ECU

ENGINE CONTROL UNIT (ECU)

Digital TECHNOLOGY (pty) ltd

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PLEASE NOTE THE FOLLOWING INFORMATION IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

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1. APPLICATION

This ENGINE CONTROLLER UNIT (ECU) was developed after the Micro Injection Control (MIC) because the market required an engine management device, which was easy, cost effective and reliable. The MIC was packed over the years with every feature someone demanded, and it has now reached a level of sophistication exceeding the average installation.

The ECU is therefore well suited for the cost conscious engine modifier, and for first time installation. This includes racing and performance engines. The unit is ideally suited for carburetor replacement, where some convenient features are not required.

The unit works with 4,6 or 8 cylinder engines. Multiple coils are not supported. The injectors are limited to 16 ohm. Injectors with 4-8 ohms can be supported with extra cooling of the unit. Multiple trigger inputs per firing are not supported.

Other Engine Management products:

- MIC Micro Injection Control
- PEC Professional Engine Control

For details and comparison on the above systems consult the Internet.

2. SPECIFICATIONS

Supply	:	6-15V 50ma
	:	Wrong polarity protected! SHORTS!
	:	Overvoltage protected
Size	:	125 x 75 x 25
Trigger input	:	Min 0.4V peak
	:	Limited, protected
	:	Max. input: 24V DC continuous
Throttle input	:	0-5V
	:	Offset and gain calibrated
	:	Requires external voltage
Engine temperature input	:	Optional, for display only
Absolute manifold pressure	:	Internal
	:	0.2 to 2.5 bar
	:	4mm connection

Injector output	:	2 drives
	:	current limited to 4 A initially
	:	reduced to holding current of 1 A
	:	voltage protected
Fuel pump relay output	:	100ma drive
LED indication output	:	5mA drive to ground
Ignition output drive	:	12V output swing
	:	Ground signal -> coil current
	:	Positive edge -> ignition
	:	Max drive 30ma
RS232 connection	:	GND, TX, RX
	:	19200 Baud, 8 bits
Temperature range	:	-10 to +60 degree C operating

3. PARAMETER MAP

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	35	2.51	2.50	-12	130	0
Eng.Temp.:	°C	93	22	6400	30	31	2.26	2.27	-12	120	0
RPM:		87	21	5500	30	29	2.10	2.09	-12	110	0
Fuel:		81	18	4750	30	27	1.95	1.95	-12	100	0
Ignition:		75	15	4100	30	25	1.79	1.80	-12	90	0
		69	12	3530	30	23	1.63	1.63	-9	80	0
Cylinders:	4	63	12	3050	30	23	1.48	1.48	-6	70	0
Rpm (F=0):	1495	57	12	2600	30	23	1.32	1.31	-4	60	0
AccDetect:	2	51	12	2260	29	20	1.16	1.16	-2	50	1
Acc Fuel:	220	45	12	1950	28	19	1.01	1.02	-1	40	2
Inj. Open:	1.0 ms	39	12	1680	27	19	0.85	0.84	0	30	3
Inp. Pol.:	0	33	12	1450	26	18	0.69	0.69	0	20	4
Rpm Limit:	6000	27	11	1250	25	18	0.54	0.55	2	10	5
Start Inj:	100	21	10	1075	24	17	0.38	0.38	4	0	6
	255	15	5	930	24	16	0.23	0.23	6	-10	7
	255	9	0	800	24	15	0.17	0.22	8	-20	8

Command: **File: dds.ec**

4. INTERFACE SIGNALS

This section explains the details of the interface signals.

4.1 THROTTLE CONNECTION

The throttle input is passive. That is to say it does NOT feed the throttle position sensor. The feeding must be done externally. Set the throttle (switch) up normally. Measure the resistance of the output wire and confirm that very small throttle movements at idle change the resistance. If not re-align the position sensor. Then open thew throttle wide and measure the resistance.

