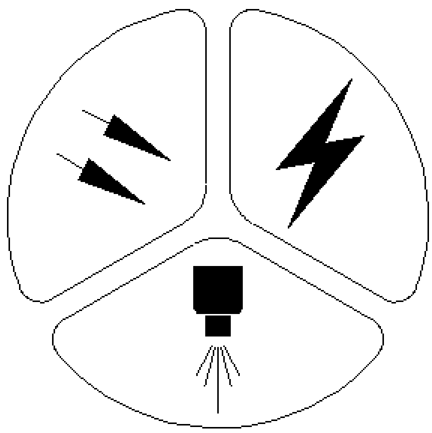
Lumenition®

COMPETITION ENGINE
MANAGEMENT SYSTEM

K400 ECU User Manual



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Document No. 90269 Rev Level 1.0 12/04/00

INTRODUCTION

The Lumenition K400 is a plug replacement engine control unit (ECU) for the 1.8 litre Rover K series engine as fitted to the Lotus Elise, Rover MGF and Rover 200i. The system functions with all the existing sensors since not all the pins on the 36-way connector are used additional features could be included. As a fully programmable unit the tuner has control over all functions of the ecu with respect to the operation of the engine and its associated systems. This gives the engine builder/tuner total freedom for modification of the power unit knowing that the ecu can be calibrated to maximise the power output, efficiency and tractability of the engine whilst retaining or eliminating many of the functions of the original ecu.

Although designed to connect to the original vehicle harness for ease of fitment to a vehicle. Lumenition can supply parts allow tuners to tailor an installation to vehicles which have donor engines fitted and the original harness is not suitable, e.g. Kit cars or Race vehicles.

All of the programmable functions of the ecu are adjusted using the Lumenition Win95 Calibration software CAL600. Also required is the communication cable Lumenition part number WH170.

If you have an alternative requirement for your K series application such as distributorless operation contact Lumenition for the latest hardware details.

CONTENTS

- K400 Lumenition K series ecu
- Anti Vibration Mounting Kit
- Lumenition Motorsport Stickers
- This Manual

INSTALLATION

The K400 ecu whilst weatherproof is not completely waterproof so should be installed in a position which is protected from water immersion. On target vehicle applications it can be fixed into the position of the original ecu. Alternatively a set of M4 anti-vibration mounting buffers is supplied to mount the K400 to a panel. Mounting hole spacing is given on the physical specification page. The buffers are assembled as shown.

CONNECTION

The original harness will connect onto the 36-way connector and secure with the integrated locking clip. Ensure that the connector is pushed fully home and secure. Note: The K400 unit currently does not support the ECU air conditioning function directly, if your vehicle is fitted with the OE aircon then a small change to the wiring harness is necessary. See Appendix, Air Conditioning Wiring.

The original manifold pressure pipe is fitted to the pressure inlet on the K400. The pipe is a push fit and should remain in place without additional clamping.

The communication connection is via the small round three-pin connector below the pressure inlet pipe. There is a keyway in the connector housing to indicate the correct orientation.

INITIAL TEST and SETUP

Lumenition despatches the K400 ecu with a standard test calibration. Before attempting to run the engine the tuner will need to either a) download a known calibration for the target engine or b) check the stored calibration and adjust to match the required settings. If you have received the K400 from one of our appointed agents it may already have a suitable calibration for your application. Check with your supplier for more information.

Upon initial ignition on the K400 ecu will operate the idle bypass valve to determine its calibration position. Allow a couple of seconds for this operation to complete before engaging the starter motor.

Once the engine is running further fine tuning and calibration can be carried out.

DIAGNOSTIC CODES

The optional Upshift Lamp output can be used as a diagnostic indicator

When the engine is running the indicator will react according to the settings for Upshift Rpm.

When the engine is not running and the K400 detects an error the light will flash a code to indicate the fault. Each fault code consists of two numbers counted out in flashes thus for code 2 3 the light will flash twice then be on for 1 second and then flash 3 times. If there is more than one fault each will be flashed in sequence with 5 seconds between each code. If there are no errors the indicator will remain steadily on.

CAL600 will also display the Error code from left to right Bit 7 to Bit 0.

Error Bit	Code	Fault Suspected
Bit 0	1 1	Throttle position sensor incorrectly adjusted or not connected.
Bit 1	1 2	MAP sensor, The manifold pressure sensor is faulty or not connected.
Bit 2	1 3	Air temperature sensor short circuit or sensor low.
Bit 3	1 4	Coolant temperature sensor high or sensor open circuit.
Bit 4	2 1	Air pressure sensor output low or not connected.
Bit 6	2 3	Oxygen sensor has failed to switch when enabled.
Bit 7	2 4	Checksum Error.

Note: Checksum Error will show during active calibration whilst memory contents are subject to operator changes. Once the CAL600 calibration session has ended the memory checksum will be recalculated and written correctly before the files are saved. If the Checksum error shows during normal operation it may indicate that fuelling or ignition data has been reprogrammed without following correct exit procedures or data memory has been corrupted. If it is suspected that the K400 internal calibration has changed the last saved file or a known file should be downloaded into the unit. Alternatively, if possible, the calibration inside the ecu can be uploaded into the CAL600 and a comparison made to see what has changed.

SENSORS

Engine Speed and Position

Engine speed and position are sensed from the original crankshaft mounted magnetic reluctance sensor. The tooth pattern differs between early and late model engines. The K400 can operate with either of the patterns that have four missing teeth. The K400 is not compatible with the earlier two-gap pattern as seen on 1.4 and 1.6 K series engines. The matching of the patterns is software controlled using calibration scalars.

Engine Load

Load sensing is used as the input to allow the use of 3D maps, these maps 14 load sites including the full load line used in 2D map configurations. Engine load can be determined using the original manifold absolute pressure sensor. A connection port is provided in the K400 to connect the original pressure pipe to the internal 1bar sensor. A throttle position sensor is also used to determine transient fuelling factors.

Alternatively, especially when multiple throttle bodies are fitted, the throttle position sensor can be used as the major engine load input. In this case both throttle position and manifold pressure can control transient fuelling. Absolute pressure reading on start-up may be used for barometric compensation if required.

For pressure boosted applications the K400 will accept input from an external MAP sensor for engine load sensing. The sensor used must be a 0-5v voltage output MAP sensor.

Coolant Temperature

The K400 measures engine coolant temperature using the original sensor. This allows the ecu to add fuel enrichment for the starting and warm-up cycles.

Air Inlet Temperature

Air inlet temperature is measured from the original sensor fitted to the intake system. If throttle bodies are fitted or the intake system has been changed then Lumenition can supply an alternative device. (Part No. ATS001 or ATS002)

Battery Voltage

This variable is sensed internally and is used to adjust the injector and coil drive times to compensate for changes in the charging voltage and load on the battery.

Exhaust Gas Oxygen Sensor

The K400 uses the existing EGO sensor fitted to the vehicle exhaust to allow closed loop operation of the fuelling. All the parameters and conditions for the closed loop operation are calibratable within the ecu.

Additional sensors

The MGF installation uses a second air temperature sensor to detect engine bay temperature and allows the ecu to operate the engine bay cooling fan independently from the inlet air temperature. This function is not present in the Elise and Rover 200 applications.

OUTPUTS

Ignition

The K400 provides has an internal ignition driver to operate the single electronic ignition coil fitted to the target vehicles. A distributor driven by one camshaft sends the HT output to each cylinder. Ignition timing output is based upon a load/rpm 3D map. Additionally an Idle spark stabilisation table is available, which applies an offset to the advance angle based upon engine rpm relative to set idle speed. The charge time for the coil is programmable. There is an option to apply an engine rev limit using ignition suppression.

