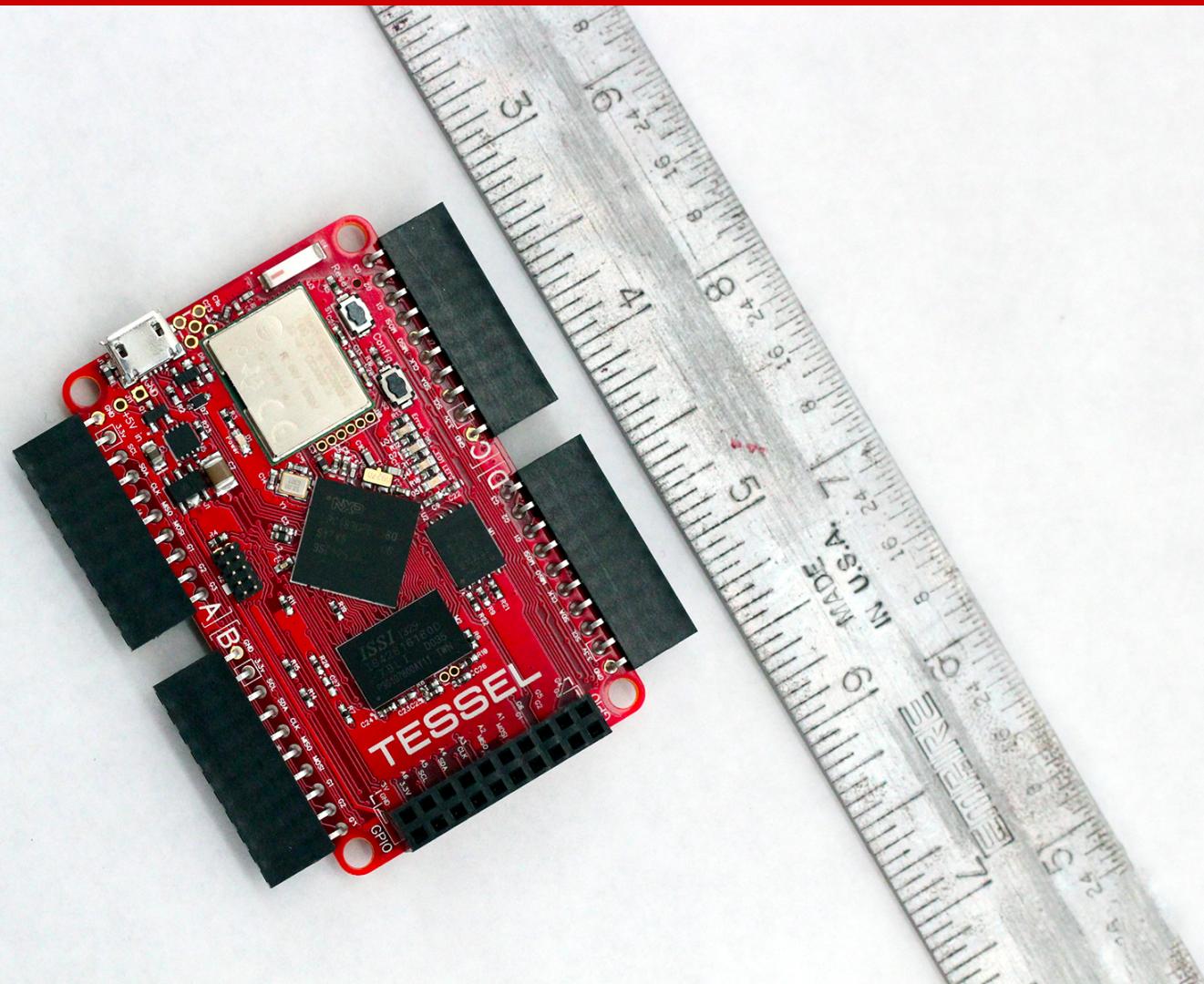




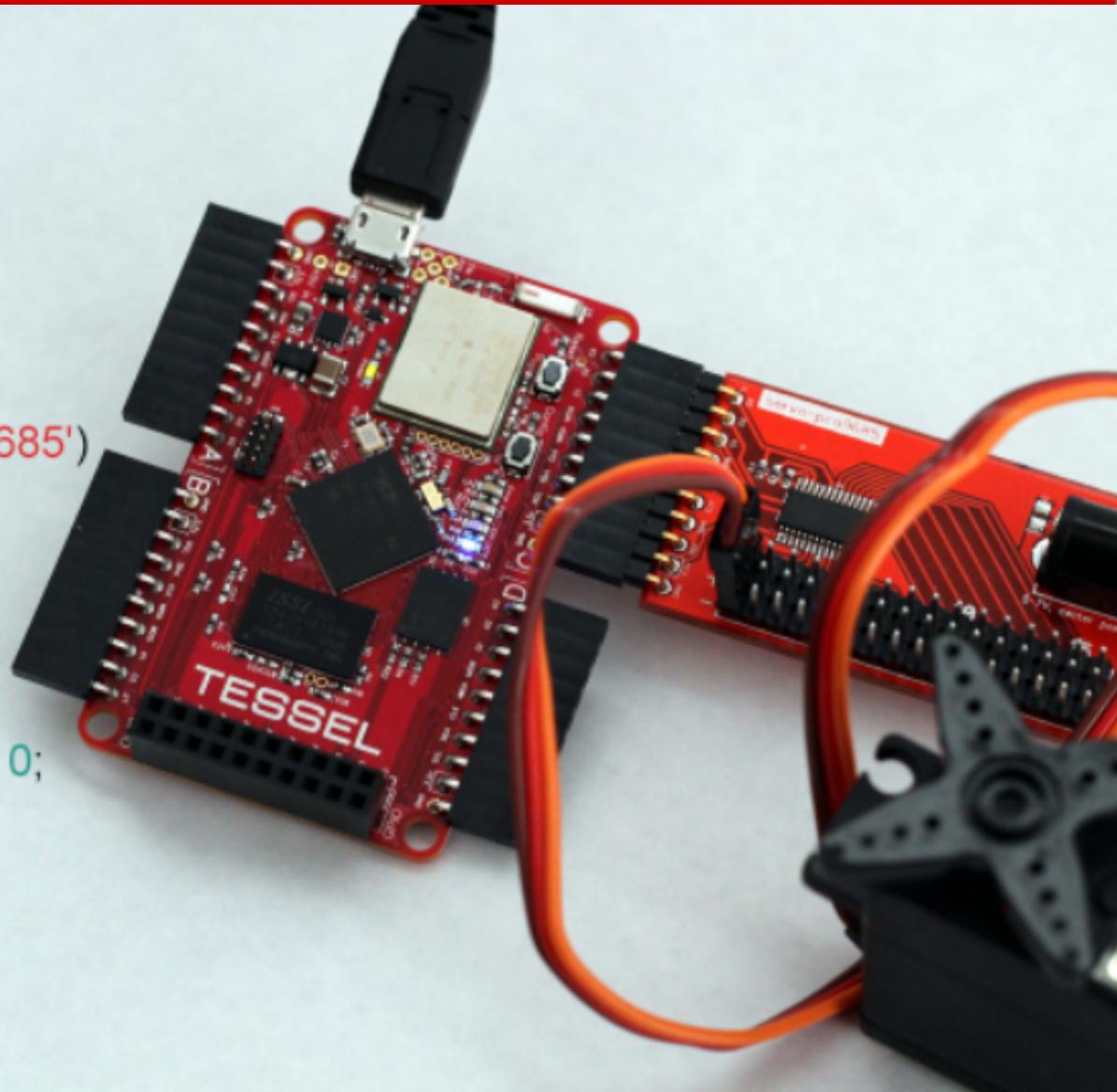
Technical Machine's Hardware Playbook

Tessel is a WiFi-enabled
microcontroller that runs JavaScript.

