

# imp006-breakout



**Intro** The imp006-breakout design is intended to serve two purposes:

1. Provide a off-the-shelf hardware platform that allows a customer to evaluate the imp006 product & Twilio/Electric Imp platform

In order to evaluate the imp006, customers need to be able to connect it to sensors and actuators, build an application, integrate it with a cloud backend , and measure various parameters such as power consumption and latency to determine if they meet requirements. To satisfy these requirements, the imp006-breakout has various on-board peripherals, industry standard expansion connectors, and a configurable power supply to satisfy several commo n power scenarios.

2. Provide a reference design that customers can use to base their own imp006 products on

The schematics presented here are modular, with source provided for both schematics and PCB; a customer requiring only cellular connectivity can simply remove the entire WiFi/BLE page (and conversely, a customer needing only WiFi/BLE can remove the cellular page). At a more granular level within e a c h schematic sheet, each functional area is boxed with a short description of the functionality it provides - for example, if GNSS is not required but cellular is , the GNSS parts of the cellular page can be removed without any side-effects.

**Index** 1: This page.

- 2: Core imp006: components on this page are all required in every customer design - the MCU, QSPI flash, blinkup and status LEDs.

- 3: Power: the power system is designed to work with both primary cells (or external power) and Li-Ion rechargeable cells; pick the power supply which suit s your application, or omit this section and supply power to the components with your own power supplies.

- 4: Connectors/Peripherals: this page is really quite breakout-specific, but shows how various peripherals can be wired (eg sensors).

- 5: Cellular: parts required to support the Quectel BG96 Cat-M/2G/NB-IoT+GNSS radio. Can be omitted for WiFi/BLE only designs.

- 6: WiFi/BLE: parts required to support the Murata 1MW dual-band 802.11ac/a/b/g/n + BLE 4.1 radio. Can be omitted for cellular only designs.



## Power selection jumpers

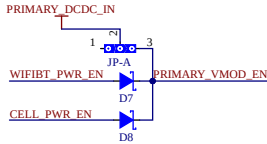
The imp006-breakout is designed for extreme power savings in multiple operating modes

### JP-A: Force buck on

JP-A is used to force the primary buck ON, regardless of whether the MCU wants either radio to be powered.

This is used when JP-A is set to 2-3, so that the primary buck will run continuously to provide the MCU with power, or when power needs to be preserved to the BG56 (eg for GPS state preserve).

If the primary cell used is <10v (and JP-C is hence set to 2-3), the primary buck will only run when required, reducing Iq

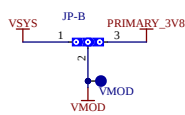


### JP-B: VMOD select

JP-B determines how VMOD, the radio power supply (both cellular and WiFi/BT), is provided.

1-2: Power VMOD from VSYS, the Li-Ion PMU system output. This is used when a Li-Ion rechargeable cell is powering the system

2-3: Power VMOD from the 3v8 buck, which is used when a primary battery pack is in use.

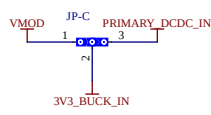


### JP-C: 3V3 select

JP-C determines how 3V3, the imp MCU power supply is provided.

1-2: Power 3V3 from VMOD, which could be VSYS or the primary buck. This is used when a Li-Ion cell is in use or a primary cell of >10V (the highest acceptable input for the 3v3 buck) is used.

2-3: power the 3V3 buck direct from the primary cell. ONLY USE THIS WHEN THE PRIMARY CELL MAX VOLTAGE IS <10V

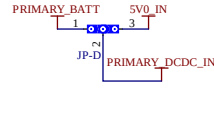


### JP-D: USB Only power

JP-D is used to bypass PMU U1 from 5V0\_IN to PRIMARY\_IN, intended for battery-less operation only from USB power input.

1-2: 3V8 DCDC taking input from Primary battery.

2-3: 3V8 DCDC taking 5V0 USB as an input.



