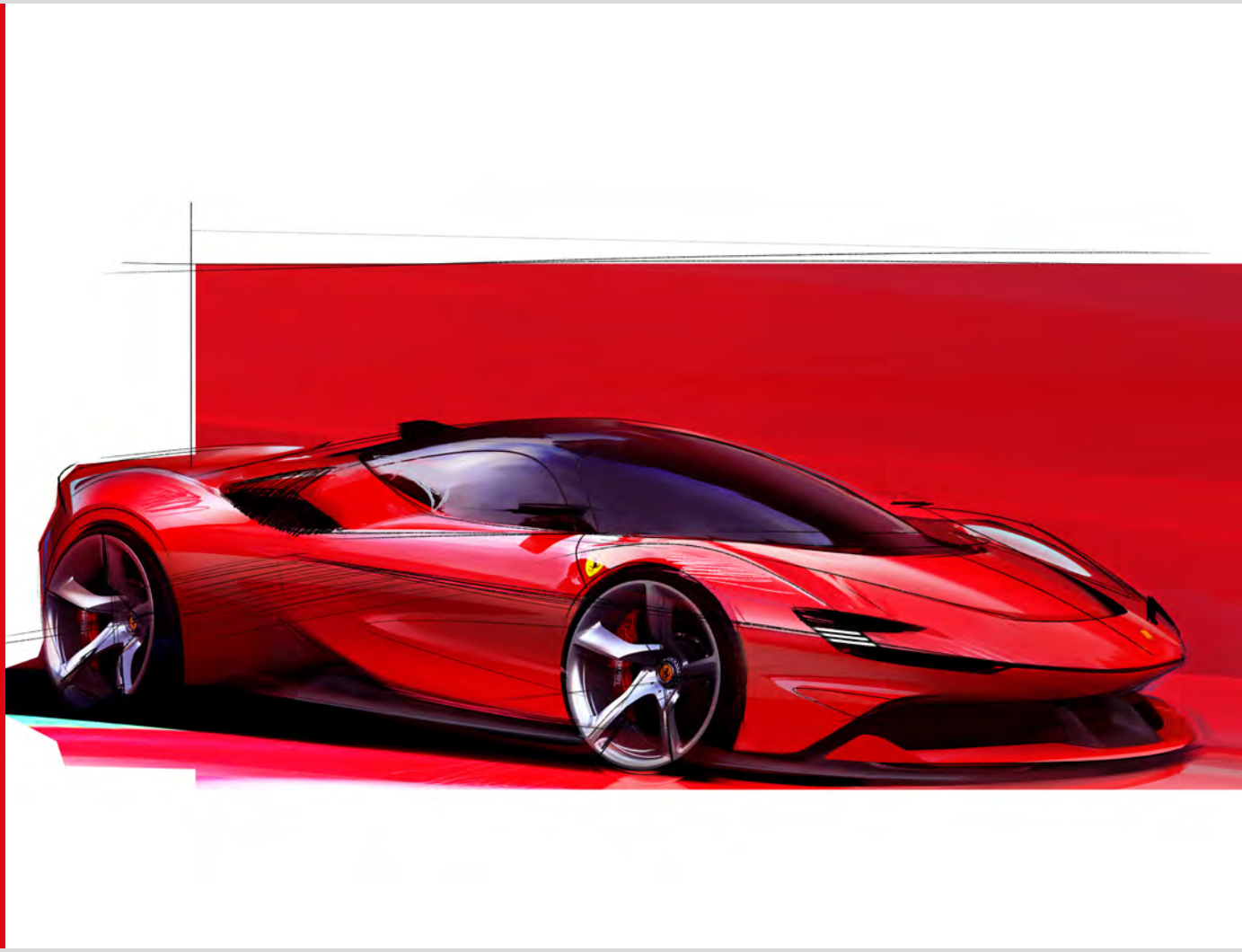
Product Information

SF90 STRADALE



May 2019

SF90 STRADALE Product Information

Product Marketing and Communication No. 02/2019
Maranello, May 2019

Dear All,

This Information Document describes the main characteristics of the Ferrari SF90 STRADALE in terms of target clients, performance and technological content.

Best regards,

Cordiali saluti,

Matteo Torconi

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Product concept and client profile

SF90 STRADALE

PRODUCT CONCEPT

"The best Ferrari ever built is the next one" is a phrase that sums up Enzo Ferrari's philosophy in a nutshell. That same philosophy continues to drive every Ferrari technician as they tackle the design of each new car, be it a Formula 1 or a road-going model.
The pressure to constantly achieve the impossible gave us with the courage to venture down a previously-unexplored avenue and open an important new chapter in the Prancing Horse's glorious history: the era of the series production Ferrari hybrid.
This paradigm shift is being ushered in by the SF90 STRADALE, a car so extreme it is an authentic production supercar in its own right, a whole new benchmark in terms of its performance and innovative content not just with regard to the Ferrari range, but also its competitors.

The choice of PHEV (Plug-in Hybrid Electric Vehicle) architecture means that the SF90 STRADALE can deliver completely unprecedented performance for a car in the range: 1.57kg/cv weight-power ratio (a new benchmark) as well as a 1,000 cv maximum power output, 780cv of which is supplied by a 90° V8 turbo engine, the highest power output of any 8-cylinder in Ferrari history. The remaining 220 cv is delivered by three electric motors, one at the rear connected to the ICE and two on the front axle.
This sophisticated system does not, however, make for a more complicated driving experience. Quite the opposite, in fact. The driver simply has to concentrate on driving as a sophisticated control logic takes care of the rest, managing the flow of power between the V8, the electric motors and the batteries to suit driving conditions.

The driver can select any of four power unit management modes using the special eManettino[1] selector:

- *eDrive*: all-electric mode capable of delivering a range of up to 25km
- *Hybrid*: prioritises efficient energy usage (default mode); the control logic decides independently how to deliver power (electric only, ICE only, combination of the two)
- *Performance*: prioritises maintaining battery charge to be prepared for a sudden sharp request for power by the driver; the ICE is kept running to guarantee maximum fun behind the wheel
- *Qualify*: ICE and electric motors working at full capacity to guarantee maximum performance

[1] *Similar to the now-classic Manettino vehicle dynamics control switch which is also on the steering wheel*

PRODUCT CONCEPT

The SF90 STRADALE is also the first Ferrari sports car to be equipped with 4WD, a step necessary to allow the incredible power unleashed by the hybrid powertrain to be fully exploited. It also allowed the designers to aim for the car to become the new benchmark for standing starts: 0-100km/h in 2.5 sec and 0-200km/h in barely 6.7 seconds.

Once again, a sophisticated control logic splits the power between the electric front axle and the ICE-electric hybrid rear axle to suit driving conditions. The driver can then just relax and make the very most of this extraordinary car's huge potential.

The hybrid architecture allowed the Ferrari technicians to further broaden the scope of the car's dynamic controls which are now integrated in the new e-SSC control system. The e-SSC, which monitors dynamic conditions from instant-to-instant and controls stability, now has two electric motors, which can independently control the torque delivered to the wheel on the outside and the wheel on the inside of a corner (Torque Vectoring), significantly improving traction coming out of the corner and making it much simpler and safer to drive on the limit with confidence.

The development of a hybrid car of this kind was a huge aerodynamic challenge. On the one hand, the significant boost in the power unit's performance brought with it an increase in the amount of heat energy to be dissipated and required the development team to carry out an in-depth review of the aerodynamic flows on the radiating masses. On the other, it also required the development of new solutions to increase downforce efficiently and guarantee maximum stability at all speeds and in all driving conditions.

The result of this long and difficult development process is an extreme aero design: with 390kgf of downforce at 250km/h, the SF90 STRADALE sets the absolute benchmark for the road cars in the range without aerodynamic appendages, in terms of downforce and efficiency.

PRODUCT CONCEPT

The many innovative solutions include:

- The *shut-off gurney*, a patented active system located at the rear of the car which adapts to driving conditions – from high efficiency mode, suited to reaching maximum speeds, to high downforce mode for cornering, braking and changes of direction
- New forged wheels (also patented) with wing profiles which recall the blown geometry derived directly from Formula 1. These wing profiles improve the interaction between the flow coming from inside the wheel and that running along the sides, reducing turbulence and boosting efficiency.

The SF90 STRADALE is epoch-changing from a stylistic perspective as it completely rewrites the mid-rear-engined sports berlinetta proportions of the last 20 years, instead taking its inspiration from Ferrari's recent supercars. A good example is the cockpit, which has a smaller frontal section and is placed closer to the front of the car to reduce drag. All achieved without impacting on on-board comfort.

The track-derived "eyes on the road, hands on the wheel" philosophy takes on a truly central role for the first time too, significantly influencing the ergonomics and styling of the interior. The result is an HMI and interior layout concept that are a complete departure from previous models.

Another major innovation is the steering wheel which now has a touchpad that allows the driver to control virtually every aspect of the car using just his thumbs. The central instrument cluster is now entirely digital with a 16" curved HD screen (a market first) which can be fully configured and controlled using the controls on the steering wheel.

On the central tunnel, improved ergonomics have been melded with an element from the past: the automatic gearbox controls are now actioned by a grille-style feature that references Ferrari's legendary manual gear-shift gate. Thus past and present skilfully meld to point the new Ferrari towards the future.

PRODUCT CONCEPT

Lastly, the ignition key was also redesigned to work in full keyless mode which means that the driver can not only start the engine but also open the doors without taking it out of his pocket. Inspired by the Ferrari badge sported on our cars' bonnets, the new key has an unprecedented symbolic significance. Thanks to a special compartment in the central tunnel, it has now also become an integral part of the car's styling as well as being something of a lucky charm to have close by even when not driving.

TARGET CLIENT

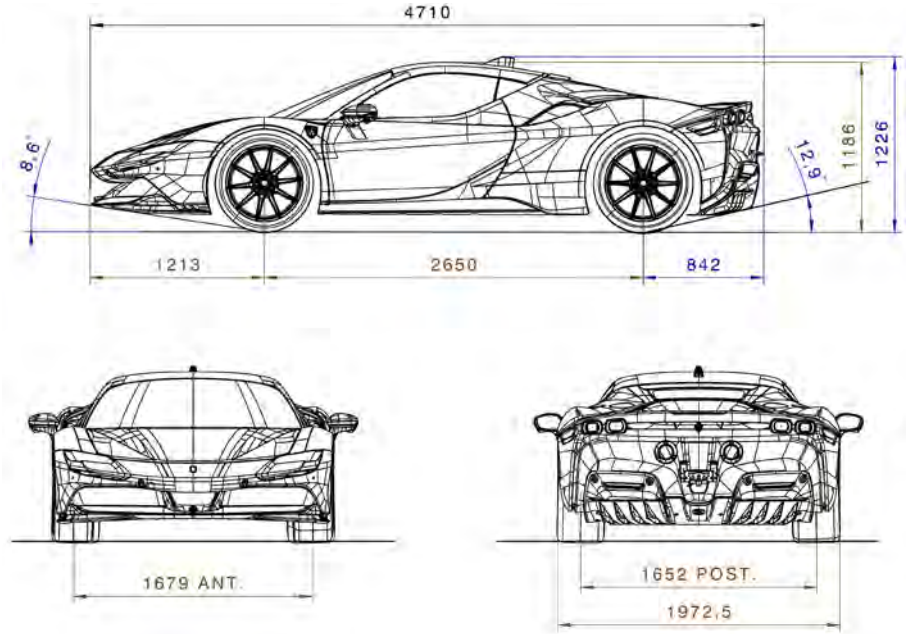
As a production *supercar*, the SF90 STRADALE is aimed at clients who demand the very best of Ferrari technology.

Client	Repeater	New
Incidence	75%	25%
Purchase motivation	• High performance / driving pleasure • Focus on maximum tech. content • Innovative, aggressive design • Series production *supercar*	
Cluster Provenance	• V8 sports car clients sensitive to the fun behind the wheel aspect and looking for maximum performance • V12 clients sensitive to maximum performance and looking for a mid-rear-engined concept that raises fun behind the wheel bar	• Our competitors' mid-rear-engined V12 clients seeking extreme performance and maximum fun behind the wheel

Table 1 – Client target of the new SF90 STRADALE

DIMENSIONS

The signature agility of Ferrari's mid-rear-engined berlinettas has been retained without interfering with wheelbase and track dimensions. The car's main dimensions are listed in Table 2.