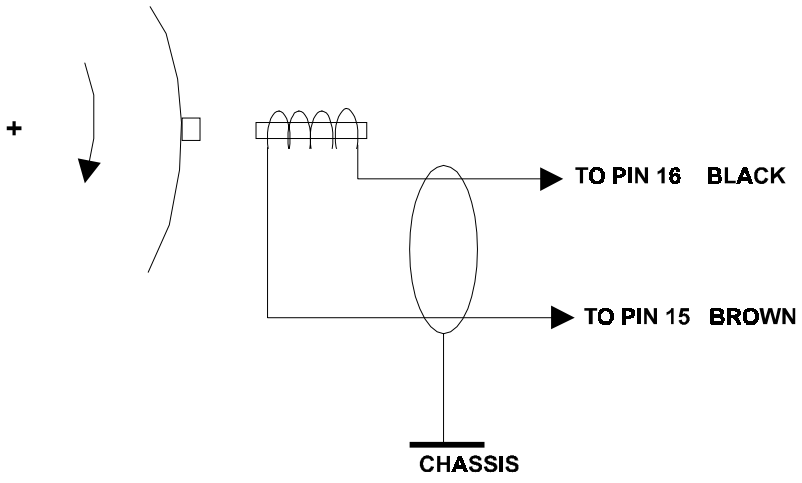
Then BUY a resistor, which is 1.7 to 2.0 times higher than the full throttle reading, and connect the resistor to +12V battery, as shown in the wiring diagram.

4.2 TRIGGER INPUT

The trigger input is self-aligning to any input source. The input is passive which means that the trigger device must supply the voltage. The ECU works with magnetic pickups (single tooth per firing), points (not recommended), hall trigger devices, and optical trigger devices.

Magnetic trigger: It has two wires (plus a screen?), supplies a small voltage and connects directly to the ECU.

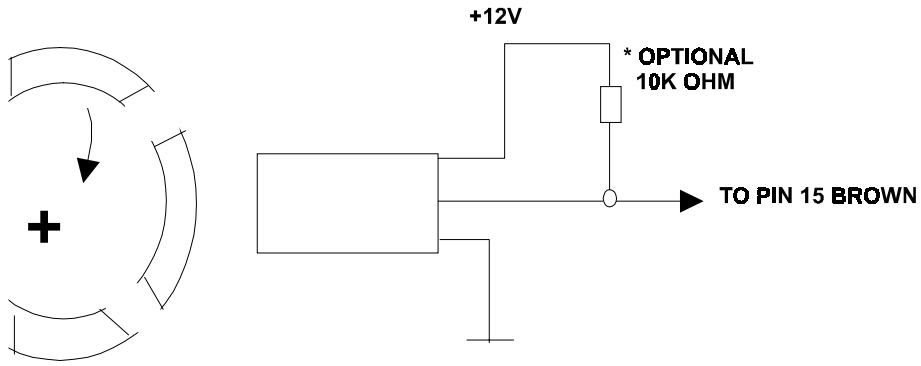
MAGNETIC TRIGGER



Hall/optical trigger:

It has 3 wires and requires +12v supply
The output is a 12V on/off signal, or a OPEN/CLOSED signal.
As shown, a optional 10K resistor may be required to produce a output voltage, in case the unit is OPEN/CLOSE type.