## Common configurations

### Li-Ion rechargeable cell

JP-A:1-2, JP-B:1-2, JP-C:1-2, JP-D:1-2

### Primary cell, 4-10v

JP-A:1-2, JP-B:2-3, JP-C:2-3, JP-D:1-2

### Primary cell, 10v-17v

JP-A:2-3, JP-B:2-3, JP-C:1-2, JP-D:1-2

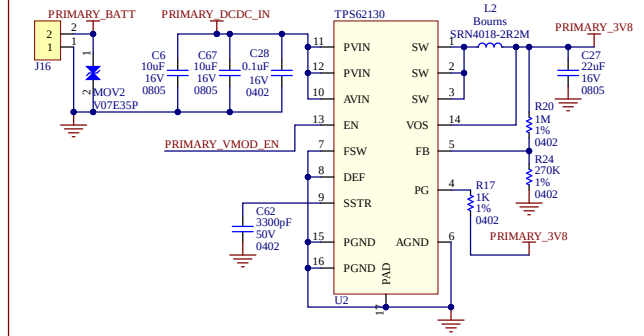
### USB Only (no battery) \*

JP-A:2-3, JP-B:2-3, JP-C:2-3, JP-D:2-3

\* Default factory state

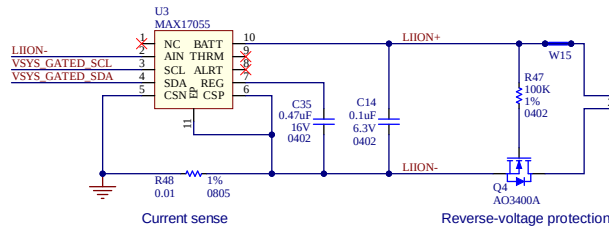
## Primary battery 3V8 supply

Input range -4v-17v



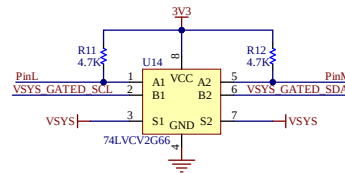
## Li-Ion battery & gas gauge

8-bit I2C address: 0x6C



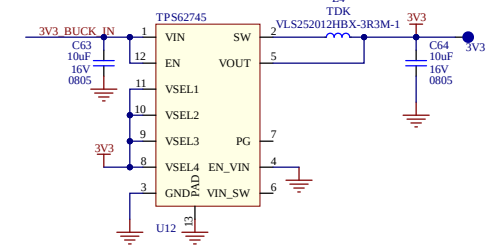
## I2C bus isolator

This ensures an unpowered PMU & GG do not load the I2C bus when a primary cell power source is used. Applicable only to this breakout board



## Ultra-low Iq 3v3 supply

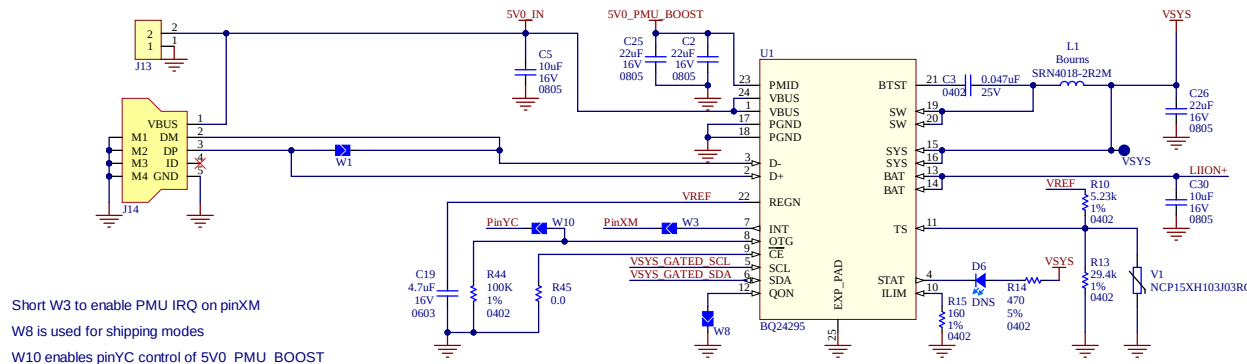
Input range -3.7v to 10v  
Used in all power configurations to power MCU and peripherals



## Li-Ion PMU/battery charger & power path

8-bit I2C address: 0xD6

When J13 is used for power input, the USB DM/DP brick detect will not work, so short W1 to set 3A input current limit