Dimensions and weight	
Length	4710 mm
Width	1972 mm
Height	1186 mm
Wheelbase	2650 mm
Front track	1679 mm
Rear track	1652 mm
Dry weight*	1,570 kg
Weight distribution	45% front - 55% rear
Boot capacity	74 l
Rear bench capacity	20 l
Fuel tank capacity	68 l (2 reserve)

Table 2 – Dimensions and weight

*With optionals

Main innovations and performance

SF90 STRADALE

MAIN INNOVATIONS AND PERFORMANCE

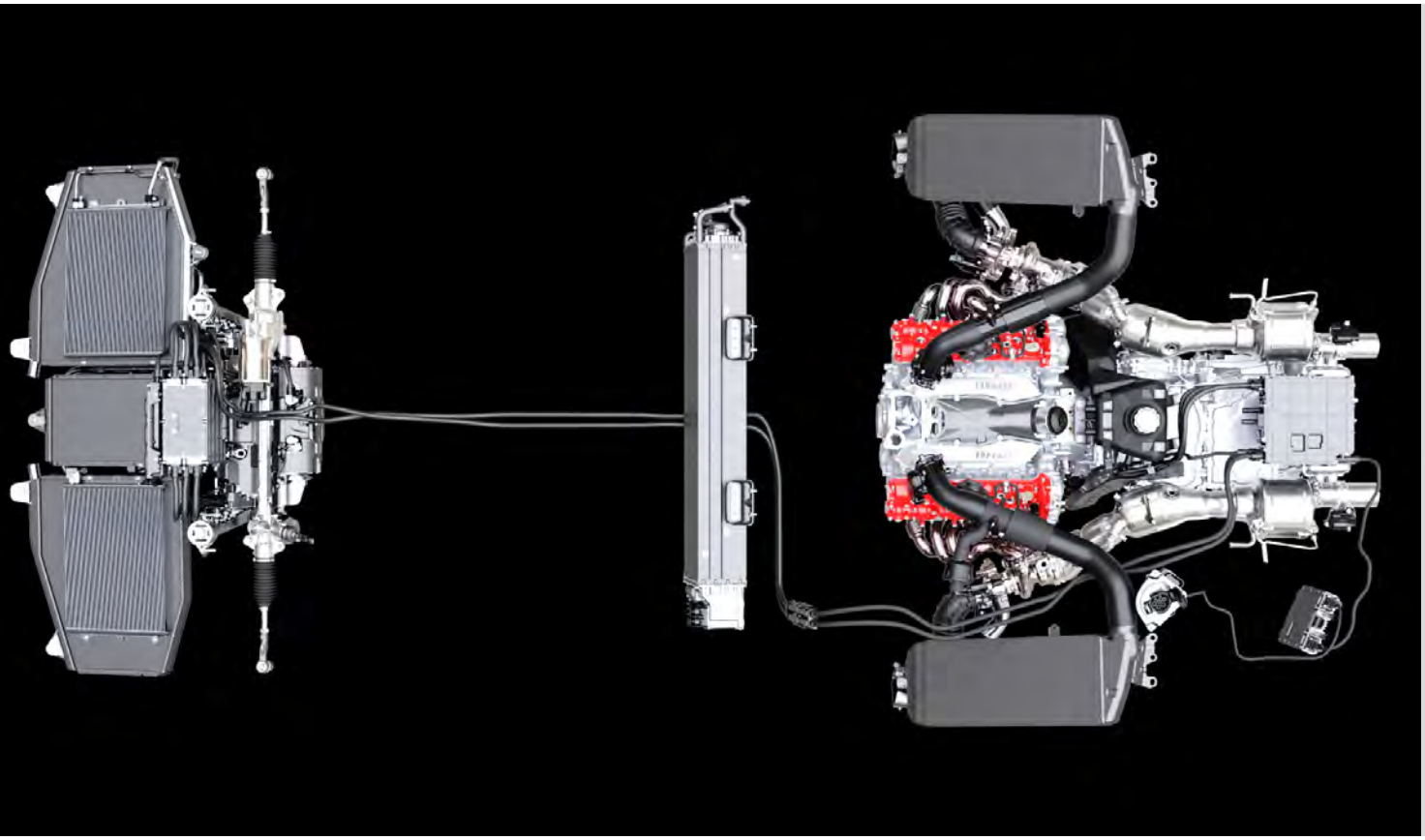
The SF90 STRADALE hails Ferrari's entry into the PHEV (Plug-in Hybrid Electric Vehicle) world. Such a radical paradigm shift could never have happened without a car this extreme: the SF90 STRADALE is essentially a series production supercar that sets the new benchmark in terms of performance and innovative content both for the current Ferrari range and its competitors.

The table below summarises the main features that have allowed this extraordinary result to be achieved:

Powertrain	• PHEV architecture with three electric motors, two independent on the front axle (RAC-E system) and one at the rear (MGU-K) between the ICE and the gearbox, generating up to 220cv in all • 780cv V8 turbo, our most powerful ever • New 8-speed dual clutch transmission with even faster gear shifting times than the previous 7-speed, which is also market benchmark
Aerodynamics	• New benchmark in terms of downforce and aerodynamic efficiency • Active rear gurney with shut-off mode (patented) • Wheels with wing profiles to extract flow from wheelarches (patented, optional)
Vehicle dynamics	• On-demand 4WD • New eSCC vehicle dynamics control system • Brake by wire to manage energy recovery under braking
HMI	• New steering wheel with completely redesigned interface that now allows all aspects of the car to be controlled without driver moving hands from wheel • Entirely digital central cluster with 16" curved screen, a market first

Table 3 – Main Product Innovations

Powertrain



SF90 STRADALE

The SF90 STRADALE is the first ever Ferrari to feature PHEV (Plug-in Hybrid Electric Vehicle) architecture which sees the internal combustion engine integrated with three electric motors, two comprising a subsystem known as RAC-E (Cornering Angle Regulator, Electric) on the front axle, with the third at the rear and known as MGU-K (Motor Generator Unit, Kinetic), like the Formula 1 system from which it is derived and takes its main functions.

The internal combustion engine and the electric motors work in synergy to unleash an incredible 1,000 cv, putting the SF90 STRADALE firmly at the very top of the range in terms of its performance.

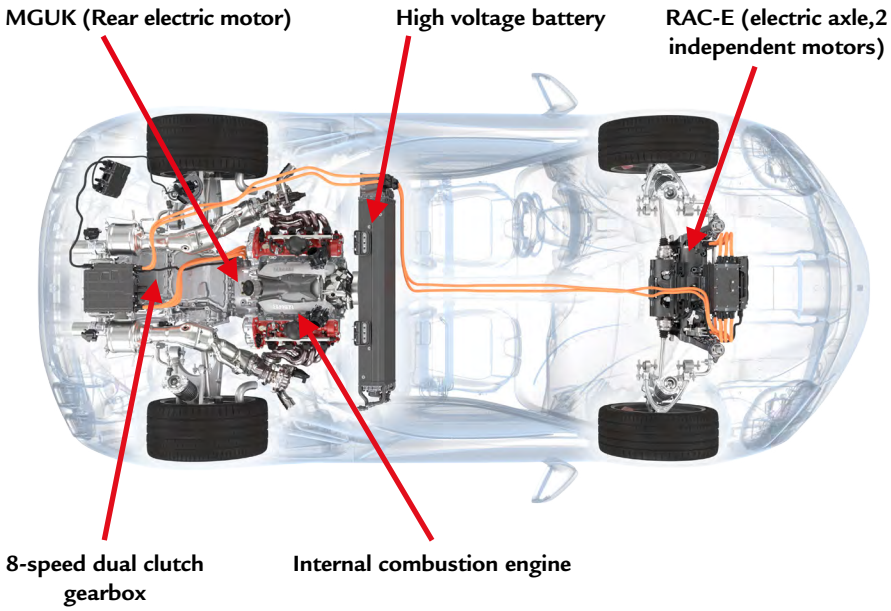


Figure 1 – SF90 STRADALE powertrain layout with PHEV architecture

The powertrain architecture comprises the following components (Figure 1):

- V8 turbo (ICE)
- 8-speed DCT with *E-Diff*
- *RAC-E* electric front axle with two independent electric motors, available on-demand up to a speed of approximately 210 km/h. The electric axle also provides sole propulsion in electric mode
- MGU-K electric motor which is connected to the engine and is located between the ICE and the gearbox
- High voltage battery
- Power electronics (inverter) to control electric motors

To describe how the hybrid system works, we can refer to two main types of power flow:

- **Power delivery** (traction, battery discharge), based on driver request via the accelerator pedal, processed by the engine control system and the hybrid control system and monitored by traction control. The power delivery modes can be divided up as follows:
  - **Electric mode**, entrusted to front axle
  - **RWD hybrid mode**
  - **4WD hybrid mode**, with electric front axle available on-demand for traction requirements exiting corners and energy recovery in lift-off/ braking

- **Energy recovery** (battery charging), managed entirely by the hybrid system's control logic using three strategies:
  - **Regenerative braking**, available on both axles both under standard braking and when ABS is active
  - **Overbraking**, active on both axles when accelerator pedal is released, managed independently on right and left front wheels
  - **ICE recharge**: battery charging function achieved by load point shifting between the ICE and the rear MGU-K electric motor.

FUNCTION MODES

Power management plays a pivotal role in a hybrid powertrain: it was thus necessary to have a selector to manage the power flows alongside the vehicle dynamics control selector (the traditional Manettino).
This is the *eManettino* and it manages power flows from and to the high voltage battery and the wheels.

The driver can choose from four different modes (Table 4):

- **eDrive**: the internal combustion engine remains off and traction is entrusted entirely to the electric front axle. Starting with a fully charged battery, the car can cover up to 25 km in this mode. The electric motors' power output is limited to 120 kW. This mode is ideal for urban areas or any other situation in which the driver wishes to avoid the roar of the Ferrari V8; the 135 km/h speed limiter means that the SF90 STRADALE can be fully used on out-of-town spins also
- **Hybrid (default)**: this is the standard driving mode in which the power flows are managed to optimise the overall efficiency of the system. The control logic autonomously decides whether to keep the internal combustion engine running or turn it off. If it is on, the internal combustion engine can run at maximum power thus guaranteeing powerful performance whenever the driver requires. In this case, electric motor power is again limited to 70 kW to prevent the battery charge being used up too quickly
- **Performance**: unlike 'Hybrid', this mode keeps the ICE running as the priority is more on charging the battery than on efficiency. This guarantees that power is instantly and fully available when required. Also in this mode, electric power is limited to 70 kW to limit battery consumption. This mode is best suited to situations in which driving pleasure and fun behind the wheel are the main focus
- **Qualify**: this mode allows the system to achieve maximum power output: it allows the electric motors to work at their maximum potential (162kW). The control logic prioritises performance over battery charging.

FUNCTION MODES

Mode Alias	eDrive	Hybrid (Default)	Performance	Qualify
Concept	Electric drive	Maximum powertrain efficiency	Sustainable performance (repeated laps)	Maximum Performance (small number of laps)
SOC* battery management strategy	Depleting	Depleting Sustaining	Charging	Charging
Energy recovery through:	RAC-E	RAC-E + MGUK	RAC-E + MGUK	RAC-E+ MGUK
Traction via:	RAC-E	RAC-E + MGUK + ICE	ICE + MGUK + RAC-E	ICE + MGUK + RAC-E
Max. Electric power [kW]	120	70	70	162
Max. ICE power [cv]	-	780	780	780
Total max. power [cv]	163	875	875	1000
Powertrain conFiguretion	FWD Vmax = 135 km/h	4WD on demand		

*SOC = State Of Charge

Table 4 – Hybrid power unit function models which are selected using the steering wheel-mounted *eManettino*. (ICE=Internal Combustion Engine, MGUK=Rear electric motor, RAC-E=Electric front axle)

BATTERY

The Li-ion battery used in the SF90 STRADALE has a 7.9kWh capacity which guarantees it a 25-kilometre range in eDrive mode.

Ferrari's engineers chose to put the battery pack immediately behind the seats, just above the chassis rear cross member, rather than going for the classic layout in which the batteries would be sunken into the floor pan. This guaranteed the best possible compromise, with the lowest centre of gravity and chassis weight possible. Positioning the cells at floor pan level would have lowered the centre of gravity of the battery, but the chassis work required to guarantee the necessary bending stiffness and torsional rigidity levels would also have increased the weight due to the extra reinforcing required, thus completely negating the benefit of the lower centre of gravity.

INTERNAL COMBUSTION ENGINE

Thanks to its 780-cv power output and 195cv/l, the turbo V8 sported by the SF90 STRADALE raises the bar for the performance limits achievable by this type of architecture, delivering 60cv more than any other Ferrari V8 turbo.

Internal Combustion Engine	
Type	V8 - 90°- Turbo - Dry sump
Total displacement	3990 cm^3
Max. power	780 cv @ 7500 rpm
Max. torque	800 Nm @ 6000 rpm
Specific power	195 cv/l
Max. rpm	8000 rpm
Compression ratio	9.5:1

Table 5 – Internal Combustion Engine specifications

To obtain this result, the Ferrari technicians focused on the intake and exhaust system which was completely redesigned.

To improve internal fluid dynamics, the ducts are all horizontally lined up at engine head height: the turbo charger assembly has been lowered while the exhaust line is higher, as testified by the fact that the tail pipes are now in the upper section of the rear bumper.

