



T1 supercharged petrol engines

Process to add a T1 supercharged petrol engine in the engine list

&

Monitoring of such engines



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History

Date/ Release	Changes
2020/10/01	Creation – 1st release
2020/11/20	<ul style="list-style-type: none"> • Add of the process time schedule • Update of the data sheet -> v. 11.11.2020 • All ignition correction mappings are requested in the data sheet • Engine sealing during engine perf. Evaluation test + possible check later • Add of the engine technical form template • Update of the hub adapter drawing + company contact following powertrain supplier change • Update of the daily cost for the perf. Evaluation test • Correction of the P(h) formula • Add of the Marelli order form + precision of the order process + conditions • Review of the FIA datalogger user guide v1.3_20201113 <ul style="list-style-type: none"> - Updated contact details for technical support - Update of looms part numbers - Pkup sensor ext loom description - 5.4- Data loom description - 5.5 Communication with the logger - Update of the RPM sensor technical data - Add in this file of the FIA_CC_2020_v3.dbc
2020/12/30	<ul style="list-style-type: none"> • Various updates in accordance with the 2021 CCR SR • Update of the data sheet -> v. 24.11.2020 • Update of the engine technical form template -> V03 • Update of the hub adapter drawing • Review of the FIA datalogger user guide -> v1.5_20201230 <ul style="list-style-type: none"> - Add in this file of the FIA_CC_2020_v4.5.dbc - Various updates and corrections
2021/01/22	<ul style="list-style-type: none"> • Update of information related to the place the engine performance evaluation test will be performed. • Update of the associated maximum cost
2021/10/15	<ul style="list-style-type: none"> • 3.c – Fuel: must be compliant with Art. 252-9.1 or 252-9.3 (2022) If use of a fuel compliant with art. 252-9.3, additional tests using a fuel compliant with art. 252-9.1 required • 3.c - List of measurements depending on Pboost levels has been reviewed • 4.a - Test location changed • 4.e – Update of the test costs • 6.b – Update of the lease conditions • 6.e – Update of the Magneti Marelli PO • Various updates related to contacts and dates



2022/01/20	<ul style="list-style-type: none">• 3.a – Update of the engine technical form template -> V04b• 3.c – Update of the data sheet -> V. 20.01.2022• 6.e – Update of the Magneti Marelli PO -> full season V09• 6.e – Clarification regarding the MM track support charge
2022/04/06	<ul style="list-style-type: none">• 2.b – Clarification of the maximum cylinder capacity of the engines + minimum associated weight• 3.c.i – Specification of the correction factor formula used for engine performance measurements.• 3.c.ii - Update of the curves list & datasheet• 4.a&b – Update of Test location• 4.b – Update of the references to the dbc. File (CC_2020_v4.6) + FIA Datalogger kit User Guide• 4.f – Contact details for invoicing• 6.a - Update of the FIA Datalogger kit User Guide (v1.8)• 6.e – Update of the Magneti Marelli Purchase Order form ver10
2022/06/17	<ul style="list-style-type: none">• 3.a – Update of the engine technical form template -> V20220509

The modifications with respect with to the last published version of this document, are highlighted yellow.

