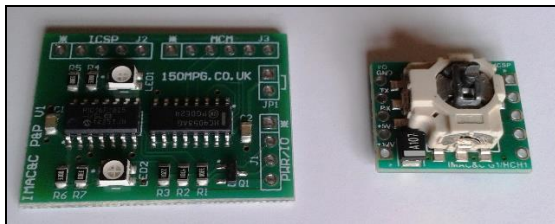


## Imac&c p&p Insight manual IMA control system

If you have had your Insight a while, you may have heard of Imac&c p&p. It's an Insight-specific, PIC-based manual IMA control system. Imac&c p&p stands for 'Integrated Motor Assist Command & Control Plug & Play'.

Imac&c p&p was designed and built by Peter Perkins, a multi Insight owner and electronics enthusiast from the UK. You can find him at [www.thehybridexpert.co.uk](http://www.thehybridexpert.co.uk)



*The custom-built, Insight-specific Imac&c p&p PCBs ready for installation.*

In normal use, the Insight uses the OEM computers and parameters to control how the IMA system operates. It balances assist and regeneration levels with throttle requests, engine load, available battery power and road conditions to give the average owner consistent IMA system operation for normal use.

This, however, can be quite restrictive and is by no means optimal in every situation. It means that the hypermiler or performance enthusiast cannot get the best out of the car.

However, with Imac&c, the skilled and enthusiastic driver gains benefit from taking over the system and controlling how the IMA operates. This can give better acceleration and deceleration performance by maximising assist and regeneration on demand. It can also give better fuel economy by utilising the available battery power and recharging opportunities to match the journey or terrain in a more energy-efficient way.

A sympathetic driver can expect to see anything from a 5-15 mpg improvement in fuel consumption when using Imac&c p&p on suitable journeys.

Imac&c is based on pioneering earlier work done by enthusiasts and owners of these impressive cars worldwide. Mike Dabrowski, a key American early developer, produced a system called MIMA (Manual Integrated Motor Assist) which gave manual control functionality to the IMA system. He developed a clever and intricate system which sold well but is sadly now out of production. Imac&c p&p is an extension and follow-on to his work and makes manual control of the IMA system possible easily and simply.

The basics of IMA manual control rely on the fact that the Insight OEM computer modules are divided into separate units and communicate with each other via the car's wiring loom.

The internal combustion engine is controlled by the ECM (Engine Control Module) which resides under the carpet in the passenger foot well.

The IMA motor is controlled by the MCM (Motor Control Module) which is located in the IMA compartment under the rear luggage area.

During normal use, the ECM sends requests for IMA assist or regeneration to the MCM and the MCM responds accordingly, providing assist or regeneration as requested. This occurs as long as the IMA battery is within its normal operating range for SOC (State of Charge) and temperature.

Manual IMA control works by intercepting or blocking signals from the ECM to the MCM,

and replacing them with new commands and requests. These requests are then acted on by the MCM as if they had come from the ECM. They are carried out without question, but comfortably the system retains its safety systems and the battery protection provided by the MCM and BCM (Battery Control Module) software. So you cannot exceed the battery safe operating zone, even if you request maximum assist for extended periods.

In use, we can request maximum assist or regeneration, or anything in between, or we can block ECM requests for the above, or modify them to suit our journey or terrain.

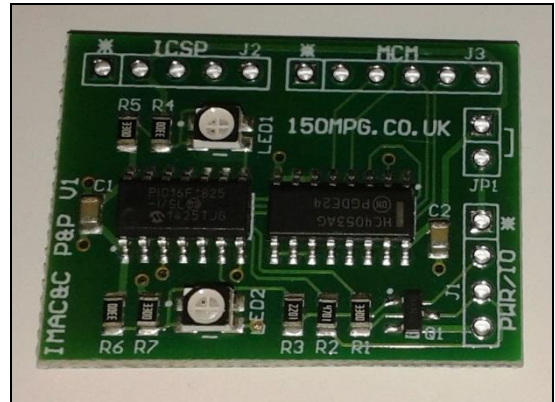
As an example, by simply using a bit more assist to crest a hill, we may be able to avoid depressing the throttle and so remain in lean cruise. We gain that few extra mpg and, as we cruise down the other side of the hill, we can command a touch of regeneration to replace that energy used.

