LOW ENERGY ANDROID GAMEPAD

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FUNCTIONAL DESCRIPTION

- Project Idea: Low power, wireless, silicone game pad for Android Devices

- Ergonomic fit with standard controller layout
  - Six buttons (4 + two triggers)
  - Analog joystick
- Wireless
  - Near Field Communication
  - Minimal battery usage on game pad and Android
- Application
  - HID driver for Android - standard library
  - Android game or app

IMPLEMENTATION STRATEGY

- Near Field Communications (NFC)
  - Intended for quick-pay, smart billboards, RFID, etc.
  - Low range – game pad will be physically next to host phone
  - Low data rate – sufficient for game pad input
  - Low power consumption for host and device
  - Available now on Google Nexus S, soon on Samsung Galaxy S II

IMPLEMENTATION STRATEGY

- NFC – Active or Passive?
  - Active Mode
    - Both sides generate a field for 2-way communication
    - Significantly more battery power on device
    - Slightly less battery power on host
    - Required if haptic feedback implemented
  - Passive Mode
    - Host generates a field to read the device
    - Significantly less battery power on device
    - Slightly more battery power on host
  - Winner
    - Passive mode if haptic feedback is not implemented
    - Mixed mode w/ haptic feedback (active mode only when needed)

HARDWARE DESIGN

- Original Design Components
  - Silicone game glove prototype
    - Will be constructed using hobby silicone mold kit
      - hobbysilicone.com
    - First create mock device (wood or clay/ceramic)
    - Modify mock device to fit design needs
    - Use mock device to mold a silicone glove
  - PCB layout and assembly (reflow) for PN531
    - Will incorporate most of circuit while we're at it
    - Interconnections and protection circuits will require design
    - No template for HVQFN40 package? May need to make one.
  - Maybe a custom antenna coil
    - So far can't find where to buy just one

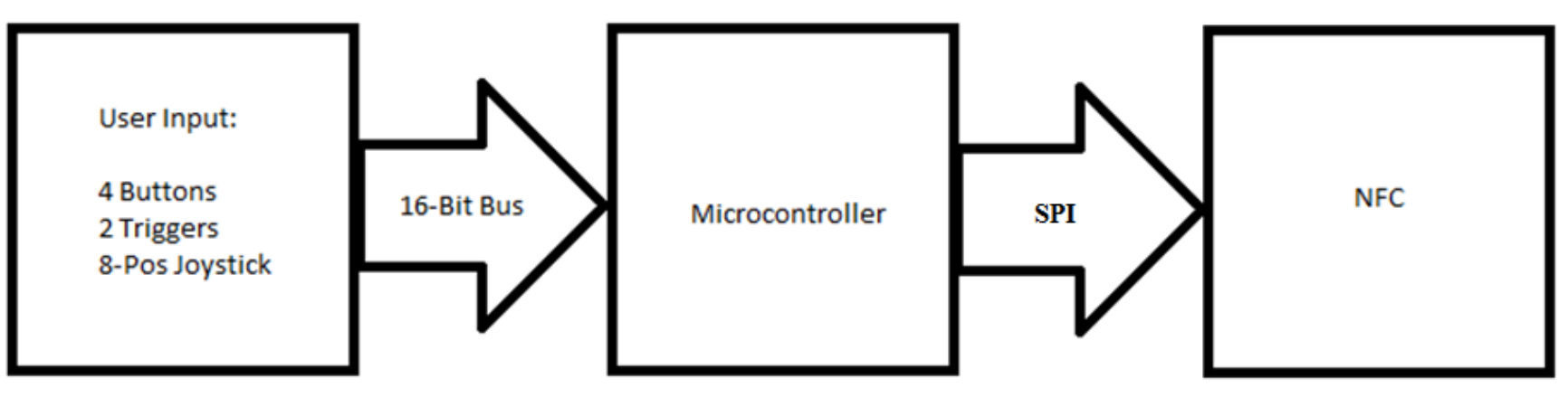
SOFTWARE DESIGN

- Microcontroller software
  - Poll for user inputs
  - De-bounce (if needed)
  - Assemble packet to transmit via NFC
  - Communicate packet to NFC via RS-232
- Android HID driver
  - Receive incoming NFC packets from device
  - Keyboard emulation of pressed/released keys
- Android game or app
  - TBD, will demo keyboard emulation of device driver