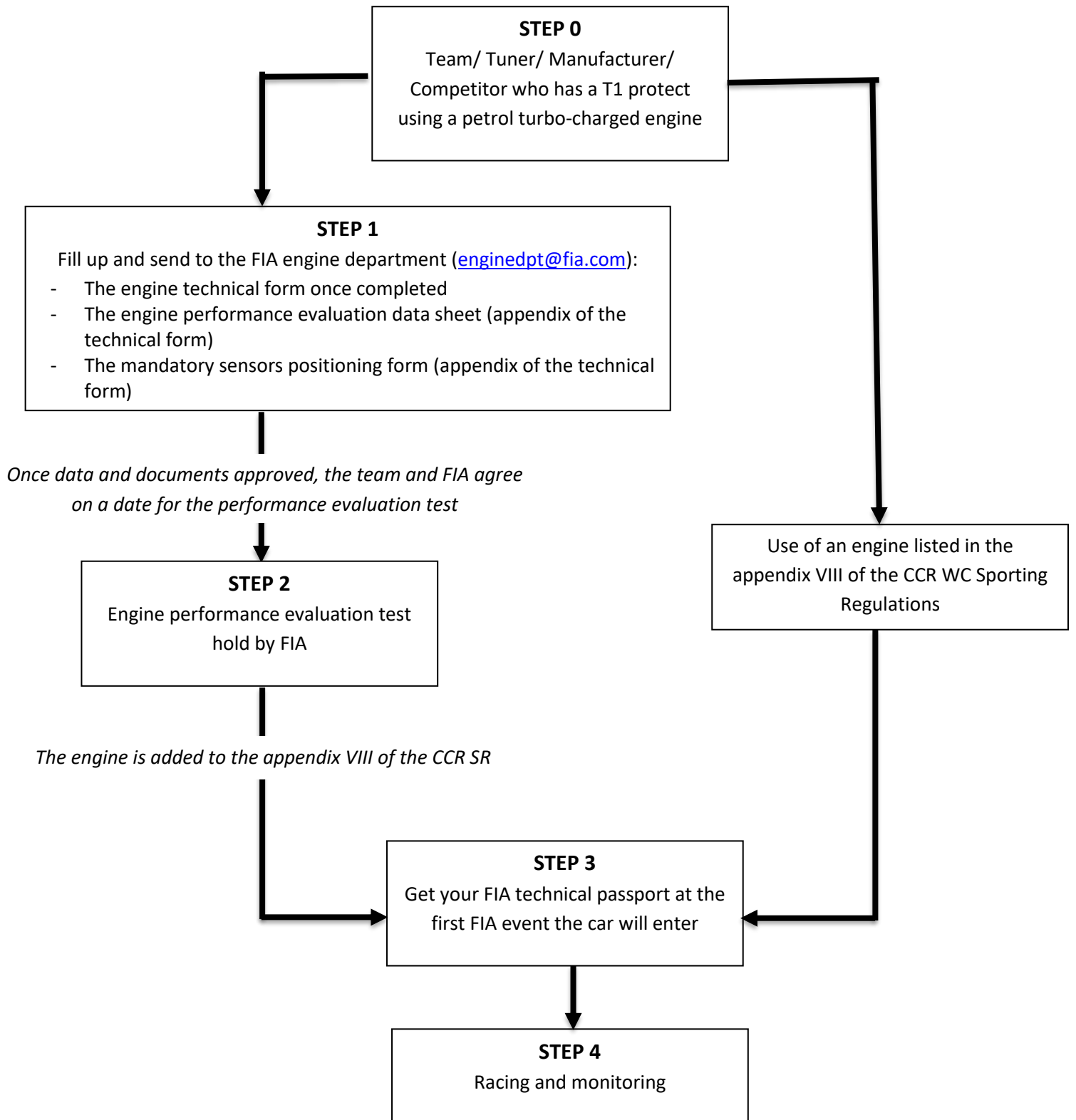
FOREWORD

All files and documents included in this document and related to the T1 turbocharged petrol engines regulations are available from FIABOX.

The link to the FIABOX folder will be sent on request to the following email address:
enginedpt@fia.com