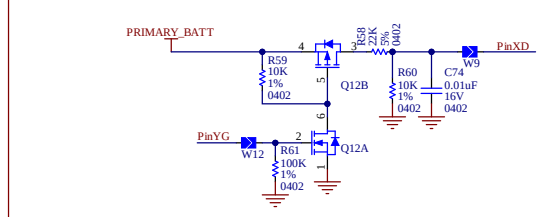
Short W3 to enable PMU IRQ on pinXM

W8 is used for shipping modes

W10 enables pinYC control of 5V0\_PMU\_BOOST

## Primary Battery Voltage Measurement

To use, short W12 and W9, then drive pinYG high to read scaled voltage on pinXD



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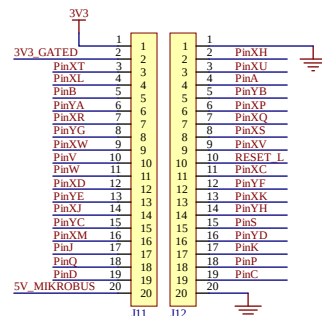
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Design: **imp006-breakout** Rev: **3.1** Twilio  
375 Beale St Suite 300, San Francisco, CA, 94105  
Sheet: 3 of 6 Date: 18/06/2020 Time: 10:08:18  
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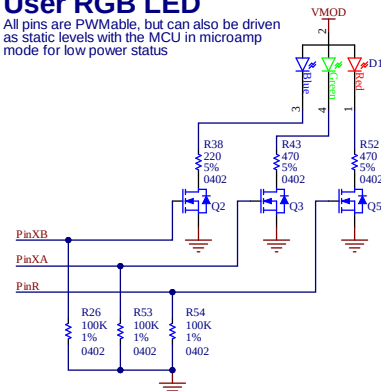


0.1" pitch 2x20 header



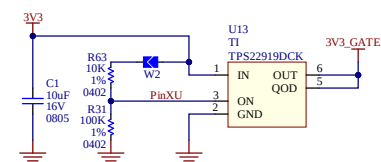
## User RGB LED

All pins are PWMable, but can also be driven as static levels with the MCU in microamp mode for low power status

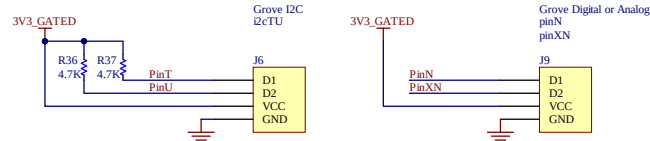


## Power gate for Grove/Mikrobus

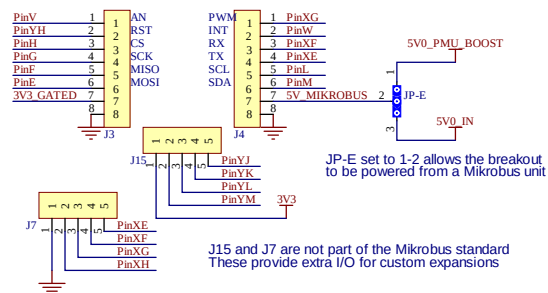
TPS22919 used to control inrush currents  
Short W2 to force 3V3\_GATED on  
(if gated peripherals need to be on during deep sleep)



## Grove connectors for I2C and digital/analog

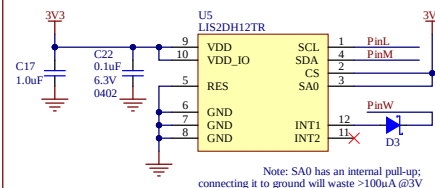


## Mikrobus socket



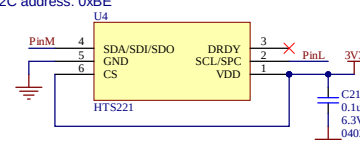
### 3-Axis Accelerometer

8-bit I2C address: 0x32 (SA0 High)  
INT1 can wake imp from deep sleep via D3



## Temperature & Humidity sensor

8-bit I2C address: 0xBE



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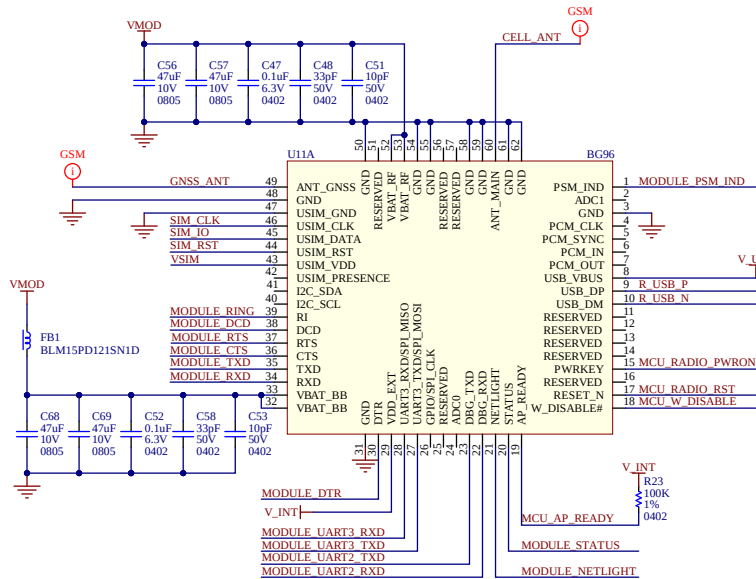
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| Design: <b>imp006-breakout</b>                                        | Rev: <b>3.1</b> | Twilio<br>375 Beale St Suite 300,<br>San Francisco, CA, 94105 |
| Sheet: 4 of 6    Date: 18/06/2020    Time: 10:08:18                   |                 |                                                               |
| File: Z:\el-hardware\imp006\imp006-breakout\imp006-breakout-connector |                 | SchDoc                                                        |



