INVITATION TO TENDER FOR SOLE SUPPLY CONTRACT

TENDER SUMMARY AND ADDITIONAL TENDER REQUIREMENTS

The FIA's objective is to select an exclusive supplier of Engine Control Units (ECUs) whose task it will be to ensure the production and delivery of the ECUs to the competitors in the 2010, 2011 and 2012 FIA GT Championship.

Interested parties are hereby invited to tender to become the exclusive supplier of ECUs to the competitors in the 2010, 2011 and 2012 FIA GT Championship.

The selected tenderer will be invited to enter into a contract with the FIA that will establish the terms of the tenderer's appointment as exclusive supplier. The exclusive supplier will supply the products directly to the teams (not to the FIA) under terms and conditions to be agreed.

Bids must be submitted in accordance with the FIA's "Invitation to tender for sole supply contract – tendering instructions" available on the FIA's website: www. FIA.com.

The FIA reserves the right to make amendments to this invitation to tender at any time and to issue a new invitation to tender.

Publication of invitation to tender:	31 July 2008
Tender submission date:	**1 October 2008**
Opening date:	3 October 2008
Notification of decision as to selection of tenderer:	10 November 2008

DRAFT CONTRACT FOR SUPPLYING ENGINE CONTROL UNITS (ECUs)
IN THE 2010, 2011 and 2012 FIA GT CHAMPIONSHIP

BETWEEN

The FEDERATION INTERNATIONALE DE L'AUTOMOBILE (FIA)
Chemin de Blandonnet, 2
CH 1215 Geneva 15 - Switzerland

hereinafter referred to as the "**COORDINATOR**"

ON THE ONE HAND,

AND

[•]

hereinafter referred to as the "**PROVIDER**"

ON THE OTHER HAND.

PART 1 - GENERAL CONDITIONS

RECITALS

(A) The COORDINATOR's authority in relation to international motor sport has been recognised since 1904 when national automobile clubs came together to establish the FIA to provide, amongst other things, an international forum to regulate motor sport internationally.

(B) The COORDINATOR is the sole body governing international motor sport and is recognised by its members as the sole authority having the sporting power with the right to organise international FIA championships, including the CHAMPIONSHIP.

(C) The COORDINATOR has an absolute obligation conferred on it by its members to safeguard its authority over all safety, sporting, technical and disciplinary matters relating to the CHAMPIONSHIP, as well as traditional values.

(D) The COORDINATOR will continue the publication annually of the GOVERNING RULES.

(E) The COORDINATOR has determined that the interests of the CHAMPIONSHIP require that a single supplier of the PRODUCT should be appointed for a limited term.

(F) It is intended that the COORDINATOR and the PROVIDER will enter into this CONTRACT pursuant to which the PROVIDER will be appointed as the sole supplier of PRODUCT to the CHAMPIONSHIP for the term set out herein.

1. APPOINTMENT AND SUPPLY

1.1 The COORDINATOR hereby appoints the PROVIDER to be the exclusive supplier of the PRODUCT to the COMPETITORS for the CHAMPIONSHIP and the PROVIDER hereby accepts this appointment and agrees to supply the PRODUCT to the COMPETITORS for the CHAMPIONSHIP in accordance with the terms of this CONTRACT and the terms of the SUPPLY AGREEMENTS.

1.2 Following from its appointment, the PROVIDER shall enter into a SUPPLY AGREEMENT with each COMPETITOR setting out the terms upon which the PRODUCT shall be supplied.

1.3 The PRODUCT that is supplied by the PROVIDER to the COMPETITORS shall be compliant with the TECHNICAL REGULATIONS and the TECHNICAL SPECIFICATIONS.

2. RELATIONS BETWEEN THE PROVIDER AND THE COMPETITORS

2.1 The PROVIDER shall treat all COMPETITORS in accordance with the PRINCIPLES OF SPORTING EQUALITY.

2.2 The PROVIDER shall supply the PRODUCT to all COMPETITORS on equivalent terms. It shall enter into a standard SUPPLY AGREEMENT with each COMPETITOR.

2.3 All SUPPLY AGREEMENTS shall be fully compliant with the PRINCIPLES OF SPORTING EQUALITY, the CONTRACT and the SPORTING REGULATIONS and TECHNICAL REGULATIONS.

2.4 Separate from the SUPPLY AGREEMENT, the PROVIDER shall be free to enter into separate agreements with COMPETITORS, containing such commercial terms, including, for the avoidance of doubt, in relation to advertising, publicity and other promotional arrangements, as those parties may agree. However, any such arrangements must not compromise the PRINCIPLES OF SPORTING EQUALITY, or be contrary to the SUPPLY AGREEMENT entered into with all COMPETITORS. In particular, the conclusion of any supplemental arrangement must in no way confer any sporting advantage upon one COMPETITOR over another.

2.5 If requested by the COORDINATOR, the PROVIDER shall supply a copy of each SUPPLY AGREEMENT in order to demonstrate that the PRINCIPLES OF SPORTING EQUALITY are maintained. With respect to the COORDINATOR, the PROVIDER hereby waives and confirms that it shall not assert or seek to rely on any confidentiality provision in any SUPPLY AGREEMENT or other agreement relevant to the supply of the PRODUCT to prevent the COORDINATOR from reviewing relevant agreements or carrying out its regulatory functions (including ensuring that the PRINCIPLES OF SPORTING EQUALITY are maintained).

2.6 The COORDINATOR may request amendments to a SUPPLY AGREEMENT if it considers that the SUPPLY AGREEMENT is not consistent or compatible with, or is otherwise contrary to, the PRINCIPLES OF SPORTING EQUALITY. For the avoidance of doubt, the PROVIDER's obligation to abide by the PRINCIPLES OF SPORTING EQUALITY shall not be limited or otherwise affected by the COORDINATOR's review of a SUPPLY AGREEMENT and/or a request for an amendment to be made.

2.7 In the event of uncertainty regarding whether any action taken or proposed to be taken by the PROVIDER may breach the PRINCIPLES OF SPORTING EQUALITY, the PROVIDER shall request guidance from the COORDINATOR, which shall make a determination in this regard. Where such a determination is made by the COORDINATOR, the PROVIDER's actions in complying with that determination shall be deemed to be in compliance with the PROVIDER's obligation in GENERAL CONDITION 2.1 to treat all COMPETITORS in accordance with the PRINCIPLES OF SPORTING EQUALITY.

3. **LIABILITY**

3.1 Without prejudice to the COORDINATOR's other rights, the PROVIDER shall indemnify and hold harmless the COORDINATOR from and against all reasonably foreseeable losses incurred by the COORDINATOR as a direct result of the PROVIDER's:

(a) failure to supply the PRODUCT of the requisite quantity;

(b) failure to supply the PRODUCT of the requisite quality; and

(c) negligence in the supply of the PRODUCT.

3.2 The PROVIDER represents and warrants that it is in a position to meet any liability that may arise under clause 3.1 of this CONTRACT up to an amount of 30,000,000 (thirty million) Euros and hereby covenants to maintain such position for the period of time during which the PROVIDER may be liable.

4. **WARRANTIES**

4.1 The PROVIDER represents and warrants that it has full power and authority to enter into and fully perform its obligations under the CONTRACT and the provisions of the CONTRACT, when executed, will constitute valid and binding obligations on the PROVIDER in accordance with its terms. The PROVIDER also represents and warrants that it has full power and authority to enter into and fully perform its obligations under the SUPPLY AGREEMENTS when executed.