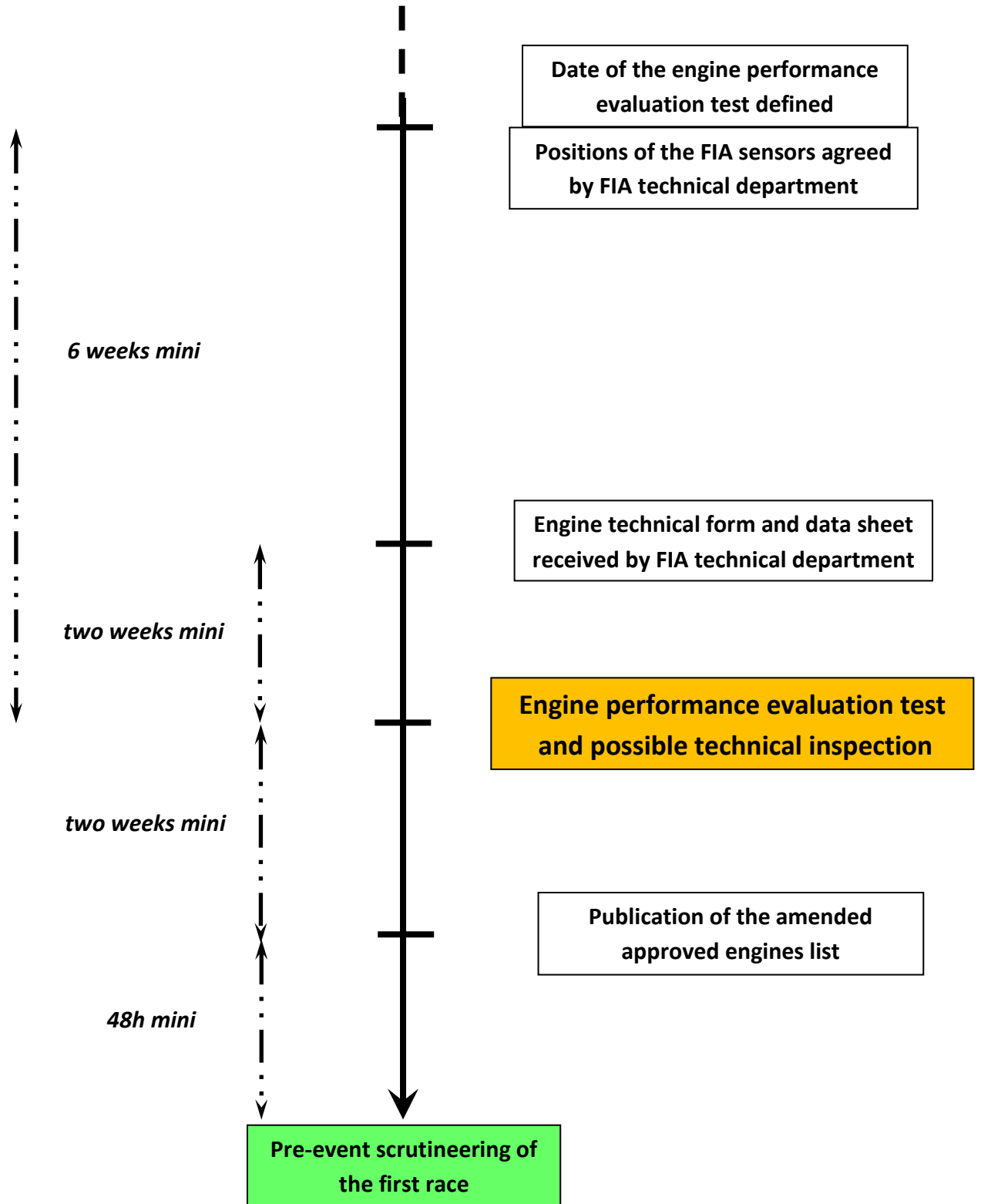
1. Process overview





Time schedule

It is strongly recommended to get in touch with the FIA technical department as early as possible
=> **The following schedule must be respected.**





2. Reminder of the main points of the current technical regulations related to T1 petrol supercharged engines

Here below you can find a reminder of the contents of the Article 285 of the Appendix J and the 2022 Cross-Country Rally Sporting Regulations.

a. Summary of the Article 285 of the Appendix J

The base engine must derive from the engine of a car able to be homologated in Group A, GT (2012 GT homologation regulations) or T2.

Its maximum cylinder capacity is 3500cm³.

Most of the parts of the base engine must remain standard; the following parts can be replaced (highlighted ones are free):

- Flywheel
- Conrod shell bearings
- Cylinder head and chain covers
- Valve springs
- Belt(s), chain(s), pulley(s) and pinion(s) -original principle must be retained
- Spark plugs, generally speaking, looms, ECU & datalogger
- Injectors and injector rail(s), but original principle and mountings have to be retained.
- Fuel pumps, water pump(s), hydraulic pumps must derive from the engine of a car able to be homologated* or come from a commercial catalogue
- Intake manifold (max volume: 5L)
- Exhaust manifold(s)
- Turbocharger(s) - coming from a model of car able to be homologated in Group A, GT or T2*
- Lubrication system: oil pump, oil filter housing, radiator, oil/water exchanger, lines, thermostat, sump and pump strainers; Dry sump allowed
- Intercooler(s) (provided they come from a model of automobile produced in a quantity of more than 2500 units + maximum internal volume of 18L between first exchanger and intake manifold inlets)
- Water radiator(s), thermostat, fan(s)
- Sensors and actuators

The FIA data logging system must be fitted on the car. It includes the following sensors which have to be fitted in FIA-approved locations:

- Crankshaft position (engine speed rpm)
- Pressure upstream of the intake system
- Temperature upstream of the intake system
- Supercharging pressure
- Temperature inside the intake manifold
- Lambda sensor(s)



Several information must be sent from the ECU to the FIA Datalogger via CAN line, provided the associated sensors are fitted on the car.

Performance wise, no turbo restrictor but the following parameters must always comply with the figures specified in Appendix VIII of the CCR sporting regulations:

- Maximum supercharging pressure ratio (to atmospheric pressure)
- Lambda minimum
- Fuel especially if an Advanced Sustainable fuel is used

b. Summary of the CCR Sporting Regulations

The appendix VIII of the CCR sporting regulations lists the turbocharged petrol engines already declared and approved, together with the values of the associated performance parameters they have to comply with.

The article 13.1 of the CCR sporting regulations reminds the use of a FIA data acquisition system is compulsory for T1 vehicles fitted with a turbocharged petrol engine.

It states also that the supercharging pressure must always comply with the parameter values contained in the table of Appendix VIII for the engine selected.

The minimum weights of the cars are defined in the article 8.4.6 of CCR SR:

Supercharged Petrol Engines <i>Moteurs essence suralimentés</i>			
Over <i>Au-dessus de</i> cm ³	Up to and including <i>Jusqu'à et incluant</i> cm ³	T1.1	T1.2
0	5950	1850	1580
T1.1 complying with T1+ specifications <i>T1.1 répondant à la définition T1+</i>		2000	

As specified in the art. 285.5.1.1.c of the Appendix J, the maximum nominal cylinder capacity (before application of the multiplication coefficient) [of a T1 turbocharged petrol engine] is set at 3500 cm³.



3. Paperwork: engine description and engine performance layout

As first steps of the process, the team/ tuner/ manufacturer or competitor has to provide the following documents and data:

- The engine technical form
- The engine performance evaluation data sheet (appendix of the technical form)
- The mandatory sensors positioning form (appendix of the technical form)

Actually, the global process is very similar to the one applied for GT3 cars.

a. The engine technical form

Any engine declaration will be associated to an engine technical form.