Sometimes the car will annoyingly start force-charging as we ascend a hill because we have depleted the battery. This is a double whammy as the extra load on the engine can force us to change down and use much more throttle than normal, so killing fuel economy. What the car does not know of course is that over the hill is a descent where we can probably use regeneration to replenish our battery while at the same time, controlling our speed without resorting to the brakes. In this scenario, we look ahead and become the computer; with Imac&c we can override the system to shut off charging during our climb and re-engage it during our descent.

Imac&c p&p uses a dedicated PIC microprocessor-based system design, and can be broken down into two main parts: the MCM slave PCB and the Joystick PCB.

### **MCM Slave PCB**

The MCM slave PCB is installed inside the OEM MCM module for protection and electrical screening. It also gives the system plug and play capability and does not require hacking into the exterior wiring harness to function. It requires about 12 fairly simple connections inside the MCM module, and provides the core IMA control functionality.



*The MCM slave PIC 16F1825 PCB in close-up.*



*The MCM slave PCB installed into the Insight MCM.*

The MCM slave PCB consists of a PIC 16F1825 processor to control the functionality and provide replacement control signals, and a switching integrated circuit to change between the OEM and manual control states. The board communicates with the separate joystick PCB using the OEM H-Line control wire in the standard loom. This H-Line is available at the OBDII port and allows our control

joystick to be plugged into the port directly or via the Obdiic&c display device (see previous section). The slave PCB sits patiently inside the MCM waiting for IMA control commands to come in over the H-Line as simple serial data packets. If it does not receive a constant stream of serial data control packets, it reverts back to OEM control within 300ms. It also has checksum error identification and other safety features built in to ensure the system cannot operate inadvertently.

### Joystick PCB

The joystick PCB is also a PIC processor based device. It is fitted with an ultra-miniature 2-axis joystick with centre push function and two miniature LED indicators (red and green). It gives full control over the IMA system by sending commands over the H-Line, either by being directly plugged into the OBD port, or indirectly via the Obdiic&c display device.

Right and left joystick movements give full proportional control of assist and regeneration, respectively. Up and down jog movements give stepped fixed levels of assist and regeneration which hold until cancelled. (This is so you can maintain set levels without trying to hold the joystick in position.)

The centre joystick push function cancels any manual control function, and if held for longer than three seconds toggles the SCS (Service Connector System) function which activates the OEM dashboard lights to flash out module-specific Honda error codes.

### So how is Imac&c p&p installed?

The heart of the system is the MCM unit with the additional Imac&c p&p slave circuit board installed inside. You can do this circuit board installation yourself, or Peter offers an

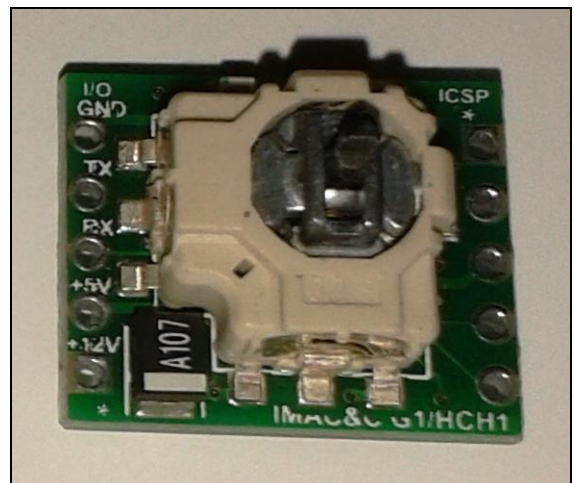
exchange MCM service for an additional \$50 fitting fee and \$200 deposit on your old MCM being received back in working order.

Fitting the now modified MCM is a very simple matter of:

1. turning off the main IMA battery
2. unbolting the rear compartment cover
3. unclipping the MCM connectors, swapping in the modified MCM for the standard one
4. re-plugging the MCM connectors
5. closing the compartment
6. turning the main IMA battery switch back on.

You then return the standard MCM to Peter, he refunds your deposit, and he modifies the old MCM for the next customer.

Fitting the joystick depends a lot on where you are going to mount it. Some people like it mounted on the gear knob, centre console, dashboard or even the steering wheel. It's small enough to fit almost anywhere and once you have it fitted in your chosen position, you can route the wire back to either the OBD2 plug or the Obdiic&c device (if fitted).



*The tiny Imac&c p&p Joystick board minus wooden knob, ready for installation.*

The Imac&c p&p slave PCB in the MCM can accept valid serial commands from any compatible device on the H-Line, and the details of the protocol and the packet structure are on the insightcentral.net forum. So you could design and build your own computer to send commands to the MCM slave. Normally however there are four control options.

