INTELLIGENT IMMERSION

Do you have solar PV panels or a wind or water turbine? Now you can heat your water free.

An Intelligent Immersion diverter is a small all electronic device for your home that, rather than exporting your surplus power to the grid, diverts electricity from a microgenerator such as solar PV or wind/water turbine to an immersion heater or other heating load. Using clever internal software it modulates the heater current to exactly match the house load and PV generation, thus delivering maximum power into the heater and a tiny power to the grid. It responds to changes in house demand or generation instantly so is always matching what the house is doing.

It is fully automatic and needs no owner adjustment or interaction. Indicator lights on the unit tell you what it is doing and how much electricity is passing to the load and the grid. The thermostat in your immersion keeps the water to the right temperature.

There are two models available. The I2 is the standard one and the I3 incorporates a Wi-Fi interface so it can communicate with phone, tablet and computer devices in an "Internet of Things" to provide increased functionality. This datasheet is for the I3, see the I2 datasheet for the other model and for more information about the I3's controlling of an immersion and its multifunction relay.

Compared with the I2 the I3 adds:

- Remote reading of up to 4 energy flows
- Data display is portable so you are not tied to having to read it at the I3
- Controlling the unit remotely, e.g. turn it on as you come back from holiday from your web connected device
- Configuring the unit remotely, e.g. modes of operation, thresholds and timing of relay settings
- Saving data in the cloud and plotting energy graphs
- Simpler alteration of embedded settings
- Retains all the standard functions and performance of an I2 with its ultra low export, reliable operation and freedom from unreliable LCD displays

- Standard immersion operation carries on even if the Wi-Fi connection is lost
- Extra analogue and sensor inputs so you can monitor two other energy flows such as PV generation and another house load meaning a total of four energy values are displayed.

The extra functionality depends on the software you use on your device.
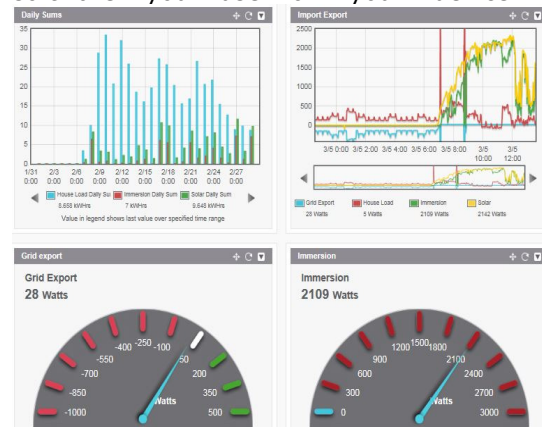
As this unit modulates the heater current it will not import electricity for heating or export when not required. The unit has a useful override switch to turn the heater fully on for a short period using grid power if your hot water needs a quick boost on a dull day.

There are no parts that will wear out or

"Thanks for the fast dispatch. I have it installed and I'm really pleased with the results so far. The unit is pleasingly robust and looks well constructed. Very simple to install as well." CY of Aberdeenshire

displays to fade. Compared with similar products it is much more robustly constructed so will last well.

It is simple to install, needing only two wires connecting into your immersion circuit and no changes to the other house wiring. A sensor clips around one of the mains wires near your meter or consumer unit. The extra 2 sensors that the I3 has compared with the I2 can be clipped to any wire you choose. Typically one of them will be the solar PV output so generation can be logged. It uses your existing 3kW immersion so there is no expense needed to change it.

"I have looked at similar products and there is no comparison. The I2 and I3 is of much higher quality construction. Very easy to install" TC from a London PV installer.

HOW DOES IT PERFORM?

These daily graphs are taken from an I3 installation in Hampshire in winter with a 4kW PV system. The vertical axis is watts. At 8.15 there was enough sun (yellow line) to exceed the house load (red line) and the immersion (green line) turned on. It stayed on till 14.45. The export (blue line) during this period was steady just above the zero line at a mere 30W.