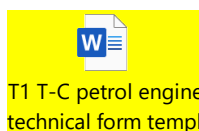
It will describe the following parts of the engine, both standard from the base engine and free or replaced, thanks to photos and measurements.

The base standard engine together with the allowed modifications	All equipment fitted on the base engine and likely affecting the performance of the powertrain
<ul style="list-style-type: none"> • Engine block including potential sleeves • Crankshaft • Conrods • Pistons + rings • Cylinder head(s) • Camshafts • Valves • Cam followers/ tappets and cam follower brackets • Variable camshaft timing system if any • Basic camshafts timings & associated timing method • Driving system • (Standard) intercooler(s) if located in the inlet manifold(s) 	<ul style="list-style-type: none"> • Flywheel • Throttle body(ies) • Inlet manifold(s) • Valve springs • Turbocharger(s) • Exhaust manifold(s) • Wastegate actuator(s) • High pressure fuel pump(s) + regulator(s) • Fuel injectors • Fuel injector rail(s) • Lubrification system (sump, oil pumps – potentially modified) • All sensors and actuators including wastegate actuator, and dump valve if any.

The FIA technical department can request to check some engine parts during or after the engine performance evaluation test which will be hold closed to FIA Valleiry.

The engine which will be fitted in the car for the performance evaluation test will be sealed. Seal(s) must not be broken or removed without the approval of the FIA technical department.

Thus, the FIA would be able to take the opportunity of a future rebuild of this engine to check it more deeply. Here is the template of this technical form:





b. The mandatory sensors positioning form

As an appendix of the engine technical form, the team/ tuner/ manufacturer or competitor has to submit for approval the locations of the mandatory sensors.

Thus the following form has to be filled up and submit:



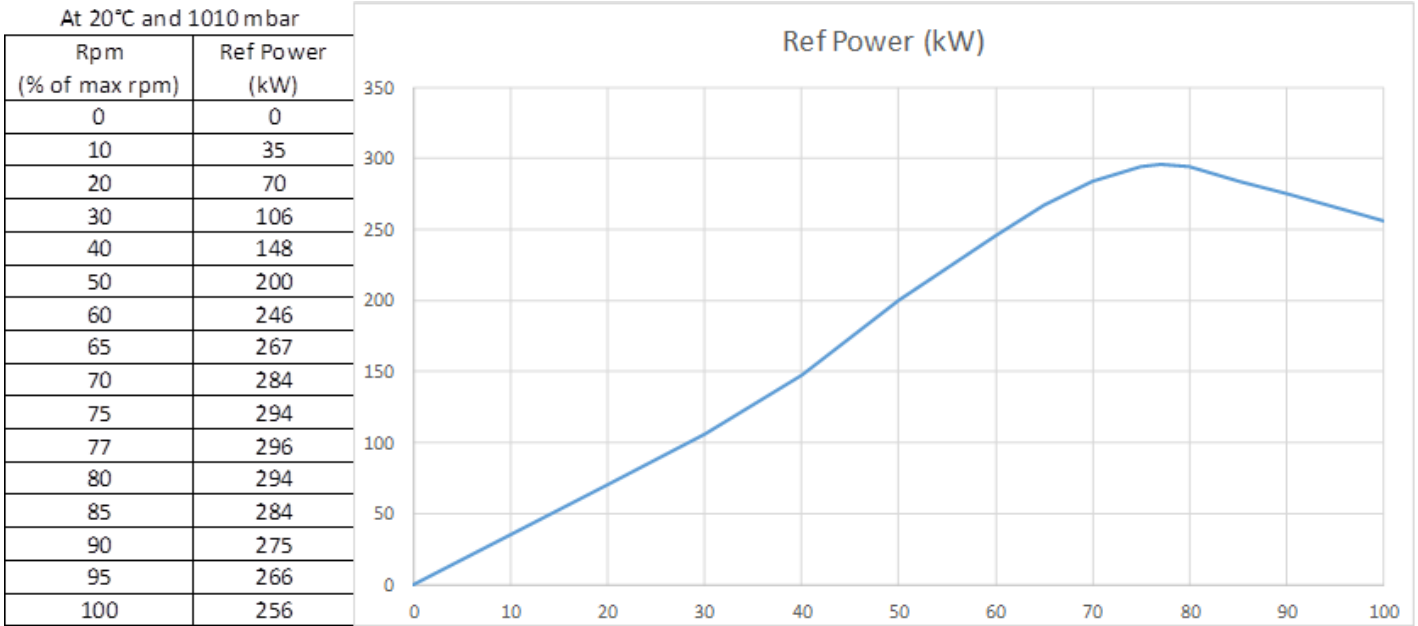
FIA Sensor
Positionning - CC BoP



c. The engine performance evaluation data

i. Performance target

The FIA engine department has built a target engine power curve as follows:



The philosophy around the building of this power curve was to use the power curve shape from a N/A engine fitted with a restrictor of 37mm in size, the power being measured at the flywheel of the engine.