Fuel

The K400 is set up to drive the 4 injectors fitted to the engine in pairs in a semi-sequential regime. Base running injector duration is derived from a load/rpm 3D map. Tables are used to control start fuelling, warm-up enrichment, acceleration and deceleration adjustments. Scalars are used to control overall fuelling calculation, battery voltage compensation and closed loop fuelling on both normal running and idle. A fuel operating rpm limit is also available. A second load/rpm map is available to control the injection firing angle. Automatic pre-set compensation for air inlet temperature and barometric pressure is provided.

Idle Air Bypass Valve

The K400 provides control for the original 5-wire stepper motor idle air bypass valve to enable adjustable air inlet under closed throttle conditions. The base control table is opening versus coolant temperature with a secondary table giving an offset against engine speed. Further Scalars allow calibration of opening for high idle and battery load compensation.
If desired the K400 can be programmed to operate a push valve with control of pulse width, duty cycle and drive frequency.

Carbon Canister

The K400 will operate the carbon canister purge valve. Full control of the opening of this device is available through the calibration of the calibration software.

Fan Relays

The K400 ecu will control the switching on and off of the radiator cooling fan with settings for both maximum and minimum operating engine temperatures. Additionally for the MGF the ecu will control the operation of the engine bay cooling fan using the auxiliary air temperature sensor.

RPM / Upshift Indicator

The K400 provides the facility on one of the original unused pins to drive a ‘Shift Light’ or similar rpm dependent device. The output can be programmed to switch on when the engine rpm reaches a set value. A lamp or LED type indicator can be connected to the output or it can be used to drive a relay.

HEGO Relay

The exhaust gas oxygen (EGO) has a heater supply, which is applied by the K400 ecu when required. This is an automatic function of the ecu.

Fuel Pump Relay

The K400 provides switching of the fuel pump relay to maintain fuel pressure whilst the engine is running. The fuel pump is energised for approximately 5 seconds on initial power on and then is re-energised when engine rpm is detected. The pump will remain on until either power is removed or the engine has stopped (stall condition). This is an automatic function and not programmable.

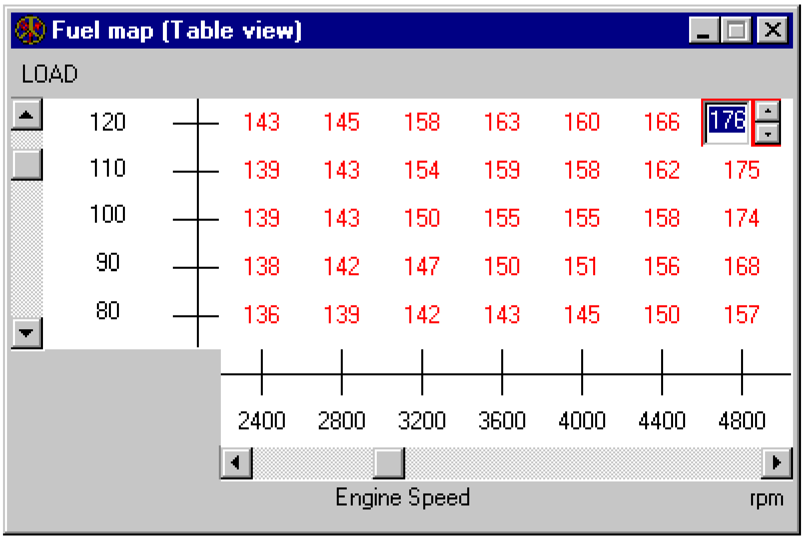
FUEL STRATEGY

Fuel Injection Map

The amount of fuel injected each cycle is dependent on the time the injector is open. This time period (or Pulse Width) is calculated by the ECU using factors for volumetric efficiency, air temperature, air pressure, engine temperature, injector flow rate and battery voltage.

Volumetric efficiency V.E., the major factor, is determined by the value of Load calculated from the manifold absolute pressure (M.A.P.) or throttle position (TPS), and Engine Rpm using a three-dimensional look-up table (map). This 3D table is a simple grid with Load along one axis and engine speed along the other.

The throttle and M.A.P. range from closed to fully open is scaled to 130 points. The throttle axis has 14 sites, one every 10 points from 0 (idle) to 130 (full load). The engine speed axis is divided into 31 sites, one every 400 r.p.m. From 0 to 12,000 r.p.m.



Fuel Map example

At each intersection of an engine speed site and a load position site there is a grid value. This is the volumetric efficiency value or Fuel No. and is directly proportional to the pulse width and therefore the amount of fuel injected.

These values are determined by running the engine on a dynamometer at each attainable point and adjusting the Fuel No. values to obtain optimum performance. Values for unattainable points, such as high-speed low load and low speed high load, are normally calculated to blend in with the determined values. If the engine is running at an exact engine speed site and an exact load position site then the Fuel No. value at the intersection of these two sites will determine the amount of fuel injected. If the engine is running at a position away from the intersection an interpolated value for Fuel No. is calculated using the surrounding site values.

Fuel Injection Calculation

As described previously a Fuel No. value is calculated (using interpolation) and taken from the Fuel Map. This value is now used as a base to calculate the injection Pulse Width to be applied to the injectors.

First the Fuel No. derived from the map is multiplied by the Fuel Table Multiplier to produce a base injection time in mS. Ie.

Base Fuel Pulse = Table Multiplier $\times$ Base Fuel No.

Then various compensations are applied to this calculation. Some are preset within the K400 ecu such as air temperature but others have calibratable features that will affect the final Pulse Width applied to the injectors. These are derived from measured sensor values and/or programmable Scalars or Tables. In addition extra factors are included for starting, acceleration, deceleration and battery voltage compensation.

This list shows the approximate order in which the calculations are made and the contributing factors affecting the fuel pulse width.

Overall Modifier	Scalar FMOD% or potbox adjustment. +/-50%
Air Temp Modifier	Air Inlet Temperature and pre-set table, +/-10% typical
Warm up Fuel	Engine Temp. and Warmup Table, 0 to +250%. Warm engine = 0%
EGO Fuel	EGO sensor, Scalars and Table, +/-10% typical.
Baro Modifier	Barometric Pressure and pre-set table, +/-10% typical.
Start Fuel	Engine Temp., Crank Fuel and Start Fuel Tables, 0 to +100%
Full Load Fuel	Throttle Sensor, Full Load Table and WOT% Scalar, 0 to100%.
Battery Compensation	Battery Voltage, Batt Comp Table and Battery Scalar.
Accel Fuel	Throttle Sensor, Scalars and Accel / Decel Tables.

Starting Fuel

During start / cranking the Fuel No. value is taken from the Crank Fuel Table instead of the main fuel map. This table is based on Throttle position only. that uses throttle position only. There is an additional Start Fuel Table that applies a percentage adjustment and a Start Decay Table that adjusts the amount of time that the additional start fuel is applied for. Both of these tables are based upon engine temperature.

Transient Fuelling (Acceleration and Deceleration)

The Fuel Map contains the fuel for steady state conditions. Transients such as acceleration and deceleration of the engine especially at gear changes can require different fuel. To prevent excessively lean or rich stumbles and emission control problems the E.C.U. has four functions: Deceleration fuel cut-off (D.F.C.O.), throttle triggered acceleration fuel enrichment, and throttle triggered deceleration enleanment, manifold absolute pressure triggered acceleration enrichment.

Decelleration fuel cut off reduces the injection time to a minimum for throttle closed when the engine is at higher rpm. This is programmed using a pair of Scalars that set the load and speed conditions when DFCO is required.