The re-engineering goes well beyond fluid-dynamics: the rationalisation of the layout has resulted in both a lower centre of gravity and a reduction in overall weight thanks to the use of Inconel instead of steel for the exhaust manifold.

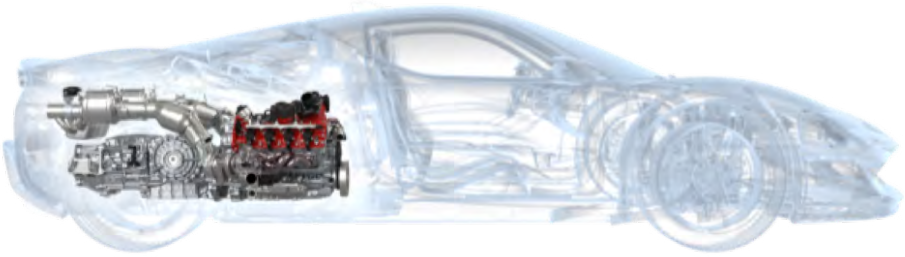


Figure 2 – Exhaust system layout. The turbocharger assembly is now lower down to yield a lower centre of gravity. The exhaust pipes have been rationalised too to improve both fluid-dynamics and weight reduction

SOUND

Meticulous attention was lavished on sound quality when redesigning the exhaust system as hearing the soundtrack is one of the pivotal factors in the joy of driving a Ferrari. The introduction of a "hot tube system", which transfers sound more directly to the cockpit, has produced fuller, richer harmonics (6th and 8th) across the entire frequency range, improving both in-car sound quality and intensity as rev rise compared to previous Ferrari V8s (Figure 3). The SF90 STRADALE's high exhaust pipes also help ensure that the engine sound is more evenly distributed in the surrounding environment.

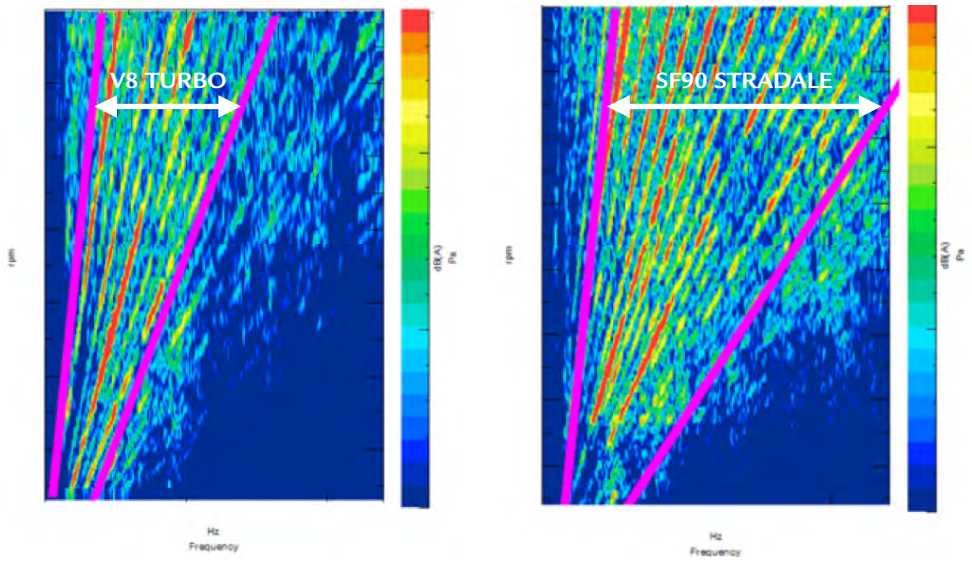


Figure 3 – Sound pressure spectrum as revs rise (yellow and red areas have highest sound pressure): the SF90 STRADALE's tube system yields a richer fuller sound across the entire frequency range compared to a standard V8 turbo (left)

GEARBOX

The SF90 STRADALE sports a completely redesigned 8-speed, oil-bath, dual- clutch transmission. An optimised layout, achieved through the adoption of a dry sump and a significantly more compact clutch assembly with a 20% smaller exterior diameter than the current gearbox, has shaved 15 mm off the installed height in the car which, in turn, lowers the centre of gravity of the running gear by the same amount.

Despite the addition of an eighth gear, a maximum torque boost to 900 Nm (the latter an increase of 20% on the current 7-speed) and the elimination of the reverse gear wheels (reverse is now entirely electric and operated by the RAC-E at the front), the gearbox's overall weight is actually 10 kg lower than its predecessor.

The new clutch's performance is 35% higher than the current one, transmitting up to 1,200 Nm in dynamic torque in gear shifts. Thanks to new-generation actuation hydraulics, clutch fill times are now 30% faster. Total gear shift times too have been slashed to 200 ms, an improvement of 30% on the previous 7-speed DTC.

Vehicle Dynamics

SF90 STRADALE

eSSC VEHICLE CONTROL SYSTEMS

The exceptional work done to boost the powertrain's power output would have been in vain without adequate dynamics research and the development of a series of solutions that would cut the SF90 STRADALE's lap times whilst still guaranteeing that drivers of all kinds would be able to handle its power not just confidently but also enjoyably.

The new hybrid architecture required extensive and long integration work of the car's many different control logics, not least:

- High voltage ecosystem controls (battery, RAC-E, MGUK, inverter)
- Engine-gearbox control
- Vehicle control (traction, braking, Torque Vectoring)

The extensive work done to integrate the existing vehicle control logics with those created as a result of the new architecture led to the development of the new eSSC vehicle control system. The eSSC introduces three innovative dynamic regulation and distribution strategies for drive/braking torque to all four wheels:

- **Electric Traction Control** (eTC): optimally manages the distribution of available drive torque – thermal and electric - to the individual wheels to suit driving conditions and grip requirements of same
- **Torque Vectoring**: available on the front axle to manage electric traction on outside and inside wheel in cornering to maximise traction in corner-exit and help ensure easy, confident, high-performance driving
- **brake-by-wire control with ABS/EBD**: allows the braking torque to be split between the hydraulic system and the electric motors (brake torque blending), allowing regenerative recovery under braking which actually boosts performance and brake feel rather than compromising them.

LONGITUDINAL DYNAMICS

Thanks to the introduction of the *RAC-E* electric axle and eTC traction control on all four wheels, it is now also possible to exploit the additional grip offered by the front wheels when accelerating. Improved overall grip combined with the improved power delivery from the electric motors at low speeds, has significantly improved the SF90 STRADALE's longitudinal acceleration, making it the new benchmark for standing starts (Table 6).

Standing starts	
0-100 km/h	2.5s
0-200 km/h	6.7s

Table 6 – Standing starts

LONGITUDINAL DYNAMICS

Even at high speeds and in higher gears, the combined contribution of the electric motors in maximum traction conditions (Figure 4) helps reduce ICE response times, significantly improving longitudinal acceleration and thus performance.

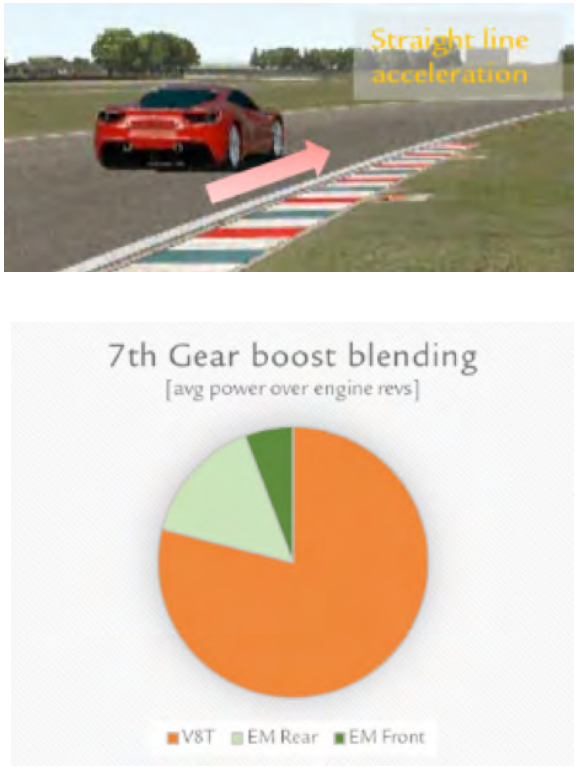


Figure 4 – Combined contribution to torque generation by the ICE (in the graphic: ●) and electric motors (in the graphic: ●) during acceleration on the straight in 7th gear

LATERAL DYNAMICS

The eSSC control logic supervises how torque is distributed between the inner and outer front wheels in cornering conditions, varying it according to the dynamic conditions (Torque Vectoring, Figure 5) in order to maximise performance and to deliver easier handling.

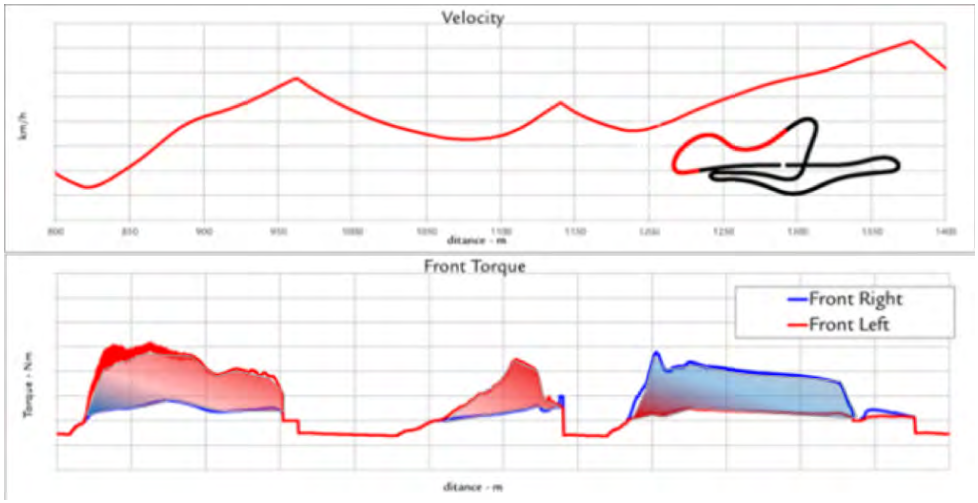


Figure 5 – Torque Vectoring on front axle. The outside wheel (left-hand wheel - in the graphic: ● - in first two corners, right-hand - in the graphic: ● - wheel in third corner) delivers more torque to help drive through corner and maximise performance

BRAKING SYSTEM

Managing braking was another challenge the technicians had to deal with. Their target was to guarantee braking performance levels (stopping distance, pedal travel and modulability) comparable to those of the past despite the boost in the SF90 STRADALE's mass and performance. Another factor was recovering kinetic energy from the electric motors to charge the batteries. To manage the increase in braking power demanded by the system, the technicians focused on efficiency, completely revising cooling flows to the front axle in particular (see dedicated section in the Aerodynamics chapter).

To make regenerative braking management transparent to the driver, the technicians drew on Ferrari's F1 experience to develop an innovative high performance brake by wire system. This system electronically splits braking torque between the hydraulic system and the electric motors, and also delivers the kind of pedal feel to the driver that is, in terms of pedal travel and downforce-deceleration, better than a traditional hydraulic system.
An example of the way the system works can be seen in Figure 6: under normal braking conditions (left-hand graphic), energy recovery using the electric motors is the priority and the hydraulic braking system intervenes to support the electric one in all sharp deceleration conditions (Figure 6, right-hand graphic).

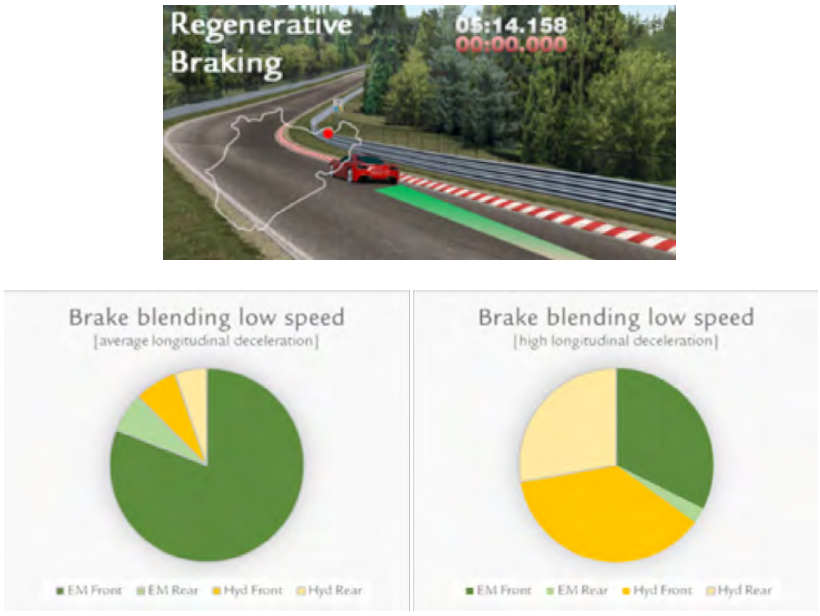


Figure 6 – Regenerative braking – In normal braking conditions (medium deceleration; left-hand graphic) the braking system's blending is shifted towards energy recovery using the electric motors (in the graphic: ●), mostly the front; The hydraulic system (in the graphic: ●): intervenes in very sharp decelerations (right-hand graphic)

WEIGHT REDUCTIONS AND CHASSIS

The introduction of the hybrid architecture posed a real challenge in terms of weight management: although the extra 270 kg required to incorporate the hybrid[2] system into the car have been amply offset by the extra power delivery (220 cv, with a weight/power ratio for the system alone of 1.23 kg/cv), in-depth research was still required to ensure that overall weight was kept to 1,570 kg, thus guaranteeing a record-breaking weight/power ratio of 1.57 kg/cv.