SOFTWARE DESIGN

- Haptic feedback (if implemented)
  - Microcontroller:
    - Receive haptic requests
    - Generate signals to drive vibration motor
    - Control when in active/passive mode
  - Another device driver to send haptic requests to device
  - Demo software will need to demo this functionality

MICROCONTROLLER INTERFACE



NFC INTERFACE SPECIFICATION

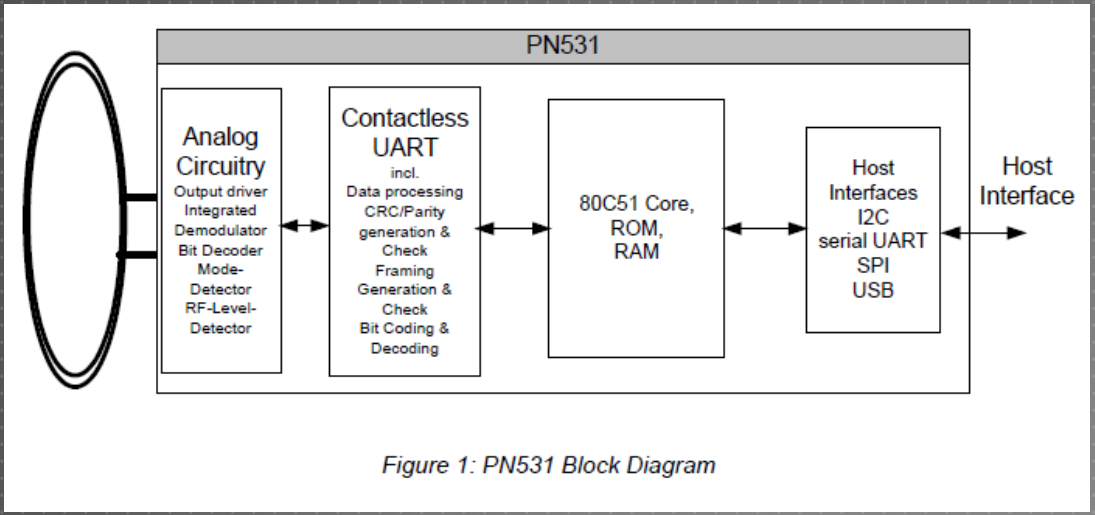


Figure 1: PN531 Block Diagram

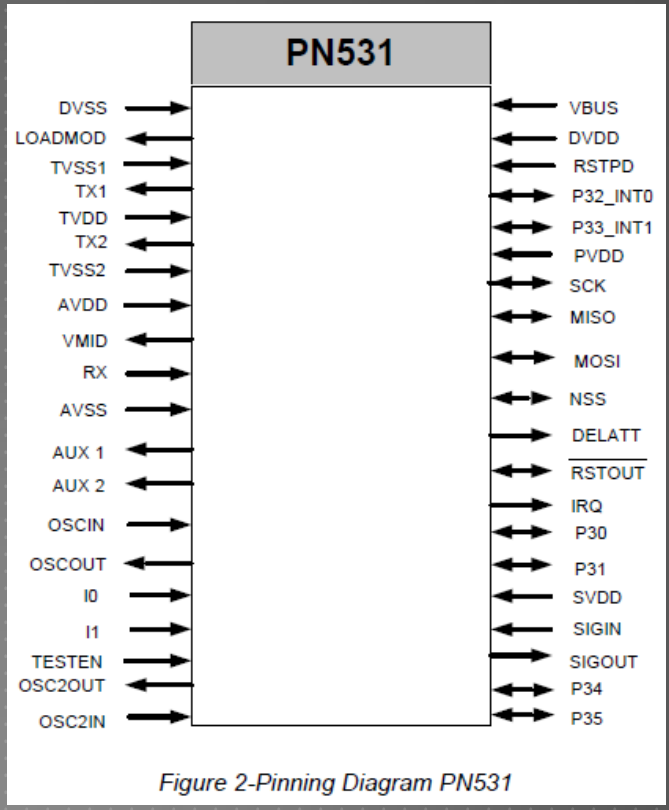


Figure 2-Pinning Diagram PN531

USER INTERFACE SPECIFICATIONS

- User inputs on joystick, 4 buttons, and two triggers
- Default keymap:
  - joy(-1, 0) = key_left
  - joy(1, 0) = key_right
  - joy(0, -1) = key_up
  - joy(0, 1) = key_dow
  - joy(-1, 1) = key_down+key_left
  - joy(1, 1) = key_down+key_right
  - joy(-1, -1) = key_up+key_left
  - joy(1, -1) = key_up+key_right,
  - button1 = key_a
  - button2 = key_s
  - button3 = key_d
  - button4 = key_f
  - trigger1 = key_j
  - trigger2 = key_k
- Android GUI to change keymap
- Android apps react to emulated keys as established by keymap