Acceleration fuelling is additional fuel required to help the engine move from one speed to another. In general the amount added is a response to throttle movement and will vary according to the size of that movement. The K400 ecu also includes an acceleration fuel element based upon manifold pressure changes. The action of the acceleration function within the K400 is calibrated using a set of Scalars to control the triggering and limits of extra fuel. Also three tables are supplied. One each for TPS Accel and MAP Accel applying percentage amounts based upon engine speed and an Accel Mod Table to apply a factor based upon current throttle position. The amount of acceleration fuel to be added, to the base injection time, is recalculated by the K400 every injection cycle or every 8 milliseconds depending upon the TAF Scalar setting. If Fast Accel is selected then the amounts are calculated every 4 milliseconds.

If the throttle change detected is negative the K400 can apply a reduction in fuel based upon the TPS Decel Table. This follows the same rules as the acceleration fuelling but the amounts are taken away from the base injection time from the Fuel Map.

Closed Loop Fuelling

The K400 can use the exhaust gas oxygen sensor to determine the fuel/air mixture being put to the engine. The tuner can programme the oxygen feedback settings to allow the K400 to monitor the fuel/air mix and automatically apply compensation fuelling to maintain a defined fuel/air ratio. The tuner has control over the parameters which determine when the K400 goes closed loop, the limits of its effect and how the changes are made. This is all carried out in a collection of Scalars.

There are separate controls for closed loop fuelling under engine idle conditions.

Injection Firing Angle

The injection pulse is timed to start from a specific tooth, in the crankshaft pattern. However a 3d map can be used to adjust the injector-firing angle in relation to this point. This allows the tuner to swing the injector opening to more closely match the inlet valve opening at the full range of load and speed conditions.

IGNITION CONTROL

Ignition Advance

Just like the fuel calculations the base ignition advance is programmed into a 3d Ignition Map. The values are displayed as ignition advance angles relative to TDC and referenced by engine load and engine rpm. The Ignition Map has 14 load sites at 10 point intervals from 0 to 130 and 31 speed sites at 400 rpm intervals from 0 to 12000 rpm. The range of ignition advance is between 0° and 60° BTDC. As in the Fuel Map interpolation is used to ensure a smooth transition from one site to the next.

The calculation for ignition advance is much simpler than that for injection time. There are only two corrections that are applied to the value that is taken from the Ignition Map. The first is the overall modifier of IMOD Scalar or potbox adjustment that allows for fine-tuning of the map sites. The second is the Idle Spark Table modifier that allows for close control of the engine idle speed by adjusting the ignition timing when the engine drifts away from the defined idle speed.

During starting or cranking the ignition timing is determined by the single Scalar of Start Advance to maintain stability during unpredictable speed changes whilst the starter motor is in operation.

Note: The K400 uses the crank tooth pattern settings to determine the TDC mark for the engine. It is important that the correct tooth pattern settings are used for ignition timing to be accurate. Scalars are used to allow an amount of adjustment so that compensation can be made for sensor or flywheel positioning.

Coil Charging

The ignition coil charging time (dwell) is controlled by the K400. A single Scalar allows the tuner to set the coil charge time to suit any coil that may be used on the engine. The K400 will use this setting to maintain the optimum energy available when the coil is fired under all conditions.

IDLE CONTROL

The K400 has a sophisticated idle control system using both the fitted idle air bypass valve and ignition timing. Idle air bypass valve opening is controlled relative to both engine temperature and engine rpm. Correction values can be applied for increased idle speed (hi idle) and battery load. The K400 can be programmed to use one of two types of bypass valves, a stepper motor or a spring return push valve. An additional high-speed control using Idle spark can also used to stabilise the idle speed.

Stepper Motor Idle Air Bypass Valve

The standard idle valve fitted to K series engines is a stepper motor. The stepper motor, is driven closed by the K400 at power on to establish the control limit of the valve. The K400 then uses the Idle Step Table based upon engine temperature and the Idle Speed Table based upon engine speed to determine the correct valve opening. In the Idle Step Table a high number will allow less air and a low number will open the valve. Corrections to this opening are made in order to maintain the desired engine idle speed based upon a set of Scalar values. There is an overall adjustment value that can be controlled using the potbox for fine tuning the stepper motor position. The current position is shown as the Idle Variable.

All of the corrections are additive, a positive number will close the valve (less air) and a negative number will open the valve (more air). The speed at which corrections are made are controlled by the Idle Rate Scalar.

Note: An idle step setting of greater than 248 will close the idle valve. A dither cycle is implemented to prevent the valve from sticking when in the closed position.

Optional Push Valve Control

If it is required for the K400 to control idle using a push valve the main controls are the same as for the stepper motor above. The Idle Step Table and the Idle Speed Table define the position of the valve with corrections applied as before. The idle value determines the duty cycle of the control pulse applied to the push valve. The Idle PW Scalar determines the applied pulse rate.

Idle RPM Control

The target engine idle rpm is programmed into the K400 and the ecu will attempt to stabilise the engine to that rpm setting under defined idle conditions. Along with the idle air bypass valve the K400 can use the Idle Spark control as outlined in the ignition description. A second Hi Idle target option is available to define the desired fast idle speed that will operate under certain conditions i.e. during engine warm-up. A compensating idle step value and time limit is given to control this option.

SCALARS

BATTERY K

Used as a time scaling factor for the Battery Compensation Table. An extra amount of injection time is added to that derived from the fuel map in compensate for the injector response time. The value taken from the Battery Compensation Table is multiplied by this factor in order to calculate that additional time. A typical value is 10µS.

BAY FAN ON

Is the engine bay temperature at which the bay fan will start in °C, Rover MGF only. This value should be higher than BAY FAN OFF.

BAY FAN OFF

Is the engine bay temperature at which the bay fan will stop in °C, Rover MGF only. This value should be lower than BAY FAN ON.

RAD FAN ON

Is the engine coolant temperature at which the radiator fan will start in °C. This value should be higher than RAD FAN OFF.

RAD FAN OFF

Is the engine coolant temperature at which the radiator fan will stop in °C. This value should be lower than RAD FAN ON.

PURGE SPEED

Purge minimum engine speed in r.p.m. At this speed the carbon canister purge valve will start to open. The valve opening will increase if the rpm remains above this speed. Below this rpm setting the purge valve will remain closed. Typical value 1500rpm.

PURGE MAX

Purge maximum represents the maximum duty cycle of the pulse applied to the valve motor. This is given as a percentage and relates to how open the valve may be.

PURGE INC

Purge Increment controls the rate at which the valve opens or closes to allow for absorption by the oxygen feedback. Higher values will open or close the valve faster.

PURGE PER

Purge period is the time between each pulse applied to the purge valve motor. PURGE INC and PURGE MAX define the width of the pulse. Larger numbers produce a slower frequency, only 0 to 7 are valid values.

REV LIGHT

This is the engine speed in r.p.m. at which the gear change lamp will illuminate. Typically this will be set to take maximum advantage of the engine's torque curve.

FUEL CUT

One of two rev limit functions that can be applied. The FUEL CUT defines the engine speed in rpm at which a complete fuel cut occurs. An ignition based rev limit is also available and these two values can be set to operate together or independently one after the other. Any rpm value can be set in increments of 100rpm.

FUEL MOD 1&4 and **FUEL MOD 2&3**

These modifiers allow for the adjustment of the injection time for a pair of fuel injector drives. The characteristics of an engine may demand that a slightly differing level of fuelling is supplied to the inner and outer cylinders. Because of the way that the injectors are driven on the K series engine it is only possible with the K400 to make adjustments for cylinders 1&4 or 2&3. An adjustment of +/-50% is available. The usual setting would be 0% to give the same injection time to all cylinders.