HALL/OPTICAL TRIGGER



4.3 IGNITION OUTPUT

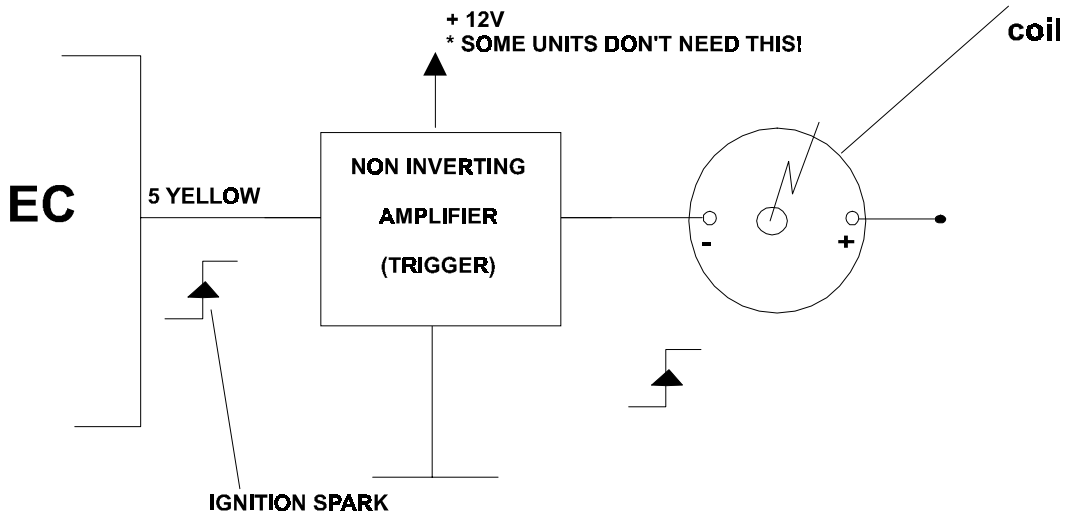
The ignition output is a low-level drive, it CAN'T drive the coil directly. A ignition amplifier must be used. Two types of amplifiers are available:

INVERTING	(most common)	fires on negative input edge
NON-INVERTING	(natural)	Fires on positive input edge

The ECU can only work with NON-INVERTING AMPLIFIERS (or TRIGGERS)! A non-inverting amplifier is available from Perfect Power, but any other can be used.

The output polarity can be changed in units with a software version higher than 6. See 6.9 Input Polarity.

IGNITION

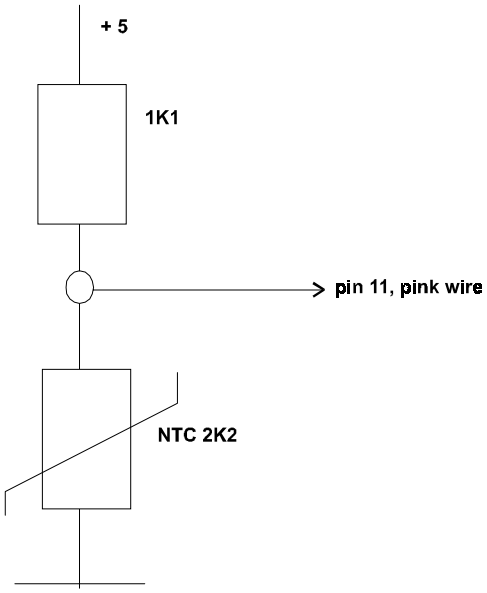


4.4 INJECTOR DRIVE

The injector drive is the Switched type, which works for all kind of injectors. The injector impedance (resistance) is recommended at 16 OHM. If lower resistance injectors are used, and depending on the operating environment, the ECU must be cooled, or mounted on a sufficient large heatsink. The initial injector current is limited to 4 Amps approx., the holding current to 1 Amp. On drive can drive 2 x 16 ohm injectors comfortable. However 4 x 16 Ohm require extra cooling.

4.5 ENGINE TEMPERATURE INPUT

This input is required for engine temperature compensation. It assumes a circuit with the following components (external).



The above circuit is not realistic. The input of the ECU (pin 11) can be connected to an existing temperature input with the following voltages:

25 degree C	3.33V
90 degree C	1.014V

If the voltages are not exactly right, then the ECU temperature display is wrong. This can be ignored, and the engine temperature compensation can be adjusted accordingly.

4.6 ALARM LED OUTPUT

This LED output shows any of the following faults:

Fuel fault	Overflow
Ignition fault	Overflow, underflow, other
RPM fault	RPM has stopped
Throttle fault	The throttle has a bad input

The connection is shown in the wiring diagram. The faults are shown as well on the PC display.

4.7 INJECTOR LED OUTPUT

This output is on as long as injector #1 or injector #2 outputs are active. The LED indication indicates fuel consumption, but looses its meaning once the injector "ON" times overlap. The display is erratic at this point.