PARTS LIST - OVERVIEW

- PN531 microcontroller (uC) based NFC transceiver
  - Requires 27.12MHz quartz
  - HVQFN40 package – 6mm x 6mm x 0.85mm
    - Custom economy PCB (~$30 from PCB123)
    - Custom plastic laser cut solder stencil (~$35 polulu.com)
    - Solder paste and toaster oven for reflow
  - 13.56 MHz antenna coil – small form factor, close range
- Microchip PIC16F727 8-bit uC
  - To collect inputs and talk to NFC chip via SPI
  - Wide operating voltage (1.8 to 5.5V)
  - Low power consumption (6uA @ 32KHz)
  - 500KHz or 16MHz internal oscillator or 32KHz crystal oscillator
  - 35 I/O pins, ADC, PWM, Capture/Compare
  - SPI Master/Slave capability
- Six push-button switches
- Miniature 2-axis resistive joystick
- CR2025 lithium button battery and holder
- Maybe vibration motor(s) for haptic feedback (and separate CR2025 battery)?

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One Time Purchase (prototype setup supplies)										
31	1	N/A	Custom Stencil	Plastic Film - Laser Cut	Polulu Robotics	446	Polulu.com	446	$ 37.00	$ 37.00
32	1	N/A	Solder Paste	Pb-No Clean 500g	Manncorp	SH-6309RMA	smtsolderpaste.com	SH-6309RMA	$ 49.00	$ 49.00
33	1	N/A	Hobby Silicone	Medium 122 Shore A 10 Lbs Kit	MPK Enterprises	N/A	hobbysilicone.com	N/A	$ 116.98	$ 116.98
34	1	N/A	Gram Scale	Pocket	American Weigh	SC-2KG	amazon.com	AMW-SC-2KG	$ 23.13	$ 23.13
35	1	N/A	Silicone Release Agent	LPS – Dry Film Silicone - 16 oz aersol can	LPS	N/A	hobbysilicone.com	N/A	$ 14.99	$ 14.99
36	1	N/A	Latex Gloves	XL - Box 100	McKesson	N/A	hobbysilicone.com	N/A	$ 11.99	$ 11.99
37	1	N/A	Mixing Sticks	Bag 100	Generic	N/A	hobbysilicone.com	N/A	$ 3.99	$ 3.99
38	1	N/A	Modeling Clay	Air Dry - 10Lb Box	AMACO	B001O5QIT2	Hobby Lobby	N/A	$ 7.47	$ 7.47
39	1	HOST	NFC Capable Android Phone	Nexus S (unlocked, no contract)	Google/Samsung	GT-I9020T	amazon.com	B004GPGDFQ	$ 615.99	$ 615.99
									Setup Cost:	$ 880.54

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Common Parts										
Index	Quantity	Reference	Value / Generic Part Number	Package / Class	Manufacturer	Manufacturer's ordering code / Orderable Part Number	Supplier	Supplier's ordering code	Unit Cost	Cost
1	1	uC1	Microcontroller	PDIP 40 (Thru-hole)	Microchip	PIC16F727-I/P	Mouser.com	579-PIC16F727-I/P	$ 2.0300	$ 50.75
6	6	PB1:PB6	Push Button	Thru-hole	E-Switch	320.08E11BLK	Digikey.com	320.08E11BLK-ND	$ 1.0848	$ 162.72
7	1	JOY	2-axis Joystick	Thru-hole	Parallax	27800	Mouser.com	619-27800	$ 4.6900	$ 117.25
16	1	PCB	Custom PCB	2 Layer Economy	Silver Circuits	PCB Production	Custompcb.com	PCB Production	$ 5.6000	$ 140.00
19	1	SW1	7-pos DIP Switch	Thru-hole	CTS	208-7	Mouser.com	774-2087	$ 0.7100	$ 17.75
20	1	LED1	Green	Thru-hole	KingBright	WP3A8GD	Mouser.com	604-WP3A8GD	$ 0.0500	$ 1.25
21	1	LED2	Red	Thru-hole	KingBright	WP7104LID	Mouser.com	604-WP7104LID	$ 0.0500	$ 1.25
22	1	LED3	Yellow	Thru-hole	KingBright	WP7104LYD	Mouser.com	604-WP7104LYD	$ 0.0600	$ 1.50
									QTY:	25
									Parts Cost:	$ 492.47
									Cost Per Unit:	$ 19.70