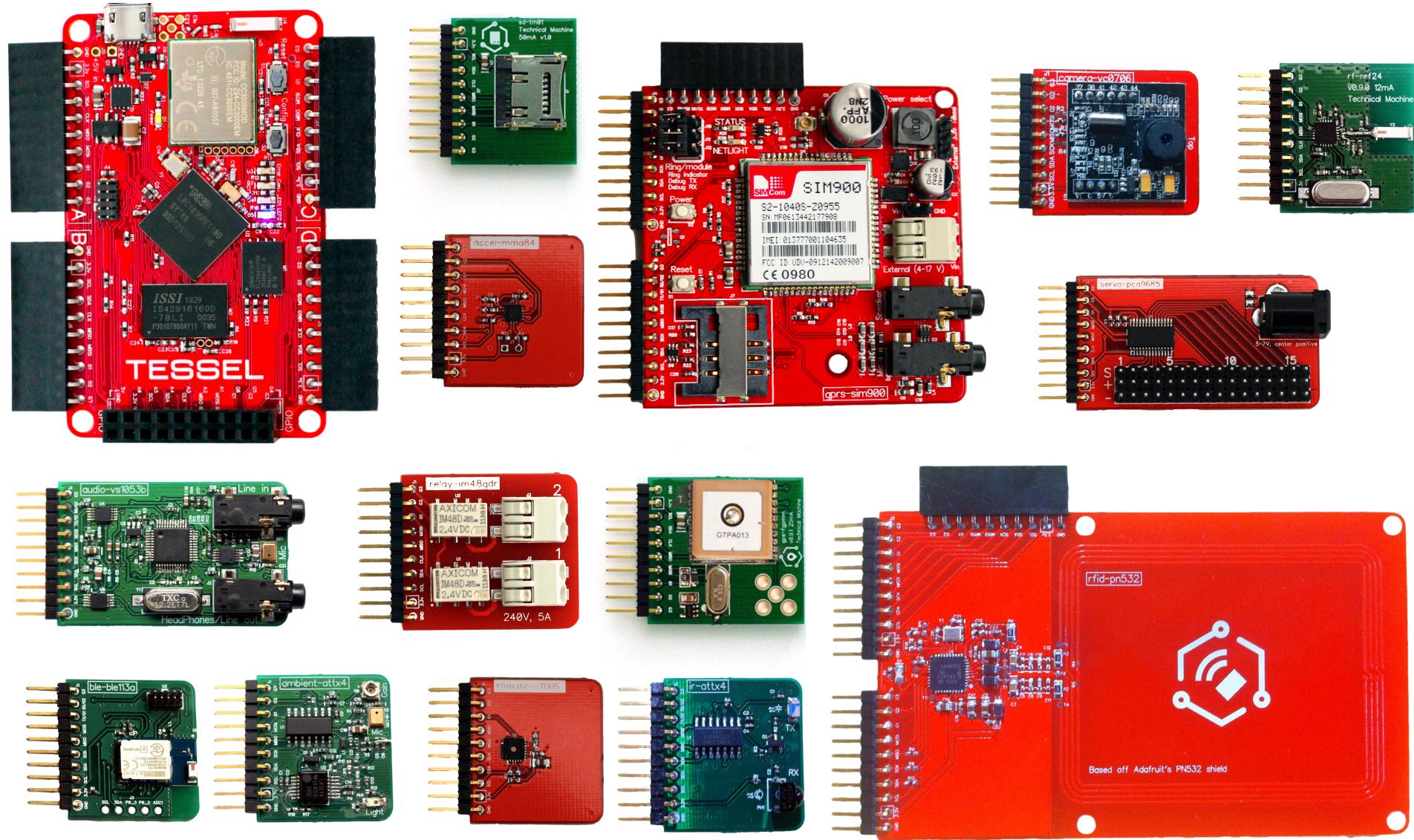


```
var tessel = require('tessel');
var servos = require('servo-pca9685')
  .connect(tessel.port('A'));

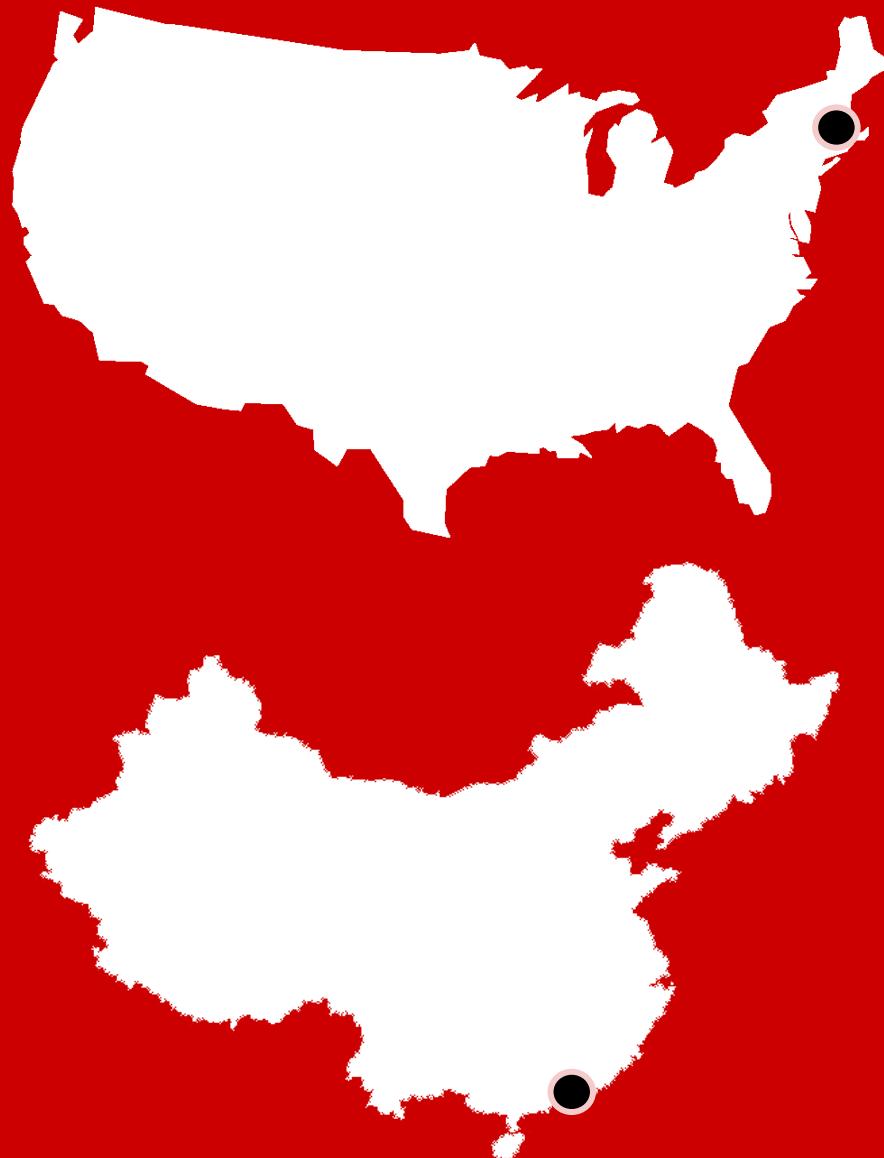
var degrees = 0;
setInterval(function () {
  servos.moveServo(1, degrees);
  degrees = degrees == 0 ? 180 : 0;
}, 500);
```



15 electrical designs, \$250k preorders



2 manufacturing locations



MA, USA

- makes Tessel
- we manage most of the supply chain

ShenZhen, China

- 14 modules
- higher overall volume

Tessel Timeline

2013

June



Work on Tessel starts

July



Work on 14 modules start

September



Tessel is “minimally functional”. Launched Crowdfunding campaign.