JADV OFFSET

This value is an overall modifier in crank degrees that can be used to offset the injector firing angle. This value modifies the injection angle taken from the Injection Angle Map. If the setting is greater than zero it will be applied to injection firing angle under all engine conditions. The adjustment range is 180°. The usual setting is zero.

ADV OFFSET

This is an overall ignition modifier in crank degrees that can be used to offset the values taken from the Ignition Map. If the setting is not zero the offset will be applied to the ignition advance angle throughout the whole control range. The adjustment range is +/-30°. The usual setting is zero. *Care should be exercised when using this setting because there will be a difference between the ignition timing on the engine and the values seen in the Ignition Map.*

FUEL OFFSET

This is an overall fuelling modifier in percent that can be used to offset the values taken from the Fuel Map. If the setting is not zero the offset will be applied to the injection time throughout the whole control range. An adjustment of +/-50% is available. The usual setting is zero.

MAP MIN and **MAP MAX**

These are the range limits applied to the manifold pressure sensor input to scale the engine load calculation. MAP MIN sets the manifold pressure for 0 engine load. MAP MAX sets the pressure reading for 130 or maximum engine load. The value is given in counts between 0 and 255, which relate to the Raw MAP variable reading. The usual settings for the internal 1bar sensor in the K400 are MAP MIN = 15 and MAP MAX = 250. These values scale the engine load axis for the normal engine operation.

TPS MIN and **TPS MAX**

These are the range limits applied to the throttle position sensor input to scale the engine load calculation. TPS MIN should be set to the Raw TPS count seen at idle or closed throttle. TPS MAX should be set to the Raw TPS seen when the throttle is at maximum. This will scale the load axis of the maps and tables from closed to fully open throttle.

LD0MPC

This is a fuel map compression factor used to improve the dynamic range of the fuel map. 255 is an uncompressed map. The Optimise function is not currently activated in CAL600 so this scalar should remain at 255.

MICROSECOND/BIT

This is the multiplier applied to the values taken from the Fuel Map to turn the Fuel No. into an injection time. This value is dependent on the size of the injector and the power of the engine. Ideally it should be adjusted so that the maximum Fuel No. in the Fuel Map is between 200 and 220. The map manipulation can be used in conjunction with MICROSECOND/BIT to optimise the dynamic range of the Fuel Map, or the automatic LD0MPC in built feature can be used. *(Not implemented in CAL600 V1.01).*

IGN CUT

One of two rev limit functions that can be applied. The IGN CUT defines the engine speed in rpm at which a complete ignition cut occurs. A fuel based rev limit is also available and these two values can be set to operate together or independently one after the other. Any rpm value can be set in increments of 100rpm.

TPS TRIG

This is the throttle change threshold beyond which transient fuelling is triggered. It is the value that Throttle reading must change in 8 milliseconds to trigger acceleration fuel enrichment (or deceleration enleanment). This value can only be determined properly by track or road testing, typical values are 3 to 10. To disable this function set the value to 255.

MAP TRIG

This is the manifold pressure change threshold beyond which transient fuelling is triggered. It is the value that Map, as Load must change in 8 milliseconds to trigger acceleration fuel enrichment. This value can only be determined properly by track or road testing, typical values are 3 to 10. To disable this function set the value to 255.

ACCEL DECAY

This value controls how quickly the acceleration fuel is removed after Accel Fuel has been added. If set to zero the acceleration fuel would be zero after one injection event, if set to 99% then the acceleration fuel would reduce by only 1% each successive calculation. A typical value is 80%.

DECEL DECAY

This value controls how quickly the deceleration fuel decays when Accel_Fuel is negative. If set to zero the acceleration fuel would be zero after one injection event, if set to 99% then the acceleration fuel would reduce by only 1% each successive calculation. A typical value is 80%.

TOOTH #1

This value specifies the tooth number for the first ignition event in an engine revolution. This would normally be set to the number of the nearest tooth prior to the maximum ignition advance value. (i.e. 60°BTDC for K400). Lumenition settings are:

Early and 1.4l pattern flywheels = 9.

Current pattern flywheels = 2.

DELAY ANGL 1

This value defines the angular distance from the first triggering tooth to the maximum advance point. The maximum advance point for K400 is 60°BTDC.

Lumenition setting = 20°.

TOOTH #2

This value specifies the tooth number for the second ignition event in an engine revolution. This would normally be set to the number of the nearest tooth prior to the maximum ignition advance value. (i.e. 60°BTDC for K400). Lumenition settings are:

Early and 1.4l pattern flywheels = 25.

Current pattern flywheels = 18.

DELAY ANGL 2

This value defines the angular distance from the first triggering tooth to the maximum advance point. The maximum advance point for K400 is 60°BTDC.

Lumenition setting = 20°.

TOOTH RUN 1, 2, 3 and **4**

These values describe the pattern of teeth and missing teeth on the flywheel / crankshaft.

Flywheel Type	Run 1	Run 2	Run 3	Run 4
Early and 1.4 L engines	4	11	5	12
Current Engines	3	13	2	14

FUEL_SYNC

This entry swaps the triggering events for the paired injectors so that they fire on the alternate half of the engine cycle. Only 0 and 1 are valid values. An entry of zero fires the injectors 1 & 4 on the first half cycle. This is the usual setting for this scalar.

START ADV

This is the ignition advance angle BTDC that will be used by the K400 whilst the engine is in cranking mode. Cranking mode is predefined as engine speeds below 400 rpm.

PICKUP FACT

This setting is used to compensate for delays in the systems timing pickup and ignition coil. All sensors have a small electrical delay that can cause an apparent timing error at high speed. This error is particularly noticeable with magnetic detectors, this error is subtracted from the nominal timing point to give a virtual timing point, so the user need not compensate in their map for this sensor error.

The pickup delay is in units of 2 microseconds thus maximum delay is 511µSec just over half a millisecond. The typical value is 50µSec.

COIL FACTOR

This value is used to control the charge time or dwell for the ignition coil. Each unit represents approximately 0.25 milliseconds of charge time. If this value is set too high energy will be wasted and there is a possibility that the coil will overheat. If the value is set too low then the coil will not reach adequate saturation and will not produce a reliable spark. The setting for the coil normally fitted to K series vehicles is 14.

Set-up bits

TEST

This setting should be OFF.

AUTO EE WRT

This selection has no function in the K400 ecu.

EDGE

If EDGE set to ON then the rising rather than falling edge of the input signal is used as the significant edge at 60 degrees BTDC point. When the standard variable reluctance sensor is used this value should be set to OFF.

MAGNETIC

This scalar allows the K400 to be set to recognise crank speed input from a hall effect type sensor. When using the standard variable reluctance sensor this scalar should be set to OFF.

FAST ACCEL

Setting this scalar to ON will run the transient fuel calculations in fast mode when TAF is ON. The K400 will recalculate the value of Accel Fuel every 4 milliseconds rather than every 8 milliseconds. The result is to double the effect of the ACCEL DECAY and DECEL DECAY settings.

TAF

If TAF is ON then Accel Fuel calculations are run by a time factor. The normal time period for accel calculations is every 8 milliseconds. This can be shortened using the FAST ACCEL setting. If TAF is OFF the Accel Fuel calculation is run for each successive injection event which will match the decay rates to engine cycles rather than time.

MAP

If MAP is set to ON then LOAD will be calculated by using the manifold pressure signal. The zero and max load points are scaled with MAP MIN and MAP MAX. If the internal 1 bar sensor is used then MAP and BAR can be set together so that when the engine is stopped a barometric correction is applied, and when out of cranking a LOAD derived from the MAP signal is used.