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NFC Parts										
Index	Quantity	Reference	Value / Generic Part Number	Package / Class	Manufacturer	code / Orderable Part	Supplier	ordering code	Unit Cost	Cost
1	1	NFC	PN531	SMT - 40-HVQFN (6mm x 6mm x 0.85mm)	NXP	PN5310A3HN/C203,55	Mouser.com	771-5310A3HNC203551	$ 7.9300	$ 198.25
*2	1	ANT1	NFC Atnenna	TBD	TBD	TBD	TBD	TBD	TBD	TBD
3	1	BAT1	Li-On Battery	20mm Button-cell	Panasonic	CR2025	Digikey.com	P188-ND	$ 0.2400	$ 6.00
4	1	PS1	Battery Holder	20mm Button-cell Holder Thru-Hole	Eagle Plastic	122-2520-GR	Mouser.com	122-2520-GR	$ 0.6100	$ 15.25
5	1	XTAL1	27.12 MHz	SMT - 1.6mm x 2mm x 0.65mm	Murata	XRCGB27M120F3M00R0	Mouser.com	81-XRCGB27M120F3M0R0	$ 0.7900	$ 19.75
									QTY:	25
									Parts Cost:	$ 731.72
									Cost Per Unit:	$ 29.27

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BLE Parts										
Index	Quantity	Reference	Value / Generic Part Number	Package / Class	Manufacturer	Manufacturer's ordering	Supplier	Supplier's	Unit Cost	Cost
6	1	BLE	BLE Module	SMT -VQFN40 (6mm x 6mm x 0.5mm)	TI	CC2540F256RHAT	Mouser.com	595-CC2540F256RHAT	$ 6.3900	$ 159.75
7	1	ANT2	BLE Antenna	SMT - 2.4GHz Antenna 1.2 dBi (7.8mm x 3.6mm x 0.9mm)	Yageo	240-4311-115-00245	Mouser.com	240-4311-115-00245	$ 2.1700	$ 54.25
8	1	BAT1	Li-On Battery	20mm Button-cell	Panasonic	CR2025	Digikey.com	P188-ND	$ 0.2400	$ 6.00
9	1	PS1	Battery Holder	20mm Button-cell Holder Thru-Hole	Eagle Plastic Devices	122-2520-GR	Mouser.com	122-2520-GR	$ 0.6100	$ 15.25
10	1	XTAL2	32 KHz	Cylinder Thru-hole	ECS	ECS-.320-12.5-13X	Mouser.com	520-ECS-32-12.5-13X	$ 0.6900	$ 17.25
11	1	XTAL3	32 MHz	SMT - 5mm x 11.5mm x 3.5mm	Abracon	ABL-32.000MHZ-B2	Mouser.com	815-ABL-32-B2	$ 0.3000	$ 7.50
12	2	C1:C2	12pF	TBD	TBD	TBD	TBD	TBD	TBD	TBD
13	3	C3:C5	1pF	TBD	TBD	TBD	TBD	TBD	TBD	TBD
14	1	C6:C7	15pF	TBD	TBD	TBD	TBD	TBD	TBD	TBD
15	1	C8:C9	18pF	TBD	TBD	TBD	TBD	TBD	TBD	TBD
16	1	C10	1uF	TBD	TBD	TBD	TBD	TBD	TBD	TBD
17	1	L1	1nH	TBD	TBD	TBD	TBD	TBD	TBD	TBD
18	2	L2:L3	2nH	TBD	TBD	TBD	TBD	TBD	TBD	TBD
19	1	L4	3nH	TBD	TBD	TBD	TBD	TBD	TBD	TBD
20	2	R1	56k	TBD	TBD	TBD	TBD	TBD	TBD	TBD
									QTY:	25
									Parts Cost:	$ 752.47
									Cost Per Unit:	$ 30.10