If the performance measurement is performed on a powertrain dyno, a measurement of the losses (from transmission and rolling) will be carried out by doing a coast down measurement.

The level of power shown here above has to be considered as a maximum within the measurement conditions set as follows:

- Inlet air temperature: 20°C
- Ambient air pressure: 1010mbar
- Intake manifold air temperature: 50°C
- Water temperature: 90°C

The max rpm level is the one the rev limiter will be set, whatever it is compared with the original/ standard one of the base engine.

Please note that the correction factor to be used during the FIA engine performance measurement process is the following one:

$$FCOTURBO = \left(\frac{Pref - P_{vap_ref}}{Pref - \left[6,1121 \cdot \exp \left\{ \left(18,678 - \frac{T_{atmo}}{234,5} \right) \cdot \frac{T_{atmo}}{T_{atmo} + 257,14} \right\} + \frac{H_{atmo}}{100} \right]} \right)^{1,109} \cdot \left(\frac{T_{manifold} + 273}{T_{manifold_ref} + 273} \right)$$

With : Pref = 1010mbar, P_{vap_ref} = 12mbar, and T_{manifold_ref} = 50°C



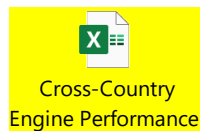
The fuel used to perform such measurements has to:

- comply with Appendix J Art.252-9.1 or Art. 252-9.3
- have a RON level of minimum 101

ii. Datasheet and engine performance evaluation

The team/ tuner/ manufacturer or competitor has to provide the Excel file below, called “datasheet”, dully filled once after the following test bench measurements have carried out:

1. Curve matching FIA requested performance,
2. Curve with PBoost level corresponding to FIA requested performance **-40mbar**,
3. Curve with PBoost level corresponding to FIA requested performance **+40mbar**,
4. Curve with PBoost level corresponding to FIA requested performance **-80mbar**,
5. Curve with PBoost level corresponding to FIA requested performance **+80mbar**,
6. Curve with PBoost level corresponding to FIA requested performance **-120mbar**,
7. Curve matching FIA requested performance, with AirT° intake manifold @ 40° (instead of 50), by adjusting the PBoost compared to the curve at 50°C above.



All measurements must be performed:

- With the same fuel, that is to say complying with Appendix J Art.252-9.1 and or 252-9.3,
- With a RON level of minimum 101
- @ water T° = 90°C
- @ air intake manifold T° = 50°C (except for curve n°7)

The setting of all other parameters, especially cam timings, ignition advance angle and Lambda level, is assumed to be the best possible ones.

In other words, any modification of the values of these parameters will lead to a loss of performance.

The Lambda figures have to be considered at full load only (throttle opening allowing to achieve the maximum performance of the engine for a given rpm).

The optimum Lambda level, which will be set for all curves, will be considered as the minimum one afterwards.

The same fuel which will have been used to perform these measurements will have to be provided for the FIA engine performance tests.

In the case of the use of an Advanced Sustainable Fuel, compliant with the art. 252-9.3 (2022), additional measurements using a fuel complying with the art. 252-9.1 with a RON level of minimum 101 will be requested to be performed.



In addition to these curves' measurement figures, we ask you to provide:

- Some basic dimensions of your vehicle
- **All** ignition correction mapping tables
- The CVT mapping tables
- The mapping tables of any other actuator that can affect the way the engine could perform.

The data sheet dully filled has to be submitted to the FIA engine department not later than 15 days before the scheduled engine performance evaluation test.

For any further question regarding the datasheet and the associated measurement tests, feel free to write to the following email addresses: enginedpt@fia.com & electronicdpt@fia.com.

