates from the information provided in this manual voids the warranty and relieves OMP Racing of all responsibility to the user.

Maintenance on the system must be performed by OMP or by an authorized licensee. Maintenance that deviates from the information provided in this manual voids the warranty and relieves OMP Racing of all responsibility to the user.

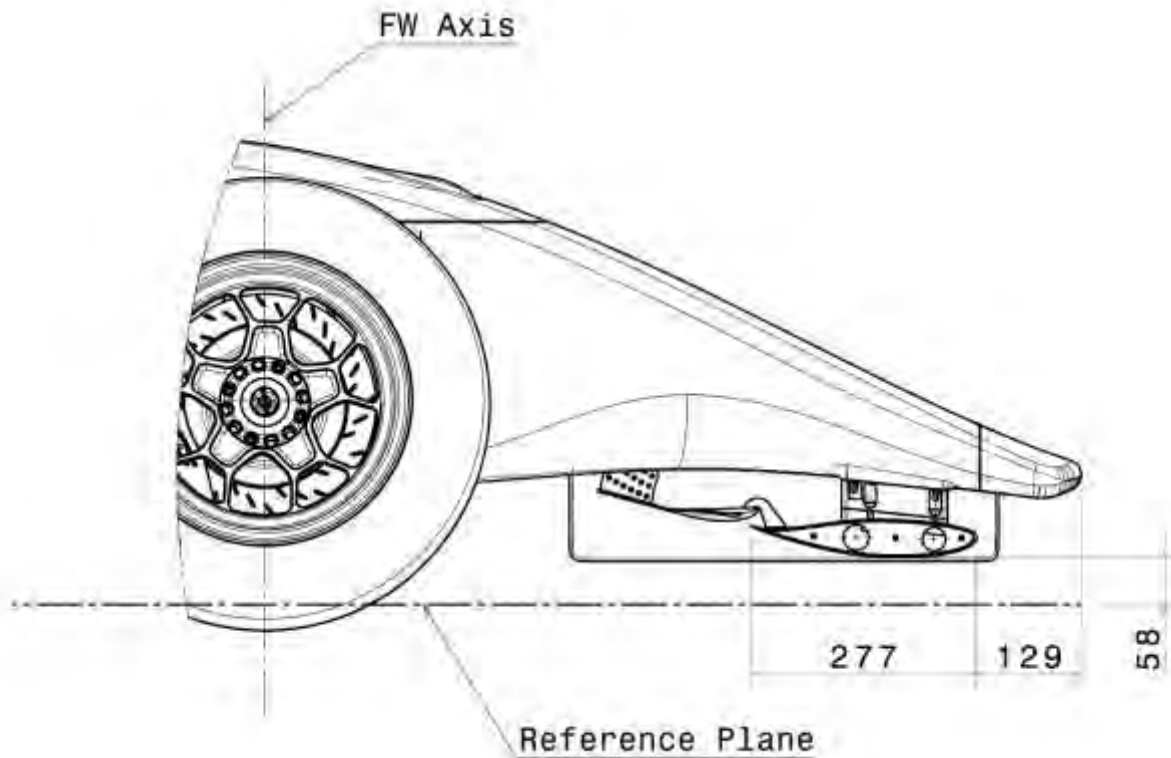
Never modify or alter your OMP extinguishing system. Alterations or modifications to the extinguishing system nullify the warranty and increase the risk of injury.

3 CHASSIS

3.1 WORKSHOP TOOLS

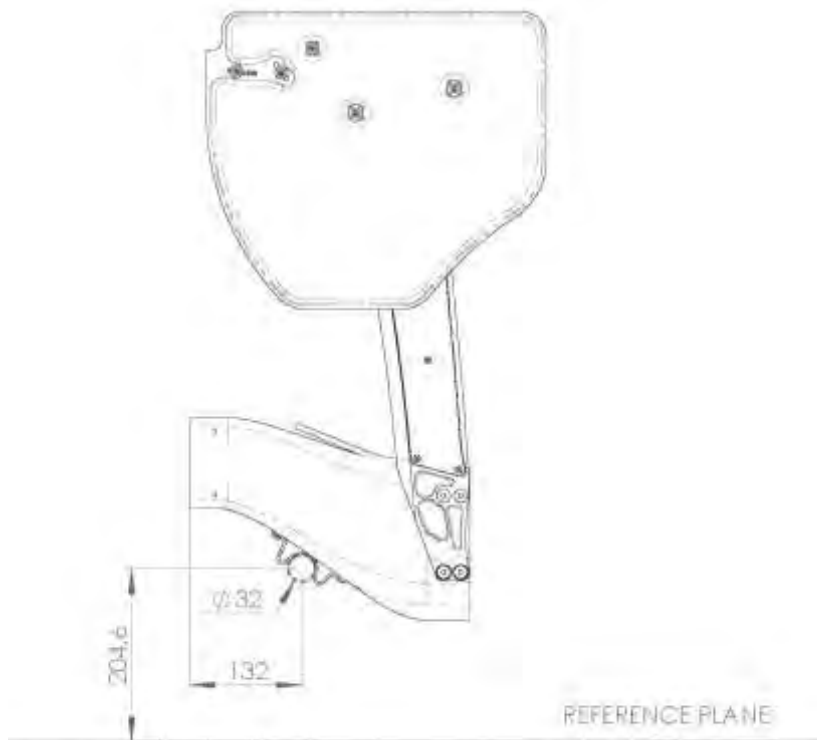
3.1.1 Front Jacking

The highlighted area is suitable to carry the weight of the car, the jack plate should fit as better as possible the underwing surface.



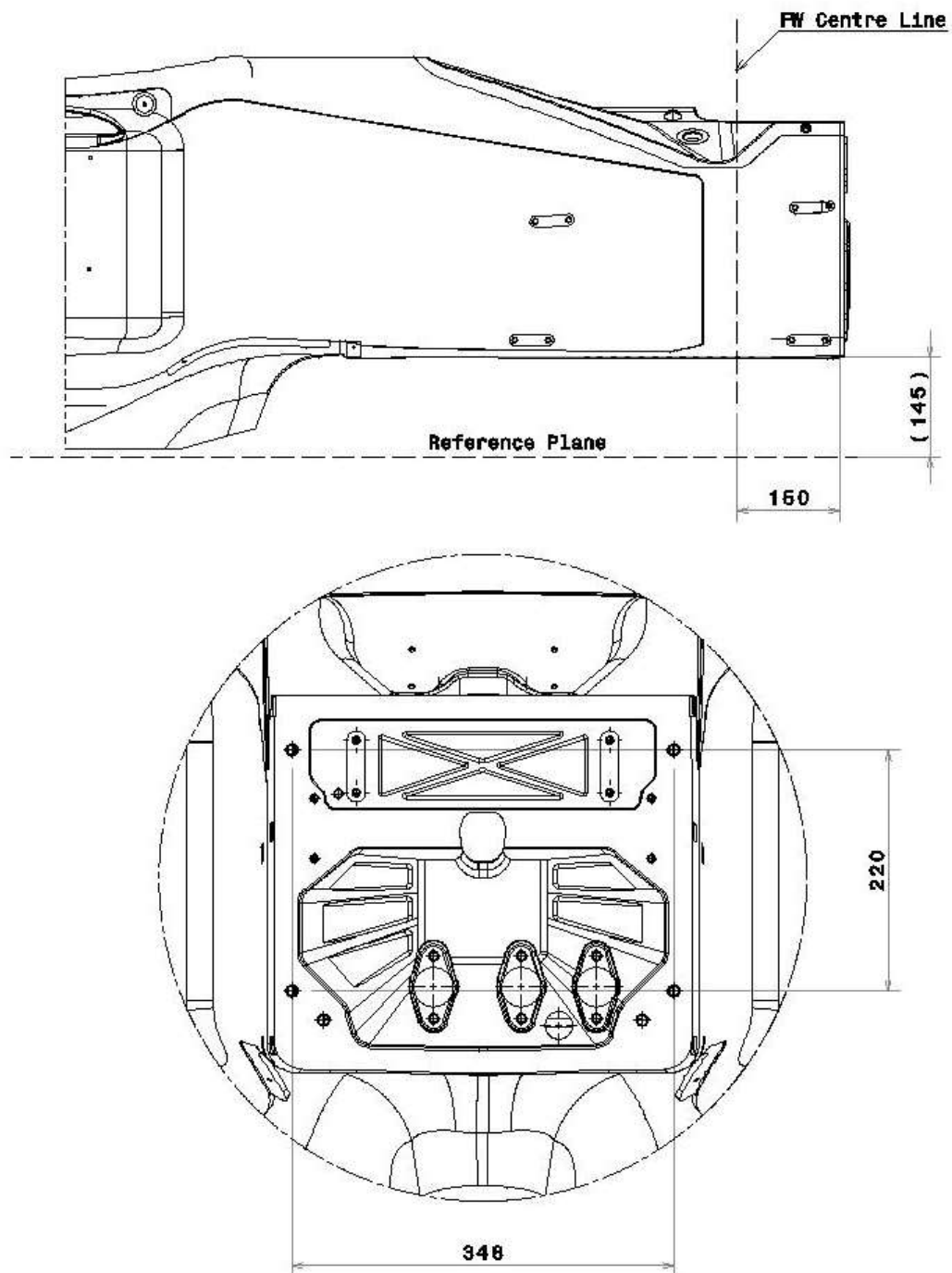
3.1.2 Rear Jacking

The highlighted jacking points are suitable to carry the weight of the car.



3.2 SETUP TOOLS

Here below some views of the main reference points



3.3 STANDARD SET-UP

Standard set-up sheet, refer to specific chapter for adjustment details:

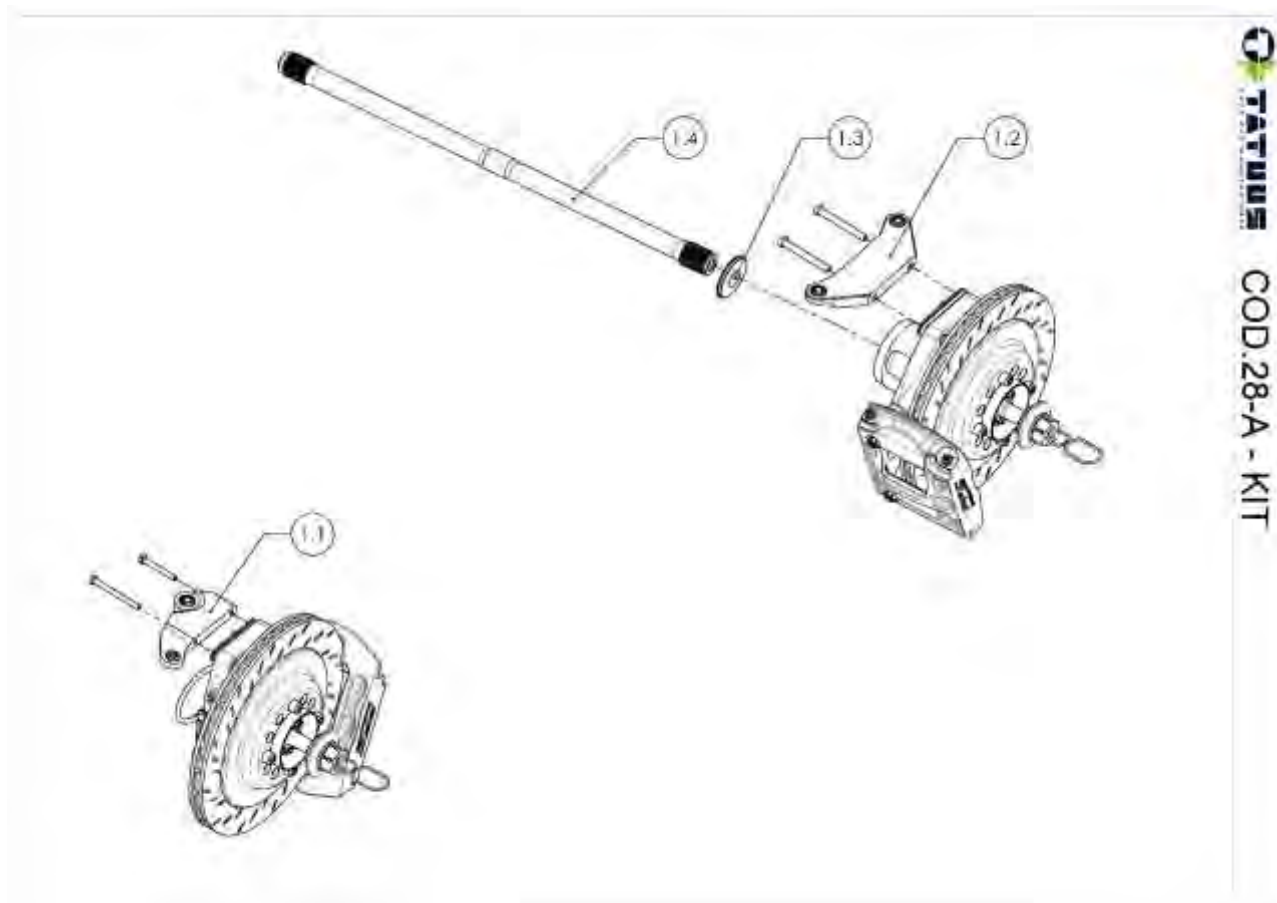
3.3.1 Road Course Set-Up

		FRONT		REAR	
GEOMETRY	Ride Height [mm]	20		34	
	Camber [deg]	-4.0°		-2.5°	
	Toe (Total) [deg]	+20' (out)		- 10' (in)	
	Rear Suspension position	BF13			
SUSPENSIONS	Springs [lb/in]	1100		1000	
	Spring preload [Turn]	1		1	
	Anti-roll [mm]	11,5		8,0	
	Anti-roll blade	H/H		H/H	
	Damper bump [0 click: full closed]	LS:8	LS:8	LS:8	HS:8
	Damper reb [0 click: full closed]	LS:8	HS:8		
AERO	Wing position	22° (B2)		15°(E5)	
	Gurney [mm]	--		--	
BRAKES	Master cylinder [mm]	17,8		20,6	
GEAR/DIFF	Diff Ramp on power	55			
	Diff Ramp off power	75			
	Diff plates config	6			
TIRES	Tire pressure (hot) [psi]	21		20	

3.3.2 Oval Set-Up

In order to achieve positive camber angles some specific parts are available (refer to spare catalogue group 28):

1.1	21 16 07 019	Front Ackermann
1.2	21 16 11 007	Rear Ackermann
1.3	09 09 11 007	Halfshaft stop
1.4	F0085934	Halfshaft



TATUUS COD.28-A - KIT

		FRONT		REAR	
GEOMETRY	Ride Height [mm]	20	25	40	42
	Camber [deg]	+2.6°	-5.2°	+2.3°	-3.8°
	Toe (Total) [deg]	+1.5mm (out)	+1.5mm (out)	+1.0mm (out)	0mm
	Rear Suspension position	BF13			
SUSPENSIONS	Springs [lb/in]	1000	1100	800	900
	Spring preload [Turn]	0.5	0.5	0.5	0.5
	Anti-roll [mm]	13,5		10.5	
	Anti-roll blade	H/H		S/S	
	Damper bump [0 click: full open]	LS:6	LS:8	LS:1	LS:3
	Damper reb [0 click: full open]	LS:6	LS:4	LS:3	LS:1
AERO	Wing position	23° (B3)		51°(E5)	
	Gurney [mm]	--		--	
BRAKES	Master cylinder [mm]	17,8		20,6	
GEAR/DIFF	Diff Ramp on power	55			
	Diff Ramp off power	75			
	Diff plates config	6			
TIRES	Tire pressure (hot) [psi]	20	28	20	28

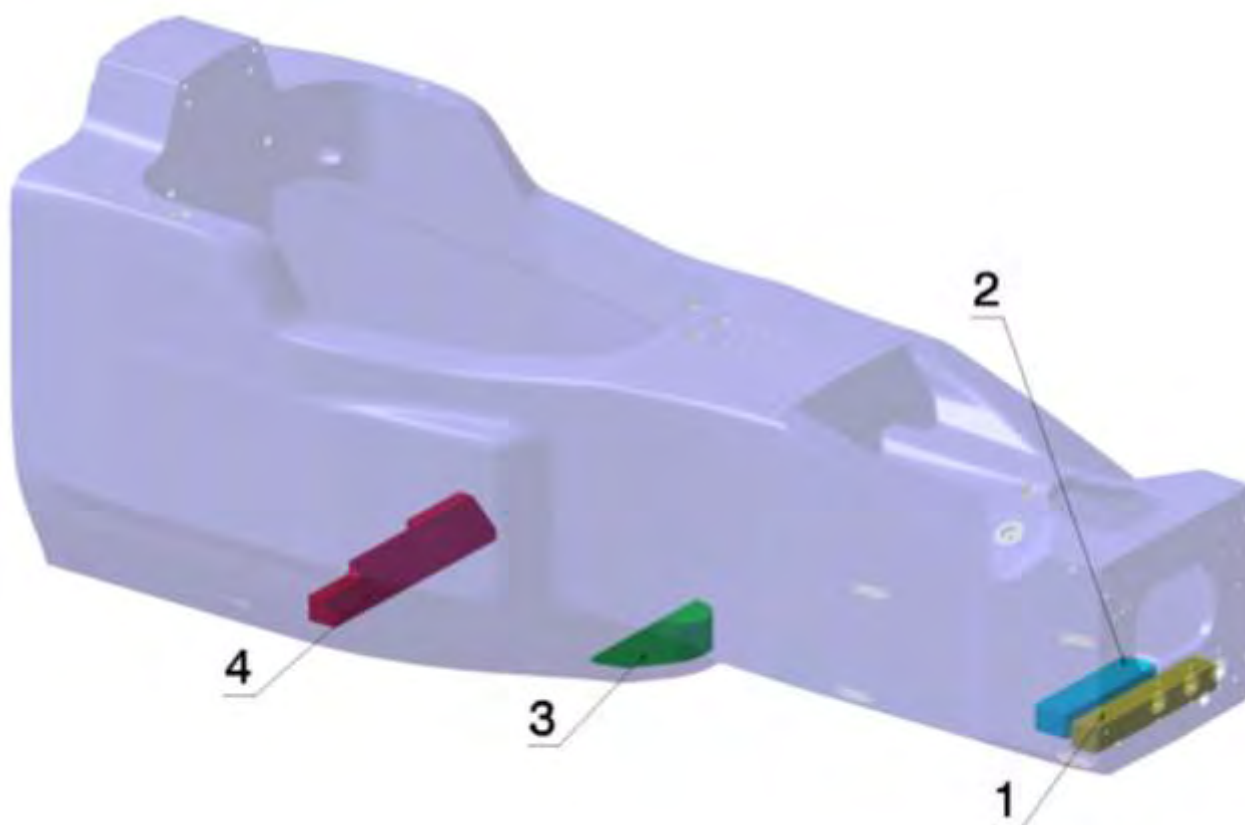
3.4 WEIGHT AND BALLAST

In order to achieve the minimum racing weight of the car it is possible to add ballast manufactured from steel, provided it is fitted in the allowed places (see pictures below) and it is fixed in such a way that tools are required for its removal.

Ballast may be constructed from steel plates or machined from solid. Welding the plates together is permitted.

It is allowed to install ballast in the following prescribed positions:

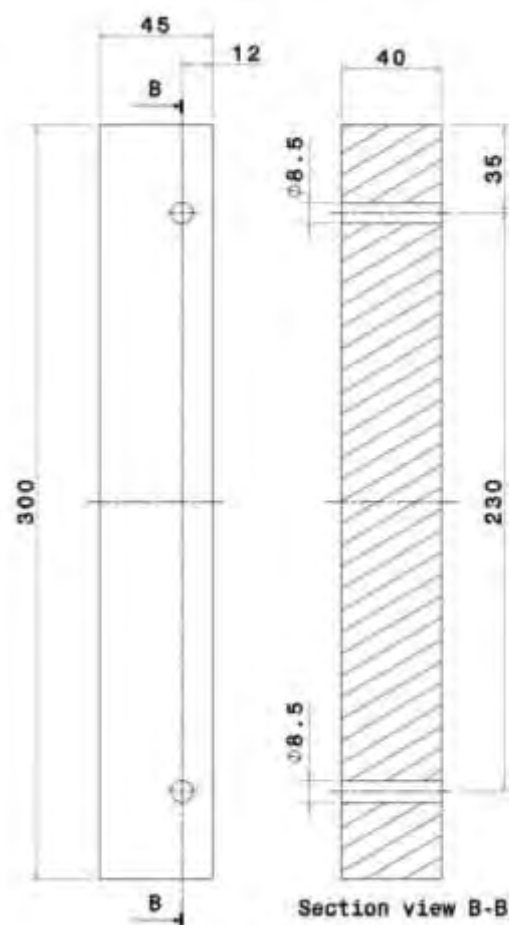
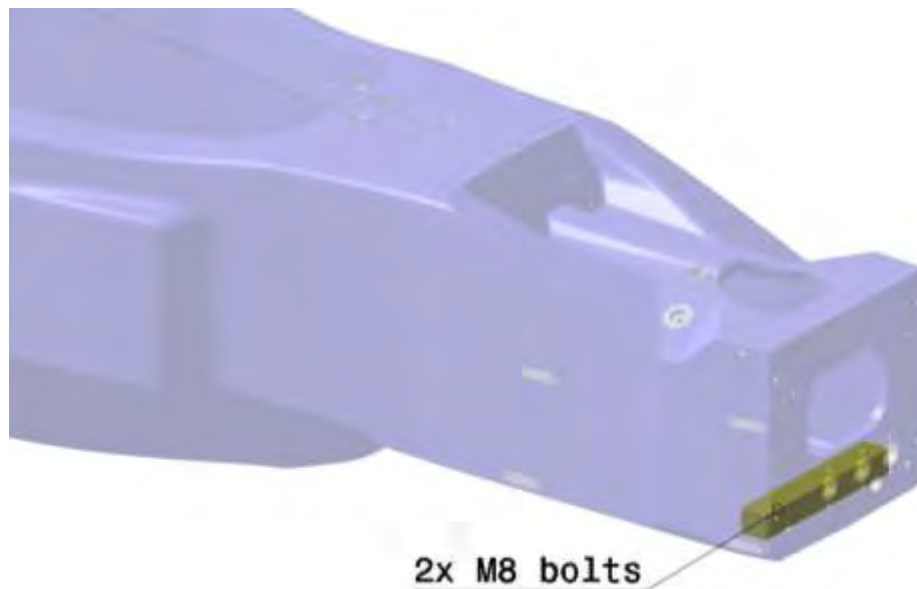
1. Front ballast
2. Pedal box ballast
3. Keel ballast
4. Driver seat ballast



3.4.1 Front ballast

Maximum 5.5 kg, fixings 2x M8 bolts. WARNING: check for any possible interference between ballast and pedals or master cylinder push rods in any functional position, and any pipes and cables or connectors. It is permitted to locally modify the ballast to achieve a necessary 10mm minimum clearance to pedal parts and 5mm minimum to pipes, cables and connectors.

(Guide drawing of overall dimensions for ballast shown below)

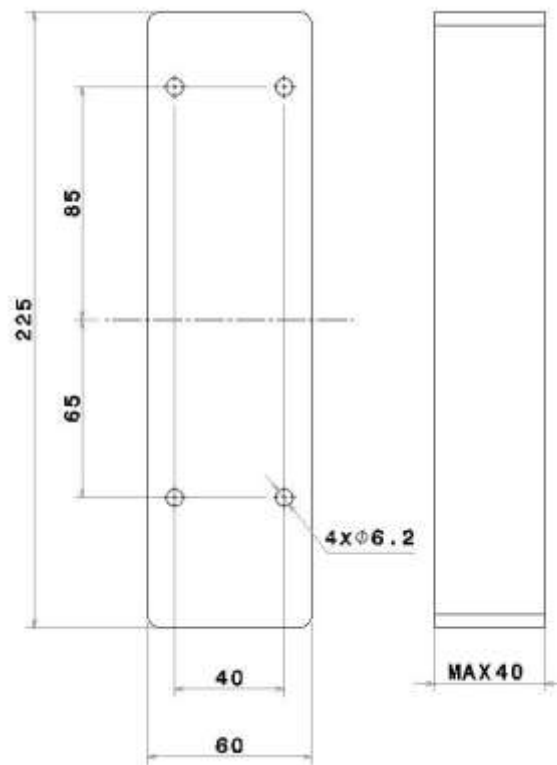
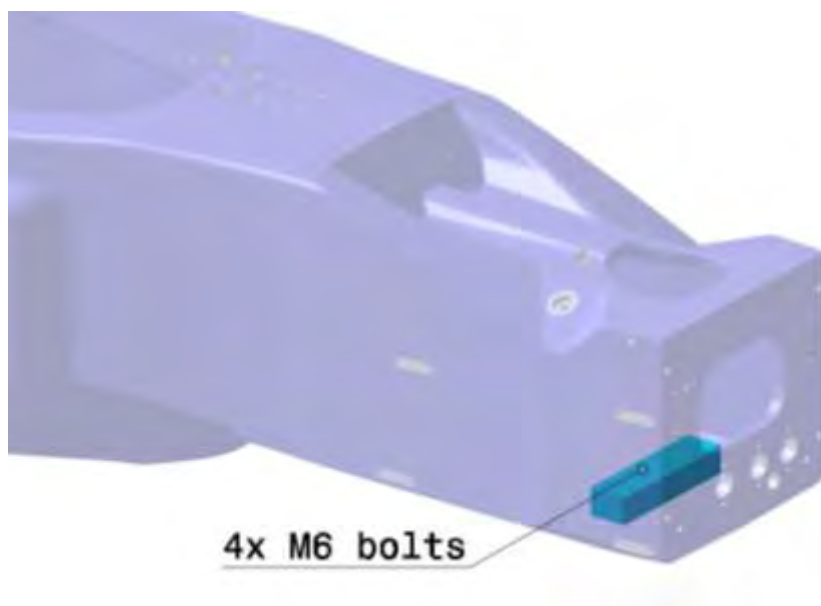


3.4.2 Pedal box ballast

Maximum 4.5 kg, fixings 4x M6 bolts. Emplacement available only for short drivers, two sets of pedal holes must be free.