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Bluetooth Parts											
Index	Quantity	Reference	Value / Generic Part Number	Package / Class	Manufacturer	Manufacturer's ordering code / Orderable Part Number	Supplier	Supplier's ordering code	Unit Cost		Cost
21	1	BLUETOOTH	Bluetooth Module	SMT - 13.4mm x 25.8 mm x 2mm	Roving Networks	RN-42	Mouser.com	765-RN-42	$	16.4700	$ 411.75
22	1	BAT3	Li-ion Rechargeable Battery	TBD	TBD	TBD	TBD	TBD	TBD		TBD
23	1	U1	3.3V LDO Voltage Regulator	SMT - DBV (SOT-23)	TI	LP2985A-33DBVTG4	Mouser.com	595-LP2985A-33DBVTG4	$	0.8400	$ 21.00
24	1	P1	DC Power Connector	2mm	Kycon	KLDHCX-0202-AC	Mouser.com	806-KLDHCX-0202-AC	$	0.8090	$ 20.23
25	2	C1:C2	15 pF	Ceramic	Xicon	140-50N5-150J-TB-RC	Mouser.com	140-50N5-150J-TB-RC	$	0.0600	$ 3.00
26	3	C3:C5	0.1uF	Ceramic	Vishay	K103M15X7RF53H5	Mouser.com	594-K103M15X7RF53H5	$	0.0400	$ 3.00
27	1	C6	4.7uF	Ceramic	Nichicon	UVR1H4R7MDD1TD	Mouser.com	647-UVR1H4R7MDD1TD	$	0.0400	$ 1.00
28	1	D1	General Purpose	Thru-hole	NXP Semiconductors	771-1N4448,133	Mouser.com	771-1N4448,133	$	0.0100	$ 0.25
29	1	R1	220	Thru-hole	Vishay	CCF07220KGKR36	Mouser.com	71-CCF07-G-220K	$	0.0400	$ 1.00
30	2	R2:R3	100K	Thru-hole	Vishay	SFR16S0001003JR500	Mouser.com	594-SFR16S0001003JR5	$	0.0300	$ 1.50
31	2	R4:R5	49.9K	Thru-hole	KOA Speer	MF1/4DCT52R4992F	Mouser.com	660-MF1/4DCT52R4992F	$	0.0500	$ 2.50
32	4	R6:R9	1K	Thru-hole	Vishay	CCF071K00GKR36	Mouser.com	71-CCF07-G-1K	$	0.0300	$ 3.00
										QTY:	25
										Parts Cost:	$ 960.70
										Cost Per Unit:	$ 38.43