BAR

If BAR is set to ON then the Manifold Pressure reading that is taken whilst the engine is stopped is used for Barometric Pressure compensation.

MIN AFUEL

This scalar sets the minimum value for Accel Fuel that will inhibit oxygen feedback. During acceleration or deceleration it is necessary to prevent the K400 applying closed loop fuelling based upon the air fuel mixture. When the amount of accel fuel is reduced below this set level the closed loop feedback will be reapplied allowing the K400 to maintain a correct mixture.

WOT EXTRA

In some circumstances it is desirable to add extra fuel when the throttle is at maximum (Wide-Open Throttle). This value sets the percentage of extra fuel added to the usual calculation when the TPS Full load value is exceeded. The Throttle value that defines wide open is set in the Full Load Table.

MIN SPEED

This scalar defines the minimum engine speed at which fuel and ignition pulses will be presented to the engine. Both ignition and fuel will not operate if the engine is turning below this rpm.

OX FB GAIN

As part of the closed loop oxygen feedback control GAIN is a multiplier applied to the values taken from the OX Error Table. This will produce the OX Error value which will be applied in the fuel calculation. This value is scaled as a binary setting so 0 gives 1 and 4 will give 16.

OX FB RATE

This scalar will regulate how often the feedback loop calculation is run in milliseconds. Lower numbers mean faster so GAIN may need to be adjusted accordingly. Zero will disable this function and effectively turn off the closed loop fuelling function.

OX SWITCH

This is the value that sets the target fuel air mixture for the closed loop fuelling. The value is based upon the reading from the EGO sensor in raw form (Raw EGO). A typical value is 70, but is best found by halving the maximum (rich) value of display variable OX raw. A higher value will move the target towards the richer mixture setting.

OX FB P

This is the proportional constant applied to the closed loop fuelling calculation. The proportional value will control how quickly the feedback factor will be changed in successive calculations.

new OXFBK = ((old OXFBK + (OXERR x INTCON)) + OXERR × OXPCON

OX FB +VE and **OX FB –VE**

These values represent the limits for oxygen feedback control. They define how much adjustment is desirable to maintain the target mixture. If the calibrated Fuel Map is good for the engine then these values could be very low to apply small adjustment. OX_FB_+ve must be a positive number, OX_FB_–ve must be a negative number..

ENGINE OK

This is the Engine Coolant Temperature above which is considered normal running conditions. When the engine reaches this temperature the deceleration fuel cut-off feature and Oxygen feedback controls are enabled.

OX LOAD

This sets the maximum load at which the oxygen feedback will still operate. If load is above this value the closed loop control is deactivated to allow fuelling to be controlled from the Fuel Map and WOT EXTRA values.

OX SPEED

This value sets the maximum speed at which the oxygen feedback is still active. When the engine is running above this rpm then fuelling values are derived directly from the Fuel Map with no closed loop feedback.

OX STEP

This scalar is a positive value added to OX_FB when the sensor first switches lean. This value is used to effectively 'kick-start' the closed loop feedback into action and bias fuelling towards the rich side for engine comfort. A typical setting would be +5%.

DFCO LOAD

This value sets the maximum load at which the deceleration fuel cut-off (DFCO) will still operate. Fuel cut-off will be applied when the engine Load drops below this setting. Note if MAP is used as Load then TPS scaled as load must be less than 8. For a MAP based system this may be as high as 50.

DFCO SPEED

This scalar sets the minimum speed at which the deceleration fuel cut-off is still active. The fuel cut-off will only be applied when the engine is running above this speed, below this rpm the Fuel Map settings will be applied. To disable DFCO set this to 25,500 rpm.

>12VOLTS IDLE

This is the compensation value applied to the idle controller in response to increased battery load. When the battery voltage drops below 12.5Volts at idle the air will be increased in order to maintain correct idle speed. This value will be added to the normal Idle value taken from the Table calculations.

A/C IDLE

This is the compensation value applied to the idle controller in response to air conditioning load. When the air conditioning requests more engine power this number is added to the current idle value taken from the Table calculations.

IDLE RATE

This sets the time between idle position pulses if no changes in position are required.

IDLE PW

This scalar will control the pulse width applied to a push valve idle air bypass unit. When using the original fitment stepper motor this scalar must be set to zero.

IDLE TROTTLE

The maximum value of throttle for idle stabilisation control loop to be active. When the Throttle reading is below this value the K400 will attempt to control the engine speed to the idle setting.

IDLE SET

The target idle speed for the idle stabilisation control loop. The K400 will attempt to maintain this engine rpm for idle using the idle air bypass control and ignition timing.

IDLE_SET+ and **IDLE_SET–**

The limits for the range of Idle_set control loop. These values represent the largest step adjustment that will be applied to the idle controller. These values must be scaled positive and negative accordingly. Typical values +20 and –20 steps.

ACCEL M and **ACCEL C**

The proportional control modifiers of Accel Fuel based upon the change in Throttle. The variables +dTPS and –dTPS indicate the amount of change. ACCEL M is the multiplier of dTPS value and ACCEL C is the constant that is always added on the first trigger of acceleration fuelling. Both these factors together provide the multiplying value for the Accel Modifier taken from the Accel Mod Table.

ACCEL LIMIT

The limit to prevent excessive Accel Fuel as a percentage of Fuel Pulse. Accel Fuel will never be higher than this percentage regardless of the actual calculated value. This prevents multiple successive throttle changes from overfuelling the engine.

HI IDLE SET

This scalar sets the desired engine speed for an elevated idle condition. This will be above the target Idle speed for normal idle running. High idle condition occurs when engine coolant temperature is below HI IDLE COOL or when the Throttle is first detected below the IDLE THROTTLE setting. The high idle will be held until HI IDLE TIME expires.

HI IDLE TIME

This value will set the time that the HI IDLE SET speed is valid after entering the idle condition. The idle speed will drop to the IDLE SET value when the HI IDLE TIME has expired.

HI IDLE STEP

This scalar gives the offset step to open the air by–pass valve to maintain a high idle condition. The number is added to the current idle value taken from the Table calculations. A typical setting for this would be –20 steps.

HI IDLE COOL

This value sets the coolant temperature below which the high idle condition is maintained. High idle speed will be maintained during engine warm-up until the temperature reaches this value and the idle speed will drop to the normal idle setting.

I OXFB GAIN and **I OXFB RATE**

These values replace OX FB GAIN and OX FB RATE when the engine is in the idle condition to ease emission control tuning when gas flows are low.

MAX IDLE

This setting is the maximum engine speed at which the idle control mechanism functions. As soon as the engine is running higher than this value, rpm idle control is turned off and fuel / ignition controls are returned to the Map related values.

TABLES

BATTERY COMP(-ensation) TABLE

The Battery Comp Table controls the way that the K400 will apply the additional injection time, which matches the injector characteristic. The table gives a scaling factor referenced by battery voltage. The value derived from the table is multiplied by the scalar BATTERY K to give the additional injection time that will be applied.

If BATTERY K is zero then a default table stored in ROM (not user changeable) is used.

The values in the Battery Comp Table are determined by the model and type of injector you are using. If you change injectors or fuel pump pressure you may need to change this table and or microsecond/bit, and re-scale the fuelling maps or tables, this may also effect the optimum settings for the Injection Angle Map.

If we use the Weber IW 058 (43005.010) as an example of a contemporary high impedance injector:

R = 14.5 ohms, L = 7.2 mHenrys, Flow rate 384 millilitre/minute at 300kPa (3 Bar).