WARNING: check for any possible interference between ballast and pedals or master cylinder push rods in any functional position, and any pipes and cables or connectors. It is permitted to locally modify the ballast in order to achieve the necessary 10mm min clearance to pedal parts and 5mm to pipes and cables. In the case of a very short driver, and when using the rearmost pedal bracket mounting holes, additional pedal box ballast may be added to the redundant pedal bracket holes. The minimum clearances of 10mm to pedal parts and 5mm to pipes, cables and connectors must be respected.

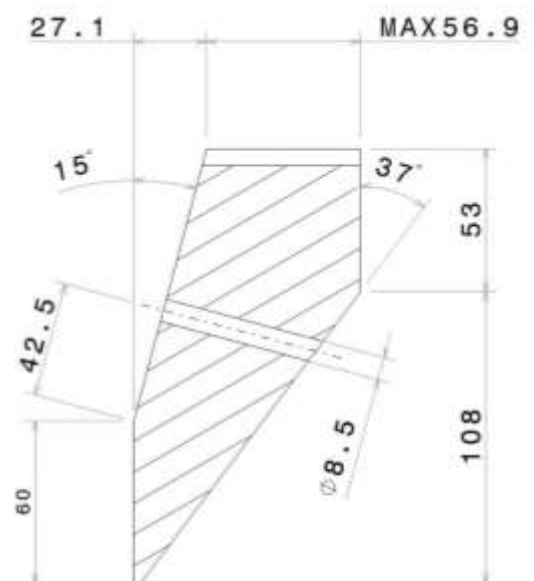
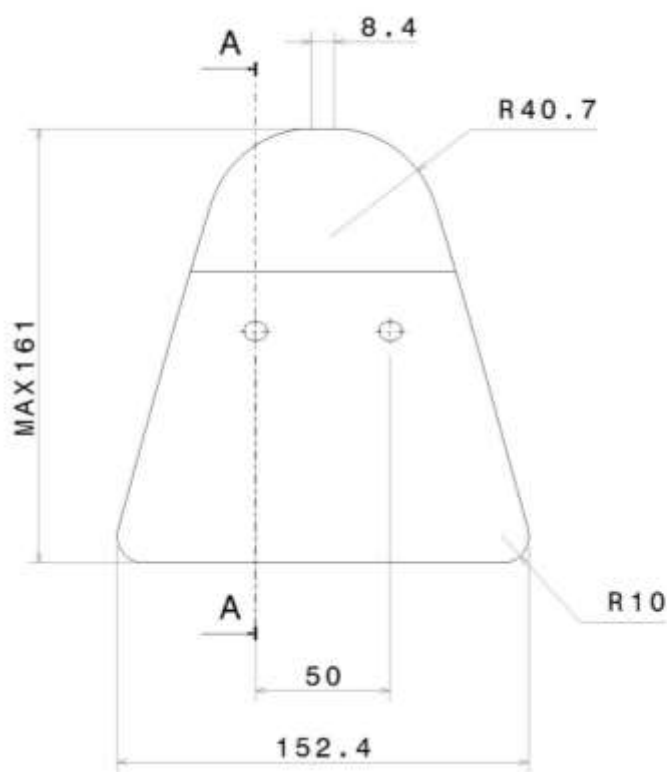
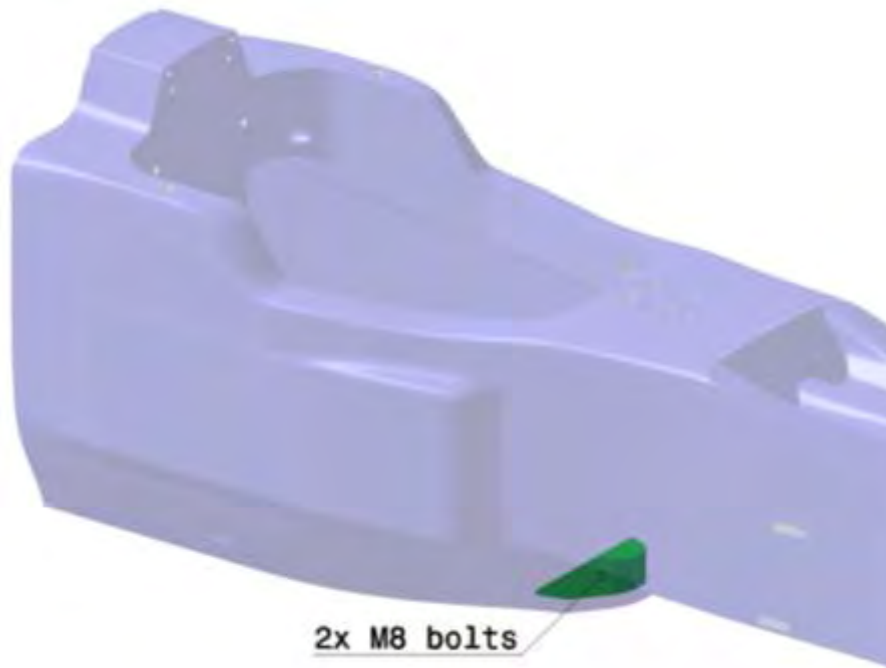
(Guide drawing of overall dimensions shown below)



3.4.3 Keel ballast

Maximum 6 kg, fixings 2x M8 bolts.

(Guide drawing of overall dimensions for ballast shown below)



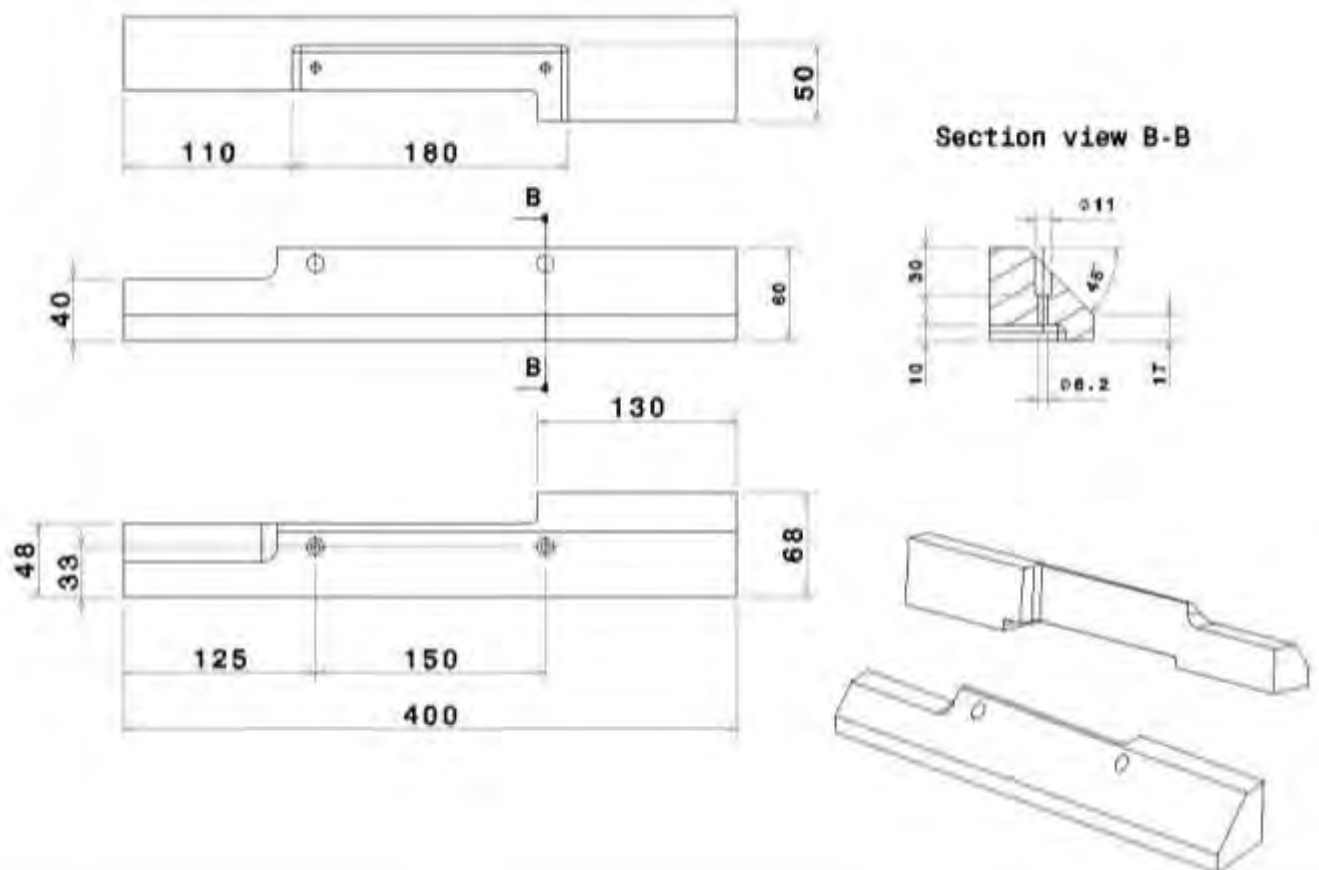
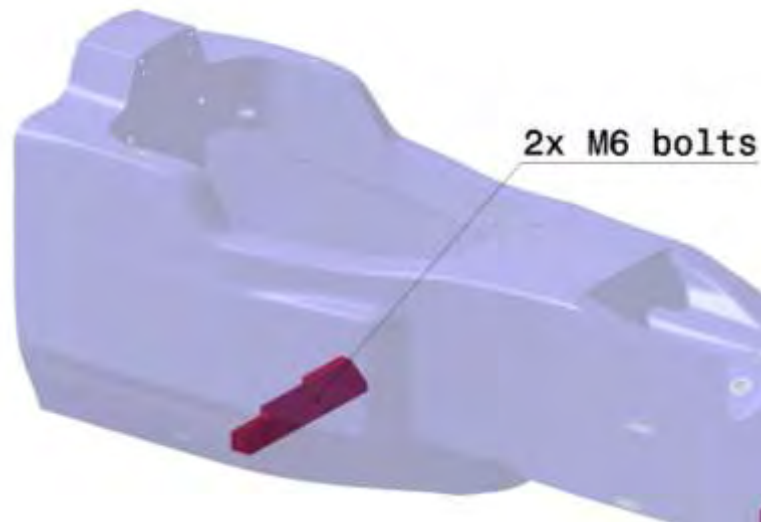
Section view A-A

3.4.4 Driver seat ballast

Maximum 10.0 kg, fixings 2x M6 bolts.

The electronic carrier plate must remain in its original position (sitting on the floor), the ballast must sit on top of this plate. It is permitted to locally modify the ballast to achieve clearance to adjacent cables and connectors.

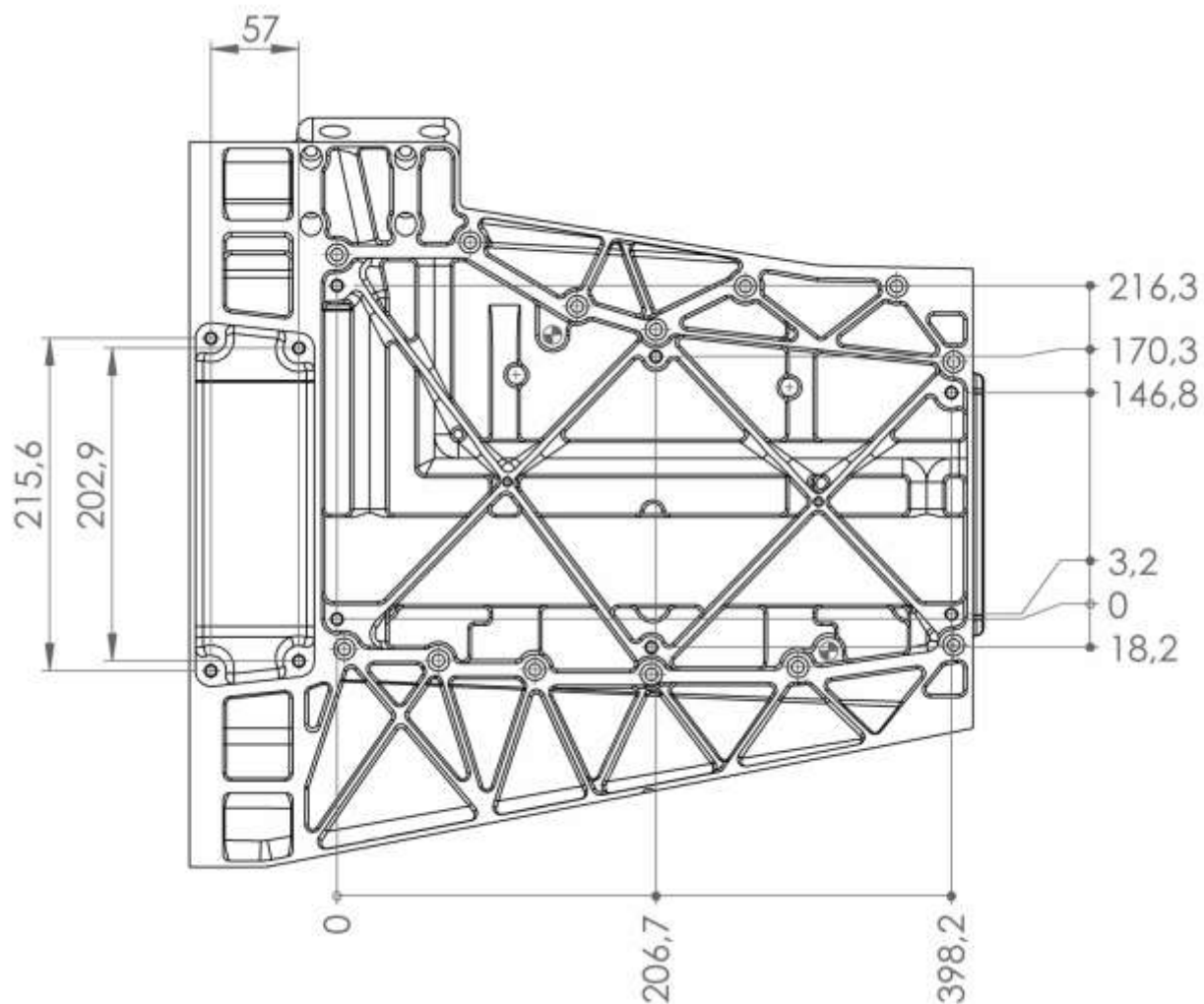
(Guide drawing of overall dimensions for ballast shown below)



3.4.5 Engine ballast

Please refer to the engine manufacturer for further details and prescriptions.

Max 15.0 kg, fixation 4x M8 bolts + 6x M8 bolts



3.5 COCKPIT

3.5.1 Commands and procedures

On the cockpit panel you can find:

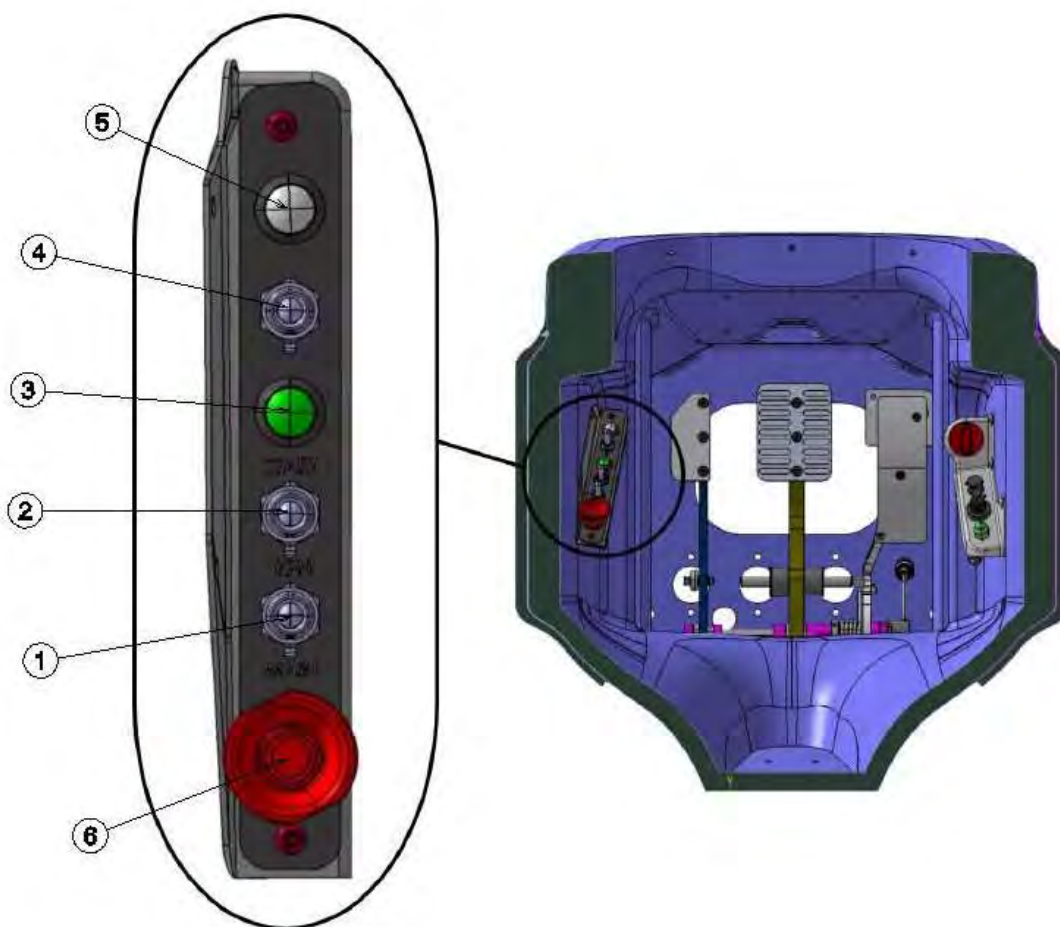
- [1] Main power switch: master switch is ON;
- [2] Ignition switch: ignition coils, injectors and alternator are powered;
- [3] Starter button (GREEN): starter motor is cranking (note that this button will crank the starter in any condition but the engine will fire up only if Ignition is ON);
- [4] Not operational
- [5] FUEL button: fuel pump override.

All the switches are ON when HIGH.

The starter button [3] can be used to crank the engine and raise up the oil pressure only if ignition switch [2] is off.

Before the engine start check to be in neutral gear, then push master switch ON [1], switch ON ignition [2], press starter button [3].

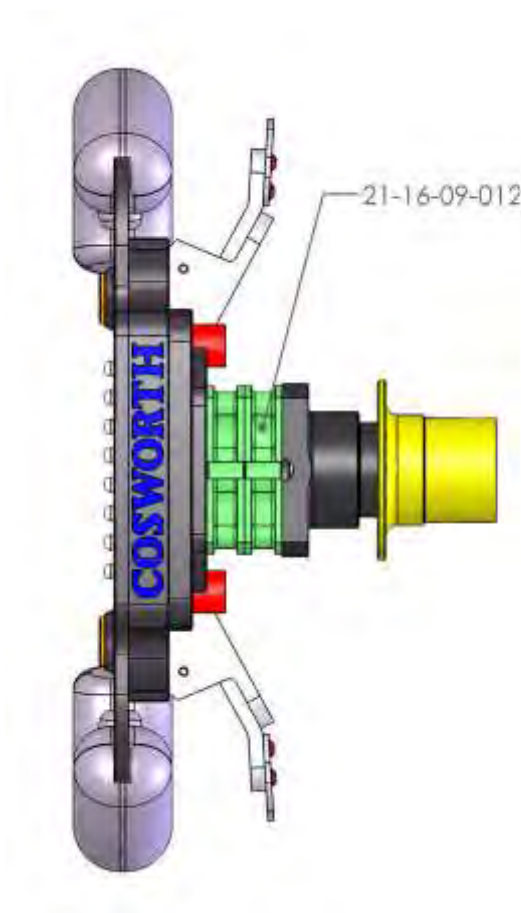
To switch off the engine it is strongly recommended to turn ignition switch OFF [2], this procedure will allow all the systems to complete the shutdown procedure.



3.5.2 Steering Wheel

Installation adjustment:

The spacers [21-16-09-012] allow the adjustment of driver position depth, each spacer add 13mm and can be stack up to three.

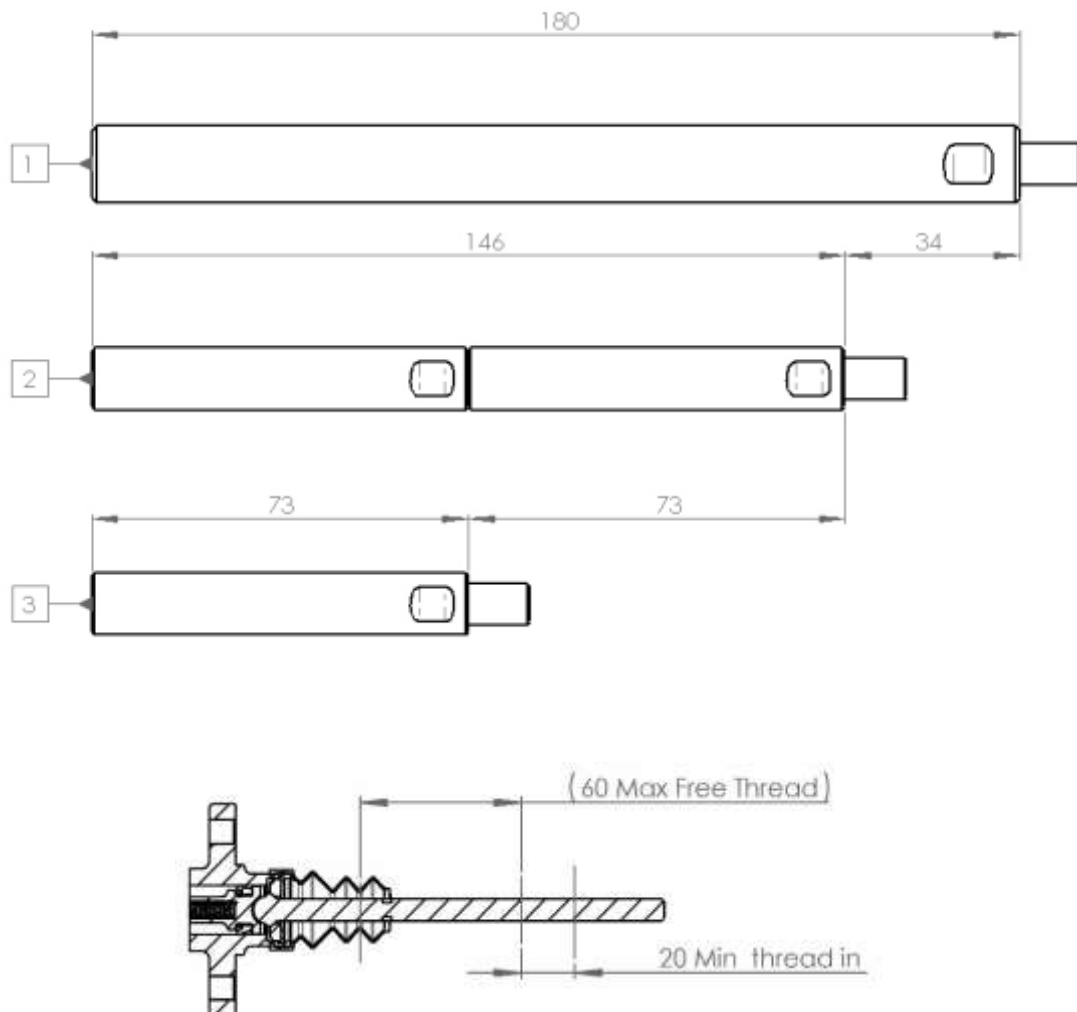


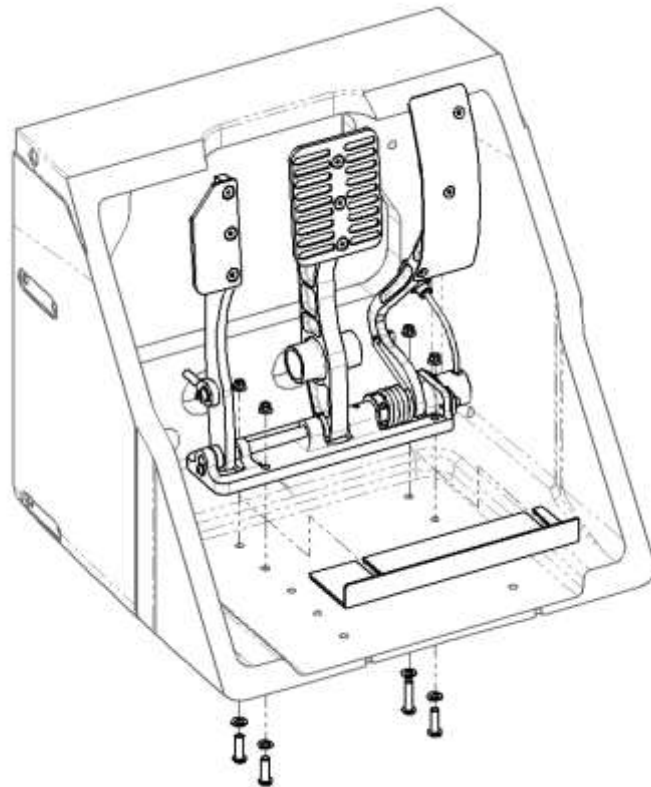
3.5.3 Pedals

The pedal box can be adjusted in position, five positions are available in the chassis, when pedal box is moved backward the pedal rod have to be adjusted to reach the master cylinders, here below the available options:

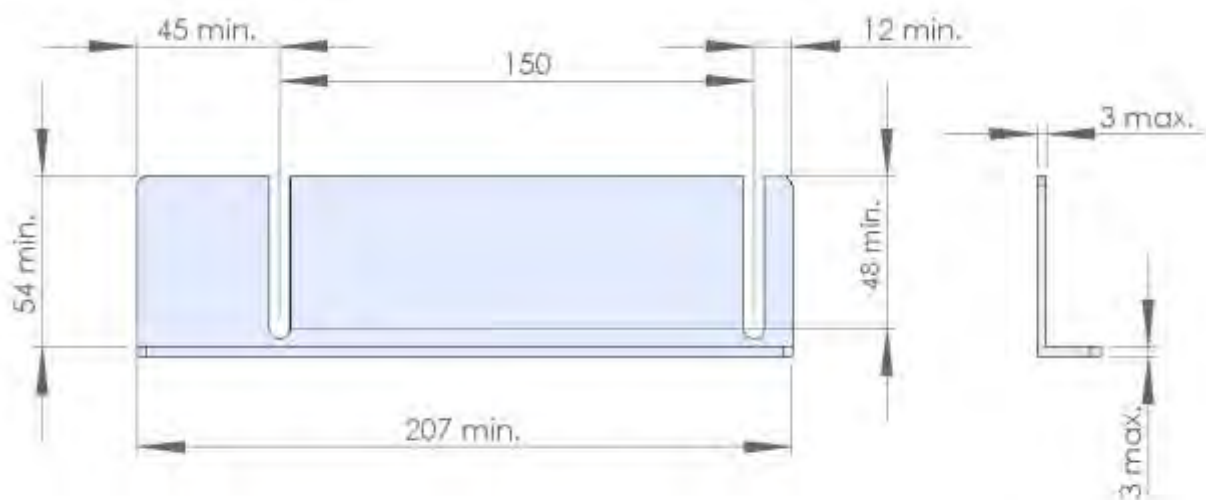
1. Long rod (ref. 16-15-16-005): it has to be added to the AP rod, the total length of the rod must be shorter than 330mm. The AP rod must be shorter than 100mm (max 60mm free thread).
2. Medium rod (2x ref. 08-06-16-009) two aluminum rod 08-06016-009 can be stacked (it must be carefully checked the planarity of the connection between the rod surfaces), the assembled rod is then tighten over the AP rod, the total length of the rod must be shorter than 280mm. The AP rod must be shorter than 100mm (max 60mm free thread).
3. Short rod (ref. 08-06-16-009) one aluminum rod 08-06016-009 has to be added to the AP rod, the total length of the rod must be shorter than 210mm. The AP rod must be shorter than 100mm (max 60mm free thread).
4. No extension rod: the original AP master cylinder rod can be kept, (overall length AP rod plus bracket about 180mm)

(Replacement AP rods are ref AP 2142-22)

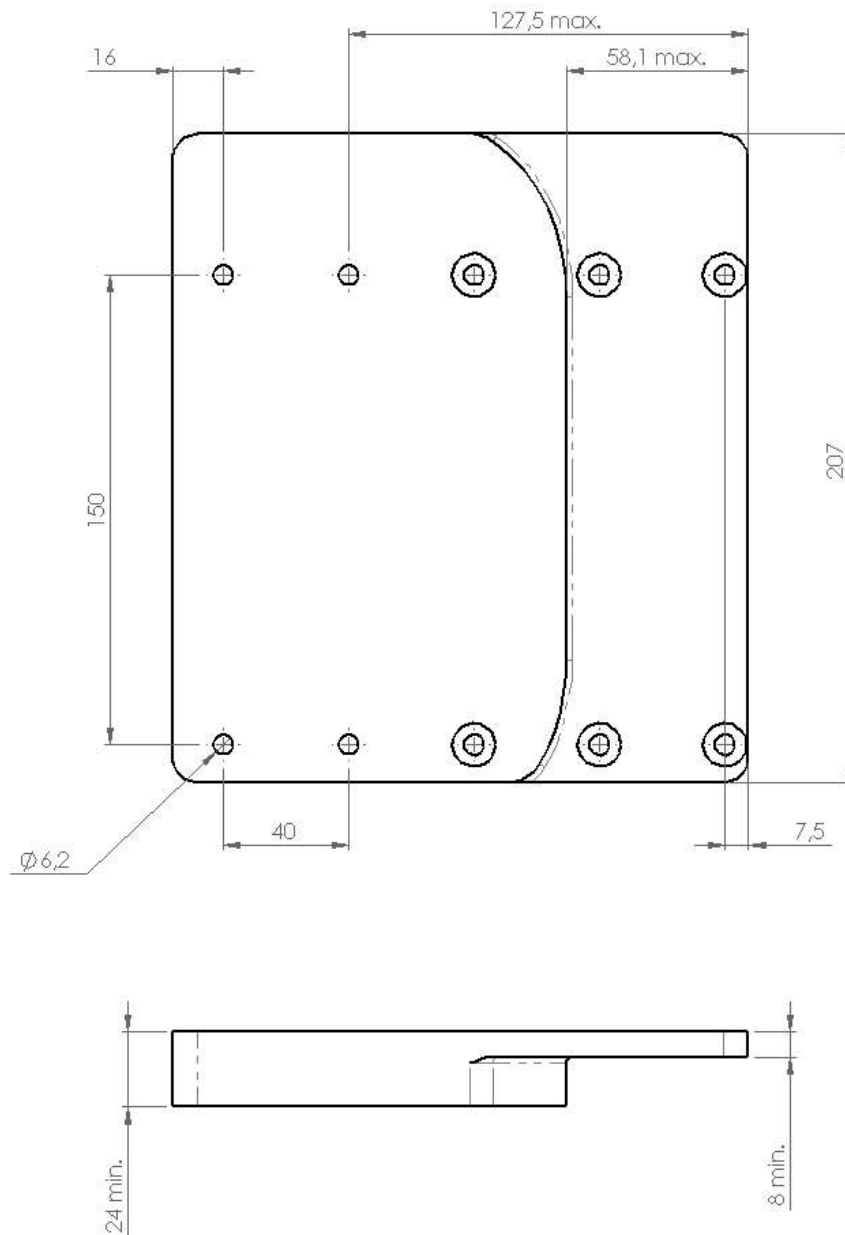




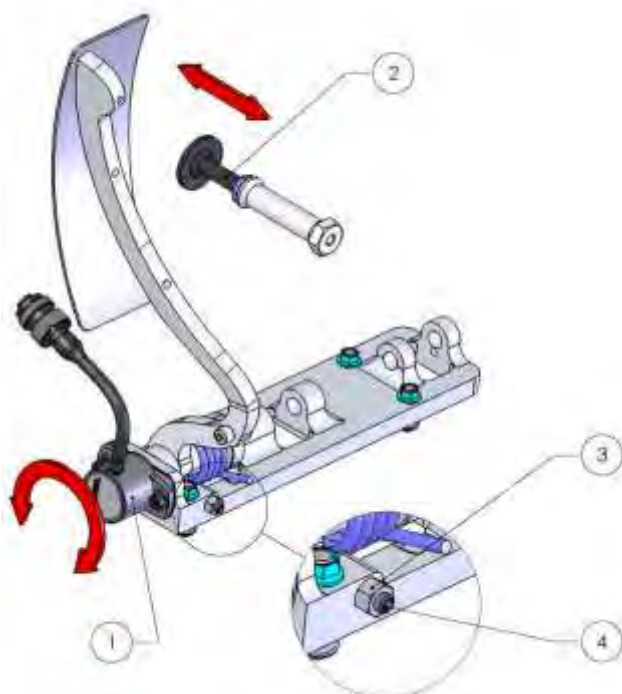
An aluminum heel rest plate can be added, here below a guideline sketch:



For very short driver customers are allowed to manufacture a pedal plate in order to shift backwards the pedal box, here below the guidelines:

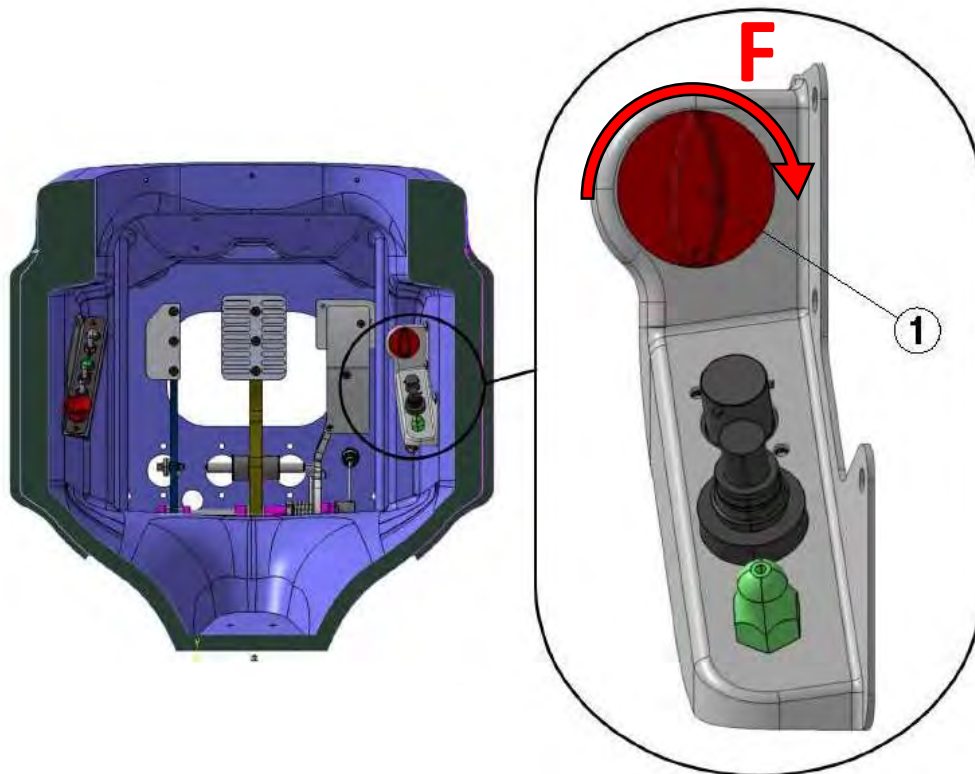


The throttle pedal potentiometer has to be set in order that when the pedal is in the idle position the voltage is set according to Cosworth prescriptions.

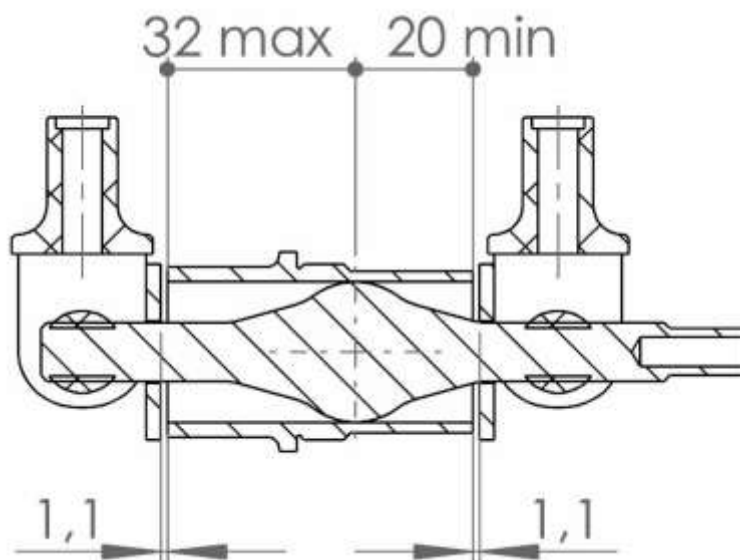


3.5.4 Brake Bias

Brake bias can be adjusted by the knob located on the top right corner of the cockpit, rotating the knob counter-clockwise will shift brake balance toward front.



It is recommended to leave about 2.2mm total free play between pedal bush and master cylinder rod bushes.



An excessive brake balance shift toward one of the axles, or an excessive asymmetry in master cylinder rod, could result in an abnormal wearing of the balance bar, if some groove is appearing on the bar the part must be immediately replaced.

It is recommended to replace balance bar every 10.000 km.



3.5.5 Brake Bias Cable

Two options are available:

- Standard length with p/n 161815005.
- Long version with p/n 2805001.

4 AERODYNAMICS

4.1 GENERAL NOTES

Drag [SCx]: total drag (including wheels) of the car resolved to the tire contact point.

Downforce [SCz]: total downforce generated by the car.

Front downforce: downforce acting at the front contact patches.

Rear downforce: downforce acting at the rear contact patches.

Balance %F: percentage of the total downforce acting at the front contact patches.

$E = L/D$: vehicle efficiency

All dimensions are full scale

All forces are reported as percentage from the datum point measurements (or its extension, see chapter 5.15.1).

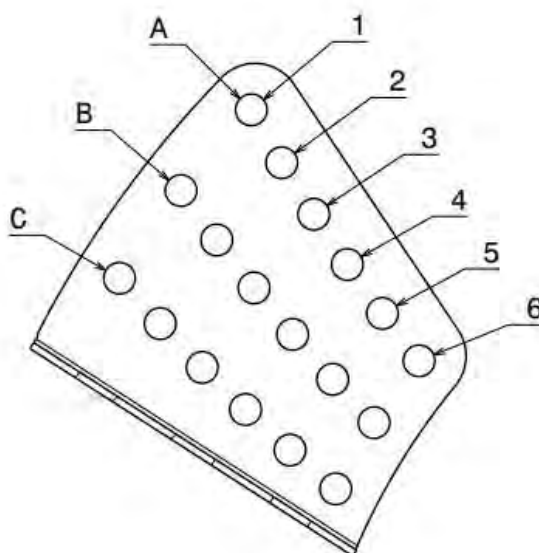
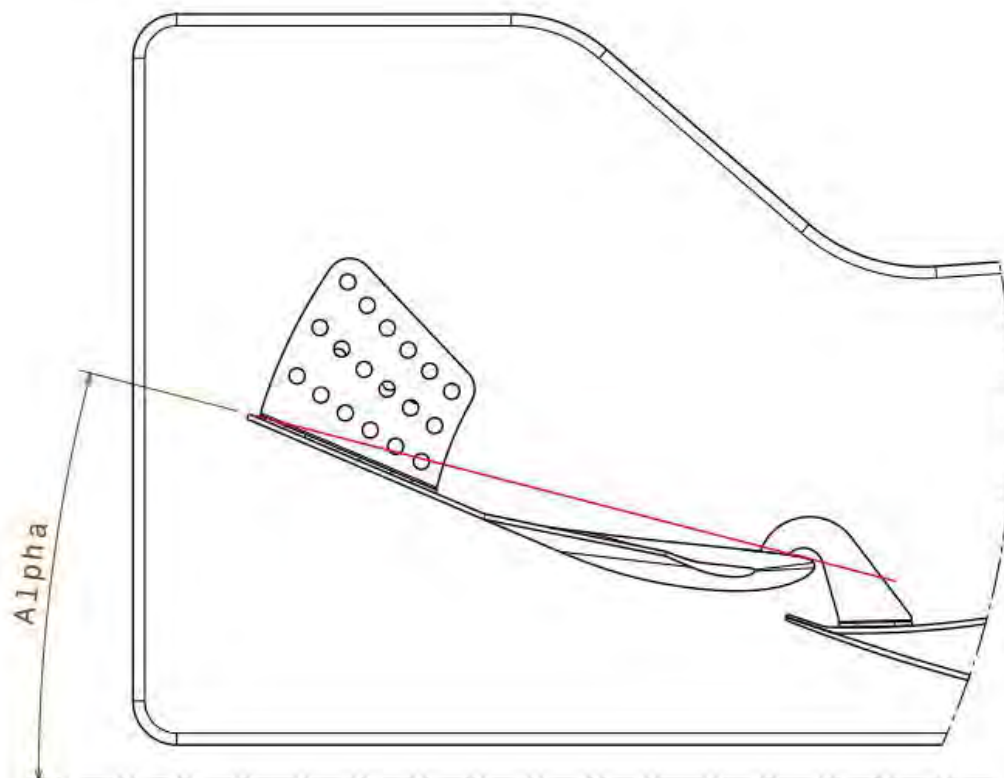
Aerodynamic loading is a function of atmospheric conditions:

- 5°C increase in ambient temperature from ISA conditions result in a 2.7% reduction in aerodynamic forces.
- 10 mbar increase in air pressure from ISA conditions results in a 1% increase in aerodynamic forces.
- 50% increase in humidity from ISA conditions results in a 0.3% reduction in aerodynamic loading.

4.2 FRONT WING SETTING

Front flap angle is adjustable via plates as indicated in the following pictures.

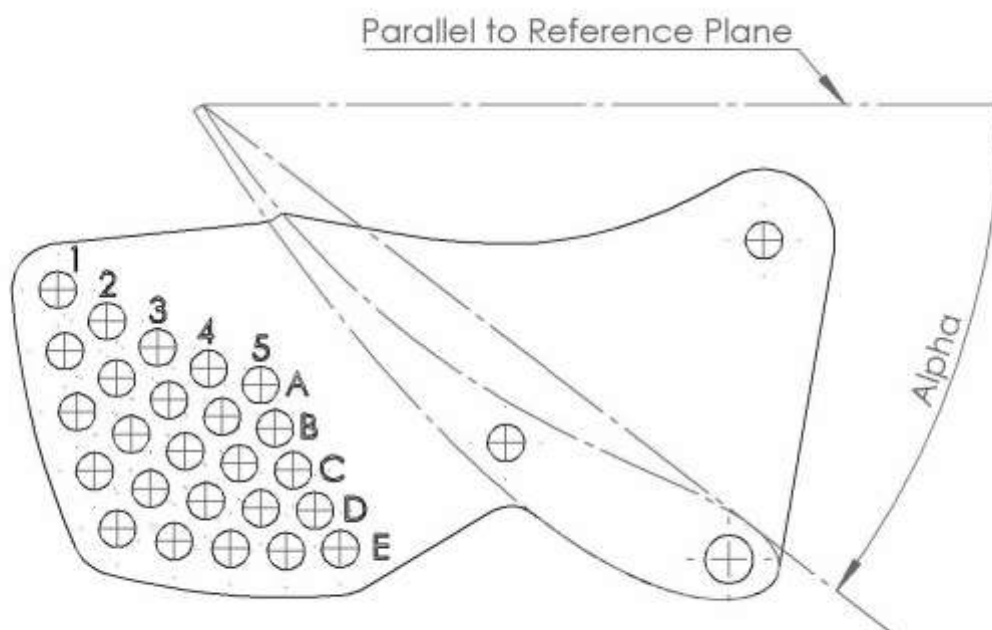
Angles are referred to a line which pass through the flap trailing edge and is tangent to the flap upper surface (highlighted in red in the figure below).



	1	2	3	4	5	6
A	6.5°	7.5°	8.5°	9.5°	10.5°	11.5°
B	12.5°	13.5°	14.5°	15.5°	16.5°	17.5°
C	18.5°	19.5°	20.5°	21.5°	22.5°	23.5°

4.3 REAR WING SETTING

Rear flap angle is adjustable via plates:



	1	2	3	4	5	
A	27°	28°	29°	30°	31°	A
B	32°	33°	34°	35°	36°	B
C	37°	38°	39°	40°	41°	C
D	42°	43°	44°	45°	46°	D
E	47°	48°	49°	50°	51°	E

4.4 AERODYNAMIC REFERENCE SETUP

Aerodynamic baseline setup (datum):

Front Ride Height: 10 mm
 Rear Ride Height: 25 mm
 Front Wing angle: 3°
 Front Flap angle: 20° (C3)
 Rear Wing angle: 45° (D4)

At the datum point aerodynamic coefficients will be:

Scz = 100%

Scx = 100%

%F = 42.8%

4.5 FRONT WING SENSITIVITY

The following table report the percentage changes from the datum point resulting from the change of front flap angle:

	SCz	SCx	%F
DFW (1 deg)	+0.29%	+0.10%	+0.77%

4.6 REAR WING SENSITIVITY

The following table report the percentage changes from the datum point resulting from the change of rear wing angle:

	SCz	SCx	%F
DRW (1 deg)	+0.44%	+0.51%	-0.33%

4.7 RIDE HEIGHT SENSITIVITY

Following tables report the percentage changes from the datum point resulting from changes in ride height:

SCz		FRH										
		5	6	7	8	9	10	11	12	13	14	15
FRH	10	108.5%	107.8%	107.1%	106.5%	105.8%	105.1%					
	12.5	108.1%	107.3%	106.5%	105.7%	104.9%	104.2%	103.8%	103.5%			
	15	107.6%	106.7%	105.8%	105.0%	104.1%	103.2%	102.6%	102.1%	101.5%	100.9%	100.4%
	17.5	107.0%	106.0%	105.1%	104.2%	103.3%	102.4%	101.6%	100.8%	100.1%	99.3%	98.6%
	20	106.3%	105.4%	104.4%	103.4%	102.5%	101.5%	100.6%	99.6%	98.7%	97.7%	96.8%
	22.5	105.5%	104.5%	103.6%	102.6%	101.7%	100.8%	99.7%	98.6%	97.5%	96.4%	95.4%
	25	104.6%	103.7%	102.8%	101.9%	100.9%	100.0%	98.8%	97.6%	96.4%	95.2%	94.0%
	27.5	103.6%	102.8%	101.9%	101.1%	100.2%	99.3%	98.1%	96.8%	95.5%	94.2%	93.0%
	30	102.6%	101.8%	101.0%	100.2%	99.5%	98.7%	97.3%	96.0%	94.7%	93.3%	92.0%
	32.5	101.3%	100.7%	100.1%	99.4%	98.8%	98.1%	96.8%	95.4%	94.1%	92.7%	91.4%
	35	100.1%	99.6%	99.1%	98.6%	98.1%	97.6%	96.2%	94.9%	93.5%	92.1%	90.8%
	37.5	98.7%	98.4%	98.0%	97.7%	97.4%	97.1%	95.8%	94.5%	93.2%	91.9%	90.6%
	40	97.2%	97.1%	97.0%	96.9%	96.8%	96.7%	95.4%	94.2%	92.9%	91.6%	90.4%

SCx		FRH										
		5	6	7	8	9	10	11	12	13	14	15
RRH	10	99.9%	99.8%	99.6%	99.5%	99.4%	99.3%					
	12.5	99.7%	99.6%	99.6%	99.5%	99.5%	99.4%	99.2%	99.0%			
	15	99.5%	99.5%	99.5%	99.6%	99.6%	99.6%	99.4%	99.2%	99.0%	98.7%	98.5%
	17.5	99.5%	99.5%	99.6%	99.6%	99.6%	99.7%	99.5%	99.3%	99.1%	98.9%	98.7%
	20	99.5%	99.5%	99.6%	99.7%	99.7%	99.8%	99.6%	99.4%	99.2%	99.0%	98.8%
	22.5	99.6%	99.6%	99.7%	99.8%	99.8%	99.9%	99.7%	99.5%	99.3%	99.2%	99.0%
	25	99.7%	99.7%	99.8%	99.9%	99.9%	100.0%	99.8%	99.7%	99.5%	99.3%	99.1%
	27.5	99.9%	100.0%	100.0%	100.0%	100.1%	100.1%	99.9%	99.8%	99.6%	99.5%	99.3%
	30	100.2%	100.2%	100.2%	100.2%	100.2%	100.2%	100.0%	99.9%	99.8%	99.6%	99.5%
	32.5	100.6%	100.5%	100.4%	100.4%	100.3%	100.3%	100.1%	100.0%	99.9%	99.8%	99.7%
	35	101.0%	100.8%	100.7%	100.6%	100.5%	100.3%	100.2%	100.2%	100.1%	100.0%	99.9%
	37.5	101.5%	101.3%	101.1%	100.8%	100.6%	100.4%	100.3%	100.3%	100.2%	100.1%	100.1%
	40	102.0%	101.7%	101.4%	101.1%	100.8%	100.5%	100.4%	100.4%	100.4%	100.3%	100.3%

%F		FRH										
		5	6	7	8	9	10	11	12	13	14	15
RRH	10	-2.7%	-3.3%	-3.9%	-4.6%	-5.2%	-5.8%					
	12.5	-1.8%	-2.4%	-3.0%	-3.6%	-4.2%	-4.8%	-5.2%	-5.5%			
	15	-0.9%	-1.5%	-2.0%	-2.6%	-3.2%	-3.7%	-4.1%	-4.5%	-4.9%	-5.3%	-5.6%
	17.5	-0.1%	-0.7%	-1.2%	-1.7%	-2.2%	-2.8%	-3.2%	-3.5%	-3.9%	-4.3%	-4.7%
	20	0.6%	0.1%	-0.3%	-0.8%	-1.3%	-1.8%	-2.2%	-2.6%	-3.0%	-3.4%	-3.8%
	22.5	1.3%	0.8%	0.4%	0.0%	-0.5%	-0.9%	-1.3%	-1.7%	-2.1%	-2.5%	-2.9%
	25	1.9%	1.5%	1.1%	0.8%	0.4%	0.0%	-0.4%	-0.8%	-1.2%	-1.6%	-2.0%
	27.5	2.4%	2.1%	1.8%	1.5%	1.1%	0.8%	0.4%	0.0%	-0.4%	-0.7%	-1.1%
	30	2.9%	2.7%	2.4%	2.2%	1.9%	1.7%	1.3%	0.9%	0.5%	0.1%	-0.3%
	32.5	3.3%	3.1%	3.0%	2.8%	2.6%	2.4%	2.0%	1.7%	1.3%	0.9%	0.5%
	35	3.7%	3.6%	3.5%	3.4%	3.3%	3.2%	2.8%	2.4%	2.1%	1.7%	1.4%
	37.5	4.0%	4.0%	3.9%	3.9%	3.9%	3.9%	3.5%	3.2%	2.8%	2.5%	2.1%
	40	4.3%	4.3%	4.4%	4.4%	4.5%	4.5%	4.2%	3.9%	3.6%	3.3%	2.9%

5 SUSPENSIONS

5.1 MEASUREMENT STANDARD

REFERENCE PLANE: it is the plane where skid plank (16 14 02 016) and wooden floor (16 14 02 016) are in contact, the skid plank is then the only suspended part of the car sitting below this plane.