4.2 The COORDINATOR represents and warrants that it has full power and authority to enter into and fully perform its obligations under the CONTRACT and the provisions of the CONTRACT, when executed, will constitute valid and binding obligations on the COORDINATOR in accordance with its terms.

5. **TERMINATION**

5.1 Notwithstanding any other provision hereof, either party may terminate the CONTRACT with immediate effect by written notice to the other if any of the following events occur:

(a) the other party has committed a material breach of the CONTRACT which is not capable of remedy or, if remediable, has not remedied it within 30 days of the non-breaching party's written notice requiring the default to be remedied (for the avoidance of doubt, a breach by the PROVIDER of any of GENERAL CONDITIONS 1.2, 1.3, 2, 3 and 4.1 and any of SPECIAL CONDITIONS is acknowledged by the parties to be a material breach);

(b) steps (including any steps analogous to those following) have been taken to wind up the other party or to place the other party into administration or to have a receiver appointed over any of its assets, other than as part of a scheme of solvent reconstruction or amalgamation; or

(c) the other party shall cease or threaten to cease carrying on business or the other party shall make any composition or arrangement with its creditors or become subject to any other insolvency process or proceeding (other than as part of a scheme of solvent reconstruction or amalgamation) or have all or any of its assets or undertakings seized by a government or governmental agency or authority (including any acts analogous to the above).

6. GOVERNING RULES

6.1 The GOVERNING RULES constitute the legal, administrative and technical framework of the CHAMPIONSHIP and the conditions set forth therein shall have binding force and prevail among the parties to the CONTRACT.

6.2 The CONTRACT shall in principle be interpreted in a manner that gives effect to the provisions of the GOVERNING RULES, the intention of the parties being to construe the provisions of the CONTRACT in the context of the more general framework of the GOVERNING RULES.

6.3 The PROVIDER acknowledges that the TECHNICAL SPECIFICATIONS and GOVERNING RULES are subject to amendment from time to time. The PROVIDER will be responsible (at its own cost) for all research and development associated with the manufacture of the PRODUCT, including the making of any changes to the PRODUCT to be supplied pursuant to the CONTRACT that may be necessitated by any amendment to the TECHNICAL SPECIFICATIONS or the GOVERNING RULES.

7. GOVERNING LAW AND LANGUAGE

7.1 The language that shall prevail for the interpretation of the CONTRACT shall be [English/French] and the CONTRACT and all documents connected with the CONTRACT shall be written in [English/French]. In the event of any conflict between the language of the CONTRACT and any translation thereof, the language of the CONTRACT, French or English, as the case may be, shall prevail. In the event of any conflict between the language of any document connected with the CONTRACT and any translation thereof, the language of the document connected with the CONTRACT, French or English, as the case may be, shall prevail.

7.2 The governing law of the CONTRACT shall be French law.

7.3 The Tribunal de Grande Instance de Paris, France, shall have sole jurisdiction to settle any dispute that may arise between the COORDINATOR and the PROVIDER in connection with the CONTRACT.

8. GENERAL

8.1 Nothing in the CONTRACT guarantees or shall be construed as guaranteeing the solvency of a COMPETITOR. The COORDINATOR is not responsible for ensuring that the COMPETITORS satisfy the terms of the SUPPLY

AGREEMENTS and the COORDINATOR shall not be liable for a failure by any COMPETITOR to satisfy the terms of a SUPPLY AGREEMENT.

8.2 No delay or omission or failure to exercise any right or remedy provided herein shall be deemed to be a waiver thereof.

8.3 The CONTRACT shall be binding on and enure to the benefit of the parties and their respective successors and permitted assigns. The PROVIDER shall not be entitled to assign or sub-contract its rights or obligations under the CONTRACT in whole or in part without the prior written consent of the COORDINATOR.

8.4 Any notice to be given under the CONTRACT shall be given in writing delivered to the other party by any one or more of the following methods:

(a) personal delivery to one of its corporate officers, in which case notice shall be treated as having been given at the time of such personal delivery;

(b) first class registered post or courier delivery service (such as DHL or UPS) to the address mentioned above (or such other address as may be notified to the other party in writing from time to time), in which case notice shall be treated as having been given on the date of actual receipt at that address (or on the next local business day if delivered on a local non-business day or after 4.00 p.m. local time on a local business day), which shall rebuttably be presumed to be the second local business day after posting; or

(c) facsimile to the numbers below (or such other facsimile number as may be notified to the other party in writing from time to time), in which case notice shall be treated as having been received at the time of actual receipt (or on the next local business day if delivered on a local non-business day or after 4.00 p.m. local time on a local business day) and rebuttably be presumed to have been duly received at the time indicated on the automatic acknowledgement transmitted by the recipient fax machine:

PROVIDER: [•]

COORDINATOR: [•]

8.5 Any variations of the CONTRACT shall be ineffective unless agreed in writing and signed by the parties.

8.6 If any term, provision or condition of the CONTRACT is held by a court of competent jurisdiction to be invalid, void or unenforceable such invalidity, voidness or unenforceability shall not invalidate the remainder of the CONTRACT, all of which shall remain in full force and effect.

8.7 The CONTRACT may be executed in any number of counterparts (whether original or facsimile counterparts) and upon due execution of all such

counterparts by all parties, each counterpart shall be deemed to be an original hereof.

8.8 GENERAL CONDITIONS 3, 7 and 8 shall survive expiry or termination of the CONTRACT for any reason (but shall terminate at the time expressly provided in the relevant GENERAL CONDITION, if any).

PART 2 - SPECIAL CONDITIONS

1. SUPPLY OF THE PRODUCT

1.1 The PRODUCT supplied by the PROVIDER shall be of a strictly uniform quality.

1.2 The COORDINATOR does not guarantee the PROVIDER a minimum quantity of the PRODUCT to be supplied.

2. PRODUCTION AND DELIVERY OF THE PRODUCT

2.1 The PROVIDER shall make available to the COORDINATOR, at the PROVIDER's own cost, two prototypes of the PRODUCT for selective bench testing on port fuel injection engine (PFI) on 12 November 2008 at the latest.

2.2 No later than 12 November 2008, the PROVIDER shall be ready to start developing necessary hardware and software systems for a Gasoline Direct Injection engine (GDI), if expressly required in writing by a COMPETITOR.

The PROVIDER undertakes to make available all the time and staff necessary to the development of the hardware and software systems of the PRODUCT for GDI engines until the COORDINATOR considers these systems entirely satisfactory.

The PROVIDER shall inform the COORDINATOR for approval of the delay necessary to design and manufacture optional extra modules (such as injector and/or fuel pump drivers).

2.3 No later than 10 December 2008, the PROVIDER shall make available to the COMPETITORS for each type of HOMOLOGATED CAR one prototype PRODUCT.

No later than 3 March 2009, the PROVIDER shall make available to each COMPETITOR any ordered prototype PRODUCT.

2.4 The PROVIDER undertakes to modify the prototype ECU as requested by the COORDINATOR and to consider any comments or suggestions received from the COMPETITORS.

2.5 The hardware and software design specifications of the PRODUCT shall be submitted to the COORDINATOR for approval on 25 March 2009 at the latest and the final approval from the COORDINATOR shall be notified to the PROVIDER on 8 April 2009 at the latest. After that date, no further modifications or alterations to the PRODUCT's specifications shall be permitted without the express consent of the COORDINATOR.

2.6 From 3 June on, the PROVIDER shall make available for purchase to each COMPETITOR any PRODUCT ordered in compliance with the SUPPLY AGREEMENT.