- 1) The user will connect the supplied joystick directly to the OBD2 port.
- 2) They will connect the joystick to the I2C port on the back of their Obdiic&c display device which in turn connects to the OBD2 port.
- 3) The third option is to use three simple buttons to control the system via the Obdiic&c display device. These simple buttons give very positive assist/regen stepped operation and are very easy to use. Construction details for these are available on the forum thread.
- 4) Finally, the Obdiic&c display device itself can utilise its own on-board 5-way joy button to give basic control capability. However, Peter recommends this only for testing, as using the Obdiic&c button on the move is quite tricky.

Future development plans include cruise control and a Bluetooth connection dongle to allow system control via a suitable Android phone running a special Imac&c app.

Peter releases new software for the Imac&c p&p several times a year and owners can update their devices to get extra functionality and features using a laptop and simple USB/serial pic programmer available from

<http://www.piccircuit.com/shop/pic-programmer/25-icp01-usb-pic-programmer.html>

If you want a hand-built Imac&c p&p for your car, contact Peter at [150mpg@gmail.com](mailto:150mpg@gmail.com)

The price depends on the options selected:

- 1) Full Imac&c p&p package including ready modified Imac&c p&p MCM, hand built and cased Obdiic&c display, Imac&c p&p joystick. \$700 + \$200 deposit for MCM return.
- 2) Full Imac&c p&p package including Imac&c p&p MCM slave PCB to modify your own MCM, hand built and cased Obdiic&c display, Imac&c p&p joystick. \$650 inc. No MCM deposit required.
- 3) No Obdiic&c option = as above options 1 or 2 but minus \$300.
- 4) PCB only option includes Imac&c p&p Mcm slave PCB and Imac&c p&p joystick. \$300
- 5) MCM slave PCB only option. \$149
- 6) Three simple buttons control board \$99

All the above come ready programmed with the latest firmware, and include postage and Paypal fees. When ordering, please state if your car is a manual or CVT, and if you require the joystick direct or via the Obdiic&c display device option.

To see a demonstration of the system in use and how it can benefit you, watch Peter's 13 mile work commute Youtube video at <https://www.youtube.com/watch?v=iF-bNTBLc7Y>



Peter's you tube channel also contains many other videos detailing his devices and installation instructions for fitting the Ima&c p&p slave PCB into the MCM.

### Operating Instructions

Ima&c p&p is controlled by the 2 axis centre push self cancelling joystick.

it is important to note that the system is programmed to utilise the joystick like a momentary switch when pressed quickly up or down, and like a proportional variable resistor when pushed right or left. The centre push is a momentary audible click action. The joystick will return to the centre position when released.

### Safety

When trying out the Ima&c functions whilst stationary, ensure the car is in neutral and the parking brake is on. The safety factors and interlocks available depend on how you have installed the system. If you have connected the joystick directly to the Obdii port then you have no brake or clutch switch detection available to disengage the system if active! It is quite possible to engage maximum assist with the car in gear causing it to move, perhaps unexpectedly!

When the car is first turned on the Ima&c p&p system is in the Oem mode and control is by the normal car systems.

If you push the joystick to the right the engine will rev up and assist bars will show on the dashboard. How much it revs depends on how far to the right you press the joystick. You can command any level of assist by pushing right, and this is useful for large temporary changes in assist level. If you are approaching a hill and

want to get over without using more throttle, push the joystick gently to the right. You can also use this full right push to start the car if the ignition is on and the engine is running.

If you push the joystick to the left the engine will slow down, regeneration bars will show on the display, and you will probably stall as you are applying a large amount of regeneration. When ticking over the internal combustion engine cannot drive the Ima motor under heavy regeneration. You use this left push on the road when descending a hill or approaching a junction and you want to slow down. Pushing left gives you full proportional regeneration control, and allows you to slow down capturing energy without wasting it as heat in the friction brakes. Remember to change down to increase regeneration current as well as your speed drops to maximise the recovered energy. The Ima motor regenerates best at above 2k rpm.

Pushing up and down is different, in that as well as being a momentary action, there are two lengths of button push.. Less than one second, and longer than one second. Pushing up or down for less than one second gives several fixed levels of assist and regeneration. These fixed levels remain engaged until cancelled, and you step up or down through them. There are 5 levels of assist available by momentarily pressing up and 4 levels of regeneration available by momentarily pushing down.