	Power [cv]	Weight [kg]	Weight/power [kg/cv]
SF90 STRADALE - ICE only	780	1300	1.67
SF90 STRADALE - electric input	220	270	1.23
SF90 STRADALE	**1000**	**1570**	**1.57**

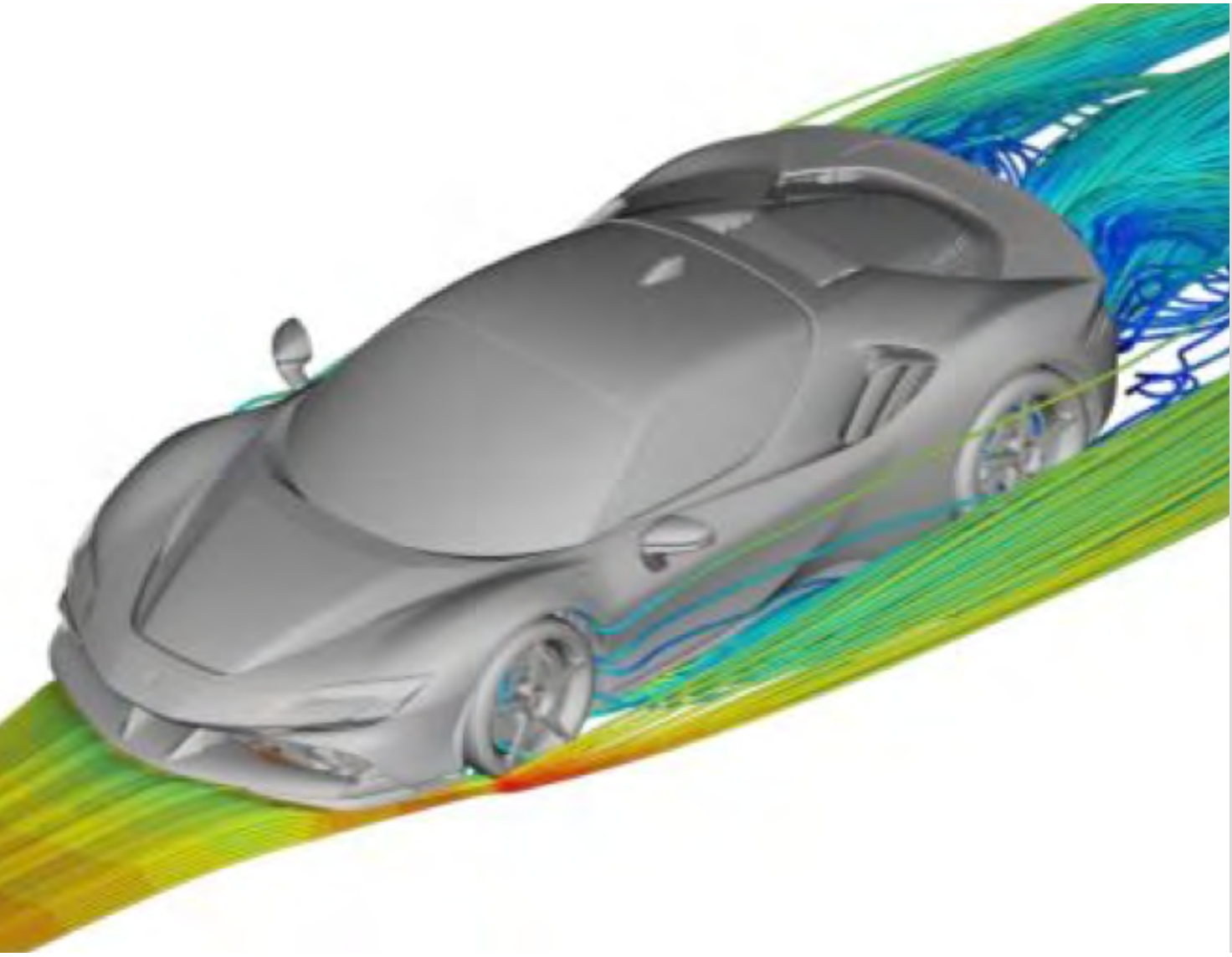
Table 7 – Weight/power

Of the various sub-assemblies reviewed, the chassis has been completely redesigned: a multi-material and multi-technology approach was used, in part to cope with the extra stresses associated with the new power unit and the introduction of 4WD. A number of technological innovations have been introduced, not least hollow castings, which replace the traditional ribbed castings. There is also new content aplenty, such as an all-carbon-fibre bulkhead between the cabin and the engine. As a result, the SF90 STRADALE chassis boasts 40% higher torsional rigidity than previous platforms without any increase in weight, greatly benefiting the car's dynamic behaviour.

Figure 7 – New aluminium chassis for PHEV architecture with engine and gearbox reinforcements using hollow castings and carbon-fibre bulkhead between engine bay and cabin

[2]Electric motors, battery, inverter, cabling, chassis structure reinforcements

Aerodynamics



SF90 STRADALE

AERODYNAMICS

The greatest challenge in crafting the aerodynamics of the SF90 STRADALE was posed by the need to deliver downforce and aerodynamic efficiency never before achieved either by Ferrari or its competitors, whilst simultaneously guaranteeing that all the subsystems of the new power unit (internal combustion engine, electric motors, battery and inverters) would always function as optimally as possible.

As always the aerodynamics department worked closely with Ferrari Design and this produced downforce and efficiency figures unmatched by any other car in the segment. Once again, they were achieved in typical Ferrari fashion: rather than using simple add-on elements, the car's forms were meticulously sculpted.

The main new features introduced in the SF90 STRADALE's aero design are:

- *Shut-off Gurney* at the rear: an active control system that varies downforce over the rear axle
- Front underbody with vortex generator strakes
- Forged wheels with wing profiles (blown geometry)

The performance results delivered are impressive indeed: 390kgf of downforce generating in cornering at 250km/h[3]!

[3]*With special Assetto Fiorano specification*

COOLING SYSTEM

Smart cooling flow management is the first step in defining a successful car layout and, in this particular case, guaranteeing that 1,000 cv can be efficiently and uncompromisingly unleashed in all kinds of driving conditions without in any way compromising aerodynamic drag and downforce coefficients.
The internal combustion engine, gearbox, turbo-charged air, battery pack and electric motors, the inverters and charging systems and, obviously, brakes all need cooling (Figure 8).

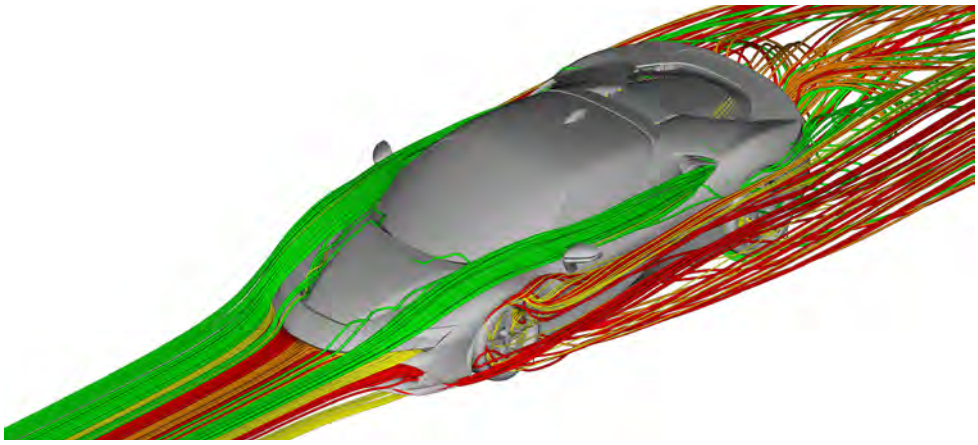


Figure 8 - Cooling flows: high temperature (internal combustion engine) in red, medium temperature (electric motors) in orange, intercoolers in green, front brakes in yellow

Meticulous attention was paid to the design of the engine bay which houses both the usual internal combustion engine systems that generate temperatures of nearly 900°C, and highly temperature-sensitive electronic components.
The coolant for the internal combustion engine and the gearbox (high temperature circuit) is cooled by two radiators located ahead of the front wheels. The hot air flow coming off those radiators is channelled into the side areas of the underbody rather than along the car's flanks (Figure 9). This means that the air flow along the flanks is cooler when it enters the air intakes ahead of the rear wheels (Figure 10), thereby boosting the efficiency of the intercooler radiators.

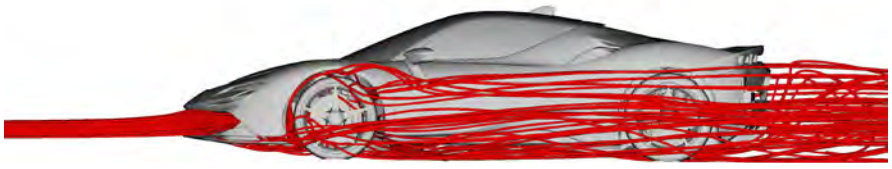


Figure 9 - High temperature radiator cooling flows (internal combustion engine): hot air exiting the radiators is evacuated into the underbody area just ahead of the wheels and so does not interfere with the flow going to the intercoolers (Figure 10)

COOLING SYSTEM

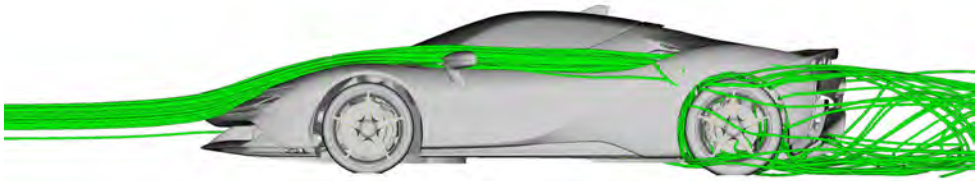


Figure 10 - Intercooler radiator cooling flow

The electric motors and the inverters are cooled by a separate circuit with its own radiator at the front of the car with a central intake on the front bumper (Figure 11).

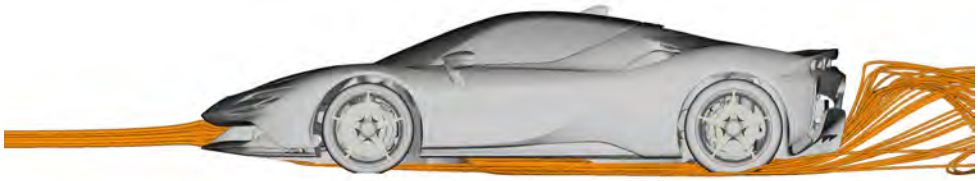


Figure 11 - Medium temperature radiator cooling flow (electric motors and inverters) via central air intake on front bumper

COOLING SYSTEM

The cooling circuit for the brakes was completely redesigned to meet the demands of the SF90 STRADALE's additional performance. A new brake calliper was developed for the front which is being used for the very first time on a road car. The calliper has an integrated aerodynamic appendage (Figure 12) to distribute the highly charged air flow from the special air intake under the lights on the front bumper (Figure 13, Figure 14), more efficiently to the brake pads and disc. The rear brakes are cooled by the flow from two air intakes on the underbody near the rear wheels.