2.7 The PROVIDER shall make available all necessary technical support,

personnel and equipment to assist with installation of the PRODUCT during the first prototype deliveries of the PRODUCT to the COMPETITORS.

The price for the first prototype of the PRODUCT includes 80 hours of one engineer provided by the PROVIDER per type of HOMOLOGATED CAR for installation, set-up and track support.

The PROVIDER will need approval from the COMPETITOR, CAR MANUFACTURER and FIA ENGINEER before supplying and charging any extra hour for installation.

The PROVIDER shall ensure that:

a) one appropriately qualified and senior representative of the PROVIDER is present on-site throughout the duration of each EVENT;

b) one appropriately qualified and senior representative of the PROVIDER per type of HOMOLOGATED CAR is present at the two EVENTS which follow the official homologation date of the HOMOLOGATED CARS concerned and at two OFFICIAL TESTING sessions which may take place before these EVENTS;

c) one appropriately qualified and senior representative of the PROVIDER per type of HOMOLOGATED CAR is present at any EVENT, if deemed necessary by the FIA ENGINEER in case of software modification or reliability issue.

2.8 The PROVIDER shall provide a representative to download the data loggers in conjunction with the COORDINATOR during the whole CHAMPIONSHIP. The COORDINATOR will pay the PROVIDER a single fee of 30,000 Euros per season for this representative.

3. MANUFACTURING CONDITIONS OF THE PRODUCT

3.1 Before starting production of the PRODUCT to be supplied pursuant to the CONTRACT, the PROVIDER shall provide to the COORDINATOR a detailed technical study for the approval of the FIA ENGINEER. In the event that an amendment is made to the TECHNICAL SPECIFICATIONS or the TECHNICAL REGULATIONS that requires an amendment to the PRODUCT supplied pursuant to the CONTRACT, the PROVIDER shall provide to the COORDINATOR a detailed technical study of the amended PRODUCT to be supplied pursuant to the CONTRACT to take account of such amendment.

3.2 The PROVIDER shall make such modifications to the PRODUCT to be supplied pursuant to the CONTRACT as the FIA ENGINEER may require.

3.3 The PROVIDER shall not make any change to the PRODUCT during the CONTRACT without the express written agreement of the COORDINATOR.

4. PRICING OF THE PRODUCT

4.1 The price of the PRODUCT supplied pursuant to the CONTRACT shall be […] (as further detailed on the PRICING FORM), which amount shall be inclusive of all taxes and charges and shall not be increased for any reason. except in accordance with SPECIAL CONDITION 4.3.

4.2 VAT (value added tax) shall not be charged to those COMPETITORS that are exempt from VAT and that have supplied proof of such exemption to the PROVIDER.

4.3 The price stated in SPECIAL CONDITION 4.1 may be adjusted for the 2011 and 2012 sporting seasons in accordance with the indexation formula provided in **Appendix I**.

5. ASSOCIATION RIGHTS

5.1 The PROVIDER is prevented from advertising, publicising or otherwise promoting in any form whatsoever, including either direct or indirect advertising, via any media, and in any country, its supply of the PRODUCT to a COMPETITOR, or its relationship with the CHAMPIONSHIP. All phases of PRODUCT delivery pursuant to the CONTRACT shall be carried out by personnel wearing no distinctive symbols or designs on their uniforms and using equipment that does not give any indication as to the identity of the PROVIDER.

5.2 Subject to GENERAL CONDITION 2.1 and SPECIAL CONDITION 5.1, the PROVIDER remains free to agree advertising, publicity or other promotional arrangements with a COMPETITOR, organiser or promoter.

PART 3 – DEFINITIONS

The following terms shall be understood to have the following meanings for the purposes of the "CONTRACT".

1.1 **CHAMPIONSHIP** means the 2010, 2011 and 2012 FIA GT Championship or any title decided from time to time by the COORDINATOR to designate the FIA GT Championship.

1.2 **COMPETITORS** means the racing teams that have been accepted by the COORDINATOR to take part in the CHAMPIONSHIP.

1.3 **CONTRACT** means the GENERAL CONDITIONS, the SPECIAL CONDITIONS and the DEFINITIONS.

1.4 **COORDINATOR** means the Fédération Internationale de l'Automobile (FIA).

1.5 **DEFINITIONS** means the definitions set out in this Part 3 of the CONTRACT.

1.6 **EVENT** means any race forming part of the CHAMPIONSHIP and entered on the International Sporting Calendar of the COORDINATOR. An EVENT is deemed to commence at the scheduled time for scrutineering and sporting checks and includes all practice, qualifying and the race itself and ends at the expiry of the deadline for the lodging of a protest under the terms of the International Sporting Code.

1.7 **FIA ENGINEER** means the technician appointed by the COORDINATOR to carry out all technical checks and controls and to grant the necessary approval prior to the starting up of production.

1.8 **GENERAL CONDITIONS** means the provisions contained in Part 1 of the CONTRACT.

1.9 **GOVERNING RULES** means:

(a) the International Sporting Code and the Appendices thereto;

(b) the General Prescriptions applicable to all FIA Championships, Challenges, Trophies and Cups and their qualifying EVENTS;

(c) the SPORTING REGULATIONS; and

(d) the TECHNICAL REGULATIONS.

1.10 **OFFICIAL TESTING** means the official testing, if any, for the CHAMPIONSHIP.

1.11 **PRICING FORM** means the pricing form provided in **Appendix II** stating the prices at which the PRODUCT will be supplied to the COMPETITORS at the EVENTS and the OFFICIAL TESTING, if any.

1.12 **PRINCIPLES OF SPORTING EQUALITY** means the equal treatment by the PROVIDER of all COMPETITORS with respect to:

(a) anything which may affect the performance of the PRODUCT;

(b) the terms on which the PRODUCT is supplied;

(c) the support, access and information made available to COMPETITORS in relation to the PRODUCT; and

(d) any other matter which affects or may have an effect, however minor, on sporting performance.

1.13 **PRODUCT** means **Engine Control Units (ECUs)**, as such term is described in the SPORTING REGULATIONS and TECHNICAL REGULATIONS.

1.14 **PROVIDER** means [•].

1.15 **PRODUCTION SITE** means the factory that will produce the PRODUCT supplied pursuant to the CONTRACT.

1.16 **SPECIAL CONDITIONS** means the provisions contained in Part 2 of the CONTRACT.

1.17 **SPORTING REGULATIONS (Appendix III)** means the Sporting Regulations applicable to the CHAMPIONSHIP as published and amended by the COORDINATOR from time to time.

1.18 **SUPPLY AGREEMENT** (**Appendix** [•]) means any agreement, and all amendments thereto, between the PROVIDER and a COMPETITOR pursuant to which the PROVIDER shall supply the PRODUCT to the COMPETITOR.

1.19 **TECHNICAL REGULATIONS (Appendix IV)** means the Technical Regulations applicable to the CHAMPIONSHIP as published and amended by the COORDINATOR from time to time.

1.20 **TECHNICAL SPECIFICATIONS (Appendix V)** means the technical requirements applicable to the PRODUCT as issued and amended by the COORDINATOR from time to time.

1.21 **HOMOLOGATED CAR** means a car homologated by the COORDINATOR to compete in the CHAMPIONSHIP.

1.22 **CAR MANUFACTURER** means a company which homologates a GT car with the COORDINATOR.