RIDE HEIGHT: it is measured at the intersection between the vertical plane passing through the axle and the vehicle center line. Zero when reference plane is coincident with ground, positive change when the car is raised.

TOE: Zero when wheels are parallel, positive change when toe-out.

CAMBER: Zero when wheels are vertical, positive change when the top of the wheel is outward

CASTOR: Zero when steering axis is vertical, positive change when the contact patch is behind the intersection of steering axis and ground.

5.2 SETUP ADJUSTMENTS

		FRONT	REAR
RIDE HEIGHT +1 turn push rod adjust.	Pushrod	+2.25mm	+2.25mm
	RH	+5.1mm	+6.6mm
CAMBER Shim +1mm		0.31° (3.2 mm/°)	0.25° (4.0 mm/°)
TOE (TOTAL) +1 turn rod adjuster		1.28°	1.64°
Wheel/Damper ratio		1.21	1.31

5.3 FRONT PICK-UP

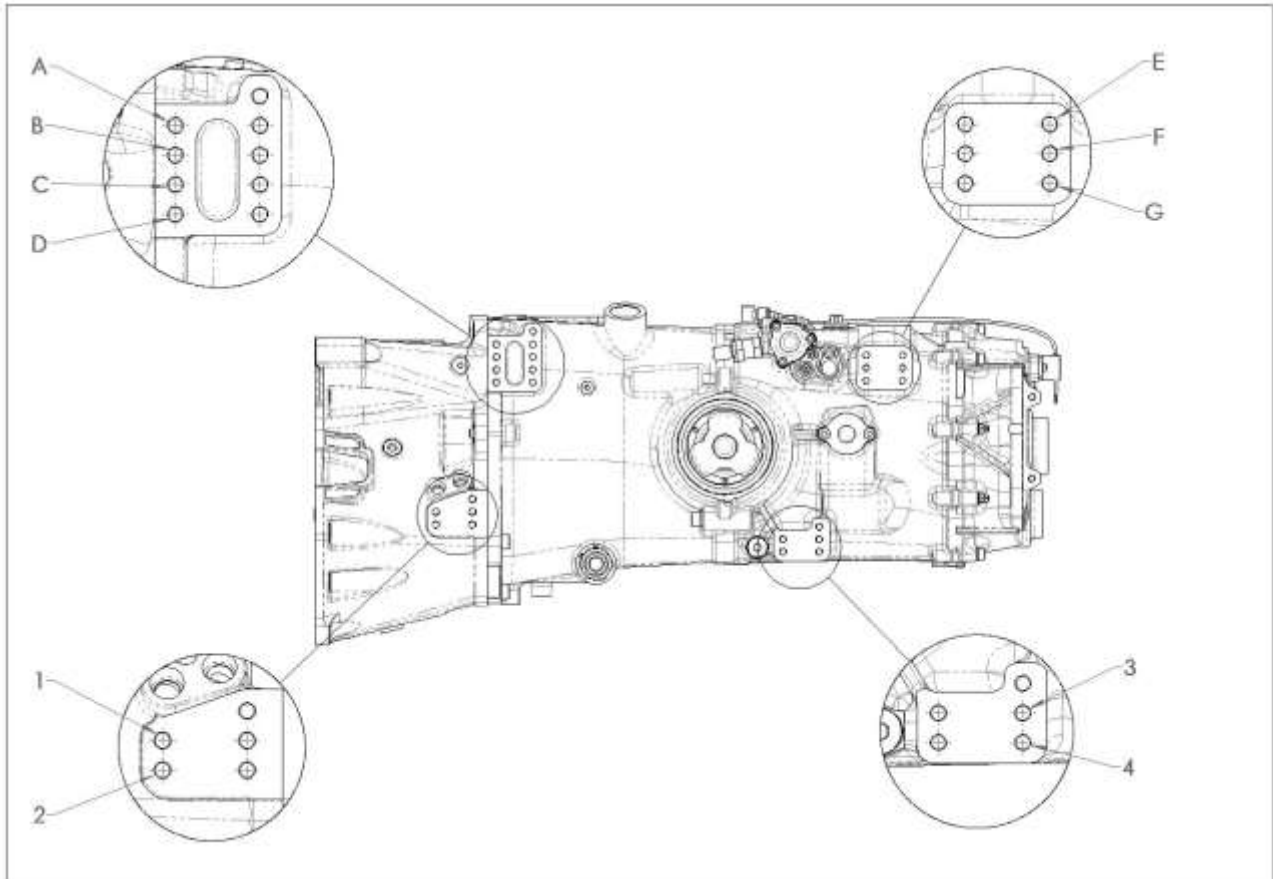
Pick-up position	RC height [mm] @ 20mm FRH	Camber derivative [°/10mm]	Anti-dive [%]
Standard	15	0.04	27

Here below the table of suspension pick-up coordinates at 20mm front ride height:

	X	Y	Z
CENTRE OF TIRE CONTACT PATCH	0,00	787,50	-20,00
CENTRE OF WHEEL	0,00	787,50	249,92
LOWER WISHBONE INNER FRONT PICKUP	-105,00	205,80	170,10
LOWER WISHBONE OUTER PICKUP	-13,00	681,90	155,00
LOWER WISHBONE INNER REAR PICKUP	300,00	214,00	170,30
UPPER WISHBONE INNER FRONT PICKUP	-110,00	207,60	365,30
UPPER WISHBONE OUTER PICKUP	16,20	644,40	339,10
UPPER WISHBONE INNER REAR PICKUP	270,00	213,60	345,10
OUTBOARD TRACKROD PICKUP	-71,70	688,60	342,10
INBOARD TRACKROD PICKUP	-168,00	206,65	368,40
SHOCK ABSORBER PICKUP ON ROCKER	360,00	65,00	523,14
SHOCK ABSORBER PICKUP ON CHASSIS	60,01	67,16	522,00
ROCKER PIVOT POINT_1 ON CHASSIS	65,00	146,74	508,00
ROCKER PIVOT POINT_2 ON CHASSIS	65,00	123,26	463,85
INBOARD PUSH-ROD PICKUP ON ROCKER	24,30	127,83	489,73
OUTBOARD PUSH-ROD PICKUP	-5,38	663,92	204,69

5.4 REAR PICK-UP

The rear wishbones can be installed on different pick-up points, only the point combinations listed on the table below can be used.



The following table enlist the suspension pick-up coordinates at 35mm rear ride height, suspension position BF13:

	X	Y	Z
CENTRE OF TIRE CONTACT PATCH	0,00	762,50	-35,00
CENTRE OF WHEEL	0,00	762,50	245,58
LOWER WISHBONE INNER FRONT PICKUP	-329,00	153,00	159,18
LOWER WISHBONE OUTER PICKUP	0,00	650,00	130,00
LOWER WISHBONE INNER REAR PICKUP	46,09	115,00	132,72
UPPER WISHBONE INNER FRONT PICKUP	-270,00	153,00	334,00
UPPER WISHBONE OUTER PICKUP	-76,93	609,86	350,74
UPPER WISHBONE INNER REAR PICKUP	138,00	115,00	322,00
OUTBOARD TRACKROD PICKUP	76,93	609,86	350,74
INBOARD TRACKROD PICKUP	138,00	115,00	322,00
SHOCK ABSORBER PICKUP ON ROCKER	133,00	50,00	421,86
SHOCK ABSORBER PICKUP ON CHASSIS	-165,90	26,40	431,87
ROCKER PIVOT POINT_1 ON CHASSIS	-148,00	102,90	399,40
ROCKER PIVOT POINT_2 ON CHASSIS	-148,00	96,61	384,58
INBOARD PUSH-ROD PICKUP ON ROCKER	-184,30	109,49	396,60
OUTBOARD PUSH-ROD PICKUP	-35,00	646,31	168,74

The following table summarize the anti-effects that can be set changing the rear pickup points, the roll center height is measured from the ground for a static rear ride height of 35mm. Only the combinations listed in this table are allowed.

Pick-up position	RC height [mm] @ 35mm RRH	Camber derivative [°/10mm]	Anti-squat [%]	Anti-lift [%]
AE-13	27	0.09	49	46
AF-13	37	0.13	71	38
BE-13	32	0.11	25	55
BF-13	42	0.16	47	47
BG-13	52	0.2	69	38
CF-13	47	0.18	24	55
CG-13	57	0.23	46	47
DF-13	52	0.2	2	64
DG-13	61	0.25	23	56
AE-14	-3	0.03	64	72
AF-14	8	0.08	86	63
BE-14	2	0.05	40	81
BF-14	13	0.1	62	72
BG-14	23	0.15	84	63
CF-14	18	0.13	39	81
CG-14	27	0.17	60	72
DF-14	23	0.15	17	89
DG-14	33	0.2	39	81

5.5 VERTICAL STIFFNESS

5.5.1 Front vertical stiffness

The table below resumes stiffness options available and relevant stiffness at the wheel:

Spring stiffness [lb/in]	600	700	800	900	1000	1100	1200
Ground stiffness [daN/mm]	7.4	8.5	9.8	11	12.2	13.4	14.6

Springs can be preloaded acting on the damper/spring platform, the pitch of the thread is 2mm.

5.5.2 Rear vertical stiffness

The table below resumes stiffness options available:

Spring stiffness [lb/in]	600	700	800	900	1000	1100	1200
Ground stiffness [daN/mm]	6.3	7.3	8.3	9.4	10.4	11.4	12.5

Springs can be preloaded acting on the damper/spring platform, the pitch of the thread is 2mm.

5.6 DAMPERS

Refer to the Dynamic Suspension information.

5.7 ROLLING STIFFNESS

5.7.1 Front roll stiffness

The motion ratio of the front anti-roll bar is:

Blade length [mm]	85	75
$\phi_{\text{Anti-rollbar}} / \phi_{\text{Chassis}} [^{\circ}/^{\circ}]$	14.6	16.7

The ratio represents the torsion angle of the antiroll bar resulting from a roll of 1° on the chassis.

The following table summarizes anti-roll bar options available:

Rollbar diameter [mm]	11.5		13.5	
Blade length [mm]	85	75	85	75
ARbar Torsion stiffness [daN*m/°]	1.71		3.23	
Roll stiffness (@ ground) [daN*m/deg]	363	474	690	900

5.7.2 Rear roll stiffness

The motion ratio of the front anti-roll bar is:

Blade length [mm]	64.5	74.5
$\phi_{\text{Anti-rollbar}} / \phi_{\text{Chassis}} [^{\circ}/^{\circ}]$	13.9	16.3

The ratio represents the torsion angle of the antiroll bar resulting from a roll of 1° on the chassis.

The following table summarizes anti-roll bar options available:

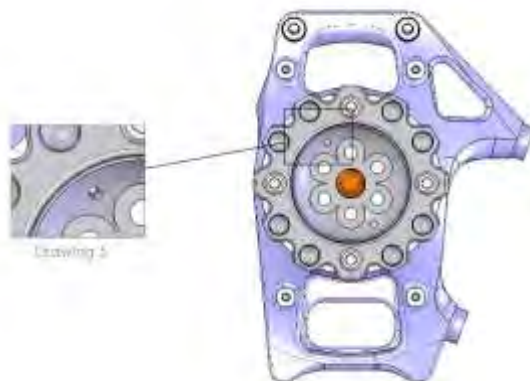
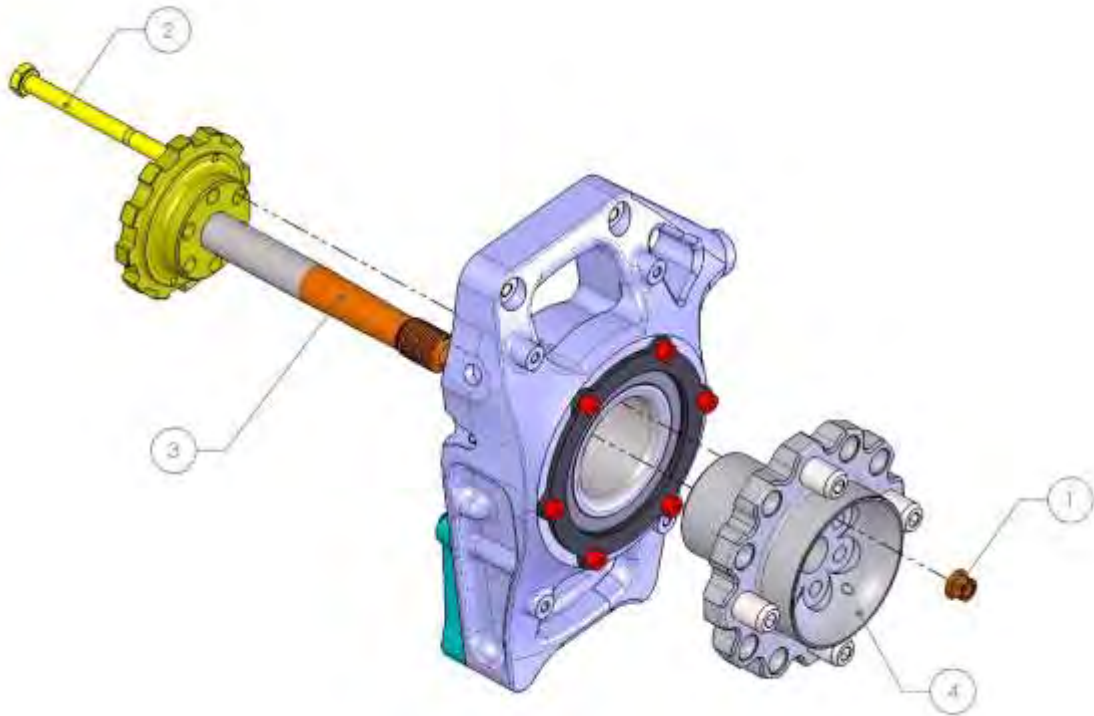
Rollbar diameter [mm]	8		10.5	
Blade length [mm]	74.5	64.5	74.5	64.5
AR_bar Torsion stiffness [daN*m/°]	0.60		1.78	
Roll stiffness (@ ground) [daN*m/deg]	115	159	344	474

5.8 SUSPENSION MAINTENANCE

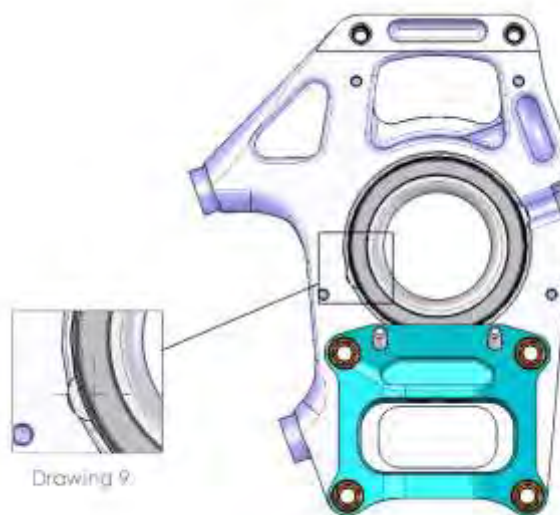
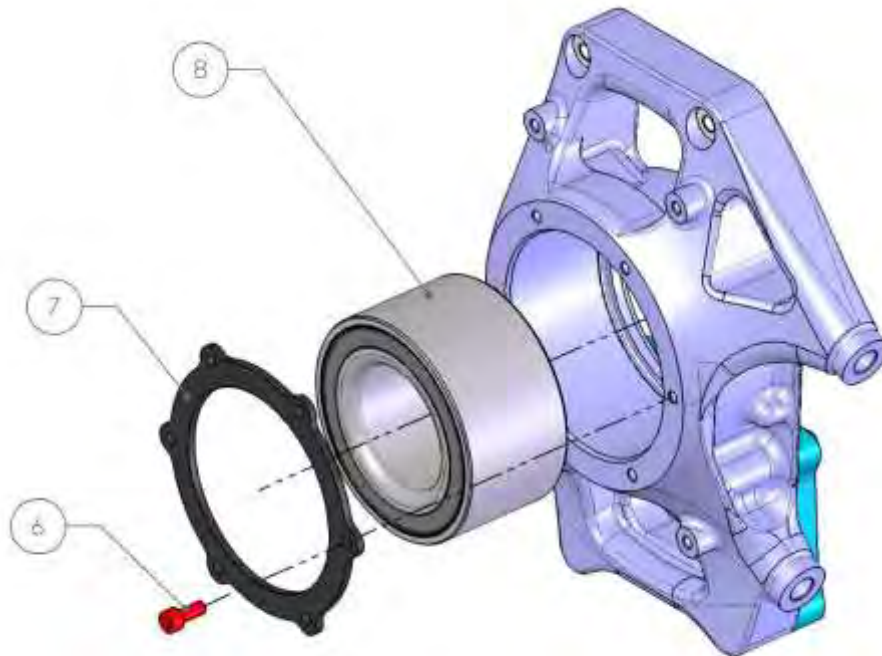
5.8.1 Wheel hub maintenance

Disassembly

- Remove nuts and bolts [1,2];
- Remove the wheel spindle [3] using a 4 mm pin drift through the proper hole in the inner hub (Drawing 5), tapping it if necessary with a plastic mallet;
- Remove the outer hub [4] from the upright



- Remove the bearing retainer [7];
- Warm the upright to 120 °C, the bearing should come out without the help of any tools, if needed use the slot (Drawing 9);



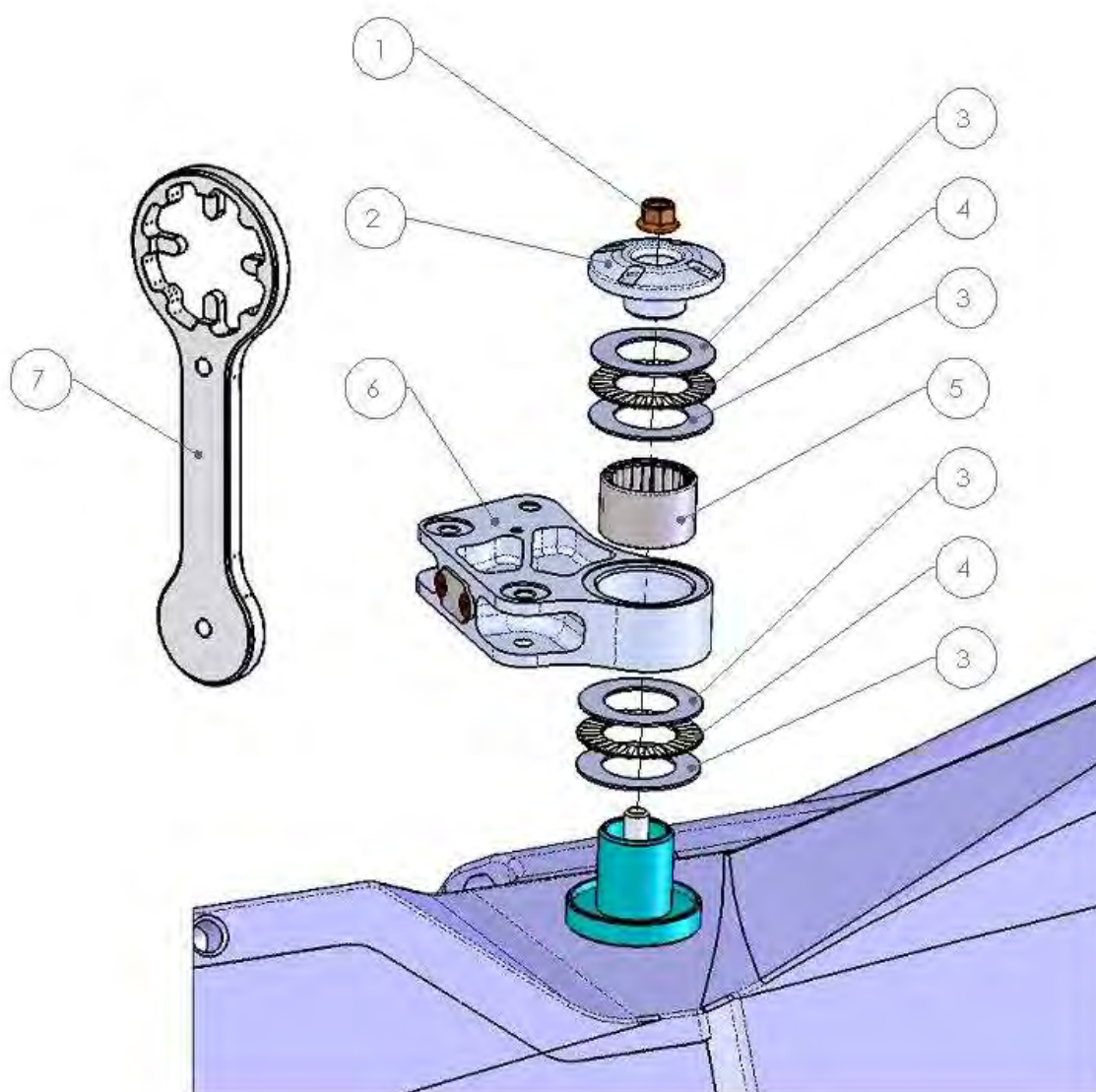
Assembly

- Warm the upright to 120 °C, the bearing should come in without the help of any tools;
- Fasten the bearing retainer [7] with Loctite 243 (tightening torque 6 Nm);
- Using a press drive the outer hub [4] in the bearing, then the inner hub with the spindle [3];
- Replace the spindle bolts [1, 2] (tightening torque 30 Nm).

5.8.2 Rockers maintenance

Front and rear rockers should be regularly adjusted to reduce play or locking, here below you can see the stacking sequence.

The rocker cap [2] should be tighten up to the disappearance of any free play (special tool 7), the counter nut [1] is then locking the stack.



6 STEERING

6.1 STEERING GEOMETRY

Pinion primitive diameter: 19.0 mm

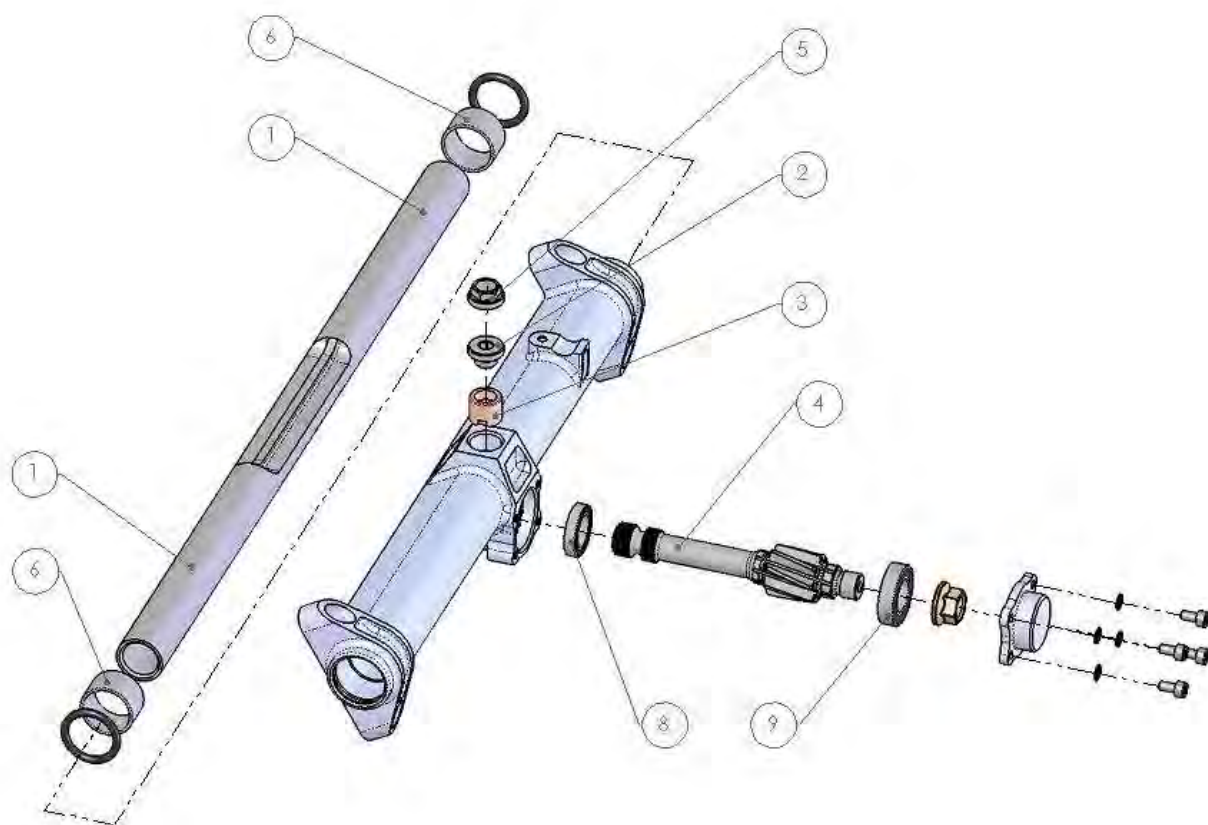
Steering ratio: 10°

Ackerman: 29%

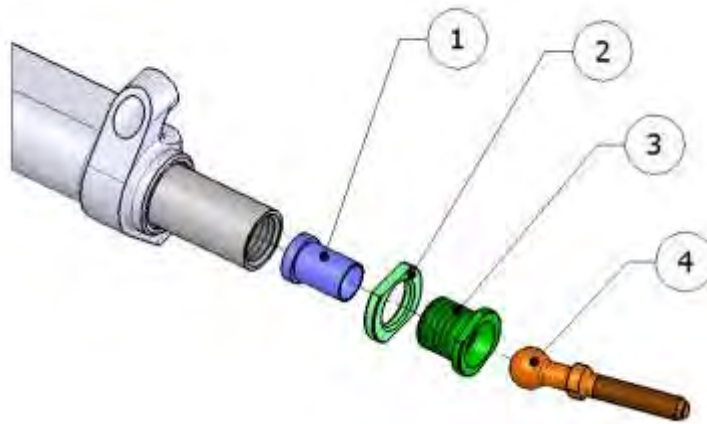
6.2 STEERING MAINTENANCE

The steering rack must be periodically inspected:

- rack pinion play [1]: the preload can be set acting on the bush [2], its position should be regularly inspected to follow system wearing, periodically inspect bush [3];
- pinion [4]: regularly inspect and lubricate;
- bearings [8-9];



Rack end assy [4]: allow some preload [2-3] to avoid any freeplay during the setting up, periodically change the bush [1].