Figure 12 - Brake calliper with aerodynamic appendage

COOLING SYSTEM

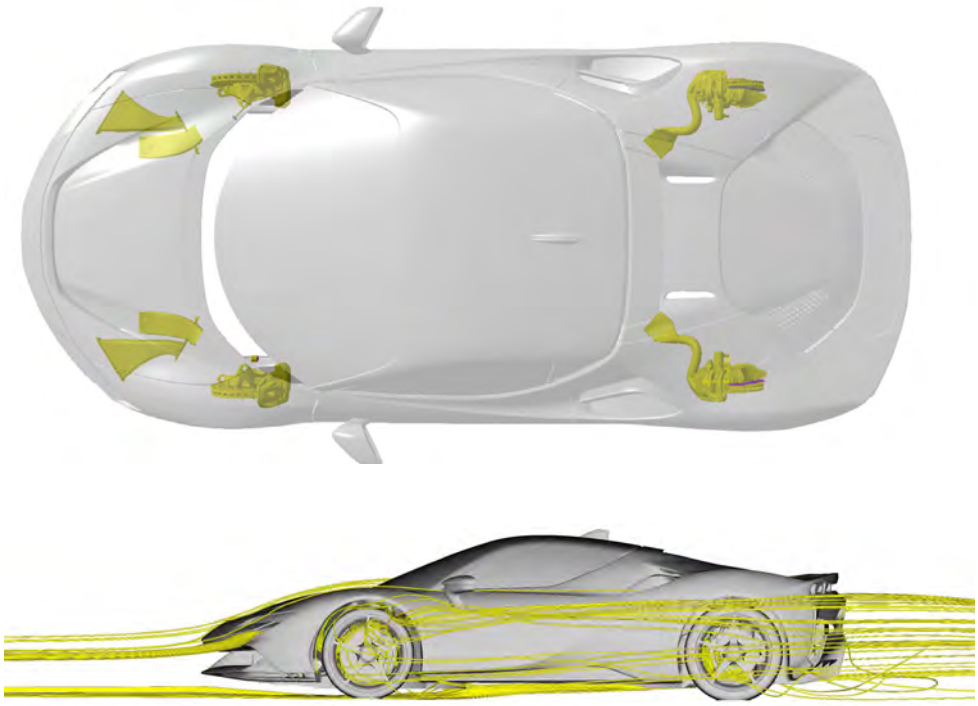


Figure 13 – Layout and cooling flow for front braking system (air intake under headlight which channels cool air to the new callipers with integrated aerodynamic appendage) and also the rear braking system (air intake on underbody just ahead of the rear wheels)

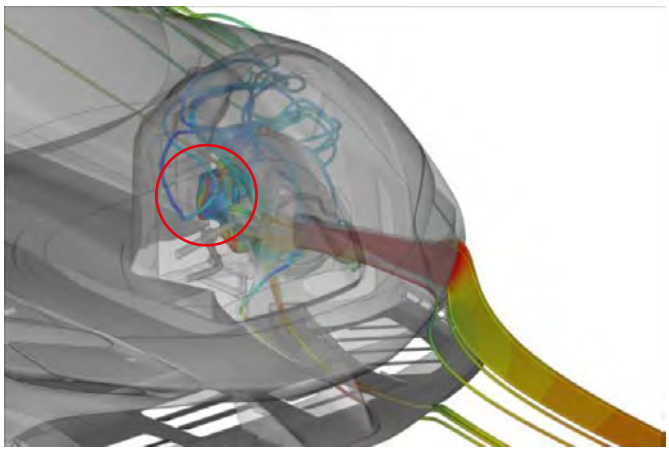


Figure 14 – Close-up of flow striking the aerodynamic appendage on the front wheel calliper

REAR AERODYNAMICS

In terms of volume design, the SF90 STRADALE's engine cover has been kept extremely low to improve the interaction between the flows over and under the body, and thus minimise drag.

The end section of the engine cover features a suspended element in two sections: one fixed, which incorporates the third brake light, and one mobile with a wedge-shaped front area.
The mobile section is connected to two electric actuators and has two different conFiguretions:

- Low Drag (on the straight); the two sections are aligned and suspended above the engine cover, with the mobile wedge acting as an efficient fairing to the fixed element, allowing the air to flow both above and beneath the *shut-off gurney* which has almost no effect on the flow (Figure 15).

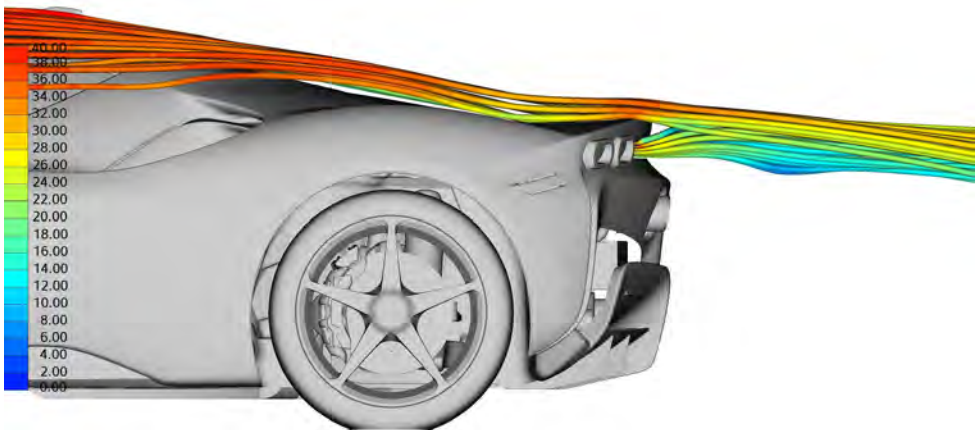


Figure 15 - Aerodynamic flows on *shut-off gurney* in low downforce, high efficiency conditions

REAR AERODYNAMICS

- High Downforce (driving through corners, braking or in abrupt changes of direction): the mobile element is lowered by a pair of electric actuators, closing the lower aperture, which in low drag conditions allows air to pass through. In this configuration, the mobile and fixed sections act as an aerodynamic profile which deflects the air flows striking it (Figure 16) and generates a significant amount of extra downforce.

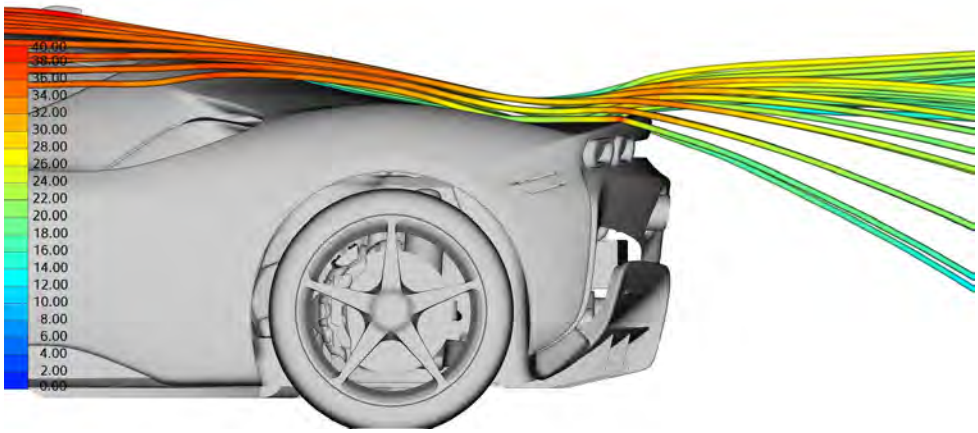


Figure 16 - Aerodynamic flows on the shut-off gurney in high downforce conditions (cornering, braking, changes of direction)

The system is controlled by a sophisticated control logic that checks parameters such as speed, acceleration, steering wheel angle and pressure on the brake pedal, hundreds of times a second in order to identify the dynamic conditions in which it is better to have more downforce, and then promptly activates the system.

The *shut-off gurney* is covered by patent and is the most innovative downforce management device introduced on the SF90 STRADALE.

FRONT AERODYNAMICS

Rear downforce is balanced at the front of the car by a complex and optimised system of vortex generator strakes (Figure 17). Although this is not its very first appearance on a Ferrari sports car, the system has been honed to the maximum on the SF90 STRADALE: the front section of the chassis has been raised 15 mm compared to the central section of the chassis at the point where the vortex generator strakes are located, thus increasing the amount of air channelled towards them and boosting their effect. This means that the SF90 STRADALE's underbody generates an unprecedented amount of downforce.

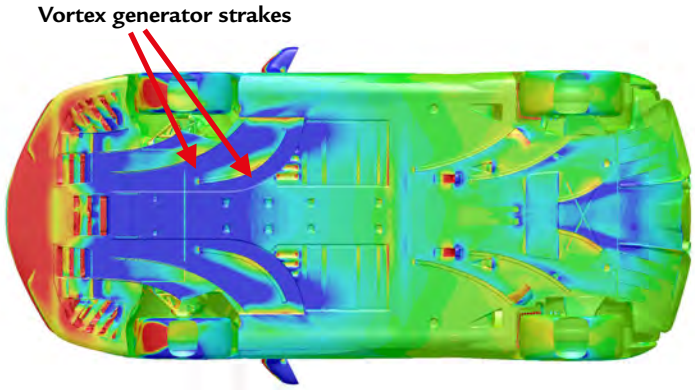


Figure 17 – Pressure map of car underbody: vortex generators boost downforce at the front of the underbody (the higher downforce areas are in blue)

The front bumper is divided into two sections that have specific wing functions. Between the upper section and the bonnet is a pronounced indent that locally compresses the flow. This feature, together with the two diffusers ahead of the front wheels, contributes to generating downforce over the front axle.

FORGED WHEELS WITH BLOWN GEOMETRY

Specific aerodynamic research went into the geometry of the forged wheels which are made using a construction technology that allows greater freedom when it comes to aerodynamic solutions. The specific geometry of the wheels incorporate radial elements on the outer channel which are equally spaced between the spokes and designed to act as wing profiles.

Figure 18 – Aerodynamic flows on the wheels with *blown* geometry

The geometry of these profiles mean that the wheel works like a rotor blade, very efficiently managing the flows from inside the wheelarch and guaranteeing two main effects:

- Air evacuation from wheel arch is boosted, creating suction that also benefits the flow that passes through the front diffusers, generating extra downforce over the front
- The flow exiting the wheel rim is lined up with the longitudinal flow running along the sides, thereby reducing deviations caused by the air mass exiting at an angle to the direction of movement, thus reducing the car's Cd.

Style

SF90 STRADALE

EXTERIOR

The SF90 STRADALE is the most advanced car in the range from a point of view of performance and technology. The crafting of its exterior forms was inspired by that principle, the aim being to create a forward-looking, innovative design that communicates both the car's racing vocation and the range *supercar* concept.

To that end, Ferrari Design completely revisited the proportions of the front, central and rear volumes in a radical evolution of the forms of Ferrari's mid-rear-engined production berlinettas of the last 20 years.

The cabin in particular features stylistic solutions inspired by Maranello's most recent supercars. It has a smaller frontal section and is placed closer to the front of the car to reduce drag and underscore its fiery temperament (Figure 19). All achieved without impacting on on-board comfort. The three main modifications to the cabin were:

- Shifted forward
- 20mm lower
- Slender A-posts and a more curved windshield

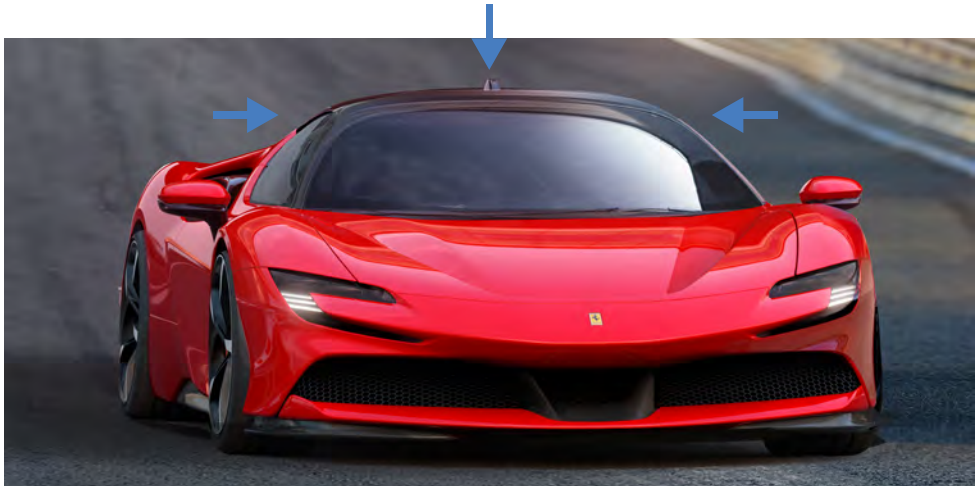


Figure 19 – SF90 STRADALE: Cabin proportions

The front of the car is dominated by a very pronounced bumper profile which incorporates wing profiles next to the headlights underscoring the car's extremely sporty nature (Figure 20).
The three air intakes at the front of the car cool the electric motors (front) and the internal combustion engine (sides).
In an absolute first for a Ferrari, the SF90 STRADALE uses matrix LED headlight technology to improve visibility in all driving conditions thanks to active beam control.

Figure 20 – SF90 STRADALE: front view

Another deviation from the styling typical of past berlinettas is the way the profile of the rear screen no longer follows the line from the roof to the rear bumper (Figure 21). This element of styling discontinuity is evidenced by the separation of the screen from the cooling grille.