Signed

On behalf of the COORDINATOR	On behalf of the PROVIDER
In his capacity as	In his capacity as
In On	In On

APPENDICES

I – INDEXATION FORMULA

II – PRICING FORM

III – SPORTING REGULATIONS (Not yet available, for example see 2008 version)

IV – TECHNICAL REGULATIONS (Not yet available, for example see 2008 version)

V – TECHNICAL SPECIFICATIONS

SUPPLY AGREEMENT (Not yet available. To be in form agreed by PROVIDER and COORDINATOR.)

Appendix I : Indexation formula

INDEXATION FORMULA

Concerning the 2011 and 2012 seasons, the prices charged to COMPETITORS shall be the amount that equals the amount shown for 2009 in the PRICING FORM increased annually in accordance with the positive variation of the “Consumer prices – All items” index published by the Organisation for Economic Cooperation and Development (OECD) in “Main Economic Indicators”. The indexation shall be in accordance with the variation between such base index and the index published in the October edition of “Main Economic Indicators” for the year to which the indexation applies.

Appendix II : Pricing Form

FIA GT Championship
Supplying of Engine Control Units and Associated Equipment (ECU) for the 2010, 2011 and 2012 seasons

Name of the
Company :.....

	BEFORE TAX IN EUROS	INCLUSIVE OF ALL TAXES AND CHARGES
Price for first ECU unit per homologated car including 80 hours of initial installation, setup, dynamometer and track support	€	€
Price per following ECU unit	€	€
Price for 5 to 9 following ECU units	€	€
Price for 10 and more following ECU units	€	€
Price for extra dynamometer and track support per day	€	€
Price for additional software development per hour	€	€
Price for the external GDI injector module (if not included in the ECU hardware)	€	€
Price for the external anti knocking controller (if not included in the ECU hardware)	€	€
Price for the Lap Trigger receiver sensor	€	€

Price for the Lap Trigger transmitter	€	€
Price for a 10 Hz GPS sensor	€	€

The TENDERER is invited to give the price of any ancillary products (dash board, data logger…) from its own product range.

Appendix III : Sporting Regulations

(The 2008 version is available on the FIA Website www.fia.com)

Appendix IV : Technical Regulations

(The 2008 version is available on the FIA Website www.fia.com)

Appendix V : Technical Specifications

COORDINATOR ECU Hardware Requirement

Specification

1. INTRODUCTION

For 2010 the COORDINATOR is introducing a standard Electronic Control Unit (ECU) for the CHAMPIONSHIP cars with the aims of reducing the cost of racing, removing driver aids such as traction control and allowing the COORDINATOR to check engine use and car performances. The standard ECU will control the Engine only, no other electronic controls being allowed.

This document is an example hardware specification for an ECU that will meet the requirements brought about by the 2010 GT regulations, i.e. be suitable for use with engines with the following characteristics:

- Up to 12 cylinder four stroke engine, with reciprocating piston or rotary piston covered by NSU-Wankel patents.
- No more than one fuel injector and one spark plug per cylinder are permitted.
- Variable valve timing is forbidden.
- Drive-by-wire throttle is forbidden.
- Any system modifying the geometry (length or section) of the intake orifices, of the intake system or of the exhaust system, is prohibited, with the exception of the throttle valve.
- Gasoline Direct Injection engines (GDI) or Port Fuel Injection engines (PFI).

This document presents in detail the inputs and outputs required for the ECU, the unit's processor core and the unit's interfaces to the other electronics units on the car (COMPETITOR data acquisition system, external modules). It also considers the mechanical, environmental, quality and manufacturing aspects for the unit.

It needs to be read in conjunction with the COORDINATOR 2010 ECU Outline Software Requirement Specification that covers in outline the control strategies the ECU needs to provide, the requirements for logging and diagnostic software within the ECU and the PC software requirements for the system. It is these that will define the amount of processing power and storage required within the unit.

A key facet of the ECU is its ability to provide high-level diagnostics making it straightforward to use and easy to diagnose faults with the cars systems.

This document focuses on the technical functionality needed and it is beyond its scope to cover detailed commercial, contractual, design, manufacturing, support and supply aspects.

However, a proposal should include annual maintenance and repair requirements and costs, software update support for the life of the tender in addition to initial development, individual COMPETITOR integration support and track support for all EVENTS.

The details of any components, such as sensors, dashboards, data logger to be proposed by the PROVIDER for use with the ECU should also be provided.

It is intended that each COMPETITOR will be permitted to build its own control loom to a standard COORDINATOR / PROVIDER connectivity specification. COMPETITOR Data logging wiring loom and ECU wiring loom will be physically separated. The only common links will be the 12 Volt supply and the CAN bus.

All parts of the system must be designed to ensure that the system will effectively prevent the use of driver aids, including but not limited to traction control, and also designed to match the following requests:

- There will be only one COORDINATOR-approved software version, which cannot be changed by the COMPETITOR.
- The COORDINATOR is in possession of a foolproof means to ensure that all software contained within the units is identical to that validated and approved for use.
- Each unit will have a unique serial number marked externally and will be sealed and have its identity tracked throughout its entire life cycle.
- Each unit must have suitable provision to allow it to be sealed to prevent tampering.
- A secure ability to restrict the data logging capability and configurability and to prevent data erasure during race weekends must be available.
- Three different identifications and consequently access levels have to be provided (COORDINATOR > CAR MANUFACTURER > COMPETITOR). The PC software supplied to the CAR MANUFACTURERS (or Independent Engineering Companies) and the COMPETITORS must recognise this and prevent unauthorised access. Engine set-up data (ECU parameters) should have definable Read/Write authorisations, set by the upper level.

2. MECHANICAL

2.1 Dimensions

To be defined by the PROVIDER. Maximised reliability by design has a higher priority than miniaturisation.

2.2 Weight

To be defined by the PROVIDER. Maximised reliability by design has a higher priority than weight reduction.

2.3 Case Material

Machined aluminium with anodised finish.

2.4 Connectors

Military spec or high quality plastic connectors are acceptable. Connectors, pins, crimping and assembly tools must be available on the market to any electrical harness manufacturer.

Mating connectors are not supplied with the ECU and are therefore not included in the price of the ECU.

2.5 Installation

2.5.1 Heat sink

The unit must be designed to ensure necessary cooling, mounted inside the cockpit at an ambient air temperature up to 60°C. If deemed necessary by the PROVIDER, a bespoke heat sink shall be fitted on the unit's enclosure.

2.5.2 Anti-Vibration Mounts

The ECU shall be supplied with anti-vibration mounts and it is required that these be used to mount the unit in the car.

3. ENVIRONMENTAL

3.1 Storage Temperature

-25 to 85 °C ambient temperature.

3.2 Operating Temperature

0 to 70 °C case temperature.

3.3 Operating Thermal Shock

1°C/second over operating temperature range.

3.4 Fluid Ingress Protection

To be rated to IP66. Impervious to all normal motor racing fluids.

3.5 Vibration

The unit must be able to run continuously without damage when vibrated using typical closed car motor-racing vibration profiles and duration.

3.6 Electromagnetic Compatibility

The ECU must comply with the requirements of electromagnetic compatibility directive 2004/108/EC that is applicable from 20th July 2007.

4. ELECTRICAL

4.1 Supply Voltage

Nominal operating voltage: 13.6 ±2.0 Volts.

Minimum start-up voltage threshold: 10.5 Volts.