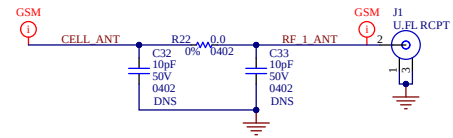
## Quectel BG96 Cat-M, NB-IoT, 2G & GNSS module

Note all I/Os are 1.8V



## Cell antenna

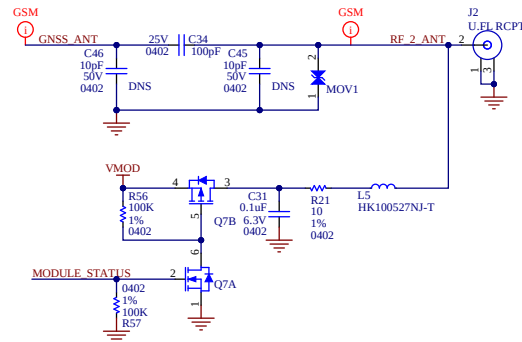
Match circuit not stuffed; assumes 50 ohm antenna



## GNSS antenna

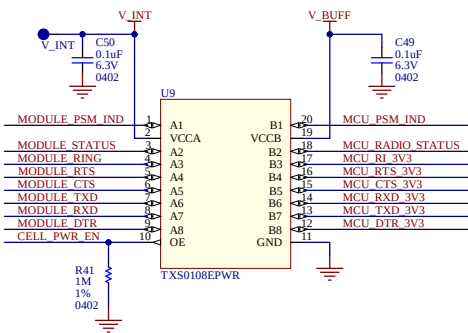
Match circuit not stuffed; assumes 50 ohm antenna

GPS antenna power is gated by MODULE\_STATUS, so is only on when module is powered and awake



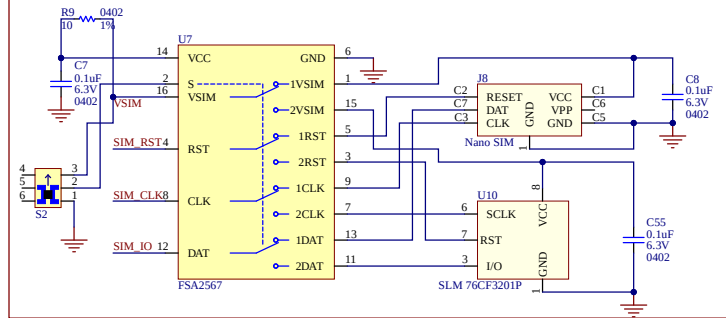
## 1v8 <=> 3v3 level shifter

TXS0108 performs bidirectional level translation  
NOTE: This part is very noise sensitive. Attaching a scope to what should be a driven output often causes unpredictable behavior



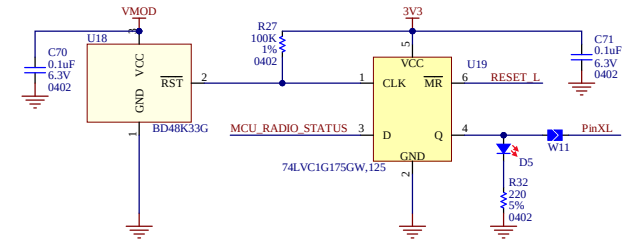
## SIM select circuit

S2 switches all SIM lines between U10 (eSIM) and J8 (nano SIM socket)  
Control signal must never float hence SPDT switch



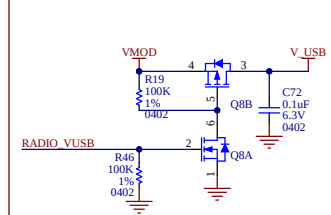
## Radio brownout indicator

This circuit detects when VMOD drops below 3.3v when the radio is powered  
If this happens, D5 is illuminated, indicating a possible supply issue. The indication is cleared by a reset  
This usually indicates insufficient current available, especially on 2G networks  
If W11 is shorted then the MCU can read this state in software