4. Engine performance evaluation test

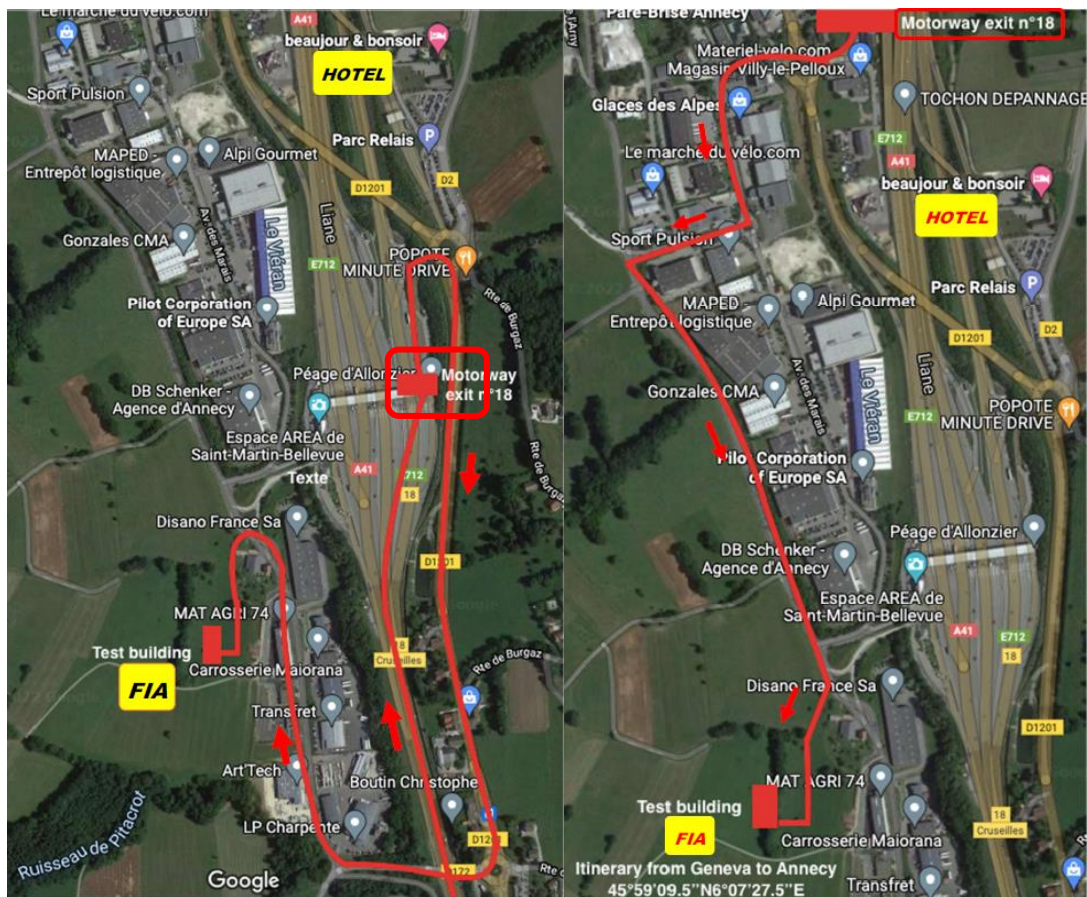
a. Test location

The test will be hold at:

TRANSFRET, Zone les terres de l'Army
74350 Allonzier-la-Caille,
FRANCE
GPS coordinates: N45°59'09.5" / E6°07'27.5"

Road accesses from:

- South/ Anancy on the right-hand side
- North/ Geneva on the left-hand side.



The test will be done in a building that is dedicated for the test. However, please note that this facility is part of a public area.

The trucks will be parked inside the building.



b. Planning, timing and schedule

- The car is expected on site **at 8:00 am latest** in the morning the day of the test.
- It is possible to bring a truck into TRANSFRET facility and to unload the car there. To ensure a smooth operation, thanks for informing us ahead of time on the dimension of the truck.
- If your truck needs to arrive a day earlier, it is possible to park it into TRANSFRET facility or at the FIA site in Valleiry, about 30kms away. You will just have to make sure of the possible opening hours with Daniel Fasano (dfasano-consultant@fia.com)
- We will provide food at midday, so please provide the number of people present at noon at least 7 days before the date of the tests.

c. Electronics installation

A FIA data logger, loom and sensors will have to be installed on the car prior to the test. All these parts will be supplied and delivered by FIA on site. The content of the FIA data logger kit and the characteristics and dimensions of each component are described in the data logger user guide.

In order to optimize the electronic installation before the test, the team/ tuner/ manufacturer or competitor is asked to prepare and fit:

- 12V power supply connection with Deutsch DTM04-6P.
- Brackets for sensors (Pintake, Pboost) as per the following documents.

FIA will also collect the channels via the CAN bus from the car ECU, as described in the [FIA_CC_2020_v4.6.dbc](#) file enclosed in the [document FIA TELEMETRY User Guide_CrossCountry_MLS_v1.8 - 20220406](#).doc that you will find enclosed further.



d. Car preparation

- Engine spec:

The engine spec has to be exactly the one described in the engine technical form.

Pboost setups: As it will be requested by FIA, following the analysis of the datasheet.

Before the end of the performance evaluation test, the engine will be sealed by the FIA in a way it will be impossible to dismantle it or to modify any setting (such as camshaft timing).

- Bodywork:

We need the car to arrive without any front, rear or lower side bodywork. Ideally with no doors either. Also remove bodywork around the exhaust for side exhausts if any.

The less body parts will be fitted on the car, the easiest and quickest the test will be performed.

- Cooling:

We need to understand the cooling layout of your car. Thus, thanks for providing a few photos of the front of your car (without front bodywork) with arrows indicating location of the coolers.

Thanks for providing and bringing adapters for coolers entry ducts that are not located in front of the car (to fit on a 250mm diameter duct) similar to parts shown hereafter.





- Hub adapters:

We need adapters to be fitted to your hubs in replacement to your wheels.

The drawing of the dyno part that your adapter will have to fit on, can be found hereafter. We ask you to produce these adapters and to come with it at the tests.

The drawing “for customer” is for info only. These parts will be provided.