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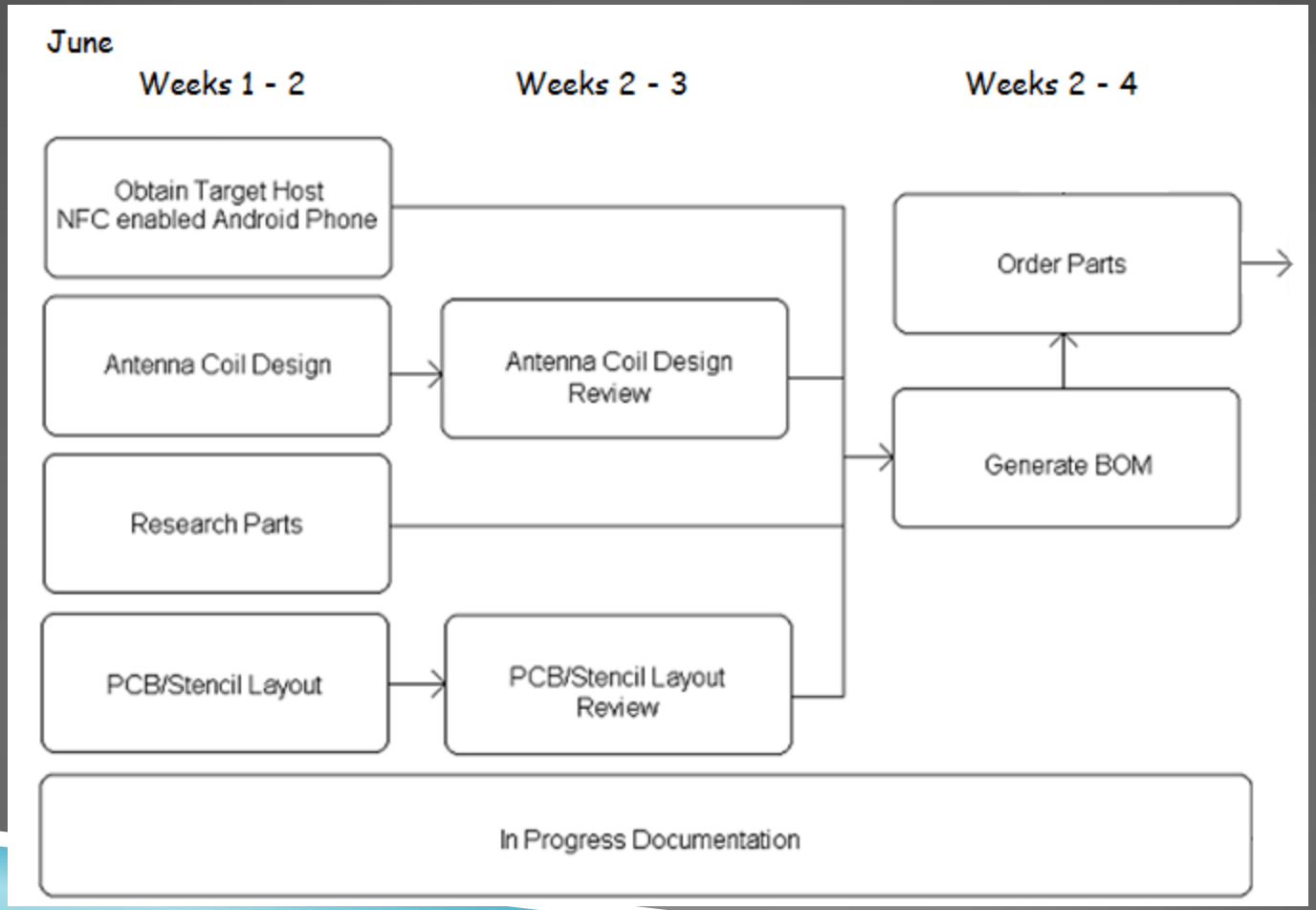
Haptic Parts										
Index	Quantity	Reference	Value / Generic Part Number	Package / Class	Manufacturer	Manufacturer's ordering code / Orderable Part Number	Supplier	Supplier's ordering code	Unit Cost	Cost
33	1	BAT2	Li-On Battery	20mm Button-cell	Panasonic	CR2025	Digikey.com	P188-ND	$ 0.2400	$ 6.00
34	2	M1:M2	Haptic (Vibration) Motor	8mm x 3.4mm Adhesive	Polulu Robotics	1637	Polulu.com	1637	$ 2.7900	$ 139.50
35	2	U2:U3	DAC	TBD	TBD	TBD	TBD	TBD	TBD	TBD
36	2		DC Motor Driver	TBD	TBD	TBD	TBD	TBD	TBD	TBD
37	2	PS2	Battery Holder	20mm Button-cell Holder Thru-Hole	Eagle Plastic Devices	122-2520-GR	Mouser.com	122-2520-GR	$ 0.6100	$ 30.50
									QTY:	25
									Parts Cost:	$ 176.00
									Cost Per Unit:	$ 7.04