Most of generation goes into the immersion, a tiny amount was exported and the rest fed the house load. The I3 has not imported any electricity to feed the immersion as the only import (blue line below zero) is when the sun is too low to feed the house load.
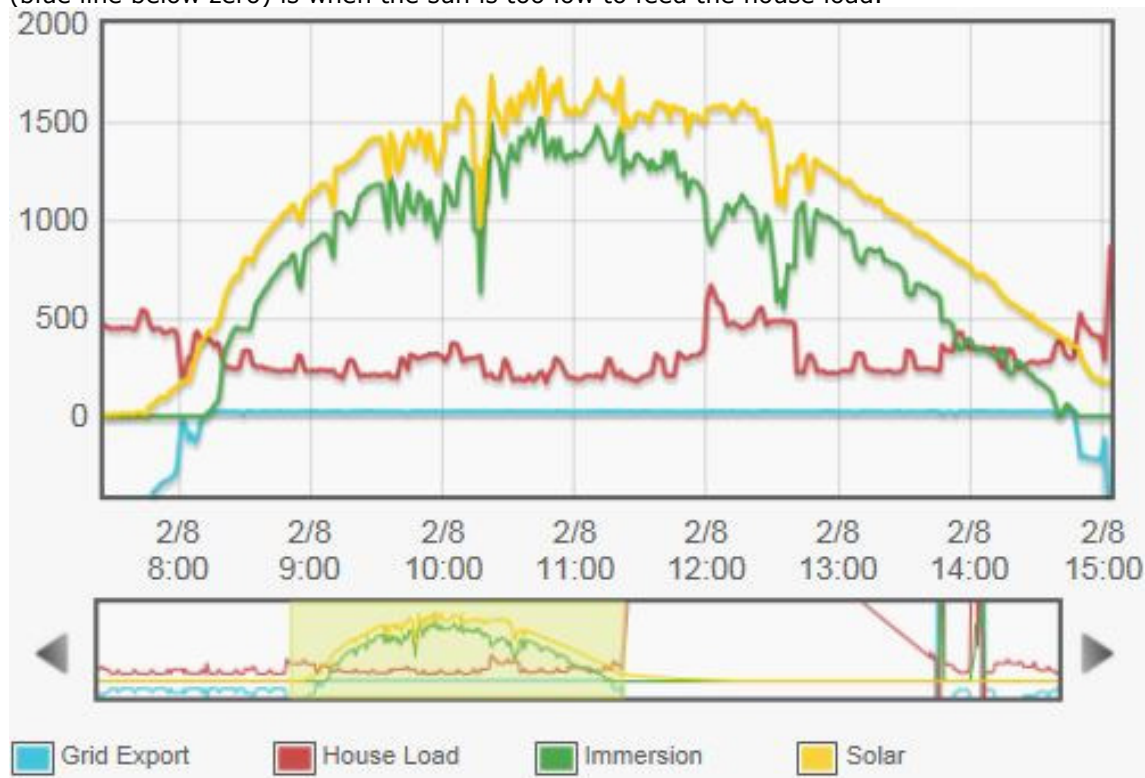

"My I2 provided enough hot water each day for most months in 2012, without resorting to switching on the gas water heating. It never imports when loads or generation change. Once installed you just forget it is there and it needs no user intervention I highly recommend the I2 device to anyone. It does exactly what it says on the tin and at a cost which makes sense from a returns point of view." KH of South Yorks

"What exemplary customer service, by the way. Truly your dedication is impressive." RM of Cumbria

"I purchased a pre-production box it works very well with no light flickering and a low switching margin. I find them very straight and knowledgeable." JU of Herts