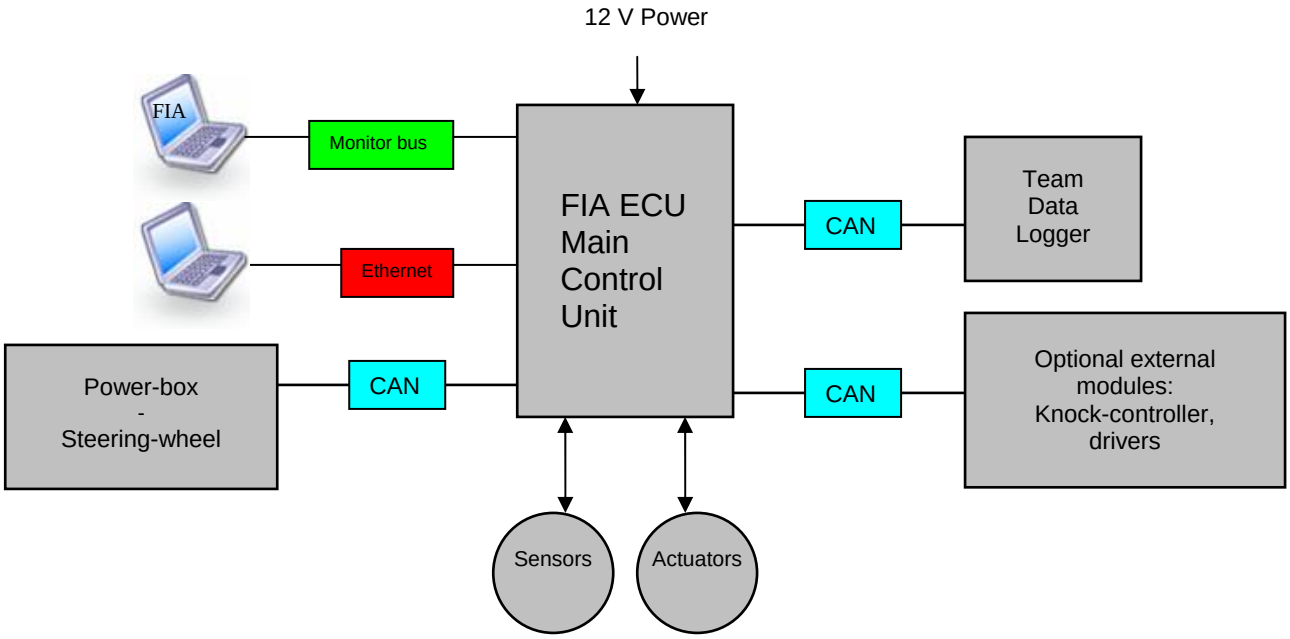
Continuous DC operating range: 9.0 - 18.0 Volts[1].

4.2 Supply Protection

Indefinite voltage reverse protection.

5. CONNECTIONS

5.1 General



1 Sensor excitation regulation, injector and ignition drive circuitry specification guaranteed only at nominal operating voltage.

Figure 1

5.2 Pinouts

To be specified by the PROVIDER.

6. SENSOR AND ACTUATOR INTERFACES

Only one base hardware build will be manufactured; all input selection options should preferably be configured via software. However, due to the large amount of necessary outputs, it will be accepted to split the hardware configuration in a minimum of versions, which can differ only on input and output drivers, the main processor core remaining identical. Each version will have to be explained and described in the tender submission.

Fairness requires that no unused inputs may be used for COMPETITOR supplementary sensors, or for data acquisition purposes. Only the sensors listed in the car's homologation form will be allowed.

6.1 Control System Input/Output Type Summary

- 3 off variable reluctance/hall effect crank & cam sensor inputs
- 18 off 0-5V single-ended analogue inputs.
- 6 off NTC or PT1000 temperature sensor inputs.
- 2 off UEGO/wideband LAMBDA sensor analogue inputs.
- 2 off K-type thermocouple inputs.
- 6 off digital switch line inputs.
- 2 off digital speed input (variable reluctance or Hall effect input types).
- 2 off digital turbo speed input.
- 4 off accelerometer knock sensor inputs, and up to 12 ionisation current sensing inputs.
- 4 off low or high side drive outputs.
- 2 off PWM outputs with current control.
- 6 off PWM drive outputs.
- 12 off inductive ignition drives.
- 12 off logic level ignition drives.
- 12 off injector drives (for solenoid PFI injectors, and GDI injectors).
- 2 off lambda sensor heater drives.

6.2 Input/Output allocations

Table 1 lists all external control sensor and actuator signals that interface to the COORDINATOR ECU.

Description	ECU Input/ Output	Type
Air temperature 1	Input	PT1000 analogue input or NTC input
Air temperature 2	Input	PT1000 analogue input or NTC input
Engine coolant pressure	Input	0-5V analogue input
Engine oil pressure	Input	0-5V analogue input
Engine oil temperature	Input	PT1000 analogue input or NTC input
Engine coolant temperature 1	Input	PT1000 analogue input or NTC input
Engine coolant temperature 2	Input	PT1000 analogue input or NTC input
Cam sensor	Input	Digital variable reluctance or hall effect, Cam input
Crank sensor 1	Input	Digital variable reluctance or Hall effect, Crank input
Crank sensor 2	Input	Digital variable reluctance or Hall effect, Crank input
Ignition drives	Output	Inductive Ignition Drive (12 off)
Ignition drives	Output	Logic level Drive (12 off)
Injector drives	Output	Peak Sustain and Hold Injector Drive (12 off)
UEGO Sensor 1	Input	UEGO analogue input
UEGO Sensor 2	Input	UEGO analogue input
UEGO Sensor Heater 1	Output	UEGO Heater
UEGO Sensor Heater 2	Output	UEGO Heater
Gearbox shift drum position	Input	0-5V analogue input
Atmospheric air pressure	Input	0-5V analogue input
Air pressure 1	Input	0-5V analogue input
Air pressure 2	Input	0-5V analogue input
Air pressure 3	Input	0-5V analogue input
Throttle Position 1	Input	0-5V analogue input
Throttle Position 2	Input	0-5V analogue input
Brake pressure	Input	0-5V analogue input
Fuel Map select position	Input	0-5V analogue input
Pit lane speed limiter	Input	Digital switch line
Engine Crankcase pressure	Input	0-5V analogue input
Lap Trigger	Input	Digital switch line
Start limiter	Input	Digital switch line
Fuel consumption reset	Input	Digital switch line
Engine kill switch	Input	Digital switch line
Wheel speed FL	Input	Digital variable reluctance or Hall effect speed input
Wheel speed FR	Input	Digital variable reluctance or Hall effect speed input
Fuel pressure pump 1	Output	PWM Drive with current control

Fuel pressure pump 2	Output	PWM Drive with current control
Boost pressure valve 1	Output	PWM Drive
Boost pressure valve 2	Output	PWM Drive
Boost pressure valve 3	Output	PWM Drive
Boost pressure valve 4	Output	PWM Drive
Fuel rail pressure valve 1	Output	PWM Drive
Fuel rail pressure valve 2	Output	PWM Drive
Gear-cut Load Cell	Input	0-5V analogue input
Fuel Pressure LP	Input	0-5V analogue input
Fuel Pressure HP1	Input	0-5V analogue input
Fuel Pressure HP2	Input	0-5V analogue input
Fuel Temperature	Input	PT1000 analogue input or NTC input
Exhaust Temperature 1	Input	Thermocouple
Exhaust Temperature 2	Input	Thermocouple
Power-steering Relay	Output	Low or high side Drive
Air conditioning Relay	Output	Low or high side Drive
Engine coolant fan Relay	Output	Low or high side Drive
Knock sensor accelerometer (4 off)	Input	Analogue input
Spare Analogue Input 1	Input	0-5V analogue input
Spare Analogue Input 2	Input	0-5V analogue input
Spare Switch Input	Input	Digital switch line
Spare Speed Input	Input	Digital variable reluctance or Hall effect speed input
Spare Digital output drive	Output	Low or high side Drive