Battery Volts	Offset time mSec
6.0	5.387
8.0	2.028
10.0	1.217
12.0	0.806
14.0	0.558
16.0	0.391

If 8 volts is the minimum battery supply for normal operation, then we can scale the system thus:

2.028 mSec/255 for finest resolution = 8 µSec per bit

Resolution of BATTERY K is 2µSec we would choose 8µSec.

This would make the Battery Comp Table look like this:

Battery Volts	Batt Comp value	Offset Time (Value x BATTERY K)
0.0	4	
8.0	255	2.04 mS
10.0	153	1.224 mS
12.0	101	0.808 mS
14.0	70	0.56 mS
16.0	49	0.392 mS

The missing values for odd voltages are best blended using the calculation functions

The original internal table would look like this:

Battery Volts	Batt Comp value	Offset Time (Value x BATTERY K)
0.0	9	for 18 µSec multiplier
8.0	255	4.59 mS
9.0	139	2.502 mS
10.0	79	1.422 mS
11.0	52	0.936 mS
12.0	30	0.54 mS
13.0	20	0.36 mS
14.0	11	0.198 mS
15.0	9	0.162 mS
16.0	7	0.126 mS

WARM-UP TABLE

This table is provided to allow the tuner to control the amount of extra fuel that is made available during the warm-up cycle when the engine is first started and running below normal temperature. Percentage values are entered for each Engine Temperature site from –17°C to +127°C. The value is in percent of the value taken from the Fuel Map for the current running condition and is additional fuel. The values in the table would generally reduce down to zero at the normal engine running temperature. Minimum value is 0% and the maximum value is 250%.

CRANK FUEL TABLE

This is a separate table to provide a base Fuel No. for the fuel calculation when cranking or starting the engine. The values from this table are used instead of those in the Fuel Map. A Fuel No. is entered for each Throttle position from 0 to 130. The Throttle position is used for this table regardless of the normal input for Engine Load. Minimum value is 0 and the maximum is 255.

START FUEL TABLE

This is a table to provide an additional amount of fuel during starting based upon the Engine Temperature. Percentage values are entered for each Engine Temperature site from –17°C to +127°C. The value is in percent of the value taken from the Crank Fuel Table and is additional fuel. The values in the table would generally reduce down to zero at the normal engine temperature. The extra Start Fuel is reduced linearly over time, whilst the engine is cranking, depending on the Start Decay Table value. Minimum value is 0% and the maximum value is 250%.

START DECAY TABLE

This table allows the tuner to adjust how quickly the additional Start Fuel is reduced over time. Time values are entered in seconds for each Engine Temperature site from –17°C to +127°C. The additional Start Fuel will be reduced to zero after the expiry of the time set for the current Engine Temperature. This decay is a linear decay in seconds after cranking commences. Minimum value is 0 Secs and the maximum value is 66 seconds.

CRANK PULSE TABLE

The Crank Pulse is a single shot of fuel that may be injected into the engine at Key on. The intention is to prime the inlet manifold before starting the engine. A value for Fuel No. is entered into the table selected for each Engine Temperature between –17°C and +127°C. The Fuel No. taken from the table will be multiplied by the MicroSec/bit (MSPB) scalar to give the Start Pulse in microseconds. The minimum value is 0 and the maximum value is 4080.

IDLE STEP TABLE

This table sets the position of idle air by-pass valve used to control engine speed at idle. This is the major control setting for the air bypass valve. The position values in the table are dependent on engine coolant temperatures from –17°C to +127°C. 0 represents a fully open valve and 255 a fully closed valve. At power on and after about 3 seconds after stopping the ECU will cycle the stepper motor to re-establish the fully closed condition. Scaled in steps of the stepper motor fitted as standard.

IDLE SPEED TABLE

This table adjusts the position of the idle stepper motor with engine speed. This allows the tuner to open or close the valve in response to the engine speed in 100 rpm steps between 0 and 2500 rpm. The value taken from this table is added to the value taken from the Idle Step Table. The range is ±128steps. Positive values will close the valve and negative values will open the valve.

IDLE SPARK TABLE

This table allows the tuner to adjust the ignition advance to control the idle speed of the engine. Adjustment values are entered in crankshaft degrees for each engine speed difference site between –325rpm and +300rpm. The engine speed difference is based on current Engine Speed and the Idle Set rpm scalar value. The advance value taken from this table is added to the value taken from the Ignition Map. Increasing advance will tend to drive the engine faster and vice-versa. The range of adjustment available is ±30 degrees.

FULL LOAD TABLE

This Engine Speed related table establishes the position of the Throttle above which is considered wide open (WOT). The value taken from this table is used to enable the WOT EXTRA fuel scalar and deactivate the oxygen feedback control.

TPS ACCEL TABLE

This Engine Speed related table determines the factor of acceleration fuel that will be added as a result of Throttle movement. A percentage value is entered for each speed site from 0 to 6400rpm. The value taken from this table operates together with the Accel Mod Table and Accel scalars to produce an Accel Fuel modifier value. The minimum value is 0% and the maximum is 100%.

MAP ACCEL TABLE

This Engine Speed related table determines the factor of acceleration fuel that will be added as a result of Manifold Pressure change. A percentage value is entered for each speed site from 0 to 6400rpm. The value taken from this table operates together with the Accel Mod Table to produce an Accel Fuel modifier value. The minimum value is 0% and the maximum is 100%.

TPS DECEL TABLE

This Engine Speed related table determines the factor of acceleration fuel that will be removed as a result of Throttle movement. A percentage value is entered for each speed site from 0 to 6400rpm. The value taken from this table operates together with the Accel Mod Table and Accel scalars to produce a negative Accel Fuel modifier value. The minimum value is 0% and the maximum is 100%.

ACCEL MOD TABLE

This table modifies the primary acceleration fuel factor taken from the Accel Table with a further percentage based upon the current Throttle position. The value taken from this table will affect Accel Fuel values derived from all of the three Accel tables (TPS and MAP Accel Tables and TPS Decel Table). Throttle points from 0 to 130 reference the sites in the table. The range of adjustment is from 0% to 100%.

OX(-ygen) ERROR TABLE

This table converts the Oxygen history of transitions to the oxygen error signal applied to the proportional and integral feedback loop. A percentage value is entered for each of the Ox History sites from 0 to 15. The minimum value is –127% and the maximum is +127%. Usual values are between +/-25%.

OX FB I CONST TABLE

This table varies the oxygen feedback integral constant with engine speed, to improve regulation with the change in transport time between the inlet and exhaust sensor. A value is entered for each of the 7 speed sites from 0 to 9600rpm. The range is +/-127. Usual values are in the range 0 to 10.

MAPS

FUEL MAP

The Fuel Map is the Load and Engine Speed map used to produce the Base Fuel No. The map has 14 Load points and 31 Engine Speed points. The Load sites are from 0 to 130 in 10 point intervals. The Speed sites are from 0 to 12000rpm in 400rpm intervals. A value can be entered in each site the range of which is 0 to 255. This interpolated value taken from the Fuel Map forms the base number from which all of the subsequent fuel calculations are made and represents the steady state fuelling for the engine.

IGNITION MAP

The Ignition Map is the Load and Engine Speed map used to produce the Base Spark Advance. The map has 14 Load points and 31 Engine Speed points. The Load sites are from 0 to 130 in 10 point intervals. The Speed sites are from 0 to 12000rpm in 400rpm intervals. A value can be entered in each site the range of which is 0 to 60°BTDC. This interpolated value taken from the Ignition Map forms the base number from which all of the subsequent ignition calculations are made and represents the steady state spark requirements for the engine.