Figure 21 – Rear screen: this element of styling discontinuity is evidenced by the separation of the screen from the cooling grille.

EXTERIOR

The rear of the car is dominated by high exhaust pipes which are the result of optimisation of the exhaust line layout. Their competition car vibe has been cleverly exploited to underscore the SF90 STRADALE's track-inspired personality (Figure 22). This effect is further heightened by the fact that the tail has been lowered. Viewed from the rear, light is clearly visible between the bumper and the *shut-off gurney* – air is allowed to pass through in low drag conditions.
The tail lights have also evolved quite radically from the iconic round shape normally seen on mid-rear-engined berlinettas and are now more elongated.

Figure 22 – SF90 STRADALE: Rear view

EXTERIOR

Seen from above, the small, tapered rear screen completes the "tear drop" shape of the glazed surfaces and emphasises the cab-forward stance. (Figure 23).

Figure 23 – SF90 STRADALE: bird's eye view, note the signature "tear drop" shape

INTERIOR

The look and feel of the cabin was driven in large part by the complete redesign of the HMI which marks a major leap forward on previous versions. The instrumentation is now predominantly digital with all the screens going completely black when the car is not running, lending the cabin a very minimalist look. But once the *Engine Start* button on the steering wheel is pushed, a "ceremony" of sorts begins that sees all the digital components in the driver cockpit gradually springing to life until the whole cockpit is aglow (Figure 24).
The areas that have been innovated most radically are the cluster, steering wheel and central tunnel.

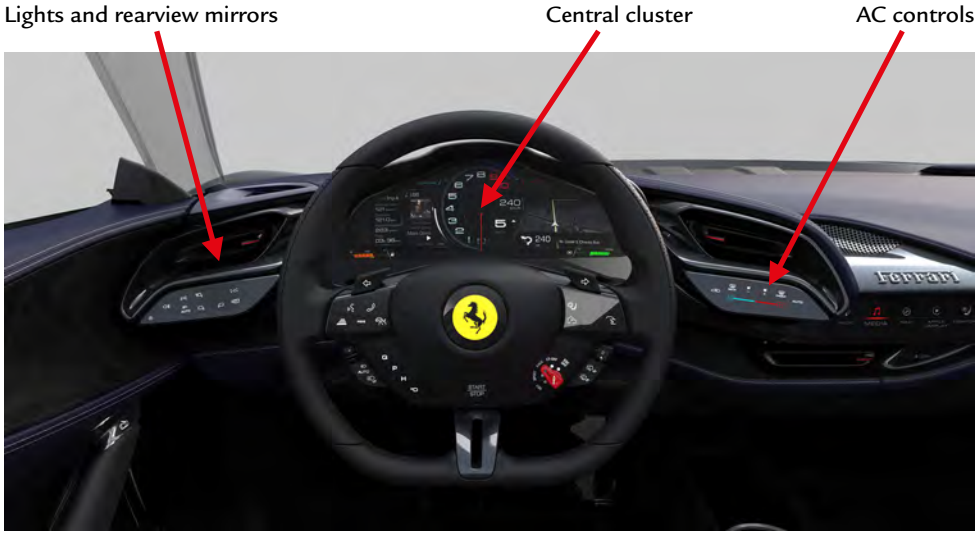


Figure 24 – New Cockpit

Central cluster

In an absolute first for a Ferrari, the central instrument cluster now comprises a single 16" HD screen which is curved towards the driver to make it easier to read and emphasise the F1-style wraparound cockpit effect. This is the first time this kind of screen has been used in a series production car.

In the default screen, everything is dominated, as per tradition, by a large circular rev counter, this time framed by the battery charge indicator (Figure 25). The navigation screen is on one side of the rev counter with the audio controls on the other.

Figure 25 – Central Cluster – standard view

The screen's large dimensions mean that there is huge flexibility in terms of personalising the displays which are also very easy to navigate using the steering wheel controls. It is, for example, possible to select a full-screen version of the navigation map (Figure 26).

Figure 26 – Central cluster – full-screen navigation map

Thanks to a new head-up display, the main information can be projected onto the section of windshield within the driver's field of vision, which means he is not distracted from the business of driving.

Steering wheel

The "Eyes on the road, hands on the wheel" philosophy has always driven the development of the HMI used on every Ferrari Formula 1 car which has gradually been applied also to our road-going sports cars. The SF90 STRADALE's steering wheel completes this track-to-road technological transfer process and ushers in a new era by introducing a series of multi-touch controls that allow the driver to control virtually any aspect of the car without ever taking his hands off the wheel (Figure 27).

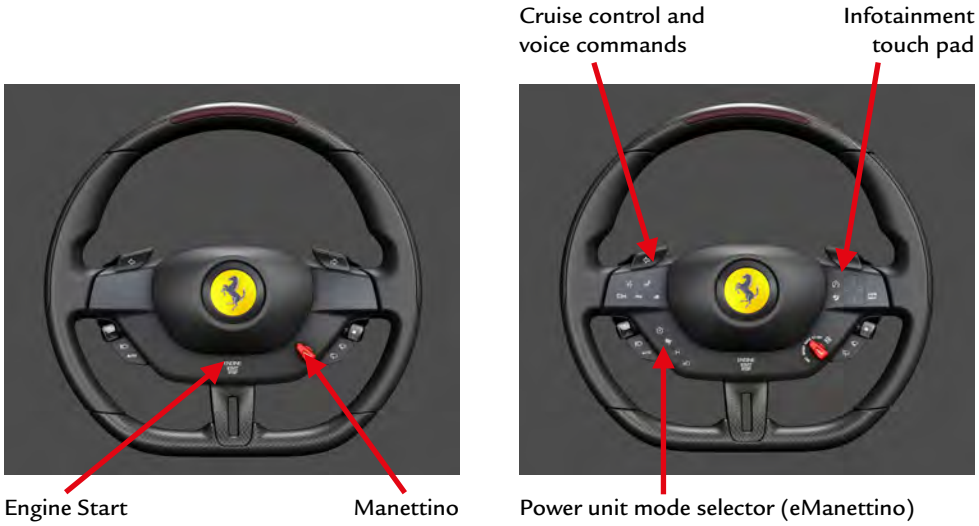


Figure 27 – New multifunctional steering wheel when car is turned off (left) and on (right)

The remaining traditional controls include the now-classic manettino for driving controls, headlights, windshield washer and indicators.

The new touch controls include a small but very practical *touch* pad on the right of the steering wheel which allows the driver to navigate the central cluster screens, while voice and cruise controls are on the left. Also noteworthy is a new cruise control rotary switch, which is also derived directly from Formula 1.
In the bottom left section of the central area, there are four buttons the driver uses to select his *power unit* mode of choice.

Tunnel

Because this is such a ground-breaking car, the designers wanted to introduce an element that would act as a link between past and future: the result is that the F1 bridge, a signature on the previous models, has now disappeared from the central tunnel and been replaced by a modern take on the glorious gear-shift gate, an iconic feature of Ferrari's manual gearboxes.
In the new gate, however, the gear-shift grille is digital as befits an automatic transmission (Figure 28).

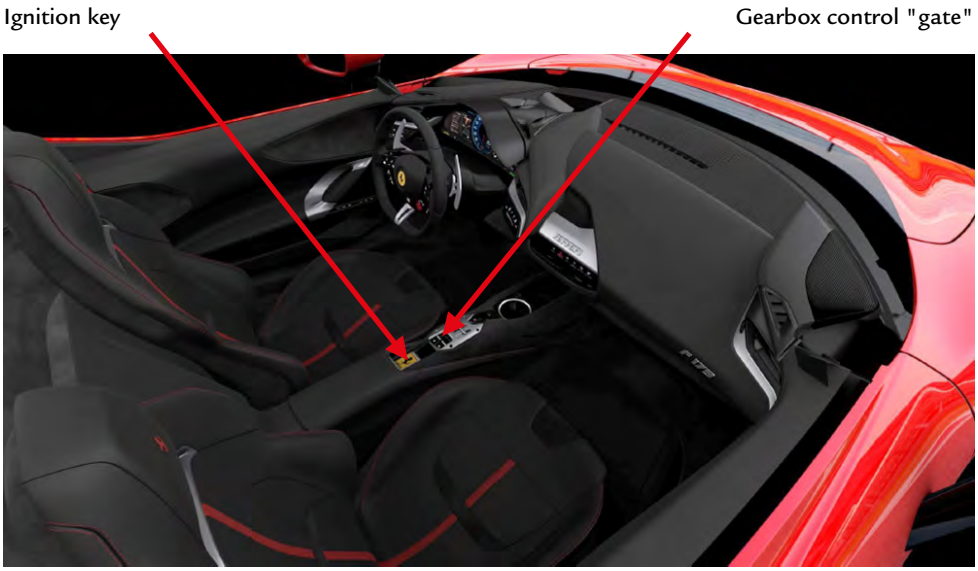


Figure 28 – View of interior and central tunnel

At the bottom of the tunnel is the compartment for stowing the new ignition key which is an exact replica of the Ferrari Prancing Horse badge found on the bonnet (Figure 29), adding an authentic finishing touch to the cabin's styling.

The new key has been completely redesigned to work in full keyless mode so that the driver can not only start the ignition but also open the doors without taking it out of his pocket.

Figure 29 – New key

Assetto Fiorano

SF90 STRADALE

ASSETTO FIORANO

For the first time on a Ferrari, uncompromising clients can chose between the standard car and a version with a more extreme, sports-oriented specification.

The Assetto Fiorano specification includes significant upgrades (Table 8), including:

- Handling: special GT racing-derived Multimatic shock absorbers optimised for track use. These replace the magnetorheological shocks with active damping control in the standard version
- Weight: a further 30 kg weight-saving compared the already-lightweight standard version, thanks to the use of high-performance materials such as carbon-fibre (door panels, underbody) and titanium (springs, entire exhaust line).
- Aero: carbon-fibre rear spoiler
- High performance tyres[4]: road-homologated Michelin Pilot Sport Cup2 tyres designed specifically to improve performance on the track in the dry. They feature a softer compound and fewer grooves than the tyres provided as standard.
- Livery: dedicated two-tone livery to underscore the specification's racing soul (available as an optional content).

[4] *Not available in all markets: check for specific contry restrictions. Sport Cup 2 R Tyres available as an optional content*

ASSETTO FIORANO

ASSETTO FIORANO: MAIN CONTENT
Titanium exhaust line
Aluminium shock absorbers
Titanium road springs
Carbon-fibre rear spoiler (fixed and mobile) in carbon-fibre
Carbon-fibre aerodynamic underbodies
Carbon-fibre door panels
Carbon-fibre rear tunnel unit
Carbon-fibre upper rear bench trim
No glove compartment
Carbon-fibre sides in pedal area
Lexan back window
High performance tyres (check market availability)
«Assetto Fiorano» moniker on inside carbon-fibre sill
Racing Livery (optional content, only in combination with Assetto Fiorano)

Table 8 – Main Assetto Fiorano features

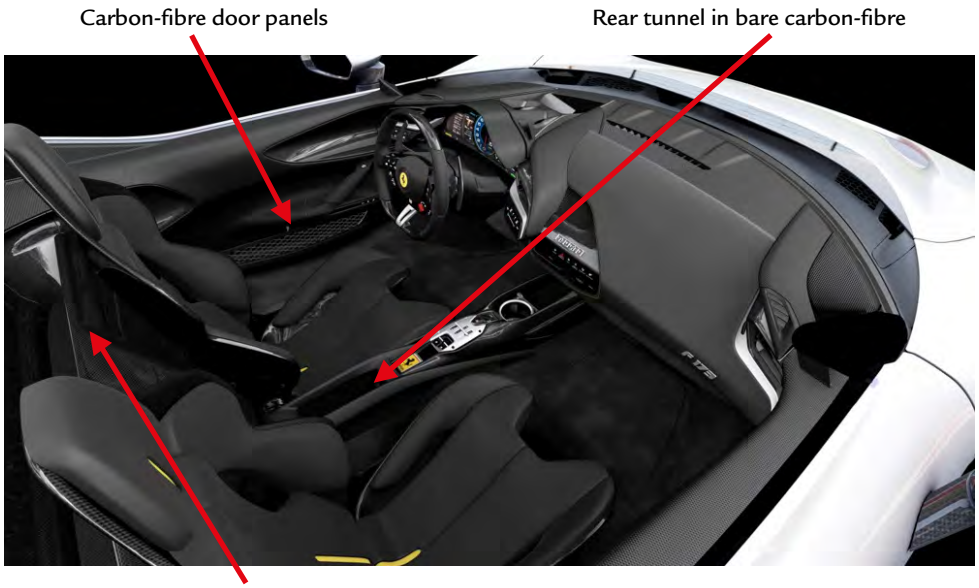


Figure 30 – Assetto Fiorano: Cabin

Optional content and illustrations

SF90 STRADALE

OPTIONAL CONTENT AND ILLUSTRATIONS

To make your SF90 STRADALE even more unique and precious, Ferrari has created a vast Personalisation Programme.
The large array of specific content designed for the new SF90 STRADALE includes:

- Forged wheels with wing profiles extract air flows from the wheelarch and improve aerodynamic efficiency; this patented solution is derived from the F1 *blown hub* concept.