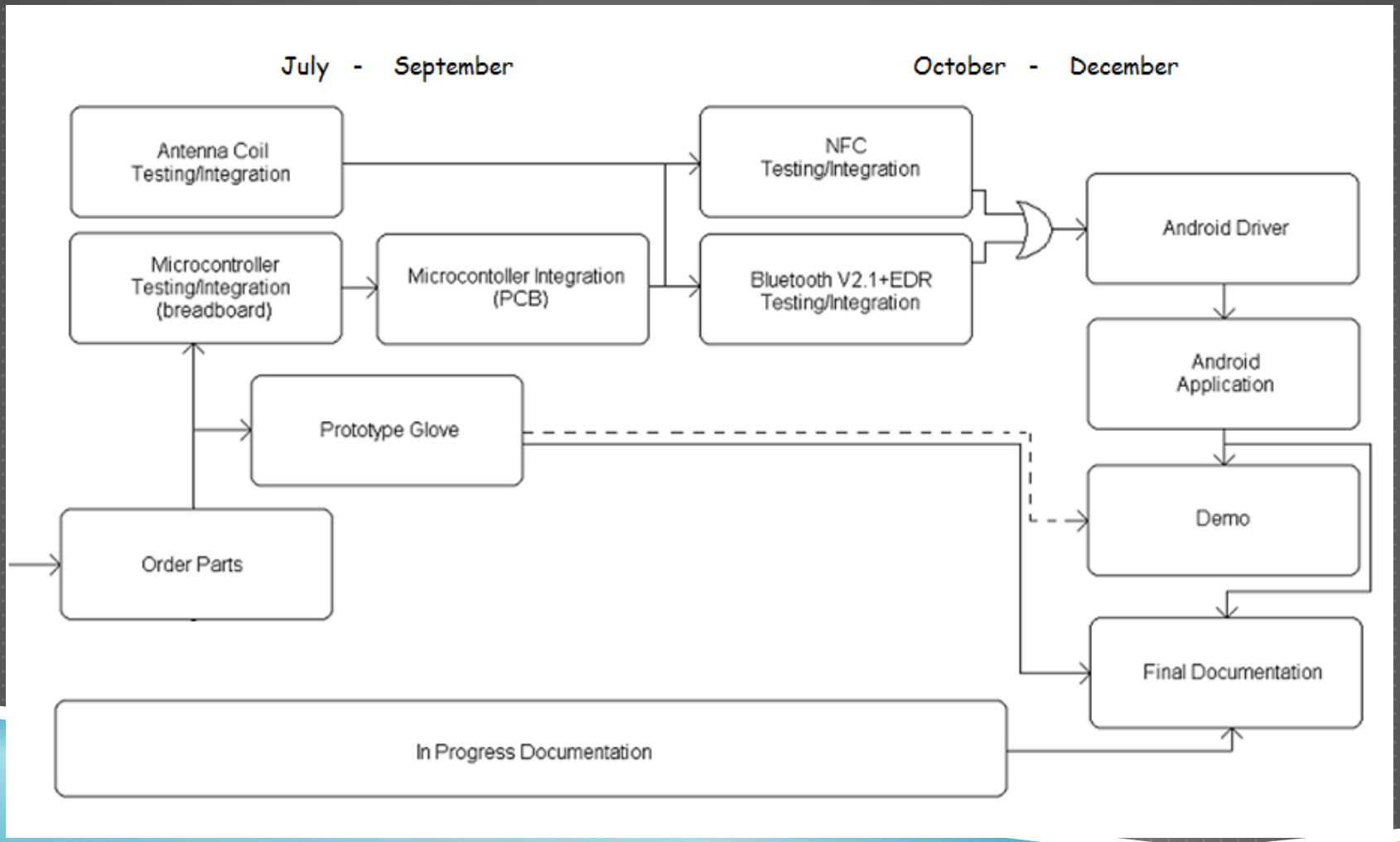
SCHEDULE – PHASE 1



TEAM LEADS – PHASE 1

Task	Lead
Obtain a Target Host Device	Andrzej
PCB/Stencil Layout	Marty
PCB/Stencil Layout Review	Andrzej
Antenna Coil Design	Andrzej
Antenna Coil Design Review	Marty
Research Parts	Marty
Generate BOM	Marty