INJECTION ANGLE MAP

The Inj Angle Map is the Load and Engine Speed map used to offset the injection timing. The map has 14 Load points and 31 Engine Speed points. The Load sites are from 0 to 130 in 10 point intervals. The Speed sites are from 0 to 12000rpm in 400rpm intervals. A value can be entered in each site the range of which is 0 to 180° Crank. This interpolated value taken from the Inj Angle Map determines the start angle for the injector pulse relative to the marker position form the crankshaft sensor. The normal value for this map is set to 24° across the entire range.

DISPLAY VARIABLES

Fmod

This is the temporary fuelling modifier showing the percentage adjustment being applied to the fuel calculation. The value is affected by using the virtual or physical potbox. The modifier is intended for fine tuning the Fuel Map entries and has a range of +/-50%.

Smod

This is the temporary ignition modifier showing the degrees adjustment being applied to the advance calculation. The value is affected by using the virtual or physical potbox. The modifier is intended for fine tuning the Ignition Map entries and has a range of +/-22.5°.

Jmod

This is the temporary injection angle modifier showing the degrees adjustment being applied to the injection timing calculation. The value is affected by using the virtual or physical potbox. The modifier is intended for fine tuning the Inj Angle Map entries and has a range of +/-90.0°.

Idle mod

This is the temporary idle step position modifier showing the step count adjustment being applied to the Idle position calculation. The value is affected by using the virtual or physical potbox. The modifier is intended for fine tuning the Idle Air Bypass valve opening and has a range of +/-128.

Engine Speed

This is the current measured engine rpm that the K400 will be using for all its calculations and map searching. The display resolution is 4 rpm.

MAP raw

Displays the reading directly from the manifold pressure sensor. This is a count value between 0 and 255 that will be converted into the Manifold Absolute Pressure reading.

MAP Pres

Manifold Absolute Pressure reading scaled as pressure in kPa.

MAP as LOAD

This is the MAP signal scaled for use as the Load input for fuel and ignition calculations. The range is 0 to 130 and the min/max points are set using the MAP MIN and MAP MAX scalars.

Delta MAP

Current change in MAP on successive readings, used for acceleration fuel calculation.

Sigma MAP

Last value for Delta MAP used for acceleration fuelling calculation.

TPS raw

Displays the reading directly from the throttle position sensor. This is a count value between 0 and 255 that will be converted into the Throttle reading.

Throttle

This is the TPS signal scaled for use as the Load input for fuel and ignition calculations. The range is 0 to 130 and the min/max points are set using the TPS MIN and TPS MAX scalars.

+dThrottle and **–dThrottle**

These values represent the current change in the value of Throttle. Positive change for acceleration and negative change for deceleration. These form the basis for throttle based accel and decel fuel calculations.

+dZThrottle and **–dZThrottle**

These values are the current change in the value of Throttle, when triggered for acceleration fuelling and scaled by Accel_M and Accel_C. These peak values are cleared to zero when Accel_Fuel is zero.

Temp Afuel

Temporary value for Accel Fuel used in the calculation for the new Accel Fuel value.

Accel_Fuel

This shows the additional fuel pulse width that has been calculated for acceleration fuel in microseconds. Accel Fuel is positive to add fuel for acceleration and negative for deceleration.

Max +Afuel and **Max –Afuel**

These values represent the working limits for Accel_Fuel in milliseconds.

LOAD

This is the Engine Load used for map and table lookup. The range is 0 to 130. If the K400 is set to use the MAP sensor for load then this will match the MAP as Load display. Otherwise the LOAD value will match the Throttle display.

Fuel Calculation

These values show the progression of the fuel injector pulse width calculation as it is affected by the various functions and modifiers from the Fuel Map to the final Pulse Width.

VE(MAP) (Base Fuel No.)

The interpolated Fuel No. value that has been drawn from the Fuel Map. The range is 0-255.

VE*FMOD

The current value of the modifier FMOD, range 0-255.

Fuel no c

This is the interpolated value VE(MAP) multiplied by microsecond/bit (Table multiplier), scaled in microseconds. The range is 0 to 131,070µSec.

Fuel comp

This shows the fuel pulse after the load factor from LD0MPC compression factor is applied. If the Fuel Map has been Optimised for better dynamic range.

Fuel FMOD

This is the fuel pulse after the FMOD user modifier, range 0-131,070µS.

Fuel air

The fuel pulse after air temperature modifier, range 0-131,070µS.

Fuel warm-up

This shows the fuel pulse after warm-up modifier, range 0-131,070µS.

Fuel OX FB

This displays the fuel pulse following Oxygen feedback correction, range 0-131,070µS.

Fuel Baro

This is the fuel pulse after the barometric modifier, if required, range 0-131,070µS.

Fuel Start

The fuel pulse after the start modifier if required, range 0-131,070µS.

Fuel PW

This shows the pulse width including any full load fuel. This represents the final calculated pulse width value based upon the Fuel Map and modifiers. The Battery Compensation and transient fuelling are extra and separate from this calibrated fuel.

Stat Flag

K400 status register used internally to indicate some current engine conditions.

ERROR1 ERROR2

This is a binary encoded byte that shows the current error condition of the input sensors and memory. The respective indicators show a 1 if the error condition is True. See the Diagnostic Code section for a description.

Ox Fail

Indicates failure of oxygen switching device following change of fuelling.

Spark adv

This is the interpolated value for ignition timing that is drawn from the Ignition Map. The range 0 to 60° BTDC.

Spark Out

Reverse of spark advance used in calculation of ignition time in relation to the Most Advanced Marker.

Spark (mod)

This is the value of Ignition Advance after modification by Spark mod.

Air Pressure

Barometric Air pressure reading. The range is 0 to 127.5 kPa.

Baro Fact

The barometric correction factor +/-15%. Determined by the reading of Baro Pressure on startup and an internal table (not calibratable).

Battery

The current battery voltage 0-16 volts.

Bat Comp F

This is the additional injector open time in µSec that is calculated from the Battery Compensation Table.

Air Temp

This is the Air Temperature reading from the Inlet air temperature sensor in degrees Celsius.

Air Temp F

The correction factor for the fuel calculation due to air temp +/-30%. This is calculated from the Air Temp reading and an internal table (not calibratable).

Cool Tmp F

The correction factor for the fuel calculation due to coolant warm-up 0-250%.

Coolant

This shows the engine coolant temperature in degrees Celsius.

Last Cyl

Last period between cylinders µS. Used in engine speed calculation.

Delta Speed

Change in period between successive measurements of engine speed in µS. Used in speed calculations.

Oxygen raw

This shows the reading directly from the oxygen signal amplifier. The range is 0 to 255.

Ox Error

This value is the current error signal taken from the oxygen error table.

OX Feedback

This value represents the output of the oxygen feedback calculation. The range is +/-50%.

Ox No Toggle

Number of cycles since last Ox switch from lean to rich and vice versa.

OX History

This is the bit pattern history of OX raw transitions.

Tooth Time

Measured time between teeth measured from crank signal input. Used in tooth pattern recognition routine.

D Tooth Time

Change in tooth time on successive measurements. Used in tooth pattern recognition.

Tooth No.

Record of current tooth number in the count around the crankshaft.

TPEER

This value represents the accumulation of timing errors, timing errors occur if an invalid number of teeth are detected between missing teeth, or if a tooth gap greater than two teeth is detected.

MTooth No.

Record of current marker tooth number in the count around the crankshaft.

ITooth No.

Record of current injection marker tooth number in the count around the crankshaft.

Inj ADV

Current interpolated value for injection advance taken from the Injection Angle Map.

Bay Temp

Scaled measurement from engine bay temperature sensor in °C (MGF). Used for engine bay fan control.

Accel mod

This is the current value taken from the throttle related Accel mod table.