MRFLBA01000A - MRFLBA00000A -
for customer.pdf NEUTRAL FLANGE C/

However, a full set of adapters could also be directly ordered for an approximate price of 2900€ w/out VAT (contact: enginedpt@fia.com). It must be ordered not later than 2 weeks before the scheduled test.

- Minimum vertical ride height:

If the vertical distance between the axis of both front and rear hubs and the lowest point of the car is lower than 300mm, the team has to warn the FIA technical department at least 3 weeks before the test date, as wedges will be needed to lift the dynos.

e. Fuel

The fuel(s) to be used for this test has to:

- comply with Appendix J Art.252-9.1 and/ or Art. 252-9.3
- have a RON level of minimum 101
- be exactly the one used for the measurements performed to fill the datasheet.

Thus, it has to be provided by the team/ tuner/ manufacturer or competitor together with the filling devices. 120L of each fuel quality, is usually enough to cover all the tests.

Please note that for commodity **it is possible to send the fuel in advance** to the test location. The contact for delivery is : Daniel Fasano, TRANSFRET, Zone les terres de l'Arny 74350 ALLONZIER-LA-CAILLE, FRANCE.

NB: before sending the barrels, please ensure the transporter is able to unload his truck alone.

Also, fuel samples for further analysis could be taken at any time during the test.



f. Costs

The cost of the test will be invoiced to the team/ tuner/ manufacturer or competitor.

Thus, you will need to provide us (enginedpt@fia.com) your contact details (table here below) in order to invoice you the costs of the engine performance evaluation tests, together with the possible engine technical inspection.

Company Name	
Legal Address	
VAT Number	
Contact Person	
Email address	
Telephone	

If you need us to mention any Purchase Order number of the final invoice, thanks for providing it within the same time.

For any further question regarding the engine performance evaluation tests, feel free to write to the following email addresses: enginedpt@fia.com & electronicdpt@fia.com.

At that point of the process and thanks to the feedback of both the content of the datasheet and the measurements performed during the engine performance evaluation test, the engine as described in the technical form can be added in the appendix VIII of the CCR SR.

In this appendix, the maximum turbo pressure levels $f(\text{rpm})$, defined by the FIA technical department will be specified, together with the Lambda value which will be considered as the minimum value (in full throttle conditions), and the fuel associated to them if relevant.



5. FIA passport

Depending from the car, 2 possibilities:

a. New vehicle or car without FIA technical passport

The process described in the article 8.3 of the CCR SR has to be followed.

b. Modified/ updated vehicle with a FIA technical passport

The existing technical passport will be replaced by the FIA technical delegate, by a new one, at the pre-event scrutineering of the first FIA event the modified car will be entered.

No pre-inspection by an ASN delegate will be needed.

The passport number and the identification stickers will remain on the roll cage.

However, we aim at banning the replacement of the original engine for a petrol turbo charged one for car compliant with a FIA technical passport and compliant with the technical regulations of Appendix J 2009, from 2021.



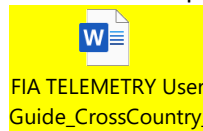
6. Racing and monitoring

The monitoring of the performance and the compliance with the working conditions stated in the appendix VIII of the CCR SR will be performed thanks to the FIA data logger together with the mandatory sensors and their associated looms.

a. Description of the device

The Data Logger User Guide here below describes:

- The content of the FIA data logger kit
- The dimensional and technical characteristics of each components
- The way each component has to be installed in the car
- The CAN line specification
- The mandatory CAN Packet data to be published by competitor in a .dbc file



For any question about the datalogger, thanks for writing to the following email address: electronicdpt@fia.com.

b. Availability and costs

From 2022, the rental cost of a data logger kits for the FIA events of the Cross-Country World Cup/ Championship will be charged to the team/ competitor.

Each team/ tuner/ manufacturer or competitor who would need a FIA data logger kit needs to send his request to crosscountry@marelli.com, with electronicdpt@fia.com in copy, **at least 3 weeks before the date the device is needed** by the team, either for race events or test purpose.

For those who would like to have a device for testing purpose, for example, the lease cost will be 310€ per month.

See the PO form to fill up and to be sent further.

General lease term and conditions are also specified in there.