December



Majority of products are pushed into production. A few are held back pending firmware changes.

2014



Tessel Timeline

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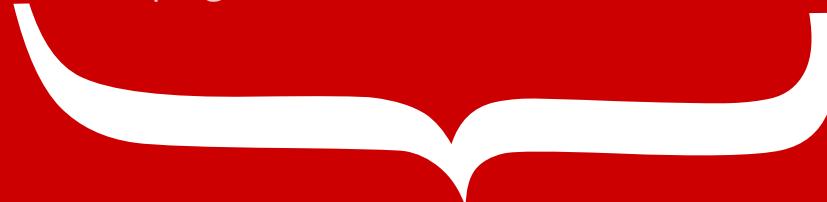
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6 months

Tessel Timeline

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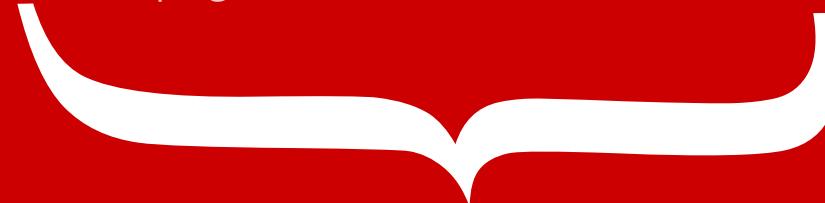
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(1.5 Hardware Engineers)

6 months
15 designs

Tessel Timeline

2013

June



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Majority of products are pushed into production. A few are held back pending firmware changes.

2014

2.5 designs/month

This is how we do it.

Production Timeline

Engineering



Supply Chain



Manufacturing



Engineering

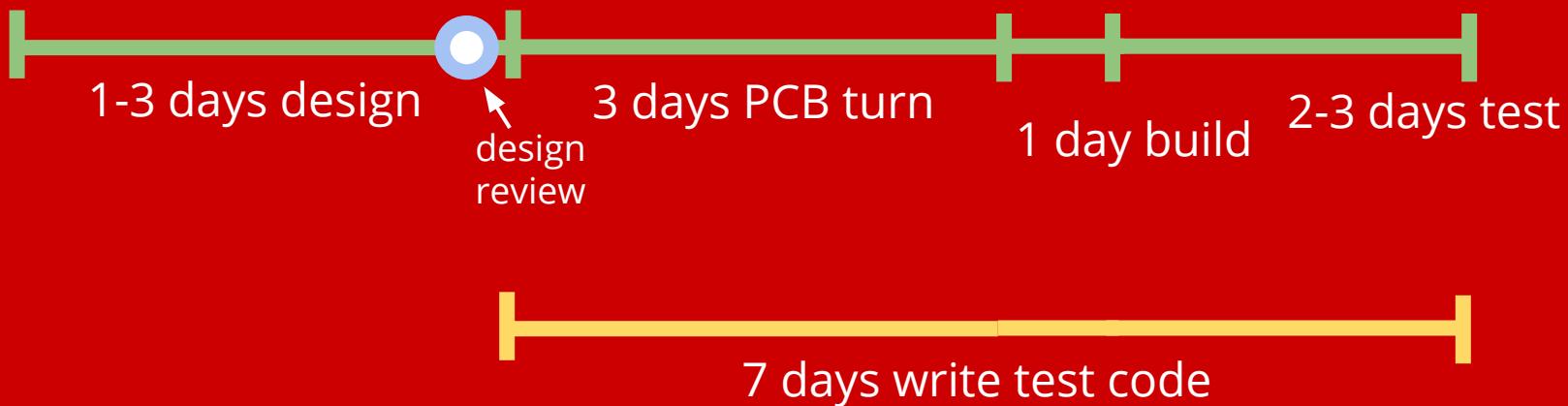
Design / Prototype / Test

First pass (~10 days)