8 BRAKE SYSTEM (PFC)

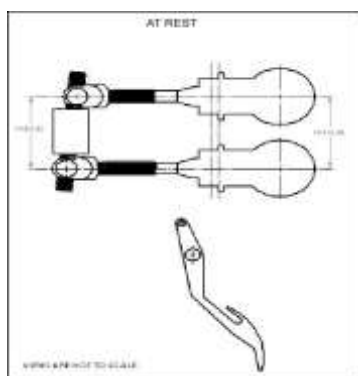
8.1 TECHNICAL NOTES

8.1.1 Balance bar

The function of a balance bar is to allow the adjustment of brake line pressure distribution between two master cylinders. This is accomplished through moving the balance bar pivot towards one master cylinder or the other. If the pivot is perfectly centered between the pushrods, the force applied to each master cylinder will be equal. This is known as the “neutral position” of the bias adjuster. If the pivot is moved closer to one master cylinder or the other, then the master cylinders will receive differential forces that are inversely proportional to the distance between the balance bar pivot point and master cylinder center lines. Being able to move the pivot point allows the driver to make incremental adjustments to the braking characteristics of the car (front-to-rear brake bias) and to alter those characteristics to account for changes in fuel load, track conditions and handling of the car.

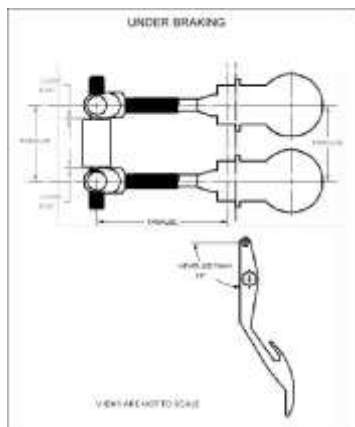
When the balance bar pivot is centered between the pushrods the resulting brake bias (with suggested m/c configurations) will be **57/58%**, remind to keep the total air gap of clevis to pedal tube at **2.2mm** (refer to chapter 3.5.4).

The distance between the centerlines of the front and rear master cylinders is 80mm, this measurement must be exactly duplicated in the center-to-center distance of the clevises threaded onto the bias adjuster. This ensures the master cylinder pushrods are actuated properly, minimizing any side loads applied to the master cylinder piston and bore. With the clevises set on the bias adjuster, measure the distance between each clevis and the pedal tube. The air gap should be more than 1.1mm (per side) and not exceed 1.5mm per side. This will prevent the balance bar from shifting while on the track and causing unpredictable change in the brake bias of the car.



With the balance bar connected to the master cylinders, and brake lines connected, the brakes should be bled. It is critical that front and rear brake circuits be bled simultaneously so that both master cylinders are allowed to use their full travel, and prevent binding or distortion of the bias adjuster.

Once satisfied that the clevises and pedal tube clearances have been properly set, now look at master cylinder pushrod length. The key is to have the balance bar pivot rod perpendicular to the master cylinder mounting when the brake pedal is under pressure. Typically, this means that the front master cylinder pushrod will be 6.0-7.0mm longer than the rear master cylinder pushrod when at rest. This is due to the front braking circuit having either larger fluid volume needed to feed the larger piston diameters of the front calipers or a smaller front master cylinder to augment the higher pressure requirements. As a result, the front master cylinder requires a higher feed rate than does the rear. If the pushrod lengths are equal, then the feed rate of the rear master cylinder is too high relative to the front and that would result in the rear circuit “hitting” before the front. So, with the pushrod lengths adjusted properly, the balance bar will be square with the pedal frame under compression, with the front and rear circuits engaging and releasing at the same moment.



8.1.2 Brake Pedal Geometry

In order for the brake system to work properly, it is important that the brake pedal get hard before it crosses the vertical plane of the brake pedal pivot. If the brake pedal crosses the vertical plane of the pedal pivot (goes “over center”) then the mechanical advantage of the pedal, over the pushrods, will be lost. That would result in a loss of pedal feel and braking force efficiency. Adjust the pedal “over center” position by lengthening both master cylinder pushrods by the same amount and until the desired pedal height is achieved.

8.1.3 Brake system bleeding procedures

Proper bleeding of the brake system is critical to the performance of any racecar. Without good quality, clean, fresh brake fluid and a properly bled brake system, the brake system cannot function properly.

Brake Fluid 101

There are 2 types of brake fluids commonly available today. Glycol-ester blends (“glycol-based”) and high percentage ester content blends (“ester-based”). More common are the glycol-based. These glycol-based fluids normally have low compressibility but are “hygroscopic” in nature. This means they are able to absorb water from the atmosphere. This contamination process occurs whenever brake fluids are exposed to the atmosphere, and even occurs somewhat through the plastic bottles most brake fluids are packaged in. This is the reason that all brake fluids must be used fresh. The susceptibility of brake fluids to hygroscopic contamination can be judged by comparing the “dry boiling point” and “wet boiling point” of the fluid: the greater the difference is between these two ratings, the more hygroscopic is the nature of that fluid. This concept is important, as it is the absorbed water that gasses off (boils) first inside the brake system and adds to the “spongy/soft/long pedal” effect.

PFC recommends its RH665 Racing Brake fluid, PN 25.0037. It has a proprietary formulation and effectively combines the best properties for stability at elevated temperatures with low compressibility. PFC recommends RH665 for its proven consistency, reduced brake drag and performance. It should be part of the maintenance routine to incorporate frequent and correct bleeding as race preparation.

The use of PFC caliper temperature stickers, PN 032.0007 is highly recommended to monitor brake fluid and caliper seal condition.

If the calipers exceed **430°F (210°C)** for an extended period, the brake fluid and or caliper seals will deteriorate.

High percentage ester blends have the promise of higher dry and wet boiling points. The ester base used in manufacturing these fluids is not hygroscopic at all. However, they are blended with a percentage of glycol for several reasons including cost (ester is more expensive to manufacture than glycol), pedal feel (ester is by nature more compressible than glycol), lubricity and seal conditioning.

Brake Bleeding How To

As with any system on a racecar, the brake system must be inspected and found to be in good working order before beginning. Inspect the entire brake system for leaks or damaged parts including the pedal assembly (refer to the Balance Bar setup guide). Inspect the master cylinder reservoir cap(s) to see that they are venting properly, as this is an overlooked and common cause for poor pedal feel. Once all of the components in the system have been inspected and serviced as necessary, begin the bleeding process by filling the master cylinder reservoir with clean, fresh, high quality brake fluid.

Depending on the type of master cylinder arrangement, follow the instructions below:

Notes on Bleed Bottles

There are many brake bleed bottles commercially available for a reasonable price. It is helpful for the bleed bottle to be clear so a visual inspection of the fluid being purged is possible. The use of clear hose that fits tightly around the bleed screws adds a visual aid to bleeding then just relying on what is seen through the bleeder bottle.

For PFC calipers, this hose should have a 3/16" ID to fit the PFC bleed screws properly.

Ensure that the bleed hose is inserted deeply enough into the bottle so that the end is always submerged in brake fluid to help close the loop. Bleed bottles should be vented as well. Discard spent brake fluid in an approved manner.

Notes on Master Cylinder Fluid Reservoirs

The master cylinder fluid level should be higher than the caliper bleed screws to insure proper bleeding. This means when a floor-mounted pedal used, the fluid reservoirs should be remote mounted above the level of the caliper bleeders. You should always take into consideration dynamic wheel movement, so placement of the reservoirs is important. The fluid volume required for a master cylinder reservoir is based upon the maximum piston displacement of the calipers being used. If there is insufficient fluid volume in the reservoir for the piston displacement required, the master cylinder will be empty before the pads are worn to their maximum. Total brake failure will result in that circuit.

It is imperative that both ends of the car be bled simultaneously when using dual master cylinders. If this is not done, the master cylinders will not be adequately purged of contaminated brake fluid. Further, the balance bar assembly may be severely damaged, leading to a failure of the brake system.

With the car on jack stands and a person sitting in the driver's seat.

Place a wrench over the inboard bleed screw on one front and one rear caliper.

Place the bleed hose attached to the bleed bottle over the bleed nipple with the wrenches.

Open the bleed screws.

With the bleed screw is open, have the "driver" slowly depress the brake pedal to the floor. With the driver holding the pedal down, gently close the bleed screws. With the bleeder closed, the driver can release the brake pedal.

Repeat this process until the fluid coming from the calipers is clear and free of all air bubbles.

Repeat this process for the outboard bleeders.

Monitor the fluid level in the reservoirs and refill as necessary during the process.

When finished torque bleeders to factory recommended settings Torque PFC bleed screws 48-60 in-lbs. Repeat these steps for the remaining calipers, bleeding the front and rear circuits simultaneously. At times it is helpful to tap the caliper body with a soft mallet to release any small air bubbles trapped inside the caliper. At this point, the brake pedal should be checked for firmness and consistency. If the fluid is free of air bubbles and the pedal is still soft or spongy, there may be further issues that need to be addressed with the brake system. When finished, fill the fluid reservoir to the "full" line, but not over.



Brake Fluid Disposal

All brake fluids must be disposed of properly. Their ability to combine with water means they can very easily contaminate ground water supplies if disposed of improperly.

8.2 BRAKE SYSTEM SETUP

For the IP22 **57/43%** pressure bias is a good starting point, checked at the master cylinders or at the calipers. This will produce **58/42%** dynamic torque bias at the wheels.

Under compression, brake pedal must get firm before it reaches vertical to the pedal's pivot so as to not over-center.

Front push rod at rest should be 6-8.0mm longer than the rear push rod to compensate for fill rate difference and ensure proper balance bar geometry. This geometry will help minimize bias migration as well.

Once system is bled, check dynamic brake engagement and release as outlined in Technical Notes.

Master cylinder suggested configuration:

	FRONT DIA	REAR DIA
Delivery	17.8mm (0.7")	20.6 (13/16")
Option	15.9 mm (0.625")	19.1mm (3/4")

Pedal ratio: 3.4/1

8.3 BRAKE SYSTEM MAINTENANCE

8.3.1 Calipers

It is always a good idea to use protective hand gloves when refurbishing the brake calipers. Removing the pistons from the calipers is far easier when using low pressure compressed air. Much care should be taken when removing the pistons. Use wooden blocks 20.0mm (.787") in width for either the front or rear caliper is highly recommended in the caliper throat to prevent the coming all the way out.

BE CAREFUL: please keep your fingers out of the throat of the calipers when disassembling with low air pressure. Once the pistons are forced most of the way out against the wooden blocks with compressed air, they can then be removed easily by hand.

When installing fresh seals and or piston assemblies it is important to insure all components are free of any dirt, brake dust or debris. Inspect bores and seal grooves for any damage or evidence of scored or scared walls in the bores. If bores or seal grooves are damaged, replace calipers.

RH665 racing brake fluid is also an excellent assembly lubricant for both seals and pistons. It is necessary to soak seals for an extended period of time; recommended time is 2 hours as PFC has found "wet seals" during the subassembly has better consistency. Carefully install the wet seals into clean seal grooves. Apply a small amount of brake fluid to the piston assemblies and install into the resealed bores. The piston assemblies will slide in with a little resistance from the seal tension. This is normal.

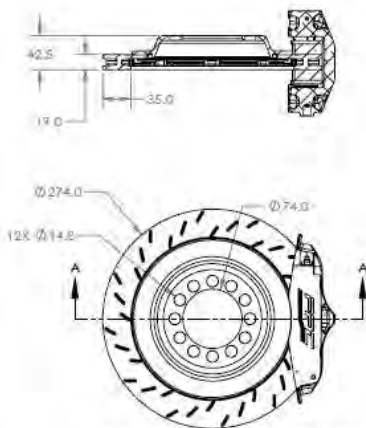
Using the wooden blocks, as caliper throat shim, get into habit of using very low air pressure to articulate the pistons in and out a few times to insure seals have seated into their grooves. Compressing the pistons back into the bores should always be done a proper brake pad changing tool and never use a pair of adjustable pliers to squeeze the pistons back into place as this can cause damage to the piston assemblies as well as the bores.

Always clean the pistons and use a few drops of PFC RH665 brake fluid as a lubricant prior to reloading fresh brake pads into the throat of the calipers.

8.3.2 Spare parts

IP-22 FRONT

NUMBER	DESCRIPTION	PER CORNER	PART NUMBER
1	BRAKE HAT, V3	1	189.740.178.15
2	BRAKE DISC, LEFT	1	274.19.0033.41
	BRAKE DISC, RIGHT	1	274.19.0033.42
3	RETAINING RING, V3	1	189.218.793.06
4	BRAKE PAD SET 13 COMPOUND	1 PER AXLE	7835.13.18.56
	BRAKE PAD SET 11 COMPOUND	1 PER AXLE	7835.11.18.56
5	CALIPER, LEFT TRAILING	1	24.284.255.290.11A
	CALIPER, RIGHT TRAILING	1	24.284.255.290.12A
6	PFC BRAKE FLUID (BOTTLE)		025.0037
	PFC BRAKE FLUID (CASE)		025.0038



DISC ASSEMBLY WEIGHT: ~ 7.05lb (3.2kg)



MAJOR CHAR. REQ'D FOR PROPER FIT OR FUNCTION
 (1) REQUIRES PFC (2) CR. CHANGING IN PROCESS
 (3) IMPROVED CUSTOMER SATISFACTION WHEN VARIATION IS IMPROVED.
 (4) ASSOCIATED PERFORMANCE FRICTION CONTROL PLANS TO BE INCORPORATED HERE IN

PROPRIETARY AND CONFIDENTIAL
 (THIS INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF PERFORMANCE FRICTION. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF PERFORMANCE FRICTION IS PROHIBITED.)

APPROVED SIGNATURE		SCALE 1:3	PFC PART NO.
DESIGNED BY	P. RANKIN	DIMENSIONS: MILLIMETERS TOLERANCES UNLESS SPECIFIED	DATE 05/16/16 FILE NAME
DESIGNED BY	M. WAGNER		
PROJECTING			
QUALITY			
PURCHASER		1 PLACE DECIMAL ± 2 PLACE DECIMAL ± ANGLE (DEG) ±	DRAWN BY P. RANKIN
PRESIDENT		DWG CLASS	
MATERIAL			

FOR PROTOTYPE USE ONLY
 REV 1 ENGINEERING CHANGE ORDER 05/16/16 PFR
 DATE INITIALS

PFC
 PERFORMANCE FRICTION CORP.
 83 CARBON METALLIC HIGHWAY
 CLOVER, SC 29710

SHEET 1 OF 1
 FCD.174.044

MDG.124.5.02 REV 7/22/13 APPROVED BY: M. WAGNER

IP-22 REAR

NUMBER	DESCRIPTION	PER CORNER	PART NUMBER
1	BRAKE HAT, V3	1	189.740.178.15
2	BRAKE DISC, LEFT	1	274.19.0033.41
3	BRAKE DISC, RIGHT	1	274.19.0033.42
3	RETAINING RING, V3	1	189.218.793.06
4	BRAKE PAD SET 13 COMPOUND	1 PER AXLE	7635.13.18.56
4	BRAKE PAD SET 11 COMPOUND	1 PER AXLE	7635.11.18.56
5	CALIPER, LEFT LEADING	1	24.284.255.290.01A
5	CALIPER, RIGHT LEADING	1	24.284.255.290.02A
6	PFC BRAKE FLUID (BOTTLE)		025.0037
6	PFC BRAKE FLUID (CASE)		025.0038

IF REQUIRED: PFC, LPS, UNLESS BY PROUDLY
 (A) MAJOR CHG. REQ'D FOR PROPER FIT OR FUNCTION
 (B) REQUIRE: PFC, CPE ONGOING IN PROCESS
 (C) IMPROVED CUSTOMER SATISFACTION WHEN VARIATION IS
 IMPROVED
 ASSOCIATED PERFORMANCE FRICTION CONTROL PLAN(S) TO BE
 INCORPORATED HERE IN



WICG.124.6.02

PFC IP-22 Tatuus Brake Components (Carl Haas Auto)

Part Number	Description
24.284.255.290.11	24 Monobloc RH Front Trailing/heat caps and insulators
24.284.255.290.12	24 Monobloc LH Front Trailing/heat caps and insulators
24.284.255.290.01	24 Monobloc LH Leading rear/heat caps and insulators
24.284.255.290.02	24 Monobloc RH Leading rear/heat caps and insulators
274.19.0033.41	274.0 x 19.0mm LH vented V3 disc
274.19.0033.42	274.0 x 19.0mm RH vented V3 disc
189.740.178.15	Tatuus "MRTI" V3 brake hats
7835.11.18.56	Race Pads, 11 compound for "MRTI" spec pads
7835.13.18.56	Race Pads, 13 compound for "MRTI" spec pads

Service Parts

Part Number	Description
900.900.100.02	24 Series Seal Kit
900.900.102.12	24 Series Piston Cap Kit
900.900.107.04	25.5mm spring O ring kit for piston cap
900.900.107.05	29.0mm spring O ring kit for piston cap
900.900.104.01	Bleed screw
900.900.104.02	Bleed screw insert kit
900.900.104.07	inlet kit-3AN
900.900.104.08	banjo adaptor kit
900.900.105.04	24 Series Abutment Kit
900.900.106.02	Small bore knockback spring kit
950.255.290.24	ZR24 Caliper Rebuild
25.0037	RH665 Brake Fluid 500ml Bottle
25.0038	RH665 Brake Fluid 12 x 500ml Bottle

9 COOLING SYSTEM

Cooling system pressure: 1.2 bar.

10 FUEL SYSTEM

10.1 OVERVIEW

The fuel system is an open-type circuit, flow is sent by the high-pressure pump through the fuel filter and then out of the bladder. Fuel pressure is regulated by the pressure regulator installed on the main flange of the fuel cell, the bleeding line ends in the fuel pump collector.

Fuel cell contains a maximum of approximately **48 liters**

Before installing the bladder, make sure that the chassis compartment is free of sharp edges and clean. It is recommended to protect the outer surfaces of the fuel bladder from scratching over carbon fibers, customers are invited to protect the carbon surfaces that are in contact with the bladder with PVC tape (i.e. Permacel) or Neoprene foam Sheet.

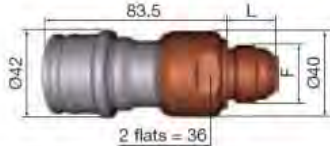
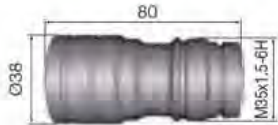
10.2 FUEL COUPLING

The feeding line to the engine is equipped with a safety dry-break:

Staubli SPT08.3655/L/JV
SPT08.7655/L/JV

The fuel tank port is equipped with a dry break

- Filling Port: Staubli N00916298 (on board)
- Mating Port:
 - o Staubli N009 161 98 (fuel bottle)
 - o Staubli SPT12.1658/L/JV (fuel machine)

SPT 12		Threads F	L (mm)	JV	JKV
Male thread socket		UNF 7/8 - 14" JIC DASH 10	19	SPT 12.1657/L/JV	SPT 12.1657/L/JKV
		UNF 1 1/16 - 12" JIC DASH 12	21.9	SPT12.1658/L/JV	SPT 12.1658/L/JKV
Non threaded socket		-	-	N 009 161 98	N 010 830 07

10.3 FUEL DRAIN PROCEDURE

Pushing the button [#5] on the cockpit panel (paragraph: 3.5.1) for longer than 0.5s will override fuel pump command, opening the quick release line will allow the tank drain.

10.4 MAINTENANCE

Regular maintenance has to be done on the following items:

- Fuel filter: check for pollution after every session when the fuel cell is brand new, then check after every meeting for impurity. Fuel filter can be inspected accessing through the cockpit port (behind the driver seat).
- Fuel pump: current consumption can be monitored within data logger.
- Quick coupling: always check that releasing cables are correctly installed and tighten.

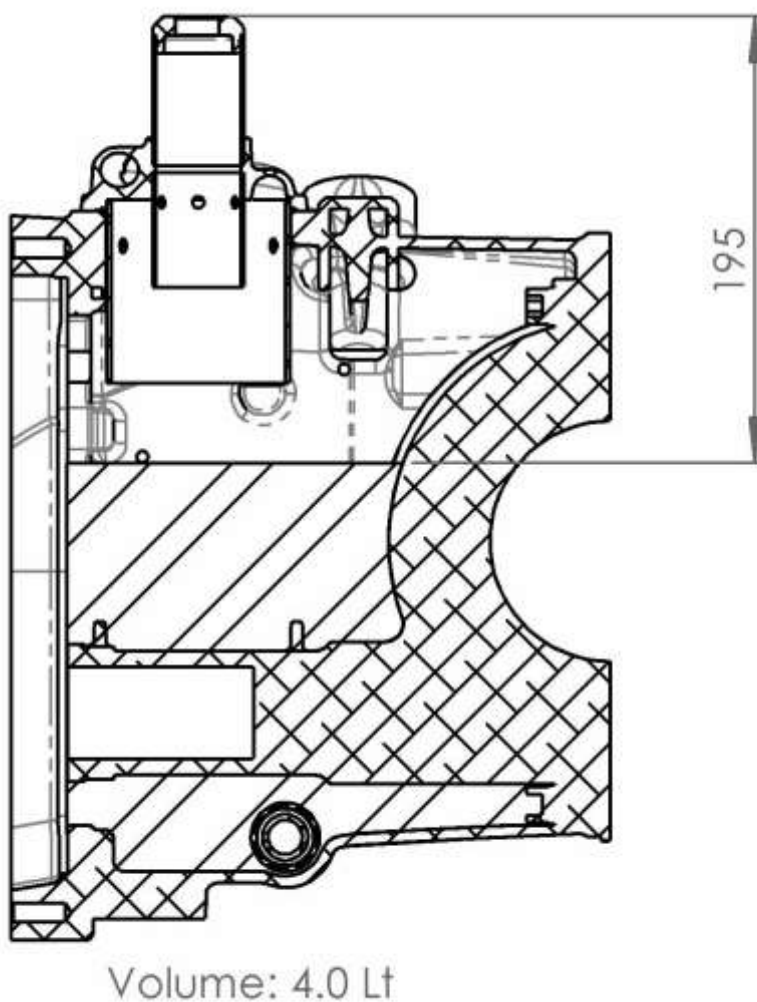
It is strongly recommended to drain all the fuel from the fuel cell before transportation to and from any event. Furthermore, Premier has advised that leaving fuel in the tank for prolonged periods of time can shorten the fuel cell's lifespan.

11 OIL SYSTEM

The oil tank is located within the gearbox bellhousing,

We recommend to respect the following procedure in order to have a consistent level measurement:

- Turn on the engine;
- Warm up temperatures (oil at 80°C);
- Run the engine for 30 second at 3000rpm;
- Turn off the engine;
- Measure the oil level: from the filler plug plate the oil level should be **195mm**.



12 ELECTRIC SYSTEM

12.1 OVERVIEW

The wiring loom is split in four main parts:

- Chassis harness
- Engine harness
- Gearbox harness
- GCU/EGA harness

The power system (+12V) includes

- Battery: installed in the cockpit behind driver seat
- Main switch: electrically operated, located on the battery carrier
- Generator: installed on the engine
- Powerbox: current distribution is provided to the vehicle by a 9 lines power distribution module
- Starter: direct power connection
- EGA (gear actuator): fused power connection

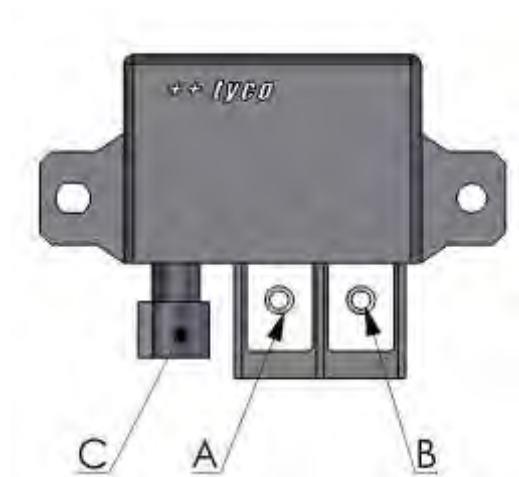
12.2 MAIN SWITCH

The master switch is actuated by the cockpit panel and emergency switches, connection schematics:

A: +12V Generator, +12V Chassis loom ring;

B: +12V Battery, Main switch coil supply;

C: chassis loom connector.



12.3 BATTERY AND ALTERNATOR

Battery is a crucial component interacting with engine and gearbox management systems always pay attention to its charge level especially if you are running reset procedures.

NOTE: running engine at low revs will not charge battery!

NOTE: if the battery power is low high current consumptions (like a gearshift actuation/recharge) can result in an engine stall, keeping higher revs and generator in charge will fix this occurrence.

12.3.1 Battery installation

It is recommended to apply a minimum of 5mm of padding, below and on the top of the battery case, and a 2mm padding per side in order to protect the battery from excessive vibration.

The padding also protects the battery casing from getting damaged. It is recommended using closed cell neoprene.

It is also important that when strapping the battery in place, the padding is not excessively compressed, as this would minimize its effect.