Figure 31 – Wheel with blown geometry

- Carbon-fibre wheels: save 12 kg compared to standard rims, setting a whole new benchmark terms of design and performance

Figure 32 – Carbon-fibre wheels

OPTIONAL CONTENT AND ILLUSTRATIONS

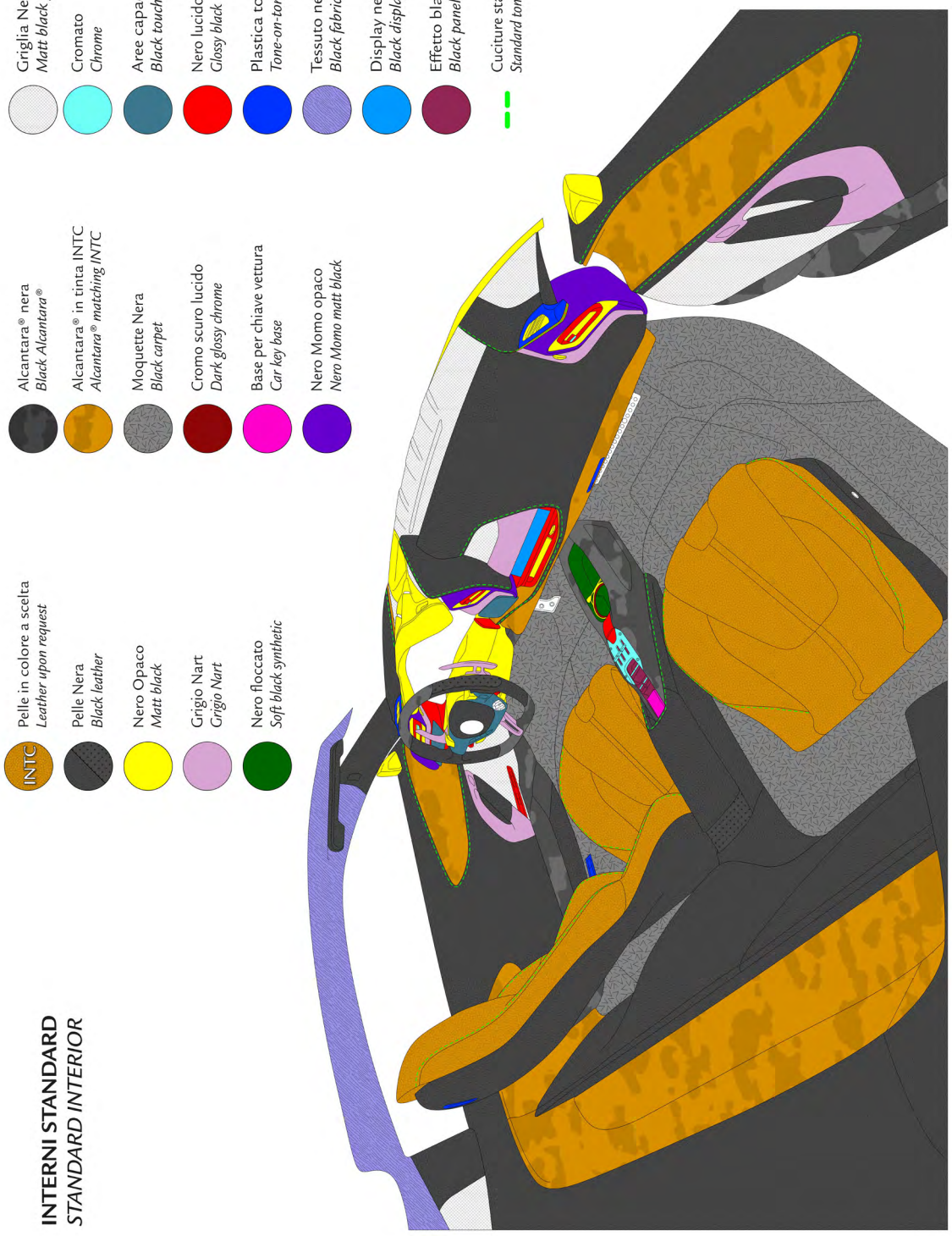
- Innovative four or six-way seat derived from our motorsport experience which is also 1 kg lighter than the current racing seat without impinging on driver comfort. This was achieved using a typical racing seat design approach which optimised the seat shape by removing material wherever it was not strictly required for ergonomic or structural strength reasons. A specific padded upholstery technology was developed also which allowed preformed leather/Alcantara inserts to be applied directly to the weight-bearing carbon-fibre double shell, which meant that the structure could be left partly-visible even at the front of the backrest.

Figure 33 – Carbon-fibre *racing* seat

Below are the illustrations of the main personalisation options in terms of interior and exterior trim.

SF90 STRADALE

INTERNI STANDARD
STANDARD INTERIOR

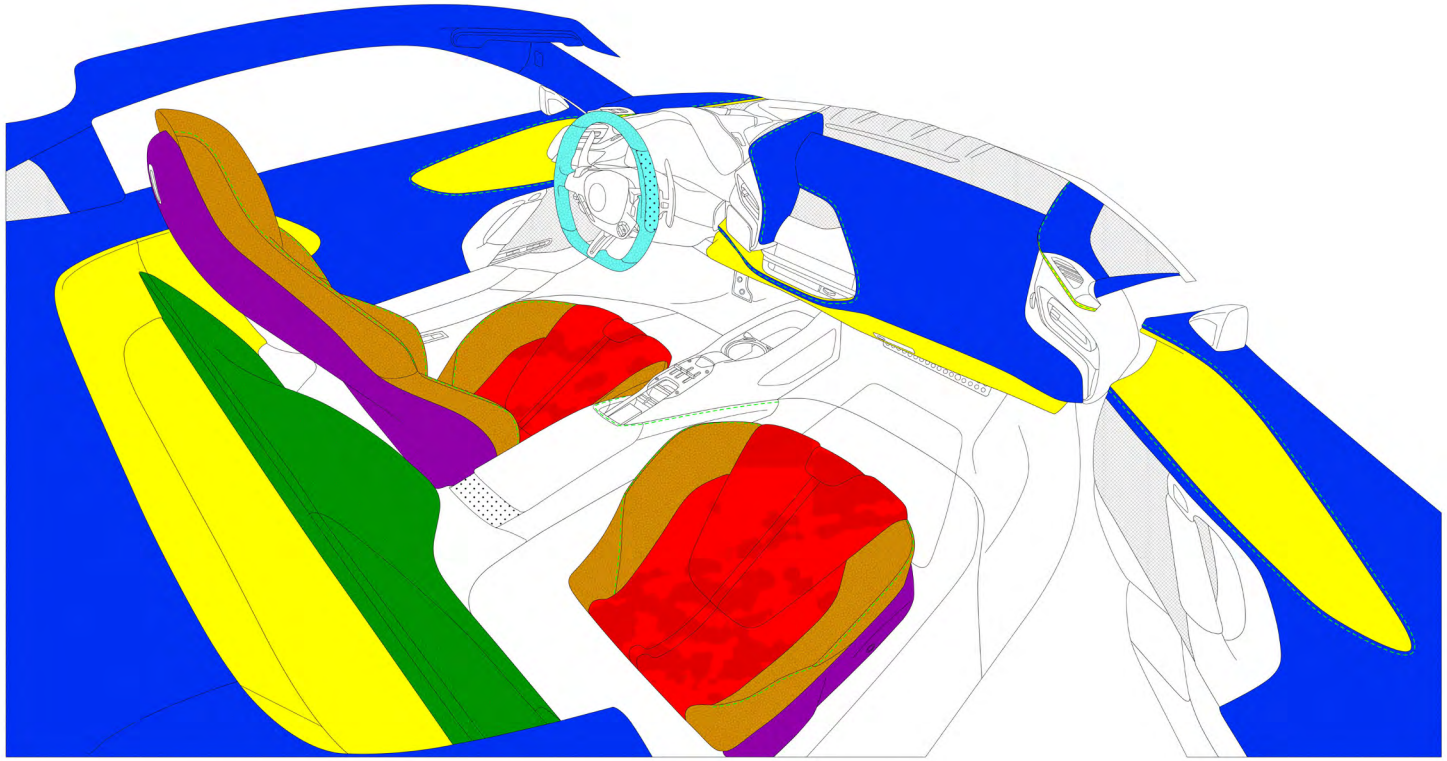


Ferrari reserves the right to make modifications to the personalisation options at any time and without prior warning

SF90 STRADALE

INTERNI OPZIONALI IN PELLE/ALCANTARA® CON TAPPETI STANDARD
OPTIONAL LEATHER/ALCANTARA® INTERIOR WITH STANDARD CARPETS

- INTC — Pelle in colore a scelta / *Leather upon request*
- PIP7/PIPS — Inserti abitacolo in Pelle/ Alcantara® a scelta / *Cockpit inserts in Leather/or Alcantara® upon request*
- BAC3 — Retroschienale e inserti sedili in pelle a scelta / *Seats backrests and inserts in leather upon request*
- DUAL — Completamento abitacolo in pelle a scelta / *Mid/upper cockpit part in leather upon request*
- SHF7 — Panchetta in pelle in tinta INTC (sostituisce zona DUAL se presente) / *Rear wall in leather matching INTC (replaces DUAL if selected)*
- ALCN — Centrale sedili in Alcantara® in tina INTC / *Central seats zone in Alcantara® matching INTC*
- STW1 — Volante in pelle/pelle traforata a scelta / *Steering wheel in leather/perforated leather upon request*
- Cuciture standard tono su tono/opzionali STC1/STC2 / *Standard tone-on-tone stitching/optional STC1/STC2*



Ferrari reserves the right to make modifications to the personalisation options at any time and without prior warning

All Personalization & Atelier Communications are available on the MODISCS portal

May 2019

INTERNI OPZIONALI IN FIBRA DI CARBONIO
OPTIONAL CARBON FIBRE INTERIOR

CIPZ
- Inserti abitacolo in carbonio lucido
  Glossy carbon fibre cockpit inserts
- Alcantara® nera - *Black Alcantara®*

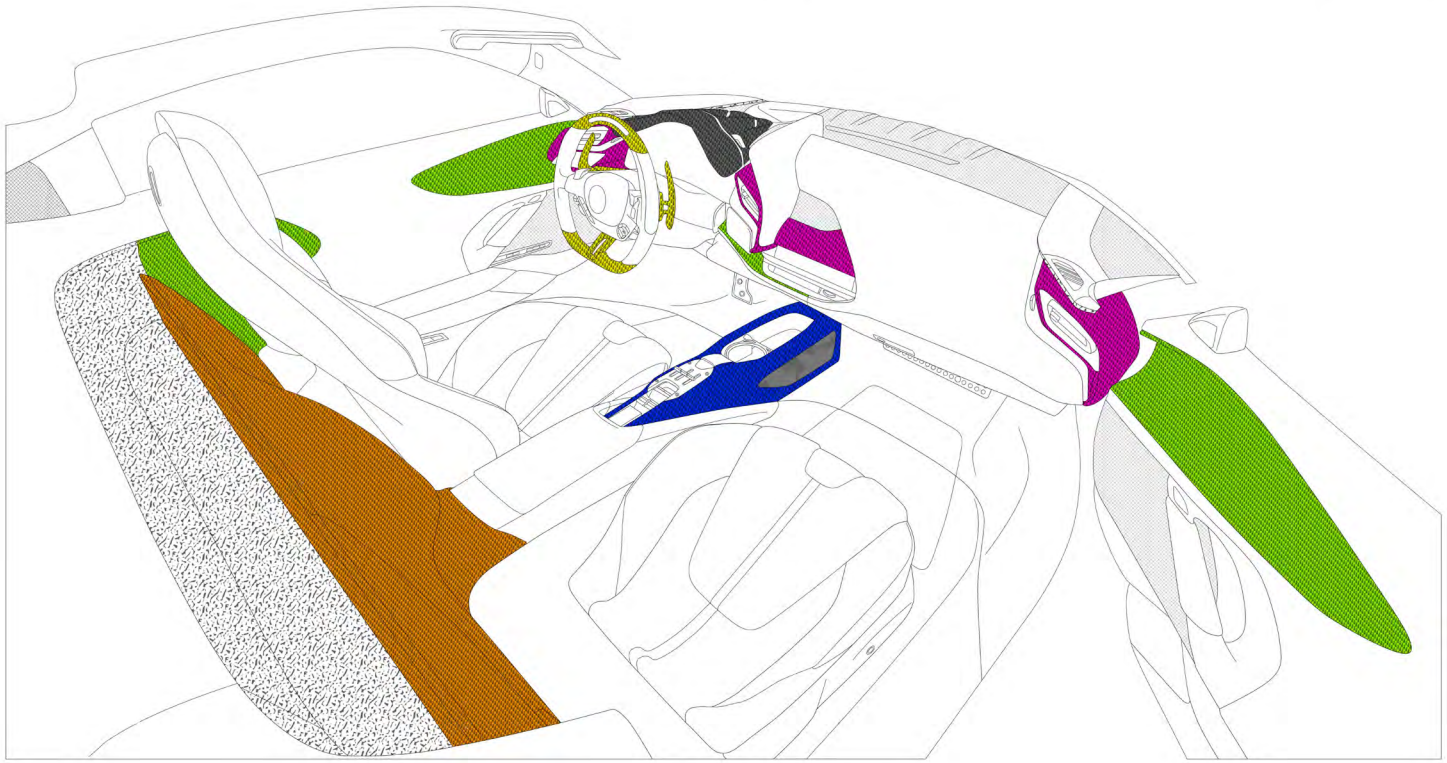
CIPN
- Panchetta in carbonio lucido
  Glossy carbon fibre rear wall