Even on days when the sun and the house load is less steady the blue line still shows tiny export showing how fast the I3 reacts to changes in conditions.
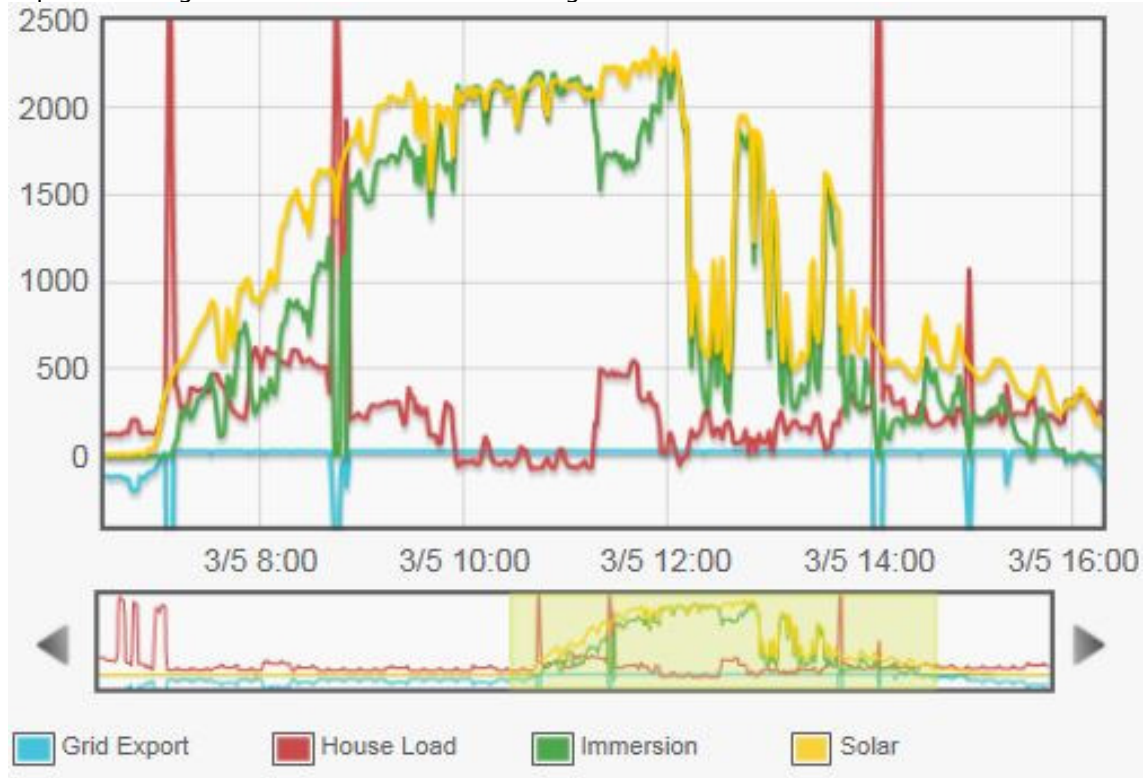
In this case there has been some import when kettles have been boiled (large red spikes) but the immersion was immediately turned off by the I3 during these so no import fed the immersion as seen in this expanded view.

In summer the days are longer and the sun more intense so although the graphs look similar the energy into the immersion increases.
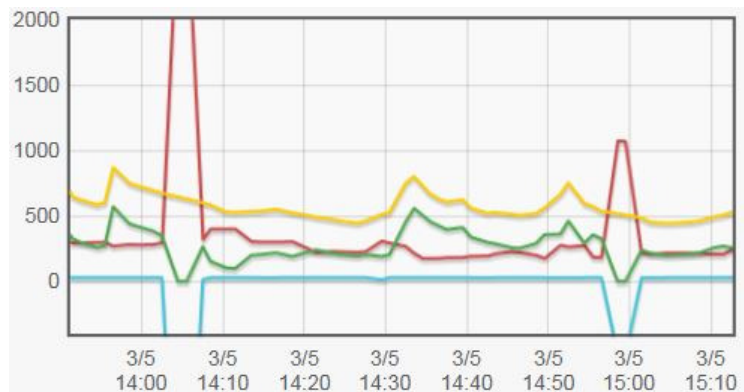
WI-FI SETUP

You need:

- A standard Wi-Fi router within range with permanent internet connection, although the I3 can also provide some functionality without this by communicating direct to a Wi-Fi device

- Windows, Android, Linux or Apple computer, tablet or smartphone device; indeed pretty much anything running a modern web browser

EXTERNAL SOFTWARE

The I3 is supplied with 2 software programmes, I3 Monitor and Exosite, for your device and more are under development. The first two are webpages rather than installed programmes so they work in any modern browser thus they are iOS/Windows/Android/Linux etc. compatible.

I3 Monitor

This is a webpage that will come up on your device when the address for your I3 is entered into the address bar. This is its main screen.

From this can be seen all the four energy flows, the difference between two of them, the status of inputs and outputs, the mode of operation and the front panel switch/relay can be overridden. Data is updated once a second giving a superbly fast view of changes in house loads.
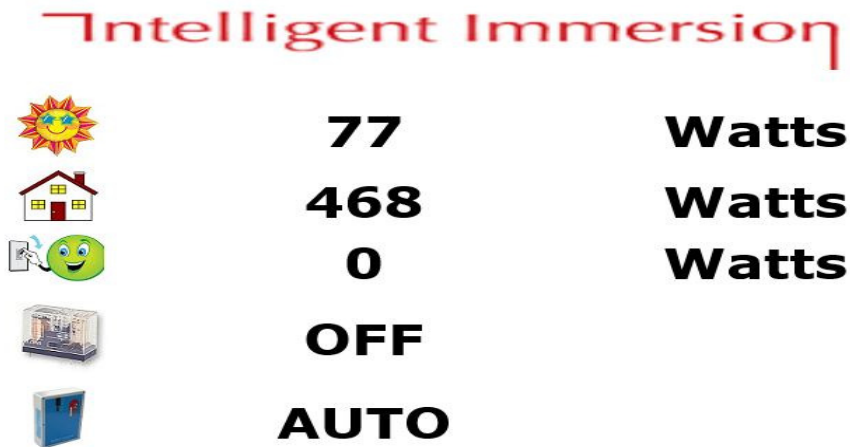
Energy thresholds can be set on this screen.