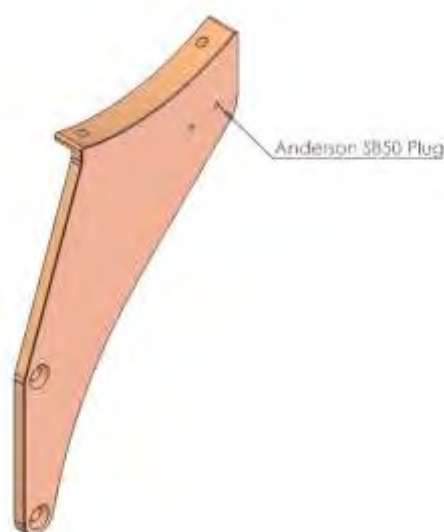
We also recommend that the battery cables are fully supported so they do not add any extra stress onto the battery terminals. If they are too short, the engines movement when revved will be transferred through the cable to the battery. If the cables are too long, they may have weigh enough and move when accelerating, braking or cornering, adding extra stress to the battery terminals.

A battery, which has been damaged due to vibration, will show a good open circuit voltage (12.8v or more), but when loaded, the voltage drops to zero. The battery casing usually also shows signs of wear on the casing. It is also important that when attaching cables to the battery terminals, that the retaining nut is tightened to 4Nm and no higher.

12.3.2 Jump battery

It is suggested the use of a jump battery during the engine crank, **the jump battery must be plugged in only when the main switch is ON.**

The rear wing pillar has a double thread suitable for the Anderson SB50 plug.



12.4 POWERBOX

The PSD9 powerbox manages the current distribution on the following power lines:

1. (pin 1A) Main Fuel Pump
2. (pin 2A) Spare Fuel Pump
3. (pin 3A): Control Units Supply (ECU, GCU, Omega Logger, Steering wheel, ADR)
4. (pin 4A): Engine (Alternator switch, Lambda)
5. (pin 5A): Vbatt Aux (Rain Light, Beacon, Timing transponder, Radio)
6. (pin 6A): Coils, injectors
7. (pin 7A): Coils, injectors (redundant)
8. (pin 8A): Starter
9. (pin 8B): Starter (redundant)

The powerbox can shut-down current supply in case of over-load, the system can be reset with a power cycle but current cut will re-occur if problem persists, here below current limits:

1. Main Fuel Pump: 16 Amp (spike 20Amp)
2. Spare Fuel Pump: 16 Amp (spike 20Amp)
3. Control Units Supply: 20 Amp (spike 27Amp)
4. Engine: 10 Amp (spike 15Amp)
5. Vbatt Aux: 10 Amp (spike 15Amp)
6. Coils, injectors: 12 Amp (spike 15Amp)
7. Coils, injectors: 12 Amp (spike 15Amp)
8. Starter: 15Amp (spike 20Amp)
9. Starter: 15 Amp (spike 20Amp)

User devices connected to customer available connections must not exceed 5A in total and 2A per power supply pin.

WARNING: Do not disconnect the powerbox connection when power is ON!

Diagnostic and functional information are available in the logger system see chapter for details.

12.5 WIRING LOOM

Refer to attached pdf files for electrical schematics.

13 ENGINE

For any technical information contact Elite Engines

14 TRANSMISSION

Sadev v. 10/10/17

The SL82-14LW standard gearbox is composed of a 6 forward speed + reverse. Its weight is approximately 43 kg to technical definition.

14.1 RATIO CHART

Here below the ratio options:

Final drive Ref.CPL9309057011	
Secondary shaft	9
Crown wheel	30

Reverse gear	
Primary shaft	15
Reverse gear	21
Secondary shaft	44

14.1.1 Standard gear

Gear	Ratio
12/34	2.83
15/30	2.00
20/32	1.60
23/32	1.39
22/27	1.23
25/28	1.12

14.2 DIFFERENTIAL

ZF type self-locking differential with triple friction discs and pressing plates with ramps acting symmetrically or not, for driving or braking condition.

Pressing plates	
Ramps	Reference
(coast) 75°/ 55° (power)	F00

Note: A drop of preload of approximately 15% after (60 kilometres running-in) will be noticed.

Note : The cold measured preload (workshop) is approximately 15% higher than that measured hot.

14.3 LUBRICATION

Oil capacity: 1.5 Liters (2.0lt when the cooling system is empty)

1rst drain	Drain frequency	Viscosity
After a 50Km running-in	Each meeting	75W140

14.3.1 Particular precautions

No additives should be added to the oil. The resulting consequences are not in any circumstances covered by SADEV.

When topping up the rear differential oil, do not mix any other oil with that already in the box.

14.3.2 Storage and use

Be particularly careful with any bottles which are open when used:

- Close the bottle again properly after use to prevent the introduction of water or dirt.
- Store bottles horizontally, protected from severe weather.
- Do not store bottles close to a washing station.
- Do not decant the oil into larger containers.

14.3.3 Washing under pressure

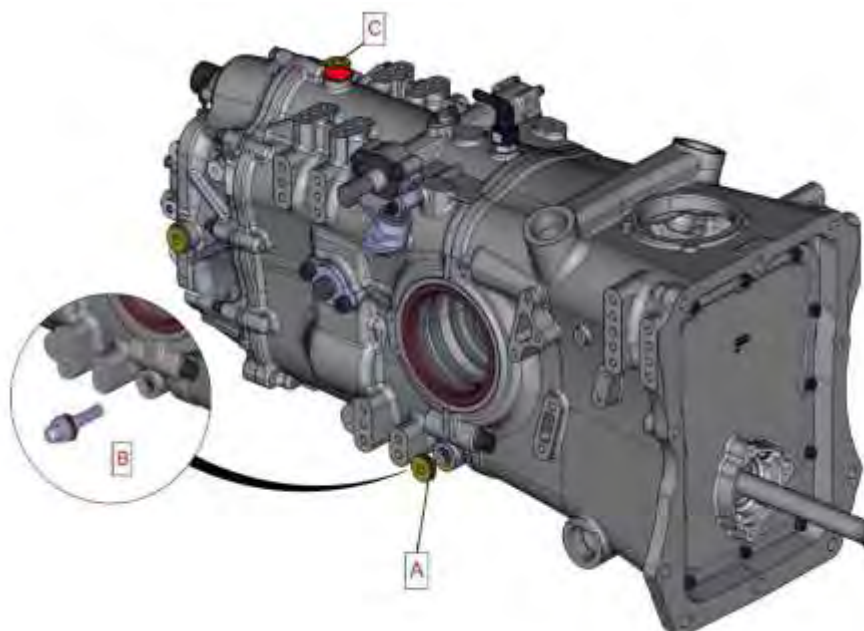
When the rear differential is removed, seal all openings correctly to prevent the ingress of water into the rear differential.

14.3.4 Oil change and oil filling

Disassemble the drain magnet plug (A), and clean it up, drain the oil and clean iron filings accumulated on the plug.

If the gearbox is equipped with the lubrication kit, remove and clean the strainer (B) at each oil change.

For fill-up, replenish the gearbox with oil 75W140 index by the filling hole (C)



14.4 GLUE COMPONENTS

Glue components and tightening torque are shown in the 3D exploded view.

WARNING:

Glue components have been chosen during tests sessions. Only 'Loctite' brand components must be used. Sadev can't ensure consequences of false glue component choice.

14.5 SENSORS

ROTARY SENSOR WITH NO CONTACT 3WING3 (F0089047B)

operational range +0.5V to +4.5V

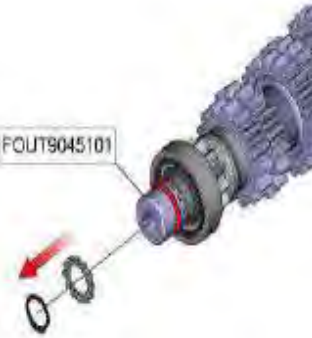
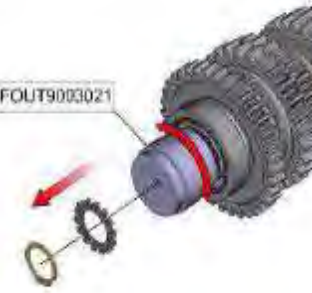
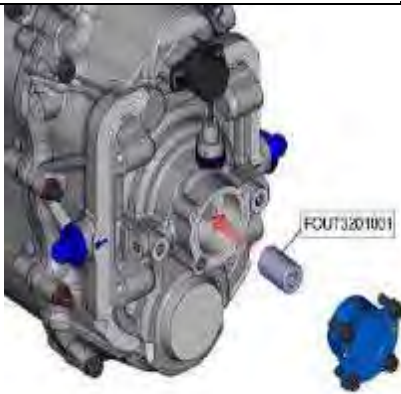
A- Red wire: +5Vdc

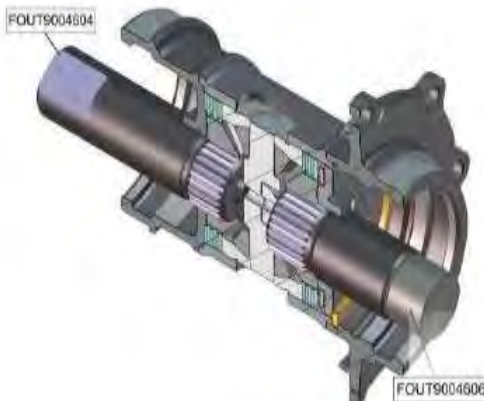
B- Black wire: Ground

C- Orange wire: Signal

Barrel Angle [deg]	Output Voltage [V]	Gear nr.
0	0.5	R
28.75	0.82	N
57.5	1.14	1
115	1.67	2
172.5	2.42	3
230	3.06	4
287.5	3.69	5
345	4.33	6

14.6 GEARBOX TOOLS

	Reference	Description	
	FOUT9057002	Locking plate	
	FOUT9045101	Primary bolt tool	
	FOUT9003021	Secondary bolt tool	
	FOUT3201001	Pump shaft bolt	

		Reference	Description	
FOUT 1910301		FOUT1910300 FOUT1910001	Compression tool mechanism (LSD)	
		0301450	CHc M6x70 Bolt (LSD)	
		FOUT9004606	Preload adjust- ment Tool (LSD)	
		FOUT9004604	Preload adjust- ment Tool (LSD)	

14.7 GEARBOX MAINTENANCE

14.7.1 BEFORE ANY WORK

Unless otherwise stated, all operations shall gearbox in neutral, drained.

It is very important to note the installation direction of each part during disassembly.

Reinstalling a part with the opposite rotational direction could lead to premature braking.

For the same reason, the assembly of fork, Dog-ring and its support, have to be kept in groups.

At each disassembly, degrease, clean and check the status of all the parts; replace if necessary.

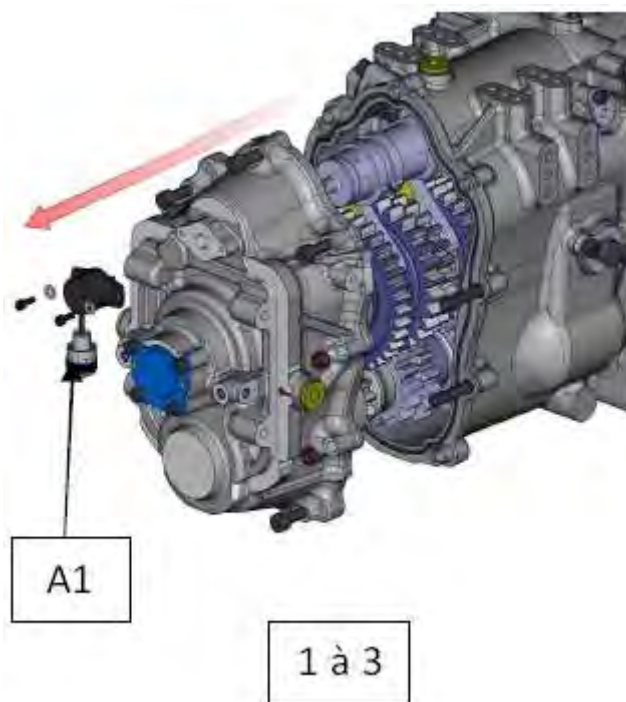
When reassembling, lubricate the bearings, needle bearings and bearing smooth with some gearbox oil.

There are 2 kits for review by technical definition of SL82-14LW (see page 61).

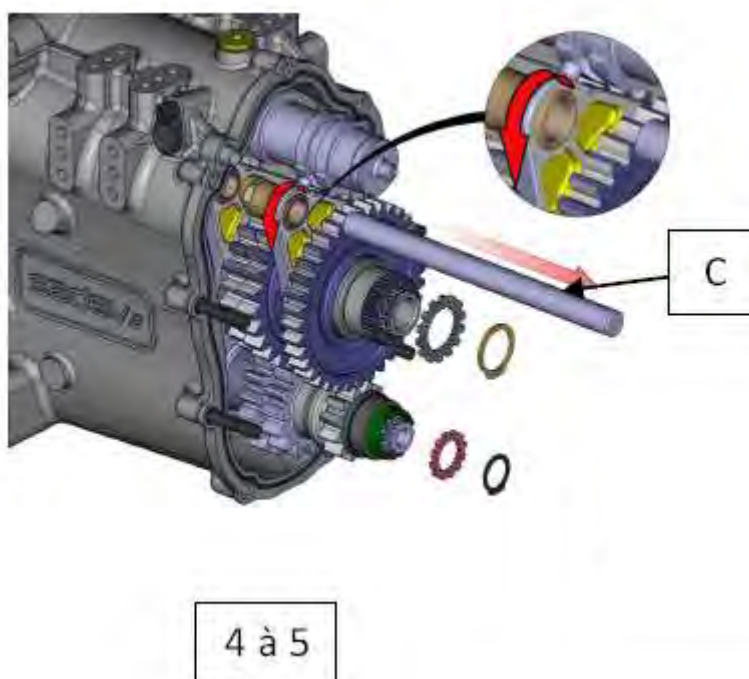
14.8 GEARTRAINS MAINTENANCE

14.8.1 Geartrains Dismantling

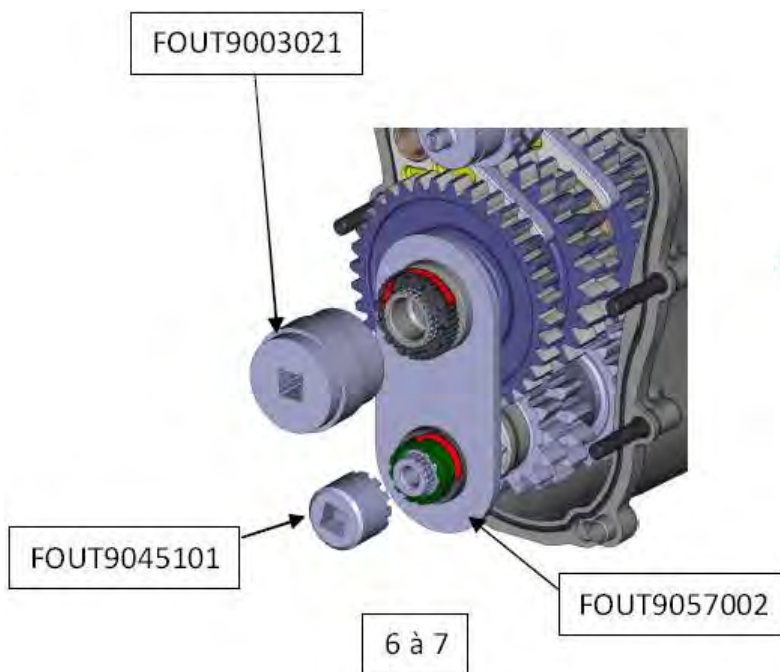
1. Drain gearbox through lower drain plug.
2. Disconnect potentiometer (A1).
3. Release the M8 screws and simmonds nuts then remove the rear housing.



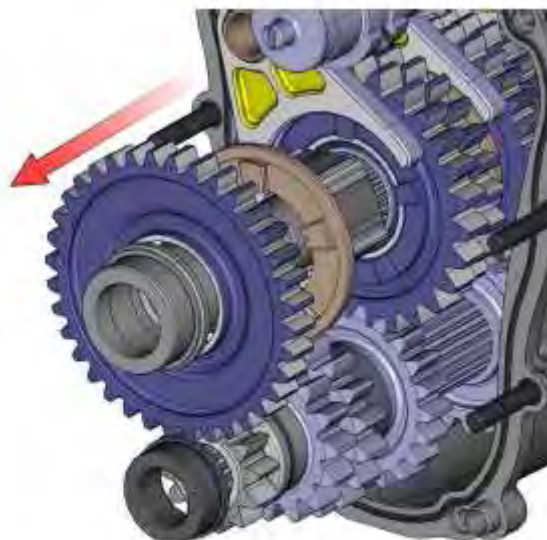
4. Remove the fork shaft (C) and swing the forks in order to release the barrel driven pins.
5. Remove the circlips and the stopping washers.



6. Fit primary and secondary shaft lock plate (FOUT9057002).
7. Release the two nuts:
 - a. primary (RH thread) with tool FOUT9045101
 - b. secondary (RH thread) with tool FOUT9003021



8. Remove the parts one by one, identifying the initial mounting direction.



8

14.8.2 Geartrains Reassembly

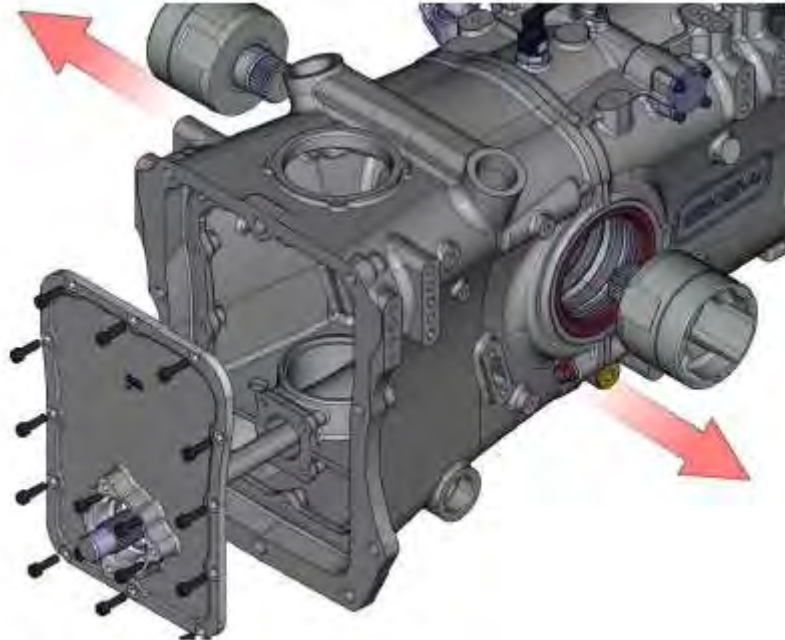
NOTE: Do not invert the gears so as to ensure their initial rotation direction: risk of gear pitting.

1. Clean and check condition of parts.
2. If you need to change the secondary shaft or the head bearing, refer to chapter ()
3. Lubricate the needle roller bearing cages using gearbox oil.
4. Replace gears in the reverse order from removal.
5. Mount lock plate FOUT9057002.
6. Clean and degrease threads on shafts and nuts.
7. Fit the primary shaft nut and the secondary shaft nut:
 - a. Primary shaft nut: 120 N.m
 - b. Secondary shaft nut: 180 N.m
8. Reinstall the splined washers and the circlips.
9. Replace the forks in their original position.
10. Replace the seal on the rear housing.
11. Refit the rear casing.
12. Connect the potentiometer ensuring that its coupling is still correct (it may be installed 180° offset).

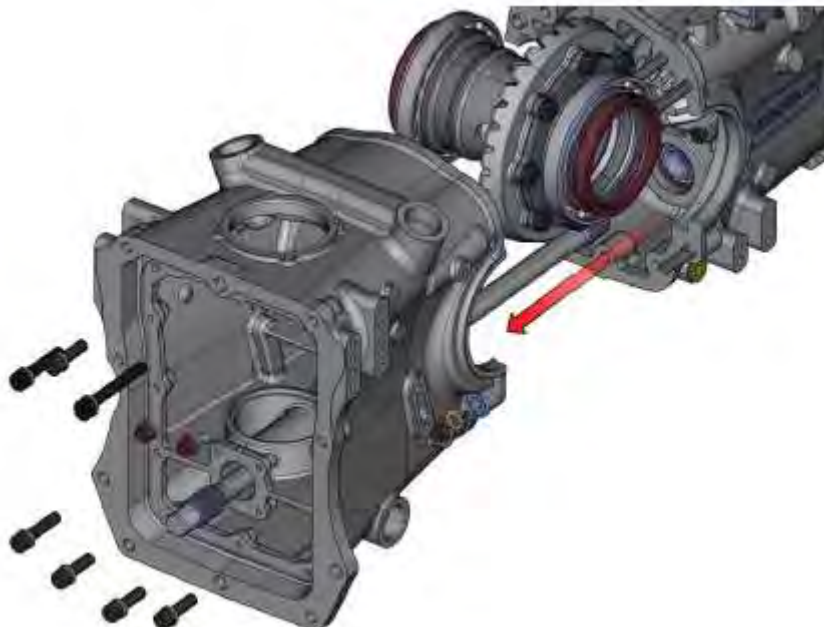
14.9 DIFFERENTIAL MAINTENANCE

14.9.1 Differential Casing Disassembly

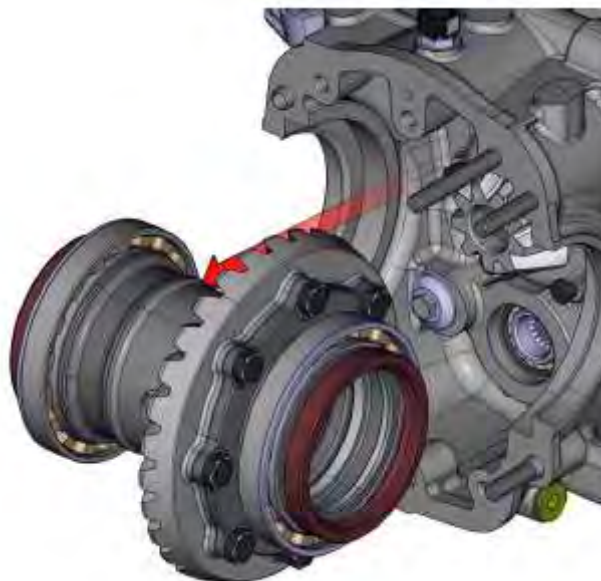
1. Drain the box through the lower drain plug.
2. Remove the tripod housing with an extractor.
3. Remove the frontal oil tank cover.



4. Remove differential housing

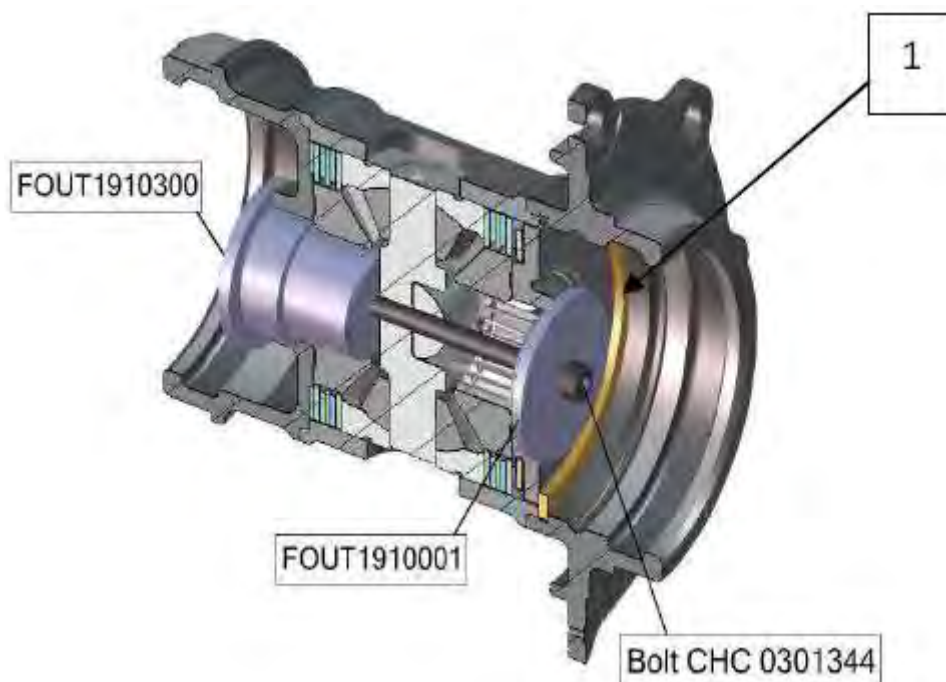


5. Extract the differential assembly.



14.9.2 Limited slip differential adjustment

6. Check the preload with tools (FOUT9004604 et FOUT9004606).
7. With the adapter (FOUT1910300) the compression washer (FOUT1910001), and the bolt Chc M6x70 compress the differential.
8. Remove the circlips (1) situated in front of the differential lid and remove the adapter and the compression washer (FOUT1910300 and FOUT1910001).



14.9.3 Limited Slip Differential refitting

1. Clean and degrease the parts, check their wear and replace them if necessary.
2. Lubricate with gearbox oil and put one by one the component inside the differential case, respecting the direction and the order noted during the disassembly.
3. Compress the differential using the tools FOUT1910300, FOUT1910001, M6x70 Chc bolt, and put the circlips inside the dedicated groove of the differential case.
4. Check again the preload with tools (FOUT9004604 et FOUT9004606).

14.10 FINAL DRIVE MAINTENANCE

14.10.1 Crown and differential bearing disassembly

1. Remove the 2 bearings with an extractor.
2. Remove the crown by removing the 10 screws M10x100. (Heat if necessary)
3. Using an M10x100 tap, clean and degrease the crown.
4. Refit the new crown using new screws glued with Loctite Blockpress 648. Tightening torque 90 N.m.
5. Replace the differential bearings with new ones.