Table 1 – Sensor and Actuator Signals

6.3 Input/Output Specific Characteristics

6.3.1 Analogue Inputs

6.3.1.1 Type 1: 0-5 Volt

- Minimum resolution: 10 bit
- Maximum sample rate: 1 kHz

6.3.1.2 Type 2: NTC or PT1000 Temperature Input

- Minimum resolution: 10 bit
- Maximum sample rate: 10 Hz

6.3.1.3 Type 3: Lambda

- Compatible with NTK or Bosch LSU 4.9

- Minimum resolution: 12 bit
- Maximum sample rate: 100 Hz

6.3.2 Digital Inputs

6.3.2.1 Type 1: Speed Input

- Variable reluctance or Hall effect type (can be of only one type, preferably Hall effect in that case)
- Maximum Input Frequency: 10 kHz

6.3.2.2 Type 2: Crank Sensor

- Variable reluctance or Hall effect type
- Maximum Input Frequency: 50 kHz
- Arm threshold : engine speed dependent
- The trigger disk configuration must be programmable to adapt the ECU to various standard production patterns.

6.3.2.3 Type 3: Cam Sensor

- Variable reluctance or Hall effect type
- Maximum Input Frequency: 10 kHz
- Arm threshold : programmable and/or engine speed dependent
- The trigger disk configuration must be programmable to adapt the ECU to various standard production patterns.

6.3.2.4 Type 4: Switch Line

- Maximum input frequency: 10 Hz
- Input voltage range: 0-5 Volts, TTL level switching
- Pull-up to 5V
- Maximum sample rate: 100 Hz

6.3.3 Digital Outputs

- Low or high side drive
- Maximum output frequency: 10 Hz
- Output maximum current: 2 A minimum.

6.3.4 Ignition Drives

- Inductive drive stage (20 A maximum peak current) or Logic level (10 mA).
- Diagnostics on open and short circuit condition detection, indication on a per drive basis.

- Will operate in wasted spark mode over full operating range if synchronisation lost.
- May include current ionisation measurement system.

Despite a preference for software configurable ignition outputs, it will be accepted to have two hardware configurations: ECUs with logic coil outputs and ECUs with inductive coil outputs.

6.3.5 Injector Drives

The ECU shall be capable of driving PFI injectors as well as GDI injectors. This can be done either via the same outputs (software selectable type), or via dedicated outputs, or possibly via an external driver box.

For common PFI injectors, the characteristics shall be, as a minimum, the following:

- Peak, Sustain and Hold with configurable peak and hold currents, sustain and hold times.
- Short and open-circuit fault detection on a per drive basis.
- Injector current monitor on a per drive basis.

The characteristics of the GDI injectors, electronically driven high pressure pumps and fuel pressure electro-valves used by a CAR MANUFACTURER (or an Independent Engineering Company) shall be supplied to the PROVIDER. In case of incapacity to deliver this information to the PROVIDER, the CAR MANUFACTURER (or the Independent Engineering Company) shall give the necessary access, at its own cost, to a fully operating and running engine with these standard components and original control system, to allow some electrical analysis and determine their driving principles. This analysis will be carried out by the PROVIDER.

6.3.6 UEGO Sensor Heater Drives

- Current drive type
- PWM low side drive
- Maximum peak current: 5 A

6.3.7 PWM Drive

- PWM low side drive
- 5 A continuous
- Maximum switching frequency: 10 kHz

6.3.8 Knock sensors inputs

The ECU shall provide 4 piezoelectric type knock sensor inputs, or include individual ionisation

current sensing system per cylinder (up to 12 inputs).

This can be realised by an external module which integrates all 12 sensing inputs, one CAN bus and the necessary computing power, memory… to send the results of the measurements to the ECU by CAN.

6.4 Internal Sensors

The ECU shall include the following internal sensors:

6.4.1 Temperatures

The ECU shall measure its core electronics temperature. This sensor shall be accurate to ±3°C over the range -20°C to 120°C.

6.4.2 Supply Voltage

The ECU shall measure the battery supply voltages to an accuracy of 0.05 V at a rate of up to 100 Hz.

6.5 Sensor Types

The PROVIDER shall supply a list of sensor types which are fully compatible with its ECU. Nevertheless for cost reduction reasons, COMPETITORS may be allowed to use another make or type of OEM sensors, which shall be compatible with the ECU. The PROVIDER shall analyse their characteristics and bench test them, to verify their technical compatibility with the PRODUCT.

Nevertheless, in case of malfunctioning, the PROVIDER may recommend the COMPETITOR to use a sensor from the above-mentioned approved list.

6.6 Internal Data Acquisition

The ECU will include internal data logging capability sufficient for development of all ECU functions, detailed signal diagnostics and COORDINATOR scrutineering data over a race distance. PC data viewing and analysis tools will be required with ability to export data to common standard formats for use by other PC tools commonly in use.

The data shall be divided into two different blocks: COMPETITOR data and COORDINATOR data, with restricted access for the latter.

COORDINATOR scrutineering data shall include the following parameters: engine speed, throttle position, gear position, airbox pressure, beacon, non-driven wheel speeds, brake pressure, optional external GPS data (connected by CAN bus), time and date of engine start and stop, engine set-up map change time and date.
The COORDINATOR reserves the right to add any other parameters to this list, in agreement with the PROVIDER

6.7 Internal Real Time Clock Hardware

The ECU shall include an internal timekeeping device which continues to accurately maintain time of day and date even when the unit is unpowered for 1 month minimum. Timekeeping must be accurate to 2 seconds a day worst case over the normal operating temperature and input voltage ranges.

7. COMMUNICATIONS INTERFACES

7.1 Pit System

A connection to the off-car server PC is provided by a 100BaseT link running a TCP/IP based protocol. This link is primarily used for the following purposes:

- Transfer of set-up and calibration parameters to the ECU.
- Offload of logged data.
- Operating diagnostic, calibration and configuration modes of the control systems.

Standard PC tools will be required as part of the supplied system to perform these functions.

7.2 Driver Controls and External modules

Two CAN 2.0B bus are provided for connection to external modules:

- one to a driver switch input system and/or to a power box and/or to COORDINATOR reserved sensors (such as GPS, accelerometers). The protocol is to be defined and published, but also programmable, in order that the COMPETITOR can set up its system to communicate with the ECU.
- one to optional modules such as knock controllers or injector driver box.

Only the following information can be received via CAN by the ECU:

- Speed limiter enable/disable request.
- Fuelling map selection.
- Fuel consumption reset.
- Start limiter.
- Engine kill switch.
- Data from the knock controller module and from external actuator modules.

No other data will be allowed to enter the ECU (except special COORDINATOR requirements) by external CAN modules.

7.3 COMPETITOR Data Acquisition System

One dedicated CAN 2.0B bus is provided. This allows the ECU to transfer channel information to the COMPETITOR's data acquisition system. The channels to be transferred, the rates, message IDs, format and calibrations are configurable from the PC software by the COMPETITOR. The software limits the configuration to ensure that the bandwidth of the bus will not be exceeded.

All channels are transferred in engineering quantities based on a defined set of units.

There is no transfer of data from the COMPETITOR system to the ECU.