Further screens to view the status of the Wi-Fi connection are provided.

For small displays and easy monitoring this simple icon display with large characters is also supplied. It displays clearly even on a small smartphone screens.

Exosite (Note1)

microchip.exosite.com/views/4020795737/2588633107 shows the live website for the benchmark I3 and you would get your own site like this for your I3 (Note 1). The dials, graphs and tables can be labelled to correspond to whatever wires you clip the sensors to. The most common set up is Export, Immersion, Solar PV generation and one other large load like electric car charger or storage heater.

It is a commercial web portal that stores all your data for display in a web browser. Current data is show on dials with historical data on graphs and tables.
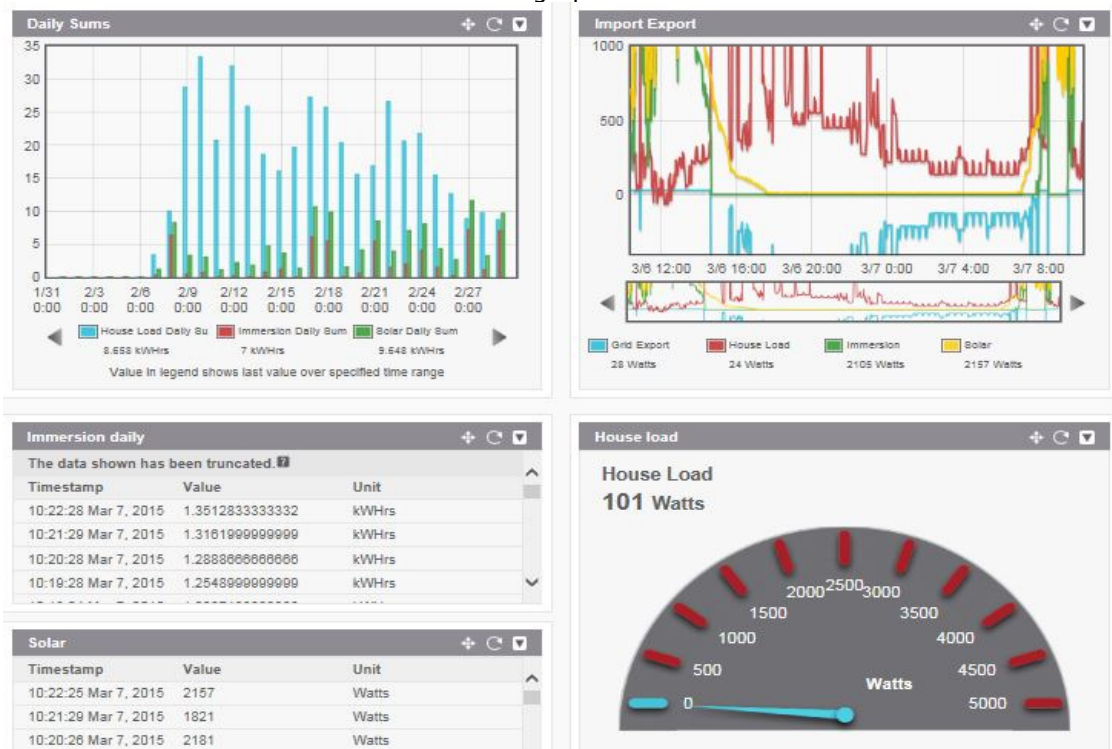
Separate pages enables the user to control the I3 remotely. The I3 is supplied with a range of dials, graphs and tables which the user can configure to suit their needs. Extra dials, etc. can be added and rules set up to trigger events such as "Generation is exceeding 2500W so send me a text and email to remind me to turn on the washing machine". These additions

require some technical skill but no software programming. We can help you to configure this. Simple tutorials are available on exosite.com/

I3 Supervisor

An Android app is under development by us that provides similar functionality to Exosite for control from remote locations. For security and reliability the storage of data will be on an Android device which is left in the home. E.g. even a very cheap tablet provides a very useful means of storing the data and gives a large easy to read display of the data that can be carried around. A spare old smartphone may suffice too. Out of the home access is still possible from a different device. Thus say a tablet in the home provides storage and a display but outside the home a smartphone or PC can read the data.