14.10.2 Secondary Shaft Removal

1. Drain the gearbox through the lower drain plug.
2. Remove the primary gears and secondary gears.
3. Remove the differential.
4. Using a mallet, remove the secondary shaft.
5. Remove the 6 M8x20 bolts. (heat if necessary)



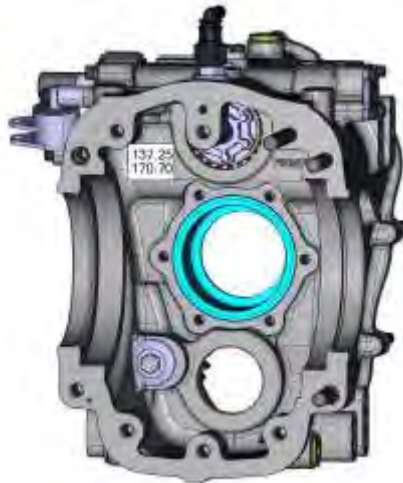
6. Remove the flange bearing NU207
7. Remove the two bearings and the O-ring $\varnothing 68 \times 2$.



8. Remove the secondary shaft shim, after removing the bearing ring with an extractor
9. Clean the internal threads of the main housing.

14.10.3 Secondary Shaft Adjustment

1. Note the smallest dimension marked in the main housing (usually around 137.25): this is dimension "A".



2. Stack both the new bearings over a marble, note the total height (ex 33.72mm): this is the dimension "B".



3. Note the value engraved on the top of the secondary shaft (usually around 99.64mm) note it as "C".



4. The following calculation provide the thickness (D) of the shim of the secondary shaft.

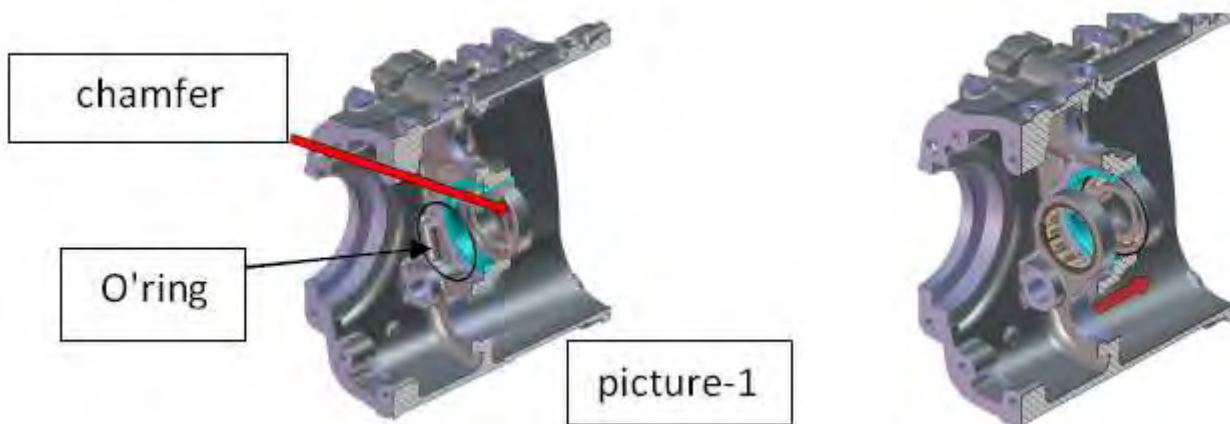
$$A - (B + C) = D$$

$$\text{Ex: } 137.25 - (33.72 + 99.64) = 3.89$$

5. Choose the shim set F19102051, assemble the shim being the closest to the calculated thickness "C". (3.90mm in the example)
6. Assemble the bearing shim NU207 to the press on the secondary shaft.

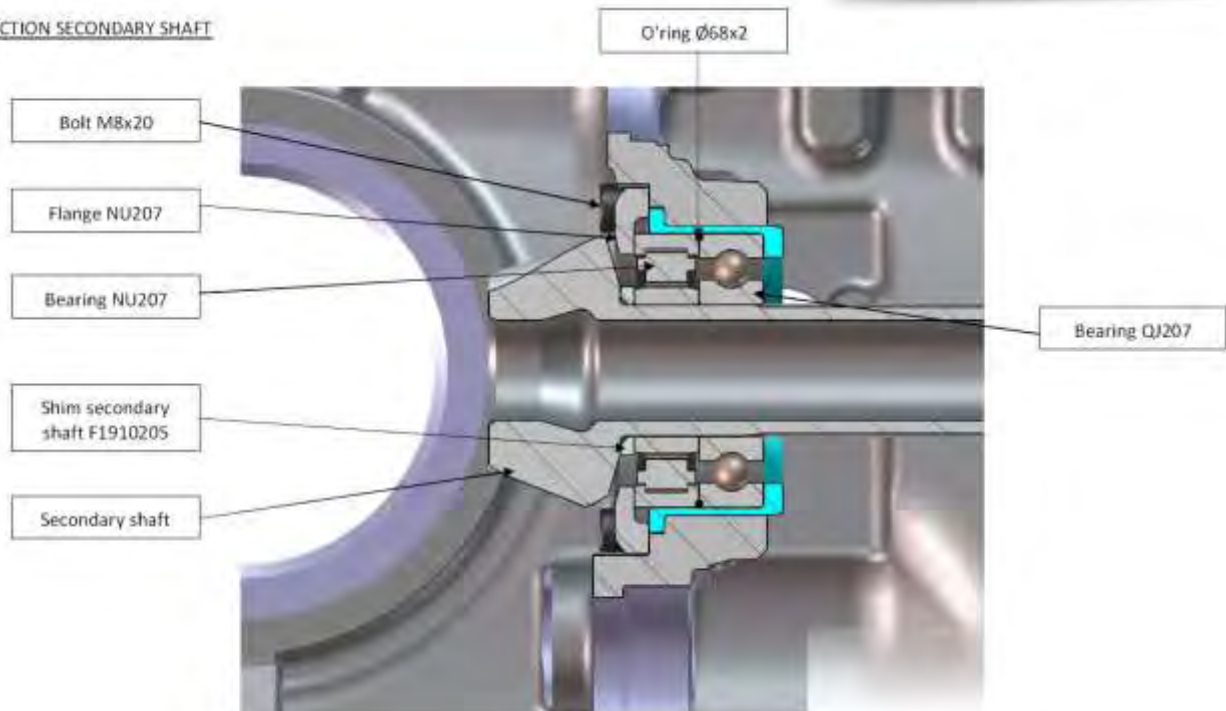


7. Refit the bearing QJ207,
 - a. WARNING: install the chamfer towards the differential
 - b. Replace the O-ring on the chamfer of the external race of the QJ207 bearing.



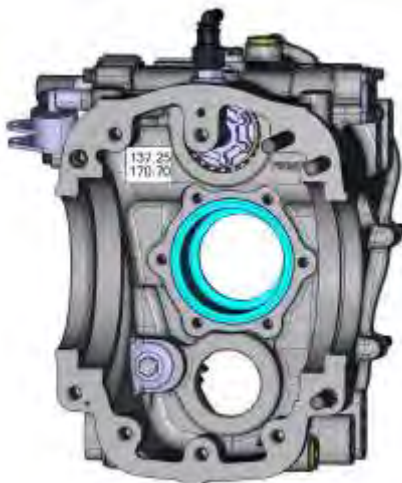
8. Place the NU207 flange on the housing, put some Loctite 270 in the internal thread M8 of the housing, and tighten bolts them to 25N.m.
9. Put the shaft through the bearings using a mallet to set it in place.

SECTION SECONDARY SHAFT

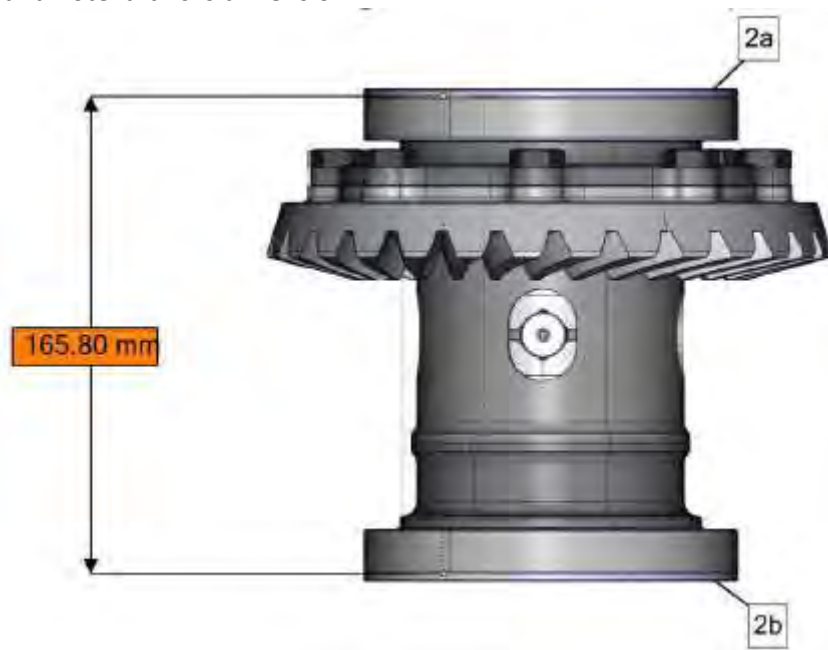


14.10.4 Differential (Crown) Operating Adjustment

1. Remove the differential.
2. Note the highest dimension marked in the main housing (around 170mm). This is dimension “X”.



3. Measure the highest distance between the external races of the bearings assembled on the differential case and note it: this is dimension “Y”.

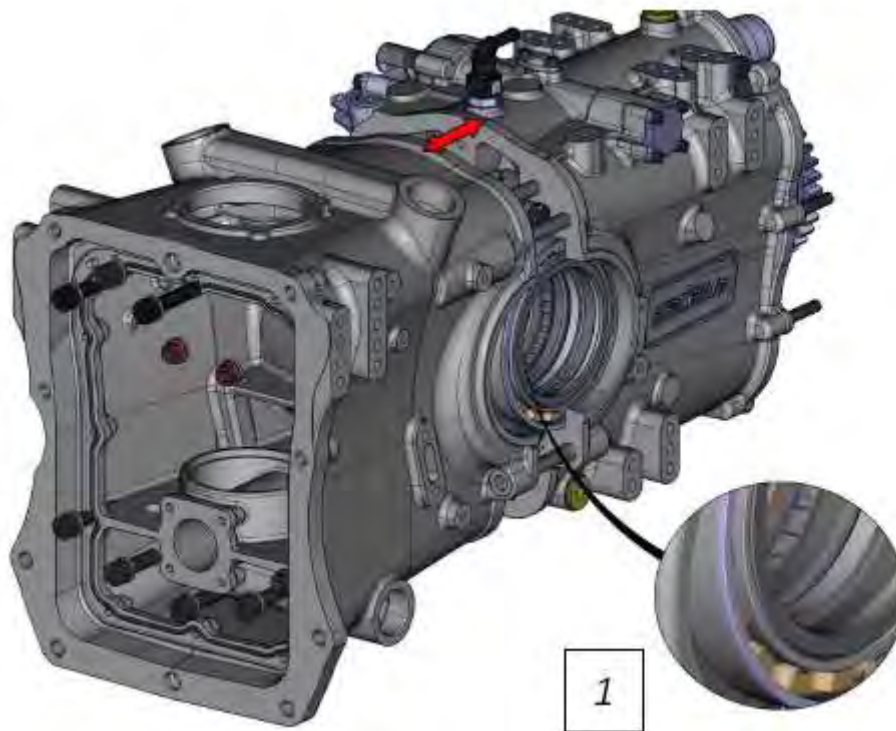


4. Do the following operation to find the total thickness “Z” of the two shims (2a and 2b):

$$X + 0.1 - Y = Z$$

Ex: $170.8 + 0.1 - 165.8 = 5.1\text{mm}$

5. Fit inside the main housing the differential case and its two crown positioning shims. The shims must be put between the main housing and each bearing. At the first attempt, use on each side an even shim thickness.



6. Fit the differential cap on the main housing and tight the bolts without gluing. (Pn. F19103201 Shim Set). (i.e. $5.1/2 = 2.55\text{mm}$)

NOTE:

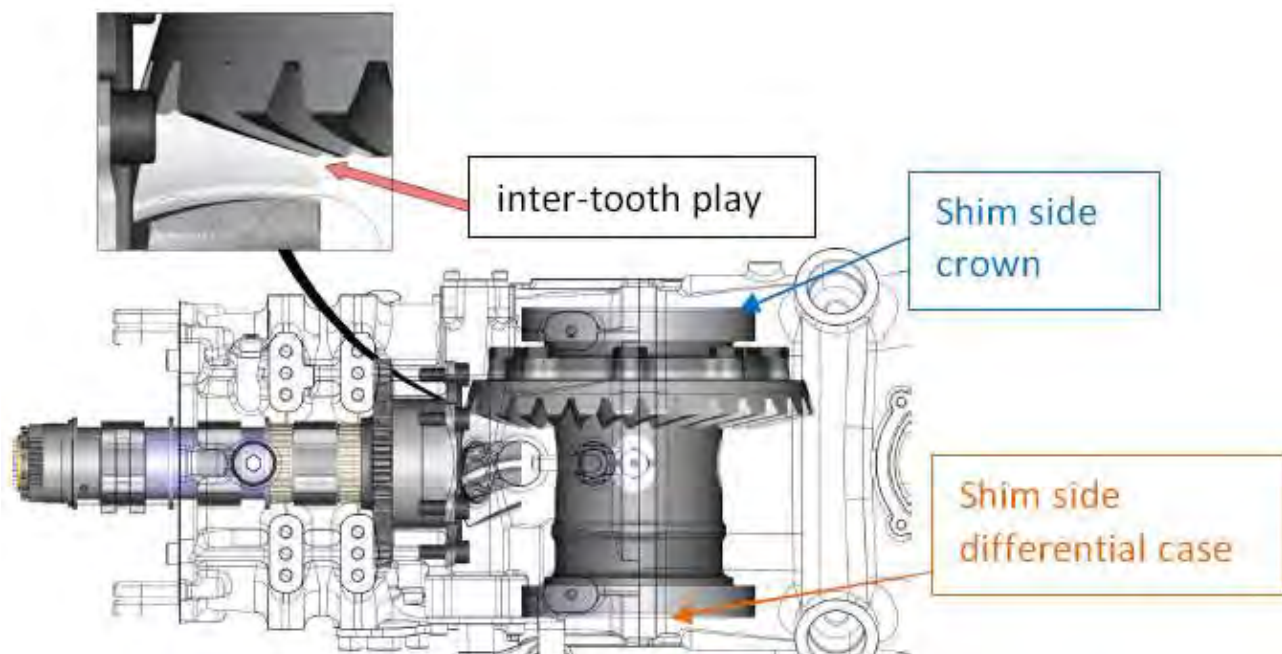
- The total thickness of both crown positioning shims must always be as close as possible of the calculated dimension Z.
- The final drive clearance shims must be installed with its chamfer outwards (1).

14.10.5 Final Drive Operating Clearance

1. Assemble all parts except the gears, engage the reverse gear on the secondary shaft.
2. Tighten the secondary nut to 180 N.m.
3. Check the inter-tooth play using a comparator (clearance indicator).
4. Read the clearance on the final drive in many teeth of the secondary nut (5 to 10 measurements on several turns of the secondary shaft).



5. The minimum clearance must be between 0.05 and 0.1mm.
 - a. if the inter-tooth play is correct fit the gears.
 - b. If the inter-tooth play is incorrect, remove the differential housing, and Remove the shims behind the differential flange and proceed as follows:
 - i. If the play is excessive: move the crown wheel closer to the pinion by increasing the thickness of the left-hand shim (crown) and reducing the thickness of the right-hand shim (housing) by the same extent.
 - ii. If the play is insufficient: move the crown wheel away from the pinion by reducing the thickness of the left-hand shim (crown) and increasing the thickness of the right-hand shim (housing) by the same extent.



NOTE:

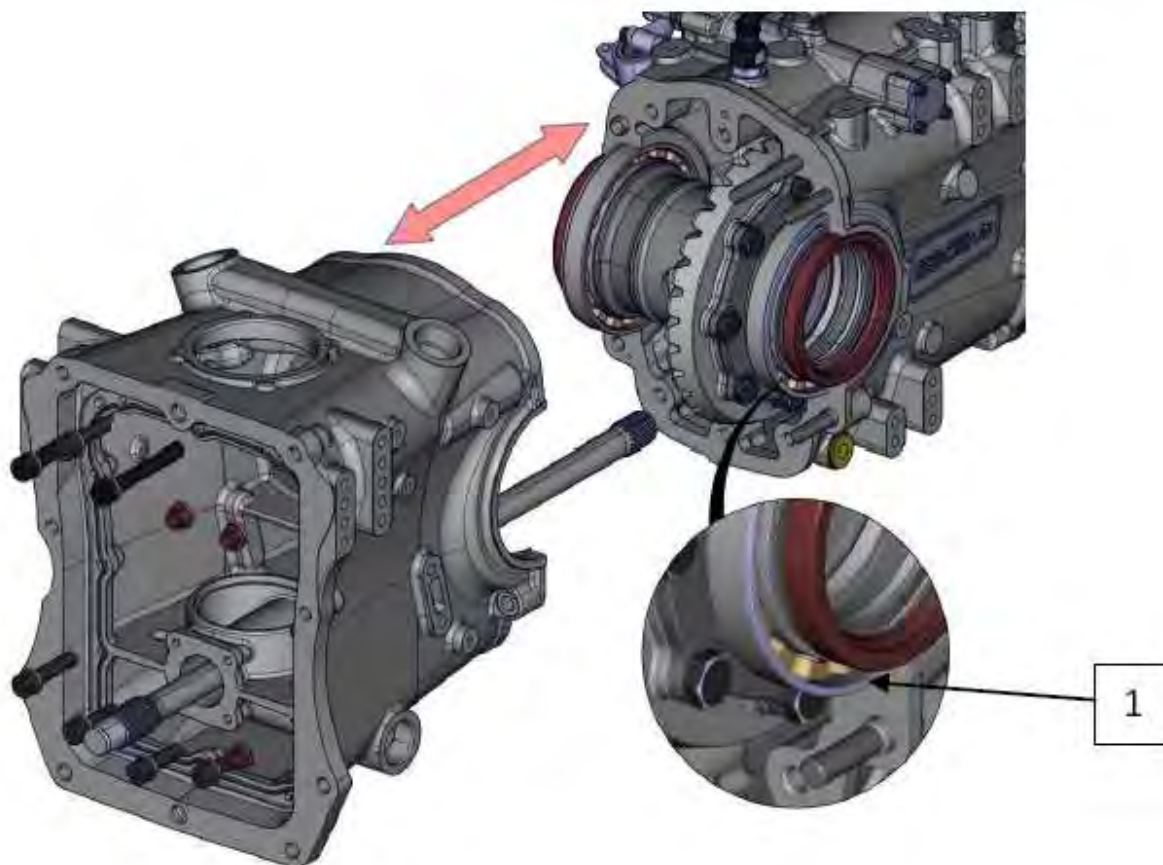
- Always keep the total thickness of the two shims constant so as not to affect the preload on the bearings.
- Recheck clearance after each operation.
- Once the clearance has been checked, refit the differential and the gears.

14.10.6 Differential refitting

Note: This operation should be completed only after the differential preload shim has been defined.

1. Clean the jointing surface of housing.
2. Reassemble the differential.
3. Apply Threebond 1215 joint compound to the casing joints.
4. Assemble the oil housing with the screws and nuts coated with Loctite 243. Tightening torque 60 N.m.
5. Replace the lip seals of the differential. (Pn. KITREVS8214LW1)

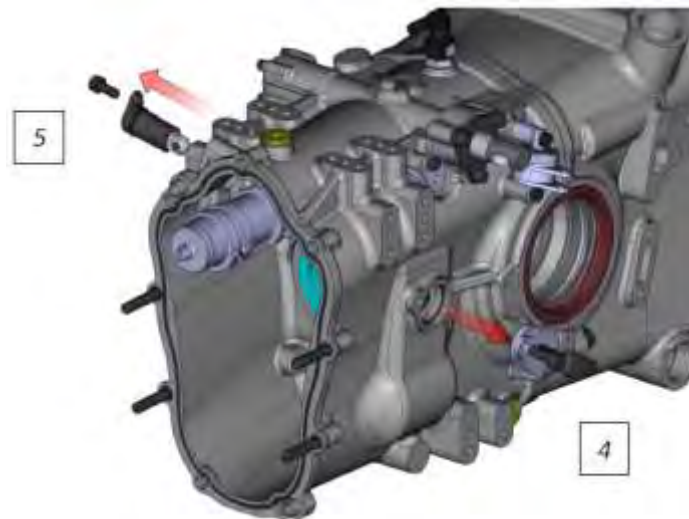
Note: Differential adjustment shims must be mounted in the correct direction (outward chamfer).



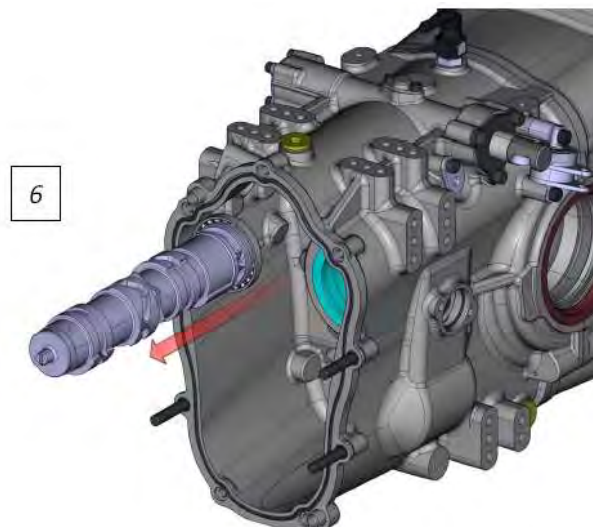
14.11 SELECTION MAINTENANCE

14.11.1 Barrel Removal

1. Drain the box through the lower drain plug.
2. Disconnect potentiometer, remove the rear housing.
3. Remove the primary gears and secondary gears.
4. Remove the complete reverse gear rocker.
5. Remove the indexer guide.



6. Remove the barrel.



7. Check the bearing and change if necessary. (Disassembly to the press)

14.11.2 Barrel Refitting

Proceed in reverse order of disassembly, and replace the seals (Rebuild kit pn. KITREVSL8214LW1).

14.11.3 Selector shaft disassembly

1. Engage reverse gear.
2. Remove the two fixing bolts of the selector rocker and remove the external gear selector.



2

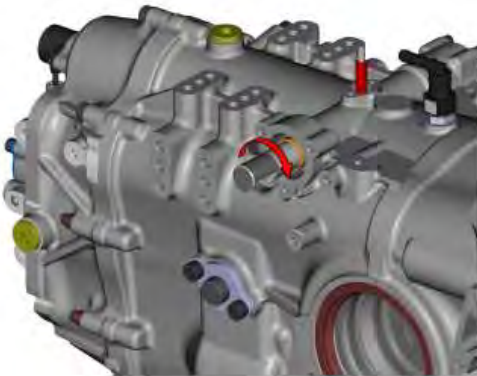
3. Unscrew the 3x bolts M6x16 and remove the right selector closing cap.
4. Remove the selector hook pusher (pay attention to its installation direction)



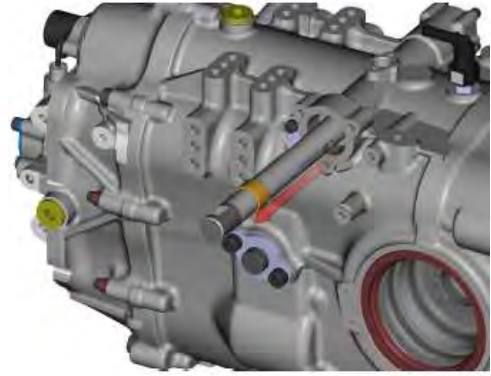
3-4

5. Pass a round magnet type FACOM (ref. 827.1) through the opening of the pusher guide and support the selector hook.

6. While holding the clip raised, pivot the control shaft one-quarter of a turn only and extract from the control block side.