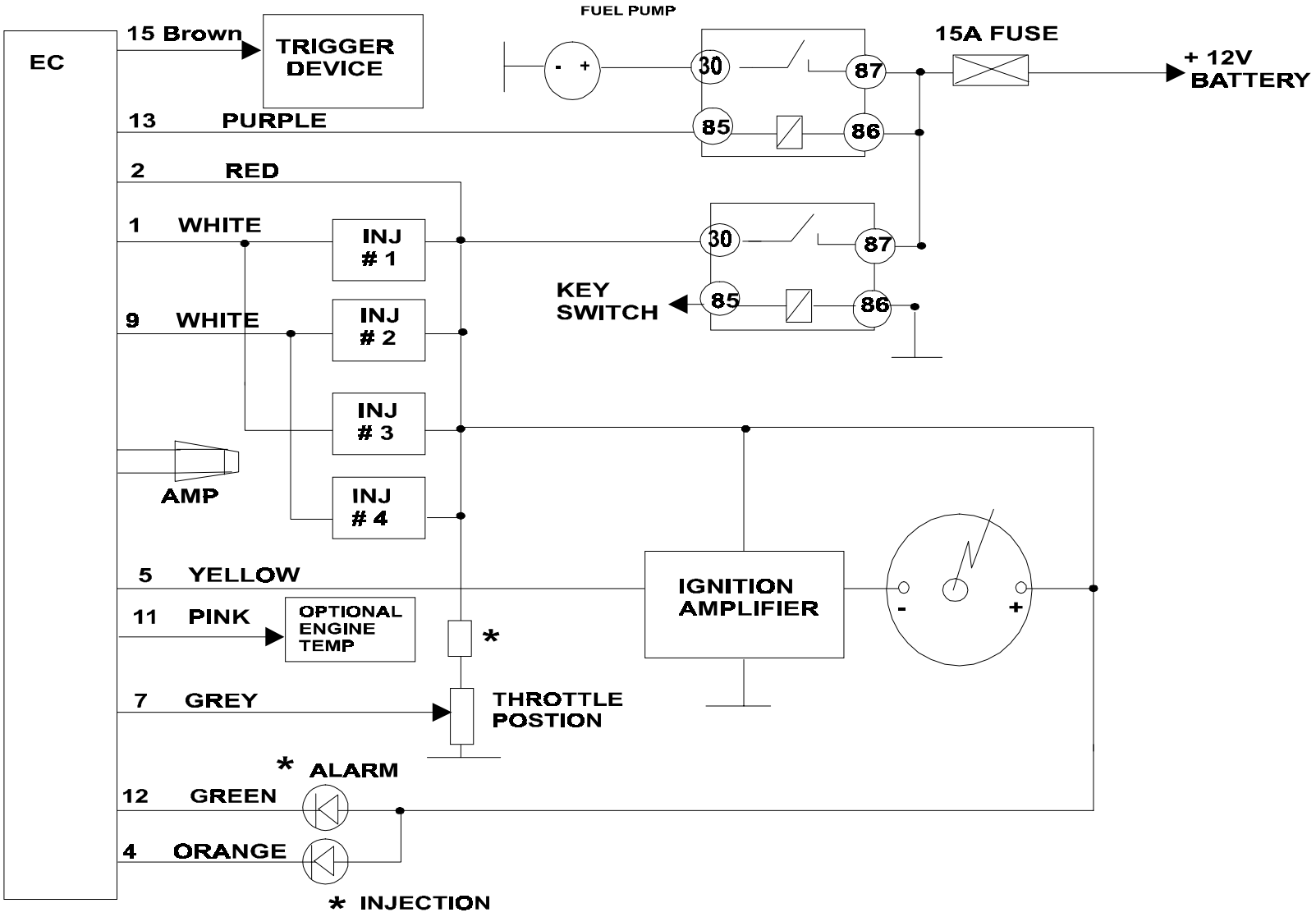
This led shows also that a input trigger has been received.

5. WIRING

The ECU comes with the minimum connections wired up, and some spare pins for your own wiring.