I3 SPECIFICATION

Parameter	Data	Notes
Voltage range	210-250VAC, 50+/-2 Hz	
Load rating of variable output	3.1kW max resistive	Do not use inductive (e.g. motor) or capacitive loads
Load rating of fixed relay output	250VAC, 14A. Volt free single pole changeover contact	Derate for inductive or capacitive loads
Terminals	DIN terminals for 2.5 or 4mm2 cable 2.5mm2 terminal strip for relay load Terminal strip for current sensor	One 3 core cable to MCB/RCBO One 3 core to main load One 3 core to second load Sensor clips near consumer unit or utility meter
Cable entry points	Two 20mm diameter holes in end wall of enclosure	Suitable for connection to conduit, fitting cable glands or using without extra parts
Turn on threshold	30W of export to grid	Default value can be easily altered by user down to zero
Quiescent power	1W	
Power consumption in unit	1W + 0.5% of load power	
Efficiency (% input power transferred to hot water)	>99% (for power more than 500W)	Gas and oil boilers are around 50 - 70% for short water heating cycles
Case	Cast aluminium with pale grey coloured enamel coating	
Thermal rise of case at a delivered 2kW	<15C	In free air
Time to stabilise load power after an instantaneous step in generation or house load	<0.5 sec	
Temperature range - operating	-10 to 50C	Assumes a free flow of cooling air around unit
Temperature range - storage	-30 to 70C	
Humidity	Non condensing	
Dust and water protection	IP50	Semi sealed. Keep away from dripping water, not for outdoor use.
Export current sensor	One clip-on current sensor around incoming mains supply. Max power 24kW, displays value accurately up to 10kW.	Wire diameter up to 13mm
Sensor cable length	2 m	Can be extended up to 30m and more if slight performance

Parameter	Data	Notes
		degradation is accepted
Internal current sensor	Measures the variable load power	User enters the load rating in I3 software so reading is accurate
Front panel controls	Switch for load off, automatic operation, load fully on, one hour top up	Can override permanently or set a one hour top up at full load power. Switch functions can also be remotely operated from I3 software
Indicators	LEDs for unit on, power level to load, import power level, export power level	LED's brightness or flash rate indicates level of power. All values available as numerical values remotely with I3 software
Enclosure size	220 x 145 x 55mm	
Weight	1.5kg	
External wiring	2.5 or 4mm2 twin and earth recommended	Must be earthed
Mounting	3 holes in back plate for screws. Mount in free air. Any orientation allowed.	Recommended to mount near consumer unit
Protection	20A and 1A fuses Surge suppressor EMC filter	
EMC and Approvals	CE marked EMC and Low Voltage Directives 2004/108/EC and 2006/95/EC BS EN 61000-6-1 Generic Immunity BS EN 61000-6-3 Generic Emissions BS EN 61000-4-3 Immunity to radiated emissions BS EN 61000-4-14 Flicker	For UK/EU use only Does not use Burst Firing to control power so no risk of causing owner's and neighbours' lights to flicker
Warrantee	3 year return to base covering parts and labour	Made in UK
Expected life	20 years	No moving parts apart from occasionally used switch
Predicted MTBF	>150,000 hours	
Supplied with	Current sensor and cable User manual Installation manual	No additional parts apart from wall screws and mains cable are needed to fit the unit
Software for Wi-Fi interface	Runs on web browsers on Windows, Mac, iPhone, Android, Linux, etc.	Almost any web browser will run it but not every variant has been tested. A screen larger than 10cm is recommended. 2 devices can communicate with the I3 at once.
Wi –fi standard	IEEE 802.11g	External swivelling aerial on enclosure
Wireless range	About 30m in free air to a standard domestic router	Walls, floors, etc. will limit the range. (Note 2)
External equipment required	A standard IEEE 802.11g (or higher) Wi-Fi router within range with permanent internet connection, although the I3 can provide some remote functionality without this by communicating direct to a Wi-Fi device.	