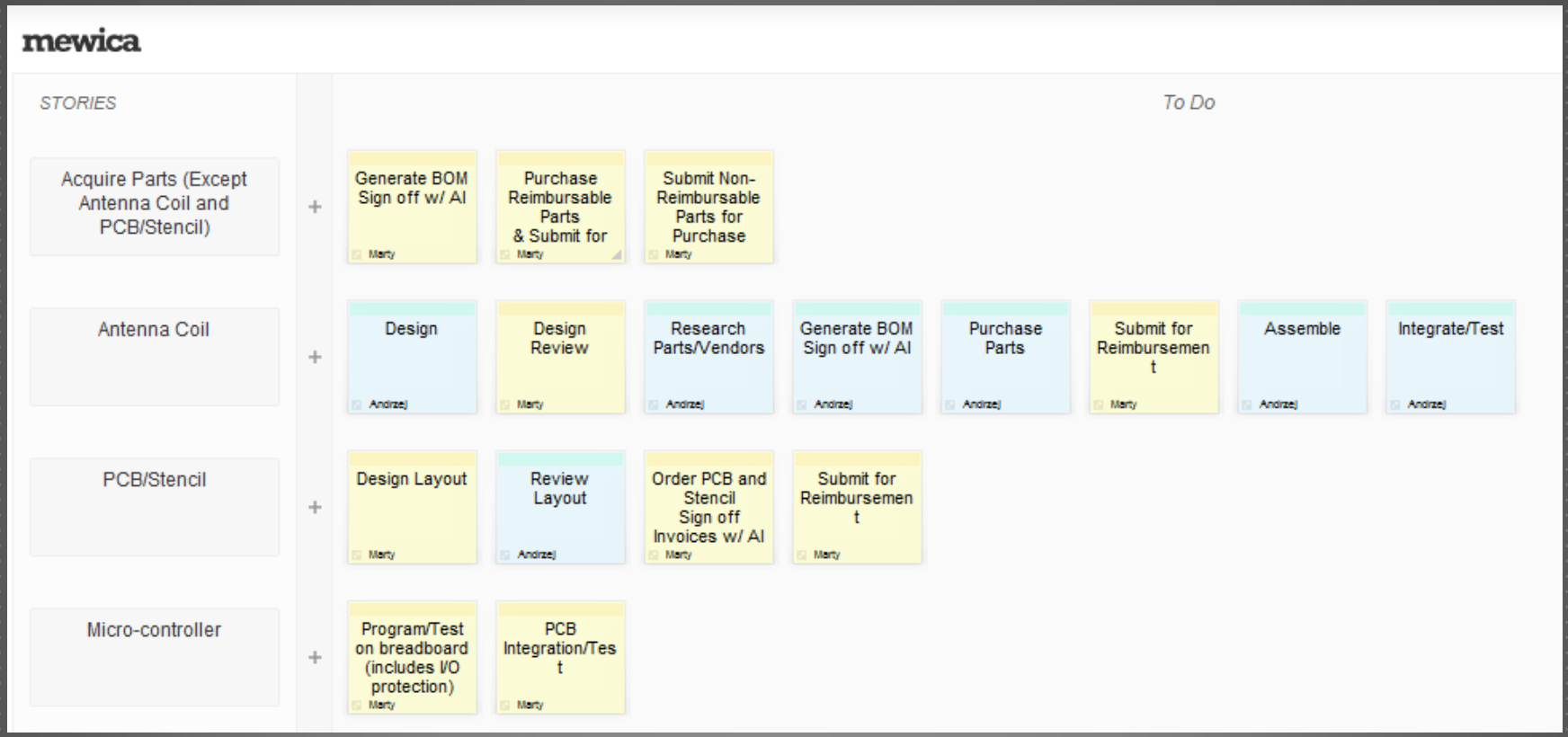
SCHEDULE – PHASE 2



TEAM LEADS – PHASE 2

Task	Lead
Antenna Coil Integration Testing	Andrzej
Microcontroller Programming Testing	Marty
Microcontroller Integration (PCB)	Marty
NFC Testing/Integration	Marty
Bluetooth V2.1+EDR Testing/Integration	Andrzej
Android Driver	Andrzej
Android App	Andrzej
Prototype Glove	Marty

SCRUM – PROGRESS TRACKER



TASK RISKS

Risk	Mitigation Plan	Backup Plan
A few Surface mount components	Custom PCB/Stencil	Other communication mediums, WIFI, USB
New use for NFC, will it work like we think?	Implement Bluetooth V2.1+EDR in tandem	Other communication mediums, WIFI, USB
No HVQFN40 PCB template	Find one	Make one, Other communication mediums, WIFI, USB
Need to design antenna coil, not well versed in antenna design	Study NFC Antenna Design Papers	Bluetooth V2.1+EDR only
Will silicone molding turn out ok?	Start early, don't let it consume too much time	Demo without enclosure
Both teammates have hectic schedules	Work over summer	Core requirements only

REFERENCES

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QUESTIONS OR COMMENTS?