CONNECTOR	Signal	Colour	Size
1	Injector #1	White	0.7
2	+12V supply	Red	0.7
3	Gnd	Black	0.7
4	Led #2 (Fuel)	Orange	0.3
5	Ignition output	Yellow	0.3
6	RS232 TX out	Blue	0.3
7	Throttle input	Grey	0.7
8	Gnd	Black	0.7
9	Injector #2	White	0.7
10	+12V supply	Red	0.7
11	Engine Temp.	Pink	0.7
12	Led #1 (Alarm)	Green	0.3
13	Fuel pump out	Purple	0.7
14	RS232 RX in	Red	0.3
15	Trigger input	Brown	0.7
16	GND	Black	0.7

ECU WIRING DIAGRAM



6. DETAILS

This section goes in to the details of each parameter and map point'

6.1 FTHR:FUEL THROTTLE MAP

The Fthr map has 16 points between idle and full throttle. The throttle position is indicated by a moving cursor, which moves on a scale frpm 0 to 100%. This is the scale applied AFTER calibration, and refers to throttle opening. The throttle INPUT percentage is displayed in the top left corner, and shows how much of the input range is used. If the throttle position sensor (switch) doesn't allow full throttle indication, then the unused positions should be filled with the full throttle fuel (numbers).

Normal tuning demands that you increase the fuel from idle, then remain constant until cruising, and increase it towards full throttle.

This is shown in the following map:

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	35	2.51	2.50	-12	130	0
Eng.Temp.:	ºC	93	22	6400	30	31	2.26	2.27	-12	120	0
RPM:		87	21	5500	30	29	2.10	2.09	-12	110	0
Fuel:		81	18	4750	30	27	1.95	1.95	-12	100	0
Ignition:		75	15	4100	30	25	1.79	1.80	-12	90	0
		69	12	3530	30	23	1.63	1.63	-9	80	0
Cylinders:	4	63	12	3050	30	23	1.48	1.48	-6	70	0
Rpm (F=0):	1495	57	12	2600	30	23	1.32	1.31	-4	60	0
AccDetect:	2	51	12	2260	29	20	1.16	1.16	-2	50	1
Acc Fuel:	220	45	12	1950	28	19	1.01	1.02	-1	40	2
Inj. Open:	1.0 ms	39	12	1680	27	19	0.85	0.84	0	30	3
Inp. Pol.:	0	33	12	1450	26	18	0.69	0.69	0	20	4
Rpm Limit:	6000	27	11	1250	25	18	0.54	0.55	2	10	5
Start Inj:	100	21	10	1075	24	17	0.38	0.38	4	0	6
	255	15	5	930	24	16	0.23	0.23	6	-10	7
	255	9	0	800	24	15	0.17	0.22	8	-20	8

Command: **File: dds.ec**

Entries in this map range from 0 to 255 (positive only)

6.2 FRPM: FUEL RPM MAP

This map emulates the rpm advance of a normal distributor. The entries must be positive. The values in this map are ADDED to the FTHR map to form the basis fuel (non-compensated for manifold pressure). On a normal aspirated racing engine they form the fuel injected in to the engine.

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

		Fthr		**Frpm**	Irpm		Famp	Iamp		FengT
Throttle:	% Thrt		RPM			AMP			C	
AMP:	B 99	23	7400	**30**	35	2.51	2.50	-12	130	0
Eng.Temp.:	°C 93	22	6400	**30**	31	2.26	2.27	-12	120	0
RPM:	87	21	5500	**30**	29	2.10	2.09	-12	110	0
Fuel:	81	18	4750	**30**	27	1.95	1.95	-12	100	0
Ignition:	75	15	4100	**30**	25	1.79	1.80	-12	90	0
	69	12	3530	**30**	23	1.63	1.63	-9	80	0
Cylinders: 4	63	12	3050	**30**	23	1.48	1.48	-6	70	0
Rpm (F=0): 1495	57	12	2600	**30**	23	1.32	1.31	-4	60	0
AccDetect: 2	51	12	2260	**29**	20	1.16	1.16	-2	50	1
Acc Fuel: 220	45	12	1950	**28**	19	1.01	1.02	-1	40	2
Inj. Open: 1.0 ms	39	12	1680	**27**	19	0.85	0.84	0	30	3
Inp. Pol.: 0	33	12	1450	**26**	18	0.69	0.69	0	20	4
Rpm Limit: 6000	27	11	1250	**25**	18	0.54	0.55	2	10	5
Start Inj: 100	21	10	1075	**24**	17	0.38	0.38	4	0	6
255	15	5	930	**24**	16	0.23	0.23	6	-10	7
255	9	0	800	**24**	15	0.17	0.22	8	-20	8

Command: File: dds.ec

6.3 IRPM: IGNITION RPM MAP

This map shows the ignition angle with rpm. The ECU uses a internal ignition base line of 40 degrees, from which it DELAYS all ignitions. That means that you can not advance beyond 40 degrees. Entries are restricted to 0-40.