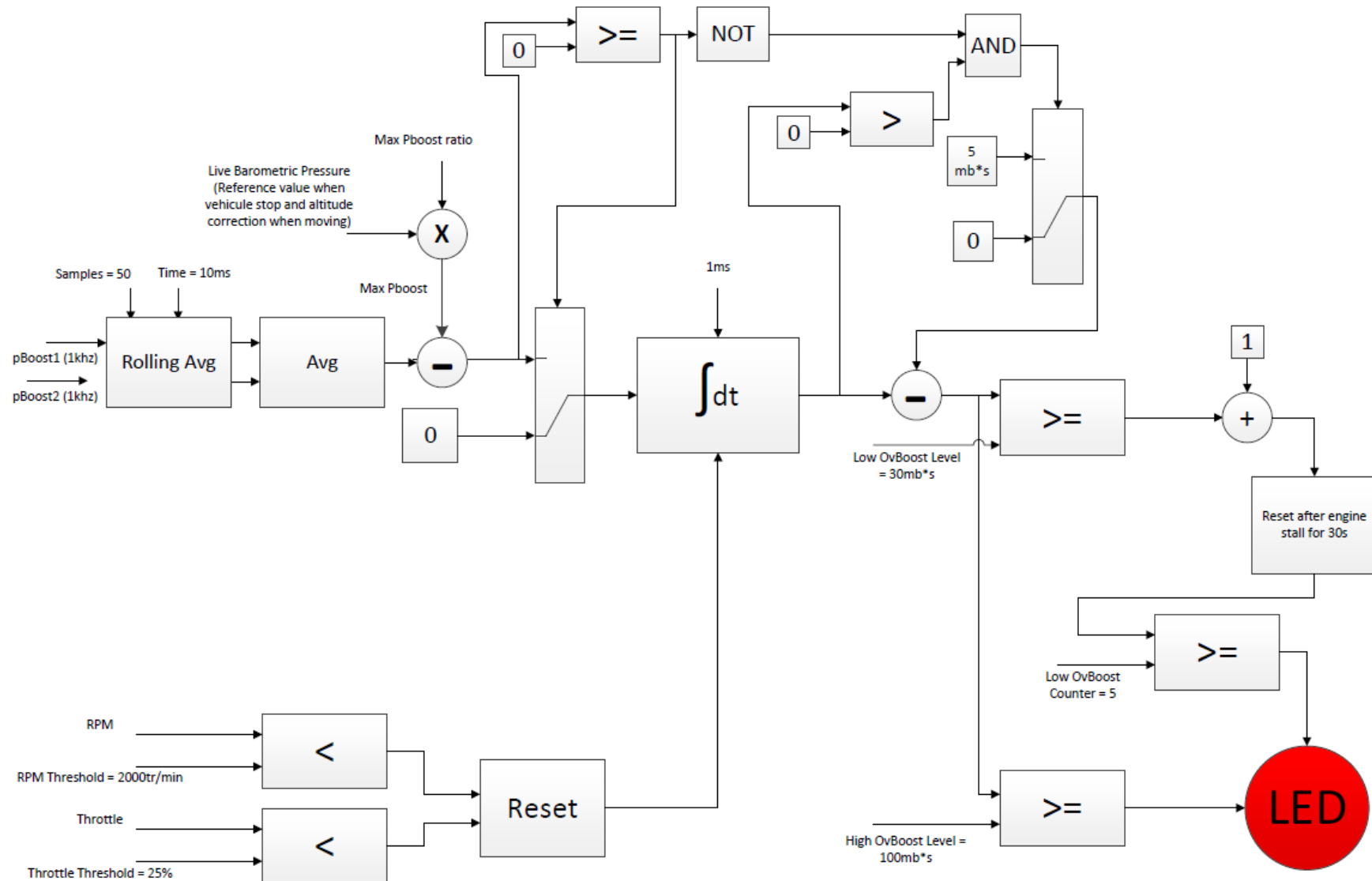
c. Monitoring of the PBoost

The engine performance will be monitored on the behalf of the FIA on FIA Cross Country events. The compliance with the article 13.1.2 of the CCR SR, accordingly with the values of max PBoost ratio specified in the appendix VIII of the CCR SR, will be checked at any time thanks to the FIA data logging device.

The way the engine Pboost will be compared to the maximum legal Pboost is described in the algorithm presented here after.



LED Boost control strategy
V1 CC T1





d. Calculated barometric pressure and Max PBoost values correction

The barometric pressure value which will be used in the control strategy will be given by the following formula:

$$P(h) = P_{Atmo}(h_0) \times (1 - 0,0065 \times (h - h_0) / T(h_0))^{5,255}$$

with $T(h_0) = T_{intake}(h) + 0,0065 * (h - h_0)$
With pressures in mbar and temperatures in °K

Where ***P_{atmo}*** is the barometric pressure measured by the FIA inlet pressure sensor, when the car speed is 0 and at the reference altitude called ***h₀***.

When the speed of the car will be positive, the altitude of the car ***h*** will be given by the altitude of the current GPS location of the car.

As a consequence, the ***Max Pboost*** value will vary regarding the calculated barometric pressure to respect a constant ratio:

$$\text{Max Pboost}(rpm, h) = \text{Max PBoost ratio}(rpm) \times P(h)$$

e. Technical support on the field

On Cross-Country FIA events, technical support will be available.

The cost of the Magneti Marelli track support will be shared in between all the competitors whose the vehicles will be fitted with a FIA datalogger (kit).

In case of damage, the parts will be analysed, and a report will then be issued.

If the analyse concludes that the failure is due to a bad installation or use of the Team, the team will have to pay for the reparation of the components and thus a specific offer will be addressed to the team.

In the PO form here after, you will find the retail prices of each component that can be ordered as spare.