Parameter	Data	Notes
	Windows, Android, Linux or Apple computer, tablet or smartphone; indeed pretty much anything running a modern web browser.	
Digital interface	8 lines based on 0 to 3.3volt logic levels. Each can be configured as an input or an output using the browser interface. Rules can be set with the web portal to operate these lines e.g. if load power is >2000W turn off line 3. If Line 2 is high turn the multifunction relay on.	Requires external protection against over and reverse voltages. External opto isolation is recommended. II Ltd can supply a recommended circuit diagram for interfacing logic. At the moment we don't supply a ready built interface. The multifunction relay, if not used for other purposes, can provide the equivalent of a one line output and it is fully mains compatible for switching say central heating on.
Extra analogue interface	2 inputs for extra current transformers of same type as main sensor. Max power 24kW, displays value accurately up to 10kW for reasonably sinusoidal load currents of close to unity power factor.	Coming later: inputs can be used for a 0 - 3.3V DC analogue signal and the voltage displayed on the device. Sensor cables can be extended up to 30m, or more if slight performance degradation is accepted
Indicative performance with a 4kW PV system in London (Note 3)		
Indicative annual input to immersion heater	1200-1700kWh	Assumes a 4 person household. Realistic maximum is around 2000kWh
Maximum daily input to immersion heater	15kWhr in summer	Can be up to 20kWh if house load is very low
Payback time with gas or Economy 7 water heating	2-3 years	Not including installation cost
Payback time with oil/LPG/full rate electricity water heating	1-2 years	Not including installation cost

Note 1: The Exosite web portal is currently free of charge so we don't charge customers for the use of it. We can not guarantee that a monthly or yearly charge may not be applied later by the portal company and this will be passed on to the I3 customer. Failure to pay could result in your account with them being suspended. Without this portal it is still possible for no cost in your home to control and monitor the I3 using our I3 Monitor application and so display current power levels and control the I3. However the saving of data in the cloud will be lost, thus daily summations of energy and long term graphs would not be possible. The ability to set rules to control the extra digital outputs from the internet will also be lost.

We are developing the Android based I3 Supervisor app that provides similar functionality to Exosite, details above.

Note 2: The I3 relies on an active Wi-Fi and internet connection to collect the energy statistics and enable remote control from outside the house. Any loss of reception will cause gaps in the saved data. Generally the I3 has better reception than a typical Wi-Fi phone or laptop as it has a better transmitter/receiver and aerial. Thus if your laptop or tablet has adequate reception at the intended I3 mounting location then the I3 should work as long as the Wi-Fi router remains active. If your reception is poor we recommend an additional aerial

or Wi-Fi slave access point. The I3 Supervisor app will not need an internet connection to work and can be placed close to the router for connection reliability.

Note 3: Performance and payback times are not guaranteed. Because every house is different in its amount of sunshine, size of PV system, use of hot water and electricity, etc. we can only provide indicative figures. We can say though that the I3 performance is as good as or better than any other proportional diversion controller currently available and much better than any that only switch the load fully on and off. It is equivalent to a medium sized solar thermal system at a much lower cost. London is reasonably representative of average English and Welsh sunshine, but the North of England and Scotland will have less in most locations.

THE COMPANY

Who is behind Intelligent Immersion Ltd?

Managing Director Edward Chase is a Cambridge University educated Chartered Engineer who has been designing electronic controllers for the solar industry for a number of years. His background in Safety and Reliability Engineering has been used in the design to develop a highly reliable and robust product. Now the owner of an electric car he is working on using the I2 or I3 to provide optimised battery charging for cars.

Technical Director Paul Mcallister like Edward was a pioneer of low cost solar diverters. They pooled their design ideas to develop the current I2 and I3. He has done the Wi-Fi development for the I3. He also designs high reliability spacecraft electronic systems.

John Spens brings his business experience from being the CEO of a £17m pa turnover company.

Manufacture is subcontracted out to competent UK companies and final testing and quality control is performed in house to ensure you receive a perfect product.

The original I2 was codeveloped with a leading PV installation company now trading as Hanergy Ltd. who are IKEA's PV installer.

Intelligent Immersion Ltd
www.intelligent-immersion.co.uk
Email info@intelligent-immersion.co.uk
Tel 07962 216671

I2 and I3 drawing. I3 has an added stub aerial on the front lid, not shown here, otherwise details are the same.