5-6

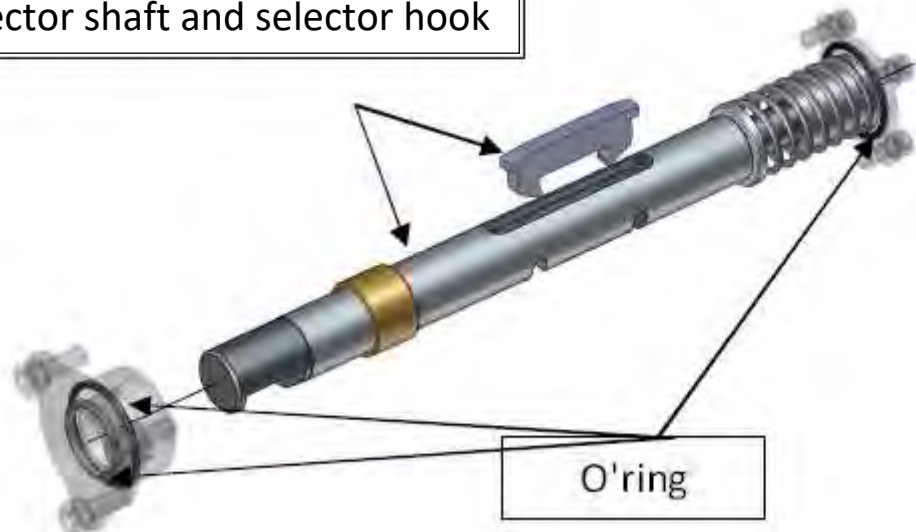


6

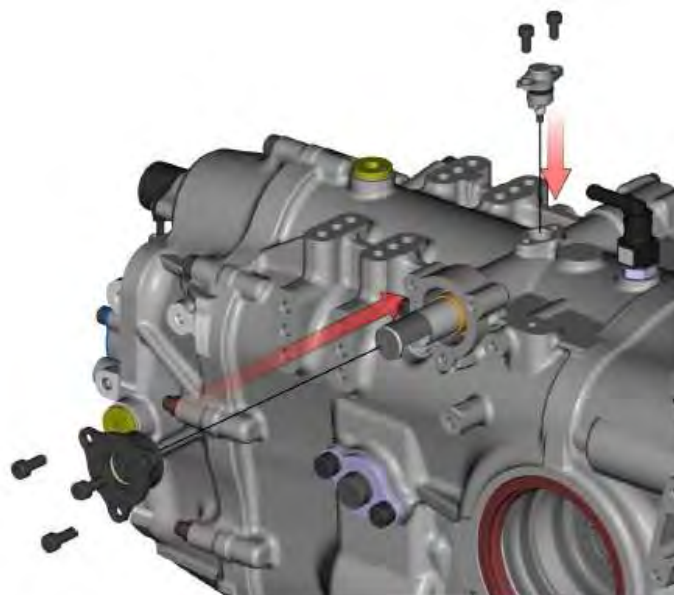
14.11.4 Selector shaft refitting

1. Put the barrel in reverse gear position.
2. Check the condition of the selector hook and the selector shaft.

Selector shaft and selector hook



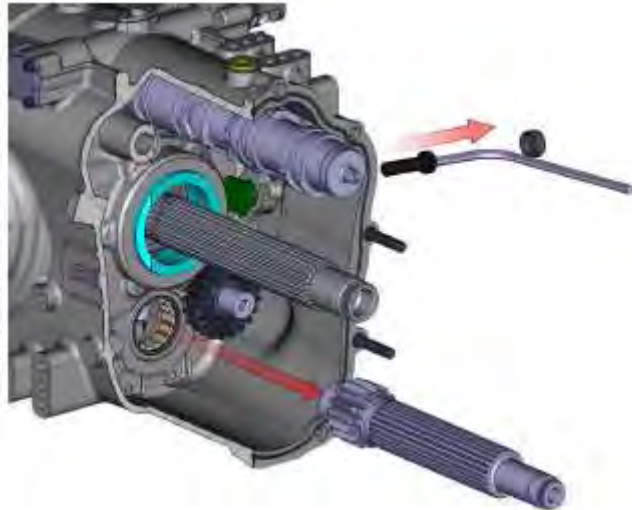
3. Check the good condition the seals (See Kit KITREVSL8214LW1)
4. Refit the selector hook on the selector axle.
5. Insert the selector shaft into casing having first made a quarter turn anti-clockwise. Once the shaft is in place, turn this back a quarter turn clockwise (towards its operational alignment).
6. Refit the selector hook and coat threads with Loctite low-strength threadlock 222 and tighten to 8 Nm.
7. Apply a few drops of Loctite normal threadlock 243 and tighten the bolts on the right selector closing cap 15Nm.



14.12 REVERSE GEAR MAINTENANCE

14.12.1 Reverse gear disassemble

1. Remove gears.
2. Remove the primary shaft.
3. Remove the bolt cap, using a flat wrench lock the inner nut of reverse gear rocker, then loose the screw M10x35.



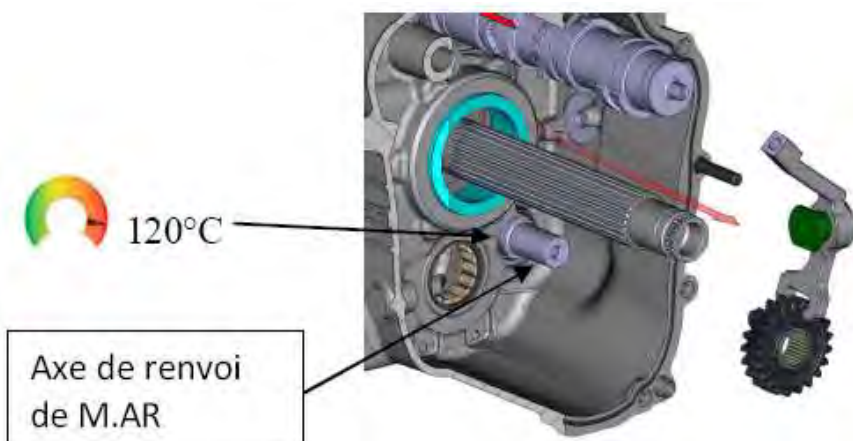
4. Remove the reverse gear rocker and the reverse gear.
5. Check condition of the axis of reverse.

14.12.2 Reverse axle replacement

1. Remove the differential.
2. Remove the axis reverse bolt (M8).



3. Heat the casing to 120°C around the reverse axle.



4. Remove the axle from the gears housing side by tapping with a mallet.



NOTE: Check that the bore of the casing has not been damaged.

14.12.3 Reverse Gear Axle Refit

1. Heat the casing to 120°C around the reverse shaft.
2. Refit the shaft by tapping it with a mallet.
3. Refit the differential assembly.

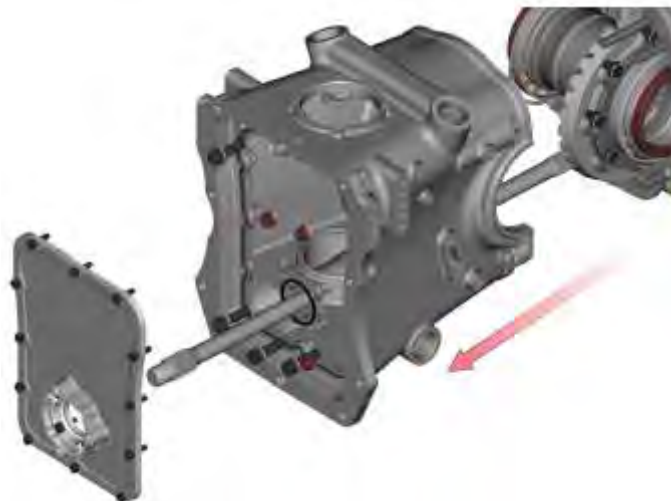
14.12.4 Reverse Gear Refit

1. Clean and check condition of parts.
2. Fit the reverse idler in the fork of the reverse gear rocker.
3. Insert the rocker control finger in the barrel groove.
4. Apply a few drops of Loctite high-strength threadlock 270 to the rocker bolt. Tighten the bolt to 55 Nm while holding the reverse nut with an open-ended spanner.
5. Refit the bolt head cap.

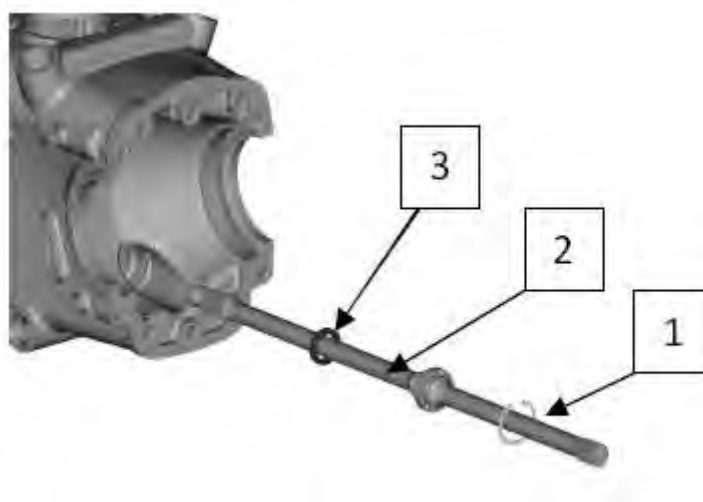
14.13 CLUTCH SHAFT MAINTENANCE

14.13.1 Clutch Shaft Removal

1. Remove the oil tank plate
2. Unscrew the M10 bolts.

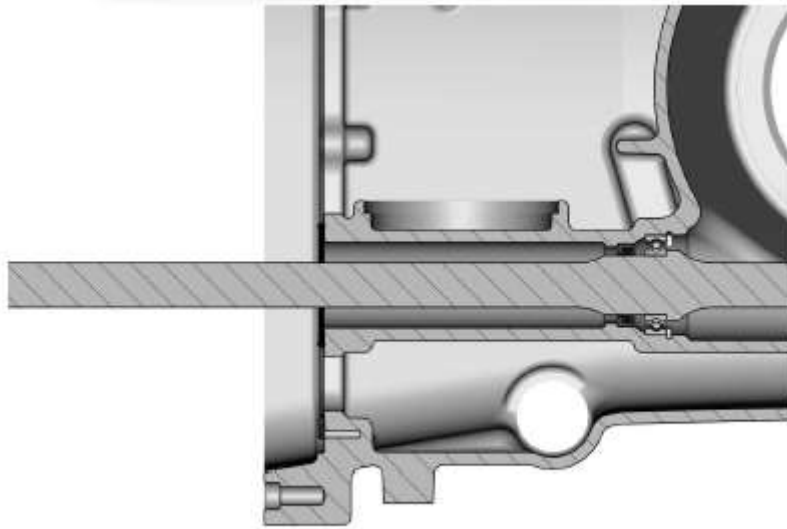


3. Remove the oil tank housing together with the clutch shaft.



4. Remove the locking ring (1)
5. Remove the clutch shaft with the bearing. (2)
6. Check the condition of the bearing, if a change is needed retire it with a press.
7. Check the condition of the shaft (splines and bearing surface)
8. Change the lip seal (see rebuilt kit KITREVSL8214LW1) (3)

14.13.2 Clutch Shaft Refit

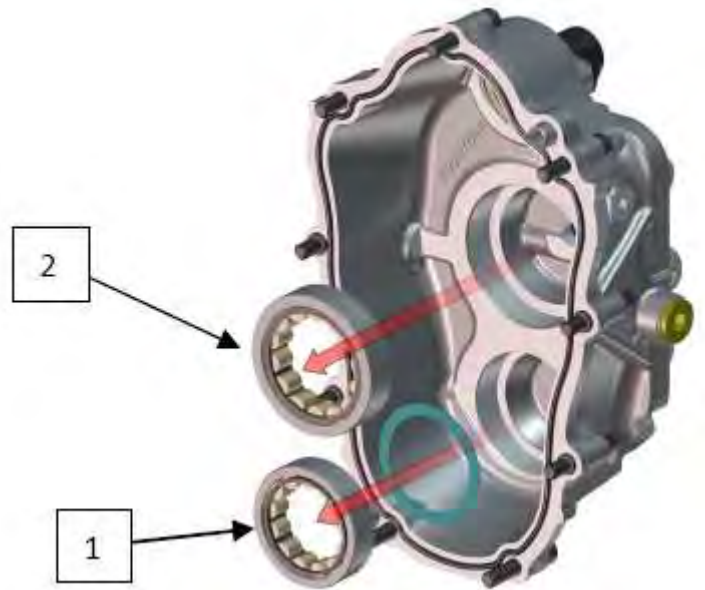


1. Clean and check the condition of the shaft (splines, bearing surface) and lip seal housing.
2. Refit the bearing on the clutch shaft.
3. Refit the new lip seal (in the tank housing).
4. Refit the clutch shaft in the housing, refit the locking ring.
5. Refit the oil tank housing.

14.14 PRIMARY AND SECONDARY SHAFT BEARINGS

14.14.1 Bearing Disassemble

1. Drain the gearbox.
2. Remove the potentiometer.
3. Remove the rear housing.
4. Heat the rear housing to 120°C
5. Use an extractor type FACOM (extractor to adapt to the bearing to be extracted) to remove bearing (1) and (2).

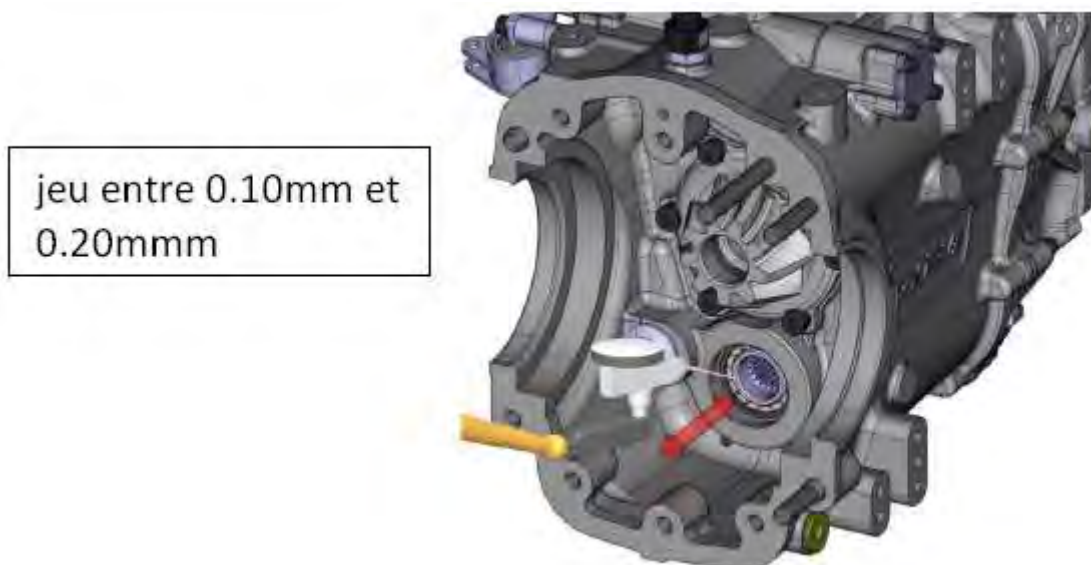


14.14.2 Secondary Shaft Bearing Refit

1. Apply a small quantity of Loctite "fixing product " 603 on the outer bearing cage.
2. Press fit the bearing of the rear casing taking care to seat this well at the bottom of its housing.

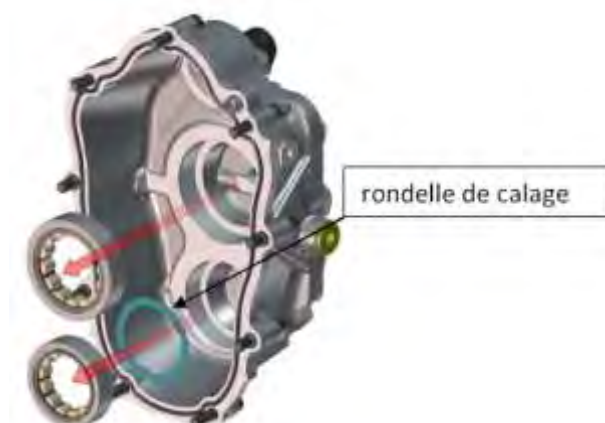
14.14.3 Primary Shaft Bearing Refit

The **axial play** of the primary shaft must be **between 0.1mm and 0.2mm**.



In order to achieve the prescribed free play, check the clearance of the primary shaft.

1. Refit the bearing NU206 ECP (ref 0103011) in the bearing housing. (Do not apply Loctite)
2. Remove the differential housing with clutch shaft.
3. Remove the secondary line. (wheels)
4. Refit the rear housing with bolt M8.
5. Place a comparator at the end of primary shaft and check the axial clearance.
6. If the clearance is more than 0.20mm place a shim behind the bearing NU206 ECP. (Pn. 0599030 Shim thk 0.10mm, 0599031 thk 0.20mm).

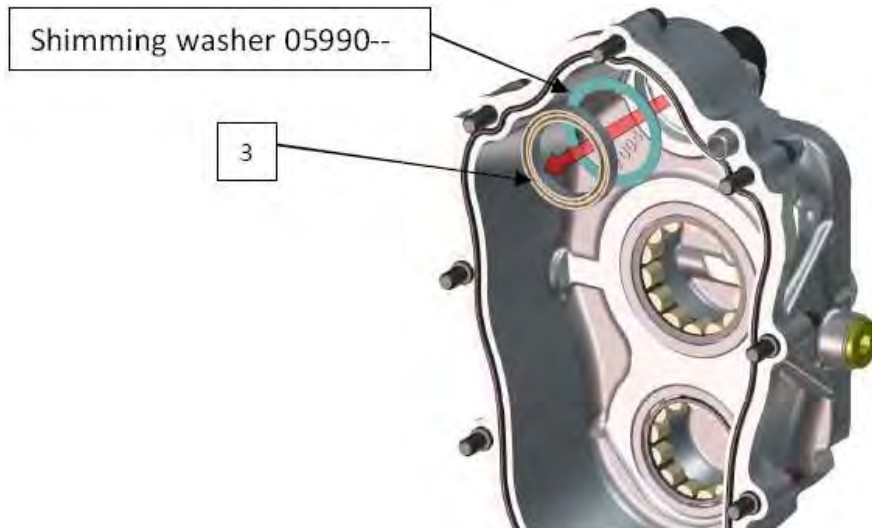


7. Once the thickness of the washer is determined, reassemble the bearing in its casing housing by applying a small amount of Loctite 603 to the bearing's outer casing. "Press fitting"

14.15 BARREL BEARING

14.15.1 Barrel Bearing Removal

1. Heat the rear housing to 120°C
2. Using an extractor FACOM (Extractor adapt to the bearing to be extracted) to remove the bearing (3).



Note: Check that the bearing housing have not been damaged while dismantling.

14.15.2 Barrel Bearing Refitting

The **axial play** of the primary shaft must be **between 0.1mm and 0.2mm**.

clearance between 0mm and 0.20mm



In order to achieve the prescribed free play, check the clearance of the barrel shaft

1. Refit the bearing 61807 (Pn. 0101064) in the bearing housing. (Do not apply Loctite)
2. Remove the differential housing with clutch shaft.
3. Remove the secondary line. (wheels)
4. Refit the rear housing with M8 bolts.
5. Place a comparator at the end of barrel and check the axial clearance.
6. If the clearance is more than 0.20mm place a shim behind the bearing 61807. (Pn. 0599024 thk. 0.10mm; Pn. 0599025 thk. 0.20mm, Pn. 0599026 thk. 0.50mm).
7. Once the thickness of the washer is determined, reassemble the bearing in its casing housing by applying a small amount of Loctite 603 to the bearing's outer casing. "Press fitting"

14.16 GEARBOX REBUILDING

14.16.1 SADEV workshop rebuilding

The gearboxes are delivered plumbed and numbered.

SADEV will adopt a careful attitude when receiving a gearbox without any 'SADEV' seals. This will also be effective if the gearbox shows minor or major damages.

Return gear boxes to revision:

At the time of the return of the gearboxes in our premises, a certain procedure of delivery has to be respected, so that our intervention can be total, and practical (casing 'closed' for passage to the bench).

We must receive the complete product as described below:

- Gear box drained and cleaned
- Release bearing in place
- Oil pump in place.
- Entry and exit of lubrication closed by plugs designed for this purpose (Goodridge, SpeedFlow...)
- Shifters and reverse gears locking solenoid," if original on gearbox "
- Drain plug and drain plug seal in place
- A card specifying the kilometers of the special stages and connection since the last service, available at the end of the technical manual.

Administrative procedure:

1. Contact our sales department
2. APPROXIMATELY 2 TO 3 WEEKS OF DELIVERY TIME MUST BE CONSIDERED, please confirm with our sales department.

14.16.2 Private revision

SADEV IS NOT RESPONSIBLE FOR ANY DAMAGE FOLLOWING A REVISION NOT EXECUTED IN A SADEV AGREED TECHNICAL SERVICE

15 SHIFT SYSTEM

15.1 SYSTEM OVERVIEW

The IP-22 is equipped with a semi-automatic shift system, here below a quick overview:

- GCU (Gear Control Unit): Cosworth SQ6, this unit manage the engine and the gearshift control
- EGA (Electric Gear Actuator): Magneti Marelli EGA, this unit driven by the GCC (Magneti Marelli) perform the physical shift, EGA is a position control unit, refer to the chapter xxx for its setting and maintenance.

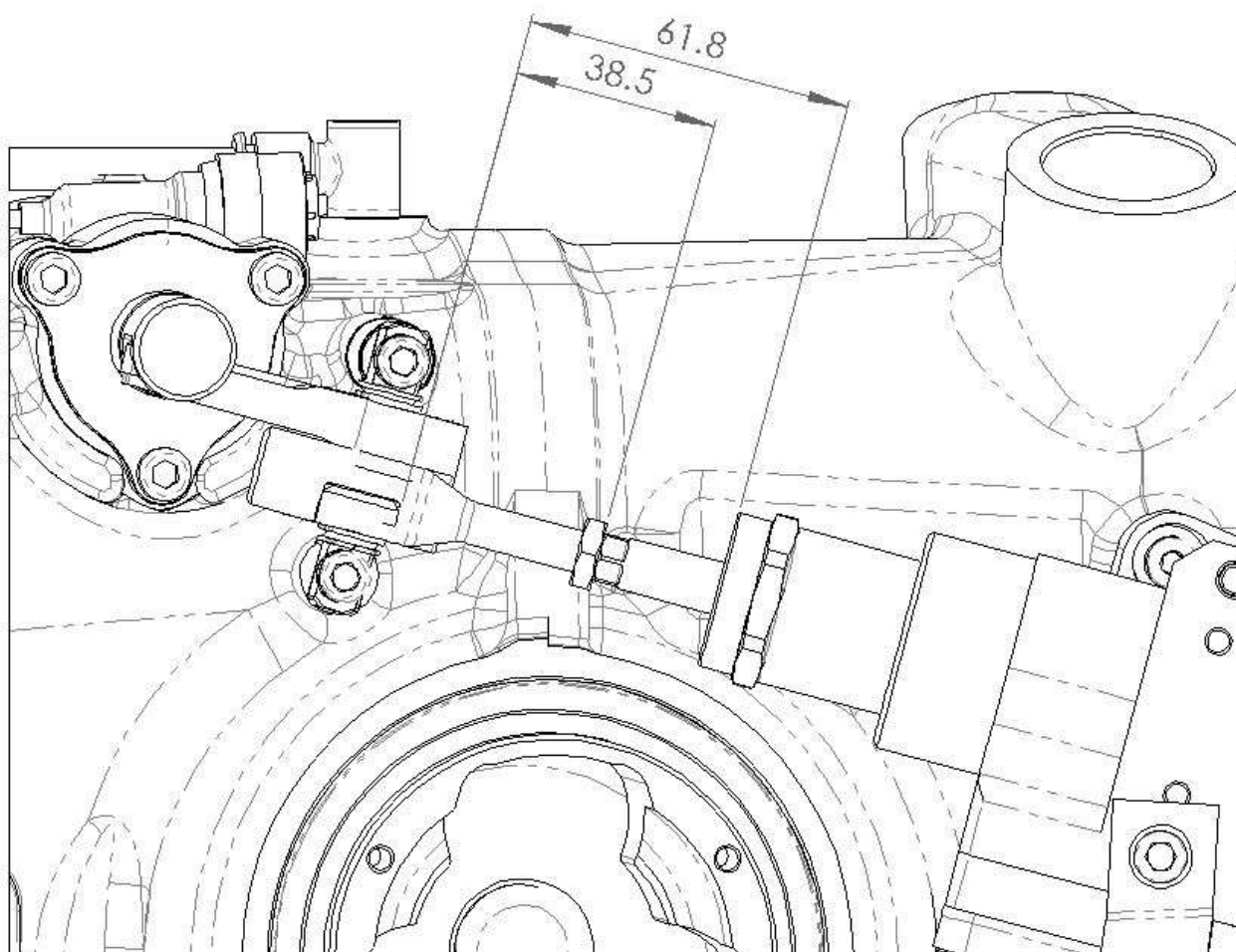
15.2 GEARSHIFT CONTROL

Refer to Cosworth documentation for procedures and strategies.

15.3 EGA MAINTENANCE

The EGA actuator have to be set to a proper “rest” length following this procedure:

- disengage actuator from gear selection rocker
- position the EGA in order that any shaft stroke cannot contact with anything
- require a shift with paddle (either upshift or downshift)
- the shaft will move and will go back to the rest position
- set the length of the selection link according to drawing (61.8 +/-0.5mm from the main EGA shaft or 38.5 +/- 0.5mm from the counternut).
- fit the EGA



In order to check the shaft length, you can inspect the EGA movement: after every actuation, the shift control is forcing the shaft to its mid position for two seconds and then leave the centering to the selection spring, if a further movement can be seen after the release of the electric control the shaft length should be adjusted to compensate it.

16 ELECTRONIC & SOFTWARE

16.1 ELECTRONIC SYSTEM

The IP-22 electronic system is managed by several units:

- Cosworth SQ6: Engine and Gearbox control (ECU/GCU)
- Cosworth Omega L2: Data logger
- Cosworth CFW: Steering wheel with display and gearshift paddles
- Magneti Marelli GCC: Gearshift Current Controller, it controls the gearshift actuation
- Next Solution PSD9: Powerbox with 9 protected electrical lines (ref chapter 12.4)
- Rain light: CAN active rain light

All these units are communicating through a common CAN bus.

16.2 SOFTWARE

- Cosworth SQ6: no software available for users
- Cosworth Omega L2: <http://www.cosworth.com/media/199745/29P-071672.pdf>
- Cosworth CFW: no software available for users
- Magneti Marelli GCC: no software available for users
- Next Solution PSD9: no software available for users
- Rain light: no software available for users

17 ANNEXES

17.1 TIGHTENING TORQUE

Thread	Pitch	8.8 grade		10.9 grade	
		Torque	Torque	Torque	Torque
[mm]	[mm]	[Nm]	[Lbs ft]	[Nm]	[Lbs ft]
3	0,5	1,2	0,92	1,8	1,3
4	0,7	2,8	2,08	4,0	2,9
5	0,8	5,8	4,26	8,1	6,0
6	1	9,7	7,13	13,6	10,0
8	1,25	23,7	17,45	33,3	24,5
8	1	26,4	19,50	37,2	27,4
10	1,5	47,0	34,70	66,2	48,8
10	1,25	51,4	37,91	72,3	53,3
12	1,75	81,0	59,72	113,9	84,0
12	1,25	93,4	68,90	131,4	96,9
14	2	129,9	95,85	182,7	134,8
14	1,5	146,9	108,34	206,6	152,3
16	2	206,5	152,30	290,4	214,2
16	1,5	229,0	168,90	322,0	237,5

		Grade 5	Grade 8
Thread	Pitch	Torque	Torque
Inch	TPI	Lbs-ft	Lbs-ft
1/4	28	7	10
5/16	24	14	20
3/8	24	25	35
7/16	20	40	55
1/2	20	60	85
9/16	18	85	120
5/8	18	120	170