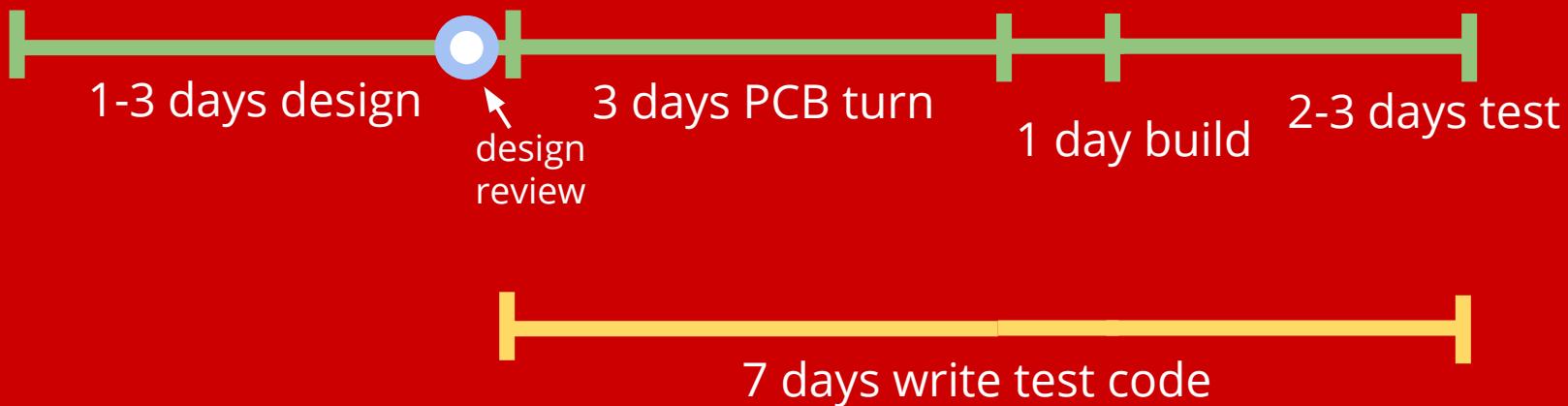
Design / Prototype / Test

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Design / Prototype / Test

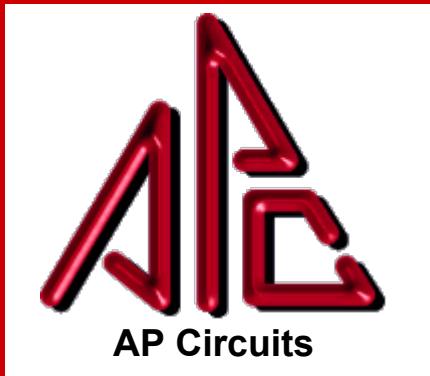
First pass (~10 days)



Subsequent passes (~5 days)



Prototype Manufacturers



Alberta, Canada
3 day turns
\$10/sq inch



KL, Malaysia
1.5 week turns
~\$70+



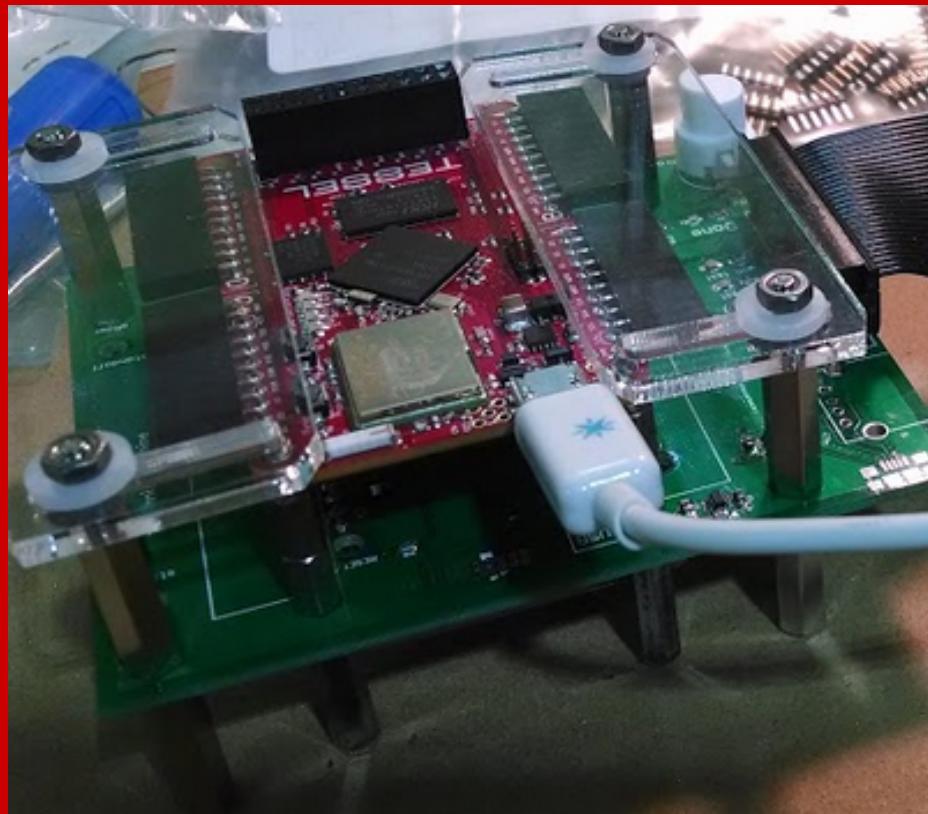
ShenZhen, China
2.5 week turns
\$10/ 40 sq inches