The 40-degree baseline must be obtained by shifting the BASEPLATE in the distributor (NOT THE DISTRIBUTOR !). The distributor can be used to fine tune (+-5 degrees) the exact position. Once this is done, the PC display must be the same as the timing light shows.

If the map is not used, then the entries should be 40 degrees. This can be done with the NI (No Ignition) command from the PC. A typical map may look like:

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	**35**	2.51	2.50	-12	130	0
Eng.Temp.:	ºC	93	22	6400	30	**31**	2.26	2.27	-12	120	0
RPM:		87	21	5500	30	**29**	2.10	2.09	-12	110	0
Fuel:		81	18	4750	30	**27**	1.95	1.95	-12	100	0
Ignition:		75	15	4100	30	**25**	1.79	1.80	-12	90	0
		69	12	3530	30	**23**	1.63	1.63	-9	80	0
Cylinders:	4	63	12	3050	30	**23**	1.48	1.48	-6	70	0
Rpm (F=0):	1495	57	12	2600	30	**23**	1.32	1.31	-4	60	0
AccDetect:	2	51	12	2260	29	**20**	1.16	1.16	-2	50	1
Acc Fuel:	220	45	12	1950	28	**19**	1.01	1.02	-1	40	2
Inj. Open:	1.0 ms	39	12	*1680*	27	**19**	0.85	0.84	0	30	3
Inp. Pol.:	0	33	12	1450	26	**18**	0.69	0.69	0	20	4
Rpm Limit:	6000	27	11	1250	25	**18**	0.54	0.55	2	10	5
Start Inj:	100	21	10	1075	24	**17**	0.38	0.38	4	0	6
	255	15	5	930	24	**16**	0.23	0.23	6	-10	7
	255	9	0	800	24	**15**	0.17	0.22	8	-20	8

Command: File: dds.ec

6.4 FAMP: FUEL AMP MAP

The FAMP map relates to the ABSOLUTE manifold pressure. The pressure scale is printed on the side of the map, and a cursor indicates the position used. Entries are in the range from 0.1 to 3.9.

The fuel obtained by adding FTHR + FRPM is multiplied by the FAMP map to give the correct injector opening. If the map is not used, then all entries should be 1.00.

FUEL = (FTHR + FRPM) x FAMP

Normal entries for a normal cam follow the pressure. The entries above 1 bar are only used in supercharged to turbocharged engines.

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	35	2.51	**2.50**	-12	130	0
Eng.Temp.:	ºC	93	22	6400	30	31	2.26	**2.27**	-12	120	0
RPM:		87	21	5500	30	29	2.10	**2.09**	-12	110	0
Fuel:		81	18	4750	30	27	1.95	**1.95**	-12	100	0
Ignition:		75	15	4100	30	25	1.79	**1.80**	-12	90	0
		69	12	3530	30	23	1.63	**1.63**	-9	80	0
Cylinders:	4	63	12	3050	30	23	1.48	**1.48**	-6	70	0
Rpm (F=0):	1495	57	12	2600	30	23	1.32	**1.31**	-4	60	0
AccDetect:	2	51	12	2260	29	20	1.16	**1.16**	-2	50	1
Acc Fuel:	220	45	12	1950	28	19	1.01	**1.02**	-1	40	2
Inj. Open:	1.0 ms	39	12	1680	27	19	0.85	**0.84**	0	30	3
Inp. Pol.:	0	33	12	1450	26	18	0.69	**0.69**	0	20	4
Rpm Limit:	6000	27	11	1250	25	18	0.54	**0.55**	2	10	5
Start Inj:	100	21	10	1075	24	17	0.38	**0.38**	4	0	6
	255	15	5	930	24	16	0.23	**0.23**	6	-10	7
	255	9	0	800	24	15	0.17	**0.22**	8	-20	8