Spark idle

This shows the current adjustment to the ignition timing taken from the Idle Spark Table when in idle condition.

HiIdle count

This shows the current status of the Hi Idle Time countdown. When this value reaches zero the time for fast idle has expired.

d Idle Speed

This displays the difference between actual Engine Speed and the target IDLE SET speeds.

Crank Time

This shows the time for which the Start Extra Fuel will be applied, valid when engine stopped.

Start Fuel

This value is the extra fuel taken from the Start Fuel table 0-250.

Start Pulse

This is the calculated one-shot fuel pulse taken from the Crank Fuel Table, to aid starting, in µSec.

Inj Angle

Final value for injection angle after adjustment by Jmod.

Inj Duty

Duty cycle value for injection pulse width in relation to firing period. Note should not be greater than 90% for good operation.

Fuel PW 1&4 and **Fuel PW 2&3**

Final values for injector pulse widths based on Fuel 1&4 and Fuel 2&3 with Battery compensation and transient fuelling.

Fuel 1&4 and **Fuel 2&3**

Independent fuel pulse width values for each pair of injectors if the Map values are modified by non zero values of Fuel mod 1&4 or Fuel mod 2&3.

DEBUG 1 to 4

Diagnostic registers.

Mduty

Duty cycle output for the push valve idle speed controller.

Idle Cnt

Current count for the idle control valve.

IDLE

This value displays the target position of the idle stepper motor, the base value is taken form the Idle Step Table.

Idle Rate

Current rate value for the control of the idle air bypass controller.

Idle speed

This value is the engine speed compensation of the idle stepper position taken from the Idle Speed Table.

Idle Set

Modifier value for the control of the idle air valve stepper motor.

KNKRAW

This is the normal 0-5volt scaled as 0-255 input on pin 10B.

Rst Cnt

Some counter?

StkPnt

Some pointer.

Accel_Trig

This shows the count of acceleration triggers and is cleared to zero if Accel_Fuel is zero.

Timer

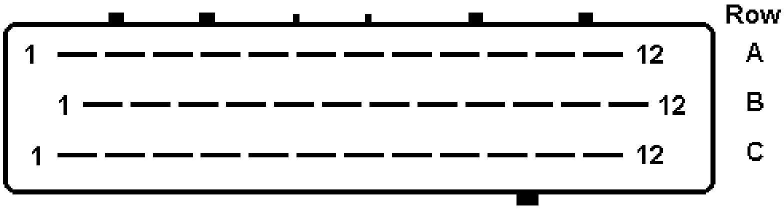
Some inconsequential timer counter value that keeps going all the time in a seemingly random fashion.

Charge Time

the coil on time in microseconds.

Appendix A

PIN OUT The 36 way K400 Connector, external view into ecu.



Latch at top

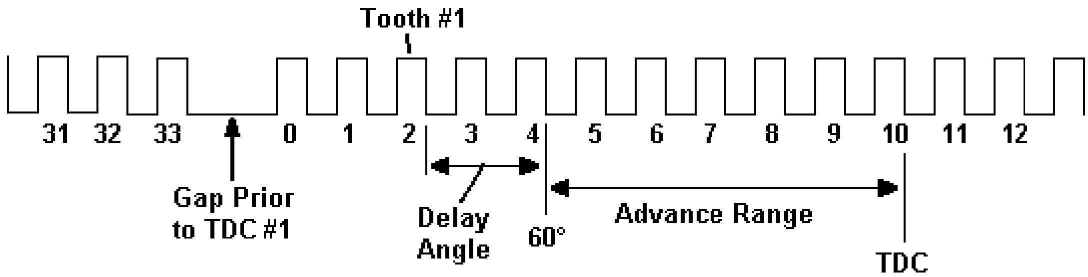
1A	Ignition output to coil.
2A	Bay Fan relay drive.
3A	Idle stepper motor drive #4. (IDLE4)
4A	Not Used.
5A	Power ground (RTN).
6A	Analogue ground (0V).
7A	Crank Signal In (T1).
8A	Crank Signal Ground (GND).
9A	Coolant temperature sensor input (CTEMP).
10A	Engine bay temperature sensor input(AUX).
11A	A/C request input. (Not Active)
12A	Oxygen sensor relay drive.
1B	Injector pair 1 drive (INJA).
2B	Injector pair 2 drive (INJB).
3B	Idle stepper motor drive #3 (IDLE3).
4B	Carbon canister purge valve drive (CANPRG).
5B	Fuel pump relay drive (FPUMP).
6B	*Optional* external MAP sensor signal input.
7B	Oxygen sensor ground (OXGND).
8B	*Optional* Upshift drive output.
9B	Inlet air temperature sensor (ATEMP).
10B	Not Active.
11B	Not Used
12B	Not Active
1C	Not Active.
2C	Idle stepper motor drive #2 (IDLE2).
3C	Idle stepper motor drive #1 (IDLE1).
4C	Not active
5C	Not Active.
6C	Radiator fan relay drive (FAN).
7C	Exhaust oxygen sensor signal input(OX).
8C	Throttle position sensor signal wiper(TPS).
9C	5 volt sensor power (TPSPWR).
10C	Not Active.
11C	Main Power .
12C	Tachometer drive (TACHO)

For installers wishing to make their own looms for a specific application Lumenition can provide matching connectors for the K400 ecu.

Appendix 2

Flywheel Tooth Patterns.

The K400 ecu is programmed to accept the crankshaft pattern of 36 teeth with 4 gaps or missing teeth around one revolution. Early engines with only 2 missing teeth per revolution cannot be used to trigger this ecu. However the enterprising engine builder can remove two further teeth from the sensor ring to match the earlier 4 gap pattern below.
Delay Angle is the angle between the selected timing tooth and a point 60°BTDC this is in degrees, note this now has the range of 20° so it now more flexible.



This is in effect an electronic adjustment of timing.

To determine the tooth pattern of the flywheel fitted to your engine you must count the teeth and note the gap positions as they pass the sensor point. You must also note which tooth is aligned with the sensor when the engine is at TDC for cylinder 1. As a general guide the style of the tooth ring can indicate the pattern. The earlier patterns that have a gap at TDC have a separate ring of teeth that is fixed into the face of the flywheel. The later pattern is machined or cast directly into the face of the flywheel.

Early Pattern Tooth count.

Gap, 4 teeth, Gap, 11 teeth, Gap, 5 teeth, Gap, 12 teeth, End
TDC in gap between 4 and 11 teeth.

Late/Current Tooth Count.

Gap, 2 teeth, Gap, 14 teeth, Gap, 3 teeth, Gap, 13 teeth, End
TDC is 2 teeth before gap between 13 and 2 tooth count.

APPENDIX 3

AIR CONDITIONING CONTROL

The ECU is intended to interact with the air conditioning system. This has not been implemented yet, the Rover documentation is some what ambiguous!

The OE system works in the following fashion.
An A/C request sense appears at pin A11 [35] active low I think.
The ECU would open the idle by–pass a bit to compensate for the additional load.
The ECU will then activate the A/C compressor clutch and fan pin B6 [19] low.

On the K400 ecu V0.16.
In the absence of ECU control, pin B6 is removed from connector and connected to A11 the compressor circuit should function.

An A/C Fan request appears at pin B10 [15] active low.
The ECU would activate the condenser fan and cooling fan#1 pin C5 [5] and cooling fan#2 pin C6 [6] (also Radiator FAN).

So to maintain this function, remove B10 and C5, then link together.

Note to remove crimps from AMP 36-way connector; demate from ECU, remove white latch plate, use small point to lift crimp latch on top of access from mate side, while gently pulling on wire.