7.4 Monitor Port

The ECU shall include a communication port, for low level monitoring and command operations including programming of application code, operating system, drivers and logic gate array devices,

as well as upload of the ECU firmware and boot code for COORDINATOR checks.

This port is not for access by the COMPETITOR and includes security measures to ensure that this is the case.

7.5 Communications Interface Summary

In summary, the ECU is to have the following Comms interfaces:

• 1 off 100 Base T Ethernet ports – for PC comms (data download, engine parameters set-up…).

• Minimum 3 off CAN 2.0B ports – to support Steering Wheel/Power box, COMPETITOR Data Acquisition and supplementary optional external modules.

• 1 off supplementary communication port for PC comms (ECU firmware uploads and downloads, COORDINATOR checks…).

8. MICROCONTROLLER

In order to provide sufficient space for further development :

- All microprocessors are not to be loaded at their maximum when running the software strategies defined as specified by the COORDINATOR, with CAN buses typically loaded and Ethernet and logging active. Control must be able to run whilst data upload is being performed.
- Main software code storage, map storage and workspace RAM are not to be fully used when running the software strategies as specified by the COORDINATOR.

All code images including control applications, operating system, drivers and logic gate array devices are programmable by external connection to the ECU with a means of verifying all of the code images programmed. This link has to be provided with security to prevent unwanted reprogramming.

9. MANUFACTURE, TESTING AND SERVICING

9.1 Service Interval

Minimum 12 months.

9.2 Design Life Period

5 racing seasons, subject to servicing at specified interval and use within operating limits.

9.3 Quality Systems

The ECU is designed, manufactured and tested by an organisation operating a quality management system that is accredited with ISO9001 or equivalent.

COORDINATOR ECU Outline Software Requirement

Specification

1. INTRODUCTION

This document gives an outline requirement specification for the software that needs to run in the ECU and in its associated pit and dyno system. This document is sufficiently detailed to allow the scope of the strategies to be assessed and their processing requirements reasonably assessed. It does not attempt to provide the full details of the strategies.

This document needs to be read in conjunction with the COORDINATOR 2008 ECU Hardware Requirement Specification that gives the requirements for the ECU hardware, including its I/O and its environmental and production requirements.

2. CONTROL FUNCTIONALITY

2.1 Summary

The ECU will provide real time control algorithms that interface via electrical input/outputs to control the engine of a COORDINATOR-GT engine. The algorithms are designed to provide the necessary control with the minimum of complexity.

When running the control algorithms described in this section, none of the ECU's processors must be loaded at its maximum, to provide scope for future development.

The algorithm of the control applications will be made available to the COMPETITORS. This ensures a detailed understanding of the exact functionality of the software and how it will act as part of the control systems.

Parameters allowing the user to calibrate and configure the strategies are provided. Three levels of 'Write' access will be configurable: COORDINATOR > CAR MANUFACTURER > COMPETITOR. Each one is configurable by the one above it. For instance, the COORDINATOR determines which parameters are modifiable by the CAR MANUFACTURER, and the latter determines which parameters are modifiable by the COMPETITOR.

Sensor input health checking routines are provided that can trigger fallback modes in the strategies in the case of fault detection.

Each control strategy algorithm is summarised in the following sections that outline the key functionality. This is intended as a top-level guide to the algorithms and not the in-depth explanation that can be afforded by detailed control specifications.

2.2 Control Strategies Not Allowed

The ECU must not include strategies that would provide the following specific functionality:

- Traction Control
- Launch Start
- Engine Braking control

2.3 Control Strategies not included initially

Any demand from a CAR MANUFACTURER (or Independent Engineering Company) for a control strategy not included in the ECU software will be discussed between that CAR MANUFACTURER, the PROVIDER and the COORDINATOR.

The final decision to implement this new strategy will be made by the COORDINATOR, in order to avoid non-fundamental controls being added.

The cost of bug fixing or fundamental control strategy add-on (which could appear with new GDI engines) shall be borne by the PROVIDER. Other software evolution costs shall be borne by the CAR MANUFACTURER (or the Independent Engineering Company) requiring the changes.

Any new software evolution will then be released and made available to all COMPETITORS at the same time.

2.4 Fuelling

- Engine speed and throttle position or manifold air pressure inputs mapped to produce base injector fuel mass. The breakpoints must be configurable.
- Independent basic fuel map for each injector.
- A number of fuel mass modifiers are applied to the base value to produce the final fuel mass as shown in Table 1.

Name	Description	Type
Engine cranking	Applied during engine cranking period (and for a configurable period after engine start) mapped from throttle position, engine speed and engine coolant temperature	Adder

Engine coolant temperature compensation	Mapped from engine coolant temperature	Multiplier
Transient throttle position compensation	Based on the gradient of throttle position and mapped from engine speed, engine coolant temperature and throttle position. Can be positive or negative	Adder
Ambient air temperature compensation	Mapped from ambient air temperature	Multiplier
Manifold absolute pressure compensation	Mapped from MAP	Multiplier
Atmospheric pressure compensation	Mapped from atmospheric pressure	Multiplier
Global trim	Global coefficient applied to base fuel mass	Multiplier
Closed loop lambda	Based on the Engine speed / Throttle position target lambda map, and following various PID parameters and limits	Multiplier
Minimum Engine Speed Controller	Value generated by the Minimum Engine Speed Controller	Multiplier
Fuel Cut-off	Mapped with engine speed and throttle position	Multiplier
Gear shift compensation	Applied during gear shift. Mapped from time and/or number of cycles	Multiplier
Dynamometer Tune	Value from dynamometer ‘Slew Box’	Multiplier

Table 1 – Fuel Mass Modifiers

- Set of different base fuel maps, selected by the driver fuel map selection potentiometer.
- Final fuel mass converted to an injector fuel time with compensation for injector supply voltage, fuel pressure and temperature.
- Fuel phase mapped from throttle position and engine speed. User defined ‘End’ or ‘Start’ of injection.
- Fuelling for individual injectors cut using cut pattern and other information from engine speed limit, gear-shift, and pit-lane controllers.
- No fuelling when engine kill is active.
- Fuel metering algorithm based on injection time updated every injection with user programmable multiplier.
- Necessary parameters specific to direct injection engine, such as multiple injections per cycle.

2.5 Ignition Control

- Common spark advance produced for all cylinders based on Engine speed and Throttle or MAP inputs.

• Independent basic spark angle correction map for each cylinder, function of Engine Speed and Throttle position.

• Engine coolant temperature, ambient air temperature and atmospheric pressure correction adders.

• Anti-knocking device correction adders.

• Gear dependent ‘adder’ applied to base map value during up shifts, with recovery gradient.

• Spark advance ‘adders’ applied from Engine Speed Controller when Engine Idling Speed control or Pit Lane Speed Limiter control is active.

• Dynamometer ‘Slew Box’ spark advance adder applied in dyno mode only.

• Dwell time mapped from supply voltage.

• Spark cut derived from engine speed limiter and gear-shift strategies.

2.6 Engine Rev Limiting

• ‘Soft’ rev limiting by use of ignition and/or fuel control, mapped from the difference between engine speed and the rev limit, the gear engaged and engine coolant temperature.

• For ‘hard’ limiter, applies full power cut if engine speed above limit.

2.7 Gear-shift

• Uses a combination of ignition and/or fuel cuts to allow gear shift at full engine load.

• Open loop controlled cut and torque re-instate, period durations mapped from gear position and throttle position.

• Triggered from switch input or load-cell input.

• Closed loop controlled cut operating on gearbox barrel position and engine speed.