If you press up once for <1s from the Oem position you will enter neutral mode, which means the Ima&c prevents any assist or regeneration requests getting through from the Oem system, but that it doesn't change the assist or regeneration levels itself. Neutral mode also engages the dc-dc converter ensuring the 12v battery remains charged. This is useful if stationary for a long period and

accessories, lights etc are draining the 12v system.

If you press up again the assist level will be set at 25% and the engine will rev, pressing up again will increase that to 50% assist, again and you have 75%, finally on the fifth up push you have 100% assist. These levels remain active until you either step down again by pushing down, or cancel by pushing the joystick left or right or pushing the joystick in.

Pushing the joystick up and holding it for more than one second will activate the special engine start cycle. This fires up the engine instantly in exactly the same way as the Oem system.

If you push down once <1s from the Oem position you will engage 25% regeneration, push again and you get 50% regeneration, again you get 75% regeneration and finally on the fourth down push you get 100% regeneration. To cancel, you either step up to drop down one level at a time (reverse of the assist mode) or press the joystick left or right or press it in.

Pushing the joystick down and holding it for more than one second will activate the special engine stop cycle. This stops the engine instantly in exactly the same way as the Oem system.

The centre joystick push mode has two functions. If pushed momentarily it cancels any assist or regeneration requests and returns the car to Oem mode. If you press and hold the button in for more than 3 seconds it activates the Scs (Service connector signal) and the dashboard begins flashing out stored error codes using the dashboard warning lights for each system. i.e. Cel, Ima, Eps, Abs, Srs etc. To cancel the error code mode simply

hold the button in again for more than 3 seconds.

If you are using the joystick or simple buttons wired via the Obdiic&c display device, then the system has additional active safety features. If you press the brake or clutch the Ima&c p&p system will disengage and return to the Oem mode.

### **Simple button control**

The three simple button control is cheap, very positive and intuitive, it operates in exactly the same way as the up and down momentary pushes on the joystick described above. Pressing the right button (instead of up with the joystick) gives five stepped levels of assist (including the first neutral position) and left (instead of down) gives four stepped levels of regeneration. The centre button cancels Ima&c p&p operation and returns to the Oem mode.

### **Obdiic&c joy button control**

I don't recommend this method for on road use, as controlling the system using the Obdiic&c onboard joy button is fiddly and insensitive. However it operates in much the same way as the three simple buttons described in the previous paragraph. Additionally pressing the joy button up or down cancels Ima&c p&p operation and returns to Oem mode. Holding the centre button in will activate the normal Obdiic&c menu system and you can then use Menu 8 to configure the system.

### **Obdiic&c Menu 8 Ima&c p&p Configuration**

If you are using the Obdiic&c display device with Imac&c p&p then once you have connected your chosen control method (joystick or buttons) to the Obdiic&c you have to configure the system.. Use the Obdiic&c joy button to go into Menu 8. Press down to cycle through the various control options until you have the one displayed that matches your configuration.

C&cMo=Off (No Imac&c installed)

C&cMo=Joy (Imac&c Joystick installed)

C&cMo=RBut (Imac&c remote three simple buttons installed)

C&cMo=LBut (Obdiic&c joy button used for control)

Pressing Up toggles the MaxAssist mode on and off! This is a special performance feature that does not require manual control to activate. When engaged the Obdiic&c device constantly monitors the throttle position value, and whenever the throttle is pushed beyond 90% Imac&c p&p will engage maximum assist for as long as the throttle is pressed and the battery can sustain it. This gives maximum acceleration for overtaking etc and is like kick down in automatic cars, and similar to the Kers system in racing cars. This feature does not need buttons or a joystick installed. If you only wanted this Max Assist mode you can do it with just the Imac&c p&p slave pcb installed in the Mcm and the Obdiic&c plugged into the Obdii port..

Once you have configured the Obdiic&c correctly and exited the menu system the Obdiic&c will reboot. It will establish communications with the joystick if installed and the normal 8 parameter display will appear. On the far right of the screen several flags will appear during Imac&c p&p operation

to denote the current operating mode. A=Assist Mode, R=Regeneration Mode, N=Neutral Mode, M=Max Assist Mode, B=Blink Mode, s=Stop Mode, S=Start Mode.

### Error flags

Error flags that may appear on the far right of the Obdiic&c .can include. T or t =Imac&c communications timeout, C=Imac&c checksum error, E=Incorrect 8<sup>th</sup> parameter.