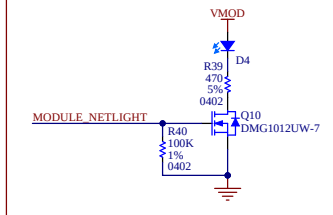
## Radio VUSB gate

This circuit supplies V\_USB from VMOD instead of 3V3  
This provides extra margin against accidental USB disconnect if 3v3 is glitched



## Network status LED

Searching for network: short on/long off  
Registered on network: long on/short off  
Data transfer: fast blinking



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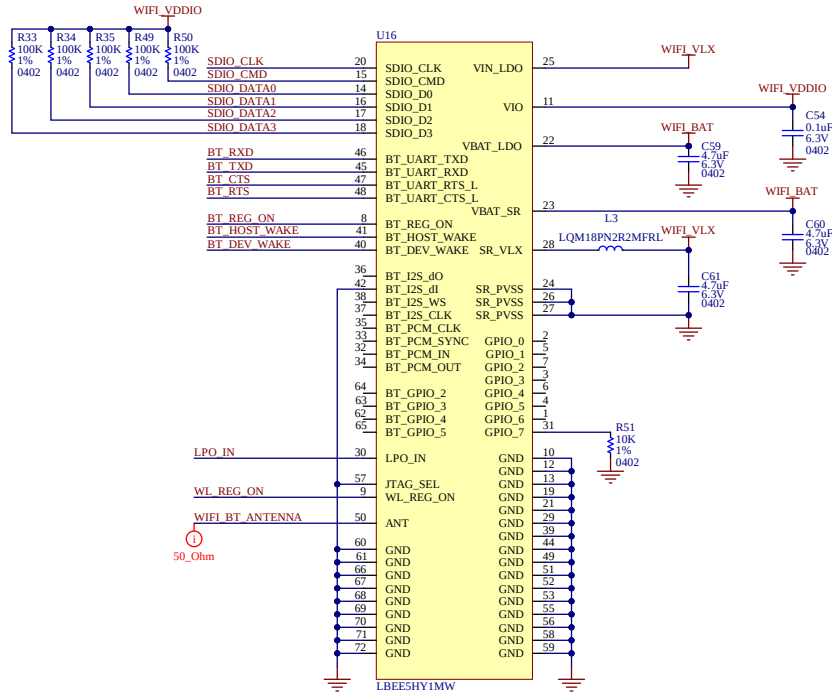


## Dual-band WiFi & BT module

The Murata LBEE5HY1MW module is used to provide 2.4 & 5GHz WiFi ac/a/b/g/n and Bluetooth capabilities.

Please contact Electric Imp for guidance on using the Murata 1DX module if only single-band WiFi & BT is required.

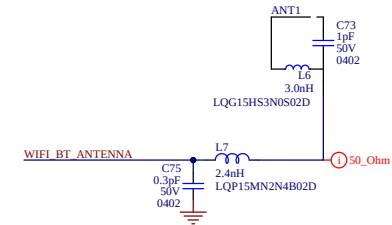
If you are not using WiFi or BT in your design, this entire page can be omitted.



## Dual-band WiFi & BT antenna

The on-board antenna is the Murata reference antenna, which was used for their FCC modular certification testing. Due to layout constraints, this antenna is not used in the best configuration on the imp006-breakout.

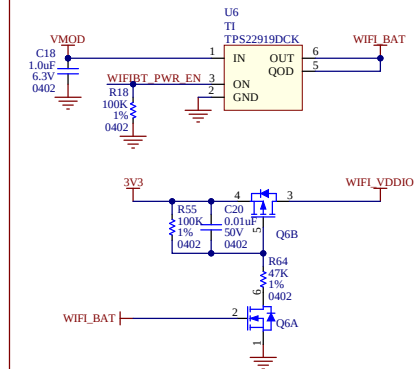
Please contact Murata for more details on correct 1MW antenna placement and usage



## WiFi / BT power gate

In this design, because someone may be using the imp006 breakout just for cellular, WiFi / BT power is gated totally when WIFI\_BT\_PWR\_EN is low; this saves 11uA for designs that aren't using WiFi or BT.

WIFI\_VDDIO is gated by WIFI\_BAT, ensuring that it comes up after WIFI\_BAT as specified in the CYW43455 datasheet.



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Sheet: 6 of 6 Date: 18/06/2020 Time: 10:08:19  
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