Command: File: dds.ec

6.5 FENGT: FUEL ENGINE TEMPERTAURE COMPENSATION MAP

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	35	2.51	2.50	-12	130	**0**
Eng.Temp.:	ºC	93	22	6400	30	31	2.26	2.27	-12	120	**0**
RPM:		87	21	5500	30	29	2.10	2.09	-12	110	**0**
Fuel:		81	18	4750	30	27	1.95	1.95	-12	100	**0**
Ignition:		75	15	4100	30	25	1.79	1.80	-12	90	**0**
		69	12	3530	30	23	1.63	1.63	-9	80	**0**
Cylinders:	4	63	12	3050	30	23	1.48	1.48	-6	70	**0**
Rpm (F=0):	1495	57	12	2600	30	23	1.32	1.31	-4	60	**0**
AccDetect:	2	51	12	2260	29	20	1.16	1.16	-2	50	**1**
Acc Fuel:	220	45	12	1950	28	19	1.01	1.02	-1	40	**2**
Inj. Open:	1.0 ms	39	12	1680	27	19	0.85	0.84	0	30	**3**
Inp. Pol.:	0	33	12	1450	26	18	0.69	0.69	0	20	**4**
Rpm Limit:	6000	27	11	1250	25	18	0.54	0.55	2	10	**5**
Start Inj:	100	21	10	1075	24	17	0.38	0.38	4	0	**6**
	255	15	5	930	24	16	0.23	0.23	6	-10	**7**
	255	9	0	800	24	15	0.17	0.22	8	-20	**8**

Command: File: dds.ec

The engine temperature is measured in the range from 0-5Volts from an external sensor. See 4.5.

The indicated fuel is added to the total map output. If the indicated temperature is different from the actual temperature, then the ECU still adjusts the fuel by the amount indicated by the highlight. At full operating temperature the fuel addition should be zero, and at very low temperatures the addition should be so high as to achieve good idle and low throttle response. Only positive numbers can be entered.

6.6 IAMP: IGNITION AMP MAP

This map shows the ignition variations with changing manifold pressure. With hot cams the manifold pressure is un-important, and the map can be made zero. Entries are in the range of +-40 degrees.

The total ignition angle is calculated as:

IGNITION = IRPM +-ITHR +- IAMP

Retarding is achieved with negative numbers.

ECU: ENGINE CONTROLLER UNIT Perfect Power Association

			Fthr		Frpm	Irpm		Famp	Iamp		FengT
Throttle:	%	Thrt		RPM			AMP			C	
AMP:	B	99	23	7400	30	35	2.51	2.50	-12	130	0
Eng.Temp.:	ºC	93	22	6400	30	31	2.26	2.27	-12	120	0
RPM:		87	21	5500	30	29	2.10	2.09	-12	110	0
Fuel:		81	18	4750	30	27	1.95	1.95	-12	100	0
Ignition:		75	15	4100	30	25	1.79	1.80	-12	90	0
		69	12	3530	30	23	1.63	1.63	-9	80	0
Cylinders:	4	63	12	3050	30	23	1.48	1.48	-6	70	0
Rpm (F=0):	1495	57	12	2600	30	23	1.32	1.31	-4	60	0
AccDetect:	2	51	12	2260	29	20	1.16	1.16	-2	50	1
Acc Fuel:	220	45	12	1950	28	19	1.01	1.02	-1	40	2
Inj. Open:	1.0 ms	39	12	1680	27	19	0.85	0.84	0	30	3
Inp. Pol.:	0	33	12	1450	26	18	0.69	0.69	0	20	4
Rpm Limit:	6000	27	11	1250	25	18	0.54	0.55	2	10	5
Start Inj:	100	21	10	1075	24	17	0.38	0.38	4	0	6
	255	15	5	930	24	16	0.23	0.23	6	-10	7
	255	9	0	800	24	15	0.17	0.22	8	-20	8

Command: File: dds.ec

6.7 ACCELERATION ENRICHMENT

The acceleration enrichment is controlled by two parameters:

AccDet:	Acceleration detection
AccFuel:	Acceleration fuel

The detection point is a number from 1 to 50, where 1 is most sensitive. A practical entry is 5. It is the DV/DT of the throttle movement for every 6.5 ms. Once a throttle movement exceeds this parameter, fuel is injected at the length specified with the acceleration fuel parameter. Typical entry is 20. Fuel entries above 65 are not effective.