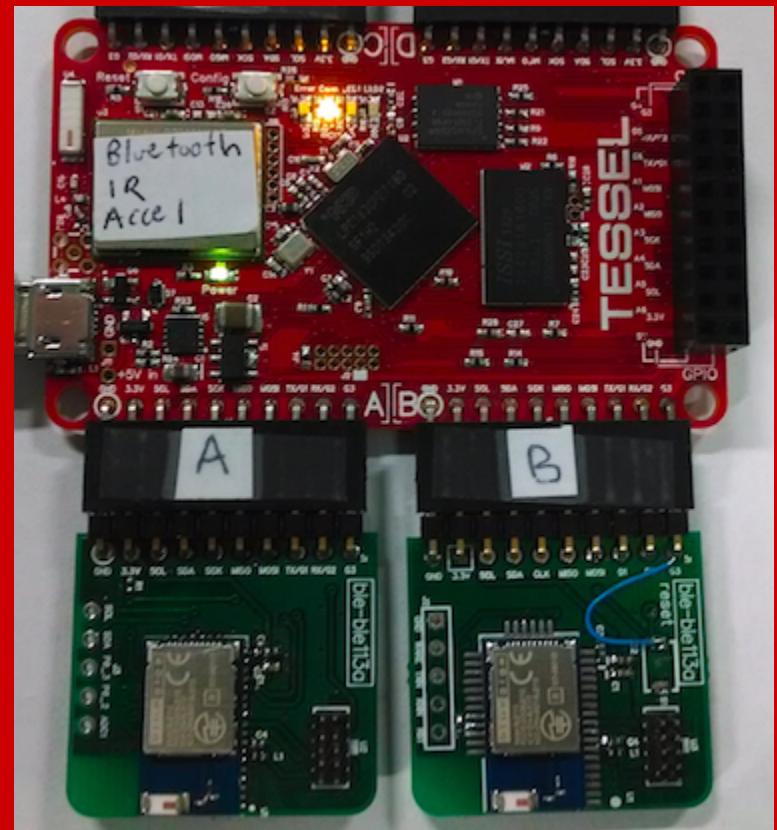
KL, Malaysia
PCBA 3 week turns
~\$300+ setup, \$8/sq inch

Test Rigs

Tessel tests Tessel



Tessel tests modules



Test Plans

Tessel - Relay Test Plan

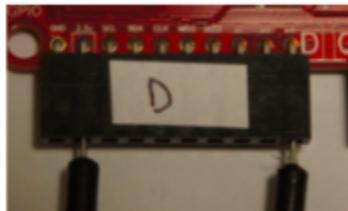
Revision #	Revised By	Date
1	Jia Huang	Dec 20, 2013

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请使用贴有Servo, Relay, 和 Climate标签的Tessels来进行测试。这三个模块都应该插在A端口上。 Tessel将根据在端口D上不同的引脚连接, 切换测试模式。 (Use the Tessels that have the Servo, Relay, and Climate label on them. All three modules plug into Port A. The Tessel switches tests based on which pins are connected on Port D.)

测试模块 (Test Used)	引脚连接 (Pin Connections)
Climate	3.3V & Port D G1
Servo	3.3V & Port D G2
Relay	3.3V & Port D G3

1. 将3.3V pin 与 端口D上的G3 pin 连接。 (Connect the 3.3V pin with the G3 pin on Port D.)



Test Plans

Tessel - Relay Test Plan

- Revision #s and dates

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Test Plans

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Test Plans

Tessel - Relay Test Plan

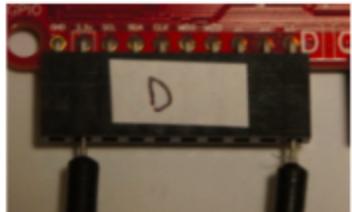
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- Revision #s and dates
- contact info
- Don't assume English proficiency
- Have redundancy among test rigs

Test Plans

Tessel - Relay Test Plan

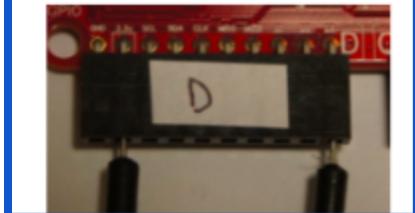
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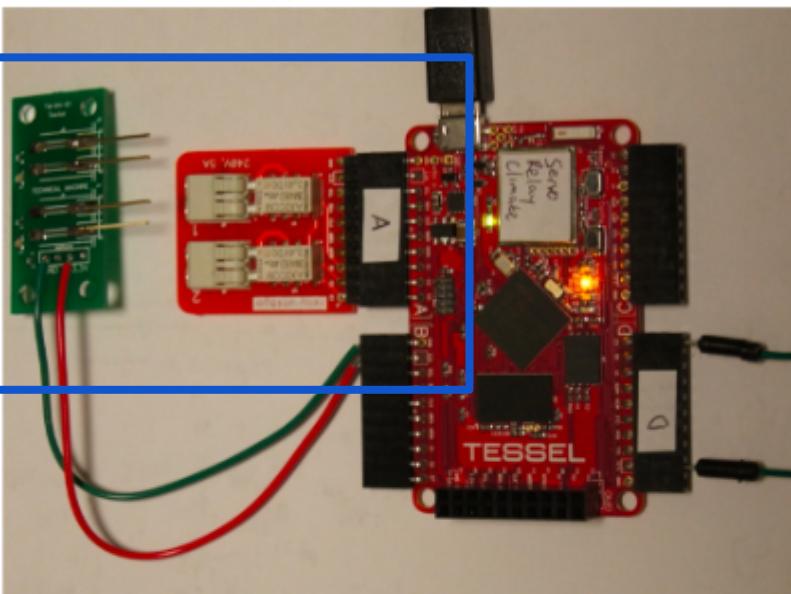
1. 将3.3V pin 与 端口D上的G3 pin 连接。 (Connect the 3.3V pin with the G3 pin on Port D.)