CITZ
- Tunnel anteriore in carbonio lucido
  Glossy carbon fibre front tunnel
- Alcantara® nera - *Black Alcantara®*

DATR
- Inserti plancia in carbonio lucido
  Glossy carbon fibre dashboard inserts

LEDS
- Volante e paddles in carbonio lucido
  Glossy carbon fibre steering wheel and paddles

CIDL
- Volante e paddles in carbonio lucido
  Glossy carbon fibre steering wheel and paddles
- Zona guida in carbonio opaco
  Matt carbon fibre driving zone

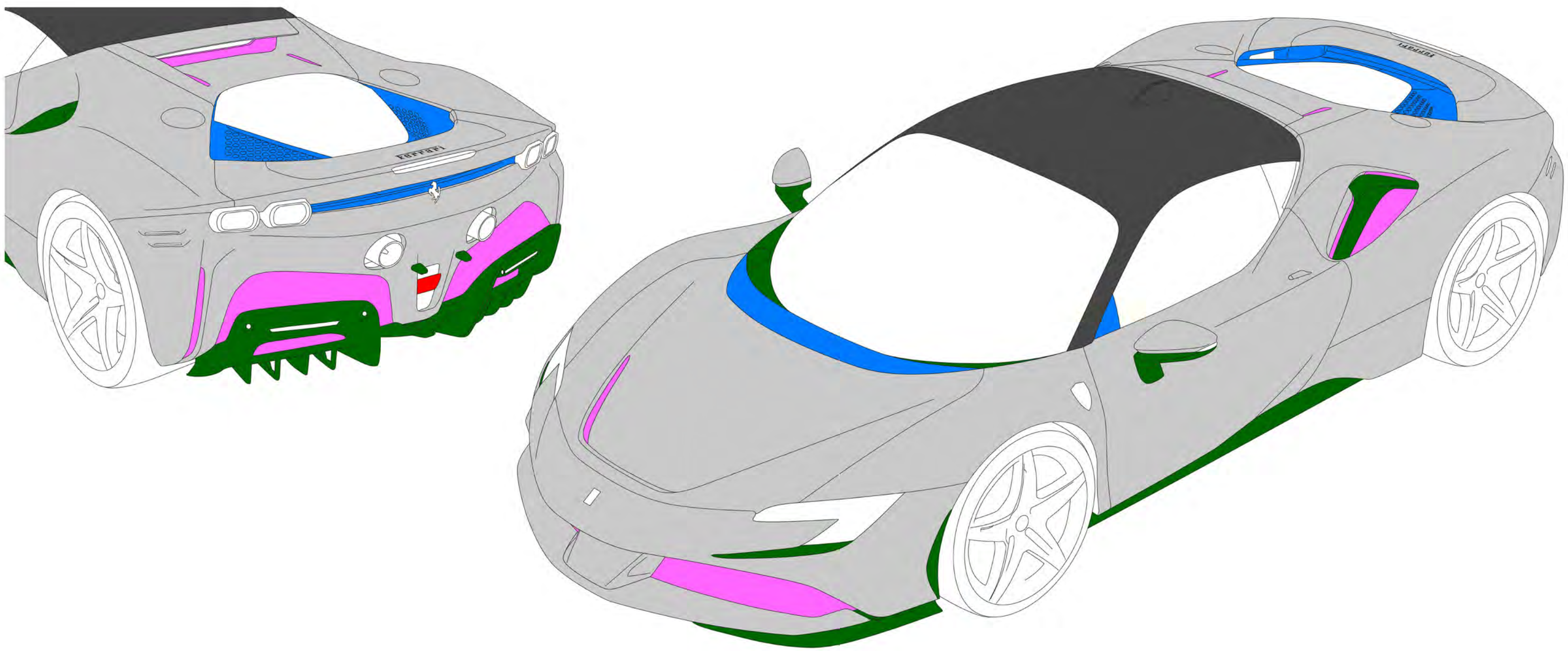


Ferrari reserves the right to make modifications to the personalisation options at any time and without prior warning

SF90 STRADALE

ESTERNI STANDARD
STANDARD EXTERIOR

- EXTC — Colore esterno / *Exterior color*
- Nero opaco / *Matt black*
- Nero lucido / *Glossy black*
- Griglia nero opaco / *Matt black grill*
- Nero opaco/Tinta carrozzeria TBD / --
- BIC2 — Tetto in colore a scelta / *Roof color upon request*



Ferrari reserves the right to make modifications to the personalisation options at any time and without prior warning

ESTERNI OPZIONALI IN FIBRA DI CARBONIO (disponibili anche per il Pacchetto Fiorano)

OPTIONAL CARBON FIBRE EXTERIOR (available also for Fiorano Pack)

CEXW — Specchi retrovisori esterni in carbonio lucido
Exterior mirrors in glossy carbon fibre

BONC — Cofano motore e spoiler superiore in carbonio lucido
Engine bonnet and upper spoiler in glossy carbon fibre

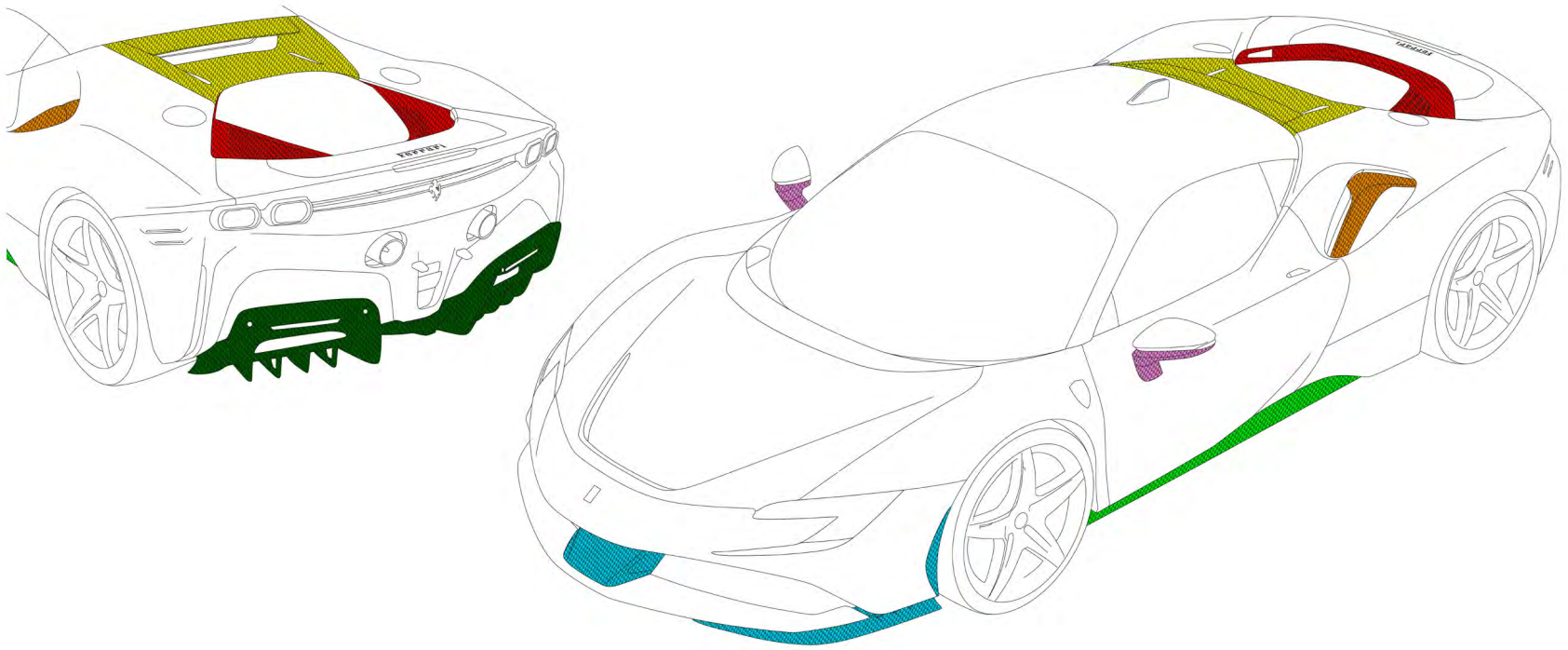
CEXD — Diffusore posteriore in carbonio lucido
Rear diffuser in glossy carbon fibre

CERB — Mostrine laterali lunotto in carbonio lucido
Engine glass side inserts in glossy carbon fibre

CEXS — Brancardo esterno in carbonio lucido
Exterior sill cover in glossy carbon fibre

CEIS — Prese aria motore laterali in carbonio lucido
Side engine air intakes in glossy carbon fibre

FCWS — Spoiler centrale e laterali anteriori in carbonio lucido
Front central and side spoilers in glossy carbon fibre



7 years maintenance

SF90 STRADALE

7 YEARS MAINTENANCE

Ferrari's unparalleled quality standards and increasing focus on client service underpin the extended seven-year maintenance programme offered with the SF90 STRADALE. Available across the entire range, the latter covers all regular maintenance for the first seven years of the car's life.
This scheduled maintenance programme for Ferraris is an exclusive service that allows clients the certainty that their car is being kept at peak performance and safety over the years. This very special service is also available to owners of pre-owned Ferraris.
Regular maintenance (at intervals of either 20,000 km or once a year with no mileage restrictions), original spares and meticulous checks by staff trained directly at the Ferrari Training Centre in Maranello using the most modern diagnostic tools are just some of the advantages of the Genuine Maintenance Programme. The service is available on all markets worldwide and from all Dealerships on the Official Dealership Network.

The Genuine Maintenance programme further extends the wide range of after-sales services offered by Ferrari to meet the needs of clients wishing to preserve the performance and excellence that are the signatures of all cars built in Maranello which itself has long been synonymous with leading-edge technology and sportiness.

Technical specifications

SF90 STRADALE

TECHNICAL SPECIFICATIONS

Dimensions and weight	
Length	185.5 in
Width	77.7 in
Height	46.7 in
Wheelbase	104.4 in
Front track	66.1 in
Rear track	65.1 in
Dry weight*	3461 lb
Weight distribution	45% front - 55% rear
Boot capacity	2.6 cu ft
Rear bench capacity	0.7 cu ft
Fuel tank capacity	18 (0.5 reserve) US gallon
Tyres	
Front	255/35 ZR 20 J95
Rear	315/30 ZR 20 J11.5
Brakes	
Front	15.7 x 8.8 x 1.5 in
Rear	14.2 x 9.2 x 1.3 in
Internal Combustion Engine	
Type	V8 - 90° - Turbo - Dry Sump
Total displacement	243.7 cu in
Max. power**	574 kW @ 7500 rpm**
Max. torque	590 lb ft @ 6000 rpm
Specific output	2.35 kW/cu in
Maximum revs per minute	8000 rpm
Compression ratio	9.5:1
Electric system	
Electric Motors Maximum power	162 kW
Battery capacity	7.9 kWh
Maximum autonomy in eDrive - NEDC cycle	15.5 mi
Performance	
Maximum Power - Hybrid mode***	735 kW
Maximum Power - eDrive	120 kW
Maximum speed	211 mph
0-62 mph	2.5 s
0-124 mph	6.7 s
62-0 mph	<97 ft
Dry weight/power ratio	4.7 lb/kW
Fiorano Lap Time	79 s
Consumption and emissions	
Fuel consumption	Under homologation
CO_2 Emissions	Under homologation

Transmission and gearbox
F1 dual clutch gearbox, 8-speed
Four wheel drive, electric front axle
Electronic controls
eSSC: RAC-E, F1-TCS, E-Diff3, SCM-E-Frs
Performance ABS/EBD with energy recovery

*With optional equipement
**With 98 Ron fuel
*** In Qualify mode(eManettino)

Table 9 – Technical specifications