2.8 Water and air conditioning pumps

• Pumps switch on based on basic defined thresholds.

2.9 Engine oil level check

• Used to limit the engine speed to a defined level for a required duration, and then kill the engine.

• Triggered by a switch input combination or a dedicated switch input (digital or via CAN bus).

2.10 Turbo charger controller

• Closed loop control of the Boost pressure (or boost pressure / atmospheric pressure ratio).

• Turbo boost pressure target mapped from Engine Speed and Throttle position inputs.

• PID controller parameters for the PWM outputs which drive the turbo control actuators (waste-gate, variable geometry turbo…).

• Only monitoring of the turbo charger speeds, but with safe mode strategies in case of over-speed or faulty sensor signals.

• A special hot turbo coast-down oil pressure control to prevent turbo charger damage.

2.11 Engine Speed Controller

• Uses a combination of ignition, fuel and turbo boost pressure demands to control engine speed.

• Takes engine speed demands and status from Idling Speed Control and Pit Lane Speed Limiter modules and arbitrates overall demand.

• Closed loop controller operating on engine speed target/actual difference generating ignition/fuel modifiers and boost pressure level demand outputs.

2.12 Pit Lane Speed Limiter

• Limits car speed to a configured maximum when active.

• Generates a target engine speed from target car speed and knowledge of power train step-down ratio.

• Demand fed to Engine Speed Controller.

• Activated by momentary driver switch press if current gear is within allowable range and not already active.

• Deactivated by momentary driver switch press if already active.

2.13 Idling Speed Control

• Idle speed function activated when engine speed and throttle position are below a threshold (and in neutral gear).

• Generates an engine speed demand that is fed to the Engine Speed Controller.

2.14 Fuel Pump Control

• Pump switched on for a priming period at system power up or removal of engine kill.

• For GDI engines, fuel pump actuators driven width PWM outputs in either open or closed loop modes, based on Engine Speed and/or Throttle position fuel pressure target maps.

• Pumps switched off when engine kill applied.

2.15 Engine Starting

• Cranking phase and synchronisation management user defined.

• Programmable cold start strategies to allow starting of the engine in any atmospheric conditions.

• Anti engine counter-starting strategy.

2.16 Closed Loop Fuelling

• Target lambda mapped from filtered engine speed and throttle position.

• Fuelling quantity adapted by providing a fuel multiplier mapped from target lambda.

• Closed loop controller used to achieve target lambda.

• Controller uses PI controller with proportional and integral gains.

• Operates only above a configurable throttle position or within a defined range of Engine speed / Throttle operation.

• Low pass filtering of UEGO sensor inputs.

• Strategy disabled if engine speed is outside of operating band, or during defined event (gear-shift, rev-limiter…).

• Independent control for each cylinder bank.

• Lambda sensor heater control.

2.17 Knock control

• The software shall supply the necessary parameters to set up the knock control strategies: windowing parameters per cylinder, programmable frequencies and filters, level of knock, spark advance correction tables…

• In case of use of an external module for ionisation current knock control, the ECU software must be designed to interface with it, to include all spark advance correction orders into the control of the engine.

2.18 Alarms / Safe modes

The ECU shall be able to monitor all control system related parameters and strategies, and flag warnings via the logged data (which can also be sent by CAN to the COMPETITOR Data logger).

Special safe mode strategies could also assert a low engine rev limit and/or stop the engine, switch from standard control mode to safe mode (for turbo charger speed for instance).

The sources monitored include: throttle position, oil pressure, engine synchronisation, water temperature, crankcase pressure, ECU temperature, turbo charger speed…

Each warnings, rev limits and engine stop configuration shall be set individually for each type of warning.

The following default mode strategies shall also be included in the ECU software:

• Oil pressure alarm threshold basically mapped from engine speed.

• Switch from Throttle position sensor input 1 to sensor input 2, in case of faulty signal.

• Use crankshaft position sensor only in case of lost synchronisation or lost camshaft position sensor.

2.19 Dyno Closed Loop Fuel Map Adaption

The purpose is to adapt the fuelling maps automatically to achieve the required air/fuel ratio based on one lambda measurement.

Strategy summary:

- Can operate only on the dynamometer.
- Uses lambda measurement from one internal UEGO input.
- Target lambda mapped from engine speed and throttle position.
- Proportional/Integral controller running on target/measured lambda values.
- Limits on fuel amount that can be contributed as a result of CLFMA.
- Automatically change the base fuel mass map.
- Processing and error checking of UEGO sensor inputs.

2.20 Sensor Fault Detection

In addition to any specific fault detection provided at the control level by the individual strategies, control sensor signals are tested, and faults flagged for the following conditions:

- Signal level outside of expected operating range, i.e. below minimum or above maximum level.
- Signal level intermittently outside of expected operating range.
- Excessive noise on signal.

Sensor fault checking is enabled only when the control system is deemed to be active.

3. DATA LOGGING

The ECU incorporates a data logger, part of which is configurable and accessible only by the COORDINATOR. The other part is accessible by the COMPETITORS and the COORDINATOR. A ‘flag system’ will indicate to the user which sessions or data sets have already been uploaded.

The capacity of the COORDINATOR reserved memory should be definable by the COORDINATOR.

The logger capabilities are shown below:

Capacity:	Minimum 128 Mbyte Logging Storage, minimum 250 channels
Data throughput:	Minimum 32 Kbyte per second
Sampling rate:	Up to 1000 Hz
Modes:	- Continuous periodic logging - Configurable as ‘keep newest’ in case of overflow.
Triggering:	Triggered by channel generated by on-board control software
Other features:	Non volatile storage of logged data Multiple logging table rates held on-board, selected by the track session type minimising configuration changes.

4. CONFIGURATION AND MONITORING

4.1 PC Configuration Software

4.1.1 Operating System Requirements

- Microsoft Windows XP and Windows Vista.

4.1.2 Features

- Editing, viewing, comparison and archiving of parameter datasets for the ECU control applications.
- Separate parameter dataset per control algorithm.
- Calibration of sensors and fuel injectors.
- Selections of channels and their transfer rate from the ECU control applications to the COMPETITOR system via the dedicated CAN 2.0b communication links.
- Set-up of data logging parameters for both “COORDINATOR scrutineering” memory (restricted access) and COMPETITOR memory. The PC configuration software will calculate and display the duration of logging before saturation of the logger memory.
- Low rate display viewing of channel values via cable link from ECU.
- Communications interface to dynamometer ‘Slew Box’.

4.2 COORDINATOR Commands

The ECU supports commands, entered via the configuration and monitoring software, for the following functions that can be issued only by COORDINATOR personnel:

- Confirm box identity (ECU serial number and software version).
- Reset COORDINATOR data.

4.3 COMPETITOR Commands

The ECU supports commands entered via the configuration and monitoring software, for the following functions:

- Reset fault detection monitoring.
- Clear/set fuel metering.
- Control engine throttle sensor relationship learning procedure.
- Control gearbox shift drum calibration learning function (for closed loop controlled gear-shift).
- Manual control switching of outputs for test and diagnostic purposes including high or low side drives, injectors and coils.

5. TEST RIG AND DYNAMOMETER SUPPORT

The ECU will provide a connection to an external ‘slew box’. The latter shall not be included in the ECU supply package, but rather as an option. This ‘slew box’ allows rapid calibration of fundamental engine parameters controlled by the ECU, by giving access to live channel values, instigation of control commands and dynamic tuning of parameters.

These features will be supported on dyno sessions only.