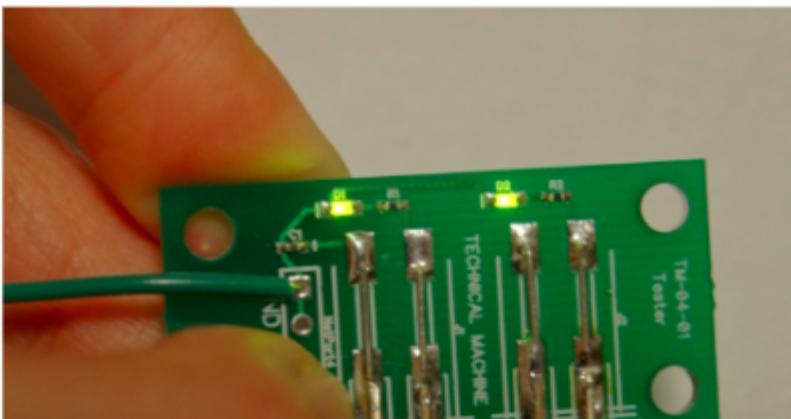
- Revision #s and dates
- contact info
- Don't assume English proficiency
- Have redundancy among test rigs
- images

Test Plans

4. 将Relay模块插入端口A. (Plug in the Relay module into port A for testing. The Relay module can only be plugged into Port A.)



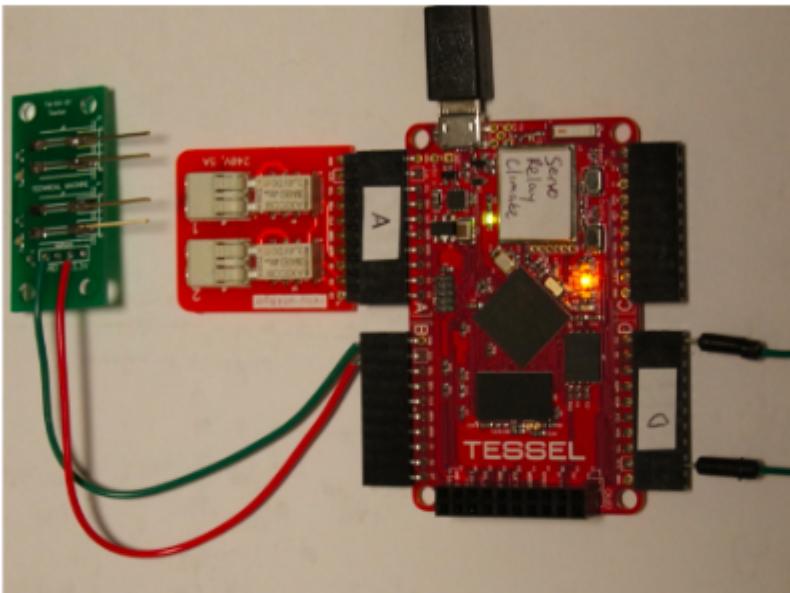
5. 让Relay Tester 与 Relay模块接触。Hold the Relay Tester to the Relay module.



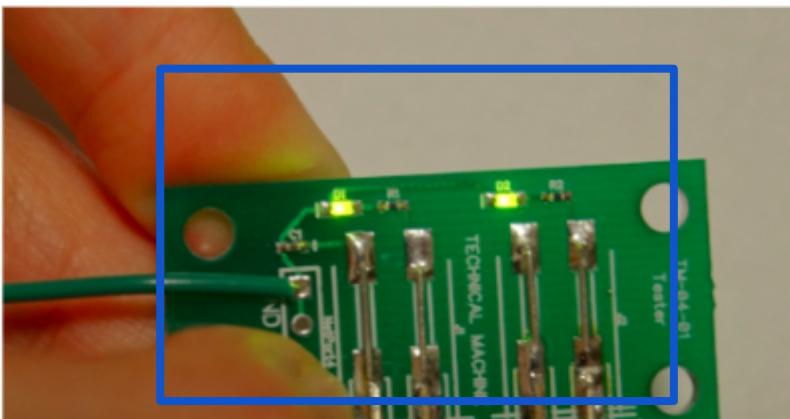
- Revision #s and dates
- contact info
- Don't assume English proficiency
- Have redundancy among test rigs
- images
- setup info

Test Plans

4. 将Relay模块插入端口A. (Plug in the Relay module into port A for testing. The Relay module can only be plugged into Port A.)



5. 让Relay Tester 与 Relay模块接触。Hold the Relay Tester to the Relay module.



- Revision #s and dates
- contact info
- Don't assume English proficiency
- Have redundancy among test rigs
- images
- setup info
- clear indicator of pass/fail

Supply Chain

Sourcing



Sourcing



Sourcing



Online prices are fake.
Find an inside sales guy.