6.8 INJECTOR OPEN TIME

This parameter has a range of 0.3 to 3.0 milliseconds. It is the time required by the injector to open fully. It can be measured with an oscilloscope or it ca be obtained from the injector manufacturer. A typical entry for a 18 ohm injector is 1.3 MS, where a 4 Ohm injector uses 0.6ms. During this time the injector current is limited to 4 Amps.

6.9 INPUT POLARITY

This parameter refers to the input trigger edge. A "1" means a positive edge, a "0" a negative. This parameter is not important with magnetic trigger devices, but with hall and optical pickups. The correct edge can be worked out by connecting a voltmeter to the pickup output and turning the engine to 40 degrees before TDC. At this point the meter should flick up (positive edge =1) or down (negative edge=0).

6.10 RPM LIMIT

At the specified point the fuel is switched off. Range is from 1000 to 9500 RPM. The software versions later than 6, the same parameter can be used to change the output polarity. The default output polarity is positive. This requires a non-inverting amplifier. To change the output polarity, add 2 to the input polarity as follows:

Input polarity	Input triggers	Output fires
0	negative	positive
1	positive	positive
2	negative	negative
3	positive	negative

Note that the “negative” output requires a “INVERTING” amplifier.

6.11 THROTTLE CALIBRATION

The throttle input is a passive device, and the ECU must be supplied with a voltage in the range from 0-5V. It can be less, but not more than 5Volts at full throttle. If more, than the "pull-up" resistor is too small, or a suitable resistor divider must be used.

The ZERO point in the map indication can be set with the CZ command. Put the throttle to idle, press CZ. Then put the throttle wide open and press CG, which sets the full-scale point.

This calibrates the throttle range. However, the throttle indication in the top left corner shows always the throttle INPUT range in percent.

Confirm proper throttle operation by moving the throttle from idle to wide open and observing that the positions highlight goes through all points linearly.

6.12 TUNING A COLUMN

Tuning of any map can by achieved by putting the cursor in to the map with the "right arrow" or "left arrow" keys, and then pressing:

TC fact

The factor entered can be 0.1 to 3.9. A factor of 1.1 changes all map points up by 10%. A factor of 0.91 deducts 10% from all map points.

6.13 DISABLING IGNITION

The ignition is not disabled, but the ECU uses no delay. That is to say that the ignition output is at the same time as the trigger input (polarity!). Since the ECU assumes a baseline of 40 degrees, the following numbers must be entered:

ITHR	all zeros
IRPM	all 40 degrees
IAMP	all zero

This can be done with the NI (No Ignition) command: NI

6.14 FAULT INDICATIONS

The ECU displays 4 faults on the PC screen, and light the fault LED if any of the faults happen.

IGNITION FAULT	IGN
FUEL FAULT	FUEL
RPM FAULT	RPM
THROTTLE FAULT	THR

If any of the above are indicated during tuning or driving, then the cause must be investigated, and eventually rectified.

6.15 COMMAND SUMMARY

This section lists all commands available from the PC (laptop) keyboard.

LF Name	-	Load File (tune map)
SF Name	-	Save tune map to file
UP “	-	Upload tune map from ECU to screen
UL	-	Same as upload
RS	-	Reset
DL	-	Download screen map to ECU
PG	-	Program ECU, same as ECU
XX	-	Reset
TC	-	Tune column pointed at
CZ	-	Set throttle zero point
CC	-	Set throttle zero point
CG	-	Set throttle gain
CO	-	Set throttle gain (open)
NI	-	No ignition