Part Swaps

Manufacturer should recommend swaps.

Part Swaps

Manufacturer should recommend swaps.

- Things that are stupidly expensive but shouldn't be
 - connectors
 - crystal oscillators
 - buttons
 - anything that is a passive component

Double checking

Make sure there is enough supply

10k supply, 26 week lead time and someone else buys them out 1 month before production starts?

Double checking

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1. Cry

Double checking

Make sure there is enough supply

10k supply, 26 week lead time and someone else buys them out 1 month before production starts?

1. Cry
2. Find a drop in replacement

Double checking

Make sure there is enough supply

10k supply, 26 week lead time and someone else buys them out 1 month before production starts?

1. Cry
2. Find a drop in replacement
3. There are none?

Double checking

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4. Do a redesign through the tears.

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Check errata documents

- Manufacturer only tests 1 axis of an accelerometer during production?

Double checking

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10k supply, 26 week lead time and someone else buys them out 1 month before production starts?

1. Cry
2. Find a drop in replacement
3. There are none?
4. Do a redesign through the tears.

Check errata documents

- Manufacturer only tests 1 axis of an accelerometer during production?
- Parameters said 2 USB ports on MCU but only 1 is functional.

Manufacturing

Getting a manufacturer

1. What kind of volumes?

- ○ <1k (Both China and America support these volumes)
- ○ <10k

Getting a manufacturer

1. What kind of volumes?
 - o <1k (Both China and America support these volumes)
 - o <10k
2. Send in Gerbers & Bom for quotation.
 - o Get a price breakdown

Name	Ambient	Audio	Bluetooth	IR	GPRS
QTY					
Unit Price (\$USD)					
--BOM + PCB Cost:					
--SMT + Assembly:					
--Overhead:					
--Profit:					
Set up fee (\$USD)					

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--Profit:					
Set up fee (\$USD)					

3. Questions to ask
 - o What's their typical client volume?
 - o Do you need special testing? FCC?
 - o Do they use 3rd parties?
 - o If something goes wrong, who are you going to be interfacing with?

China vs America

Costs (sample size ~10 manufacturers)



China vs America

Costs (sample size ~10 manufacturers)



China

- Really good at part swaps / DFM

America

- Really good at English

Pre-production

Do a pre-production run. (10+ units)

- Quality
- Communication
- Test Process

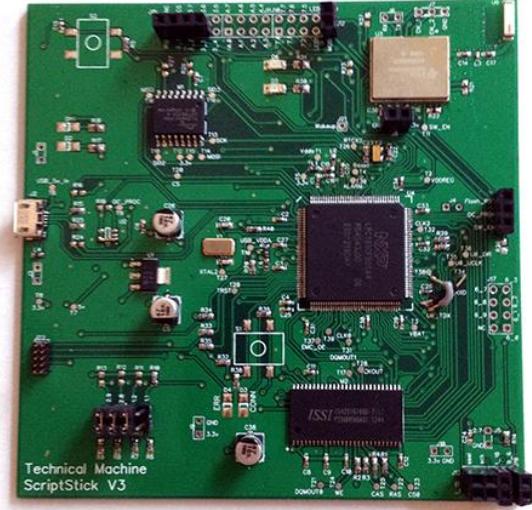
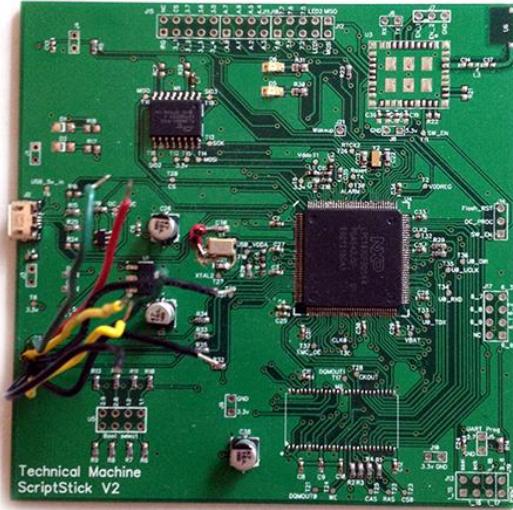
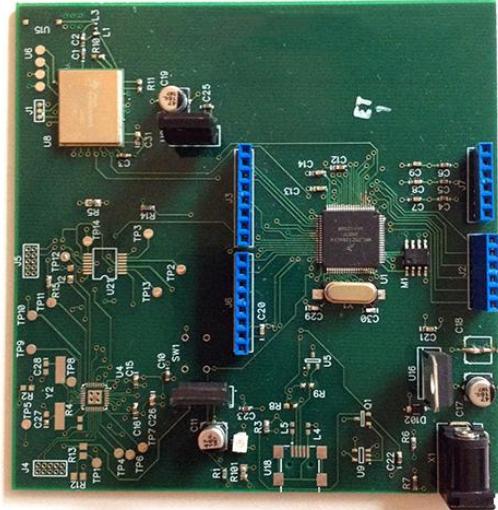
Production

Put out fires.

Production

Put out fires.

Pray.



YMMV.

<https://tessel.io>
jia@technical.io
@technicalhumans

